

THE VEGETATION OF IRISH LAKES

2

<u>ן</u>

J

J

]

]

]

J

]

1984

•

BY HESTER HEUFF

Wildlife Service Office of Public Works

.

	. 1 .		
П	CONTENTS	PAGE 2	NO
	ABSTRACT	2	
]	ACKNOWLEDGEMENT	3	
	INTRODUCTION		
]	AIMS OF THE SURVEY	5	
	METHODOLOGY	6	
	1. Lake choice	6	
	2. Physico - chemical investigation	6	
]	3. Botanical investigation	7	
u	 Environmental indicator values 	8	
ר		q	
	RESULTS AND DISCUSSIONS	9	
ال آ	1. Description of the individual lakes (Appendix)	- 9	
i M	2. Description of the macrophyte communicies, including		
ר	notes on argae	33	
j J	4. The opperie, epiricate and opperior 5	38	
]]	 The phytoprumeton Classification of the lakes from the aquatic macrophyt vegetation 	e 41	
]	6. Environmental indicator values (Ellenberg, 1979)	43	
	CONCLUSIONS		
	1. The macrophyte vegetation	47	
-	2. The benthic algae: a) growth forms	47	
]	b) vegetation classification	49	1
	3. The phytoplankton and lake classification	50 ⊑1	
'	4. Lake classification from the aquatic macrophytes	יר ג1	
	5. Environmental indicator values	51	
]]	GENERAL CONCLUSIONS	52	:
]	RECOMMENDATIONS		
ב	REFERENCES 55		
]	APPENDIX : containing description of the individual lakes including maps, eight tables and four figures.		

ABSTRACT

Forty one lakes throughout the country were examined botanically in order to provide a baseline against which the conservation All three major value of other lakes could be assessed. botanical components of lakes, the phytoplankton, the benthic algae and the macrophytes were examined. In the phytoplankton 20 potential indicator taxa and 10 major species groupings were Amongst the benthic algae 11 growth forms, 7 identified. communities and 18 potential indicator taxa were identified. Thirty seven macrophyte communities were described of which 20 were previously unrecorded in Ireland and some are probably new From the aquatic macrophyte communities it was to Europe. possible to identify the following 6 lake types: (1) Nitella lakes, (2) Lobelia lakes, (3) Najas lakes, (4) Charetum asperae The nitrogen and lakes, (5) Elodea lakes, (6) Marl lakes. reaction indicator values of the macrophytes (Ellenberg, 1979) suggest that the following three major lake types occur: (1) acid, calcium poor, nitrogen poor, (2) neutral to alkaline, calcium rich and nitrogen rich, (3) neutral to alkaline calcium rich and nitrogen poor. The last type includes the marl lakes and is thought to be rare in Europe.

It is recommended:

J

J

]

]

]

That a list of lakes of international importance is drawn up by means of a national inventory;

That lakes of all six types are given conservation status and especially that immediate attention is given to the oligo-to mesotrophic calcareous lakes, as these are most threatened.

. 2 .

ACKNOWLEDGEMENT

. 3 .

]

J

]

]

J

]

]

]

Thanks are due to Anne Basset, Catherine Duff, Noel McGough, Tony Kavanagh, Niel Lockhart and Micheline Skeffington who all endured long working hours and bad weather conditions during the Special thanks are due to Jim Ryan who was survey periods. responsible for the organisation of the survey. Tom Curtis and Noel McGough are thanked for the releves from Lough Bunny and Thanks are also due to Professor Victor Lough Inchiquin. and the vegetation advice on discussions Westhoff for classification.

INTRODUCTION

Lakes consist of two major physical components: the water and The quality of the the basin in which the water is contained. water is mainly determined by the geology and ecology of the catchment of the lake, in which human factors may play an important role (e.g. agricultural pollution). The retention time (time it takes for all the water in a lake to be replaced) also influences water quality, and this factor becomes more important the longer it takes to replace all the water. The soil conditions in the lake are determined by the geology of the lake bottom and by various factors like erosion by wave actions and deposition of silt and organic matter. The plants living in such a system can be divided into plants which are suspended in the water and plants which root on the lake bottom. The former consist mainly of microscopic species (the phytoplankton) while the latter are mainly aquatic macrophytes, comprising vascular plants, large algae like the stoneworths (Charophyta) and a few Macroscopic non-rooting plants occur also (e.g. moss species. Lemna minor and Lemna trisulca) and microscopic alqae are attached to the lake bottom and to the rooted plants. The quality of the physical and chemical environment determines which combinations of plant species occur in the different lakes. It can be expected that certain combinations of plant species will occur in several lakes and hence these lakes will all be of a similar type. It is the objective of this survey to describe a sufficient number of lakes in order to establish which lake types This information is intended to be used as a occur in Ireland. base-line against which the ecological status of any individual measured in order to establish the potential lake can be conservation value of such a lake. This survey is intended to be followed by a national inventory so that a complete list of lakes These lakes should of international importance can be drawn up. This report describes a then be given conservation status. number of lakes of international importance and recommends these its nature, claim to be for conservation, but can not, by comprehensive in this respect. It is of the utmost importance that a complete list be drawn up as soon as possible.

4.

In the past, few lakes were investigated botanically in Ireland. Phytoplankton was most frequently sampled (e.g. Flanagan & Toner, An Foras Forbartha is conducting phytoplankton work on a 1975). routine basis since 1970, but detailed species lists have not been published, although these are presumably available. The bottom dwelling and epiphytic algae have been almost totally ignored except for the diatoms which were investigated by Foged Vascular plants were studied in Co. Kerry by Visser & (1977). Zoer (1972), in Lough Ree by Hessel & Rubers (1971), and by Klein (1975), and at Dooachtery, Co. Mayo, by Groenendael et. al (1979), and in Connemara by Brock et. al (1978). Specific plant communities (Littorelletea) have been described by Schoof-van Pelt (1973) from several lakes in the west of Ireland. Of course many records of individual aquatic plant species are available. Information on submerged plant and others). (Praeger, 1934 lacking, and is not otherwise Ireland is in communities sufficient for the construction of a base line as described above.

AIMS OF THE SURVEY

The objective of the Lake Survey is to provide a botanical base line against which the ecological status of any individual lake can be assessed, in order to decide on its potential for conservation.

In order to achieve this aim the following questions need to be answered:

- 1. What are the major aquatic vegetation types of Irish lakes?
- 2. Can the lakes be classified into types using any or all of its botanical components?
- 3. Is it likely that the full range of variation present in Ireland was sampled and do we have a sufficient number of representatives of each type to describe the variation present within each type?

Ì

J

]

J

]

]

METHODOLOGY

1. Lake Choice

In order to assure a representative sample the country was divided into six divisions based on geology, associated soil groups and their plant community complexes as follows (Moore, 1973, slightly revised: "burren limestone" excluded and "coastal" added):

- 1. Atlantic lowland blanket bog complex
- 2. Mountain blanket bog complex
- 3. Central lowland calcareous till
- 4. Drumlin complex
- 5. Acid brown earths, free drainage
- 6. Coastal

Lakes were chosen according to the ecology of their catchments, indicated by the six divisions, as this is thought to determine to a great extent lake ecology and hence lake type. This method of site choice was used to help assure the description of a full range of lake types. Forty-one lakes in all were investigated mainly during the summers of 1977 and 1978, a few sites were visited during 1979, 1981 and 1984 (see table 1). Their distribution in the country is shown by fig. 1.

2. Physico-chemical investigation

The lakes were described in physical terms including surface area, altitude, geology, ecological division, drainage order of maximum length, maximum maximum depth, stream, inflowing vegetated depth, nature of bottom (in the shallows and in deeper Water was collected in water) and surrounding landscape. polyethylene bottles from a boat and analysed in the laboratory the following methods (see table 2) for standard using Ca²⁺, Mg²⁺, K⁺, Na⁺, Cl⁻, Ca-hardness, total parameters; The results of the total hardness, and total Phosphorus. Phosphorus determinations need to be treated with caution, as the The following parameters were method used is unreliable. alkalinity, conductivity and field: measured in the transparency. (Secchi-disk depth).

3. Botanical Investigation

5

J

J

J

It was attempted to include all major aquatic vegetation types present in each lake (or in part thereof if it concerned a large lake e.g. Lough Corrib, Lough Gowna etc). For macrophytes this was usually achieved by describing an exposed and a sheltered The zonation of emergent and floating leaf plants was shore. described in general from dominance features, the surrounding The submerged and floating leaf wetlands were not included. communities as well as the wetter emergent zones were then described in detail, using the methodology described first by The usual scale of abundance Braun-Blanquet and Tuxen (1934). of +, R, 1, 2, 3, 4, 5 was used, as well as a value of N indicating a plant thought to belong to the community in question, but prèsent just outside the quadrat. In theory the quadrat should have been bigger to include the species in these cases, but this was not always possible for practical reasons Epipelic (growing on soil), Epilithic (growing on rocks or gravel) and/or epiphytic algae (growing on plants), which were clearly visible macroscopically, were collected for all quadrats of submerged plant species, as well as for some of the emergent plant communities as it is likely that these will yield useful Snorkeling techniques were used for environmental indicators. all plants growing in more than 30 cm of water and recording was done by a person in a boat assisting the divers. Further relevés were taken in shallow water on foot, and these usually do not have algal records attached. Soil cores were taken and their physical features described. , Another important plant component of a lake is the phytoplankton and this was collected with a 40 mesh net from open water, either by the divers or from the boat. Algae were preserved in 4% formaldehyde and identified in the laboratory from fresh samples and from the preserved material, using the following standard taxonomic works: Geitler (1932); Hudstedt (1930); Bourrelly (1966, 1968, 1970). Identification was mostly to the genus level, as identification to the species level is often very time consuming and in some cases impossible. In this survey the aim was to identify environmental indicator groups which can then be concentrated on and identified to species level at a later stage.

A semi-quantitative scale of abundance of 1 to 5 was employed for the algal records as follows:

- 1 rare (seen up to 3 times)
- 2 occasional
- 3 common
- 4 dominant or co-dominant species
- 5 bloom

]

Environmental indicator values (Ellenberg, 1979)

Ellenberg (1979) expresses numerically the ecological behaviour of many vascular plants for six different factors of which the occurrence in relation to soil acidity (R) and the occurrence in relation to the ammonia and nitrate supply (N) are the most important for this report. The other factors are: The light figure (L) which expresses the occurrance in relation to relative light intensity during summer time; The temperature figure (T) which expresses main distribution according to latitutional zones and altitudinal belts; The Continentality figure (K) which expresses main distribution according to the degree of continentality of the general climate with special emphasis on minimum and maximum temperature; The moisture figure (F) which expresses occurance in relation to soil moisture or water level. For a detailed list of the meaning of the numericals see Ellenberg 1979 p. 108 and 109 and the relevant tables and graphs

of this report.

Most of the Irish vascular plants are included in Ellenberg's Eleocharis multicaulis, Callitriche species, except lists bulbosus, flexilis, Najas Juncus Eriocaulon aquaticum, Ranunculus trichophyllus, Scirpus berchtoldii, Potamogeton fluitans and Veronica catanata, mosses and Charophytes are also Although the indicator values are not specifically excluded. researched for plants growing under Irish conditions and several Irish taxa have no indicator values, it is still usefull to calculate the combined values for species combinations occurring in relevés, communities or lakes, as this will give an insight species which the environmental conditions under into combinations may grow. Calculations were carried out by hand and therefore the values were not weighted for abundance, although it The values for individual would no doubt be useful to do this. relevés of Subunits I to XII (the emergent vegetation, see Table 3) were excluded because they are transitional between the true lake vegetation and the lake side wetlands, the latter were not surveyed. Values for L, T, K, F, R and N were plotted against each other to see if any ecological gradients could be discovered and to provide an ordination of the lakes.

RESULTS AND DISCUSSIONS

1. Description of the individual lakes (see appendix)

J

]

IJ

General descriptions of the lake, the water chemistry (for units see Table 2), the macrophyte zonation and details of the relevés including remarks on the algae, ecological indicator values (Ellenberg, 1979, see the relevant chapters for an explanation) and maps of the sites can be found in Appendix 1. The lakes are numbered in alphabetical order.

