**BTO Research Report No. 617**

# The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for 2011/12

**Authors**

**C.A. Morrison, R. Taylor, A. Hallam, N.H.K. Burton**

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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 2012. Results are compared to those reported between 2002 and 2012. 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/March and August). During the period of study, mudflats were dredged between 7 and 15 March 2012. 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 2012, before the latest dredging commenced, and March 2012, after dredging operations had been completed.

4. Ten waterbird species were recorded using the mudflats affected by dredging in January and March 2012. These included four of the 10 species of wildfowl and wader that had been recorded on the equivalent mudflats prior to barrage construction – Shelduck, Mallard, Oystercatcher and Redshank – together with Cormorant, Bar-tailed Godwit, Black-headed Gull, Lesser Black-backed Gull, Herring Gull, and Great Black-backed Gull. With the exception of Bar-tailed Godwit, 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 Redshank were recorded in numbers of greater than 10 on any one of these mudflats, Black-headed Gull, Herring Gull, Lesser Black-backed Gull utilised all three mudflats.

6. The overall numbers of wildfowl and waders using the mudflats affected by dredging were very low. Low tide densities of Black-headed Gull and Herring Gull were greater on the comparative mudflats.

7. There is some limited evidence that the dredging in March 2012 might have had an effect in the short term, with numbers of Cormorant, Mallard and Redshank declining on the mudflats by the barrage between January and March. Greater declines occurred in numbers of Black-headed Gull, Lesser Black-backed Gull and Herring Gull following the operations.

8. Evidence that dredging has had a long-term effect on the numbers of birds using the mudflats by the barrage is also limited. Over the 10 winters since monitoring began, none of the four most numerous species (Cormorant, Black-headed Gull, Lesser Black-backed Gull and Herring Gull) have shown a significant decline in numbers on the mudflats affected by dredging. Numbers of both 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 2012. 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/March and August). During the period of study, mudflats were dredged between 7 and 15 March 2012.

Data are presented separately for periods immediately before and after dredging, in January and March 2012, 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, Cook & Burton 2009, Cook & Burton 2010).

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 *Anas acuta*, Shoveler *Anas clypeata*, Ringed Plover *Charadrius hiaticula* and Dunlin *Calidris alpina* (Holt *et al.* 2011) 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 2012. 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 2012. Counts were undertaken on 24-25 January and 24-25 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 2012. 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 10 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*, 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 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 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 2012. 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 of10 waterbird species were recorded using the mudflats affected by dredging, i.e. B2, B3 and B5, in January and March 2012. These included four species of wildfowl and wader – Shelduck, Mallard, Oystercatcher *Haematopus ostralegus* and Redshank *Tringa totanus* – and in addition, Cormorant, Bar-tailed Godwit *Limosa lapponica* and four species of gull – Black-headed Gull, Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull *L. marinus*. Five other species – Mute Swan *Cygnus olor*, Coot *Fulica atra*, Curlew *Numenius arquata*, Common Gull *Larus canus*, and Kittiwake *Rissa tridactyla* – have been recorded on the mudflats affected by dredging since August 2001.

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 Redshank were recorded in numbers of greater than 10 on any one of these mudflats (Table 3.3). Tables 3.2 and 3.3 show that Black-headed, Lesser Black-backed and Herring 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 Black-headed Gull and Herring Gull. In contrast, few Mallard, 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 2012 (pre-dredging) with those in March 2012 (post-dredging). On the mudflats affected by operations, numbers of Cormorant, Mallard and Redshank were lower following the dredging in March 2012. Greater declines occurred in numbers of Black-headed Gull, Lesser Black-backed Gull and Herring Gull following the operations.

Over the longer term, numbers of Cormorant have shown a significant increase on the mudflats affected by dredging ($F_{1,324}$ = 37.13, $P$ < 0.0001). This trend was not repeated on the other mudflats monitored ($F_{1,211}$ = 0.17, $P$ = 0.68). Gull species have typically shown much greater year-to-year fluctuations in their numbers. Black-headed Gull numbers showed no significant trend over the 10 winters since monitoring began on the mudflats affected by dredging ($F_{1,317}$ = 0.04, $P$ = 0.85) but a significant decline on adjacent mudflats ($F_{1,210}$ = 16.20, $P$ < 0.0001). In contrast, numbers of Herring Gull have increased significantly on the mudflats affected by dredging ($F_{1,317}$ = 15.27, $P$ < 0.0001) as well as those adjacent ($F_{1,210}$ = 64.50, $P$ < 0.0001). Numbers of Lesser Black-backed Gull have shown no trend on the mudflats affected by dredging ($F_{1,317}$= 0.41, $P$ = 0.52) but a slight though non-significant decline on those adjacent ($F_{1,210}$ =3.04, $P$ = 0.08).

