BOTTLENOSE DOLPHINS

&

BOAT TRAFFIC

ON THE

CEREDIGION MARINE HERITAGE COAST, WEST WALES

2002 & 2003

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&

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INTRODUCTION

This study has now completed 10 years of data gathering from four sites in southern Ceredigion. Previous reports on the analysis of this data set include: Cetacean Site Use and Boat Traffic on the Ceredigion Marine Heritage Coast, West Wales 1994-1999, (Pierpoint & Allan 2000); Cetacean Site Use and Boat Traffic at New Quay on the Ceredigion Marine Heritage Coast, West Wales 2000 (Pierpoint & Allan 2001) and Cetacean Site Use & Boat Traffic on the Ceredigion Marine Heritage Coast, West Wales 2001 (Pierpoint and Allan 2002).

When the study started in 1994, the aim was to obtain further information on cetacean site use and boating traffic that would help guide future management of the recently formed voluntary Marine Heritage Coast (MHC). This community-led initiative was established because of concerns over perceived increases in powered craft activity and its potential adverse effect on the local bottlenose dolphin population. The study was designed in such a way to encourage local people to take part and it was hoped that in doing so, it would build support for the MHC and raise public awareness of the issue of boat disturbance. Several hundred people have taken part over the years, some of which have participated in the survey since 1994. Since that time, the area has been included in the Cardigan Bay candidate Special Area of Conservation (cSAC), and the potential for recreational vessels to have a significant impact on the dolphins has been identified within the management plan for the site. It is therefore considered important to continue with the study as long as it is practicable and the local support remains.

A number of related education and interpretation initiatives have taken place over the last few years. The Code of Conduct information has been produced in various formats: in the Harbours, Beaches and Marine Conservation leaflet, in the Ceredigion tide tables booklet, and at information panels at launch sites. A “Dolphin Watch” newsletter was produced and circulated widely in 2003 and spring 2004 designed to give feedback to the volunteer watchers and to inform the wider public as to the findings and issues. In addition, an 8½-minute video was produced in 2002 and this has been shown at various venues.

Another development has been the restoration of the old coastguard hut at Birds Rock, New Quay with the financial help of the Crown Estate. This has meant that not only do the observers there have more comfortable conditions to undertake their watches, but also information is available at the Lookout all year round to visitors walking the coast-path. These initiatives have not only generated additional interest in the study, but have helped to spread the word regarding the potential problems that recreational boating traffic can cause cetaceans if proper management is not in place.

We have learnt from the results of the study that there is still much to do, and with this in mind, Ceredigion County Council recently submitted an Objective 1 bid for funds for a three-year recreational boating scheme. The scheme will employ a Water Ranger and project officer who will patrol the inshore waters to ensure compliance with the code of conduct and local byelaws. They will also provide additional information on the code of conduct for distribution at all launch sites and at sea.

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METHODS

We examined observations of bottlenose dolphin recorded at study sites in Cardigan Bay, Wales, from June to September in 2002 and 2003. These data were collected by a team of volunteers, most of whom had already taken part in the project in previous years. Three 2 h watches were scheduled daily, beginning at 11:00, 13:00 and 15:00. The number of dolphins present, the number of calves, observed behaviour and environmental factors including sea state (HMSO, 1983) were recorded for successive 15 min periods. The times at which sightings began and ended was also noted, with the directions by which dolphins entered and left the sites. A count of all boats present or transiting through the site in 2 h was made. When boats and dolphins were both present the type of boat that was closest to dolphins was recorded; the minimum distance between dolphins and this boat was estimated and a code recorded indicating whether the boat stopped or remained underway during the encounter.

From these data we derived sighting rates for bottlenose dolphins: comparisons between study sites and between the current data and previous years were made using the proportion of 2 h watches in which dolphins were recorded and the average number of dolphins present per 15 min in each watch. Site occupancy was calculated as the number of 15 min effort intervals in which bottlenose dolphins were present. Sighting rates were calculated using only data for complete 2 h observation periods in which the sea state did not rise above sea state 3 and no sea mist was recorded.

Levels of boat traffic in 2002 and 2003 were compared with previous years using standardised 2 h boat counts. Boat use was described in general terms by comparing the relative frequency with which different types of boat were recorded at each site. We tested correlation between levels of boat traffic and bottlenose dolphin sighting rates.

Previously we investigated trends in a number of parameters that described encounters between boats and dolphins. This year we again examined the following factors for evidence that boat users are now more likely to adhere to publicised codes of conduct:

i) The average (minimum) separation distance during encounters between dolphins and boats

ii) The frequency with which boats stopped or drifted during encounters with dolphins

iii) Observed rates of dolphin behaviour in the presence of boats.

Observational data were recorded on sighting forms, then later transcribed in electronic format and managed within a Microsoft Access database. Summary data were obtained for various time frames using macro routines written in Visual Basic. Statistical tests were carried out using non-parametric methods against a p = 0.05 level of significance.

The location of the four study sites on the south coast of Cardigan Bay, in Ceredigion, West Wales, is shown in Fig. 1.

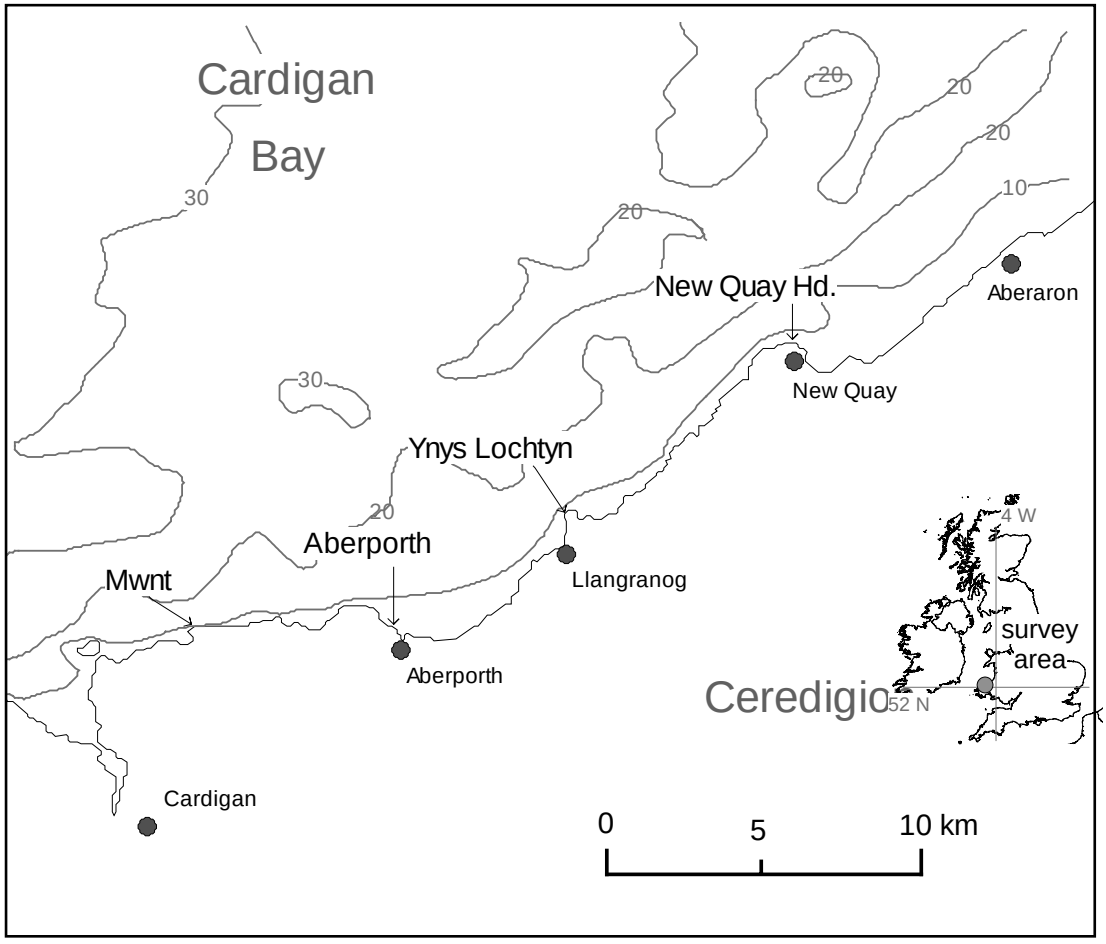

Figure 1 *The location of four study sites: Mwnt, Aberporth, Ynys Lochtyn & New Quay Head in Ceredigion, West Wales. Water depth is shown in metres.*

RESULTS

Observer effort

In 2002 and 2003, 208 and 350 observation periods (watches) were carried out respectively. Since 1994, a total of 3213 watches have been completed; this equates to 5285 h observer effort. Table 1 shows at which sites observations were carried out and total effort hours for each year. Originally observations were carried out at three sites in the MHC: Aberporth, New Quay Head and Ynys Lochtyn. In 1998 an additional site was included at Mwnt, and in 2003 all four sites were monitored for the first time since this date.

Table 1 Study sites and total effort hours 1994 – 2003.

	1994	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*
AB	X	X	X	X	X	X				X
M					X	X		X	X	X
NQ	X	X	X	X	X		X	X	X	X
YL	X	X	X	X	X	X			X	X
Hours	251	770	992	885	694	426	171	270	399	678

Sighting conditions

Since 1995, 1887 of 2252 watches (75%) have been carried out in relatively good sighting conditions (sea state 3 or less, good visibility). The proportion of watches carried out in good conditions each year is shown in Table 2. Observers in 2002 and 2003 experienced a relatively high frequency of good weather, especially in comparison with the two preceding years. For 77% of 185 watches in 2002 and 81% of 327 watches in 2003 the sea state remained below sea state 3.

Table 2 *The percentage of 2 h watches carried out in sea state 3 or less and without any sea mist recorded: 1995 - 2003.*

Year	*Total 2 h watches*	*Good conditions*	*% Good conditions*
1995	378	310	82%
1996	475	335	71%
1997	418	333	80%
1998	331	208	63%
1999	202	158	78%
2000	85	55	65%
2001	121	82	68%
2002	185	142	77%
2003	327	264	81%

The proportion of observations carried out in different sea states in 2002 and 2003 is shown in Fig. 1 and compared with data from 1995-01. The modal sea state in both 2002 and 2003 was sea state 1.

