

NATIONAL PARKS AND WILDLIFE SERVICE



NATURAL HERITAGE AREAS
(NHAS) FOR CALAMINARIAN
GRASSLAND: SELECTION
CRITERIA



Neil Lockhart



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Local Government and Heritage

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Front cover, small photographs from top row:

Limestone pavement, Bricklieve Mountains, Co. Sligo, Andy Bleasdale; **Meadow Saffron** *Colchicum autumnale*, Lorcan Scott; **Garden Tiger** *Arctia caja*, Brian Nelson; **Fulmar** *Fulmarus glacialis*, David Tierney; **Common Newt** *Lissotriton vulgaris*, Brian Nelson; **Scots Pine** *Pinus sylvestris*, Jenni Roche; **Raised bog pool**, Derrinea Bog, Co. Roscommon, Fernando Fernandez Valverde; **Coastal heath**, Howth Head, Co. Dublin, Maurice Eakin; **A deep water fly trap anemone** *Phelliactis* sp., Yvonne Leahy; **Violet Crystalwort** *Riccia huebeneriana*, Robert Thompson

Main photograph:

Calaminarian Grassland, Glendasan, Co. Wicklow, Neil Lockhart



Natural Heritage Areas (NHAs) for Calaminarian Grassland: Selection Criteria

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Executive Summary

Calaminarian Grassland vegetation is characterised by the presence of metallophyte plants, *i.e.* plants that can tolerate high levels of heavy metals. In Ireland, metallophyte vegetation no longer occurs naturally, but it may develop locally in habitats created by past mining activities, particularly on old copper or lead mine spoils. Survey work in 2006, 2008 and 2018 has found that such vegetation can support some very rare bryophyte species (mosses and liverworts), several of which are threatened with extinction in Europe, and has concluded that only 6.2 ha of Calaminarian Grassland habitat remains in Ireland. Calaminarian Grassland is listed under Annex I of the EU Habitats Directive and five Special Areas of Conservation (SACs) in Ireland are selected for this habitat as a qualifying interest.

This report aims to identify and rank the most important mine sites that should be considered for protection as Natural Heritage Areas (NHAs). It uses four selection criteria (rare bryophytes, area of Calaminarian Grassland, structure and functions of vegetation and occurrence within existing designated areas) and applied these criteria to 29 mine sites. Results show that seven of the 12 top-ranked mine sites occur within SACs and that one is within a Special Protection Area (SPA). Another mine site, ranked further down the list, is also within an SAC for which Calaminarian Grassland is a qualifying interest. These nine mine sites are recommended for designation as biological NHAs under habitat Theme 'Grassland and Marsh', based on the presence of Calaminarian Grassland. A further four mine sites, with no other site protection status, would also benefit for consideration as biological NHAs.

Acknowledgements

I would like to thank David Holyoak, Nick Hodgetts, Rory Hodd and Christina Campbell for their bryophyte research work with NPWS. The data that they gathered forms the basis for the proposed NHA selection criteria that could be used to identify and protect the most important sites for this vulnerable habitat in Ireland. I am grateful to Aoife Delaney and Domhnall Finch for reading and editing this IWM.

1 Introduction

A Natural Heritage Area (NHA) is defined under the Wildlife (Amendment) Act, 2000 as “an area which is worthy of conservation for one or more species, communities, habitats, landforms or geological or geomorphological features, or for its diversity of natural attributes”. For over 40 years the National Parks and Wildlife Service (NPWS) has been surveying and assessing the ecological importance of natural and semi-natural habitats and species in Ireland, with the aim of protecting the most important sites. The internationally important sites have largely been identified as part of the Natura 2000 network. These sites are listed as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) and have been selected using the Natura 2000 assessment criteria (European Commission, 2011). The SACs represent the best examples in Ireland of sites containing a significant presence of Annex I habitats and Annex II species, as listed in the EU Habitats Directive (Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora). The SPA network protects the Annex I Bird Species listed in the EU Birds Directive (Directive 2009/147/EC on the conservation of wild birds).

The remaining sites of national, regional or local importance have been listed by NPWS as ‘candidate Natural Heritage Areas’ (cNHAs). A cNHA is defined here as any site that has been identified by NPWS as potentially of interest for nature conservation. The list of sites includes a suite of proposed NHAs (pNHAs) that were advertised by NPWS in 1995, as well as additional sites that have been identified since 1995 through NPWS surveys, County Council surveys, NGO recommendations, Environmental Impact Assessments (EIAs) and private appeals for NHA designation. The majority of these sites have had their boundaries mapped, but a proportion of them have not yet been delineated. All SACs and SPAs have also been assigned cNHA coverage and site codes because these sites may need consideration for NHA designation for the protection of features not covered by the EU Habitats or Bird Directives.

A possible scheme for designating NHAs is under broadly defined ‘NHA Themes’. There are eight NHA habitat themes which mostly correspond to Level 1 of the Heritage Council habitat classification system (Fossitt, 2000):

1. Freshwater
2. Grassland and Marsh
3. Heath and Dense Bracken
4. Peatlands
5. Woodland and Scrub
6. Exposed Rock and Disturbed Ground
7. Coastland
8. Marine

There are also six NHA species themes which correspond to the main species categories of the Natura 2000 assessment form (European Commission, 2011):

1. Invertebrates
2. Fish
3. Amphibians/Reptiles
4. Birds
5. Mammals
6. Plants/Fungi

The aim of this report is to identify and apply a set of selection criteria that could be used to assess sites that might be suitable for designation as biological NHAs under habitat Theme 2, *i.e.* Grassland and Marsh, based on the presence of Calaminarian Grassland.

2 Calaminarian Grassland in Ireland

2.1 Metallophyte Vegetation in Ireland

Calaminarian Grassland is a EUNIS habitat type (code E1.B2) described as “Open formations colonizing heavy metal soils, either natural or resulting from past mining operations”. The Interpretation Manual of European Union Habitats, version EU28 (2013), calls this habitat “Calaminarian grasslands of the *Violetalia calaminariae*” (Natura 2000 code 6130) and defines it as “Generally open natural or semi-natural grasslands 1) on natural rock outcrops, rich in heavy metals (e.g. lead, zinc), 2) river gravels and shingles, 3) on old terrils or spoil heaps around mines”. It is listed under Annex I of the EU Habitats Directive.

Calaminarian Grassland vegetation is characterised by the presence of metallophyte plants, *i.e.* plants that can tolerate high levels of heavy metals. In Ireland, the classic vegetation study by Braun-Blanquet & Tüxen (1952) described the peculiar '*Armeria-Silene maritima-Gesellschaft*' found on copper-mine spoil at Ross Island (Co. Kerry). Little attention has been paid to metallophyte vegetation in Ireland since then, although Lötschert (1982) described vegetation of another disused copper mine at Camillan Wood (near Muckross, Co. Kerry), which was similar to that at Ross Island. A significant contribution by Doyle (1982) attributed rather different plant associations on lead and zinc mine spoils near Carran in the Burren (Co. Clare) to the *Minuartio-Thlaspietum alpestris* (Koch 1932) Shimwell 1968 association of the *Violetea calaminariae* (cf. Ernst 1976). Hence, although Fossitt (2000) appears to have been correct in pointing out that metallophyte vegetation does not occur naturally in Ireland, it is apparent that it may develop locally in habitats created by past mining activities.

Phanerogams (*i.e.* seed-producing plants) provide a weaker basis for characterising metallophyte vegetation types in Ireland than in continental Europe. *Thlaspi caerulescens* (syn. *T. alpestre*) and *Viola calaminaria* (DC.) Lej. do not occur at all, while the few 'characteristic' Irish metallophyte species occur more widely in other habitats. Bryophytes provide a better basis for recognition of metallophyte vegetation because they include stenophilous species, the so-called 'copper mosses', which are characteristic of substrata rich in copper, lead or zinc (*e.g.* Brown, 1982).

