

A miniature world in decline

European Red List of Mosses, Liverworts and Hornworts

Nick Hodgetts, Marta Cáliz, Eve Englefield, Nicholas Fettes, Mariana García Criado, Lea Patin, Ana Nieto, Ariel Bergamini, Irene Bisang, Elvira Baisheva, Patrizia Campisi, Annalena Cogoni, Tomas Hallingbäck, Nadya Konstantinova, Neil Lockhart, Marko Sabovljevic, Norbert Schnyder, Christian Schröck, Cecilia Sérgio, Manuela Sim Sim, Jan Vrba, Catarina C. Ferreira, Olga Afonina, Tom Blockeel, Hans Blom, Steffen Caspari, Rosalina Gabriel, César Garcia, Ricardo Garilleti, Juana González Mancebo, Irina Goldberg, Lars Hedenäs, David Holyoak, Vincent Hugonnot, Sanna Huttunen, Mikhail Ignatov, Elena Ignatova, Marta Infante, Riikka Juutinen, Thomas Kiebacher, Heribert Köckinger, Jan Kučera, Niklas Lönnell, Michael Lüth, Anabela Martins, Oleg Maslovsky, Beáta Papp, Ron Porley, Gordon Rothero, Lars Söderström, Sorin Ștefănuț, Kimmo Syrjänen, Alain Untereiner, Jiri Váňa †, Alain Vanderpoorten, Kai Vellak, Michele Aleffi, Jeff Bates, Neil Bell, Monserrat Brugués, Nils Cronberg, Jo Denyer, Jeff Duckett, H.J. During, Johannes Enroth, Vladimir Fedosov, Kjell-Ivar Flatberg, Anna Ganeva, Piotr Gorski, Urban Gunnarsson, Kristian Hassel, Helena Hespanhol, Mark Hill, Rory Hodd, Kristofer Hylander, Nele Ingerpuu, Sanna Laaka-Lindberg, Francisco Lara, Vicente Mazimpaka, Anna Mežaka, Frank Müller, Jose David Orgaz, Jairo Patiño, Sharon Pilkington, Felisa Puche, Rosa M. Ros, Fred Rumsey, J.G. Segarra-Moragues, Ana Seneca, Adam Stebel, Risto Virtanen, Henrik Weibull, Jo Wilbraham and Jan Żarnowiec



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† Deceased

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Foreword

Europe has a rich natural heritage, with habitats ranging from dry Mediterranean maquis in the south to the Arctic tundra in the far north. Much of Europe's landscape has been shaped by centuries of diverse farming and forestry traditions. As a result, a large number of agricultural and semi-natural landscapes have emerged and significantly influenced the continent's biodiversity.

Biodiversity loss as a result of human impacts is one of the major challenges that the world currently faces, and this has considerably affected valuable ecosystem services. In order to halt the loss of biodiversity, the EU Biodiversity Strategy aims to protect, value and restore biodiversity and the services it provides – Europe's natural capital. This is important not only to protect nature for its own sake, but also for its essential contribution to human well-being and economic prosperity, and to avert catastrophic changes caused by biodiversity loss. After all, everyone will understand that we cannot act sustainably if we keep destroying nature.

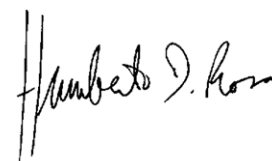
In recent years, awareness has risen surrounding the crucial role of plants in providing ecosystem services and on their decline – they are one of the essential foundations of healthy ecosystems that we depend on. However, significant gaps in knowledge still remain. In this context, *A miniature world in decline: European Red List of Mosses, Liverworts and Hornworts* provides the first-ever comprehensive assessment of the extinction risk of all native bryophyte species to Europe. With 1,817 species assessed, this assessment highlights that 22.5% of bryophyte species are threatened with extinction in Europe. Main threats to these species include land modifications such as those caused by the construction of dams and through increased frequency of fires, the impacts of climate change as well as agricultural and forestry practices, such as the conversion of natural forest to plantation woodland. While 88.2% of species are recorded in at least one protected area (whether it

is a national park, Natura 2000 site or nature reserve), eight species are already lost from Europe, and so it is clear that we continue to have a responsibility to conserve these unique species to prevent further extinctions in our region.

By comparison to European bryophytes, 2% of medicinal plants, 8% of aquatic plants, 16% of crop-wild relatives, 20% of ferns and lycopods, 42% of trees and 57% of “policy plants” (listed under European or international policy instruments) are threatened, ranking bryophytes third as the most threatened group of plant species assessed so far.

Immediate action must be taken in order to improve the status of European bryophytes. A multidisciplinary approach needs to be established; while species and protected area management are key, the proper implementation of the existing European legislation will be crucial in providing protection to the species, including the EU Birds and Habitats Directive.

I hope that this new IUCN European Red List will help place plants higher on the conservation agenda as well as inform the wider debate and contribute to the discussion on priorities within the conservation community. A network of bryophyte experts is already in place, therefore more investment in scientific research, and increasing awareness and communications will help towards the delivery of real results and positive impacts for these species.



Humberto Delgado Rosa
Director for Natural Capital
DG Environment, European Commission

Preface

This publication has been prepared by IUCN (International Union for Conservation of Nature) as a deliverable of the LIFE European Red Lists project (LIFE14 PRE BE 001). *A miniature world in decline: The European Red List of Mosses, Liverworts and Hornworts* is, therefore, a part of a series of publications released since 2015, when the project began, that also include:

- *European Red List of Lycopods and Ferns*, 2017
- *European Red List of Saprophytic Beetles*, 2018
- *European Red list of Terrestrial Molluscs: slugs, snails, and semi-slugs*, 2019
- *European Red list of Trees*, 2019
- *European Red list of Selected Endemic Shrubs*, 2019

Based on other European Red List assessments, 59% of freshwater molluscs, 40% of freshwater fishes, 28% of grasshoppers, crickets and bush-crickets, 23% of amphibians, 20% of reptiles, 20% of ferns and lycopods, 17% of mammals, 16% of dragonflies, 13% of birds, 9% of butterflies and bees, 8% of aquatic plants and 2% of medicinal plants are threatened at the European level (Allen et al., 2014; IUCN, 2015; Hochkirch et al., 2016; García Criado et al., 2017). Additional European Red Lists assessing a selection of species showed that 22% of terrestrial molluscs, 16% of crop wild relatives and 18% of saprophytic beetles are also threatened (Cuttelod et al., 2011; Bilz et al., 2011; Cáliz et al., 2018). The findings of this work suggest that 23% of bryophytes are threatened species in Europe, representing the fifth most threatened group of plants assessed so far.



Lindenberg's featherwort *Adelanthus lindenbergianus* (Endangered liverwort) © Rory Hodd

Acknowledgements

All of IUCN's Red Listing processes rely on the willingness of scientists to contribute and pool their collective knowledge to make the most reliable estimates of the status of a species. Without their enthusiastic commitment to species conservation, this kind of regional overview would not be possible. Bryophytes are no exception, and the knowledge mobilized through the Europe-wide network of members of the European Committee for the Conservation of Bryophytes (ECCB) has been pivotal to the completion of this Red List. We are therefore indebted for their support and contributions.

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The European Red List of Mosses, Liverworts and Hornworts, and consequently this publication, are required as part of a LIFE project funded by the European Commission and other donors (LIFE14 PRE BE 001 – LIFE European Red Lists). In particular, we would like to thank Frank Vassen (European Commission) and the LIFE monitors, particularly Kristijan Civic, for their support throughout the project, allowing for a smooth implementation.

Executive summary

Aim

This Red List is a summary of the conservation status of the European species of mosses, liverworts and hornworts, collectively known as bryophytes, evaluated according to IUCN's Guidelines for Application of IUCN Red List Criteria at Regional Level. It provides the first comprehensive, region-wide assessment of bryophytes and it identifies those species that are threatened with extinction at a European level, so that appropriate policy measures and conservation actions, based on the best available evidence, can be taken to improve their status.

Scope

All bryophytes native to or naturalised in Europe (a total of 1,817 species), have been included in this Red List. In Europe, 1,796 species were assessed, with the remaining 21 species considered Not Applicable (NA). For the EU 28, 1,728 species were assessed, with a remaining 20 species considered NA and 69 species considered Not Evaluated (NE). The geographical scope is continent-wide, extending from Iceland in the west to the Urals in

the east, and from Franz Josef Land in the north to the Canary Islands in the south. The Caucasus region is not included. Red List assessments were made at two regional levels: for geographical Europe and for the 28 Member States of the European Union.

Results

Overall, 22.5% of European bryophyte species assessed in this study are considered threatened in Europe, with two species classified as Extinct and six assessed as Regionally Extinct (RE). A further 9.6% (173 species) are considered Near Threatened and 63.5% (1,140 species) are assessed as Least Concern. For 93 species (5.3%), there was insufficient information available to be able to evaluate their risk of extinction and thus they were classified as Data Deficient (DD). The main threats identified were natural system modifications (i.e., dam construction, increases in fire frequency/intensity, and water management/use), climate change (mainly increasing frequency of droughts and temperature extremes), agriculture (including pollution from agricultural effluents) and aquaculture.



Exormotheca welwitschii (Endangered liverwort) © Michael Lüth

Recommendations

Policy measures

- Use the European Red List as the scientific basis to inform regional/national lists of rare and threatened species and to identify priorities for conservation action in addition to the requirements of the Habitats Directive, thereby highlighting the conservation status of bryophytes at the regional/local level.
- Use the European Red List to support the integration of conservation policy with the Common Agricultural Policy (CAP) and other national and international policies. For example, CAP Strategic Plans should include biodiversity recovery commitments that could anticipate, among others, the creation of Important Bryophyte Areas. An increased involvement of national environmental agencies in the preparation of these strategic plans, and more broadly in ongoing discussions on the Future CAP Green Architecture, would likely also ensure the design of conservation measures better tailored to conserve bryophytes in agricultural landscapes.
- Update the European Red List every decade to ensure that the data remains current and relevant.
- Develop Key Biodiversity Areas for bryophytes in Europe with a view to ensuring adequate site-based protection for bryophytes.

Research and monitoring

- Use the European Red List as a basis for future targeted fieldwork on possibly extinct and understudied species.
- Establish a monitoring programme for targeted species (for example, threatened species and/or arable bryophytes).
- Use the European Red List to obtain funding for research into the biology and ecology of key targeted species.

Action on the ground

- Use the European Red List as evidence to support multi-scale conservation initiatives, including designation of protected areas, reform of agricultural practices and land management, habitat restoration and rewilding, and pollution reduction measures.
- Use the European Red List as a tool to target species that would benefit the most from the widespread implementation of the solutions offered by the 1991 Nitrates Directive (Council Directive 91/676/EEC), including the application of correct amounts of nutrients for each crop, only in periods of crop growth under suitable climatic conditions and never during periods of heavy rainfall or on frozen ground, and the creation of buffer zones to protect waters from run-off from the application of fertilizers.

Ex situ conservation

- Undertake ex situ conservation of species of conservation concern in botanic gardens and spore and gene banks, with a view to reintroduction where appropriate.

1. Background

1.1 The European context

Europe is the world's second smallest continent in terms of area after Australia, covering approximately 10.4 million km², or 2% of the Earth's surface. In terms of human population, Europe is the third largest continent (after Asia and Africa) with a population of around 546 million (UN DESA, 2018) – about 13% of the world's population. Therefore, Europe is one of the smallest and one of the most densely populated continents in the world.

The European Union (EU), consisting of 28 Member States (EU 28), is Europe's largest political and economic entity. The ecological footprint of the EU 28 has been estimated to exceed the region's biological capacity (the total area of cropland, pasture, forest, and fishing grounds available to produce food, fibre and timber, and absorb waste) by 2.6 times (EEA, 2015).

Europe has a great diversity of landscapes and habitats and a wealth of flora and fauna. For example, the Mediterranean Basin, which is especially rich in plant and animal species, many of them endemic to that region, has been recognised as a global biodiversity hotspot (Mittermeier et al., 2004; Cuttelod et al., 2008).

The European continent has a highly fragmented landscape, and up to 80% of land in Europe is currently used for settlement, industry, production systems (including agriculture and forestry) and infrastructure (EEA, 2006; Pedrolí & Meiner, 2017). Consequently, European species are to a large extent dependent upon habitats created and maintained by human activity, and many are affected by overexploitation, pollution and the impacts of invasive alien species. Additionally, climate change is becoming an increasingly serious threat. Europe is a diverse region and the relative importance of different threats varies widely across its biogeographic regions and countries.

Although considerable efforts have been made to protect and conserve European habitats and species (see Sections 4.1 and 4.2), and the Natura 2000 network of protected areas covers more than 18% of the EU terrestrial territory, biodiversity decline and the associated loss

of vital ecosystem services (such as water purification, pollination, flood protection and carbon sequestration) continues to be a major concern in the region.

1.2 European mosses, liverworts and hornworts

Bryophytes are a large, diverse group of plants. According to Villareal et al. (2010), there are between 18,000 and 23,000 described species worldwide, comprising about 11,000-13,000 mosses, 7,000-9,000 liverworts and 200-250 hornworts, making them second only to flowering plants in terms of species richness. This could, however, be an underestimate, with molecular studies revealing 'new' species all the time. Each of the three groups of bryophytes has been traditionally considered to be a separate phylum (or division): Bryophyta (mosses), Marchantiophyta (liverworts) and Anthocerotophyta (hornworts) (Frey & Stech, 2009), although the latest evidence, with increasing support, suggests that mosses and liverworts form a clade, termed "Setaphyta" (Puttick et al., 2018). Nevertheless a number of biological and ecological characters are common to the three groups: They are small (rarely larger than a few centimeters), unable to produce lignin (they cannot become woody), have their life cycle dominated by the gametophyte (rather than the sporophyte) generation – see Box 1 - and are able to dry out completely in dry periods, quickly resuming their metabolism when rewetted. They fulfill a range of important ecological functions, particularly in water retention, soil-building and in their relationships with other organisms. For example, bog-moss (*Sphagnum* spp.) is one of the most important plants, and certainly the most important peat producer in the world, locking away an enormous amount of carbon and holding vast quantities of water: bogs are essentially huge sponges. Bryophytes, particularly epiphytes, are also great indicators of air pollution. Bryophytes show a vast range of specific sensitivity and visible symptoms to pollutants greatly exceeding that of higher plants (Govindaparyi et al., 2010).

Mosses

The most species-rich of the three main groups of bryophytes, mosses, encompasses a wide range of forms. 'Typical' mosses (class Bryopsida) are mostly small,

Box 1 - The life history of bryophytes

What distinguishes bryophytes collectively from all other land plants is that their life cycle is dominated by the gametophyte generation; that is, by the haploid or sexual phase, as opposed to the diploid, spore-producing phase. In contrast, all flowering plants, conifers and ferns are dominated by the sporophyte generation, with the gametophyte much reduced, often to just a few cells. In other words, the main plant that one sees, the leafy green part, that is mainly photosynthetic, is the gametophyte in bryophytes, whereas it is the sporophyte in all other plants. The bryophyte sporophyte is usually reduced to a spore-producing, stalked capsule that remains attached to the gametophyte, and is entirely dependent on it for sustenance.

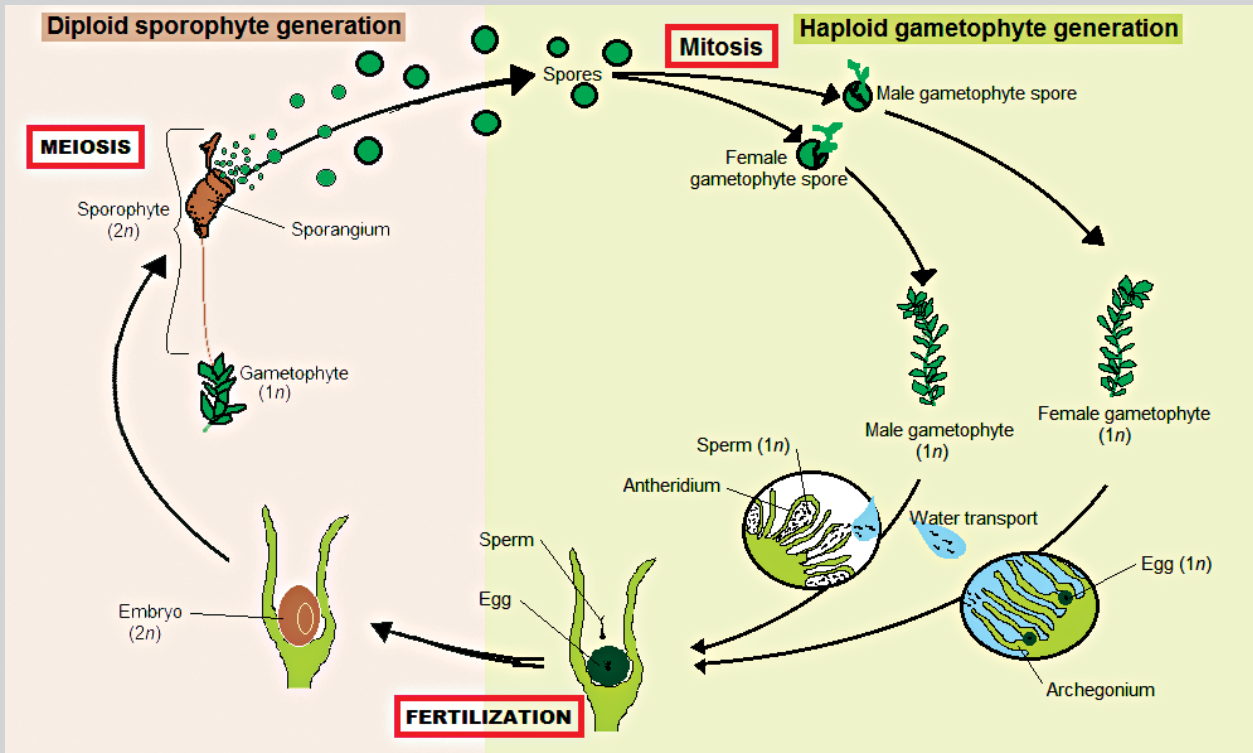


Figure 1. The life cycle of a bryophyte © MADBRYO initiative

The spore is the first stage in the haploid gametophyte generation, with a single set of unpaired chromosomes. Spores germinate into a green protonema, from which the mature gametophyte grows, either producing a structure with a stem and leaves (as in mosses and leafy liverworts) or a structure with no differentiation, usually a flat plate of tissue called a thallus (as in thallose liverworts and hornworts). The gametophyte produces (either on the same plant [bisexual, Figure 1] or on separate plants [unisexual, Fig. 1]) male and female sex organs (antheridia and archegonia, respectively). The antheridia produce sperm, which swim in a film of water to the archegonia. In each archegonium only a single egg cell is found which may be fertilized by a sperm cell. If fertilization has been successful, i.e. if male and female elements of the gametophyte have fused, a new sporophyte starts to develop. The sporophyte relies largely on the gametophyte for its nutrition. At maturity it eventually produces spores by the process of meiosis, the kind of cell division that halves the number of chromosomes. In other words, the brief reign of the sporophyte is over, and a new gametophyte generation is ready to develop.

While there is a lot of variation in the detail of how bryophytes conduct their life cycle, they all conform to this basic pattern. In addition, many of them produce specialised asexual reproductive organs, such as gemmae, which circumvent the sporophyte generation entirely, simply replicating the gametophyte parent. In addition, all bryophytes are to some extent totipotent: they can regenerate from fragments, or even single cells, making them great survivors.

rather delicate, often translucent plants that absorb water and nutrients externally, over their entire surface. The sporophyte consists of a capsule in which the spores are produced supported by a stalk (seta). When mature, the capsule releases its spores through an opening at the top, which is usually surrounded by a ring of tooth-like structures (the peristome).

Not all mosses conform to this general template. There are a few groups of mosses that are so distinctive they are put in their own classes within the Bryophyta. Most obviously, and certainly most importantly, are the bog-mosses, the genus *Sphagnum* (class Sphagnopsida) with 61 species in Europe. They differ from typical mosses in almost every respect, except for the dominance of the gametophyte generation. Its unique cell structure allows *Sphagnum* to take up water quickly by capillary action, and release it only very slowly, like a sponge.

Other features of its physiology and morphology make it possible for *Sphagnum* to dominate entire landscapes, as in the extensive boglands of northern Europe, which store tremendous amounts of peat built by thousands of years of *Sphagnum* growth.

A further oddity among the mosses is *Andreaea* (rock-moss, class Andreaeopsida), tiny black or very dark red-brown tufts on acid rocks in the mountains, with a capsule that splits into four lobes joined at the top, a bit like a miniature Japanese lantern. Then there are the haircap mosses, the genus *Polytrichum* and its allies (class Polytrichopsida). As well as having a distinctive spore capsule, these plants have an internal conduction system somewhat analogous to the xylem and phloem of vascular plants, enabling them to grow much bigger than 'ordinary' mosses, and shoots of *Polytrichum* are capable of attaining heights of half a metre or even more.



A) Five-ranked Bog-moss *Sphagnum quinquesarium* (Least Concern moss) © Christian Schröck, B) snow rock-moss *Andreaea nivalis* (Near Threatened moss) © Michael Lüth, C) *Polytrichum commune* (Least Concern moss) © Fred Rumsey, D) *Oedipodium griffithianum* (Near Threatened moss) © Vladimiar Fedosov

Another couple of small classes, the Oedipodiopsida and the Tetraphidopsida, differ fundamentally from the Bryopsida in features of the sporophyte, but have few species.

Liverworts

A less species-rich group than mosses, yet showing a greater range of forms, liverworts can be subdivided into leafy (class Jungermanniopsida) and thallose (class Marchantiopsida), plus a group of rather anomalous plants that show features of both leafy and thallose liverworts (class Haplomitriopsida, with only a single species in Europe).

Leafy liverworts are especially diverse in the form of the leaves, which range from entire and rounded, through simply bilobed or trilobed, to deeply divided into filaments or asymmetrically divided so that one lobe is larger than the other, or even modified into a tiny pocket or helmet-shaped structure. Furthermore, while leafy liverworts typically have two rows of main (lateral) leaves running down opposite sides of the stem, many species have an additional row of leaves on the under-surface of the stem (underleaves, or amphigastria): these are usually smaller than the lateral leaves, and often quite different in shape.

The form of the sporophyte is relatively uniform among the liverworts, although there is great variation in the various gametophytic structures that support and protect it. Unlike mosses, where the spore capsule and seta mature slowly together, and then spores are released gradually, the liverwort capsule matures inside a protective sheath (usually a structure derived from modified leaves

called a perianth), and is raised up on a seta only when ready to release its spores. The seta therefore grows at a tremendously fast rate, by sudden elongation of its cells, and forms a delicate, ephemeral structure which lasts just long enough for the mature capsule to release all its spores at once.

Hornworts

The least species-rich group of bryophytes, the hornworts, superficially resemble thallose liverworts, but are not closely related. They probably emerged as a group at about the same time as the other bryophytes, in the Ordovician period about 470 million years ago, or even earlier (Morris et al., 2018), but whether they were even then part of the same taxonomic group as other bryophytes is still a matter for research. They have an unusual combination of features, some shared with other bryophytes, some having more in common with vascular plants or algae. For example, the thallus cells contain just one large chloroplast, while the sporophyte, which is a long narrow structure with no differentiation into seta and capsule, has stomata. Hornworts reach their greatest diversity in the tropics, with only a small handful of species occurring in Europe. Nonetheless, certain species can be locally abundant given the right conditions.

Distribution, habitats and ecology

Bryophytes occur on all continents and in many different habitats except in the sea. They are almost ubiquitous, growing even in very dry semi-deserts, but require some moisture, at least at some stages of their life cycle. Unlike vascular plants, most species are poorly equipped to regulate their water content internally, instead drying out and rewetting rapidly according to external conditions



A) *Mannia triandra* (Vulnerable liverwort) © Christian Schröck, B) *Phaeoceros carolinianus* (Near Threatened hornwort) © Michael Lüth



Grimmia mollis (Vulnerable moss) © Michael Lüth

(poikilohydric). This means that they are often luxuriant in moist forest and in high rainfall areas. Bryophytes absorb water, along with the minimal amounts of nutrients they require, over their entire surface from the surrounding environment, rather than taking it up through roots and a vascular system. However, many bryophytes, and most of the European bryophytes, have a physiology that allows them to dry out completely in the absence of moisture, suspend physiological activity, and then ‘come back to life’ when wetted again. Different species do this to different degrees, but herbarium specimens of the great hairy screw-moss (*Syntrichia ruralis*) were recently found to have retained their vitality after over 20 years dried in a packet (Stark et al., 2016), and there are unsubstantiated anecdotes about much longer periods of survival in the herbarium. Many species which grow directly on rock in exposed conditions (*Grimmia*, *Didymodon*, etc.) dry out and rehydrate virtually on a daily basis, particularly in warmer climates; this is their strategy for enduring drought. This contrasts with most vascular plants, which could not survive this level of dehydration.

Bryophytes have several ecological attributes that are very distinctive:

- They are poikilohydric, i.e., they dry out and rewet rapidly according to external conditions.
- They grow in ‘microhabitats’: whether they grow in woodland, heathland or grassland is less important

than the immediate micro-environment, such as a rock crevice or a moist patch of soil.

- A large proportion of species are colonists, and therefore form pioneer communities and assemblages. There are, for example, many short-lived ruderal (weedy) species that colonise bare ground, disappearing as vegetational succession proceeds.
- Many species are very efficient at dispersal, with spores and vegetative propagules potentially capable of travelling worldwide in the air or via vectors such as migratory birds.
- Due to the latter, levels of endemism are low (in Europe, ca. 10% compared to ca. 28% vascular plants; Patino & Vanderpoorten, 2018), but levels of disjunction are high (for example, a species may occur in western Europe, the Himalayas and British Columbia).
- Those species that are less efficient at dispersal often have large spores that can remain viable in the soil for a long time.
- They are often excellent ecological indicators (for example, of nutrient status or pH).

Ecosystem services and commercial use

The ecosystem services that bryophyte species provide might not be conspicuous, but investigation soon shows us that these small plants, useless as food or building materials, are actually of vital importance. In particular, there are three main features of bryophytes that make them important in the ecosystem:

- Their ability to retain water. All bryophytes act to some extent as sponges, taking up water rapidly, holding it, and releasing it only slowly. This is most obvious in bog-moss *Sphagnum*, which dominates vast areas of mire in northern Europe. On hillsides and hilltops, *Sphagnum* is an important stabilising influence in areas with heavy rainfall. A similar effect is seen in forest ecosystems. A substantial part of the water-holding capacity of forests is bound up in the bryophytes, and when it is clear-felled, the resultant erosion, flooding and destabilisation is at least partly because the bryophytes have been removed from the landscape along with the trees.
- They are efficient colonisers and stabilisers of bare substrates. When natural erosion occurs, bryophytes are usually the first plants to appear on the newly exposed surfaces. After volcanic eruptions, bryophytes are the first to colonise the cooling lava flows. In post-industrial landscapes, and in urban habitats more generally, bryophytes often build up thick carpets over crumbling concrete and tarmac, trapping detritus, building new soils, providing rooting substrates for larger plants and ultimately the basis for entire new ecosystems.
- They serve as hosts for blue-green algae (cyanobacteria), which have an important role in nitrogen (N)

fixation, and provide a major source of N for boreal ecosystems (for example, Ackerman, 2013). It is likely that epiphytic cyanobacteria are a key factor in determining the abundance of feather mosses across the boreal biome (Zackrisson et al., 2019).

Additionally, they provide habitats for other organisms; seed-beds for vascular plants, shelter and food for invertebrates, nesting material for birds and small mammals. Bogs in particular form entire ecosystems fundamentally dependent on bryophytes.

Sphagnum mosses are used commercially - peat is (or has been, historically) burned for fuel. However, this has rarely been done in a sustainable way, and several countries have established peat-burning power stations, which have had a devastating effect on peatlands. It has also been used as a mildly antiseptic dressing for wounds (it was harvested for this purpose during the First World War), and as an absorbent material in babies' nappies. Bryophytes are harvested commercially (sustainably or otherwise) for horticultural purposes such as packing material for bulbs or a water-retentive substrate for hanging baskets. *Sphagnum* harvested for horticultural purposes is also not usually sustainable. A more modern use is that of mosses, particularly the Habitats Directive



The procession of 'moss men' in Béjar, Spain, commemorating the use of moss as camouflage in battles during the 12th century by local Christians © Eloy Díaz-Redondo

Annex V *Leucobryum*, for ‘moss walls’ and other ‘green’ architectural purposes. Other commercial uses are largely historical or minor: *Polytrichum commune* for brooms, mosses as insulation for homes, decorative garlands and even clothing for the famous ‘moss men’ of Béjar in Spain.

1.3 Assessment of species extinction risk

The conservation status of plants, animals and fungi is one of the most widely used indicators for assessing the condition of ecosystems and their biodiversity. At the global scale, the primary source of information on the extinction risk of plants and animals is *The IUCN Red List of Threatened Species*TM (www.iucnredlist.org), which contributes to understanding the conservation status of assessed species.

The *IUCN Red List Categories and Criteria* (IUCN, 2012a) are designed to determine the relative risk of extinction of a taxon, with the main purpose of cataloguing and highlighting those taxa that are facing a high risk of extinction. The IUCN Red List Categories are based on a set of quantitative criteria linked to population trends, size and structure, threats, and geographic ranges of species. When conducting regional or national assessments, the IUCN Red List Regional Guidelines (IUCN, 2012b) are applied to assign the IUCN Red List Categories (Figure 2).

As the extinction risk of a species can be assessed at global, regional or national levels, a species may have a different Red List Category on the global Red List than on the regional Red List. Logically, an endemic species should have the same Category at regional and global levels, as it is not present anywhere else in the world.

1.4 Objectives of the assessment

The European Red List of Mosses, Liverworts and Hornworts has four main objectives:

- to contribute to regional conservation planning through provision of a baseline dataset reporting the conservation status of European bryophyte species;
- to identify those priority geographic areas and habitats needing to be conserved to prevent extinctions and to ensure that European bryophytes reach and maintain a favourable conservation status;
- to identify the major threats and to propose potential mitigating measures and conservation actions to address them;
- to strengthen the network of experts focused on bryophyte conservation in Europe, so that the assessment information can be kept current and expertise can be targeted to address the highest conservation priorities.

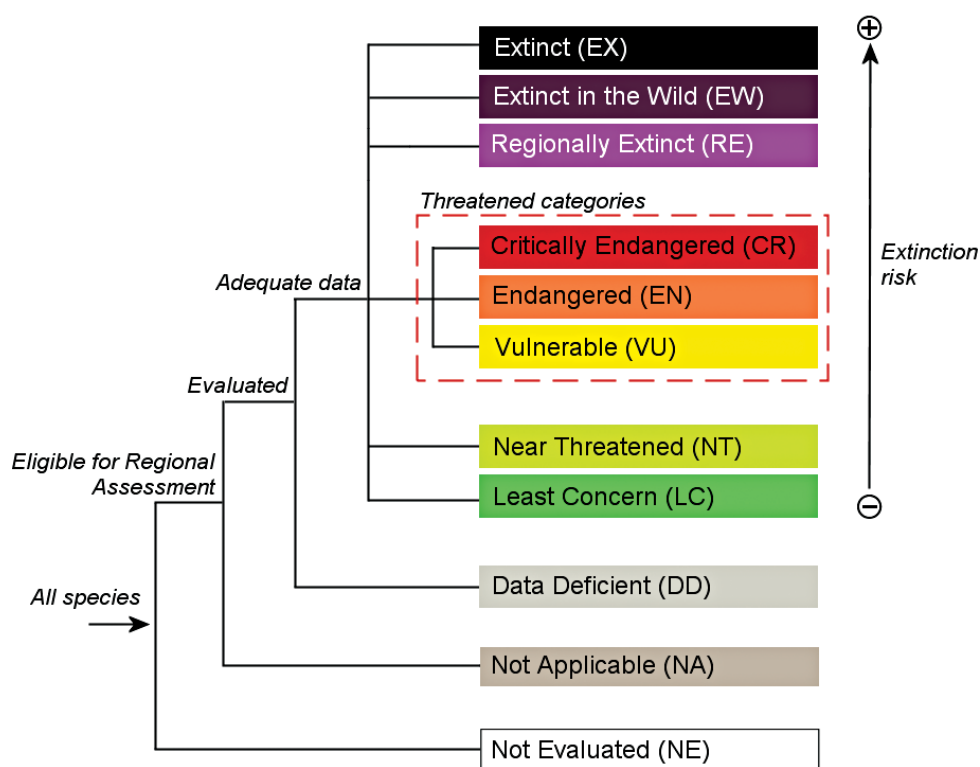


Figure 2. The IUCN Red List Categories at the regional scale.

The assessment provides three main outputs:

- summary reports on the status of all 1,817 European bryophyte species;
- a freely available database holding the baseline data on the status and distribution of European bryophytes;
- a website and data portal (<http://ec.europa.eu/environment/nature/conservation/species/redlist> and www.iucnredlist.org/initiatives/europe) showcasing these data in the form of species factsheets for all

European bryophytes included in this study, along with background and other interpretative material.

- This Red List provides the first comprehensive, region-wide assessment of bryophytes and builds on the previous work of the European Committee for the Conservation of Bryophytes (ECCB). The enormous amount of new fieldwork, data and knowledge accumulated since then means that it should be much more robust and authoritative. Efforts will continue to update the database which will also be made freely and widely available.



Matted bryum *Bryum calophyllum* (Endangered moss) © Neil Lockhart

2. Assessment methodology

2.1 Geographic scope

The geographic scope is continent-wide, extending from Iceland in the west to the Urals in the east (including European parts of the Russian Federation), and from Franz Josef Land in the north to the Mediterranean in the south (Figure 3). The Canary Islands, Selvagens, Madeira, the Azores, Malta and Cyprus are also included. In the southeast, the Caucasus region and Anatolia are excluded.

Red List assessments were made at two regional levels: 1) for geographical Europe (limits described above); and 2) for the area of the 28 Member States of the European Union (EU 28) (as of 2018).

2.2 Taxonomic scope

The European Red List of Mosses, Liverworts and Hornworts has assessed the status of all bryophyte species

considered native to or naturalised in Europe. The original list of species was based on Hodgetts (2015), which was in turn based on Hill et al. (2006) for the mosses and Söderström et al. (2007) for the liverworts and hornworts. The inclusion of newly described or species which have undergone taxonomic change (up to the end of 2018) was undertaken following consultation with the relevant experts. When there were discrepancies in the identity of a species, consultation was sought among the different specialists and decisions were made through consensus.

2.3 Assessment protocol

For all the bryophyte species assessments, the following data were compiled:

- taxonomic classification and notes
- geographic range and list of countries of occurrence (including a range map)



Figure 3. European assessment boundaries: regional assessments were made for two areas: geographical Europe and the EU 28.

- population information and overall population trends
- habitat preferences and primary ecological requirements, including pertinent biological information (for example, generation length, maximum size and age, etc.)
- species use and trade
- major threats
- research needs
- conservation measures (in place and needed)
- IUCN Red List Category and Criteria and rationale
- key literature references

Some critical terms like ‘mature individual’, ‘generation length’, and ‘severely fragmented’ had to be interpreted in a pragmatic way so that they became applicable to bryophytes. Work over several years (for example, Hallingbäck et al., 1998) and collaboration with the IUCN under this project, has culminated in a paper addressing these issues (Bergamini et al., 2019)¹.

The task of collecting the initial data was divided geographically between 11 Assessors (Appendix 1), and information on each species was based on published and unpublished data and expert knowledge. The IUCN Species Information Service (SIS) was used to enter and store all species data.

