Abstract

The Cardigan Bay Marine Wildlife Centre (CBMWC), part of the Wildlife Trust of South and West Wales (WTSWW), was originally established in 1996 as a non-profit organisation dedicated to conserve Cardigan Bay’s marine wildlife through education and research. CBMWC conducts boat and land surveys to monitor the population of bottlenose dolphins (Tursiops truncatus) in Cardigan Bay, and since 2005, researchers at CBMWC have been photographing bottlenose dolphin dorsal fins (under licence) during boat surveys to develop a photo-identification (photo-ID) catalogue.

Initiated in 2014, the ShoreFin project is a dedicated land-based bottlenose dolphin photo-ID project located in New Quay Bay. In 2015, the project was conducted from April until September. Continuing on from the pilot year, this second year aimed to apply the ShoreFin protocols established in 2014 and develop them in order to optimise the photo-ID methodology and database management. Moreover, the primary aim of this season was to provide additional data to the CBMWC database to improve the understanding of bottlenose dolphin site usage within New Quay Bay, to identify which individuals visit this site, how frequently and for what purpose.

Since 2014, the ShoreFin project has identified a total of 92 different dolphins that have used New Quay Bay. In 2015, 61 individuals were identified from photographs taken by the ShoreFin project, 19 of which were new to the CBMWC catalogue; eight of these dolphins were photographed by the ShoreFin project only and not during boat surveys. The peak number of encounters in 2015 occurred in June, the majority of the individuals were observed in four primary locations: the end of harbour wall, Penpolion, the fish factory and to the right of cardinal buoy off Llanina reef.

The ShoreFin project provided further evidence of the frequent use of New Quay Bay by mother and calf pairs: seven were photographed in 2014 and ten in 2015. The area is believed to be favoured by these mothers for its sheltered shallow waters where their calves are safe to socialise and learn to forage. Individuals showed different degrees of site fidelity; those who were photographed regularly, likely to be semi-residents and those seen only once during the season, therefore likely to be in transit. The results highlight similarities and differences in the bottlenose dolphin population dynamics over the two years of the project.

A longer term data set would enable the long-term temporal and spatial variations of the population dynamics to be determined with greater precision. Ideally a more in-depth behavioural study would be undertaken alongside the ShoreFin project to determine whether environmental factors and human activities impact on dolphins’ behaviour, as well as further developing the study of prey species preference in Cardigan Bay bottlenose dolphins.

Bottlenose dolphins in Cardigan Bay are exposed to potentially disturbing activities that could pose conservation challenges. The continuation of the ShoreFin project will help provide rigorous scientific assessments of the population to help develop effective and adaptive management strategies and conservation measures.
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1. Introduction

The bottlenose dolphin, *Tursiops truncatus* (Montagu, 1821), is a cosmopolitan species with a global distribution, being found in both tropical and temperate seas in the northern and southern hemispheres. They occupy a range of habitats from coastal to oceanic waters (Figure 1) (Klinowska, 1991; Reid et al., 2003), although frequently favour inshore waters (Bristow and Rees, 2001) which makes them easier to study, resulting in bottlenose dolphins being one of the most widely researched cetacean species.

![Figure 1: The extent of the global distribution of the bottlenose dolphin, *Tursiops truncatus* (Hammond et al., 2012)](image)

Bottlenose dolphin life expectancy is approximately 45 years in males and 50 years in females. Males mature between 9 and 14 years of age and females reach reproductive age earlier between 7 and 12 years. They have a 12 month gestation period after which a calf will remain with the adult for 3 to 6 years (Wells and Scott, 2002). They are a social species, typically forming groups of 2 to 5 individuals but will occasionally form larger groups, usually in offshore environments for feeding (Evans, 2008). Bottlenose dolphins have a fluid social system whereby will leave and join groups on a fission-fusion basis (Mann et al., 2000). The strongest bonds observed are between mothers and calves, but associations will also form between adult and juvenile males (Reid et al., 2003).

The size of bottlenose dolphins is variable, with adults ranging from approximately 3.2 to 3.5m, and weighting around 365kg: they show sexual dimorphism with males being larger than females (Evans, 2008). Populations in colder waters, such as Cardigan Bay, are typically larger than bottlenose dolphins found in other geographic locations (Evans et al., 2003). Bottlenose dolphins feed on a wide variety of fish including pelagic and benthic species, so are regarded as selective opportunistic feeders (Evans, 2008). They have been observed...
exhibiting different behaviours including travelling, feeding, leaping and tail slapping (Reid et al., 2003).

In the UK, bottlenose dolphins are found predominantly around the North-east Scottish coast, Cardigan Bay in west Wales, the Shannon estuary in Ireland and the North Sea (Figure 2). There are two main populations around the UK that are considered to be resident or semi-resident, one being the Moray Firth, Scotland and the other being Cardigan Bay, Wales (Evans et al., 2003; Lusseau et al., 2006).

Cardigan Bay (Figure 3) is the largest bay in the British Isles, covering an area of approximately 5500km$^2$ (Gregory and Rowden, 2001). Bottlenose dolphins in Cardigan Bay are classed as being part of an open population as individuals identified in the area have also been identified elsewhere, for example around the North Wales coast (Evans et al., 2003; Reid et al., 2003; Pesante et al., 2008). In coastal habitats such as Cardigan Bay they are known to show a degree of site fidelity (Evans, 2008). In 2004, parts of Cardigan Bay were designated as a Special Area of Conservation (SAC) (Figure 3) under the European Union (EU) habitats directive (Pierpoint et al., 2009). Bottlenose dolphins are an EU habitats directive Annex II species and a primary reason for the selection of the Cardigan Bay SAC (Council Directive 92/43/EEC) site selection (Bristow and Rees, 2001).
Within Cardigan Bay, New Quay Bay (52° 13'N, 004° 21'W) (Figure 4) is a hotspot for bottlenose dolphins due to the unique characteristics of the bay. It is a shallow semi-enclosed bay with a typical depth range of 1 to 12m and a restricted tidal flow (Gregory and Rowden, 2001). Llanina reef to the east of the bay provides shelter for a variety of fish species which attracts dolphins to the area to feed. A shellfish processing factory is also located on New Quay headland, predominantly processing the common whelk, *Buccinum undatum*, which is licenced to dispose of the shell discharge into the water below (Denton, 2012). Small fish species are attracted to feed on the discards which attract larger fish, creating a foraging area for the dolphins. Harbour and bay areas are known to attract species which bottlenose dolphins feed on including mullet, salmonid species and pelagic shoaling fish (Pierpoint et al., 2009). The regular presence of mother and calves has been seen in previous studies of the area, suggesting the bay is used as a nursery area (Bristow and Rees, 2001).

Figure 4: The key features of the survey area, New Quay Bay, Wales (Bristow and Rees, 2001)
New Quay is a popular tourist destination: the local dolphin watching businesses attract large numbers of tourists, particularly during the summer (Feingold and Evans, 2009). These trips form a major part of the tourism industry in the area and are important to the local economy, contributing an estimated £4.9 million to the region (Ceredigion) during 2013 (García Hernández, 2015). In addition, personal watercraft and commercial fishing vessels contribute to an increase in boat traffic in and around New Quay Bay, creating potential problems, as dolphins have previously been shown to react negatively to certain boats (Pierpoint et al., 2009).

Photo-identification is a mark-recapture technique frequently used to identify individuals through the use of photographs taken at sighting events (de Boer et al., 2013). It is considered an essential monitoring tool for helping to estimate the size of a population, identifying the extent of distribution ranges and site fidelity and observing behaviours and patterns of association (Markowitz et al., 2003). The technique is widely used as it is much less invasive than traditional mark-recapture techniques which involve direct contact and artificial marking e.g. tagging, and is relatively cheap (Stewman et al., 2006). Whilst this process is applied to a variety of terrestrial and marine species, it is used most for cetacean species due to their distinctive markings which make individuals unique and distinguishable from one another, and their elusive nature which makes tagging difficult (Würsig and Jefferson, 1974; Gowans and Whitehead, 2001).

Cetaceans can be identified by a number of unique morphological characteristics including the shape of the dorsal fin, distinctive markings, scars, pigmentation or lesions (Hartman et al., 2008). For bottlenose dolphins, it is typically the dorsal fin that is used as the primary focus of photo-ID as they can develop nicks and notches (Figure 5) which provide long-term markings unique to an individual (Markowitz et al., 2003). The key features of an individual are then used to compare them to other individuals to find matches and re-sightings. Identified individuals are typically entered into a database and/or catalogue to allow re-sightings to be determined over the years (Hartman et al., 2008). Photo-ID is typically carried out from boat-based platforms due to their mobility and manoeuvrability which allow them to adjust the position of the boat to take photographs of optimal quality for photo-ID, as well as being able to cover a greater range.

![Figure 5: An example of an individual (413) from the Cardigan Bay Marine Wildlife Centre Bottlenose dolphin catalogue that can be identified from nicks, notches and tooth rakes](image)
The Cardigan Bay Marine Wildlife Centre (CBMWC) is part of the Wildlife Trust of South and West Wales (WTSWW) (as of April 2015), the largest charitable organisation working exclusively on all aspects of wildlife Conservation in south and west Wales. The WTSWW's Living Seas marine team based at the Cardigan Bay Marine Wildlife Centre conducts marine megafauna research from boat surveys throughout Cardigan Bay and land-based surveys in the New Quay Bay area, as well as operating a visitor centre and education centre for visitors to the area, the local community and schools. CBMWC began a photo-identification catalogue in 2005 and over the last ten years has developed an extensive catalogue of the individual dolphins which have been photographed in Cardigan Bay. Initially, photography was conducted from boat surveys on an opportunistic basis or through invoking a photo-ID licence, issued by Natural Resources Wales (NRW), when appropriate. These surveys are carried out in collaboration with Dolphin Survey Boat Trips (DSBT), a local eco-tourism business.

Due to the restrictions of the Ceredigion marine code of conduct (Appendix 1) and photo-ID licence protocols which state that the licence cannot be invoked within the New Quay harbour area or in the presence of other tourism vessels, only opportunistic photographs can be taken in the harbour. This means that unless the dolphins actively come close to the boat whilst it is following its pre-determined route out of the harbour, photographs of good enough quality for photo-ID cannot be obtained and opportunities to photograph all the dolphins coming into New Quay Bay are missed. The ShoreFin project was established in 2014 as a dedicated land-based photo-ID project in order to try to fill this data gap; to identify a greater proportion of individuals frequenting New Quay Bay.

Photographers from land based vantage points face unique challenges as fewer factors can be controlled. Photographs are taken from a static platform which cannot be manoeuvred around the dolphins, as can be done on a boat-based platform to achieve the optimum angle, lighting and distance to take the high quality of photograph required to identify an individual. Land-based photo-ID however has the advantage of being completely non-invasive (Würsig and Jefferson, 1990), and can still be conducted in adverse sea states when boat surveys cannot.

2015 marked the second year of the ShoreFin project, enabling photo-ID data from New Quay Bay to be collected to further contribute to the CBMWC database and to enhance the understanding of the individuals using the harbour. This season also aimed to build on the ShoreFin protocols and procedures established in the pilot year of study (2014) to improve the methodology for land-based photo-ID for future iterations of the ShoreFin project, ensuring the collection of a viable long-term dataset. The project also aimed to determine which individuals were using the bay, how frequently and for what activities. Understanding the spatial and temporal variation in the bottlenose dolphin abundance in Cardigan Bay is essential to determining appropriate management actions for the area and the effectiveness of current conservation measures (Evans and Hammond, 2004).
2. Methodology

2.1. Fieldwork
The 2015 ShoreFin project data collection took place from the 6th of April 2015 to the 30th of September 2015. Throughout the day volunteers with CBMWC undertook two hour marine mammal surveys from New Quay harbour wall as part of the Ceredigion County Council’s Dolphin Watch Project (Appendix 2). Their assistance was vital to the success of this project as volunteers would radio ShoreFin officers when dolphins were in the bay, particularly close to the harbour wall or the fish factory, so that a ShoreFin encounter could occur.

