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THE EFFECT OF THE CARDIFF BAY BARRAGE ON WATERFOWL POPULATIONS

2. DISTRIBUTION AND MOVEMENT STUDIES

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by

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EXECUTIVE SUMMARY

1. This report presents the results of the second season of intensive monitoring of the wildfowl and waders on the Taff/Ely and Rhymney estuaries and the intertidal areas between these estuaries. More extensive monitoring also covered the intertidal areas between the Taff/Ely estuary and the mouth of the River Usk. The first season of monitoring, the results of which are published elsewhere, covered the period from November 1989 to May 1990. The results presented in this report are derived from data collected between August 1990 and May 1991.

2. The present programme of monitoring is designed to yield information on the distributions, movements and populations of wildfowl and waders in order to allow an assessment to be made of the effects on bird species of the proposed impoundment of the Taff and Ely rivers by an amenity barrage. This proposal would lead to the permanent inundation of areas which are at present intertidal.

3. There were no large changes in the overall populations of waterfowl present on the north west Severn between the two seasons of monitoring, although several distributional changes were apparent for some species. In particular, Dunlin and Shelduck increased in numbers on the St.Brides and Peterstone sections of the north west Severn but decreased on eastern areas of the Rhymney estuary.

4. Patterns of waterfowl movement within and between the study areas were found to be similar to those recorded during the first season of monitoring. One exception was the use by Dunlin of the Taff/Ely estuary during the hard weather in February 1991, when large numbers of birds arrived on the estuary where they remained throughout the tidal cycle. This species usually used the Taff/Ely estuary only on the advancing and receding tides.

5. 150 Redshank were colour-ringed and dye-marked in January 1991 in order to examine the pattern of movements of Redshank around the study area and to determine the rate of turnover of the Taff/Ely wintering population of this species. Subsequent observations showed that there was no movement of this species out of the Taff/Ely estuary until March, when birds departing for their breeding grounds were partly replaced by passage migrants.

6. Biometric data obtained from the sample of birds caught on the Taff/Ely showed that around two thirds of the wintering population of Redshank on that estuary were British breeding birds, the remainder being birds of the Icelandic race. These proportions are similar to those which have been found on the Severn as a whole.

GENERAL INTRODUCTION

This report is in two sections. The first section summarises the results of the second season of monitoring waterfowl populations on the Taff/Ely and Rhymney estuaries and areas between. The second section analyses the results of waterfowl movement studies based upon observations of colour-marked Redshank.

Details of the first winter and spring monitoring of waterfowl (ie. wildfowl and waders) using the Taff/Ely and Rhymney estuaries are given in Evans et al. (1990). The present report summarises the results of a second winter and spring of monitoring. In addition, results are presented from a first autumn of monitoring. The monitoring of waterfowl distributions and movements in the Cardiff area is aimed at detecting the effect on bird populations of the construction of an amenity barrage across the mouth of the Taff/Ely estuary. This barrage would replace the existing intertidal mudflats with a permanent freshwater lake. Continued monitoring of the birds in the area after barrage construction should reveal the extent to which birds displaced by the creation of an artificial lake have been accommodated on other areas along the north Severn. The success of any mitigating provisions, such as artificial feeding grounds to partly compensate for loss of habitat in the Taff/Ely, could also be assessed from continued monitoring after construction of the barrage.

Largest numbers of wildfowl and waders are found in the Taff/Ely and Rhymney estuaries during the winter months. Many of the waders migrate to breed in areas stretching from northern Canada to Siberia, where they benefit from long daylight hours and

abundant food supplies during the short Arctic summer. They arrive in Britain in autumn where the vast majority spend the winter feeding on the invertebrates which inhabit the intertidal mudflats and saltmarshes of estuaries. Some species of wildfowl, such as Teal, may also be long distance migrants whereas others, such as Shelduck, both breed and winter in Britain (Cramp et al., 1977; Prater, 1981; Owen et al., 1986).

The Birds of Estuaries Enquiry (BoEE) has monitored bird populations on all British estuaries since 1969. These counts are used to determine qualifying levels for national and international importance and for calculating a national annual population index to show population trends. If an estuary regularly holds 1% or more of the national population of a species, it is held to be nationally important for that species. At present, the Taff/Ely falls just short of being of national importance for Dunlin, whilst Redshank numbers approach levels of national importance (Table 1.1). If an estuary regularly holds 1% or more of a distinct geographical international population it is considered to be of international importance. Although the Taff/Ely does not support numbers of national or international importance itself, it does contribute importantly towards the international importance of the Severn. The Severn regularly supports internationally important numbers of Shelduck, Dunlin, Curlew and Redshank (Table 1.2) and is the ninth most important site in Britain for waders in terms of overall numbers (Kirby et al., 1990). Previous work (particularly Clark 1989, 1990) has shown that the distribution of waterfowl on the Severn is not uniform, with most birds being concentrated onto a few areas, particularly around river mouths. Very large areas of intertidal mudflat support few or no birds. The Taff/Ely estuary and the adjacent Rhymney estuary support one of the densest concentrations of birds to be found anywhere on the Severn (Clark 1990).

PART 1 : DISTRIBUTION STUDIES

1 INTRODUCTION

The following section describes and discusses the feeding distributions of waterfowl using the Taff/Ely and Rhymney estuaries between August 1990 and May 1991. Where possible, comparisons are made with the patterns of distribution found during the first year of monitoring (Evans et al., 1990). The distribution of roosting birds on the Taff/Ely estuary was recently discussed in Donald & Clark (1991).

The second season of monitoring has led to an increased understanding of the distributions of waterfowl using the Taff/Ely and Rhymney estuaries and also provides some indication of the ways in which patterns of distribution and abundance change between years. The following section does not present detailed statistical analysis of changes between the two monitoring seasons since future analysis using more data than is available at present will provide a more accurate picture of variability between years.

Between-year variability may arise through physical, biological or climatic changes, although biological changes are often the result of physical or climatic factors (Clark et al., 1990a).

The most frequent types of natural physical change to estuaries result from changes in the paths of rivers and from storm erosion. The Severn estuary, with its wide, westerly facing mouth and very high tidal range, is particularly prone to storm erosion. A heavy storm can strip large quantities of invertebrate-bearing sediment from the substrate, severely reducing the availability of food for waders (Clark, 1983; Ferns, 1983). Storms and surge tides are also capable of depositing new sediments over the existing substrate. The new sediments may be more favourable or less favourable to invertebrates than the previous benthos and bird numbers using the area could change as a result. Changes in the type of sediment can influence bird numbers independently of the numbers

of invertebrates present by altering the detectability of prey. Species using different feeding methods may react in different ways to sediment changes. After the deposition of a layer of soft mud over part of the North Wirral shore, Cheshire, in 1989, numbers of Knot and Bar-tailed Godwit increased dramatically whilst Oystercatcher virtually abandoned the site (Clark et al., 1990b).

Of the biological factors which can influence variability between years, breeding success on the nesting grounds is perhaps the most important in terms of affecting abundance, at least at the start of the winter. Densities of birds and invertebrates are often related (Goss-Custard et al., 1977), so biological factors affecting the reproductive success, numbers and distributions of invertebrates will also affect bird numbers and distributions. Nutrient supply and organic enrichment can have both positive and negative effects on invertebrate populations and consequently on bird populations (Green, 1990).

Waterfowl numbers and distributions can also be influenced by climatic factors. Prolonged spells of hard weather cause waterfowl to leave affected estuaries and move to more sheltered sites, significantly altering distributions (eg. Dobinson & Richards, 1964; Clark, 1982). Prolonged freezing of mudflats can also severely deplete invertebrate stocks at times when the demand is highest. If these conditions persist and birds do not leave the affected areas, mass mortalities may occur. After the freezing weather of February 1991, over 3,000 wader corpses were found on the Wash alone.

Superimposed on this background of factors capable of changing numbers and distributions of waterfowl between successive years is the behaviour of the birds themselves. In a study comparing the distributional changes between two years on the Mersey, Clark et al. (1990a) found that species which fed at low densities showed less variability in distribution than did species feeding at high densities.

2 METHODS

Two types of counts were carried out for the present report.

2.1 All Day Counts

In order to allow direct comparisons between seasons and years, the counting and recording techniques employed during the second season of monitoring (August 1990 - May 1991) were kept as similar as possible to those used during the first (November 1989 - May 1990) (Evans et al., 1990). The study area again consisted of three sites; the Taff/Ely estuary (Figure 2.1), Orchard Ledges and the Rhymney estuary (Figure 2.2). To allow for increased count accuracy and to allow detailed analysis of results, each site was divided into several count areas. The Taff/Ely was divided into 19 count areas, Orchard Ledges into two count areas and the Rhymney into 17 count areas. The boundaries of the count areas were retained from the first season of monitoring (Evans et al., op cit). The pitted area between the Orchard Ledges and Rhymney sites (Figure 2.1) was not counted in either season since the broken nature of the surface made birds impossible to count from either the Orchard Ledges or Rhymney observation points. The area is known, however, to support good numbers of Turnstone, Curlew, Dunlin and Oystercatcher around low tide (P.F. Donald, pers obs.).

Counts were divided into three seasons; autumn (August - September 1990), winter (November 1990 - March 1991) and spring (April - May 1991). Each site was counted at least twice a month, with one count on a spring tide and one on a neap tide if possible. All count areas of each site were counted once every hour throughout the hours of daylight or for 12 hours (whichever was shorter) to assess changes in the usage of different sites throughout the tidal cycle. Feeding and roosting birds were counted separately and factors such as disturbance to the site

or impaired visibility noted. Only birds present on exposed mudflats were counted; wildfowl which were just offshore of the tide edge and which were obviously feeding on invertebrates in the substrate, were counted but wildfowl out on the open water were not.

Adverse weather, particularly between February and April 1991, caused several counts to be missed, but sufficient data were collected to allow detailed analysis of the pattern of distribution of feeding waterfowl.

No differences in the sites were observed between the two seasons of monitoring with the exception of the north western corner of the Taff/Ely (count area 7 in Figure 2.1). Here a small area of mudflat was buried beneath the new Peripheral Distributor Road (PDR) embankment. Considerable disturbance to waterfowl feeding and roosting in this part of the Taff/Ely resulted from construction work on the PDR on both sides of the River Taff (Donald & Clark, 1991).

For each season, all day counts were used to calculate the following:
1. the average exposure times per tidal cycle of each count area
2. the average number of feeding bird hours per tidal cycle (`All day usage')
3. the average number of birds present on each of the three sites at each hour of the tidal cycle and the proportion feeding, and 4. the relationship between exposure time (an index of mudflat height) and feeding effort.
Each of these analyses follow Evans et al. (1990). All day usage is calculated using:

$$\text{Usage} = \sum_{A=-6}^{A=+5} (B \times C)$$

where:

A = Hours from low tide

B = Average number of birds feeding at time A when area was exposed

C = Proportion of counts when area was exposed at time A

For winter and spring counts, where data were available from both monitoring seasons, graphs are given showing a comparison of all day usage values between seasons. Each point represents one count area. The change in feeding density between seasons is plotted against exposure time to determine whether there was any change in preference for mudflats between the two years. The change in feeding density (Usc) was calculated using:

$$Usc = \frac{Us2 - Us1}{\text{Area of Mudflat}}$$

Where:

Us2 = All day usage value for second season

and Us1 = All day usage value for first season

1.2.2 Low Tide Counts

In addition to the all day counts, extensive low tide counts were carried out at two-weekly intervals along the north Severn shore. These counts were carried out by BTO volunteers, all of whom were experienced in counting their own allocated areas. It was considered that birds using the Taff/Ely and the Rhymney were unlikely to move east of the River Usk, so only areas west of this were counted in the second season (Figure 2.3). As with the all day counts, the area was broken down into count areas, which were larger on average than the all day count areas. The average number of birds present on each of the count areas is shown for each species. Low tide counts were only made during the winter months.

