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Natural Resources Wales

Ditrichum plumbicola survey of Gwydyr Forest Mines SAC 2024

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Vegetation Survey and Assessment Ltd

Evidence Report No 732
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Mae arolwg o hen fwyngloddiau plwm dethol yn diweddaru gwybodaeth gyfredol am statws *Ditrichum plumbicola* yn ACA Mwyngloddiau Fforest Gwydir. Mae hefyd yn ategu asesiad cynhwysfawr o'r rhywogaeth hon ar draws yr ACA a gynhaliwyd yn 2021.

Darganfuwyd poblogaethau bach o *D. plumbicola* mewn pedair uned ACA (neu rannau ohonynt) lle mae wedi'i gofnodi'n hanesyddol ond heb ei fonitro'n ddiweddar. Cafwyd hyd i boblogaeth fach arall y tu allan i'r ACA. Argymhellwyd rhywfaint o waith rheoli cynefin i ddiogelu a/neu wella'r cynefin sy'n cefnogi rhai o'r poblogaethau hyn.

Roedd arolygon o sawl uned ACA arall yn aflwyddiannus, yn bennaf oherwydd nad oedd glaswelltir Calaminaraidd bellach yn addas ar gyfer *D. plumbicola*.

Mae un o chwe phant a grafwyd yn 2022 i ddarparu cynefin ffres ar gyfer *D. plumbicola* wedi cael ei gytrefu'n llwyddiannus.

2. Executive Summary

A survey of selected former lead mines updates contemporary knowledge of the status of *Ditrichum plumbicola* in Mwyngloddiau Fforest Gwydir/ Gwydyr Forest Mines SAC. It also complements a comprehensive assessment of this species across the SAC undertaken in 2021.

Small extant populations of *D. plumbicola* were found in four SAC units (or parts thereof) where it has been recorded historically but not monitored recently. Another small population was found outside the SAC. Minor habitat management work was recommended to safeguard and/or enhance the habitat supporting some of these populations.

Surveys of several other SAC units were unsuccessful, primarily because Calaminarian grassland was clearly no longer suitable for *D. plumbicola*.

One of six scrapes dug in 2022 to provide fresh habitat for *D. plumbicola* has been successfully colonised.

3. Introduction

Ditrichum plumbicola (Lead-moss) (Plate 1) is a Nationally Scarce specialist of lead-rich toxic spoil in disused mines across Britain and Ireland. Outside of Britain and Ireland, *D. plumbicola* is known only from SW Germany and Belgium. Mwyngloddiau Fforest Gwydir/ Gwydyr Forest Mines SAC (and Mwyngloddiau a Chreigiau Gwydyr SSSI, which underpins it) supports the largest known concentration of colonies of *D. plumbicola* in the world.

The SAC has 44 units of varying size scattered across the Gwydyr Forest. Its disused lead and zinc workings support the Annex I habitat *6130 Calaminarian grasslands of the Violetalia calaminariae* that is the primary reason for selection of this SAC. The Calaminarian grassland of the Gwydyr Forest is of foremost importance for the local frequency of *D. plumbicola.*

Monitoring of the extent and condition of *D. plumbicola* in 27 of the 44 SAC units in the Gwydyr Forest was undertaken in 2021 (Pilkington, 2021) and before that, in 2011, 2006 and 2001. This report documents the results of monitoring SAC units (or parts of units) not recently surveyed, scrapes dug in 2022 and other areas where management work has been undertaken recently. It also identifies where any habitat management or other action is needed in the future to conserve populations of *D. plumbicola*.

Plate 1. *Ditrichum plumbicola,* Gwydyr Forest Mines SAC

4. Approach

4.1. Field Survey

Twelve SAC units (Table 1) were surveyed in good weather conditions (dry and mild after heavy rainfall) between 30th January and 1st February 2024 by Sharon Pilkington CEnv MCIEEM, a professional botanist specialising in bryophytes. On the 31st January, she was joined by Caroline Bateson of NRW and on 1st February, by Philippa Thompson, a local amateur bryologist.

Although historical records were helpful in locating *D. plumbicola* habitats in some of the units, the most effective survey approach was a careful search for the kind of sheltered, toxic spoil microhabitat preferred by *D. plumbicola* and, once found, to undertake a hands-and-knees search for it.

In the scrapes, the survey focussed on detecting patches of suitable moist clay substrate on the sides or in micro-depressions in the scrape where there would be some shelter. Any such patches were then scrutinised for shoots of *D. plumbicola*.

When a patch of *D. plumbicola* was detected, its location was recorded as a 10-figure grid reference by means of a high-sensitivity GPS/GLONASS receiver (Garmin model GPSMAP 64S, a receiver that connects to both GPS and GLONASS satellite networks to give a typical positioning accuracy of 3m, even in obscured terrain). An estimate of patch/colony area and frequency (DAFOR) was made in the Calaminarian grassland in each unit. Any obvious threats to all or part of each unit's population of *D. plumbicola* were also noted.

Quantum GIS software (QGIS Development Team, 2024) was used in planning fieldwork and the digitisation, presentation and analysis of results. Use of the Tom.bio QGIS plugin also enabled the visualisation and calculation of 10m and 1m Ordnance Survey grid square occupancy. In scrapes, only OS 10m square occupancy was mapped/calculated.

4.2. Limitations

In Coed Mawr Pool Mine (unit 37), this moss was closely associated with frost-heaved clay-rich spoil where it grew as small, highly inconspicuous tufts. This substrate was easily flattened by a boot or a knee and so the survey was mainly undertaken from adjacent loose substrate to minimise damage. This may however mean that some small colonies could have been overlooked.

Two of the scrapes - in units 6 and 27 - held shallow standing water and these areas could not be searched. *D. plumbicola* is not likely to be found on such wet ground.

