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The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for 2002/2003

Authors

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EXECUTIVE SUMMARY

1. This study reports the impact of maintenance dredging on the birds utilising mudflats within and adjoining the outer harbour of the Cardiff Bay barrage using data collected between August 2002 and March 2003. Results are compared to those reported in March 2002. Dredging is required to maintain a channel from the outer harbour to the sea and to prevent sediment build up within this harbour. Dredging took place in August 2000, May 2001, in February and March 2002 and, during the period of study, between 8 and 31 August 2002 and between 5 and 26 February 2003. Dredging will be undertaken twice a year henceforth. Within the outer harbour, mudflats reform naturally after dredging.

2. Cardiff Bay was formed by the combined estuaries of the Rivers Taff and Ely and is situated at the mouth of the larger Severn Estuary. The bay was impounded by a barrage constructed at its mouth in November 1999. The mudflats that now adjoin the Cardiff Bay barrage historically formed part of the intertidal mudflats of the bay

3. Data are presented for the period August 2002 to March 2003 and also separately for August 2002 and February 2003, when counts were undertaken during periods when dredging operations were being undertaken. Comparative data are presented for August 2001 to March 2002, and separately for August 2001 and February 2002.

4. Nine waterbird species were recorded using the mudflats affected by dredging between August 2002 and March 2003. These included five of the 10 species of wildfowl and wader that had been recorded on the equivalent mudflats prior to barrage construction – Shelduck, Mallard, Oystercatcher, Curlew and Redshank – three species of gull – Black-headed Gull, Lesser Black-backed Gull and Herring Gull – and Cormorant. These species, and also Mute Swan *Cygnus olor* and Great Black-backed Gull *L. marinus*, had been recorded on these mudflats during the previous year's fieldwork

5. By far the most numerous species on the mudflats affected by dredging were Black-headed Gull and Lesser Black-backed Gull. Aside from these, only Mallard and Herring Gull were recorded in numbers of greater than 10 on any one of the mudflats. Black-headed and Lesser Black-backed Gulls utilised all three mudflat areas, whilst Mallard particularly favoured the area within the outer harbour.

6. Although the overall numbers of wildfowl and waders using the mudflats affected by dredging are very low, the average low tide densities of two of the species found on these mudflats were higher than those on comparative areas of mudflat nearby. Densities of both Black-headed Gull and Lesser Black-backed Gull, were greater on the comparative mudflats, however.

7. There is no evidence for the dredging in August 2002 (like that in February/March 2002) having an effect in the short term on the numbers of birds using the mudflats by the barrage. Indeed, numbers of the three most numerous species – Mallard, Black-headed Gull and Lesser Black-backed Gull – were higher on average than over August to March as a whole. Numbers of Mallard in August 2002 were also greater than those found the previous August. In contrast, numbers of foraging Black-headed and Lesser Black-backed Gulls on these mudflats were lower than average in February 2003, though large numbers of roosting birds were recorded. However, it is not clear whether or not this may have been due to the effects of dredging.

8. Black-headed Gulls occurred in higher numbers on the mudflats by the barrage in 2002/03 than in 2001/02 and thus, at present, there is no evidence that they have been affected over the longer term by dredging operations. Mallard numbers, in contrast, were slightly lower in 2002/03. Overall, however, the numbers of birds that might be affected by dredging are small in relation to the substantial populations found locally.

9. Further monitoring should enable a more complete assessment of whether waterbirds are affected by the dredging in either the short or long term

1. INTRODUCTION

This study reports the impact of maintenance dredging on the birds utilising mudflats within and adjoining the outer harbour of the Cardiff Bay barrage using data collected between August 2002 and March 2003. Results are compared to and presented in a similar format to those reported in March 2002 (Burton & Clark 2002b). Dredging is required to maintain a channel from the outer harbour to the sea and to prevent sediment build up within the harbour. Within the outer harbour, mudflats reform naturally after dredging. Initial dredging took place during the construction of the barrage and has since taken place in August 2000, May 2001, in February and March 2002 and, during the period of study, between 8 and 31 August 2002 and between 5 and 26 February 2003. In future, dredging will typically take place twice a year, usually in February and August.

Data are presented for the period August 2002 to March 2003. (Data for April to May 2002 were reported by Burton *et al.* 2003). Additionally, data are presented for August 2002 and February 2003 alone, when counts were undertaken during periods when dredging operations were being undertaken. Comparative data are presented for August 2001 to March 2002, August 2001 and February 2002. Dredging was undertaken in February 2002 though not in August 2001.

The ornithological significance of these mudflats was assessed in previous reports (Burton & Clark 2002a, 2002b) by comparing counts made between August 2001 and March 2001 with historic data collected prior to the construction of the barrage and with concurrent count data from two adjacent areas of mudflat.

Cardiff Bay was formed by the combined estuaries of the Rivers Taff and Ely and is situated at the mouth of the larger Severn Estuary. The bay was impounded by a barrage constructed at its mouth in November 1999. The Severn Estuary is ornithologically important because of the populations of waterbirds (i.e. grebes, cormorants, herons, rails, wildfowl, waders, gulls and terns) that it supports in winter and as a result is designated as a Special Protection Area (SPA). Some of the mudflats beside the Cardiff Bay barrage are included in this area.

