Important Plant Areas for Algae

A provisional review of sites and areas of importance for algae in the United Kingdom

NATURAL HISTORY MUSEUM
THE BRITISH PHYCOLOGICAL SOCIETY
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LIST OF ABBREVIATIONS

AONB	Area of Outstanding Natural Beauty
ASSI	Area of Special Scientific Interest
BAP	Biodiversity Action Plan
BM	Herbarium abbreviation for the Natural History Museum, London
BPS	British Phycological Society
dSAC	Designated Special Area of Conservation
DW	David Williamson
ESA	Environmentally Sensitive Area
EU	European Union
EUNIS	European Union Nature Information
IPA	Important Plant Area
IUCN	International Union for the Conservation of Nature
MCA	Marine Conservation Area
MNR	Marine Nature Reserve
MPA	Marine Protected Area
NNR	National Nature Reserve
NP	National Park
pSAC	Possible Special Area of Conservation
SAC	Special Area of Conservation
SPA	Special Protected Area
SSSI	Site of Special Scientific Interest
VMCA	Voluntary Marine Conservation Area
VMPA	Voluntary Marine Protected Area
VMR	Voluntary Marine Reserve

Citation

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1.0 SUMMARY

For the first time, the Important Plant Area (IPA) concept, a mechanism for identifying the most important plant areas in the world, has been applied to the UK marine algae (seaweeds) and freshwater algae (excluding stoneworts) in order to determine which sites to propose as the first list of UK algal sites with IPA designation ('European IPAs'). An initial list of 83 marine/brackish and 130 freshwater sites ('UK IPAs') were nominated by the membership of the British Phycological Society (BPS). The principal selection criteria used were the number of potential Red Data List algae (desmids only), presence and number of rare species, concentration of records (diversity 'hotspots'), and a long history of recording. Some criteria were refined to take account of the special problems encountered when treating a data deficient group such as the algae. Also included are sites considered as potential IPAs but for which further information is required ('data deficient' IPAs). All sites were then assessed for their suitability to be nominated as potential European IPAs in the first round of assessment organised by Plantlife by applying the following criteria: A: the site holds significant populations of one or more species that are of global or European conservation concern, B: the site has an exceptionally rich flora in a European context in relation to its biogeographic zone; C: the site is an outstanding example of a habitat type of global or European plant conservation and botanical importance.

For the seaweeds, criterion A was applied to an assessed list of 'rare' species, compiled using two sources of distribution maps (i) 'Atlas' of the seaweeds of Britain and Ireland and ii) those based on herbarium collections housed in the Natural History Museum (NHM) in London) and the list formed the basis of a potential Red Data List. Criterion A could be assigned to UK IPAs but not to the proposed European IPAs because no Red Data List exists for these marine algae. Criterion B was applied at both the UK and European level by undertaking consensus mapping of all the UK specimens in the NHM. Criterion C was only applied to sites where habitats listed in Annex 1 of the EU Habitats Directive were present. Of the 83 UK IPAs, 9 sites (6 in England, 1 in Scotland, 1 in Wales, and 1 in Northern Ireland) were proposed as possible European IPAs.

Of the freshwater algal IPA nominations received, almost two-thirds were for desmids, five for diatoms and the remainder based on a long history of study. Desmids and diatoms are the most species-rich and well-researched groups of freshwater algae in the UK. In the case of desmids (green algae), the majority of site-specific records date back more than 50 years and many sites have disappeared or changed significantly often due to nutrient enrichment. A UK site-specific desmid dataset compiled since 1975 by David Williamson was analysed to discover the most desmid-diverse sites and to prepare a potential Red Data List of UK desmids. Red Data List desmids were confined to habitats having nutrient-poor and non-alkaline waters; all are considered threatened or vulnerable. Desmids were placed into one of three IUCN categories: critically endangered, endangered and vulnerable. Rarity was estimated by determining the number of sites a desmid had been recorded from by David Williamson over the past 30 years. Only criterion B was applied to European IPAs (exceptionally rich desmid floras) and all or most criteria were used to define UK IPAs. Six European Desmid IPAs (5 in England, 1 in Wales) and 12 UK Desmid IPAs (9 in England, 2 in Scotland, 1 in Wales) are recognised under criteria A, B and C. A further 27 sites/areas are recognised as potential UK IPAs for freshwater algae (19 in England, 5 in Scotland, 2 in Wales, 1 in Northern Ireland) but require further investigation.

2.0 IMPORTANT PLANT AREAS

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The IPA concept was conceived in 1995 at the first Planta Europa conference held in Hyères, France. An IPA is defined as *'a natural or semi-natural site exhibiting exceptional botanical richness and/or supporting an outstanding assemblage of rare, threatened and/or endemic plant species and/or vegetation of high botanic value'*. Three criteria (Anderson, 2002; Box 1) have been used for recognising IPAs and a programme developed to identify and protect a network of the best sites/areas for plant conservation throughout Europe and in the rest of the world.

The *Global Strategy for Plant Conservation* was adopted in 2002 by the parties to the Convention on Biological Diversity (Convention on Biological Diversity, 2002). The Strategy has 16 outcome-orientated targets with the fifth one calling for the protection of 50% of the most important areas for plant diversity by 2010. IPAs were considered to be the principle mechanism for identifying such areas or sites. The UK government's first response to the Strategy document was published in 2002 *Plant Diversity Challenge* (Cheffings *et al*., 2004).

Knowledge of the distribution patterns and conservation status of 'lower plant' groups lags well behind that for 'higher' plants. There is a need to use what information exists to recognise sites important for these groups and protect them before they disappear or become irreversibly changed. This report is the first attempt to recognise IPAs for freshwater algae and seaweeds.

BOX 1 Criteria for IPA identification

Criterion A
Site holds significant populations of one or more species that are of global or European conservation concern.

Criterion B
Site has an exceptionally rich flora in a European context in relation to its biogeographical zone.

Criterion C
Site is an outstanding example of a habitat type of global or European plant conservation and botanical importance.

3.0 ALGAE

Juliet Brodie and David M. John

3.1 INTRODUCTION

The 'algae' are an artificial assemblage of organisms grouped together in large part on the basis of their ability to photosynthesise. Morphologically they are extremely diverse and range from single-celled microbes through to structurally complex multicellular forms up to several metres in length. The classification of the algae has undergone radical reorganisation in recent years and eukaryotic algae are now placed in most of the major lineages of life on earth (Box 2). Algae are worldwide in distribution and occupy an extremely wide range of habitats (Box 3).

BOX 2 Classification of algae

In some classifications, the prokaryotic blue-green algae or cyanobacteria are included. Current classifications[1] of the eukaryotic algae recognize four major groupings: Primiplantae: Rhodophytes (red algae) Charophytes (include stoneworts), Chlorophytes (green algae), Glaucophytes; Chromalveolates: Phaeophytes (brown algae), Chrysophytes (golden brown algae = Synurophyta, Dictyochophyta, Pedinellophyta), Eustigmatophyta, Raphidophyta, Bacillariophytes (diatoms), Haptophytes, Cryptophytes (cryptomonads), Dinophytes (dinoflagellates), Xanthophyta (=Tribophyta; 'Yellow-Green Algae'); Excavates: Euglenophytes (euglenoids); Rhizaria: Chlorarachniophytes.

Most 'seaweeds' belong to the Chlorophytes, Phaeophytes and Rhodophytes.

[1]e.g. Keeling (2004).

About 34,000 species are recognised today although it has been estimated that there could be in excess of 350,000 algal species worldwide. Of this number about one-third are macroscopic of which seaweeds are important in the marine environment and stoneworts in freshwaters.

BOX 3 Where algae occur

Algae are most abundant and diverse in seas, oceans, river systems and standing waters (from puddles through to lakes) where attached (benthic), free-floating (plankton) or loosely associated with hard surfaces and sediments. Some live in association with soil, soil-free surfaces (e.g., tree trunks, rocks, snow, ice) and in symbiotic partnership with a fungus to form a lichen; some also live within animals and plants. They are key primary producers, probably accounting for well over 50% of the global carbon budget and are at the base of most aquatic food chains.

3.2 UK ALGAL DIVERSITY

Hardy & Guiry (2003) recorded 692 species in *The Atlas of Marine Algae of Britain and Ireland* (6 only known from Ireland), which represents approximately 14% of the world's known marine algae. The number of species mentioned in *The Freshwater Algal Flora of the British Isles* (John *et al.*, 2002) is about 5,000 and these are listed in *A Coded List of British Freshwater Algae* (Whitton *et al.*, 2003). The number of seaweeds is almost certainly a more accurate figure since most microscopic algae are poorly known. A comparison of the number of species in the groups covered in this document is given in Box 4.

BOX 4 Species Diversity in the UK

Numbers for marine algae refer only to 'seaweeds' (benthic macroalgae) growing in brackish water and/or under fully marine conditions. These are compared to the numbers of freshwater species that occur in each of these phyla. For the species diversity of other freshwater phyla in the UK, see John *et al.* (2002).

	Freshwater	Marine
Rhodophyta (red algae)	22	339
Phaeophyceae (brown algae)	2	185
Chlorophyta (green algae)	c. 1000*	100
Xanthophyta/Tribophyta (Yellow-green algae)	73	16

*includes 30 stoneworts and over 800 desmids

3.3 ALGAL HABITATS AND THEIR CLASSIFICATION

Algae occur not only in a wide range of aquatic habitats but are also common in terrestrial habitats including soil and soil-free surfaces. Little is known of the status of terrestrial algae or freshwater and marine algae in many of those habitats recognised in the European Union Nature Information System (EUNIS) classification of habitat types. (For the most important habitats for the algae under EUNIS, see Box 5.)

BOX 5 EUNIS Habitat Classification

Habitats most important for algae. Asterisk denotes those habitats Stewart (2004) considered when selecting areas important for stoneworts.

Level 1
Marine Habitats (A); Coastal Habitats (B); Inland Surface Water Habitats (C); Mire, Bog & Fen (D)

Level 2
A1 Littoral rock and other hard substrata; A2 Littoral sediments; A3 Sublittoral rock and other hard substrata; A4 Sublittoral sediments; B1 Coastal dune and sand habitats (includes wet dune slacks and machair)*; B3 Rock cliffs, ledges and shores, including the supralittoral; C1 Surface standing water*; C2 Surface running waters*, C3 Littoral zone of inland surface waterbodies; D1 Raised and blanket bogs; D2 Valley mires, poor fens and transition mires; D4 Base-rich fens*; D5 Sedge and reed beds; D6 Inland saline and brackish marshes and reed beds.

3.4 CONSERVATION LEGISLATION COVERING ALGAE

Marine algae have been mentioned as an important feature in a range of site designations. These include Marine Nature Reserves (MNRs), Areas or Sites of Special Scientific Interest (ASSIs, SSSIs) or Special Areas of Conservation (SACs). The Skomer MNR was designated partly on the richness of the seaweed flora (Brodie & Watson, 1999). In contrast, algae other than stoneworts are rarely mentioned when designating freshwater sites or areas.

Biodiversity Action Plans (BAPs) have been drawn up for only very few algae. Until now BAPs have only been prepared for 12 species of stonewort in freshwater/brackish habitats and two seaweeds: *Anotrichium barbatum* and *Ascophyllum nodosum* ecad *mackayi* in the marine environment (http://www.ukbap.org.uk/species.aspx). BAP listings are currently under review and 11 more species of marine algae have been put forward as possible candidates (Brodie, pers. comm.). The only seaweed listed in Appendix 1 of the Bern Convention that occurs in the UK is the kelp *Laminaria ochroleuca.* Any site containing a Bern Convention species is considered threatened and qualifies automatically for inclusion as a marine IPA; in the case of *L. ochroleuca,* this only applies to the species in the Mediterranean. Until now no freshwater algae in the UK have been listed as endangered or vulnerable with the exception of stoneworts.

4.0. IMPORTANT PLANT AREAS FOR MARINE ALGAE

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4.1 INTRODUCTION

Given that approximately 14% of the world's known marine seaweeds have been recorded from the UK (see section 3.2), it is crucial that those sites of algal importance are identified and recognised. The aim of this work is to develop an inventory of sites considered to be important for the marine algae in a UK (national) context and to apply the IPA criteria in order to determine which should be proposed as possible European (international) IPAs. All UK sites included here are potentially of European importance but for now these are distinguished as UK IPAs which may eventually feed into the European

inventory when more data become available. Those sites which were selected from the UK inventory to go forward as potential IPAs are referred to as European IPAs.

4.11 Habitats and threats

The varied geology and geomorphology of the UK is reflected in the coastline. The range of tidal height around the UK, which includes the second largest tidal range in the world at the Bristol Channel, means that extensive and geologically diverse seashores are a feature of the UK and they support a wide diversity of habitats from solid bedrock through boulders to sand and mud. A number of habitats are also created by the organisms themselves, e.g., maerl beds, which are areas of calcareous red algae that support a rich and unusual seaweed flora. Habitats that have already been identified as important and under potential threat for algae are i) chalk, ii) *Zostera* beds and iii) maerl (http://www.ukbap.org.uk/habitats.aspx).

4.2 METHODS FOR IPA SELECTION

4.21 Nomination and assessment of sites

Site nomination

In order to compile a list of the UK sites that could be potentially put forward as possible European IPAs for the marine algae, the members of the British Phycological Society were asked to nominate sites. The request by e-mail and in *The Phycologist* (Autumn, 2003, p. 3), asked for the following information: 1. Name and location of site, 2. Reason for proposing site (e.g., history of research, number of species, presence of rare species), 3. Would you be willing to be contacted to supply further information regarding the site?

The result of this request was the nomination of 47 marine sites (Brodie & John, 2004a) followed by approximately 40 more sites, nominated by Ian Tittley (Brodie & John, 2004b). All sites were then assessed for their suitability to be nominated as potential IPAs in the first round of assessment organised by Plantlife.

Site assessment

A description of each site was constructed using data derived from a range of different sources including BPS field reports and survey reports (Appendix 7.1), Joint Nature Conservation Committee site (http://www.jncc.gov.uk/), Countryside Council for Wales (http://www.ccw.gov.uk/) and Scottish Natural Heritage (http://www.snh.org.uk/). The inclusion of type species recorded from some localities is only for red species at this stage; data for these are derived from *The Seaweeds of the British Isles* series (Dixon & Irvine, 1977; Irvine, 1983; Maggs & Hommersand, 1993; Irvine & Chamberlain, 1994; Brodie & Irvine, 2003). Where possible, the following information has been included:

i) Site name and Vice-County.
The name of the site was mainly as given by the nominator, although in a few cases where there were two or more sites in close proximity, these were amalgamated. A small number of sites were eliminated on the grounds that they did not fit with the criteria for marine sites. Vice Counties have been used, as these are not subject to council boundary changes.

ii) Grid reference
This varied from giving a grid reference to indicate a general area, to the central point of the site. For some sites, the two ends of a shore were given.

iii) Status
In some cases the sites fell within SACs or SSSIs. Here the status is included but the IPA proposed may only be a part of the designated area.

iv) Application of IPA criteria for UK IPAs
At the UK level, the qualifying criteria applied were those stated in Box 1 plus an additional criterion D:

Criterion A: Site holds significant populations of one or more species that are of global or European conservation concern.
Criterion B: Site has an exceptionally rich flora in a European context in relation to its biogeographical zone.
Criterion C: Site is an outstanding example of a habitat type of global or European plant conservation and botanical importance.
Criterion D: A nominated site considered to be important but for which further information is required ('data deficient').

At the UK level the criteria were applied as follows:

Criterion A was assigned to a site if there was a species or species:
i) confined to a specific habitat or habitats that are rare or absent elsewhere in Europe in the marine context, e.g., chalk cliffs, maerl beds;
ii) nationally rare (Table 4.4), possibly declining and, if known, rare in a European context;
iii) confined to only one known site in the UK;
iv) nationally rare and a large proportion of the world's known population (e.g., *Schmitzia hiscockiana* - about 98% of the world's population occurs in the sea around the UK).

Criterion B was assigned to a site if a large number of species had been recorded from it. If this information was not directly available, it was ascertained by consensus mapping (see 4.23) which was also used to confirm sites based on recorded numbers of species. Habitats and species composition (assemblages) were also taken into account. One site might not be diverse in terms of number of habitats present or have habitat types which typically have large numbers of species but might be rich in numbers of species or species assemblages for that particular habitat or geographical location.

Criterion C was assigned to a site if it was an outstanding example for the algae of
habitats which already have UK BAP conservation status: chalk, maerl and eel grass (*Zostera*), plus exceptional reef systems supporting rich algal communities, and saltmarsh and gravel sites to which some algae are confined and these are frequently neglected habitats.

v) Number of species recorded
For many sites it was not possible to provide this information. Where it has been possible, e.g. published species lists of good quality, an indication of diversity has been given based approximately on <50 species = low diversity, 50-100 = medium diversity, 100–200 = high diversity and >200 = very high diversity. However, the habitat was also taken into account when assessing the richness of the site, given that some have inherently higher diversity than others.

vi) Site description
Site descriptions were compiled from a variety of sources including from the nominee, additional personal knowledge of the authors of this report, literature and web-based sources. Given the enormous range of sources and the difficulty of assessing the quality of some of these, a comprehensive literature search was not undertaken, but a list of the main references consulted are given in Appendix 7.1.

vii) Threatened or rare marine algae
The concept of rare species was based primarily on a revised list of Brodie *et al.* (2005) (see 4.22 below). As with site descriptions, a variety of sources were used to obtain this information.

4.22 Determining a list of 'rare marine algae'

One of the goals of this work is to consider potential algal species for a UK Red Data List which will assist in the recognition of IPAs. In order to compile a list of species that could be assessed as potentially rare, mapping records were used. Those that occurred at ten sites or less have been included in the list. Two sources of maps were used: i) those in Hardy & Guiry (2003) and ii) those based on the collections in the herbarium at the Natural History Museum (BM). The initial list that resulted included approximately half the British flora. Each species on the list was given an initial category (Table 4.4) based on species information in Hardy & Guiry (2003) and personal knowledge. The list was then refined by removing species known to be common but under-recorded for one or other set of maps. The list was then circulated in *The Phycologist* (Brodie *et al*., 2005) and the BPS members asked to comment. Following that, the list was further refined by consulting individuals with particular expertise in different groups of algae (Table 4.4) and the category 'data deficient' added. It was then possible to use the information in relation to Criterion A.

4.23 Consensus map

A consensus map of the number of individuals recorded at each site around Britain was achieved by counting the number of specimens of each species. The map was created using DMAP for Windows (2005) using intervals of 30 species for each category.

4.24 Selection of the first European IPAs to be proposed

The philosophy behind IPAs is that once they have been selected, they should not be de-selected. The assessment of the sites that were nominated by the BPS membership (Tables 4.2 and 4.3) was based on a combination of well-documented data and anecdotal information. To select from that list the first potential European IPAs to be put forward for the algae (Table 4.1), sites were selected where there was well documented and verifiable data for the algae and where in the majority of cases the sites were already internationally recognised as important for a number of reasons which may include for the algae. The IPA Criteria A, B and C were then reapplied stringently in a European context, following strict guidelines.

Criterion A could only be applied to sites where there were species which were known to be Ai) Globally threatened, Aii) European threatened, Aiii) on National Red List as Critical, Endangered or Vulnerable AND endemic, Aiv) National Red List as Critical, Endangered or Vulnerable AND near endemic (ie in just 2 or 3 countries in total). Therefore it was not possible to apply this with certainty to any of the European IPA proposed, given the data available, i.e. no Red Data Lists.

Criterion C could only be applied to sites where habitats listed in Annex 1 of the EU Habitats Directive were present (mainly reefs in the context of the algae here, but for full list see: www.jncc.gov.uk/publications/jncc312/uk_habitat_list.asp).

4.3 RESULTS

4.31 List of UK sites nominated as potential IPAs

A total of 83 sites were nominated for marine algae (Tables 4.2 and 4.3, and Fig. 4.1), including 39 in England, 14 in Wales, 25 from Scotland, 4 in Northern Ireland, plus 1 from the Isle of Man.

Figure 4.1 Map showing the approximate distribution of all IPAs and potential IPAs ('data deficient') for freshwater algae/desmids and seaweeds in the UK.
Rockall is the only IPA not on the map.

