APPENDIX 3

Pilot Environmental Impact Assessment

Lough Carra East

Vegetation Report

by

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September, 1982.

Acknowledgements

I would like to thank the staff of the Forest and Wildlife Service who assisted with this project, most especially Mr. Jim Ryan for his invaluable advice, Dr. Hester Heuff for her help with the computer analysis, Mr. Des Higgins for his endurance during field work and Mrs. Gerardine McGrath and Ms. Theresa O'Brien for typing the report.

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September, 1982.

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SUMMARY

Vegetation in the Annies and Ballyglass catchments was surveyed and mapped. Species, communities and sites of scientific interest were evaluated to assess their present status. Two sites of national importance, two of regional importance and four of local importance were identified. Drainage scheme activities were examined and their likely impact on species, communities and sites of scientific interest estimated. Taking into account the possible evolution of vegetation in the absence of drainage, the proposed drainage scheme is expected to cause the extinction of eight species from the catchments, one of them considered rare at a local level, the loss of a large proportion of all wetland communities and the destruction of six sites of scientific interest, two of which are nationally important.

General guidelines for minimising the negative impacts of drainage on vegetation are given and all eight sites of scientific interest are recommended to be omitted from scheme. The costs, in terms of loss of benefit, saving in arterial drainage, compensation and conservation management, have been calculated for each site. An outline for a monitoring program is suggested and is also costed. Requirements for further research, arising from the present study are listed.

1. INTRODUCTION

1.1 Objectives

This study was commissioned by the EEC and subcontracted to the Forest and Wildlife Service through consultants Hydro-M of Toulouse, France. The basic aim of the project was to formulate a methodology for assessing the impacts of drainage on the environment. The site chosen for the study was the small catchments of the Annies and Ballyglass Rivers (4,636 hectares) which drain into the east of Lough Carra, County Mayo (Figure 1). These catchments are considered to be reasonably representative of the pre-arterial drainage situation in Ireland and contain a variety of wetland habitats.

The specific objectives of the vegetation study were as follows ...

(a) To assess the present status of vegetation in the area, with particular reference to the lands directly affected by drainage projects, and including the vegetation of Lough Carra and its shoreline.

(b) To describe the relationship of the present vegetation to the components of the natural environment (e.g. soils and water) in a framework of reasonably large homogeneous units.

(c) To assist the wildlife consultant in describing the function of vegetation as habitat for wildlife.

(d) To estimate the likely evolution of vegetation in the absence of drainage, taking into account past trends.

(e) To estimate the likely changes in vegetation brought about by the proposed drainage project and its maintenance.

(f) To make proposals for minimising the negative impacts of drainage on vegetation.

(g) To make proposals aimed at facilitating future environmental impact assessments.

1.2 Site Description

The Annies and Ballyglass catchments lie at the western edge of the Central Plain

of Ireland and are underlain by Carboniferous limestone. Glaciation has moulded a topography of low drumlin hills in the northern part of the catchments and gently undulating lowlands in the south, interspersed by numerous basins and depressions (Figure 2). Mineral soils, derived from glacial drift, cover the upland areas and occupy about 75% (3,470 ha) of the catchments. These consist mostly of Brown Earths and Grey Brown Podzolics ranging in depth from about 40-100 cms with loam surface textures (Walsh and Burke (1)). The basins and depressions which occupy the remaining 25% (1,166 ha) are filled with Basin Peats and some Peaty Gleys. The climate of the region is strongly influenced by the Atlantic Ocean with prevailing winds coming from the west and south-west at an annual average speed of around 5 m/s and annual rainfall approximately 1,200 mm. Temperatures range from an average 5°C in January to 15°C in July and sunshine duration from approximately 1-6 hours/day for the same months. Evapotranspiration is low with a maximum average of 65 mm/month for July.

The present vegetation of the catchments is strongly man-modified. The relatively well drained mineral soils support grassland vegetation, mostly of the Centaureo-Cynosuretum typical sub-association (O'Sullivan (2)), which is primarily used as pasture for cattle and sheep. Livestock density was estimated to be 163 LU/100 ha in 1974 which represents about 62% of the estimated potential capacity of these soils under high nitrogen inputs (Walsh (3)). Woodland is uncommon, consisting mostly of small patches of scrub dominated by Hazel (Corylus avellana), and is restricted to the thinner soils and the relatively few areas of limestone outcrop. Trees and shrubs occur in hedgerows which form the field boundaries over most of the study area. The most common species are Hawthorn (Crataegus monogyna), Blackthorn (Prunus spinosa), Ash (Fraxinus excelsior) and occasionally Willows (Salix spp) (O'Sullivan (4)) with small numbers of Elm (Ulmus glabra), Oaks (Quercus robur, Q. petraea), Sycamore (Acer pseudoplatanus), Elder (Sambucus nigra) and Irish Whitebeam (Sorbus hibernica). In the south and east of the area, however, where soil is thinner, field boundaries consist mostly of limestone walls with only the occasional Ash, Hazel or Hawthorn occurring. One small conifer plantation in the Annies catchment occurs partly on mineral soil and partly on peat.

The wet organic soils of the basins and depressions have been repeatedly drained in the past, most intensively during the 1850's. The reclaimed areas on peat support moist grassland characterised by the presence of the Soft Rush (Juncus effusus). Livestock density for these soils was estimated to be around 24 LU/100 ha in 1974. This represents about 16% of their estimated potential capacity with high nitrogen inputs, further drainage and careful land management practices (Walsh (3)). The remaining wetlands comprise a variety of calcareous fens, river

floodplains and acid peat bogs. The fen areas occupy former lake basins, as at Ballyglass Marsh and Lough Beg in Carrowmore North Townland, or occur where bog peat has been cut away to fen peat or marl. Flood plains have been mostly reclaimed for pasture but limited areas of ungrazed floodplain meadows, such as at Kilskeagh Townland west of Mullingar Bridge, and isolated reedbeds, such as at Rinaneel Townland near Annies Bridge, still occur scattered throughout the catchments. Floodplain woodland is restricted to a single stand of Birch (Betula pubescens)/Alder (Alnus glutinosa)/Willow (Salix atrocinerea) wood in the Annies catchment and a small area of Alder wood in Carrowslattery Townland in the south of the Ballyglass catchment. Peat bogs still occupy about a quarter of the wetland area in the catchments. These are of the Raised Transitional type (Hammond (5)) but all have been severely damaged by drainage and peat cutting.

Eight lakes, ranging in size from 0.5-12 hectares, occur in the Annies catchment. These are mostly highly calcareous and oligo-to mesotrophic in nature. The larger lakes, Cloonboorhy, Carrownacon North and Carrownacon South, are over 15m deep with steeply shelving margins and generally have poorly developed aquatic and emergent vegetation. The smaller lakes, Loughs Frank, Manan, Beg and the lake at Rinaneel Townland, are more shallow, less exposed and probably less oligotrophic and tend to have more extensively developed vegetation. Seven (possibly eight) turloughs also occur mainly in the Annies catchment. Turloughs (Gaelic: tur; dry and loch; lake) are temporary lakes apparently unique to the limestone areas of western Ireland which fill and empty mainly through underground channels. Their generally short herbaceous vegetation is adapted to prolonged inundation by water during winter months and to near drought conditions and heavy grazing pressure during summer.

The two rivers, the Annies and the Ballyglass, are no more than streams for most of their lengths and were mostly channelised during the drainage works of the 1850's. Consequently there are very few natural river stretches left in the catchments and meanders and riffle/pool sequences are uncommon. The vegetation of the rivers is largely macrophytic with bryophyte, lichen and encrusting algal communities poorly developed or absent.

Both rivers flow into the eastern side of Lough Carra. This is a large (1,900 ha) calcareous lake with deep marl (calcium carbonate) deposits and an extremely indented shoreline. Unlike the larger lakes in the Annies catchment it is mostly shallow, 2-3m deep, with numerous islands and only occasional pockets of deeper water. Aquatic and emergent vegetation is generally sparse but above summer water level the shoreline vegetation is species rich and diverse, showing several transitions from fen to limestone pavement, limestone grassland and woodland.

2. METHODS

2.1 Field Survey

The primary objective of the vegetation study was to assess the present status of vegetation in the catchments, particularly that of lands directly affected by the proposed drainage scheme. In order to do this efforts were concentrated on areas delimited by the Office of Public Works (OPW) as 'damaged' land i.e. lands currently affected by flooding or impeded drainage. Of the 4,636 hectares comprising the Annies and Ballyglass catchments approximately 1,166 hectares (25%) are classified by OPW as 'damaged' land of which 800 hectares (17%) are expected to benefit from the drainage scheme.

With the objective of producing a vegetation map of the catchments a number of aerial photographs were examined at the Geological Survey Office in Dublin. The most recent photographs available were taken in 1973 at a height of 30,000 feet and printed to a scale of approximately 1:25,000. Unfortunately these photographs were in black and white and taken during the month of April, too early to show full seasonal development of vegetation. Consequently they were found to be of limited use for mapping herbaceous vegetation but were used effectively for mapping the distribution of woodlands, scrub and cut-away bog and for delimiting the areas of 'damaged' land.

In the absence of a provisional vegetation map drawn from aerial photographs a selective sampling regime for a field survey was considered impractical. As a result each area of 'damaged' land had to be visited and surveyed extensively on foot. Field work took place mostly during August and September 1981. Due to the scale of the task involved and the short time available for field work the Braun-Blanquet method of vegetation sampling (Westhoff and van der Maarel (7)), which was considered to be the most suitable, could not be adopted. Instead, a less time consuming adaptation of the method was undertaken. Each area of 'damaged' land was visited and for every major vegetation type encountered full species lists were made and notes taken of the following ...

(a) Dominant Species - those species with a cover of greater than 10% or, where total cover was low, the most common species present.

(b) Vegetation Structure - height of vegetation and percentage cover of each structural layer i.e. trees shrubs, dwarf shrubs, herbs, bryophytes, open water, bare ground and litter.

(c) Microtopography - slope, aspect, terrain (whether tussocky, hummocky, flat), poaching etc.

(d) Surface Soil Type - sampled by digging into the top 5-10 cms of soil and classified into the broad categories of peat, marl, mineral, marly peat, silty peat etc.

(e) Management Activity - whether grazed, burned, reseeded etc.

The three main lakes of the catchments, Cloonboorhy and Carrownacon North and South were investigated by a diving team during September 1981 and sampled in a similar manner. The smaller Loughs Frank were sampled for aquatic vegetation by throwing in a wire grab from the shore and the eastern part of Lough Carra by towing a drag line from a boat. Loughs Manan, Beg and the lake at Rinaneel Townland were not sampled for aquatic vegetation. Lake bed profiles of Cloonboorhy and the Carrownacon loughs were made by echo sounding from a boat in roughly north/south and east/west transects (Figure 3). The vegetation of drains and river channels was sampled at point localities throughout the catchments.

In total 321 sites were sampled, of which 24 were of drains and rivers, 7 of lakes and 20 of sites outside 'damaged' land (agricultural grassland or woodland) on mineral soil. The location of these sample sites is shown in Figure 4.

2.2 Analytical Methods

286 of the vegetation samples were coded for computer analysis. The remaining 35 out of the total 321 were recorded after the bulk of the computer analysis had been completed on subsequent visits to the catchments. Each species was given an abundance rating of either '1' for presence or '2' for present and dominant. Species which were dominant were weighted in the analysis to emphasise the similarity between samples with dominant species in common. Data were entered in a suitable format to a Twinspan package program (Hill (8)). This program is designed to arrange multi-variate data in an ordered two-way table by a classification of individuals (species) and attributes (abundances). Essentially

it works by making a series of dichotomous divisions of the data, first by constructing a classification of the vegetation samples and then using this classification to make a classification of the species according to their ecological preferences. The two classifications are then used together to obtain an ordered two way table which expresses the species synecological relations as succinctly as possible.

The program was run several times, each time with samples from the more obvious vegetation types omitted from the data set. This program was found to be useful for identifying and classifying the major trends of variation in the more man-modified sedge/grassland vegetation. The Twinspan analysis, in conjunction with field notes, led to the eventual recognition of 32 plant communities. These were then analysed for ecological behaviour and lifeform characteristics using the method devised by Ellenburg (9). This method operates through a system of assigned values, or scores, for species based on their fidelity as indicators of ecological conditions. Ellenburg lists scores for nearly 2,000 European plant species for factors such as soil reaction (pH) soil nitrogen, soil moisture, periodic waterlogging and flooding, amongst others. Lifeform characteristics such as persistence of leaves, anatomical structure and Raunkiaer lifeform types are also given for each species. Objective comparisons of plant communities were made by comparing their average scores for ecological behaviour and principle lifeform characteristics. It should be noted that the Ellenburg method was developed for use in central Europe and indicator scores cannot be taken as absolute in Ireland due to differences in climate and plant behavioural responses. In practice the method proved useful in relative terms and highlighted many of the differences between communities. Each community was classified on the system of Cowardin et al (10) and linked in as far as possible to its related Braun-Blanquet phytosociological association using the keys and descriptions published by White (11) and White and Doyle (12). For mapping purposes the 32 communities were grouped into 19 vegetation types. These were further grouped into 5 major ecosystems - Lakes, Rivers, Bogs, Turloughs and Uplands. The Vegetation Map (Figure 5) was drawn by using the vegetation classification with reference to maps drawn in the field. The distribution of woodland, scrub and cut-away bog was mapped from the 1973 Geological Survey aerial photographs. To aid the work of the wildlife consultant a Vegetation Structure Map (Figure 6) was also produced. This was drawn by using the vegetation classification in conjunction with information on vegetation structure gathered during field work.

2.3 Evaluation Methods

Assessment of the present vegetation was made by evaluating the status in Ireland of species, communities and sites of scientific interest found in the catchments. This was necessary in order to make an appraisal of the negative impacts of the drainage scheme and to suggest measures for minimising them. Evaluation was hampered from the outset by the absence of an existing, widely accepted methodology and lack of comparable, up to date information.

(a) Species: A total list of plant species for the catchments was drawn up from information gathered from the vegetation samples. A crude estimate of their relative abundance can be inferred from their frequency of occurrence in the samples. Species regarded as not native to Ireland, according to Webb (13) and Smith (14), were noted and listed. The distribution and status of species was examined by reference to Flora Europaea (Tutin et al (15)), the Atlas of the British Flora (Perring and Walters (16)), An Irish Flora (Webb (13)), the Census Catalogue of the Flora of Ireland (Scannell and Synnott (17)), the Moss Flora of Britain and Ireland (Smith (14)), the Census Catalogue of British Mosses (Warburg (18)), the Census Catalogue of British Hepatics (Paton (19)), the British Characeae (Grove and Bullock-Webster (20))and Lichens - An Illustrated Guide (Dobson (21)).

Status in Ireland (i.e. frequency) has not been given for all species due to lack of information but those which were considered to have a relatively restricted distribution have been listed and discussed. Restricted vascular plants were rated in terms of their rarity at local, regional and national levels on the basis of the number of 10 km grid squares in which they are recorded in the Atlas of the British Flora (Perring and Walters (16)). This method is used by Ratcliffe(22) in defining rarity of British vascular plants but is considered unsatisfactory here because of the shortage of records for Irish species and the age of the publication (1st edition 1962, 2nd edition 1976). To supplement this rating the number of vice-counties in which a species has been recorded in the Census Catalogue of the Flora of Ireland (Scannell and

Synnott (17)) and the number of European Territories from which a species is listed in Flora Europaea (Tutin et al (15)) has also been given. The distribution and status of bryophytes, charophytes and lichens in Ireland is still imperfectly understood so no attempt has been made to rate those found in the catchments. A list of the bryophytes not previously recorded from the vice-county (East-Mayo, 26) was made however.

(b) Communities: Some indication of the status and distribution communities at a national level was made by reference to White and Doyle (12) and at a European level by reference to Westhoff (23). However, an accurate assessment of their local, regional and national importance could not be made because sufficient information on their distribution in Ireland is not available. Despite this some form of comparative rating was regarded as essential in order to evaluate the changes brought about by drainage. It was considered that a crude but useful catchment rating could be produced, using the following criteria.

