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Mycology in the UK - the taxonomic impediment

Executive Summary

February 2007

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Mycology in the UK - the taxonomic impediment

Executive Summary

Fungi are critically important terrestrial organisms as symbionts of most plants, as recyclers of carbohydrates and minerals, as pathogens of plant and animal disease, as food sources for humans and other animals, as sources of valuable chemicals and in food and beverage processing.

Fungi are ubiquitous and among the most poorly understood organisms on earth because for most species their small size and/or subterranean existence mean that they are largely invisible and their importance unappreciated by most people, including many scientists.

Identification and classification of the fungi present a particular challenge, due not only to their generally small size and more importantly to the frequency with which they are found in the asexual state, lacking the main features on which morphological classifications are based.

The majority of the world's fungi (estimated at 1.5 million species, of which only 8-10% have been described) are as yet unknown to science, and even in the UK where native biodiversity is relatively well documented dozens of species of fungi new to science are discovered each year.

The development of DNA barcoding methodologies presents an unprecedented opportunity to tackle these problems at a scale proportional to the magnitude of the task. Of critical importance to the success of these techniques is a reference dataset derived from reliably identified specimens using morphological techniques, a resource that depends on ongoing input by taxonomic mycologists.

Taxonomic expertise in mycology has been dwindling in the UK over the past decade, especially in the university sector. What remains of the UK's mycological systematics community now resides in just a handful of institutions, and even in these remaining 'strongholds' there has been a decline of > 50% in the number of PhD-level taxonomic mycologists. The expert mycologists that remain in these institutions are, typically, in their 50s and, despite careful succession planning in some instances, budget cuts have meant that the majority of these specialists are unlikely to be replaced upon their retirement in 5-10 years time.

Current levels of mycological expertise in the UK are inadequate to meet UK needs, for example, to meet the targets agreed in the UK Plant Diversity Challenge (the UK's response to the CBD's Global Strategy Plant Conservation), let alone to meet the UK's international obligations under the Convention on Biological Diversity as a major repository of the world's systematic mycological resources.

Despite the gloomy picture painted above, some exciting opportunities are open to UK mycology at present:

- The UK has the potential to lead the world in the area of DNA barcoding for fungi, based on the unique collections deposited in our natural history collections;
- There is still time to develop and roll out an explicit succession-planning scheme, focused on enhancing taxonomic research, training future generations of experts in taxonomic mycology and transferring the expertise of the generation about to retire both to their successors and also to databases and other products accessible to the broader scientific community;
- The proposed merger of the Kew and CABI collections presents an opportunity to build on existing strengths and implement a concerted approach to succession planning and the application of expertise to issues of economic relevance;
- The recognition that the case for seedbanking is greatly strengthened by associated banking of fungal associates offers an opportunity for a global fungal conservation programme of unprecedented scale, building on the success of Kew's Millennium Seed Bank.
- Natural England's expressed interest in setting up a fungal conservation unit could lead to tangible conservation outcomes for UK priority species, but relies on a sound base of taxonomic expertise;
- The proposal for a Fungal Portal unites professional and amateur mycologists in the UK and would enable science and conservation bodies to capture and benefit from the vast wealth of mycological data that is held by experts in the remaining centres of professional mycological expertise.
- The International Mycological Congress to be held in Edinburgh in 2010 could be an event at which the UK signals its renewed commitment to mycological systematics in the service of conservation and sustainable use.

All of these opportunities are funding dependent and unlikely to be realised in the current financial climate without the direct intervention of Defra, recognising the importance of mycological systematics to the science base in the UK.

Mycology in the UK - the taxonomic impediment

Fungi are critically important terrestrial organisms in terms of their beneficial relationships with most plants and roles in recycling of carbohydrates and minerals (decomposition), their activities as agents of plant and animal (including human) disease, their use as food sources by humans and animals, their uses as sources of valuable chemicals (especially industrial enzymes and pharmaceuticals and their use in food and beverage processing (bread, alcohol etc.). They are also common in all aquatic habitats, in which they exhibit similar strategies, but terrestrial fungi are the focus of this report. Fungi are ubiquitous and among the most poorly understood organisms on earth because for most of them their small size and/or subterranean existence means that they are largely invisible and their importance unappreciated by most people, including many scientists.

When fungi are active in the environment, they consist of a mycelium, which is a mass of filaments of such extremely simple form that it is impossible to identify to which species it belongs using what can be seen with the eye. The reproductive structures on which scientific classifications of the fungi are primarily based are often ephemeral, making identification difficult. The problems associated with their study when reproductive stages are absent can now be overcome through efforts to produce DNA barcodes for them. However without a matching emphasis on their taxonomy these efforts cannot be effectively focused; being able to employ DNA barcoding depends on the existence of a complete and accurate DNA reference database linked to identifications that have been performed using extant (morphology-based) methodology. For the successful development of this library, major taxonomic input is required to develop appropriate concepts of what species limits are in fungi. This process will also be important as a tool for developing an understanding of genus, family and higher level taxonomic arrangements.

With the capacity to use DNA to identify fungi in their sterile, underground phases, it will be possible to study their community ecology (e.g. beneficial relationships with plants, disease-causing phases etc.) in ways never previously thought possible. Thus, an effort to bolster taxonomic expertise at this point is strategic and could be the springboard to ground-breaking studies and a greatly enhanced understanding of the role of fungi in the ecosystems, this at a time when the effects of climate change on the distribution of fungi and their plant associates is more important than ever. In this last regard, it should be mentioned that lichenized fungi (or lichens) are especially diverse in the UK and are extremely sensitive to environmental degradation, making them particularly good indicators of climate change and the effects of man-made disturbance and pollution. UK expertise in this area has been employed in biomonitoring in a number of other countries.

There has been considerable loss of mycological expertise during the past decade, particularly in UK universities. For example, no one studies fungi any longer at Reading or Exeter, and effort is much reduced at London, Sheffield and Newcastle. Where mycology is still present in the universities, it is mostly applied (e. g. Canterbury) or on medical aspects; plant-fungal interactions (fungal ecology) are studied in several places

(e.g. Aberdeen, Sheffield and Yorkshire), but few taxonomic studies are produced any longer by UK university-based researchers. Two taxonomic mycologists remain in Liverpool John Moores University and Birkbeck College, London, but these posts are unlikely to be replaced upon retirement of the individuals involved; no UK university has a programme in fungal taxonomy or is involved in succession planning).

