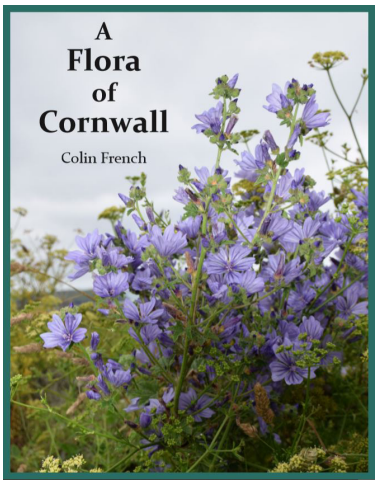
THE DECLINING FLORA OF CORNWALL



The latest *Flora of Cornwall* was published in June (French, 2020) and is based on a systematic survey of almost every 1km square. Analysis of the 2.25 million vascular plant records for Cornwall concluded that:

- At least half of the native and archaeophyte plants were more widespread before 2000.
- A minimum of 40% of Cornwall has lost 90% of its wild flowers in the last 50 years.

  Cornwall has lost most of its biodiversity in the agricultural landscape as a result of agricultural 'improvements' - chiefly the intensification of arable and horticultural fields and the conversion of hay fields to silage resulting in a monoculture of Perennial Rye-grass (*Lolium perenne*) or sometimes Italian Rye-grass (*Lolium multiflorum*) or more recently Maize (*Zea mays*). In both cases there has been a massive decline in the number of species (flora and fauna), above and below ground, within the cultivated area. Increasingly arable fields are being found where only a single plant grows amongst the crop. This is either Annual Meadow-grass (*Poa annua*) or Common Chickweed (*Stellaria media*) - the survival of which presumably depends on the herbicide regime. Similarly the thick Rye-grass sward of 'improved' grass leys support very few other species with normally only a few representatives of less than six flowering plant species dotted about the cultivated plot. Herbicides, pesticides, fungicides and artificial fertillisers have taken an immense toll such that a greater area than West Cornwall (VC1) has lost 90% of its wild flowers in the last 50 years.

Native and archaeophyte losses

It is not possible to accurately quantify which plants were more widespread before 2000 because the survey data before and after this date were collected by different people, using different survey techniques and technologies, with recording taking place at different resolutions and having a different geographic coverage. For example, the much greater intensity, areal extent and amount of recording, since 2000, has meant that new sites have been found for many declining plants which, when mapped, gives the false impression that they have become more common. Nevertheless, it proved possible to categorise the native and archaeophyte plants according to whether they have definitely declined, probably declined or likely declined (see Table 1). Those that have definitely declined are plants with more known sites before 2000 than subsequently. Those that have probably or likely to have declined are plants that have been reported from more sites after 2000 (an artefact of more intensive recording) but have been individually assessed as having, in reality, declined and have been placed in one of those two categories according to the degree of probability. According to this assessment:

- 441 (51%) of native species have been recorded in fewer 1km squares since 1999.
- 100 (63%) of archaeophytes have been recorded in fewer 1km squares since 1999.
- 52% of native and archaeophyte species have declined.

The species that are considered to have declined are representative of a number of habitat types. There are a significant number of arable weeds in the list, such as Dwarf Spurge (*Euphorbia exigua*), Black Bent (*Agrostis gigantea*) and various fumitories. There are also coastal plants such as Frosted Orache (*Atriplex laciniata*) and Prickly Saltwort (*Salsola kali*) which inhabit the areas subject to the greatest tourist pressure. However, the majority of the declining species are typical of wetlands, moorlands and heathlands, which are amongst the most important habitats of nature conservation value.

