British Trust for Ornithology

BTO Research Report No. 116

THE ROOSTING BEHAVIOUR OF WADERS AND WILDFOWL IN CARDIFF BAY: WINTER 1992/93

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May 1993

Report of work carried out by
The British Trust for Ornithology
under contract to
Cardiff Bay Development Corporation

LIST OF CONTENTS

Page No

LIST OF TABLES AND FIGURES

Page No.

EXECUTIVE SUMMARY

1.This is the third study, commissioned and funded by Cardiff Bay Development Corporation, to examine changes in the pattern of roosting behaviour of waders and wildfowl in Cardiff Bay.

2.The aim of the present study was to examine the specific effects of Phase 1 and Phase 2 saltmarsh reclamation that has been completed so far. The use of the alternative high tide roost sites that were created in 1991/92 was monitored.

3.Intensive observations of high tide roosts were made during the autumn and winter of 1991/92. Further observations obtained from work being undertaken by the BTO on the distribution of feeding birds were used where these were relevant. This latter work is also funded by CBDC.

4.Further changes to areas previously used as roost sites was noted as well as increased disturbance of other roost areas. The new pattern of roosting and the use of different areas was assessed. The pattern of behaviour was related to the species and the height of the tide.

5.The species that roost in the bay have continued to adapt to the change of available roost sites. The artificial high tide roost island has become one of the most important roost sites on high spring tides. The floating platform roost was damaged by fire in early autumn considerably reducing its potential usefulness.

6.Redshank continued to be the species most likely to be affected by the engineering work in the bay. Two of the gathering and roosting sites regularly used by Redshank in previous years have been subjected to change or increased disturbance. This species was found to use two new areas for gathering, pre-roosting and roosting when they remained uncovered. One previously used area of saltmarsh has become more important for roosting Redshank as nearby areas have become disturbed. This site will be affected by Phase 2a development work.

7.At high spring tides, the artificial roost island remained the preferred area for roosting and was used by all species that roosted on terrestrial sites. When saltmarsh sites were covered, all of the Redshank and Curlew feeding in the bay roosted on the artificial roost island. Curlew that fed on areas adjacent to Cardiff Bay flew into the bay to roost, using the artificial roost island on higher spring tides. The number of Curlew roosting in the bay has increased compared with the previous study. Most of the Dunlin that fed in the bay left to roost at high tide. Those remaining roosted with the Redshank, using the artificial roost island on high tides.

8.Phase 2 reclamation work will change some roost sites. Further monitoring will be necessary to assess the adaptability of waders to the loss of roosting habitat.

1. INTRODUCTION

The aim of this project was to assess the effects further Phase 1 and 2 development and Peripheral Distributor Road (PDR) works on roosting behaviour of waders and wildfowl in Cardiff Bay. This is the third report on such roosting behaviour.

Some of the theoretical aspects of roosting behaviour have been discussed and reviewed in the previous reports (Donald & Clark, 1991a; Toomer & Clark, 1992a). Waders or wildfowl feeding on mudflats that become covered at high tide must cease feeding unless they have alternative feeding grounds away from the shore. To avoid unnecessary energy expenditure at these times, birds usually roost. Roosting is not essential if food intake has to continue to balance a bird's energy. For instance, Redshank have been observed to continue feeding over the high tide period on nearby fields on the Ythan estuary during the day light, without roosting during a 24 hour period (Goss-Custard, 1969).

Birds roost so as to expend as little energy as possible until feeding can resume on the falling tide. The choice of site for roosting varies with species and is inevitably a balance between security of the site from disturbance and predators and distance from the feeding grounds. Flying to sites at some distance from feeding areas involves energy expenditure which can be considerable at times. Dunlin have been recorded flying 17km across the Severn estuary to roost (Clark, 1990) and Knot moved from roost sites because of disturbance to new areas over 20km away (Mitchell *et al.*, 1988). In the latter case, this involved a 14% increase of the total daily energy expenditure. In contrast, Redshank require a secure roost site close to their feeding grounds. The availability of a new secure roost has been shown to result in an increase in the number of feeding birds in an area (Furness, 1973). Different species have different specific requirements of roost sites. Curlew will tolerate taller saltmarsh vegetation as they are relatively large waders and can find shelter while maintaining vigilance for predators, whereas birds such as Ringed Plover choose shingle shores with stones of a specific size to allow some shelter without loss of visibility (Ferns, 1992).

The success of an area for wintering waders and wildfowl is therefore as much dependent on availability of suitable roost sites as of feeding areas.

The success of the provision of a secure high tide roost area was discussed in the previous report. The continued effectiveness of this and of other measures is documented below.

2. METHODS

To enable direct comparison between years, the methods used for the current study were the same as those described in the two previous reports. They will be described again here for completeness, although it is recommended that this report is read in conjunction with the reports for the winters of 1990/91 and 1991/92 (Donald & Clark, 1991a; Toomer and Clark, 1992a).

During the period from December 1992 to March 1993, detailed observations were made on the formation of high tide roosts by waterfowl in Cardiff Bay. 15 days were chosen for intensive study during this period, allowing the monitoring of a wide range of tide heights. A further 11 less intensive observations were made during the autumn and winter of 1992/93. Together with general observations of the behaviour of the waders and wildfowl found in Cardiff Bay obtained during further work on the distribution and movement of these birds, these data produce a comprehensive picture of roosting behaviour for the autumn and winter of 1992/93.

