# Identifying potential new locations for veteran and ancient trees in Cornwall

(A report for the Great Trees of Cornwall project)

ERCCIS

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Skoodhys gans An Gwari-Dall Kenedhlek Der Argh Ertach an Gwari-Dall

Cornwall ancient tree forum

Gwydh Meur a Gernow | Great Trees of Cornwall

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Identifying potential new locations for veteran and ancient trees in Cornwall

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Front page image by Alison Forward

# Introduction

The Cornwall Ancient Tree Forum has been managing the Great Trees of Cornwall (GToC) project in conjunction with the National Trust over three years (2008 – 2011). The Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS) has been asked to investigate any correlation between the extensive habitat and species information (held and managed by ERCCIS) and the ancient, veteran and maiden tree data set (called ancient and veteran trees in this report) produced as part of the GToC project to predict the possible location of other ancient and veteran trees and to inform recording effort in the future. This report aims to answer two questions;

Q1. Is there a correlation between the records of 'key' indicator species (lichen, fungi & invertebrates full list in the Appendix) and the recorded veteran and ancient trees in Cornwall?

Q2. Can spatial analysis and geo-analysis of the data set be used to predict the location of ancient and veteran trees?

# Methods

**Indicator species and ancient tree data**

With National experts and County Recorders, a list was compiled of the species known to be associated with ancient and veteran trees. Three species groups were decided as the most useful indicators; invertebrates; lichens and fungi. The full list can be found in the Appendix and is referred to as the indicator species list throughout this report. The indicator species list was checked against known distribution and presence in Cornwall and resulted in some species being removed where normal distribution in Cornwall was unclear. This resulted in a list of 16 fungi; 71 lichens and nine invertebrates species all associated with ancient and veteran trees.

Species dictionaries were used to ensure that all 96 species were taxonomically correct and as many of the fungi and lichen have a variety of synonyms, historical and vernacular names. The resulting search for the indicator species totalled 457 species names. This was run against the approximately 3 million species records held by ERCCIS (May 2011).

The Cornwall Ancient Tree Forum, with partner organisations and individual recorders, co-ordinated through the GToC project, have sent all their ancient and veteran tree data to the Woodland Trust. This data set of recorded and verified ancient, veteran and notable trees in Cornwall resulted in 608 records to use in this investigation. For recording, verification methodology and further details on recording of ancient trees see www.ancient-tree-hunt.org.uk.

# Methods

## Geo-spatial Statistics

Geo-spatial statistics were used to investigate the relationship between known ancient and veteran trees and indicator species. This field of statistics has been emerging for several years and now thanks to desktop GIS packages allows easily repeatable and interpretable data analysis. Data sets were subject to 2 statistical tests;

1. * Hotspot analysis (calculating the Getis-Ord Gi* statistic)
2. ** Kriging analysis

Figure one demonstrates the mapped location of the known ancient and veteran trees data and the associated indicator species data. The collected indicator species data is summarised in table 1.

| Species Group | Number of species found in ERCCIS database (number of species searched for in brackets) | Number of records found in the ERCCIS database | Date Range |
|---|---|---|---|
| Fungi | 4 (16) | 56 | 1882 to 2010 |
| Invertebrates | 8 (9) | 10 | 1906 to 2009 |
| Lichens | 63 (71) | 3290 | 1799 to 2010 |

**Table 1** : Summary of the data search through ERCCIS database for indicator species.

* The Getis-Ord Gi* statistic look to see if values with either high or low values are clustered spatially, the returned information for each feature in the data set is called a z-score. For statistically significant positive z-scores, the larger the z-score, the more intense the clustering of high values (hot spot). For statistically significant negative z-scores, the smaller the z-score, the more intense the clustering of low values (cold spot).

** The Kriging model uses z-values from the points to create an estimate geographic surface; it assumes that the distance or direction between sample points reflects a spatial correlation that can be used to explain variation in the surface, in our case that the location of trees or associated species will predict the most likely location of currently unknown trees. Spatial autocorrelation (which include Kriging) quantifies a basic principle of geography; things that are closer together are more alike than things that are farther apart. The models can be used to describe and demonstrate spatial patterns and predict the possible values at unmeasured locations and also predict the uncertainty at the unmeasured locations.