The Severn Estuary currently holds internationally important numbers of European White-fronted Goose *Anser albifrons albifrons*, Shelduck *Tadorna tadorna*, Gadwall *Anas strepera*, Dunlin *Calidris alpina* and Redshank *Tringa totanus* (Musgrove *et al.* 2001) and Cardiff Bay itself formerly held nationally important numbers of Dunlin (Burton *et al.* 2002). (Sites are considered internationally important for a species if they regularly hold at least 1% of the individuals in a population of that species. Sites within Britain are considered nationally important for a species if they regularly hold 1% or more of the estimated British population of that species.) Current national importance thresholds for the waterbird species referred to in this report are shown in Appendix 1.

2. METHODS

Figure 2.1 shows the areas subject to maintenance dredging and Figure 2.2, the numbered mudflat count areas that have been surveyed between August 2001 and March 2003. Areas B2 and B3 include remnants of the mudflats of the bay that were dissected by the building of the barrage. Accretion of sediments has enlarged these mudflats and also occurs naturally within the barrage's outer harbour – 'mudflat' B5. (This area would also previously have formed part of the bay's intertidal area). Dredging of these three mudflats is required to allow continued passage of boats from the barrage gates to the sea. Two further areas of mudflat – areas B1 and B4 – were also surveyed to provide comparative counts. Mudflat B1 was similar to B2, both being entirely muddy, whilst mudflats B3 and B4 contained a mix of mud and rocky substrate. The five mudflats were 4.8, 11.9, 7.0, 19.8 and 3.3 ha in size, respectively.

The waterbirds using mudflats B1-B4 were counted at hourly intervals (relative to low tide) over the time that the mudflats were exposed, twice a month from August 2002 to March 2003. (Dates of counts are given in Appendix 2). The mudflats became exposed between 3 and 2 hours before low tide and became inundated again 2 to 3 hours afterwards.

Counts of area B5 within the barrage's outer harbour included birds on the water and on the small area of mudflat that formed at low tide. This area was counted at low tide and high tide, again twice a month from August 2002 to March 2003.

The mean numbers and densities of waterbirds recorded on mudflats B1-B5 at low tide were tabulated for August 2001 to March 2002, August 2001, February 2002, August 2002 to March 2003, August 2002 and February 2003. Further tables provide information on the numbers and densities of birds using 'mudflat' B5 at high tide, the mean bird hours recorded per tidal cycle (i.e. the sum of the average number of birds each hour) on mudflats B1-B4 and the peak numbers of each species recorded on each mudflat. Data for August 2002 and February 2003 are listed separately as they were collected during periods of dredging (see Appendix 2). Data for August 2001 to March 2002, August 2001 and February 2002 are provided for comparative purposes. (Gulls and Cormorants were not counted in August 2001 and neither was mudflat B5). By tabulating the data in this way, it is possible to assess whether the numbers of birds occurring on the mudflats during the periods of dredging differed from those that occurred over the autumn and winter as a whole and whether numbers have been affected by dredging over the longer term.

3. RESULTS

Table 3.1 reports the mean numbers and densities of waterbirds recorded on mudflats B1-B5 at low tide between August 2001 and March 2002, in August 2001 and February 2002 alone, between August 2002 and March 2003 and in August 2002 and February 2003 alone. Table 3.2 similarly reports the numbers and densities using 'mudflat' B5 at high tide. Table 3.3 indicates the overall usage of mudflats B1-B4 through the tidal cycle and Table 3.4, the peak numbers of birds recorded on each mudflat.

A total of nine waterbird species were recorded using the mudflats affected by dredging, i.e. B2, B3 and B5, between August 2002 and March 2003. These included five species of wildfowl and wader that had been recorded on the equivalent mudflats prior to barrage construction (Burton & Clark 2002a, 2002b) – Shelduck, Mallard *Anas platyrhynchos*, Oystercatcher *Haematopus ostralegus*, Curlew *Numenius arquata* and Redshank. In addition, three species of gull – Black-headed Gull *Larus ridibundus*, Lesser Black-backed Gull *L. fuscus* and Herring Gull *L. argentatus* – and Cormorants *Phalacrocorax carbo* were recorded on these mudflats. These species, and also Mute Swan *Cygnus olor* and Great Black-backed Gull *L. marinus*, had been recorded on these mudflats during the previous year's fieldwork (Burton & Clark 2002b).

By far the most numerous species on these mudflats were Black-headed Gull and Lesser Black-backed Gull. Aside from these, only Mallard and Herring Gull were recorded in numbers of greater than 10 on any one of the mudflats (Table 3.4). Tables 3.1 and 3.4 show that Black-headed and Lesser Black-backed Gulls utilised all three mudflats, whilst Mallard particularly favoured mudflat B5, within the outer harbour. The latter mudflat was also used by Cormorants, Herring Gulls and a single Curlew. Shelduck, Oystercatcher and Redshank were only recorded outwith the outer harbour between August 2002 and March 2003.

Gulls were particularly associated with the channel and seaward edge of mudflats, whilst wildfowl and waders were found higher up the mudflats. Typically, the overwhelming majority of the birds that were recorded on these mudflats were feeding. However, on 10 February 2003, a large congregation of roosting Black-headed and Lesser Black-backed Gulls was recorded on mudflat B2.

Table 3.1 also allows comparison to be made between the densities found on these mudflats at low tide and those found on mudflats B1 and B4, which have not been affected by dredging. In the period between August 2002 and March 2003, Shelduck occurred in much higher densities at low tide on the latter mudflats than on mudflats B2, B3 and B5. In contrast, neither Mallard nor Redshank were recorded on either mudflat B1 or B4. Low tide densities of Oystercatcher and Curlew were similar (though low) across the two sets of mudflats.

