A review of limestone woundwort *Stachys alpina* L. with special reference to Wales

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Crynodeb Gweithredol

Mae Briwlys y calchfaen *Stachys alpina* yn blanhigyn prin iawn sydd wedi ei warchod yn statudol yng Nghymru a Lloegr. Cafwyd rhywfaint o ddadlau ynghylch a yw'n gynhenid neu a gafodd ei gyflwyno ac mae angen aflonyddwch aml arno i'w gynnal fel planhigyn blodeuog, gweledol yn ei gynefinoedd yng Nghymru. Felly comisiynodd Cyfoeth Naturiol Cymru astudiaeth ddesg i adolygu ei statws a'i warchodaeth gan gyfeirio'n arbennig at Gymru, gyda'r amcanion canlynol:

- Adolygiad o'i hanes yng Nghymru a'r DU;
- Adolygiad o'i statws brodorol / anfrodorol;
- Coladu holl gofnodion yng Nghymru;
- Mapiau crynodeb o boblogaethau Cymru;
- Adolygiad o reolaeth / trawsleoli poblogaethau Cymru;
- Argymhellion ar gyfer astudiaeth bellach o'i statws yn y DU / Cymru; ac
- Argymhellion ar gyfer rheolaeth.

Casglwyd ac adolygwyd y wybodaeth allan o ffeiliau Cyfoeth Naturiol Cymru, gan fotanegwyr gyda gwybodaeth o *S. alpina*, allan o gasgliadau a lluniau ar-lein o sbesimenau llysieufa, o gronfa ddata dosbarthiad BSBI, o gronfa ddata COFNOD, o lenyddiaeth gyhoeddedig ac o ymchwil ar y rhyngrwyd. Ni chynhaliwyd unrhyw waith maes.

Nid yw *Stachys alpina* yn byw yn hir ond mae'n arbenigo ar fyw ar gyrion coedwigoedd gyda (mae'n debyg) banc o hadau hir dymor sy'n egino mewn ymateb i golli canopi coed sy'n gysylltiedig ag aflonyddu'r tir / pridd. Nid yw'n goroesi mewn cysgod trwm. Yn gyffredinol, fe'i cysylltir â phridd sy'n llawn maeth cyfoethog i gymhedrol, yn llaith a chalchaidd. Mae'n oddefgar i hinsawdd eang.

Mae *Stachys alpina* wedi ei ddarganfod mewn tri safle yn Sir Ddinbych, Cymru. Adroddwyd amdano am y tro cyntaf yn 1927 yng Ngherrigydrudion a pharhaodd yno nes y dinistrwyd y safle tua 1960; cafodd planhigion eu trawsleoli yno yn 1998. Fe'i darganfuwyd yn Eyarth yn 1908 er nad oedd wedi ei adnabod tan 1990 ac mae'n digwydd yn achlysurol fel swm bach iawn. Daethpwyd o hyd iddo yng Nghil-y-groeslwyd yn 1973 ac mae wedi ei drawsleoli yno ers hynny. Fe'i darganfuwyd ym Mhrydain am y tro cyntaf yn 1897 yn Sir Gaerloyw ac mae wedi digwydd mewn tair poblogaeth yno.

Fe'i derbyniwyd gan bob awdur fel rhywbeth cynhenid nes i Kay a John (1995) ei adolygu ac awgrymu bod 'amheuaeth gref nad yw'n gynhenid' ar sail lledaeniad cyflym mewn ardal oedd wedi ei adolygu'n dda, nad oedd unrhywbeth anghyffredin ynghylch ei gynefin ac nad oedd yn arddangos fawr ddim o amrywiaeth isosym. Cafwyd dadleuon gwrthwynebus arwyddocaol i'r holl bwyntiau hyn ac arddangoswyd bod rhai ohonynt yn anghywir.

Mae prawf statws yn erbyn y meini prawf, i gymryd yn ganiataol ei fod yn gynhenid, yn dangos, yn gyffredinol, ei fod yn llawer mwy tebygol fod *S. alpina* yn gynhenid nac wedi ei gyflwyno (cefnogaeth gref o ddau faen prawf a chefnogaeth wan o bedwar maen prawf ei fod yn gynhenid, cefnogaeth wan o ddau faen prawf ei fod wedi ei gyflwyno). Byddai astudiaethau pellach o'r berthynas enynnol mewn cyd-destun Ewropeaidd, map gwell yn

dangos dosbarthiad y byd, astudiaethau o'r banc hadau a'r ymateb i astudiaethau clefyd yr onnen yn Eyarth ac Wotton-under-Edge, yn helpu darparu gwybodaeth bellach er mwyn barnu'r statws.

Casglwyd cofnodion *Stachys alpina* mewn taenlen a'u hasesu gan ddefnyddio dull lleihäwr oherwydd y nifer o ddyblygiadau a chofnodion anghyflawn. Cyflwynir y data llawn o 125 o gofnodion o Gymru ac 101 o gofnodion o Loegr ar daenlen ar wahân.

Lluniwyd hanes y trawsleoliadau yn y tri safle Cymreig o ffeiliau Cyfoeth Naturiol Cymru. Mae wedi ei blannu'n helaeth yng Ngherrigydrudion a Chil-y-groeslwyd. Dim ond un trawsleoliad sydd wedi digwydd yng Nghoedwig Eyarth yn 1989 ac mae hyn yn bwysig gan mai Coedwig Eyarth bellach yw'r unig safle, o bosib, yng Nghymru gyda phoblogaethau gwreiddiol.

Cyflwynir argymhellion ar reoli cadwraeth. Y flaenoriaeth nawr yw archwiliadau systematig o'r holl safleoedd cynhenid i gasglu had, wrth iddo ymateb i'r epidemig clefyd yr onnen ac agor allan y coetir; gall hyn fod yn gyfle unwaith mewn bywyd. Ar hyn o bryd argymhellir y dylid cynnal rheolaeth i gynnal poblogaethau, trwy balu dros leiniau o dir agored a / neu waredu tir prysgwydd, bob 3-5 blynedd, unwaith bydd y planhigion wedi marw ar ôl yr aflonyddwch blaenorol.

Mae rhaid cynnal mwy o ymchwil i hysbysu penderfyniadau cadwraeth i weddu i'w ecoleg fel arbenigwr â bywyd byr sy'n byw wrth ymyl y goedwig. Mae'r rhain yn cynnwys astudiaethau ar y banc hadau a hirhoedledd y planhigyn i hysbysu'r cylch rheoli, profi bod adolygu'n offer rheoli priodol, ac astudiaethau ar rôl maeth y pridd ar dwf a dyfalbarhad. Dylid cynnal moratoriwm ar ailgyflwyniadau ychwanegol nes bod astudiaethau llawnach wedi eu cynnal er mwyn osgoi cymhlethu ymhellach y llun genynnol ymhellach.

Executive summary

Limestone woundwort or Briwlys y calchfaen *Stachys alpina* is a very rare statutorily protected plant in Wales and England. There has been some debate as to whether it is native or introduced, and it requires frequent intervention to maintain it as a visible, flowering plant in its Welsh sites. Natural Resources Wales therefore commissioned a desk study to review its status and conservation with special reference to Wales with the following aims:

- A review of the history in Wales and the UK;
- A review of its native/non-native status;
- Collation of all records in Wales;
- Summary maps of Welsh populations;
- A review of management/translocation of the Welsh populations;
- Recommendations for a further study of its status in the UK/Wales; and
- Recommendations for management.

Information was compiled and reviewed from Natural Resources Wales files, botanists with knowledge of *S. alpina*, collections and online images of herbarium specimens, the BSBI distribution database, the COFNOD database, published literature and internet searches. No field work was undertaken.

Stachys alpina is a short-lived, woodland edge specialist with (probably) a long-term seed bank which germinates in response to loss of tree canopy in association with ground/soil disturbance. It does not persist in heavy shade. It is generally associated with nutrient-rich to nutrient-moderate, moist, calcareous soils. It has a broad climate tolerance.

Stachys alpina has been found in three sites in Denbighshire, Wales. It was first reported in 1927 at Cerrigydrudion and persisted until the site was destroyed in about 1960; plants were translocated there in 1998. It was found at Eyarth in 1908 though not recognised until 1990 and occurs sporadically in very small quantity. It was found at Cil-y-groeslwyd in 1973 and has been repeatedly translocated there since. It was first found in Britain in 1897 in Gloucestershire and has occurred in three populations there.

It was accepted by all authors as native until Kay & John (1995) reviewed it and suggested it was ‘extremely doubtfully native’ on the basis of rapid spread in a well surveyed area, that there was nothing particularly unusual about the habitat and that it showed little or no isozyme variation. All these points have significant counter arguments and some are demonstrated to be incorrect.

A test of the status against criteria for presuming native status shows that on balance overall *S. alpina* is much more likely to be native than introduced (strong support from two criteria and weak support from four criteria for it being native, weak support from two criteria to be introduced). Further studies of the genetic relationship in a European context, a better world distribution map, studies of the seed bank and the response to ash dieback studies at Eyarth and Wotton-under-Edge would help provide further information on which to judge the status.

Stachys alpina records were compiled into a spreadsheet and assessed using a reductionist approach due to the number of duplicates and incomplete records. The full

data of 125 records from Wales and 101 records for England are presented in a separate spreadsheet.

A history of the translocations at each of the three Welsh sites has been compiled from the NRW files. It has been extensively planted at Cerrigydrudion and Cil-y-groeslwyd. Only one transplant has occurred at Eyarth Wood in 1989 which is important as Eyarth Wood is now potentially the only Welsh site with some original populations.

Recommendations on conservation management are given. The immediate priority is for systematic searches of all native sites to collect seed as it responds to the current ash dieback epidemic opening up the woodland; this may be a once in a lifetime opportunity. It is currently recommended that management to maintain populations occurs by digging over open plots and/or clearing scrub every 3-5 years once the plants have died out from previous disturbance.

Further research is required to inform conservation decisions to fit with its ecology as a short-lived woodland edge specialist. These include studies on the seed bank and plant longevity to inform the management cycle, testing that disturbance is a suitable management tool and studies on the role of soil nutrients on growth and persistence. A moratorium on further reintroductions should be implemented until fuller studies have been carried out to avoid further complicating the genetic picture any further.

Introduction

Limestone woundwort or Briwlys y calchfaen *Stachys alpina* L. (Lamiaceae) is a very rare plant in Britain. It is statutorily protected in Britain under Schedule 8 of the Wildlife and Country Act (as amended). In Wales, it is a Denbighshire Local Biodiversity Action Plan species (Denbighshire County Council 2006), a Welsh Assembly Government Trunk Road Estate Biodiversity Action Plan species (Welsh Assembly Government 2004) and is designated as the county flower of Denbighshire/Sir Ddinbych (Denbighshire County Council 2006; Plantlife 2020).

Although once accepted as native to Denbighshire and Gloucestershire, there has been some recent debate as to whether it is native or introduced to Britain. Furthermore, it has proved hard to conserve it in its Welsh sites where it requires frequent intervention to maintain its populations. In 2020, Natural Resources Wales therefore commissioned a desk study to review its status and conservation with special reference to Wales.

The aims of this desk study were as follows:

- A review of the history of *S. alpina* in Wales and the UK;
- A review of its native/non-native status;
- Collation of all records of *S. alpina* in Wales;
- Summary maps of Welsh populations;
- A review of management/translocation of the Welsh populations from existing records;
- Recommendations for a further study of its status in the UK/Wales; and
- Recommendations on species management.

Plant nomenclature follows Stace (2019).

Sources of information

The following sources were used:

- Four *S. alpina* files held by Natural Resources Wales (including the former Countryside Council for Wales) held in the NRW Buckley Office (Figure 1) and one *S. alpina* Rare Plant file held by J. P. Woodman, Rare Plants Specialist, Natural Resources Wales held in the NRW St Mellons office; some other NRW files may hold 'context' for translocation / management decisions (e.g. SH 94.1.3 Y Glyn Diffwys SSSI – Highways Directorate, SJ 15.2.7 – Cil-y-Groeslwyd SSSI and S15 Management Agreement AMP (J. Osley pers. comm. 2022).

Figure 1 *Stachys alpina* files from NRW Buckley Office

- Correspondence and discussions with botanists with experience of *S. alpina*, for example Clare and Mark Kitchen, former BSBI VC Recorders Gloucestershire who have worked extensively on *S. alpina*, Hugh McAllister, formerly of Ness Botanic Gardens and Helena Crouch who has grown plants for many years in her garden.
- Collections in the following herbaria: Bristol City Museum and Art Gallery (**BRISTM**), Natural History Museum, London (**BM**), Royal Botanic Gardens, Edinburgh (**E**), National Museum of Wales (**NMW**), Oxford University (**OXF**), Warrington Museum (**WRN**);
- Images of specimens on Herbaria@home (http://herbariaunited.org/atHome/; accessed many times 2020);
- BSBI Distribution Database (https://database.bsbi.org/; accessed many times 2020-2021);
- COFNOD database; data extracted 11/12/2020;
- Published literature in journal and floras (as referenced);
- Internet searches (many occasions 2020-2021).

