Notes following discussions with Kerstin Kober (JNCC) and with Alex Banks & Mike Meadows (NE) regarding identification of the preferred approach to draw a revised boundary for the Greater Wash pSPA in the light of the re-distribution of red throated divers in and around the constructed Lincs and Lynn & Inner Dowsing windfarms.

Background

The survey data on which the boundary of the Greater Wash pSPA (as put out to public consultation) is based were collected between 2002 and 2008. Since then, offshore windfarms (Lincs, Lynn & Inner Dowsing and LID6) have been consented and constructed within the boundary of the newly proposed pSPA. Post consent monitoring of the sea areas around these windfarms, including the three most recent years of post-construction monitoring, has revealed a significant shift in the distribution of red-throated divers in comparison with the pre-construction (baseline) and construction periods.

In fact, in terms of the **absolute numbers** of divers recorded within the windfarms and the buffer zones around them, there are only 2 instances in which these have been lower post construction than in the pre-construction baseline (i.e. within the windfarm boundaries in the 1st and 2nd years of post-construction). In all other distance bands (up to 10km) and phases of windfarm development the absolute numbers of divers estimated to be present were greater in the construction and post construction years than in the one pre-construction (baseline) year.

HOWEVER, what HAS declined over time is the **RELATIVE importance** to divers of the sea areas within c 10km of the windfarm boundaries. In the baseline year these waters held about 55% of all divers recorded throughout the wider survey area (which extended up to 25km from the windfarm boundaries). In subsequent years that has declined to c 34%, 28%, 29%, 26%. That reduction in the % of all divers held within a given sea area has been most pronounced within and close to the windfarms – eg 83% within the windfarms, 77% within 1km, 71% between 1 and 2km……. declining to eg 33% reduction between 7 and 8 km.

It is this change in the **RELATIVE importance** of these waters to divers that matters when thinking about the validity of the existing pSPA boundary and whether the waters in and around the windfarms still support sufficient numbers of divers to merit inclusion within the site boundary. This is because the use of Maximum Curvature Analysis to define a threshold density for inclusion means that cells are either included or excluded on the basis of their importance (in terms of numbers supported) **RELATIVE to other cells**. So, although the absolute numbers of birds in the windfarms and within say 5-10km of them are no lower now than before the windfarms were built, the fact that numbers throughout the rest of the wider areas surveyed by the windfarm developers (which covers c 1/3 of the entire pSPA) have increased means that were MCA to be applied to the most recent data, the cells in and around the windfarm would occupy positions lower down the rank order of cells (when ranked from highest diver numbers to lowest) and so likely fall below the threshold for inclusion defined by application of MCA to cumulative curves of birds vs area.

Accepting that to be the case (i.e. without having done the analysis to prove it) it is necessary to consider how best to go about reconfiguring the site boundary to accommodate the reduced RELATIVE importance for red throated divers of the waters in and around the windfarms. The preferred option to doing this (and three variants of that) is set out below.

Option 1. Cut a hole in the existing 2002-2008 visual aerial survey data derived pSPA boundary. THIS IS THE PREFERRED OPTION

There are three sub-options – of varying complexity:

a) Remove from the pSPA boundary all waters within the sea areas covered by the planning permissions granted to the Lincs, LID and LID6 windfarms.

Advantage. Simple to do. Assuming the areas within which planning permission has been granted for these windfarm developments are clearly established, it is a simple GIS exercise to remove these from the existing pSPA boundary. All that is then required is to overlay the revised boundary onto the distance re-scaled survey map for each of the surveys between 2002 and 2008 included in the original analyses and re-calculate the numbers of birds within that revised boundary on each survey. The mean of those numbers across surveys becomes the revised (lower) mean of peak count for each species.

Disadvantage. This approach takes no account of the way in which the most recent survey data indicates the red throated divers have redistributed**.**

b) Remove from the pSPA boundary all waters within the windfarm footprints and some generic concentric buffer zone around their boundaries

In applying this approach it will be necessary to decide upon the width of the generic buffer zone around the windfarm boundaries within which it is considered that relative diver usage has been so reduced as to no longer merit inclusion within the pSPA. One option would be to use a generic distance of say 4km (based on existing NE/JNCC guidance on assessment of displacement effects on divers). A better option would be to use the Lincs windfarm survey data which indicates that on average across the three years of post-construction data, the significant reduction in the % of birds held within concentric buffers around the windfarm boundaries extends out to 8km. Having decided upon that distance, the approach would be to draw that buffer around the windfarms' boundaries and use GIS to remove these areas from the existing pSPA boundary. The procedure would then be exactly the same as in Option 1a.

