

Site fidelity and behaviour of bottlenose dolphins (*Tursiops truncatus*) in Cardigan Bay, Wales

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Abstract

Bottlenose dolphins (*Tursiops truncatus*) often come close to land at New Quay, Cardigan Bay, Wales. Systematic shore-based observations from January 1989 to January 1997 recorded their presence on 47% of the 2223 days when watches were possible. They came to this cold-temperate water bay in all months, but less often during winter. Average sightings of groups were 0.02 per hour in March and 0.18 per hour in July. The high proportion of dolphins with calves indicated that the area was favoured as a nursery area, with groups of females and calves joined intermittently by large males and other dolphins. Extrapolating from the ratio of individually recognised dolphins, the population using these inshore waters was estimated at about 50, which appeared to be stable over the years. Some individually recognised females appeared to be absent for long periods during years when they probably had no accompanying calf. Cross-reference with an earlier study showed that some individuals came to the bay over an 11-year period. Observations showed a general level of tolerance to increasing boat traffic over the period, with reactions varying by boat type.

Key words: bottlenose dolphin, *Tursiops*, site fidelity, Cardigan Bay.

Introduction

Bottlenose dolphins, *Tursiops truncatus* (Montagu), have a world-wide distribution, using a range of coastal habitats, including lagoons, estuaries and open coastal waters, as well as the open ocean in temperate and tropical seas (Kenney, 1990; Shane, 1990). Although highly mobile, they favour inshore locations where they occur with some regularity. Of at least six favoured locations around north-western Europe, one is the southern part of Cardigan Bay, Wales, notably off the small fishing port of New Quay. Anecdotal evidence from local

fishermen indicated that dolphins have frequented this location since the 1920s. The dolphins of Cardigan Bay have attracted increasing attention since the early 1980s, resulting in several studies of this population (Morris, 1990; Grellier *et al.*, 1995). Since this study began, southern Cardigan Bay was designated as a candidate Special Area of Conservation (eSAC) for this species under the EU Habitats Directive (Council Directive 92/43/EEC).

Most studies of dolphins in Cardigan Bay since 1986 have been intermittent. A boat-based photo-identification study from 1990 to 1994 (Grellier *et al.*, 1995), conducted inshore and offshore during summer months, was sometimes limited to 2 days per month, and had gaps in the records sometimes exceeding 6 months. Estimates of the numbers of dolphins visiting the wider bay were made, but the study gave few clues as to why dolphins preferentially use this small area of the sea. The study by Morris (1990), over 29 months from October 1986 to June 1990, averaged 6 days per month and demonstrated the presence of dolphins in all months of the year. It was partly land-based and partly boat-based, using both visual and acoustic methods. The last 10 months of the Morris study relied solely on observations from the shore. The first author of this study was one of Morris' observers and responsible for developing and expanding the shore-based observations.

For over 8 years beginning in January 1989, year-round daily records of the dolphins were made from the land at New Quay (except for only 5 and 10 days per year). During these years, watches were made consistently from the upper floor of a building overlooking New Quay Bay, where dolphins habitually come close inshore. Although the area in view was but a small part of the foraging range of the dolphins, this systematic recording confirmed that they frequented this bay throughout the year. Records of group size, group composition, and characteristically marked individuals helped determine the site fidelity of individuals and groups on a seasonal and yearly basis. Together with noting

dolphin behaviour and responses to boats, the original intention was to determine whether this site usage was increasing or decreasing. Subsequently, it became apparent that the regular observations from the land might provide cost-effective monitoring and could help formulate hypotheses to explain the preferential use of these inshore waters. If it were shown that a particular segment of the dolphin population preferentially came close inshore at New Quay, this might suggest site fidelity and hence identify features of the site that were likely to be important in managing the cSAC.

Materials and Methods

Study location

New Quay Bay (Lat. 52°13'N, Long. 4°21'W) is one of a number of small, shallow, sandy bays that indent the cliffed coast of southern Cardigan Bay, Wales (Fig. 1). Cardigan Bay is a large shallow embayment on the east side of the 80-km wide St. George's Channel entrance to the semi-enclosed Irish Sea basin. New Quay Bay is outside the strong tidal streams that characterise the southern Irish Sea, and because it faces NNW, open sea swells coming in from the Celtic Sea are attenuated.

Observation methods

Observations were made mainly from inside the top floor of a building close to the shore and 30 m above sea level, these often were confirmed by further observations from the quay or a rocky promontory at New Quay Head or the cliff top. From the primary observation position, a 90° arc of sea could be covered from New Quay Head to Ina Point. In good conditions, dolphins were detectable by eye or by scanning with 10 × 50 binoculars. Sightings out to 5 km were confirmed with 35 × 50 binoculars. Positions were estimated to the nearest 100 m with temporary summer buoys aiding distance estimates.