As in previous years the prevailing wind directions in 2002 and 2003 were NW, W and SW; these winds accounted for 63 % of data in both 2003 and in 1995-01 pooled. In 2002 there were fewer observations with the wind in sectors between N and SE: winds from NW – SW accounted for 80 % of observations.

Air temperature and general weather were also recorded each 15 min using the descriptive categories shown in Table 3.

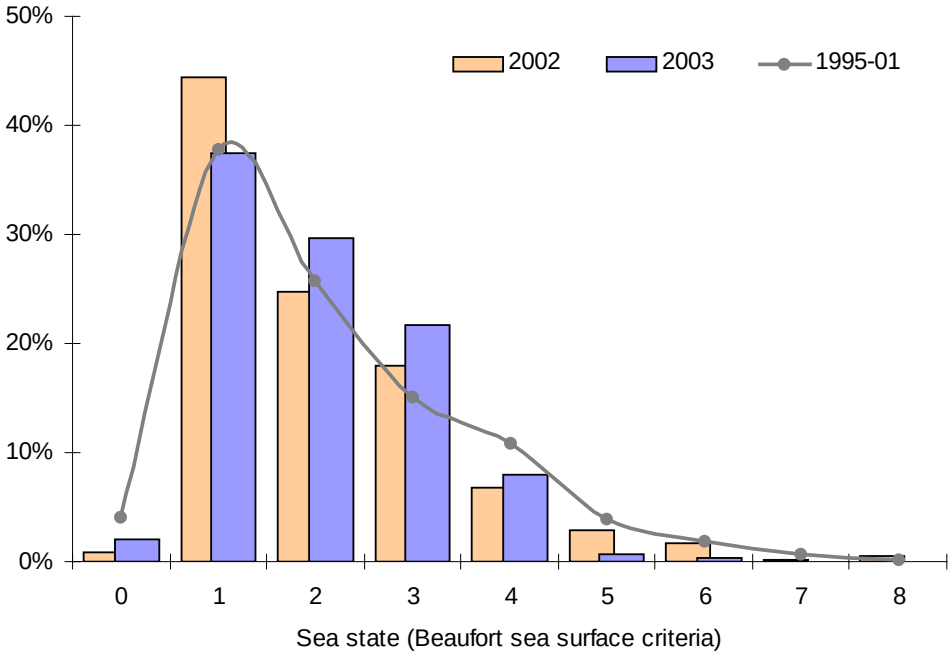

Figure 2 *Relative frequencies of sea states recorded each 15 min in 2002 & 2003 compared to all previous years combined.*

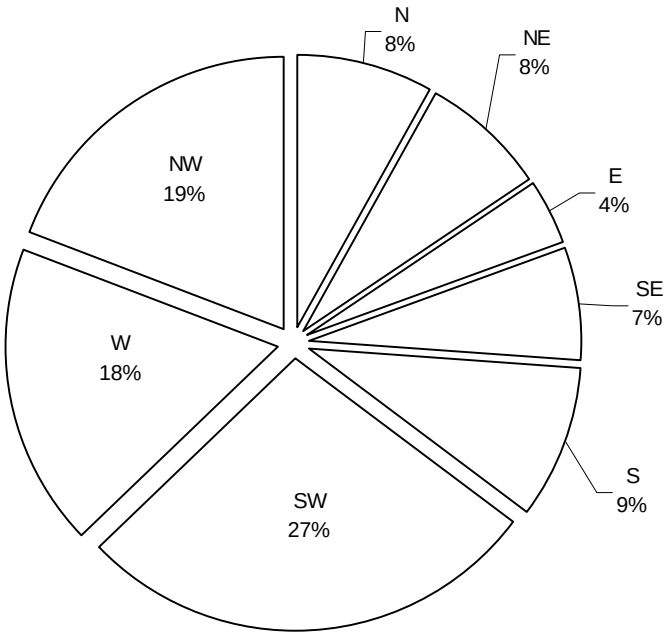

Figure 3 *Wind directions recorded for 15 min intervals: 1995-2003.*

Table 3 Air temperature and general weather 1995-01, 2002 & 2003.

Air Temperature	*1995-01*	*2002*	*2003*
cool	*16%*	*23%*	*12%*
moderate	*29%*	*36%*	*36%*
warm	*38%*	*37%*	*45%*
hot	*17%*	*4%*	*8%*

General Weather

fair	*17%*	*20%*	*16%*
sunny	*48%*	*35%*	*45%*
dull	*23%*	*30%*	*27%*
wet	*6%*	*6%*	*5%*
sea mist	*4%*	*7%*	*6%*
sun and showers	*2%*	*1%*	*1%*

Sighting rates of bottlenose dolphins

Annual variation in average sighting rates is shown in Figs. 4 & 5. Fig. 4 shows the proportion of 2 h watches carried out in good conditions, in which dolphins were recorded. Fig. 5 gives the average number of dolphins present per 15 min interval per 2 h watch. Sighting rates for 2002 and 2003 are compared below, site by site, with observations in previous years.

Aberporth

In the summer of 2003, bottlenose dolphins were recorded in 12 of 50 two-hour watches (24%) carried out at Aberporth in favourable sighting conditions. This was a similar to previous years: when observations were last made at this site in 1998 and 1999 for example, dolphins were sighted in 26% and 24% of watches respectively. The average number of dolphins present per 15 min was 0.35 (95% CI = 0.15 to 0.54). This was lower than at other study sites, but consistent with previous years. There was no significant trend in sighting rate over the period 1995-03.

Mwnt

As in previous years dolphins were sighted more frequently at Mwnt than at any other site. In 2002 dolphins were recorded in 27 of 38 watches (71%) and in 2003, in 53 of 86 watches (62%). The average number of animals present each 15 min was 1.54 (95% CI = 0.99 to 2.08) and 1.05 (95% CI = 0.74 to 1.34) respectively. This was also similar to previous years and no significant trend in sighting rate was detected.

New Quay Head

Sighting rates at New Quay were lower in 2002 and 2003 than rates recorded from both the Old Coastguard Hut from 1994 to 1997, and the present observation position[a]. We used Cuzick's Trend Test to compare sighting rates for 786 watches over 8 field seasons from 1995 to 2003 and found a significant trend for sighting rates to decline over this period (z: corrected for ties = -4.888, two-sided $P < 0.0001$).

[a] Observations were made from the Old Coastguard Hut on New Quay Head from 1994 to 1997. Since 1998 watches have been carried out from the New Coastguard Hut, located above Bird Rock and 1 km to the WSW of the previous location.

Dolphins were present at New Quay Head in 24 of 73 two-hour watches in 2002 (33%) and 32 of 89 watches in 2003 (36%). From 1994-97 the frequency with which dolphins were sighted varied little and ranged between 50 - 56% of watches. From the present observation position, dolphins were recorded in 47% of watches in both 1998 and 2000 (no watches were carried out at this site in 1999).

The average number of dolphins present in each 15 min interval in 2002 and 2003 was 0.35 (95% CI = 0.16 to 0.54) and 0.51 (95% CI = 0.30 to 0.72) respectively. From 1995-97 this sighting rate ranged from 0.89 to 1.10 animals / 15 min.

Ynys Lochtyn

Observed sighting rates at Ynys Lochtyn have been more variable than at other sites with no significant trend detected. Relatively low sighting rates were recorded at Ynys Lochtyn in 1997 and 1998; otherwise, sighting rates in 2002 and 2003 were similar to other years. The proportion of watches in which dolphins were seen was higher in 2002 than had previously been recorded. Bottlenose dolphins were recorded in 20 of 31 watches in 2002 (65%) and in 19 of 39 watches in 2003 (49%). The average number of dolphins present each 15 min was 0.71 (95%CI = 0.41 to 1.01) in 2002 and 0.56 (95%CI = 0.27 to 0.85) in 2003.

Sightings of other cetaceans & seals

Harbour porpoises (*Phocoena phocoena*) were recorded in 14 watches in 2002 (when observations were carried out at 3 sites only) and 19 watches in 2003. In both years most porpoise sightings were made at Mwnt (in 9 and 14 watches respectively). Bottlenose dolphin and harbour porpoise have been the only cetaceans recorded during the survey so far. Both species were simultaneously present during 7 watches at Mwnt and 1 watch at Ynys Lochtyn. Coincident occupation by dolphins and porpoises has been recorded at all four sites since 1994 but no interaction between the two species has yet been observed. Grey seals (*Halichoerus grypus*) were frequently seen at Mwnt, New Quay and Ynys Lochtyn, and were present in 46, 21 and 12 watches at these sites respectively in the last two seasons. There were also 6 reports of sunfish (*Mola mola*), 4 from Mwnt and 2 from New Quay.