An encounter was classed as a sighting of bottlenose dolphins where photographs were taken. An encounter started when the first picture was taken and ended when the last picture was taken. An encounter ended either when the group of dolphins left the survey area, or when all dolphins within range had been photographed successfully. If the same group came back into the survey area after having left, a new encounter occurred. The survey area was divided into 8 zones (Figure 6) and the ShoreFin team used 3 different land-based platforms (Figure 6) to try and maximise the zones that could be covered:
- 1. Harbour wall
- 2. Fish factory
- 3. Penpolion pier (small pier)

Figure 6: Survey area zones: 1. Offshore. Further than twice the distance to New Quay Head, parallel to line z. 2. Fish factory. Between line z and offshore zone, west from buoy zone. 3. Buoy. Between line x and offshore zone, 400m E&W from buoy (closer to buoy than pier). 4. Between line x and offshore zone beyond buoy zone. 5. Pier. Between lines x and z and closer to observer than to buoy. 6. Harbour. S from line x and W from line y. 7. Beach. S from x and E from y. 8. S from x and beyond reef.

Photographs were taken using a Canon 550D DSLR camera (Canon UK Ltd., Woodhatch, UK) and a Sigma 50-500mm lens (Sigma Imaging (UK) Ltd., Welwyn Garden City, UK) (Figure 7). The lens has significant enough zoom to capture photographs of dolphins in the area within a kilometre of the designated land based vantage points.

During an encounter, the priority was to photograph both the left and right sides of the dolphins’ dorsal fins. Attempts were also made to obtain photographs of individual’s heads, dorsal, ventral (underneath) areas and flukes, as well as any interesting behaviours observed. There are a number of important parameters to consider when taking photographs of suitable quality for photo-ID: focus, contrast, angle, proportion of fin visible and proportion of frame filled by fin.

The quality of the photographs taken during ShoreFin encounters was heavily reliant on dolphin behaviour, angle of surfacing, time of day, weather conditions and distance from the shore. ShoreFin used the three platforms available to achieve the closest possible position for photography, and the majority of photographs were taken only of individuals within an acceptable range of the camera.

2.2. Data entry
Immediately after an encounter, a ShoreFin encounter form (Appendix 3) was filled in to detail important information including the time of the encounter, location of the photographer, and the environmental conditions (cloud cover, sea state, visibility, wind and general weather, tides). The number of groups, group size and composition were estimated and recorded and each group was then marked on the map on the encounter form. Subjective notes regarding the dolphins’ behaviour and usage of the area were written by the photographer. All the groups present in the survey area during the encounter were recorded regardless of whether they were in range of the camera as it was not possible to determine if these groups were interacting with those being photographed or if they were separate. The total number of individuals observed and photographed was then estimated. The form used was designed after the pilot year of study and was amended prior to the start of the season with space to include additional information regarding the dolphin groups. All data were recorded and stored on excel spreadsheets.

All photographs without dolphins in the frame (i.e. water shots) were immediately deleted and only those with dolphins in the frame were kept for processing and identification. Photographs were then renamed and cropped using ACDSee Pro 3.0 (ACD Systems, British Columbia, Canada), then graded based on photographic quality (Appendix 4). Only those photographs designated Grade 3 were used for identifying individuals in the encounter, although on occasion Grade 2 photographs were sufficient to identify particularly well-marked individuals (Table 1). The photographs in each encounter were sorted into separate individuals based on permanent markings (notches, nicks), non-permanent markings (i.e.
rake marks) and fin shape. Once sorted, attempts to match the individuals to those in the CBMWC catalogue and database from previous years or to others seen within the 2015 season. PowerPoint slides with the best pictures of the right and left profiles of all individuals identified during the season were made to make the fin matching process easier, especially for frequently photographed individuals.

Table 1: A description of the grading system used to determine whether photographs were suitable for identification

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
<th>Used for photo-ID?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>Photographs that were out of focus or showed less than 1 cm of fin</td>
<td>No</td>
</tr>
<tr>
<td>Grade 2</td>
<td>Photographs that did not show the entire fin or where the fin was not at a perpendicular angle</td>
<td>No (unless well-marked individual)</td>
</tr>
<tr>
<td>Grade 3</td>
<td>Photographs showing the entire fin perpendicular to the camera, and preferably front lit and bright</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Matches made to numbered, catalogued dolphins were checked by a second matcher, and then confirmed by the Living Seas Science Officer, Sarah Perry. If an individual could not be matched, after confirmation of this, a new ID number was created. A new ID number was also created for newborns, and these were linked to their mothers when possible.

Each individual in the database and all new individuals were assigned a marking category, depending on the degree of markings of the dorsal fin:

- Well Marked (WM)
  These can be identified by nicks visible from either side of the fin and are also recognised from low quality photos.
- Slightly Marked (SM)
  These can be identified from either side of the fin but not if photos are of lower quality.
- Right (R)
  Animals are only recognisable from the right side of the fin, with a smooth fin and no irregularities
- Left (L)
  Animals are only recognisable from the left side of the fin, with a smooth fin and no irregularities

It was also possible to identify some of the frequently seen well-marked individuals from lower quality photographs. The photo-identification procedure is summarised in Appendix 5.
2.3. Data analysis
All data were entered, sorted and analysed using Microsoft Office Excel. Results from the ShoreFin 2014 field season (Metcalfe et al., 2014) were also used to allow comparisons to be made between the findings of both years.

2.3.1. Photo-ID effort
The time spent photographing dolphins during encounters was calculated using the start and end time of the encounters, recorded on the ShoreFin data sheets. A record was kept of the hours spent when a ShoreFin encounter could have occurred so that encounter data could be adjusted for effort. The effort data equates to the number of Dolphin Watch survey hours each day as the number of Dolphin watch surveys conducted each day varied from 4 surveys (8 hours) to 6 surveys (12 hours). This data was recorded to remove bias regarding the opportunity for and thus the number of encounters in each month to ensure that more encounters were not occurring in a month purely due to an increase in effort. This also enables data to be compared directly in future year's.

2.3.2. Photo-ID results
The success of photo-ID was measured as the percentage of Dolphin Watch groups photographed and identified by ShoreFin. The number of individuals identified by the ShoreFin project was determined from the encounters data, along with the number of returning and new individuals identified. This data was compared to the 2015 boat data, allowing the number of returning and new individuals that were uniquely identified by the ShoreFin project to be calculated. Results were also compared to 2014 data.

The number of different individuals present in New Quay Bay each month was estimated by dividing the number of individuals identified by a distinctiveness ratio.

\[
\text{Distinctiveness ratio} = \frac{\text{Total no. of individuals identified in encounter}}{\text{Total no. of individuals observed in encounter}}
\]

This was calculated based on the distinctiveness ratio used by Balmer et al. (2008), which calculated the ratio of distinctive to non-distinctive (clean) dolphin fins photographed in every sighting. The ratio was calculated for each encounter and the mean was taken for each month to calculate the estimate of the number of different individuals actually present. It was also used to estimate the total number of different individuals likely to have been present in New Quay Bay throughout the whole season, based on a mean distinctiveness ratio of all the encounters.

The percentage similarity of the individuals identified between months was compared by dividing the number of the same individuals identified in both months by the total number of different dolphins identified in both months. The cumulative number of new individuals identified each month was also calculated.
Re-encounters were analysed in terms of the number of days individuals were encountered each month. This was to examine the modal frequency of encounters, and the variations in encounters between months. For each individual, the number of months it was identified in was also determined.

2.3.3. Sex categories
Each individual in the photo-ID catalogue was classified as “female”, “possible female”, “male”, “possible male” or “unknown”. The CBMWC catalogue and photographs were used to determine the sex of each individual. The close proximity of a calf to an adult was used to determine a “possible female”, and if a dolphin was seen on more than two occasions with a calf, it was categorised as a definite female. It has been shown that males have a higher degree of scarring, mainly through intraspecific interactions (Tolley et al, 1995), so these were determined to be “possible males”. An adult seen without a calf for more than 6 years was also classed as a “possible male”. If the genital area of a dolphin was seen, a definite distinction could be made for either sex. During the different encounters, the ShoreFin team attempted to photograph the genital area to identify the sex.

The percentage of each sex category observed was calculated for 2014 and 2015. To determine the proportion of males and females in the total number of individuals identified, the sex ratio was calculated:

\[
\text{Sex ratio} = \frac{\text{Total no. of definite males}}{\text{Total no. of definite females}}
\]

To estimate the variation of each sex category during the season, the cumulative number of times each category was observed each month was determined.

2.3.4. Life history (Adults, juveniles and calves)
Photographs of each individual identified were analysed and classified as adult, juvenile or calf. This was assessed based on the dolphin's size and colouring. “Calves” included neonatal calves in their first days or weeks of life with a yellow/green tinge to their skin, and younger animals with pale skin and visible foetal folds on their flank and those that were still present with adults up to 5 years after first being observed. Those classified as “juveniles” had pale skin and were approximately two thirds of the length of adults, and “adults” were fully grown dolphins with a darker skin colour and those identified with calves and newborns. The percentage of the dolphins identified at each life stage over the whole study period was calculated. To examine the trends in the usage of New Quay Bay for adults, juveniles and calves, the cumulative number of days on which individuals of each life stage were identified during each month was calculated.

2.3.5. Mothers and calves
The number of mother and calf pairings observed in 2015 and the number of days they were identified on were calculated. These were analysed on a monthly basis and compared to 2014
results to allow information to be obtained regarding the presence/absence of the different pairings in New Quay Bay over the field season (April to September).

The three most frequently identified mother and calf pairings were selected as case studies for further analysis: Connie (004) and calf Finn (673), Nick (015) and juvenile 220, and Jacky (376) and calf 657. For each of these pairings, the number of encounters in which they were identified per month were analysed and compared to encounters from 2014. To obtain further information on the site usage, the total number of encounters were calculated for each pairing for each two hour survey time period. (e.g. 7am-9am, 9am-11am, 11am-1pm, 1pm-3pm, 3pm-5pm, 5pm-7pm).

2.3.6. Behaviour
Fourteen behaviour types based on the classifications used by the Dolphin Watch project were used to classify the behaviours observed during ShoreFin encounters (Appendix 6). The percentage of encounters in which each behaviour category was observed in was calculated and a chi-squared test for goodness of fit was then conducted to determine whether a particular type of behaviour was recorded more frequently.

2.3.7. Prey species
Photographers attempted to take pictures of dolphins interacting with prey at the surface e.g. fish in the mouth or fish tossing, in order to improve the current knowledge on bottlenose dolphin diet in New Quay Bay. The best quality pictures where fish could clearly be seen were sent to experts at NRW for identification in order to determine the prey species that bottlenose dolphins were feeding on and at what time of year these species were being predated on.

2.4. Case studies
Four individuals identified in 2015 (036, 244, 302, and 665) were selected as case studies for further analysis due to their frequency of occurrence in the study area or because they exhibited interesting behaviours. Moreover, 036 was a case study last year so was selected to allow comparisons of its behaviour to be made between the two years.

The total number of encounters during which these dolphins were photographed in New Quay Bay over the season was calculated. The percentage of each land watch time period (7am-9am, 9am-11am, 11am-1pm, 1pm-3pm, 3pm-5pm, and 5pm-7pm) each case study individual was identified in was calculated to determine if individuals displayed a preference for certain times of day. The encounters each individual was identified in were displayed on maps created using QGIS 2.12.0 (QGIS, 2015) to obtain more information on the site usage: the data was taken from the original map made showing the groups observed by Dolphin Watch and ShoreFin. The dominant behaviours and associations observed are also discussed.
3. Results

3.1. Photo ID Effort
Over the ShoreFin field season, a total of 1788 hours of Dolphin Watch surveys were undertaken where there was the potential for a ShoreFin photo-ID encounter to occur. During this time, 199 hours 15 minutes were spent photographing bottlenose dolphins from one of three land-based vantage points. This was a 66.90% increase on the time spent photographing during the 2014 field season (119 hours 35 minutes), which resulted in a total of 278 ShoreFin encounters in 2015, compared to 261 in 2014.

Substantially more encounters occurred in June (87), with July and August having a similar number of encounters (51 and 50 respectively). The fewest encounters occurred in April (28) (Figure 8).