# Results

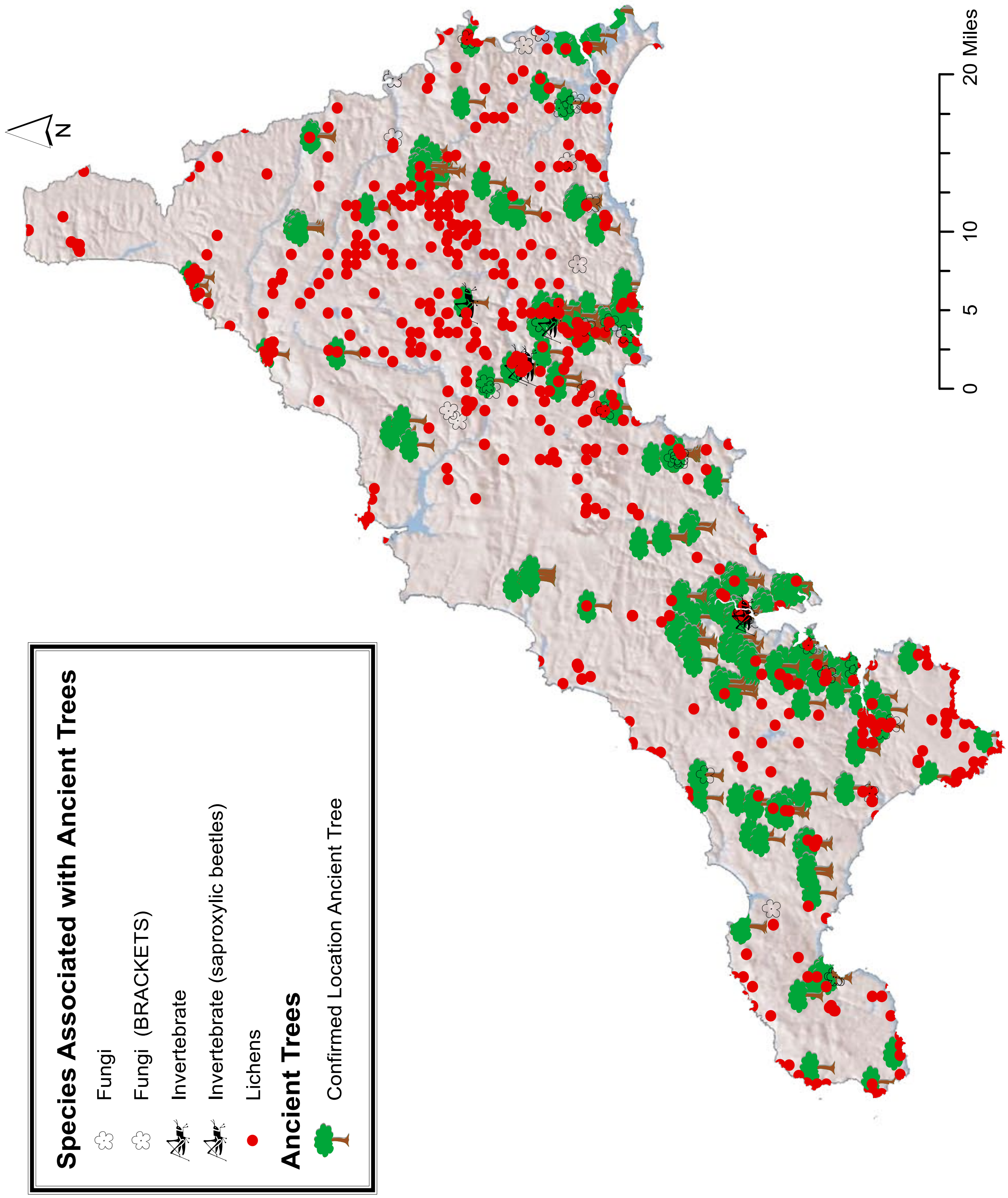



**Figure 1** : Location of the known ancient and veteran trees (Woodland Trust data set) and indicator species associated with ancient and veteran trees (ERCCIS data set).

# Results

The analysis began with two null hypotheses;

1. That there is no clustering of indicator species records, that the species records are a result of chance.

2. That there are no areas in Cornwall that are more likely to contain ancient trees than any other.

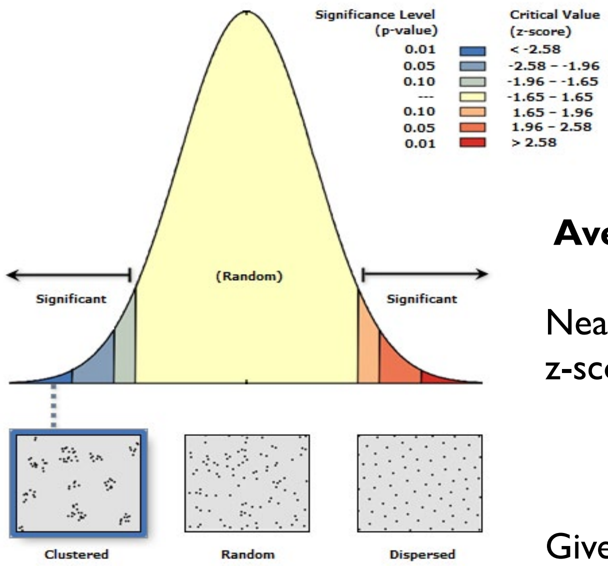
We ask the first hypothesis to establish that the species records are clustered, as we would expect that ancient trees would only be found in certain landscape areas, for example parkland. Figure 2 demonstrates that there is clustering and therefore answers the first hypothesis. This is answered using a nearest neighbour analysis (this could also be achieved by buffering the tree location to a fixed distance and looking at the overlaps). The result is expected to show clustering, which is a very high or very low z-score.