(i) Naturalness (agricultural, semi-natural, near-natural)
(ii) Status in the catchments(common, occasional, uncommon)
(iii) Threat in the catchments (low, moderate, high)
(iv) Rare species (absent, present)

The ratings for each criteria was then given a value as follows:

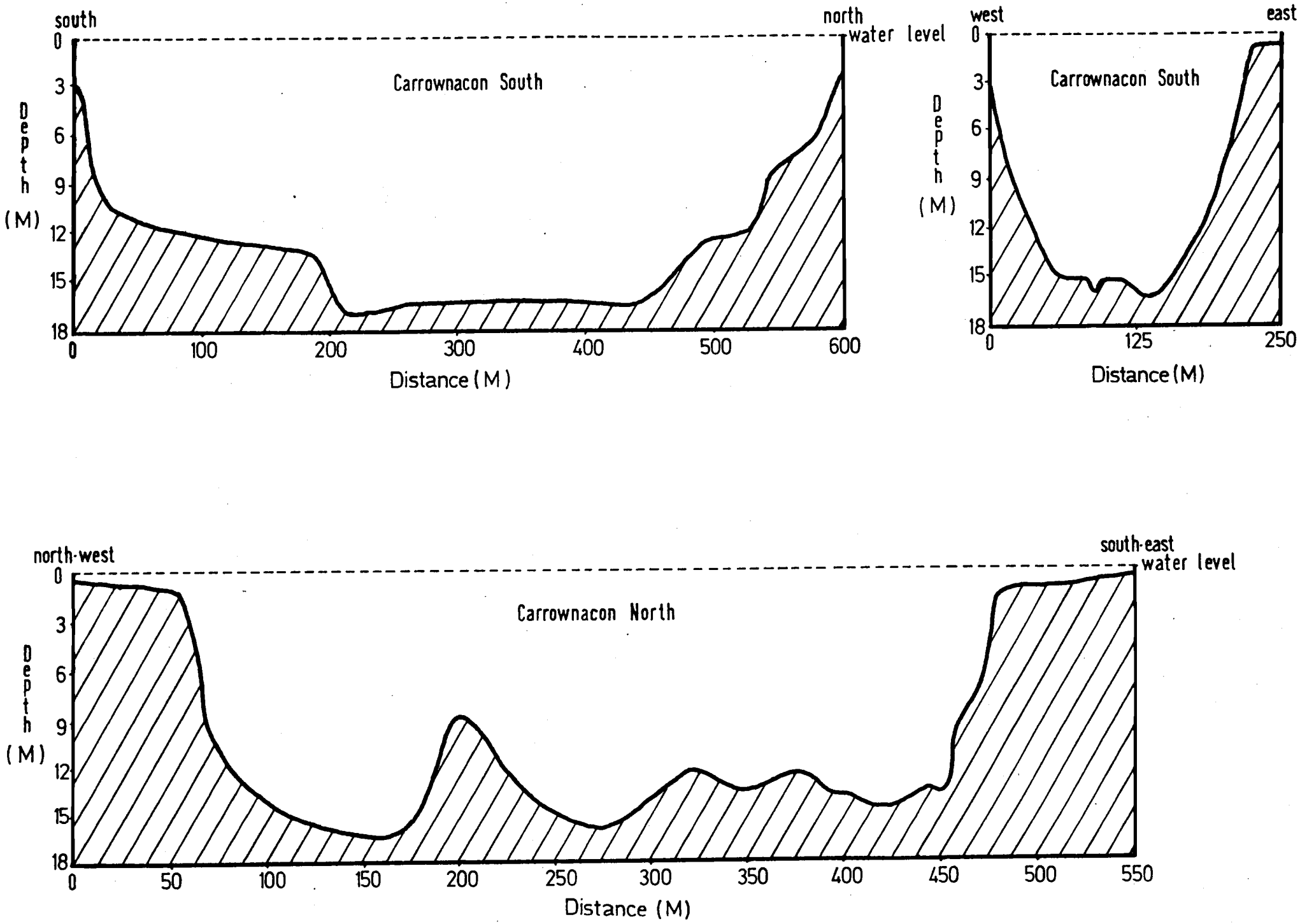
0 = Absent
1 = Agricultural, common, low, present
2 = Semi-natural, occasional, moderate
3 = near-natural, uncommon, high

The final rating for each community was obtained by summing the values for the four criteria. It must be stressed that these ratings were only used as a rough guide in helping to decide whether the replacement of one community by another as a result of drainage should be regarded as a positive or negative impact.

(c) Sites of Scientific Interest: These were initially selected on

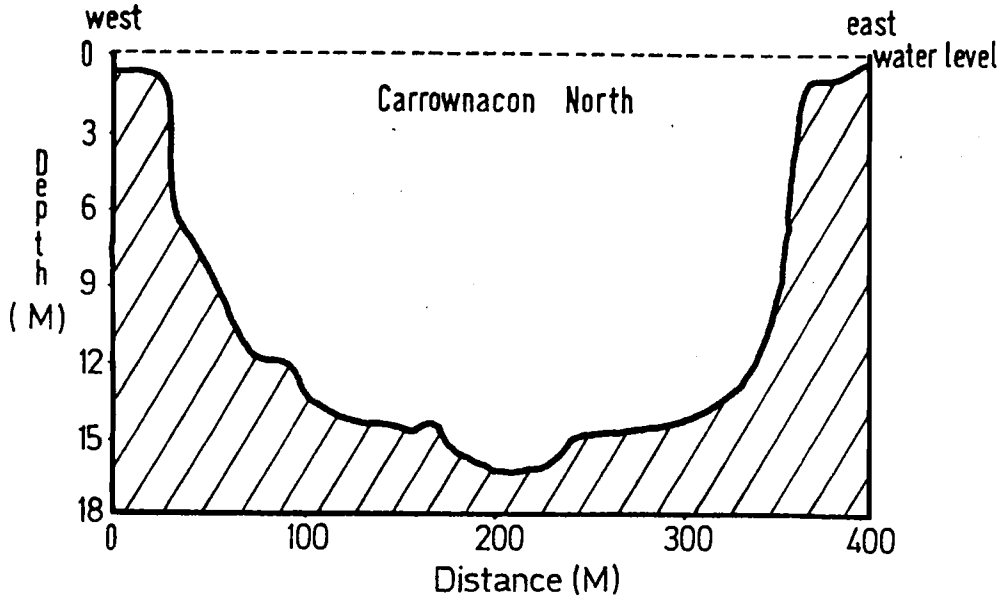
LAKE BED PROFILES

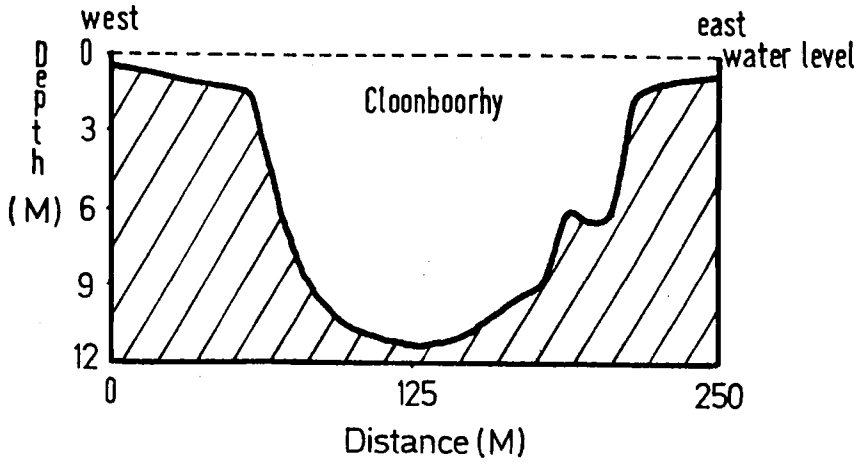
FIGURE · 3 ·

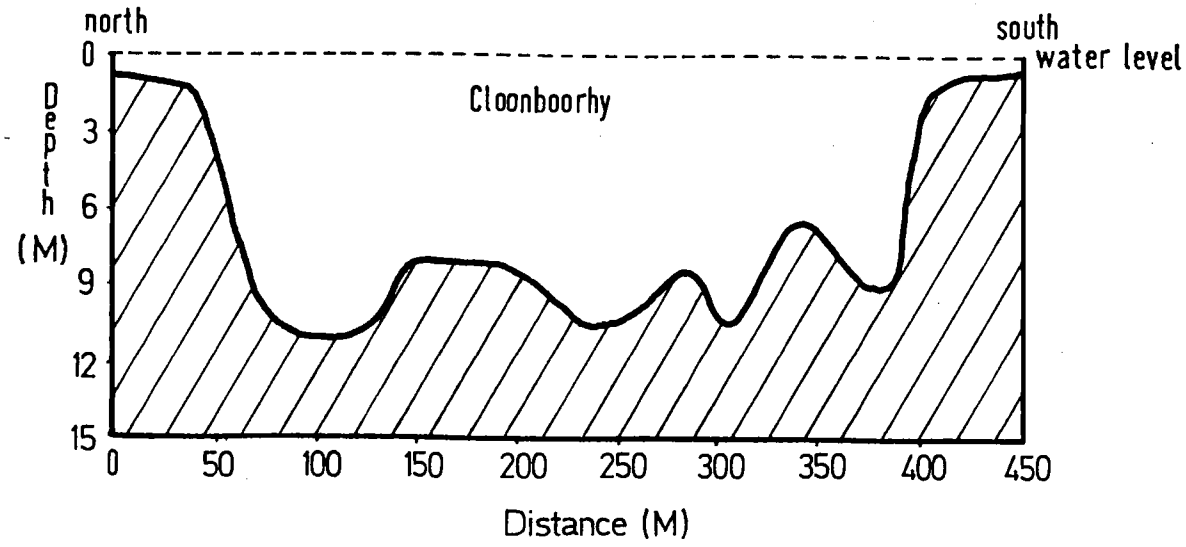


LAKE BED PROFILES

FIGURE 3







the basis of their naturalness and feasibility for conservation. An assessment of their relative importance as sites of scientific interest was made by applying the criteria and site rating scale used by An Foras Forbartha (Appendix 3.1 and 3.2). However, this method was considered to be inadequate as the site rating criteria are not well defined and could lead to wide variations in the ratings given to an area by different people. An alternative approach was therefore developed using more numerous and better defined criteria to select and evaluate sites. Using this method, once an area was considered to be of possible conservation interest, the following aspects were assessed.

(i) Threat - was the site to be drained? In general, other aspects of the site being equal threat was treated as a negative factor.

(ii) Status - were the site types, communities and rare species present thought to be declining, static or expanding in Ireland?

(iii) Protection - How many sites containing the rare species communities or site types present were already protected in Ireland?

(iv) Conservation interest - considering 1-3 above was the site of conservation interest?

(v) Management Feasibility - Would it be technically possible to maintain the conservation interest of the area in the long term e.g. 50 years?

If the site was of conservation interest and could be conserved in the long term it was then rated as of local, regional, national or international importance based on the following criteria -

(i) Scarcity (species, communities, site type and geomorphology)
(ii) Diversity (species and communities)
(iii) Proximity to other sites of scientific interest

(iv) Size

(v) Naturalness

(vi) Research and Educational potential

The selection of an overall rating was then made on a subjective basis with most weight being given to the values for rarity of site type and geomorphology, the number of communities present, naturalness, research potential and their proximity to other sites of scientific interest.

2.4 Impact Assessment Methods

Drainage scheme activities and the areas that are likely to be affected by them were identified and defined by the OPW schedule of works and the maps of benefiting land. Impact assessments were made by relating drainage scheme activities to the known ecological requirements of species and vegetation types. The likely impact on species has been expressed in terms of expansion, contraction or extinction of range within the catchments. The areas and percentages of vegetation types likely to be affected were calculated by planimeter measurement from the vegetation maps. The impact on sites of scientific interest have also been considered. In estimating the net effects of the drainage scheme possible positional changes in vegetation types post-drainage and the probable evolution of vegetation in the absence of drainage have been taken into account.

2.5 Costing Methods

The costs of omitting selected sites of scientific interest from the drainage scheme were calculated from figures supplied by OPW. Savings would be made by not having to carry out arterial and field drainage and their subsequent maintenance. Losses would be incurred by the non-

supplied by OPW, adjusted to current rates on the Land Commission's assumptions that land prices had trebled since 1974. The costs of minimal conservation management programs were calculated from the salaries of the various staff grades of the Forest and Wildlife Service that would be involved. Salaries were doubled to take into account hidden costs for clerical backup etc. In accordance with the methods used in OPW's cost benefit analysis, labour was costed at nominal prices and all costs were discounted at 3½% over 50 years.

The costs of a monitoring program to study the effects of the drainage scheme were estimated at current prices for salaries, overheads and equipment involved. The cost for a study on the hydrology of turloughs was supplied by Drew (24) and for aerial photography by Rottier (25).

3. ASSESSMENT OF THE PRESENT VEGETATION

3.1. Species

A total of 371 species of vascular plants, bryophytes, lichens and stoneworts (Characeae) were listed from the catchments (Appendix 3.4). Most (356) had been recorded from the vegetation samples analysed by computer and for these an absolute and percentage frequency of occurrance is given. As virtually all samples were taken from "damaged" land this list does not include all the species which may occur in upland (non-wetland) areas and it therefore cannot be regarded as a definative list for the catchments. It does however include most of the species that are likely to be affected by the drainage scheme. Unfortunately there were no other species lists of this area available from the Biological Records Centre.

All the species in Appendix 3.4 are generally regarded as native, with the exception of the following:-

Campylopus introflexus (Moss)
Aesculus hippocastanum (Horse Chestnut)
Acer pseudoplatanus (Sycamore)
Pinus sylvestris (Scots Pine)
Pinus contorta (Lodgepole pine)
Picea abies (Norway Spruce)
Picea sitchensis (Sitka Spruce)

3.1.1 Rare or Threatened Species

Most of the species in the catchments are regarded as common in Ireland. However, ten are considered to be rather rare and under threat from drainage and these have been rated in Table I . In the discussion which follows anglicised names are taken from The Concise British Flora in Colour (28) and notes on ecology and distribution from An Irish Flora (13), Atlas of the British Flora (16) and Flora Europaea (15).

Table I: Rating of Selected Rare or Threatened Species on the Basis of Records of Known Distribution.

Species	No. of 10 km Grid Squares*			No. of Vice* counties in Census Catalogue	No. of European Territories	Rating
	East Mayo	Connaught	Ireland			
(a) Thelypteris palustris	0	0	9	17	28	R
(b) Stellaria palustris	0	3	13	16	24	R
(c) Myriophyllum verticillatum	0	1	19	10	34	R
(d) Carex limosa	1	11	32	26	25	L
(e) Carex lasiocarpa	1	13	31	26	24	L
(f) Potamogeton praelongus	1	4	23	17	22	L
(g) Oenanthe fluviatilis	0	4	11	11	6	L
(h) Ranunculus lingua	3	17	42	34	28	-
(i) Sparganium minimum	3	27	59	38	26	-
(j) Juncus subnodulosus	9	28	60	32	27	-
Maximum No. Possible	c27	c206	964	40	39	

*Only records since 1930 included

N = National (≤5 10 km grid squares in Ireland)
R = Regional (≤3 10 km grid squares in Connaught)
L = Local (≤1 10 km grid squares in the vice-county)
- = not rated.

a) Thelypteris palustris (Marsh Fern) Rating: Regional

This species generally occurs in marshes, fens and occasionally in wet woodland. It was only found in small amounts amongst Carex paniculata tussocks around Lough Manan in the Annies catchment. It is thought to be uncommon in Ireland with a scattered distribution and has disappeared since 1930 from several of its former stations in the midlands. Occurs throughout most of Europe except Spain and the extreme north.

b) Stellaria palustris (Marsh Stitchwort) Rating: Regional

Also occurs in marshes and fens. Locally abundant on the site of the former Lough Beg in Carrowmore North Townland in the Annies catchment. Formerly more widespread in Ireland but now found mostly in the centre, especially in the Shannon and Erne basins. Occurs in northern and central Europe extending southwards to Corsica, Bulgaria and the Ukraine.

c) Myriophyllum verticillatum (Whorled Water-milfoil) Rating: Regional

Occurs in pools, drains, canals and slow flowing streams. Found in several drains in both the Annies and Ballyglass catchments and also in Cloonboorhy and Carrownacon Loughs. Generally local in Ireland, found mostly in the centre. Widespread throughout Europe.

d) Carex limosa (Mud Sedge) Rating: Local

Occurs on wet bogs and lake margins, often characteristic of the fen/bog transition stage (O'Connell (29)). Found in small amounts amongst the Reedbeds of the former Lough Beg in Carrowmore North Townland in the Annies catchment. Local in the north and west of Ireland but very rare elsewhere in the country. Occurs in north, north-west and central Europe extending locally southward to the Pyrenees, southern Bulgaria and south-east Russia.

e) Carex lasiocarpa (Downy-fruited Sedge) Rating: Local

Occurs in bogs and marshes. Found in small amounts around Cloonboorhy and Carrownacon South and in a small marsh in Catford Townland. Occasional in the west of Ireland but very rare elsewhere in the country. Occurs across Europe extending southwards to the Pyrenees, central Italy, southern

Yugoslavia and southern Ukraine.

f) Potamogeton praelongus (Long-stalked Pondweed) Rating: Local

Occurs in lakes. Found around the margins of Cloonboorhy Lough. Uncommon in Ireland, mostly in lakes near the west and north coasts. Occurs in northern and central Europe, extending southwards to southern France, central Bulgaria and central Ukraine.

g) Oenanthe fluviatilis (River Water-dropwort) Rating: Local

Occurs in ponds, streams and rivers. Found in the outflow of Loughs Frank. Uncommon in Ireland, mainly in the centre. Restricted to Atlantic western Europe.

h) Ranunculus lingua (Greater Spearwort) Rating: None

Occurs in marshes, canals and reedbeds. Found amongst the reedbeds at Rinaneel Townland, north of Annies Bridge, and amongst Carex paniculata tussocks around Lough Beg. Occasional in the centre of Ireland but rather rare elsewhere in the country. Occurs throughout Europe but rare in the Mediterranean region.

i) Sparganium minimum (Small Bur-reed) Rating: None

Occurs in bogs, drains and peaty lakes. Found at Cloonboorhy Lough in the Annies catchment. Occasional in scattered localities throughout Ireland. Occurs across Europe extending southward to the Pyrenees, northern Appennines and southern Bulgaria.

j) Juncus subnodulosus (Blunt-flowered Rush) Rating: None

Occurs in fens and marshes. Found in several localities in both the Annies and Ballyglass catchments. Frequent in the west and centre of Ireland, but decreasing, and very rare in the north and south. Occurs in western, central and southern Europe extending northwards to Estonia.

