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Autor: Hallingbäck, Tomas
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THE PRACTICE OF BRYOPHYTE CONSERVATION

TOMAS HALLINGBÄCK
Swedish Threatened Species Unit, Swedish University of Agricultural Sciences, P. O. Box 7072, S-750 07 Uppsala, Sweden

SUMMARY — Progress in bryophyte conservation lags far behind that of animals and vascular plants. There is very little development of conservation techniques or methods of preserving bryophytes and different vegetation dominated by bryophytes. This situation is largely due to the small number of bryologists, together with the lack of awareness and knowledge among conservationists, land managers and public authorities. The so far most commonly, and up to now, the most successfully attempted approach to conservation of threatened bryophytes is the protection of their sites as nature reserves etc. Some frequently applied methods in bryophyte conservation such as the use of Red Data Lists, inventories, Environmental Impact Assessment (EIA), protection of sites and habitats, management and recovery programmes, education and information, translocation, ex situ *conservation and monitoring are reviewed and discussed. General guidelines for practical bryophyte conservation based on experiences from Sweden are outlined. Still more work is needed to counteract the adverse effects by human civilization and more research is needed on how to improve the viability and population sizes of threatened species. Highest priority should be given to the development of recovery programmes targeted at species which are on a world level at the brink of extinction.*

KEYWORDS — Threatened bryophytes, conservation methods, guidelines, Sweden

ZUSAMMENFASSUNG — Praktischer Moosschutz

Der Moosschutz hinkt weit hinter dem Schutz von Tieren und Höheren Pflanzen her. Es gibt sehr wenige Fortschritte in der Entwicklung von Methoden, Moose und von Moosen dominierte Vegetation zu schützen. Diese Situation ist weitgehend auf die geringe Zahl von Fachleuten der Bryologie zurückzuführen, ausserdem darauf, dass den im Naturschutz und in der Landnutzung Tätigen und den Behörden die Probleme nicht bewusst sind und entsprechende Kenntnisse fehlen. Der bisher am häufigsten beschrittene und erfolgreichste Weg, gefährdete Moose zu erhalten, ist der Schutz ihrer lokalen Lebensräume, z. B. als Naturschutzgebiete. Einige im Moosschutz häufig angewandte Methoden wie der Gebrauch von Roten Listen, Inventare, Umweltverträglichkeits-Prüfung, Schutz von lokalen Vorkommen und von Lebensräumen, Pflegepläne und Regenerationsprogramme, Erziehung und Information, Verpflanzung, Ex-situ-Erhaltung und Überwachung werden besprochen. Aufgrund von Erfahrungen in Schweden werden allgemeine Richtlinien für den praktischen Moosschutz umrissen. Noch braucht es viel Arbeit, um die nachteiligen Auswirkungen der menschlichen Zivilisation zu neutralisieren, und mehr Forschung ist nötig für das Verständnis, wie die Überlebenschancen und die Populationsgrösse gefährdeter Arten verbessert werden können. Höchste Priorität hat die Ausarbeitung von Schutz- und Regenerationsprogrammen für Arten, die weltweit dem Aussterben nahe sind.

Introduction

Bryophyte conservation receives much less attention than conservation of many species of animals or of vascular plants. There is very little development of techniques or methods for preserving bryophytes or different vegetation types dominated by bryophytes. This does not imply that bryophytes are less threatened or less worthy of protection, but is mainly due to the small number of bryologists, and the lack of awareness and poor knowledge about bryophytes. The aims of this paper are to review the so far most frequently applied methods in bryophyte conservation and to present some guidelines based on successful approaches in Sweden.