In order to account for differences in effort over the season, the number of encounters per hour was calculated to determine a more accurate representation of the distribution of encounters over the season (Figure 9). Once adjusted for effort, April was seen to have a higher encounter rate than May; September had the lowest encounter rate. This also showed that encounter frequency was highest in June (0.27 encounters/hour) followed by July and August. In 2014, encounter frequency was highest in July (0.25 encounters/hour). In 2015 the average number of encounters was 0.164 per hour compared to 0.156 per hour in 2014.

During the 178 days of the ShoreFin project, encounters occurred on 136 days, resulting in dolphin presence on 76.40% of survey days.

3.2. Photo-ID results
Of the 278 encounters, 45 did not contain photographs of sufficient quality for any identification to be made, giving a total of 233 encounters where at least one individual could be identified: an 83.81% success rate. In 2014, 231 of the 269 encounters resulted in useable
photographs. During encounters in 2015, a total of 510 groups of bottlenose dolphins were observed, accounting for 49.70% of the groups observed through Dolphin Watch surveys.

61 individuals were identified by the ShoreFin project (Appendix 7): 42 were matched to individuals previously identified in the CBMWC bottlenose dolphin photo-identification catalogue, 19 were dolphins that could not be matched to an existing individual in the catalogue and were added to the catalogue as new individuals (Appendix 8). Whilst this is fewer individuals than were identified from Boat encounters (96), 19 of these individuals, eight of which were new in 2015, were unique to ShoreFin encounters so would not have been identified as present in Cardigan Bay. 41 individuals were identified both by ShoreFin and Boat. When comparing 2015 to the pilot year of study, results were quite similar: only two more dolphins were identified in 2015, three more unique individuals and two less new individuals were identified.

Over the two years, a total of 92 different individuals have been identified by the ShoreFin project, and 30.43% of these were identified in both years. This resulted in the individuals identified in 2015 showing a 45.90% similarity to those in 2014.

A mean of 27.5 (± 2.59 SE, n=6) individuals were identified each month. The highest number of individual dolphins were identified in June (35), with a decline in the number of individuals identified being seen either side of this peak (Figure 10). The fewest number of individuals were identified in September (18). To estimate the number of individuals that were actually present in New Quay Bay each month a mean distinctiveness ratio was then calculated. From this it was estimated that a mean of 44 different individuals were present each month (± 4.85 SE, n=6), with a mean distinctiveness rate of 0.64 (± 0.04 SE, n=6). The ratio was highest in August, meaning that a greater proportion of the individuals in each encounter were identified. Despite the greatest number of individuals being identified in June, it was estimated that more individuals were actually present during May (58). The number of different individuals present during the ShoreFin season was estimated at 92, based on a mean distinctiveness ratio of 0.66.

Figure 10: The number of dolphins identified each month, the distinctiveness ratio and the estimated total number of dolphins in New Quay Bay each month.
The greatest similarity in the individuals identified occurred between May and June where 65.83% of the individuals were the same, and similarity between May and July was also high (56.76%). September had the most different individuals to all other months, showing less than 30% similarity, with the greatest difference being between July and September (19.44% similarity) (Table 2).

<table>
<thead>
<tr>
<th></th>
<th>April</th>
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<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
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<tbody>
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<td>-</td>
<td>40.91</td>
<td>44.44</td>
<td>30.95</td>
<td>37.50</td>
<td>29.73</td>
</tr>
<tr>
<td>May</td>
<td>-</td>
<td>-</td>
<td>65.85</td>
<td>56.76</td>
<td>41.46</td>
<td>21.43</td>
</tr>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>46.34</td>
<td>39.53</td>
<td>23.26</td>
</tr>
<tr>
<td>July</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>51.52</td>
<td>19.44</td>
</tr>
<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>26.47</td>
</tr>
<tr>
<td>September</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The discovery curve of the cumulative frequency of individual dolphins (Figure 11) shows that the number of new dolphins identified declined as the season progressed. However, no plateau was reached as four individuals that had not previously been identified during the season were photographed in September, indicating that there are likely to be other individuals in New Quay Bay that had not previously been photographed and identified.

Figure 11: Cumulative number of bottlenose dolphins identified in New Quay Bay in 2015, by month
The mean number of encounters of an individual was 10.85 (±0.07 SE, n=61), and the maximum number of encounters was 87, this was individual 376 (Jacky) (see Appendix 7 for the number of encounters for all individuals identified). 48.50% of individuals were identified on only one day during the season, and this was the mode in all months (Figure 12). The maximum number of days an individual was encountered during a month was 16, this occurred in June with one individual.

Encounters were also relatively high in August, with one individual being identified on 15 days and another on 13 days. April showed the lowest number of encounters, with the maximum being one individual which was photographed six times.

The majority of the individuals identified (24) were also only photographed during one of the six months surveyed (Figure 13), although they may have been photographed on multiple occasions within that month. Only four individuals were identified in all six months of surveying: individuals 036, 302, 657 and 376 (Jacky) (Appendix 9). Nearly half of the individuals seen (30) were identified in at least half of the months surveyed, suggesting that some individuals are more regular to the bay.
Figure 14 shows the location of all the groups of dolphins recorded during ShoreFin encounters during the season, as well as all the Dolphin Watch sightings for the same period. Not all of the groups in the ShoreFin encounters were within the required range of the camera to take Grade 3 photographs for identification. Successful photo-ID encounters occurred primarily in zones 2, 5 and 6, although some of the individuals that were initially marked in zones further out did come within photographable range during the encounters. The majority of groups were observed in zone 5. There were main clusters of groups which coincided with the three platforms available for photography: the harbour wall, Penpolion and the fish factory. There was also a fourth cluster to the right of the cardinal buoy but individuals seen here were generally too far away to be identified, with the exception of some of the well-marked individuals.
3.3. Sex categories

In 2015, 61 individuals were identified by the ShoreFin project and 59 individuals in 2014: figure 15 illustrates the percentage of individuals identified in each sex category (see Appendix 7 for sex of each individual identified in 2015). In 2015, six individuals identified were definite females, ten were possible females, five were definite males, 12 were possible males, and 28 were of unknown sex. The individuals identified as definite female or definite male represented 18% of the individuals observed this season.

The sex category results from 2014 and 2015 were compared. The number of definite females and definite males observed was similar in both years, resulting in a similar proportion of individuals whose sex was confirmed during the two seasons (16% in 2014 and 18% in 2015). The percentage of possible females was higher in 2015 (16%), contributing to this increase was the identifications of two possible females (708 and 712) that were new to the CBMWC catalogue this year.

The sex ratio was calculated at 0.80 (0.80 male for 1 female) in 2014 and at 0.83 (0.83 male for 1 female) in 2015. This means that in both years the number of females observed was slightly higher than the number of males.

When looking at the frequency at which different sexes were encountered (Figure 16), overall, the number of possible males observed was higher throughout the 2014 than in 2015. Last year, individual 007, a possible male named ‘Bond’, was encountered 65 times over the season but was not observed at all in 2015. Last year, a peak in the number of times possible males observed occurred in July (42) which was the month where Bond was seen most (21). In 2015, the number of possible males was lower and constant throughout the season.

In 2014, the number of times possible females were encountered was generally lower than in 2015 and consistently low (<8) during the season. This year, the highest number of possible female encounters occurred in June (22) which can be correlated with the frequent activity of possible females 686 and 691 photographed and identified in eight and nine encounters respectively during this month.
The number of times definite males were observed was low compared to the other categories for both years (Figure 16). The only way to confirm the identification of a male was to photograph its genital area; the opportunities to sex a male were therefore less frequent. This year, individuals 220 and 716 were identified as definite males thanks to photographs of their genital area taken by the ShoreFin team. The presence of these two individuals explains why the number of males was higher in June.

The number of times definite females encountered was potentially higher than the other categories in both years as the females can be determined in different ways: on photographing the genital area like with males or when the adult was observed with a calf more than twice.

In 2015, the number of times females were observed was generally higher than in 2014 (Figure 16). This difference can be attributed to the regular presence of female 665 in 2015 (32) compared to 2014 (3). In 2015, a peak in the number times definite females were photographed occurred in June (48). This is attributed to the fact that there was a peak in mother (definite female) and calf observations in June (40).

Overall, the number of times individuals of unknown sex were photographed was higher in 2014 (54 %) than in 2015 (46%).

The peak number of encounters of individuals of unknown sex occurred in June in 2015 (55); this was substantially higher than 2014 (39). This could also be attributed to the number of calves observed, as all calves are of unknown sex. For example, individual 676 (calf of 686) was observed four times in June 2014 and 12 times in June 2015 which is three times higher.

---

**Figure 16: Number of times Males (M), Possible Males (PM), Females (F), Possible Females (PF) and Unknown (U) were identified each month in 2014 (right) and 2015 (left).**
3.4. Adults, juveniles and calves

The life stage of each individual was identified through existing information in the CBMWC catalogue and by looking for key features e.g. foetal folds, in photographs of new individuals, to gain an understanding of the structure of the population of dolphins using New Quay Bay. 80% of individuals identified were classified as adults, accounting for the majority of the individuals photographed (Figure 17). The percentage of calves/newborns (13%) was very similar to 2014 (12%), but the proportion of juveniles was markedly less than last year (7% compared to 32% in 2014).

The peak number of adult, juvenile and calf/newborn encounters all occurred in June and declined in the months either side (Figure 18). There was also a second peak in the number of calf/newborn encounters in August: this coincided with the first sightings of two of the three newborns seen in 2015.

3.5. Mothers and calves
One of the most dominant and interesting aspects of the ShoreFin project was the number of mothers and calf pairings that were photographed using the area and how frequently they were observed.

The high use of the bay throughout the season suggests that is a favoured area for mothers and their young. Between April and September ten mother and calf pairings were photographed (Table 3).

Four newborns were observed this year; 711 was first observed in April, 713 was first observed in May and 731 and 734 were both first seen in August. 665 was photographed alone at the beginning of the season and was seen with a newborn (734) in August (see case study 4).

Table 3: Mother and calf pairings identified in during the 2015 ShoreFin season

<table>
<thead>
<tr>
<th>Mother and calf pairings observed by ShoreFin</th>
<th>First time seen</th>
<th>Presence of newborn</th>
<th>Number of days the pairing was identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>004 &amp; 673</td>
<td>2014</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td>015 &amp; 220</td>
<td>2010</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>136 &amp; 716</td>
<td>2012</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>225 &amp; 705</td>
<td>2015</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>227 &amp; 711</td>
<td>2015</td>
<td>Yes</td>
<td>9</td>
</tr>
<tr>
<td>376 &amp; 657</td>
<td>2013</td>
<td></td>
<td>58</td>
</tr>
<tr>
<td>665 &amp; 734</td>
<td>2015</td>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>686 &amp; 676</td>
<td>2014</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>708 &amp; 731</td>
<td>2015</td>
<td>Yes</td>
<td>2</td>
</tr>
<tr>
<td>712 &amp; 713</td>
<td>2015</td>
<td>Yes</td>
<td>3</td>
</tr>
</tbody>
</table>

Mother and calf pairings were observed in the bay each month of the season in 2014 and 2015 (Figure 19).

In 2015, the number of mother calf pairings increased during the season to reach a peak in June with 40 encounters and then decreased. A slight increase of the encounters was observed in August due to the presence of 665 and her newborn (734). In 2014, the peak of encounters was later in the season (July and August) and lower in number (29 encounters).
Amongst the mother and calf pairings, the most regularly photographed dolphins were Connie (004) and newly named calf Finn (673), Nick (015) and juvenile (220) and Jacky (376) and calf (657). These individuals are examined in more detail in the following sections.
Case study 1: Connie (004) and Finn (673)

Connie is one of the dolphins available as part of the CBMWC Adopt a Dolphin scheme. This individual was first seen in 2005 (Figure 20) and has been photographed every year in the bay since then. Her calf Finn was first seen in 2014.

In 2014 and 2015, Connie and Finn were observed throughout the season except for September (Figure 21) and a similar number of times (23 in 2014 and 26 in 2015). However the distribution of the number of days photographed was different between the two seasons. In 2014, the mother and calf pairing were photographed more frequently during May (6) and August (7). In 2015, they were photographed on more occasions throughout the season; most frequently during May (9) and June (10). However, the number of encounters during July and August was lower compared with 2014.

