Aerial Surveys of Waterbirds in Strategic Windfarm Areas: 2007 Final Report

WWT Consulting
Report to
Department for Business, Enterprise
and Regulatory Reform

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1. ACKNOWLEDGEMENTS

1.1 The "Aerial Surveys for Waterbirds Strategic Windfarm Areas: 2007 Final Report" has been produced by the Department for Business, Enterprise and Regulatory Reform (formerly the Department of Trade and Industry (DTI)). The preparation of this report has been conducted by a Steering Group, comprising Wildfowl & Wetlands Trust Consulting expertise; Philip Bloor (BERR project manager) and Angela Wratten (BERR). Without the encouragement, support and invaluable expertise provided by members of the expert working group chaired by Mark Tasker (JNCC) and comprising of representatives from Joint Nature Conservation committee (JNCC), Natural England (NE), Countryside Council for Wales (CCW), Scottish Natural Heritage (SNH) and Department for Environment, Food and Rural Affairs (DEFRA) the project would have not been the success that it was. We are indebted to the input from WWT Consulting with regard to the coordination of the aerial surveys and the collation of data. Additionally, we would like to thank all of the funders of this project for their co-operation, including Centrica Renewable Energy Limited, Countryside Council for Wales, Department for Environment, Food and Rural Affairs, Department of Trade and Industry, DONG Walney (UK) Limited, Greater Gabbard Offshore Winds Limited, Kentish Flats Limited, London Array Limited, Npower Renewables Limited, Ormonde Energy Limited, Scira Offshore Energy Limited, Scottish Power UK plc, Seascape Energy Limited, Thanet Offshore Wind Limited and the Joint Nature Conservation Committee.

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2. INTRODUCTION

2.1 Data on the numbers and distribution of waterbirds and seabirds in UK inshore waters are required for a variety of purposes, including strategic environmental assessment for the second round of offshore windfarm (OWF) development, the Environmental Impact Assessments required by Round 2 wind farms, compliance with licence conditions for constructed Round 1 windfarms, for monitoring of waterbird numbers and distribution in inshore waters, and identification of Special Protection Areas (SPAs).

2.2 Prior to 2004, only limited data on the abundance or distribution of birds was available for many nearshore waters in England and Wales (*eg* Cranswick *et al* 2003, Wetlands Advisory Service 2003, Cranswick *et al* 2004). Consequently, the then Department of Trade and Industry (now the Department for Business, Enterprise and Regulatory Reform (DBERR)), supported by other Government departments, agencies and industry, commissioned large-scale survey of strategic areas identified for the second round of OWF development, plus adjoining areas identified as potentially important for birds.

2.3 The first comprehensive survey was undertaken by WWT Consulting in 2004/05 (Department of Trade and Industry 2006), with a subsequent programme of surveys from winter 2005/06 through to summer 2006 (DBERR in press). These provided large-scale survey data covering the nearshore waters of strategic windfarm areas in Northwest England (from Anglesey to the Solway Firth), in the Greater Wash and in the Thames (from Flamborough Head, Yorkshire, to Sandwich Bay, Kent). DBERR commissioned a third programme of aerial surveys to be undertaken between January and March 2007, which included repeat surveys of many of the areas surveyed in the previous surveys.

Objectives

2.4 This report provides results from aerial surveys between January and March 2007. Numbers of birds encountered are provided, and estimates of total numbers calculated using 'distance analysis' are provided for the more numerous species of conservation importance. Maps are provided showing the large-scale distribution of waterbirds in each of the three strategic windfarm areas. Brief comparisons are made with the results of previous surveys.

3. METHODS

Aerial survey

3.1 Aerial surveys used for this report were undertaken using a methodology developed in Denmark by the National Environment Research Institute (NERI) (Kahlert *et al* 2000; see also Camphuysen *et al* 2004). This involved a 'distance sampling' approach (see Buckland *et al* 2001), whereby the distance to each bird/flock of birds was recorded. Because birds further from the observer will be more difficult to detect, recording of distance allows the number of missed birds to be estimated. This approach allows statistical analyses of the data (*eg* confidence limits to be calculated for estimates of numbers) that are not possible with data collected using previous aerial survey methods. Further, using a combination of the time at which birds were encountered and the track flown by the plane (recorded using a Global Positioning System (GPS)), the locations of observed birds can be calculated with considerable accuracy (in most cases, to within a few hundred metres).

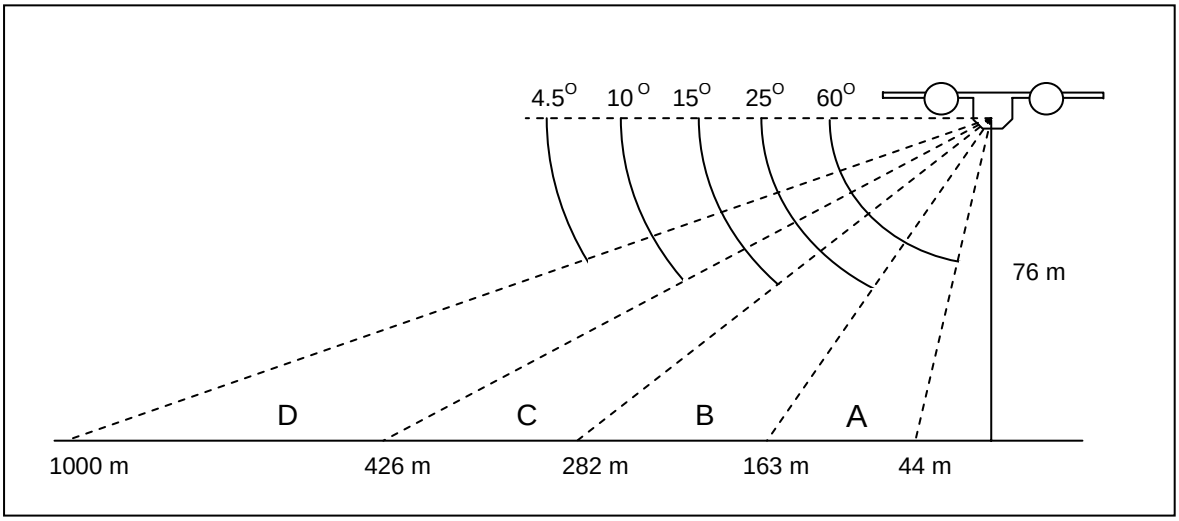
3.2 Aerial surveys were undertaken by WWT Consulting using experienced observers who have undertaken aerial surveys previously for many of the OWF sites and to identify sites for potential classification as SPAs in the UK between 2001/02 and 2005/06.

3.3 A number of Partenavia PN68 aircraft were used, flying at an altitude of 76 m and at a speed of approximately 200 kmh^{-1}. The location of the plane was recorded every five seconds using a GPS, with a second, backup GPS, recording location every eight seconds.

3.4 A series of north-south transects spaced 2 km apart was designed to cover nearshore waters. Transects that run north-south reduce the effect of glare during the survey, thus aiding the detection and identification of birds. The transects are assigned to flying blocks, which represent the optimal length of survey (approximately 600 km). For the 2007 programme, any transects used in previous large-scale or regional surveys were retained to enable comparison of data with previous results. For ease of planning transects followed northings of the GB Ordnance Survey grid.

3.5 For each bird or flock of birds, the species, number, behaviour, distance band and the time at which it was perpendicular to the flight path of the plane were recorded using a dictaphone. Using a clinometer, birds were located in one of four distance bands covering an area from 44 m to 1,000 m either the side of the plane (Figure i); birds beyond 1,000 m from the flight path of the plane were not recorded. The survey method assumes that all birds in distance Band A were detected, and effort was concentrated on this band. Inevitably, birds further from the plane in other bands are missed owing to their distance from their plane and the need for the observers to concentrate observation on the area of sea nearest the flight line.

Figure i – Distance bands used for aerial survey (not to scale)



3.6 Surveys were generally made during a four-hour period centred on midday GMT to minimise the effects of glare on counts. Surveys were undertaken in good weather conditions, generally with wind speeds of 15 knots or less.

3.7 Survey was suspended during the turns between transects, though significant observations, *eg* notable bird species, cetaceans or large flocks of birds, were sometimes recorded on an *ad hoc* basis.

3.8 A cautionary approach was taken with regard to species identification, such that only those individuals that were observed clearly were identified to species level; otherwise, birds were identified as belonging to a species group. In the case of large, near mono-specific flocks, such as Common Scoter *Melanitta nigra*, individual, similar, but less common species, may not have been identified, particularly in the further distance bands.

3.9 Scoters at large distances are not easily identifiable as Common Scoter, as they are indistinguishable from Velvet Scoter *Melanitta fusca* at that range. However, experience has shown that the vast majority of birds in Bands A and B can be identified to species – and any Velvet Scoter, even out to

B and C, can be readily distinguished. As only small numbers of Velvet Scoters have been recorded in previous years, it has been assumed that the vast majority of scoters present were Common Scoters.

3.10 Divers *Gavia* spp. not identified to species level were recorded as 'diver spp'. Caution is exercised given the possibility of confusion between Red-throated and Black-throated Divers *Gavia arctica* and the relative inexperience of observers in seeing this species from the air. The latter species is rarely encountered in the areas surveyed to date. Great Northern Divers *Gavia immer* are readily separated from both Red-throated and Black-throated Divers and very few, if any will have been overlooked within those birds recorded as 'diver spp.'.

3.11 Gulls not identified to species level were identified as being in one of the following species groups: 'grey gull' (Common Gull *Larus canus* or Herring Gull *Larus argentatus*), 'black-backed gull' (Lesser Black-backed Gull *Larus fuscus* or Great Black-backed Gull *Larus marinus*), 'large gull' (Herring Gull, Lesser Black-backed Gull or Great Black-backed Gull), 'small gull' (Black-headed Gull *Larus ribidundus*, Common Gull, Little Gull *Larus minutus* or Kittiwake *Rissa tridactyla*) or gull (*Larus* spp. or Kittiwake).

3.12 Auks are not readily identified to species level during aerial survey and most observations are recorded as 'auk sp'. The majority of auks encountered during the survey are believed to have been Guillemots *Uria aalge,* with fewer numbers of Razorbills *Alca torda*. Whilst only one Puffin *Fratecula arctica* and no Little Auks *Alle alle* were specifically identified, a small proportion of observations were suspected to be of these species.

3.13 Cormorants *Phalacrocorax carbo* and Shags *Phalacrocorax aristotelis* can be difficult to distinguish from each other during aerial survey. Any birds not identified to species level were recorded as 'Cormorant spp.'.

3.14 Other species groups were also used as appropriate, where specific identification of birds to species level was not possible, *eg* 'duck spp.', 'goose spp.', and 'wader spp.'.

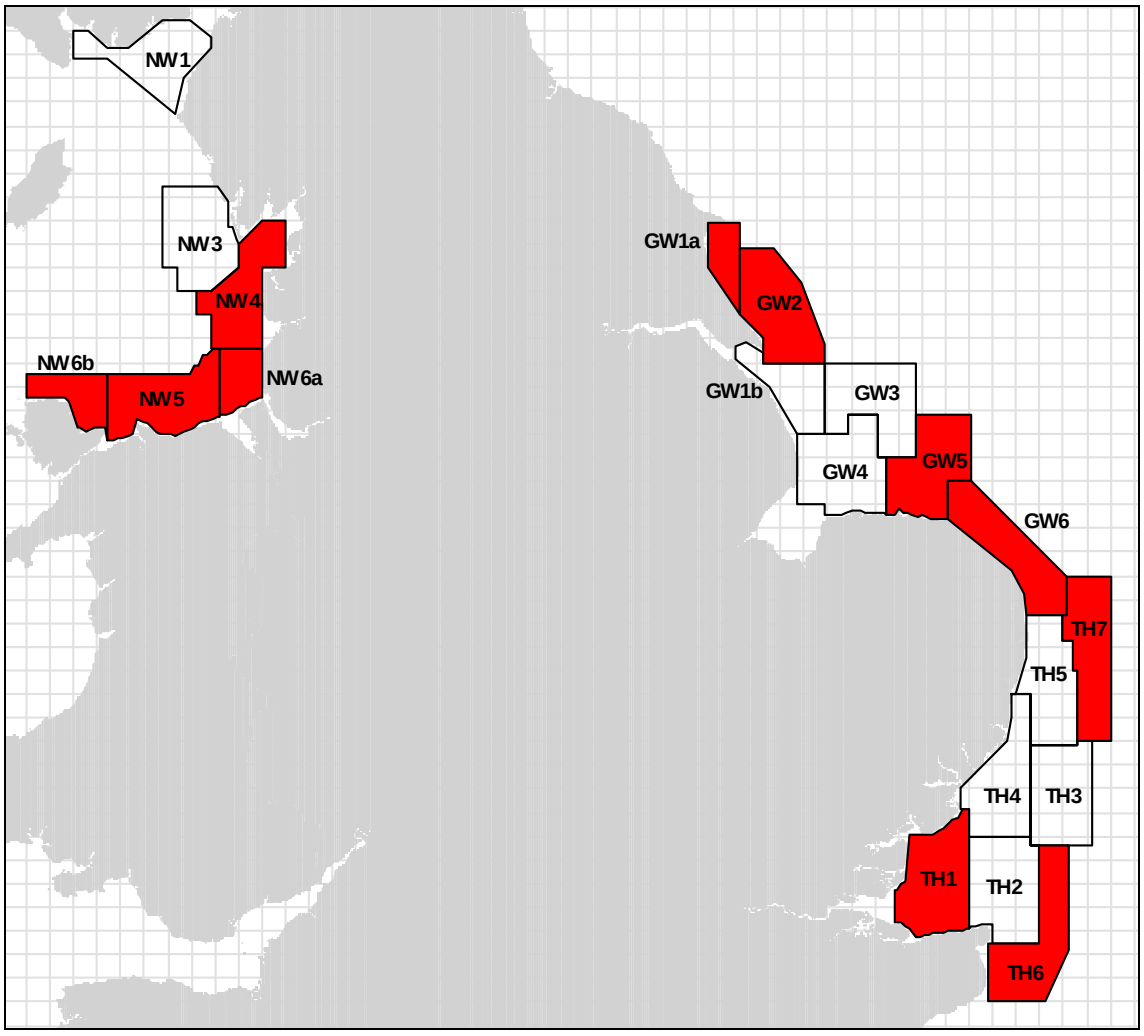
Survey area

3.15 The survey area was divided into a series of survey blocks that could be covered by a single plane in one day (approximately 600 km). The survey area was designed to cover all Round 2 OWF sites being investigated, plus a buffer zone and any control areas, and to cover areas known or thought to be important for waterbirds and seabirds. The boundaries of the survey blocks were placed to avoid cutting any possible OWF footprints and any areas known to be important for marked concentrations of birds, such as shallow water over sand banks.

3.16 Five survey blocks were identified for the North West Strategic Area, four for the Greater Wash and three for the Thames (Figure ii).

3.17 Work in survey blocks NW4 and NW6, covering Shell Flat to the Dee Estuary, and Red Wharf Bay, was commissioned by the Countryside Council for Wales (CCW) to enable coverage of important areas for Common Scoter not included in the coverage for DBERR. Data are included in this report in order to present a more comprehensive account of bird numbers and distribution in the North West and enable comparisons with data from previous years.

Figure ii – Survey Blocks – red boxes indicate survey blocks flown in 2007 aerial surveys, or areas where at least some of the survey block was flown. Hollow boxes indicate survey blocks flown in previous aerial survey programmes but not in 2007.



Coverage

3.18 The distribution of many waterbirds wintering in the UK changes during the course of the winter, for example, because many breed outside the UK and migrate here at different times of year, and because of changes in food resources or weather. Changes during summer months will relate particularly to breeding and fledging of young. In previous aerial survey projects seven survey Periods were identified to record changes in abundance and distribution during the course of the year (Table 1). For this project data were collected in Periods 3 and 4, though with slight variation in the start and end dates to the Periods for practical reasons.

3.19 The dates of flights in each survey block are given in Tables 2-4. Some small parts of some survey blocks could not be flown, for example, because of 2-km flying exclusion zones around nuclear power stations (at Wylfa, Anglesey). In some survey blocks on some dates, survey was also curtailed by military activity in danger zones (notably, the northwest corner of NW3 in Period 4) but this generally affected only small areas at the periphery of the survey block.

3.20 Due to weather deterioration and unannounced military activity, two blocks in the Greater Wash Strategic Area (GW2 and GW5) were conducted on different days (Table 3).

3.21 Due to complications with obtaining Civil Aviation Authority (CAA) approval, it was not possible to fly through and therefore survey within the footprint of constructed windfarms. At these sites, the plane flew at a higher altitude over the windfarm (preventing survey using the prescribed methods within the footprint and for a distance of 1-2 km before and after the windfarm) or flew

around the windfarm, departing from the intended transect route by approximately 1 km. This affected coverage of North Hoyle OWF in NW5 and Scroby Sands OWF in GW6.

3.22 In 2007 the programme of aerial surveys differed to that of 2004/04, and 2005/06 in a number of ways. Surveys were only carried out in Periods 3 and 4 in 2007; no surveys were made during Periods 1 and 2, in the latter part of 2006. Also, coverage of NW4 and NW6 was not required. A 'new' survey block was, however, flown in Period 4, covering those parts of NW4 and NW6 important for Common Scoters Previous aerial survey programmes covered much larger areas of the North West, and included flights during October-December.

Analysis and map production

3.23 The precise location of each bird or flock of birds was calculated by linking the time (to the nearest second) at which they were recorded to the location of the plane, recorded by the GPS (generally, every five seconds). Interpolation of the GPS data enabled the position of the plane to be located along the flight path at each second. The locations of birds detected were displaced either side of the flight path at a distance roughly in the middle of the distance band in which they were recorded. The location of most observations is consequently considered to be accurate to within 200-300 m.

3.24 The distribution of the more numerous species (or species groups) in each Strategic Area is shown using encounter rate, *ie* the numbers of birds counted per unit length of transect flown. Data are summarised by 2x2 km grid squares, corrected for survey effort (distance flown over which observers were actively looking for birds) in each cell. Casual observations of 'out of transect birds' (*eg* those recorded while the plane was turning between transects) were omitted from this analysis.

3.25 The density scales used in the maps were selected to illustrate the distribution patterns of encounter rates. They are broadly consistent between surveys but small variations will occur owing to the different conditions of visibility during and between surveys, and the different abilities of observers. Densities are not, however, comparable between species due to the different detection rates of different species. Note that the range of relative density values may vary markedly between species and reference should be made to the key in each figure to interpret apparent high concentrations of birds appropriately.

Analytical methods for population assessment

3.26 The density and population abundance of Common Scoters and of all diver species combined were estimated using Distance 5.0 software (Thomas *et al* 2005). Line transect methods were employed for the diver analyses and strip transect methods for Common Scoter (due to complications arising from the tendency for scoter to move away from the flight path in response to the plane). No significant differences between observers were found and it was thus unnecessary to include observer as a covariate. Data were post-stratified by flock size or survey block to improve precision, and 95% confidence intervals were obtained by bootstrap simulation. Observations were combined by geographic region (East Coast, combining observations made in the Thames and Greater Wash, and the North West) within each of the two survey Periods, and abundance estimates are thus presented as regional totals for each survey Period (unless insufficient observations were collected to permit analysis).

4. RESULTS

Overall numbers and distribution

4.1 Maps showing the distribution of bird observations of all species in Periods 3 and 4 for the North West, Greater Wash and Thames OWF Strategic Areas are presented in Figures 1-6. Relative densities of all birds encountered in winter for each of the Strategic Areas are presented in Figures 7-12. These maps show total numbers of birds counted per 2x2 km grid cell (summing the numbers of birds recorded in flocks), corrected for survey effort.

4.2 Total numbers of birds encountered during aerial surveys of the North West, Greater Wash and Thames OWF Strategic Areas are given in Tables 5-7. Numbers recorded in each individual survey block are given in Tables 13-18. Note these are not absolute numbers of birds in the survey areas, which need to be calculated using 'distance', allowing for the numbers of birds which are missed with increasing distance from the transect line.

4.3 Over the whole area surveyed bird numbers were considerably higher in Period 4 (42,456) than Period 3 (14,770), primarily due to the much higher numbers of birds recorded during the additional coverage of parts of survey blocks NW4, NW6a and NW6b in Period 4 (see Tables 13 and 14 for comparison). Numbers of birds also increased in the Thames at this time, while numbers in the Greater Wash were lower (Tables 15-18).

4.4 In both Periods combined the North West held by far the largest numbers of birds (34,647). However, when numbers of Common Scoters (which account for well over half of the total numbers in the North West) are removed, this area held the fewest birds of all three Strategic Areas (5,414), with the Thames then holding the largest numbers (13,821), and then the Greater Wash (5,850. Figure excludes Common Scoter).

4.5 The Thames held large numbers of waders, gulls, divers, scoters and various wildfowl species distributed over shallow intertidal sandbanks around the estuary mouth, with divers and more pelagic species such as auks, Gannets and Kittiwakes, reaching high densities in offshore areas.

4.6 During Period 3, the Greater Wash held the highest numbers of birds, followed by the North West, then the Thames (Tables 15, 13 & 17 respectively). In Period 4, due to increased coverage of the North West, the highest numbers were observed in this area, followed by the Thames, then the Greater Wash (Tables 14, 18 & 16 respectively).

4.7 The highest densities of birds occurred close to shore in the North West and the Wash, particularly in Liverpool Bay, North Wales, around Flamborough, Yorkshire and close to the Suffolk and Essex shores, where flocks of scoters, divers and gulls were encountered (Figures 7-12). In the Thames, high densities also occurred further offshore in Period 4 (Figure 12), largely comprising auks and Gannets.

4.8 In the North West birds were recorded in moderate to large numbers well into offshore areas in both survey Periods (Figures 1, 2, 7 & 8). The most concentrated observations and highest densities were observed in Period 4 over Shell Flat off Blackpool, Lancashire, and off Formby Point, Merseyside (mainly Common Scoters), and along the North Wales coast (Common Scoters, auks and birds associated with intertidal areas). Many of the observations in offshore areas were of single birds, leading to low relative densities in these areas.

4.9 Of the two Northwest blocks surveyed in both Periods, bird numbers in NW5 increased considerably between Periods 3 and 4 (from 3,291 to 9,599; tables 13 & 14 respectively), primarily due to scoters, and to a lesser degree, Herring Gulls and auks, whilst only a slight increase was

observed in NW3. In Period 4 birds were more evenly distributed throughout NW3, occurring in similar densities to those observed in Period 3 but now extending further offshore (Figures 7 & 8).

4.10 In the Thames Strategic Area the highest numbers of observations in Period 3 were recorded around inner parts of the Thames Estuary, spanning the area between Foulness and the Isle of Sheppey (Figure 5). Many of the large numbers of observations made close to shore were a result of flocks of waders, gulls and wildfowl feeding or loafing on mudflats and sandbanks exposed at low tide. Divers were also observed close to shore in these areas. Smaller numbers of observations and lower densities extended well offshore in survey blocks TH6 and TH7 (Figures 5 & 11). In contrast, these offshore areas held the highest numbers of observations in Period 4 as a result of large numbers of feeding seabirds and divers (Figure 6). An increase of around 9,000 birds was seen in the Thames between Periods 3 and 4, and was reflected across the whole survey area (Tables 17 & 18).

4.11 In the Greater Wash during Period 3 the largest numbers of observations were recorded throughout GW1a (Figure 3), with high densities occurring south of Flamborough due to the presence of large numbers of divers, gulls and auks (Figure 9). Larger numbers of birds were observed across the whole survey area in this Period (Tables 15 & 16), accounted for mainly by gulls, auks, and one 2,800-strong flock of scoters. In Period 4 observations were relatively evenly distributed (Figure 4), though with fewer observations in all areas. Observations extended well offshore in both survey Periods.

Common Scoter

4.12 Total numbers of scoters in each survey block during Periods 3 and 4 are given in Table 8. Estimates of scoter numbers calculated using 'distance' for the North West are given in Table 9 for both Periods. Relative densities of scoters found during Periods 3 and 4 in the North West, Greater Wash and the Thames are shown in Figures 13 to 18.

4.13 By far the highest numbers were recorded in the North West, moderate numbers in the Greater Wash and small numbers in the Thames. The distribution was clumped, with a large proportion of birds occurring in just one or two survey blocks.

4.14 In the North West the count of 26,329 in Period 4 was markedly higher than in Period 3 (2,903), mainly due to the coverage of parts of NW4 and NW6 in Period 4. Numbers in the two blocks surveyed in both Periods also increased, however (Table 8): numbers off North Wales in NW5 increased from 2,847 to 8,453, and the small numbers recorded in NW3 doubled.

4.15 As the survey block holding most scoters (NW4) was only surveyed once it is not possible to describe any gross changes in distribution through the mid-late winter period in the North West.

4.16 The highest numbers of scoters were located over Shell Flat, extending south to the mouth of the Ribble and Formby Point, and off the North Wales coast from the Point of Ayr to Colwyn Bay (Figures 13 & 14). Smaller numbers were recorded off Barrow, Cumbria and in Conwy and Red Wharf Bays when covered in Period 4.

4.17 Moderate numbers of scoters were recorded in the Greater Wash during Period 3, with a peak of 2,867 in GW5 (Table 8). This comprised a large discrete flock of 2,800 birds close to the shore off Blakeney Point. Much smaller numbers were counted close to the shore in outer parts of the Greater Wash, specifically near Flamborough Head and Cromer, Norfolk (Figure 15).

4.18 Only three observations of scoters were made in the Greater Wash in Period 4, with none exceeding 25 birds (Table 8; Figure 16). Similar numbers were counted in both Periods around Flamborough Head (GW1a) (60 and 40 birds in Periods 3 and 4 respectively).

4.19 TH1 was the only survey block to hold Common Scoters in the Thames Strategic Area, the 698 birds in Period 4 never exceeding the 16 counted in Period 3 (Table 8). The majority of birds were found near the shore within the Thames Estuary, specifically off Dengie Flat, Essex; Foulness, Essex and the Isle of Sheppey, Kent (Figures 17 & 18).

4.20 Numbers of scoters calculated using 'distance' were between up to 3.5 times greater than actual counts (Table 9). The large confidence intervals are partially a result of the aggregated distribution of this species, and partially due to their tendency to flush in front of the plane away from the transect line, sometimes resulting in the lower confidence intervals falling below the actual number.

4.21 The North West Strategic Area held significantly higher numbers than the East Coast (Greater Wash and Thames). In Period 4 the North West held numbers exceeding the international 1% threshold (Wetlands International 2006). For Period 3 scoter numbers were lower than the international threshold, as the most important area for the species (NW4) was not surveyed.

Divers

4.22 Total numbers of divers (Red-throated, Black-throated, Great Northern and those not identified to species) counted in each survey block during Periods 3 and 4 are given in Table 10. Estimates of diver numbers calculated using 'distance' for the North West and East Coast (Greater Wash and Thames combined) are given in Table 11 for each Period in which significant numbers were recorded. Relative densities of divers found during Periods 3 and 4 in the North West, Greater Wash and the Thames are shown in Figures 19 to 24.

4.23 The Thames held up to three times as many divers as the other two areas combined (Table 10), but numbers were relatively similar between Periods 3 and 4 in the three Strategic Areas.

4.24 Divers were distributed throughout each of the three Strategic Areas. Although high concentrations were generally found close to shore, birds were consistently found a long way from shore in all three areas, with particularly high densities extending to the outer limits of the Thames survey area in Period 4 (Figure 24).

4.25 High concentrations of divers occurred in the Thames Estuary close to shore near Foulness and off the Kent coast (Figures 23 & 24), but with sizeable flocks also occurring mid-channel. In Period 4 fewer divers were found in the south, with birds appearing to concentrate further north (Figure 24). In particular, high numbers occurred in TH7 in Period 4 (431 compared with 79 in Period 3), coinciding with a reduction in the TH1, from 457 to 174 (Table 10). Smaller numbers (up to 40) were observed in TH6, mainly in nearshore parts of the survey area.

4.26 Divers were present in low numbers in the North West throughout both Periods. The increase in Period 4 (from 51 in Period 3, to 117; table 10) was largely due to increased coverage during this Period, as numbers in blocks surveyed in both Periods either decreased (NW3) or remained the same (NW5). The concentration of divers off Cumbria and Barrow in Period 3 was no longer present in Period 4, whilst large concentrations were then observed from the Ribble Estuary South to Formby, and up to 16 km offshore (Figures 19 & 20). Divers were sparsely distributed along the North Wales coast, although formed a more concentrated distribution off Colwyn Bay in Period 4.

4.27 Moderate numbers of divers were recorded in all survey blocks of the Greater Wash, with 184 birds in Period 3 decreasing to 94 in Period 4 (Table 10).

4.28 Distribution of divers throughout the Greater Wash Strategic Area differed between the two surveyed Periods, with GW5, then GW2 holding the largest numbers in Periods 3 and 4 respectively. The largest concentrations were found in GW1a and GW2 between Flamborough and Spurn Head, although numbers here were considerably lower in Period 4 (from 60-26 in GW1a and

from 51-7 birds in GW2. Table 10; Figures 21 & 22), the distribution changing from a relatively even distribution in nearshore areas, to more isolated concentrations closer to shore. Despite occurring in relatively low numbers, divers along the north Norfolk coast appeared to be more concentrated in the east during Period 3, and in the west during Period 4. Only very small numbers of divers occurred more than 20 km from shore in the Greater Wash.

4.29 Seemingly high relative density for divers occurred in two grid cells – one just offshore from Hornsea, Yorkshire, in Period 3, the other close to shore to the north of Great Yarmouth, Norfolk, in Period 4 (Figures 21 & 22). Closer examination of the data revealed that these densities are artefacts of low survey coverage in these grid squares rather than the presence of large numbers of divers.

4.30 Numbers of divers calculated using 'distance' gave estimates between 3 and 9 times greater than actual counts (Tables 10 & 11), with confidence intervals much smaller than those for scoters, largely a consequence of the more even distribution of divers.

4.31 Estimates of divers were much higher for the East Coast than the North West Strategic Area in both survey Periods. Estimated numbers in the East exceeded the international 1% threshold of 3,000 individuals (Wetlands International 2006) in both Periods, while numbers in the North West were below 700.

Little Gull

4.32 Total numbers of Little Gulls counted in Periods 3 and 4 in each survey block are given in Table 12. Only very small numbers were recorded and relative densities have therefore not been calculated for this species. Table 12 has been retained to allow comparison with data from previous years.

Eider

4.33 The highest numbers of Eiders occurred in the Greater Wash, with 70-80 birds recorded in both Periods 3 and 4 (Table 6). Eiders occurred from Blakeney Point and further round the coast to the east, with individual flocks more closely aggregated in Period 3 (Figures 25 & 26).

4.34 Small numbers of Eiders were counted in the North West, with almost identical numbers of around 25 birds in both Periods (Table 6). Eiders occurred off Walney Island, Cumbria, and close to shore over Shell Flat when this area was included in the coverage (Figures 27 & 28). As the main area for Eiders in the North West is Morecambe Bay, not covered in the 2007 survey programme, these small numbers are unlikely to be representative of the whole North West population at this time.

4.35 Very few Eiders were recorded in the Thames OWF Strategic Area.

4.36 The majority of Eiders were found in shallow inshore waters, with most flocks occurring within 6 km of the shore.

Gannet

4.37 Moderate numbers of Gannets were observed in the Thames during Period 4, with counts of 578 and 340 birds in TH6 and TH7 respectively, a notable increase from those counted in Period 3 (56 birds for the whole area combined; tables 17 & 18).

4.38 The majority of Gannets in the Thames occurred in the southeast corner of the survey area, and in northern areas (TH7), well offshore, and with high densities continuing up to the limits of the survey area (Figures 29 & 30). No Gannets were observed in the inner Thames Estuary (TH1).

4.39 The Greater Wash held moderate numbers of Gannets (134) in Period 3, which reduced by half in Period 4 (Table 6). The largest concentration was observed in Period 3 off Flamborough, whilst in Period 4 the distribution was spread evenly between GW1a and GW2 (Figures 31 & 32).

4.40 No Gannets were recorded in the North West Strategic Area.

Cormorant and Shag

4.41 The Thames held moderate numbers of Cormorants and Shags (and those not identified to species), with 95 in Period 3 and nearly twice as many (175) in Period 4 (Table 7). Birds were located almost exclusively in TH1, with the largest concentrations occurring in dense flocks and in almost exactly the same area – off Herne Bay (Kent) – in both Periods (Figures 33 & 34). The majority of observations were made close to shore, and most of the birds identified to species level were Cormorants.

4.42 Moderate numbers of cormorant spp. were found in the North West, the 167 in Period 4 a considerable increase from the 29 encountered in Period 3 (Table 5). This was largely due to the more extensive survey coverage during Period 4, although a considerable increase in bird numbers also occurred in NW5 from mid to late winter (Tables 17 & 18).

4.43 The areas holding the highest numbers of cormorant species in the North West were nearshore waters from the mouth of Ribble along the North Wales coast to Conwy Bay (Figures 35 & 36). The majority of birds identified to species level in the North West were Cormorants, small numbers of Shags (23 in both Periods combined) occurring along the North Wales coast, from Conwy Bay to the Wirral.

4.44 The Greater Wash held no more than six birds in each survey Period, all within 6 km of the shore (Figures 37 & 38).

Gulls

4.45 Six species of gull: Black-headed Gull, Common Gull, Lesser Black-backed Gull, Herring Gull, Greater Black-backed Gull and Kittiwake, were commonly recorded during the surveys (Figures 39-44). The first five species are found in large numbers at coastal and inland sites; Kittiwakes are generally pelagic and separate maps are therefore presented for this species.

4.46 Large numbers of gulls were recorded in all Strategic Areas during the winter. The Thames held the largest numbers, followed by the Greater Wash, with the North West holding the fewest (Tables 5-7).

4.47 The Thames held large numbers of gulls throughout the mid to late winter period surveyed, with numbers increasing from 1,342, to 2,259. The highest numbers were in TH1 and TH6 (Tables 17 & 18). Gulls were distributed in small numbers throughout much of the survey area, with higher concentrations found around coastal sandbanks in TH1 (Figure 43), particularly from Foulness south to the Isle of Sheppey in Period 3. In Period 4 densities in this area were lower and more evenly spread along the coast (Figure 44). Larger numbers were found in offshore areas (TH6 & TH7), where small densities were distributed throughout, but with occasional isolated areas of high concentration.

4.48 The number of gulls in the Greater Wash was considerably higher in Period 3 (2,088 birds) compared with Period 4 (529 birds) (Table 6). During the busiest Period, GW1a and GW2 held the most gulls, with denser aggregations off Bempton, Yorkshire, and more evenly spread smaller densities further south to the mouth of the Humber. Small concentrations were relatively evenly distributed in GW2 in Period 4, and along the Norfolk coast in both survey Periods (Figures 41 &

42). Gull distribution extended well offshore throughout the whole survey area, with no obvious movement in or away from shore in either Period.

4.49 Gull numbers in the North West were 197 in Period 3 compared with 721 in Period 4, the difference primarily due to the increased area of coverage in the latter Period (Table 5). Gulls were generally distributed in small densities throughout the survey area, with a few small areas of high density occurring close to shore off Formby, Colwyn Bay and Great Orme's Head (Period 4) (Figures 39 & 40).

Kittiwake

4.50 Kittiwakes were widely distributed throughout all three Strategic Areas, consistently occurring in dense aggregations from close to shore to the outer limits of survey areas (Figures 45-50).

4.51 All three areas held moderate numbers of Kittiwakes, with numbers more than doubling in the North West and the Thames, and decreasing in the Greater Wash, between the survey Periods (Tables 5-7).

4.52 In the Thames the highest numbers were recorded during Period 4 (174), where the densest aggregations comprised discrete feeding flocks located in the south west corner of TH6 and far offshore in the southern half of TH7. Numbers in TH6 increased from 40 to 102 birds between Periods 3 and 4 (Tables 17 & 18). Birds in the Thames generally exhibited a more clumped distribution than in the other Strategic Areas (Figures 49 & 50).