However with only 3356 indicator species records in the land area of Cornwall (361,000 hectares), there will be a high degree of uncertainty in the results. Also it is expected that recorders will record in certain clustered areas (for example their home tetrad) so be aware that the results may be more indicative of recording effort and patterns.

The z-score shown in figure 2 disproves the first null hypothesis and allowing for possible errors indicates that indicator species data is clustered and may indicate ancient and veteran tree locations. Table 1 demonstrates that 66 invertebrate and fungi records were found from the ERCCIS database search. Sixty four of the 66 records are within 100 metres of recorded ancient trees, so this thus providing two potential new locations to search!

Only 1% of lichen records were within 100 metres of known ancient trees. This could indicate that there are a lot of possible locations to search. However there are a large numbers of lichen species around areas not currently thought to have ancient trees. This implies that the selected lichen will also be present on non-ancient tree substrate. Without significant additional data manipulation and input from an expert lichen recorder this issue is outside of the scope of this report.

# Results




### Average Nearest Neighbour Summary

Nearest Neighbour Ratio: 0.146587
z-score: -82.541122

### Result

Given the z-score of -82.54, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

**Figure 2** : Results of nearest neighbour test and graph demonstrating result.

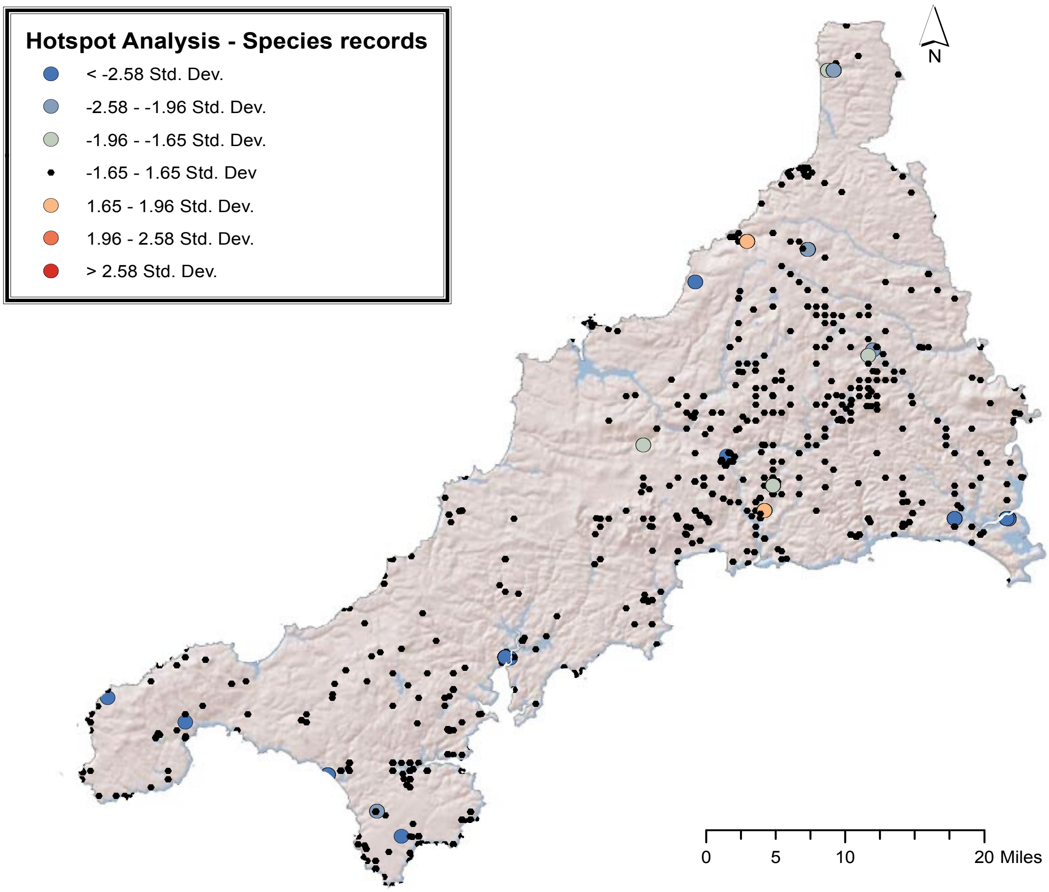



**Figure 3** : Hotspot analysis of indicator species associated with ancient and veteran trees.

# Results

The second null hypothesis was used to investigate the indicator species data set. Answering the second null hypothesis proved problematic as any geographic analysis works best if comparing numerical values within polygons, for example the level or size of something. The indicator species data set was found to have no suitable comparable data. Various methodologies were tried including; polygon conversion; number input and grid transformation, the resultant hot-spot analysis (figure 3) is the best available interpretation of the data.