A training workshop was held in October 2015 in Paris (France) in order to train the experts on the IUCN Red List methodology. After the preliminary information was collected by the Lead Assessors, five assessment workshops were held to review and discuss the assessments and distribution maps, add new information to the assessments, and agree on the final IUCN Red List Category and Criteria for each species. The workshops took place at the Faculty of Sciences of the University of Lisbon (Portugal; December 2016), the Ministry of Environment of the Czech Republic (Prague; January 2017), the IUCN European Regional Office in Brussels (Belgium; February 2017), the National Botanical Gardens of Ireland (Dublin; April 2017), and ArtDatabanken at the Swedish University of Agricultural Sciences (Uppsala, June 2017). In addition, some discussions on the methodology were held at an external workshop in Ekenäs (Sweden). Overall, 60 experts participated in the assessment workshops.

¹ The recommendations from this paper will need to be formally considered by the IUCN SSC Red List Standards and Petitions Committee, and if approved, incorporated into a future update of the Red List Guidelines. For the purposes of this project and for the publication of the assessments on the IUCN Red List website, the modified approach has been provisionally approved.

Following the workshops, the information was edited and any remaining questions were resolved through communications with the Lead Assessors. An additional peer-review process was carried out, with all assessments checked by external Reviewers who had not been previously involved in the assessment process. Consistency in the use of IUCN Categories and Criteria was systematically checked by IUCN staff. The resulting finalised IUCN Red List assessments are a product of scientific consensus concerning species status and are supported by relevant literature and data sources (see example in Appendix 2). The final list of species is found in Appendix 3.

2.4 Species mapping

Distribution data were mainly obtained from published literature, herbarium specimens, internet sources (for example, GBIF) and several global and regional citizen science projects. The species experts provided the distribution data to the Ministry of Environment of the Czech Republic (MZP) where Jan Vrba compiled the data in order to produce the final distribution maps.

Range maps were created using the distribution data available, which varied in terms of quality; for some regions, distributional data were available as point locality data (latitude/longitude) or in grid cell format, and were therefore spatially precise. Where point or grid data were available, these were projected in a Geographical Information System (GIS) (ESRI ArcMap). Polygons were then drawn manually, clustering occurrence data where appropriate. In some rare cases where no point data was available and it was only possible to assign presence at the country level, the distribution was mapped for the whole country.

The spatial analyses presented in this publication (see section 3.3) were done using a geodesic discrete global grid system, defined on an icosahedron and projected to the sphere using the inverse Icosahedral Snyder Equal Area (ISEA) Projection (S39). This corresponds to a hexagonal grid composed of individual units (cells) that retain their shape and area (864 km²) throughout the globe. These are more suitable for a range of ecological applications rather than the most commonly used rectangular grids (S40). The known current distributions (IUCN, 2014) of extant and possibly extant species were converted to the hexagonal grid for the purposes of the analysis. Coastal cells were clipped to the coastline.

3. Results

3.1 Threat status

At the European level, 22.5% of bryophyte species are considered threatened (i.e., assessed as having an elevated risk of extinction). However, the proportion of threatened species is uncertain given the number of Data Deficient (DD) species and could lie between 21.4% (if all DD species are not threatened) and 26.6% (if all DD species are threatened) for Europe (IUCN, 2011; Table 1). The mid-point figure provides the best estimation of the proportion of threatened species (IUCN, 2011). In the EU 28, 24.3% of species are considered to be threatened, with the proportion of threatened species lying between 23.1% (if all DD species are not threatened) and 27.9% (if all DD species are threatened, Table 1). Appendix 3 provides an exhaustive list of all bryophyte species assessed under the current European Red List and corresponding conservation status in Europe, EU28 also indicating if the species is endemic or not to Europe.

In Europe, six species (0.3%) are assessed as Regionally Extinct, with two endemic species assessed as Extinct (0.1%). 59 species (3.3%) are Critically Endangered, 143 species (8%) are Endangered, and 180 species (10%) are Vulnerable (Table 2). A further 173 species (9.6%) are classified as Near Threatened. For 93 species (5.2%) there were insufficient data to evaluate their risk of extinction and so they were classified as Data Deficient (Table 2, Figure 4). There were 21 species that were classed as Not Applicable in Europe (species introduced after AD 1500 or species of marginal occurrence). As more data become available and taxonomic issues are clarified, it is possible that some of these species may also prove to be threatened.

In the EU 28, six species (0.3%) are assessed as Regionally Extinct, two are assessed as Extinct (0.1%). 65 species

(3.8%) are Critically Endangered, 150 species (8.7%) are Endangered, and 183 species (10.6%) are Vulnerable. A further 173 species (10%) are classified as Near Threatened. For 82 species (4.8%) in the EU 28 there were insufficient data to evaluate their risk of extinction and so they were classified as Data Deficient (Table 2, Figure 4). Not Evaluated refers to species occurring at the European level that did not occur within the EU Member States (for example, only occurs in European Russia).

3.2 Status by taxonomic group

Table 3 presents the status of European bryophyte species organised by major group, split into mosses, liverworts and hornworts. It is not considered useful to break it down further into orders or families because the higher classification of bryophytes is continually changing with ongoing research. A stable consensus on the higher classification of bryophytes will probably not be reached for several years. There are many more species of mosses (1,327) than liverworts (461) and hornworts (8) in Europe.

The percentages of species in different threat categories are similar for mosses and liverworts. This similarity may reflect the fact that there is nothing particularly distinctive about their ecology or distribution that may influence extinction risk. Instead, different life strategies and ecologies are spread widely throughout both liverworts and mosses, with plants in closely related genera and families often having quite different ecological requirements. The percentage figure for hornworts cannot be directly compared with that for mosses or liverworts because there are only eight species occurring in Europe. Of these, only two species are considered endangered in Europe.

Table 1. Proportion of threatened mosses, liverworts and hornworts in Europe and EU 28.

	Europe % species threatened	EU 28 % species threatened
Lower bound (CR+EN+VU) / (assessed – EX)	21.4	23.1
Mid-point (CR+EN+VU) / (assessed – EX – DD)	22.5	24.3
Upper bound (CR+EN+VU+DD) / (assessed – EX)	26.6	27.9

Table 2. Summary of numbers of mosses, liverworts and hornworts within each Red List Category. Numbers of endemic species are shown in brackets

IUCN Red List Categories	No. species Europe (no. endemic species)	No. species EU 28 (no. endemic species)
Extinct (EX)	2 (2)	2 (2)
Extinct in the Wild (EW)	0 (0)	0 (0)
Regionally Extinct (RE)	6 (0)	6 (0)
Critically Endangered (CR)	59 (18)	65 (15)
Endangered (EN)	143 (40)	150 (28)
Vulnerable (VU)	180 (36)	183 (25)
Near Threatened (NT)	173 (33)	173 (22)
Least Concern (LC)	1140 (45)	1067 (13)
Data Deficient (DD)	93 (17)	82 (11)
Total number of species analysed	1,796 (191)	1,728 (116)
Not Applicable (NA)	21 (0)	20 (0)
Not Evaluated (NE)	-	69 (0)
Total number of species considered	1,817 (191)	1,817 (116)

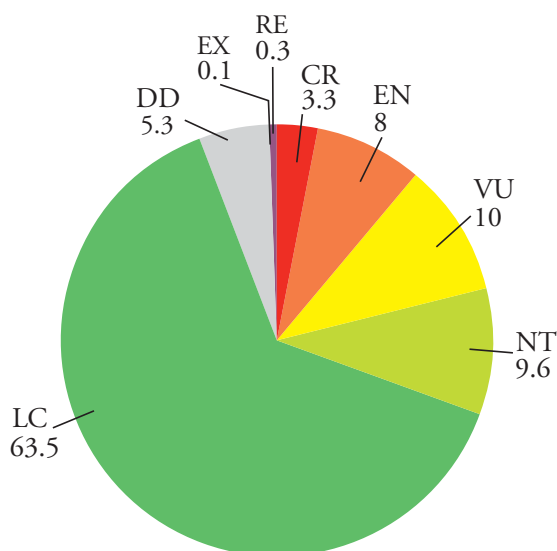


Figure 4. IUCN Red List status of mosses, liverworts and hornworts in Europe.

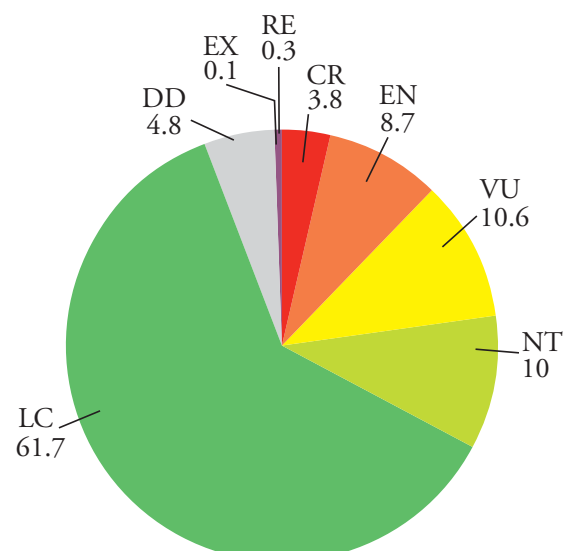


Figure 5. IUCN Red List status of mosses, liverworts and hornworts in the EU 28.

Table 3. IUCN Red List status (at the European level) of mosses, liverworts and hornworts.

	Total	CR	EN	VU	NT	LC	DD	EX or RE	Best estimate of % threatened*
Mosses	1,327	43 (3.2%)	103 (7.8%)	137 (10.3%)	120 (9.0%)	853 (64.3%)	64 (4.8%)	7 (0.5%)	22.5
Liverworts	461	16 (3.5%)	38 (8.2%)	43 (9.3%)	51 (11.1%)	283 (61.4%)	29 (6.3%)	1 (0.2%)	22.5
Hornworts	8	0	2 (25.0%)	0	2 (25.0%)	4 (50.0%)	0	0	25.0
Total	1,796	59 (3.3%)	143 (8.0%)	180 (10.0%)	173 (9.6%)	1,140 (63.5%)	93 (5.2%)	8 (0.4%)	22.5

*The percentage of threatened species provides the mid-point figure as the best estimation of extinction risk. In addition, 21 NA species were not included in this table.



False dog-tooth *Cynodontium fallax* (Near threatened moss) © Tomas Hallingbäck



Polytrichum juniperinum (Least Concern moss) © Lars Hedenäs

3.3 Spatial distribution of species

3.3.1. Species richness

The geographic distribution of bryophyte richness in Europe is shown in Figure 6 and is based on all native and naturalised species (post 1500 AD) with extant and possibly extant occurrence (1,796 species).

The areas with the highest species richness include central Europe, namely mountainous areas in the Alps, and to some degree in Scandinavia, Scotland, Wales, Pyrenees, and Eastern Europe, including the Carpathians. Species richness gradually declines towards the south and the east of Europe. It is clear that mountainous areas score most highly in terms of species richness. While there is some overlap of species, each of these areas has its own distinctive character, with the Scottish mountains, for example, supporting a high diversity of Atlantic species, in contrast to the Austrian Alps, where the flora is more continental (see Box 2).

3.3.2. Endemic and near-endemic species richness

In Figure 7, the richness of endemic European bryophyte species is shown based on the presence of 184 species (the

analysis does not include species where their presence is uncertain).

The incidence of endemic species is fairly constant throughout most of Europe, with an increase in hyperoceanic and mountainous areas, particularly Macaronesia. Levels of endemism are low in bryophytes, relative to vascular plants, although recent studies are revealing an increasing number of previously unrecognised endemic species (for example, Carter *et al.*, 2016, Patino & Vanderpoorten, 2018). It is therefore more instructive to look at areas where there is high diversity and large numbers of ecologically specialised, disjunct and near-endemic species. Thus, the hyperoceanic parts of Europe, including Macaronesia, western Britain, Ireland, Norway, France (Brittany) and north-western Spain, support rich communities of oceanic species, few of which are endemic (except in Macaronesia) but many are globally rare and disjunct, elsewhere occurring only in widely-spaced but climatically similar areas, such as Yunnan in China and British Columbia in Canada (for example, Blockeel *et al.*, 2014). This is largely because of the very efficient dispersal mechanisms in bryophytes, although some isolated and disjunct populations may be relict. For example, the large liverwort *Anastrophyllum alpinum* occurs in north-west

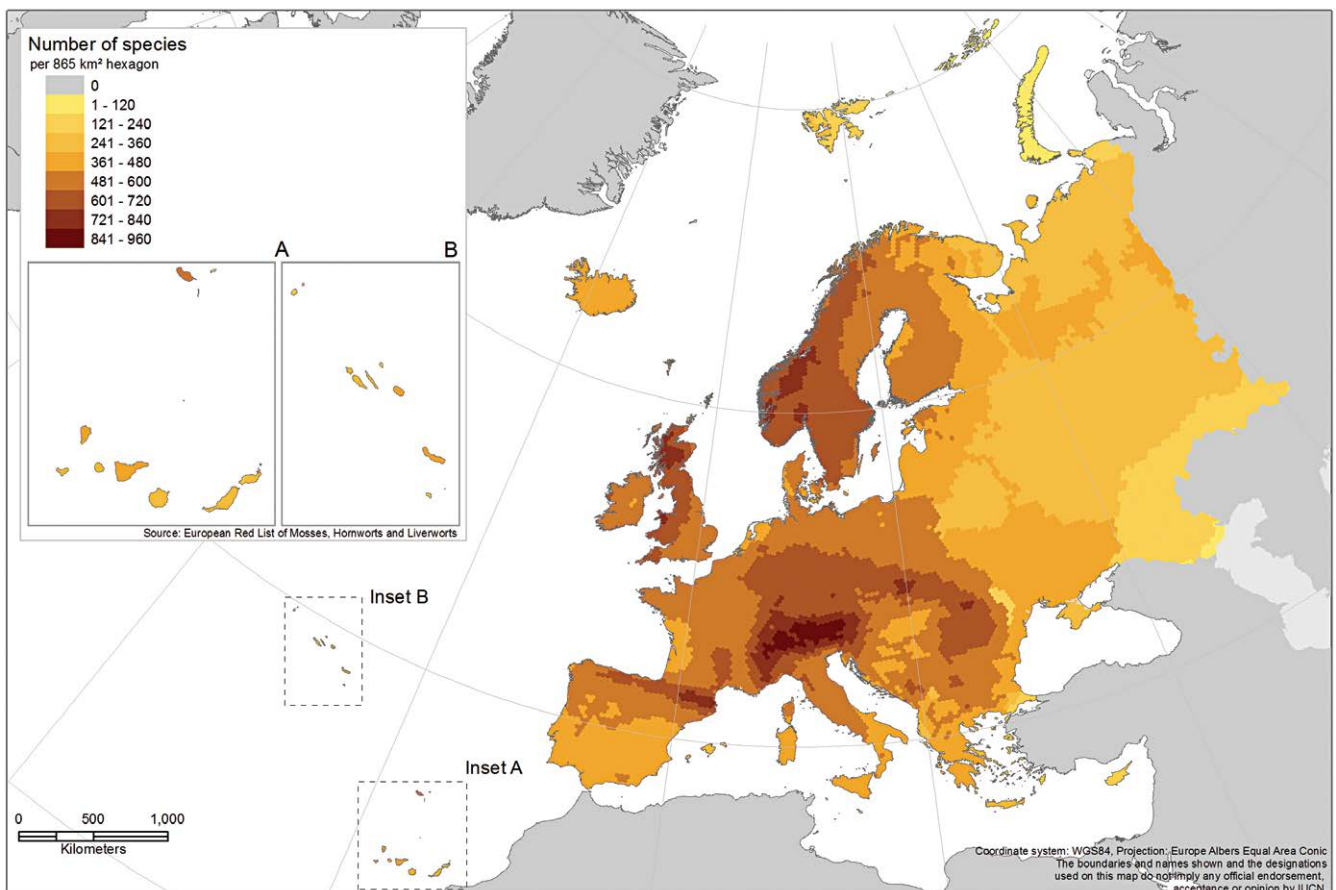


Figure 6. Species richness of European mosses, liverworts and hornworts.

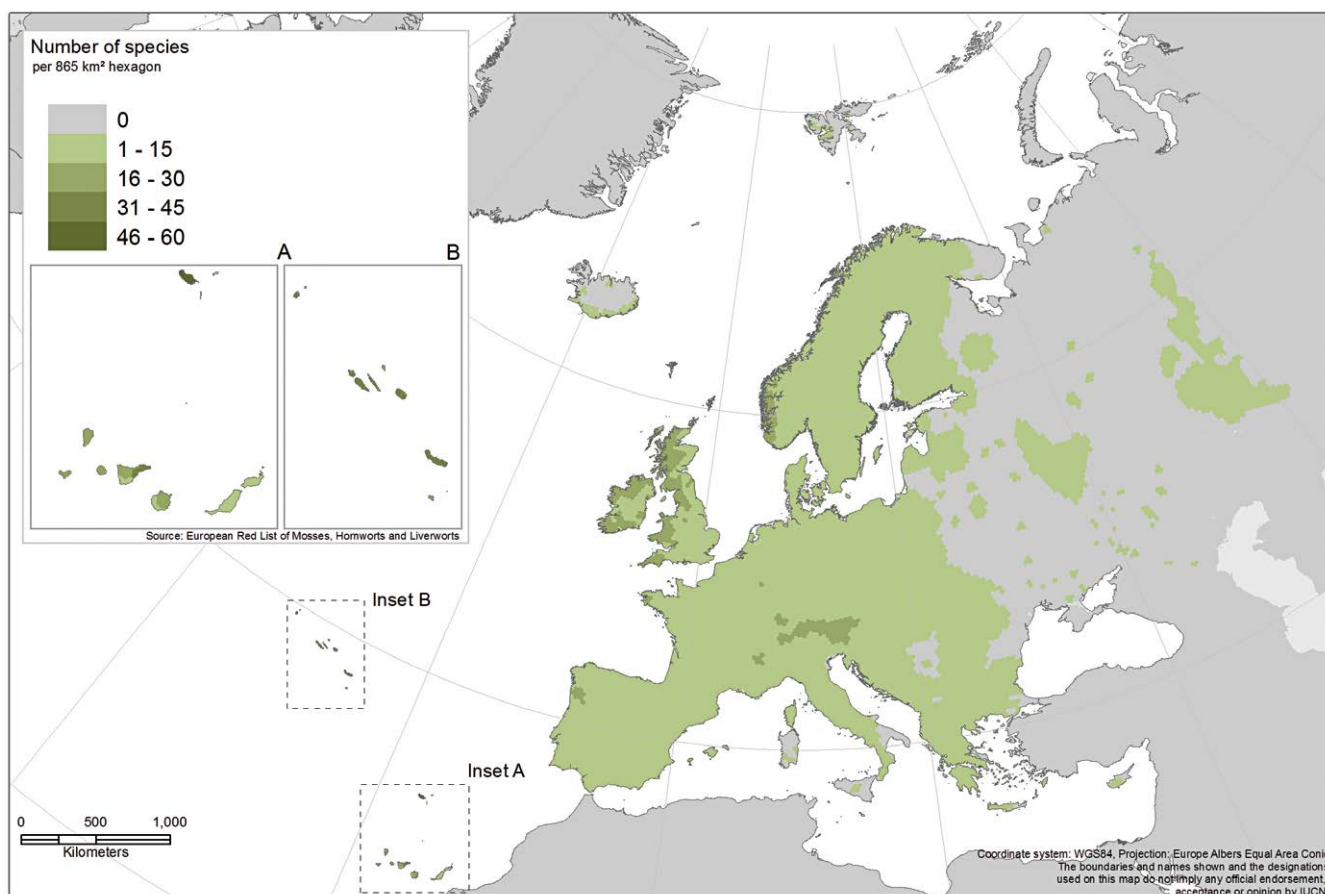


Figure 7. Distribution of endemic mosses, liverworts and hornworts in Europe.

Scotland, and elsewhere only in the Himalayas, Yunnan and the Aleutian Islands. Similarly, southern Europe supports a distinctive Mediterranean flora with many species restricted to the Mediterranean basin, but not necessarily endemic to Europe, occurring also in North Africa, Turkey and adjacent countries (for example, Ros et al., 2013). The tiny moss *Acaulon fontiquerianum* is a rare species of southern Europe and the Canary Islands that is also reported from Asiatic Turkey. There are few endemics in northern Scandinavia and Arctic Russia, but the bryophyte flora is very distinctive and largely restricted to the far north of Asia and North America, as well as Europe: *Drepanocladus arcticus* is a strictly Arctic moss confined to Svalbard, Arctic Russia (European and Asian) and Arctic North America.

3.3.3. Distribution of threatened species

In Figure 8, the distribution of threatened bryophytes in Europe is presented based on data for 374 threatened species (the analysis does not include species where their presence is uncertain).

Figure 8 displays the number of threatened species (CR, EN, VU) per unit area (865 km² hexagon). As for overall species richness (Figure 6), it shows a high number of

species in the Alps, especially in the eastern Alps, followed by other mountainous areas, notably the Carpathians, the eastern Pyrenees and the Scandinavian mountains. This emphasises the importance of mountain habitats for threatened bryophytes and their conservation. It may also flag the impact of climate change on the mountainous bryophyte flora, and pressure from land use change and tourist developments in the high mountains. Furthermore, many mountainous species are naturally rare and therefore susceptible to stochastic events. Two regions notable for their numbers of threatened species are an area located in central Germany and Macaronesia (Figure 6). While the high numbers in central Germany are difficult to explain, the laurel forests of Macaronesian islands, which contain many rare, threatened and endemic (Figure 7) bryophytes, are under considerable threat from climate change, wildfires and forestry [see Box 2].

With the exception of these relatively restricted areas, numbers of threatened species are fairly constant throughout Europe. The map above (Figure 8) clearly illustrates regions with a concentration of threatened species, which deserve special attention for conservation implementation. They largely agree with the regions with

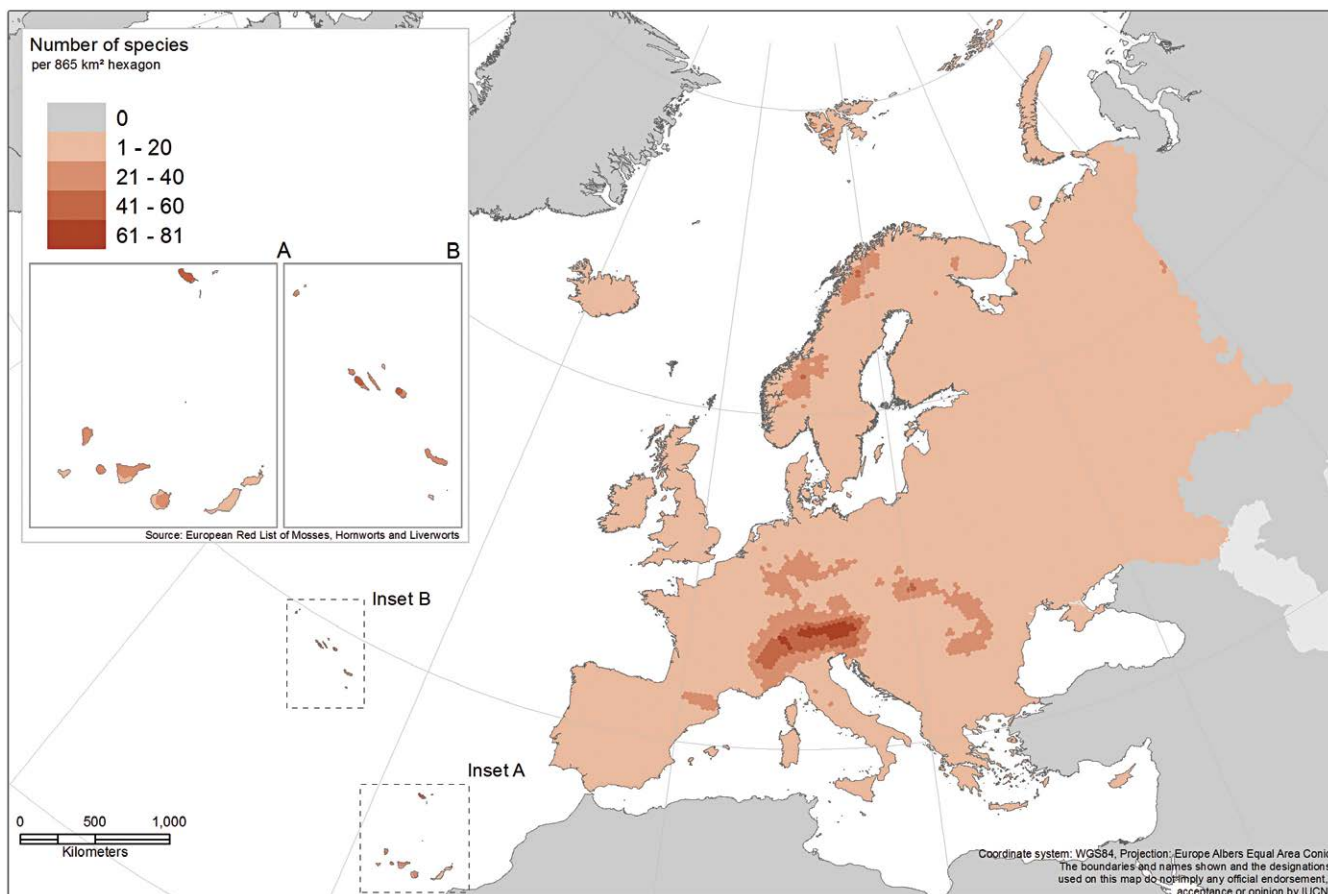


Figure 8. Distribution of threatened (CR, EN, VU) mosses, liverworts and hornworts in Europe.

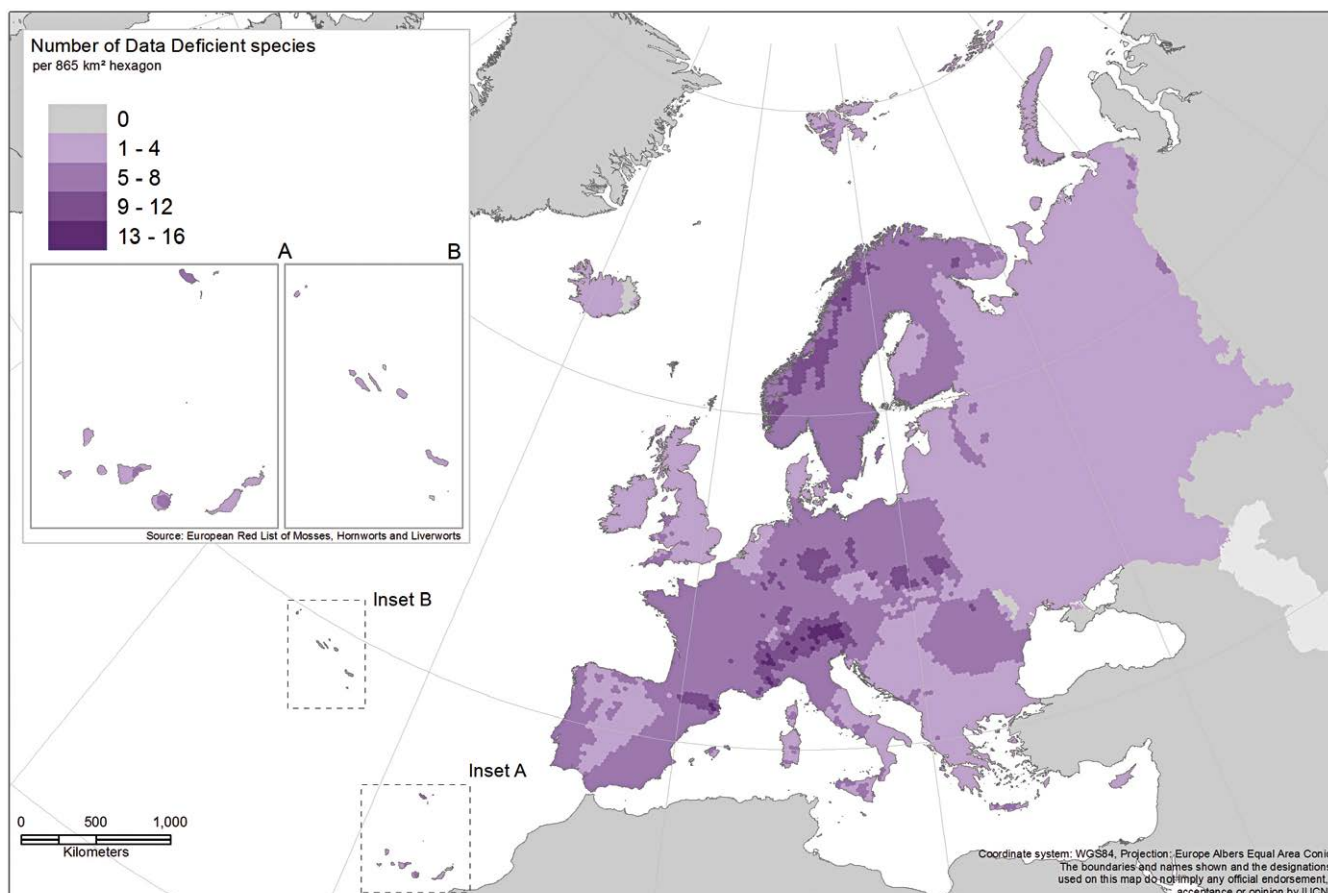


Figure 9. Distribution of Data Deficient mosses, liverworts and hornworts in Europe.

Box 2 - Taking a closer look: Atlantic bryophytes

The extreme west of Europe, where the climate is warm and wet, neither too hot nor too cold, supports a rich and varied selection of mosses and liverworts that are collectively referred to as oceanic or Atlantic. These were first defined (in western Britain and Ireland) by the late Derek Ratcliffe in 1968, who identified the species that are more or less confined to parts of Britain and Ireland which have more than 200 'wet days' per year, with wet days defined as days with over 1 mm of rain (Ratcliffe, 1968): in other words, the extreme west, where the influence of the Atlantic is at its strongest. The same suite of species extends to the Faroe Islands and, in less abundance, to western Norway, western France (Brittany) and north-western Spain.

A lowland ravine in western Scotland may support upwards of 200 species in its sheltered, humid interior, including many oceanic species. The Atlantic influence in Scotland extends into the mountains, where a community defined by Ratcliffe as the 'mixed hepatic mat' occurs in luxuriance in suitable north-east-facing corries. This consists of large leafy liverworts such as species of *Anastrophyllum*, *Bazzania*, *Herbertus*, *Plagiochila* and *Scapania*. Many of these species, as well as being strictly confined in Europe to the extreme west, are globally rare and more or less threatened.



Herbertus borealis (Vulnerable liverwort) is endemic to Scotland © Michael Lüth

The oceanic flora is even better developed in Macaronesia, where the native laurel forest supports a very rich assemblage of species, including a higher proportion of endemic species than is usual with bryophytes, especially in Madeira. The subtropical forest is more or less constantly humid and warm and the trees are festooned with mosses and liverworts, including tiny species of *Acrobolbus* and *Lejeunea*, as well as much larger *Plagiochila* and *Herbertus*. These small areas of forest are under great threat from climate change, wildfires and developments related to tourism.

Europe's Atlantic bryophytes have clear affinities with the tropical bryophyte flora of South America, and several species once thought to be European endemics are now known to be identical with South American plants: *Plagiochila bifaria*, for example, formerly known in Europe as *P. killarniensis* (Heinrichs et al., 1998). This is probably the result of long distance dispersal of some species from South America to Europe via Macaronesia.

high general species richness, and partly with regions of high levels of endemism (Figures 6 and 7).

However, it does not inform on relative regional threat pressures. For this, the number of threatened species would need to be represented as proportions of total species number per region, a level of analysis that should be done in future work. It is likely that lowland areas which have experienced massive changes in land use due to agricultural intensification and rural development since the early 20th Century, still face a greater negative impact than many mountainous areas; at least as long a climate change has not yet have full effect on population decline.

3.3.4. Distribution of Data Deficient species

In Figure 9, the distribution of Data Deficient (DD) species is presented based on data for 88 DD species (the analysis does not include species where their presence is uncertain). Some species are listed as DD because they have been recently described and there is no information to elucidate their trends, while others have been assessed as DD due to taxonomic uncertainty and the difficulty to differentiate between different species unless studied genetically.

The incidence of DD species is often high in mountainous areas, which could be attributed to the fact that they are the most species-rich areas (Figure 6), but could also be because they are usually more remote and difficult to survey than the lowlands. There are also more DD species in relatively under-recorded parts of Europe, such

as Romania, than there are in well-recorded areas, such as Britain and Ireland. The low number of DD species throughout most of European Russia, may simply reflect the fact that much of it has low bryological diversity; alternatively, it might indicate that this is an area which is poorly surveyed and hence poorly known.

3.4 Major threats to moss, liverwort and hornwort species in Europe

A comprehensive overview of the threats to bryophytes in Europe is not possible, as some of the threats to the species remain unknown. In total, it was possible to identify threats for 1,099 species, often with multiple threats listed for a species. Based on the best available knowledge, 559 species are thought to have no current or major threats, and for 159 species the threats are unknown at present. Threats to bryophytes are complex and often difficult to categorise. There are sometimes synergistic effects between threats e.g., between climate change and increased fire frequency and it is hard to determine which threat is the key driver impacting a bryophyte. In other cases there may be several threats affecting an area e.g., climate change, increased fire frequency and unregulated planting of Eucalyptus and conifer plantations, etc., these threats are all closely linked and it is hard to identify which one is the key threat impacting a bryophyte species.

A summary of the major threats to threatened and not threatened (DD, LC and NT) species is shown in Figure 10.

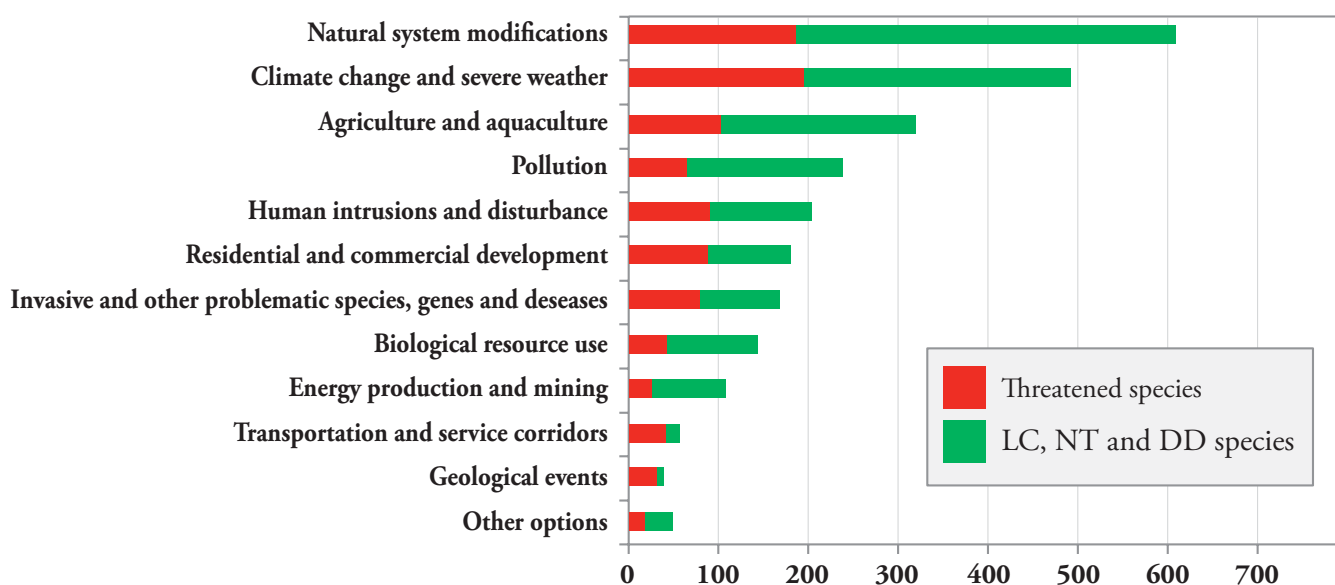


Figure 10. Major threats to all assessed mosses, liverworts and hornworts in Europe. *Note:* Species can be affected by more than one threat.