4.53 Despite the increased coverage in Period 4, numbers of Kittiwakes in the additional areas surveyed in the North West were low and did not contribute significantly to the increase in numbers between mid- and late-winter. Instead, numbers in the twice-surveyed areas (NW3 and NW5) more than doubled in Period 4 (Tables 13 & 14).

4.54 Kittiwakes were distributed widely throughout the North West in low densities, with generally fewer observations in coastal areas (Figures 45 & 46). The highest numbers were recorded off North Wales in Period 4: within Conwy Bay, off Great Orme's Head, and extending well offshore from Walney Island.

4.55 In the Greater Wash there was a decline in Kittiwake numbers from 130 to 48 birds between Periods 3 and 4, (Tables 15 & 16). Birds were spread thinly over a large area from the coast to the outer limit of survey the area (Figures 47 & 48), with the highest relative densities occurring offshore. Survey blocks GW2 and GW5 held the majority of the observed Kittiwakes throughout mid and late winter.

Auks

4.56 Very few auks were identified to species level, although the majority of birds encountered are believed to have been Guillemots *Uria aalge* and Razorbills *Alca torda*, with smaller numbers of Puffins *Fratecula actica.*

4.57 Large numbers of auks were recorded throughout winter in all Strategic Areas, with the highest numbers in the Greater Wash during Period 3, and the Thames in Period 4 (Tables 5-7). All three areas held over 1,000 auks in one of the two Periods.

4.58 In the Thames there were almost three times as many auks recorded in Period 4 than in Period 3 (1,405 compared with 532). Almost all auks occurred in survey blocks TH6 and TH7, offshore in the southeast and north of the Strategic Area (Figures 55 & 56). In Period 3 birds were well distributed across both areas, although with some denser aggregations offshore in the far southeast.

In Period 4 birds formed denser concentrations in the southern parts of TH7, with fewer, more scattered occurrences further north and inland. In TH6 auk numbers increased considerably from 389 to 1076 birds in Period 4, and formed large concentrations in the southeast.

4.59 Auks were widespread throughout the Greater Wash, with numbers declining from 1,767 to 357 between Periods 3 and 4, largely accounted for by the dramatic decline from 1,240 to 24 in GW1a (Tables 15 & 16).

4.60 In Period 3 the largest concentrations of auks in the Greater Wash were located off Bempton, Yorkshire, with relative density generally decreasing further south to Spurn Head (Figure 53). Fewer birds were observed off the north Norfolk coast, although, as with the Greater Wash as a whole, birds were widely distributed throughout coastal and offshore areas. Few auks were observed off Cromer, Norfolk, despite the regular occurrence of low densities to the east and west.

4.61 During Period 4 auks were more uniformly spread throughout the Greater Wash, with no large aggregations as observed in Period 3 (Figure 54).

4.62 In the North West auk numbers increased from 347 to 1,191 birds between mid and late winter, partially due to increased coverage in the Strategic Area during Period 4, although numbers in the twice-surveyed NW3 and NW5 also increased (Tables 13 & 14).

4.63 During Period 3 auks were well distributed throughout NW5 and NW3, and extended well offshore (Figure 51). Many observations of auks extended offshore from Prestatyn and the Point of Ayr. During Period 4 the distribution was more clumped, with the larger aggregations offshore from breeding colonies at Great Orme's Head and in Red Wharf Bay (Figure 52). Smaller densities occurred in offshore waters between Blackpool and the Dee Estuary, and in offshore areas of NW3.

5. DISCUSSION

Overall summary

5.1 Survey in 2007 was the third season of co-ordinated survey of Offshore Wind Farm Strategic Areas and potential SPA sites. Boundaries of individual survey blocks remained the same, although a block combining parts of NW4, NW6a and NW6b was used to cover key areas for Common Scoters in Period 4. Coverage differed from previous years such that survey blocks NW1, GW3, GW4, GW5, GW7, TH3, TH4, and TH5 were excluded from the 2007 programme. This allows only broad comparisons of data between years. The two additional survey blocks (TH6 & TH7), created for the 2005/06 survey programme were again covered in 2007.

5.2 One of the major factors affecting bird numbers was the differential coverage in the North West OWF Strategic Area between mid and late winter. Several key areas known to be particularly important for Common Scoter were not surveyed in Period 3, specifically NW4 and NW6a and NW6b. Coverage was reduced to a lesser degree in the Greater Wash during Period 3, when five transects in the west of GW6 were not covered due to unforeseen circumstances on the survey day. It is unlikely that full coverage of this small area would have shown any major distributional differences in sparsely distributed species, although it is possible that some aggregations of species occurring in dense flocks *eg* seaducks, could have been missed.

5.3 As it was not always possible to survey adjacent blocks - or parts of blocks - on the same day (Table 3), some birds or flocks could have been counted multiple times or missed should they have moved between areas surveyed on different days. This should be considered when comparing datasets collected on different days.

5.4 Tidal state is another important factor in determining distribution, especially of species which feed on exposed sand banks, such as gulls and waders.

5.5 Over the whole area surveyed bird numbers were much higher during Period 4 (42,456) than in Period 3 (14,770), with numbers increasing in both the North West and the Thames but decreasing in the Greater Wash. The difference in numbers is primarily due to the increased coverage in NW4, NW6a and NW6b in Period 4, which resulted in much higher numbers of birds (primarily scoters) (Tables 13 & 14).

5.6 Large differences in bird numbers between Periods 3 and 4 were recorded in the North West and the Thames, where peak numbers occurred in late winter. Despite the increased coverage of the North West in Period 4, which resulted in significantly higher bird numbers, an increase of over 3,000 birds was also observed in areas surveyed in both Periods (largely due to the increase in scoter numbers recorded in NW5). The late winter influx of pelagic species, notably auks, Gannets and Kittiwakes, to offshore areas of the Thames accounted for peak numbers in this Strategic Area. A notable offshore concentration of seabirds in the southeast Thames also occurred in the 2005/06 survey programme.

5.7 It is not possible to identify any distributional and abundance trends throughout the winter period due to the limited number of repeat surveys carried out. Even differences described between the surveyed periods could merely be consequences of bird movements between different feeding grounds not included in the 2007 coverage, and do not necessarily represent seasonal changes. Nor are they likely to be representative of numbers in a Strategic Area as a whole.

5.8 Overall distributions were similar to those observed during the 2004/05 and 2005/06 survey programmes, with high densities of birds in inshore areas, in areas where scoters occurred, and in offshore waters of the Thames in late winter.

Common Scoter

5.9 The number of Common Scoters in the North West during Period 4 estimated using 'distance' (63,387) easily surpassed the level for international importance (16,000; Wetlands International 2006), as indeed did the lower confidence interval of the estimate (39,318). During Period 3 estimated numbers of scoters were well below this threshold, although the survey block holding most scoters (NW4) was not surveyed. Estimates of Common Scoter numbers calculated in previous years for this Period, when NW4 was included, have consistently surpassed the level for international importance, and should this survey block have been covered it is likely that the estimates would again have exceeded the threshold.

5.10 Winter maxima for Common Scoters in Liverpool Bay during 2001/02 to 2005/06 were 27,800, 79,100, 42,900, 46,900, and 60,200 (Smith *et al* 2007). The 2007 maximum (63,400) falls above the average of these figures (51,400), demonstrating the regular and continuous presence of internationally important numbers at this site. The designation of this site as a marine SPA is currently under review (Webb *et al* 2004).

5.11 Due to the limited number of surveys and reduced coverage of the key area (Shell Flat), it is possible that the peak number of Common Scoters was missed in 2006/07. However, peak counts have traditionally been recorded in late winter (February), suggesting that the 2007 maximum (63,400) observed in Period 4 is probably representative of the true winter peak.

5.12 Previous survey seasons in the North West have noted a movement to offshore areas as a response to food depletion in shallower, more energetically profitable inshore waters, during the course of the winter. Assessment of the extent of these movements in winter 2007 was, however, limited due to the small number of repeated surveys and reduced coverage of NW4.

5.13 Moderate numbers of Common Scoters were observed off Blakeney Point, Norfolk, in mid winter, where a single, discrete flock of 2800 birds was observed. This number exceeds the winter peak for the whole Strategic Area recorded in 2005/06 (2,565) and approaches that of 2004/05 (3,217), suggesting that a large proportion of scoters in the Greater Wash may have been present in this single flock. Scoters have been observed in such dense flocks occupying localised sites in previous aerial surveys of the Greater Wash and Thames Strategic Areas (Department of Trade and Industry 2006, WWT Wetlands Advisory Service 2006, WWT Consulting 2007), contrasting sharply with distributions observed in Carmarthen Bay, and Liverpool Bay, where scoters are distributed over large areas in flocks of uneven density.

5.14 Birds were generally found at predictable locations in inshore waters, as has been observed in previous winters. Due to the lack of coverage of central Wash areas where large flocks are regularly found, for example, at localised sites off Titchwell and Hunstanton (Department of Trade and Industry 2006, WWT Consulting 2007, Norfolk Bird Reports), it is likely that a degree of movement occurred between surveyed areas and other favoured locations. Some aggregated flocks of scoters, such as those described above, may therefore have been missed during surveys in adjacent Periods.

5.15 Small numbers of Common Scoters were found in the Thames, an area that has historically held significant numbers (Lack 1986). Consistently used sites in recent years, as well as in 2007, are around Foulness and west of the Isle of Sheppey (WWT Consulting 2007, Department of Trade and Industry 2006), although exact numbers of birds and locations appear rather variable, highlighting the need for continued surveys to identify current areas of importance for sensitive species such as Common Scoter.

5.16 Several other sites in the UK are important for Common Scoter. These include Carmarthen Bay which regularly holds 20,000 birds (Cranswick *et al* 2005) and is designated as the UK's first marine SPA based on its Common Scoter numbers. Cardigan Bay was estimated to hold 11,800 scoters in 2003/04 (Hall *et al* 2005). Aerial surveys in Scotland have recorded scoter in Aberdeen Bay (258 in February 2005), Firth of Tay (1,085 in December 2004), Firth of Forth (70 in February 2005), Moray Firth (693 in March 2005) and Luce Bay (265 in February 2006), with peaks for individual sites occurring in different months (Wilson *et al* 2006 and 2006a). Estimates of numbers present at these sites using 'distance' analysis are not yet available.

5.17 Although the current published estimate for the number of Common Scoters wintering in Britain is 50,000 (Cranswick 2000, Kershaw & Cranswick 2003), this figure was calculated prior to the recent increase in aerial survey activity and is certainly too low. The true British total is likely to number more than 100,000 birds (Smith *et al* 2007).

5.18 The estimate for the biogeographic population of Common Scoters is 1.6 million, with the majority of the European wintering population found in the Baltic and Kattegat. The eastern North Sea holds several hundred thousands, with smaller numbers in France, Portugal and northern Africa. During cold winters it is thought that many of the birds from the Baltic and Kattegat move into the North Sea (Skov *et al* 1995).

Red-throated Diver

5.19 Divers were encountered widely throughout all Strategic Areas. Although not all could be identified to species, it is believed that the vast majority were Red-throated Divers and all unidentified divers are treated as such here.

5.20 The international population estimate of Red-throated Divers is between 150,000 and 450,000 and an international 1% threshold of 3,000 birds has recently been adopted (Wetlands International 2007).

5.21 Estimates of numbers of divers calculated using 'distance' exceeded 3,000 birds off the East Coast (Greater Wash and Thames combined, though most birds occurred in the Thames) in Periods 2, 3 and 4. Estimates for just survey blocks TH1 and TH2 combined exceeded 3,000 birds in Periods 3 and 4 indicating the presence of internationally important numbers.

5.22 Winter maxima for Red-throated Divers in the Thames during 2002/03 to 2005/06 were 11,100, 7,700, 5,600, and 8,000 (Webb *et al* 2005, Department of Trade and Industry 2006, WWT Consulting 2007). The figures recorded in 2005/06 and 2007 (3,300) are in fact estimates for the English East coast, from Kent to Yorkshire, but only a small proportion of divers occur outside the Thames. Unlike in previous years, the 2007 figure does not include data for survey blocks TH2, TH3, TH4 or TH5, other historically important areas for large numbers of divers, and thus is likely considerably underestimate the numbers in the Strategic Area as a whole. Nevertheless these figures demonstrate the regular and continued presence of large numbers of Red-throated Divers in the Thames, which exceed the 1% international threshold. The boundaries of a potential SPA for divers in the Thames are currently being prepared.

5.23 Only a few sites in Northwest Europe hold comparable numbers to those in the Thames, and are usually found over much larger areas. In the eastern German Bight 23,500 divers (a mixture of Red-throated and Black-throated) occurred over 13,000 km² (Skov *et al* 1995); those recorded in the Thames were found in an area of 8,233 km².

5.24 High concentrations of divers occurred mid-channel between Essex and Kent, and in the north of the Strategic Area, as noted in previous years. As with surveys in recent years (*eg* WWT Consulting 2007) birds in the Thames Estuary appeared to be distributed near sand banks despite turbid and very shallow water, possibly making foraging difficult for these visual diving feeders). It has been suggested that divers in such waters have switched their diet in late-winter/early-spring, perhaps to spawning fish/eggs, as is the case in other areas (Guse *et al* in press). However, the 2007 survey programme saw a late-winter shift in distribution to deeper offshore areas of the Thames Strategic Area, perhaps suggesting that divers markedly shift their distribution both within and between winters in response to sporadic changes in abundance of profitable prey.

5.25 Numbers of divers in the Thames appeared fairly consistent between Periods 3 and 4, although a marked shift in distribution was observed. Notably, numbers in the estuary mouth (TH1) and TH6 decreased, while large concentrations formed offshore in the north of the Strategic Area (TH7). Numbers were generally lower than in 2004/05 and 2005/06 due to limited coverage of the Strategic Area. However, the three areas surveyed in this project together held half of the total numbers observed in 2005/06 when coverage included the whole of the Thames.

5.26 Large-scale changes in the distribution of divers between Periods are unsurprising for a species that feeds on fish, a widespread and mobile food resource. It might be speculated that the timing and distribution of arrival of the winter influx of divers is driven by seasonal occurrence of fish species, particularly spawning fish. Lower numbers of divers in recent years (the highest peak of 11,100 birds recorded in 2002/03 has not since been reached) may be as a result of reduced fish stocks in the western North Sea, or due to more favourable conditions in other wintering grounds, perhaps as a result of mild winters or high food availability.

5.27 In 2005/06 the extent of the survey area was extended further offshore specifically to investigate the limits of diver distribution. Although small numbers of divers were still recorded in the outer limits of these survey areas (off Suffolk, Kent and Norfolk) in both 2005/06 and 2007, the large increase in numbers (approaching the numbers observed in TH1 in Period 3) extending well offshore in the northeast of the Strategic Area was only observed in 2007. This coincided with a decline in TH1 numbers, suggesting possible movement of birds between different parts of the Thames Strategic Area. This project has confirmed the importance of offshore areas to divers in addition to those recorded previously in the inner Thames, and suggests large numbers of divers may at times extend

even further offshore from the current Strategic Area. Red-throated Divers have been recorded throughout the North Sea to the 20 m depth contour (Skov *et al* 1995), though there has been little coverage of central areas in recent years.

5.28 Movement of Red-throated Divers within the Thames between months indicates that the whole of the survey area – and perhaps unsurveyed areas beyond – represents a coherent site for this species. Future surveys should ensure synchronised coverage across this broad region, and if so, beyond, to ensure an accurate assessment of numbers in this area, and to avoid missing birds.

5.29 Diver distribution in the North West and Greater Wash in 2007 was broadly similar to previous years, with between-year variation no greater than within-year variation resulting from small-scale movements between areas.

5.30 Moderate numbers of divers were recorded in the Greater Wash in 2007, mainly in inshore areas, though extending over 20 km offshore in some areas. Distribution varied between mid- and late-winter, with the largest concentrations found off the Yorkshire coast. The decline in numbers in the Greater Wash during Period 4 corresponds with the large increase seen in neighbouring TH7, suggesting possible movement of divers into an area of abundant prey at this time. However, due to the lack of coverage of central areas of The Wash, it is also possible that there is considerable movement of birds in and out of these waters.

5.31 Winter maxima for Red-throated Divers in Liverpool Bay during 2001/02 to 2005/06 were 1,600, 1,000, 600, 1,000, and 1,500 (Webb *et al* 2004, WWT Consulting 2007, Department of Trade and Industry 2006, Hall *et al* 2005). The 2007 maximum (700) falls below the average of these figures (1,140) due to the reduced coverage within the Strategic Area. Although these numbers demonstrate regular and continued presence of large numbers within the area, they do not surpass the level for international importance. As with the 2007 maximum, surveys in the last two winters have observed peak numbers in Period 4.

5.32 The UK Government has, however, adopted selection guidelines for SPAs that include areas regularly used by 1% or more of the Great Britain population of species listed in Annex 1 of the EC Birds Directive (Stroud *et al* 2001). Consequently, as the current British estimate is 4,850 birds and the 1% threshold for national importance is 50 birds (Kershaw & Cranswick 2003), numbers in Liverpool Bay are sufficient for this site to be selected as an SPA for Red-throated Divers. The proposed SPA for Common Scoter in Liverpool Bay will include the important areas for divers.

5.33 Aerial surveys of other sites in the UK in recent years recorded moderate numbers of Red-throated Divers in the Tay (33 in February 2006), Firth of Forth (57 in December 2005) and Aberdeen Bay (31 in December 05) (Wilson *et al* 2006). Estimates of actual numbers calculated using distance analysis are not yet available. Shore-based counts of Aberdeen Bay recorded a peak of 423 Red-throated Divers in May 2005 (Wilson *et al* 2006*)*. Estimates of divers calculated using distance analysis for Cardigan Bay suggested 1,200 were present in March 2004 (Hall *et al* 2005).

5.34 Increased aerial surveys over the past three winters have greatly increased our knowledge on Red-throated Divers wintering in UK waters and show the current British wintering estimate to be a considerable underestimate. A revised estimate is currently in preparation, and is likely to be 15,000 birds (O'Brien *et al* in press). Although the revised 1% threshold for national importance would therefore be increased to 150, numbers in Liverpool Bay still easily surpass this figure.

Other species

5.35 Gannet distribution in the Thames was highly concentrated in the southeast limits of the survey area in late winter, where other species of seabird were also recorded in high densities. Similarly, Gannets and other seabirds (of similar species to those in the Thames) formed mid-winter concentrations off

Flamborough, Yorkshire, suggesting the presence of abundant food resources here at this time. Multi-species concentrations in the southeast of the Thames survey area were also observed in 2005/06, suggesting that this area may regularly hold abundant food resources.

5.36 Large numbers of gulls were observed in all Strategic Areas throughout mid to late winter, with some variation in distribution between Periods. Many gull species (except for Kittiwakes) were associated with exposed sand banks during counts at mid to low tide. During high-tide gulls from these intertidal areas may move inland to forage, and therefore outside of the survey area. Tidal state is an important factor in determining the numbers and distribution of gulls during aerial surveys.

5.37 Small areas of high densities of gulls in the offshore parts of survey blocks, particularly in the Thames, were in many cases due to association with fishing vessels. The large offshore concentration of gulls in the southeast of the Thames in Period 4 and off Flamborough in Period 3 overlaps with high concentrations of other seabirds in the area, where they were presumably feeding on the same food resources, or parasitising other species for food. Such associations of gulls with other seabirds in the Thames were also observed in 2005/06.

5.38 Kittiwakes occurred extensively throughout the Strategic Areas, generally evenly spread in small numbers, with higher densities in offshore areas and lower numbers close to shore compared with other less pelagic gull species. The decrease in numbers of Kittiwakes in the Greater Wash during Period 4 may be due to small-scale movement of birds as a response to fluctuations in distribution and abundance of prey. Birds may have moved within the Greater Wash, entering areas not surveyed in 2007, or south into the Thames Strategic Area coinciding with the increase observed in the Thames during Period 4. Possible movement of Kittiwakes further south in mid to late winter was also suggested in the 2005/06 winter survey season (WWT Consulting 2007), and could be a response to movement or changes in food resources.

5.39 Auks were found mainly in offshore areas, with distribution varying between Periods 3 and 4, presumably as auks follow mobile fish stocks. Large areas of high density occurred in offshore parts of the Thames in late winter, coinciding with the influx of other pelagic species (Kittiwakes and Gannets) to these areas. High densities were observed in the North West, around the breeding colonies at Great Orme's Head and Puffin Island in late winter, and Bempton Cliffs, Yorkshire, in Period 3.

5.40 The North West and the Wash have historically held a large proportion of the total numbers of Eiders of the three Strategic Areas (Department of Trade and Industry 2006, WWT Consulting 2007). However, the majority of Eiders in these areas typically occur in Morecambe Bay and the inner Wash, areas not covered by the 2007 survey programme. Thus the relatively low numbers recorded in 2007 are not representative of the true numbers of birds in these Strategic Areas.

5.41 Numbers of Little Gulls in previous years typically reach peak numbers in late autumn or early winter (Periods 1 and 2) (Department of Trade and Industry 2006, WWT Consulting 2007), and thus the considerably lower numbers recorded in Periods 3 and 4 are unlikely to be representative of numbers of the species for the winter as a whole.

6. REFERENCES

Buckland, ST, D Anderson, K Burnham, J Laake, D Borchers & L Thomas. 2001 *Introduction to distance sampling: estimating abundance of biological populations*. Oxford University Press, Oxford.

Camphuysen, CJ, AD Fox, MF Leopold & IK Petersen. 2004. *Towards standardised seabird at sea census techniques in connection with environmental impact assessments for offshore wind farms in the UK: a comparison of ship and aerial sampling methods for marine birds, and their applicability to offshore wind farm assessments*. NIOZ report to COWRIE.

Cranswick, PA, C Hall & L Smith. 2003. *Aerial surveys of birds in proposed strategic areas for offshore windfarm development, round 2: preliminary report, winter 2002/03*. WWT, Slimbridge. 13 pp.

Cranswick, PA, C Hall & L Smith. 2004. *All Wales Common Scoter survey: report on 2002/03 work programme*. WWT Wetlands Advisory Service report to Countryside Council for Wales, CCW Contract Science Report no 615.

Cranswick, PA, J Worden, RM Ward, HE Rowell, C Hall, AJ Musgrove, RD Hearn, SJ Holloway, AN Banks, GE Austin, LR Griffin, B Hughes, M Kershaw, MJ O'Connell, MS Pollitt, EC Rees & LE Smith. 2005. *The Wetland Bird Survey 2001-03: Wildfowl & Wader Counts*. BTO/WWT/RSPB/JNCC, Slimbridge.

Department of Trade and Industry. 2006. *Aerial Surveys of Waterbirds in Strategic Windfarm Areas: 2004/05 Final Report*. Department of Trade and Industry, London.

Guse, N, S Garthe & R Mundry. In press. *Spring or winter menu? The impact of season on the diet of Red-throated Divers in the southern Baltic Sea*. Proceedings of the 9th International Seabird Group Conference, Aberdeen, Scotland 2006.

Hall, C, L Smith & PA Cranswick. 2005. *All Wales Common Scoter survey: report on 2003/04 work programme*. WWT Wetlands Advisory Service report to Countryside Council for Wales, CCW Contract Science Report No 709.

Johnston, SM, CG Turnbull & ML Tasker. 2002. *Natura 2000 in UK Offshore Waters: Advice to support the implementation of the EC Habitats and Birds Directives in UK offshore waters*. JNCC Report No 325.

Kahlert, J, M Desholm, I Clausager & IK Petersen. 2000. *Environmental impact assessment of an offshore wind park at Rødsand*. Natural Environment Research Institute, Rønde.

Kershaw, M, & PA Cranswick. 2003. Numbers of wintering waterbirds in Great Britain, 1994/1995-1998/1999: I. Wildfowl and selected waterbirds. *Biological Conservation* 111: 91-104.

Lack, P. 1986. *The Atlas of Wintering Birds in Britain and Ireland*. T & AD Poyser, London.

Mitchell, PI, SF Newton, N Ratcliffe & TE Dunn. 2004. *Seabird Populations of Britain and Ireland. Results of the Seabird 2000*. T & AD Poyser, London.

O'Brien, SH, LJ Wilson, A Webb & PA Cranswick. In press. Revised estimate of numbers of wintering Red-throated Divers *Gavia stellata* in Great Britain. *Bird Study*.

Smith LE, C Hall, PA Cranswick, AN Banks, WG Sanderson & S Whitehead. 2007. The status of Common Scoter *Melanitta nigra* in Welsh waters and Liverpool Bay, 2001-2006. *Welsh Birds* 5: 4-28.

Stroud, DA, D Chambers, S Cook, N Buxton, B Fraser, P Clement, P Lewis, I McLean, H Baker & S Whitehead. 2001. *The UK SPA network: its scope and content*. JNCC, Peterborough.

Skov, H, J Durinck, MF Leopold & ML Tasker. 1995. *Important Bird Areas for seabirds in the North Sea.* BirdLife International, Cambridge.

Thomas, L, JL Laake, S Strindberg, FFC Marques, ST Buckland, DL Borchers, DR Anderson, KP Burnham, SL Hedley, JH Pollard, JRB Bishop & TA Marques. 2005. *Distance 5.0. Release Beta 5*. Research Unit for Wildlife Population Assessment, University of St Andrews, UK. http://www.ruwpa.st-and.ac.uk/distance/

Webb, A, CA McSorley, A Webb, BJ Dean, JB Reid, PA Cranswick, L Smith & C Hall. 2004. *An assessment of the numbers and distribution of inshore aggregations of waterbirds using Liverpool Bay during the non-breeding season.* JNCC Report No 373.

Webb, A, CA McSorley, BJ Dean, S O'Brien, JB Reid, PA Cranswick, LE Smith & C Hall. 2005. *An assessment of the numbers and distribution of aggregations of inshore waterbirds using the Greater Thames during the non-breeding season.* JNCC Report No 374.

Wilson, LJ, BJ Dean, A Webb, CA McSorley & JB Reid. 2006 *Wintering seaducks, divers and grebes in UK inshore areas: Aerial surveys and shore-based counts 2004/05*. JNCC Report No 371.

Wetlands International. 2006. *Waterbird Population Estimates – Fourth Edition.* Wetlands International, Wageningen, the Netherlands.

WWT Consulting. 2007. *Aerial Surveys of waterbirds in Strategic Windfarm Areas: 2005/06 Final Report.* WWT Consulting Report to Department of Trade and Industry.

WWT Wetlands Advisory Service. 2003. *All Wales Common Scoter Survey: report on 2001/02 work programme*. CCW Contract Science Report No 568.

WWT Wetlands Advisory Service. 2006. *Aerial Surveys of Waterbirds in the Wash, 2005/06*. WWT Wetlands Advisory Service report to English Nature.

Figures

Observations of birds in the North West, Greater Wash and Thames OWF Strategic Areas are presented in Figures 1-6. A single record of birds (whether an individual or flock) is treated as one observation. The approximate boundary of the individual Survey Blocks is shown in green (see Figure ii for reference). The grid is the 10 km national OS grid. Note, a higher proportion of birds is detected close the plane, hence the apparent distribution is of lines of birds running north-south along the path of the transects. Note some survey blocks or parts of survey blocks were not surveyed in all months.

Relative density of birds in the North West, Greater Wash and Thames OWF Strategic Areas are presented in Figures 7-56. Numbers of all species are summed by 2x2 km grid squares, corrected for survey effort.

Figure 1 - Observations of birds in the North West OWF Strategic Area during aerial surveys, Period 3.

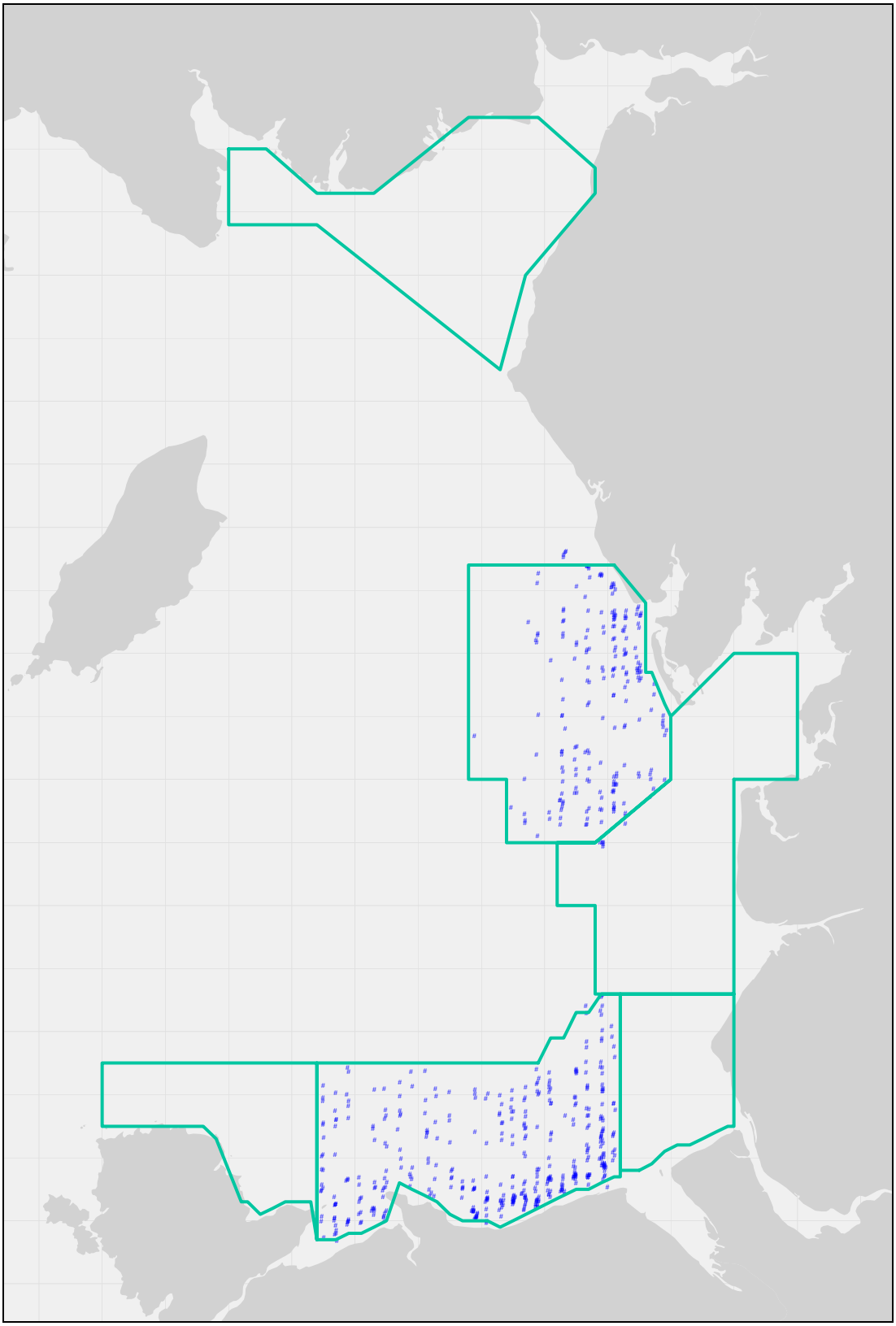


Figure 2 - Observations of birds in the North West OWF Strategic Area during aerial surveys, Period 4.

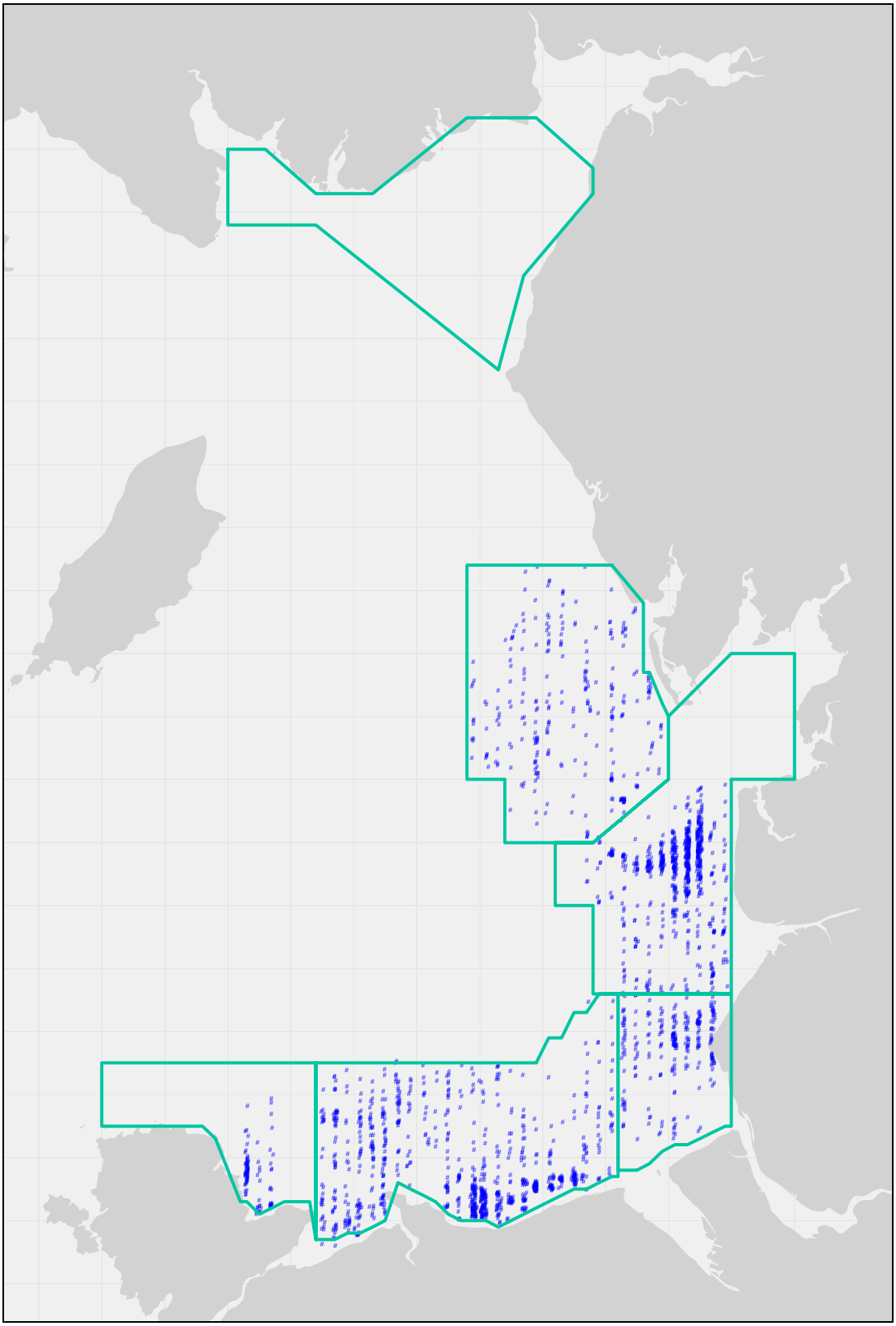


Figure 3 - Observations of birds in the Greater Wash OWF Strategic Area during aerial surveys, Period 3.