Over the 10 winters since monitoring began, the numbers of Cormorants (CA) and Herring Gull (HG) have been similar before and after dredging both on affected mudflats (CA: $F_{1,317,}$ = 3.26, $P$ = 0.07, HG: $F_{317,}$ = 3.44, $P$ = 0.06 ) and on adjacent sites (CA: $F_{1,210}$= 0.34, $P$ = 0.56, HG: $F_{1,210}$ = 0.51, $P$ = 0.47). Numbers of Mallard (MA), Black-headed Gull (BH) and Lesser Black-backed Gull (LB) on affected

mudflats have been consistently lower following dredging (MA: $F_{1,317}$ = 33.97, $P$ <0.0001 BH: $F_{1,317}$ = 21.79, $P$ <0.0001 LB: $F_{1,317}$ = 6.45, $P$ = 0.01). The numbers of Black-headed and Lesser Black-backed Gulls have also shown consistent declines on adjacent sites following dredging (BH: $F_{1,210}$ = 21.75, $P$ <0.0001 LB: $F_{1,210}$ = 42.14, $P$ <0.0001).

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

A total of 10 waterbird species were recorded using the mudflats affected by dredging, i.e. B2, B3 and B5, in January and March 2012. These included four species of wildfowl and wader that had been recorded on the equivalent mudflats prior to barrage construction (Burton & Clark 2002a, 2002b) – Shelduck, Mallard, Oystercatcher and Redshank. In addition, Cormorant, Bar-tailed Godwit and four species of gull – Black-headed Gull, Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull were also recorded on these mudflats. With the exception of Bar-tailed Godwit, all these species had been recorded on these mudflats during previous fieldwork (Cook & Burton 2010).

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). Although 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 2012 and other recent winters – Mallard and Redshank – have not typically been recorded on the comparative areas of mudflat nearby. However, low tide densities of Black-headed Gull and Herring Gull were greater on the comparative mudflats. These findings are similar to those of August 2001 to March 2009 (Burton & Clark 2002a, 2002b, Burton *et al.* 2003a, 2003b, 2005, Burton & Holloway 2006, Burton & Maclean 2007, Holloway *et al.* 2004, Cook & Burton 2009, Cook & Burton 2010).

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 Cormorant, Mallard, Redshank, Black-headed Gull and Lesser Black-backed Gull have all decreased after dredging in some, though not all, of the years of study. Results of analyses also show that numbers of Mallard, Black-headed Gull and Lesser Black-backed Gull on affected mudflats are consistently significantly lower following dredging, though numbers of the latter two species are also lower following dredging on the comparative mudflats. 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.

This winter, there was some limited evidence that the dredging in March 2012 might have had an effect in the short-term. Numbers of Cormorant, Mallard and Redshank fell on the mudflats affected by operations following dredging. Greater declines occurred in numbers of Black-headed Gull, Lesser Black-backed Gull and Herring Gull 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 10 winters since monitoring began, none of the four most numerous species (Cormorant, Black-headed Gull, Lesser Black-backed Gull and Herring Gull) have shown a significant decline in numbers on the mudflats affected by dredging. Numbers of both 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.

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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## References


Burton, N.H.K., Baylis, S. & Holloway, S.J. (2005) *The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for 2004/05*. BTO Research Report No. 399 to Cardiff Harbour Authority. BTO, Thetford

Burton, N.H.K. & Clark, N.A. (2002a) *The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Interim Report January 2002*. BTO Research Report No. 276 to Cardiff Harbour Authority. BTO, Thetford.

Burton, N.H.K. & Clark, N.A. (2002b) *The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for 2001/02*. BTO Research Report No. 285 to Cardiff Harbour Authority. BTO, Thetford.