2. <u>Description of the macrophyte communities including notes on</u> the algae

The macrophyte records were initially classified using the Cornell Ecology Computer Programme TWINSPAN (Hill, 1979) as an aid to table work. The resulting rough vegetation table was further improved by rearranging the species and relevés by hand in the traditional manner. The epipelic, epilithic and epiphytic algae recorded from the same relevés were classified in the same manner as far as the species were concerned, the relevés were arranged in the same order as the final arrangement of the macrophyte relevés, so that the algal and macrophyte tables match.

Table 3 represents the macrophyte vegetation classified into plant communities. Table 4 lists the algae recorded from the

same quadrats. Corresponding relevé numbers indicate the same The plant communities have been quadrats in both tables. assigned Class, Alliance and Association names in accordance with the European vegetation classification system. The nomenclature used by Westhoff and Den Held (1969) and in some cases by indicator values Ecological was used. Obendorfer (1977) (Ellenberg, 1979) were calculated for each community. For an explanation of these values see the relevant chapter. Below follows a description of the different plant communities, Subunit numbers refer to Tables 3 and 4.

Subunit I: Community of Oenanthe aquatica and Apium inundatum

Lough relevé from This community is represented by one Ballyteige, Co. Clare (No. 79). The diagnostic species are Oenanthe aquatica and Apium inundatum. Lemna trisulca occurs Species occurring more sparsely are: Nasturtium abundantly. officinale agg., Myosotis secunda group, Equisetum fluviatile, Hippuris vulgaris and Baldellia ranunculoides. The dominant alga was a species of Spirogyra >96µ in width. It occurred in free floating clouds suspended in between the vascular plants. А species of Zygnema (>24 μ) was also common. These large filamentous green algae also occurred attached to the vascular This vegetation dies off in winter. It occurred in plants. calcareous water at 0.50m depth on soft marl in a sheltered The conductivity of the location on gently sloping ground. water was 334 umho's and the calcium content was $28.2mg1^{-1}Ca^{2+}$.

The following ecological indicator values were calculated: L=7.4; T=5.6; K=3.0; F=10.7; R=7.3; N=5.8

Syntaxanomy: This community, represented by only one relevé, belongs to the Alliance Oenanthion aquaticae and could be a new subassociation of the association Rorippo-Oenanthetum aquaticae (Order Phragmetetalia). The species Apium inundatum indicates an affinity to the Littorellion. Of course more relevés of this type are needed to decide its definite status. The alliance is unrecorded from Ireland.

1

n

Subunit II: The association Carecetum rostratae Rubel 12

This association is represented by 12 relevés recorded from the following lakes: Akibbon and Mullaghderg (Co. Donegal); Belle (Co. Waterford); Cregduff (Co. Galway); Glin (Co. Roscommon); Round (Co. Cavan) and the Screen lakes (Co. Wexford). Character species of the association is Carex rostata.

Equiseteum fluviatile occurs sparsely in all the relevés but one. Menyanthes trifoliata occurs in six of the twelve relevés, Hydrocotyle vulgaris in eight of the twelve relevés, both occur sparsely. Algae have been recorded from the vascular plants of the relevés in the Screen lakes. In Screen lake A (Relevé No. 110) Spirogyra was dominant, in Screen lake B (Relevé No. 124) the green filamentous algae Spirogyra and Bulbochaete and the bluegreens Hapalosiphon and Scytonema are the dominants.

This association was recorded from sheltered locations on gently sloping or level ground on sand, soft mud, peat or mixtures thereof. The depth of the water was 0.05-0.50m. It was hard or soft with a conductivity of 206 ± 54 umho's (range: 150 - 305 umho's) and a calcium content of 13.4 ± 10.1 mgl⁻¹Ca²⁺ (range 3.5-29 mgl⁻¹ Ca²⁺).

The following ecological indicator values were calculated: Subunit IIa L=7.2; T=5.4; K=2.8; F=9.4; R=5.2; N=3.5 Subunit IIb L=7.6; T=5.1; K=3.6; F=10; R=5.6; N=4.6

Syntaxonomy: This association belongs to the Magnocaricion. Subunit IIa lists 8 relevés representing a new subassociation of the Carecetum rostratae containing elements of the Littorellion. The following species are differential: Juncus bulbosus, Littorella uniflora, Scirpus fluitans, Potamogeton polygonifolius and Apium inundatum. Subunit IIb contains relevés typical of the core of the Carecetum rostratae.

Subunit III : Sociation of Carex lasiocarpa

]

]

]

]

]

]

This sociation is represented by one relevé from Lough Corrib (no. 145). The diagnostic species is Carex lasiocarpa, it occurs with a high cover value in a sheltered inlet at 0.20m depth, on marl. The conductivity of the water was 250 umho's and the calcium content was 22 mgl⁻¹Ca²⁺.

Ecological indicator values are as follows: L = 8.0; T = 5.0; K = 4; F = 10; R = 5.5; and N = 4.3.

Syntaxonomy: This is a sociation of the Magnocaricion

Subunit IV: The association Cladietum marisci

This association is represented by two relevés from Lough George (Co. Clare). Character species is Cladium mariscus. The association was found in shallow calcareous water (0.05-0.20m depth) on peaty clay or fen peat in sheltered, level areas of the lake. Conductivity of the water was 362 umho's and Calcium content $28.5 \text{ mgl}^{-1}\text{Ca}^{2+}$.

The indicator values are: L=8.3; T=6; K=3; F=10; R=8; N=4.3

Syntaxonomy: This association belongs to the Magnocaricion.

Subunit V: Community of Eleocharis palustris

This community was found in Lough Ballyroe (Co. Wexford), Belle Lake (Co. Waterford) and in Lough Owel (Co. Westmeath). The diagnostic species is Eleocharis palustis. Other species occurring sparingly in all three relevés are: Ranunculus flammula and Mentha aquatica. The community was found in shallow calcareous water (0.05 - 0.30m depth) on soft gravel or peaty mud in sheltered and relatively exposed situations on level ground. Conductivity of the water was 297 + 38 umho's and Calcium content' was 27.9 + 7.1 mgl⁻¹Ca²⁺.

The ecological indicater values are as follows: L=7.0; T=5.5; K=3.5; F=9.6; R=5.8; N=5.0 Syntaxonomy: This community belongs to the Alliance Apion nodiflori Segal. Further relevés are needed to clarify the exact position of this community within the Apion nodiflori.

Subunit VI: Community of Berula erecta and Scirpus lacustris.

This community is represented by three relevés from Doon Lake (Co. Galway), Lough Owel and Sleevin's lake, both in Co. Westmeath. Diagnostic species is Berula erecta. The community was found in shallow water (up to 25cm. depth) on fen peat, soft peaty mud on rocky, level or gently sloping ground. The conductivity of the water was 422 ± 145 umho's (range 255 - 520 umho's) and the calcium content was 39.5 ± 18.7 mgl⁻¹Ca.²⁺ (range 27.4 - 61 mg⁻¹Ca²⁺.

Ecological indicator values are: L = 7.5; T = 5.5; K = 3.2; F = 9.2; R = 5.1; N = 4.6.

Syntaxonomy: This community represents probably a new association of the Phragmition, typical of shallow calcareous water. More relevés of this type are needed to establish the validity of the association.

Subunit VII: The association Typhetum latifoliae Soó 1927.

This association was recorded only once, in Doon Lake, Co. Galway (no. 143). The character species is Typha latifolia. It was found growing in marly mud in calcareous water of 0.70m depth on a level, sheltered shore. Conductivity of the water was 490 umho's and calcium content 30 mgl⁻¹Ca²⁺.

Ecological indicator values: L = 7.1; T = 5.3; K = 4.0; F = 10.3; R = 7; N = 6.

Syntaxonomy: This association belongs to the Phragmition.

J

]

]

]

J

]

J

J

]

J

J

J

]

]

]

This association was recorded once in Belle Lake, Co. Waterford, (no. 9). Its character species is Typha angustifolia. It was found in calcareous water (28.4 mgl⁻¹Ca²⁺) of 1m depth on fen peat in a sheltered, level area. The dominant algae growing on the Typha stems are the bluegreens Oscillatoria splendida and Phormidium species ($2 \le 4\mu$) and ($4 \le 8\mu$). These species form a bright green algal mat on the plant stems. Conductivity of the water was 305 umho's.

The ecological indicator values are as follows: L = 7.5; T = 5.5; K = 5; F = 10.5; R = 7; N = 6.

Syntaxonomy: This association belongs to the Alliance Phragmition.

Subunit IX: The association Phragmitetum australis Schmale 39.

Five relevés are listed for this association from four lakes: Akibbon (Co. Donegal), Nabeist (Co. Wexford), Corrib (Co. Galway) The character species is and Upr. Glendalough (Co. Wicklow). Phragmites australis. In one relevé (from L. Nabeist) Polygonum amphibium occurs abundantly, in the relevé from L. Akibbon Carex lasiocarpa is represented. Algae were recorded from L. Nabeist (relevé 2 and 5), the bluegreen taxa Tolypothrix, Oscillatoria splendida and Phormidium (<2µ) are most common on the plant Tolypothrix grows in tufts and the latter two species stems. form a bright green algal mat. The association was found in soft and hard water up to 1m depth on marl, silt, fen peat or sand and steep level ground. on or shores, sheltered gravel on Conductivity of the water was 178 ± 98 umho's (range 42 - 250umho's), and calcium content was $12.5 \pm 10.7 \text{ mgl}^{-1}\text{Ca}^{2+}$ (range: $2.2 - 22 \text{ mgl}^{-1}\text{Ca}^{2+}$).

The ecological indicator values are as follows: L = 7.5; T = 4.7; K = 3.0; F = 9.8; R = 5.5; N = 3.9. Syntaxonomy: This association belongs to the Phragmition.

]

Subunit X: The association Scirpo-Phragmitetum W. Koch 1926

association is represented by six relevés from Belle This Lake, Co. Waterford, Lough Carra (Co. Mayo), Lough Gowna (Co. Longford) and Lough Nabeist (Co. Wexford). The character species Scirpus lacustris and Phragmites australis. Equisetum are fluviatile occurs in four relevés, while Fontinalis antipyretica is very abundant in two relevés and present in a third relevé. Algae were collected for three lakes (relevé no's 4,8 and 71). Cladophora is a taxon common to all three relevés. In Lough Nabeist and Lough Gowna a mixture of other species were found on the plants, with not one species being the more dominant. In Belle Lake the rare "lake ball" Cladophora aegagrophila was encountered lying on the bottom between the reeds, these lake balls were up to 15 cm in diameter and were even more common outside the reed fringe. They support a community of epiphytic This association was recorded from exposed and sheltered algae. shores in calcareous water up to 1.50m depth, in steep and level Soils were fine mud over sand, fen peat or marl. The areas. conductivity of the water was 267 ± 27 umho's (range 245 - 305umho's) and the calcium content was 26.8 \pm 3.7 mg1⁻¹Ca²⁺.

The ecological indicator values are: L = 7.5; T = 5.2; K = 3.7; F = 9.9; R = 5.8; N = 4.8.

Syntaxonomy: This association belongs to the Phragmition. It can be considered transitional between the Phragmitetum australis and the Scirpetum lacustris.

Subunit XI: The association Scirpetum lacustris Schmale 39

This association is represented by 3 relevés from Lough Corrib, Doon Lake (Co. Galway) and Lough Gowna (Co. Longford). The character species is Scirpus lacustris. Lemna trisulca was very abundant in one of the relevés. The association was found in shallow calcareous water (up to 0.30m depth) on sheltered or exposed level areas in peaty, stony, marly or muddy ground. The conductivity of the water was 336 \pm 133 umho's (range 250 - 490 umho's) and the calcium content was 27.3 \pm 4.6 mg1⁻¹Ca²⁺.

The ecological indicator values are as follows: L = 7.5; T = 5.5; K = 3.3; F = 11.2; R = 7.3; N = 4.4.