The tide heights of the observation days ranged from 9.4m to 13.7m and included seven neap and eight spring tides for the fifteen intensive observations. (For Cardiff Bay, neap high tides are considered to be less than 10.85m above Chart Datum and spring tides over 10.85m above Chart Datum.) The less intensive observations were made mainly on spring tides in order to re-assess the effectiveness of the artificial high tide roost island. The proportions of tides of varying heights observed during the study are shown in Figure 2.1a and b.

For each intensive daytime observation, roost formation was monitored continuously from two hours preceding high tide to two hours after high tide. The high PDR mound on the west side of the River Taff afforded an excellent view over the north end of the bay and this was used as an observation point. All potential roost sites identified before the start of the study could be observed from there, other than the east side of the artificial high tide roost mound. It was, however, possible to monitor the movement of birds onto this roost site even though they were out of view once they had arrived there. To ensure that full and accurate observations were being made, for several high tides, an alternative observation point was used. This was from within the docks, east of the artificial roost mound. As roosts started to develop on the rising tide, their positions were recorded at 20 minute intervals. This was continued through the period of high tide until the roosts started to break up on the falling tide. For the additional observations, the positions of the final roosts at high tide was recorded. All other information relevant to roost formation, such as the weather and disturbance by birds of prey, was noted for each roost observation.

The actual tide height at high tide on each day of observation was obtained from the Harbour Master in Cardiff Docks. These values were also used in calculating the height of the tide for each 20 minute period with the aid of Admiralty conversion charts. This information was then used to determine which roost sites were used at different tide heights during the tidal cycle.

All roosting birds were noted but detailed observations were confined to those species that previous BTO fieldwork had shown to roost regularly in the bay ie. Redshank, Curlew, Dunlin, Teal and Shelduck. These species used areas that may be affected by the Phase 1 and Phase 2 land claim and the PDR construction work.

In addition to the day-time observations, the identified roosts were visited at night on a spring tide. Observations were confined to determining the location of a night-time roost and to the identification of the species involved, as counts were not practical.

3.RESULTS

Since the winter of 1990/91, considerable changes have taken place at the north end of Cardiff Bay. These changes are the result of land reclamation by infill on areas adjacent to Hamadryad Hospital and the west end of Windsor Esplanade and from the work associated with the PDR itself. The changes from autumn 1990 to autumn 1992 and the effect these have had on roosting birds have been documented by Donald & Clark, (1991a) and Toomer and Clark, (1992a). Further changes have resulted in continued changes in the pattern of roosting behaviour of the waders and wildfowl. One additional form of disturbance to roosting birds was the occurrence of low flying helicopters hovering over the bay, especially the northern part. Although helicopters have been observed in the previous winters, their presence has become more frequent. Birds such as Shelduck could roost on the open water when disturbed. This was not possible for all other species, which invariably returned to the eastern end of the saltmarsh or to the high tide roost island after flying around the bay for varying periods of time. This would put extra demands on the energy balance of such birds.

The roost sites identified in the two previous reports are reproduced in Figure 3.1a and b. Some of these areas are no longer used by roosting birds, while other areas have become new roost sites. The areas identified as roosting sites during the current study are shown in Figure 3.2.

The results are given below in two sections. Firstly, the current roost sites and any changes that have occurred to their nature and use by roosting birds since 1992 are described below. Secondly, details of the use of these sites by roosting birds is given in the species accounts (Section 3.2).

3.1 Roost Sites

Reference should be made to Figure 3.2.

Area A

This area has remained unchanged since autumn 1990.

It consists of the upper mudflats on the southern edge of the saltmarsh at the western end of Windsor Esplanade. Areas adjacent to the creeks from the saltmarsh remained uncovered on neap tides.

Most of the area was covered by tides in excess of 11.0m although there were raised muddy banks of the creek where it emerged from the saltmarsh which remained exposed for longer. These parts were particularly important as gathering areas for waders as the lower areas of mudflats became covered on the rising tide. Some Teal also pre-roosted there before swimming into the creek. When these banks remained uncovered at neap high tide several species would roost there, including Redshank, Dunlin, Oystercatchers and Cormorants. On falling spring tides, birds that returned to this area occasionally formed temporary roosts. This was a less common occurrence than had been observed in the two previous winters. This area remained virtually undisturbed.

Area B

The original area referred to as Area B in the 1991 report has undergone considerable change and been subjected to considerable disturbance. In the first report, this area was treated as one area. By the winter of 1991/92, the developing PDR works had divided it into two parts and covered some of the more frequently used parts of the saltmarsh and mudflats. For that report, the area was treated as two separate areas, Area B1 and Area B2 (Figure 3.1b). Further work associated with the PDR has virtually covered the Area referred to as B1 and it was no longer used by roosting birds.

The remaining area (Area B2 in the previous report), now just referred to as Area B, is an area of saltmarsh and creeks enclosed by the PDR bank on the eastern side of the River Taff and the western end of Windsor Esplanade.

Tides higher than 12.3m covered this section of the saltmarsh.