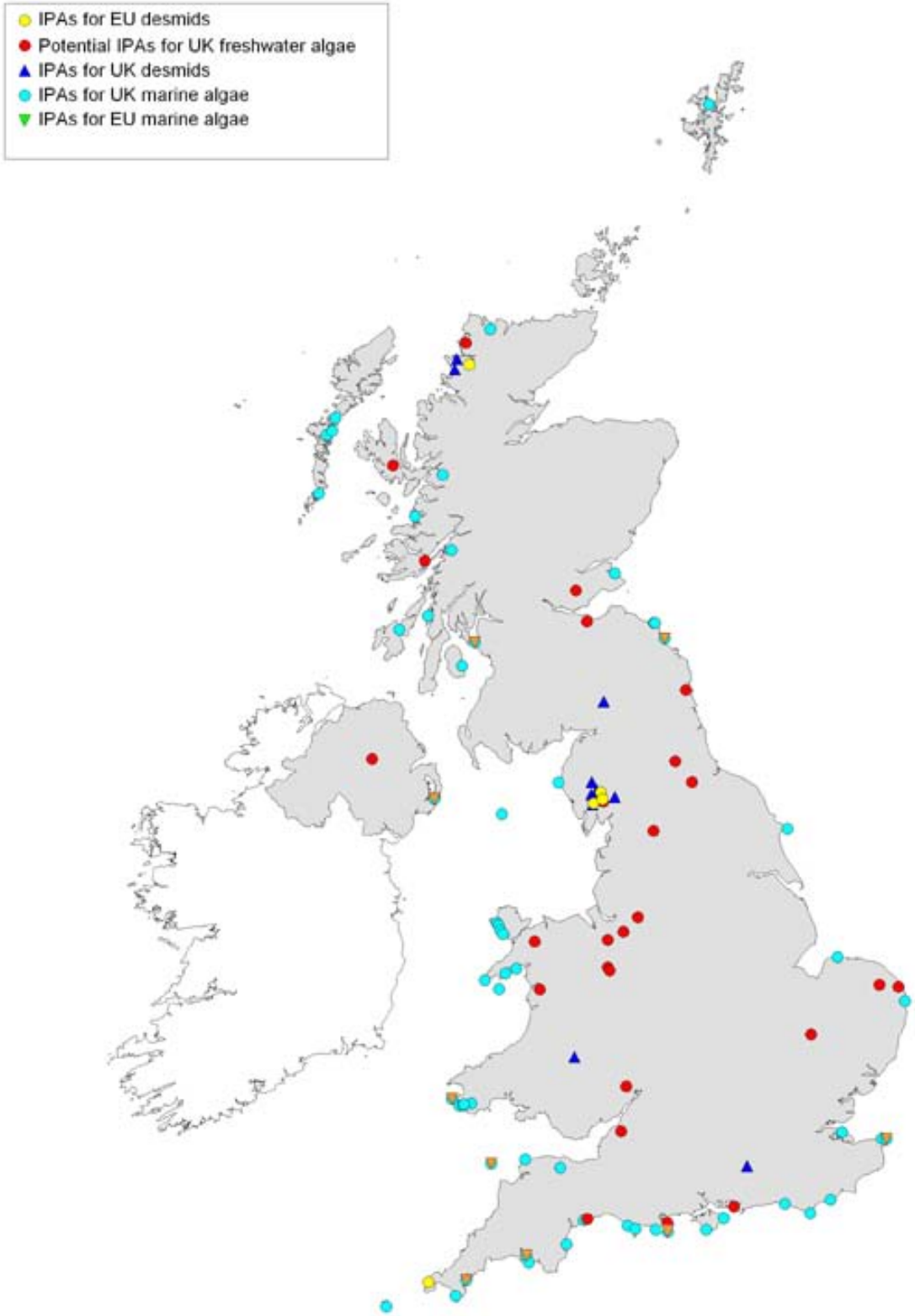


Table 4.1 Sites nominated as European Important Plant Areas for marine algae
Site number refers to the map in Figure 4.1.

	Site	Grid ref.	Status	Qualifying criteria	No. of species	Site description
	ENGLAND					
1	Berwick-upon-Tweed, Northumberland	NU005540	SAC, AONB	B	High	The site has many algal 'diversity hotspots' and includes nationally rare species. It has a long history of algal study and is the type locality for several species of algae.
11	Whiteness Gap, Thanet, Kent	TR396710	SSSI, SAC	B	Medium	This site has unique assemblages associated with chalk platforms and caves and is the type locality for some chalk cliff algae. It has a long history of algal study.
21	Peveril Point to Durlston Head, Swanage, Dorset	SZ780034	Durlston: VMCA	B	Very high	This site is a 'diversity hotspot' with many nationally rare species. It has a long history of algal study.
28	Plymouth, Devon	SX485535	SAC	B	Very high	This site has a very high algal diversity. It has a long history of algal study and it is the type locality for several species of algae.
29	Falmouth and Helford, Cornwall	SW813321	SAC	B, C	Very high	This area has sheltered intertidal mudflats and sandflats. It has a particularly diverse algal flora including a number of warm water species. It is the location of the largest and most southerly maerl bed in the UK. It has a long history of algal study.
32	Lundy Island, Devon	SS1345	MNR, SAC, SSSI	B, C	Very high	This site consists of granite and slate reef systems and a variety of habitats on the reefs. It is a 'diversity hotspot' for algae with over 300 species recorded. It has a long history of algal study.
	WALES					
41	Skomer Island, Pembrokeshire	SM735095	SAC MNR	B	Very high	This site has a wide range of habitats, including excellent examples of algal communities on bedrock, boulders and cobble habitats. It has a very high diversity of algae, with over 240 species recorded.
	SCOTLAND					
53	Isle of Cumbrae, Argyll	NS160540		B	High	This site has a high diversity of algae, a long history of study and is the type locality for species of algae.
	NORTHERN IRELAND					
82	Strangford Lough, Co. Down	J589496	SAC MNR	B	High	The southern half of the site has high algal diversity for eastern Ireland, maerl beds and a long history of research.

Table 4.2 Sites nominated as IPAs for marine algae in the UK.
Qualifying criteria: A = Site holds significant populations of one or more species that are of global or European conservation concern; B = Site has an exceptionally rich flora in a European context in relation to its biogeographical zone; C = Site is an outstanding example of a habitat type of global or European plant conservation and botanical importance. Site number refers to the map in Figure 4.1.

	Site	**Grid ref.**	**Status**	**Qualifying criteria**	**No. of species**	**Site description**	**Threatened or rare species**
	ENGLAND						
1	Berwick-upon-Tweed, Northumberland	NU005540	SAC; AONB	B	High	Rocky shore including Bucket Rocks, Ladies Skerrs and Sharper's Head. The site has many algal 'diversity hotspots' and includes nationally rare species. It has a long history of algal study and is the type locality for several species of algae including, *Acrochaetium battersianum* G. Hamel, *Phyllophora traillii* Holmes ex Batters, *Porphyrodiscus simulans* Batters and *Lithophyllum crouanii* Foslie.	*Callophyllis cristata* *Chlorochytrium dermatocolax* *Chroodactylon ornatum* *Kuetzingiella holmsii* *Myriactula haydenii* *Myrionema liechtensternii* *Pilinia rimosa* *Pseudendoclonium fucicola* *Sphacelaria caespitula* *Sphacelaria mirabilis* *Sphacelaria nana* *Sphacelaria racemosa* *Stragularia spongiocarpa* *Streblonema breve* *Streblonema fasciculatum* *Streblonema helophorum* *Symphyocarpus strangulans*
4	Flamborough Head, West Riding, Yorkshire	TA2570	SSSI; SAC; Heritage Coast	C	>100	Includes Flamborough Headland, Thornwick Bay, Chatterthrow Bay, North Landing, Selwick's Bay, Cough Hole, Stack's Pinnacle, South Landing area and Sewerby Rocks. Northern limit of chalk in UK. The best stretch of undisturbed chalk cliff coastline in the UK. Embayments, with chalk platforms and slabs, chalk boulders and cobbles with flint, shingle/gravel. Also caves, arches and pinnacles. This site has unique assemblages associated with calcareous platforms and caves. Southern limit for several algae, e.g. *Ptilota gunneri* P.C. Silva, Maggs & L.M. Irvine. Chrysophyte species include: *Apistonema carterae* Anand, *Entodesmis maritima* (Anand) Parke & Green and *Thallochrysis litoralis* Anand. Several recent surveys.	*Acrochaete wittrockii* *Cruoria cruoriaeformis* *Pseudendoclonium submarinum* *Porphyrostromium ciliare* *Pilinia rimosa* *Pneophyllum myriocarpum* *Rhodymenia delicatula* *Sphacelaria nana*
5	Scolt Head, Norfolk	TF802463	NNR	C, D	Low	Offshore barrier island with some of the finest saltmarshes in UK. Algal diversity is low but site is an excellent example of saltmarsh	

						habitat which is rarely considered for marine algae in the UK. The site has not been studied recently for the algae. There are collections at BM. It has classical saltmarsh communities with e.g., *Bostrychia scorpioides* (Hudson) Montagne. Notable algal communities occur in the tidal channels and macrophytes are found on consolidated cobble.	
7	Great Yarmouth, Norfolk	TG527065		B, D		The site includes Gorlestone and mouth of River Yar. A large expanse of sand, consolidated gravel and shingle, with wooden groynes and piers; site much altered by human activity. It has a long history of algal study, including by Dawson Turner. It is an important locality in eastern England for type species, including: *Naccaria wiggii* (Turner) Endlicher, *Bonnemaisonia asparagoides* (Woodward) C. Agardh, possibly *Halarachnion ligulatum* (Woodward) Kützing, possibly *Compsothamnion thuyoides* (J.E. Smith) Nägeli, *Plenosporium borreri* (J.E. Smith) Nägeli, *Halurus flosculosus* (J. Ellis) Maggs & Hommersand, *Apoglossum ruscifolium* (Turner) J. Agardh and *Chondria dasyphylla* (Woodward) C. Agardh.	*Pilinia rimosa*
9	Thames Estuary, Essex/Kent?	mid Thames c. Sheerness: TQ915754		B	High	Eocene clay and man-made structures. This site has a long history of study with records dating back to the 1600s. It is probably an area with a change in diversity with species lost and species gained due to dynamic changes in habitat and communities. There are seagrass beds and saltmarsh communities. Sheerness is the type location for *Gloiosiphonia capillaris* (Hudson) Carmichael, *Ulva linza* Linnaeus and *Gracilariopsis longissima* (S.G. Gmelin) M. Steentoft, L.M. Irvine & W.F. Farnham.	
10	Thanet area, Kent	TR348711	SSSI; SAC	C		The Thanet Coast is the longest continuous stretch of coastal chalk in the UK. This site contains subtidal chalk reefs that extend into the intertidal zone forming chalk cliffs. These cliffs are the second most extensive representative of chalk caves in the UK. The caves support some specialised algal communities, for example, *Pseudenoclonium submarinum* Wille and *Chrysonema litoralis* P.L.Anand. Is the type locality for some chalk cliff algae (Anand, 1937).	*Pilinia rimosa* *Apistonema carterae*
11	Whiteness Gap, Thanet, Kent	TR396 710	SSSI; SAC	A	Medium	This site has unique algal assemblages associated with chalk platforms and caves and is the type locality for some chalk cliff algae. It has a long history of algal study.	*Scytosiphon dotyi*
14	Beachy Head, Eastbourne, Sussex	TV594955		C		A site with chalk and upper greensand. Beachy Head is chalk. To the east, The Pound is a series of upper greensand reefs between which are shallow lagoons with diverse alga flora, and to the west towards Birling Gap there is chalk foreshore reef and associated algal	Unique chrysophytes (Anand, 1937) *Dasya punicea* (Zanardini) Meneghini ex Zanardini

						communities. The range of geology is reflected in the algal communities, e.g. *Pelvetia canaliculata* and *Ascophyllum nodosum* occur on the reefs but not on chalk. The lagoons have a diverse algal flora. There are also cliff and cave algae. It is a site of historical importance.	
15	Brighton, Sussex	TQ315037		B, C		Chalk shore to east of Brighton. It has a long history of algal study (Merryfield collections in 19th century and earlier) and is the type locality for several species, including: *Seirospora interrupta* (J.E. Smith) F. Schmitz, *Callithamnion corymbosum* (J.E. Smith) Lyngbye, *Anotrichium barbatum* (C. Agardh) Nägeli, *Monosporus pedicellatus* (J.E. Smith) Solier and *Polysiphonia fibrillosa* (Dillwyn) Sprengel. The site is at the boundary of warm-water south-western species. Some historical interest.	*Helminthocladia calvadosii*
18	Bembridge, Isle of Wight	SZ650887	SAC	A, D		Unusual and diverse algal communities. The first record of *Sargassum muticum* in the UK was found from this site. Not a long history of study. Seagrass beds.	*Aglaothamnion bipinnatum* *Polysiphonia ceramiaeformis* *Rhodophysema georgei*
19	South Wight, Isle of Wight	SZ462771	SAC	A?, B, C	High	This site has chalk platforms and caves with hard and soft chalk. There are unique algal assemblages associated with these platforms and caves, including possibly undescribed red crusts. Cave algal communities as described by Anand (1937). The algal communities vary depending on the substratum. It is designated an SAC because of the cliff and cave communities. It is also a biogeographical boundary; e.g., *Cystoseira* spp, *Halopitys incurvatus* and *Himanthalia elongata* are absent attached east of the Isle of Wight. There is a moderate history of algal recording with several recent studies and moderate collections.	*Pilinia rimosa*
20	Studland, Dorset	SZ037825	Part of SAC	B		Restricted area of chalk cliffs, reefs, platform and caves with a good diversity of algae. The site has a long history of collecting with good collections at the BM, but no recent collections. It is the type locality for *Apoglossocolax pusilla* Maggs & Hommersand.	*Dasya corymbifera* *Dasya punicea* *Polysiphonia furcellata* *Polysiphonia simulans*
21	Peveril Point to Durlston Head, Swanage, Dorset	SZ780034	Durlston VMCA	B	Very high	This site is a ‘diversity hotspot’ with many nationally rare species. It has a long history of algal study. Swanage is the type locality for *Acrochaetium trifilum* (Buffham) Batters.	*Atractophora hypnoides* *Bornetia secundiflora* *Dasya corymbifera* *Erythrotrichia welwitschii* *Laurencia pyramidalis* *Polysiphonia simulans* *Polysiphonia subulifera* *Rhodophysema georgei* *Stragularia spongiocarpa*

22	Kimmeridge Ledges	SY9177	VMR	A, D		Jurassic limestone ledges. Unusual algal assemblages.	Only known site for *Ceramium circinatum*
23	Weymouth, Dorset	SY683781		B, D	High	It has a long history of study and is the type locality for several species of algae including: *Callocolax neglectus* F. Schmitz ex Batters, *Nitophyllum punctatum* (Stackhouse) Greville and *Chondria capillaris* (Hudson) M.J. Wynne. Good historical records and good collections at the BM.	*Atractophora hypnoides* *Dasya corymbifera* *Helminthocladia calvadosii* *Lophosiphonia reptabunda* *Polysiphonia simulans* *Polysiphonia subulifera* *Rhodophysema georgei* *Titanoderma laminariae*
24	The Fleet, Dorset	SY6081	Part of SAC (Chesil and Fleet)	A, C		The Fleet is the largest example of a lagoon in England and has features of both lagoonal inlets and percolation lagoons. It has fully saline to reduced salinity regions. It supports extensive populations of *Zostera* spp.	*Lamprothamnion papulosum* (nationally rare charophyte). *Zostera* spp *Grateloupia turuturu* *Sarcodiotheca gaudichaudii* *Solieria chordalis*
25	Sidmouth, Devon	SY1287		B	High	This site has a wide range of habitats including sand interspersed with boulder and bedrock, worm reefs and granite boulder sea defences. It has a long history of algal study and is the type locality for several species of algae including: *Porphyra linearis* Greville, *P. dioica* Brodie & L. Irvine, *Cordylecladia erecta* (Greville) J. Agardh, *Polysiphonia devoniensis* Maggs & Hommersand, *P. elongella* Harvey, *Gelidium pusillum* (Stackhouse) Le Jolis and *Gymnogongrus griffithsiae* (Turner) C.F.P. Martius.	*Lophosiphonia reptabunda*
26	Torquay, Devon	SX930640		B, D	High	This site has a long history of algal study. It has a high diversity of species and is the type locality for several species of algae including *Kallymenia microphylla* J. Agardh, *Compsothamnion gracillimum* De Toni, *Ceramium echinotum* J. Agardh, *C. pallidum* (Nägeli ex Kützing) Maggs & Hommersand, *C. siliquosum* (Kützing) Maggs & Hommersand and *Sphondylothamnion multifidum* (Hudson) Nägeli.	*Gelidium corneum* *Polysiphonia furcellata* *Polysiphonia subulifera* *Rhodophysema georgei*
27	Wembury, Devon	SX5147	VMCA	B, D	High	A moderately exposed shore with varied intertidal rocky communities. This site has a long history of study and is a diversity hotspot.	*Bornetia secundiflora*
28	Plymouth, Devon	SX485535	SAC	B	Very high	This site has a very high algal diversity. It has a long history of algal study and it is the type locality for several species of algae including *Acrochaetium brebneri* (Batters) G. Hamel, *Colaconema endophyticum* (Batters) J.T. Harper & G.W. Saunders, *C. bonnemaisoniae* Batters and *Polysiphonia foetidissima* Cocks ex Bornet. *Laminaria ochroleuca* is recorded from this site.	*Atractophora hypnoides* *Bornetia secundifora* *Helminthocladia calvadosii* *Gigartina pistillata* *Polysiphonia simulans* *Rhodophysema georgei*

							Schmitzia hiscokiana *Schmitzia neapolitana*
29	Falmouth and Helford, Cornwall	SW813321	SAC	A, B, C	Very high	This area has sheltered intertidal mudflats and sandflats. It has a particularly diverse algal flora including a number of warm water species. It is the location of the largest and most southerly maerl bed in the UK. It has a long history of algal study. Type species include *Phymatolithon calcareum* (Pallas) Adey & D.L. McKibbin. There are extensive populations of *Zostera*.	*Acrothrix gracilis* *Cruoria cruoriaeformis* *Gelidium corneum* *Grateloupia dichotoma* *Halymenia latifolia* *Itonoa marginifera* *Lithothamnion corallioides* *Rhodymenia delicatula* *Schmitzia hiscockiana*
30	Lizard, Cornwall	SW690174 (SAC grid red)	NNR; SAC	A, B	High	Historical site with high diversity.	*Audouinella lorrain-smithiae* *Bornetia secundiflora* *Codium adhaerens* *Dasya ocellata* *Desmarestia dresnayi* *Gelidium corneum* *Gigartina pistillata* *Grateloupia dichotoma* *Microcaldia glandulosa* *Pterosiphonia pennata* *Pringsheimiella scutata* *Sphacelaria tribuloides*
31	Scilly Isles, Cornwall	SV912111	SSSI; SAC; SPA; AONB; Ramsar; MPA; ATBI	A, B	High	An archipelago of granite islands off southwest of England with a high diversity of marine habitats and communities in a range of exposure conditions. It is the type locality for several species of algae including: *Rhodophysema georgei* Batters and *Erythrotrichia bertholdii* Batters. There are extensive seagrass beds of *Zostera marina*. There is a high diversity of algae. There are historical studies. It is designated a European ATBI site.	*Atractophora hypnoides* *Bornetia secundiflora* *Desmarestia dresnayi* *Halymenia latifolia* *Lithothamnion corallioides* *Rhodophysema georgei* *Rhodymenia delicatula* *Pterosiphonia pennata* *Schmitzia hiscokiana* *Schmitzia neapolitana*
32	Lundy Island, Devon	SS1345	MNR; SAC; SSSI	A, B, C	Very high	This site consists of granite and slate reef systems and a variety of habitats on the reefs. It is a ‘diversity hotspot’ for algae with over 300 species recorded. It is the most northerly site recorded *Laminaria ochroleuca*. It has a long history of algal study.	*Codium vermilara* *Colacodictyon reticulatum* *Itonoa marginifera* *Kuetzingiella battersii* *Microcladia glandulosa* *Myriactula stellulata*

							Pringsheimiella scutata
33	Ilfracombe, Devon	SS500476		B, D		This is a site with good diversity and historical records. It is the type locality for *Calliblepharis jubata* (Goodenough & Woodward) Kützing.	*Gelidium corneum*
36	Bees Head, Cumbria, Cumberland	NX940146		A	Medium	An isolated outcrop of red sandstone - effectively an island - in an area with few rocky sites in north-west England. A good range of algal communities in the intertidal site. *Zostera angustifolia*.	*Pilinia rimosa*
	WALES						
37	The Gower/Swansea, Glamorgan	SS875385 to SS871635	AONB; NNR; SSSI	B, D	High	This includes Worms Head, Port Eynon, Oxwich and Mumbles Head. It was the first SSSI in Britain. It is an area of high algal diversity.	
38	Milford Haven Waterway, Pembrokeshire	SM8604 (site of maerl bed within the SAC)	SAC; part NP; part SSSI; part ESA	A?, C, D?	High	A ria with a wide range of environmental conditions, including seabed substrates, tidal streams and salinity gradients. There is a high diversity of species and extensive beds of *Zostera*.	Maerl and associated species: *Cruoria cruoriaeformis* *Gelidiella calcicola* *Petrosiphonia pennata*
39	West Angle Bay, Pembrokeshire	SM849032	SSSI; SAC; NP	B	High	West Angle Bay is a small, westfacing rocky bay at the southern edge of Milford Haven Waterway and is a mixture of moderately exposed rocky cliffs, platforms, rockpools and overhangs with some sand on the mid and upper shore in the centre of the bay. This site is one of the richest sites for marine flora and fauna in South and West Wales. The shore platforms at West Angle Bay are of considerable importance, for the algal communities within rockpools.	*Gigartina pistillata*
40	St. Anne's Head, Pembrokeshire	SM810029	SSSI; SAC; NP	A?, D?		An exposed rocky headland on the northern side of the entrance to Milford Haven Waterway. Large rockpools in midshore support *Cystoseira baccata* a south-western and western species of limited distribution.	*Mesogloia lanosa* *Sphacelaria mirabilis* *Hydrolithon cruciatum* *Hinksia ovata*
41	Skomer Island, Pembrokeshire	SM735095	SAC MNR	B, C	Very high	This site has a wide range of habitats, including excellent examples of algal communities on bedrock, boulders and cobble habitats. It has a very high diversity of algae, with over 240 species recorded.	*Atractophora hypnoides* *Schmitzia hiscockiana* *Schmitzia neapolitana* *Pilinia rimosa*
42	Cymyran Strait, Anglesey	SH290770	SSSI	A		Sheltered sand and mud strait between the Inland Sea and the west coast of Anglesey. The strait drains to a channel at low water with sand along the shore and mud, saltmarsh and bedrock along the mud and uppershore. The site supports an unusual form of *Ascophyllum nodosum* ecad *scorpioides* and *Zostera* spp.	*Pringsheimiella scutata*