Identification

Stachys alpina is a distinct species, characterised by the clumped growth form to c. 1 m tall with greenish-hairy leaves, with a long, interrupted spike of dense close whorls of large, pinkish-purple flowers with large bracts throughout, and glandular-hairs above (Figure 2).

Figure 2 *Stachys alpina* in cultivation in Cardiff

There are seven other *Stachys* species in Britain (Stace 2019), of which *S. alpina* is only likely to be confused with the very common hedge woundwort *Stachys sylvatica* L. which can look similar. They differ as follows (Table 1; note the difference between bracts and bracteoles):

Table 1 Characters separating *Stachys alpina* and *S. sylvatica*.

Character	***S. alpina***	***S. sylvatica***
Growth form	Clump forming	Rhizomatous
Inflorescence	Long, interrupted spike of dense, close whorls with sparse glandular and simple hairs 	Loose terminal spike with many whorls, with abundant glandular hairs and sparse simple hairs 
Bracts (subtending whorls of flowers)	Large and leaf-like throughout inflorescence 	Lowest 1-4 whorls may have leaf-like bracts, upper reduced and up to as long as calyx 
Bracteoles (subtending individual flowers)	About as long as calyx, conspicuous (cf. picture above)	Very small and reduced, shorter than calyx and scarcely as long as pedicels, inconspicuous
Calyx	Teeth triangular-ovate 	Teeth triangular-lanceolate 
Corolla	Pinkish-purple, 12-20 mm 	Reddish-purple, 13-18 mm 

In 2021, the hybrid *S. alpina* x *S. sylvatica* = *S.* x *medebachensis* J. Feld & O. Koenen) occurred spontaneously in the garden of Helena Crouch in Somerset where both species were cultivated. It was obviously intermediate in morphology between the parents. The hybrid has been reported from France, Germany, Spain and Switzerland but not from the wild in Britain (a record from Wotton-under-Edge was an error; Grenfell 1986). There is some concern that that some of the translocated plants at Cil-y-Groeslwyd might be this hybrid (J. P. Woodman, pers. comm. 2022).

Downy woundwort *Stachys germanica* L., another very rare Schedule 8-protected species, differs in being densely white-hairy with long, white, silky hairs throughout and lacks glandular hairs in the inflorescence. The hybrid *S. alpina* x *S. germanica* = *S.* x *digenea* Legué has originated twice in gardens in the UK (Salmon 1919; Lousley 1934; Stace et al. 2015), but not in the wild as the parents do not overlap in distribution. Salmon (1919) described the hybrid in detail and showed that it was most similar to *S. germanica* with copious white silky simple hairs, but that *S. alpina* was indicated by the strong peculiar scent of the leaves, the presence of glandular hairs and the coarsely rugulose seeds. Salmon's detailed description may be useful for assessing if plants for transplant have been hybridised in cultivation.

In the 1990s, it became evident that at least one of the Cil-y-Groeslwyd NWWT reserve transplants grown by Sheila Evans were extremely hairy (J. Osley, pers. comm. 2022). These were thought to be hybrids of *S. alpina* with the garden plant lamb's-ears *S. byzantina* K. Koch as the latter was also growing nearby in her garden. These plants were uprooted and destroyed.

The very common wetland relative marsh woundwort *Stachys palustris* is a very different plant with oblong leaves.

Biology and ecology

Life cycle

Stachys alpina is a short-lived perennial which forms clumps (Clapham et al. 1987; Stace 2019). There are no specific studies on how long individual plants live. Evans (1990) recorded transplants only lived for 1-3 years, and Jones & Osley (2010) noted from following up translocated plants that they can live for up to 5-6 years, with one especially large, long-lived plant present in the 1980s near the corner of the footpath by the sheds before the entrance to the Cil-y-Groeslwyd NWWT reserve (J. Osley, pers. comm. 2022).

Seeds are adapted to long periods of dormancy and plants can appear after scrub or woodland clearance (Evans 1999). Seeds are dormant when ripe but can be induced to germinate either by treatment with gibberellin or by mechanical damage. Laboratory studies, which may have limited relevance to wild seed banks, show chilling, which results in production of endogenous gibberellins which stimulate germination and loss of inhibitors, resulted only in limited increases in germination even after 140 days (Pinfield et al. 1972, 1975). The seeds are likely to germinate in the spring.

A basal rosette of 4-6 leaves is produced in the first summer, and plants remain vegetative in their first year (Brummitt 1981). The rosettes overwinter as a clump of wintergreen basal leaves in Britain. Overwintering plants are prone to rotting and slug or snail attacks (Denbighshire County Council 2006).

The shoots begin to elongate in spring in the second and subsequent years. It comes into flower in June and July, sometimes continuing to August or September. It is pollinated by bees in gardens (see below) but there are no specific observations published of pollination in the wild. Seed is set about a month after pollination and the seeds are c. 2.5-3 mm long and ovoid with low rounded swellings. There are no specialised seed dispersal mechanisms though local dispersal of undigested seed could occur by mammals eating infructescences or by seed-eating birds.

Reproductive biology

Self-compatibility

One isolated plant of *S. alpina* (first year rosette courtesy M & C Kitchen, originally from Wotton-under-Edge) was grown in my Cardiff garden in summer 2021. It flowered in July and August and was allowed to naturally open-pollinate. This single plant set abundant seed, which, in the absence of another plant of the same species, provisionally indicates that it is self-compatible (NB seeds have been sown to check in case they are hybrids with *S. sylvatica*).

Pollinators

Following the standard pollinator observation protocol of recording which species visit the flowers within a 10 minute observation period, insects observed visiting *S. alpina* in gardens by Tim Rich (Cardiff, garden), Clare and Mark Kitchen (Bevington, garden) and

Helena Crouch (Paulton, garden) are listed in Table 2 (see also Figure 3). At least six common and widespread bees and hoverflies were observed visiting *S. alpina* flowers 27 times in 2.5 hours in the three gardens.

Clare and Mark Kitchen also reported a wool carder bee *Anthidium manicatum* has visited *S. alpina*. *Bombus pascuorum* and *Anthophora furcata* were also observed visiting *S. sylvatica* in my Cardiff garden both separately and immediately following visits to *S. alpina*.

Table 2 Pollinators observed visiting *Stachys alpina* in gardens in 2021

Observer	Date	Start time	Species
TR	2/7/21	18.20	*Bombus pascuorum* (worker) 1 visit
TR	4/7/21	09.05	*Bombus pascuorum* (worker) 1 visit
TR	4/7/21	10.29	*Bombus pascuorum* (worker) 1 visit
TR	4/7/21	12.53	*Bombus pascuorum* (worker) 2 visits
TR	4/7/21	17.30	*Bombus hortorum* (worker) 1 visit
TR	4/7/21	18.11	None
TR	5/7/21	08.44	*Anthophora furcata* 1 visit
TR	5/7/21	09.31	None
TR	5/7/21	10.44	None
TR	5/7/21	13.55	*Anthophora furcata* 2 visits
HC	6/7/21	pm	*Anthophora furcata* 2 visits, *Bombus hortorum* (worker) 3 visits, *Episyrphus balteatus** 2 visits and *Platycheirus albimanus** 2 visits
TR	8/7/21	15.52	*Anthophora furcata* 1 visit
TR	9/7/21	13.42	*Anthophora furcata* 2 visits
TR	9/7/21	13.42	*Anthophora furcata* 2 visits and *Bombus pascuorum* (worker) 2 visits
M&CK	18/7/21	11.00	*Apis mellifera* 1 visit and *Bombus* sp. 1 visit

*David Clements kindly identified the hoverflies from pictures

Figure 3 Pollinators of *Stachys alpina* in Cardiff garden. Left to right - *Anthophora furcata, Bombus pascuorum* and *Bombus hortorum*

Ecology

In Britain, *S. alpina* is a plant of open woods, glades, wood borders, hedge banks and trackways on thin soils overlying calcareous rock (Evans 1999; Walker 2002). It usually occurs in sunny or sheltered locations. White (1900) noted that where it occurs adjacent to roads or tracks it was always on the far side of the hedge.

Geologically the underlying bedrock at Wotton-under-Edge is Salperton Limestones and Birdlip Limestones (Jurassic), and at Trillis it is on alluvium below Oolite slopes. In Wales at Coed Cil-y-Groeslwyd and Eyarth it occurs on Loggerheads Limestone Formation (Carboniferous), and at Cerrigydrudion it may have been on Gelli-Grin Formation (igneous calcareous tuff), Glyn Gower Siltstones or Rhiwlas Limestone (Ordovician) where it was first found. There are no details of the actual soils it occurs on, though Bucknall (1897) described the soils at Wotton-under-Edge as Upper Lias sands.

Stachys alpina is typically associated with *Arrhenatherum elatius, Bromopsis ramosa, Geum urbanum, Heracleum sphondylium, Mercurialis perennis, Silene dioica, Stachys sylvatica* and *Urtica dioica* in Britain (Evans 1999). Bucknall (1897) listed it as occurring with *Campanula glomerata, Convallaria majalis, Hypericum* sp.*, Polygonatum odoratum, Rubus* sp.*, Sorbus aria, Stachys sylvatica* and *Valeriana officinalis* at Wotton-under-Edge, and he noted it occurred with a similar suite of species in the South Tyrol, Austria.

Stachys alpina is reported to respond to disturbance to woodlands, which could occur by forestry or coppicing, wind-throw or through animals such as wild boar, beavers or badgers or, at sites in north Wales from domestic animals such as ponies and chickens (J. Osley, pers. comm. 2022). Bucknall (1897) recorded that it occurred in areas where the underwood had been coppiced in the previous 1-2 years.

Its ecological characteristics were summarised in Britain using the Ellenberg attribute method by Hill et al. (2004):

- Light – 7 = plants in generally well-lit places, but also occurring in partial shade;
- Moisture – 5 = Moist site indicators, mainly on fresh soils of average dampness;
- Reaction (i.e. soil pH) – 8 = strong indicator of basic soils, intermediate between plants of weakly acid to weakly basic conditions and plants always found on calcareous or other high pH soils;
- Nitrogen (i.e. soil fertility in general) – 7 = often found on richly fertile places;
- Salt tolerance – 0 = absent from saline sites.

Unusually, Ellenberg (1988) does not list its ecological characteristics for central Europe, though he does for other *Stachys* species.

A review of floras shows *S. alpina* occurs in a broader range of habitats in Europe and Asia Minor than in Britain including a range of subalpine broad-leaved and conifer woodlands, subalpine meadows, tall herb vegetation, clearings and woodland edges (Table 3).

Table 3 Characteristic habitats of *Stachys alpina* in Europe and Asia Minor as extracted from floras held in NMW library and some papers

Area/country	**Habitats and notes**
General (Meusel et al. 1978)	Oceanic and suboceanic mesophilic mountain perennial and high forest perennial.
Central Europe (Hegi 1908-1931)	Herbaceous corridors, scrubby pastures, deciduous and conifers woodlands with open canopies, avalanche impact areas, scree slopes in the mountains and subalpine … to 1600 m
Alps (Aeschimann et al. 2004)	Common in Alps. Flowering June-September, strong calcicole, medium water status, mostly moderate altitudes.
Bosnia and Herze-govina (Degen 1937)	On bushy slopes, on the edge of forests, in logged areas, in foothills of the Alps, rarely, 600-1400 m.
Belgium (Lambinon & Verloove 2012)	Forest edges, logged areas, rather lime-loving species. Sometimes introduced
Bulgaria (Velenovský 1891)	Alpine meadows
Czech Republic (Dostal 1989)	Damp forests, mountain floodplains, overgrown rubble, clearings and forest edges, floodplain forests, on moist, nutrient-rich often limey soil with clay
France (Coste 1937; Guinochet & Vilmorin 1975, Tison & de Foucault 2014, Dume et al 2018)	Clearings of forests, hedges and bushes, beech-fir groves, maple groves, pine woods, subalpine tall-forb vegetation. Subalpine 100-2000 m. Sunny to semi-shade places on calcareous to mesotrophic clays and silts rich in elements, basic to weakly acidic.
Germany (Senghas & Seybold 2000)	Forests, tall herbaceous vegetation, clearings especially montane and subalpine to 1700 m. Calcicolous.
Holland (Duistermaat 2020)	On forest edges and logged areas on calcareous soils, recently found in one place in the south, possibly overlooked.
Iran (Salmaki et al. 2012)	Slopes of mountainous forests, preferring soils with high percentage of clay and humus; elevation 900–2000 m.
Italy (Baroni 1969; Zángheri 1976)	Woods, hedges and meadows. Alps and Apennines.
Poland (Pawłowski 1967, Zając1996, Zając & Zając 2001)	Frequent in the Western and Eastern Carpathians in mountain forests (mainly *Fagus sylvatica* and *Abies alba*), and mainly on calcareous limestone and sandstone up to 1200 m and 1625 m in the Tatra Mountains. Very rare in the Sudetes Mountains. Its occurrence outside mountainous areas consists of disjunct relict populations. A species of the *Atropion belladonnae* Alliance Br.-Bl. 1930 em. Oberd. 1957
Romania (Săvulescu 1952)	Forests and mountain scrub
Spain (Rollán 1985, Santiago & Morales Valverde 2010)	Meadows or tall herb vegetation in understory in humid places, sometimes nitrophilic, on siliceous or limestone substrates 90-1600 m. In shady places, especially in the mountains.
Switzerland (Hess et al 1972)	Loose/fresh, moist, nutrient-rich loamy soil in warm areas, preferably in half-shade, dry meadows, tracks, thin forests, forest clearings, tall herb communities, rock debris, bottoms of

	cliffs, dumps/rubble. Probably only naturalised in a few places. 200-1700 m
Turkey (Davis 1982)	Rocky slopes and pastures, c. 900 m
USSR (Shishkin 1978)	Forests and scrub

The altitudinal range in Britain is c. 165-245 m (White 1912; Wilson 1956) and in Europe is 90-2000 m. As White (1912) noted, despite its *alpina* epithet, it is not restricted to high altitudes and is not strictly an alpine plant.

