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# Lappel Bank And Fagbury Flats Compensatory Measures Site Suitability For Waterbirds: Phase I Extension

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## EXECUTIVE SUMMARY

1. Lappel Bank and Fagbury Flats held important numbers of feeding and roosting waterbirds prior to port development, which was completed in 1994/95. Under the EU Habitats Directive, compensatory measures are to be provided to accommodate birds displaced by the developments. In this report six candidate sites are reviewed as potential replacements for the loss of habitat. Three sites lie on the Blackwater Estuary, two on the Crouch-Roach Estuary, and one on the Swale Estuary.

2. Possible numbers of waterbirds attracted to replacement sites are predicted using BTO and WeBS datasets. These predictions are used in conjunction with adjacent area bird densities and other site information, including geographical and ecological variables, to assess the suitability of the six sites as compensatory areas. The approach used to make these predictions does not take into account site-specific hydrological or morphological variation.

3. To make a preliminary assessment of the value of the proposed sites and their ability to compensate for losses at Lappel Bank and Fagbury Flats, the predictions of bird numbers are compared against the following two provisional waterbird abundance compensation targets:

   - Target 1 - The number of birds recorded feeding at Lappel Bank and roosting at Fagbury Flats prior to completion of port developments.

   - Target 2 - Number of feeding birds only at Lappel Bank and Fagbury Flats prior to completion of port developments.

4. According to this preliminary analysis the six candidate sites will support between 16% and 35% of the compensation target for feeding and roosting birds and 31% to 66% of the target for feeding birds alone, based on predicted mean values. Maylandsea consistently represented the best location overall and is estimated to support 35% of feeding and roosting birds, and 66% of the target for feeding birds only, whilst Weymarks and Nagden Marshes may support 29% of the target for feeding and roosting birds, with an estimated fulfilment of 54% of the feeding birds target. The latter two sites are more exposed and may be subject to sandier sediment and thus reduced infaunal biomass, which may make it less likely that they will reach the predicted percentage of these targets. Low densities of waterbirds on the adjacent parts of the Crouch-Roach suggest that both Wallasea options may not meet their predicted percentage of the targets, whilst Mell Farm is only predicted to hold 16% of the feeding and roosting target, and 31% of the feeding birds target.

| Site | Predicted mean number of birds | Percentage of target reached[1] | Percentage of target reached[2] | Predicted peak number of birds | Percentage of target reached[1] | Percentage of target reached[2] |
|---|---|---|---|---|---|---|
| Nagden marshes | 1508 | 29% | 54% | 20,809 | 395% | 744% |
| Wallasea: option I | 1480 | 28% | 53% | 19,087 | 362% | 682% |
| Wallasea: option II | 1467 | 28% | 52% | 18,983 | 360% | 678% |
| Maylandsea | 1854 | 35% | 66% | 19,870 | 377% | 707% |
| Mell Farm | 857 | 16% | 31% | 10,393 | 197% | 371% |
| Weymarks | 1519 | 29% | 54% | 19,096 | 362% | 682% |

[1] Provisional compensation target including feeding and roosting birds. [2] Provisional compensation target including feeding birds only.

5. When the final preferred compensation sites(s) is/are identified it is recommended that further detailed simulation modelling be carried out, to ensure that the number and range of waterbird species displaced through the loss of Lappel Bank and Fagbury Flats can be compensated for by the short-listed compensatory site(s) over a period of at least 50 years.

# 1. INTRODUCTION

Under Article 6.4 of the Habitats Directive, retrospective compensation is to be provided for the loss of two sites to port development; Lappel Bank, on the Medway Estuary, and Fagbury Flats, on the Orwell Estuary, both formerly holding large numbers of wintering waterbirds (including cormorants, swans, geese, ducks and waders). Six candidate sites are analysed to assess their suitability as compensatory areas: three on the Blackwater Estuary, two on the Crouch & Roach Estuary and one on the Swale Estuary (Figure 1).

Port development led to 42 ha of mudflats and 12 ha of saltmarsh being reclaimed, habitat that had provided winter-feeding and roosting sites for important numbers of waterbirds. Table 1.1 lists the main species concerned. On one or more compensatory sites, replacement habitat is to be created by breaching existing sea defences, allowing mudflat and saltmarsh to develop. Bird usage of the compensatory sites is likely to depend primarily on the density of suitable prey, which in turn will depend on appropriate habitat and substrate composition. The presence of nearby high-water roosting sites will improve the attractiveness of potential replacement locations (*e.g.* Burton *et al.* 1996, Rehfisch *et al.* 1996, in press b), although such habitat may be included in designs of compensation areas. The science of artificial roost site creation is quite advanced although creating these on small sites may be undesirable, as waterbirds generally prefer larger exposed sites. Thus, in this context, the provision of one large site is likely to be preferable to many small sites as the larger and "squarer" a site is the smaller the proportion of the site that is close to land and higher levels of disturbance.

A previous report (Field *et al.* 1999; also available at http://www.defra.gov.uk/wildlife-countryside/ewd/weymarks/index.htm) described Phase I of the compensation process, and reviewed the ecological and topographical features required for estuarine sites to accommodate waterbirds displaced from Lappel Bank and Fagbury Flats. The potential of nine sites to harbour displaced birds was also assessed. This report, as an extension of Phase I, aims to contribute an initial assessment of the suitability of six further putative compensatory sites and should be read in conjunction with Field *et al.* (1999). The estimated waterbird usage at each site is modelled using information supplied by ABP Marine Environmental Research Ltd (ABPmer) on predicted intertidal habitat areas (based on provisional schematic site designs) in conjunction with estimates of waterbird densities on estuaries in Southeast England (Holloway *et al.* 1996) and WeBS Low Tide Count data for Dark-bellied Brent Geese on the three relevant estuaries.

Aims:

1. To model the suitability of six candidate sites as replacement habitat for Lappel Bank and Fagbury Flats, using a simple habitat area to waterbird usage approach;

2. To estimate the overall suitability of each potential site for waterbirds from knowledge of the literature and estuarine ecology.

## 2. THE COMPENSATION TARGET

### 2.1 Methods

During Phase I of this report, the British Trust for Ornithology (BTO) and ABP Research (now ABPmer) estimated the numbers of birds likely to be displaced by the development of Lappel Bank and Fagbury Flats (Field *et al.* 1999). Estimates were based on data from Holloway *et al.* (1996) and Wetland Bird Survey (WeBS) counts. The data were collected by two methods. On coastal sites, high tide or "Core Counts" are made at peak high tide and predominantly reflect numbers of roosting waterbirds, whereas "Low Tide Counts" are made two hours either side of low tide, and largely measure the numbers and distribution of feeding birds (Musgrove *et al.* 2001).

When judging the suitability of sites as compensatory areas, the provision of suitable feeding grounds should be prioritised over roosting locations. If local relocation to suitable roosts is not possible, artificial replacement roosts can be straightforward to generate (Burton *et al.* 1996, Field *et al.* 1999). Therefore, Low Tide Counts are likely to be more instructive than Core Counts in stipulating the compensation target.

### 2.2 Lappel Bank

Prior to reclamation, Lappel Bank supported large numbers of wintering waterbirds, which exploited the 22 ha of mudflat for feeding. Seven species utilising Lappel Bank did so at higher mean densities than for the Medway estuary as a whole (Table 2.2.1). These were Shelduck, Oystercatcher, Ringed Plover, Dunlin, Curlew, Redshank and Turnstone. It should be noted that although these density measures were from a comparable time period, the whole estuary data are based on Core Counts, whilst the site-specific data are based on mean Low Tide Counts. However, the importance of Lappel Bank as a feeding area is emphasised, particularly in the high densities of Shelduck, Curlew, Redshank and especially Dunlin. The Medway holds internationally important numbers of Shelduck, Grey Plover, Dunlin and Redshank, and nationally important numbers of five other species (Table 2.2.2).

The past importance of Lappel Bank as a feeding site is emphasised when considering the bird densities previously found there in the context of WeBS Low Tide Count sectors across the UK as a whole. Musgrove *et al.* (in press) looked at every estuarine count sector surveyed for the WeBS Low Tide Counts during the period 1992-93 to 1998-99 and, for each species, ranked the sectors in order of the mean density of that species. Using this system, which is a rudimentary and rather crude approach to the issue, pre-development densities of feeding Curlew, Dunlin and Shelduck on Lappel Bank were comparable to those on the top 1% of Low Tide Count sectors nationwide. Similarly, Ringed Plover and Redshank occurred at densities equivalent to the top 5% nationally, and Oystercatcher and Turnstone were also close to the top 5% level.

Provision for Dunlin, Redshank and Shelduck, all of which were found in high densities at Lappel Bank and contributed to internationally important estuary-wide bird numbers is to be recommended when creating compensation habitat. Curlew, Oystercatcher, Ringed Plover and Turnstone also occurred at relatively high densities.

### 2.3 Fagbury Flats

The habitat lost at Fagbury Flats was slightly different to that at Lappel Bank, consisting of mudflats but also mussel beds and saltmarsh, spanning an area of 32 ha. The first phase of development spanned the period 1988-1989; further developments of the site occurred in 1994 and 1995-1996. Before the initial development, greater numbers of waterbirds than recorded by the Low Tide Counts were attracted to the area as high tide approached, to exploit flooded oyster beds (M. Wright [organiser of waterbird counts on the Orwell since the 1980s], *pers. comm.*). Low Tide Counts are therefore likely to have under-represented the total actual number of individual birds feeding at Fagbury Flats. Additionally, Low Tide Counts were only recorded for one year; ideally a longer data

run of five years is desired to obtain a more representative measurement of bird numbers. However, using the method described in section 2.2 (Musgrove *et al.* in press), data suggest that Dark-bellied Brent Geese, Grey Plover, Lapwing, Sanderling and Turnstone occurred at densities amongst the top 5% of national Low Tide Count sectors, with densities of Dunlin, Redshank and Ringed Plover also close to the top 5%.

A further consequence of the initial development was to create a very undisturbed high water refuge, which was utilised in large numbers by roosting waterbirds. Core Counts therefore reflect the importance of this roosting habitat, which was eventually also lost during the later stages of port development from 1995 onwards. Comparison of pre-development mean counts for Fagbury Flats and the Orwell estuary shows that in particular densities of Dark-bellied Brent Geese, Dunlin, Grey Plover, Lapwing, Ringed Plover and Turnstone using the flats either to feed (Low Tide Counts) or roost (High Tide Counts) were higher than for the estuary as a whole (Table 2.2.3). The Orwell holds internationally important numbers of Redshank and nationally important numbers of a further five species (Table 2.2.2). As discussed, Fagbury was particularly important as a roosting area (Field *et al.* 1999; Evans 1997). Comparatively large numbers of Dark-bellied Brent Geese, Lapwing, Grey Plover and Oystercatcher roosted at Fagbury, although roosts of Dunlin were greatest, estimated to exceed 2,500 birds.

## 2.4 National Populations and Displaced Birds

The numbers of some species displaced from Lappel Bank and Fagbury Flats represented substantial proportions (<0.1 to 0.47%) of the then respective national populations (Table 2.4). The two sites generally differed in the species harboured, although Dunlin were found frequently at both locations. Lappel Bank held over 0.1% of the national populations of Shelduck, Dunlin, Curlew and Redshank, whilst Fagbury Flats supported relatively large proportions of Dark-bellied Brent Geese, Ringed Plover, Grey Plover and Dunlin.

## 2.5 Target Numbers for Replacement

As part of the proposed drive to select compensation sites for the loss of the Lappel Bank and Fagbury Flats developments, a series of design objectives have been identified. These objectives are as follows:

- *To provide intertidal habitat for the number and range of bird species displaced as a result of the loss of Lappel Bank and Fagbury Flats.*
- *To offset any impacts on the integrity of the originally proposed Medway and Stour & Orwell SPAs caused by the developments at Lappel Bank and Fagbury Flats respectively, for example adverse impacts of modified physical processes.*
- *To ensure that the compensatory measures themselves do not have an adverse impact on the geomorphological or ecological functioning of the area in which they are located.*
- *To construct a self-sustaining system (or systems) which can evolve in response to natural physical, chemical and biological changes and which is able to maintain the bird populations for which it was created over a period of at least 50 years.*
- *To provide compensatory measures for the loss of wetland functions (if any) which cannot be adequately replaced.*

No specific compensation targets for waterfowl abundance have been identified, although clearly the central aim is provide a habitat that will support '*the number and range of bird species displaced* [from] *Lappel Bank and Fagbury Flats'*. Therefore, for this study (and the previous BTO study undertaken during the Phase 1 review) a set of 'provisional compensation targets' were set up based

on the abundance of birds at Lappel Bank and Fagbury prior to the port developments. The predictions of bird numbers at each of the six proposed realignment sites were then compared against these provisional targets to gauge their value as potential compensation measures.

These targets use a series of mean low-tide RSPB and NRA counts (for Lappel Bank and Fagbury Flats) and high-tide WeBS counts (for Fagbury Flats only) to determine the number of birds using the sites before their development. These figures are then broken down by species (Table 2.5), and the overall mean counts across species form the provisional compensation targets that were used for this report.

At Lappel Bank, an average of 1709 birds from all species were recorded at low water and this represents the provisional compensation target for this site. The majority of these were Dunlin (59% of the local population), Curlew (17%), Redshank (11%) and Shelduck (6%). At Fagbury Flats there was an estimated average of 3563 roosting birds, the majority of which were Dunlin (73% of the local population), Dark-bellied Brent Geese (10%), Lapwing (5%), Grey Plover (4%) and Oystercatcher (3%). The same site supported 1089 feeding birds (based on a single winter survey in 1988/89), although this figure is likely to be a conservative estimate (section 2.3). Lapwing were present in largest numbers (43%), with additional substantial feeding populations of Dunlin (30%), Redshank (9%) and Dark-bellied Brent Geese (7%).

From these data, two provisional compensation targets were calculated. To recognise the importance of Fagbury Flats as a roost site, the first target of 5272 birds is based on pre-development Low Tide Counts for Lappel Bank (1709) and High Tide Counts for Fagbury (3563), known henceforth as the feeding and roosting bird target. The second target treats only counts of birds likely to be feeding at Low Tide for both sites (1709 at Lappel and 1089 at Fagbury), and stands at 2798 birds, known henceforth as the feeding bird target. The latter target, based on numbers of feeding waterbirds at Fagbury, is likely to underestimate the importance of Fagbury Flats. The numbers of birds displaced from this site were based on Low Tide Counts from the winter of 1988/89. However, habitat quality at Fagbury was already diminishing by this time, as port development had begun. During the period 1984/85 to 1989/90, a 96% decline in feeding waterbird numbers was recorded at Fagbury Flats (Wright 2000); therefore the compensation target for feeding birds only is probably under-representative of the former importance of the site.

## 2.6 Estimating Numbers of Waterbirds on Proposed Compensation Sites

The numbers of waterbirds predicted to occur at the six potential compensation sites were estimated using the methodology of Field *et al.* (1999). Using data from Holloway *et al.* (1996), the mean and peak densities of waterbirds found on various habitat types across six estuaries (Breydon Water, Blyth, Alde, Deben, Swale and Pagham Harbour) in the southeast of England were averaged (Table 2.6.1). Mean values were calculated for four habitat types: mud, sand, sandy mud and saltmarsh. These mean values were then multiplied by the predicted areas of each habitat likely to develop at each site supplied by ABPmer (Tables 3.1.1i-3.1.6i). This made it possible to estimate the numbers of 12 species of waterbird that could be attracted to the compensation sites following the proposed management. As such data were lacking for Dark-bellied Brent Geese, WeBS Low Tide Counts for the three relevant estuaries were used to estimate future densities for this species at compensation sites (Table 2.6.2). No Cormorant data were available from any source.

Predictions were made for each of the 13 species on three habitat combinations (saltmarsh and mud, saltmarsh and sand, saltmarsh and muddy sand) at each of the six sites (Tables 3.1.1ii-3.1.6ii). The estimates for each species were then summed across species to give the total estimated mean and peak number of waterbirds likely to be found on each compensation site and these numbers were then presented as a proportion of the compensation target (Table 2.6.3). Interpretation of site suitability was complemented by information from three additional sources. ABPmer supplied site characteristic data (Tables 3.1.1i-3.1.6i). English Nature (Essex, Herts. and London Team) advised on biotopes thought likely to develop at the candidate sites. Finally, WeBS Low Tide Count data were used to calculate

mean bird densities on the count areas adjacent to the six potential sites (Tables 3.1.1ii-3.1.6ii) to help assess the general attractiveness of the area to waterbirds. Only the count sectors (areas) that bordered any part of the compensation site were included in this calculation.

It is important to highlight that the estimates of waterbird densities that could be present on the compensation sites based on the peak densities are almost certainly unrealistically high in the large majority of cases. The peak densities of each species did not all occur on a single estuary and therefore summing such peak densities across species will generate site density and thus numerical estimates that will very rarely, if ever, be found under natural conditions. Therefore the majority of analyses, and all conclusions about fulfilment of the provisional compensation targets, were based on mean density values for each species, as calculated by Holloway *et al.* (1996) or from WeBS data (Tables 2.6.1 and 2.6.2).

# 3. SUITABILITY OF CANDIDATE SITES FOR COMPENSATION

## 3.1 Blackwater Estuary

### 3.1.1 Maylandsea

This site provides considerably larger expanses of both mudflat (67 ha) and saltmarsh (264 ha) than were lost from Lappel Bank and Fagbury Flats (Table 3.1.1i). The sheltered position in the upper estuary is likely to promote a substrate of mud and sandy mud, which in turn would support polychaete worms, bivalves and *Hydrobia* snails (English Nature, *pers. comm.*). The large area of grazing marsh is suitable for Dark-bellied Brent Geese, which are predicted to use the site in target numbers at mean densities (Table 3.1.1ii). The provision of extensive mudflat and saltmarsh, coupled with the creation of muddy creeks, could also attract feeding Redshank. Shelduck are found at relatively high densities on adjacent mudflats, and should also be found at Maylandsea, if there is colonisation by large numbers of *Hydrobia* snails. Furthermore, adjacent areas currently support high densities of Dunlin (Figures 3.1.1-3.1.10 for density of all species on the Blackwater). Although mean estimates of Dunlin using saltmarsh and mud fall short of the provisional target numbers, occurrence at half of peak predictions would approach the equivalent compensation target for feeding and roosting birds.

Mean estimates of numbers of Curlew and Ringed Plover do not reach either of the provisional targets, irrespective of whether mud, sand or muddy sand develops. However, peak estimates for mud, although unlikely to be reached, can exceed these targets. If mudflat creation incorporated some areas of muddy sand, then Ringed Plover may occur at higher numbers. Predictions for Grey Plover suggest that muddy or sandy substrates, in addition to saltmarsh, would support numbers of birds acceptable within the provisional target for feeding birds only. Additionally, the 159 ha of grassland accompanying this site may encourage foraging Curlew and Lapwing. This habitat may also be utilised as a roosting area.

The potential for human disturbance is fairly high, as villages lie directly to the east and west of the site. Additionally, there is a marina at Maylandsea; activity from yachting could perturb feeding waterbirds, although traffic may not directly pass areas likely to support birds. The provision of creeks may be viewed as a negative feature, as such areas may be associated with much increased predation risk, leading to avoidance in waders including Redshank (Cresswell 1994).

On the basis of extrapolation from mean southeast estuary bird densities, this site is predicted to hold an average of 35% of those feeding and roosting birds displaced from Lappel Bank and Fagbury, and 66% of the target for feeding birds only (Table 2.6.3).

### 3.1.2 Mell Farm

Intertidal macrofauna are likely to resemble those at Maylandsea, comprising polychaete worms, bivalves and mud snails. The slightly more exposed position on the mid-estuary may lead to a sandier substrate than at Maylandsea.

Mell Farm is the smallest of the proposed compensation sites, although providing a similar area of mudflat to that lost (43 ha), and a larger area (44 ha) of saltmarsh (Table 3.1.2i). Using mean southeast estuary bird densities, few species are predicted to occur in numbers large enough to fulfil either of the provisional compensation targets. The provisional target is only met for feeding Oystercatcher on muddy sand, Grey Plover on sand, and Knot on sand or muddy sand. No other species matches either provisional target (Table 3.1.2ii).