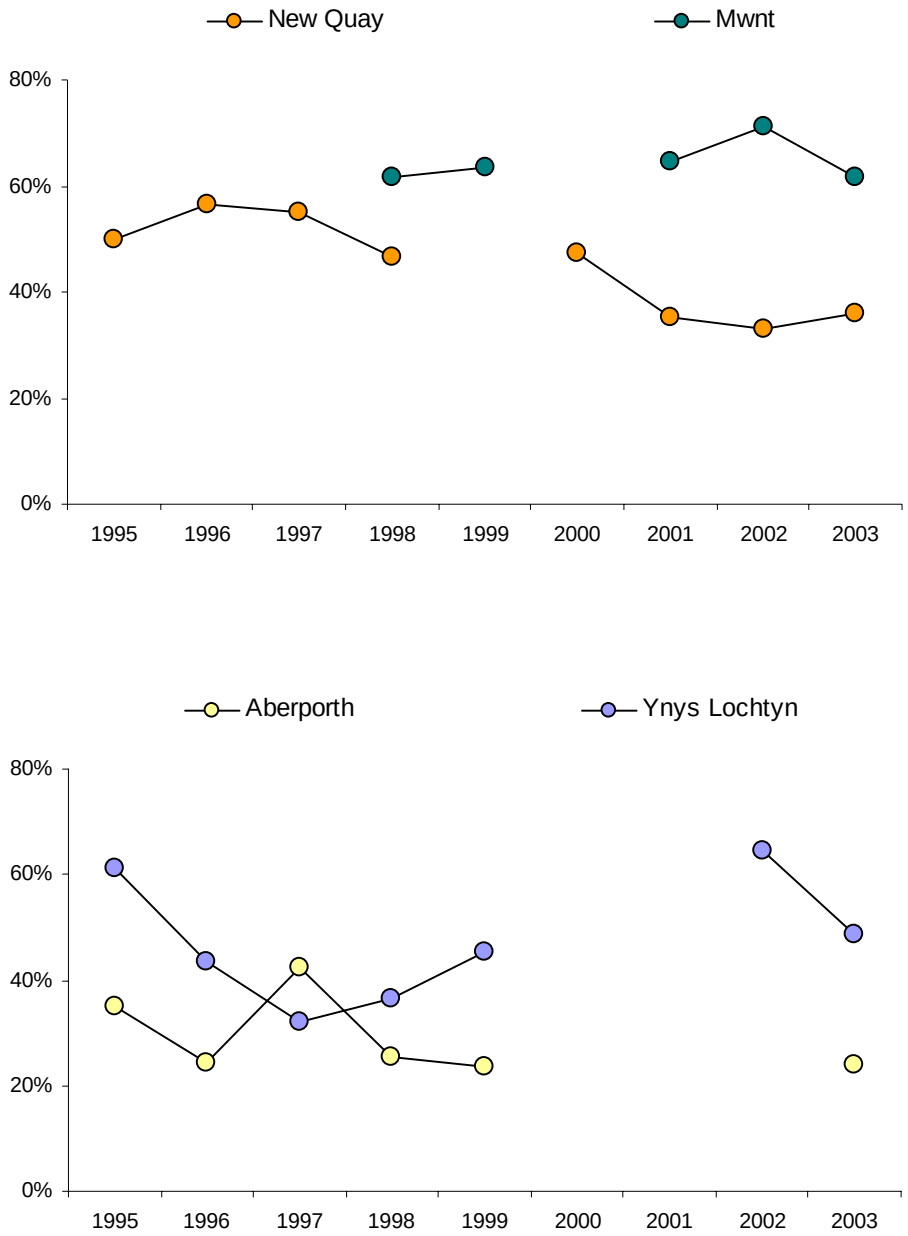

Figure 4 *The proportion of 2 h watches in which bottlenose dolphins were recorded: 1995-2003. Data for watches carried out in sea state 3 or less and good visibility only.*

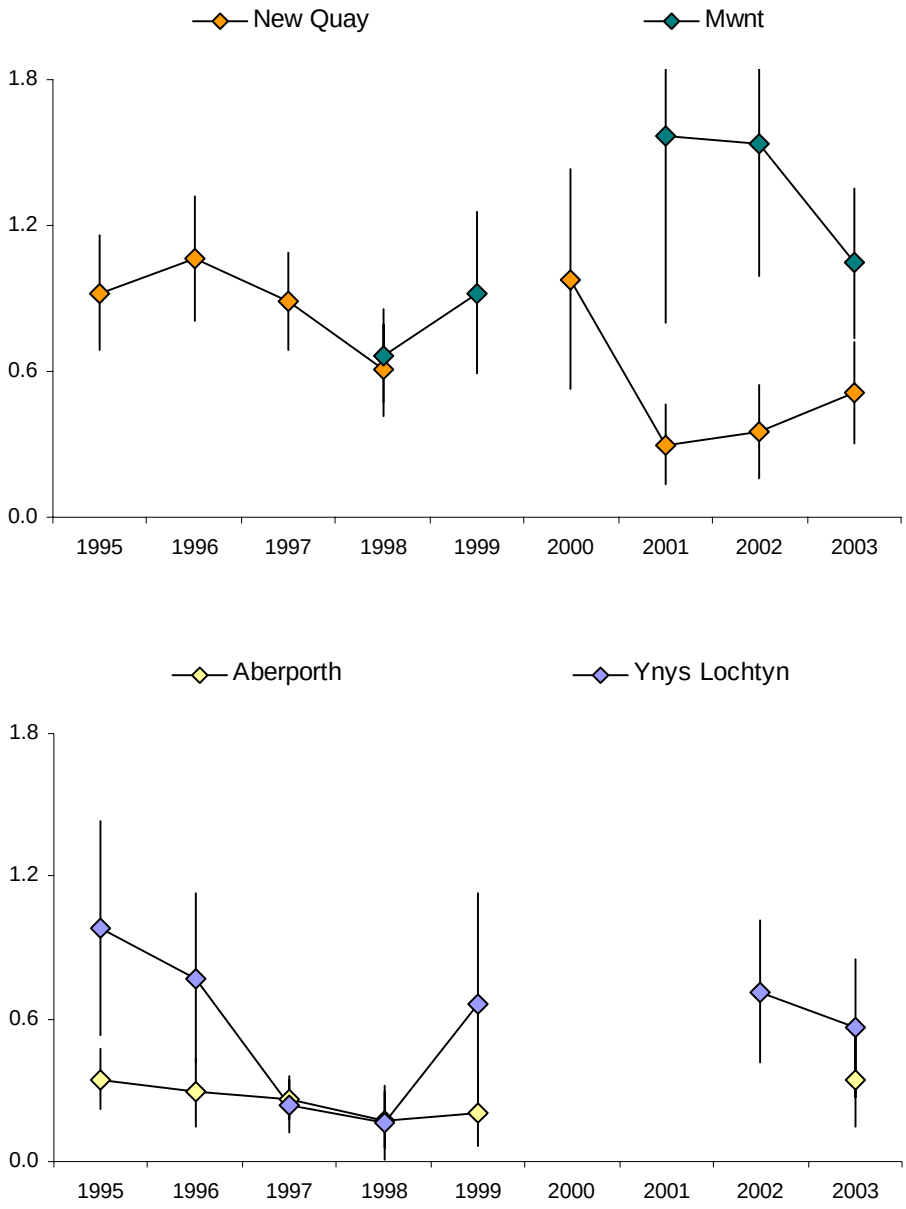

Figure 5 *The average number of bottlenose dolphins present per 15 min per 2 h watch: 1995-2003. Error bars show the 95% CI of the annual mean sighting rate. Data for watches carried out in sea state 3 or less and good visibility only.*

Group Size

We used counts of the number of dolphins recorded 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. In this case therefore, group size does not imply that an association existed between animals but refers simply to the number of animals present at a study site at any one time.

Table 4 *Mean counts of animals present during bottlenose dolphin sightings. Data for sea state 3 or less.*

	Aberporth	*Mwnt*	*New Quay*	*Ynys Lochtyn*
1995	*2.5*	*-*	*3.1*	*3.8*
1996	*2.6*	*-*	*3.5*	*3.5*
1997	*1.8*	*-*	*3.0*	*2.2*
1998	*1.6*	*2.7*	*2.4*	*1.5*
1999	*2.1*	*3.8*	*-*	*3.2*
2000	*-*	*-*	*3.4*	*-*
2001	*-*	*3.8*	*2.0*	*-*
2002	*-*	*3.4*	*2.7*	*2.5*
2003	*2.4*	*3.9*	*3.8*	*3.4*

We found previously that group size at Aberporth tended to be less than at other sites. This was again the case in 2003. When average (median) counts at the four sites are compared over the period 1995 – 2003 as a whole, lower numbers of dolphins were found at Aberporth than all other sites. Also, the average count at Mwnt was significantly higher than any other site (Kruskal-Wallis / Dwass-Steel-Chrichlow-Flinger, T adj. = 145.4, $P < 0.001$).

In 2003, average counts at all sites were higher than had been recorded in recent years. Although sighting rates have declined at New Quay Head from those of the mid-1990s, the average number of animals present in 2003 was higher than in previous field seasons. The maximum counts in 2002 at Mwnt, New Quay and Ynys Lochtyn were 13, 10 and 6 dolphins respectively (no observations at Aberporth). In 2003 the maximum counts at Ynys Lochtyn, Mwnt, New Quay and Aberporth were 17, 14, 9 and 6 respectively.

Site occupancy

Occupancy, in this case, refers to the amount of time that bottlenose dolphins were present at each study site. Observers recorded the start and end times of each sighting and previously, the total amount of time that dolphins were present was summed for each watch. This year however, we looked at the total of 15 min intervals in which dolphins were recorded and the overall proportion of 'positive intervals'. We extracted data from 2 h watches carried out in good sighting conditions and compared occupancy values for each year. The aim of this analysis was to investigate whether the absolute amount of time bottlenose dolphins utilised habitat at different sites varied, and whether there was any evidence of longer-term changes. Summary data for all field seasons at each site are shown in Table 5. From 1995-99 we found that dolphins at New Quay were present for longer periods than elsewhere (Pierpoint & Allan 2000), although they spent less time at this site in 2001 than previously (Pierpoint & Allan 2002).

Table 5 *Average number of positive intervals per watch (PI = 15 min intervals with dolphins in each 2 h watch) and percentage of intervals with dolphins (% PI) for all years combined.*

	Mean PI (sd)	*% PI*
Aberporth	*1.0 (sd = 1.94)*	*31 %*
Ynys Lochtyn	*1.6 (sd = 2.26)*	*47 %*
New Quay	*2.0 (sd = 2.64)*	*48 %*
Mwnt	*2.4 (sd = 2.54)*	*64 %*

We ranked the four sites by the amount of time that each was occupied by bottlenose dolphins and found that dolphins spent less time at Aberporth and more time at Mwnt than elsewhere. Differences between sites were consistent between years: the proportion of positive 15 min intervals with dolphins in view at Aberporth was lower that than other sites in 5 of 6 years; the highest proportion of positive 15 min intervals was recorded at Mwnt in 5 of 5 years. As expected therefore, these results mirrored the frequency of dolphin sightings at each site.

We also examined the amount of time each site was occupied during only those watches in which dolphins were sighted at least once, i.e. independently of the frequency with which sightings were recorded. When occupancy in these watches was compared, differences between the four sites were less evident, with dolphins generally occupying each site for 40-50% of 2 h watches. This suggested that although dolphins were seen at some sites more than others, when dolphins were seen they appeared to stay at each site for approximately equal amounts of time. We looked at variation in this occupancy rate over time. Using Cuzick's Trend Test (two-sided test, adjusted for ties), we found no significant trend at Aberporth ($P = 0.142$ ns), Ynys Lochtyn ($P = 0.717$ ns) or Mwnt ($P = 0.262$ ns). At New Quay however, a significant trend was found ($z = -3.909$, $P < 0.001$), with the amount of time dolphins occupied this site having declined markedly since 2000 (Fig. 6). The data suggested that when bottlenose dolphins were sighted at New Quay Head animals were less likely to stay and more likely to pass though the study site in 2001, 2002 and 2003 than in years prior to 2001.

