BIODIVERSITY IN IRELAND

A review of species diversity in the Irish Flora.

by

J. A. Neff MSc.(Ecol). MIEEM.

for

the Heritage Policy Unit

of the

Department of Arts, Culture and the Gaeltacht

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"Lists of this kind must be ongoing
- there is only one final list
- when everything is extinct".

(Ing, 1992a)

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J.Neff. May 1996.

SUMMARY

The study examines aspects of species diversity at various taxonomic levels, according to the Study Brief - Appendix XI. The information comes from a wide variety of sources comprising some 74 texts and 30 personal communications from individual experts.

Current legislation, national and international, relating to conservation are summarised. Red Data Book Categories are also summarised in the context of new IUCN categories.

Where information is available, species diversity, conservation status and socio - economic importance is given for each group. Where possible comparisons are made with Britain, Europe and Globally. The lack of information for some groups - particularly in the lower plant groups is noted and probable causes are discussed.

Vascular Plants:

There are 1309 vascular plants - which include the Pteridophytes (ferns) and the Spermophytes, or seed - bearing (flowering) plants - in Ireland. This number is based on a fairly complete knowledge of the flora. Ireland's flowering plants account for less then 5% of the known species in the world and only 11% of those in Europe as a whole. This belies the fact that many of the communities are ecologically highly significant and despite a relatively poor flora in terms of species numbers, Ireland has a responsibility for the uniqueness of its flora in the widest context. At present Irish vascular threatened species comprise 6% of the native total (815). The main threats to species are habitat -related. These include: total habitat loss, damage, alteration through land use management changes, constriction of suitable habitat by impinging activities such as developments and so on.

The situation is therefore potentially critical. Urgent conservation measures are needed if this trend is to be at the very least halted, if not actually reversed.

Alien, garden and commercial plant species are discussed briefly. Genetic and plant resources are summarised.

Bryophytes (Mosses and Liverworts):

Bryophytes are a significant element of the Irish flora in that they are diverse both in their form, numbers of taxa and in the variety of habitats in which they occur. There are 759 species of bryophyte known in Ireland though in reality the figure is probably much greater, this represents less than fiver per cent of the world's bryophytes. Of the total number of 759, 46 species of liverwort and 146 species of moss are included in the Red Data Book for Ireland.

Undue emphasis should not be placed on species numbers, but rather the overall contribution to ecosystems by bryophytes. Their importance lies in their abundance rather than the species richness. Bryophyte communities and species are important and often very evident components in Irish habitats, often accounting for a high proportion of the species present, especially in terms of cover. Because of their abundance, Ireland has a special responsibility for bryophyte communities.

Fungi:

Fungi are one of the largest groups of organisms in the world. The exact number of fungal species in Ireland, as with the rest of the world is not known. Approximately 3500 species of fungi are known at present in Ireland, although it is believed that the true figure is likely to be nearer to 7800 species. The basis for this figure and the reasons for under-recording of fungi are discussed in Chapter 3. Their importance in ecological, economic and social terms is also discussed.

There is an urgent need for review, co-ordination and standardisation of fungal recording in Ireland, including the provision of a central data-base.

Lichens:

Figures for lichen diversity are reasonably up to date. The Census Catalogue of Irish Lichens based on vice-county distribution was published 1994 and lists 1050 taxa in 223 genera. The taxa include 4 subspecies, 13 varieties and 2 forms. In addition the Catalogue lists 25 taxa of lichenicolous fungi and non lichenised fungi in 12 genera. 147 taxa were added to the Irish lichen flora and 56 taxa omitted since the previous Census Catalogue of 1984. With almost 30% of the European taxa, Ireland's lichen flora is significantin an international context.

Thirty-four of the Irish species are regarded as threatened in Europe. That lichens are highly sensitive to aerial pollutants is a well -established fact. This may account for the presence of certain species in greater abundance than in continental Europe where air pollution levels would generally be far higher. Ireland's geographical position on the north -west fringe of Europe almost certainly has a bearing on this.

Algae:

Generally speaking it is not wise to attempt to estimate overall species diversity relating to algae since our knowledge is limited, with the exception of the two groups for which there is more information - the Seaweeds and the Charophytes (Stoneworts).

Algae are a vast and diverse group in terms of number, form and habitat, comprising macro- and micro-algae (including phytoplankton). They are ecologically and economically a very significant group - particularly the micro-algae or phytoplankton. Their importance lies in their role as primary producers, often the only ones present. Ireland is particularly suited to the growth of algae, combining climate and a wide variety of suitable habitats.

Ireland's long coastline with its variety of habitats, has long been the subject of studies of marine algae so that there is reasonably reliable information on the seaweeds with regard to their numbers, though different sources vary slightly - presumably due to taxonomic changes. Figures are given for marine macro-algae in Chapter 5. Information on marine phytoplankton comes largely as a result of a research on coastal waters, often in the context of fisheries and aquaculture. As a group they are very important, being responsible for nearly all the primary production in the sea. The main threats to marine algae are discussed.

Freshwater algae are ubiquitous, occurring wherever there is a body of freshwater- large or small - which is exposed to sunlight. Terrestrial algae,which occur on the surfaces of soil, walls and buildings etc. - are probably the least known algal group.

As for other lower plant groups, there appears to be an urgent need for more study,

a central records facility, not just for the algae, but other groups of lower plants too, is evident. particularly of the phytoplankton, and the drawing together of records. The need for

General conclusions:

Despite the small size of the country and the relatively low number of vascular plants, Ireland is of importance in terms of its flora and plant resources . In recognition of this , the following action is needed:

a. Much more work is needed, in particular in the lower plants before Ireland can make any informed statement as to the status of these groups.

b. There is a strong case for a centrally coordinated approach to the collection and collation of species records in Ireland. This is particularly so for lower plant groups such as fungi and algae A properly resourced central records data -base for all plant taxonomic groups is essential if species diversity is to be properly monitored

c. There is a real need for expertise in field recording - especially for Irish experts. Recording in the past has been done by visitors who tend to concentrate on particular areas of "botanical interest" resulting in patchy distributions eg. for the bryophytes. However, without the input of visiting botanists our state of knowledge of the Irish Flora would be much worse than it is at present.

d. Ireland must fulfil its obligations at national and international levels regarding the conservation of species and habitats. There is an urgent need for legal protection for habitats. This is seen as the only hope of survival for many species.

INTRODUCTION

a. Preamble.

The purpose of this review is to form a basis,along with the status review on the fauna, for the Irish Biodiversity Action Plan to be prepared later this year (1996).

The status review of the flora has involved contacting many individuals and institutions to achieve as wide a perspective as possible. In a period of two months (study time -scale) 33 individuals were contacted by letter, telephone and fax. Of these 30 responded in some way, if only to direct the author to other sources. In some cases respondents gave detailed comments in relation to biodiversity and their particular speciality. A full list of respondents is given at 7. Sources at the end of the report.

The review deals with the main groups of plants, covering each taxon in turn. The descending order was chosen arbitrarily - it could equally have been considered in reverse.

Where there is detailed information to be presented in a large tabular form it has been put into an appendix. The reason for this being an attempt to allow the (necessarily somewhat fragmented in places) text to flow as easily as possible. Smaller tables are included in the text of each section.

There is inevitably more information on certain aspects of some taxa more so than others. The report attempts to present the information factually and as equitably as possible. Other sections of the Introduction below cover aspects of relevance to all groups of flora.

b. The Irish Flora

No review of this kind would be complete without reference to the past. Much has been written on the history of the Irish flora, its distribution, origins and past study . It is considered that this has been adequately dealt with and summarised in a number of texts for example: Webb. 1983; and Praeger. 1950 and while it is not the purpose of this study to reiterate these earlier writings, their contribution to the general debate, understanding of and perspective on the Irish flora has been invaluable.

However, when examining any aspect of the Irish flora, it is vital that it should be considered in its overall climatic, geographical and geological context. Also - and probably of greater significance than is often recognised - the effect of man's activities: including forest clearance, drainage, the extension of urban areas and all the associated environmental impacts - over the course of time is probably the greatest contributory factor to the formation of habitats as we see them today.

c. Legislation

For conservation measures and the maintenance of biodiversity to stand any chance of success, legal protection of species and habitats is essential. The following is a summary of the existing and proposed legislation as it applies to the flora.

Wildlife Act 1976 : under this Act endangered species of plants are protected under Section 21's provision for ministerial Flora Protection Orders. The most recent was made in 1987 when 68 species of vascular plants were listed. No lower plants were included. A revised FPO is expected to be announced shortly, it is understood that the list includes some species of lower plants (Curtis, pers. comm.). Appendix IX gives a list of species for the 1996 Flora Protection Order, however it will only be included in this report when the Ministerial announcement has been made.

The provision under the Act for National Nature Reserves benefits the flora within their confines. At present there is no legal protection for habitats - with the exception

of nature reserves - though Amendments to the Wildlife Act 1976 are anticipated. These are expected to give legal protection to about 1200 proposed Natural Heritage Area (NHAs). This should be of significant benefit for species of the flora.
In addition, the National Parks and Heritage Areas Bill (currently being drafted), if enacted, will give protection to species occurring within the confines of National Parks (Stapleton, 1996).

Northern Ireland

Endangered species of plants (52 species) are protected at present by the Wildlife (NI) Order 1985 . It is understood that this is due for revision in 1996 (Furphy, pers. comm.). It is not known if lower plant species will be included in any revised list. Areas of Special Scientific Interest and Nature Reserves are protected under the Nature Conservation and Amenity (NI) Order, 1985.

The International Context

EU Directive (No. 92/43/EEC) on the conservation of natural habitats and of wild fauna and flora establishes a common framework for habitats and species throughout Europe with its Special Areas of Conservation (SACs).
The "Natura 2000" network of habitats as proposed under the "Habitats" Directive should contribute to the maintenance and restoration of biodiversity in the EU countries.
The Special Protection Areas (SPAs) set up under the Birds Directive (79/409/EEC) indirectly benefit the plant species within them.

In addition to EU legislation, Ireland is a signatory to a six international conventions of which some are directly of benefit to the flora and others indirectly.

Ramsar - important wetlands - primarily for wildfowl but indirectly benefits the flora. Designated Ramsar sites in Ireland also happen to be national nature reserves.

Bern Convention on the Conservation of European Wildlife and Habitats (1982) - this was the first real attempt to introduce formal measures to protect species and their habitats in Europe.

Rio Convention for the Maintenance of Biodiversity - this was jointly ratified by EU Member States in 1992.

Washington Convention on the International Trade of Endangered Species - CITES. - provisions are implemented by Ireland and ratification is anticipated soon.

The following conventions are mentioned to keep the list complete, though they do not apply to the flora:

Bonn - for migratory species - not directly affecting the flora.

The International Convention for the Regulation of Whaling (1985)

In addition to the conventions and EU habitat legislation, there are two networks of reserves of which there are designated sites in Ireland, these are:

Council of Europe Biogenetic Reserves - requiring fulfilment of specific criteria, there are 14 in the Republic, all of which are national nature reserves and as such have protection under the Wildlife Act, 1976.