Due to the limited numbers of invertebrate and fungi records and the uncertainty in the lichen growth substrate, it was decided that the investigation of the indicator species data set was taken as far as possible, but figure three does not answer the second question posed in the introduction (Q2.) asking where is best to search for ancient and veteran trees.

Other data sources and options were investigated. Two possible alternatives were to look at all the species records for trees held by ERCCIS, approximately 40,000 records (May 2011). Secondly the land cover GIS layer could be compared to historic maps (for example the 1880 Ordnance Survey (OS) maps), looking at known historic estates.

Unfortunately investigation into a huge species data set with limited information on size of tree or a wide scale habitat analysis is outside scope of this project and provides no guarantee it would reveal any new ancient or veteran tree information. Without significant amount of data manipulation and verification the species and habitat data was of limited use in this investigation and did not give us a satisfactory answer to the question posed in the introduction.

A hotspot analysis was therefore performed on the verified ancient and veteran tree layer, indicating the areas of significance of known trees not unknown trees. The analysis showed that parks (for example Lanhydrock) and urban areas (for example Truro) are hugely significant for ancient and veteran trees, probably an indication that people have only recorded in these areas.

Therefore to answer the second question, if the data sets provided a level of location prediction, a geo-spatial analysis (Kriging analysis) of known locations was performed to predict values at unmeasured locations (figure 4). This used the measured girth of the trees, the spatial location and contours or base heights to predict where ancient trees might be located.

# Results

The model was then used to look at the uncertainly of the results. Figure 5 shows the map of predicted spatial areas that may contain ancient and veteran trees with a girth over 4 metres (please see www.ancient-tree-hunt.org.uk for tree measuring techniques). While certain tree species, for example Hawthorn (*Crataegus monogyna*) and Holly (*ilex sp.*) count as ancient or veteran trees when they attain a diameter of a couple of metres these species made up only 5% of the data set (31 out of 608), it was decided to predict location of the large tree species.

Figure 5 prediction map has a 40% certainty of success in the most probable areas, due to the low number of records over a large geographic area. However the map is a great starting point and shows that the valleys of the River Camel and the River Fowey would statistically be the best locations to start looking for unrecorded ancient and veteran trees.