Advantage. Simple to do. Has the added advantage over option 1a of using information of the distance over which the relative importance of waters to divers (in terms of relative numbers present) has been seen to be reduced due to displacement of the birds.

Disadvantage: Makes the simplifying assumption that the displacement of divers has been equally distributed around the perimeter of the windfarms. The survey data indicate this is not the case. This approach would risk excluding from the pSPA some areas around the north of the windfarms where there is no evidence of a reduction in relative importance to the birds and continued inclusion of some areas to the south of the windfarms where relative importance has declined significantly.

c) Remove from the pSPA boundary all waters within which it can be determined that the reduced relative importance to divers apparent from the recent survey data, when applied to the original survey data, would result in a density below the existing MCA derived threshold density used to define the pSPA boundary.

Method:

Interrogate the LINCS/LID digital aerial dataset and establish the % change between pre (phase 1) and post (phase 6) construction in the % of all red throated divers recorded across the entire survey area that is held within each 1km by 1km cell within the windfarm footprint and each 1km buffer zone around that out to a max distance of say 10km – any maybe across the whole of GW4.

Interrogate the original 2002-2008 mean density surface used to perform the MCA (maybe just the GW4 bit). Calculate the % of the overall numbers of divers across that entire surface that is supported in each 1km * 1km grid cell. Apply the location specific % reduction values derived from the recent DAS data to the % values of the grid cells in the mean 2002-2008 density surface for divers that was used to define the existing pSPA. That will yield an area within the windfarms + say 10km buffer in which the % values are reduced such that across the entire surface the % values will no longer sum to 100%. Although not perfect, one could use those reduced % values to estimate reduced densities in each affected cell (imperfect because without any increased % values the total densities across the entire AoS will no longer add up to the right number of birds).

Alternatively one may be able to use the entire Lincs/LID dataset (GW4) to derive the % change in % supported per grid cell including the majority of the area across which those % values have increased from phase 1 to phase 6. That will sum to 100% in both phases but highlight the declines in % values in and around the OWFs. Perhaps one could then chop that equivalent GW4 are out of the original 2002-2008 mean density surface, calculate the cell by cell % of the total numbers within THAT area and then apply the % change values to those % values and then convert those altered % values back to densities to sum back up to the correct total numbers of birds across GW4 in the 2002-2008 mean density surface. That will yield lower densities in and around the OWFs and higher densities elsewhere within GW4.

Then, use the existing MCA derived threshold diver density to identify those cells in and around the windfarms where the revised diver density now falls below that threshold.

Either: i) revise the boundary by simply excluding all cells where revised diver density falls below the threshold OR ii) apply a pragmatic approach based on the resultant map of revised densities to define a more simple revised boundary which uses the minimum number of straight lines to exclude the bulk of the cells in which densities in and around the OWFs now calculated to fall below the MCA threshold.

Finally, overlay this revised boundary on the distance re-scaled survey maps for each of the surveys between 2002 and 2008 included in the original analyses and re-calculate the numbers of birds within that revised boundary on each survey. The mean of those numbers across surveys becomes the revised (lower) mean of peak count for each species.

Advantages:

Relatively simple to do.

This is probably the most scientifically justifiable of the sub-options. It has the advantage of making use of the site specific redistribution data, and could lead to a revised boundary that reflects that redistribution in quite a detailed way – i.e. varying distances from the windfarm boundaries in different directions. It also has the advantage of meaning that the entire boundary of the pSPA is informed by use of the same MCA threshold for divers.

It is highly unlikely that the numbers of any of the three qualifying features, although reduced within the revised boundary, will be reduced to the point that they no longer meet the qualifying criteria on which they were selected (this is also true of 1a and 1b).

No need to revise any other part of the site boundary so presumably no need to re-consult (this is also true of 1a and 1b).

Disadvantages:

More complex than 1a or 1b. To do in the most refined cell-by-cell way would likely involve some crunching of the Lincs developer's dataset (if we have access to that).