3 RESULTS AND SPECIES ACCOUNTS

The results of each low tide count are given in Tables 3.1 to 3.6. These show the total numbers of birds counted on the Welsh Severn west of the River Usk. Maps showing the average numbers of each species present during the winter months are included in the following species accounts. Each species account consists of four sections. Results of all day and low tide counts and comparisons of these with results from the first season of monitoring are presented in sections relating to autumn 1990, winter 1990/91 and spring 1991. A final section discusses the results with relation to factors such as feeding ecology and behaviour, migration patterns and changes to the sites between years.

Presentation of the results of the all day counts follows Evans et al. (1990). In addition, charts showing comparisons of usage of count areas between the two winter and spring seasons are given where sufficient data exist. Usage values are plotted on logged scales and increased by one to allow zero usage values to be included. For the most important species, charts comparing usage of count areas in autumn 1990 and winter 1990/91 are presented.

The order of the following species accounts follows Voous (1973).

3.1 Shelduck

Autumn 1990

Small numbers of Shelduck were present on the Taff/Ely and Rhymney sites throughout the autumn of 1990. Birds were widely distributed at both sites (Figures 3.1.1, 3.1.2). No Shelduck were present at the Orchard Ledges site in autumn.

Numbers of Shelduck on the Taff/Ely in autumn remained constant during the five hours before low tide, with an increasing proportion of birds feeding as low tide was approached. This proportion declined steeply on the rising tide as birds roosted on the rising water (and were therefore not counted) rather than following the tide line back up the shore (Figure 3.1.3.a). A similar situation was observed at the Rhymney (Figure 3.1.3.c). There was no obvious preference for feeding on higher or lower mudflats (Figure 3.1.4.a), since birds followed the tide line from the higher mudflats just after high tide down to the lower areas at low tide, thus using areas of all heights.

Winter 1990/91

Tables 3.1 to 3.6 show that during the winter 1990/91, peak numbers of Shelduck at low tide on the north west Severn were reached in February 1991. The distribution and average numbers of Shelduck feeding on each of the low tide count areas west of the Usk during winter 1990/91 are shown in Figure 3.1.5. As in previous years, the Rhymney was found to be an extremely important area for this species. Clark (1989) found the Rhymney to be the second most important site on the Severn, after Bridgwater Bay. However, large increases in numbers of this species on the north Severn shore meant that in the winter 1990/91, the Taff/Ely, Peterstone and St.Brides low tide count sections all had similar numbers of Shelduck to the Rhymney, where numbers were lower than those recorded in 1989/90 (Figure 3.1.5). Increases in the numbers of Shelduck in the areas of the north Severn shore west of the Usk had been continuing for at least four years prior to 1990/91.

All day counts revealed a similar pattern of usage in the Taff/Ely during the winter 1990/91 to that found during the previous winter (Figure 3.1.6), although numbers on some areas were slightly higher. The reduction in numbers of Shelduck feeding at the Rhymney in the second winter as shown by the low tide counts is reflected by the all day usage (Figure 3.1.7).

Comparison of usage values between the two winters shows a considerable fall in the numbers of Shelduck feeding on count areas 11, 12, 14 and 15 in the second winter, although on areas west of the River Rhymney channel, numbers were generally slightly higher. As with the autumn counts there was no apparent preference for higher or lower mudflats (Figure 3.1.4.b).

From January 1991, up to 80 Shelduck began to feed around low tide along the western section of Orchard Ledges. Birds were then recorded from this area until March. Very few Shelduck have used this area in previous years (Clark, 1989,1990; Evans et al., 1990). Figure 3.1.7 does not reflect the true importance of this area for Shelduck in the late winter of 1990/91, since the value given is averaged out over the whole winter.

Whereas autumn counts showed the numbers of Shelduck present on the count areas to decrease after low tide, winter counts on the Taff/Ely show numbers to remain fairly stable throughout the period when most count areas were exposed (Figure 3.1.8.a). A high proportion of the birds present on the mudflats were feeding, except around high tide, when birds either roosted on the open water or on saltmarsh or embankments around the estuary (Donald & Clark, 1991). As the tide receded at Rhymney, numbers of Shelduck present on the exposed mudflats increased more slowly than on the Taff/Ely (Figure 3.1.8.c) since birds tended to roost on the open water longer and so commenced feeding when the tide had receded further than did the birds on the Taff/Ely. Numbers of birds present on the Rhymney fell around low tide, possibly the result of birds moving to other feeding grounds east of the study site. Numbers increased again as the rising tide pushed birds back into view but soon fell off as birds began to roost on the open water. Highest numbers of Shelduck on Orchard Ledges were recorded around low tide as birds left the Taff/Ely to feed for the short time Orchard Ledges was exposed. A high proportion of the birds present on this site were feeding.

A comparison of the all day usage values of each count area for the two winters 1989/90 and 1990/91 (Figure 3.1.9.a) shows that on the Taff/Ely, almost all count areas had higher usage values in the second winter. Four count areas were used in the second winter but not in the first, whereas only one count area (area 7) had birds in the first but not the second winter. On the Rhymney, the six count areas with the highest numbers of birds all showed lower usage values in the second winter than the first.

Very little change in feeding density was recorded between the two winters at any of the Taff/Ely count areas (Figure 3.1.9.b) although considerable decreases in feeding density were noted at several count areas on the Rhymney. These did not seem to be related to the height of the area concerned.

A comparison of autumn 1990 and winter 1990/91 usage values from each of the count areas shows that in all cases, winter values were higher than the equivalent autumn values (Figure 3.1.10).

Spring 1991

Numbers of Shelduck using the Taff/Ely during spring 1991 were not substantially lower than during the winter (Figure 3.1.11), whereas at the Rhymney and on Orchard Ledges, numbers were much reduced (Figure 3.1.12). As with autumn and winter, a higher proportion of birds were observed to be feeding on the falling rather than the rising tide on both the Taff/Ely and the Rhymney (Figure 3.1.13). Feeding effort in spring was concentrated on the higher count areas (Figure 3.1.14). This was not found to be the case in autumn or winter. A comparison of data collected during spring 1991 with that collected during spring 1990 shows that on most count areas in the Taff/Ely, usage was higher during spring 1991, whereas on the Rhymney usage was generally lower in the second spring (Figure 3.1.15.a). There was no consistent change in feeding density at either site (Figure 3.1.15.b).

Discussion

Shelduck is an unusual wildfowl species in that the British population is almost exclusively estuarine in its distribution both in winter and summer (Owen et al., 1986). The main prey species is the small gastropod snail Hydrobia ulvae (Olney, 1965), although a wide range of prey species, including bivalve molluscs and oligochaete worms, are also taken (eg. Patterson, 1982). These prey items are sifted from soft sediments, often at the tide line.

The majority of British breeding birds remain in the country to winter and these form the bulk of the British wintering population, although they are joined by a small but as yet unknown number of birds from northern Europe (Prater, 1981). Between June and August, the vast majority of adults and some immature birds leave the breeding grounds and undertake a moult migration to a small number of known moulting areas. By far the largest of these is the Grosser Knechsand on the German Waddensea (Coombes, 1950), although smaller moult sites are known to occur within Britain. Of these, the most important is Bridgwater Bay (Prater, 1981), although small moulting concentrations also occur on a number of other British estuaries, such as the Firth of Forth (Bryant & Waugh, 1976). During the moult period, the only Shelduck present on most estuaries are young birds, often in `creches', which are looked after by small numbers of adults. After moulting, birds begin to move back to their wintering estuaries from the moulting grounds. Returning Shelduck spread from the Waddensea across to eastern England, then into northern, southern and, finally, into western areas (Prater, 1981). The origin of birds moulting in Bridgwater Bay is uncertain, although Eltringham & Boyd (1960) considered the birds to originate in Ireland.

The low numbers of this species recorded throughout the study area in autumn 1990 were to be expected given the pattern of

movements described above. Tables 3.1 to 3.6 show a peak count of this species on the north Severn west of the Usk in mid-February, although on the Severn as a whole numbers remained relatively stable from December onwards. Either the birds which moulted at Bridgwater Bay had spread out across the Severn in late winter or birds arriving from the Waddensea had replaced those birds which had moulted on the Severn and left for their wintering grounds, perhaps in Ireland.

The numbers of Shelduck feeding along the western end of Orchard Ledges during January and February 1991 were unprecedented. One possible explanation for these high numbers could be a change in sediment type over the area leading to increased invertebrate numbers. Another possibility is that as numbers of this species increased in the Taff/Ely, increased competition forced birds to seek alternative feeding sites for part of the tidal cycle.

Numbers of Shelduck present on the Taff/Ely in spring 1991 were not noticeably lower than those recorded during the winter, suggesting that a high proportion of the wintering population remained in the area to breed. Spring observations showed most birds to be paired, suggesting that birds present were breeders rather than non-breeders. Large numbers of Shelduck breed on Flatholme island, with a few more on coastal areas and coastal defences around Cardiff. Creches of young birds have been seen crossing the Severn from Flatholme to the Taff/Ely.

At the Rhymney, numbers of Shelduck present in spring 1991 were markedly lower than during the winter, suggesting that many birds leave the site for breeding grounds outside the study area.

In all seasons, the proportion of Shelduck feeding was highest on the falling tide. This is in contrast to observations from the Firth of Forth, where feeding effort was more concentrated on the rising tide (Bryant & Leng, 1975). On the Clyde, there was apparently no preference for either rising or falling tides

(Thompson, 1981). The reason for these regional variations are as yet unknown.

3.2 Wigeon

Wigeon occurred infrequently and in very small numbers in the Taff/Ely and Rhymney estuaries throughout the winter 1990/91. This species was found at low tide on only one count area at St.Brides and one at Peterstone (Figure 3.2.1), again in low numbers at each site.

3.3 Mallard

Autumn 1990

Small numbers of Mallard were recorded feeding during autumn 1990 at both the Taff/Ely and Rhymney estuaries (Figures 3.3.1, 3.3.2). On the Taff/Ely, the majority of birds roosted throughout the tidal cycle (Figure 3.3.3.a), either on the exposed mud or on the open water, where they were not counted. This indicates that measuring feeding effort (as in Figure 3.3.1) does not always give an accurate assessment of actual abundance. On the Rhymney, a higher proportion of the birds that were present on exposed mudflats did feed through the tidal cycle, particularly around low tide and on the advancing tide (Figure 3.3.3.c). No birds were observed at Orchard Ledges. As with winter counts, it was seen that the majority of the Mallard present at either the Taff/Ely or the Rhymney roosted on the open water throughout the tidal cycle and were therefore not counted. Those birds which did feed showed no apparent preference for higher or lower mudflats (Figure 3.3.4.a).

Winter 1990/91

The low tide distribution of Mallard on the north west Severn during winter 1990/91 shows the species to be widespread in the Taff/Ely but patchily distributed elsewhere (Figure 3.3.5). Feeding effort in the Taff/Ely was extremely low (Figure 3.3.6) and was negligible on the Rhymney. The majority of birds present on both sites roosted on the open water or in saltmarsh, where they were not counted, or on the tide line. The number of birds roosting on the tide line on the Taff/Ely fell as the tide receded and birds followed the tide down into the river channels, where birds could not be seen. Numbers rose again after low tide as birds were pushed back up into view (Figure 3.3.7.a). Numbers of Mallard recorded on the Taff/Ely during winter 1990/91 were slightly higher than those recorded during the previous winter (see Evans et al., 1990), although the proportion feeding was much lower.