Table 1: Flowering Plants and Ferns that were more widespread before 2000

Colour codes: Declined, Probably declined, Likely to have declined

Achillea maritima, *Achillea ptarmica*, *Aconitum napellus*, *Adiantum capillus-veneris*, *Adonis annua*, *Adoxa moschatellina*, *Aegonychon purpureocaeruleum*, *Aethusa cynapium*, *Agrimonia procera*, *Agrostemma githago*, *Agrostis gigantea*, *Alchemilla filicaulis* subsp. *vestita*, *Alisma plantago-aquatica*, *Allium ampeloprasum* var. *ampeloprasum*, *Allium cepa*, *Allium porrum*, *Allium schoenoprasum*, *Alopecurus bulbosus*, *Ammophila arenaria*, *Anacamptis morio*, *Anacamptis pyramidalis*, *Anethum graveolens*, *Antennaria dioica*, *Anthemis arvensis*, *Anthemis cotula*, *Anthriscus caucalis*, *Anthriscus cerefolium*, *Apera spica-venti*, *Apium graveolens*, *Arabis hirsuta*, *Arctium lappa*, *Arctium nemorosum*, *Arenaria leptoclados*, *Arenaria serpyllifolia* subsp. *serpyllifolia*, *Armoracia rusticana*, *Artemisia absinthium*, *Asparagus prostratus*, *Asplenium ceterach*, *Asplenium obovatum* subsp. *billotii*, *Atriplex glabriuscula*, *Atriplex laciniata*, *Atriplex littoralis*, *Atriplex portulacoides*, *Atropa belladonna*, *Avenula pubescens*, *Baldellia ranunculoides*, *Ballota nigra* subsp. *meridionalis*, *Barbarea vulgaris*, *Berula erecta*, *Bidens cernua*, *Bidens tripartita*, *Bistorta officinalis*, *Blackstonia perfoliata*, *Blitum bonus-henricus*, *Blysmus compressus*, *Bolboschoenus maritimus*, *Botrychium lunaria*, *Brachypodium pinnatum*, *Brassica oleracea* var. *oleracea*, *Briza media*, *Bromopsis erecta*, *Bromopsis ramosa*, *Bromus commutatus*, *Bromus hordeaceus* subsp. *ferronii*, *Bromus racemosus*, *Bromus secalinus*, *Bryonia dioica*, *Buglossoides arvensis*, *Bupleurum rotundifolium*, *Cakile maritima*, *Calamagrostis epigejos*, *Callitriche brutia* subsp. *hamulata*, *Callitriche obtusangula*, *Callitriche platycarpa*, *Caltha palustris*, *Calystegia soldanella*, *Camelina sativa*, *Campanula rotundifolia* subsp. *montana*, *Cannabis sativa*, *Carduus crispus* subsp. *multiflorus*, *Carduus nutans*, *Carduus tenuiflorus*, *Carex acutiformis*, *Carex arenaria*, *Carex canescens*, *Carex dioica*, *Carex distans*, *Carex disticha*, *Carex divisa*, *Carex extensa*, *Carex hirta*, *Carex hostiana*, *Carex montana*, *Carex nigra*, *Carex pallescens*, *Carex pulicaris*, *Carex punctata*, *Carex riparia*, *Carex rostrata*, *Carex vesicaria*, *Carlina vulgaris*, *Carum carvi*, *Catabrosa aquatica*, *Caucalis platycarpos*, *Centaurea calcitrapa*, *Centaurea cyanus*, *Centaurea scabiosa*, *Centaurium pulchellum*, *Cerastium semidecandrum*, *Ceratocapnos claviculata*, *Ceratophyllum demersum*, *Chaenorhinum minus*, *Chenopodiastrum murale*, *Chenopodium vulvaria*, *Cicendia filiformis*, *Cichorium intybus*, *Cirsium acaule*, *Cirsium dissectum*, *Cladium mariscus*, *Clinopodium acinos*, *Cochlearia anglica*, *Coeloglossum viride*, *Comarum palustre*, *Conium maculatum*, *Crambe maritima*, *Crepis biennis*, *Cuscuta epithymum*, *Cynoglossum officinale*, *Cyperus longus*, *Cystopteris fragilis*, *Dactylorhiza fuchsii*, *Dactylorhiza incarnata* subsp. *coccinea*, *Dactylorhiza incarnata* subsp. *incarnata*, *Dactylorhiza incarnata* subsp. *pulchella*, *Dactylorhiza maculata* subsp. *ericetorum*, *Dactylorhiza praetermissa*, *Daphne laureola*, *Descurainia sophia*, *Dianthus armeria*, *Diplotaxis tenuifolia*, *Drosera anglica*, *Drosera intermedia*, *Drosera rotundifolia*, *Dryopteris carthusiana*, *Echium plantagineum*, *Echium vulgare*, *Elatine hexandra*, *Eleocharis acicularis*, *Eleocharis palustris*, *Eleocharis quinqueflora*, *Eleocharis uniglumis*, *Elymus caninus*, *Elymus junceiformis*, *Epilobium palustre*, *Epipactis helleborine*, *Epipactis palustris*, *Equisetum fluviatile*, *Equisetum palustre*, *Equisetum sylvaticum*, *Erica ciliaris*, *Erica vagans*, *Erigeron acris*, *Eriophorum vaginatum*, *Erodium aethiopicum*, *Erodium cicutarium*, *Erodium moschatum*, *Erophila glabrescens*, *Erophila majuscula*, *Eruca vesicaria*, *Ervilia sylvatica*, *Eryngium campestre*, *Eryngium maritimum*, *Erysimum cheiranthoides*, *Erysimum cheiri*, *Euphorbia amygdaloides*, *Euphorbia exigua*, *Euphorbia paralias*, *Euphorbia peplis*, *Euphorbia platyphyllos*, *Euphorbia portlandica*, *Euphrasia arctica* subsp. *borealis*, *Euphrasia confusa*, *Euphrasia micrantha*, *Euphrasia officinalis* subsp. *anglica*, *Euphrasia vigursii*, *Filago germanica*, *Filago pyramidata*, *Filipendula vulgaris*, *Frangula alnus*, *Fumaria capreolata* subsp. *babingtonii*, *Fumaria densiflora*, *Fumaria muralis* subsp. *neglecta*, *Fumaria officinalis* subsp. *officinalis*, *Fumaria parviflora*, *Fumaria purpurea*, *Galeopsis angustifolia*, *Galeopsis speciosa*, *Galium odoratum*, *Galium pumilum*, *Galium saxatile*, *Galium tricornutum*, *Galium uliginosum*, *Gastridium ventricosum*, *Genista anglica*, *Genista pilosa*, *Genista tinctoria* subsp. *littoralis*, *Gentianella amarella* subsp. *amarella*, *Gentianella amarella* subsp. *anglica*, *Gentianella campestris*, *Geranium pratense*, *Geranium purpureum*, *Geranium pusillum*, *Geranium sanguineum*, *Geum rivale*, *Glaucium flavum*, *Glebionis segetum*, *Glyceria notata*, *Gymnadenia borealis*, *Gymnadenia densiflora*, *Gymnocarpium dryopteris*, *Hammarbya paludosa*, *Helosciadium inundatum*, *Herniaria ciliolata* subsp. *ciliolata*, *Honckenya peploides*, *Hordeum secalinum*, *Hordeum vulgare*, *Humulus lupulus*, *Huperzia selago*, *Hydrocotyle vulgaris*, *Hylotelephium telephium*, *Hymenophyllum tunbrigense*, *Hymenophyllum wilsonii*, *Hyoscyamus niger*, *Hypericum elodes*, *Hypericum linariifolium*, *Hypericum maculatum*, *Hypericum montanum*, *Hypericum undulatum*, *Hypochaeris glabra*, *Hypochaeris maculata*, *Illecebrum verticillatum*, *Inula conyzae*, *Inula helenium*, *Isatis tinctoria*, *Isoetes echinospora*, *Isoetes histrix*, *Isolepis cernua*, *Jasione montana*, *Juncus acutus*, *Juncus capitatus*, *Juncus compressus*, *Juncus maritimus*, *Juncus pygmaeus*, *Juncus ranarius*, *Juncus squarrosus*, *Juniperus communis* subsp. *hemisphaerica*, *Kickxia spuria*, *Knautia arvensis*, *Koeleria macrantha*, *Lactuca saligna*, *Lactuca virosa*, *Lamiastrum galeobdolon* subsp. *montanum*, *Lamium amplexicaule*, *Lamium hybridum*, *Lathyrus nissolia*, *Lathyrus sylvestris*, *Legousia hybrida*, *Lepidium campestre*, *Lepidium heterophyllum*, *Lepidium ruderale*, *Leymus arenarius*, *Limonium loganicum*, *Limosella aquatica*, *Linaria repens*, *Linum bienne*, *Linum catharticum*, *Linum radiola*, *Lithospermum officinale*, *Littorella uniflora*, *Logfia minima*, *Lolium temulentum*, *Lotus angustissimus*, *Lotus subbiflorus*, *Lotus tenuis*, *Luzula forsteri*, *Lycopodiella inundata*, *Lycopodium clavatum*, *Lycopsis arvensis*, *Lysimachia foemina*, *Lysimachia maritima*, *Lysimachia minima*, *Lysimachia vulgaris*, *Malus sylvestris*, *Malva neglecta*, *Marrubium vulgare*, *Matricaria chamomilla*, *Matthiola sinuata*, *Medicago polymorpha*, *Melampyrum pratense*, *Melica nutans*, *Melilotus 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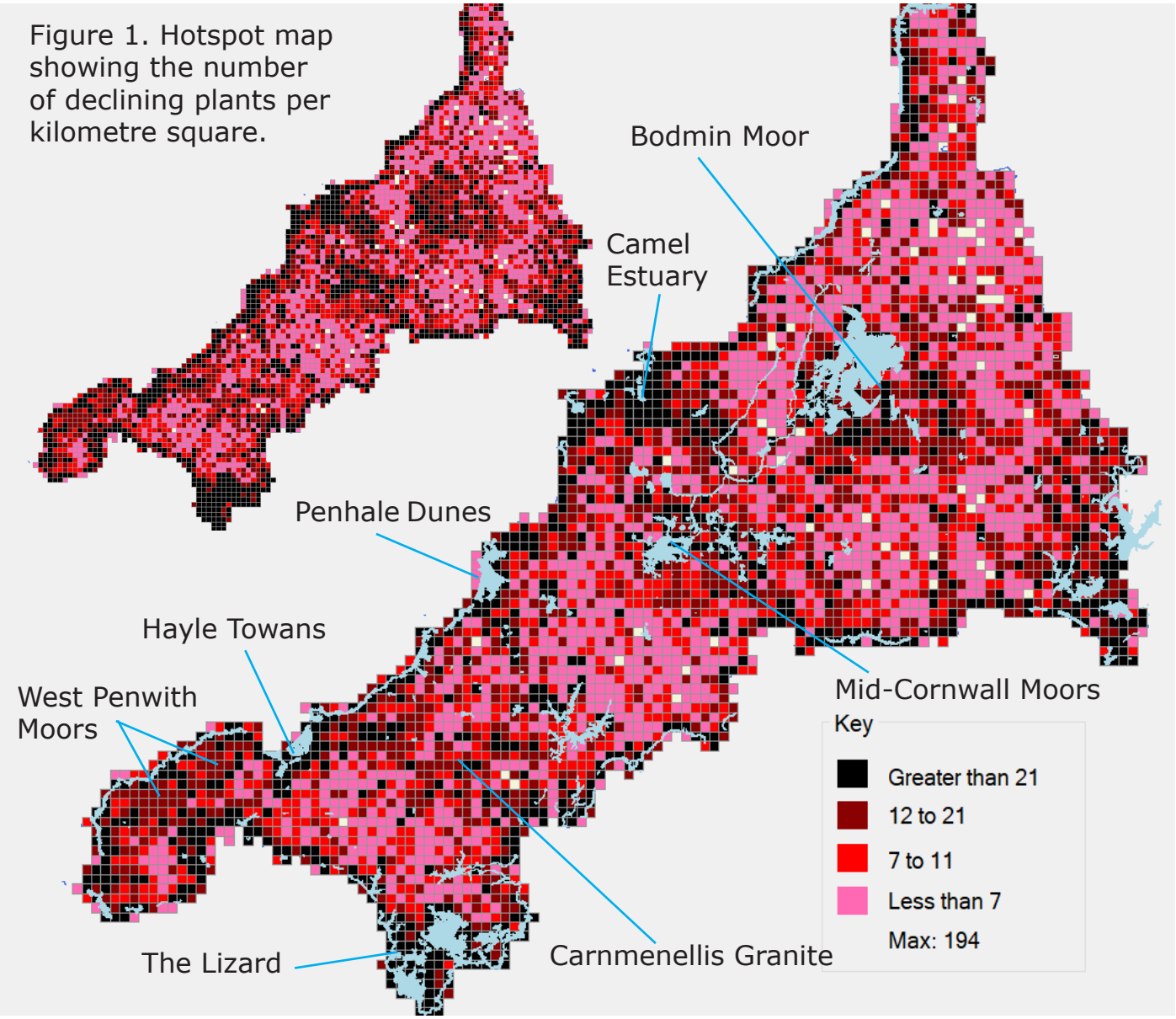
scutellata*, *Vicia bithynica*, *Vicia lathyroides*, *Vicia lens*, *Vicia lutea*, *Vicia orobus*, *Viola canina* subsp. *canina*, *Viola hirta*, *Viola kitaibeliana*, *Viola lactea*, *Viola palustris* subsp. *juressi*, *Viola reichenbachiana*, *Viola tricolor*, *Viola tricolor* subsp. *curtisii*, *Viscum album*, *Vulpia fasciculata*, *Wahlenbergia hederacea*, *Wolffia arrhiza*, *Zannichellia palustris*, *Zostera marina*, *Zostera noltei*.



