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The Effects on Waterbirds of Dredging at the Cardiff Bay Barrage Report for 2001/2002

Authors

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EXECUTIVE SUMMARY

1. This report investigates the potential impact of maintenance dredging on the birds utilising mudflats within and adjoining the outer harbour of the Cardiff Bay barrage and updates results reported in January 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 and, during the period of study, between 15 February and 12 March 2002, and 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. The ornithological significance of the mudflats that adjoin the barrage is assessed 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.

4. Only five of the 10 species of wildfowl and wader recorded between 1990/91 and 1993/94 on the mudflats that were subsequently dissected by the barrage were seen on the equivalent mudflats between August 2001 and March 2002. These were Shelduck, Mallard, Oystercatcher, Curlew and Redshank. In addition, the mudflats were utilised by Cormorants, Black-headed, Lesser Black-backed and Herring Gulls, a single Mute Swan and a single Great Black-backed Gull.

5. Densities of Shelduck, Mallard, Oystercatcher, Curlew and Redshank were also between 38 and 99% lower on these mudflats than in the four years prior to construction of the barrage in 1994. Thus, it is clear that much of the study area's value has been lost due to the building of the barrage and the displacement of intertidal waterbirds from the bay.

6. Although the overall numbers of wildfowl and waders using the mudflats affected by dredging are now very low, average low tide densities of Curlew were not dissimilar to those on comparative areas of mudflat, whilst Mallard and Redshank only occurred on the mudflats by the barrage. Densities of Cormorants and gulls on these comparative mudflats were considerably higher, however.

7. In view of the similarity in the densities of most waders and wildfowl using the mudflats by the barrage and those surveyed for comparison, it is reasonable to conclude that the dredging undertaken prior to the start of counts has had no long-term impact on these species.

8. Following the dredging undertaken between 15 February and 12 March 2002, there was a decrease in the numbers of Mallard, Black-headed Gull and Lesser Black-backed Gull using the mudflats by the barrage. However, the fall in these species' numbers would have been partly or wholly due to movements of birds away from the area to breeding grounds elsewhere.

9. This report will be updated again in March 2003 following the completion of counts through 2002 and over the winter of 2002/03 and a further assessment made of the impacts of dredging.

1. INTRODUCTION

This report investigates the impact of maintenance dredging on the birds utilising mudflats within and adjoining the outer harbour of the Cardiff Bay barrage and updates results reported in January 2002 (Burton & Clark 2002). 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 and, during the period of study, between 15 February and 12 March 2002. In future dredging will typically take place twice a year, usually in February and August.

The ornithological significance of these mudflats is assessed 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 and waders) 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.* 2001). (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

2.1 Analysis of Historic Datasets

The mudflats that now adjoin the Cardiff Bay barrage historically formed part of the intertidal mudflats of the bay and the waterbirds that used them were monitored by the BTO as part of the programme set up to investigate the impacts of the bay's impoundment. Counts of the intertidal mudflats began in 1989 and continued until barrage-closure in November 1999. To facilitate counting, the intertidal area was divided into 19 count areas. Three of these were subsequently dissected by the construction of the barrage – mudflats A1, A5 and A18 (Fig. 2.1.1). Birds were counted on the mudflats at hourly intervals through two complete tidal cycles per month (with the exception of April when just a single count took place) from August to May each year (Burton *et al.* 2001). The counts included wildfowl and waders, but not other waterbirds or gulls.

To provide a comparison with the densities and numbers of birds recorded on the mudflats by the barrage between August 2001 and March 2002, the mean densities (birds/ha) of birds using mudflats A1, A5 and A18 at low tide were calculated for each complete autumn and winter (August to March) prior to the start of barrage construction in 1994, i.e. from 1990/91 to 1993/94. (The mudflats at the mouth of the bay were only exposed for a few hours around low tide.) Estimated numbers of birds using those areas of mudflat that lay beyond the future position of the barrage were then also calculated. These areas comprised 7.8 ha (21%) of the 37.6 ha of mudflats A1, A5 and A18.

2.2 Waterbird Monitoring between August 2001 and March 2002

Figure 2.2.1 shows the areas subject to maintenance dredging and Figure 2.2.2, the numbered mudflat count areas surveyed between August 2001 and March 2002. 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 and gulls using mudflats B1-B4 were counted at hourly intervals (relative to low water) over the time that the mudflats were exposed, twice a month from August 2001 to March 2002. (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 twice a month at low tide and high tide from October 2001.

Gulls and Cormorants *Phalacrocorax carbo* were first monitored in September 2001.

