Using an appropriate spatial resolution.
Why has a 1km resolution been used for these maps?

The maps of natural capital metrics presented here are derived using statistical modelling. These techniques extrapolate from a set of sampled locations, to national scale. As not everywhere is sampled, values assigned to unobserved locations are predicted from the statistical model. When presenting predictive maps of natural capital metrics, it is important to consider the scale at which the information is presented. There are inherent trade-offs when using fine or coarse scale spatial resolutions and, to avoid false accuracies, any decision will need to be influenced by the resolution of the underlying data sets within the statistical model. The choice of spatial scale in model predictions can influence:

1. **The accuracy of prediction -** Depending on the underlying data and model, fine spatial resolutions can often give a false sense of accuracy; they can present results at a resolution not borne out by the data. Coarser resolutions, however, can fail to show sufficient detail. Essentially coarser resolutions average out the extreme ranges of the variable being modelled.
2. **The uncertainty of the prediction -** There can be increased uncertainty when trying to predict at a fine resolution because the underlying data is more variable at that scale. At a coarser resolution, where the detail has been smoothed out, uncertainty can increase because the predictions are no longer representative of the raw data.

We investigated both of these issues in detail to decide an appropriate spatial scale to use.

1. Prediction Accuracy

We investigated this by predicting the number of nectar providing plant species in a small area of west Cumbria, across varying scales: 25m, 1km and 10km. These predictions are based on models that take into account the land cover, altitude, temperature, precipitation and nitrogen deposition. The resulting maps are shown in Figure 1. The maps highlight issues with both the 25m and 10km maps. In the 25m map, the black circle shows a clear straight line north to south of a red block. Here, one of the key data sets used within the model was only available at 1km resolution. This straight line is an artificial artefact, as predictions are being made at a finer resolution than some of the underlying data is available at.

Increased resolution also increases the uncertainty of the data that underlies the predictions. For example, land cover map is less accurate at finer resolutions, due to potential misclassification. The 25m map also shows a level of false accuracy by predicting areas that the underlying data is not truly representative of. The blue arrow highlights a small island on Derwent Water where a prediction is made despite the fact that the data upon which the predictions are based do not adequately sample or reflect this type of environment. This is because no sampling takes place there; small islands such as this could constitute a completely different environment outside the sampled space. In the 10km map, the vast majority of detail has been lost and the variation in the landscape has been smoothed over. The red arrow also shows that the detail of the coast has been lost.

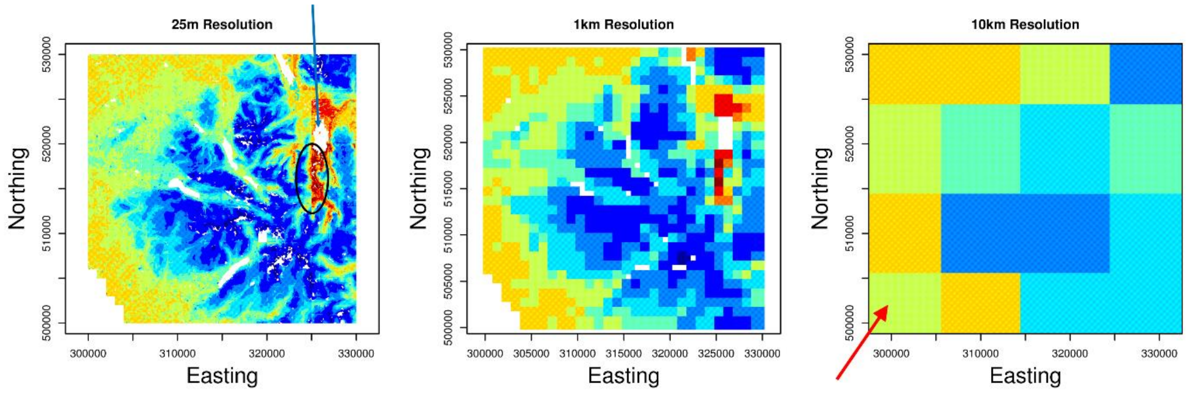

Figure 1. Predictive maps of the number of nectar producing plant species at 25m, 1km and 10km spatial resolutions respectively for an area of west Cumbria.

2. Increased uncertainty in predictions

The uncertainty in the predictions was established by comparing the predicted number of nectar producing plant species against the observed number, across the three spatial scales (25m, 1km and 10km). Figure 2 shows the results of this, plotted on a graph. The blue line represents where the observed value is the same as the predicted. On the plot for 25m resolution, one can see a large amount of scatter, representing a high level of uncertainty, around the 1:1 blue line. At this resolution, observed values are counts (hence the striping effect), whereas for the 1km and the 10km resolutions the observed values are averages. The cloud of points, and hence uncertainty, is less in the 1km predictions. This demonstrates that it can be easier to predict an average value, rather than a specific value, from the sample data. The 10km plot shows less uncertainty than the 25m one, but looks similar to the plot based on 1km predictions.