Some of the phytosociological studies of Irish mine-spoil have unfortunately paid little attention to bryophytes or apparently misidentified those that do occur. Records from Ireland of the 'copper mosses' have anyway been rare until recently, with none in the classical compilations by McArdle (1904) and Lett (1915), and only four records of two species (*Cephaloziella massalongi* and *Pohlia andalusica*) accumulated by 2000 (Castell, 1957; Paton, 1967; Holyoak, 2003). A number of lichens are also indicative of metal-rich substrates (see Purvis, 1993; Purvis & Halls, 1996; Fox, 1999; Giavarini, 2011) although to date, there has been no systematic national survey of metallophyte lichens in Ireland.

2.2 Bryophytes and Metallophyte Vegetation — Surveys 2008 and 2018

During 1999–2005 an extensive programme of research on Irish bryophytes was undertaken by NPWS, producing many new finds, although few involved 'copper mosses' (Holyoak, 2006). Continuation of this work into Co. Cork in 2006 and Co. Waterford in 2007 resulted in the first Irish records of the 'copper mosses' *Cephaloziella nicholsonii*, *Ditrichum cornubicum* and *Scopelophila cataractae*. This led to suspicion that other populations of metallophyte bryophytes may hitherto have been overlooked elsewhere in Ireland. A wide-ranging survey of bryophytes at Irish metalliferous mine sites was therefore undertaken by NPWS during April to early June 2008 (Holyoak, 2008, 2009; Holyoak & Lockhart, 2011). This produced numerous new finds, including the lead-tolerant *Ditrichum plumbicola* new to Ireland. The 2008 survey examined mine spoil sites that might support Calaminarian Grassland and metallophyte bryophytes. An initial list of sites that might be worth surveying was compiled from several sources. Phytosociological publications (Doyle, 1982; Lötschert, 1982) described only a few small-disused lead-mines. Cole (1922) provided an extensive review of mine sites worked up to the 1920s, including

tonnage of ore extracted. More recent information was obtained from mining, mining company and mining history websites. A total of 35 sites for survey (see Table 1 below) were therefore chosen from: (a) sites already known to have rare metallophyte bryophytes; (b) sites that produced highest tonnages of Cu, Pb or Zn historically, especially in relatively recent past; (c) sites where extensive spoil tips had not been reclaimed or re-vegetated; (d) sites of continuing interest to mineral collectors and (e) sites with spoil in damp, low-lying settings but with largely unshaded fine-grained clayey spoil, rather than open sunny sites, or tree-shaded and gravelly sites.

Table 1 Summary of data on mine sites surveyed in 2008

Sites	County	Grid ref.	Metal(s)	Bedrock	Ore Tonnage	Year
1. Ballyhickey	Clare	R417768	Pb	limestone	3,182	1836–1846
2. Sheshodonnell East	Clare	R268969	Pb	limestone		
3. Mogouhy	Clare	R274983	Pb	limestone		
4. Allihies (Mountain)	Cork	V590458	Cu	sandstone	>206,574	1813–1918
5. N. of Caminches	Cork	V594455	Cu	sandstone		
6. NE of Caminches	Cork	V597455	Cu	sandstone		
7. Dooneen	Cork	V577459	Cu	sandstone		
8. Cappagh	Cork	V990324	Cu	sandstone	1,133	1819–1873
9. Brow Head	Cork	V771235	Cu	sandstone		
10. Polleenateada	Cork	V780306	Cu	sandstone		
11. Keeldrum	Donegal	B903262	Pb	quartzite, etc.	1,229	1826–1862
12. Ballycorus	Dublin	O225208	Pb	mica-schist		
13. Tynagh	Galway	M753133	Cu	limestone		
14. Muckcross Lake	Kerry	V948859	Cu	limestone		
15. Ross Island	Kerry	V945880	Cu, Pb	limestone	>4,749	1804–1810
16. Galmoy (trial cells)	Kilkenny	S274722	Zn, Pb	carbonates	650,000 p.a.	1986–2008
17. Galmoy (dam)	Kilkenny	S271724	Zn, Pb	carbonates		
18. Tara	Meath	N858716	Zn, Pb	shale/slate	2,000,000	1977–2008
19. Lackamore	Tipperary	R788602	Cu	shale	2,848	1819–1859
20. Shallee	Tipperary	R806712	Pb	shale	678	1847–1874
21. Garryard West	Tipperary	R826710	Pb, ?Zn	calc. shale	Pb>218,Zn-9,541	1819–1872
22. Bunmahon	Waterford	X444986	Cu	slate	>80,000	1730–1907
23. Tankardstown	Waterford	X451986	Cu	slate		
24. Knockmahon	Waterford	X438990	Cu	metamorphic		
25. Caim	Wexford	S885409	Cu	metamorphic	1,245	1815–1855
26. Cronebane	Wicklow	T208831	Cu, S,	shale, schist	38,909	1720–1912
27. nr Connary Hall	Wicklow	T211838	Cu	shale, etc.	15,206	1832–1885
28. Glendasan(old works)	Wicklow	T098981	Pb	granite, schist	12,900	1807–1900
29. Foxrock Mine	Wicklow	T104982	Pb	granite, schist		
30. Ballymurtagh	Wicklow	T192815	Cu, S, Fe	schistose	52,111	1755–1879
31. Tigroney West	Wicklow	T199822	Cu, Fe, S	schistose	26,390	1822–1854
32. Ballinafunshoge	Wicklow	T082925	Pb	schistose	1,395	1797–1864
33. Vale of Glendasan	Wicklow	T108977	Pb	schistose		
34. Brockagh	Wicklow	T093992	Pb	schistose		
35. E. of L. Nahanagan	Wicklow	T092988	Pb	schistose		

The presence of indicator species was taken as the strongest evidence of Calaminarian Grassland vegetation. Thus, obligate Cu bryophytes (*i.e.* species that can only survive in the presence of copper) were considered to be *Cephaloziella massalongi*, *C. nicholsonii*, *Ditrichum cornubicum* and *Scopelophila*

cataractae; the only obligate Pb bryophyte was *Ditrichum plumbicola*. Facultative metallophytes (*i.e.* species which can tolerate high levels of metals, but are not confined to such conditions) most indicative of high Cu included *Cephaloziella integerrima*, *C. stellulifera*, *Gymnocolea inflata*, *Solenostoma gracillimum*, *Pohlia andalusica*, *Scapania compacta* and *Weissia controversa* var. *densifolia*; some indicative of Pb or Zn were *Bryum pallescens* and *Weissia controversa* var. *densifolia*. All vascular plants were considered to be facultative indicators: *Minuartia verna* (Pb and Zn), inland stands of *Silene uniflora* and inland lowland populations of *Armeria maritima* (Cu, Pb and Zn).

Study of modern open-cast mine sites (Cronebane and Connary, most of Ballymurtagh and Garryard West) and those with tailings dams (Galmoy, Tara, Tynagh) failed to disclose any rare bryophytes or any habitat suitable for them. In contrast, a wider variety of mining techniques were used at mines worked during the eighteenth, nineteenth and early twentieth centuries, some of which resulted in spillage of ore or incomplete recovery of low-grade ore. The rare metallophytes have persisted at some of those sites where metals were left behind.