However, existing adjacent mudflats currently harbour many species at high densities (Figures 3.1.1-3.1.10). Dark-bellied Brent Geese, Dunlin and Grey Plover are especially prevalent, suggesting that this site could become similarly populated. One drawback associated with this site is that it is used to

access oyster lays; there are also footpaths running along the sea wall and into the two nearby farms, both of which activities could cause disturbance to waterbirds.

The presence of relatively high densities of waterbirds on nearby mudflats increases confidence that Mell Farm will hold the 16% of the provisional compensation target for feeding and roosting birds or 31% of the provisional target for feeding birds only that it is predicted to hold by this preliminary analysis (Table 2.6.3).

### 3.1.3 Weymarks Marsh

On the lower reaches of the estuary, this exposed site is likely to be characterised by sediment richer in sand and shingle than many other Blackwater sites (English Nature, *pers. comm.*), a type of habitat typically more impoverished in benthic fauna than less exposed locations. Although remaining sections of the sea wall may limit the build up of coarse substrate, reservations were expressed in Phase I of this report (Field *et al.* 1999) that this feature could also shelter hunting raptors and discourage species with preferences for wide-open habitat. Public footpaths and agricultural activity may also disturb feeding waterbirds (Table 3.1.3i).

Unless mud develops the predicted mean densities are below the provisional compensation targets for all priority species (Table 3.1.3ii). If mud develops, the Redshank target (feeding and roosting birds) may be approached, but this estimate must be treated with caution, as this species is not found at high densities on adjacent WeBS count areas (Figure 3.1.8). Although the site comprises 27 ha of saltmarsh and 84 ha of mudflat, the predicted numbers of Dunlin or Ringed Plover fall below the provisional compensation targets. If the provisional compensation target for feeding birds is considered, this site could provide adequate support for populations of Dark-bellied Brent Geese, Grey Plover (if mud or sand develops) and Oystercatcher (if sand or muddy sand develops).

At this site it is estimated that overall 29% of the provisional total feeding and roosting compensation target may be achieved through development of this site, in comparison with 54% of the corresponding target for feeding birds.

## 3.2 Crouch & Roach Estuary

### 3.2.1 Wallasea: Option I

Lying on the north bank of Wallasea Island, the site is moderately exposed to tidal fetch and prevailing winds, although Foulness Island to the east affords it some shelter. Sediment is likely to be soft mud with lower species richness than would be found in slightly sandier substrates. The biotope likely to develop is characterised by the near absence of bivalves and reduced polychaete communities (English Nature, *pers. comm.*). ABPmer provisionally predict that there will be a development of 84 ha of mudflat and 31 ha of saltmarsh.

Densities of foraging waterbirds on count areas adjacent to the potential development site are notably low (Figures 3.2.1-3.2.9). Most species are rarely found, although small numbers of Curlew and Redshank may be present. As Wallasea is relatively inaccessible, recreational disturbance from walkers is likely to be low but some recreational activity, including a nearby marina and occasional wildfowling, may deter wintering waterbirds. Hunting, in particular, can be disruptive to foraging waterbirds (Robinson & Pollitt 2002).

Priority species such as Dunlin and Ringed Plover are not predicted to occur in numbers large enough to satisfy either of the provisional compensation targets, although Dark-bellied Brent Geese are predicted to be found at a level above that the lower feeding birds target. Redshank and Shelduck numbers are also predicted to be close to both the provisional feeding and roosting and the feeding bird only targets.

Although, based on mean densities, it is predicted that 28% of the provisional target for feeding and roosting birds overall will be met, and that 53% of the target could be reached using the feeding birds only data (Table 2.6.3), low avian abundance in surrounding areas is not encouraging. It is considered more likely that the predicted numbers are reached when high bird densities are recorded on adjacent count sectors.

### 3.2.2 Wallasea: Option II

Option II involves realignment on the south side of Wallasea, in addition to a breach on the north bank. The south site has a southeasterly aspect and is more sheltered than the north. This protection and mid-shore location should allow predominantly muddy flats to be created. Infaunal species diversity on the south side would be greater than that predicted to occur on the more exposed north bank. Prey species are likely to include bivalves, polychaetes and mud snails, with further possible growth of algae, including *Enteromorpha* spp., on the proposed 25 ha of saltmarsh and 84 ha of mudflat (57 ha on the south bank, 27 ha on the north bank).

The range of invertebrates that are expected to occur includes most species preyed upon by the waders displaced from the two reclaimed sites. Furthermore, the presence of marine algae may attract foraging Dark-bellied Brent Geese during the winter. These geese are already found at reasonable densities on count areas adjacent to the south bank, as are Shelduck, Dunlin and Redshank (Figures 3.2.1-3.2.9 for all species).

This option is broadly similar to the alternative Wallasea option in size, and based on mean densities it is also estimated to meet 28% of the provisional feeding and roosting compensation target, and 52% of the provisional target for feeding birds only (Table 2.6.3). This may be a more realistic estimate than that for Wallasea Option I, as higher densities on the better southern side habitat could balance the potentially low waterbird densities on the northern side. Disturbance may result from the activities mentioned for Option I, although as Wallasea is relatively inaccessible, recreational disturbance from walkers is likely to be low.

## 3.3 Swale Estuary

### 3.3.1 Nagden Marshes

Nagden has a relatively exposed location on the outer Swale. This will make it prone to the build-up of coarse shell and shingle sediment, and it is expected to be the sandiest of the potential compensation sites. The proposed developments include 84 ha of mudflat and 160 ha of saltmarsh. Associated infauna is likely to resemble the biotope expected with option I at Wallasea. However, current waterbird densities suggest that enough prey is found on neighbouring mudflats to support substantial numbers of Shelduck, Dunlin and Redshank (Figures 3.3.1-3.3.10 for all species on the Swale). The combination of saltmarsh and muddy creeks, which border the west of the proposed development, may be especially attractive to Redshank, as predicted by the model (Table 3.3.1i). The proximity of the footpath currently running through the site should nonetheless be considered a drawback, as waders foraging on the Wadden Sea can flush within 100m of humans (Smit & Visser 1993). Agricultural and sailing activity also occurs close by.

Predictions of mean bird densities reach 29% and 54% of the provisional compensation targets for feeding and roosting, and feeding birds only, respectively (Table 2.6.3). Between them, these figures include appropriate numbers of Dark-bellied Brent Geese, Grey Plover, Redshank and Shelduck, although other important displaced species (Curlew, Dunlin, and Ringed Plover) may be under-represented. However, estimations of target fulfilment are amongst the highest for the six sites considered.

## 3.4 Summary of Site Recommendations

For each of the six sites considered, based on mean waterbird densities across Southeast estuaries, the total numbers of birds predicted to occur are lower than either of the two provisional compensation targets that were used for this study. Lappel Bank and Fagbury Flats were both originally high quality feeding and roosting sites, with birds often using the sites at higher densities than on their respective estuaries as a whole. Even on a national basis, Lappel Bank had unusually high densities of waterbirds, in particular Curlew, Dunlin, and Shelduck (comparable with the top 1% of national count units); and Redshank and Ringed Plover (comparable to the top 5% of national count units).

Predictions based on mean waterbird densities suggest that Maylandsea and Weymarks on the Blackwater, and Nagden Marshes on the Swale would support the highest bird numbers. Maylandsea would be predicted to hold 35% of the provisional feeding and roosting bird compensation target and 66% of the provisional feeding birds only target, whilst Weymarks and Nagden are predicted to each hold 29% and 54% of the same targets (Table 2.6.3). There are potential disadvantages with all three sites. Plans for the development of Maylandsea include the promotion of dendritic creek systems. Whilst such features would likely be rich in macrofauna attractive to birds, studies show that the same features may be avoided by waders, because of the increased risk of surprise attacks from raptors (Cresswell 1994). Furthermore, human activity at the marina may also disturb birds attracted to Maylandsea. Weymarks and Nagden are the most exposed of the sites here considered, and subsequently may be less suitable due to the development of deposits of coarse sediments, which tend to harbour less suitable prey species. However, sandier substrates are favoured by Grey Plover and Oystercatcher.

The two Wallasea options are predicted to support 28% of the provisional feeding and roosting compensation target (Table 2.6.3). Option II is considered preferable to Option I, as the latest bird counts indicate that bird densities on adjacent mudflats are especially low on the north of Wallasea Island (Figures 3.2.1-3.2.9), although both options are estimated to hold similar proportions of the provisional compensation target for feeding birds only (Option I: 53%; Option II: 52%). Mell Farm, as a result of its relatively small size, performed most poorly and is predicted to provide only 16% of the provisional target for all birds, and 31% of the target for feeding birds.

The provisional compensation targets used within this report are based on the best available information about the baseline waterbird numbers at Lappel and Fagbury Flats and the initial predictions for each site are based on the best available data on bird habitat preferences and bird usage of the areas surrounding the proposed compensation sites. However, it is important to recognise that the sites under review are at the preliminary evaluation stage and therefore a number of assumptions are inherent in these analyses (including the predictions of habitat extent, sediment composition and bird roosting/feeding behaviour) and therefore the results presented do not represent a definitive prediction at this stage. They do however provide a valuable indication of the relative values of the sites under consideration to inform the process of site selection. It is recommended that further detailed simulation modelling of any short-listed compensation sites is undertaken to provide more accurate indication of their potential to support waterbird species in the numbers required (see section 3.5).

## 3.5 Likely Waterbird Usage of Short-listed Sites

In view of the assumptions that are inherent in the current analysis, it is highly recommended that as part of the ongoing processes of site evaluation, detailed simulation modelling is carried out for the preferred site(s) to ensure that the number and range of waterbird species displaced as a result of the loss of Lappel Bank and Fagbury Flats can be compensated for in the requisite proportions (Drewitt, in press) over a period of at least 50 years.

Existing robust and extensively tested mathematical models based on estuary morphology (*e.g.* area, length, width, shore and channel widths), geographical location, and sediment cover (Austin *et al.*

1996, Holloway *et al.* 1996, Rehfisch *et al.* 1997, 2000, Yates *et al.* 1996) make it possible to predict waterbird densities and numbers on different types of coastal sites and under different sea-level rise scenarios (Austin & Rehfisch 2003). These models have been used successfully to predict waterbird densities on British estuaries that through the centuries have been extensively manipulated by man, increasing the confidence that the model predictions for totally man-made sites, such as those proposed as compensation for Fagbury Flats and Lappel Bank, are likely to be realistic. The models should be run to simulate the capacity of the site to provide overwintering grounds for waterbirds under varying management scenarios. For example, the effect of varying the width of the openings in the seawall on the densities of waterbirds (and sediment composition) could have a major effect on the waterbird densities held by a site.

The assessment of the likely value of short-listed sites provided as compensation should also take into account several factors that will be important in determining the numbers of waterbirds that they hold. Firstly overwintering waterbird distributions have broadly shifted from West to East and South to North in Britain over the last 15 years (Austin *et al.* 2000, Rehfisch *et al.* in press a) with increasing winter temperatures. With the predicted 2.5 to 3°C increase in mean winter temperature under the 2080 Medium-high scenario (Hulme & Jenkins 1998) waterbirds presently overwintering in Britain may start wintering in Continental Europe (Rehfisch 2000, Rehfisch *et al.* 2003a, Rehfisch & Crick 2003) leading to lower than expected numbers on the sites provided as compensation. The numbers of several species of waders are already declining in Britain (Rehfisch *et al.* 2003a, 2003b), possibly as a result of such redistribution. Secondly, increase in predicted sea-level rise that is predicted to occur with climate change is likely to be particularly large in the South East of Britain. This will obviously impact the capacity of the short-listed sites provided as compensation to hold waterbirds (see Austin & Rehfisch 2003 for the effect of sea-level rise on waterbird densities) in varying ways according to their location and design. Finally, it takes several years before newly created or restored habitat has stabilised out sufficiently to be used by high densities of waterbirds (Atkinson *et al.* 2001, in press, Atkinson 2003) and evidence from the States where restoration schemes have been in operation for longer than in Britain suggests that even after several decades saltmarsh and other intertidal habitats have often not attained the biodiversity of similar natural habitats.

This information would help provide a reasoned judgement of how the preferred site(s) will perform purely in terms for its/their suitability for waterbirds, although other requirements such as flood defence, cost and long-term sustainability will have to be incorporated into the final cost-benefit assessment of the exact scheme selected.

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| Species | | Two-letter Species Code |
|---|---|---|
| Cormorant | *Phalacrocorax carbo* | CA |
| Dark-bellied Brent Goose | *Branta bernicla bernicla* | DB |
| Shelduck | *Tadorna tadorna* | SU |
| Mallard | *Anas platyrhynchos* | MA |
| Oystercatcher | *Haematopus ostralegus* | OC |
| Ringed Plover | *Charadrius hiaticula* | RP |
| Grey Plover | *Pluvialis squatarola* | GV |
| Lapwing | *Vanellus vanellus* | L. |
| Knot | *Calidris canutus* | KN |
| Sanderling | *Calidris alba* | SS |
| Dunlin | *Calidris alpina* | DN |
| Curlew | *Numenius arquata* | CU |
| Redshank | *Tringa totanus* | RK |
| Turnstone | *Arenaria interpres* | TT |

**Table 1.1** The 14 species of waterbirds considered in this report, selected on the basis of occurrence at Lappel Bank and Fagbury Flats by Field *et al.* (1999).

| Species | Lappel Bank 1987/88 - 1991/92[a] | Density *ha* $^{-1}$ | Medway estuary 1987/88-1991/92[b] | Density *ha* $^{-1}$ + | Medway Estuary 1996/97[c] | Density *ha* $^{-1}$ | Medway estuary 1992/93-1996/97[d] | Density *ha* $^{-1}$ + |
|---|---|---|---|---|---|---|---|---|
| CA | 2 | 0.09 | 504 | 0.14 | * | * | 184 | 0.05 |
| DB | 3 | 0.14 | 3697 | 1.03 | 1226 | 0.34 | 3461 | 0.96 |
| SU | 108 | 4.91 | 5059 | 1.1 | 367 | 1.01 | 5082 | 1.41 |
| MA | 5 | 0.23 | 1202 | 0.33 | 397 | 0.11 | 142 | 0.40 |
| OC | 70 | 3.18 | 3339 | 0.93 | 1708 | 0.47 | 3629 | 1.01 |
| RP | 15 | 0.68 | 750 | 0.21 | 430 | 0.12 | 814 | 0.23 |
| GV | 6 | 0.27 | 4808 | 1.34 | 1583 | 0.44 | 2841 | 0.79 |
| KN | * | 0.00 | 2615 | 0.73 | 1710 | 0.48 | 477 | 0.13 |
| DN | 1012 | 46.00 | 27,873 | 7.74 | 21,151 | 5.88 | 26,878 | 7.47 |
| CU | 288 | 13.09 | 1945 | 0.54 | 650 | 0.18 | 1715 | 0.48 |
| RK | 192 | 8.73 | 4639 | 1.29 | 2149 | 0.6 | 2936 | 0.82 |
| TT | 8 | 0.36 | 633 | 0.18 | 35 | 0.01 | 552 | 0.15 |
| **Total** | **1709** | | | | | | | |

**Table 2.2.1** Lappel Bank and whole Medway Estuary bird numbers and densities before and after loss of the Lappel Bank site. (Sources a: RSPB five-year mean Low Tide winter counts; b: WeBS High Tide mean winter count; c: WeBS Low Tide mean winter count; d: WeBS High Tide five-year mean winter count). See Table 1.1 for two letter species codes.

**+** It should be noted that these densities are probably over-estimations as roosts may include birds from outside Lappel Bank and the estuary.

* Data not available

| | Medway | Orwell | Stour | Swale | Blackwater |
|---|---|---|---|---|---|
| **CA** | GB | GB | GB | GB | GB |
| **DB** | GB | GB | GB | GB | I |
| **SU** | I | GB | GB | GB | I |
| **OC** | GB | | | GB | |
| **RP** | GB | | GB | GB | |
| **GV** | I | GB | I | I | I |
| **KN** | | | I | I | |
| **DN** | I | GB | I | GB | I |
| **CU** | GB | | GB | GB | GB |
| **RK** | I | I | I | GB | I |

**Table 2.2.2** The relative importance of wintering populations of some waterbird species on five Southeast estuaries (from Musgrove *et al.* 2001). (GB = nationally important, I = internationally important). See Table 1.1 for two letter species codes.

| Species | Fagbury Flats 1988/89[a] | Density $ha^{-1}$ | Fagbury Flats 1990/91-1994/95[b] | Density $ha^{-1}$ + | Orwell Estuary 1996/97[c] | Density $ha^{-1}$ | Orwell Estuary 1992/93-1996/97[d] | Density $ha^{-1}$ + |
|---|---|---|---|---|---|---|---|---|
| CA | 3 | 0.09 | 5 | 0.16 | 38 | 0.04 | * | * |
| DB | 80 | 2.50 | 346 | 10.81 | 571 | 0.67 | 1393 | 1.64 |
| SU | 3 | 0.09 | 19 | 0.59 | 722 | 0.85 | 2309 | 2.72 |
| MA | 4 | 0.13 | 0 | 0.00 | 527 | 0.62 | * | * |
| OC | 23 | 0.72 | 105 | 3.28 | 745 | 0.88 | 972 | 1.14 |
| RP | 9 | 0.28 | 54 | 1.69 | 133 | 0.16 | 407 | 0.48 |
| GV | 34 | 1.06 | 127 | 3.97 | 136 | 0.16 | 335 | 0.39 |
| L. | 467 | 14.59 | 175 | 5.47 | 1109 | 1.30 | 1891 | 2.22 |
| KN | 9 | 0.28 | 24 | 0.75 | 705 | 0.83 | 836 | 0.98 |
| SS | 9 | 0.28 | 4 | 0.13 | 0 | 0 | 3 | 0.00 |
| DN | 325 | 10.16 | 2610 | 81.56 | 6575 | 7.74 | 9835 | 11.58 |
| CU | 1 | 0.03 | 1 | 0.03 | 567 | 0.67 | 750 | 0.88 |
| RK | 100 | 3.13 | 43 | 1.34 | 2007 | 2.36 | 1744 | 2.05 |
| TT | 22 | 0.69 | 50 | 1.56 | 50 | 0.06 | 250 | 0.29 |
| **Total** | **1089** | | **3563** | | | | | |

**Table 2.2.3** Fagbury Flats and whole Orwell Estuary bird numbers and densities before and after loss of the Fagbury Flats site. (Sources: a: NRA mean winter low tide count 1988/89; b: WeBS five- year mean High Tide winter count for 1990/91-1994/95; c: WeBS Low Tide mean winter count for 1996/97) d: WeBS five- year mean High Tide winter counts for 1992/93-1996/97). See Table 1.1 for two letter species codes.

+ It should be noted that these densities are probably over-estimations as roosts may include birds from outside Fagbury Flats and the estuary.

* Data not available

| Species | Number | | | | National Population | Proportion of National Population (%) | |
|---|---|---|---|---|---|---|---|
| | Lappel Bank | % of total (1709) | Fagbury Flats | % of total (3563) | | Lappel Bank | Fagbury Flats |
| CA | 2 | 0.11 | 5 | 0.14 | 23,000 | <0.1 | <0.1 |
| DB | 3 | 0.17 | 346 | 9.71 | 98,100 | <0.1 | 0.35 |
| SU | 108 | 6.32 | 19 | 0.53 | 78,200 | 0.14 | <0.1 |
| MA | 5 | 0.26 | * | * | 352,000 | <0.1 | <0.1 |
| OC | 70 | 4.1 | 105 | 2.95 | 315,200 | <0.1 | <0.1 |
| RP | 15 | 0.9 | 54 | 1.52 | 32,450 | <0.1 | 0.17 |
| GV | 6 | 0.4 | 127 | 3.56 | 52,750 | <0.1 | 0.24 |
| L. | 0 | 0 | 175 | 4.91 | 2,000,000 | 0 | <0.1 |
| KN | * | 0 | 24 | 0.67 | 283,600 | * | <0.1 |
| SS | 0 | 0 | 4 | 0.11 | 20,540 | 0 | <0.1 |
| DN | 1012 | 59.2 | 2610 | 73.25 | 555,800 | 0.18 | 0.47 |
| CU | 288 | 16.9 | 1 | 0.03 | 147,100 | 0.20 | <0.1 |
| RK | 192 | 11.2 | 43 | 1.21 | 116,100 | 0.17 | <0.1 |
| TT | 8 | 0.5 | 50 | 1.40 | 49,550 | <0.1 | <0.1 |
| Total | 1709 | | 3563 | | | | |

**Table 2.4** Proportion of national populations of wintering waterfowl displaced by the developments on Lappel Bank and Fagbury Flats (feeding and roosting birds). Bird numbers supplied by WeBS and RSPB (see section 2.5 for details). National populations are based on the most recent estimates: wildfowl follow Kershaw & Cranswick (2003) and waders follow Rehfisch *et al.* (2003). See Table 1.1 for two letter species codes.

