

**BOTTLENOSE DOLPHINS
&
BOAT TRAFFIC
ON THE
CEREDIGION COAST,
WEST WALES**

2004 & 2005

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SUMMARY

- The Ceredigion Coast Bottlenose Dolphin and Boat Traffic Survey provides a thirteen year time-series of cetacean occurrence, habitat use, levels of boat traffic and interactions between bottlenose dolphins and boats in Cardigan Bay. Observer effort exceeds 8000 h.
- Sighting rates of bottlenose dolphins were highest at Mwnt in 2004 and in 2005, when dolphins were present in 81% of 2 h observation periods. Sighting rates were higher at Mwnt, Ynys Lochtyn and New Quay Harbour than at Aberporth, New Quay Birds Rock and at Aberystwyth. Sighting rates in 2004-05 were comparable with previous seasons.
- Dolphin aggregations at Mwnt were significantly larger at Mwnt in both years (e.g. 2004 mean = 5.0, 95% CI = 4.2-5.8, n = 66) than at Aberporth (mean = 2.8), New Quay Birds Rock (mean = 2.9) and New Quay Harbour (mean = 3.6). Double figure counts were recorded at Mwnt, Ynys Lochtyn and New Quay Harbour in 2004 and in 2005.
- Dolphins occupied most sites for similar periods, but for significantly longer at New Quay Harbour than at Birds Rock.
- In accordance with previous reports, female dolphins with calves were recorded more frequently at Mwnt than elsewhere; the high level of occurrence (> 50% of watches in which dolphins were present) suggested site fidelity by females with calves through the summer months.
- The locations of bottlenose dolphin sightings were plotted for 2004 and 2005 and the data used to describe dolphin high-use areas or 'hot spots' within the study sites.
- The relative frequency of a wide range of dolphin activity states was reported. Most observations were of location-based or 'staying' activity, emphasising the importance of local habitats. The relative frequencies of 'staying' and 'travelling' varied between sites.
- Deep foraging was the most common activity – characterised by repeated long dives around the same location. The ratio of deep foraging to other activities was particularly high at New Quay Harbour. In common with the Moray Firth, bottlenose dolphins at our study sites appear to use some specific high-use feeding areas. In contrast however, foraging for prey close to

the sea-bed appears more common in Cardigan Bay than prey pursuit close to the surface. This difference is likely to reflect the exploitation of distinctly different foraging habitats in the two regions.

- Clear differences in levels of boat traffic were evident between the busiest sites (New Quay Harbour and Aberystwyth) and the other sites. Mwnt continued as the site with lowest levels of boat traffic. There was little evidence of increasing boat traffic levels at Mwnt or elsewhere.
- Encounter rates between boats and bottlenose dolphins were highest at New Quay Harbour and Ynys Lochtyn. Recreational motorboats accounted for the highest encounter rates at most sites, although Visitor Passenger Boat trips were important contributors at New Quay Harbour, Birds Rock and Ynys Lochtyn.
- 945 boat encounters were examined for rates of compliance / non-compliance with codes of conduct for boat users. Compliance with the code of conduct was high, particularly at New Quay Harbour (93%) and New Quay Birds Rock (92% of boat encounters). Rates of compliance fell slightly with increasing distance from New Quay. The public awareness programme works well at New Quay but more attention is required at more remote boat launching points.
- Most cases of non-compliance involved vessels travelling too fast when close to dolphins. Operators of fast boats (speedboats, water-skiers and jet-skis) were those most likely not to follow the code of conduct.
- However, compliance with the code of conduct significantly reduced the incidence of negative response behaviours by bottlenose dolphin schools (these behaviours included heading directly away from the boat quickly, steadily or making long dives to avoid vessels). The frequency with which the structure of groups changed (close groups formed or aggregations of animals split up) was also lower when the code of conduct was followed. These results accounted for the density of boats in the vicinity of the dolphins at the time.

INTRODUCTION

Observations at six study sites in 2004 and 2005 represented the eleventh and twelfth season respectively, of the Marine Heritage Coast Bottlenose Dolphin and Boat Traffic survey. This is our fifth survey report (Pierpoint & Allan 2000; 2001; 2002; 2004) and the project continues to evolve. Originally observations focussed on three study sites to look at bottlenose dolphin occurrence and the use of boats within the Marine Heritage Coast (MHC). We added a fourth site at Mwnt with the help of the South & West Wales Wildlife Trust when the then candidate Cardigan Bay Special Area of Conservation (SAC) was established. In 2004 we introduced a new site at Castle Rocks, Aberystwyth with the support of Friends of Cardigan Bay, and we also collaborated with the Sea Watch Foundation and the Cardigan Bay Marine Wildlife Centre in establishing a study site at New Quay Harbour for the first time. The Aberystwyth site is allowing us to make comparisons between the managed recreational boating areas of the SAC and elsewhere on the Ceredigion coastline. The collaborative study at New Quay enabled us to compare the busy harbour area with data from our established location above Birds Rock, on the western side of the New Quay Headland.

We also made some fundamental changes to the information we collect: we switched to a map-based recording system, and we also made direct assessment of the compliance of boat operators with the existing codes of conduct. These changes have yielded a wealth of information. The present report continues to follow the existing time-series of sighting rates and boat traffic. Sightings are plotted and used to identify important bottlenose dolphin habitat. The relative occurrence of various dolphin behaviours is described. Interaction between dolphins and boats are examined and the data are applied to help guide management of boating in the coastal zone. The adoption of Geographic Information System methods however, provides opportunities for additional analysis, beyond the scope of the present report - we hope that the project will continue to attract collaborative studies to improve the detail of our understanding of bottlenose dolphin ecology in Cardigan Bay.

METHODS

We examined observations of bottlenose dolphin at six study sites in Cardigan Bay, Wales, from June to September in 2004 and 2005. These data were collected by a team of volunteers, most of who had already taken part in the project in previous years. The study sites were located at Mwnt, Aberporth, Ynys Lochdyn, New Quay Head (Bird's Rock look-out), New Quay Harbour and Castle Rocks Aberystwyth (Fig. 1). Records at New Quay Harbour were collected and contributed to the MHC database by the Sea Watch Foundation and the Cardigan Bay Marine Wildlife Centre.

Habitat use by bottlenose dolphins

Three 2 h watches were scheduled daily at each site beginning at 11:00, 13:00 and 15:00. At New Quay Harbour, SeaWatch carried out additional watches beginning at 07:00 and 09:00. The two-hour watches were divided into eight successive 15 min intervals. At the beginning of each interval the start time and information on sighting conditions (general weather and visibility, wind direction and sea state) were recorded on a data sheet (Appendix 2). This information was later used to extract a sub-set of observations made in good conditions (visibility at least 2 km, sea state 3 or less) for which sighting rates of bottlenose dolphins were calculated and comparisons made between study sites.

When marine mammals were present at the site (or any other mega-fauna such as basking shark and ocean sunfish) their locations were marked on a map form (Appendix 3). Locations were estimated by eye within a grid of guidelines to landmarks. A 'school' was considered to be animals of the same species in close proximity (within about 10 body lengths of another animal) and behaving in a similar manner. Abbreviated codes were written against each school location giving species name, group size, number of small calves and activity state at the beginning of the 15 min interval or when first seen.

From these systematic counts we derived sighting rates for bottlenose dolphins. We used two indices to make comparisons between sites and with previous field seasons. The indices were a) the proportion of 2 h watches in which dolphins were recorded; and b) the average count of dolphins per 15 min per 2 h observation period. Sea Watch operated a longer field season New Quay Harbour (April - November). A preliminary

look at these data showed that numbers of sightings increased at New Quay from June onwards. In site comparisons therefore, sighting rates were calculated from observations recorded between the beginning of June and the end of September. Sighting rates for each site in 2004 and 2005 were compared statistically, initially using Kruskal-Wallis tests; if a significant difference was found between any sites (at $P < 0.05$) then all pair-wise comparisons were made (Dwass-Steel-Christchlow-Fligner).

For watches in which dolphins were recorded at least once we calculated a further three indices: c) Group size ~ as a measure of the average group size or number of dolphins aggregated at each site, we used the mean of the highest count recorded in each watch. By using the maximum counts we did not estimate the total number of dolphins seen in each two hours, as we could not identify individual animals or account for those which may have transited through the site earlier or later in the watch.

d) Occurrence of bottlenose dolphin calves ~ we looked at the proportion of watches in which small calves were seen. Young bottlenose dolphins were recorded as calves if they were distinctly paler than the accompanying adult and approximately or less than, 2/3 of the adult length. Foetal folds were often visible on a calf's flanks.

e) Site occupancy ~ to examine the amount of time that dolphins tended to occupy habitats at each site we calculated the average number of 15 min intervals with bottlenose dolphins present per watch, for watches in which dolphins were recorded at least once.

Observers were asked to assign an activity code to each dolphin group at the beginning of every 15 min interval. This allowed us to describe the relative frequencies with which different dolphin behaviours occurred. Nine activity codes were used (Appendix 1). These were sub-divided into 'staying' behaviours, for activity centred around the same approximate location; and 'travelling' behaviours, which occurred as animals moved into or across the study sites. To help observers decide on the most appropriate code to use, dolphin behaviour was further grouped into fast-moving, energetic or 'hi-key' activity and predominantly slow-moving or 'lo-key' activity. Although some observers also recorded changes in activity through the 15 min intervals, only the first activity has been

used here and this was considered as a systematic sample of dolphin activity state at each site.

The locations of all sightings were transferred manually from the map forms to a Geographic Information System. This was carried out as precisely as possible, and positions relative to the same guidelines used on the map forms. Each location was then tagged with an index providing a link all other data from the observation, which stored in a Microsoft Access database. This enabled us to extract and plot animal locations by any of the associated sighting data (e.g. species, calves), effort data (e.g. date, time of day) or environmental data (e.g. sea state, wind direction). Sightings have been displayed here with depth contours, but the data are available for comparison with any information that can be stored as a GIS layer. This might include detailed information on bathymetry, sea-bed communities or fish distribution.

Encounters between bottlenose dolphins and boats

Further information was recorded on the data sheet when boats came within 300 m of a bottlenose dolphin school. This event constituted a 'boat encounter'. Only the first encounter in each 15 min interval was recorded - as we wished to calculate relative encounter with different types of boat, this procedure reduced the likelihood of bias towards particular types of boat that observers may have considered to have greater impact on dolphin behaviour. For each boat encounter the observer recorded the type of boat that was closest to a dolphin; the total number of boats within 300 m radius of the dolphin group; an assessment of whether this boat complied with the code of conduct for boat users; and listed the dolphin behaviours that were observed.

Observers assessed whether boat operators complied with the existing codes of conduct. Boat operators were considered to have complied if they either passed the animals at no-wake speed, with no erratic alterations of course (code Y1), or slowed down gradually and stopped (Y2). Four codes available for cases when the operators did not comply, either because: they were travelling too fast within 300 m of dolphins (N1); they followed an erratic course to approach, avoid or follow dolphins (N2); they attempted to touch, feed or swim with dolphins (N3); or they were clearly exceeding 8 kt within a buoyed, low speed zone at New Quay (N4). A special code (R) was used when the boat involved was a vessel permitted under licence from the Countryside Council for

Wales, to approach bottlenose dolphins for research purposes. These vessels carried a flag or banner with which to identify themselves when they were engaged in research.

We examined whether following the code of conduct affected how dolphins responded to encounters with boats. Observers recorded the occurrence of 'response behaviours' during encounters (appendix 1). In analyses reported here some behaviours were grouped together - for example 'heading away, fast swimming' and 'heading away steadily or in a series of long dives' were grouped as *negative response* (a change of dolphin behaviour to move away from a boat); similarly, 'approaching', 'bow-riding' and 'following boat' were grouped as *positive response*. It is likely that the overall density of boats as well as the proximity and behaviour of closest boat, affect the response of dolphins during boat encounters. We accounted for boat density initially with six boat density categories here (Table 1). Categories A and B, and D & E were combined in some cases to improve sample sizes. Goodness-of-Fit tests were used to compare the frequencies that responses were recorded in different circumstances.

General levels of boat traffic in 2004 and 2005 were compared to previous years using standard 2 h boat counts. These data were tally counts of different types of boat in each watch. Boat use at each site was described by comparing the relative frequency with which different types of boat were recorded at each site.

Table 1. Boat density categories used within this report.

<i>Boat density category</i>	<i>Boats within 50 m</i>	<i>Total boats within 300 m</i>
A	at least 1	5 or more
B	at least 1	2 to 4
C	at least 1	1 only
D	none	5 or more
E	none	2 to 4
F	none	1 only

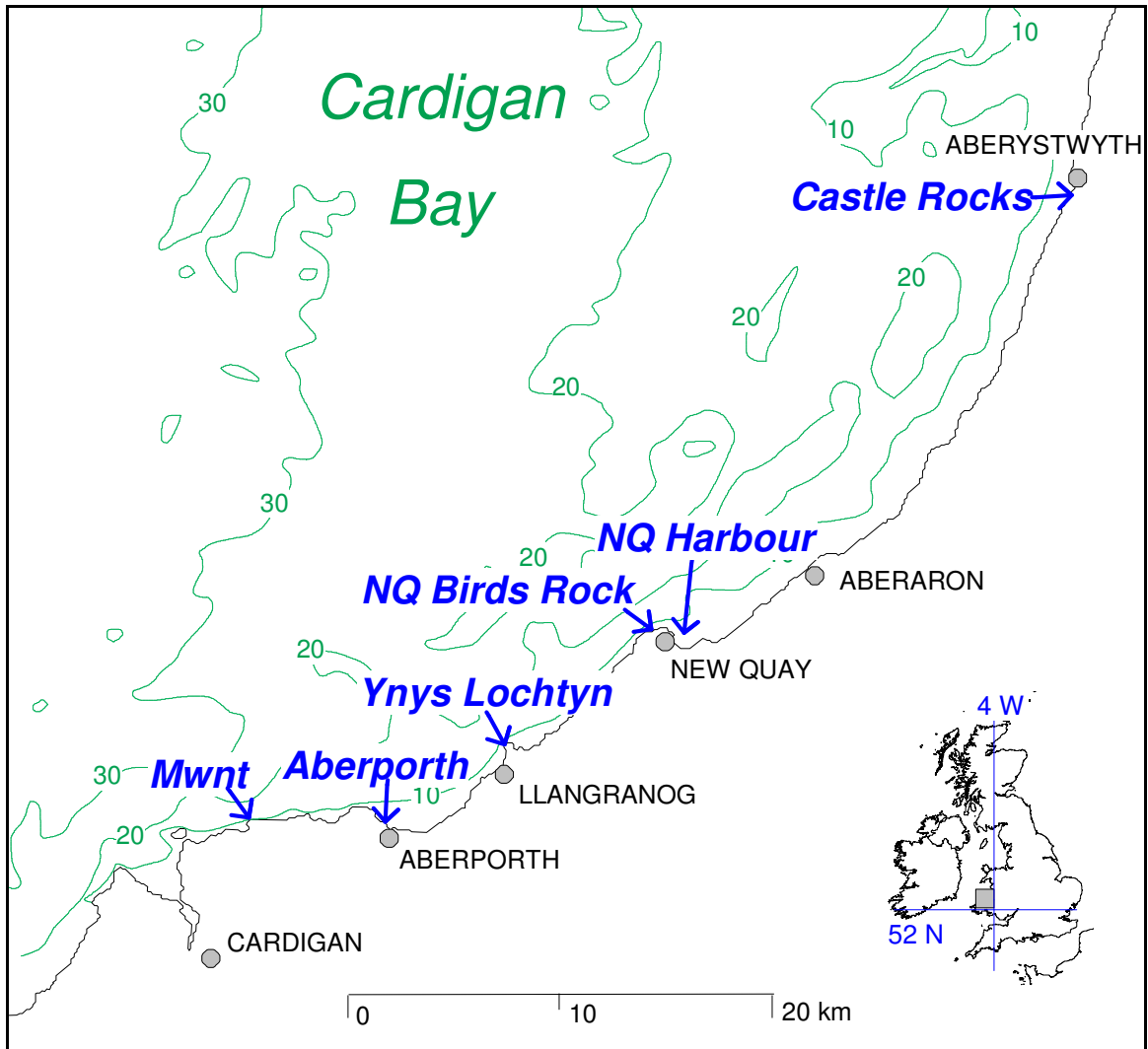


Fig. 1 The location of the six study sites: Mwnt, Aberporth, Ynys Lochtyn, New Quay Birds Rock, New Quay Harbour & Castle Rocks Aberystwyth, in Ceredigion, West Wales. Water depth is shown in metres.