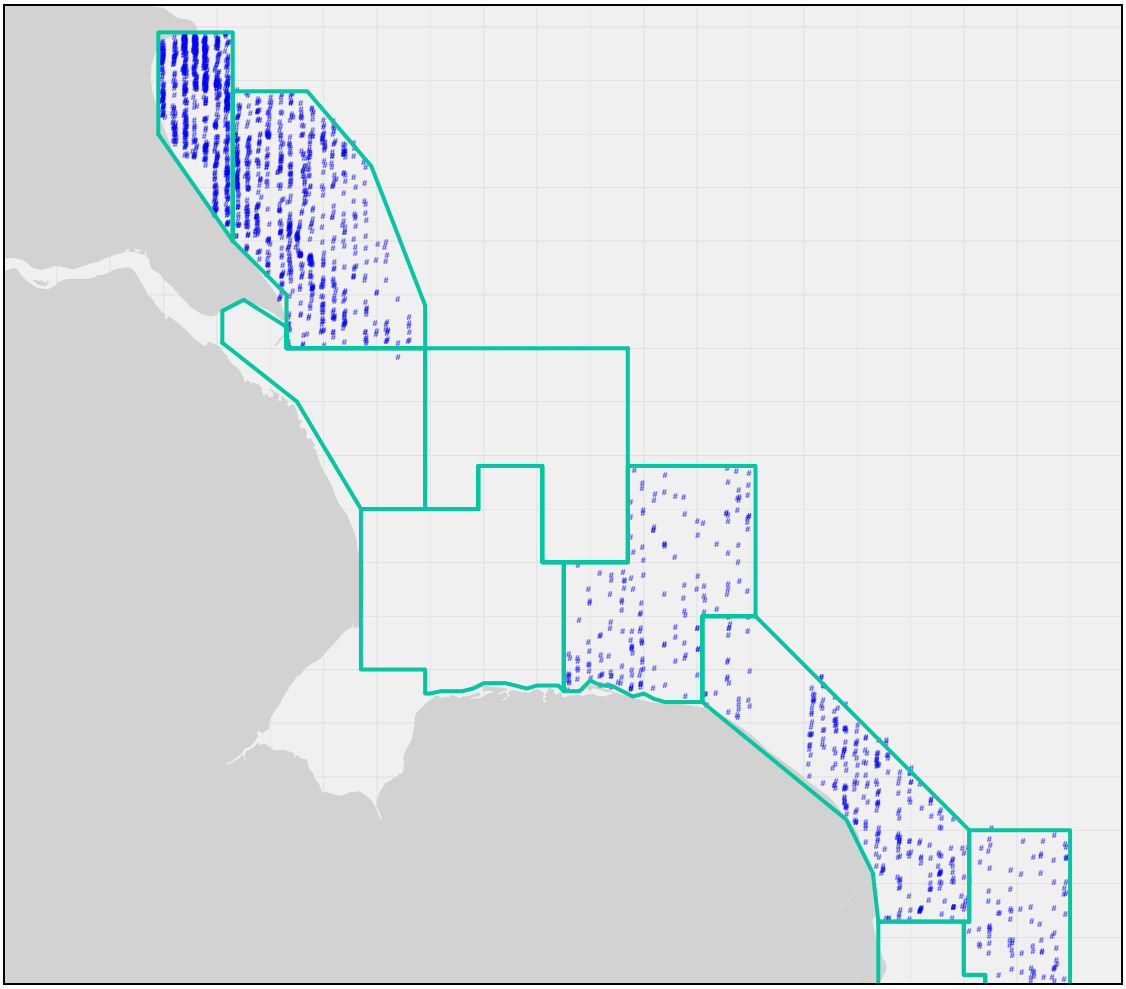


Figure 4 - Observations of birds in the Greater Wash OWF Strategic Area during aerial surveys, Period 4.

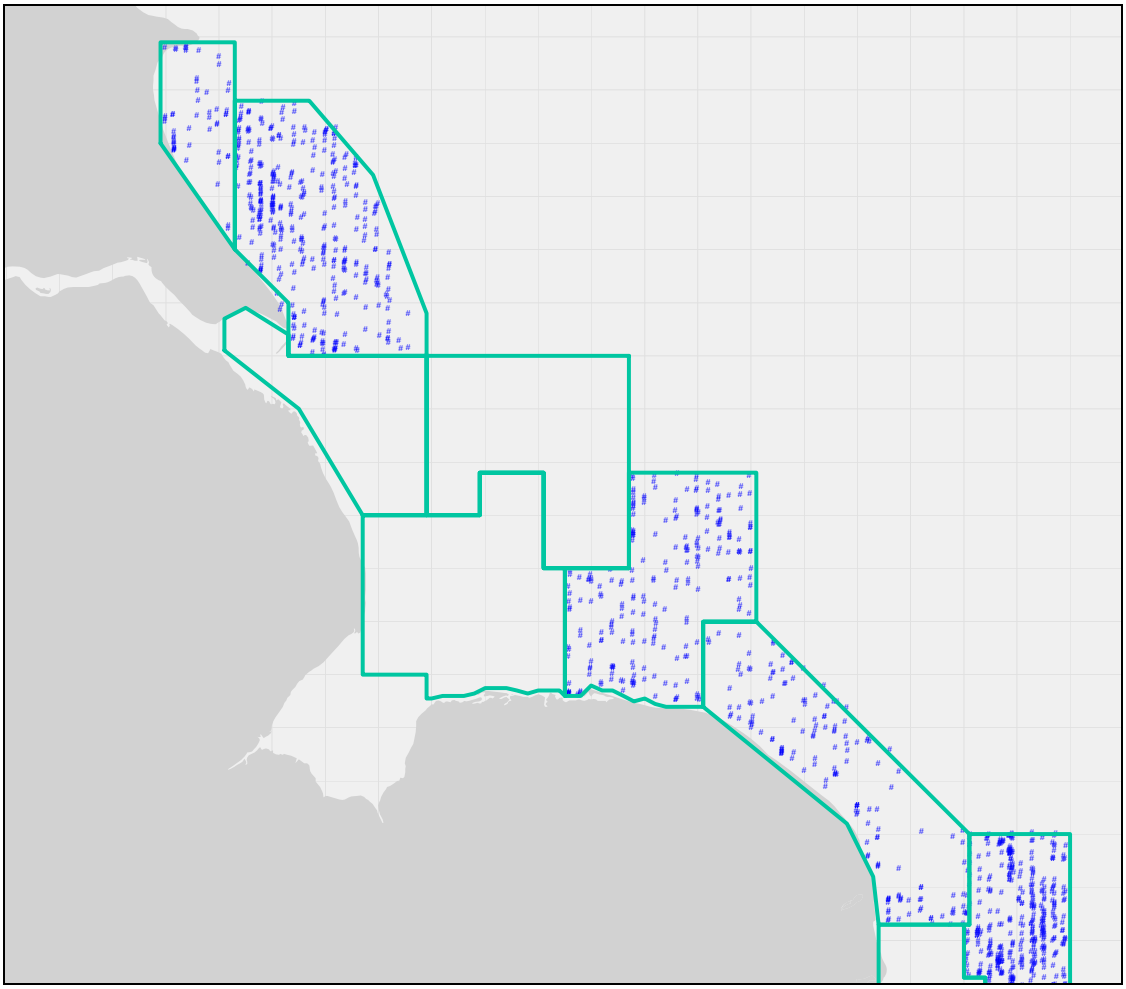


Figure 5 - Observations of birds in the Thames OWF Strategic Area during aerial surveys, Period 3.

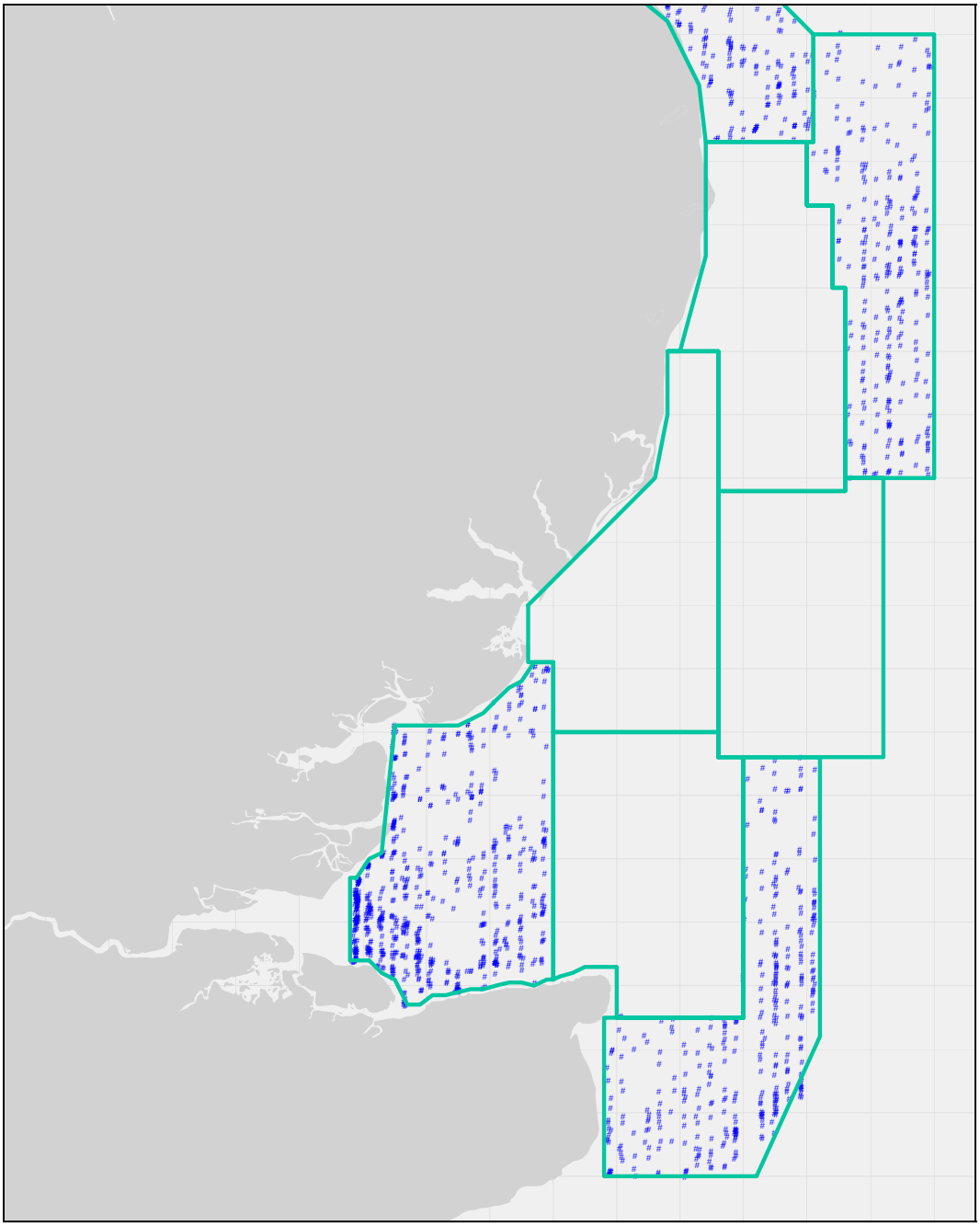


Figure 6 - Observations of birds in the Thames OWF Strategic Area during aerial surveys, Period 4.

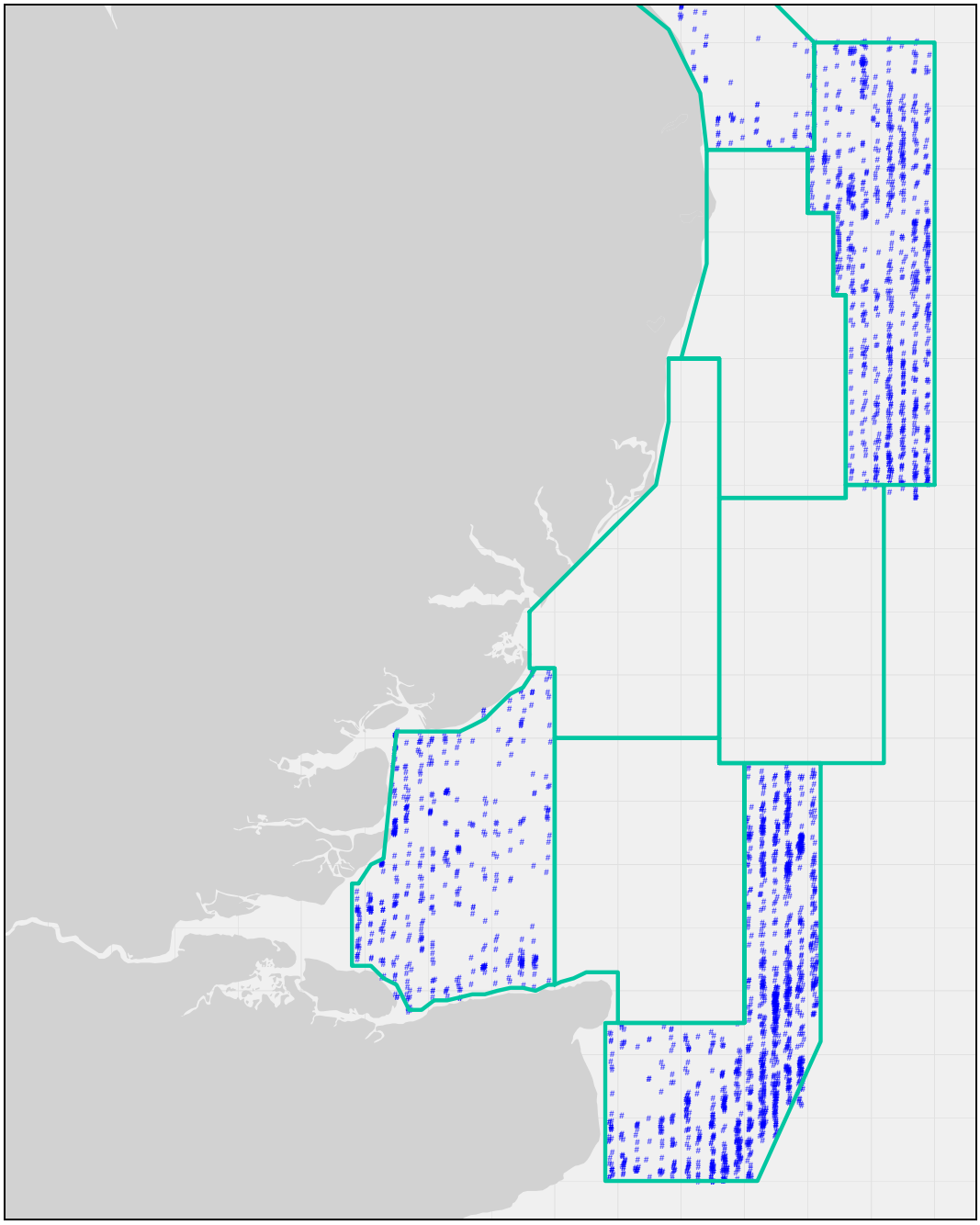


Figure 7 - Relative density of birds recorded in North West OWF Strategic Area during aerial surveys, Period 3.

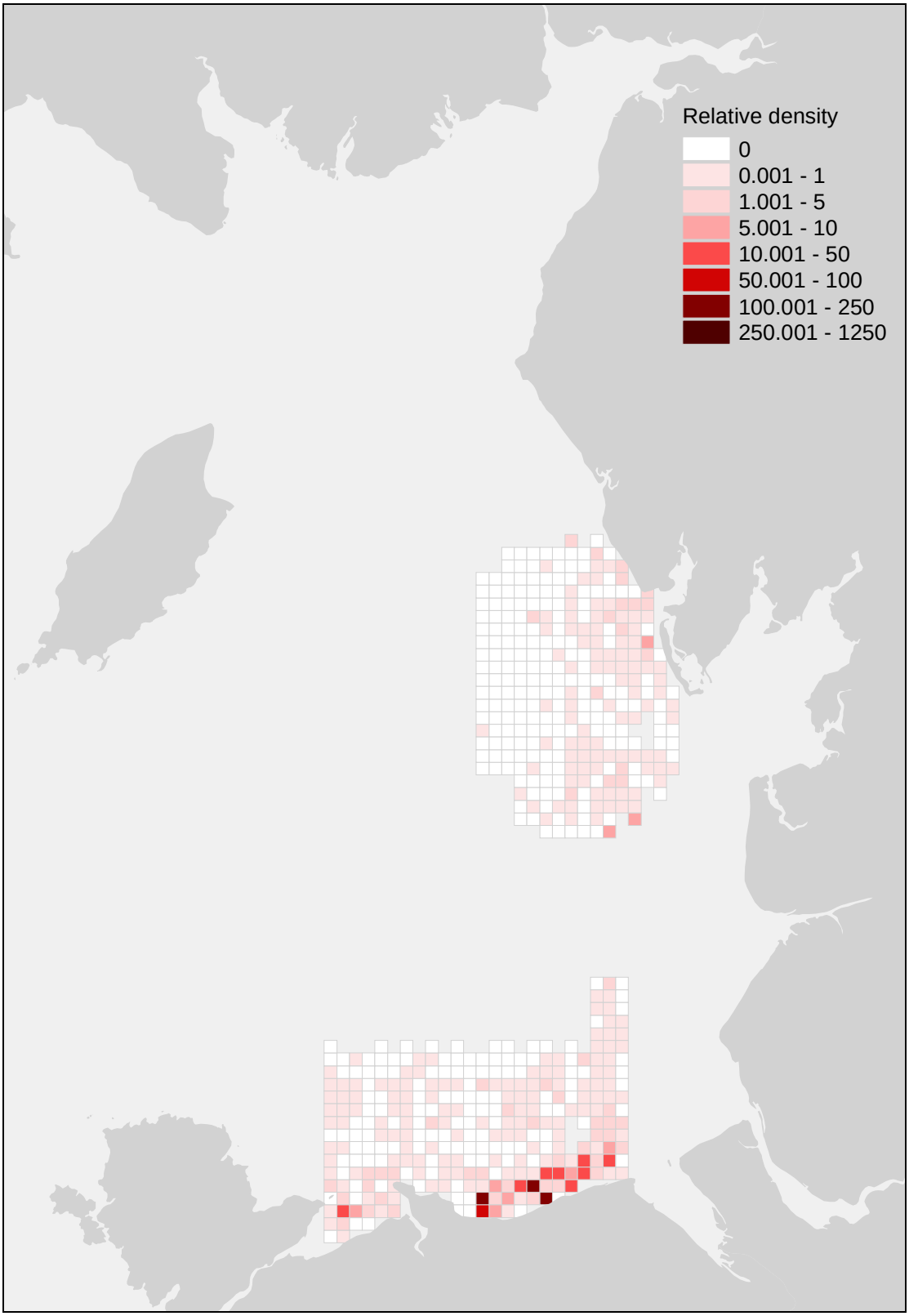


Figure 8 - Relative density of birds recorded in North West OWF Strategic Area during aerial surveys, Period 4.

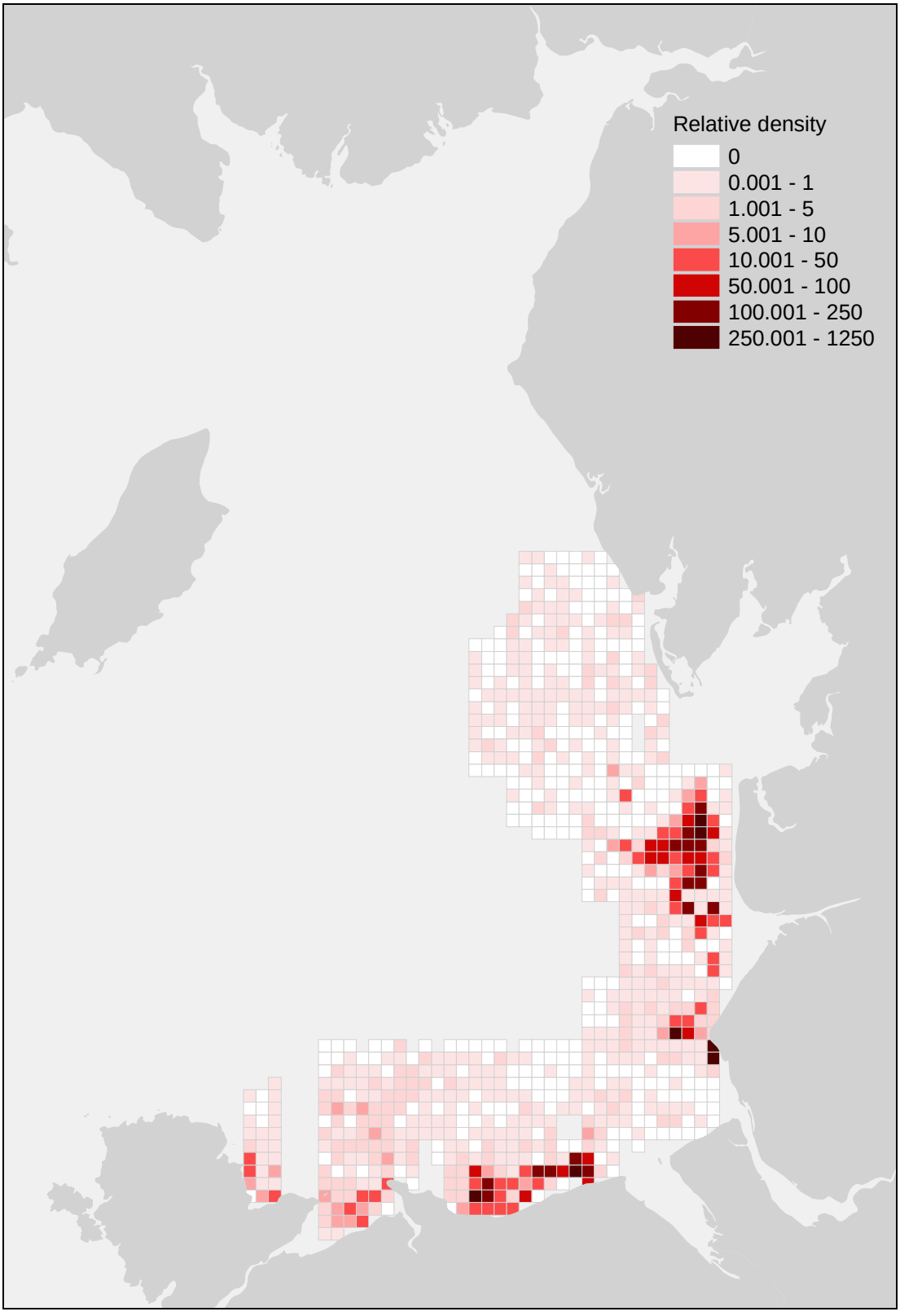


Figure 9 - Relative density of birds recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 3.

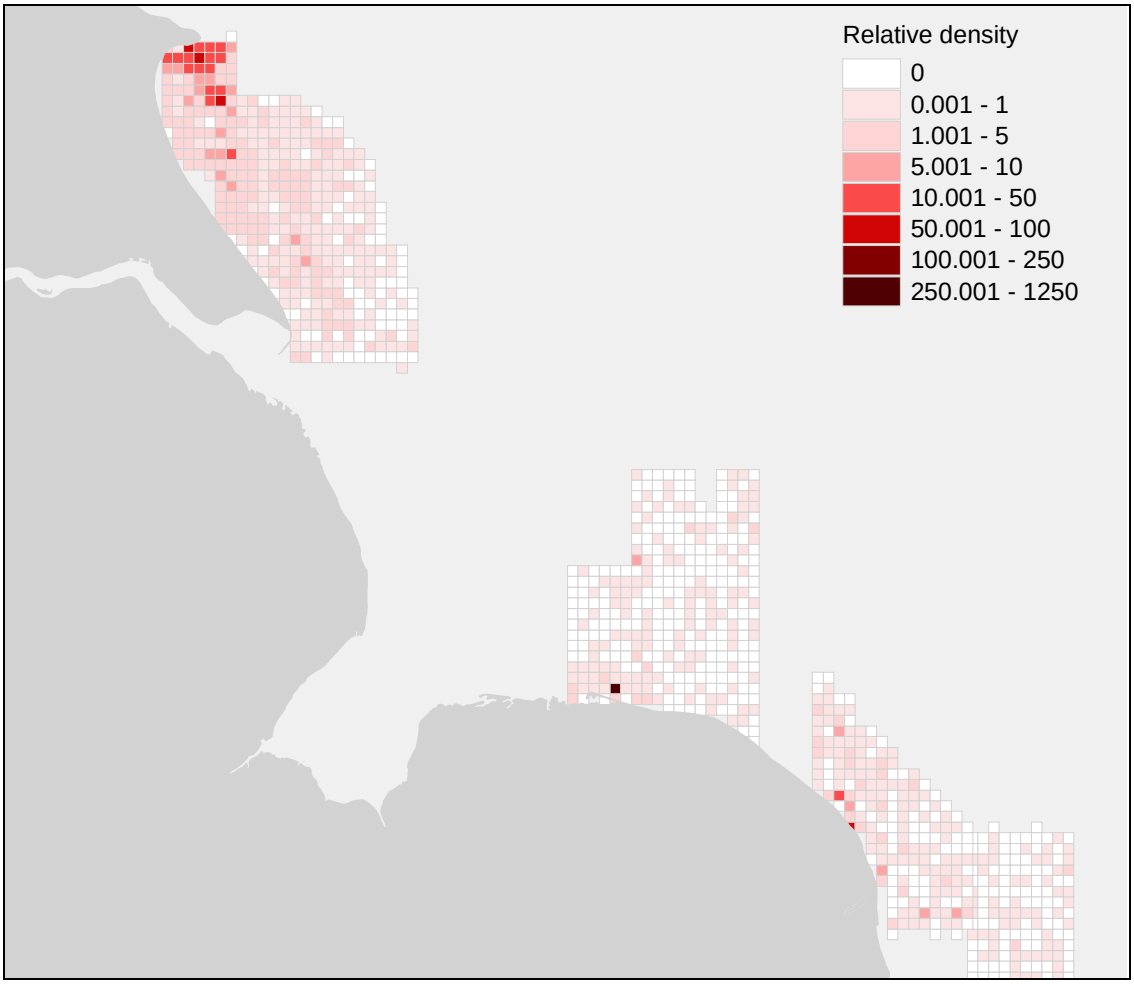


Figure 10 - Relative density of birds recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 4.

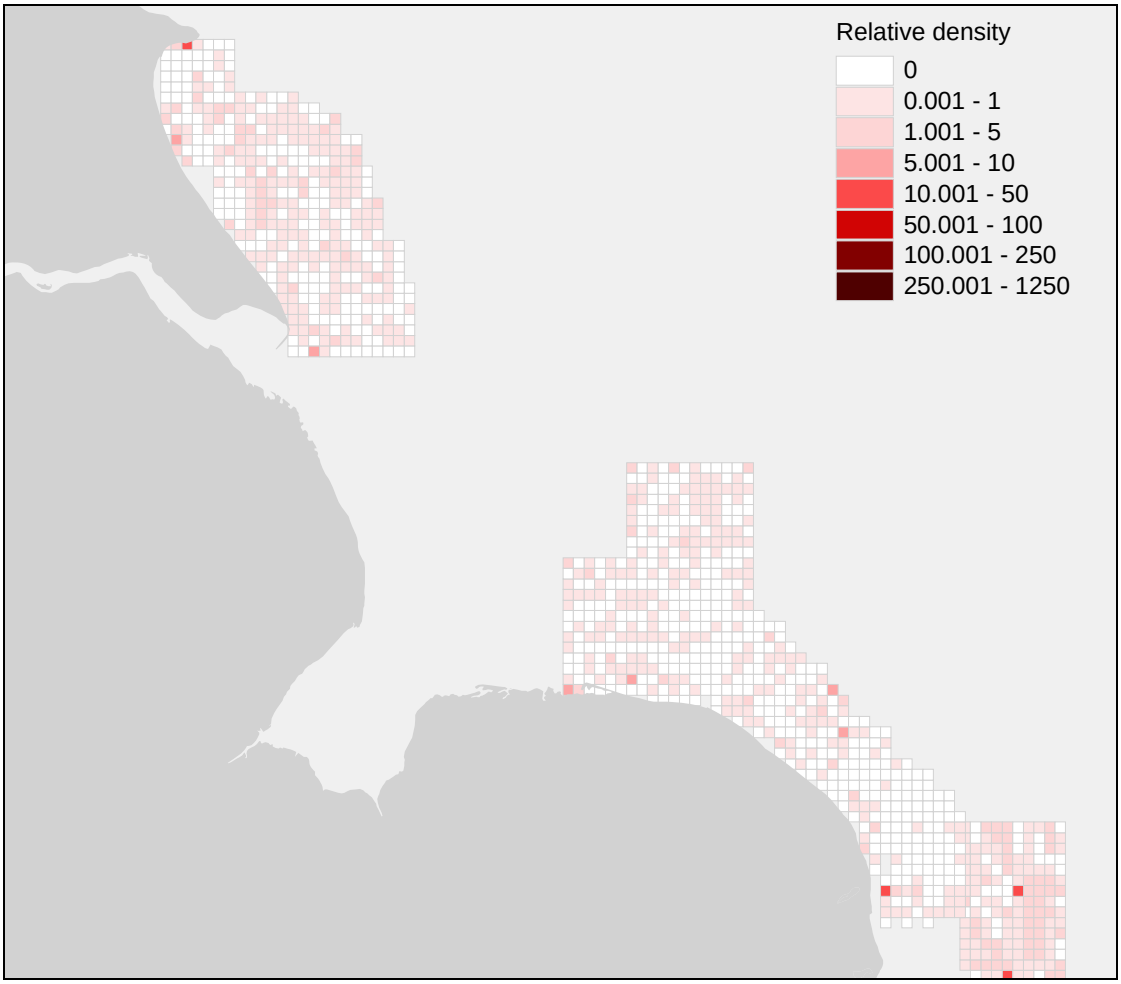


Figure 11 - Relative density of birds recorded in Thames OWF Strategic Area during aerial surveys, Period 3.

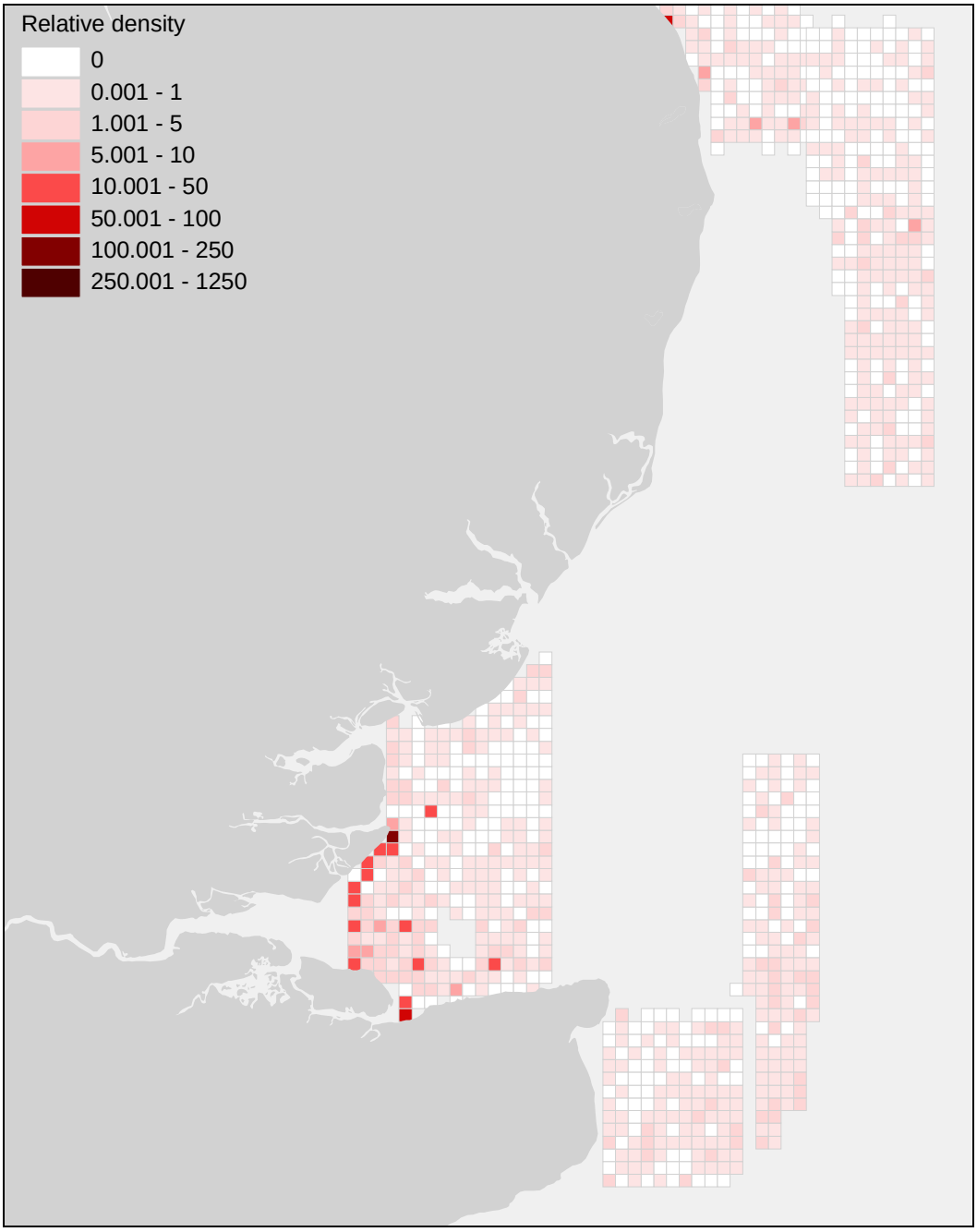


Figure 12 - Relative density of birds recorded in Thames OWF Strategic Area during aerial surveys, Period 4.

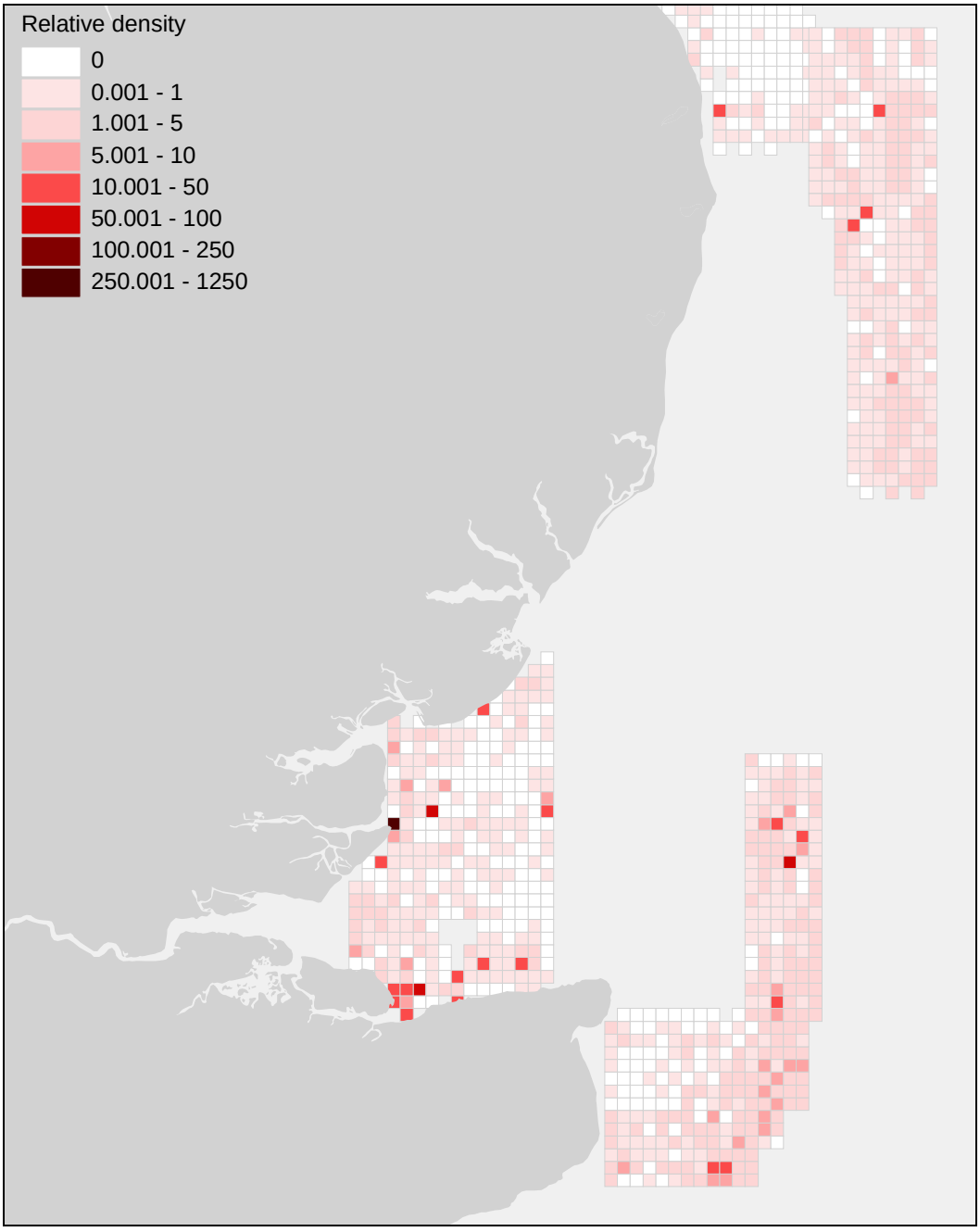


Figure 13 - Relative density of Common Scoters *Melanitta nigra* recorded in North West OWF Strategic Area during aerial surveys, Period 3.