Counts carried out at high tide of birds roosting on the open water suggested that the actual overwintering populations of Mallard at the Taff/Ely and Rhymney varied between 100 and 200 birds in each case, with occasional higher counts.

On the Rhymney, birds roosted predominantly on the open water on the falling tide, flying back onto the mudflats to roost as the tide rose again (Figure 3.3.7.c). A favoured roost site was on the old wooden piles just east of the Rhymney observation point (Rhymney count area 17). As was noted on the Taff/Ely, the overall numbers of Mallard present on the Rhymney during winter 1990/91 were slightly higher than during the previous winter, but the proportion of birds feeding was lower. The number of count areas on which feeding was recorded was far lower than during the previous winter (Figure 3.3.8.a) and a reduced feeding density was recorded on all count areas relative to the first winter (Figure 3.3.8.b). Feeding was recorded from too few count areas to determine whether birds were feeding preferentially on lower or higher mudflats (Figure 3.3.4.b).

This species was absent from Orchard Ledges.

Spring 1991

This species was not recorded in sufficient numbers at any of the all day sites to allow analysis.

Discussion

Although slightly higher numbers of Mallard were recorded during winter 1990/91 than during the previous winter at both the Taff/Ely and the Rhymney, the proportion of these birds recorded as actually feeding was far lower on both sites. A possible explanation for this is that birds may have been feeding predominantly at night, possibly outside the estuaries, during the second winter. Night feeding is known to occur commonly amongst most wildfowl and waders on estuaries (eg. Clark et al., 1990a). The heavy disturbance during the day in the north west corner of the Taff/Ely, resulting from construction work on the PDR, may have encouraged increased night feeding, although this does not explain the differences observed between the two winters at the Rhymney.

3.4 Teal

Autumn 1990

Small numbers of Teal fed throughout the tidal cycle at the Taff/Ely during autumn 1990 (Figure 3.4.1). Feeding was seen to be concentrated along the channel of the River Taff. A high proportion of the small numbers of birds present on the open mudflats appeared to be feeding around low tide (Figure 3.4.2.a), although the low number of count areas on which this species was recorded makes feeding effort difficult to assess. No birds were recorded at the Orchard Ledges or Rhymney all day sites. Birds were recorded from an insufficient number of count areas in the Taff/Ely to allow an accurate assessment of preference for mudflats of particular heights (Figure 3.4.3.a).

Winter 1990/91

The low tide distribution of Teal on the north west Severn shows birds to be concentrated on the Taff/Ely and St.Brides sections (Figure 3.4.4), with few birds present at Rhymney or Peterstone. Low tide counts (Tables 3.1 to 3.6) showed numbers of Teal to reach a peak in late January, with much reduced numbers present during February.

Most of the Teal feeding in the Taff/Ely during winter 1990/91 fed along the channel of the River Taff (Figure 3.4.5). No birds were recorded on count areas 7 and 9, where they had been recorded feeding during winter 1989/90, but birds were recorded feeding on count area 2, where no feeding had been recorded during the first winter. The overall numbers of Teal fell around low tide as both feeding and roosting birds followed the tide line down into river channels, thus being lost from sight, before being pushed back up by the rising tide (Figure 3.4.6.a). The proportion of feeding birds fluctuated through the tidal cycle but remained low at all times. At the Rhymney the vast majority of birds roosted throughout the tidal cycle. The absence of many deep channels and `blind spots' meant that numbers did not fall around low tide (Figure 3.4.6.c).

As with Mallard, the majority of Teal present at both the Taff/Ely and the Rhymney roosted on the open water or remained hidden in the saltmarsh throughout the tidal cycle. High tide counts of birds roosting on the open water showed the population of Teal in the Taff/Ely rose to around 500 birds early in 1991, and to around 200 birds at the Rhymney. This species was not recorded at Orchard Ledges.

Feeding by Teal on the Taff/Ely appeared to be concentrated on higher mudflats (Figure 3.4.3.b), although this species' habit of feeding at the tide line meant that birds could be missed on lower mudflats.

A comparison of usage values from each winter shows that feeding birds were recorded from more count areas and in generally higher numbers during the first winter (Figure 3.4.7.a). There was a decrease in feeding density on most count areas during the second winter compared with the first (Figure 3.4.7.b).

Spring 1991

This species was not recorded in spring from any of the three all day sites.

Discussion

Changes in the pattern of feeding between the two winters of monitoring mirror those noted for Mallard, with larger numbers of birds present during the second winter but a lower proportion of these feeding. The complete disappearance of feeding birds from two count areas in the north west of the Taff/Ely provides some evidence that the construction work associated with the PDR has caused disturbance to patterns of wildfowl feeding. This does not explain the changes noted on the Rhymney, the reasons for which are unclear.

The majority of Teal wintering in Britain breed in Russia, Fennoscandia and northern Europe (Prater, 1981; Owen et al., 1986). A December or January peak count is usual for this species, with birds beginning to leave for the northern breeding grounds during February. This pattern of movement accounts for the much reduced numbers of Teal recorded from the study area after the beginning of February and the complete absence of this species during Spring.

3.5 Pintail

Autumn 1990

This species was present in autumn only at the Rhymney all day site (Figure 3.5.1). Numbers recorded were too small to assess accurately the proportion of birds which were feeding at each hour of the tidal cycle.

Winter 1990/91

The low tide distribution of Pintail on the north west Severn showed this species to be concentrated around the Rhymney (Figure 3.5.2). This species tended to be under-recorded at low tide due to its habit of forming offshore roosting flocks throughout much of the tidal cycle. Counts of birds roosting on the open water at high tide at Rhymney indicated a population of around 250 birds in January, although many of these moved east towards Peterstone after high tide. Pintail were found to feed predominantly on the lower areas of the Rhymney and on areas along the Rhymney river channel (Figure 3.5.3). A high proportion of the birds recorded on mudflats at Rhymney were feeding around low tide, with this proportion decreasing as birds roosted on the advancing tide (Figure 3.5.4.c). Very few Pintail were seen in the Taff/Ely and none on Orchard Ledges. A comparison of feeding usage of count areas between winters shows that feeding birds were recorded on more areas and in generally higher numbers during the second winter (Figure 3.5.5.a). Feeding density was lower on most count areas during the second winter than during the first (Figure 3.5.5.b).

Spring 1991

Pintail were not recorded from any of the three all day sites during spring 1991.

Discussion

The decline in feeding usage by Pintail at the Rhymney during the second winter of monitoring reflects similar trends recorded for Mallard and Teal. It is thought that, at least in the case of Pintail, some movement of birds to areas east of the Rhymney might have taken place, birds often being seen moving up the Severn in an easterly direction. No such movements were observed for either of the other two species.

Overall numbers of Pintail in the two winters, as measured by counts of birds on the water at high tide, revealed similar overwintering populations to be present in both years, despite the apparent decrease in the number of feeding birds.

The disappearance of Pintail from the Rhymney in spring corresponds to the return migration of this species to the breeding grounds, which lie principally in Russia and Fennoscandia.

3.6 Oystercatcher

Autumn 1990

Although small numbers of Oystercatchers were present feeding along the higher western count areas of the Taff/Ely (Figure 3.6.1), largest numbers were recorded in autumn from Orchard Ledges and the Rhymney (Figure 3.6.2). The area to the east of the Y&P sewer outfall (Rhymney count area 13) held particularly high numbers of both feeding and roosting Oystercatchers.

At the Taff/Ely, numbers peaked four hours before low tide (Figure 3.6.3.a) whereas numbers peaked around low tide at both the Orchard Ledges and Rhymney sites (Figures 3.6.3.b, 3.6.3.c). The proportion of feeding birds was high in all cases, except on

the advancing tide at Orchard Ledges, where the few birds which had not already left the site formed roosting flocks.

Birds feeding at the Rhymney showed no feeding preference for higher or lower count areas, whereas those on the Taff/Ely showed a slight preference for feeding on higher areas (Figure 3.6.4.a).

Winter 1990/91

Low tide counts of the north west Severn during the winter 1990/91 showed Oystercatchers to be concentrated in the Rhymney and Peterstone sections, with few birds present at the Taff/Ely or the eastern end of St.Brides (Figure 3.6.5). Peak numbers on the north west Severn during the winter were reached during March 1991 (Table 3.6).

The very low numbers of this species recorded in the Taff/Ely at low tide match the low numbers of birds found feeding at that site throughout the tidal cycle (Figure 3.6.6), where, as in autumn, feeding was concentrated around the western areas of the estuary. Numbers in the Taff/Ely were lowest around low tide but peaked three hours after low tide (Figure 3.6.8.a). Feeding was more widely recorded on the Orchard Ledges and Rhymney sites than at the Taff/Ely (Figure 3.6.7). Orchard Ledges and the eastern end of the Rhymney site were the areas most frequently used by feeding birds. Lower areas generally held higher densities of feeding birds than higher areas (Figure 3.6.4.b) at the Rhymney. Oystercatchers arrived at Orchard Ledges immediately the area became uncovered by the retreating tide, after which numbers increased to a peak one hour before low tide (Figure 3.6.8.b). Birds were also present on the Rhymney almost throughout the tidal cycle (Figure 3.6.8.c), where numbers rose through the low tide period to a peak three hours after low tide. At both Orchard Ledges and the Rhymney, the proportion of birds which were recorded as feeding were high throughout the tidal cycle.

A comparison of the all day usage values calculated for each count area in each of the two winters of monitoring showed no overall changes to have taken place on the Rhymney, with approximately equal numbers of count areas recording increases and decreases in the second winter (Figure 3.6.9.a). On the Taff/Ely, however, it was found that no count area held feeding birds in both winters, although the total number of count areas involved was too small to determine whether this represented a significant shift in distribution. At the Rhymney, few count areas recorded large changes in feeding density between the two winters (Figure 3.6.9.b).

A comparison of all day usage values calculated for each count area for autumn 1990 and winter 1990/91 shows that on the Taff/Ely, the majority of count areas which were used in either season were used only in autumn, whereas on the Rhymney the majority of count areas were used only in the winter (Figure 3.6.10).

Spring 1991

On the Taff/Ely, the distribution of feeding Oystercatcher followed more closely than in winter the channel of the River Taff (Figure 3.6.11), although overall numbers of this species feeding at the site were similar to those recorded during the winter. At Orchard Ledges, feeding birds were reduced in number relative to the winter, although this site still attracted the largest numbers of Oystercatcher to be found in the whole study site (Figure 3.6.12). The spring feeding distribution of Oystercatchers on the Rhymney was more patchy than that found during the winter, with the species apparently deserting some large count areas (Figure 3.6.12).

Most Oystercatchers were found on the Taff/Ely on the rising tide during spring 1991, although numbers were small (Figure 3.6.13.a), whereas on Orchard Ledges and the Rhymney, numbers

were highest on the receding tide and at around low tide (Figures 3.6.13.a, 3.6.13.b). At both these sites, a high proportion of birds were recorded as feeding, but this proportion was not as high as that recorded during the winter. There appeared to be no preference for feeding on higher or lower mudflats (Figure 3.6.14).

A comparison of feeding usage values calculated for each count area during each of the two spring monitoring periods showed no overall change on the Rhymney but did show an increase in the number of count areas used during the second spring of monitoring on the Taff/Ely (Figure 3.6.15.a). There was no apparent pattern to the changes in feeding density on count areas between years when compared with mudflat height (Figure 3.6.15.b).