The main threat to both mosses and liverworts is natural system modification; 452 species of mosses and 180 species of liverworts are impacted by this driver of decline, of which 144 and 52 species, respectively, are threatened. For hornworts, the most prevalent threat is agriculture, affecting seven species (of which two are threatened). However, it should be noted that only eight hornwort species were assessed in total, so this result should be interpreted cautiously. Climate change ranked second in the list of threats to bryophytes in Europe.

3.4.1 Natural system modifications

A total of 234 species are affected by water management and use, including 83 species assessed as CR, EN or VU. This was considered the most common threat to bryophytes across Europe, including species assessed as threatened and species assessed as Near Threatened or Least Concern. This includes the abstraction of ground and surface water for different uses, including agricultural, commercial and domestic uses, and the construction of dams. Species that are water-dependent, such as *Campylophyllum montanum* and many of its relatives, and those that tend to grow in sites targeted for dam construction, such as *Bryum blindii*, are most at risk from these threats.

Bogs and fens are among the most threatened habitats in Europe (Janssen et al., 2016). In the lowlands, draining wetlands has led to a substantial decline in many bog and fen bryophyte species in central Europe (for example,

Sphagnum spp., *Hamatocaulis vernicosus*, *Scorpidium scorpioides*, etc.), that are still quite common in the far north. Remaining bryophyte-rich wetland sites, particularly in central and southern Europe, face multiple threats, and all require protection. In the uplands, construction of large-scale dams and reservoirs has destroyed many rich sites, and continues to threaten the survival of many species, including those likely to be impacted by climate change (for example, *Andreaea crassinervia*).

257 species appear to be at risk of an increase in fire frequency and/or intensity. Out of these, 94 species are considered to be threatened. This threat is closely associated with climate change, and becomes more serious with a warmer and drier environment. The problem is particularly serious in the laurel forests of Macaronesia, where many rare and endemic species confined to these forests are threatened by the increasing incidence of wildfires. There is also a greater risk of wildfires where there has been large-scale planting of non-native Pinus and Eucalyptus, as in much of southern Portugal and northern Spain.

A total of 215 species are affected by a variety of other modifications to ecosystems, 75 of which have been assessed as threatened.

3.4.2 Climate change

A total of 493 species are affected by climate change and severe weather, of which 196 are threatened. Under this



Cheilolejeunea cedercreutzii (Endangered liverwort) © Tomas Hallingbäck



Echinodium renauldii (Endangered moss) © César García

broad threat, 209 species are estimated to be or will be affected by droughts, including 146 threatened species. A total of 235 species are affected by habitat shifting and alteration, including 109 threatened species. 163 species are considered to be at risk from temperature extremes, of which 78 species are threatened. With increasing temperatures across Europe, as a result of climate change, periods of droughts are already increasing (Vicente-Serrano, 2014). The effects of climate change are often unpredictable but the threat will only become more prominent in the coming decades.

Some of the species most likely to be threatened by climate change are those confined to wetlands. Already greatly reduced, especially in central and southern Europe, due to land-use changes including agricultural expansion and intensification, drainage, pollution, construction activities and invasive species, the remaining wetlands are under extra pressure from desiccation caused by climate change. Species of bryophytes that are found at high elevations, and/or in northern environments, are probably significantly more prone to the impacts of climate change than other species, as they have nowhere else to go if temperatures increase significantly. For example, the survival of *Herbertus sendtneri*, a species of the high Austrian Alps, is very doubtful if the extent and duration of alpine snow-patches deteriorate significantly. On the other hand, at least the bryophytes of higher elevations are usually less at risk from other factors; for those that grow on lower mountains, climate change

is just one more threat to add to the other pressures affecting them, such as land-use change.

The bryophytes of the laurel forests of Macaronesia are also at great risk through climate change (Patiño & Vanderpoorten 2018). The forests appear to be drying out, wildfires are becoming more frequent, and projections show a significantly increased risk of extinction for many of the special species of this habitat in the coming years, including endemic species such as *Cheilolejeunea cedercreutzii*.

The bryophytes of southern Europe in general are also at an increasingly higher risk of extinction as the climate becomes warmer and drier. Already some areas have been affected by desertification, and while many species have strategies for avoiding or tolerating drought (for example *Gigaspermum mouretii*, and many species in the family Pottiaceae), even these species will be unable to survive in conditions of more extreme desertification.

3.4.3 Agriculture and aquaculture

A total of 323 species are affected by agriculture and aquaculture, of which 102 are threatened. Under this broad threat, wood and pulp plantations affect 200 species of bryophyte in Europe, including 61 threatened species. Different species are impacted by plantations at different scales, but particularly by agro-industry plantations. At this scale, 124 species are at risk, of which 26 are threatened.



Dead wood is an important substrate for many specialised bryophytes; this old rotting tree trunk supports many species, including *Scapania apiculata* (Near Threatened liverwort)
© Michael Lüth

Most plantations are on sites where there used to be natural or semi-natural forest, so the main species threatened by conversion of natural forest to plantation woodland are those dependent on the long ecological continuity provided by a stable, humid, natural forest. Specialists of dead wood such as *Scapania apiculata* have been particularly impacted, as amounts of deadwood are often very low in managed forests.

Generally, land-use conversion practices (including the intensification of agriculture and forestry) are considered the most common threat to biodiversity in undisturbed habitats (IPBES, 2018). These have been designed to increase the production of crops (for example, by increased fertilizer and pesticide applications), livestock, aquaculture, forest biomass, as well as urban development, and are highly detrimental to bryophytes.

A total of 151 species are affected by livestock farming and ranching, including 65 threatened species. This includes grazing at three scales; nomadic, small-holders and agro-industry. The majority of the species (95, of which 41 are threatened) are affected by small-holder grazing, ranching or farming. Overgrazing, under-grazing, and burning are all activities that may affect bryophytes. One activity that is particularly associated with livestock farming is the treatment of stock with ivermectins and other chemicals to treat parasite infestations. One of the unintended consequences of this is that it makes the dung of these animals effectively sterile, which has knock-on

effects on the large numbers of organisms that depend on animal dung for survival. These include a unique suite of mosses - the dung mosses - that grow only on the dung (or sometime bones) of herbivores and which have an intimate relationship with dung invertebrates for the dispersal of their spores. Most of these species, some of them among our most attractive bryophytes (*Splachnum*, *Tetraplodon*, *Aplodon*, etc), have declined drastically in recent years (Porley & Hodgetts, 2005).

3.4.4 Other threats to bryophytes

Residential and commercial development

A total of 185 species are affected by residential and commercial development, of which 88 are threatened. Under the umbrella of residential and commercial development, a key threat to bryophytes in Europe was identified as the development of areas for tourism and recreation. 181 species in total are impacted by tourism and recreation, including 99 threatened species. Tourism encompasses many sorts of threat, including uncontrolled building of hotels and other tourist facilities in rich coastal or alpine habitats, water abstraction, disturbance through increasing numbers of people, etc. 'Urban sprawl' which occurs in order to accommodate the ever-increasing human population, often replaces woodland, species-rich grasslands and wetlands.

Pollution

A total of 240 species are affected by pollution, of which 66 are threatened. Under this broad threat, a total of 165

species are affected by agricultural and forestry effluents, including 58 threatened species. This includes 97 species (of which 34 are threatened) that are specifically at risk from nutrient loads, 29 species (of which ten are threatened) that are specifically at risk from herbicides and pesticides, and 16 species (of which ten are threatened) that are specifically at risk from soil erosion and sedimentation.

Bryophytes are also considered to be affected by other sorts of pollution in Europe. 78 species (of which 19 are threatened) are impacted by air-borne pollutants, for example acid rain and smog, and 32 species (of which nine are threatened) are impacted by waste water, such as run-off and sewage [see Box 3].

Invasive non-native/alien species/diseases

A total of 169 species are affected by invasive and other problematic species, genes and diseases, of which 79 are threatened. Under this broad threat, 161 species are affected by invasive alien species, including 79 threatened bryophytes. Most of these problematic species are unspecified, but 64 species (of which 40 are threatened) are affected by known species. One of the most problematic invasive plants for bryophytes in Europe is non-native rhododendron (*Rhododendron ponticum*), which has spread from gardens and now covers large areas of hillside in oceanic areas, casting a deep shade and dropping very acid leaf litter that prevents anything else from growing. The effects of this invader on bryophytes are particularly bad in areas of the UK and Ireland. However, it is important to note that rhododendron (*R. ponticum*) is a native and non-invasive plant in ravines in southern Spain and Portugal; these rhododendron ravines are threatened habitats and rich in bryophytes. The aquatic environment is particularly sensitive to invasive species, and plants such as *Crassula helmsii* are as much a threat to aquatic bryophytes as they are to vascular plants. A minority of species may be under threat from invasive alien bryophytes: In north-western Europe, *Orthodonium gracile* appears to be a poor competitor against the invasive southern African species *O. lineare*.

Human intrusions and disturbance

A total of 204 species are affected by human intrusions and disturbance, of which 92 are threatened. Under this broad threat, human disturbance to areas where bryophytes grow, specifically for access to recreational activities, is considered to impact 159 species, of which 81 are threatened. This includes intrusions relating to, for example, erosion at popular tourist sites owing to the

sheer numbers of people; mountain summits in tourist areas are particularly vulnerable in this respect. Some coastal cliff top paths in southern England with rare mosses are becoming increasingly eutrophicated by dog faeces, leading to loss of habitat. Hunting and shooting for sport is not a direct threat to bryophytes, but when important sites are managed primarily for these activities, it can result in loss and degradation of habitat, as has taken place on the grouse moors of Scotland, where large areas are regularly burned to encourage the growth of new heather (*Calluna vulgaris*) shoots, resulting not only in a species-poor monoculture, but also destabilisation of soils and increased erosion.

Additional threats

There are many other threats to European bryophytes. Biological resource use, which includes unintentional impacts of fishing, hunting and harvesting biological resources, affects 152 species, of which 46 are threatened. In addition, 116 species are threatened by industrial activities, such as energy production and mining, including 31 threatened species. Under this threat classification, most species (72, of which 12 are threatened) are at risk from mining and quarrying, although renewable energy production and oil and gas drilling also impact some species in Europe. In some areas, such as central Ireland, industrial-scale peat extraction for fuel has damaged or destroyed many important bryophyte sites. The remaining ones now receive statutory protection. Land-based wind farms often cause considerable damage, especially if sited on sensitive peaty substrates.

The establishment of transportation and service corridors, such as roads and service lines, affects 69 species, of which 54 are threatened.

3.5 Population trends

Documenting the population trend of a species provides key information when assessing its Red List status. As part of this process, the whole population of each species in Europe was assessed as declining, stable, increasing or unknown.

Overall, 17.1% (307 species) of bryophyte species in Europe are thought to be in decline, including 52.8% of threatened species (162 species). The majority of species (59.3%; 1,062 species) are considered to be stable, including 8.3% of threatened species (88 species), and 1.9% (34 species) are increasing (Figure 11), all of which

are LC. However, 21.7% of species (389 species) have unknown population trends, with 129 threatened species (33.2%).

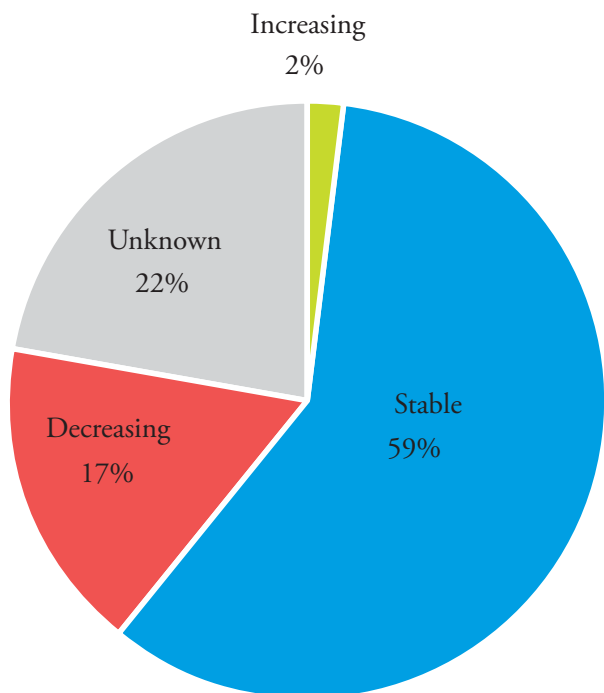


Figure 11. Population trends of European mosses, liverworts and hornworts.

3.6 Gaps in knowledge

While there was not enough information to assign a Red List Category to 93 species (hence considered as Data Deficient), the information collected was sufficient to identify the major knowledge gaps for bryophytes in Europe (Figure 12).

Overall, the absence of, or the existence of few, data on population size and distribution, as well as trends are systematically highlighted as a knowledge gap for bryophytes by the expert community assessing the conservation status of these species. This pattern affects both threatened and non-threatened taxa. Knowledge on habitats trends and impact of threats is also still incipient for the majority of these species, with particular regions severely understudied (for example, Russia).

While this pattern can be partially justified by the fact that some species have been recently described, and so there is no information available on these parameters, the reality is that monitoring efforts are becoming increasingly difficult to sustain and to fund. This, coupled with the absence of baseline data (for example, historical data) on species numbers and distribution, hamper a comprehensive understanding of the threats to

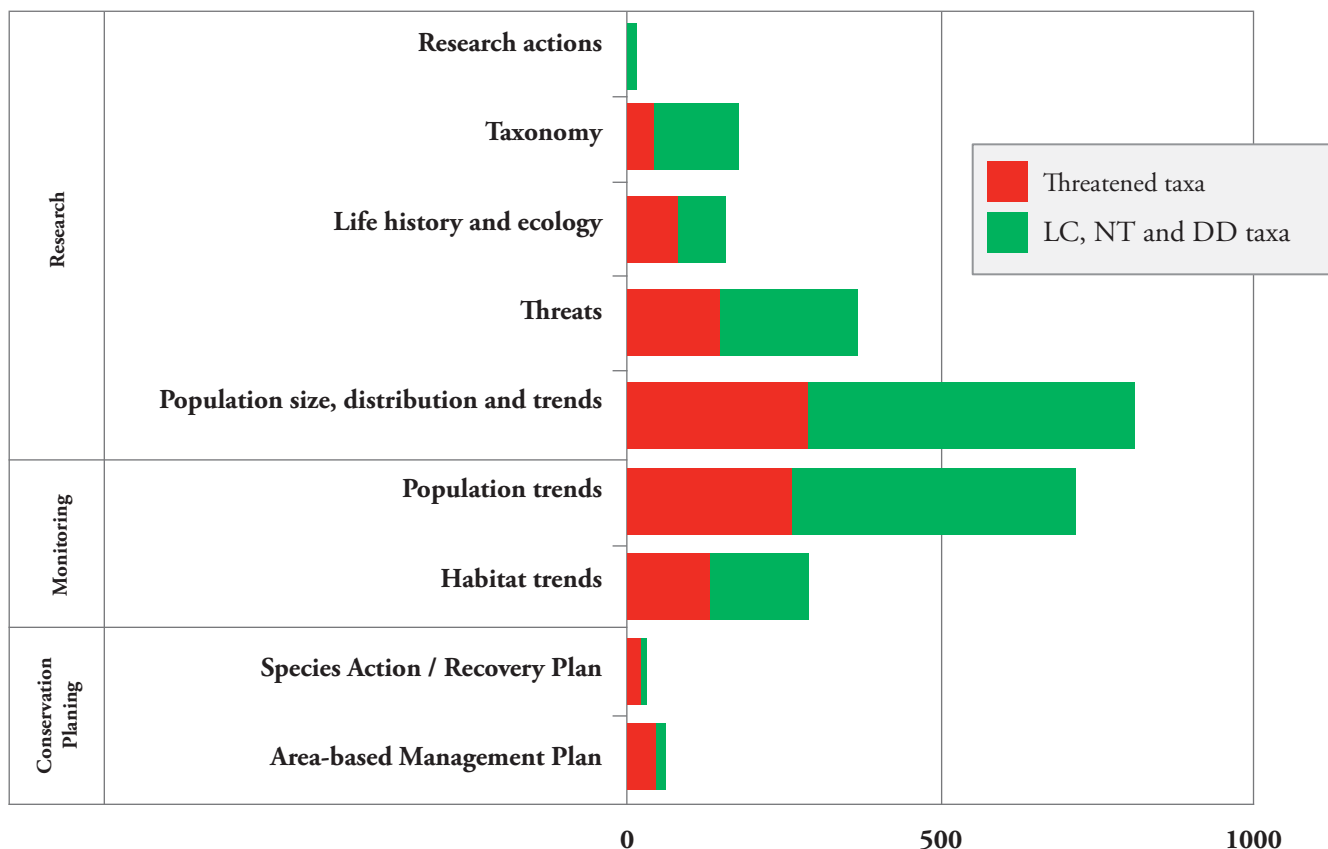


Figure 12. Research needs for European mosses, liverworts and hornworts. Note: Species can be included in more than one category.

these species in Europe, and how these stressors interact. Collecting information on these topics is paramount for sound conservation planning and effective recovery of threatened taxa, and will allow for more concrete messages to be mainstreamed to the most impactful sectors. The establishment of an expert network to facilitate information exchange would certainly help address the

knowledge gaps identified for these species throughout their European range; the experts brought together through this project provide a good starting point to expand this network. In any case, relevant conservation and management measures should move ahead despite any current data gaps, while also considering taxonomic uncertainty where relevant.



Hymenoloma compactum (Data Deficient moss) © Tomas Hallingbäck

Box 3 - Poisoned bryophytes: the impact of over-fertilization

One of the major threats to bryophytes is habitat modification through intensification of agricultural practices and pollution (which may also come from agriculture). The greatest pollution threat in the 20th Century was sulphur dioxide pollution through the widespread burning of dirty coal. Many bryophytes, particularly epiphytic species, are very sensitive to sulphur dioxide (SO₂) levels, and these plants, such as species of *Orthotrichum* and *Ulova*, virtually disappeared from large areas of Europe. When legislation for clean air was introduced in the mid-to late-20th Century, these plants gradually, and later rapidly, began to recolonise. Nowadays, trees throughout most of Europe, even in areas formerly heavily impacted by SO₂ pollution, are covered with *Orthotrichum* and *Ulova* and other species.

Currently, the problem is nitrogen. Despite generally improving air quality in Europe, including reductions in nitrogen emissions, there is an ever-increasing amount of nitrogen in the environment because of agricultural practices and vehicle emissions. Locally, in agricultural areas, one can smell ammonia because of the enthusiastic spreading of manure, and observe the homogenous green of ‘improved’ pasture devoid of wild flowers or much natural interest at all. Vehicle emissions are a big source of pollution by nitrogen compounds in densely populated areas. However, the main cause is the worldwide increase in the very inefficient use of artificial nitrogen-rich fertilisers in agriculture. In Europe, fertilisers are still spread over fields, but more than half the nitrogen does not go into improved crop yields, it simply runs off into ditches, streams, rivers and ultimately the sea. Much of it, via the nitrogen cycle, is returned to the land through precipitation. The consequences for bryophytes are evident. All over Europe, even in remote upland areas, the natural species-rich bryophyte flora of streams is being replaced with a monocultural slime of green algae; even in bogs, in some areas *Sphagnum* hummocks are becoming overwhelmed by algal scum. On rock faces, a layer of green algae replaces the mosses and liverworts. In open habitats, the nutrient-poor ‘bare ground’ habitat of so many threatened species is disappearing, being overtaken by vigorous, nutrient-demanding grasses.

This is a worldwide problem that can only be addressed by worldwide solutions. Most agricultural land is currently over-fertilised (Pearce, 2018), and so possible solutions include more targeted, ‘precision agriculture’, distributing smaller amounts of nitrogen much more efficiently, so that it goes to plant roots and does not run off into the surrounding environment.



Urn bristle-moss *Orthotrichum urnigerum* (Vulnerable moss) © Michael Lüth

4. Conservation actions

4.1 Conservation of moss, liverwort and hornwort species in Europe

The results of this Red List assessment indicate that 88.2% of species (1,603 species, of which 319 are threatened) were recorded in at least one protected area (including national parks, Natura 2000 sites or nature reserves). This is positive, as site protection is the most commonly identified conservation action needed for European bryophytes (Figure 13). The second most important action is site/area management, and bryophytes are often not considered in management plans. Additional conservation measures proposed for European bryophytes are shown below (Figure 13).

The nature conservation policy of the European Union is based on two main pieces of EU legislation - the 1979 Birds Directive (Directive 79/409/EEC) and the 1992 Habitats Directive (Directive 92/43/EEC; jointly referred to as the Nature Directives). There are

32 bryophyte species currently listed in Annex II of the Habitats Directive, not all of which are endemic to Europe. No species of bryophytes is listed under Annex IV and only three genera are listed under Annex V of the Habitats Directive. The Bern Convention, on the other hand, is a binding international legal instrument that aims to conserve wild flora and fauna and their natural habitats and promote European cooperation towards that objective. It covers all European countries and some African states. In Appendix I of the Bern Convention (Strictly Protected Flora Species), a total of 26 bryophyte species are listed. Appendix 4 provides the full list of bryophytes species listed under the Habitats Directive and the Bern Convention, and the corresponding Red List status as determined by this assessment. Of the 1,729 bryophyte species present in the EU 28, 7.5% are endemic to the EU 28, highlighting the conservation responsibility of the EU towards these species. Some have made a remarkable recovery following listing under the Habitats Directive and the Bern Convention, and

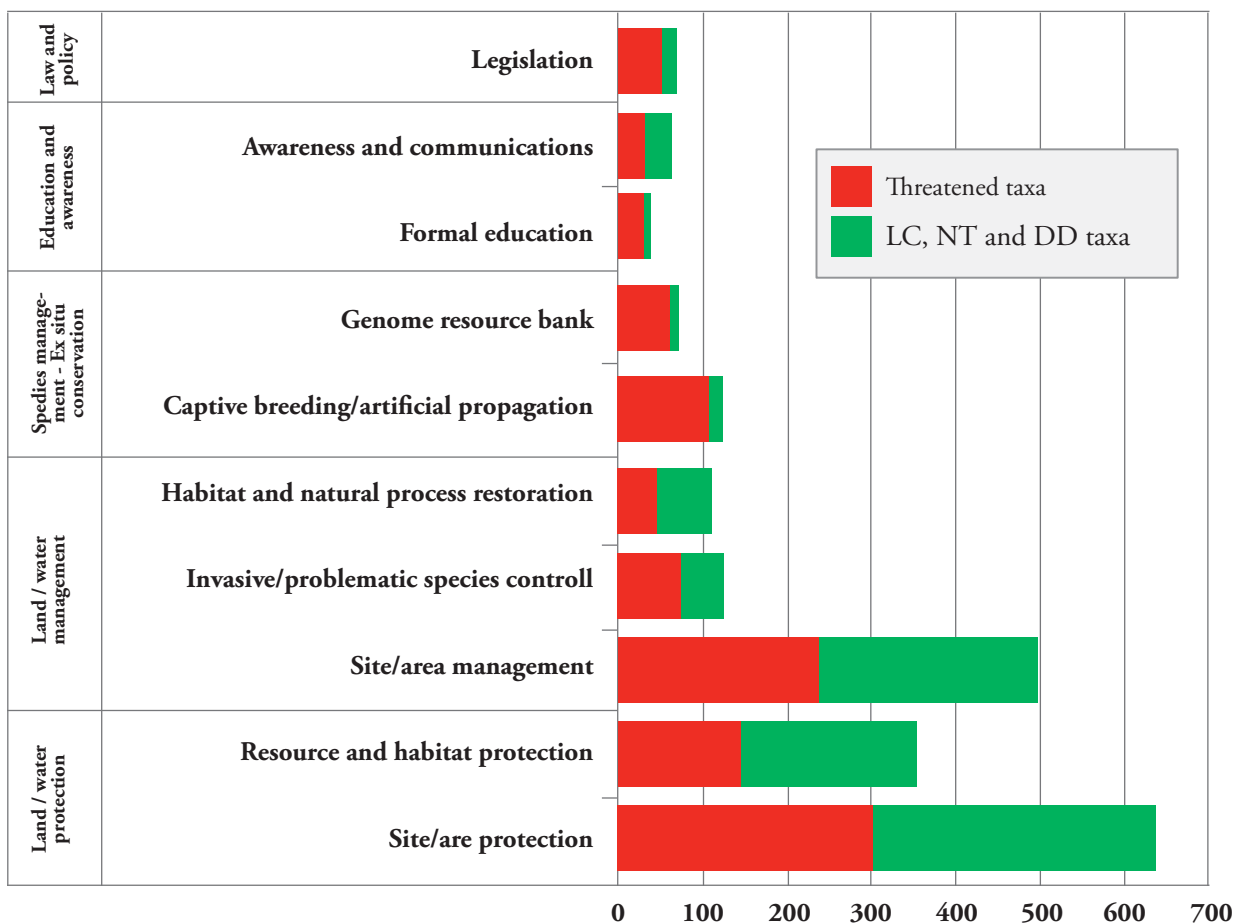


Figure 13. Main conservation actions needed identified for European mosses, liverworts and hornworts. Note: More than one conservation action was assigned to each species.

targeted conservation actions (for example, *Hamatocaulis vernicosus* - see Box 4).

One of the main tools to enhance and maintain biodiversity in Europe is the Natura 2000 network of protected areas, which currently consists of over 27,500 sites, it covers 18% of land territory but 27.5% land and marine area (EC, 2018). Natura 2000 sites provide an essential tool in conservation even if the sites were not specifically designated for the preservation of particular bryophyte species, as indirectly the general protection of habitats usually also benefits the bryophytes. However, it is sometimes necessary to target the ecological needs of these small plants more directly, which becomes challenging when conservation actions are usually targeted at more charismatic and well-known organisms. The well-supported agri-environmental schemes devised to promote sustainable farming across Europe are a good illustration of the limited effects on bryophytes of such widespread, untargeted conservation measures, particularly for rare bryophyte species (Valentini et al.,

2016). Actions better tailored to promote bryophyte conservation include, for example, rotational set-aside and retention of winter stubbles in cereal, rape and linseed crops (Bosanquet, 2003; Bisang et al., 2009).

Many threatened bryophytes occur in protected areas, and depend, like other groups, on the conservation of multi-scale areas of semi-natural habitat. However, many species tend to grow in 'micro-habitats' in non-protected areas. This means that the sympathetic management of the wider countryside is particularly important for bryophytes. For example, the suite of species which have their main habitat in arable fields, such as the threatened hornwort *Anthoceros neesii*, are entirely dependent for their survival on overwintering stubble fields, so wider agricultural policy needs to promote agricultural practices that favour this habitat. Similarly, a certain amount of dead wood needs to be left in situ in managed forestry plantations, as well as in old-growth forest, in order to provide substrate for the many bryophytes that specialise in this habitat. While the Habitats Directive



Soft brook-moss *Platyhypnum molle* (Vulnerable moss) © Tomas Hallingbäck

and the Natura 2000 network are of vital importance, there needs to be much more coordination between different elements of policy, so that, to choose the most obvious example, policies contained within the Common Agricultural Policy (CAP) do not work against those in the Habitats Directive. Measures within other national or international policies, including Agri-Environmental Schemes that provide payments to farmers who subscribe, on a voluntary basis, to environmental commitments related to the preservation of the environment, need to be aligned with statutory protection for species to ensure that efforts to protect these species are synergistic and not in vain.

European countries and EU Member States are signatories to a number of important conventions aimed at conserving biodiversity, including the 1979 Bern Convention on the Conservation of European Wildlife and Natural Habitats, and the 1992 Convention on Biological Diversity (CBD). Through the CBD, the Strategic Plan 2011–2020 was established, which includes 20 targets (Aichi Targets) that guide the implementation of the CBD and all the other biodiversity conventions. In particular, Target 12 focuses on preventing the extinction of known threatened species and improving their status (CBD, 2011). The outcomes of this Red List project certainly help to measure the progress made towards meeting these targets, and the current results suggest that, for bryophytes, Europe is not on track to meet these targets.

The Global Strategy for Plant Conservation (GSPC) was adopted by the CBD at the 2002 Conference of the Parties and updated at the 10th Conference of the Parties. In order to coordinate the implementation of the GSPC at the regional level, the European Strategy for Plant Conservation (ESPC) was adopted. In particular, Target 2 (calling for an assessment of the conservation status of plant species), Target 5 (through the identification of Important Plant Areas), Target 7 (*in situ* conservation), Target 8 (*ex situ* conservation), Target 12 (preventing the extinction of known threatened species and improving their status), Target 13 (sustainable practices associated with plant use) and Target 14 (awareness raising) (CBD, 2011) are relevant for the conservation of bryophytes.

European countries across the continent endorsed the Pan-European 2020 Strategy for Biodiversity (UNEP, 2011), which re-focuses efforts to prevent further loss of biodiversity in the region. It also provides a European mechanism for supporting the implementation of the global Strategic Plan for Biodiversity. No native European bryophyte species are listed in the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The EU Water Framework Directive, adopted in 2000 and aimed at protecting European waters, can also be relevant for aquatic and water-dependant bryophyte species. A good ecological status of surface waters, as promoted by the



Grey-cushioned grimmia *Grimmia pulvinata* (Least Concern moss) © Michael Lüth



Tayloria rudolphiana (Near Threatened moss) © Norbert Schnyder

Directive, has positive effects on ecosystem function (Janauer et al., 2015).

Plant habitat conservation efforts have in part been focused through the identification of Important Plant Areas (IPAs). IPAs are internationally significant sites for wild plants and threatened habitats. Identified at a national level, they provide a framework for implementing Target 5 of the CBD GSPC, and are a tool for targeting conservation actions on wild plants and *in situ* habitat protection. IPAs contain over 700 of the most threatened species in Europe and include millions of hectares of the most threatened habitats. At least 1,770 IPAs have been identified in 16 European countries (Anderson & Radford, 2010). A first attempt was made to identify Important Bryophyte Areas in Europe during the production of the first Red List (European Committee for the Conservation of Bryophytes, 1995), and it is anticipated that the current Red List will facilitate an update of this initiative. These exercises are incredibly valuable to ensure species protection and a stepping stone to promote nature conservation in Europe.

The EU has committed to a long-term (2050) vision and mid-term headline target for biodiversity, which

is “*To halt the loss of biodiversity and the degradation of ecosystem services in the EU by 2020 and restore them in so far as possible, while stepping up the EU contribution to averting global biodiversity loss.*” This target underpins the EU Biodiversity Strategy 2011–2020. The establishment of these policy instruments indicates the high political commitment to biodiversity and the need to monitor the status of biodiversity and to assess progress towards meeting conservation objectives and targets. Measuring whether policy targets have been met is only possible by establishing comprehensive monitoring programmes that allow the gathering of the necessary data for a reliable re-assessment in the coming years. The results of the present Red List assessment indicate that, for the bryophytes, Europe is currently not on track to meet these targets. For the latter to happen, immediate conservation action for species with a high extinction risk is needed.

Most European countries have developed specific actions at the national or regional level in order to enhance bryophyte populations. National Red Lists or Red Data Books of bryophyte species are available for the following countries: Austria, Bulgaria, Czechia, Estonia, Finland, Germany, Great Britain (excluding Northern Ireland), Hungary, Ireland (including Northern Ireland),

Italy (including Sardinia), Luxembourg, Montenegro, Netherlands, Norway, Poland, Portugal (including Madeira), Romania, Serbia, Slovakia, Slovenia, Spain and the Canary Islands, Sweden, and Switzerland.

However, there are some countries in which no national Red List has been developed (for example, France). It is also noteworthy that some national Red Lists are outdated and should be maintained and updated in order to remain relevant. In addition, several countries have developed management or action plans for several species, and have legislation in place to protect certain species legally (for example, Schedule 8 of the Wildlife & Countryside Act 1981 in the UK). Some examples of successful action plans include *Tayloria rudolphiana*, epiphytic species of central Europe for which several studies have been undertaken to count the sites or individuals of the plants (Hofmann et al., 2006; Hofmann et al., 2016; Müller, 2016; Kiebacher et al., 2018) and attempts have been made to protect the host trees and to increase awareness for this species. LIFE projects have been undertaken at the European level to enhance the status of certain habitats and species, some of which have focused on specific species bryophytes, or produced management plans as a result of these projects.

4.2 Red List versus priority for conservation action

Assessing the extinction risk and setting conservation priorities are related but distinct processes. The purpose of the IUCN Red List assessment is to produce an estimate of the likelihood of extinction of a species. On the other hand, setting conservation priorities also takes into account other factors such as ecological, phylogenetic, historical, economical or cultural preferences for some taxa over others. Also, the probability of success of conservation actions, availability of funds or personnel, cost-effectiveness and legal frameworks for the conservation of threatened taxa is taken into account. In the context of regional risk assessments, a number of additional pieces of information are valuable for setting conservation priorities. For example, it is important to consider not only conditions within the region, but also the Red List status of the taxon from a global perspective and the proportion of the global population that occurs within the region. The decision on how these three variables, and the other factors, are used for establishing conservation priorities is a matter for the regional authorities to determine, taking into account the Red List status of the species of concern.

Box 4 - Conservation works: bryophytes bounce back

For bryophytes, as for other organisms, conservation works. Bogs that have been damaged by peat-cutting or drainage can be restored or re-instated by blocking drains; degraded forest can be restored (eventually) merely by non-intervention; damaged wetlands can have a new lease of life through proper management. Giving species legal protection can be very effective. For example, Slender green feather-moss (*Hamatocaulis vernicosus*) was one of a small handful of species placed on Appendix I of the Bern Convention in the early 1990s. Along with most of the other Bern species, it was also included on Annex II of the EU Habitats Directive soon afterwards. This means that the signatory countries to these conventions have an obligation to protect it under the Natura 2000 network, with sites designated and managed for its protection. The results of this have been dramatic, with sites established for *Hamatocaulis* all over Europe, or at least within the EU, with several non-EU countries following suit. Because it is a key species of mineral-rich, mesotrophic mires, fens and flushes, this has meant that many important and threatened wetland sites that might otherwise have been destroyed now receive statutory protection. In other words, the conservation benefits of placing this moss on the protected species list extend much further than merely protecting the moss itself: whole habitats have been saved.

Furthermore, including *Hamatocaulis* on these international conventions has resulted in a massively increased programme of research to find out more about its distribution, abundance, ecology and conservation requirements. Recent research in Sweden has even found that what we call *H. vernicosus* actually comprises two cryptic species (genetically different but apparently morphologically identical), both of which occur in protected areas (Hedenäs, 2018). Paradoxically, an increase in survey and recording effort targeted at *H. vernicosus* means that it now seems to be more common than was once thought. This is not the case: we simply now know more about it, and the increase in records in recent years is entirely due to that increase in recording effort. If we had more baseline data going back through the decades it would certainly show a decline because of habitat destruction through drainage and other anthropogenic factors.



Slender green feather-moss *Hamatocaulis vernicosus* (Vulnerable moss) © Michael Lüth

5. Recommendations

5.1 Recommended actions

Currently, 22.5% of bryophytes are threatened at the European level. The most important threats to bryophytes in Europe come from natural systems modifications (i.e., habitat destruction and degradation), climate change, and current agricultural practices. Hence, improving the conservation status of bryophytes, and preventing current and future declines in Europe, requires increasing efforts and commitments from various parties, from the EU to regional assemblies, and from statutory bodies to conservation charities. Perhaps most importantly, measures for bryophyte conservation (and indeed for nature conservation generally) need to be integrated into regular planning and land management procedures and practices. Below, a series of recommendations are proposed to strengthen the long-term survival of European bryophytes:

Policy measures

- Use the European Red List as the scientific basis to inform regional/national lists of rare and threatened species and to identify priorities for conservation action in addition to the requirements of the Habitats Directive, thereby highlighting the conservation status of bryophytes at the regional/local level.
- Use the European Red List to support the integration of conservation policy with the Common Agricultural Policy (CAP) and other national and international policies. For example, CAP Strategic Plans should include biodiversity recovery commitments that could anticipate, among others, the creation of Important Bryophyte Areas. An increased involvement of national environmental agencies in the preparation of these strategic plans, and more broadly in ongoing discussions on the Future CAP Green Architecture, would likely also ensure the design of conservation measures better tailored to conserve bryophytes in agricultural landscapes.
- Update the European Red List every decade to ensure that the data remains current and relevant.
- Develop Key Biodiversity Areas for bryophytes in Europe with a view to ensuring adequate site-based protection for bryophytes.