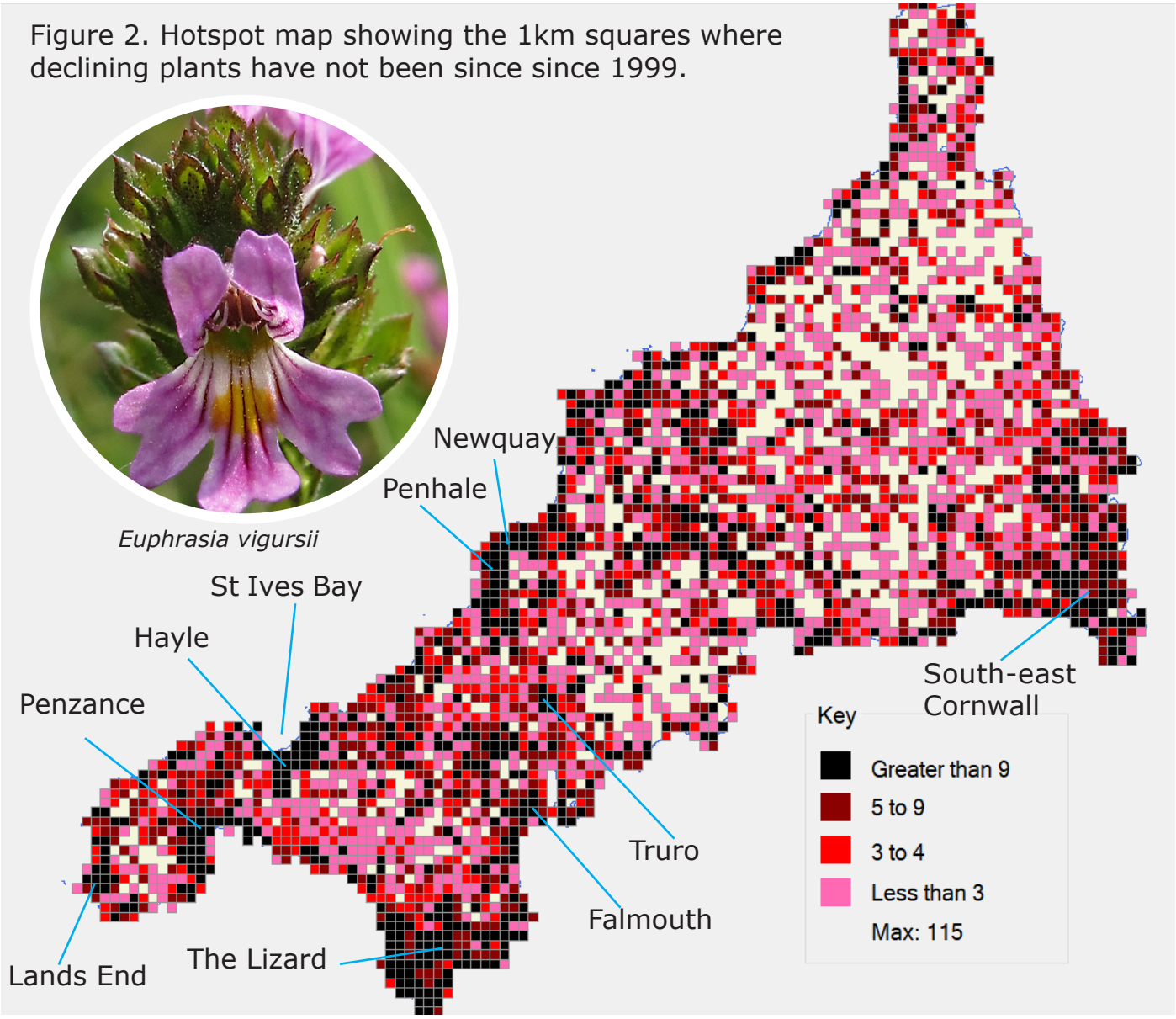
The hotspot map (figure 1) showing the number of declining plants per kilometre square demonstrates that declining plants have been recorded in almost every 1km square. More importantly it highlights distinct areas where the greatest concentration of declining plants grow or have grown and as such are the most suitable for those plants. The main map has the Sites of Special Scientific Interest (SSSI) boundaries overlain whilst the SSSIs are not shown on the inset map. It can be seen that many of the areas with the highest concentration of declining plants correspond to SSSIs. These include much of the coastal fringe, The Lizard, Hayle Towans, Penhale Dunes, the Mid-Cornwall Moors and parts of Bodmin Moor. SSSIs tend to be the places with significant assemblages of rare and/or threatened plants thus it is to be expected that SSSIs coincide with areas with high numbers of declining plants.