Table 1. Surveyed SAC units

Unit	Name	Gridref	Background
5	Pen y Fridd Quarry 1	SH779613	Overgrown, but past records.
6	Nant Gwydr	SH790614	2 scrapes dug in 2022, no past records.
7	Pen y Fridd Quarry 2	SH778610	Overgrown, but past records.
8	Pen y Fridd Quarry 3	SH778609	Overgrown, but past records.
13	Hafna Lead Mine 1	SH779600	Recent tree clearance. Past records.
15	Hafna Lead Mine 3	SH781600	2 scrapes dug in 2022, no past records.
18	Parc Mine	SH787600	Trees cleared from spoil recently. No past records.
20	Bryn y Fawnog	SH772593	Spoil heaps overgrown but past records.
27	Cyffty Mine	SH771588	2 scrapes dug in 2022. Past records inc. 2021.
28	Pencraig Uchaf 1	SH775589	Suitable habitat and past records.
30	Pencraig Uchaf 2	SH777589	Suitable habitat and past records.
37	Coed Mawr Pool Mine	SH779584	Calaminarian grassland not surveyed in 2021. Past records.

5. Results

D. plumbicola was found in 5 SAC units and also in the vicinity of unit 13, although not within the SAC (Table 2). Appendix 9.I lists all of the localities where *D. plumbicola* was found, with summaries of estimated population size (area). Summary descriptions of these populations are given in Sections 5.1 and 5.2.

Table 2. Confirmed populations of *D. plumbicola* from the current survey. Threats identified exclude ongoing natural succession and naturally decreasing soil toxicity

Unit	Name	Population notes	Frequency in Calaminarian grassland	Threats identified
8	Pen y Fridd Quarry 3	A very small patch on the brink of extinction	Rare	Yes
27	Cyffty Mine	Scattered colonist of new scrape	Locally frequent (in wider SAC unit)	No
28	Pencraig Uchaf 1	Very small colonies on two spoil heaps	Rare	No
30	Pencraig Uchaf 2	Very small colonies on two spoil heaps	Rare	No
37	Coed Mawr Pool Mine	Widely scattered but locally frequent	Occasional	No
N/A	Close to Hafna Lead Mine 1 (unit 13)	New site - single small patch	Rare	Yes

No *D. plumbicola* was found in units 5, 7 or 20. The spoil tips in these units are in deep shade below tall conifers in mature woodland and are overgrown by large bryophytes, plants and lichens. Although they previously supported *D. plumbicola* they are clearly no longer suitable.

Recent tree clearance in Parc Mine (unit 18) has exposed a bank of spoil at the northern end of the unit. A search of this area was unsuccessful, with the spoil found to be too old and ameliorated to offer habitat to *D. plumbicola*. Clearance of a bank at the southern end of the unit did not reveal any potentially suitable habitat and this area was not surveyed.

Appendix 9.2 includes selected photographs of spoil in these units.

Names of bryophytes used in this report follow Blockeel *et al.* (2021) and Stace (2019) for higher plants.

5.1. Populations by SAC unit

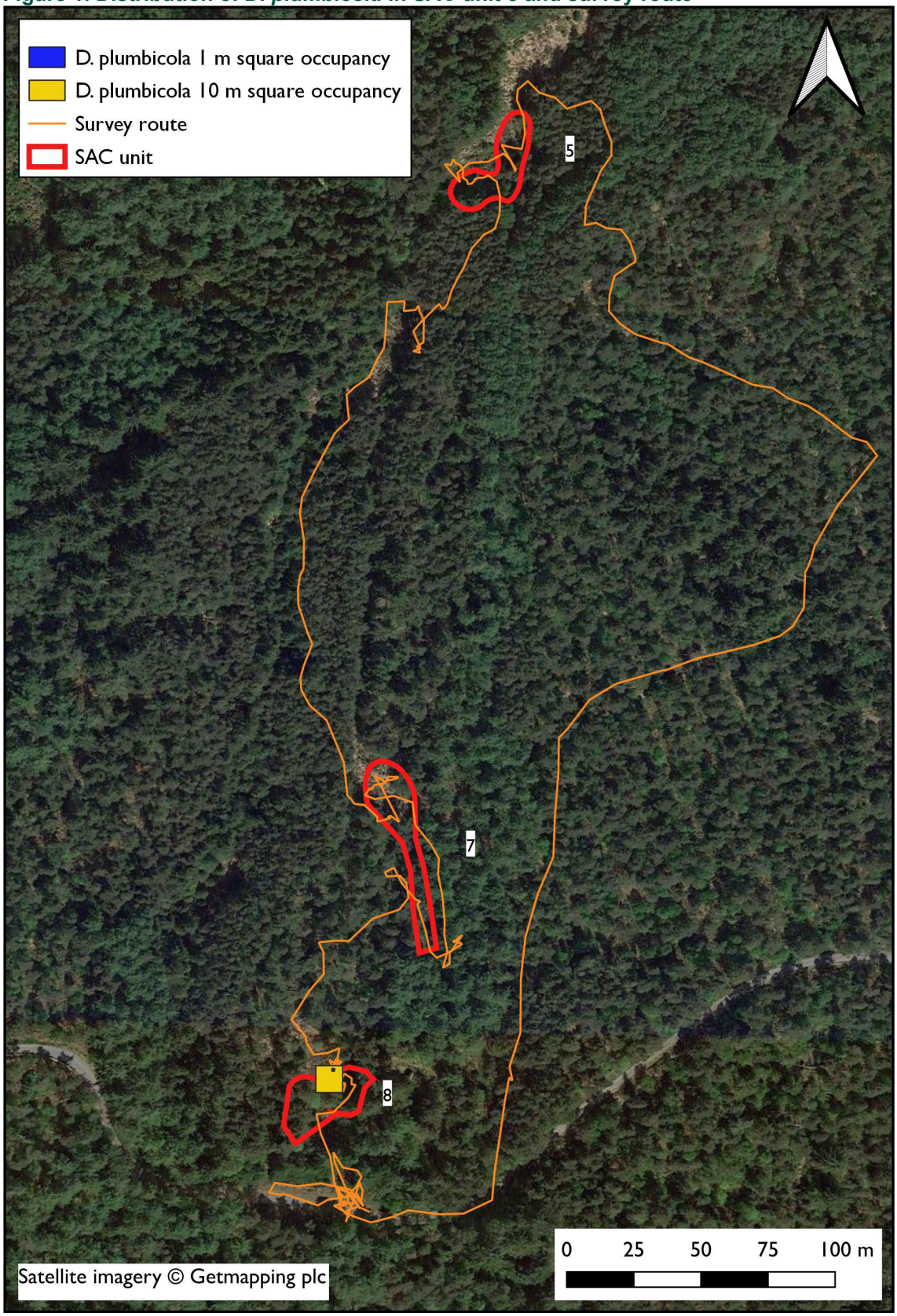
5.1.1. Unit 8 Pen y Fridd Quarry 3

A single colony of *D. plumbicola* (two tiny patches of shoots 10cm apart) occupied 3cm^2 of ground (an occupancy of 1 x 1m OS square) on a spoil heap (Plate 2 and Figure 1). The mine lies within a dense stand of mature conifers and this spoil is close to the point where natural processes of stabilisation and aging make it unsuitable for *D. plumbicola*.