The mean numbers and densities of waterbirds and gulls recorded on mudflats B1-B5 at low tide are tabulated for comparison with the historic data. 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 March 2002, which were collected after the period of dredging from 15 February to 12 March (see Appendix 2), are also listed separately in these tables. By tabulating the data in this way, it is possible to assess whether numbers of birds following the dredging differed from the average for the autumn and winter as a whole.

3. RESULTS

3.1 Analysis of Historic Datasets

Table 3.1.1 shows the mean densities of waterbirds recorded at low tide in the autumns and winters from 1990/91 to 1993/94 on mudflats A1, A5 and A18 of Cardiff Bay, i.e. those that were subsequently dissected by the building of the barrage. The table also indicates the numbers of birds that would have been found on those areas of mudflat that, though part of the bay's intertidal area, lay beyond the future position of the barrage. (In calculating these figures, it is assumed that birds were evenly distributed across the three mudflats).

In total, 10 wildfowl and wader species were recorded in autumn on these three mudflats prior to the start of construction work on the barrage: Shelduck, Mallard *Anas platyrhynchos*, Teal *Anas crecca*, Pochard *Aythya ferina*, Oystercatcher *Haematopus ostralegus*, Ringed Plover *Charadrius hiaticula*, Grey Plover *Pluvialis squatarola*, Dunlin, Curlew *Numenius arquata* and Redshank. Redshank were the most numerous (density = 0.9 birds/ha), whilst Shelduck and Dunlin also occurred in densities of around 0.6 birds per hectare.

3.2 Waterbird Monitoring between August 2001 and March 2002

Table 3.2.1 reports the mean numbers and densities of waterbirds and gulls recorded on mudflats B1-B5 at low water between August 2001 and March 2002 and Table 3.2.2, numbers and densities using 'mudflat' B5 at high tide. Table 3.2.3 indicates the overall usage of mudflats B1-B4 through the tidal cycle and Table 3.2.4, the peak numbers of birds recorded on each mudflat.

Only five of the 10 wildfowl and wader species recorded on mudflats A1, A5 and A18 prior to barrage construction were seen at low tide on the equivalent mudflats, B2, B3 and B5, between August 2001 and March 2002. These were Shelduck, Mallard, Oystercatcher, Curlew and Redshank. In addition, one Mute Swan *Cygnus olor* was recorded by mudflat B2 in January. Comparison between Tables 3.1.1 and 3.2.1 also indicates that the average densities of all of the above species were lower on mudflats B2, B3 and B5 than those previously recorded on mudflats A1, A5 and A18. Prior to barrage construction, densities of 0.62 Shelduck, 0.13 Mallard, 0.03 Oystercatcher, 0.14 Curlew and 0.90 Redshank per ha were recorded at low tide, whilst between August 2001 and March 2002 there were densities of only 0.02, 0.08, 0.01, 0.05 and 0.01 respectively.

The mudflats to be affected by dredging (B2, B3 and B5) also held Black-headed Gulls *Larus ridibundus* and Lesser Black-backed Gulls *L. fuscus*, occasional Herring Gulls *L. argentatus* in March, and on one date in February, a single Great Black-backed Gull *L. marinus*. Black-headed and Lesser Black-backed Gulls utilised all three mudflats, whilst mudflat B5 was particularly favoured by Mallard. Cormorants, Shelduck and Curlew were also recorded on all three mudflats, Redshank on mudflats B2 and B5 and Oystercatchers on mudflat B3. Gulls were particularly associated with the channel and seaward edge of mudflats, whilst wildfowl and waders were found higher up the mudflats. The overwhelming majority of the birds that were recorded on these mudflats were feeding.

Table 3.2.1 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 were not affected by the building of the barrage and will not be affected by dredging. Densities of Curlew were similar on each set of mudflats. In contrast, neither Mallard nor Redshank were recorded on either mudflat B1 or B4 at low tide. Shelduck and Oystercatcher, though, were recorded in greatest densities on mudflats B1 and B4 respectively.

In comparison to mudflats B2, B3 and B5, mudflats B1 and B4 held much higher densities of Cormorants and Black-headed, Lesser Black-backed and Herring Gulls. In addition, these mudflats also supported Common Gulls *Larus canus*.

There were no consistent differences in the numbers and densities of birds recorded on mudflats B2, B3 and B5 in March 2002 after the dredging over the previous month and those for the winter as a whole.

Low tide densities of the most numerous species – Mallard, Black-headed Gull and Lesser Black-backed Gull – were lower in March, though Shelduck and Curlew densities increased and Herring Gulls were recorded on the mudflats for the first time.