Perhaps this importance of this map is it highlights areas that are not SSSIs such as the south-eastern half of Bodmin Moor, West Penwith Moors and the Carnmenellis Granite which should potentially be considered for SSSI designation. In the case of the West Penwith Moors this process is thankfully underway.

One other notable large area that has a high concentration of declining plants but little SSSI representation is the flanks of the Camel Estuary. This area is known for its arable fields some of which retain a rich weed flora and many of those plants are declining. Such arable fields were never considered to be SSSI candidates.

Figure 2. Hotspot map showing the 1km squares where declining plants have not been since since 1999.

Euphrasia vigursii



This map was created by computing, for each declining plant, which 1km squares had records before 2000 but not since. These lists were then combined to produce the hotspot map. In effect it shows where the greatest losses have occurred. Some of the most urbanised areas can be picked out such as Penzance, Hayle, Newquay, Falmouth and Truro. With the exception of Truro the area with high losses markedly extends beyond the confines of the boundaries of those towns. In the case of Newquay it extends along the coast to include the large sand dune system at Penhale. Similarly the extensive Hayle Towans which fringe St Ives Bay have incurred significant losses. Perhaps the greatest surprise on this map is the Lizard which is the most protected part of Cornwall in terms of SSSI coverage and yet stands out as an area which has lost significant numbers of declining species. The Lizard and the concentration of lost declining plants in South-east Cornwall are clearly worthy of further investigation.

Using Ellenberg values

The following extends the analysis published in the *Flora of Cornwall* and uses the native and archaeophyte plants which have been assigned Ellenberg values (Hill *et al.*, 1999) for reaction, moisture and light. These are key environmental factors and each species is assigned a value representing its optimum position on a scale of usually 1-9. In the case of the category *Ellenberg values for reaction* this scale effectively ranges from very acid to calcareous or high-pH soils.

Ellenberg values for reaction

Figures 3 and 4 compare the total number of plant species for Cornwall that have been assigned Ellenberg values with the declining species listed in table 1. It can be seen that the highest number of species corresponds with Ellenberg value 7 which are *Indicators of weakly acid to weakly basic conditions; never found on very acid soils* and includes such species as Lords-and-ladies (*Arum maculatum*), False Fox-sedge (*Carex otrobae*)and Hard Rush (*Juncus inflexus*). Remarkably the overall shape of the two bar charts is very similar suggesting that plants have been declining across the board.