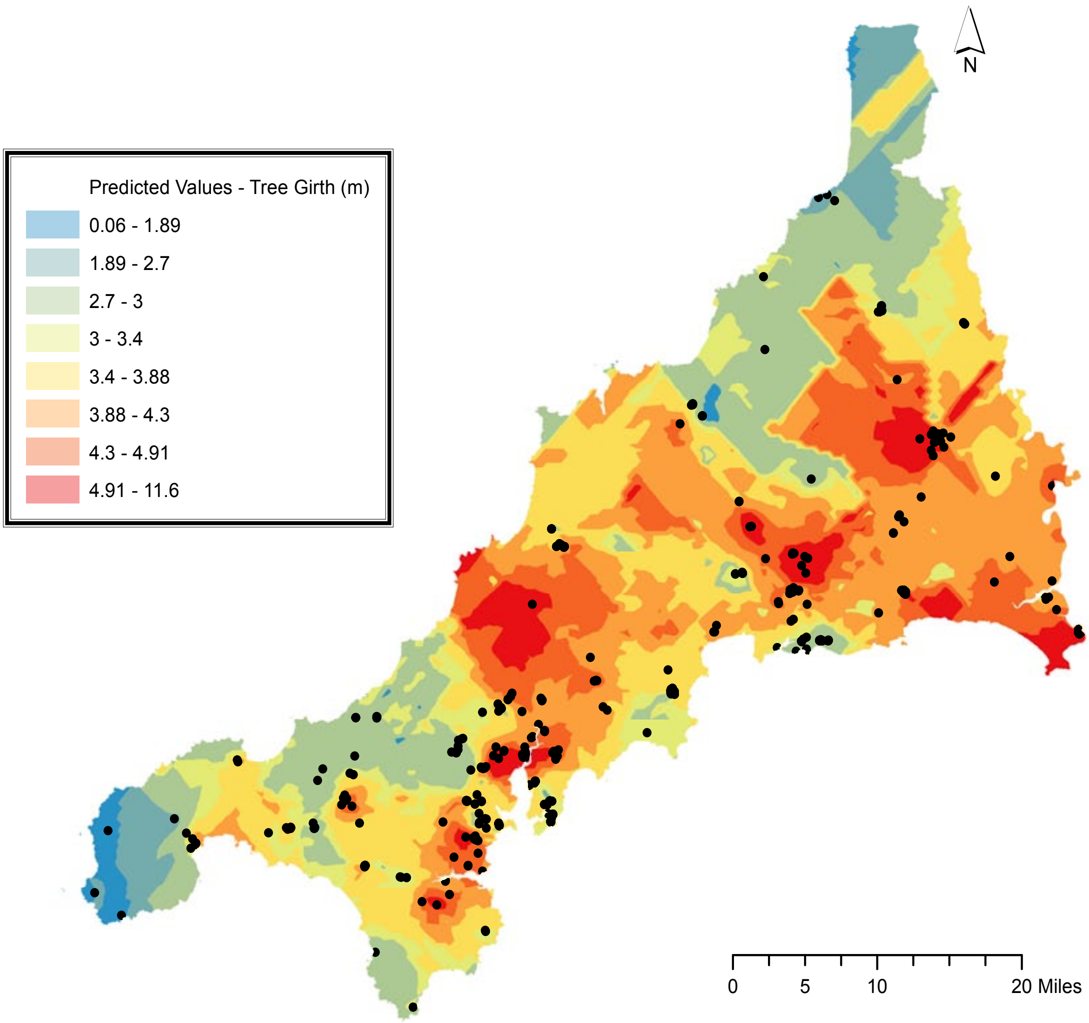



**Figure 4** : Kriging prediction analysis of the ancient and veteran tree data set. Black spots are the known ancient and veteran trees (Woodland Trust data set)

# Results

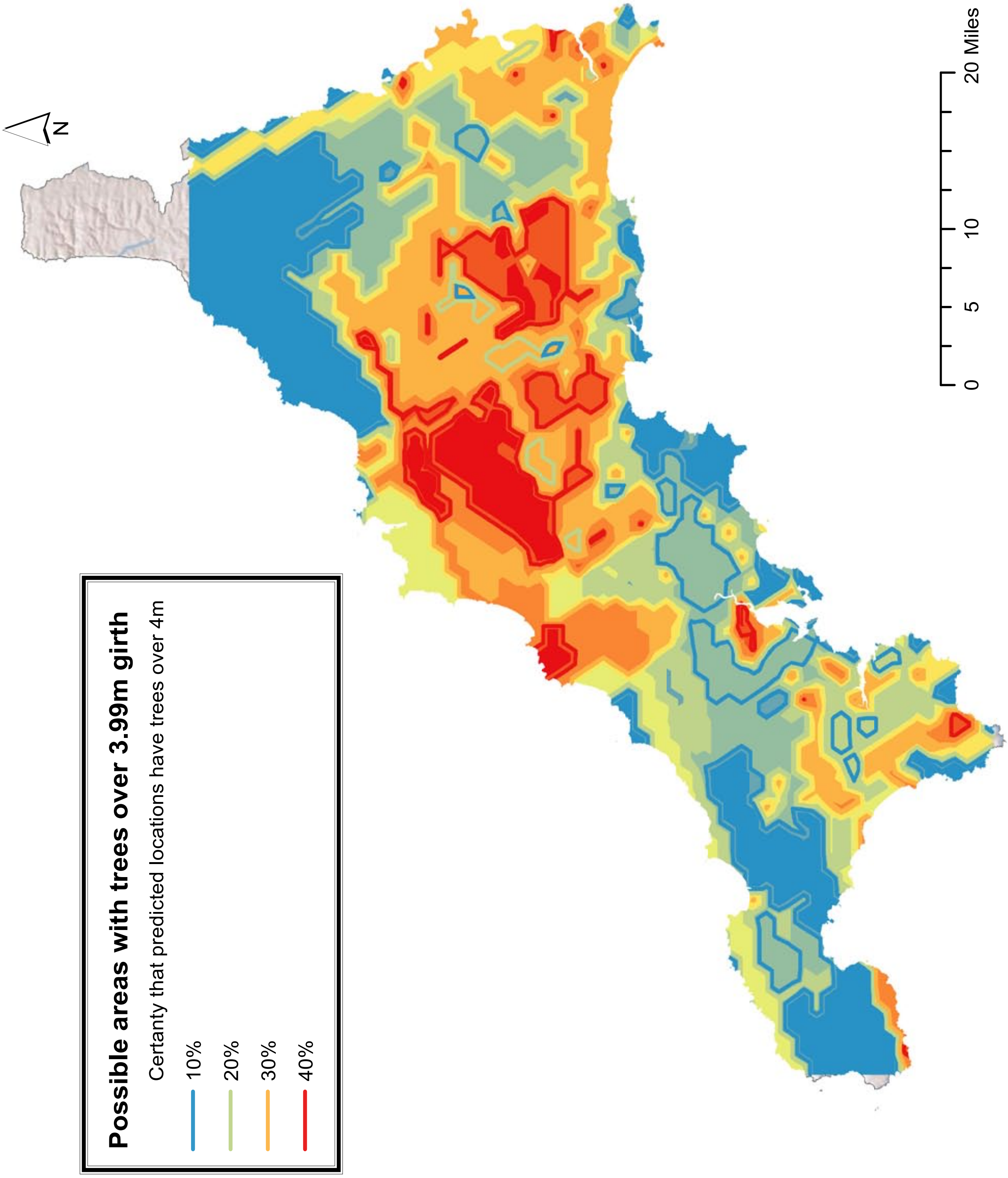



**Figure 5** : Kriging prediction of the most likely location of ancient trees in Cornwall.

# Conclusion and Future Work

This investigation has resulted in a map that members of the public, recorders and interested parties can view and investigate and will hopefully be used as a first point of reference before going and looking for new ancient and veteran trees. The map will be stored at ERCCIS and the Cornwall and Scilly Historic Environment Record (HER) at Cornwall Council. The map contains the following information;