43	Enlli and Pen Llŷn, Caernarvon	SH1324 and around	SAC; NNR	A, B	Very high	Bedrock, cliffs, caves and gullies on wave and tide exposed shores. Bedrock cliffs, boulders, caves and gullies in the subtidal with generally clear water all result in a large infralittoral zone. The site was proposed because of *Schmitzia hiscockiana* and the diversity of intertidal and subtidal algal assemblages; the number of species is very high (207) in a relatively small area.	*Schmitzia hiscockiana*
44	Oyster Bank, Tremadog Bay, Caernarvon	SH3530	MNR; SAC	A, C		The Oyster Bank at Pwllheli is a sheltered area of mud and sand bottom with stabilised pebbles and shells including small cobbles and pebbles in a muddy matrix. The site lies at a depth of 8 m within Tremadog Bay which is in the Pen Llŷn Sarnau marine SAC. It is the only known site in the UK for *Anotrichium barbatum*. *Dermocorynus montagnei* is a truly rare species confined to gravel.	*Anotrichium barbatum* *Dermocorynus montagnei* *Polysiphonia furcellata* *Osmunda truncata*
46	The Sarnau, Caernarvon	Various (as stated by CCW)	SAC	A?, B, D?	High?	The Sarnau is comprised of three unusual shallow subtidal reefs (Sarn Badrig, Sarn-y-Bwch and Sarn Cynfelyn) which extend south-west into Cardigan Bay. The largest of the reefs, Sarn Badrig, extends about 24 km offshore. The Sarnau are thought to be the remains of glacial moraines formed during the last glaciation, and are considered to be unique sublittoral reef features in the British Isles (Coastal Geomorphology Partnership) and are composed entirely of boulders, cobbles and pebbles with various grades of sediments mixed in. The communities of the Sarnau are typically composed of ephemeral seaweed species that grow rapidly during the summer or are very robust species that resist scour by sand mobilised by winter storms.	*Atractophora hypnoides* *Ceramium cimbricum* *Compsothamnion gracillimum* *Gloiosiphonia capillaris* *Polysiphonia devoniensis* *Rhodymenia delicatula*
48	Porth Cwyfan, Caernarvon	SH335684	SSSI	B?, D		Two small bays and an island (with causeway) on the west coast of Anglesey. The shore is made up of complex rugged platforms which support a wide range of habitats including rockpools, overhangs and boulders. The platforms are covered with a dense canopy of fucoids, kelps and red algae. The site was nominated because of its diverse algal community and for *Cystoseira*.	*Osmundea truncata*
49	Rhosneigr Reef, Anglesey	SH3172	SSSI; AONB	B		A series of reefs and pools on the west coast of Anglesey at Rhosneigr. It was designated as an SSSI in 1980 for its rich algal assemblage. This site under threat from non-native species e.g., *Sargassum muticum.*	
50	Wear Point, Caernarvon	SM94119429 / SM939044	SAC	A?		Low shore muddy shingle spit.	*Chondracanthus teedei*
	SCOTLAND						

52	Lamlash Bay, Arran, Argyll	NS030315	MPA	A, B		Some of the seabed of Lamlash Bay consists of soft substrata including patches of seagrass. There are also the remains of a deep maerl bed, which although has been extensively damaged by scallop dredging since the 1970s, still has significant area of maerl. More recently, previously undiscovered patches of maerl were found in excellent condition. There are also *Zostera* spp.	*Lithothamnion corallioides*
53	Isle of Cumbrae	NS160540		B	High	This site has a high diversity of algae and a long and extensive history of study, especially since the mid 19th C. There are large collections in the BM. Maerl has been found between the Cumbrae Islands. It is the type locality for species of algae including *Petrocelis hennedyi* (Harvey) Batters.	
54	Loch Sween, Argyll	NR720820	MCA	A		This site has diverse and unusual algal assemblages.	*Phymatolithon calcareum*
55	Tiree, Argyll	NM980450		B		This site is a diversity hotspot and is the northernmost limit for some algal species.	
56	Sound of Islay, Inner Hebrides	NR435700		C		Site has maerl beds.	
58	Sound of Arisaig, Inner Hebrides	NM650800	SAC; SSSI	A, C		The site is of sublittoral sandbanks on the west coast of Scotland with some of the most extensive beds of maerl in the UK. There are rich communities associated with the maerl, including several rare and scarce species, such as the alga *Gloiosiphonia capillaris*. *Zostera marina* is found on shallow sand in outer Loch Ailort. The site is an important part of the transition from southern to northern communities that occurs along the coast of the UK.	*Ascophyllum nodosum* ecad *mackayi* *Gloiosiphonia capillaris*
59	Barra/Eriskay Sound, Outer Hebrides	NF760080	dSAC	B, C		This site is a diversity hotspot and supports maerl beds.	
60	Loch Maddy complex, north Uist, Outer Hebrides (including Loch Eport, North Uist, Outer Hebrides)	NF930680/ NF880645	SAC	A, C		This site is representative of fjardic sea lochs on the coast of north-west Scotland. There are numerous rocks and islands. There are dense beds of knotted wrack *Ascophyllum nodosum* ecad *mackayi* and a variety of kelp forest types that illustrate the wave exposure gradient in the loch. There are also maerl communities.	*Ascophyllum nodosum* ecad *mackayi* *Callophyllis cristata*
62	Sound of Harris, Outer Hebrides	NF970810		B, D		This site is a possible diversity hotspot.	
67	Loch Duich Head, Ross and Cromerty	NG930190	SAC; SSSI	C		The reef system at this site is considered to be one of the best areas in the UK. There is maerl.	*Ascophyllum nodosum* ecad *mackayi* *Cruoria cruoriaeformis*

68	Loch Eriboll, Sutherland	NC430590		A? C		This site is a diversity hotspot for uncommon sublittoral algae. Maerl.	
71	Sullom Voe/Lerwick, Shetland	Sullom Voe: HU380757	SAC	A	High	Sullom Voe is the only Scottish example of a ria. The flora is boreal-arctic (northern) and species-rich. There is a good recent history of study over the past 30-40 years. There are detached *Phyllophora* communities and unusual forms of *Saccharina latissima.* There is maerl at the mouth of the voe. There is a good check list for the area and the exceptionally long list of rare or threatened species reflects the intensity of study by algal experts at the site. *Fucus distichus* (as *evanescens*) occurs in the harbour.	*Acrochaetium nemalii* *Acrothrix gracilis* *Antithamnionella floccosa* *Blastophysa rhizopus* *Botrytella micromora* *Capsosiphon fulvescens* *Colacodictyon reticulatum* *Dictyosiphon chordaria* *Ulva ralfsii* *Epicladia perforans* *Gloiosiphonia capillaris* *Hincksia ovata* *Leptonella fasciculata* *Mesogloia lanosa* *Myrionema papillosum* *Phaeostroma pustulosum* *Phycocelis crouaniorum* *Pringsheimiella scutata* *Psuedendoclonium fucicola* *Rhodophysema georgei* *Scageliothamnion pusillum* *Stictyosiphon soriferus* *Streblonema fasciculatum* *Streblonema infestans* *Streblonema parasiticum* *Titanoderma laminariae*
75	St. Andrews, Fife	NO5318		B, C		This site has a long history of collecting, is a diversity hotspot and has a unique rockpool flora.	
77	Pettico Wick, Scottish Borders	NT9069		B, D		Mixture of sand, shingle, boulders and bedrock. This site has a long history of study of sublittoral algae and is a diversity hotspot.	
78	St. Abbs Head, Scottish Borders	NT9169	NNR; MNR; VMR; SAC	B, C		Rocky coastline with exposed shores. Sublittoral habitats include bedrock, boulders, caves, reefs, gravel and sand further offshore. This site is a diversity hotspot especially for sublittoral algae. Generally recognised as a site for marine biological studies.	
	NORTHERN IRELAND						

82	Strangford Lough, Co. Down	J589496	MNR; SAC	A, B	High	The southern half of the site has high algal diversity for eastern Ireland, maerl beds and a long history of research. All *Zostera* species present.	*Aglaothamnion tripinnatum* *Compsothamnion gracillimum* *Feldmannia paradoxa* *Pringsheimiella scutata* *Rhodochorton concrescens* *Rhodymenia delicatula* *Ulva ralfsii*
	ISLE OF MAN						
83	Isle of Man	SC360854 (centre of Isle of Man)		B	High	Notably Port Erin and Port St Mary. There is a diverse range of habitats from sheltered to exposed. There is a continuous history from 19th C with collections at the BM. *Odonthalia dentata* and *Porphyra amplissima* are at their southern limits. It is the type locality for *Lithophyllum nitorum* W.H. Adey & P.J. Adey.	*Cruoria cruoriaeformis* *Lithothamnion corallioides*

Table 4.3 Sites nominated as potential IPAs for marine algae in the UK, but for which more data are required (data deficient). Site number refers to the map in Figure 4.1.

	Site	Grid ref.	Status	Qualifying criteria	No. of species	Site description	Threatened or rare species
	ENGLAND						
2	Low Newton-by-the-Sea, Northumberland	NU2424		D		Also known as St Mary's, Newton Haven. Bedrock, boulders and sand. This site has a long history of study.	
3	St. Mary's Island, North Tyneside, Durham	NZ3575		D		Also known as Bait Island. Rocky shore. This site has a long history of study and is a diversity hot spot. It is the type locality and only known site for *Acrochaetium sanctae-mariae* (Darbishire) G. Hamel.	*Acrochaetium sanctae-mariae*
6	Sheringham, Runton and Cromer, Norfolk	TG145435 to TG225 425. 2-3 km centred on West Runton: TG185435		D		Includes Robin Friend, West Runton, East Runton and Cromer. Rock outcrops with sand, consolidated gravel and shingle. It is a significant eastern site because it is an isolated area of 2-3 km of chalk on an otherwise soft coastline. It has a long history of algal study with very old historical collections including by Dawson Turner (1775-1858) and has been a focus for algal growth studies, including by I. Tittley, 1980s-1990s.	*Helminthocladia calvadosii* – an early record from Sheringham, 1797.
8	Harwich, Essex	TM262320		D		An isolated outcrop of cement stone, which was formerly widespread but apparently decreasing; a comparable habitat in Felixstowe has been destroyed. The site has a long history of study including by Samuel Dale Padina (1700s). There are some unusual species, including *Cutleria multifida* and its other life history phase, *Aglaozonia*. It is the type locality for *Osmundea pinnatifida* (Hudson) Stackhouse.	
12	Folkstone/East Wear Bay/Dover			D		A site of diverse geology, including hard rocky substrata, in south east England, including lower greens and, gault and chalk with very diverse microhabitats and exposures. This is reflected in the algae. There are good communities of species which are uncommon in south east England, including a natural zonation of brown algae (*Pelvetia canaliculata* - only place in south east England, *Ascophyllum nodosum*, fucoids and kelps) and a good diversity of species (*Choriocolax polysiphoniae* (very rare at the site), *Chorda filum, Scinaia forcellata, Mastocarpus stellatus*).	
13	Hastings, Sussex	TQ813092		D	Medium	A site with unusual geology of Wealden series of rocks. Algal communities, patchy and restricted in this part of Sussex, are present on intertidal reefs. There is a good historical record. It is the type locality for *Rhodymenia holmesii* Ardissone.	
16	Mixon Hole, Sussex	SZ865902	Marine SNCI	D	44 species listed	Limestone capping a clay bed exposed as a clay cliff face off the coast of Chichester and Selsey Bill. It has been referred to in diving reports. There are unusual marine communities including algae. There is no historical record.	

17	Hayling Island/ Solent/ Portsmouth, Hampshire	SU683017 (centre of Langstone Harbour)	Part of SAC	D		An area of consolidated boulder gravel, saltmarshes, seagrass and man-made habitats including a large marina. The site is potentially threatened by introduced species. An unusual diversity of algae occurs in the various harbours. Algal epiphytes in the marina. Alien algae were first recorded in the Solent area: *Sargassum muticum, Undaria pinnatifida, Grateloupia turuturu, Solieria chordalis, Sarcodiotheca gaudichaudii*.	*Chondria coerulescens*
34	Lilstock, Somerset	ST1644	SSSI	D		A series of Jurassic limestone ledges. Reasonably diverse flora given location up the Bristol Channel. Site of recent research into green endophytes of *Chondrus crispus* (Bown et al., 2003).	
35	Walney Island, South Cumbria, Cumberland (might be deleted)	SD184665 (centre of Walney Island)	SSSI	D		A large rock in vast area of mud. There are historical records. It is the type locality for *Dictyota dichotoma* (Hudson) J.V. Lamouroux. There are *Zostera* communities on one side and *Sabellaria* communities on other side. There are very rich algal communities on scars nearby, e.g. Roa Island.	
	WALES						
45	The Inland Sea, Caernarvon	SH275795	SSSI	D		The Inland Sea is a permanent water body between Anglesey and Holy Island. It has two restricted man-made in and out flow points and never dries to a channel at low water. The shores of the Inland Sea are a mixture of sheltered bedrock, mud and saltmarsh. It appears to be a site with southern species, e.g. *Griffithsia devoniensis, Gracilaria bursa-pastoris* (the most northern record for this species).	
47	Pennar Gut, Caernarvon	SM943030	SAC	D		Exceptionally rare habitats supporting particularly unusual biotope combinations and/or species assemblages; where the actual biotopes or assemblages may not in themselves be of the overriding importance, but the physical condition which they represent is the primary importance.	
	SCOTLAND						
51	Loch Ryan/ Stranraer, Wigtown	NX056662 NX06-61		D?		A site with a long history of study and unusual assemblages. It is reported to be the most northerly record for *Spyridia filamentosa* in the UK.	
57	Coll, Inner Hebrides	NM200570					
61	Rockall, Outer Hebrides	57°35’48’’N, 13°41’19’’W	SSSI	D?		Isolated granite rock in sea. There are few collections although some at BM. *Alaria esculenta* has been reported from 33 m depth.	
63	St. Kilda, Outer Hebrides	NF090990	SAC, World Heritage Site	D		An isolated site with a good range of habitats from sheltered to exposed. It is reported to be the most northern limit of *Carpomitra costata*. The site appears to be understudied for the algae.	
64	Dunvegan, Skye	NG255468	SAC	D			*Lithothamnion corallioides* (qv note in Irvine &

							Chamberlain, 1994)
65	Loch na h'Airde, Skye	NG393163		D		This site has unusual algal assemblages.	
66	Ord, Skye	NG616132		D		This site has unusual algal assemblages.	
69	Stenness/Skaill, Kirkwall, Orkney		SAC			This area has a good diversity of habitats, communities and species. Loch Stenness is an inland tidal, saline lake with unusual algal communities. Skaill has a long history of study with good historical collections to early 19th C. There are collections from Kirkwall, but the site has changed and some habitats are lost. *Fucus distichus* is around the southern end of its range here.	
70	Otterswick, Sanday, Orkney	HY690428		D		The site has unusual algal assemblage. There are old collections in BM.	
72	Aberdeen	NJ7964-NJ7262		D		This area has not been localised to any particular site. It covers Gardenstown in the north to the tidal limit of the North Esk estuary in the south. There are historical records (see Wilkinson, 1979).	*Antithamnionella floccosa* *Prasiola furfuracea*
73	Elie to Anstruther, Fife	Coast between NO491001-NO564036		D		An area of rocky reef, pool and lagoons. There are very good historical collections in mid to late 19th C. Comparisons of recent and old studies suggest that the flora is stable and that the diversity of species is similar to those that were found in Edinburgh in the past but are now lost.	
74	Isle of May, Fife	NT655994	SAC	D	High	A site with a good diversity of habitats.	
76	Lamberton Beach, Scottish Borders	NT9758		D		Rocky shore site with a long history of study.	
	NORTHERN IRELAND						
79	Rathlin Island, Co. Antrim	SAC = D133518	SAC; SSSI/ ASSI; NNR		High	An area of intertidal and subtidal rock, including rocky reefs with caves. There is *Zostera marina*.	*Compsothamnion gracillimum* *Cruoria cruoriaeformis* *Desmarestia dresnayi* *Pringsheimiella scutata* *Rhodymenia delicatula* *Schmitzia hiscockiana*
80	Barr Hall Bay, Co. Down	J6146					
81	Kearney Point, Co. Down	J6451					

4.32 Determining a list of 'rare algae'

Table 4.4 is a provisional list of 'rare' species with the initial category based on species information in Hardy & Guiry (2003) and personal knowledge, and the result after assessment by experts in the different algal groups. Prior to the assessment of all the species on the list, almost half of the British flora was listed (Table 4.5). After assessment, this was down to 19%. For the brown algae, 35% of species were assessed as rare but none of the species was data deficient, whereas overall 10% of the flora was deemed data deficient.

Table 4.4 Provisional list of 'rare' marine red, brown and green seaweed species in the UK flora. Rarity status before and after assessment by experts is shown.

Assessors: Juliet Brodie, Christian Boedeker, Yvonne Chamberlain, Robert Fletcher, Linda Irvine, Frederik Leliaert, Christine A. Maggs, Fabio Rindi, Barbara Rinkel.

R = rare; U = under-recorded; I = identification problems; T = taxonomic problem; L = localized; N = northern; S = southern; A = alien; dd = data deficient; C = common; BAP = Biodiversity Action Plan species; Ab = abundant; LC = locally common.

SPECIES	**Initial category**	**After assessment**
RED ALGAE		
Acrochaetium battersianum G. Hamel	R	dd
Acrochaetium minutum (Suhr) G. Hamel	U	dd
Acr n Acrochaetium nemalii (De Notaris ex L. Dufour) Bornet	R	R
Agardhiella subulata (C. Agardh) Kraft & M.J. Wynne	A	A
Aglaothamnion bipinnatum (P.L. Crouan & H.M. Crouan) Feldmann-Mazoyer	U, L	R but not threatened
Aglaothamnion diaphanum L'Hardy Halos & Maggs	R	U
Aglaothamnion feldmanniae Halos	S	Possible A
Aglaothamnion gallicum (Nägeli) Halos ex Ardré	U, S	C
Aglaothamnion priceanum Maggs, Guiry & Rueness	R	U
Aglaothamnion pseudobyssoides (P.L. Crouan & H.M. Crouan) Halos	R, S, U	R
Aglaothamnion tripinnatum (C. Agardh) Feldmann-Mazoyer	S	Fairly R
Anotrichium barbatum (C. Agardh) Nägeli	R, S	BAP species
Anotrichium furcellatum (J. Agardh) Baldock	R, I, S, A	A
Antithamnion villosum (Kützing) Athanasiadis in Maggs & Hommersand	S	C
Antithamnionella floccosa (O.F. Müller) Whittick	R, N	R
Antithamnionella spirographidis (Schiffner) Wollaston	I, A	A
Antithamnionella ternifolia (J.D. Hooker & Harvey) Lyle	I, A	A
Apoglossocolax pusilla Maggs & Hommersand	R	R
Asterocolax erythroglossi J. Feldmann & G. Feldmann	R	C
Atractophora hypnoides P.L. Crouan & H.M. Crouan	R	R
Bornetia secundiflora (J. Agardh) Thuret	S	R
Callophyllis cristata (C. Agardh) Kützing	U, N	R
Calosiphonia vermicularis (J. Agardh) F. Schmitz	S	R
Ceramium cimbricum H.E. Peterson	R, U, T	R
Ceramium circinatum (Kützing) J. Agardh	R, I, S	extremely R, declined, Kimmeridge only
Ceramium flaccidum (Kützing) Ardissone	U	Not C
Ceramium pallidum (Nägeli ex Kützing) Maggs & Hommersand	U	Extremely C
Ceratocolax hartzii Rosenvinge	N	U

