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A case study of the impacts of pipeline construction on bird distribution in the Duddon Estuary.

by

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EXECUTIVE SUMMARY

This report was commissioned by British Gas to investigate the impact of gas pipeline construction on waterfowl in the Duddon Estuary. Although there have been numerous pipelines laid across estuaries, little work has been done on the effects of disturbance on the sediments, invertebrates or feeding waterfowl. This project acts as a case study for assessing the impacts of pipelines on birds in estuaries.

In 1987 British Gas laid a gas pipeline across the Duddon Estuary and propose to construct another pipeline, along a nearby route in 1992. A preliminary study of the Duddon Estuary by the ITE in 1991 made several recommendations for studies relating to the environmental impacts of constructing pipelines, and the objectives of this project are in response to their first three recommendations.

The first objective of this project was to survey the birds present at low water on the whole intertidal area of the estuary during the winter and spring of 1991/92. This was to establish the areas of importance for feeding waders and to determine whether the routes for the proposed new pipeline and the existing pipeline crossed these areas of importance. A repetition of this baseline survey would enable any further detailed studies on the effects of the new pipeline, to be divorced from natural shifts in bird distribution within the estuary. The results of this general survey of the whole estuary are presented in the first part of this report. All species reached their peak numbers in winter, except for Ringed Plover which was present in the highest numbers in the spring. Although the feeding and roosting distribution patterns varied between species, the highest numbers of birds were generally found on the south shore of the estuary, north and south of Askam. A high proportion of four species were present in the vicinity of the pipeline routes. These were Dunlin, Redshank, Oystercatcher and Curlew.

The second objective of this project was to carry out a detailed survey of the birds using the area around the existing pipeline route during the winter of 1991/92. This was to determine whether the distribution of the birds on a local scale was affected by the pipeline constructed four years previously.

The third objective of this project was to carry out a detailed survey of the birds in the area of the proposed pipeline route. This would establish the distribution of the birds in the 1991/92 winter and could be repeated after the pipeline had been constructed to assess any immediate changes in distribution.

As the two pipeline routes were so close together, the second and third objectives were carried out simultaneously and are presented together in the second part of the report. There was no apparent evidence of any residual effects of the existing pipeline on the distribution of birds in the area. The detailed survey carried out will provide a baseline for any future studies.

It is recommended that the low tide survey and the detailed transect survey are repeated in the winter following construction of the new pipeline. This will enable any shorter term impacts of pipeline construction on the bird distributions to be assessed.

1. INTRODUCTION

The Duddon Estuary is situated in the south-west corner of the Lake District, near Barrow-in Furness. In 1987 British Gas laid a gas pipeline across the estuary between Askam and Millom. A new pipeline will be constructed, along a route nearby, in 1992.

A wetland is considered Internationally Important if it regularly holds 1% of the individuals in a population of one species or subspecies of waterfowl, while any site regularly holding a total of 20,000 waterfowl also qualifies. Britain and Ireland's wildfowl belong to the north-west European population (Pirot et al. 1989), and the waders to the east Atlantic flyway population (Smit and Piersma 1989). A wetland in Britain is considered Nationally Important if it regularly holds 1% of the estimated British population of one species or subspecies of waterfowl (Kirby et al. 1990).

The Duddon Estuary has a very high conservation value and in 1991 five previously separate SSSIs (Duddon Sands, Haverigg Haws, Hodbarrow Lagoon, North Walney and Sandscale Haws) were amalgamated to form a single SSSI (6814 ha.) which encompasses the whole estuary. Although it is not currently designated as such, the Duddon also qualifies as a Ramsar site and Special Protection Area (SPA). The Duddon Estuary is of international and national importance for wintering waders and wildfowl and provides a vital link in the chain of west coast estuaries used by migrating birds (Tables 1.1 and 1.2). Although the key areas for high tide roosts for waders and wildfowl had been studied for many years in the Birds of Estuaries Enquiry (BoEE), the key low tide feeding areas were not so well defined.

This project was commissioned by British Gas in order to assess the potential problems, in relation to the important waterfowl populations using the estuary, which may be posed by the construction of a new gas pipeline.

The first objective of this project was to survey the birds present at low water on the whole intertidal area of the estuary during the winter and spring of 1991/92. This was to establish the areas of importance for feeding waterfowl and to determine whether the routes for the proposed new pipeline and the existing pipeline crossed these areas of importance. The survey also provides a repeatable baseline, against which overall shifts in waterfowl distribution on the estuary can be identified in any future studies. The results of this general survey of the whole estuary are presented in the first part of this report.

The second objective of this project was to carry out a detailed survey of the birds using the area around the existing pipeline route during the winter of 1991/92. This was to determine whether the distribution of the birds on a local scale was affected by the pipeline constructed four years previously.

The third objective of this project was to carry out a detailed survey of the birds in the area of the proposed pipeline route. This would establish the distribution of the birds in the 1991/92 winter and could be repeated after the pipeline had been constructed to assess any immediate changes in distribution.

As the two pipeline routes were so close together, the second and third objectives were carried out simultaneously and are presented together in the second part of this report.

2. METHODS

2.1 Data Collection

To obtain extensive data on how waterfowl utilise the intertidal areas of the estuary, fortnightly counts were carried out around low water, through the 1991/92 winter and spring by a team of experienced volunteers. Before the counts started in early December, the estuary had been divided into forty sections (count areas) (Figure 2.1.1).