UNESCO - Biosphere Reserves - these must fulfil a number of criteria in addition to ecological factors. Research, monitoring, education and social importance are all factors taken into consideration for Biosphere Reserves. Two have been designated in the Republic: Killarney National Park and the North Bull Island,Dublin.

d. Red Data Book Categories

These are calculated on the basis of a number of criteria and reflect the degree of threat to any particular species. Red Data

Books, for the most part from Ireland and Britain, are referred to throughout this study and the categories are more or less consistent throughout - with minor modifications relating to the types of plants and habitats. The categories broadly follow the early IUCN divisions and are (from Curtis and McGough, 1988):

Extinct -

Endangered - in danger of becoming extinct and whose survival is unlikely if the casual factors continue operating. Also included are taxa whose numbers are critically low or whose habitats have been reduced to the extent that they are in danger of extinction.

Vulnerable - taxa which are considered likely to move into the en - dangered category if casual factors continue to operate.

Rare - Taxa with small populations which are not endangered or vulnerable, but are at risk.

Indeterminate - species which are any of the above but there is not enough information to say which category is appropriate.

The IUCN categories have been revised (IUCN, 1994) and there are now ten categories, including subdivisions.

The new IUCN Categories are:

Extinct (EX)
Extinct in the Wild (EW)
Critically Endangered (CR)
Endangered (EN)
Vulnerable (VU)
Lower Risk (LR)
    Conservation Dependent (cd)
    Near threatened (nt)
    Least concern (lc)
Data Deficient (DD).

While Lower Risk - as a single category - is probably a useful one, it is difficult to see how so many categories can be applied to the relatively small floras of Ireland and Britain.

For the moment, at least the Red Data Books are consistent in their approach using the old categories - thus making comparisons and evaluations reasonably straightforward.
It would appear that more work needs to be done on the new categories before they can be readily applied to the Irish situation - ie. that of relatively few species compared with Europe and the rest of the world.

1. VASCULAR PLANTS

1.1. Introduction

Vascular plants include the Pteridophytes (ferns) and the Spermophytes, or seed - bearing (flowering) plants. The latter comprise Gymnosperms (conifers) and Angiosperms -which in turn include the dicots and monocots.

1.2. Native and Introduced Species

1.2.1. Systematics and Diversity

The total number of vascular plants in Ireland is taken as 1309 (Scannell and Synnott, 1987; Curtis and McGough, 1988) which represents and increase of 300 species since the first Census Catalogue was published in 1972 (Scannell and Synnott). This figure of 1309, which includes native plants and those introductions which are regarded as being well - established in the wild, is based on a reasonably complete knowledge of the flora.

815 species are regarded as being native (Webb, 1983), though this is thought to be a conservative figure and that the real native total is nearer to 1000 (Curtis and McGough (1988).

The number of species in Appendix I (table of systematic diversity) when totalled is greater than 1309. This discrepancy can be accounted for by the inclusion in the species figures of some hybrids - for the most part the numbers of hybrids in each family is shown.

Of the total vascular plants in Ireland about 50% of them are widespread throughout Europe. The remaining species make up what is considered to be a number of distinct groups and distributional elements. These are described by Webb (op.cit.) - though some are considered problematic by other botanists - are:

Atlantic - 30 species
Sub - Atlantic - 12 species
Atlantic - Mediterranean - 25 species
Arctic - Alpine - 16 species
Plants with their northern limit in Ireland - - 27 species.
Disjunctly distributed species - 15

The latter do not occur in Britain and have a disjunct distribution - these are listed at Appendix II and shown with their nearest station outside Ireland.

Webb (op.cit.) described the Irish vascular plant flora as impoverished flora and put foreword explanations to account for it - as indeed Praeger had attempted to explain it earlier (1950). Man's activities in particular have contributed greatly to the impoverishment of the flora. For example, forest and woodland clearance throughout history have led to a depletion in species numbers.

Probably the most important point to bring out here is that the significance of Ireland's flora lies, not in the number of species present but in their communities - ie. their ecological groupings. These phyto-sociological associations and their characteristically associated species are described by White and Doyle (1982). The various plant communities associated with raised and blanket bogs are particularly significant both in the Irish context and in the wider european context. Similarly those associated with the Burren in Co.Clare.

In terms of species diversity, Table 1.1. below gives a summary of species numbers in each of the main groups of vascular plants. Appendix I.shows a summary of systematic diversity.

If one compares the Irish figures with those of Britain, it can be seen that Ireland has

almost the same number of fern species as Britain,, while the flowering plants represent 87% of the British total.

Table. 1.1. Summary of Vascular Plant Diversity

	No. genera	No. species
Pteridophytes	33	78
Gymnosperms	3	3
Angiosperms	493	1228
Total number	529	1309

In the wider context, Ireland's flowering plants account for less then 5% of the known species in the world and only 11% of those in Europe as a whole. This belies the fact that many of the communities are ecologically highly significant and despite a relatively poor flora in terms of species numbers, Ireland has a responsibility for the uniqueness of its flora in the widest context.

1.2.2. Conservation and Threats

Legislation has been discussed in general terms in the main introduction to the report above. It has been noted that Under section 21 of the Act there is provision for a ministerial Flora Protection Order, the most recent of which was in 1987 when 68 vascular species were listed.

A revised Flora Protection Order is expected to be announced shortly and is understood to have changed little with regards to vascular plants. (Curtis, pers. comm.1996). Appendix X gives the list of species for the Flora Protection Order. This appendix will be included in the report only when the Flora Protection Order 1996 has been announced by the Minister.

In Northern Ireland listed plants come under the protection of the Wildlife (NI) Order. The most recent of these was in 1985 when 52 species were listed. It is understood that the list for Northern Ireland is also being revised. (Furphy, pers. comm. 1996).

A revised Red Data List for plants species is expected to be published in 1996.

Not all species on the Red List can be protected under the Flora Protection Order (RI) or the Wildlife (NI) Order. There is a need for prioritisation. This is done by evaluating how threatened an individual species is. There are different levels of threat, depending on a variety of factors such as: accessibility, habitat vulnerability - ie. threat from human activities, number of suitable habitats and so on. Species are assigned to categories depending upon the level of threat which they are subject to. These categories include: Endangered, Vulnerable, Rare, Threatened, etc. . All Endangered species were included on the FPO of 1987.s

b. The wider context.

Table 1.2. shows species which occur in Ireland and are listed as rare and threatened in Europe as a whole. All but one of them - *Dryopteris aemula* - is a listed European Red Data Book species. It is so common in Ireland that it was deemed unnecessary to include in the a Red List. Ireland's responsibility for the other species in national and European terms is evident.

Table 1.2. European rare and threatened species which occur in Ireland*

Species	
Dryopteris aemula	common
Deschampsia setacea	P
Eriophorum gracile	P
Hammarbya paludosa	P
Hypericum canadense	P
Najalis flexilis	P
Spiranthes romanzoffiana	P
Trichomanes speciosum	P

*from Curtis and McGough (op.cit.)
P = protected.

In addition, Ireland has one of the Bern Convention's (referred to in the main introduction under international legislation) Annex I species - *Limonium paradoxum*. However this is regarded as a subspecies and the Irish Red Data Book (op cit) notes that other species such as *Hammarbya paludosa* and *Pilularia globulifera* are the most threatened European species found in Ireland - see Table 1.2. above.

In a world context, Stapleton (1996) quotes figures from the IUCN/WWF Plant Advisory Group and states that:

> " as many as 60,000 plant species, approximately one in five of the world's total, are estimated to become extinct by the year 2050 if present trends continue".

Applying the 1 in 5 ratio to Ireland's native vascular flora would result in a loss of some 31 species in the next fifty years.

Europe has some 11,000 species of vascular plants of which 1500 are considered threatened (Curtis and McGough, op.cit). - percentage of threatened species in Europe is >13%. At present Irish vascular threatened species comprise 6% of the native total (815). However, if the European percentage were applied to Ireland this would gives a projected total of threatened species as >110.

The main threats to species are habitat - related. These include: total habitat loss, damage, alteration through land use management changes, constriction of suitable habitat by impinging activities such as developments and so on.

The situation is therefore potentially critical. Urgent conservation measures are needed if this trend is to be at the very least halted, if not actually reversed.

1.3. Others: Aliens, Garden Plants and Commercial Plant Species

1.3.1. Aliens

There are approximately 800 taxa of alien species of vascular plants, of these 300 are considered "established" and are included in the Census Catalogue (Scannell and Synnott, op. cit).

The remaining 540 species are regarded as "casual aliens". These are species include ones found, for example, at ports, on waste ground and on rubbish tips. Species which have escaped from cultivation are also included in this total. An annotated check list of these is currently in preparation (Reynolds, pers. comm. 1996).

1.3.2. Garden and Arboretum Plants

a. General

Information on the numbers of species, cultivars, forms etc. is highly dispersed. (Synnott, pers. comm. 1996). However, there are texts which give an insight into the wide variety of species, cultivars etc. which are in cultivation in Ireland (Nelson, 1984; and Forrest, 1985),

Nelson (op.cit.) examines the history of Irish garden plants including cultivars which have been bred from plants collected from the wild and those developed from exotic stock in Irish gardens - 110 species in all. The Irish Garden Plant Society's the journal Moorea publishes records of new cultivars etc. - for example: Nelson (1989).

Forrest (1985), in her book "Trees and Shrubs Cultivated in Ireland", lists 7000 species (including varieties and forms) of trees and shrubs in cultivation in Irish gardens and arboreta. This total can be broken down as follows:

70 families of dicots
3 families of monocots
8 families of Gymnosperms (230 species in 45 genera).

Forrest (pers. comm. 1996) believes that the total figure now would probably be in the region of 10,000. It should be noted that these figures are for woody plants only.

There are no such figures readily available for herbaceaous species.

b. Gardens and arboreta

Collections were started at different times from the mid - 19th century (Fota and Powerscourt) to more recent times. Each garden and arboretum has records of its collection.

For example, the JFK Arboretum in Co. Wexford holds records of 4,500 taxa including species, varieties, cultivars, down to provenance level of certain forest species - about 200 of which are represented in forest plots. (Kelly, pers. comm. 1996).

The role of gardens and arboreta is an important one in the context of conservation of genetic resource material and in developing new lines. For example daffodils and primulas are currently being bred and new cultivars developed in Northern Ireland.

c. National Collections

In the current National Plant Collections Directory (1996), Ireland is listed as having three such collections of note. Two of them are in the National Botanic Gardens (*Garrya* and *Potentilla fruticosa*) and the third is administered by Fingal County Council at Malahide Castle (*Olearia*). The numbers are:

Garrya: 4 species and 4 cultivars.

Potentilla fruticosa: 60 cultivars.

Olearia: 39 species and 9 cultivars.

These collections are significant resources for genetic material in an international context.

1.3.3. Commercial/ Crop Species

The climate favours the growth of a wide range of crops - grass, cereals and roots, vegetables and fruit. The principal crops are cereals, potatoes and sugar beet. (Byrne, 1995). There is a resurgence of interest in old varieties and breeds, some of which for example were known to be resistant to disease (Appendix III).