There is limited information on its response to grazing. Most *Stachys* species have strong smell when rubbed and may be generally distasteful to grazing animals. It does not grow well in pony fields or grassy pasture at Cil-y-Groeslwyd, suggesting susceptibility to some grazing animals. Plants in cultivation may be susceptible to being eaten by slugs and/or snails (Denbighshire County Council 2006), though H. McAllister did not find so at Ness (pers. comm. to J. Osley, file note 4/12/1997) and I find only minor damage in Cardiff.

Thus it seems to be a short-lived woodland edge specialist with a long-term seed bank which germinates in response to loss of tree or vegetation canopy (forestry, windthrow or animal activity) with ground disturbance and prefers open conditions but does not persist in heavy shade. It is associated with nutrient-rich to nutrient-moderate, moist, generally calcareous soils. The wide geographic distribution and lowland to submontane altitudinal range suggests it has a broad climate tolerance.

History of limestone woundwort in Wales and the UK

History in Wales

Stachys alpina has been found in three sites in Wales.

It was first reported in Wales in July 1927 by Albert Wilson at Cerrigydrudion, Denbighshire. Brummitt (1981) records that 'tradition has it that he was returning to North Wales by car, when he stopped at the roadside for a picnic and to his surprise saw a clump of *S. alpina*'. Wilson recorded the "plant was growing partly in shade … The habitat was on a steep bank (on limestone), wooded at the top. The plants growing with it, or close to it, were *Agrimonia odorata, Stachys sylvatica, Origanum vulgare* and *Urtica dioica* … it was not confined to one spot, but occurs in three or more, in nice quantity" (letter to J. W. White, 27 August 1927, **BRISTM**). There is some doubt about Wilson's exact site but it is now generally accepted as on the A5 four miles south-east of Cerrigydrudion (Brummitt 1981). The site was subsequently destroyed by road widening by about 1960 (Brummitt 1981). In 1998, plants were translocated to this site and adjacent woodland (see below).

However, this is not the earliest Welsh record. Following the 1973 discovery of *S. alpina* at Cil-y-Groeslwyd (see below), Brummitt (1981) reviewed the data and noted that there was an odd 1908 "*Stachys germanica"* literature record by William Hodge from Eyarth Woods determined by 'Dr Russell' (Dallman 1911) and suggested that it might refer to *S. alpina* rather than to *S germanica.* The original specimen on which this record is based has not been traced but a second specimen collected the following year has been traced in William Hodge's herbarium (held in Warrington Museum, **WRN**). This specimen was collected from the limestone at Pwll-Glâs, Ruthin in August 1909 by "Jos Harnaman". It was incorrectly named as *S. germanica* by Hodge but is *S. alpina* thus strongly indicating that Hodge's 1908 record was also *S. alpina* (as surmised by Jones 2011). Hence William Hodge can be credited with the earliest Welsh record at Eyarth Woods in 1908. This Eyarth site was rediscovered in 1990 by Jean Green when she investigated areas of Eyarth Woods which had been clear-felled in 1987 (Evans 1992; Green 1992). Presumably the woodland clearance had stimulated the seed to germinate as five separate plants were found, indicating a widespread seed bank (Evans 1990). Only one plant survived to 1994 (Evans & Ellis 1994; Osley 1996). Brummit and Wright had searched Eyarth Woods unsuccessfully in the early 1970s following their discovery of it at Cil-y-Groeslwyd (see below), and they concluded it was unlikely to be present as the closed woodland habitat was different to Cil-y-Groeslwyd (J. Brummit letter to R. G. Ellis, 12 June 1976, NRW file). Eyarth House has a limestone rockery and garden which was developed in the 1930s so cannot be a potential source of introduction.

The third site for *S. alpina* was found near Pwll-Glâs at Cil-y-Groeslwyd in 1973 when two plants were found by Bruce Ing (Brummitt 1981). John Brummitt and David Wright saw two plants in 1975, collected seed from them and translocated 11 plants in 1977 when the original plants were no longer present (Brummitt 1981). Since 1975 many more plants have been transplanted into Cil-y-Groeslwyd and the adjacent North Wales Wildlife Trust (NWWT) Reserve but some have also been found in other parts of the woodland which could be of native origin but it is now impossible to tell to what extent new subpopulations could be from the original seed bank or a result from transplants (see also below).

History in UK

Stachys alpina was first found in Britain by Cedric Bucknall on 30 June 1897 near Wotton-under-Edge, Gloucestershire (Bucknall 1897), only 11 years before the Welsh record. The following week with James W. White, Bucknall found it scattered through woodland, thickets and roadside over an area of less than a mile. By 1898 it was found to occur over about two square miles (Anon 1900; White 1900, 1912), and White noted it seemed to prefer the sunniest and most sheltered spots. It was clearly long-established in the area over quite an area. Perring & Farrell (1977) reported that at one time it was known from eight sites in Gloucestershire, but by 1977 was only known from one locality where it was threatened by growth of rank grasses and conifer planting, though the site had recently become a nature reserve with a more secure future.

Riddelsdell (1948) also listed a 1913 H. H. Haines record from near Berry Hill Farm, c. 2 miles SW of Wotton-under-Edge, in an area of pasture and hedges. This has not been seen again.

In June 2020, a new site was discovered at Trillis, Gloucestershire when a good population of a few flowering and many vegetative plants was found under hazel by the canal towpath. This site is about 14 miles ENE of Wotton-under-Edge located in an area with similar hilly and wooded landscape, and further searches are required of the surrounding area to see if more colonies are present.

There is an unconfirmed BSBI database record from Nibley Lane, Yate, Gloucestershire ST6935082234 from 1981 without details of a collector; this record is currently not accepted.

A review of native or introduced status of limestone woundwort

Background

There are two interpretations of the distribution shown by *S. alpina* in Britain. First, it is a rare and/or declining native species relict from a wider post-glacial distribution. Second, it is a rare introduction escaped from gardens or otherwise introduced. The native/introduced status is important as it determines the priority for conservation.

A timeline of the status as described by different authors is given in Table 4. This shows all authors accepted it as native until Kay & John (1995) reviewed it and suggested it was 'extremely doubtfully native'.

Table 4 Chronological sequence of changes in published national status of *Stachys alpina*

Author	**Status**
Bucknall (1897)	Native
White (1912)	Native
Riddelsdell et al. (1948)	Native
Clapham et al. (1952)	Native
Perring & Farrell (1977)	Native
Ellis (1983)	Native
Kay & John (1995)	Not native
Walker (2002)	Neophyte
Green (2005)	Native (Denbighshire)
Pearman (2007)	Neophyte
Kitchen & Kitchen (2007)	Native
Sell & Murrell (2009)	Native
Stace (2019)	Naturalised neophyte

Kay & John's (1995) arguments that it was an introduction can be summarised as follows:

1. It had spread considerably in 15 years between discovery over one square mile in 1897 and two square miles in 1912;

2. The area it was found in at Wotton-under-Edge was not remote and had been visited by botanists, so it could be a recent introduction or would have been found earlier;

3. There is nothing particularly unusual about the habitat or locality (i.e. is not an obvious refugium like the Gower Peninsular);

4. As a robust, competitive species, it could have previously spread through the Cotswolds if native; and

5. The Gloucestershire and Denbighshire plants are genetically closely related and show little or no isozyme variation.

Pearman (2007) also briefly reviewed its status, citing Kay & John's (1995) work, and concluded "it seems totally unlikely that its British distribution should be only three localities, in habitats that are either secondary woodland or ruderal sites".

All these points have significant counter arguments, and some are demonstrably incorrect (Kitchen & Kitchen 2007, and see below):

1. Kay & John's (1995) interpretation of 'considerable spread in 15 years to two square miles' is incorrect; White had already reported it as occurring in two square miles by 1898, the year after it had been found (Anon 1900; White 1900; White's specimens from these new sites are in **BRISTM**). Kay & John (1995) had presumably not seen these publications and had simply interpreted the spread in terms of the publication date of White's (1912) flora. As Anon (1900) and White (1900) showed clearly, immediately after it had been found, White had given more attention to the newly discovered interesting species and immediately found more local populations. The occurrence over two square miles 1897-1898 is clear evidence of a long-established population.

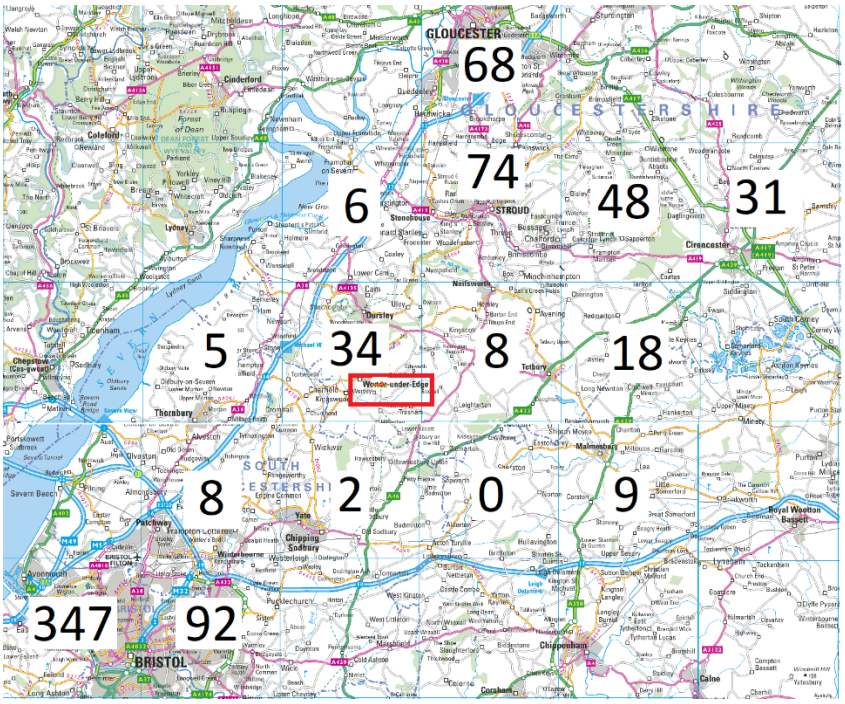
2. Kay & John's (1995) assertion the Wotton-under-Edge area had been already explored by botanists is only partly true, but the lack of coverage was the precise reason why Bucknall and White were investigating it. Bucknall (1897) was explicit in stating that whilst the flora of the Bristol coalfield had been well-explored, the south-west corner of the Cotswolds was comparatively unexplored. Bucknall (1897) and White (1900, 1912) also suggested the *Stachys* had been overlooked due to few botanists visiting the area coinciding with the 15-20 year coppice cycle of the woodland. The immediate discovery of so many subpopulations within the area showed *S. alpina* is most likely to have simply been overlooked in a poorly visited area. Bucknall has also found *Hordelymus europaeus* at Westridge Woods in 1897, previously unknown in the Bristol area, and *Cephalanthera rubra* was not discovered there until 1962 (Kitchen & Kitchen 2007).