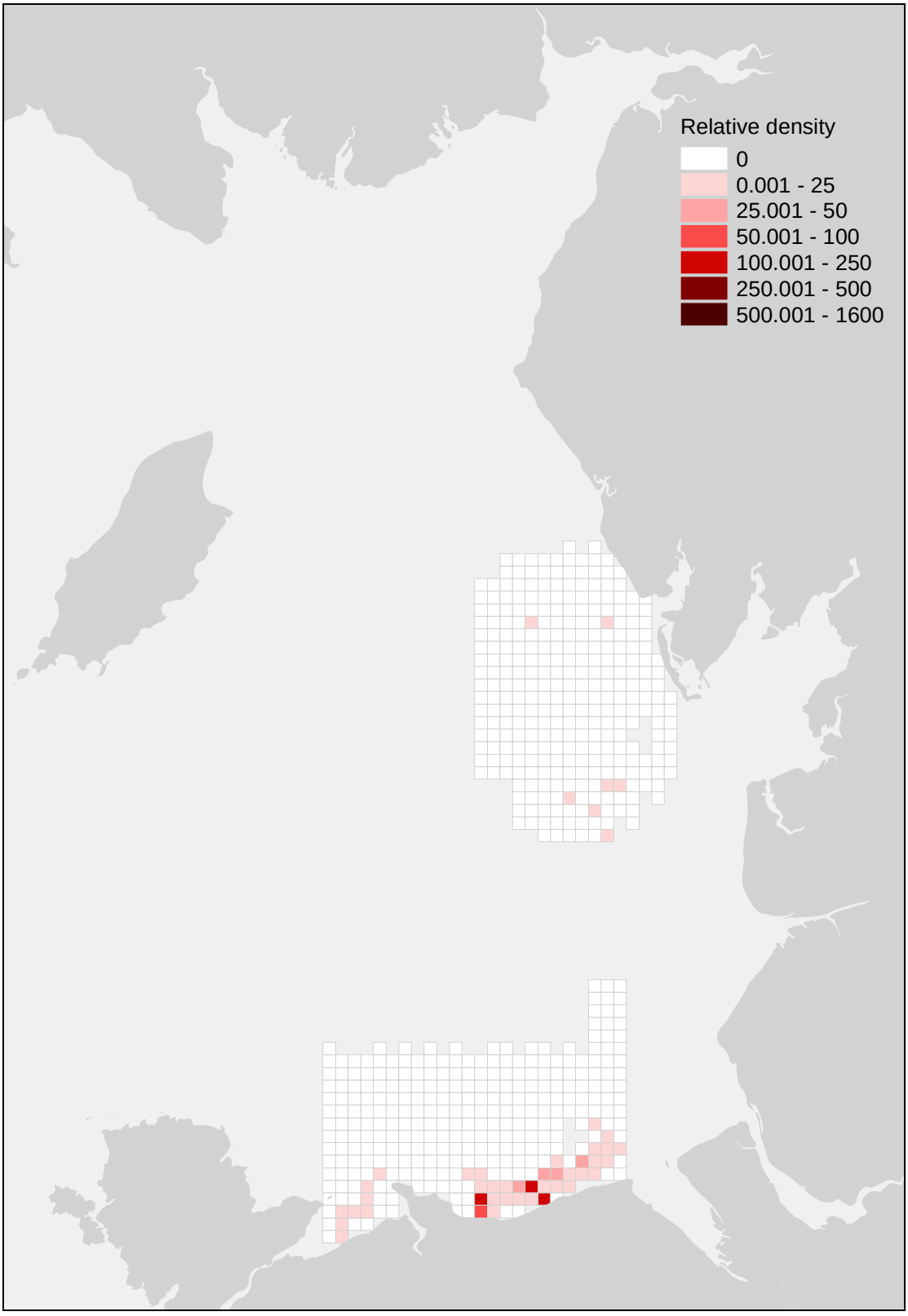


Figure 14 - Relative density of Common Scoters *Melanitta nigra* recorded in North West OWF Strategic Area during aerial surveys, Period 4.

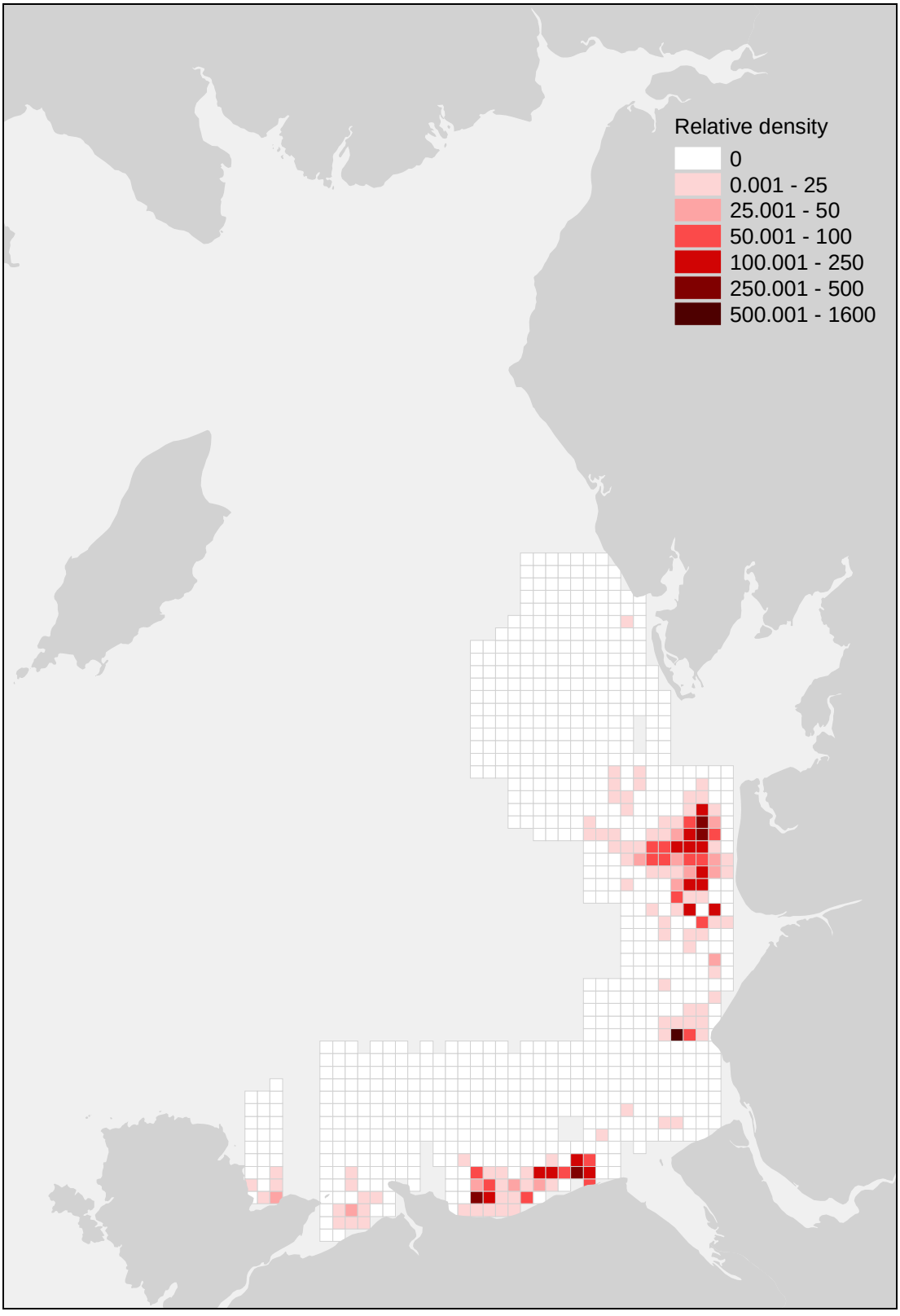


Figure 15 - Relative density of Common Scoters *Melanitta nigra* recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 3.

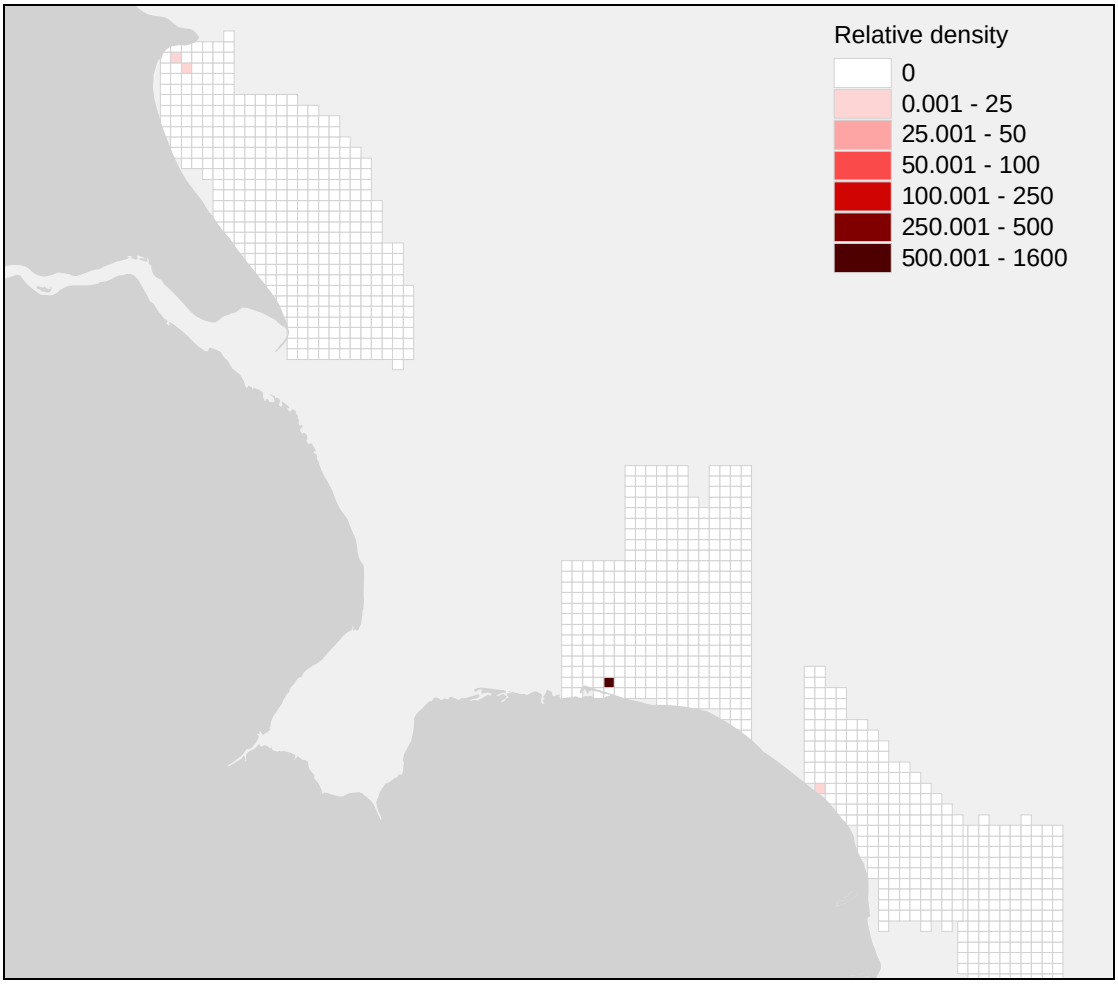


Figure 16 - Relative density of Common Scoters *Melanitta nigra* recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 4.

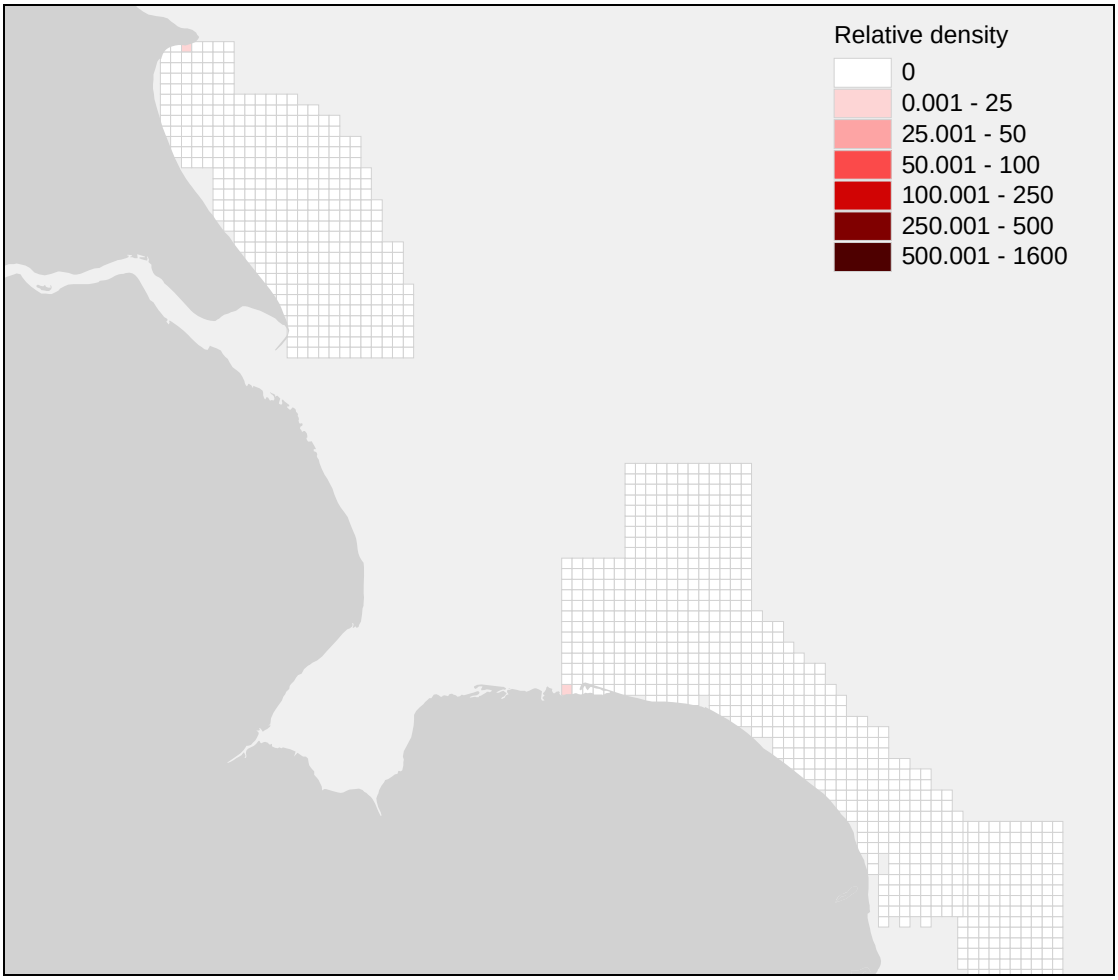


Figure 17 - Relative density of Common Scoters *Melanitta nigra* recorded in Thames OWF Strategic Area during aerial surveys, Period 3.

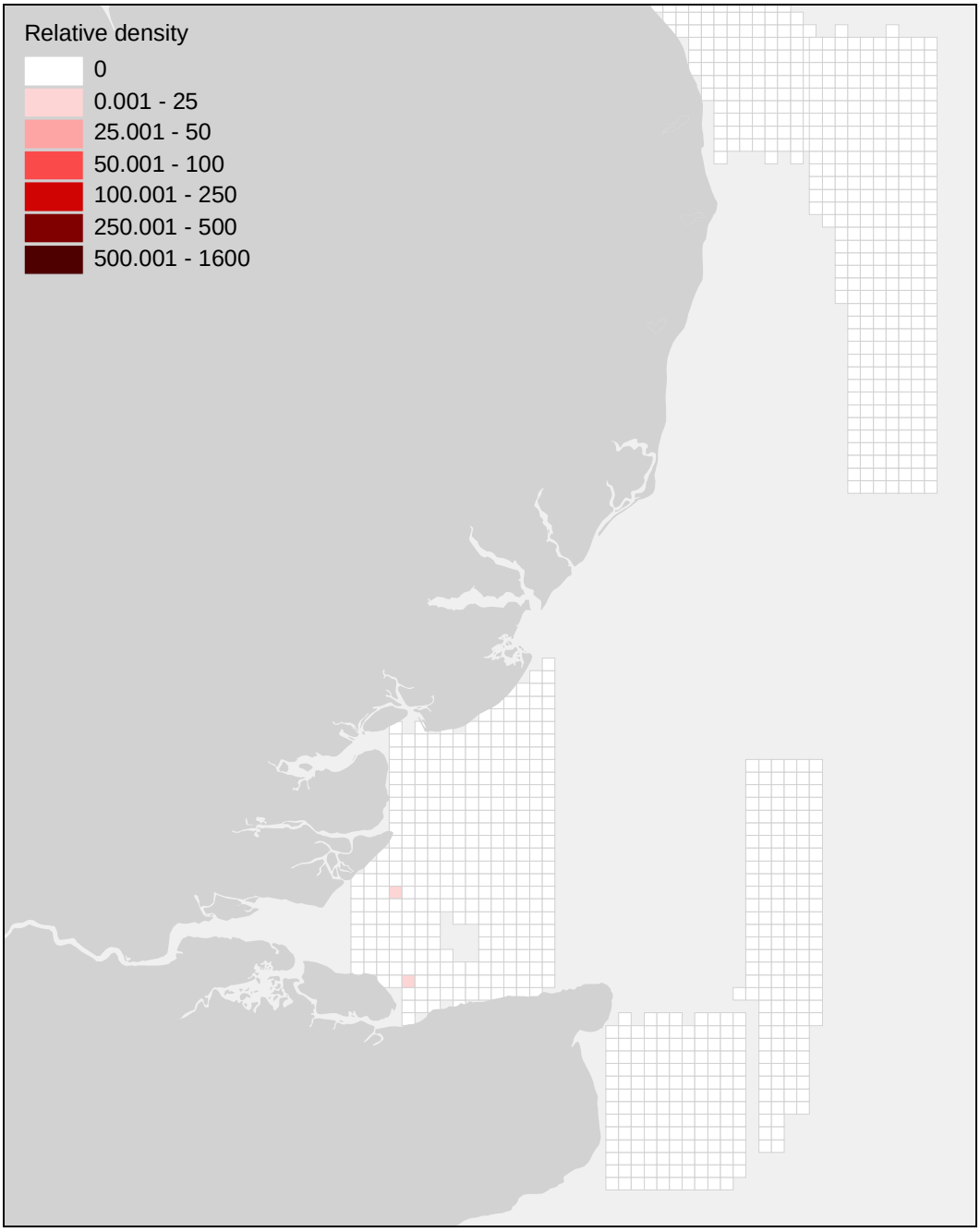


Figure 18 - Relative density of Common Scoters *Melanitta nigra* recorded in Thames OWF Strategic Area during aerial surveys, Period 4.

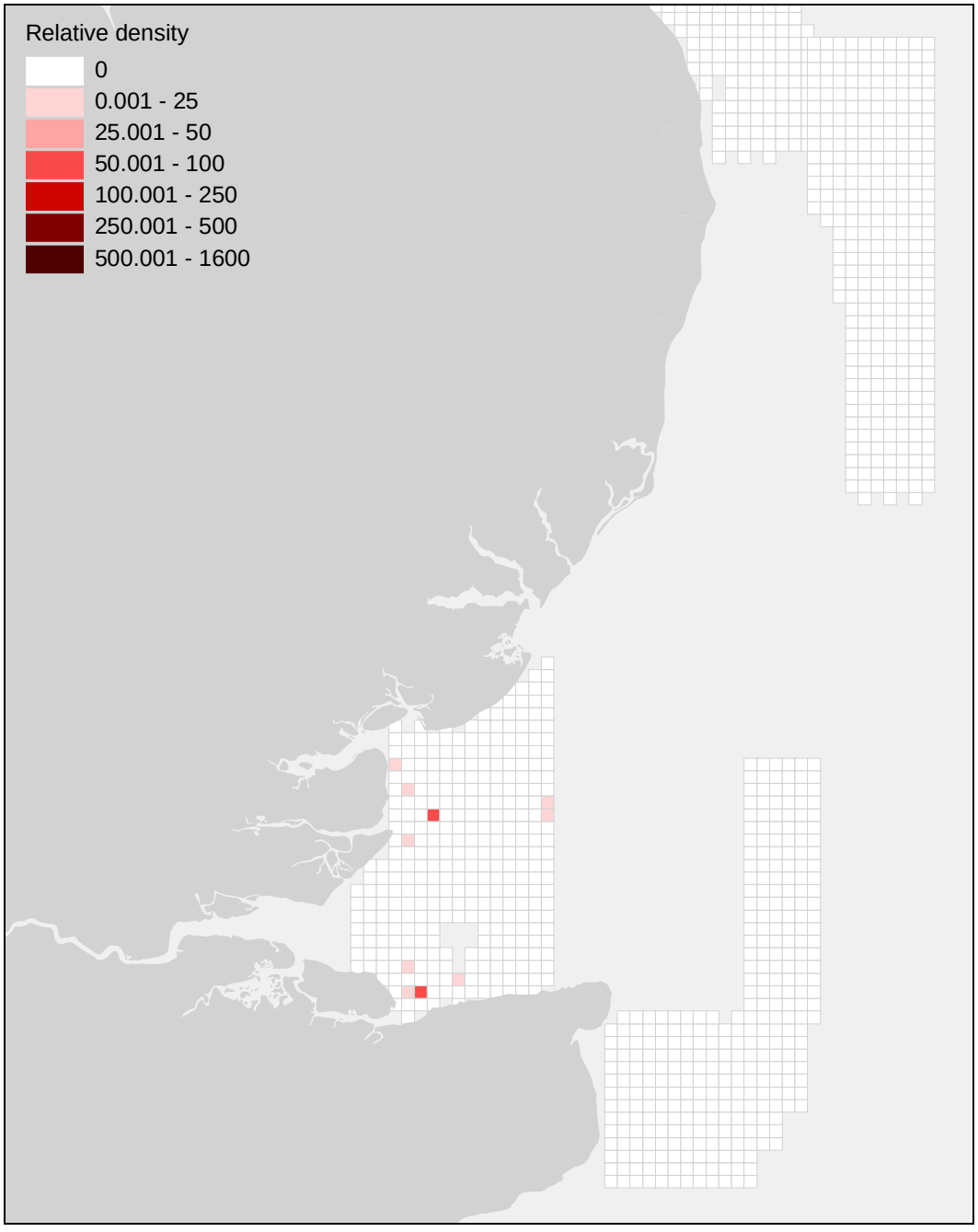


Figure 19 - Relative density of divers *Gavia* spp. recorded in North West OWF Strategic Area during aerial surveys, Period 3.

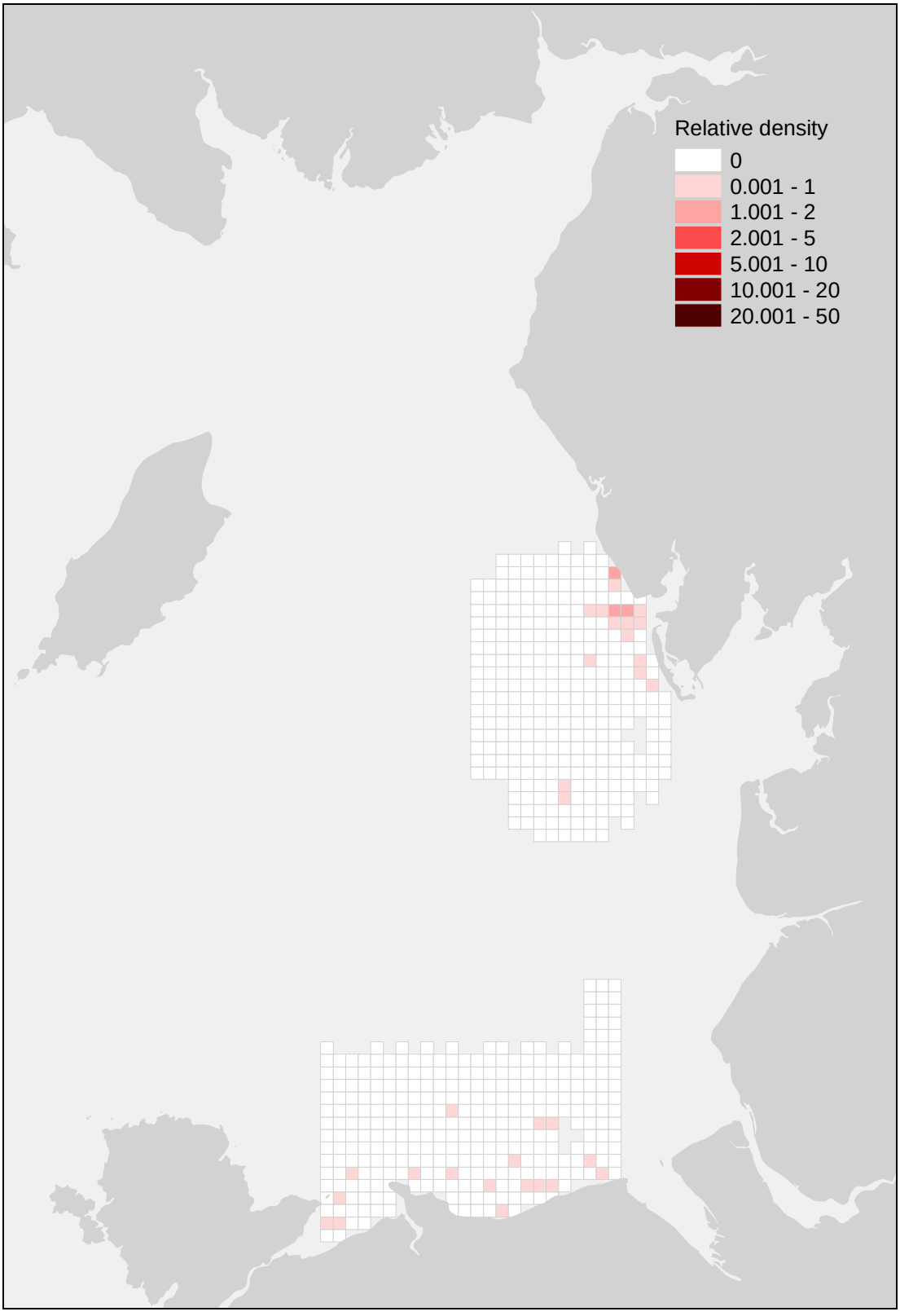


Figure 20 - Relative density of divers *Gavia* spp. recorded in North West OWF Strategic Area during aerial surveys, Period 4.

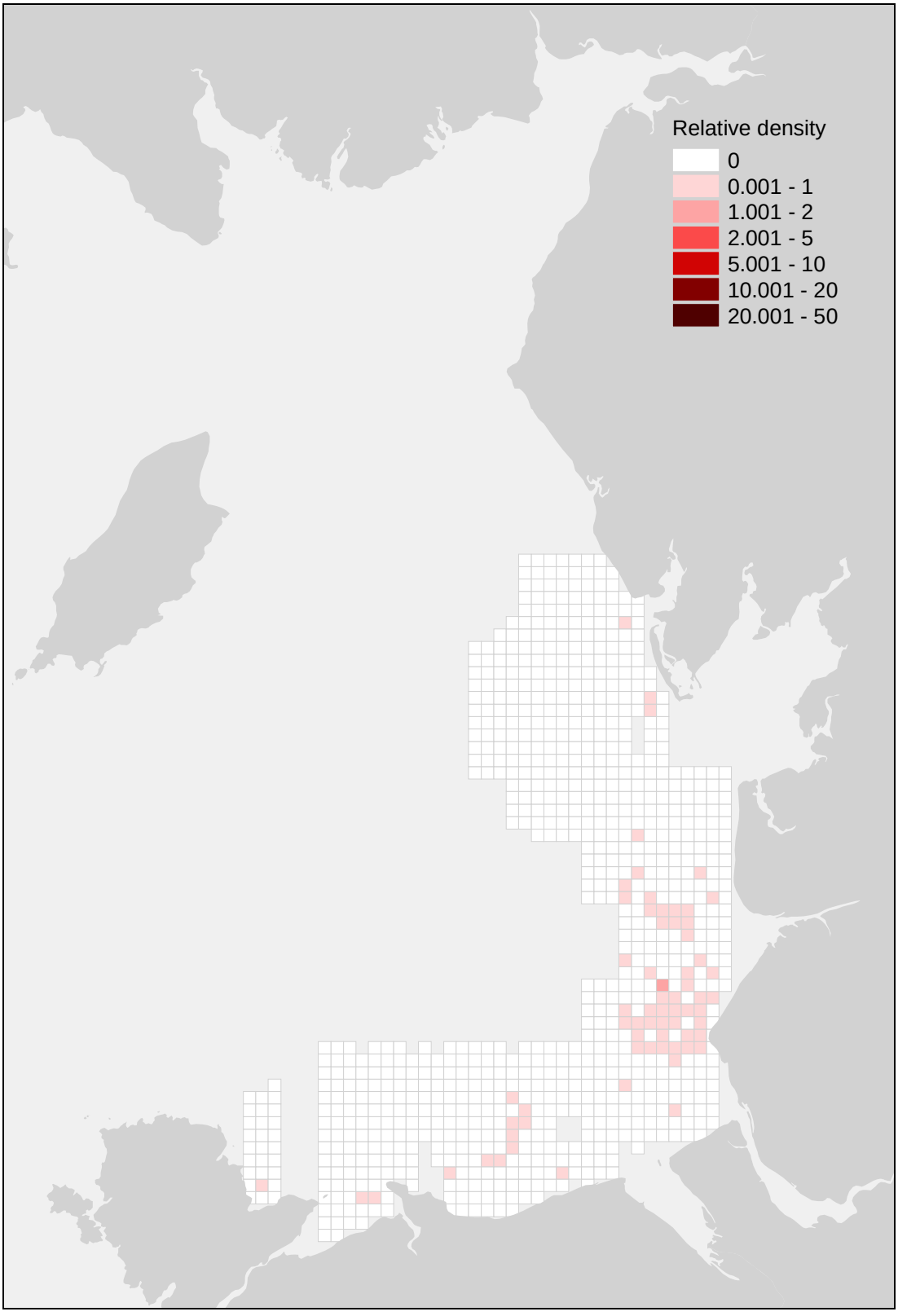


Figure 21 - Relative density of divers *Gavia* spp. recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 3.

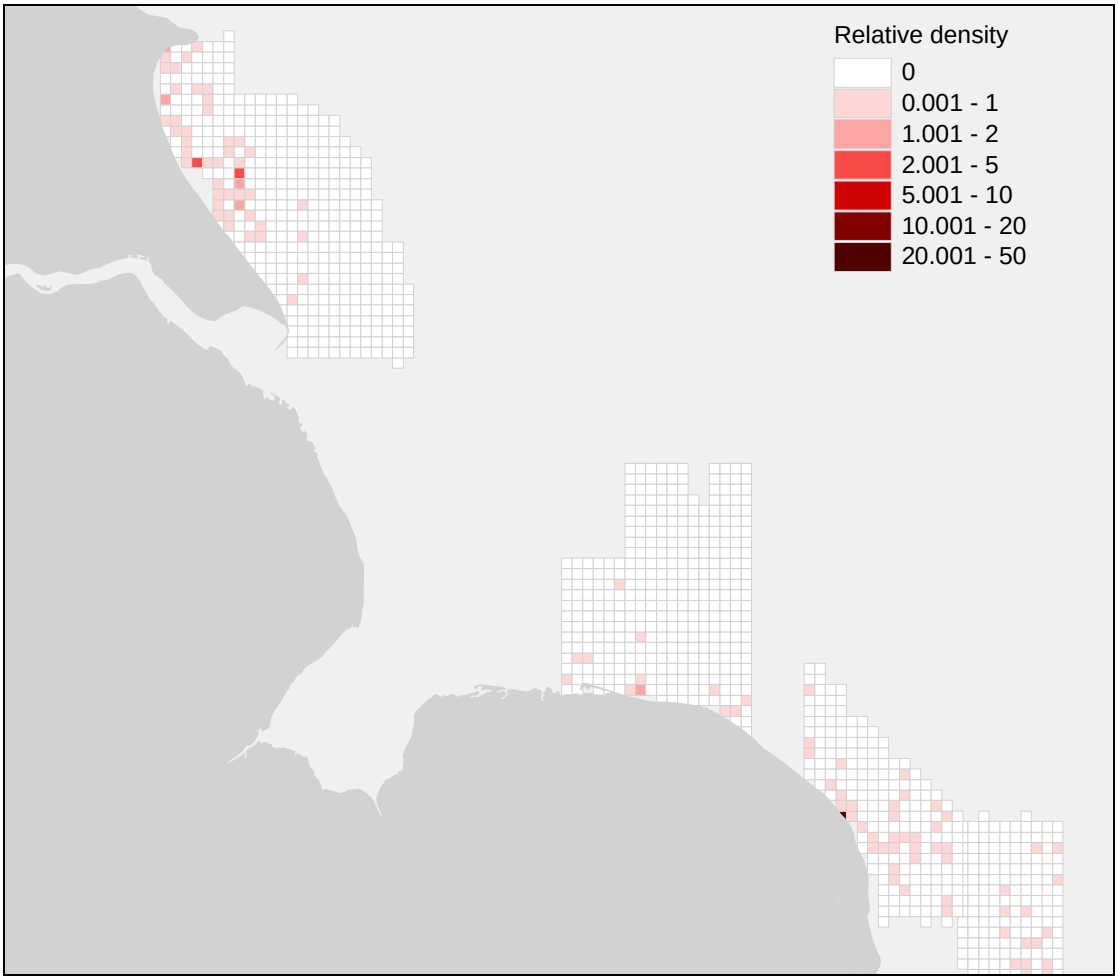


Figure 22 - Relative density of divers *Gavia* spp. recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 4.