Syntaxonomy: This association belongs to the Phragmition. The three relevés were all recorded from shallow calcareous water. Scirpus lacustris beds growing in deeper water have been classified with the communities of submergent plants associated with it.

Subunit XII: <u>Community of Littorella uniflora and Scirpus</u> lacustris

This community was recorded eight times in all from the following lakes: Carrickaport (Co. Leitrim), Castle Lake, Dromore (Co. Clare), Glin (Co. Roscommon), Gowna (Co. Longford), Mullaghderg (Co. Donegal) and Round (Co. Cavan). Diagnostic species are Littorella uniflora and Scirpus lacustris. Lemna trisulca was very abundant in one of the relevés. Algae were collected from L. Glin and Belle Lake. In Belle Lake bluegreen algae were dominant on the plant stems: Gloeotrichia consists of small macroscopic globose colonies and Oscillatoria splendida forms bright green algal mats. In L. Glin a mixture of species occured on the plants and the peaty soil : Filamentous greens and blue green species (e.g. Nostoc species) were more common than diatoms. This community was found in shallow water (up to 0.50 in depth) on exposed or sheltered shores on level ground and various soils (stones and gravel, sand, marl or peaty sand). The conductivity of the water was 229 ± 53.4 umho's (range: 170 - 305 umho's) and calcium content was $20.4 \pm 8.2 \text{ mgl}^{-1}\text{Ca}^{2+}$ (range: 11.5 $- 29 mg1^{-1}Ca^{2+}$).

The ecological indicator values are as follows: L = 7.6; T = 4.9; K = 3.2; F = 10.3; R = 6.4; N = 4.6.

Syntaxonomy: This community is transitional between the. Littorellion and the Phragmition. It could be considered as a new subassociation of the Scirpetum lacustris: the Scirpetum -Littorelletosum.

. 16 .

IJ

]

J

0

]

This community was recorded only once from Lough Bunny. The diagnostic species are Juncus bulbosus and Potamogeton coloratus. It was found in calcareous places with fluctuating water table on the landward side of the reed fringe on marly, sandy soil.

The ecological indicator values are as follows: L = 7.6; T = 6.3; K = 1.8; F = 10.4; R = 8; N = 1.7.

Syntaxonomy: This community should probably be classified with the Littorellion as it has four Littorellion character species. Oberdorfer describes a Potamogetan coloratus community from flowing water and classifies it provisionally with the Potamion. This community is more eutrophic and it has only 3 species in community (Potamogeton coloratus, present with the common Ranunculus trichophyllus and Veronica catenata). This type of relevé could also belong to the Charetea. In the above situation. Potamogeton coloratus is often found with Chara species. Τn Lough George Littorella uniflora, Juncus bulbosus and Utricularia intermedia were found with Chara delicatula and Chara hispida (no It seems likely that a submers calcareous oligo relevé taken). to mesotrophic part of the Littorellion exists and that this community, as well as the record from Lough George (relevé 99), This has not been described before to my belong to it. knowledge. It would be necessary to record more relevés of this type to establish the validity of such a group within the Littorellion, see also subunit XIV.

Subunit XIV: Community of Chara species and Juncus bulbosus

This community was recorded once in Lough George. Diagnostic species is Juncus bulbosus and Chara species. This community was recorded from calcareous water of 1m depth, growing in a soft marl bottom. Juncus bulbosus f. fluitans was encrusted with a lime deposit. Further along the shore of Lough George Juncus bulbosus was seen growing with Samolus valerandi. This Juncus

D

]

]

bulbosus zone occurred from 0.80 - 2m depth on a steeply shelving shore. Echinodorus ranunculoides occurred at the top end of the zône, Elodea canadensis and Nuphar lutea occurred at the lower edge of this zone.

The ecological indicator values of the community (relevé no. 99) are: L = (6.5; T = 6; K = 2; F = 11.5; R = 6.8; N = 3.7.

Syntaxonomy: It is suspected that this community belongs to a calcareous, and submers part of the Littorellion, so far undescribed. It is probably closely related to the Samolo - Littorelletum, an association of the Littorellion first described by Westhoff in 1943. This also contains communities of calcareous habitat. See also subunit XIII.

Subunit XVa. The association Eriocaulo - Lobelietum

]

<u>]</u>

J

J

This association was recorded sixteen times from six different lakes: Beaghcauneen, Nafeakle and Pollacappul in Co. Galway and Akibbon, Mullaghderg and Veagh in Co. Donegal. The character species are Lobelia dortmanna and Eriocaulon aquaticum.

Green filametous algae (Oedogonium, Bulbochaete and Spirogyra) are common. The diatom Tabellaria occurred in four relevés and the bluegreen coccoid Aphanothece occurred in all five relevés examined for algae. The bluegreens Tolypothrix and Nostoc occurred in one relevé as the dominant (in Lough Mullaghderg). The association was encountered in soft water from 0.05 - 2m

depth in exposed or sheltered areas on mixtures of sand, silt and mud with or without rocks and stones or on peaty mud on level or gently sloping ground.

The conductivity of the water was 127 ± 64 umho's (range 63.5 - 250 umho's) and the calcium content was 5.1 ± 3.2 mgl⁻¹Ca²⁻ (range: 2.7 - 11.5 mgl⁻¹Ca²⁺).

The ecological indicator values are as follows: L = 7.4; T = 4.9; K = 2.8; F = 10.4; R = 4.9; N = 3.3.

. 18 .

The association Eriocaulo - Lobelietum belongs to Syntaxonomy: The name Eriocaulo - Lobelietum is preferable the Littorellion. over Isoeto - Lobelietum as in my opinion Isoetes lacustris has its optimum in deeper water and Eriocaulon aquaticum is a good character species of the association in Ireland. Relevé 165 contains Pilularia globulifera. It could be considered as a record of the sub-association of Pilularia globulifera but as only one relevé is available it has not been separated. Relevé 148 and 147 contain Apium inundatum, relevé 12 has Myriophyllum considered as all been These have alterniflorum etc. subassociations of the Isoeto - Lobelietum by previous authors. Relevé 26 has affinity with the Charetum asperae, as described under subunit XXV.

Subunit XVb: <u>The sub-association Eriocaulo - Lobelietum</u> Isoetetosum.

This community was recorded six times in all in the following Akibbon (Co. Donegal), Beaghcauneen, Kylemore and lakes: Pollacappul (Co. Galway) and Caragh (Co. Kerry). The character species are Eriocaulon aquaticum, Lobelia dortmanna and Isoetes The dominant epiphytes are green filamentous forms lacustris. (Spirogyra and Oedogonium). The blue green Tolypothrix occurred The soft water diatoms Achnanthes in five of the six relevés. and Tabellaria occurred in four of the six relevés. The sub-association was found in soft water from 0.50 - 2.20m depth in exposed or sheltered areas on sand, mixtures of sand, silt and mud or on stones and gravel, on level or steeply sloping ground. It probably never occurs emers. Conductively of the water was 109 ± 38 umho's (range 75 - 170 umho's) and calcium content was low: $3.5 \pm 0.8 \text{ mgl}^{-1}\text{Ca}^{2+}$.

The ecological indicator values are: L = 7.5; T = 5.1; K = 2.6; F = 10.6; R = 4.7; N = 3.2.

Syntaxonomy: This community can be considered as a sub-association of the Eriocaulo - Lobelietum of the Alliance Littorellion. It is transitional to the Isoetetum lacustris, see subunit XVII.

]

J

]

]

J

Releves 33, 31 and 16 contain Pilularia globulifera and could be considered as a separate subassociation, or as a variant of this subassociation with Pilularia globulifera.

J

]

 $\left[\right]$

]

]

]

Subunit XVc: Eriocaulo-Lobelietum, subassociation with Eleocharis multicaulis and Utricularia intermedia.

This subassociation was recorded six times, all in the same lake: The diagnostic species are in Co. Galway. Lough Ergooa Eriocaulon aquaticum, Lobelia dortmanna, Eleocharis multicaulis and Utricularia intermedia. Green filamentous algae (Mougeotia, and Oedogonium), the soft water diatom Tabellaria, Zygnema Closterium, genera of the (e.g. species desmid several Pleurotaenium, Pinnularia and Euastrum) occur in all relevés, as do Pediastrum, Merismopedia and Dinobryon.

The subassociation was found in soft water from 0.30-1m depth on fine mud, peat or rocks and gravel in sheltered or exposed areas. Conductivity of the water was 92 umho's and calcium content was low: $1.6 \text{ mgl}^{-1}\text{Ca}^{2+}$.

The ecological indicator values are as follows: L=7.4; T=4.g; K=2.5; F=10.3; R=4.5; N=3.1

Syntaxonomy: This is possibly a new subassociation of the а described has Schoof-Van Pelt Eriocaulo-Lobelietum. Eleocharis multicaulis, present the subassociation with subassociation could be identical to her subassociation except that an extra differential species, Utricularia intermedia, appears to be present. More relevés are needed, especially from different locations, to establish if this community is a different subassociation from the subassociation described by Schoof-Van Pelt.

Subunit XVI: Community of Juncus bulbosus f. fluitans

J

J

]

J

This community was recorded once in Lough Nafeakle, Co. Galway, however, it was also observed in other lakes but no relevés are available. The diagnostic species is Juncus bulbosus, f. fluitans.

The dominant alga was the bleugreen Hapalosiphon and the filamentous green alga Spirogyra. Other filamentous greens also occurred, as did the diatom Tabellaria and the bleugreen coccoid Aphanothece. Nostoc was also common.

The community was found growing on peaty soil at 0.75-2m depth in sheltered locations in soft water lakes. It is always submers. The conducitivity of the water was 110 umho's and the calcium content low: $3.8 \text{ mgl}^{-1}\text{Ca}^{2+}$.

The ecological indicator values are as follows: L06.0; T=4.0; K=5.0; F=12.0; R=6.0; N=6.0

Syntaxonomy: This community of deep oligotrophic soft water is probably an association in its own right and should be placed in the Littorellion. Obviously more relevés are needed. It is different from the Eriocaulo-Lobelietum as it is from deeper water and is unlikely ever to dry out. During the survey it was noted as a distinct zone in several lakes, usually between Eriocaulo-Lobelietum and the Community of Isoetes lacustris.

Subunit XVII: Community of Isoetes lacustris.

Ten records were taken of this community in the following lakes: Beaghcauneen and Ergooa (Co. Galway), Caragh and Yganavan (Co. Kerry), Belle (Co. Waterford), Glenade (Co. Leitrim), Tay (Co. Wicklow) and Veagh (Co. Donegal).

The diagnostic species is Isoetes lacustris. The epiphytic and epilithic algae do not show a general pattern for this community. The community was found from 0.30 - 3m depth in exposed areas of open water on level or steeply sloping ground, the soil was sandy, muddy, peaty or gravelly. The water generally soft, poor in nutrients and acidic, but can be quite calcareous in some cases (L. Glenade, Belle lake). The conductivity of the water was 131 ± 89 umho's (range 47 - 305) and calcium content 11.7 \pm 12.2 mgl⁻¹Ca²⁺ (range: 2.6 - 28.4 $mg1^{-1}Ca^{2+}$).

The ecological indicator values are as follows: L = 7; T = 5; K = 2.9; F = 11.5; R = 5.5; N = 3.8.

Syntaxonomy: This community could considered be as an impoverished form of the Eriocaulo - Lobelietum, however neither Eriocaulon aquaticum nor Lobelia dortmanna are present. The community is submers and typical of oligotrophic to mesotrophic The optimum of Isoetes lacustris lies in deeper water lakes. than that of the typical Eriocaulo - Lobelietum plants, hence this community is more likely to be an association in its own right and could be referred to the association Isoetetum Elements of the Parvopotamion are present and the lacustris. community occupies a transitional position between the Littorellion and the Parvopotamion.

Subunit XVIII: The association Sparganietum angustifolii.

This association was recorded once in Lough Yganavan, Co. Kerry. The character species is Sparganium augustifolium. Filamentous green algae were the typical epiphytes in this quadrat. It was growing in brown soft water on peat at 0.60 m depth in a sheltered level area. Conductivity of the water was 129 umho's and calcium content was $3.5 \text{ mgl}^{-1}\text{Ca}^{2+}$.