The muddy creeks within the saltmarsh and their banks were important sites for roosting waders and Teal on moderate spring tides that covered the mud on areas A and J but did not cover the saltmarsh. The larger creek at the eastern end of this area was especially important in the formation of these roosts. Birds moved onto the raised creek banks as the tide covered the mudflats where they would either pre-roost before moving further into the saltmarsh creek or remain there over the high tide period if the saltmarsh remained uncovered. This area remained relatively unaffected by the surrounding work so far, but future work of the Phase 2 land reclamation could both change and disturb this area. This should be monitored as the work commences. A large part of this area remained relatively free from disturbance, but the increase in work on the adjacent PDR has resulted in a large part of the western half of this area only being occasionally used by pre-roosting and roosting birds.

Area C

This area remains unchanged.

It is the saltmarsh south of Windsor Esplanade extending to the eastern extremity.
The whole of this area of saltmarsh was covered by tides higher than 13.0m.

This area was virtually free from disturbance. It was used mainly by Curlew and a limited number of Shelduck and Mallard on tides that covered the mud area adjacent to this part of the saltmarsh. This part of the saltmarsh was relatively high with taller vegetation and lacked any sizeable creeks. It is probably because of this that smaller waders did not use this area for roosting. Only occasionally were Dunlin and Redshank observed on this area. These occurrences coincided with times when roosts were disturbed by birds of prey or by helicopters. The raised south east edge of the saltmarsh of Area C was the part used by the displaced birds.

Area E

This is the artificial high tide roost island near the northeast end of Area C created in 1992. The area has been artificially raised and the surfaces graded. Natural and cut deep channels and raised banks protect this area from intrusion by humans at spring tides higher than 12.0m and from visibility from the shore.

This area remains uncovered at all heights of tide.

On high spring tides, when areas of saltmarsh were covered by the tide, the top and sloping surfaces were used by roosting waders and Shelduck. This newly modified area was an important roost area throughout the previous winter. There was virtually no disturbance of this area other than by helicopters and birds of prey.

Area F

This area was referred to as Area F1 in the last report and it has remained essentially unchanged.

It is the saltmarsh and adjacent mud in the corner formed where the PDR development on the western side of the River Taff meets Ferry Road. The upper reaches of this area remain uncovered on low and moderate neap tides. Waders and Shelduck that feed on the adjacent mudflats may form small roosts on the open mud or edges of the saltmarsh. The only changes resulted from more intensive work on the nearby PDR mound which caused increased disturbance.

Area G

This area has undergone considerable change since the previous report.

The large area of saltmarsh that existed then has been almost completely covered by the second stage of infill near the Hamadryad Hospital (Phase 2). A thin band of saltmarsh now remains adjacent to the raised mound of the infill. This strip of saltmarsh is covered by tides in excess of 13.0m. Together with the muddy raised bank of the River Taff, the area still acted as a roost site for a limited number of Redshank on some low neap tides. The sloping side of the infill, which remains uncovered by tides of all heights, was also used by Redshank and some Dunlin on three of the observation days. The amount of disturbance at the southern end of this area varied with the nature of the PDR work, but was considerable at times.

Area H

This area remained unchanged.

It consists of the rocky boulder strip adjacent to Ferry Road and the mud immediately to its east. The mud and boulders were covered by moderate neap tides but almost all tide heights left the sloping concrete side to Ferry Road uncovered.

Turnstones that fed along the seaweed covered stones roosted there and others would fly in

from feeding sites elsewhere.

Area I

This area was formed before the winter of 1991/92 as part of the Hamadryad infill site (Phase 1) and was used occasionally by roosting Lapwing flocks during that winter. Since then the surface has been raised considerably by further infilling work. This has altered the nature of the area and produced considerable disturbance. It was used by very small numbers of Lapwing on two days during the study period. It will not be considered further in this report.

Area J

This area remains unchanged.

It is the area of upper mudflats on the southern edge of the saltmarsh south of Windsor Esplanade (Area C).

It is covered by tides higher than 11.0m.

Curlew formed pre-roosts on this area as the rising tide gradually covered the adjacent areas of mudflats. Other birds were observed to use this area for pre-roosting less frequently than during the previous studies. The only disturbance was from birds of prey and helicopters.

Area K

Although birds have used this area in the past winters to a limited extent, the area has assumed more importance this winter.

It is the muddy creeks and adjacent mudflats on the side of the River Taff on the south side of the west PDR mound.

The creeks are full at tide heights greater than 9.4m and the adjacent mudflats are covered by tides in excess of 10.5m.

This area was used by waders that gathered on the bank of the River Taff on the rising tide. Dunlin and Redshank moved up the sides of the creek as the tide rises and eventually congregated on the flatter surface of the immediately adjacent mudflats before moving to other roosts. It was primarily used as a pre-roost area, although on low neap tides when this area remains uncovered at high tide, some of the Redshank and Dunlin remaining in the bay roosted there on several occasions. It was virtually free from disturbance.

Area L

This area has been used occasionally in previous winters as a gathering site for roosting birds but was more important in the 1992/93 winter.

It is the area of muddy creeks and associated saltmarsh edges immediately south of the artificial high tide roost island, Area E. This area is to the north of Area C, but because of its specific use must now be considered as a separate roost area. It was mainly used as an intermediate roost site on spring tides by Redshank and Dunlin that had moved from other areas. These birds then moved to the nearby Area E on high spring tides but were observed to remain on Area L throughout the high tide period on several occasions. This area was free from all disturbance other than birds of prey and helicopters.