Discussion

This species was found to occur throughout the study site in autumn and spring in numbers not dissimilar to those found in winter. Birds present in early autumn and spring are likely to be British breeding and non-breeding birds whose numbers are increased in winter by birds from Iceland, the Faroes and Norway (Prater, 1981). The small groups of Oystercatcher found roosting on Orchard Ledges in spring may have been migrants.

The numbers of birds recorded in winter at each of the three sites throughout the tidal cycle support observations of movements between areas. The Taff/Ely is used primarily by birds displaced from Orchard Ledges by the advancing tide, leading to a winter peak three hours after low tide. Some of these birds remained in the Taff/Ely to roost over high tide (Donald & Clark, 1991). The disappearance of feeding Oystercatcher from the areas around the mouth of the South Glamorgan Canal may have been a result of disturbance in the area arising from construction work on the PDR.

A fall in numbers of Oystercatcher around low tide on the Rhymney, due to a movement of birds to Orchard Ledges, was noted during the first winter of monitoring (Evans et al., 1990). This was not recorded during the second winter of monitoring. The extremely high numbers of Oystercatcher recorded on very low spring low tides on two small areas of broken ground around the mouth of the River Rhymney suggested that birds gathered in this area rather than moving on to Orchard Ledges in the second winter.

3.7 Ringed Plover

Autumn 1990

The feeding distribution of this species was limited to Orchard Ledges and a few count areas on the Taff/Ely and Rhymney (Figures 3.7.1, 3.7.2). The majority of feeding usage values resulted from a few sporadic visits by often sizeable flocks of this species rather than from regular usage by small numbers. Numbers of this species present on the Taff/Ely fluctuated throughout the tidal cycle (Figure 3.7.3.a), indicating that even when large flocks were recorded on that estuary, they were present only for short periods of time. At Orchard Ledges and the Rhymney, numbers throughout the tidal cycle were more stable, although the large standard errors attached to these average numbers show that there was great fluctuation in numbers (Figures 3.7.3.b, 3.7.3.c). Feeding was recorded from too few count areas to determine whether there was any preference for higher or lower count areas (Figure 3.7.4.a), although observation showed large flocks to be present on higher areas. The largest flocks seen at each of the three all day sites were 61 (Taff/Ely, 20th October 1990), 40 (Orchard Ledges, 28th September 1990) and 57 (Rhymney, 26th October, 1990).

Winter 1990/91

Very few Ringed Plover were present at low tide on the north west Severn, with birds only being recorded at two count areas at St.Brides (Figure 3.7.5). The all day counts showed very small numbers to be present at Orchard Ledges and the Rhymney. At Orchard Ledges, peak numbers were recorded three hours before and after low tide, whereas at the Rhymney, peak numbers occurred four hours after low tide (Figures 3.7.6.b, 3.7.6.c). Feeding was recorded on too few count areas to assess whether feeding was concentrated on higher or lower mudflats (Figure 3.7.4.b).

A comparison of feeding usage between the two winters shows that feeding occurred on more count areas during winter 1989/90 than during 1990/91 (Figure 3.7.7.a). Changes in feeding density in relation to mudflat height showed no apparent pattern (Figure 3.7.7.b).

Spring 1991

Ringed Plover were not recorded at any all day site during spring 1991.

Discussion

This species is notoriously difficult to detect due to its cryptic plumage and habit of remaining motionless for long periods of time. It is thus possible that sizeable groups of birds were missed, especially at Orchard Ledges, where the broken nature of the ground makes all species difficult to count accurately. The large autumn flocks of these species almost certainly consisted of passage migrants, possibly en route to wintering grounds as far away as north or west Africa.

The two peaks, three hours either side of low tide, recorded at Orchard Ledges during the winter coincide with times when only the upper flats at this site are exposed. Birds on these areas are more easily detected and it seems likely that numbers of

this species at Orchard Ledges are stable throughout the low tide period. The peak noted four hours after low tide on the Rhymney coincides with a movement of Ringed Plover away from Orchard Ledges due to displacement by the rising tide. The location of the high tide roost of this species in the study area is uncertain, but birds have been seen to roost in previous years just east of Cardiff Heliport (Rhymney count area 1).

Despite the difficulties involved in detecting and accurately counting this species, it seems likely that numbers of this species present in the study area during winter 1990/91 were considerably lower than during winter 1989/90.

3.8 Grey Plover

Autumn 1990

Grey Plover were not recorded at any all day site during autumn 1990.

Winter 1990/91

Low tide counts of the north west Severn showed Grey Plover to be well distributed on the Peterstone section, with further birds present at the western end of the St.Brides section and in the Taff/Ely (Figure 3.8.1). The peak low tide count was in February 1991 (Table 3.5). All day counts showed Grey Plover to be present only on the Taff/Ely site, where birds fed predominantly on areas adjacent to the Windsor Esplanade saltmarsh (Figure 3.8.2). Numbers remained stable throughout the tidal cycle, with a high proportion of birds feeding (Figure 3.8.3.a). Peak numbers of this species were reached in the Taff/Ely during January 1991, when around 25 birds were present, although one observation of a roosting flock of around 50 birds suggests that birds feeding elsewhere may occasionally roost in the Taff/Ely (Donald & Clark, 1991). This species was recorded

in larger numbers on the Taff/Ely during winter 1990/91 than during 1989/90.

Although the numbers of count areas from which feeding was recorded was small, there appeared to be a preference for higher mudflats (Figure 3.8.4). Field observations showed Grey Plover to feed primarily on the higher areas where a clay substrate was overlain by a thin layer of soft mud.

Spring 1991

Grey Plover were not recorded from any all day site during spring 1991.

Discussion

Grey Plover wintering in Britain originate from breeding grounds in northern Russia, from the White Sea to the Taimyr Peninsula (Branson & Minton, 1976). The majority of British wintering birds moult in autumn on the Waddensea or in south east England. There is thus relatively little autumn passage on estuaries in western Britain, accounting for the absence of this species from the study site in autumn. By April, many birds have departed for the breeding grounds, particularly from western estuaries, explaining why no Grey Plovers were seen in the study site during spring.

The increase in numbers of Grey Plover on the Taff/Ely during the winter 1990/91 relative to the previous winter reflects the continuing long-term increase in numbers of this species wintering in Britain. The occurrence of a flock of 50 roosting birds on one occasion in February 1991 is not considered unusual since this species is known to appear in large numbers on estuaries for short periods of time (eg. Clark, 1989; Goodall, 1988). The origins of these mobile flocks in unknown.

The preference for higher, drier mudflats noted on the Taff/Ely during winter 1990/91 accords well with what is known about Grey Plover feeding behaviour. Townshend et al., (1984) showed that wintering Grey Plover which did not hold territories tended to feed on higher mudflats than those holding territories. No evidence of territoriality was noted on the Taff/Ely.

3.9 Lapwing

Autumn 1990

Lapwing were found feeding in the study area primarily in the north west corner of the Taff/Ely (Figure 3.9.1), although a very small number were also present on the Rhymney. Numbers of Lapwing present on the Taff/Ely remained stable throughout most of the tidal cycle, numbers falling off around high tide as birds moved into the saltmarsh or up the River Taff to roost (Figure 3.9.2.a). The proportion of birds which were feeding was high throughout the low tide period. This species showed a preference for higher mudflats (Figure 3.9.3.a).

Winter 1990/91

Low tide counts showed Lapwing to be present on the north west Severn in greatest numbers at St.Brides, although birds were also recorded at the western end of Peterstone and the northern side of the Taff/Ely (Figure 3.9.4). Peak numbers were recorded during January 1991 (Table 3.5), when 785 birds were roosting on the north west Severn at low tide.

As was found to be the case in autumn, feeding Lapwing on the Taff/Ely were found only on mudflats in the north west corner of the estuary (Figure 3.9.5). Numbers of birds recorded at this site peaked soon after high tide as birds left roost sites in the saltmarsh and gathered on the exposed upper mudflats, allowing easy detection. After this, birds moved down onto the

broken lower ground of count area 8 where they were much harder to detect, leading to an apparent fall in numbers (Figure 3.9.6.a). The proportion of birds feeding was low throughout most of the tidal cycle.

Small numbers of Lapwing roosted throughout the tidal cycle at Rhymney (Figure 3.9.6.c). These birds were difficult to locate since they often roosted in saltmarsh around the mouth of the River Rhymney. The actual number of birds present at this site could have been considerably higher than the few recorded.

Feeding usage values were generally lower on the Taff/Ely during the winter 1990/91 relative to the previous winter (Figure 3.9.7.a), with a decline in feeding density on most count areas (Figure 3.9.7.b).

Spring 1991

This species was not recorded from any of the three all day sites during spring 1991.

Discussion

Lapwing is not a truly estuarine species, with the bulk of the British wintering population (which consists of both British breeding birds and Continental immigrants) feeding and roosting on inland fields. During particularly hard weather, many birds move to estuaries when fields and grassland freeze. The Taff/Ely population, however, feeds and roosts on the estuary throughout the winter irrespective of weather conditions. The January peak in numbers occurs as a result of the continuing arrival of birds from Scandinavia. Early return migration, starting in late January and continuing until March, accounts for the absence of this species from the study site in spring, although several pairs were seen defending breeding territories on several areas around the Taff/Ely, particularly in Cardiff Docks.

The most striking difference between the two winters of monitoring was the far lower proportion of birds feeding during the day in the second winter. This was thought to be due to disturbance to the main feeding areas resulting from construction work on the PDR. Instead of feeding around the edge of the Windsor Esplanade saltmarsh, as in previous years, birds followed the tide down to the lower parts of count area 8. Difficulty in detecting birds on this area led to an apparent decline in the population in the second winter.

3.10 Knot

Autumn 1990

This species was not recorded at any of the three all day sites during autumn 1990.

Winter 1990/91

Low tide counts of the north west Severn showed this species to be present on the Peterstone and St.Brides sites (Figure 3.10.1). The species was only recorded in February and March, when large numbers were recorded from a few areas (Tables 3.5, 3.6). All the birds recorded at low tide were feeding.

Only very small numbers of this species were recorded on the Taff/Ely and then only during the extremely hard weather in February 1991.

Spring 1991

This species was not recorded from any of the three all day count sites during spring 1991.

Discussion

This species feeds in large, highly mobile flocks which move within and between estuaries to exploit local, temporary food reserves (Dugan, 1981). Its occurrence on the Taff/Ely and the Rhymney in recent years has been sporadic, although birds occur more regularly on Peterstone and St.Brides.

3.11 Dunlin

Autumn 1990

Feeding Dunlin were recorded from all three all day sites during autumn 1990 (Figures 3.11.1, 3.11.2). On the Taff/Ely, feeding was recorded on an number of count areas, particularly the high count area 4. Numbers of this species on the Taff/Ely were highest on the receding tide, with very low numbers present during low tide and on the advancing tide (Figure 3.11.3.a). On the Rhymney, maximum numbers were recorded through the low tide period, with very few birds present more than two hours before or after low tide (Figure 3.11.3.c). All birds recorded at both the Taff/Ely and the Rhymney were feeding. There was no apparent preference for feeding on higher or lower mudflats, although the bulk of feeding effort on the Taff/Ely was on a high count area (Figure 3.11.4.a).

Very small numbers of birds were recorded on Orchard Ledges during autumn 1990.

Winter 1990/91

The low tide counts carried out on the north west Severn over winter 1990/91 showed very large numbers of Dunlin to be present on the Peterstone and St.Brides sections and at the eastern end of the Rhymney. Smaller numbers were present at the western end of the Rhymney section and on the Taff/Ely (Figure 3.11.5). Peak numbers at low tide were recorded during late January 1991, when over 32,500 birds were feeding west of the Usk (Table 3.4). Low tide counts carried out during winter 1990/91 showed lower numbers of this species present than were recorded during the

previous winter on the Rhymney and Taff/Ely sites, but higher numbers at Peterstone and St.Brides.