This division of the estuary was done with the help of local knowledge from the volunteers and in such a way that the count areas could be distinguished between counts. It was necessary to count from both sides of the estuary and so, to avoid double counting, central channels were used for some of the count area boundaries. Sight lines were also to mark boundaries of count areas across the estuary. In the event of river channels migrating, count areas separated by channels would have to be amalgamated up to the nearest permanent sight lines, in future studies. Although there were some channel movements during the period of the 1991/92 survey, these were not of any great magnitude.

Changes in habitat or substrate type were also used to separate count areas. The intertidal area is, for the most part, composed of sand. This grades from highly mobile coarse sand, forming mega-ripples in the lower half of the estuary, to fine sand and silt in the sheltered areas upstream of Askam pier. Stretches of raised saltmarsh flank the upper reaches of the estuary (count areas 17, 21, 26, 27, 28, 30 and 32) and by North Walney (count area 2). The only zones of rocky shore are situated east of North Walney (count areas 3, 4 and 7). *Spartina* grades from dense cover to scattered clumps within count area 5. The river channels were included in the adjacent count area, except for count areas 39 and 40 which were composed of main river channels and the adjacent banks at the mouth of the estuary.

Eight counts were carried out during the winter, between December and March, and four counts through the spring, in April and May (Table 2.1.1). Volunteers recorded the number of each species feeding and the number of each species roosting on a count area.

Should a further survey of the pipeline area be carried out after construction, repetition of the low tide counts will be necessary to show whether any shift in distribution is due to a local event, such as the pipeline, or has occurred throughout the estuary.

2.2 Data Analysis

For each species recorded on the estuary an average was calculated for the numbers feeding and the numbers roosting on each count area in each season. The distribution of feeding birds during the winter was plotted for each species with an average of more than five birds. For species which showed a high proportion roosting at low water during the winter, such as many of the duck species, the winter roosting distribution was also plotted. For species which had an average of more than 25 birds feeding on a count area during the spring, the feeding distributions were plotted. Of these species only Shelduck had a high proportion roosting at low tide during the spring. These distribution patterns are presented in the following sections with a short account for each species. In the

following section, the 'pipeline area' refers to the area covered within the detailed survey around the two pipeline routes (Figure 2.2.1).

3. RESULTS AND DISCUSSION

A summary of the low tide counts is presented in Tables 3.1-3.3. Table 3.4 gives the current qualifying levels for national and international importance for waders and wildfowl. If species on the Duddon has reached either of these qualifying levels it is stated in the following species accounts.

3.1 Pink-footed Goose

The highest numbers of Pinkfeet were recorded in February and early March, feeding on the raised saltmarsh at the head of the estuary (Figure 3.1.1). No Pinkfeet were observed in the area of the pipeline and all birds had left the estuary by late March.

3.2 Greylag Goose

Small numbers of Greylags were also observed feeding on the saltmarsh near the head of the estuary from mid-January to early April (Figure 3.2.1). It is likely that the majority of these birds were feral. No Greylags were recorded in the area of the pipeline.

3.3 Shelduck

The Duddon Estuary is a nationally important site for Shelduck during the winter. Shelduck were recorded feeding on virtually all count areas throughout the estuary during the winter, but the highest concentrations were found on sandy intertidal areas adjacent to saltmarsh (count areas 6 and 29) (Figure 3.3.1). On average, 40% of the Shelduck recorded were roosting at low water, these mainly occurred on the upper half of the estuary and adjacent to Walney Island (Figure 3.3.2). Around 600 Shelduck were present on the Duddon during the winter and numbers only dropped by about 20% during the spring counts, as many birds also use the Duddon Estuary as a breeding site. The feeding and roosting distributions were similar in both seasons although slightly less extensive during the spring (Figures 3.3.3 and 3.3.4). Small numbers of Shelduck were present on the pipeline area in winter and spring.

3.4 Wigeon

Wigeon were only recorded on a few count areas of the estuary, north of Askam and around north Walney, between December and February; the majority of Wigeon were roosting at low water (Figures 3.4.1 and 3.4.2). Small numbers of Wigeon were present on the pipeline area.

3.5 Mallard

The highest numbers of Mallard were recorded in mid-winter, with the majority roosting at low water. Feeding Mallard were not widespread on the estuary (Figure 3.5.1), but roosting birds were recorded on most count areas away from the mouth of the estuary (Figure 3.5.2). Mallard were only present in small numbers on the pipeline area.

3.6 Pintail

The Duddon is nationally and internationally important for Pintail during the winter. Large numbers of Pintail were recorded during the winter, feeding and roosting along the river channels in the upper half of the estuary (Figures 3.6.1 and 3.6.2). By early spring only small numbers were present and no birds were observed on the pipeline area.

3.7 Eider

The largest number of Eider recorded on low tide counts was in mid-winter. The main flock was feeding on the mussel beds near the mouth of the estuary (Figure 3.7.1). Very small numbers were occasionally observed within the pipeline area.

3.8 Goldeneye

The highest numbers of Goldeneye were recorded in January feeding in the outer half of the estuary (Figure 3.8). Few birds remained on the Duddon after mid-April. Very small numbers were occasionally observed within the pipeline area.