3.1.2 Bryophytes

Thirteen bryophytes not previously recorded for East Mayo (vice-county 26) in the Census Catalogue of British Mosses (18) and the Census Catalogue of British Hepatics (19) were discovered during the survey. These are listed as follows:-

Musci	Hepaticae
Campylopus paradoxus	Calypogeia sphagnicola
Philonotis calcarea	Cephalozia connivens
Plagiomnium affine	Chiloscyphus pallescens
Sphagnum auriculatum var inundatum	Leiocolea badensis
Sphagnum contortum	Lepidozia setacea
Splachnum ampullaceum	Mylia anomola
	Solenostoma triste

3.2 Ecosystems, Vegetation Types and Communities

The 19 vegetation types (Figure 5), their constituent communities and the ecosystems in which they occur are listed in Table II. Vegetation types and communities are discussed in detail in Appendix 3.5 under the following headings: -

a) Cowardin Classification
b) Phytosociology (ecology and distribution)
c) Sample Number
d) Average Number of Vascular Plants per Sample
e) Dominant Species
f) Associated Species
g) Structure
h) Distribution (within the catchments)
i) Substrate
j) Management
k) Comments

The relationship between vegetation and ecological factors is shown in Table III. Figures for Moisture, Soil Reaction and Soil Nitrogen are those used by Ellenburg (9) and are briefly defined below. It should be stressed once more that these values can only be regarded as relative

Table II: Ecosystems, Vegetation types and Communities of the Annies and Ballyglass catchments.

Ecosystem	Vegetation Type		Community	
I LAKES	1 Lakes		1a*	Profundal Zone
			1b	Lower Infralittoral Zone
			1c*	Plankton
	4 Reedbeds	4a Upper Infralittoral	4a(i)	Scirpus lacustris
			4a(ii)	Phragmites australis
			4a(iii)	Carex elata
		4c Oligotrophic	4c	Schoenus nigricans/Molinia caerulea
	5 Schoenus Marsh		5	Schoenus Marsh
	6 Carex elata Marsh		6	Carex elata Marsh
	12 Lake Floodplain Pasture		12	Lake Floodplain Pasture
	17 Scraw		17	Scraw
II RIVERS	4 Reedbeds	4b Mesotrophic	4b(i)	Carex paniculata
			4b(ii)	Carex nigra/Galium palustre
	8 Hazel Scrub and Mixed Woodland		8b	Alder wood
			8c	Wet Birch Scrub
	13 River Floodplain Pasture		13	River Floodplain Pasture
	16 Dry Tall Herb		16	Dry Tall Herb
	19 River Channels and Ditches		19	River Channels and Ditches
III BOGS	3 Bogs		3a	Actively Growing Acid Bog Areas
			3b	Bog Pools
			3c	Dry Ridges
			3d	Molinia Dominated Areas
			3e	Areas cut down to Fen Peat or Marl
	9 Gorse Scrub		9	Gorse Scrub
	11 Improved Wet Pasture		11	Improved Wet Pasture
	14 Wet Sedge Swards		14	Wet Sedge Swards
	15 Dry Sedge Molinia Swards		15	Dry Sedge Molinia Swards
	18 Carex rostrata Marsh		18	Carex rostrata Marsh
IV TURLOUGHS	2 Turloughs	2a Semi-Permanent Open Water	2a(i)	Polygonum amphibium/Chara spp
			2a(ii)	Carex rostrata/Glyceria fluitans
			2a(iii)	Carex disticha/Menyanthes trifoliata
		2b Flooded Pasture	2b	Flooded pasture
V UPLANDS	7 Coniferous Plantation		7*	Coniferous Plantation
	8 Hazel Scrub and Mixed Woodland		8a	Hazel Scrub
	10 Pasture and Arable		10a	Pasture
			10b*	Arable

* Either devoid of vegetation (1a) or not sampled (1c, 7, 10b).

TABLE III: Relationship between vegetation and major ecological factors

ECOSYSTEM	NO.	COMMUNITY	Ecological Behaviour					Anatomical Structure									
			Moisture	% Periodic Moistening	% Flooding	Soil Reaction	Soil Nitrogen	% Hydromorphic	% Helomorphic	% Hygromorphic	% Mesomorphic	% Scleromorphic	% Leaf Succulent	Permanent Open Water	[1] Grazing	Burning	[2] Soil Type
LAKES	1b	Lower Infralittoral Zone	11.50	0	0	6.2	5.00	100	-	-	-	-	-	+	-		Ma
	4a(i)	Scirpus lacustris	11.00	0	0	6.38	6.22	66	33	-	-	-	-	+	-		Ma
	4a(ii)	Phragmites australis	10.15	19	19	6.40	4.13	36	58	6	-	6	-	+	-		Ma
	4a(iii)	Carex elata	9.67	33	26	5.89	4.63	21	54	39	8	-	-		-		Ma
	4c	Schoenus nigricans/Molinia caerulea	8.53	30	26	5.09	2.97	8	53	7	20	11	1		-		Ma
	5	Schoenus Marsh	8.11	32	17	5.11	2.58	2	56	10	14	15	2		L		Ma
	6	Carex elata Marsh	8.61	50	29	5.05	2.97	7	62	18	9	4	-		-		Ma
	12	Lake Floodplain Pasture	7.06	36	11	4.78	3.73	1	34	17	39	9	1		M		Ma/P
	17	Scraw	9.75	20	15	7.00	5.39	30	47	10	10	3	-		-		SLS
RIVERS	4b(i)	Carex paniculata	11.00	0	0	6.38	6.22	66	33	-	-	-	-	+	-		SP
	4b(ii)	Carex nigra/Galium palustre	10.15	19	19	6.40	4.13	36	58	6	-	6	-		-		SP
	8b	Alder Wood	6.75	14	14	6.08	5.18	-	25	25	41	9	-		-		P
	8c	Wet Birch Scrub	7.33	33	19	5.64	3.92	-	41	9	32	18	-		-		SP
	13	River Floodplain Pasture	7.82	42	18	4.44	4.34	5	47	19	23	5	-		M		SP
	16	Dry Tall Herb	7.47	37	18	4.66	3.56	1	47	14	27	12	-		-		P/SP
	19	River Channels and Ditches	9.92	6	19	6.83	5.33	45	44	6	2	2	-		-		M
BOGS	3a	Actively Growing Acid Bog Areas	7.73	52	11	3.08	2.24	-	36	-	32	28	4		L	+	P
	3b	Bog Pools	9.60	24	18	4.5	2.66	21	58	-	11	5	5	+	-		P/Ma
	3c	Dry Ridges	7.57	38	9	3.23	2.64	1	33	5	32	26	3		L	+	P
	3d	Molinia Dominated Areas	7.72	40	12	3.49	2.70	1	37	4	34	23	1		L	+	P
	3e	Areas cut down to Fen Peat or Marl.	8.31	34	24	4.53	2.64	6	51	3	25	14	1		L	+	P/Ma
	9	Gorse Scrub	6.29	36	0	3.00	3.33	-	15	-	62	23	-		L	+	P/M
	11	Improved Wet Pasture	6.79	38	7	4.11	4.05	1	32	14	43	11	-		H		P/SP
	14	Wet Sedge Swards	7.65	41	15	4.81	2.75	2	40	11	32	15	1		M		P/Ma
	15	Dry Sedge Molinia Swards	6.35	34	8	4.56	3.38	1	30	8	46	16	-		L		P/Ma/M
	18	Carex rostrata Marsh	9.03	22	33	4.63	3.00	11	55	17	9	8	-		L		P/Ma
TURLOUGHS	2a(i)	Polygonum amphibium/Chara spp	9.60	14	24	6.80	5.05	27	54	12	3	3	-		L		Ma/M
	2a(ii)	Carex rostrata/Glyceria fluitans	10.28	32	20	4.82	4.71	26	55	13	5	-	-		L		Ma/M
	2a(iii)	Cares disticha/Menyanthes trifoliata	9.70	16	27	6.00	4.96	32	48	9	9	-	-		-		Ma/M
	2b	Flooded Pasture	7.35	46	14	4.77	4.35	4	42	20	27	7	-		H		M
UP-LANDS	8a	Hazel Scrub	5.74	9	0	6.25	5.65	-	9	31	50	9	-		M		M
	10a	Pasture	5.67	13	1	3.83	5.92	-	10	22	65	7	-		H		M

[1] Grazing L = Light, M = Medium, H = Heavy

[2] Soil Type Ma = Marl, P = Peat, SLS = Semi-liquid silt, S = Silt, M = Mineral, SP = Silty Peat, P/Ma = Peat and/or Marl.

indications because of the differences in climatic conditions between Ireland and central Europe.

Moisture -	3	dry soils
	5	fresh soils (intermediate)
	7	moist soils which do not dry out
	9	wet, often not well aerated soils
	10	frequently inundated soils
	11	emergent aquatic vegetation
	12	submergent aquatic vegetation
Soil Reaction -	3	mostly acid soils
	5	mostly weakly acid soils
	7	mostly in neutral soils, but also in acid and basic ones
	9	only in neutral or basic soils
Soil Nitrogen -	1	only in soils very poor in mineral nitrogen
	3	mostly in poor soils
	5	mostly in intermediate soils
	7	mostly in soils rich in mineral nitrogen
	8	nitrogen indicator

Figures for periodic moistening and flooding are the percentages of the species in a community which indicate those conditions. Anatomical structure is expressed as the percentage of species in a community showing particular adaptations with regard to water balance and gas exchange. The results from this table were used in the description of vegetation types and communities in Appendix 3.5 and formed the basis for considering the impacts of the drainage scheme.

The Cowardin Classification (Cowardin et al (10)) in Appendix 3.5 is an attempt to define habitat types. This was felt necessary in order to facilitate comparison with other habitat types both within and outside the catchments. Turloughs were notably difficult to define using this system however. The floristic (phytosociological) affinities of vegetation types and communities proved more useful in this respect and enabled some idea of their general distribution to be obtained from the published literature (White and Doyle (12), Westhoff (23)). Although no accurate

Table IV Comparative ratings of communities and vegetation types

		Natural-ness	Status	Threat	Rare Species	Rating out of 10
1b	Lower Infralittoral Zone	NN	C	L	+	6
2a(i)	Polygonum amphibium/Chara spp	NN	R	H	+	9
2a(ii)	Carex rostrata/Glyceria fluitans	SN	O	H	-	7
2a(iii)	Carex disticha/Menyanthes trifoliata	NN	R	H	-	9
2b	Flooded Pasture	SN	C	H	-	6.5
3a	Actively Growing Acid Bog Areas	NN	R	H	-	9
3b	Bog Pools	NN	C	L	-	5
3c	Dry Ridges	SN	C	L	-	4
3d	Molinia Dominated Areas	SN	C	L	-	4
3e	Areas cut down to Fen- Peat or Marl	SN	C	M-L	-	4.5
4a(i)	Scirpus lacustris reedbed	NN	C	L	+	6
4a(ii)	Phragmites australis reedbed	NN	C	L	+	6
4a(iii)	Carex elata reedbed	NN	O	M	+	8
4b(i)	Carex paniculata reedbed	NN	R	M-H	+	8.5
4b(ii)	Carex nigra/Galium palustre reedbed	NN	O	M	+	8
4c	Schoenus/Molinia reedbed	NN	C	M	+	7
5	Schoenus Marsh	NN	C	M	-	6
6	Carex elata Marsh	NN	O	H	-	8
7	Coniferous Plantation	A	C	L	-	3
8a	Hazel Scrub	SN	C	L	-	4
8b	Alder Wood	NN	R	H	-	9
8c	Wet Birch Scrub	NN	R	H	-	9
9	Gorse Scrub	SN	C	L	-	4
10a	Pasture	A-SN	C	L	-	3.5
10b	Arable	A	C	L	-	3
11	Improved Wet Pasture	SN	C	M	-	5
12	Lake Floodplain Pasture	SN	C	H	-	6
13	River Floodplain Pasture	SN	C	H	-	6
14	Wet Sedge Swards	SN	C	M	-	5
15	Dry Sedge Molinia Swards	SN	C	M	-	5
16	Dry Tall Herb	SN	O	H	-	7
17	Scraw	NN	R	H	+	10
18	Carex rostrata Marsh	SN	O	L	-	6
19	River Channels and Ditches	SN	C	H	+	7

Naturalness NN = near natural, SN = semi-natural A = agricultural

Status in catchments C = common, O = occasional R = rare

Threat in catchments L = low M = moderate H = high

Rare species + = present, - = absent

rating as to their importance at local, regional and national levels was possible, their relative importance in terms of the catchments can be seen from Table IV. Those that are near-natural, threatened, uncommon and contain rare species are considered the most important.

3.2.1 Summary Description of Ecosystems, Vegetation Types and Communities

A brief description of the vegetation types and communities and the ecosystems in which they occur is given below. Numbers in brackets following communities or types mentioned in the text refer to the numbers by which they are described in Appendix 3.5.Anglicised names for plant species are taken from Keble Martin (28) and Webb (13).

I Lakes

The lacustrine ecosystem is defined as including the open water areas of the lakes themselves, their surrounding reedbeds and marshes and the winter flooded Eulittoral margins. The former lakes, now overgrown by marsh vegetation, at Ballyglass and Lough Beg in Carrowmore North Townland have also been included in the lacustrine ecosystem in this discussion. The eight lakes, all of which occur in the Annies catchment are Cloonboorhy, Carrownacon North, Carrownacon South, Frank North, Frank South, Beg, Manan and the lake at Rinaneel Townland. These are mostly calcareous, marl depositing and oligo- to mesotrophic in nature. The large lakes, Cloonboorhy, Carrownacon North and South and Frank North and South, are deep (c. 15m) with narrow Littoral margins and steeply shelving sides (see Figure 3) and are devoid of benthic (bottom) vegetation except for a narrow zone just outside the reedbeds dominated mostly by Chara species (1b). Lough Beg and the lake at Rinaneel Townland were not examined for aquatic vegetation but are probably similar in nature. Lough Manan is shallow, however, and is presently being overgrown by floating-leaf vegetation.

This sort of development is further advanced at Ballyglass Marsh where marginal vegetation has overgrown open water to form a floating mat or Scraw (17).

Four types of Reedbed communities associated with lakes were identified The Scirpus lacustris (4a(i)), Phragmites australis (4a(ii)) and Carex elata (4a(iii)) Reedbed communities are characterised by tall emergent vegetation and occur as zones on the Littoral margins of most of the lakes. The Carex

elata (4a (iii)) community also occurs south of the road bridge at Ballyglass Marsh. The fourth type, the Schoenus nigricans/Molinia caerulea (4c) Reedbed community, is similar in structure to the Carex elata (4a (iii)) community and occurs most extensively at the site of the former Lough Beg in Carrowmore North Townland. Two major types of fen vegetation, Schoenus Marsh (5) and Carex elata Marsh (6), occur behind the Reedbeds on ground flooded annually by the lakes. These are similar in their tussock form structure but differ in species composition. Schoenus Marsh is widespread, occurring mostly in the Annies catchment and can also be found in association with bogs where acid peat has been cut down to fen peat or marl. Carex elata Marsh is restricted to the margins of Cloonboorhy and Carrownacon South but is most extensively developed at Ballyglass Marsh.

The Eulittoral floodplains of Cloonboorhy, Carrownacon North and South, and to a lesser extent the two Loughs Frank, are occupied by short, often heavily grazed, sedge dominated herbaceous vegetation. These Lake Floodplain Pastures (12) occur on marly peat and have developed on the land that was exposed when the water levels of the lakes were lowered in the 1850's.

