Cardigan Bay Marine Wildlife Centre
Canolfan Bywyd Gwyllt Morol Bae Ceredigion

YMDDIRIEDOLAETH natur WILDLIFE TRUST
South and West Wales
De a Gorllewin Cymru

ShoreFin 2016

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Summary

This report details the Cardigan Bay Marine Wildlife Centre's ShoreFin project, the first land-based bottlenose dolphin photo-id project in New Quay, Ceredigion. Now in the third year of study, the primary aim during this research season was to analyse the data to begin to identify any trends in the data collected. By documenting the individual animals that visit New Quay Bay, a greater understanding of individual movements of the Cardigan Bay bottlenose dolphin population can be acquired. The data collected during this project will contribute to knowledge on bottlenose dolphin spatial and temporal site usage with regards to age and sex, as well as documenting 'real-time' prey choice. Limitations to the study and recommendations are also discussed.

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The ShoreFin Project Team 2016 from the Cardigan Bay Marine Wildlife Centre compiled this report as part of the Wildlife Trust of South and West Wales' Living Seas work. The information contained within this report was correct at the time of writing, March 2017.

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1.0 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. The species occupies a range of habitats from coastal to oceanic waters (Klinowska, 1991; Reid *et al.,* 2003), although frequently favour inshore waters (Bristow & Rees, 2001). Bottlenose dolphins are the most common species of Delphinidae, the oceanic dolphin family, and occupy a range of habitats which bring them in close proximity to humans, resulting in this species being one of the most widely researched cetaceans (Bearzi, 2005; Leatherwood, 2012).

Photo-identification (Photo-id) of marine mammals is an effective method of population monitoring (Markowitz *et al*., 2003). Since its inception in the 1970s (Würsig & Würsig, 1977; Katona *et al.,* 1979), photo-id of cetaceans has developed as a reliable system for assessing population dynamics, social groups, migration, and animal life history (Mann, 2000; Markowitz *et al.,* 2003). As aquatic animals come under threat from anthropogenic alterations to their habitat, understanding these aspects of their biology is of paramount importance to allow effective management and conservation efforts (Hixon *et al.,* 2001; Evans & Hammond, 2004; Costa *et al.*, 2012). The technique is regarded as non-invasive, as it does not require direct contact and artificial marking of the animal. Satellite tags can also be used to track individual cetaceans, but in some cases have been associated with negative effects, on the behaviour and welfare of the animal, for example causing drag on the streamlined body, incurring energetic costs and reducing individual fitness (Wilson & McMahon, 2006).

The photo-id process requires photographing particular body parts that have characteristics unique to the individual, such as distinctive markings, scars, pigmentation or lesions (Hartman *et al.*, 2008). The body part varies depending on the species, for example humpback whales are often identified using the pigmentation patterns on the flukes, while dorsal fin variations are typically used in bottlenose dolphin identification (Würsig & Jefferson, 1990). Photo-id data can allow the estimation of population size via application of mark-release-recapture models (Pusineri *et al.*, 2014).

There are two main populations of bottlenose dolphins around the UK that are considered resident or semi-resident: Moray Firth, Scotland and Cardigan Bay, Wales (Evans *et al.,* 2003; Lusseau *et al.,* 2006) (Figure 1). Bottlenose dolphins in Cardigan Bay are categorised as an open population, as individuals here have also been identified further afield, for example around the coast of North Wales (Evans *et al.,* 2003; Reid *et al.,* 2003; Pesante *et al*., 2008) and around the Isle of Man (Pesante et al., 2008). Bottlenose dolphins are under protection via the EU habitats directive Annex II, and are a primary reason for the selection of the

Cardigan Bay Special Area of Conservation (Council Directive 92/43/EEC) (Bristow & Rees, 2001). New Quay Bay a known area of high bottlenose dolphin activity and population density within Cardigan Bay (Bristow & Rees, 2001) (Figure 2).

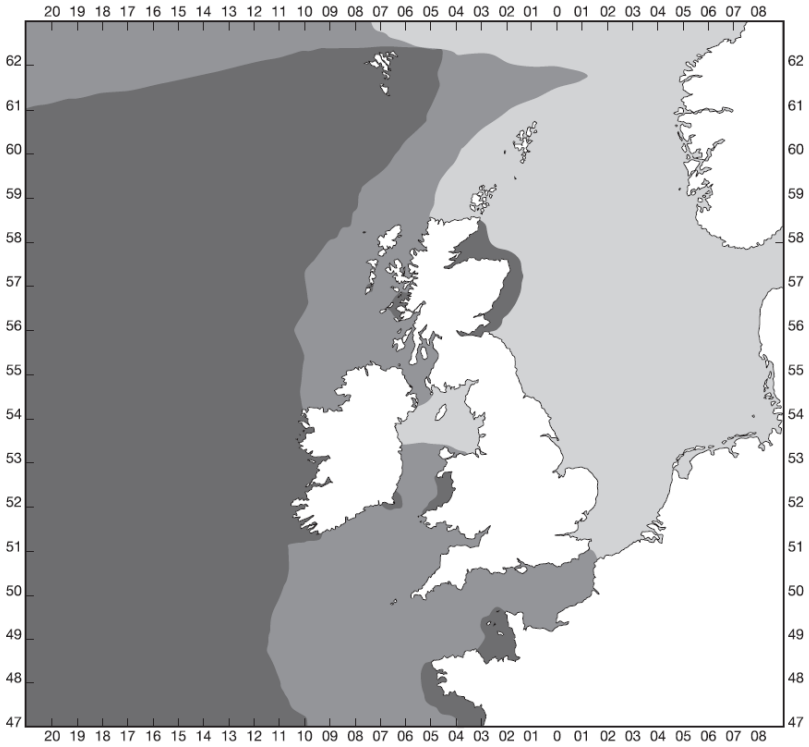

Figure 1: The distribution of bottlenose dolphins around the UK. Darker shades signify a high population density, particularly around the Moray Firth, Scotland and Cardigan Bay, Wales (Evans, 2008).

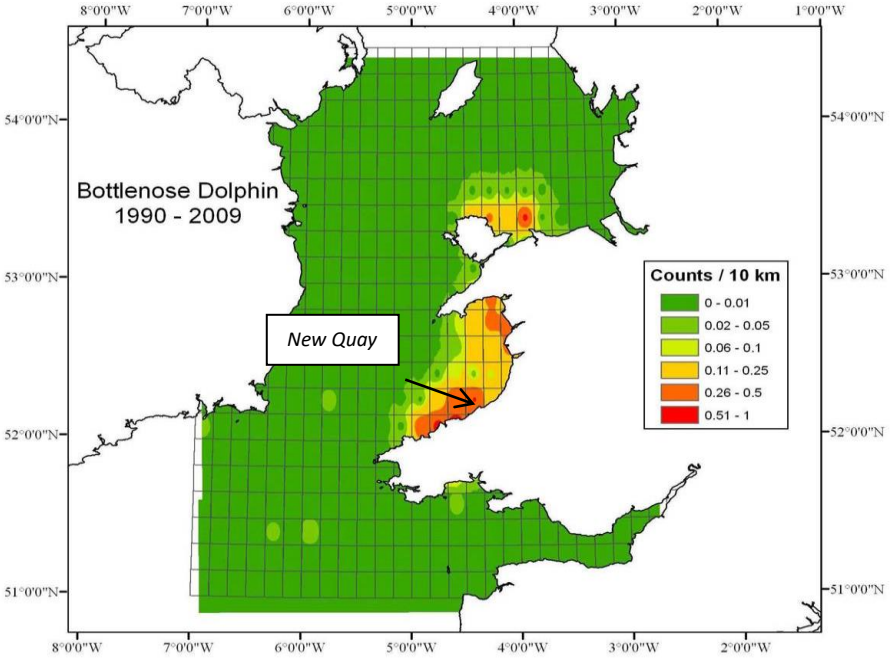

Figure 2: Bottlenose dolphin distribution in Wales, denoting a hotspot around New Quay, Wales (Baines & Evans, 2009).

The Cardigan Bay Marine Wildlife Centre (CBMWC) is a part of the Wildlife Trust of South and West Wales (WTSWW). The WTSWW Living Seas team of staff and volunteers based at CBMWC conduct visual surveys of marine wildlife from boat-based platforms throughout Cardigan Bay, and land-based platforms in the New Quay Bay area. CBMWC began a bottlenose dolphin photo-id catalogue in 2005 and over the last 11 years has developed an extensive catalogue and database of the individual dolphins photographed in Cardigan Bay. Since 2005, the majority of photography has been conducted during boat-based surveys on an opportunistic basis or through invoking a strict photo-id licence applied for (annually) and issued by Natural Resources Wales (NRW).

Due to the restrictions of the Ceredigion marine code of conduct (Appendix 1) designed to protect marine wildlife from unnecessary disturbance, 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 tourist vessels, only opportunistic photographs of dolphins could be taken in the New Quay Bay area. This meant that unless the dolphins actively came close to the boat, photographs of good enough quality for photo-id could not easily be obtained and opportunities to photograph the dolphins using New Quay Bay were 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.

Now in its third year, the ShoreFin project aimed to analyse the data collected during the 2016 field season, compare data collected during previous years and explore potential trends in the data. The project also aimed to determine if different individuals are photographed during boat-based photo-id encounters outside of the New Quay Bay area compared to land-based encounters, which individuals are using the bay, and how frequently.

2.0 Methodology

2.1 Study Site

Data collection took place at multiple locations around New Quay Bay (52° 13'N, 004° 21'W) (Figure 3). New Quay Bay is semi-enclosed with a restricted tidal flow, and generally shallow with a depth ranging from one metre to twelve metres (Gregory & Rowden, 2001). Llanina reef is found to the east of the bay (Figure 3), and provides shelter for many species of fish. Quay Fresh and Frozen Foods Ltd. is a shellfish processing factory located on New Quay headland to the west of New Quay Bay (Figure 3). The primary product processed at the factory is the common whelk (*Buccinum undatum*), and post-processing the factory is licensed to safely discard of the shell discharge into the water below (Denton, 2011).

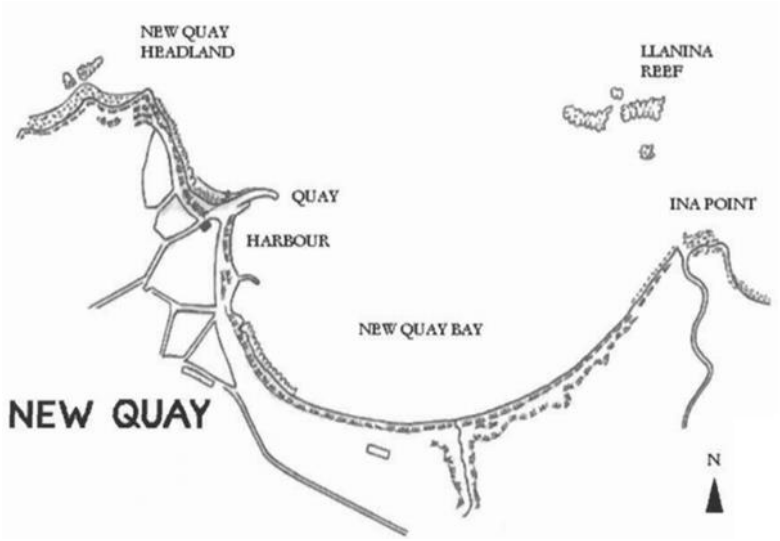

Figure 3: The study site, New Quay Bay, Wales (52° 13'N, 004° 21'W), with some key features labelled.

2.2 Fieldwork

The 2016 ShoreFin data collection began on 1st April 2016 and continued until 30th September 2016. CBMWC volunteers conducted two-hour visual marine mammal surveys from New Quay harbour wall (Figure 4), collecting data to contribute to the Ceredigion County Council's Dolphin Watch Project (Appendix 2). Daily surveys occurred between the hours of 09:00-17:00, and additional surveys took place between 07:00-09:00 and 17:00-19:00, observer availability, weather and daylight hours permitting. If a dolphin sighting occurred during the surveys, the observers would inform the ShoreFin officer via radio. An

'encounter' occurred when photographs were successfully captured by ShoreFin officers. An encounter ended either when the group of dolphins left the survey area, or when all dolphins within range were successfully photographed. Each encounter spanned from when the first picture of a dolphin was taken to when the last photo was taken. 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 head, dorsal, ventral (underneath) areas and flukes, as well as interesting behaviours observed and any potential prey items observed during foraging and feeding activity. The quality of photographs taken during ShoreFin encounters was heavily reliant on dolphin behaviour, angle of surfacing, time of day, weather conditions and animal distance from the shore.

The survey area was divided into 8 zones (Figure 4) and the ShoreFin team used three different land-based platforms to maximise the zones that could be covered: New Quay harbour wall, fish factory on the headland, and Penpolion pier.

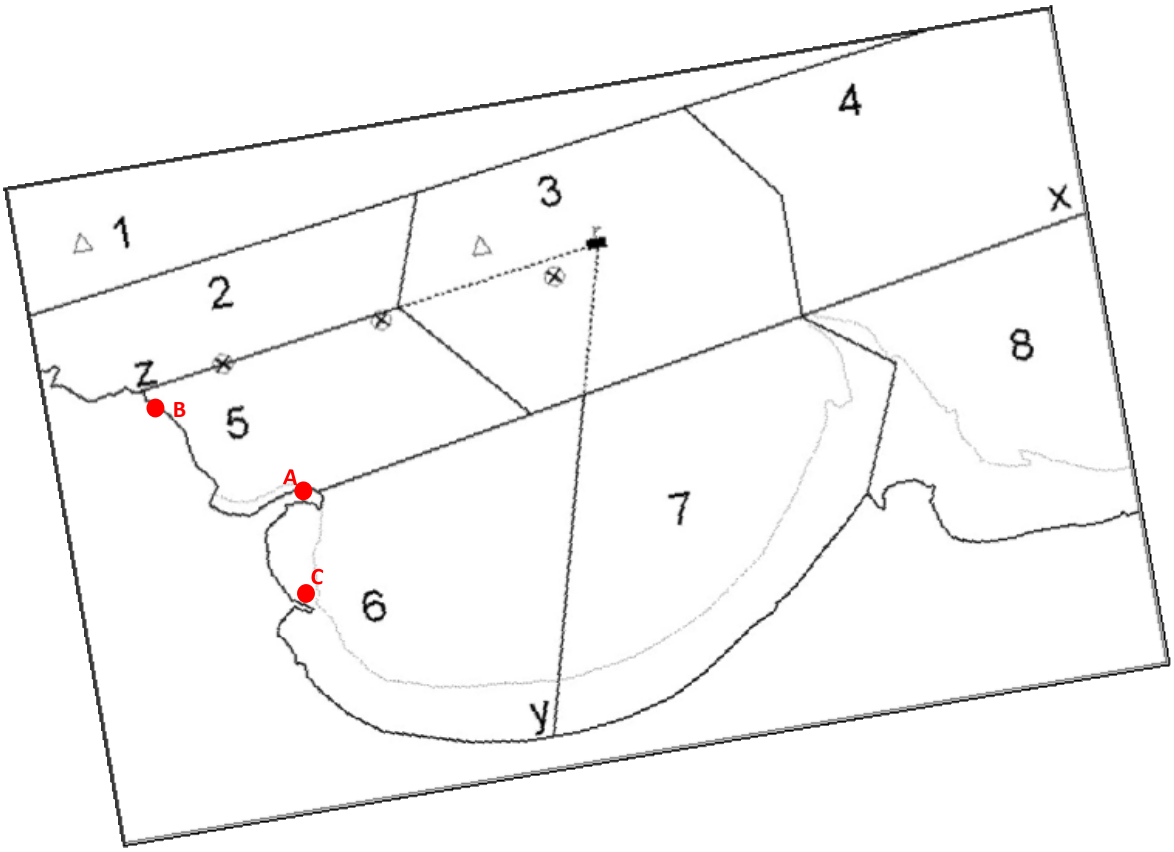

Figure 4: Survey area zones: 1. Offshore, 2. Fish factory, 3. Buoy, 4. Llanina Offshore, 5. Harbour wall, 6. Harbour, 7. Beach, 8. Llanina**. Land-based platforms:** A. Harbour wall, B. Fish Factory, C. Penpolion

Photographs were taken using a Canon 550D DSLR (Canon UK Ltd., Woodhatch, UK) (Figure 5) between 01/04/2016 and 05/05/2016, until the camera was upgraded to a Canon 70D DSLR on 06/05/2016. The camera lens was a Sigma 50-500mm lens (Sigma Imaging (UK)

Ltd., Welwyn Garden City, UK). The lens has a substantial zoom to allow photographs of dolphins at a range of almost a kilometre from the land-based vantage points around New Quay Bay to be captured.

Figure 5: Cameras & lens used for the ShoreFin project. Left image: Canon 550D DSLR and lens. Right image: Canon 70D DSLR and lens.

2.3 Data Entry

Immediately after an encounter, a ShoreFin Encounter Form was filled in to detail important information on the environmental conditions, and dolphin group size, behaviour, composition, and location (Appendix 3). All groups observed in the area were recorded even if they were not photographed. Notes regarding the dolphins' behaviour and usage of the area were written by the photographer (Appendix 4).

Only photographs taken with dolphins in the frame were kept, then renamed and cropped using ACDSee Pro 3 3.0 (ACD Systems, British Columbia, Canada). The photographs in each encounter were sorted into separate individuals that could then be identified. Attempts were made to match the individuals to those in the existing CBMWC catalogue and database from previous years or to others seen within the 2016 season. Matches made to numbered, catalogued dolphins were assigned the corresponding ID number, and, if an individual could not be matched, a new ID number was created. All IDs were checked and verified by a second person.

Individual dolphins were identified using permanent (i.e. nicks and notches in the fin profile, fin shape) and semi-permanent (i.e. tooth-rake scars and pigmentation patterns) variations in the dorsal fin (Würsig & Jefferson, 1990) (Figure 6). Each dolphin was assigned a marking category, dependent on the degree of dorsal fin markings:

- *Well Marked (WM):* Animals with nicks which are visible from either side of the fin and are also recognised from low quality photos (figure 6).
- *Slightly Marked (SM):* Animals can be identified from either side of the fin but not if photos are of lower quality.

- *Right (R):* Animals only recognisable using right side of the fin, with a smooth fin and no irregularities
- *Left (L):* Animals only recognisable using left side of the fin, with a smooth fin and no irregularities

Figure 6: An example of 'Well Marked' individual (413) from the CBMWC bottlenose dolphin catalogue: identifiable from nicks, notches and scars.