* = Data not available.

| Species | Bird numbers | | |
|---|---|---|---|
| | Lappel Bank | Fagbury Flats[1] | Fagbury Flats[2] |
| | 1987/88-1991/92 | 1990/91-1994/95 | 1988/89 |
| CA | 2 | 5 | 3 |
| DB | 3 | 346 | 80 |
| SU | 108 | 19 | 3 |
| MA | 5 | 0 | 4 |
| OC | 70 | 105 | 23 |
| RP | 15 | 54 | 9 |
| GV | 6 | 127 | 34 |
| L. | 0 | 175 | 467 |
| KN | * | 24 | 9 |
| SS | 0 | 4 | 9 |
| DN | 1012 | 2610 | 325 |
| CU | 288 | 1 | 1 |
| RK | 192 | 43 | 100 |
| TT | 8 | 50 | 22 |
| TOTAL | 1709 | 3563 | 1089 |

**Table 2.5** The 'provisional compensation targets'. Lappel Bank numbers are five-year peak mean winter Low Tide Counts (RSPB 1987/88-1991/92) that will be recording largely feeding birds. Fagbury Flats[1] numbers are five-year peak mean winter High Tide Counts (WeBS 1990/91-1994/95) that will be recording largely roosting birds. Fagbury Flats[2] numbers are mean winter Low Tide Counts (NRA 1988/89) that will be recording largely feeding birds (see caveats; section 2.3). See Table 1.1 for two letter species codes.

| Species | Sediment Types (n) | | | | | |
|---|---|---|---|---|---|---|
| | Mud (136) | Other (17) | Saltmarsh (37) | Mixed (21) | Sand (32) | Mud/Sand (4) |
| **SU** | 1.116 | 0.022 | 0.137 | 0.386 | 0.161 | 0.256 |
| | 7.419 | 0.348 | 1.445 | 2.251 | 3.782 | 1.241 |
| **MA** | 0.051 | 0.008 | 0.026 | 0.113 | 0.075 | 0.015 |
| | 3.077 | 0.136 | 0.441 | 1.076 | 1.585 | 0.153 |
| **OC** | 0.347 | 2.098 | 0.016 | 0.911 | 2.003 | 2.297 |
| | 5.777 | 7.653 | 0.655 | 5.038 | 36.694 | 6.041 |
| **RP** | 0.119 | 0.112 | 0.005 | 0.119 | 0.150 | 0.020 |
| | 4.707 | 0.545 | 0.364 | 1.986 | 2.527 | 0.116 |
| **GV** | 0.474 | 0.685 | 0.047 | 0.880 | 0.963 | 0.170 |
| | 6.683 | 5.685 | 0.867 | 25.101 | 15.117 | 0.557 |
| **L.** | 0.796 | 0.000 | 0.061 | 1.892 | 0.024 | 0.001 |
| | 27.176 | 0.000 | 1.795 | 7.952 | 1.529 | 0.011 |
| **KN** | 0.418 | 4.118 | 0.000 | 0.913 | 2.355 | 2.563 |
| | 35.460 | 19.009 | 0.000 | 17.613 | 23.345 | 14.864 |
| **SS** | 0.004 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 0.838 | 0.034 | 0.000 | 0.000 | 0.000 | 0.000 |
| **DN** | 9.208 | 10.044 | 0.107 | 2.293 | 3.830 | 1.902 |
| | 88.055 | 51.542 | 3.152 | 14.804 | 49.424 | 7.317 |
| **CU** | 0.488 | 0.802 | 0.075 | 0.292 | 0.159 | 0.143 |
| | 9.221 | 2.950 | 0.609 | 2.088 | 1.020 | 0.495 |
| **RK** | 2.309 | 0.562 | 0.293 | 1.050 | 0.324 | 0.214 |
| | 25.697 | 4.119 | 2.741 | 13.436 | 3.422 | 0.589 |
| **TT** | 0.048 | 0.498 | 0.033 | 0.583 | 0.176 | 0.125 |
| | 3.743 | 6.809 | 2.153 | 11.620 | 1.929 | 0.305 |

**Table 2.6.1** Mean (top) and peak (below) densities ($ha^{-1}$) of waterbirds observed in count units of differing substratum type on six Southeast estuaries (data from Holloway *et al.* 1996). See Table 1.1 for two letter species codes.

| Estuary | Mean $ha^{-1}$ | Peak $ha^{-1}$ |
|---|---|---|
| Blackwater | 1.85 | 4.59 |
| Crouch & Roach | 1.42 | 3.01 |
| Swale | 0.36 | 0.96 |

**Table 2.6.2** Densities of Dark-bellied Brent Geese on the three estuaries considered in this report. Data from WeBS Low Tide Counts (Blackwater: 1994/95; Crouch & Roach: 1995/96; Swale: 2001/02).

| Site | Predicted mean number of birds | Percentage of target reached[1] | Percentage of target reached[2] | Predicted peak number of birds | Percentage of target reached[1] | Percentage of target reached[2] |
|---|---|---|---|---|---|---|
| Maylandsea | 1854 | 35% | 66% | 19,870 | 377% | 707% |
| Mell Farm | 857 | 16% | 31% | 10,393 | 197% | 371% |
| Weymarks | 1519 | 29% | 54% | 19,096 | 362% | 682% |
| Wallasea: option I | 1480 | 28% | 53% | 19,087 | 362% | 682% |
| Wallasea: option II | 1467 | 28% | 52% | 18,983 | 360% | 678% |
| Nagden marshes | 1508 | 29% | 54% | 20,809 | 395% | 744% |

**Table 2.6.3** Predicted waterfowl numbers for a mud and saltmarsh habitat based on mean and peak densities (Tables 2.6.1 and 2.6.2) as a percentage of the target numbers needed to replace the birds that had been present on Fagbury Flats and Lappel Bank. [1] Provisional compensation target including feeding and roosting birds. [2] Provisional compensation target including feeding birds only.

| | |
|---|---|
| **Estuary characteristics** | Coastal Plain Macrotidal estuary<br>Intertidal area 3320ha<br>Tidal range 4.6m. |
| **Situation and Site Characteristics** | South shore of the Blackwater Estuary. |
| **Size of Site and Habitat coverage** | Total area – 490ha<br>Mudflat - 67ha<br>Saltmarsh - 264ha<br>(Plus Grassland - 159ha) |
| **Exposure Level** | Sheltered upper estuary. |
| **Existing land use** | Agricultural. |
| **Adjacent Land use** | Agricultural, residential (Maylandsea east, Maldon west), Marina at Maylandsea. |
| **Nature of Adjacent Intertidal Sediments** | Saltmarsh around margins of this extensive site fronting large expanse of mudflat to the north and smaller areas of mudflat within the Maldon creek complex to the east. |
| **Nature of Adjacent Intertidal Vegetation** | Atlantic saltmarsh across all upper shore areas<br>Bare mudflat possible subject colonisation by ephemeral species such as *Enteromorpha* sp. |
| **Nature of Adjacent Intertidal benthos** | Limited quantitative data collated on infaunal assemblages – summary data on Blackwater communities available in Field *et al.* (1999) (Table 8.2.10). Typical middle estuary mudflat fauna likely. |
| **Disturbance** | Agricultural activities, yacht moorings. |

**Table 3.1.1i** Environmental site characteristics for Site 1: Maylandsea. (Source: ABPmer, with JNCC UK estuary database; English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994).

| Species | Average density on adjacent mudflats *ha*$^{-1}$ | Numbers displaced from Lappel Bank and Fagbury Flats | | Predicted bird numbers using site | | |
|---|---|---|---|---|---|---|
| | | a | b | Saltmarsh and mud | Saltmarsh and sand | Saltmarsh and muddy sand |
| CA | N/a | 7 | 5 | N/a | N/a | N/a |
| DB | 0.08 | 349 | 83 | 612 (1519) | 612 (1519) | 612 (1519) |
| SU | 1.65 | 127 | 111 | 111 (879) | 47 (635) | 53 (465) |
| MA | 0.06 | 5 | 9 | 10 (323) | 12 (223) | 8 (127) |
| OC | 0.13 | 175 | 93 | 27 (560) | 138 (2631) | 158 (578) |
| **RP** | <0.01 | 69 | 24 | 9 (411) | 11 (265) | 3 (104) |
| **GV** | 0.12 | 133 | 40 | 44 (677) | 77 (1242) | 24 (266) |
| **L.** | 1.75 | 175 | 467 | 69 (2295) | 18 (576) | 16 (475) |
| **KN** | 0.10 | 24 | 9 | 28 (2376) | 158 (1564) | 172 (996) |
| **SS** | 0 | 4 | 9 | 0 (56) | 0 (0) | 0 (0) |
| **DN** | 4.77 | 3622 | 1337 | 645 (6732) | 285 (4144) | 156 (1322) |
| **CU** | 0.13 | 289 | 289 | 52 (779) | 30 (229) | 29 (194) |
| **RK** | 0.77 | 235 | 292 | 232 (2445) | 99 (953) | 92 (763) |
| **TT** | <0.01 | 58 | 30 | 12 (819) | 21 (698) | 17 (589) |
| **TOTAL** | | 5272 | 2798 | 1854 (19,870) | 1508 (14,679) | 1340 (7397) |

**Table 3.1.1ii** Estimated bird numbers using Maylandsea after development, allowing for 264 ha saltmarsh and 67 ha mudflat (mud, muddy sand and sand). Numbers displaced are based on compensation targets for (a) feeding and roosting birds and (b) feeding birds only. Numbers of Brent Geese estimated using Low Tide Count whole estuary densities (Table 2.6.2); numbers of other species estimated using densities in Table 2.6.1. See Table 1.1 for two letter species codes.

| | |
|---|---|
| **Estuary characteristics** | Coastal Plain Macrotidal estuary<br>Intertidal area 3320ha<br>Tidal range 4.6m. |
| **Situation and Site Characteristics** | North shore of Blackwater Estuary. |
| **Size of Site and Habitat coverage** | Total area – 105ha.<br>Mudflat - 43ha<br>Saltmarsh - 44ha<br>(Plus Grassland - 18ha) |
| **Exposure Level** | Moderately Exposed –Located in middle section of Blackwater estuary northeastern side of site exposed to moderate fetch in an easterly direction (i.e. towards estuary mouth). |
| **Nature of Adjacent Intertidal Sediments** | Mudflat habitat along the west side of the site and well-developed saltmarshes to the west.<br>Intertidal rock communities to be found in areas upstream and downstream of the site. |
| **Nature of Adjacent Intertidal Vegetation** | Bare mudflat to the east (possible colonisation by ephemeral species such as *Enteromorpha* sp),<br>Atlantic saltmarsh across to the west side of the site. |
| **Nature of Adjacent Intertidal benthos** | Limited quantitative data collated on infaunal assemblages – summary data on Blackwater communities available in Field *et al.* (1999) (Table 8.2.10). Typical middle/outer estuary mudflat fauna likely. |
| **Disturbance** | Footpath along sea wall and into the site along track to Rolls Farm and track to Decoy farm. Site also used to access oyster lays. |

**Table 3.1.2i** Environmental site characteristics for Site 2: Mell Farm. (Source: ABPmer, with JNCC UK estuary database; English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994).

| Species | Average density on adjacent mudflats *ha*$^{-1}$ | Numbers displaced from Lappel Bank and Fagbury Flats | | Predicted bird numbers using site | | |
|---|---|---|---|---|---|---|
| | | a | b | Saltmarsh and mud | Saltmarsh and sand | Saltmarsh and muddy sand |
| CA | N/a | 7 | 5 | N/a | N/a | N/a |
| DB | 1.58 | 349 | 83 | 161 (399) | 161 (399) | 161 (399) |
| SU | 0.08 | 127 | 111 | 54 (383) | 13 (226) | 17 (117) |
| MA | 0.08 | 5 | 9 | 3 (152) | 4 (88) | 2 (26) |
| OC | 0.24 | 175 | 93 | 16 (277) | 87 (1607) | 99 (289) |
| RP | 0.04 | 69 | 24 | 5 (218) | 7 (125) | 1 (21) |
| GV | 1.89 | 133 | 40 | 22 (326) | 43 (688) | 9 (62) |
| L. | 1.57 | 175 | 467 | 37 (1248) | 4 (145) | 3 (79) |
| KN | 0.04 | 24 | 9 | 18 (1525) | 101 (1004) | 110 (639) |
| SS | 0 | 4 | 9 | 0 (36) | 0 (0) | 0 (0) |
| DN | 6.68 | 3622 | 1337 | 401 (3925) | 169 (2264) | 86 (453) |
| CU | 0.14 | 289 | 289 | 24 (423) | 10 (71) | 9 (48) |
| RK | 0.58 | 235 | 292 | 112 (1226) | 27 (268) | 22 (146) |
| TT | 0.28 | 58 | 30 | 4 (256) | 9 (178) | 7 (108) |
| **TOTAL** | | 5272 | 2798 | 857 (10,393) | 636 (7061) | 528 (2388) |

**Table 3.1.2ii** Estimated bird numbers using Mell Farm after development, allowing for 44 ha saltmarsh and 43 ha mudflat (mud, muddy sand and sand). Numbers displaced are based on compensation targets for (a) feeding and roosting birds and (b) feeding birds only. Numbers of Brent Geese estimated using Low Tide Count whole estuary densities (Table 2.6.2); numbers of other species estimated using densities in Table 2.6.1. See Table 1.1 for two letter species codes.

| | |
|---|---|
| **Estuary characteristics** | Coastal Plain Macrotidal estuary<br>Intertidal area 3320ha<br>Tidal range 4.6m.<br>Blackwater SPA |
| **Situation and Site Characteristics** | South bank of Blackwater near mouth of estuary. |
| **Size of Site and Habitat coverage** | Total area - 111ha<br>Mudflat - 84ha<br>Saltmarsh - 27ha |
| **Exposure Level** | Site exposed to long northeasterly fetch and high-energy regime. In general very exposed but some protection afforded by offshore barges. |
| **Nature of Adjacent Intertidal Sediments** | Coarse shell/sand beach in front of upper shore saltmarsh (Atlantic saltmeadow) along most of the site.<br>Sections of mudflat across upper shore and lower shore areas to the east. |
| **Nature of Adjacent Intertidal Vegetation** | Well developed Atlantic Salt meadow to the east and west. |
| **Nature of Adjacent Intertidal benthos** | Limited quantitative data collated on infaunal assemblages – summary data on Blackwater communities available in Field *et al.* (1999) (Table 8.2.10). Typical outer estuary sand and mudflat fauna likely. Intertidal sand and gravel habitat along the majority of the adjacent foreshore with some intertidal mudflat communities at its eastern side.<br>Mixed sediment communities in subtidal areas in front of site. |
| **Disturbance** | Public footpath along seafront. Power station and agricultural activities. |

**Table 3.1.3i** Environmental site characteristics for Site 3: Weymarks Marsh. (Source: ABPmer, with JNCC UK estuary database; English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994).

| Species | Average density on adjacent mudflats *ha*$^{-1}$ | Numbers displaced from Lappel Bank and Fagbury Flats | | Predicted bird numbers using site | | |
|---|---|---|---|---|---|---|
| | | a | b | Saltmarsh and mud | Saltmarsh and sand | Saltmarsh and muddy sand |
| CA | N/a | 7 | 5 | N/a | N/a | N/a |
| DB | 0.09 | 349 | 83 | 205 (413) | 205 (413) | 205 (413) |
| SU | 0 | 127 | 111 | 97 (662) | 17 (357) | 25 (143) |
| MA | 0 | 5 | 9 | 5 (270) | 7 (145) | 2 (25) |
| OC | 0.02 | 175 | 93 | 30 (503) | 169 (3100) | 193 (525) |
| RP | 0.01 | 69 | 24 | 10 (405) | 13 (222) | 2 (20) |
| GV | 0.04 | 133 | 40 | 41 (585) | 82 (1293) | 16 (70) |
| L. | 0 | 175 | 467 | 69 (2331) | 4 (177) | 2 (49) |
| KN | 0 | 24 | 9 | 35 (2979) | 198 (1961) | 215 (1249) |
| SS | 0.09 | 4 | 9 | 0 (70) | 0 (0) | 0 (0) |
| DN | 0.19 | 3622 | 1337 | 776 (7482) | 325 (4237) | 163 (700) |
| CU | 0.02 | 289 | 289 | 43 (791) | 15 (102) | 14 (58) |
| RK | 0.10 | 235 | 292 | 202 (2233) | 35 (361) | 26 (123) |
| TT | 0.12 | 58 | 30 | 5 (373) | 16 (220) | 11 (84) |
| TOTAL | | 5272 | 2798 | 1519 (19,096) | 1085 (12,588) | 874 (3458) |

**Table 3.1.3ii** Estimated bird numbers using Weymarks Marsh after development, allowing for 27 ha saltmarsh and 84 ha mudflat (mud, muddy sand and sand). Numbers displaced are based on compensation targets for (a) feeding and roosting birds and (b) feeding birds only. Numbers of Brent Geese estimated using Low Tide Count whole estuary densities (Table 2.6.2); numbers of other species estimated using densities in Table 2.6.1. See Table 1.1 for two letter species codes.

| | |
|---|---|
| **Crouch-Roach Estuary characteristics** | Coastal Plain Macrotidal estuary<br>Intertidal area 1540ha<br>Tidal range 5m. |
| **Situation and Site Characteristics** | Island located between the convergence of the Crouch and Roach Estuaries to the west of Foulness. |
| **Size of Site and Habitat coverage** | Total area 115ha.<br>Mudflat - 84ha<br>Saltmarsh - 31ha (created through sediment recharge). |
| **Exposure Level** | Moderately Exposed – although located in middle section of Crouch Estuary northeastern side of site exposed to large fetch in an easterly direction (i.e. towards estuary mouth). The north bank is also exposed to prevalent northerly winds. |
| **Existing Land use** | Agricultural (wheat and peas).<br>Secondary wall already constructed at Grapnells Farm on north bank. This covers about 50 ha and is currently set-aside land that is being managed and surveyed by RSPB. |
| **Adjacent Land use** | Recreational and residential (Caravan/campsite and pub) and Marina. |
| **Nature of Adjacent Intertidal Sediments** | North bank narrow area of mudflat along the length of the site with occasional patches of saltmarsh in sheltered embayments. |
| **Nature of Adjacent Intertidal Vegetation** | Patches of Atlantic salt meadow in embayments otherwise bare mudflat (possible colonisation by ephemeral algal species such as *Enteromorpha* sp). |
| **Nature of Adjacent Intertidal benthos** | No quantitative data collated on infaunal assemblages but typical middle/outer estuary mudflat fauna likely. Subtidal muddy sand communities in front of upstream sections of the site. |
| **Disturbance** | MOD testing on Foulness island, agricultural activities.<br>Public right of way along northern sea wall and part way along eastern wall, but as this is a relatively inaccessible site, disturbance from terrestrial recreational activities (walkers, dogs) is low.<br>Some wildfowling on site. |

**Table 3.1.4i** Environmental site characteristics for Site 4: Wallasea: Option I. (Source: ABPmer, with JNCC UK estuary database; English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994).