Conservation objectives, strategies and priorities

Before suggesting practical and perhaps expensive measures for protection of bryophytes, one should consider at first what is most urgent. With an increasing rate of habitat destruction, air and water pollution and extinction of species (Primack 1993), one of the most urgent tasks today is to stop the decline of threatened species and to improve the situation of these. The knowledge of the main threats is relatively good, compared to what we know about conservation measures. Some extensive research on environmental pollution and negative human impacts on bryophyte species and vegetation was presented at the symposium on endangered bryophytes in Uppsala (e.g., Greven 1992, Hallingbäck 1992, Laaka 1992, Meinunger 1992, Urmi & al. 1992).

Depending on legislation and traditions in each country, there are varying strategies to protect species and habitats. In some countries, or in some cases, protection must be enforced by governmental decisions. In other countries, it may be enough to discuss the goals and practical measures of conservation with the local authorities and arrange for some kind of unilateral commitment, or to sign a contract with landowners in order to eliminate or to reduce harmful effects.

Bryologists should be more active and be involved at an early stage of the planning of conservation as well as exploitation activities and should suggest the priorities regarding species, habitats and managements, rather than to leave this exclusively to, for example, flowering plant conservationists, because the habitat requirements of bryophytes generally differ from those of flowering plants. Due to limited resources a ranking of habitat types and species regarding conservation priorities is greatly needed even if we, as scientists, consider all species and ecosystems to be of equal value. One way to rank species in need of urgent action might be to estimate the global rate of decline or the risk of extinction according to the criteria proposed by the International Union for the Conservation of Nature and Natural Resources (IUCN). The international threat criterias of IUCN have recently been revised (Mace & Stuart 1994) and are now better adopted to plants and even to bryophytes. Other criteria can also be used as alternatives or complements when considering priority, e.g., endemism, national responsibility (of international importance), keystone function, marginal populations, phylogenetic uniqueness, effects of co-ordination with other conservation actions, etc.

It is also possible to redlist sites, bryophyte communities and habitat types that contain the taxa we would like to protect. Compared with the system of assessing and listing single species, the idea of assessing plant sites, communities and habitats offers a number of advantages to practical conservation work. By grouping species that share the same or similar habitat types and substrates - and therefore face the same or similar threats - it should be possible to create protection and recovery programmes that cover a number of species simultaneously. Resources, research, and publicity must be directed at the sites, habitats, and substrates that most urgently require protection (Reid & Miller 1989, Ayres & al. 1991, Koponen 1992).

Many efforts towards management and protection of redlisted bryophyte species and/or sites will benefit from co-ordination with the conservation actions taken for other organism groups like ferns, lichens, fungi, invertebrates etc., even if situations of conflicting priorities between different organism groups may sometimes occur. However, according to experiences made in Sweden the priorities usually coincide, especially between cryptogams and invertebrates.

Experiences from Sweden show also that most, but not all, conservation work should be done at a regional or local level because then it will be carried out more effectively and the follow-up process will be easier. Of course, this implies a certain amount of regional or local bryological competence and a keen interest in conservation issues since success in conservation frequently depends on the enthusiasm and hard work of a few devoted persons.

The use of Red Data Lists (RDL)

A species-based approach may be tactical in one country but the habitat approach could be preferred in other countries. Nevertheless, species, habitats, and sites must always be protected in one way or another.

An advantage of presenting a Red Data List (RDL) of species might be that this focuses the attention of the general public on something specific, i. e. it can identify a threatened organism. Red data listing has proved to be an efficient instrument in European bryophyte conservation.

The list can be restricted to those species that are endangered on a global perspective or in need of immediate action (Tan & al. 1993) but in fact the most useful lists are those delimited to countries or even smaller areas and include not only endangered but also more common species that are at present declining. A RDL can be based on a number of criteria and conservation values, but should also give the global extinction risk according to the IUCN criteria. The RDLs, like those produced by WCMC (World Conservation Monitoring Centre), give some ideas on how to produce RDLs in general. The users of RDLs are mainly authorities, professional and amateur naturalist and conservationists, planners and managers of nature reserves and parks, but also scientists. Species included in these lists are very important as arguments for protecting different kinds of areas or habitats.