![Figure 20: Left and right profiles of Connie (004) and Finn (673)](image)

![Figure 21: The number of days Connie and her calf were identified from April to September in 2014 and 2015](image)
The highest percentage of presence (16.67%) of this pairing occurred during 17:00 to 19:00 land watches (Figure 22). For the other land watch time periods, the percentage of presence was low and varied between 2.22% and 8.89%.

![Figure 22: The percentage (%) of each two hour landwatch period Connie and calf Finn was identified in 2015.](image)

This pairing was frequently seen alone, only occasionally as part of larger group. Connie would repeatedly forage with her calf in shallow waters off the harbour (section 6 of the survey area). They were photographed often at the end of the harbour wall and in between Penpolion pier and the boat moorings in the bay. Finn exhibited tail slapping behaviour during most of its encounters.

The pair were generally seen together in the characteristic mother and calf echelon position, where the calf swims close to the mothers upper to mid flank, and infant position, where the calf swims in close proximity under the mother’s tail section (Shoele and Zhu, 2015), but were also seen to separate on occasions.

During one encounter in June, Connie was observed foraging off Penpolion and Finn was photographed in a group of adults and calves milling and feeding off the end of the harbour wall. When this group began to travel away, Finn was seen to tail slap repeatedly, Connie fast travelled over from Penpolion and they both travelled back into the harbour area whilst the rest of the dolphins in the group swam off past the cardinal marker.
Case study 2: Nick (015) and juvenile (220)

Nick was first seen in 2005, and is one of the dolphins available as part of the CBMWC Adopt a Dolphin (Figure 23). 220 was first photographed in 2010, and after five years can now be considered a juvenile: it was identified as a male due to photographs of the genital area taken during an encounter.

Nick and her juvenile were photographed less often than Connie, Jacky and their calves. They were photographed 14 times in 2014 and 17 times in 2015 (Figure 24). In 2015, Nick and her juvenile were photographed earlier in the season and for three months from May to July. They were photographed most frequently in June during 17 encounters. In 2014, they were photographed from June to September with a peak in July (6).
The percentage of presence seems to be higher during the 17:00 to 19:00 land watches (8.33%) and constant during the rest of the day (Figure 25).

Nick was frequently photographed feeding and foraging around the harbour wall with her juvenile and was quite often photographed travelling into New Quay as part of a group. Individual 220 was observed foraging independently from its mother and was also frequently seen in association with suspected mother and calf pair 691 and 692.
Case study 3: Jacky (376) and calf (657)

Jacky was first seen in 2011 and her calf 657 was born in 2013 (Figure 26). This mother and calf pairing were ShoreFin's most frequently photographed dolphins this season. Since 2011, she has been photographed each year.

They were photographed on 58 days in 2015, and were present in New Quay Bay from April to September (Figure 27). It was a similar case in 2014 where they were encountered throughout the whole season on 53 days.

In 2014, they were photographed most frequently during July (14). In 2015, the peak number of days encountered occurred later, in August (15). The number of days encountered per month is higher in all months in 2015, except for June and July. They were observed more at the beginning of season in April in 2015 (5) than in 2014 (1).

Jacky and calf were observed less frequently between 13:00 to 15:00 land watches (5.00%) (Figure 28). The percentage presence appears to be higher in the morning during the 7:00 to 9:00 land watches (20.29%) and the 9:00 to 11:00 land watches (17.78%).
Jacky and calf were regularly photographed in zone 6 of the survey area, frequently observed foraging close to the end of the harbour wall and Penpolion pier. They were also observed near the swimming area and off Dolau beach. All these locations reflect sheltered, shallow waters. Jacky was observed several times feeding and tossing fish in the air.

During the majority of encounters Jacky and 657 were observed travelling in echelon position between the harbour wall, the fish factory and the cardinal marker. On occasions, however, 657 was observed being more independent, venturing further from its mother. An example of this was when Jacky was seen foraging alone near Penpolion pier and 657 was foraging independently between the harbour wall and the cardinal marker. 657 was then observed travelling fast to join its mother.

Jacky and her calf were photographed with 244, a male, predominantly between 13th July 2015 and 5th August 2015 (see individual Case study 2); sexual interactions were observed. 657 was also seen to develop new markings on its dorsal fin (Figure 29) and back which may have occurred as a result of these interactions.

![Figure 28: The percentage (%) of each two hour landwatch period Jacky and her calf was identified in 2015.](image)

![Figure 29: The fin of individual 657 a) prior to interaction with 244 and b) after interaction with 244](image)
3.6. Behaviour

During the 278 ShoreFin encounters in 2015, a total of 939 behaviours were recorded, with mean of 3.38 (±0.10 SE) behaviours per encounter, a minimum of one and a maximum of 11.

The behaviours observed most frequently were T1 (19%), S6 (18%), S2 (15%), S3 (14%) and T2 (13%) (see Appendix 6 for behaviour code explanations) (Figure 30). All other behaviours were observed much less frequently, all being seen with <6% frequency. It should be noted that associations with seabirds (SB) was actually seen on four occasions, but as this equated to less than 0.5% it shows as 0%.

![Figure 30: The percentage of each type of behaviour observed during ShoreFin encounters. (See Appendix 6 for more details behaviour code explanations).](image)

A chi-squared test for goodness of fit was used to test whether there was a behaviour type observed. A significant difference was found between the occurrence of the behaviours the dolphins exhibited in New Quay Bay ($\chi^2_{(d.f=13, n= 939)} = 34.528, p> 0.001$). The five dominant behaviours observed were seen significantly more often than all other behaviours.
3.7. Prey species

Figure 31: Prey species bottlenose dolphins were photographed feeding on in New Quay Bay: a) mackerel, possible horse mackerel; b) bass sp.; c) sandeel; d) salmon; e) mullet; f) salmon; g) possible garfish or pipefish; h) mackerel

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With the help of experts from NRW, the three primary species bottlenose dolphins were photographed feeding on were identified as salmon (*Salmo salar*), mullet (*Mugilidae sp.*) and mackerel (*Scomber scombrus*) (Figure 31). They were also seen feeding on sandeels (*Ammodytes tobianus* or *Hyperoplus lanceolatus*), bass (*Dicentrarchus labrax*) and possibly garfish (*Belone belone*) or pipefish (*Syngnathinae sp.*), and it was suspected that they were feeding on other salmonid species including sea trout (*Salmo trutta*) and small clupeid species such as herring (*Clupea harengus*). On some of the fish, scale loss patterns could be seen from cetacean predation (Figure 32), likely from tooth rakes. Similarly occurring scale loss patterns (Figure 31) have been observed in fish species off the south Wales coast, although causation has not been determined (NRW).

Dolphins were photographed with fish in all months of the ShoreFin project. Encounters when fish were seen were highest in June. During one encounter, Nick (015) was seen with juvenile 220 fishing just off the harbour wall (Figure 33). Nick was identified swimming around with large salmon in her mouth and was releasing and recapturing them. In the same encounter, Nick was also seen catching mackerel, possibly horse mackerel (*Trachurus trachurus*).
3.8. Individual dolphin Case Studies
The following section highlights four of the regularly occurring dolphins that frequented New Quay bay during the 2015 field.

Case study 1: Individual 036

CBMWC CATALOGUE NAME: 036-05W5
Nickname: None
Gender: Probable male
Number of ShoreFin encounters in 2015: 25
Number of ShoreFin encounters in 2014: 37

Individual 036 (Figure 34) was first identified in 2005 and is a possible male. It is a well-marked individual that can be readily identified due to the three notches on the middle to lower trailing edge of the dorsal fin, as well as white pigmentation and scarring on the right and left sides of the fin. Due to the distinctiveness of the fin, 036 was able to be identified at a greater distance and with lower grade photographs.

036 was first photographed early on in the season during April (Figure 35), and was one of only four individuals to be photographed during all six months of data collection. The peak encounter frequency occurred in June where 036 was photographed nine times. In all other months it was identified less than five times, only being photographed once during August. 036 was also photographed once during a boat encounter in August.

In 2015, it was identified in 25 encounters, 12 less than in 2014, but was photographed over a longer period of time as it was not photographed during September last year. Despite being
photographed less in all months (with the exception of September) when comparing the overall trends, peak encounter frequency occurred one month earlier in June during 2015.

![Figure 35: The number of ShoreFin encounters individual 036 was identified in from April to September 2015](image)

036 was photographed most often during the 11:00 to 13:00 land watch, being photographed on 6.01% of land watches during this period (Figure 36). It was also photographed during more than 4% of land watches between 13:00 to 15:00 and 17:00 to 19:00.

![Figure 36: The percentage (%) of each two hour landwatch period individual 036 was identified in over the 2015 field season](image)
036 was observed most frequently throughout zone 5 (Figure 37), with a small cluster of encounters at the end of the harbour wall and also in zone 2 by the fish factory. Animal 036 was regularly seen in the bay as part of a group of six individuals, but was also seen alone as well as in a group with 16 individuals of one occasion.

036 was often identified in association with 015 (Nick), being photographed in the Bay at the same time during ten encounters. 036 exhibited a variety of behaviours whilst in the harbour, most commonly observed foraging and travelling through the harbour with regular surfacing.

*Figure 37: A map of the distribution of ShoreFin photo-ID encounters where 036 was identified during the 2015 field season*
Case study 2: Individual 244

CBMWC CATALOGUE NAME: 244-06W4
Nickname: None
Gender: Male
Number of ShoreFin encounters in 2015: 13
Number of ShoreFin encounters in 2014: 14

Figure 38: Left and right profile of individual 244

First photographed in 2006, individual 244 (Figure 38) is a male bottlenose dolphin, identified as such from pictures of the genital area. This individual is categorised as well-marked due to the large protruding section of fin with a nick in it on the lower half of the trailing edge of the dorsal fin, along with a few smaller nicks on the mid and upper fin.

Dolphin 244 also has distinctive white pigmentation and scarring on both the left and right leading edges of the dorsal fin. As with other well-marked individuals, the distinctive fin shape meant it was possible to identify 244 at a greater distance and with lower grade photographs.

244 was photographed during four of the six months, from May until August (Figure 39). The peak encounter frequency (7) occurred in July, followed by August (5), with few encounters during May (2) and June (1). 244 was also photographed just once during a boat encounter in August in the same encounter as 036. 244 was also photographed 14 times in 2014, which is comparable with data from this year, but he was identified most often during August.
244 was photographed in the greatest percentage of 09:00 to 11:00 landwatches (5.56%) (Figure 40). The percentage of presence during all other landwatch periods was low (>2.08%), and 244 was not photographed during the 07:00 to 09:00 land watches.

244 was photographed in zones 2 and 5 only (Figure 41). It was observed mostly in small groups, on average in a group of six individuals, but was never observed on its own. During encounters, when photographed, there was a minimum of three and a maximum of 13 individuals in the bay.
There were nine encounters where 244 was observed in association with Jacky (376) and calf (657) from April to September. They were first photographed together at the end of May, but all other interactions were observed between 13th July 2015 and 5th August 2015. It was then that sexual behaviour was observed between 244 and Jacky: this included physical contact, circling, belly rubbing and splashing behaviour (Figure 42). During three of these encounters, just 244, 376 and 657 were observed together, and more sexual activity was observed during these encounters.

657 was seen involved in some of the sexual behaviour, and was also identified with new scarring in the centre of the left side of the dorsal fin and along the back during this period of association – it is possible that this scarring may have resulted from these interactions.
Case study 3: Individual 302

CBMWC CATALOGUE NAME: 302-08W4

Nickname: None

Gender: Probable male

Number of ShoreFin encounters in 2015: 30
Number of ShoreFin encounters in 2014: 20

Individual 302 (Figure 43) is a well-marked dolphin, first photographed in 2008, thought to be male due to the high degree of scarring. It can be distinguished predominantly by the large lower nick on the trailing edge of the dorsal fin as well as many smaller nicks and notches on the fin. There is also a large patch of white pigmentation and scarring on the top of the leading edge on the left and right side.