Additionally, it is important to note that the loss of taxonomic expertise within fungal groups has been uneven. Much of the current research is limited to the kingdom *Fungi* (particularly the ascomycetes & basidiomycetes). Other lineages of fungal organism are no longer the focus of taxonomic study; in particular, oomycetes (*Peronosporomycetes*), a relatively small group of major economic impact are no longer studied (with the exception of the important plant pathogen genus *Phytophthora*). Other groups, such as the slime moulds, labyrinthulids, thraustochytrids and hyphochytrids, representatives of which are significant components of many habitats are largely ignored, despite their importance in ecosystem function. It also important to note that these groups are under-researched due to their ‘peripheral’ position; often, they are ignored by the mycological research community as they are viewed as ‘pseudo-fungi’ whereas protistologists tend to ignore them for comparable reasons or believe they are the purview of the mycological/botanical community.

UK taxonomic expertise in mycology (including the study of lichen-forming fungi) is therefore currently focused on five organisations:

	Mycology	Lichenology
CABI	+	
Natural History Museum		+
National Museum of Wales		+
Royal Botanic Garden, Edinburgh	+	+
Royal Botanic Gardens, Kew	+	

All of these hold extensive fungal reference (herbarium) collections. In the 1960s there was a rationalisation and exchange of collections and associated expertise among RBG Kew and the Natural History Museum; since that time RBG Kew has focused on fungi and the Natural History Museum on lichens. Mycology remains one of the few areas of taxonomic expertise that is maintained at CABI, although it is much reduced now relative to its past strength. RBG Edinburgh continues to study lichens and mycology.

Number of PhD-grade taxonomists	Mycologists			Lichenologists		
	1996	2002	2006	1996	2002	2006
CABI	14	5	3	2	0	0
Natural History Museum				3	2	2
National Museum of Wales				1	1	1
RBG Edinburgh	2	1	1	1	1	2

RBG, Kew	5	4	4	0	0	0
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In evidence submitted to the House of Lords Inquiry on Systematic Biology and Conservation (2001/2), the Natural History Museum and Royal Botanic Gardens, Edinburgh and Kew, all reported that their grant-in-aid funding had decreased in real-terms since 1992 with negative effects on research and collections management and loss of professional taxonomist posts. Since then, each of the institutions has had modest increases in grant-in-aid, but not sufficient to bring them back to the 1992 levels in real terms. CABI's core funding from its member governments has declined substantially since that date to the point where it is less than 3% of income and financial support for its maintenance of the UK National Culture Collection ceased in 1989.

The Plant Diversity Challenge, the UK's response to the Global Strategy for Plant Conservation, contains agreed targets for fungi, but with current UK resources available for fungal study, these targets are not achievable. New taxa are being described each year (ca. 35 per year in the over the last ten years, all of which require conservation assessments), and this is largely due to the efforts of the exceptionally large amateur organisations in the UK. There is a great deal of other information available through the efforts of the British Mycological Society, the British Lichen Society and more than 30 'amateur' Local Recording Groups, but their very substantial data resources cannot be accessed as efficiently as required by all those interested and there is little strategic direction on a nation-wide scale. The Fungal Portal proposal (see below) was developed as a strategy for addressing both of these concerns, but this approach was deemed too expensive by Defra; nonetheless, if no further action is taken in this regard, these resources will remain largely unavailable to UK scientists and conservation agencies.

Mycology at RBGE

In 2000 and again in 2002, there was pressure from the conservation agencies, conservation NGOs and specialist societies to seek help from RBGE to address the lack of expertise in mycology and lichenology to support conservation initiatives. In particular, in 2002, the British Lichen Society presented a paper on the key role of the lichen taxonomist in supporting conservation initiatives (see Appendix 1), and Scottish Natural Heritage (SNH) raised the same issue at a Scientific Advisory Committee meeting and took this forward to a wider meeting of the Joint Nature Conservation Committee (see Appendix 2).

In 2003 the Science Visiting Group to the Royal Botanic Garden Edinburgh recommended the need for '*one or more high-level appointments... in the field of mycology*'. At that time there were two mycologists on the staff, a principal research taxonomist in lichenology and a senior mycologist with expertise in rusts. The senior principal basidiomycete specialist had retired in 1998, and the post had not been replaced.

Later in 2003 there were actions to help remedy the shortage in expertise in lichenology.

1. SNH provided funding to the British Lichen Society (BLS) to support the training of 'lichen apprentices' [SNH also provided funds to support the task of databasing all the

BLS records that were at the time held only as hard copy]. Over three years training was provided by RBGE's lichen taxonomist and the then BLS president through a series of field-based and reference collection workshops and formal training in site monitoring for lichens. There is now an active group of these lichen trainees, drawn from Scotland and the wider UK, who are contributing to conservation projects and scientific research on lichens. The results of this project are summarised in a report produced by the British Lichen Society for the BRISC (Biological Recording in Scotland) newsletter (see Appendix 3)

2. RBGE developed and implemented a new succession planning strategy to address the challenge of maintaining taxonomic expertise. In a field where expertise is sparse, the priority was to build on RBGE's strengths, to avoid the potential loss of expertise. Plans were developed to recruit a "trainee" lichenologist on external funding, to work alongside the lichen taxonomist; this post has been supported for three years by the Esmée Fairbairn Foundation and a benefactor and is now funded directly by RBGE. This strategy has been extremely successful in bringing together the skills of an ecologist with the lichen taxonomist to tackle issues of lichen conservation that need to be addressed at the habitat and ecosystem level, and the ecologist continues to expand his knowledge and skills in lichenology.

Unfortunately this succession planning strategy cannot be applied for mycology at RBGE as RBGE's basidiomycete taxonomist retired in 1998. Currently resources are not available to fund a high-level appointment in mycology.

Mycology at RBG Kew.

The capacity to carry out major projects is diminishing in all institutions but Kew alone has made major investments in terms of housing for the collections (purpose-built herbarium for the 800,000 accessions, making RBGK one of the three largest mycological collections in the world). RBGK currently has four core-funded mycologists, two of whom are senior research posts (one each specialising on Basidiomycetes and Ascomycetes, the two major groups of fungi); there are also collection and laboratory managers (two junior posts). In addition, there is a jointly funded post (with Imperial College) for a researcher who focuses on ecological aspects of plant/fungal interactions. In 2004, an attempt to appoint a senior researcher to lead the Kew mycology team failed for lack of a suitably qualified candidate. A further attempt had been envisaged for the financial year 2006/07 but has been delayed due to in-year funding cuts by Defra. Succession planning is now of major importance because the two senior researchers will be retiring in a short time (most likely within the next five years).