Cryptogam specialists have been criticised for including taxa in RDLs which are comparatively poorly known regarding their distribution and ecological requirements. This is to some extent true: species may be overlooked due to their small size, and knowledge about the ecology of many species is insufficient. Nonetheless, species that have not been recorded for many years and whose habitats have been heavily damaged by human activity should still be included in RDLs as threatened, until field studies have been undertaken to determine their true status (Diamond 1987). In other words, an argument can be made that the focus should be shifted from presuming a species to be safe **until** it is known to be threatened, to presuming a species to be threatened **unless** it is known to be secure. But in doubtful cases, this kind of species can instead be allocated to a candidate list or 'insufficiently known'. Excessively long lists of ambiguous taxa may counteract the purpose of red data listing. Also the possibility to de-list species should be clearly emphasised since the ultimate goal of successful conservation should be to protect or manage the habitat until the species is safe so it can be removed from the RDL. This objective is important for politicians and other decision-makers and helps making RDLs trustworthy.

Inventories and recording

The aim of basic inventories is to gain knowledge on the distribution and on individual sites of threatened species. The land management agencies can be persuaded to employ experts to conduct surveys, and suggestions can be made to national governments that they should initiate surveys to locate redlisted species and habitats within their borders. Not only experts do collect field information on the occurrence of rare species, but also volunteer amateurs and bryological societies could be engaged.

Information on sites and localities for redlisted bryophytes can be found in herbaria, literature and among bryologists. The location of each site must be described very accurately since most administrators and landowners know very little about bryophytes and few recognise any of them in the field. Data sheets with descriptions of the site and the habitat including a detailed map, and recommendations for practical actions to be conducted must be delivered to relevant local authorities and preferably also to the landowner.

A strategic search for only RDL bryophytes in areas that are not yet used for exploitation is to be ahead of the exploiters. For some years we have had in Sweden several groups called 'One Step Ahead', which actively searched for species that are redlisted or habitats with high conservation values (Karström 1992). This kind of information in advance has proved to be important to authorities, planners, and developers when different exploitation activities were going to take place or were planned, for example clear-felling, construction of roads, and industries. Reporting to conservation bodies is important since they rarely have their own bryological expertise to carry out surveys or to assess sites, and they are often unaware of the importance of bryophytes in their area. Local offensive conservation groups or NGOs (nongovernmental organisations, e.g., bryological societies) may here play an important role in assessing areas to be protected and suggesting relevant measures.

Example: an inventory of Woodland Key Habitats in Sweden

In 1992 the Swedish National Board of Forestry started to survey habitats and sites for rare and threatened woodland plants, fungi and animals. These important habitats and sites have been termed Woodland Key Habitats. A Woodland Key Habitat should have certain ecological qualities and should be a site or a potential site for redlisted species. Examples of some abundant Woodland Key Habitat types are forested rocky outcrops, virgin swamp forest and forest patches with a high abundance of dead trees, both standing and fallen. The reason for focusing on habitat types that are potential sites for redlisted species instead of searching the actual sites for each species is that the latter alternative is very time-consuming. Additionally, different redlisted species often coexist and may sometimes aggregate in great numbers in specified habitat types in the forest landscape. These Key Habitats therefore function as refuges for threatened species. In the future they may serve as starting points and later as source areas for the restoration of woodland communities (Nitare & Norén 1992). The search for Key Habitats includes studies with aerial photographs and forestry maps. The field studies also include recording of indicator species of cryptogams and some vascular plants. Most weight is put on the occurrence of epiphytic woodland lichens, macro-fungi, epiphytic and epixylic bryophytes. The value of using bryophyte species as indicators of woodlands of high conservation importance has been evaluated in a previous study (Gustafsson & al. 1992). Fifty bryophytes are used as Key Habitat indicators in Sweden (Hallingbäck 1991). The inventory has not yet been completed but a rough estimation is that about 75 000 sites filling the criteria of a Key Habitat will be found in the whole of Sweden. These will cover about 2% of the productive forest land in northern Sweden and 1% in southern Sweden.