Chondracanthus teedei (Mertens ex Roth) Kützing	S	S
Chondria coerulescens (J. Agardh) Falkenberg	S	S
Choreonema thuretii (Bornet) F. Schmitz	U	dd
Chroodactylon ornatum (C. Agardh) Basson	R, U	dd
Colacodictyon reticulatum (Batters) Feldmann	R, U	dd
Colaconema caespitosum (J. Agardh) Jackleman, Stegenga & J.J. Bolton	U	dd
Colaconema endophyticum (Batters) J.T. Harper & G.W. Saunders	U	dd
Compsothamnion decompositum (J. Agardh) Maggs & L'Hardy-Halos	Not recorded from Britain	Not recorded from Britain
Compsothamnion gracillimum De Toni	R, U, I	Not C
Compsothamnion thuyoides (J.E. Smith) Nägeli	U	C - Ab
Corallina elongata J. Ellis & Solander	U, S, I	Not C
Crouania attenuata (C. Agardh) J. Agardh	R, S	S
Cruoria cruoriaeformis (P.L. Crouan & H.M. Crouan) Denizot	L	On maerl, BAP
Cryptonemia seminervis (C. Agardh) J. Agardh	R, S	R
Dasya corymbifera J. Agardh	R, I, S	Has declined
Dasya ocellata (Grateloup) Harvey	R., S	Relatively C
Dasya punicea (Zanardini) Meneghini ex Zanardini	R, I, S	Very R
Dermocorynus montagnei P.L. Crouan & H.M. Crouan	R, U	Truly R - gravel
Drachiella minuta (Kylin) Maggs & Hommersand	R, U	S, truly R
Erythrocladia irregularis Rosenvinge	U	C
Erythrotrichia bertholdii Batters	R, U	dd
Erythrotrichia investiens (Zanardini) Bornet	R, U, T	dd
Erythrotrichia reflexa (P.L. Crouan & H.M. Crouan) Thuret ex De Toni	R, U, S	dd
Erythrotrichia welwitschii (Ruprecht) Batters	U	dd
Erythropeltis discigera v. *flustrae* Batters	R, U, I, S	dd
Exilicrusta parva Y.M. Chamberlain	R, I, S	dd
Gastroclonium reflexum (Chauvin) Kützing	R, S	C
Gelidiella calcicola Maggs & Guiry	U	On maerl
Gelidium corneum (Hudson) J.V. Lamouroux	R, S	T, dd
Gelidium maggsiae Rico & Guiry	Not recorded from Britain	Milford Haven
Gigartina pistillata (S.G. Gmelin) Stackhouse	S	R
Gonimophyllum buffhamii Batters	U	C
Gracilaria bursa-pastoris (S.G. Gmelin) P. C. Silva	S	S
Gracilaria multipartita (Clemente) Harvey	S	S
Gracilariopsis longissima (S.G. Gmelin) Steentoft, L.M. Irvine & Farnham	U, I	Ab
Grateloupia dichotoma J. Agardh	S	R
Grateloupia luxurians (A. Gepp & E.S. Gepp) de Clerk *et al.*	R, A	A
Grateloupia turuturu Yamada	R, A	A
Haemescharia hennedyi (Harvey) K.L. Vinogradova & T. Yacovleva	R, U	U
Halosacciocolax kjellmanii S. Lund	R, U	C
Halymenia latifolia P.L. Crouan & H.M. Crouan ex Kützing	L	R? On maerl
Helminthocladia calvadosii (J.V. Lamouroux ex Duby) Setchell	R	R
Holmsella pachyderma (Reinsch) Sturch	R, U	C
Hydrolithon boreale (Foslie) Y.M. Chamberlain	U	dd
Hydrolithon cruciatum (Bressan) Y.M. Chamberlain	R	dd
Hydrolithon samoense (Foslie) Keats & Y.M. Chamberlain	R, T	dd
Hydrolithon sargassi (Foslie) Y.M. Chamberlain	T, S	dd
Itonoa marginifera Masuda & Guiry	R	R, S
Laurencia pyramidalis Bory de Saint-Vincent ex Kützing	R, S	R, declined
Leptophytum bornetii (Foslie) Adey	R	dd
Leptophytum elatum Y.M. Chamberlain	R	dd
Leptophytum leave (Strömfelt) Adey	N	dd; C in N; deep water species
Lithophyllum duckerae Woelkerling	Only one subfossil	Only one subfossil

	specimen in BM	specimen in BM
Lithophyllum fasciculatum (Lamarck) Foslie	R	dd; no recent material or records confirmed
Lithophyllum hibernicum Foslie	Not recorded from Britain	Not recorded from Britain
Lithophyllum nitorum W.H. Adey & P.J. Adey	R	dd
Lithothamnion lemoineae Adey	R, N	dd
Lophosiphonia reptabunda (Suhr) Kylin	R, S	R? Threatened, declined
Meiodiscus spetsbergensis Saunders & McLachlan	R, T, N	dd
Microcladia glandulosa (Solander ex Turner) Greville	R, S	R, no decline
Neevea repens Batters	R, U	dd
Osmundea osmunda (S.G. Gmelin) K.W. Nam & Maggs	U	C
Osmundea ramossisima (Oeder) Athanasiadis	R, I	C
Osmundea truncata (Kützing) K.W. Nam & Maggs	R	R (2 sites)
Peyssonnelia armorica (P.L. Crouan & H.M. Crouan) Weber-van Bosse	R, S	Very R
Peyssonnelia atropurpurea P.L. Crouan & H.M. Crouan	S	S
Peyssonnelia immersa Maggs & L.M. Irvine	U	U
Phymatolithon brunneum Y.M. Chamberlain	R, S	dd; West Angle Bay, Wales
Pikea californica Harvey	S, A	A
Plagiospora gracilis Kuckuck	U	U
Pneophyllum confervicola (Kützing) Y.M. Chamberlain	U	dd
Pneophyllum coronatum (Rosanoff) Penrose	U	dd
Pneophyllum limitatum (Foslie) Y.M. Chamberlain	U	dd
Pneophyllum lobescens Y.M. Chamberlain	U	dd
Pneophyllum myriocarpum (P.L. Crouan & H.M. Crouan) Y.M. Chamberlain	U	dd
Polysiphonia ceramiaeformis P.L. Crouan & H.M. Crouan	R	R
Polysiphonia denudata (Dillwyn) Greville ex Harvey	R, S	S
Polysiphonia devoniensis Maggs & Hommersand	R, S	S
Polysiphonia foetidissima Cocks ex Bornet	R	Declined; found once in Wales
Polysiphonia furcellata (C. Agardh) Harvey	R	R
Polysiphonia harveyi J. Bailey	U, A	A
Polysiphonia opaca (C. Agardh) Moris & De Notarius	R, S	R; declined, Jersey
Polysiphonia simulans Harvey	R, S	Uncommon
Polysiphonia subulifera (C. Agardh) Harvey	R, L	R, except in Ireland; maerl
Porphyra drachii J. Feldmann	U, A	dd
Porphyridium purpureum (Bory de Saint-Vincent) K. Drew & Ross	U	dd
Porphyrostromium boryanum (Montagne) P.C. Silva	R, U	dd
Porphyrostromium ciliare (Carmichael) M.J. Wynne	U	dd
Pterosiphonia ardreana Maggs & Hommersand	R	R, S
Pterosiphonia pennata (C. Agardh) Sauvageau	R, S	R, S
Pterosiphonia pinnulata (Kützing) Maggs & Hommersand	R	R, A?
Pterothamnion crispum (Ducluzeau) Nägeli	R, I, S	Fairly C
Pterothamnion polyacanthum (Kützing) Nägeli	R	Not recorded from Britain
Ptilothamnion sphaericum (P.L. Crouan & H.M. Crouan ex J. Agardh) Maggs & Hommersand	R	R
Rhodella maculata Evans	R	dd
Rhodochorton concrescens K.M. Drew	R, U	dd
Rhodophysema feldmannii Cabioch	Not recorded	Not recorded

	from Britain	from Britain
Rhodophysema georgei Batters	R	R; on Zostera
Rhodymenia delicatula P. Dangeard	R	R
Sahlingia subintegra (Rosenvinge) Kornmann	U	C
Sarcodiotheca gaudichaudii (Montagne) Gabrielson	R, A	A
Scagelothamnion pusillum (Ruprecht) Athanasiadis	R, I	R, N
Schmitzia hiscockiana Maggs & Guiry	R	R
Schmitzia neapolitana (Berthold) Lagerheim ex P.C. Silva	R	R
Solieria chordalis (C. Agardh) J. Agardh	R, A	A
Spermothamnion strictum (C. Agardh) Ardissone	R	R
Stylonema alsidii (Zanardini) K. Drew	U	C
Titanoderma corallinae (P.L. Crouan & H.M. Crouan) Woelkerling, Y.M. Chamberlain & P. C. Silva	U	Quite C
Titanoderma laminariae (P.L. Crouan & H.M. Crouan) Y.M. Chamberlain	R	R
Tsengia bairdii (Farlow) K.C. Fan & Y.P. Fan	R	R; occurs intermittantly
BROWN ALGAE		
Acrothrix gracilis Kylin	R	R
Asperococcus ensiformis (Delle Chiaje) M.J. Wynne	R	R
Asperococcus scaber Kuckuck	R, U	R
Botrytella micromora Bory de Saint-Vincent	R	R
Botrytella reinboldii (Reinke) Kornmann & Sahling	R	R
Buffhamia speciosa Batters	R	R
Chilionema hispanicum (Sauvageau) R.L. Fletcher	R, U	R
Chilionema ocellatum (Kützing) Kornmann	U	U
Choristocarpus tenellus Zanardini	R	R; on gravel
Cladosiphon contortus (Thuret) Kylin	R	R
Compsonema microspongium (Batters) Kornmann	R	R
Compsonema minutum (C. Agardh) Kornmann	R, U	R
Compsonema saxicolum (Kuckuck) Kornmann	R, U	U
Corynophloea crispa (Harvey) Kuckuck	U?	U
Cylindrocarpus microscopicus P.L.Crouan & H.M. Crouan	R	R
Cystoseira humilis v. *myriophylloides* (Sauvageau) J.H. Price & D.M. John	R, S	R
Desmarestia dresnayi J.V. Lamouroux ex Leman	U	RR
Dichosporangium chordariae Wollney	R, N	R
Dictyosiphon ekmanii Areschoug	N	N, R
Dictyota spiralis Montagne	U, I, S	U, I, S
Elachista stellaris Areshoug	R, S	R, S
Felmannia irregularis (Kützing) G. Hamel	U	U
Feldmannia lebelii (Areschoug ex P.L. Crouan & H.M. Crouan) G. Hamel	R	R
Feldmannia paradoxa (Montagne) G. Hamel	R, U	R
Fucus cottonii M.J. Wynne & Magne	L	C in W. Scotland
Fucus distichus Linnaeus	N	N Scotland
Fucus evanescens C. Agardh	R, N	Not in UK; nomenclatural problem
Giraudia sphacelarioides Derbès & Solier	R	R
Halothrix lumbricalis (Kützing) Reinke	R, U	R
Haplospora globosa Kjellman	R	R
Herponema solitarium (Sauvageau) G. Hamel	Not recorded in Britain	Not recorded in Britain
Hinksia fenestrata (Harevey ex Berkeley) P.C. Silva	R, N	R
Hincksia mitchelliae (Harvey) P.C. Silva	U	U
Hincksia ovata (Kjellman) P.C. Silva	R	R, U
Hincksia sandriana (Zanardini) P.C. Silva	U	U

Hincksia secunda (Kützing) P.C. Silva	U	U
Kuetzingiella battersii (Bornet & Sauvageau) Kornmann	R	R
Kuetzingiella holmesii (Batters) Kornmann	R	R
Laminaria ochroleuca Bachelot de la Pylaie	S	LC, SW
Laminariocolax aecidioides (Rosenvinge) Burkhardt & Peters	U	U
Leblondiella densa (Batters) G. Hamel	R	R
Leptonematella fasciculata (Rienke) P.C. Silva	R	R
Mesogloia lanosa P.L. Crouan & H.M. Crouan	R	R
Microcoryne ocellata Strömfelt	R	R
Microspongium globosum Reinke	R	R
Microspongium immersum (Levring) P.M. Pedersen	R	R
Mikrosyphar polysiphoniae Kuckuck	U	U
Mikrosyphar porphyrae Kuckuck	U	U
Myriactula areschougii (P.L. Crouan & H.M. Crouan) G. Hamel	U	U
Myriactula chordae (J.E. Areschoug) Levring	U	U
Myriactula clandestina (P.L. Crouan & H.M. Crouan) Feldmann	U	U
Myriactula haydenii (Gatty) Levring	R, U	R, U
Myriactula stellulata (Harvey) Levring	R	R, U
Myriocladia lovenii J. Agardh	R	R
Myriocladia tomentosa P.L. Crouan & H.M. Crouan	R	R
Myrionema corunnae Sauvageau	U	U
Myrionema liechtensternii Hauck	U	R, U
Myrionema magnusii (Sauvageau) Loiseaux	R	U
Myrionema papillosum Sauvageau	R, I	R, I
Padina pavonica (Linnaeus) Thivy	S	S
Petalonia filiformis (Batters) Kuntze	U	U
Petroderma maculiforme (Wollny) Kuckuck	U	U
Phaeostroma pustulosum Kuckuck	R, U	R, U?
Phycocelis crouaniorum Athanasiadis	R, U	R, U?
Phycocelis foecunda Strömfelt	R, U	U
Pilinia rimosa Kützing	R	R, U
Pleurocladia lacustris A. Braun	R	R
Pogotrichum filiforme Rienke	U	U
Protectocarpus speciosus (Børgesen) Kuckuck ex Kornmann	U	U
Pseudolithoderma roscoffense Loiseaux	R, I, S	S, U, I
Punctaria crispata (Kützing) Batters	R, S	R, S
Punctaria tenuissima (C. Agarh) Greville	U	U
Scytosiphon dotyi M.J. Wynne	R, U	R, U
Sorapion kjellmanii (Wille) Rosenvinge	R, I	R, I
Sorapion simulans Kuckuck	R, U	R
Sphacelaria caespitula Lyngbye	R, N	R, N
Sphacelaria mirabilis (Reinke ex Batters) Prud'homme van Reine	R	R, N
Sphacelaria nana Nägeli ex Kützing	R	R
Sphacelaria racemosa Greville	R	R
Sphacelaria rigidula Kützing	U	U
Sphacelaria tribuloides Meneghini	R	R
Sphaerotrichia divaricata (C. Agardh) Kylin	R	R
Stictyosiphon soriferus (Reinke) Rosenvinge	R, N	R, not north
Stilopsis lejolisii (Thuret) Kuckuck & Nienburg ex G. Hamel	R	R
Stragularia spongiocarpa (Batters) G. Hamel	R	R
Streblonema breve (Sauvageau) De Toni	R	R
Streblonema fasciculatum Thuret	R	R
Streblonema helophorum (Rosenvinge) Batters	R	R
Streblonema infestans (H. Gran) Batters	U	R
Streblonema intestinum (Reinsch) Batters	R	R
Streblonema myriocladiae (P.L. Crouan & H.M. Crouan) G.R. South & Tittley	R	R
Streblonema parasiticum (Sauvageau) Levring	R, U	R

Streblonema stilophorae (P.L. Crouan & H.M. Crouan) Kylin	R, S	R
Strepsithalia buffhamiana (Batters) Batters	R	R
Symphyocarpus strangulans Rosenvinge	R	R
Zanardinia typus (Nardo) G. Furnari	S	Declined
GREEN ALGAE		
Acrochaete heteroclada Correa & Nielsen	U, T	U
Acrochaete leptochaete (Huber) R. Nielsen	R	R, U
Acrochaete operculata Correa & Nielsen	U, T	dd
Acrochaete repens Pringsheim	U, T	C, T
Acrochaete wittrockii (Wille) Nielsen	U	dd
Blastophysa rhizopus Reinke	R, T	dd
Bolbocoleon piliferum Pringsheim	U	U
Capsosiphon fulvescens (C. Agardh) Setchell & N.L. Gardner	U, I	dd
Chaetomorpha aerea (Dillwyn) Kützing	U, I	dd
Chaetomorpha crassa (C. Agardh) Kützing	I, T	dd
Characium marinum Kjellman	R, U	dd
Chlorochytrium cohnii E.P. Wright	U	dd
Chlorochytrium dermatocolax Reinke	R, U, N	dd
Chlorochytrium facciolae (Borzi) Bristol	R, U	dd
Cladophora aegagropila (Linnaeus) Trevisan	U	brackish
Cladophora battersii Hoek	R	R, L
Cladophora coelothrix Kützing	R	R, L
Cladophora dalmatica Kützing	R, U, I	I, U?
Cladophora flexuosa (O.F. Müller) Kützing	R, U, I	I, U?
Cladophora prolifera (Roth) Kützing	R, U, I	R, L
Cladophora retroflexa (Bonnemaison ex P.L. Crouan & H.M. Crouan) Hoek	R, U	R. L
Cladophora vagabunda (Linnaeus) Hoek	R, U, I	C?
Codium adhaerens C. Agardh	R	R; declined
Codium bursa (Linneaus) C. Agardh	R	R; declined
Codium vermilara (Olivi) Delle Chiaje	R, U, S	R; declined
Derbesia marina (Lyngbye) Solier	U, I	dd
Derbesia tenuissima (Moris & De Notaris) P.L. Crouan & H.M. Crouan	R, I	R? dd
Epicladia perforans (Huber) R. Nielsen	I	dd
Ochlochaete hystrix Thwaites ex Harvey	U	dd
Ostreobium queketii Bornet & Flahault	U	C
Phaeophila dendroides (P.L. Crouan & H.M. Crouan) Batters	U, T	dd
Pilinia rimosa Kützing	T	dd
Prasiola calophylla (Carmichael ex Greville) Kützing		R
Prasiola crispa (Lightfoot) Kützing	U	LC
Prasiola furfuracea (Mertens ex Hornemann) Kützing	U, I, N	R
Pringsheimiella scutata (Reinke) Höhnel ex Marchewianka	R, U, I	dd
Protomonostroma undulatum (Wittrock) K.L. Vinogradova	R	dd
Psuedendoclonium fucicola (Rosenvinge) R. Nielsen	U, T	dd
Pseudendoclonium submarinum Wille	U, T	dd
Pseudopringsheimia confluens (Rosenvinge) Wille	R, U, I	dd
Rosenvingiella polyrhiza (Rosenvinge) P.C. Silva	U	LC, N
Sykidion dyeri E.P. Wright	R, U, I	Dd
Tellamia contorta Batters (incl intricata)	U	C
Ulothrix implexa (Kützing) Kützing	U	C
Ulva ralfsii (Harvey) Le Jolis	R, U, T	R?
Ulva rigida C. Agardh	U, I	C
Ulvella lens P.L. Crouan & H.M. Crouan	U	Dd
Umbraulva olivascens (P.L.J. Dangeard) E.H. Bae & I.K. Lee	U, I, S	A?
Urospora neglecta (Kornmann) Lokhorst & Trask	R	Dd
Urospora wormskioldii (Mertens ex Hornemann) Rosenvinge	U	C

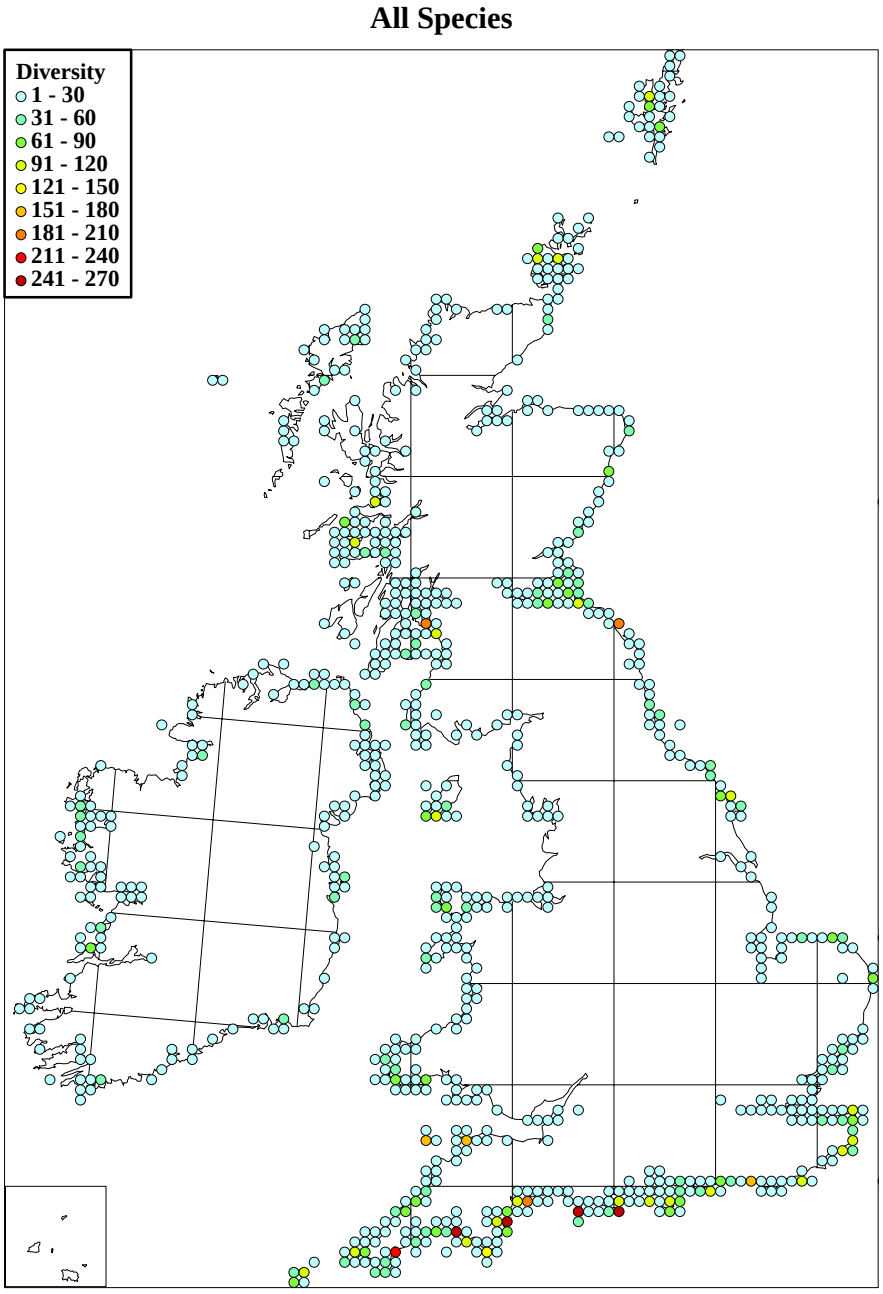
Table 4.5 Assessment of the proportion of the flora that are rare or data deficient.