Pine needles and mucilaginous algae cover much of the near-bare surface of this spoil and it is being colonised by *Pohlia nutans*, *Polytrichum* species and *Cladonia* lichens. The rest of unit 8 has no suitable habitat for *D. plumbicola* and urgent intervention is required to prevent its imminent loss.

Plate 2. Unit 8 – location of *D. plumbicola* (red peg and polygon) at SH 77846 60978

Figure 1. Distribution of *D. plumbicola* in SAC unit 8 and survey route



5.1.2. Unit 27 Cyffty Mine

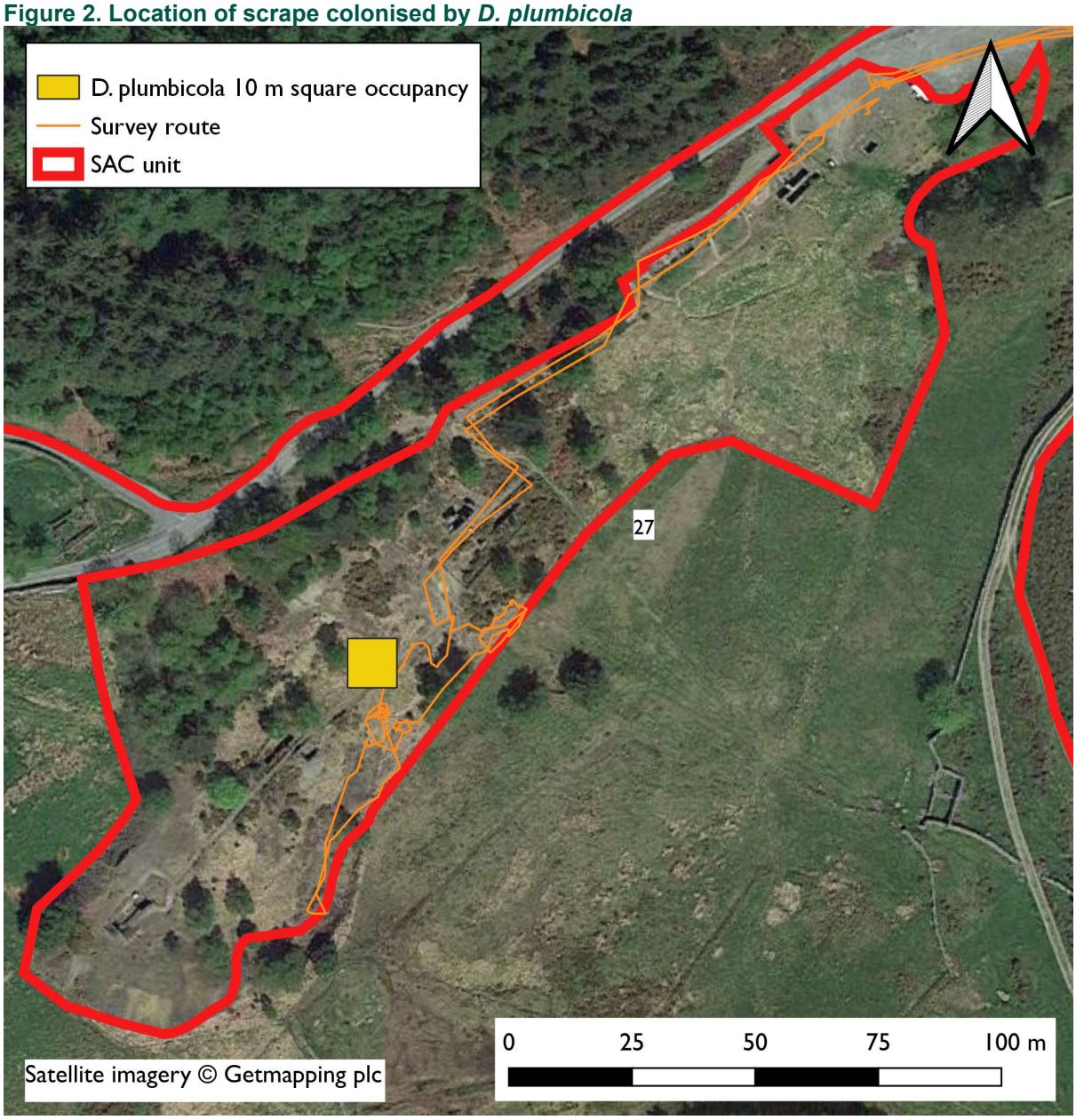
In 2021, Cyffty Mine was found to support probably the largest single population in the SAC. The focus of the current work was to monitor two scrapes that were subsequently dug in ground that did not support *D. plumbicola.*

The smaller of the two scrapes (Plate 3), measuring approximately 3m x 6m x 15cm had been colonised by *D. plumbicola*, which was scattered on small patches of clay in half of the scrape covering a total estimated area of 50cm^2 within a single 10m OS grid square (Figure 2).

Plate 3. Red polygon denotes part of scrape colonised by *D. plumbicola* at SH 77139 58780.

Another, larger scrape measuring approximately 10m x 2m at SH 77163 58794 (also within unit 27) had no *D. plumbicola.* It had been colonised by significant cover of *Ceratodon purpureus*, *Pohlia nutans* and *Weissia controversa* var. *controversa*. Its substrate was a mixture of rock fragments and finer, friable spoil that lacked the small lumps of clay that were important for *D. plumbicola* in the other scrape nearby.

Figure 2. Location of scrape colonised by *D. plumbicola*



5.1.3. Unit 28 Pencraig Uchaf 1

Unit 28 has several spoil heaps in open, grazed moorland. They were found to be coarsely textured (stone fragments) with very little fine-grained clay substrate. Such areas had typically been colonised by e.g. *Polytrichum* species and *Diplophyllum albicans* and may no longer have high concentrations of lead and other heavy metals at or near the surface.