Burton, N.H.K. & Holloway, S.J. (2006) *The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for 2005/06*. BTO Research Report No. 434 to Cardiff Harbour Authority. BTO, Thetford.

Burton, N.H.K., Holloway, S.J. & Clark, N.A. (2003a) *The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for April to December 2002*. BTO Research Report No. 309 to Cardiff Harbour Authority. BTO, Thetford.

Burton, N.H.K., Holloway, S.J. & Clark, N.A. (2003b) *The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for August 2002 to March 2003*. BTO Research Report No. 314 to Cardiff Harbour Authority. BTO, Thetford

Burton, N.H.K., Rehfisch, M.M. & Clark, N.A. (2003c) *The Effect of the Cardiff Bay Barrage on Waterbird Populations. Final Report*. BTO Research Report No. 343 to the Council of the City and County of Cardiff. BTO, Thetford.

Burton, N.H.K., & Maclean, I.M.D. (2007) *The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for 2006/07*. BTO Research Report No. 465 to Cardiff Harbour Authority. BTO, Thetford.

Cook, A.S.C.P. & Burton, N.H.K. (2009) *The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for 2008/09*. BTO Research Report No. 530 to Cardiff Harbour Authority. BTO, Thetford.

Cook, A.S.C.P. & Burton, N.H.K. (2010) *The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for 2008/09*. BTO Research Report No. 533 to Cardiff Harbour Authority. BTO, Thetford.

Crawley, M.J. (1993) *Methods in ecology: GLIM for ecologists*. Blackwell Scientific Publications, Oxford.

Holloway, S.J., Grantham, M.J., Collier, M.P. & Burton, N.H.K. (2004) *The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for 2003/2004*. BTO Research Report No. 360 to the Council of the City and County of Cardiff. BTO, Thetford.

Holt, C.A., Austin, G.E., Calbrade, N.A., Mellan, H.J., Mitchell, C., Stroud, D.A., Wotton, S.R. & Musgrove, A.J. 2011. *Waterbirds in the UK 2009/10: The Wetland Bird Survey*. BTO/RSPB/JNCC, Thetford.

SAS Institute Inc. (1999-2001) *SAS release 8.02*. Cary, NC, U.S.A.

| | Jan 2012 | | Mar 2012 | |
|---|---|---|---|---|
| | n | d | n | d |
| **Shelduck** | | | | |
| Mudflat B1 | 4 | 0.83 | 0 | 0 |
| *Mudflat B2* | 2 | 0.17 | 1 | 0.08 |
| *Mudflat B3* | 0 | 0 | 2 | 0.28 |
| Mudflat B4 | 0 | 0 | 4 | 0.20 |
| *Mudflat B5* | 0 | 0 | 0 | 0 |
| **Mudflats B1, B4** | 4 | 0.03 | 4 | 0.20 |
| ***Mudflats B2, B3, B5*** | 2 | 0.09 | 3 | 0.13 |
| | | | | |
| **Mallard** | | | | |
| Mudflat B1 | 0 | 0 | 0 | 0 |
| *Mudflat B2* | 0 | 0 | 0 | 0 |
| *Mudflat B3* | 0 | 0 | 0 | 0 |
| Mudflat B4 | 0 | 0 | 0 | 0 |
| *Mudflat B5* | 6 | 1.98 | 0 | 0 |
| **Mudflats B1, B4** | 0 | 0 | 0 | 0 |
| ***Mudflats B2, B3, B5*** | 6 | 0.27 | 0 | 0 |
| | | | | |
| **Cormorant** | | | | |
| Mudflat B1 | 0 | 0 | 0 | 0 |
| *Mudflat B2* | 5 | 0.42 | 0 | 0 |
| *Mudflat B3* | 0 | 0 | 0 | 0 |
| Mudflat B4 | 4 | 0.20 | 0 | 0 |
| *Mudflat B5* | 0 | 0 | 0 | 0 |
| **Mudflats B1, B4** | 4 | 0.16 | 0 | 0 |
| ***Mudflats B2, B3, B5*** | 5 | 0.22 | 0 | 0 |
| | | | | |
| **Bar-tailed Godwit** | | | | |
| Mudflat B1 | 0 | 0 | 0 | 0 |
| *Mudflat B2* | 3 | 0.25 | 0 | 0 |
| *Mudflat B3* | 0 | 0 | 0 | 0 |
| Mudflat B4 | 0 | 0 | 0 | 0 |
| *Mudflat B5* | 0 | 0 | 0 | 0 |
| **Mudflats B1, B4** | 0 | 0 | 0 | 0 |
| ***Mudflats B2, B3, B5*** | 0 | 0.14 | 0 | 0 |
| | | | | |
| **Oystercatcher** | | | | |
| Mudflat B1 | 0 | 0 | 0 | 0 |
| *Mudflat B2* | 0 | 0 | 0 | 0 |
| *Mudflat B3* | 0 | 0 | 0 | 0 |
| Mudflat B4 | 0 | 0 | 0 | 0 |
| *Mudflat B5* | 0 | 0 | 0 | 0 |
| **Mudflats B1, B4** | 0 | 0 | 0 | 0 |
| ***Mudflats B2, B3, B5*** | | | | |