Artificial Floating Roost Platform

This wooden platform with a raised area in the centre was anchored off of Ferry Road in March, 1992. Because of this timing, it was not possible to determine how effective it would be at the time of writing the previous report. During the autumn of 1992, as waders and wildfowl numbers built up in the bay, there was no evidence of it being adopted as a roost by these birds. Gulls and Cormorants used it regularly at high tide. Unfortunately, before the winter observations started, the platform suffered extensive fire damage. This resulted in the centre section being destroyed, leaving the ends to float at high tide. The platform continued to be used by gulls and Cormorants but it was not possible to determine how effective it might have been for waders and wildfowl.

Open Water

Variable proportions of the Shelduck, Teal and Mallard populations roosted on the open water of the bay. The size and positions of the roosting flocks varied with tide height. There was relatively little disturbance on the open water.

Roosts outside Cardiff Bay

Most of the birds that feed within the area of Cardiff Bay also roost there over high tide. The main exception continued to be Dunlin. Observations of nearby Sully Island to the west of Cardiff Bay as part of the BTO Birds of Estuary Enquiry showed that it continued to support large roosting flocks of Dunlin at high tide. Further discussion of the possible alternative roosts of Dunlin can be found in the previous reports (Donald & Clark, 1991a; Toomer and Clark, 1992a).

3.2 Species Accounts

The approximate numbers of waders and waterfowl that roosted over the high tide periods in Cardiff Bay during the autumn and winter of 1992/93 are shown in Table 3.2.1. These numbers are approximate means from the numbers counted on the observation days during the study period. Because of the position chosen by roosting flocks in creeks and amongst saltmarsh vegetation, exact counts of numbers was often difficult.

3.2.1 Shelduck

Shelduck return to Cardiff Bay in the early autumn to overwinter. They fed on the mudflats as they became exposed by the falling tide and continued to do so until the rising tide covers these areas again. Between 230-400 Shelduck roosted in the bay during the study period, compared with 300-450 in 1991/92. When the feeding grounds were covered, the majority of birds roosted on the open water, usually distributed around the north and west parts of the bay. Variable numbers of birds roosted on some of the roost areas identified in Figure 3.2. The sites used by the roosting Shelduck are shown in Figure 3.2.1.1. The use of these roost sites in relation to tide height is shown in Figure 3.2.1.2.

On neap tides when Areas A and J were not covered, 20-30 Shelduck were observed to cease feeding and roost there until the tide receded. Many of the birds remaining on these areas at this time, as well as many on the uncovered areas in front of Area H and Area F, continued feeding throughout the high tide period. On tides high enough to cover these feeding areas, some of the Shelduck moved further up the shore and onto the front edge of the saltmarsh, Area C. On spring tides over 11.6m, when the saltmarsh was beginning to become covered, Shelduck flew onto the artificial high tide roost, Area E. Some birds could also be found roosting here at lower tide heights. Most birds using Area E roosted on the top level surface, where they could roost sitting down, although there were always a few birds roosting on the sloping east side of the mound.

As observed in the previous winter, Shelduck would often continue to move from the water to Area E beyond the time of high tide, increasing the number of birds on this roost site. The number of Shelduck using this area during the study period usually ranged from 40-95.

The increased occurrence of helicopters in the bay, usually flying low, easily disturbed the Shelduck, which would take off, disturbing other species in turn. Disturbed shelduck could resort to roosting on the open water.

The only obvious change in pattern of roosting behaviour was the absence of roosting birds in front of Area H on low neap tides and the occasional use of the newly used roost site Area L. Areas E and C remain the most important land roost sites for Shelduck during spring and neap tides respectively.

3.2.2 Teal

There was very little change in the roosting behaviour of Teal compared with 1990/91 and 1991/92. A maximum of 440 Teal was observed roosting in the bay during the study period, a marked increase over the number observed in 1991/92. The roost sites regularly used by Teal are shown in Figure 3.2.2.1 and the use of these sites in relation to tide height is shown in Figure 3.2.2.2.

A preferred area for roosting before 1990/91 was the old South Glamorgan canal. Its use had been considerably reduced by the previous study. This area is one that has been completely covered by the Phase 2 landfill and the mound associated with the west

PDR bank (see Figures 3.1a, 3.1b and 3.2). Many of the Teal remained on the water over high tide. About half of the population roosted on terrestrial sites. As the tide rose, Teal gathered at the north end of the bay, near to the saltmarsh. Birds that roosted on land moved out of the water and collected on the raised muddy banks of the creeks that emerge from the saltmarsh. The creek banks produce raised muddy mounds on Area A, which were the last part of the mudflats in the bay to become covered. When the tide was of sufficient height to result in the covering of these raised banks, Teal moved further up the creek to roost on its bank or on the creek water. The movement of the Teal frequently preceded the covering of the muddy banks by some considerable time. Area J was used by a small number of birds on two neap tides during the study period. If the tide was high enough to partially inundate the saltmarsh, Teal remained there, roosting on the water amongst the vegetation. On high spring tides, when the saltmarsh in front of Windsor Esplanade became completely covered, most Teal took to the open water to roost, but 10-15 birds were found on the south sloping face of Area E on two occasions.