Algal group	Number of species in the UK	Proportion of the flora assessed as rare before assessment (%)	Proportion of the flora assessed as rare after assessment (%)	Proportion of the flora assessed as data deficient after assessment (%)
Red	339	41	12.5	11
Brown	185	53.5	35	0
Green	100	52	10	26
Total	624	47	19	10

4.33 Consensus map

The consensus map is shown in Fig. 4.2. The majority of sites with a high diversity are scattered along the south-west and southern coasts of England, although several northern sites, notably Berwick upon Tweed and the Clyde (Millport) also have large numbers of species recorded from them.

Figure 4.2 Consensus map of all species for all sites based on Natural History Museum herbarium records.



4.34 Selection of proposed European IPAs

The first 9 IPAs submitted are listed in Table 4.1. There were 6 sites from England, 1 from Scotland, 1 from Wales and 1 from Northern Ireland. With the exception of two sites (Peveril Point to Durlson, and the Isle of Cumbrae), all sites selected are within an area that has a European conservation designation.

Qualifying for criterion A
At present no species qualify under Criterion A but this may change in the future as the preliminary assessment of species status is refined.

Qualifying for criterion B
Sites were selected because of their high or very high diversity, and/or as outstanding examples of habitats considered to be of algal importance e.g. maerl beds and/or because of their unique assemblages of algae.

Qualifying for criterion C
Two of the sites, Lundy and Falmouth & Helford, have outstanding habitats that are listed in Annex 1 of the EU Habitats Directive.

Some sites such as Lundy, Falmouth & Helford and Skomer are already well established as important sites for marine algae. Other sites in this list will almost certainly qualify under other criteria but more data are required to verify this.

4.4 DISCUSSION

This is the first time that an attempt has been made to apply the IPA criteria to the marine algae in the UK and elsewhere in Europe. The large number of sites nominated and their extensive coverage of the coastline around the UK reflects two main things: i) the richness and diversity of algal sites around the UK and ii) the immense wealth of knowledge amongst the phycological community. It appears that a number of sites have been nominated based on the intuition ('gut feeling') of these people, or the studies that they have undertaken at these sites. This also resulted in it being difficult to gain an indication of the actual boundaries of a site hence difficult to assign grid references to each site. Furthermore, some of these sites were SACs or within SACs, which also made it difficult to supply grid references that reflected the algal sites. As a consequence, many of these grid references need to be re-evaluated and the boundaries of each site to be determined.

Also problematic has been the assessment of the sites, and the search for information is by no means exhaustive. Tracking down the grey literature, particularly before widespread use of electronic publishing, is problematic, and one of the recommendations from this work is that that the many reports that do exist should be fully documented and widely accessible.

The ability to apply the IPA criteria also varied from site to site depending on the data available. While the application of IPA criterion C of outstanding example of habitat type was relatively straightforward, although unsatisfactory, for UK sites, given that most of the relevant habitats already had UK conservation legislation (chalk, maerl, Zostera beds), it was much more restrictive for European sites. Sites of international importance for particular habitats important for marine algae, but which are not Annex 1 habitats, have not yet been included. Future work should ensure omissions of, for example, Zostera beds, would be addressed. The application of criteria A and B was less straightforward. This often reflected the lack of verifiable data so the novel approach of utilising specimens from the algal herbarium and distribution maps was devised.

It is possible to be critical of the way that criterion A has been applied. Some UK sites that have qualified under this criterion have done so because they contain species that have been determined as rare based on their presence at 10 sites or less in Britain and Ireland. In many cases, however, little or nothing is known about the status of the populations of these species. For criterion B, the use of consensus mapping to determine the very rich sites was valuable to provide confirmation for sites that were already considered or documented to be rich and to provide information for other sites where these data were lacking. A potential difficulty here is defining what is meant by rich, given that number of species alone is not necessarily an indication of the diversity of a site and to overcome this, the habitat type has also been taken into account. The use of criterion D was deemed necessary for sites where other data were lacking but the site was considered worth nominating.

The data reveal that further assessment of many of the UK sites will be necessary before they can be nominated as European IPAs. There are relatively little data available for site assessment that is recent. Many of the collections that were used as data in this work were made over 50 years ago. An analysis of the proportion of seaweed samples collected over 50 years intervals since 1800 (Table 4.6) indicates that almost 60% of the collections were made before 1900 with a peak in the second half of the 19th C, and about 75% before 1950. These collections provide an excellent comparative perspective for assessing the status of sites today but the lack of comparative modern collections should be addressed to maintain the ability to make such comparisons. There was a drive for marine surveys in the 1980s with the consideration of sites for conservation status (e.g., MNRs). There has been comparatively little recent acquisition of data for the marine algae. The approach that we have taken also reflects the lack of comparative data for marine algae for the rest of Europe (or indeed other parts of the world), although we recommend that in the absence of direct data a similar method could be adopted where there are other well-developed herbarium collections.

Table 4.6 Proportion of seaweed samples from the UK held at the Natural History Museum herbarium collected from pre 1800 to present.

Time period	Proportion of specimens collected (%)
Pre 1800	1
1800-1849	14
1850-1899	44.5
1900-1949	16
1950-1999	24
2000-	0.5

Determining the number of species recorded at each site was not always possible, although for the nine sites that were put forward as potential European IPAs, good information was available. The consensus map based on herbarium data was valuable in confirming these sites in terms of diversity. Obviously such maps reflect where the collectors have been and this often reflects the transport system of the time or favourite coastal resorts. However, this hapazardness coupled with the large sampling effort, has left an important legacy – a reference point for the marine algae of the UK from about 100-150 years ago. Furthermore, the collections as a whole are a verifiable record of an alga's existence in space and time.

The value of diversity also needs to be considered carefully: sites which are clearly extremely diverse in terms of numbers of species are almost certainly important, but other sites, such as saltmarsh sites may not have a high diversity of species but are nevertheless important as habitats for algae in their own right. However, up to date check-lists for sites are valuable, especially if comparisons can be made with earlier lists.

The threatened or rare species listed for sites were derived from the assessed list of rare species (Table 4.4) in conjunction with species lists from the various sources we used. The finding that approximately 19% of the flora is rare, with the largest proportion being brown algae, is of note. It is possible that a number of the species are under-recorded, given that many of them are small and filamentous and some endophytic or endozoic (i.e. living within another alga or animal), and not necessarily easily seen or identified. The finding that approximately 10% of the flora is data deficient in terms of knowing whether a species is rare or not indicates that much greater input is needed to really determine the extent of species distribution. As discussed in relation to site assessment, much of the information is from sources that are quite old, so the exact nature of the flora today for many areas requires reassessment. It is therefore our opinion that virtually all of these species require re-evaluation at all the sites that they have been recorded from as well as at other sites around the UK. We need to be able to assess whether species are genuinely rare or under-recorded. The species on this list also need assessment to determine their status and whether they have declined in order to see if they have potential for Red Data List inclusion.

The IPA process has been criticised because it is a selection of sites and what is not selected is therefore potentially neglected. Some would argue that the whole of the coastline of the UK should be made an IPA for the marine algae and no doubt this should be aspired to. However, counter to that, some sites are better than no sites; many of the sites are already in areas designated for their conservation importance for a whole range of reasons, e.g., plants, geology, invertebrates. Although IPAs have no legal status, nevertheless they are a means of raising awareness among the general public and represent a potentially useful tool in that aim.

4.5 RECOMMENDATIONS

- A number of findings have resulted as a consequence of this work and these are summarised in the following recommendations:

- A comprehensive collection of literature relating to site assessment should be brought together and be available electronically and physically.

- An up to date assessment should be made of sites proposed as IPAs, including good checklists of the flora.

- Species listed as rare or data deficient need reassessment.

- Up to date collections of marine algae should be made from around the UK.

- The approach adopted for the development of IPAs as put forward in this document should be discussed and applied elsewhere.

5.0 IMPORTANT PLANT AREAS FOR FRESHWATER ALGAE

David M. John and David B. Williamson

5.1 HABITATS AND THREATS

The Atlantic climate together with differences in geology and geomorphology account for the extremely varied landscape of the UK and abundance of rivers, streams, lakes, ponds and boggy or fenland pools. Distribution of these aquatic habitats relate to differences in geology, rainfall patterns and human activity. As a consequence, the UK can be divided roughly into (a) a more northerly and westerly part dominated by hard, igneous or metamorphic Palaeozoic rocks where the climate is cooler, rainier and more oceanic, and (b) a lowland part where the geology is more varied and the climate warmer and drier. The total area of standing inland water is significantly greater in Scotland (about 1604 km²) compared to Wales (125 km²) and England (675 km²). In the Scotland there are over 30,000 lochs and lochans together with over 10,000 burns and rivers. High rainfall areas are often in mountainous uplands where the rocks are generally resistant to weathering and the waters are naturally nutrient-poor and of low fertility. By way of contrast, many lowland areas have softer, fine grain, sedimentary rocks and glacially deposited clays and silts. In such lowland and populous areas most waters are shallow, nutrient-rich and ponds and lakes are frequently artificially enriched (‘eutrophicated’) by plant nutrients.

Many waters in the UK have irreversibly changed or disappeared through neglect, mismanagement, water abstraction, land reclamation, dam construction, peat extraction, acidification and nutrient enrichment. In nutrient-poor water with an acid pH, the desmids are the most common and abundant algae. These green algae are gradually replaced by a succession of other algae if these waters become enriched by nutrients above natural background levels, a process known as ‘eutrophication’ (see Duckworth *et al*., 2002). Inevitably the threats to the conservation status of freshwaters are significantly greater in the more populous and agriculturally important lowlands compared to the wetter and more mountainous areas. Scotland has the greatest area (c.1364 km²) of still relatively nutrient-poor water (‘oligotrophic’) in the UK although even once ‘pristine’ lochs have undergone phosphorus enrichment over the past century (Fozzard *et al.,* 1999). Desmid diversity and abundance is exceptionally high in oligotrophic waters, especially in such lentic habitats as moorland pools, ponds and shallow lakes. All these threatened or vulnerable freshwater habitats are most abundant in north-west Scotland, North Wales and the English Lake District. Organisms largely restricted to such soft ‘acid’waters are therefore also vulnerable and

threatened hence our focus on desmids. Upland blanket bogs, raised lowland bogs and associated lakes are listed as threatened habitats in Annex 1 of the EU Habitat Directive (see Table 5.3).

5.2 METHODS FOR IPA SELECTION

The British Phycological Society membership was asked by Brodie & John (2004a) to nominate the most important UK areas/sites for freshwater and marine algae. Over 140 nominations were received for freshwater algal IPAs of which 80 were important for desmids (Box 6) (about two-thirds of sites), 5 for diatoms and the rest for other algal groups or because they have a long history of study. Only in the case of desmids were nominations supported by site-specific records although most modern lists are unpublished. The majority of the most comprehensive desmid lists were published at least a century ago but often fail to mention specific localities. There is no doubt that many sites/areas have undergone considerable change since they were originally sampled.

BOX 6 Desmids (Order Zygnematales, Phylum Chlorophyta)

Desmids are a very distinctive microbial group of green algae that are commonly very beautiful and remarkably elaborate. They are single-celled or filamentous and usually recognized by having a noticeable central constriction to the cell or bilaterally symmetrical cell contents. Desmid growth is linked to bicarbonate whose concentration is linked to pH, carbonic acid and carbon dioxide. They are most common in soft and generally 'acid' waters where they make use of the higher concentration of carbon dioxide and carbonic acid. It seems they have intrinsically slow growth rates thus allowing them to cope with low nutrient levels (principally nitrogen and phosphorus).

Potential IPAs for desmids were selected using site-specific records compiled over the past 30 years by one of us (DW). These IPAs are all believed to have not undergone significant change over this period and still remain relatively nutrient-poor aquatic habitats with an acid pH ('non-alkaline'). These sites are all EUNIS habitat types that are regarded as threatened (see Table 5.2). The number of records of a desmid species at such threatened sites was used to give an indication of its conservation status and to assist in deciding to which of the following IUCN Red List categories to assign it: critically endangered, endangered or vulnerable. Potential UK Red Data List desmid taxa recognised here are listed in Appendix 8.2. The presence and number of potential Red Data List species is a criterion used for designating desmid IPAs.

We have focused on desmid species although a large numbers of infraspecific taxa are recognised often based on subtle differences in morphology. Doubt attaches to the status of many forms and varieties although others are distinctive and can be more commonly encountered than the type or 'nominal' form. Infraspecific forms are only mentioned if very common and distinctive (see Appendix 8.2).

The following is a summary of the sources of information consulted in drawing up a potential list of UK and European IPAs:

Site-specific data on desmids compiled by one of us (DW); stored as a card index and with many records supported by line drawings.
Site-specific records extracted from literature sources.
Information on IPAs nominated by members of the British Phycological Society.
Advice sought by contacting experts and other competent persons on key groups.
Unpublished records compiled by the authors and taken from published sources of information including the desmid Red Data Lists published for Austria (Lenzenweger, 1999), Germany (Gutowski & Mollenhauer, 1996) and the Netherlands (Coesel, 1998).

Information from report on UK stoneworts IPAs (Stewart, 2004).

Information on the type locality of species known only from UK or rarely reported outside.

5.3 SITES AND AREAS

Many larger water bodies (e.g., reservoirs or lakes) represent a single 'site' or unit. Sometimes also treated as single units are clusters of similar pieces of water lying in close geographical proximity or within a well-defined area (e.g., pools/ponds in a particular *Sphagnum* bog).

Flowing waters are more unstable compared to standing water and for this reason are excluded unless having a long history of study. Over time ponds and lakes undergo change, but generally this takes place over decades unlike streams and rivers where changes can be dramatic even over a season. If the only available records date back more than 50 years then uncertainty surrounds the present status of a site or area. If there is doubt concerning the present status of a site then it might be designated as a 'data deficient' IPA.

5.4 SELECTION CRITERIA

Anderson (2002) identified three criteria for selecting European IPAs and these were adapted and further developed by Stewart (2004) when selecting Important Stonewort Areas (ISAs). A similar exercise has been carried out when considering IPAs in the context of desmids (Table 5.1).

Table 5.1 Criteria adopted here for selecting potential desmid IPAs.
The IUCN categories are critically endangered (category 1), endangered (category 2) and vulnerable (category 3).

Criterion	**European IPA**	**UK IPA**
A *Site/area containing potential UK Red Data List desmid species*	-	Contains 5 or more desmid species in potential UK Red Data List categories 1 or 2
B1 *Site/area having an exceptionally rich algal flora*	Site/area has an exceptionally rich algal flora (over 70 desmid species) or 500 species of freshwater algae	Site has an exceptionally rich desmid flora (over 50 desmid species)
B2 *Long history of algal recording*	-	Site has a long history of desmid records
C *Site of a priority threatened habitat of major significance to desmids/algae in Annex I of the EU Habitat Directive*	Site is a priority threatened habitat of major significance to desmids/algae and is in Annex I of the EU Habitat Directive	Site is a priority threatened habitat of major significance to desmids/algae and is in Annex I of the EU Habitat Directive
D *Site referred to as 'data deficient'*	-	Site considered important for algae but for which further information is needed, sometimes known historically to be an algal biodiversity 'hotspot' but not studied since about 1950 or information otherwise incomplete

Table 5.2 EUNIS level 3 habitat types used for desmid IPA selection.
Almost two-thirds of the more than 800 species of desmid known from the UK are restricted to these habitat types.

Code and habitat description
C1 Surface standing water C1.1 - Permanent oligotrophic lakes, ponds and pools C1.4 - Permanent dystrophic lakes, ponds and pools D1 Raised and blanket bogs D1.1 - Raised bogs

5.41 Criterion A – threatened species

As mentioned above, IUCN criteria have been adopted when assessing potential UK Red Data List desmids (see Appendix 8.1). One of the criteria used for selecting an important site/site complex (area) is the number of potential UK Red Data List desmid species present.

We defined the 'best' UK desmid sites as *those containing 'at least 5 desmids belonging to the potential Red Data List falling into the IUCN categories of critically endangered (Category 1) and endangered (Category 2)'*.

The extinct category has not been used although a significant number of desmid taxa have not been recorded for at least 50 years. Very probably these desmids are very rare and might simply have been 'missed' by DW. Any desmid not recorded over the past 50 years is regarded here as 'Data Deficient' rather than extinct. Some of these 'missing' desmids are endemics with the majority known only from endangered or vulnerable habitat types mentioned in the EUNIS list.

5.42 Criterion B1 – species-richness

UK and European IPAs: UK IPAs for desmids are defined here as '*those in vulnerable or threatened habitats containing at least 40 desmid species. Some sites/areas with lower diversities are only included if containing at least 5 potential UK Red List species';* European IPAs for desmids are defined as '*those in vulnerable or threatened habitats containing at least 70 desmid species'*.

5.43 Criterion B2 - long history of study

The provisional assessment of the best UK fungi sites (Evans *et al.,* 2001) uses criteria in addition to those recommended by Anderson (2002). The potential fungal sites include those having long lists of species, assemblages of rare and indicative species, new records of UK species, a long history of recording and sites 'outstanding' for fungi.

The criterion of 'long history of study' is used for considering important sites/areas for freshwater algae in the UK. It can be applied to permanent standing bodies of water for which records sometimes go back over several decades (e.g., Windermere, Priest Pot, Lough Neagh, Loch Leven). Sometimes these sites may be representative of a particular habitat type (e.g., nutrient-enriched lakes). All these sites or areas are also considered 'data deficient' since uncertainty surrounds their current status.

5.44 Criterion C - priority threatened habitats

According to Anderson (2002), the criteria for selecting IPAs allow for '*the five 'best' sites, of priority threatened habitat of major significance on Annex 1 of the EU Habitats Directive'*, or '*up to 5 'best' sites of other threatened (but non-priority) habitats listed on the annex'*. Threatened and priority threatened habitats mentioned in Annex 1 that are of special significance to desmids are listed in Table 5.3. It is not possible to readily select the 'best' 5 sites since the data are too incomplete. A possible approach might be to choose those containg at least 5 potential UK Red List species. For now all desmid sites that conform to the criteria selected here are listed with the most species-rich ones considered of European importance.

Table 5.3 EU Habitat Directive Annex 1 showing threatened and priority threatened habitats of special significance to UK desmids.

Code and Habitat Directive Descriptive
3. Freshwater Habitats 31. Standing Water 3110/3110 Oligotrophic waters containing very few minerals 3160 Natural dystrophic lakes and ponds 7. Raised Bogs and Mires and Fens 71. *Sphagnum* Acid Bogs 71.10 Active raised bogs 71.20 Degraded raised bogs still capable of natural regeneration 71.30 Blanket Bogs

5.45 Criterion D – important but 'data deficient'

Many aquatic habitats disappear over time or become dramatically altered due to changes in water chemistry and/or other factors. For this reason, sites/areas recognised as 'hotspots' of algal diversity are 'data deficient' if their current/recent status is unknown. This is also the case for many historically important water bodies.

Data deficient sites/areas are believed to be important but require confirmation through further study. The sites or areas identified here under criterion D are potential IPAs for freshwater algae in the UK but require further work. Sites of similar status were recognized when designating fungal IPAs (Evans *et al.*, 2001) and Stewart (2004) who listed them as 'Locally Important Stonewort Sites'.

5.46 In summary

The best sites/areas are judged on the number of potential UK Red Data List desmids (Criterion A), diversity of desmids and/or other algal groups (Criterion B1), long history of recording (Category B2) and whether confined to endangered, threatened or vulnerable (C) habitats recognised by EUNIS (see Table 5.2). To qualify for IPA status a site/area must meet at least two of these criteria.

5.5 RESULTS

A total of 45 sites/areas are recognised. Of these, six are IPAs for desmids, considered to be of European/International importance (5 English, 1 Scottish) and 12 are IPAs of UK importance (9 English, 2 Scottish, 1 Welsh) for desmids. The remaining 27 are potential UK IPAs (areas/sites) for freshwater algae (19 English, 5 Scottish, 2 Welsh, 1 Northern Irish) pending further investigation. One of these is possibly a potential European/International IPA: Snowdonia area: Capel Curig/Cader Idris. The proposed UK and European/International IPAs for freshwater algae are based on species diversity and/or long history of study (Tables 5.4, 5.5, 5.6; see details in Appendix 8.3) although potential Red Data List desmids are also taken into account. The six European/International IPAs for desmids form part of the UK IPA inventory comprising sites of European importance for vascular plants, bryophytes, lichens and marine algae. The distribution of all UK IPAs and the 27 potential IPAs for freshwater algae are shown in the map (Fig. 4.1).

Table 5.4 Sites nominated as European/International IPAs for desmids in the UK.
Nomination based on the following qualifying criteria: A, B1, B2, C.

No.	Site name	Grid reference	Desmid diversity	No. of potential Red Data List desmids	No. of European Red Data List desmids *	Qualifying criteria	Nominator
1	Loughrigg Fell	NY 364040	70+	6	11	A; B1, B2; C	David Williamson
2	Kelly Hall Tarn	SD288933	70+	9	9	A; B1, B2; C	David Williamson
3	Three Dubs Tarn	SD378974	70+	11	8	A; B1, B2; C	David Williamson
4	Lochan Feoir	NC227250	70+	6	8	A, A2; B1, B2; C	David Williamson
5	Long Moss Tarn	SD291936	70+	5	11	A; B1, B2; C	David Williamson
6	Lower Bostraze (St. Just area)	SW392321	100	2	1	B1, B2; C	David Williamson

* Austria, Germany, Netherlands

Table 5.5 Sites nominated as UK IPAs for desmids.
Nomination based on the following qualifying criteria: A, B1, B2, C.