**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 2012.

Only species recorded between January and March 2012 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 2012 | | Mar 2012 | |
|---|---|---|---|---|
| | n | d | n | d |
| **Redshank** | | | | |
| Mudflat B1 | 0 | 0 | 0 | 0 |
| *Mudflat B2* | 14 | 1.18 | 0 | 0 |
| *Mudflat B3* | 0 | 0 | 0 | 0 |
| Mudflat B4 | 0 | 0 | 0 | 0 |
| *Mudflat B5* | 0 | 0 | 0 | 0 |
| **Mudflats B1, B4** | 0 | 0 | 0 | 0 |
| ***Mudflats B2, B3, B5*** | 14 | 0.64 | 0 | 0 |
| | | | | |
| **Black-headed Gull** | | | | |
| Mudflat B1 | 0 | 0 | 0 | 0 |
| *Mudflat B2* | 9 | 0.76 | 0 | 0 |
| *Mudflat B3* | 18 | 2.56 | 0.5 | 0.07 |
| Mudflat B4 | 81 | 4.10 | 0 | 0 |
| *Mudflat B5* | 25 | 8.25 | 0 | 0 |
| **Mudflats B1, B4** | 81 | 3.29 | 0 | 0 |
| ***Mudflats B2, B3, B5*** | 52 | 2.37 | 0.5 | 0.02 |
| | | | | |
| **Lesser Black-backed Gull** | | | | |
| Mudflat B1 | 0 | 0 | 1.5 | 0.31 |
| *Mudflat B2* | 0 | 0 | 0 | 0 |
| *Mudflat B3* | 26 | 3.70 | 3.5 | 0.50 |
| Mudflat B4 | 31 | 1.57 | 2 | 0.10 |
| *Mudflat B5* | 3 | 0.99 | 0 | 0 |
| **Mudflats B1, B4** | 31 | 1.26 | 2 | 0.08 |
| ***Mudflats B2, B3, B5*** | 39 | 1.78 | 5.5 | 0.25 |
| | | | | |
| **Herring Gull** | | | | |
| Mudflat B1 | 0 | 0 | 2 | 0.41 |
| *Mudflat B2* | 1 | 0.08 | 2 | 0.17 |
| *Mudflat B3* | 28 | 3.98 | 0 | 0 |
| Mudflat B4 | 181 | 9.16 | 4 | 0.20 |
| *Mudflat B5* | 2 | 0.66 | 17.5 | 5.78 |
| **Mudflats B1, B4** | 181 | 7.36 | 6 | 0.24 |
| ***Mudflats B2, B3, B5*** | 31 | 1.41 | 19.5 | 0.89 |
| | | | | |
| **Great Black-backed Gull** | | | | |
| Mudflat B1 | 0 | 0 | 0 | 0 |
| *Mudflat B2* | 0 | 0 | 0 | 0 |
| *Mudflat B3* | 5 | 0.71 | 0 | 0 |
| Mudflat B4 | 5 | 0.25 | 0 | 0 |
| *Mudflat B5* | 0 | 0 | 0 | 0 |
| **Mudflats B1, B4** | 5 | 0.21 | 0 | 0 |
| ***Mudflats B2, B3, B5*** | 5 | 0.23 | 0 | 0 |