Forests are also commercial crops - most species being introduced. The main commercial species used in Irish forests, most of which are intensively managed, are*:

Sitka Spruce	39%
Lodgepole Pine	22%
Norway Spruce	8%
Scots Pine	7%
Japanese Larch	3%
Other conifers	8%
Broadleaves (oak, ash, beech)	13%

*Figures from Thompson, (1995 and pers. comm. 1996).

Commercial and crop species are also included in the section on Genetic Resources below and in Appendix III.

1.4. Genetic Resources.

The International Conference and Programme for Plant Genetic Resources (ICPPGR) Country Report for Ireland (Byrne, 1995) discusses the various issues in some detail. It lists a number of recommendations under the headings of: national needs, policies , legislation and training. The report concludes that indigenous plant genotypes unique to Ireland may exist due its isolation and westerly location from mainland Europe. It states that a national programme to co-ordinate plant genetic resource activities will be undertaken.

Research and development in relation to genetic resources for native and crop species is carried out by a number of institutions.

The ICPPGR report (Byrne, op.cit.) a number of species which are either wild or wild relatives of economic plants which are currently threatened in Ireland. These are listed in Appendix III. Some of these are the subject of work currently being undertaken by Trinity College, Dublin (Martin, pers. comm. 1996; and Martin et al. 1995?) as part of a collaborative project between Trinity College's Botanic Gardens, the

National Botanic Gardens, the National Parks and Wildlife Service and the Irish Genetic resources Conservation Trust (IGRCT) - funded by the Heritage Council.

While much of the commercial development research involves "exotic" commercial species some is carried out on indigenous species.

For example: the in vitro micropropogation of elite indigenous woody species (in this case *Fraxinus excelsior* - Ash) by the BioResearch Ireland in the Department of National Agriculture and Veterinary Biotechnology Centre (Roche, pers. comm. 1996).

Reserves of genetic resources take a number of forms: seed collections, germoplasm banks and plant collections. These are summarised in Appendix III . This list should be regarded more as a guideline than a definitive list. It is possible that there are omissions, though care was taken to follow up all leads given regarding source material. Appendix III does not include the garden plant collections referred to at 1.3.2. above.

In the context of species collected from old pasture ecosystems - see Appendix III, The ICPPGR report (Byrne, op.cit) notes that there are many other species which were not collected, but merit collection. Examples of these are: *Trifolium pratense, Lotus* , *Vicia* and *Lathyrus*.

Information on forest species from Coillte Teoranta (Thompson, 1995 and Pilcher et al 1995) gives details of trials on provenances, clones and progeny over a period of 40 years for 14 species of conifer and 7 species of broadleaf tree species. Forest seed stands and orchards are listed separately in Appendix IV .

1.5. Conclusions

Despite the small size of the country and the relatively low number of vascular plants, that Ireland is of importance in terms of her flora and plant resources cannot be denied.

The significance of the Irish vascular flora lies in the species communities and phytosociological groupings referred to above.

2. BRYOPHYTES

Mosses and Liverworts

2.1. Introduction

Ireland is particularly rich in bryophytes owing to its mild wet climate, and relatively unpolluted atmosphere - a result of our oceanic climate. Bryophyte communities grow in almost every habitat and in many they play an important role. It is not surprising therefore that they came to the attention of botanists at an early date.

The historical aspects of bryophyte study in Ireland are well documented. Praeger (op.cit.) and Stewart and Church (1996) all give summaries of the development of bryophyte study. Hill et al. (1991-1994) in their Atlas of the Bryophytes of Britain and Ireland give a very detailed account of the history, including the individuals involved and their publications from the early days to the present time.

Systematic recording began in the mid - 1800s. The Moss Exchange Club, founded in 1860, gave the impetus needed to present the known distribution on a vice-county basis. As a result of the years of work, the bryophyte flora of Ireland (and Britain) is among the best known in the world, indeed " in its Atlantic bryophyte element, it is not only the richest part of the whole continent, but also one of the richest areas of the world" (Ratcliffe 1968).

Irish bryologists have always been few in number, so that the contribution of visiting bryologists has been very significant. However, this has resulted in somewhat patchy recording since visitors tend to go to the species -rich areas of the western sea - board. This is a recognised problem where recording of species relies to a large degree on visiting experts.

2.2. Diversity

Stewart and Church (op.cit.) note that the Irish and British bryophyte flora combined numbers some 1000 species which represents over 60% of the European flora. This is a far higher proportion than for vascular plants due mainly to the climatic element favouring (ibid).

Table 2.1. summarises the bryophyte diversity in Ireland - figures are taken from the Atlas of the Bryophytes of Britain and Ireland (Hill et al. op.cit.). Figures in ( ) are those given by Praeger in 1950 and are shown for comparison.

Table 2.1. Summary of Bryophyte Diversity in Ireland:

	Families	Genera	Species
Mosses	47	153	533 (410)
Liverworts	40	80	226 (190)
Totals:	87	233	759 (600)

Table 2.2. compares the Irish bryophyte total number of species with those of Britain, Europe and the World. It also shows the percentage of the Irish bryophyte flora in this wider context.

Table 2.2. Ireland's Bryophytes in context: (mosses and liverworts)*

	Ireland	Britain	Europe	World
No. of species	759	1000	1800	>14000
%		75%	42%	>5%

Table 2.3. compares the separate figures for mosses and liverworts for Ireland in a global context and shows the percentage of the known world species which is known to occur in Ireland.

Table 2.3. Mosses and Liverworts - species numbers in a global context.*

	Ireland	World	%
Mosses	533	8000	>6
Liverworts	226	6000	>3

* European and world figures in Tables 2.2. and 2.3. are taken from Groombridge (1992).

The figures cited for Ireland should not be regarded as definitive, but should be examined in the knowledge that there has been less recording in some areas than others.

Appendices V and VI give summaries of systematic diversity for the mosses and liverworts in Ireland - including orders and families.

2.3. Endemics

The following list comprises those species regarded by Hill (op. cit) as being endemic to Ireland. The dates represent when each was originally recorded and / or described is given. ( ) inicates a species new to science.

Oystegus hibernicus - 1867
Fissidens celticus - 1958 (1965)
Fossombronia fimbriata - 1967 (1974)
Anoetangium warburgii - 1871 (1978)
Plagiochila britannica - 1979
Barbula tomaculosa - 1981.

The published "endemics" list in the Atlas of Bryophytes by Hill et al, comprises 19 species - "Irish and British endemics" . The list is described as "motley" by the authors who regard that such a list will look very different in fifty years time! This view would be endorsed by many botanists!
In the list of Irish species above, *Fossombronia fimbriata* does not occur on the European mainland; *Plagiochila britannica* is so far only known in Britain and Ireland,- though it is thought unlikely to prove endemic in the long run; and *Barbula tomaculosa* has not been recorded outside Britain and Ireland and appears to be genuinely rare.

In addition, fifteen native non-endemic Irish bryophytes are absent from continental Europe (though 3 of them occur in the Faroes). Of these fifteen, two do not occur in Britain. Appendix VII lists these species and their distribution outside Europe.

2.4. Conservation and Threats.

The Red Data Book of Britain and Ireland for Bryophytes lists 46 species of liverwort and 146 species of moss in six categories for Ireland. These are summarised in Table 2.4. in comparison with the British Red List, together with percentages expressed in terms of the total bryophyte flora (from Stewart and Church, op.cit.).

Table 2.4. Summary table of Red Data Book Bryophyte Classes.

	Britain		Ireland	
	Liverworts	Mosses	Liverworts	Mosses
Ex	0	16	3	16
I	0	0	2	6
E	7	24	4	13
V	18	46	12	44
R	32	71	24	54
K	0	9	1	13
Total	57	166	46	146
% of bryophyte flora	20%	23%	20%	27%

Ex - extinct. V - vulnerable.
I - indeterminate R - rare.
E - endangered. K - insufficiently known.

Most northern European countries now have Red Data Books for Bryophytes and in all

cases the proportion of the bryophyte which is threatened is between 20% and 30% - ie.as for Britain and Ireland. (Stewart et al 1995). Threats and conservation needs are listed for each species in the Red Data Book.

General threats to the bryophyte flora can be summarised as: over-exploitation, damage and/or destruction of habitat, environmental disturbance, pollution , colonisation of bare soils on rocky slopes by scrub (ie. removal of available habitat suitable for colonising bryophytes.), commercial exploitation etc..

With regards to the Wildlife Act 1976, bryophytes were not included in the list covered by the 1987 Flora Protection Order. However, it is understood that the Draft list for a 1996 Flora Protection Order Wildlife Act of 1976), under consideration at time of writing, includes 13 mosses and 6 liverworts - including two species of threatened European bryophytes, *Drepanoclados vernocosis* and *Petalophyllum ralphsii*.

Regarding an all Ireland context, it is understood that the Wildlife (Northern Ireland) Order 1985 is currently being revised (Furphy pers. comm). It is not known if any bryophytes will be included in the updated list.

2.5. Economic and social importance

The Red Data Book lists many examples of ways in which bryophytes have an economic, commercial or cultural use - a few of which are summarised here.

a. For Ireland probably the most obvious cases are those of fuel (turf and peat briquettes), in domestic and commercial use - including power generation; and peat moss - both originating from *Sphagnum* - dominated bogs.

b. In horticulture - in addition to peat moss, mosses are used in hanging baskets and floral arrangements.

c. Recent pharmaceutical studies have indicated that some liverworts produce cancer -inhibiting chemicals.

d. Historically Sphagnum was used during war -time (First World War) for dressings when there was a lack of cotton, this usage is re-emerging for cases where chemical allergy prevents the use of sterilised dressings.

2.6. Conclusions

Bryophyte communities and species are important and often very evident components in Irish habitats. For example: in western oceanic woodlands where they form a significant part of the ground cover and are abundant as epiphytes; also in raised and blanket bogs where they account for a high proportion of the species present, especially in terms of cover, and often species numbers also. They are important colonisers of bare ground, food plants for herbivores and invertebrates and a source of nesting material for birds.

Bryophytes are potentially very useful indicators as to the longevity and management of ecosystems. The presence of certain species could indicate, for example: that the habitat had not been disturbed for a long period or that there had been recent burning. As such they are very useful tools for the conservationist.

Bryophytes are a significant element of the Irish flora in that they are diverse both in their form, numbers of taxa and in the variety of habitats in which they occur.

Undue emphasis should not be placed on species numbers, but rather the overall contribution to ecosystems by bryophytes. Their importance lies in their abundance rather necessarily the species richness.

Because of their abundance, Ireland has a special responsibility for bryophyte communities. In the past Ireland has relied heavily on the expertise of visiting bryologists, but this has resulted in patchy distributions more attributable to where the botanists went rather than necesssarily where the bryophytes are - paragraph 2.1. above.

3. FUNGI

3.1. Diversity.

Fungi are one of the largest groups of organisms in the world - second only to the insects (Hawksworth 1990). The exact number of fungal species in Ireland, as with the rest of the world is not known.

There have been few attempts to enumerate fungi in Ireland in the past. The first was by Adams and Pethybridge (1910) who note that there had been many studies on fungi but no earlier attempt to enumerate them. They noted that the fungi "embrace by far the largest section of the flora as regards number of species....".