Environmental Impact Assessment and improvements of legislation

Bryologists as well as any other person or government should demand an environmental impact assessment (EIA) study before permitting any major public or private construction work to start (Roberts & Roberts 1984, Zhu & al. 1994). This could, of course, include an inventory of the bryophyte flora. An EIA aims to ensure that development projects have no disastrous environmental consequences (Gilpin 1994).

Conservation laws and laws of land use cover a number of activities that directly affect species and bryophyte habitats. To use and to improve these laws in order to benefit legal protection of species, sites and habitats is very urgently needed in some parts of the world.

Example: Recent legislation improvements in Sweden

The signing of the Convention on Biological Diversity in Rio in 1992 by Sweden has meant an important incitement to amend the law on nature conservation and the Forestry Act. The Rio convention has also led to a broader recognition of all kinds of organisms which will make it easier to consider also bryophytes in conservation efforts.

The main features of the new Forestry Act (valid from January 1, 1994) are:

- the land-owner must inform the authorities on how nature conservation is to be considered at each felling site.
- Environmental impact assessments for new silvicultural and other new kind of exploitations must be undertaken following a decision by the National Board of Forestry.
- Nature conservation aspects must be integrated into all kinds of forest management and operations.

The implementation of the new Forestry Act has already been visible in the forest landscapes where many groups of trees, fallen logs, snags, etc. have been left after the clear-felling.

According to additions to the Nature Conservation Act of Sweden in 1993 «enterprises that can harm the natural environment are not allowed within smaller areas (biotopes) which are habitats for redlisted species or species that are worth special consideration» (21 § NVL). This is an improvement which will hopefully automatically exclude thousands of small sites from being exploited. Examples of such biotopes are lines of old trees along roads, old stone walls, ravines and rich fens.

Protection of sites

Protection of sites with redlisted taxa is by far the most common measure used within nature conservation in Europe. Strict protection of sites may be successful in conserving many bryophyte species. This approach should, of course, not be used for species whose survival depends on some kind of disturbance. A number of taxa will probably need a special kind of management to survive in the long run, but our knowledge in these fields of ecology and conservation biology is still very poor. Until we know more about the specific management requirements for each redlisted bryophyte species, we must protect the sites as if they would require a strictly protected habitat without any management efforts. If the habitat has been managed (e.g., traditionally cultivated arable fields) and the species benefit from this treatment, this management should be continued.

The most common, and up to now most successful, measure in Sweden is to protect the sites as nature reserves. They should be large enough to be able to function as self-maintaining units as well as to avoid excessive edge effects. The minimal size of a reserve can vary considerably between different kinds of habitats and kinds of threatened species. For example, a protected forest must be larger than 100 000 m^2 and must include a buffer zone around the threatened organism broader than 100 m (Olsen 1988). In many countries, protection of sites is not only the most effective but probably also the only realistic way to preserve bryophyte species, because we do not have the resources or knowledge to preserve species by species either *in* or *ex situ*. Protected sites with the targeted species in viable and fertile conditions can function as source areas (Söderström 1995). When protecting new areas, the distance to already established reserves should be considered in order to make a gene flow possible. A buffer zone surrounding the site and forming a context area should be prescribed in order to institute a transition zone between the core area and the 'outside world'.

The protected sites should be large enough not only to provide for habitat needs but also to ensure metapopulation dynamics and to minimise the risk of negative edge effects like alteration of microclimate. An argument for protecting large areas instead of small sites is that special habitat types occur as unique combinations of abiotic and biotic conditions which are very scattered, such as a specific tree species in a swamp forest at a low altitude, etc.