From 1 January 1989 to 31 January 1997, for at least 355 days per year, between 4 and 7 h of observation were made each day. The core observations were 0730–0930, 1030–1100, 1230–1400, 1500–1530, 1730–1830 and during summer 1930–2130 hours. Times were maintained whether Greenwich Mean Time or British Summer Time prevailed. Outside the core hours intermittent scans were done at 10–15 min intervals.

At each sighting, the total number of dolphins, their grouping (for example 3+2+1), and their spatial arrangement in relation to reference points in the bay were recorded. The activity and behaviour of the group was recorded by 3-min sampling, this being summarised in fourteen categories for analysis purposes (Table 1). Birds (10 spp.) in close company with the dolphins and any boats within

100 m were noted. A sighting was defined as a single event, whether a dolphin or a group remained visible in the study area for only a few minutes or for several hours. If an additional group of dolphins was seen, with the original group still in sight, this was treated as a new sighting. When no dolphins were seen for 20 min a subsequent sighting was treated as a new one. In addition to close groupings, 2 or 3 large adults travelling parallel as much as 100 m apart were treated as a single group, as were split groups forming an arc for feeding, or when a single large adult seemed to flank or lead a closer group. Body size estimates, assisted by behaviour and colour were used to categorise animals as: small calves (<1.5 m), large calves (1.5–2.0 m), juveniles (2.0–2.5 m) or adults (3–4 m).

At each sighting, records were made of weather conditions, sea state, wind strength and direction, together with air temperature, sea surface temperature, times of high water, and any instances of visible pollution on that day.

Results

Sightings and group sizes

Bottlenose dolphins were sighted on 1050 days over the 8 years, representing 47.2% of the 2223 days when conditions were suitable. Yearly sightings varied between 104 and 175 days (Table 2), with an increase in days with sightings over the years. Total dolphin sightings, including multiple sightings in a day, varied from 155 to 251 per year. Dolphins made greatest use of New Quay Bay between April and November (Fig. 2), this part of the year accounted for 1404 of 1534 sightings (92%). The summer months (June, July and August) yielded 48% of the sightings. When expressed as sightings per hour, allowing for daylight differences, sightings were lowest in March (0.02 h.) and highest in July (0.18 h.).

The distribution of sightings by dolphin group size was skewed towards small groups (Fig. 3). Of the 1534 sightings, 82% were <6 individuals and only 4% were >8. A maximum of 26 dolphins were seen together at New Quay in September 1993. The monthly mean group size was smaller during the summer months, (3.39 ± 0.20 , $P=0.95$), when sightings were at a peak. Group size increased between September and December with more sightings of groups of 9 to 14, mean group size was 4.59 ± 0.47 ($P=0.95$). Small calves were seen in 40% of the 1534 sightings, and 26% of groups included a large calf. Groups of the same composition were often seen on several days in the same month, sometimes consecutively. However, at other times, groups of about the same size, but with different compositions were seen on successive days. Either the associations within the groups were somewhat fluid or several groups

