



BTO Research Report No. 530

**The Effects on Waterbirds
of Dredging at the
Cardiff Bay Barrage
Report for 2008/09**

Authors

A.S.C.P. Cook & N.H.K. Burton

March 2009

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EXECUTIVE SUMMARY

1. This study reports on the effects of maintenance dredging on the birds utilising mudflats within and adjoining the outer harbour of the Cardiff Bay barrage using data collected in January and March 2009. Results are compared to those reported between 2002 and 2007. Dredging is required to maintain a channel from the outer harbour to the sea and to prevent sediment build up within this harbour. Initial dredging took place during the construction of the barrage and since August 2000 has usually taken place twice annually (in February and August). During the period of study, mudflats were dredged between 9 and 28 February 2009. 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 months of January 2009, before the latest dredging commenced, and March 2009, after dredging operations had been completed.
4. Twelve waterbird species were recorded using the mudflats affected by dredging in January and March 2009. 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 – together with Cormorant and six species of gull – Black-headed Gull, Common Gull, Lesser Black-backed Gull, Herring Gull, Great Black-backed Gull and Kittiwake. With the exception of Kittiwake, all these species had been recorded on these mudflats during previous periods of post-barrage fieldwork.
5. By far the most numerous species on the mudflats affected by dredging were Black-headed Gull, Lesser Black-backed Gull and Herring Gull. Aside from these, only Cormorant, Mallard and Redshank were recorded in numbers of greater than 10 on any one of these mudflats. Mallard, Shelduck, Black-headed Gull and Lesser Black-backed Gull utilised all three mudflats.
6. Although the overall numbers of wildfowl and waders using the mudflats affected by dredging are very low, two species found on these mudflats – Mallard and Redshank – were not recorded on comparative areas of mudflat nearby. However, low tide densities of Shelduck, Lesser Black-backed Gull and Herring Gull were greater on the comparative mudflats.
7. There is some evidence that the dredging in February 2009 might have had an effect in the short term, with numbers of Cormorant, Mallard, Redshank, Black-headed Gull and Lesser Black-backed Gull declining on the mudflats by the barrage between January and March. However, it is important to note that other factors may have also affected numbers of these species over this period. For example, the observed declines of gulls may have also occurred because by March some birds were beginning to move back to their breeding areas.

8. Evidence that dredging has had a long-term effect on the numbers of birds using the mudflats by the barrage is more limited. Over the six years of monitoring, numbers of Black-headed Gull have shown a significant decline on the mudflats affected by dredging. This might suggest that the regular dredging that has occurred since the barrage was completed has had a limited effect on the long-term development of invertebrate food supplies – if so, this would be an inevitable consequence of complying with the statutory requirements of the Cardiff Bay Barrage Act 1993. However, it should also be noted that in Black-headed Gull numbers also declined significantly on adjacent mudflats, suggesting that changes were part of a wider trend. Numbers of Cormorant and Herring Gull have actually increased on the mudflats affected by dredging and this would suggest that waterbird food supplies have not been detrimentally affected by the operations in the long-term.
9. Densities of wader and wildfowl species on the mudflats affected by dredging are lower than those found prior to construction of the barrage and this may in part be due to disturbance. Overall, the numbers of birds that might be affected by dredging are very small in relation to the substantial populations found locally.
10. Further monitoring is recommended in order to allow future assessment of the effects of dredging over both the short and long term.

1. INTRODUCTION

This study reports on the effects of maintenance dredging on the birds utilising mudflats within and adjoining the outer harbour of the Cardiff Bay barrage using data collected in January and March 2009. 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 since August 2000 has usually taken place twice annually (in February and August). During the period of study, mudflats were dredged between 9 and 28 February 2009.

Data are presented separately for periods immediately before and after dredging, in January and March 2009, so as to assess whether there were any short-term effects of the operations. Longer-term effects are assessed through comparison with the data collected for previous reports (Burton & Clark 2002a, 2002b, Burton *et al.* 2003a, 2003b, 2005, Burton & Holloway 2006, Holloway *et al.* 2004, Burton & Maclean 2007).

The ornithological significance of the mudflats by the barrage was assessed in previous reports (Burton & Clark 2002a, 2002b) by comparing counts made between August 2001 and March 2002 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 Mute Swan *Cygnus olor*, Bewick's Swan *Cygnus columbianus*, Shelduck *Tadorna tadorna*, Pintail *A. acuta*, Shoveler *Anas clypeata*, Ringed Plover *Charadrius hiaticula* and Dunlin *Calidris alpina* (Austin *et al.* 2008) and Cardiff Bay itself formerly held nationally important numbers of Dunlin (Burton *et al.* 2003c). 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 2009. 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 is similar to B2, both being entirely muddy, whilst mudflats B3 and B4 contain a mix of mud and rocky substrate. The five mudflats are, respectively, 4.8, 11.9, 7.0, 19.8 and 3.3 ha in size at mean low tide.