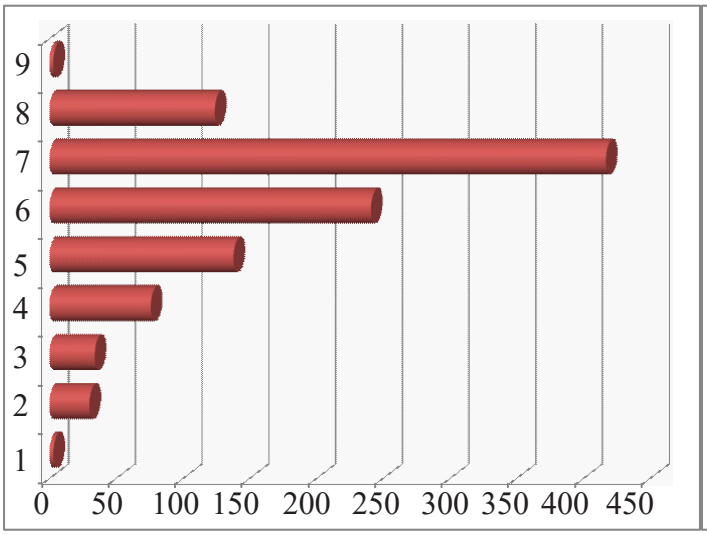


Figure 3. The total number of plant species per Ellenberg value for reaction.

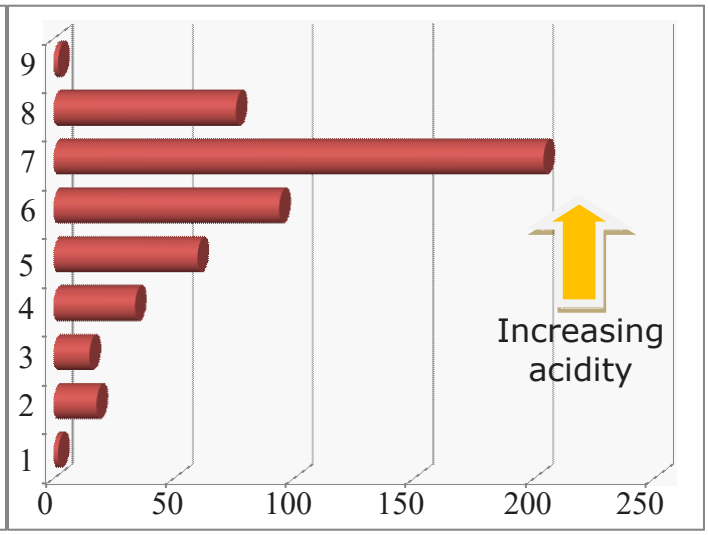


Figure 4. The total number of declining plant species per Ellenberg value for reaction.

However, when one examines the proportion of declining species for each Ellenberg value (see figure 5), it can be seen that the highest percentage losses have occurred at the extremes amongst the species that are either representative of the most acidic or most alkaline conditions. Remarkably the Ellenberg value with the least percentage loss corresponds with value 7 - the one that has the most plant species.

Figure 6 is a measure of how widespread each Ellenberg value is in Cornwall. It uses the total number of 1km squares for each species and charts the average number for each Ellenberg value. It is interesting to note that the Ellenberg value containing the most widespread species (value 6) is not the most species-rich Ellenberg value (value 7). Comparing figures 4 and 5 it is apparent that the Ellenberg values with the highest percentage of declining plants are those with the least widespread species.

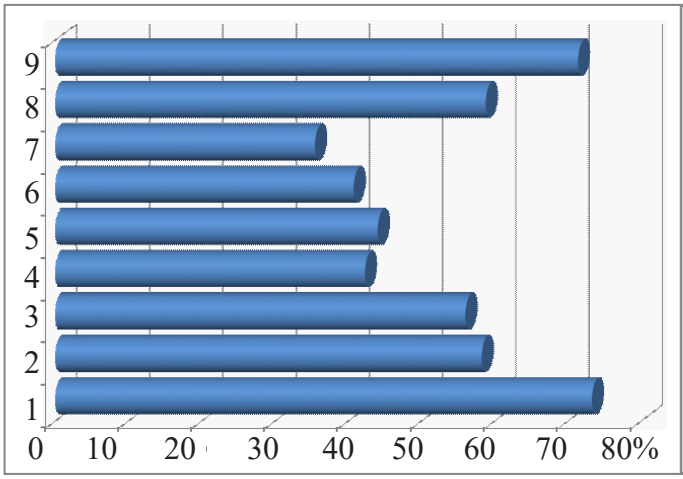


Figure 5. The percentage of declining species per Ellenberg value for reaction.

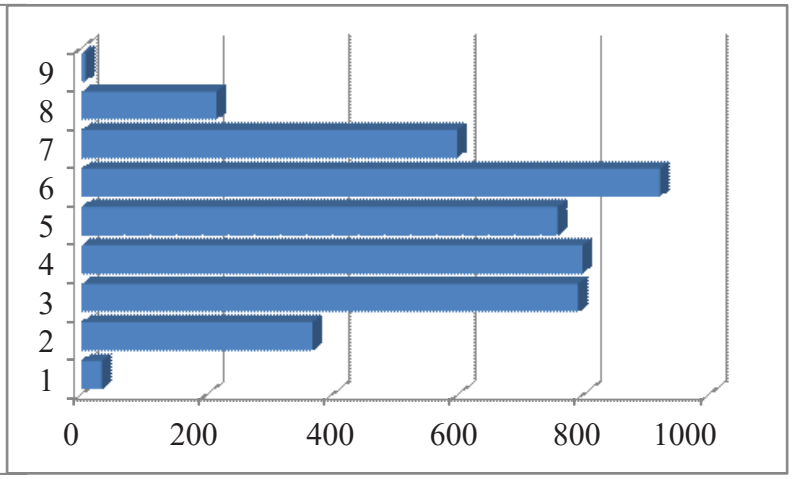


Figure 6. The average number 1km squares per Ellenberg value for reaction.