Lough Carra, due to it's larger size,shallowness and highly indented shoreline tends to have a more varied and species rich vegetation than the other lakes mentioned above. The flora of the lake and its surroundings have been the subject of numerous investigations i.e. Praeger (30) (31), Shackleton (32), Goodwillie (33), Kelly and Kirby (34), Ryan (unpublished) and An Foras Forbartha have rated it as internationally important ecologically as the largest and best example of a marl lake in Ireland. Most of the features of purely botanical interest are confined to the limestone outcrops, the woodlands (Corylo-Fraxinetum,8a) and limestone grassland (probably Antennarietum hibernicae) which occur on the islands and the upper lake shore. The grassland in particular, which is probably rarely flooded, contains many Orchids and several species which are at the northern limit of their range in Ireland. Below these communities, on marl or thin peat subject to winter flooding, extensive areas of relatively species rich Schoenus Marsh (5) occur which include such species as the Marsh Helleborine (Epipactis palustris) and the Fly Orchid (Ophrys insectifera). In more continuously wet and probably more nutrient rich sites this community is replaced by others dominated by large sedges such as Bottle Sedge (Carex rostrata), Downy Fruited Sedge (Carex lasiocarpa) or

Saw Sedge (Cladium mariscus). These communities are related to the Carex elata Reedbed type (4a(iii)) and Carex rostrata Marsh (18).

In the open water of the lake species poor Scirpus (4a(i)) and Phragmites (4a(ii)) Reedbeds occur but these are confined to the relatively sheltered western shores or the leeward side of islands or peninsulas. All the reedbeds are open and stunted due to the extremely oligotrophic nature of the marl substrate (Shackleton (32)). On exposed shores aquatic emergent vegetation is absent, the first vegetation zone consisting of a very open species poor vegetation characterised by late flowering sedge (Carex serotina), Jointed Rush (Juncus articulatus) and Shoreweed (Littorella uniflora) at approximately summer water level. The submerged vegetation is similar to but more species rich than that found in the other lakes (1b). It is however relatively restricted in occurrence as it is absent from most areas of the lake less than 2.5 metres deep due to wave action. Well developed Chara beds are only found in the few deep areas of the Lake, called Pike Holes, where they occur down to 7 metres deep. At this depth they are replaced by blue green algal mats which fade out at about 8 metres deep. Below this zone no vegetation occurs and the Profundal zone begins.

II Rivers

The riverine ecosystem includes the channels of the rivers, the drains and the lands affected by river flooding. The rivers were mostly channelised in the 1850's and their vegetation today is largely macrophytic with more slow-growing aquatic bryophyte, lichen and encrusting algal communities poorly developed. Their floodplain vegetation types are primarily influenced by high, but fluctuating, water tables and relatively high levels of nutrients, brought in as silt. Two types of Reedbed communities were found in association with the rivers. The Carex paniculata (4b(i)) community is dominated by Reeds (Phragmites australis) and large tussocks of Carex paniculata and is found on the flooded banks of the Annies River around Lough Beg and to a lesser extent around Lough Manan. The Carex nigra/Galium palustre (4b(ii)) community is also dominated by Reeds and occurs as a single large stand around the lake in Rinaneel Townland, north of Annies Bridge.

River Floodplain Pastures (13) are widespread throughout both catchments. These are usually grazed in summer and dominated by grasses such as Float Grass (Glyceria fluitans) and Creeping Bent-grass (Agrostis stolonifera). An ungrazed version, dominated by tall Yellow Flag (Iris pseudacorus) with Water Cress (Nasturtium officinals) and Marsh Marigold (Caltha palustris) is extensively developed at Kilskeagh Townland, west of Mullingar Bridge. A drier form of this vegetation, Dry Tall Herb (16), is found in scattered localities on the river banks near their outlets. This too is ungrazed and dominated by tall herbaceous plants such as Meadow-sweet (Filipendula ulmaria), Tall Fescue (Festuca arundinacea) and Reed Canary Grass (Phalaris arundinacea). It has a restricted distribution within the catchments but is most extensively developed near the outlet of the Ballyglass River in Cloondaver Townland.

Floodplain woodland is relatively rare within the catchments. The Wet Birch Scrub (8c) community is dominated by Birch (Betula pubescens), Alder (Alnus glutinosa) and Willow (Salix atrocinerea) and is structurally diverse with shrub, dwarf shrub, herb and bryophyte layers present. It only occurs around Lough Beg and along the banks of the Annies River south of the lake and intergrades to some extent with the Carex paniculata (4b(i)) Reedbed community described above. The Alder Wood (8b) community is restricted to a single stand in Carrowslattery Townland in the south of the Ballyglass catchment. It too is structurally diverse but is dominated by tall Alders and Ash (Fraxinus excelsior) with Blackthorn (Prunus spinosa) as an understorey. This wood was being felled for land reclamation during September 1981.

III Bogs

The bog ecosystem includes all remaining bogs and many of the vegetation types that have developed on reclaimed bogs. The bogs themselves are transitional between Raised Bogs and Blanket Bogs (Hammond (5)) but their distribution within the catchment is fragmentory and all have been severely disturbed by drainage and peat cutting. Five major communities were recognised on the cutaways - Actively growing acid bog areas (3a), Bog pools (3b) Dry ridges (3c), Molinia dominated areas (3d), and Areas cut down to fen-peat or marl (3e). The Actively growing acid bog areas (3a) occur only on the wettest bogs interspersed with cutaway bog pools (3b) and Dry ridges (3c). Molinia caerulea (3d) is dominant and widespread on many of the drained but unmanaged bogs. Schoenus nigricans is often

established in the areas cut down to fen-peat or marl (3e) and this community is closely related to the Schoenus Marsh (5) community described for the lacustrine ecosystem. Some of the wetter alkaline cutaways are dominated by Bottle Sedge (Carex rostrata) and Bog Cotton (Eriophorum angustifolium) which constitute the Carex rostrata Marsh (18) community.

Drained bogs have also given rise to several other vegetation types. The driest and least managed acid peat areas have frequently been invaded by Gorse (Ulex europaeus) to form the Gorse Scrub (9) community. Gorse scrub however is not confined to drained bogs and also occurs on poorly managed upland mineral soils. The more managed reclaimed bogs support three main herbaceous vegetation types, all of which are closely related and contain derivatives of the Junco acutiflori- Molinietum association (White and Doyle (12)). The Improved Wet Pasture (11) type is generally characterised by an abundance of Soft Rush (Juncus effusus), Creeping Bent-grass, and Carnation Grass (Carex panicea) and is widely distributed throughout both catchments. Wet Sedge Swards (14) contain more sedge species (Carex panicea, C. flacca, C. lepidocarpa, C. echinata, C. pulicaris) and fewer grasses and occur on cutaway peat or marly peat subject to winter flooding. This type is also widespread and is probably closely related to the Lake Floodplain Pasture (12) type described for the lacustrine ecosystem. The Dry Sedge Molinia Sward (15) type also contains an abundance of sedges but is more species rich than the Wet Sedge Swards and is frequently dominated by poor quality grasses like Purple Moor Grass (Molinia caerulea), Creeping Red Fescue (Festuca rubra) and Scented Vernal Grass (Anthoxanthum odoratum). This type occurs on the margins of drained bogs, receives less flooding than the Wet Sedge Sward type and is probably related to the Molinia dominated (3d) cutaways described above.

IV Turloughs

Turloughs are thought to be unique to the limestone areas of western Ireland. They are characterised by dramatically fluctuating water levels and drainage through underground channels and vary in the length of time they remain flooded in winter and to the extent that they dry out in summer. Seven, or possibly eight, occur in the catchments - Mountpleasant School, Slishmeen, Rathnacreeva, Ballyglass, Carrowreaghmony , Burren, Deerpark and one in Cornfield Townland. Four main plant communities were recognised - Flooded Pasture (2b) and three types of semi-permanent open water

vegetation (2a(i), (ii), (iii)). The Polygonum amphibium/Chara spp (2a(i)) community is a mixture of emergent, floating-leaved and submergent vegetation occurring in highly calcareous water and dominated by a variety of Stoneworts (Chara spp), Amphibious Persicaria (Polygonum amphibium), Floating Marsh-wort (Apium inundatum) and mosses (Calliergon giganteum, Drepanocladus revolvens). It is found in limited amounts in Slishmeen and Rathnacreeva Turloughs but is most extensively developed in Mount-pleasant School Turlough. The distribution of this community in Ireland is unknown but it may well be rare. The Carex rostrata/Glyceria fluitans (2a(ii)) community may be related to some of the River Floodplain Pasture (13) types and is probably more widespread in Ireland than the Polygonum amphibium/Chara spp community. It too contains a mixture of emergent, floating-leaved and submergent vegetation but is dominated by Bottle Sedge and some more nutrient demanding plants such as Float Grass and Water Cress. This type of vegetation is found in Burren, Deerpark and Carrowreaghmony Turloughs. The third type of semi-permanent open water vegetation, the Carex disticha/Menyanthes trifoliata (2a(iii)) community is only found in Ballyglass Turlough. This turlough is unusual, and possibly unique, in having its swallow hole at a level above that of its floor. As a result it rarely dries out completely and its vegetation is marsh-like in character bearing some affinity to the Carex rostrata Marsh (18) type.

All the turloughs are surrounded, to varying extents, by herbaceous, winter Flooded Pastures (2b). These are usually heavily grazed in summer and dominated by sedges (Carex nigra, C. panicea), Silverweed (Potentilla anserina) and Creeping Bent-grass. This type of vegetation is very characteristic of many of the turloughs in western Ireland.

V. Uplands

The upland ecosystem in this disucssion includes all non-wetland vegetation which, with the exception of the turloughs, can roughly be defined as vegetation occurring on mineral soils. About 95% of this area (3,300 ha), or 71% of the catchments as a whole, are occupied by agricultural grassland of the Centaureo-Cynosuretum typical subassociation (O'Sullivan (2)) and are primarily used as Pasture (10a) for cattle and sheep. These are generally species poor, moderate quality pastures dominated by low yield grasses such as Crested Dog's Tail (Cynosurus cristatus), Yorkshire Fog (Holcus lanatus) and Common Bent-grass (Agrostis tenuis). Arable (10b) farming, generally potatoes and barley, covers a very low percentage of the catchment area (c.1%).

Scrub woodland primarily Hazel Scrub (8a), occurs on the thinner mineral soils but has a highly fragmented distribution within the catchments. This community is usually species rich and structurally diverse with shrubs; mainly Hazel (Corylus avellana) with Hawthorn (Crataegus monogyna) and Ash, dwarf shrubs; mainly Blackthorn, herbs; mainly Wild Strawberry (Fragaria vesca), Wood Sorrel (Oxalis acetosella) and Enchanter's Nightshade (Circaea lutetiana) and bryophytes; mainly Rhytidiadelphus triquetrus and Eurhynchium striatum. The hedgerows, which form the field boundaries over most of the catchments, are probably related to the Hazel Scrub community and contain many of the same species but also include Willows (Salix spp) Elms (Ulmus glabra) and Oaks (Quercus robur, Q. petraea) amongst others.

The single Coniferous Plantation (7) in the Annies catchment is also included in the upland ecosystem because it mostly occurs on mineral soil. This is under the management of the Forest and Wildlife Service and contains monodominant stands of Norway Spruce (Picea abies), Lodgepole pine (Pinus contorta), Scots pine (Pinus sylvestris) and Sitka spruce (Picea sitchensis) together with small amounts of Ash, Alder and Sycamore (Acer pseudoplatanus).

3.3 Sites of Scientific Interest

Eight sites of scientific interest were identified in the catchments - Mountpleasant School Turlough, Ballyglass Turlough, Ballyglass Marsh, Lough Beg, Mullingar Bridge, Cloonboorhy Lough, Lough Manan and Lough Beg North in Carrowmore North Townland. These were rated as to their importance at local, regional and national levels by using the criteria and rating method described by An Foras Forbartha (6) (Appendix 3.1 and 3.2). The results of this are given in Table V. An alternative methodology was developed and applied to the selected sites in the catchments, the results of which are shown in Table VI. An explanation of the terms used in this evaluation is given in Appendix 3.3. Both assessment methods concluded the following site ratings -

Mountpleasant School Turlough	-	National Importance
Ballyglass Turlough	-	National Importance
Ballyglass Marsh	-	Regional Importance
Lough Beg	-	Regional Importance

Table V: Rating of Sites of Scientific Interest based on An Foras Forbartha criteria (Appendix 2).

	Mountpleasant School Turlough	Ballyglass Turlough	Ballyglass Marsh	Lough Beg	Mullingar Bridge	Cloonboorhy Lough	Lough Manan	Lough Beg (North)
Only area of its type	-	I*	-	-	-	-	-	-
One of a few such localities	N	N	R	R	L	-	R⊕	R+
One of a natural series	N	N	R	R	L	L	L	L
Fine example of its kind	N	?	R	R	R	L	-	L
Specialised educational importance	N	N	R	R	L	-	-	L
General educational importance	L	L	L	L	L	L	L	L
Overall rating of importance	N	N	R	R	L	L	L	L

I = in the world (International)
N = in the country (National)
R = in the province (Regional)
L = in the county (Local).

* possibly unique turlough
⊕ site of Marsh Fern (Thelypteris palustris)
\+ site of Marsh Stitchwort (Stellaria palustris)

Table VI: Rating of Sites of Scientific Interest based on selected criteria

		Mountpleasant School Turlough	Ballyglass Turlough	Ballyglass Marsh	Lough Beg	Mullingar Bridge	Cloonboorhy Lough	Lough Manan	Lough Beg (North)
1. Sites Threatened		+	+	+	+	+	+	+	+
2. Status in Ireland	(a) Rare Species	x	x	d	d	x	d	d	d
	(b) Communities	dr	?	d	d	dr	s	d	d
	(c) Site Type	dr	dr	dr	dr	dr	s	d	dr
3. Protection Status in Ireland (Number already conserved)	(a) Rare Species	x	x	0	0	x	0	1	0
	(b) Communities	1	0	0	1?	0	0	1	0
	(c) Site Type	1	0	0	1?	0	0	1	0
4. Site of Conservation Interest		+	+	+	+	+	+	+	+
5. Technically Conservable		+	+	+	+	+	+	+	+
6. Scarcity Rating	(a) Species	-	-	C	L	-	L	R	R
	(b) Communities	N?	N?	?	R?	?	?	?	?
	(c) Site Type	R	N/I	L	L/R	L	-	-	C
	(d) Geomorphological Phenomenon	R	N/I	-	-	L	-	-	-
7. Diversity	(a) Number of Species	26	37	54	72	66	106	83	81
	(b) Number of Communities	2	2	6	4	3	9	6	3
8. Close other Sites of Scientific Interest	(a) Same Communities	+	+	-	-	-	-	-	-
	(b) Same Site Type	+	+	-	-	-	-	-	-
	(c) Different Communities	+	+	+	-	-	-	-	-
	(d) Different Site Types	+	+	+	-	-	-	-	-
9. Size Rating		R	C	R	L	L	L	-	L
10. Naturalness		NN?	NN?	SN	NN?	SN	SN	SN	SN
11. Educational Potential Rating	(a) Research	N	N	R	R	L	-	-	L
	(b) General	L	L	L	L	L	L	L	L
12. Overall Site Rating		N	N	R	R	L	L	L	L

I = in the world (International)
N = in the country (National)
R = in the province (Regional)
L = in the county (Local)
C = in the catchments
SN = semi-natural
NN = near-natural

d = decreasing
dr = decreasing rapidly
s = static
+ = yes
- = no
x = not applicable
? = unknown

Mullingar Bridge	-	Local Importance
Cloonboorhy Lough	-	Local Importance
Lough Manan	-	Local Importance
Lough Beg North, Carrowmore North Townland.	-	Local Importance

3.3.1 Description of Sites of Scientific Interest

The areas given for the eight sites discussed in the following description were supplied by OPW and refer to the areas of benefiting land that would be affected if they were omitted from the drainage scheme.

(a) Mountpleasant School Turlough (Figure 7)

Area: 26.5 ha Rating: National Importance

Description: The largest of the turloughs in the catchments with particularly well developed and extensive beds of Stoneworts (Characeae) with Amphibious Persicaria (Polygonum amphibium), Floating Marsh-wort (Apium inundatum) and mosses (Calliergon giganteum, Drepanocladus revolvens and Scorpidium scorpioides). Winter flooded margins are dominated by sedges (Carex nigra, C. panicea), Silverweed (Potentilla anserina) and Creeping Bent-grass (Agrostis stolonifera) and are heavily grazed in summer.

Value: Turloughs are apparently unique to Ireland and are becoming increasingly rare due to drainage (Ryan (35) has estimated that about 70% of the areas known to contain turloughs have already been drained). Hydrological extremes of prolonged inundation in winter and near drought conditions in summer have given rise to many unusual forms of otherwise common plants. As turloughs are natural phenomena and may have existed for thousands of years their present vegetation probably constitutes an important gene pool of unusual adaptations. Although little studied they are undoubtedly

of interest to specialists both from Ireland and abroad. As an increasingly rare and threatened geomorphological feature they are also valuable at a general educational level. This particular turlough is important because of its exceptionally well developed semi-aquatic vegetation.

(b) Ballyglass Turlough (Figure 7)

Area: 5.26 ha Rating: National Importance

Description: Although relatively small in area this turlough is the only one of its type known in Ireland (Ryan (35)). It is unique in having its swallow hole at a level above that of the turlough basin and thus remains wet throughout the year. The vegetation is that of a marsh or quaking scraw dominated by Creeping Brown Sedge (Carex disticha), Bogbean (Menyanthes trifoliata), Horsetail (Equisetum fluviatile) and Common Bladderwort (Utrichularia vulgaris agg.). Relatively ungrazed, which in itself is unusual for a turlough, it floods to a high level in winter.