   Two other sources of evidence indicate the Wotton-under-Edge area was poorly known at the time of discovery. First, a search was carried out for floristic lists and papers published for the Wotton-under-Edge area in the *Bibliographic Index to the British flora* (Simpson 1960), which indexes all contemporary literature. There are many papers cited for Bristol, Cirencester and Gloucester, with a few papers cited for Stroud, and many for the Cotswolds in general from the Cotteswold Naturalist's Field Club. The absence of any cited papers for the Wotton-under-Edge area suggests, but does not prove, limited botanical exploration of the area.

   Second, a provisional analysis of the extent to which the Wotton-under-Edge area had been botanically explored has also been carried out by counting the records up to 1897 (the year in which *S. alpina* was found) in the BSBI Big Database for each 10-km square (Figure 4). These counts have to be interpreted with caution as the historical data in the database are incomplete and are biased towards species and places for which data have been extracted (for example there are very few records from Bucknall's or White's herbaria as the data from their collections in **BRISTM** have simply not been extracted yet). None-the-less, the counts show some interesting trends when taken at face value. The larger towns/cities (Bristol, Gloucester, Stroud, Cirencester) have the highest number of records per 10-km

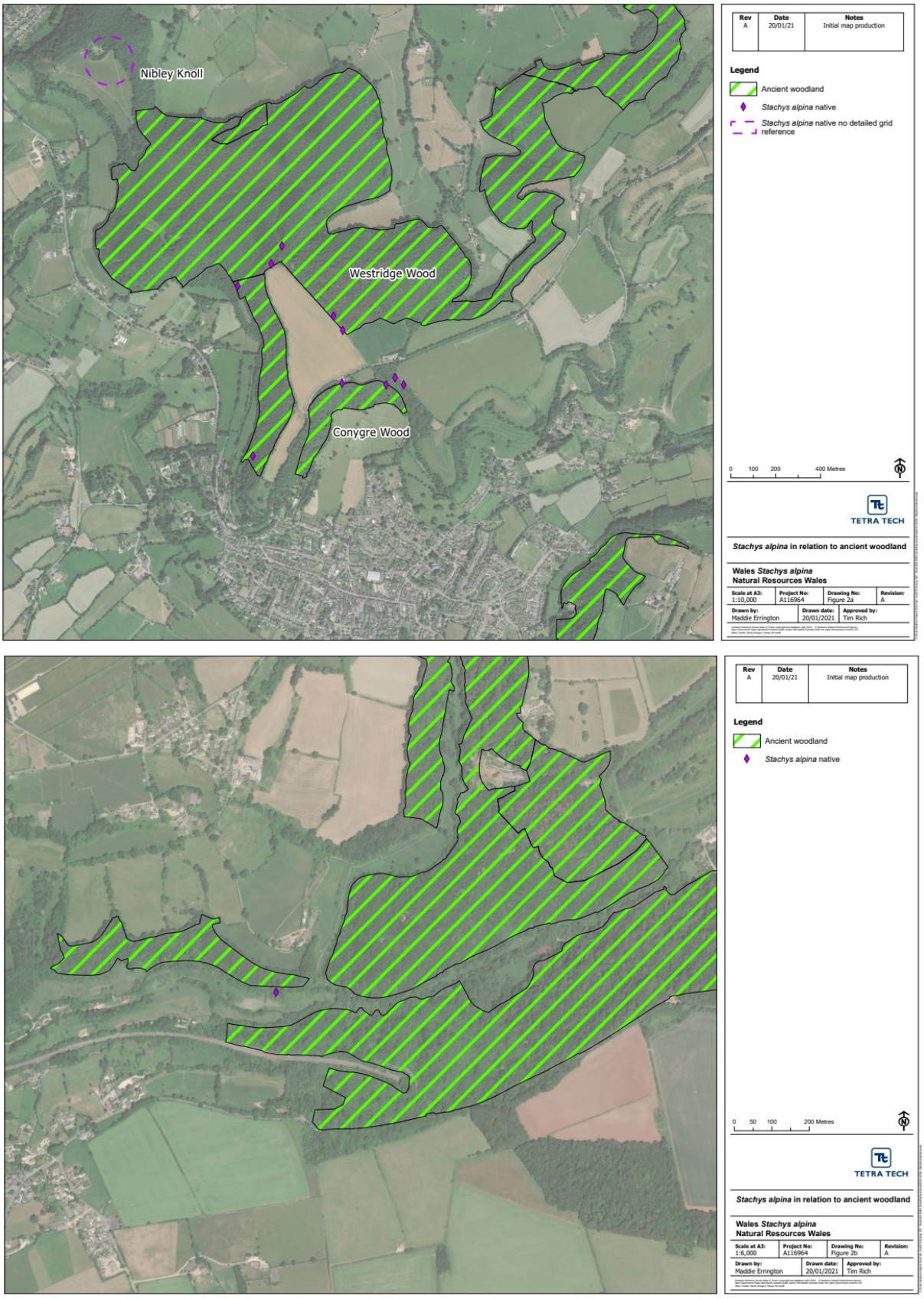
square (68-347 records) as might be expected as this is where the majority of botanists will have lived in the local centres of population (cf. Rich 2006). The 10-km squares between Bristol and Stroud generally have very few records (0-8 records), whilst the Wotton-under-Edge 10-km square has an intermediate number of records (34 records). A closer examination of these 34 records shows only two specifically for Wotton-under-Edge (*Polygonatum odoratum* and *Rubus rufescens*) with most records for Tortworth, Kingswood and Dursley. This general pattern supports Bucknall's and White's assertion that the area had been comparatively unexplored but requires compilation of all historical records to be certain.

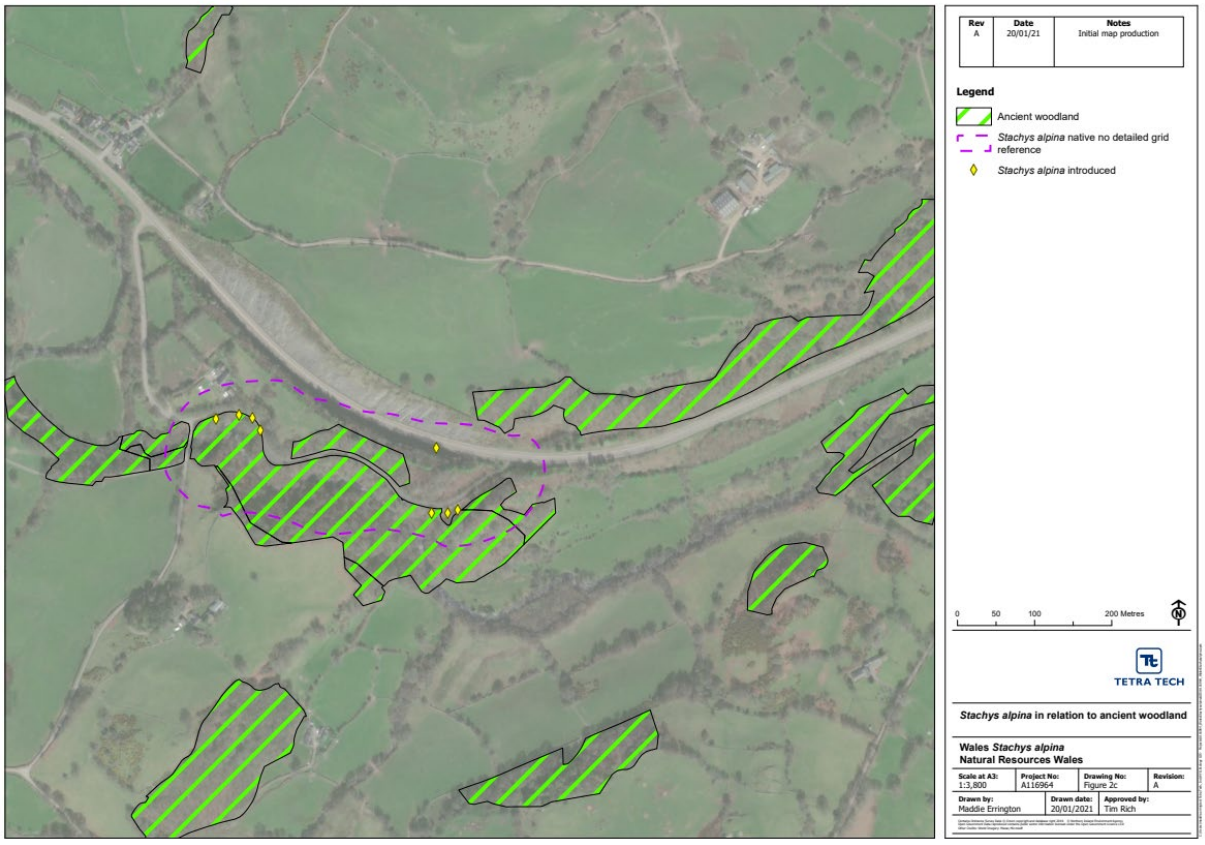
Figure 4 Number of vascular plant records up to 1897 held in BSBI big database for each 10-km square (accessed December 2020). Wotton under-Edge is highlighted.



3 Whilst the Wotton-under-Edge and North Wales habitats are not refugia of the same type as the Gower Peninsular with its open habitats (cf. Pigott & Walters 1954; Rose 1957), the four general localities all have complexes of ancient and more recent woodlands, deep valleys and hedges which provide numerous suitable habitats for woodland edge species like *S. alpina,* giving the potential for meta-population dynamics through time as shown by the associations of *S. alpina* sites with Ancient Woodland and woodland edges in Figure 5. Figure 5 also demonstrates Pearman's (2007) contention that the habitats were secondary woodland or ruderal sites is incorrect and he failed to take into account the context of the landscape in which *S. alpina* occurs.

Figure 5 Association of *Stachys alpina* records with ancient woodland complexes. A, Wotton-under-Edge. B, Trillis. C, Cerrigydrudion- Y Glyn Diffwys. D, Cil-y-Groeslwyd Woods and Eyarth.

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Natural Resources Wales
Scale at A3:
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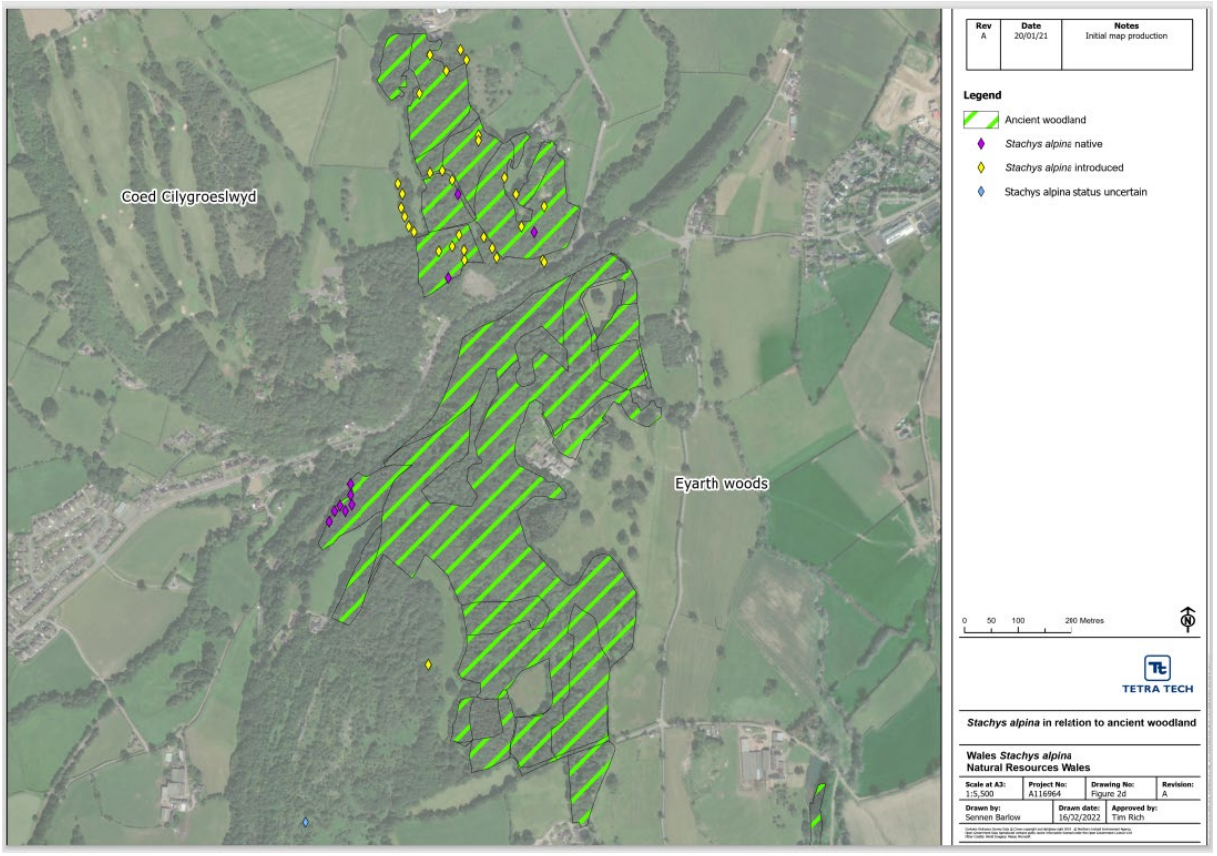
Maddie Errington
Drawn date:
20/01/2021
Approved by:
Tim Rich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Drawn by:
Sennen Barlow
Drawn date:
16/02/2022
Approved by:
Tim Rich

Other rare plants of old woodlands in the immediate Wotton-under-Edge area were *Cephalanthera rubra, Polygonatum odoratum* and *Rubus bucknallii*. There are also clear parallels to the distribution of its native relative *Stachys germanica* which occurs in ancient woodland complexes around Wychwood, Oxfordshire in the eastern Cotswolds (Marren 1988). There are also several somewhat disjunct thermophilic species in NE Wales such as *Lithospermum purpureocaeruleum* and *Carex muricata* subsp. *muricata* suggesting refugia there too.