Photograph processing and analysis is summarised in Appendix 5.

2.4 Data Analysis

All data were entered, sorted and analysed using Microsoft Office Excel. Results from the ShoreFin 2014 and 2015 field season were also used to allow comparisons to be made between the findings across the years.

2.4.1. Photo-id Effort

The time spent photographing dolphins during encounters was calculated using the start and end time of the encounters. Encounter frequency per month was analysed, and adjusted for effort to standardise the data, based on the number of hours per month when ShoreFin researchers were available to take photographs.

2.4.2. Photo-id Results

The encounter data was used to calculate the number of individuals identified by the ShoreFin 2016 project, and similarity to individuals identified in previous years was calculated. The data was compared to the individuals identified from boat encounters, 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 and 2015 data.

Encounter success rate was assessed; with a successful encounter regarded as an encounter during which photo-id images were obtained from which at least one individual could be identified.

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.

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

This was 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 mean distinctiveness ratio for the whole season was calculated to estimate the total number of individuals present over the six month period. The monthly mean ratio was also calculated to estimate the number of different individuals present each month.

A 'discovery curve' was calculated using the cumulative frequency of new dolphins identified each month of the research season. The discovery data from ShoreFin 2014, 2015 and 2016 were combined to enable analysis of discovery since project initiation. Average re-encounters of individuals were calculated, and dolphins displaying high site fidelity (identified in at least 4 months) were analysed in terms of number of visitation days per month. The locations of dolphins during encounters were mapped using QGIS 2.12.0 (QGIS, 2015).

The similarity in the number and percentage of individuals identified each year was analysed as well as the number of new dolphins observed each year.

A map was created using QGIS 2.12.0 (QGIS, 2015) to show the location of all dolphin groups observed by ShoreFin in 2016 to show site usage for the year. Groups that could be photographed and those that were not were differentiated to show the extent of the range of photo-id.

2.4.3. 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 female. It has been shown that males have a higher degree of scarring, mainly through intraspecific interactions (Tolley *et al.,* 1995), so these individuals 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 photographed, a

definite distinction could be made for either sex. When processing photographs, the ShoreFin team looked carefully for any images containing the genital area, which would allow sex to be determined.

The number of individuals in each sex category was divided by the total number of dolphins identified to calculate the percentage of each sex category observed in the 2016 research season. This was compared to the percentage of each sex category photographed in 2014 and 2015, and monthly sex population dynamics were analysed.

2.4.4. Life History Categories (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, and the number of years it had been observed for. "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. 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, or identified with a calf. The percentage of the dolphins identified at each life stage over the study period (April-September) was calculated, and the number of encounters per month was analysed for all three years of study. The number of encounters per mother and calf pair were calculated and the two most frequently identified mother and calf pairs were also investigated further as case studies: Jacky (376) and calf Joey (657), and Echo (665) and calf Panda (734). 376 and 657 were selected to allow comparisons to be made with the 2014 and 2015 season, and 665 was an individual case study in 2015 and had a calf during that year. The total number of days during which these dolphins were photographed in New Quay Bay over the season was calculated. The number of encounters occurring in each land watch survey period (07:00-09:00, 09:00-11:00, 11:00-13:00, 13:00-15:00, 15:00-17:00, and 17:00-19:00) was calculated for both pairs to determine if they displayed a preference for certain times of day. The encounters they were identified in were displayed on maps created using QGIS 2.12.0 (QGIS, 2015) to obtain more information on the site usage.

2.4.5. Prey Species

Photographers attempted to capture 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.

2.5 Dolphin Case Studies

Two individuals photographed in 2016 (302 and 561) were selected as case studies for further analysis due to the frequency of their occurrence in the study area or because they exhibited interesting behaviours. Moreover, Vader (302) featured in both 2014 and 2015 ShoreFin reports, so was selected to allow comparisons to be made between the three years.

The total number of encounters during which these dolphins were photographed in New Quay Bay over the season was calculated. As with the mother and calf case studies, the number of encounters occurring in each land watch survey period was calculated for both individuals to determine if they 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.

3.0 Results

3.1 Photo-id Effort

During the ShoreFin 2016 research season, there was the opportunity for photo-id encounters during the 1950 hours of Dolphin Watch land surveys between 07:00 and 19:00. There was a marked increase in surveys undertaken outside of the core 09:00-17:00 survey hours compared to previous years, owing to increased volunteer effort (Table 1). During this time, the ShoreFin project amassed 121 hours of photographic encounter duration, a 1% increase from 2014, but a 39% decrease from 2015. There were 282 photographic encounters in 2016, an increase from previous years (8.15% increase on 2014 and a 1.41% increase on 2015) (Figure 7). Thus, there were more bottlenose dolphin encounters during 2016 than 2015, although these were of a shorter time duration. During the 183 days of the 2016 ShoreFin project, photographic encounters occurred on 123 days (67%).

Table 1: Number of land surveys conducted by Dolphin Watch volunteers in each time slot during 2014, 2015 and 2016 ShoreFin field seasons (April-September).

	07.00-09.00	09.00-11.00	11.00-13.00	13.00-15.00	15.00-17.00	17.00-19.00
2016	129	182	180	180	181	123
2015	70	181	183	181	182	48
2014	58	174	173	174	176	52

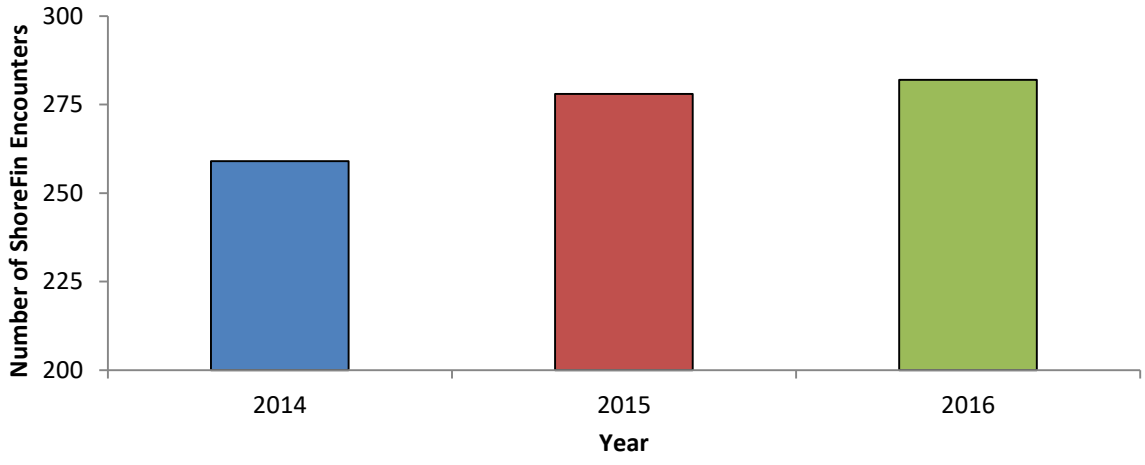

Figure 7: Total number of ShoreFin encounters in 2014, 2015 and 2016.

The majority of 2016 encounters took place in July (79), as in ShoreFin 2014 (74 in July), in 2015 the greatest number of encounters occurred in June (86) (Figure 8). All years were similar across the field season in that April was the month with the fewest bottlenose dolphin encounters.

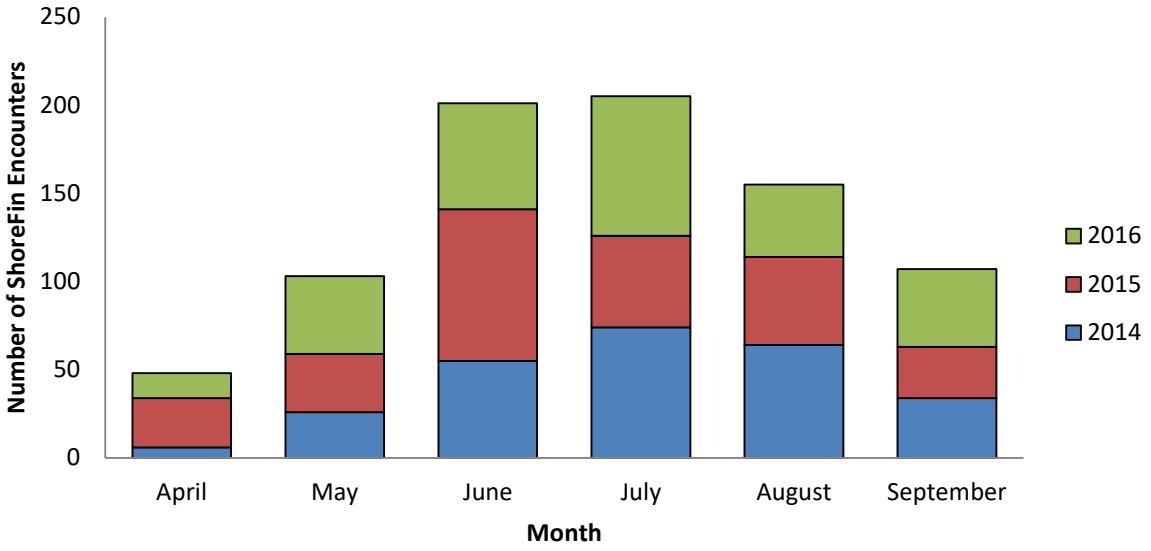

Figure 8: Total number of ShoreFin encounters per month in 2014, 2015 and 2016.

The number of encounters per hour was calculated to determine a more accurate representation of encounter distribution across the research season (Figure 9). Once adjusted for effort, April remained the month with the lowest encounter rate (0.05/hour), increasing to 0.22/hour in July. The same number of encounters occurred during May and September (44) but when adjusted for effort September had a higher rate of encounters (0.14/hour) than May (0.13/hour).

When comparing the 2015 data to the 2016 data, there were a greater number of ShoreFin encounters in May 2016 (44) than 2015 (33) (Figure 8), however once adjusted for effort (Figure 9), the encounter rate per hour difference between May 2015 and 2016 is minimal (0.006/hour). 2014 data could not be included as the effort data recorded was not comparable.

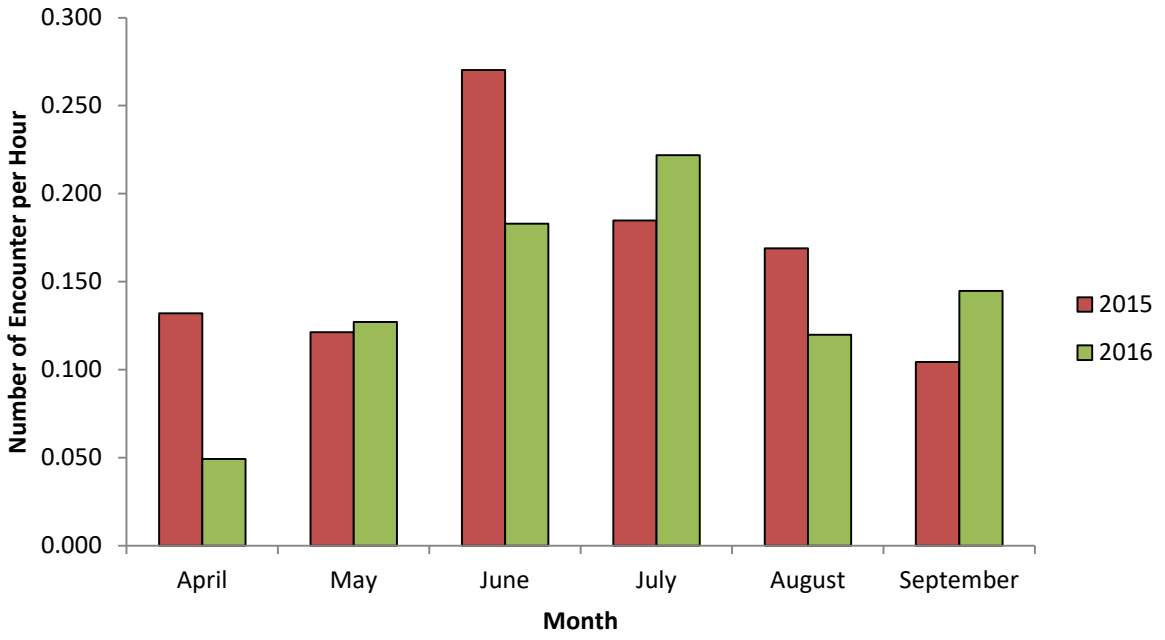

Figure 9: The number of bottlenose dolphin encounters per hour from April to September in 2015 and 2016.

3.2 Photo-id Results

The total number of dolphins identified by the ShoreFin project has increased every year from 59 in 2014 to 61 in 2015. From April to September 2016, the ShoreFin project successfully identified 74 different bottlenose dolphin individuals (Appendix 6), 22 of which were new to the CBMWC database (Appendix 7). Of these 22 individuals, 8 were categorised as well marked and a further 12 were slightly marked, one left side only and one right side only. Since the ShoreFin project began in 2014, 136 individual dolphins have been photographed and identified, 67 of which were identified via ShoreFin and had not previously been identified in the CBMWC identification catalogue (Appendix 7).

During the 2016 research season, 256 encounters contained photographs of suitable quality to allow the identification of at least one individual in that encounter. Encounter success rate is summarised in Appendix 7.

3.2.1. Population Estimate

The highest number of individual dolphins were identified in May and June (both 36), with a steady decline in August (26) and an increase in September (30) (Figure 10). The fewest number of individuals were identified in April (12) (Figure 10).

An estimate of the actual number of dolphins present in New Quay Bay during each month and the whole season can be calculated using the photo-id data and a mean distinctiveness

ratio. It was estimated that a mean number of 46 dolphins (±3.33 SE, n=6) were present in New Quay Bay each month, with a mean distinctiveness ratio of 0.67 (±0.02 SE, n=288) calculated for the field season. The distinctiveness ratio was highest in July (0.79), this was the month when the highest number of dolphins that were available in the bay to photograph, were photographed and identified.

Using the distinctiveness ratio calculations it was estimated that the greatest number of dolphins in New Quay Bay occurred during June (55). During April and September, it was estimated that there were a high number of bottlenose dolphins present in New Quay Bay that were not photographed and identified. Overall, it was estimated that 111 different dolphins were present in New Quay Bay over the research season, an increase of 20.7% from the 2015 population estimate (92).

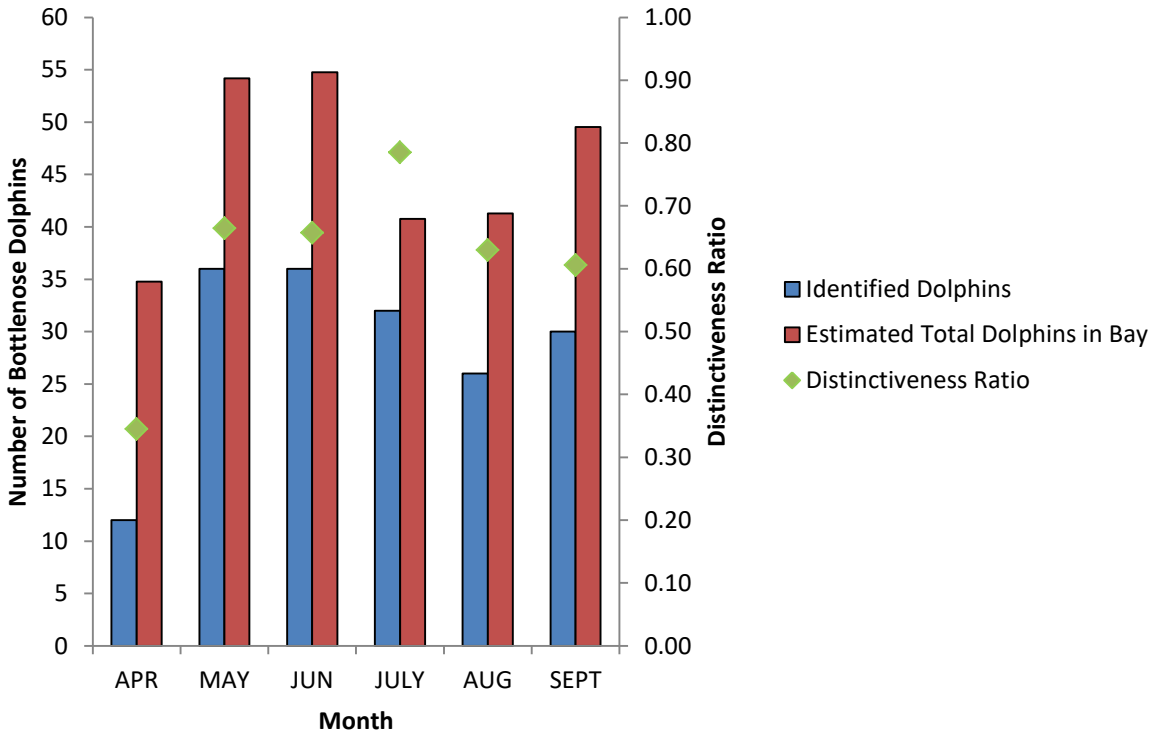

Figure 10: The number of bottlenose dolphins identified, the distinctiveness ratio and the estimated total number of dolphins in New Quay Bay each month.

3.2.2. Discovery Curve

The discovery curve shows that the number of dolphins identified in 2016 started low in April (12 individuals) but reached no plateau and by September had reached the highest cumulative number of dolphins identified of any year of ShoreFin (Figure 11). 2014 also began with a low frequency discovery of dolphins in April (16), while 2015 began with a much higher level of discovery (30), though both reached around the same number of

dolphins by the end of the research season (Figure 11). When the discovery curves across all years were combined, no plateau was reached, so additional dolphins are being discovered each year and it is likely that more individuals new to the area will be identified in the following years of ShoreFin (Figure 12).