Natural England (NE; previously English Nature) has prepared a document proposing establishment of a Fungus Conservation Unit. This would consist of three full-time equivalent posts (2 full-time and 2 half-time), providing support for the Biodiversity Action Plan, preparing conservation assessments for fungi in the UK and within a European context, and raising public awareness of the importance of fungal conservation. NE identified RBG Kew as an excellent base for this development, given the reputation and collections of the Mycology Section and our institutional commitment to UK

biodiversity. In preliminary discussions, RBG Kew has indicated a wish to support and house such a unit in the Jodrell Laboratory. NE would now like further discussions to take place as a matter of some urgency, so that decisions can be made regarding timing and funding. Such a unit would be complementary to and very much dependent on a functioning team of taxonomic mycologists with the ability to identify and classify fungal material.

It has been recognised that continued seed banking (at the Millennium Seed Bank at the Wakehurst Place site of RBGK) without concern for banking of the fungal associates that many of these plants need to survive is only a partial strategy. Longer-term efforts to bank the seed of 30% of the world's plants have been proposed, but reintroduction of the majority of these species would be difficult, if not impossible, if their fungal associates are not studied and similarly conserved. However, before such a fungal conservation initiative can be added to the work of the seed bank, a great deal of taxonomic study will also be required. DNA barcoding can be of great assistance in this effort but, as noted above, such efforts depend on the existence of a well-studied taxonomic reference library and taxonomic expertise.

CABI and RBGK are now in discussions about merging of their fungal reference collections on the Kew site and future areas of collaboration. A small monetary investment at this stage again would be strategic and lead to more synergy and solidification of resources and research foci. CABI are also particularly interested in the banking of fungal cultures, and this would complement the work of the Millennium Seed Bank.

Mycology at CABI.

CABI has focused on taxonomic mycology for over 90 years, originally being established to provide identifications of, and information on, crop pests for what was then the British Empire. It has intergovernmental status and is owned by a consortium of 45 member countries (including the UK). Its headquarters are in the UK, and it has played a major role in the support of UK mycology for the whole of its existence. Unlike most intergovernmental organizations, it is largely self-supporting financially, with only 3% of its annual budget contributed by member countries as core funding. The remaining 97% is earned through information provision (CABI owns the largest agricultural science abstract database in the world) and service provision (identifications, consultancy, culture sales, project work etc.).

Despite substantial reductions in core funding over the years, CABI remains committed to taxonomic mycology with a focus on economically important species, especially pest and environmentally significant organisms. It owns globally important collections of fungi, including a fully databased dried fungal reference collection containing around 400,000 specimens and a living collection (incorporating the UK National Collection of Fungus Cultures) of around 28,000 strains. CABI receives no financial support from the UK Government to maintain these collections, despite their significance as a UK

scientific resource. CABI has also had a long history of collaboration with UK and other mycology societies. Among many other activities, it was instrumental in establishing and continues to support the 1.2 million-record Fungal Records Database for Britain and Ireland (and associated checklist) on behalf of the British Mycological Society and numerous other stakeholders. CABI has a long track record of capacity building in mycology through training courses, PhD placements etc. and has been granted no less than ten awards from DEFRA's Darwin Initiative with a substantial taxonomic mycology component.

In 2006, CABI separated its mycology activities into a dedicated Bioservices unit, focusing on using fungi for the global good. Its operations include information provision (including the free-to-access Index Fungorum (www.indexfungorum.org); in association with the Index Fungorum Partnership) and associated database and publication of key reference works); research into the use of fungi as biopesticides; conservation and sustainable use; diagnostic and analytical services operating on a quality-managed commercial basis using morphological and molecular methods (including barcoding approaches); and maintenance of the culture collection and provision of associated services. CABI is planning joint ventures (including with RBGK) to gain added value from its culture collection by screening strains for commercially valuable properties.

CABI's staff complement of mycologists has decreased substantially over the last 10 years. Currently it employs three senior taxonomists, six senior staff associated with the culture collection, biopesticide and molecular biology activities, and 11 technical staff. CABI's funding structure dictates that its taxonomists focus most of their efforts into income generation through publications, identification etc., and there is currently little opportunity for taxonomic research. All three of the taxonomists are over 50 years of age, and CABI shares the concerns of RBGE and RBGK that a valuable legacy will be lost completely when they retire.

CABI and RBGK have historically cooperated in sharing the brunt of the taxonomic mycology burden on behalf of the UK, with CABI concentrating on microfungi (especially economically important groups) and its culture collection, and RBGK on macrofungi. Their expertise and resources are strongly synergistic, and CABI would welcome further collaborations, which could involve integration of some activities. CABI also retains some expertise and knowledge of lichen groups (including their preservation as living cultures) and a more active four-way collaboration including RBGE and NHM would have many benefits. CABI would welcome reassessment by the Government of the contribution made by the four UK taxonomy organizations to UK mycology and a more strategic approach to the provision of expert resources for fungi.

Mycology at NHM.

Although NHM is home to the nation's largest and probably the world's most historically significant collection of lichen specimens, taxonomic expertise on British lichens at NHM has been significantly reduced in recent years. The collections are also of global significance, with particularly important collections from Southeast Asia. The expertise/

research of the last three curators has focused on foreign, rather than British, lichens. The collections are currently managed by an experienced lichen curator with considerable research experience, although his research activities are limited by other duties. In addition, the last three curators have had non-overlapping appointments, which has resulted in a lack of continuity of taxonomic and curatorial knowledge.

In 1996 NHM hired a lichen taxonomist, who trained a number of young, foreign lichenologists in molecular systematics before leaving in 2000. Unfortunately, his post was not replaced, and the resources for funding this position have subsequently been lost.

The current lichen researcher at NHM was hired in 1988 and immediately began work on *The Lichen Flora of Great Britain & Ireland*, published in 1992. Currently, his research activities are almost exclusively on biomonitoring and heavy-metal accumulation in lichens.

Despite the reduction in expertise on British lichens at NHM, it is still the base of operations for the British Lichen Society and its president. The NHM continues to support the BLS and its activities, including providing resources for amateur lichenologists, the SNH-funded Scottish lichen project, and the production of an almost-complete, new edition of the *Flora*. The president has a thorough knowledge of British lichens; however, she is not a paid NHM staff member. Thus, the future of British lichen taxonomy at NHM is uncertain after she finishes her current term (December 2007).

In addition to its lichen herbaria, the NHM houses a historically important slime mould (myxomycete) herbarium, including many types (some 250 of the 1000 species represented) and geographical unicats. As there is a rapidly increasing interest in this group of organisms worldwide, NHM is ideally positioned to play a leading role in researching these organisms.