Value: This turlough is a unique variant of an increasingly rare and threatened geomorphological phenomenon. It's vegetation, which remains wet throughout the year, is unlike that of any other turlough known (Ryan (35)). It's swallow hole lies at the northern end of the upper rim of the turlough basin which as far as is known is a unique geological and hydrological feature. It's proximity to Mountpleasant School Turlough, to the north, and Ballyglass Marsh, to the south, makes it especially valuable as part of an important wetland complex. As such it has both general and specialised educational potential. As a unique variant this turlough must be regarded as the only known example of its kind in the world.

(c) Ballyglass Marsh (Figure 7)

Area: 24.7 ha Rating: Regional Importance

Description: Formerly a shallow lake prior to drainage in the 1850's but now supports a variety of vegetation types representing several stages in the development of fen from open water. The fen area is dominated by large tussocks of Tufted Sedge (Carex elata) and forms the largest and most well developed stand of Carex elata Marsh in the catchments (11.1 ha) and possibly one of the largest monodominant stands of this sedge in the country. Several interesting species occur amongst the fen including Saw Sedge (Cladium mariscus), Blunt-flowered Rush (Juncus subnodulosus) and Black Bog Rush (Schoenus nigricans). Open water (0.4 ha), being invaded by quaking scraw (1.6 ha), occurs north of the road bridge. Species rich Reedbeds (type 4a(iii)) (1.2 ha) with scattered Ash saplings (Fraxinus excelsior) are found south of the bridge.

Value: Although the result of previous drainage works Ballyglass Marsh is at present little grazed and in a realtively undisturbed, semi-natural condition. The diversity of stages in fen development and species richness of the area is of considerable botanical importance. The particularly fine stand of Tufted Sedge (Carex elata) and the presence of the relatively uncommon and increasingly threatened Blunt-flowered Rush (Juncus subnodulosus) are valuable features. Fens are uncommon in Ireland and the relatively large area of this one makes it important. It's proximity to Ballyglass and Mountpleasant School Turloughs adds to its importance - the three together constitute a wetland complex showing considerable diversity of habitats and species. The various stages of fen development at Ballyglass Marsh makes it valuable at both general and specialised educational levels. Proximity to the road makes the marsh particularly suitable for nature study by the general public. Although sediment depth is unknown the marsh may be of interest for paleoecological studies. The known date of change over from lake to marsh is valuable in this respect.

(d) Lough Beg (Figure 8)

Area: 29.5 ha Rating: Regional Importance

Description: A small lake (1 ha), fed by springs and on the main Annies River channel, surrounded by Mesotrophic Reedbeds (type 4b(i)) (1 ha) and Wet Birch Scrub (3 ha). This area occurs amongst a coniferous plantation owned by the Department of Fisheries and Forestry and borders a small bog to the west. High water tables and flooding by the river creates nutrient rich conditions for the Tussock Sedge (Carex paniculata) which occurs around the lake and amongst the Wet Birch Scrub. The scrub itself is dominated by Birch (Betula pubescens), Willow (Salix atrocinerea) and Alder (Alnus glutinosa) and contains the uncommon Great Spearwort (Ranunculus lingua). Undisturbed by grazing this area is relatively natural in appearance and is the only area of wet woodland of its type in the catchments.

Values: The Wet Birch Scrub type is uncommon in Ireland and decreasing through drainage and land reclamation. The protection from grazing afforded by the surrounding forestry plantation has allowed the Birch Scrub to develop in a natural manner and makes the lake and its surroundings the most natural and undisturbed area in the catchments. Particularly fine stands of Reeds (Phragmites australis), Tussock sedge (Carex paniculata) and Alder (Alnus glutinosa) with Bulrush (Typha latifolia) and the uncommon Great Spearwort (Ranunculus lingua) occur in the vicinity of the lake itself. The Wet Birch Scrub is typical of a once more widespread type of woodland. This makes it of considerable educational value both to the general public and to scientific research. The seclusion of the lake makes it a refuge for waterfowl (see specialist's report). The flooding and siltation of the Reedbeds and Wet Birch Scrub add water purification and water storage values to the area. The springs which feed the lake are

themselves of educational and hydrological value and are in fact used as rearing pens for ducks.

(e) Mullingar Bridge (Figure 9)

Area: 14.16 ha Rating: Local Importance

Description: River Floodplain vegetation, largely ungrazed, with considerable diversity ranging from river channel vegetation, Reed Canary Grass (Phalaris arundinacea) bank vegetation, Yellow Flag (Iris pseudacorus) Water Cress (Nasturtium officinale) communities, Dry Tall Herb and acid Bog Myrtle (Myrica gale) communities. Dependent upon a high water table and nutrient inputs by siltation from flooding. The most extensive, diverse and least disturbed river floodplain vegetation in the catchments. Developed on peat with evidence of former turf cutting leaving a locally undulating terrain of wetter troughs and drier ridges.

Values: River floodplain vegetation is becoming increasingly rare and threatened both in Ireland and in Europe because of drainage. This area is relatively undisturbed by grazing and supports a wide range of floodplain vegetation types. It incorporates one of the few stretches of meandering river left in the catchments. It acts as a silt depositing area and thus has a water purification value. It has both general and specialised educational importance especially in view of the decreasing frequency of such areas in Ireland. Fossil evidence in peat cores showed that the area was formerly wooded. If grazing were excluded completely trees would tend to recolonise increasing the educational and scientific value of the area. Flooding is extensive in winter and the area is used as a feeding ground for ducks and swans (see specialist's report) and as a spawning area for perch and pike (see specialist's report). It also serves as a water storage area for storm and flood waters.

(f) Cloonboorhy Lough (Figure 10)

Area: 19.8 ha Rating: Local Importance

Description: A relatively large oligotrophic, marl depositing lake (6.5 ha open water) surrounded by the most extensive and best developed lacustrine Reedbeds (types 4a(i), (ii), (iii)) (2.5 ha) in the catchments and diverse areas of Carex elata Marsh (2 ha), Schoenus Marsh (2 ha), Wet Sedge Swards (2 ha), Lake Floodplain Pasture (5.5 ha) and Improved Wet Pasture (3.5 ha). A profile of the lake (see Figure 3) shows wide Eulittoral floodplains, wide Upper Infralittoral reedbeds, narrow steeply shelving Lower Infralittoral and deep (15 m) Profundal zones. The uncommon Small Bur-reed (Sparganium minimum), Whorled Water-milfoil (Myriophyllum verticillatum), Long-stalked Pondweed (Potamogeton praelongus) and Downy-fruited Sedge (Carex lasiocarpa) occur amongst the Reedbeds and Lower Infralittoral zone surrounding the lake. The Eulittoral floodplains are heavily grazed for most of the year.

Values: The best developed and most species rich submergent and emergent lacustrine vegetation in the catchments. The presence of four uncommon plants in the Littoral zone and the unusual occurrence of Branched Bur-reed (Sparganium erectum) in deep water are valuable features. A fine example of an oligotrophic marl lake, typical of the region. Serves as a spawning and feeding area for perch and pike and a roosting area for birds (see specialists' reports).

(g) Lough Manan (Figure 8)

Area: 11.3 ha Rating: Local Importance

Description: A small shallow lake (0.5 ha) surrounded by Reedbeds (type 4b(i)), Bog and Wet Sedge Swards. The uncommon Marsh Fern (Thelypteris palustris) occurs amongst the

Reedbeds on the northern side of the lake. The neighbouring bog, to the south and west, is extremely cutover and the Wet Sedge Swards, to the north and east, are heavily grazed in summer. The lake may be fed by underground water or by springs arising to the north-east. Flooding is probably extensive in winter.

Values: Despite the relatively small area of botanical interest (1.5 ha) the lake and its surrounding Reedbeds are species rich. The Marsh Fern is now very uncommon in Ireland and is probably decreasing due to drainage. Lough Manan is its only station in the catchments.

(h) Lough Beg North, Carrowmore North Townland (Figure 11)

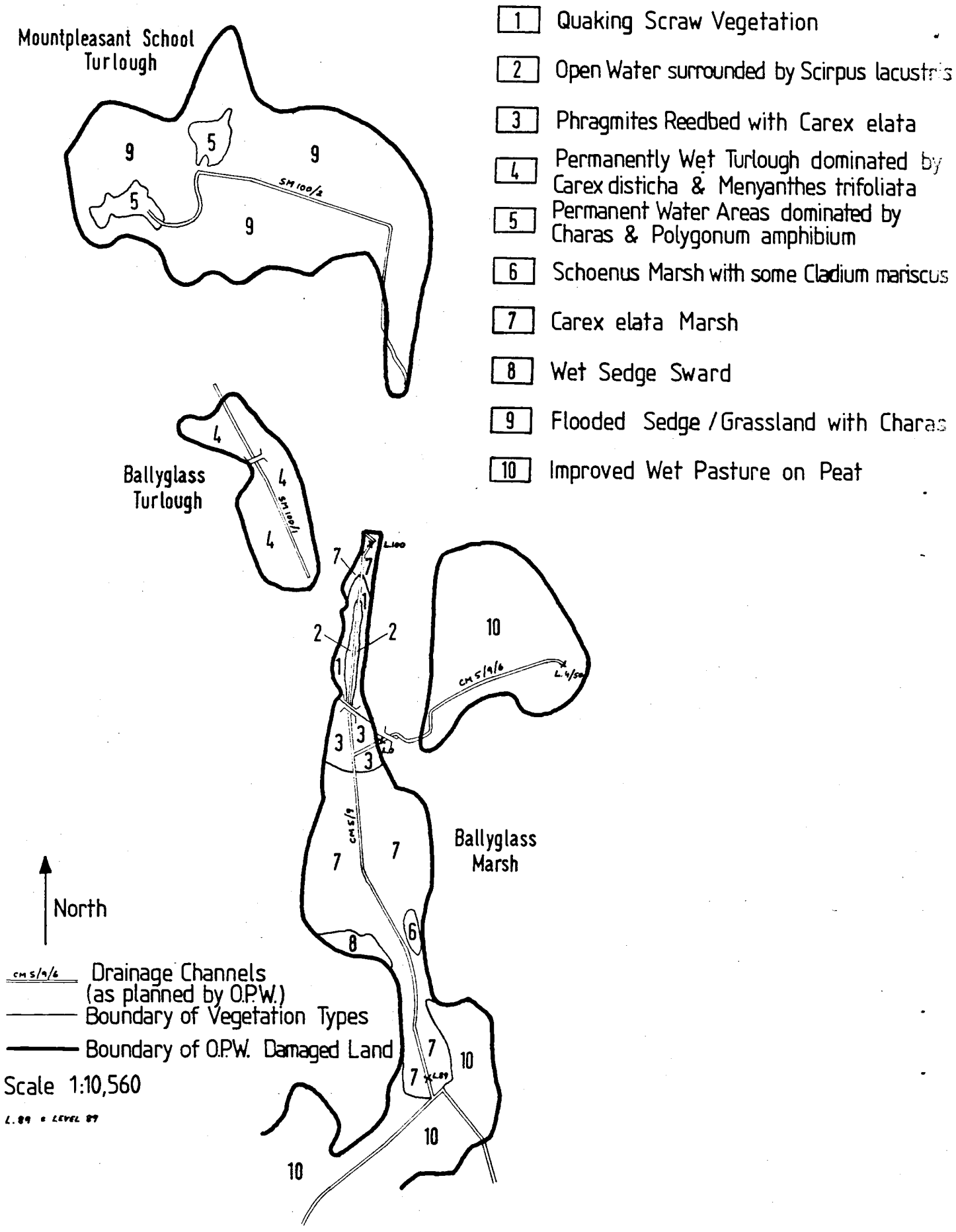
Area: 14.16 ha Rating: Local Importance

Description: This area includes 9 ha of Oligotrophic Reedbeds (type 4c) and 5 ha of Schoenus Marsh on benefiting land. Adjoining this are 30 ha of bog on partially benefiting land and 75 ha of bog on non-benefiting land. The whole adds up to the largest bog complex in the catchments. The Reedbeds were formed when Lough Beg was drained in the 1850's. This area is now dominated by Black Bog-rush (Schoenus nigricans), Purple Moor Grass (Molinia caerulea), mosses(Campylium stellatum) and poorly developed Reeds (Phragmites australis) and contains several uncommon species including Mud Sedge (Carex limosa) and Marsh Stitchwort (Stellaria palustris). The Schoenus Marsh has developed on peat cut away to marl and contains a typical calcicole fen flora. The other bog areas are extensively cut away but retain many elements of a Transitional Raised Bog flora.

Values: The lake infill at Lough Beg shows several interesting stages of fen development and contains the only known stations for the Mud Sedge and Marsh Stitchwort in the catchments. Adjoining Schoenus Marsh and partially and non-benefiting bog areas form the largest bog complex in the catchments. Variety