| Species | Average density on adjacent mudflats *ha*$^{-1}$ | Numbers displaced from Lappel Bank and Fagbury Flats | | Predicted bird numbers using site | | |
|---|---|---|---|---|---|---|
| | | a | b | Saltmarsh and mud | Saltmarsh and sand | Saltmarsh and muddy sand |
| CA | N/a | 7 | 5 | N/a | N/a | N/a |
| DB | 0 | 349 | 83 | 163 (346) | 163 (436) | 163 (436) |
| SU | 0 | 127 | 111 | 98 (668) | 18 (362) | 26 (149) |
| MA | 0 | 5 | 9 | 5 (272) | 7 (147) | 2 (27) |
| OC | 0 | 175 | 93 | 30 (506) | 169 (3103) | 193 (528) |
| RP | 0 | 69 | 24 | 10 (407) | 13 (224) | 2 (21) |
| GV | 0 | 133 | 40 | 41 (588) | 82 (1297) | 16 (57) |
| L. | 0 | 175 | 467 | 69 (2338) | 4 (184) | 2 (57) |
| KN | 0 | 24 | 9 | 35 (2979) | 198 (1961) | 215 (1249) |
| SS | 0 | 4 | 9 | 0 (70) | 0 (0) | 0 (0) |
| DN | 0 | 3622 | 1337 | 777 (7494) | 325 (4249) | 163 (712) |
| CU | 0.02 | 289 | 289 | 43 (793) | 16 (105) | 14 (60) |
| RK | 0.02 | 235 | 292 | 203 (2244) | 36 (372) | 27 (134) |
| TT | 0 | 58 | 30 | 5 (381) | 16 (229) | 12 (92) |
| TOTAL | | 5272 | 2798 | 1480 (19,087) | 1047 (12,578) | 835 (3449) |

**Table 3.1.4ii** Estimated bird numbers using Wallasea: Option I after development, allowing for 31 ha saltmarsh and 84 ha mudflat (mud, muddy sand and sand). Numbers displaced are based on compensation targets for (a) feeding and roosting birds and (b) feeding birds only. Numbers of Brent Geese estimated using Low Tide Count whole estuary densities (Table 2.6.2); numbers of other species estimated using densities in Table 2.6.1. See Table 1.1 for two letter species codes.

| | |
|---|---|
| **Crouch-Roach Estuary characteristics** | Coastal Plain Macrotidal estuary<br>Intertidal area 1540ha<br>Tidal range 5m. |
| **Situation and Site Characteristics** | Island located between the convergence of the Crouch and Roach Estuaries to the west of Foulness. |
| **Size of Site and Habitat coverage** | Total area 109ha.<br>Mudflat - 84ha (inc. 57ha on south bank and 27ha on north bank)<br>Saltmarsh – 25ha (created through sediment recharge on north bank) |
| **Exposure Level** | Sheltered/Moderately Exposed – North bank site in middle section of Crouch estuary small fetch distance but exposed to prevalent northerly winds. South bank in middle section of Roach with negligible fetch and shelter from northerly winds. |
| **Existing Land use** | Agricultural (wheat and peas).<br>Secondary wall already constructed at Grapnells Farm on north bank. This covers about 50ha and is currently set-aside land that is being managed and surveyed by RSPB. |
| **Adjacent Land use** | Recreational and residential (Caravan/campsite and pub) and Marina |
| **Nature of Adjacent Intertidal Sediments** | South bank site has narrow area of mudflat along its southern boundary, and saltmarsh habitat to the west (i.e. at mouth of Paglesham creek). |
| **Nature of Adjacent Intertidal Vegetation** | Atlantic salt meadow to the west of the site otherwise bare mudflat (possible colonisation by ephemeral algal species such as *Enteromorpha* sp). |
| **Nature of Adjacent Intertidal benthos** | No quantitative data collated on infaunal assemblages but typical middle estuary mudflat fauna likely. Subtidal muddy sand communities in front of upstream sections of the site with commercially exploited oyster layings present. |
| **Disturbance** | MOD testing on Foulness island, agricultural activities<br>Public right of way along northern sea wall and part way along eastern wall but the as this is a relatively inaccessible site disturbance from terrestrial recreational activities (walkers, dogs) is low.<br>Some wildfowling on site. |

**Table 3.1.5i** Environmental site characteristics for Site 5: Wallasea: Option II. (Source: ABPmer, with JNCC UK estuary database; English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994).

| Species | Average density on adjacent mudflats *ha*$^{-1}$ | Numbers displaced from Lappel Bank and Fagbury Flats | | Predicted bird numbers using site | | |
|---|---|---|---|---|---|---|
| | | a | b | Saltmarsh and mud | Saltmarsh and sand | Saltmarsh and muddy sand |
| CA | N/a | 7 | 5 | N/a | N/a | N/a |
| DB | 0.29 | 349 | 83 | 155 (328) | 155 (328) | 155 (328) |
| SU | 1.03 | 127 | 111 | 97 (659) | 17 (354) | 25 (140) |
| MA | 0.19 | 5 | 9 | 5 (269) | 7 (144) | 2 (24) |
| OC | 0.01 | 175 | 93 | 30 (502) | 169 (3099) | 193 (524) |
| RP | 0.07 | 69 | 24 | 10 (404) | 13 (221) | 2 (19) |
| GV | 0.16 | 133 | 40 | 41 (583) | 82 (1292) | 15 (68) |
| L. | 0 | 175 | 467 | 68 (2328) | 4 (173) | 2 (46) |
| KN | 0 | 24 | 9 | 35 (2979) | 198 (1961) | 215 (1249) |
| SS | 0 | 4 | 9 | 0 (70) | 0 (0) | 0 (0) |
| DN | 1.10 | 3622 | 1337 | 776 (7475) | 324 (4230) | 162 (693) |
| CU | 0.13 | 289 | 289 | 43 (790) | 15 (101) | 14 (57) |
| RK | 0.61 | 235 | 292 | 201 (2227) | 35 (356) | 25 (118) |
| TT | 0 | 58 | 30 | 5 (368) | 16 (216) | 11 (79) |
| TOTAL | | 5272 | 2798 | 1467 (18,983) | 1033 (12,475) | 822 (3346) |

**Table 3.1.5ii** Estimated bird numbers using Wallasea: Option II after development, allowing for 25 ha saltmarsh and 84 ha mudflat (mud, muddy sand and sand). Numbers displaced are based on compensation targets for (a) feeding and roosting birds and (b) feeding birds only. Numbers of Brent Geese estimated using Low Tide Count whole estuary densities (Table 2.6.2); numbers of other species estimated using densities in Table 2.6.1. See Table 1.1 for two letter species codes.

| | |
|---|---|
| **Estuary characteristics** | Coastal Plain Macrotidal estuary<br>Intertidal area 2670ha<br>Tidal range 4.9m. |
| **Situation and Site Characteristics** | Outer Swale Estuary south bank and adjacent to Faversham Creek.<br>Agricultural areas, marshland and borrow dykes fronting intertidal mudflats.<br>Pylons run across central section of the flood plain area (in an east west direction) and therefore a provisional alignment for the new counterwall has been selected such that it is located seaward of these pylons. |
| **Size of Site and Habitat coverage** | Total - 244ha<br>Mudflat – 84ha<br>Saltmarsh – 160ha |
| **Exposure Level** | Exposed - Large fetch from mouth of estuary in an east by northeast direction. |
| **Nature of Adjacent Intertidal Sediments** | Large area of intertidal mudflats within margin of coarse shell/shingle along the upper shore.<br>Prominent shingle/shell spit and saltmarsh habitat at centre of site. |
| **Nature of Adjacent Intertidal Vegetation** | Bare mudflat (possible colonisation by ephemeral species such as *Enteromorpha* sp), saltmarsh (in particular large area especially at centre of site) and *Zostera* Beds at Faversham. |
| **Nature of Adjacent Intertidal benthos** | No quantitative data collated on infaunal assemblages but typical outer estuary mudflat fauna likely.<br>Mudflats support large shellfish populations including oyster/mussel beds at Seasalter (4-5km downstream). |
| **Disturbance** | Public footpath (Saxon Shore Way) along the seafront. Agriculture and sailing activities. |

**Table 3.1.6i** Environmental site characteristics for Site 6: Nagden Marshes. (Source: ABPmer, with JNCC UK estuary database).

| Species | Average density on adjacent mudflats *ha*$^{-1}$ | Numbers displaced from Lappel Bank and Fagbury Flats | | Predicted bird numbers using site | | |
|---|---|---|---|---|---|---|
| | | a | b | Saltmarsh and mud | Saltmarsh and sand | Saltmarsh and muddy sand |
| CA | N/a | 7 | 5 | N/a | N/a | N/a |
| DB | 0 | 349 | 83 | 88 (234) | 88 (234) | 88 (234) |
| SU | 0.43 | 127 | 111 | 116 (854) | 35 (549) | 43 (335) |
| MA | 0.04 | 5 | 9 | 8 (329) | 10 (204) | 5 (83) |
| OC | 0.02 | 175 | 93 | 32 (590) | 171 (3187) | 196 (612) |
| RP | 0.14 | 69 | 24 | 11 (454) | 13 (271) | 2 (68) |
| GV | 0.12 | 133 | 40 | 47 (700) | 88 (1409) | 22 (186) |
| L. | 0 | 175 | 467 | 77 (2570) | 12 (416) | 10 (288) |
| KN | 0 | 24 | 9 | 35 (2979) | 198 (1961) | 215 (1249) |
| SS | 0 | 4 | 9 | 0 (70) | 0 (0) | 0 (0) |
| DN | 1.09 | 3622 | 1337 | 791 (7901) | 339 (4656) | 177 (1119) |
| CU | 0.07 | 289 | 289 | 53 (872) | 25 (183) | 24 (139) |
| RK | 0.93 | 235 | 292 | 241 (2597) | 74 (726) | 65 (488) |
| TT | 0.03 | 58 | 30 | 9 (659) | 20 (507) | 16 (370) |
| TOTAL | | 5272 | 2798 | 1508 (20,809) | 1074 (14,301) | 863 (5172) |

**Table 3.1.6ii** Estimated bird numbers using Nagden Marshes after development, allowing for 160 ha saltmarsh and 84 ha mudflat (mud, muddy sand and sand). Numbers displaced are based on compensation targets for (a) feeding and roosting birds and (b) feeding birds only. Numbers of Brent Geese estimated using Low Tide Count whole estuary densities (Table 2.6.2); numbers of other species estimated using densities in Table 2.6.1. See Table 1.1 for two letter species codes.

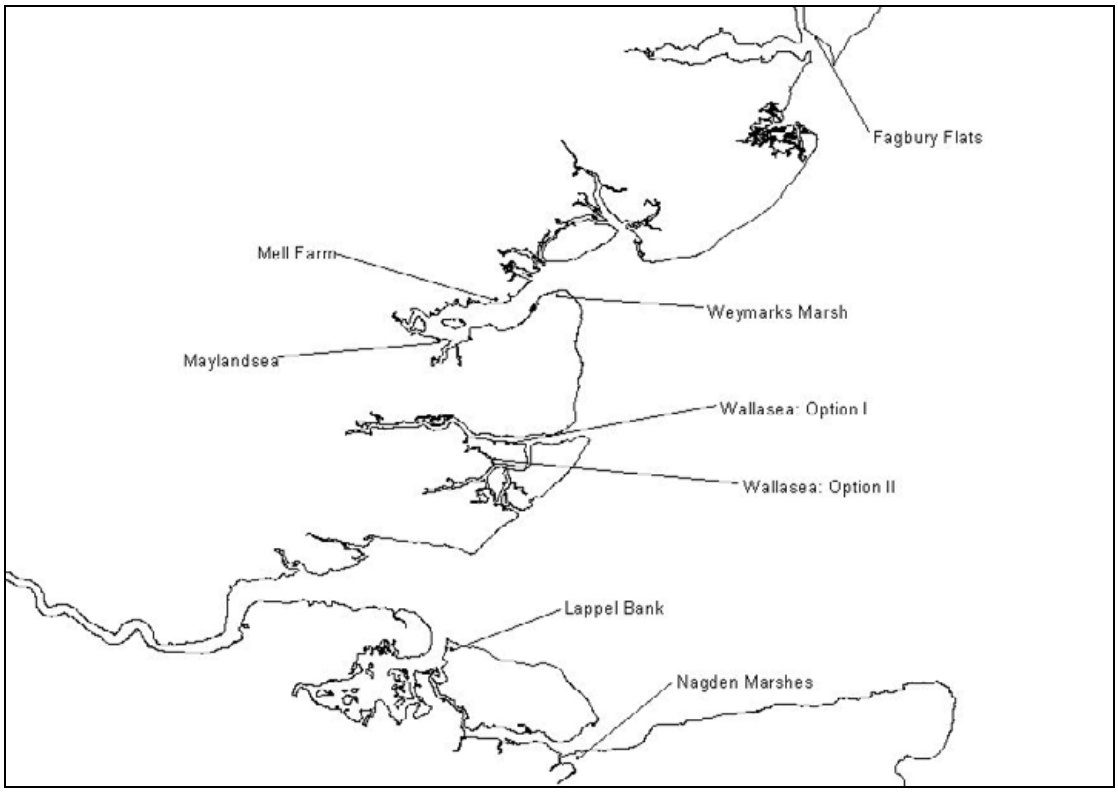


**Figure 1.1** Map of Southeast England showing the locations of Lappel Bank and Fagbury Flats, plus the six candidate compensation sites.

**Figure 1.2** Map of Britain showing area of detail in Figure 1.1.

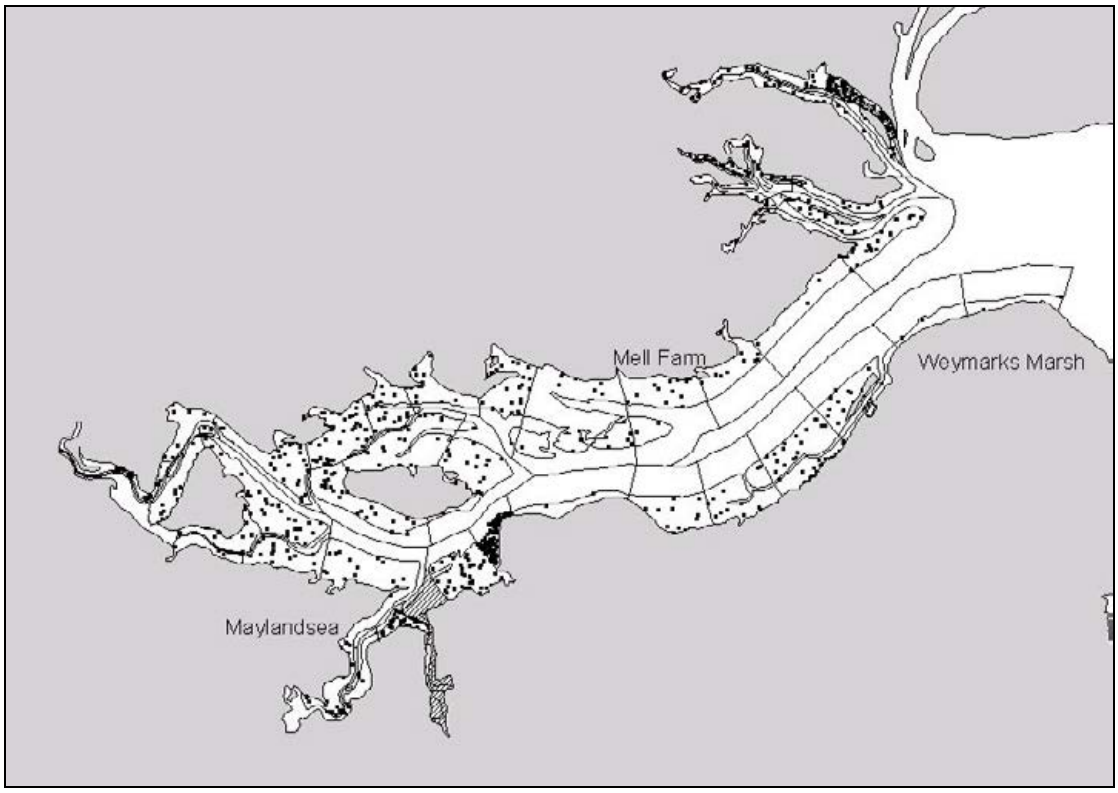


**Figure 3.1.1** Mean density of Curlew on the Blackwater estuary (data from WeBS low tide counts 1994-95). One dot=0.02 birds. Hatched area was unsurveyed.

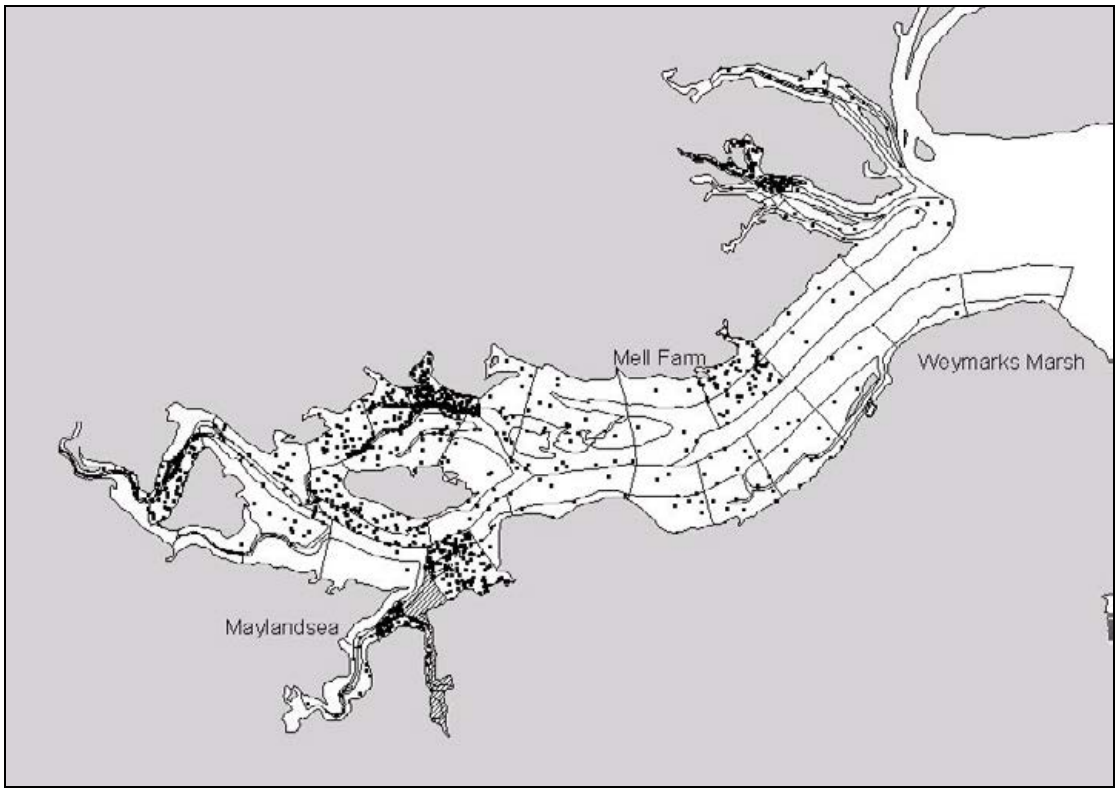


**Figure 3.1.2** Mean density of Dark-bellied Brent Goose on the Blackwater estuary (data from WeBS low tide counts 1994-95). One dot=0.20 birds. Hatched area was unsurveyed.