In comparison to mudflats B2, B3 and B5, mudflats B1 and B4 held slightly higher low tide densities of Cormorants and much higher densities of Black-headed, Lesser Black-backed and Herring Gulls in this period. In addition, these mudflats also supported occasional Common Gulls *L. canus* and Great Black-backed Gulls.

The counts undertaken between August 2002 and March 2003 show some differences with those undertaken between August 2001 and March 2002. Examination of Tables 3.3 and 3.4 shows that, over the tidal cycle as a whole, Black-headed Gulls occurred in much higher numbers on mudflats B2, B3 and B5 in 2002/03 than in 2001/02. In contrast, numbers of Mallard were lower on mudflats B2, B3 and B5 in 2002/03 and those of Cormorant, Shelduck, Curlew and Redshank lower on mudflat B2. It should be noted, however, that numbers of the latter four species were very small in both years.

The effects of dredging can be examined by comparing average counts in the months when operations took place with those for the entire autumn and winter. In August 2002, for example, the average low tide counts of Mallard, Black-headed and Lesser Black-backed Gulls on mudflats B2, B3 and B5 were higher than those over August 2002 to March 2003 as a whole (Table 3.1). These species were also

more numerous on mudflat B3 over the tidal cycle as a whole in August 2002 (Table 3.3). However, no birds were recorded at high tide within the outer harbour in August (Table 3.2).

Average low tide counts of Mallard were also slightly higher on mudflat B5 in February 2003, than over 2002/03 as a whole, though few Black-headed Gulls and no Lesser Black-backed Gulls were recorded on mudflats B2, B3 and B5 at low tide that month (Table 3.1). Over the tidal cycle, average counts of Black-headed and Lesser Black-backed Gulls were much greater on mudflat B2 in February 2003 than over 2002/03 as a whole (Table 3.3), mainly due to the large congregation of roosting birds observed that month.

The effects of dredging in August 2002 can also be looked at by comparing counts from this month with those undertaken the previous August, when no dredging took place. (Gulls and Cormorants were not counted in August 2001 and neither was mudflat B5). Tables 3.1, 3.3 and 3.4 indicate that Mallard, Oystercatcher and Curlew numbers were greater in August 2002 on mudflats B2 and B3 than the previous August, but that neither Shelduck nor Redshank were recorded on these mudflats in either period. Again, it should be noted that numbers of Oystercatcher and Curlew were very small in both years. It was not possible to evaluate the effects of dredging in February 2003 with such a comparison, as dredging also took place in February 2002.

4. ASSESSMENT OF THE ORNITHOLOGICAL IMPORTANCE OF THE STUDY AREA AND THE POTENTIAL IMPACT OF DREDGING

Nine waterbird species – Cormorant, Shelduck, Mallard, Oystercatcher, Curlew, Redshank, Black-headed Gull, Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull – were recorded between August 2002 and March 2003 on the mudflats by the Cardiff Bay barrage affected by dredging. Mute Swan and Great Black-backed Gull were also recorded on these mudflats the previous year (Burton & Clark 2002b).

The report for 2001/02 found that the densities of Shelduck, Mallard, Oystercatcher, Curlew and Redshank were less than those found in the four years immediately prior to construction of the barrage and that five species of wildfowl and wader recorded in those years were absent (Burton & Clark 2002b). However, though the overall numbers of wildfowl and waders using the mudflats affected by dredging are now very low, the average low tide densities of two of the species found on these mudflats in 2002/03 were higher than those on comparative areas of mudflat nearby. Densities of both Black-headed Gull and Lesser Black-backed Gull, were greater on the comparative mudflats, however. As in the previous year (Burton & Clark 2002b), Lesser Black-backed Gulls were most numerous in August and September and declined thereafter, as birds moved away from their breeding colonies within Cardiff and on Steep Holm and Flat Holm (Poulding 1954).

The report for 2001/02 found little evidence that densities of waterbirds had been affected in the short term by the dredging undertaken between February and March 2002. Although there was a short-term decrease in the numbers of Mallard, Black-headed Gull and Lesser Black-backed Gull using mudflats B2, B3 and B5 by the barrage, it was noted that this would have been partly or wholly due to movements of birds away from the area to breeding grounds elsewhere.

There is, likewise, no evidence for the dredging in August 2002 having an effect on the numbers of birds using the mudflats in the short term. Indeed, numbers of the three most numerous species – Mallard, Black-headed and Lesser Black-backed Gull – at low tide and across the tidal cycle were higher on average than over August to March as a whole. Numbers of Mallard in August 2002 were also greater than those found the previous August. In contrast, though Mallard numbers were also slightly higher than average on these mudflats during the period of dredging operations in February 2003, numbers of foraging Black-headed and Lesser Black-backed Gulls were lower. (Numbers of these species were only high in February due to a large congregation of roosting birds).

It is possible that dredging in August may have made some food resources temporarily more available to Mallard and Black-headed and Lesser Black-backed Gulls, which often forage over the open water. As the levels of the food resources in the water and sediments are not being measured, however, it is not possible to say whether they will be affected by dredging in the longer-term or whether this was the reason for the lower numbers of foraging Black-headed and Lesser Black-backed Gulls in February.

Comparison between years showed that the average numbers of Black-headed Gull, the most common species on the mudflats by the barrage, have actually increased and thus, at present, there is no evidence that they have been affected by the dredging in the longer term. There was a slight fall between years in the numbers of Mallard, though. Overall, however, the numbers of birds that might be affected by dredging are very small in relation to the substantial populations found locally (see Burton *et al.* 2002).

Further monitoring should enable a more complete assessment of the immediate and long term effects of the dredging on waterbirds.