RESULTS

Observer effort

In 2004 and 2005, 658 and 751 observation periods (watches) were carried out respectively. Since the first season's field work in 1994, a total of 3854 watches have been completed; this equates to 8075 h observer effort. Table 2 shows at which sites observations were carried out each year and each year's total effort hours. Originally observations were carried out at three sites in the MHC: Aberporth, New Quay Head and Ynys Lochlyn. A survey at Mwnt was included in 1998. In 2004, watches at Aberystwyth were carried out for the first time. The Sea Watch Foundation with support from the Cardigan Bay Marine Wildlife Centre, also began collecting data at New Quay Harbour using the same protocol in 2004 and the project benefited from the substantial number of observations carried out at this site in 2004 and 2005.

Sighting conditions

In 2004 and 2005, 89% and 88% of 2 h watches were completed in relatively good conditions for observing marine mammals. During these watches there was always at least 2 km visibility and sea state did not exceed Beaufort 3 sea surface criteria (HMSO 1983) in each of eight successive 15 min intervals. Sighting rates for bottlenose dolphin on the Cardigan Bay coast from June to September, were thereby calculated from 1127 observation periods: 564 in 2004 and 563 in 2005. In both years and at all sites with the exception of New Quay Harbour, the median sea state value recorded was 2 (small wavelets and no white-caps). At New Quay Harbour, which is afforded some shelter from the prevailing winds, the median sea state was 1 in both 2004 and 2005. The most frequent wind direction was south-west: westerly, south-westerly and north-westerly winds accounted for 74% and 65% of observations in 2004 and 2005 respectively. Some scheduled watch periods were cancelled due to poor visibility and of the watches that were carried out, sea mist affected 10 (2%) and 24 (3%) observation periods in 2004 and 2005 respectively. Fog or mist was slightly more prevalent in 2005 than in 2004 and affected 5-8% of watches at Aberporth, New Quay Birds Rock, Mwnt and Ynys Lochlyn. Although sea mist reduced visibility in 8% of watches at Birds Rock in 2005, it was only recorded in 1% of observation periods at the adjacent harbour area in both years.

Table 2. Study sites and total effort hours. Years in which observations were made at each site from 1999-2003 are indicated with an 'X'. Total effort hours are provided for each year, and for each study site in 2004 and 2005.

Sites	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AB	X	X	X	X	X	X				X	166	165
CR											67	51
M					X	X		X	X	X	216	204
NQ BR	X	X	X	X	X		X	X	X	X	213	237
NQ HA											554	762
YL	X	X	X	X	X	X			X	X	77	80
Hours	251	770	992	885	694	426	171	270	399	678	1294	1498

Sites:

AB	Aberporth
CR	Aberystwyth, Castle Rocks
M	Mwnt
NQ BR	New Quay, Bird's Rock
NQ HA	New Quay Harbour
YL	Ynys Lochtyn

Sighting rates of bottlenose dolphins

The highest sighting rates for bottlenose dolphins in 2004 and 2005 were observed at Mwnt, Ynys Lochtyn and New Quay Harbour (Fig. 3). The average number of dolphins recorded per 15 min per 2 h observation period was significantly higher at Mwnt than at Aberporth, New Quay Birds Rock and at Aberystwyth in both years (Dwass-Steel-Chritchlow-Fligner, $P < 0.05$), and higher than that recorded at New Quay Harbour in 2005 ($P < 0.01$). Inter-annual variation is shown in Figs. 4 - the average number of dolphins present per 15 min interval per 2 h watch, and Fig. 5 - the proportion of 2 h watches in which dolphins were recorded year by year. Sighting rates for 2004 and 2005 are summarised below for each site.

Mwnt

As in previous years, the highest sighting rates of bottlenose dolphins were recorded at Mwnt. Dolphins were present in 73% and 81% of 90 and 84 observation periods carried out in 2004 and 2005 respectively. This was the highest occurrence of dolphins yet recorded at this or any other study site. The number of dolphins recorded per 15 min effort was higher than elsewhere and very similar in 2004 (1.34) and 2005 (1.37).

Aberporth

In 2004, bottlenose dolphins were recorded in 39 of 72 observation periods (54%) carried out at Aberporth in favourable sighting conditions. This is the highest occurrence of dolphins recorded at Aberporth so far. In 2005, dolphins were present in 22 of 66 two-hour watches (33%), which is also higher than in several previous seasons.

The average number of dolphins present per 15 min was 0.64 in 2004, again the highest sighting rate yet recorded at this site. The sighting rate in 2005 was 0.32 animals per 15 min observation; this was lower than was recorded at Mwnt, Ynys Lochtyn and New Quay Harbour but consistent with previous years' sighting rates at Aberporth.

Ynys Lochtyn

Bottlenose dolphins were recorded in 52% and 57% of 30 and 28 observation periods at Ynys Lochtyn in 2004 and 2005, in which it was the third and second highest ranking site. A wide confidence interval associated with the average number dolphins / 15 min / 2 h value, was due to relatively few observation periods having been carried out at Ynys Lochtyn compared to most other sites. Sighting rates at this site in 2004 (0.89) and 2005 (1.05) were however, some of the highest values observed since 1996.

New Quay Birds Rock

Sighting rates at New Quay Head in 2004 were similar to those recorded in recent years and lower than rates of dolphin occurrence recorded in 2000 and during the mid- to late-1990s. Sighting rates fell further in 2005 however, when dolphins were recorded in 29% of 82 observation periods. Average counts were 0.38 in 2004, and 0.27 in 2005.

New Quay Harbour

Sea Watch recorded high rates of dolphin occurrence in New Quay Harbour. Dolphins were present in 61% and 54% of 262 and 281 watches carried out between June and September, in 2004 and 2005 respectively. The sighting rate at New Quay Harbour was lower in 2005 than 2004 as it was at New Quay Birds Rock also. Average counts were 0.93 and 0.70 dolphins per 15 min per 2 h, which was significantly higher than at New Quay Birds Rock in both 2004 and 2005 ($P < 0.01$).

Castle Rocks, Aberystwyth

Sighting rates were lower in Aberystwyth than at study sites elsewhere. Dolphins were seen in only one (the first) of 31 observation periods in 2004 and in 4 of 22 observation periods in 2005. Mean counts were 0.05 and 0.09 dolphins per 15 min per 2 h in 2004 and 2005 respectively.

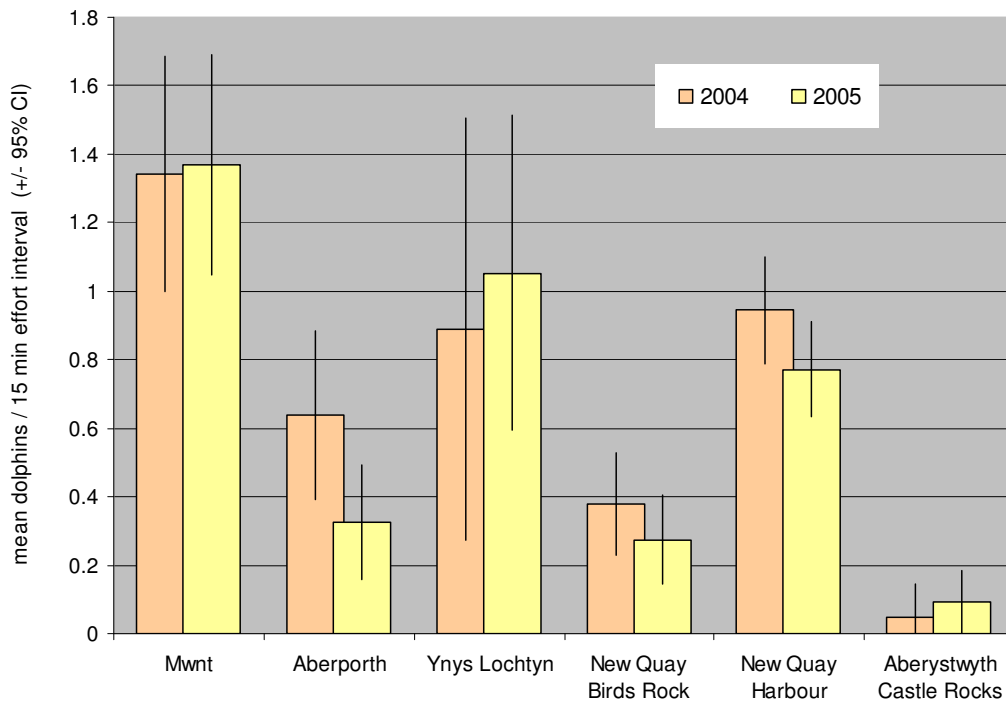


Fig. 3 The average number of bottlenose dolphins present per 15 min per 2 h watch: June-Sept 2004 and 2005.

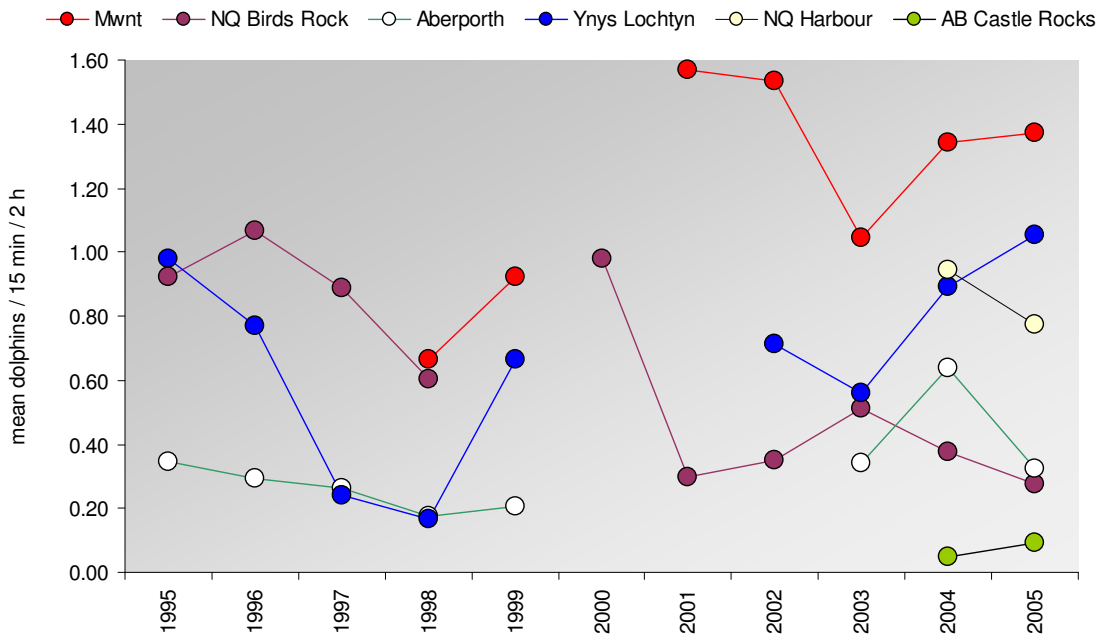


Fig. 4 The average number of bottlenose dolphins present per 15 min per 2 h watch: 1995-2005.

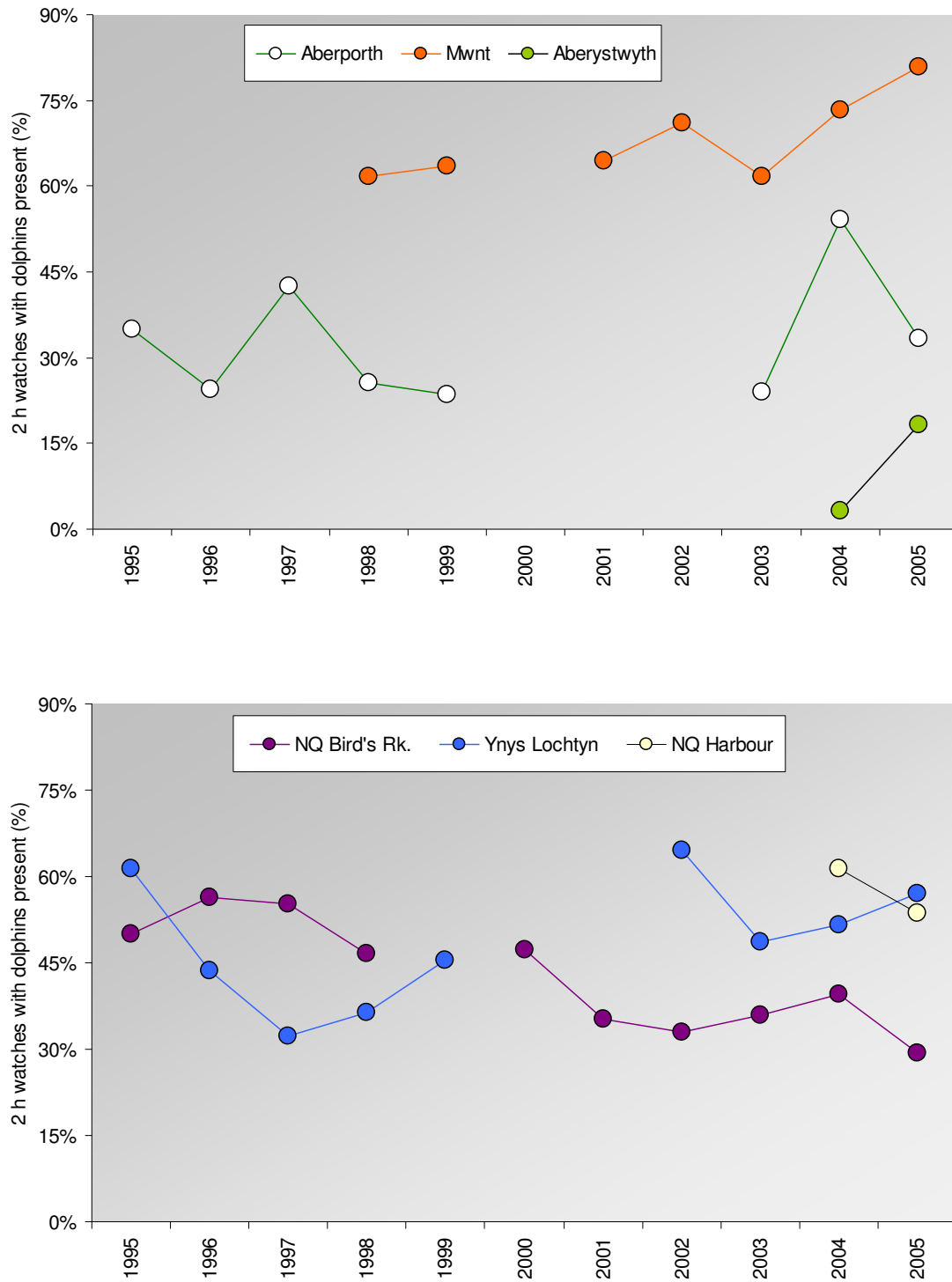


Fig. 5 The proportion of 2 h watches in which bottlenose dolphins were recorded: June-Sept 1995-2005. Data for watches carried out in sea state 3 or less and good visibility only.