A resurvey of 29 of these sites was carried out in 2018 as part of a monitoring project to assess the conservation status of Calaminarian Grasslands in Ireland (Hodd & Hodgetts, 2018). The results from this survey showed that Calaminarian Grassland is undergoing a continuing decline, as the toxicity of the spoil exposed by mining activities decreases over time. This is leading to succession to other vegetation communities, particularly to scrub, heath and acid grassland. As most old mine sites are regarded as marginal land, human activities are also impacting this habitat, with pollution, land reclamation and recreational and agricultural activities negatively impacting many sites. Of the 29 sites surveyed, nine sites were assessed as being in Favourable condition, 13 were assessed as being in Unfavourable-inadequate condition and seven were assessed as being in Unfavourable-bad condition. Two sites in particular, Shallee and Knockmahon, of those that are of high importance for rare bryophytes, are in poor condition and require conservation effort to maintain their importance. Two rare bryophyte species, *Ditrichum plumbicola* and *Cephaloziella integerrima*, were found to have declined at Calaminarian Grassland sites, and may be in danger of extinction in Ireland. *D. plumbicola* was not refound at two sites where it previously grew, at one of which it grew in good quantity in 2008. It was refound at a third site, but in very small quantity and poor condition. *C. integerrima* was found at only one site, where it showed a marked decline due to pollution. *Ditrichum cornubicum* is also of concern, as it was only found in very small quantity at its only known site.

The 2018 survey calculated that only 6.2 ha of Calaminarian Grassland remains within the sites surveyed. This differs significantly from the previous 2008 survey, when a figure of 13.6 ha was estimated. The difference in area is largely due to a more accurate methodology used to delineate the habitat extent for the 2018 survey, and does not represent a dramatic decline in the habitat. The total area of the habitat in Ireland is nonetheless very small.

3 Selection criteria for candidate NHAs

3.1 Criterion 1 – Rare and threatened metallophyte bryophyte species

Conservation of Calaminarian Grassland vegetation for its own sake would appear to have little appeal, particularly when it consists of pure stands of metal-tolerant ecotypes of the common grass *Agrostis capillaris* with or without such common herbs as *Cerastium fontanum* and *Rumex acetosa*. It is the presence of rare and threatened species in the metallophyte vegetation that necessitates conservation concern. Presence of rare and threatened bryophyte species is taken as the first criterion for choosing candidate sites for protection for potential NHA designation. Presence of metallophyte lichens has not been used, due to lack of data for all the sites, although this would have been an equally valid criterion.

The conservation importance of Calaminarian Grassland is highlighted by the recently published IUCN Red List of European Bryophytes (Hodgetts *et al.*, 2019). Of the 31 Irish bryophyte species that are assessed as threatened with a risk of extinction at a European level (*i.e.* Critically Endangered, Endangered or Vulnerable), six of them are confined almost exclusively to this habitat in Ireland. Furthermore, three of these species are also endemic to Europe and are assessed at a Global level as either Critically Endangered, with an “extremely high risk of extinction in the wild”, or Endangered, with a “very high risk of extinction in the wild” (IUCN, 2012). Eight species of bryophytes from the Irish Red List (Lockhart *et al.*, 2012a, 2012b) are closely associated with metalliferous sites, six of which are legally protected under the Flora (Protection) Order, 2015 (see Table 2). Sites from which these species have been recorded are listed in Table 3.

Table 2 Threat and protection status of rare metallophyte bryophytes (CR – Critically Endangered; EN – Endangered; VU – Vulnerable; LC – Least Concern; NE – Not Evaluated)

Taxon	Threat Status Ireland*	Threat Status Europe**	Threat Status Global**	Protection Status Ireland
<i>Cephaloziella integerrima</i>	VU	EN	NE	Not protected
<i>Cephaloziella massalongi</i>	VU	EN	NE	Flora (Protection) Order, 2015
<i>Cephaloziella nicholsonii</i>	VU	EN	EN	Flora (Protection) Order, 2015
<i>Ditrichum cornubicum</i>	CR	CR	CR	Flora (Protection) Order, 2015
<i>Ditrichum lineare</i>	CR	LC	NE	Flora (Protection) Order, 2015
<i>Ditrichum plumbicola</i>	EN	EN	EN	Flora (Protection) Order, 2015
<i>Pohlia andalusica</i>	EN	LC	NE	Flora (Protection) Order, 2015
<i>Scopelophila cataractae</i>	VU	EN	NE	Not protected

* Lockhart, N., Hodgetts, N. & Holyoak, D. 2012b. *Ireland Red List No.8: Bryophytes*

** IUCN European Red List assessment 2019

Table 3 Order of mine sites by number of rare and threatened metallophyte bryophytes

Sites	No. of rare bryophytes	Species recorded in 2008 and/or 2018
Allihies (Mountain)	7	<i>Cephaloziella integerrima</i> , <i>C. massalongi</i> , <i>C. nicholsonii</i> , <i>Ditrichum cornubicum</i> , <i>D. lineare</i> , <i>Pohlia andalusica</i> , <i>Scopelophila cataractae</i>
Knockmahon	4	<i>Cephaloziella integerrima</i> , <i>C. nicholsonii</i> , <i>C. massalongi</i> , <i>Pohlia andalusica</i>
Cappagh	4	<i>Cephaloziella nicholsonii</i> , <i>C. massalongi</i> , <i>Pohlia andalusica</i> , <i>Scopelophila cataractae</i>
Glendasan (Old Works)	3	<i>Cephaloziella massalongi</i> , <i>C. nicholsonii</i> , <i>Ditrichum plumbicola</i>
Shallee	2	<i>Cephaloziella nicholsonii</i> , <i>Ditrichum plumbicola</i>
Ballycorus	2	<i>Cephaloziella massalongi</i> , <i>Ditrichum plumbicola</i>
Bunmahon	2	<i>Cephaloziella massalongi</i> , <i>Pohlia andalusica</i>
Caim	2	<i>Cephaloziella nicholsonii</i> , <i>Scopelophila cataractae</i>
Tigroney West	1	<i>Cephaloziella nicholsonii</i>
Muckcross Lake	1	<i>Cephaloziella massalongi</i>
Ross Island	1	<i>Cephaloziella massalongi</i>
N. of Caminches	1	<i>Pohlia andalusica</i>
Dooneen	1	<i>Cephaloziella massalongi</i>

3.2 Criterion 2 – Area of Calaminarian Grassland vegetation

The extent of Calaminarian Grassland is taken as the second selection criterion. It can be difficult to measure the accurate extent of this habitat because it can often occur in patches in mosaic with other vegetation types. Mapping for all sites was carried out by a combination of handheld GPS and annotation on field maps. Sites are ordered in descending order (Table 4) based on area figures from the 2018 survey. Some modern mine workings, which produce fine-grained spoil that is unsuitable for Calaminarian Grassland, were visited in 2008 and are listed below as n/a (not applicable).