**Table 3.1** Continued.

| | Jan 2012 | Mar 2012 |
|---|---|---|
| **Shelduck** | | |
| Mudflat B1 | 0.57 | 0 |
| *Mudflat B2* | 0.71 | 0.21 |
| *Mudflat B3* | 0 | 0.5 |
| Mudflat B4 | 0.43 | 1.43 |
| *Mudflat B5* | 0 | 0 |
| | | |
| **Mallard** | | |
| Mudflat B1 | 0 | 0 |
| *Mudflat B2* | 0 | 0 |
| *Mudflat B3* | 0 | 0 |
| Mudflat B4 | 0 | 0 |
| *Mudflat B5* | 0.57 | 0 |
| | | |
| **Cormorant** | | |
| Mudflat B1 | 0 | 0.11 |
| *Mudflat B2* | 0.64 | 0 |
| *Mudflat B3* | 0 | 0 |
| Mudflat B4 | 1 | 0 |
| *Mudflat B5* | 0 | 0 |
| | | |
| **Bar-tailed Godwit** | | |
| Mudflat B1 | 0 | 0 |
| *Mudflat B2* | 0.43 | 0 |
| *Mudflat B3* | 0 | 0 |
| Mudflat B4 | 0 | 0 |
| *Mudflat B5* | 0 | 0 |
| | | |
| **Oystercatcher** | | |
| Mudflat B1 | 0 | 0 |
| *Mudflat B2* | 0 | 0 |
| *Mudflat B3* | 0 | 0 |
| Mudflat B4 | 0.79 | 0 |
| *Mudflat B5* | 0.43 | 0 |
| | | |
| **Redshank** | | |
| Mudflat B1 | 0 | 0 |
| *Mudflat B2* | 3.86 | 0 |
| *Mudflat B3* | 0 | 0 |
| Mudflat B4 | 0 | 0 |
| *Mudflat B5* | 0 | 0 |
| | | |
| **Black-headed Gull** | | |
| Mudflat B1 | 0.42 | 0 |
| *Mudflat B2* | 73.29 | 0 |
| *Mudflat B3* | 3.36 | 0.04 |
| Mudflat B4 | 18.14 | 0.39 |
| *Mudflat B5* | 5.71 | 0 |

**Table 3.2** Mean numbers of bird hours per tidal cycle recorded on mudflats near the Cardiff Bay barrage in January and March 2012.

Only species recorded between January and March 2012 on mudflats affected by dredging (shown italicised) are included.

| | Jan 2012 | Mar 2012 |
|---|---|---|
| **Black-headed Gull** | | |
| Mudflat B1 | 0.42 | 0 |
| *Mudflat B2* | 73.29 | 0 |
| *Mudflat B3* | 3.36 | 0.04 |
| Mudflat B4 | 18.14 | 0.39 |
| *Mudflat B5* | 5.71 | 0 |
| | | |
| **Lesser Black-backed Gull** | | |
| Mudflat B1 | 0 | 0.11 |
| *Mudflat B2* | 0.14 | 0 |
| *Mudflat B3* | 2.57 | 0.32 |
| Mudflat B4 | 6.64 | 1.5 |
| *Mudflat B5* | 0.21 | 0 |
| | | |
| **Herring Gull** | | |
| Mudflat B1 | 0.5 | 0.43 |
| *Mudflat B2* | 0.93 | 0 |
| *Mudflat B3* | 5.86 | 1.57 |
| Mudflat B4 | 41 | 4.32 |
| *Mudflat B5* | 0.21 | 0 |
| | | |
| **Great Black-backed Gull** | | |
| Mudflat B1 | 0 | 0 |
| *Mudflat B2* | 0 | 0 |
| *Mudflat B3* | 0.5 | 0 |
| Mudflat B4 | 1.0 | 0.14 |
| *Mudflat B5* | 0 | 0 |