The ecological indicator values are as follows: L = 8; T = 4; K = 3; F = 11; R = 3; N = 1.

Syntaxonomy: This community, which belongs to the association Sparganietum augustifolii, is growing on peat and therefore it should probably be classified with the Scheuchzerietea, although it is considered to belong to the Littorellion by some authors (Tuxen 1937, Oberdorfer et al 1967). Structurally Sparganium angustifolium is a 'floating leaf plant' and in that sense it could be classified in the Nympheion. Subunit XIX: Community of Najas flexilis and Potamogeton berchtoldii.
The relevés were recorded from the following lakes: Akibbon and

J

]

J

Mullaghderg (Co. Donegal); Caragh (Co. Kerry); Cregduff, Kylemore and Nafeakle (Co. Galway) and Glenade (Co. Leitrim). The flexilis and Potamogeton Najas species are diagnostic berchtoldii. Nitella flexilis agg. and Potamogeton praelongus occur in over half of the relevés. None of the algal species recorded occur in all the relevés, with the algae of Lough Glenade and Lough Akibbon being most different from those of the In Lough Glenade the epiphytes Cocconeis and other lakes. In Lough Akibbon a Chaemaesiphon are the dominant species. floating algal cloud of Mougeotia occurs in relevé 73 while in relevé 45 a mixture of epiphytes of Chara fragilis are the In the other lakes the green filamentous forms dominant algae. where Hapalosiphon is in relevé 40 dominant, except are This community was found in open water from 0.75 - 4m abundant. depth in areas protected from strong wave action (by either The soil always consists of adjacent reed beds or deep water). soft accumulated silt, sometimes containing a large proportion of organic matter (peaty) or overlying sand on gently sloping or The conductivity of the water was 164 ± 64.5 level ground. umho's (range 80 - 250 umho's) and its calcium content was 8.7 \pm 7.3 $mgl^{-1}Ca^2$ (range 2.6 - 22.8 $mgl^{-1}Ca^{2+}$). The community grows in lakes of oligo - to mesotrophic character with clear or brown water, generally acid. However, Lough Glenade is alkaline, with a high calcium content (22.8 $mg1^{-1}Ca^{2+}$).

The ecological indicator values are as follows: L = 7; T = 4.4; K = 3.5; F = 11.6; R = 6; N = 4.2. Syntaxonomy: This community does not correspond floristically or ecologically with any of the existing associations. The most related associations are probably the Najadetum closelv intermediae (Koch 26) Lang 73 and the Potametonetum filiformis Koch 28. Najas flexilis is a character species of the former and this association is found on sandy bottom, but the species combinations are quite different. Potamogeton praelongis is a character species of the Potametonetum filiformis Koch 28 but this is an association of shallow water and several of the present association are missing. the species typical of Therefore, the present community should be considered as a new association and should be classified with the Potamion. This association has characteristics of both the Parvopotamion and the Magnopotamion so that it is not useful to distinguish these alliances here.

Subunit XX: Community of Potamogeton praelongus.

in Lough Carrickaport. recorded once community was This Potamogeton praelongus is the diagnostic species. The bluegreen epiphyte Gloeotrichia was the dominant alga. It was found on an eroding shore, lakeward of reed beds, at a depth of 1.70m. The ground was level and consisted of sandy mud, with woody remains The lake is obviously slightly present in the soil core. eutrophicated and the water has a conductivity of 188 umho's and a calcium content of 20 mg1⁻¹Ca²⁺.

The ecological indicator values are as follows: L = 7.5; T = 5.0; K = 5; F = 12; R = 8; N = 5.5.

Syntaxonomy: The community belongs to the Magnopotamion. To establish its exact taxonomic position and validity as an association more relevés of this kind are needed.

 $\left[\right]$

]

Subunit XXI A and B: <u>Community of Nitella flexilis</u> var flexilis and Community of Nitella translucens.

The first community was recorded four times in Lough Coumshingaun (Co. Waterford) and in Lough Nabeist (Co. Wexford) and the second community was recorded twice in Screen lakes A and B (Co. The alliance character species are Nitella flexilis Wexford). v. flexilis and Nitella translucens. The dominant algal species are filamentous greens (Oedogonium, Bulbochaete, and also Mougeotia in Lough Nabeist). The communities were found from 1-4m depth in exposed and sheltered situations on level areas and The substrate varied from black organic mud, fine steep slopes. silt and silt overlying sand, to areas where the Nitella flexilis roots on rocks and stones which are covered in a thin layer of loose silt. The conductivity was low and the environment acidic for 5 of the 6 relevés (48 - 150 umho's, 2.6 - 3.5 mgl⁻¹Ca²⁺). In Lough Nabeist Nitella flexilis occured within dense Fontinalis antipyretica and conductivity was 250 umho's and calcium content was high (21.5 $mgl^{-1}Ca^{2+}$), indicating a more basic environment.

The environmental indicator values are based on Potamogeton polygonifolius only, as all other species are algae or mosses: L = 7; T = 6; K = 2; F = 11; R = 3; N = 2.

Syntaxonomy: These communities are core communities of the Alliance Nitellion flexilis (Corill 57) W. Krause 69.

Subunit XXII: Sociation of Nymphaea alba

This sociation is represented by only 1 relevé from Doon Lake, Co. Galway. The Alliance character species is Nymphaea alba. Cladophora and the epiphyte Gloeotrichia were the dominant algae. The sociation was found in calcareous water on silty soil at 2.70m depth on a gentle slope in a sheltered location. The conductivity of the water was 490 umho's and calcium content 30mgl⁻¹Ca²⁺.

Ecological indicator values are: L = 8; T = 4; K = 3; F = 10.5; R = 7; N = 6.

J

D

]

U

J

<u>ן</u>

]

J

]

Syntaxonomy: This sociation belongs to the Alliance Nymphaeion.

Subunit XXIII: Community of Polygonum amphibium var aquaticum

This community was recorded three times in Lough Nabeist and in Lough Ballyroe, Co. Wexford. The diagnostic species in Polygonum amphibium var. aquaticum. In Lough Ballyroe macroscopic balls (diameter 2cm) of the bluegreen alga Aphanocapsa with cells of 5u were common and in Lough Nabeist (relevé 7) Cladophora was the dominant algae. The community was found in calcareous water ($21.5 \text{ mgl}^{-1}\text{Ca}^{2+}$) in sheltered locations from 0.15 - 2m depth on organic mud, silty mud and sand on steep slopes and level ground. The conductivity of the water was 290 ± 57 umho's (range 250 - 330 umho's).

The ecological indicator values are as follows: L = 6.9; T = 5; K = 3.3; F = 10; R = 5; N = 4.8.

Syntaxonomy: This community belongs to the Nymphaeion. More relevés, from other parts of the country are needed to see if it has association status.

Subunit XXIV: Community of Potamogeton natans.

This community was recorded twice in Belle lake (Co. Waterford) and in Doon Lake (Co. Galway). The diagnostic species is Potamogeton natans. Algae were recorded from Belle Lake only were a large cloud of green filamentous algae (Mougeotia species) was suspended over and in between the macrophytes. A cloud of this species had also been recorded in Lough Akibbon (releve 73), in the community of Najas flexilis and Potamogeton berchtoldii. The present community was found on muddy marl or fen peat in sheltered locations on level ground from 0.40 - 1m depth. Conductivity of the water was 398 ± 131 umho's (range: 305 - 490umho's) and calcium content 29.2 ± 1.1 mgl⁻¹Ca²⁺.

The ecological indicator factors are as follows: L = 7; T = 4.8; K = 4.3; F = 11.3; R = 7; N = 5.8.

Syntaxonomy: This community belongs to the Nymphaeion.

Seventeen relevés were recorded in nine lakes in all: Ballyallia and Inchiquin (Co. Clare), Belle (Co. Waterford), Bunduft (Co. Sligo), Carrickaport (Co. Leitrim), Corrib and Doon (Co. Galway), Gur (Co. Limerick) and Nabeist (Co. Wexford). Character species of the association are Chara aspera, Myriophyllum spicatum and Potamogeton pectinatus. The algae don't show a very strong pattern except that the only unbranched filamentous green that is common in most relevés is Oedogonium, diatoms are common epiphytes and Cosmarium, a Desmid genus containing some members typical of calcareous waters, is common too. Other common taxa are the bluegreens Tolypothrix, Lyngbya (2µ) and Gloeotrichia, and the areen Cladophora the and encrusting areen taxon Chaetophorales (including This Coleochaete orbicularis). association was encountered in calcareous water from 0.15 - 2.60m depth. The substrate was (shell) sand, mud or mixtures thereof, sometimes mixed with gravel, or silty marl, sometimes with a Conductivity and calcium content of the water peaty content. were relatively high: 320 ± 93 umho's; range: 188 - 490 umho's and 25.6 \pm 4.0 mg1⁻¹Ca²⁺; range 20 - 30 mg1⁻¹Ca²⁺.

The ecological indicator values are as follows: L = 6.9; T = 5.2; K = 3.8; F = 11; R = 6.7; N = 5.6.

The above relevés have been assigned to Syntaxonomy: the Charetum asperae. This association is usually assigned to the Charetea, however it contains many Parvopotamion species. Relevés 64, 63, 76, 85 and 77 form the core of the association, while on the left a form of Myriophyllum spicatum and on the right a form of Potamogeton pectinatus is represented. These forms are probably subassociations, while the community of Chara contraria, described under subunit XXXI can be considered as the subassociation of Chara contraria, and the community of Chara desmacantha (Subunit XXX) the subassociation of as Chara desmacantha. Here most of the Parvopotamion species are missing. The first two subassociations mentioned above can be further divided as follows: Relevé 52 is a form with almost pure Myriophyllum spicatum; Relevés 55 and 61 is a form with

Potamogeton perfoliatus and Chara fragilis and Relevés 58 and 60 have Ceratophyllum demersum; Relevés 53 and 54 represent a form with Potamogeton perfoliatus (of the subassociation of Potamogeton pectinatus) of poorer nutrient status while relevés 59 and 62 represent a richer version with Ceratophyllum demersum Lemna trisulca; relevé 59 has Chara delicatula (abundance = and 5). further division of This course needs investigation, possibly subassociation status is valid for some of them. If the Charetum asperae should be classified with the Charetea or that it could be assigned to the Parvopotamion remains to be seen. Chara aspera and Chara contraria are widely distributed in Irish lakes and therefore the Charetum asperae can best be studied in this country. It is highly recommended that vegetations containing Chara species are thoroughly researched in Ireland, as Ireland is one of the last countries in Europe were eutrophication of the surface water has not been as extensive as in the rest of Europe, resulting in the disappearance of these vegetation types. These vegetations are in need of immediate protection.

Subunit XXVI: Community of Elodea canadensis and Lemna trisulca.

Eleven relevés were recorded from six lakes in all: Ballyallia and Ballyteige (Co. Clare), Belle (Co. Waterford), Glin (Co. Roscommon), Gowna (Co. Longford) and Round (Co. Cavan). Diagnostic species are Elodea canadensis and Lemna trisulca. The algae don't show a clear trend, common in most relevés are Epithemia and Cocconeis, both epiphytic diatoms and Gloeotrichia, bluegreen epiphyte, а green encrusting algae of the group Chaetophorales and Cladophora occur in a number of the relevés. Anabaena is co-dominant with Epithemia in relevé 65 (Round lake) and Oscillatoria spendida dominant in relevé 75 (Ballyallia The filamentous algae Oedogonium and Bulbochaete are lake). common in most relevés, and dominant in relevé 66 (Round lake), in relevé 78 (Ballyteige Lake) a free floating cloud of Spirogyra (96u) was suspended over and through the vegetation, this was also noted in the community of Oenanthe aquatica and Apium inundatum in the same lake (relevé 79). The community was found from 0.40 - 4m depth on generally soft substrate on level or gently sloping ground in sheltered locations. The soil ranged

from muddy sand, soft black mud to fine marl and fen peat. The conductivity of the water was 276 \pm 67 umho's (range 170 - 345 umho's) and the calcium content was 26.2 \pm 6.5 mgl⁻¹Ca²⁺ (range: 13 - 30 mgl⁻¹Ca²⁺).