Two small patches of *D. plumbicola* were found on different spoil heaps (Plates 4 and 5), occupying a total area estimated to be 60cm^2. Both were associated with small pockets of clay substrate in gaps between stones. In this unit, therefore, *D. plumbicola* occupied 2 x 1m OS squares (Figure 3). There were no obvious threats to the population, although the age of the spoil suggests its suitability for *D. plumbicola* may have naturally waned over time.

Plate 4. Spoil heap supporting *D. plumbicola* at SH 77528 58928 (marked by the red peg).

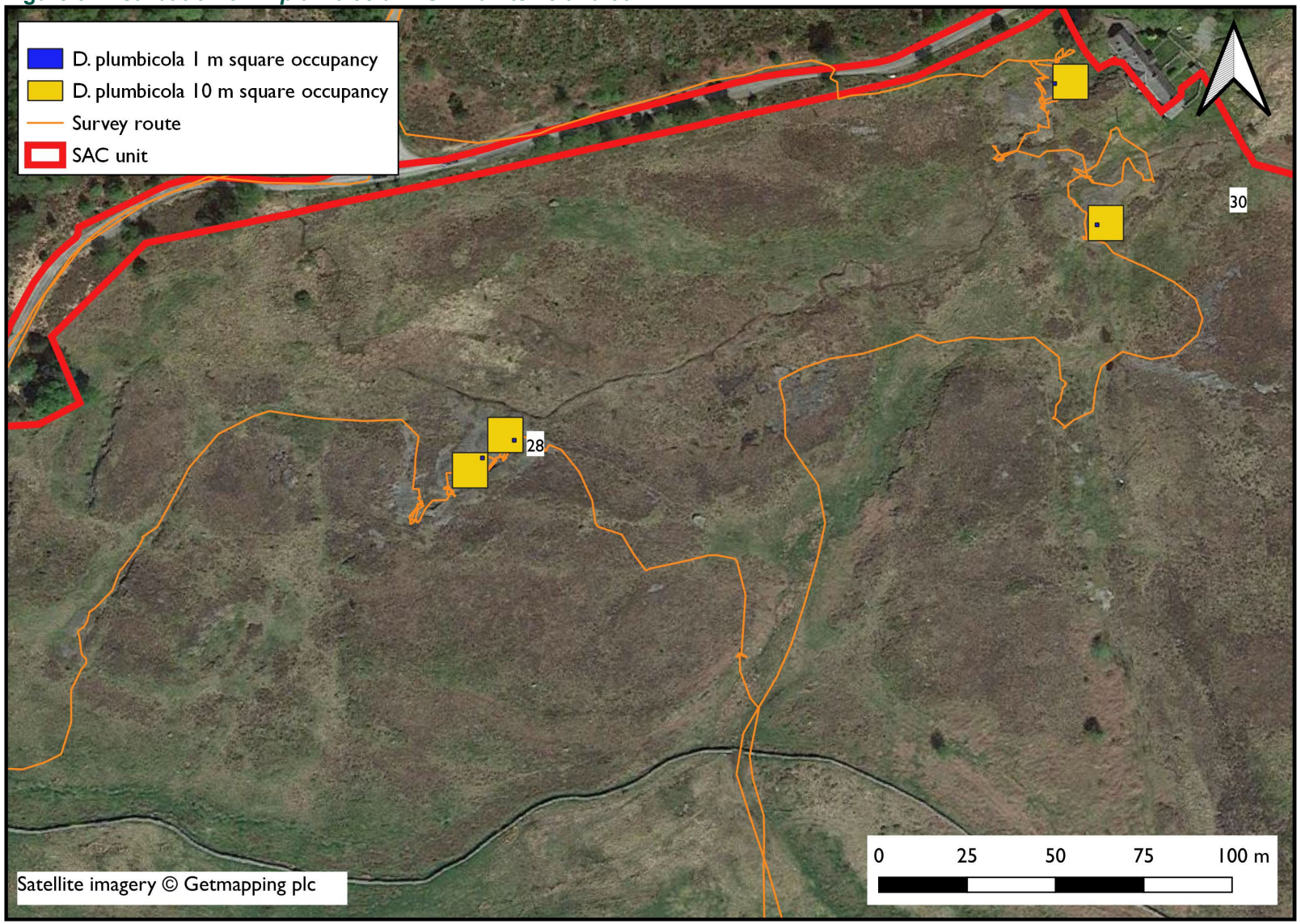
Plate 5. Close-up of Plate 4 – there is around 50cm^2 of *D. plumbicola* here

5.1.4. Unit 30 Pencraig Uchaf 2

Unit 30 was very similar to Unit 28 in having a quite extensive areas of coarse spoil that offered little good habitat to *D. plumbicola*. Two small colonies were found on spoil heaps 40m apart (Plate 6 and Figure 3). In total, *D. plumbicola* occupied an estimated area of only 6cm^2 in this unit with an occupancy of 2 x 1m OS squares. There were no obvious threats to the population other than natural processes of spoil aging and amelioration.

Plate 6. Unit 30 - 2cm^2 of *D. plumbicola* on clay at SH 77690 59034.

Figure 3. Distribution of *D. plumbicola* in SAC units 28 and 30



5.1.5. Unit 37 Coed Mawr Pool Mine

Pilkington (2021) surveyed the easternmost part of this large mine complex, finding small, scattered but healthy-looking patches. The current work targeted other areas of spoil, with similar results; *D. plumbicola* was found in 10 x 1m^2 grid squares (within 8 x10m grid squares), as shown in Figure 4.

Except for a single 30cm^2 patch on the side of a spoil heap at the northern edge of the unit (Plates 7 and 8), the populations were found on nearly bare, toxic-looking spoil in the south of the unit. These included 80cm^2 at SH779583 (Plates 9 and 10) and another 150cm^2 close to a ruined mine structure at SH781584 (Plates 11 and 12). A further small population (14cm^2) was found on toxic-looking bare spoil south of a track at SH780583 (Plates 13 and 14).

In this unit, *D. plumbicola* had a clear preference for frost-heaved bare spoil with a high clay content, although individual colonies in this situation were typically very small and are probably highly dynamic.