The waterbirds using mudflats B1-B5 were counted at hourly intervals (relative to low tide) over the time that the mudflats were exposed, twice in both January and March 2009. Counts were undertaken on 24-26 January and 8-9 March. The mudflats became exposed around 3 hours before low tide and became inundated around 3 hours afterwards. The counts made in January were before the latest dredging took place, whilst those in March were made after dredging operations had finished.

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.

The mean numbers and densities of waterbirds recorded on mudflats B1-B5 at low tide are tabulated for both January and March. Further tables provide information on the mean bird hours recorded per tidal cycle (i.e. the sum of the average number of birds each hour) on mudflats B1-B5 and the peak numbers of each species recorded on each mudflat. By tabulating the data in this way, it is possible to assess whether the numbers of birds occurring on the mudflats after dredging differed from those that occurred prior to operations.

The longer term effects of dredging were considered by looking for trends in waterbird numbers over the eight winters since monitoring began in 2001/02. Analyses were only undertaken for those species that had been regularly recorded on the mudflats affected by dredging in numbers of greater than 10, i.e. Cormorant *Phalacrocorax carbo*, Mallard *Anas platyrhynchos*, Black-headed Gull *Larus ridibundus*, Lesser Black-backed Gull *L. fuscus* and Herring Gull *L. argentatus*.

For each of these species, generalized linear models (GLMs) were used to relate the number of birds on each count to the year, period (pre-dredging or post-dredging), state of tide (hour relative to low water at which the count was undertaken) and the mudflat count section. Models assumed a Poisson distribution and a log link function, treated period, state of tide and mudflat count section as class variables and used the PSCALE option to account for overdispersion (SAS Institute Inc. 1999-2001). To avoid problems of pseudoreplication, counts of the same count section undertaken at the same state of tide and within the same period and year were summed and the natural logarithm of the number of counts as an offset. Pre-dredging counts used in the analyses were undertaken in January in each of the six years of monitoring; post-dredging counts were undertaken either in late February or early March. Analyses were undertaken separately for the mudflats affected by dredging (B2, B3 and B5) and those not (B1 and B4). In each analysis, models were initially fitted with all variables included. A backward deletion method was then used to sequentially remove those variables with the largest *P* value based on likelihood-ratio tests (Crawley 1993). A final model was reached when no variables could be deleted from the model without causing a significant change based on *P* = 0.05.

3. RESULTS

Table 3.1 reports the mean numbers and densities of waterbirds recorded on mudflats B1-B5 at low tide in January and March 2009. Table 3.2 indicates the overall usage of mudflats B1-B5 through the tidal cycle and Table 3.3, the peak numbers of birds recorded on each mudflat.

A total of 12 waterbird species were recorded using the mudflats affected by dredging, i.e. B2, B3 and B5, in January and March 2009. These included five species of wildfowl and wader – Shelduck, Mallard, Oystercatcher *Haematopus ostralegus*, Curlew *Numenius arquata* and Redshank *Tringa totanus* – and in addition, Cormorant and six species of gull – Kittiwake *Rissa tridactyla*, Black-headed Gull, Common Gull *Larus canus*, Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull *L. marinus*.

By far the most numerous species on the mudflats affected by dredging were Black-headed Gull, Lesser Black-backed Gull and Herring Gull. Aside from these, only Cormorant, Mallard and Redshank were recorded in numbers of greater than 10 on any one of these mudflats (Table 3.3). Tables 3.1 and 3.3 show that Mallard, Shelduck and Black-headed and Lesser Black-backed Gulls utilised all three mudflats.

Gulls were particularly associated with the channel and seaward edge of mudflats, whilst other species were found higher up the mudflats. Typically, the overwhelming majority of the waders and wildfowl that were recorded on these mudflats were feeding, though many gulls also used the mudflats to loaf or rest. Cormorants also rested on metal structures around the outer harbour.

Table 3.1 also allows comparison to be made between the low tide densities found on the mudflats affected by the dredging (B2, B3 & B5) and those found on mudflats B1 and B4, which have not been affected by dredging. In comparison to mudflats B2, B3 and B5, mudflats B1 and B4 held higher low tide densities of Shelduck, Lesser Black-backed Gull and Herring Gull. In contrast, no Mallard or Redshank were recorded on mudflats B1 or B4 either at low tide or any other stage of the tidal cycle

The possible short term effects of dredging can be examined by comparing the numbers of birds recorded in January 2009 (pre-dredging) with those in March 2009 (post-dredging). On the mudflats affected by operations, numbers of Cormorant, Mallard, Redshank, Black-headed Gull and Lesser Black-backed Gull were lower following the dredging in February 2009. In contrast, there was a slight increase in the numbers of Shelduck following the operations.