4 The failure of *S. alpina*, a competitive species able to compete in relatively nutrient-rich habitats, to colonise the Cotswolds has many potential explanations. Kay & John (1995) suggested that had not colonised elsewhere as it was a recent colonist. The failure to spread from botanist's gardens in Britain shows it has little propensity to spread locally whilst the 2020 discovery of the Trillis canal site also shows that it has occurred elsewhere in the Cotswolds. Other explanations for failure to spread could include lower fecundity from in-breeding depression as a result of long-term isolation – indeed Kay & John (1995) noted the white flowered plants reported by Holland (1986) could indicate inbreeding from a narrow genetic basis.

5 The limited genetic diversity reported by Kay & John (1995) could be a result of the tiny sample size (as few as ten plants which may have been derived from four parents; Jones 2011; 2020) or the allozyme method which shows only limited polymorphisms compared to DNA methods, or could result from spread from one site to another within Britain. Limited genetic diversity would also be predicted for founder effects in edge of range populations, a well-established phenomenon, and especially if the Welsh populations were originally derived from the Cotswold populations. Given the British populations are likely to have been isolated from continental populations once the English Channel flooded c. 8500 years ago, they might be expected to be genetically impoverished. However, some genetic differences between the Cotswold and North Wales sites might be expected as suggested by Kay & John (1995).

Review of native/introduced status based in current evidence

Jones (2011; 2020) discussed the problem of the status of *S. alpina* in Wales and suggested that further investigations would be worthwhile, especially to address the limited genetic sampling by Kay & John (1995). The status has therefore been reviewed below using the ten criteria for presuming native status (Webb 1985; Preston 1986; Rich & Pryor 2003).

Fossil evidence

No fossil records are listed in Godwin (1975). As an insect-pollinated species of dry woodlands, *S. alpina* is unlikely to deposit either pollen or macrofossils. This criterion therefore provides no evidence towards native or introduced status.

Historical evidence

Stachys alpina was first recorded in cultivation in Britain in 1597 (Lindley 1823). There is no indication how frequently it has been generally grown in gardens rather than by

botanists; a Google search of current plant suppliers only gives one pot plant supplier and no seed suppliers (Google searches 16 September 2020). Pearman (2007) regarded it as a “garden plant of very little value”.

The first record in the wild was in 1897 in Gloucestershire which is relatively recent by the standards of much of the British flora. The first Denbighshire record in 1908 is similar, and Denbighshire had been relatively poorly botanised by comparison due to few local botanists (Carter 1960; Rich 2006).

The early date of cultivation and late discovery are weak circumstantial evidence in favour of it being an introduced species.

Habitat

The Gloucestershire and Denbighshire habitats are semi-natural in open woods, glades, wood borders, hedge banks and trackways, usually associated with ancient woodlands and basic thin soils over Carboniferous and Jurassic Limestones (Figure 5). These habitats are a clear subset of the habitats in Europe (Table 3; Bucknall 1897), which are also often disturbed woodland edge habitats in the lowlands. IN Europe it is not exclusively on basic substrates.

There is one 1913 record from near Berry Hill Farm (Riddelsdell 1948), an area of pasture and hedges which does not clearly fit this pattern though the precise habitat was not stated. This site is not far from Wotton-under-Edge and could be from local spread.

Bucknall (1897) noted *S. alpina* is associated with many similar plant species in Gloucestershire and Austria, which would be expected for a species showing natural spread.

This habitat in Britain is not one with a high incidence of non-native plants, but introduced species do occur.

This clear similarity in habitat and associated species between Britain and Europe is strong evidence in favour of native status.

Geographical distribution

The Gloucestershire and Denbighshire localities are somewhat disjunct (400-320 km) from the nearest sites in Europe. Pearman (2007) argues the distribution of *S. alpina* has no spatial coherence in Britain.

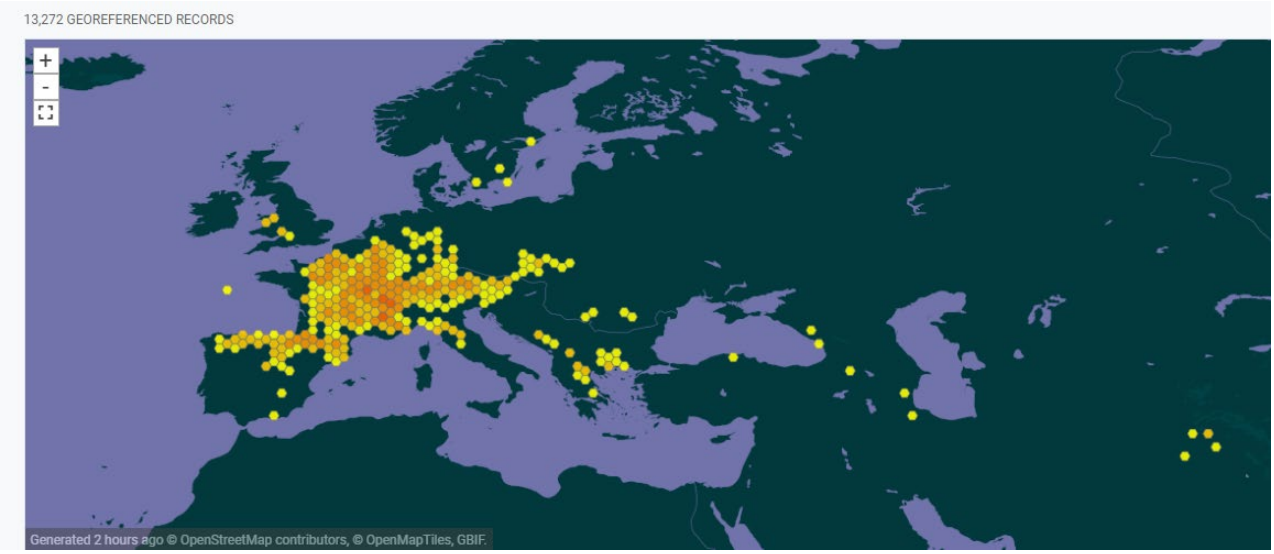
Figure 6 shows a world distribution map from the Global Biodiversity Information Facility (GBIF, https://www.gbif.org/), showing *S. alpina* is relatively common and widespread in central and western Europe extending to Belgium and northern France with many disjunct localities in the east (note that better data are required here as GBIF has relative few data checks and no indication of native/introduced status). The world distribution pattern with many disjunct localities could result from long-distance dispersal events or might reflect a relict distribution from a former more widespread continuous distribution.

When seen in this wider context, the British distribution is not atypical and is consistent with this wider world distribution pattern. Many other rare native plants such as *Stachys*

germanica also show disjunctions. It has also been found recently in southern Holland where it was regarded as possibly overlooked (Duistermaat 2020).

This British distribution pattern consistent with the world pattern is weak evidence in favour of native status.

Figure 6 World distribution of *Stachys alpina* from GBIF. Records in Scandinavia are introduction. This map requires cautious interpretation as some dots are apparently errors and there is only limited quality control on source data. The eastern-most sites may refer to another related species.



Frequency of known naturalisation

Other than the three Gloucestershire and two Denbighshire records for cited above, there are no other British records, despite being known in cultivation since 1597. It is not known how widely it has actually been grown but herbarium collections and Riddelsdell et al. (1948) show it has been cultivated by botanists in Devon (Bovey Tracey), Durham (Westgate), Gloucestershire (Bristol, Clifton, Minchinhampton, Sedbury), Herefordshire (Sellack), Oxfordshire (Bloxham), Surrey (Reigate, West Byfleet), Sussex (Worthing, Lindfield) and Warwickshire (Little Compton). Evans (1992) recorded that in Dick Brummitt's garden in Colwyn Bay, 'it is apparently something of a weed which he has been trying to eliminate' but had not spread outside the garden. M. & C. Kitchen, H. Couch and F. Rumsey currently grow *S. alpina* in their gardens and have done for years and it has not spread outside them either. Despite these 17 examples of cultivation in gardens, it has not been recorded as naturalised from gardens in Britain.

There are no records associated with potential sources of introduction to Britain such as bird seed (Hanson & Mason 1985; G. Hanson pers. comm 2020), 'wild flower' seed, grain imports or forestry.

Outside Britain, *S. alpina* was introduced after 1800 to man-made habitats to three sites in Sweden but did not persist (T. Tyler, pers. comm. 2020). In Belgium it was suggested to be sometimes introduced (Lambinon & Verloove 2012). In Switzerland it is locally common and only spread or carried in a very few places (Hess et al. 1972).

The lack of naturalisation is weak evidence in favour of native status.

Genetic diversity

Kay & John (1995) found the Gloucestershire and Denbighshire plants were virtually monomorphic for isozymes. Material obtained from plants grown from seed from the Millennium Seed Bank (8 samples Gloucestershire, 2 samples Denbighshire) gave nine enzyme systems yielded thirteen loci of which two showed variation, indicating a common origin from a very limited genetic base. However, the original seed samples may also have been from very few plants (Kay & John 1995), perhaps as few as 2 maternal plants, and the allozyme method gives only limited polymorphisms compared to DNA methods. Kitchen & Kitchen (2007) noted all the plants from the London Road site – the probable source of the Seed Bank samples from Gloucestershire - were derived from material found in 1972 by E. Milne-Redhead. There are no European isozyme data to compare the Kay & John (1995) study with. The lack of isozymes diversity could either be evidence for native status (limited genetic diversity at edge of range) or against native status (indicative of rare introduction, and introduction to Denbighshire from Gloucestershire as these would be expected to show differences given the geographical isolation).

No studies looking at genetic variation in DNA have been traced in Britain or Europe for *S. alpina*, though other species have been studied (e.g. Kochieva et al. 2006). Five specimens (three from Wales, one from Germany and one unspecified) have sequences from rbcL, matK or ITS DNA barcodes (BOLD 2021), but these barcodes are not designed to analyse genetic variation.

Stachys alpina is uniform in chromosome number in Britain and Europe. Plants from Wotton-under-Edge had a chromosome number of 2n=30 (Morton 1973), which has also been widely reported from the continent (e.g. Bulgaria, Baltisberger 2006; Poland Pogan et al. 1980; Romania, Baltisberger & Widmer 2009; Slovakia, Murín & Májovský 1978, Marhold et al. 2007; Spain, Santiago & Morales Valverde 2010; Switzerland, Hess et al 1972; Turkey, as subsp. *macrophylla*; Martin et al. 2011). Chromosome numbers provides no evidence for or against native status.

The limited genetic data of Kay & John (1995) are weak evidence in favour of introduced status but require further investigation.

Reproductive pattern

Stachys alpina only reproduces by seed. Kay & John (1995) suggest it was protandrous, self-compatible and pollinated by bees, as for related *Stachys* taxa, in which case a single introduction could self-seed. Our limited garden study (cf. above) suggests it is self-compatible and confirms it is pollinated by bees, and suitable pollinators are widespread in Britain. Once present, it would be able to set seed and reproduce, so the reproductive data are strong evidence in favour of native status.

Included under this criterion is ‘persistence’ (as used by Pearman 2007, native species are more likely to be persistent at a locality, either as plants or in seed banks) but is an issue of which has been obscured by conservation action in Britain. It has been persistent at Wotton-under-Edge since at least 1897, and the occurrence at Eyarth woods between 1908 and 1990 at least is indicative of long-persistence, which is weak evidence in favour of native status.