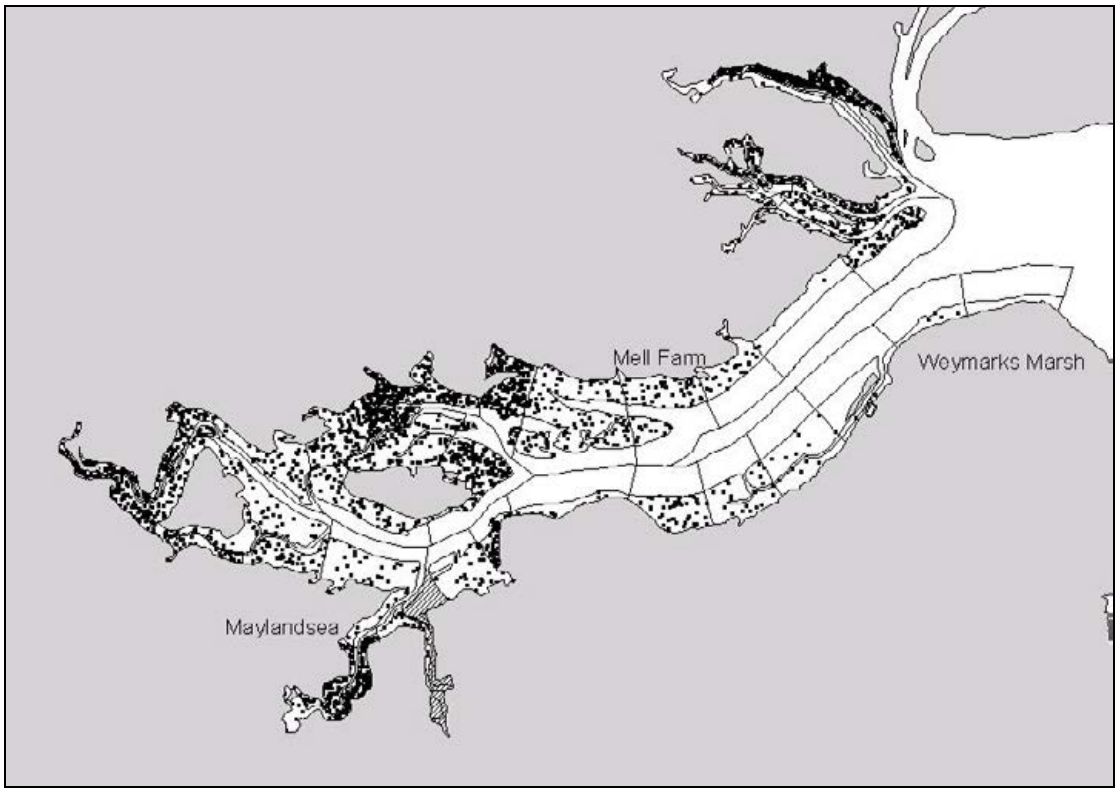


**Figure 3.1.3** Mean density of Dunlin on the Blackwater estuary (data from WeBS low tide counts 1994-95). One dot=0.20 birds. Hatched area was unsurveyed.

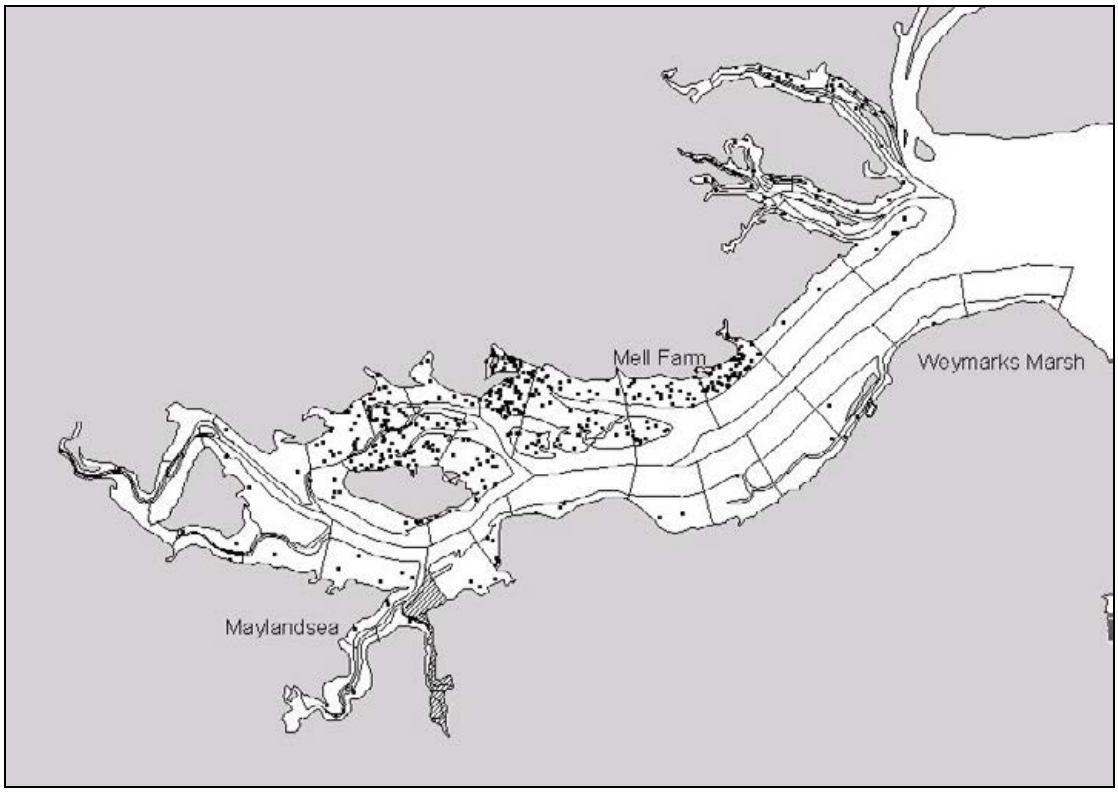


**Figure 3.1.4** Mean density of Grey Plover on the Blackwater estuary (data from WeBS low tide counts 1994-95). One dot=0.08 birds. Hatched area was unsurveyed.

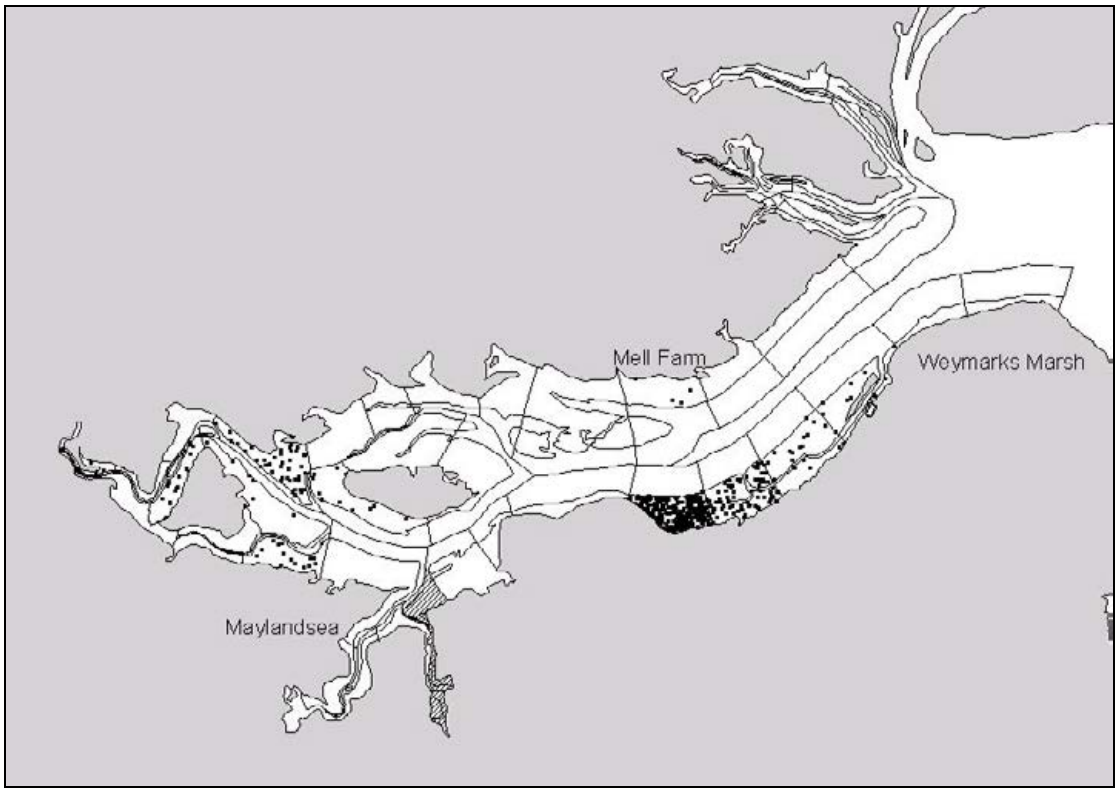


**Figure 3.1.5** Mean density of Knot on the Blackwater estuary (data from WeBS low tide counts 1994-95). One dot=0.05 birds. Hatched area was unsurveyed.

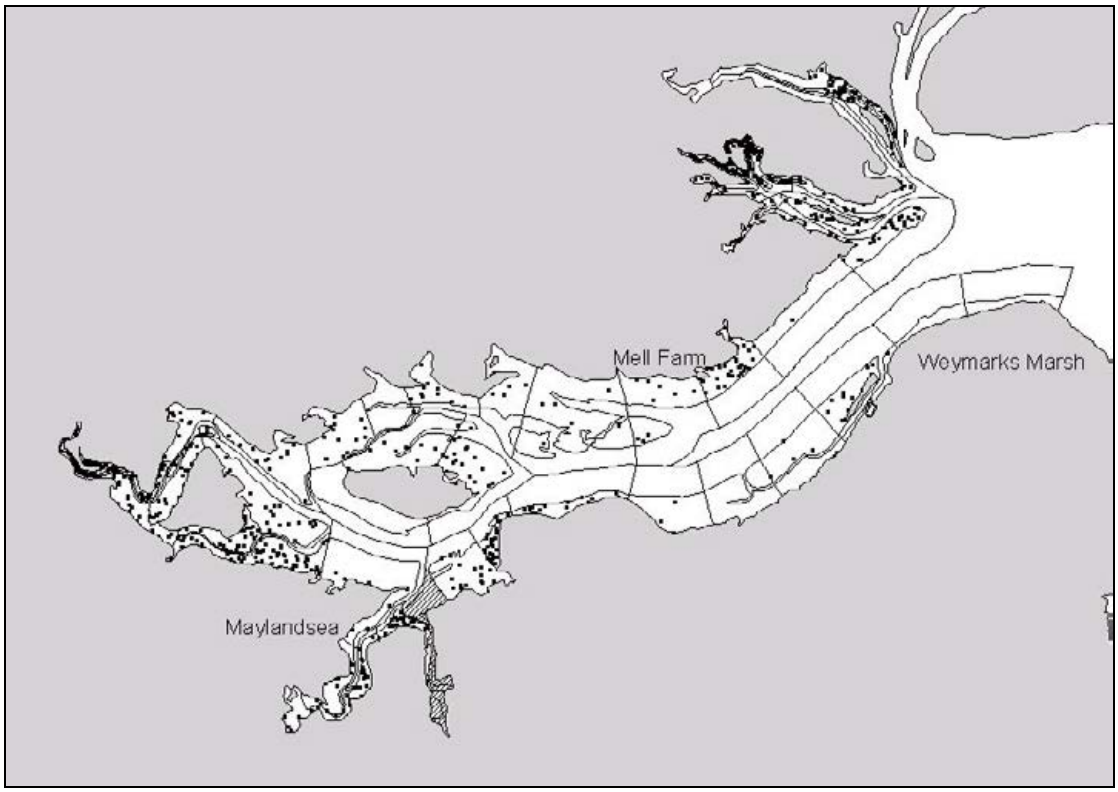


**Figure 3.1.6** Mean density of Lapwing on the Blackwater estuary (data from WeBS low tide counts 1994-95). One dot=0.20 birds. Hatched area was unsurveyed.

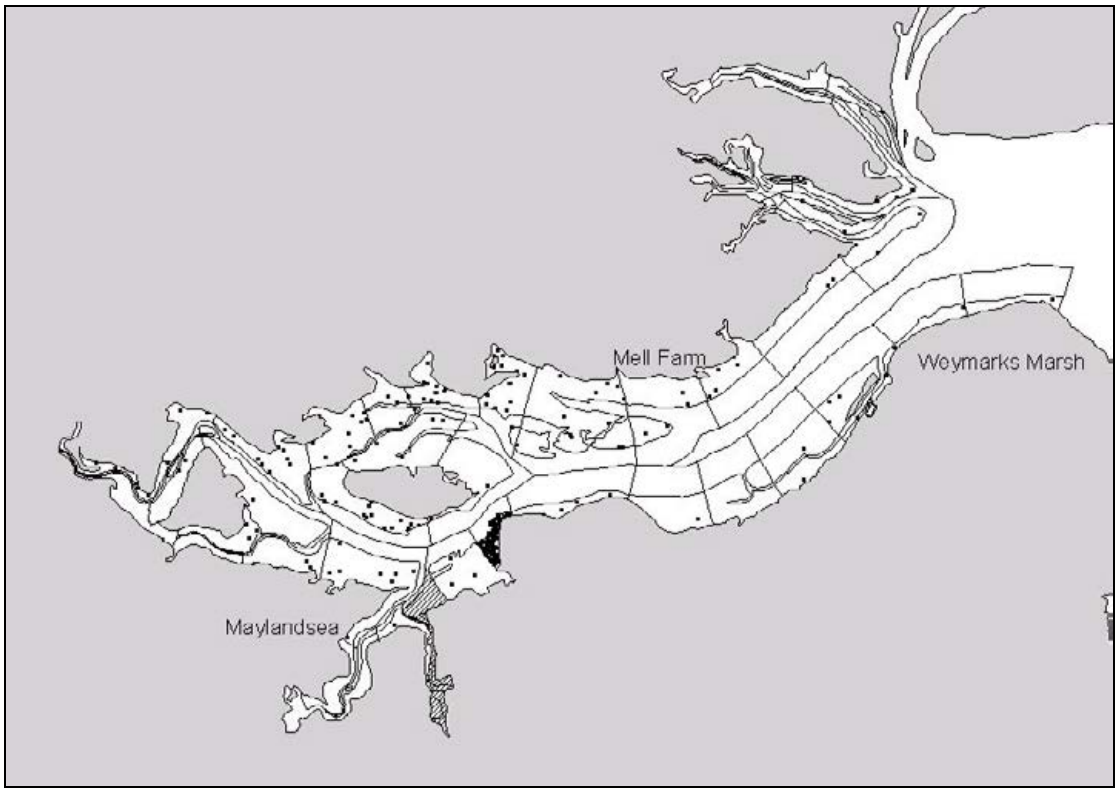


**Figure 3.1.7** Mean density of Oystercatchers on the Blackwater estuary (data from WeBS low tide counts 1994-95). One dot=0.07 birds. Hatched area was unsurveyed.

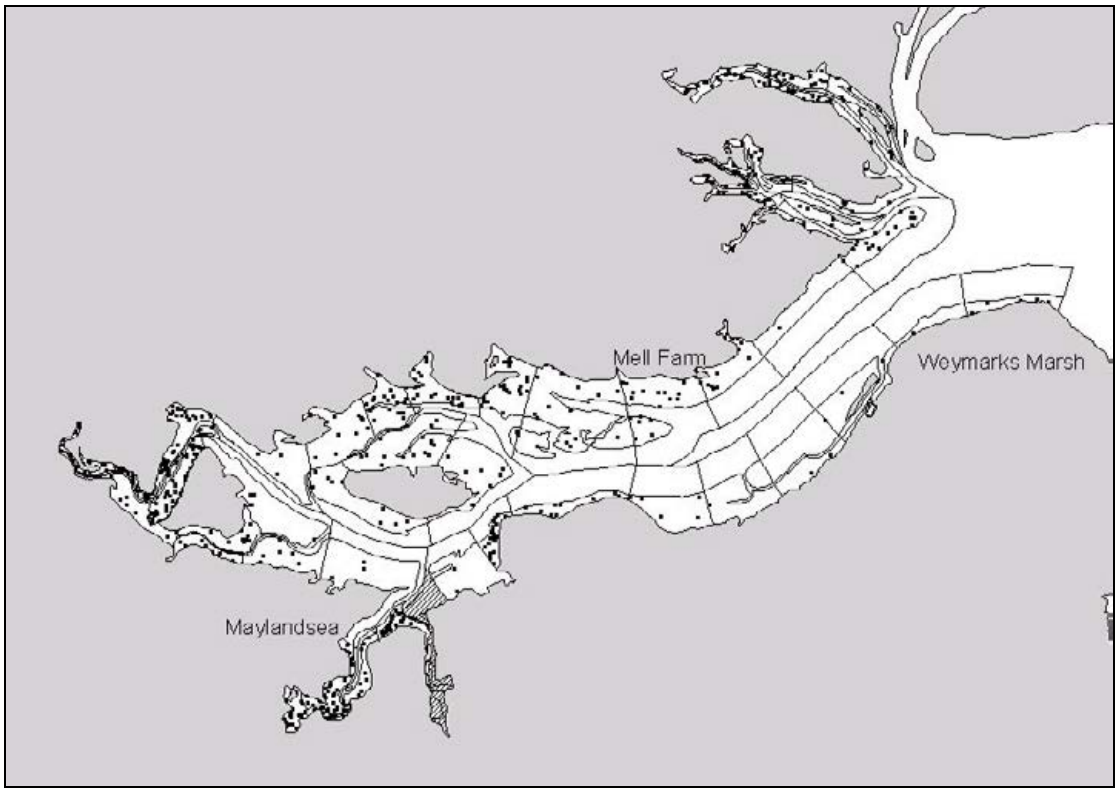


**Figure 3.1.8** Mean density of Redshank on the Blackwater estuary (data from WeBS low tide counts 1994-95). One dot=0.07 birds. Hatched area was unsurveyed.

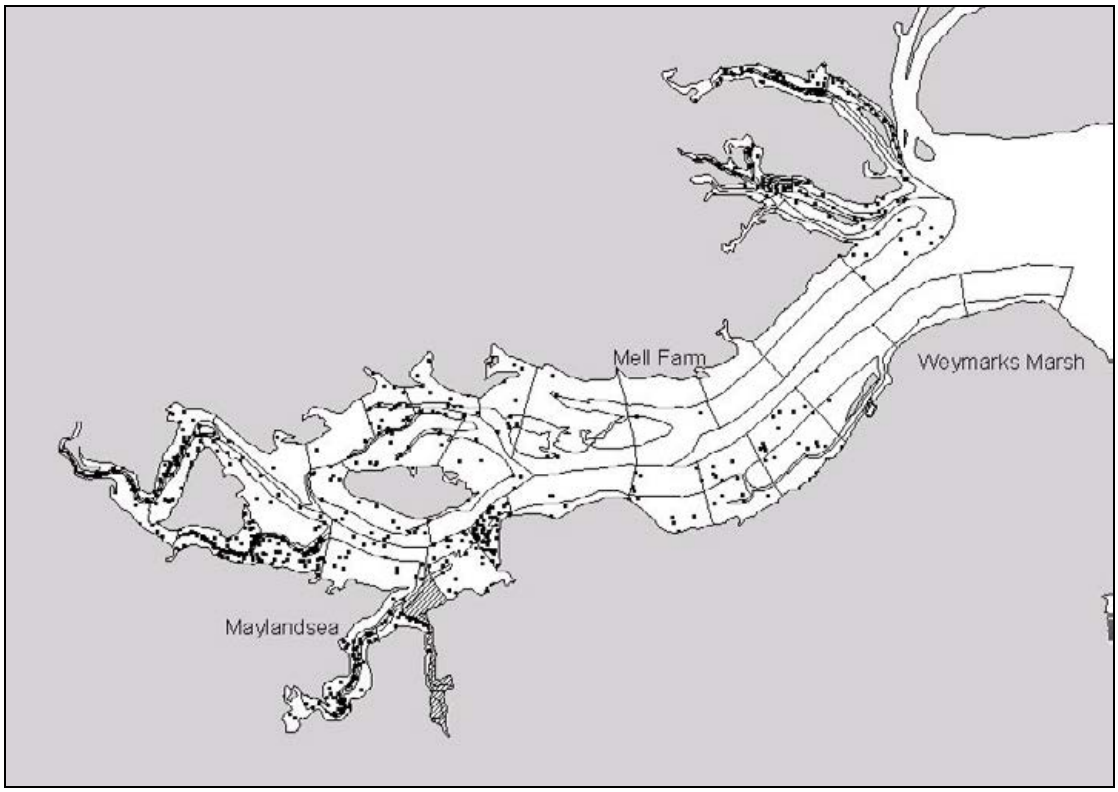


**Figure 3.1.9** Mean density of Shelduck on the Blackwater estuary (data from WeBS low tide counts 1994-95). One dot=0.09 birds. Hatched area was unsurveyed.