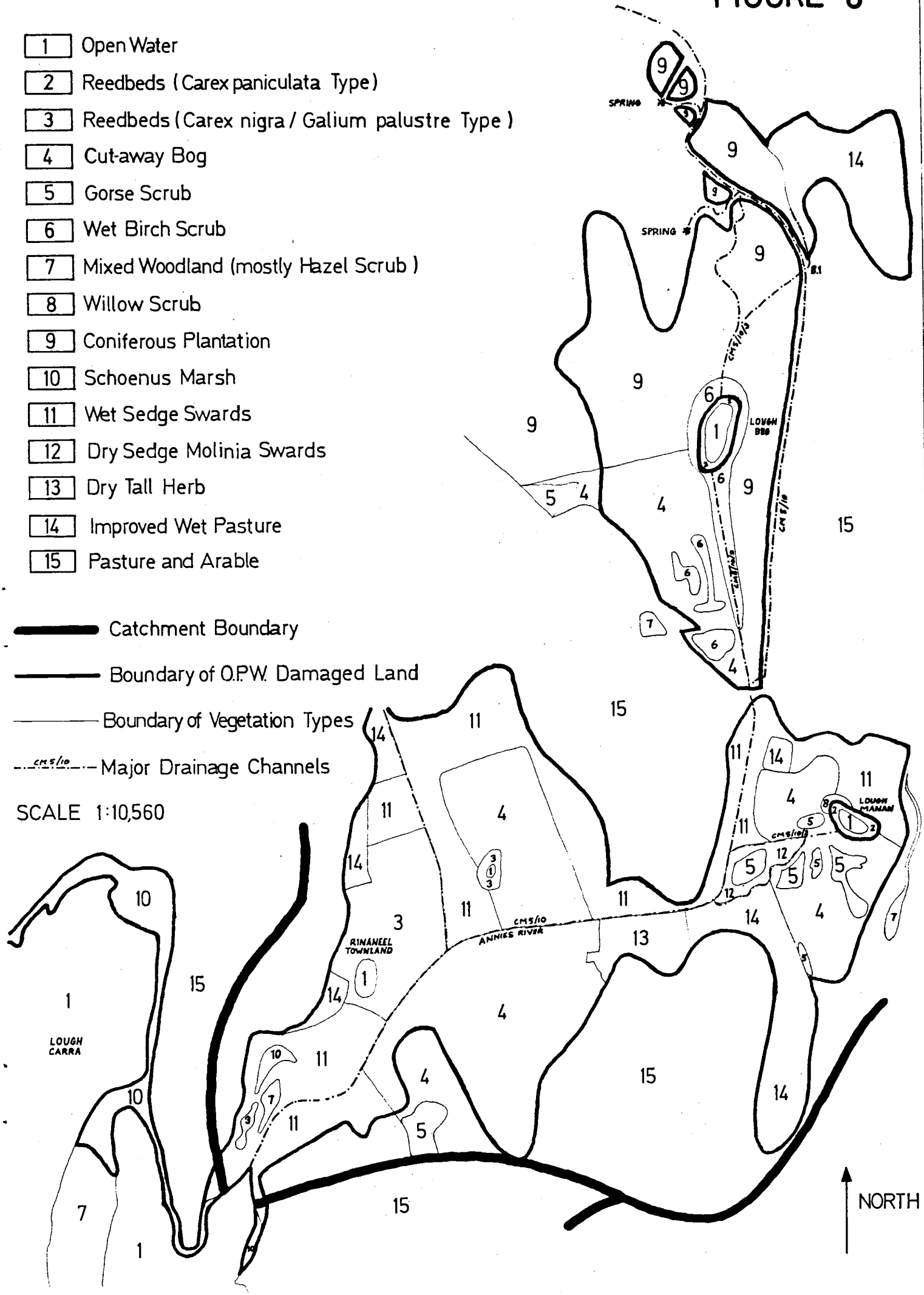
VEGETATION MAP OF BALLYGLASS MARSH & TURLOUGH AND MOUNTPLEASANT SCHOOL TURLOUGH

FIGURE 7



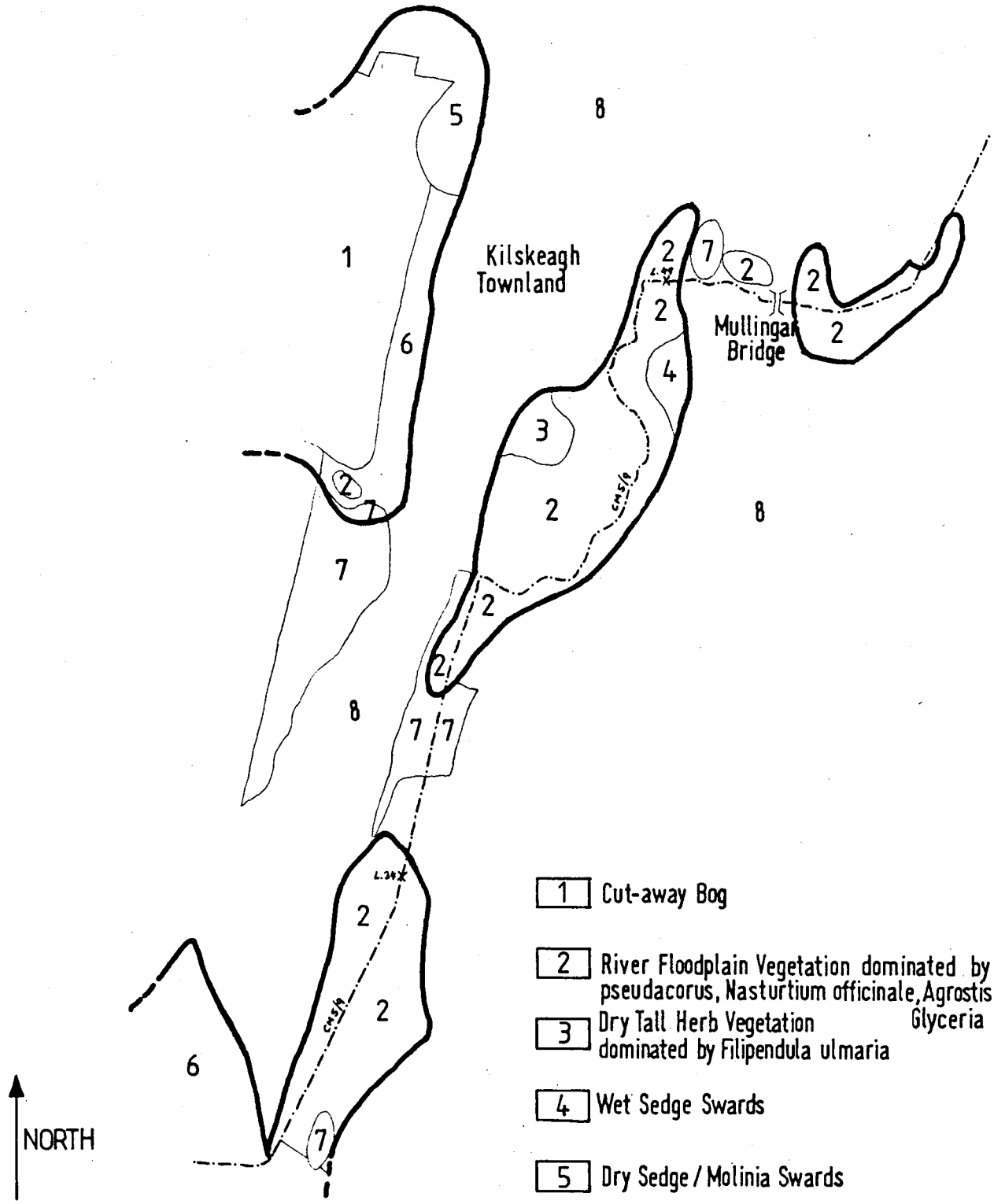
VEGETATION MAP OF LOUGH BEG AND LOUGH MANAN

FIGURE 8



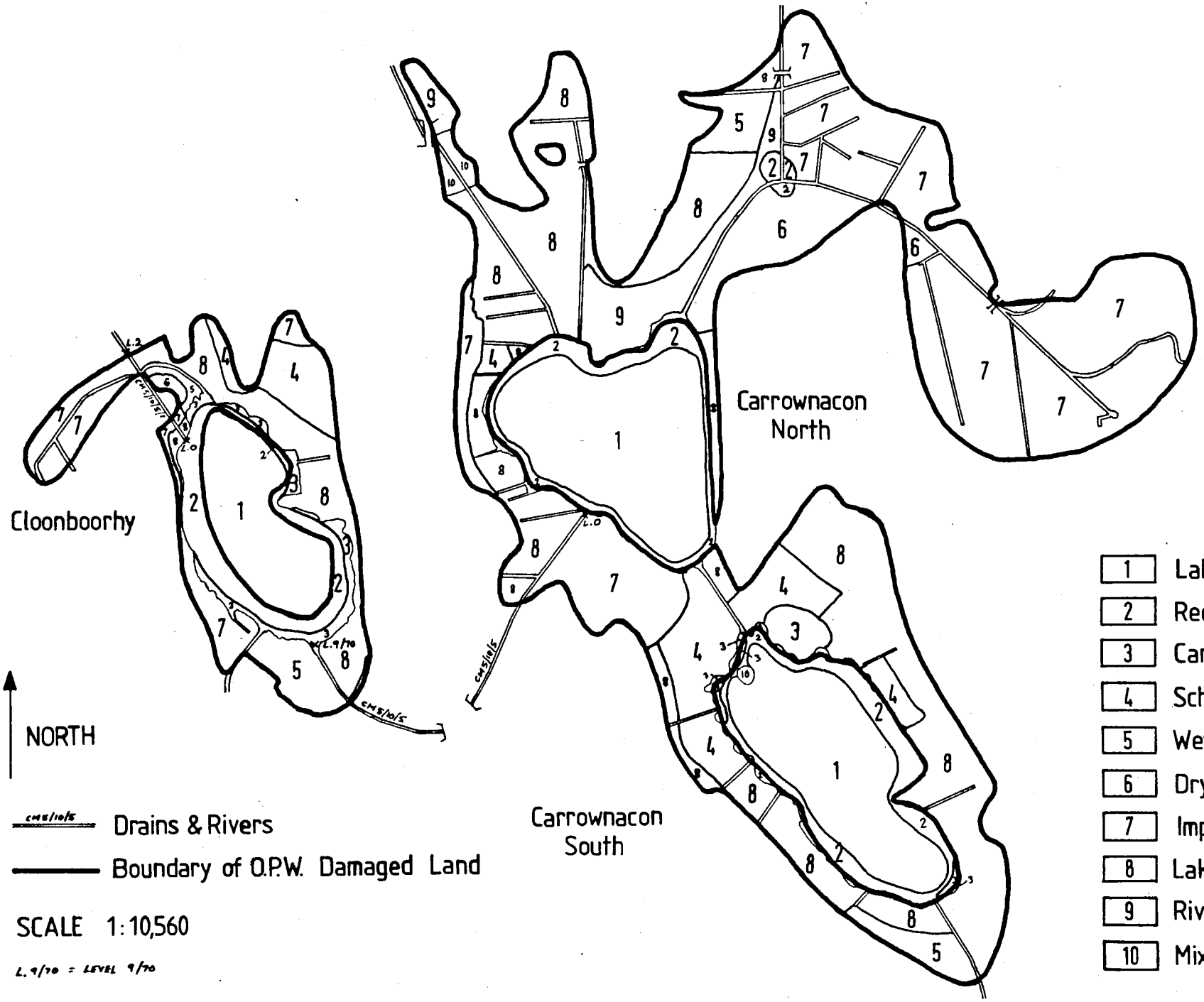
VEGETATION MAP OF MULLINGAR BRIDGE AREA

FIGURE 9



VEGETATION MAP OF CLOONBOORHY AND CARROWNACON LOUGHS

FIGURE 10



1 Lakes
2 Reedbeds
3 Carex elata Marsh
4 Schoenus Marsh
5 Wet Sedge Swards
6 Dry Sedge / Molinia Swards
7 Improved Wet Pasture
8 Lake Floodplain Pasture
9 River Floodplain Pasture
10 Mixed Woodland

CMS/10/5 Drains & Rivers

Boundary of O.P.W. Damaged Land

SCALE 1:10,560

L.9/70 = LEVEL 9/70

VEGETATION MAP OF LOUGH BEG AND CARROWMORE NORTH TOWNLAND BOG

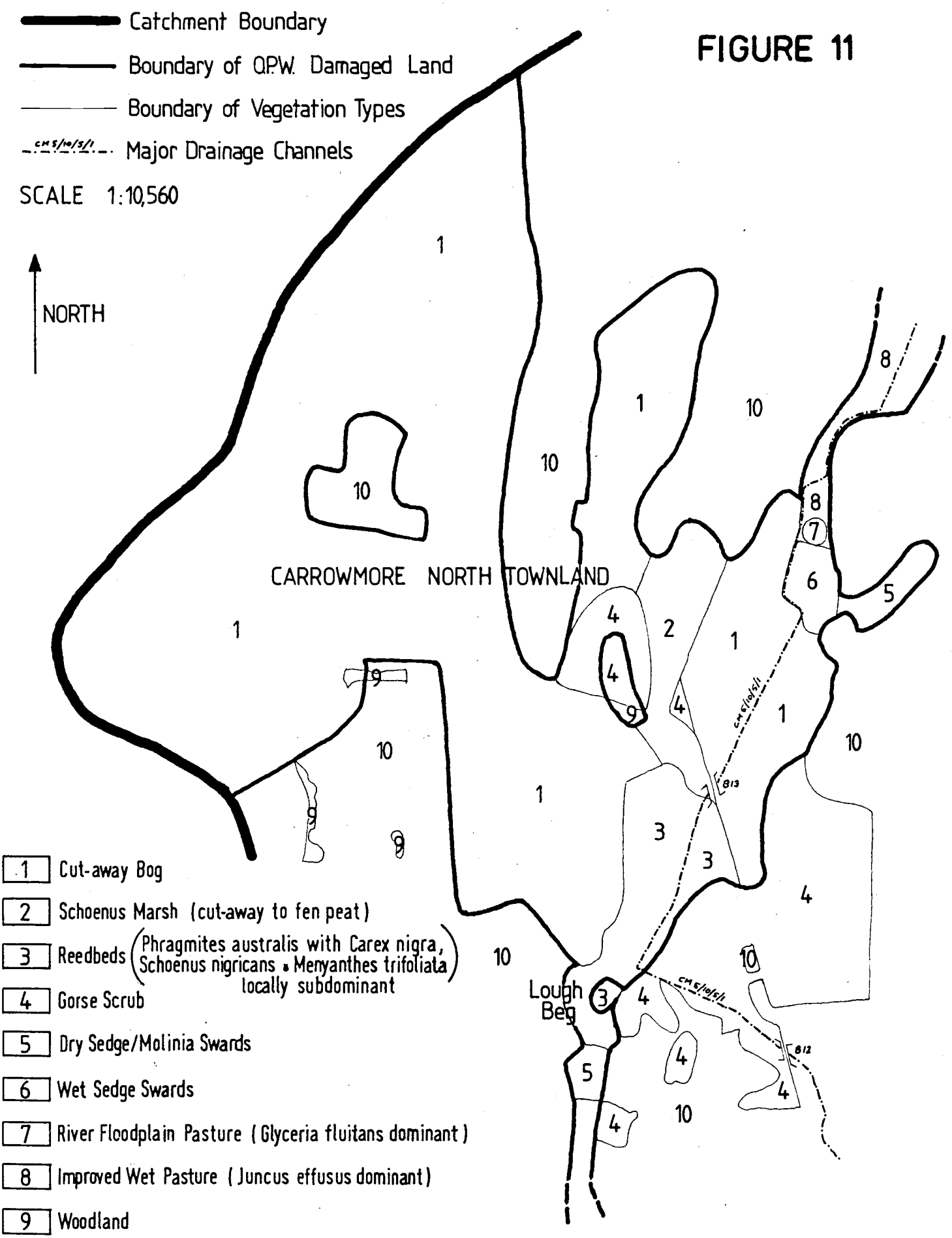


FIGURE 11

4. ESTIMATION OF IMPACTS

When estimating the likely impacts of drainage on vegetation some consideration must be given to the past trends of vegetational development. By doing this the changes in the vegetation which would occur in the absence of drainage can be taken into account when considering the impacts of the proposed drainage scheme. Consequently the following discussion has been divided into three major sections, the first dealing with historical development of vegetation, the second with its likely evolution in the absence of drainage and the third with the expected impacts of the proposed scheme. In general this discussion is based upon the vegetation types and communities of Appendix 3.5 (see Figure 5), considered under the headings of the ecosystems in which they occur. Rare species and areas of scientific interest are dealt with where appropriate. In the historical development section no attempt has been made to estimate the possible status of species now considered to be rare, although, as all are wetland plants, most were probably more widespread in the past.

In the concluding section on expected impacts a brief outline of the technical aspects of the drainage scheme is given and the net effects of the scheme on species, communities and sites of scientific interest are discussed.

4.1 Historical Development of Vegetation

4.1.1. Early Vegetational Development

During the latter part of the last Ice Age much of Ireland was covered by thick sheets of glacial ice. In the area now drained by the Annies and Ballyglass Rivers moving ice scoured the underlying Carboniferous limestone and deposited glacial till to form the drumlins and undulating topography which characterise the catchments today. With the advent of warmer conditions water became free to percolate through the newly exposed mineral soils and brought about the chemical and structural changes that initiated the formation of the present soil profiles.

Palynological evidence from several localities in Ireland suggests that Willows (*Salix spp*) and Birches(*Betula spp*) were the first trees to colonise

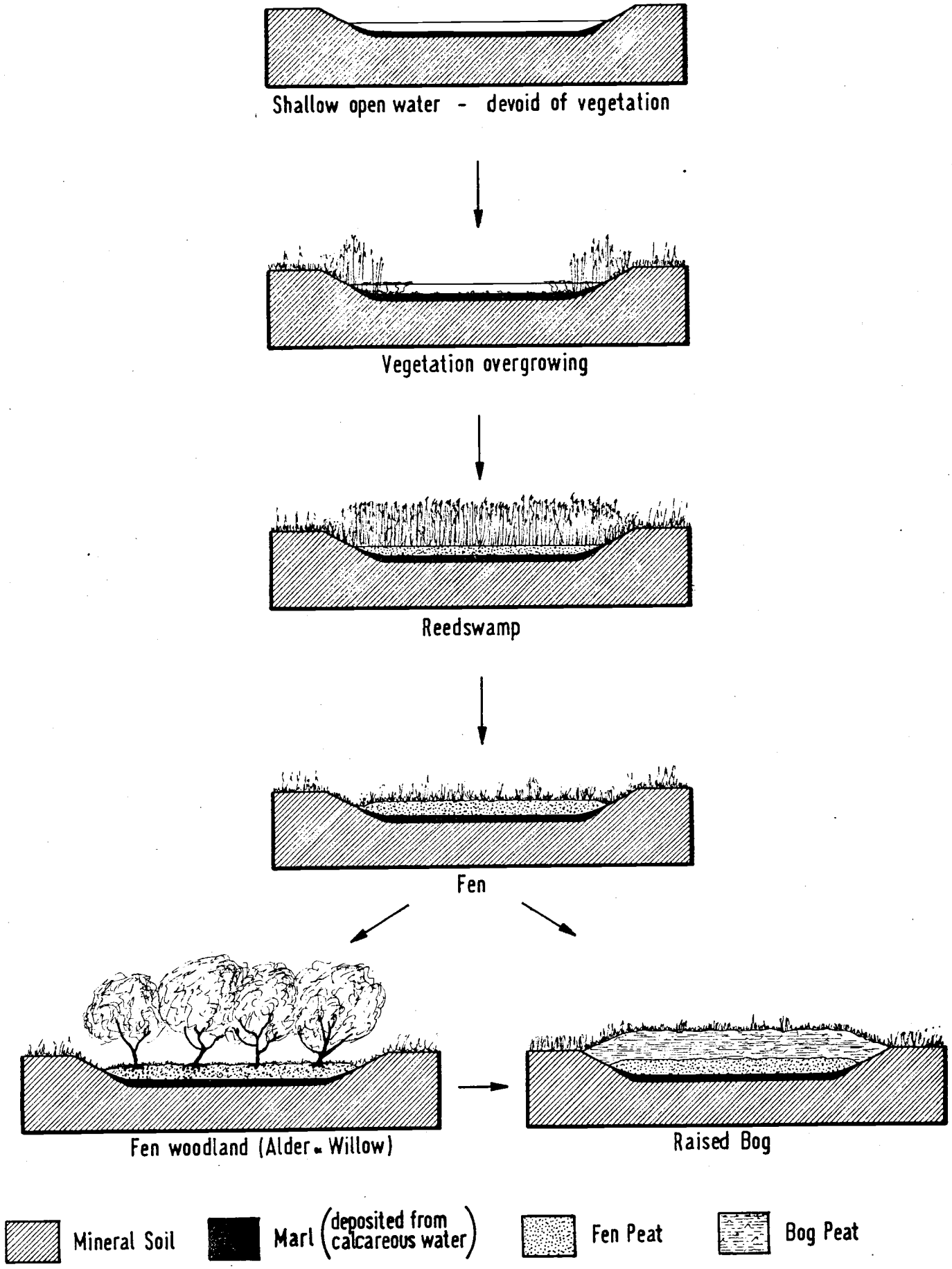
much of the country after the ice had retreated around 10,000 BP* (Mitchell (37)). As climatic conditions ameliorated many other trees became established in Ireland and by 8,000 BP it is probable that the upland soils in the Annies and Ballyglass catchments were wooded by Oaks (Quercus spp), Elms (Ulmus spp), Hazel (Corylus avellana) and possibly Ash (Fraxinus excelsior). Woodlands continued to dominate the Irish landscape until about 5,500 BP when the first Neolithic farmers began clearing the land for agriculture (Mitchell (37). When glacial ice finally melted the numerous basins and depressions in the Annies and Ballyglass catchments were probably filled with open water to form a network of lakes. Only the deeper lakes, some of which formed when limestone collapsed under the weight of over burdening ice (McCarthy (38)), have survived to the present. Many of the shallower lakes, by a combination of marl deposition, accumulation of undecomposed plant debris and siltation, became overgrown by vegetation to form reed swamps and fens. This sequence of events (Figure 12) is still in evidence in the catchments today, notably at Ballyglass Marsh and Lough Beg in Carrowmore North Townland, although in these cases the transition from open water to fen has been artifically accelerated by drainage. Peat accumulation and fen development probably also took place in low lying areas flooded by the rivers. In these situations trees may have established to form fen woodlands. Evidence that this may have taken place in the catchments was found at Kilskeagh Townland, west of Mullingar Bridge, where wood deposits were found in peat cores.