Table 3.1. shows the breakdown of numbers of fungi in each province. Adams and Pethybridge conclude that the total number of 1464 "probably represents less than half the fungal flora as nearly 6000 had already been recorded from Great Britain. It will also be noted that there was a significant difference in numbers from each province - presumably reflecting the areas where studies had been done.

Table. 3.1. Fungi in Irish Provinces*

	M.	C.	L.	U.	Total.
Total:	495	98	1128	562	1464

(*from Adams and Pethybridge, 1910).

The most recent attempts to enumerate the fungi have come from Muskett and Malone (1978 -1985) who catalogue all - a total of 3365 species - with the exception of the Myxomycetes which were subsequently catalogued (Ing and Mitchell 1980) and revised (Ing and McHugh 1988) - 190 species. Table 3.2. gives a summary of fungal diversity based on these sets of catalogue data.

Appendices VIII. and IX show systematic summaries of these figures (- in terms of families and orders in the case of the Myxomycetes).

Table 3.2. Summary of Fungal Diversity in Ireland.*

	Genera	Species
Gastromycetes	20	44
Hymenomycetes	210	1168
Teliomycetes	29	211
Ascomycotina	305	721
Mastigomycotina	36	12
Zygomycotina	22	83
Deuteromycotina	320	1017
Myxomycotina	42	190
Total:	984	3555

* Muskett & Malone(op.cit.); Ing& McHugh(op.cit.)

Despite the largely increased number of taxa it is believed that the fungi are still very under-recorded as a group. Hawksworth (1990) notes than 700 species (globally) were described new to science each year between 1920 and 1950.

Hawksworth (op.cit.) has devised a method of predicting the numbers of fungi present by relating them mathematically and scientifically to the number of vascular plants present . Thus his ratio of vascular plants: fungi of 1: 6 can be applied to the Irish flora to give an indication as to the likely number of fungi present.

If one takes the vascular species total to be 1309 (Curtis and McGough,op.cit.) then the number of fungal species in Ireland would be expected to be in the region of 7800. Which means that only 45% of the total fungal taxa in Ireland have been recorded to date.

That there are many taxa to be found can be readily demonstrated. Recent mycological research in University College Dublin on fungi associated with sheep dung has resulted in the isolation of 100 species, of

which up to 40 are probably new to Ireland (Fuller 1996, personal communication).

Similarly Ing and McHugh (op.cit.) list 28 species of myxomycete new to Ireland since the published catalogue of Ing and Mitchell (ibid) eight years previously, of which two are rare - Cribaria microcarpa (rare in W. Europe) and the (very rare) Diderma sauteri and one - Licea iridis is described as new to science. To cite another instance, research in University College, Galway has found new records of marine Ascomycetes, Fungi Imperfecti (Curran, 1975 and 1995; Hegarty and Curran, 1980 and 1982; O'Flynn and Curran 1994).

Under-recording can be attributed to a number of factors:

a. Some areas are worked more thoroughly than others, particularly by visiting mycologists.

b. Fungi tend to be recorded when the fruiting bodies are visible, so that the effect of seasonability should not be under-estimated (Watling 1994). In northern Europe, for example, there is a concentration of fungal forays in the autumn.

c. Finally, there are too few experienced field mycologists so that identification is often either not possible or unreliable (Orton 1994). Watling (ibid) puts forward a strong case for education at all levels.

To put the Irish fungal flora in context - neighbouring Great Britain has 15000 taxa, compared to a world total to date of 70,000 (Biodiversity, UK Action Plan).

If one applies the 1:6 ratio in a global context, a conservative estimate of 1.5 million fungal taxa would be expected (Hawksworth ibid). Ireland's projected estimate of 7800 species represents approximately 0.5% of the global fungal flora.

3.2. Conservation and Threats.

While no Red Data List exists for Irish fungi there have been a number of publications in recent years relating to conservation and threats in the wider context of Britain, Europe.

Arnolds (1989) published a Preliminary Red Data List of Macrofungi in the Netherlands and Ing (1992 and 1992a) published a list for British fungi. The XIth Congress of European Mycologists' report "Fungi of Europe" includes a significant section entitled Conservation of European Fungi (Pegler et al 1992).

In his paper on the Netherlands Red Data List, Arnolds (op.cit.) lists 944 species, including 91 extinct and 182 directly threatened. He notes that species with a very narrow ecological range are considered as more vulnerable than species with a wide range. He considers that 75% of these belong to the agarics and lists the causes of decline as follows:

i. destruction of habitat;
ii. alteration of habitat;
iii. changes in land management;
iv. effects of agricultural management
v. air pollution.

Air pollution appears to be responsible for the decline in ectomycorrhyzal fungi.There seems to be a consensus that there is a particularly strong decline in species diversity in old grasslands as a result of habitat loss and intensification of farming methods(Arnolds, op.cit.; McHugh 1996 per. comm., Fuller, 1996,op.cit.).

The preliminary Red Data List for Britain (Ing ibid) lists 583 fungal species which are reasonably well understood taxonomically and includes some plant pathogens where the "status of their hosts puts them at risk".

Ing lists the major threats to British fungi as: loss of forest (old deciduous) and old grassland due to change in farming and forest practices; the development of sites and atmospheric pollution.

Orton (1994) believes that Ing's Red Data List is premature and in some ways misleading as " our status of knowledge is

too immature at present to give even a moderately accurate picture". He stresses that what really matters is the diminution or disappearance of the habitat.

Arnolds and de Vries (1992) examined 11 Red Data Lists from Europe which comprised 2984 taxa of macrofungi (2658 basidiomycetes and 326 ascomycetes). They concluded that interpretation of many data was hampered by lack of accurate data on distribution and ecology. They suggested that " ...far more work is needed on these and other topics before a reliable picture of threatened fungi in Europe can be given." On the basis of information available to them the general conclusion was that the overall situation for the mycoflora (fungi) is rapidly deteriorating in large parts of Europe.

3.3. Economic and Social Importance

Historically, Ireland is all too aware of the devastating socio-economic effects of the fungal plant pathogen Phytophthora infestans - potato blight - in the last century which caused the Great Famine. Today it is probably the only pest species in north west Europe for which a national meteorological service gives weather warnings of suitable conditions.

Other pest species include a wide range of pathogens which affect animals and plants (Kavanagh and Brennan, 1993).

The positive perspective is that many species of fungi have greatly assisted man in a variety of ways: baking, brewing, food (mushrooms) pharmaceuticals, vitamins, pesticides and degradation and so on.

A wider environmental use of fungi is discussed by Arnolds (op.cit.) who notes that macrofungi appear to be excellent potential bioindicators, especially in forest ecosystems, and Fellner (1992) who provides evidence of this from the former Czechoslovakia where he has studied the effects of air pollution on forest ecosystems in relation to ectomycorrhiza.

3.4. Conclusions

"Why is fungal diversity significant? The scant attention fungi have received in the biodiversity debate (so far) is due in most cases to a lack of awareness amongst biologists of their significance in evolution, ecosystem function, human progress." (Hawksworth ibid).

There is considerable discussion in the literature as to the significance of fungi in ecosystems - particularly the mycorrhyza. "Most woody plants need them to survive and most herbs need them to thrive" (Cranbrook, 1994). The ability to switch host may be the key to their survival (Watling, ibid). This has wide implications for plant communities such as woods and forests if their fungal symbiotic partners are adversely affected by air pollution.

There may be a role in future for fungi as indicators of environmental change and quality similar to the way in which lichens have been used to date.

The situation with regards to fungal diversity in Ireland is that much work needs to be done - lists cannot be regarded as remotely complete. As has been shown, the present known numbers are only a fraction of the total taxa yet to be found. it is appropriate to quote from Adams and Pethybridge (ibid): "The fungi have not been neglected, - many studies and records.... ....the actual records are still wanting."

Nearly 90 years on little has changed; as it is realised that, in real terms, as regards taxa numbers the scale of the fungi as a group is immense. Their importance in ecological, economic and social terms should not be overlooked.

There is no central database for fungal records, records are currently held by individuals some of whom send them to the British Mycological Society. There is obviously an urgent need for review, co-ordination and standardisation of fungal recording in Ireland.

4. LICHENS

4.1. Introduction

The history of lichenological activity in Ireland is well documented by Praeger (1950) and Seaward (1984 and 1994).

The earliest list is attributed to Threlkeld in 1726 who gave 7 species under the name of lichen, of which it turned out that only one was a true lichen - the remainder being mosses or liverworts. Praeger comments on the poverty of the Irish alpine lichen flora compared with Britain, though concedes that this may in part be due to the lower altitude of Irish mountains also they may not have been thoroughly searched.

Subsequent work has resulted in two Census Catalogues (Seaward 1984 and 1994) and a provisional Red Data List for Ireland (Stewart, 1989).

4.2. Diversity.

Figures for lichen diversity are reasonably up to date. The Census Catalogue of Irish Lichens based on vice-county distribution was published by Seaward in 1994 and lists 1050 taxa in 223 genera. The taxa include 4 subspecies, 13 varieties and 2 forms. In addition the Catalogue lists 25 taxa of lichenicolous fungi and non lichenised fungi in 12 genera.

147 taxa were added to the Irish lichen flora and 56 taxa omitted since the previous Census Catalogue of 1984.

Seaward summarises the records thus:

" 1050 taxa have been recorded from Ireland over the past 300 years, of which less than 10% of the taxa are based on old records; some of these taxa can be presumed extinct since they have not been seen for over a century".

For the purposes of comparison, Table 4.1. shows the number of species in Britain and Europe (Coppins et al. 1996) and shows the percentage of the global figure which is taken to be >17,000. Estimates for the global numbers vary greatly though it is thought that there are probably as many as 20,000 taxa world wide (Groombridge, op.cit.). It should be noted that Ireland, small as it is, has 6% of the world's lichens - a much higher figure than would be expected in terms of land area.

Table 4.1. Summary of lichen diversity:

	Ireland	Britain	Europe
No. of taxa:	1050	1700	5000
% of world	6%	10%	29%

4.3. Conservation and Threats

The Draft Red Data List for Ireland (Stewart ibid) lists possible macrolichen species which were selected as follows:

a. species occurring in less than 10 10km squares - 171 species;
b. species with more records than this, but which have shown a decline of more than 66% - 140 species; and
c. species threatened in Europe but not in Ireland - 34 species.

In addition Stewart lists 564 species of microlichen which are possible Red Data List species. These numbers are not definitive and pre-date the publication of the 1994 Census Catalogue (Seaward, op.cit.).

The Red Data Book for British Lichens - Volume 1 (Coppins et al) is at press at the time of writing this report. 363 species representing 22% of the current checklist for Britain and Ireland are covered in this

publication. If this percentage were extrapolated to Ireland then one might expect a Red Data List in the order of 231 species which is considerably less than listed in the earlier Draft Red Data List for Ireland. It is understood that one lichen species - *Fulgensia fulgens* - is to be included in the forthcoming Flora Protection Order.

A separate Red Data Book is to be published for Ireland as Volume 2. of the Lichens (Red Data Books of Britain and Ireland). The projected publication date for this is 1997. From the figures above it appears that a considerable amount of work needs yet to be done.