Group Size

We used the highest counts of dolphins present in observation periods when sightings occurred, as a measure of group size. The counts may have included both groups of dolphins that habitually travelled together and temporary aggregations of unassociated animals.

Two sites tended to attract larger groups of dolphins than other sites: the average maximum count at Mwnt and at Ynys Lochtyn was higher than 4 animals in both 2004 and 2005 (Table 3). Average group size at New Quay Harbour was intermediate between these two sites and Aberporth and Birds Rock where relatively small aggregations of animals were seen. There were significant differences in average counts between sites in 2004 (Kruskal-Wallis: $T(\text{adj}) = 24.9$, $P = 0.001$) and in 2005 ($T(\text{adj}) = 29.1$, $P < 0.001$). Pairwise comparisons found significantly higher group size at Mwnt than at Aberporth, New Quay Birds Rock and New Quay Harbour in both years.

Table 3 Highest counts per 2 h as a measure of group size. The table shows the average highest count watches in which bottlenose dolphins were recorded, the 95% Confidence Interval and the number of 2 h observation period included (n).

	2004 mean	95% CI (n)	2005 mean	95% CI (n)
<i>Mwnt</i>	5.0	4.2 – 5.8 (66)	4.7	4.0 – 5.4 (68)
<i>Aberporth</i>	2.8	2.2 – 3.5 (39)	2.7	1.9 – 3.4 (22)
<i>Ynys Lochtyn</i>	4.1	2.4 – 5.8 (17)	4.6	3.1 – 6.1 (16)
<i>New Quay Birds Rock</i>	2.9	2.2 – 3.6 (30)	2.9	2.2 – 3.6 (24)
<i>New Quay Harbour</i>	3.6	3.2 – 4.0 (161)	3.1	2.8 – 3.4 (170)
<i>Aberystwyth Castle Rocks</i>	5.0	n = 1 only	2.0	2.0 – 2.0 (4)

The highest counts recorded at each site in 2004 and 2005 were as follows: Mwnt = 19 & 14 dolphins; Aberporth = 8 & 7 dolphins; Ynys Lochtyn = 14 & 23 dolphins; New Quay Birds Rock = 9 & 7 dolphins; New Quay Harbour = 15 & 16 dolphins; Aberystwyth Castle Rocks = 5 & 2 dolphins.

Site occupancy

Occupancy, in this case, refers to the amount of time that bottlenose dolphins were present at each study site. It has been measured as the average number of 15 min intervals with dolphins recorded per 2 h watch in which dolphins were seen.

In general we found that there was little difference in the amount of time that bottlenose dolphins tended to occupy each of the study sites and that the average values were similar from 2004 to 2005. Excluding Aberystwyth, for which there were too few watches with dolphins to allow fair comparisons with other sites, the highest rates of occupancy were found at New Quay Harbour and Ynys Lochtyn. Occupancy at Ynys Lochtyn was not significantly different from other sites, but dolphins spent longer periods at New Quay Harbour than at New Quay Birds Rock in both 2004 and 2005 (Dwass-Steel-Chritchlow-Fligner, $P < 0.05$).

Sightings of bottlenose dolphin calves

Bottlenose dolphin calves were more often seen at Mwnt than at other sites: calves were present in over 50% of observation periods with dolphins. A high proportion of watches with dolphin calves present (56%) was also recorded at Ynys Lochtyn in 2005. Elsewhere calves were recorded in approximately 15-25% of observation periods. Similar rates of calf occurrence were recorded at both New Quay sites, and showed an increase in 2005 from the previous year.

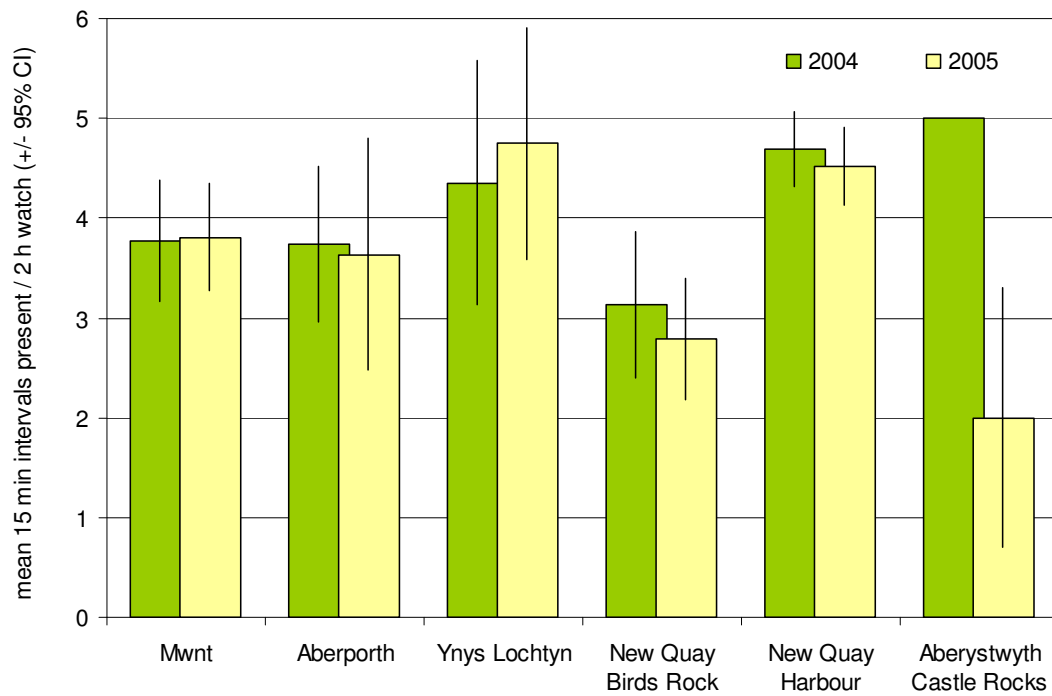


Fig. 6 The average number of 15 min intervals that sites were occupied by bottlenose dolphins.

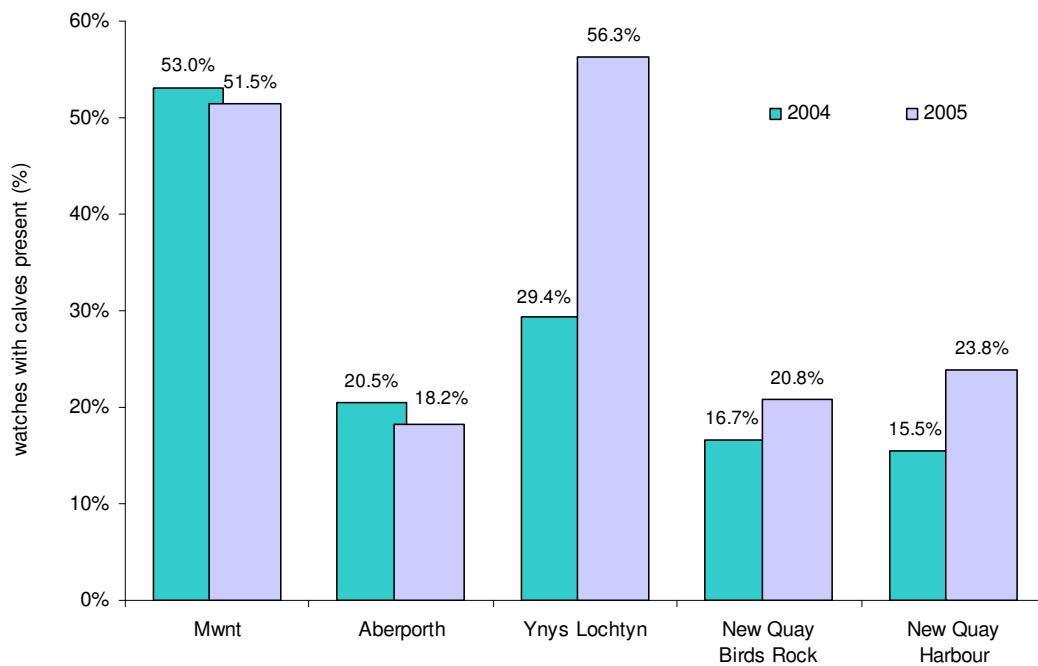


Fig. 7 The proportion of watches with dolphins present in which dolphin calves were also recorded.

Fine-scale site use

The location of each bottlenose dolphin school was plotted for 2004 and 2005 (Figs. 8-13). Specific parts of each site attracted more dolphin activity than others. Although sightings were widespread they appeared focused at these locations rather than being randomly distributed through each site.

At Mwnt, dolphins spent most time within approximately 500 m and north of the observers' position on the headland. Clusters of sightings were recorded west of the headland also and in 2005, off the Pen Peles reef.

At Aberporth, dolphin activity was concentrated at Pencribach at the western side of bay. There were relatively few sightings close to the observers' position and in the central and eastern parts of the bay.

The rocky promontory of Ynys Lochtyn also proved a focus for bottlenose dolphin activity. This is evident in Fig. 10, in which sightings in both years were concentrated north of the observers' position and close in shore around the tip of the headland.

Sightings on the western side of New Quay Head occurred mainly directly offshore from the observers' position, and north-east of this position. There were very few sightings south-west of Birds Rock. Animals in transit down the coast tended to head offshore from New Quay Head rather than following the coast south-west, the direct route towards Ynys Lochtyn. Other sightings documented dolphin schools travelling close inshore, to and from the direction of New Quay Harbour.

There were disappointingly few sightings at Aberystwyth. The locations of schools in 2004 and 2005 were supported by anecdotal sightings however, with most activity tending to occur off the mouth of the harbour and off Castle Rocks.

At New Quay Harbour, where observers assigned sightings to grid cells, most dolphin activity occurred either immediately north and north-east of the harbour wall or off the western side of Llanina Reef. In 2004 there were many records south of the harbour wall close to the boat mooring area. In 2005 there were more sightings off the north-east coast of New Quay headland.

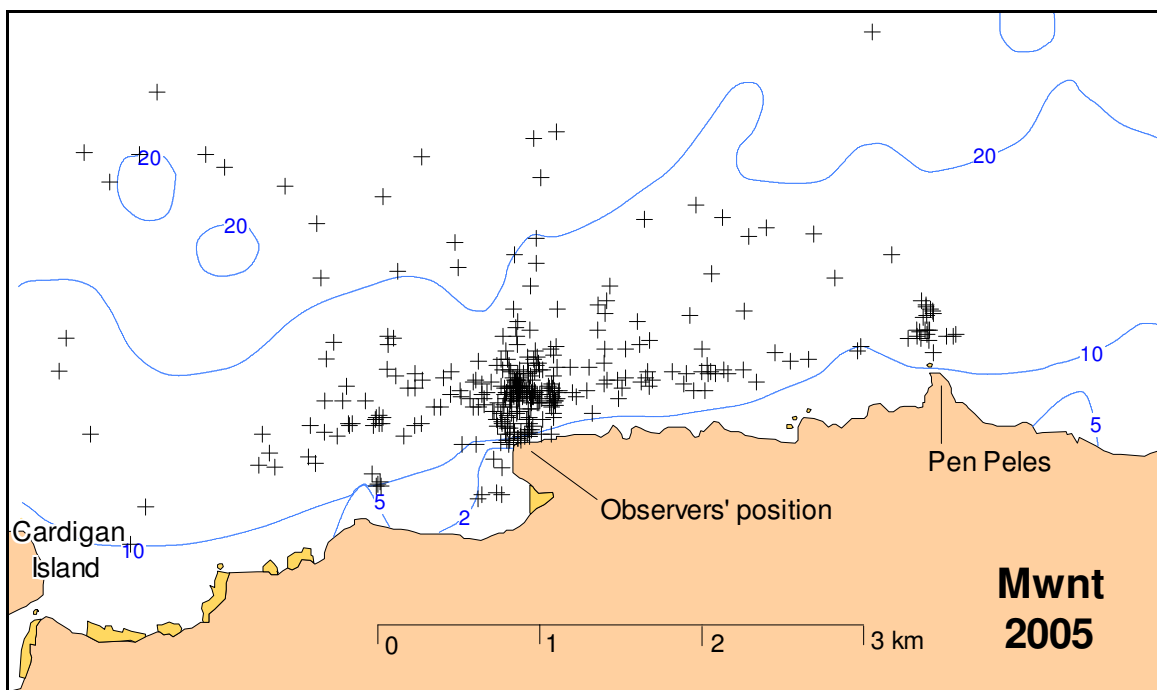
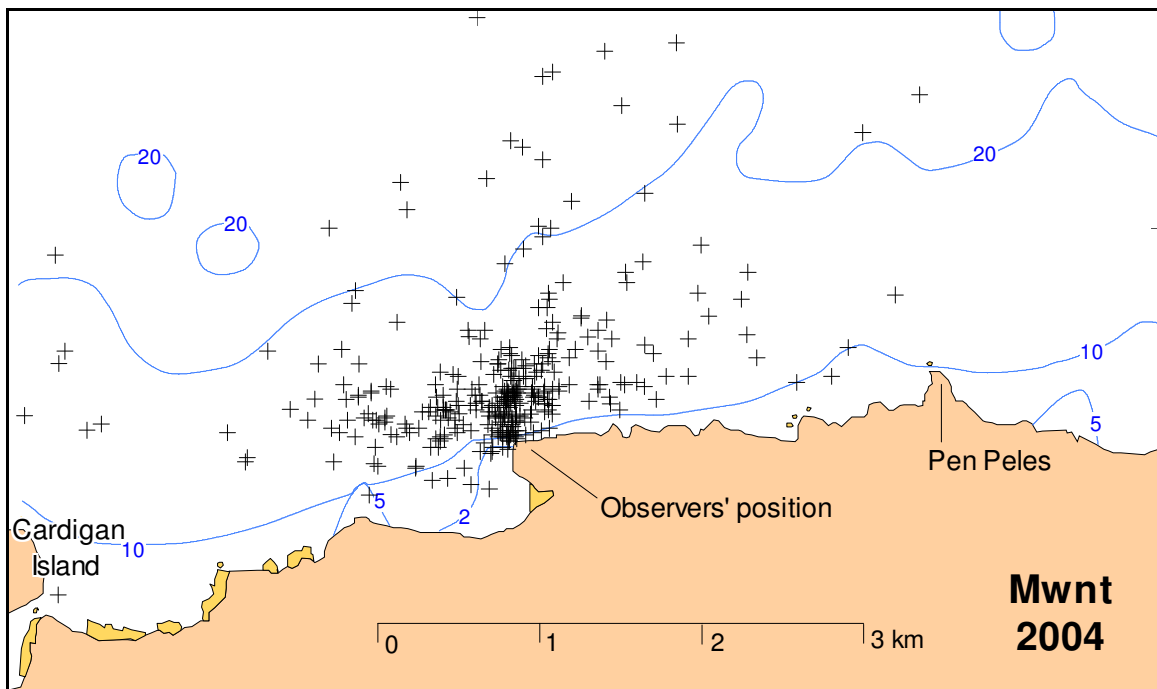


Fig. 8 The location of bottlenose dolphin sightings at Mwnt in 2004 and 2005.