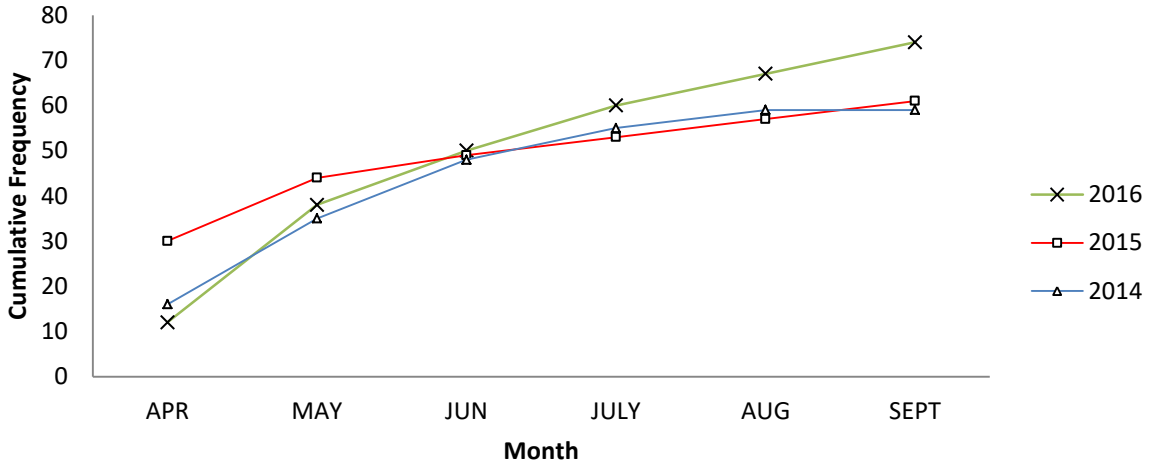

Figure 11: Cumulative number of bottlenose dolphins identified in New Quay Bay per month across the 2014, 2015 and 2016 research season (April-September).

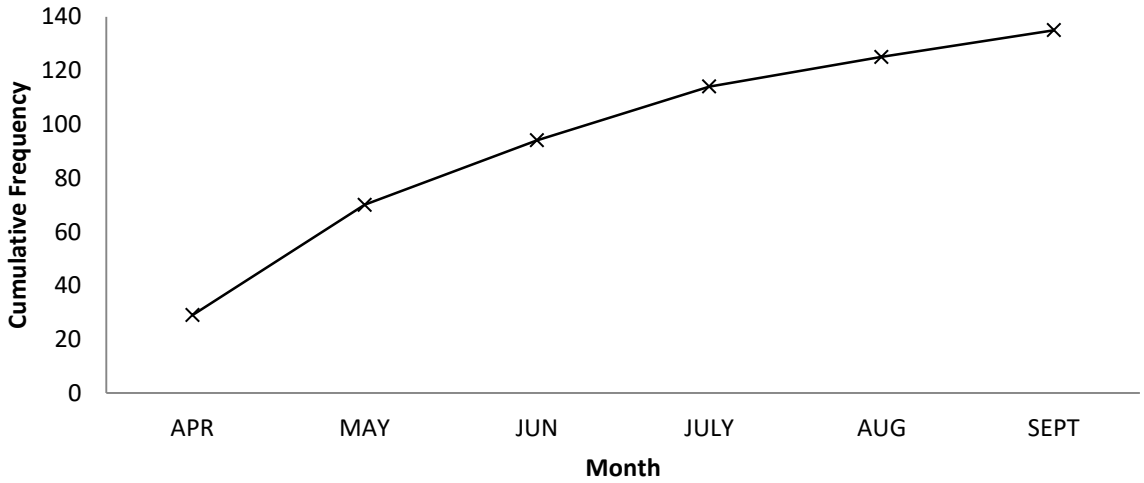

Figure 12: Combined cumulative frequency of new individuals per month 2014-2016.

Over the season re-encounters of individual dolphins averaged 7.77 (±5.74 SE, n=74), with 50 individuals being re-captured. Nineteen (26%) individuals displayed site fidelity (identified in at least four months) during the research season, the majority of which were photographed and identified most frequently during July (Figure 13). Eight additional individual dolphins were photographed and identified in at least 3 months of the field season. Just four individuals were identified during every month of the research season: dolphins Vader (302), Dylan (561), Jacky (376) and her calf Joey (657) (Appendix 8), with

Vader, Jacky and Joey also being identified in every month during 2015. These four (5%) dolphins show high site fidelity. Forty three (58%) individual dolphins were identified 3 times or less, of those 24 (32%) were photographed and identified only once.

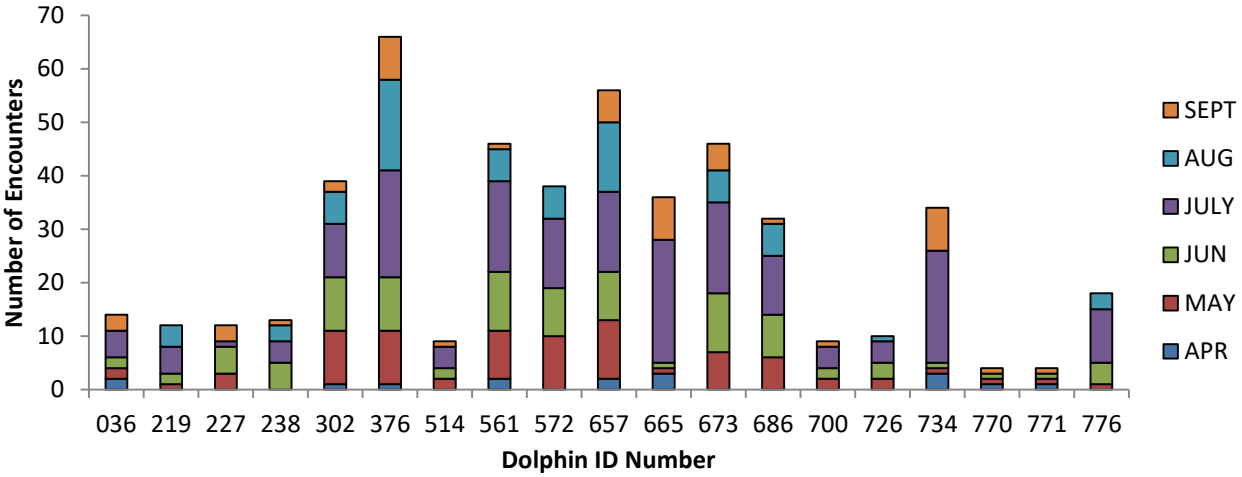

Figure 13: Number of times each individual showing high site fidelity (identified in at least 4 months) were encountered per month.

3.2.3. Similarity between years

The similarity between the individuals identified each year was summarised in Table 2. The greatest similarity in individuals was seen between 2015 and 2016 (30). Fewest similarities, both in terms of number (19) and percentage (16.67%) were found between the individuals identified in 2014 and 2016. Only 18 (13.24%) of the 136 individuals identified by ShoreFin were seen in all three years of study. New dolphins have been identified during each year of ShoreFin (Table 3), with the greatest number of new individuals in 2014 (26): numbers in 2015 and 2016 were lower but still contribute substantially to the total of 67 new individuals over the three years.

Table 2: Number (%) Similarity between individuals identified per year of ShoreFin.

Years	Number of dolphins	Percentage similarity (%)
2014 and 2015	27	29.03
2014 and 2016	19	16.67
2015 and 2016	30	28.57

Table 3: Number (%) of identified individuals new to the CBMWC database each year of ShoreFin.

Year	Number of new dolphins	Percentage of identified dolphins (%)
2014	26	44.07
2015	19	31.15
2016	22	30.14

3.2.4. Site Usage

Figure 14 displays the location of dolphin groups in New Quay Bay during ShoreFin encounters, including groups observed but not photographed during the encounters. A number of groups of dolphins over 400 metres from land were not successfully photographed, especially in zone 3. Photography was attempted for some of the more distant groups, though many were beyond the range of the ShoreFin camera equipment, thus too distant to obtain useable photographs for photo-id. The majority of groups were observed in zone 5. There were three main clusters of groups that coincided with the platforms available for photography: the harbour wall, Penpolion and the fish factory. There was also a fourth cluster around the cardinal buoy but individuals observed here were generally too far away for our equipment to capture good enough quality images for identification, with the exception of some of the well-marked individuals. During the majority of encounters photographs were taken from New Quay harbour wall (77.62%), followed by the fish factory (21.65%), and Penpolion pier (0.73%) (Figure 15).

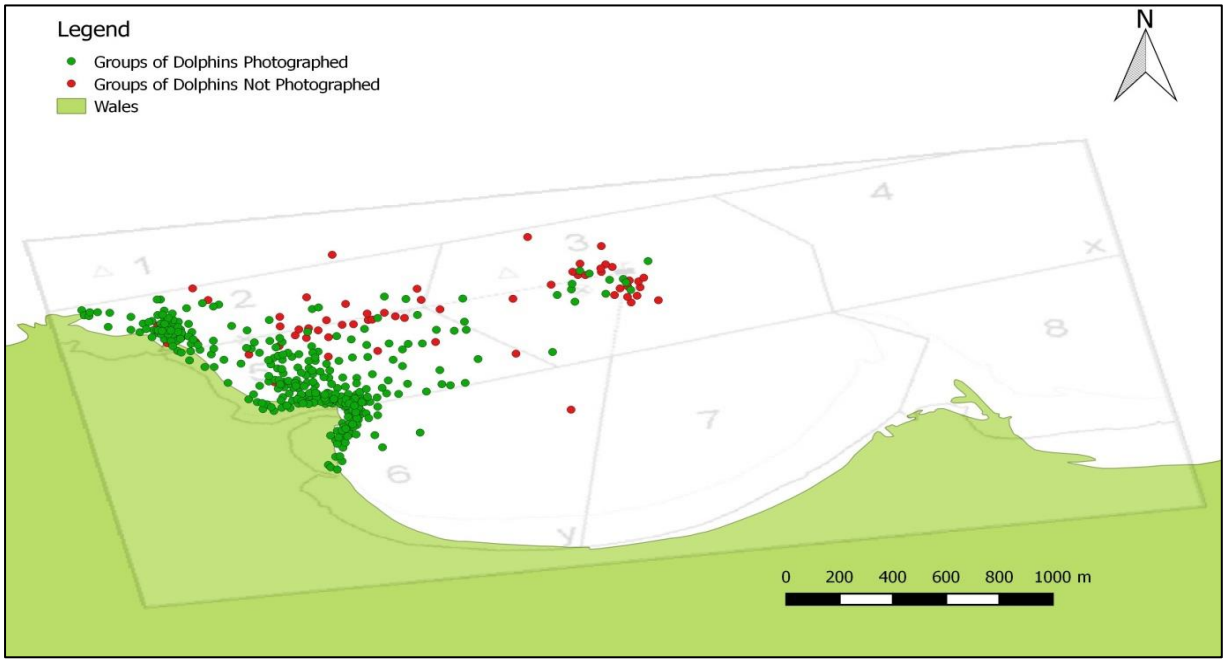

Figure 14: Distribution map of dolphins present during ShoreFin encounters, and the location of groups which were photographed and not photographed.

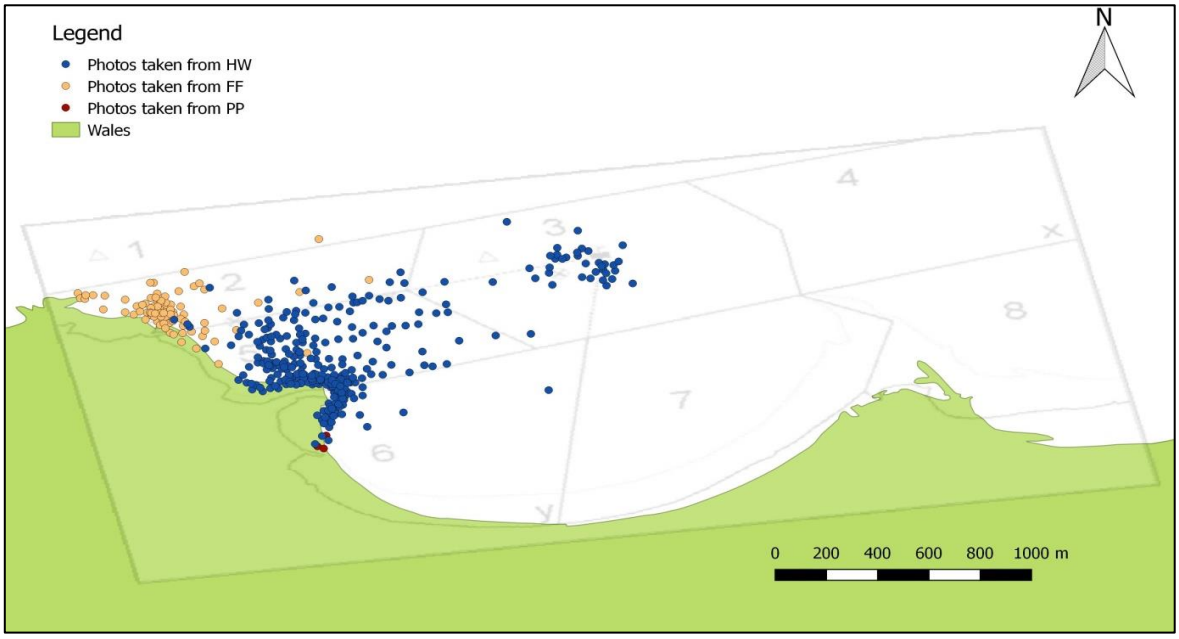

Figure 15: Location of dolphins from the three photographic platforms used by ShoreFin: New Quay harbour wall (HW), the fish factory (FF) and Penpolion pier (PP).

3.2.5. Land v Boat encounters

A higher number of individual bottlenose dolphins were identified during boat encounters (81) compared to the number of dolphins identified during ShoreFin encounters (74) (Appendix 7).

A total of 114 individual dolphins were photographed and identified during boat and ShoreFin encounters during 2016 ShoreFin field season (April to end September); 33 (29%) dolphins were unique to ShoreFin, and of these 10 were new to the photo-id catalogue. There were 40 (35%) individuals unique to boat encounters, 14 of which were new to the photo-id catalogue and 41 (36%) dolphins were identified by both ShoreFin and boat encounters. A total of 24 individual dolphins photographed and identified from both boat and ShoreFin encounters during 2016 (April to end September) were new to the CBMWC photo-id catalogue.

Over the three years of the ShoreFin project 136 dolphins have been identified, 29 of these were new individuals to the CBMWC bottlenose dolphin photo-id catalogue, 12 in 2014, 7 in 2015 and 10 in 2016, these were bottlenose dolphins that were photographed and identified by the ShoreFin project in their respective years only. Of the 29 new individuals, 26 have only ever been photographed by the ShoreFin project over the last three years (2014-2016).

3.3 Sex Categories

During the 2016 research season, eight individuals identified were male, 13 were possible males, 11 were female, eight were possible females and 34 were of unknown sex. The individuals identified as female or male represented 26% of the individuals observed during the 2016 research season, increasing on the 18% of sexed dolphins in the 2015 research season (Figure 16). The percentage of males has increased over the ShoreFin research years from 2014 (7%) to 2016 (10%), as has the percentage of females (9% to 16%). The percentage of possible males has remained the same from 2014 to 2016.

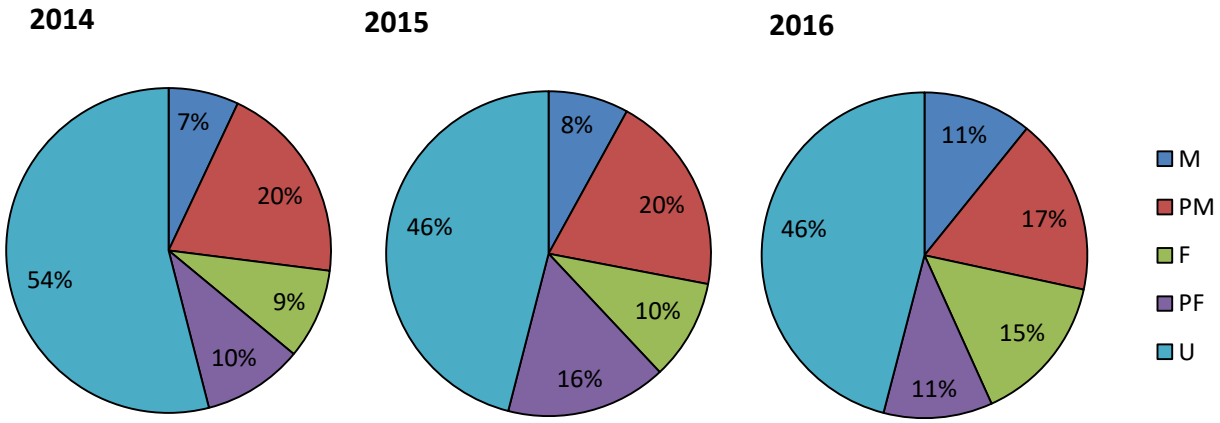

Figure 16: Percentages of the total number of individuals identified by ShoreFin that were Males (M), Possible Males (PM), Females (F), Possible Females (PF) and Unknown (U) during the season in 2014, 2015 and 2016.

The sightings of female dolphins peaked in July (49), but sightings of males peaked earlier in June (41) (Figure 17). Sightings of both sexes were lowest in April (males = 2, females = 5) and September was also low for males (2). It is interesting to note that the presence of female dolphins in New Quay Bay was significantly higher than males in September, and presence of male dolphins was only higher than females in June. There is a high percentage of unknown sex dolphins across all years.

Inclusion of possible male and female dolphins could have an impact on the proportions of the sexes. Figure 18 shows the potentially effect on the proportion of sexes if "possible" are included. In this scenario sightings of male dolphins would dramatically increase during September (20), and for all other months the inclusion of possible males would mean that there are more males than females identified in all months except September. In addition, 46% of identified dolphins were of an unknown sex (Figure 16), and the contribution of these data could further affect the population dynamics in Figure 17.