In 2015, individual 302 was first observed in the second encounter in the season and was another of the individuals to be observed in all six months, being photographed in a total of 30 encounters (Figure 44). The peak encounter frequency occurred in June where 302 was observed nine times, and the lowest encounter frequency was in September (2). All other months had a similar number of encounters. 302 was identified twice from boat encounters, once in June and once in August. 302 was identified in a third more encounters than in the previous year, and in 2014 peak encounter frequency occurred a month later in July.
302 was identified in more than 6.5% of the 09:00 to 11:00 and 13:00 to 15:00 land watches, with the former being slightly higher (6.67%). The individual was photographed in more than 5% of 07:00 to 09:00 and 13:00 to 15:00 but was not seen as often in the last two land watch periods (Figure 45).

302 was identified predominantly in zone 5 as well as zone 2, and was able to be identified from photographs taken when it was near the cardinal buoy in zone 3 due to its distinctive markings (Figure 46). During one encounter, 302 was photographed inside the harbour in the area typically favoured by the mother and calf pairs.
302 was often a solitary individual, identified in six encounters where it was the only individual present in the Bay but was on average identified in a group of 5 individuals. When with other dolphins, 302 was often seen with mother and calf pairs including 015 and 220, 004 and 657, 686 and 676 and 376 and 657 and was seen engaging in sexual behaviour with 376 with physical contact and belly rubbing. Foraging and milling where the behaviours observed most often and 302 was also seen displaying S6 behaviour including leaping and tail slapping (Figure 47).
Case study 4: Individual 665

CBMWC CATALOGUE NAME: 665-14 and 734-15
Nickname: None
Gender: Possible Female
Number of ShoreFin encounters in 2015: 32
Number of ShoreFin encounters in 2014: 3

Individual 665 (Figure 48) was first identified during the pilot year of the ShoreFin project and is a slightly-marked individual. There are no obvious nicks or notches on 665’s dorsal fin, meaning that the individual was more difficult to identify unless Grade 3 photographs were taken or the encounter was close to the photography platform. Unlike the other case study
individuals, 665 had to be identified by the scarring and pigmentation on the sides of the dorsal fin including the two distinct white patches and white spot at the base of the fin on the left side and the large white patch on the right side with scarring. There are a number of other individuals in the catalogue which also express a white patch on the right side, so a set of rake marks of the body and a scar in line with the dorsal fin were also used to help identification (Figure 49). 665’s sex was unknown in 2014, but was identified as female this year due to the presence of a newborn on more than two occasions.

665 was identified on 32 occasions, being photographed from April to August (Figure 50). Of the months 665 was identified in, encounter frequency was lowest in April (2) and this gradually increased each month to reach peak encounter frequency in July (13), before declining again in August (4). Individual 665 was also identified in five boat encounters, once in April and twice in June and August.

Figure 49: The right side of 665’s body where rake marks and scarring can be seen

Figure 50: The number of ShoreFin encounters individual 665 was identified in from April to September 2015
665 was photographed during a greater percentage of early and late land watches, and during a lower percentage of those during the middle of the day (Figure 51). The highest percentage of presence (8.89%) occurred during 09:00 to 11:00 land watches. It is possible that 665 was seen during a higher percentage of these watches as she was either pregnant or with a newborn and so visited the harbour at times when there was likely less boat activity in the area.

665 was identified in 3 zones: 2, 5 and 6 (Figure 52). 665 showed the most clustered distribution of the case study individuals, being seen almost exclusively off the fish factory headland and off the end of the harbour wall in front of the lower viewing area.

Figure 51: The percentage (%) of each two hour landwatch period individual 665 was identified in over the field season

Figure 52: A map of the distribution of ShoreFin photo-ID encounters where 665 was identified during the season
665 was seen on a number of occasions chasing prey at the surface and was photographed whilst feeding (Figure 53). Other behaviours observed regularly were foraging and milling, the latter of which was particularly prevalent at the end of the harbour wall.

![Image of individual 665 catching fish off the fish factory headland](© Anna Stevens/ CBMWC)

*Figure 53: Individual 665 catching fish off the fish factory headland*

Early on in the season, 665 exhibited some particularly interesting behaviour. 665 was frequently photographed alone, being the only dolphin seen in 22.58% of the encounters she was identified in, and even when other dolphins were also present in the bay, 665 often remained separate with seemingly little interaction, or would leave when other dolphins arrived. It was later determined that during this period of behaviour 665 was pregnant.

665 was identified as female after being seen with newborn 734 (Figure 54) during three encounters on the 17th August 2015. During the first two of these, individual 238 (Gwanwyn) was observed with the mother-newborn pair in very close proximity, and during the third encounter 665 and 734 were alone. The pair were actually identified for the first time from a boat encounter 12 days previously in a group with three adult females and a fourth adult who is a probable male.

![Image of 665 with newborn 734 in New Quay Bay](© Anna Stevens/ CBMWC)

*Figure 54: 665 with newborn 734 in New Quay Bay*
4. Discussion

4.1. Population estimates

The number of bottlenose dolphins that have frequented Cardigan Bay at some time between 2005 and 2015 is estimated to be a minimum of 385 individuals: this figure is based on the number of marked (including well-marked and slightly-marked) individuals that have been photographed and recorded in the CBMWC catalogue from 2005 to 2015. In 2015, the ShoreFin project identified 61 individuals, suggesting that approximately 16% of the bottlenose dolphins known to visit Cardigan Bay were photographed: these individuals were seen to use New Quay Bay between April and September. Using the distinctiveness ratio, it was estimated that 92 dolphins were present in New Quay Bay in 2015. Coincidentally, since the project began in 2014, a total of 92 individuals have been identified. Whether the unidentified 31 dolphins in 2015 were dolphins successfully identified in 2014 is unknown. It is difficult to determine an exact population estimate for the area as the dolphins in Cardigan Bay are considered to be part of an open population (Evans et al., 2003; Reid et al., 2003).

Of the 61 individuals identified, 41 were also identified from boat encounters, 19 were unique to the ShoreFin project. This suggests that some individuals express a greater preference for New Quay Bay, whilst others use both the bay and the surrounding coastal and offshore areas. Conversely, there were individuals that were identified in boat encounters that were not photographed by ShoreFin in 2015, showing that individuals have different patterns of site usage and habitat ranging (Lusseau et al., 2006). Spatial stratification has been observed in a number of vertebrate species, with individuals showing different degrees of site fidelity, and is usually as a result of dietary needs, territoriality and maternal care (Wilson et al., 1997; Evans, 2008), although the degree of stratification in Cardigan Bay is unknown.

Of the individuals identified using New Quay Bay, 30 of these were seen on a more regular basis, in at least half of the months surveyed. The most regular individuals photographed were Jacky (376) and her calf 657, identified in all months with 84 and 74 encounters respectively. Two other individuals were also seen in all months, 036 and 302.

Historic abundance estimates for the Cardigan Bay SAC indicate that the number of bottlenose dolphins frequenting the area is stable or slightly increasing (Pesante et al., 2008), but more recent estimates indicate that there has been decline in sightings in the SAC since 2011 (Feingold and Evans, 2014). This is also evident in New Quay Bay specifically where there has been a steady decline in bottlenose dolphin occurrence since 1994 (Pierpoint et al., 2009). The ShoreFin project identified 61 different individuals in 2015 and 59 in 2014, indicating little change in the number of dolphins using the area, but further years of data are needed to determine the overall trend. Whilst the overall numbers of dolphins identified did not change significantly between the two years, the different individuals identified varied: there was a 45.90% similarity in the individuals identified in both years. This indicates that individuals’ usage of the bay varies between years.
The discovery curve of cumulative frequency did not reach a peak in September, suggesting that additional individuals, not previously photographed, would likely be identified if studies continued throughout the winter. Indeed, opportunistic photography of individuals sighted during land watches in October has already led to the identification of individuals that had not previously been identified during the ShoreFin season (April to end of September).

4.2. Distribution in New Quay Bay

There were four primary locations at which the majority of ShoreFin groups were encountered: the end of harbour wall, Penpolion, the fish factory and to the right of cardinal buoy off Llanina reef. These hotspots provide some of the key features of the bay.

Both the main harbour wall and Penpolion offer shelter and protection from the prevailing winds and wave energy (Metcalfe et al., 2014). The shellfish processing factory headland is considered to be a hotspot due to the discards attracting small fish species which attract the larger prey species on which dolphins feed. This creates a convenient foraging area (Denton, 2012), and indeed dolphins were photographed on multiple occasions with both large and small fish species in this area. There were also encounters where large numbers of seabirds including herring gulls and gannets were observed in association and diving, indicating the presence of fish and suggesting the dolphins were feeding. The fourth site, Llanina reef, is thought to provide shelter for fish species creating an optimal feeding environment (Metcalfe et al., 2014).

Dolphins encountered by the end of the harbour wall, Penpolion and the fish factory were easier to photograph, but those near the cardinal marker were beyond the range of the camera lens for obtaining photographs suitable for identification purposes unless individuals were particularly well-marked. This area of the bay proved to be popular in both years: typically only well-marked individuals could be identified in this zone. The distribution of encounters therefore affects the quality of photographs that can be taken and consequently the success of photo-ID, making it important that the three observation platforms are utilised effectively so that photographs can be taken at the closest possible distance.

4.3. Temporal variation

In the UK, studies have found that peak sightings of bottlenose dolphins usually occur in the summer between July and August, with a second peak in some areas between March and April (Evans, 1992; Wilson et al., 1997). Previous studies of Cardigan Bay and New Quay Bay have shown dolphins to be present all year round, although numbers are highest between April and November, with peak sightings during June, July and August (Bristow and Rees, 2001), similar to the general UK pattern. The ShoreFin project found that the peak number of encounters occurred in June (before and after adjustment for effort). Whilst this is in line with previous research, the peak occurred earlier in the summer than in 2014 when the peak encounters occurred in July (although it should be noted that this data was not adjusted for effort).
The majority of peaks in the analyses also occurred in June, including cumulative frequency of adults, juveniles and calves and the frequency of mother and calf pairings. The case studies, however, did show that some individuals were identified more frequently in other months e.g. Jacky (376) and 657 was identified more frequently in August, and 244 and 665 in July. Nick (015) was also present earlier on in the year in 2015, being photographed from May to July in 2015 and from June to September in 2014.

When looking at the variation in the individuals identified each month, the individuals photographed in September showed the least similarity to all other months, and four individuals that were not photographed during the rest of the season were identified. May, June and July showed the highest percentage similarities. The results indicate that individuals have varying temporal patterns of site usage: temporal variations in site preference of individuals observed during the ShoreFin season may be due to a combination of factors including food availability, rearing young and breeding (Wilson et al., 1997).

4.4. Sex categories
Of the 61 individuals identified by the ShoreFin team in 2015, sex could be determined for 18% which represents a small percentage of the population. Several criteria were used to identify the different genders but male and female dolphins were not equally able to be sexed. Both males and females can be sexed by direct observation; in addition, sex can be inferred for females due to close association with a calf on multiple occasions. Opportunities to sex males were therefore less frequent as the genital area was difficult to photograph during the survey, although two individuals were identified as definite males in 2015 (220 and 716) (Figure 55). Consequently, the sex ratio may be biased, especially in the case of males, which could result in an underestimation of the gender stratification of the population structure.

Figure 55: A series of photographs that enabled individual 220 to be identified and sexed. The absence of mammary slits and two distinct genital slits meant 220 was identified as a definite male
Bottlenose dolphins show diffused seasonal peaks in reproduction; the timing varies with different parameters such as food availability, risk of predation, water temperature and sea conditions (Urian et al., 1996). In 2015, the results showed a peak in both definite males and females in June, suggesting that during this month conditions were at their optimum for both sexes which could be indicative of a reproductive season. However, as only a small percentage of the individuals observed had a known sex, it is difficult to draw reliable conclusions.

Sexual interactions between males and females usually depend upon a female’s reproductive status (Wells et al., 1987). An interaction of this kind was observed between definite male 244 (case study 2) and definite female Jacky (376) between 13th July 2015 and 5th August 2015. This interaction occurred close to the main harbour wall: as a result the identification of both individuals was possible (Grade 3 photos) and sexual behaviour including physical contact, circling and belly rubbing could be identified. An encounter of this quality was rare because individuals displaying this kind of behaviour were often too far from the photographers so could not be identified, or, if they could, the sex was unknown so the behaviour could not be precisely determined as sexual.