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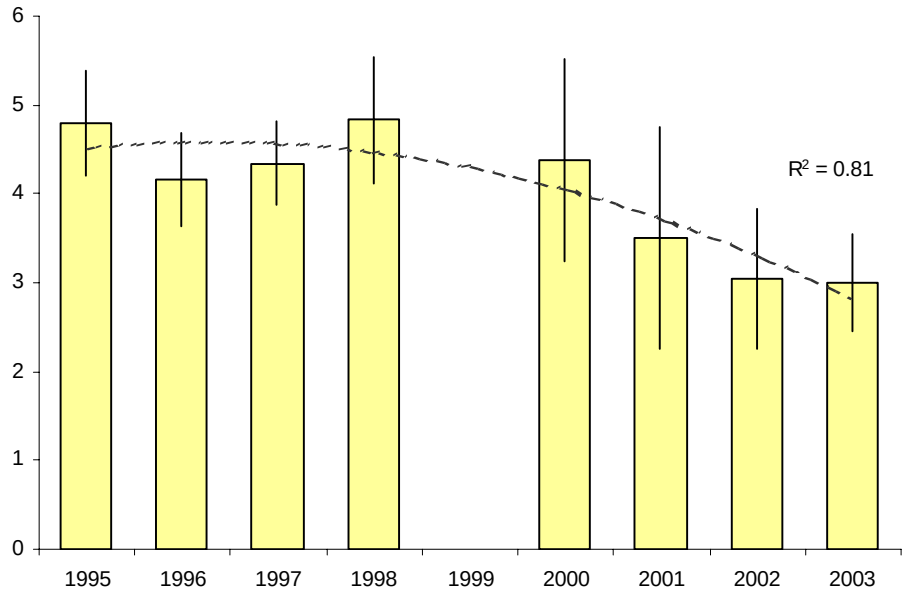

Figure 6 *New Quay: the mean number of 15 min intervals that bottlenose dolphins occupied the study site, during 2 h watches in which they were recorded at least once. A polynomial trend line has been fitted to illustrate trend 1995 – 2003.*

Sightings of bottlenose dolphin calves

In 2002 bottlenose dolphin calves were recorded in 20 watches at Mwnt, 8 at New Quay and 3 at Ynys Lochtyn. In 2003, calves were recorded in 26 watches at Mwnt, 12 at New Quay, 4 at Ynys Lochtyn and 5 at Aberporth.

These data appeared consistent with sightings in previous years. At Mwnt calves have been recorded in 38 – 59% of watches in which dolphins were sighted each year. At New Quay they have been recorded in 29 – 34% of watches, and at Ynys Lochtyn 11 – 17% of watches. Little information is available concerning the habitat preference for female bottlenose dolphins with calves, but observed differences in the rate at which calves are sighted at different study sites in the MHC suggest that this aspect of dolphin ecology deserves further investigation.

Levels of boat traffic

2 h boat counts

The level of boat traffic was recorded for each watch as a count of the total number of boats of different types seen at the site in 2 h. Data from several previous years were available with which to compare 2002 and 2003 (Fig. 7). Levels of boat traffic were higher at weekends than during the week. In general, average counts on weekdays in 2002 and 2003 were similar to previous years and slightly higher at weekends than in previous years. With the exception of Aberporth where average counts were more variable than elsewhere, highest levels of boat traffic were experienced at New Quay Head, slightly fewer boats were seen at Ynys Lochtyn, and the lowest levels of boat activity were recorded at Mwnt.

On average, at New Quay Head weekday counts have been similar since 2000 (4.6 – 6.7 boats / 2h. The average weekend count was higher in 2003 (14.0) than in recent years but remained lower than that recorded in 1994 and 1998 (16.9 and 18.7 respectively). At Ynys Lochtyn, counts were higher at the weekends in 2002 (7.0) and 2003 (9.8) and higher during the week in 2002 (7.0), than was recorded in previous years (range: 3.1 - 5.4). Mwnt also saw raised levels of boat traffic on weekdays in 2002 (3.3) and 2003 (2.8), and higher counts on weekends in 2003 (6.1) than in 1998 and 1999 (weekdays: 0.8 & 1.4 & weekends: 3.2 & 4.2 boats / 2 h respectively).

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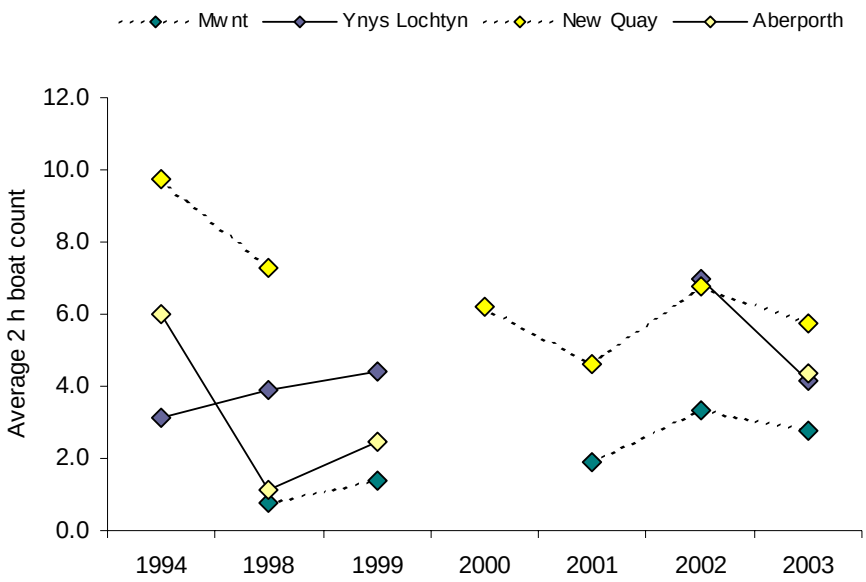
Weekdays



Weekends

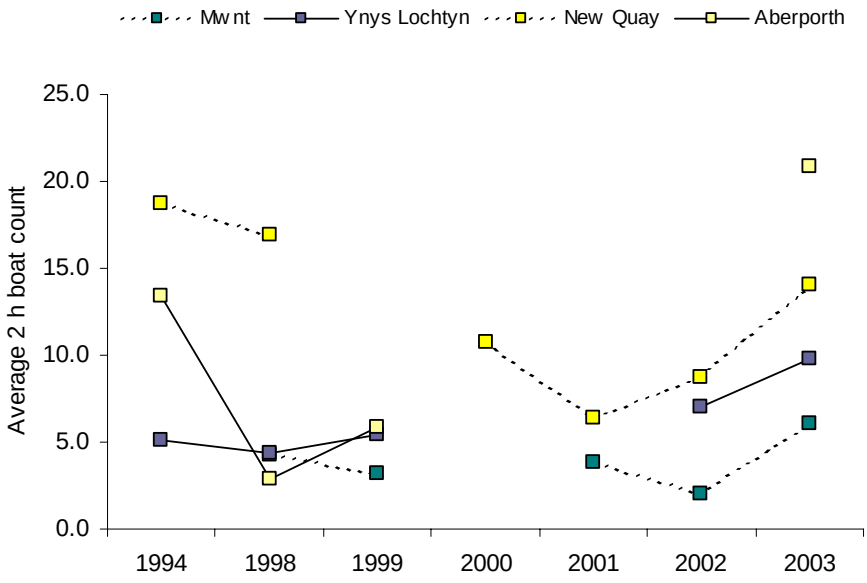


Figure 7 Average 2 h boat counts: 1994-03, plotted separately for weekdays and weekends.

Boat types

The proportions of different types of boats recorded at each site are shown in Fig. 9. The most distinct differences in boat use were observed between New Quay Head and Ynys Lochtyn, which were regularly visited by trip boats, and Aberporth and Mwnt located further to the southwest, which were not. The proportion of visitor passenger boats (VPB) at New Quay and Ynys Lochtyn was 22% and 11% respectively, whereas this type of boat represented only 1% of boat traffic at both Aberporth and Mwnt. VPB operators are currently based at New Quay and at Aberaeron. Another marked difference was found between the proportion of commercial fishing boats (CF) at Mwnt compared with other sites: 22% at Mwnt, 9% at New Quay, 9% at Ynys Lochtyn, 2% at Aberporth. There have been no discernable changes in the relative importance of different types of boats at any site since 1998 (e.g. VPB: Fig. 8).

Figure 8 Percentage of visitor passenger boats of all boats counted in 2 h: 1998 – 2003.