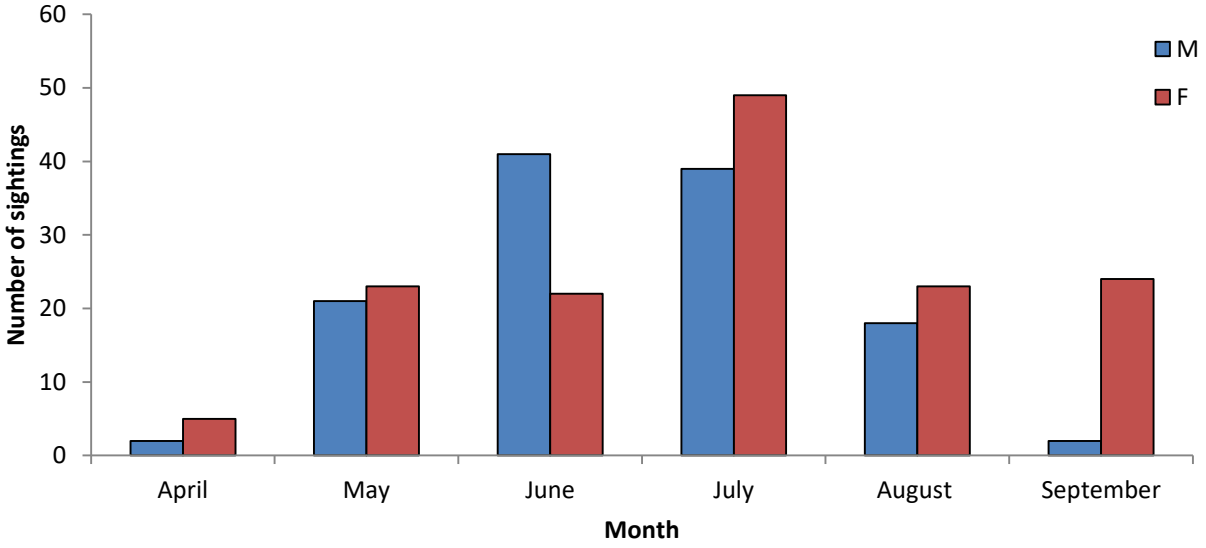

Figure 17: Sighting frequency of definite male (M) and female (F) bottlenose dolphins per month of the 2016 research season.

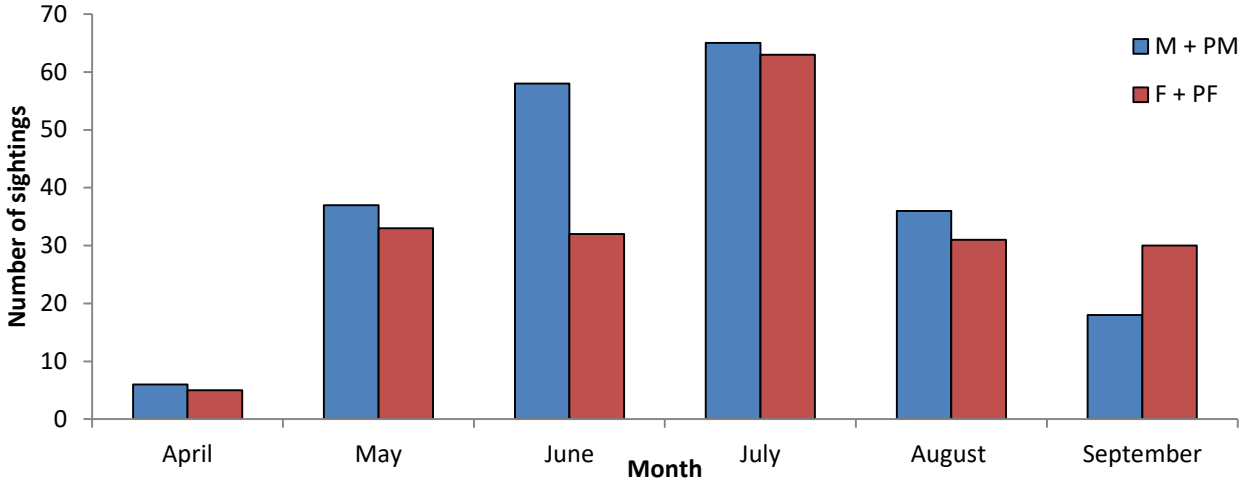

Figure 18: Sighting frequency of male (M) and female (F) bottlenose dolphins, including individuals considered possible male (PM) and possible female (PF), per month.

3.4 Life History Categories

During the study period, the majority of individuals identified were adult bottlenose dolphins, and there were more calves (10) than juveniles (4) observed (figure 19). In 2015 the proportion of each life category was very similar to 2016 (80% adult presence), though in 2014 only 56% of dolphins identified were adults, and there were three times as many juveniles as calves (Metcalfe *et al.,* 2014). During 2016, calves were present in 27% of all encounters, and a calf or juvenile was present in 48% of encounters. Abundance of adults during encounters in 2016 follows the general pattern observed during encounters

throughout the year (figure 8; figure 20) with the peak occurring in July. In 2016, despite low numbers, juveniles were observed more frequently than calves during every month except April (figure 20), with a peak in July (32). Peak calf sightings also occurred in July (25), with another smaller peak during September (12).

During 2014 and 2015, calves were observed with a higher frequency than juveniles were in every month, with a peak in August 2014 and a peak in June 2015 (Metcalfe *et al.,* 2014; Stevens *et al.,* 2015). It should also be noted that no newborn dolphins were photographed and identified in New Quay Bay by the ShoreFin project in 2016, compared to previous years, one in 2014 and four in 2015.

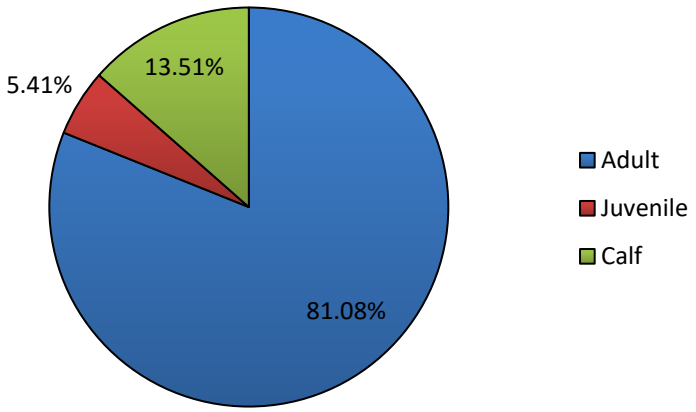

Figure 19: Percentage of each life history category in the 74 dolphins identified by the ShoreFin project 2016.

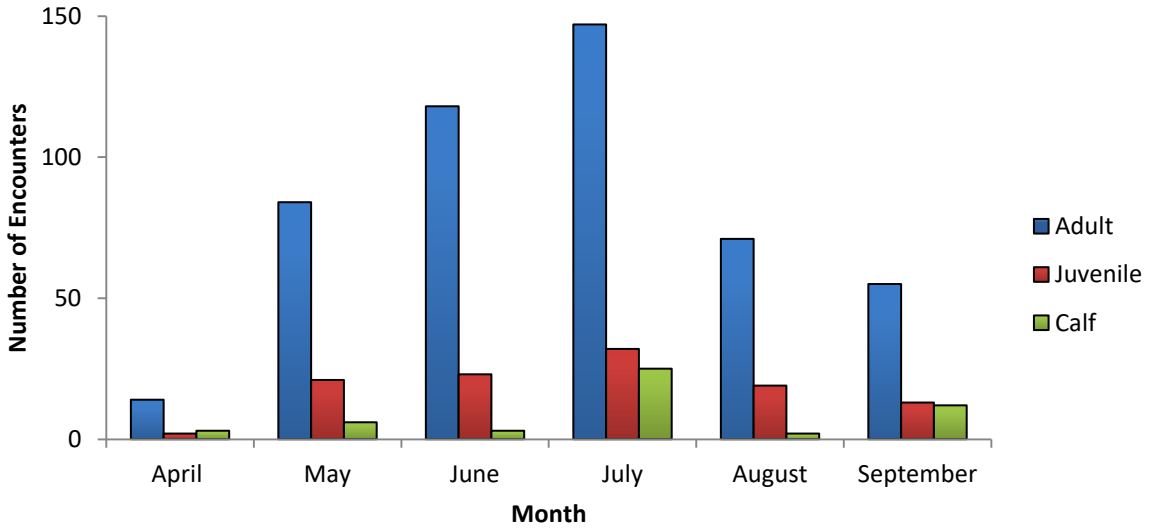

Figure 20: Encounters with each life category identified per month of the research season in 2016.

A total of 13 mother and calf pairs were photographed and identified in 2016 (Table 4), with seven of these also identified in 2015. Jacky (376) and Joey (657) were regularly observed in all three years. Five new mother and calf pairings were photographed in 2016, although all of these are regarded as possible, rather than definite mother and calf pairings due to a low number of re-captures (Table 4). The remaining pairs were first observed together during 2015, with the exception of Jacky (376) and Joey (657) (first identified together in 2013), Joey is now considered a juvenile. Of the 13 mothers identified in 2016, four are known to have had at least one other calf in previous years.

Table 4: Mother and Calf Pairs Identified During 2016 ShoreFin*.

Mother and Calf Pairings (previous calf number and year first identified)	**Total Number of Encounters**	**First Year Calf Observed**
014 + 706 (258 in 2009)	1	2015
136 + 341** (013 in 2009 & 659 in 2013)	1	2016
225 + 705 (353 in 2008)	2	2015
227 (Snowcap) + 711 (Snowdon)	7	2015
272 + 590 **	2	2016
279 + 598**	1	2016
376 (Jacky) + 657 (Joey)	48	2013
177 (Marissa) + 700 (181 in 2005 & 535 in 2012)	8	2015
665 (Echo) + 734 (Panda)	34	2015
708 + 731	6	2015
756 + 757**	1	2016
767 + 768**	1	2016
770 + 771	3	2015

*Note that juvenile Finn (673) was not included in the mother and calf pairs as its mother Connie (004) was not observed this year.

**Note these are possible mother and calf pairings

Presence of mother and calf pairs peaked between 07:00 and 09:00, and decreased through the day with the lowest presence during the 17:00-19:00 Dolphin Watch surveys (Figure 21).

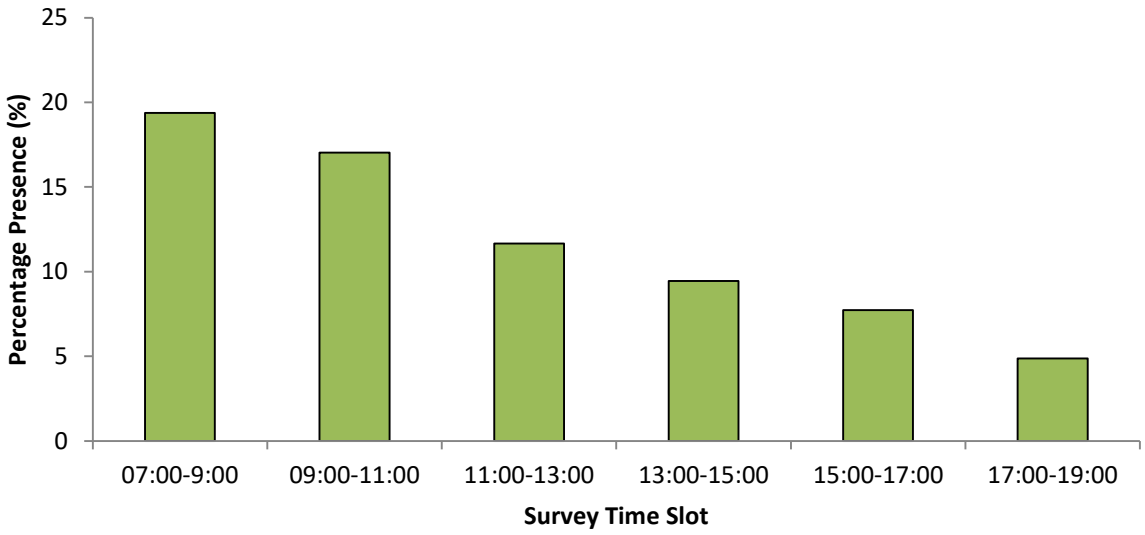

Figure 21: Percentage presence of mother and calf pairs during each Dolphin Watch survey time period.

Case Study 1: Jacky (376) and Joey (657)

Jacky (376) was first photographed and identified in 2011 and has been photographed in New Quay Bay every year since. Jacky is the mother of Joey (657) (Figure 22), who was photographed as a newborn for the first time in 2013 (Figure 23). This mother and calf pairing were the most frequently photographed dolphins in the 2014, 2015 and 2016 research seasons, and were identified in every month (April to September) for all three years.

Figure 22: Left and right profiles of Jacky (376) and Joey (657). Joey is the left-hand side of the left photo, and the right-hand side of the right photo.

Figure 23: Joey (657) photographed in 2013 as a newborn calf with Jacky (376).

In 2014 and 2015, Jacky and Joey were observed together in all 6 months of the research season (Figure 24) and a similar number of days (53 in 2014 and 58 in 2015). In 2016, the pair were photographed and identified together on 34 days and only one of the pair was photographed and identified on 22 days over the field season. In the 2014 season, the greatest number of days in which Jacky and Joey were photographed was July (14 days), in 2015 it was August (15 days) and in 2016 it was an equal number of days in June and July (8 days).

During 2016, Jacky and Joey were occasionally photographed and identified more than once in a single day. In five of the survey days, they were photographed and identified in two different encounters on the same day; on a further five days they were photographed and identified in three different encounters on the same day suggesting that Jacky and Joey use New Quay Bay for extended periods of time. As they are not very well marked, it is likely that they were present on other occasions but were not photographed or were unable to be identified from photographs captured.

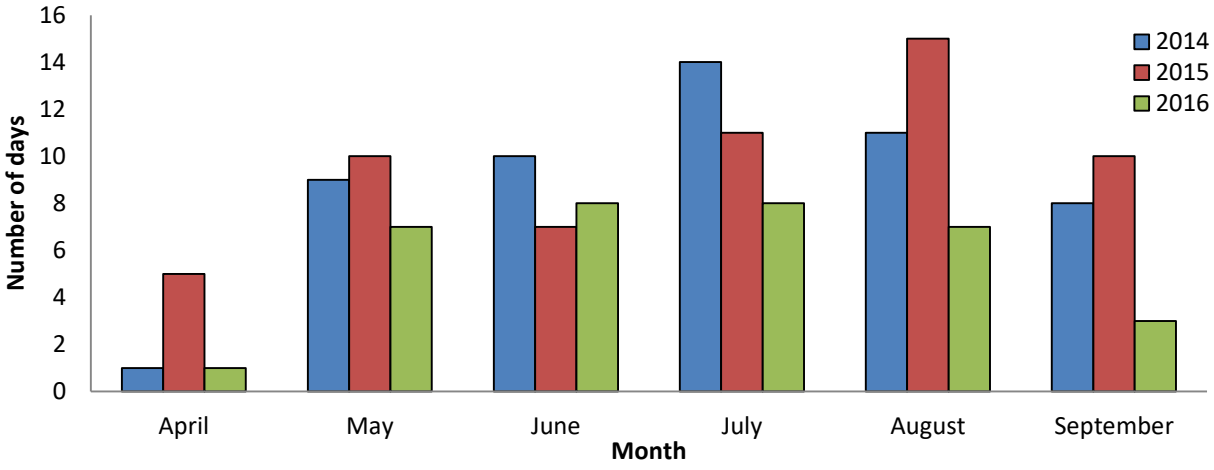

Figure 24: The number of days Jacky (376) and Joey (657) were identified during each month of the research seasons in 2014, 2015 and 2016.

In all project years (2014-2016), the sightings for Jacky and Joey show a similar trend (Figure 25), they were photographed and identified the greatest number of times during the 09:00-11:00 land surveys. They were photographed least often between 17:00-19:00 in 2014 and 2015 and between 15:00-17:00 in 2016.

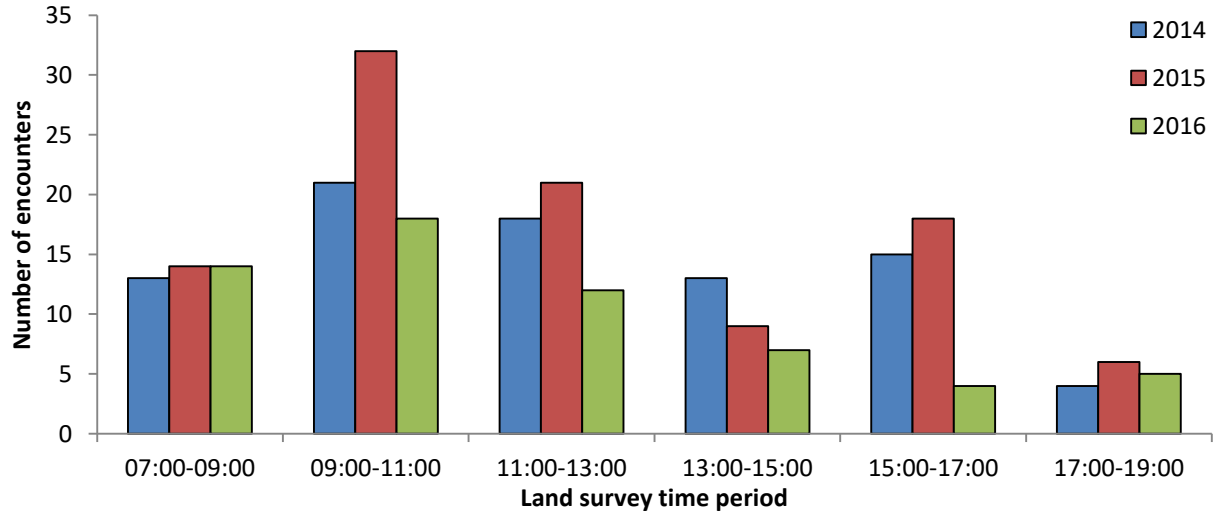

Figure 25: The number of each two-hour land survey when Jacky (376) and Joey (657) were photographed and identified.

In 2015, Joey was only observed spending time away from its mother Jacky on a few occasions, foraging independently and at a distance from its mother: in 2016, there were 17 encounters in which Jacky was photographed without Joey and during 10 of these encounters Jacky was the only dolphin observed in the survey area. However, during six of these encounters there were other dolphins observed in the survey area that could not be photographed or identified, thus it is possible that both dolphins were present.

During the 2016 research season, there were also eight encounters in which Joey was photographed and identified and Jacky was not, suggesting that if Jacky was also in the survey area they were not in close proximity to each other. Joey has been identified in the same group as 572, a young adult male and Finn (673), a juvenile known to the CBMWC photo-id catalogue as the three-year-old offspring of Connie (004) on multiple occasions. It is known that 'juvenile pods' form between young dolphins, where they still interact with adults, but form associations with dolphins of a similar age (Gero *et al.,* 2005).

During one of the encounters in which Jacky was not present, Echo (665) and her one-year-old calf Panda (734) were present in the group. Research has shown that juveniles usually separate from their mothers between 3-6 years of age (Wells & Scott, 2002) therefore, it is likely that Joey is becoming independent of its mother, accounting for the lower number of sightings of the pair (Figure 38) than in the previous two years. Future photo-id effort in New Quay Bay will provide information on future associations.

