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Urban Breeding Gull Surveys: A Survey Design Simulation ANNEX: Results for Northwest England

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To support delivery of the latest census of the breeding seabird population of Britain and Ireland, a previous Natural England commissioned report (Ross *et al.* 2016) reviewed the survey methods in order to make recommendations for the most cost-effective survey design for quantifying (urban) gull abundance in UK and Ireland. Within that report, recommendations were made on the expected necessary coverage, with reference to previous analogous bird surveys across similar geographic scales. This report builds on Ross *et al.* (2016) using computer simulations to examine how survey coverage affects the precision of population estimates. This work will provide a first step towards improving the population estimates of urban gulls, assuming surveys go ahead in the future.

In this Annex, we provide specific results for northwest England. The definition of the region follows that presented in Ross *et al.* (2016), which itself follows that used by the 2003/04-2005/06 Winter Gulls Roost Survey (Burton *et al.* 2013).

As for other regions, the confidence intervals around population estimates of Lesser Black-backed Gulls and Herring Gulls reduced with increased coverage of both tetrads and 10-km grid squares (Figures A1 and A2 respectively). However, the improvement was most apparent through increased coverage of 10-km grid squares. This likely reflects that (within any one region), at low levels of coverage, there is likely to be greater variability in the relative abundance of gull populations between 10-km squares than within a given 10-km square.

Similarly, as for most other regions, confidence intervals dropped sharply with an increase in coverage of 10-km grid squares up to around 20-40 squares, but beyond this, the benefits of increased coverage were less.

The urban weighting was effective at reducing the size of confidence intervals relative to increased coverage of 10-km grid squares for both species (Figures A3 and A5 respectively), although this effect was less apparent than for some other regions (such as Wales, Scotland and Ireland). The coastal weighting was more effective at reducing the size of confidence intervals relative to increased coverage of 10-km grid squares for Herring Gull than Lesser Black-backed Gull (Figures A4 and A6 respectively) and, for Herring Gull, also more effective in comparison to the urban weighting. (It should be noted that the protected sites at which the species are listed as interest features, i.e. the Bowland Fells SPA, the Ribble & Alt Estuaries SPA, the South Walney and Piel Channel Flats SSSI.)

Based on these results, a provisional recommendation for the region might be that there should be a minimum of 20 10-km squares covered, with 50% coverage within these 10-km squares. Ostensibly, the 10-km squares selected within a region for a survey of Lesser Black-backed Gull should not need to differ to those selected for a survey of Herring Gull. However, a weighting towards the coastal stratum would be of benefit for Herring Gull.