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	Aug 2001 - Mar 2002		Aug 2001		Feb 2002		Aug 2002 - Mar 2003		Aug 2002		Feb 2003	
	n	d	n	d	n	d	n	d	n	d	n	d
CA												
Mudflat B2	0.1	0.01			0.5	0.04	0	0	0	0	0	0
Mudflat B3	0	0			0	0	0	0	0	0	0	0
Mudflat B5	0	0			0	0	0.2	0.06	0	0	0	0
Mudflat B1	0.4	0.09			1.0	0.21	0.1	0.01	0	0	0	0
Mudflat B4	5.4	0.27			9.5	0.48	0.2	0.01	0	0	0	0
Mudflats B2,B3,B5	**0.1**	**0**			**0.5**	**0.02**	**0.2**	**0.01**	**0**	**0**	**0**	**0**
Mudflats B1, B4	**5.9**	**0.24**			**10.5**	**0.43**	**0.3**	**0.01**	**0**	**0**	**0**	**0**
MS												
Mudflat B2	0.1	0.01	0	0	0	0	0	0	0	0	0	0
Mudflat B3	0	0	0	0	0	0	0	0	0	0	0	0
Mudflat B5	0	0			0	0	0	0	0	0	0	0
Mudflat B1	0	0	0	0	0	0	0	0	0	0	0	0
Mudflat B4	0	0	0	0	0	0	0	0	0	0	0	0
Mudflats B2,B3,B5	**0.1**	**0**			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Mudflats B1, B4	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
SU												
Mudflat B2	0.1	0.01	0	0	0	0	0	0	0	0	0	0
Mudflat B3	0.3	0.04	0	0	1.5	0.21	0.3	0.04	0	0	0.5	0.07
Mudflat B5	0	0			0	0	0	0	0	0	0	0
Mudflat B1	1.8	0.38	0	0	10.0	2.08	0.1	0.03	0	0	0	0
Mudflat B4	0	0	0	0	0	0	3.4	0.17	3.0	0.15	13.0	0.66
Mudflats B2,B3,B5	**0.4**	**0.02**			**1.5**	**0.07**	**0.3**	**0.01**	**0**	**0**	**0.5**	**0.02**
Mudflats B1, B4	**1.8**	**0.07**	**0**	**0**	**10.0**	**0.41**	**3.6**	**0.14**	**3.0**	**0.12**	**13.0**	**0.53**
MA												
Mudflat B2	0.5	0.04	0	0	4.0	0.34	0	0	0	0	0	0
Mudflat B3	0.2	0.03	0	0	0	0	0.4	0.05	3.0	0.43	0	0
Mudflat B5	1.2	0.35			0	0	0.7	0.21	1.0	0.30	1.5	0.45
Mudflat B1	0	0	0	0	0	0	0	0	0	0	0	0
Mudflat B4	0	0	0	0	0	0	0	0	0	0	0	0
Mudflats B2,B3,B5	**1.9**	**0.08**			**4.0**	**0.18**	**1.1**	**0.05**	**4.0**	**0.18**	**1.5**	**0.07**
Mudflats B1, B4	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
OC												
Mudflat B2	0	0	0	0	0	0	0	0	0	0	0	0
Mudflat B3	0.1	0.02	0.5	0.07	0	0	0.3	0.04	1.5	0.21	0	0
Mudflat B5	0	0			0	0	0	0	0	0	0	0
Mudflat B1	0	0	0	0	0	0	0	0	0	0	0	0
Mudflat B4	0.6	0.03	1.5	0.08	0	0	0.3	0.02	0	0	1.0	0.05
Mudflats B2,B3,B5	**0.1**	**0.01**			**0**	**0**	**0.3**	**0.01**	**1.5**	**0.07**	**0**	**0**
Mudflats B1, B4	**0.6**	**0.02**	**1.5**	**0.06**	**0**	**0**	**0.3**	**0.01**	**0**	**0**	**1.0**	**0.04**

Table 3.1 Mean low tide numbers (n) and densities (d) (birds/ha) of waterbirds using mudflats near the Cardiff Bay barrage at low tide between August 2001 and March 2002, in August 2001 and February 2002 alone, between August 2002 and March 2003 and in August 2002 and February 2003 alone.

Only species recorded since August 2001 at low tide on mudflats affected by dredging (shown italicised) are included. Figures in bold are total numbers and densities for mudflats B2, B3 and B5 combined and for mudflats B1 and B4 combined. CA = Cormorant, MS = Mute Swan, SU = Shelduck, MA = Mallard, OC = Oystercatcher, CU = Curlew, RK = Redshank, BH = Black-headed Gull, LB = Lesser Black-backed Gull, HG = Herring Gull, GB = Great Black-backed Gull.