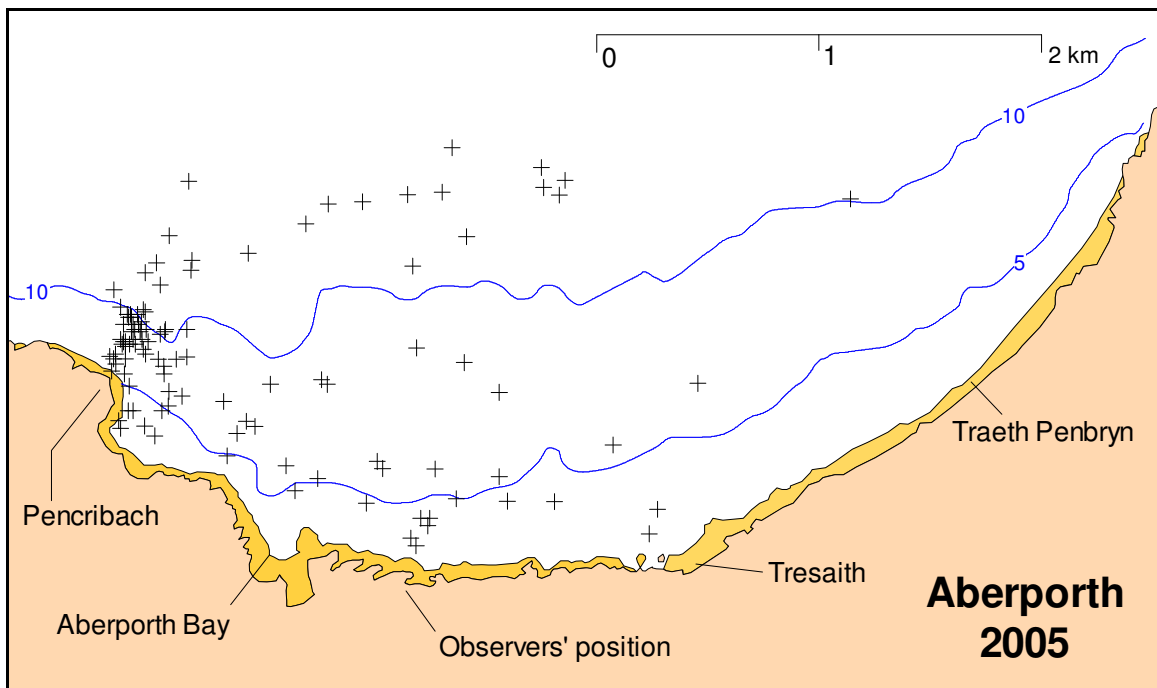
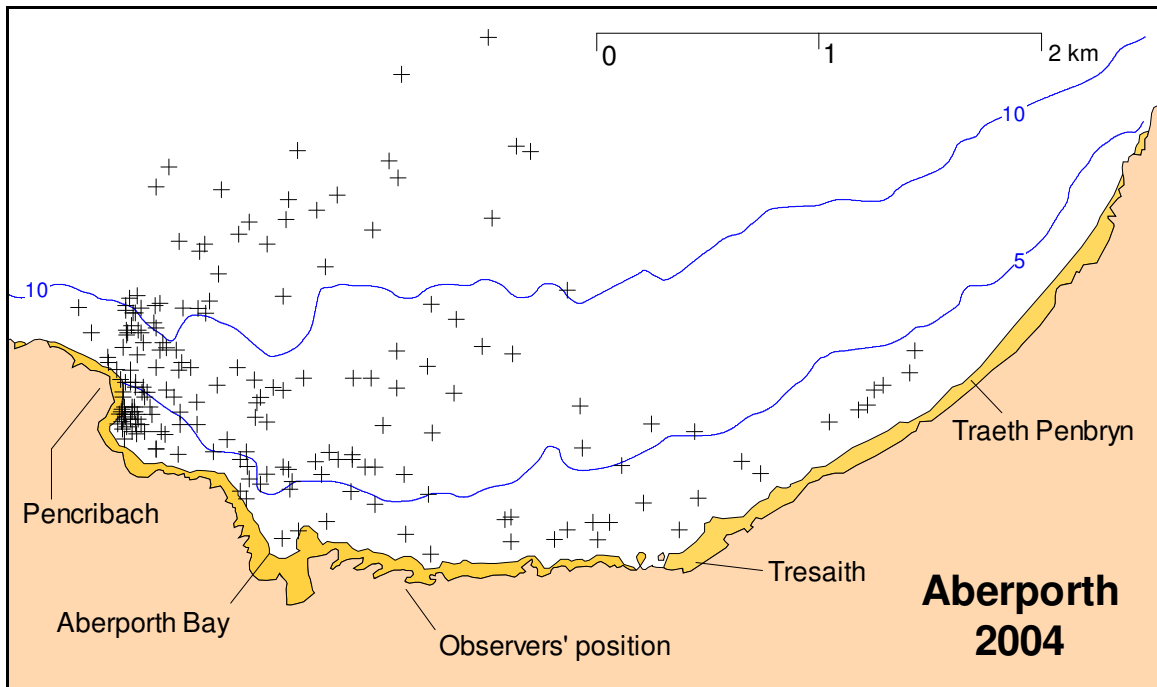


Fig. 9 The location of bottlenose dolphin sightings at Aberporth in 2004 and 2005.

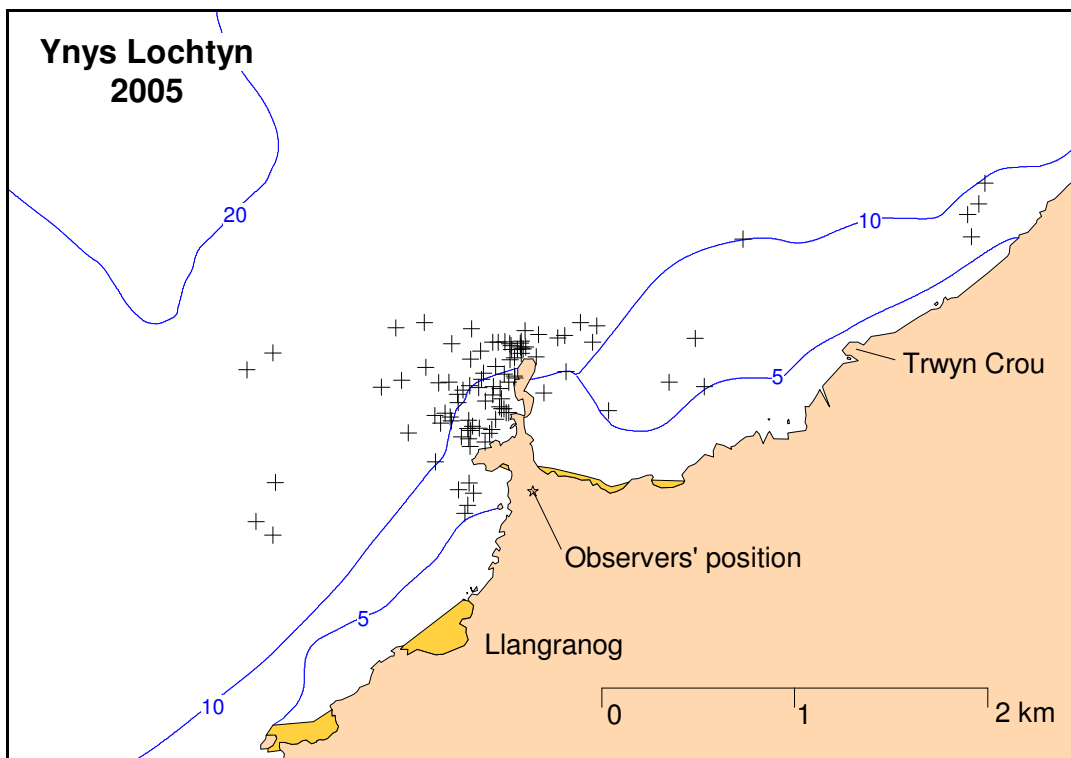
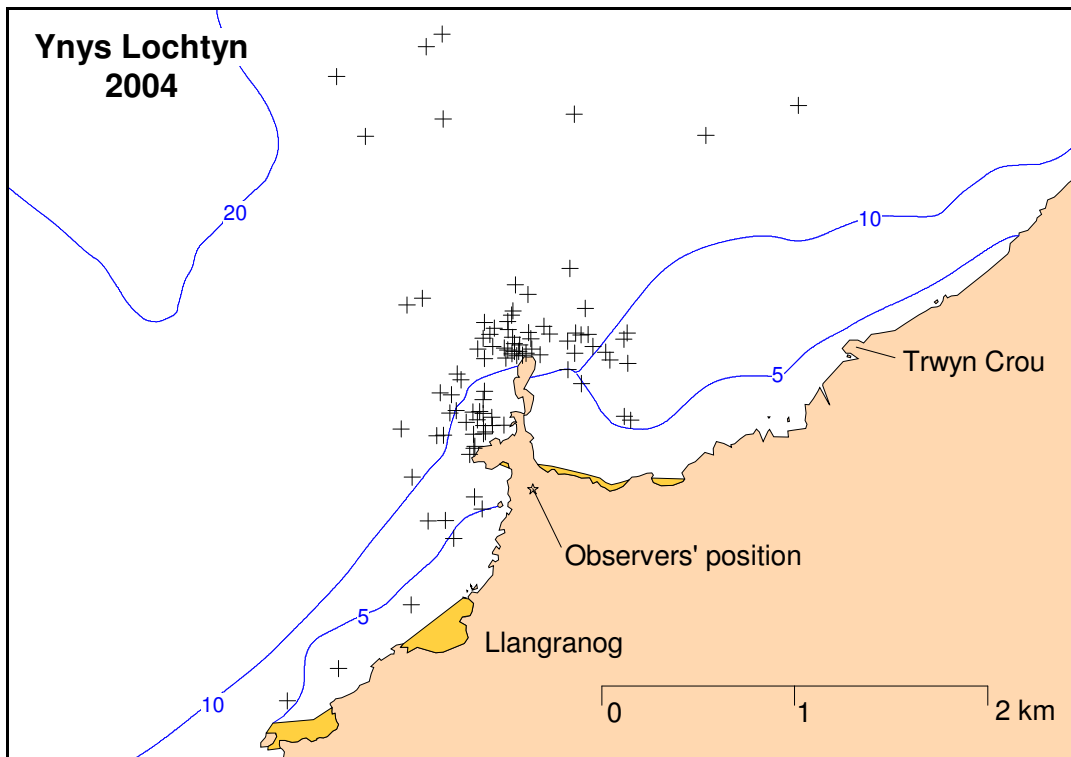


Fig. 10 The location of bottlenose dolphin sightings at Ynys Lochtyn in 2004 and 2005.

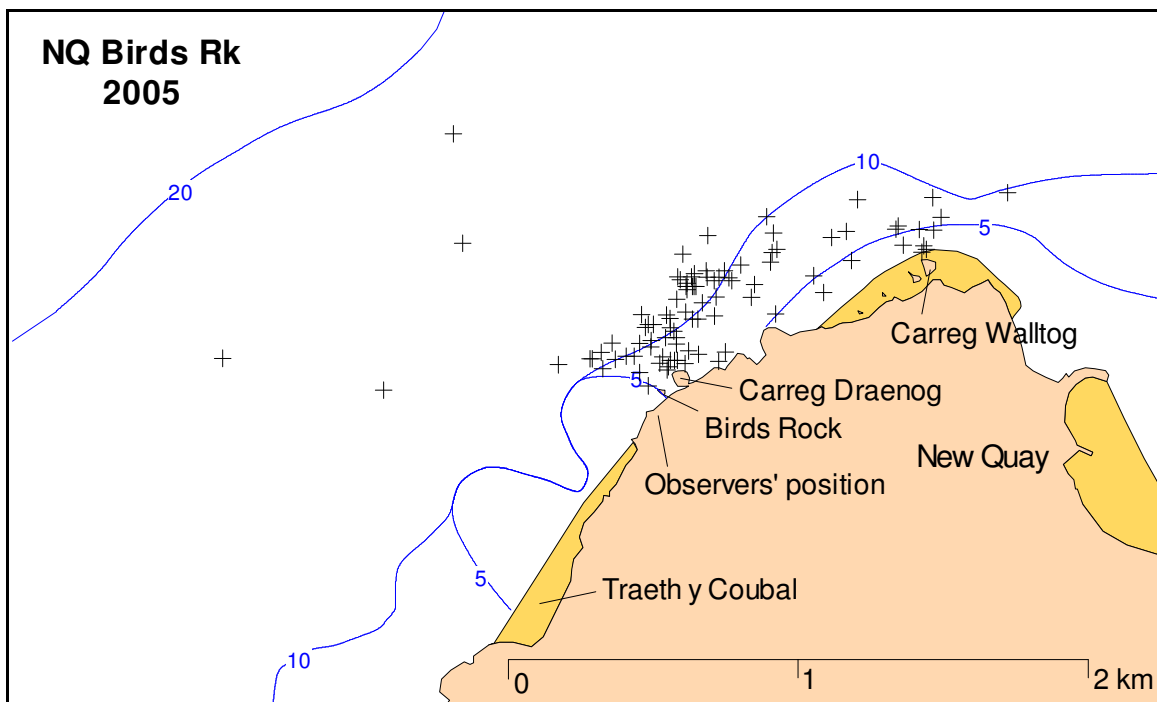
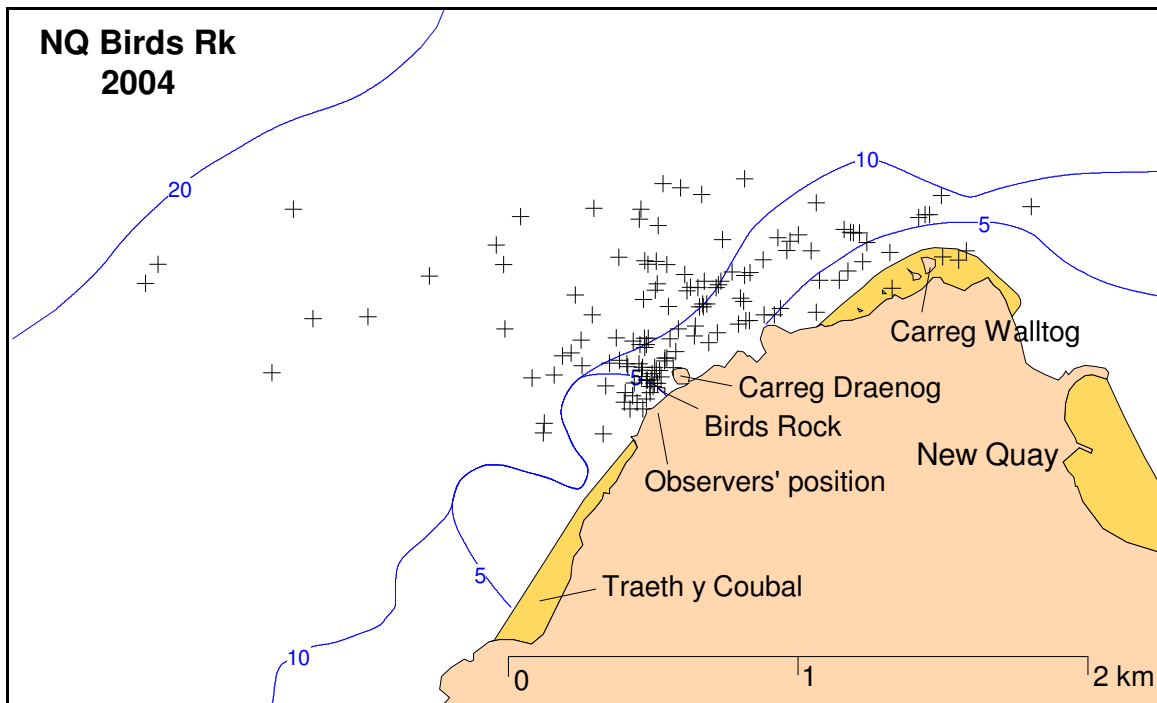


Fig. 11 The location of bottlenose dolphin sightings recorded from the New Quay Birds Rock Lookout in 2004 and 2005.