Finally, it should be noted that NHM has expertise in some of the fungal groups that are no longer the focus of taxonomic study elsewhere. Fungal organisms with tinsel flagellum are members of a diverse lineage (referred to as chromists or straminipiles) of organisms including protists, algae and fungal groups (such as oomycetes). Currently, there is only one comprehensive culture collection of oomycetes worldwide, this is privately owned by a NHM staff member, who is not employed as a mycologist. The NHM (uniquely) has expertise within its scientific departments that encompasses all of these groups. The importance of this diverse lineage as a model for understanding the evolution of eukaryotic life-strategies has been under-appreciated. In addition, the importance of tinsel-flagellum-bearing fungal organisms in mediating marine microbial community populations remains largely un-investigated. However, the absence of recent taxonomic (either morphology or DNA-based) treatment of these groups is a serious impediment to progress in these arenas.

Mycology at National Museum of Wales

The NMW has one lichenologist on the staff whose contribution focuses on conservation work on UK lichens.

Fungal portal

The Fungal Portal concept was initiated as a joint venture between the British Mycological Society, CABI, RBGK and a private benefactor. Its overall aim was to establish an integrated and comprehensive digital fungal information and recording service. It would be a web-based information network that could be used to exchange data and disseminate information about fungi, initially within the UK and potentially world-wide, as a public service. An aim was to trigger a change in public understanding of fungi through innovative linkages between non-specialists and the scientific community. The Portal was to have linked a number of major existing databases that contain information about British fungi (including lichens) to provide a greatly enhanced and fully searchable facility, with an extensive image library and other information resources for identification and education. It would have provided a mechanism for individuals, local recording groups and non-specialist institutions including schools to validate and store their own information and make it available alongside the major databases as a shared resource.

A scoping exercise for the Portal was undertaken by RBGK (with input from CABI) in response to a funded request from Defra, but the resulting proposal was not acted upon due to cost and sustainability concerns. All parties involved would welcome resurrection of the concept, perhaps on a more fundable scale.

Mycotas, checklists and other publications

All four taxonomic institutions have substantial expertise in the production of information resources for fungal taxonomy. RBGE has had a long-running programme to publish an account of the UK basidiomycetes, and it and the NHM have collaborated with a number of other groups to produce an account of British lichen-forming fungi (a second edition is currently in preparation). RBGK and CABI have worked for some years on an account of the UK ascomycetes, which requires further investment for its completion. CABI produced the first modern checklist of the British Ascomycota (including lichen-forming Ascomycota) in the 1980s and provided IT support for the production of the recent *Checklist of the British and Irish Basidiomycota* (2005, published by RBGK). Both products were linked into and augmented CABI's 'Species Fungorum – towards a global checklist of the fungi' contribution to the Catalogue of Life (Species 2000 and ITIS) and also the *Fungal Records Database of Britain and Ireland* (hosted by CABI), making updates and new editions immensely less expensive and time-consuming. One of CABI's Darwin Initiative projects led to publication of the *Fungi of the Caribbean*, a database-driven annotated checklist running to over 900 pages. CABI also produces database-driven publications such as the *Index of Fungi* (the mycology equivalent of the International Plant Names Index, incorporating *Index Kewensis*), the *Bibliography of Systematic Mycology* (the mycology equivalent of *Kew Record*) and the *Dictionary of the Fungi*, the key reference work for fungal taxonomy worldwide. All four institutions produce books, scientific revisions, popular guides and academic papers on a regular basis. There is demand by the mycology community to develop further publications, including completion of the mycotas, extension of the checklist programme

to the missing groups of fungi and fungal analogues (slime moulds and downy mildews) and further integration with on-line resources. This will not be possible without continuing investment in the subject.

Opportunities to improve the standing of Mycology in theUK

Mycology and other similar disciplines where there is a 'taxonomic impediment' would benefit from a scheme similar to that funded by USA's National Science Foundation – the PEET initiative (Partnerships for Enhancing Expertise in Taxonomy): in partnership with academic institutions, botanical gardens, freshwater and marine institutes, and natural history museums, the National Science Foundation seeks to enhance taxonomic research and help prepare future generations of experts. Through its Special Biennial Competition in Systematic Biology, NSF supports competitively reviewed projects that target groups of poorly known organisms for modern monographic research. Projects must train new taxonomists (two per project minimally) and must translate current expertise into electronic databases and other products with broad accessibility to the scientific community. Examples of projects from this initiative include a comprehensive study of the Lasiosphaeriaceae (Fungi, Ascomycetes), and a Systematic Monography of the Gnomoniaceae (Ascomycetes).

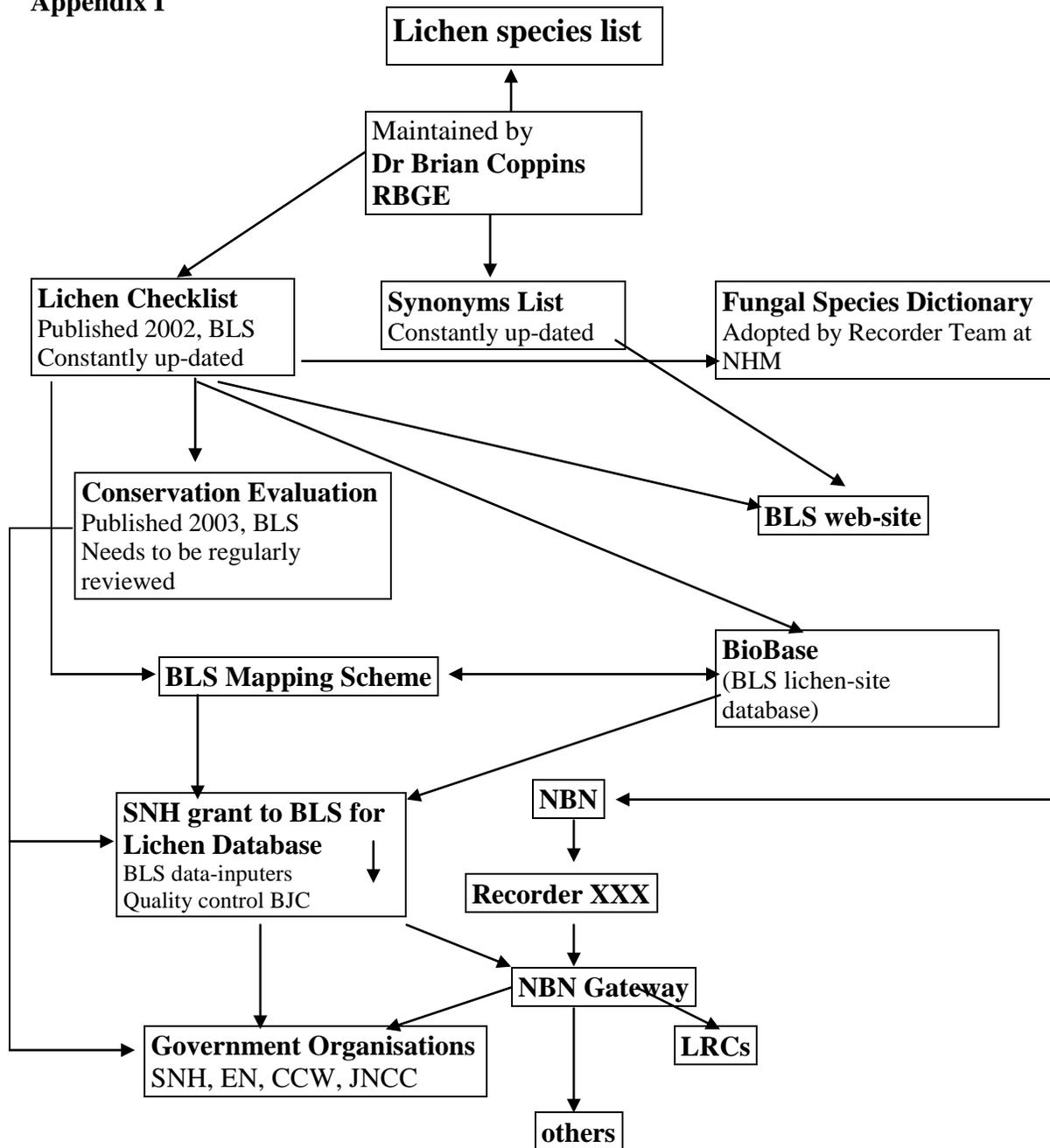
A scaled-down version of the Fungal Portal could be developed that would enable professional mycologists to tap into the wealth of information and enthusiasm of amateur mycologists and their organizations within the UK.