Research and monitoring

- Use the European Red List as a basis for future targeted fieldwork on possibly extinct and understudied species.
- Establish a monitoring programme for targeted species (for example, threatened species and/or arable bryophytes).
- Use the European Red List to obtain funding for research into the biology and ecology of key targeted species.

Action on the ground

- Use the European Red List as evidence to support multi-scale conservation initiatives, including designation of protected areas, reform of agricultural practices and land management, habitat restoration and rewilding, and pollution reduction measures.
- Use the European Red List as a tool to target species that would benefit the most from the widespread implementation of the solutions offered by the 1991 Nitrates Directive (Council Directive 91/676/EEC), including the application of correct amounts of nutrients for each crop, only in periods of crop growth under suitable climatic conditions and never during periods of heavy rainfall or on frozen ground, and the creation of buffer zones to protect waters from run-off from the application of fertilizers.

Ex situ conservation

- Undertake ex situ conservation of species of conservation concern in botanic gardens and spore and gene banks, with a view to reintroduction where appropriate.

Awareness raising

Mosses and liverworts are small and do not impinge very much on the public consciousness, except as things to remove from the lawn or the roof. As an integral and important part of the natural world, they deserve better. There are now many attractive publications and websites that present bryophytes as beautiful and useful, and these should receive more publicity and promotion; for example, *Sphagnum mosses - The Stars of European Mires* (Laine et



Plagiomnium confertidens (*Vulnerable moss*) © Elvira Baisheva

al., 2018), Robert Muma's beautiful moss paintings and sketches (<http://worldofmosses.com/paintings/index.html>), Michael Lüth's amazing photographic collection (<http://www.milueth.de/Moose/index.htm>), to name but a few). Many nature reserves where bryophytes are important now have information boards and other material to promote bryophytes, and this should continue to be prioritised wherever appropriate.

In particular, this Red List should be used to publicise bryophytes and to obtain funding for future conservation work. For example, LIFE+ Nature and Biodiversity² provides targeted funding for species conservation actions, supporting projects aimed at conserving threatened species listed in the annexes of the EU Habitats Directive, Birds Directive and the European Red List.

5.2 Application of project outputs

The European Red List of mosses, liverworts and hornworts is part of a wider initiative aimed at assessing the status of all European species. It provides key resources for decision makers, policy makers, resource managers, environmental planners, NGOs and the concerned public by compiling large amounts of data on the population, ecology, habitats, threats and recommended conservation actions for each bryophyte species. Red List assessments are intended to be policy-relevant and can be used to inform conservation planning and priority setting processes. However, they are not intended to be policy-prescriptive and are not in

² <http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.getProjects&strandID=2>

themselves a system for setting biodiversity conservation priorities. These data are freely available on the IUCN Red List website (<https://www.iucnredlist.org/regions/europe>), on the European Commission's website (<http://ec.europa.eu/environment/nature/conservation/species/redlist>) and through paper publications (see the list of European Red Lists published at the end of this report).

Red Lists are a dynamic tool that will evolve with time as species are re-assessed according to new information or situations. They are aimed at stimulating and supporting research, monitoring and conservation action at local, regional and international levels, especially for threatened, Near Threatened and Data Deficient species.

Each species assessment lists the major threats affecting the specific bryophyte species and conservation actions that are in place or recommended. This is useful to inform the application of conservation actions for each species. The outputs of this project can be applied to inform policies and to identify priority sites for biodiversity and priority species to include in research and monitoring programmes.

5.3 Future work

Through the strong collaboration established between the ECCB and the IUCN SSC Bryophyte Specialist Group during this project, a network of European and national bryophyte experts, and their extensive knowledge and expertise, were mobilised that will persist long after the project ends and will be instrumental in defining priorities

for bryophyte conservation in Europe. The project has benefited greatly from the work and information held by additional relevant organisations and stakeholders, such as national bryophyte societies, university research programmes and statutory and voluntary conservation bodies. The wealth of knowledge and data compiled during the elaboration of this European Red List will be invaluable to expand research efforts on bryophytes at the European level, ultimately benefiting their conservation. One aspect worth noting is that the assessment of the European endemics can be transcribed directly into the corresponding global Red List.

Through the process of compiling data for the European Red List, a number of knowledge gaps have been identified. Across Europe there are significant geographic, geopolitical and taxonomic biases in the quality of data available on the distribution and status of species, and these are the aspects that a unified knowledge network will need to overcome to advance bryophyte conservation in the region.

There is a clear need for drawing together information from all data compilation initiatives, under way or planned, and for a wider European bryophyte conservation action plan to be explored, developed and progressed. It is hoped that by presenting this assessment, local, national, regional and international research will be stimulated to provide new data and to improve on the quality of the current available data.

Key challenges for the future are to improve monitoring, research and data quality and dissemination so that the information and analyses presented here can be updated and improved. This will contribute to recommend conservation actions based on a solid scientific basis. The further dissemination of this information to concerned European citizens will also lead to progressive policies at various jurisdictional levels that promote conservation. There is also a need for education, both of the general public and those involved in nature conservation, to raise awareness and to take bryophytes into account in conservation initiatives.

If the bryophyte assessments are periodically updated, they will enable the changing status of these species to be tracked over time via the production of a Red List Index (Butchart et al., 2004; 2005; 2006; 2007). To date, this indicator has been produced for birds, mammals, amphibians and reptiles at the European level and has been adopted as one of the headline biodiversity indicators to monitor progress towards halting biodiversity loss in Europe by 2020 (EEA, 2007). The development of such an index will be important to evaluate progress towards meeting Target 6 of the EU Biodiversity Strategy and for discussions shaping the Post-2020 Biodiversity Framework in order for Europe to step up its contribution to averting global biodiversity loss, and Aichi Target 12 of the CBD, which focuses on preventing the extinction of known threatened species and improving their status.



Sphagnum arcticum (Near Threatened moss) © Michael Lüth

References

- Allen, D. J., Bilz, M., Leaman, D. J., Miller, R. M., Timoshyna, A. and Window, J. (2014). *European Red List of Medicinal Plants*. Luxembourg: Publications Office of the European Union. doi: 10.2779/907382.
- Bergamini, A., Bisang, I., Hodgetts, N., Lockhart, N., van Rooy, J. and Hallingbäck, T. (2019). 'Recommendations for the use of critical terms when applying IUCN red-listing criteria to bryophytes'. *Lindbergia*. doi: 10.25227/linbg.01117
- Bilz, M., Kell, S.P., Maxted, N. and Lansdown, R.V. (2011). *European Red List of Vascular Plants*. Luxembourg: Publications Office of the European Union. doi:10.2779/8515
- Bisang I., Bergamini, A. and Lienhard, L. (2009). 'Environmental-friendly farming in Switzerland is not hornwort-friendly'. *Biological Conservation* 142: 2104–2113. Doi: 10.1016/j.biocon.2009.04.006
- Blockeel, T.L., Bosanquet, S.D.S., Hill, M.O. and Preston, C.D. (eds.) (2014). *Atlas of British and Irish bryophytes*. Newbury, Pisces Publications.
- Butchart, S.H.M., Akcakaya, H.R., Chanson, J., Baillie, J.E.M., Collen, B., Quader, S., Turner, W.R., Amin, R., Stuart, S.N. and Hilton-Taylor, C. (2007). 'Improvements to the Red List Index'. *PLoS ONE* 2(1): e140. doi: 10.1371/journal.pone.0000140.
- Butchart, S.H.M., Akcakaya, H.R., Kennedy, E. and Hilton-Taylor, C. (2006). 'Biodiversity indicators based on trends in conservation status: strengths of the IUCN Red List Index'. *Conservation Biology* 20: 579–581. Doi: 10.1111/j.1523-1739.2006.00410.x
- Butchart, S.H.M., Stattersfield, A.J., Baillie, J.E.M., Bennun, L.A., Stuart, S.N., Akcakaya, H.R., Hilton-Taylor, C. and Mace, G.M. (2005). 'Using Red List Indices to measure progress towards the 2010 target and beyond'. *Philosophical Transactions of the Royal Society of London B* 360: 255–268.
- Butchart, S.H.M., Stattersfield, A.J., Bennun, L.A., Shutes, S.M., Akcakaya, H.R., Baillie, J.E.M., Stuart, S.N., Hilton-Taylor, C. and Mace, M.M. (2004). 'Measuring global trends in the status of biodiversity: Red List Indices for birds'. *PLoS Biology* 2: e383. Doi: 10.1371/journal.pbio.0020383
- Cálix, M., Alexander, K.N.A., Nieto, A., Dodelin, B., Soldati, F., Telnov, D., Vazquez-Albalade, X., Aleksandrowicz, O., Audisio, P., Istrate, P., Jansson, N., Legakis, A., Liberto, A., Makris, C., Merkl, O., Mugerwa Pettersson, R., Schlaghamersky, J., Bologna, M.A., Brustel, H., Buse, J., Novák, V. and Purchart, L. (2018). *European Red List of Saproxylic Beetles*. Brussels, Belgium: IUCN. Available at: <https://portals.iucn.org/library/node/47296>
- Carter, B.E., Shaw, B. and Shaw, A.J. (2016). Endemism in the moss flora of North America. *American Journal of Botany* 103(4): 769–779. Doi: 10.3732/ajb.1500484
- [CBD] Convention on Biological Diversity (2011). *Aichi Biodiversity Targets*. Available online from: <https://www.cbd.int/sp/targets/>. Accessed on 8 February 2017.
- Cuttelod, A., García, N., Malak, D.A., Temple, H.J. and Katariya, V., (2009). *The Mediterranean: a biodiversity hotspot under threat. Wildlife in a Changing World—an analysis of the 2008 IUCN Red List of Threatened Species*, 89.
- Cuttelod, A., Seddon, M. and Neubert, E. (2011). *European Red List of Non-marine Molluscs*. Luxembourg: Publications Office of the European Union. doi:10.2779/84538
- European Commission (EC) – DG Environment (2018). *Natura 2000 Barometer*. Available online: http://ec.europa.eu/environment/nature/natura2000/barometer/index_en.htm (accessed on 11 June 2019).
- European Environment Agency (EEA) (2006). *Urban sprawl in Europe – The ignored challenge*. EEA Report No 10/2006. Luxembourg: Publications Office of the European Union.
- EEA (2017). *Halting the loss of biodiversity by 2010: proposal for a first set of indicators to monitor progress in Europe*. EEA Technical Report No. 11/2007. Luxembourg: Publications Office of the European Union.
- EEA (2015). *Ecological footprint of European countries*. European Environment Agency. Available online from: <http://www.eea.europa.eu/data-and-maps/indicators/ecological-footprint-of-european-countries/ecologicalfootprint-of-european-countries-2>. Accessed on 5 August 2016.
- European Committee for the Conservation of Bryophytes (ECCB) (1995). *Red Data Book of European bryophytes*. European Committee for the Conservation of Bryophytes, Trondheim.
- Frey, W. and Stech, M. (2009). 'Marchantiophyta, Bryophyta, Anthocerotophyta'. In: Frey, W. (ed.), *Syllabus of plant families. A Engler's Syllabus der Pflanzenfamilien*, 13th edn, Part 3 Bryophytes and seedless vascular plants. Gebr. Borntraeger Verlagsbuchhandlung, Stuttgart, pp. 13–263.
- García Criado, M., Väre, H., Nieto, A., Bento Elias, R., Dyer, R., Ivanenko, Y., Ivanova, D., Lansdown, R., Molina, J.A., Rouhan, G., Rumsey, F., Troia, A., Vrba, J. and Christenhusz, M.J.M. (2017). *European Red List of*

- Lycopods and Ferns*. Brussels, Belgium: IUCN. iv + 59pp. doi: 10.2305/IUCN.CH.2017.ERL.1.en
- Hallingbäck, T., Hodgetts, N., Raeymaekers, G., Schumacker, R., Sérgio, C., Söderström, L., Stewart, N. and Váňa, J. (1998). 'Guidelines for application of the revised IUCN threat categories to bryophytes'. *Lindbergia* 23: 6-12.
- Heinrichs, J., Grolle, R. and Drehwald, U. (1998). 'The conspecificity of *Plagiochila killarniensis* Pearson and *P. bifaria* (Sw.) Lindenb. (Hepaticae)'. *Journal of Bryology* 20: 495-497.
- Hill, M.O., Bell, N., Bruggeman-Nannenga, M.A., Brugués, M., Cano, M.J., Enroth, J., Flatberg, K.I., Frahm, J.-P., Gallego, M.T., Garilleti, R., Guerra, J., Hedenäs, L., Holyoak, D.T., Hyvönen, J., Ignatov, M.S., Lara, F., Mazimpaka, V., Muñoz, J. & Söderström, L. (2006). 'An annotated checklist of the mosses of Europe and Macaronesia'. *Journal of Bryology* 28: 198–267. Doi: 10.1179/174328206X119998
- Hochkirch, A., Nieto, A., García Criado, M., Cáliz, M., Braud, Y., Buzzetti, F. M., Chobanov, D., Odé, B., Presa Asensio, J. J., Willemse, L., Zuna-Kratky, T., Barranco Vega, P., Bushell, M., Clemente, M.E., Correas, J. R., Dusoulier, F., Ferreira, S., Fontana, P., García, M. D., Heller, K.-G., Iorgu I. Ş., Ivković, S., Kati, V., Kleukers, R., Krištín, A., Lemonnier-Darcemont, M., Lemos, P., Massa, B., Monnerat, C., Papapavlou, K. P., Prunier, F., Pushkar, T., Roesti, C., Rutschmann, F., Şirin, D., Skejo, J., Szövényi, G., Tzirkalli, E., Vedenina, V., Barat Domenech, J., Barros, F., Cordero Tapia, P. J., Defaut, B., Fartmann, T., Gomboc, S., Gutiérrez-Rodríguez, J., Holuša, J., Illich, I., Karjalainen, S., Kočárek, P., Korsunovskaya, O., Liana, A., López, H., Morin, D., Olmo-Vidal, J. M., Puskás, G., Savitsky, V., Stalling, T. and Tumbrinck, J. (2016). *European Red List of grasshoppers, crickets and bush-crickets*. Luxembourg: Publications Office of the European Union. doi:10.2779/60944
- Hodgetts, N.G. (2015). *Checklist and country status of European bryophytes – towards a new Red List for Europe*. Irish Wildlife Manuals, No. 84. National Parks & Wildlife Service, Department of Arts, Heritage & the Gaeltacht, Ireland.
- Hofmann, H., Senn-Irlet, B. and Stofer, S. (2006). *Prioritätensetzung für Pilze, Flechten und Moose im Kanton Bern*. Naturschutzinspektorat des Kantons Bern, Bern.
- Hofmann, H., Schnyder, N. and Kiebacher, T. (2016). *Rudolphis Trompetenmoos – Nachsuche im Kanton Bern*. Abteilung Naturförderung des Kantons Bern (ANF).
- International Union for Conservation of Nature (IUCN) (2011). 'Guidelines for reporting on proportion threatened. Version 1.0.' In: IUCN (2011). *Guidelines for appropriate uses of IUCN Red List data. Incorporating the guidelines for reporting on proportion threatened and the guidelines on scientific collecting of threatened species. Version 2*. Adopted by the IUCN Red List Committee and IUCN SSC Steering Committee. Downloadable from: http://www.iucnredlist.org/documents/RL_Guidelines_Data_Use.pdf
- IUCN (2012a). *IUCN Red List categories and criteria: Version 3.1*. Second edition. Gland, Switzerland and Cambridge, UK: IUCN.
- IUCN (2012b). *Guidelines for application of IUCN Red List criteria at regional and national levels. Version 4.0*. IUCN Species Survival Commission. Gland: IUCN.
- IUCN (2014). *Guidelines for using the IUCN Red List categories and criteria*. Version 11. Prepared by the Standards and Petitions Subcommittee. Gland, Switzerland and Cambridge, UK: IUCN. Available at: <http://www.iucnredlist.org/documents/RedListGuidelines.pdf>.
- IUCN (2015). *European species under threat. Overview of European Red Lists results*. Downloadable from: https://www.iucn.org/downloads/red_list_overview_new_1.pdf
- Janauer, G.A., Albrecht, J. and Stratmann, L. (2015). 'Synergies and conflicts between Water Framework Directive and Nature 2000: legal requirements technical guidance and experience from practice'. In: Ignar, S. and Grygoruk, M. (eds.), 'Wetlands and Water Framework Directive. Protection, management and climate change'. *GeoPlanet: Earth and Planetary Sciences*. Springer Open, ISSN 2190-5193, pp. 9–29.
- Kiebacher, T., Bergamini, A., Scheidegger, C. and Bürgi, M. (2018). *Bergahornweiden im Alpenraum: Kulturgeschichte, Biodiversität und Rudolphis Trompetenmoos*. Haupt.
- Laine, J., Flatberg, K.I., Harju, P., Timonen, T., Minkkinen, K., Laine, A., Tuittila, E.-S. and Vasander, H. (2018). *Sphagnum mosses - the stars of European mires*. Helsinki, University of Helsinki.
- Meinunger, L. and Schröder, W. (2007). *Verbreitungsatlas der Moose Deutschlands - Band 2*. Oliver Dürhammer für die Regensburgische Botanische Gesellschaft, Regensburg.
- Morris, J.L., Puttick, M.N., Clark, J.W., Edwards, D., Kenrick, P., Pressel, S., Wellman, C.H., Yang, Z., Schneider, H. and Donoghue, P.C.J. (2018). 'The timescale of early land plant evolution'. *Proceedings of the National Academy of Sciences of the United States of America* 115(10): E2274-E2283. Doi: 10.1073/pnas.1719588115
- Müller, N. (2016). 'Überraschend üppige Population von *Tayloria rudolphiana* auf dem Grüscher Älpeli'. *Meylania* 58: 14-18.
- Patiño, J. and Vanderpoorten, A. (2018). 'Bryophyte Biogeography'. *Critical Reviews in Plant Sciences* 37:2-3, 175-209, doi: 10.1080/07352689.2018.1482444

- Pearce, F. (2018). 'Can the World Find Solutions to the Nitrogen Pollution Crisis?'. *Yale Environment* 360. Available at: <https://e360.yale.edu/features/can-the-world-find-solutions-to-the-nitrogen-pollution-crisis>
- Pedroli, G.B.M. and Meiner, A. (2017). *Landscapes in transition*. No. 10/2017. European Environment Agency (EEA).
- Porley, R. and Hodgetts, N. (2005). *Mosses and Liverworts*. *New Naturalist* No. 97. HarperCollins, London.
- Puttick, M.N., Morris, J.L., Williams, T.A., Cox, C.J., Edwards, D., Kenrick, P., Pressel, S., Wellman, C.H., Schneider, H., Pisani, D. and Donoghue, P.C.J. (2018). 'The Interrelationships of Land Plants and the Nature of the Ancestral Embryophyte'. *Current Biology* 28, 733–745. doi: 10.1016/j.cub.2018.01.063
- Ratcliffe, D.A. (1968). 'An ecological account of Atlantic bryophytes in the British isles'. *New Phytologist* 67: 365-439.
- Ros, R.M., Mazimpaka, V., Abou-Salama, U., Aleffi, M., Blockeel, T.L., Brugués, M., Cros, R.M., Dia, M.G., Dirkse, G.M., Draper, I., El-Saadawi, W., Erdağ, A., Ganeva, A., Gabriel, R., González-Mancebo, J.M., Granger, C., Herrnstadt, I., Hugonnot, V., Khalil, K., Kürschner, H., Losada-Lima, A., Luís, L., Mifsud, S., Privitera, M., Puglisi, M., Sabovljević, M., Sérgio, C., Shabbara, H.M., Sim-Sim, M., Sotiaux, A., Tacchi, R., Vanderpoorten, A. and Werner, O. (2013). 'Mosses of the Mediterranean, an annotated checklist'. *Cryptogamie, Bryologie* 34: 99-283. doi: 10.7872/cryb.v34.iss2.2013.99
- Söderström, L., Urmi, E. and Váňa, J. (2007). 'The distribution of Hepaticae and Anthocerotae in Europe and Macaronesia – Update 1–427'. *Cryptogamie, Bryologie* 28: 299–350.
- Stark, L.R., Greenwood, J.L. and Brinda, J.C. (2016). 'Desiccated *Syntrichia ruralis* shoots regenerate after 20 years in the herbarium'. *Journal of Bryology* 39(1): 85-93. doi: 10.1080/03736687.2016.1176307
- UN DESA (2015). *World Population Prospects: The 2015 Revision*. United Nations, Department of Economic and Social Affairs. Available online from: <http://esa.un.org/unpd/wpp/ExcelData/population.htm>. Accessed on 8 September 2016.
- UNEP (2011). *Pan-European 2020 Strategy For Biodiversity. With a focus on: Cooperation for the conservation and sustainable use of PanEuropean biodiversity and the coordinated national implementation of biodiversity-related Multilateral Environmental Agreements (MEAs)*. Nairobi: United Nations Environment Programme.
- Valentini, M., Bisang, I., Jacot, K. and Bergamini, A. (2016). 'Do Bryophytes Profit from Agri-environmental Schemes? A Comparison of Different "Ecological Focus Area" in the Swiss Lowlands'. Conference paper. 9th Conference of European Committee for Conservation of Bryophytes. 26-29. April 2016. Bečići, Montenegro.
- Vicente-Serrano, S.M., Lopez-Moreno, J.I., Beguería, S., Lorenzo-Lacruz, J., Sanchez-Lorenzo, A., García-Ruiz, J.M., Azorin-Molina, C., Morán-Tejeda, E., Revuelto, J. and Trigo, R. (2014). 'Evidence of increasing drought severity caused by temperature rise in southern Europe'. *Environmental Research Letters* 9(4): 1-9. Doi: 10.1088/1748-9326/9/4/044001
- Villareal, J.C., Cargill, D.C., Hagborg, A., Söderström, S. and Renzaglia, K.S. (2010). 'A synthesis of hornwort diversity: patterns, causes and future work'. *Phytotaxa* 9: 150-166. Doi: 10.11646/phytotaxa.9.1.8

Appendix 1. List of lead assessors by geographical region

- Central Europe: Norbert Schnyder and Christian Schröck
- Eastern Europe: Nadya Konstantinova and Elvira Baisheva
- Macaronesia: Manuela Sim Sim
- Northern Europe: Tomas Hallingbäck
- Northwestern Europe: Nick Hodgetts
- Southern Europe: Patrizia Campisi and Annalena Cogoni
- Southeastern Europe: Marko Sabovljevic
- Southwestern Europe: Cecilia Sérgio

Appendix 2. Example of species summary and distribution map

The Red List assessment of *Orthotrichum urnigerum* on the following pages provides an example of the information that has been compiled for all the European bryophyte species, including a distribution map. You can search for and download all the assessments and distribution maps from the European Red List website and data portal available online at <http://ec.europa.eu/environment/nature/conservation/species/redlist/> and <https://www.iucnredlist.org/regions/europe>.



Encalypta mutica - I. Hagen

PLANTAE - BRYOPHYTA - BRYOPSIDA - ENCALYPTALES - ENCALYPTACEAE - Encalypta - mutica

Common Names: Trubbklockmossa (Swedish)

Synonyms: No Synonyms

Red List Status

VU - Vulnerable, C2a(i) (IUCN version 3.1)

Red List Assessment

Assessment Information

Reviewed?	Date of Review:	Status:	Reasons for Rejection:	Improvements Needed:
true	2017-07-26	Passed -	-	-

Assessor(s): Hodgetts, N., Blockeel, T., Konstantinova, N., Lönnell, N., Papp, B., Schnyder, N., Schröck, C., Sergio, C. & Untereiner, A.

Reviewer(s): Wilbraham, J. & Cáliz, M.

Assessment Rationale

European regional assessment: Vulnerable (VU)

EU 28 regional assessment: Vulnerable (VU)

Encalypta mutica is an essentially Arctic species that for a long time was thought to be a Scandinavian endemic, but it is now also known from Estonia and Arctic European Russia. This rare species is assessed as Vulnerable since it is estimated that there are fewer than 10,000 individual-equivalents in Europe and in the EU 28, and that each subpopulation has fewer than 1,000 individual-equivalents. One individual-equivalent (i.e., mature individual) is considered to be one square meter on which the species grows. In addition, the current population trend is decreasing slightly.

Although the threats to this species appear to be largely unknown, it is certainly threatened, as it is both rare and apparently declining. It appears that it may be threatened by a lack of grazing in some localities. In the south part of Scandinavia, it is affected by the overgrowing of higher vegetation. Three localities were taken under monitoring in Estonia, where either grazing or simulation of grazing is needed in order to re-create and preserve suitable open soil patches for this species. Similar management can be recommended elsewhere. Research into threats is also recommended.

Distribution

Geographic Range

Encalypta mutica is an essentially Arctic species that for a long time was thought to be a Scandinavian endemic, but it is now also known from Estonia and Arctic European Russia. The record from the Czech Republic was excluded in the 2003 edition of the Czech Red List (Kučera and Váňa 2003), but is considered at best uncertain in this assessment. Old records from Romania are probably errors (S. Stefanut pers. comm. 2016). There are also records from the lowlands of Ukraine but, without further details or specimens, these have to be regarded with scepticism. Elsewhere it occurs in Siberia, Greenland and northern North America. This species' area of occupancy (AOO) is estimated at 452 km², and its extent of occurrence (EOO) at ca 2.9 million km².

Elevation / Depth / Depth Zones

Elevation Lower Limit (in metres above sea level): 0

Elevation Upper Limit (in metres above sea level): 900

Map Status

Map Status	How the map was created, including data sources/methods used:	Please state reason for map not available:	Data Sensitive?	Justification	Geographic range this applies to:	Date restriction imposed:
Done	-	-	-	-	-	-

Biogeographic Realms

Biogeographic Realm: Palearctic

Occurrence

Countries of Occurrence

Country	Presence	Origin	Formerly Bred	Seasonality
Czechia	Presence Uncertain	Native	-	Resident
Estonia	Extant	Native	-	Resident
Finland	Extant	Native	-	Resident
Norway	Extant	Native	-	Resident
Romania	Presence Uncertain	Native	-	Resident
Russian Federation	Extant	Native	-	Resident
Russian Federation -> European Russia	Extant	Native	-	Resident
Russian Federation -> European Russia -> North European Russia	Extant	Native	-	Resident
Svalbard and Jan Mayen	Extant	Native	-	Resident
Sweden	Extant	Native	-	Resident
Ukraine	Presence Uncertain	Native	-	Resident
Ukraine -> Ukraine (main part)	Presence Uncertain	Native	-	Resident

Population

This species may have disappeared from some of its Norwegian localities, including the type locality near Trondheim (Hallingbäck et al. 2006). It seems to be threatened and declining in Estonia, where, in 2006, it was not found at one previously known locality (Vellak & Ingerpuu 2012). In Murmansk there is only one locality (where it is rare), and a single locality in Karelia and in the Polar Urals. The species is rather overlooked in the mountains where it is stable, although in the lowlands it can be declining in limestone quarries. The overall current population trend is considered to be decreasing slightly. The population is not severely fragmented. It is estimated that there are fewer than 10,000 individual-equivalents in Europe and in the EU 28, and that each subpopulation has fewer than 1,000 individual-equivalents. One individual-equivalent (i.e., mature individual) is considered to be one square meter on which the species grows.

Habitats and Ecology

This essentially Arctic species grows on bare calcareous, and periodically wet, soil, typically in very sun-exposed situations, for example on alvar heaths, in limestone quarries and on gravel produced by weathering at the base of south-facing, calcium-rich alpine slopes. Associates include *Ditrichum flexicaule*, *Encalypta vulgaris*, *Myurella julacea* and *Weissia controversa*. The altitudinal range is from sea level up to 900 m Asl.

IUCN Habitats Classification Scheme

Habitat	Season	Suitability	Major Importance?
4.2. Grassland -> Grassland - Subarctic	Resident	Suitable	Yes
6. Rocky areas (eg. inland cliffs, mountain peaks)	Resident	Suitable	Yes

Systems

System: Terrestrial

Use and Trade

General Use and Trade Information

This species is not utilised or traded.

Threats

Although the threats to this species appear to be largely unknown, it is certainly threatened, as it is both rare and apparently declining. It appears that it may be threatened by a lack of grazing in some localities. In the south part of Scandinavia, it is affected by the overgrowing of higher vegetation.

Conservation

Three localities were taken under monitoring in Estonia, where either grazing or simulation of grazing is needed (by breaking the sod and opening the soil artificially) in order to re-create and preserve suitable open soil patches for this species (Vellak and Ingerpuu 2012). Similar management can be recommended elsewhere. Research into threats is also recommended. It is listed as Endangered in Finland, Vulnerable in Norway and Near Threatened in Sweden (Hodgetts 2015). It is known to occur in protected areas.

Bibliography

Hallingbäck, T., Lönnell, N. and Weibull, H. 2006. *Encyclopedia of the Swedish Flora and Fauna: Bladmossor: Sköldmossor–Blåmossor. Bryophyta: Buxbaumia–Leucobryum*. ArtDatabanken, Uppsala.

Hodgetts, N.G. 2015. Checklist and country status of European bryophytes – towards a new Red List for Europe. *Irish Wildlife Manuals*, No. 84. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Ireland.

IUCN. 2019. The IUCN Red List of Threatened Species. Version 2019-2. Available at: www.iucnredlist.org. (Accessed: 04 July 2019).

Kučera, J. and Váňa, J. 2003. Check- and Red List of bryophytes of the Czech Republic. *Preslia* 75: 193-222.

Vellak, K. and Ingerpuu, N. 2012. The state of bryophyte conservation in Estonia. *Studia Botanica Hungarica* 43: 59-68.



Encalypta mutica

Range

- Extant (resident)
- Presence Uncertain

Citation:
International Union for Conservation
of Nature (IUCN) & GBIF

Map created 06/01/2019



THE IUCN RED LIST
OF THREATENED SPECIES™

The boundaries and names shown and the designations used on this map do not imply any official endorsement, acceptance or opinion by IUCN.