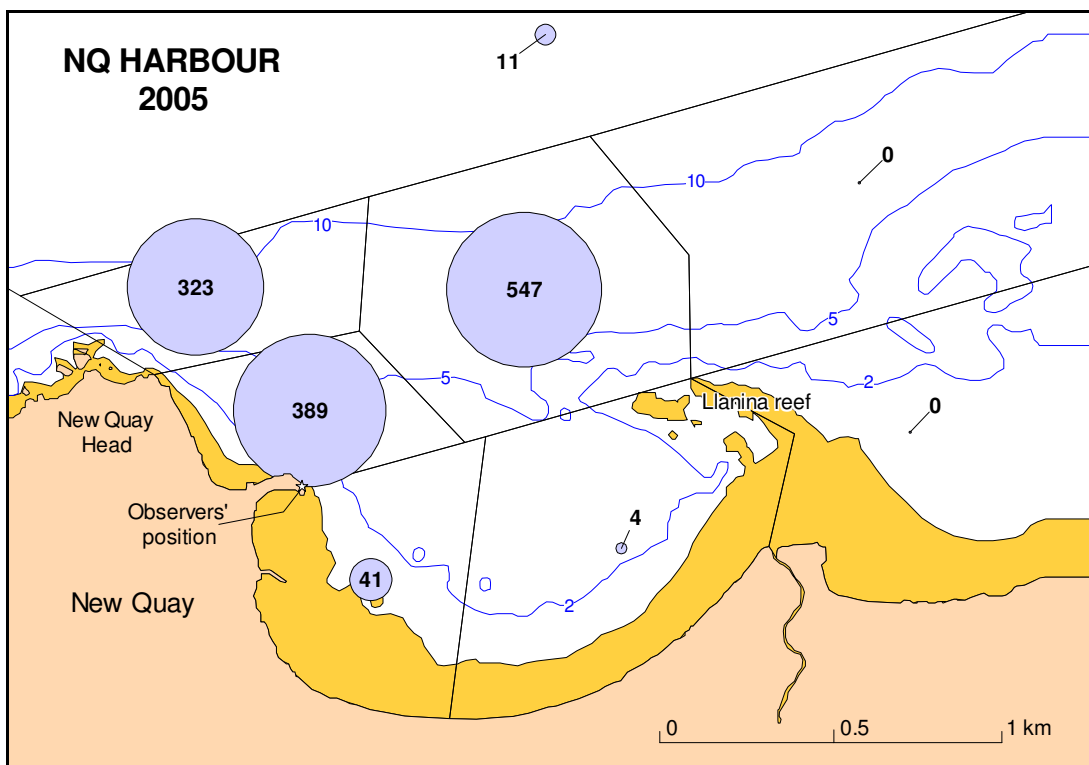
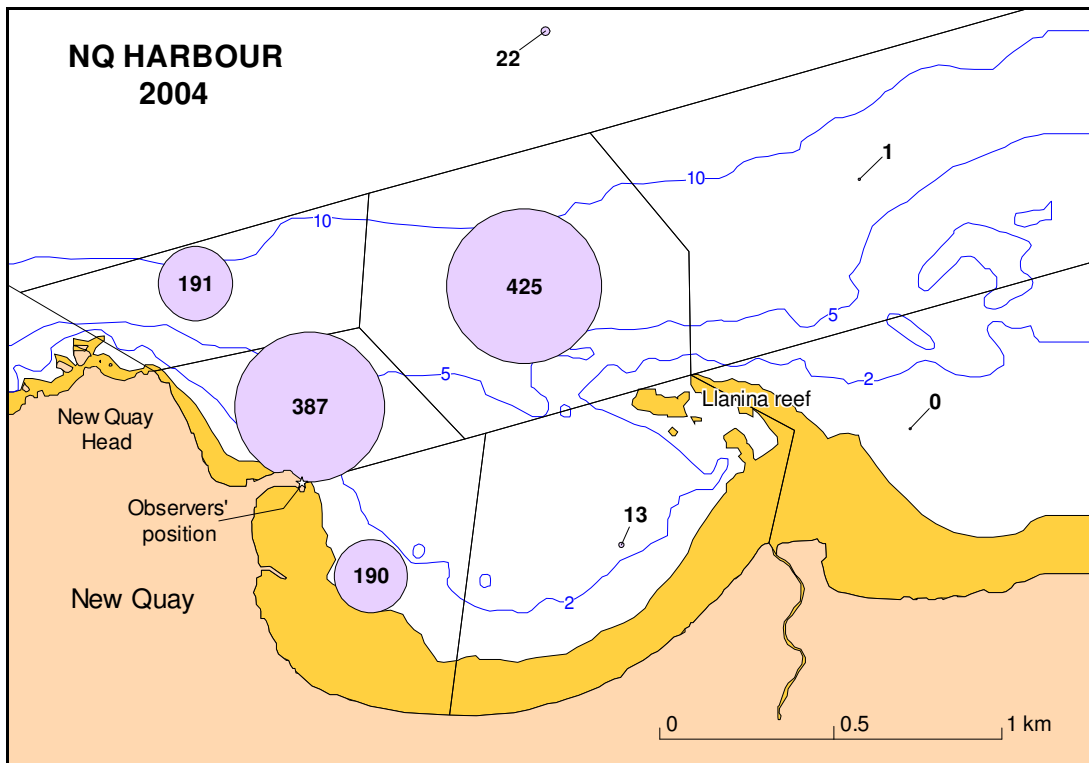


Fig. 12 Bottlenose dolphin sightings at New Quay Harbour in 2004 and 2005. The total number of records in each grid cell is shown.

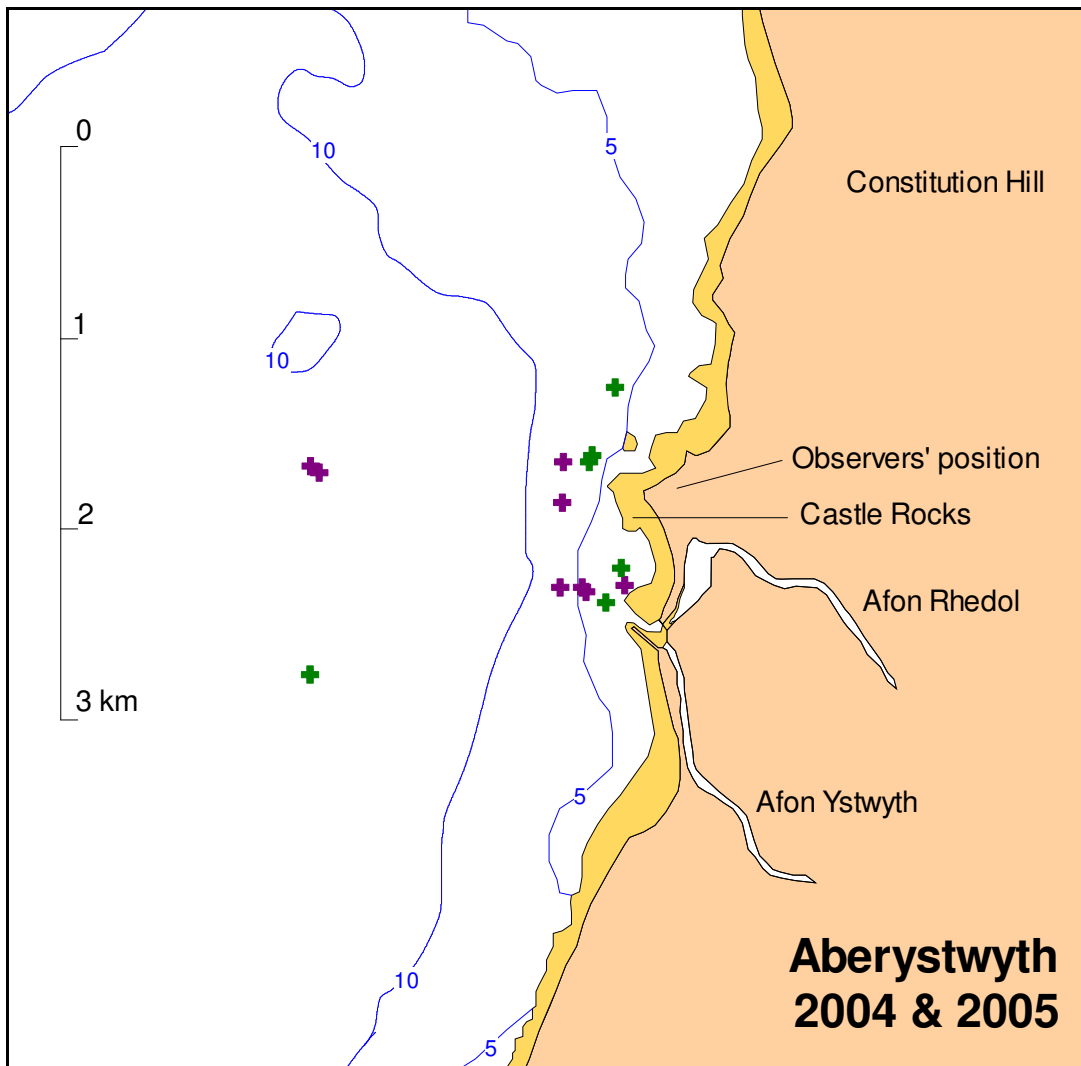


Fig. 13 The location of bottlenose dolphin sightings at Aberystwyth, Castle Rocks, in 2004 (green crosses) and 2005 (mauve crosses).

Bottlenose dolphin behaviour at the study sites

Using data from all study sites, the relative frequencies with which activity states were recorded are shown in Fig. 14. Overall 76% of recorded activity was focused around static locations, compared to 24% of travelling into and through the study sites. The most common behaviours were S3 – apparently diving around the same location, an activity interpreted as foraging at the sea-bed. This accounted for 56% of dolphin activity. S2 – lo-key milling or intermingling of individuals was the second most frequently recorded 'staying' activity (14%). The most frequent travelling activities were T1 – slow, steady travel (13%) and T2 – slow travel interspersed with stops and long dives at certain locations (10%). This latter category is interpreted as 'travel-foraging' – opportunistic foraging, probably at the sea-bed, as animals travel through the area. These were the most frequently assigned activity states for bottlenose dolphin schools, but all nine categories were recorded to varying degrees. Other activities included S4 - chasing prey at the surface; S6 - energetic milling and social interaction; and T3 - fast, porpoising travel. The least frequently recorded behaviours were S1 – logging, resting, stationary at the surface; and S5 – playing with objects such as algae or jellyfish.

We compared the relative frequencies of 'staying' activities and 'travelling' activities at different sites (Tables 4 & 5). 'Staying' or location-based activity was prevalent at all sites and comprised 76-86% of observed behaviour at most sites. A higher proportion of travelling was observed at NQ Birds Rock and at Mwnt; at these sites travelling accounted for 36% of observations.

Table 4 The proportion of bottlenose dolphin sightings at each study site that were recorded with 'staying' and with 'travelling' activity states.

	<i>'Staying'</i>	<i>'Travelling'</i>
Aberporth	76%	24%
Mwnt	64%	36%
NQ Birds Rock	64%	36%
AB Castle Rocks	86%	14%
Ynys Lochtyn	79%	21%
NQ Harbour	80%	20%

Table 5 The relative frequencies of activity states by site.

	<i>Aberporth</i>	<i>Mwnt</i>	<i>NQ Birds Rock</i>	<i>AB Castle Rocks</i>	<i>Ynys Lochtyn</i>	<i>NQ Harbour</i>
S1 - lo-key: resting, drifting at surface	0%	1%	1%	0%	1%	0%
S2 - lo-key: milling, social interaction	27%	23%	46%	36%	38%	5%
S3 - lo-key: deep dives about same location	44%	33%	12%	50%	29%	72%
S4 - hi-key: chasing prey at surface	1%	1%	1%	0%	1%	1%
S5 - hi-key: object play	0%	0%	0%	0%	0%	0%
S6 - hi-key: fast milling, slaps, leaps, etc.	5%	5%	3%	0%	11%	3%
T1 - lo-key: slow travel, regular surfacing	9%	22%	25%	14%	16%	9%
T2 - lo-key: deep foraging with slow travel, long dives	13%	13%	12%	0%	4%	10%
T3 hi-key: fast travel, porpoising, splashy	2%	1%	0%	0%	1%	1%

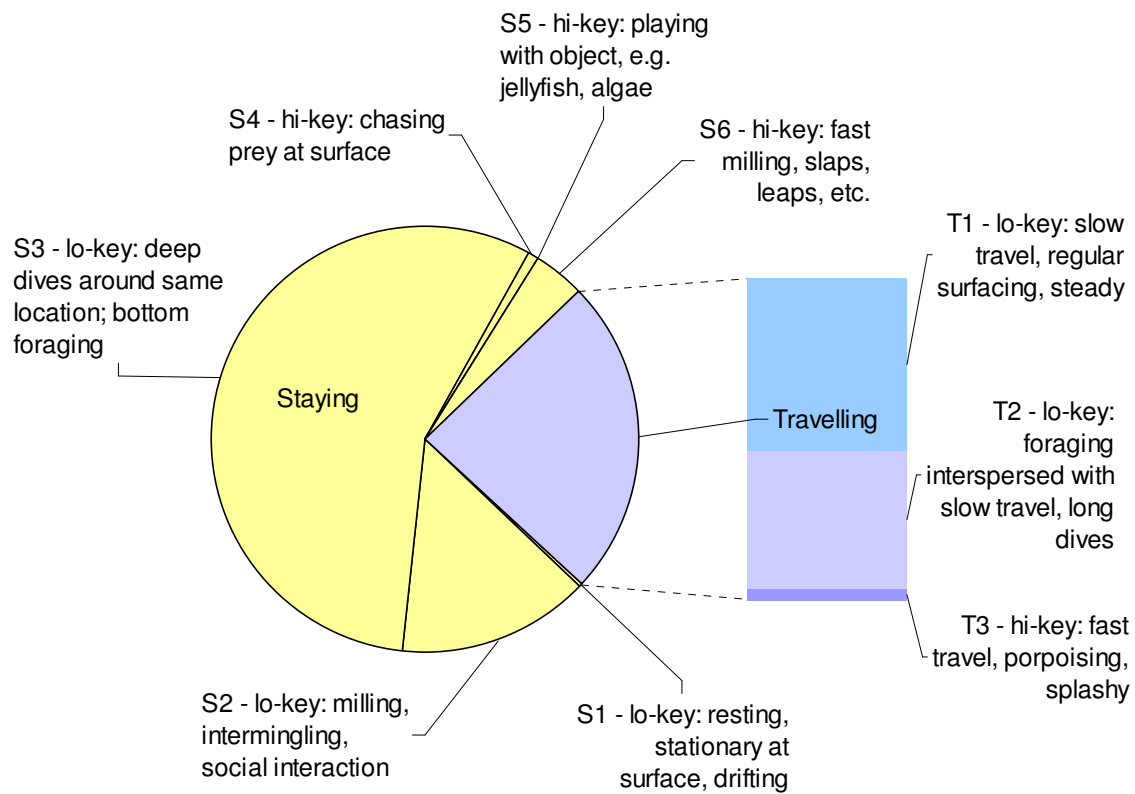


Fig. 14 The relative frequency with which activity states were recorded at the beginning of 15 min effort periods. The behavioural categories were divided into 'staying' and 'travelling' activities and then further into 'hi-key' or fast-moving, and 'lo-key' or slow-moving activities.