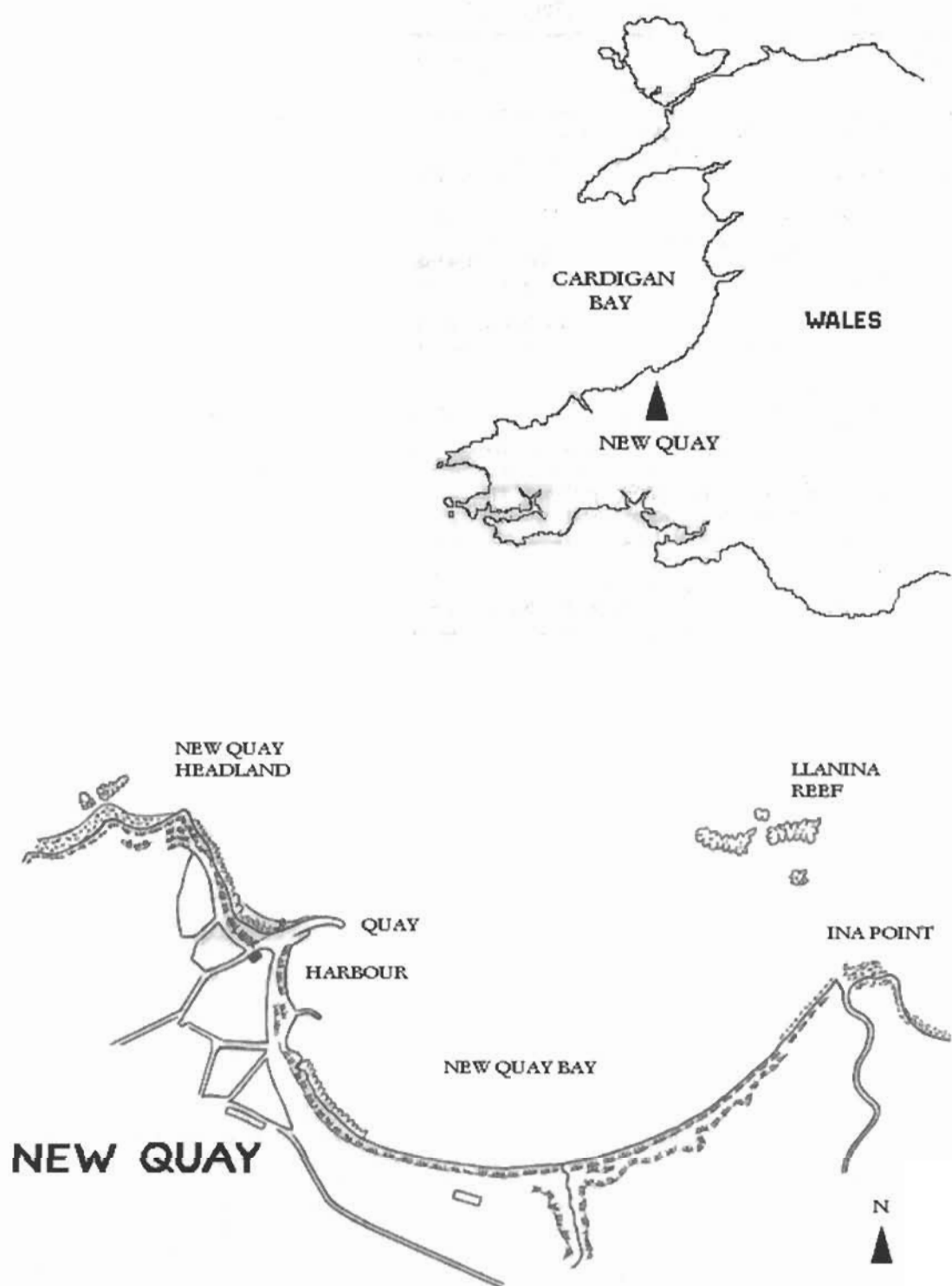


Figure 1. Site location map.

Table 1. Dolphin activities and behavioural categories.

Code	Definitions
F	Feeding: chasing fish at the surface, throwing fish, deep dives and surfacing with fish.
T	Travelling: in groups, often NE across New Quay Bay in mornings and SW across the bay in afternoons, around the shoreline of bay, or by the quay and harbour.
P	Playing: in groups, rough and tumble play, leaping over one another, throwing objects, such as pebbles or floats, in the air.
G	Group feeding: split groups feeding in an arc, then closing the arc to encircle fish.
B	Breaching: somersaults and back-flips.
R	Fast runs: often accompany feeding or after boat disturbance.
V	High vertical leaps: spins and rolls, often 'competitive' and repeated by 2 or 3 dolphins during play and social activity.
H	Long horizontal leaps: often accompany fast travel across the bay.
S	Swell riding or Bow riding: seen when long swells roll into Bay on W wind, or when bow riding yachts or other craft.
D	Disturbance: curtailed feeding or curtailed social activity in the presence of boats, tail slapping (rarely seen in New Quay), apparent attempts by single dolphins to 'decoy' boats away from a mother and calf.
A	Avoidance: submerge to sea bed for several minutes in presence of boats then head offshore, lay to one side to obscure dorsal fin or hide a calf in presence of boat.
W	Waking in alarm: at the approach of a boat, characteristically, one or two huge leaps, then no further sighting.
O	Odd or unusual behaviour: head stands, rising backwards from the water, mutual back-scratching.
L	Lying still in the water: lying still on the surface.

Table 2. Number of days per month when bottlenose dolphins were sighted at New Quay.

	1989	1990	1991	1992	1993	1994	1995	1996
January	1	3	6	3	2	1	2	3
February	1	0	5	3	3	2	3	3
March	2	3	1	0	3	3	4	6
April	3	6	6	7	18	11	12	18
May	11	11	15	6	11	12	18	14
June	17	16	12	14	17	23	15	19
July	16	16	23	24	22	23	23	28
August	19	10	24	12	18	18	25	25
September	7	13	15	15	12	10	15	23
October	11	12	12	6	12	17	19	18
November	10	9	6	11	11	10	17	13
December	10	6	7	3	3	2	9	5
Annual Total	108	105	132	104	132	132	162	175

Note: Totals do not include separate sightings on any one day.

used the area. The composition of the larger groups seen in autumn suggested that they were formed by amalgamation of the smaller groups.