It seems essential to improve current knowledge regarding the gender of the population of the bottlenose dolphins to achieve accurate analysis e.g. sex ratio. The ShoreFin project will continue to try and sex individuals to reduce the number of unknown and possible male and female individuals in the catalogue. This will allow a better understanding of the population dynamics in New Quay Bay to be obtained.

4.5. Life history stages

The ShoreFin project found that mothers and calves frequently used New Quay Bay during the season. Bottlenose dolphins are known to calve throughout the year, but predominantly from July to September (Feingold and Evans, 2014), and in a number of locations around the UK including the Shannon Estuary and Moray Firth, newborn numbers have been found to peak in August (Rogan et al., 2000): this study found that two out of the four newborns (734 and 731) were first observed and identified in August. Prey availability is considered to be a contributing factor to the timing of calf births: the changes in prey distribution affect the body conditions of the dolphins and will therefore have an impact on reproductive success (Urian et al., 1996).

The sheltered, shallow coastal waters of New Quay Bay are thought to attract mothers and calves that may seek protection from adverse environmental conditions including strong winds and low sea temperatures (Wilson et al., 1997). The presence of ten mother and calf pairs throughout the season, three of which were regular, substantiate the idea that the area is favoured as a nursery ground (Bristow and Rees, 2001). The end of the harbour wall and Penpolion were particularly favoured by mother and calf pairs, potentially because these areas were more sheltered than the rest of the bay. Penpolion was frequented more by mothers and calves, particularly by Connie (004) and Finn (673), and Jacky (376) and 657: this area is considered more sheltered than the main harbour wall as the sea state there was
often lower, and was used for foraging and teaching calves to fish. Jacky and Connie were regularly seen in association at the start of the season (April, May and June), and showed co-operative foraging behaviour on a number of occasions. Research has shown that female bottlenose dolphins invest heavily in their calves (Mann et al., 2000), as seen in the ShoreFin project.

Pierpoint et al. (2009) found evidence that an increase in boat traffic affected site usage of bottlenose dolphins. The ShoreFin project found mother and calf pairings were present in a greater percentage of early and later land watches, and less frequently during the middle of the day when boat activity was usually highest. This trend could be a result of avoidance behaviour to protect the calves (Feingold and Evans, 2014). This preference was not as dominant amongst the male/suspected male case study individuals, although they were still identified at these times. These results should be considered with caution as the number of encounters of some individuals was low.

Significantly fewer juveniles and more adults were observed than in 2014. This was not as a direct result of the maturation of individuals classified as juvenile in 2014, as none of the age classifications of individuals identified changed from juvenile to adult in 2015. However, some of last year’s juveniles may now have matured and separated from their mothers, typically after three to six years (Wells and Scott, 2002) and formed different associations that did not frequent New Quay Bay.

4.6. Behaviour

Results indicated that the dolphins in New Quay Bay exhibited a mixture of foraging, social and travelling behaviour. Foraging behaviour was observed predominantly in the form of S3 and S2 where the milling behaviour and long dives suggested they were searching for prey. The success of foraging is dependent on the environmental conditions (Whitehead and Rendell, 2004). The energetic costs of foraging are often reduced in sheltered areas such as bays due to favourable currents (Wilson et al., 1997) and this, combined with the fish aggregations caused by the shellfish factory discards and the topography of the seabed at Llanina reef, makes New Quay Bay a suitable environment for foraging activity. Both solitary feeding and co-operative feeding in groups by trapping prey at the surface (Wilson et al, 1997; Reid et al., 2003; Evans, 2008) were observed and photographed by the ShoreFin project, showing varied methods of foraging occur in the bay.
The high level of socialising behaviour was likely to have been observed as bottlenose dolphins are a highly social species (Mann et al., 2000); this was primarily observed in the form of active S6 behaviour including leaping and tail slapping, which are usually considered to be social activities. This behaviour was observed in all life history stages, with even newborns being observed leaping, and some individuals were seen playing with algae or tossing jellyfish (Figure 56). Sexual behaviour was also observed on a number of occasions particularly between 244 and Jacky (see case study 2). Observations of sexual activity also substantiate the suggestion that New Quay Bay is used as a breeding ground (Bristow and Rees, 2001) and indicate that newborns may be observed with particular individuals next year.

Travelling behaviour was observed frequently in the form of T1 and T2 as the majority of encounters began or finished with individuals traveling in or out of the bay. Individuals generally displayed other behaviours once in the bay, but some individuals just travelled through, further out in the bay. It was generally difficult to photograph these individuals as encounters were short and surfacing was less predictable, meaning individuals that were predominantly travelling were often not able to be identified. Bow-riding was seen in association with visitor passenger boats travelling in and out of the harbour and with sail boats in the bay. Travelling in this way is considered to provide an energetic advantage (Williams et al., 1992).
The results of the behavioural analysis in 2015 cannot however be directly compared to last year as the methodology used was different as behaviours were not categorised as travelling, foraging and social for analysis. It was decided that whilst some behaviours fitted clearly into these three categories, with others such as tight group or spy hopping, it was difficult to determine the purpose of these actions. In order to be able to analyse the dolphins’ use of the bay in more depth and on a temporal scale, the use of the Dolphin Watch categorisations used should be clarified for next year’s study to allow comparisons to be made, or an alternative method should be developed to allow the results to be analysed in greater depth.

The behavioural observations made from land were conducted in a non-obtrusive manner, meaning that the behaviour of the dolphins was unaffected by data collection (Pierpoint et al., 2009), resulting in a more accurate representation of the dolphin’s natural behaviours. The behaviour could, however be affected by interactions with boats in the harbour as a number of tourist operations run from the end of the harbour wall (Feingold and Evans, 2014). Boat interactions have been shown to affect dolphin behaviour by stopping feeding and displacing individuals which reduces their prey consumption, resulting in a need to spend more time travelling and foraging for prey (Pierpoint et al., 2009). Feingold and Evans (2014) found that the relative abundance of dolphins sighted is inversely related to the number of boats present. The Ceredigion Marine Code of Conduct is in place to try and prevent this type of behavioural alterations, but during Dolphin Watch surveys and ShoreFin encounters negative reactions were observed to boats including long dives and changing direction to head away from the boat.

4.7. Prey species

Photographs were taken of bottlenose dolphins feeding in New Quay Bay, providing evidence that the dolphins are using the bay as a feeding site. Bottlenose dolphins are known to be catholic feeders, consuming a variety of species, both benthic and pelagic and schooling and solitary. From dietary analysis in European bottlenose dolphins, they have been found to feed on species including haddock (Melanogrammus aeglefinus), cod (Gadus morhua), mullet (Mugilidae sp.), salmon (Salmo salar), sea trout (Salmo trutta), bass (Dicentrarchus labrax), sandeels (Hyperoplus lanceolatus or Ammodytes tobianus), as well as some cephalopod species (Reid et al., 2003; Evans, 2008; Pierpoint et al., 2009). Many of these species were identified by the ShoreFin project with the help of NRW experts, with salmon, mullet and mackerel being the most frequently photographed species, all of which were also photographed in 2014.

Unlike in 2014, feeding on gadoid sp. i.e. cod, was not photographed this year: this does not however mean that the dolphins were not feeding on these species as it is known these are a common prey species (Reid et al., 2003), just that no evidence was available to support this. It may also be that there were fewer gadoid sp. in the area this year, reducing the chances that a feeding event where they were photographed would occur. The majority of prey observations occurred in June, when the majority of the photographs of the larger fish species were taken.
Fewer photographs of fish were taken in September, and these were predominantly of smaller species such as mackerel, herring and sprat. Differences in prey selection and individual preferences are thought to contribute to the temporal variations in individual site usage (Wilson et al., 1997; Evans, 2008): certain individuals such as Nick (015) showed a particular preference for foraging and feeding behaviour.

Information regarding bottlenose dolphin diet is typically gained from examining the stomach contents of stranded bottlenose dolphins, but this data has the potential to be misrepresentative as stranded individuals are often sick or injured and therefore not feeding properly prior to death. Using photographs to determine the species being predated on has the advantage of giving ‘real-time’ examination of the dolphins’ diet in their natural environment, as well as providing data regarding the species available and the seasonal changes in availability. It was, however, challenging to photograph as some species were very small and fast moving, and there was often lots of spray obscuring the fish.

4. 8. Limitations

Land based studies are limited by the height of the platform and the field of vision (Pierpoint et al., 2009). As a result of the coastal features of New Quay Bay, the field of vision was limited, particularly by the headland, but the platforms were all raised above sea level, meaning that dolphins could sometimes be seen several kilometres in the distance. Whilst this was not of direct use to the ShoreFin project as the camera has a maximum range of up to a kilometre but was most effective within a 500m range, it allowed the Dolphin Watch surveyors to follow the movements of dolphins into the bay and alert the ShoreFin team to dolphins in the area.

ShoreFin officers were called out from the office to an observation platform when dolphins were present, but if dolphins were only close to the harbour wall for a short period of time before travelling further out, opportunities to photograph dolphins were sometimes missed or images of Grade 3 standard could not be taken. There was however still a reasonable success rate with ShoreFin being able to photograph approximately 50% of the Dolphin Watch groups sighted. Therefore, this is still considered to be the most practical way to undertake the ShoreFin project, as it should be considered that data entry and photo-ID also have to be completed, so this provides the most effective utilisation of time.

As previously mentioned, the quality of photographs taken for identification was heavily dependent on the distance from the shore. This limitation is unique to land-based studies as there is no manoeuvrability to account for the dolphin’s movements and range to ensure the best quality photographs can be taken. This is obviously a factor that cannot be controlled, but can be minimised by good utilisation of the available platforms, and has the benefit of being completely non-invasive (Würsig and Jefferson, 1990).

The number of land watches that were undertaken on a daily basis was limited by a number of factors including the weather, time of sunrise and sunset and the timetabling of the
volunteers available, meaning that 7am to 7pm land watches were not always conducted. ShoreFin did try to account for this by adjusting the data regarding the number of encounters each month for effort, which will also allow data to be compared with future years, but this is still considered to be a limiting factor. It is suggested that more consistent surveying of all land watch periods would improve the robustness of this study by potentially allowing an increasing number of encounters to occur and gaining a better understanding of the temporal changes in site usage during the day.

4.9. Recommendations

4.9.1. Data and photo-ID

The ShoreFin encounter form has been revised (Appendix 10) for 2016 in order to improve the efficiency of data collection for future years. Additional space has been added for tidal height and to allow information to be recorded regarding whether or not individuals in each of the marked groups have been photographed to assist with determining the groups the individuals identified were first seen in. Space has also been added for the GIS ID assigned to each group of individuals when they are entered into a mapping program e.g. QGIS, and it is recommended that this mapping is undertaken immediately after an encounter as part of the data entry process to allow the data to be entered in manageable amounts.

A catalogue of all the individuals identified by ShoreFin thus far has been created to improve the efficiency of photo analysis in future years. This can be built in future years to gain a better understanding of the population numbers and individuals using New Quay Bay. It is also recommended that the main CBMWC catalogue and database are kept up to date with the most recent photographs of all the individuals prior to the field season to make matching individuals photographed during the season easier.

Over the past two years the ShoreFin project has improved the understanding of the bottlenose dolphin population dynamics in New Quay Bay from April to October. If data were collected year round this would improve current knowledge of bottlenose dolphin site usage during the winter and enable comparisons between winter and summer seasons to be made. This extension of the land-based photo-identification survey to the whole year would allow individuals that are present all year round to be identified.

This year, the ShoreFin team were given access to photographs from other locations including Fishguard (Pembrokeshire). Two individuals observed in Fishguard were identified in the CBMWC catalogue and were also photographed in New Quay Bay during the season. Contributions by individuals and collaborations between organisations can help to provide additional information on dolphin migrations and improve the knowledge of population dynamics.

Further research investigating the analysis of associations between bottlenose dolphins would provide additional insight into the population dynamics. Conclusions in this report
regarding individual associations were made based on visual observation. Identifying the occurrence, number and composition of social preferences would allow an understanding of individual association preferences to be gathered providing a better understanding of the social structure (Whitehead, 1997; Lusseau et al., 2006).