Over the longer term, numbers of Cormorant have shown a significant increase on the mudflats affected by dredging ($F_{1,240} = 61.75, P < 0.0001$). This trend was not repeated on the other mudflats monitored ($F_{1,155} = 0.42, P = 0.5167$).

Gull species have typically shown much greater year-to-year fluctuations in their numbers. Black-headed Gull numbers showed a significant downward trend over the eight year period both on the mudflats affected by dredging ($F_{1,233} = 4.14, P = 0.0414$) and on adjacent mudflats ($F_{1,1154} = 9.05, P = 0.0031$). In contrast, numbers of Herring Gull have increased significantly both on the mudflats affected by dredging ($F_{1,233} = 10.21, P < 0.0014$) as well as those adjacent ($F_{1,155} = 28.33, P < 0.0001$).

Over the eight years of study, the numbers of Mallard (MA), Black-headed Gull (BH) and Lesser Black-backed Gull (LB) on affected mudflats have been consistently lower following dredging (MA: $F_{1,240} = 32.86, P < 0.0001$ BH: $F_{1,233} = 4.14, P < 0.0001$ LB: $F_{1,236} = 7.12, P = 0.0076$). The numbers of Black-headed and Lesser Black-backed Gulls have also shown consistent declines on adjacent sites following dredging (BH: $F_{1,154} = 20.86, P < 0.0001$ LB: $F_{1,155} = 45.15, P < 0.0001$). In contrast, numbers of Shelduck (SU) and Herring Gull (HG) have shown consistent increases on affected sections following dredging (SU: $F_{1,240} = 54.66, P < 0.0001$ HG: $F_{1,233} = 10.61, P = 0.0011$).

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

A total of 12 waterbird species were recorded using the mudflats affected by dredging, i.e. B2, B3 and B5, in January and March 2009. 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, Oystercatcher, Curlew and Redshank. In addition, Cormorant and six species of gull – Black-headed Gull, Common Gull, Lesser Black-backed Gull, Herring Gull, Great Black-backed Gull and Kittiwake were also recorded on these mudflats. With the exception of Kittiwake, all these species had been recorded on these mudflats during previous fieldwork (Burton & Maclean 2007).

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, two species found on these mudflats in January / March 2009 – Mallard and Redshank – were not recorded on comparative areas of mudflat nearby. However, low tide densities of Shelduck, Oystercatcher and Common, Lesser Black-backed and Herring Gulls were greater on the comparative mudflats. These findings are similar to those of August 2001 to March 2007 (Burton & Clark 2002a, 2002b, Burton *et al.* 2003a, 2003b, 2005, Burton & Holloway 2006, Burton & Maclean 2007, Holloway *et al.* 2004).

The reports for previous winters found some evidence that numbers of waterbirds might have been affected by dredging operations in the short term. For example, numbers of Black-headed and Lesser Black-backed Gulls decreased after dredging in 2003 and 2004, and, likewise, numbers of Mallard and Black-headed Gull fell following dredging in February 2006. It is possible that declines in waterbird numbers in those years were linked to a short-term decline in food resources, possibly as a result of dredging activities. However, as the levels of the food resources in the water and sediments were not measured, it is not possible to say for sure. In 2005, there was no evidence that the dredging had any effects in the short-term; indeed numbers of Black-headed, Lesser Black-backed and Herring Gulls were all higher following the operations than beforehand.

This winter, numbers of Cormorant, Mallard, Redshank, Black-headed Gull and Lesser Black-backed Gull all fell on the mudflats affected by operations following dredging, again suggesting that dredging may have had an effect in the short-term. However, it is important to note that other factors may have also affected numbers of these species over this period. The observed declines of gulls (in 2009 and previous years) may have also occurred because by March some birds were beginning to move back to their breeding areas. Among other species, it should be noted that there was a slight increase in the numbers of Shelduck following the operations.

There was little evidence that dredging has had a long-term effect on the numbers of birds using mudflats by the barrage. Over the eight years of monitoring, numbers of Black-headed Gull – the most numerous species in the area – showed a significant decline on the mudflats affected by dredging. This might suggest that the regular dredging that has occurred since the barrage was completed has had a limited effect on the long-term development of invertebrate food supplies in these areas. If so, this would be an inevitable consequence of complying with the statutory requirements of the Cardiff Bay Barrage Act 1993. Alternatively, it is also possible that numbers of Black-headed Gulls have been affected by disturbance from people on the barrage or along the Penarth shore. This is most likely to affect birds on mudflats B3 and B5 and be most intense at weekends. It should also be noted, though, that there was a much larger, significant decrease in Black-headed Gull numbers on adjacent mudflats, suggesting that changes were part of a wider trend.