Throughout the year more dolphins were seen in the morning; 46% between 0800 and 1200, and 18% between 0800 and 0900 h. In summer, sightings were lower during the afternoon, the time of day when recreational boats were most active. In winter, the fewer sightings were spread throughout daylight hours (Fig. 4).

Identifiable individuals

In this location, dolphins came within 10 m of the quay and the rocky promontory below New Quay Head, allowing the identification of individual dolphins with large and distinctive natural dorsal fin markings on a regular basis. By the end of the study, 16 adult dolphins were recognised from their fin markings (Fig. 5). Observations of these dolphins, their associates, and their behaviour, singly, in groups, or with accompanying calves, indicated

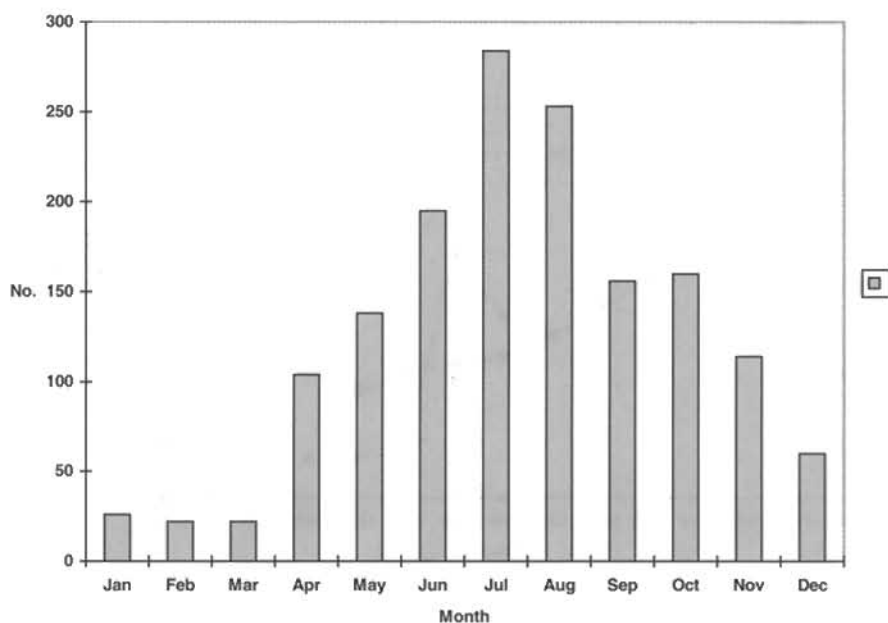


Figure 2. Total number of bottlenose dolphin sightings by month at New Quay.

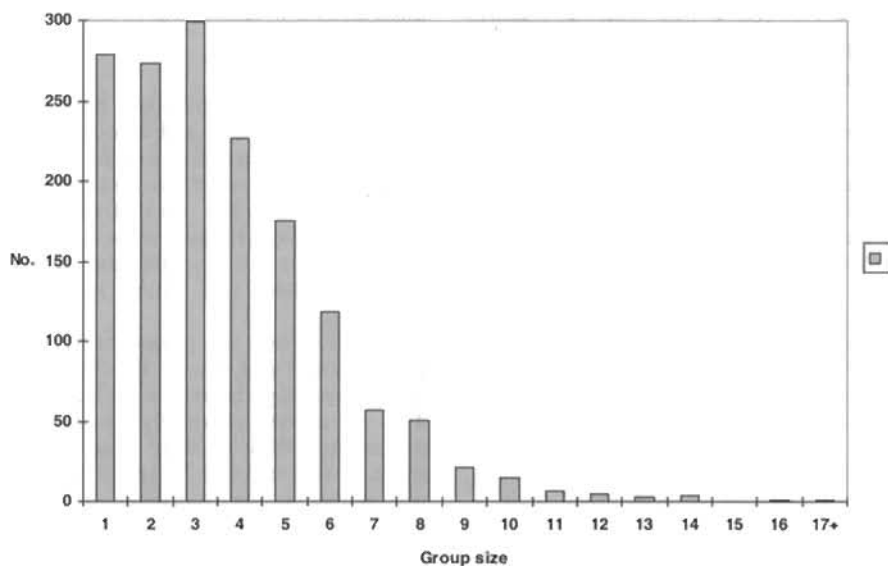


Figure 3. Total number of bottlenose dolphin sightings distributed by group size.

that 2 of them were probably adult males and 14 were probably adult females.