	Aug 2001 - Mar 2002		Aug 2001		Feb 2002		Aug 2002 - Mar 2003		Aug 2002		Feb 2003	
	n	d	n	d	n	d	n	d	n	d	n	d
CU												
Mudflat B2	0.4	0.04	0	0	0.5	0.04	0	0	0	0	0	0
Mudflat B3	0.6	0.08	1.0	0.14	0	0	0.7	0.10	1.0	0.14	1.0	0.14
Mudflat B5	0	0			0	0	0.1	0.02	0	0	0.5	0.15
Mudflat B1	0.4	0.09	0	0	3.5	0.73	0.1	0.03	0	0	0	0
Mudflat B4	0.9	0.04	0.5	0.03	0	0	0.8	0.04	2.5	0.13	0.5	0.03
Mudflats B2,B3,B5	**1.0**	**0.05**			**0.5**	**0.02**	**0.8**	**0.03**	**1.0**	**0.05**	**1.5**	**0.07**
Mudflats B1, B4	**1.3**	**0.05**	**0.5**	**0.02**	**3.5**	**0.14**	**0.9**	**0.04**	**2.5**	**0.10**	**0.5**	**0.02**
RK												
Mudflat B2	0.1	0.01	0	0	0.5	0.04	0.1	0.01	0	0	0	0
Mudflat B3	0	0	0	0	0	0	0	0	0	0	0	0
Mudflat B5	0.1	0.03			0	0	0	0	0	0	0	0
Mudflat B1	0	0	0	0	0	0	0	0	0	0	0	0
Mudflat B4	0	0	0	0	0	0	0	0	0	0	0	0
Mudflats B2,B3,B5	**0.2**	**0.01**			**0.5**	**0.02**	**0.1**	**0.01**	**0**	**0**	**0**	**0**
Mudflats B1, B4	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
BH												
Mudflat B2	5.7	0.48			11.0	0.92	7.3	0.61	20.0	1.68	1.0	0.08
Mudflat B3	4.6	0.66			1.0	0.14	7.0	1.00	50.0	7.14	0	0
Mudflat B5	9.3	2.80			11.0	3.33	6.4	1.93	15.5	4.70	1.0	0.30
Mudflat B1	1.2	0.25			0	0	1.7	0.35	7.5	1.56	0	0
Mudflat B4	43.6	2.20			7.5	0.38	81.3	4.11	42.5	2.15	11.0	0.56
Mudflats B2,B3,B5	**19.6**	**0.88**			**23.0**	**1.04**	**20.7**	**0.93**	**85.5**	**3.85**	**2.0**	**0.09**
Mudflats B1, B4	**44.8**	**1.82**			**7.5**	**0.30**	**83.0**	**3.37**	**50.0**	**2.03**	**11.0**	**0.45**
LB												
Mudflat B2	6.2	0.52			4.0	0.34	3.6	0.30	7.5	0.63	0	0
Mudflat B3	1.9	0.28			1.0	0.14	4.4	0.63	17.0	2.43	0	0
Mudflat B5	0.8	0.25			0.5	0.15	0.9	0.27	0	0	0	0
Mudflat B1	1.7	0.36			0	0	0.4	0.09	2.0	0.42	0	0
Mudflat B4	46.9	2.37			6.0	0.30	41.6	2.10	38.5	1.94	4.0	0.20
Mudflats B2,B3,B5	**9.0**	**0.40**			**5.5**	**0.25**	**8.9**	**0.40**	**24.5**	**1.10**	**0**	**0**
Mudflats B1, B4	**48.6**	**1.98**			**6.0**	**0.24**	**42.0**	**1.71**	**40.5**	**1.65**	**4.0**	**0.16**
HG												
Mudflat B2	0	0			0	0	0	0	0	0	0	0
Mudflat B3	0.9	0.12			0	0	0.3	0.04	0	0	0	0
Mudflat B5	0	0			0	0	0.4	0.11	0	0	0	0
Mudflat B1	0.2	0.04			0	0	0	0	0	0	0	0
Mudflat B4	5.9	0.30			0	0	19.8	1.00	28.0	1.41	1.0	0.05
Mudflats B2,B3,B5	**0.9**	**0.04**			**0**	**0**	**0.6**	**0.03**	**0**	**0**	**0**	**0**
Mudflats B1, B4	**6.1**	**0.25**			**0**	**0**	**19.8**	**0.81**	**28.0**	**1.14**	**1.0**	**0.04**
GB												
Mudflat B2	0.1	0.01			0.5	0.04	0	0	0	0	0	0
Mudflat B3	0	0			0	0	0	0	0	0	0	0
Mudflat B5	0	0			0	0	0	0	0	0	0	0
Mudflat B1	0	0			0	0	0	0	0	0	0	0
Mudflat B4	0.1	0.01			0	0	0.3	0.02	0	0	0	0
Mudflats B2,B3,B5	**0.1**	**0**			**0.5**	**0.02**	**0**	**0**	**0**	**0**	**0**	**0**
Mudflats B1, B4	**0.1**	**0.01**			**0**	**0**	**0.3**	**0.01**	**0**	**0**	**0**	**0**

Table 3.1 Continued.

	Oct 2001 -Mar 2002		Feb 2002		Aug 2002 -Mar 2003		Aug 2002		Feb 2003	
	n	d	n	d	n	d	n	d	n	d
CA	0.2	0.05	0	0	0.2	0.06	0	0	0	0
SU	0.2	0.05	0	0	0	0	0	0	0	0
MA	2.9	0.88	2.0	0.61	1.6	0.47	0	0	1.0	0.30
CU	0.1	0.03	0	0	0	0	0	0	0	0
BH	29.0	8.79	47.5	14.39	25.6	7.77	0	0	17.0	5.15
LB	0.3	0.08	1.0	0.30	0.7	0.21	0	0	1.0	0.30
HG	0	0	0	0	0.1	0.02	0	0	0	0

Table 3.2 Mean high tide numbers and densities (birds/ha) of waterbirds using 'mudflat' B5 within the outer harbour of the Cardiff Bay barrage between October 2001 and March 2002, in February 2002 alone, between August 2002 and March 2003 and in August 2002 and February 2003 alone.

Only species recorded since August 2001 in this count area are included. CA = Cormorant, SU = Shelduck, MA = Mallard, CU = Curlew, BH = Black-headed Gull, LB = Lesser Black-backed Gull, HG = Herring Gull.