Protection of habitats

Ideally, areas to be protected should first be thoroughly investigated. They should preferably include habitats that are rich in species, that contain communities which are under-represented in already protected areas, and that are known or supposed to harbour redlisted and/or endemic species. However, we have to realise that we very rarely know where all these habitats are located. Since exploitation does not wait for the bryologists to conduct a thorough search region by region, we sometimes have to protect land areas about which we have insufficient data, but which we believe may have high bryological values. A promising short-cut is to use indicator species and indicator elements to identify sites where redlisted species most probably occur. This method is used in Britain when identifying Sites for Special Scientific Interest (Hodgetts 1992). In Sweden it was applied in the inventory of Woodland Key Habitats (Hallingbäck 1991, Nitare & Norén 1992) and suggested for identification of wetlands of special interest (Hedenäs & Löfroth 1992).

Due to the lack of specific and detailed knowledge it is also important to base decisions on general and sound principles of conservation biology (Spellerberg 1992). One of the principles relevant for bryophytes is that sites should preferably include habitats rich in microhabitats since we know that high species diversity is correlated with a high diversity in microhabitats (Vitt & Yenhung 1993). Other principles are to protect areas with a long habitat continuity or areas that are known to contain endemic species.

Information and education

Bryophytes, the second largest land plant group, constitute a major part of the vegetation in the bottom layer of different forest types, of wetlands, and of tundra ecosystems. They can be used as bio-monitors in industrialised countries. Information about the relevance of bryophytes should be directed at planners, land-owners, foresters, conservation agency people, and politicians. This spreading of information is essential since very few people know anything of this organism group. The acceptance of conservation of bryophytes is low compared with that of vascular plants among conservation practitioners. Therefore, it is a challenge to increase our efforts to provide information. One important target group among practitioners are people working directly with implementation of conservation plans. Bryologists should try to become acquainted with the staff that administrate public or private land of interest in this respect. They should also use common names of bryophytes (if there are any) and avoid excessive scientific jargon. This will speed up the work and misunderstandings can be avoided.

Bryophytes should be included in broader information campaigns and in the more popular books in biology and nature conservation. Small booklets with colour illustrations could draw attention to bryophytes as organisms and to their risk of extinction. Bryologists should inform the land-owners in a way that they become proud of the rare moss or hepatic, an attitude which will lead to a more genuine wish to conserve in particular that rare species growing on the own land.

Additionally, bryophytes should be included in the education of students, preferably already at school (grammar school etc.), as well as of postgraduate students of conservation biology, and in the training of teachers, practitioners, and people working in conservation agencies and administration. The role of bryophytes in ecosystems is especially to be emphasised. This automatically describes the moss or hepatic in terms the layman and general public can better understand and identify with.

The basic data of species and habitats are necessary in planning all conservation activities. In Sweden, information on threatened species has been published in 'Red Data Handbooks' with monographs included for each species (Ingelög & al. 1987, 1993). Such monographs should continuously be updated to be of ongoing relevance. The users and target groups for the information of red data monographs are different conservation bodies, local and regional authorities, NGOs, landowners, planners, exploiters, researchers, etc.

Management

One important task in conservation is to manage protected areas in such a way that threatened species will increase and persist in viable populations. In most cases, it is sufficient to eliminate the causes of the threat, but specific management methods and practical techniques may need to be designed for species, habitats, or for a certain site. The techniques must be tested before they are used in full scale.

Very little work has taken place on practical techniques on how to manage sites for threatened bryophytes. In Sweden, there have been some small experiments with liming bryophyte vegetation which include among others *Neckera pumila* Hedw. to ameliorate the negative impact of acidification, but without positive results. Some small management projects in Britain have included clearing scrubs and rubbish to encourage the status of *Didymodon glaucus* Ryan and management of old pollard woodland to save e.g., *Zygodon forsteri* (With.) Mitt. (Hodgetts, pers. comm.).

In Germany, attempts have been made to restore raised bogs by the establishment of selected *Sphagnum* species by sod replanting (Pfadenhauer 1989). In the Netherlands, projects aiming at bringing back some rich fens to their original status have been tried (Kooijman 1992). Some large-scale experimental attempts to rehabilitate *Sphagnum* bogs through blocking drainage ditches have been reported from the United Kingdom (Hodgetts pers. comm.).