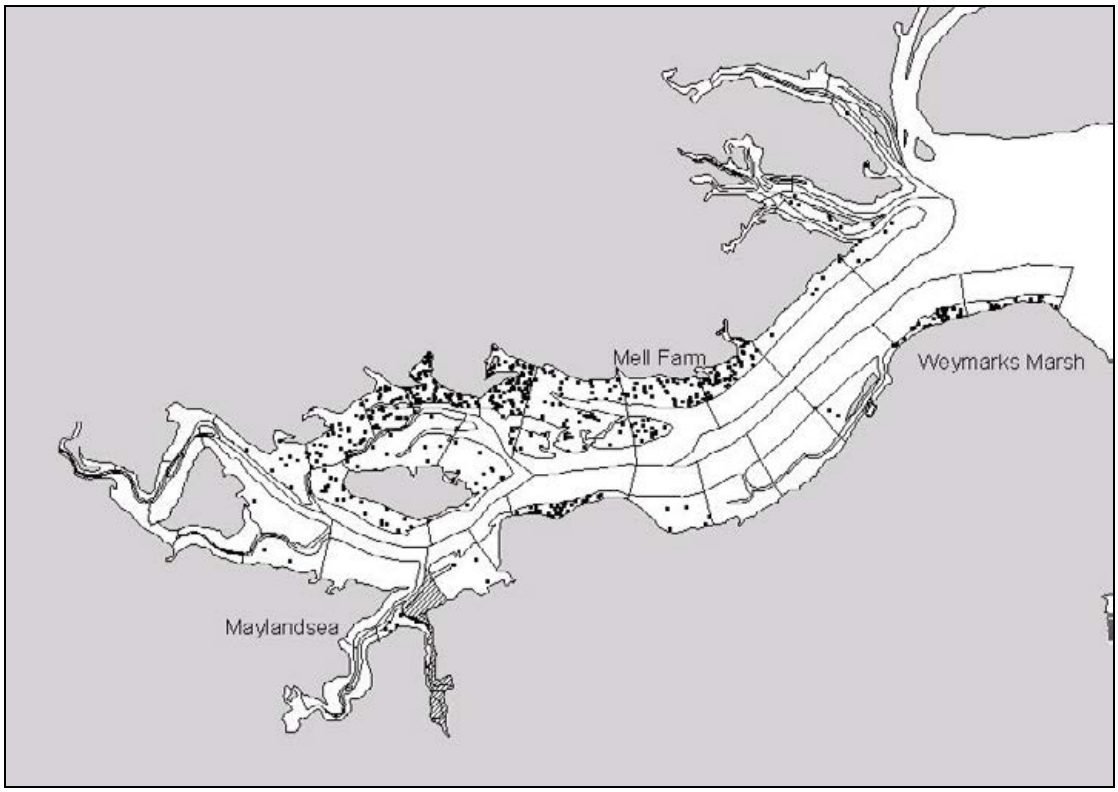


**Figure 3.1.10** Mean density of Turnstone on the Blackwater estuary (data from WeBS low tide counts 1994-95). One dot=0.01 birds. Hatched area was unsurveyed.

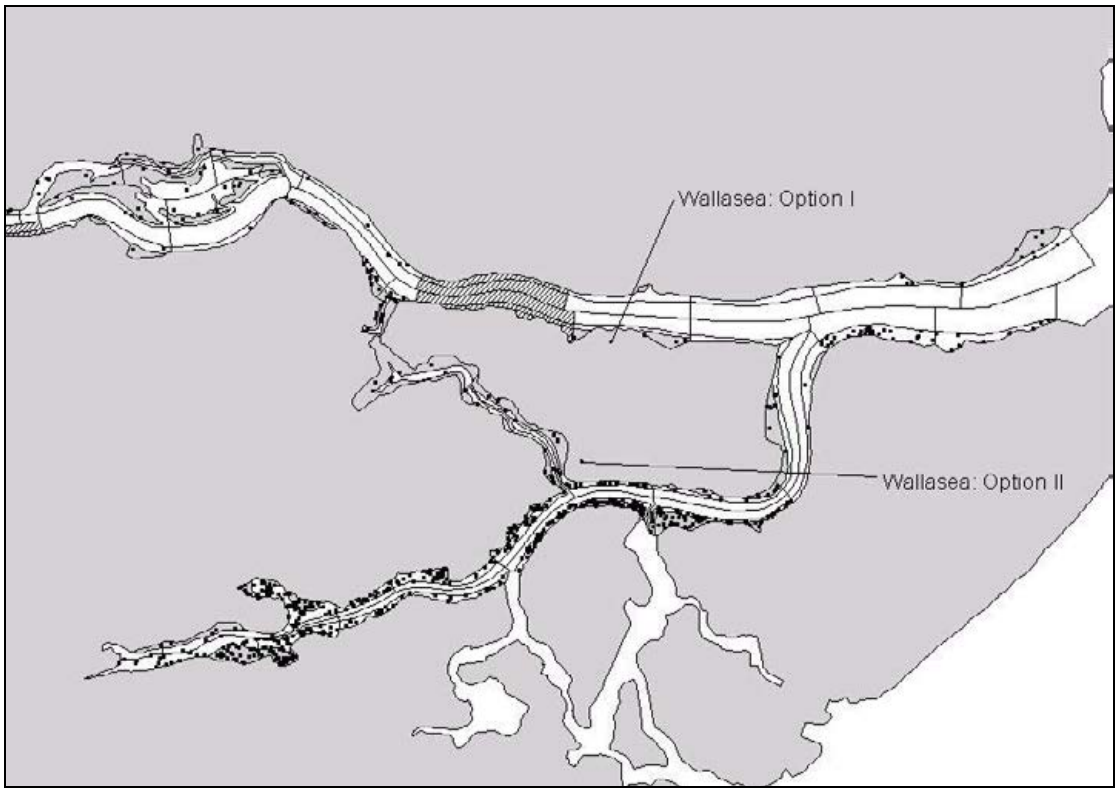


**Figure 3.2.1** Mean density of Curlew on the Crouch & Roach Estuary (data from WeBS low tide counts 1995-96). One dot=0.02 birds. Hatched area was unsurveyed.

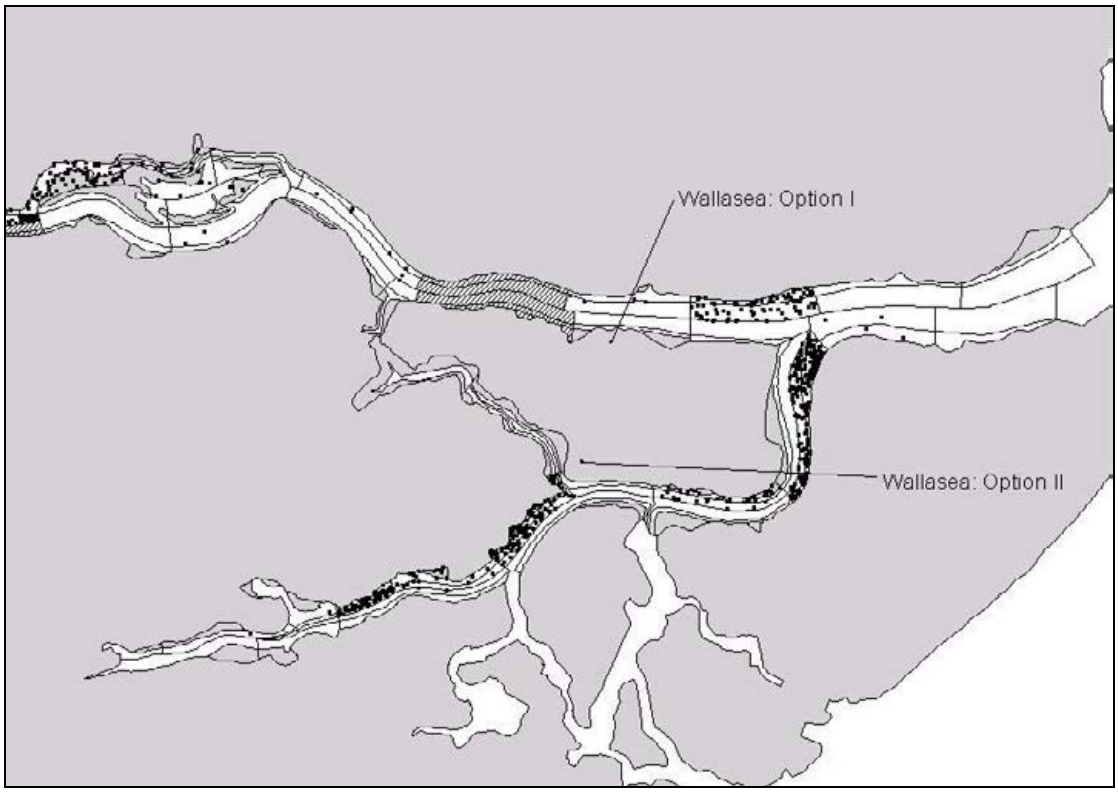


**Figure 3.2.2** Mean density of Dark-bellied Brent Goose on the Crouch & Roach Estuary (data from WeBS low tide counts 1995-96). One dot=0.06 birds. Hatched area was unsurveyed.

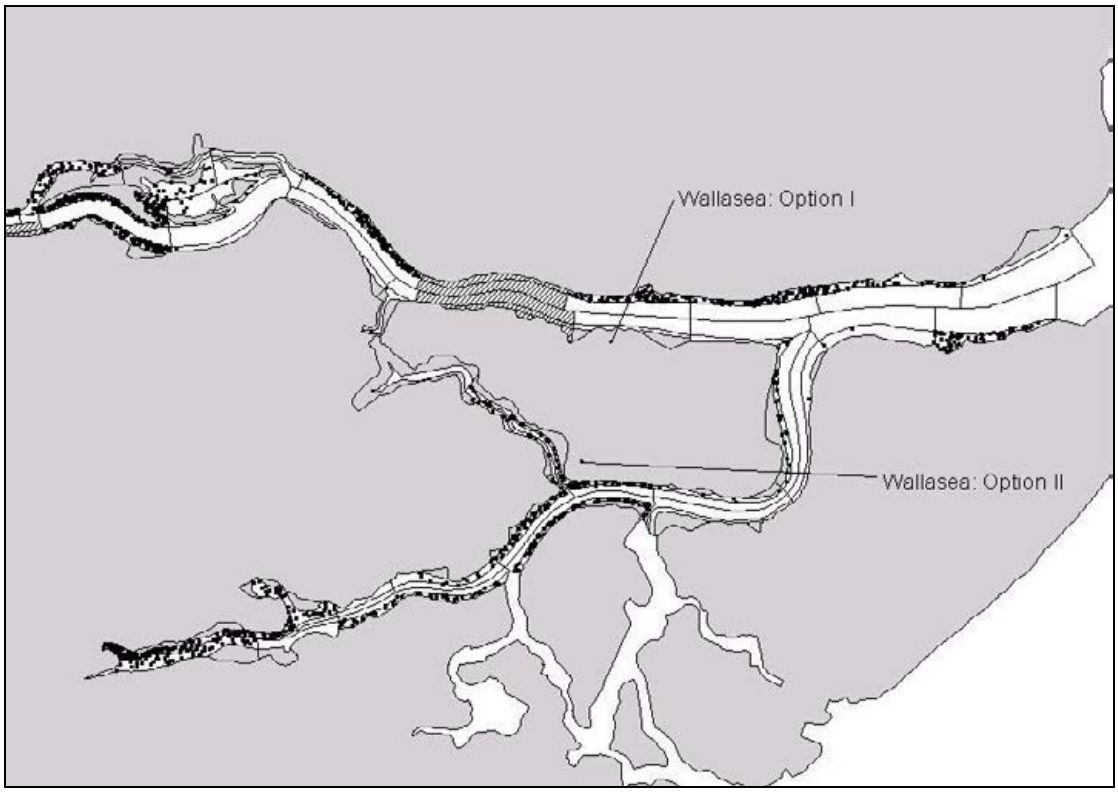


**Figure 3.2.3** Mean density of Dunlin on the Crouch & Roach Estuary (data from WeBS low tide counts 1995-96). One dot=0.10 birds. Hatched area was unsurveyed.

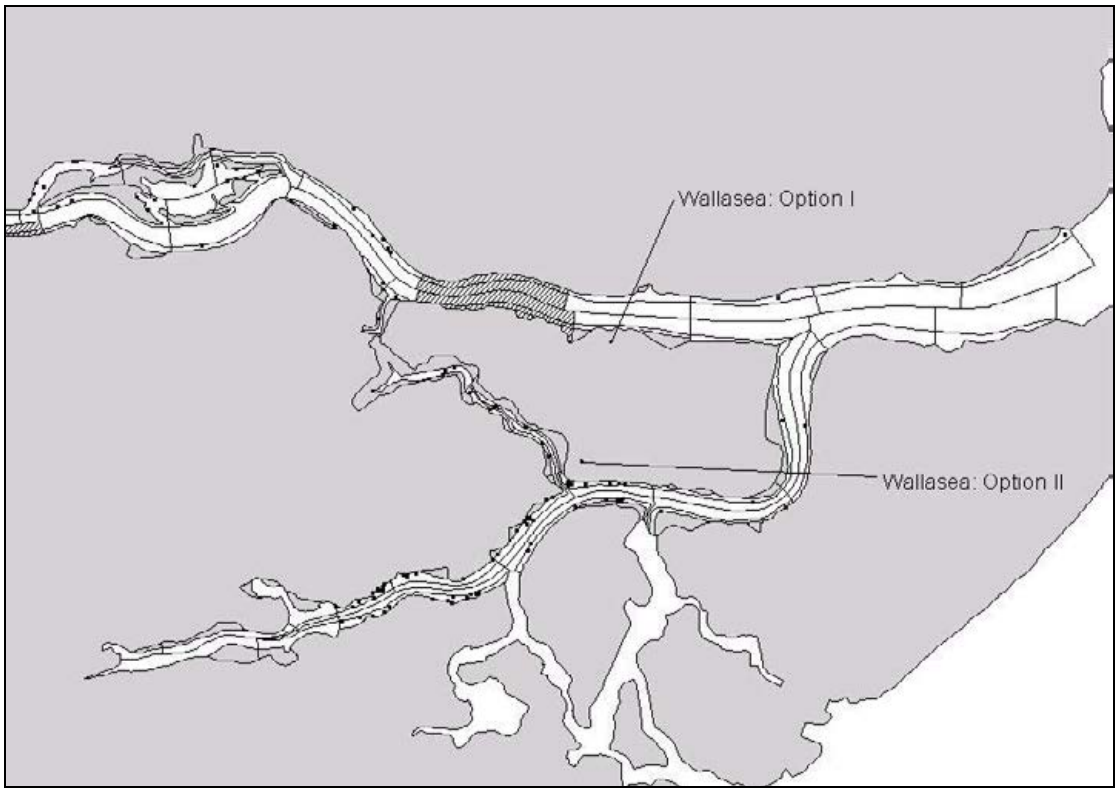


**Figure 3.2.4** Mean density of Grey Plover on the Crouch & Roach Estuary (data from WeBS low tide counts 1995-96). One dot=0.08 birds. Hatched area was unsurveyed.

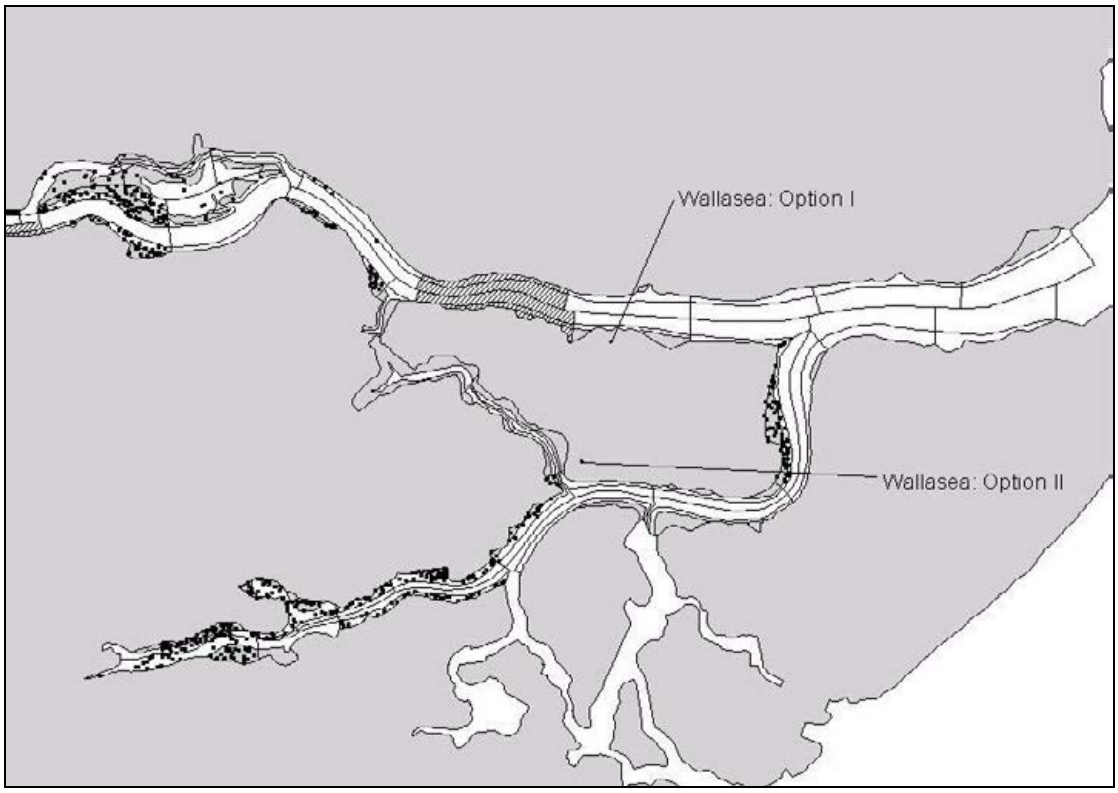


**Figure 3.2.5** Mean density of Lapwing on the Crouch & Roach Estuary (data from WeBS low tide counts 1995-96). One dot=0.04 birds. Hatched area was unsurveyed.

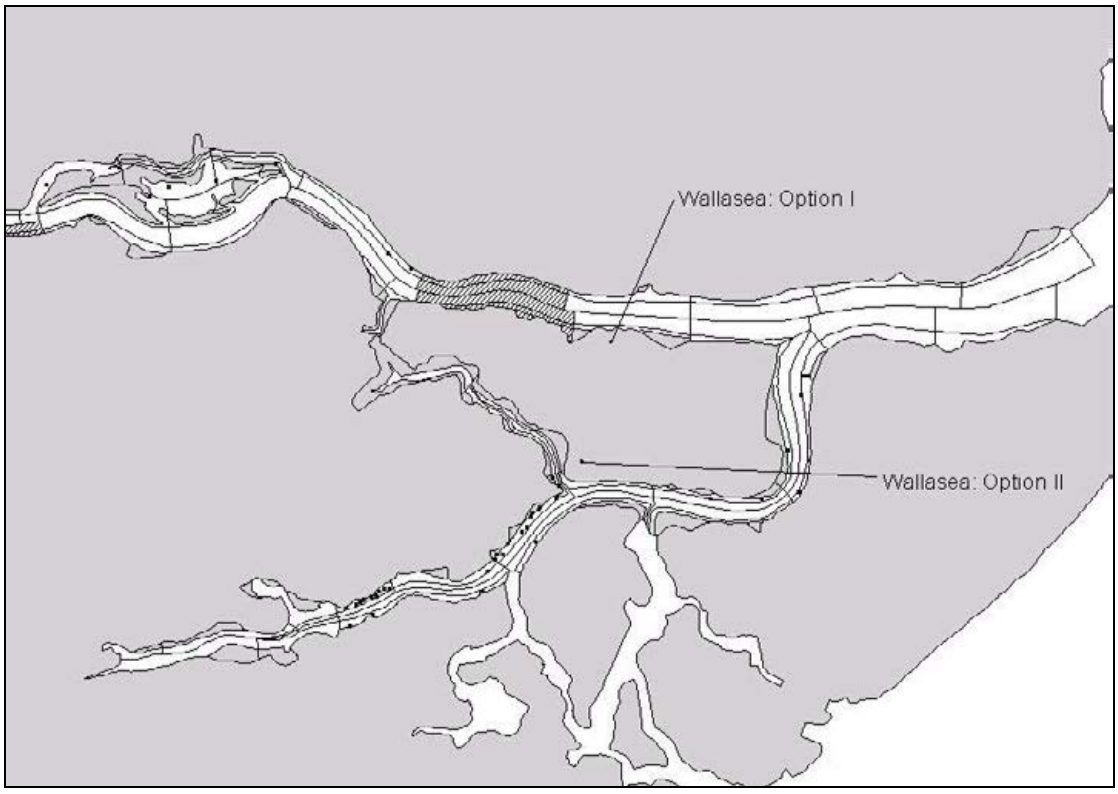


**Figure 3.2.6** Mean density of Oystercatchers on the Crouch & Roach Estuary (data from WeBS low tide counts 1995-96). One dot=0.05 birds. Hatched area was unsurveyed.