Table 4 Order of mine sites by extent of Calaminarian Grassland vegetation in 2018

Site	Calaminarian Grassland (ha)	Site	Calaminarian Grassland (ha)
Allihies (Mountain)	1.316	Muckcross Lake	0.027
Glendasan (Old Works)	1.268	N. of Caminches	0.026
near Connary Hall	0.613	Keeldrum	0.013
Vale of Glendasan	0.519	Ballyhickey	0.011
Shallee	0.472	Sheshodonnell East	0.009
Caim	0.350	Brow Head	0.007
Knockmahon	0.279	NE of Caminches	0.007
Foxrock Mine	0.273	Tankardstown	0.006
Dooneen	0.226	Ballymurtagh	0.004
Polleenateada	0.143	Tigroney West	0.003
Ballinafunshoge	0.127	Lackamore	0
Brockagh	0.109	Galmoy (trial cells)	n/a
Ballycorus	0.106	Tynagh	n/a
Cappagh	0.063	Galmoy (dam)	n/a
Bunmahon	0.061	Cronebane	n/a
Ross Island	0.055	Mogouhy	n/a
Garryard West	0.040	Tara	n/a
E. of L. Nahanagan	0.035		

3.3 Criterion 3 – Structure and functions

Structure and functions of Calaminarian grassland is an assessment that aims to provide information on the proportion of the habitat area in ‘good’ and ‘not-good’ condition, its trends, and typical species (DG Environment, 2017). Such an assessment was carried out on 29 sites as part of the survey to monitor Calaminarian grassland sites for the EU Article 17 report (Hodd & Hodgetts, 2018). Sites were evaluated as Favourable or Unfavourable using a combination of positive indicator species, amount of scrub encroachment and percentage of the Calaminarian grassland vegetation impacted negatively by human activities. In addition to the rare and threatened bryophytes listed in Table 3, indicator species also included the bryophytes *Bryum pallescens*, *Cephaloziella stellulifera*, *Gymnocolea inflata*, *Solenostoma gracillimum*, *Scapania compacta*, *Weissia controversa* var. *densifolia* and the vascular species *Minuartia verna* and inland, lowland occurrences of *Armeria maritima*, *Plantago maritima* and *Silene uniflora*.

Table 5 Assessment of the Structure and functions (see Hodd & Hodgetts, 2018)

Site number	Indicator spp.	Scrub (%)	Human impact (%)	Assessment
Ballycorus	3	1	45	Unfavourable
nr Connary Hall	2	5	0	Favourable
Glendasan	7	0	10	Favourable
Foxrock Mine	3	0	0	Favourable
Ballymurtagh	1	0	10	Favourable
Tigroney West	2	0	0	Favourable
Ballinafunshoge	2	10	50	Unfavourable
Vale of Glendasan	1	10	0	Favourable
Brockagh	5	0	80	Unfavourable
E. of L Nahanagan	2	0	0	Favourable
Bunmahon	5	0	33	Unfavourable
Tankardstown	1	0	66	Unfavourable
Knockmahon	7	15	50	Unfavourable
Muckross Lake	2	20	5	Unfavourable
Ross Island	4	2.5	30	Unfavourable
Allihies	7	0	5	Favourable
N. of Caminches	1	0	5	Favourable
NE. of Caminches	2	0	50	Unfavourable
Dooneen	3	0	45	Unfavourable
Cappagh	5	15	10	Favourable
Brow Head	5	0	0	Favourable
Polleenateada	3	0	0	Favourable
Lackamore	0	0	100	Unfavourable
Shallee	5	50	90	Unfavourable
Garryard West	3	40	30	Unfavourable
Ballyhickey	0	0	100	Unfavourable
Sheshodonnell East	4	0	80	Unfavourable
Keeldrum	2	10	10	Favourable
Caim	5	15	10	Favourable

3.4 Criterion 4 – Occurrence within ‘designated’ sites

Occurrence within existing designated sites was taken as the fourth selection criterion. Sites already designated for nature conservation, such as SACs, are relevant when assessing candidate NHAs for Calaminarian Grassland because their protection status can more readily facilitate conservation of this additional habitat. Pre-existing protected areas, selected for wider conservation interests, may themselves be enhanced by the addition of further conservation interest and thereby add to their nature conservation value. Mine sites that occur within SACs and where the Annex I habitat Calaminarian Grassland is selected as one of the Qualifying Interests for the SAC, means that the habitat is assessed as occurring with a significant presence on the site and that the site is of European importance for this habitat. It therefore follows that if the same site is assessed at a national level, it should automatically qualify as an NHA for Calaminarian Grassland under habitat Theme 2, *i.e.* Grassland and Marsh. Occurrence within an SPA may also confer some protection, even if only indirectly.

Table 6 Occurrence of mine sites within ‘designated’ areas (SACs and SPAs).

Sites	SAC or SPA Name (Site Code)	SAC selected for Calaminarian Grassland as a Qualifying Interest
Allihies (Mountain)	Kenmare River SAC (002158)	Yes
Glendasan (Old Works) near Connary Hall	Wicklow Mountains SAC (002122)	Yes
Vale of Glendasan		
Shallee	Silvermines Mountains West SAC (002258)	Yes
Caim		
Knockmahon		
Foxrock Mine	Wicklow Mountains SAC (002122)	Yes
Dooneen		
Polleenateada		
Ballinafunshoge		
Brockagh		
Ballycorus		
Cappagh		
Bunmahon	Mid-Waterford Coast SPA (004193)	
Ross Island	Killarney National Park, Macgillycuddy’s Reeks and Caragh River Catchment SAC (000365)	Yes
Garryard West		
E. of L. Nahanagan	Wicklow Mountains SAC (002122)	Yes
Muckross Lake	Killarney National Park, Macgillycuddy’s Reeks and Caragh River Catchment SAC (000365)	Yes
N. of Caminches		
Keeldrum		
Ballyhickey		
Sheshodonnell East	East Burren Complex SAC (001926)	Yes
Brow Head	Barley Cove to Ballyrisode Point SAC (001040)	No
NE of Caminches		
Tankardstown		
Ballymurtagh		
Tigroney West		
Lackamore		

4 Results

Assessment scores of mine sites and recommendations for NHA status are shown in Table 7. Scores are based on the sum of the following criteria:

Criterion 1. Number of rare bryophytes species (as per Table 3).

Criterion 2. Area of Calaminarian Grassland habitat, where 1 = 0.003-0.1 ha; 2 = 0.101-0.99 ha; 3 = 1.00-1.316 ha (as per Table 4).

Criterion 3. Structure and functions, where 0 = Unfavourable; 1 = Favourable (as per Table 5).

Criterion 4. Occurrence within a protected area (SAC), where 0 = Calaminarian Grassland is not within an SAC or is not a Qualifying Interest for an SAC; 1 = Calaminarian Grassland is a Qualifying Interest for an SAC (as per Table 6).

Table 7 Assessment score of mine sites and recommendations for NHA status.

Sites	Criterion 1 No. of rare bryophytes	Criterion 2 Area (ha)	Criterion 3 Structure and functions	Criterion 4 Protected site	Total Score	Select as NHA
Allihies (Mountain)	7	3	1	1	12	Yes (QI for SAC)
Glendasan (Old Works)	3	3	1	1	8	Yes (QI for SAC)
Knockmahon	4	2	0	0	6	Yes
Cappagh	4	1	1	0	6	Yes
Shallee	2	2	0	1	5	Yes (QI for SAC)
Caim	2	2	1	0	5	Yes
Ballycorus	2	2	0	0	4	Yes
Foxrock Mine	0	2	1	1	4	Yes (QI for SAC)
Bunmahon	2	1	0	0	3	Yes (in an SPA)
Ross Island	1	1	0	1	3	Yes (QI for SAC)
Muckcross Lake	1	1	0	1	3	Yes (QI for SAC)
E. of L. Nahanagan	0	1	1	1	3	Yes (QI for SAC)
Vale of Glendasan	0	2	1	0	3	No
Dooneen	1	2	0	0	3	No
Tigroney West	1	1	1	0	3	No
N. of Caminches	1	1	1	0	3	No
near Connary Hall	0	2	1	0	3	No
Polleenateada	0	2	1	0	3	No
Brockagh	0	2	0	0	2	No
Sheshodonnell East	0	1	0	1	2	Yes (QI for SAC)
Brow Head	0	1	1	0	2	No
Ballinafunshoge	0	2	0	0	2	No
Keeldrum	0	1	1	0	2	No
Ballymurtagh	0	1	1	0	2	No
Garryard West	0	1	0	0	1	No
NE of Caminches	0	1	0	0	1	No
Ballyhickey	0	1	0	0	1	No
Tankardstown	0	1	0	0	1	No
Lackamore	0	0	0	0	0	No

A combination of all four selection criteria reveals a site ranking which shows that most of the best Calaminarian Grassland sites are within SACs. The SAC network contains 3,455 ha of Calaminarian Grassland, which represents 56% of the national area. In terms of rare bryophyte species, 14 of the 31 occurrences of the eight species listed in Table 3 are found within SACs. The richest site is at Allihies, with seven rare species, and this site is already protected within the Kenmare River SAC (002158). Glendasan, in Wicklow Mountains SAC (002122), has three rare species, followed closely by Shallee, in Silvermines Mountains West SAC (002258), with two rare species and Muckcross and Ross Island, both in Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment SAC (000365), each with one rare species. Bunmahon, with two rare species, is within Mid Waterford Coast SPA (004193) and this site might derive some protection from SPA designation status.