Appendix 3. Red List status of European mosses, liverworts and hornworts

Taxonomy	IUCN Red List Category (Europe)	IUCN Red List Criteria (Europe)	IUCN Red List Category (EU 28)	IUCN Red List Criteria (EU 28)	Endemic to Europe	Endemic to EU 28
<i>ACROBOLBACEAE</i>						
<i>Acrobolbus azoricus</i>	EN	B2ab(iii,iv,v)	EN	B2ab(iii,iv,v)	Yes	Yes
<i>Acrobolbus madeirensis</i>	EN	B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v); C2a(i)	EN	B2ab(ii,iii,iv,v); C2a(i)	Yes	Yes
<i>Acrobolbus wilsonii</i>	VU	D1	VU	D1	Yes	No
<i>ADELANTHACEAE</i>						
<i>Adelanthus lindenbergianus</i>	EN	C2a(i)	EN	C2a(i)	No	No
<i>Pseudomarsupidium decipiens</i>	LC		LC		No	No
<i>AMBLYSTEGIACEAE</i>						
<i>Amblystegium serpens</i>	LC		LC		No	No
<i>Anacamptodon splachnoides</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Arvernella microclada</i>	EN	D	EN	D	Yes	Yes
<i>Campyliadelphus chrysophyllus</i>	LC		LC		No	No
<i>Campyliadelphus elodes</i>	NT	A2c	NT	A2c	No	No
<i>Campylium laxifolium</i>	LC		LC		No	No
<i>Campylium longicuspis</i>	VU	D1	CR	D	No	No
<i>Campylium protensum</i>	LC		LC		No	No
<i>Campylium stellatum</i>	LC		LC		No	No
<i>Campylophyllopsis calcarea</i>	LC		LC		No	No
<i>Campylophyllopsis sommerfeltii</i>	LC		LC		No	No
<i>Conardia compacta</i>	NT	D1	NT	D1	No	No
<i>Cratoneuron curvicaule</i>	LC		LC		No	No
<i>Cratoneuron filicinum</i>	LC		LC		No	No
<i>Drepanocladus aduncus</i>	LC		LC		No	No
<i>Drepanocladus angustifolius</i>	VU	B2ab(iii)	VU	B2ab(iii); C2a (i)	No	No
<i>Drepanocladus arcticus</i>	NT	B2b(iii)	NE		No	No
<i>Drepanocladus brevifolius</i>	LC		NE		No	No
<i>Drepanocladus capillifolius</i>	NT	B1b(iii,v)	NT		No	No
<i>Drepanocladus lycopodioides</i>	VU	A2c; B2ab(ii,iii,iv,v)	VU	A2c; B2ab(ii,iii,iv,v)	No	No
<i>Drepanocladus polygamus</i>	LC		LC		No	No
<i>Drepanocladus sendtneri</i>	VU	A2c; B2ab(ii,iii,iv,v); C2a(i)	VU	A2c; B2ab(ii,iii,iv,v); C2a(i)	No	No
<i>Drepanocladus sordidus</i>	NT	B2ab(i)	NT		No	No
<i>Drepanocladus trifarius</i>	LC		LC		No	No
<i>Drepanocladus turgescens</i>	LC		VU	C2a(i)	No	No
<i>Hygroamblystegium fluviatile</i>	LC		LC		No	No
<i>Hygroamblystegium humile</i>	LC		LC		No	No
<i>Hygroamblystegium tenax</i>	LC		LC		No	No
<i>Hygroamblystegium varium</i>	LC		LC		No	No
<i>Hygrohypnella ochracea</i>	LC		LC		No	No
<i>Hygrohypnella polaris</i>	LC		NT		No	No

Taxonomy	IUCN Red List Category (Europe)	IUCN Red List Criteria (Europe)	IUCN Red List Category (EU 28)	IUCN Red List Criteria (EU 28)	Endemic to Europe	Endemic to EU 28
<i>Hygrohypnum luridum</i>	LC		LC		No	No
<i>Hygrohypnum styriacum</i>	EN	B2ab(iii); C2a(i)	EN	B2ab(iii); C2a(i)	No	No
<i>Leptodictyum riparium</i>	LC		LC		No	No
<i>Ochyraea tatrensis</i>	CR	B1ab(iii,v)+2ab(iii,v); C2a(i); D	CR	B1ab(iii)+2ab(iii); C2a(i); D	No	No
<i>Palustriella commutata</i>	LC		LC		No	No
<i>Palustriella decipiens</i>	LC		LC		No	No
<i>Palustriella falcata</i>	LC		LC		No	No
<i>Platydictya jungermannioides</i>	LC		LC		No	No
<i>Platyhypnum alpestre</i>	LC		LC		No	No
<i>Platyhypnum alpinum</i>	LC		LC		No	No
<i>Platyhypnum cochlearifolium</i>	EN	C2a(i)	EN	C2a (i)	No	No
<i>Platyhypnum duriusculum</i>	LC		LC		No	No
<i>Platyhypnum molle</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Platyhypnum norvegicum</i>	VU	D1	EN	D	No	No
<i>Platyhypnum smithii</i>	LC		LC		No	No
<i>Pseudoamblystegium subtile</i>	LC		LC		No	No
<i>Pseudocampylium radicale</i>	LC		LC		No	No
<i>Pseudohygrohypnum eugyrium</i>	LC		LC		No	No
<i>Pseudohygrohypnum subeugyrium</i>	NT	D1	VU	D1	No	No
<i>Sanionia nivalis</i>	NT	B2b(iii)	NT		No	No
<i>Sanionia orthothecoides</i>	LC		LC		No	No
<i>Sanionia uncinata</i>	LC		LC		No	No
<i>Serpoleskea confervoides</i>	LC		LC		No	No
ANASTROPHYLLACEAE						
<i>Biantheridion undulifolium</i>	EN	B2ab(i,ii,iii,iv,v); C2a(i)	EN	B2ab(i,ii,iii,iv,v); C2a(i)	No	No
<i>Crossocalyx hellerianus</i>	LC		LC		No	No
<i>Neoorthocaulis attenuatus</i>	LC		LC		No	No
<i>Neoorthocaulis binsteadii</i>	LC		LC		No	No
<i>Neoorthocaulis floerkei</i>	LC		LC		No	No
<i>Neoorthocaulis hyperboreus</i>	VU	D1	NE		No	No
<i>Orthocaulis atlanticus</i>	LC		LC		No	No
<i>Orthocaulis cavifolius</i>	DD		DD		No	No
<i>Schljakovia kunzeana</i>	LC		LC		No	No
<i>Schljakovianthus quadrilobus</i>	LC		LC		No	No
<i>Tetralophozia filiformis</i>	CR	D	CR	D	No	No
<i>Tetralophozia setiformis</i>	LC		NT		No	No
ANDREAEACEAE						
<i>Andreaea alpestris</i>	DD		DD		Yes	No
<i>Andreaea alpina</i>	LC		LC		No	No
<i>Andreaea blyttii</i>	NT	A3c; B2b(iii,iv,v)	NT		No	No
<i>Andreaea crassinervia</i>	EN	C2a(i)	EN	C2a(i)	No	No
<i>Andreaea flexuosa</i>	EN	B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v)	EN	B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v)	No	No
<i>Andreaea frigida</i>	VU	C1	VU	C1	Yes	No
<i>Andreaea heinemannii</i>	NT	B2a	NT	B2a	No	No
<i>Andreaea hookeri</i>	LC		LC		No	No

Taxonomy	IUCN Red List Category (Europe)	IUCN Red List Criteria (Europe)	IUCN Red List Category (EU 28)	IUCN Red List Criteria (EU 28)	Endemic to Europe	Endemic to EU 28
<i>Andreaea megistospora</i>	LC		LC		No	No
<i>Andreaea mutabilis</i>	LC		LC		No	No
<i>Andreaea nivalis</i>	NT		LC		No	No
<i>Andreaea rothii</i>	LC		LC		No	No
<i>Andreaea rupestris</i>	LC		LC		No	No
<i>Andreaea sinuosa</i>	VU	D1+2	VU	D1+2	No	No
ANEURACEAE						
<i>Aneura latissima</i>	EN	B2ab(ii,iii)	EN	B2ab(ii,iii)	No	No
<i>Aneura maxima</i>	DD		DD		No	No
<i>Aneura mirabilis</i>	NT	D1	NT		No	No
<i>Aneura pinguis</i>	LC		LC		No	No
<i>Riccardia chamedryfolia</i>	LC		LC		No	No
<i>Riccardia incurvata</i>	LC		LC		No	No
<i>Riccardia latifrons</i>	LC		LC		No	No
<i>Riccardia multifida</i>	LC		LC		No	No
<i>Riccardia palmata</i>	LC		LC		No	No
ANOMODONTACEAE						
<i>Anomodon attenuatus</i>	LC		LC		No	No
<i>Anomodon longifolius</i>	LC		LC		No	No
<i>Anomodon rugelii</i>	NT	D1	VU	D1	No	No
<i>Anomodon tristis</i>	VU	D1	VU		No	No
<i>Anomodon viticulosus</i>	LC		LC		No	No
ANTHELIACEAE						
<i>Anthelia julacea</i>	LC		LC		No	No
<i>Anthelia juratzkana</i>	LC		LC		No	No
ANTHOCEROTACEAE						
<i>Anthoceros agrestis</i>	NT	A2c+3c	NT	A2c+3c	No	No
<i>Anthoceros caucasicus</i>	LC		LC		No	No
<i>Anthoceros neesii</i>	EN	B2ab(iii)	EN	B2ab(iii)	Yes	Yes
<i>Anthoceros punctatus</i>	LC		LC		No	No
ARCHIDIACEAE						
<i>Archidium alternifolium</i>	LC		LC		No	No
ARNELLIACEAE						
<i>Arnellia fennica</i>	LC		NT		No	No
<i>Gongylanthus ericetorum</i>	LC		LC		No	No
<i>Southbya nigrella</i>	LC		LC		No	No
<i>Southbya tophacea</i>	LC		LC		No	No
AULACOMNIACEAE						
<i>Aulacomnium androgynum</i>	LC		LC		No	No
<i>Aulacomnium palustre</i>	LC		LC		No	No
<i>Aulacomnium turgidum</i>	LC		LC		No	No
AYTONIACEAE						
<i>Asterella africana</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Asterella lindenbergiana</i>	LC		LC		No	No
<i>Asterella saccata</i>	EN	B2ab(iii,iv,v)	EN	B2ab(iii,iv,v)	No	No
<i>Mannia androgyna</i>	LC		LC		No	No
<i>Mannia californica</i>	EN	D	EN	D	No	No

Taxonomy	IUCN Red List Category (Europe)	IUCN Red List Criteria (Europe)	IUCN Red List Category (EU 28)	IUCN Red List Criteria (EU 28)	Endemic to Europe	Endemic to EU 28
<i>Mannia controversa</i>	EN	D	EN	D	No	No
<i>Mannia fragrans</i>	VU	A2c	VU	A2c	No	No
<i>Mannia gracilis</i>	LC		LC		No	No
<i>Mannia pilosa</i>	LC		LC		No	No
<i>Mannia sibirica</i>	CR	D	CR	D	No	No
<i>Mannia triandra</i>	VU	D1	VU	D1	No	No
<i>Plagiochasma appendiculatum</i>	VU	D2	VU	D2	No	No
<i>Plagiochasma rupestre</i>	LC		LC		No	No
<i>Reboulia hemisphaerica</i>	LC		LC		No	No
BARTRAMIACEAE						
<i>Anacolia menziesii</i>	VU	D1	VU	D1	No	No
<i>Anacolia webbii</i>	LC		LC		No	No
<i>Bartramia aprica</i>	LC		LC		No	No
<i>Bartramia breviseta</i>	VU	D1	NE		No	No
<i>Bartramia halleriana</i>	LC		LC		No	No
<i>Bartramia ithyphylla</i>	LC		LC		No	No
<i>Bartramia laevisphaera</i>	EN	D	EN	D	No	No
<i>Bartramia pomiformis</i>	LC		LC		No	No
<i>Bartramia subulata</i>	EN	D	EN	D	No	No
<i>Breutelia azorica</i>	EN	A3c; B2ab(iii,v)	EN	A3c; B2ab(iii,v)	Yes	Yes
<i>Breutelia chrysocoma</i>	LC		LC		Yes	No
<i>Conostomum tetragonum</i>	LC		LC		No	No
<i>Philonotis caespitosa</i>	LC		LC		No	No
<i>Philonotis calcarea</i>	NT	A3c	NT	A3c	No	No
<i>Philonotis capillaris</i>	LC		LC		No	No
<i>Philonotis cernua</i>	CR	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C2a(i); D	CR	B2ab(i,ii,iii,iv,v); C2a(i); D	No	No
<i>Philonotis fontana</i>	LC		LC		No	No
<i>Philonotis hastata</i>	NT	B2ab(iii)	NT	B2ab(iii)	No	No
<i>Philonotis marchica</i>	EN	C2a(i)	EN	C2a(i)	No	No
<i>Philonotis rigida</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Philonotis seriata</i>	LC		LC		No	No
<i>Philonotis tomentella</i>	LC		NT		No	No
<i>Philonotis uncinata</i>	VU	B2ab(iii)	VU	B2ab(iii)	No	No
<i>Plagiopus oederianus</i>	LC		LC		No	No
BLASIACEAE						
<i>Blasia pusilla</i>	LC		LC		No	No
BRACHYTHECIACEAE						
<i>Brachytheciastrum collinum</i>	LC		NT	D1	No	No
<i>Brachytheciastrum dieckei</i>	LC		LC		No	No
<i>Brachytheciastrum olympicum</i>	VU	B2ab(ii,iv)	VU	B2ab(ii,iv)	No	No
<i>Brachytheciastrum trachypodium</i>	LC		LC		No	No
<i>Brachytheciastrum vanekii</i>	EN	B1ab(iii,iv,v)+2ab(iii,iv,v)	EN	B1ab(iii,iv,v)+2ab(iii,iv,v)	Yes	Yes
<i>Brachytheciastrum velutinum</i>	LC		LC		No	No
<i>Brachythecium albicans</i>	LC		LC		No	No
<i>Brachythecium buchananii</i>	EN	B2ab(iii); D	NE		No	No
<i>Brachythecium campestre</i>	LC		LC		No	No
<i>Brachythecium capillaceum</i>	LC		DD		No	No

Taxonomy	IUCN Red List Category (Europe)	IUCN Red List Criteria (Europe)	IUCN Red List Category (EU 28)	IUCN Red List Criteria (EU 28)	Endemic to Europe	Endemic to EU 28
<i>Brachythecium cirrosom</i>	LC		LC		No	No
<i>Brachythecium erythrorrhizon</i>	LC		LC		No	No
<i>Brachythecium funkii</i>	VU	D1	VU	D1	Yes	Yes
<i>Brachythecium gebeebii</i>	VU	D1	VU	D1	Yes	No
<i>Brachythecium glareosum</i>	LC		LC		No	No
<i>Brachythecium japygum</i>	LC		LC		Yes	No
<i>Brachythecium laetum</i>	LC		LC		No	No
<i>Brachythecium mildeanum</i>	LC		LC		No	No
<i>Brachythecium novae-angliae</i>	LC		VU	D1	No	No
<i>Brachythecium rivulare</i>	LC		LC		No	No
<i>Brachythecium rutabulum</i>	LC		LC		No	No
<i>Brachythecium salebrosum</i>	LC		LC		No	No
<i>Brachythecium tauriscorum</i>	LC		LC		No	No
<i>Brachythecium tenuicaule</i>	LC		LC		Yes	No
<i>Brachythecium tommasinii</i>	LC		LC		No	No
<i>Brachythecium turgidum</i>	LC		LC		No	No
<i>Brachythecium udum</i>	LC		LC		No	No
<i>Cirriphyllum crassinervium</i>	LC		LC		No	No
<i>Cirriphyllum piliferum</i>	LC		LC		No	No
<i>Clasmatodon parvulus</i>	RE		RE		No	No
<i>Eurhynchiastrum pulchellum</i>	LC		LC		No	No
<i>Eurhynchium angustirete</i>	LC		LC		No	No
<i>Eurhynchium striatum</i>	LC		LC		No	No
<i>Hedenasiastrum percurrans</i>	EN	A3c	EN	A3c	Yes	Yes
<i>Homalothecium aureum</i>	LC		LC		No	No
<i>Homalothecium lutescens</i>	LC		LC		No	No
<i>Homalothecium mandonii</i>	VU	A3c	VU	A3c	No	No
<i>Homalothecium meridionale</i>	LC		LC		Yes	No
<i>Homalothecium philippeanum</i>	LC		LC		No	No
<i>Homalothecium sericeum</i>	LC		LC		No	No
<i>Kindbergia praelonga</i>	LC		LC		No	No
<i>Microeurhynchium pumilum</i>	LC		LC		No	No
<i>Myuroclada longiramea</i>	DD		NA		No	No
<i>Myuroclada maximowiczii</i>	NA		NE		No	No
<i>Nobregaea latinervis</i>	EX		EX		Yes	Yes
<i>Oxyrrhynchium bians</i>	LC		LC		No	No
<i>Oxyrrhynchium schleicheri</i>	LC		LC		No	No
<i>Oxyrrhynchium speciosum</i>	LC		LC		No	No
<i>Palamocladium euchloron</i>	EN	B2ab(iii); D	CR	D	No	No
<i>Platyhypnidium grolleanum</i>	DD		DD		Yes	Yes
<i>Pseudorhynchostegiella duriaei</i>	NT		NT		No	No
<i>Pseudoscleropodium purum</i>	LC		LC		No	No
<i>Rhynchostegiella azorica</i>	NT	B1a+2a	NT	B1a+2a	Yes	Yes
<i>Rhynchostegiella bourgaeana</i>	EN	A3c; B2ab(iii)	EN	A3c; B2ab(iii)	Yes	Yes
<i>Rhynchostegiella curviseta</i>	LC		LC		No	No
<i>Rhynchostegiella litorea</i>	LC		LC		No	No

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<i>Rhynchostegiella pseudolitorea</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Rhynchostegiella tenella</i>	LC		LC		No	No
<i>Rhynchostegiella teneriffae</i>	LC		LC		No	No
<i>Rhynchostegiella trichophylla</i>	VU	A3c	VU	A3c	Yes	Yes
<i>Rhynchostegiella tubulosa</i>	DD		DD		Yes	Yes
<i>Rhynchostegium alopecuroides</i>	LC		LC		Yes	No
<i>Rhynchostegium confertum</i>	LC		LC		No	No
<i>Rhynchostegium confusum</i>	VU	D1	VU	D1	Yes	Yes
<i>Rhynchostegium megapolitanum</i>	LC		LC		No	No
<i>Rhynchostegium murale</i>	LC		LC		No	No
<i>Rhynchostegium riparioides</i>	LC		LC		No	No
<i>Rhynchostegium rotundifolium</i>	LC		LC		No	No
<i>Rhynchostegium strongylense</i>	EN	D	EN	D	Yes	Yes
<i>Sciuro-hypnum curtum</i>	LC		LC		No	No
<i>Sciuro-hypnum dovreense</i>	VU	C2a(i)	EN	C2a(i)	No	No
<i>Sciuro-hypnum flotowianum</i>	LC		LC		No	No
<i>Sciuro-hypnum glaciale</i>	LC		LC		No	No
<i>Sciuro-hypnum latifolium</i>	LC		NT		No	No
<i>Sciuro-hypnum oedipodium</i>	DD		NE		No	No
<i>Sciuro-hypnum ornellanum</i>	EN	D	EN	D	No	No
<i>Sciuro-hypnum plumosum</i>	LC		LC		No	No
<i>Sciuro-hypnum populeum</i>	LC		LC		No	No
<i>Sciuro-hypnum reflexum</i>	LC		LC		No	No
<i>Sciuro-hypnum starkei</i>	LC		LC		No	No
<i>Sciuro-hypnum tromsoeense</i>	LC		LC		No	No
<i>Scleropodium cespitans</i>	LC		LC		No	No
<i>Scleropodium touretii</i>	LC		LC		No	No
<i>Scorpiurium circinatum</i>	LC		LC		No	No
<i>Scorpiurium deflexifolium</i>	LC		LC		No	No
<i>Scorpiurium sendtneri</i>	LC		LC		No	No
<i>Tomentypnum nitens</i>	NT	A2c	NT		No	No
BRUCHIACEAE						
<i>Bruchia flexuosa</i>	CR	D	CR	D	No	No
<i>Bruchia vogesiaca</i>	EN	B2ab(ii,iii,iv)	EN	B2ab(ii,iii,iv)	No	No
<i>Trematodon ambiguus</i>	LC		LC		No	No
<i>Trematodon brevicollis</i>	VU	D1	VU	D1	No	No
<i>Trematodon laetevirens</i>	EN	D	EN	D	No	No
<i>Trematodon longicollis</i>	VU	D1	VU	D1	No	No
<i>Trematodon perssoniorum</i>	CR	B1ab(iii)	CR	B1ab(iii)	Yes	Yes
BRYACEAE						
<i>Anomobryum bavaricum</i>	VU	D1	VU	D1	No	No
<i>Anomobryum concinatum</i>	LC		LC		No	No
<i>Anomobryum julaceum</i>	LC		LC		No	No
<i>Anomobryum lusitanicum</i>	VU	D1	VU	D1	Yes	Yes
<i>Brachymenium notarisii</i>	NT	B2b(iii,iv,v)	NT	B2b(iii,iv,v)	No	No
<i>Brachymenium paradoxum</i>	DD		NE		Yes	No
<i>Brachymenium philonotula</i>	RE		RE		No	No

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<i>Bryum apiculatum</i>	LC		LC		No	No
<i>Bryum argenteum</i>	LC		LC		No	No
<i>Bryum austriacum</i>	VU	D1	VU	D1	Yes	No
<i>Bryum blindii</i>	EN	D	EN	D	No	No
<i>Bryum calophyllum</i>	EN	B2ab(ii,iii,iv,v)	EN	B2ab(ii,iii,iv,v)	No	No
<i>Bryum canariense</i>	LC		LC		No	No
<i>Bryum cellulare</i>	EN	B2ab(iii)	EN	B2ab(iii)	No	No
<i>Bryum cryophilum</i>	NT	B2b(i,ii,iii,iv,v)	VU	C2a(i)	No	No
<i>Bryum demaretianum</i>	DD		DD		Yes	No
<i>Bryum dichotomum</i>	LC		LC		No	No
<i>Bryum dixonii</i>	NT	D1	NT	D1	Yes	No
<i>Bryum dyffrynense</i>	NT	B2b(iii,iv,v)	NT	B2b(iii,iv,v)	Yes	No
<i>Bryum elegans</i>	LC		LC		No	No
<i>Bryum funkii</i>	VU	B2ab(iii)	EN	B2ab(iii)	No	No
<i>Bryum gemmiferum</i>	LC		LC		No	No
<i>Bryum gemmilucens</i>	LC		LC		No	No
<i>Bryum gemmiparum</i>	LC		LC		No	No
<i>Bryum intermedium</i>	DD		DD		No	No
<i>Bryum klinggraeffii</i>	LC		LC		No	No
<i>Bryum knowltonii</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Bryum kunzei</i>	LC		LC		No	No
<i>Bryum marratii</i>	EN	B2ab(ii,iii,iv,v)	EN	B2ab(ii,iii,iv,v)	No	No
<i>Bryum miniatum</i>	VU	D1	NE		No	No
<i>Bryum minii</i>	LC		LC		Yes	Yes
<i>Bryum oblongum</i>	NT	C2a(i)	VU	C2a(i)	No	No
<i>Bryum radiculosum</i>	LC		LC		No	No
<i>Bryum riparium</i>	VU	D1	VU	D1	No	No
<i>Bryum ruderale</i>	LC		LC		No	No
<i>Bryum salinum</i>	VU	C2a(i)	EN	C2a(i)	No	No
<i>Bryum sauteri</i>	LC		LC		No	No
<i>Bryum schleicheri</i>	LC		LC		No	No
<i>Bryum subapiculatum</i>	LC		LC		No	No
<i>Bryum tenuisetum</i>	LC		LC		No	No
<i>Bryum turbinatum</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Bryum valparaisense</i>	VU	D1	VU	D1	No	No
<i>Bryum versicolor</i>	EN	B2b(ii,iii,iv,v)c(iii,iv)	EN	B2b(ii,iii,iv,v)c(iii,iv)	Yes	No
<i>Bryum violaceum</i>	LC		LC		No	No
<i>Bryum warneum</i>	VU	B2ab(i,ii,iii,iv,v)	VU	B2ab(i,ii,iii,iv,v)	No	No
<i>Bryum weigeli</i>	LC		LC		No	No
<i>Bryum wrightii</i>	NT		VU	D1	No	No
<i>Imbriobryum alpinum</i>	LC		LC		No	No
<i>Imbriobryum mildeanum</i>	LC		LC		No	No
<i>Imbriobryum muehlenbeckii</i>	LC		LC		No	No
<i>Ptychostomum arcticum</i>	LC		LC		No	No
<i>Ptychostomum bornholmense</i>	LC		LC		Yes	No
<i>Ptychostomum capillare</i>	LC		LC		No	No

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<i>Ptychostomum cernuum</i>	EN	B2ab(i,ii,iii,iv,v)	EN	B2ab(i,ii,iii,iv,v)	No	No
<i>Ptychostomum compactum</i>	LC		LC		No	No
<i>Ptychostomum creberrimum</i>	LC		LC		No	No
<i>Ptychostomum cyclophyllum</i>	LC		LC		No	No
<i>Ptychostomum demissum</i>	EN	C2a(i)	EN	C2a(i)	No	No
<i>Ptychostomum donianum</i>	LC		LC		No	No
<i>Ptychostomum imbricatulum</i>	LC		LC		No	No
<i>Ptychostomum inclinatum</i>	LC		LC		No	No
<i>Ptychostomum longisetum</i>	CR	C2a(i)	CR	C2a(i)	No	No
<i>Ptychostomum moravicum</i>	LC		LC		No	No
<i>Ptychostomum pallens</i>	LC		LC		No	No
<i>Ptychostomum pallescens</i>	LC		LC		No	No
<i>Ptychostomum pseudotriquetrum</i>	LC		LC		No	No
<i>Ptychostomum rubens</i>	LC		LC		No	No
<i>Ptychostomum torquescens</i>	LC		LC		No	No
<i>Ptychostomum zieri</i>	LC		LC		No	No
<i>Rhodobryum ontariense</i>	LC		LC		No	No
<i>Rhodobryum roseum</i>	LC		LC		No	No
BRYOXIPHIACEAE						
<i>Bryoxiphium madeirense</i>	EN	A3c	EN	A3c	No	No
<i>Bryoxiphium norvegicum</i>	LC		CR	B1ab(iii)+2ab(iii); D	No	No
BUXBAUMIACEAE						
<i>Buxbaumia aphylla</i>	LC		LC		No	No
<i>Buxbaumia viridis</i>	LC		LC		No	No
CALLIERGONACEAE						
<i>Calliergon cordifolium</i>	LC		LC		No	No
<i>Calliergon giganteum</i>	LC		LC		No	No
<i>Calliergon megalophyllum</i>	LC		LC		No	No
<i>Calliergon richardsonii</i>	LC		LC		No	No
<i>Hamatocaulis lapponicus</i>	EN	B2ab(i,ii,iii,iv,v)	EN	B2ab(i,ii,iii,iv,v)	No	No
<i>Hamatocaulis vernicosus</i>	VU	A2c	VU	A2c	No	No
<i>Loeskygnum badium</i>	LC		LC		No	No
<i>Sarmentypnum exannulatum</i>	LC		LC		No	No
<i>Sarmentypnum sarmentosum</i>	LC		LC		No	No
<i>Straminergon stramineum</i>	LC		LC		No	No
<i>Warnstorfia fluitans</i>	LC		LC		No	No
<i>Warnstorfia procera</i>	LC		LC		No	No
<i>Warnstorfia pseudostraminea</i>	LC		LC		No	No
<i>Warnstorfia trichophylla</i>	LC		LC		No	No
<i>Warnstorfia tundrae</i>	LC		LC		No	No
CALYCVLARIACEAE						
<i>Calycularia laxa</i>	CR	D	NE		No	No
CALYMPERACEAE						
<i>Calymperes erosum</i>	CR	D	CR	D	No	No
CALYPOGEIACEAE						
<i>Calypogeia arguta</i>	LC		LC		No	No
<i>Calypogeia azorica</i>	EN	B2ab(ii,iii)	EN	B2ab(ii,iii)	Yes	Yes

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<i>Calypogeia azurea</i>	LC		LC		No	No
<i>Calypogeia fissa</i>	LC		LC		No	No
<i>Calypogeia integristipula</i>	LC		LC		No	No
<i>Calypogeia muelleriana</i>	LC		LC		No	No
<i>Calypogeia neesiana</i>	LC		LC		No	No
<i>Calypogeia sphagnicola</i>	LC		LC		No	No
<i>Calypogeia suecica</i>	LC		LC		No	No
<i>Mnioloma fuscum</i>	VU	C2a(i)	VU	C2a(i)	No	No
CATOSCOPIACEAE						
<i>Catoscopium nigritum</i>	LC		LC		No	No
CEPHALOZIACEAE						
<i>Cephalozia ambigua</i>	LC		LC		No	No
<i>Cephalozia bicuspidata</i>	LC		LC		No	No
<i>Cephalozia lacinulata</i>	CR	C2a(i); D	CR	C2a(i); D	No	No
<i>Cephalozia macounii</i>	CR	D	CR	D	No	No
<i>Fuscocephaloziopsis affinis</i>	NT		NT		No	No
<i>Fuscocephaloziopsis albescens</i>	LC		NT		No	No
<i>Fuscocephaloziopsis catenulata</i>	LC		LC		No	No
<i>Fuscocephaloziopsis connivens</i>	LC		LC		No	No
<i>Fuscocephaloziopsis crassifolia</i>	LC		LC		No	No
<i>Fuscocephaloziopsis leucantha</i>	LC		LC		No	No
<i>Fuscocephaloziopsis loitlesbergeri</i>	LC		LC		No	No
<i>Fuscocephaloziopsis lumulifolia</i>	LC		LC		No	No
<i>Fuscocephaloziopsis macrostachya</i>	LC		LC		No	No
<i>Fuscocephaloziopsis pleniceps</i>	LC		LC		No	No
<i>Hygrobiella laxifolia</i>	LC		LC		No	No
<i>Nowellia curvifolia</i>	LC		LC		No	No
<i>Odontoschisma denudatum</i>	LC		LC		No	No
<i>Odontoschisma elongatum</i>	LC		LC		No	No
<i>Odontoschisma fluitans</i>	LC		LC		No	No
<i>Odontoschisma francisci</i>	NT	C2a(i)	VU	C2a(i)	No	No
<i>Odontoschisma macounii</i>	LC		LC		No	No
<i>Odontoschisma sphagni</i>	LC		LC		No	No
CEPHALOZIELLACEAE						
<i>Cephaloziella arctogena</i>	VU	D1	EN	D	No	No
<i>Cephaloziella aspericaulis</i>	CR	D	DD		No	No
<i>Cephaloziella baumgartneri</i>	LC		LC		No	No
<i>Cephaloziella calyculata</i>	NT		NT		No	No
<i>Cephaloziella dentata</i>	EN	B2ab(iii,v)	EN	B2ab(iii,v)	No	No
<i>Cephaloziella divaricata</i>	LC		LC		No	No
<i>Cephaloziella elachista</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Cephaloziella elegans</i>	DD		DD		No	No
<i>Cephaloziella granatensis</i>	EN	B1ab(iii,iv)+2ab(iii,iv)	EN	B1ab(iii,iv)+2ab(iii,iv)	No	No
<i>Cephaloziella grimsulana</i>	DD		DD		No	No
<i>Cephaloziella hampeana</i>	LC		LC		No	No
<i>Cephaloziella integerrima</i>	EN	B2ab(iii,v); C2a(i)	EN	B2ab(iii,v); C2a(i)	No	No

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<i>Cephaloziella massalongi</i>	EN	B2ab(ii,iii,iv,v)	EN	B2ab(ii,iii,iv,v)	No	No
<i>Cephaloziella nicholsonii</i>	EN	C2a(i)	EN	C2a(i)	Yes	Yes
<i>Cephaloziella phyllacantha</i>	CR	D	CR	D	No	No
<i>Cephaloziella polystratosa</i>	EN	D	NE		No	No
<i>Cephaloziella rubella</i>	LC		LC		No	No
<i>Cephaloziella spinigera</i>	NT	B2b(iv,v)	NT		No	No
<i>Cephaloziella stellulifera</i>	LC		LC		No	No
<i>Cephaloziella turneri</i>	LC		LC		No	No
<i>Cephaloziella uncinata</i>	NT	B2b(iii,iv)	DD		No	No
<i>Cephaloziella varians</i>	LC		LC		No	No
CINCLIDOTACEAE						
<i>Cinclidotus aquaticus</i>	LC		LC		No	No
<i>Cinclidotus danubicus</i>	LC		LC		No	No
<i>Cinclidotus fontinaloides</i>	LC		LC		No	No
<i>Cinclidotus riparius</i>	LC		LC		No	No
<i>Cinclidotus vivesii</i>	DD		DD		Yes	Yes
CLEVEACEAE						
<i>Clevea hyalina</i>	LC		LC		No	No
<i>Clevea spathysii</i>	NT		NT		No	No
<i>Peltolepis quadrata</i>	LC		LC		No	No
<i>Sauteria alpina</i>	LC		LC		No	No
CLIMACIACEAE						
<i>Climacium dendroides</i>	LC		LC		No	No
CONOCEPHALACEAE						
<i>Conocephalum conicum</i>	LC		LC		No	No
<i>Conocephalum salebrosum</i>	LC		LC		No	No
CORSINIACEAE						
<i>Corsinia coriandrina</i>	LC		LC		No	No
CRYPHAEACEAE						
<i>Cryphaea heteromalla</i>	LC		LC		No	No
<i>Dendrocryphaea lamyana</i>	NT		LC		Yes	Yes
CYATHODIACEAE						
<i>Cyathodium foetidissimum</i>	CR	D	CR	D	No	No
DALTONIACEAE						
<i>Achrophyllum dentatum</i>	NA		NA		No	No
<i>Calypstrochaeta apiculata</i>	NA		NA		No	No
<i>Daltonia splachnoides</i>	LC		LC		No	No
<i>Daltonia stenophylla</i>	EN	B2ab(iii)	EN	B2ab(iii)	No	No
<i>Distichophyllum carinatum</i>	CR	C2a(i); D	CR	C2a(i); D	No	No
DELAVAYELLACEAE						
<i>Lioclaena lanceolata</i>	LC		LC		No	No
<i>Lioclaena subulata</i>	NT		NT		No	No
DICRANACEAE						
<i>Aongstroemia longipes</i>	LC		LC		No	No
<i>Cnestrum alpestre</i>	LC		NT		No	No
<i>Cnestrum glaucescens</i>	NT		VU	D1	No	No
<i>Cnestrum schisti</i>	LC		LC		No	No

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<i>Dicranella cerviculata</i>	LC		LC		No	No
<i>Dicranella crispa</i>	LC		LC		No	No
<i>Dicranella grevilleana</i>	LC		LC		No	No
<i>Dicranella heteromalla</i>	LC		LC		No	No
<i>Dicranella howei</i>	LC		LC		No	No
<i>Dicranella humilis</i>	LC		LC		No	No
<i>Dicranella rufescens</i>	LC		LC		No	No
<i>Dicranella schreberiana</i>	LC		LC		No	No
<i>Dicranella staphylina</i>	LC		LC		No	No
<i>Dicranella subulata</i>	LC		LC		No	No
<i>Dicranella varia</i>	LC		LC		No	No
<i>Dicranum acutifolium</i>	LC		LC		No	No
<i>Dicranum angustum</i>	LC		LC		No	No
<i>Dicranum bardunovii</i>	DD		NE		No	No
<i>Dicranum bonjeanii</i>	LC		LC		No	No
<i>Dicranum brevifolium</i>	LC		LC		No	No
<i>Dicranum crassifolium</i>	NT	B2b(i)	LC		Yes	Yes
<i>Dicranum dispersum</i>	EN	D	EN	D	No	No
<i>Dicranum drummondii</i>	LC		NT		No	No
<i>Dicranum elongatum</i>	LC		LC		No	No
<i>Dicranum flagellare</i>	LC		LC		No	No
<i>Dicranum flexicaule</i>	LC		LC		No	No
<i>Dicranum fragilifolium</i>	LC		NT		No	No
<i>Dicranum fulvum</i>	LC		LC		No	No
<i>Dicranum fuscescens</i>	LC		LC		No	No
<i>Dicranum groenlandicum</i>	LC		NT		No	No
<i>Dicranum laevidens</i>	LC		VU	D	No	No
<i>Dicranum leioneuron</i>	LC		LC		No	No
<i>Dicranum majus</i>	LC		LC		No	No
<i>Dicranum montanum</i>	LC		LC		No	No
<i>Dicranum muehlenbeckii</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Dicranum polysetum</i>	LC		LC		No	No
<i>Dicranum schljakovii</i>	DD		NE		No	No
<i>Dicranum scoparium</i>	LC		LC		No	No
<i>Dicranum scottianum</i>	LC		LC		Yes	No
<i>Dicranum septentrionale</i>	NT		NT		No	No
<i>Dicranum spadiceum</i>	LC		LC		No	No
<i>Dicranum spurium</i>	LC		LC		No	No
<i>Dicranum tauricum</i>	LC		LC		No	No
<i>Dicranum transylvanicum</i>	CR	D	CR	D	No	No
<i>Dicranum undulatum</i>	LC		LC		No	No
<i>Dicranum viride</i>	LC		LC		No	No
<i>Diobelonella palustris</i>	LC		LC		No	No
<i>Paraleucobryum enerve</i>	LC		LC		No	No
<i>Paraleucobryum longifolium</i>	LC		LC		No	No
<i>Paraleucobryum sauteri</i>	NT	B2b(iii,v); C2a(i)	NT	B2b(iii,v); C2a(i)	No	No
<i>Pseudephemerum nitidum</i>	LC		LC		No	No

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<i>DIPHYSCIACEAE</i>						
<i>Diphyscium foliosum</i>	LC		LC		No	No
<i>DISCELLIACEAE</i>						
<i>Discelium nudum</i>	LC		LC		No	No
<i>DITRICHACEAE</i>						
<i>Ceratodon conicus</i>	NT	D1	NT	D1	No	No
<i>Ceratodon purpureus</i>	LC		LC		No	No
<i>Cheilothela chloropus</i>	LC		LC		No	No
<i>Cleistocarpidium palustre</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Distichium capillaceum</i>	LC		LC		No	No
<i>Distichium hagenii</i>	NT	D1	EN	D	No	No
<i>Distichium inclinatum</i>	LC		LC		No	No
<i>Ditrichum cornubicum</i>	CR	D	CR	D	Yes	Yes
<i>Ditrichum heteromallum</i>	LC		LC		No	No
<i>Ditrichum lineare</i>	LC		LC		No	No
<i>Ditrichum pallidum</i>	NT	B2b(iii); D1	NT	B2b(iii); D1	No	No
<i>Ditrichum plumbicola</i>	EN	B2ab(iii,iv,v)c(iv)	EN	B2ab(iii,iv,v)c(iv)	Yes	Yes
<i>Ditrichum punctulatum</i>	NT	B2ab(iii)	NT	B2ab(iii)	No	No
<i>Ditrichum pusillum</i>	LC		LC		No	No
<i>Ditrichum subulatum</i>	LC		LC		No	No
<i>Ditrichum zonatum</i>	LC		LC		No	No
<i>Pleuridium acuminatum</i>	LC		LC		No	No
<i>Pleuridium subulatum</i>	LC		LC		No	No
<i>Rhamphidium purpuratum</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Saelania glaucescens</i>	LC		LC		No	No
<i>Trichodon cylindricus</i>	LC		LC		No	No
<i>DUMORTIERACEAE</i>						
<i>Dumortiera hirsuta</i>	NT	C2a(i)	NT	C2a(i)	No	No
<i>ECHINODIACEAE</i>						
<i>Echinodium renauldii</i>	EN	A3c; C2a(i)	EN	A3c; C2a(i)	No	No
<i>Echinodium setigerum</i>	EN	A3c; C2a(i)	EN	A3c; C2a(i)	Yes	Yes
<i>Echinodium spinosum</i>	EN	A3c; C2a(i)	EN	A3c; C2a(i)	Yes	Yes
<i>ENCALYPTACEAE</i>						
<i>Bryobrittonia longipes</i>	VU	D2	NE		No	No
<i>Encalypta affinis</i>	DD		DD		No	No
<i>Encalypta alpina</i>	LC		LC		No	No
<i>Encalypta brevicolla</i>	LC		NT		No	No
<i>Encalypta brevipes</i>	EN	D	CR	D	No	No
<i>Encalypta ciliata</i>	LC		LC		No	No
<i>Encalypta longicolla</i>	LC		LC		No	No
<i>Encalypta microstoma</i>	LC		LC		No	No
<i>Encalypta mutica</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Encalypta pilifera</i>	LC		LC		No	No
<i>Encalypta procera</i>	LC		LC		No	No
<i>Encalypta rhaptocarpa</i>	LC		LC		No	No
<i>Encalypta spathulata</i>	VU	D1	EN	D	No	No
<i>Encalypta streptocarpa</i>	LC		LC		No	No