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

Six waterbird species – Mute Swan, Shelduck, Mallard, Oystercatcher, Curlew and Redshank – and four species of gull – Black-headed Gull, Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull – were recorded between August 2001 and March 2002 on the mudflats by the Cardiff Bay barrage affected by dredging. Only Mute Swan, Herring Gull and Great Black-backed Gull had not been recorded on these mudflats in the autumn (Burton & Clark 2002).

Densities of Shelduck, Mallard, Oystercatcher, Curlew and Redshank were between 38 and 99% lower on these mudflats than on equivalent mudflats in the four years prior to construction of the barrage. In addition, five species of wildfowl and wader recorded in those years were absent. It should also be noted that the mudflats of the bay formerly held much higher densities than those recorded on the comparative areas of mudflat (B1 and B4) beyond its mouth. It is clear, therefore, that much of the study area's value has been lost due to the building of the barrage and the displacement of intertidal waterbirds from the bay (Burton *et al.* 2001).

Although the overall numbers of wildfowl and waders using the mudflats affected by dredging are now very low, average low tide densities of Curlew were not dissimilar to those on comparative areas of mudflat, whilst Mallard and Redshank only occurred on the mudflats by the barrage at low tide. Lesser Black-backed Gulls were most numerous in September and declined thereafter, as birds moved away from their breeding colonies within Cardiff and on Steep Holm and Flat Holm (Poulding 1954).

In view of the similarity in the densities of most waders and wildfowl using the mudflats by the barrage and those surveyed for comparison, it is reasonable to conclude that the dredging undertaken prior to the start of counts has had no long-term impact on these species. Following the dredging undertaken between 15 February and 12 March 2002, however, 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 should be noted, though, that the fall in these species' numbers would have been partly or wholly due to movements of birds away from the area to breeding grounds elsewhere. The food resources taken by gulls foraging on the open water within the outer harbour should be largely unaffected by dredging and so their numbers should return to their previous levels next autumn as birds return to the area to overwinter. Mallard should also return as mudflats reform, provided that their vegetable and invertebrate food supplies are not diminished (though it should be noted that the levels of these resources are not being measured).

The numbers of birds which might be affected by dredging are very small in relation to the substantial populations found locally (see Burton *et al.* 2001). Further monitoring will determine if there are any impacts on birds over the forthcoming year.

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	1990/91		1991/92		1992/93		1993/94		**All Years**	
	n	d	n	d	n	d	n	d	**n**	**d**
SU	5.96	0.76	4.52	0.58	6.53	0.84	2.32	0.30	**4.84**	**0.62**
MA	0.26	0.03	0.91	0.12	2.11	0.27	0.82	0.10	**1.02**	**0.13**
T.	0.13	0.02	1.54	0.20	1.36	0.17	2.06	0.26	**1.27**	**0.16**
PO	0.00	0.00	0.00	0.00	0.21	0.03	0.06	0.01	**0.07**	**0.01**
OC	0.16	0.02	0.08	0.01	0.36	0.05	0.39	0.05	**0.25**	**0.03**
RP	0.00	0.00	0.05	0.01	0.05	0.01	0.00	0.00	**0.03**	**0.00**
GV	0.55	0.07	0.00	0.00	0.00	0.00	0.00	0.00	**0.14**	**0.02**
DN	3.15	0.40	3.02	0.39	0.56	0.07	14.26	1.83	**5.25**	**0.67**
CU	1.15	0.15	0.79	0.10	1.17	0.15	1.32	0.17	**1.11**	**0.14**
RK	9.52	1.22	5.63	0.72	7.43	0.95	5.64	0.72	**7.05**	**0.90**

Table 3.1.1 Mean low tide densities (d) (birds/ha) and estimated numbers (n) of waterbirds using those areas of mudflats A1, A5 and A18 of Cardiff Bay, which lay beyond the future position of the barrage.

Data are taken from 1990/91 to 1993/94. SU = Shelduck, MA = Mallard, T. = Teal, PO = Pochard, OC = Oystercatcher, RP = Ringed Plover, GV = Grey Plover, DN = Dunlin, CU = Curlew, RK = Redshank.