3.9 Red-breasted Merganser

The Duddon Estuary is nationally important for Red-breasted Merganser. The highest numbers recorded on low tide counts were in January, but birds were present throughout the winter and spring. Mergansers were observed feeding along the river channels on the outer half of the estuary (occasionally some within the pipeline area) and between Walney Island and the mainland (Figure 3.9.1).

3.10 Oystercatcher

The Duddon is a nationally important site for Oystercatchers in autumn and winter. Oystercatchers were recorded feeding on all the intertidal areas during the winter but the concentrations inland of North Walney, along the river channel at the mouth of the estuary and around Askam, were very much higher than found elsewhere (Figure 3.10.1). Smaller numbers of birds were present during spring but the areas mentioned above remained of relatively greater importance (Figure 3.10.2). The Askam side of the pipeline area is one of the most important feeding sites for Oystercatchers during the winter months.

3.11 Ringed Plover

The Duddon is a nationally important site for Ringed Plover in autumn and winter. During the winter, Ringed Plover were observed feeding in small flocks spread around the edges of the outer half of the estuary and North Walney (Figure 3.11.1). Small numbers occurred within the pipeline area. The highest numbers of Ringed Plover recorded at low tide were during the spring passage, from late April to late May, when larger flocks concentrated on fewer count areas than in winter. These were north of Askam (within the pipeline area) and around North Walney (Figure 3.11.2).

3.12 Grey Plover

The Duddon is a nationally important site for Grey Plover in the winter. Small flocks of Grey Plover were recorded along the southern coast of the estuary, with the highest numbers near North Walney (Figure 3.12.1). Small numbers occurred on the Askam side of the pipeline area. Few birds remained on the Duddon after March.

3.13 Lapwing

Lapwing mainly use estuaries as roost sites and feed on fields inland. This was illustrated on the Duddon by the contrast in the numbers feeding and roosting during the winter (Figures 3.13.1 and 3.13.2). Small flocks of feeding Lapwing were observed on raised saltmarsh in the upper half of the estuary and scattered on a few of the intertidal areas. Large flocks of roosting Lapwing were recorded near Walney Island and on intertidal areas north of Askam. Small numbers of feeding and roosting birds were present within the pipeline area. By early March the majority of birds had left the estuary.

3.14 Knot

The Duddon is a nationally important site for Knot in the winter. This is known to be a highly mobile species (Dugan 1981) and, from the difference in the figures recorded on the low tide and BoEE counts, it would seem that many birds which roost on the Duddon move out of the estuary to feed at low water, possibly moving round to Roosecote Sands near south Walney Island. Those which remained on the Duddon fed on intertidal areas just south of Askam and inland of North Walney (Figure 3.14.1). Very few birds were recorded within the pipeline area.

3.15 Sanderling

The Duddon is a nationally important site for Sanderling in winter, spring and autumn. The peak number of Sanderling recorded feeding on the estuary was in late February. During the winter there were small flocks of Sanderling on sandy outer half of the estuary with the most important feeding area just south of Askam (Figure 3.15.1). Small numbers occurred within the pipeline area. The feeding distribution altered in the spring with all the Sanderling flocks recorded near the mouth of the estuary and around North Walney, with no birds recorded in the pipeline area (Figure 3.15.2). Spring passage of Sanderling occurred in early May.

3.16 Dunlin

The Duddon Estuary is a nationally important site for Dunlin in the winter and autumn. The peak low tide count was recorded in mid-January. Small flocks of Dunlin were observed on the whole length of the estuary but by far the most important feeding areas, during the winter, were within the pipeline area just north of Askam (Figure 3.16.1). Numbers of Dunlin had decreased by the spring coinciding with a reduced distribution of feeding birds (Figure 3.16.2).

3.17 Bar-tailed Godwit

Small numbers of feeding Bar-tailed Godwit were recorded just south of Askam, around North Walney and near the mouth of the estuary during the winter (Figure 3.17.1). No Bar-tailed Godwits were observed in the pipeline area.

3.18 Curlew

The Duddon Estuary is a site of national importance for Curlew during the winter, spring and autumn. Curlew recorded on all but one count area during the winter (Figure 3.18.1). This distribution is similar to that found at low tide on other estuaries, such as the Severn (Clark 1989, Clark *et al.*1990). The areas with on average the highest numbers of birds were all in the middle section of the estuary. Many birds were feeding within the Askam side of the pipeline area. Smaller numbers of birds were present during the spring but the middle part of the estuary remained the most important feeding area (Figure 3.18.2).

3.19 Redshank

The Duddon is a site of national importance for Redshank during the winter and Redshank numbers reach levels of international importance during the autumn. Redshank were widespread in their feeding locations on the Duddon, with the largest numbers occurring along river channels, near Millom and Askam, and in some of the saltmarsh areas, near North Walney (Figure 3.19.1). The count area with, on average, the highest number of feeding birds was within the area of the pipeline on the Askam shore. This was also the most important feeding area for Redshank during the spring (Figure 3.19.2).

3.20 Turnstone

The Duddon is a site of national importance for Turnstone during autumn passage. Small numbers of Turnstone were recorded feeding near Walney Island and on the lower half of the estuary during the winter (Figure 3.20.1). Few birds were observed within the pipeline area.