The ecological indicator values are: L = 7; T = 5.3; K = 4.5; F = 11.3; R = 7.1; N = 5.9.

Syntaxonomy: This community belongs to the Parvopotamion and is probably most closely related to the Potametum lucentis Hueck 31. A form with Potamogeton obtusifolius can be distinguished (relevés 68, 69, 70, 50). This may be a new subassociation of the above association. Relevés 66, 65 and 67 contain Stratiotes aloides.

Subunit XXVII: Community of Potamogeton filiformis

This community was recorded once in Lough Gara. The diagnostic species is Potamogeton filiformis. The dominant epiphyte on plant stems is the blue green alga Rivularia. This community was found in very shallow (0.10m depth) calcium rich water growing on marly, sandy soil in a level area. Conductivity of the water was 395 umho's and the calcium content was 29.9 mgl⁻¹Ca²⁺.

The ecological indicator values are: L = 8; T = 4; F = 10; N = 5; K and R unknown.

Syntaxonomy: This community belongs to the Parvopotamion and may be identical to the association Potametum filiformis Koch 28, however more relevés of this type are needed to establish its exact identity.

Subunit XXVIII: <u>Community of Chara fragilis and Tolypella</u> nidifera var glomerata.

This community was recorded once in Lough Gara. The diagnostic species are Chara fragilis and Tolypella midifera var glomerata. The community was encountered on level marly soil in an exposed area at 1.10m depth. Conductivity of the water was 395 umho's and the calcium content 29.9 mgl-1Ca2+.

. 29 .

J

]

]

[]

The ecological indicator values are as follows: L = 8; T = 6; K = 2; F = 12; R = 5.5; N = 5.

Syntaxonomy: It is not possible to say what the syntaxonomic status of this releve is. For the present it has been classified with the Charetea.

Subunit XXIX: Sociation of Chara fragilis

This sociation was recorded twice, in Lough Errit and in Belle lake. The diagnostic species is Chara fragilis. Diatoms epiphytic on the Chara species are the dominant algae. It was found in open water from 2-3.60m depth on gently sloping sandy marl or silty mud in exposed situations. Conductivity of the water was 228-305 umho's and the calcium content 26.9-28.4mgl⁻¹Ca²⁺.

Syntaxonomy: These releves belong to the core community of the Charetea.

Subunit XXX: Community of Chara desmacantha

This community was recorded four times in all in the following lakes: Carra (Co. Mayo), Errit (Co. Roscommon), George and Muckanagh (Co. Clare). The diagnostic species is Chara desmacantha. The dominant micro algae are diatom species epiphytic on the Chara plants, of the genera Navicula, Cymbella and Gomphonema, also common are diatoms of the genera Eunotia and Ephithema. The desmid Cosmarium is also common in most relevés. This community was found from 0.50-2.75m depth in open calcareous water on marl or sandy marl soils in level or gently sloping sheltered or exposed areas. The conductivity of the water was 278 ± 73 umho's (range 228-362 umho's and the calcium content was 27.6 ± 0.8 mgl⁻¹Ca²⁺ (range 26.9-28.5 mgl⁻¹Ca²⁺).

The ecological indicator values are: L=7; T=4; K=3; F=11.1; R=7.1; N=4.

Syntaxonomy: This community probably belongs to the Charetea. It

represents a new association or subassociation with restricted distribution, as its diagnostic species Chara desmacantha occurs mainly in Britain and Ireland. Its ecology is thought to be similar to that of Chara aspera of the Alliance Charion asperae.

More relevés with Chara desmacantha are needed to confirm that this is a new association of the Charatea or that it is a subassociation of the Charetum asperae, as decsribed in Subunit XXV. Relevé 37 from Lough Errit indicates the latter.

Subunit XXXI Community of Chara contraria.

]

]

]

]

Nine relevés were recorded from the following lakes: Carra (Co. Mayo), Corrib (Co. Galway), George (Co. Clare) and The diagnostic species is Chara Westmeath). 0wel (Co. The algae show a similar pattern as in subunit XXX., contraria. although not as clear. In six of the eight relevés investigated the diatoms are the dominant epiphytes (species of the genera Navicula, Cymbella, Gomphonema and Epithemia), while in the other two relevés diatoms of the genus Cocconeis are common as well as In a few relevés other species e.g. the Desmid Cosmarium. Diatoms of the genus Eunotia are co-dominant or common also. The community was found in calcareous water from 0.10 - 6m depth on marl, silty marl, mud or marly clay, sometimes with shell remains in the soil, on level areas or steeply sloping ground in This is the most common sheltered or exposed situations. community of Irish calcareous lakes. Chara submerged Conductivity of the water was 278 ± 56 umho's (range 245-362umho's) and the calcium content was $26.3 \pm 2.9 \text{ mgl}^{-1}\text{Ca}^{2+}$ (range $22-28.5 \text{ mgl}^{-1}\text{Ca}^{2+}$).

The ecological indicator values were as follows, keeping in mind that vascular plants only determine these figures: L=6.7; T=5.1; K=4.2; F=11.5; R=7; N=5.5

Syntaxonomy: Corillion places communities of this type in the Charetum asperae Corill.57. The community should be considered as a separate subassociation in my opinion. Relevés 89 and 160 represent sociations of the association. Relevés 88, 92 and 94, represent a form of the new subassociation with Chara rudris and relevés 87, 83, 84 and 86 represent a form with Potamogeton perfoliatus. If the association with its subassociation should be classified with the Charetea or with the Parvopotamion remains to be seen. Many more relevés are needed to validate the new subassociations and its forms, see also subunit XXV and XXX.

Subunit XXXII Community of Chara aculeolata

i

IJ

D

Π

Two relevés of the community were recorded from Lough Errit (Co. Roscommon) and Lough Owel (Co. Westmeath). The diagnostic species is Chara aculeolata. Algae show a pattern similar to that described under subunit XXX and XXXI. The community was found in exposed places in open calcareous water from 0.52-2.30m depth in silty or sandy marly soil (with shell remains, sometimes overlying fen peat). Conductivity of the water was 228-255 umho's and calcium content 26.9-27.4 mgl⁻¹Ca²⁺.

The ecological indicator values are: L=7; F=11; R=7.5; N=4.5; T and K unknown.

Syntaxonomy: Corillion classifies pure stands of Chara aculeolata with the association Charetum hispidae Corill.57, of the alliance Charion asperae, possibly this association may be expanded to contain vegetations of the above type. Chara aculeolata occurs in Lough Errit with Utricularia intermedia, a species of soils poor in nitrogen, and in Lough Owel with Potamogeton lucens, usually considered a nitrogen indicator. More relevés of this type are clearly needed to validate their taxonomic place and it would be necessary to investigate this apparent anomaly further.

Subunit XXXIII Sociation of Chara rudris

This sociation was recorded once in Granston Lake, Co. Laois. The diagnostic species is Chara rudris. The dominant epiphytes were diatoms of the genus Cymbella. The plants were found in calcareous open water of 2.40m depth in gently sloping marl soil, offshore from a reed bed.

Syntaxonomy: This sociation belongs to the Charetea.

3. The Epipelic, Epilithic and Epiphytic Algae

a. Growth forms.

IJ

0

Ū

 \int

J

<u>|</u>

benthic algal communities about little known is very As lakes, vegetation in Irish littoral associated with macroscopically visible algae were collected in conjunction with the macrophyte records. It was found that epiphytic algae (algae growing on plants) were usually the dominant form, but in sparse vegetation epilithic (growing on rocks or gravel) and epipelic algae (growing on soil) also attained a macroscopically visable biomass and in that case these forms were collected together with the epiphytes, the species lists were pooled. Not all the algae were firmly attached to a substratum, some were suspended in large diffuse masses over and amongst the macrophytes while others were lying loose on the bottom. Below follows a list of the major growth forms that were encountered:

A. Unattached or very loosely attached forms.

- Very large diffuse free floating clouds of filamentous green algae suspended over and amongst the macrophyte vegetation. Clouds of Mougeotia were recorded from Belle Lake (relevé 73). Clouds of a species of Spirogyra, 96u in width, were recorded in Lough Ballyallia (relevé 78 and 79).
- 2. Algae with a flocculated appearance, loosely suspended over and attached to small vascular plants or rocks and soil in sheltered areas of soft water lakes, consisting of species of the green filamentous genera, Mougeotia, Oedogonium and/or Bulbochaete, the diatoms Tabellaria and Achnanthes are also commonly dispersed amongst these. Examples are several of the relevés of the soft water communities (see Table 5, relevés 15, 26).
- 3. Balls of Cladophora aegagrophila of up to 15 cm in diameter were found in Belle Lake. These "lake balls" lie loose on the substratum and are rolled around by currents and wave action. A pebble, or in this case it often was a piece of peat, is found in the centre of the ball on which the plant originally started to grow. The lake ball functions as a substratum for many other algae.

. 33 .

- Unattached gelatinous balls of macroscopic size, usually 4. found washed up or rolling around in the shallows or on the bottom in deeper water. Three different genera were found to have this growth form. Balls with a leathery texture were formed by members of the bleugreen genera Nostoc (e.g. found in Lough Gowna) and Aphanocapsa (found in Lough Ballyroe, Co. Wexford, relevé 3). Very common in a lot of lakes were balls of a softer consistency. These proved to be animals. The surface of the mucilage is densely covered in a layer of rotifers () containing green algal cells, which make the balls look It is not known were the major plant like at first view. part of the ball (the mucilage) derives from.
- Bright green slimy algal patches consisting of bleugreen 5. Phormidium or sliding filaments of the genera an alqal mat, often Oscillatoria interwoven into containing a small number of bleugreen coccoid species and a few diatoms as well. These mats can occur loosely attached to plant stems including the Charophytes, and are found to grow up to 10m depth (Lough Carra), deeper than any of the vascular plants or Charophytes can grow. In that case the mats were pink in colour, this is a Table 5, Community of (See chromatic adaptation. Spirulina, relevé 167).

B. Attached Forms

]

л Ц

- Small macroscopic gelatinous globose colonies on plant stems, rocks or stones, usually of the genera Gloeotrichia or Rivularia.
- 2. Encrusting forms closely attached to plant stems or rocks, often of the group Chaetophorales. The red alga Hildenbrandia rivularis forms bright red thin crusts on rocks and stones and was found in Lough Glenade.

- 3. Relatively long branched and unbranched filaments of the Chlorophyta. Species of the genera Oedogonium, Spirogyra and Bulbochaete are very common in most of the lakes. These algae can usually not be identified to the species level unless fruiting material is present, which is very rarely found. Cladophora species are usually confined to the richer, more calcareous lakes, but was also found in Lough Nabeist (relevé 8), which has an intermediate calcium level (See Table 5).
- 4. Shortly tufted species attached to rocks and plants usually of the bleugreen genera Tolypothrix, Hapalosiphon or Stigonema. The green alga Cladophora can also exhibit this growth form.

Г И

- 5. Shortly branched gelatinous forms of the genera Batrachospermum, Drapernaldia or Chaetophora attached to plants or rocks.
- Brown, often fluffy looking stuff covering plants or 6. rocks, which can usually easily be dislodged. This is almost always build up of diatom cells. When brown in colour it occurs in soft water or water intermediate in calcium content, in harder water it is usually partly encrusted with calcium and is brittle with a marly especially when growing on Charophytes. appearance, Different diatoms form various colony shapes and these algae are almost certainly very good environmental level is Identification to the species indicators. relatively straightforward, but time consuming. Some of the major forms could probably be recognised in the field from their typical colony shape.
- b. Vegetation classification of the benthic algae.