- Location of verified ancient and veteran trees (figure 1)
- Areas to search to possibly discover ancient and veteran trees (figure 5)
- All information for a further more detailed study, including; possible search locations; location of known ancient and veteran trees; location of associated species; location of woodland from 2005 land cover (figure 6)

This investigation has demonstrated the huge amount of potential work that could be undertaken to discover ancient and veteran trees in Cornwall. As a priority there are two areas of work that need to be undertaken; adding missing records and testing the prediction map. Six hundred and eight verified ancient and veteran trees in Cornwall is a good dataset, but having consulted with recorders it has been noted that there are hundreds of records still to be sent to Woodland Trust for inclusion in the ancient and veteran tree database. The complete dataset will be available in late summer 2011, unfortunately too late for this report. Secondly testing of the prediction map, would involve asking recorders to prioritise their recording to areas with a predicted higher likelihood of containing ancient and veteran tree (for example the Camel Valley), coupled with locations containing indicator species. The results of these recording trips would be used to check the accuracy and improve the prediction map.

If more funding or staff time was available two investigations could yield excellent results. Firstly a comparison of the parkland and other landscape areas associated with ancient and veteran trees from the ERCCIS land cover layer (for detail of land cover see www.erccis.co.uk/projects/cornwall_landcover_change) with the 1880 OS map and known ancient and veteran tree location to see if a more accurate geo-spatial model could be made. Alternatively an investigation of the ERCCIS tree data sets could uncover some interesting new areas to search.

As a low priority, further study could be undertaken to split the ancient and veteran tree data set to look for tree species that have a smaller trunk diameter when they are classed and ancient and veteran trees, for example Hawthorns. An expert could re-visit locations of verified ancient and veteran trees to look for new records of the associated fungi, lichens and invertebrates species to give further guidance.

It is hoped that future work on the ancient and veteran trees of Cornwall will add to this information source and lead to the protection and preservation of ancient trees in Cornwall.