As this substrate was very fragile it was impossible to find every small patch of *D. plumbicola* without damaging it by footfall and kneeling. For this reason (and those of brevity) only a representative selection of photographs were taken.

Figure 4. Distribution of *D. plumbicola* in selected parts of SAC unit 37

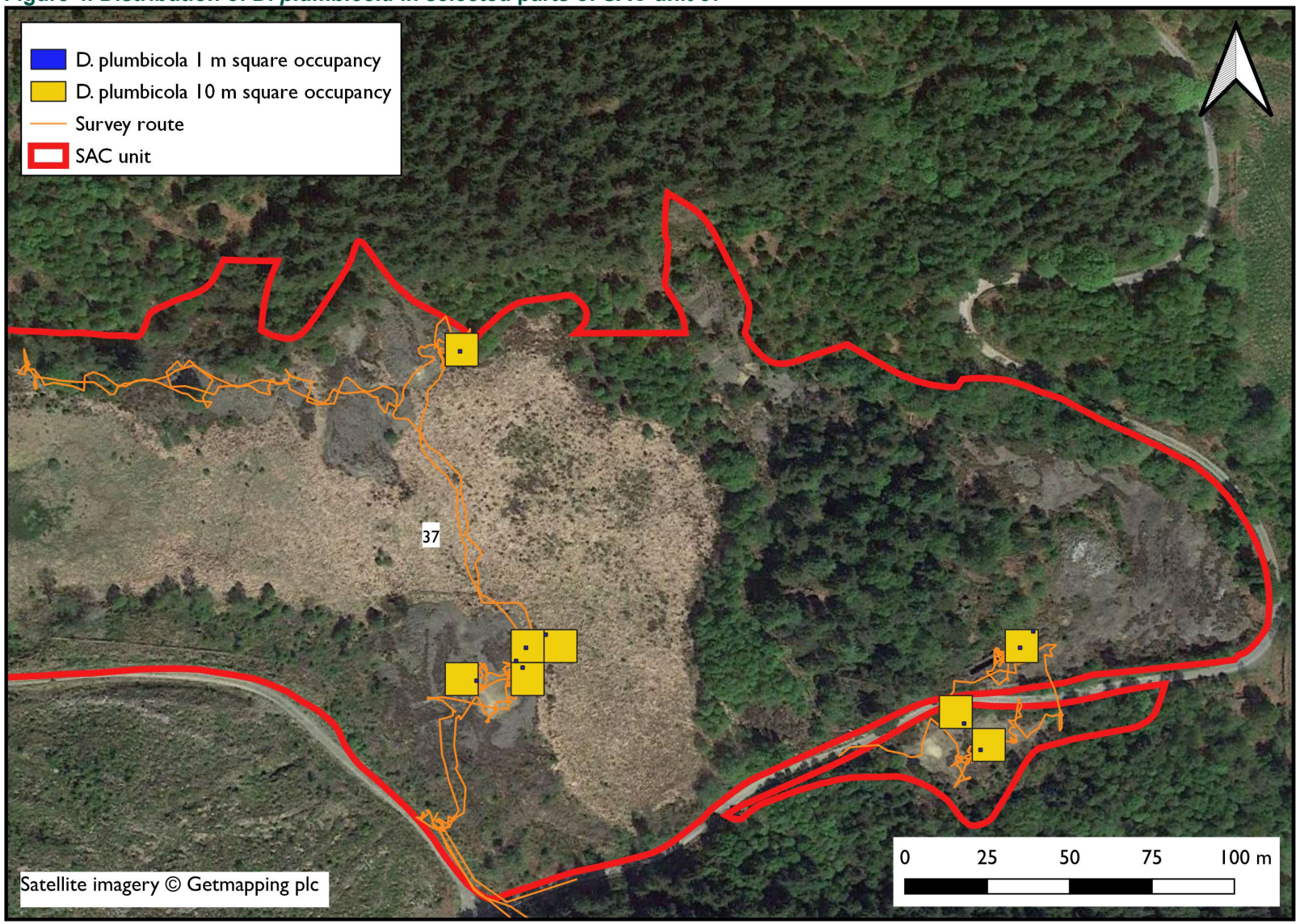


Plate 7. Red peg marks location of *D. plumbicola* at SH 77944 58494.

Plate 8. 30cm^2 patch of *D. plumbicola* (close-up of Plate 7)