Ellenberg values for moisture

The pattern shown by the bar charts for Ellenberg values for moisture is broadly similar to that of reaction. Losses are seen for every Ellenberg value and the highest number of species corresponds with Ellenberg value 5 which are *Moist-site Indicators, mainly on fresh soils of average dampness* and includes such species as Crow Garlic (*Allium vineale*), Glaucous Sedge (*Carex flacca*) and Fennel (*Foeniculum vulgare*). In contrast the highest number of declining species is at value 4 which is a drier category and includes such plants as Lesser Burdock (*Arctium minus*) and Pale Flax (*Linum bienne*).

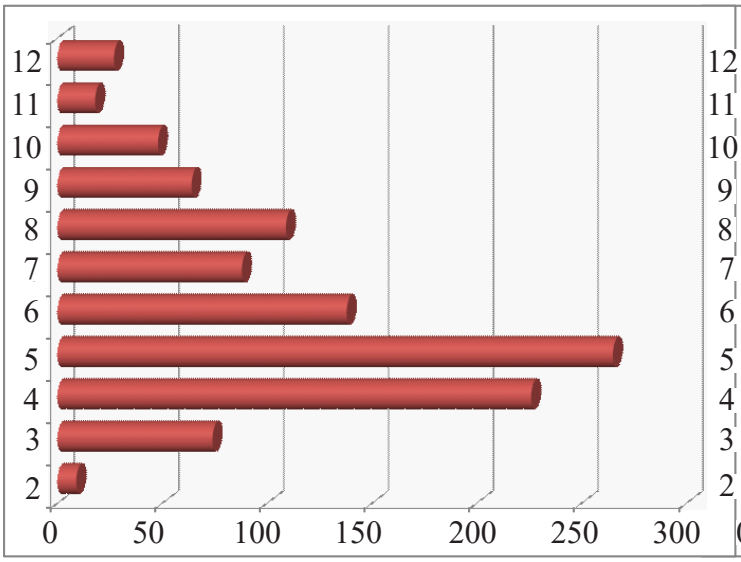


Figure 7. The total number of plant species per Ellenberg value for moisture.

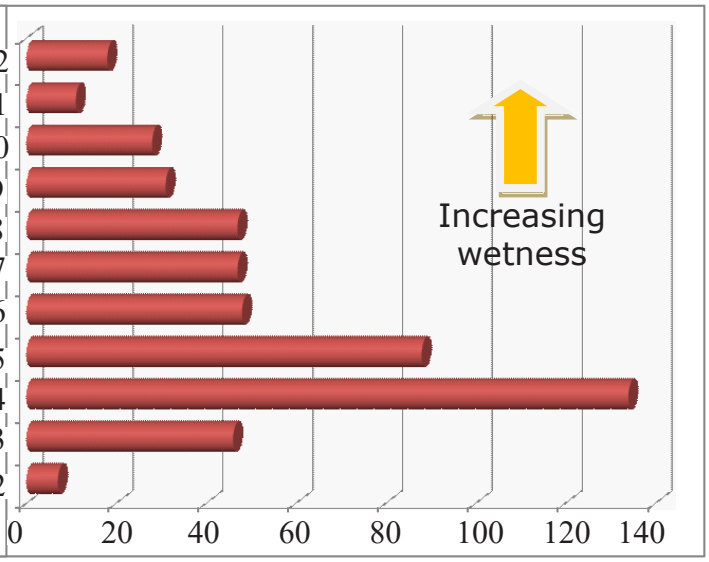


Figure 8. The total number of declining plant species per Ellenberg value for moisture.

Figure 9 reaffirms the notion that the highest percentage losses occurs at the extreme ends of the Ellenberg range - namely the wettest and driest habitats. It is also seen that the Ellenberg value with the least percentage loss corresponds with value 5 - the category with the most plant species overall.

As with the findings for reaction, comparing figures 9 and 10 shows that the highest percentage of declining plants corresponds to the Ellenberg values with the least widespread species.

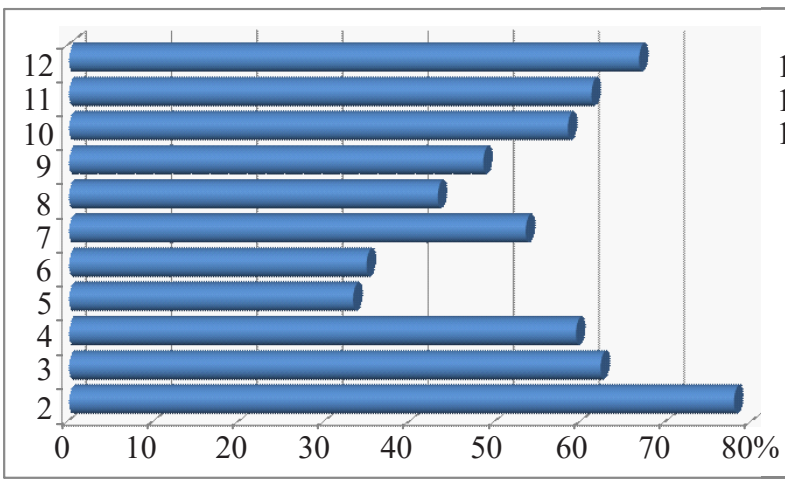


Figure 9. The percentage of declining species per Ellenberg value for moisture.

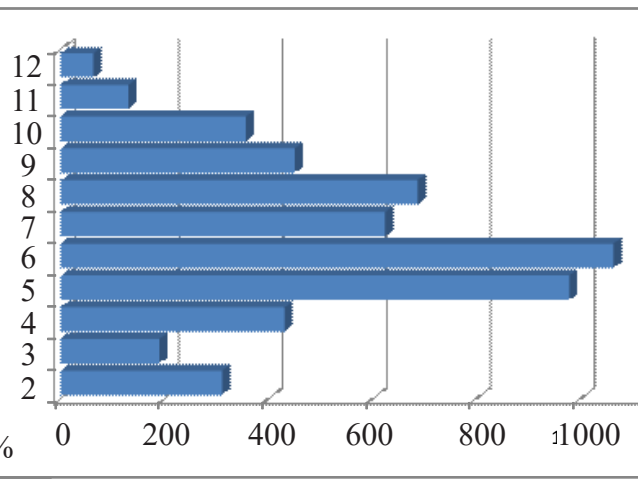


Figure 10. The average number 1km squares per Ellenberg value for moisture.