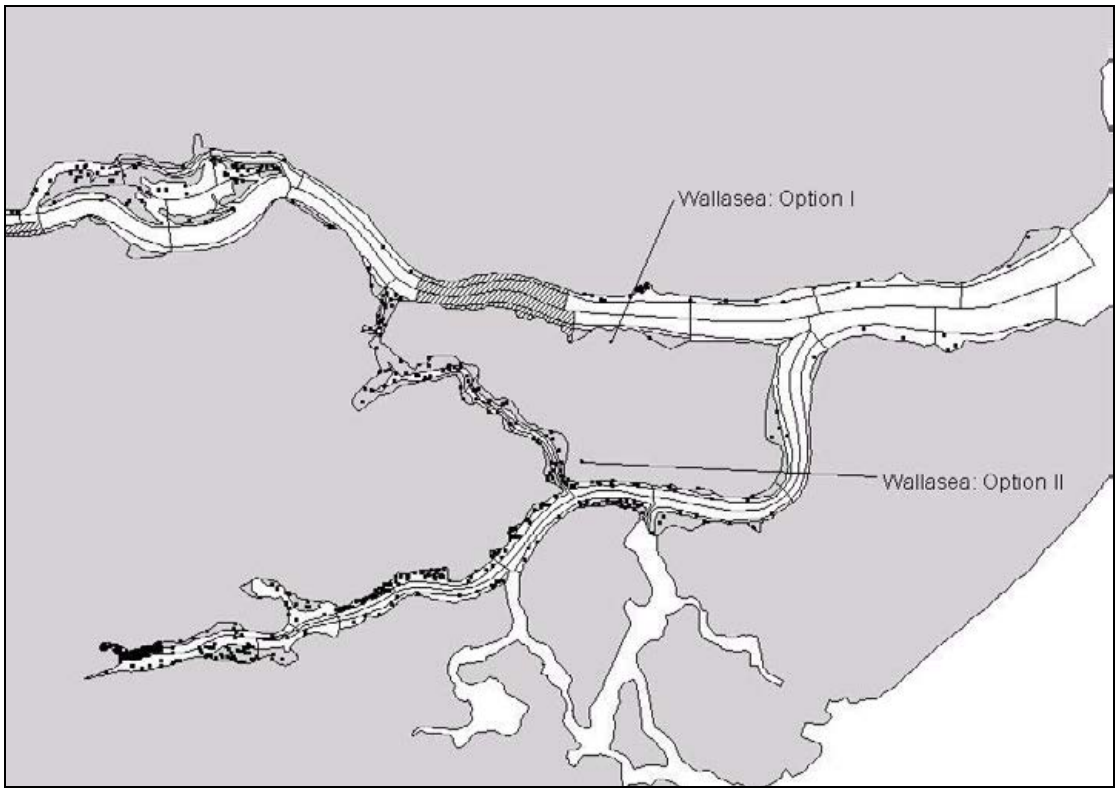


**Figure 3.2.7** Mean density of Redshank on the Crouch & Roach Estuary (data from WeBS low tide counts 1995-96). One dot=0.10 birds. Hatched area was unsurveyed.

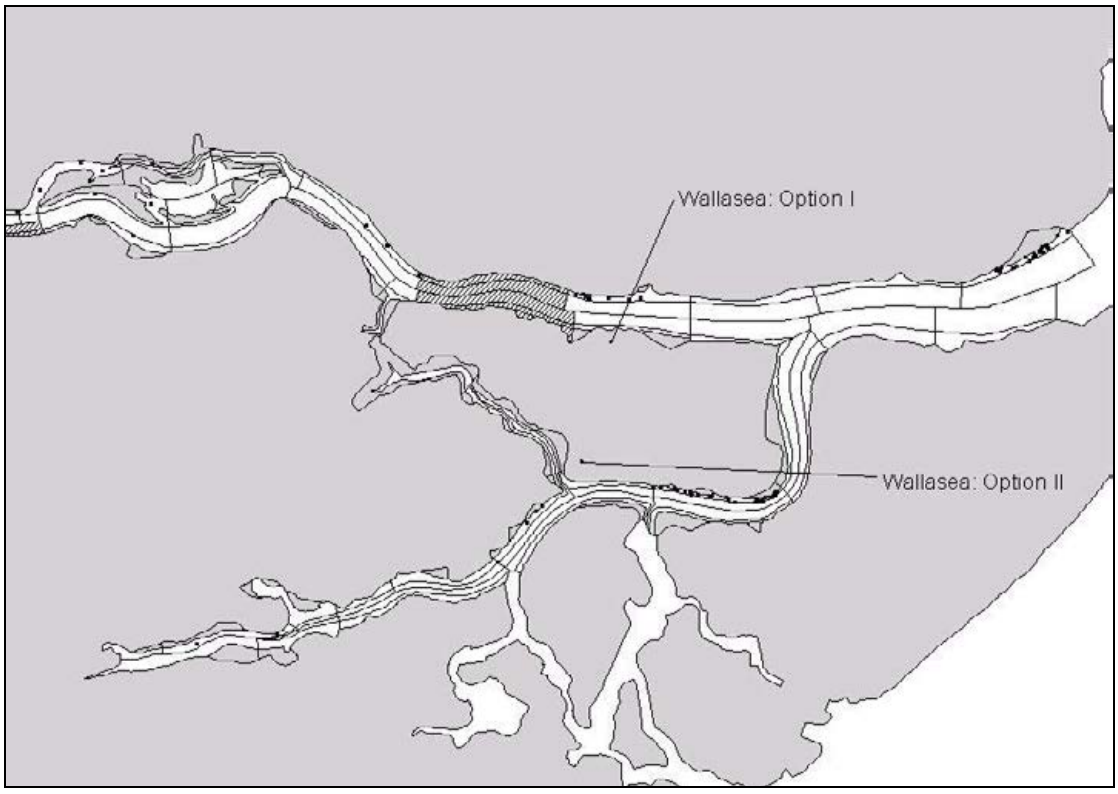


**Figure 3.2.8** Mean density of Ringed Plover on the Crouch & Roach Estuary (data from WeBS low tide counts 2001-02). One dot=0.02 birds. Hatched area was unsurveyed.

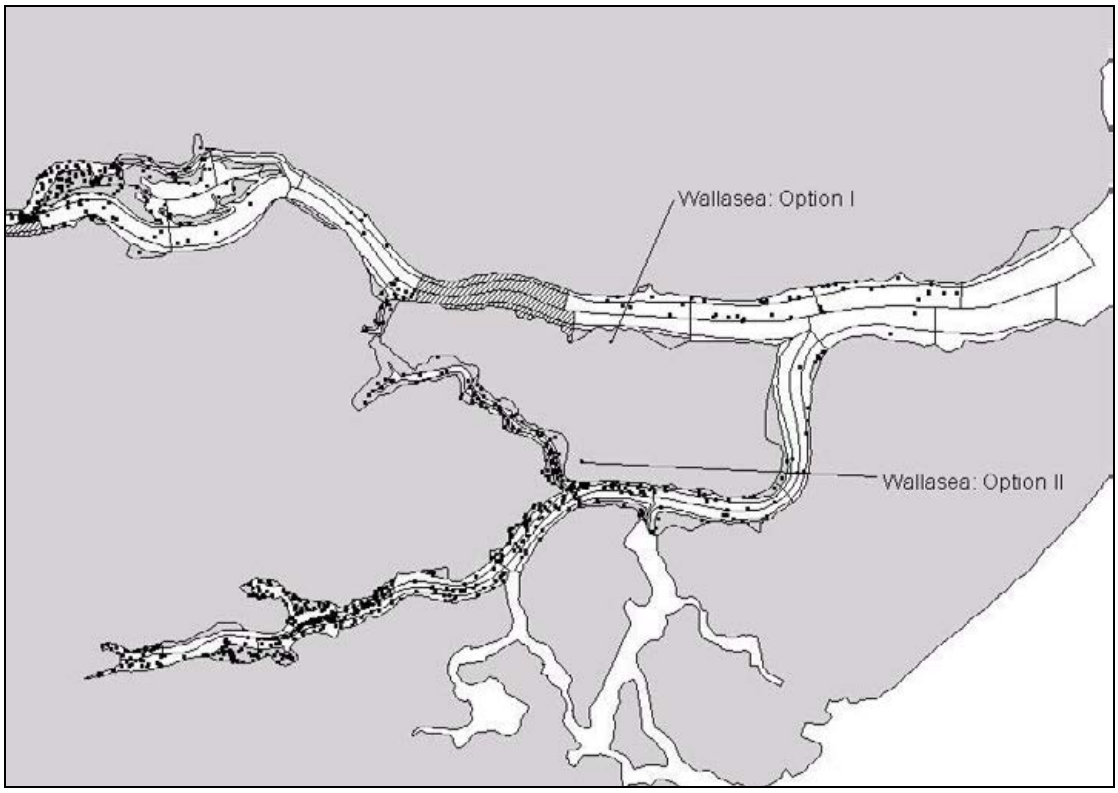


**Figure 3.2.9** Mean density of Shelduck on the Crouch & Roach Estuary (data from WeBS low tide counts 1995-96). One dot=0.07 birds. Hatched area was unsurveyed.

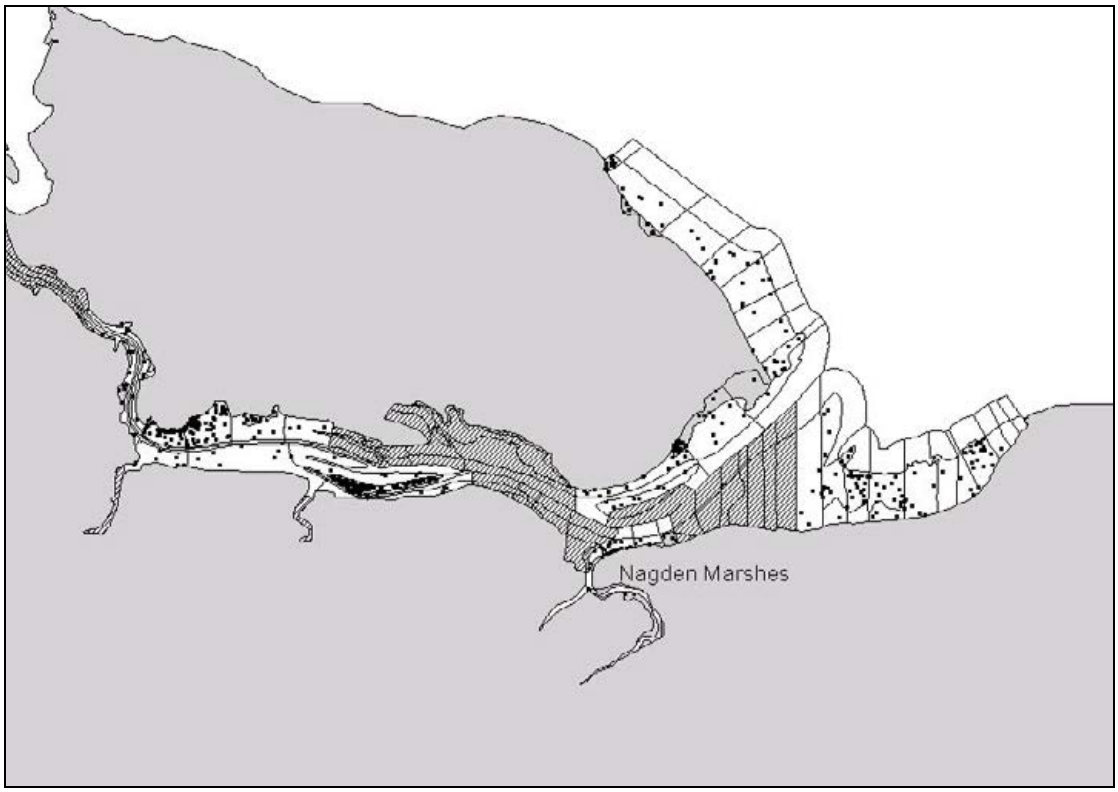


**Figure 3.3.1** Mean density of Curlew on the Swale Estuary (data from WeBS low tide counts 2001-02). One dot= 0.05 birds. Hatched area was unsurveyed.

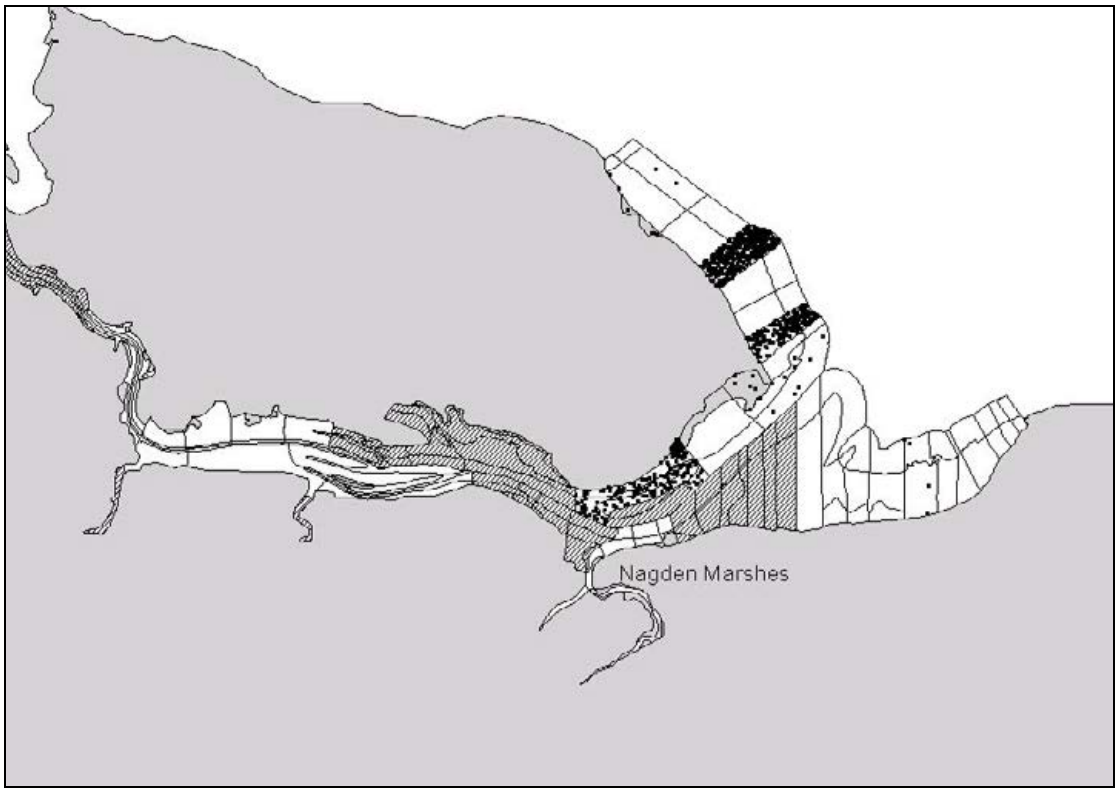


**Figure 3.3.2** Mean density of Dark-bellied Brent Goose on the Swale Estuary (data from WeBS low tide counts 2001-02). One dot=0.02 birds. Hatched area was unsurveyed.

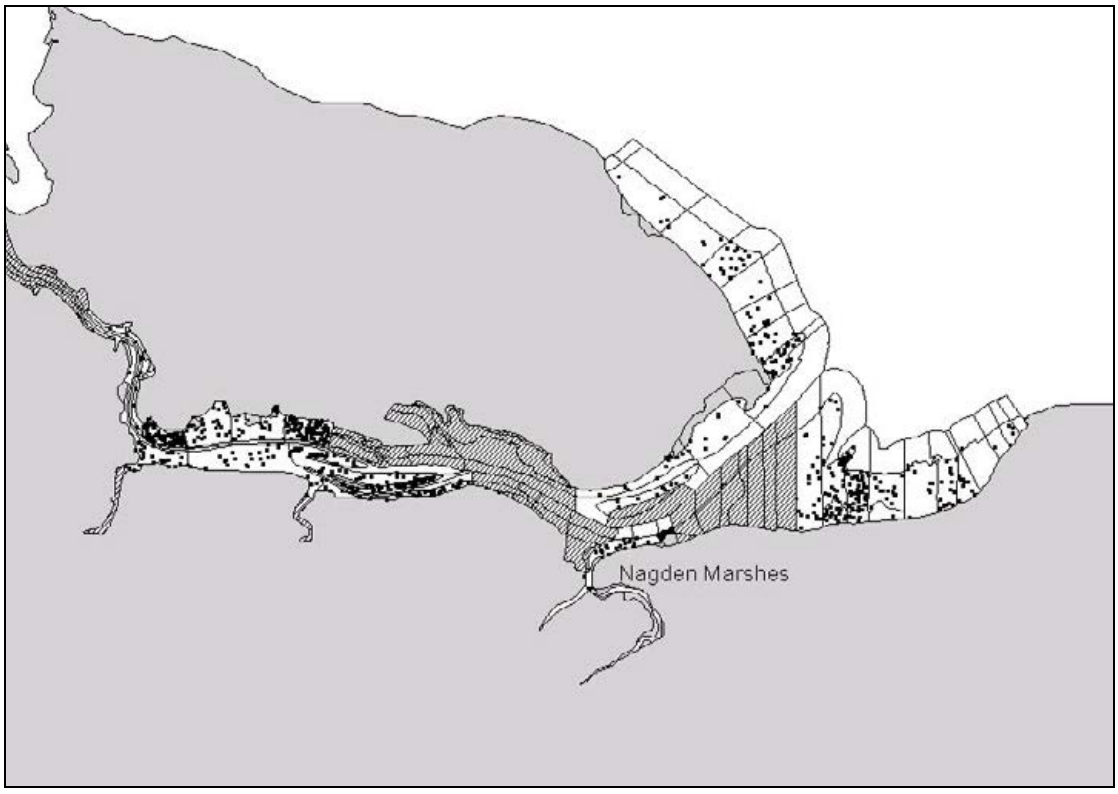


**Figure 3.3.3** Mean density of Dunlin on the Swale Estuary (data from WeBS low tide counts 2001-02). One dot= 0.20 birds. Hatched area was unsurveyed.