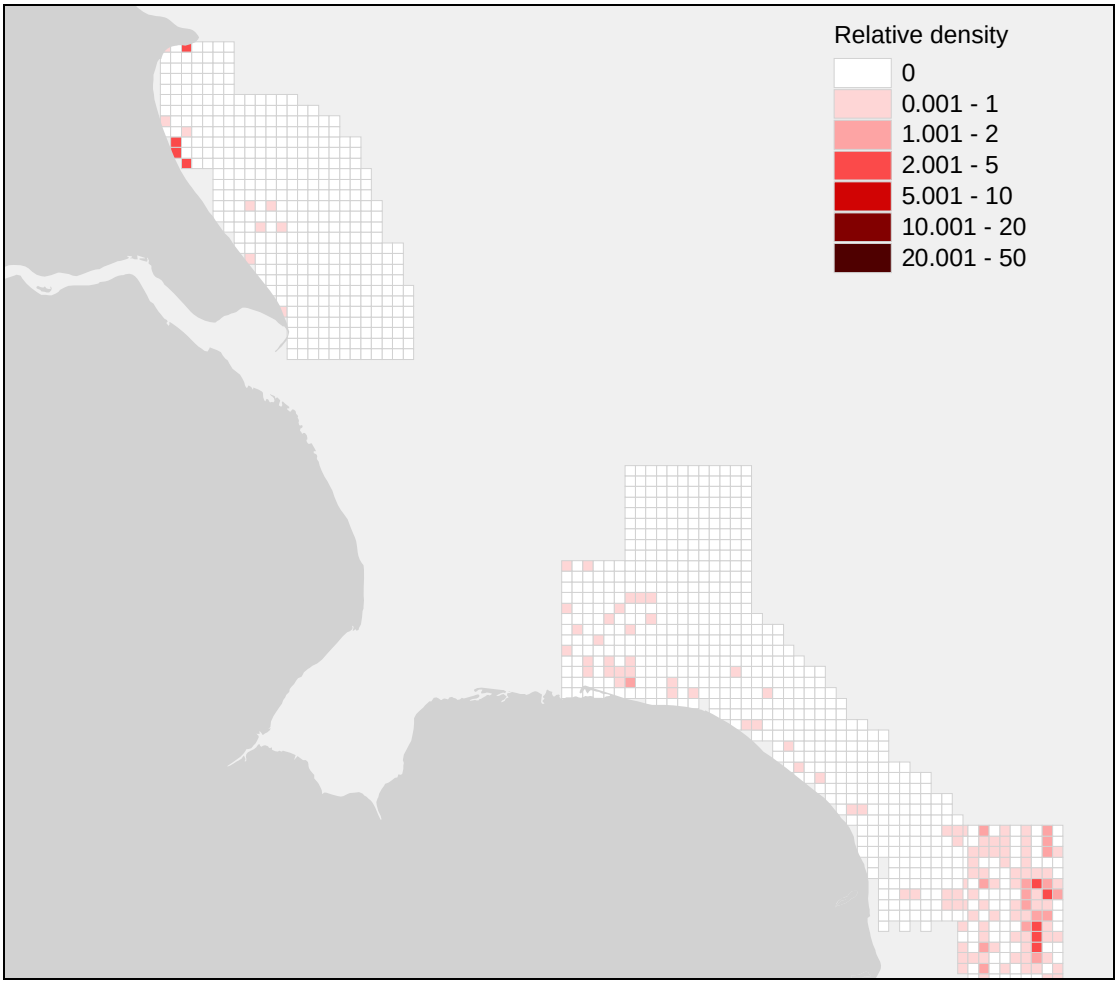


Figure 23 - Relative density of divers *Gavia* spp. recorded in Thames OWF Strategic Area during aerial surveys, Period 3.

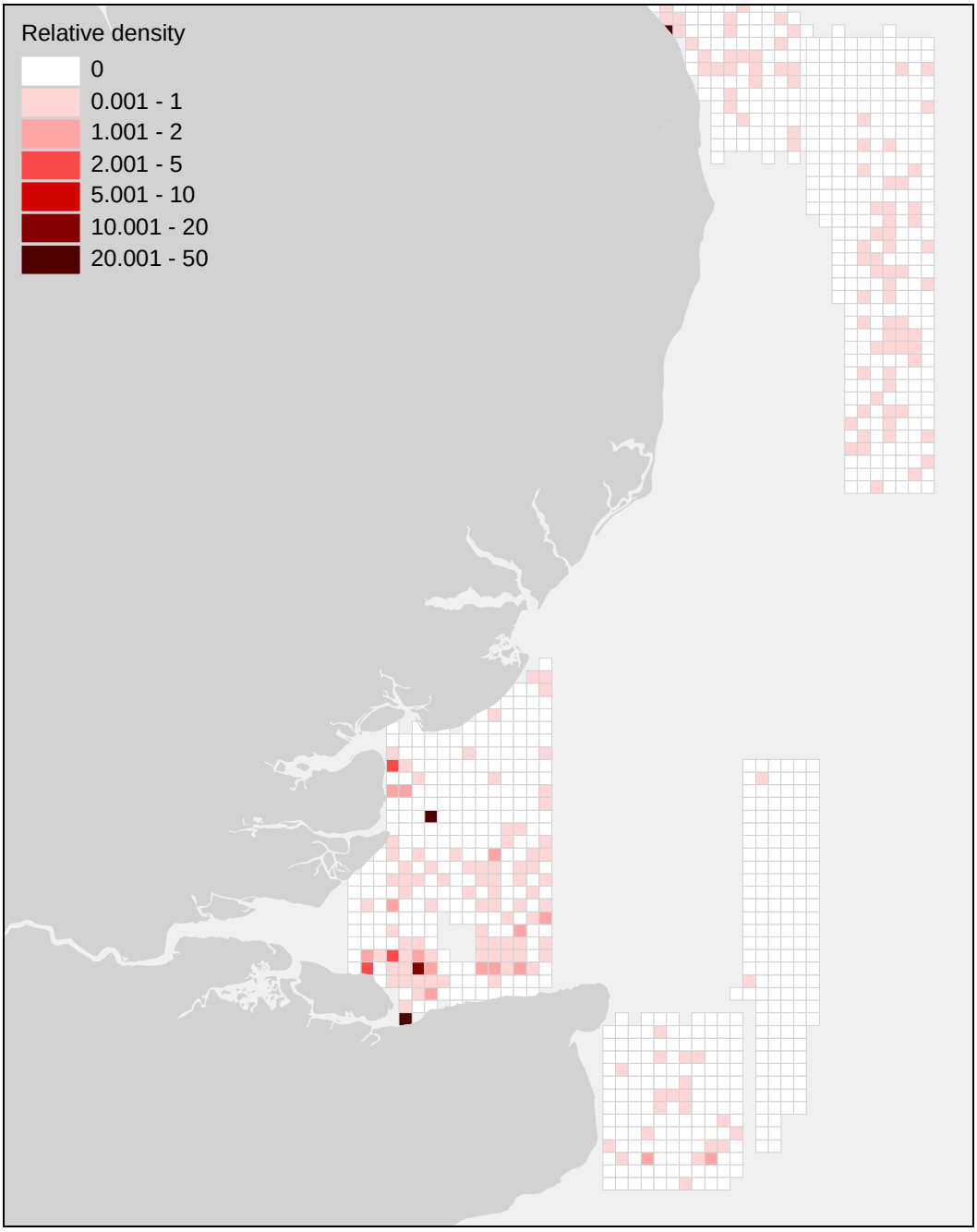


Figure 24 - Relative density of divers *Gavia* spp. recorded in Thames OWF Strategic Area during aerial surveys, Period 4.

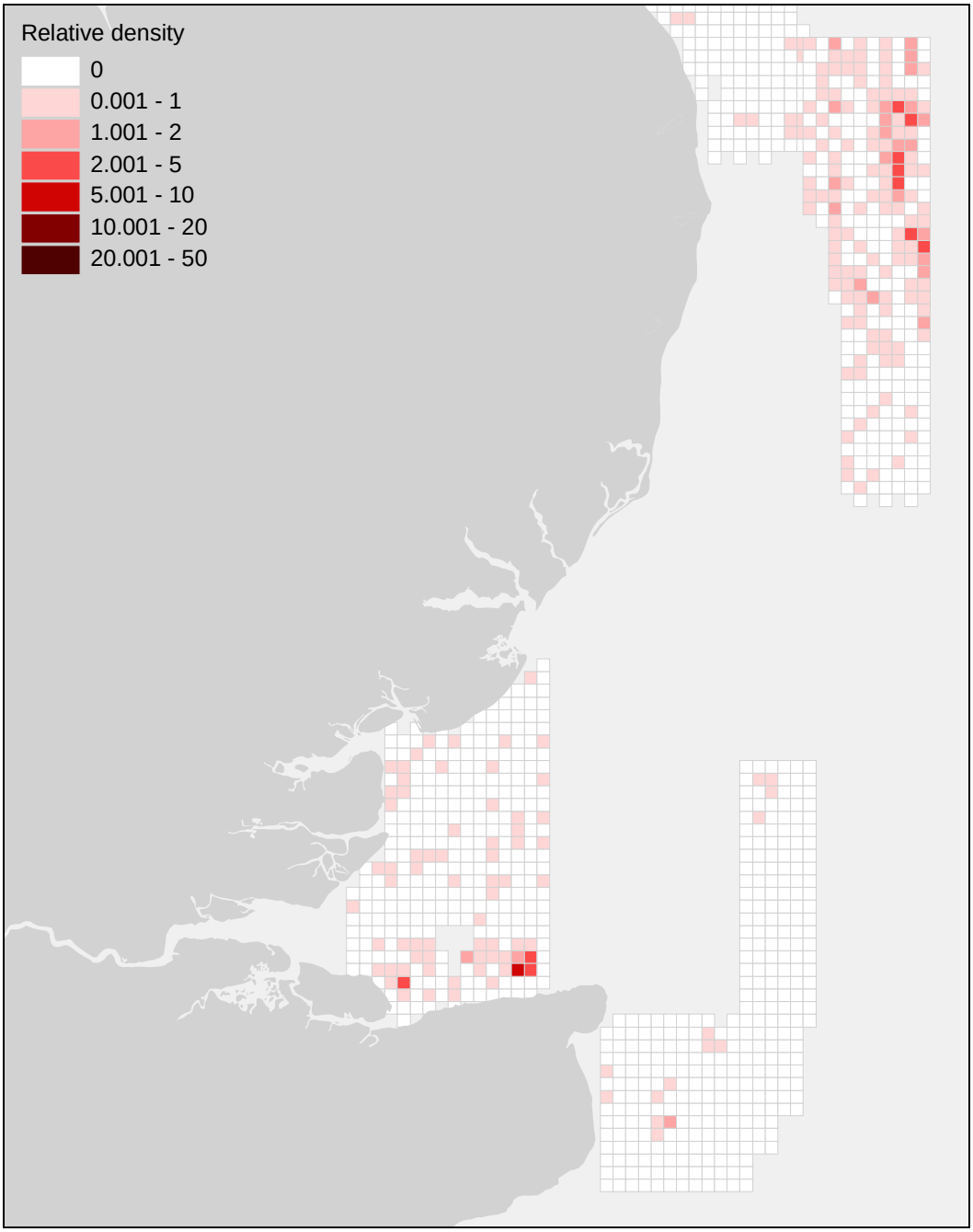


Figure 25 - Relative density of Eiders *Somateria mollissima* recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 3.

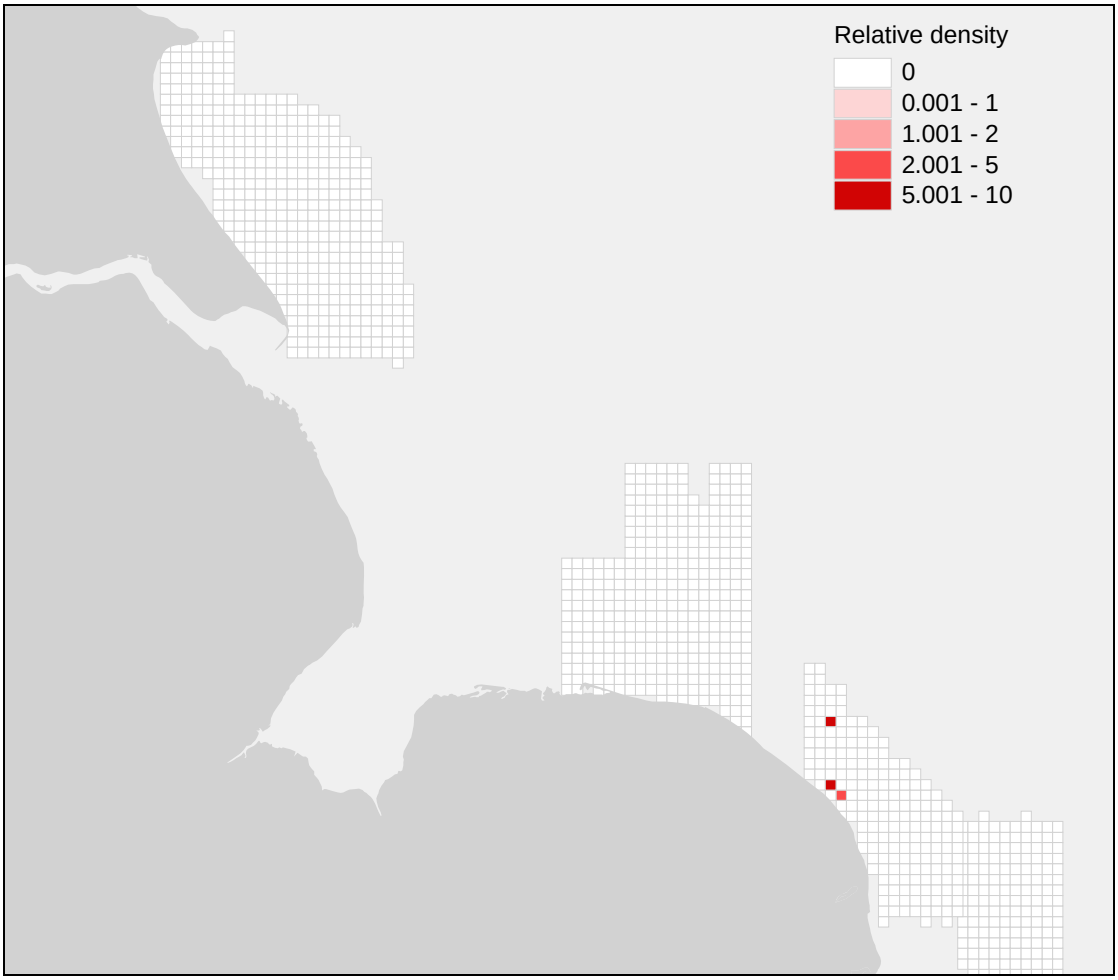


Figure 26 - Relative density of Eiders *Somateria mollissima* recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 4.

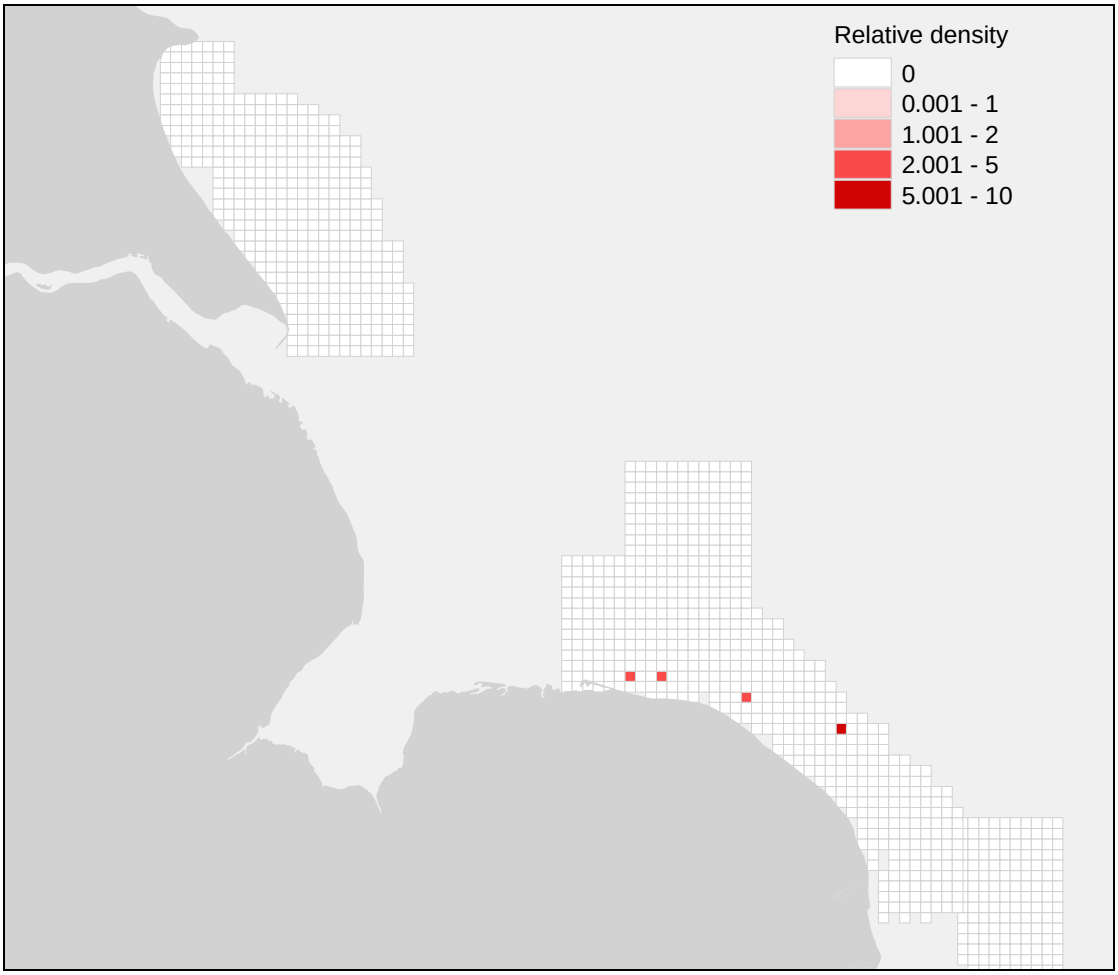


Figure 27 - Relative density of Eiders *Somateria mollissima* recorded in North West OWF Strategic Area during aerial surveys, Period 3.

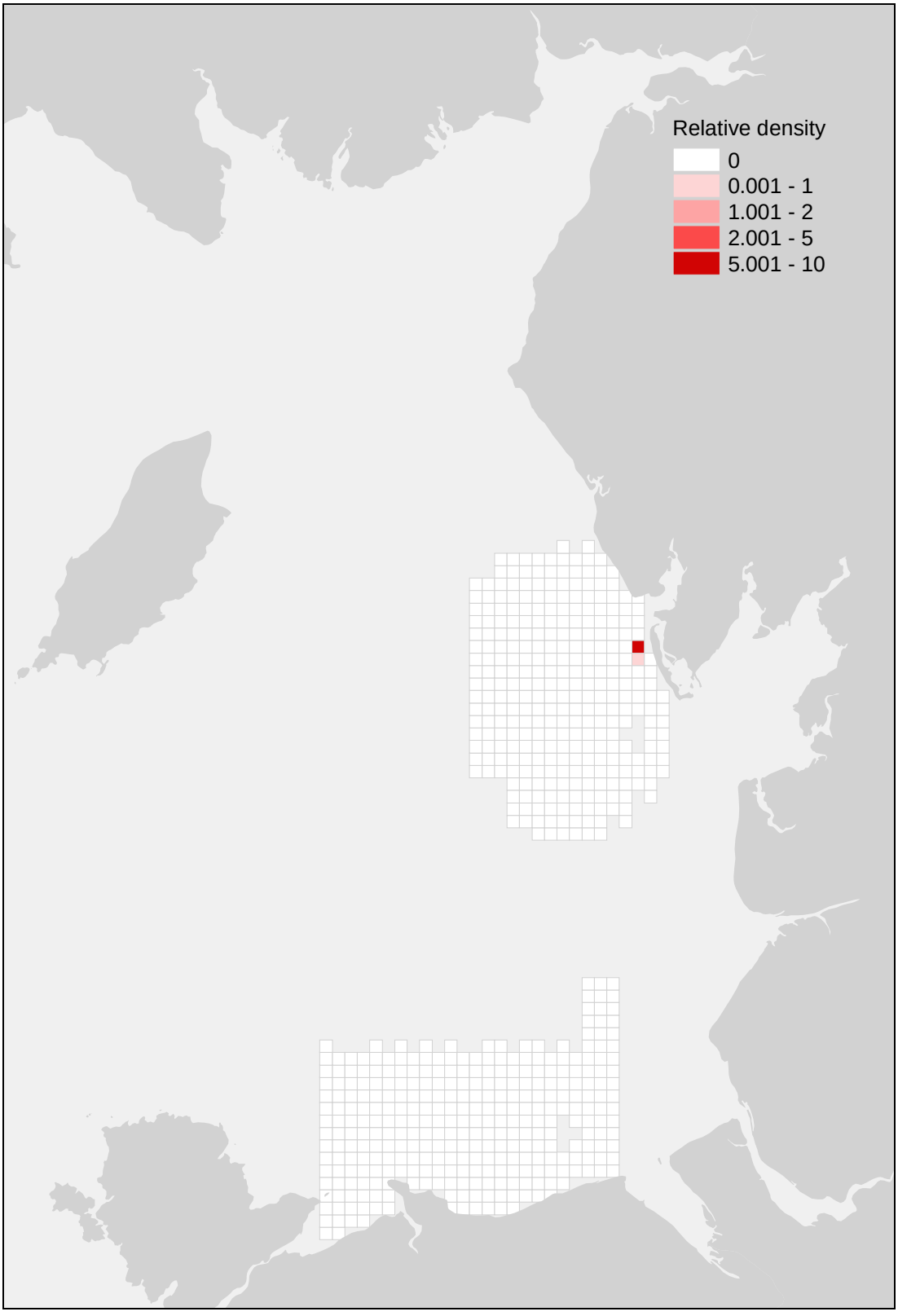


Figure 28 - Relative density of Eiders *Somateria mollissima* recorded in North West OWF Strategic Area during aerial surveys, Period 4.

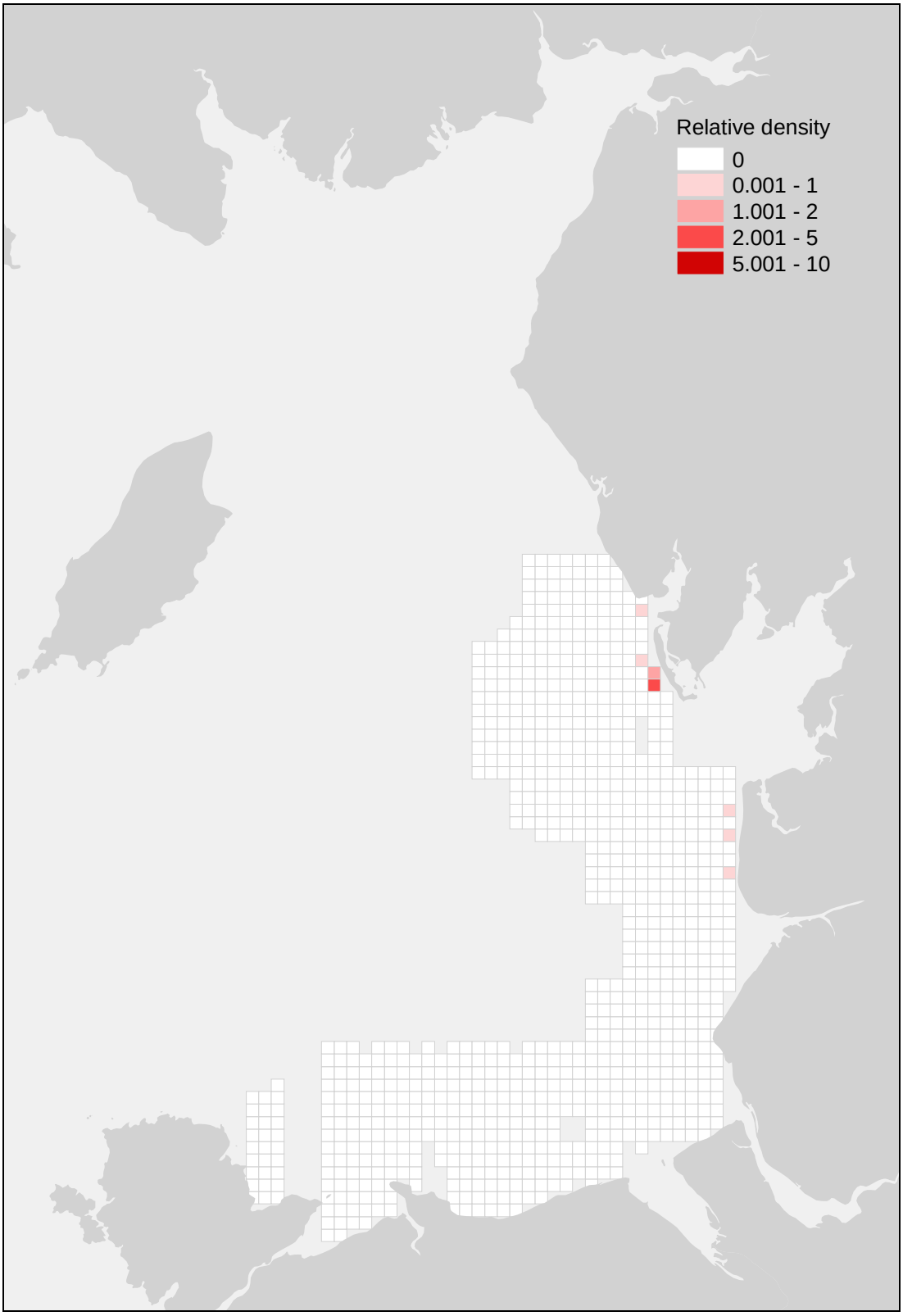


Figure 29 - Relative density of Gannets *Morus bassana* recorded in Thames OWF Strategic Area during aerial surveys, Period 3.

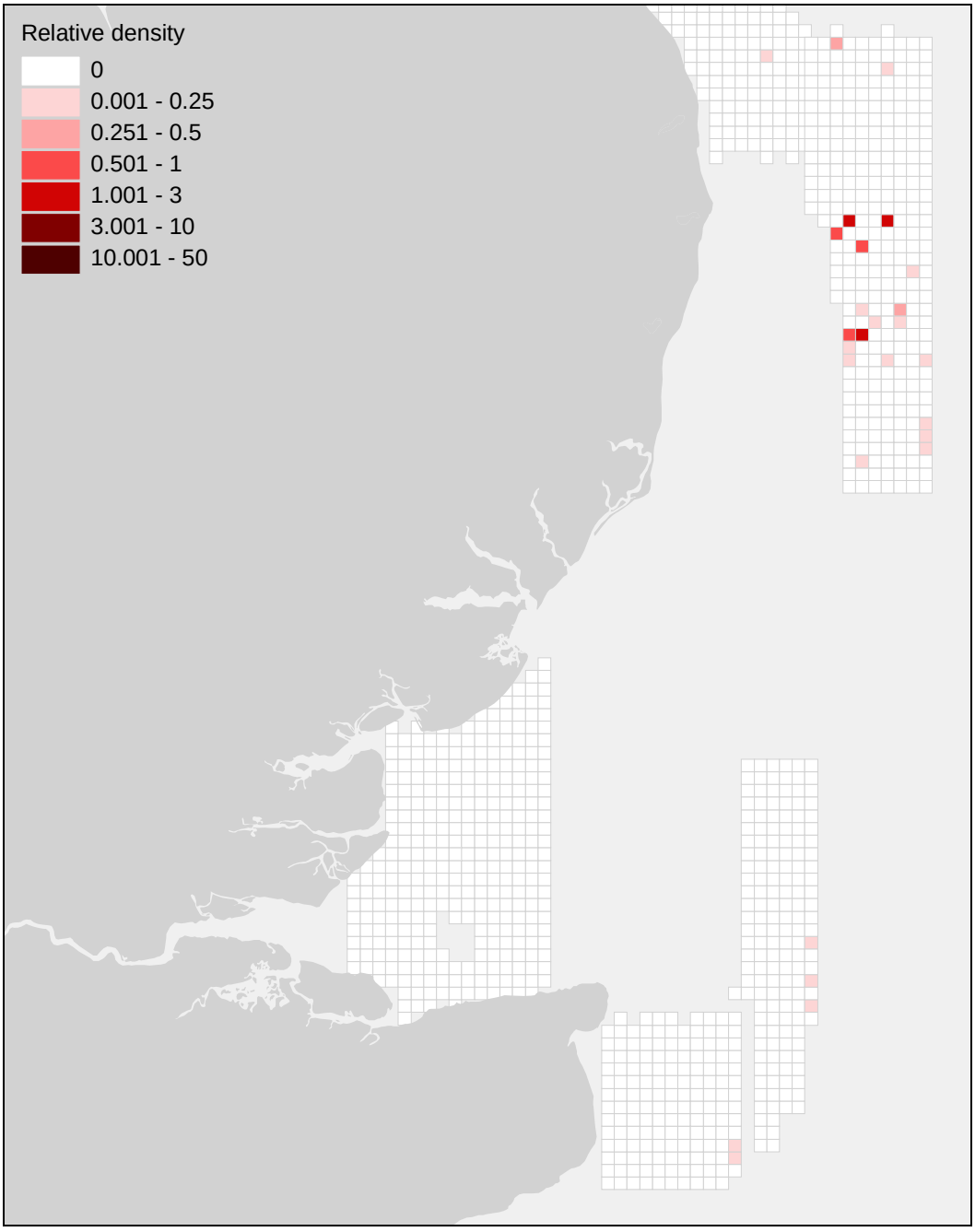


Figure 30 - Relative density of Gannets *Morus bassana* recorded in Thames OWF Strategic Area during aerial surveys, Period 4.

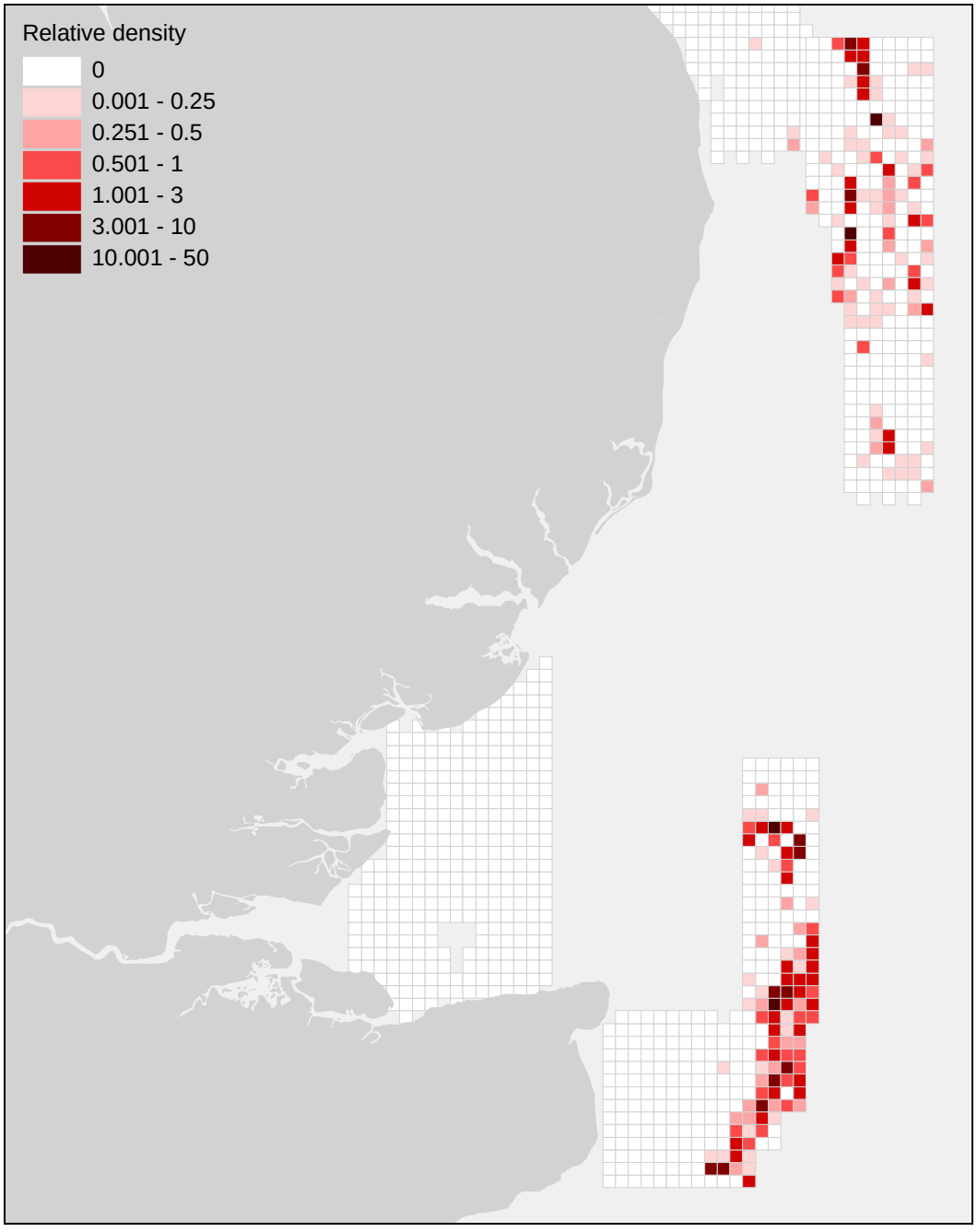


Figure 31 - Relative density of Gannets *Morus bassana* recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 3.

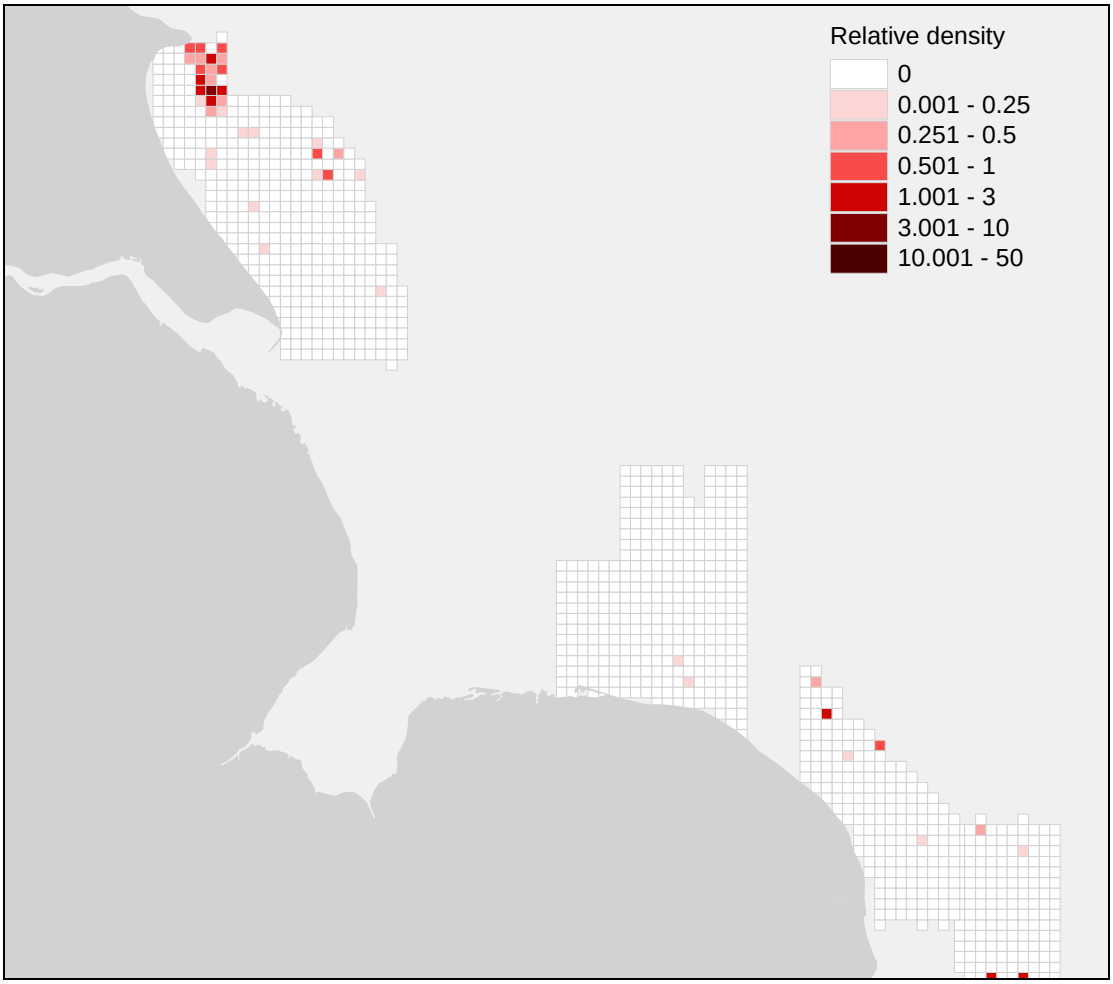


Figure 32 - Relative density of Gannets *Morus bassana* recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 4.