Site boundary and numbers of birds supported within it will still be based on relatively old data (now c 10 years + old) gathered using a survey method that has been superseded. Our understanding of the distribution of divers within the revised pSPA boundary (and any conservation objectives that may reflect that understanding) will not reflect the current distribution of birds that may at least in part have arisen due to the re-distribution of birds away from the windfarm areas and into the remaining parts of the pSPA. This disadvantage also apply to Options 1a and 1b.

WHAT FOLLOWS COVERS THE OTHER OPTIONS AND COULD BE DELETED FOR A PAPER THAT PRESENTS ONLY THE FRONT-RUNNER

Option 2. Use the most recent digital aerial survey data (post-construction) in isolation as the basis for defining a new pSPA boundary and numbers of birds supported within that boundary. This is NOT really a viable option

Method:

Use only the most recent years' digital aerial survey data from the LINCS/LID windfarms and analyse in the same way as was done for each of the years of visual aerial survey between 202 and 2008. Generate a density surface map for each species in each survey in each winter season. Combine the maps from the peak surveys across years into a mean density surface for each species.

Apply Max Curve Analysis (MCA) to the mean diver density surface and define a new boundary based on diver distribution.

Calculate numbers of divers, scoters and little gulls supported within this revised site boundary.

Advantages:

Would effectively provide an "up to date" evidence base for the pSPA taking account of the shift in the distribution of divers. Evidence base would be derived from a single up to date survey method (digital survey).

Disadvantages:

The areas covered by the digital surveys include only a proportion of the wider Area of Search covered by the original 2002-2008 visual aerial surveys. The digital survey data omits large chunks of the pSPA to the north and south of The Wash. It covers an area broadly equivalent to the area covered by surveys in 2007/08 which JNCC considered unsuitable for inclusion within their original analyses due to incomplete coverage of the RT Diver population across the wider Area of search. Any boundary derived from these data in isolation would NOT reflect the full extent of the "most suitable territory" for divers (or the other species) on this stretch of the English coast – large areas and numbers of birds would be omitted. This disadvantage is so great that really this is NOT a viable option. Furthermore, any revised boundary that came out of this approach would be so radically different to that of the existing pSPA (albeit probably a lot smaller) that re-consultation would probably be necessary.

Option 3. Combine the recent DAS data from the windfarm developers with the original visual aerial data sets from 2002-2008. This is a very messy and complicated option.

Method:

The original analyses of the visual aerial survey data from 2002-2008 involved the synthesis of survey coverage across years in only 2 of which was the entire Area of Search surveyed. In other years there was only partial coverage. Provided these surveys with partial coverage were considered "representative" they were included in the analysis in which surveys form different years were combined. In theory, the restricted survey areas covered by digital surveys in the more recent years could be included in the same way if considered "representative" enough (though as noted above the windfarm DAS surveys cover an area equivalent to that surveyed in 2007/08 which was previously considered unrepresentative).

In this case, each DAS could be used to generate a density surface map for eg RT divers, scoters and little gulls. The survey in each winter that resulted in the peak abundance of each species could then be incorporated with those used already for each species (based on the older visual data) to generate a new mean density surface map. That could then be subjected to MCA to arrive at a new threshold density for inclusion for red throated divers and thence a new proposed boundary for the site. This would almost certainly result in the exclusion of areas in and around the Lincs/LID windfarms due to the recent reduction in **relative** usage of those areas by divers. By the same token it is almost certain that the boundary of the whole of the pSPA would change due to: i) a revised threshold density of divers for inclusion, ii) the change to the mean density surface for divers resulting from the inclusion of the additional data for the central part of the pSPA.

Advantages:

The revised site boundary and numbers of birds supported would be based on making use of ALL available survey data and take account of the altered distribution of red-throated divers following windfarm construction, and so exclude areas of sea that effectively are no longer supporting habitat for this species, or likely to be for the foreseeable future (next 20+ years).

Disadvantages:

There are numerous methodological issues that would complicate this analysis and its interpretation:

Visual aerial survey and digital aerial survey do not necessarily yield the same population abundance estimates due to differences in the detectability of the birds by these two survey methods. The evidence for the comparability of these methods is equivocal and it is not clear whether or not a correction factor would need to be applied to bring abundance estimates from the two methods into line, and if so, what that correction factor would be.

Incorporation of new digital-based data from the central portion of the pSPA into an across year synthesis would generate a mean density surface in which the densities of divers reported in the central part of the pSPA would include the recent redistribution of birds within that survey area but would not account for any redistribution that may have also occurred (due to the windfarms?) elsewhere within the remainder of the current pSPA boundary.