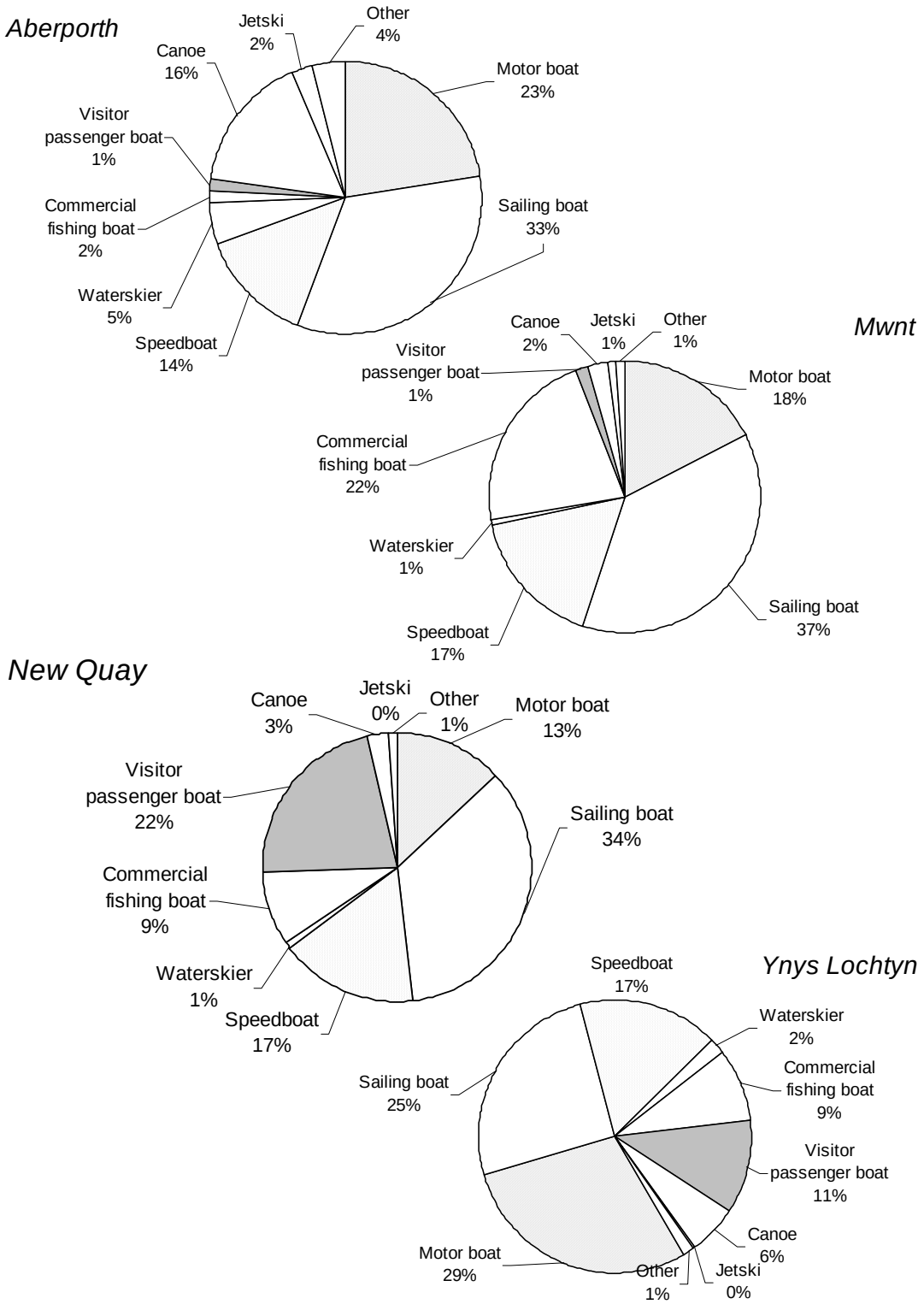


Figure 9 *The relative proportions of different types of boats recorded during 2 h counts at Aberporth, Mwnt, New Quay and Ynys Lochtyn: 1994 - 2003.*

Boat traffic v bottlenose dolphin sighting rate

We investigated the relationship between the level of boat traffic and the frequency of bottlenose dolphin sightings. We first tested for correlation between total boats counted in 2 h, and the sighting rate of bottlenose dolphins in the same period. We found concordance (positive correlation) in the numbers of boats and the dolphin sighting rate at Mwnt, New Quay and Ynys Lochtyn. The results were ambiguous however, as both factors were also strongly correlated with sea state: dolphin sighting rates and the level of boat traffic increased as sea state decreased. Dolphins were sighted more frequently in low sea states, perhaps because they were easier to spot at greater range in calmer seas; calmer seas were also more attractive to recreational boat users.

To reduce the effect of sea state as a compounding factor the correlation tests were repeated separately for sea states 1, 2 and 3 (the median sea state value for the 2 h was used). We carried out the test site by site, using data from 2002 & 2003. P-values calculated for Kendall's Rank Correlation are shown in Table 6. When the effect of variation in sea state was controlled, no significant correlation was found between the level of boat traffic and dolphin sighting rate (5% level of significance). This was also found to be the case when dolphin occupancy (the number of 15 min intervals with dolphins present) was compared against the level of boat traffic, and when both sighting rates were tested against counts of motor-driven boats only.

Table 6 *Correlation between total boat count and bottlenose dolphin sighting rate in sea state 1, 2 and 3: two-sided p-values calculated for Kendall's Ranked Correlation Test (adjusted for ties).*

	Sea state1	*Sea state 2*	*Sea state 3*
Mwnt	*0.054*	*0.252*	*0.752*
New Quay	*0.496*	*0.979*	*0.770*
Ynys Lochtyn	*0.975*	*0.077*	*0.727*

Encounters between dolphins and boat users

A 15min period in which dolphins and boats were recorded within a nominal distance of 800 m of each other was termed an 'encounter'. The MHC database holds records of 1412 encounters. Of this total, 876 (62%) occurred at New Quay while 16%, 11% and 10% were recorded at Ynys Lochtyn, Aberporth and Mwnt respectively. The percentage of encounters with different types of boat is shown in Table 7.

Table 7 *The percentage of bottlenose dolphin encounters with different types of boat & the total number of encounters recorded at each site since 1994.*

	Aberporth	*Mwnt*	*New Quay*	*Ynys Lochtyn*
Visitor passenger boat	*4%*	*3%*	*44%*	*28%*
Sailing boat	*15%*	*22%*	*20%*	*15%*
Speedboat	*19%*	*20%*	*16%*	*16%*
Motor boat	*41%*	*18%*	*13%*	*35%*
Commercial fishing boat	*6%*	*31%*	*5%*	*4%*
Canoe	*7%*	*5%*	*1%*	*1%*
Jet ski	*1%*	*0%*	*0%*	*0%*
Other	*2%*	*1%*	*0%*	*0%*
Water-skier	*4%*	*0%*	*0%*	*0%*
Total encounters	*162*	*147*	*876*	*227*

Since 1994, most encounters at the busiest site, New Quay, have involved VPB. These vessels have accounted for a relatively high proportion of encounters at Ynys Lochtyn also. Recreational motor boats and speedboats (RMB) also accounted for 29% of encounters at New Quay and 51% at Ynys Lochtyn. Sailing boats were recorded in 20% and 15% of encounters at these sites respectively.

At Aberporth 64% of encounters were between dolphins and RMB, and 15% with sailing boats. At Mwnt 38% of encounters involved RMB and 22% sailing boats. There was a higher proportion of encounters with canoes at Aberporth than elsewhere (7%). A higher proportion of commercial fishing boats were recorded in encounters at Mwnt than at other sites (31%).

Separation distance between dolphins and boats

Separation distance refers to the minimum distance between dolphins and boats observed during encounters. It was recorded once each 15min, for the closest boat during this period. Distances were estimated by eye and recorded in metres. The separation distance is a product of the movements of both boat and dolphins. When boat operators follow codes of conduct, dolphins are able to choose the extent to which they approach boats. Increases in the frequency of close encounters between boats and dolphins would not necessarily mean that boat owners were behaving inappropriately close to dolphin schools. However, trends in separation distance may give some indication of whether codes of conduct are being adhered to, and to which groups of water-users information on best practice when close to cetaceans would best be targeted. We looked for changes in the nature of encounters in 2002 and 2003 from those observed in previous years.

In 2002 and 2003 there was a general increase from recent seasons in the number of close encounters recorded (encounters with a estimated separation distance of 50 m or less). An increase in close encounters was recorded with a range of different types of boat, including RMB at Ynys Lochtyn and Mwnt. At Ynys Lochtyn the increase in the number of close encounters observed in both 2002 and 2003 was accounted for by increased close encounters between dolphins and VPB. An increase in close VPB encounters was also observed at New Quay in 2003, although it should be noted that fewer close VPB encounters were recorded than annually during the 1990s. Fig. 10 illustrates how the frequency of close encounters between dolphins and VPB increased at Ynys Lochtyn in 2002 and 2003. At New Quay, an increase in these encounters in 2003 is seen against a general decrease, perhaps associated with a decline in sightings at this site. VPB encounters constitute a high percentage of total boat encounters at New Quay, and data shown in Fig. 10 mirrors the trend for all boat encounters at this site. The higher number of close approaches by VPB in 2003 was explained, at least in

part, by the activities of the vessel *Sulaire*. *Sulaire* was operated by the Cardigan Bay Marine Wildlife Centre and licensed by the Countryside Council for Wales to carry out a photo-ID study of bottlenose dolphins within Cardigan Bay SAC. To carry out this study the vessel regularly approached dolphins closely in order to photograph individual animals. It was not possible to differentiate data for *Sulaire* from that of other VPB.

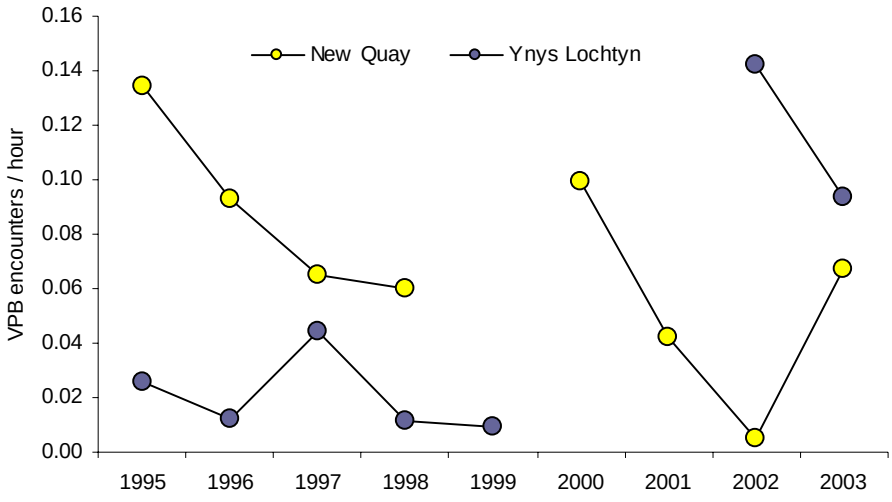


Figure 10 *Encounters between bottlenose dolphin and visitor passenger boats (VPB): rate at which close encounters (those with a separation distance 50 m or less) were recorded at New Quay and Ynys Lochtyn 1995-03.*

Previously we found that the average separation distance during encounters between dolphins and VPB increased following the introduction of a voluntary code of conduct in 1997 (Pierpoint & Allan 2000), and the average separation distance in 2002 was similar to other years since the code was introduced (Fig. 11). In 2003 however, the average distance was lower than in recent years. Again, this was likely to be due to the inclusion of encounters involving *Sulaire*, a vessel licensed to closely approach dolphin schools. The average closest distance during encounters in 2002 was 151 m (95% CI = 100 to 202 m, n = 33 encounters). The equivalent distance in 2003 was 117 m (95% CI = 72 to 162 m, n = 51 encounters). A significant trend for increasing separation distance was still apparent for the period 1994-03 (Cuzick's Trend Test, z = 2.54, one-sided P = 0.006).