The British Biodiversity Action Plan (1994) lists the following habitats as being of particular importance for lichens: broad-leaved and yew woodland, native pine woodland, lowland wood pastures and parkland, calcareous grasslands, lowland heathland, rivers and streams, montane, upland heath, maritime cliff and slope, shingle above the high tide mark, boulders and rock above the high tide mark, machair, sand dune and limestone pavements. Many of these would apply to the Irish situation also.

The threat depends greatly upon the habitat involved. For example mountain and cliff habitats are far less at risk than lowland woodland adjacent to intense agriculture or industry. Pollution from these sources - particularly aerial nitrogen inputs - are probably the greatest threat to the lichen flora.

Lichens have been known to be sensitive to air pollution for many years and have been used extensively as bio-indicators for air quality.

4.4. Conclusions:

With almost 30% of the European taxa, Ireland's lichen flora is quite significant since the land area is relatively very small.

It is interesting to note that 34 of the Irish species are regarded as threatened in Europe. That lichens are highly sensitive to aerial pollutants is a well -established fact. This may account for the presence of certain species in greater abundance than in continental Europe where air pollution levels would generally be far higher. Ireland's geographical position on the north -west fringe of Europe almost certainly has a bearing on this.

Since they are combinations of algae and fungi, lichens display properties of both and to some degree conclusions drawn regarding the other two groups would apply to lichens also.

5. ALGAE

5. 1. Introduction

Algae are a vast and diverse group in terms of number, form and habitat, comprising macro- and micro-algae (including phytoplankton). Adams (1908) notes that Ireland is particularly suited to the growth of algae, combining climate and a wide variety of suitable habitats.

Both Adams (op.cit.), and Praeger (op.cit.) refer to algal records dating back to Threlkeld, 1726, and Harvey, in 1836.

The status of some groups, for example the marine macro-algae - the seaweeds are reasonably well known but not definitive. The main problems with systematics occur within the micro-algae whose status in terms of species diversity is not known. (Ottway, 1996 ,pers. comm.).

For the purposes of this report marine and freshwater algae are dealt with separately.

5. 2. Marine Algae

5.2.1. General

Ireland's long coastline with its variety of habitats, has long been the subject of studies of marine algae.

There is reasonably reliable information on the seaweeds with regard to their numbers, though different sources vary slightly - presumably due to taxonomic changes. Detailed information on this is not available at the time of report preparation

In addition to the historical sources noted in 5.1. above, and other more localised studies eg. Cullinane (1950), there are two main recent sources for marine macro-algae in Ireland. These are Guiry and Morton.

Guiry (1996 - pers. comm.) has produced a checklist of northern European species and their distribution, this has been regularly up-dated over a number of years,it is as yet unpublished and is on the Internet.

Information on marine phytoplankton comes largely as a result of a research on coastal waters, often in the context of fisheries and aquaculture. As a group they are very important, being responsible for nearly all the primary production in the sea. (Raine et al, 1993)

Marine phytoplankton are regarded as being more or less ubiquitous in distribution within large areas of the sea, for example the temperate North Atlantic or European waters. Often they occur in such small numbers that they are virtually undetectable, but when conditions are suitable the populations will develop and grow, often exponentially - hence the algal blooms caused by some species. As a result of this their measurable abundance may vary dramatically. (Ottway, 1996; Roden,1984). They are known to develop characteristic patterns in Irish coastal waters in the summer. These patterns relate to water column stability - thermal stratification in particular - and in certain parts of the coast, tidal mixing, and up-wellings. (Roden et al 1987; Raine et al, 1990; Raine et.al.1993; McMahon et al, 1995;)

5.2.2. Diversity

The earliest record of species numbers referred to by Adams (op. cit.) is that of 12 seaweeds listed by Threlkeld. A summary of Harvey's -1836 - (from Adams, op.cit.) and Adam's own figures for marine algae are shown in Table 5.1. for comparison with the recent estimates for Ireland, 1979 and 1996 (Guiry op.cit.) and Morton (1994).

The + and - signs below the 1996 figures indicate the changes in numbers since 1979 (Guiry, op.cit.). The Cyanophyta, or blue/green algae are included here for

convenience, though they are not strictly regarded as marine species. For this reason they are not included in the totals.

The dates and initials on the left hand side of the table indicate the various sources listed here.

Table 5.1. Marine algae 1836 to 1996

	C	P	R	Total*	Cy
1836(H)	28	63	111	202	9
1908(A)	79	120	229	428	31
1994(M)	83	143	267	493	
1979(G)	87	147	246	480	
1996(G)	83	147	294	524	26
	-4	0	+48	+44	

Key: C - Chlorophyta (Green)
P - Phaeophyta (Brown)
R - Rhodophyta (Red)
Cy - Cyanophyta (Blue/Green)
* does not include the Cyanophyta

Guiry accounts for the differences in the figures from 1979 and 1996 as follows:

The decrease in the number of Chlorophyta is attributable to taxonomic changes. The 8% increase in species of Rhodophyta is largely due to the work done by Guiry's team at University College, Galway over a period of twenty years and includes at least one or two undescribed species.

In addition to the above, Guiry's checklist includes 10 species of *Vaucheria* which might be regarded as marine species since they occupy brackish habitats.

The Fisheries Research Centre of the Marine Institute (Dept. of the Marine) regularly check water samples from 50 locations in Irish coastal waters. This monitoring is done to detect the presence of toxic or harmful blooms (see 5.2.4. below). All species of phytoplankton found in these samples are recorded in a data base.

From these records 181 species from 63 genera have been noted over a ten year period. (McMahon and Silke ,1996)

Despite the recent monitoring work and historical studies, it is not possible to make a definitive statement on the status of species diversity in marine phytoplankton.

Species diversity relating to algae in comparative terms beyond Ireland is discussed below in paragraph 5.4 of this chapter.

5.2.3. Conservation and Threats

Without an overall idea of the status of species diversity in marine algae it is not possible to comment on their conservation status. However the main threats to marine algae, in particular the micro algae are known..

i. Ozone depletion; many species are very UV sensitive and the levels of ozone depletion which are being recorded will inevitably affect some species (Ottway, op.cit).

ii. Introduction of "exotic species" species probably in ballast water which is jettisoned when ships take on a cargo. There are examples of species moving from one hemisphere to the other (both directions) and as with many other introductions these have displaced other species. One such species is the dinoflagellate *Gyrodinium areolum*, unknown in Europe before 1970, now a dominant organism in the summer plankton off the south and west coasts of Ireland (and elsewhere in Europe), which causes significant mortalities in marine organisms
(Ottway).

iii. Pollution: on a regional scale (sea areas involved - para. 5.2.1. above) this is too localised to have any real impact on micro-algal diversity apart from initial local effects (Ottway).

5.2.4. Economic and Social Importance.

As primary producers algae are a food source for the herbivores of the marine ecosystems so that in terms of the food chain they are of economic importance in the fishery industry,

The usage of seaweeds in agriculture (as fertilizer), as food, in food products (Carrigeen, agar etc) and for animal fodder (seaweeds mixed with potatoes) in the past is well documented. (Brennan ed., 1950).

Currently seaweeds are experiencing a resurgence in this context, also in commercially produced food, industrial and health products.

Unfortunately not all the economic effects are positive. There have been a number of references in the preceding paragraphs to the adverse effects of some noxious species of marine micro-algae/ phytoplankton. Silke and Jackson (1993) studied harmful and nuisance algal blooms in Irish coastal waters and identified a number of species which are toxic to shellfish and fin fish. For example, mortalities of farmed salmonids, littoral and sub-littoral organisms in Irish waters have been attributed to *Gyrodinium aureolum*. A recently identified flagellate - probably *Heterosigma akashiwo* - first described in Japan - has been known to cause fish kill on the west coast of Ireland.

5.3. Freshwater and Terrestrial Algae

5.3.1. General

Freshwater algae are ubiquitous, occurring wherever there is a body of freshwater, large or small, which is exposed to sunlight. Habitats include ponds, lakes, rivers, streams, ditches, puddles and man-made habitats such as canals, quarry pools, drainage channels etc. Their importance lies in their role as primary producers, often the only ones present.

Terrestrial algae,which occur on the surfaces of soil, walls and buildings etc. - are probably the least known assemblage (John, 1994).

There is no shortage of studies on freshwater algae in Ireland, to a large extent by British - based scientists.

An early attempt to quantify freshwater algal groups was made by Adams (op.cit.). The subsequent scientific literature is rich in papers, however virtually all the studies have been very localised - albeit quite comprehensive in many cases, for example the Clare Island Survey (West and West 1912 and John et al. 1990) and the Lough Neagh (Wood and Smith, 1993 and Gibson, 1993.) or they have concentrated on specific groups of species in particular locations. For example, a series of studies in the 1950s on the phytoplankton in Irish loughs (Brook, 1958 Round, 1959; Round and Brook, 1959;).

Some of these studies were taxonomically - based while others were related to trophic status of which algae are good indicators (Ottway, op.cit.).

John (1994) notes that the "majority of freshwater algae are of microscopic size and many are poorly understood because of uncertainties surrounding what constitutes a species. Difficulty in accurately identifying algae remains one of the principal reasons for the lack of reliable information on their occurrence and distribution.."

The consensus seems to be that the only group of freshwater algae about which we know sufficient to comment on diversity and conservation status at this time is the Charophyta, the Stoneworts. (personal communications from: Caffrey; John; Ryan; Wood; Morton, 1996; and Whitton per Morton 1994). The Stoneworts, are probably the most easily identified group of algae which, because of their growth form, were originally thought to be types of *Equisetum*.

A checklist of freshwater algae in the British Isles as a whole is currently being drawn up for the British Freshwater Algal Flora Project (John,1996). However, Irish records are not

being distinguished from the others so that, while the checklist will be useful in broad terms and in the absence of any until now, it cannot be of specific use to Ireland.

5.3.2. Diversity, Conservation and Threats

The only current figures available for biodiversity in freshwater algal groups are those relating to the Charophytes or Stoneworts. The Red Data Book for Stoneworts of Britain and Ireland (Stewart and Church ,1992) gives comparative figures for each category of Red List species in the context of the Stonewort floras of both Britain and Ireland.These figures are shown in Table 5.2. below.

About 400 taxa of Charophyte are recorded worldwide, though Stewart and Church note that this probably represents no more than 250 species - presumably allowing for taxonomic changes and interpretation.

33 Charophyte species are known from Britain and Ireland - 13% of the world's species if one takes the global figure to be 250. Ireland has 25 species given a global percentage of 10%.

Table. 5.2. Summary List of RDB* Statuses

	Number of species	
	Ireland	Britain
Extinct	2	2
Endangered	0	2
Vulnerable	5	7
Rare	3	3
Indeterminate	2	2
Insufficiently known	0	1

48% (12 out of 25) of the Irish Stonewort flora is in the RDB.
57% (17 out of 30) of the British Stonewort flora is in the RDB.
*Stewart and Church (1992).

Two stoneworts will be included in the forthcoming Flora Protection Order.

With regards to other groups, Ottway (1996) - who regards desmids as a key group as indicators when monitoring water quality - estimates there are perhaps between 700 and 1000 species of desmid in Ireland.

Figures, even conjectured, are not available for other groups.