	Aug 2001 - Mar 2002	Aug 2001	Feb 2002	Aug 2002 - Mar 2003	Aug 2002	Feb 2003
CA						
Mudflat B2	1.2		3.5	0.5	1.0	0
Mudflat B3	0.2		0	0	0	0
Mudflat B1	1.9		4.5	0.8	2.0	0
Mudflat B4	9.2		9.5	3.8	1.0	0
MS						
Mudflat B2	0.1	0	0	0	0	0
Mudflat B3	0	0	0	0	0	0
Mudflat B1	0	0	0	0	0	0
Mudflat B4	0	0	0	0	0	0
SU						
Mudflat B2	0.8	0	5.5	0	0	0
Mudflat B3	1.2	0	4.0	0.8	0	1.0
Mudflat B1	2.9	0	12.0	0.8	1.0	0
Mudflat B4	3.1	0	3.5	7.4	3.0	32.5
MA						
Mudflat B2	0.9	0.5	5.5	0.1	0	0
Mudflat B3	0.8	0	3.0	0.4	3.0	0
Mudflat B1	0.4	0	0	0	0	0
Mudflat B4	0	0	0	0	0	0
OC						
Mudflat B2	0	0	0	0	0	0
Mudflat B3	0.8	1.5	0	1.3	7.5	0
Mudflat B1	0	0	0	0.1	0	0
Mudflat B4	1.2	3.0	0	1.0	0	1.0
CU						
Mudflat B2	1.5	0	1.5	0	0	0
Mudflat B3	3.9	3.0	3.5	3.0	5.5	3.0
Mudflat B1	1.1	0	8.5	0.4	1.0	0
Mudflat B4	5.0	7.0	0.5	3.9	10.5	0.5
RK						
Mudflat B2	2.4	0	9.5	0.3	0	0
Mudflat B3	0	0	0	0	0	0
Mudflat B1	0	0	0	0	0	0
Mudflat B4	0.1	0	0	0	0	0

Table 3.3 Mean numbers of bird hours per tidal cycle recorded on mudflats near the Cardiff Bay barrage between August 2001 and March 2002, in August 2001 and February 2002 alone, between August 2002 and March 2003 and in August 2002 and February 2003 alone.

Only species recorded since August 2001 on mudflats affected by dredging (shown italicised) are included. CA = Cormorant, MS = Mute Swan, SU = Shelduck, MA = Mallard, OC = Oystercatcher, CU = Curlew, RK = Redshank, BH = Black-headed Gull, LB = Lesser Black-backed Gull, HG = Herring Gull, GB = Great Black-backed Gull.

	Aug 2001 - Mar 2002	Aug 2001	Feb 2002	Aug 2002 - Mar 2003	Aug 2002	Feb 2003
BH						
Mudflat B2	50.9		42.0	117.6	85.5	529.5
Mudflat B3	17.6		15.5	35.6	150.5	0
Mudflat B1	23.4		1.0	20.2	38.5	75.0
Mudflat B4	177.7		23.5	313.6	190.5	329.0
LB						
Mudflat B2	18.1		20.5	21.3	41.0	36.0
Mudflat B3	21.9		2.0	25.3	57.0	0.5
Mudflat B1	6.5		1.0	4.5	20.0	3.5
Mudflat B4	176.5		25.0	170.4	299.5	19.5
HG						
Mudflat B2	0.1		0	0.4	0	1.0
Mudflat B3	3.7		0	2.6	0	0
Mudflat B1	1.8		0.5	0.2	0	0
Mudflat B4	20.2		2.5	76.6	55.0	1.0
GB						
Mudflat B2	0.1		0.5	0	0	0
Mudflat B3	0		0	0	0	0
Mudflat B1	0		0	0	0	0
Mudflat B4	0.9		0	1.3	0	0

Table 3.3 Continued.

	Aug 2001 - Mar 2002	Aug 2001	Feb 2002	Aug 2002 - Mar 2003	Aug 2002	Feb 2003
CA						
Mudflat B2	3		3	4	2	0
Mudflat B3	1		0	0	0	0
Mudflat B5	1		0	2	0	0
Mudflat B1	5		5	4	4	0
Mudflat B4	14		14	20	1	0
MS						
Mudflat B2	1	0	0	0	0	0
Mudflat B3	0	0	0	0	0	0
Mudflat B5	0		0	0	0	0
Mudflat B1	0	0	0	0	0	0
Mudflat B4	0	0	0	0	0	0
SU						
Mudflat B2	11	0	11	0	0	0
Mudflat B3	5	0	5	3	0	1
Mudflat B5	2		0	0	0	0
Mudflat B1	20	0	20	3	2	0
Mudflat B4	13	0	7	18	4	16
MA						
Mudflat B2	5	1	5	1	0	0
Mudflat B3	3	0	3	6	6	0
Mudflat B5	12		3	20	2	3
Mudflat B1	2	0	0	0	0	0
Mudflat B4	0	0	0	0	0	0
OC						
Mudflat B2	0	0	0	0	0	0
Mudflat B3	3	2	0	3	3	0
Mudflat B5	0		0	0	0	0
Mudflat B1	0	0	0	1	0	0
Mudflat B4	3	3	0	4	0	2
CU						
Mudflat B2	2	0	1	0	0	0
Mudflat B3	2	1	2	2	2	2
Mudflat B5	1		0	1	0	1
Mudflat B1	4	0	4	1	1	0
Mudflat B4	7	4	1	5	5	1
RK						
Mudflat B2	5	0	5	3	0	0
Mudflat B3	0	0	0	0	0	0
Mudflat B5	1		0	0	0	0
Mudflat B1	0	0	0	0	0	0
Mudflat B4	1	0	0	0	0	0

Table 3.4 Peak numbers of waterbirds recorded on mudflats near the Cardiff Bay barrage between August 2001 and March 2002, in August 2001 and February 2002 alone, between August 2002 and March 2003 and in August 2002 and February 2003 alone.