In contrast, numbers of Cormorant and Herring Gull have actually increased on the mudflats affected by dredging. This would suggest that waterbird food supplies have not been detrimentally affected by the operations in the long-term.

As reported previously, densities of wader and wildfowl species on the mudflats affected by dredging are lower than those found prior to construction of the barrage (Burton & Clark 2002b) and this may in part be due to disturbance. Overall, 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.* 2003c).

Further monitoring is recommended in order to allow future assessment of the effects of dredging over both the short and long term.

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	Jan 2009		Mar 2009	
	n	d	n	d
Cormorant				
<i>Mudflat B2</i>	18.0	1.51	7.0	0.00
<i>Mudflat B3</i>	0.0	0.00	0.0	0.59
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	1.5	0.31	0.0	0.00
Mudflat B4	2.0	0.10	0.0	0.00
Mudflats B2,B3,B5	18.0	0.81	7.0	0.32
Mudflats B1, B4	3.5	0.14	0.0	0.00
Mute Swan				
<i>Mudflat B2</i>	0.0	0.00	0.0	0.00
<i>Mudflat B3</i>	0.0	0.00	0.0	0.00
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	0.0	0.00	0.0	0.00
Mudflat B4	0.0	0.00	0.0	0.00
Mudflats B2,B3,B5	0.0	0.00	0.0	0.00
Mudflats B1, B4	0.0	0.00	0.0	0.00
Shelduck				
<i>Mudflat B2</i>	0.0	0.00	0.0	0.00
<i>Mudflat B3</i>	0.0	0.00	1.0	0.14
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	2.0	0.42	4.5	0.94
Mudflat B4	0.0	0.00	0.0	0.00
Mudflats B2,B3,B5	0.0	0.00	1.0	0.05
Mudflats B1, B4	2.0	0.08	4.5	0.18
Mallard				
<i>Mudflat B2</i>	1.0	0.08	0.0	0.00
<i>Mudflat B3</i>	2.0	0.29	0.5	0.07
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	0.0	0.00	0.0	0.00
Mudflat B4	0.0	0.00	0.0	0.00
Mudflats B2,B3,B5	3.0	0.14	0.5	0.02
Mudflats B1, B4	0.0	0.00	0.0	0.00
Oystercatcher				
<i>Mudflat B2</i>	0.0	0.00	0.0	0.00
<i>Mudflat B3</i>	0.0	0.00	0.0	0.00
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	0.0	0.00	0.0	0.00
Mudflat B4	1.0	0.05	0.0	0.00
Mudflats B2,B3,B5	0.0	0.00	0.0	0.00
Mudflats B1, B4	1.0	0.04	0.0	0.00
Curlew				
<i>Mudflat B2</i>	0.0	0.00	0.0	0.00
<i>Mudflat B3</i>	1.5	0.21	0.0	0.00
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	0.0	0.00	0.0	0.00
Mudflat B4	0.0	0.00	2.5	0.13
Mudflats B2,B3,B5	1.5	0.07	0.0	0.00
Mudflats B1, B4	0.0	0.00	2.5	0.10

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 in January and March 2009.

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.