The benthic algae were tabulated in the same order as the macrophyte relevés (Table 4) and as could be expected since most of the taxa were purposely not identified to species level (see methodology) no new character species were found in addition to those for the macrophyte communities. Taxa that occur in several

communities contain almost certainly useful indicator species. Genera especially likely to yield results in this respect are first and foremost the diatom genera, especially the genera Cymbella, Gomphonema, Navicula, Epithemia, Cocconeis, Eunotia, Tabellaria and Achnanthes. Species of the Desmid genera Cosmarium and Euastrum, the green algae of the genus Cladophora, Pediastrum and Scenedesmus and the bleugreens Gloeotrichia, Rivularia, Hapalosiphon, Tolypothrix and Merismopedia are also likely to be useful indicators.

The benthic algae were also analysed independently of the macrophyte records, to see if any algal communities could be identified at this stage. The algal species lists were analysed in the usual manner until an algal vegetation table was arrived at, using TWINSPAN for the initial classification. Table 5 is the final algal vegetation table listing all data occurring more than seven times in the dataset. This table shows two large groups, which are more or less clearly separated from each other as follows:

1. The soft water communities (Table 5)

J

]

The following taxa appear to be mostly restricted to this Hapalosiphon, Achnanthes, Stigonema, Oedogonium group: punctato striatum and several desmids of rare occurrence in the whole table. The following algal taxa were absent from or rarely found in the soft water communities: diatoms of genera Navicula, Cymbella, Gomphonema, Epithemia, the the green alga Cocconeis, Gyrosigma, Cyclotella and Anabaena, Rivularia and the bleugreens Cladophora and Nitrogen values for the soft-water communities Microcystis. were calculated from the macrophyte lists (Ellenberg 1979, see the relevant section and tables). From this soils of the soft water communities can be expected to have a low or that these This means intermediate Nitrogen level. communities are sensitive to eutrophication. Algae are often the first organisms to indicate eutrophication, before the vascular plants are seen to change. The algal soft water communities can therefore be used for pollution monitoring work.

. 37 .

2. The hard water communities (Table 5, Subunits a-e).

These communities consist of three clearly defined groups (Subunits b,c and e) and two other groups of more doubtfull status (Subunits a and d). Diatoms are abundant or common in all hard water groups.

Subunit b. This is a community of Cosmarium, Navicula, Cymbella and Gomphonema. The nitrogen content of the soil in which the macrophytes of these releves are rooted is expected to be low or intermediate (calculated from Nitrogen values). Half the epiphytic records in this community are from the surface of Charophytes.

Subunits a and d. These two communities are both expected to have an intermediate to high nitrogen level in the soil (calculated from Nitrogen values) and in most relevés the epiphytes are growing on Charophytes. Fewer species are present than in the previous community. Pediastrum, Scenedesmus and Lyngbya (2μ) are common in Subunit a and almost absent in Subunit d.

Subunit e. This is a community of Spirulina subsalsa var. crassior growing on pure marl, in the absence of any macrophytes. This community is an algal mat and can grow to a greater depth than the macrophytes. Bluegreen filamentous forms (either Phormidium (2μ) or Oscillatoria (2μ) make up the bulk of the mat. In one case Navicula was co-dominant (relevé 168). This is an interesting community which needs looking at in more detail, especially since it can grow where no macrophytes are found.

Subunit d. This is a community of Cladophora species with the epiphytic diatoms Cocconeis and Epithemia as associated species (the latter two are also common or co-dominant in relevés from Subunit b). Gloeotrichia, Lyngbya (2μ) and species of the group Chaetophorales are common in at least half of the relevés. The macrophytes indicate a soil rich or intermediate in nitrogen.

Unattached clouds of Spirogyra (>96µ) (relevé 79) and of Mougeotia (relevés 10 and 73) have been grouped separately

from the other relevés (Table 5). Associated macrophytes indicate an intermediate nitrogen content of the soil in all three relevés, as is also the case for the Spirogyra cloud of relevé 78, which was grouped with Subunit b of the hard water communities. Relevés 10 and 79 are also from hard water, but relevé 73 is from a soft water lake.

As can be seen from Table 5 the benthic algal communities occur under distinct environmental conditions: soft water low to intermediate in nitrogen; hard water low to intermediate in nitrogen or hard water intermediate to high in nitrogen, and therefore they can be used for lake classification. If the species level the indicator taxa are identified to major community groups of Table 5 will be split up into smaller units, which would give rise to a more detailed lake classification. In future benthic algae should be sampled because, as is shown above, they are useful for lake classification, especialy if identification to the species level is concentrated on the Algae are not necessarily associated with indicator groups. macrophytes, in fact they can grow where macrophytes can not, on very exposed wave washed shores, in deep water where light is at freely (the floating in open water а minimum, or phytoplankton). In those cases algae are the only environmental indicators (apart from animals) that can be used to monitor or The survey has pinpointed indicator characterise such places. are useful for of benthic algae which lake groups classification. It is also clear that algae are in some cases the only possible organisms to characterise parts of lakes or whole lakes especially at the exposed oligotrophic end of the scale, and Ireland has many of these lakes. Last but not least, algae are sentisitive to eutrophication and could be used as an early warning system when monitoring future nature reserves.

4. The phytoplankton

The phytoplankton records were arranged into a vegetation table in the usual manner using the computer program TWINSPAN, followed by rearrangement by hand. The best arrangement produced Table 6, which provides a classification of the lakes at the same time. Phytoplankton taxa recorded less than three times are listed in Table 6A. the following groups can be distinguished:

- 1. Extreme oligotrophic and species poor lakes. This includes Coumshingaun (Co. Waterford), Glendalough Upr. and Lough Tay (Co. Wicklow). Coumshingaun was sampled twice on 2/8 and on 19/9 of 1978. On both dates a Peridinium species dominated the plankton. This is a motile form, capable of staying in the epilimnion, and hence well adapted to survive conditions in a deep lake. In Upper Glendalough the plankton was very scarce, with Tabellaria flocculosa the main species present. In Lough Tay the diatom Eunotia was dominant. The conductivity and calcium content of all three lakes was very low (range:42-69 umho's; 2.2 - 2.6mgl-1Ca²⁺).
- 2. Oligo- to mesotrophic and species rich lakes.
 - The following Desmid genera are almost totally restricted to Spondylosium, Staurodesmus, Xanthidium and group: this The Desmid Staurastrum is more frequent in Arthrodesmus. this group than any other group, as are species of the Rhizosolenia the species diatom genera Tabellaria, and The filamentous algae Oedogonium and Botyococcus braunii. Spirogyra, although not strictly planktonic, are also almost completely restricted to this group. The lakes are almost all soft water lakes, of low nutrient status, except Lough Mullaghderg and Bunduft lake which have respectively an intermediate and a high calcium content and an intermediate These two lakes appear to be to high Nitrogen figure. misclassified, especially Bunduft lake. (However, see under Najas lakes p. 41). The algae Coelosphaerium, Ceratium hirundinella and Anabaena $(4 \leq 8\mu)$ are present in the seven lakes on the right of this group and these taxa are also shared with the next group.

D

2

IJ

[

3. Meso- to eutrophic and species rich lakes.

Ŋ

J

In these lakes the following genera occur almost exclusively: Pandorina, Microcystis, Fragillaria crotonensis (only in the left hand group), Gyrosigma, Melosira, Sphaerocystis, Volvox, Gomphosphaeria, Chroococcus (sheets not striated >8 \leq 16u), Eudorina, and Anabaena (8µ). Coelosphaerium (left hand side only), Ceratium hirundinella and Anabaena (4 \leq 8u) are shared with the right hand side of the oligo - to mesotrophic group. These are all hard water lakes, except Lough Akibbon, which is soft and appears to be misclassified.

- 4. Ballyroe Lake, Co. Wexford, is species poor. A motile Pyrrophyte is the dominant alga. This lake is very overgrown and dries out almost completely in summer. Lough Cregduff is dominated by a Dinobryon species and a Synedra species. Neither of these lakes fit in with the groups described above.
- 5. Phytoplankton was sampled from Lady's Island Lake, Co. Wexford. It was dominated by a species of cf. Hapalosiphon, Anabaenopsis and Chaetoceros muelleri were common. The latter species is typical of brackish water, it occurs here in chains of 3 to 10 cells approximately. The number of species is remarkably low. The plankton in this brackish lake is different from that in all other investigated lakes.

The above shows that it is possible to classify lakes from the phytoplankton. If the taxa are identified to species level more groups can be distinguished. The genera that typify the larger groups should be used, with a few exceptions because of identification problems. The indicator taxa are as follows: Peridinium, Spondylosium, Staurodesmus, Xanthidium, Arthrodesmus, Staurastrum, Coelospaerium, Pandorina, Microcystis, Gyrosigma, Melosira, Sphaerocystis, Volvox, Gomphosphaeria, Eudorina and Chaetoceros.

Other genera that could contain usefull indicator species are probably the Desmids Cosmarium, the bluegreen Merismopedia, the green Pediastrum and Dinobryon because these are widespread and frequent and each contain a number of species which are expected to be adapted to different environmental conditions. The

. 40 .

phytoplankton provides a quick and relatively easy way to both monitor and classify large numbers of lakes. An Foras Forbartha have available many species lists for Irish lakes and these should probably be used, if possible, to refine above classification before any more work is undertaken. Their data set, to my knowledge, does not cover many nutrient poor, soft water lakes, so these at least need to be sampled in addition.

5. <u>Classification of the lakes from the aquatic macrophyte</u> vegetation

The lakes were classified using the subunits of the submergent and floating leaf vegetations as attributes (see Table 3). The emergent vegetation (Subunits I to XII) were excluded, because they are transitional between the truly aquatic vegetation and the wetlands associated with lakes. As the latter were not described the former may confuse the picture at this stage. The results of the classification are presented in Table 7 and the following lake types can be distinguished:

1. Nitella lakes

1

Į

IJ

These are soft water lakes and the submerged soils have a low nitrogen content (calculated from Ellenberg's indicator values 1979). They are sparsely vegetated with Nitella communities (subunit XXI) and probably closely related to the Lobelia lakes, but generally poorer in nutrients and species. The community of Nitella flexilis also occurred in Lough Nabeist, but this lake was classified with the Charetum asperae lakes (see below).

2. Najas lakes

These are lakes containing the new association of Najas flexilis and Potamogeton berchtoldii (Subunit XIX). Communities of the Littoreletea also occur, but the present lakes are slightly richer than the Lobelia lakes (see below). Both hard and soft water lakes are involved, as Najas flexilis occur in either. It is interesting that, when classifying the lakes from the plankton, a group emerged which also contained hard and soft water lakes (the oligo to mesotrophic and species rich lakes, see Table 6), in fact one of the lakes (Lough Mullaghderg) is classified in either group by both plankton or macrophytes alike. Other factors apart from calcium must be involved. This group of lakes is obviously of great conservation interest. Najas flexilis is a plant protected under the Wildlife Act. Therefore it would be very important to study the ecology of these lakes further.

3. Lobelia lakes

U

U

These lakes contain communities of the Littorelletea and are closely related to the previous group but lack the community of Najas flexilis and Potamogetan berchtoldii. They are all oligotrophic soft water lakes, the soil is low in nitrogen (calculated according to Ellenberg 1979). All soft water lakes are known to suffer if acid rain pollution is present. The Littorelletea vegetations of Swedish and German lakes have been impoverished because of this. They are also highly of in need susceptable to eutrophication and are conservation.

4. Charetum asperae lakes

These are all meso - to eutrophic hard water lakes, the association indicates soils the figure for Nitrogen intermediate in nitrogen. Belle Lake contains an association typical of the Lobelia lakes and also a community typical of the Elodea lakes (see below). Belle Lake was classified with the present lake type because it is a hard water lake and the occurrence of Isoetes lacustris is atypical and in need of an ecological explanation. Belle Lake is an unusually varied lake, apparently eutrophic and more oligotrophic parts of the lake exist side by side. Lough Corrib contains a community This lake was classified in the typical of the marl lakes. present group because it also contains vegetations of the The marl lakes are obviously closely Charetum asperae. related to the present group, but do not support large stands They are probably poorer in nutrients. of vascular plants. Ballyallia lake is transitional between the present group and the Elodea lakes, which are richer in nutrients. Charetum asperae lakes are probably rare in Europe due to widespread eutrophication as they occur in fertile limestone areas and are therefore in urgent need of conservation and further study.