Of the 1534 sightings of dolphin groups, at least 352 included recognised individuals. Some of these individuals showed a high degree of site fidelity. For example, dolphins B, E and I were seen in all months of the year. Others (such as dolphins F, H, L, and P) were only seen at certain times of the

year. Although weather conditions sometimes prevented recognition, long periods during which a recognised individual was not seen were taken to imply that it was not visiting the study area at that time. Dolphins A, D, and G apparently were absent for a year or more before being seen again. Cross-reference with earlier photographs taken by Bob Morris in 1986–1989 (Morris, 1990), and by the late

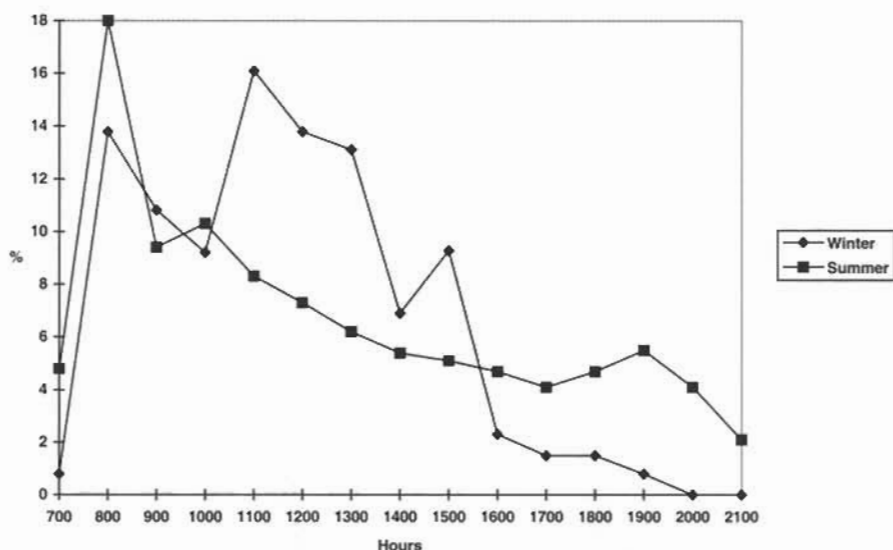


Figure 4. Variations in hourly dolphin sightings in summer and winter.

Tony Wenden in 1988–1990, showed that some of the recognised individuals were present in Cardigan Bay as adults before this 8-year study. It follows that some of the dolphins recognised from the land at New Quay, including dolphins A, B, C, F, K, L, M, and P were probably at least 14 or 15 years old.

Although some animals were only recognised in the later years of the study and some others apparently were absent for a year or more, the numbers of known individuals regularly accompanied by calves gave an indication of the proportion that were probably females (Fig. 6). On average, 50% of the recognised adults thought to be females were seen in the course of a year to have a calf. The same adults were seen less often in years when they did not have accompanying calves. By implication, the years when particular individuals did not appear off New Quay could have been ones when they did not have a calf.

From the ratio between the 16 identifiable individuals and the unmarked or unidentified ones, a rough minimum population estimate could be derived for the immediate New Quay Bay part of Cardigan Bay as 51 dolphins; 35 adults, 11 calves, and 5 juveniles.

Analysis over the 8 years of the association between identifiable dolphins that had calves in close company at some time, suggested that there could have been some loss of small calves; i.e., dolphin A lost a calf in 1989, E lost one in 1990, G in 1991 and dolphin J could have lost a calf in 1995. Some dolphins (C, E, and P) had either small or large calves with them for periods of 4 or 5 years. Unusually, an isolated small calf was observed off

New Quay for 5 weeks in June and July 1990, remaining apart from any of the mother and calf groups.

Activity

At each sighting of bottlenose dolphins, their main activity was assessed and throughout the sighting their behaviour recorded. For the purpose of analysis, these were grouped into 14 categories (Table 1). The major activities were 'travelling', 'feeding', and 'social/play'. Because most activity was seen to be purposeful, the few instances that might have been considered as 'idling' were included as 'travelling'.

Travelling was the predominant activity during both summer and winter. Feeding was the second most frequently observed activity; representing 13–43% of recorded activity by months. Highest levels of feeding (38–43%) were observed in May and again in October and November. Feeding activity was higher in the mornings between 0800 and 0900 h, and the evenings between 1900 and 2000 h. A wide range of social/play activity was observed during the study (Table 1). Social activity was seen most often in the afternoons and evenings, and was highest (20–24%) in August, October and December. It was lowest (7–13%) from January to April, when sea surface temperatures were below 10°C.