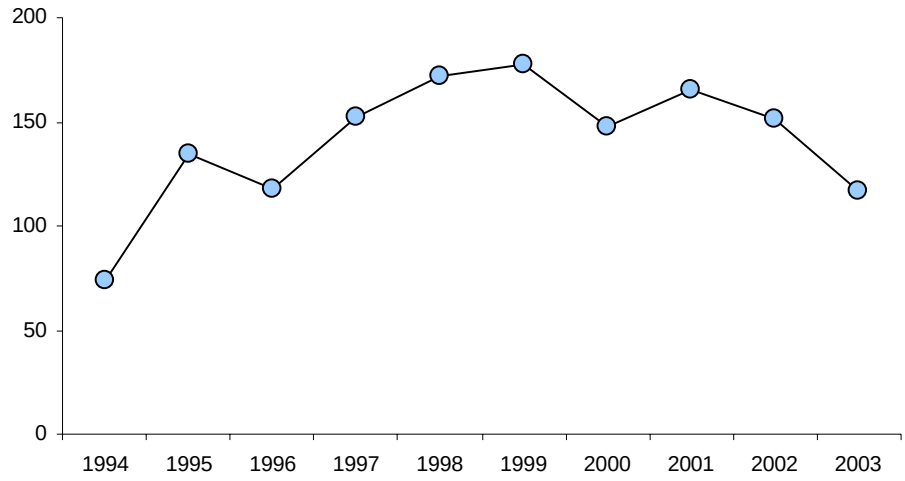
There was no clear trend in the average separation distance for RMB (recreational motor boats and speedboats) (Cuzick's Trend Test, P = 0.406 ns). Data for 2002 and 2003 appeared to fall within the variation observed in previous years of the survey (Fig. 11). The average closest distance during RMB encounters in 2002 was 102 m (95% CI = 62 to 143 m, n = 49 encounters) and 207 m (95% CI = 146 to 268 m, n = 54 encounters) in 2003.

Moving and stationary boats

Present codes of conduct for VPB operators, RMB and all other boat users require vessels to maintain a steady course and 'no wake' speed when within 300 m from dolphins, or to slow down gradually. Boats drivers are advised to stop and drift when within 100 m of a group. We looked at the proportion of close encounters in which vessels complied with the code. We found that VPB stopped when within 50 m of dolphins on 6 of 12 occasions in 2002 and 12 of 25 occasions in 2003 (Fig. 12). These boats have stopped to drift in 51% of close encounters recorded since the introduction of their code of conduct in 1997.

When we looked at RMB we found differences between vessels classified by observers as motor boats and those classified as speedboats; these two types of boat were subsequently examined separately. We found that speedboats were less likely to stop when in the close vicinity of dolphins than other types of RMB. In 2002 and 2003 speedboats stopped only 4 of 20 times when within 50 m of dolphins, whereas other motor boats stopped on 28 of 36 occasions. This difference between speedboats and motor boats has been evident in most years since 1997 (Fig. 12). Nine of 12 instances of speedboats not stopping in 2002 occurred at Mwnt. During at least 5 of these encounters, the boat driver headed directly for a school of dolphins at high speed. On one occasion the driver may not have been aware that dolphins were present as the boat passed directly over the dolphins' location at an estimated 25 kt. On all other occasions the boats changed course to head for dolphins when they were sighted.

Visitor passenger boats



Recreational motor boats & speedboats

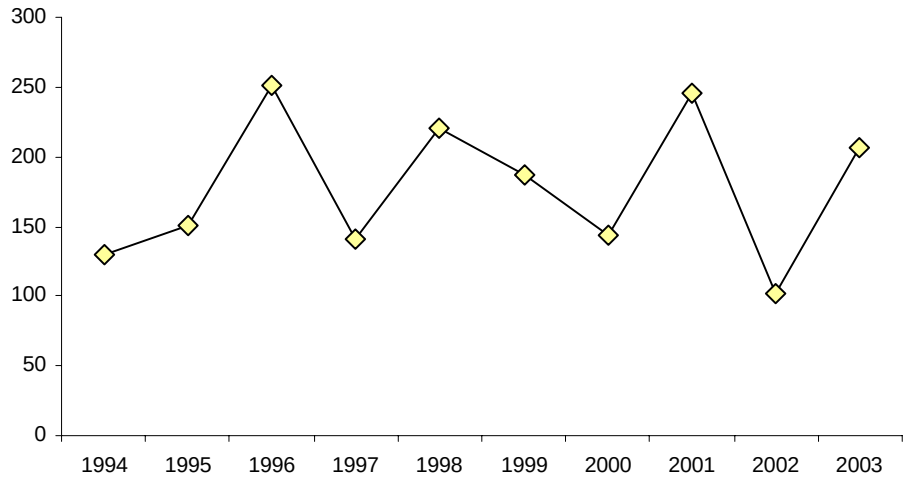
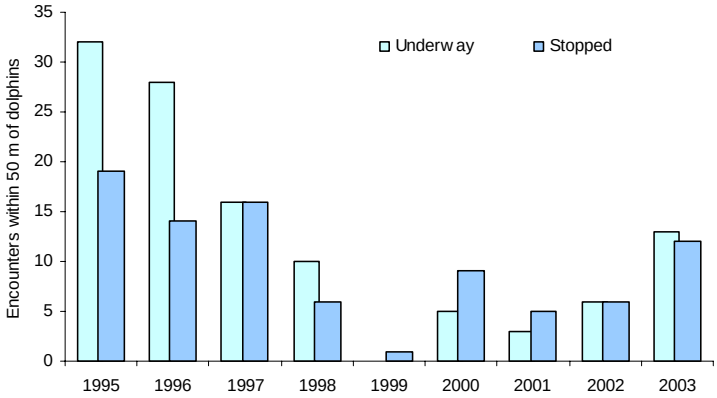
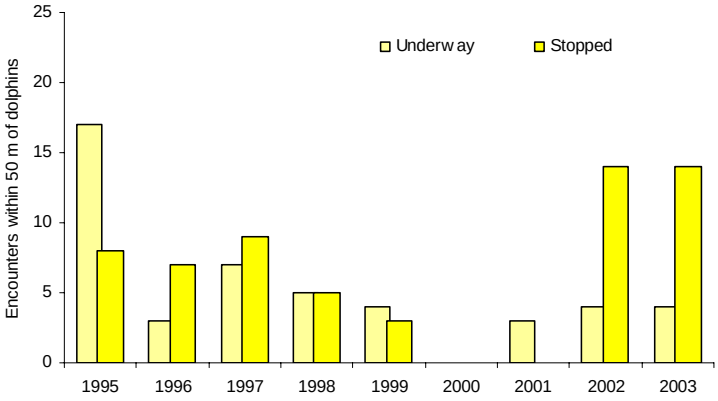


Figure 11 *Average separation distance (closest approach distance) during encounters between bottlenose dolphins and visitor passenger boats and between bottlenose dolphins and recreational motor boats / speedboats: 1994 – 2003 (error bars omitted for clarity).*

Visitor passenger boats



Recreational motor boats



Speedboats & speedboats with water-skiers

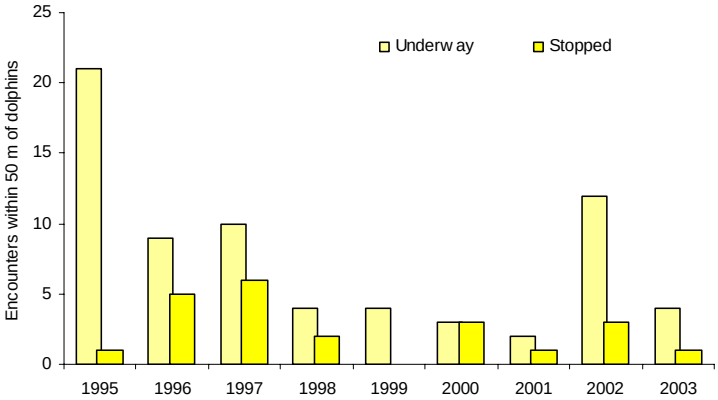


Figure 12 Encounters within 50 m of dolphins in which visitor passenger boats, motor boats and speedboats stopped or remained underway.

Dolphin behaviour during boat encounters

Observers systematically listed all dolphin behaviours observed in each 15 min interval. Codes for the following range of activities were available to observers:

S	staying at same location
H	heading away from boat
A	approaching boat
B	bow-riding boat
L	leaping
T	tail-slapping
BS	seabirds associated with dolphins
F	fish seen when pursued or thrown by dolphins.

Some of the codes refer to interactive behaviour between dolphins and boats (*H*, *A*, *B*), others may take place in the presence and absence of boats (*S*, *L*, *BS*, *F*). We looked at the relative frequency of different behaviours when boats were absent; when boats of different types approached within 100 - 400 m of dolphins; and during encounters within 50 m both when boat drivers did, and did not, slow and stop. To do this we pooled all available data for different years each site.

i) Boats absent (no boats within 800 m)

Table 8 shows the relative frequency that dolphin behaviours were recorded at each study site in the absence of boats. Frequency is expressed as the percentage of 15 min intervals during sightings in which each behaviour was recorded. The most frequently recorded behaviours were 'staying' (remaining at the same location) and 'leaping'. 'Staying' was recorded in 30 – 54% of sightings, 'leaping' in 32 – 50% of sightings. The relatively high frequency of 'staying' was consistent with the level of site occupancy dolphins exhibit at the study sites (see section e. above). If a low level of site occupancy had been observed the frequency of 'staying' would have been likely to be low also, indicating a tendency for animals to transit through sites rather than remaining to utilise local habitat. At Aberporth, where bottlenose dolphins were recorded in fewer 15 min intervals than at other sites, the relative frequency of 'staying' was also lower than elsewhere.

Table 8 *The percentage of sightings (15 min intervals with bottlenose dolphins) in which a range of behaviours were recorded: no boats present.*

	AB	*M*	*NQ*	*YL*
Staying	30 %	54 %	47 %	51 %
Leaping	41 %	32 %	32 %	50 %
Tail-slapping	2 %	11 %	2 %	5 %
Fish pursuit	2 %	2 %	4 %	3 %
Seabirds present	16 %	15 %	11 %	14 %

ii) Boats approached within 100 - 400 m

We compared the frequencies that behaviours were recorded when different types of boat approached to between 400 and 100 m (Table 9). The most commonly recorded behaviours were ‘staying’, ‘heading away’ and ‘leaping’, with ‘staying’ being recorded in 50 – 67% of sightings with each type of boat. Dolphins headed towards sailing boats more often than other types of boat and least often towards speedboats. Conversely, dolphins headed way from speedboats (and also fishing boats) more than from other types of boat and least often from boats under sail (and also canoes, although this was based on only 11 encounters). ‘Leaping’ occurred most frequently in the presence of sailing boats and canoes, and least often with fishing boats.