Most of the early Post Glacial fens, however, have since been overgrown by acid peat bogs. Radio carbon dating of peat cores indicates that bogs had started to form in the midlands and north of Ireland at least 7,000 years ago (Mitchell (37), Hammond (39)) and some of the bogs in the catchment may date from this time. The transition from calcareous fen to acid peat bog (Figure 12) occurs when fens, through accumulation of peat, grow above the level of the ground water table. Whilst plants on the peat surface are still in contact with nutrient rich calcareous ground water, either through direct contact with mineral soil underneath or through flooding, the vegetation will be primarily calcicole but when ground water contact is lost the peat surface becomes available for colonisation by less nutrient demanding, and more calcifuge plants and acid bog development commences.

*Before Present.

DIAGRAM SHOWING SEQUENTIAL STAGES
OF RAISED BOG DEVELOPMENT

FIGURE 12



Once initiated bog growth probably became self-perpetuating, depending only upon nutrients and water brought in by rainfall. The bogs in the Annies and Ballyglass catchments, which are of an intermediate type between midland Raised Bogs and western Blanket Bogs (Hammond (5)), have probably been growing more or less continuously since early Post Glacial times.

Little is known about the early history of turloughs. If in fact they date back to Post Glacial times some of the shallower and less frequently flooded ones may have at some stage been wooded, possibly by Alders (Alnus glutinosa). The deeper ones may have always remained free of woodland and thus their present vegetation may have developed more or less undisturbed for thousands of years. Equally little is known about the development of the rivers in the catchments. It is probable that in early Post Glacial times drainage was largely overground and that the underground channels, so characteristic of limestone geomorphology, developed through subsequent solution of the limestone.

4.1.2 Early Impacts on Vegetation

The gradual decline of Irish woodlands can be traced by the fossil record from the early attempts at land clearance by Neolithic farmers around 5,500 BP through the Bronze and Iron Age cultures to 300 AD. At this date there appears to have been a dramatic expansion of agriculture attributable to the introduction of the coulter plough (Mitchell 37)). Large areas of remaining secondary woodland were cleared resulting in the modern, relatively treeless landscape of Ireland. Only in more recent times, through the planting of exotic trees such as Beech (Fagus sylvatica), Sycamore (Acer pseudoplatanus) and Horse Chestnut (Aesculus hippocastanum) in estate woodlands during the 18th and 19th centuries and afforestation with exotic conifers in the present century, have woodlands to some extent re-emerged.

Peat bogs in the catchments have probably had a long history of disturbance by turf cutting. In many cases peat has been cut down by several metres to the fen peat or marl layers underneath. This has given rise to some of the vegetation types now found in the catchments e.g. Schoenus Marsh (Type 5), Wet Sedge Swards (Type 14).

4.1.3 Impacts of the 1850's Drainage Scheme

Wetland vegetation in the Annies and Ballyglass catchments has been greatly influenced by numerous attempts at drainage in the past. One of the most intensive drainage schemes took place during the 1850's, at a time when population density and demands upon land for agriculture were considerably higher than today. This scheme was largely responsible for the drainage network that exists at present. Some idea of what vegetation may have existed prior to 1850 was gained by examining the 1837 6-inch Ordnance Survey maps at the National Library in Dublin. The impact that the 1850's drainage work had on vegetation is discussed below in terms of the Ecosystems - Lakes, Rivers, Bogs, Turloughs and Uplands and their constituent vegetation types (see Table II). Some reference is also made to the 1931 6-inch Ordnance Survey maps and to the Vegetation Map (Figure 5). Numbers in brackets following vegetation types mentioned in the text refer to the numbers by which they are described in Appendix 3.5.

(I) Lakes

The 1837 maps show that most of the lakes in the catchments were considerably larger than they are today. The two Carrownacon lakes, Carrownacon North and South, were formerly one large lake, as were the two Loughs Frank, and Loughs Cloonboorhy, Carrownacon and Frank had at that time no natural outlets. The digging of outlets in the 1850's, in the case of Carrownacon and Frank by cutting deep into bedrock, had dramatic effects upon open water levels. Prior to drainage these three lakes, especially Cloonboorhy and Carrownacon, would have had wide shallow Littoral margins. These would probably have supported extensive Reedbeds (4a(i), 4a(ii), 4a(iii)), Carex elata Marsh and submerged aquatic vegetation. When the lakes were lowered these vegetation types would have become restricted to the relatively narrow bands where they occur today. The newly exposed lands around the margins, which were predominantly on a marly substrate and which flooded annually, subsequently became the Lake Floodplain Pasture type. The more permanently wet areas on marl between the two Carrownacon lakes and to the north-east of Cloonboorhy were colonised by Black Bog Rush to form the Schoenus Marsh type.

The smaller lakes, Lough Manan, Lough Beg and the lake at Rinaneel Townland, do not appear to have changed as dramatically as the three larger ones. Open water areas formerly occurred at Ballyglass Lough and the northern Lough Beg in Carrowmore North Townland however. These lakes were probably shallow, and when drained, were overgrown by vegetation to form the extensive Reedbeds (4a(iii), 4c) and Carex elata Marsh that occur there today. The open water levels of Lough Carra itself were not greatly affected by the drainage and it seems probable that the Schoenus Marsh that presently occurs on the Eulittoral margins existed prior to the scheme. The increased siltation which would have resulted from the drainage works possibly had an affect on the water quality, and hence the submerged vegetation, in the eastern part of the lake. How severe these affects might have been is not detectable from Ordnance Survey maps.

(II) Rivers

Prior to the drainage activities of the 1850's the Annies and Ballyglass Rivers followed more natural drainage courses. The 1837 maps show that both rivers had more meanders, especially in the slower flowing reaches towards their outlets. They may also have had more riffle and pool sequences and more gravel beds but this is not discernable from the Ordnance Survey maps. They were certainly in a less disturbed state than they are at present and may have supported aquatic bryophyte, lichen and encrusting algal communities which are very poorly developed or entirely absent from most of their lengths today.

Both rivers probably tended to flood more frequently and more extensively prior to the drainage works. If so then the vegetation types associated with river flooding such as Mesotrophic Reedbeds (4b(i), 4b(ii)), Dry Tall Herb and River Floodplain Pasture were also probably more extensive. The straightening and deepening of the river channels during the 1850's would have reduced the frequency and extent of flooding and caused a contraction of Mesotrophic Reedbeds, positional changes in Dry Tall Herb and a decrease in the amount of Floodplain Pastures. The Mesotrophic Reedbeds (4b(ii)) at Rinaneel Townland may have disappeared almost entirely as the 1931 Ordnance Survey maps show this area as Rough Grazing. The present Reedbed, which must be of relatively recent origin, probably re-established through subsequent lack of maintenance of the drainage channels. Such lack of maintenance may also have resulted in the recent expansion of Wet Birch Scrub. Prior to

1850 Lough Beg was entirely fed by springs arising to the north in Towerhill Demesne and the Wet Birch Scrub was restricted to its margins. When the outlet to the Carrownacon lakes was dug the water from these lakes flowed southward partly along a channel cut to the east of Lough Beg which joined up with the Lough Beg outflow at the Mill Bridge in Clooneenkillew Townland. This eastern channel is now disused and most of the water from the Carrownacon lakes presently flows through Lough Beg. This increased flow probably gave rise to flooding which resulted in the expansion of Wet Birch Scrub.

(III) Bogs

Although the bogs in the Annies and Ballyglass catchments probably have a long history of human interference the 1837 maps show them to have been considerably more extensive than they are today. The 1850's drainage works would have dried out many of the smaller bogs making them more available for turf cutting and more suitable for reclamation as pastures. Most of the Improved Wet Pasture shown in Figure 5 occurs on such reclaimed bogs. The larger bogs would have remained wet at their centres with only the margins tending to dry out. The driest margins were reclaimed as pastures but the partially dried ones probably gave rise to the Dry Sedge Molinia Sward type. Where turf extraction lowered the surface of peat, allowing occasional flooding, the Wet Sedge Sward type and the Carex rostrata Marsh type may have developed. Drainage of bogs must also have aided the expansion of Gorse Scrub in some areas.

(IV) Turloughs

It is difficult to assess from the Ordnance Survey maps whether the 1850's drainage works had any affect upon the vegetation of the turloughs. It is not known whether attempts were made to open the sink holes at this time but if so they were either unsuccessful or the underground water channels subsequently blocked up again. It is also not known if the semi-permanent water levels in summer, and the levels to which the turloughs flooded in winter, were affected by the general lowering of water levels which must have occurred elsewhere in the catchments.

(V) Uplands

The vegetation of the uplands, which is mostly agricultural grassland, was not directly affected by the drainage works. It is interesting to note, however, that since 1837 virtually all of the old estate woodlands have been cleared and most of the large regular fields of that time have been subdivided. Hazel Scrub, which mostly occurs on upland soils, was also probably unaffected by the drainage scheme but was probably more restricted than it is today (Mitchell (37)).

4.2 Evolution of Vegetation in the Absence of the Proposed Drainage Scheme.

The present vegetation has already been described in Section 3. The likely course of evolution of this vegetation, in the absence of the proposed drainage scheme is considered here at two possible levels of drainage and agricultural development. The first assumes that there will be no change in the present state of drainage in the catchments and that there will be no further agricultural development of existing wetlands. This is broadly speaking the assumption made by OPW in their cost/benefit analysis of the drainage scheme (Howard (41)). Under this assumption the only changes which are likely to occur in wetland vegetation are those which can be expected to take place naturally. As a large proportion of wetland vegetation is currently maintained by grazing natural development will only occur in areas which receive minimal management. The second possibility, which takes into account these possible natural changes, assumes that there will be more regular maintenance of the existing drainage channels and that piecemeal reclamation of wetlands will be carried out where possible. This seems to be the more likely possibility of the two and will be discussed here in some detail under the headings of the 5 major ecosystems (see Table II). No attempt has been made to put an accurate time scale on the events discussed but in general any changes in vegetation will be slow to occur. Where communities are naturally replaced by others, reference should be made to Table IV to gain some indication of their relative importance in terms of the catchment.

(I) Lakes

Under this assumption the existing water levels and fluctuations of the larger lakes, Cloonboorhy and Carrownacon North and South and Loughs Frank, are unlikely to change and consequently their surrounding Lower Infralittoral communities, Upper Infralittoral Reedbeds (4a(i), 4a(ii), 4a(iii)) and Eulittoral Floodplain Pastures are likely to remain. The extensive Reedbeds (4c) to the north of Lough Frank, however, are in a somewhat drier condition and are already beginning to accumulate fen peat. In the long term these Reedbeds may be replaced by Carex elata Marsh or Schoenus Marsh and if undisturbed the area may eventually be colonised by Willows to form fen woodland. Little change is anticipated in the smaller lakes except that Lough Manan, which is apparently quite shallow (Glass (40)),may in the long term be naturally overgrown by Reedbeds or fen vegetation.

Ballyglass Marsh shows several stages of development from open water to fen. The existing Scraw vegetation north of the road bridge is likely to expand to cover the remaining stretch of open water. This in turn is likely to be colonised by Carex elata Marsh, as has been the case south of the road. The present Carex elata Marsh is largely inaccessible to grazing animals and may in time be colonised by Willows to form fen woodland. The Reedbeds (4a(iii)) immediately south of the road bridge are wetter and will tend to remain longer before being replaced by Carex elata. Overall, the different sequential stages of fen development at Ballyglass are tending to accumulate fen peat. In the long term, if peat growth is permitted to continue to the point where plants on the surface lose contact with mineral groundwater underneath, this area would develop into a small raised bog. The Oligotrophic Reedbeds (4c) in the Lough Beg area of Carrowmore North Townland are currently being more intensively drained however, and if this continues these Reedbeds are likely to be replaced by Schoenus Marsh, and later by Wet Sedge Swards.

The Schoenus Marsh areas on the Eulittoral margins of Lough Carra are unlikely to change floristically if the present fluctuations in water levels are maintained.

(II) Rivers

The present extent of river floodplain vegetation types is to a small degree the result of lack of maintenance of the 1850's drainage network. If the drainage channels were more regularly maintained then some decrease in the area of floodplain vegetation types would be expected. The Mesotrophic Reedbeds (4b(ii)) at Rinaneel Townland are dependent not only upon flooding by the river but also upon the existence of a relatively high water table. If water tables were lowered by more regular channel maintenance then these Reedbeds would tend to become more sparse and open facilitating the establishment of trees. Several small Willow bushes (Salix atrocinerea) were observed growing amongst the Reedbed at present and it is likely that if undisturbed this area would develop into Willow scrub woodland with possibly some Alder and Birch. Little change is anticipated in the Mesotrophic Reedbeds (4b(i)) and Wet Birch Scrub around Lough Beg if the main channel from Carrownacon continues to flow through the lake.

The Dry Tall Herb type, which is dependent upon some nutrient input through flooding by the rivers but which requires a lower water table than the Reedbeds, would be expected to be colonised by Willows and Alders. However, no evidence that this is taking place was noted in the field suggesting that some disturbance factor, possibly fire, is in operation at present. If this disturbance factor continues to operate in the future the Dry Tall Herb vegetation will remain open. If channel maintenance reduces the extent of flooding then there may be a corresponding decrease in the extent of this vegetation type. River Floodplain Pastures might also decline for the same reasons leaving some areas available for agricultural improvement. The very wet, ungrazed floodplain areas in Kilskeagh Townland, west of Mullingar Bridge, will probably still remain however. In the long term this area may be colonised by trees, probably by Alder and Willow, but again, no evidence that this is currently taking place was noted in the field.

The small stand of Alder Wood in Carrowslattery Townland occurs on peat which is occasionally flooded. More regular drainage maintenance is unlikely to dry out the peat sufficiently for the wood to be replaced by another community. However, this area faces a more imminent threat from land reclamation as part of the wood was being felled during field work in

September 1981.

The vegetation of the river channels themselves was probably substantially altered by the drainage of the 1850's. Continued channel maintenance will eliminate the possibility of establishment of slow growing aquatic algal, bryophyte and lichen communities. Macrophyte communities which can establish more rapidly will tend to be more adaptable to regular disturbance by channel maintenance and continue to exist.

(III) Bogs

In general the remaining bog areas in the catchments will tend to dry out still further with continued drainage. Drier conditions will encourage the Ericaceous plants such as Calluna vulgaris and probably also the lichens (notably Cladonia species) but will cause the loss of Sphagnum mosses and most of the hydrophilous bog plants. Gorse Scrub, already established on many of the bogs, is likely to expand to be replaced in the long term by Birch and possibly Scots Pine (Pinus sylvestris). The development of woodland on the drier bogs will depend upon the present low grazing pressure being maintained and upon an infrequent burning regime.

The Wet Sedge Sward type usually occurs on the wetter parts of drained bogs which, as a result of peat shrinkage or more probably because of peat extraction, receive periodic inputs of nutrients by flooding from drainage channels. Should the frequency and extent of flooding decrease because of regular drainage channel maintenance then this type is likely to contract and be reclaimed as Improved Wet Pasture. Remaining areas of Wet Sedge Swards are unlikely to change floristically however if present grazing pressure is maintained. If grazing is eliminated then Willows and Alder may invade. Wet Sedge Swards may establish in areas where Carex rostrata Marsh dries out.