Feeding Dunlin were found almost throughout the Taff/Ely during winter 1990/91 (Figure 3.11.6). Highest numbers were recorded on the falling and rising tides, with very few birds present around low tide (Figure 3.11.8.a). All birds were feeding except around high tide, when small numbers of birds occasionally roosted at the site. There was no apparent preference for higher or lower mudflats on the Taff/Ely (Figure 3.11.4.b), although observations indicated that birds were using the highest parts of low-lying mudflats. Overall numbers of this species using the Taff/Ely were considerably lower than those recorded during the first winter of monitoring. Numbers recorded during the second winter would have been higher than they were had the large numbers of this species seen on the Taff/Ely during the cold weather in early February 1991 coincided with an all day count. As it was, these birds were counted during fieldwork on roost sites on the Taff/Ely (Donald & Clark, 1991).

Comparison of the feeding distribution of Dunlin at the Rhymney during the winter 1990/91 (Figure 3.11.7) with that found in the previous winter (Evans et al., 1990) showed a decrease in numbers west of the channel of the River Rhymney but an increase east of the river channel. Numbers of Dunlin on the Rhymney rose as the tide receded and remained high throughout the low tide period before falling off again as birds were displaced by the rising tide. All birds were recorded as feeding almost throughout the tidal cycle, although there were some observations early in the winter of birds roosting on the advancing tide. Feeding on lower count areas accounted for a high proportion of the total feeding effort at this site, indicating a preference for lower mudflats (Figure 3.11.4.b).

Highest numbers of Dunlin on Orchard Ledges were recorded around low tide, when all birds were feeding (Figure 3.11.8.b). This species was not recorded on Orchard Ledges around high tide.

There was a low feeding density of Dunlin at this site (Figure 3.11.4.b).

A comparison of feeding usage values calculated for each count area in each of the two winters of monitoring showed a decrease in usage in the second winter at most Taff/Ely and Rhymney count areas (Figure 3.11.9.a). There were two notable exceptions: Rhymney count area 13 (the area east of the Y&P sewer outfall) which recorded a high usage value in the second winter but was not used at all during the first winter, and Rhymney count area 12 where the usage value was ten times higher in the second winter than the first. These two count areas were the only ones to show an increase in feeding density in the second winter, the majority of count areas showing no change or a reduction in feeding density (Figure 3.11.9.b).

A comparison of feeding usage values calculated for each count area during autumn 1990 with those calculated during winter 1990/91 showed that in the majority of cases autumn usage values were substantially lower than winter values (Figure 3.11.10). No count areas had higher autumn usage values than winter.

Spring 1991

Very small numbers of Dunlin were recorded from the Taff/Ely and Rhymney estuaries during spring 1991, with no birds at all at Orchard Ledges. Small flocks of birds appeared sporadically at unpredictable intervals. On the Taff/Ely, birds were recorded only five hours before and four hours after low tide (Figure 3.11.11.a), matching to some extent the pattern of usage observed during the winter.

Small numbers of feeding Dunlin were recorded feeding on the Rhymney (Figure 3.11.12). Numbers of birds were highest on the receding tide, when all birds were feeding (Figure 3.11.11.c). Although the number of mudflats on which feeding was recorded

was low, there appeared to be a preference for mudflats of lower tidal heights (Figure 3.11.13).

Discussion

Both low tide and all day counts suggested a shift in the feeding distribution of Dunlin between the two winters of monitoring, with higher numbers in the second winter to the east of the Rhymney river channel and lower numbers to the west. Despite this change, the pattern of usage through the tidal cycle at each of the all day sites remained the same. Peaks in numbers of birds on the Taff/Ely on the receding and advancing tides are caused by birds entering the estuary to feed on the higher mudflats, which are exposed by the receding tide at this site before any others in the study area and covered by the advancing tide later. Birds were able to start feeding at this site earlier than Dunlin elsewhere in the study area. As the tide fell, numbers of Dunlin on the Taff/Ely dropped as birds moved to the Rhymney to feed through the low tide period. As these areas became covered over by the advancing tide, birds moved back to the Taff/Ely to feed almost until high tide. This increased feeding time available to the birds was seen to be utilised by large numbers of Dunlin during the extremely cold weather in early February 1991.

The reasons for the apparent increases in the numbers of Dunlin in the eastern half of the north west Severn and the decreases in the western half are not known. The decreases on the Taff/Ely and on the Rhymney are thought to be connected, since the pattern of movements observed since monitoring started indicates that at least some birds use both sites during each tidal cycle. The higher numbers of birds present on the eastern half of the north west Severn may have been due to changes in sediment or increased invertebrate abundance.

The vast majority of Dunlin wintering on the Severn belong to the race alpina, which breeds in northern Scandinavia and Russia. Two other races also occur in Britain. The race schinzii breeds in south east Greenland, Britain, Iceland, the Netherlands and around the Baltic whereas the race arctica

breeds in northern Greenland. Both races winter chiefly in north and west Africa. A very few schinzii and arctica are found amongst wintering alpina on the Severn in winter (Clark, 1983). The small, wandering flocks of Dunlin recorded on the study area in autumn 1990 and spring 1991 were likely to be mainly migrant schinzii with an unknown but probably small proportion of arctica.

3.12 Bar-tailed Godwit

This species was recorded by all day counts in very small numbers on the Taff/Ely and Rhymney estuaries throughout the study period. Low tide counts also showed the species to be present in small numbers at Peterstone and St.Brides (Figure 3.12.1).

3.13 Curlew

Autumn 1990

Feeding Curlew on the Taff/Ely during autumn 1990 were concentrated on two count areas in the centre of the estuary (Figure 3.13.1). Large numbers of birds fed on Orchard Ledges, with smaller numbers spread widely throughout the Rhymney (Figure 3.13.2).

Highest numbers of birds were present on the Taff/Ely on the rising and falling tides (Figure 3.13.3.a). After high tide, birds moved out of the saltmarsh roost site to either continue roosting on the open mud or to start feeding. Numbers dropped towards low tide as birds moved to the recently exposed areas of Orchard Ledges (Figure 3.13.3.b). As the rising tide covered Orchard ledges, birds moved back into the Taff/Ely where the majority of birds formed a sub-roost on the exposed mud adjacent

to the Windsor Esplanade saltmarsh before being pushed onto the high tide roost by the rising tide (Donald & Clark, 1991).

On the Rhymney, highest numbers of Curlew were recorded on the falling tide as birds emerged from the large high tide roost on Peterstone Great Wharf and started to feed on the exposed mudflats (Figure 3.13.3.c). Numbers fell during the low tide period as birds moved to Orchard Ledges and the area of broken ground east of Cardiff Heliport to feed. Numbers remained low on the rising tide as birds were displaced from Orchard Ledges and flew straight into the high tide roost on Peterstone Great Wharf.

There was no apparent overall preference for feeding on higher or lower mudflats (Figure 3.13.4.a), although around low tide it was noticed that most birds fed on lower areas. The two Orchard Ledges count areas held the highest feeding densities of Curlew (Figure 3.13.4.a).

Winter 1990/91

Low tide counts showed Curlew to be well distributed on the north west Severn, with birds being recorded on all count areas (Figure 3.13.5). This represents a spread in distribution relative to the previous winter, when a third of the 21 low tide count areas west of the Usk were not used by this species. Highest numbers of Curlew during winter 1990/91 were recorded in late January 1991 (Table 3.4).

All day counts showed feeding Curlew to be concentrated on the Taff/Ely at only four count areas (Figure 3.13.6). Large numbers fed on Orchard Ledges with smaller numbers evenly distributed throughout the Rhymney site (Figure 3.13.7). Field observations showed that the mud at the extreme western end of Orchard Ledges usually held the highest density of feeding Curlew in the study site. The rocky areas at the end of the channel of the River Rhymney, thought to hold large numbers of the large polychaete

worm *Nereis virens*, held higher densities but these were only exposed on the lowest spring low tides and then only for one or two hours.

There was no apparent preference for feeding on higher or lower areas at the Rhymney, but higher feeding densities were recorded from lower count areas on the Taff/Ely (Figure 3.13.4.b).

The patterns of usage on the Taff/Ely were similar to those in autumn, with highest numbers of birds on the advancing and receding tides and low numbers around high tide (Figure 3.13.8.a). The proportion of birds recorded as feeding was highest around low tide.

On Orchard Ledges, numbers built up to a peak around low tide (Figure 3.13.8.b) as birds moved to the area from the Taff/Ely and from the Rhymney. All birds were recorded as feeding at this site. Much higher numbers of this species were present on Orchard Ledges during winter 1990/91 than were recorded during the first winter of monitoring.

The pattern of usage observed at the Rhymney was very different from that recorded during the autumn, with numbers building up to a peak at low tide and remaining high on the advancing tide (Figure 3.13.8.c). This was thought to be due to birds roosting east of the Rhymney site gradually moving onto the Rhymney as feeding grounds there became exposed. A small increase in numbers three hours after low tide was probably due to the arrival on the Rhymney of birds displaced from Orchard Ledges by the rising tide.

A comparison of the feeding usage values calculated for each count area between the two winters of monitoring shows that there was no overall trend in the pattern of increases and decreases (Figure 3.13.9.a). There was also no apparent trend in the pattern of changes in feeding density between the two winters (Figure 3.13.9.b).

A comparison of the usage values calculated for each count area during autumn 1990 with those from winter 1990/91 showed that on many count areas there was little difference in feeding usage between the two seasons (Figure 3.13.10).

Spring 1991

Feeding Curlew were only found in appreciable numbers on Orchard Ledges during spring 1991 (Figure 3.13.11). Very few feeding birds were recorded from the Taff/Ely or Rhymney sites. The pattern of usage on Orchard Ledges was similar to that observed during autumn and winter, although numbers were lower (Figure 3.13.12.b).

The true numbers of Curlew present on Orchard Ledges during spring 1991 were difficult to assess. Counting this site during spring was more difficult than usual due to the problems of finding birds through a heat haze. In difficult conditions and at a distance, it was not always possible to be sure whether Curlew or the very similar Whimbrel were present, or, if both, in what proportions. Whimbrel were seen in very small numbers at all three all day sites during spring 1991.

Discussion

The Curlew wintering on British estuaries are predominantly British breeders, although an unknown proportion of birds from northern Europe are also present during the winter months (Bainbridge & Minton, 1978). Maximum numbers of this species are found on British estuaries during the autumn (Prater, 1981), although on the Severn maximum numbers are reached in January. The high autumn numbers and slightly higher winter numbers recorded on the study site reflect this pattern of seasonal occurrence.

In a recent study of between-year variability in bird distributions and numbers on the Mersey (Clark et al., 1990a), Curlew was found to be one of the species which showed the least variability. A preliminary assessment of changes in the numbers and distributions of this species in the study area between the two winters of monitoring suggests that this low variability holds true for the Taff/Ely and Rhymney estuaries.

3.14 Redshank

Autumn 1990

Feeding Redshank were widely distributed around the Taff/Ely during autumn 1990, with feeding recorded from all but one count area (Figure 3.14.1). On the Rhymney, feeding Redshank were concentrated on those count areas bordering the channel of the River Rhymney (Figure 3.14.2). This species was not recorded from Orchard Ledges.

Numbers of this species present on the Taff/Ely during autumn 1990 were fairly constant on the receding and advancing tides, although there was a fall in numbers around low tide as birds followed the tide line into channels where they could not be seen (Figure 3.14.3.a). Around high tide, the small number of birds still present on any exposed mud were all roosting. The proportion of feeding birds was high between four hours before and three hours after low tide.