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<i>Encalypta vulgaris</i>	LC		LC		No	No
ENDOGENMATACEAE						
<i>Endogemma caespiticia</i>	LC		NT		No	No
ENTODONTACEAE						
<i>Entodon cladorrhizans</i>	DD		DD		No	No
<i>Entodon concinnus</i>	LC		LC		No	No
<i>Entodon schleicheri</i>	LC		LC		No	No
EPHEMERACEAE						
<i>Ephemerum cohaerens</i>	VU	B2b(i,ii,iii,iv,v)c(iii,iv)	VU	B2b(i,ii,iii,iv,v) c(iii,iv)	No	No
<i>Ephemerum crassinervium</i>	NT	B2b(iii,v)	NT	B2b(iii,v)	No	No
<i>Ephemerum minutissimum</i>	LC		LC		No	No
<i>Ephemerum recurvifolium</i>	NT	B2b(iii,v)	NT	B2b(iii,v)	No	No
<i>Ephemerum serratum</i>	LC		LC		No	No
<i>Ephemerum spinulosum</i>	DD		DD		No	No
<i>Micromitrium tenerum</i>	EN	B2ab(iii)c(iii,iv)	EN	B2ab(iii)c(iii,iv)	No	No
EXORMOTHECACEAE						
<i>Exormotheca pustulosa</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Exormotheca welwitschii</i>	EN	B2ab(iii,v)	EN	B2ab(iii,v)	No	No
FABRONIACEAE						
<i>Fabronia ciliaris</i>	VU	D1	VU	D1	No	No
<i>Fabronia pusilla</i>	LC		LC		No	No
FISSIDENTACEAE						
<i>Fissidens adianthoides</i>	LC		LC		No	No
<i>Fissidens arcticus</i>	EN	D	NE		No	No
<i>Fissidens arnoldii</i>	VU	D1	VU	D1	No	No
<i>Fissidens asplenoides</i>	LC		LC		No	No
<i>Fissidens azoricus</i>	CR	B1ab(iii)+2ab(iii); D	CR	B1ab(iii)+2ab(iii); D	Yes	Yes
<i>Fissidens bryoides</i>	LC		LC		No	No
<i>Fissidens celticus</i>	LC		LC		Yes	No
<i>Fissidens coacervatus</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Fissidens crassipes</i>	LC		LC		No	No
<i>Fissidens crispus</i>	LC		LC		No	No
<i>Fissidens curvatus</i>	DD		DD		No	No
<i>Fissidens dubius</i>	LC		LC		No	No
<i>Fissidens exilis</i>	LC		LC		No	No
<i>Fissidens fontanus</i>	LC		LC		No	No
<i>Fissidens gracilifolius</i>	LC		LC		No	No
<i>Fissidens grandifrons</i>	LC		LC		No	No
<i>Fissidens gymnandrus</i>	LC		LC		No	No
<i>Fissidens jansenii</i>	CR	B1ab(iii)+2ab(iii); D	CR	B1ab(iii)+2ab(iii); D	Yes	Yes
<i>Fissidens microstictus</i>	EX		EX		Yes	Yes
<i>Fissidens monguillonii</i>	DD		DD		No	No
<i>Fissidens nobreganus</i>	EN	C2a(i)	EN	C2a(i)	Yes	Yes
<i>Fissidens osmundoides</i>	LC		LC		No	No
<i>Fissidens ovatifolius</i>	DD		DD		No	No
<i>Fissidens polyphyllus</i>	LC		LC		No	No

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<i>Fissidens pusillus</i>	LC		LC		No	No
<i>Fissidens rivularis</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Fissidens rufulus</i>	LC		LC		No	No
<i>Fissidens serratus</i>	EN	C2a(i)	EN	C2a(i)	No	No
<i>Fissidens serrulatus</i>	LC		LC		No	No
<i>Fissidens sublimbatus</i>	DD		DD		No	No
<i>Fissidens sublineaefolius</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Fissidens taxifolius</i>	LC		LC		No	No
<i>Fissidens viridulus</i>	LC		LC		No	No
FLEXITRICHACEAE						
<i>Flexitrichum flexicaule</i>	LC		LC		No	No
<i>Flexitrichum gracile</i>	LC		LC		No	No
FONTINALACEAE						
<i>Dichelyma capillaceum</i>	NT	C2a(i)	NT		No	No
<i>Dichelyma falcatum</i>	LC		LC		No	No
<i>Fontinalis antipyretica</i>	LC		LC		No	No
<i>Fontinalis dalearlica</i>	NT	B2b(iii)	NT		No	No
<i>Fontinalis dichelymoides</i>	NT		NT		Yes	No
<i>Fontinalis hypnoides</i>	LC		LC		No	No
<i>Fontinalis squamosa</i>	LC		LC		No	No
FOSSOMBRONACEAE						
<i>Fossombronina angulosa</i>	LC		LC		No	No
<i>Fossombronina caespitiformis</i>	LC		LC		No	No
<i>Fossombronina echinata</i>	NT		NT		No	No
<i>Fossombronina fimbriata</i>	LC		LC		Yes	Yes
<i>Fossombronina fleischeri</i>	DD		DD		Yes	Yes
<i>Fossombronina fleischeri</i>	DD		DD		Yes	Yes
<i>Fossombronina foveolata</i>	LC		NT		No	No
<i>Fossombronina incurva</i>	LC		LC		Yes	No
<i>Fossombronina leucoxantha</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Fossombronina maritima</i>	LC		LC		Yes	No
<i>Fossombronina mittenii</i>	DD		DD		No	No
<i>Fossombronina pusilla</i>	LC		LC		No	No
<i>Fossombronina wondraczekii</i>	LC		LC		No	No
FRULLANIACEAE						
<i>Frullania acicularis</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Frullania azorica</i>	LC		LC		Yes	Yes
<i>Frullania bolanderi</i>	NT		CR	B2ab(iii)	No	No
<i>Frullania calcarifera</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Frullania dilatata</i>	LC		LC		No	No
<i>Frullania ericoides</i>	LC		LC		No	No
<i>Frullania fragilifolia</i>	LC		LC		No	No
<i>Frullania inflata</i>	EN	B2ab(iii)	EN	B2ab(iii)	No	No
<i>Frullania jackii</i>	VU	D1	VU	D1	Yes	No
<i>Frullania microphylla</i>	LC		LC		Yes	No
<i>Frullania oakesiana</i>	EN	C2a(i)	EN	C2a(i)	No	No
<i>Frullania parvistipula</i>	CR	C2a(i)	CR	C2a(i)	No	No

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<i>Frullania polysticta</i>	VU	A3c	VU	A3c	No	No
<i>Frullania riparia</i>	EN	B2ab(iii); D	EN	B2ab(iii); D	No	No
<i>Frullania sergiae</i>	CR	D	CR	D2	No	No
<i>Frullania subarctica</i>	DD		NE		No	No
<i>Frullania tamarisci</i>	LC		LC		No	No
<i>Frullania teneriffae</i>	LC		LC		No	No
FUNARIACEAE						
<i>Entosthodon attenuatus</i>	LC		LC		No	No
<i>Entosthodon commutatus</i>	EN	B2ab(iii,v)	EN	B2ab(iii,v)	No	No
<i>Entosthodon convexus</i>	LC		LC		No	No
<i>Entosthodon duriaei</i>	NT		NT		No	No
<i>Entosthodon fascicularis</i>	LC		LC		No	No
<i>Entosthodon hungaricus</i>	LC		LC		No	No
<i>Entosthodon kroonkurk</i>	LC		LC		Yes	Yes
<i>Entosthodon mouretii</i>	NT		NT		No	No
<i>Entosthodon mühlenbergii</i>	NT	B2b(iii,v)	NT	B2b(iii,v)	No	No
<i>Entosthodon obtusus</i>	LC		LC		No	No
<i>Entosthodon pulchellus</i>	LC		LC		No	No
<i>Entosthodon schimperi</i>	NT	B2b(iii,v)	NT	B2b(iii,v)	No	No
<i>Funaria arctica</i>	VU	D1	DD		No	No
<i>Funaria hygrometrica</i>	LC		LC		No	No
<i>Funaria microstoma</i>	DD		DD		No	No
<i>Funariella curviseta</i>	VU	B2ab(iii,v)	VU	B2ab(iii,v)	No	No
<i>Goniomitrium seroi</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Physcomitrella patens</i>	LC		LC		No	No
<i>Physcomitridium readeri</i>	VU	D1	VU	D1	No	No
<i>Physcomitrium arenicola</i>	EN	B2ac(iv)	NE		Yes	No
<i>Physcomitrium eurystomum</i>	VU	B2b(ii,iii)c(iii,iv)	EN	B2b(ii,iii)c(iii,iv)	No	No
<i>Physcomitrium pyriforme</i>	LC		LC		No	No
<i>Physcomitrium sphaericum</i>	VU	B2b(ii,iii)c(iii,iv)	VU	B2b(ii,iii)c(iii,iv)	No	No
<i>Pyramidula tetragona</i>	EN	B2ab(iii)	EN	B2ab(iii)	No	No
GEOCALYCEAE						
<i>Geocalyx graveolens</i>	NT	C2a(i)	NT		No	No
<i>Harpanthus flotovianus</i>	LC		LC		No	No
<i>Harpanthus scutatus</i>	LC		LC		No	No
<i>Saccogyna viticulosa</i>	LC		LC		No	No
GIGASPERMACEAE						
<i>Gigaspermum mouretii</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Oedipodiella australis</i>	EN	B2ab(i,ii,iii,v); D	EN	B2b(i,ii,iii,v); D1	No	No
GRIMMIACEAE						
<i>Coscinodon cribrosus</i>	LC		LC		No	No
<i>Coscinodon horridus</i>	DD		DD		Yes	Yes
<i>Coscinodon humilis</i>	DD		DD		Yes	No
<i>Coscinodon monchiquensis</i>	CR	B1ab(iii)+2ab(iii)	CR	B1ab(iii)+2ab(iii)	Yes	Yes
<i>Grimmia alpestris</i>	LC		LC		No	No
<i>Grimmia anodon</i>	LC		LC		No	No
<i>Grimmia anomala</i>	LC		LC		No	No

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<i>Grimmia arenaria</i>	DD		DD		Yes	No
<i>Grimmia atrata</i>	LC		LC		No	No
<i>Grimmia caespiticia</i>	LC		LC		No	No
<i>Grimmia capillata</i>	VU	D1	VU	D1	No	No
<i>Grimmia crinita</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Grimmia crinitoleucophaea</i>	LC		LC		No	No
<i>Grimmia curviseta</i>	VU	D2	VU	D2	Yes	Yes
<i>Grimmia decipiens</i>	LC		LC		No	No
<i>Grimmia dissimulata</i>	LC		LC		No	No
<i>Grimmia donniana</i>	LC		LC		No	No
<i>Grimmia elatior</i>	LC		LC		No	No
<i>Grimmia elongata</i>	LC		LC		No	No
<i>Grimmia funalis</i>	LC		LC		No	No
<i>Grimmia fuscolutea</i>	VU	D1	VU	D1	No	No
<i>Grimmia bartmanii</i>	LC		LC		No	No
<i>Grimmia incurva</i>	LC		LC		No	No
<i>Grimmia laevigata</i>	LC		LC		No	No
<i>Grimmia lisae</i>	LC		LC		No	No
<i>Grimmia longirostris</i>	LC		LC		No	No
<i>Grimmia meridionalis</i>	LC		LC		No	No
<i>Grimmia mollis</i>	VU	D1	VU	D1	No	No
<i>Grimmia montana</i>	LC		LC		No	No
<i>Grimmia muehlenbeckii</i>	LC		LC		No	No
<i>Grimmia nutans</i>	EN	B2ab(iii); D	EN	B2ab(iii); D	No	No
<i>Grimmia orbicularis</i>	LC		LC		No	No
<i>Grimmia ovalis</i>	LC		LC		No	No
<i>Grimmia plagiopodia</i>	VU	D1	VU	D1	No	No
<i>Grimmia pulvinata</i>	LC		LC		No	No
<i>Grimmia ramondii</i>	LC		LC		No	No
<i>Grimmia reflexidens</i>	LC		LC		No	No
<i>Grimmia teretinervis</i>	NT	B2a; D1	VU	D1	No	No
<i>Grimmia tergestina</i>	LC		LC		No	No
<i>Grimmia torquata</i>	LC		LC		No	No
<i>Grimmia trichophylla</i>	LC		LC		No	No
<i>Grimmia triformis</i>	DD		DD		No	No
<i>Grimmia ungeri</i>	EN	D	EN	D	No	No
<i>Grimmia unicolor</i>	LC		LC		No	No
<i>Racomitrium aciculare</i>	LC		LC		No	No
<i>Racomitrium affine</i>	LC		LC		No	No
<i>Racomitrium aquaticum</i>	LC		LC		No	No
<i>Racomitrium canescens</i>	LC		LC		No	No
<i>Racomitrium ellipticum</i>	LC		LC		No	No
<i>Racomitrium elongatum</i>	LC		LC		No	No
<i>Racomitrium ericoides</i>	LC		LC		No	No
<i>Racomitrium fasciculare</i>	LC		LC		No	No
<i>Racomitrium hespericum</i>	NT		NT		Yes	Yes

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<i>Racomitrium heterostichum</i>	LC		LC		No	No
<i>Racomitrium himalayicum</i>	VU	D1	VU	D1	No	No
<i>Racomitrium lamprocarpum</i>	NT	B2b(ii,iii)	NT		No	No
<i>Racomitrium lanuginosum</i>	LC		LC		No	No
<i>Racomitrium lusitanicum</i>	EN	B2ab(iii,v)	EN	B2ab(iii)	Yes	Yes
<i>Racomitrium macounii</i>	LC		LC		No	No
<i>Racomitrium microcarpon</i>	LC		LC		No	No
<i>Racomitrium nivale</i>	VU	D1	VU	D1	Yes	No
<i>Racomitrium obtusum</i>	LC		LC		Yes	No
<i>Racomitrium panschii</i>	LC		NE		No	No
<i>Racomitrium sudeticum</i>	LC		LC		No	No
<i>Schistidium abrupticostatum</i>	LC		DD		No	No
<i>Schistidium agassizii</i>	LC		LC		No	No
<i>Schistidium andreaeopsis</i>	DD		NE		No	No
<i>Schistidium apocarpum</i>	LC		LC		No	No
<i>Schistidium atrofusum</i>	LC		LC		No	No
<i>Schistidium boreale</i>	LC		LC		No	No
<i>Schistidium brunnescens</i>	LC		LC		No	No
<i>Schistidium bryhnii</i>	VU	D1	NE		Yes	No
<i>Schistidium canadense</i>	DD		NE		No	No
<i>Schistidium confertum</i>	LC		LC		No	No
<i>Schistidium confusum</i>	LC		LC		No	No
<i>Schistidium crassipilum</i>	LC		LC		No	No
<i>Schistidium crenatum</i>	LC		LC		No	No
<i>Schistidium dupretii</i>	LC		LC		No	No
<i>Schistidium echinatum</i>	EN	D	EN	D	No	No
<i>Schistidium elegantulum</i>	LC		LC		No	No
<i>Schistidium flaccidum</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Schistidium flexipile</i>	LC		LC		No	No
<i>Schistidium frigidum</i>	LC		LC		No	No
<i>Schistidium frisvollianum</i>	VU	D1	VU	D1	No	No
<i>Schistidium grande</i>	VU	D1	VU	D1	Yes	No
<i>Schistidium grandirete</i>	VU	D1	VU	D1	No	No
<i>Schistidium helveticum</i>	LC		LC		No	No
<i>Schistidium holmenianum</i>	CR	C2a(i)	NE		No	No
<i>Schistidium lancifolium</i>	LC		LC		No	No
<i>Schistidium maritimum</i>	LC		LC		No	No
<i>Schistidium obscurum</i>	DD		DD		No	No
<i>Schistidium occidentale</i>	CR	D	CR	D	No	No
<i>Schistidium papillosum</i>	LC		LC		No	No
<i>Schistidium platyphyllum</i>	LC		LC		No	No
<i>Schistidium poeltii</i>	LC		LC		No	No
<i>Schistidium pruinatum</i>	LC		LC		No	No
<i>Schistidium pulchrum</i>	LC		LC		No	No
<i>Schistidium recurvum</i>	LC		LC		No	No
<i>Schistidium rivulare</i>	LC		LC		No	No

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<i>Schistidium robustum</i>	LC		LC		No	No
<i>Schistidium scandicum</i>	LC		LC		Yes	No
<i>Schistidium sibiricum</i>	VU	D1	DD		No	No
<i>Schistidium sinensiapocarpum</i>	LC		LC		No	No
<i>Schistidium sordidum</i>	LC		DD		No	No
<i>Schistidium spinosum</i>	CR	C2a(i)	CR	C2a(i)	Yes	No
<i>Schistidium strictum</i>	LC		LC		No	No
<i>Schistidium subflaccidum</i>	LC		LC		No	No
<i>Schistidium subjulaceum</i>	LC		LC		No	No
<i>Schistidium submuticum</i>	LC		VU	D1	Yes	No
<i>Schistidium tenerum</i>	VU	D1	EN	D	No	No
<i>Schistidium trichodon</i>	LC		LC		No	No
<i>Schistidium umbrosum</i>	LC		DD		No	No
<i>Schistidium venetum</i>	LC		VU	D1	No	No
GYMNOMITRIACEAE						
<i>Gymnomitrium adustum</i>	LC		LC		Yes	No
<i>Gymnomitrium alpinum</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Gymnomitrium brevissimum</i>	LC		LC		No	No
<i>Gymnomitrium commutatum</i>	LC		LC		No	No
<i>Gymnomitrium concinnatum</i>	LC		LC		No	No
<i>Gymnomitrium corallioides</i>	LC		LC		No	No
<i>Gymnomitrium crenulatum</i>	LC		LC		Yes	No
<i>Gymnomitrium obtusum</i>	LC		LC		No	No
<i>Gymnomitrium revolutum</i>	NT	D1	VU	D1	No	No
<i>Marsupella andreaeoides</i>	NT		NE		Yes	No
<i>Marsupella apiculata</i>	LC		LC		No	No
<i>Marsupella aquatica</i>	LC		LC		No	No
<i>Marsupella arctica</i>	VU	D1	EN	D	No	No
<i>Marsupella boeckii</i>	LC		VU	D1	No	No
<i>Marsupella condensata</i>	VU	C2a(i)	EN	C2a(i)	No	No
<i>Marsupella emarginata</i>	LC		LC		No	No
<i>Marsupella funkii</i>	LC		LC		No	No
<i>Marsupella profunda</i>	VU	D1	VU	D1	No	No
<i>Marsupella sparsifolia</i>	NT	B2b(iii)	VU	B2a,b(ii,iii)	No	No
<i>Marsupella sphaelata</i>	LC		LC		No	No
<i>Marsupella spiniloba</i>	DD		DD		No	No
<i>Marsupella sprucei</i>	LC		LC		No	No
<i>Marsupella stableri</i>	NT	B2b(iii,v)	NT	B2b(iii,v)	No	No
<i>Prasanthus suecicus</i>	LC		LC		No	No
HAPLOMITRIACEAE						
<i>Haplomitrium hookeri</i>	LC		LC		No	No
HEDWIGIACEAE						
<i>Braunia alopecura</i>	VU	D1	VU	D1	No	No
<i>Braunia imberbis</i>	NT	C2a(i)	LC		No	No
<i>Hedwigia ciliata</i>	LC		LC		No	No
<i>Hedwigia mollis</i>	LC		NE		No	No
<i>Hedwigia nemoralis</i>	DD		NE		No	No

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<i>Hedwigia stellata</i>	LC		LC		No	No
<i>Hedwigia striata</i>	NT	B2a	NT		No	No
<i>HELODIACEAE</i>						
<i>Helodium blandowii</i>	NT	A2c	NT	A2c	No	No
<i>HERBERTACEAE</i>						
<i>Herbertus azoricus</i>	EN	B2ab(iii)	EN	B2ab(iii)	Yes	Yes
<i>Herbertus borealis</i>	VU	D2	VU	D2	Yes	Yes
<i>Herbertus hutchinsiae</i>	NT	B2b(iii,v)	NT	B2b(iii,v)	Yes	No
<i>Herbertus norenius</i>	VU	D1	EN	D	Yes	No
<i>Herbertus sendtneri</i>	EN	C2a(i)	EN	C2a(i)	No	No
<i>Herbertus stramineus</i>	LC		LC		No	No
<i>HOOKERIAACEAE</i>						
<i>Hookeria lucens</i>	LC		LC		No	No
<i>HYLOCOMIACEAE</i>						
<i>Hylocomiastrum pyrenaicum</i>	LC		LC		No	No
<i>Hylocomiastrum umbratum</i>	LC		LC		No	No
<i>Hylocomium splendens</i>	LC		LC		No	No
<i>Hylocomium armoricum</i>	LC		LC		No	No
<i>Loeskeobryum brevirostre</i>	LC		LC		No	No
<i>Pleurozium schreberi</i>	LC		LC		No	No
<i>Rhytidiadelphus loreus</i>	LC		LC		No	No
<i>Rhytidiadelphus squarrosus</i>	LC		LC		No	No
<i>Rhytidiadelphus subpinnatus</i>	LC		LC		No	No
<i>Rhytidiadelphus triquetrus</i>	LC		LC		No	No
<i>HYPNACEAE</i>						
<i>Andoa berthelotiana</i>	VU	A3c	VU	A3c	Yes	Yes
<i>Breidleria pratensis</i>	LC		NT		No	No
<i>Callicladium baldanianum</i>	LC		LC		No	No
<i>Calliergonella cuspidata</i>	LC		LC		No	No
<i>Calliergonella lindbergii</i>	LC		LC		No	No
<i>Campylophyllum halleri</i>	LC		LC		No	No
<i>Campylophyllum montanum</i>	VU	C2a(i)	VU	C2a(i), D1	No	No
<i>Ctenidium molluscum</i>	LC		LC		No	No
<i>Hageniella micans</i>	NT	B2b(iii,v)	NT	B2b(iii,v)	No	No
<i>Herzogiella seligeri</i>	LC		LC		No	No
<i>Herzogiella striatella</i>	LC		LC		No	No
<i>Herzogiella turfacea</i>	NT		VU	C2a(i)	No	No
<i>Homomallium incurvatum</i>	LC		LC		No	No
<i>Hypnum aemulans</i>	DD		DD		Yes	No
<i>Hypnum andoi</i>	LC		LC		No	No
<i>Hypnum bambergeri</i>	LC		LC		No	No
<i>Hypnum callichroum</i>	LC		LC		No	No
<i>Hypnum cupressiforme</i>	LC		LC		No	No
<i>Hypnum fertile</i>	CR	C2a(i)	CR	C2a(i)	Yes	No
<i>Hypnum hamulosum</i>	LC		LC		No	No
<i>Hypnum holmenii</i>	VU	D1	VU	D1	No	No
<i>Hypnum imponens</i>	NT	B2ab(iii)	NT	B2ab(iii)	No	No
<i>Hypnum jutlandicum</i>	LC		LC		No	No
<i>Hypnum pallescens</i>	LC		LC		No	No
<i>Hypnum plicatulum</i>	CR	C2a(i); D	CR	C2a(i); D	No	No

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<i>Hypnum recurvatum</i>	LC				No	No
<i>Hypnum sauteri</i>	LC		LC		Yes	No
<i>Hypnum subimponens</i>	EN	B2ab(i,ii,iii,iv,v)	EN	B2ab(i,ii,iii,iv,v)	No	No
<i>Hypnum uncinulatum</i>	LC		LC		No	No
<i>Isopterygium tenerum</i>	EN	B2ab(ii); D	EN	B2ab(ii); D	No	No
<i>Orthothecium chryseon</i>	NT	B2b(i,ii,iii,iv,v); C2a(i)	VU	C2a(i)	No	No
<i>Orthothecium intricatum</i>	LC		LC		No	No
<i>Orthothecium lapponicum</i>	VU	D1	EN	D	No	No
<i>Orthothecium rufescens</i>	LC		LC		No	No
<i>Orthothecium strictum</i>	LC		NT		No	No
<i>Platygyrium repens</i>	LC		LC		No	No
<i>Pseudotaxiphyllum elegans</i>	LC		LC		No	No
<i>Pseudotaxiphyllum laetevirens</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Ptilium crista-castrensis</i>	LC		LC		No	No
<i>Pylaisia polyantha</i>	LC		LC		No	No
<i>Pylaisia selwynii</i>	LC		NE		No	No
<i>Taxiphyllum densifolium</i>	EN	B2ab(v)	EN	B2ab(v)	No	No
<i>Taxiphyllum wissgrillii</i>	LC		LC		No	No
HYOPTERYGIACEAE						
<i>Hypopterygium tamarisci</i>	NA		NA		No	No
JAMESONIELLACEAE						
<i>Syzygiella autumnalis</i>	LC		LC		No	No
<i>Syzygiella rubricaulis</i>	EN	B1ab(iii)+2ab(iii)	EN	B1ab(iii)+2ab(iii)	No	No
JUBULACEAE						
<i>Jubula hutchinsiae</i>	LC		LC		No	No
JUNGERMANNIACEAE						
<i>Eremonotus myriocarpus</i>	NT	D1	VU	D1	No	No
<i>Heterogemma capitata</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Heterogemma laxa</i>	VU	C2a(i)	EN	C2a(i)	No	No
<i>Jungermannia atrovirens</i>	LC		LC		No	No
<i>Jungermannia borealis</i>	LC		NT		No	No
<i>Jungermannia calcicola</i>	DD		DD		No	No
<i>Jungermannia exsertifolia</i>	LC		LC		No	No
<i>Jungermannia polaris</i>	LC		VU	D1	No	No
<i>Jungermannia polaris</i>	LC		VU	D1	No	No
<i>Jungermannia pumila</i>	LC		LC		No	No
<i>Lophoziopsis excisa</i>	LC		LC		No	No
<i>Lophoziopsis longidens</i>	LC		LC		No	No
<i>Lophoziopsis pellucida</i>	VU	D1	EN	D	No	No
<i>Lophoziopsis polaris</i>	LC		NT		No	No
<i>Lophoziopsis propagulifera</i>	LC		VU	D1	No	No
<i>Lophoziopsis rubrigemma</i>	DD		NE		No	No
<i>Mesoptychia badensis</i>	LC		LC		No	No
<i>Mesoptychia bantriensis</i>	LC		LC		No	No
<i>Mesoptychia collaris</i>	LC		LC		No	No
<i>Mesoptychia fitzgeraldiae</i>	NT	D1	NT	D1	Yes	Yes
<i>Mesoptychia gillmanii</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Mesoptychia heterocolpos</i>	LC		LC		No	No
<i>Mesoptychia rutheana</i>	NT	A2c	NT	A2c	No	No
<i>Mesoptychia sahlbergii</i>	DD		NE		No	No
<i>Mesoptychia turbinata</i>	LC		LC		No	No

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<i>Obtusifolium obtusum</i>	LC		LC		No	No
<i>Protolophozia elongata</i>	VU	D1	DD		No	No
<i>Protolophozia herzogiana</i>	CR	D	CR	D	No	No
<i>Pseudotritomaria heterophylla</i>	DD		NE		No	No
<i>Saccobasis polita</i>	LC		LC		No	No
<i>Saccobasis polymorpha</i>	LC		NE		No	No
<i>Schizophyllopsis sphenoloboides</i>	EN	D	CR	D	No	No
LEJEUNEACEAE						
<i>Acanthocoleus aberrans</i>	EN	B2ab(iii,iv,v)	EN	B2ab(iii,iv,v)	No	No
<i>Cheilejeunea cedercreutzii</i>	EN	B2ab(ii,iii); C2a(i)	EN	B2ab(ii,iii); C2a(i)	Yes	Yes
<i>Cololejeunea azorica</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Cololejeunea calcarea</i>	LC		LC		No	No
<i>Cololejeunea madeirensis</i>	EN	B2ab(iii,v); C2a(i)	EN	B2ab(iii,v); C2a(i)	Yes	Yes
<i>Cololejeunea microscopica</i>	LC		LC		No	No
<i>Cololejeunea rossettiana</i>	LC		LC		No	No
<i>Cololejeunea schaeferi</i>	VU	A3c	VU	A3c	Yes	Yes
<i>Cololejeunea sintenisii</i>	EN	B2ab(ii,iii,v)	EN	B2ab(ii,iii,v)	No	No
<i>Colura calyptrifolia</i>	LC		LC		No	No
<i>Drepanolejeunea hamatifolia</i>	LC		LC		No	No
<i>Harpalejeunea molleri</i>	LC		LC		No	No
<i>Lejeunea canariensis</i>	VU	B2ab(iii)	VU	B2ab(iii)	Yes	Yes
<i>Lejeunea cavifolia</i>	LC		LC		No	No
<i>Lejeunea eckloniana</i>	LC		LC		No	No
<i>Lejeunea flava</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Lejeunea hibernica</i>	NT	B2ab(iii)	NT	B2ab(iii)	Yes	Yes
<i>Lejeunea lamacerina</i>	LC		LC		No	No
<i>Lejeunea mandonii</i>	VU	B2ab(iii,v)	VU	B2ab(iii,v)	Yes	Yes
<i>Lejeunea patens</i>	LC		LC		No	No
<i>Marchesinia mackaii</i>	LC		LC		No	No
<i>Microlejeunea ulicina</i>	LC		LC		No	No
<i>Myriocoleopsis minutissima</i>	LC		LC		No	No
LEMBOPHYLLACEAE						
<i>Isothecium algarvicum</i>	LC		LC		No	No
<i>Isothecium alopecuroides</i>	LC		LC		No	No
<i>Isothecium holtii</i>	LC		LC		No	No
<i>Isothecium montanum</i>	CR	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C2a(i); D	CR	B1ab(i,ii,iii,iv,v)+2ab(i,ii,iii,iv,v); C2a(i); D	Yes	Yes
<i>Isothecium myosuroides</i>	LC		LC		No	No
<i>Isothecium prolixum</i>	VU	A3c	VU	A3c	Yes	Yes
<i>Plasteurhynchium meridionale</i>	LC		LC		No	No
<i>Plasteurhynchium striatulum</i>	LC		LC		No	No
LEPIDOZIACEAE						
<i>Bazzania azorica</i>	EN	A3c; B2ab(ii,iii,iv,v)	EN	A3c; B2ab(ii,iii,iv,v)	Yes	Yes
<i>Bazzania flaccida</i>	LC		LC		No	No
<i>Bazzania pearsonii</i>	NT	B2b(iii,iv,v)	NT	B2b(iii,iv,v)	No	No
<i>Bazzania tricrenata</i>	LC		LC		No	No
<i>Bazzania trilobata</i>	LC		LC		No	No
<i>Kurzia pauciflora</i>	LC		LC		No	No
<i>Kurzia sylvatica</i>	LC		LC		No	No
<i>Kurzia trichoclados</i>	LC		LC		No	No

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<i>Lepidozia cupressina</i>	LC		LC		No	No
<i>Lepidozia pearsonii</i>	LC		LC		No	No
<i>Lepidozia reptans</i>	LC		LC		No	No
<i>Lepidozia stuhlmannii</i>	EN	B1ab(iii)+2ab(iii)	EN	B1ab(iii)+2ab(iii)	No	No
<i>Telaranea azorica</i>	EN	B2ab(iii)	EN	B2ab(iii)	Yes	Yes
<i>Telaranea europaea</i>	LC		LC		Yes	Yes
<i>Tricholepidozia tetradactyla</i>	NA		NA		No	No
LEPTODONTACEAE						
<i>Leptodon corsicus</i>	CR	D	CR	D	Yes	Yes
<i>Leptodon longisetus</i>	VU	A3c	VU	A3c	Yes	Yes
<i>Leptodon smithii</i>	LC		LC		No	No
LESKEACEAE						
<i>Lescuraea incurvata</i>	LC		LC		No	No
<i>Lescuraea mutabilis</i>	LC		LC		No	No
<i>Lescuraea patens</i>	LC		LC		No	No
<i>Lescuraea plicata</i>	LC		LC		No	No
<i>Lescuraea radicata</i>	LC		LC		No	No
<i>Lescuraea saviana</i>	LC		LC		No	No
<i>Lescuraea saxicola</i>	LC		LC		No	No
<i>Lescuraea secunda</i>	VU	D1	NE		No	No
<i>Leskea polycarpa</i>	LC		LC		No	No
<i>Pseudoleskea artariae</i>	EN	D	EN	D	No	No
<i>Pseudoleskeella catenulata</i>	LC		LC		No	No
<i>Pseudoleskeella nervosa</i>	LC		LC		No	No
<i>Pseudoleskeella papillosa</i>	VU	D1	VU	D1	No	No
<i>Pseudoleskeella rupestris</i>	LC		LC		No	No
<i>Pseudoleskeella tectorum</i>	LC		LC		No	No
LEUCOBRYACEAE						
<i>Atractylocarpus alpinus</i>	CR	C2a(i); D	CR	C2a(i); D	No	No
<i>Campylopus atrovirens</i>	LC		LC		No	No
<i>Campylopus brevipilus</i>	LC		LC		No	No
<i>Campylopus cygneus</i>	LC		LC		No	No
<i>Campylopus flaccidus</i>	EN	B2ab(i,ii,iii,iv,v); C2a(i)	EN	B2ab(i,ii,iii,iv,v); C2a(i)	No	No
<i>Campylopus flexuosus</i>	LC		LC		No	No
<i>Campylopus fragilis</i>	LC		LC		No	No
<i>Campylopus gracilis</i>	LC		LC		No	No
<i>Campylopus incrassatus</i>	LC		LC		No	No
<i>Campylopus introflexus</i>	NA		NA		No	No
<i>Campylopus oerstedianus</i>	DD		DD		No	No
<i>Campylopus pilifer</i>	LC		LC		No	No
<i>Campylopus pyriformis</i>	LC		LC		No	No
<i>Campylopus schimperi</i>	LC		LC		No	No
<i>Campylopus setifolius</i>	LC		LC		Yes	Yes
<i>Campylopus shawii</i>	LC		LC		No	No
<i>Campylopus subporodictyon</i>	VU	D1	VU	D1	No	No
<i>Campylopus subulatus</i>	DD		DD		No	No
<i>Dicranodontium asperulum</i>	LC		LC		No	No
<i>Dicranodontium denudatum</i>	LC		LC		No	No
<i>Dicranodontium uncinatum</i>	LC		LC		No	No
<i>Leucobryum albidum</i>	DD		DD		No	No