**Table 3.2** Continued.

| | Jan 2012 | Mar 2012 |
|---|---|---|
| **Shelduck** | | |
| Mudflat B1 | 4 | 0 |
| *Mudflat B2* | 6 | 2 |
| *Mudflat B3* | 0 | 2 |
| Mudflat B4 | 4 | 7 |
| *Mudflat B5* | 0 | 0 |
| | | |
| **Mallard** | | |
| Mudflat B1 | 0 | 0 |
| *Mudflat B2* | 0 | 0 |
| *Mudflat B3* | 0 | 0 |
| Mudflat B4 | 0 | 0 |
| *Mudflat B5* | 6 | 0 |
| | | |
| **Cormorant** | | |
| Mudflat B1 | 0 | 3 |
| *Mudflat B2* | 5 | 0 |
| *Mudflat B3* | 0 | 0 |
| Mudflat B4 | 7 | 0 |
| *Mudflat B5* | 0 | 0 |
| | | |
| **Bar-tailed Godwit** | | |
| Mudflat B1 | 0 | 0 |
| *Mudflat B2* | 3 | 0 |
| *Mudflat B3* | 0 | 0 |
| Mudflat B4 | 0 | 0 |
| *Mudflat B5* | 0 | 0 |
| | | |
| **Oystercatcher** | | |
| Mudflat B1 | 0 | 0 |
| *Mudflat B2* | 0 | 0 |
| *Mudflat B3* | 0 | 0 |
| Mudflat B4 | 11 | 0 |
| *Mudflat B5* | 6 | 0 |
| | | |
| **Redshank** | | |
| Mudflat B1 | 0 | 0 |
| *Mudflat B2* | 18 | 0 |
| *Mudflat B3* | 0 | 0 |
| Mudflat B4 | 0 | 0 |
| *Mudflat B5* | 0 | 0 |
| | | |
| **Black-headed Gull** | | |
| Mudflat B1 | 6 | 0 |
| *Mudflat B2* | 797 | 0 |
| *Mudflat B3* | 19 | 1 |
| Mudflat B4 | 81 | 5 |
| *Mudflat B5* | 25 | 0 |

**Table 3.3** Peak numbers of waterbirds recorded on mudflats near the Cardiff Bay barrage in January and March 2012.

Only species recorded between January and March 2012 on mudflats affected by dredging (shown italicised) are included.

| | Jan 2012 | Mar 2012 |
|---|---|---|
| **Black-headed Gull** | | |
| Mudflat B1 | 6 | 0 |
| *Mudflat B2* | 797 | 0 |
| *Mudflat B3* | 19 | 1 |
| Mudflat B4 | 81 | 5 |
| *Mudflat B5* | 25 | 0 |
| | | |
| **Lesser Black-backed Gull** | | |
| Mudflat B1 | 0 | 2 |
| *Mudflat B2* | 2 | 0 |
| *Mudflat B3* | 26 | 7 |
| Mudflat B4 | 32 | 14 |
| *Mudflat B5* | 3 | 0 |
| | | |
| **Herring Gull** | | |
| Mudflat B1 | 7 | 8 |
| *Mudflat B2* | 7 | 0 |
| *Mudflat B3* | 29 | 14 |
| Mudflat B4 | 181 | 31 |
| *Mudflat B5* | 2 | 0 |
| | | |
| **Great Black-backed Gull** | | |
| Mudflat B1 | 0 | 0 |
| *Mudflat B2* | 0 | 0 |
| *Mudflat B3* | 5 | 0 |
| Mudflat B4 | 5 | 2 |
| *Mudflat B5* | 0 | 0 |