	Jan 2009		Mar 2009	
	N	d	n	d
Redshank				
<i>Mudflat B2</i>	1.5	0.13	0.0	0.00
<i>Mudflat B3</i>	0.0	0.00	0.0	0.00
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	0.0	0.00	0.0	0.00
Mudflat B4	0.0	0.00	0.0	0.00
Mudflats B2,B3,B5	1.5	0.07	0.0	0.00
Mudflats B1, B4	0.0	0.00	0.0	0.00
Black-headed Gull				
<i>Mudflat B2</i>	11.0	0.92	10.5	0.88
<i>Mudflat B3</i>	5.5	0.79	11.0	1.57
<i>Mudflat B5</i>	0.5	0.15	0.0	0.00
Mudflat B1	5.0	1.04	0.0	0.00
Mudflat B4	66.0	3.33	1.5	0.08
Mudflats B2,B3,B5	17.0	0.77	21.5	0.97
Mudflats B1, B4	71.0	2.89	1.5	0.06
Common Gull				
<i>Mudflat B2</i>	0.0	0.00	0.0	0.00
<i>Mudflat B3</i>	0.0	0.00	0.0	0.00
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	0.5	0.10	0.0	0.00
Mudflat B4	3.5	0.18	0.0	0.00
Mudflats B2,B3,B5	0.0	0.00	0.0	0.00
Mudflats B1, B4	4.0	0.16	0.0	0.00
Lesser Black-backed Gull				
<i>Mudflat B2</i>	2.0	0.17	0.5	0.04
<i>Mudflat B3</i>	5.0	0.71	0.0	0.00
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	0.0	0.00	0.0	0.00
Mudflat B4	64.0	3.23	3.5	0.18
Mudflats B2,B3,B5	7.0	0.32	0.5	0.02
Mudflats B1, B4	64.0	2.60	3.5	0.14
Herring Gull				
<i>Mudflat B2</i>	0.0	0.00	0.0	0.00
<i>Mudflat B3</i>	5.0	0.71	6.5	0.93
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	0.0	0.00	0.0	0.00
Mudflat B4	26.5	1.34	21.5	1.09
Mudflats B2,B3,B5	5.0	0.23	6.5	0.29
Mudflats B1, B4	26.5	1.08	21.5	0.87
Great Black-backed Gull				
<i>Mudflat B2</i>	0.5	0.04	0.0	0.00
<i>Mudflat B3</i>	0.5	0.07	0.0	0.00
<i>Mudflat B5</i>	0.0	0.00	0.0	0.00
Mudflat B1	0.0	0.00	0.0	0.00
Mudflat B4	0.0	0.00	0.0	0.00
Mudflats B2,B3,B5	1.0	0.05	0.0	0.00
Mudflats B1, B4	0.0	0.00	0.0	0.00

Table 3.1 Continued.

	Jan 2009	Mar 2009
Cormorant		
<i>Mudflat B2</i>	85.0	14.0
<i>Mudflat B3</i>	0.0	0.0
<i>Mudflat B5</i>	0.0	0.0
Mudflat B1	2.0	0.0
Mudflat B4	4.0	0.0
Mute Swan		
<i>Mudflat B2</i>	0.0	0.0
<i>Mudflat B3</i>	0.0	0.0
<i>Mudflat B5</i>	0.0	0.0
Mudflat B1	0.0	0.0
Mudflat B4	0.0	0.0
Shelduck		
<i>Mudflat B2</i>	0.0	5.5
<i>Mudflat B3</i>	0.0	4.0
<i>Mudflat B5</i>	0.0	1.0
Mudflat B1	11.5	10.0
Mudflat B4	0.0	0.5
Mallard		
<i>Mudflat B2</i>	1.0	0.0
<i>Mudflat B3</i>	8.0	1.0
<i>Mudflat B5</i>	14.5	0.0
Mudflat B1	0.0	0.0
Mudflat B4	0.0	0.0
Oystercatcher		
<i>Mudflat B2</i>	0.0	0.0
<i>Mudflat B3</i>	1.0	0.0
<i>Mudflat B5</i>	0.0	0.0
Mudflat B1	0.0	0.0
Mudflat B4	2.0	0.0
Curlew		
<i>Mudflat B2</i>	0.0	0.0
<i>Mudflat B3</i>	2.0	0.5
<i>Mudflat B5</i>	0.5	0.0
Mudflat B1	0.5	0.0
Mudflat B4	0.0	2.5
Redshank		
<i>Mudflat B2</i>	20.0	4.5
<i>Mudflat B3</i>	0.0	0.0
<i>Mudflat B5</i>	0.5	0.0
Mudflat B1	0.0	0.0
Mudflat B4	0.0	0.0

Table 3.2 Mean numbers of bird hours per tidal cycle recorded on mudflats near the Cardiff Bay barrage in January and March 2009.

Only species recorded since August 2001 on mudflats affected by dredging (shown italicised) are included.