Whilst ShoreFin is primarily a project focusing on photo-ID, it is difficult to study in isolation; anthropogenic and environmental factors that affect the presence or absence of dolphins in the bay should also be considered. As suggested in 2014, behavioural analysis could be run as a study in parallel with the ShoreFin project to provide a more in-depth study. Looking at behavioural changes with regards to boat interactions would be interesting, particularly looking at different individuals’ reactions and whether an increase in boats results in a decrease in dolphin numbers as suggested by Feingold and Evans (2014). Further study of prey species could be undertaken to determine which species are being eaten at certain times of year and how this relates to the dolphin activity e.g. calving and mating. Incorporating data of fish catches in the local area could help to determine the potential prey species present.

4.9.2. Public awareness
Members of the public, both local and visitors showed great interest in the presence of CBMWC ShoreFin researchers photographing dolphins on the harbour wall, as they did in 2014. They were interested in engaging with the ShoreFin officers, in understanding what they were doing and were keen to learn about photo-ID and the project. The ShoreFin project has helped to raise awareness of CBMWC through their presence on the wall as well as through the use of social media with Twitter updates including sightings of regular individuals, newborns and interesting behaviour displays. The ShoreFin project has also helped CBMWC maintain an up to date account of the dolphins featured in the Adopt a Dolphin programme through the provision of information on their presence and photographs for the newsletters sent out to adopters. Additional tools could be used to raise public awareness, for example the creation of posters explaining the ShoreFin project, presentations or training on the photo-identification method.

In the future we hope to provide the CBMWC volunteers with additional information to disseminate to interested members of the public during land surveys throughout the field season. Members of the public are particularly interested in finding out which dolphins they could potentially see in New Quay Bay; the data collected by the ShoreFin project provides us with the opportunity to extract this information to further engage the public.
5. Conclusion

In conclusion, New Quay Bay is considered an important location for bottlenose dolphins, providing an area for foraging, feeding, socialising and raising calves, rather than a migration corridor along the Welsh coastline. The ShoreFin project is considered to have achieved the aim of filling the data gap, providing vital information on individual dolphins’ site usage of New Quay Bay. It is believed that a greater number of ShoreFin encounters occurred using the shore based observation platforms than could be achieved opportunistically, if photo-identification were allowed within the harbour area during vessel surveys. Shore based platforms are not as weather dependent as vessel based platforms and therefore New Quay bay can be surveyed when the sea state or other factors mean boat surveys are not possible.

The ShoreFin project identified 19 individuals that were not identified from boat encounters, including eight new individuals, two of which were newborns, increasing the proportion of the population of Cardigan Bay that were identified this year. The data indicated that there may be a degree of separation in the group of individuals using New Quay Bay and those that are using the coastal and offshore waters of the Cardigan Bay SAC; with individuals showing different degrees of site fidelity, this has given an understanding of individuals likely to be resident to New Quay Bay.

ShoreFin has highlighted the importance of adhering to conservation measures such as the Ceredigion marine code of conduct. Whilst individuals were photographed on approximately 76% of surveyed days, only 61 different individuals were identified out of an estimated 92 dolphins present, meaning that the same dolphins were often frequenting the bay. If negative encounters with boats discourage dolphin presence then the number of individuals using the bay and consequently the number of days dolphins are seen, could significantly decline. Compliance with the code of conduct will minimise the amount of disturbance to the dolphins and help to preserve the unique opportunity the local boat businesses have for dolphin watching.

The project has also identified potential areas of study that could be useful to examine in greater depth than is possible as part of the ShoreFin project, for example detailed behavioural and prey analyses to be conducted alongside this project.

The ShoreFin project will create a long term dataset of the individuals using New Quay Bay: data collected in future years will enable temporal trends to be investigated. The continuation of this project is important to the monitoring of the bottlenose dolphins in New Quay Bay; gaining a better understanding of the Cardigan Bay population, their site usage and the spatial and temporal patterns of occurrence will enable appropriate management of the area to be undertaken.
Acknowledgements
The ShoreFin project team would like to thank the staff, seasonal and local volunteers and work experience students of Cardigan Bay Marine Wildlife Centre 2015: Charly Alexander, Matthew Allen, Rebecca Bakker, Laura Bampton, Rachel Buckley, James Clarke, Jasmine Collins, Barry Davies, Sue Davies, Lucy Dewhurst, Laura Evans, Rhian Forrest, Gary Hartley, Julie Hanks, Tim Hickish, Daisy Hunt, Emma Lowe, Linda Lee, Ffion Lloyd, Dave Martin, Sinead Martin, Michael Naylor, Rhiannon Nichol, Jessica Offord, Laura Palmer, Samantha Patek, Natasha Pickett, Sam Ryan, Leonie Schulz, Maša Švent, Sarah Torode, Danielle Thomas, Jamie Thorpe, Greg Williams, Sarah Williams, Polly Willis and Honor Wright.

We would also like to thank Steve Hartley and Dolphin Survey Boat Trips for their assistance with data collection.

Also, thank you to Lisa Morris for sending in dolphin photographs for us to identify.

ShoreFin Project Team 2015
The Wildlife Trust of South and West Wales Living Seas team would like to thank our two ShoreFin project volunteers, Anna Stevens and Manon Chautard, for their hard work and dedication throughout the 2015 field season. The ShoreFin project is managed and overseen by Sarah Perry, WTSWW Living Seas Science Officer.

Please note The Wildlife Trust of South and West Wales has not received any direct funding to carry out this project to date, we rely entirely on the support of our team of volunteers and grants to purchase vital equipment.

Support our Living Seas work
The Wildlife Trust of South and West Wales needs to raise thousands of pounds each year to continue our vital work raising awareness of and protecting Welsh wildlife. This includes raising funds to enable us to initiate and run projects such as this one.

If you would like to support our Living Seas work you can make a donation online, by post or by telephone or you can become a member. Please do not hesitate to contact us for further information.
References


Appendicies

Appendix 1: The Ceredigion Marine Code of Conduct

Ceredigion Marine Code

In general keep a good look out and keep your distance. Do not approach marine mammals, let them come to you. Headlands and reefs such as Mwnt, Aberporth, Ynys Lochtyn, New Quay and Sam Cynfelyn are very important feeding areas for dolphins and porpoises; take extra care to travel slowly and not to disturb animals in these areas. Please operate all boats with care and attention for the safety of occupants and respect for all other sea users. Do not discard litter or fishing tackle at sea.

Dolphins, Porpoises & Seals
If these creatures are encountered at sea please:
- Slow down gradually to minimum speed. Do not make sudden changes in speed or course.
- Do not steer directly towards them or approach within 100m.
- Do not attempt to touch, feed or swim with them.
- Take extra care to avoid disturbing animals with young.
- Do not approach seals resting on the shore, and do not enter sea caves during the pupping season (1st August to 31st October).
- Avoid any unnecessary noise near the animals.

Birds
- Keep out from cliffs in the breeding season, 1st March – 31st July.
- Avoid any unnecessary noise close to cliffs.
- Keep clear of groups of birds resting or feeding on the sea.

This code applies to all recreational vessels including motor boats, yachts, dinghies, personal watercraft, kayaks and canoes. Always comply with requests from the local patrol boats and be aware of speed restrictions around bathing beaches and wildlife sites.

Note that Ceredigion Harbourmasters and Launch Control Officers are authorised to withdraw launching and/or mooring permits from vessels and individuals not observing local regulations, byelaws or the Ceredigion Marine Code. Deliberate or reckless disturbance of any protected species (such as dolphins) is a criminal offence.

Ceredigion County Council Department of Environmental Services and Housing
Appendix 2: Protocol for Dolphin Watch Program

Dolphin Watch Project – CBMWC Land based data collection in New Quay bay

Data collection methodology

These surveys were primarily designed to monitor bottlenose dolphin site usage and investigate potential anthropogenic impacts on dolphins, including boating activity at each site. Training sessions were conducted by Sarah Perry (CBMWC Science officer) for all new volunteer researchers taking part in these surveys and additional support and feedback were provided in the field by more experienced observers.

The method used was to scan each area with a combination of the naked eye and low powered binoculars for 2 hour observation periods. Each 2 hour watch was divided into eight successive 15 minute intervals. Environmental information including sea state which was recorded using the Beaufort scale, visibility, general weather conditions and wind direction were recorded at the start of each 15 minute interval. A simple map of the survey area was used to record the location, size and activity of each marine mammal sighting at the beginning of each 15 minute interval or when the animal was first seen. Position estimation on the map was aided by map guidelines, including known distances to prominent coastal features and to marker buoys. Groups of animals were defined as animals in close proximity, within ten body lengths. For cetaceans the number of calves present was recorded: calves were defined as juvenile animals less than or approximately 2/3 adult length, closely accompanied by an adult. An activity code is then allocated to each group that best summarised the animals behaviour observed.

Further detailed information on methods for these surveys can be found in Pierpoint et al (2009).
Appendix 3: Encounter form used in 2015

**SHOREFIN LAND ENCOUNTER FORM**

<table>
<thead>
<tr>
<th>Name of the photographer:</th>
<th>Location</th>
<th>HW</th>
<th>H</th>
<th>Other</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Start Time</th>
<th>End Time</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Cloud Cover (0-8)</th>
<th>Sea State (0-9)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Visibility (km) (&lt;1, 1-5, &gt;5)</th>
<th>Wind direction</th>
</tr>
</thead>
</table>

**General weather**

<table>
<thead>
<tr>
<th>High Tide</th>
<th>Low Tide</th>
</tr>
</thead>
</table>

**Behaviours**

- [ ] Resting
- [ ] Milling
- [ ] Long Dives
- [ ] Travel, regular surfacing
- [ ] Travel, long dives
- [ ] Feeding (fish seen)
- [ ] Playing (w/ seaweed, jellyfish, etc.)
- [ ] Leaping
- [ ] Socializing
- [ ] Fast Travel
- [ ] Bow-riding
- [ ] Tight Group
- [ ] Tail Slap
- [ ] Spy-hopping
- [ ] Foraging/suspecting feeding

**Notes**


Total No Observed | Adults | Juvenile | Calf | New-born
--- | --- | --- | --- | ---

Total No photographed | Adults | Juvenile | Calf | New-born
--- | --- | --- | --- | ---

Number of groups

Number of individuals in each group

**Encounter Locations**

![Map of Encounter Locations]
**Appendix 4: Grading Criteria for Photographs**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the picture in focus</td>
<td>NO</td>
</tr>
<tr>
<td>Is fin height at least 1 cm</td>
<td>NO</td>
</tr>
<tr>
<td>Is entire fin in frame</td>
<td>NO</td>
</tr>
<tr>
<td>Is fin perpendicular</td>
<td>NO</td>
</tr>
<tr>
<td>Dull light</td>
<td>YES</td>
</tr>
<tr>
<td>Backlit/Silhouette</td>
<td>YES</td>
</tr>
<tr>
<td>Bright light, clear image</td>
<td>YES</td>
</tr>
</tbody>
</table>

**GRADE 1**

**GRADE 2**

**GRADE 3.1**

**GRADE 3.2**

**GRADE 3.3**
Appendix 5: Photo-identification procedure

**FIELDWORK**
- Photo-ID land-based encounter
- Fill in ShoreFin encounter form

**EXCEL DATASHEET**
- Enter encounter data into excel datasheet

**TO BE SORTED FOLDER**
- Download photos into the “to be sorted folder”
- To name the encounter folder: Date (yyymmdd)_start time on the encounter (xxxx)_Encounter number (xxx) with L for land encounter
- Delete pictures unusable for ID

**CATALOGUE AND ENCOUNTERS FOLDER**
- Rename photos
  Date (yyymmdd)_Encounter number (xxx)_Location (xxx)_Photographer (xxx)_Organisation (CBMWC)_Species(Tt)_Unique number (###)
  Ex: 150415_001_NQP_SLP_CBMWC_Tt_###
- Crop photos