Impacts to freshwater algae include both threats and benefits:

Changes in water quality:

pollution (nitrates, phosphates and acid rain effects);
salinity (in the case of those species which prefer brackish water in which the salinity levels can be critical);

Habitat destruction;

Physical disturbance :
damaging: dredging, boating, water level changes;

beneficial: creation of open habitats.

Some of the above would have greater impact on some groups than others. For example, physical disturbance such as dredging would have longer lasting effects on the Charophytes than say on phyto-plankton species.

In the case of some micro-algal species, ozone depletion and consequent increases in UV radiation is probably detrimental (Ottway pers. comm., 1996).

In general conservation terms, and regarding freshwater algae other than Charophytes, the comments made by John (op.cit) in his "Prospectus for a Plant Conservation Strategy - Freshwater Algae" on the situation in the U.K. are equally applicable to the Irish situation and are an appropriate way to end this section.

" The algal flora of freshwater systems remains under described and under sampled, and consequently knowledge of their distribution, abundance and conservation status is at an early stage". (John, 1994)

5.4. Conclusions - algae.

Generally speaking it is not wise to attempt to estimate overall species diversity relating to algae since our knowledge is limited. As reported above, global figures available for species diversity tend not to differentiate between marine and freshwater algae which makes comparisons impossible.

With this in mind, any attempts to compare species numbers in the wider context is unwise with the exception of the two groups for which there is more information - the Seaweeds and the Charophytes. The reason for this greater knowledge is probably two - fold. They are larger - hence more easily found and for most cases, more readily identified. As John (op.cit.) commented: "Difficulty in accurately identifying algae remains one of the principal reasons for the lack of reliable information on their occurrence and distribution.."

What can be said with certainty is that the algae form a large group within the plant kingdom. We have seen above that they are ecologically and economically a very significant group - particularly the micro-algae or phytoplankton.

There appears to be a desperate need for study and the drawing together of records. Ireland needs a central records facility, not just for the algae but other groups of lower plants too.

6. CONCLUSIONS

Where there have been conclusions to be drawn for the above groups individually these have been included in the text above. The purpose of this section is to focus on the overall picture in the context of what has been presented so far.

One overriding fact appears time and again. This is that the number of taxa in Ireland for any given group of plants is low in comparison to our neighbours, but in some groups it is clearly rich, eg. bryophytes and stoneworts. In the case of most taxa it is appreciably lower than our immediate neighbours and only a fraction of European totals. (see Table 6.1) below.

Table 6.1. Comparative Species Numbers

	Irl.	GB.	Europe	World
Vascular	1309	1400	12500	>260,000
Bryophytes	759	1000	1800	>14,000
Lichens	1050	1700	5000	>17,000
Fungi	unknown	>15,000	unknown	?>70,000
Algae	"	>20,000	"	?>40,000
(Stone -worts)	25	30	"	440

Figures for fungi and algae are probably much higher than those shown above and as such it is probably not fair to make comparisons.

Throughout the literature there are references to climate, geology, human influences and environmental factors. All are considered to contribute in some way to the "impoverished" flora of Ireland. The human influence has been the greatest and most wide-ranging: from the early days of forest clearance, to drainage; land reclamation; land and water pollution and so on.

It seems that one single fact is generally overlooked in this debate - that of relative land area. Table 6.2. below shows the relative land areas for Ireland, Britain and Europe. In this case Europe is taken as the accepted geographical region - not the European Community.

The land area of Ireland is less than 36% that of Britain and less then 1% of

Europe. Yet in terms of species for the various groups known figures are much higher - > 75% compared with Britain; and up to 40+% eg. the bryophytes, in European terms.

Table.6.2. Relative Land Areas - (sq.kms.)

Ireland	82,375
Britain	230,287
(England	130,763)
(Scotland	78,762)
(Wales	20,762)
Europe	10,400,000

So perhaps when comparing numbers of species the land area factor should not be forgotten, as this indicates the available area for habitat types is in turn much lower. In the context of being less than 1% of the land area of Europe, but with a far higher percentage of species - relatively to land area - Ireland can be seen to have a significant role to play in the conservation of species.

A factor of course, which is not evident from figures such as these, is the actual area of land available to species and habitats.

That some species are at greater risk than others is indisputable. Where figures are available for endangered species they have been presented in relevant the sections above.

It is difficult - and even dangerous - to make

comparisons when numbers are not certain or unknown. For example in the case of the lichens, where the draft Red Data Book lists predates the latest Census Catalogue and , if taken at face value, would indicate an extremely high percentage of endangered species - which is unlikely. For this reason no attempt has been made to draw conclusions of this nature.

However there are points which are can be made and are generally acknowledged.

These can be summarised as follows:

a. Much more work is needed, in particular in the lower plants - fungi, algae and to some extent lichens, before Ireland can make any informed statement as to the status of these groups. (To a much lesser extent the bryophytes should also be included here, largely owing to the history of patchy recording).

b. Ireland must fulfil its obligations at national and international levels regarding the conservation of species and habitats - legislation is eagerly awaited.

c. There is a strong case for a centrally coordinated approach to the collection and collation of species records for lower plant groups in Ireland. A properly resourced central records data -base for all plant species is essential if species diversity is to be properly monitored

d. There is a desperate need for expertise in field recording - especially for Irish experts. Recording in the past has been done by visitors who tend to concentrate on particular areas of "botanical interest" - resulting in patchy distributions eg. for the bryophytes.

However, it must be said that without the input of visiting botanists our state of knowledge of the Irish Flora would be much worse than it is at present.

7. SOURCES

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Forrest, M. Dept. of Crop Science, Horticulture and Forestry, UC D.
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Hennerty, M. Dept. of Crop Science, Horticulture and Forestry, UC D.
John, D. Dept. of Botany, Natural History Museum, London.
Kelly, C. J.F.K. Aboretum, Co. Wexford.
McHugh, R. D.I.T. College of Catering, Cahal Brugha Street,Dublin 1.
McMahon, T. Fisheries Research Centre, Marine Institute, Abbotstown.
Martin, J. Dept. of Botany, Trinity College, Dublin.
Mitchell.M. Galway
Morton. O. Dept. of Botany, Ulster Museum, Belfast.
O'Keeffe, K. National Parks and Wildlife Service, Dublin 2.
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APPENDIX

APPENDIX I.

Vascular Plants: a summary of systematic diversity*.

	Family	Genera	Species (+ = subsp.)
PTERIDOPHYTA			
Lycopsida			
	Lycopodiaceae	4	4
	Selaginellaceae	1	2
	Isoetaceae	1	2
Sphenopsida			
	Equisetaceae	1	8 & 5 hybrids
Filicopsida			
	Ophioglossaceae	2	3
	Osmundaceae	1	1
	Adiantaceae	2	2
	Hymenophyllaceae	2	3
	Polypodiaceae	1	4 & 3 hybrids
	Hypolepidaceae	1	1
	Thelypteridaceae	3	3
	Aspleniaceae	3	9 + 3 & 3 hybrid
	Athyriaceae	4	5
	Aspidiaceae	3	11 + 4 & 5 hybrids
	Blechnaceae	1	2
	Marsileaceae	1	1
	Azollaceae	1	1
SPERMATOPHYTA			
Gymnospermae			
Coniferopsida			
Coniferales			
	Pinaceae	1	1
	Cupressaceae	1	1+2
Taxopsida			
Taxales			
	Taxaceae	1	1

* Source: Scannell and Synnott (1987).

Appendix I (cont.). ii. Vascular Plants: a summary of systematic diversity.

Family	Genera	Species (+ = subsp.)
SPERMATOPHYTA		
Angiospermae		
Dicotyledones		
Salicales		
Salicaceae	2	16 + 5 & 20 hybrids
Myricales		
Myricaceae	1	1
Fagales		
Betulaceae	2	4 & 2 hybrids
Corylaceae	2	2
Fagaceae	3	5 & 1 hybrid
Urticales		
Ulmaceae	1	3
Cannabaceae	1	1
Urticaceae	3	4
Polygonales		
Polygonaceae	6	33 + 1 & 5 hybrids
Centrospermae		
Chenopodiaceae	8	23 + 1 & 2 hybrids
Aizoaceae	2	2
Portulacaceae	1	3 + 4
Caryophyllaceae	14	42 + 4 & 1 hybrid
Ranales		
Nymphaceae	2	2 + 1
Ceratophyllaceae	1	1
Ranunculaceae	7	28 + 4
Berberidaceae	1	1
Rhoeadales		
Papaveraceae		
subfamily Papaveroideae	4	9
subfamily Fumarioideae	2	8 + 2
Cruciferae		
(Brassicaceae)	34	62 + 2 & 6 hybrids
Resedaceae	1	3
Sarraceniales		
Sarraceniaceae	1	1
Droseraceae	1	3 & 1 hybrid

Appendix I (cont.). iii. Vascular Plants: a summary of systematic diversity.

	Family	Genera	Species (+ = subsp.)
Angiospermae			
Dicotyledones			
Rosales			
	Crassulaceae	4	10
	Saxifragaceae	3	14 & 3 hybrids
	Parnassiaceae	1	1
	Escalloniaceae	1	1
	Grossulariaceae	1	3
	Rosaceae	20	75 + 4 & 35 hybrids Rubus / microsp. 78 (Rosa - hybrids 31)
	Leguminosae (Fabaceae)	14	50 + 7 & 1 hybrid
Geraniales			
	Oxalidaceae	1	4
	Geraniaceae	2	17 + 2
	Linaceae	2	3
	Euphorbiaceae	2	10 & 1 hybrid
Rutales			
	Polygalaceae	1	2
Sapindales			
	Aceraceae	1	3
	Hippocastanaceae	1	1
	Balsaminaceae	1	1
	Aquifoliaceae	1	1
Celastrales			
	Celastraceae	1	1
Rhamnales			
	Rhamnaceae	2	2
Malvales			
	Tiliaceae	1	- & 1 hybrid
	Malvaceae	3	5
Thymelaeles			
	Elaeagnaceae	1	1
Guttiferales			
	Guttiferae (Hypericaceae)	1	11 + 1 & 1 hybrid

Appendix I (cont.).iv. Vascular Plants: a summary of systematic diversity.

	Family	Genera	Species (+ = subsp.)
Angiospermae			
Dicotyledones			
Violales			
	Violaceae	1	11 + 3 & 6 hybrids
	Cistaceae	2	3
	Elatinaceae	1	2
Myrtales			
	Lythraceae	1	2
	Onagraceae	4	16 & 13 hybrids
	Haloragaceae	2	4
	Hippuridaceae	1	1
Umbellales			
	Cornaceae	1	2
	Araliaceae	1	1
	Umbelliferae (Apiaceae)	29	43 + 1 & 1 hybrid
Ericales			
	Pyrolaceae	3	7 + 1
	Ericaceae	10	18 & 2 hybrids
	Empetraceae	1	1
Primulales			
	Primulaceae	6	12 & 1 hybrid
Plumbaginales			
	Plumbaginaceae	2	5 + 3
Oleales			
	Oleaceae	2	2
Gentianales			
	Gentianaceae	5	8
	Menyanthaceae	2	2
	Rubiaceae	5	14 & 1 hybrid
Tubiflorae			
	Convolvulaceae	3	6 + 1
	Boraginaceae	11	16 + 1 & 1 hybrid
	Verbenaceae	1	1
	Callitrichaceae	1	7 + 2
	Labiatae (Lamiaceae)	22	42 + 3 & 8 hybrids

Appendix I (cont.). v. Vascular Plants: a summary of systematic diversity.