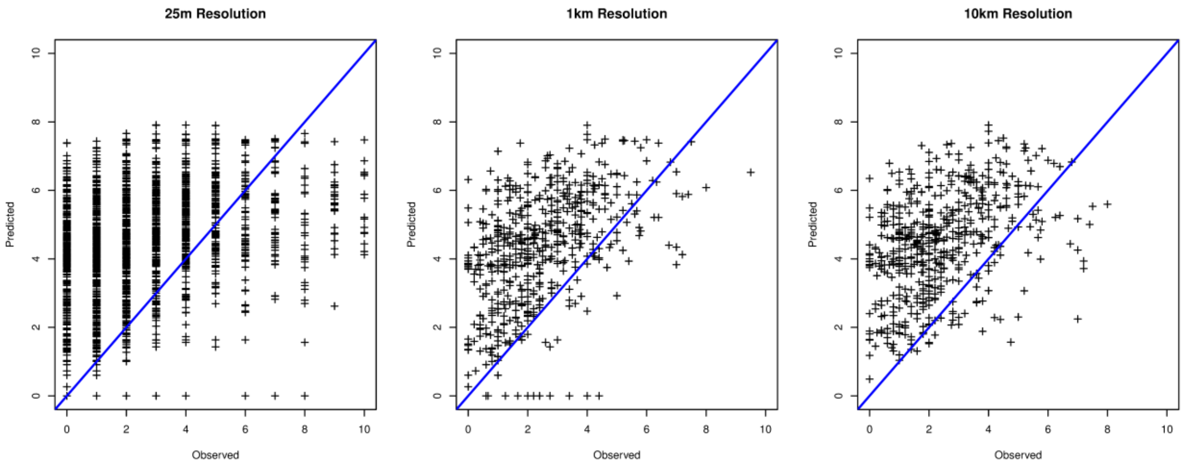

***Figure 2**. Plots of observed number of nectar producing plant species versus the predicted number based on models using data at different spatial resolutions from 25m to 1km to 10km. Note that the underlying model used here has a tendency to over-predict values, hence the reason why the points are aggregated above the 1:1 line (shown in blue), but the main aim here is on comparison between resolutions rather than on model performance* per se

To quantitatively assess the uncertainty in these predictions, and assign a value to the amount of scatter shown in the plots in Figure 2, we calculated the root mean square error. This represents the average error in the predictions against the observed values. Doing this showed that the average error was 3.01 species for the 25m predictions, 2.54 for 1km and 2.67 for 10km. The error and uncertainty was therefore less for the 1km based predictions. Though this error may seem high, its calculation here allows us to compare the error between the different scales.

Finally, the maps of uncertainty produced by the model were looked at. These are shown in Figure 3 and correspond to the predictions in Figure 1. The 25m predictions again show up some strange artefacts of the data when attempting to predict at fine resolutions. Both straight and diagonal grey lines can clearly be seen in the map. This highlights once again the issue of false accuracy, beyond the scope of the underlying model and data. In moving to coarser resolutions, the uncertainty of the predictions is essentially smoothed out across the region and the maps become more homogeneous.

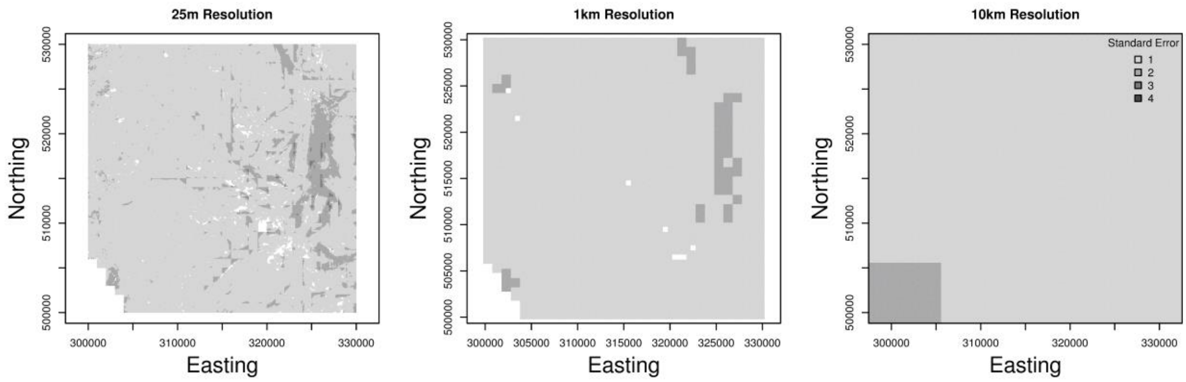

Figure 3. Maps of the uncertainty in model predictions of nectar producing plant species at the 25m, 1km and 10km spatial scales respectively for an area of west Cumbria. These correspond directly to estimates shown in Figure 1.

Conclusion

From this investigation, it was decided that 1km resolution was the most appropriate scale to use for predictions and maps of natural capital in this project. This was considered both in terms of accuracy and uncertainty.