Table 9 *The percentage of sightings (15 min intervals with bottlenose dolphins) in which a range of behaviours were recorded: boats approached 100 – 400 m. VPB = visitor passenger boat, MB = motor boat, SB / SS = speedboat / speedboat with water-skier, SAIL = sailing boat under sail, CF = commercial fishing boat, CAN = canoe.*

	VPB	*MB*	*SB / SS*	*SAIL*	*CF*	*CAN*
Approaching	6 %	10 %	4 %	12 %	8 %	9 %
Heading away	21 %	25 %	37 %	19 %	31 %	9 %
Staying	61 %	67 %	50 %	61 %	51 %	55 %
Leaping	26 %	22 %	23 %	30 %	18 %	45 %
Tail-slapping	1 %	5 %	0 %	3 %	10 %	0 %
Fish pursuit	1 %	1 %	0 %	3 %	3 %	18 %
Seabirds present	10 %	6 %	7 %	9 %	13 %	9 %
Encounters	145	88	70	74	39	11

iii) Boats approached within 50 m

During close encounters, it was consistently found that dolphins approached different types of boat more often when the boat slowed and stopped (Table 10). 'Staying' also was recorded more frequently in encounters with VPB and RMB (motor boats and speedboats) when these boats stopped. Except in the case of speedboats, 'leaping' occurred more frequently when boats stopped when within 50 m of dolphins. 'Leaping' was noted less often when speedboats stopped than when they continued underway, but this activity was still recorded in almost a third of encounters with this type of boat.

Dolphins headed away from boats less often during encounters with VPB, motor boats, speedboats and sailing boats when these boats stopped when within 50 m of dolphin schools. The reverse was found for close encounters with commercial fishing boats, although in this case there were data from relatively few encounters.

Table 10 *The percentage of sightings (15 min intervals with bottlenose dolphins) in which a range of behaviours were recorded: boats approached within 50 m, either stopping or continuing underway. The number of sightings in which behaviours were recorded is given for commercial fishing boats and canoes for which relatively few data were available.*

	VPB		*MB*		*SB / SS*	
Stopped ?	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*
Approaching	17 %	11 %	19 %	7 %	9 %	5 %
Heading away	14 %	30 %	18 %	36 %	23 %	41 %
Bow-riding	4 %	8 %	2 %	7 %	5 %	3 %
Staying	68 %	48 %	61 %	47 %	64 %	53 %
Leaping	36 %	31 %	39 %	29 %	27 %	36 %
Tail-slapping	1 %	2 %	11 %	2 %	5 %	3 %
Fish pursuit	4 %	0 %	2 %	0 %	0 %	2 %
Seabirds present	2 %	3 %	9 %	9 %	14 %	6 %
Encounters	84	107	57	45	22	64

	SAIL		*CF*		*CAN*	
Stopped ?	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*
Approaching	12 %	11 %	1	2	1	0
Heading away	12 %	27 %	2	5	2	2
Bow-riding	26 %	8 %	0	1	2	1
Staying	47 %	47 %	2	8	2	2
Leaping	49 %	18 %	3	2	2	2
Tail-slapping	5 %	4 %	0	0	2	1
Fish pursuit	0 %	4 %	0	0	0	1
Seabirds present	12 %	4 %	0	2	0	0
Encounters	43	45	4	16	3	6

DISCUSSION

The MHC Cetacean and Boat Traffic Survey now draws upon 10 years of observation at coastal sites in Cardigan Bay. As well as examining year-to-year variation in boat activity and cetacean sighting rates, we can begin to view our data in longer-term perspective - bottlenose dolphins may live as long as 50 years (Connor *et al* 2000) and calves first seen at the onset of the project at New Quay, Aberporth and Ynys Lochtyn are now likely to be sexually mature and capable to producing calves of their own.

With the inclusion of data collected in the summer of 2002 and 2003, total survey effort exceeds 5500 h. Sighting conditions in 2002 and 2003 were good: 77% of watches in 2002 and 81% of watches in 2003 were carried out in sea state 3 or less and with good visibility. Observers in the preceding two years experienced similarly favourable conditions in only 65% and 68% of watches respectively. As the prevailing conditions strongly affect the likelihood that cetaceans are seen and the maximum range at which sightings are reliably made, sighting rates were only derived for watches carried out in relatively good conditions (sea state 3 or less and good visibility). In terms of the proportion of 2 h watches in which bottlenose dolphins were recorded, our study sites have ranked relatively consistently from year to year since 1994. In 2002 and 2003, bottlenose dolphins were sighted more frequently at Mwnt (71% and 62% of 2 h watches respectively) than at Ynys Lochtyn (65% and 49%), New Quay Head (33% and 36%) and Aberporth (24%). The frequency of sightings at all sites is considered high - bottlenose dolphins occur regularly in few discrete areas of UK coastline (see Evans *et al 2003*) and sighting rates reported for this survey highlight the importance of inshore habitats in Cardigan Bay for this species.

When average counts of dolphins per unit effort in 2002 and 2003 were compared to previous years, the highest rates were again found at Mwnt (1.5 & 1.0 animals / 15 min interval / 2 h watch in 2002 and 2003 respectively). Rates at Ynys Lochtyn (0.7 & 0.6) were similar to most other years for which we have data, and higher than in 1997 and 1998 when sightings were relatively infrequent. When observations recommenced at Aberporth in 2003, the sighting rate (0.3) was lower than at the other three study sites, but consistent with previous years' data from this site. Sighting rates at New Quay in 2002 (0.3) and 2003 (0.5) were similar to those in 2001 (0.3), and lower than was

observed at New Quay in the mid to late-1990s (1995-00 range: 0.6 – 1.0). In part, lower sighting rates at New Quay may have resulted from a change in the observation position. From 1994 to 1997 observers watched from a point just below the Old Coastguard Hut on New Quay Head. In 1998, observers moved 1 km WSW to the present location, the New Coastguard Hut above Birds Rock. Although the field of view has remained similar, the old location allowed observers to track dolphins approaching and leaving New Quay harbour along the coast from, and to the north, and this is not now possible. Dolphins are also known to regularly frequent the harbour area itself (Bristow & Rees 2001).

Data collected since the move however, indicated that there have now been three consecutive seasons with relatively low levels of dolphin occurrence at New Quay Head. If this decline in sighting rates were mirrored over the same period at other sites, it would suggest that fewer dolphins were present in the coastal region as a whole. This was not the case however, and no trend was evident elsewhere. Previously, we speculated that observed changes in dolphin site use at New Quay Head reflected changes in habitat resources, possibly a reduction in the local availability of prey (Pierpoint & Allan 2002). Changes in benthic prey communities or communities otherwise restricted to specific localities would be more likely to affect cetaceans at a single site than variation in the distribution of pelagic prey. Changes in the abundance of schooling fish that range over the wider area, for example, may affect cetaceans in the coastal region as a whole. The impact of changes in the abundance of prey species associated with static features (e.g. resident reef fish) are clearly however, more likely to be restricted in extent. When investigating factors affecting sighting rates of bottlenose dolphins at only one of our study sites we looked for habitat changes known to have occurred at New Quay itself. In fact, few data were available with which to investigate this in detail. We were able to examine two possible factors: changes that have been made in near-shore discharges from a shellfish processing factory operated by Quay Fresh & Frozen Foods Ltd., and levels of boat traffic recorded during our study.

During the period of our study, the changes in operating procedure at Quay Fresh have involved an increase in clean crushed shell waste discharged into near-shore waters from 750 t of clean whelk shell waste in 1996, to 2000 t in 2003. Despite the increases in shell waste deposits, there is little evidence of shell waste outside a 50 m radius of the

discharge point; any direct effect on cetacean prey in benthic habitats would therefore be limited to only a small area of seabed.

Other changes concerned discharges of organic shellfish waste. Up until 1998, whelk meat was removed manually from unbroken shells that were discharged whole, probably with a certain amount of organic waste attached. Approximately 100 kg of whelk pieces were discharged as waste with crushed shells from the factory each working day up until a point between 2001 and 2003 when the practice ceased. It is conceivable that a reduction in the quantity organic matter discharged from the factory has affected changes in habitat resources for bottlenose dolphins. Both bottlenose dolphins and harbour porpoises have been regularly observed foraging close to the end of the outfall pipe from the factory, perhaps attracted by fish that scavenge discharged organic waste. A reduction in organic discharge may therefore have reduced the local availability of cetacean prey and affected dolphin sighting rates at New Quay.

One alternative explanation for the decline in dolphin occurrence is that dolphins have been increasingly excluded from the site by high levels of boat activity. New Quay is the busiest of our study sites for recreational and commercial boat traffic. However, we found that levels of boat traffic have remained similar since 2000[b]. Rate at which close encounters (approaches within 50 m) between boats and dolphins have been recorded at New Quay were lower in 2001-03 than in each year between 1995 and 2000. Further, we found no correlation between sighting rates of bottlenose dolphin and counts of either total boat traffic or motor powered craft during 2 h watches. The data suggest therefore, that the reduction in dolphin sighting rates at New Quay was unlikely to have been caused by any corresponding increase in boat activity. In a previous study at New Quay, Bristow & Rees (2001) report a 'general tolerance' to increasing levels of boat traffic from 1989 – 97, with 'reactions varying with boat type'.

The absolute amount of time that dolphins occupied habitat at each site can be expressed as the percentage of 15 min intervals with dolphins present. Over the course of the survey this has represented 31% of observer effort at Aberporth, 47% at Ynys

[b] Levels of boat traffic were lower during this period than when previous counts were made in 1994 and 1998, although relatively high counts in 1994 may have been affected by the use of a different observer position with more extensive views over the approaches to New Quay harbour.