Recovery programmes

Since the flora of large parts of the world has been extensively modified by historical human activities in the last 50 years a number of restoration projects will be necessary (Jackson & Akeroyd 1994). These restorations of the flora include among other things also recovery programmes for bryophytes. Jackson and Akeroyd (1994) list a number of guidelines to be followed in the design of such programmes. Although designed for vascular plants some can be relevant for bryophytes as well.

Example: The Swedish National Environmental Protection Agency intends to initiate recovery programmes for a number of bryophytes on the RDL. The selection of species to be included in a recovery programme should, among other options, be based on:

- the degree of threat to the species/habitat
- the probability of the species to vanish if no action is taken
- the fact whether the species is endemic or has a major part of its distribution within the country
- the association with other threatened bryophytes, and if an action can benefit other organisms
- recent field surveys in which the actual threat status was estimated.

The aims of these recovery programmes for bryophytes are to :

- analyse their ecology, dispersal abilities, abiotic requirements etc.
- analyse the threats
- look for additional sites in the vicinity of the old known localities
- pinpoint sites of particularly high interest for conservation measures
- suggest measures in order to maintain the populations in a viable condition
- suggest additional experiments and research.

A number of questions in relation to the aims mentioned above should be addressed in a species recovery plan, for example:

1) What is the reproductive biology: frequency of sporophyte production, dispersal strategy, etc ?
2) How are the population dynamics (recruitment and mortality)?
3) How fast is the species growing?
4) What are the relationships to other organisms: is the species outcompeted by neighbouring plants?
5) How does the threatened species react to different kinds of changes in the immediate environment ? Is it sensitive to, for example, drought or to air/water pollution?
6) For how long has the species been in decline?

Translocating and Sowing

A ' last minute' measure is to sow diaspores and to translocate, transplant or in other ways to recover threatened taxa. The aim of translocating bryophytes is to counteract the loss of biodiversity caused by man. To plant species that formerly had a natural and viable population in a region is one way. These planted populations could then function as 'starter populations', which would be beneficial in protected sites. Such patches may then become the source of genetic material, and propagules could disperse into nearby stands when conditions become suitable. Even if recolonization, in the long run, can proceed without any help from man, several of the threatened bryophytes, for example woodland species, have limited dispersal capabilities and are unable to disperse across extensive areas of, for example, urban or agricultural land. Therefore, one way to speed up recovery is to translocate back to the site those species that were lost when it was destroyed or impoverished.

When planning translocations, the ecological requirements of the species in question should be known. The qualities of the new site should be carefully looked at since each site, especially the immediate microsite, always offers a number of limiting factors for plant survival. Bryophytes are generally very vulnerable to drought but also the competition of algae, lichens and vascular plants. Therefore, the selection of good sites for translocating or sowing, but also the use of plants in a healthy condition should be carefully considered.

Experimental sowing of diaspores and translocation of redlisted species should be done according to a programme that has been approved by an official authority and is considered legal and scientifically sound. Legislators and scientists alike must fully understand that the establishment of new populations through regenerating programmes in no way reduces the need to protect the original populations of the threatened species. The original native site is more likely to have the most complete gene pool of the species and the most intact interaction with other members of the biological community (Primack 1993).

The potential harm to the threatened species caused by these translocation measures is relatively insignificant in comparison with the actual massive loss of bryological diversity being caused by habitat destruction like clear-felling of forests, drainage of wetlands, and air pollution.