On the Rhymney, the number of birds remained stable through the tidal cycle except around high tide, when the majority of birds were displaced from the count areas (Figure 3.14.3.a). A high proportion of birds were feeding on the receding and advancing tides and around low tide.

There was no apparent preference for feeding on higher or lower mudflats on the Taff/Ely, with too few occupied count areas on

the Rhymney to allow an assessment for that site (Figure 3.14.4.a). Three count areas on the Rhymney, all alongside the river channel, were found to hold particularly high numbers of feeding Redshank.

Winter 1990/91

Low tide counts of the north west Severn during winter 1990/91 showed Redshank to be concentrated on the Taff/Ely and the western end of Peterstone (which falls into the Rhymney all day site), with smaller numbers at the western end of the Rhymney and at the St.Brides sites (Figure 3.14.5). No Redshank were recorded at the St.Brides site during the first winter of monitoring. Low tide counts showed relatively stable numbers of Redshank on the north west Severn throughout the winter (Tables 3.1 to 3.6).

All day counts on the Taff/Ely showed feeding to occur on all count areas, with highest numbers on the western areas of the estuary (Figure 3.14.6). On the Rhymney, feeding Redshank were concentrated on those count areas along the channel of the River Rhymney, in which the vast majority of Redshank fed throughout the tidal cycle (Figure 3.14.7). No Redshank were recorded on Orchard Ledges.

On the Taff/Ely, numbers of Redshank were low around high tide as the majority of birds left the count areas for the high tide roost. Throughout the rest of the tidal cycle, numbers of this species remained fairly stable with a high proportion of birds feeding (Figure 3.14.8.a). The same pattern of usage was recorded at the Rhymney (Figure 3.14.8.c).

On the Taff/Ely, there was no apparent concentration of feeding effort on higher or lower count areas, whereas at the Rhymney there were higher numbers of bird feeding hours on the higher count areas (Figure 3.14.4.b).

A comparison of the usage values calculated for each count area during winter 1990/91 with those calculated for 1989/90 shows that there was generally little change in usage between the two winters (Figure 3.14.9.a). There was no apparent trend to the pattern of changes in feeding density between the two winters (Figure 3.14.9.b).

A comparison of the usage values calculated for each count area during autumn 1990 with those calculated for the winter 1990/91 showed that on approximately half the count areas usage values were the same in both seasons, whereas on the other half of the count areas, usage values were higher in the first winter (Figure 3.14.10).

Spring 1991

Redshank were not recorded from any all day site during spring 1991.

Discussion

As noted by Clark (1989, 1990), the distribution of Redshank on the Severn is concentrated around sub-estuarine river mouths. The Taff/Ely and Rhymney river mouths hold large numbers of this species during the autumn and winter months. Continued monitoring further emphasises the importance of river channels (and, on the Taff/Ely, also dredged approach channels) for this species. On the Rhymney, few birds were recorded feeding away from the steep banks of the channel of the River Rhymney and the majority of birds feeding on the Taff/Ely did so on the soft mud around the river channels. On the few occasions when large numbers of birds roosted for a short time around the low tide period, these roosts were usually found on the sides of steep channels. This habit of feeding in channels led to birds being missed for long periods of time. Counts of roosting flocks at high tide on the Taff/Ely (Donald & Clark, 1991) suggest that

counts of feeding birds may not always provide accurate assessments of the true numbers present.

All day counts carried out during autumn 1990 showed Redshank to be present in approximately the same numbers on both the Taff/Ely and the Rhymney as were found during winter 1990/91. Peak numbers of this species are present on British estuaries in September, when almost the whole British breeding population and a large part of the Icelandic breeding population are present (Prater, 1981). The first low tide count carried out during the winter 1990/91 recorded the highest number of Redshank and had a low tide count been carried out during autumn 1990, even higher numbers may have been recorded. However, peak numbers are reached slightly later on estuaries in the south west than in the rest of the country, since a higher proportion of the birds wintering on these estuaries are of the Icelandic race, which arrives on British estuaries later in the autumn (see Section 2).

The fact that numbers of Redshank observed at the Taff/Ely and at the Rhymney remained stable throughout the period when mudflats were exposed suggests that birds do not move between sites. This supports previous observations (eg. Evans et al., 1990) that the Taff/Ely and Rhymney populations are discrete and site-faithful during the winter months. Further evidence supporting this is presented in Section 2.

The similarity in the feeding distributions and numbers of this species recorded during each of the two winters of monitoring and, on the Taff/Ely, the apparent ubiquity of birds both suggest that Redshank, like Curlew, exhibit little between-year variability in numbers and spread out over the available suitable habitat to feed singly or in small, dispersed flocks. The similarities in the feeding dispersion of these two species were also noted by Goss-Custard (1970).

3.15 Turnstone

Autumn 1990

During autumn 1990, small numbers of Turnstone were found feeding along the western shores of the Taff/Ely and around the mouth of the river Rhymney (Figures 3.15.1, 3.15.2). Larger numbers of this species fed along Orchard Ledges.

Highest numbers of this species on the Taff/Ely were found around high tide (Figure 3.15.3.a) when birds both roosted and fed on the stony banks of the sea wall on the western shore of the estuary. This area remained uncovered on all but the highest tides, when birds often moved to an alternative site further up the River Ely. This accounts for the slight fall in numbers at high tide relative to the hours either side of high tide. Very few birds were seen on the Taff/Ely around low tide.

The sharp drop in numbers of Turnstone on the Taff/Ely around low tide coincides with the appearance of birds on Orchard Ledges (Figure 3.15.3.b). The whole of the Taff/Ely population of Turnstone fed on Orchard Ledges for the whole time that site was exposed. All birds recorded on Orchard Ledges were feeding.

The few feeding birds recorded at the Rhymney occurred mainly on the receding tide. These birds were usually seen to be part of a flock of this species which regularly roosted at various points along the Rhymney shore. The majority of these birds moved to Orchard Ledges as soon as that site became exposed.

Winter 1990/91

Counts carried out at low tide along the north west Severn during winter 1990/91 showed Turnstone to be present only on Orchard Ledges (Figure 3.15.4). Numbers of this species were difficult to assess due to the extreme difficulty in locating birds on the broken ground of Orchard Ledges.

All day counts carried out during winter 1990/91 showed the feeding distribution of Turnstone on the Taff/Ely and Rhymney estuaries to be similar to that found during the autumn (Figures 3.15.5, 3.15.6). Largest numbers of feeding birds were again present along Orchard Ledges.

The patterns of usage were again found to be similar to those observed during autumn 1990. On the Taff/Ely, birds were present around high tide but completely absent during the low tide period (Figure 3.15.7.a). After high tide, when most birds present were roosting, the proportion of Turnstone feeding rose to include all birds before departure for Orchard Ledges.

On Orchard Ledges, numbers of Turnstone remained fairly stable throughout the time the site was exposed. All birds recorded on this site were feeding. It was suspected that the numbers of birds present were higher than counts indicated, due to the difficulties involved in counting this species.

On the Rhymney, this species was only recorded on the falling and rising tides (Figure 3.15.7.c). The few birds recorded on the falling tide soon moved onto Orchard Ledges. Birds arrived at the site on the advancing tide after being displaced from Orchard Ledges. Small roosts were often found along the length of the Rhymney shore.

The patterns of usage noted at each of the three all day sites during both autumn 1990 and winter 1990/91 were very similar to those recorded during the winter 1989/90, although in the second winter higher numbers were present, particularly at Orchard Ledges.

Spring 1991

Feeding Turnstone were present in spring 1991 only on Orchard Ledges, where they were found in lower numbers than during the

winter months (Figure 3.15.8). Small numbers of birds roosted on the Taff/Ely at high tide before leaving the site for Orchard Ledges as that site became exposed (Figure 3.15.9.a). Numbers of this species feeding on Orchard Ledges remained relatively stable throughout the time that site was exposed (Figure 3.15.9.b).

Discussion

The Turnstone wintering in Britain originate from breeding populations in Greenland and Canada, although this species has a circumpolar breeding distribution. High counts of birds during autumn 1990, including one count of nearly 200 birds on Orchard Ledges, probably included large numbers of migrants en route to wintering grounds in West Africa (Branson et al., 1978). By the beginning of April, return passage of wintering birds staging posts en route to the breeding grounds in Greenland and Canada caused a fall in numbers of this species in the study area compared with winter counts. The majority of Turnstone return via Iceland, where birds fatten up before continuing on migration. The few birds still present on the study site in May were possibly birds which were about to migrate back to the breeding grounds without stopping in Iceland. These birds are known to leave the wintering grounds later in the year than those breaking their migration (Clapham, 1979). Alternatively, they may have been first year birds, a proportion of which remain on the wintering grounds during their first summer.

Counts of Turnstone on Orchard Ledges, where birds were hard to detect, usually exceeded those made around high tide on the Taff/Ely, where birds were easily counted. This indicates that Turnstone arrive on Orchard Ledges from the east as well as from the Taff/Ely to the west. Whilst only small numbers of birds were seen feeding at the Rhymney, larger flocks of roosting birds were observed on several occasions. It was thought that the regular roost site of these birds lay just to the east of Cardiff Heliport, out of sight of the Rhymney observation point.

The extent to which birds roosting on the Rhymney intermix on Orchard Ledges with those which roost on the Taff/Ely is not known.

4 CONCLUSIONS

The continuation of intensive monitoring of waterfowl populations and distributions on the Taff/Ely and Rhymney estuaries and extensive waterfowl counts at low tide along the north west Severn have led to a greatly increased understanding of the way birds use intertidal mudflats in these areas. Monitoring such as this is essential if an accurate assessment is to be made of the impacts of development on estuaries. Further monitoring work will allow the changes in populations and distributions of waterfowl between years to be more fully understood and so enable the impact of the proposed Cardiff Bay Barrage to be assessed.

Work carried out for the present study has shown that the patterns of waterfowl movement around and between the Taff/Ely and Rhymney estuaries were similar to those found during the previous season of monitoring. Although no detailed analyses into population changes have been attempted in the present report, counts showed that the wintering populations of certain species had increased or decreased relative to the previous winter. Thus numbers of Shelduck increased on the Taff/Ely and on the north west Severn generally but decreased on the Rhymney. Numbers of Mallard, Teal, Grey Plover and Turnstone were all found to be higher during the second season of monitoring than during the first, although the feeding strategies of the wildfowl species were different. A higher proportion of these species were seen to be roosting during the day than was observed in previous monitoring. This was thought to be at least partly due to heavy disturbance on part of the Taff/Ely. Numbers of Pintail, Oystercatcher, Lapwing, Curlew and Redshank all remained relatively unchanged between the two seasons of monitoring. The numbers of several species, most notably

Shelduck, Pintail and Dunlin, were found to be lower numbers on the Rhymney and, in the case of Dunlin, on the Taff/Ely but higher on the Peterstone and St.Brides areas of the north west Severn. This shift in populations was probably the result of changes in sediment type or changes in the invertebrate populations of certain areas. Further monitoring will reveal whether this change in distribution was a short term effect due to year to year variability in the use made of the north west Severn or was part of a longer term change in distributions in the area.