Family	Genera	Species (+ = subsp.)
Angiospermae		
Dicotyledones		
Tubiflorae (cont.)		
Solanaceae	5	8
Buddlejaceae	1	1
Scrophulariaceae	22	61 + 7 & 5 hybrids
Orobanchaceae	1	4
Lentibulariaceae	2	7 & 1 hybrid
Plantaginales		
Plantaginaceae	2	6
Dipsacales		
Caprifoliaceae	5	7
Adoxaceae	1	1
Valerianaceae	3	7
Dipsacaceae	3	3
Campanulales		
Campanulaceae	4	7
Compositae		
(Asteraceae)	48	90 + 2 & 6 hybrids
	1	77 microsp. in 11 sections.
sub.genera	2	49 + 11
Monocotyledones		
Alismatales		
Alismataceae	3	4
Butomaceae	1	1
Hydrocharitaceae	4	5
Scheuchzeriaceae	1	1 (extinct)
Juncaginaceae	1	2
Potamogetonaceae	3	18 & 11 hybrids
Zosteraceae	1	3
Zannichelliaceae	1	1
Najadaceae	1	1

Appendix I (cont.). vi. Vascular Plants: a summary of systematic diversity.

	Family	Genera	Species (+ = subsp.)
Angiospermae			
Monocotyledones			
Liliales			
	Liliaceae	7	14 + 2
	Amaryllidaceae	2	1 & 1 hybrid
	Dioscoreaceae	1	1
	Pontederiaceae	1	1
	Iridaceae	3	5
Juncales			
	Juncaceae	2	23 & 3 hybrids
	Eriocauliaceae	1	1
Graminales			
	Graminae (Poaceae)	45	104 + 13 & 8 hybrids [1 generic cross & 4 hybrid spp.]
Spathiflorae			
	Araceae	3	4
	Lemnaceae	2	4
Pandanales			
	Sparganiaceae	1	4 + 4
	Typhaceae	1	2
Cyperales			
	Cyperaceae	8	77 + 7 & 16 hybrids
Orchidales			
	Orchidaceae	16	30 + 10 & 10 hybrids [1 generic cross & 3 hybrid spp.]

APPENDIX II

Species which are considered to belong to various biogeographical groups .*

Species	Nearest Station outside Ireland	Minimum disjunction km.
Neotinea maculata	Isle of Man	350
	N. Spain	1000
Simethis planifolia	Brittany	550
Arbutus unedo	Brittany	550
	W. France	950
Inula salicina	Normandy	700
Daboecia cantabrica	W. France	900
Saxifraga spathularis	N.W.Spain	900
Pinguicula grandiflora	W.Spain (Asturias)	950
Saxifraga hirsuta	N. Spain (Asturias)	950
Erica erigena	Near Bordeaux	1100
Erica mackaiana	N.W.Spain, (E. Galicia)	1100
Minuartia recurva	N.E. Portugal	1100
Euphrasia salisburgensis	Vosges	1250
Arenaria ciliata	Jura	1350
Hypericum canadense	Newfoundland	3250
Sisyrhynchium bermudiana	Newfoundland	3250

*from Webb (1983).

APPENDIX III

Summary of Plant Genetic Resources in Ireland*

Species/Crop	Nature of Resource	Institution/Organisation	Notes
Potato (*Solanum tuberosum*)	Breeders' collection - Germoplasm.	Teagasc, Oak Park	
Potato	In vivo collection of old varieties.	Dept. Agric., Food & Forestry. in Co.Donegal	
Wheat (*Triticum aestivum* + inter specific & intergeneric hybrids).	Germoplasm 20,000 lines of N.W.European & exotic origin.	UCD, Dept. Agric.	Wheat breeding programme
Field Bean Vicia faba	Germoplasm	Formerly UCD, Dept. of Agric. now the State Department of Agriculture	Concern expressed re: future of this resource.
Forage species:	Germoplasm No. accessions	Teagasc, Oak Park.	collected from old pasture ecosystems.
Lolium perenne	535		
Phleum pratense	27		
Dactylis glomerata	55		
Festuca pratensis	7		
Festuca arundinacea	5		
Festuca rubra			
Trifolium repens	78		
Trifolium dubium	2		
Malting Barley	Germoplasm	Dept. Agric./Guinness	Collection of old varities of Irish origin and breeder's lines.

*Sources: see end of table.

Appendix III. (continued): Summary of Plant Genetic Resources in Ireland *

Species/Crop	Nature of Resource	Institution/Organisation	Notes
Fruit - Commercial: collections of:		UCD. Dept. of Crop Science, Horticulture and Forestry.	
Apples, Pears, Plums, Grapes, Strawberries, Black & Red Currants, Blueberries, Raspberries, Gooseberries, and Hybrid Berries.			
Fruit - Old Varieties:		UCD. Dept. of Crop	Lambe-Clarke
Apples	40 varieties	Science, Horticulture & Crop Science/Irish Seed Savers Assoc.	Irish Historical Apple Collection.
Vegetables and Garden flowers	No. of: varieties	Irish Seed Savers Association	from catalogue of seed available.
Beans	7		
Cabbage	1		
Kale	1		
Lettuce	4		
Maize	1		
Melon	2		
Onion	2		
Peas	2		
Potatoes	8		
Squash	3		
Tomatoes	6		
Herbs	6 spp.		
Flowers	6 spp. many vars.		
Vegetables and Garden flowers		Irish Branch of the Henry Doubleday Research Association	Details not available.
Forest Species:	Germoplasm	Coillte Teo.	Germoplasm Collection. Thousands of provenances, clones and families.
Conifer	14 species.		
Broadleave	7 species.		

*Sources: see end of table.

Appendix III. (continued): Summary of Plant Genetic Resources in Ireland *

Species/Crop	Nature of Resource	Institution/Organisation	Notes
Rare and Threatened Species (common name):	seedbank	Irish Genetic Resources Conservation Trust/ Nat. Botanic Gardens/ Trinity College, Botanic Gardens.	Threatened Irish seed bank. + - those species targeted for seed collection by the IPGRG.
+Allium schoenoprasum(Chives) +Asparagus officinalis subsp.prostratus (Wild Asparagus) +Avena strigosa (Bristle Oat) +Bromus racemosus (Smooth Brome) +Colchicum autumnale (Meadow Saffron) +Crambe maritima (Sea Kale) +Hordeum secalinum (Meadow Barley) +Hyoscyamus niger (Henbane) +Lathyrus japonicus (Sea pea) +Ligustrum scoticum (Scot's Lovage) +Lolium temulentum (Darnel)			These species are wild or wild relatives of economic plants.
Mentha pulegium (Pennyroyal Mint) Pyrola media (Intermediate Wintergreen) Pyrola minor (Common Wintergreen) Pyrola rotundifolia (Round-leaved Wintergreen) Potentilla fruticosa (Shrubby Cinquefoil) Salvia verbenaca (Wild Sage) Trifolium glomeratum (Clustered Clover) Trifolium subterraneum) (Subterranean Clover) Vicia lathyroides (Spring Vetch) Vicia orobus (Wood Bitter Vetch).			

* Sources: Martin; Walshe; Hennerty; Connolly; Hayes; and Thompson - (1996 -personal communications);
Byrne, I. (1995.op.cit.) Thompson, D. (1995 .op.cit)

APPENDIX IV.

Seed Production Areas - forest species*

Registered Seed Stands

Species	No. of Stands	Area (ha.)
Sitka Spruce	68	852
Norway Spruce	16	182
Beech	7	48
Scots Pine	24 stands + 2 seed orchards	215
Sessile Oak	14	561
Pedunculate Oak	10	198
Total		1960 ha.

Seed Orchards

Species	No. of Orchards	Area (ha.)
Lodgepole Pine	4	12.0
Scots Pine	3	5.8
Douglas Fir	1	0.5
Japanese Larch	2	1.5
European Larch	1	2.0
Hybrid Larch	1	1.0
Beech	1	2.0
Total		24.8 ha.

*from Coillte Teo (Thompson, 1995)

APPENDIX V.

Mosses : a summary of systematic diversity*.

	Family	Genera	Species
Sphagnopsida			
Sphagnales			
	Sphagnaceae	1	28
Andreaeopsida			
Andreaeales			
	Andreaeaceae	1	4
Bryopsida			
Polytrichideae			
Tetraphidales			
	Tetraphidaceae	2	2
Polytrichales			
	Polytrichaceae	4	15
Buxaumiideae			
Buxbaumiales			
	Buxbaumiaceae	1	1
Eubryideae			
Archidiales			
	Archidiaceae	1	1
Dicranales			
	Ditrichaceae	4	11
	Selageriaceae	3	9
	Dicranaceae	11	43
	Leucobryaceae	1	2
Fissidentales			
	Fissidentaceae	2	21
Encalytales			
	Encalytaceae	1	5
Pottiales			
	Pottiaceae	23	82
Grimmiales			
	Grimmiaceae	4	31
	Ptychomitriaceae	3	3
Funariales			
	Disceliaceae	1	1
	Funariaceae	3	7
	Ephemeraceae	1	4
	Oedipodiaceae	1	1
	Splachnaceae	3	5
Schistostegales			
	Schistostegaceae	0	0

Appendix V. (cont.).

Mosses : a summary of systematic diversity*.

	Family	Genera	Species
Bryopsida			
Eubryideae			
Bryales			
	Bryaceae	8	59
	Mniaceae	4	13
	Aulacomniaceae	1	2
	Meesiaceae	2	2
	Catoscopiaceae	1	1
	Bartramiaceae	5	11
	Timmiaceae	1	2
Orthotrichales			
	Orthotrichaceae	4	24
	Hedwigiaceae	1	2
Isobryales			
	Fontinalaceae	1	2
	Climaciaceae	1	1
	Cryphaeaceae	1	1
	Leucodontaceae	3	3
	Myuriaceae	1	1
	Neckeraceae	3	5
	Thamniaceae	1	1
Hookerales			
	Hookeriaceae	2	2
	Daltoniaceae	1	1
Thuidiales			
	Theliaceae	1	1
	Fabroniaceae	0	0
	Leskaceae	2	2
	Thuidiaceae	3	9
Hypnobryales			
	Amblystegiaceae	9	37
	Brachytheciaceae	10	37
	Entodontaceae	2	3
	Plagiotheciaceae	4	14
	Sematophyllaceae	1	2
	Hypnaceae	9	19

* from Hill et al. (1992 & 1994)

APPENDIX VI

Liverworts : a summary of systematic diversity*.