The merging of the RBGK and CABI herbaria presents an opportunity to develop more focused efforts on the study of fungi, particularly those of direct economic consequences, and preservation of living fungi so that would enhance the efforts to bank seeds. These efforts have significant cost implications, and larger impacts would be obtained if there were increased financial support available.

In particular, the NE proposal to set up a fungal conservation unit at RBGK requires fund-raising to meet its goals. There would be three posts required (two full-time and two part-time). NE and RBGK both see this as a major boon to conservation efforts on UK fungi and are embarking on efforts to raise the funding required to set up the programme and fund it over the longer term.

The British Mycological Society will host the International Mycological Congress 9 in Edinburgh in 2010 (see www.britmycolsoc.org.uk/news/shownews.asp?NewsID=96), and this would be an opportunity to publicise our efforts to improve the standing of mycology in the UK.

Appendix I



This illustrates the fundamental importance of having an experienced lichen taxonomist(s) in professional posts. The basis of all lichen names can only be arrived at in the first instance by taxonomists: (i) through understanding the concepts of 'what is a species' within their specialist group; (ii) through access to properly maintained national herbaria; (iii) through access to a wide body of literature published world-wide; (iv) through contact with colleagues world-wide; (v) to understanding the complexities of the International Code of Botanical Nomenclature.

It also illustrates the extreme vulnerability of the present situation. There is currently no other person in the UK (either within, or outside of, a national institution) who could assume the role presently being undertaken by Dr Brian Coppins.

Appendix II

JOINT NATURE CONSERVATION COMMITTEE

THE STATE OF FIELD LICHENOLOGY IN SCOTLAND AND THE UK

Paper by Michael Scott and Colin Galbraith, SNH

1. Introduction

1.1 This paper is being tabled following discussions by SNH's Scientific Advisory Committee on 25th February 2002, and by the Chief Scientists' Meeting on 17th May, and following discussions between SNH, Plantlife and the Royal Botanic Garden (Edinburgh). It reports on a 'crisis' in the status of field lichenology in Scotland, and by extension throughout the rest of the UK and for other cryptogamic plants, and considers the impact of this on, amongst other things, Site Condition Monitoring for SSSIs which are of importance for these taxa, and Biodiversity Action Plan (BAP) commitments. It invites comments on possible solutions.

1.2 The committee is invited to:-

- (a) consider the issues raised, and their likely impact;**
- (b) comment on the tentative solutions proposed;**
- (c) offer other possible solutions to ensure that our obligations for monitoring these important taxa are met;**
- (d) consider whether any of these initiatives should be taken forward, and, if so, on what basis.**

2. Background

2.1 In Scotland in 2001, there were four field lichenologists of repute available for site monitoring and other contract work relating to the identification and survey of lichens. As it happens, these were two couples: Brian and Sandy Coppins, based in the RBG(E), and Les and Sheila Street from Kingussie. Les Street was the northern reserves officer for the RSPB, but was available for limited contract work with his wife, who had 15 years of field experience in lichen surveying. However, in early 2002, Les Street

accepted a new RSPB post in the Isle of Wight, and he and Sheila have indicated that they are no longer available for contract work in Scotland.

- 2.2 In February 2002, Stephen Ward, who has responsibility for 'lower plants' in Advisory Services of SNH, received a letter from Brian Coppins, indicating that he intended to "withdraw as a main player" from field work relating to the Biodiversity Action Plan, and to "concentrate for my remaining seven years [until retiral] at RBGE on taxonomic studies, curation of my large collections from Borneo, Chile and Sweden, and, hopefully, supervision of post-graduate taxonomic studies in lichenology and mycology". He added: "Perhaps my absence from the 'centre stage' will highlight the critical state of lichenology in the British Isles, and lead to at least one new core lichenological appointment in the UK. If it doesn't, then I have certainly made the correct decision!"
- 2.3 Brian Coppin's letter continued: "The BAP process has brought tremendous benefits to our knowledge of the distribution, autecology and conservation requirements of many lichens. I would like to see this extended to the many other species (and their habitats) that are deserving of equal attention. Furthermore, the current round of work (i.e. preparation of species dossiers) is not the end of the story - actions are prescribed, and suitably trained and experienced personnel are required to carry out or supervise such work. The UK BAP (and related) work also needs to be taken more in to the international scene, with, for example, involvement in the objectives emanating from the Planta Europa 2001 conference. These amount to a full-time obligation, especially as the UK, in particular Scotland, is a biodiversity hotspot for lichens, and the high degree of 'international responsibility' needs to be recognized. I must admit to being disheartened by the UK government's piecemeal approach to the BAP process. And, why is it that there are core appointments in GOs and NGOs for co-ordinators... but none whatsoever for 'whole organism' specialists?"
- 2.4 Brian's letter also indicated that his wife, Sandy is contracted to major field surveys in Somerset for EN and NT, initiated in 2000. In addition, she has cut back on her consultancy work to allow time for her duties as President of the British Lichen Society in 2002 and 2003. She, therefore, is not available for survey work in Scotland in the foreseeable future.
- 2.5 In his briefing to the Chief Scientists' Meeting, Stephen Ward noted: "This memo addresses the immediate crisis facing SNH with respect to lichenology, where I know of no experienced consultants resident within Scotland and only two elsewhere in UK (Bryan Edwards & Vince Giavarini who both happen to be based in Dorset; Vince has carried out work in Scotland as a subcontractor to the RBGE). The situation is little better with respect to fungi, where I know of just one field mycologist (Liz Holden), able to tender for SNH's requirements. Thankfully, the situation

for field bryology is a little better with 3 or 4 consultants available to work in Scotland.”