There were 8 instances where dolphins were seen lying still at the surface, and 7 instances of previously unobserved dolphins apparently 'waking in alarm'. It appeared that sleeping animals suddenly awoke to the close proximity of

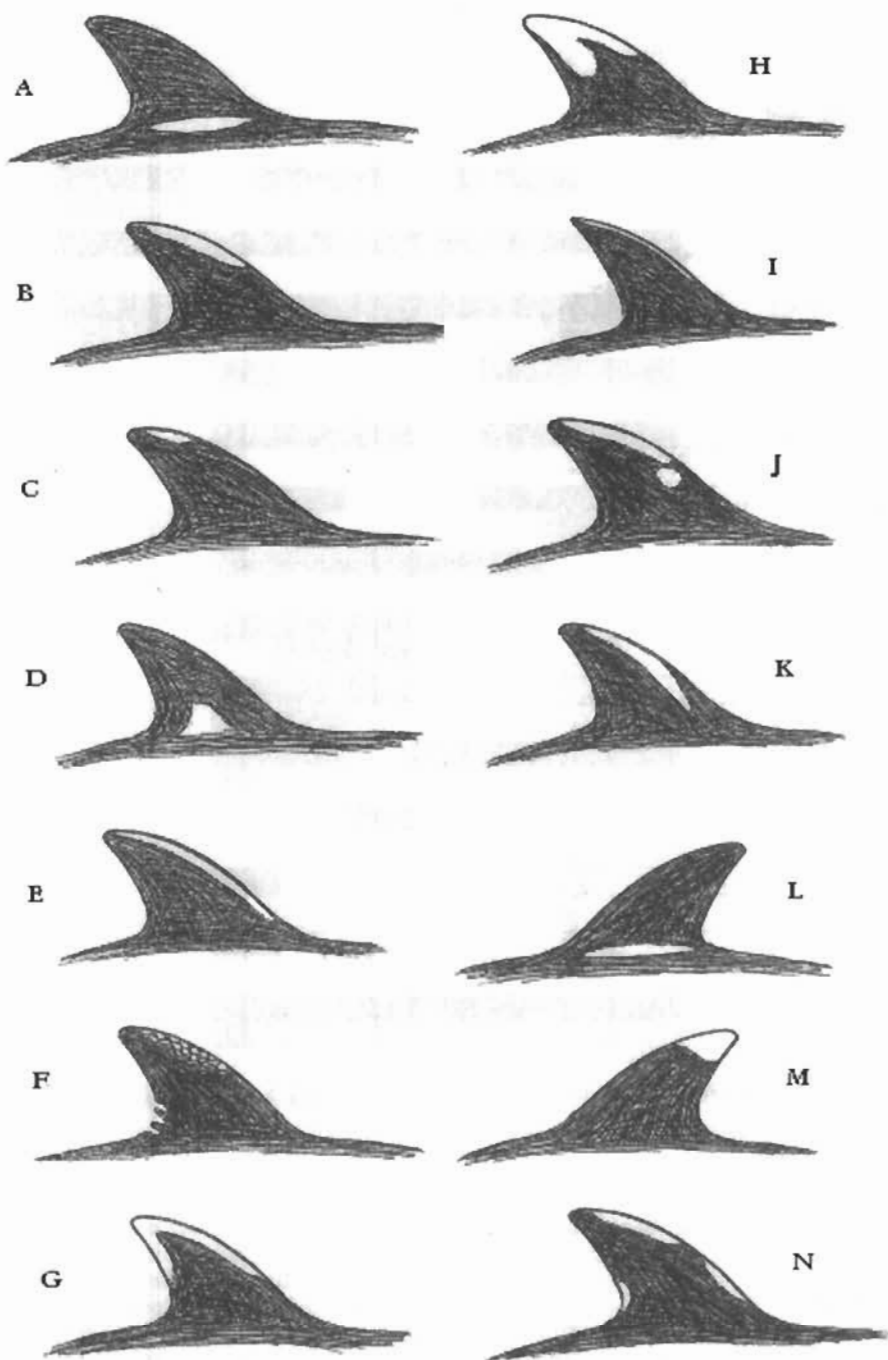


Figure 5. Examples of dorsal fin markings of recognised individuals (one side shown only).

an approaching boat, and made one or two huge leaps, almost as a reflex action. Subsequent observations close to the quay, in clear water (first

author and Glanville, 1999, personal communication), confirmed that 'sleeping' dolphins, seen in a surface-hanging position, behaved this