	August-March		March	
	n	d	n	d
CA				
Mudflat B2	0.1	0.01	0.0	0.00
Mudflat B3	0.0	0.00	0.0	0.00
Mudflat B5	0.0	0.00	0.0	0.00
Mudflat B1	0.4	0.09	0.0	0.00
Mudflat B4	5.4	0.27	4.0	0.20
Mudflats B2, B3, B5	**0.1**	**0.00**	**0.0**	**0.00**
Mudflats B1, B4	**5.8**	**0.24**	**4.0**	**0.16**
MS				
Mudflat B2	0.1	0.01	0.00	0.00
Mudflat B3	0.0	0.00	0.00	0.00
Mudflat B5	0.0	0.00	0.00	0.00
Mudflat B1	0.0	0.00	0.00	0.00
Mudflat B4	0.0	0.00	0.00	0.00
Mudflats B2, B3, B5	**0.1**	**0.00**	**0.00**	**0.00**
Mudflats B1, B4	**0.0**	**0.00**	**0.00**	**0.00**
SU				
Mudflat B2	0.1	0.01	0.0	0.00
Mudflat B3	0.3	0.04	1.0	0.14
Mudflat B5	0.0	0.00	0.0	0.00
Mudflat B1	1.8	0.38	4.5	0.94
Mudflat B4	0.0	0.00	0.0	0.00
Mudflats B2, B3, B5	**0.7**	**0.02**	**1.0**	**0.05**
Mudflats B1, B4	**1.8**	**0.07**	**4.5**	**0.18**
MA				
Mudflat B2	0.5	0.04	0.0	0.00
Mudflat B3	0.2	0.03	0.0	0.00
Mudflat B5	1.2	0.35	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	**1.9**	**0.08**	**0.0**	**0.00**
Mudflats B1, B4	**0.0**	**0.00**	**0.0**	**0.00**
OC				
Mudflat B2	0.0	0.00	0.0	0.00
Mudflat B3	0.1	0.02	0.0	0.00
Mudflat B5	0.0	0.00	0.0	0.00
Mudflat B1	0.0	0.00	0.0	0.00
Mudflat B4	0.6	0.03	0.5	0.03
Mudflats B2, B3, B5	**0.1**	**0.01**	**0.0**	**0.00**
Mudflats B1, B4	**0.6**	**0.02**	**0.5**	**0.02**
CU				
Mudflat B2	0.4	0.04	2.0	0.17
Mudflat B3	0.6	0.08	1.0	0.14
Mudflat B5	0.0	0.00	0.0	0.00
Mudflat B1	0.4	0.09	0.0	0.00
Mudflat B4	0.9	0.04	0.0	0.00
Mudflats B2, B3, B5	**1.0**	**0.05**	**3.0**	**0.14**
Mudflats B1, B4	**1.3**	**0.05**	**0.0**	**0.00**

	August-March		March	
	n	d	n	d
RK				
Mudflat B2	0.1	0.01	0.00	0.00
Mudflat B3	0.0	0.00	0.00	0.00
Mudflat B5	0.1	0.03	0.00	0.00
Mudflat B1	0.0	0.00	0.00	0.00
Mudflat B4	0.0	0.00	0.00	0.00
Mudflats B2, B3, B5	**0.2**	**0.01**	**0.00**	**0.00**
Mudflats B1, B4	**0.0**	**0.00**	**0.00**	**0.00**
BH				
Mudflat B2	5.7	0.48	0.0	0.00
Mudflat B3	4.6	0.66	0.0	0.00
Mudflat B5	9.3	2.80	0.0	0.00
Mudflat B1	1.2	0.25	1.5	0.31
Mudflat B4	43.6	2.20	0.0	0.00
Mudflats B2, B3, B5	**19.6**	**0.88**	**0.0**	**0.00**
Mudflats B1, B4	**44.8**	**1.82**	**1.5**	**0.06**
LB				
Mudflat B2	6.2	0.52	1.0	0.08
Mudflat B3	1.9	0.28	1.0	0.14
Mudflat B5	0.8	0.25	1.5	0.45
Mudflat B1	1.7	0.36	1.0	0.21
Mudflat B4	46.9	2.37	9.0	0.45
Mudflats B2, B3, B5	**8.9**	**0.40**	**3.5**	**0.16**
Mudflats B1, B4	**48.6**	**1.98**	**10.0**	**0.41**
HG				
Mudflat B2	0.0	0.00	0.0	0.00
Mudflat B3	0.9	0.12	6.0	0.86
Mudflat B5	0.0	0.00	0.0	0.00
Mudflat B1	0.2	0.04	1.5	0.31
Mudflat B4	5.9	0.30	5.5	0.28
Mudflats B2, B3, B5	**0.9**	**0.04**	**6.0**	**0.27**
Mudflats B1, B4	**6.1**	**0.25**	**7.0**	**0.28**
GB				
Mudflat B2	0.1	0.01	0.00	0.00
Mudflat B3	0.0	0.00	0.00	0.00
Mudflat B5	0.0	0.00	0.00	0.00
Mudflat B1	0.0	0.00	0.00	0.00
Mudflat B4	0.1	0.01	0.00	0.00
Mudflats B2, B3, B5	**0.1**	**0.00**	**0.00**	**0.00**
Mudflats B1, B4	**0.1**	**0.01**	**0.00**	**0.00**

Table 3.2.1 Mean low tide numbers (n) and densities (d) (birds/ha) of waterbirds and gulls using mudflats near the Cardiff Bay barrage at low tide between August 2001 and March 2002, and in March 2002 alone.