No.	Site name	Grid reference	Desmid diversity	No. of potential Red Data List desmids	No. of European Red Data List desmids*	Qualifying criteria	Nominator
7	Torver Tarn	SD281926	50+	10	6	A; B1, B2; C	David Williamson
8	Dock Tarn	NY274144	50+	13	7	A; B1, B2; C	David Williamson
9	Barngate Tarn ('Drunken Duck' Tarn)	NY351011	40+	4	2	A; B2; C	David Williamson
10	Silver Howe Fell	NY325065	50+	2	5	A; B1, B2; C	David Williamson
11	Goosey Foot Tarn	SD338970	50+	2	8	A; B1, B2; C	David Williamson
12	Culag Wood Bog	NC093214	50+	4	10	A; B1, B2; C	David Williamson
13	Podnet Moss	NY405925	50+	7	8	A, B1, B2; C	David Williamson
14	Gurnals Dub Tarn	SD503992	50+	5	4	B1, B2; C	David Williamson
15	Wrynose Pass, pools on summit	NY2702	50+	6	3	A; B1, B2; C	David Williamson
16	Thursley Common	SU9040	50+	2	4	B1, B2; C	David Williamson
17	Pant y Llyn (near Builth Wells)	SO048468	50+	3	0	B1, B2; C	David Williamson
18	Loch Bad an Og	NC116312	50+	5	7	A; B1, B2; C	David Williamson

* Austria, Germany, Netherlands

Table 5.6 Potential UK IPAs (areas/sites19-45) for freshwater algae pending further investigation - 'data deficient' (often no modern data).

No.	Site name	Grid reference	Desmid diversity	No. of potential Red Data List desmids	Qualifying criteria	Nominator
19	Cwm Bochlwd	SH657597			C; D	David John
20	Claise Fearna SE 1	NC206466	20	3	C; D	Alan Joyce
21	Loch an Eilean	NG472306	incomplete list	3	C; D	David Williamson
22	Cader Idris/Capel Curig area	SH7013/SH7258	600+		B1, B2; C; D	David John & David Williamson
23	Malham Tarn area	SD8966	600+		B2; D	Alan Brook
24	The Serpentine, Eaton Park	SJ416600			B2; D	David John
25	Priest Pot	SD357978	140+		B2; D	Hilary Belcher & Erica Swale
26	Hells Kettles (near Darlington)	NZ280140			B2; D	Brian Whitton
27	Rostherne Mere	SJ732819			B2; D	Brian Moss
28	Crose Mere	SJ4330			B2; D	Brian Moss
29	White Mere	SJ 414330			B2; D	Brian Moss
30	Oakmere	SJ576676			B2; D	Brian Moss
31	Little Sea, Studland	SZ035835			B2; D	D.C. Stevens
32	Martham Broad	TG 4520			B2; D	Brian Moss
33	River Wear	NZ1134 NZ24, NZ28, NY94			B2; D	Brian Whitton
34	River Bure	TG2521			B2; D	Keith Clarke
35	Abbot's Pond (near Bristol)	ST536732			B2; D	David Mann
36	Lake Windermere	SD3995 SD4197 (West-mid) SD38 and NY38	140+		B2; D	John Lund
37	River Coquet	NU212036			B2; D	Martyn Kelly
38	Stream Weston Combe (near Branscombe)	SY1688			B2; D	David John
39	Wicken Fen	TL 5570			B2; D	Hilary Belcher & Erica Swale
40	River Thames	SU761003 (near mid-point)			B2; D	David John
41	River Wye	SO597168 (near mid-point)			B2; D	David John
42	Loch Leven	NO150015			B2; D	Brian Whitton
43	Blackford Pond	NT 253709			B2; D	David Mann
44	Isle of Mull	NM7236	600+		B2; D	David John
45	Lough Neagh, Traad Beach	H955870 (Irish Grid)			B2; D	David Jewson

5.6 DISCUSSION

Considerable progress has been made designating IPAs for other data deficient cryptogam groupings including fungi, lichens and bryophytes. For the most part, these groups are macroscopic and there is a large following of competent amateurs. As a consequence considerably more is known of their distribution, ecology and abundance compared to microscopic algae. The lack of comprehensive site-specific floristic data collected over the last 50 years is one of several reasons why the task of selecting IPAs for freshwater microalgae has been so daunting. Other reasons include the absence of persons competent to identify microalgae, identification is time consuming and requires a compound light microscope, complex sample preparation is sometimes required, key microhabitats are not sampled, flawed sampling methods (e.g., incorrect mesh size of plankton nets) and a lack until recently of a comprehensive identification guide to UK freshwater algae.

A factor that must be taken into account is the quality of the information. Sometimes records are suspect and acceptance often depends on a judgement made on the competence of the person identifying the material. As in other cryptogamic groups, there are very many species recorded on just a few occasions and these therefore fall into the IUCN Red List Category of 'data deficient'. All too often surveys fail to take any or adequate account of algae and sampling tends to focus on just a few of the more obvious microhabitats. Even when sampling is comprehensive there is a tendency to record only the more conspicuous and better known algal groups or phyla with the result that the rest are ignored or receive only cursory consideration. Despite all these problems it has been possible to recognise a number of provisional IPAs for microalgae. Such a defensible list of IPAs for algae is important since it draws attention to the need to ensure that (a) lesser known groups are considered when a site or area is designated for its conservation importance, and (b) account is taken of algae in the management planning. Some of the provisional IPAs recognised are already given some form of protection.

5.7 RECOMMENDATIONS

Literature relating to each proposed freshwater IPA should be compiled and made readily available.

New and comprehensive surveys of the freshwater algae need to be undertaken at all of the IPAs proposed.

Further assessment of the status of the potential Red List desmids is required through literature searches and new data before a desmid Red List can be produced.

Published and unpublished data sets for other groups of freshwater algae (e.g., diatoms, red algae) should be examined to determine whether provisional IPAs can be recognised for them.

New surveys are required at sites/areas considered to be important for freshwater algae but that are 'data deficient'.

6.0 ACKNOWLEDGEMENTS

We wish to express our thanks to all those who nominated IPAs and apologise if your nomination was not one of those chosen. We also acknowledge the support of CCW, notably Paul Brazier, who supplied us with considerable information. We are also grateful to the Friends of the Earth volunteers who undertook the bulk of the census work in the herbarium at The Natural History Museum. We are also grateful to all the experts who helped to assess the rare species list (their names are listed in Table 4.4). Special thanks to Chris Maggs who has provided tremendous input at various stages, Alan Brook and Alan Joyce who provided us with unpublished site data on desmids, and Jim Chimonides for preparing maps showing the distribution of the IPAs. We acknowledge the support of the British Phycological Society for a grant to enable aspects of this work to be undertaken. Thanks also to Plantlife who gave us the original inspiration for this work at a workshop in November 2003 and who encouraged us to continue with what seemed at times to be an impossible task. Special thanks go to Jenny Duckworth who gave us much valuable advice especially in the final stages. We also thank Deborah Long and Jill Williams at Plantlife for their assistance in the final production of this document.

7.0 APPENDIX - MARINE ALGAE

7.1. MAIN REFERENCES USED FOR SITE DESCRIPTIONS

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8.0 APPENDIX - FRESHWATER ALGAE

8.1 DESMID IPAS AND POTENTIAL UK RED LIST SPECIES

8.11 Introduction

The IUCN has developed criteria for determining the conservation status of individual species. Those taxa demonstrated to be endangered, vulnerable or critically endangered are published in Red Data Lists. One of the principal criteria for selection is a population decline over time. Often such a change in aquatic organisms is the result of habitat loss or changes in water chemistry resulting in an increase in some species/species-groups and a decline in others. In largely microscopic groups any increase or decrease in abundance is difficult if not impossible to quantify and therefore has often had to be inferred from habitat changes. Many freshwater species/ species groups in European Red Data Lists are restricted mostly to endangered or threatened habitat. Some of the most threatened aquatic habitats are often those whose water is typically poor in nutrients ('oligotrophic') and has a low pH ('acid' pH) (Table 5.3). Not only are these habitats commonly threatened by nutrient enrichment ('eutrophication'), but are also becoming lost or depleted due to several factors that include drainage, afforestation and peat removal. Small-scale peat digging or 'turf cutting' is not in itself disadvantageous since the new areas of open water often in time become *Sphagnum*-filled pools.

8.12 Selection of potential UK Red List desmids

The selection of a desmid as endangered or vulnerable is based upon our knowledge of their ecology in the UK. All desmids largely confined to nutrient-poor and non-alkaline waters (occasionally circumneutral) are regarded as threatened. The ecological information is taken from a variety of sources including the desmid chapters in *The Freshwater Algal Flora of the British Isles* (see Brook, 2002), a review by Lenzenweger (2003) and our own unpublished data.

A special difficulty has been deciding to which of the three IUCN Red List categories to place a desmid since it is necessary to know how rare or common is the taxon. The solution to this problem was to use site-specific records compiled by one of us (DBW) to discover how many sites/areas a particular desmid taxon had been recorded over the past 30 years. It follows that the rarest and most endangered desmids are those recorded on the fewest number of occasions. All these desmid taxa were placed in one of the three IUCN categories depending on the number of sites/areas from whence they had been recorded.

The following numbers of desmid records were used to define each category:

Category 1 - critically endangered: *not recorded by DW*.
Category 2 - endangered: *recorded by DW at 1 to 10 sites*.
Category 3 - vulnerable: *recorded by DW at 11 or more sites*

Our approach has been to regard as threatened, those desmids that are almost wholly confined to nutrient-poor and non-alkaline waters. All species in the UK falling into these categories are listed in Table 8.1 (Appendix 8.2).

All these potential UK Red Data List Desmids in the UK are confined to nutrient poor lakes as well as ponds and pools associated with blanket bog and raised bog areas that are very common in the north and west of the British Isles. These habitats are very extensive in Scotland and are probably less impacted by human activity than many areas in Europe as suggested by the larger numbers of critically endangered desmids listed for Germany, Austria and the Netherlands. A possible way to select Red Data List Desimids in the UK is to consider the status in the UK of those in European Red Data Lists. Any

conclusions drawn would need to be treated with caution since there are very few European Red Data Lists. Also the Red Data List of desmids for the Netherlands (Coesel, 1998) was not based on IUCN criteria although many of the same taxa are also in lists for Germany (Gutowski & Mollenhauer, 1996) and Austria (Lenzenweger, 1999). The Scottish Highlands and the English Lake District are 'hotspots' of desmid diversity in the UK (John *et al.*, 2006). Only a few UK important desmid areas have been recognised elsewhere and all are relatively limited in extent (e.g., Thursley Common in Surrey; Bostraze in Cornwall).

Comprehensive data on distribution and ecology are lacking for desmids. Until more information is forthcoming it is impossible to further assess the conservation status of desmids and meaningfully comment on the most important centres of desmid diversity.

8.2 LIST OF POTENTIAL RED DATA LIST DESMIDS IN THE UK

Table 8.1. The number of desmid species recorded by David Williamson (DW) between 1975 and 2005 restricted to threatened/vulnerable oligotrophic, non-alkaline waters in the UK.
Red Data List categories recognised by the IUCN (1994) are as follows: 1 Critical - threatened with extinction since very rare and habitat endangered (not recorded by DW, very rare and habitat endangered); 2. Endangered - rare and habitat endangered (1-10 records by DW); 3. Vulnerable - common but confined to threatened/vulnerable habitats (11+ records by DW). All species are represented by the type/nominal variety and other varieties are simply listed, 'only' is used in cases where the type variety has not been recorded.

Genus	**Species**	**Includes following varieties/forms**	**No DW records**	**Categories**		
				1	2	3
Actinotaenium	*capax*	*minus*	0	+		
Actinotaenium	*crassiusculum*		0	+		
Actinotaenium	*lagenarioides*		0	+		
Actinotaenium	*minutissimum*		0	+		
Actinotaenium	*mooreanum*		0	+		
Actinotaenium	*phymatosporum*		0	+		
Actinotaenium	*spinospermum*		0	+		
Actinotaenium	*truncatum*		0	+		
Actinotaenium	*wollei*		0	+		
Closterium	*decorum*		0	+		
Closterium	*delpontei*		0	+		
Closterium	*exile*		0	+		
Closterium	*subjuncidiforme*		0	+		
Closterium	*variabile*		0	+		
Cosmarium	*asphaerosporum*	*strigosum*	0	+		
Cosmarium	*broomei*		0	+		
Cosmarium	*canaliculatum*		0	+		
Cosmarium	*clepsydra*		0	+		
Cosmarium	*fastidiosum*		0	+		
Cosmarium	*garrolense*		0	+		
Cosmarium	*geminatum*		0	+		
Cosmarium	*geometricum*		0	+		
Cosmarium	*jenisejense*		0	+		
Cosmarium	*kjellmanii*	*grande, ornatum*	0	+		
Cosmarium	*latifrons*		0	+		

Cosmarium	*logiense*		0	+		
Cosmarium	*nitidulum*		0	+		
Cosmarium	*obsoletum*		0	+		
Cosmarium	*ocellatum*	*incrassatum*	0	+		
Cosmarium	*prominulum*	*subundulatum*	0	+		
Cosmarium	*protuberans*	*padulosa*	0	+		
Cosmarium	*pseudobiremum*		0	+		
Cosmarium	*pulcherrimum*		0	+		
Cosmarium	*pusillum*		0	+		
Cosmarium	*quadrangulatum*		0	+		
Cosmarium	*quasillus*		0	+		
Cosmarium	*retusiforme*		0	+		
Cosmarium	*retusum*	*angustatum*	0	+		
Cosmarium	*sinostegos*	*obtusius*	0	+		
Cosmarium	*speciosissimum*		0	+		
Cosmarium	*subbroomei*		0	+		
Cosmarium	*subquadratum*		0	+		
Cosmarium	*taxichondriforme*		0	+		
Cosmarium	*taxichondrum*		0	+		
Cosmarium	*tetragonum*	*lundellii, elegans, heterocrenatum,*	0	+		
Cosmarium	*trachydermum*		0	+		
Cosmarium	*tumidum*		0	+		
Cosmarium	*ungerianum*	*subtriplicatum*	0	+		
Cosmarium	*wittrockii*		0	+		
Cosmocladium	*constrictum*		0	+		
Cosmocladium	*perissum*		0	+		
Cylindrocystis	*gracilis*		0	+		
Euastrum	*crassicolle*		0	+		
Euastrum	*intermedium*		0	+		
Gonatozygon	*pilosum*		0	+		
Penium	*didymocarpum*		0	+		
Penium	*polymorphum*		0	+		
Pleurotaenium	*eugeneum*		0	+		
Sphaerozosma	*vertebratum*	*latius, punctulatum*	0	+		
Spondylosium	*ellipticum*		0	+		
Spondylosium	*pygmaeum*	*compressum*	0	+		
Spondylosium	*secedens*		0	+		
Staurastrum	*arnellii*	*inornatum, spiniferum*	0	+		
Staurastrum	*conspicuum*		0	+		
Staurastrum	*eboracense*		0	+		
Staurastrum	*echinodermum*		0	+		
Staurastrum	*heimerlianum*	*spinulosum*	0	+		
Staurastrum	*kaiseri*		0	+		
Staurastrum	*pachyrhynchum*		0	+		
Staurastrum	*pseudosebaldi*	*simplicius*	0	+		
Staurastrum	*pseudotetracerum*		0	+		
Staurastrum	*pungens*		0	+		
Staurastrum	*quadrispinatum*		0	+		
Staurastrum	*rugulosum*		0	+		
Staurastrum	*spiniferum*		0	+		
Staurastrum	*striatum*		0	+		
Staurastrum	*subpygmaeum*	*subangulatum*	0	+		
Staurodesmus	*quadratus*		0	+		
Staurodesmus	*pterosporum*		0	+		

Xanthidium	*tenuissimum*		0	+		
Actinotaenium	*adelochondrum*		1		+	
Actinotaenium	*clevei*		1		+	
Actinotaenium	*colpopelta*		1		+	
Actinotaenium	*cruciferum*		1		+	
Actinotaenium	*curtum*		10		+	
Actinotaenium	*gelidum*		2		+	
Actinotaenium	*inconspicuum*		1		+	
Actinotaenium	*obcuneatum*		7		+	
Actinotaenium	*perminutum*		2		+	
Actinotaenium	*rufescens*		5		+	
Actinotaenium	*subtile*		4		+	
Actinotaenium	*turgidum*		9		+	
Closterium	*anguineum*		1		+	
Closterium	*archerianum*	*pseudocynthia*	8		+	
Closterium	*calosporum*	*brasiliense*	10		+	
Closterium	*limneticum*		3		+	
Closterium	*nematodes*	*proboscideum*	1		+	
Closterium	*nylandicum*		4		+	
Closterium	*pygmaeum*		4		+	
Closterium	*sublaterale*		3		+	
Closterium	*subscoticum*		2		+	
Closterium	*subulatum*		1		+	
Closterium	*toxon*		8		+	
Closterium	*variabile*		1		+	
Cosmarium	*alpestre*		2		+	
Cosmarium	*bioculatum*	*depressum*	9		+	
Cosmarium	*capitulum*	*groenlandicum*	2		+	
Cosmarium	*commissurale*	*acutum, crassum*	6		+	
Cosmarium	*cyclicum*	*arcticum, nordstedtianum*	7		+	
Cosmarium	*cymatopleurum*		2		+	
Cosmarium	*dentiferum*		2		+	
Cosmarium	*dybowskii*		1		+	
Cosmarium	*eductum*		1		+	
Cosmarium	*eichlerianum*		2		+	
Cosmarium	*entochondrum*		1		+	
Cosmarium	*fictopraemorsum*		1		+	
Cosmarium	*fontigenum*		6		+	
Cosmarium	*hammeri*	*homalodermum, protuberans*	3		+	
Cosmarium	*isthmium*	*hibernicum, horizontale*	9		+	
Cosmarium	*isthmochondrum*	*decussiferum, pergranulatum*	4		+	
Cosmarium	*carinthiacum*		9		+	
Cosmarium	*lundellii*	*corruptum, ellipticum*	2		+	
Cosmarium	*luxuriosum*		2		+	
Cosmarium	*microsphinctum*	*maius, parvula*	1		+	
Cosmarium	*nasutum*	*asperum, granulatum*only	1		+	
Cosmarium	*norimbergense*	*depressum*	3		+	
Cosmarium	*novae-semliae*	*granulatum, sibiricum*	4		+	
Cosmarium	*obliquum*	*ovale, tatricum, trigonum,*	4		+	
Cosmarium	*ordinatum*	*schulzii*	4		+	
Cosmarium	*pachydermum*	*aethiopicum*	1		+	
Cosmarium	*paragranatoides*		3		+	
Cosmarium	*perforatum*		1		+	
Cosmarium	*pericymatium*	*corrugatum, eboracense*	8		+	

Cosmarium	*phaseolus*	*elevatum, minus, skujae*	9		+	
Cosmarium	*plicatum*		4		+	
Cosmarium	*pokornyanum*	*taylorii*	4		+	
Cosmarium	*polygonum*		1		+	
Cosmarium	*praegrande*		4		+	
Cosmarium	*pseudamoenum*	*basilare*	5		+	
Cosmarium	*pseudobroomei*	*convexum*	1		+	
Cosmarium	*pseudocommissurale*		1		+	
Cosmarium	*pseudoexiguum*		2		+	
Cosmarium	*pseudonitidulum*	*validum*	4		+	
Cosmarium	*pseudoornatum*		4		+	
Cosmarium	*pseudoprotuberans*	*alpinum, kossinskajae*	1		+	
Cosmarium	*pygmaeum*		8		+	
Cosmarium	*quadratulum*		3		+	
Cosmarium	*rectangulare*	*cambrense, hexagonum*	3		+	
Cosmarium	*repandum*	*minus, papillatum*	1		+	
Cosmarium	*simplicius*		2		+	
Cosmarium	*sphagnicolum*		1		+	
Cosmarium	*sphalerostichum*		4		+	
Cosmarium	*subalatum*		1		+	
Cosmarium	*subarctoum*	*punctatum*	2		+	
Cosmarium	*subimpressulum*		2		+	
Cosmarium	*subspeciosum*	*validius*	4		+	
Cosmarium	*tatricum*	*novizelandicum, sphaeruliferum*	2		+	
Cosmarium	*tenue*		1		+	
Cosmarium	*tetrachondrum*		2		+	
Cosmarium	*thwaitesii*	*penioides*	1		+	
Cosmarium	*trachypleurum*	*minus*	1		+	
Cosmarium	*truncatellum*		1		+	
Cosmarium	*tumidum*	*subrectangulare*	6		+	
Cosmarium	*tyrolicum*	*beanlandii*	5		+	
Cosmarium	*umbilicatum*		3		+	
Cosmarium	*undulatum*	*minutum, wollei*	10		+	
Cosmarium	*vexatum*	*lacustre*	8		+	
Cosmarium	*vogesiacum*		1		+	
Cosmarium	*woloszynskae*		2		+	
Cosmarium	*binum*		6		+	
Cosmocladium	*pulchellum*		1		+	
Cosmocladium	*saxonicum*		2		+	
Cosmocladium	*tuberculatum*		2		+	
Cosmocladium	*tumidum*		1		+	
Desmidium	*aptogonum*	*ehrenbergii, acutius*	6		+	
Desmidium	*pseudostreptonema*		5		+	
Docidium	*undulatum*	*perundulatum*	2		+	
Euastrum	*aboense*		1		+	
Euastrum	*boldtii*		2		+	
Euastrum	*cornubiense*		1		+	
Euastrum	*divaricatum*		1		+	
Euastrum	*dubium*	*anglicanum, cambrense, ornatum, snowdoniense*	1		+	
Euastrum	*erosum*	*granulosum*	1		+	
Euastrum	*gayanum*		6		+	
Euastrum	*gemmatum*		9		+	
Euastrum	*inerme*		3		+	