	Jan 2009	Mar 2009
Black-headed Gull		
<i>Mudflat B2</i>	166.5	66.0
<i>Mudflat B3</i>	62.5	27.5
<i>Mudflat B5</i>	27.5	42.0
Mudflat B1	18.5	0.0
Mudflat B4	255.5	61.5
Common Gull		
<i>Mudflat B2</i>	3.5	1.5
<i>Mudflat B3</i>	0.0	0.0
<i>Mudflat B5</i>	0.0	0.0
Mudflat B1	0.5	0.0
Mudflat B4	4.0	0.0
Lesser Black-backed Gull		
<i>Mudflat B2</i>	12.0	3.0
<i>Mudflat B3</i>	47.5	3.0
<i>Mudflat B5</i>	5.5	4.5
Mudflat B1	6.5	0.5
Mudflat B4	162.0	14.0
Yellow-legged Gull		
<i>Mudflat B2</i>	0.0	0.0
<i>Mudflat B3</i>	0.0	0.0
<i>Mudflat B5</i>	0.0	0.0
Mudflat B1	0.0	0.0
Mudflat B4	0.5	0.0
Herring Gull		
<i>Mudflat B2</i>	0.0	0.0
<i>Mudflat B3</i>	31.5	28.0
<i>Mudflat B5</i>	0.0	0.0
Mudflat B1	2.5	2.5
Mudflat B4	84.0	113.5
Great Black-backed Gull		
<i>Mudflat B2</i>	0.5	0.0
<i>Mudflat B3</i>	1.0	0.0
<i>Mudflat B5</i>	0.5	0.0
Mudflat B1	0.0	0.0
Mudflat B4	1.0	0.0
Kittiwake		
<i>Mudflat B2</i>	1.0	0.0
<i>Mudflat B3</i>	0.0	0.0
<i>Mudflat B5</i>	0.0	0.0
Mudflat B1	0.0	0.0
Mudflat B4	0.0	0.0

Table 3.2 Continued.

	Jan 2009	Mar 2009
Cormorant		
<i>Mudflat B2</i>	21	14
<i>Mudflat B3</i>	0	0
<i>Mudflat B5</i>	0	0
Mudflat B1	3	0
Mudflat B4	3	0
Mute Swan		
<i>Mudflat B2</i>	0	0
<i>Mudflat B3</i>	0	0
<i>Mudflat B5</i>	0	0
Mudflat B1	0	0
Mudflat B4	0	0
Shelduck		
<i>Mudflat B2</i>	0	9
<i>Mudflat B3</i>	0	2
<i>Mudflat B5</i>	0	2
Mudflat B1	8	9
Mudflat B4	0	1
Mallard		
<i>Mudflat B2</i>	2	0
<i>Mudflat B3</i>	6	1
<i>Mudflat B5</i>	18	0
Mudflat B1	0	0
Mudflat B4	0	0
Oystercatcher		
<i>Mudflat B2</i>	0	0
<i>Mudflat B3</i>	1	0
<i>Mudflat B5</i>	0	0
Mudflat B1	0	0
Mudflat B4	1	0
Curlew		
<i>Mudflat B2</i>	0	0
<i>Mudflat B3</i>	3	1
<i>Mudflat B5</i>	0	0
Mudflat B1	1	0
Mudflat B4	0	5
Redshank		
<i>Mudflat B2</i>	10	8
<i>Mudflat B3</i>	0	0
<i>Mudflat B5</i>	1	0
Mudflat B1	0	0
Mudflat B4	0	0

Table 3.3 Peak numbers of waterbirds recorded on mudflats near the Cardiff Bay barrage in January and March 2009.

Only species recorded since August 2001 on mudflats affected by dredging (shown italicised) are included.

	Jan 2009	Mar 2009
Black-headed Gull		
<i>Mudflat B2</i>	180	39
<i>Mudflat B3</i>	38	19
<i>Mudflat B5</i>	19	33
Mudflat B1	18	0
Mudflat B4	160	53
Common Gull		
<i>Mudflat B2</i>	6	3
<i>Mudflat B3</i>	0	0
<i>Mudflat B5</i>	0	0
Mudflat B1	1	0
Mudflat B4	5	0
Lesser Black-backed Gull		
<i>Mudflat B2</i>	6	2
<i>Mudflat B3</i>	30	6
<i>Mudflat B5</i>	5	3
Mudflat B1	6	1
Mudflat B4	80	7
Yellow-legged Gull		
<i>Mudflat B2</i>	0	0
<i>Mudflat B3</i>	0	0
<i>Mudflat B5</i>	0	0
Mudflat B1	0	0
Mudflat B4	1	0
Herring Gull		
<i>Mudflat B2</i>	0	0
<i>Mudflat B3</i>	25	39
<i>Mudflat B5</i>	0	0
Mudflat B1	3	3
Mudflat B4	40	57
Great Black-backed Gull		
<i>Mudflat B2</i>	1	0
<i>Mudflat B3</i>	1	0
<i>Mudflat B5</i>	1	0
Mudflat B1	0	0
Mudflat B4	1	0
Kittiwake		
<i>Mudflat B2</i>	1	0
<i>Mudflat B3</i>	0	0
<i>Mudflat B5</i>	0	0
Mudflat B1	0	0
Mudflat B4	0	0

Table 3.3 Continued.