Levels of boat traffic

Boat traffic was monitored as in previous years, by tally counts of vessels over each 2 h observation period. Average boat counts are compared between sites and between years in Fig. 15. Aberystwyth and New Quay Harbour were highlighted as the two busiest sites for boat traffic; Birds Rock, Ynys Lochtyn and Aberporth experienced similar levels of boat traffic; and the lowest counts were made at Mwnt. There was little evidence of recent change in traffic levels at the study sites, although higher counts have been recorded at Aberporth since 2003 than during the late 1990s (Fig. 15).

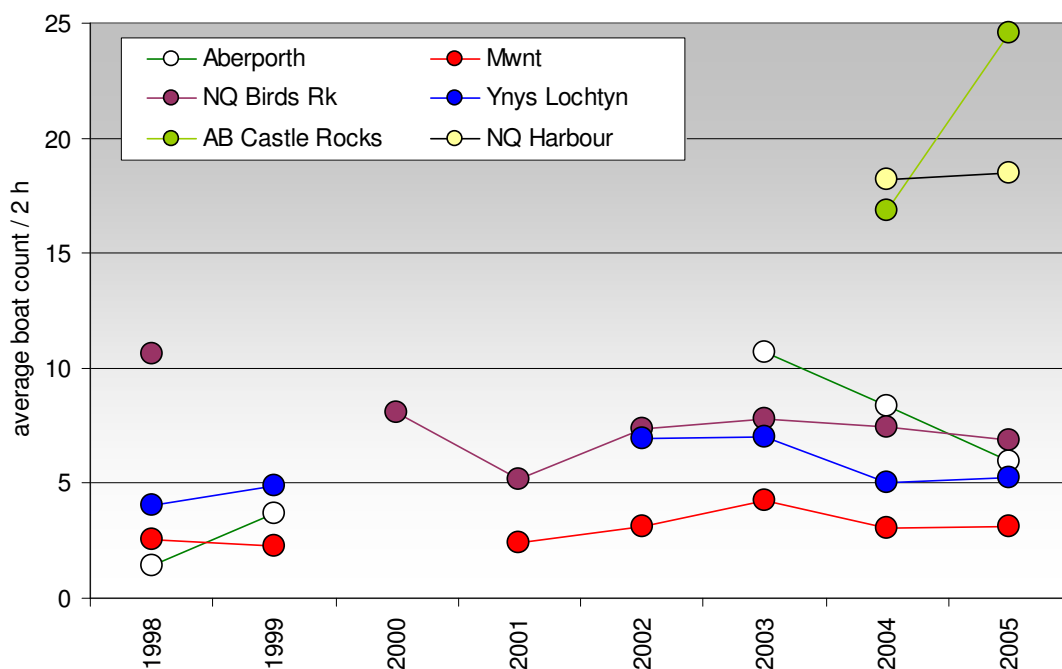


Fig. 15 Average 2 h boat counts: 1998-05.

Average recording rates for different types of boat are shown in Fig. 16. Higher levels of boat traffic at New Quay Harbour and at Aberystwyth were accounted for mainly by greater numbers of recreational motor boats and sailing boats. Numbers of speedboats were also highest at these two sites. Visitor passenger boats (VPB) were most evident at New Quay Harbour and New Quay Head, although regular trips were made to Ynys Lochtyn. Relatively high numbers of canoes and kayaks were seen at New Quay Harbour, and Aberporth where sailing was also popular. Most jet-skis ('personal water craft') were reported from Aberystwyth.

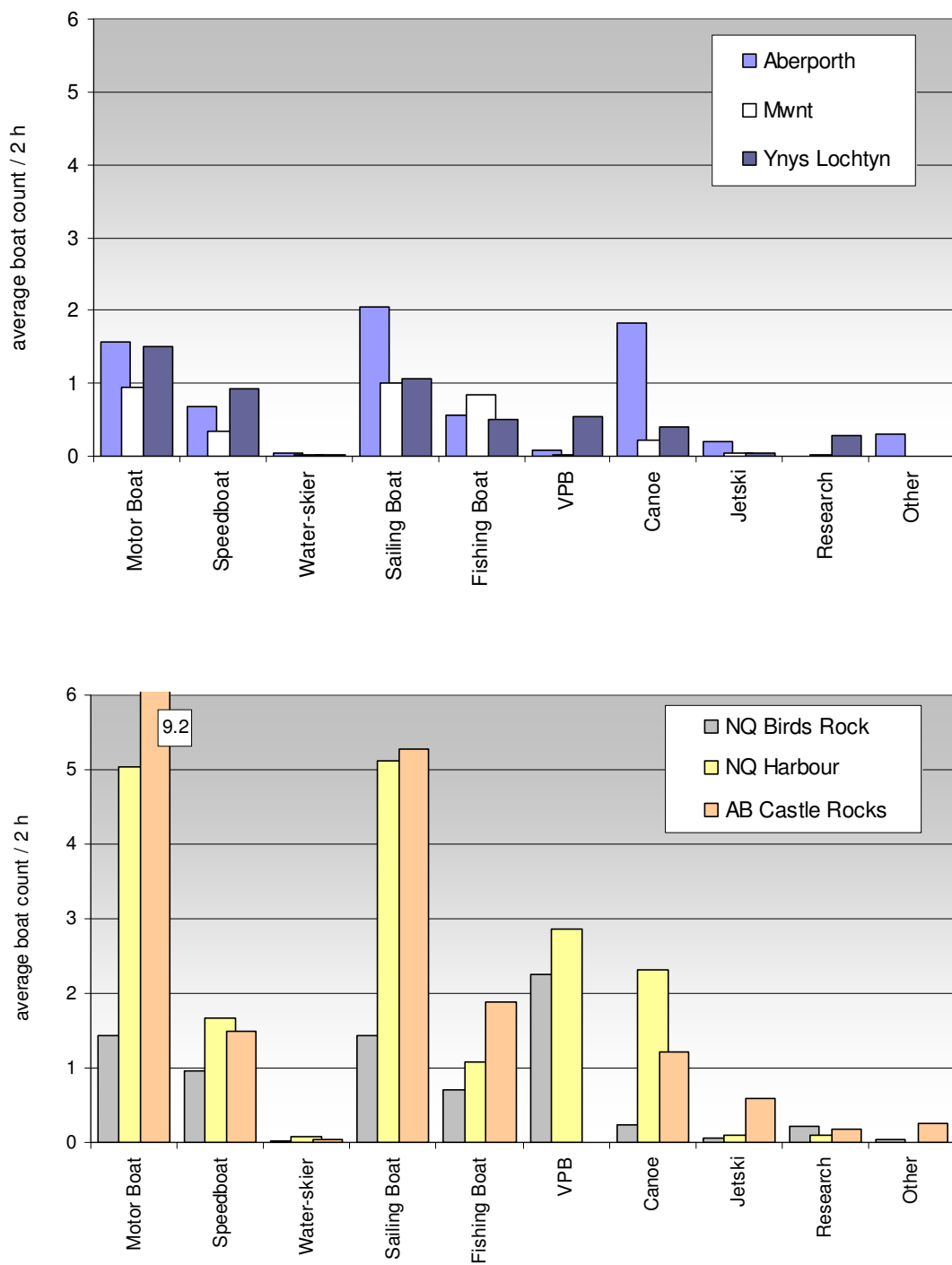


Fig. 16 Comparison of average 2 h counts of different types of boat between study sites: data for 2004 and 2005 combined. The most southerly and northerly sites are grouped separately for clarity, although both graphs use the same y-axis scaling.

Encounters between dolphins and boat users

Boat encounter rates with bottlenose dolphins

In all, 1026 encounters were recorded between boats and bottlenose dolphins: 598 in 2004 and 428 in 2005. Encounters occurred most frequently at New Quay Harbour, followed by Ynys Lochtyn (Fig. 17). At New Quay, boat encounters were reported at an average rate of 1-1.5 encounters per 2 h observation period between June and September. Of propeller-driven vessels, dolphin encounters with recreational motor boats were most common, although relatively high encounter rates with VPBs occurred at New Quay Harbour, New Quay Birds Rock and Ynys Lochtyn (Fig. 18). Encounters with the fastest vessels (speedboats, water-skiers and jet-skis) were recorded at all study sites, but most frequently at Ynys Lochtyn and New Quay Harbour.

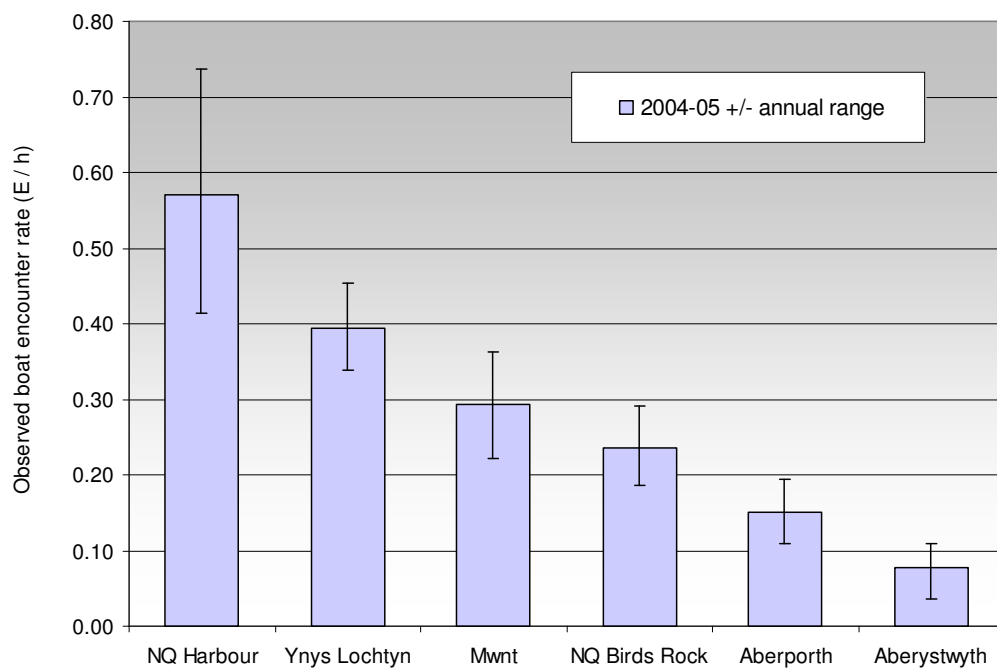


Fig. 17 Comparison of the observed boat encounter rate at the six study sites.

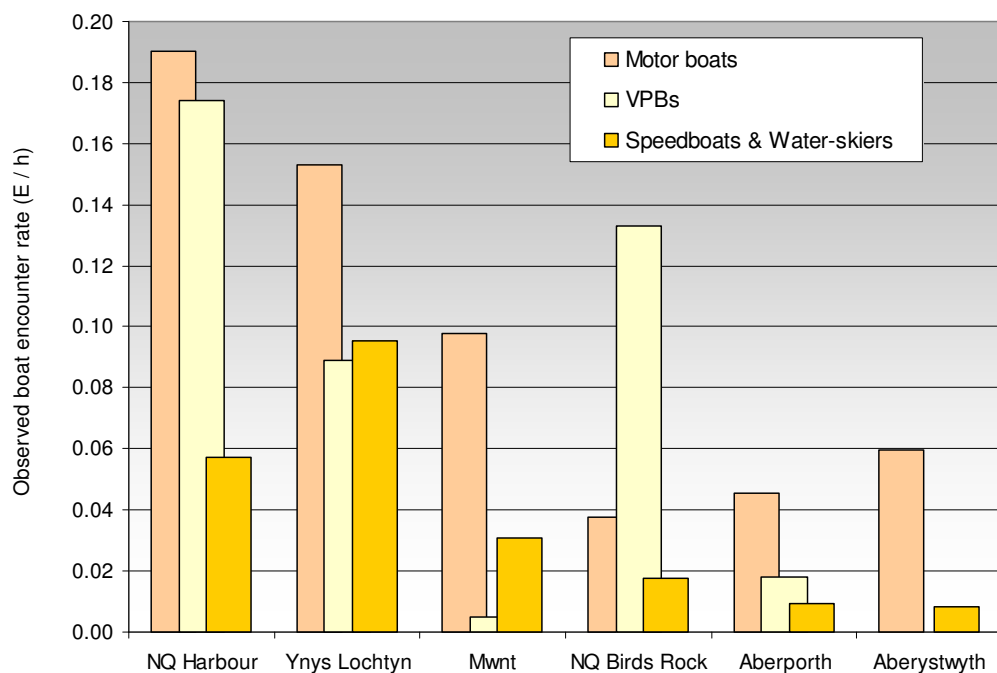


Fig. 18 Comparison of boat encounter rates for the three most regularly recorded propeller-driven vessels: motor boats, speedboats and speedboats with water-skiers, and visitor passenger boats.

Compliance with Codes of Conduct

We looked at 945 boat encounters for which the observer had assigned a code to denote compliance or non-compliance with the relevant code of conduct, i.e. the guidelines for either recreational boat users or for VPBs. Boat operators were found to comply with the code of conduct in 90% of encounters with bottlenose dolphins. There were 92 cases in which boat operators did not follow the code of conduct. The number of boat encounters with dolphins and the rate of compliance varied to some degree with location (Table 6). Most encounters occurred at New Quay Harbour and compliance here was very high (93% of encounters). Compliance was similarly high at New Quay Birds Rock (92%). The proportion of boat operators that complied with the code was lower away from New Quay (78-82%).

Table 6. Compliance and non-compliance with codes of conduct for boat operators on encountering bottlenose dolphins.

<i>Site</i>	<i>Compliance (%)</i>	<i>Non-compliance with code of conduct</i>		
		<i>2004</i>	<i>2005</i>	<i>Both Years</i>
NQ Harbour	93% of 628	26	18	44
NQ Birds Rock	92% of 96	2	6	8
Mwnt	82% of 106	13	6	19
Aberporth	81% of 48	5	3	8
Ynys Lochtyn	81% of 58	5	6	11
AB Castle Rocks	78% of 9	0	2	2
<i>Total</i>	<i>90% of 945 encounters</i>	<i>51</i>	<i>41</i>	<i>92</i>

Most cases of non-compliance were related to speed. In 60 encounters the boat operator was driving too fast, including 4 incidents within the buoyed 8 kt zone at New Quay (Table 7). A further 31 cases involved boat operators following an erratic course to remain close to a dolphin school.

Most cases of non-compliance involved recreational motor boats and speedboats (Table 8). Motor boats accounted for 46% of incidents over the two years; speedboats, water-skiers and jet-skis a further 36%. The rate of non-compliance for speedboats etc. was higher than other types of boat – non-compliance was reported for approximately 30% of dolphin encounters with these vessels in both 2004 and 2005.

Table 7. Reasons cited for non-compliance with codes of contact for boat users.