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<i>Leucobryum glaucum</i>	LC		LC		No	No
<i>Leucobryum juniperoideum</i>	LC		LC		No	No
<i>Microcampylopus laevigatus</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
LEUCODONTACEAE						
<i>Antitrichia californica</i>	LC		LC		No	No
<i>Antitrichia curtispindula</i>	LC		LC		No	No
<i>Leucodon canariensis</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Leucodon pendulus</i>	NA		NE		No	No
<i>Leucodon sciurooides</i>	LC		LC		No	No
<i>Leucodon treleasei</i>	VU	C2a(i)	VU	C2a(i)	Yes	Yes
<i>Nogopterium gracile</i>	LC		LC		No	No
LEUCOMIACEAE						
<i>Tetrastichium fontanum</i>	VU	B2ab(iii,v); C2a(i); D1	VU	B2ab(iii,v); C2a(i); D1	Yes	Yes
<i>Tetrastichium virens</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
LOPHOCOLEACEAE						
<i>Chiloscyphus pallescens</i>	LC		LC		No	No
<i>Chiloscyphus polyanthos</i>	LC		LC		No	No
<i>Heteroscyphus denticulatus</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Heteroscyphus fissistipus</i>	NA		NA		No	No
<i>Leptoscyphus cuneifolius</i>	LC		LC		No	No
<i>Leptoscyphus porphyrius</i>	EN	B2ab(ii,iii,iv,v)	EN	B2ab(ii,iii,iv,v)	No	No
<i>Lophocolea bidentata</i>	LC		LC		No	No
<i>Lophocolea bispinosa</i>	NA		NA		No	No
<i>Lophocolea brookwoodiana</i>	DD		DD		Yes	Yes
<i>Lophocolea coadunata</i>	LC		LC		No	No
<i>Lophocolea fragrans</i>	LC		LC		No	No
<i>Lophocolea heterophylla</i>	LC		LC		No	No
<i>Lophocolea minor</i>	LC		LC		No	No
<i>Lophocolea semiteres</i>	NA		NA		No	No
LOPHOZIACEAE						
<i>Lophozia ascendens</i>	LC		LC		No	No
<i>Lophozia ciliata</i>	NT	C2a(i)	NT		No	No
<i>Lophozia guttulata</i>	LC		LC		No	No
<i>Lophozia longiflora</i>	LC		NT		No	No
<i>Lophozia murmanica</i>	DD		NE		No	No
<i>Lophozia savicziae</i>	VU	D1	EN	D	No	No
<i>Lophozia schusteriana</i>	LC		NE		No	No
<i>Lophozia silvicoloides</i>	DD		NE		No	No
<i>Lophozia subapiculata</i>	DD		NE		No	No
<i>Lophozia ventricosa</i>	LC		LC		No	No
<i>Lophozia wenzelii</i>	LC		LC		No	No
<i>Oleolophozia perssonii</i>	LC		LC		No	No
<i>Trilophozia quinquedentata</i>	LC		LC		No	No
<i>Tritomaria exsecta</i>	LC		LC		No	No
<i>Tritomaria exsectiformis</i>	LC		LC		No	No
<i>Tritomaria scitula</i>	LC		LC		No	No
LUNULARIACEAE						
<i>Lunularia cruciata</i>	LC		LC		No	No
MARCHANTIACEAE						
<i>Marchantia paleacea</i>	VU	D1	VU	D1	No	No

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<i>Marchantia polymorpha</i>	LC		LC		No	No
<i>Marchantia quadrata</i>	LC		LC		No	No
<i>Marchantia romanica</i>	VU	D1	VU	D1	No	No
MASTIGOPHORACEAE						
<i>Mastigophora woodsii</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
MEESIACEAE						
<i>Amblyodon dealbatus</i>	LC		LC		No	No
<i>Leptobryum pyriforme</i>	LC		LC		No	No
<i>Meesia hexasticha</i>	VU	D1	VU	D1	No	No
<i>Meesia longiseta</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Meesia triquetra</i>	NT	C2a(i)	VU	C2a(i)	No	No
<i>Meesia uliginosa</i>	LC		LC		No	No
<i>Paludella squarrosa</i>	LC		NT	A2c	No	No
METZGERIACEAE						
<i>Metzgeria conjugata</i>	LC		LC		No	No
<i>Metzgeria consanguinea</i>	LC		LC		No	No
<i>Metzgeria furcata</i>	LC		LC		No	No
<i>Metzgeria leptoneura</i>	LC		LC		No	No
<i>Metzgeria pubescens</i>	LC		LC		No	No
<i>Metzgeria simplex</i>	DD		DD		No	No
<i>Metzgeria violacea</i>	LC		LC		No	No
MNIACEAE						
<i>Cinclidium arcticum</i>	LC		NT		No	No
<i>Cinclidium latifolium</i>	NT		NE		No	No
<i>Cinclidium stygium</i>	LC		NT		No	No
<i>Cinclidium subrotundum</i>	LC		LC		No	No
<i>Cyrtomnium hymenophylloides</i>	LC		NT		No	No
<i>Cyrtomnium hymenophyllum</i>	LC		NT		No	No
<i>Epipterygium tozeri</i>	LC		LC		No	No
<i>Mielichhoferia elongata</i>	VU	D1	VU	D1	No	No
<i>Mielichhoferia mielichhoferiana</i>	NT	D1	VU	D1	No	No
<i>Mnium blyttii</i>	LC		LC		No	No
<i>Mnium heterophyllum</i>	RE		NE		No	No
<i>Mnium hornum</i>	LC		LC		No	No
<i>Mnium lycopodioides</i>	LC		LC		No	No
<i>Mnium marginatum</i>	LC		LC		No	No
<i>Mnium spinosum</i>	LC		LC		No	No
<i>Mnium spinulosum</i>	LC		LC		No	No
<i>Mnium stellare</i>	LC		LC		No	No
<i>Mnium thomsonii</i>	LC		LC		No	No
<i>Plagiomnium affine</i>	LC		LC		No	No
<i>Plagiomnium confertidens</i>	VU	D1	NE		No	No
<i>Plagiomnium curvatulum</i>	LC		NT	D1	No	No
<i>Plagiomnium cuspidatum</i>	LC		LC		No	No
<i>Plagiomnium drummondii</i>	EN	B2ab(ii,iii,iv)	EN	B2ab(ii,iii,iv)	No	No
<i>Plagiomnium elatum</i>	LC		LC		No	No
<i>Plagiomnium ellipticum</i>	LC		LC		No	No
<i>Plagiomnium medium</i>	LC		LC		No	No
<i>Plagiomnium rostratum</i>	LC		LC		No	No
<i>Plagiomnium undulatum</i>	LC		LC		No	No
<i>Pohlia andalusica</i>	LC		LC		No	No

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<i>Poblia andrewsii</i>	NT	D1	NT		No	No
<i>Poblia annotina</i>	LC		LC		No	No
<i>Poblia atropurpurea</i>	NT	D1	VU	D1	No	No
<i>Poblia beringiensis</i>	CR	B2ab(iii); D	NE		No	No
<i>Poblia bolanderi</i>	EN	B2ab(iii)	EN	B2ab(iii)	No	No
<i>Poblia bulbifera</i>	LC		LC		No	No
<i>Poblia camptotrachela</i>	LC		LC		No	No
<i>Poblia cruda</i>	LC		LC		No	No
<i>Poblia crudoides</i>	VU	D1	VU	D1	No	No
<i>Poblia drummondii</i>	LC		LC		No	No
<i>Poblia elongata</i>	LC		LC		No	No
<i>Poblia erecta</i>	EN	C2a(i)	CR	C2a(i,ii); D	No	No
<i>Poblia filum</i>	LC		LC		No	No
<i>Poblia flexuosa</i>	LC		LC		No	No
<i>Poblia lescuriana</i>	LC		LC		No	No
<i>Poblia longicolla</i>	LC		LC		No	No
<i>Poblia ludwigii</i>	LC		LC		No	No
<i>Poblia lutescens</i>	LC		LC		No	No
<i>Poblia melanodon</i>	LC		LC		No	No
<i>Poblia nutans</i>	LC		LC		No	No
<i>Poblia obtusifolia</i>	LC		LC		No	No
<i>Poblia prolifera</i>	LC		LC		No	No
<i>Poblia scotica</i>	LC		LC		Yes	Yes
<i>Poblia sphagnicola</i>	DD		DD		No	No
<i>Poblia tundrae</i>	DD		DD		No	No
<i>Poblia vexans</i>	EN	B2ab(ii,iii,iv,v)	EN	B2ab(ii,iii,iv,v)	No	No
<i>Poblia wahlenbergii</i>	LC		LC		No	No
<i>Pseudobryum cinclidioides</i>	LC		LC		No	No
<i>Rhizomnium andrewsianum</i>	EN	B2ab(iii); C2a(i)	EN	EN B2ab (iii); C2a (i)	No	No
<i>Rhizomnium gracile</i>	CR	D	CR	D	No	No
<i>Rhizomnium magnifolium</i>	LC		LC		No	No
<i>Rhizomnium pseudopunctatum</i>	LC		LC		No	No
<i>Rhizomnium punctatum</i>	LC		LC		No	No
<i>Schizymenium pontevedrense</i>	VU	C2a(i)	VU	C2a(i)	Yes	Yes
MOERCKIACEAE						
<i>Moerckia blyttii</i>	VU	B2ab(iii)	VU	B2ab(iii)	No	No
<i>Moerckia flotoviana</i>	NT	B2b(iii)	NT		No	No
<i>Moerckia hibernica</i>	VU	D1	VU	D1	No	No
MYLIACEAE						
<i>Mylia anomala</i>	LC		LC		No	No
<i>Mylia taylorii</i>	LC		LC		No	No
MYRINIACEAE						
<i>Helicodontium capillare</i>	RE		RE		No	No
<i>Myrinia pulvinata</i>	NT	B2b(iii)	VU	C2a(i)	No	No
MYURIACEAE						
<i>Myurium bochstetteri</i>	LC		LC		Yes	Yes
NECKERACEAE						
<i>Alleniella besseri</i>	LC		LC		No	No
<i>Alleniella complanata</i>	LC		LC		No	No
<i>Exsertotheca baetica</i>	EN	D	EN	D	Yes	Yes

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<i>Exsertotheca crispa</i>	LC		LC		No	No
<i>Exsertotheca intermedia</i>	VU	A3c	VU	A3c	Yes	Yes
<i>Homalia lusitanica</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Homalia trichomanoides</i>	LC		LC		No	No
<i>Homalia webbiana</i>	EN	B2ab(iii,v)	EN	B2ab(iii,v)	Yes	No
<i>Neckera cephalonica</i>	NT	B2ab(iii)	NT	B2ab(iii)	Yes	No
<i>Neckera menziesii</i>	LC		LC		No	No
<i>Neckera oligocarpa</i>	LC		NT		No	No
<i>Neckera pennata</i>	LC		VU	C2a(i)	No	No
<i>Neckera pumila</i>	LC		LC		No	No
<i>Thamnobryum alopecurum</i>	LC		LC		No	No
<i>Thamnobryum angustifolium</i>	CR	D	CR	D	Yes	Yes
<i>Thamnobryum cataractarum</i>	CR	D	CR	D	Yes	Yes
<i>Thamnobryum fernandesii</i>	VU	B1ab(iii)+2ab(iii)	VU	B1ab(iii)+2ab(iii)	Yes	Yes
<i>Thamnobryum maderense</i>	NT	B2ab(iii)	NT	B2ab(iii)	No	No
<i>Thamnobryum neckeroides</i>	VU	D1	VU	D1	No	No
<i>Thamnobryum rudolphianum</i>	EN	B2ab(iii)	EN	B2ab(iii)	Yes	Yes
<i>Thamnobryum subserratum</i>	EN	D	EN	D	No	No
NOTOTHYLADACEAE						
<i>Notothyas orbicularis</i>	EN	B2ab(ii,iii,v)	EN	B2ab(ii,iii,v)	No	No
<i>Phaeoceros carolinianus</i>	NT	A2c	NT	A2c	No	No
<i>Phaeoceros laevis</i>	LC		LC		No	No
OEDIPODIACEAE						
<i>Oedipodium griffithianum</i>	NT		NT		No	No
ORTHODONTIACEAE						
<i>Leptotheca gaudichaudii</i>	NA		NA		No	No
<i>Orthodontium gracile</i>	CR	C2a(i)	CR	C2a(i)	No	No
<i>Orthodontium lineare</i>	NA		NA		No	No
<i>Orthodontium pellucens</i>	VU	B1ab(iii)+2ab(iii); D2	VU	B1ab(iii)+2ab(iii); D2	No	No
ORTHOTRICHACEAE						
<i>Codonoblepharon forsteri</i>	EN	B2ab(ii,iii)	NT		No	No
<i>Lewinskya acuminata</i>	LC		LC		No	No
<i>Lewinskya affinis</i>	LC		LC		No	No
<i>Lewinskya breviseta</i>	LC		LC		No	No
<i>Lewinskya iberica</i>	LC		LC		No	No
<i>Lewinskya laevigata</i>	VU	D1	EN	D	No	No
<i>Lewinskya pylaisii</i>	LC		NT		No	No
<i>Lewinskya rupestris</i>	LC		LC		No	No
<i>Lewinskya shawii</i>	LC		LC		No	No
<i>Lewinskya sordida</i>	DD		NE		No	No
<i>Lewinskya speciosa</i>	LC		LC		No	No
<i>Lewinskya striata</i>	LC		LC		No	No
<i>Lewinskya tortidontia</i>	LC		LC		No	No
<i>Nyholmiella gymnostoma</i>	LC		LC		No	No
<i>Nyholmiella obtusifolia</i>	LC		LC		No	No
<i>Orthotrichum alpestre</i>	LC		LC		No	No
<i>Orthotrichum anomalum</i>	LC		LC		No	No
<i>Orthotrichum callistomum</i>	RE		NE		No	No
<i>Orthotrichum cambrense</i>	DD		DD		Yes	Yes
<i>Orthotrichum casasianum</i>	CR	B1ab(iii)+2ab(iii)	CR	B1ab(iii)+2ab(iii)	Yes	Yes

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<i>Orthotrichum columbicum</i>	LC		DD		No	No
<i>Orthotrichum comosum</i>	LC		LC		No	No
<i>Orthotrichum consobrinum</i>	CR	D	CR	D	No	No
<i>Orthotrichum crenulatum</i>	VU	D1	VU	D1	No	No
<i>Orthotrichum cupulatum</i>	LC		LC		No	No
<i>Orthotrichum dentatum</i>	VU	D1	VU	D1	Yes	No
<i>Orthotrichum diaphanum</i>	LC		LC		No	No
<i>Orthotrichum handiense</i>	CR	B1ab(iii,v)+2ab(iii,v); C2a(i,ii); D	CR	B1ab(iii,v)+2ab(iii,v); C2a(i,ii); D	Yes	Yes
<i>Orthotrichum hispanicum</i>	NT		NT		No	No
<i>Orthotrichum macrocephalum</i>	LC		LC		No	No
<i>Orthotrichum microcarpum</i>	VU	D1	EN	D	No	No
<i>Orthotrichum moravicum</i>	DD		DD		No	No
<i>Orthotrichum pallens</i>	LC		LC		No	No
<i>Orthotrichum patens</i>	LC		LC		No	No
<i>Orthotrichum pellucidum</i>	VU	C2a(i)	CR	C2a(i)	No	No
<i>Orthotrichum philibertii</i>	LC		LC		No	No
<i>Orthotrichum pulchellum</i>	LC		LC		No	No
<i>Orthotrichum pumilum</i>	LC		LC		No	No
<i>Orthotrichum rivulare</i>	LC		LC		No	No
<i>Orthotrichum rogeri</i>	LC		LC		No	No
<i>Orthotrichum scanicum</i>	LC		LC		No	No
<i>Orthotrichum schimperi</i>	LC		LC		No	No
<i>Orthotrichum sibiricum</i>	DD		NE		No	No
<i>Orthotrichum sprucei</i>	LC		LC		No	No
<i>Orthotrichum stellatum</i>	VU	D1	VU	D1	No	No
<i>Orthotrichum stramineum</i>	LC		LC		No	No
<i>Orthotrichum tenellum</i>	LC		LC		No	No
<i>Orthotrichum urnigerum</i>	VU	D1	VU	D1	No	No
<i>Orthotrichum vittii</i>	NT		NT		No	No
<i>Plenogemma phyllantha</i>	LC		LC		No	No
<i>Pulviger a lyellii</i>	LC		LC		No	No
<i>Ulot a bruchii</i>	LC		LC		Yes	No
<i>Ulot a calvescens</i>	LC		LC		Yes	No
<i>Ulot a coarctata</i>	LC		LC		No	No
<i>Ulot a crispa</i>	LC		LC		No	No
<i>Ulot a crispula</i>	LC		LC		No	No
<i>Ulot a curvifolia</i>	LC		LC		No	No
<i>Ulot a drummondii</i>	LC		LC		No	No
<i>Ulot a hutchinsiae</i>	LC		LC		No	No
<i>Ulot a intermedia</i>	LC		LC		No	No
<i>Ulot a macrospora</i>	EN	D	EN	D	Yes	No
<i>Ulot a rehmannii</i>	CR	D	CR	D	No	No
<i>Zygodon catarinoid</i>	LC		LC		No	No
<i>Zygodon conoideus</i>	LC		LC		No	No
<i>Zygodon dentatus</i>	LC		LC		No	No
<i>Zygodon gracilis</i>	VU	D1	VU	D1	No	No
<i>Zygodon rupestris</i>	LC		LC		No	No
<i>Zygodon sibiricus</i>	DD		NE		No	No
<i>Zygodon stirtonii</i>	LC		LC		No	No
<i>Zygodon viridissimus</i>	LC		LC		No	No

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<i>OXYMITRACEAE</i>						
<i>Oxymitra incrassata</i>	LC		LC		No	No
<i>PALLAVICINIACEAE</i>						
<i>Pallavicinia lyellii</i>	VU	B2ab(ii,iii,iv,v)	VU	B2ab(ii,iii,iv,v)	No	No
<i>PELLIACEAE</i>						
<i>Apopellia endiviifolia</i>	LC		LC		No	No
<i>Pellia epiphylla</i>	LC		LC		No	No
<i>Pellia neesiana</i>	LC		LC		No	No
<i>PETALOPHYLLACEAE</i>						
<i>Petalophyllum ralfsii</i>	LC		LC		No	No
<i>PHYMATOCEROTACEAE</i>						
<i>Phymatoceros bulbiculosus</i>	LC		LC		No	No
<i>PILOTTRICHACEAE</i>						
<i>Cyclodictyon laetevirens</i>	LC		LC		No	No
<i>PLAGIOCHILACEAE</i>						
<i>Pedinophyllum interruptum</i>	LC		LC		No	No
<i>Plagiochila arctica</i>	DD		NE		No	No
<i>Plagiochila asplenioides</i>	LC		LC		No	No
<i>Plagiochila bifaria</i>	LC		LC		No	No
<i>Plagiochila britannica</i>	LC		LC		Yes	No
<i>Plagiochila carringtonii</i>	NT	B2b(iii,iv,v)	NT	B2b(iii,iv,v)	No	No
<i>Plagiochila exigua</i>	LC		LC		No	No
<i>Plagiochila heterophylla</i>	LC		LC		No	No
<i>Plagiochila longispina</i>	EN	A3c	EN	A3c	No	No
<i>Plagiochila maderensis</i>	EN	A3c	EN	A3c	Yes	Yes
<i>Plagiochila papillifolia</i>	CR	B1ab(iii,v)+2ab(iii,v); C2a(ii)	CR	B1ab(iii,v)+2ab(iii,v); C2a(ii)	No	No
<i>Plagiochila porelloides</i>	LC		LC		No	No
<i>Plagiochila punctata</i>	LC		LC		No	No
<i>Plagiochila retrorsa</i>	EN	A3c	EN	A3c	No	No
<i>Plagiochila spinulosa</i>	LC		LC		Yes	No
<i>Plagiochila stricta</i>	EN	A3c	EN	A3c	No	No
<i>Plagiochila virginica</i>	EN	A3c; C2a(i)	EN	A3c; C2a(i)	No	No
<i>PLAGIOTHECIACEAE</i>						
<i>Isopterygiopsis alpicola</i>	EN	D	CR	D	No	No
<i>Isopterygiopsis muelleriana</i>	LC		LC		No	No
<i>Isopterygiopsis pulchella</i>	LC		LC		No	No
<i>Plagiothecium berggrenianum</i>	VU	D1	NE		No	No
<i>Plagiothecium cavifolium</i>	LC		LC		No	No
<i>Plagiothecium curvifolium</i>	LC		LC		No	No
<i>Plagiothecium denticulatum</i>	LC		LC		No	No
<i>Plagiothecium handelii</i>	VU	D1	VU	D1	No	No
<i>Plagiothecium laetum</i>	LC		LC		No	No
<i>Plagiothecium latebricola</i>	LC		LC		No	No
<i>Plagiothecium neckeroideum</i>	VU	D1	VU	D1	No	No
<i>Plagiothecium nemorale</i>	LC		LC		No	No
<i>Plagiothecium piliferum</i>	LC		LC		No	No
<i>Plagiothecium platyphyllum</i>	LC		LC		No	No
<i>Plagiothecium succulentum</i>	LC		LC		No	No
<i>Plagiothecium svalbardense</i>	DD		NE		No	No
<i>Plagiothecium undulatum</i>	LC		LC		No	No

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<i>PLEUROZIACEAE</i>						
<i>Pleurozia purpurea</i>	LC		LC		No	No
<i>POLYTRICHACEAE</i>						
<i>Alophosia azorica</i>	NT	A3c; B2b(iii)	NT	A3c; B2b(iii)	Yes	Yes
<i>Atrichum androgynum</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Atrichum angustatum</i>	VU	B2ab(ii,iii,iv,v)	EN	B2ab(ii,iii,iv,v)	No	No
<i>Atrichum crispum</i>	NA		NA		No	No
<i>Atrichum flavisetum</i>	LC		DD		No	No
<i>Atrichum tenellum</i>	LC		LC		No	No
<i>Atrichum undulatum</i>	LC		LC		No	No
<i>Oligotrichum bercynicum</i>	LC		LC		No	No
<i>Pogonatum aloides</i>	LC		LC		No	No
<i>Pogonatum dentatum</i>	LC		LC		No	No
<i>Pogonatum nanum</i>	LC		LC		No	No
<i>Pogonatum urnigerum</i>	LC		LC		No	No
<i>Polytrichastrum alpinum</i>	LC		LC		No	No
<i>Polytrichastrum altaicum</i>	DD		DD		No	No
<i>Polytrichastrum fragile</i>	DD		NE		No	No
<i>Polytrichastrum septentrionale</i>	DD		DD		No	No
<i>Polytrichastrum sexangulare</i>	NT	A3c	VU	A3c	No	No
<i>Polytrichastrum sphaerothecium</i>	VU	D1	NE		No	No
<i>Polytrichum commune</i>	LC		LC		No	No
<i>Polytrichum densifolium</i>	LC		DD		No	No
<i>Polytrichum formosum</i>	LC		LC		No	No
<i>Polytrichum hyperboreum</i>	LC		NT		No	No
<i>Polytrichum jensenii</i>	LC		LC		No	No
<i>Polytrichum juniperinum</i>	LC		LC		No	No
<i>Polytrichum longisetum</i>	LC		LC		No	No
<i>Polytrichum pallidisetum</i>	NT		EN	B2ab(ii,iii)	No	No
<i>Polytrichum piliferum</i>	LC		LC		No	No
<i>Polytrichum strictum</i>	LC		LC		No	No
<i>Polytrichum swartzii</i>	LC		DD		No	No
<i>Psilopilum cavifolium</i>	NT	B2b(iii)	EN	B2ab(iii)	No	No
<i>Psilopilum laevigatum</i>	LC		VU	D1	No	No
<i>PORELLACEAE</i>						
<i>Porella arboris-vitae</i>	NT	C2a(i)	NT	C2a(i)	No	No
<i>Porella baueri</i>	DD		DD		No	No
<i>Porella canariensis</i>	LC		LC		No	No
<i>Porella cordaeana</i>	LC		LC		No	No
<i>Porella inaequalis</i>	EN	C2a(i)	EN	C2a(i)	Yes	Yes
<i>Porella obtusata</i>	LC		LC		No	No
<i>Porella pinnata</i>	LC		LC		No	No
<i>Porella platyphylla</i>	LC		LC		No	No
<i>POTTIACEAE</i>						
<i>Acaulon casasianum</i>	NT		NT		Yes	Yes
<i>Acaulon fontiquerianum</i>	NT	B2a	NT		No	No
<i>Acaulon mediterraneum</i>	NT	B2a	NT	B2a	No	No
<i>Acaulon muticum</i>	NT	B2b(i,ii,iii,iv,v)	NT	B2b(i,ii,iii,iv,v)	No	No
<i>Acaulon piligerum</i>	DD		DD		Yes	Yes
<i>Acaulon triquetrum</i>	LC		LC		No	No
<i>Aloina aloides</i>	LC		LC		No	No

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<i>Aloina ambigua</i>	LC		LC		No	No
<i>Aloina bifrons</i>	NT	B2a	LC		No	No
<i>Aloina brevirostris</i>	LC		LC		No	No
<i>Aloina humilis</i>	DD		DD		Yes	Yes
<i>Aloina obliquifolia</i>	LC		LC		No	No
<i>Aloina rigida</i>	LC		LC		No	No
<i>Anoetangium aestivum</i>	LC		LC		No	No
<i>Aschisma carniolicum</i>	EN	B2ab(iii)	EN	B2b(iii)	No	No
<i>Aschisma cuynetii</i>	VU	D1	VU	D1	Yes	Yes
<i>Barbula unguiculata</i>	LC		LC		No	No
<i>Bryoerythrophyllum alpigenum</i>	VU	D1	VU	D1	No	No
<i>Bryoerythrophyllum caledonicum</i>	VU	D1	VU	D1	Yes	Yes
<i>Bryoerythrophyllum campylocarpum</i>	VU	B2ab(ii,iii,iv,v)	VU	B2ab(ii,iii,iv,v)	No	No
<i>Bryoerythrophyllum duellii</i>	VU	D1	VU	D1	Yes	Yes
<i>Bryoerythrophyllum ferruginascens</i>	LC		LC		No	No
<i>Bryoerythrophyllum inaequalifolium</i>	VU	D1	VU	D1	No	No
<i>Bryoerythrophyllum recurvirostrum</i>	LC		LC		No	No
<i>Bryoerythrophyllum rubrum</i>	NT	D1	NT	D1	No	No
<i>Chionoloma daldinianum</i>	LC		LC		No	No
<i>Chionoloma hibernicum</i>	LC		LC		Yes	No
<i>Chionoloma minus</i>	DD		DD		Yes	No
<i>Chionoloma recurvifolium</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Chionoloma tenuirostre</i>	LC		LC		No	No
<i>Crossidium aberrans</i>	LC		LC		No	No
<i>Crossidium crassinervium</i>	LC		LC		No	No
<i>Crossidium davidai</i>	LC		LC		No	No
<i>Crossidium geheebii</i>	NT		NT		No	No
<i>Crossidium laevipilum</i>	NT		NT		No	No
<i>Crossidium laxefilamentosum</i>	EN	B2ab(iii)	EN	B2ab(iii)	No	No
<i>Crossidium squamiferum</i>	LC		LC		No	No
<i>Dialytrichia mucronata</i>	LC		LC		No	No
<i>Dialytrichia saxicola</i>	LC		LC		Yes	Yes
<i>Didymodon acutus</i>	LC		LC		No	No
<i>Didymodon asperifolius</i>	NT	B2ab(iii,v); D1	VU	D1	No	No
<i>Didymodon australasiae</i>	LC		LC		No	No
<i>Didymodon bistratosus</i>	LC		LC		No	No
<i>Didymodon brachyphyllus</i>	EN	D	CR	D	No	No
<i>Didymodon cordatus</i>	LC		LC		No	No
<i>Didymodon eckeliae</i>	LC		LC		No	No
<i>Didymodon fallax</i>	LC		LC		No	No
<i>Didymodon ferrugineus</i>	LC		LC		No	No
<i>Didymodon giganteus</i>	LC		LC		No	No
<i>Didymodon glaucus</i>	VU	D1	VU	D1	No	No
<i>Didymodon icmadophilus</i>	LC		LC		No	No
<i>Didymodon insulanus</i>	LC		LC		No	No
<i>Didymodon johansenii</i>	VU	D1	VU	D1	No	No
<i>Didymodon luridus</i>	LC		LC		No	No
<i>Didymodon maschalogenus</i>	EN	D	EN	D	No	No
<i>Didymodon maximus</i>	VU	D1	VU	D1	No	No
<i>Didymodon nicholsonii</i>	LC		LC		No	No
<i>Didymodon rigidulus</i>	LC		LC		No	No

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<i>Didymodon sinuosus</i>	LC		LC		No	No
<i>Didymodon spadiceus</i>	LC		LC		No	No
<i>Didymodon subandreaeoides</i>	NT	B2a; D1	NT	B2a; D1	No	No
<i>Didymodon tomaculosus</i>	LC		LC		Yes	Yes
<i>Didymodon tophaceus</i>	LC		LC		No	No
<i>Didymodon umbrosus</i>	LC		LC		No	No
<i>Didymodon validus</i>	VU	D1	VU	D1	No	No
<i>Didymodon vinealis</i>	LC		LC		No	No
<i>Eucladium verticillatum</i>	LC		LC		No	No
<i>Gymnobarbula bicolor</i>	VU	D1	VU	D1	Yes	No
<i>Gymnostomum aeruginosum</i>	LC		LC		No	No
<i>Gymnostomum calcareum</i>	LC		LC		No	No
<i>Gymnostomum viridulum</i>	LC		LC		No	No
<i>Gyroweisia reflexa</i>	NT	B2a	NT	B2a	No	No
<i>Gyroweisia tenuis</i>	LC		LC		No	No
<i>Henediella heimii</i>	LC		LC		No	No
<i>Henediella macrophylla</i>	NA		NA		No	No
<i>Henediella stanfordensis</i>	NA		NA		No	No
<i>Hilpertia velenovskyi</i>	CR	C2a(i); D	CR	C2a(i); D	No	No
<i>Hydrogonium amplexifolium</i>	LC		LC		No	No
<i>Hydrogonium bolleanum</i>	DD		DD		No	No
<i>Hydrogonium consanguineum</i>	DD		DD		No	No
<i>Hydrogonium croceum</i>	LC		LC		No	No
<i>Hymenostylium gracillimum</i>	EN	D	EN	D	Yes	No
<i>Hymenostylium recurvirostrum</i>	LC		LC		No	No
<i>Hymenostylium xerophilum</i>	LC		LC		No	No
<i>Hyophila involuta</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Leptobarbula berica</i>	LC		LC		No	No
<i>Leptodontium flexifolium</i>	NT	B2b(ii,iv,v)	NT	B2b(ii,iv,v)	No	No
<i>Leptodontium gemmascens</i>	VU	D1	VU	D1	No	No
<i>Leptodontium proliferum</i>	NA		NA		No	No
<i>Leptodontium styriacum</i>	VU	D1	VU	D1	No	No
<i>Leptophascum leptophyllum</i>	LC		LC		No	No
<i>Microbryum curvicollum</i>	LC		LC		No	No
<i>Microbryum davallianum</i>	LC		LC		No	No
<i>Microbryum floerkeanum</i>	LC		NT	B2b(ii,iii,v)	No	No
<i>Microbryum fosbergii</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Microbryum longipes</i>	VU	D1	VU	D1	Yes	Yes
<i>Microbryum rectum</i>	LC		LC		No	No
<i>Microbryum starckeanum</i>	LC		LC		No	No
<i>Molendoa hornsuschiana</i>	VU	D1	VU	D1	No	No
<i>Molendoa schliephackei</i>	EN	D	EN	D	No	No
<i>Molendoa taeniatifolia</i>	EN	D	EN	D	Yes	No
<i>Molendoa warburgii</i>	LC		LC		No	No
<i>Pottiopsis caespitosa</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Pseudocrossidium hornsuschianum</i>	LC		LC		No	No
<i>Pseudocrossidium obtusulum</i>	DD		DD		No	No
<i>Pseudocrossidium replicatum</i>	EN	D	EN	D	No	No
<i>Pseudocrossidium revolutum</i>	LC		LC		No	No
<i>Pterygoneurum kozlovii</i>	CR	D	CR	D	No	No
<i>Pterygoneurum lamellatum</i>	LC		LC		No	No

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<i>Pterygoneurum ovatum</i>	LC		LC		No	No
<i>Pterygoneurum papillosum</i>	DD		DD		Yes	Yes
<i>Pterygoneurum sampaianum</i>	NT		NT		No	No
<i>Pterygoneurum subsessile</i>	LC		NT		No	No
<i>Scopelophila cataractae</i>	EN	B2ab(ii,iii,iv,v)	EN	B2ab(ii,iii,iv,v)	No	No
<i>Scopelophila ligulata</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Stegonia latifolia</i>	NT	C2a(i)	VU	C2a(i)	No	No
<i>Streblotrichum commutatum</i>	LC		LC		No	No
<i>Streblotrichum convolutum</i>	LC		LC		No	No
<i>Streblotrichum enderesii</i>	VU	D1	VU	D1	No	No
<i>Syntrichia bogotensis</i>	EN	B1ab(ii,iii,iv)+ 2ab(ii,iii,iv)	EN	B1ab(ii,iii,iv)+ 2ab(ii,iii,iv)	No	No
<i>Syntrichia calcicola</i>	LC		LC		No	No
<i>Syntrichia caninervis</i>	LC		LC		No	No
<i>Syntrichia echinata</i>	VU	D1	VU	D1	No	No
<i>Syntrichia fragilis</i>	LC		LC		No	No
<i>Syntrichia handelii</i>	DD		DD		No	No
<i>Syntrichia laevipila</i>	LC		LC		No	No
<i>Syntrichia latifolia</i>	LC		LC		No	No
<i>Syntrichia minor</i>	DD		DD		No	No
<i>Syntrichia montana</i>	LC		LC		No	No
<i>Syntrichia norvegica</i>	LC		LC		No	No
<i>Syntrichia papillosa</i>	LC		LC		No	No
<i>Syntrichia papillosissima</i>	LC		LC		No	No
<i>Syntrichia princeps</i>	LC		LC		No	No
<i>Syntrichia rigescens</i>	CR	D	CR	D	No	No
<i>Syntrichia ruralis</i>	LC		LC		No	No
<i>Syntrichia sinensis</i>	VU	D1	VU	D1	No	No
<i>Syntrichia subpapillosissima</i>	DD		DD		No	No
<i>Syntrichia virescens</i>	LC		LC		No	No
<i>Timmiella anomala</i>	LC		LC		No	No
<i>Timmiella barbuloides</i>	LC		LC		No	No
<i>Timmiella flexisetata</i>	DD		DD		No	No
<i>Tortella alpicola</i>	LC		LC		No	No
<i>Tortella cuspidatissima</i>	EN	B2ab(ii,iii,iv)	CR	B2ab(ii,iii,iv)	No	No
<i>Tortella fasciculata</i>	LC		LC		Yes	No
<i>Tortella flavovirens</i>	LC		LC		No	No
<i>Tortella fragilis</i>	LC		LC		No	No
<i>Tortella humilis</i>	LC		LC		No	No
<i>Tortella inclinata</i>	LC		LC		No	No
<i>Tortella inflexa</i>	LC		LC		No	No
<i>Tortella limbata</i>	VU	B2ab(iii)	VU	B2ab(iii)	Yes	Yes
<i>Tortella nitida</i>	LC		LC		No	No
<i>Tortella pseudofragilis</i>	LC		LC		Yes	No
<i>Tortella rigens</i>	LC		LC		No	No
<i>Tortella spitsbergensis</i>	EN	B2ab(i,ii,iii,iv,v)	NE		No	No
<i>Tortella squarrosa</i>	LC		LC		No	No
<i>Tortella tortuosa</i>	LC		LC		No	No
<i>Tortula acaulon</i>	LC		LC		No	No
<i>Tortula amplexa</i>	NA		NA		No	No
<i>Tortula ampliretis</i>	LC		LC		Yes	Yes