Euastrum	*jenneri*		5		+	
Euastrum	*montanum*		1		+	
Euastrum	*sinuosum*		1		+	
Euastrum	*sublobatum*	*dissimile*	1		+	
Euastrum	*turneri*		4		+	
Euastrum	*ventricosum*		8		+	
Genicularia	*elegans*		4		+	
Genicularia	*spirotaenia*		1		+	
Gonatozygon	*kinahanii*		3		+	
Groenbladia	*neglecta*		2		+	
Groenbladia	*undulata*	*kriegeri, perundulata*	3		+	
Mesotaenium	*macrococcum*	*minus*	3		+	
Micrasterias	*brachyptera*		2		+	
Micrasterias	*conferta*	*hamata*	7		+	
Micrasterias	*furcata*	*dichotoma, pseudocrux*	5		+	
Micrasterias	*mahabuleshwarensis*	*dichotoma, europaea, wallichii*	1		+	
Micrasterias	*verrucosa*		3		+	
Pleurotaenium	*maximum*		3		+	
Pleurotaenium	*nodosum*		7		+	
Pleurotaenium	*nodulosum*		6		+	
Pleurotaenium	*rectum* (=*Haplotaenium rectum*)		7		+	
Pleurotaenium	*tridentulum*	*capitatum*	9		+	
Pleurotaenium	*truncatum*	*crassum, farquharsonii*	5		+	
Roya	*cambrica*		1		+	
Roya	*obtusa*	*montana*	2		+	
Spondylosium	*papillosum*		9		+	
Spondylosium	*planum*		10		+	
Spondylosium	*pulchellum*	*pyramidatum*	10		+	
Staurastrum	*arcuatum*		1		+	
Staurastrum	*asperum*		5		+	
Staurastrum	*bicorne*		0		+	
Staurastrum	*bifidum*		0		+	
Staurastrum	*bloklandii*		0		+	
Staurastrum	*boreale*		4		+	
Staurastrum	*borgeanum*		1		+	
Staurastrum	*brachycerum*		1		+	
Staurastrum	*brasiliense*	*lundelli*	6		+	
Staurastrum	*brebissonii*	*brevispinum*	9		+	
Staurastrum	*capitulum*	*spetsbergense*	7		+	
Staurastrum	*cerastes*	*triradiatum*	3		+	
Staurastrum	*chavesii*		2		+	
Staurastrum	*circulare*	*americanum* only	1		+	
Staurastrum	*clepsydra*	*sibiricum* only	3		+	
Staurastrum	*coarctatum*	*subcurtum*	2		+	
Staurastrum	*cosmarioides*		1		+	
Staurastrum	*cosmospinosum*		1		+	
Staurastrum	*cristatum*		3		+	
Staurastrum	*cyathipes*		2		+	
Staurastrum	*denticulatum*		2		+	
Staurastrum	*dispar*		4		+	
Staurastrum	*disputatum*		2		+	
Staurastrum	*donardense*		2		+	
Staurastrum	*duacense*		1		+	

Staurastrum	*elongatum*		4		+	
Staurastrum	*erasum*		5		+	
Staurastrum	*forficulatum*		2		+	
Staurastrum	*furcatum*	*aciculiferum, subsenarium*	8		+	
Staurastrum	*gladiosum*	*delicatulum*	3		+	
Staurastrum	*gracile*		3		+	
Staurastrum	*hexacerum*		3		+	
Staurastrum	*hystrix*		7		+	
Staurastrum	*iotanum*		1		+	
Staurastrum	*kouwetsii* (=*S. subbrebissonii*)		4		+	
Staurastrum	*laeve*		2		+	
Staurastrum	*laevispinum*		1		+	
Staurastrum	*longispinum*	*bidentatum*	6		+	
Staurastrum	*manfeldtii*	*annulatum, splendidum*	6		+	
Staurastrum	meriani	*minutum*	6		+	
Staurastrum	*micron*	*perpendiculatum*	1		+	
Staurastrum	*monticulosum*	*bifarium, groenlandicum*	1		+	
Staurastrum	*muticum*	*depressum*	5		+	
Staurastrum	*natator*		1		+	
Staurastrum	*neglectum*		2		+	
Staurastrum	*nodosum*		0		+	
Staurastrum	*oligacanthum*	*incisum*	4		+	
Staurastrum	*oxyacanthum*	*polyacanthum*	6		+	
Staurastrum	*paradoxum*		7		+	
Staurastrum	*pileolatum*	*cristatum*	4		+	
Staurastrum	*pilosum*		3		+	
Staurastrum	*polymorphum*	*munitum, pusillum, simplex*	3		+	
Staurastrum	*proboscideum*		3		+	
Staurastrum	*pyramidatum*		7		+	
Staurastrum	*quadrangulare*		2		+	
Staurastrum	*scabrum*		7		+	
Staurastrum	*sebaldi*	*ornatum, productum*	9		+	
Staurastrum	*senarium*		4		+	
Staurastrum	*setigerum*		1		+	
Staurastrum	*sexangulare*		7		+	
Staurastrum	*striolatum*		5		+	
Staurastrum	*subarcuatum* (= S. *avicula* var. *subarcuatum*)		5		+	
Staurastrum	*subavicula*		4		+	
Staurastrum	*subcruciatum*		6		+	
Staurastrum	*subnudibrachiatum*		3		+	
Staurastrum	*subpygmaeum*		3		+	
Staurastrum	*subscabrum*		3		+	
Staurastrum	*tohopekaligense*	*trifurcatum*	2		+	
Staurastrum	*trapezicum*		2		+	
Staurastrum	*turgescens*	*arcticum*	1		+	
Staurastrum	*uhtuense*		1		+	
Staurastrum	*verticillatum*		5		+	
Staurastrum	*bulbosum*		1		+	
Staurastrum	*echinatum*		2		+	
Staurodesmus	*aristiferus*	*protuberans*	2		+	
Staurodesmus	*aversus*		2		+	
Staurodesmus	*bulnheimii*	*subincus*	8		+	

Staurodesmus	*connatus*		3		+	
Staurodesmus	*controversus*		2		+	
Staurodesmus	*corniculatus*		2		+	
Staurodesmus	*grandis*	*parvus*	3		+	
Staurodesmus	*incus*	*ralfsii*	6		+	
Staurodesmus	*lanceolatus*	*compressus*	2		+	
Staurodesmus	*megacanthus*	*orientalis, subcurvatus*	1		+	
Staurodesmus	*mucronatus*	*subtriangularis*	4		+	
Staurodesmus	*omearae*	*minutus*	4		+	
Staurodesmus	*patens*		1		+	
Staurodesmus	*phimus*	*occidentalis*	1		+	
Staurodesmus	*sellatus*		1		+	
Staurodesmus	*spencerianus*		4		+	
Staurodesmus	*subtriangularis*		2		+	
Staurodesmus	*validus*		8		+	
Teilingia	*excavata*	*subquadrata*	4		+	
Tortitaenia	*alpina*		3?		+	
Tortitaenia	*luetkemuelleri*		2		+	
Xanthidium	*basidentatum*		2		+	
Xanthidium	*bifidum*		4		+	
Xanthidium	*brebissonii*	*varians*	6		+	
Xanthidium	*concinnum*	*boldtianum*	4		+	
Xanthidium	*fasciculatum*	*oronense*	7		+	
Xanthidium	*impar*		2		+	
Xanthidium	*variabile*		6		+	
Actinotaenium	*cucurbita*		50			+
Actinotaenium	*cucurbitinum*		50			+
Actinotaenium	*diplosporum*		17			+
Actinotaenium	*silvae-nigrae*		12			+
Bambusina	*brebissonii*		72			+
Closterium	*abruptum*	*maius, nilssonii*	39			+
Closterium	*angustatum*	*gracilius, sculptum*	57			+
Closterium	*attenuatum*		64			+
Closterium	*baillyanum*	*alpinum*	111			+
Closterium	*closterioides*	*varieties*	101			+
Closterium	*cornu*	*varieties*	34			+
Closterium	*costatum*	*westii*	88			+
Closterium	*didymotocum*	*crassum*	30			+
Closterium	*directum*	*oligocampylum*	94			+
Closterium	*idiosporum*		28			+
Closterium	*intermedium*	*hibernicum*	75			+
Closterium	*jenneri*		19			+
Closterium	*juncidum*	*varieties*	65			+
Closterium	*lineatum*	*varieties*	39			+
Closterium	*lunula*	*varieties*	73			+
Closterium	*navicula*		37			+
Closterium	*pritchardianum*	*angustum*	25			+
Closterium	*ralfsii*	*hybridum*	30			+
Closterium	*rostratum*	*brevirostratum*	47			+
Closterium	*setaceum*	*elongatum*	48			+
Closterium	*striolatum*	*rectum, subtruncatum*	105+			+
Closterium	*turgidum*		30			+
Closterium	*dianae*	*varieties*	141			+
Cosmarium	*amoenum*	*mediolaeve*	93			+

Cosmarium	*boeckii*		36			+
Cosmarium	*brebissonii*		82			+
Cosmarium	*connatum*		38			+
Cosmarium	*crenulatum*		13			+
Cosmarium	*cucumis*	*magnum*	25			+
Cosmarium	*difficile*	*sublaeve*	135			+
Cosmarium	*excavatum*	*duplo-maius*	13			+
Cosmarium	*galeritum*		24			+
Cosmarium	*margaritatum*		45			+
Cosmarium	*margaritiferum*	*subrotundatum*	168			+
Cosmarium	*monomazum*	*polymazum*	25			+
Cosmarium	*nymannianum*		23			+
Cosmarium	*ochthodes*	*amoebum*	13			+
Cosmarium	*ornatum*		136			+
Cosmarium	*orthostichum*	*compactum, pumilum*	21			+
Cosmarium	*ovale*	*subglabrum*	33			+
Cosmarium	*pseudoconnatum*	*ellipsoideum*	21			+
Cosmarium	*pseudopyramidatum*	*carniolicum, lentiferum, maximum*	32			+
Cosmarium	*quadratum*	*angustatum, willei*	118			+
Cosmarium	*quadrifarium*	*polyticha, hexastichum, octastichum*	22			+
Cosmarium	*quadrum*		20			+
Cosmarium	*quinarium*		18			+
Cosmarium	*ralfsii*	*montanum, rotundatum*	53			+
Cosmarium	*regnellii*	*minimum, pseudoregnellii*	11			+
Cosmarium	*regnesii*	*montanum, tritum*	12			+
Cosmarium	*speciosum*	*biforme, rostafinskii, simplex*	22			+
Cosmarium	*sphaeroideum*		11			+
Cosmarium	*sportella*	*subnudum*	11			+
Cosmarium	*subcostatum*	*beckii*	12			+
Cosmarium	*subcrenatum*	*divaricatum*	34			+
Cosmarium	*subcucumis*		12			+
Cosmarium	*subundulatum*		31			+
Cosmarium	*tetraophthalmum*		112			+
Cosmarium	*turpinii*	*eximium, podolicum*	13			+
Cosmarium	*variolatum*	*cataractarum, rotundatum, skujae*	36			+
Cosmarium	*venustum*	*excavatum, hypohexagonum, minus*	13			+
Cosmarium	*conspersum*	*latum, rotundatum, subrotundatum*	14			+
Cylindrocystis	*brebissonii*	*minor, turgida*	36			+
Desmidium	*grevillei* (=*cylindricum*)		12			+
Desmidium	*swartzii*	*amblyodon*	51			+
Docidium	*baculum*		28			+
Euastrum	*ampullaceum*		71			+
Euastrum	*bidentatum*	*oculatum*	75			+
Euastrum	*binale*	*gutwinskii, hians,, minus, retusum*	29			+
Euastrum	*crassum*	*microcephalum*	76			+
Euastrum	*cuneatum*		43			+
Euastrum	*denticulatum*		54			+
Euastrum	*didelta*		38			+
Euastrum	*elegans*	*ornatum, novae semliae, ornithocephalum, pseudelegans, spinosum*	142			+
Euastrum	*humerosum*	*affine*	39			+
Euastrum	*insigne*		33			+
Euastrum	*pectinatum*	*brachylobum*	150			+
Euastrum	*pinnatum*		21			+

Euastrum	*pulchellum*		15			+
Euastrum	*verrucosum*	*alatum, coarctatum, planctonicum*	108			+
Gonatozygon	*aculeatum*	*groenbladii*	18			+
Gonatozygon	*brebissonii*	*kjellmanii, laeve, minutum, vulgare*	83			+
Gonatozygon	*monotaenium*	*pilosellum*	83			+
Micrasterias	*americana*	*boldtii, lewisiana*	31			+
Micrasterias	*apiculata*		29			+
Micrasterias	*crux-melitensis*		16			+
Micrasterias	*denticulata*	*angulosa*	95			+
Micrasterias	*fimbriata*	*spinosa*	34			+
Micrasterias	*jenneri*		36			+
Micrasterias	*oscitans*	*mucronata*	37			+
Micrasterias	*papillifera*	*includes pseudomurrayi*	68			+
Micrasterias	*pinnatifida*	*pseudoscitans*	44			+
Micrasterias	*radiosa*	*elegantior, ornata, murrayi*	26			+
Micrasterias	*rotata*		43			+
Micrasterias	*thomasiana*	*notata, pucherrima*	51			+
Micrasterias	*truncata*	*bahusiensis , semiradiata*	50+?			+
Netrium	*digitus*	*curtum, latum, lamellosum, naegeli, parvum, rhomboideum*	100+			+
Netrium	*interruptum*	*minor, sectum*	51			+
Netrium	*oblongum*	*cylindricum*	50			+
Penium	*cylindrus*	*cuticulare*	32			+
Penium	*exiguum*		31			+
Penium	*margaritaceum*		20			+
Penium	*spirostriolatum*	*amplificatum*	71			+
Pleurotaenium	*coronatum*	*fluctuatum, robustum*	44			+
Pleurotaenium	*minutum*(*=Haplotaenium minutum*)	*crassum*	70			+
Roya	*anglica*		16			+
Sphaerozosma	*filiformis* (*=Onchyonema filiforme*)		12			+
Sphaerozosma	*vertebratum*		29			+
Staurastrum	*alternans*	*basichondrum*	20			+
Staurastrum	*arachne*	*arachnoides, basiornatum, curvatum*	17			+
Staurastrum	*arctiscon*		20			+
Staurastrum	*brachiatum*		28			+
Staurastrum	*cyrtocerum*	*compactum*	12			+
Staurastrum	*dilatatum*	*hibernicum*	25			+
Staurastrum	*furcigerum*	*armigerum, reductum*	44			+
Staurastrum	*hirsutum*	*muricatum*	47			+
Staurastrum	*inconspicuum*	*crassum, planctonicum*	25			+
Staurastrum	*inflexum*		19			+
Staurastrum	*johnsonii*		11			+
Staurastrum	*lapponicum*		19			+
Staurastrum	*maamense*		12			+
Staurastrum	*margaritaceum*	*coronulatum, hirtum, robustum, subcontortum*	67			+
Staurastrum	*ophiura*	*cambricum*	14			+
Staurastrum	*polytrichum*		15			+
Staurastrum	*punctulatum*	*coronatum, kjellmani, pygmaeum, subproductum*	51			+
Staurastrum	*sexcostatum*	*productum*	15			+
Staurastrum	*simonyi*		12			+

Staurastrum	*spongiosum*	*perbifidum*	14			+
Staurastrum	*teliferum*		126			+
Staurodesmus	*brevispina*	*altus, boldtii, obversus*	19			+
Staurodesmus	*convergens*	*laportei, pumilus, ralfsii*	49			+
Staurodesmus	*dickiei*	*circularis, rhomboideus*	14			+
Staurodesmus	*extensus*	*joshuae, longispinus, vulgaris*	25			+
Staurodesmus	*glaber*	*debaryanus*	12			+
Staurodesmus	*indentatus*		27			+
Staurodesmus	*mamillatus*	*maximus*	17			+
Staurodesmus	*triangularis*	*americanus, limneticus*	13			+
Staurodesmus	*tumidus*	(=*Staurastrum tumidum*)	25			+
Tetmemorus	*brebissonii*	*minor*	95			+
Tetmemorus	*granulatus*		200+			+
Tetmemorus	*laevis*	*minutus*	21			+
Xanthidium	*aculeatum*		12			+
Xanthidium	*antilopaeum*	*depauperatum, hebridarum, laeve, polymazum, oligocanthum, planum, triquetrum*	158			+
Xanthidium	*armatum*	*cervicorne, fissum, irregularis*	83			+
Xanthidium	*controversum*	*planctonicum*	12			+
Xanthidium	*cristatum*	*angulatum, delpontii, leiodermum, uncinatum*	18			+
Xanthidium	*octocorne*		59			+
Xanthidium	*robinsonianum*		11			+
Xanthidium	*smithii*	*collum, maius*	17			+
				78	236	153

8.3 DETAILS OF IPAS FOR FRESHWATER ALGAE

European IPA for Desmids

1. Loughrigg Fell, Cumbria

Grid ref:	NY364040
Status:	SSSI
Ownership:	unknown
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	70 plus
No. of potential UK Red List desmids	6
Survey period	July 1979 - May 1993 (13 visits)
Records contact:	David Williamson

Site description

The fell lies to the north-east of Windermere, its summit (235 m) being approximately 3 km west of Ambleside. The fell lies along the north eastern side of Loughrigg Tarn but is at a higher level. Besides many flushes there are many soft water pools and ponds with an acid pH. There is a pond sufficiently large to be considered a tarn, Lily Tarn, whose algal flora is dominated by the desmid genus *Staurastrum*. It is significant that this is one of the most frequently sampled areas.

Potential UK Red Data List desmids

Cosmarium variolatum, Hyalotheca mucosa, Staurastrum oxycanthum, S. margaritaceum, S. scabrum, S. senarium.

European IPA for Desmids

2. Kelly Hall Tarn, Cumbria

Grid ref:	SD288933
Status:	unknown
Ownership:	National Trust
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	70 plus
No. of potential UK Red List desmids	9
Survey period	May 1981 – June 2000 (8 visits by DW and Alan Brook)
Records contact:	David Williamson

Site description
Small shallow lake (about 1.5 m deep) although a dam has been added to increase depth and volume. A reservoir with a sign saying the water is used for drinking water and so no swimming allowed.

Potential UK Red Data List desmids
Cosmarium pseudoconnatum, C. retusiforme var. *incrassatum, Desmidium aptogonum, Sphaerozosma vertebratum, Staurastrum laeve, S. manfeldtii, S. quadrangulare, S. spongiosum, S. striolatum.*

European IPA for Desmids

3. Three Dubs Tarn, Cumbria

Grid ref:	SD378974
Status:	unknown
Ownership:	unknown
Qualifying criteria:	A, A2, B1, B2, C
No. of species recorded:	70 plus
No. of potential UK Red List desmids	11
Survey period	June 1980 – April 1990 (4 visits)
Records contact:	David Williamson

Site description
Small shallow lake.

Potential UK Red Data List desmids
Actinotaenium obcuneatum, Closterium toxon, Cosmarium entochondrum, C. excavatum var. *duplo-maius, C. pseudoconnatum, C. pyramidatum, Groenbladia undulata* var. *perundulata, Hyalotheca mucosa, Staurastrum brasiliense* var. *lundellii, S. longispinum, Staurodesmus validus.*

European IPA for Desmids

4. Lochan Feoir, Highlands (Sutherland)

Grid ref:	NC227250
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	70
No. of potential UK Red List desmids	6
Survey period	Sept 1993 - Sept 1994 (2 visits)

Records contact: David Williamson; *Desmidium* records from Alan Joyce

Site description
Small loch (area 2.6 ha) and oligotrophic.

Potential UK Red Data List desmids
Cosmarium excavatum var. *duplo-maius, Desmidium graciliceps, D. occidentale, Micrasterias conferta, Sphaerozosma vertebratum, Staurastrum sexangulare.*

European IPA for Desmids

5. Long Moss Tarn, Cumbria

Grid ref:	SD291936
Status:	unknown
Ownership:	National Trust
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	70 plus
No. of potential UK Red List desmids	5
Survey	May 1981-Oct 1999 (6 visits)
Records contact:	David Williamson

Site description
The lake lies in a narrow, linear hollow scoured out by ice flowing south-southwest and parallel to Coniston water (see Haworth *et al.*, 2003). It is a small (area 5.75 km²), shallow (<1 m deep), oligotrophic whose water has an acid pH.