Jacky and Joey were frequently photographed in zone 5 (Figure 26) and in zone 6, between New Quay harbour wall and the Penpolion pier. Despite being not being very well marked, it was possible to identify Jacky and Joey from photographs taken of them from a greater distance than usual this included photographs captured close to the cardinal marker. Good light conditions enabled the ShoreFin project team to capture photographs which highlighted the markings of these individuals' dorsal fins. In addition, the regular presence of the pair meant that there is a larger bank of photographs that can be used to assist matching. The pair were also photographed close to the headland in the northwest of zone 2 (Figure 26). Jacky and Joey frequently displayed foraging behaviour in New Quay Bay and it is therefore likely that they use the area as feeding grounds.

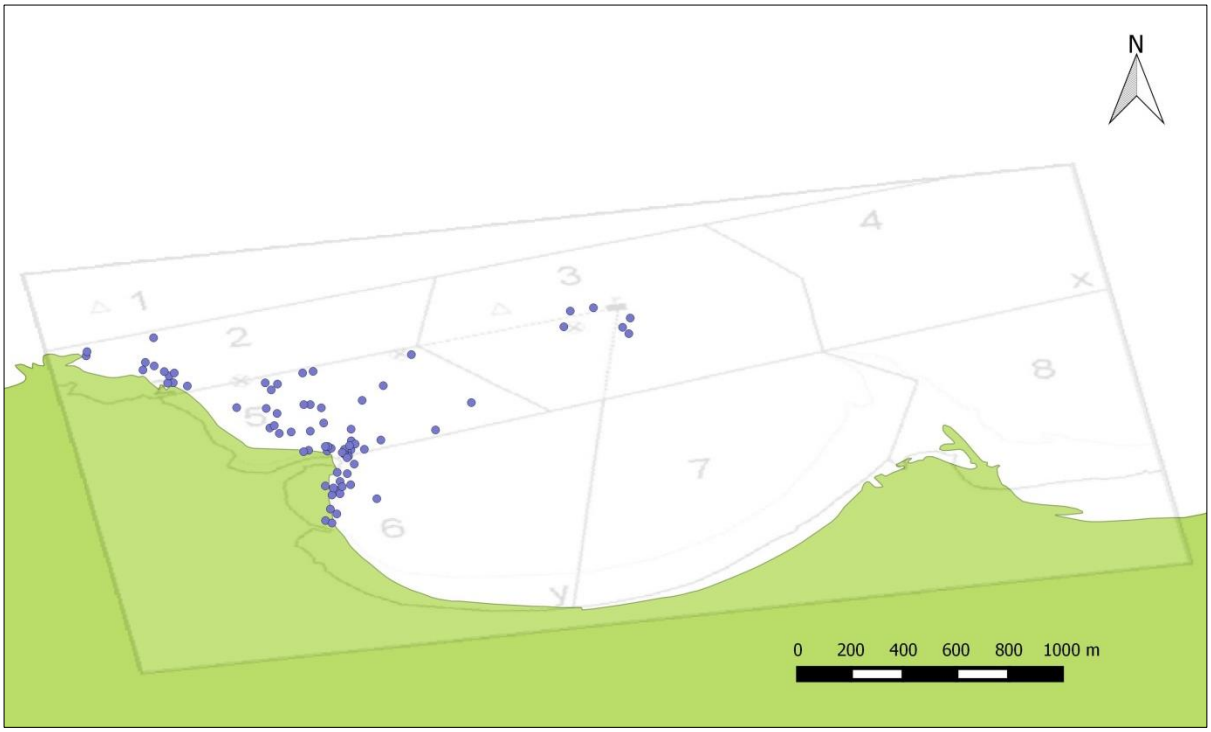

Figure 26: A map of the distribution of ShoreFin Photo-id encounters in which Jacky (376) and Joey (657) were identified together.

Case Study 2: Echo (665) and Panda (734)

Echo was first photographed during the pilot year of the ShoreFin study in 2014 (Figure 27), her calf Panda was photographed as a newborn during August of the 2015 ShoreFin season. The pair were photographed during the first ShoreFin encounter of 2016 and returned to New Quay Bay frequently over the research season. The identifying features for Echo include a large area of scarring on the top of the dorsal fin and along the leading edge of the fin. Panda is harder to identify using the fin as there are only a few dark of scars on the top of the left hand side dorsal fin with a small black scar on the right hand side: the most predominant feature used to identify the calf is a large F-shaped scar on the right hand side of the animal's flank (Figure 28).

Figure 27: Left and right profiles of Echo (665) and Panda (734).

Figure 28: F-shaped scar on right flank of 734.

Echo and Panda were photographed together on 19 days during 2016 (Figure 29). In 2015, Panda was first observed with Echo as a newborn in August when they were photographed on three days. Prior to this, Echo had been identified on a further 22 days between from

April and July, and was also photographed three times in 2014, the first year she was identified.

The peak sightings occurred in July in 2015 and 2016; in 2016 the pair were identified on 10 days, multiple encounters were recorded on some of these days as 21 encounters occurred in total for this month. The pair were not photographed during August 2016 (Figure 29), but were photographed in September. The increase in sightings over the last two years may be due to the birth of Panda and Echo may be using New Quay Bay as a nursery area. Studies have shown that shallower areas with much gentle environmental conditions do provide relief for smaller dolphins, therefore benefitting individuals with calves (Weir *et al.,* 2008).

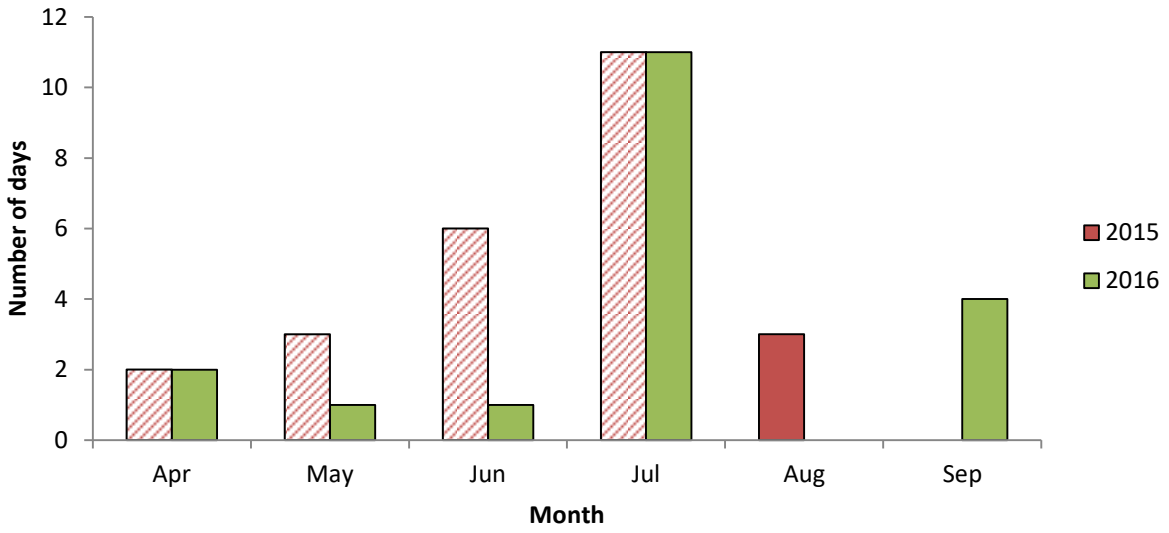

Figure 29: Comparisons of the number days per month in 2015/2016. Shaded bars indicate data prior to the photographing of newborn Panda (734).

When looking at times of encounters (Figure 30), little difference can be seen between each survey time in 2016, with the maximum being nine encounters during the 13:00-15:00 watches and the minimum of three during the 17:00-19:00 watches. In 2015, there was a noticeable difference in occurrence with the encounters tending to be earlier in the day, most often from 09:00-11:00 (Figure 46). When looking at the encounters per day the data shows that in July the pair were photographed multiple times per day over a number of days throughout the month, in other months they were only encountered once per day.

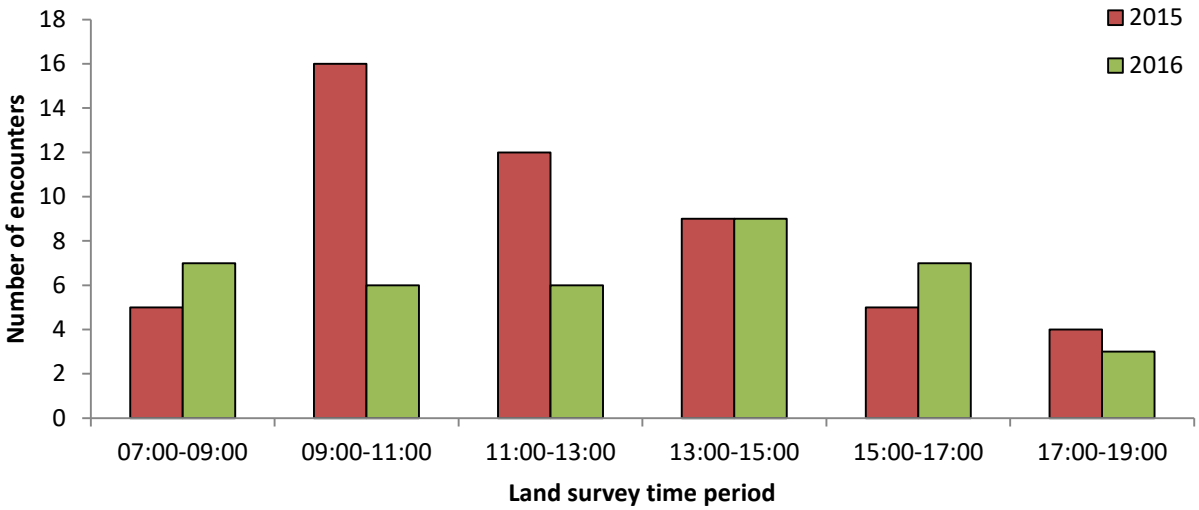

Figure 30: The number of encounters Echo (655) and Panda (734) were identified in per land watch survey period during 2015 and 2016. 2015 data also includes ecnounters where only Echo was present prior to the observations of a calf.

Panda displayed several interesting behaviours over the 2016 season, including interacting with seaweed (Figure 33). This type of behaviour has been observed in many mammals, it allows young individuals to experience new behaviours and practice skills that will become critical to their survival in adulthood (Loizos, 1967, Janik 2015). It has also been suggested to help with other stimuli such as stress (Spinka *et al.,* 2001), help with long term social attachments in certain species (Pellis & Pellis, 1987) and the development of foraging in various species (Janik, 2015).

Figure 31: Panda (734) playing with seaweed.

Echo and Panda were typically seen in zones 5 and 6, very close to the harbour wall where they displayed behaviours such as leaping and foraging (Figure 32). This corresponds with the data for 2015 when Echo was predominantly observed by the harbour wall and the fish factory.

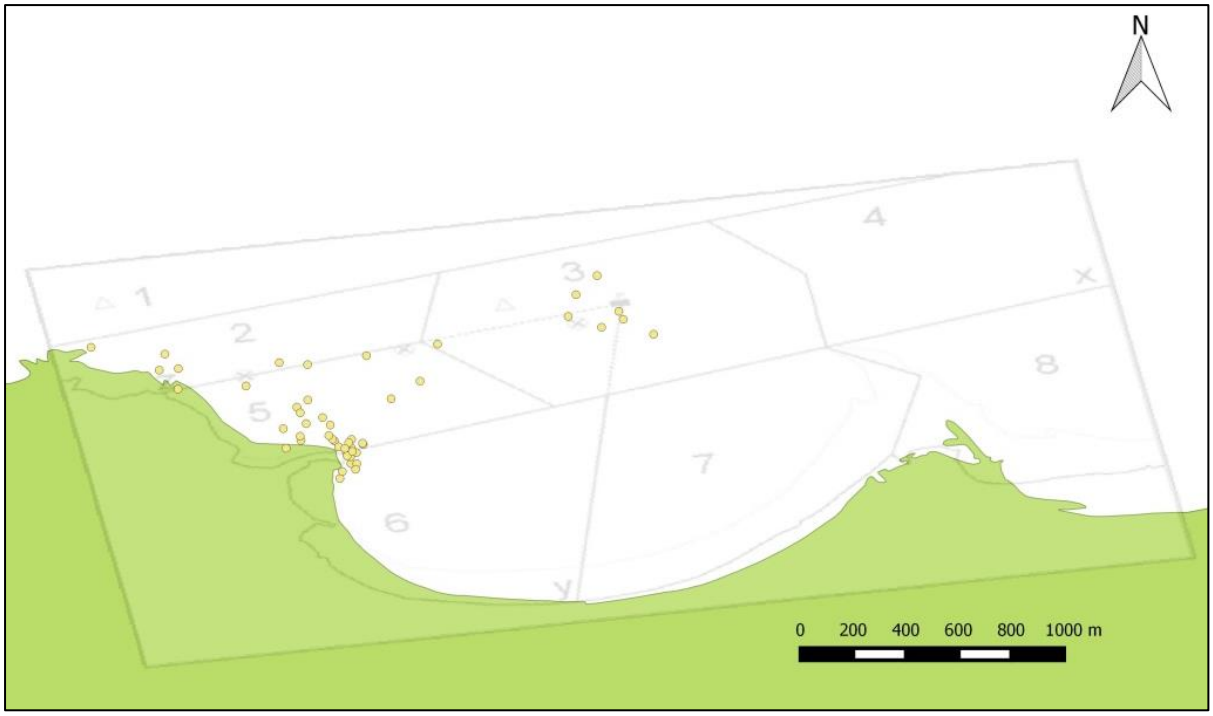

Figure 32: A map of the distribution of ShoreFin Photo-id encounters in which Echo (665) and Panda (734) were identified.

3.5 Prey Species

Figure 33: Prey species A- Salmon; B- Herring (possibly); C- Garfish; D- Garfish; E-Mullet; F- Tope; G- Bass; H-Salmon. Photos A-E, G-H ©CBMWC, Image F © Nigel Barlow

During the 2016 research season, dolphins were photographed feeding on salmon (*Salmo salar*), mullet (*Muligidae* sp.), garfish (*Belone belone*), sea trout (*Salmo trutta*), bass (*Morone* sp.) and herring (*Clupea harengus*) (Figure 33). On the 12th August a member of the public (Nigel Barlow) photographed a tope (*Galeorhinus galeus*) being chased by a bottlenose dolphin (Figure 22, F) in New Quay Bay. It is not known whether the dolphin was attempting to feed, or if it was an aggressive interaction, similar to those previously observed by researchers from CBMWC between bottlenose dolphins and harbour porpoises (known as porpicide). To our knowledge such a shark-dolphin encounter has not previously been documented in Cardigan Bay. The dolphin involved in this encounter (Vader/302) has been analysed as a case study in the following section of this report.

3.6 Dolphin Case Studies

Case Study 1: Vader (302)

CBMWC CATALOGUE NAME: 302-08W4

Nickname: Vader

Gender: Possible male

Number of ShoreFin encounters in 2016: 39

Number of ShoreFin encounters in 2015: 30

Number of ShoreFin encounters in 2014: 20

Figure 34: Left and right profile of Vader (302).

Individual 302 (Figure 34), nicknamed Vader, was first identified in 2008, and is one of the most distinctive dolphins in the CBMWC photo-id catalogue with prominent nicks down the trailing edge of the dorsal fin and white pigmentation on the tip of the fin, possibly due to scarring and abrasions from interactions with other dolphins. The heavy scarring pattern and the absence of a calf for more than six years have led to this individual being categorised as a possible male.

Vader was one of the most regularly sighted individuals of 2016 ShoreFin project, being identified in all months of study (Figure 35) in a total of 39 encounters, equating to 7.23% of the total encounters for that year. In 2016, there was an increase of 23% in the number of sightings of Vader from 2015 and a 48% increase compared to 2014. The first sighting occurred at the end of April, then sightings increased in the subsequent months May, June and July, all with ten sightings (Figure 36). This trend does not follow the previous year exactly but does show some similarity where the peak occurrence was in June. When 302 was sighted it was typically identified only once during that day with only the occasional multiple encounters on a single day.

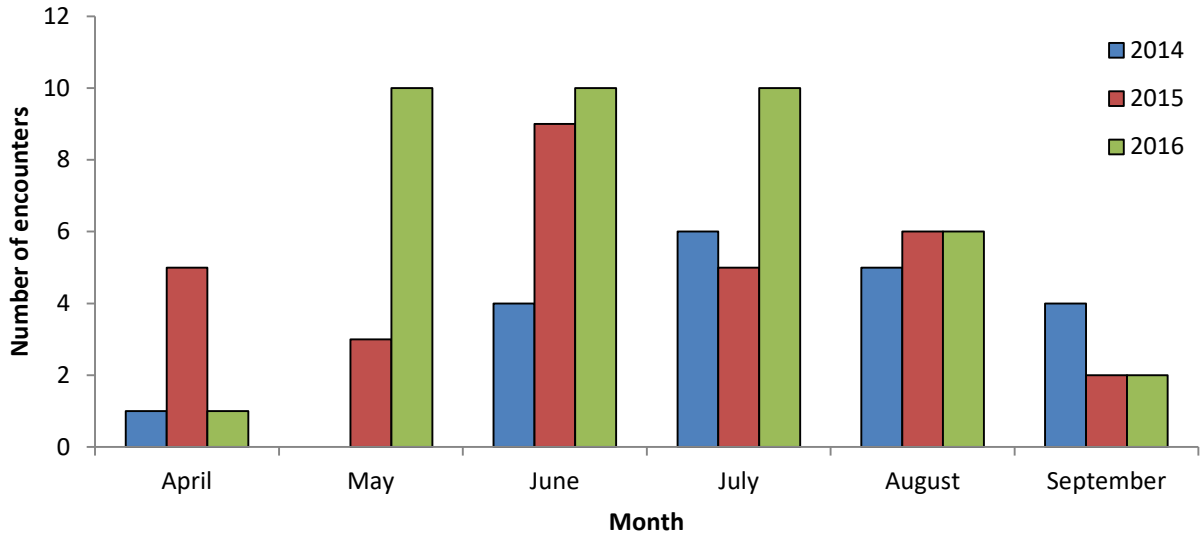

Figure 35: Total number of encounters Vader (302) was identified in each month in 2014, 2015 and 2016.