Summary

Although there was a great diversity of species recorded on the Duddon, there were only a few species that regularly occurred in sufficient numbers within the pipeline area to warrant any further discussion in the second part of this report. These were Shelduck, Oystercatcher, Ringed Plover, Sanderling, Dunlin, Curlew and Redshank.

PIPELINE TRANSECTS

4. METHODS

4.1 Data Collection

The area to which the site maps refer, in the following section, is in the middle portion of the Duddon Estuary (Figure 4.1.1). Although the existing and proposed pipeline routes were not exactly parallel they were so close together it would not have been practical to set up two sets of transects. In the event of further work being carried out, following pipeline construction, it was decided that the study site should be set up by pegging out coloured marker posts, in 100m wide transects, parallel to the proposed pipeline route (Figure 4.1.2). Although the working width of the pipeline construction will be much less than 100m, it was felt that transects narrower than 100m would a) be difficult to survey and b) posts erected nearer than this may themselves have affected the bird distributions e.g. pools of water and weed can collect around them and they can act as vantage points for birds of prey.

The setting up of the site was delayed until an exact location of the proposed and existing pipeline routes on the ground could be given by British Gas and, as a result of this delay, fieldwork did not commence on this site until January. Several transects were positioned so that one was centred over the proposed pipeline route (transect 5) and three were situated to either side of this line. It was thought that the outer transects would be far enough away from the effects of construction to act as controls in any future work. An extra transect (transect 9) was marked out upstream so that there were also three transects to either side of the existing pipeline route. Additional adjacent areas, <200m either side of the central transects, were also surveyed (transects 1 and 10) in order to assess the importance of nearby areas to birds, especially as on the preliminary site visit the sheltered intertidal area beside Askam pier was favoured by high numbers of waders.

The transects were further divided into three sections across the estuary. The Askam channel marked the lower boundary of count areas 1-10, and another minor channel marked the lower boundary of count areas 1.2-10.2. These channels did not move significantly during the course of the survey. The majority of the upper shore near Askam was composed of fine-medium, rippled sand. The sheltered area near Askam pier held some surface mud. There was evidence of the deposition of sand and mud on much of this upper shore during the course of the winter. The main river channel lay within the central section (count areas 1.1-10.1) and the substrate type was sand, which in areas of high mobility formed mega-ripples. On the upper shore near Millom (count areas 1.2-10.2), the main substrate type was firm rippled sand.

Each intertidal count area was counted once in every hour throughout the period of daylight giving information throughout the tidal cycle. Roosting and feeding birds were recorded separately. Several days of fieldwork were lost in January and February due to bad weather; fog, gales or heavy rain. As a result of the delay in setting up the site and the poor weather which followed, a high proportion of the data was collected in March. From the low tide counts, it can be seen that the timing of the peak counts of many species will be poorly represented and the following section may underestimate the numbers which occur within the pipeline area. However, it was considered that this

would not cause any distributional bias in the data collected, and hence not affect the validity of the study.

4.2 Data Analysis

Data were analysed for each species which had an average peak count of 5 or more birds, on all count areas combined, at any time interval. For each species, the all day usage was calculated for each area using the following equation

$$\text{All day usage (average number of bird hours per tidal cycle)} = \sum_{A=+5}^{A=\_6} (BxC)\,1$$

where:
A = hours from low tide
B = Average number of birds feeding at time A when area is exposed
C = Proportion of counts when count area is exposed at time A

A measure of the density in which each species occurred on each count area was also calculated and is referred to as bird density within the following sections.

Bird density = All day usage/area of count area (Av.no.bird hours/tidal cycle/ha.)

The bird density of species which occurred on several count areas was plotted on maps of the study site.

Profiles of the bird density across the count areas (Figure 4.2.1) are also presented in the next section.

5. RESULTS AND DISCUSSION

5.1 Shelduck

Very low numbers of Shelduck occurred on the site, with around 30 being the highest recorded at any one time (Figure 5.1.1). Numbers were highest over the low tide period and the percentage feeding varied over the tidal cycle. As with many of the duck species, it can be seen that low tide is not the optimal time to record feeding Shelduck. The small numbers of Shelduck which were present on the site did not occur at high densities in any transect (Figure 5.1.2). The majority of birds were distributed along the south shore and the southern end of the north shore. It is very unlikely that any effect of the pipeline would be detectable with such small numbers.

5.2 Oystercatcher

Around 150-300 Oystercatchers were present on the site through most of the tidal cycle (Figure 5.2.1). The highest numbers occurred just after high tide, with additional birds arriving to feed on the site as it became exposed, then moving off the site as more of the estuary became available. The highest proportion of birds fed on the site over the high tide period, when the tide covered many intertidal feeding areas. Oystercatchers were distributed over all the transects on the upper shore near Askam and in the central count areas (Figure 5.2.2). The distribution of birds on the north shore was more variable. The highest densities of Oystercatcher within the study site were adjacent to Askam pier (count areas 1 and 2) and on count area 9.2 on the north shore (Figure 5.2.3). On the two profiles where Oystercatcher occurred on all the count areas (A-B and C-D), the density of birds was fairly even, with no noticeable difference over the existing pipeline.

5.3 Ringed Plover

A small flock of between 5 and 20 Ringed Plover were present on the site throughout the tidal cycle, and were usually seen feeding (Figure 5.3.1). Figure 5.3.2 shows that this small flock occurred at different times on most of the count areas on the south shore. There was no noticeable difference over the existing pipeline, although with such small numbers it is unlikely that any effects would be apparent. As shown by the low tide counts, slightly higher numbers of Ringed Plover occurred within this general area during the spring.