# Conclusion and Future Work

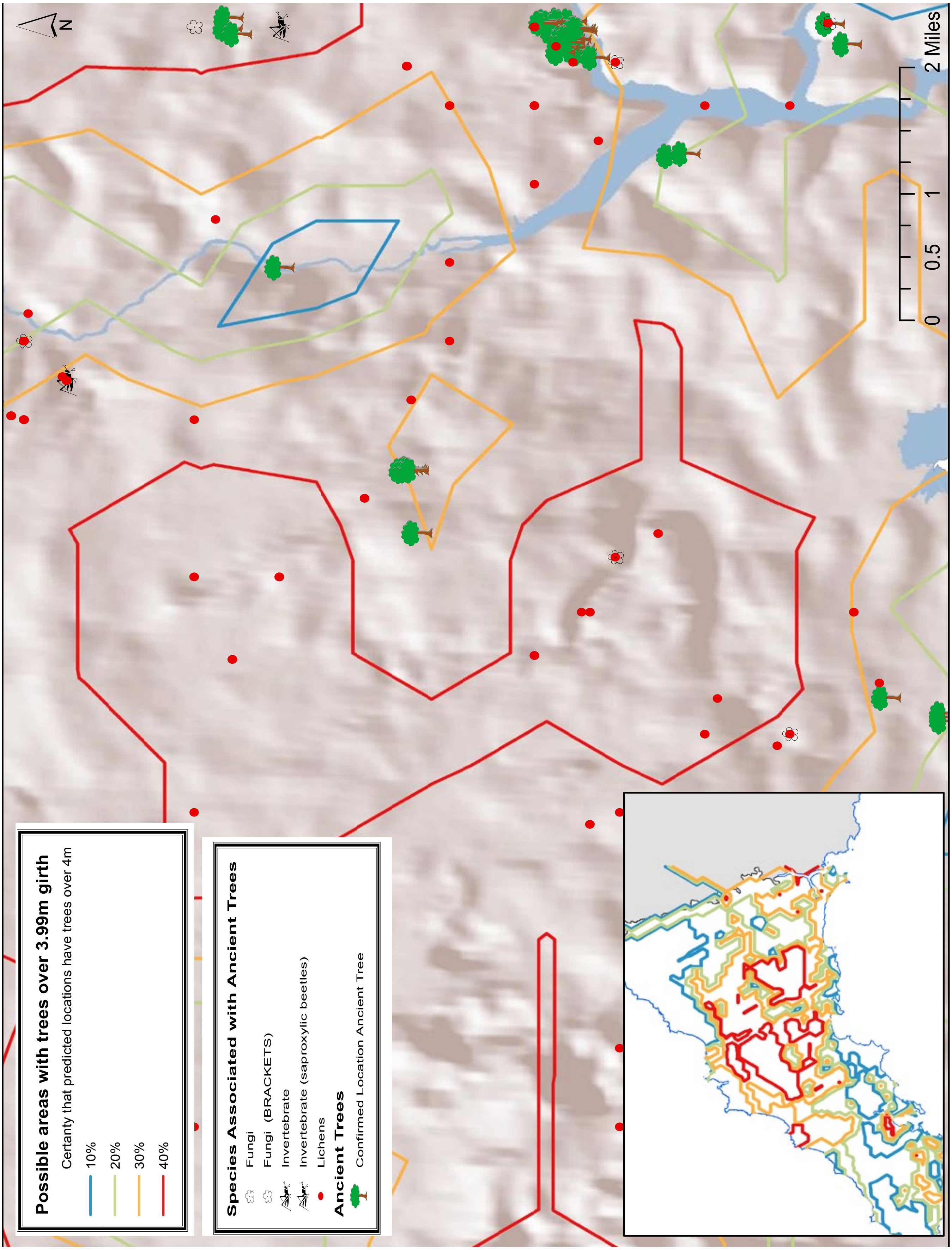



**Figure 6** : Example of an area (West Looe River Valley) to search for ancient trees with associated species and known ancient and veteran trees, map stored at ERCCIS.

# Appendix

| No of Species | Species Type | Species Name | Total No of synonyms | Total No of records in ERCCIS database |
|---|---|---|---|---|
| 1 | Fungi | *Xerocomellus engelii* | 1 | 3 |
| 2 | Fungi | *Xerocomellus ripariellus* | 2 | 0 |
| 3 | Fungi | *Xerocomellus cisalpinus* | 2 | 0 |
| 4 | Fungi | *Volvariella bombycina* | 4 | 0 |
| 5 | Fungi | *Lentinellus ursinus* | 3 | 0 |
| 6 | Fungi | *Hohenbuehelia auriscalpium* | 3 | 1 |
| 7 | Fungi (RESUPINATES) | *Ceriporiopsis pannocincta* | 5 | 0 |
| 8 | Fungi (RESUPINATES) | *Fibriciellum silvae-ryae* | 2 | 0 |
| 9 | Fungi (RESUPINATES) | *Hypochnicium analogum* | 4 | 0 |
| 10 | Fungi (RESUPINATES) | *Mycoacia nothofagi* | 2 | 0 |
| 11 | Fungi (RESUPINATES) | *Scytinostroma portentosum* | 5 | 0 |
| 12 | Fungi (BRACKETS) | *Coriolopsis galica* | 2 | 0 |
| 13 | Fungi (BRACKETS) | *Spongipellis delectans* | 4 | 0 |
| 14 | Fungi (BRACKETS) | *Aurantioporus alborubescens* | 2 | 0 |
| 15 | Fungi (BRACKETS) | *Inonotus dryadeus* | 4 | 31 |
| 16 | Fungi (BRACKETS) | *Inonotus hispidus* | 8 | 21 |
| 17 | Lichen | *Acrocordia gemmata* | 8 | 79 |
| 18 | Lichen | *Anisomeridium ranuncuiosporum* | 1 | 0 |
| 19 | Lichen | *Anisomeridium robustum ad int* | 2 | 0 |
| 20 | Lichen | *Arthonia anombrophila* | 4 | 2 |
| 21 | Lichen | *Arthonia invadens* | 3 | 1 |
| 22 | Lichen | *Arthonia pruinata* | 5 | 28 |
| 23 | Lichen | *Arthonia vinosa* | 7 | 30 |
| 24 | Lichen | *Bacidia biatorina* | 4 | 16 |
| 25 | Lichen | *Bacidia delicata* | 4 | 5 |
| 26 | Lichen | *Bacidia incompta* | 3 | 24 |
| 27 | Lichen | *Bacidia rubella* | 10 | 47 |
| 28 | Lichen | *Bacidia viridifarinosa* | 2 | 18 |
| 29 | Lichen | *Catinaria atropurpurea* | 5 | 24 |
| 30 | Lichen | *Chaenotheca trirhialis* | 2 | 0 |
| 31 | Lichen | *Chrysothrix candelaris* | 7 | 142 |
| 32 | Lichen | *Cladonia digitata* | 2 | 21 |
| 33 | Lichen | *Cladonia parasitica* | 3 | 9 |
| 34 | Lichen | *Cladonia polydactyla* | 7 | 26 |
| 35 | Lichen | *Cladonia pyxidata* | 15 | 247 |
| 36 | Lichen | *Cresponea premnea* | 14 | 62 |
| 37 | Lichen | *Dimerella lutea* | 8 | 106 |
| | | | | |