When looking at times of encounters (Figure 36), in 2016 302 was photographed more frequently during the 07:00-09:00 survey period (11), accounting for 28% of the encounters it was photographed in. In 2015, the numbers of encounters during these periods were much lower (4) and were highest from 09:00-11:00 (9). In 2015 the lowest number of encounters occurred during the 17:00-19:00 survey period and in 2016 the lowest number were during the 13:00-15:00 survey period.

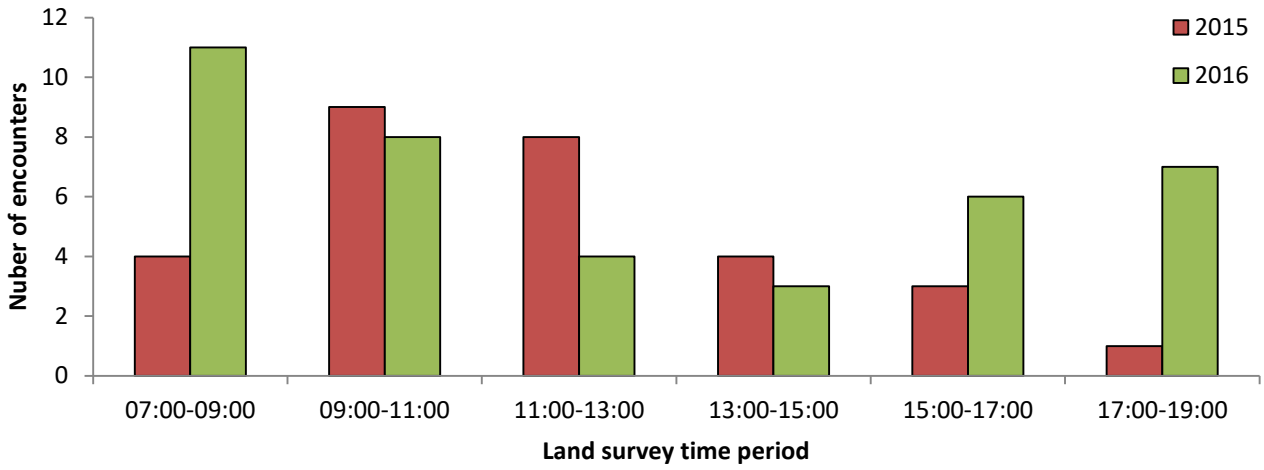

Figure 36: The number of encounters Vader (302) was identified in per land watch survey period during 2015 and 2016.

Encounters with Vader predominantly occurred in zones 2 and 5 (Figure 37), due to the distinctiveness for the dorsal fin the ShoreFin project were able to photograph and identify this individual from photographs captured at greater distances from the observation platform. Vader was relatively solitary when in New Quay Bay during the 2016 research season, being the only dolphin observed in 14 encounters, and was photographed a further six times in encounters where other individuals were present in the harbour but in a separate group. This matched the trends observed in the 2015 data.

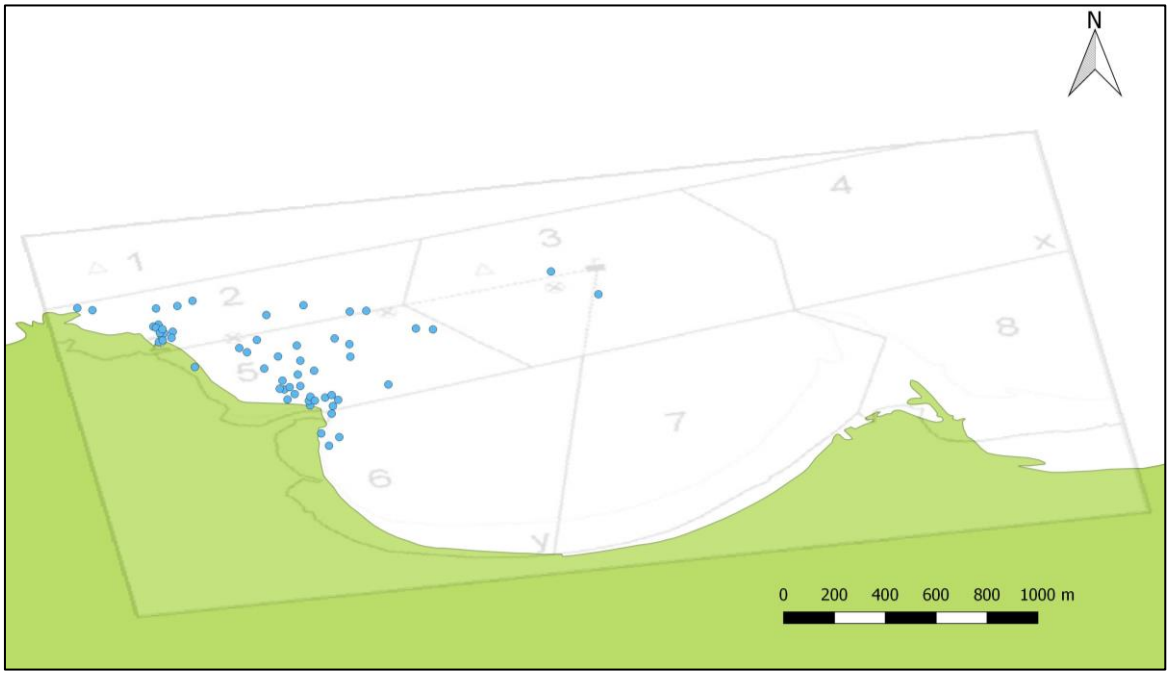

Figure 37: Location of Vader (302) during encounters.

On the 12th of August 2016, Vader displayed some very interesting behaviour that was photographed by a member of the public (Nigel Barlow). The encounter took place during a

ShoreFin encounter in which mother and calf paring Echo and Panda were also present. Vader was observed leaping and upon closer inspection of the images it was clear that the dolphin was interacting with a species of shark known as a Tope, *(Galeorhinus galeus)* (Figure 38). Similar aggressive behaviour is observed between bottlenose dolphins and harbour porpoises (*Phocoena phocoena*), known as porpicide, the reason for these types of interactions is unclear although speculation suggests it could be due to competition for food or Infanticide (Patterson *et al.,* 1998; Spitz *et al.,* 2006).

Figure 38: Vader (302) encounter with tope shark (*Galeorhinus galeus*).

Case Study 2: Dylan (561)

CBMWC CATALOGUE NAME: 561-16W3

Nickname: Dylan

Gender: Male

Number of ShoreFin encounters in 2016: 46

Figure 39: Left and right profile of Dylan (561).

Individual 561, nicknamed Dylan (Figure 39), was first photographed during the 2016 ShoreFin research season and is confirmed to be a male (Figure 40). Dylan is regarded as a well-marked individual that can be identified via notches in the middle of the trailing edge of the dorsal fin (Figure 30). In 2016, Dylan also displayed prominent tooth rake marks on the left and right side of the fin, though as an identification feature these are regarded as semi-permanent markings as they fade over time.

Figure 40: Dylan (561), identified as male – photographs shows genital slit and lacks mammary slits.

The ShoreFin project team were able to identify this dolphin using low quality photographs, or photographs taken at a distance, for example when the individual was photographed close to the cardinal marker (~1km away), due to the distinctive notches on the trailing edge of the fin.

As this individual is new to 2016, it was difficult to determine its age. Initially thought to be an adult due to lack of obvious association with an adult female and its size compared to other adults, photographs were captured with the individual displaying what is possibly faded foetal folds during a boat encounter that occurred in September (Figure 41). It is therefore possible that the individual is a young adult, as it is paler and smaller than many of the known adults identified in the same encounters. The possibility of incorrect classification of an individual is a challenge faced during any photo-id study, and a degree of error should be acknowledged in the life history analysis.

Figure 41: Dylan (561) displaying possible faded foetal folds.

Dylan was initially photographed at the beginning of the research season in April (Figure 42), and was photographed during all subsequent months of the season. Dylan was photographed in a total of 46 encounters across 35 different days between April and September. On 11 survey days, Dylan was photographed in more than one encounter, indicating that he was using the area for an extended period on these days. Encounter frequency steadily increased from April, peaking in July when Dylan was photographed and identified in 17 encounters on 12 different days during the month. The number of days in which Dylan was photographed and identified declined in August and decreased further in September to the lowest frequency of the season (Figure 34).

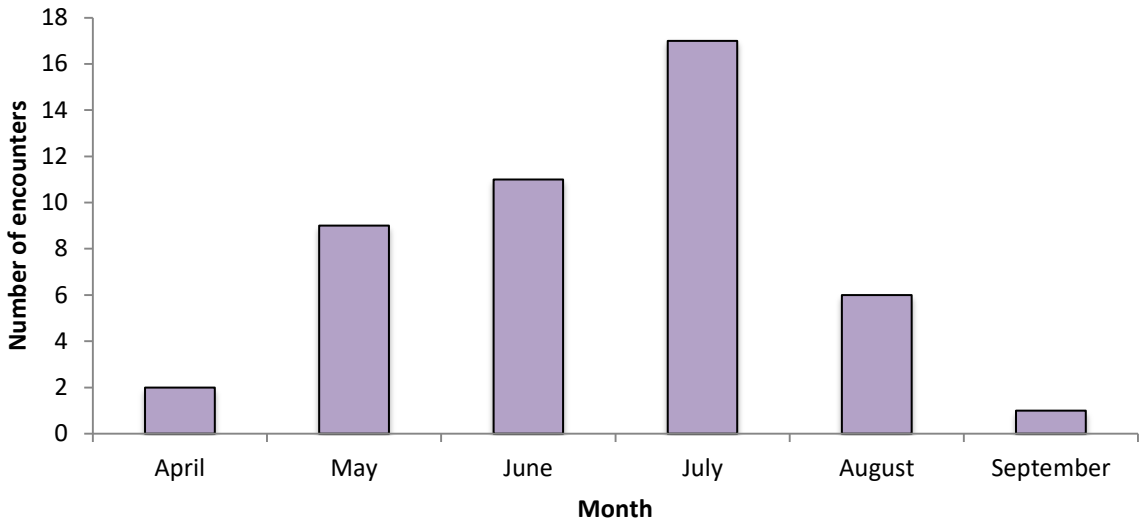

Figure 42: The number of encounters per month in which Dylan (561) was identified.

Dylan showed a preference for using New Quay bay earlier in the day (Figure 43) with 50% of encounters occurring between 07:00 -09.00 (28%) and 09.00-11.00 (22%), fewer photo-id encounters occurred later during the day during the 17:00-19:00 survey period.

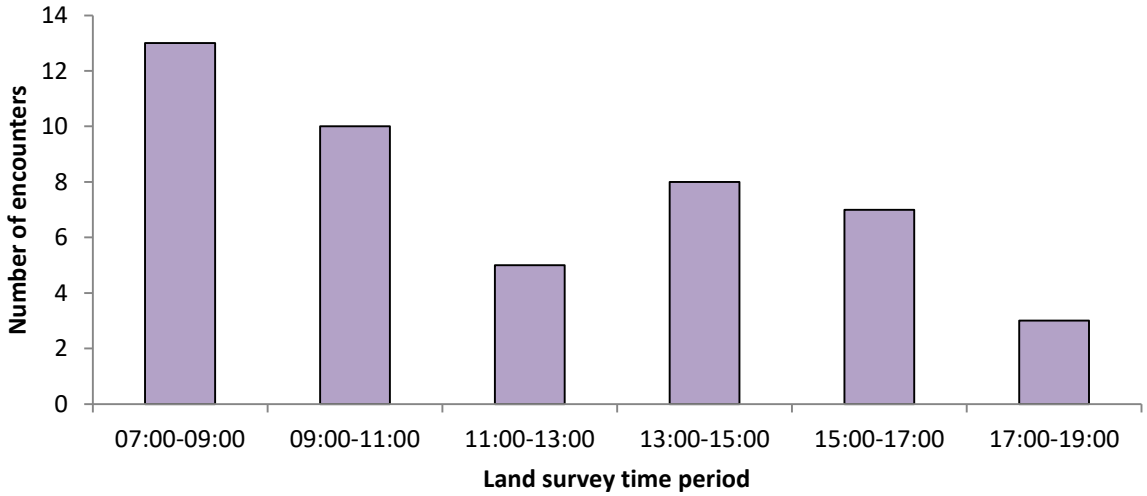

Figure 43: The number of encounters Dylan (561) was identified in per land watch survey period during 2016.

Dylan was photographed and identified in the most encounters within zone 5 of the survey area (Figure 44), and was also photographed and identified from the headland near the Fish Factory.

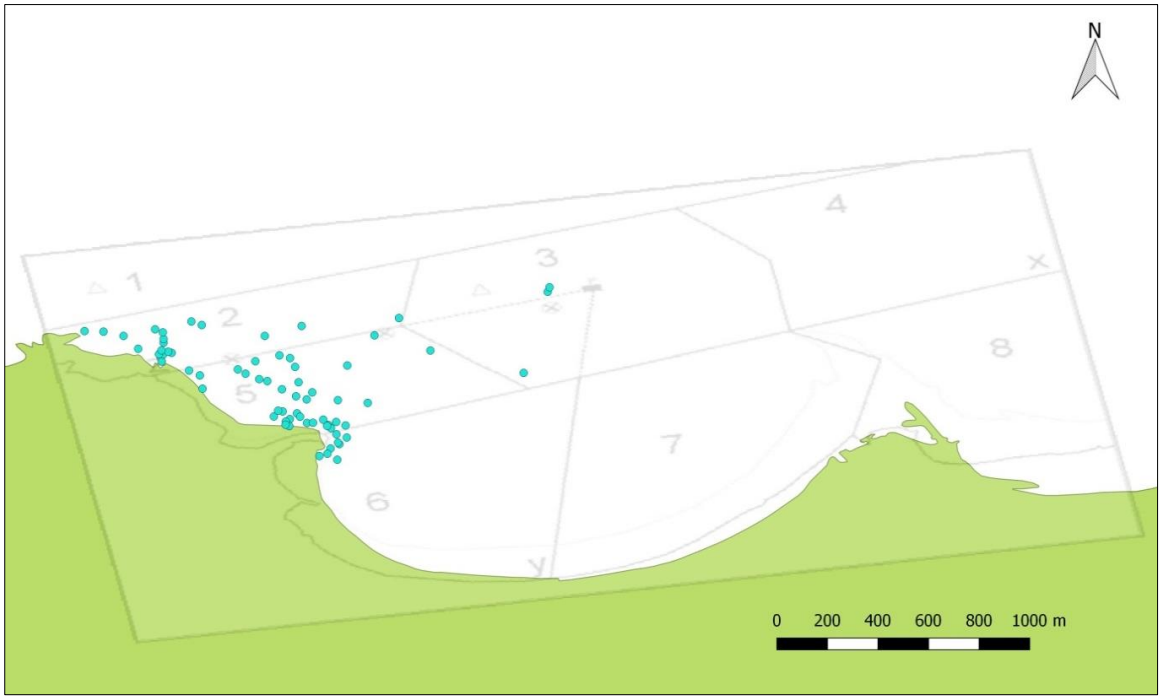

Figure 44: Distribution map of ShoreFin Photo-id encounters in which Dylan (561) was identified.

4.0. Discussion

4.1. Population Estimate

The Cardigan Bay bottlenose dolphin population is estimated to have 250-300 individuals (Evans *et al.,* 2000; Feingold & Evans 2014). Since 2005, CBMWC have identified 195 well marked and 200 slightly marked dolphins, however it is difficult to determine an exact population estimate as the bottlenose dolphins are considered part of an open population (Evans *et al.,* 2003; Reid *et al.,* 2003) and recent studies describe a decrease in the population (Feingold & Evans, 2014).

Based on the number of dolphins present in New Quay Bay during 2016 (111) calculated using the distinctiveness ratio, it can be estimated that approximately 37-44% of the Cardigan Bay population visited New Quay Bay between April and September 2016. Since the project inception in 2014, 135 different dolphins have been photographed and identified, equating to 45-54% of the population, although it must be acknowledged that there will likely have been more individuals that were either not photographed or photographs were of too poor quality for identification, therefore this should be regarded as minimum estimate.

During the three years of ShoreFin project, there has been a small increase in the number of dolphins identified by ShoreFin (59 in 2014 to 74 in 2016), with at least 19 new individuals being photographed each year. The percentage similarity in individuals identified since 2014 was low (135) with only 18 individuals being identified every year. A few of the dolphins who were particularly prevalent in previous years of the ShoreFin project have not been photographed since. For example, in 2014, 007 was one of the most frequently observed individuals, identified on 56 occasions spanning all months of survey. Furthermore, two females photographed frequently over the 2014 and 2015 research seasons, Connie (004) and Nick (015), were also absent in 2016, although both their offspring have been photographed in ShoreFin encounters. All three of these dolphins were first photographed in 2005 when the CBMWC photo-id catalogue was initiated and were all photographed every year up to 2014 (007) or 2015 (Connie and Nick), with the exception of Nick (015) who was not photographed in 2006. This supports the theory that dolphins using New Quay Bay are part of an open population and that some individual dolphins show temporal site fidelity related to life history traits.

The data indicates that the New Quay Bay area is of high importance to these animals. This is concurrent with literature finding that New Quay is a favoured feeding ground for Cardigan Bay bottlenose dolphins (Bristow & Rees, 2001; Gregory & Rowden, 2001). Collecting population estimates is key to determining the scientific basis for conservation

planning (Dawson *et al.,* 2008; Sutaria & Marsh, 2011), particularly for coastal species, which suffer a greater impact from anthropogenic sources than in any other marine mammal habitat (Dawson *et al.,* 2008).

4. 2. Spatial Variation

Analysis of the data collected as part of the ShoreFin project indicated that individual dolphins exhibit site preferences. Since inception of the ShoreFin project, 26 individual dolphins have been identified exclusively via ShoreFin encounters in New Quay Bay, highlighting the unique value of this a shore-based project. Four dolphins were photographed and identified in all months of the project period, and a further 11 dolphins also showed high site fidelity in 2016, with these individuals exhibiting high presence across much of the survey period in all years. Thus, some individuals display a degree of seasonal residency to New Quay Bay, while many other individuals were photographed just once. This is consistent with findings in other studies, describing patterns in UK waters where some bottlenose dolphins are resident to an area, whilst others are transient or infrequent visitors (Arnold, 1993; Lewis & Evans, 1993; Bristow & Rees, 2001; Veneruso & Evans, 2012), this trait has also been displayed in bottlenose dolphin populations across the Atlantic (Maze & Würsig, 1999; Campbell *et al*., 2002). Intraspecific differences in degree of site fidelity and habitat ranging has been observed in many vertebrate species, resulting in spatial stratification that is thought to be a consequence of dietary needs, territoriality and maternal care (Wilson *et al.,* 1997; Evans, 2008; Sargeant & Mann, 2009). Degree of site fidelity is also thought to be linked to the fission-fusion social structure of bottlenose dolphins, where fluid group composition leads to frequent temporary interactions between individuals, with some individuals preferentially associating with another (Sargeant & Mann, 2009).