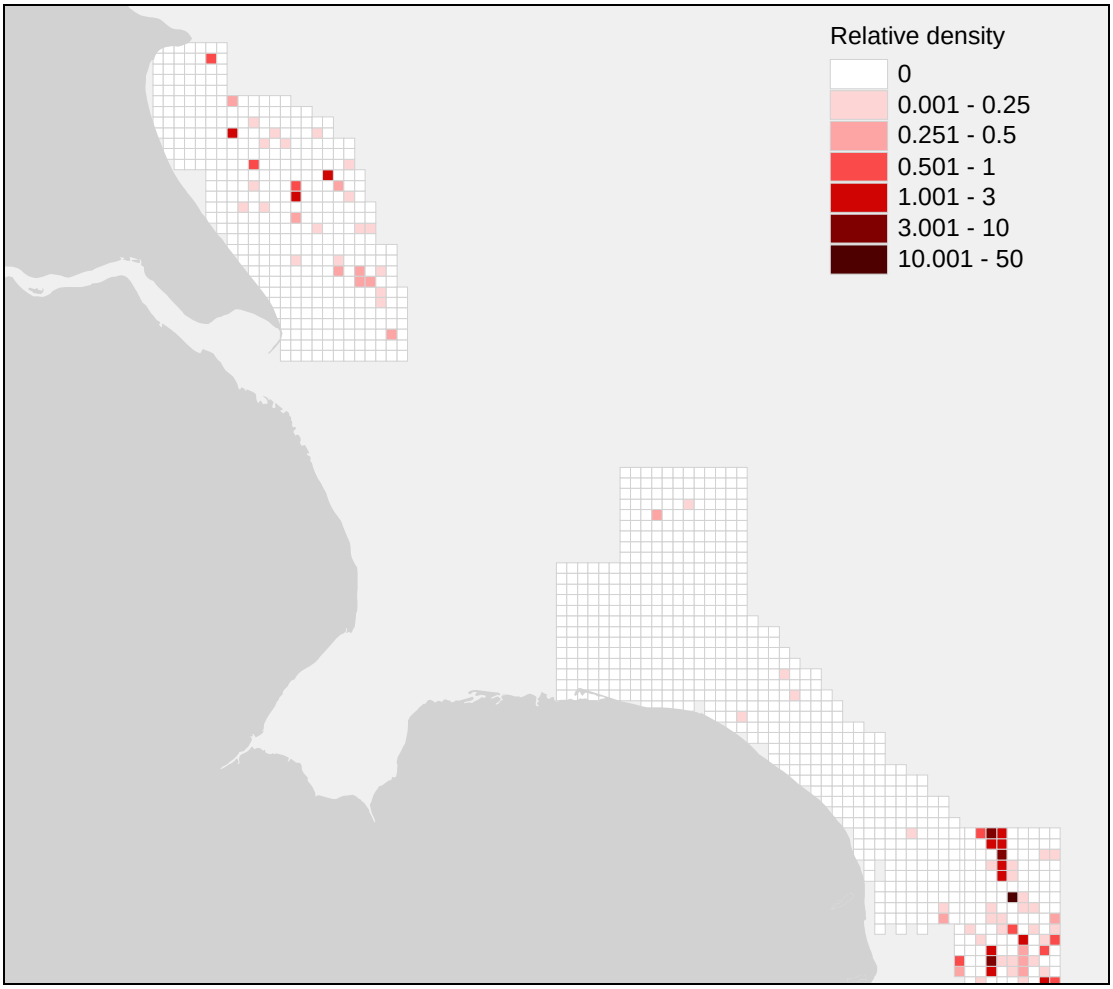


Figure 33 - Relative density of cormorants *Phalacrocorax* spp. recorded in Thames OWF Strategic Area during aerial surveys, Period 3.

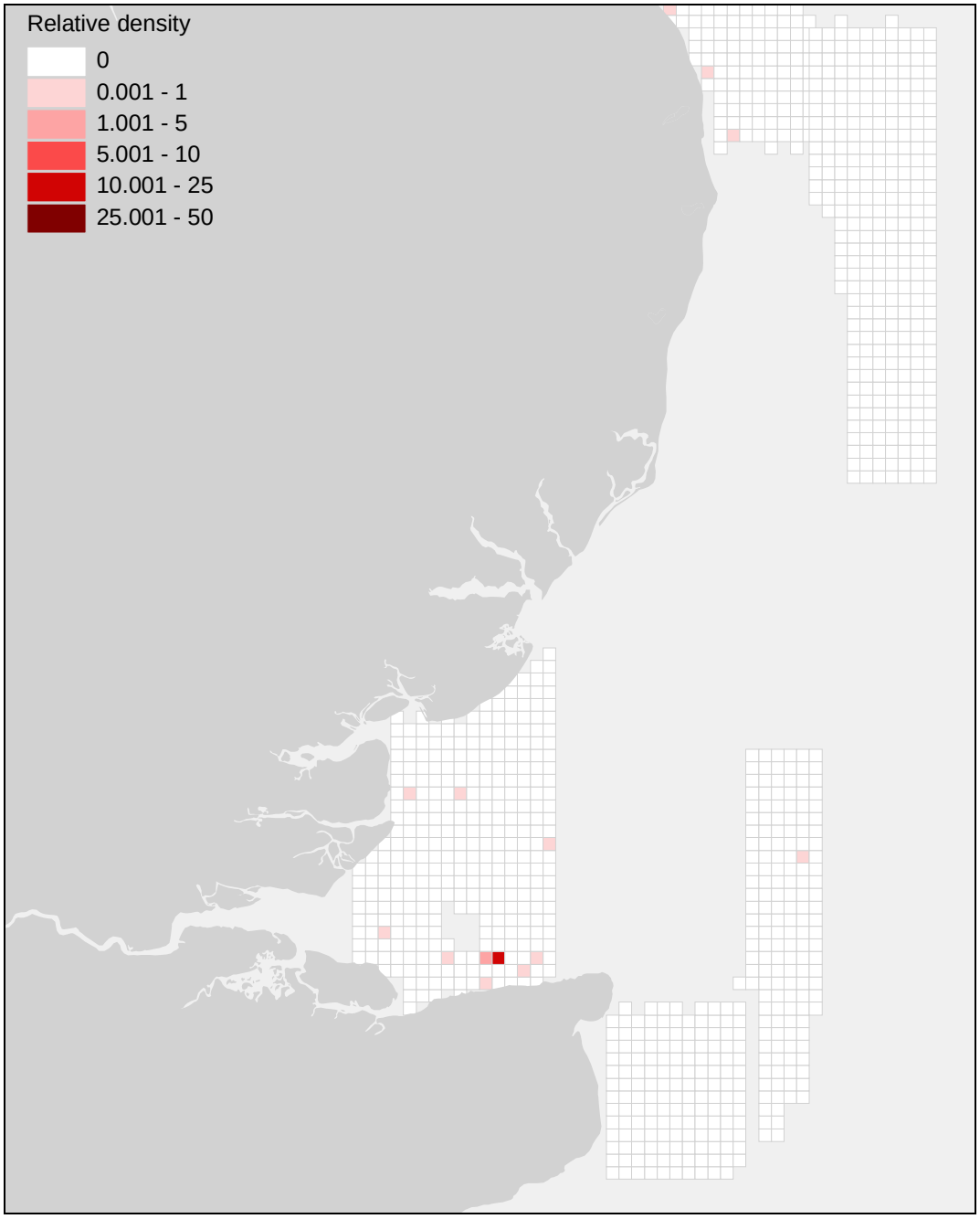


Figure 34 - Relative density of cormorants *Phalacrocorax* spp. recorded in Thames OWF Strategic Area during aerial surveys, Period 4.

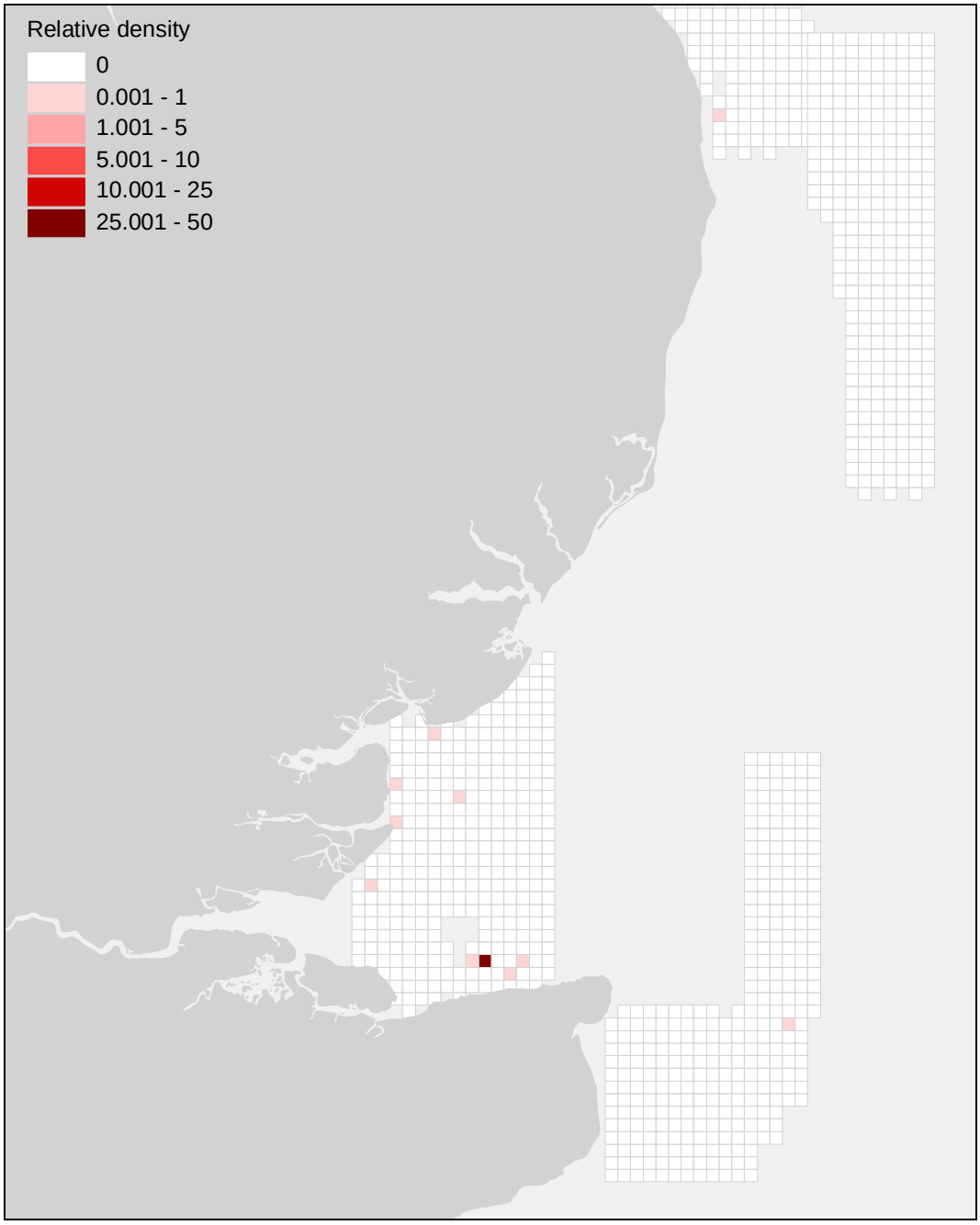


Figure 35 - Relative density of cormorants *Phalacrocorax* spp. recorded in North West OWF Strategic Area during aerial surveys, Period 3.

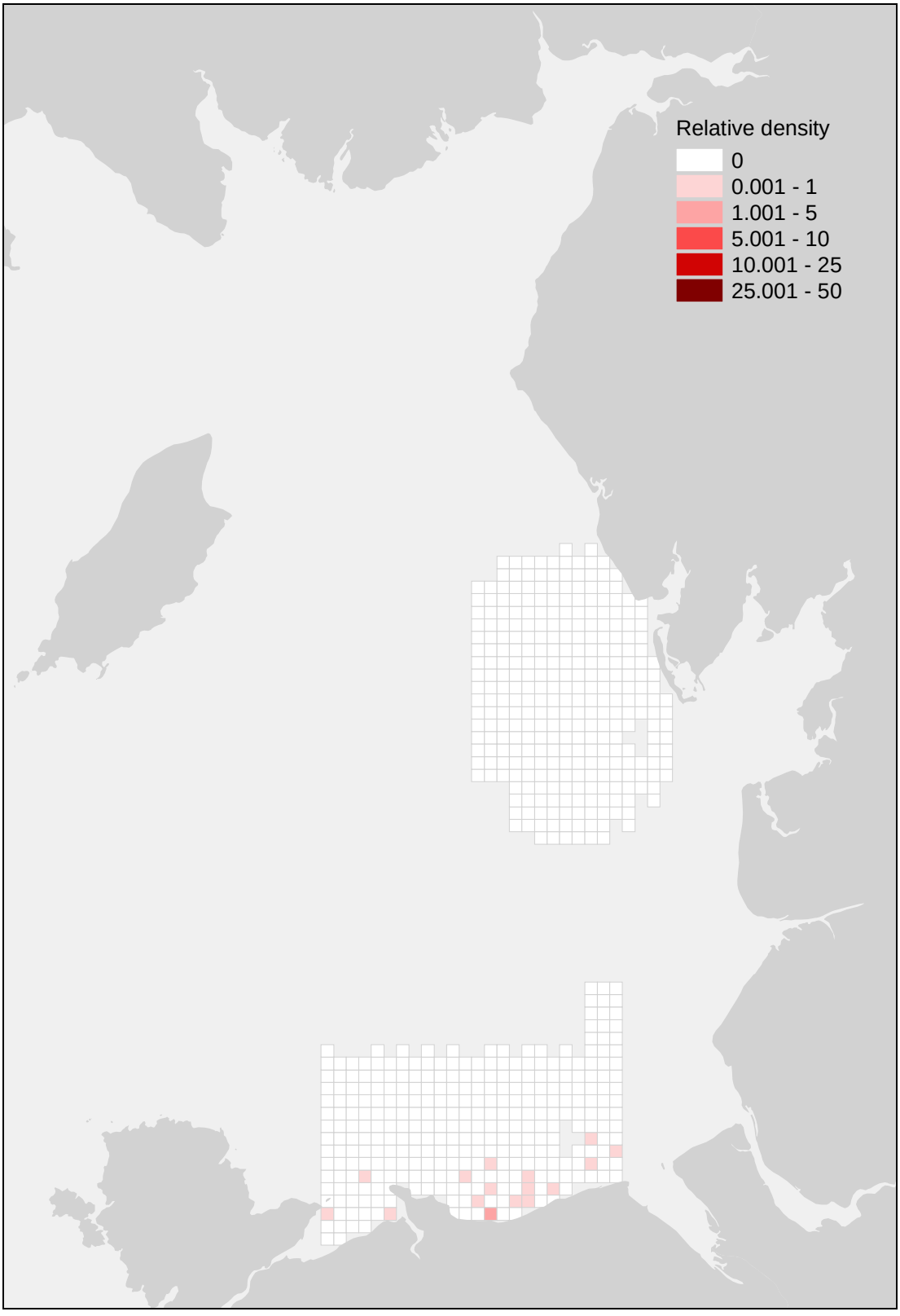


Figure 36 - Relative density of cormorants *Phalacrocorax* spp. recorded in North West OWF Strategic Area during aerial surveys, Period 4.

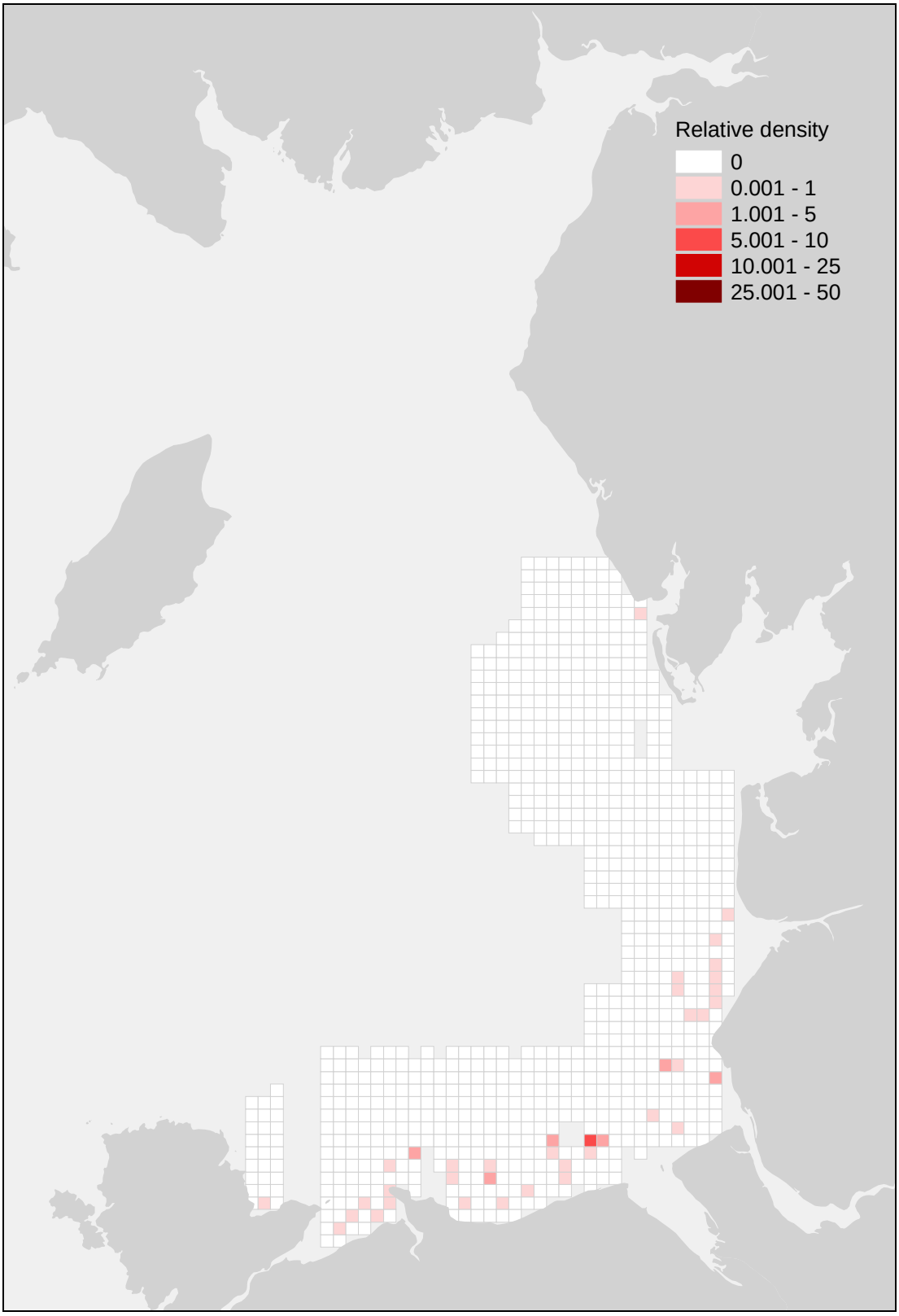


Figure 37 - Relative density of cormorants *Phalacrocorax* spp. recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 3.

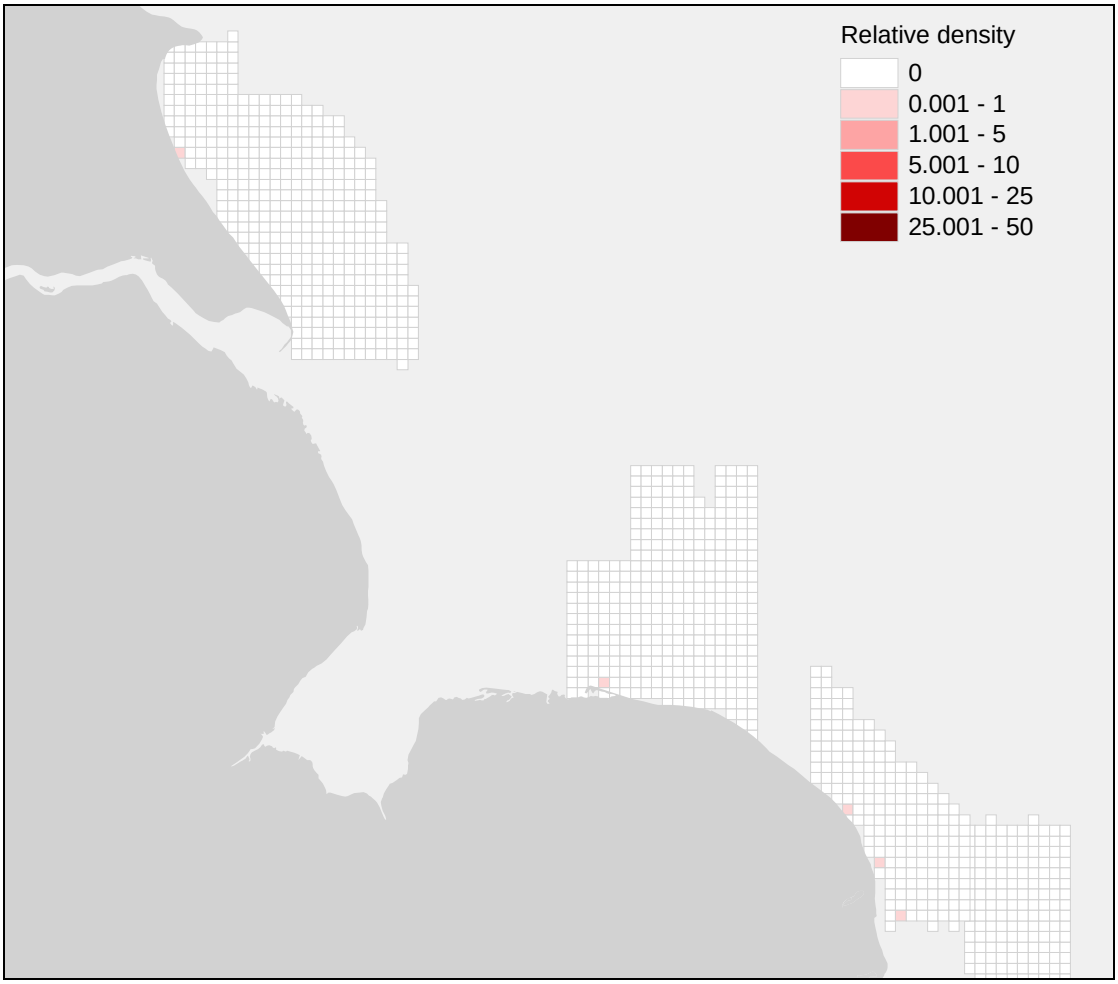


Figure 38 - Relative density of cormorants *Phalacrocorax* spp. recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 4.

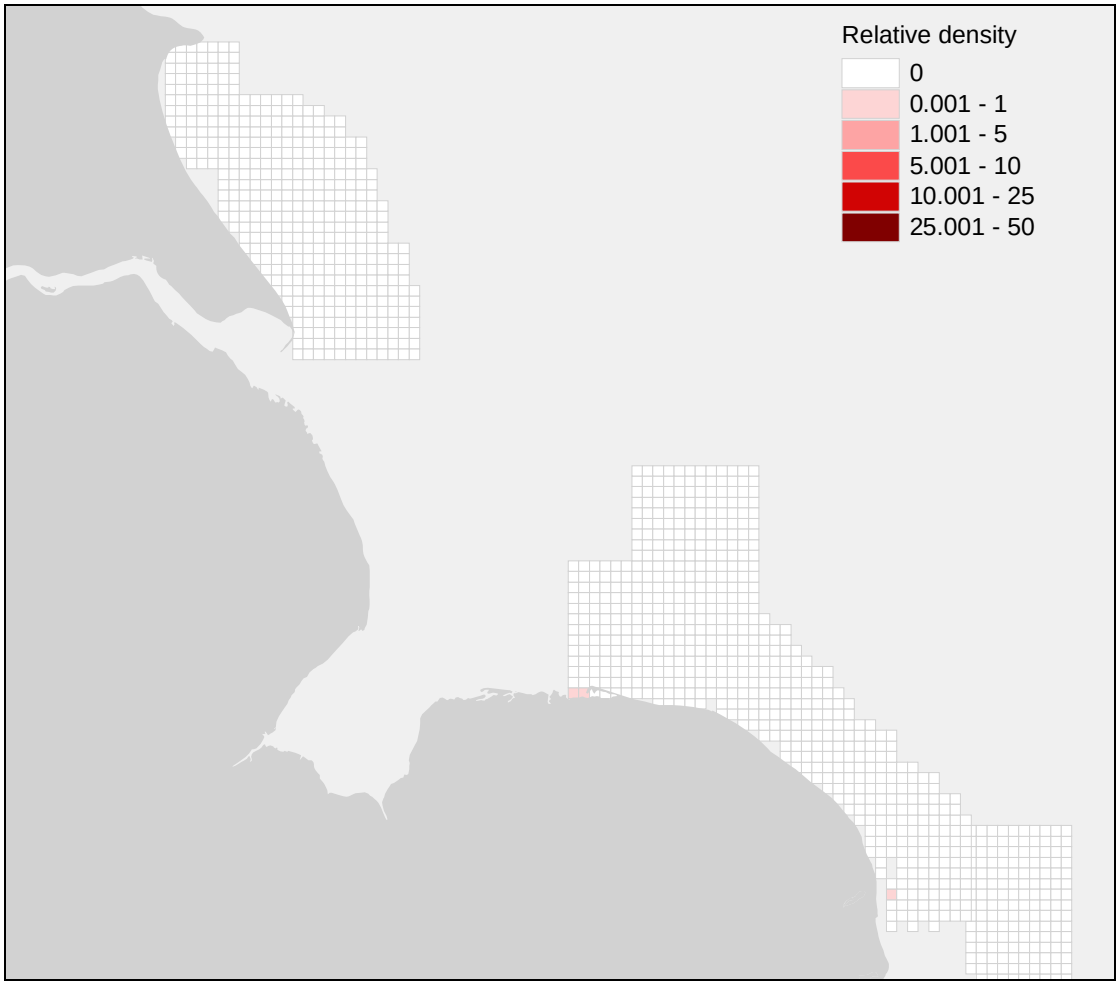


Figure 39 - Relative density of gulls Larinae. recorded in North West OWF Strategic Area during aerial surveys, Period 3.

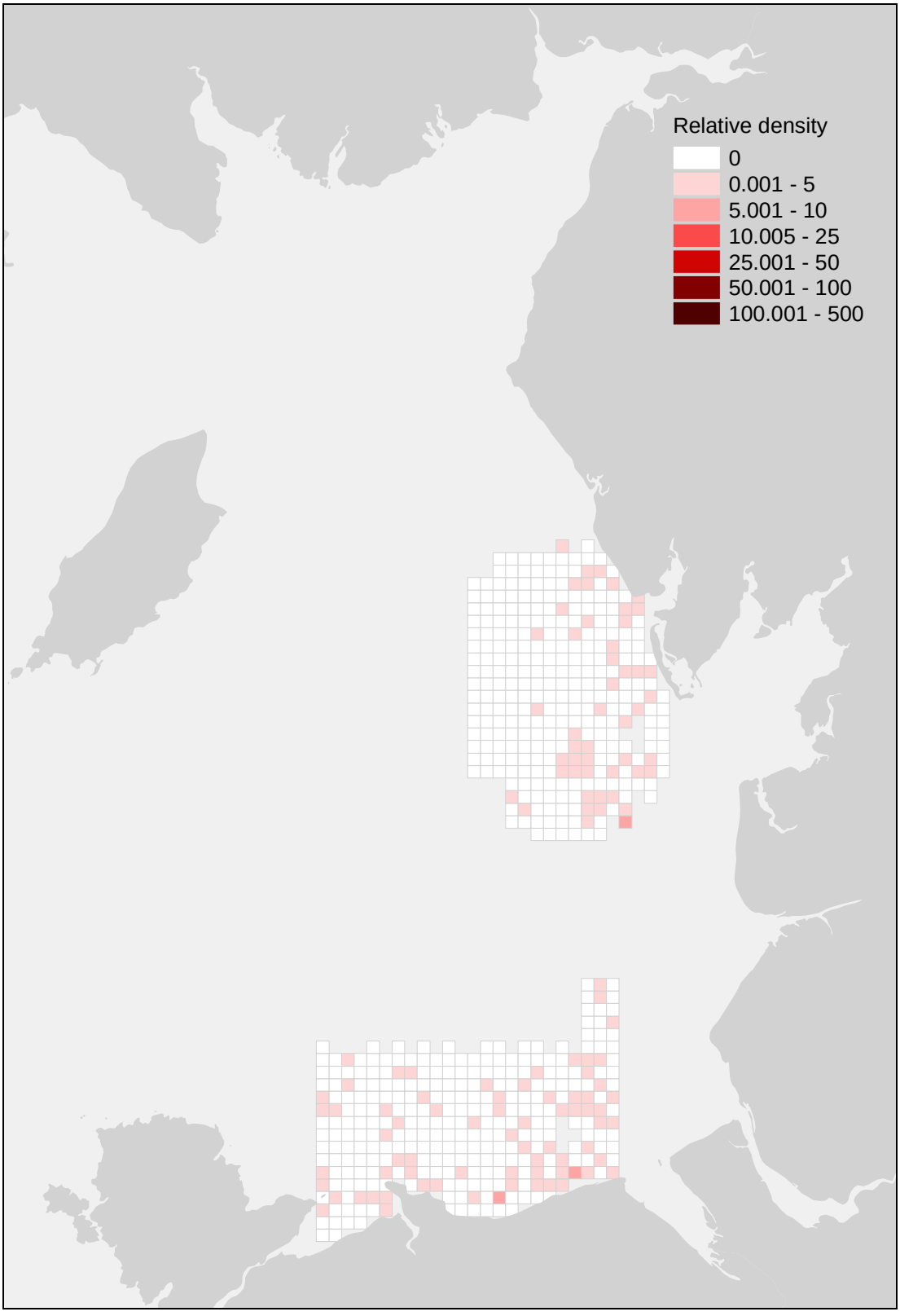


Figure 40 - Relative density of gulls Larinae. recorded in North West OWF Strategic Area during aerial surveys, Period 4.

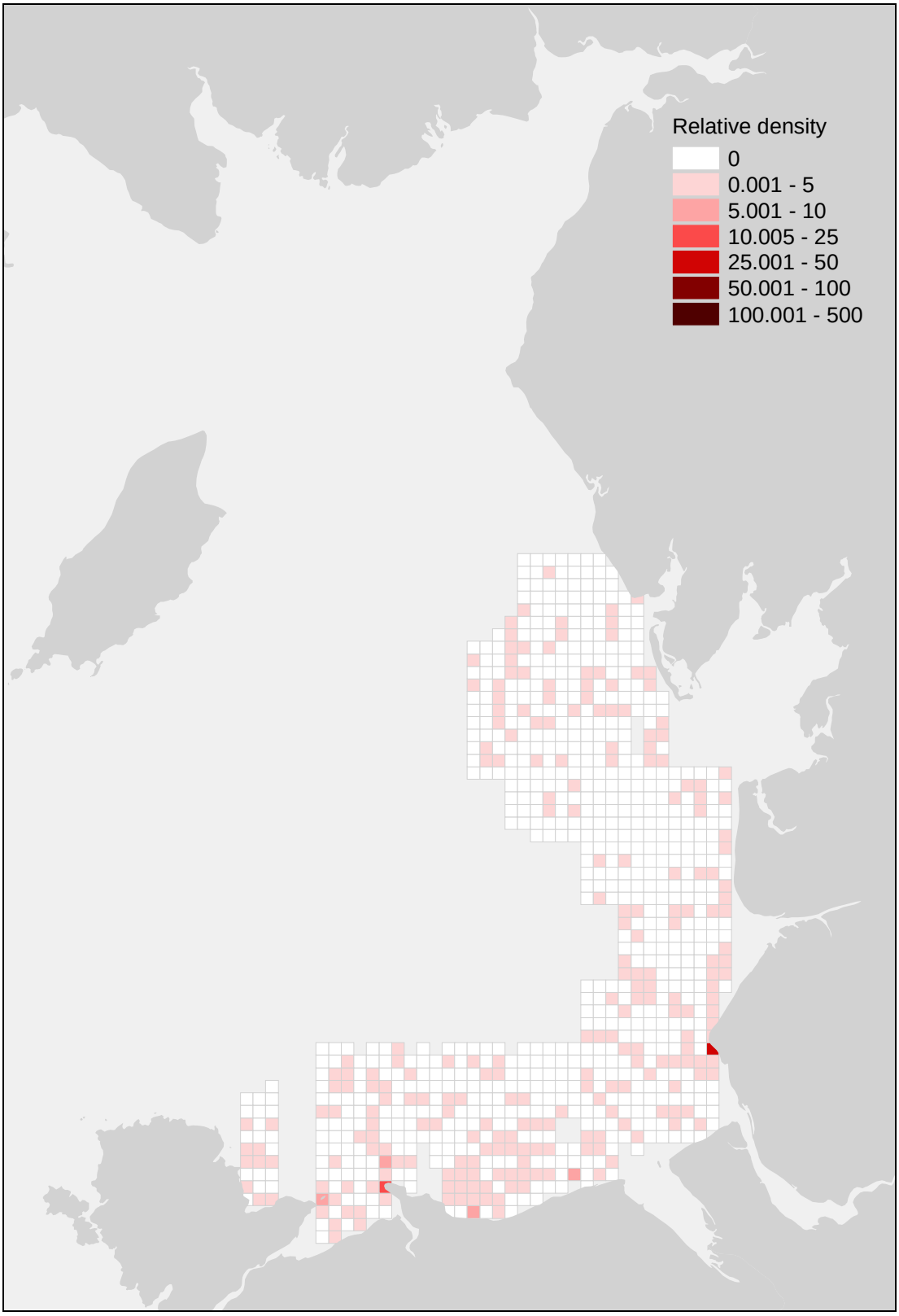


Figure 41 - Relative density of gulls Larinae. recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 3.

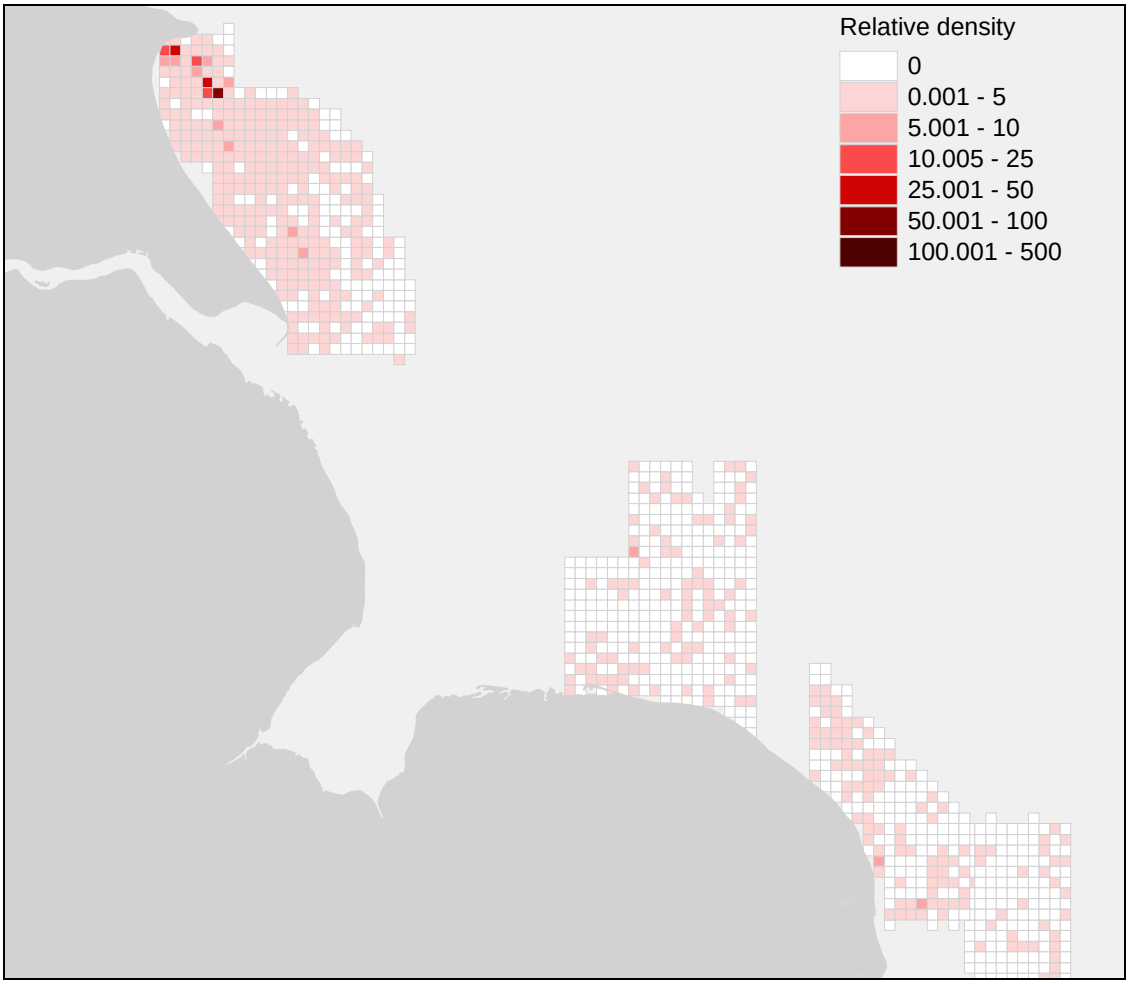


Figure 42 - Relative density of gulls Larinae. recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 4.