Experiments in Sweden with sowing of diaspores of redlisted bryophytes have been partly unsuccessful, although the sites appeared to be suitable (Hallingbäck, in prep.). Without success spores of *Antitrichia curtipendula* (Hedw.) Brid. and *Neckera pennata* Hedw. were sown on more than 10 'suitable' tree trunks in a region where these two species formerly occurred and where there is no severe air pollution today. Successful results were achieved with sowing leaf fragments. Fragmented leaf tips from *Dicranum viride* (Sull. & Lesq.) Lindb. became established rather quickly and are still thriving after 6 years. These and other small experiments indicate that some important ecological requirements must be fulfilled. One of these is that the new substrate should probably have a similar structure and acidity as the original one and that the sowing should be done in the beginning of a period with high air humidity. Best results were achieved when translocating parts of *Neckera pennata* Hedw. with an attached slice of bark included.

Gene Bank

Ex situ conservation is playing an increasingly important role in the conservation of higher plants and might be a suitable method for endangered bryophytes, especially in regions with high environmental impacts like Europe. A network of botanical gardens is cultivating a large number of threatened vascular plant species (Primack 1993). The objective of *ex situ* propagation programmes is to provide support for survival of populations in their natural environment. At least two moss gardens have tried to cultivate especially threatened bryophytes. A gardener in England is growing a number of endangered bryophytes in his private garden and has also published a handbook on bryophyte cultivation (Fletcher 1991). The other moss garden for threatened bryophytes is known as the 'Experimental Moss Garden' at Kumaon in northern India (Pant 1992). Other moss gardens are, for example, those in Japan (Ando & Matsuo 1984), Great Britain (Walters 1987) and The Netherlands (Schoenmakers 1985), where mosses are mainly grown for decorative purposes.

Monitoring

Monitoring should especially comprise species that are shown or believed to be declining. The aim of monitoring is to indicate changes in the threat status, in the decline or recovery trends, and in the fertility during the year. The monitoring of bryophytes should preferably follow a research plan which must be evaluated at the end in order to learn more about population dynamics and recovery processes.

Example: results from the bryological part of the Swedish 'Flora Guardians'

Sweden has got a long-term monitoring project financed by WWF Sweden named 'Flora Guardians'. The purpose is to monitor threatened plant populations and their sites with the help of local amateur botanists. The monitoring is organised by the Swedish Threatened Species Unit and also includes an education programme for some of the guardians. Hitherto, most work has been concentrated on species with no or very few modern records. Old sites have been revisited in order to check if the redlisted species are still occurring. Since the start of the bryological part in 1989, 71 species have been investigated and about 300 sites have been visited. At ca. 50% of the sites the populations were confirmed. If a species was refound, the local conservation authority was informed about its occurrence, and detailed instructions were given on how to maintain or to increase the vitality and size of the population. If the species was not refound, the guardian was asked to assess possible causes for its local extinction. After a couple of years, the guardian should revisit each site for a second time to record any improvement or decline of the species at hand as precisely as possible. The 'Flora Guardians' is a stimulating project since it activates amateur bryologists who enjoy field work. The results will clearly give the conservation bryologists a better understanding of the changes in population sizes and provide data for formulating measures to protect the relevant sites.

Conclusion

Conservation activities for lower plants in general and bryophytes in particular in Sweden are focused on protecting sites with many kinds of micro-habitats typical for bryophytes. Good co-operation with land-users and owners, with NGOs, central or local Forest boards, bryological societies, etc. is required for a successful implementation of different conservation steps. In particular, we should not hesitate or be modest about asking the exploiters and people from the industry to give more consideration to nature and biodiversity, pointing out that conservation can give them better publicity and goodwill in return.

International conservation groups like the IUCN specialist group for bryophytes and the IAB standing Committee for Endangered Bryophytes (ICEB) can support the local or national conservationists with guidelines and letters of support, but in the end, it is up to national and local governments to determine their own strategies and priorities. The European Committee for the Conservation of Bryophytes (ECCB) aims at preserving the species in Europe and has assessed a Red Data Book of European and Macaronesian Bryophytes which among other things includes species fact sheets and a register of important bryophytes sites in Europe (ECCB, in press).

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