3.2.3 Dunlin

Ongoing studies for CBDC on the distribution of waders and wildfowl in Cardiff Bay have revealed a somewhat unpredictable pattern of behaviour of Dunlin in the bay (Evans *et al.*, 1990; Donald and Clark, 1991b; Toomer and Clark, 1992b; Toomer and Clark, 1993). In the previous study it was noted that variable numbers of Dunlin fed in the bay and of these, variable numbers roosted over high tide in a pattern apparently unrelated to tide height. The distribution of roost sites used over high tide on neap and spring tides and the use of these in relation to tide height is shown in Figure 3.2.3.1 and 3.2.3.2.

The number of Dunlin remaining in the bay over the high tide period ranged from less than 10 to in excess of 1000 birds. This was not related to the number of birds feeding in the bay. During the study period, up to 4,000 birds were found feeding in the bay, primarily on the mudflats on the west side of the River Taff, south of the PDR mound.

On neap tides, when the mudflats remained partially uncovered, at least part of the population of Dunlin continued to feed over the high tide period. On two such tides, between 1000-3000 birds remained in the bay on the mudflats to the north and east of Area F, on the edge of Area K. At any one time, part of this population was seen to have ceased feeding and to be roosting. The more usual pattern was for the feeding flock to move onto the upper banks of the River Taff near to the north side of sector 4 (Figure 3.2). Here a number of small creeks ran from the mudflats of Area K to the edge of the river. As the tide rose in the River Taff the feeding and roosting birds moved up the banks of the creek and onto the flat surface of Area K. This was a frequent gathering area for the Dunlin in the bay, as the tide rose, whether or not birds remained here or elsewhere in the bay to roost or not.

With further increase in the height of the rising tide, the Dunlin flock left Area K to fly to other roost sites. If large numbers of birds were in the bay, on most observation days the majority of these would fly out of the bay to the west, towards the known roost site of Sully Island. The birds that remained in the bay flew to the raised muddy

banks of the creeks emerging from the saltmarsh of Area B onto Area A. If these banks remained uncovered over high tide, the birds remained there to roost. Further increase in the height of the tide resulted in the Dunlin moving into the saltmarsh Area B where they roosted on the creek banks. On tides when this area would become covered, the birds flew to the east end of the saltmarsh, directly to the sloping east side of the high tide roost island or first onto the adjacent area of saltmarsh and creek, Area L. Dunlin roosted on this area if it remained uncovered over high tide on a number of observation days. Smaller numbers of birds were seen to be roosting on Area L on neap tides, when the saltmarsh creeks of Area B were still uncovered.

The high tide roost island, Area E, was the preferred roost site on spring tides where the creeks and saltmarsh were covered. On one study day in February, however, a large proportion of the Dunlin remaining in the bay to roost were located on the steep slopes of the Phase 2 landfill site above Area G. (This coincided with a weekend, when there was little disturbance from the nearby work-site.)

The main change in the roosting pattern of Dunlin has been the use of Areas K and L as gathering areas and occasional roost areas.

3.2.4 Curlew

The provision of a secure high tide roost island, Area E resulted in a changed pattern of roosting behaviour on high spring tides during the winter of 1991/92 compared with 1990/91. This was described in the previous report. The number of Curlew roosting over the high tide period in Cardiff Bay remained high in 1992/93 (Table 3.2.1) reaching a maximum in February when over 160 gathered to pre-roost on the mudflats in the middle of the bay.

The roost sites used by Curlew on neap and spring tides is shown in Figure 3.2.4.1 and the relationship between use of these sites and tide height is given in Figure 3.2.4.2.

The pattern of behaviour was similar to that described previously. Between two and three hours before high tide Curlew that had been feeding in the bay started to pre-roost on mudflats 16 and 17. Curlew that had been feeding on Orchard Ledges, the intertidal area immediately to the east of the mouth of Cardiff Bay, would have to move to other areas as this area became covered about three hours after low tide. Separate observations as part of the ongoing study of the birds of Cardiff Bay for CBDC showed that these birds flew either east, to roost beyond the Rhymney Estuary, or west and into Cardiff Bay to roost. Although quantitative studies have not been made, it appears that the increased number of Curlew that roosted in Cardiff Bay was in part because of increased numbers of birds arriving from the Orchard Ledges feeding population.

As the tide rose and covered the mudflats in the middle of the bay, the Curlew moved up the shore towards the saltmarsh. On neap tides, where some mudflat remains uncovered, the birds roosted on the open mud or tucked under the edge of the main saltmarsh or its small 'islands'. The latter case was most noticeable on windy days when birds were located on the leeward side of any area of saltmarsh or tussock.

Neap tide roosts occurred more commonly on Area J, but during this study roosts were also observed further to the west on Area A.

With increasing heights of tide, Curlew moved onto the raised front edge of the saltmarsh of Area C or more commonly into the middle of this area. The east end of Area C was the preferred roost site when any saltmarsh remained uncovered. Curlew, being a large long-legged wader, readily roost in saltmarsh vegetation unlike many smaller waders. On high spring tides, the preferred roost site was the high tide roost island, Area E. Birds flew directly to the east slope or the top of this area from the saltmarsh and occasionally from the mudflats where they had been pre-roosting.

As the tide receded, the Curlew would disperse from their high tide roost to the saltmarsh of Area C or to the mudflats of Area J and sectors 16 and 17 where the common behaviour was to resume roosting until up to three hours after high tide.