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<i>Tortula atrovirens</i>	LC		LC		No	No
<i>Tortula bogosica</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Tortula bolanderi</i>	EN	B2ab(iii)	EN	B2ab(iii)	No	No
<i>Tortula brevissima</i>	LC		LC		No	No
<i>Tortula canescens</i>	LC		LC		No	No
<i>Tortula caucasica</i>	LC		LC		No	No
<i>Tortula cernua</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Tortula cuneifolia</i>	LC		LC		No	No
<i>Tortula freibergii</i>	LC		LC		No	No
<i>Tortula guelpinii</i>	LC		NT		No	No
<i>Tortula hoppeana</i>	LC		LC		No	No
<i>Tortula inermis</i>	LC		LC		No	No
<i>Tortula israelis</i>	LC		LC		No	No
<i>Tortula laureri</i>	CR	C2a(i)	EN	C2a(i)	No	No
<i>Tortula leucostoma</i>	EN	D	EN	D	No	No
<i>Tortula lindbergii</i>	LC		LC		No	No
<i>Tortula lingulata</i>	VU	D1	VU	D1	No	No
<i>Tortula marginata</i>	LC		LC		No	No
<i>Tortula mucronifolia</i>	NT		NT		No	No
<i>Tortula muralis</i>	LC		LC		No	No
<i>Tortula pallida</i>	LC		LC		No	No
<i>Tortula protobryoides</i>	LC		NT		No	No
<i>Tortula randii</i>	EN	B2ab(iv); C2a(i)	EN	B2ab(iv); C2a(i)	No	No
<i>Tortula revolvens</i>	LC		LC		No	No
<i>Tortula schimperi</i>	LC		LC		No	No
<i>Tortula solmsii</i>	LC		LC		No	No
<i>Tortula subulata</i>	LC		LC		No	No
<i>Tortula systylia</i>	EN	B2ab(iii,iv)	VU	B2b(ii,iii)	No	No
<i>Tortula truncata</i>	LC		LC		No	No
<i>Tortula ucrainica</i>	DD		NE		No	No
<i>Tortula vahlbiana</i>	LC		LC		No	No
<i>Tortula viridifolia</i>	LC		LC		No	No
<i>Tortula vlassovii</i>	EN	B2ab(ii,iii,iv); D	EN	B2ab(ii,iii,iv); D	No	No
<i>Tortula wilsonii</i>	LC		LC		No	No
<i>Trichostomum brachydontium</i>	LC		LC		No	No
<i>Trichostomum crispulum</i>	LC		LC		No	No
<i>Triquetrella anapilensis</i>	NT		NT		Yes	Yes
<i>Weissia brachycarpa</i>	LC		LC		No	No
<i>Weissia condensa</i>	LC		LC		No	No
<i>Weissia controversa</i>	LC		LC		No	No
<i>Weissia levieri</i>	LC		LC		No	No
<i>Weissia longifolia</i>	LC		LC		No	No
<i>Weissia multicapsularis</i>	DD		DD		Yes	Yes
<i>Weissia personii</i>	LC		LC		Yes	No
<i>Weissia rostellata</i>	NT	C2a(i)	VU	C2a(i)	Yes	No
<i>Weissia rutilans</i>	LC		LC		No	No
<i>Weissia squarrosa</i>	VU	B2ab(ii,iii)	VU	B2ab(ii,iii)	Yes	No
<i>Weissia sterilis</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Weissia wimmeriana</i>	LC		LC		No	No
PSEUDOLEPICOLEACEAE						
<i>Blepharostoma trichophyllum</i>	LC		LC		No	No

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<i>PTERIGYNANDRACEAE</i>						
<i>Habrodon perpusillus</i>	LC		LC		No	No
<i>Heterocladium dimorphum</i>	LC		LC		No	No
<i>Heterocladium flaccidum</i>	LC		LC		Yes	No
<i>Heterocladium heteropterum</i>	LC		LC		No	No
<i>Heterocladium wulfsbergii</i>	LC		LC		Yes	No
<i>Iwatsukiella leucotricha</i>	LC		NE		No	No
<i>Myurella julacea</i>	LC		LC		No	No
<i>Myurella sibirica</i>	VU	B2ab(ii,iii,iv)	VU	B2ab (ii, iii, iv).	No	No
<i>Myurella tenerima</i>	LC		LC		No	No
<i>Pterigynandrum filiforme</i>	LC		LC		No	No
<i>PTILIDIACEAE</i>						
<i>Prilidium ciliare</i>	LC		LC		No	No
<i>Ptilidium pulcherrimum</i>	LC		LC		No	No
<i>PTYCHOMITRIACEAE</i>						
<i>Campylostelium pitardii</i>	EN	D	EN	D	No	No
<i>Campylostelium saxicola</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Campylostelium strictum</i>	EN	B2ab(iii)	EN	B2ab(ii,iii)	No	No
<i>Ptychomitrium incurvum</i>	CR	B2ab(ii,iv,v)	CR	B2ab(ii,iv,v)	No	No
<i>Ptychomitrium nigrescens</i>	LC		LC		No	No
<i>Ptychomitrium polyphyllum</i>	LC		LC		Yes	No
<i>PYLAIACEAE</i>						
<i>Buckia vaucheri</i>	LC		LC		No	No
<i>Pseudostereodon procerrimus</i>	LC		LC		No	No
<i>Roaldia revoluta</i>	LC		LC		No	No
<i>PYLAIASDELPHACEAE</i>						
<i>Heterophyllum affine</i>	DD		DD		No	No
<i>RADULACEAE</i>						
<i>Radula aquilegia</i>	LC		LC		No	No
<i>Radula carringtonii</i>	NT	B2ab(iii)	NT	B2ab(iii)	Yes	Yes
<i>Radula complanata</i>	LC		LC		No	No
<i>Radula holtii</i>	NT	B2ab(iii)	NT	B2ab(iii)	Yes	Yes
<i>Radula jonesii</i>	EN	C2a(i)	EN	C2a(i)	Yes	Yes
<i>Radula lindenbergiana</i>	LC		LC		No	No
<i>Radula nudicaulis</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Radula visianica</i>	CR	D	CR	D	Yes	Yes
<i>Radula voluta</i>	NT	D1	NT	D1	No	No
<i>Radula wichurae</i>	NT	A3c	NT	A3c	Yes	Yes
<i>RHABDOWEISACEAE</i>						
<i>Amphidium curvipes</i>	NT	B2b(iii)	NT	B2b(iii)	Yes	Yes
<i>Amphidium lapponicum</i>	LC		LC		No	No
<i>Amphidium mougeotii</i>	LC		LC		No	No
<i>Arctoa anderssonii</i>	VU	D1	EN	D	No	No
<i>Arctoa fulvella</i>	LC		LC		No	No
<i>Arctoa hyperborea</i>	VU	D1	VU	D1	No	No
<i>Cynodontium asperifolium</i>	NT	B2a	NE		No	No
<i>Cynodontium bruntonii</i>	LC		LC		No	No
<i>Cynodontium fallax</i>	NT	D1	VU	D1	No	No
<i>Cynodontium gracilescens</i>	LC		LC		No	No
<i>Cynodontium jenneri</i>	LC		LC		No	No
<i>Cynodontium polycarpon</i>	LC		LC		No	No

Taxonomy	IUCN Red List Category (Europe)	IUCN Red List Criteria (Europe)	IUCN Red List Category (EU 28)	IUCN Red List Criteria (EU 28)	Endemic to Europe	Endemic to EU 28
<i>Cynodontium strumiferum</i>	LC		LC		No	No
<i>Cynodontium succicum</i>	LC		LC		Yes	No
<i>Cynodontium tenellum</i>	LC		LC		No	No
<i>Dichodontium flavescens</i>	DD		DD		No	No
<i>Dichodontium pellucidum</i>	LC		LC		No	No
<i>Dicranoweisia cirrata</i>	LC		LC		No	No
<i>Glyphomitrium daviesii</i>	LC		LC		Yes	No
<i>Hymenoloma compactum</i>	DD		DD		No	No
<i>Hymenoloma crispulum</i>	LC		LC		No	No
<i>Hymenoloma mulahaceni</i>	DD		DD		No	No
<i>Kiaeria blyttii</i>	LC		LC		No	No
<i>Kiaeria falcata</i>	LC		NT		No	No
<i>Kiaeria glacialis</i>	LC		NT		No	No
<i>Kiaeria riparia</i>	CR	C2a(i)	CR	C2a(i); D	No	No
<i>Kiaeria starkei</i>	LC		NT		No	No
<i>Oncophorus demetrii</i>	LC		LC		No	No
<i>Oncophorus dendrophilus</i>	CR	D	CR	D	No	No
<i>Oncophorus elongatus</i>	LC		LC		No	No
<i>Oncophorus integerrimus</i>	LC		LC		Yes	No
<i>Oncophorus virens</i>	LC		LC		No	No
<i>Oncophorus wahlenbergii</i>	LC		LC		No	No
<i>Oreas martiana</i>	VU	D1	VU	D1	No	No
<i>Oreoweisia torquescens</i>	VU	D1	VU	D1	No	No
<i>Rhabdoweisia crenulata</i>	LC		LC		No	No
<i>Rhabdoweisia crispata</i>	LC		LC		No	No
<i>Rhabdoweisia fugax</i>	LC		LC		No	No
RHIZOGONIACEAE						
<i>Calomnion complanatum</i>	NA		NA		No	No
RHYTIDIACEAE						
<i>Rhytidium rugosum</i>	LC		LC		No	No
RICCIACEAE						
<i>Riccia atlantica</i>	CR	C2a(i)	CR	C2a(i)	Yes	Yes
<i>Riccia atromarginata</i>	EN	B2ab(iii)	EN	B2ab(iii)	No	No
<i>Riccia beyrichiana</i>	LC		LC		No	No
<i>Riccia bicarinata</i>	LC		LC		No	No
<i>Riccia bifurca</i>	LC		LC		No	No
<i>Riccia breidleri</i>	VU	D1	VU	D1	No	No
<i>Riccia canaliculata</i>	LC		LC		No	No
<i>Riccia cavernosa</i>	LC		LC		No	No
<i>Riccia ciliata</i>	DD		DD		No	No
<i>Riccia ciliifera</i>	LC		LC		No	No
<i>Riccia crinita</i>	LC		LC		No	No
<i>Riccia crozalsii</i>	LC		LC		No	No
<i>Riccia crustata</i>	VU	B2ab(i,iii)	NT		No	No
<i>Riccia crystallina</i>	LC		LC		No	No
<i>Riccia duplex</i>	DD		DD		No	No
<i>Riccia fluitans</i>	LC		LC		No	No
<i>Riccia frostii</i>	LC		LC		No	No
<i>Riccia glauca</i>	LC		LC		No	No
<i>Riccia gothica</i>	NT	D1	NT		Yes	No
<i>Riccia gougetiana</i>	LC		LC		No	No

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<i>Riccia huebeneriana</i>	LC		LC		No	No
<i>Riccia lamellosa</i>	LC		LC		No	No
<i>Riccia ligula</i>	EN	B2ab(v)	EN	B2ab(v)	No	No
<i>Riccia macrocarpa</i>	LC		LC		No	No
<i>Riccia michelii</i>	LC		LC		No	No
<i>Riccia nigrella</i>	LC		LC		No	No
<i>Riccia papillosa</i>	LC		LC		No	No
<i>Riccia perennis</i>	LC		LC		No	No
<i>Riccia rhenana</i>	LC		LC		No	No
<i>Riccia sommieri</i>	NT	B2b(iii,v)	NT	B2b(iii,v)	No	No
<i>Riccia sorocarpa</i>	LC		LC		No	No
<i>Riccia subbifurca</i>	LC		LC		No	No
<i>Riccia trabutiana</i>	LC		LC		No	No
<i>Riccia warnstorffii</i>	VU	C2a(i)	VU	C2a(i)	No	No
<i>Riccocarpos natans</i>	LC		LC		No	No
<i>RIELLACEAE</i>						
<i>Riella affinis</i>	EN	B1ab(iii)+2ab(iii)	EN	B1ab(iii)+2ab(iii)	No	No
<i>Riella bialata</i>	DD		DD		No	No
<i>Riella cossoniana</i>	NT		NT		No	No
<i>Riella echinata</i>	EN	B2ab(iii,v)	EN	B2ab(iii,v)	No	No
<i>Riella helicophylla</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Riella mediterranea</i>	DD		DD		No	No
<i>Riella notarisii</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Riella parisii</i>	RE		RE		No	No
<i>SCAPANLACEAE</i>						
<i>Anastrepta orcadensis</i>	LC		LC		No	No
<i>Anastrophyllum alpinum</i>	NT	D1	NT	D1	No	No
<i>Anastrophyllum assimile</i>	LC		VU	D1	No	No
<i>Anastrophyllum donnianum</i>	NT		NT		No	No
<i>Anastrophyllum joergensenii</i>	VU	D1	VU	D1	No	No
<i>Anastrophyllum michauxii</i>	NT		NT		No	No
<i>Barbilophozia barbata</i>	LC		LC		No	No
<i>Barbilophozia hatcheri</i>	LC		LC		No	No
<i>Barbilophozia lycopodioides</i>	LC		LC		No	No
<i>Barbilophozia rubescens</i>	DD		DD		No	No
<i>Barbilophozia sudetica</i>	LC		LC		No	No
<i>Diplophyllum albicans</i>	LC		LC		No	No
<i>Diplophyllum obtusatum</i>	DD		DD		No	No
<i>Diplophyllum obtusifolium</i>	LC		LC		No	No
<i>Diplophyllum taxifolium</i>	LC		LC		No	No
<i>Douinia ovata</i>	LC		LC		No	No
<i>Gymnocolea borealis</i>	LC		LC		No	No
<i>Gymnocolea fascinifera</i>	DD		NE		No	No
<i>Gymnocolea inflata</i>	LC		LC		No	No
<i>Isopaches alboviridis</i>	DD		NE		No	No
<i>Isopaches bicrenatus</i>	LC		LC		No	No
<i>Isopaches decolorans</i>	VU	D1	EN	D	No	No
<i>Scapania aequiloba</i>	LC		LC		No	No
<i>Scapania apiculata</i>	NT		NT		No	No
<i>Scapania aspera</i>	LC		LC		No	No
<i>Scapania brevicaulis</i>	VU	C2a(i)	VU	C2a(i)	No	No

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<i>Scapania calcicola</i>	LC		LC		No	No
<i>Scapania carinthiaca</i>	EN	C2a(i)	EN	C2a(i)	No	No
<i>Scapania compacta</i>	LC		LC		No	No
<i>Scapania crassiretis</i>	LC		VU	D1	No	No
<i>Scapania curta</i>	LC		LC		No	No
<i>Scapania cuspiduligera</i>	LC		LC		No	No
<i>Scapania degenii</i>	NT		NT		No	No
<i>Scapania glaucocephala</i>	EN	B2ab(ii,iii,iv,v); C2a(i)	CR	C2a(i)	No	No
<i>Scapania gracilis</i>	LC		LC		No	No
<i>Scapania gymnostomophila</i>	LC		VU	C2a(i)	No	No
<i>Scapania helvetica</i>	LC		LC		No	No
<i>Scapania hyperborea</i>	LC		LC		No	No
<i>Scapania irrigua</i>	LC		LC		No	No
<i>Scapania kaurinii</i>	VU	D1	VU	D1	No	No
<i>Scapania ligulifolia</i>	DD		NE		No	No
<i>Scapania lingulata</i>	NT	D1	NT		No	No
<i>Scapania mucronata</i>	LC		LC		No	No
<i>Scapania nemorea</i>	LC		LC		No	No
<i>Scapania nimbosea</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Scapania obcordata</i>	LC		DD		No	No
<i>Scapania obscura</i>	DD		DD		No	No
<i>Scapania ornithopodioides</i>	NT	B2b(iii,iv,v)	NT	B2b(iii,iv,v)	No	No
<i>Scapania paludicola</i>	LC		LC		No	No
<i>Scapania paludosa</i>	LC		LC		No	No
<i>Scapania parvifolia</i>	NT	D1	VU	D1	No	No
<i>Scapania praetervisa</i>	LC		LC		No	No
<i>Scapania scandica</i>	LC		LC		No	No
<i>Scapania scapanioides</i>	CR	D	CR	D	Yes	No
<i>Scapania simmonsii</i>	VU	D2	NE		No	No
<i>Scapania sphaerifera</i>	CR	D	NE		No	No
<i>Scapania spitsbergensis</i>	VU	B2ab(iii,iv,v)	EN	B2ab(iii,iv,v); C2a(i)	No	No
<i>Scapania subalpina</i>	LC		LC		No	No
<i>Scapania tundrae</i>	LC		LC		No	No
<i>Scapania uliginosa</i>	LC		LC		No	No
<i>Scapania umbrosa</i>	LC		LC		No	No
<i>Scapania undulata</i>	LC		LC		No	No
<i>Scapania verrucosa</i>	VU	D1	VU	D1	No	No
<i>Scapania zemliae</i>	DD		NE		No	No
<i>Schistochilopsis grandiretis</i>	LC		VU	B2ab(ii,iii,iv,v); C2a(i)	No	No
<i>Schistochilopsis hyperarctica</i>	DD		NE		No	No
<i>Schistochilopsis incisa</i>	LC		LC		No	No
<i>Schistochilopsis opacifolia</i>	LC		LC		No	No
<i>Sphenolobopsis pearsonii</i>	LC		LC		No	No
<i>Sphenolobus minutus</i>	LC		LC		No	No
<i>Sphenolobus saxicola</i>	LC		LC		No	No
SCHISTOSTEGACEAE						
<i>Schistostega pennata</i>	LC		LC		No	No
SCORPIDIACEAE						
<i>Scorpidium cossonii</i>	LC		LC		No	No
<i>Scorpidium revolvens</i>	LC		LC		No	No

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<i>Scorpidium scorpioides</i>	NT		NT		No	No
SELIGERIACEAE						
<i>Blindia acuta</i>	LC		LC		No	No
<i>Blindia caespiticia</i>	LC		LC		No	No
<i>Blindiadelphus campylopodus</i>	NT	B2b(ii,iii,iv,v); C2a(i)	NT		No	No
<i>Blindiadelphus diversifolius</i>	NT	D1	VU	D1	No	No
<i>Blindiadelphus polaris</i>	VU	D1	NE		No	No
<i>Blindiadelphus recurvatus</i>	LC		LC		No	No
<i>Blindiadelphus subimmersus</i>	EN	D	EN	D	No	No
<i>Brachydontium trichodes</i>	LC		LC		No	No
<i>Seligeria acutifolia</i>	LC		LC		No	No
<i>Seligeria austriaca</i>	VU	D1	VU	D1	No	No
<i>Seligeria brevifolia</i>	LC		LC		No	No
<i>Seligeria calcarea</i>	LC		LC		No	No
<i>Seligeria calycina</i>	LC		LC		Yes	No
<i>Seligeria carniolica</i>	EN	D	EN	D	Yes	No
<i>Seligeria donniana</i>	LC		LC		No	No
<i>Seligeria irrigata</i>	VU	D1	VU	D1	Yes	Yes
<i>Seligeria oelandica</i>	NT	D1	VU	D1	No	No
<i>Seligeria patula</i>	LC		LC		No	No
<i>Seligeria pusilla</i>	LC		LC		No	No
<i>Seligeria trifaria</i>	DD		DD		No	No
<i>Seligeria tristichoides</i>	NT	D1	VU	D1	No	No
SEMATOPHYLLACEAE						
<i>Brotherella lorentziana</i>	NT	D1	VU	D1	Yes	No
<i>Sematophyllum adnatum</i>	NA		NA		No	No
<i>Sematophyllum demissum</i>	LC		LC		No	No
<i>Sematophyllum substrumulosum</i>	LC		LC		No	No
SOLENOSTOMATACEAE						
<i>Cryptocolea imbricata</i>	CR	D	RE		No	No
<i>Nardia breidleri</i>	LC		VU	C2ai	No	No
<i>Nardia compressa</i>	LC		LC		No	No
<i>Nardia geoscypbus</i>	LC		LC		No	No
<i>Nardia insecta</i>	LC		LC		No	No
<i>Nardia japonica</i>	LC		DD		No	No
<i>Nardia scalaris</i>	LC		LC		No	No
<i>Solenostoma callithrix</i>	NT	B2ab(iii,v)	NT	B2ab(iii,v)	No	No
<i>Solenostoma confertissimum</i>	LC		LC		No	No
<i>Solenostoma gracillimum</i>	LC		LC		No	No
<i>Solenostoma handelii</i>	CR	C2a(i); D	CR	C2a(i); D	No	No
<i>Solenostoma hyalinum</i>	LC		LC		No	No
<i>Solenostoma obovatum</i>	LC		LC		No	No
<i>Solenostoma paroicum</i>	LC		LC		Yes	No
<i>Solenostoma sphaerocarpum</i>	LC		LC		No	No
SPHAEROCARPACEAE						
<i>Sphaerocarpos europaeus</i>	LC		LC		No	No
<i>Sphaerocarpos michelii</i>	LC		LC		No	No
<i>Sphaerocarpos stipitatus</i>	NA		NA		No	No
SPHAGNACEAE						
<i>Sphagnum affine</i>	LC		NT		No	No
<i>Sphagnum angermanicum</i>	LC		NT		No	No

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<i>Sphagnum angustifolium</i>	LC		LC		No	No
<i>Sphagnum annulatum</i>	LC		LC		No	No
<i>Sphagnum aongstroemii</i>	LC		LC		No	No
<i>Sphagnum arcticum</i>	NT	D1	NE		No	No
<i>Sphagnum auriculatum</i>	LC		LC		No	No
<i>Sphagnum austinii</i>	NT	A3c	NT	A3c	No	No
<i>Sphagnum balticum</i>	LC		LC		No	No
<i>Sphagnum beothuk</i>	LC		NT		No	No
<i>Sphagnum capillifolium</i>	LC		LC		No	No
<i>Sphagnum centrale</i>	LC		LC		No	No
<i>Sphagnum compactum</i>	LC		LC		No	No
<i>Sphagnum contortum</i>	LC		LC		No	No
<i>Sphagnum cuspidatum</i>	LC		LC		No	No
<i>Sphagnum divinum</i>	LC		LC		No	No
<i>Sphagnum fallax</i>	LC		LC		No	No
<i>Sphagnum fimbriatum</i>	LC		LC		No	No
<i>Sphagnum flexuosum</i>	LC		LC		No	No
<i>Sphagnum fuscum</i>	LC		NT		No	No
<i>Sphagnum girgensohnii</i>	LC		LC		No	No
<i>Sphagnum inundatum</i>	LC		LC		No	No
<i>Sphagnum jensenii</i>	LC		LC		No	No
<i>Sphagnum lenense</i>	NT	B2b(iii)	NE		No	No
<i>Sphagnum lindbergii</i>	LC		LC		No	No
<i>Sphagnum majus</i>	LC		LC		No	No
<i>Sphagnum medium</i>	LC		LC		No	No
<i>Sphagnum molle</i>	LC		LC		No	No
<i>Sphagnum nitidulum</i>	CR	B1ab(iii)	CR	B1ab(iii)	Yes	Yes
<i>Sphagnum obtusum</i>	LC		LC		No	No
<i>Sphagnum olafii</i>	VU	D1	NE		No	No
<i>Sphagnum palustre</i>	LC		LC		No	No
<i>Sphagnum papillosum</i>	LC		LC		No	No
<i>Sphagnum platyphyllum</i>	LC		LC		No	No
<i>Sphagnum pulchrum</i>	LC		LC		No	No
<i>Sphagnum pylaesii</i>	EN	B2ab(iii)	EN	B2ab(iii)	No	No
<i>Sphagnum quinquefarium</i>	LC		LC		No	No
<i>Sphagnum recurvum</i>	EN	B1ab(iii)+2ab(iii)	EN	B1ab(iii)+2ab(iii)	No	No
<i>Sphagnum riparium</i>	LC		NT		No	No
<i>Sphagnum rubellum</i>	LC		LC		No	No
<i>Sphagnum rubiginosum</i>	LC		NE		No	No
<i>Sphagnum russowii</i>	LC		LC		No	No
<i>Sphagnum skyense</i>	LC		LC		Yes	Yes
<i>Sphagnum squarrosum</i>	LC		LC		No	No
<i>Sphagnum strictum</i>	LC		LC		No	No
<i>Sphagnum subfulvum</i>	LC		LC		No	No
<i>Sphagnum subnitens</i>	LC		LC		No	No
<i>Sphagnum subsecundum</i>	LC		LC		No	No
<i>Sphagnum tenellum</i>	LC		LC		No	No
<i>Sphagnum teres</i>	LC		LC		No	No
<i>Sphagnum troendelagicum</i>	EN	B2ab(iii); C2a(i)	NE		Yes	No
<i>Sphagnum tundrae</i>	NT	D1	NE		No	No
<i>Sphagnum venustum</i>	DD		NE		No	No

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<i>Sphagnum warnstorffii</i>	LC		LC		No	No
<i>Sphagnum wulfianum</i>	LC		LC		No	No
SPLACHNACEAE						
<i>Aplodon wormskioldii</i>	LC		NT		No	No
<i>Splachnum ampullaceum</i>	NT		VU	C2a(i)b	No	No
<i>Splachnum luteum</i>	LC		LC		No	No
<i>Splachnum melanocaulon</i>	EN	C2a(i)	EN	C2a(i)	Yes	No
<i>Splachnum pensylvanicum</i>	DD		DD		No	No
<i>Splachnum rubrum</i>	LC		LC		No	No
<i>Splachnum sphaericum</i>	LC		LC		No	No
<i>Splachnum vasculosum</i>	LC		LC		No	No
<i>Tayloria acuminata</i>	VU	D1	CR	D	No	No
<i>Tayloria froelichiana</i>	NT	B2b(iii)	NT	B2b(iii)	No	No
<i>Tayloria hornschurchii</i>	EN	D	EN	D	No	No
<i>Tayloria lingulata</i>	LC		LC		No	No
<i>Tayloria rudolphiana</i>	EN	B2ab(i,ii,iii,iv,v); C2a(i)	EN	B2ab(i,ii,iii,iv,v); C2a(i)	No	No
<i>Tayloria serrata</i>	NT	B2b(iii,v)	NT		No	No
<i>Tayloria splachnoides</i>	LC		LC		No	No
<i>Tayloria tenuis</i>	VU	C2a(i)	EN	C2a(i)	No	No
<i>Tetraplodon angustatus</i>	LC		LC		No	No
<i>Tetraplodon blyttii</i>	EN	D	RE		Yes	No
<i>Tetraplodon mnioides</i>	LC		LC		No	No
<i>Tetraplodon pallidus</i>	LC		LC		No	No
<i>Tetraplodon paradoxus</i>	VU	D1	EN	D	No	No
<i>Tetraplodon urceolatus</i>	EN	D	EN	D	No	No
<i>Voitia hyperborea</i>	VU	D1	NE		No	No
<i>Voitia nivalis</i>	CR	C2a(i); D	CR	C2a(i); D	No	No
SPLACHNOBRYACEAE						
<i>Splachnobryum obtusum</i>	VU	D1	VU	D1	No	No
TARGIONLACEAE						
<i>Targionia hypophylla</i>	LC		LC		No	No
<i>Targionia lorbeeriana</i>	LC		LC		No	No
TETRAPHIDACEAE						
<i>Tetraphis pellucida</i>	LC		LC		No	No
<i>Tetradontium brownianum</i>	LC		LC		No	No
<i>Tetradontium ovatum</i>	NT	B2b(iii,iv)	NT		No	No
<i>Tetradontium repandum</i>	LC		NT		No	No
THUIDIACEAE						
<i>Abietinella abietina</i>	LC		LC		No	No
<i>Claopodium rostratum</i>	VU	D1	VU	D1	No	No
<i>Claopodium whippleanum</i>	LC		LC		No	No
<i>Haplocladium angustifolium</i>	DD		DD		No	No
<i>Haplocladium microphyllum</i>	CR	C2a(i); D	DD		No	No
<i>Haplocladium virginianum</i>	CR	D	CR	D	No	No
<i>Pelekium atlanticum</i>	EN	C2a(i)	EN	C2a(i)	Yes	Yes
<i>Pelekium minutulum</i>	EN	B2ab(iii,v); C2a(i)	EN	B2ab(i, ii, iii, iv), C2a(i)	No	No
<i>Thuidiopsis sparsa</i>	NA		NA		No	No
<i>Thuidium assimile</i>	LC		LC		No	No
<i>Thuidium delicatulum</i>	LC		LC		No	No

Taxonomy	IUCN Red List Category (Europe)	IUCN Red List Criteria (Europe)	IUCN Red List Category (EU 28)	IUCN Red List Criteria (EU 28)	Endemic to Europe	Endemic to EU 28
<i>Thuidium recognitum</i>	LC		LC		No	No
<i>Thuidium tamariscinum</i>	LC		LC		No	No
<i>TIMMIACEAE</i>						
<i>Timmia austriaca</i>	LC		LC		No	No
<i>Timmia bavarica</i>	LC		LC		No	No
<i>Timmia comata</i>	LC		VU	D1	No	No
<i>Timmia megapolitana</i>	LC		NT		No	No
<i>Timmia norvegica</i>	LC		LC		No	No
<i>Timmia sibirica</i>	EN	B2ab(iii,v); C2a(i)	CR	B2ab(iii,v); C2a(i,ii); D	No	No
<i>TRICHOCOLEACEAE</i>						
<i>Trichocolea tomentella</i>	NT	A2c	NT	A2c	No	No

Appendix 4. Listing of bryophyte species under Annex II and Annex V of the Habitats Directive, Appendix I of the Bern Convention, and the Red List status on the current European Red List

Species protected under the:	Habitats Directive		Bern Convention	Red List Status
	ANNEX II	ANNEX V	APPENDIX I	
<i>Bruchia vogesiaca</i> Schwaegr.	√		√	EN
<i>Brachythecium novae-angliae</i> (Sull & Lesq.) A.Jaeger (<i>Bryhnia novae-angliae</i> (Sull & Lesq.) Grou)	√			LC
<i>Bryoerythrophyllum campylocarpum</i> (C. Müll.) Crum. (<i>Bryoerythrophyllum machadoanum</i> (Sergio) M.O. Hill)	√		√	VU
<i>Buxbaumia viridis</i> (Moug.) Moug. & Nestl.	√		√	LC
<i>Cephalozia macounii</i> (Aust.) Aust.	√		√	CR
<i>Cynodontium suecicum</i> (H. Arn. & C. Jens.) I. Hag.	√		√	LC
<i>Dichelyma capillaceum</i> (Dicks) Myr.	√		√	NT
<i>Dicranum viride</i> (Sull. & Lesq.) Lindb.	√		√	LC
<i>Distichophyllum carinatum</i> Dix. & Nich.	√		√	CR
<i>Hamatocaulis (Drepanocladus) vernicosus</i> (Mitt.) Hedenäs.	√		√	VU
<i>Encalypta mutica</i> (I. Hagen)	√			VU
<i>Hamatocaulis lapponicus</i> (Norrl.) Hedenäs	√			EN
<i>Herzogiella turfacea</i> (Lindb.) I. Wats.	√			NT
<i>Hygrohypnum montanum</i> (Lindb.) Broth.	√			VU
<i>Jungermannia handelii</i> (Schiffn.) Amak.	√		√	CR
<i>Mannia triandra</i> (Scop.) Grolle	√		√	VU
<i>Marsupella profunda</i> Lindb.	√		√	VU
<i>Meesia longiseta</i> Hedw.	√		√	VU
<i>Notothylas orbicularis</i> (Schwein.) Sull.*	√		√	EN
<i>Ochyraea tatrensis</i> Vana	√			CR
<i>Orthothecium lapponicum</i> (Schimp.) C. Hartm.	√			VU
<i>Orthotrichum rogeri</i> Brid.	√		√	LC
<i>Petalophyllum ralfsii</i> (Wils.) Nees & Gott.	√		√	LC
<i>Plagiomnium drummondii</i> (Bruch & Schimp.) T. Kop.	√			EN
<i>Riccia breidleri</i> Jur.	√		√	VU
<i>Riella helicophylla</i> (Bory & Mont.) Mont.	√		√	NT
<i>Scapania carinthiaca</i> J.B. Jack ex Lindb. (<i>Scapania massolongi</i> (K. Müll.) K. Müll.)	√		√	EN
<i>Sphagnum pylaesii</i> Brid. (<i>Sphagnum pylaisii</i> Brid.)	√		√	EN
<i>Tayloria rudolphiana</i> (Garov) B. & S.	√		√	EN
<i>Tortella rigens</i> (N. Alberts)	√			LC

Species protected under the:	Habitats Directive		Bern Convention	Red List Status
	ANNEX II	ANNEX V	APPENDIX I	
<i>Echinodium spinosum</i> (Mitt.) Jur.	√		√	EN
<i>Thamnobryum fernandesii</i> Sergio	√		√	VU
MUSCI		√		All species under this genus, as stated in Appendix 3
LEUCOBRYACEAE <i>Leucobryum glaucum</i> (Hedw.) AAngstr.		√		LC
SPHAGNACEAE <i>Sphagnum L.</i> spp. (except <i>Sphagnum pylaisii</i> Brid.)		√		All species under this genus (except <i>Sphagnum pylaisii</i> Brid.), as stated in Appendix 3
<i>Frullania parvistipula</i> Steph.			√	CR
<i>Atractylocarpus alpinus</i> (Schimp. ex Milde) Lindb.			√	CR
<i>Pyramidula tetragona</i> (Brid.) Brid.			√	EN

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- ***The Status and Distribution of European Mammals***. Temple and Terry (compilers), 2007.
<https://portals.iucn.org/library/node/9047>
- ***European Red List of Reptiles***. Cox and Temple (compilers), 2009.
<https://doi.org/10.2779/74504>
- ***European Red List of Amphibians***. Temple and Cox (compilers), 2009.
<https://doi.org/10.2779/73661>
- ***European Red List of Dragonflies***. Kalkman et al. (compilers), 2010.
<https://doi.org/10.2779/84650>
- ***European Red List of Saproxyllic Beetles***. Nieto and Alexander (compilers), 2010.
<https://doi.org/10.2779/84561>
- ***European Red List of Butterflies***. van Swaay et al. (compilers), 2010.
<https://doi.org/10.2779/83897>
- ***European Red List of Non-marine Molluscs***. Cuttelod et al., 2011.
<https://doi.org/10.2779/84538>
- ***European Red List of Freshwater Fishes***. Freyhof and Brooks, 2011.
<https://doi.org/10.2779/85903>
- ***European Red List of Vascular Plants***. Bilz et al., 2011.
<https://doi.org/10.2779/8515>
- ***European Red List of Medicinal Plants***. Allen et al., 2014.
<https://doi.org/10.2779/907382>
- ***European Red List of Bees***. Nieto et al., 2014.
<https://doi.org/10.2779/51181>
- ***European Red List of Birds***. BirdLife International, 2015.
<https://doi.org/10.2779/975810>
- ***European Red List of Marine Fishes***. Nieto et al., 2015.
<https://doi.org/10.2779/082723>
- ***European Red List of Grasshoppers, Crickets and Bush-Crickets***. Hochkirch et al., 2016.
<https://doi.org/10.2779/60944>
- ***European Red List of Lycopods and Ferns***. García Criado et al., 2017.
<https://doi.org/10.2305/IUCN.CH.2017.ERL.1.en>
- ***European Red List of Saproxyllic Beetles***. Cáliz et al., 2018. Update to Nieto and Alexander, (2010).
<https://portals.iucn.org/library/node/47296>
- ***A miniature world in decline: European Red List of Mosses, Liverworts and Hornworts***. Hodgetts et al., 2019.
<https://doi.org/10.2305/IUCN.CH.2019.ERL.2.en>
- ***European Red List of Trees***. Rivers et al., 2019.
<https://doi.org/10.2305/IUCN.CH.2019.ERL.1.en>
- ***European Red List of Terrestrial Molluscs: Snails, slugs, and semi-slugs***. Neubert et al., 2019. Update to Cuttelod et al., 2011.
<https://portals.iucn.org/library/node/48439>
- ***European Red List of Selected Endemic Shrubs***. Wilson et al., 2019.
<https://portals.iucn.org/library/node/48438>

The European Red List is a review of the status of European species according to IUCN regional Red Listing guidelines. It identifies those species that are threatened with extinction at the regional level – in order that appropriate conservation action can be taken to improve their status.

This publication summarises results for all Europe's native species of mosses, liverworts and hornworts (1,817 species). 22.5% of species are threatened with extinction at the European level mainly due to human-induced modifications to natural systems, climate change, and agriculture.

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It is available online at
<http://ec.europa.eu/environment/nature/conservation/species/redlist>
and
<https://www.iucnredlist.org/regions/europe>