5.4 Lapwing

Small numbers of Lapwing were present on the site, most regularly in the few hours after high tide (Figure 5.4.1). As can be seen by the percentage feeding, the site was also occasionally used as a roost site. Lapwing occurred on very few count areas and at low densities, some birds using count area 1 for feeding as well as roosting and flocks of roosting birds occasionally recorded on count area 6 (Figure 5.4.2). It would be difficult to detect any effects of the existing pipeline with such small numbers, especially with a species such as Lapwing for which intertidal areas are not a main feeding site.

5.5 Sanderling

Although up to 80 Sanderling were recorded on the site at high tide, the number recorded was very variable (as can be seen by the high error bar, Figure 5.5.1). Numbers steadily decreased during the three hours following high tide and virtually no Sanderling were present on the site for the rest of the tidal cycle. From the low tide counts it is likely that birds moved onto the sandy areas just south of Askam pier to feed at low tide. Sanderling only occurred on a few of the count areas and at very low densities (Figure 5.5.2). Again it is not possible to detect any effects of the pipeline on the distribution of such a small number of birds.

5.6 Dunlin

High and variable numbers of Dunlin were recorded on the site (Figure 5.6.1). Much of this variability was due to disturbance by raptors, which sometimes caused the Dunlin to fly off the site altogether and feed elsewhere. On average, around 1000-1500 Dunlin were feeding on the site through most of the tidal cycle. Dunlin were distributed over many of the count areas on the Askam shore and central section, but only used the most southerly count area on the north shore (Figure 5.6.2).

High densities of Dunlin occurred in count areas 1 and 2 adjacent to Askam pier (Figure 5.6.3). This is probably due to better feeding conditions in this area, which is sheltered by Askam pier and retains the fine sediments which are beneficial to the invertebrate prey of many wading birds. The higher densities occurring in count area 7 are again likely to be due to better feeding conditions. As this is between 100m and 200m away from the existing pipeline, the pipeline is not likely to have influenced these feeding conditions. Although Dunlin were recorded on many of the central sections, they occurred at very low densities. Again the higher densities on count area 1.2 are unlikely to be related to the position of the pipeline.

5.7 Curlew

On average, between 150 and 350 Curlew were recorded on the site depending on the state of the tide (Figure 5.7.1). Numbers were generally highest two hours after high tide, falling thereafter to their lowest levels over the high tide period. Curlew were evenly distributed along the south shore and central count areas, but only occurred in about half of the count areas on the north shore (Figure 5.7.2). Figure 5.7.3 shows that the densities of Curlew vary over the south shore, but not in a way that is clearly related to the position of the existing pipeline. Although the densities in the central count areas were lower, they were extremely even. The variable densities recorded on the north shore are probably again due to a distribution of preferred feeding areas that is unrelated to the existing pipeline route.

5.8 Redshank

Between 100 and 200 Redshank were regularly recorded on the site, with a high proportion of these feeding throughout the tidal cycle (Figure 5.8.1). These were mostly distributed along the south shore with lower densities more irregularly distributed along the north shore (Figure 5.8.2). Few birds were observed in the sandy central area. Figure

5.8.3 shows that, as with Dunlin, count areas 1 and 2 were the preferred feeding areas with far lower densities on all the other count areas.

5.9 Turnstone

Less than 10 Turnstone were present throughout the tidal cycle (Figure 5.9.1), and were restricted in their distribution to only three count areas on the south shore (Figure 5.9.2). Unlike many of the other species, Turnstone prefer to feed on rocky areas and their distribution coincided with the small areas of this substrate that was available.

6. OVERALL CONCLUSIONS

From the excellent low tide coverage we have gained a detailed picture of the numbers of birds using the estuary at low water during the winter and spring as well as which areas of the estuary are of most importance to each waterfowl species. This has given a sound baseline, against which post-construction changes in the distribution of birds can be assessed.

Apart from Ringed Plover, all species were present in lower numbers during the spring. Although some Ringed Plover may be resident and breed on the estuary, the higher numbers during the spring were probably due to a high turnover of birds on spring passage. Many birds which use British estuaries as feeding areas during the winter leave during the spring for breeding grounds, either elsewhere in Britain or in the arctic. Many Shelduck remain through the spring to breed on the Duddon Estuary.

Although waterfowl used the entire estuary, the areas which typically held the highest number of feeding birds during the winter were on the south shore of the estuary, north and south of Askam pier and within the sheltered bay east of North Walney (Figure 6.1). During the winter the southern shore of the pipeline area was the most important feeding area on the estuary for Dunlin and Redshank and one of the most important feeding areas for Oystercatcher and Curlew.

It was suggested that the construction of a gas pipeline may affect the sediments in the vicinity of the pipeline in such a way that the rate at which the birds could feed would be affected. This could happen because the numbers of invertebrates might change, the body size of the prey might change or the birds ability to capture the prey might change if, for example, the sediments above the pipe remained wetter so that the birds could penetrate the sand more easily with their bills (Goss-Custard and McGrorty 1991). If the pipeline were to alter feeding opportunities there might also be a change in the feeding distribution of birds over the intertidal area.