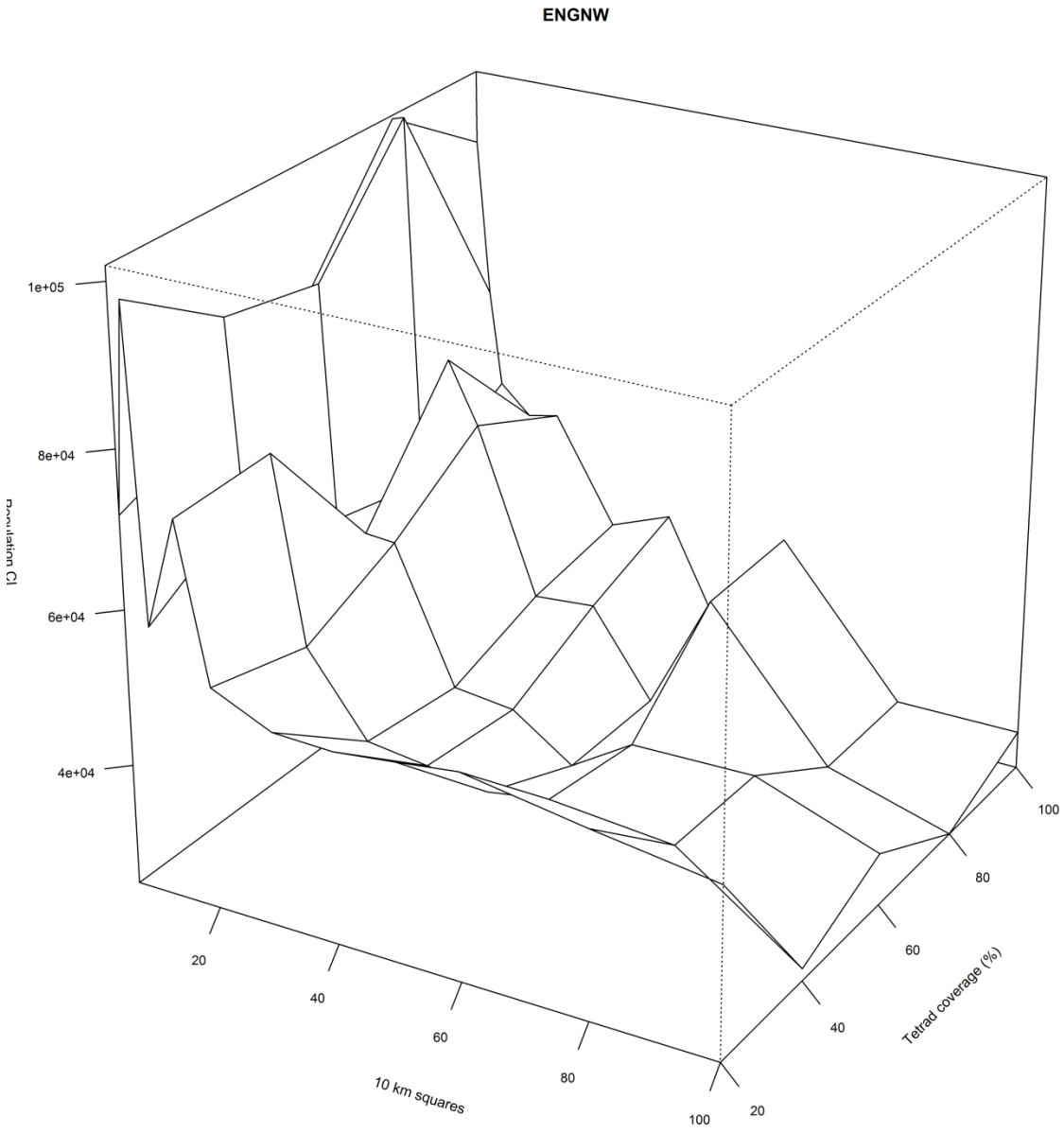

Figure A1 Confidence intervals around population estimates for Lesser Black-backed Gulls in northwest England based on different levels of survey coverage simulated by sampling from the Bird Atlas 2007-11 data and with sample coverage un-weighted in relation to coastal/inland or urban/non-urban strata.