The short spell of extremely hard weather during February 1991 provided the first opportunity during the present monitoring programme to determine whether freezing conditions altered waterfowl distributions in the study area. Conditions were made particularly harsh by the succession of low neap tides during the worst of the weather. These ensured that the frozen upper mudflats were not covered at high tide and consequently that there was no thawing. Despite this, no major changes in the numbers or distributions were found to take place with the exception of particularly high numbers of Dunlin being present on the Taff/Ely. The sheltered nature of the Taff/Ely estuary was thought to provide some protection to the birds from the extremely cold easterly wind prevalent at the time. It was noted that Dunlin present on the Taff/Ely around this time remained on the estuary throughout the tidal cycle. This represented a completely different pattern of usage to that shown by monitoring at other times, when birds only used the estuary on the rising and falling tides. The importance of the Taff/Ely for this species thus appears to be increased during hard weather.

PART 2 : DISTRIBUTION STUDIES

5 INTRODUCTION

Previous work on the birds of the Taff/Ely and Rhymney estuaries (eg. Ferns, 1987; Worrall, 1988; Clark, 1989,1990; Evans et al., 1990) has investigated distributions and demonstrated patterns of waterfowl movement through the tidal cycle around the north Severn area for most species. One important aspect of the ecology of the overwintering populations of waterfowl in the study area that has received little attention is the rate of turnover, ie. the extent to which birds move around and between estuaries during the winter months. The rate of exchange of Redshank between the Taff/Ely and Rhymney estuaries and the turnover of Redshank were investigated for the present study using observations of 150 dye-marked and colour-ringed Redshank which were caught and marked on the Taff/Ely in January 1991. This species was investigated for several reasons:

1. Although this species was never seen to leave the Taff/Ely during the winter, the extent to which the Taff/Ely population is physically discrete from other Redshank populations on the Severn, particularly that on the Rhymney, was not known. Previous work has demonstrated the movement patterns of most other species around the study site.

2. Redshank frequently roosted in the Taff/Ely at high tide during the winter 1990/91 on the partially constructed banks of the Peripheral Distributor Road (PDR) embankment and the waste land to the north of the construction site (Donald & Clark, 1991). The use of these suitable catching sites made it more likely that a larger sample of the population could be caught than would be possible with any other species.

3. This species occurs in large numbers on the Taff/Ely and Rhymney estuaries on areas close to suitable observation points, from where the dye and colour rings (or their absence) would be easily visible. Most other wader species fed further from the

shore, which would have made observation of colour marks more difficult.

4. It has long been known that Redshank wintering in Britain originate from both Icelandic and British breeding populations (eg. Ogilvie, 1963; Hale, 1973). Although these two races cannot be distinguished in the field, certain measurements, such as wing length and bill length, are known to differ on average between the two populations (Witherby et al., 1940). Complex statistical methods for estimating the proportion of each population present in a mixed flock have been developed (Summers et al., 1988). The proportions of Icelandic and British breeding birds wintering on the Taff/Ely was unknown. Measurements taken during the ringing and colour marking process would allow an assessment of the proportions of these two populations using the Taff/Ely outside the breeding season.

Previous work has shown many wader species to be site faithful between winters (eg. Clark, 1983) and within winters (eg. Symonds et al., 1984), with certain individuals of several species actually defending winter territories. This behaviour has been well documented for the Grey Plover (Townshend, 1985). In one study on the Firth of Forth (Symonds et al., 1984), Turnstone, Grey Plover, Oystercatcher and Redshank all showed a high degree of site fidelity throughout the winter and a high proportion of birds returned to the same estuary in subsequent winters. Other species, particularly Knot, form large and highly mobile flocks which move freely within and between estuaries through the winter in order to exploit locally abundant food sources. Even these species, however, are traditionally associated with certain estuaries where large numbers of birds arrive every year.

The observation of colour-marked Redshank in order to determine the winter turnover of this species on an individual estuary has previously been carried out on the Inner Clyde (Furness &

Galbraith, 1980). The results of the present survey are compared with the results of these observations.

6 METHODS

On 20th January 1991, 151 Redshank were caught using cannon nets at high tide by BTO workers on the waste ground to the north of the PDR construction site on the west bank of the Taff/Ely estuary. Intensive counts at high tide the day before birds were caught showed the total number of Redshank present in the Bay to be 370 birds. This figure corresponded well with counts carried out as part of the distribution studies.

The Redshank were aged, weighed and measured and fitted with a metal BTO ring embossed with a unique letter and number code to allow individual identification in the event of the bird being retrapped. Measurements taken included wing length, bill length, total head length and tarsus and toe length as well as an assessment of the state of moult. 133 adult birds were then colour-ringed with yellow over white plastic rings on the right leg and dye-marked with an application of rhodamine B dye dissolved in isopropyl alcohol to the breast and underwings. The 14 first-year birds were dye-marked on the vent and tail but were not colour-ringed.

When first applied, rhodamine is a dark purple dye. This colour fades to pink after a few weeks and is visible at a considerable distance for around three months. Colour marking does not affect the bird's behaviour or the behaviour of other birds towards it. Colour rings normally remain on the bird for the duration of its life. The presence of these rings will allow future assessments to be made of the proportion of Redshank returning to the Taff/Ely in subsequent winters.

Intensive observations of Redshank on the Taff/Ely did not commence until one week after the ringing operation, giving time for the birds to revert to their normal patterns of behaviour if

the ringing operation had interrupted them. Such disturbance was noted after cannon-netting on the Clyde (Furness & Galbraith, 1980). After this settling down period, observations of Redshank were carried out regularly on the Taff/Ely and irregularly on the Rhymney until the end of February. After this time, numbers of Redshank declined considerably as a result of birds returning to the breeding grounds (see Section 3.14). The few birds present in March were difficult to observe closely, although a few counts of small numbers of colour-marked birds were obtained during the last week of March. All Redshank had left the estuary by the beginning of April (Section 3.14).

Local observers were informed of the presence of colour-marked birds and asked to submit details of sightings.

Observations of Redshank on the Taff/Ely were carried out primarily on two areas of the estuary (Figure 6.1). On the advancing and, particularly, retreating tides, large numbers of Redshank were often found feeding on the exposed mudflats adjacent to Ferry Road on the western shore of the estuary (Site A in Figure 6.1). Birds in this area were easily viewed from a car and colour markings were usually visible in all weather conditions. As the tide advanced or retreated, birds either left the area for their high tide roost or followed the tide down into the channel of the River Taff, where they were lost from view. At low tide, many birds gathered to feed along the banks of the Entrance Channel on the eastern side of the estuary (Site B in Figure 6.1). Birds were more distant at this site and the deep, soft mud frequently obscured the leg rings. Thus observations could only be carried out in good visibility.

Large numbers of Redshank were visible from the Rhymney all day observation point. Attempts to assess the proportion of marked birds at high tide roosts on both the Taff/Ely and the Rhymney proved futile. Birds were too closely packed to allow more than a few birds to be seen in detail.

On each count, the largest possible number of Redshank on which it was possible to determine the presence or absence of colour markings was counted and the numbers of colour marked adults and first year birds noted. Several counts were made and the largest total count used to calculate the proportion of colour marked birds present. If groups of birds were counted at more than one site on the estuary or at different times of day, the highest total counts at each site or during each period of observation were summed and the proportion of colour-marked birds calculated.

The proportion of colour-marked birds observed on the Taff/Ely on each count date was compared with the proportion of birds known to be marked on the day of capture. If the proportion of marked birds decreased, it could be assumed that Redshank were moving around estuaries during the winter. Additionally, the proportions of marked adults and first year birds at each of the two main observation sites on the Taff/Ely were compared in an attempt to determine whether either area was favoured by a particular age group.

The biometric data collected during the ringing operation were analysed by Dr.P.N.Ferns and J.Tobias of University College, Cardiff using the following discriminant function analysis:

x = [6.05220 x bill(mm)] + [8.09453 x wing(mm)] - 779.02026
y = [5.27091 x bill(mm)] + [8.65678 x wing(mm)] - 839.82202
If x > y, there is a 83% certainty the bird is British
If y > x, there is a 93% certainty the bird is Icelandic

The analysis is based upon the an examination of museum skins, so a correction factor to allow for shrinkage of the museum specimens was applied to the biometric data obtained from the Redshank ringed on the Taff/Ely to allow direct comparison.

Results of the discriminant function analysis of data collected from birds on the Taff/Ely are compared with similar data collected from birds on the wider Severn.

7 RESULTS AND DISCUSSION

The results of observations carried out to assess the proportions of colour-marked birds on the Taff/Ely and Rhymney estuaries are shown in Tables 7.1 to 7.3.

The proportion of marked adults and first-year birds on the Taff/Ely remained similar to that known to be present on the day of capture during the first month after catching (Figure 7.1). The observed proportion of marked birds was generally slightly lower than the proportion known to be marked. This was thought to be the result of colour marks being missed rather than to birds leaving the estuary. This was confirmed by the virtual absence of colour-marked birds from the rest of the north shore of the Severn; only one colour-marked adult was seen on several occasions on the Rhymney. This was the only record of colour-marked birds being seen outside the Taff/Ely up to the beginning of March. Thus there was no large scale movement of Redshank into or out of the Taff/Ely between 20th January and 20th February 1991. Clearly during the winter 1990/91, there was virtually no interchange between the Taff/Ely and Rhymney populations of this species.

Much lower numbers of Redshank were present on the Taff/Ely during March 1991 than had been present during the previous two months (see Section 3.14). This was thought to be due to birds leaving the estuary to return to the breeding grounds. The presence of two colour-marked adults at Llyn Bach, Porthmadog, Gwynedd on the 11th and 12th of March indicated that at least some of the Taff/Ely wintering population were moving north. The few observations possible on the Taff/Ely during March 1991 (Table 7.3) showed a very low proportion of colour-marked birds to be still present on the estuary. One bird ringed on the Taff/Ely on the 20th January 1991 was found dead in Lancashire on 22nd of April, having swallowed the hook on the end of a length of discarded fishing line.

The relative proportions of marked and unmarked birds at each of the two main observation areas (see Figure 6.1) are shown in Figure 7.2. These values are calculated from data collected during January and February 1991 only. At site A, the proportion of marked adult and first-year birds observed during the month after the capture date was not significantly different from that found on the capture date itself (χ^2 = 1.9, $p>0.05$). At site B, however, the proportion of marked adult and first-winter birds was significantly different from that found on the capture date (χ^2 = 8.48, $p<0.01$). A higher proportion of marked first-winter birds and a lower proportion of marked adults were observed than would have been predicted from the initial capture data.

The results of discriminant function analysis of the biometric data collected from the sample of Redshank caught on the Taff/Ely for the present study are given in Table 7.4. These show that approximately two thirds of the wintering population of Redshank on the Taff/Ely are British breeders and one third Icelandic breeders. These results compare well with previous estimates of the relative proportions of the two races wintering on the Severn as a whole (Allen, 1986) (Table 7.5).

Further analysis of the biometric data by Dr.P.N.Ferns and J.Tobias, suggested that the Icelandic birds were further advanced in their moult into summer plumage than the British breeders (Table 7.6). The apparently low proportion of first-winter birds of the Icelandic race (Table 7.7) should be viewed with extreme caution, since the sample size is small, and, since the discriminant functions were calculated from skins of adult birds, the is a degree uncertainty as to whether the discriminant function analysis used is valid for immature birds. It should also be noted that first-winter birds may be very slightly smaller than adults, which may cause a proportion of Icelandic first-winter birds being classified as British birds.

On the date of capture, one Redshank was found to be already ringed and colour-ringed. BTO records show that this bird had

been ringed as a breeding adult on 21st May, 1985 at Grogary Loch, South Uist (Outer Hebrides). A colour-ringed Redshank observed on the Taff/Ely on 18th February 1988 had also been ringed on South Uist, in May 1986 (P.N.Ferns, pers comm.). This bird was present on the Taff/Ely until at least the end of February 1991. The breeding Redshank of the Outer Hebrides are now known to be entirely migratory, with available evidence suggesting that birds breeding on the Western Isles regularly winter on the Taff/Ely.