3.2.5 Redshank

This species was identified in the first report as that most likely to be affected by the Phase 1 and Phase 2 land reclamation work. Redshank are known to be site-faithful and to require secure roost sites near to their feeding grounds. Part of other ongoing studies for CBDC has shown there to be very little interchange between the Redshank population in Cardiff Bay and other populations nearby in the Severn Estuary (Donald & Clark, 1991b; Toomer & Clark, 1992b). The loss of some of the main roost areas used by Redshank prior to autumn 1991 resulted in a changed pattern of roosting behaviour which was described in the previous report. Then, the creeks of Area B became the preferred roost site while the saltmarsh remained uncovered (except on low neap tides). When the saltmarsh was covered by high spring tides, the most frequently used roost was the newly formed high tide roost island, Area E.

The changes that have occurred to the roosting habitats since 1991/92 have not directly affected the areas used by Redshank during that winter but nevertheless there has been a shift in roosting behaviour.

The number of Redshank roosting in the bay during the autumn and winter ranged from 300-500 birds, the number then falling in March.

The roost sites used by Redshank during the study period and the relationship of their use to tide height is given in Figures 3.2.5.1 and 3.2.5.2. The two areas that have become more important during the current study are Areas K and L. Feeding Redshank were found widely distributed throughout the bay but the main concentrations were located in three areas, the inner River Taff, (sectors 8, 9 and 10) the inner harbour, (sectors 15 and 19) and the south part of the bay, (sectors 1, 2 and part of 5) (see Figure 3.2). This resulted in three gathering areas as the tide rose although these were not necessarily always related to the nearest feeding group.

On most tides, Redshank gathered on the banks of the River Taff in the creeks running from sector 4. As the tide rose, the Redshank moved up the banks of the creek onto the flat mud surface of sector 4. Observation suggested that these were primarily the birds from the southern part of the bay. On low neap tides, these birds remained there until forced to move by the rising tide. The flock left in several groups on most

occasions, flying to the raised creek banks of Area A or of Area B. On most observations, a small number of birds would remain and be moved by the tide onto Area F and either remain roosting there over the high tide period or also fly to Area A or B.

The second feeding group, located on the banks of the River Taff north of the PDR crossing, gathered on the edge of the bank above the rising river water on sectors 8, 9 and 10. This group moved up the mud banks sometimes into the edge of the strip of remaining saltmarsh. These birds usually flew from this area before the tide covered the saltmarsh edge and were observed to fly to Area A and B. A small number of birds remained there to roost on some neap tides.

The third group in the inner harbour gathered on the upper reaches of sector 15 on the rising tide before moving onto the creek emerging at Area L, or moved directly onto the sloping side of the high tide roost island, Area E.

Area A was an important gathering place for Redshank as they moved from other pre-roost areas. Some birds used the raised creek banks as a neap tide roost. On higher tides, the birds were observed to fly into the saltmarsh along the creek where they again would roost if this remained uncovered. When the saltmarsh was about to become covered, birds roosting there flew either to Area L or directly to the sloping side of Area E.

This pattern of movement with rising tide was well established and is summarised in Figure 3.2.5.3. However, as is the case with all biological studies, unpredictable results can arise for no apparent reason. Two occurrences of high tide roosts of Redshank on the sloping rubble infill above sectors 8 and 9 were over a weekend when there was little disturbance from the nearby PDR work. The third occurrence, however, was on a working day and did not seem to be related to any change in activity elsewhere in the bay.

Area L assumed an important role for roosting Redshank. For many tides, it was the pre-roost site used before birds moved onto the slopes of Area E. Birds frequently moved there as the main high tide roosts on Area E broke up. In 1990/91 and 1991/92 Area B was the main area where birds would gather post roosting.

Figure 3.2.5.4 shows the results of identifying roost positions every 20 minutes through tidal cycles of differing tide heights. Because of the balance of tide heights observed and the fact that higher tides also have pre-roosts of birds as the water rises, the proportion of observations at different heights varies (see Figure 2.1c). Although this must be borne in mind when interpreting the results, the pattern of roost site use is fairly clear. On lower neap tides, Redshank used several areas for roosting or pre-roosting (Areas A, G, J and K). While Area A remained uncovered, birds used this as a pre-roost or roost site. Area B became the next main roost and pre-roost site as Area A was covered. Redshank started to use the high tide roost island, Area E, on tides as low as 10.1m. This area became the preferred roost or pre-roost site on tides above 11.1m and was used exclusively at tides over 12.6m.

3.2.6 Other Species

Several other species occurring in Cardiff Bay remained there to roost over the high tide period.

Cormorants were observed throughout the tidal cycle, with small numbers feeding along the River Taff. As the mudflats became covered with the rising tide, the birds in the bay moved onto the raised mud banks of the creeks emerging from the saltmarsh at Area A to pre-roost or to roost if the tide was a low neap tide. The number of birds increased as more Cormorants flew in from the mouth of the bay. When this area was becoming covered by the rising tide the birds flew to the damaged floating platform to roost over the high tide period.

A population of Mallard was resident throughout the autumn and winter, with the number of birds falling in March. The winter population ranged from 90-135 birds. The majority of these roosted on the open water during high tide but between 10 and 50 birds used a variety of the high tide roost sites at different tide heights. On low neap tides, Area A and J were used by roosting birds. When these areas were covered, Mallard not roosting on the open water moved into the water-filled creeks in the saltmarsh of Area B and onto the south edge of the saltmarsh of Area C.