Ellenberg values for light

The pattern shown by the bar charts for Ellenberg values for light is also broadly similar to that of reaction and moisture. Losses are seen for every Ellenberg value and the highest number of species corresponds with Ellenberg value 7 which are *Plants generally in well lit places, but also occurring in partial shade* and includes such species as Yarrow (*Achillea millefolium*), Tormentil (*Potentilla erecta*) and Fiddle Dock (*Rumex Pulcher*).

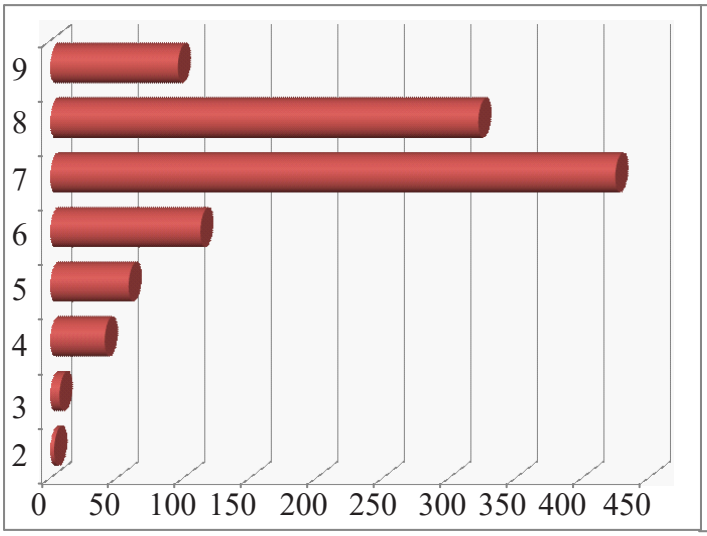


Figure 11. The total number of plant species per Ellenberg value for light.

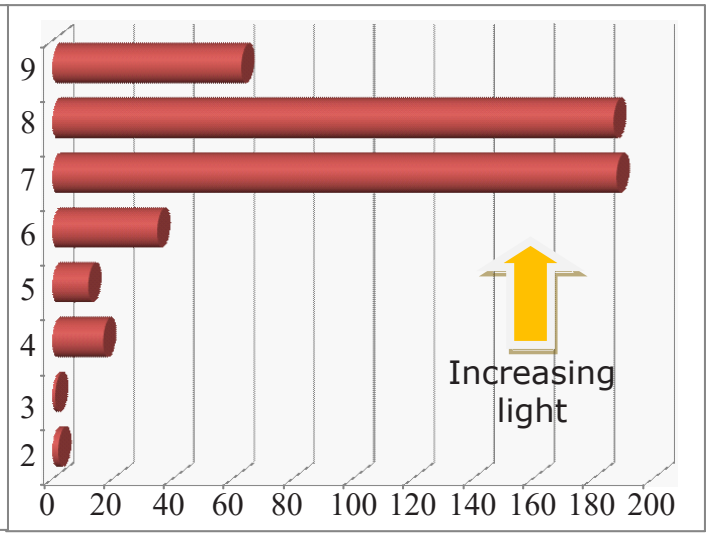


Figure 12. The total number of declining plant species per Ellenberg value for light.

As with the findings for reaction and moisture, Figure 13 shows that the highest percentage losses occurs at the extreme ends of the Ellenberg range - namely the shadiest and most open habitats. However, unlike reaction and moisture the the Ellenberg value with the least percentage loss (value 5) does not correspond with the category with the most plant species overall (value 7). Instead it matches the value that has the most widespread plants on average.

Apart from Ellenberg value 3 a comparison of figures 13 and 14 demonstrates an inverse relationship between the percentage of declining plants and how widespread the plants occur. Ellenberg value 3 only includes ten plants so the aberration may be a function of so few data.

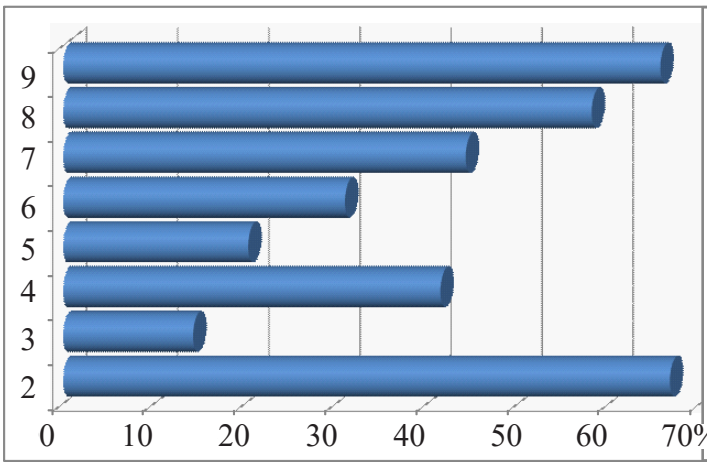


Figure 13. The percentage of declining species per Ellenberg value for light.