In summary, there are nine mine sites that occur within the Natura network, eight of which are qualifying interests for Calaminarian Grassland in SACs and one of which is in an SPA. If these Natura sites are eventually designated at a national level as NHAs, they should be selected for NHA habitat theme: Grassland and Marsh on the basis of their Calaminarian Grassland:

- (005090) Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment cNHA
- (005286) East Burren Complex cNHA
- (005319) Wicklow Mountains cNHA
- (005332) Kenmare River cNHA
- (005408) Slievefelim to Silvermines Mountains cNHA
- (005415) Mid-Waterford Coast cNHA

In addition, there are further four significant sites for Calaminarian Grassland that lie outside the Natura network. All four are ranked highly on the combined scores shown in Table 7 and these are also proposed for NHA designation, selected for their Calaminarian Grassland under the NHA habitat theme: Grassland and Marsh:-

- (002254) Knockmahon Copper Mine cNHA
- (002851) Cappagh Copper Mine cNHA
- (002995) Caim Lead Mine cNHA
- (002253) Ballycorus Lead Mine cNHA

These four sites are described in some detail in sections 4.1–4.4, below, with location maps and photographs, aerial images and maps delimiting the areas of interest.

It can be noted that nine of the 10 of the sites listed above, the exception being Mid-Waterford Coast cNHA, are also recommended for NHA designation under the NHA species Theme: Plants/Fungi on the basis of their rare bryophyte species (Campbell and Lockhart, 2017 Natural Heritage Areas (NHAs) for Bryophytes: Selection Criteria. *Irish Wildlife Manuals, No. 100*).

4.1 Knockmahon Copper Mine (002254)

Knockmahon is a copper-mine spoil site located on the south Waterford coast. The OS six-inch maps show mines shafts just to the north-east and east of the current spoil area. The spoil occurs on a gently, south-facing, hill slope just north-west of Knockmahon village. An old trackway, surfaced with spoil, adjoins the site at the south-east corner. Knockmahon is included within the UNESCO Copper Coast Geopark.

In 2008, the site was described as holding the largest populations in Ireland of *Cephaloziella integerrima* and *Pohlia andalusica*, with very strong populations of *Cephaloziella nicholsonii* (Holyoak, 2008). Calaminarian grassland is still supported on the site (0.279 ha), but it has deteriorated over time, with some taken over by gorse, and a film of algae now covers much of lower lying areas of the site (Hodd & Hodgetts, 2018). The original locations for *Cephaloziella nicholsonii*, at the side of the central channel, are now heavily eutrophicated and are currently unsuitable for this species. *Cephaloziella integerrima*, *C. nicholsonii* and *Pohlia andalusica* were all re-found in 2018, and *Cephaloziella massalongi* found in addition, in a mixed stand with *C. divaricata*. Both *C. integerrima* and *C. nicholsonii* were recorded in very small amounts. *P. andalusica* was seen in two places, being very locally frequent at one of them.

The most pressing conservation measures needed are to restrict the encroachment of gorse and to address the pollution from eutrophicated water coming down from uphill. This water not only affects the central channel, but spreads over the whole site, except on hummocks, leading to an increase in coarse vascular plant vegetation and, perhaps even more damagingly, to a virtually ubiquitous film of algae. Dumping also needs to be discouraged. It is recommended that, rather the site being left as a local eyesore, it is carefully developed as a point of botanical interest for visitors, in a similar fashion to the way in which the geology has been highlighted in the nearby 'geology trail'.

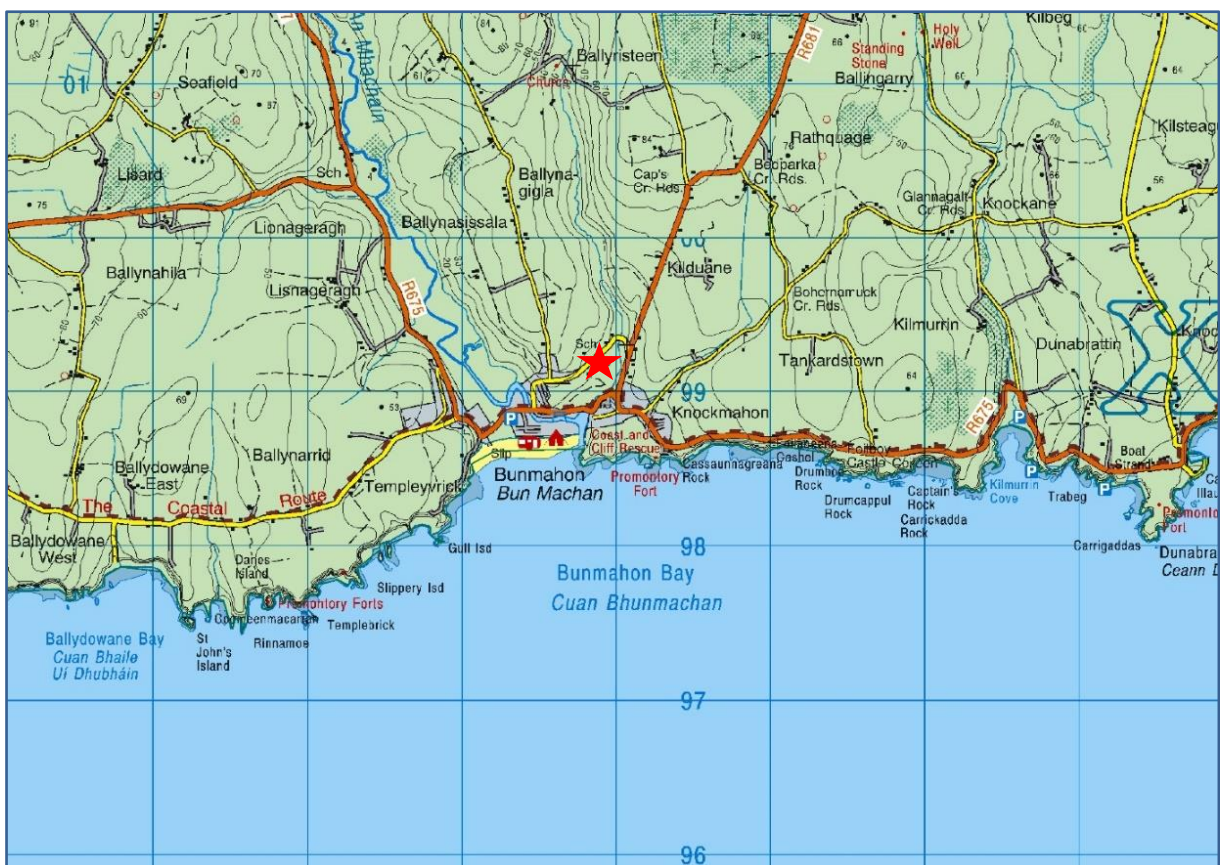




Figure 2 Ordnance Survey Digital Globe Image 2011-2013, showing the mine spoil area (red outline) at Knockmahon Copper Mine (Scale is ca. 1:3,000). Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.