5. Elodea lakes

IJ

The community of Elodea canadensis and Lemna trisulca (Subunit XXVI) is common in these lakes, while few if any other types of vegetation occur. The lakes are meso - to eutrophic, Phosphorus is probably abundant. The Nitrogen figure for the community is 5.9 which lies within the intermediate range.

6. Marl lakes

These are hard water lakes in which communities of Chara contraria or Chara desmacantha are common. The nutrient status of these lakes is probably quite low and the bottom has a high percentage of pure marl. In Lough George and Lough Bunny (the latter is presumably also of the present type) two unusual communities, which should probably be classified with the Littorelletea, were found. This lake type is rare in Europe due to widespread eutrophication and is in urgent need of conservation and further study.

It is clear that the macrophytes are usefull for lake classification and also that more work needs to be done, especially in the hard water range. Obviously several internationally important lake types are present in Ireland.

6. Environmental indicator values (Ellenberg, 1979)

Environmental indicator values for the relevés and the lakes can be found in the Appendix and for the communities under the descriptions of macrophyte communities and associations, p. 10-32.

The light figures for the relevés (Subunits I to XII excluded) range between 5.5 - 8, which means that the stands we are dealing with here receive more than 10% light during the summer months (5), but usually less than 50% (8). The lower categories are not present i.e. "full shadow plant", receiving less than 1% (1) or "shadow plant" (3). This is not surprising as water plants are usually not restricted to low light levels, as woodland plants can be. The only exceptions are possibly some species of Charophyte or Najas flexilis, but these plants do not occur on Ellenberg's list.

The Temperature figures for the relevés range between 3.5 -7 which means that the stands are typical of a cool to warm climate: 3 = mostly in cool climate (montane to sub alpine); 5 = intermediate, concentrated in the submontane belt of Central Europe; 7 = mostly in warm climate (more or less rare in Northern Central Europe). Stands typical of boreal arctic or alpine climate or of a mediterranean climate are not found in the lakes. The Continentality figures for the relevés range between 1.8-5, which means from euoceanic, reaching Central Europe only in the extreme west (1), through oceanic (2) to intermediate, from suboceanic to subcontinental (5). This is as would be expected in a country on the Western seaboard of Europe. The Moisture figures of the relevés range from 9.2-12 which corresponds to : in wet often not well aerated soil (9) to under-

water plant (12). This is as expected.

The Reaction figures (R) and Nitrogen figures (N) for the relevés, the communities (Subunits of Table 3) and the lakes are graphed in respectively fig. 2, fig. 3 and fig. 4. R and N for the communities were calculated from the combined species list for each Subunit. R and N for the lakes are the means of the R and N values for all relevés from each lake, excluding the relevés from Subunits I to XII, as they belong to the transition of lake to wetland. The general trend of an acid (and calcium poor), low nitrogen environment to a neutral or alkaline (and calcium rich), high nitrogen environment can be observed in all three graphs. It is also evident that a neutral or alkaline (calcium rich), low nitrogen environment exists, however, this appears to be quite rare. Relevés 95 and 151 from Lough Errit and Lough Bunny are extreme examples of this. Subunit XIII, the Community of Potamogeton coloratus and Juncus bulbosus f. fluitans, occurs in Lough Bunny (relevé 151) and is shown as

 $\left[\right]$

neutral or alkaline and low in nitrogen in fig. 3. Subunit XXXIII, the Community of Chara aculeolata, occurs in Lough Errit (relevé 95), but doesn't show quite such an extreme position in fig. 3, because it also occurs in Lough Owel, a lake which ordinates close to a group of nutrient rich lakes (fig.4). Lough Owel was suspected of being artifically enriched at the time of investigation (pers. comm., Inland Fisheries Trust) and the occurrance of Potamogeton lucens (N = 8) in the lake supports Naturally, the lake is probably poor in nitrogen. The this. relevés from Lough Errit (relevé 37) and Lough Muckanagh (relevé 98) of the Community of Chara desmacantha (Subunit XXX) are also ordinated with the neutral or alkaline (and calcium rich) poor This community (N = 4) occurs Nitrogen environment (fig. 2). also in Lough Carra (relevé 90) and Lough George (relevé 96) and these lakes appear to have an intermediate nitrogen level (fig. The Community of Chara species and Juncus bulbosus f. 4). fluitans (Subunit XIV) from Lough George (relevé 99) is also quite low in soil nitrogen (N = 3.7) and neutral or alkaline These lakes are all classified with the group of Marl (fig. 3). lakes in Table 7, which all have hard water, are high in calcium and are apparently low to intermediate in Nitrogen and are hence classified as oligo - to mesotrophic. This rare environment may in fact be in danger of disappearing through eutrophication and conservation, further in urgent need of and is therefore research, especially research into the Charophytes, would be The nutrient poor, alkaline environment may be typically useful. Irish, but was probably widespread in Europe, and has now all but disappeared through eutrophication, mainly because the catchment of this type of lake is always made up of good agricultural land. Careless agricultural practices are likely to lead to the extinction of this type of lake, unless proper planning is implemented.

A group of soft water lakes (acid) of poor nutrient status can also be distinguished in fig. 4, including Lough Akibbon, Cregduff and Mullaghderg. This group corresponds to the group of Nitella lakes, Najas lakes and Lobelia lakes, except for Screen B and Lough Nafeakle, which appear to be somewhat richer than the others, and Glenade, which is in the hard water group of intermediate Nitrogen. Screen B has very few indicator species

0

J

IJ

and may be misclassified in fig. 4 because of this. Nafeakle and Glenade are both in the Najas group of lakes, and this group probably overlaps somewhat with the intermediate Nitrogen range of fig. 4.

The remaining lakes of fig. 4 are in the Charetum asperae group of lakes or in the group of Elodea lakes of Table 7. The environmental indicator species show Lough Gowna, Gur, Doon and in nitrogen, while the rest is in the Ballyallia as rich Lough Nabeist and Lough Gara are shown in intermediate range. 4 to contain plants indicative of weakly acid soils. fia. measured as water was of calcium content the However, This is well within the respectively 21.5 and 29.9 mgl-1Ca²⁺. alkaline range. In all other lakes the R values and the measured calcium content of the water agree quite well. Lough Gara has peaty shores and its R value is based on only two indicators, two acid and two alkaline. One of the relevés is part of an acid verlanding (relevé 102) and hence the whole lake is misclassified This emphasises that the indicator values for a in fig. 4. whole lake must be based on a sufficient number of species and also that different parts of a lake can be quite different, especially if an exposed and a sheltered shore are present. (See Belle lake!). If the lake itself is to be considered as an unit it is important to exclude the surrounding wetlands, as they can be ecologically very different and may mask the nature of the For conservation lake itself (as happened with Lough Nabeist). it would be important to first find out what basic types of lakes exist and then to look for diversity within each lake and hence look at parts of lakes.

The lakes of the ecological divisions 1 and 2 (see Table 1) are mostly in the soft water group (fig. 4, below the intermittent horizontal line) and lakes of ecological divisions 3, 4 and 5 are in the hard water group, while the coastal lakes (division 6) are that clear is From the above it throughout. dispersed Ellenberg's indicator values can be used to obtain an insight into the ecological factors ruling Irish lake ecology. However, it would be useful to assign ecological indicator values to the Irish plants not on Ellenberg's list. To do this more research needs to be done, including work on the Charophytes.

CONCLUSIONS

1. The Macrophyte Vegetation

Ð

J

D

Thirty-seven vegetation units were recorded from the forty-one lakes that were investigated. Twenty of these are either unrecorded for Ireland or (probably) new to science. (White & Doyle, 1982) Below follows a summary of these Subunits (See Table 3).

Subunit I: The Alliance Oenanthion aquaticae is unrecorded from Ireland and the relevé recorded in Lough Ballyteige may represent a new subassociation of the association Rorippo-Oenanthetum aquaticae. Of course more relevés of this type are needed to describe the subassociation properly.

Subunit II: This is a new subassociation of the Carecetum rostratae, containing many differential species typical of the Littorellion. It appears to be wide spread in Irish lakes.

Subunit V: The Community of Eleocharis palustris belongs to the Apion nodiflori. More relevés are needed to clarify the exact position of these relevés within the Apion nodiflori. The associations of the Apion nodiflori are unrecorded for Ireland.

Subunit IV: Community of Berula erecta and Scirpus lacustris. This is probably a new association of the Phragmition, typical of shallow calcareous water. More relevés are needed to establish the validity of this community as an association.

Subunit XII: The Community of Littorella uniflora and Scirpus lacustris is transitional between the Phragmition and the Littorellion. It is a new subassociation of the Scirpetum lacustris and can be named the Scirpetum-Littorelletosum. Subunit XIII and XIV: Two relevés recorded from Lough Bunny and Lough George represent two different communities with Juncus bulbosus and are of great interest. They indicate that probably an oligotrophic calcareous part of the Littorellion exists, sofar undescribed, except by Westholf (1943), who describes a related, but not identical association: the Samolo-Littorelletum, which also contains communities of calcareous habitat. It is highly recommended that more work is done in this area. See also the Marl lakes.

Û

ĺ

Π

 \prod

Ĵ

J

Subunit XVc: The Eriocaulo-Lobelietum, subassociation with Eleocharis multicaulis and Utricularia intermedia was recorded six times in one lake. To establish that it is different from Schoof Van Pelt's subassociation of Eleocharis multicaulis it will have to be recorded from other locations also.

Subunit XVI: The community of Juncus bulbosus f. fluitans typical of deeper water, but shallower than the community of Isoetes lacustris is probably a new association in its own right, typical of oligotrophic soft water.

The community of Isoetes lacustris has been Subunit XVII: separate association but is usually before as a described considered as a subassociation of the Eriocaulo-Lobelietum. However it is typical of deep oligotrophic soft water which is the optimum habitat for Isoetes lacustris. It will never be emers as the vegetations of that association and should be The association occupies considered as a separate association. the Littorellion and between position transitional а Parvopotamion.

Subunit XIX: The community of Najas flexilis and Potamogeton berchtoldii is an association never described before, which should be classified with the Potamion. It has characteristics of both Magno- and Parvopotamion.

Subunit XX: The community of Potamogeton praelongis was only recorded once, to establish its taxonomic position more relevés of this type are needed. It is unrecorded for Ireland.

Subunit XXIb: The Community of Nitella translucens was recorded from two kettle holes in Co. Wexford. It is a core community of the Nitellion flexilis, sofar unrecorded for Ireland. The association Charetum asperae was amended by Subunit XXV: Heuff and Ryan. present. It is recommended that this association is studied further in this country, as it is well developed and endangered by eutrophication. especially because it has all but disappeared in the rest of Europe. The Community of Chara desmacantha is a Subunit XXX: association or subassociation with restricted distribution. is typical of oligotrophic calcareous waters. The Community of Chara contraria should be Subunit XXXIb: considered as a separate subassociation of the Charetum asperae. Subunits XXVIII, XXIX, XXXII and XXXIII, comprising the other Chara communities, have not been recorded for Ireland.

 \bigcup

I

Most of the groups described above are from oligo to mesotrophic habitats. It is of the utmost importance that all are further researched, as they are endangered through eutrophication and in need of urgent conservation. Especially the rare oligotrophic calcareous communities must get immediate attention (see the Marl lakes and also the Charetum asperae lakes).

The benthic algae 2.

Benthic algae were sampled in conjunction with the macrophytes in order to identify environmental indicator species, which could then be used for lake classification in the next step of this Eleven growth forms were described of which six were survey. firmly attached to macrophytes or rocks and the remainder was unattached or loosely attached. Some forms were not associated with macrophytes and these occurred either on exposed rocky shores or in water too deep for any macrophytes to survive the low light conditions.