Only species recorded since August 2001 on mudflats affected by dredging (shown italicised) are included. CA = Cormorant, MS = Mute Swan, SU = Shelduck, MA = Mallard, OC = Oystercatcher, CU = Curlew, RK = Redshank, BH = Black-headed Gull, LB = Lesser Black-backed Gull, HG = Herring Gull, GB = Great Black-backed Gull.

	Aug 2001 - Mar 2002	Aug 2001	Feb 2002	Aug 2002 - Mar 2003	Aug 2002	Feb 2003
BH						
Mudflat B2	125		45	520	36	520
Mudflat B3	22		22	50	50	0
Mudflat B5	115		95	105	31	28
Mudflat B1	82		2	80	24	80
Mudflat B4	180		22	610	165	510
LB						
Mudflat B2	39		13	42	29	42
Mudflat B3	54		2	40	28	1
Mudflat B5	5		2	11	0	2
Mudflat B1	18		2	25	25	7
Mudflat B4	205		18	180	180	20
HG						
Mudflat B2	1		0	2	0	2
Mudflat B3	8		0	31	0	0
Mudflat B5	0		0	6	0	0
Mudflat B1	12		1	2	0	0
Mudflat B4	40		3	110	55	2
GB						
Mudflat B2	1		1	0	0	0
Mudflat B3	0		0	0	0	0
Mudflat B5	0		0	0	0	0
Mudflat B1	0		0	0	0	0
Mudflat B4	2		0	2	0	0

Table 3.4 Continued.

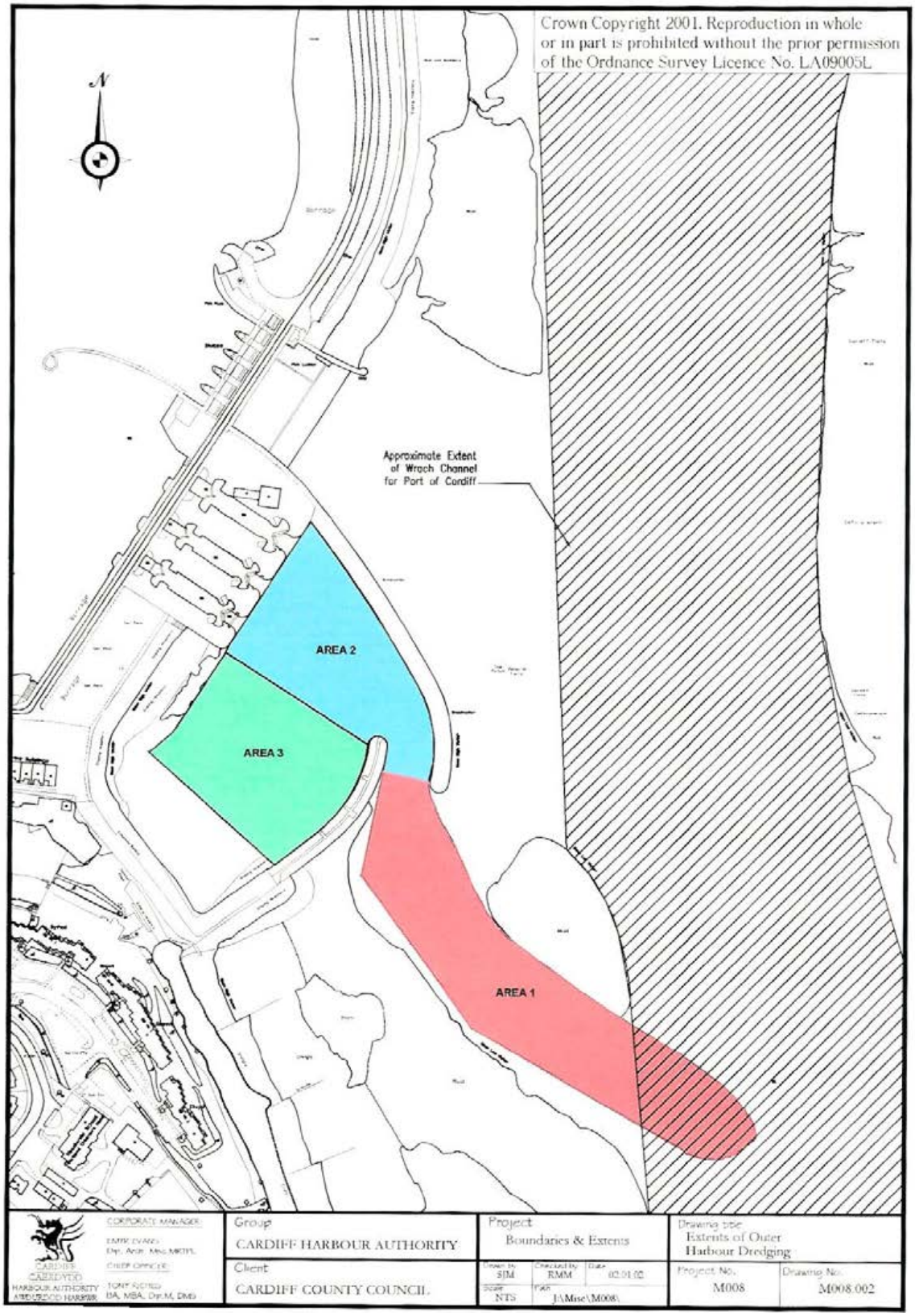

Figure 2.1 The Cardiff Bay barrage showing areas (shaded grey) subject to maintenance dredging.