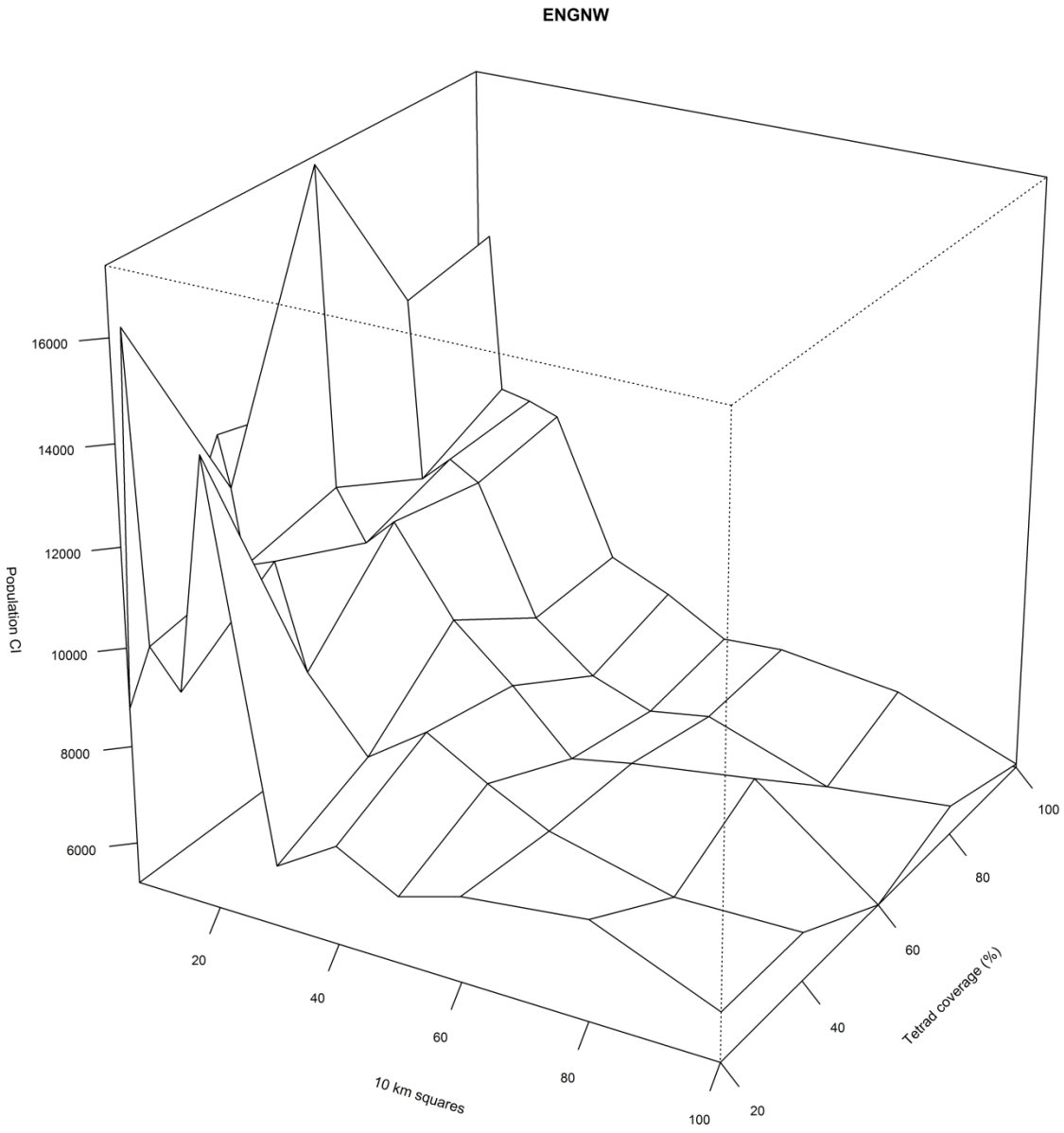

Figure A2 Confidence intervals around population estimates for Herring Gulls in northwest England based on different levels of survey coverage simulated by sampling from the Bird Atlas 2007-11 data and with sample coverage un-weighted in relation to coastal/inland or urban/non-urban strata.