The substrate types differed between the three count areas in each transect. The majority of the substrate in the count areas on the north shore was fairly hard and dry, rippled sand, although this became softer and wetter near the adjacent river channel. Most feeding birds were observed within this area of softer sediment along the river channel, where the birds would have found it easier to penetrate the substrate when foraging, and invertebrate prey densities are likely to be greater (Prater 1981).

The substrate in the central count areas was sand. In parts of these sections the sand formed mega-ripples, an indicator of high current flow and high sediment mobility. Fewer invertebrates will tolerate this kind of environment (Prater 1981).

The count areas on the south shore varied slightly in their substrate type, but comprised mostly wet rippled sand. In the sheltered area upstream of Askam pier there was a surface layer of fine sand and mud, as well as a small river channel and area of saltmarsh. Studies carried out by McCulloch and Clark (1992) showed a strong inverse correlation between numbers of Dunlin and particle size on feeding areas.

Four species were present around the existing pipeline in sufficient numbers to show any effect of the pipeline on the feeding distribution in the area: Dunlin, Redshank, Oystercatcher and Curlew. From the detailed studies carried out within the pipeline transects it was seen that these species were all present at higher densities on the south side of the estuary. It is highly probable that this was because the south side of the estuary naturally provided the best feeding areas. All these species also occurred at their highest densities in the count areas adjacent to Askam pier. Again, this is probably due to this sheltered area providing the greatest abundance of invertebrate prey. There was no consistent increase or decrease in the densities of birds feeding over the pipeline and there was no apparent evidence that the existing pipeline, laid four years ago, has any remaining effects on distribution of feeding birds.

As there does not appear to be any residual effect of the existing pipeline, its presence will not influence any studies to monitor shorter term effects following the construction of the new pipeline.

7. RECOMMENDATIONS FOR FURTHER WORK

1. Bird densities should be correlated with invertebrate data collected by the ITE within the transects during spring 1992. This would show whether there were any effects of the previous pipeline not apparent from studying bird densities but it would also provide baseline data for invertebrates species, diversity and abundance, should further work be required on the short term effects of the new pipeline construction.

2. Although these studies have not shown any effects of the existing pipeline on the distribution of birds in the area, four years after the pipeline was constructed, it is not known what, if any, are the shorter term effects of such disturbance. Depending on the method of pipeline construction, a repetition of the low tide survey covering the whole estuary and a detailed survey over the pipeline route, during the winter following construction, would provide such information.

3. Should the pipeline on the Duddon Estuary be constructed using the direct drilling method it would be a useful case study to compare the disturbance effects of this method with alternative methods on other estuaries, for example trench laying across Rooscote Sands, near Walney Island.

4. Should any further construction be proposed, by British Gas or others for, the Duddon Estuary, a site of high conservation value, then additional invertebrate work should also be carried out on other areas of the estuary which have been shown by the low tide survey to be of particular importance to feeding birds.

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SPECIES	WINTER			SPRING			AUTUMN		
		% of population			% of population			% of population	
	Mean	% British	% European	Mean	% British	% European	Mean	% British	% European
Oystercatcher	6651	2.38	0.74	2169	0.77	0.24	7269	2.60	0.81
Laping	1790	0.18	0.09	246	0.02	0.01	1289	0.13	0.06
Ringed Plover	255	1.11	0.51	267	0.89	0.53	412	1.37	0.82
Grey Plover	250	1.19	0.17	50	0.24	0.03	183	0.87	0.12
Golden Plover	186	0.09	0.02	19	0.01	<0.01	168	0.08	0.02
Turnstone	305	0.68	0.44	229	0.51	0.33	545	1.21	0.78
Curlew	2062	2.27	0.59	1012	1.11	0.29	2879	3.16	0.82
Bar-tailed Godwit	196	0.32	0.20	32	0.05	0.03	71	0.12	0.07
Redshank	1457	1.94	0.97	858	0.71	0.57	1801	1.50	1.20
Knot	3342	1.52	0.95	87	0.04	0.02	437	0.20	0.12
Dunlin	8045	1.87	0.57	729	0.36	0.05	2478	1.24	0.18
Sanderling	455	3.25	0.45	717	2.39	0.72	488	1.63	0.49
Purple Sandpiper	47	0.29	0.09	40	0.25	0.08	1	0.01	<0.01

Table 1.1The national and international importance of the Duddon Estuary for waders 1986-1991

SPECIES	Average Peak	% of population	
		British	NW European
Pink-footed Goose	236.0	0.2	0.2
Greylag Goose	121.6	0.1	0.1
Shelduck	807.2	1.1	0.3
Wigeon	891.0	0.4	0.1
Teal	671.0	0.7	0.2
Mallard	984.0	0.2	<0.1
Pintail	1143.4	4.6	1.6
Pochard	95.4	0.2	<0.1
Eider	105.6	0.2	<0.1
Goldeneye	60.0	0.4	<0.1
Red-breasted Merganser	153.8	1.5	0.2
Coot	178.8	0.2	<0.1

Table 1.2The national and international importance of the Duddon Estuary for wildfowl 1984-1989. Most recent data available from the Wildfowl and Wetlands Trust.