- 2.6 It is therefore difficult to see how SNH can meet its commitments for lichen survey and monitoring, as required for Site Condition Monitoring of SSSIs in which lichens and other lower plants as a significant interest. As noted by Brian Coppins in para 2.3, it is also unclear how some of the requirements flowing from the UKBAP for lichens and other lower plants can be addressed without suitably experienced experts able to take on work in the field. Although appropriate contractors may still be available in England and Wales, these are clearly few in number and limited in their overall capacity; any further loss of contractors could therefore lead to similar problems in the other country agencies. The situation for the fungi may also become critical in the near future.
- 2.7 Discussions with Mary Gibby, Head of Science at the RBGE and a member of SNH’s Scientific Advisory Committee, confirmed that the RBGE recognised this issue to be part of what it called the ‘**taxonomic impediment**’. This was considered in evidence presented by the RBGE to the House of Lords Select Committee inquiry into Systematic Biology and Biodiversity. This states (para 6): “Within RBGE there are now serious gaps in expertise, most notably in fungi where replacement of our retired specialist Professor Watling has been postponed for a number of years to save costs.” It goes on to state (para 25) “Additional grant in aid would allow RBGE to recruit taxonomists in strategic areas including fungi, cryptogamic plants and certain large and complex groups of higher plants.” The RBGE evidence to the Select Committee is appended as Annex 1, but it is unlikely that RBGE is alone in facing staff shortages of this kind, and Committee members may be aware of losses of similar experts from other institutes.

3. Possible Ways Forward

- 3.1 This matter was considered at a regular liaison meeting between botanists in SNH Advisory Services (Chris Sydes and Stephen Ward) and Plantlife, as the leading plant conservation charity in the UK (represented by Martin Harper, Director of Conservation, Andy Byfield, Biodiversity Manager, and Michael Scott, Coordinator of Plantlife Scotland) on 21st February 2002, and further considered at the Plantlife Link meeting in London on 14th March.
- 3.2 These meetings identified a number of short- and medium-term measures that might be considered to begin to address this ‘taxonomic impediment’. As noted below, each of these has some benefits and some weaknesses:-

(a) Trawl all research institutes and universities to identify whether there are lichenologists and other lower plant experts within these institutes who might be available to tender for research and survey work *[it seems relatively unlikely that many such individuals exist, and, if they do, they may be fully occupied on other commitments within their institutes]*;

(b) ‘Import’ lichenologists from the Continent, since countries like Denmark still produce specialists in these fields who might well appreciate the opportunity to study lichens in Scotland *[this is likely to be a more expensive option, in view of travel costs, and the relevance of their experience to Scotland and the UK may be somewhat limited]*;

(c) Prepare practical business guidance advice to encourage amateur lichenologists to step across the divide into freelance contract work, recognising that there is significant demand for such contract appointments *[it is not immediately clear whether there are suitable skilled amateurs available, and it is unlikely that many of these will be tempted to take the financial risk of an uncertain future as a freelance]*;

(d) Grant-aid a studentship in lichenology at a suitable university or research institute *[this would be, at best, a medium-term solution, and there is always a risk in investing in one individual who could not be guaranteed to take on field work at the end of the studentship]*;

(e) Grant-aid a course in lower plants at one or more universities and/or research institutes, to encourage more students to consider studying cryptogams *[this would also be, at best, a medium-term solution, and there would be no guarantee that practical field ecologists would emerge at the end of the course]*;

(f) Grant-aid a ‘champion’ for lichens, through the British Lichen Society or Plantlife, perhaps based at one of the botanic gardens or other appropriate institutes, to promote the study of lichens, and the career opportunities they may present, through lectures and other available academic channels *[potentially less expensive than options (d) or (e), but, at best, likely to have a medium-term impact and with no guaranteed outcomes]*.

3.3 **Committee is invited to consider the options above and offer their views on their likely effectiveness, and to suggest whether any other solutions can be identified. Committee is also asked to consider whether and how any of these options could or should be taken forward.**

Appendix 3

SNH grant to British Lichen Society (BLS) for Scottish Site Lichen Database (SSLD) and Training

Sixth and final period (April 1st 2006 to end 30th September 2006)

The BioBase Scottish Site Lichen Database now exists! Data input for the funded phase is now complete, and the last few months have seen the bulk of the work carried out by Janet Simkin (BLS BioBase Data Recorder):

- setting up site details in BioBase
- merging duplicates
- grouping closely related sites together under master sites
- standardising the spelling of location names
- checking and correcting grid references and Vice Counties.

There are 10,591 cards containing over a quarter of a million records (256,318 records) for 1,945 taxa, and it includes 8,670 sites and subsites.

The BioBase database is currently being converted to Recorder2002, with a comprehensive site hierarchy amounting to 9,187 locations (including Vice County, Region, site and sub-site). Andy Brewer (NBN Technical Support) is developing the Recorder import and has already provided a preliminary version of the Recorder database for testing. Monk's Wood are helping with the site data 'cleaning' by putting our data through their GIS. About a 5% error rate has been detected from the data input, but the close scrutiny, checking and corrections mean that this will be one of the 'cleanest' datasets of its type. At present the import is being done to Recorder2002 but the database will be converted to R6 and then made available to the NBN Gateway.

The potential use of the SSLD can be tremendous; during the building phase it has already been used to provide data for SSSIs that were to undergo Site Condition Monitoring, and post SCM data has now been fed into the database, providing comprehensive and up-to-date data for those sites. Other uses of the database include:

- forming the basis for drawing up a census catalogue of lichens in Scotland, with the associated spin-offs that such a catalogue will engender;
- justification of the 'Scottish list', and form a useful basis for future revisions;
- it will form the basis for a Threatened Lichen Database for Scotland;
- provide data for ecological research, e.g. numbers of lichens recorded from sycamore; distribution of particular species; coastal lichen diversity etc., etc.