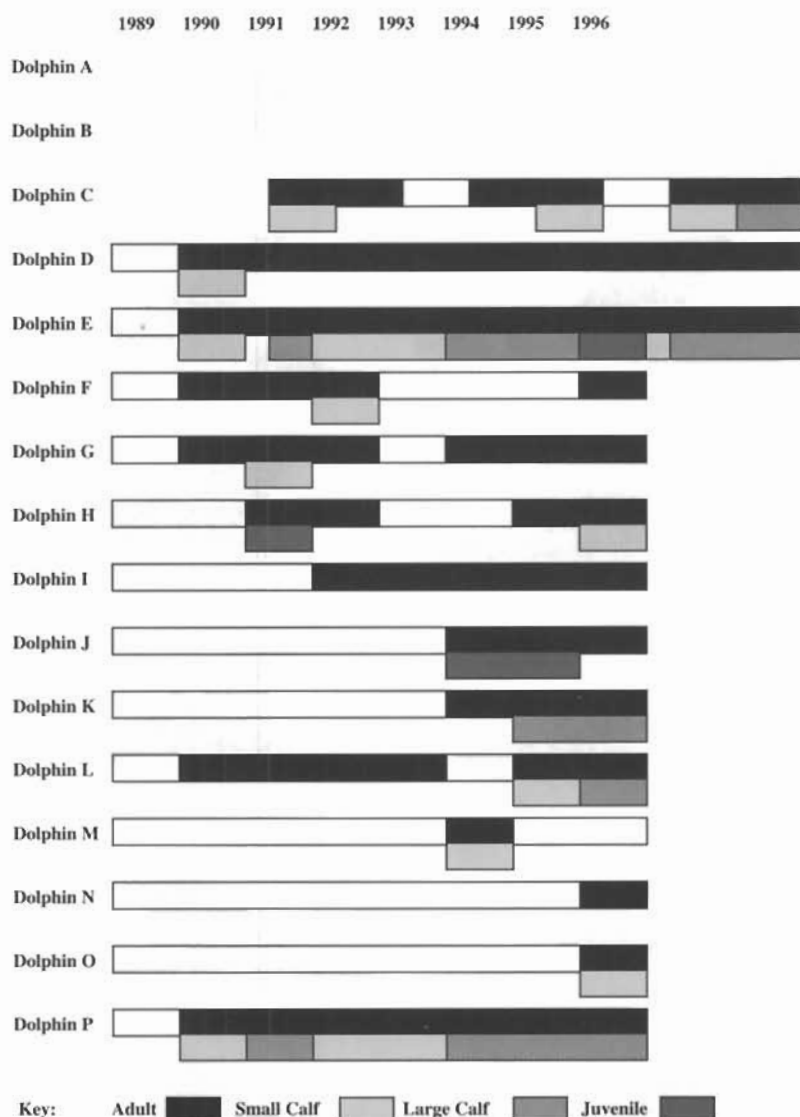


Figure 6. Site fidelity and calf associations for recognised individuals.

way when approached by a boat leaving the harbour.

Dolphins and boats

Encounters between boats and groups of dolphins were recorded for boats that came within 100 m. The dolphin responses were recorded and assessed as positive, negative or no response. Bow riding was considered a positive response and other changes in behaviour, resulting in disturbance or avoidance (Table 1), were regarded as negative. Over the 8 years of the study, boat encounters

within 100 m during observation hours, increased from 8 in 1989, to 79 and 71 in 1995 and 1996 respectively, by which time they represented 32% and 28% of yearly dolphin sightings. Negative responses increased from 2 in 1989, to 11 in both 1995 and 1996, while positive responses increased from 2 in 1989, to 9 and 5 in 1995 and 1996, respectively. Analysis by boat type showed that yachts and small commercial fishing vessels induced most bow riding, or positive, responses, while commercial trip boats and other powerboats induced most negative responses.

Interactions with other sea mammals

Harbour porpoises (*Phocoena phocoena*) were only noted on 57 days over the 8-year period of this study, of these, 43 were in the January to April period when the frequency of dolphin sightings was low. On only 17 days were the two species seen on the same day, and on 15 of these they were present at different times. In winter, the porpoises came close inshore, but if seen at all in summer, when there was more boat and dolphin activity, they remained well offshore. On two occasions, in July 1989 and November 1996, groups of porpoises and dolphins were seen in close proximity, either travelling only 200 m apart, or swell riding and playing within 100–200 m of each other. In the second instance both groups contained a calf. In neither instance did the larger species attempt to drive the other away.

Grey seals (*Halichoerus grypus*) are common along the Cardigan Bay coast and were regularly seen close to the quay at New Quay, but no interactions with dolphins were observed.

Tidal states and sea surface temperatures

Dolphins appeared close inshore at New Quay at all states of the tide, but no relationship was found between sightings and different tidal states.