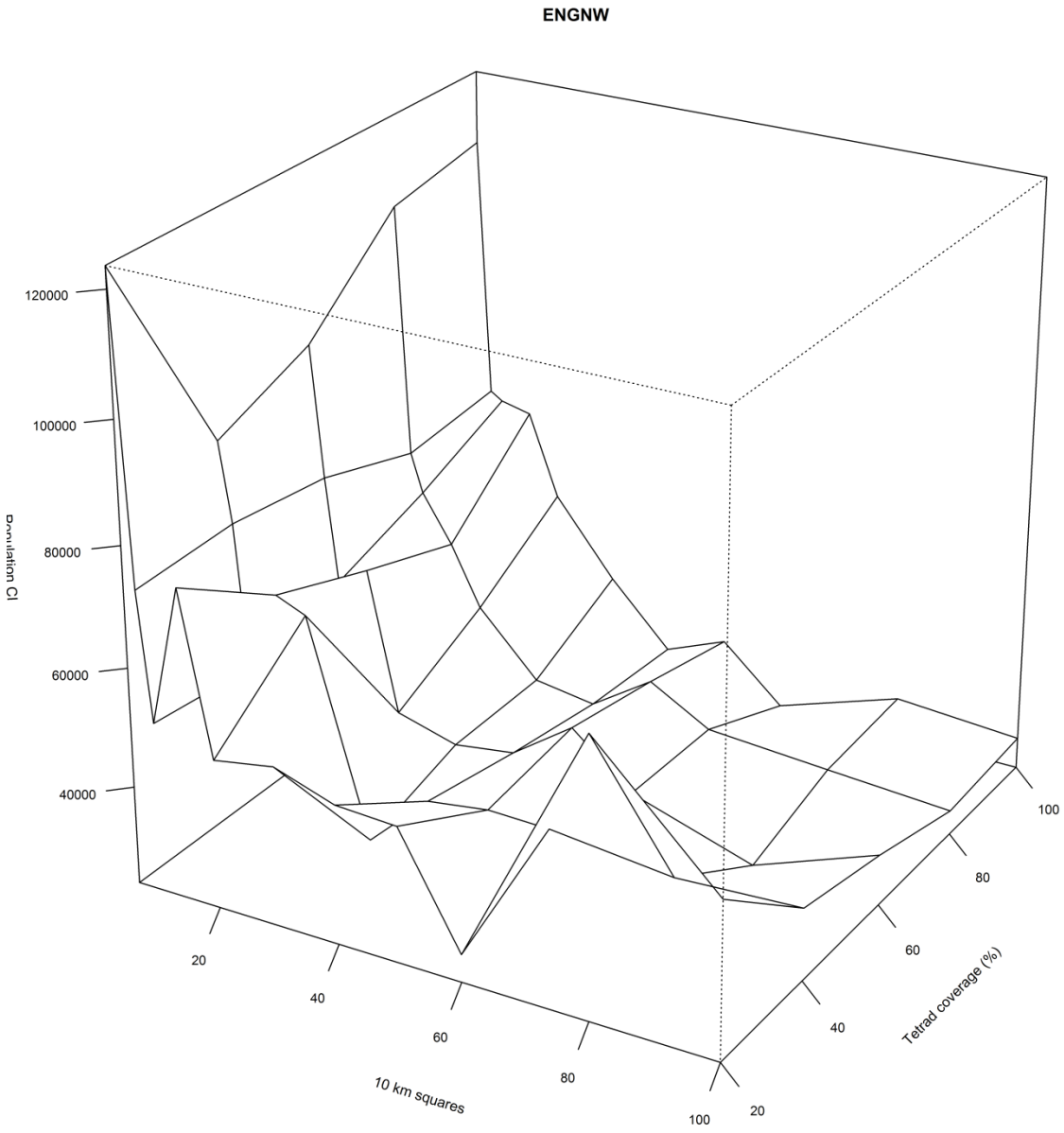

Figure A3 Confidence intervals around population estimates of Lesser Black-backed Gulls in northwest England based on different levels of survey coverage simulated by sampling from the Bird Atlas 2007-11 data and with sample coverage weighted to urban 10-km squares (see methods).