<i>Reason for non-compliance</i>	<i>Encounters</i>	<i>%</i>
N1: too fast, wake speed within 300 m of dolphins	56	61%
N2: erratic course to follow dolphins	31	34%
N3: attempted to touch, feed or swim with dolphins	1	1%
N4: > 8 kt within the New Quay zoned area	4	4%

Table 8. The incidence of non-compliance for operators of different types of boat. The number of encounters (E) and the percentage of encounters between this type of vessel and dolphins that this represented (%), is shown for each year. The proportion of the total number of non-compliance incidents that were accounted for by each type of boat, is also shown.

<i>Boat Type</i>	<i>Non-compliance with code of conduct</i>				<i>Proportion of all transgressions accounted for</i>
	<i>E 2004</i>	<i>E 2005</i>	<i>% 2004</i>	<i>% 2005</i>	
Motor Boat	31	11	17%	9%	0.46
Speedboat	8	19	26%	31%	0.29
Commercial Fishing Boat	5	-	10%	-	0.05
Sailing Boat	1	3	1%	8%	0.04
Water-skier	2	2	67%	50%	0.04
Visitor Passenger Boat	1	3	1%	3%	0.04
Canoe	-	2	-	13%	0.02
Jet-ski	1	1	25%	100%	0.02
Other	2	-	29%	-	0.02
<i>All Boats</i>	<i>51</i>	<i>41</i>	<i>9%</i>	<i>11%</i>	<i>1.00</i>

Effects of non-compliance on bottlenose dolphin behaviour during boat encounters

We examined whether dolphins responded differently to boats when boat operators followed a code of conduct. Of particular concern was the incidence of 'negative' responses – dolphin schools that changed their activity state and headed away from the boat. Changes in group structure - dolphin schools that either grouped closely together or conversely, split up, were examined separately. We also looked at 'positive' response – dolphins that swam towards, bow-rode or followed a boat; and the incidence of dolphins 'leaping' or beginning aerial behaviours during boat encounters was also examined. We investigated the relative incidence of these behaviours during encounters in which boat operators either complied or did not comply with the code of conduct, and with different numbers of boats in the vicinity.

We found that the frequency with which 'negative' responses were recorded was higher when the boat operator did not comply with the code of conduct (Fig. 19). This was the case both when the closest boat was within 50 m of dolphins and several other boats were within 300 m of the school (boat densities A-C), and when there were fewer boats present (boat densities D-F). The same result was found for changes in dolphin group structure, and this was only rarely recorded when boat operators followed the code of conduct. For encounters with all types of boat combined, the frequency that a negative response was recorded was significantly less when the code of conduct was followed than that expected based on the frequency of this response during encounters when the code was not followed (Table 9). There were insufficient data to repeat this test individually for different types of boat, but when encounters with recreational motor boats and fast craft (speedboats, water-skiers, jet-skis) were both examined, the general case was confirmed – there were lower rates of negative response from dolphins when the code was adhered to, regardless of boat density in the vicinity of the dolphin school. This was also true for the frequency with which changes in group structure were recorded.

Conversely, dolphins approached boats often when the code of conduct was followed (Fig. 19). The rate of positive response was higher with boats within 50 m (boat densities A-C), but in this case the separation distance reflects the movement of dolphins towards the vessel as well as the boat operator's approach. Leaping was also recorded more frequently when boat operators complied. In cases when the code was followed, boat density appeared to have little effect on the incidence of leaping, although it occurred more often when dolphins were within 50 m of at least one boat than when boats were further off. When the code of conduct was not complied with however, the incidence of leaping appeared depressed when the offending boat was close by.

Table 9. *Chi2 Goodness-Of-Fit test of the observed and expected frequency with which negative response was recorded from bottlenose dolphin schools during encounters with boats, when the boat operator followed the code of conduct. Expected values were calculated from the proportion of encounters with this response when the code of conduct was not adhered to. Boat density increases from A-F (see Table x).*

<i>Boat Density</i>	<i>Observed</i>	<i>Expected</i>	<i>Total X^2, df</i>	<i>P</i>
A + B	21	52.7	137.5, 3 df	P < 0.0001
C	21	95		
D + E	4	25.4		
F	16	71.2		

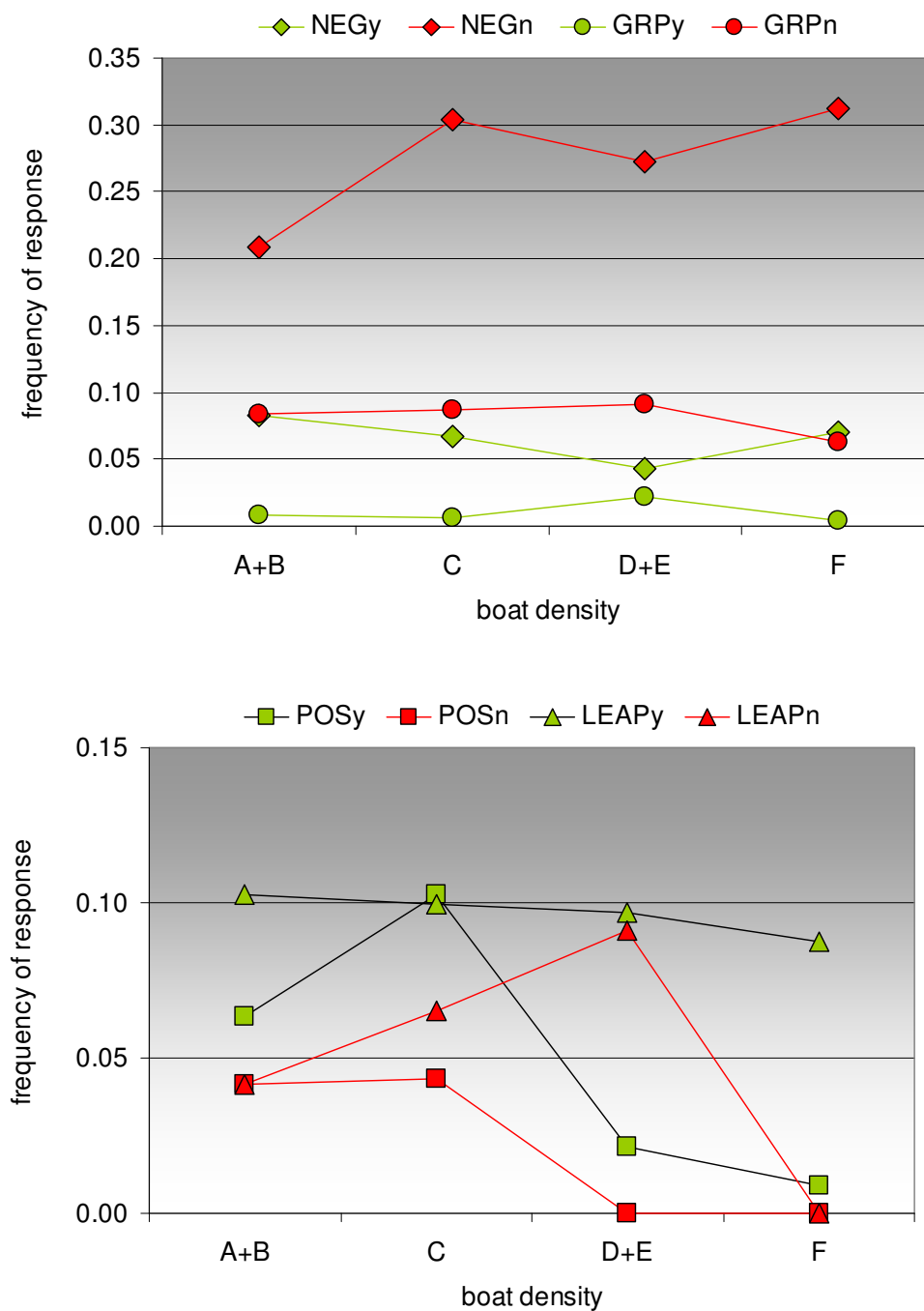


Fig. 19 The frequency (behavioural responses per total number of encounters) that behaviours NEG (headed away), GRP (group split or coalesced), POS (approached, followed or bow-rode), LEAP (leaping or began leaping) were recorded during boat encounters with boat densities A-F. **Green** = boat complied, **Red** = boat did not comply with code of conduct.

DISCUSSION

The MHC Cetacean and Boat Traffic Survey has been carried out annually for twelve years. The survey provides a substantial time-series of data on bottlenose dolphin occurrence in the coastal waters of Cardigan Bay and levels of boat traffic. It documents interaction between dolphins and boats, collecting data with which to guide management of Ceredigion inshore waters and to reduce the risk of disturbance or injury to coastal wildlife, particularly bottlenose dolphins. In 2004 and 2005 the survey was expanded - volunteer teams from local communities, the Sea Watch Foundation and Cardigan Bay Marine Wildlife Centre at New Quay, and Friends of Cardigan Bay in Aberystwyth increased the number of study sites from four to six. With the inclusion of data collected in the summer of 2004 and 2005, total survey effort now exceeds 8300 h. This is the fifth survey report (Pierpoint & Allan 2000; 2001; 2002; 2004). In 2004, observers began a new, map-based system of data recording and this has allowed new aspects of site use by bottlenose dolphins to be included for the first time.

When study sites were ranked by the rate at which bottlenose dolphins were recorded, then those of the original four study sites remained similar to that reported previously: dolphins were seen most often at Mwnt and the average number of animals per unit of observer effort was higher at this site than elsewhere. Bottlenose dolphins were recorded in a remarkable 81% of observation periods at Mwnt in 2005. Sighting rates at Ynys Lochdyn have in the past been more variable than other study sites, but 2004 and 2005 both proved to be very 'good' years for site use here by bottlenose dolphins.

New Quay Harbour has long been known as an important haven for this species (Morris 1991; Bristow *et al.* 2001). As expected, and using data collected using the same methodology as elsewhere in the MHC, bottlenose dolphin occurrence at New Quay Harbour ranked highly in 2004-05. This was our first opportunity to compare sighting rates at New Quay Harbour and New Quay Birds Rock, and dolphin sightings were found to be more frequent in the Harbour than at Birds Rock. Sighting rates at Birds Rock have been consistently lower since 2000 than in the mid- to late-1990s: dolphins are now seen in 30-35% rather than to 45-55% of observation periods. Reasons for this may include the relocation of observers in 1998, which changed the extent to which animals north of New Quay Head were visible. The decline in sightings continued since

this change however, perhaps implicating other local factors such as a reduction in the quantity of organic shell waste released into the sea from a shellfish-processing factory (Pierpoint & Allan 2004). It was thought unlikely that dolphins were being excluded from this site by high levels of boat traffic, as there was no evidence of a coincidental rise in boating intensity; in fact, the level of boat traffic had fallen somewhat over the same time period.

Sighting rates at Birds Rock were particularly low in 2005, when the fall from 2004 levels of activity was mirrored at New Quay Harbour. Bristow (2004) reports a decline in the number of observer days on which sightings were made at New Quay Harbour: dolphins were recorded on less than 30-40% of days from 2000-2002, whereas schools were typically present on 45-50% of days from 1995-99. Bristow's data suggest a return from 2000 onwards, to sighting rates recorded in the late-1980s and the early-1990s. This perhaps helps to place our own records from Birds Rock within longer-term cycles of variation.

Sightings at Aberporth were higher in 2004 than 2003, as they were at Mwnt and Ynys Lochtyn, adjacent sites to the south and north of Aberporth respectively. Indeed sighting rates at both Aberporth and Mwnt were higher in 2004 than had yet been recorded. It is interesting to consider the possibility of region-wide changes in dolphin distribution, or preference for particular sites, from one year to the next. From 2004 to 2005 (and from 2003-05 for the sites we have data for), the average numbers of dolphins recorded per unit observer effort increased in successive years at Mwnt and Ynys Lochtyn, whilst declining at New Quay Harbour and New Quay Birds Rock. This suggested that in 2004-05 some animals preferentially selected habitats south of New Quay rather than at the New Quay sites themselves. The ongoing programme of photo-id in Cardigan Bay is beginning to shed some light on the site fidelity of individual animals - some seasonal residents appear to have preferred home ranges within the bay that persist for several years (Lott 2004). Future work may determine whether year-to-year change in the distribution of animals is a general trend or involves site selection by groups of affiliated animals.

Other than rates of dolphin occurrence differences between sites were found in the average number of animals present; the amount of time that dolphins tended to occupy

habitats at each site; the presence of mothers with calves; and to some extent, the rates with which certain dolphin activities were observed. These results were broadly similar to our findings in previous years. Observations at Aberystwyth were valuable and placed sighting rates at the other sites in 2004 and 2005 into wider perspective. Sightings at Castle Rocks were relatively scarce, but observers began to identify the broad areas at which dolphin activity was concentrated and the rate at which encounters between dolphins and boats occurred at this busy harbour.

The average size of dolphin aggregations was higher at Mwnt and Ynys Lochtyn than other sites. Previously we found that group sizes were similar across most sites, but higher at Mwnt, New Quay Birds Rock and Ynys Lochtyn, than at Aberporth. Again in 2004 and 2005, we found that average counts at Aberporth were lower than elsewhere, but in these two years counts were also similarly low at Birds Rock. Counts were higher at New Quay Harbour, but lower at this site than at Mwnt and Ynys Lochtyn. Double-figure counts were made at New Quay Harbour, Mwnt and Ynys Lochtyn in both years.

Previously we have reported similar rates of occupancy at different sites. By 'occupancy' we refer to the period of time that dolphins were present at each site, measured as the average number of 15-min intervals with dolphins in each 2 h watch. We aimed to use rates of site occupancy to support differences in behaviour noted at different sites – to examine whether dolphins tended to visit and remain at the study sites, rather than transiting through en route to other areas. We reported that in watches when sightings were made, dolphins tended to be present for 40-50% of each 2 h watch, but that there had been a significant decline in occupancy at New Quay Birds Rock since 2000 (Pierpoint & Allan 2004). With the present data we tested differences between sites in 2004 and 2005 and found only one significant pairwise difference – in both years, bottlenose dolphins tended to occupy New Quay Harbour for longer periods than they occupied the Birds Rock study site. This implied that dolphins at the harbour were more likely to remain there for longer, taking advantage of the site's habitat resources, and that dolphins seen at Birds Rock were more often in transit up or down the coast.

Bottlenose dolphin calves were seen at every site apart from at Aberystwyth, in both 2004 and 2005. Mother-calf groups were however, recorded more often at Mwnt than elsewhere, with the exception of Ynys Lochtyn where an equally high proportion of

watches in 2005 (56%) included sightings of calves. The data for Mwnt were consistent with previous records – this site appeared particularly attractive to females with calves. If it can be assumed that of all bottlenose dolphin groups in the region only a minority include mother-calf pairs, then the uniquely high occurrence of calves at Mwnt suggests that mother-calf pairs repeatedly visited the site during the summer, exhibiting a degree of site fidelity. That calves were consistently recorded more frequently at Mwnt than elsewhere also suggests that this site either provided particularly suitable habitat for mother or calf (in terms of water temperature, current speed or prey resources for example) or, although predator avoidance is unlikely in west Wales, that mother and calf incurred a lower risk of detrimental impacts, from boats for example, or even aggressive affiliations of male dolphins. Patterson *et al.* (1998) report evidence of infanticide in the Moray Firth population of bottlenose dolphins and propose a link between infanticide and fatal attacks by bottlenose dolphins on harbour porpoises, which have become increasingly common in Cardigan Bay since 1995 (Rogan *et al.* 2001). Perhaps females with young calves seek safety within larger aggregations of animals.