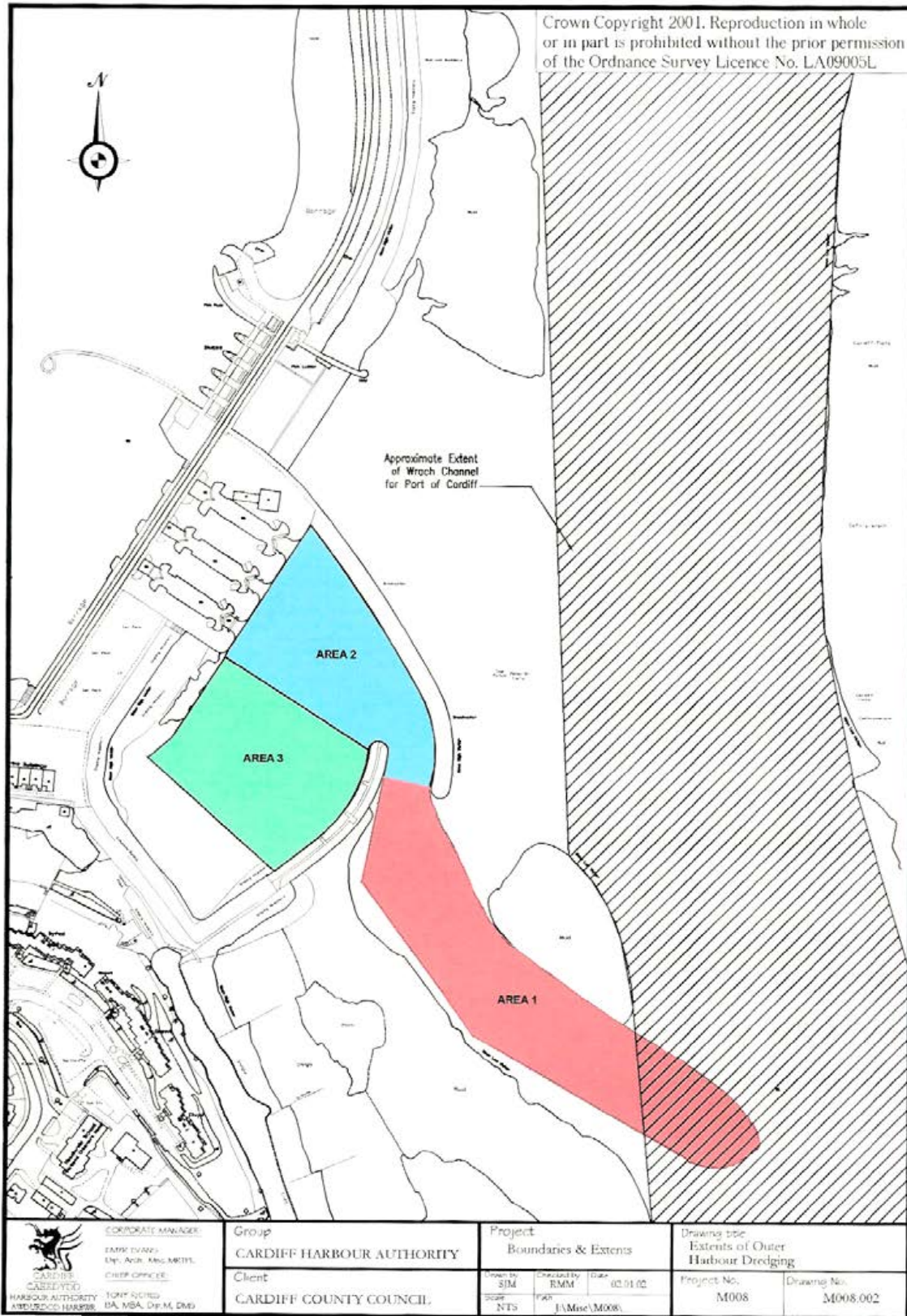


Figure 2.1 The Cardiff Bay barrage showing areas (shaded grey) subject to maintenance dredging.