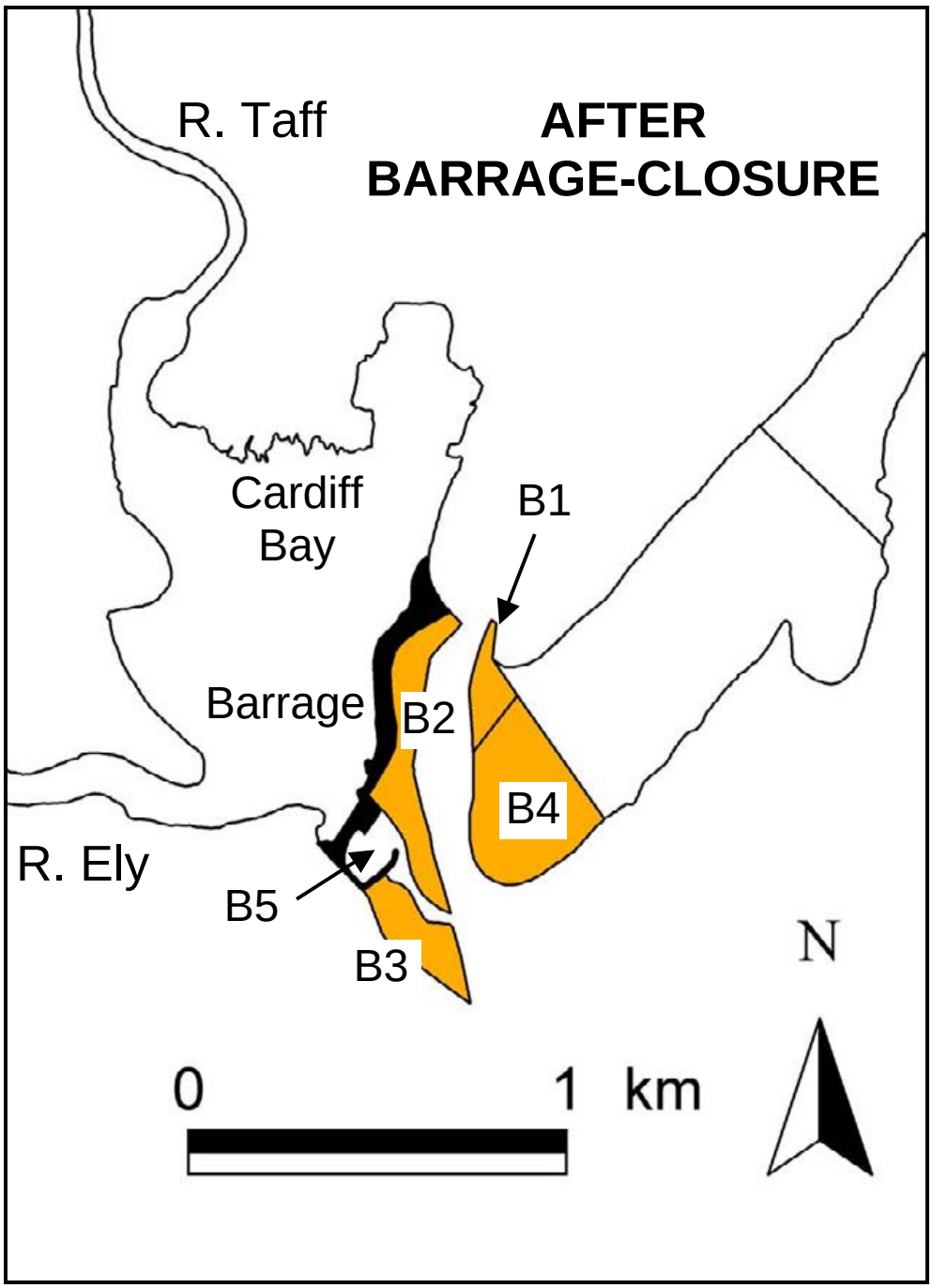

Figure 2.2 The Cardiff Bay barrage showing numbered mudflat count areas (shaded grey) used between August 2001 and March 2003.

Appendix 1 National importance thresholds for waterbird species referred to in this report (taken from Musgrove *et al.* 2001).

Cormorant *Phalacrocorax carbo*	130
Mute Swan *Cygnus olor*	260
European White-fronted Goose *Anser albifrons albifrons*	6000
Shelduck *Tadorna tadorna*	750
Gadwall *Anas strepera*	300
Mallard *Anas platyrhynchos*	5000
Oystercatcher *Haematopus ostralegus*	3600
Dunlin *Calidris alpina*	5300
Curlew *Numenius arquata*	1200
Redshank *Tringa totanus*	1100
Black-headed Gull *Larus ridibundus*	19000
Common Gull *Larus canus*	9000
Lesser Black-backed Gull *Larus fuscus*	500
Herring Gull *Larus argentatus*	4500
Great Black-backed Gull *Larus marinus*	400

Appendix 2 Dates of waterbird counts undertaken at the Cardiff Bay barrage in 2002/03.

21-24 August 2002
4-7 September 2002
13-17 October 2002
19-21 November 2002
3-7 December 2002
20-23 January 2003
10-13 February 2003
2-6 March 2003