The lack of movement of Redshank found to occur between the Taff/Ely and Rhymney estuaries supports similar observations of this species made on other estuaries, particularly the Firth of Forth (Symonds et al., 1984), the Wash (Minton, 1975) and the Firth of Clyde (Mackie, 1976). Later observations on the Inner Clyde (Furness & Galbraith, 1980) showed that during the early winter, colour-marked Redshank roosted in the same roost from which they were caught. The proportion of marked to unmarked birds remained the same as that known to be present on the date of capture, but numbers fell substantially throughout the winter. This was thought to be due to unusually low numbers of Corophium (the main Redshank prey species on this estuary).

Some Redshank hold winter feeding territories whilst others feed in loose flocks. Observations of birds with distinctive patterns of dye showed some birds always to be present on certain areas, although other distinctively marked birds appeared at both the main observation areas. The proportion of birds holding winter territories was thought to be low and territoriality was not thought to be an important contributory factor to the sedentary nature of this species.

The proportions of marked to unmarked birds on the Taff/Ely did not change significantly between the date of capture in mid January 1991 and the end of February 1991. Overall numbers of this species also remained relatively stable during this period, although the difficulties involved in making accurate counts of

this species on the Taff/Ely may have obscured some movement of birds away from the area. What is certain is that during the months concerned there was no significant turnover of Redshank on the Taff/Ely. Had birds arrived on the estuary after the capture date, the proportion of marked birds would have decreased. Even during the hard weather in early February 1991 there was no detectable change in the numbers of Redshank present on the Taff/Ely or in the proportion of marked birds. This indicated that there was no influx onto the estuary of birds wintering elsewhere (as there was with Dunlin) and that wintering birds did not leave the area.

Numbers of Redshank present on the Taff/Ely fell considerably during March 1991 and birds became more difficult to observe closely as they tended to feed on more central areas of the estuary. The few observations possible during this time showed that the proportion of marked birds was far lower than on the date of capture and throughout February. This indicated that there had been a movement of wintering birds out of the estuary, with these birds being replaced to some extent by passage migrants. Observations of Ringed Plover and Turnstone on the Solway Firth (Moser & Carrier, 1983) and of Redshank on the Clyde (Furness & Galbraith, 1980) have shown that population turnover of these species on spring passage may be high. Thus whilst winter counts of this species give an accurate estimate of the numbers of birds using the Taff/Ely estuary, the numbers of birds using the estuary on passage are as yet impossible to estimate.

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Species	Mean Peak Winter Count	% British Population	% European Population
Oystercatcher	38	0.01	-
Lapwing	114	0.01	0.01
Ringed Plover	45	0.20	0.09
Grey Plover	19	0.09	0.01
Turnstone	66	0.15	0.09
Curlew	94	0.10	0.03
Redshank	615	0.82	0.41
Knot	281	0.13	0.08
Dunlin	4193	0.98	0.30

Table 1.1 The National and International Importance of the Taff/Ely Estuary for Waders, 1986/87 to 1990/91. (Data for wildfowl species not available at time of publishing).

Species	Mean Peak Winter Count	% British Population	% European Population
Shelduck	2833	3.80	1.10
Oystercatcher	692	0.25	0.08
Lapwing	2904	0.29	0.15
Ringed Plover	265	1.15	0.53
Grey Plover	1039	4.95	0.69
Turnstone	421	0.94	0.60
Curlew	3300	3.63	0.94
Black-tailed Godwit	21	-	-
Bar-tailed Godwit	55	0.09	0.05
Redshank	2693	3.59	1.80
Knot	3188	1.45	0.91
Dunlin	49198	11.44	3.51

Table 1.2 The National and International Importance of the Severn Estuary for Waders and Shelduck, 1986/87 to 1990/91. (Data for other wildfowl species not available at time of publishing).

COUNT 1: 17/18 NOVEMBER 1990

SPECIES	NUMBER FEEDING	NUMBER ROOSTING
OYSTERCATCHER	72	50
LAPWING	0	50
RINGED PLOVER	0	0
GREY PLOVER	25	0
KNOT	0	0
DUNLIN	1451	0
CURLEW	94	30
BAR-TAILED GODWIT	0	0
REDSHANK	711	1
TURNSTONE	10	0
SHELDUCK	502	47
MALLARD	10	72
TEAL	0	250
PINTAIL	0	0

Table 3.1. The Number of Waterfowl present on the North West Severn on 17/18th November 1990.

COUNT 2: 1/2 DECEMBER 1990

SPECIES	NUMBER FEEDING	NUMBER ROOSTING
OYSTERCATCHER	209	0
LAPWING	0	197
RINGED PLOVER	0	0
GREY PLOVER	40	0
KNOT	0	0
DUNLIN	8002	0
CURLEW	243	12
BAR-TAILED GODWIT	3	0
REDSHANK	608	20
TURNSTONE	35	0
SHELDUCK	740	70
MALLARD	460	131
TEAL	620	231
PINTAIL	40	0

Table 3.2. The Number of Waterfowl present on the North West Severn on 1/2 December 1990.

COUNT 3: 15/16 DECEMBER 1990

SPECIES	NUMBER FEEDING	NUMBER ROOSTING
OYSTERCATCHER	104	7
LAPWING	0	0
RINGED PLOVER	39	0
GREY PLOVER	4	0
KNOT	0	0
DUNLIN	7621	0
CURLEW	197	0
BAR-TAILED GODWIT	0	0
REDSHANK	690	0
TURNSTONE	73	0
SHELDUCK	904	30
MALLARD	20	80
TEAL	250	175
PINTAIL	0	1

Table 3.3. The Number of Waterfowl present on the North West Severn on 15/16 December, 1990

COUNT 4: 13/14 JANUARY 1991

SPECIES	NUMBER FEEDING	NUMBER ROOSTING
OYSTERCATCHER	135	0
LAPWING	3	454
RING PLOVER	0	0
GREY PLOVER	0	0
KNOT	0	0
DUNLIN	16320	0
CURLEW	282	2
BAR-TAILED GODWIT	5	0
REDSHANK	679	40
TURNSTONE	80	0
SHELDUCK	820	10
MALLARD	536	99
TEAL	550	464
PINTAIL	45	0

Table 3.4. The Number of Waterfowl present on the North West Severn on 12/13 January 1991.

COUNT 5: 26/27 JANUARY 1991

SPECIES	NUMBER FEEDING	NUMBER ROOSTING
OYSTERCATCHER	259	0
LAPWING	0	785
RINGED PLOVER	0	0
GREY PLOVER	179	7
KNOT	0	0
DUNLIN	32684	0
CURLEW	225	115
BAR-TAILED GODWIT	15	0
REDSHANK	371	0
TURNSTONE	40	0
SHELDUCK	1245	2
MALLARD	5	67
TEAL	864	313
PINTAIL	9	0

Table 3.5. The Number of Waterfowl present on the North West Severn on 26/27 January 1991.

COUNT 6: 16/17 FEBRUARY 1991

SPECIES	NUMBER FEEDING	NUMBER ROOSTING
OYSTERCATCHER	200	6
LAPWING	0	10
RINGED PLOVER	32	0
GREY PLOVER	202	0
KNOT	6764	0
DUNLIN	17528	0
CURLEW	133	0
BAR-TAILED GODWIT	1	0
REDSHANK	602	0
TURNSTONE	75	0
SHELDUCK	1309	30
MALLARD	53	56
TEAL	40	51
PINTAIL	31	0

Table 3.6. The Number of Waterfowl present on the North West Severn on 16/17 February 1991.

COUNT 7: 2/3 MARCH 1991

SPECIES	NUMBER FEEDING	NUMBER ROOSTING
OYSTERCATCHER	278	1
LAPWING	0	2
RINGED PLOVER	30	0
GREY PLOVER	92	0
KNOT	4880	0
DUNLIN	17471	0
CURLEW	276	17
BAR-TAILED GODWIT	0	0
REDSHANK	375	0
TURNSTONE	34	0
SHELDUCK	779	71
MALLARD	189	4
TEAL	74	70
PINTAIL	27	0

Table 3.7. The Number of Waterfowl present on the North West Severn on 2/3 March 1991.

Date	Site	Total Birds	Numbers marked (%) Adults	First-yrs
20/1/91	Taff/Ely	370	133 (35.9)	14 (3.8)
29/1/91	Taff/Ely	204	56 (27.5)	6 (2.9)
30/1/91	Taff/Ely	111	33 (29.7)	10 (9.0)
31/1/91	Taff/Ely	54	21 (38.8)	3 (5.5)

Table 7.1. Numbers and proportions of colour-marked Redshank in January 1991. The date of capture of the Redshank is represented by the shaded line.

Date	Site	Total Birds	Numbers marked (%) Adults	First-yrs
1/2/91	Rhymney	120	1 (<1.0)	0
1/2/91	Taff/Ely	230	73 (31.7)	6 (2.6)
4/2/91	Taff/Ely	275	79 (28.7)	12 (4.3)
5/2/91	Rhymney	410	0	0
5/2/91	Taff/Ely	39	11 (28.2)	1 (2.5)
6/2/91	Taff/Ely	163	57 (34.9)	9 (5.5)
7/2/91	Taff/Ely	193	63 (32.6)	6 (3.1)
8/2/91	Taff/Ely	199	60 (30.1)	9 (4.5)
9/2/91	Taff/Ely	210	62 (29.5)	10 (4.7)
16/2/91	Taff/Ely	212	79 (37.2)	8 (3.7)
18/2/91	Rhymney	130	1 (<1.0)	0
19/2/91	Taff/Ely	245	83 (33.8)	9 (3.6)
20/2/91	Taff/Ely	228	79 (34.6)	10 (4.3)

Table 7.2. Numbers and proportion of colour-marked Redshank in February 1991.

Date	Site	Total Birds	Numbers marked (%) Adults	First-yrs
1/3/91	Rhymney	90	0	0
21/3/91	Taff/Ely	20	1 (5.0)	0
22/3/91	Taff/Ely	28	1 (3.5)	0

Table 7.3. Numbers and proportion of colour-marked Redshank in March 1991.

	British	Icelandic	Total
Number of Redshank	94	56	150
Percentage of Total	62.7	37.3	

Table 7.4. The racial composition of the Taff/Ely wintering Redshank population, based upon a sample caught on 20th January 1991. Note that the figures given can only be regarded as approximate, since the discriminant function analysis has attached confidence limits.

	British	Icelandic	Total
Number of Redshank	181	90	271
Percentage of Total	66.8	33.2	

Table 7.5. The racial composition of the Severn Estuary wintering Redshank population based upon data collected around the Severn Estuary between 1972 and 1983 (from Allen, 1986). Note that the figures given can only be regarded as approximate, since the discriminant function analysis has attached confidence limits.

	Plumage Index							Total	Average Site
	1	2	3	4	5	6	7		
British	19	11	24	15	2	2	3	76	2.7
Icelandic	13	3	12	5	8	3	2	46	3.1

Table 7.6. The stage of moult into summer plumage of Redshank of two races classified by discriminant function analysis. Data collected from 151 birds on the Taff/Ely on 20th January 1991. The plumage index ranges from 1 (full winter plumage) to 7 (full summer plumage). Note that the figures given must be regarded as approximate, since the discriminant function analysis has attached confidence limits.

	British	Icelandic
Adults	83	54
First-winters	12	2

Table 7.7. The population structure of Redshank of two different races of Redshank wintering on the Taff/Ely. Birds were assigned to race on the basis of discriminant function analysis. The figures given are therefore approximate. See also the caveats on Page 57.