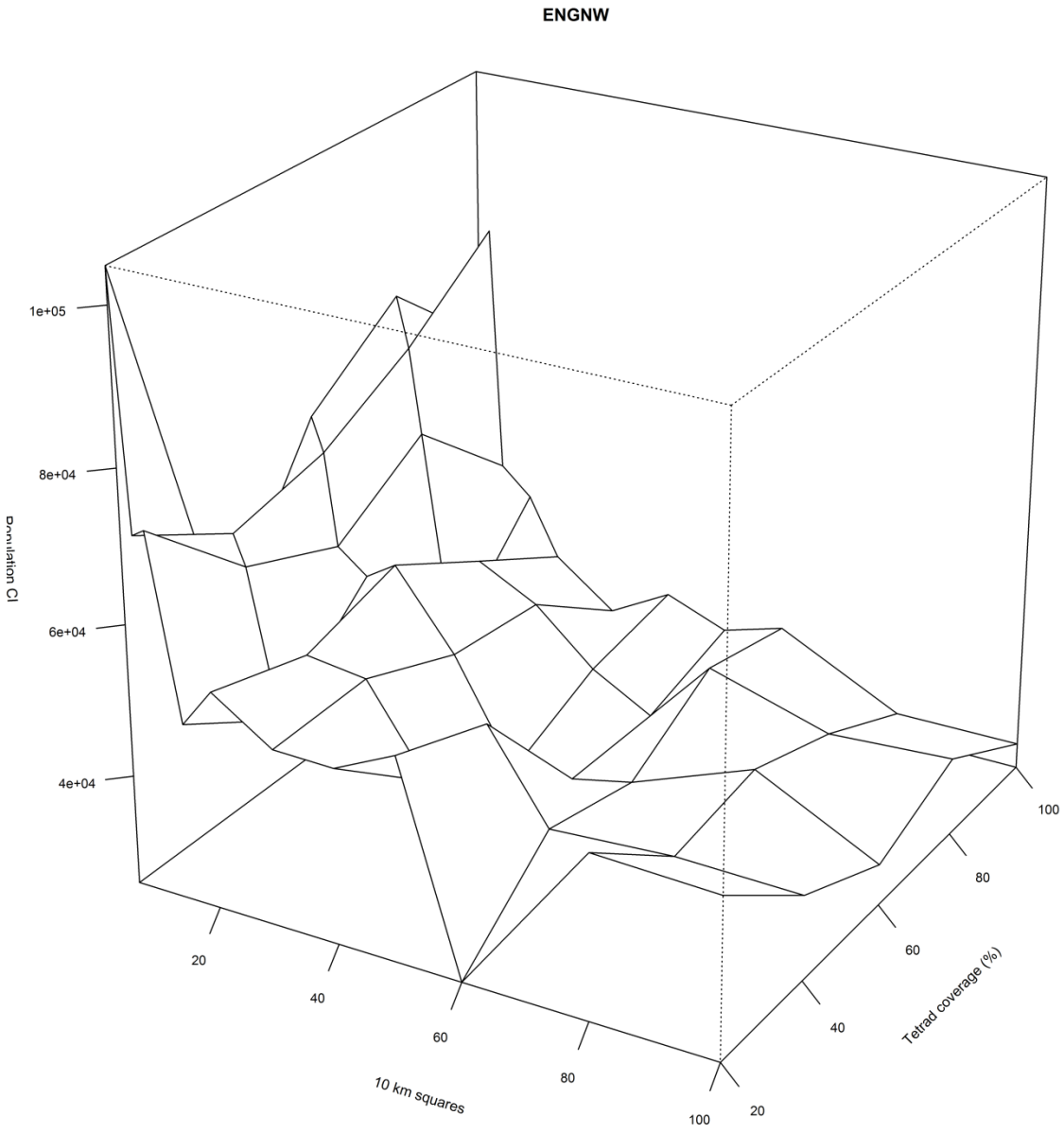

Figure A4 Confidence intervals around population estimates of Lesser Black-backed Gulls in northwest England based on different levels of survey coverage simulated by sampling from the Bird Atlas 2007-11 data and with sample coverage weighted to coastal 10-km squares (see methods).