Within New Quay itself, the majority of dolphins photographed in ShoreFin encounters were in close proximity to New Quay harbour wall, the Fish Factory and Llanina reef. The distribution of dolphins was primarily clustered around these areas with fewer dolphin groups observed in between. Prey availability and distribution has a fundamental influence over distribution of bottlenose dolphins (Hansen & Defran, 1993; Bearzi *et al.,* 1999; Mann *et al.,* 2000). It is thought that bottlenose dolphins favour such shallow waters as those found in and around New Quay Bay, as less energy is required when searching for prey than at depth (Gregory & Rowden, 2001). Additionally, a positive relationship has previously been found between the activity at the whelk processing factory and abundance of bottlenose dolphins (Denton, 2011). The processing of whelk shells leaves minute vestiges of organic material on the shell before it is discharged into the water, potentially attracting smaller bait fish to the local area and establishing a cascading food chain with dolphins at the apex (Denton, 2011). Furthermore, the topography of Llanina reef provides shelter for a

variety of fish species, providing a suitable foraging environment and potentially resulting in the high abundance of dolphins observed here. Thus, the spatial distribution found in New Quay Bay is most likely dependant on prey availability, and foraging behaviour was regularly photographed at these locations in the 2016 ShoreFin season.

4.3. Temporal Variation

Bottlenose dolphin populations generally exhibit patterns where some individuals are present in a site throughout the year, some seasonal, and others present some years and could be absent for a year or more (Bristow & Rees, 2001; O'Brien *et al.,* 2009). This could explain why a higher number of dolphins were estimated to have visited New Quay in 2016 (111) than 2015 (92). It could also explain the low similarity of individuals seen as the years of the ShoreFin study progresses, and how some individuals only seen in 2014 were identified again in 2016. Individuals already known to the database may be re-visiting New Quay after time elsewhere: the CBMWC photo-id catalogue includes animals photographed from boat-based encounters since 2005 so increases the opportunity for matches to be found. Varied seasonality in individual animals can also explain why different individuals are being identified in each month of each year of study, resulting in a discovery curve with no plateau. Though the percentage of new animals being added to the database is decreasing as the project continues, new animals are still being identified, thus continued effort is required to achieve a more comprehensive data set.

During the 2016 research season, the greatest number of different dolphins were photographed and identified in July, and population estimates peaked in June. These results are in line with studies of UK populations describing a partially seasonal population with highest dolphin abundance occurs in the summer months, particularly July (Wilson *et al.,* 1997; Bristow & Rees, 2001; Evans *et al.,* 2003; Pierpoint *et al.,* 2009; Simon *et al.,* 2010). Previous ShoreFin project years also correspond with this, finding peaks in abundance of different individuals during July (2014) and June (2015) (Metcalfe *et al.,* 2014; Stevens *et al.,* 2015). Fewest individual dolphins have been identified either side of the summer peak, during April (2014 and 2016) and September (2015). Studies of Cardigan Bay bottlenose dolphins found the fewest sightings in March (Bristow & Rees, 2001), with continued sightings of low frequency after the summer peak, between October and April (Gregory & Rowden 2001; Evans *et al.,* 2003; Simon *et al.,* 2010).

During the winter, evidence suggests that there is a strong seasonal migration northwards of the Cardigan Bay population, with the waters around the Isle of Man thought to be the northernmost extent of this population. Photo-id encounters around North Anglesey (Veneruso & Evans, 2012) and the Isle of Man (Perry, S.L. personal comment, Nov 2016) in the winter months have identified dolphins that have previously been photographed in

Cardigan Bay. This highlights the value that open-source, shared photo-id catalogues around the UK could have, as movements of individual animals could be more effectively tracked, to date no matches to the Cardigan Bay population have been found outside of the Irish Sea (Pesante *et al.*, 2008). Photo identification studies through the winter would also enhance knowledge of individual dolphin's seasonal movements.

Seasonal fluctuations in abundance are thought to occur due to the variations in distribution of prey throughout coastal regions (Wilson *et al.,* 1997; Evans *et al.,* 2003, Bristow, 2004). Water temperature has an impact on prey items as many species spawn during the summer months, potentially drawing the dolphins to the area (Alford, 2006). It is also thought that the summer months have more favourable sea conditions and a lower risk of predation on young calves (Berrow *et al.,* 1996). Such patterns of visitation after years away could be due to bottlenose dolphins calving at intervals of approximately three to four years. It is thought that some female dolphins use an area solely as a nursey ground and will not return to such grounds when not with a calf (Englund *et al.,* 2008). Furthermore, some dolphin individuals photographed and identified only once could have been using the area as a migration corridor (Robinson *et al.,* 2012).

The dolphins analysed in the case studies displayed a higher presence in the early and late land survey watches, correlating with times of lower boat activity. However, the level of impact boat activity has on bottlenose dolphins in New Quay is uncertain, with some studies determining an adverse impact (Lamb & Ugarte, 2005; Pierpoint *et al.,* 2009), and some finding little impact (Gregory & Rowden, 2001; Veneruso *et al.,* 2011). Consequently, further more detailed investigation is required to ascertain the effect of boat traffic on dolphin movements and behaviour. The described temporal variation could also be due to variations in diurnal prey abundance. Several studies of bottlenose dolphins have indicated a trend toward feeding in the morning and at dusk due to prey movements (Brager, 1993; Hansen & Defran, 1993; Bearzi *et al.,* 1999). When analysed in closer detail, the case study dolphins in this report exhibited patterns in which they were identified multiple times in one day. In some instances, the dolphins were identified in consecutive encounters throughout the day, while other times they were identified again many hours apart. It is possible that some dolphins return to New Quay at different times in the same day after spending time elsewhere. New Quay Bay is clearly an important area for these individuals, and they perhaps spend extended periods in the area searching for more inconspicuous prey such as benthic fish that have previously been found in abundance in the shallow areas of New Quay (Gregory & Rowden, 2001).

4.4. Sex Categories

There were only a small proportion of individuals where a definite sex could be determined. An increasing percentage of individuals were identified as female each year, possibly because opportunities to positively sex females are greater as they can be sexed via the presence of a calf as well as direct observation of genitalia. The result is a potentially bias sex ratio. Moreover, when individuals considered possibly male and female were included in analysis, a higher sex ratio of males to females was found in all years. The percentage of the individuals identified that are known to be male and female has increased since 2014 as an increase in the number of photographs taken improves the chances of obtaining photographs suitable for use to identify the sex of the dolphins and the chance of mother-calf pairs being re-captured.

Population structure and dispersal strategies typically vary between male and female bottlenose dolphins, generally based on local habitat dependence (Natoli *et al*., 2005). It has been found that female bottlenose dolphins are more likely to remain loyal to the area they were born than males (Möller & Beheregaray, 2004). This is because females are more reliant on the habitat to raise calves, which can remain with the mother for 3-6 years (Wells & Scott, 2002), suggesting higher site fidelity in females than males (Wells, 1986; Campbell *et al*., 2002).

In both 2015 and 2016, it was found that the numbers of male and female individuals peaked during the same period, though this could be due to a number of reasons ranging from prey availability to reproduction (Mann *et al.,* 2000). Opportunity to mate could therefore be a reason for variation in seasonal abundance patterns. As half of dolphins could not be sexed, it is difficult to make assumptions on sex ratio. Further study is required to assess residency patterns of male and female dolphins throughout the year, and increase the opportunities for photographs of the genitals to be captured to allow for more positive sex identification to occur.

4.5. Life History Categories

New Quay is regarded as a significant nursery ground for the Cardigan Bay bottlenose dolphin population, as calves are observed in a high percentage of sightings. This study found a presence of young animals (calves or juveniles) in nearly half of all encounters, another study in 2001 reported sightings of calves in 40% of encounters in New Quay (Bristow & Rees, 2001). Additionally, four of the mothers identified in 2016 have previously been photographed with a calf in the surrounding areas since the CBMWC photo-id records began in 2005. Therefore, ShoreFin 2016 confirms the importance of New Quay Bay as a nursery ground for Cardigan Bay bottlenose dolphins. New Quay is considered a sheltered bay that can provide mother and calf pairs with protection from strong winds and lower sea

temperatures of deeper waters (Wilson *et al.,* 1997). Weather and sea condition are factors that impact both the mother and calf's body condition, and viability of the calf (Wilson *et al.,* 1997; Bristow & Rees, 2001).

ShoreFin 2016 observed peak calf encounters in New Quay during July. Bottlenose dolphins are known to calve all year, but predominately during the summer months (Feingold & Evans, 2014), generally peaking in August (Rogan *et al.,* 2000). Prey availability is considered to contribute to the timing of calf births as it has a direct impact on reproductive success both in the health of the mother and the calf (Berrow *et al.,* 1996). Prey availability is an important factor influencing spatial and temporal distribution of mother and calf pairs in Cardigan Bay (Pierpoint *et al.,* 2009).

A greater number of calves than juveniles were identified in 2016 however, the life category status of juveniles is more difficult to quantify as they are close to adult size, and are not in constant close proximity to an adult. Therefore, there is the potential for some juveniles to be classified as adults rather than juveniles. Though fewer juveniles were identified than calves this year, they were observed with a higher frequency than calves were. This is primarily due to the high visitation frequency of Joey (657) and Finn (673), as both changed from being classed as calves in ShoreFin 2015, to juveniles in ShoreFin 2016 and the fact that a number of calves were photographed only once. It is likely that these individuals either display higher residency in a different location or at a different time outside of te ShoreFin projects survey periods, as bottlenose dolphin mother and calf pairs tend to exhibit higher levels of site fidelity and residency than other dolphins (Vermeulen & Cammareri, 2009). This is also further evidence to suggest that some dolphins visiting New Quay are transient and use the area as a migration corridor. Regular sharing of photo-id catalogues across Wales and the UK could potentially facilitate matching of these mother and calves to different locations. It is also interesting to note that, whilst they may have been observed in groups outside of New Quay Bay, no newborn and mother pairs were photographed and identified in New Quay Bay in 2016, compared to four in 2015 and one in 2014. This may be because fewer newborns were born in 2016, or those mothers that had newborns were not using New Quay Bay.

Finn's mother Connie (004) was not photographed and identified during this year's ShoreFin project, however in the past Connie has shown high site fidelity to New Quay, and Joey's mother Jacky (376) has shown high site fidelity to New Quay in every year of ShoreFin project (Metcalfe *et al.,* 2014; Stevens *et al.,* 2015). Bottlenose dolphins have a long period of dependency and juvenile development, not unlike primates (Mann *et al.,* 2000). Juveniles may display high site fidelity as they are still semi-dependant on their mothers, who already show high site fidelity to New Quay. Considering Finn and Joey are thought to be a similar age (approximately three years) it is interesting to observe such independence by Finn from mother Connie, though it is a possibility that Connie is no longer alive. There appears to be a

dearth of study into spatial separation habits of juvenile bottlenose dolphins from adults, which could be an invaluable addition of knowledge provided by photo-id studies. It will be interesting to observe Joey in the future and to document whether Joey continues to display high site fidelity to New Quay once gaining full independence from Jacky.

Analysis of the two most frequently observed mother and calf pairs, this study found that they were present across all survey time periods. Whilst there was no definitive pattern observed over the last two years, they were identified more frequently in the 09:00-11:00 survey period, and the number of encounters declined in the afternoon from 15:00-19:00. This could be related to motherly avoidance activity in order to protect calves (Feingold & Evans 2014), though other studies have found little impact on dolphin behaviour from boat activities (Gregory & Rowden, 2001). In addition, lowest mother and calf presence occurred during a period of typically low boat activity between 17:00 and 19:00. There are many intervening factors such as weather condition and prey availability that could influence this temporal choice (Bristow & Rees, 2001), data collected over a longer period of time as well as data obtained on a greater number of mother and calf pairs would provide valuable information in order to fully understand trends in activity.

4.6. Prey species

Bottlenose dolphins are drawn to Cardigan Bay due to a range of factors, including the rich and abundant fauna (Evans *et al.,* 2000). This species of dolphin exhibits a catholic diet, preying on benthic and pelagic fish: wrasse (Labridae), dragonet (Callionymus spp.), pollock (*Pollachius polachius*), sand eel (Ammodytidae), flatfish (Pleuronectidae), and blennies (Blenniidae) (Evans *et al.,* 2000; Dunn & Pawson, 2002; Pierpoint *et al.,* 2009). New Quay attracts white salmonids, mullet (Mullidae), and pelagic shoaling species such as bass (*Dicentrarchus labrax*) and mackerel (*Scomber scombrus*) and these species are known to be eaten by bottlenose dolphins in the area (Reid *et al*., 2003; Evans, 2002; Pierpoint *et al.,* 2009, Stevens *et al.,* 2015). Photographic data collected during the 2016 field season confirms that bottlenose dolphins in New Quay Bay feed upon salmon (*Salmo salar*), mullet (*Muligidae* sp.), garfish (*Belone belone*), sea trout (*Salmo trutta*), bass (*Morone sp.*) and herring (*Clupea harengus*). Data collected in previous years also confirm dolphins feed upon salmon, mullet, mackerel and cod. In the Moray Firth, the main prey eaten by bottlenose dolphins included cod (*Gadus morhua*), saithe (*Pollachius virens*) and whiting (*Merlangius merlangus*) (Santos *et al.*, 2001). Bottlenose dolphins are known to have a catholic diet, feeding on what is available in the area with the least energetic cost, feeding on pelagic species in deeper waters, and more benthic species in shallow waters (Gregory & Rowden, 2001). Diet analysis in dolphins generally occurs via stomach content examination in stranded individuals. However, this may not exhibit the diet of a dolphin in good health (Santos *et al.,* 2001; Hernandez-Milian *et al.,* 2015), thus photographic evidence of prey

species is an important source of 'real-time' analysis of dolphin prey preference and availability in New Quay Bay.

A greater number of photographs of dolphins feeding on fish, particularly the larger species have been taken in previous years. However, photographs of feeding events are captured opportunistically and not a direct reflection of prey availability. Further years of study will assist the identification of any trends in the data, and studies into local fisheries would help to determine which species are available in the area and when they are most abundant.

4.7. Limitations

ShoreFin officers called to photograph dolphins close to one of the photographic platforms often found that dolphins would be out of photographic range before they arrived at the chosen platform. However, behaviour of wild animals is impossible to predict, and such a limitation can be found in many studies concerning wild animals. There is little alternative to the methodology, but success rate (Appendix 7) of ShoreFin photo-id encounters suggests that the methodology is adequate.

Land-based studies as a whole are cost-effective, but limited by field of vision (Pierpoint *et al.,* 2009). The coastal features of New Quay allow a view of several kilometres from the survey location, except in the westerly location where vision is limited by the presence of the headland. Thus, dolphins could be within photographic distance from the headland but not in the view of Dolphin Watch surveyors. Surveys from a static location also lack the convenience of mobility and manoeuvrability around the subject, as can be achieved on a boat-based platform allowing optimum angle, lighting and distance for a high quality photograph. In land-based photography, fewer factors can be controlled, but is completely non-invasive to the subject species (Würsig and Jefferson, 1990; Gregory & Rowden, 2001) and can be conducted in weather conditions too adverse for boat surveys. It has also enabled an additional 26 individuals to be identified over the three years of the project that would not otherwise have been identified (Appendix 7) in the area had only boat surveys been conducted, further proving the wider benefits of this project.

The frequency of Dolphin Watch land surveys were limited by factors such as weather and daylight hours, but data were adjusted for effort in analysis to account for this. An increased volunteer effort during the 2016 research season allowed for a more even number of land surveys per time period compared to previous years (Table 1).

4.8. Recommendations

Following the field season in 2016 the ShoreFin encounter form was revised (Appendix 9) to improve data collection in future years. The project also recommends that once an individual dolphin has been identified for the first time that year, the associated photographs in the core catalogue (left and right sides of the fin) are updated to ensure the highest quality, most recent image is readily available to assist with analysis. This will help to reduce the chance of misidentification or duplication of the individual and to facilitate ease of identification in future encounters.

A dedicated behavioural study of the dolphins of New Quay, as suggested by Stevens *et al.*, 2015 would provide a more thorough understanding of the ecological function of these core areas, and a better understanding of social structure (Lusseau *et al.,* 2006).

In addition, photo-id data collection during the winter months would provide additional information on bottlenose dolphin site usage year around; this would be dependent on weather conditions and volunteer availability during the winter months.

5.0. Conclusion

The data collected as part of the ShoreFin project in 2016 provides evidence to demonstrate the importance of the New Quay area for the bottlenose dolphins of Cardigan Bay. The project photographed and identified 74 different dolphins throughout the 2016 field season.

The ShoreFin project has shown that the dolphin population visiting New Quay exhibits site fidelity consistent with other studies, wherein some individuals are resident, while others are infrequent visitors (Arnold, 1993; Lewis & Evans, 1993; Bristow & Rees, 2001; Veneruso & Evans, 2012). This distribution is generally attributed to dietary needs, territoriality and maternal care (Wilson *et al.,* 1997; Evans, 2008; Sargeant & Mann, 2009). Temporally, some individuals have been found to be present throughout the year, some seasonal, and others present in some years and then absent for a year or more. Though a summer peak in abundance has been found in all years of study, dolphin sightings remain moderate at the end of the research season in September, suggesting a dolphin population is present past this point, and opportunistic land watches and photo-id conducted outside the season confirm this. However, more consistent study outside of the current research season is required to more accurately determine year-round abundance and distribution. Seasonal fluctuations are attributed to prey distribution and favourable sea conditions in coastal areas (Berrow *et al.,* 1996; Evans *et al.,* 2003, Bristow, 2004). Bottlenose dolphins in New Quay Bay have been observed feeding on salmon (*Salmo salar*), mullet (*Muligidae* sp.), garfish (*Belone belone*), sea trout (Salmo trutta), bass (*Morone sp.*) and herring (*Clupea harengus*). Visits of extended periods of time by some individuals further proves the importance of this area for individual bottlenose dolphins.