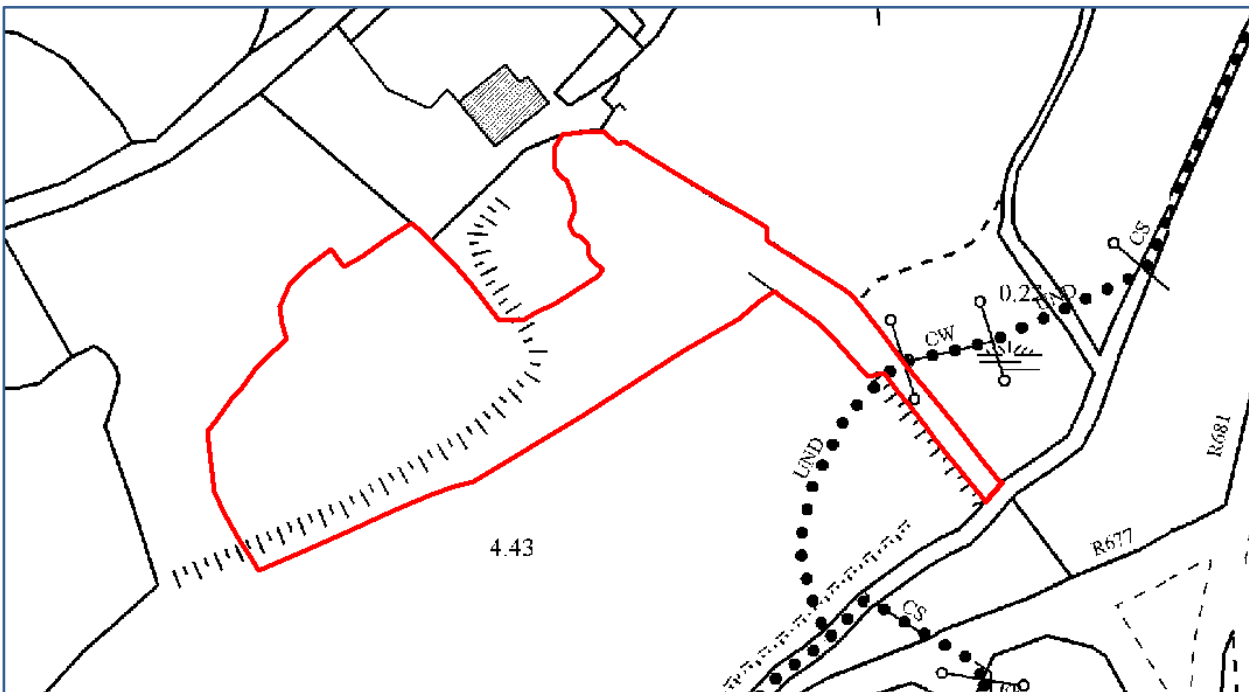


Figure 3 Ordnance Survey 1:5000 series map series, showing the mine spoil area and proposed NHA boundary (red outline) at Knockmahon Copper Mine (Scale is ca. 1:3,000). Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.



Figure 4 General view of spoil area at Knockmahon Copper Mine, with relatively extensive open areas of spoil. Photograph by Nick Hodgetts.



Figure 5 *Cephaloziella nicholsonii*. Photograph by Neil Lockhart.

4.2 Cappagh Copper Mine (002851)

Cappagh Copper Mine is located about 3 km south of Ballydehob, Co. Cork. The site of the former copper mines occurs on flat ground and gently south-facing slopes, with several low rocky ridges and wet hollows. Productive copper mines were worked here from prior to 1819 to cessation in 1873. There was no revival of mining activity during the 20th century. Parts of the original mine site area is now occupied by houses, with more being built, and used for tipping (soil) and parking/storage. Some quarrying has also taken place. There are three remaining areas of open spoil. The lower, southernmost area is surrounded by gorse scrub and covers an area of ca. 5 x 10 m. The other two areas are linear tracks surfaced with mine spoil. The lower of these also has a bank of spoil below it, and spoil in a rocky area by the eastern end of the track.

The Calaminarian grassland in the lower area forms a sparse cover, with scattered *Bryum cf. pallescens*, *Pohlia andalusica*, *P. annotina*, *P. nutans* and *Agrostis capillaris*. A strong population of *Cephaloziella nicholsonii/massalongi* grows along a nearby wall. Material from this wall was identified by D.T. Holyoak as *C. nicholsonii* in 2008, but as *C. massalongi* by N.G. Hodgetts in 2018. It seems unlikely that both species are present here intermixed, and this highlights the taxonomic difficulties of these *Cephaloziella* species. *Pohlia andalusica* was found to be abundant at multiple locations in the lower area of Calaminarian grassland and along the track in the middle of the site. The areas of Calaminarian grassland along the tracks have much *Cephaloziella stellulifera*, with carpets of *Dichodontium pellucidum* in places and some strong patches of *Scapania compacta*. The rare *Scopelophila cataractae* was found here in 2006, but not refound in 2008 and in 2018, so may have been lost due to competition by other bryophytes or by shading, etc. This site is highly vulnerable to the impacts of future developments and areas of Calaminarian grassland on track surfaces would be lost if resurfacing were to take place.



Figure 6 Ordnance Survey Discovery Map series, showing location of Cappagh Copper Mine indicated by red star. Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.



Figure 7 Ordnance Survey Digital Globe Image 2011-2013, showing the mine spoil area (red outline) at Cappagh Copper Mine (Scale is ca. 1:3,000). Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.