Only species recorded 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, HG = Herring Gull, LB = Lesser Black-backed Gull, GB = Great Black-backed Gull.

	October-March		March	
	Number	Density	Number	Density
CA	0.2	0.05	0.0	0.00
SU	0.2	0.05	1.0	0.30
MA	2.9	0.88	0.5	0.15
CU	0.1	0.03	0.0	0.00
BH	29.0	8.79	0.0	0.00
LB	0.3	0.08	0.0	0.00

Table 3.2.2 Mean high tide numbers and densities (birds/ha) of waterbirds and gulls using 'mudflat' B5 within the outer harbour of the Cardiff Bay barrage between October 2001 and March 2002, and in March 2002 alone.

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

	August-March	March
CA		
Mudflat B2	1.2	0.0
Mudflat B3	0.2	0.0
Mudflat B1	1.9	0.0
Mudflat B4	9.2	9.5
MS		
Mudflat B2	0.1	0.0
Mudflat B3	0.0	0.0
Mudflat B1	0.0	0.0
Mudflat B4	0.0	0.0
SU		
Mudflat B2	0.8	0.0
Mudflat B3	1.2	4.0
Mudflat B1	2.9	10.0
Mudflat B4	3.1	1.0
MA		
Mudflat B2	0.9	1.5
Mudflat B3	0.8	0.0
Mudflat B1	0.4	3.0
Mudflat B4	0.0	0.0
OC		
Mudflat B2	0.0	0.0
Mudflat B3	0.8	3.0
Mudflat B1	0.0	0.0
Mudflat B4	1.2	0.5
CU		
Mudflat B2	1.5	5.5
Mudflat B3	3.9	6.0
Mudflat B1	1.1	0.0
Mudflat B4	5.0	0.0

	August-March	March
RK		
Mudflat B2	2.4	0.0
Mudflat B3	0.0	0.0
Mudflat B1	0.0	0.0
Mudflat B4	0.1	0.0
BH		
Mudflat B2	50.9	1.5
Mudflat B3	17.6	8.5
Mudflat B1	23.4	63.5
Mudflat B4	177.7	10.0
LB		
Mudflat B2	18.1	2.0
Mudflat B3	21.9	4.5
Mudflat B1	6.5	7.5
Mudflat B4	176.5	14.5
HG		
Mudflat B2	0.1	0.5
Mudflat B3	3.7	26.0
Mudflat B1	1.8	12.0
Mudflat B4	20.2	11.0
GB		
Mudflat B2	0.1	0.0
Mudflat B3	0.0	0.0
Mudflat B1	0.0	0.0
Mudflat B4	0.9	0.0

Table 3.2.3 The mean number of bird hours per tidal cycle recorded on mudflats near the Cardiff Bay barrage between August 2001 and March 2002, and in March 2002 alone.

Only species recorded 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.

	August-March	March
CA		
Mudflat B2	3	0
Mudflat B3	1	0
Mudflat B5	1	0
Mudflat B1	5	0
Mudflat B4	14	6
MS		
Mudflat B2	1	0
Mudflat B3	0	0
Mudflat B5	0	0
Mudflat B1	0	0
Mudflat B4	0	0
SU		
Mudflat B2	11	0
Mudflat B3	5	2
Mudflat B5	2	2
Mudflat B1	20	6
Mudflat B4	13	2
MA		
Mudflat B2	5	3
Mudflat B3	3	0
Mudflat B5	12	1
Mudflat B1	2	2
Mudflat B4	0	0
OC		
Mudflat B2	0	0
Mudflat B3	3	3
Mudflat B5	0	0
Mudflat B1	0	0
Mudflat B4	3	1
CU		
Mudflat B2	2	2
Mudflat B3	2	2
Mudflat B5	1	0
Mudflat B1	4	0
Mudflat B4	7	0