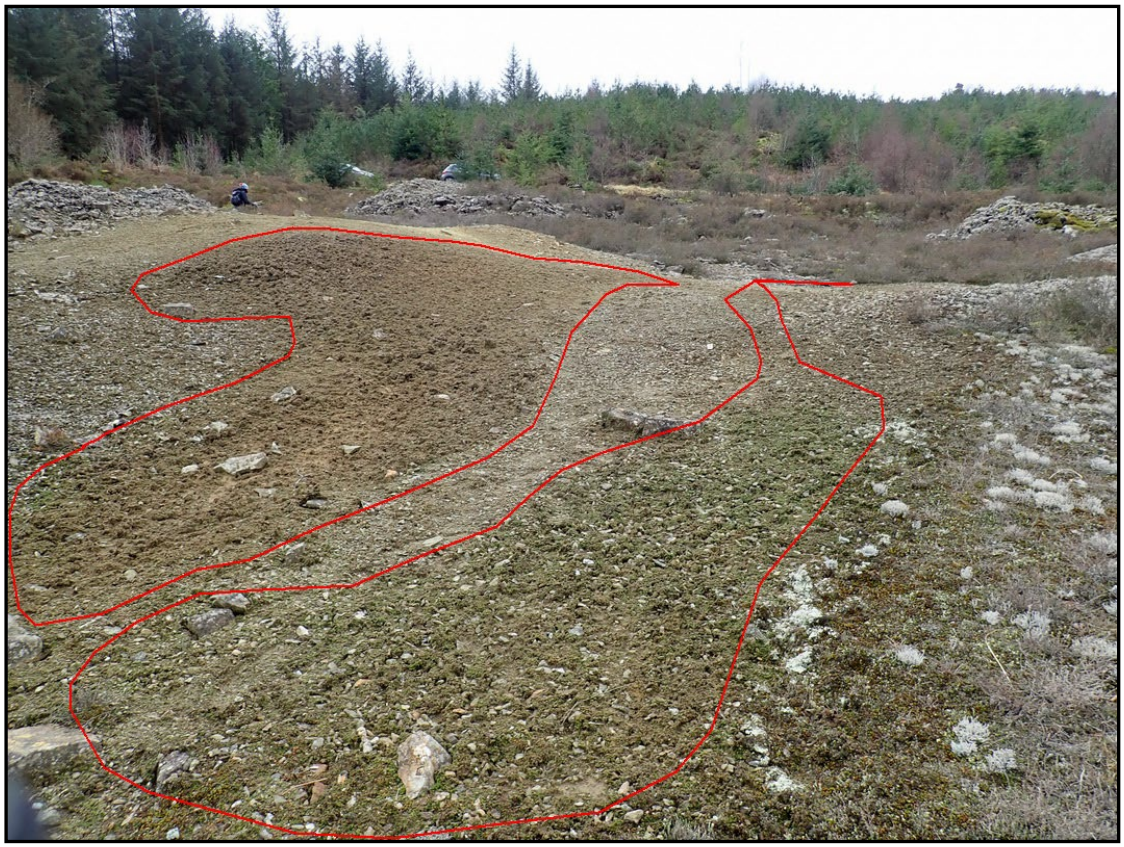


Plate 9. Spoil at SH 779583 where *D. plumbicola* occupies 5 x 1m OS squares

Plate 10. 2cm^2 of *D. plumbicola* in typical habitat of frost-heaved clay at SH 77964 58404.

Plate 11. 10-20 patches of *D. plumbicola* totalling 150cm^2 within red polygon east of ruined building

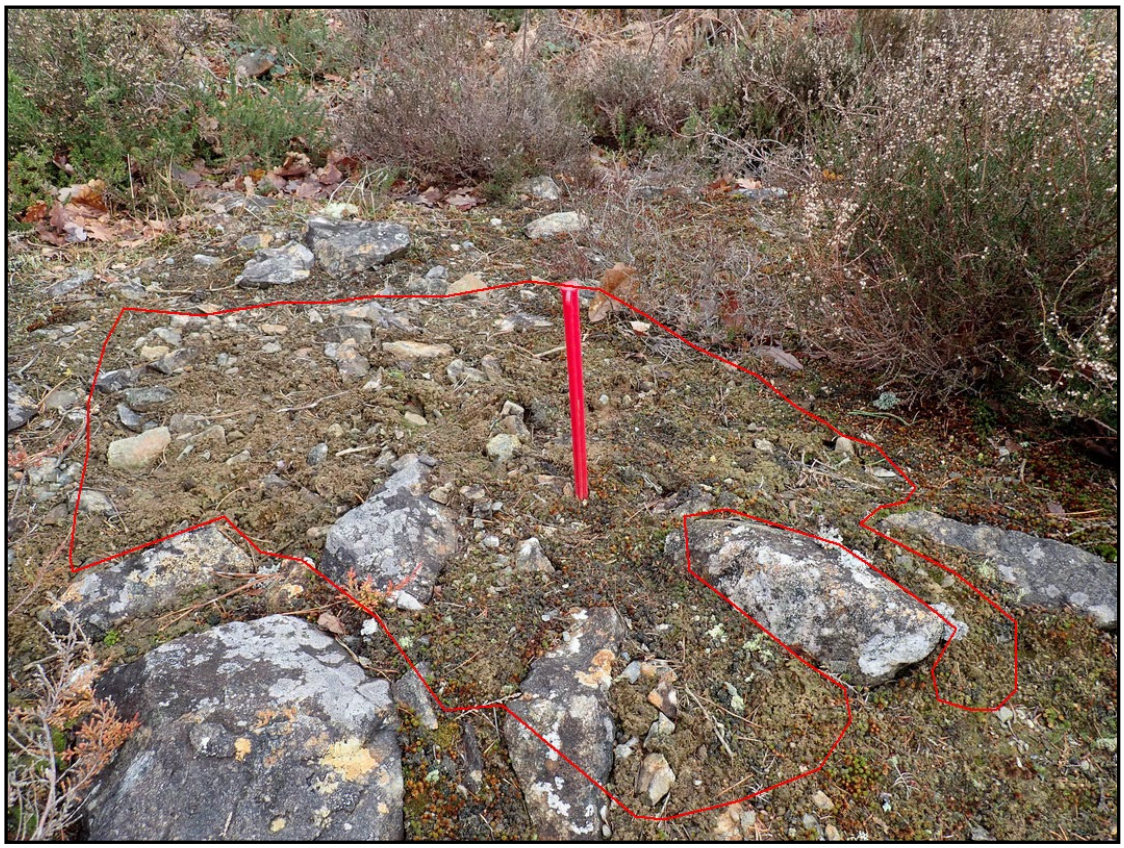


Plate 12. Clay habitat at SH 78118 58409 (close up of area in Plate 11)

Plate 13. *D. plumbicola* covers around 14cm^2 within 2 x 1m grid squares in this extensive area of spoil at SH 780583

Plate 14. 6cm^2 of *D. plumbicola* at SH 78099 58373 (within area of Plate 13)

5.2. Non-SAC populations

Hafna Lead mine 1 (unit 13) is a complex area of afforested Calaminarian grassland mine spoil on a steep south-east facing slope. Clearance of trees and scrub has recently been undertaken from the northern part of the unit where there is an old record of *D. plumbicola*.

No *D. plumbicola* was found within the SAC unit in the current work but other spoil heaps along a small, wooded stream gully to the immediate south were also speculatively surveyed.

A single small population of approximately 150cm^2 within a single OS 1m square was found on the lowest of these (Figure 5 and Plates 15 and 16). This is a new site for *D. plumbicola* in Gwydyr Forest.