It will be a living database, constantly updated and constantly used by field lichenologists, including those undertaking commissioned survey work in Scotland. It is planned to have a local, Scottish database manager, who will regularly feed changes, updates and additions into the central BLS lichen database. Above all, it is the BLS's commitment that the SSLD will be available to all on the NBN.

The appended maps demonstrate how the SSLD (on BioBase) has progressed from the outset of the project (before March 2004) to completion (September 2006), showing diversity for 5km squares. (Records for which we only have 10km or 100km square grid refs are shown in the SW corner of the square to which they apply). The BLS also holds species data on Distribution Maps (at 10 km square scale, run by Prof. M.R.D. Seaward, Bradford)), and maintains its own Species Dictionary and a Synonyms List (Brian Coppins at RBGE).

Lichen training

Apart from the SSLD, the other main purpose of the SNH grant to the BLS was to raise awareness of lichens and provide training and encouragement to young lichenologists, to ensure that there will be a viable future for lichenology in Scotland. Over the three years of the project, this has been achieved, with the setting up of the **Lichen Apprentices** scheme.

There is a core of five young Lichen Apprentices, with a further six (at least) who have also benefited from the training opportunities offered, and can now be counted as 'active' lichenologists. It was fortunate that Site Condition Monitoring (SCM) for Lichens in Scotland was being undertaken at this time, as expert lichenologists carrying out SCM agreed to take Lichen Apprentices with them whilst carrying out fieldwork. Three Lichen Apprentices gained sufficient expertise to be able to undertake SCM themselves in Dumfries and Galloway (with some guidance from Brian Coppins), and Andy Acton also carried out SCM at Glen Nant, and Joe Hope for Glen Affric.

As part of the training, a workshop on montane lichens was organised (the Rockers' Workshop). This was set up to tackle the acute shortage in the UK of young, active lichenologists able to undertake work in montane habitats. In a time of growing awareness of the effects of global warming, it is vital to record and attempt to understand more about these fragile and ancient montane lichen communities that will be at the forefront of climate change. Publicity in local newspapers and local Scottish Radio, as well as an article in SNH's magazine reported on the Rockers' Workshop.

Together with the setting up of the SSLD, the Lichen Apprentice scheme has been one of the great success stories resulting from the SNH grant to BLS. Other groups and organisations in Scotland are now seeking to replicate the scheme, most notably BTCV with their Natural Talents Bursary.

As a practical and positive outcome, the BLS now have active, young lichenologists as members. Two of these are currently serving on the BLS Council (Chris Ellis and John Douglass).

Lichen training and awareness-raising events that have occurred as a direct result of the available funding to members of the BLS from SNH:

- two days training at CEH Banchory, of lichens of upland terricolous habitats, by Brian & Sandy Coppins;
- churchyard lichens, a three day course at Alloa (partly sponsored by Clackmannanshire Council), and run by BLS member Joy Ricketts;
- as a direct result of the above, setting up of the Scottish Churchyard Lichen Group by Peder Aspen and John Douglass; so far, three meetings have been held, with short reports appearing in the BLS *Bulletin*, and the records sent to the SSLD;
- two days training for North East Scotland Biological Recording Centre (NESBReC), by Brian & Sandy Coppins;
- links set up with Heritage Scotland by Peder Aspen and John Douglass, to ensure lichen awareness on Scotland's historical monuments and the built environment; this includes talks given at a seminar by BLS member Vince Giavarini. One example of a site visit was the survey of the fountain in Holyrood Palace, after Her Majesty the Queen felt that the stonework was being disfigured by 'growths'. A short report by Joe Hope appeared in the BLS *Bulletin*;
- two day Lichen Days for Children and Adults, run by Peder Aspen and John Douglass at St Andrews Botanic Garden;
- training and awareness-raising of Historic Scotland Rangers in Holyrood Park by Brian Coppins;
- John Douglass (Ranger for South Lanarkshire Council, and a Lichen Apprentice) raising awareness of lichens locally through talks and training in local schools and as part of the opportunities offered by the Ranger Service, as well as ensuring that lichens are included in site inventories for SINCS, churchyards, cemeteries and for planning applications;
- two-days training for Caithness Rangers and volunteers, at Dunnet Head and Dunbeath Strath, by Brian & Sandy Coppins (partly funded by Highland Council);
- As a direct result of the above, setting up lichen monitoring project as part of an LBAP for Caithness Rangers and volunteers at Dunbeath Strath, by Brian & Sandy Coppins (also partly funded by Highland Council);
- Joe Hope ran a tw-day course for Forestry Commission and Local Rangers in Wales;
- two-day workshop for Lichen Apprentices held at RBGE, on Lichen Taxonomy, Thin Layer Chromatography (TLC) and the value and use of National Herbaria and Libraries, run by Brian Coppins;
- Brian Coppins on-going support (field trips, identification checks, general advice and tips) for Lichen Apprentices as continuing encouragement to their expertise and development as competent lichenologists.
- Perhaps as a direct result of the opportunities offered, and the training and encouragement facilitated by the SNH grant, young John Douglass has emerged as something of a star. He has worked extremely hard, and received a lot of support from South Lanarkshire Council; together, they have produced a stunning major lichen exhibition (*The Secret Life of Lichens*), currently showing at Chatelherault Country Park, Hamilton and due to tour the UK after November 2006. John is also now actively engaged in undertaking lichen contracts.
- Other 'former' Lichen Apprentices regularly undertaking commissioned lichen contracts include Andy Acton and Joe Hope.

- The 'LichenIreland' project (part of the CEDaR project, Centre for Environmental Data and Recording, organised by National Museums & Galleries of Northern Ireland (MAGNI), is an all-Ireland lichen data gathering exercise which has recruited former Lichen Apprentices Joe Hope, Andy Acton, John Douglass, Peder Aspen, Andrea Britton and Richard Hewison to carry out 'square-bashing' in under-recorded areas of Ireland and Northern Ireland (see www.habitas.org.uk);
- Lichen habitat leaflets; the first is being produced by Andrea Britton (on montane heaths), with support from the Macaulay Institute.