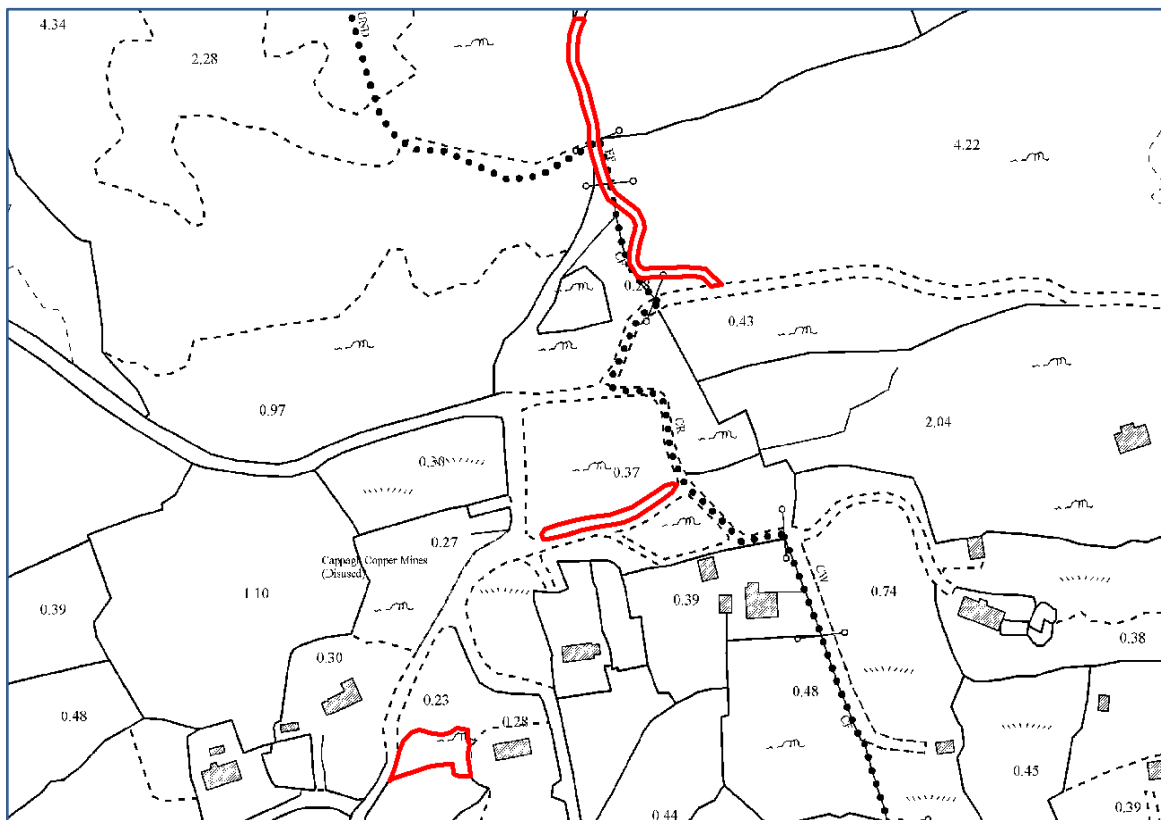


Figure 8 Ordnance Survey 1:5000 series map series, showing the mine spoil area and proposed NHA boundary (red outline) at Cappagh Copper Mine (Scale is ca. 1:3,000). Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.



Figure 9 General view of spoil area at Cappagh Copper Mine, with relatively small open area of spoil. Photograph by David Holyoak.



Figure 10 Track surfaced with spoil, with Calaminarian grassland formed in the centre and in small patches to the side. Photograph by Rory Hodd.

4.3 Caim Lead Mine (002995)

Caim Lead Mine is located about 9 km west of Enniscorthy, Co. Wexford. The site is situated on a gentle south-west facing slope, surrounded by conifer plantation, amidst pastoral farmland. It was mined between about 1815 and 1855, mainly for lead, for which it was very productive between 1840 and 1843. Copper pyrites was also mined in the early years. Two ruined chimneys and a shaft are now in or at the edges of scrub. An area of bare spoil occurs in the middle of the site, surrounded by gorse, within which there are smaller areas of Calaminarian grassland, ruderal vegetation and planted conifers. A new fence has been erected enclosing much of the central bare spoil.

Calaminarian grassland occurs in substantial stands within the new fence, and in smaller stands elsewhere, in patches among the gorse and other vegetation. *Scopelophila cataractae* is abundant in the central fenced area, often virtually to the exclusion of any other species, and occurs in smaller patches to the south of the fenced area. Calaminarian grassland out-with the fence often has abundant *Cephaloziella* spp., most of which seems to be *C. stellulifera*. There is one patch of *C. nicholsonii* to the south of the fenced area, where it grows with *C. stellulifera*. Other associates within patches of Calaminarian grassland include *Agrostis capillaris*, *Bryum* spp., *Ceratodon purpureus*, *Diplophyllum albicans*, *Funaria hygrometrica*, *Pohlia annotina*, *Sagina procumbens* and *Solenostoma gracillimum*. Near the old engine house, the Calaminarian grassland intergrades into more ruderal vegetation, and the northern 'arm' of the site becomes increasingly wet and eutrophicated at its north end, dominated by grasses, *Calliargonella cuspidata*, *Rhytidiadelphus squarrosus* and *Cirsium arvense*.



Figure 11 Ordnance Survey Discovery Map series, showing location of Caim Lead Mine indicated by red star. Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.



Figure 12 Ordnance Survey Digital Globe Image 2011-2013, showing the mine spoil area (red outline) at Caim Lead Mine (Scale is ca. 1:3,000). Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.

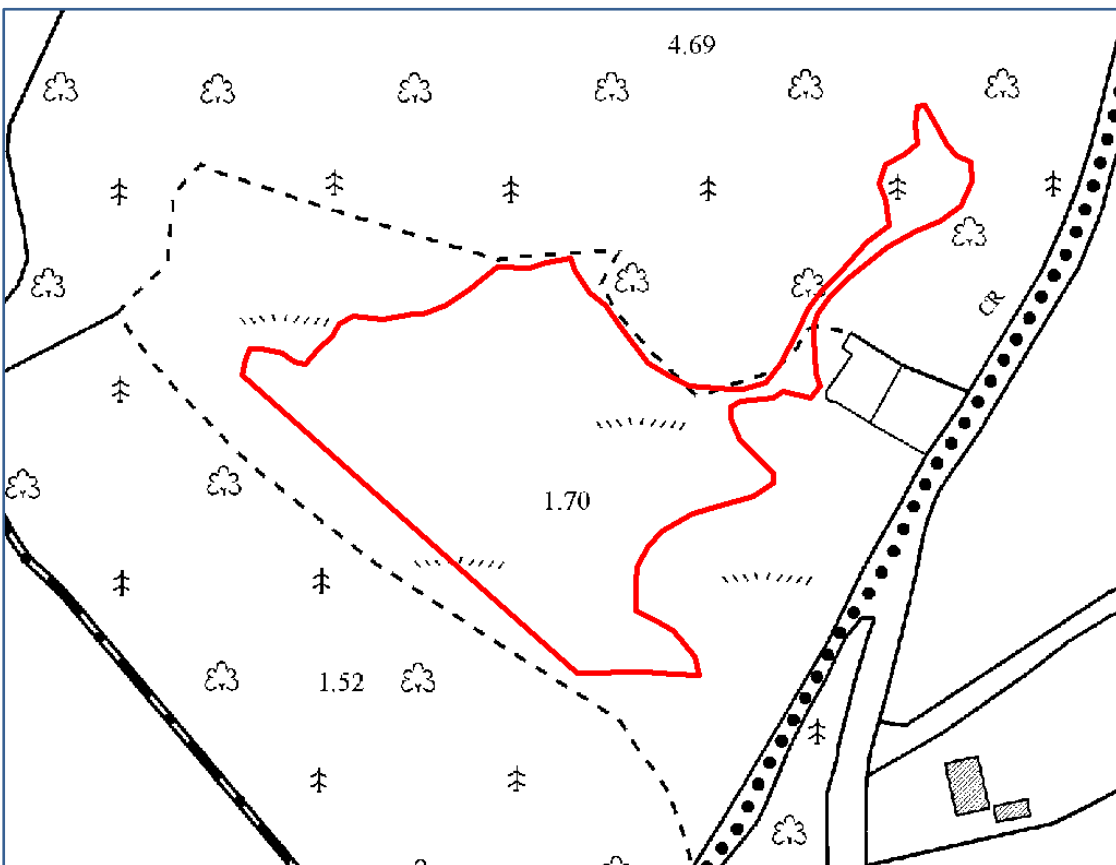


Figure 13 Ordnance Survey 1:5000 series map series, showing the mine spoil area and proposed NHA boundary (red outline) at Caim Lead Mine (Scale is ca. 1:3,000). Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.



Figure 14 Central area at Caim Lead Mine, with extensive populations of *Scopelophila cataractae* in the shaded and damp recesses of the spoil heaps. Photograph by David Holyoak.



Figure 15 Patch of *Cephaloziella nicholsonii* at Caim Lead Mine. Photograph by Neil Lockhart.

4.4 Ballycorus Lead Mine (002253)

Ballycorus is situated about 3 km west of Shankill, Co. Dublin. An open-cast lead mine began here before 1807, roughly infilled with granite blocks in about 1919. An area of open spoil still occurs, kept open by a combination of steep slope, toxicity of the spoil and erosion.

Calaminarian grassland occurs intermittently throughout, interspersed with loose bare spoil, and is dominated in most parts by *Solenostoma gracillimum*, with *Polytrichum piliferum*, *Diplophyllum albicans* and *Ceratodon purpureus* also prominent in places. Vascular plants are mostly absent, except for occasional scattered *Agrostis capillaris*. Metallophyte bryophyte interest is concentrated at the base of the slope, partially shaded by *Pinus sylvestris*, where *Ditrichum plumbicola* and *Cephaloziella massalongi* occur in small quantity.