LOW TIDE COUNTS
WINTER
Count 112/13 December 1991
Count 227/28 December 1991
Count 314 January 1992
Count 427 January 1992
Count 512/13 February 1992
Count 625/26 February 1992
Count 712 March 1992
Count 826 March 1992
SPRING
Count 19 April 1992
Count 223/24 April 1992
Count 37/8 May 1992
Count 422 May 1992

Table 2.1.1Low tide dates for the 1991/92 winter and 1992 spring.

WINTER COUNTS 1991/92	COUNT 1			COUNT 2			COUNT 3			COUNT 4		
	12/13 Dec 1991			27/28 Dec 1991			14 Jan 1992			27 Jan 1992		
SPECIES	F	R	T	F	R	T	F	R	T	F	R	T
Pink-footed Goose	0	0	0	0	58	58	11	0	11	130	0	130
Greylag Goose	0	0	0	1	0	1	60	0	60	42	6	48
Shelduck	304	378	682	314	96	410	536	76	612	329	310	639
Wigeon	92	141	233	6	118	124	20	48	68	73	73	146
Teal	0	72	72	0	0	0	0	0	0	4	2	6
Mallard	213	321	534	19	306	325	12	193	205	18	382	400
Pintail	0	14	14	0	1200	1200	19	1076	1095	1006	183	1189
Eider	1	0	1	800	302	1102	5	0	5	70	3	73
Goldeneye	9	0	9	11	3	14	111	2	113	127	1	128
Red-breasted Merganser	55	0	55	6	42	48	83	0	83	127	0	127
Oystercatcher	2336	209	2545	3556	829	4385	2777	42	2819	2357	569	2926
Ringed Plover	53	0	53	37	0	37	73	0	73	73	0	73
Grey Plover	109	0	109	85	0	85	266	8	274	159	0	159
Lapwing	85	249	334	0	1088	1088	182	1001	1183	62	133	195
Knot	43	0	43	27	0	27	216	105	321	249	200	449
Sanderling	24	0	24	96	0	96	9	0	9	8	0	8
Dunlin	9841	4	9845	7978	91	8069	11044	65	11109	9443	0	9443
Snipe	1	0	1	0	21	21	12	0	12	5	0	5
Bar-tailed Godwit	127	0	127	18	0	18	56	0	56	7	0	7
Curlew	589	2	591	861	88	949	979	413	1392	763	221	984
Redshank	662	3	665	576	1	577	830	0	830	634	2	636
Turnstone	45	0	45	18	12	30	23	0	23	75	0	75
Heron	4	0	4	3	8	11	2	3	5	3	2	5
Cormorant	1	0	1	3	7	10	4	7	11	3	8	11

Peregrine	0	1	1	0	0	0	1	0	1	0	0	0

Table 3.1A summary of the low tide counts during December 1991 and January 1992 (F= Feeding, R=Roosting and T=Total)

WINTER COUNTS 1991/92	COUNT 5			COUNT 6			COUNT 7			COUNT 8		
	12/13 Feb 1992			25/26 Feb 1992			12 Mar 1992			26 Mar 1992		
SPECIES	F	R	T	F	R	T	F	R	T	F	R	T
Pink-footed Goose	424	0	424	1400	0	1400	360	0	360	0	0	0
Greylag Goose	68	55	123	54	0	54	18	2	20	63	0	63
Shelduck	599	83	682	369	515	884	207	394	601	200	250	450
Wigeon	55	365	420	22	0	22	0	0	0	0	0	0
Teal	0	0	0	0	2	2	0	0	0	0	0	0
Mallard	31	218	249	12	132	144	14	48	62	2	10	12
Pintail	31	1049	1080	25	1031	1056	8	549	557	3	60	63
Eider	0	9	9	0	13	13	14	2	16	28	0	28
Goldeneye	36	0	36	45	6	51	34	5	39	17	0	17
Red-breasted Merganser	66	0	66	76	0	76	36	13	49	38	40	78
Oystercatcher	2275	827	3102	1760	1270	3030	879	927	1806	704	1039	1743
Ringed Plover	46	5	51	123	7	130	108	0	108	41	23	64
Grey Plover	68	1	69	56	0	56	198	0	198	96	0	96
Lapwing	64	250	314	260	422	682	0	58	58	0	32	32
Knot	14	0	14	442	0	442	146	0	146	0	0	0
Sanderling	159	0	159	311	71	382	22	0	22	36	0	36
Dunlin	5622	0	5622	5695	710	6405	3379	70	3449	314	38	352
Snipe	0	0	0	0	0	0	4	0	4	0	0	0
Bar-tailed Godwit	8	0	0	2	0	2	8	0	8	0	0	0
Curlew	943	401	1344	759	1421	2180	350	267	617	760	341	1101
Redshank	823	14	837	720	17	737	818	6	824	358	149	507
Turnstone	71	0	71	62	0	62	38	2	40	28	0	28
Heron	0	0	0	0	0	0	0	0	0	0	1	1
Cormorant	3	15	18	7	12	19	3	3	6	0	13	13

Peregrine	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.2A summary of the low tide counts during February and March 1992 (F=Feeding, R=Roosting and T=Total)