Figure 5. Distribution of *D. plumbicola* near SAC unit 13

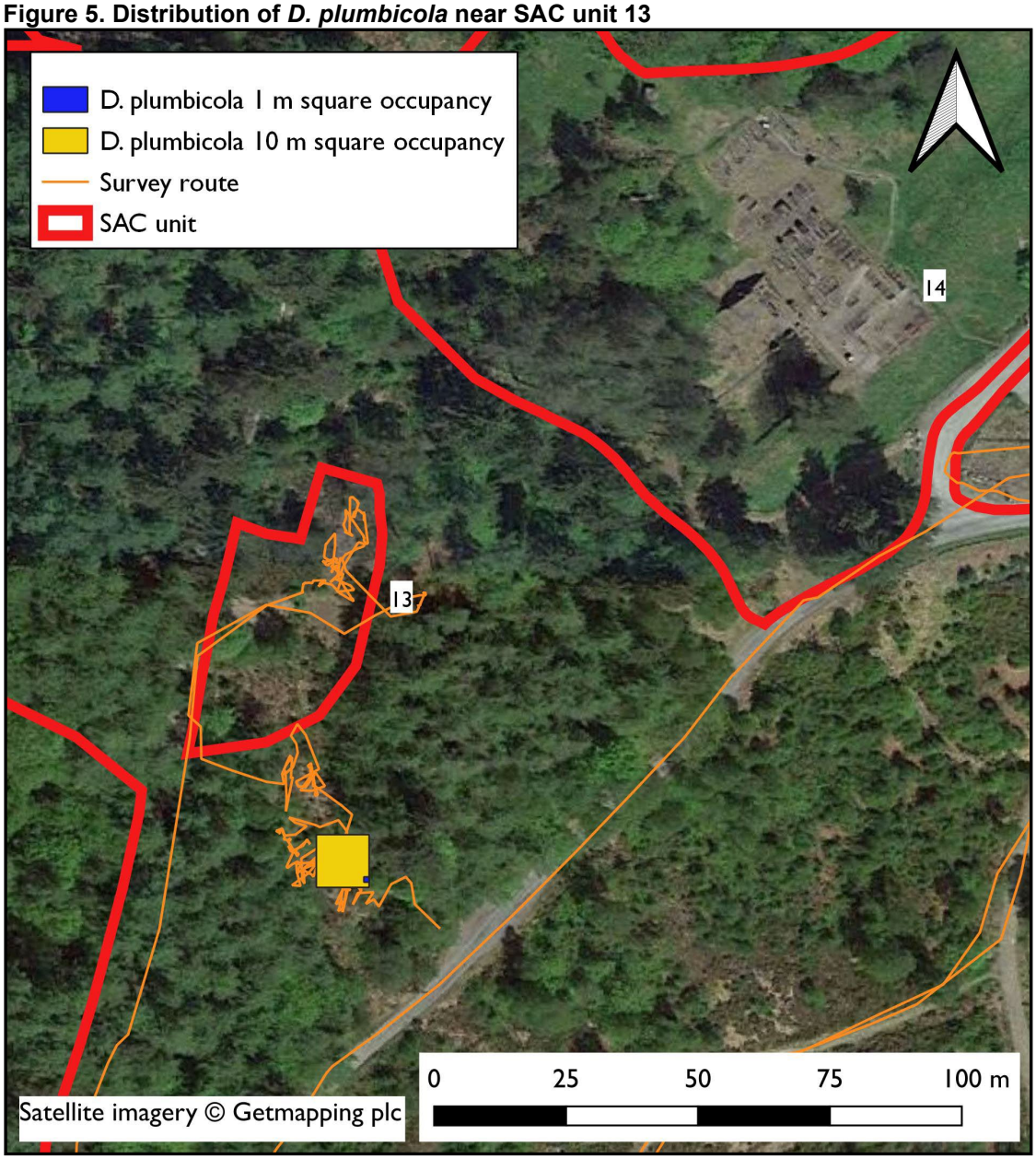


Plate 15. Near unit 13 – red peg marks location of *D. plumbicola* at SH 77979 60001. Photo taken looking uphill in a north-westerly direction.

Plate 16. Close-up of population in Plate 15

5.3. Scrapes

Searches of scrapes made in Nant Gwydr (unit 6) and Hafna Lead Mine 3 (unit 15) were unsuccessful. In both localities the scrapes had exposed substrate that was an unconsolidated mixture of coarse stones and fine, friable sediment with negligible clay.

Colonisation of the scrapes in unit 6 was already underway, with estimated cover of 40% small bryophytes and 20% vascular plants. *Ceratodon purpureus*, *Bryum dichotomum*, *Didymodon fallax*, *Dicranella varia* and *Streblotrichum convolutum* var. *convolutum* were frequent to abundant, together with frequent *Festuca* cf. *rubra*, *Cerastium fontanum* and *Plantago lanceolata*.

In unit 15, both scrapes supported 40-50% cover of small mosses, especially *Weissia controversa* var. *controversa*, *Pohlia nutans* and *D. varia*. with vascular plants of the surrounding Calaminarian grassland e.g. *Agrostis capillaris*, *Festuca ovina*, *Holcus lanatus* and *Noccaea caerulescens*.

The rapid colonisation of the vegetation in the scrapes in both units is indicative of a substrate that has inadequate concentrations of lead for *D. plumbicola*.

6. Conclusions

The current work fills in some gaps in the contemporary understanding of the population size and distribution of *D. plumbicola* in the Gwydyr Forest Mines SAC. In 2021, populations were confirmed in 18 different SAC units. The current work confirms another 3 units where populations survive. However, the rediscovered populations are very small and confined to no more than two discrete places in each unit (units 28 and 30) or a single place on the brink of extinction (unit 8). The processes of spoil amelioration and natural succession are advanced in all three units and very little good habitat remains. Units 5, 7 and 20, where *D. plumbicola* has also previously been found, no longer support it, for the same reasons.

This work also highlights the high importance of the extensive areas of Calaminarian grassland in unit 37 for *D. plumbicola*, where there is a substantial but scattered population. Coed Mawr Pool Mine should now be considered to be on a par with unit 1 (New Pandora Leadworks), unit 27 (Cyffty Mine), unit 35 (Forest Enterprise 3) and unit 39 (Castle Terrace 2) as a unit of the highest importance for *D. plumbicola* in the SAC.

A previously unknown small population in woodland close to SAC unit 13 Hafna Lead Mine 1 is a welcome discovery, although without statutory protection its future is unclear.

Other than natural processes, the single main threat to extant colonies of *D. plumbicola* is the proximity of pine, spruce and birch trees, many of which grow as adventive saplings on spoil tips. Leaf/needle drop can smother tiny populations of *D. plumbicola* and amplify the processes of natural succession, whilst shade cast by trees may have a negative impact on colonies.