Several new subassociations are probably

It is in urgent needed of protection,

new

It

Eighteen genera including eight diatom genera, were recommended as indicator taxa. Seven benthic algal communities (see Table 5) were recognised and these occurred under distinct environmental conditions, determined by calcium content of the water and the Nitrogen figure Ellenberg, 1979) of the soils, in which the the this respect associated macrophytes were rooted. In macrophytes were useful environmental markers for the benthic For any future work it is recommended that a species list algae. of the macrophytes, and the vegetation type if possible, is noted when sampling benthos associated with macrophytes, as well as the sampling of benthic algae independently of macrophytes, taking report. this in described growth forms account the into the indicator Identification should be to species level for The seven benthic algal communities described were found taxa. under distinct environmental conditions indicated by the calcium content of the water and the nitrogen figure derived from the intermediate in macrophytes: soft water low to associated Nitrogen; hard water low to intermediate in soil nitrogen or hard Therefore, a lake water intermediate to high in soil nitrogen. classification based on benthic algae, especially in addition to Algae are also macrophytes and/or plankton would be very useful. of great use in monitoring work, as they react quicker to environmental change than macrophytes do.

3. The phytoplankton and lake classification

Ten plankton groups (and therefore lake types) were distinguished (see Table 6) of which five "groups" consisted of single species Most of the lakes belong to the three large groups lists. corresponding environmentally to trophy level as follows: extreme (species poor); oligo-to mesotrophic (species oligotrophic Twenty indicator taxa rich); meso- to eutrophic (species rich). were recommended, the majority typify the three major groups. Species from six of these genera are proposed as good indicators by Rose (1981), who describes a plankton survey of 1250 lakes in Sweden. As six "groups" of the present survey consist of samples from six individual lakes, it is recommended that a further classification is attempted using existing material as much as surveys). Forbartha's lake Foras from An (e.g. possible Additional sampling of soft water lakes and brackish lakes may be

T

1

ы

r

Ł

2

IJ

. 51 .

necessary also. The present survey shows that plankton can be used to classify lakes and it identifies twenty indicator taxa. Of course plankton is also indispensable for monitoring water quality in any future nature reserves.

Lake classification from the aquatic macrophytes

Twentyone subunits of macrophyte vegetation (this is the truely aquatic vegetation) were used to classify the lakes and six lake types emerged as follows (see Table 7): Nitella lakes, Najas lakes, Lobelia lakes, Charetum asperae lakes, Elodea lakes and the reader is referred to the chapter in question Marl lakes. these lake types and for the environmental for details of As fifteen of the conditions thought to prevail in each type. twentyone vegetation subunits used to classify the lakes are either unrecorded for Ireland, or new to science, it follows that the lake types have also never been described before, at least not in this country. It is recommended that the Najas lakes, the Charetum asperae lakes and the Marl lakes are studied further, as all are in urgent need of conservation because of the general increase in eutrophication of the surface waters in thiscountry. Many of these lakes are surrounded by good agricultural land and therefore are under immediate treat. The Lobelia lakes, although usually surrounded by poor land, are very sensitive to acid rain, as has been shown for Swedish lakes. All soft waters are of course also sensitive to eutrophication.

5. Environmental indicator values (Ellenberg, 1979)

The Nitrogen figures (N) and Reaction figures the of (R) macrophytes were used throughout this report to measure the behaviour of relevés, vegetation subunits and environmental The measured calcium content of the water and the lakes. calculated Nitrogen figures of the macrophytes were used to understand ecologically plankton and benthic algal groups. The reader is referred to the relevant sections of the report for It is recommended that further research is done in order each. to assign indicator values to Irish plants not on Ellenberg's list, especially work on the Charophytes, as the Ellenberg values used sofar have proven to be extremely useful. The general trend apparent throughout the report and clearly demonstrated in figure 2. 3 and 4 is as follows: - an acid, calcium poor and nitrogen poor environment grad ates to a neutral to alkaline calcium rich and Nitrogen rich environment, while a neutral to alkaline, Calcium rich and nitrogen poor environment also clearly exists. The latter appears to be quite rare. The classification of the benthic algal communities and of the lakes from the macrophytes reflect these three basic types of environment. The lakes of the ecological divisions 1 and 2 are mostly of the soft water group and those of the ecological divisions 3, 4 and 5 are of the hard water group, while those of the coastal group (6) are in either the soft or the hard water group. It is evident that the ecological division of the county (Moore, 1973) has led to a good spread of ecological conditions and hence a good sample of lakes, which is likely to have covered all types present. The only types of lakes that may have escaped survey are probably small water bodys, the ecology of which is determined by very localised conditions.

GENERAL CONCLUSION

Thirty-seven macrophyte vegetation units were described of which twenty are unrecorded for Ireland or new to science. Six lake types were defined from the aquatic macrophyte vegetation as follows:-

Nitella lakes, Najas lakes, Lobelia lakes, Charetum asperae lakes, Elodea lakes and Marl lakes.

Eleven benthic algal growth forms were described and seven communities were defined, which occur under benthic algal Eighteen benthic algal distinct environmental conditions. indicator taxa were recommended. Ten plankton groups were distinguished consisting of three large groups reflecting well defined environmental conditions, as well as several single Twenty plankton sample "groups" in need of further study. Reaction figures and Nitrogen indicator taxa were recommended. figures (Ellenberg, 1979) were calculated for the relevés, the. vegetation units and the lakes and a gradient is evident between the following major types of environment:

1. acid, calcium poor and nitrogen poor;

2. neutral to alkaline, calcium rich and nitrogen rich;

3. neutral to alkaline, calcium rich and nitrogen poor.

3. neutral to alkaline, curcium richard and includes lakes of the "Marl" Type 3 appears to be quite rare and includes lakes of the "Marl" type. All calcareous oligo-to mesotrophic lakes are under immediate threat from eutrophication as the catchment generally contains mainly good agricultural land. Of course, soft water lakes are also sensitive to eutrophication. It is recommended that lakes of all six types are set aside for conservation and that immediate attention is given to the oligo-to mesotrophic calcareous habitat.

RECOMMENDATIONS

It is recommended:

Ы

L

0

- That work on the vegetation units that are unrecorded for Ireland or new to science is continued, especially on the Charetum asperae and the communities of the Class Charetea, but also on all other new communities which are not characterised by a sufficient number of relevés sofar.
- That more work is done to characterise oligo-to mesotrophic calcareous lakes of the Marl type in particular, but also of the Charetum asperae type.
- That further research is done in order to assign indicator values to Irish plants not on Ellenberg's list (1979), especially work on the Charophytes.
- That more work is done on very big lakes, as few were included in this survey.
- 5. That brackish lakes are investigated. Lady's Island Lake was the only brackish lake sampled, and it has plankton very different from all other lakes.
- That more work is done on benthic algae were macrophytes are absent (rocky shores, deep water).

- 7. That more work is done on phytoplankton as a means of classifying and monitoring lakes, in co-operation with An Foras Forbartha.
- 8. That a thorough literature search is done of aquatic lake vegetation (including macrophytes, benthics and phytoplankton).
- 9. That the seasonal dynamics of the different vegetation types be investigated (e.g. to answer questions like is a certain type of aquatic vegetation available as food for birds? etc.)

It is strongly recommended :

Ľ

5

J

- 10. THAT A LIST OF IRISH LAKES OF INTERNATIONAL IMPORTANCE IS DRAWN UP BY MEANS OF A NATIONAL INVENTORY.
- 11. THAT LAKES OF ALL SIX TYPES DESCRIBED IN THIS REPORT ARE SET ASIDE FOR CONSERVATION AS SOON AS POSSIBLE AND THAT IMMEDIATE ATTENTION IS GIVEN TO THE OLIGO-TO MESOTROPHIC CALCAREOUS HABITAT IN THIS RESPECT.

LIST OF REFERENCES

Bourrelly, P. (1966, 1968, 1970) Les Algues d'Eau Douce Vol. 1,2, 3. Boubée et Cie, Paris.

J

J

- Braun Blanquet, J. (1964) Pflanzensoziologie. Springer Verlag, Wien, New York.
- Brock, T., Frigge, P. van der Ster, H. (1978). A vegetation study of the pools and surrounding wetlands in the Dooaghtery area, Co. Mayo, Republic of Ireland. Thesis, laboratory for Geobotany, Catholic University, Nijmegen.
- Ellenberg, H (1979). Zeigerwerte per Gefasspflanzen Mitteleuropas. Scripta Geobotanica IX, 2.Auflage, Erich Goltze KG, Gottingen, 122 pp.
- Flanagan, P.J., Toner, P.F. (1975) A preliminary survey of Irish lakes. An Foras Forbartha, Water Resources Division, and all reports following this one.
- Foged, N. (1977). Freshwater diatoms in Ireland. Biotechnica Phycologica 34 J. Cramer 123 pp.
- Geitler, L. (1932). Cyanophyceae, Rabenhorst's. Kryptogamenflora. Band XIV. Akademische Verlagsgesellschaft M.B.H. Leipzig, Germany.
- Hessel, P., Rubers, W.V. (1971) Flora, vegetatie, en bodem in het stroomgebied van de Shannon, met name in de omgeving van Lough Ree. Doctoraal verslag, instituut voor, systematische plantkunde, Rijksuniversiteit, Utrecht.
- Hill, M.O. (1979) TWINSPAN. A FORTRAN Program for arranging Multivariate Data in an Ordered Two-way Table by Classification of the Individuals and Attributes, Ecology and Systematics, Cornell University, Ithaca, New York 14250.

J J] J J]

Hustedt, F. (1930). Bacillariophyta. Süsswasserflora Mitteleuropas Heft 10. Fisher Verlag.

- Klein, J. (1975). An Irish Landscape: a study of natural and semi-natural vegetations in the Lough Ree area of the Shannon basin. Doctoraal Thesis, Rijksuniversiteit, Utrecht.
- Mackareth, F.J.H. (1963). Some methods of Water Analysis for Limnologists. Scient. Publs. Freshwater. Biol. Ass. 21, 77pp.
- Moore, J.J. (1973) Ireland. The ecological background. In: The future of Irish Wildlife - A blueprint for development. Eds.: 0'Gorman, F. Wynes, E. p.13 - 18.
- Obendorfer, E. (1977) Süddeutsche Pflanzengesellschaften. Part 1, Gustav Fischer, Stuttgart 311,pp.
- Praeger, R.L. (1934). The Botanist in Ireland. Hodgis Figgis & Co. Dublin, 587 pp.
- Rosen, G. (1981). Phytoplankton indicators and their relations to certain chemical and physical factors. Limnologica (Berlin) 13(2) p.263 - 290.
- Schoof van Pelt, M.M. (1973) Littorelletea: A study of the vegetation of some amphiphytic communities of Western Europe. Thesis, Nijmegen, 216 pp.
- van Groenendael, J.M., Hochstenbach, S.M.H., van Mansfeld, M.J.M. and Roozen, A.J.M. (1979). The influence of the sea and of parent material on wetlands and blanket bog in West Connemara, Ireland. Thesis, Laboratory of Geobotany, Catholic University, Nijmegen.
- Visser, G., Zoer, J.A. (1972). Verslag van een botanisch/malaxologische studiereis naar Z.W. Ierland van 20 Juli tot 12 Augustus 1971. Rijksinstituut vooor Natuurbeheer, Vestiging Leersum.

Westhoff, V., Den Held, A.J. (1969) Plantengemeenschappen in Nederland. Thieme, Zutphen, 324 pp.

White, J., Doyle, G. (1982). The Vegetation of Ireland. A Catalogue raisonné. J. Life Sci. R. Dubl. Soc. 3(2) p. 289-368.

ţ

APPENDIX

,

CONTENTS

]

]

J

	Table 1	List of lakes
	Table 2	Methods of water analysis
	Table 3	Vegetation classification of aquatic macrophytes
	Table 4	Benthic algae in same order as aquatic macrophytes
•	Table 5	Vegetation classification of benthic algae
	Table 6	Vegetation classification of plankton
	Table 6A	Plankton taxa occurring less than three times in
		Table 6
	Table 7	Classification of the lakes
		·
	Figure 1	Location of the lakes
	Figure 2	Reaction figures and nitrogen figures for the relevés
	Figure 3	Reaction and nitrogen figures for the vegetation
		subunits
	Figure 4	Reaction and nitrogen figures for the lakes

Descriptions of the individual lakes, including location maps.

•

• '