Lochtyn, 48% at New Quay, and 64% at Mwnt. Prior to 2000, dolphins tended to occupy habitat at New Quay for significantly longer than at other sites (Pierpoint & Allan 2000). The amount of time that bottlenose dolphins have occupied this site however, has fallen in recent years: in watches with dolphins recorded (i.e. independently of the rate at which schools were sighted) dolphins were present for approximately 4-5 of eight intervals from 1995 to 2000, compared with 3 intervals, on average, in each watch in 2002 and 2003.

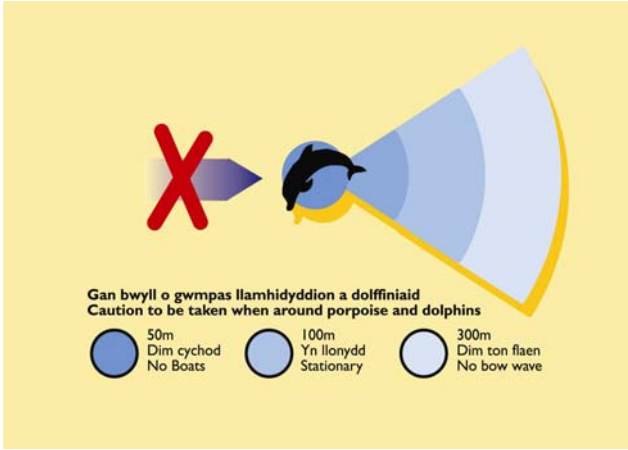
A reduction in site use at New Quay may have resulted in a redistribution of animals to adjacent sites of preferred habitat. Interestingly, years of low sighting frequency at New Quay appeared to correspond with particularly high sighting rates at Mwnt. In 2002 and 2003, variation in sighting rates at Ynys Lochtyn also appeared to coincide with a contrary trend in rates at New Quay. There may be some evidence therefore that a change in site use observed as a decline in bottlenose dolphin occurrence at New Quay has been accommodated for by increased site use at other near-shore locations in the Cardigan Bay SAC.

Counts of the number of dolphins present at the study sites in 2002 and 2003 ranged from 1 – 17 animals. On average, the highest counts were made at Mwnt (3.4 and 3.9 animals respectively), followed by New Quay (2.7 and 3.8 animals), Ynys Lochtyn (2.5 and 3.4 animals) and Aberporth (2.4 animals). The relative difference between average counts at the four sites in 2002 and 2003 were typical of previous years of the study. When the median counts each year were compared, it was found that average counts at Aberporth were significantly lower and at Mwnt significantly higher than at other sites. Counts were similar on average at New Quay and Ynys Lochtyn.

Neonate or young bottlenose dolphin calves were seen at each site in 2002 and 2003. Small animals were classified as calves if closely accompanied by an adult, less than or approximately 2/3 of adult size, with relatively pale flanks and back and possibly with foetal folds present. Calves were present at Mwnt in 59% and 42% of sightings, at New Quay Head in 29% and 32% of sightings and at Ynys Lochtyn in 12% and 17% of sightings in 2002 and 2003 respectively. As the proportion of sightings with calves present was similar in successive years at each site, but consistently different between study sites, the data suggested that female bottlenose dolphins with calves may have

expressed preference for certain sites over others. Nursing females may have specific habitat preferences but detailed information is lacking both on how dolphins use these sites, and concerning the physical and biological attributes of the sites themselves.

The MHC database holds records of 1412 encounters between bottlenose dolphins and boats. The majority of these occurred at New Quay (62%) the home port of several dolphin-watching trip-boat operators (VPB) and generally the busiest site. We examined data from encounters for indications that boat operators complied with the publicised codes of conduct. We looked at trends in the frequency of close approaches to dolphins (those to within 50 m) for different types of boat. The average separation distance was compared between years (this was the closest estimated distance between dolphins and boats during encounters). We looked at the relative frequency with which boat operators slowed and stopped when within 50 m of dolphins. We also looked at the behaviour of bottlenose dolphins in the presence and absence of different types of boat approaching to different ranges.



In 2002 and 2003, there was a general increase from recent years in the number of close encounters recorded. Increases were noted for a range of different boat types: the rate of close encounters for recreational motor boats (RMB) was higher than in previous years at Ynys Lochtyn and higher than had previously been recorded at Mwnt. There were also more close VPB encounters at Ynys Lochtyn in 2002 and 2003. The number of close VPB encounters increased at New Quay in 2003 after having fallen in 2001 and 2002. The average separation distance for VPB was similar in 2002 to other years since 1997 when trip boat operators introduced a voluntary code of conduct. The reduction in average separation distance in 2003, and the observed increase in close VPB encounters, probably resulted from the inclusion of data for the vessel *Sulaire*. *Sulaire*, a VPB and research vessel operated by the Cardigan Bay Marine Wildlife Centre was licensed by the Countryside Council for Wales (CCW) to approach dolphin schools in

order to carry out a photo-identification study. Unfortunately, it was not possible to differentiate these data from those of other passenger trip boats.

Unlike for the VPB fleet, the average separation distance for RMB users varied erratically from year to year with no apparent trend. This suggested that the introduction of a code of conduct has had less impact on the behaviour of RMB users than on VPB operators. When we examined the frequency with which RMB operators stopped when within 50 m of dolphins, we found differences between speedboats and recreational motor boats in general. Speedboats were consistently less likely to stop when close to dolphins. Several incidents were recorded in which these boats passed close to dolphin schools at high speed, either diverting to approach the school or continuing their course apparently oblivious to the presence of dolphins. In contrast, in 2002 and 2003 there was a clear improvement from previous years in the frequency with which users of other types of motor boat slowed down and stopped when close to dolphins.

These data were supported by a comparison of dolphin behaviour observed during close encounters when boats either did or did not stop. For all boat types the frequency with which dolphins remained at the same location (recorded as 'staying') was higher when boats stopped, as was the frequency with which dolphins approached boats. For different boat types the frequency with which dolphins avoided or headed away from boats was in each case higher when boats did not stop. Heading away was recorded more often with speedboats than with other RMB, VPB or sailing boats. At ranges of 100 to 400 m 'staying' was recorded in 50% of encounters with speedboats, 51% with fishing boats, 55% with canoes and 60-67% of encounters with VPB, motor boats and sailing boats. Dolphins 'heading away' were again most frequently recorded, and 'approaching' least frequently recorded, during encounters with speedboats.

RPB users represent a diverse group who launch vessels from many harbours and beaches. Each season they include people visiting the area for the first time. Promoting adherence to a code of conduct for this group is therefore a more difficult undertaking than for established VPB operators who were directly involved in the introduction their own code. Whilst the present results suggest some recent success in promoting of the code of conduct to recreational motor boat users, they highlight the necessity to further target speedboat operators in order to reduce the risk of propeller or collision injury to

cetaceans from encounters with these vessels. The majority of incidents in which speedboat users failed to comply with the code of conduct in 2002 and 2003 took place at Mwnt. Boats are not commonly launched from Mwnt beach itself; there is therefore a necessity to target public awareness information towards speedboat and other boat users at more remote launching sites, including Cardigan, Gwbert and Poppit Sands in the estuary of the River Teifi.

In summary, observations in 2002 and 2003 continued to record high rates of occurrence for bottlenose dolphins at sites in southern Cardigan Bay. Highest sighting rates were recorded at Mwnt. Sighting rates at New Quay Head were again lower than those recorded in the mid to late-1990s. We speculate that the reduction in site use is a local phenomenon, and is more likely to have resulted from changes in prey availability than from disturbance by boats. Levels of boat traffic however, increased at all sites in 2003 from recent years. Speedboats were highlighted as the type of boat least likely to slow down and stop when in the close proximity of dolphins. Bottlenose dolphins were less likely to remain at the same location and more likely to head away from boats that remained underway when within 50 m, than those that stopped to drift. The highest frequency of boat avoidance by dolphins was recorded with speedboats. The increased frequency with which recreational motor boats (other than speedboats) stopped when close to dolphins in 2002 and 2003 suggested an improvement in promotion of the code of conduct for these boat users, but highlighted the need to further target public awareness information at speedboat users.

Future developments

This survey is allowing us to monitor trends in sighting rates of bottlenose dolphins at a number of coastal sites, but we know little about how the dolphins utilise these habitats. In 2004 we hope to trial a new system of data collection that will map the distribution of sightings and allow examination of dolphin habitat use on a finer scale. We hope to gain insight into which areas are of particular importance for bottlenose dolphins, and whether for example, females with calves exhibit specific habitat preferences. The use of a map-based system, we hope, will provide more detailed information on which to base future management measures.

The behaviour of both dolphin schools and boat users will also be recorded in more detail. Descriptive accounts of dolphin activity suggest that observers require a wider range of codes with which to record common behaviours and interaction with boats – these will be brought into line with data routinely collected during similar studies being carried out elsewhere (following Shane *et al* 1986).

By modifying our data collection forms it will be possible to record the behaviour of boat operators in more detail. This will be recorded with direct reference to compliance with the code of conduct. If possible, the names of boats that infringe the code of conduct will be included in the database to help identify instances in which boats repeatedly fail to adhere to the code of conduct.

Data for research boats licensed to approach dolphins will be differentiated from that of similar vessels. These boats will be asked to display a distinctive pennant or marker when carrying out research, so that observers and other boat users will be aware that they are permitted to approach dolphins for research purposes.

We hope to collect more data on harbour porpoises, the most abundant cetacean in Welsh waters. Harbour porpoise and bottlenose dolphin share habitat and are regularly seen at study sites at the same time. The most frequent cause of death attributed to porpoises in Welsh waters however, is trauma caused by an attack by bottlenose dolphin (R. Penrose, Marine Environmental Monitoring, pers. comm.). Fine-scale mapping may provide an opportunity to determine the extent to which critical habitat for these species overlaps and to observe the circumstances under which porpoises and bottlenose dolphin interact.

Observations will be carried out two further sites in 2004: Castle Point at Aberystwyth and New Quay Harbour. Castle Point overlooks an important port for boats visiting and working in the waters of Cardigan Bay. The inclusion of this site will provide information in encounters between dolphins and boat users north of the MHC. It will also allow sighting rates at the established sites to be viewed in a wider geographical perspective. Observations will be made at New Quay Harbour by intern volunteers at the Cardigan Bay Marine Wildlife Centre. Bottlenose dolphins frequent the harbour area throughout

much of the year and these data will allow direct comparisons to be made with the area of open coast presently observed at New Quay Head.

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