	August-March	March
RK		
Mudflat B2	5	0
Mudflat B3	0	0
Mudflat B5	1	0
Mudflat B1	0	0
Mudflat B4	1	0
BH		
Mudflat B2	125	2
Mudflat B3	22	9
Mudflat B5	115	0
Mudflat B1	82	82
Mudflat B4	180	14
LB		
Mudflat B2	39	2
Mudflat B3	54	5
Mudflat B5	5	2
Mudflat B1	18	9
Mudflat B4	205	11
HG		
Mudflat B2	1	1
Mudflat B3	8	8
Mudflat B5	0	0
Mudflat B1	12	12
Mudflat B4	40	7
GB		
Mudflat B2	1	0
Mudflat B3	0	0
Mudflat B5	0	0
Mudflat B1	0	0
Mudflat B4	2	0

Table 3.2.4 Peak numbers of waterbirds and gulls recorded on mudflats near the Cardiff Bay barrage between August 2001 and March 2002, and in March 2002 alone.

Only species recorded 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.

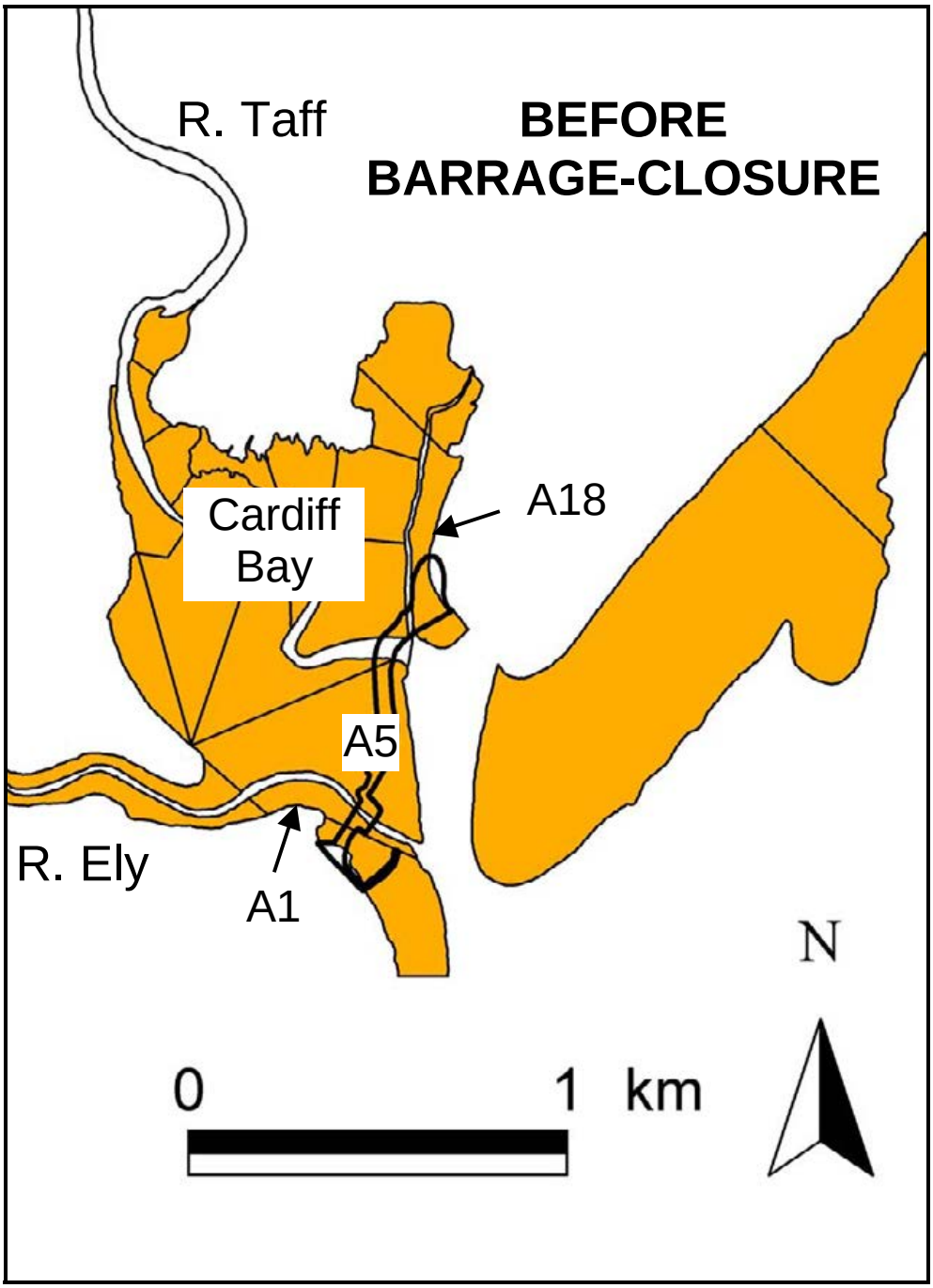

Figure 2.1.1 Cardiff Bay prior to barrage-closure showing numbered mudflat count areas subsequently dissected by the Barrage (highlighted in bold).