A small group of Pochard (12-22) was present in the bay from the end of January to the end of the study period. This group spent a lot of time roosting on the open water, anywhere from the mouth of the bay to the area adjacent to the saltmarsh at the north of the bay.

A small population of Oystercatchers fed on the mudflats on some of the study days. These birds, numbering 10-60, moved up the shore with the tide line as the water level rose and pre-roosted on Area A or J. Not all the birds remained in the bay to roost and if the tide was high enough to cover the mud in front of the saltmarsh, they flew out of the bay to roost elsewhere. Birds were observed flying east past Orchard Ledges on many occasions, possibly to roost further along the River Severn at Peterstone.

Fewer Lapwing were observed to remain in Cardiff Bay over the high tide period than had been reported for the previous two studies. A flock of birds, sometimes numbering over 150, was often located on the shore of the inner River Taff on sector 8. Many of these were observed to roost through much of the tidal cycle while this area remained uncovered, including over the high tide period on a low neap tide. In the previous winters, the Lapwing flock moved to the area above sector 8 to roost over high tide, but this area has been altered considerably by Phase 2 reclamation work. Between 20 and 70 birds used the raised landfill area above roost Area G on several occasions, with one flock of over 150 birds being seen on one day. There was no consistency to these roosts, however, and on many days during the study period, Lapwing were absent over the high tide period.

One of the most difficult species to observe in the bay was Snipe. They fed and roost in saltmarsh and were very difficult to see because of their behaviour and cryptic coloration. On high tides when the saltmarsh at the north end of the bay or near Area F was becoming covered, Snipe were observed to fly to higher areas of ground.

The number of birds was not determined but up to five birds were seen on more than one observation period in both the saltmarsh at the north of the bay and that near Area F. When the saltmarsh was completely covered at high tide, Snipe were observed to roost on adjacent raised stony areas, where again, they were well camouflaged. On one occasion, two birds were disturbed roosting on the raised ground immediately north of the high tide roost island, Area E, and it is likely that the roost island itself may also be used on some tides.

Turnstone feed on the area to the east of the mouth of Cardiff Bay known as Orchard Ledges. This area becomes covered two to three hours before high tide and the birds leave to feed and roost elsewhere. One of the roost areas is in Cardiff Bay on the stones or sloping concrete surface adjacent to Ferry Road (Area H). Birds arriving from outside of the bay frequently fed on the intertidal patch of stones. With increasing height of water, the birds stopped feeding and roosted over the high tide period on this area. Turnstone were reluctant to leave this area even on some of the highest tides of the year when they were found right at the top of the sloping concrete, just below the level of the road. Several birds were seen on two occasions in early autumn roosting on sector 8 and on the end of the east PDR mound.

4. DISCUSSION AND CONCLUSION

The study in 1991/92 reported on the effects of roost habitat changes up to that time. It was evident then that the waders and wildfowl that roosted in Cardiff Bay had responded to these changes and adapted to the new conditions without any obvious deleterious effects. The change to the west PDR mound, the partial covering of the old South Glamorgan Canal and the saltmarsh adjacent to the Hamadryad Hospital, all of which had previously been well used roost areas, had led to birds using alternative roost sites. There had been no apparent decrease in numbers feeding in the bay or remaining over high tide to roost. In fact there was some evidence that Curlew remained in the bay over high spring tide periods when previously they would have left to roost elsewhere. The provision of a new, secure high tide roost site, the high tide roost island was thought to be in part responsible for this.

The waders and wildfowl of Cardiff Bay had responded to the changes that were occurring to the roost habitats by modifying their roosting behaviour. The habitat changes are, however, inevitably accumulative. Loss of roost habitat and further disturbance of other roost areas is continuing. This report shows how the birds have responded since the 1991/92 study.

The five species that were most likely to be affected, Redshank, Dunlin, Shelduck, Teal and Curlew have shown no significant decline in numbers since the last study. In fact all five species were found to be present at the same level or higher than in 1991/92. Teal and Curlew showed an increase in numbers remaining in the bay to roost over high tide.

The most important changes within the bay that could affect roosting birds were in the vicinity of the east PDR mound, near to Hamadryad Hospital, and on the east side of the River Taff north of the PDR crossing point. All of these areas have been used by roosting birds in the past. The additional material deposited on the landfill site near the Hamadryad Hospital (Phase 2) has raised its level considerably. At the same time, this has extended westwards to cover most of the saltmarsh above the muddy bank of the River Taff. Changes that had occurred prior to 1991/92 winter resulted in the area adjacent to Hamadryad Hospital being used occasionally by roosting Lapwing only. The further changes to this area since then have resulted in Lapwing roosting in the bay less frequently than during the previous winter. Although this was a loss to the bay, it does not appear to have reduced the number of birds that were found at other stages of the tidal cycle. Lapwing readily move to inland fields to feed and roost in other areas. The number of birds involved was small when compared with the national wintering population (>1 million) and so the change is unlikely to be of major significance.