	Family	Genera	Species
Hepaticae			
Jungermanniideae			
Calobryales			
	Haplomitriaceae	1	1
Jungermanniales			
	Lepicoleaceae	1	1
	Herbertaceae	1	1
	Pseudolepicoleaceae	1	1
	Trichocoleaceae	1	1
	Lepidoziaceae	4	10
	Calypogeiaceae	1	8
	Adelanthaceae	1	2
	Cephaloziaceae	5	16
	Cephaloziellaceae	1	9
	Antheliaceae	1	2
	Lophoziaceae	9	28
	Jungermanniaceae	3	14
	Gymnomitriaceae	2	9
	Scapaniaceae	3	20
	Geocalycaceae	6	9
	Plagiochilaceae	2	10
	Amelliaceae	1	1
	Acrobolbaceae	1	1
	Pleuroziaceae	1	1
	Radulaceae	1	6
	Ptilidiaceae	1	2
	Porellaceae	1	5
	Frullaniaceae	1	5
	Jubulaceae	1	1
	Lejeunaceae	7	16
Metzgeriales			
	Codoniaceae	2	9
	Pelliaceae	1	3
	Pallaviciniaceae	2	2
	Blasiaceae	1	1
	Aneuraceae	3	7
	Metzgeriaceae	2	6
Marchantiideae			
Sphaerocarpales			
	Spaerocarpaceae	0	0

* From Hill et al.(1991)

Appendix VI. (cont.).

Liverworts : a summary of systematic diversity.

Family	Genera	Species
Hepaticae		
Marchantiales		
Targioniaceae	1	1
Lunulariaceae	1	1
Weisnerellaceae	1	1
Conocephalaceae	1	1
Aytoniaceae	1	1
Marchantiaceae	2	2
Ricciaceae	2	8
Anthocerotae		
Anthocerotales		
Anthocerotaceae	2	3

APPENDIX VII

Bryophytes which occur in Ireland but are absent from continental Europe.

Species:	Extra-European distribution.
a. Macaronesian element:	
Acrobolbus wilsonii (h)	Azores, Madeira.
Lejeuna flava ssp. moorei (h)	Azores, Madeira, Canaries, Cape Verde Islands.
L. hibernica (h) Irl.	Azores, Madeira, Canaries.
Campylopus shawii (m)	Azores, Caribbean Islands.
Myurium hochstettii (m)	Azores, Madeira, Canaries.
b. Oceanic subalpine element:	
Bazzania pearsonii (h)	Western N. America, Japan, Thailand, Himalaya, Sri Lanka.
Mastigiomorpha woodsii (h)*	West ern N.America, China , Himalaya..
Plagioghila carringtonii (h)*	Himalaya (ssp. *lobuchensis*)
Gymnostomum insigne (m)	Western N. America.
Leptodontium recurvifolium (m)	Wetsren N. America.
c. Miscellaneous species:	
Adelanthus linenbergianus (h)Irl.	Tropical and southern Africa, C. and S. America, Antarctic.
Metzgeria leptoneura (h)*	Widespread in the tropics and southern hemisphere.
Radula voluta (h)	Eastern N. America.
Barbula maxima (m) Irl.	Canada (N.W.Territories.
Bartramidula wilsonii (m)	N.,C. and S. America, China, Fernando Po.

Key: (h) = liverwort;
(m) = moss.
Irl. = species is absent from Britain.
* - occurs in theFaroes.

Source: Hill et. al. (1992)

Appendix VIII

Fungi

A summary of systematic diversity - excluding the Myxomycetes .*

	Families	Genera	Species
Gastromycetes	12	20	44
Hymenomycetes	40	210	1168
Teliomycetes	5	29	211
Ascomycotina		305	721
Mastigomycotina (Zoosporic fungi)		36	121
Zygomycotina		22	83
Deuteromycotina		320	1017
		942	3365

* taken from Muskett and Malone (1978 - 1985)

APPENDIX IX

Fungi

Irish Myxomycetes: a summary of systematic diversity.

	Family	Genera	Species
Acrasiomycetes			
Acrasiales			
	Acrasiaceae	(1)1	(1)1
Ceratiomyxomycetes			
Certiomyxales			
	Ceratiomyxaceae	(1)1	(1)1
Myxomycetes			
Echinostelilales			
	Echinosteliaceae	(1)1	(4)5
	Clasterdermataceae	(1)1	(2)2
Liceales			
	Liceaceae	(1)1	(8)18
	Reticulariaceae	(4)4	(7)8
	Cribrariaceae	(1)1	(11)12
Trichiales			
	Dianemaceae	(2)2	(2)3
	Trichiaceae	(8)8	(31)32
Stemonitales			
	Stemonitaceae	(12)12	(34)39
Physarales			
	Physaraceae	(6)6	(41)46
	Didymiaceae	(4)4	(21)24

Nos. in ( ) = those listed by Ing. & Mitchell 1980.

Others = Ing & McHugh 1988

APPENDIX X

Proposed Red Data List * (from: Curtis 1996)

(*not for publication until after the Minister's announcement).

P = Protected: R = Red: F = Frequent? Note: Scarce species (K) are not included.

SPECIES	STATUS	SPECIES	STATUS
Acinos arvensis	P	Epilobium alsinifolium	P
Adoxa moschatellina	P NI only	Epipactis palustris	F NI
Agrostemma githago	R Extinct	Epipactis phyllanthes	R
Ajuga pyramidalis	R	Equisetum pratense	R
Alchemilla alpina	R	Equisetum x moorei	P
Allium schoenoprasum	P	Erica ciliaris	P
Alopecurus aequalis	P	Erica mackaiana	R
Andromeda polifolia	F NI	Erica vagans	R NI only
Anthemis arvensis	R Extinct	Erigeron acer	P NI-needRI
Arenaria ciliata	P	Eriophorum gracile	P
Artemesia maritima	F Declining	Euphorbia peplis	R Extinct
Arthrocnemum perenne	P	Festuca heterphylla	R
Asparagus officinalis	P	Filipendula vulgaris	R
Asplenium billottii	P	Frangula alnus	P NI
Asplenium septentrionale	P	Galeopsis angustifolia	P
Astragalus danicus	P	Geranium purpureum	R
xCalamagrostis epigejos	P	Geranium rotundifolium	R
Calamagrostis stricta	P NI only	Geranium sylvaticam	P NI only
Callitriche truncata	R	Groenlandia densa	P
Campanula trachelium	P	Gymnocarpium dryopteris	P NI Ex RI
Cardamine amara	R	Gymnocarpium robertianum	P
Cardamine impatiens	P	Hammarbya paludosa	P
Cardaminopsis petraea	P	Helianthemum canum	R
Carduus nutans	R	Helianthemum nummularium	P
Carex depauperata	P	Hierochloe odorata	P NI only
Carex divisa	R	Hordelymus europaeus	P NI only
Carex elongata	R	Hordeum secalinum	P
Carex magellanica	P NI only	Hottonia palustris	P NI only
Carex pauciflora	P NI only	Hydrilla verticillata	P
Centaurea cyanus	R	Hyoscyamus niger	R
Centaureum littorale	P NI only	Hypericum canadense	P
Centaureum pulchellum	P	Hypericum hirsutum	P
Cephalanthera longifolia	R	Hypochaeris glabra	P NI only
Cicuta virosa	F Declining	Inula salicina	P
Cirsium helenioides	P NI only?	Juncus compressus	R
Colchicum autumnale	P	Kickxia elatine	P
Crambe maritima	R	Lamiastrum galeobdolon	R
Cryptogramma crispa	P	Lathyrus japonicus	P
Dactylorhiza traunsteineri	F NI	Lathyrus palustris	P NI
Deschampsia setacea	P	Lepidotis inundata	P NI
Draba incana	R	Ligusticum scoticum	R
Dryas octapetala	F NI	Limosella aquatica	R NI
Elatine hydropiper	P NI only	Logfia minima	P
Eleocharis parvula	R Extinct RI	Lolium temulentum	R

APPENDIX X

Proposed Red Data List * (from: Curtis 1996)

(*not for publication until after the Minister's announcement).

P = Protected: R = Red: F = Frequent? Note: Scarce species (K) are not included.

SPECIES	STATUS	SPECIES	STATUS
Lotus subbiflorus	P	Rumex maritimus	R
Matthiola sinuata	R Extinct	Ruppia spiralis	F declining
Melampyrum sylvaticum	P NI Ex RI	Salix phylicifolia	R
Mentha pulegium	P NI RI	Salvia v erbenaca	R
Mertensia maritima	P	Sanguisorba officinalis	P
Minuartia recurva	P	Sausserea alpina	P
Misopates orontium	P	Saxifraga aizoides	P NI
Monotropa hypopitys	P NI	Saxifrga granulata	P
Najas flexilis	P	Saxifraga hartii	P
Neottia nidus - avis	P NI	Saxifraga hirculus	P NI RI
Oenanthe pimpinelloides	P	Saxifraga nivalis	P
Omalotheca sylvatica	P	Saxifraga oppositifolia	P NI
Ophrys apifera	P NI	Scandix pecten-veneris	R Extinct
Orchis morio	P	Scheutzeria palustris	R Extinct
Ornithopus perpusillus	P	Scilla vema	F declining
Orobanche hederae	P	Scirpus triqueter	P
Orobanche rapum-genistae	R	Scleranthus annuus	P
Orthilia secunda	P	Scrophularia umbrosa	R
Otanthus maritimus	P	Serratula tinctora	R Extinct
Papaver hybridum	P	Sibthorpia europaea	R
Parapholis strigosa	F declining	Silene acaulis	P
Parentucellia viscosa	F declining	Simethis planifolia	P
Pilularia globifera	P NI RI	Sisyrinchium bermudiana	P NI
Poa alpina	R	Spiranthes romanzoffiana	P NI RI
Poa palustris	R	Stachys officinalis	P NI RI
Polygonum maritimum	P Extinct ?	Stellaria palustris	F declining
Polygonum viviparum	P	Teesdalia nudicaulis	P NI only
Polystichum lonchitis	P NI	Thelypteris palustris	F declining
Potentilla fruticosa	R	Trichomanes speciosum	P NI RI
Primula veris	F NI	Trifolium glomeratum	P
Prunus padus	R	Trifolium subterraneum	P
Pseudorchis albida	P	Trollius europaeus	P NI RI
Puccinellia fasciculata	P	Tuberaria guttata	R
Pyrola media	R	Vicia lathyroides	R
Pyrola rotundifolia maritima	P	Vicia orobus	P v.threatened
Ranunculus fluitans	P NI only	Vicia sylvatica	F declining
Ranunculus tripartitus	P	Viola hirta	P
Rorippa islandica	R	Viola lactea	P
Rubus chamaemorus	P NI only	Viola persicifolia	P

APPENDIX XI

STUDY BRIEF

for

The review of the status of species diversity in Ireland.

Purpose: is to report on the biological and conservation status of the Irish flora in preparation for the drafting of the Biodiversity Action Plan.

1. Inventory of biological diversity (at genetic, population, species levels on a taxonomic basis;

2. Assessment of the current status (abundance, distribution, range) of taxa in Ireland and of their significance in national and international terms;

3. Identification of threats to their conservation status;

4. Where possible, the association of species/taxa with habitats /ecosystems;

The study will be based on current information and will involve discussions with relevant experts in Ireland and a review of relevant literature.

The study will review species and genetic diversity in terrestrial, freshwater and marine ecosystems and covers all taxa.