Possible means of introduction

The seeds have no obvious dispersal mechanisms (like all Lamiaceae), so recent, natural, long-distance dispersal to Gloucestershire and Denbighshire is unlikely. As it has been grown in gardens it could have escaped or been thrown out, but if this was the case it might be expected to have occurred in the wild near to gardens too (see also above). There is no evidence that it is associated with forestry stock imported from Europe (as has been suggested for example for *Linnaea borealis*).

The lack of an obvious introduction means is weak evidence in favour of native status.

Relationship to species-specific oligophagous insects

Some invertebrates associated with *Stachys* in general have been recorded on *S. alpina*. The woundwort shieldbug *Eysarcoris venustissimus*, primarily known from *S. sylvatica*, occurs on *S. alpina* in gardens in Britain (M. & C. Kitchen pers. comm. 2020). The *Stachys*-flower specialist bee *Anthophora furcata* pollinates *S. alpina* at least in gardens in Britain (there are no studies of wild plants).

No specific studies of invertebrates specifically associated with *S. alpina* or *Stachys* in general have been published in Britain or elsewhere, so this criterion cannot be assessed.

Use by man

Stachys alpina has been grown in Britain since 1597 (Lindley 1823) but is regarded as of little value (Pearman 2007) and does not seem widely grown except by botanists.

Despite the English generic name ‘woundwort’, *S. alpina* is not listed in any British herbals as having medicinal usage, though other members of *Stachys* are (e.g. Gerard 1633, Brookes 1763, Allen & Hatfield 2004). González-Tejero et al. (2008) list it as used for treatment of nutritional tract health issues in Albania. Uritu et al. (2018) list three other *Stachys* species with active compounds with pain relieving properties but not *S. alpina*. No other clinical or pharmacological usages of *S. alpina* have been traced in medical plants books held in the botany library at NMW (H. Pardoe, pers. comm. 2021).

Stachys alpina is not used for food. Gören (2014) reviewed use of numerous *Stachys* species and listed some as consumed as teas (but not *S. alpina*).

The minimal use of *S. alpina* by man in Britain is weak evidence in favour of it being native as it is not likely to be deliberately introduced for use.

Summary of status criteria

The criteria are summarised in Table 5 and show that there is strong support from two criteria and weak support from four criteria for it being native, and weak support from two criteria to be introduced. On balance overall *S. alpina* is much more likely to be native than introduced.

Table 5 Summary of evidence for native and introduced status of *Stachys alpina* based on current evidence.

Criterion	Native status	Introduced status
Fossil evidence	n/a	n/a
Historical evidence	n/a	Weak
Habitat	Strong	n/a
Geographical distribution	Weak	n/a
Frequency of known naturalisation	Weak	n/a
Genetic diversity	n/a	Weak
Reproductive pattern	Strong	n/a
Possible means of introduction	Weak	n/a
Relationship to oligophagous insects	n/a	n/a
Use by man	Weak	n/a

Recommendations for status study in the UK/Wales and the status of the Welsh population including DNA methods

The review of native or introduced status above suggests that on balance overall *S. alpina* is more likely to be native than introduced. The following studies may help clarify the status further:

Genetic relationships

There are only limited genetic data available from one isozyme study, so further genetic DNA studies may help to place British plants in a European context and inform the native/introduced status. If *S. alpina* is native and has spread at some stage after the last ice age, it is predicted that the Denbighshire and Gloucestershire populations would be relatively closely related genetically, and that they would also be more closely related to the nearest populations in Northern France/Belgium (if it migrated from the south-east) or to Spanish populations (if it migrated from the south-west) than to eastern European or Western Asian populations.

Caution will be required sampling from Britain. It is suggested that sampling concentrates on the more natural populations in Eyarth Woods and the woodlands around Wotton-under-Edge, with only limited sampling from the reserves where it has been repeatedly restocked (e.g. all the plants at Cil-y-Groeslwyd may be derived from original two plants collected in 1975). Sampling will be required across a wide area of Europe including the nearest sites in Holland, Belgium and France as well as more distant localities to cover the range of variation.

To maximise the potential for information from historical herbarium material from Britain, a method should be used which will work with old specimens (consent will be required to sample plants from museum collections).

The molecular methods selected to look at geographic genetic structuring depend on budget and sampling but should include a combination of chloroplast and nuclear markers (as for example used by Fay et al. 2009 for *Cypripedium calceolus*). Chloroplast haplotypes are cheap, easy to use and work with herbarium material but only give information about the maternal lines. Nuclear microsatellites are more expensive to develop and use, but they give biparental information. Two possible methods are (M. Fay, pers. comm. 2021):

1. RADseq (or one of the variants). Although relatively expensive and not working with herbarium material, RADseq provides information for 1000s of loci which can give a broad basis for analysis of geographic variation.
2. Probe sets (such as the Angiosperm-353 or, if available, a Lamiaceae-specific set) which amplify a set of loci which are then sequenced. As the regions flanking the exons are more variable, there is some variation which gives some population structure within each of the species.

World distribution map

Compilation of a more detailed distribution world map (improving on the GBIF data in Figure 6) would help to show the pattern of disjunctions across its range, allowing the British sites to be put into context better. This would take a significant amount of work compiling distribution data from floras and herbaria and would probably need to be done from a botanical institution with ready access to such data.

Seed bank studies

The ecology review suggest that there should be a long-lived seed bank (for example 20+ years to fit with a woodland coppicing cycle) but there is no experimental evidence to support this. Long-term seed bank studies can be carried out by burying seeds in marked nylon bags and then periodically exhuming and germinating seeds in the laboratory for 25+ years (for example as shown for *Carex depauperata* by Birkinshaw 1999).

A small scale study could be commissioned from the Millennium Seed Bank to review what is already known about *S. alpina* and similar species which would enable seed bank behaviour to be predicted.

Life cycle transition studies

A standard life cycle study looking at transitions between different stages of the life cycle (seed germination, germination to seedlings, seedlings established plants, 1st year plants to second year/flowering, etc.) would establish which are the most sensitive parts of the life cycle and thus indicate where successful management beyond regular coppicing would help (for example, by indicating which stages might be susceptible to slugs and snails).

Response to ash dieback studies at Eyarth Woods and Wotton-under-Edge

Related to the seed bank studies above, if *S. alpina* is native it is likely that it has been present at Eyarth Woods and Wotton-under-Edge for centuries. Hence if the seeds are

long-lived, as the ash dieback *Hymenoscyphus fraxineus* epidemic kills ash trees and opens up the canopy, it is predicted that *S. alpina* should appear in scattered subpopulations in the woods. This may be a once-in-a-lifetime opportunity which should not be missed.

Review and collation of all records of the species in Wales

Stachys alpina records were compiled into a spreadsheet and assessed using a reductionist approach due to the number of duplicates and incomplete records. The full data of 226 records for England and Wales, including cultivated material, are presented in a separate spreadsheet, but the 125 Welsh records (excluding one specimen cultivated in Bangor) are summarised below for the three sites ordered by date.

The records are given in order of locality name (usually the original site name), grid reference, recorder, date, notes and source. The source herbarium acronyms as follows:

ABS	Aberystwyth University Herbarium (images from herbaria@home)
BIRM	University of Birmingham (images from herbaria@home)
BRISTM	Bristol City Museum and Art gallery (courtesy Rhian Rowson)
E	Royal Botanic Gardens Edinburgh (courtesy Lesley Scott)
K	Royal Botanic Gardens, Kew (images from herbaria@home)
MANCH	Manchester Museum (images from herbaria@home)
SLBI	South London Botanical Institute (images from herbaria@home)
NMW	National Museum Wales, Cardiff (courtesy Heather Pardoe)
BM	British Museum (Natural History), London
OXF	Oxford University Fielding-Druce herbarium (courtesy Stephen Harris)
WRN	Warrington Museum (courtesy Craig Sherwood)

Cerrigydrudion - Y Glyn Diffwys

Cerrigydrudion, SH9944, Wilson, A., 1927-08-01, Partly in the shade on a steep limestone bank, wooded at the top, by the road near Cerrigydrudion. Associated species listed. Edge of thicket, ca. 800ft. Limestone., BM; BRISTM; K; MANCH; NMW; OXF

Cerrigydrudion, SH9944, Wilson, A., 1931-08-02, Limestone., BIRM

Cerrigydrudion, SH9944, Wilson, A., 1931-08-16, wooded cliff, 800 ft, limestone, NMW

Cerrigydrudion, SH9944, Wilson, A., 1936-08-03, K

Cerrigydrudion, SH9944, Whellan, J.A., 1940-07-27, NMW

Y Glyn-Diffwys, Afon Ceirw Gorge, SH992443, Anon, 1954

Cerrigydrudion, SH9944, Frost, L.W., 1954-07-06, On a steep bank below the road, above the river.

Cerrigydrudion, SH9944, Roberts, E., 1968

Glyn Diffwys Bends, SH9944, Colebrook, J., 2001-07-20,17 translocated plants (Colebrook 2001)

Glyn Diffwys Bends, SH9944,Colebrook, J., 2002-07-10, 5 translocated plants (Colebrook 2002)

Glyn Diffwys Bends, SH99354433, Jones, A.L. et al., 2006-04-07, On south side of cutting 1 plant

Glyn Diffwys Bends, SH99354433, Jones, A.L. et al., 2006-04-07, 2 small plants

Glyn Diffwys Bends, SH9944, Jones, A.L. et al., 2006-04-07, Self-seeded 2m SW of old power cable tie, 1 plant

Glyn Diffwys Bends, SH99354433, Jones, A.L.; et al., 2006-04-07, 1 large plant
Glyn Diffwys Bends, SH9944, Jones, A.L. et al., 2006-04-07, Near to the wall, 1 large plant
Glyn Diffwys Bends, SH99354433, Jones, A.L. et al., 2006-04-07, 1 large plant
Glyn Diffwys Bends, SH99354433, Jones, A.L. et al., 2006-04-07, South side of road by left turn sign, bottom of cliff. 1 young plant
Glyn Diffwys Bends, SH99424428, Phillips, J., 2008-07-29, Situated on road, almost opp. memorial. Both multi-stemmed and of normal height. 2 plants
Glyn Diffwys Bends, SH99354433, Phillips, J., 2008-07-29, On second bend, opposite side from Afon Ceirw. 2 multi-stemmed plants with 20-25 stems on each, over 1m high. 2 shorter plants, one had 1 stem and the other was multi-stemmed.
Glyn Diffwys Bends, SH99424428, Phillips, J., 2008-07-29, Short distance down road from memorial, in field. All 45 plants multi-stemmed. 4 were over 1m high.
Glyn Diffwys Bends, SH9944, Berry, G.; Phillips, J., 2010-07-21, 262 flowering 87 rosettes, Berry & Phillips 2010
Glyn Diffwys Bends, Site 1, SH99244437, Jones, A.L.; Phillips, J., 2009-06-25, 3 clusters, 21 spikes in total, all flowering
Glyn Diffwys Bends, Site 1, SH9924444369, Berry, G.; Phillips, J., 2010-07-21, 3 plants, 23 stems, 1 rosette
Glyn Diffwys Bends, SH9944, Jones, H.W.; Osley, J., 2010-07-27, 20 translocated plants with 229 flowering spikes
Glyn Diffwys Bends, Site 1, SH9924444369, Jones, A.L.; Sullivan, L.; Phillips, J., 2011-05-26, 2 plants, 8 stems
Glyn Diffwys Bends, Site 1, SH9924444369, Jones, A.L.; Phillips, J., 2012-03-21, 2 Small plants
Glyn Diffwys Bends, Site 1, SH9924444369, Berry, G.; Phillips, J., 2012-07-30, 2 plants, 11 stems.
Glyn Diffwys Bends, Site 2, SH99274432, Jones, A.L.; Phillips, J., 2009-06-25, 2 clusters >30cm diameter near patch of false oat grass. 34 spikes and 8 spikes respectively.
Glyn Diffwys Bends, Site 2, SH9928044320, Berry, G.; Phillips, J., 2010-07-21, 7m transect SH9928044320 to SH9928744321. 6 plants, 33 stems, 4 rosettes
Glyn Diffwys Bends, Site 2, SH9928044320, Jones, A.L.; Sullivan, L.; Phillips, J., 2011-05-26, 7m transect from SH9928044320 to SH992874432. 4 plants, 27 stems.
Glyn Diffwys Bends, Site 2, SH9928044320, Jones, A.L.; Phillips, J., 2012-03-21, 7m transect from SH9928044320 to SH9928744321. 3plnts
Glyn Diffwys Bends, Site 2, SH9928044320, Berry, G.; Phillips, J., 2012-07-30, 7m transect, SH9928044320 to SH9928744321. 2 plants, 15 stems.
Glyn Diffwys Bends, Site 3, SH99424428, Jones, A.L.; Phillips, J., 2009-06-25, 2 clusters 20cm diameter, 12 flowering spikes
Glyn Diffwys Bends, Site 3, SH9940844268, Berry, G.; Phillips, J., 2010-07-21, 2 plants, 44 stems
Glyn Diffwys Bends, Site 3, SH99484425, Berry, G.; Phillips, J., 2010-07-21, 26 plants, 162 stems and 82 rosettes. Transect between SH9948444255 and SH9950744268.
Glyn Diffwys Bends, Site 3, SH9940844268, Jones, A.L.; Sullivan, L.; Phillips, J., 2011-05-26, 2 plants, 21 stems
Glyn Diffwys Bends, Site 3, SH9940844268, Jones, A.L.; Phillips, J., 2012-03-21, 2 large plants
Glyn Diffwys Bends, Site 3, SH9940844268, Berry, G.; Phillips, J., 2012-07-30, 2 plants, 44 stems
Glyn Diffwys Bends, Site 4, SH99514426, Jones, A.L.; Phillips, J., 2009-06-25, Transect working westwards, 19 plants with ~188 spikes