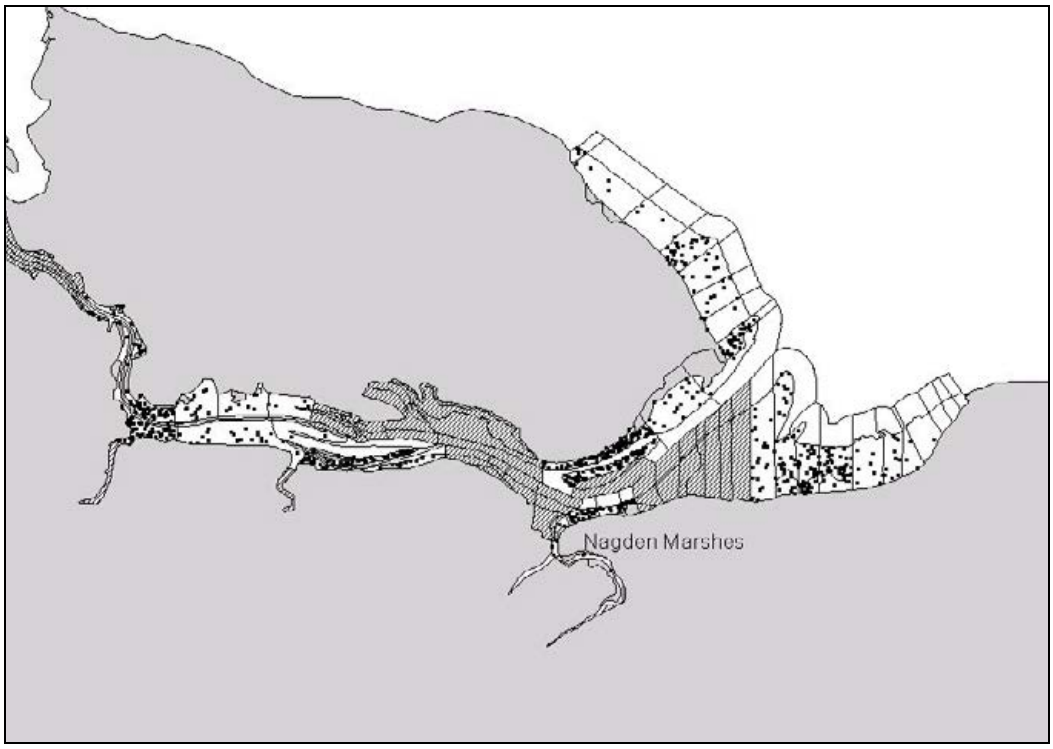


**Figure 3.3.4** Mean density of Grey Plover on the Swale Estuary (data from WeBS low tide counts 2001-02). One dot= 0.03 birds. Hatched area was unsurveyed.

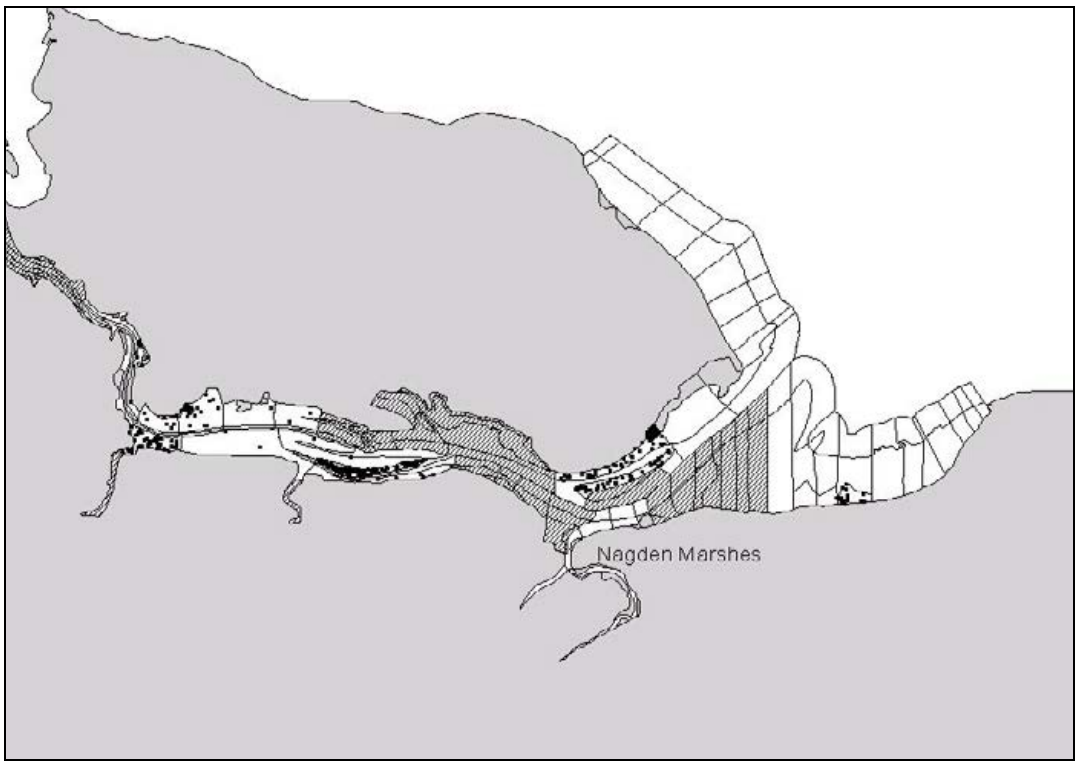


**Figure 3.4.5** Mean density of Lapwing on the Swale Estuary (data from WeBS low tide counts 2001-02). One dot= 0.10 birds. Hatched area was unsurveyed.

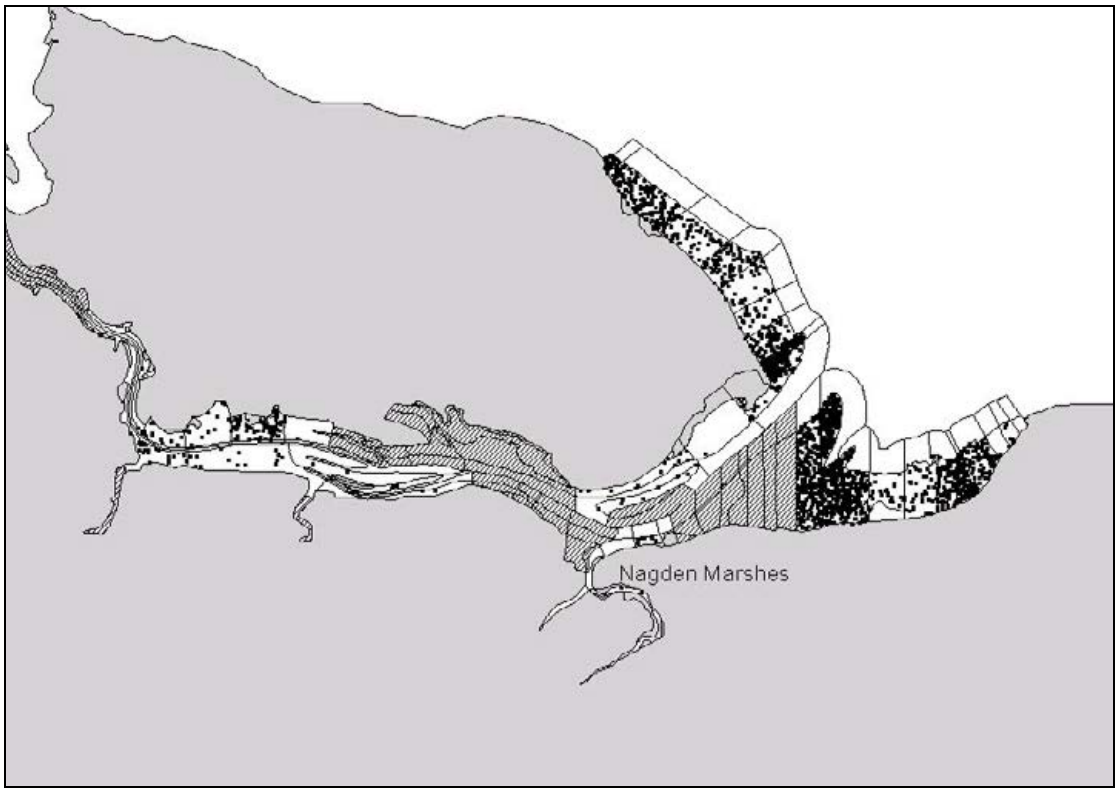


**Figure 3.4.6** Mean density of Oystercatchers on the Swale Estuary (data from WeBS low tide counts 2001-02). One dot=0.04 birds. Hatched area was unsurveyed.

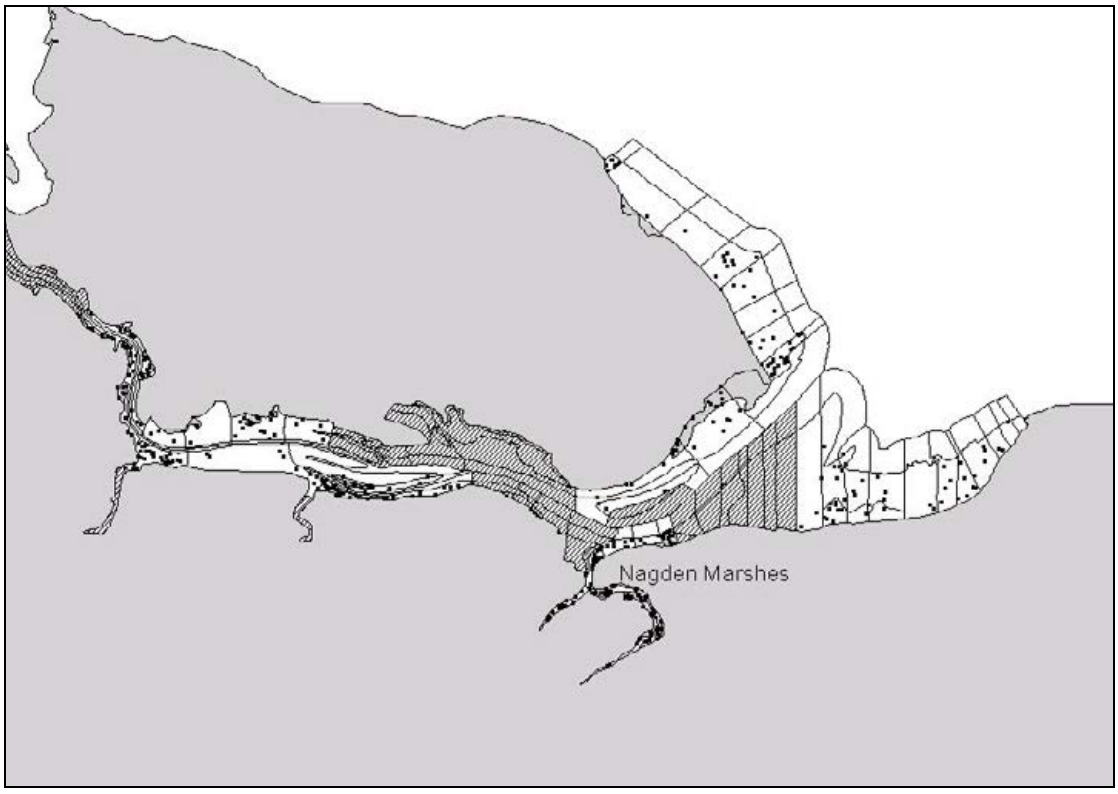


**Figure 3.4.7** Mean density of Redshank on the Swale Estuary (data from WeBS low tide counts 2001-02). One dot= 0.20 birds. Hatched area was unsurveyed.

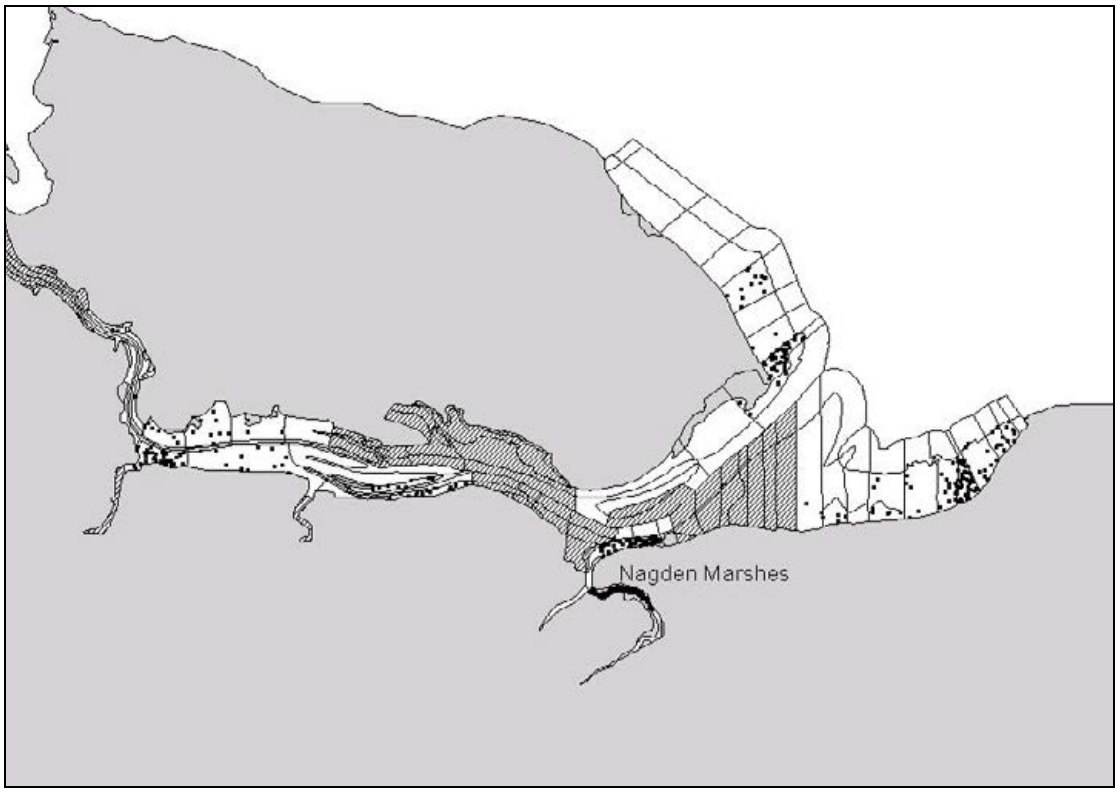


**Figure 3.4.8** Mean density of Ringed Plover on the Swale Estuary (data from WeBS low tide counts 2001-02). One dot= 0.01 birds. Hatched area was unsurveyed.

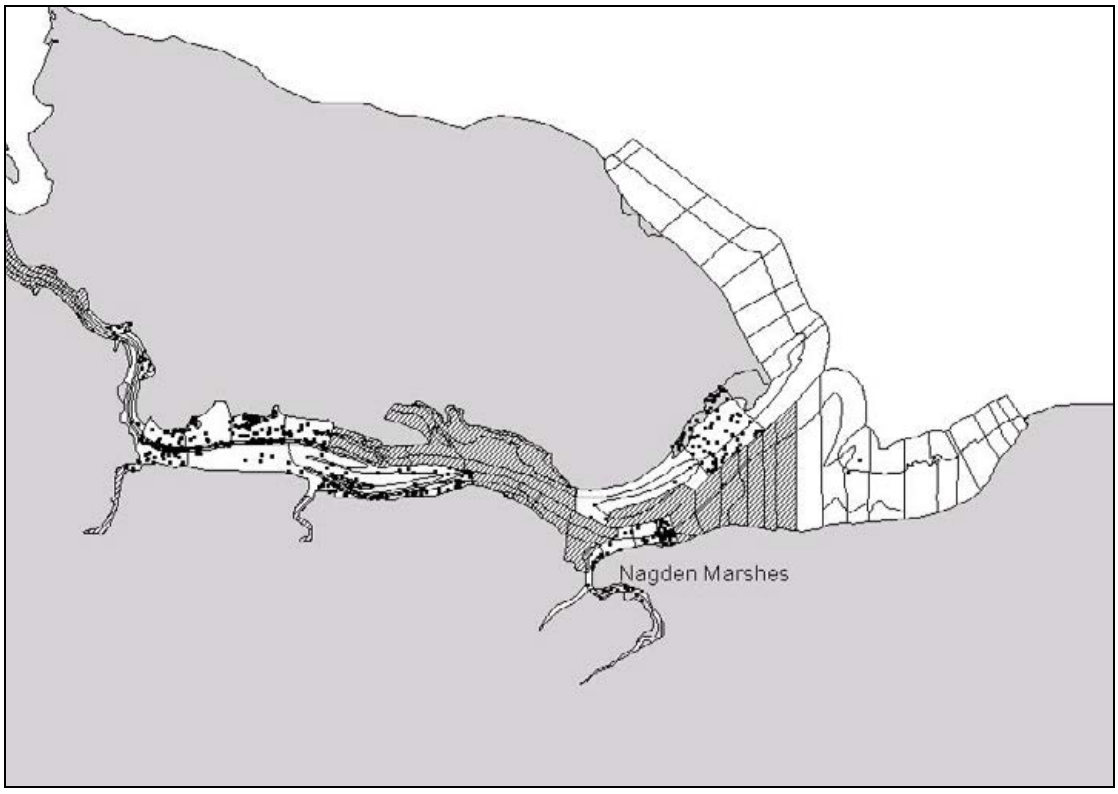


**Figure 3.3.9** Mean density of Shelduck on the Swale Estuary (data from WeBS low tide counts 2001-02). One dot= 0.10 birds. Hatched area was unsurveyed.

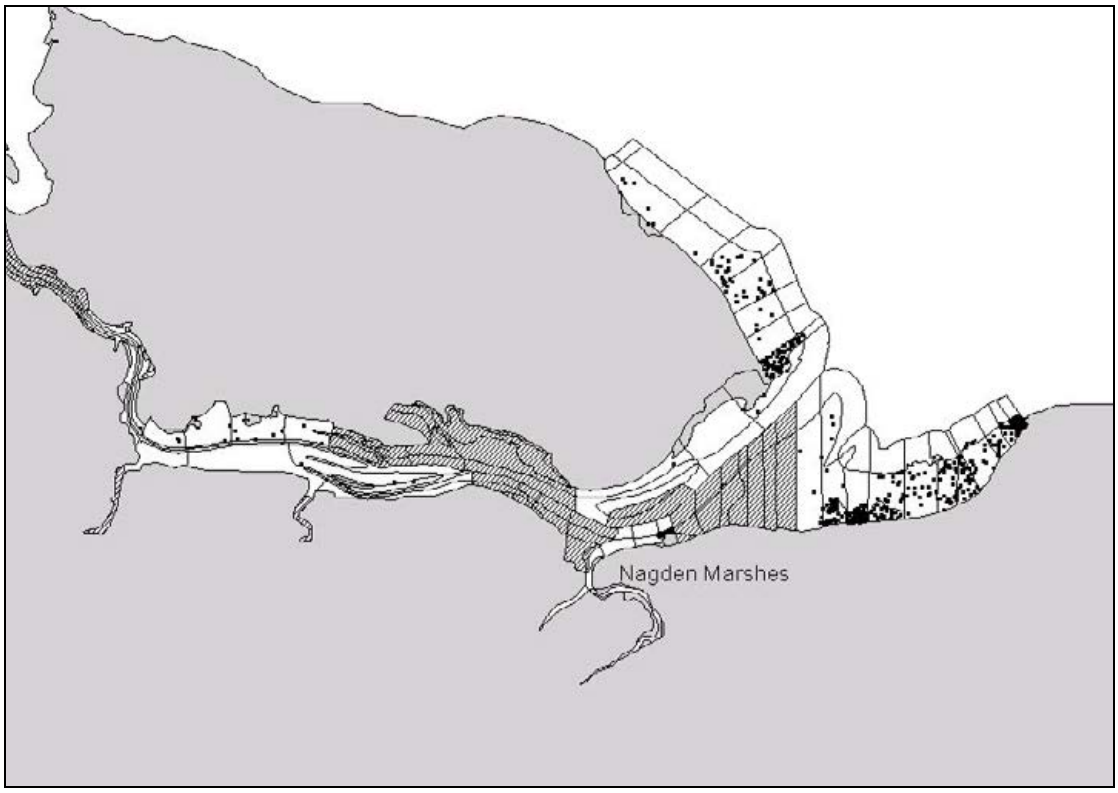


**Figure 3.3.10** Mean density of Turnstone on the Swale Estuary (data from WeBS low tide counts 2001-02). One dot= 0.02 birds. Hatched area was unsurveyed.