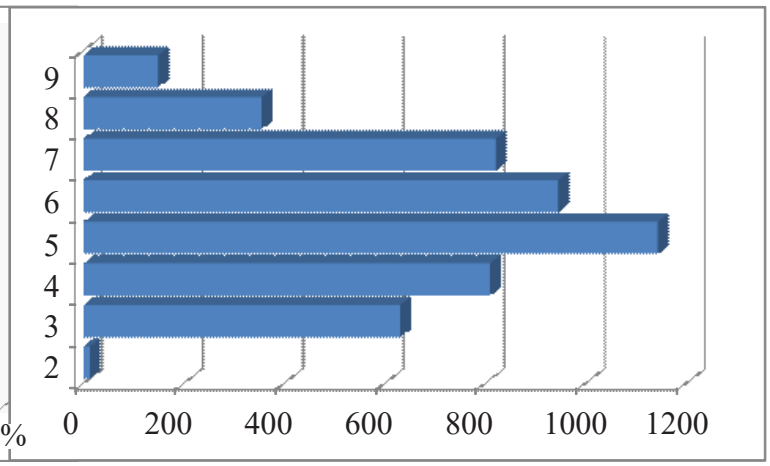
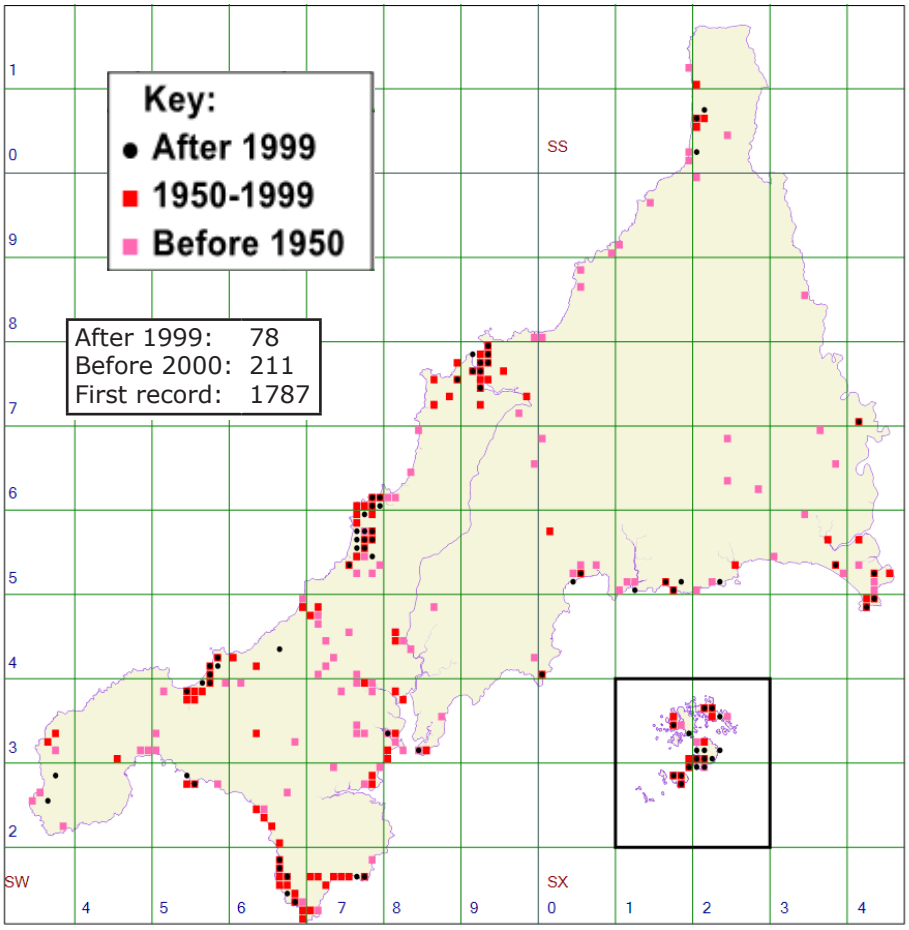


Figure 14. The average number 1km squares per Ellenberg value for light.



Spiranthes spiralis (L.) Chevall.
Autumn Lady's-tresses

Autumn Lady's-tresses has the distinction of being the species that has declined the most. It is a light-loving plant of calcareous grassland, a very rare habitat in Cornwall, and has the Ellenberg values for moisture of 4, for reaction of 6 and for light of 8. It has disappeared from most inland sites in Cornwall but can still be found in abundance at a few sites such as Sennen School football pitch (SW3625) and at Upton Towans amongst the former cordite factory ruins (SW5740) in the sand dunes.

Conclusion

Analysing the plants that have been identified as declining in Cornwall together with their individual Ellenberg values for reaction, moisture and light indicates that the greatest losses are at the extreme ends of the Ellenberg range. Namely the most acidic or most alkaline habitats; the wettest or driest habitats and the most shaded or lightest communities. In the light of this observation, it is perhaps unsurprising that the greatest losses also correspond to the Ellenberg values containing the least widespread plants on average and that many of these areas have been designated as SSSIs.

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Useful websites

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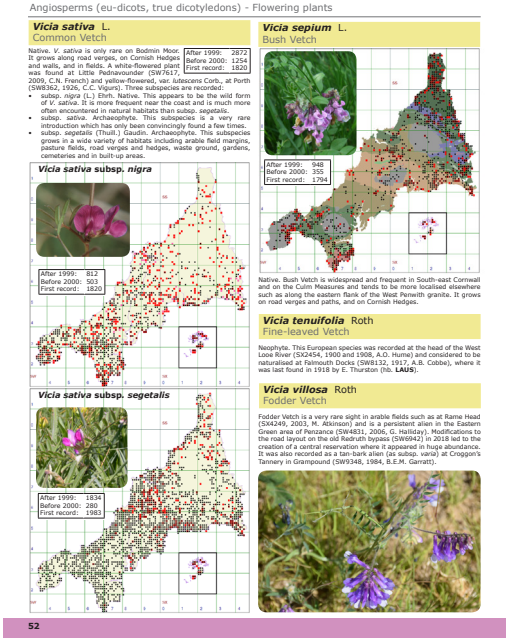

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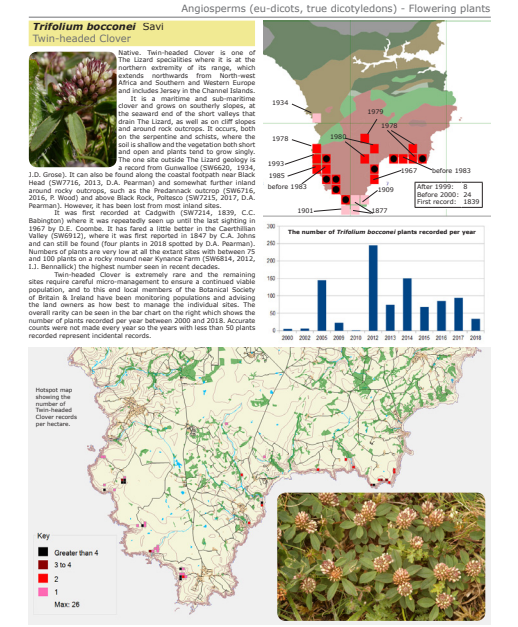

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