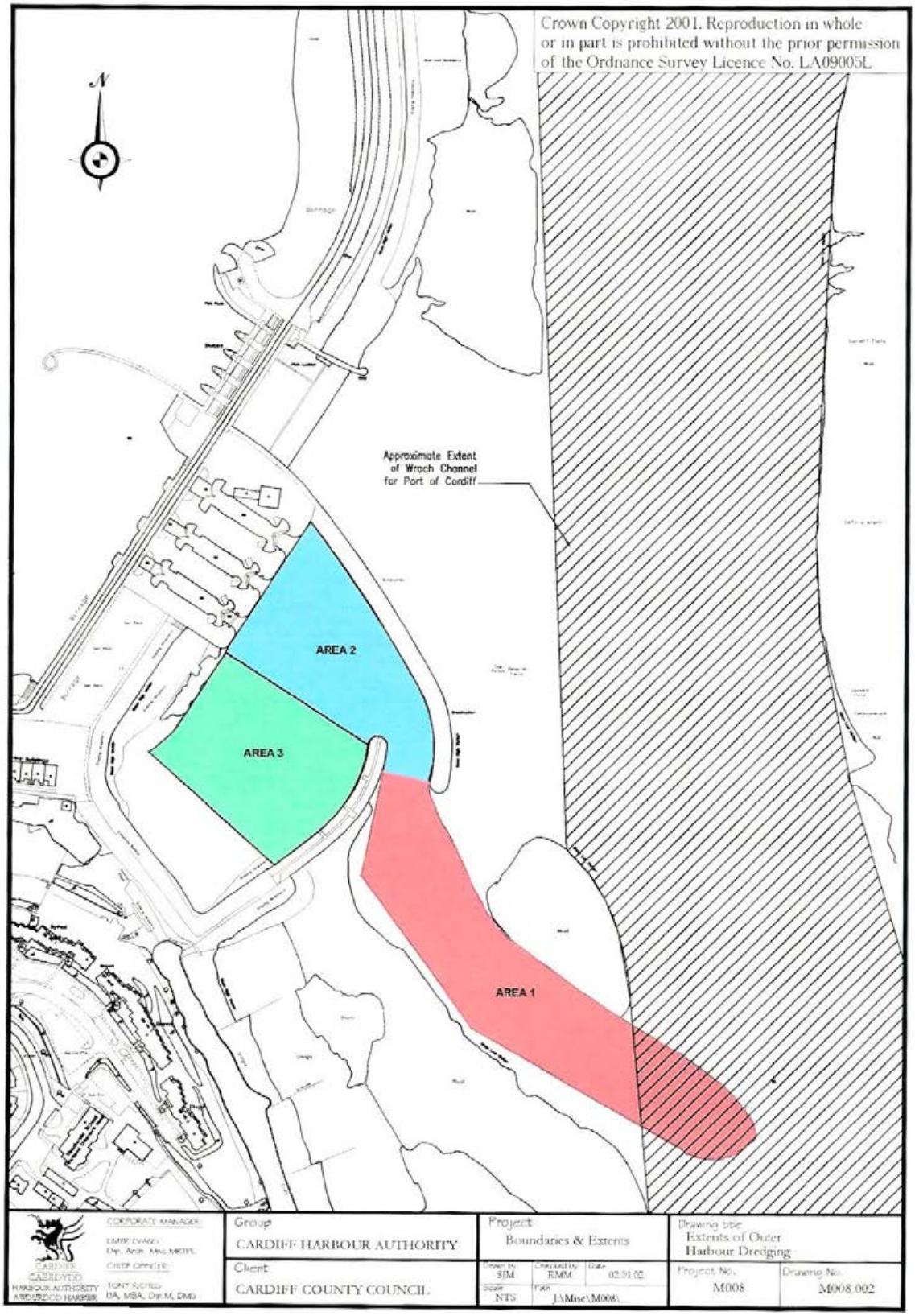

Figure 2.2.1 The Cardiff Bay Barrage showing areas (shaded grey) subject to maintenance dredging.