The area of saltmarsh adjacent to the Phase 2 landfill referred to above was used by roosting Redshank on some tides in 1991/92. Although there was still a narrow strip of saltmarsh remaining, this no longer offered the same high tide roost habitat. On neap tides Redshank almost always moved away to other sites, even though large numbers fed and gathered to pre-roost on the mud bank of the river on some study days. As stated in the previous reports, it is Redshank that could be most affected by changes to roost habitat. Other studies in Cardiff Bay (Donald & Clark, 1991a;

Toomer & Clark, 1992a) and work in other estuaries (Minton, 1975; Mackie, 1976; Symonds *et al*., 1984) have shown some species of waders, in particular Redshank, to be highly site-specific. This species is site-faithful from one year to the next and requires roosting areas to be available relatively close to feeding grounds. In 1991/92, partial loss of the old South Glamorgan Canal area, one of the main roost sites for Redshank, did not have a noticeable effect on the numbers of birds in the bay. The population responded by using alternative areas including the newly created roost island. Further loss of habitat in this area has put more pressure on remaining potential roost sites. The saltmarsh area to the immediate south-east side of the east PDR mound, the west end of Area B, has been subject to much more disturbance as the PDR work continued and has resulted in this area not being used to any extent by pre-roosting and roosting birds. One of the creeks emerged in this area and it had been one of the important gathering areas for roosting birds, especially Redshank. Loss of this site does not seem to have affected the Redshank population which continues to use the other creek in this patch of saltmarsh for gathering. In addition, two other areas have become important as gathering areas, described as Area K and Area L. These areas have not changed in any way since 1991/92 and their use reflects in part the adaptability of Redshank. At the same time, this also reflects the pressure that is being put on sub-habitats within the bay, as gathering and roosting sites that have been used in the past become unsuitable. The high tide roost island, Area E, that was created before the previous report, continued to be a very important roost site for Redshank, being used almost exclusively at tides over 12.0m high. Although the site is not very large, the surfaces provided offer ample space for the birds using it at the moment. The sub-area used by Redshank, that is the sloping east surface, was only used by a few other birds, and could theoretically support larger roosting populations. As more pressure is put on available roost areas, this may assume even more importance. With the adjacent area of saltmarsh and creek being used more extensively as a gathering, pre-roosting and roosting area, Areas L and E together provide the most important site for Redshank.

Dunlin have responded to the changes in roosting behaviour of the Redshank, with both species occurring together at most roost sites. Although the Dunlin that remain in the bay have adapted to change, their overall behaviour means that it is unlikely that this species will suffer from further loss of potential roosting habitat as they can roost outside of the bay.

Shelduck and Teal have not been greatly affected by the changes described. Both species roost on the open water as well as on terrestrial roost sites and further changes to the latter may only result in more birds remaining on the water over high tide. The high tide roost island, Area E, continued to be used by Shelduck over many high tide periods, with a third to a half of the population moving onto the upper surface on some study days. Part of the Teal population regularly moved into the shelter of the creeks in the saltmarsh on intermediate heights of tide. This, however, cannot be essential for the Teal, as at higher tides when the saltmarsh was covered, the birds would resume roosting on the open water.

In the previous report, it was stated that Curlew had possibly benefited from the provision of a high tide roost island. The current report supports this, with larger numbers of Curlew flying into the bay from areas on the nearby Severn Estuary and roosting

over high tide. The east end of saltmarsh remained the preferred roost when this area was uncovered, but all the birds moved to the side or top of the high tide roost island on higher tides.

To summarize, Phase 1 and Phase 2 landfill, as well as the disturbance and changes to habitat from the continuing PDR work, have not resulted in any reduction of the populations of waders and wildfowl in the bay. Loss or disturbance of existing roosting habitat has continued to cause modified patterns of behaviour for several species as they gather to roost over high tide. Redshank and Dunlin now use a creek area on the bank of the River Taff to gather before moving to other pre-roost or roost sites. An area adjacent to the high tide roost island has become a second important gathering and roosting site. These two sites have taken over as part of the series of areas used by pre-roosting waders as the height of the tide increases. Together with the high tide roost island, use of these areas has compensated for the loss and disturbance of other pre-roost and roost areas. The high tide roost island has continued to provide the preferred roost site on high spring tide days for waders remaining in the bay as well as for up to half the Shelduck population. The effectiveness of the floating roost platform could not be determined because of its partial destruction. The second stage of the Phase 2 landfill work will cover up a large section of the saltmarsh to the south west of Windsor Esplanade. This area, with its well-developed creeks, is currently used as pre-roost and roost site by several species. Further monitoring will determine if this loss of roost habitat can be tolerated by the birds in Cardiff Bay.

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ACKNOWLEDGEMENTS

This report was funded by Cardiff Bay Development Corporation. Thanks to Mrs. Pat Forest for her help and cooperation.

Grateful thanks to Mr. John Lawton of South Glamorgan County Council for obtaining permission to have access to the PDR site and to DMD for agreeing to this.

The production of this report was aided by the secretarial help of Miss S. Foulger.

Species	Dec.	Jan.	Feb.	Mar.
Shelduck	240	230	340	200
Teal	420	350	370	60
Dunlin	340	250	1100	10
Curlew	130	120	160	70
Redshank	410	350	400	100
Other Sp.				
Cormorant	0	20	25	22
Mallard	0	135	90	10
Pochard	0	0	22	12
Oystercatcher	0	0	35	16
Turnstone	0	40	50	5

Table 3.2.1Mean numbers of waders and wildfowl roosting in Cardiff Bay at high tide from September 1992 to March 1993. (Data from high tide roost observations only).