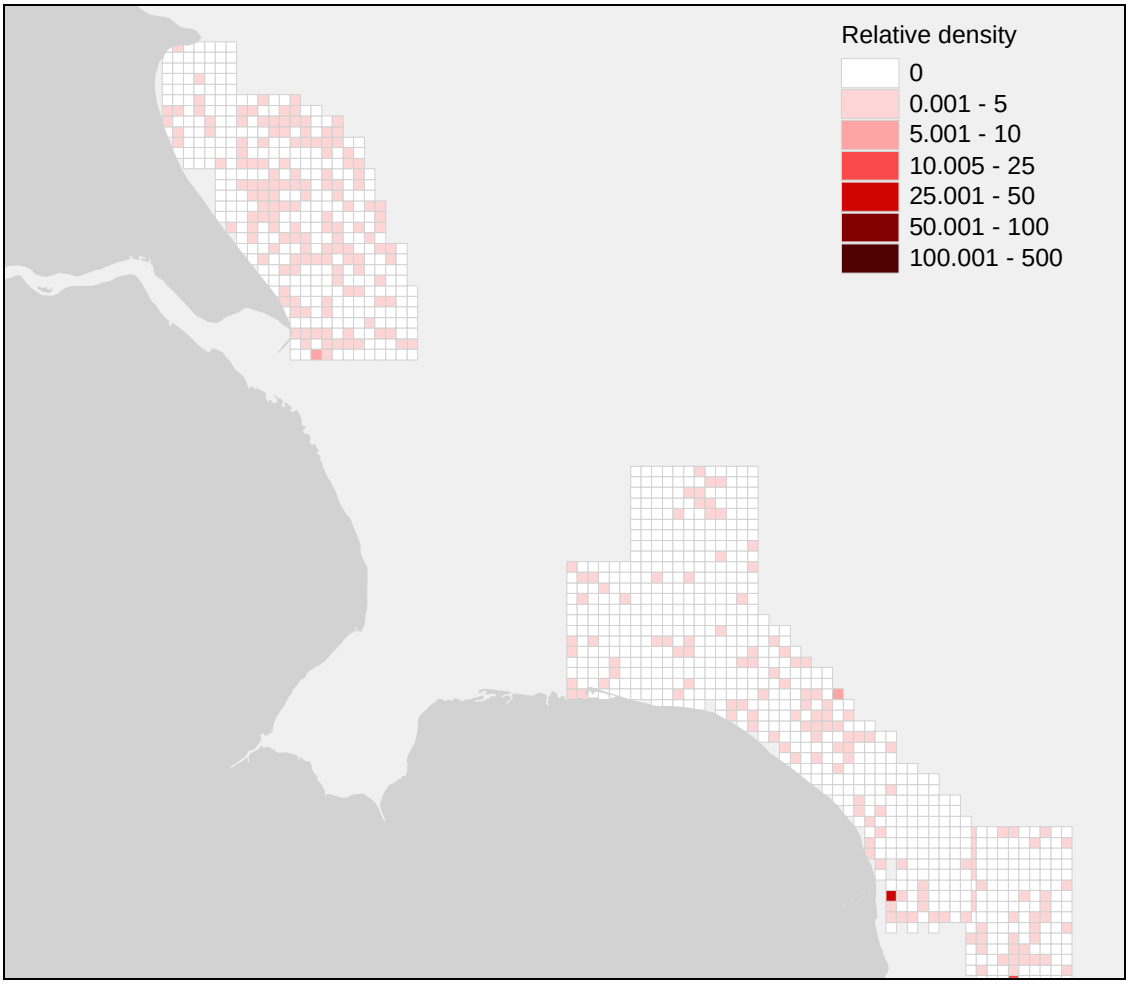


Figure 43 - Relative density of gulls Larinae. recorded in Thames OWF Strategic Area during aerial surveys, Period 3.

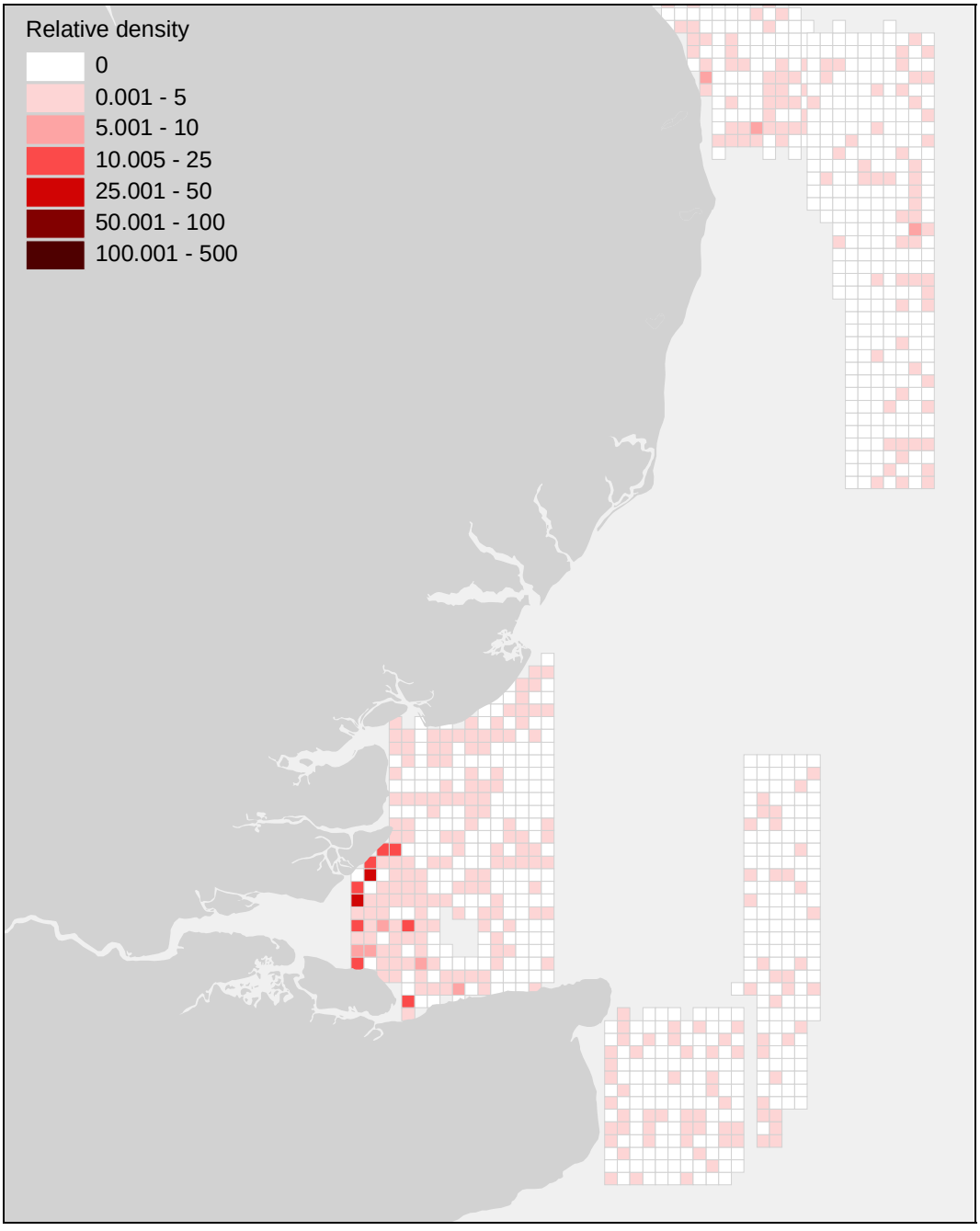


Figure 44 - Relative density of gulls Larinae. recorded in Thames OWF Strategic Area during aerial surveys, Period 4.

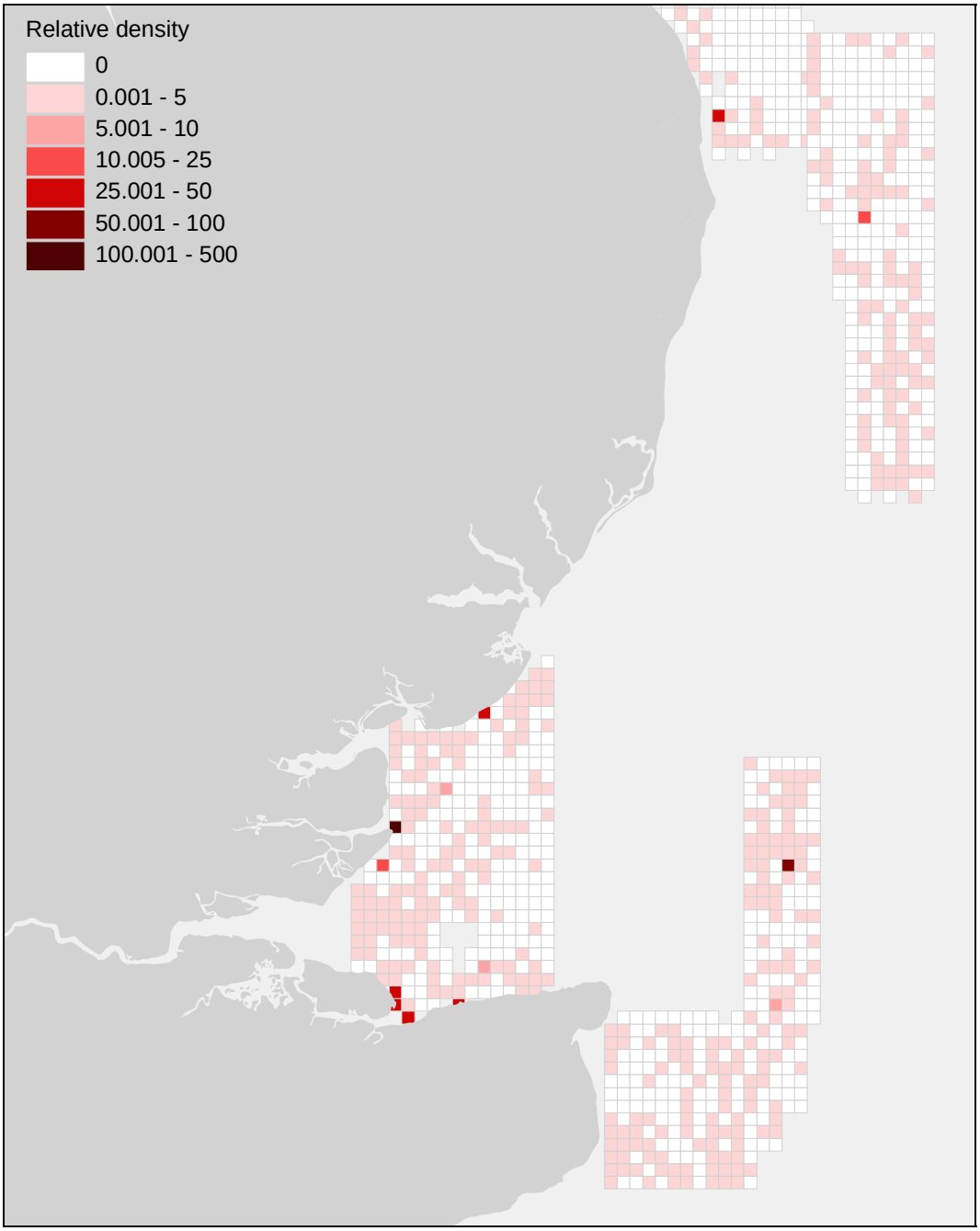


Figure 45 - Relative density of Kittiwakes *Rissa tridactyla* recorded in North West OWF Strategic Area during aerial surveys, Period 3.

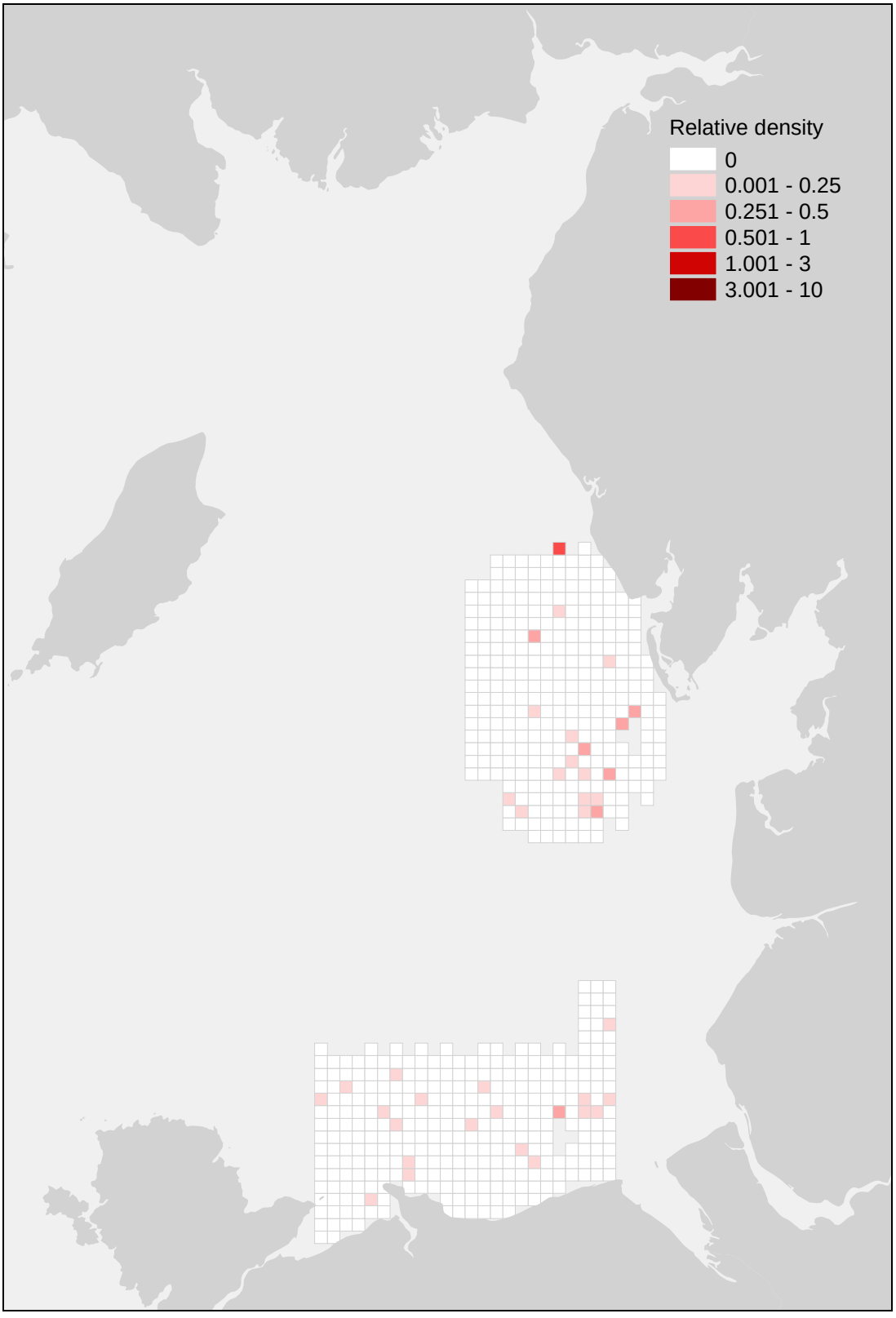


Figure 46 - Relative density of Kittiwakes *Rissa tridactyla* recorded in North West OWF Strategic Area during aerial surveys, Period 4.

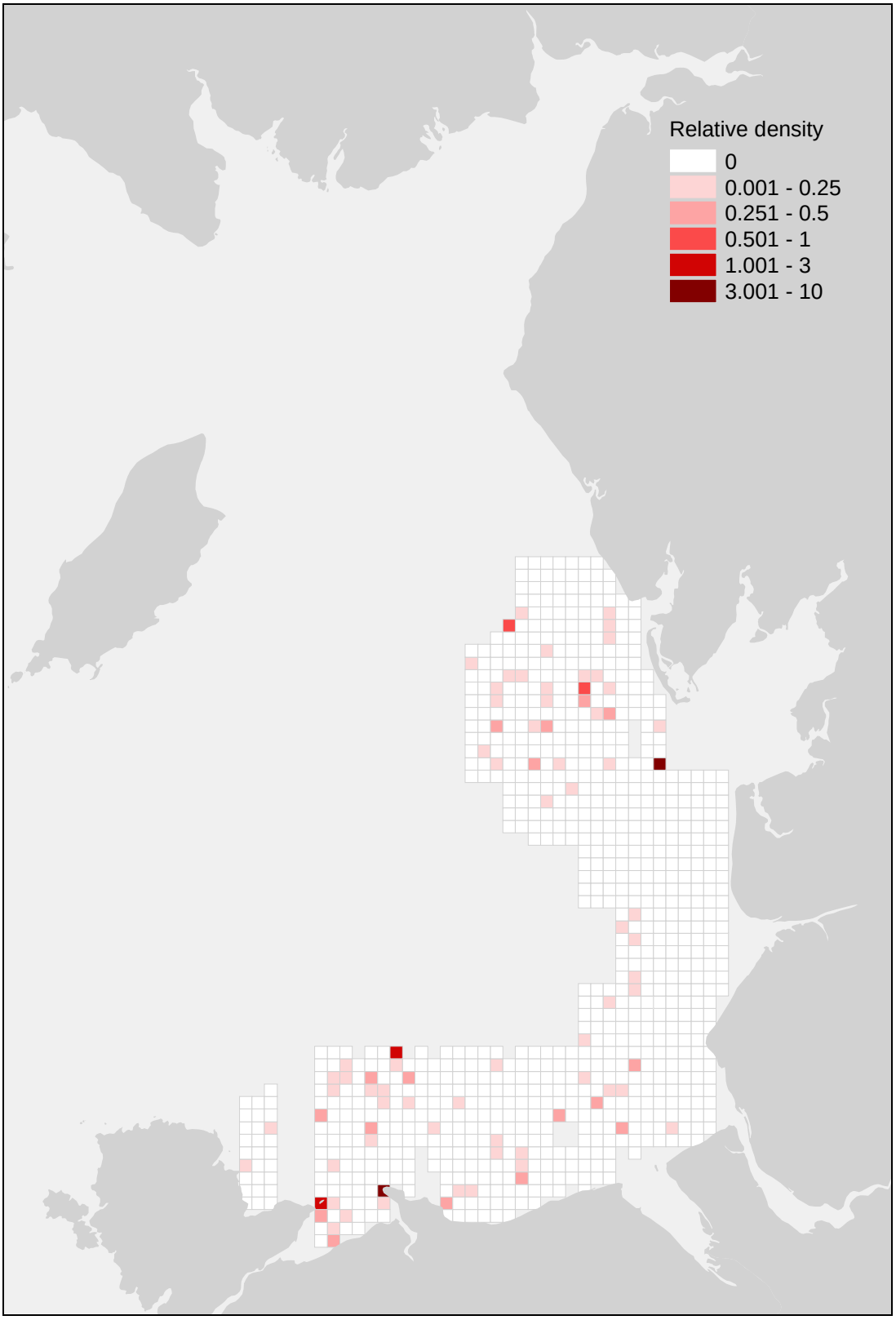


Figure 47 - Relative density of Kittiwakes *Rissa tridactyla* recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 3.

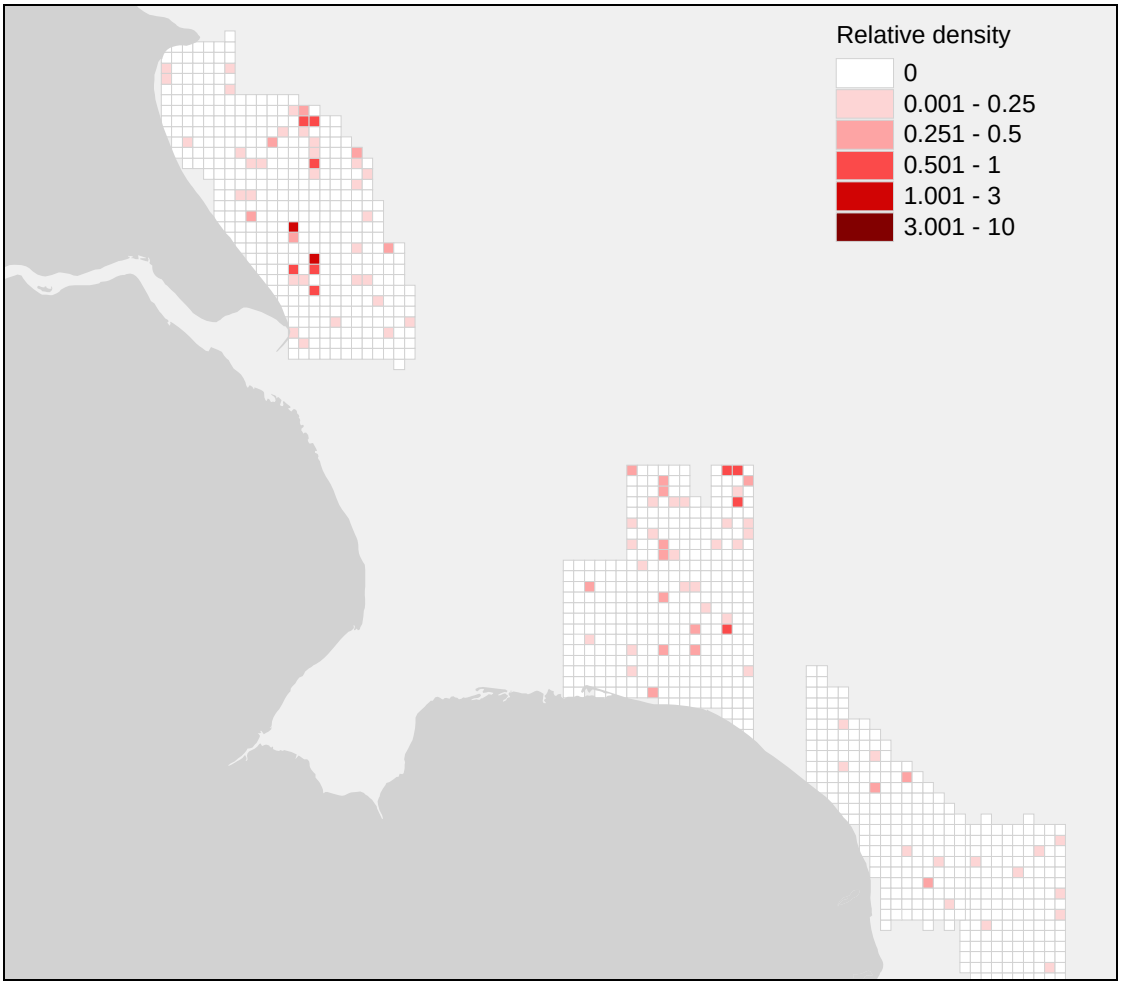


Figure 48 - Relative density of Kittiwakes *Rissa tridactyla* recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 4.

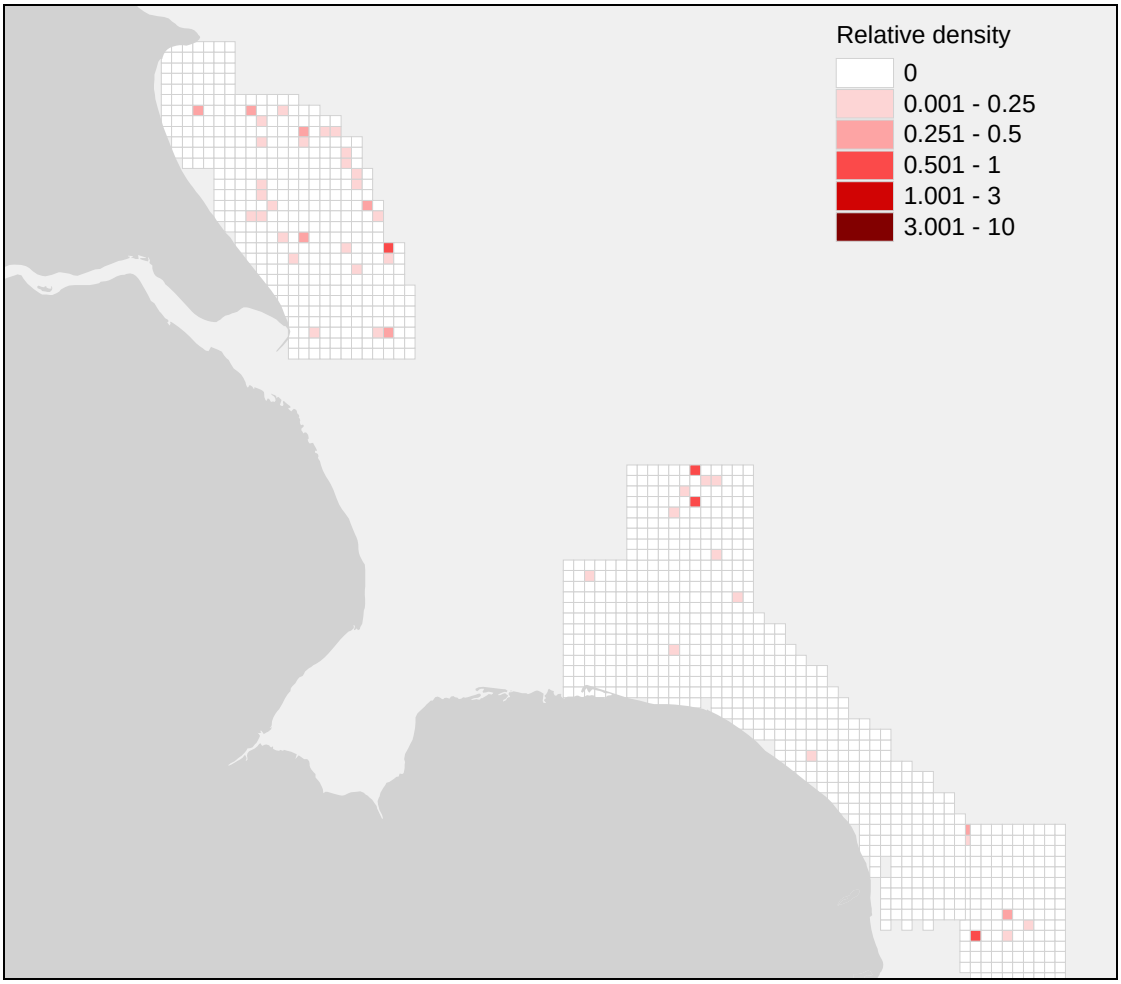


Figure 49 - Relative density of Kittiwakes *Rissa tridactyla* recorded in Thames OWF Strategic Area during aerial surveys, Period 3.

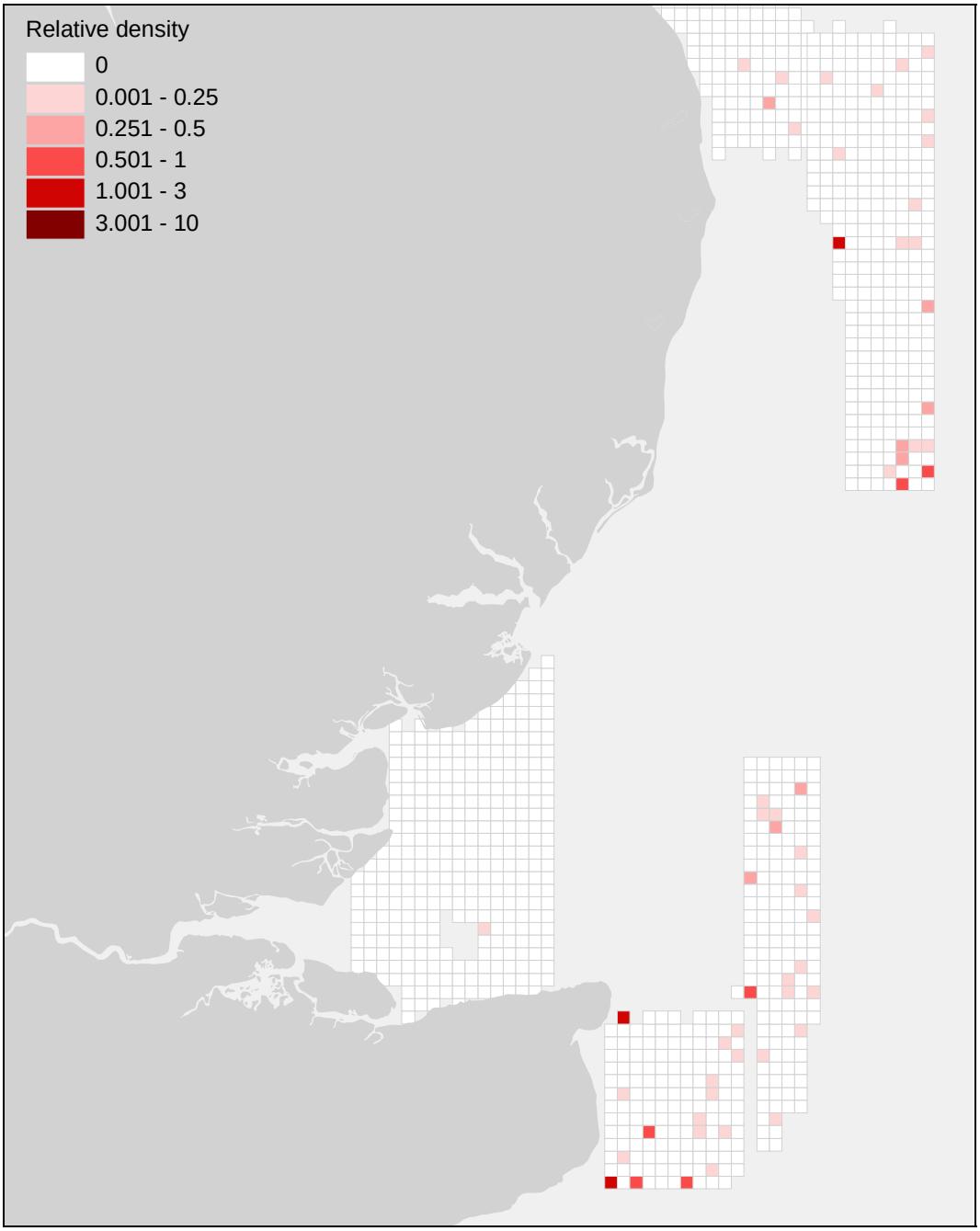


Figure 50 - Relative density of Kittiwakes *Rissa tridactyla* recorded in Thames OWF Strategic Area during aerial surveys, Period 4.

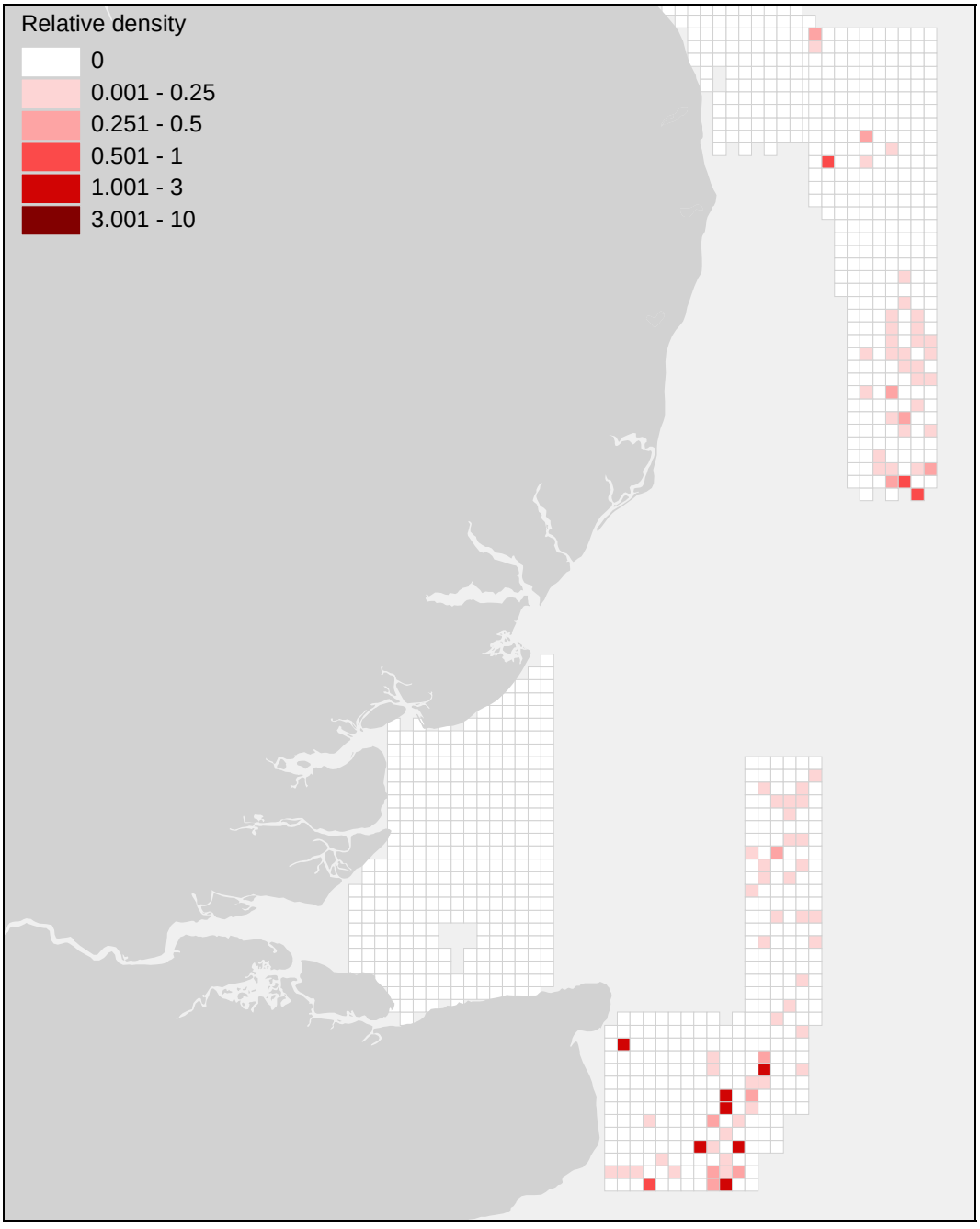


Figure 51 - Relative density of auks Alcidae. recorded in North West OWF Strategic Area during aerial surveys, Period 3.