Glyn Diffwys Bends, Site 4, SH9948444255, Jones, A.L.; Sullivan, L.; Phillips, J., 2011-05-26, Transect from SH9948444255 to SH9950744268. 30 plants and 198 stems.
Glyn Diffwys Bends, Site 4, SH9948444255, Jones, A.L.; Phillips, J., 2012-03-21, Transect from SH9948444255 to SH9950744268. 26 plants
Glyn Diffwys Bends, Site 4, SH9948444255, Berry, G.; Phillips, J., 2012-07-30, Transect from SH9948444255 to SH9950744268. 23 plants, 226 stems and 3 seedlings
Nant Bends, SH994443, Green, J.A., 1999, Some twenty plants - all planted.
Nant Bends, SH994443, Parker, P., 2007-07, SH992 443. 2 clumps. on narrow verge, N of old road, below steep rocky face. Shady.
Pont y Glyn-Diffwys, SH993443, Denbs Group (Williams, D.), 2016-08-21, along old road within SSSI
Pont y Glyn-Diffwys, SH99284432, Osley, N.J.; Osley, S.K., 2018-07-22, On the old A5. Three large rosettes. Underneath Ash, in dog's mercury, bramble, nettles
Pont y Glyn-Diffwys, SH99494426, Osley, N.J.; Osley, S.K., 2018-07-22, Beneath low roadside wall. 11 large rosettes in flower, 6 non-flowering, 2 seedlings. Swamped by nettle, raspberry & hogweed although healthy plants. Possibly more.

Cil-y-Groeslwyd

Cil-y-Groeslwyd Wood, SJ1255, Ing, B., 1973, Bruce Ing discovered it here in the autumn of 1973 and wrote to Ian Bonner, ARO for the area. I was not able to confirm it until 1975 (Brummitt).
Cil-y-Groeslwyd Wood, SJ1255, Brummitt, J.M.; Wright, D., 1975-08-17, We went to CilyGroeslwyd Wood and found the plants with no trouble. There were two, growing close together, with well-developed fruits and a few flowers. I took one shoot and sent it to Dr Harley at Kew. A week later I collected a number of ripe fruits and raised a dozen plants which will be given to the reserve's management committee, K
Cil-y-Groeslwyd [Cil-y-Groeslwyd] Wood, SJ1255, Brummitt, J.M.; Wright, D., 1975-08-20, K
Cil-y-Groeslwyd Wood SSSI, SJ124553, Wright, 1977
Cil-y-Groeslwyd Wood, SJ1255, Blackstock, T.H., 1977. 8 plants.
Cil-y-Groeslwyd Wood, SJ124553, Deadman, A., 1982-02, A party from Chester College led by Dr Bruce Ing cleared scrub and planted a total of 28 seeds in 6 groups (from plants grown by Dr Brummitt from seed collected at this site).
Cil-y-Groeslwyd Woods, SJ123555, Williams, P., 1990, 15 plants, a new site, Green 1992
Cil-y-Groeslwyd Wood, SJ123553, Perring, F.H., 1990-07-13, Two spikes seen at CilyGroeslwyd. Associated species listed. Map in NRW file
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI, SJ123544, Anon, 1989, 10 plants introduced
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI, SJ123544, Anon, 1989, 10 plants introduced - 6 have survived and flowered in 1990
Cil-y-Groeslwyd Wood, SJ123555, Williams, P., 1990
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI, SJ12545537, Day, P.; Starling, L., 1991-12-19
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI, SJ12555532, Day, P.; Starling, L., 1991-12-19
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI, SJ12475529, Anon, 1990 - 1991

Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site 1, SJ12225483, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site 2, SJ12185476, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site 3, SJ12195478, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site 4, SJ12205479, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site 5, SJ12225481, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site 6, SJ12215478, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site A, SJ12345530, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site B, SJ12335531, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site C, SJ12305537, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site D, SJ12315539, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site E, SJ12545531, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site F, SJ12535537, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site T1, SJ12375541, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site T2, SJ12335555, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site T3, SJ12405560, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site T5, SJ12465548, Anon, 1990 - 1991
Cil-y-Groeslwyd Woods, Eyarth Woods & Rocks and Craig Adwy-Wynt SSSI; Site T6, SJ12465547, Anon, 1990 - 1991
Cil-y-Groeslwyd Wood, SJ1255, Stokes, R.M., 1993-06-29, Pwll-Glâs-Ruthven.
Cil-y-Groeslwyd Woods, SJ1211055530, Ellis, M.; Evans, D., 1993-09-03, K
Cil-y-Groeslwyd Woods, SJ124553, Anon, 1994, 1-5
Cil-y-Groeslwyd Woods, Eyarth Woods and rocks and Craig Adwy-Wynt SSSI, Eyarth rocks, SJ122548, Anon, 1994
Cilygroeslwyd Wood, SJ1255, Green, J.A., July 1995,3 plants in transplant sites
Cilygroeslwyd Wood, SJ12585525, Williams, P., July 1995,2 plants on rocky verge
Coed Cil-y-Groeslwyd; opposite Pwll-Glâs, SJ121541, Hardy, E., 1996-06
Cil-y-Groeslwyd Wood, SJ126554, Green, J.A., 1999, Twenty plants - all planted.
Coed Cil-y-Groeslwyd pony paddocks, SJ1255, Anon, 2001-07-20, 19 plants in sites A-D, NRW files note
Coed Cil-y-Groeslwyd Reserve, SJ1255, Anon, 2001-07-20, 14 plants in sites EF, NRW files note
Coed Cil-y-Groeslwyd Reserve, SJ1255, Anon, 2002-07-20, 9 plants in sites EF, NRW files note

Coed Cil-y-Groeslwyd pony paddocks, SJ1255, Anon, 2002-07-20, 10 plants in sites A-D, NRW files note
Cil-y-Groeslwyd Quarry, SJ125552, Anon, Before 2004
Coed Cil-y-Groeslwyd, SJ124554, Phillips, J., 2008-07-29, On ledge below disused quarry face. Very tall plants, over a metre in height. Multi-stemmed and had flowered profusely. 8 plants
Coed Cil-y-Groeslwyd, SJ124554, Phillips, J., 2008-07-29, On quarry floor, 3 low growing multi-stemmed plants of average height.
Coed Cil-y-Groeslwyd, SJ124554, Phillips, J., 2008-07-29, On ledge below disused quarry face. 25 plants of medium height, 16 producing multi-stems, 7 single stems, 2 rosettes. 23 had flowered.
Coed Cil-y-Groeslwyd, SJ124554, Phillips, J., 2008-07-29, Away from quarry face, open area. 25 in main colony, 1 growing a short distance away. Main colony: 24 multi-stemmed plants, 1 rosette.
Coed Cil-y-Groeslwyd, SJ124554, Jones, A.L.; Phillips, J., 2009-06-25, 220 non-flowering spikes; 13 plants; 4 clusters
Coed Cil-y-Groeslwyd, Transect 1, SJ124554, Jones, A.L.; Phillips, J., 2009-03-29, 16 plants
Coed Cil-y-Groeslwyd, Transect 2, SJ124554, Jones, A.L.; Phillips, J., 2009-03-29, 5 plants
Coed Cil-y-Groeslwyd, Transect 3, SJ124554, Jones, A.L.; Phillips, J., 2009-03-29, 26 plants
Coed Cil-y-Groeslwyd, SJ124554, Berry, G.; Phillips, J., 2010-07-21, Transect 2: 5 plants, 33 stems.
Coed Cil-y-Groeslwyd, SJ124554, Berry, G.; Phillips, J., 2010-07-21, Transect 2: 16 plants, 97 stems and 11 rosettes.
Coed Cil-y-Groeslwyd, SJ124554, Berry, G.; Phillips, J., 2010-07-21, Below transect 1: 3 plants, 9 stems and 1 rosette.
Coed Cil-y-Groeslwyd, SJ124554, Berry, G.; Phillips, J., 2010-07-21, Transect 1. 9 plants, 102 rosettes (incl. one large clump of 67 stems) and 10 rosettes.
Coed Cil-y-Groeslwyd, SJ1255, Berry, G.; Phillips, J., 2010-07-21, 241 flowering 22 rosettes, Berry & Phillips 2010
Cil-y-Groeslwyd Wood, SJ125555, Thomas, P.L., 2011-06-26, SJ124 556. Scrape in NE of Reserve, S of Bron Eyarth. 2 clumps, 1m2 each
Coed Cil-y-Groeslwyd, SJ124554, Berry, G.; Phillips, J., 2012-07-30, Under limestone cliff face: 8 plants, 19 stems, 5 seedlings
Coed Cil-y-Groeslwyd, SJ124554, Berry, G.; Phillips, J., 2012-07-30, On bank to East, orientated North to South. 12 plants, 32 stems, 10 seedlings.
Coed Cil-y-Groeslwyd, SJ124554, Berry, G.; Phillips, J., 2012-07-30, South of Yew tree: 3 plants, 6 stems, 4 seedlings
Coed Cil-y-Groeslwyd, SJ124554, Berry, G.; Phillips, J., 2012-07-30, Stone 2m towards southern boundary of glade: 2 plants, 5 stems, 3 seedlings
Cil-y-Groeslwyd Wood, SJ1239655634, Williams, D., 2013-08-08, SJ1239655634. Quarry area of SSSI. Several plants along rock face.
Cil-y-Groeslwyd Wood, SJ12395563 Williams, D., 2019-07-01, Several stands, some protected, in the old quarry site

Eyarth

Eyarth Woods, SJ1255, Hodge, William, 1908, Stachys germanica, Eyarth Wood. [See J. Bot. 1911. "Probably *Stachys alpina* at Cil-y-Groeslwyd Wood," J.M. Brummitt.]
Eyarth Woods, SJ123548, Green, J.A., 1990, 5 separate wild plants in Eyarth Wood (COFNOD "Some 2-3 wild plants in Eyarth Wood."), Green 1992; Evans 1992
Eyarth Woods, SJ122548, Green, J.A., 1990-06-22, 6 plants, NMW
Eyarth, SJ123548, Anon, 1999
Eyarth Woods, SJ1254255321, Green, J.A., 2005-07-06, 6 plants
Eyarth Woods, SJ1255, Beacham, R., 2011-07-23

Review of management/translocation of the Welsh population from existing records

A history of the translocations for each of the Welsh sites has been compiled from the NRW files (cf. Figure 1).

Coed Cil-y-Groeslwyd

J. Brummitt and D. Wright collected seed in 1975, grew plants and planted them out in the same woodland in 1977; eight plants flowered (Brummitt, 1981). Two non-flowering plants were present in 1978 (Brummitt 1981).

A.J. Deadman and B. Ing planted 28 seeds in six groups in February 1982 (seeds from J. Brummitt) along the same path sides at c. SJ12516 55352 (NRW file note). ‘there were no flowering plants surviving and only 5 seedlings’ by July 1982 (Evans 1990).

The next re-stocking was carried out in 1989 by Sheila Evans and Jean Green using ‘garden-grown stock, scatter[ing] their plants more widely around the reserve…[planting] a total of ten plants’; eight of these plants still present with six in flower in 1990 (Evans 1990). Evans also recorded plants at locations away from the 1977-c.1989 re-stocking, with ‘wild’ plants in flower in a field to the west of the NWWT reserve ‘Cil-y-Groeslwyd field’ and within Eyarth Woods (Evans 1990).

During her 1990 survey, Evans collected seed from plants which were known to be from earlier re-stocking and from plants she recorded as ‘wild’ (Evans, 1990). The seed was mixed and delivered to Treborth Botanic Garden, Bangor for propagation (reported by Evans (1992) to have been unsuccessful) and was also sown into the Cil-y-Groeslwyd field of ‘wild’ plants.