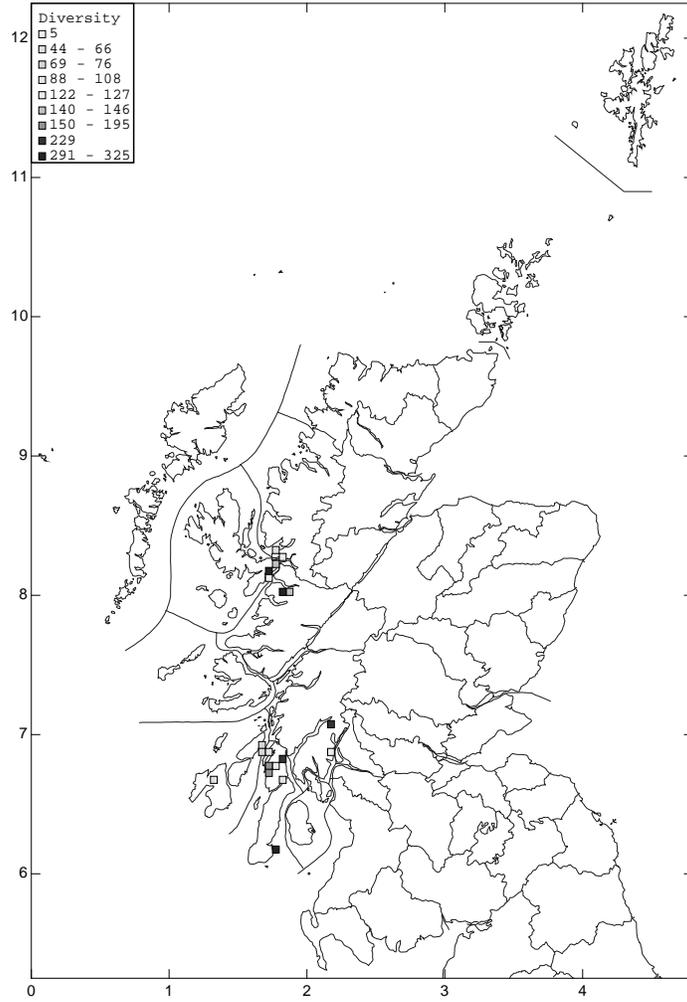
The 'Scottish project' has run for three years; it has involved BLS members in a range of activities, from data inputting, to training. It has achieved the objectives that were set out at the beginning of the project; this in itself is an amazing feat, not least to consider that putting together such a comprehensive database (which included having to design, develop and test spreadsheets and database conversion modules at all stages along the way), and access data from a wide and disparate variety of sources, all this has been achieved within the timescale and budget set out at the beginning.

The BLS are indeed grateful to SNH for providing this grant, and lichenology in Scotland seems to be on a surer footing, and fairly well assured for the immediate future. Credit must also be given to the way SNH managed the grant, especially to Dr Chris Sydes, whose support and common sense approach throughout was much appreciated. We are also grateful to the time and support that Andy Brewer and the NBN have put into the project. This has been a real bonus, and taken the database forward more quickly and for less cost than it would have otherwise have done.

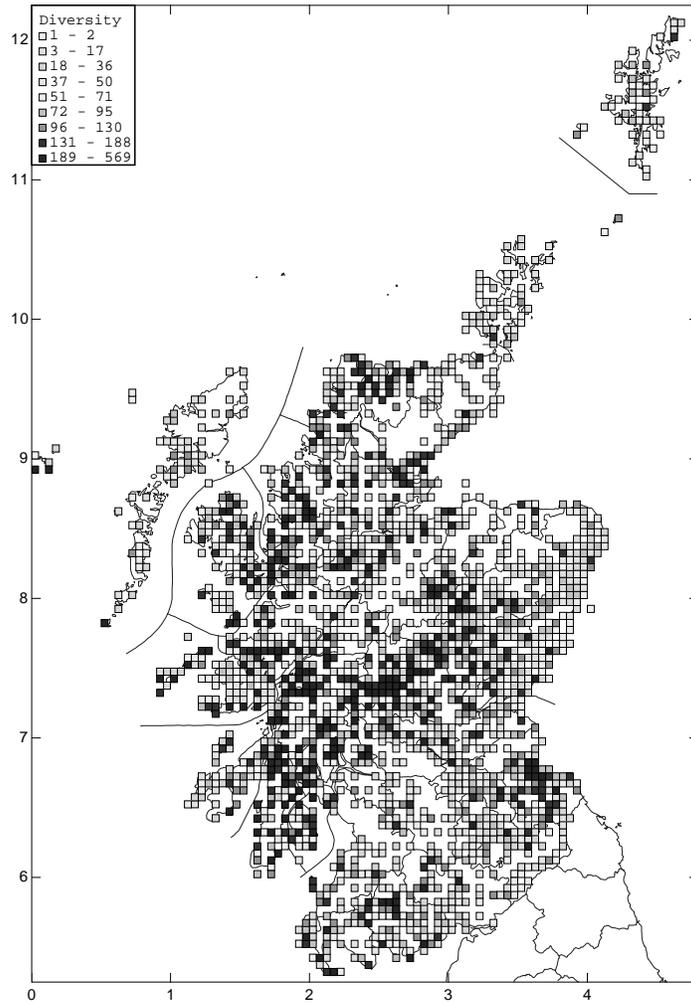
Sandy Coppins, British Lichen Society, October 2006

lichensEL@btinternet.com

Lichen sites on BioBase before (March 2004)



After (September 2006)



Appendix 2. List of Acronyms.

Acronym	Full name
BAP	Biodiversity Action Plan
BLS	British Lichen Society
BMSFRD	British Mycological Society Fungi Records Database
BRISC	Biological Recording in Scotland
CABI	CAB International (formerly the Commonwealth Agricultural Bureau)
CCW	Countryside Council for Wales

CEDAR	Centre for Environmental Data and Recording
CEH	Centre for Ecology and Hydrology
Defra	Department for Environment, Food and Rural Affairs (UK government; formally MAFF)
DNA	Deoxyribonucleic Acid
EN	English Nature [now forms Natural England]
GIS	Geographic Information System
GO	Government Organisation
GSPC	Global Strategy for Plant Conservation
ITIS	Integrated Taxonomic Infrastructure System
JNCC	Joint Nature Conservation Committee
LBAP	Local Biodiversity Action Plan
MAGNI	Museums & Galleries of Northern Ireland
MSB	Millennium Seed Bank
MSc	Master of Science
NBN	National Biodiversity Network
NE	Natural England
NESBReC	North East Scotland Biological Recording Centre
NGO	Non-Governmental Organisation
NHM	Natural History Museum
NSF	National Science Foundation
NT	National Trust
PEET	Partnerships for Enhancing Expertise in Taxonomy
RBGE	Royal Botanic Garden, Edinburgh
RBG Kew	Royal Botanic Gardens, Kew
RSPB	Royal Society for the Protection of Birds
SCM	Site Condition Monitoring
SINC	Sites of Importance for Nature Conservation
SNH	Scottish Natural Heritage
SP2K	Species 2000
SSLD	Scottish Site Lichen Database

SSSI	Site of Special Scientific Interest
TLC	Thin Layer Chromatography
UK	United Kingdom
UKBAP	United Kingdom Biodiversity Action Plan