There has been limited success with the scrapes so far, but the colonisation of one, at Cyffty Mine (unit 27) suggests that any further scrapes are most likely to be successful if they are dug in ground where the following criteria are met:

(i) there is a substantial population of *D. plumbicola* nearby and ideally upslope;
(ii) the scrape is afforded shelter by aspect, microtopography and/or well-grown dwarf shrubs;
(iii) the underlying substrate has significant content of clay with high lead concentrations.

7. Management Recommendations

Management work is required to safeguard colonies of *D. plumbicola* in two SAC units and ideally, in another small area just outside an SAC unit where opportunities for habitat restoration could also be explored. This work is largely of a small-scale nature and is detailed in Table 3.

Table 3. Management and habitat restoration recommendations

SAC Unit	Name	Action needed	Gridref of *D. plumbicola*
8	Pen y Fridd Quarry 3	**Urgent action is needed to prevent extinction of *D. plumbicola* in this unit**: Fell mature conifers overhanging or nearly overhanging its spoil heap. Cut down conifers / other tree saplings colonising this spoil heap within a 10m radius. Scrape off 1 – 5cm of the upper surface of the spoil heap within 1m of where *D. plumbicola* grows (with a spade) to expose a small area of bare spoil i.e. 1-2 m^2) to create new habitat. **Great care will need to be taken to protect the very small and inconspicuous patch of *D. plumbicola* during this work and the spoil heap scraping should be undertaken (or at least supervised) by a bryologist.**	SH 77846 60978
13 (near)	Hafna Lead Mine 1 (near)	Fell pine trees within a 10m radius of the spoil heap where *D. plumbicola* is found. Cut down birch saplings and tall gorse within 5m of the spoil heap and cut down all tree saplings growing in the heap. Great care will need to be taken to protect the very single small colony of *D. plumbicola* during this work.	SH 77979 60001
37	Coed Mawr Pool Mine	No specific habitat management is currently needed but the clay spoil favoured by *D. plumbicola* is a fragile habitat and could easily be damaged by off-road cyclists, motorbikes or walkers. Current forest access protocols successfully prevent this and should be maintained.	Various

Should funding for habitat restoration relevant to *D. plumbicola* colonies that are not within the SAC be available, there is also potential for exploring habitat restoration of spoil close to unit 13 (Hafna Lead Mine 1). A bank of toxic-looking clay spoil (Plate 17) occupies a very steep, east-facing slope in open coniferous

woodland above in a stream gully. Brash from nearby forestry operations is strewn across the bank and its surface is covered in pine needles and fallen leaves from nearby trees. Removal of brash and leaves and scraping off the uppermost few centimetres of spoil and developing vegetation with a rake might restore suitable habitat for *D. plumbicola*. Removal of nearby trees would also limit leaf-fall in this area.

This spoil heap is on the opposite side of a small stream to the small population of *D. plumbicola* at SH 77979 60001 (Section 5.2), so if this work went ahead, it would be imperative to protect it from inadvertent trampling or other damage by contractors.

Plate 17. Spoil bank at SH 7797 6000

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9. Appendices

9.1. Confirmed Colonies of *Ditrichum plumbicola*

SAC unit	Gridref	Date	Remarks
8	SH7784660978	30-Jan-24	Two very small patches c. 10cm apart and totalling 3cm^2. Close to extinction here.
13, near	SH7797960001	30-Jan-24	On narrow strip of spoil low down on slope by small stream in gully. Patch area is c. 150cm^2.
27	SH7713958780	01-Feb-24	In a 3 x 6m scrape dug in 2022. Scattered thinly over 3m x 3m, total area c. 50cm^2.
28	SH7752858928	01-Feb-24	On top of spoil heap growing on clayey soil infilling coarse spoil fragments. Patch area is c. 50cm^2.
28	SH7753758933	01-Feb-24	10cm^2 on clay at base of low spoil heap.
30	SH7769059034	01-Feb-24	2cm^2 on clay on slope of otherwise coarse spoil heap.
30	SH7770258994	01-Feb-24	Single patch 4cm^2 in scoop next to rocks.
37	SH7794458494	31-Jan-24	Four small patches totalling c. 30cm^2 close together on south-facing slope of spoil heap.
37	SH7794958394	31-Jan-24	Two patches 25cm apart close to edge of bare spoil on frost-heaved clay sheltered by tall *Calluna*. Patch 1 is 16cm^2. Patch 2 is c. 40cm^2.
37	SH7796158400	31-Jan-24	2cm^2 on frost-heaved clay spoil.
37	SH7796358398	31-Jan-24	Two patches totalling 15cm^2 on frost-heaved clay spoil.
37	SH7796458404	31-Jan-24	Two small patches totalling c. 3cm^2 on frost-heaved clay spoil.
37	SH7797058408	31-Jan-24	Two patches totalling c. 2cm^2 on frost-heaved clay spoil about 50cm apart.
37	SH7809758381	01-Feb-24	6cm^2 on frost-heaved clay spoil.
37	SH7810258373	01-Feb-24	A very small patch (<1cm^2) on frost-heaved clay spoil
37	SH7810258373	01-Feb-24	7cm^2 on frost-heaved clay spoil.
37	SH7811458404	01-Feb-24	Small, dense patch 2cm^2 in frost-heaved clay spoil.
37	SH7811858409	01-Feb-24	10-20 patches scattered over 2m x 2.5m of frost-heaved clayey spoil near ruined building. Estimated total area of plants is c. 150cm^2.

9.2. Photographic record of units lacking *D. plumbicola*

Unit 5. Substantial old spoil heaps, now overgrown

Unit 6. Eastern scrape at SH 79104 61270

Unit 7. Old and overgrown spoil heap

Unit 15. Scrape at SH 78175 60013 (Hafna Mine in the background)

Unit 18. Deforested spoil on an east-facing bank at SH 787 603

Unit 20. Substantial but unsuitable area of spoil on a forested bank

Cyfoeth Naturiol Cymru
Natural Resources Wales

Data Archive Appendix

Data outputs associated with this project are archived on server–based storage at Natural Resources Wales.

The data archive contains:

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

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'.

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