**ACDSEE SOFTWARE**
- Sort photos per individuals
- Grade photos on quality

**PHOTO-ID CATALOGUE**
- Individual identification
- Double check of the fin matching
  Confirmation of the new individuals

**DATABASE**
- Update the database (recent photos of left and right profiles, number of encounters age range, sex, relationships to known individuals)
- Enter new individuals into the database
### Appendix 6: Dolphin Behaviour ethogram

<table>
<thead>
<tr>
<th>Behaviours used for ShoreFin</th>
<th>Description</th>
<th>Equivalence with Dolphin watch behaviours</th>
<th>Illustrations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Travel, long dives</strong></td>
<td>Surfacing at irregular intervals, thought to be searching for prey while on the move.</td>
<td>T2</td>
<td></td>
</tr>
<tr>
<td><strong>Travel, regular surfacing</strong></td>
<td>Regular surfacing at a fairly constant speed, in a constant direction, no associated splashes, group spacing varies, constant dive intervals</td>
<td>T1</td>
<td></td>
</tr>
<tr>
<td><strong>Fast travel</strong></td>
<td>Rapid swimming, with frequent surfacing creating splashes at a speed &gt;3 knots</td>
<td>T3</td>
<td></td>
</tr>
<tr>
<td><strong>Foraging/Suspecting feeding</strong></td>
<td>Same behaviour as feeding but no evidence of predator prey contact. (Foraging at depth – tail fluke up raised up before diving)</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td><strong>Feeding (fish seen)</strong></td>
<td>Evidence of fish seen either in dolphin’s mouth or being thrown out of the water, rapid changes of dolphin movement in pursuit of prey and predatory dives associated with flukes up.</td>
<td>S4</td>
<td></td>
</tr>
<tr>
<td><strong>Leaping</strong></td>
<td>Forward airborne leap out of the water, progressing forward whilst in the dorsal position, with a slight concave arch of the body axis</td>
<td>S6</td>
<td></td>
</tr>
<tr>
<td><strong>Tail slap</strong></td>
<td>Tail fluke raised above the surface of the water and brought down flat hitting the surface of the water, done during travel or while the dolphin is stationary.</td>
<td>S6</td>
<td></td>
</tr>
<tr>
<td><strong>Resting</strong></td>
<td>Group/individual moves very slowly in a constant direction, swimming with short, constant synchronous dive intervals, individuals often tightly grouped, dolphins may lie almost motionless at the surface for a prolonged length of time.</td>
<td>S1</td>
<td></td>
</tr>
<tr>
<td><strong>Milling</strong></td>
<td>Very slow swimming around the surface waters &lt;3 knots, no geographic movement in direction of travel, dive intervals variable but generally short, group spacing variable</td>
<td>S2</td>
<td></td>
</tr>
<tr>
<td><strong>Bow riding</strong></td>
<td>Swimming in close contact to the boat and riding in bow wave</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Socialising</td>
<td>Two or more dolphins in close/physical contact. Multiple activities seen possible mating or aggression with flukes breaking the surface of the water. Belly to belly behaviour, variable dive intervals</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Tight Group</td>
<td>Individual dolphins in group are less than one body length from other members</td>
<td>GF</td>
<td></td>
</tr>
<tr>
<td>Spy-hopping</td>
<td>Raising the head vertically out of the water high enough for the eyes to view above the surface. The head usually then sinks below without making a splash.</td>
<td>SH</td>
<td></td>
</tr>
<tr>
<td>Long Dives</td>
<td>Staying – long dives, thought to be foraging at depth</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Playing (w/seaweed, jellyfish...)</td>
<td>Playing with / tossing jellyfish, seaweed or other objects</td>
<td>S5</td>
<td></td>
</tr>
<tr>
<td>Association with birds</td>
<td>Seabirds following or feeding amongst cetaceans</td>
<td>SB</td>
<td></td>
</tr>
</tbody>
</table>
### Appendix 7: Bottlenose dolphins identified by ShoreFin 2015

<table>
<thead>
<tr>
<th>Dolphin ID number</th>
<th>Nickname</th>
<th>Number of ShoreFin encounters</th>
<th>Sex</th>
<th>Age</th>
<th>Marking category</th>
<th>First seen</th>
</tr>
</thead>
<tbody>
<tr>
<td>004</td>
<td>Connie</td>
<td>43</td>
<td>Female</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>008</td>
<td></td>
<td>3</td>
<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>014</td>
<td></td>
<td>1</td>
<td>Possible female</td>
<td>Adult</td>
<td>Slightly marked</td>
<td>2005</td>
</tr>
<tr>
<td>015</td>
<td>Nick</td>
<td>40</td>
<td>Female</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>017</td>
<td></td>
<td>1</td>
<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>022</td>
<td></td>
<td>4</td>
<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>025</td>
<td></td>
<td>3</td>
<td>Unknown</td>
<td>Adult</td>
<td>Slightly marked</td>
<td>2005</td>
</tr>
<tr>
<td>032</td>
<td>Cadfael</td>
<td>6</td>
<td>Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>036</td>
<td></td>
<td>25</td>
<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>042</td>
<td></td>
<td>1</td>
<td>Possible female</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>070</td>
<td>Ingo</td>
<td>1</td>
<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>089</td>
<td></td>
<td>1</td>
<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>103</td>
<td>Lipstick</td>
<td>10</td>
<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
</tr>
<tr>
<td>113</td>
<td></td>
<td>2</td>
<td>Unknown</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
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<tr>
<td>118</td>
<td></td>
<td>1</td>
<td>Unknown</td>
<td>Adult</td>
<td>Well marked</td>
<td>2005</td>
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<tr>
<td>136</td>
<td>Cross</td>
<td>7</td>
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<td>Adult</td>
<td>Slightly marked</td>
<td>2005</td>
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<tr>
<td>158</td>
<td></td>
<td>2</td>
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<td>Adult</td>
<td>Well marked</td>
<td>2009</td>
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<tr>
<td>177</td>
<td>Marissa</td>
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<td>Adult</td>
<td>Slightly marked</td>
<td>2005</td>
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<td>219</td>
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<td>Adult</td>
<td>Well marked</td>
<td>2006</td>
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<tr>
<td>220</td>
<td></td>
<td>23</td>
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<td>Juvenile</td>
<td>Slightly marked</td>
<td>2010</td>
</tr>
<tr>
<td>225</td>
<td></td>
<td>3</td>
<td>Female</td>
<td>Adult</td>
<td>Slightly marked</td>
<td>2006</td>
</tr>
<tr>
<td>227</td>
<td>Snowcap (aka Jack)</td>
<td>12</td>
<td>Female</td>
<td>Adult</td>
<td>Slightly marked</td>
<td>2006</td>
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<tr>
<td>238</td>
<td></td>
<td>12</td>
<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2007</td>
</tr>
<tr>
<td>244</td>
<td></td>
<td>13</td>
<td>Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2006</td>
</tr>
<tr>
<td>302</td>
<td></td>
<td>29</td>
<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2008</td>
</tr>
<tr>
<td>322</td>
<td></td>
<td>3</td>
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<td>Adult</td>
<td>Well marked</td>
<td>2007</td>
</tr>
<tr>
<td>367</td>
<td></td>
<td>1</td>
<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2011</td>
</tr>
<tr>
<td>376</td>
<td>Jacky</td>
<td>84</td>
<td>Female</td>
<td>Adult</td>
<td>Slightly marked</td>
<td>2011</td>
</tr>
<tr>
<td>381</td>
<td></td>
<td>1</td>
<td>Unknown</td>
<td>Adult</td>
<td>Right side only</td>
<td>2011</td>
</tr>
<tr>
<td>450</td>
<td></td>
<td>1</td>
<td>Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2011</td>
</tr>
<tr>
<td>504</td>
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<td>Unknown</td>
<td>Adult</td>
<td>Slightly marked</td>
<td>2012</td>
</tr>
<tr>
<td>534</td>
<td></td>
<td>4</td>
<td>Unknown</td>
<td>Adult</td>
<td>Well marked</td>
<td>2012</td>
</tr>
<tr>
<td>554</td>
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<td>Possible Male</td>
<td>Adult</td>
<td>Well marked</td>
<td>2012</td>
</tr>
<tr>
<td>ID</td>
<td>Age</td>
<td>Sex</td>
<td>Category</td>
<td>Marking</td>
<td>Year</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>----------</td>
<td>---------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>574</td>
<td>2</td>
<td>Unknown</td>
<td>Adult</td>
<td>Slightly marked</td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>657</td>
<td>74</td>
<td>Unknown</td>
<td>Calf</td>
<td>Slightly marked</td>
<td>2013</td>
<td></td>
</tr>
<tr>
<td>665</td>
<td>31</td>
<td>Female</td>
<td>Adult</td>
<td>Slightly marked</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>666</td>
<td>1</td>
<td>Unknown</td>
<td>Adult</td>
<td>Slightly marked</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>673</td>
<td>Finn &quot;Slappy&quot;</td>
<td>34</td>
<td>Unknown</td>
<td>Calf</td>
<td>Slightly marked</td>
<td>2014</td>
</tr>
<tr>
<td>676</td>
<td>30</td>
<td>Unknown</td>
<td>Calf</td>
<td>Slightly marked</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>686</td>
<td>27</td>
<td>Possible Female</td>
<td>Adult</td>
<td>Slightly marked</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>691</td>
<td>24</td>
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<td>Adult</td>
<td>Slightly marked</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>692</td>
<td>25</td>
<td>Unknown</td>
<td>Juvenile</td>
<td>Slightly marked</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>705</td>
<td>3</td>
<td>Unknown</td>
<td>Calf</td>
<td>Slightly marked</td>
<td>2015</td>
<td></td>
</tr>
<tr>
<td>707</td>
<td>Wizard</td>
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<td>2015</td>
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<td>708</td>
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<td>Possible female</td>
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<td>Well marked</td>
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</tr>
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<td>Slightly marked</td>
<td>2015</td>
<td></td>
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<tr>
<td>711</td>
<td>Snowdon</td>
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<td>Unknown</td>
<td>Newborn</td>
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<td>2015</td>
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<tr>
<td>712</td>
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<td>Possible female</td>
<td>Adult</td>
<td>Right side only</td>
<td>2015</td>
<td></td>
</tr>
<tr>
<td>713</td>
<td>3</td>
<td>Unknown</td>
<td>Calf</td>
<td>Right side only</td>
<td>2015</td>
<td></td>
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<td>715</td>
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<td>Adult</td>
<td>Slightly marked</td>
<td>2015</td>
<td></td>
</tr>
<tr>
<td>716</td>
<td>11</td>
<td>Male</td>
<td>Juvenile</td>
<td>Slightly marked</td>
<td>2014</td>
<td></td>
</tr>
<tr>
<td>717</td>
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Appendix 8: A comparison of the number of bottlenose dolphins identified from ShoreFin encounters and Boat encounters in 2015 and 2014

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Appendix 9: Presence and absence of the individuals identified by ShoreFin during each month in 2015

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Appendix 10: Revised ShoreFin encounter form

SHOREFIN LAND ENCOUNTER FORM

Name of the photographer: ____________________________

Date ____________________________ Location HW H Small Pier Other

Start Time ____________________________ End Time ____________________________

Cloud Cover (0-8) ____________________________ Sea State (0-9) ____________________________

Visibility (km) (<1, 1-5, >5) ____________________________ Wind direction ____________________________

General weather ____________________________

High Tide __________ Height __________ Low Tide __________ Height __________

Behaviours

☐ Resting       ☐ Milling       ☐ Long Dives       ☐ Travel, regular surfacing
☐ Travel, long dives       ☐ Feeding (fish seen)       ☐ Playing (w/ seaweed, jellyfish, etc.)       ☐ Leaping
☐ Socializing       ☐ Fast Travel       ☐ Bow-riding       ☐ Tight Group       ☐ Tail Slap
☐ Spy-hopping       ☐ Foraging/suspecting feeding       ☐ Sexual behaviour

Notes

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

__________________________________________________________________________________________

Total No Observed Adults Juvenile Calf New-born

Total No photographed Adults Juvenile Calf New-born

Number of groups

Group photographed: Yes (Y) or No (N)

Number of individuals in each group

GIS ID Numbers

Encounter Locations

[Map with numbered locations]