Inshore sea surface temperatures for southern Cardigan Bay were supplied by the Meteorological Office based at the military test facility, Aberporth, 14 km south-west of New Quay, and were taken from an automated buoy moored offshore. During the 8-year period of this study, summer maximum sea surface temperatures ranged from 16.5 to 18.5°C, always exceeding the previous 50-year average of 15°C (1905–1954). Winter minimum sea surface temperatures ranged from 5 to 8°C. On average over the study period, sea temperatures fell below 10°C by 31 December and did not rise above 10°C until the end of April. This coincided with the period with fewer sightings, indeed throughout the year the frequency of sightings correlated with sea temperature. In February 1991 and February 1996, sea surface temperatures fell to 5°C, the result of persistent northerly winds. Dolphin sightings were infrequent at those times, and the low temperatures induced a marked change in behaviour with very slow travel and greatly increased diving and blowing intervals.

Discussion

This long continuous study of an open-coastal bottlenose dolphin population originated from an earlier more intermittent study (Morris, 1990). The main aim was to discover more about the ways dolphins use New Quay Bay, by recording as many

aspects of activity and behaviour as possible from shore-based observations.

Morris (1990) described a 'resident' group of between 5 and 9 bottlenose dolphins based on New Quay with a 'home range' of 32 km of coastline. Although his study only covered a limited number of days per year, observations from the present study fit his suggestion that there were 'resident' dolphins, regular 'visitors' and 'migrants' that sometimes joined the 'residents' for periods of days or weeks.

The present study provided confirmation of year-round use of the waters off New Quay by bottlenose dolphins. The data on recognised adults showed that some were seen throughout the year, some seasonally, some irregularly, and others were present throughout some years, but apparently were absent from the area for a year or more. However, this study supported the view that group associations were somewhat fluid and the situation was more complex than a single coherent 'resident' group staying in the New Quay area. Some dolphins showed a high degree of site fidelity, having been observed at New Quay for 11 years (Morris, 1990 and this study).

The high proportion of sightings of groups of adults with accompanying calves, together with the site fidelity shown by recognised individuals when accompanied by calves, strongly indicated that this sheltered location was a nursery area for the species. Several dolphins had accompanying calves for 4 or 5 years, which accords with the findings from the long-term study at Sarasota, Florida, where calves, although weaned at 18 months, continued to associate with their mothers for 3–6 years (Wells, 1991). The records of recognised dolphins with calves over the 8 years, indicated the loss of some small calves. Morris, in his study, reported the death of a small calf in June 1988, that had been born to dolphin L in July 1987. This study showed that dolphin L was present in 6 out of 8 years, and had another accompanying calf in 1995 and 1996.

The extrapolated estimate of 51 dolphins coming into New Quay Bay during the period of this study is considerably more than the 'resident' group postulated by Morris (1990). This could indicate that several groups use the inshore waters around New Quay, coming together mainly between September and December. A boat-based photo-identification study of the wider Cardigan Bay area between 1990 and 1994 (Grellier *et al.*, 1995), estimated that the minimum population using or visiting Cardigan Bay was around 127 dolphins. However, that was based on only 105 encounters with bottlenose dolphins, of which just 71 were inshore observations. Grellier *et al.*, also stated that there was insufficient data for the December–June period each year to assess distribution and group size in that period.

Therefore, the three studies would appear to leave open the question of how many bottlenose dolphins use Cardigan Bay.

The observation of bottlenose dolphins and harbour porpoises together on two occasions during this study is interesting. In the Moray Firth, the other location in the U.K. with a well-documented 'resident' bottlenose dolphin population, the dolphins have attacked harbour porpoises (Ross & Wilson, 1996). It also was reported that in Cardigan Bay, one stranded harbour porpoise was found on post-mortem examination to have sustained traumatic injuries consistent with a dolphin attack (Jepson & Baker, 1998). The observations in this study gave no indications of such reactions between the two species.

Around New Quay the bottlenose dolphins showed a tolerance to increasing boat traffic. This suggests that whatever features make southern Cardigan Bay attractive to them, outweighs the levels of disturbance they were subjected to. The dolphins also regularly visited the area at 8–10 day intervals, when winter sea surface temperatures were as low as 5°C. If fisheries landing statistics by ICES statistical rectangles can be taken as a rough guide to relative fish productivity in different parts of the Irish Sea, Cardigan Bay is only a tenth as productive as the north-western part of the Irish Sea, where conversely there are few records of bottlenose dolphins. Close inshore in southern Cardigan Bay; however, there are relatively small patches of muddy heterogeneous ground, supporting a relatively rich benthos (Mackie *et al.*, 1995).

This study leaves no doubt that the area off New Quay is favoured by bottlenose dolphins, possibly as a sheltered location suitable for calf-rearing. This underscores the importance of year-round, detailed, observations of dolphin activity in the area. In the particular circumstances of this location, year-round surveillance from the land by trained volunteer observers could provide a cost-effective means of detecting changes in site usage. A group was set up to maintain such watches from 1998 onwards.

Acknowledgments

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