# Appendix

| No of Species | Species Type | Species Name | Total No of synonyms | Total No of records in ERCCIS database |
|---|---|---|---|---|
| 38 | Lichen | *Enterographa crassa* | 12 | 216 |
| 39 | Lichen | *Enterographa hutchinsiae* | 5 | 12 |
| 40 | Lichen | *Enterographa sorediata* | 1 | 0 |
| 41 | Lichen | *Graphina ruiziana* | 8 | 14 |
| 42 | Lichen | *Gyalecta truncigena* | 3 | 27 |
| 43 | Lichen | *Haematomma ochroleucum* | 11 | 12 |
| 44 | Lichen | *Lecanactis subabietina* | 1 | 72 |
| 45 | Lichen | *Lecania chlorotiza* | 5 | 2 |
| 46 | Lichen | *Lecanographa lyncea* | 4 | 38 |
| 47 | Lichen | *Lecidea doliiformis* | 1 | 9 |
| 48 | Lichen | *Leptogium lichenoides* | 13 | 41 |
| 49 | Lichen | *Leptogium teretiusculum* | 3 | 43 |
| 50 | Lichen | *Lobaria pulmonaria* | 10 | 173 |
| 51 | Lichen | *Lobaria virens* | 8 | 67 |
| 52 | Lichen | *Loxospora elatina* | 5 | 16 |
| 53 | Lichen | *Melaspilea lentiginosa* | 3 | 7 |
| 54 | Lichen | *Mycoporum antecellans* | 2 | 24 |
| 55 | Lichen | *Nephroma laevigatum* | 9 | 89 |
| 56 | Lichen | *Normnandina pulchella* | 4 | 0 |
| 57 | Lichen | *Ochrolechia inversa* | 3 | 21 |
| 58 | Lichen | *Opegrapha corticola* | 1 | 47 |
| 59 | Lichen | *Opegrapha ochrocheila* | 23 | 11 |
| 60 | Lichen | *Opegrapha varia* | 8 | 37 |
| 61 | Lichen | *Opegrapha vermicellifera* | 3 | 34 |
| 62 | Lichen | *Opegrapha xerica* | 6 | 1 |
| 63 | Lichen | *Pachyphiale carneola* | 6 | 13 |
| 64 | Lichen | *Parmelinopsis minarum* | 9 | 27 |
| 65 | Lichen | *Parmotrema reticulatum* | 6 | 109 |
| 66 | Lichen | *Peltigera horizontalis* | 14 | 60 |
| 67 | Lichen | *Peltigera praetextata* | 9 | 58 |
| 68 | Lichen | *Pertusaria amara var. 'pulvinata'* | 3 | 0 |
| 69 | Lichen | *Pertusaria hemisphaerica* | 2 | 20 |
| 70 | Lichen | *Phyllopsora rosei* | 1 | 24 |
| 71 | Lichen | *Porina coralloidea* | 2 | 5 |
| 72 | Lichen | *Porina hibernica* | 2 | 8 |
| 73 | Lichen | *Porina rosei* | 2 | 0 |
| 74 | Lichen | *Punctelia reddenda* | 3 | 71 |
| 75 | Lichen | *Rinodina roboris* | 4 | 63 |
| | | | | |

# Appendix

| No of Species | Species Type | Species Name | Total No of synonyms | Total No of records in ERCCIS database |
|---|---|---|---|---|
| 76 | Lichen | *Schismatomma cretaceum* | 6 | 37 |
| 77 | Lichen | *Schismatomma decolorans* | 2 | 84 |
| 78 | Lichen | *Schismatomma niveum* | 1 | 65 |
| 79 | Lichen | *Schismatomma quercicola* | 1 | 7 |
| 80 | Lichen | *Sticta canariensis sensu stricto* | 7 | 0 |
| 81 | Lichen | *Sticta fuliginosa* | 4 | 94 |
| 82 | Lichen | *Sticta limbata* | 3 | 122 |
| 83 | Lichen | *Sticta sylvatica* | 4 | 101 |
| 84 | Lichen | *Thelopsis rubella* | 1 | 16 |
| 85 | Lichen | *Thelotrema lepadinum* | 7 | 76 |
| 86 | Lichen | *Usnea articulata* | 6 | 214 |
| 87 | Lichen | *Usnea ceratina* | 18 | 116 |
| 88 | Invertebrate | *Pyrrhidium sanguineum* | 2 | 0 |
| 89 | Invertebrate | *Hypulus quercinus* | 1 | 1 |
| 90 | Invertebrate | *Megatoma undata* | 1 | 1 |
| 91 | Invertebrate | *Ctesias serra* | 2 | 1 |
| 92 | Invertebrate | *Xestobium rufovillosum* | 3 | 1 |
| 93 | Invertebrate | *Mycetophagus quadriguttatus* | 1 | 3 |
| 94 | Invertebrate (saproxylic beetle) | *Mycetophagus piceus* | 1 | 1 |
| 95 | Invertebrate (saproxylic beetle) | *Dorcatoma chrysomelina* | 1 | 0 |
| 96 | Invertebrate (saproxylic beetle) | *Aplocnemus nigricornis* | 1 | 2 |
| | | **Grand Total** | **457** | **3356** |