WINTER COUNTS 1991/92	COUNT 5			COUNT 6			COUNT 7			COUNT 8		
	12/13 Feb 1992			25/26 Feb 1992			12 Mar 1992			26 Mar 1992		
SPECIES	F	R	T	F	R	T	F	R	T	F	R	T
Pink-footed Goose	424	0	424	1400	0	1400	360	0	360	0	0	0
Greylag Goose	68	55	123	54	0	54	18	2	20	63	0	63
Shelduck	599	83	682	369	515	884	207	394	601	200	250	450
Wigeon	55	365	420	22	0	22	0	0	0	0	0	0
Teal	0	0	0	0	2	2	0	0	0	0	0	0
Mallard	31	218	249	12	132	144	14	48	62	2	10	12
Pintail	31	1049	1080	25	1031	1056	8	549	557	3	60	63
Eider	0	9	9	0	13	13	14	2	16	28	0	28
Goldeneye	36	0	36	45	6	51	34	5	39	17	0	17
Red-breasted Merganser	66	0	66	76	0	76	36	13	49	38	40	78
Oystercatcher	2275	827	3102	1760	1270	3030	879	927	1806	704	1039	1743
Ringed Plover	46	5	51	123	7	130	108	0	108	41	23	64
Grey Plover	68	1	69	56	0	56	198	0	198	96	0	96
Lapwing	64	250	314	260	422	682	0	58	58	0	32	32
Knot	14	0	14	442	0	442	146	0	146	0	0	0
Sanderling	159	0	159	311	71	382	22	0	22	36	0	36
Dunlin	5622	0	5622	5695	710	6405	3379	70	3449	314	38	352
Snipe	0	0	0	0	0	0	4	0	4	0	0	0
Bar-tailed Godwit	8	0	0	2	0	2	8	0	8	0	0	0
Curlew	943	401	1344	759	1421	2180	350	267	617	760	341	1101
Redshank	823	14	837	720	17	737	818	6	824	358	149	507
Turnstone	71	0	71	62	0	62	38	2	40	28	0	28
Heron	0	0	0	0	0	0	0	0	0	0	1	1
Cormorant	3	15	18	7	12	19	3	3	6	0	13	13

SPRING COUNTS 1991/92	COUNT 1			COUNT 2			COUNT 3			COUNT 4		
	9 Apr 1992			23/24 Apr 1992			7/8 May 1992			22 May 1992		
SPECIES	F	R	T	F	R	T	F	R	T	F	R	T
Pink-footed Goose	0	0	0	0	0	0	0	0	0	0	0	0
Greylag Goose	11	39	50	1	0	1	0	3	3	0	0	0
Shelduck	330	208	538	261	103	364	292	322	614	242	228	470
Wigeon	0	0	0	0	0	0	0	0	0	0	0	0
Teal	0	28	28	2	2	4	0	0	0	0	0	0
Mallard	0	12	12	7	74	81	5	39	44	64	103	167
Pintail	0	82	82	0	0	0	0	0	0	0	0	0
Eider	7	0	7	37	0	37	41	8	49	12	58	70
Goldeneye	41	0	41	3	1	4	2	0	2	0	0	0
Red-breasted Merganser	40	0	40	36	0	36	49	0	49	22	10	32
Oystercatcher	1149	460	1609	1030	387	1417	770	770	1540	461	398	859
Ringed Plover	39	8	47	236	7	243	187	48	235	201	0	201
Grey Plover	13	0	13	0	0	0	13	0	13	2	0	2
Lapwing	6	74	80	0	28	28	7	28	35	6	29	35
Knot	0	0	0	45	0	45	0	0	0	0	0	0
Sanderling	0	0	0	46	0	46	134	0	134	55	0	55
Dunlin	1102	0	1102	341	0	341	986	0	986	505	0	505
Snipe	0	2	2	0	0	0	0	0	0	0	0	0
Bar-tailed Godwit	0	0	0	4	0	4	0	0	0	49	0	49
Curlew	531	115	646	429	113	542	52	16	68	26	14	40
Redshank	725	3	728	72	137	209	11	32	43	15	8	23
Turnstone	29	0	29	26	0	26	33	0	33	2	0	2
Heron	2	0	2	0	0	0	0	2	2	1	0	1
Cormorant	0	17	17	5	14	19	7	7	14	9	0	9

Peregrine	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.3A summary of the low tide counts during April and May 1992 (F=Feeding, R=Roosting and T=Total)

QUALIFYING LEVELS FOR NATIONAL & INTERNATIONAL IMPORTANCE		
SPECIES	**National (GB)**	**International**
Pink-footed Goose: Iceland/Greenland	1,100	1,100
Greylag Goose: Iceland	1,000	1,000
Shelduck	750	2,500
Wigeon	2,500	7,500
Mallard	5,000	*50,000
Pintail	250	700
Eider	700	*20,000
Goldeneye	150	3,000
Red-breasted Merganser	100	1,000
Oystercatcher	2,800	9,000
Ringed Plover	230 (passage: 300)	500
Grey Plover	210	1,500
Lapwing	10,000	*20,000
Knot	2,200	3,500
Sanderling	140 (passage: 300)	1,000
Dunlin	4,300 (passage: 2,000)	14,000
Bar-tailed Godwit	610	1,000
Curlew	910	3,500
Redshank	750 (passage: 1,200)	1,500
Turnstone	450	700

*A site regularly holding more than 10,000 wildfowl or 20,000 waders qualifies as Internationally Important by virtue of absolute numbers.

Table 3.4Qualifying levels for National and International Importance (from Wildfowl and Wader Counts 1990-91).