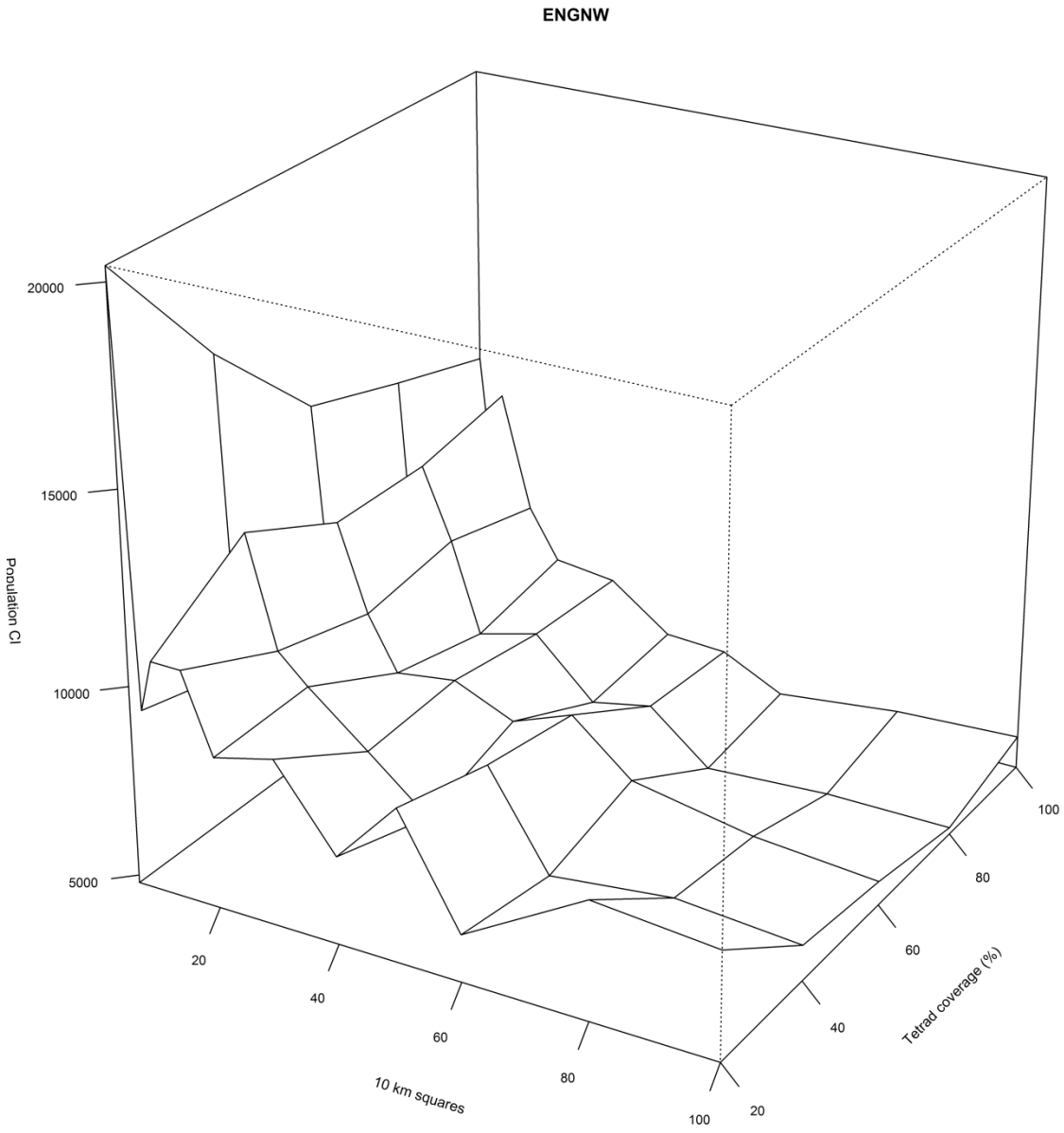

Figure A5 Confidence intervals around population estimates of Herring Gulls in northwest England based on different levels of survey coverage simulated by sampling from the Bird Atlas 2007-11 data and with sample coverage weighted to urban 10-km squares (see methods).