Trees to the west shade parts of the site, including where rare species grow, and has resulted in the deposition of much needle litter and the growth of algae in bryophyte niches, which is impacting the health of *D. plumbicola*. There is an unofficial walking path through the site, and evidence of pony trekking and riding of scrambler bikes at the top and on west side of site. Burning of gorse scrub has also taken place, but has no impact on Calaminarian grassland.

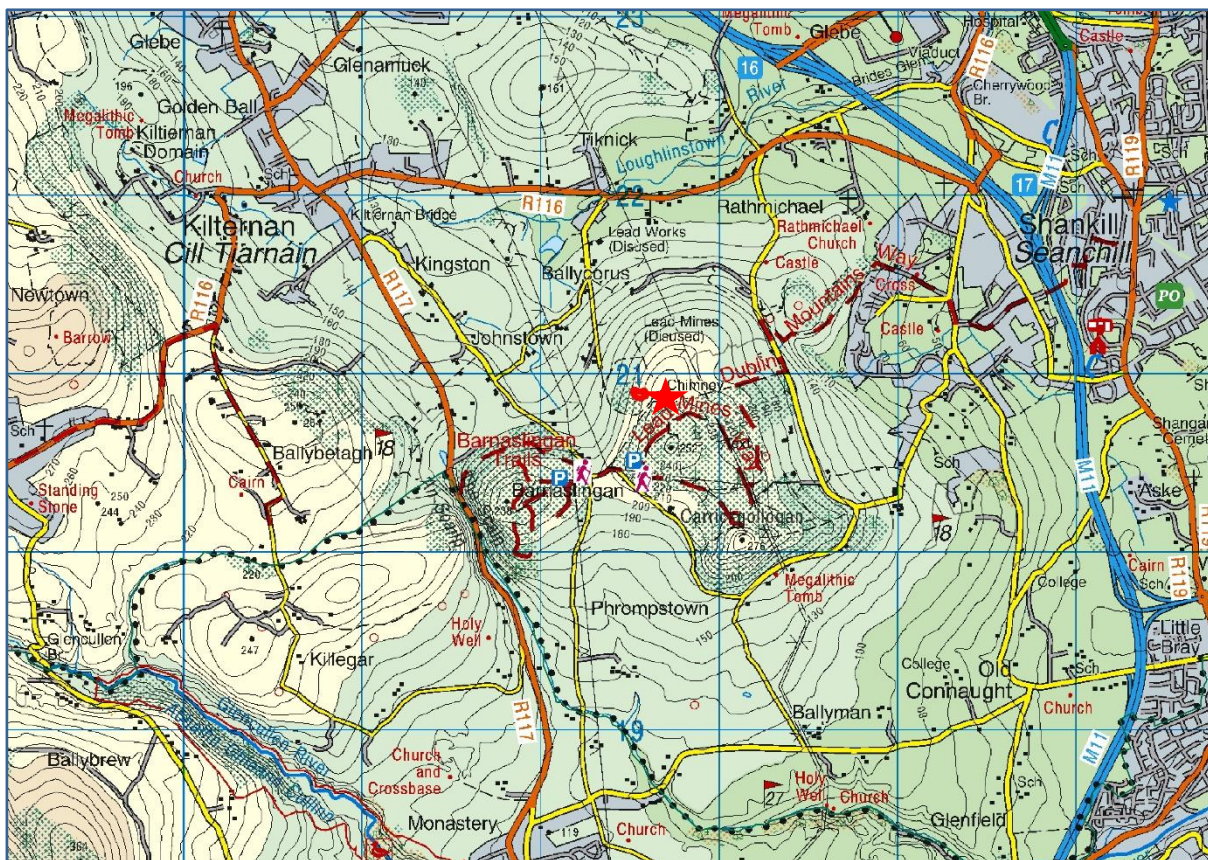


Figure 16 Ordnance Survey Discovery Map series, showing location of Ballycorus Lead Mine indicated by red star. Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.



Figure 17 Ordnance Survey Digital Globe Image 2011-2013, showing the mine spoil area (red outline) at Ballycorus Lead Mine (Scale is ca. 1:3,000). Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.

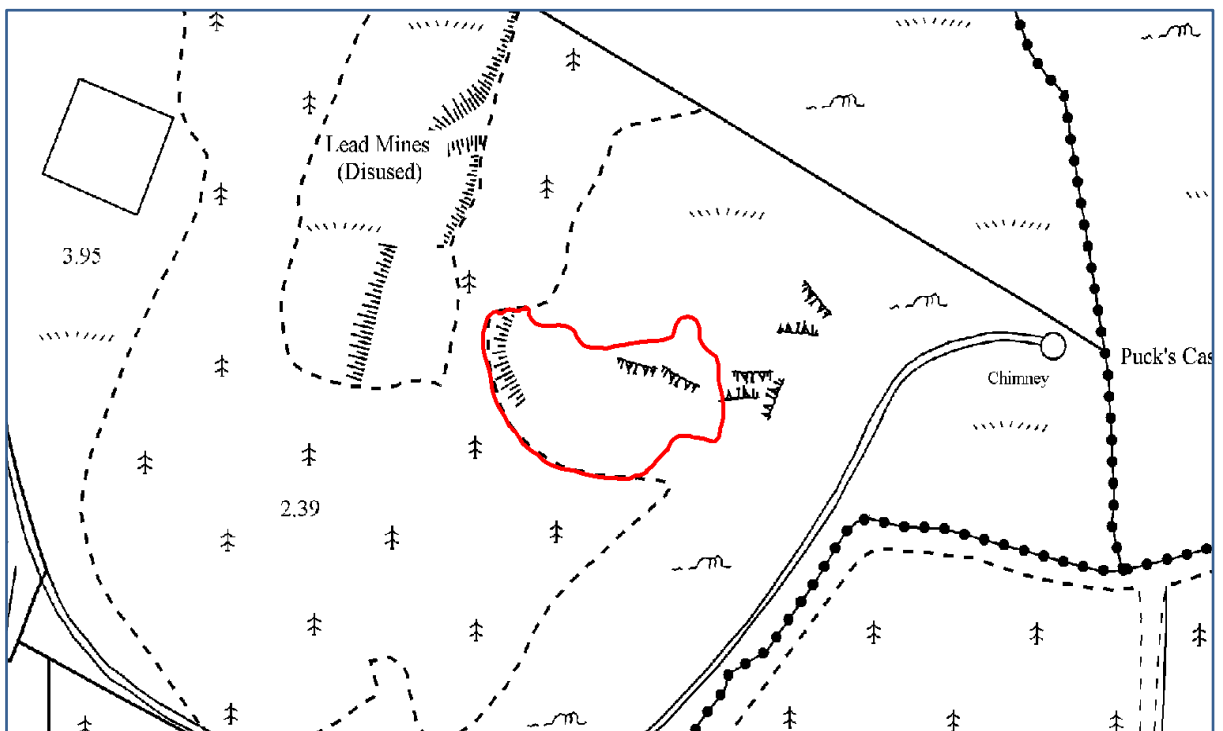


Figure 18 Ordnance Survey 1:5000 series map series, showing the mine spoil area and proposed NHA boundary (red outline) at Ballycorus Lead Mine (Scale is ca. 1:3,000). Ordnance Survey Ireland Licence No EN 0059216 © Ordnance Survey Ireland / Government of Ireland.



Figure 19 Spoil area at Ballycorus Lead Mine, looking downslope to the west, towards patch of *Cephaloziella massalongi* and the base of the site. Photograph by Neil Lockhart.

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