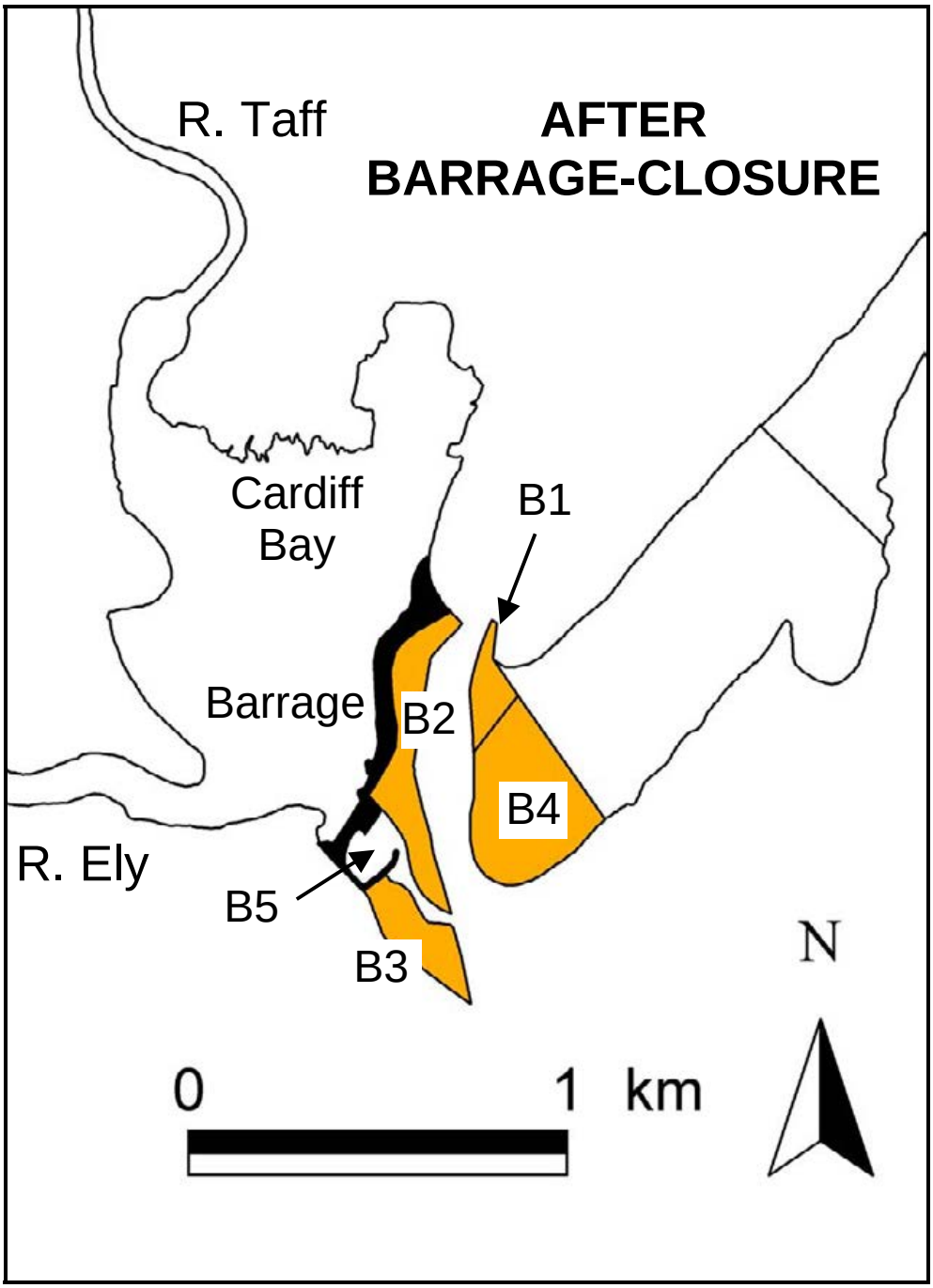

Figure 2.2.2 The Cardiff Bay Barrage showing numbered mudflat count areas (shaded grey) used between August and November 2001.

Appendix 1 National importance thresholds for waterbird and gull 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
Teal *Anas crecca*	1400
Mallard *Anas platyrhynchos*	5000
Pochard *Aythya ferina*	440
Oystercatcher *Haematopus ostralegus*	3600
Ringed Plover *Charadrius hiaticula*	290
Grey Plover *Pluvialis squatarola*	430
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 between August 2001 and March 2002.

20-23 August 2001
16-18 September 2001
8-13 October 2001
13-17 November 2001
12-16 December 2001
11-15 January 2002
4-9 February 2002
18-22 March 2002