**Table 3.3** Continued.

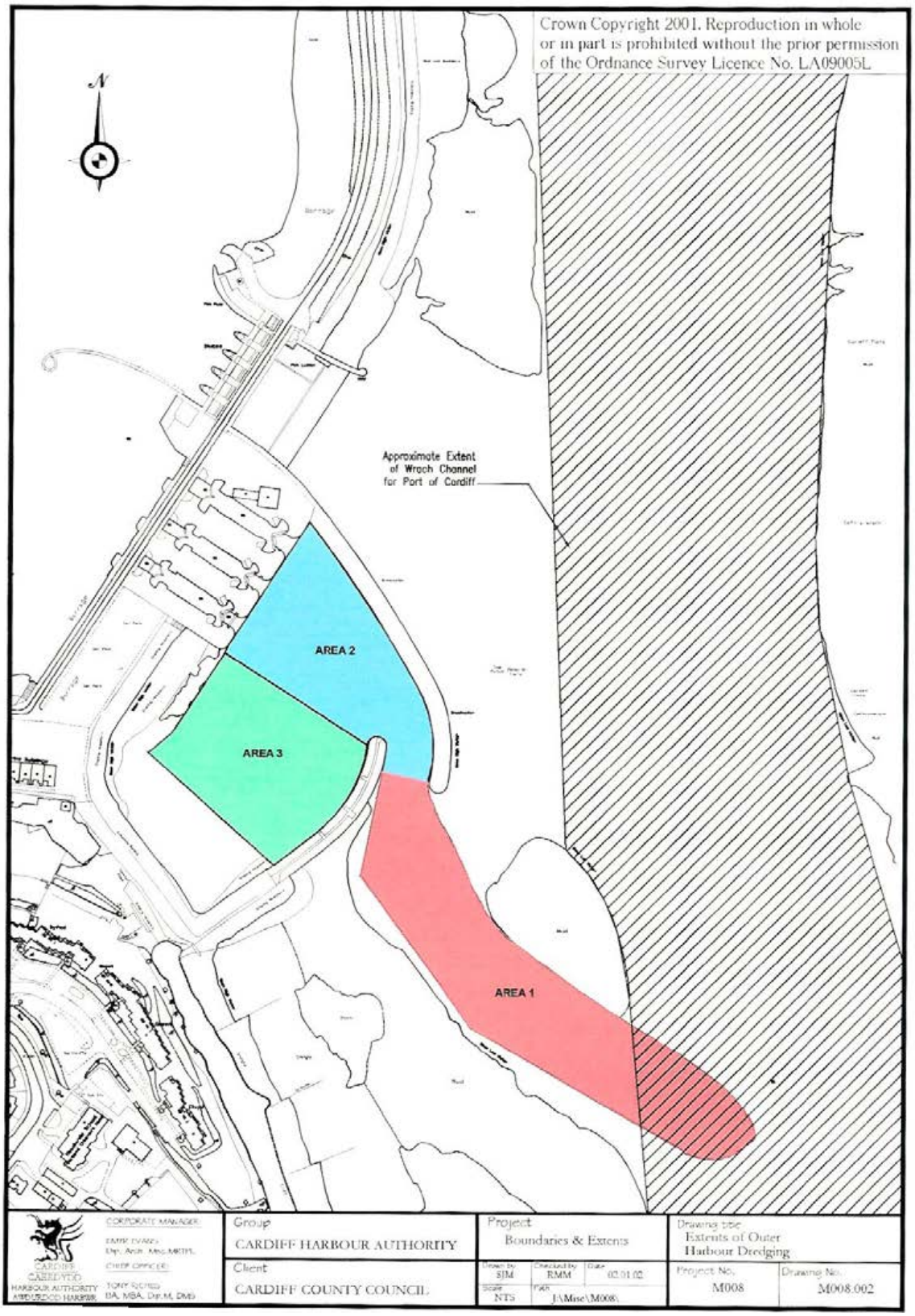


**Figure 2.1** The Cardiff Bay barrage showing areas subject to maintenance dredging.

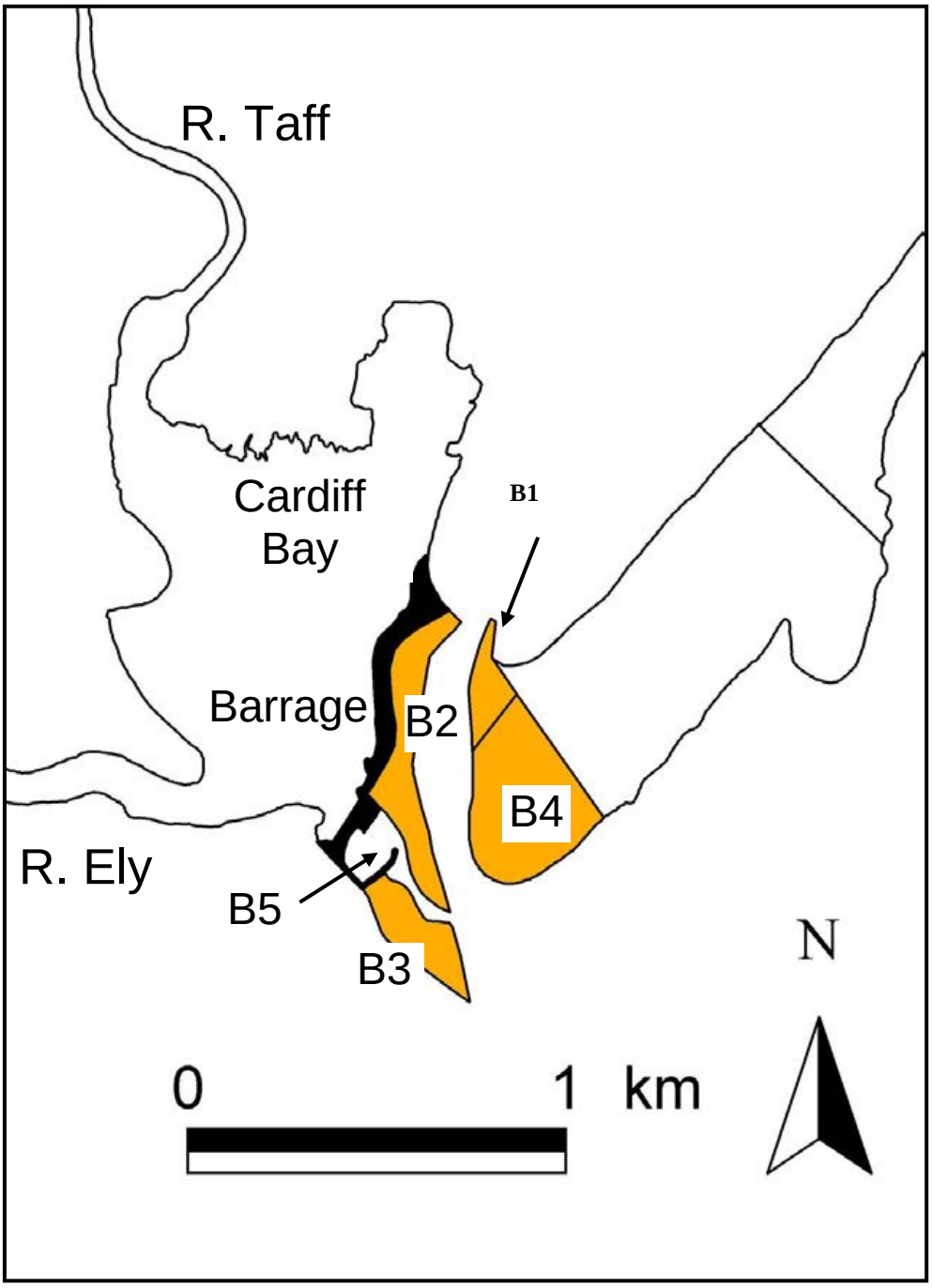


**Figure 2.2** The Cardiff Bay barrage showing numbered mudflat count areas (shaded) monitored between August 2001 and March 2009.

**Appendix 1** National importance thresholds for waterbird species referred to in this report (taken from Holt *et al.* 2011).

| | |
|---|---|
| Mute Swan *Cygnus olor* | 320 |
| Bewick's Swan *Cygnus columbianus* | 70 |
| Shelduck *Tadorna tadorna* | 610 |
| Mallard *Anas platyrhynchos* | 6,800 |
| Pintail *Anas acuta* | 290 |
| Shoveler *Anas clypeata* | 180 |
| Cormorant *Phalacrocorax carbo* | 350 |
| Coot *Fulica atra* | 1,800 |
| Oystercatcher *Haematopus ostralegus* | 3,200 |
| Ringed Plover *Charadrius hiaticula* | 340 |
| Dunlin *Calidris alpina* | 3,500 |
| Curlew *Numenius arquata* | 1,400 |
| Redshank *Tringa totanus* | 1,200 |
| Black-headed Gull *Larus ridibundus* | 22,000 |
| Common Gull *Larus canus* | 7,000 |
| Lesser Black-backed Gull *Larus fuscus* | 1,200 |
| Herring Gull *Larus argentatus* | 7,300 |
| Great Black-backed Gull *Larus marinus* | 760 |

* 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.