Potential UK Red Data List desmids
Cosmarium sportella, Groenbladia undulata var. *perundulata, Hyalotheca mucosa, Haplotaenium rectum, Staurodesmus bulnheimii, S. validus.*

European IPA for Desmids

6. Lower Bostraze (St. Just area), West Cornwall

Grid ref:	SW392321
Status:	SSSI
Ownership:	County Wildlife Trusts
Qualifying criteria:	B1, B2; C
No. of species recorded:	100
No. of potential UK Red List desmids	2
Survey period	1983 - 1993
Records contact:	David Williamson

Site description
Series of pools that are probably old extraction pits filled with water. So far the most important desmid site on the south-west Peninsula of England although many other sites were sampled, especially in the middle part of the 19th century by John Ralfs, one of the most influential desmid specialists at that time. Some of his more significant collecting sites are known but the present status of the desmid flora in them remains to be determined.

UK IPA for Desmids

7. Torver Tarn, Cumbria

Grid ref:	SD281926
Status:	SSSI
Ownership:	National Trust
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	50 plus
No. of potential UK Red List desmids	10
Survey period	May 1981 – July 1990 (6 visits)
Records contact:	David Williamson

Site description
A small tarn just 1.5 m in maximum depth and slightly alkaline with a comparatively high in calcium (Haworth *et al*., 2003). The shallow extremities and the inflow on the north side are surrounded by *Sphagnum* peat. Its small catchment is mainly rock, bracken and peat.

Potential UK Red Data List desmids
Actinotaenium inconspicuum, Cosmarium regnesii, C. sportella, Groenbladia undulata var. *perundulata, Hyalotheca mucosa, Staurastrum incus, S. glaber, S. laeve, S. longispinum, Sphaerozosma vertebratum.*

UK IPA for Desmids

8. Dock Tarn, Cumbria

Grid ref:	NY274144
Status:	SSSI
Ownership:	unknown
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	50 plus
No. of potential UK Red List desmids	13
Survey period	Sept 1981 – May 1988 (5 visits)
Records contact:	David Williamson

Site description
One of the largest of the Cumbrian tarns (over 34 km²) lying in a moorland hollow on the upland between lower Eskdale and Dunnerdale. Its water has a low to circumneutral pH and is nutrient-poor (oligotrophic). The small catchment is of rough grassland, heather moor, rock outcrops and wet peat.

Potential UK Red Data List desmids
Actinotaenium capax, Cosmarium galeritum, C. regnellii, C. undulatum, C. excavatum, C. pseudonitidulum, Gonatozygon monotaenium, Hyalotheca mucosa, Staurastrum brasilense, S. longispinum, S. sebaldi, S. senarium, S. sexangulare.

UK IPA for Desmids

9. Barngate Tarn ('Drunken Duck' tarn), Cumbria

Grid ref:	NY351011
Status:	unknown
Ownership:	unknown
Qualifying criteria:	A; B2; C
No. of species recorded:	40
No. of potential UK Red List desmids	4
Survey period	July 1979 – March 1986 (5 visits)
Records contact:	David Williamson

Site description
Small lake.

Potential UK Red Data List desmids
Cosmarium phaseolus, C. sportella, C. subtumidum, Hyalotheca mucosa.

UK IPA for Desmids

10. Silver Howe Fell, Cumbria

Grid ref:	NY325065
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	50
No. of potential UK Red List desmids	2
Survey period	August 1982 – May 1993 (4 visits); 2 records for August 1973 by Edna Lind.
Records contact:	David Williamson

Site description
The moss has many soft water and acid pH bog pools and small tarns.

Potential UK Red Data List desmids
Cosmarium undulatum, Euastrum humerosum.

UK IPA for Desmids

11. Goosey Foot Tarn, Cumbria

Grid ref:	SD338970
Status:	unknown
Ownership:	National Trust
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	50
No. of potential UK Red List desmids	2
Survey period	June 1981- June 2003 (6 visits)
Records contact:	David Williamson

Site description
Artificial impoundment with a low dam at either end and was formerly the reservoir for the village of Hawkshead. Its water is oligo- to mesotrophic, covers an area of about 1.5 ha and is about 2.5 m deep.

Potential UK Red Data List desmids
Roya cambrica var. *limnetica, Euastrum humerosum* var. *affine.*

UK IPAs for Desmids

12. Culag Wood Bog, Assynt (Sutherland)

Grid ref:	NC093214
Status:	unknown
Ownership:	Assynt Estates
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	50
No. of potential UK Red List desmids	4
Survey period	March 1994 – Oct 2003 (8 visits)
Records contact:	David Williamson

Site description
Wood covers 36 hectares and contains many boggy pools. Sampled by David Williamson, I. Evans, Peter York and David John.

Potential UK Red Data List desmids
Cosmarium variolatum, C. praegrande, Pleurotaenium rectum, Closterium toxon.

UK IPA for Desmids

13. Podnet Moss, Cumbria

Grid ref:	NY405925
Status:	unknown
Ownership:	unknown
Qualifying criteria:	A, B1, B2; C
No. of species recorded:	50 plus
No. of potential UK Red List desmids	7
Records contact:	David Williamson

Site description
Many soft, acid water bog pools. David Williamson and Edna Lind sampled these pools between 1979 and 1996.

Potential UK Red Data List desmids
Cosmarium perforatum, Euastrum dubium, Staurodesmus incus, S. spencerianus, Staurastrum oxyacanthum, S. quadrangulare, S. subcruciatum.

UK IPA for Desmids

14. Gurnal Dubs Tarn, Cumbria

Grid ref:	SD503992
Status:	unknown
Ownership:	unknown
Qualifying criteria:	B1, B2; C
No. of species recorded:	50 plus

No. of potential UK Red List desmids	5
Survey period	July 1979 – April 1983 (4 visits)
Records contact:	David Williamson

Site description
Shallow lake.

Potential UK Red Data List desmids
Cosmarium regnesii, Sphaerozosma vertebratum, Staurastrum hystrix, S. longispinum, S. teliferum.

UK IPA for Desmids

15. Wrynose Pass, pools on summit, Cumbria

Grid ref:	NY2702
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	50 plus
No. of potential UK Red List desmids	6
Records contact:	David Williamson

Site description
Bog pools at the summit have been sampled by David Williamson between 1979 and 2000.

Potential UK Red Data List desmids
Actinotaenium obcuneatum, Cosmarium conspersum, C. variolatum, Euastrum ventricosum, Staurodesmus glaber, S. incus.

UK IPA for Desmids

16. Thursley Common, Surrey

Grid ref:	SU9040
Status:	SSSI, cSAC, RAMSAR Site
Ownership:	unknown
Qualifying criteria:	B1, B2; C
No. of species recorded:	50 plus
No. of potential UK Red List desmids	2
Survey period	March 1981 - June 1984
Records contact:	David Williamson

Site description
Thursley Common in north-west Surrey represents an area of northern Atlantic wet heath and consists of woodland, heath and bog in north-west Surrey. There are several ponds as well as *Sphagnum*-filled peaty pools whose water is soft with an acid pH. A causeway dam and weirs maintain the water level high and the ponds are actively managed. Historically known to be a desmid-rich area and probably the most important desmid area in south-east of England.

Potential UK Red Data List desmids
Cosmarium ornatum, Closterium pritchardianum, C. ralfsii var. *hybridum.*

UK IPA for Desmids

17. Pant y Llyn (near Builth Wells), Powys

Grid ref:	SO048468
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	B1, B2 ; C
No. of species recorded:	50
No. of potential UK Red List desmids	3
Records contact:	David Williamson

Site description
The lake has been artificially deepened by two dams and drains water running off the blanket bog on Pant y Llyn Hill. The blanket bog and Llyn should be considered as a unit.

Potential UK Red Data List desmids
Cosmarium pygmaeum, C. paragranatoides, Euastrum gayanum.

UK IPA for Desmids

18. Loch Bad an Og, Highlands (Sutherland)

Grid ref:	NC116312
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	A; B1, B2; C
No. of species recorded:	50
No. of potential UK Red List desmids	5
Records contact:	David Williamson

Site description
David Williamson has sampled this small loch in September 1994 and June 1995.

Potential UK Red Data List desmids
Cosmarium cyclicum, C. variolatum, C. venustum, Staurastrum striolatum, Staurodesmus corniculatus.

Potential IPAs (areas/sites19-45) pending further investigation - ‘data deficient’ (often no modern data)

Potential Desmid IPAs (19-21)

19. Cwm Bochlwyd, Snowdonia

Grid ref:	SH657597
Status:	Snowdonia National Park
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	150 spp.

Site description
The last comprehensive study was in 1956 and focused on the desmids. No complete list of desmids

published (Duthie, 1965) hence its 'data deficient' status.

20. Claise Fearna SE 1, Scourie South

Grid ref:	NC206466
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	C; D
No. of species recorded:	Unknown
No. of potential UK Red List desmids	3
Records contact:	Alan Joyce

Site description
Small lake.

Potential UK Red Data List desmids
Desmidium pseudostreptonema, D. occidentale, D. graciliceps.

21. Loch an Eilean, South Sky

Grid ref:	NG472306
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	C; D
No. of species recorded:	Unknown
No. of potential UK Red List desmids	3
Records contact:	Alan Joyce

Site description
Small lake.

Potential UK Red Data List desmids
Desmidium pseudostreptonema, D. occidentale, D. graciliceps.

Potential Freshwater Algal IPAs (22-45)

It is possible that areas 22 and 23 might prove to be sites also of European importance.

Snowdonia National Park

There are well over a hundred lakes more than an acre in size in Snowdonia, from Llyn Ogwen in the north to Tal y Llyn in the south. Many were studied by George and William West in the early years of the 20th century who considered the area around Capel Curig as 'record-breaking' in terms of desmid diversity. Further surveys of many lakes, ponds and pools carried in the 1950's and 60's (Duthie, 1965; Woodhead & Tweed, 1954-55) confirm the area to be one of the most algal diverse areas in the UK and possibly Europe. They report finding at least 1500 algal species and over 500 subspecies in Caernarvonshire and Anglesey in the 1950s. Unfortunately there are no modern data.

22. Cader Idris and Capel Curig area

Grid ref: SH7013/SH7258

Status:	Snowdonia National Park
Ownership:	SSSIs, cSAC
Qualifying criteria:	B1, B2; C; D
No. of species recorded:	1500 plus

Site description

Areas of lakes, ponds and bogs are especially rich in desmids. Long history of study, unusual assemblages of algae associated with lime-rich waters.

23. Malham Tarn Area, Yorkshire

Grid ref:	SD8966
Status:	SSSI, cSAC
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	600 plus

Site description

One of the areas in the United Kingdom known to have an exceptionally diverse an algal flora (over 600 species) that includes several endemics and notable rarities (see Pentecost, 2004). The area includes Malham Tarn (2 ha. in area) as well as patches of calcareous mire and fen, and numerous permanent and ephemeral streams and springs (mostly neutral or alkaline). The tarn is one of the few UK sites where *Cladophora* balls are recorded. According to Stewart (2004), a site of national importance for stoneworts. Nationally rare green algae include endolithic *Oocardium calcareum*. Very comprehensive investigations of the algal flora of the Malhal Tarn area were carried out in the 1950's by Lund (1961) and, more recently, by Pentecost (2004).

24. The Serpentine, Eaton Park, Cheshire

Grid ref:	SJ416600
Status:	unknown
Ownership:	unknown
Qualifying criteria:	B2; D
No. of species recorded:	unknown
Survey period	1932-1965

Site description

One of the few small lakes in the UK whose algal flora has been studied over an extended period. Seasonality was studied by E.G. Williams over a 20-year period (1932-1965) and he discovered a number of algae rarely reported in the UK (e.g., *Chrysolykos planctonicus*, Chrysophyta). There have been no modern studies on the lake and therefore it is not known whether it has changed over the past 40 years (see Williams, 1965).

25. Priest Pot, Cumbria

Grid ref:	SD357978
Status:	SSSI
Ownership:	Unknown
Qualifying criteria:	B2; D?
No. of species recorded:	Over 140 spp.
Survey period	1965-1991 (main period)

Site description
A small freshwater lake (1 hectare) lying within a hollow in a wooded fen at the northern end of Esthwaite Water. Relatively undisturbed since its isolation from Esthwaite Water about 400 years ago. It has been the subject of intensive study with Findlay & Maberley (2000) remarking that 'more is already known about the natural history of Priest Pot than any other water body of similar size'. For a summary of information on the pond, see Findlay & Maberley (2000).

26. Hells Kettles (near Darlington), Durham

Grid ref:	NZ280140
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	Unknown
Survey period	

Site description
The 'kettles' consist of two small ponds formed by subsidence of the underlying Magnesian limestone. All submerged surfaces are usually marl-encrusted but management changes in the past few years have resulted in nutrient enrichment resulting in dramatic changes in its algal flora (including stoneworts). Until recently the Kettles contained an assemblage of attached algae characteristic of hard, alkaline water. One of the few UK sites from which the very rare brown alga *Pleurocladia lacustris* has been recorded, a possible potential Red List species. Several detailed ecological studies have been carried out in the Kettles including an inventory of the algae (see Hudson *et al*., 1971). The most recent changes in its ecology are believed to be a consequence of the raising of the water level causing wash-in of nutrient from the surrounding grazing land. An Important Stonewort Area of local importance.

27. Rostherne Mere, Cheshire

Grid ref:	SJ732819
Status:	SSSI, RAMSAR
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	Unknown

Site description
A large (48.7 ha) and deep (27 m) lake receiving water from a stream derived ultimately from Little Mere and Mere Mere, as well as streams and ground water. Blue-green algal blooms have probably occurred in this nutrient-rich lake for several thousand years. One of the few lakes where nutrient enrichment is caused from secondarily treated sewage. The phytoplankton have been monitored over a long period (see Belcher & Storey, 1968).

28. Crose Mere, Shropshire

Grid ref:	SJ 430305
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	Unknown

Site description
Moderately large (15.2 ha) lake occupying the southern part of a complex peat- and water-filled basin lying between hummocks of morainic sands and gravels. Principally fed by relatively nutrient rich ground water. Seasonal changes in the phytoplankton were studied between January 1966 and December 1971 by Reynolds & Allen (1968) and Reynolds (1973).

29. White Mere, Shropshire

Grid ref:	SJ 414330
Status:	SSSI, RAMSAR
Ownership:	unknown
Qualifying criteria:	B2; D
No. of species recorded:	unknown

Site description
The lake is a large and isolated basin about 25 ha in area and has no apparent permanent surface inflow other than a small inlet flowing in from Lee Wood. Largely fed by ground water and is a perched water body surrounded by sand and gravel as well as clay deposits. It is believed to be a natural nutrient-rich lake that has had blue-green algal blooms probably for several thousand years. The mere became an SSSI in 1986 and is part of the West Midland Meres and Mosses RAMSAR site. Agricultural activities probably account for the recent phase of eutrophication.

30. Oakmere, Cheshire

Grid ref:	SJ576676
Status:	unknown
Ownership:	unknown
Qualifying criteria:	B2; D
No. of species recorded:	unknown

Site description
The algae have been studied on several occasions between about 1944 and 1968 (see Lind 1944).

31. Little Sea, Studland, Dorset

Grid ref:	SY035835
Status:	Reserve, managed by the National Trust
Ownership:	unknown
Qualifying criteria:	B2; D
No. of species recorded:	Unknown
Records contact:	D.C. Stevens

Site description
Cut-off from the sea around 1890 by the accumulation of sand dunes. Originally brackish-water but now an oligotrophic lake. A UK site of local importance for stoneworts. Information on this lake is to be found in unpublished reports by D.C. Stevens (voluntary warden, National Trust) who began monitoring it in 1991.

32. Martham Broad (north and south), Norfolk

Grid ref:	TG4520

Status:	SSSI, cSAC, All Ramsar
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	Unknown

Site description
The two broads largely escaped the enrichment pollution that resulted in the loss of the rooted vegetation (including stoneworts) from most in the 1970s. There are records of algae (other than stoneworts) extending back well before the main phase of pollution in the area. It is of regional importance for algae on two accounts: (a) existence of a reasonably comprehensive baseline of information on its algal flora, and (b) being one of the few broads not impacted by nutrient enrichment. Stewart (2004) considers it to be a site of European importance for stoneworts since 10 species belonging to this group have been recorded from it.

33. River Wear, Durham

Grid ref:	NZ1134 NZ24, NZ28, NY94
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	Unknown

Site description
Long history of study (see Whitton & Buckmaster, 1970; Whitton *et al.*, 1998).

34. River Bure, Norfolk

Grid ref:	TG2521
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	Unknown

Site description
Most of the River Bure valley lying above the junction of the River Thurne. The Broadland part of the valley is an area of marshland, woodland and scattered broads. Considerable baseline and long-term information on the phytoplankton in the slow-flowing Bure River (e.g., Moss *et al.*, 1984,1988), including in some cases its floodplain lake and broads.

35. Abbot's Pond (near Bristol), Somerset

Grid ref:	ST536732
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	Unknown

Site description
One of the most researched small ponds in the UK (see Moss, 1969a, 1969b; Round & Eaton, 1966, Round & Happy, 1965). No recent investigations so unknown whether conditions today are similar to when intensively investigated in the 1960s.

36. Lake Windermere, Cumbria

Grid ref:	SD3995, SD4197 (West-mid) SD38 & NY38
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	150 plus spp.

Site description

Windermere is not only the largest (ca. 14.8 km²) but the most thoroughly researched natural lake in England. This glacial ribbon lake is divided into a deeper north basin and a shallower more productive south basin. Data sets extend back more than 50 years and cover the period in the 1960s when its algal flora changed in response to the discharge into the lake of mineralised, secondary-treated sewage. Almost 150 species of algae have been recorded in the phytoplankton of the lake. For a list of the planktonic algae recorded from Windermere and a summary of earlier research, see Reynolds & Irish (2000).

37. River Coquet, Northumberland

Grid ref:	NU212036
Status:	SSSI
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	Unknown
Records contact:	Martin Kelly

Site description

Drains the southern flanks of the Cheviot Hills in Northumberland. Diatom sites in Coquetdale sampled from the middle part of the 20th century (Donkin, 1869). Notable for the unusual abundance of the diatom *Didymosphenia geminata* in the UK.

38. Stream, Weston Combe (near Branscombe), Devon

Grid ref:	SY1688
Status:	Unknown
Ownership:	Unknown
Qualifying criteria:	B2; D
No. of species recorded:	Unknown

Site description

A stream running through a small coastal valley running lying between Sidmouth and Branscombe on the south Devon coast. The small catchment is of woodland and pasture with the water alkaline and many surfaces marl-encrusted. What proved to be a new species of algae was collected by a Mr Scourfield in 1917 as small, green, lime-encrusted cushion-like growths on and within the splash and spray of a small waterfall about 10 m from where the stream runs onto the shore (West, 1918; Johnson & John, 1992). This is the type locality of *Gongrosira scourfieldii* G.S. West, a green alga still unrecorded from elsewhere. Observed growing its type locality (June 2004) around the waterfall close to the beach and along much of the course of the stream.

39. Wicken Fen, Cambrideshire

Grid ref:	TL 5570
Status:	SSSI, cSAC, RAMSAR
Ownership:	National Trust
Qualifying criteria:	B2; D
No. of species recorded:	267

Site description

Much of the fen (247 hectares) is a nature reserve owned by the National Trust. It comprises a mixture of sedge fen, carr scrub and includes various aquatic habitats such as ditches. The fen is is one of the only areas of undrained peat fen for which there is a long history of algal study. For a summary of information on the fen and its aquatic algae, see Friday & Harley (2000). Designated a stonewort site of European importance by Stewart (2004), partly on account of stonewort diversity (12 spp).

40. River Thames, Southern England

Grid ref:	SU761003 (near mid-point of course)
Status:	unknown
Ownership:	Various
Qualifying criteria:	B2; D
No. of species recorded:	unknown

Site description

Various early studies of the plankton and more recently (mostly 1980s) of the benthic algae.

41. River Wye, England/Wales

Grid ref:	SO597168 (near mid-point of course)
Status:	SSSI (in part)
Ownership:	Various
Qualifying criteria:	B2; D
No. of species recorded:	unknown

Site description

Several studies of the benthic and planktonic algae (including unpublished reports) with some focusing on the diatoms.

42. Loch Leven, Perth & Kindross

Grid ref:	NO150015
Status:	unknown
Ownership:	unknown
Qualifying criteria:	B2; D
No. of species recorded:	unknown

Site description

Large, mostly fairly shallow lake that has become increasingly eutrophicated. For summary of long-term studies on this lake, see Bailey-Watts (1974, 1978).

43. Blackford Pond, Edinburgh

Grid ref:	NT253709
Status:	unknown
Ownership:	unknown
Qualifying criteria:	B2; D
No. of species recorded:	unknown
Records contact:	David Mann

Site description

Various studies but all focusing on diatoms.

44. Isle of Mull, Argyll & Bute

Grid ref:	NM7236
Status:	Unknown
Ownership:	Various
Qualifying criteria:	B2; D
No. of species recorded:	600 spp. Plus

Site description

Mull Survey carried out by staff of the Natural History Museum, London between 1965-1970. Wide range of habitats including lochs, small pools, etc. (see Jermy & Crabbe, 1978).

45. Lough Neagh, Traad Beach, Northern Ireland

Grid ref:	H955870 (Irish Grid)
Status:	unknown
Ownership:	various
Qualifying criteria:	B2; D
No. of species recorded:	unknown

Site description

This large mesotrophic lake has a long history of study (see Gibson, 1993), especially Traad beach (see Jewson *et al.*, 2006).

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