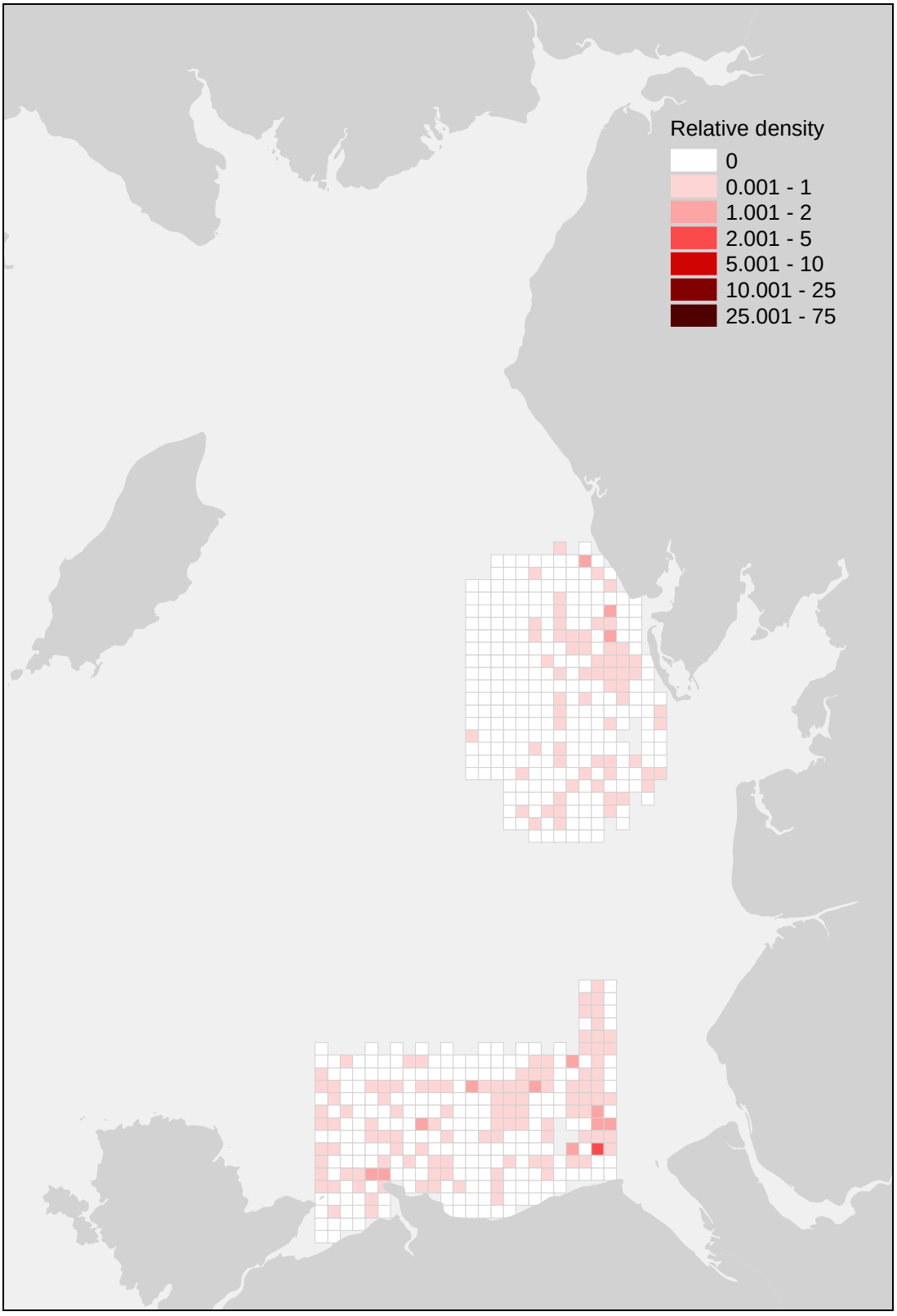


Figure 52 - Relative density of auks Alcidae. recorded in North West OWF Strategic Area during aerial surveys, Period 4.

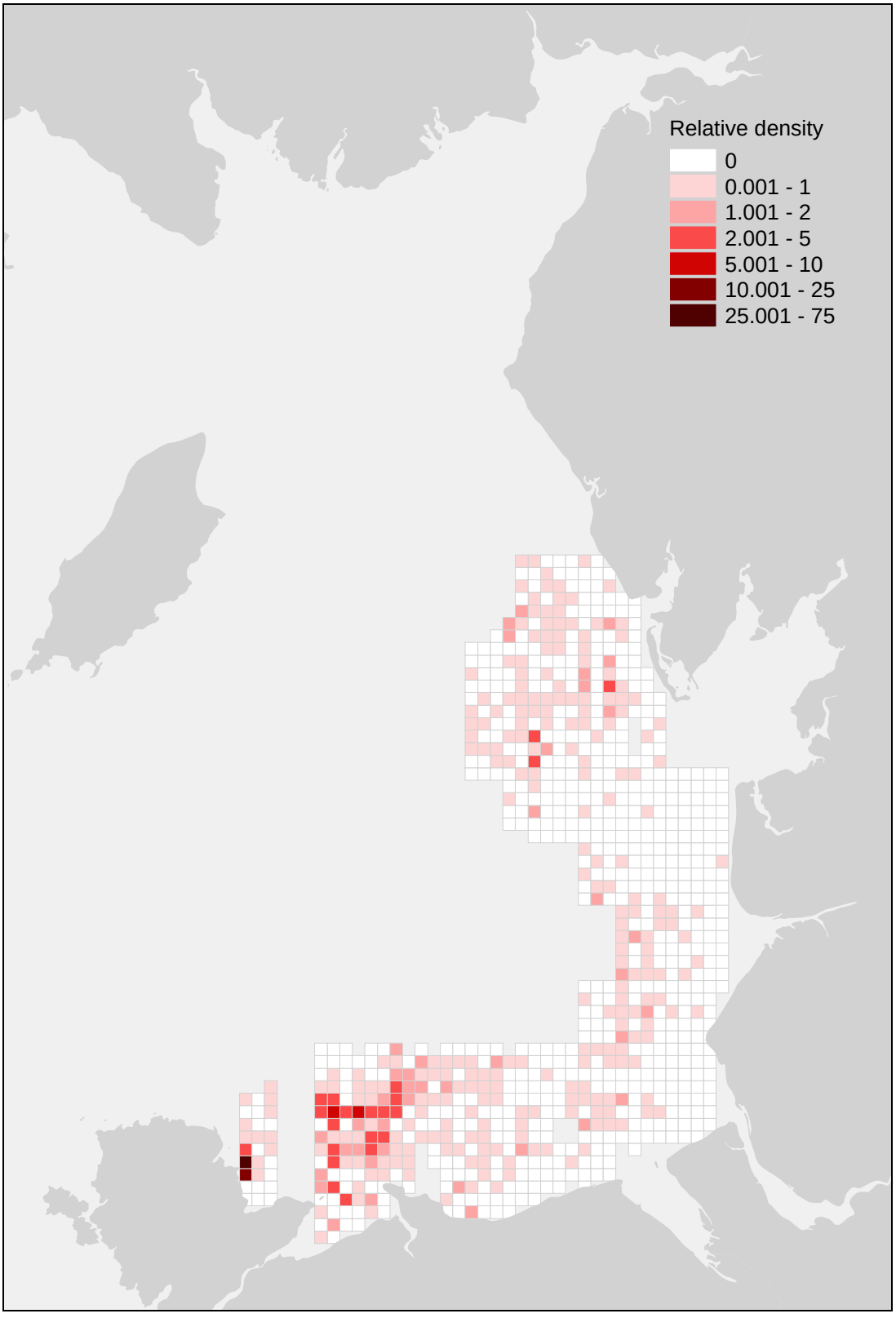


Figure 53 - Relative density of auks Alcidae. recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 3.

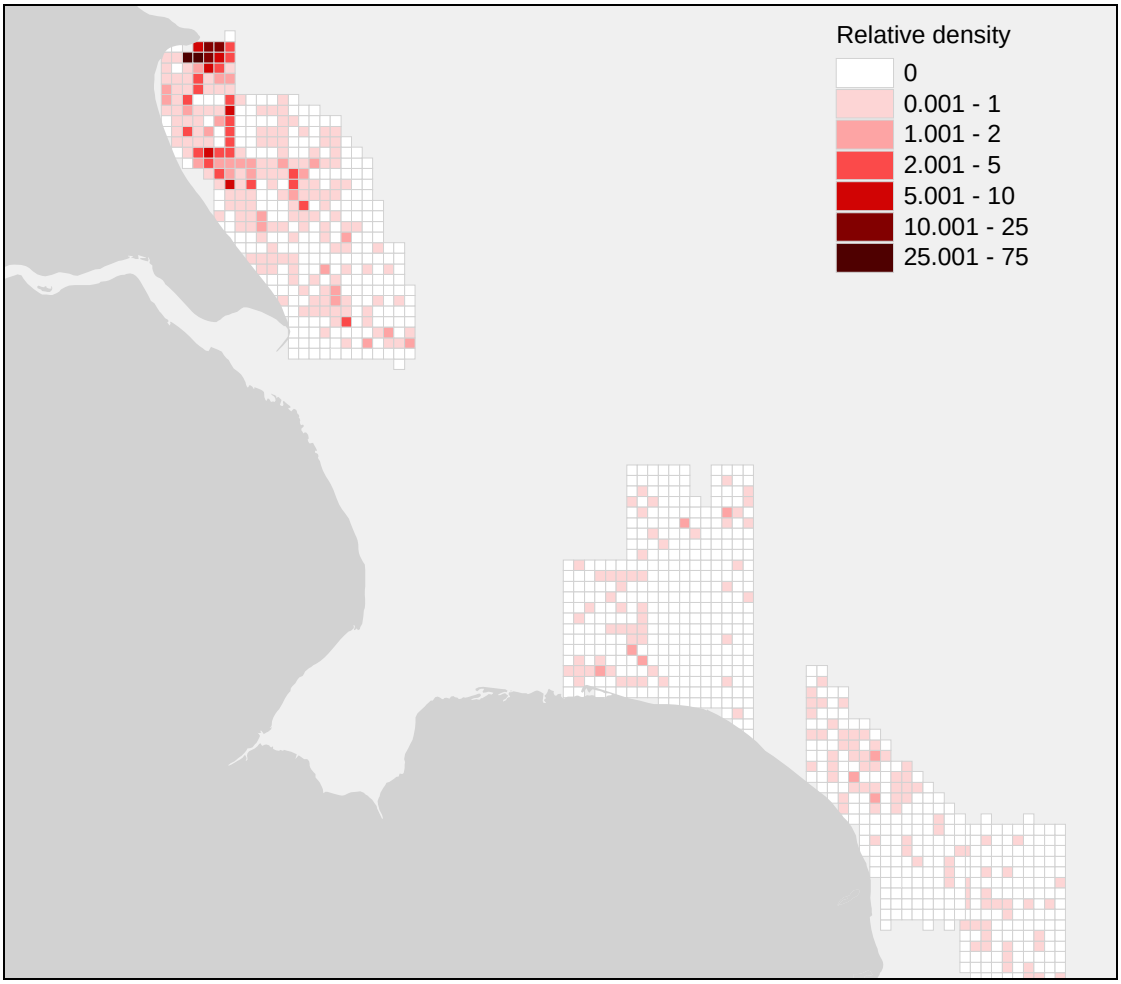


Figure 54 - Relative density of auks Alcidae. recorded in Greater Wash OWF Strategic Area during aerial surveys, Period 4.

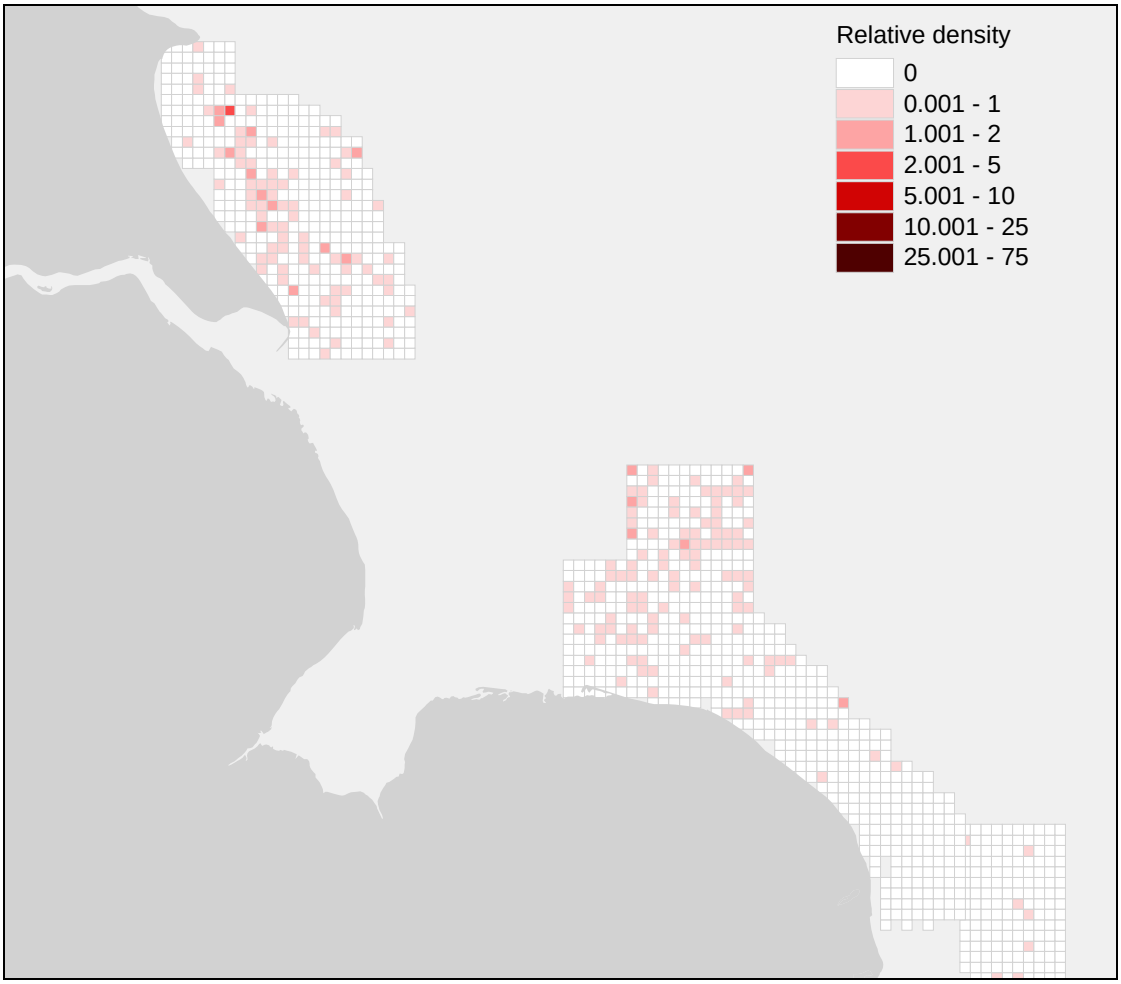


Figure 55 - Relative density of auks Alcidae. recorded in Thames OWF Strategic Area during aerial surveys, Period 3.

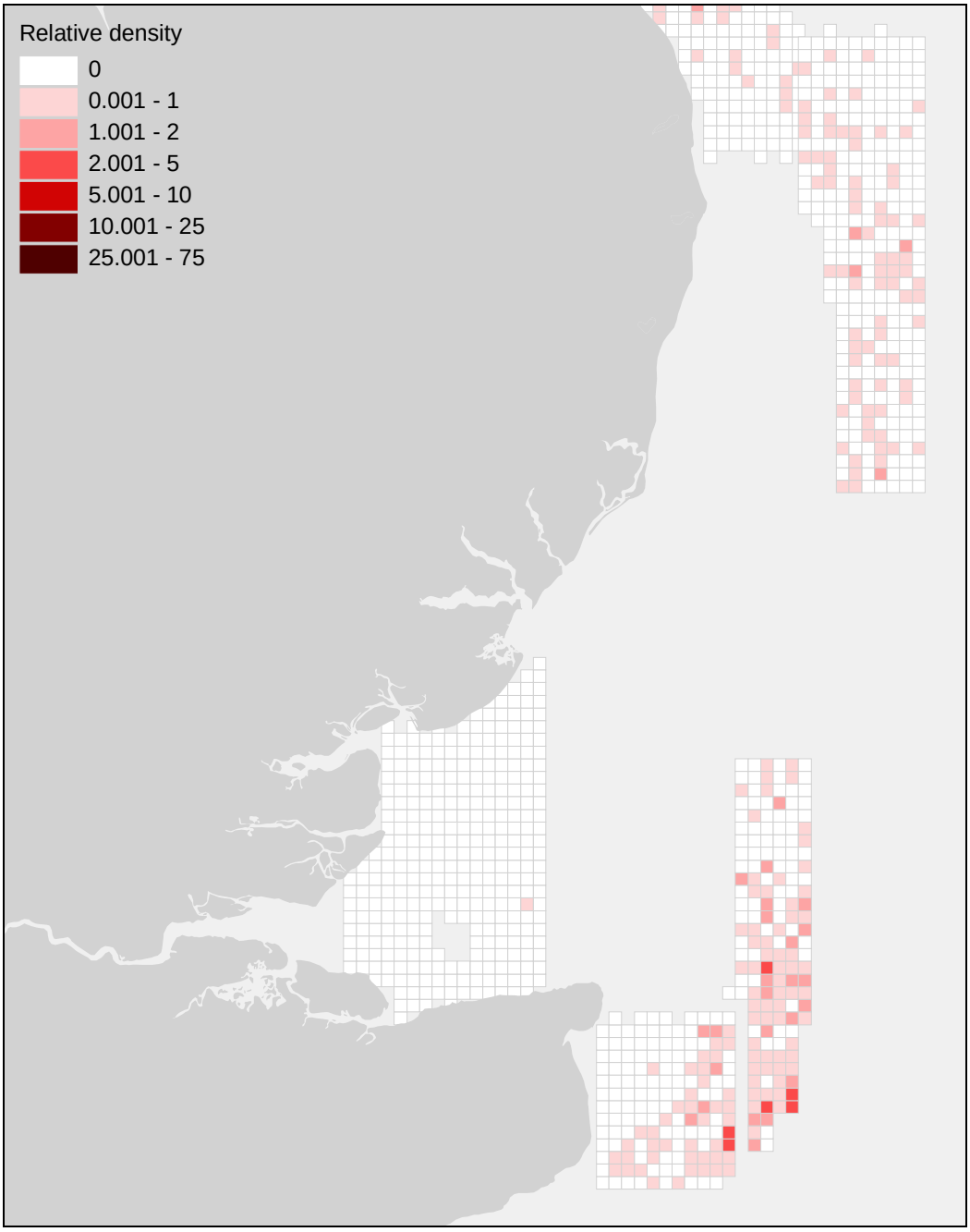
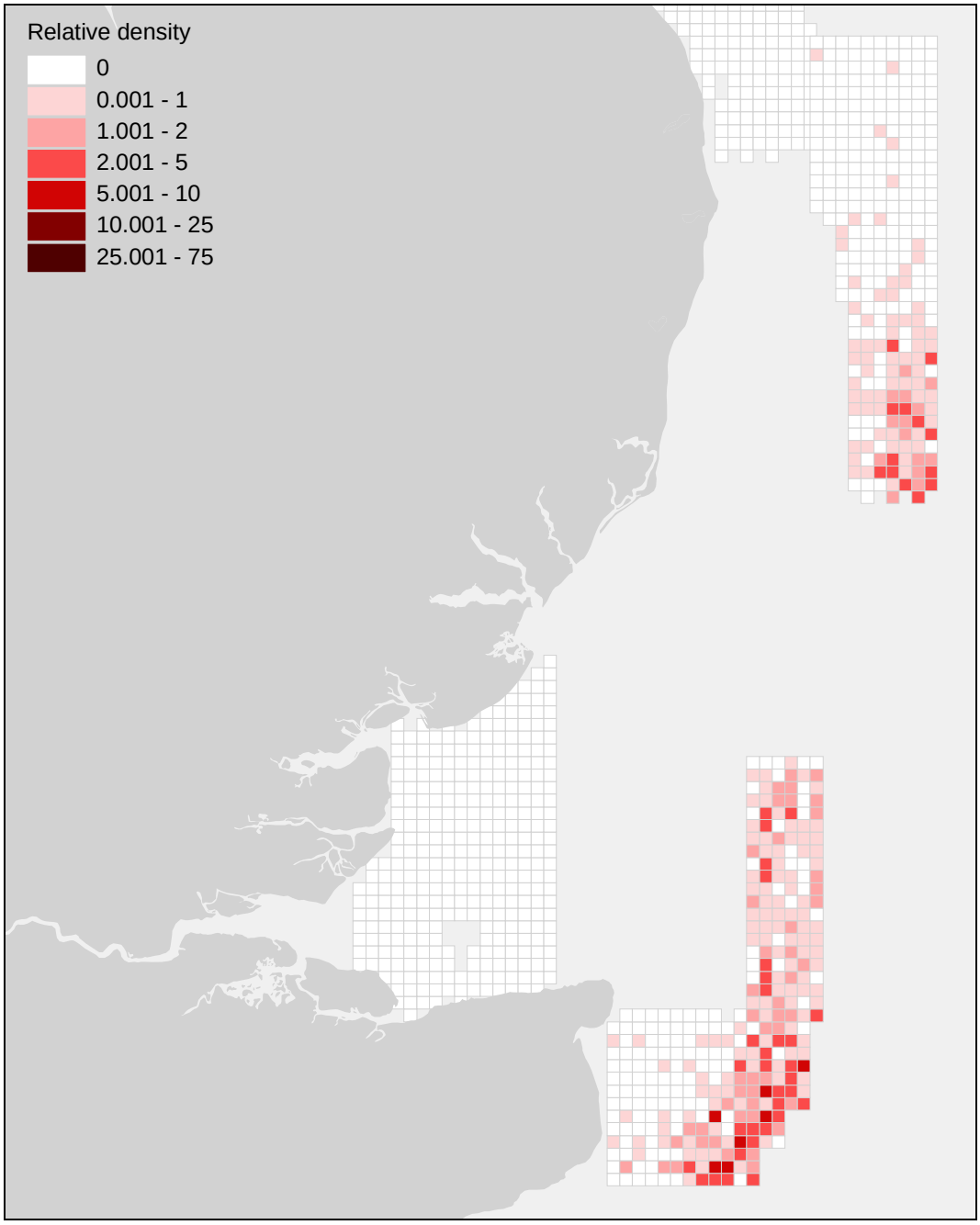


Figure 56 - Relative density of auks Alcidae. recorded in Thames OWF Strategic Area during aerial surveys, Period 4.



TABLES

Tables presenting total numbers (Tables 5-7, 8, 10, 12 & 13-18) are not absolute numbers of birds in the survey area, which need to be calculated using 'distance', to allow for the numbers of birds missed with increasing distance from the plane.

Estimated numbers of Common Scoter and divers, presented in tables 9 and 11 respectively, were calculated using *Distance 5.0*. Estimates were calculated for Common Scoter off the West coast (North West Strategic Area) and for divers off the West coast and East coast (Greater Wash and Thames Strategic Areas combined.). Estimates for survey blocks holding significant numbers of each species are also given. Areas with insufficient data to allow estimates to be calculated were excluded.

Table 1 - Survey periods used for aerial surveys, 2007.

Survey Period	Description	2004/05	2005/06	2007
3	Mid winter (2)	1 Jan - 9 Feb	1 Jan - 12 Feb	16 Jan - 17 Feb
4	Late winter	10 Feb - 11 Mar	13 Feb - 12 Mar	18 Feb - 8 Mar

Table 2 - Dates of survey flights in the North West Strategic Area, Periods 3 and 4.

North West	NW3	NW4/6	NW5
Period 3	16 Jan	-	23 Jan
Period 4	21 Feb	03 Mar	24 Feb

Table 3 - Dates of survey flights in the Greater Wash Strategic Area, Periods 3 and 4.

Greater Wash	GW1a	GW2	GW5	GW6
Period 3	01 Feb	16 Jan, 01 & 02 Feb	16 Jan & 19 Feb	17 Feb
Period 4	23 Feb	23 Feb	07 Mar	07 Mar

Table 4 – Dates of survey flights in the Thames Strategic Area, Periods 3 and 4.

Thames	TH1	TH6	TH7
Period 3	3 Feb	31 Jan	2 Feb & 17 Feb
Period 4	18 Feb	08 Mar	08 Mar

Table 5 - Total numbers of all species recorded in the North West Strategic Area, Periods 3 and 4.

Species	Period 3	Period 4
Red-throated Diver	21	58
Great Northern Diver	1	4
diver spp.	29	55
Fulmar	2	6
Cormorant	15	132
Shag	13	10
Cormorant/Shag	1	25
Shelduck		1
Scaup	3	
Eider	27	23
Common Scoter	2903	26329
Velvet Scoter	2	3
Red-breasted Merganser	12	32
duck spp.		2
Oystercatcher		46
small wader spp.		2258
Little Gull	1	14
Black-headed Gull	9	7
Common Gull	15	13
Lesser Black-backed Gull	6	8
Herring Gull	24	274
Great Black-backed Gull	7	12
Kittiwake	43	119
grey gull spp. (Herring or Common)	67	59
black-backed gull spp.	6	13
large gull spp.	6	36
small gull spp.	31	30
gull spp.	26	269
Guillemot	1	
auk spp.	346	1191
Carrion Crow		1

Table 6 - Total numbers of all species recorded in the Greater Wash Strategic Area, Periods 3 and 4.

Species	Period 3	Period 4
Red-throated Diver	35	40
Great Northern Diver	2	
diver spp.	147	54
Fulmar	45	31
Gannet	134	67
Cormorant	4	5
Cormorant/Shag	2	
Eider	82	71
Common Scoter	2867	41
Red-breasted Merganser	2	
Oystercatcher		3
Lapwing		4
small wader spp.		1
Little Gull		1
Black-headed Gull	8	19
Common Gull	259	29
Lesser Black-backed Gull	11	2
Herring Gull	99	100
Great Black-backed Gull	47	1
Kittiwake	130	48
grey gull spp. (Herring or Common)	930	114
Black-backed gull spp.	93	12
large gull spp.	101	29
small gull spp.	42	47
gull spp.	498	176
Guillemot		1
Razorbill		1
Puffin		1
auk spp.	1767	354

Table 7 - Total numbers of all species recorded in the Thames Strategic Area, Periods 3 and 4.

Species	Period 3	Period 4
Black-throated Diver	1	
Red-throated Diver	168	321
Great Northern Diver		4
diver spp.	407	307
Great Crested Grebe		1
grebe spp.		5
Fulmar	10	68
Gannet	56	918
Cormorant	91	8
Shag		2
Cormorant/Shag	4	165
Greylag Goose		7
Brent Goose	3	117
goose spp.	31	
Shelduck	2	
Wigeon		14
Eider	9	
Common Scoter	16	698
Red-breasted Merganser		31
duck spp.		133
Oystercatcher		3521
wader spp.	901	35
Little Gull	2	4
Black-headed Gull	389	134
Common Gull	7	6
Lesser Black-backed Gull	17	16
Herring Gull	45	697
Great Black-backed Gull	18	23
Kittiwake	72	147
grey gull spp. (Herring or Common)	42	125
black-backed gull spp.	52	43
large gull spp.	64	165
small gull spp.	114	137
gull spp.	594	913
tern spp.		3
Guillemot		1
auk spp.	532	1404

Species	Period 3	Period 4
Carrion Crow		1

Table 8 - Numbers of Common Scoters *Melanitta nigra* recorded in Periods 3 and 4 ("-" indicates no coverage).

Survey block	Period 3	Period 4
NW3	56	115
NW4	-	13851
NW5	2847	8453
NW6a (part)	-	3776
NW6b (part)	-	134
North West Total	2903	26329
GW1a	60	40
GW2	0	0
GW5	2800	1
GW6	7	0
Greater Wash Total	2867	41
TH1	16	698
TH6	0	0
TH7	0	0
Thames Total	16	698

Table 9 - Estimates of Common Scoter *Melanitta nigra* numbers in the North West Strategic Area (with 95% confidence intervals) for each period.

Survey block	Estimate	Lower confidence interval	Upper confidence interval
Period 3	4765	2557	8132
Period 4	63387	39318	92340

Table 10 - Numbers of divers *Gavia* spp. recorded in Periods 3 and 4 ("-" indicates no coverage).

Survey Block	Period 3	Period 4
NW3	33	6
NW4	-	36
NW5	18	18
NW6a (part)	-	56
NW6b (part)	-	1
North West Total	51	117
GW1a	60	26
GW2	51	7
GW5	20	38
GW6	53	23
Greater Wash Total	184	94
TH1	457	174
TH6	40	27
TH7	79	431
Thames Total	576	632

Table 11 - Estimates of diver *Gavia* spp. numbers (with 95% confidence intervals) for each period off the East coast and the North West (NW) Strategic Area.

Survey block	Estimate	Lower confidence interval	Upper confidence interval
Period 3 East	3067	2311	5753
Period 3 NW	270	146	468
Period 4 East	3268	2574	4092
Period 4 NW	680	464	975

Table 12 - Numbers of Little Gulls *Larus minutus* recorded in Periods 3 and 4 ("-" indicates no coverage).

Survey Block	Period 3	Period 4
NW3	1	2
NW4	-	11
NW5	0	0
NW6a (part)	-	1
NW6b (part)	-	0
North West Total	1	14
GW1a	0	0
GW2	0	0
GW5	0	1
GW6	0	0
Greater Wash Total	0	1
TH1	0	3
TH6	0	1
TH7	2	0
Thames Total	2	4

Table 13 - Numbers of birds counted in individual survey blocks during aerial survey of the North West, Period 3 ("-" indicates no coverage).

Species	NW3	NW4	NW5	NW6a	NW6b	Total
Red-throated Diver	20	-	1	-	-	21
Great Northern Diver		-	1	-	-	1
diver spp.	13	-	16	-	-	29
Fulmar		-	2	-	-	2
Cormorant		-	15	-	-	15
Shag		-	13	-	-	13
Cormorant/Shag		-	1	-	-	1
Scaup		-	3	-	-	3
Eider	27	-		-	-	27
Common Scoter	56	-	2847	-	-	2903
Velvet Scoter		-	2	-	-	2
Red-breasted Merganser	4	-	8	-	-	12
Little Gull	1	-		-	-	1
Black-headed Gull	5	-	4	-	-	9
Common Gull	4	-	11	-	-	15
Lesser Black-backed Gull	2	-	4	-	-	6
Herring Gull	14	-	10	-	-	24
Great Black-backed Gull	4	-	3	-	-	7
Kittiwake	23	-	20	-	-	43
grey gull spp. (Herring or Common)	17	-	50	-	-	67
black-backed gull spp.	1	-	5	-	-	6
large gull spp.	2	-	4	-	-	6
small gull spp.	1	-	30	-	-	31
gull spp.	17	-	9	-	-	26
Guillemot	1	-		-	-	1
auk spp.	114	-	232	-	-	346
Total	326	-	3291	-	-	3617

Table 14 - Numbers of birds counted in individual survey blocks during aerial survey of the North West, Period 4.

Species	NW3	NW4	NW5	NW6a	NW6b	Total
Red-throated Diver		15	8	34	1	58
Great Northern Diver			3	1		4
diver spp.	6	21	7	21		55
Fulmar			6			6
Cormorant		9	84	39		132
Shag			8	2		10
Cormorant/Shag	1		21	2	1	25
Shelduck				1		1
Eider	18	5				23
Common Scoter	115	13851	8453	3776	134	26329
Velvet Scoter		3				3
Red-breasted Merganser		2	23	7		32
duck spp.				2		2
Oystercatcher				40	6	46
small wader spp.				2258		2258
Little Gull	2	11		1		14
Black-headed Gull		4		3		7
Common Gull		1	2	10		13
Lesser Black-backed Gull		7	1			8
Herring Gull	5	19	217	25	8	274
Great Black-backed Gull	5	1	6			12
Kittiwake	46	4	60	7	2	119
grey gull spp. (Herring or Common)	8	8	20	21	2	59
black-backed gull spp.	5	2	2	4		13
large gull spp.	2	8	15	9	2	36
small gull spp.	6	5	17	1	1	30
gull spp.	2	15	40	197	15	269
auk spp.	241	60	606	55	229	1191
Carrion Crow				1		1
Total	462	14051	9599	6517	401	31030

Table 15 - Numbers of birds counted in individual survey blocks during aerial survey of the Greater Wash, Period 3.

Species	GW1a	GW2	GW5	GW6	Total
Red-throated Diver	26		4	5	35
Great Northern Diver	1	1			2
diver spp.	33	50	16	48	147
Fulmar	11	29	5		45
Gannet	105	16	2	11	134
Cormorant			1	3	4
Cormorant/Shag	2				2
Eider				82	82
Common Scoter	60		2800	7	2867
Red-breasted Merganser	2				2
Black-headed Gull	3			5	8
Common Gull	159	87	1	12	259
Lesser Black-backed Gull	1	5	2	3	11
Herring Gull	21	46	11	21	99
Great Black-backed Gull	9	33	3	2	47
Kittiwake	5	67	46	12	130
grey gull spp. (Herring or Common)	669	204	17	40	930
black-backed gull spp.	36	35	16	6	93
large gull spp.	32	21	1	47	101
small gull spp.		23	15	4	42
gull spp.	221	106	45	126	498
auk spp.	1240	332	106	89	1767
Total	2649	1074	3108	675	7506

Table 16 - Numbers of birds counted in individual survey blocks during aerial survey of the Greater Wash, Period 4.

Species	GW1a	GW2	GW5	GW6	Total
Red-throated Diver	2	7	31		40
diver spp.	24		7	23	54
Fulmar	4	21	2	4	31
Gannet	2	57	2	6	67
Cormorant			2	3	5
Eider			34	37	71
Common Scoter	40		1		41
Oystercatcher			3		3
Lapwing		4			4
small wader spp.			1		1
Little Gull			1		1
Black-headed Gull			4	15	19
Common Gull	2	24	3		29
Lesser Black-backed Gull		1	1		2
Herring Gull	19	52	13	16	100
Great Black-backed Gull		1			1
Kittiwake	1	33	13	1	48
grey gull spp. (Herring or Common)	6	52	28	28	114
black-backed gull spp.	1	7		4	12
large gull spp.		1	3	25	29
small gull spp.		31	3	13	47
gull spp.		13	7	156	176
Guillemot		1			1
Razorbill		1			1
Puffin			1		1
auk spp.	24	150	156	24	354
Total	125	456	316	355	1252

Table 17 - Numbers of birds counted in individual survey blocks during aerial survey of the Thames, Period 3.

Species	TH1	TH6	TH7	Total
Black-throated Diver	1			1
Red-throated Diver	115	22	31	168
diver spp.	341	18	48	407
Fulmar		9	1	10
Gannet		5	51	56
Cormorant	91			91
Cormorant/Shag	3	1		4
Brent Goose	3			3
goose spp.	29	2		31
Shelduck			2	2
Eider	7	2		9
Common Scoter	16			16
wader spp.	901			901
Little Gull			2	2
Black-headed Gull	389			389
Common Gull	7			7
Lesser Black-backed Gull	15	1	1	17
Herring Gull	33	5	7	45
Great Black-backed Gull	10	3	5	18
Kittiwake	1	40	31	72
grey gull spp. (Herring or Common)	15	8	19	42
black-backed gull spp.	33	5	14	52
large gull spp.	54	5	5	64
small gull spp.	101	9	4	114
gull spp.	528	37	29	594
auk spp.	1	389	142	532
Total	2694	561	392	3647

Table 18 - Numbers of birds counted in individual survey blocks during aerial survey of the Thames, Period 4.

Species	TH1	TH6	TH7	Total
Red-throated Diver	8		313	321
Great Northern Diver	3		1	4
diver spp.	163	27	117	307
Great Crested Grebe	1			1
grebe spp.	5			5
Fulmar		61	7	68
Gannet		578	340	918
Cormorant	7	1		8
Shag	2			2
Cormorant/Shag	165			165
Greylag Goose	7			7
Brent Goose	117			117
Wigeon	14			14
Common Scoter	698			698
Red-breasted Merganser	31			31
duck spp.	131		2	133
Oystercatcher	3521			3521
wader spp.	35			35
Little Gull	3	1		4
Black-headed Gull	134			134
Common Gull		1	5	6
Lesser Black-backed Gull	5	4	7	16
Herring Gull	663	5	29	697
Great Black-backed Gull	18		5	23
Kittiwake		102	45	147
grey gull spp. (Herring or Common)	42	20	63	125
black-backed gull spp.	25	12	6	43
large gull spp.	24	60	81	165
small gull spp.	15	119	3	137
gull spp.	341	550	22	913
tern spp.		3		3
Guillemot			1	1
auk spp.		1076	328	1404
Carrion Crow			1	1
Total	6178	2620	1376	10174