Mapping the location of sightings has largely confirmed that which regular observers at these study sites knew already: that although bottlenose dolphins move freely through each site, activity tends to be focussed in particular sub-areas. At each site, we found that the main focus of dolphin activity was consistent for 2004 and 2005. The data describe the location of these dolphin 'hot spots', and also areas within each site that the dolphins rarely appeared to use. Sightings were concentrated in waters immediately adjacent to rocky promontories or reefs (e.g. Ynys Lochdyn; Pencribach at Aberporth), although some open and embayed areas (e.g. New Quay Harbour) were also clearly important. Regular transit routes that convey dolphins to and from foraging locations (e.g. the area due west of New Quay Head; the coastal zone between Mwnt and Aberporth Head) perhaps deserve equal attention from coastal zone managers however.

We examined the dolphin behaviours that predominated at our study sites. Activity state was recorded for each bottlenose dolphin group when the school were first seen and thereafter, at 15 min intervals. This mode of data collection was likely to under-record behaviours that are usually of short duration. It was however, well suited to our existing framework of data collection and provided a good overview of bottlenose dolphin activity

at the study sites. It permitted a systematic assessment of the relative frequencies of foraging, social interaction and travelling to be made.

The majority of data described location-based or 'staying' activity – behaviour centred at specific locations, rather than occurring whilst dolphins were in transit through the study sites. 'Staying' activities accounted for 76-86% of observations at Aberporth, Ynys Lochtyn, New Quay Harbour and Aberystwyth, and 64% at New Quay Birds Rock and Mwnt. The most common activity was repeated diving at approximately the same location. Due to the typically long duration of these dives in relatively shallow waters; the lack of travel between the start and end points of the dive; and as this activity was often observed for single animals or dispersed groups of individuals; this activity was interpreted as foraging, for prey at or close to, the sea-bed. A common travel activity also, was steady travel with stops and long dives at intervals on the dolphin's track - this was interpreted as opportunistic 'travel-foraging'. Both lo-key and more energetic social interaction was commonly observed. Prey pursuit at the surface, object play and resting ('logging') at the sea surface were documented, but were observed less frequently.

Resting was recorded far less frequently (< 1% of all activity) than for some other bottlenose dolphin populations - Constantine *et al.* (2004), for example, recorded resting as 11% of all behaviour in the Bay of Islands, New Zealand, and found that resting was significantly affected by the presence of boats. Constantine *et al.* report that a relatively frequent occurrence of resting is common to other regions also, but that a far lower incidence has been reported for the Shannon Estuary, Eire, (2%, Ingram 2000) and the Sado Estuary, Portugal (0.2%, Harzen 1998). These sites are subject to strong tides; they are thought to be important foraging areas, but not to provide suitable habitat for dolphins to rest at the surface. The tides are not strong in Cardigan Bay, although both Gregory & Rowden (2001) and Lamb (2004) report correlations between dolphin movements, foraging behaviour and state of tide. The reason why dolphins are only infrequently observed resting at the surface remains unresolved. It is possible however, that in Cardigan Bay resting occurs more frequently at night, when the likelihood of boat encounters is lower.

The relative proportion of time that dolphins were observed foraging and interacting socially varied: at Aberporth and at Mwnt there were more records of foraging than of

social interaction (44% cf. 31%, and 33% cf. 28% at the two sites respectively). A similar ratio of these activities was found at Aberystwyth. A more strikingly diverse ratio was observed at New Quay Harbour, where there was a strong prevalence of foraging over social interaction (72% sea-bed foraging cf. 8% hi- or lo-key interaction between individuals). Conversely, at Ynys Lochtyn and Birds Rock more social interaction (this included close milling and acrobatic displays) was recorded than foraging (48% cf. 29%, and 49% cf. 12% at the two sites respectively). Grellier *et al.* (1995) report that foraging has been widely observed throughout the area now designated as Cardigan Bay SAC, and no preference is shown for particular areas. The present data indicated that foraging is more frequent at some sites than others however, and that New Quay Harbour, Mwnt and Aberporth are high-use foraging areas.

Bottlenose dolphin activity within the Moray Firth, NE Scotland, is concentrated around deep, narrow channels with strong tidal flows (Wilson *et al.* 1997). These are distinctly different habitats from our study sites in Cardigan Bay, where dolphin activity is often concentrated in areas of charted depth less than 10 m, and which are subject to only slight or moderate tidal currents. Moray Firth dolphins use several preferred foraging sites, characterised by steep sea-bed gradients (Hastie *et al.* 2004). At these feeding sites dolphins are observed in high-speed pursuit of fish, often salmonids (e.g. Atlantic salmon, sea trout), close to the surface. Arnold (1993) reports observations of bottlenose dolphins in Cardigan Bay feeding at the surface on species including salmonids, clupeids (e.g. sprat, herring), mullids (mulletts) and scombrids (mackerel). Surface feeding was also recorded during the present study, and was likely to have been under-recorded in the instantaneous 15 min activity samples as prey pursuit is usually completed quickly, but this feeding method did appear relatively uncommon in comparison to foraging at depth. Foraging near the sea-bed in shallow water may also culminate in surface capture on occasion of course, if prey are herded towards the surface or pelagic species are pursued opportunistically. Considering the differences in the foraging habitat of bottlenose dolphins in coastal Cardigan Bay and the Moray Firth however, and the range of foraging techniques that bottlenose dolphins are known to employ throughout their range (see e.g. Shane 1990), we might expect alternate modes of foraging to be important in the shallow waters of our study sites.

We have interpreted commonly observed dolphin behaviour as foraging close to the sea-bed, but actual prey capture at depth has not been observed. We require more information on the character of the sea-bed sediments and benthic fauna locally, if we are to fully understand how dolphins forage and on what prey they feed at these sites. We hope that the opportunity will arise to investigate these locations further, in which case data collected here may prove useful in targeted survey effort at high-use foraging areas. Benthic communities are subject to seasonal cycles, succession and environmental perturbation from storms or pollution events. These may cause local changes in the availability of benthic or demersal prey. Prey resources at headland sites which concentrate pelagic prey due to the interaction of tides and topography, are probably less affected by changes on the sea-bed but reflect the seasonal movements of pelagic species. The fortunes of migratory fish and cephalopods may also be subject to wide-ranging factors including climate change & fisheries throughout their range. The relative importance and location of present high-use foraging areas for bottlenose dolphins may therefore, vary both seasonally and from one year to the next. We aim to record this variation in forthcoming field seasons.

Equally, the quality of these habitats may be prone to chronic disturbance, including that due to inappropriate boat use. Fast boats may cause injury to dolphins through collision or impacts with propellers. Dolphins also incur energetic costs associated with interrupted foraging and other changes of behaviour that take place in response to disturbance. High levels of boat disturbance may potentially exclude dolphins from preferred habitat, at least for periods during which the disturbance persists. Lamb (2004) found that dolphin activity at New Quay peaked during the night, the data suggesting that dolphins used the harbour less during periods of high boat use. Information on fine-scale site use by dolphins may therefore prove useful if boat use is managed by zoning. If additional low speed areas for recreational boats were to be established, for example, data are now available with which to determine the most suitable areas and an appropriate range offshore to which they should extend.

We looked in detail at the use of the existing codes of conduct for boat operators: whether these have been widely adopted by boat users, and whether they reduce the impact of boats on bottlenose dolphins. The response of bottlenose dolphin schools to boats was compared for boat encounters during which the code was followed and

encounters when boat operators did not comply. The results took into account the density of boats in the vicinity at the time. When boat operators complied with the code of conduct there was a significantly lower incidence of negative dolphin response (i.e. dolphins fleeing quickly or otherwise moving away from the boat). There was also reduced incidence of changes in dolphin group structure (i.e. groups either moving close together or splitting up). Following the code of conduct reduced the incidence of these behaviours; it also increased the likelihood that dolphins would approach boats, or that leaping would occur.

In this respect, the code of conduct appeared to fulfil its objective of reducing the risk of injury or disturbance to dolphins during encounters with boats. The rate of compliance overall was high (90% of almost 1000 encounters between bottlenose dolphins and boats). Compliance was highest at New Quay, both within the harbour and on the other side of the headland at Birds Rock. The rate of uptake of the code of conduct fell slightly with distance from New Quay, where more opportunities exist of making boat users aware of the dolphin code of conduct.

We looked at the reasons cited for non-compliance with the code and at the types of boat least likely to comply. Non-compliance was mostly due to speed (65% of cases of non-compliance). Also, a number of boats followed an erratic course to pursue dolphin schools (34% of non-compliance) rather than allowing the dolphins the choice of approaching the boat, continuing their current activity or moving away. Recreational motor boats were the commonest type of boat on the coast and were responsible for the highest number of cases of non-compliance overall. The operators of fast vessels - speedboats, water-skiers and jet-skis, also accounted for a high proportion of cases of non-compliance, but were however, less likely to comply with the code of conduct than the operators of any other type of boat. Visitor Passenger Boats ('trip boats') featured highly in boat counts at New Quay Harbour, Birds Rock and at Ynys Lochlyn. Even so, very few instances of non-compliance with the code of conduct were recorded; the operators of these vessels were the most likely to adhere to the code.

The results from 2004 and 2005 indicate that if boat users follow the code of conduct then this is good for bottlenose dolphins. Additional effort at dolphin awareness should be targeted at recreational motor boat users, and in particular those who drive fast boats.

It is likely that the occupants of boats travelling at high speed often do not see dolphin schools until they are very close. Compliance with the code of conduct is already high at New Quay, showing that public awareness measures work well locally. Other launching sites still require more effort so that boat operators remain aware of the likelihood that they will encounter bottlenose dolphins and other marine wildlife, and of the locations at which encounters are particularly likely to occur. Additional measures may prove necessary to protect dolphins at some more remote sites. These could for example, include buoyed low speed areas at dolphin hot spots. Water rangers at sea could be employed to provide advice to boat users and would maintain a visible reminder on the Marine Heritage Coast and Cardigan Bay SAC that these popular sites are of national importance for bottlenose dolphins. These, and other measures, were identified in the proposal "The Ceredigion Recreational Boating Scheme", an Objective One bid prepared by the Coast & Countryside Section of Ceredigion County Council in 2004. The bid for funds was a direct result of the outcomes of previous survey reports, as the Council's Cabinet authorised officers to take additional measures to strengthen the Ceredigion Marine Code of Conduct. Unfortunately, the bid was not successful, but match funding secured from the Crown Estate Marine Stewardship Fund enabled the establishment of the Cardigan Bay Boat Place on New Quay harbour to go ahead. This new information centre for skippers and boat users aims to take forward the important work of influencing behaviour at sea, and provides a base from which the Scheme can develop in the future.

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New Quay Birds Rock: Penny Sharp

New Quay Harbour: Helen Bates & Tom Felce

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APPENDIX 1

KEY

TO CODES USED ON DATA SHEETS & MAPS



GENERAL WEATHER	
1	Fair
2	Sunny
3	Overcast / Dull
4	Rain
5	Mist, visibility < 2 km
6	Sun & Showers

SEA STATE			
0	Calm, glassy; mirror sea	4	Longer waves (1-1.5 m high); frequent whitecaps
1	Calm, rippled surface	5	Many white horses, waves (~ 2m high)
2	Wavelets; glassy crests do not break	6 +	Rough; white foam crests everywhere; waves > 2.5 m high
3	Small waves (< 1 m); occasional whitecaps	NB. Wind Direction as compass points please (N, NW, etc).	

DOLPHIN & PORPOISE BEHAVIOUR	
<p>On maps = record activity of each group at the beginning of the 15 min, or when cetaceans first seen (CHOOSE ONE CODE ONLY FROM A,B,C NOT D)</p> <p>On data forms = list all activities seen during a boat encounter you record (ANY FROM A,B,C OR D)</p>	
<p>A : SLOW MOVING predominantly slow moving or 'normal surfacing' activities</p>	<p>C : INTERACTION WITH A BOAT</p>
<p>S 1 Staying – lying motionless at the surface (like a log)</p>	<p>H Heading directly away from boat</p>
<p>S 2 Staying – slow circling, milling around (mingling) at the surface</p>	<p>A Approaching or following boat</p>
<p>S 3 Staying – long dives, thought to be foraging at depth</p>	<p>B Bow-riding</p>
<p>T 1 Travel – regular surfacing, all animals keep same, consistent heading making determined progress</p>	<p>D : OTHER BEHAVIOUR only use the following on data form, in lists of behaviour during boat encounters</p>
<p>T 2 Travel – long dives, surfacing at irregular intervals, thought to be searching for prey while on the move</p>	<p>NC No change in previous behaviour since boat within 300 m</p>
<p>B : FAST MOVING fast moving, energetic activities causing splashes & white-water</p>	<p>L or BL Leaping or Begin leaping</p>
<p>S 4 Chasing prey at surface, fish seen</p>	<p>TS Tail-slap</p>
<p>S 5 Playing with / tossing jellyfish, seaweed or other objects</p>	<p>SB Seabirds following or feeding amongst cetaceans</p>
<p>S 6 Staying - fast circling (mingling) at surface, leaps, tail slaps or lunges</p>	<p>GF Form close, tight group</p>
<p>T 3 Travel – rapid progress with forward leaps or otherwise splashy surfacing</p>	<p>GS Group splits, disperses</p>
	<p>O Other – specify in notes please</p>

BOATING BEHAVIOUR WITHIN 300 metres	
Y 1	No-wake speed and no erratic changes in course when passing cetaceans
Y 2	Slowed down gradually & stopped
N 1	Too fast: bow / wake speed, white-water visible
N 2	Erratic course to approach, avoid or follow cetaceans
N 3	Attempted to touch / feed or swim with cetaceans
N 4	Exceeded 8 kt inside yellow buoys (New Quay only)
R	Research vessel photographing individual animals (photo-ID) (specify vessel's name please)

For assistance & information
please contact:
Liz Allan, Ceredigion Coast & Countryside
Project Officer:
01545 572142 or 07779 318609

APPENDIX 2

Name : *Penny Leonard*

Location : *Abberforth*

Date : *4/9/04*

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MAP	15 Min INT.	WEATHER			CETACEANS	BOAT ENCOUNTER					NOTES	
		Start Time	General	Wind Direction		Sea State	Species Seen	Type	Range / Distance	Total no. of boats within 300 m		Boat Behaviour
A	13.00	3	S	1	0	-	-	-	-	-	-	<p>1 x KINGFISHER FLEW out FROM CLIFFS BELOW</p> <p>RETRIEVING LOST BOAT - STATIONARY.</p> <p>C.G. & T/C.S.C DESH/C.S.C. 0 SEP 2004</p>
B	13.15	3	S	1	1 BND	-	-	-	-	-		
C	13.30	3	S	1	1 BND	-	-	-	-	-		
D	13.45	3	S	1	2 BND	CA 376 C.F.B	100m	1	Y2	S2		
E	14.00	3	S	1	2 BND	CA 376 C.F.B	100m	1	Y2	S2		
F	14.15	3	S	1	0	-	-	-	-	-		
G	14.30	3	S	1	2 (1)	-	-	-	-	-		
H	14.45	3	S	1	2 (1)	-	-	-	-	-		

The Number of Different Boats Seen in 2 Hours

(If none seen - '0's in Total column please; if no count made, leave blank).

BOAT TYPE		LOG	TOTAL
MB	Recreational motor boat	11	2
SB / SS	Racing type speedboat or RIB/Water-ski	11	2
SAIL	Any boat under sail including wind-surfer		
CF	Commercial fishing boat	1	1

BOAT TYPE		LOG	TOTAL
VPB	Visitor Passenger Boat		
C	Canoe	4	4
J	Jet ski, Personal Water-Craft		
R	Cetacean Research Boat (please record boat's name)		

APPENDIX 3