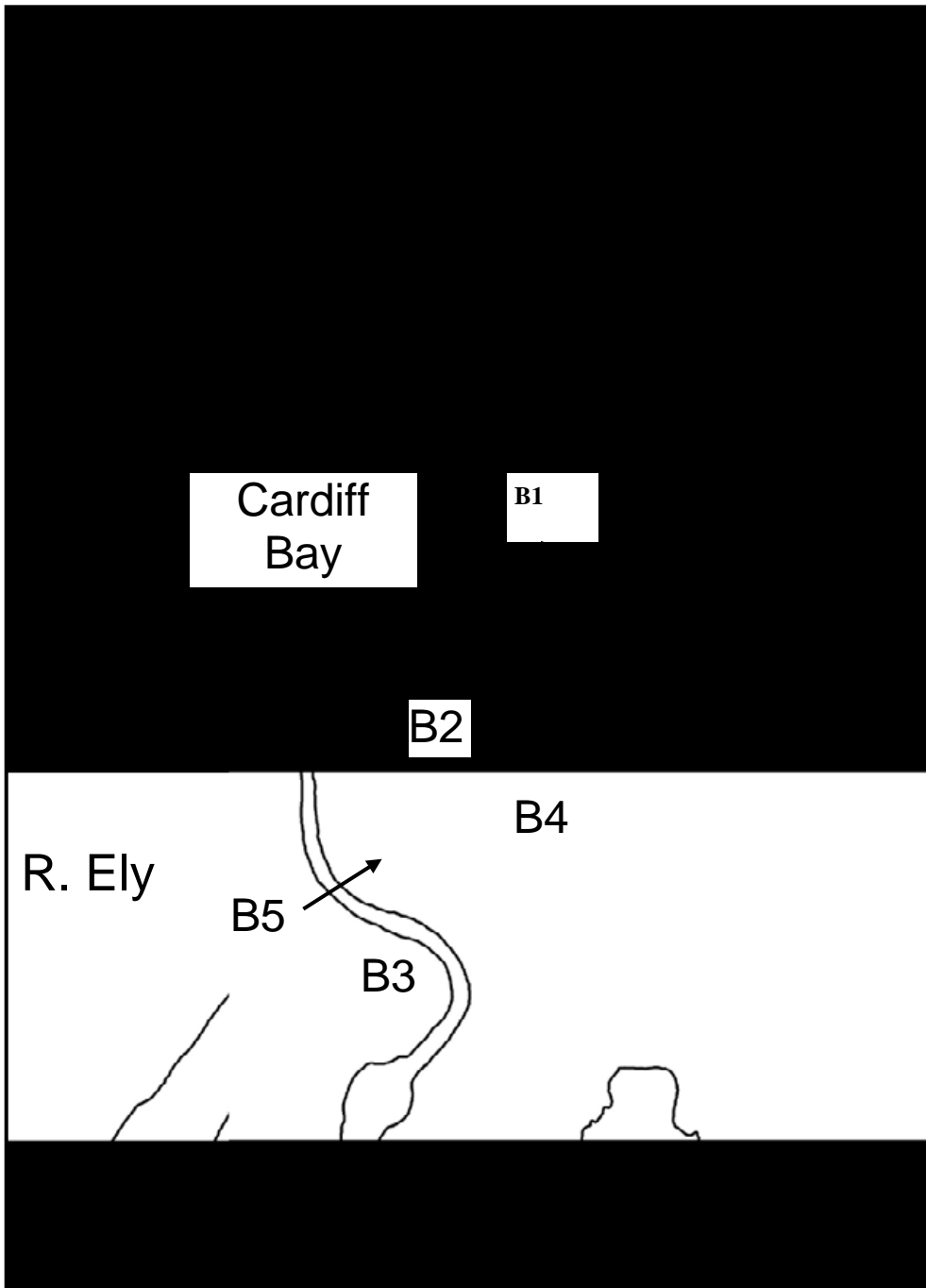


Figure 2.2 The Cardiff Bay barrage showing numbered mudflat count areas (shaded) monitored between August 2001 and March 2009.

Appendix 1 National importance thresholds for waterbird species referred to in this report (taken from Austin *et al.* 2008).

Cormorant <i>Phalacrocorax carbo</i>	230
Mute Swan <i>Cygnus olor</i>	375
Bewick's Swan <i>Cygnus columbianus</i>	81
Shelduck <i>Tadorna tadorna</i>	782
Mallard <i>Anas platyrhynchos</i>	3,520
Pintail <i>Anas acuta</i>	279
Shoveler <i>Anas clypeata</i>	148
Oystercatcher <i>Haematopus ostralegus</i>	3,200
Ringed Plover <i>Charadrius hiaticula</i>	330
Dunlin <i>Calidris alpina</i>	5,600
Curlew <i>Numenius arquata</i>	1,500
Redshank <i>Tringa totanus</i>	1,200
Black-headed Gull <i>Larus ridibundus</i>	19,000
Common Gull <i>Larus canus</i>	9,000
Lesser Black-backed Gull <i>Larus fuscus</i>	500
Yellow-legged Gull <i>Larus michahellis</i>	50*
Herring Gull <i>Larus argentatus</i>	4,500
Great Black-backed Gull <i>Larus marinus</i>	400

* Where 1% of the British wintering population is less than 50 birds, 50 is normally used as a minimum qualifying level for national importance. No British importance threshold has been set for Kittiwake.