Evans repeated her surveys for the following four years (Evans 1991, 1992 and 1994) continuing to record plants at the re-stocking site in the NWWT reserve and Cil-y-Groeslwyd field. Two additional plants were also found in woodland immediately to the south-east of the NWWT reserve. By 1994, only one plant was re-found in Eyarth Woods with the remainder encroached by regenerating scrub.

During survey in 1992 seed was again collected from both ‘wild’ plants and re-stocked plants and again sown into the ‘wild’ population in the Cil-y-Groeslwyd field (Evans, 1992; Evans, 1994). A seedling from this sowing was recorded in 1993 and flowered in 1994 (Evans, 1994). Seed was also subsequently sown into pots though there appears to be no record of the results.

In 1993 and 1994 seed was collected from Cil-y-Groeslwyd field (from ‘wild’ plants) and sent to Royal Botanic Gardens, Kew for long-term storage (Evans, 1994).

In July 1995 Peter Williams found two plants on a rocky roadside verge which had been recently mown, and Jean Green found three plants in transplant sites (J. Green, letter 28/9/1995).

Monitoring undertaken by CCW in 1996 recorded a total of five plants (4 ‘wild’ plants and 1 re-stock). The locations of these plants are not clearly recorded.

On 22 October 1996 Hugh McAllister of Ness Botanic Gardens collected seed from the 1995 rocky roadside site for use in the reintroduction programme. Plants were grown at Ness.

On 8 July 1997 Sarah Hamley found 2 plants. On 18 December 1997 John Osley and Hugh McAllister saw three plants on the roadside.

The next re-stocking programme was carried out on 3 April 1998 with a total of thirteen plants re-stocked into woodlands immediately south of the NWWT reserve (CCW, 1998). All 13 plants were present on 22 July 1998 (NRW file note). In addition, a further two plants were recorded on the roadside verge (presumably the same location as 1997) and fourteen plants were found by the kennels adjacent to the footpath on recently cleared land (CCW, 1998). Some transplants outside the NWWT Reserve and the A494 may have been vandalised by persons unknown (J. Osley, pers. comm. 2022).

On 14 July 1999 the transplants were monitored by John Osley, Sarah Hamley and Jean Green. Seven out of the 13 translocated plants were found with five self-seeded plants (NRW file note).

On 27 May 1999 Jean Green found a plant which had appeared by the original track resulting from clear felling operations during winter 1998/1999 (J. Green letter to NRW 27/5/1999).

On 11 April 2000, plants were planted in four groups by John Osley and Ness Botanic Garden staff, 12 plants in site A, 8 plants in site B, 9 plants in site C and 8 plants in site D (NRW file notes) using material from Ness Botanic Gardens.

On 18 April 2000, more plants were planted in two groups of nine in site E (old quarry) and F by John Osley and Neil Griffiths in the NWWT Reserve (NRW file notes) using material from Ness Botanic Gardens. These plants were reported to be doing well on 29 May 2000.

On 20 July 2001 the translocated plants were monitored with 19 plants in sites A-D and 14 plants in sites E and F (NRW file note dated 20/7/200[1]2).

On 20 July 2002 the translocated plants were monitored with 10 plants in sites A-D and 9 plants in sites E and F (NRW file note dated 20/7/200[1]2).

In April May 2008– fifty plants grown by Chester Zoo (source unknown but possibly from Ness Botanic Gardens) were planted out in site E (old quarry) with 60 shoots flowering in July 2008 (Phillips 2008; North Wales Wildlife Trust 2008). Since this time, planting has not taken place in any other location and the old quarry has been maintained as a glade to favour the plants.

On 25 June 2009, 220 flowering spikes were counted (note these are not directly equivalent to number of plants) and on 29 March 2010, 47 rosettes were counted (Phillips & Jones 2010).

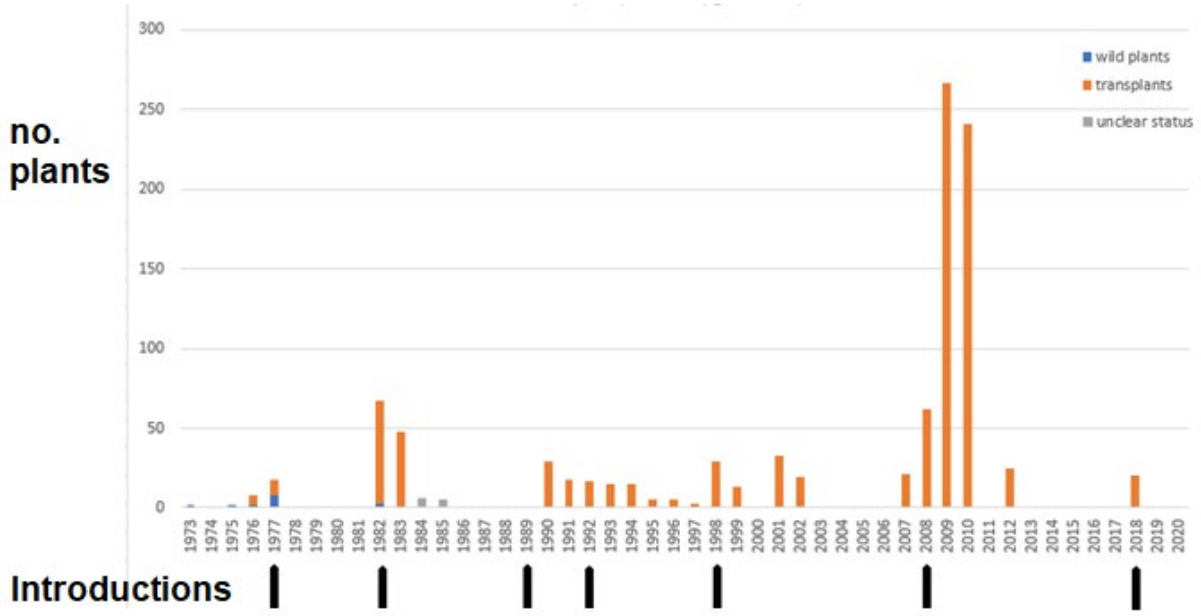
On 27 April 2010, H Wyn Jones and John Osley saw about 40 rosettes in site E (old quarry) where first planted in 18 April 2000 (NRW file note).

On 21 July 2010, G. Berry and J. Phillips counted 241 flowering and 22 rosettes (Berry & Phillips 2010).

In 2018 a further 15 plants, propagated from the seeds of previously translocated plants were planted out in the old quarry (site E) (NRW file note).

The population counts at Cil-y-Groeslwyd are summarised in Figure 7. This shows a pattern of high numbers immediately following reintroduction followed by declines over periods of 3-7 years, when the absence of growing plants again prompts reintroduction. This suggests that the reintroduction/restocking strategy is not working in the short term in terms of plants growing, though seeds may be present in the seed bank.

Figure 7 Summary of native and transplanted population *Stachys alpina* counts at Cil-y-Groeslwyd with dates of reintroductions (derived from Osley 1997 NRW file report and subsequent data)



A5 improvement at Glyn Diffwys bends

In 1998 plants were planted out as part of the project between Countryside Council for Wales and Ness Botanic Gardens (the latter contracted to Welsh Government Transport Wales Network Management Division) (Denbighshire County Council 2006).

On 20 July 2001, Jess Colebrook monitored the translocated plants and found on 17 plants out of the 88 plants introduced (Colebrook 2001). She noted discarded vegetation and soil material had been fly-tipped obliterating some of the plants.

On 10 July 2002, Jess Colebrook monitored the translocated plants again and found only 5 plants remaining (Colebrook 2002). She noted discarded vegetation and soil material had been fly-tipped obliterating some of the plants.

In October 2002, Ness Botanic Gardens proposed a study into use of residual herbicides to help establishment of *S. alpina* in the wild; this was not undertaken.

In 2003 further plants were added by Ness Botanic Gardens, assisted by the Forestry Commission (Denbighshire County Council 2006).

In April-May 2008, fifty plants grown at Chester Zoo were planted out with 50 shoots flowering in July 2008 (Phillips 2008; North Wales Wildlife Trust 2008).

On 25 June 2009, 262 flowering spikes were counted (note these are not directly equivalent to number of plants; Phillips & Jones 2010).

On 21 July 2010, G. Berry and J. Phillips counted 37 plants (Berry & Phillips 2010). Jones & Osley (2010) visited on 27 July and noted 20 plants,

On 26 May 2011, 38 plants were reported with many more flowering stems (North Wales Wildlife Trust 2012).

Consent to add plants since 2012 has since been refused.

Eyarth Woods and Rocks

There appears to only have been one transplant at Eyarth in 1989 at SJ123544.

Requests to plant *S. alpina* at Eyarth Woods and Rocks Reserve/SSSI were subsequently rejected (CCW letter 15 October 2007). This is important as Eyarth Wood is now potentially the only site with near-original populations, albeit in the seed bank.

Recommendations on conservation management

As a priority, given the current ash dieback *Hymenoscyphus fraxineus* epidemic killing ash trees and opening up the canopies of many woods, it is proposed that all five sites are searched systematically over the next 1-5 years as trees die and seed collected from any naturally-occurring plants which may appear and deposited in the Millennium Seed Bank. This may be a once in a lifetime opportunity which should not be missed.

Subject to further information, it is currently recommended that management occurs to re-establish historic populations by glade creation and ground disturbance and maintain more recent populations by digging over open plots and/or clearing scrub every 3-5 years once the plants have died out from previous disturbance.

Further research is required to inform conservation decisions to fit with its ecology as a short-lived woodland edge specialist:

First, a discussion of the philosophy of conservation of *S. alpina* in Britain should be undertaken with a range of stakeholders. Do plants need to be present in quantity every year in every site (a standard measure of conservation success), or can a longer term view of its successful conservation be taken as appearance of only a few plants varying sporadically in space and time? In Britain *S. alpina* fits a pattern of small population sizes occurring in a narrow geographic range with a restricted habitat (woodland edge habitats) and low temporal frequency (i.e. sporadic occurrences through time); this is a relatively unusual form of rarity as defined by Rabinowitz (1981). Thus, it may be acceptable to have a few sporadic *S. alpina* plants for most of the sites, absent in some years, with conservation success measured as persistence in the long term (perhaps over a 20-25 year cycle). However, this form of rarity does not appear to be the case in Central Europe where it is locally common. If desired for social purposes, one site could be maintained and stocked to provide a place for people to see it.

Second, studies on the seed bank should be undertaken (as described above) and on how long plants live for in the wild (for example by making individual plants and recording life cycle every 3-6 months to determine longevity); these are needed to inform the management cycle.

Third, trials on soil/ground disturbance as a management tool are required to test the hypothesis that it responds to such management as this has been inferred rather than tested experimentally. This could be done by replicated, randomised disturbance of 1 m² plots with controls across plots where it has been recorded, or by setting up uniform plots with buried seed to similarly disturb at specific time intervals (e.g. 5, 10, 20 years) in the future. However, rotovation of former transplant site at Glyn Diffwys Bends resulted in a ‘thicket’ of hogweed *Heracleum sphondylium* and no new *S. alpina* seedlings (J. Osley pers. comm. 2022).

Fourth, studies on role of soil nutrients on growth and persistence are required. One possible reason for the lack of success of reintroduction programmes is that plants are put into nutrient-poor sites and thus grow poorly, when it may perform much better in nutrient-rich places. This could be easily tested by measuring seed production, longevity and persistence on plots with a range of nutrients status (e.g. by applying fertiliser). There are many anecdotal examples of plants appearing after logging, coppicing or wind-throw, and

coupled with the increase in light and a short-term increase in soil nutrients which then decline.

Fifth, it is recommended that the moratorium on further reintroductions in Wales is continued until fuller studies have been carried out to avoid further complicating the genetic picture any further.

Sixth, as there have been concerns about hybridisation with related species (for example *S. byzantina, S. germanica* and *S. sylvatica*), material cultivated in botanical gardens for restocking should be tested for purity before being planted out (e.g. material grown at Ness was tested for uniformity of isozymes before being used; NRW file note 11/4/2000).

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Data Archive Appendix

Data outputs associated with this project are archived in [NRW to enter relevant corporate store and / or reference numbers] on server–based storage at Natural Resources Wales.

The data archive contains:

[A] The final report in Microsoft Word and Adobe PDF formats.

[B] An Excel spreadsheet of biological records for *Stachys alpina* (see Section 9).

[C] Images of herbarium specimens seen

[D] Pdf copies of *Stachys alpina* literature

Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue https://libcat.naturalresources.wales (English Version) and https://catllyfr.cyfoethnaturiol.cymru (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no [NRW to insert this number]

Further copies of this report are available from library@cyfoethnaturiolcymru.gov.uk