Similarly, the values of the mean density surface for divers within the grid cells covered by the more recent digital surveys would reflect the inclusion of those recent data. That may well see the mean densities reported across that area increased (barring the area in and around the windfarms) whereas that will not be the case out with the areas surveyed by the windfarm developers where there is no new digital data. The resulting mean density surface for divers may then be biased high over most of the areas covered by the recent digital surveys and biased low everywhere else. Application of MCA to the entire surface may generate a new higher density threshold for inclusion that would see the pSPA boundary shrink away from the more peripheral areas covered only by the older visual surveys where in fact we have no new digital survey information to tell us whether the densities in those areas are also higher now than they used to be.

All of these complications mean that it will be very hard to make a compelling case that any outcome is scientifically robust.

This approach, with all its complications, would certainly lead to an altered boundary that would lead to the need for a re-consultation.

Option 4. Conduct a new digital aerial survey programme. This is the most scientifically justifiable option but comes with considerable financial and time costs.

Method:

Start from square one. Commission a programme of digital aerial surveys of the entire Area of Search originally covered by visual aerial surveys between 2002 and 2008. At least two complete surveys per winter would be needed – and arguably more than that if the aim is to capture the

differing periods of peak abundance of little gulls in comparison with the divers and scoters. Surveys would be needed over a minimum of two years and ideally three successive winters.

All of those survey data would then need to be subjected to the approach applied previously to the 2002-2008 datasets to generate new mean density surface maps for each species and then each of those subjected (where possible) to Max Curve Analysis to identify a revised site boundary and thence revised population abundance estimates for each of the site's qualifying features.

Advantages.

This would be entirely scientifically justifiable. The resultant site boundaries would reflect the current distribution of all species. Any areas that now support densities that are too low to merit inclusion using the MCA approach (due eg to any recent redistribution) would be excluded. Population abundance estimates used at classification would be "current" and based on the current survey method of choice i.e. digital survey. Thus Conservation Objectives for the site can be based on an understanding of the current distributions and abundances of each of the site's qualifying features. This approach may allow for the inclusion of additional features which the new survey method may identify.

Disadvantages:

Considerable time implications. Too late to kick start surveys this winter. So earliest re-surveys would start in autumn 2018 (for little gull). Minimum of 2 years to gather data (possibly 3). With just two winters' data collection, surveys will not be complete until March 2020 (March 2021 if three years data collected). Thereafter at least one and probably two more years of "process" to get back to where we are now.

Considerable staff resource implications and financial implications. Each individual survey flight may cost c£20k. That would be maybe £60k per winter * 3 winters = £180k PLUS the costs of all associated data analyses and reporting.

Conclusions.

There is a host of alternative approaches that could be considered. The most scientifically robust approach would be to start again and to carry out a 2-3 years programme of repeated surveys of the entire Area of Search originally covered between 2002 and 2008, this time using digital aerial photography (Option 4). The resultant data would be analysed as before to define a revised boundary for all of the sites features (which incidentally may change). This option comes with large time and financial costs.

The other options seek to make use of existing survey data. These options vary in their complexity. The consensus view is that if any of these are to be pursued, the simplest option (options 1 a-c) is to be preferred as the more complex approaches are also more "messy" and so less scientifically robust.

With the exception of Option 4, the merits of all of the others would need to take account of the caveat that none of them will deliver a pSPA (and Conservation Objectives for that pSPA) that is based on an understanding of the current distribution and abundance of the site's qualifying

features throughout the site. Thus, additional survey work, of the type described under Option 4, would be needed to provide that up to date evidence base (in the same way as we are currently engaged in re-surveying the Outer Thames Estuary SPA using digital aerial survey methods).

Of all of the options, Option 1 is the one that is easiest and quickest to deliver. It is also the simplest to explain what has been done. Of the 3 sub-options, option 1c provides the most pragmatic approach to the problem of the divers' redistribution and the fact that the areas in and around the windfarms that previously supported relatively high densities of these birds no longer do so and are unlikely to do so for two to three decades.

However, having, in our previous advice to Defra on this site, made the case that to reconfigure the boundary this way would risk compromising the integrity of the site, due to the exclusion of an area of inherently suitable marine habitat from a core location within the pSPA (that habitat with all of its functional linkages to the habitat around it still remaining) that advice has to remain the same.