More females than males were identified in 2016; however there is more opportunity to reliably sex females and the vast number of individuals identified are of unknown sex, thus analysis of sex ratios is difficult. A number of mother and calf pairs frequent the bay, suggesting New Quay is an important nursery ground possibly due to the sheltered conditions and an abundant food source (Wilson *et al*., 1997). It is imperative the area is safeguarded from future threats, and protection of the wider area, which provides important habitat for crucial life history stages of Cardigan Bay bottlenose dolphins, is enforced.

Variations in data over the three years of study confirm the necessity for a longer-term data set. Continued photographic monitoring of bottlenose dolphins in New Quay Bay and the wider Cardigan Bay area is paramount to understanding the population's movements and dynamics, and these data can contribute to the management of the Special Area of Conservation (SAC).

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Appendix

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 Sarn 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.

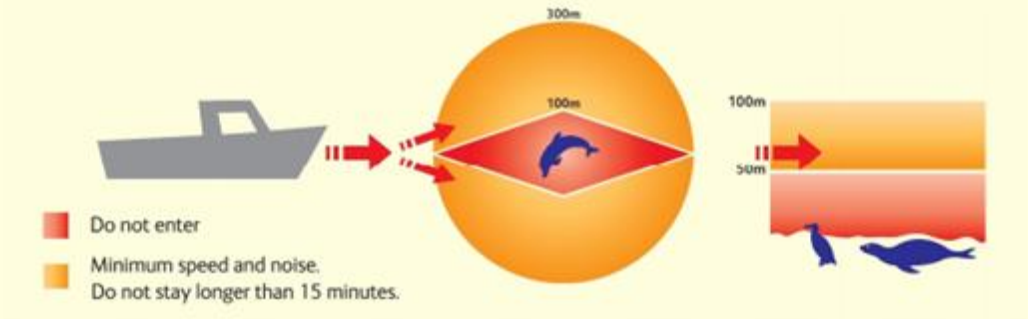
Dolphins, Porpoises & Seals

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 2016.

Cardigan Bay Marine Wildlife Centre
Canolfan Bywyd Gwyllt Morol Bae Ceredigion

SHOREFIN LAND ENCOUNTER FORM EN_____

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

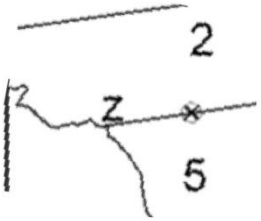
☐ Spy-hopping ☐ Foraging/suspecting feeding ☐ Sexual behaviour

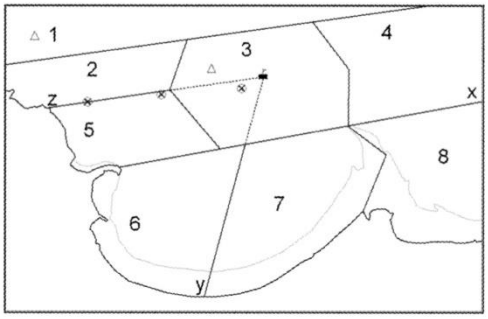
Notes _____

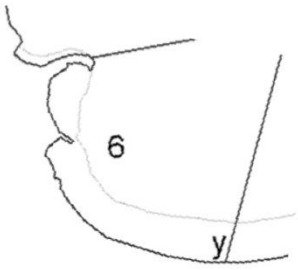
Total No Observed		Adults		Juvenile		Calf		New-born	
Total No photographed		Adults		Juvenile		Calf		New-born	

Number of groups					
Group photographed: Yes (Y) or No (N)					
Number of individuals in each group					
GIS ID Numbers					

Encounter Locations





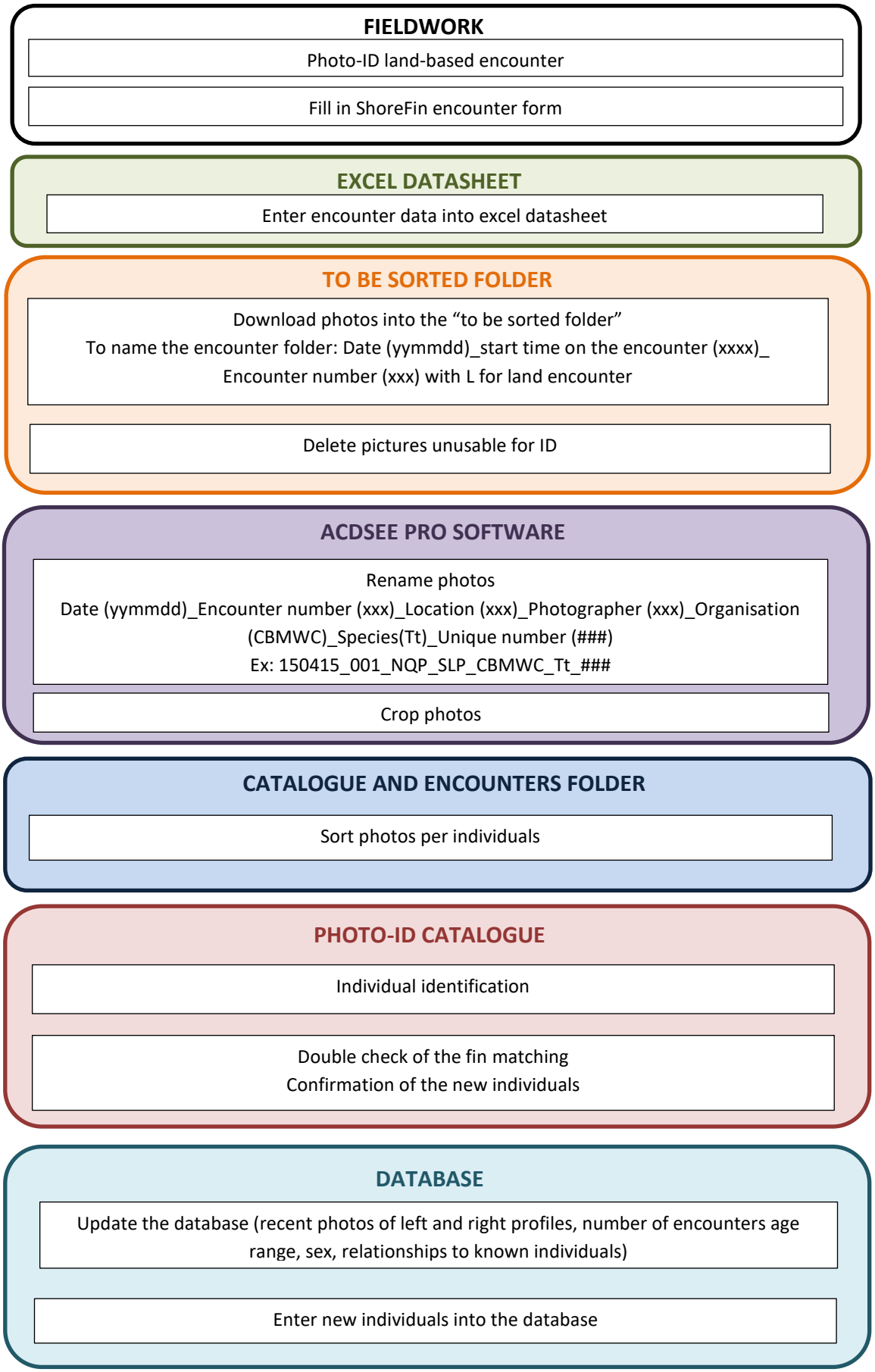


Appendix 4: Dolphin Behaviour Ethogram.

Behaviours used for ShoreFin	Description	Illustrations
Travel, long dives	Surfacing at irregular intervals, thought to be searching for prey while on the move.	
Travel, regular surfacing	Regular surfacing at a fairly constant speed, in a constant direction, no associated splashes, group spacing varies, constant dive intervals	
Fast travel	Rapid swimming, with frequent surfacing creating splashes at a speed >3 knots	
Foraging/Suspecting feeding	Same behaviour as feeding but no evidence of predator prey contact. (Foraging at depth – tail fluke up raised up before diving)	
Feeding (fish seen)	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.	
Leaping	Forward airborne leap out of the water, progressing forward whilst in the dorsal position, with a slight concave arch of the body axis	
Tail slap	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.	
Resting	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.	
Milling	Very slow swimming around the surface waters <3 knots, no geographic movement in direction of travel, dive intervals variable but generally short, group spacing variable	
Bow riding	Swimming in close contact to the boat and riding in bow wave	

Socialising	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	
Sexual behaviour	Two dolphins in close physical contact, obvious mating behaviour observed.	
Close Group	Individual dolphins in group are less than one body length from other members	
Loose Group	Dolphins more irregularly spread over an area with individuals >ten body lengths from each other.	
Spy-hopping	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.	
Long Dives	Staying – long dives, thought to be foraging at depth	
Playing (w/seaweed, jellyfish…)	Playing with / tossing jellyfish, seaweed or other objects	
Association with birds	Seabirds following or feeding amongst cetaceans	
Unknown	Behaviour unable to be verified and may be described using additional notes.	

Appendix 5: Photo-identification procedure.



Appendix 6: Bottlenose dolphins identified by ShoreFin 2016.

Dolphin ID number	Nickname	Number of ShoreFin Encounters	Sex	Age	Marking Category	First seen
008		6	Possible Male	Adult	Well-Marked 4	2005
014		2	Female	Adult	Slightly Marked	2009
016		1	Possible Male	Adult	Well-Marked 4	2005
017		2	Possible Male	Adult	Well-Marked 4	2005
021	Sue	1	Female	Adult	Slightly Marked	2005
027		1	Female	Adult	Slightly Marked	2005
032	Cadfael	3	Male	Adult	Well-Marked 5	2005
036		14	Possible Male	Adult	Well-Marked 5	2005
042		1	Possible Female	Adult	Well-Marked 1	2005
048		1	Possible Male	Adult	Well-Marked 2	2005
050		1	Unknown	Adult	Slightly Marked	2005
059		1	Female	Adult	Well-Marked 2	2005
103	Lipstick	9	Possible Male	Adult	Well-Marked 5	2005
127		1	Unknown	Adult	Well-Marked 2	2005
136		4	Female	Adult	Slightly Marked	2005
177	Marissa	9	Female	Adult	Slightly Marked	2005
184		2	Possible Male	Adult	Well-Marked 1	2006
219	Frankie	12	Possible Male	Adult	Well-Marked 2	2006
220		3	Male	Adult	Well-Marked 2	2010
225		3	Female	Adult	Slightly Marked	2006
227	Snowcap	12	Female	Adult	Slightly Marked	2006
238	Gwanwyn	13	Male	Adult	Well-Marked 1	2007
244		9	Male	Adult	Well-Marked 4	2006
255		3	Unknown	Adult	Slightly Marked	2016
271		1	Unknown	Adult	Well-Marked 2	2016
272		3	Possible Female	Adult	Well-Marked 3	2007
277		1	Unknown	Adult	Well-Marked 1	2016
279		3	Unknown	Adult	Well-Marked 1	2016
285		2	Unknown	Adult	Well-Marked 1	2015
302	Vader	39	Possible Male	Adult	Well-Marked 4	2008
322		3	Possible Female	Adult	Well-Marked 1	2007
341		1	Unknown	Calf	Right Side Only	2016
376	Jacky	66	Female	Adult	Slightly Marked	2011
388		1	Possible Male	Adult	Well-Marked 3	2011
401		1	Unknown	Adult	Well-Marked 1	2011
486		1	Unknown	Adult	Well-Marked 5	2012
504		8	Unknown	Adult	Slightly Marked	2016
511		6	Possible Male	Adult	Well-Marked 5	2012
512		1	Possible Male	Adult	Well-Marked 4	2012

517		1	Unknown	Adult	Well-Marked 2	2015
561	Dylan	46	Male	Adult	Well-Marked 3	2016
562		4	Unknown	Adult	Slightly Marked	2012
572		38	Male	Adult	Slightly Marked	2016
574		1	Male	Adult	Slightly Marked	2013
590		2	Unknown	Calf	Slightly Marked	2016
598		1	Unknown	Calf	Slightly Marked	2016
657	Joey	56	Unknown	Juvenile	Slightly Marked	2013
659		18	Male	Adult	Slightly Marked	2013
665	Echo	36	female	Adult	Slightly Marked	2014
666		2	Unknown	Adult	Well-Marked 2	2014
673	Finn	46	Unknown	Juvenile	Slightly Marked	2013
686		32	Possible Female	Adult	Slightly Marked	2014
689		3	Unknown	Adult	Left Side Only	2014
700		9	Unknown	Calf	Slightly Marked	2015
705		2	Unknown	Calf	Slightly Marked	2015
706		1	Unknown	Calf	Slightly Marked	2015
708		6	Unknown	Adult	Well-Marked 1	2015
711	Snowdon	7	Unknown	Juvenile	Slightly Marked	2015
724		5	Unknown	Adult	Slightly Marked	2015
726		10	Male	Adult	Slightly Marked	2015
729		3	Unknown	Adult	Well-Marked 2	2015
731		6	Female	Adult	Right Side Only	2015
734	Panda	34	Unknown	Calf	Slightly Marked	2015
756		1	Possible Female	Adult	Slightly Marked	2016
757		1	Unknown	Juvenile	Left Side Only	2016
758		3	Possible Male	Adult	Well-Marked 4	2016
760		1	Unknown	Adult	Well-Marked 3	2016
766		9	Female	Adult	Slightly Marked	2016
767		1	Unknown	Adult	Slightly Marked	2016
768		1	Unknown	Calf	Slightly Marked	2016
770		4	Unknown	Adult	Slightly Marked	2016
771		4	Unknown	Calf	Slightly Marked	2016
772		2	Unknown	Adult	Well-Marked 1	2016
774		2	Unknown	Adult	Well-Marked 1	2016

Appendix 7: A comparison of the number of bottlenose dolphins identified from ShoreFin encounters and Boat encounters in 2014, 2015 and 2016.

ShoreFin encounters (New Quay Bay only)	2016	2015	2014	Totals
Total BND Identified from ShoreFin	74	61	59	-
Total BND identified from ShoreFin only	33	20	17	-
Total new BND identified from ShoreFin	20	18	26	64
Total new BND identified from ShoreFin only	10	7	12	29
Total BND re-sighted	54	43	33	-
Total BND only photographed by ShoreFin				26
ShoreFin encounter Success Rate (%)	90.78	83.81	85.87	-
Boat Encounters	**2016**	**2015**	**2014**	**Totals**
Total BND Identified from Boat	81	96	103	-
Total BND identified from Boat only	40	55	61	-
Total new BND identified from Boat	21	41	37	99
Total new BND identified from Boat only	14	26	21	61
Total BND re-sighted	60	55	66	-
Boat encounter Success Rate (%)	95.83	97.56	100.00	-

Appendix 8: Presence and absence of the individuals identified by ShoreFin during each month in 2016 (✓= presence; x = absence).

ID Number	April	May	June	July	August	September
008	✓	x	x	x	✓	✓
014	x	x	x	x	✓	✓
016	x	x	x	✓	x	x
017	x	✓	✓	x	x	x
021	x	x	✓	x	x	x
027	x	x	x	x	✓	x
032	x	x	✓	x	x	x
036	✓	✓	✓	✓	x	✓
042	x	✓	x	x	x	x
048	x	x	x	✓	x	x
050	x	x	x	✓	x	x
059	x	x	x	x	✓	x
103	x	x	✓	x	✓	✓
127	x	x	x	✓	x	x
136	x	x	x	✓	✓	x
177	x	✓	✓	✓	x	✓
184	x	✓	x	x	x	✓
219	x	✓	✓	✓	✓	x
220	x	x	✓	x	x	x
255	x	x	✓	x	x	x
271	x	x	x	✓	x	x
272	x	✓	x	x	x	✓
277	x	x	x	✓	x	x
279	x	✓	x	x	x	✓
285	x	x	✓	x	x	x
302	✓	✓	✓	✓	✓	✓
322	x	x	✓	x	✓	x
341	x	x	x	x	✓	x
376	✓	✓	✓	✓	✓	✓
388	x	x	x	x	✓	x
401	x	x	x	✓	x	x
486	x	x	x	✓	x	x
504	x	✓	✓	x	x	x
511	x	✓	x	✓	✓	x
512	x	x	x	x	x	✓
517	x	x	✓	x	x	x
561	✓	✓	✓	✓	✓	✓
562	x	x	✓	x	x	x
572	x	✓	✓	✓	✓	x
574	x	x	x	x	✓	x
590	x	✓	x	x	x	✓

598	x	✓	x	x	x	x
657	✓	✓	✓	✓	✓	✓
659	x	✓	✓	✓	✓	x
665	✓	✓	✓	✓	x	✓
666	x	✓	✓	x	x	x
673	x	✓	✓	✓	✓	✓
686	x	✓	✓	✓	✓	✓
689	x	✓	x	x	x	x
700	x	✓	✓	✓	x	✓
705	x	x	x	x	x	✓
706	x	x	x	x	✓	x
708	✓	✓	✓	x	x	x
711	x	✓	✓	x	x	✓
724	x	x	✓	✓	x	x
726	x	✓	✓	✓	✓	x
729	x	x	x	✓	✓	x
731	✓	✓	✓	x	x	x
734	✓	✓	✓	✓	x	✓
756	x	x	x	x	x	✓
757	x	x	x	x	x	✓
758	x	x	x	x	x	✓
760	x	✓	x	x	x	x
766	x	✓	x	✓	✓	x
767	x	✓	x	x	x	x
768	x	✓	x	x	x	x
770	✓	✓	✓	x	x	✓
771	✓	✓	✓	x	x	✓
772	x	x	x	✓	x	x
774	x	x	x	x	x	✓

Appendix 9: Revised ShoreFin Encounter Form to be used in 2017.

Cardigan Bay Marine Wildlife Centre
Canolfan Bywyd Gwyllt Morol Bae Ceredigion

SHOREFIN LAND ENCOUNTER FORM WK_____ E_____

Name
Date Location of photographer HW FF PP 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 ☐ Bird association

☐ Socializing ☐ Fast Travel ☐ Bow-riding ☐ Close Group ☐ Tail Slap

☐ Spy-hopping ☐ Foraging/suspecting feeding ☐ Sexual behaviour ☐ Loose Group ☐ Unknown

Notes _____

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

Group Identifier (A, B, C etc.)					
Group photographed: Yes (Y) or No (N)					
Number of individuals in group					
Encounter Zone					

GIS ID Numbers					
Number Identified					

Encounter Locations