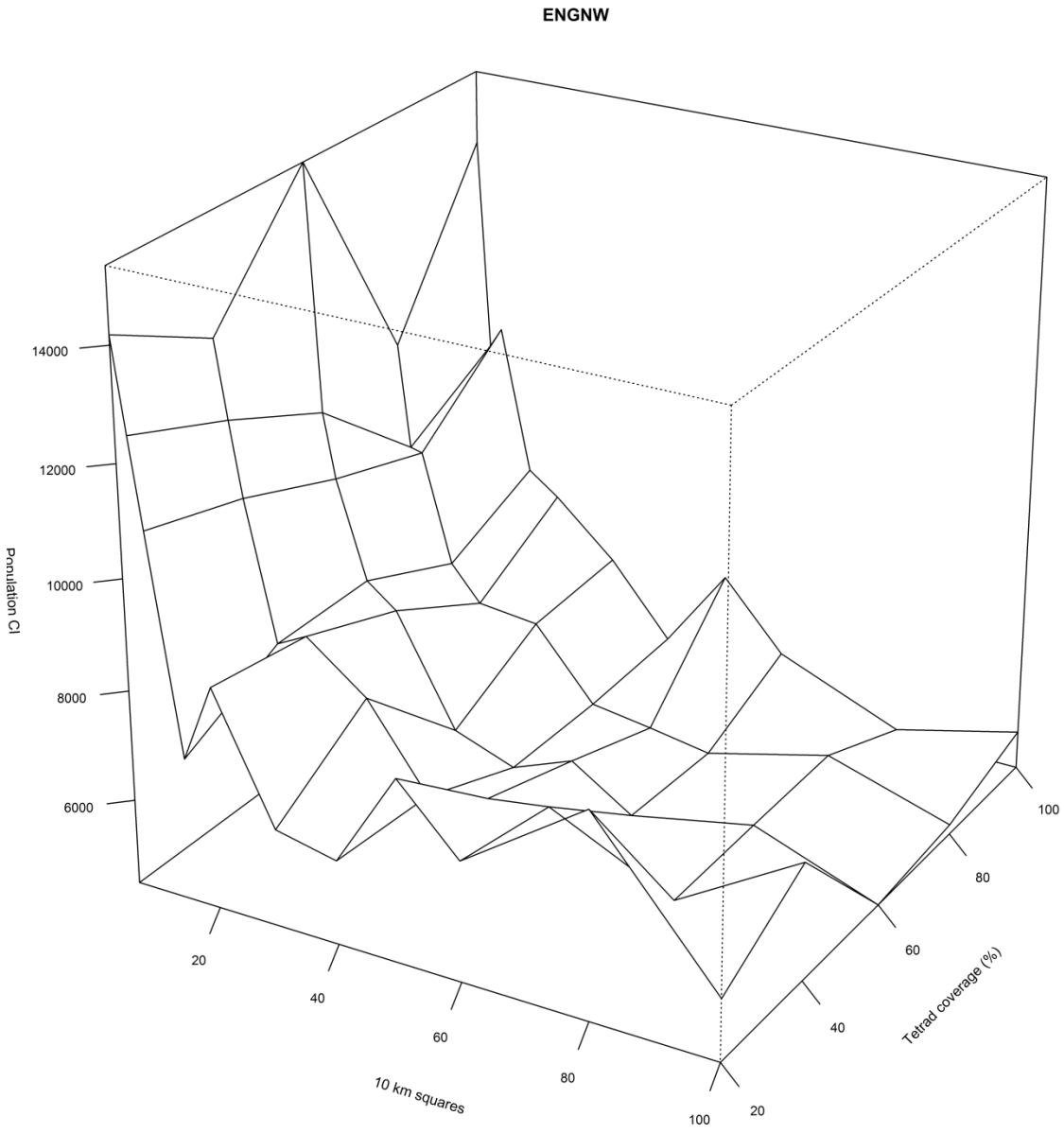

Figure A6 Confidence intervals around population estimates of Herring Gulls in northwest England based on different levels of survey coverage simulated by sampling from the Bird Atlas 2007-11 data and with sample coverage weighted to coastal 10-km squares (see methods).