The Dry Sedge Molinia Sward type usually occurs on peat, frequently on the drier margins of drained bogs, and is governed by a complexity of ecological factors which are as yet imprecisely understood. It seems that this type is dependent upon relatively low water tables and low levels of nutrients (see Table III) brought in either by runoff from surrounding hills or by occasional flooding by drainage channels, or gained by direct access of plant roots to mineral soils. If water tables are lowered still further

by continued drainage of the bogs this type is unlikely to expand from its existing localities onto deeper peat areas due to lack of nutrients but may establish in other localities where peat becomes drier and where the required nutrients are available. Under continued grazing the existing Dry Sedge Molinia Swards are unlikely to change floristically but ungrazed areas could, in the long term, be invaded by Birch trees.

The Improved Wet Pasture type also occurs mostly on drained bogs but is in general not affected by flooding. If present land management practices continue there should be little vegetational change in these pastures. If peat continues to dry out there could be a slight loss of the upper peat layers through oxidation but this is likely to be a very slow process. Part of the Coniferous Plantation also occurs on peat but drying out here will probably not enhance tree growth which is apparently limited by the high pH of underlying marl (Murray (52)).

(IV) Turloughs

No floristic changes are envisaged in the turloughs if present landuse activities are continued.

(V) Uplands

Pasture and arable vegetation on the drier upland soils is unlikely to change overall if present landuse practices continue. Hazel Scrub, most of which is on mineral soil, is probably maintained at present by grazing animals and coppicing. If this pressure were removed Ash, Sycamore and possibly Beech would grow to form closed canopy woodland with Hazel as an understorey.

4.3 Impacts of the Proposed Drainage Scheme

4.3.1 Drainage Design and Implementation

The Annies and Ballyglass catchments form part of the larger Corrib Mask Drainage Scheme. According to the Cost Benefit Analysis Report for this scheme (Howard (41)) the design drainage depth is 0.75 m. In other words, lands which will achieve full benefit from the scheme will have their water

tables lowered to 0.75m below the ground surface. Of the estimated 1,166 hectares of damaged land (lands with impeded drainage) in the Annies and Ballyglass catchments approximately 800 hectares are classified by OPW as benefiting land and a further 100 hectares (mostly bog) as partially benefiting. Arterial drainage alone is expected to benefit 25% of benefiting land (200 ha). Of this 25% approximately 60% (15% of total or 120 ha) will benefit in the first year of drainage and 40% (10% of total or 80 ha) will benefit in the second year. The remaining 75% of benefiting land (600 ha) will require field drainage. It has been estimated (Howard (41)) that 55% of this remainder (41.25% of total or 330 ha) would require only perimeter drains whilst 45% (33.75% of total or 270 ha) would require both perimeter drains and under drains (pipes, tiles etc) to achieve full benefit. The rate at which full benefit is achieved will depend upon the rate at which farms enter into the scheme. In the Corrib Mask Cost Benefit Analysis Report (Howard (41)) the rate at which full benefit is achieved is predicted as follows (the inferred areas benefiting in the Annies and Ballyglass catchments are included in brackets).

Years after completion of Arterial Drainage	% of total area of benefiting land to achieve benefit	
1	15%	(120 ha)
2	35%	(280 ha)
3	45%	(360 ha)
4	55%	(440 ha)
5	65%	(520 ha)
6	75%	(600 ha)
7	88.75%	(710 ha)

The remaining 11.25% (90 ha) are not expected to achieve full benefit because some farms will not avail of the scheme. As 25% of the total area of benefiting land will benefit directly from arterial drainage this 11.25% will comprise areas that would require some form of field drainage.

The increase in density of livestock units on lands that benefit from the scheme is expected to cease growing at 2.6 l.u. per hectare. The greatest rate of increase is expected to occur in the first few years after arterial

drainage e.g. 50% of the increase in livestock density achieved over 50 years occurs in the first eight years (Howard 41)). After this time the rate of increase is expected to decline. Therefore most of the vegetation changes caused by the drainage scheme should, unless otherwise stated, occur within the first 8 to 12 years after the scheme comes into operation.

4.3.2 General Impacts

The impacts of the proposed drainage scheme can be considered in two stages, firstly the impacts of arterial drainage alone and secondly the impacts of subsequent land reclamation by scrub and woodland clearance, installation of field drains and improvement in land management practices.

4.3.2.1 Arterial Drainage

The affects of arterial drainage on vegetation can be subdivided into direct and indirect impacts. Direct impacts will be caused by the actual carrying out of arterial drainage works through dredging of channels, bank clearance and disposal of spoil and will primarily affect the vegetation of the rivers and their banks. Dredging will physically remove aquatic vegetation from the rivers and cause an increase in silting in downstream areas. Bank clearance will be necessary to allow dredging machinery access to the rivers and will cause damage to bank vegetation by the removal of obstructing trees and shrubs. The disposal of spoil from dredging, either by spreading on surrounding lands or by mounding into ridges on the river banks, will destroy vegetation and cause long term alterations of soil chemistry and structure. All of these impacts can be regarded as semi-permanent if regular maintenance of arterial drains is carried out.

Indirect impacts will result from deepening and widening river channels, straightening river courses and levelling and smoothing river beds to eliminate obstacles. These activities will cause an overall lowering of water tables in neighbouring wetlands and the elimination of flooding. This in turn will affect wetland vegetation, most especially the aquatic, semi-aquatic and seasonally flooded vegetation types. Opening swallow holes in turloughs will probably eliminate flooding and result in the loss of characteristic turlough vegetation. Regular maintenance will permanently exclude any possibility of a return to high water tables and flooding.

4.3.2.2 Land Reclamation

Land reclamation will take place by clearance of woodland and scrub (where necessary), installation of field drains and improvement of land management practices. The impacts of these activites, although important in themselves, can be regarded as secondary as they will generally act upon the drier vegetation types resulting from arterial drainage. Where woodland and scrub clearance takes place the impact on vegetation will be major and direct. The impacts of field drainage, however, will be both direct and indirect. The direct impacts will be caused by the physical disturbance of vegetation during the installation of pipes and tiles. Indirect impacts will result from the decreased waterlogging of the soils and will cause a decline in hydrophilous plants. Once land has been drained improved land management practices, through ploughing and reseeding, will completely change the composition, structure and relative abundances of species in the vegetation.

Any vestiges of wetland vegetation can be expected to have been removed at this stage. Subsequent use of fertilisers will improve productivity, encourage vigorous growing grasses and clovers and permanently exclude the original species. Widespread use of fertiliser may lead to an increase in plant nutrients in water courses and lakes. This tendency may be exacerbated by the anticipated increase in livestock density and may lead to changes in aquatic vegetation. The use of herbicides for maintenance of drains would also have a major impact on aquatic vegetation.

4.3.3 Specific Impacts

Specific impacts of the drainage scheme are considered under the headings of Species, Vegetation Types and Communities and Sites of Scientific Interest.

4.3.3.1 Impacts on Species

The impacts on species were estimated by examining their ecological behaviour, using Ellenburg (9), White and Doyle (12) and Webb (13) and their known distribution within the catchments. Of the total 371 species recorded, 30 can be expected to expand their range due to drainage,

163 remain unaffected, 165 decline, 6 possibly become extinct and 7 almost certainly become extinct from the catchments. These are listed in Appendix 3.4. The possible and probable extinctions are listed separately below.

Possible Extinctions	Probable Extinctions
Splachnum ampullaceum	Sparganium minimum*
Ranunculus lingua*	Thelypteris palustris*
Ranunculus trichophyllus	Stellaria palustris*
Drosera anglica	Carex limosa*
Pinguicula lusitanica	Carex dioica
Oenanthe fluviatilis*	Eleocharis quinquiflora
	Philonotis calcarea

Those marked with an asterisk are considered under Section 3.1.1. as rare or threatened species. It is not considered likely that any native species new to the catchments will become established because of the drainage scheme.

4.3.3.2 Impacts on Vegetation Types and Communities

The impacts on vegetation types and communities were estimated by comparing their known ecological requirements (Table III) and their known distribution (Figure 5) with the areas expected to benefit from the drainage scheme (OPW). These are discussed below under the headings of the 5 major ecosystems (see Table II). In general the impacts under discussion are those of arterial drainage. It can be assumed that any subsequent land reclamation will completely destroy wetland vegetation in favour of agricultural grassland. Where possible the approximate areas of vegetation types and communities affected are given in hectares. A summary table (Table VII) showing the areas of vegetation types (a) probably affected, (b) possibly affected and (c) unaffected is given at the end of the section. Where vegetation types are likely to disappear from one area but may re-establish in another an attempt has been made to estimate the area of re-establishment.

(I) Lakes

In Cloonboorhy and the Carrownacon lakes flooding will be eliminated and the summer water levels dropped by approximated 0.3 m. and 1 m. respectively. This will cause the loss of their surrounding Lake Floodplain Pasture (35 ha), Schoenus Marsh (8 ha) River Floodplain Pasture (3.5 ha) and Wet Sedge Swards (6 ha). These areas, if not further reclaimed may be replaced by Improved Wet Pasture or Dry Sedge Molinia Swards. In the Carrownacon lakes the Upper Infralittoral Reedbeds (4a(i), 4a(ii), 4a(iii)) (5 ha) and Carex elata Marsh (2 ha) may be almost entirely lost or perhaps restricted to a narrow band on the steeply shelving Lower Infralittoral zone (see Figure 3). In Cloonboorhy these types will contract to occupy much narrower zones than they do at present and much of the Carex elata Marsh (2.5 ha) may be lost to be replaced by Schoenus Marsh. In the smaller lakes, Loughs Frank, Manan, Beg and the lake at Rinaneel Townland drops in the water table will result in the loss of Reedbeds (8 ha). At Loughs Frank, which have a similar bottom profile to the larger lakes (McCarthy (38)) and where Reedbeds (4a(i), (ii), (iii), 4c) are extensively developed, drainage will restrict them to the present narrow Lower Infralittoral zone. The profiles of Lough Beg and the Rinaneel Townland Lake are not known and here Reedbeds may simply re-establish at a lower level. Lough Manan, however, is known to be shallow and open water (0.5 ha) may be lost entirely to be replaced by Reedbeds or fen vegetation.

In general the submerged and floating-leaf vegetation of the Lower Infralittoral will respond to drainage by becoming established at a lower level than at present. However if the lakes become more eutrophic, due to the increased fertilizer use associated with the drainage scheme, light penetration will decrease due to increased plankton crops and the Lower Infralittoral vegetation will be restricted to relatively shallow water. In this respect it is worth noting that the decreased depth and volumes of the lakes will make them more susceptible to eutrophication.

At Ballyglass there will be a large drain over 1m deep running north to south through the Scraw, Reedbeds and Carex elata Marsh. This will effectively accelerate the successional stages of fen development in the area. There will be a loss of open water (0.5 ha) from the Scraw

area north of the road bridge and a replacement of the Scraw itself (1.5 ha) by Reedbeds or Carex elata Marsh, depending upon how low water levels are dropped. Such an area may prove to be unmanageable for agriculture and may eventually be invaded by Willow and Alder scrub.

South of the road bridge the Reedbeds (4a(iii)) (1 ha) will be lost and in turn be replaced by Carex elata Marsh and scrub woodland, assuming no further human interference. The Carex elata Marsh itself (11 ha) will dry out and would if undisturbed be invaded by scrub. However, as it is likely that some attempt will be made to reclaim this area after drainage scrub development will probably not be allowed to take place. The extremely uneven topography and soft marl substrate will mean that considerable inputs, in terms of mechanical levelling, fertiliser applications and careful management practices, will be required for this land to be made productive for agriculture.

With a lowering of the water table the Oligotrophic Reedbeds (4c) (9 ha) in the Lough Beg area of Carrowmore North Townland will disappear to be replaced temporarily by Schoenus Marsh. This in turn, if unmanaged, could be colonised by Willows or Birch woodland. If reclaimed and fertilized, however, this area could support a species poor pasture.

At Lough Carra there will be a reduction in the extent of water level fluctuations due to the drainage scheme. The summer water level will be maintained but the winter levels will be reduced by about 45 cms. This is likely to significantly reduce the extent of the Eulittoral Schoenus Marsh which will tend to be replaced at its upper edge by limestone pasture, on marly soils, or by Dry Sedge Molinia Swards, on peat. If fertilised both of these would be converted into species poor grassland. It is not considered likely that the Reedbeds would be effected as the summer water level will not be changed. However the lowering of the winter water level would expose the submerged vegetation to increased turbulance by winter storms and could possibly restrict the area in which it now occurs. If at the same time the lake was to become more eutrophic the decreased light penetration would restrict the growth of submerged vegetation to shallower water. The net effect of the operation of these two factors would be a severe reduction in the submerged vegetation of the lake. It is worth noting that the International rating given to

Lough Carra (An Foras Forbartha (6)) as the largest and best of the marl lakes in Ireland, which by their nature tend to be oligotrophic, would be reduced to a national or even regional rating if the lake were to become eutrophic.

(II) Rivers

The impact of the drainage scheme on the vegetation of the rivers themselves will vary depending largely upon how much bed levels are lowered and upon the depth and flow of water in the channels. In some areas, especially near the rivers' outlets, the increase in water depth and flow may be sufficient to eliminate aquatic vegetation altogether but in others macrophyte communities may re-establish after the initial drainage works have been completed. Regular maintenance of the drainage channels will however exclude the possibility of the long term development of aquatic bryophyte and lichen communities and some of the more slow growing algae. The loss of riffle and pool sequences may cause the disappearance of plants that require fast flowing, well oxygenated water such as the moss Rhychostegium riparioides. In general terms, however, because the present drainage network has been so greatly influenced by previous drainage schemes the impact of the proposed scheme on the aquatic vegetation of the rivers is not considered serious.

The impact on the terrestrial vegetation types associated with the rivers, which are dependent upon high water tables or periodic flooding or a combination of both, will however, be more dramatic. The affect of the arterial drainage will be to lower water tables and eliminate flooding. In consequence the Mesotrophic Reedbeds (4b(i)) around Lough Beg (1 ha) will decline. The Tussock Sedge (Carex paniculata) associated with these Reedbeds may persist for some time but will eventually be overgrown by Birch from the surrounding woodland. The Wet Birch Scrub itself (3 ha) will become drier and although the Birch trees may be expected to survive, the understorey and ground flora will change to a drier type. As the area becomes drier it is more likely to be planted with conifers. The Mesotrophic Reedbeds (4b(ii)) in Rinaneel Townland (8 ha), north of Annies Bridge, may become restricted to the wetter margins of the lake. As the Reedbeds dry out they can be expected to be reclaimed for pasture.

The Dry Tall Herb (11 ha) and River Floodplain Pasture (55.5 ha) types,

which are dependent upon relatively high water tables and occasional flooding, may almost entirely disappear from the catchments. Some isolated patches of River Floodplain Pasture (total 9 ha) occur in areas which are not due to be drained by the proposed scheme and consequently are likely to remain. After drainage the areas formerly occupied by Dry Tall Herb and River Floodplain Pasture are likely to be reclaimed for pasture.

The Small Alder Wood (1 ha) in Carrowslattery Townland, if drained, might eventually be replaced by Ash, Sycamore or Beech woodland. If cleared, however, the peat substrate would be suitable for pasture.

(III) Bogs

Arterial drainage will effectively speed up the decline of the remaining bogs in the catchments. Of a total 340 ha of bog, approximately 115 ha are expected to fully benefit, and a further 100 ha to partially benefit from this scheme. These figures however, do not reflect the total area of bog that is likely to be affected, as many of the non-benefiting bogs are actually part of or directly adjoin bogs that will be drained. A bog system is a hydrological unit and the draining of any one part of it is bound to affect the rest. In reality a large proportion of the bogs in the catchment will be affected by the drainage scheme. Those which do not have arterial drains running directly across them will tend to dry out more slowly and if unmanaged may be invaded by Gorse Scrub and Birch woodland. The more intensely drained bogs will dry out more rapidly and will probably be reclaimed for pasture. Much of the Gorse Scrub (51 ha), which often occurs on bogs, will be cleared as part of land reclamation. The many areas of Schoenus Marsh (12 ha) that occur in association with bogs will also disappear to be reclaimed for pasture. Carex rostrata Marsh (4 ha), if drained, would follow the same pattern but as most of this type is not due to be drained it should remain unaffected.

Most of the Wet Sedge Swards (103 ha) and Dry Sedge Molinia Swards (45 ha) will also be drained and reclaimed for pasture. However these types may re-establish to a limited extent on other drained bogs that are not reclaimed if suitable niches become available. Improved Wet Pastures (308 ha) may be expected to dry out and may be further improved in many cases by the installation of field drains and the elimination of the Soft

Rush (Juncus effusus). Improved drainage would normally enhance tree growth in the Coniferous Plantation but as underlying marl appears to be the limiting growth factor the benefit from drainage will actually be marginal.

(IV) Turloughs

Three of the eight turloughs (Slishmeen, 18 ha, Mountpleasant School, 26 ha and Ballyglass, 5 ha) are due to be drained. If drainage is successful flooded and semi-permanent water areas and their associated vegetation types will disappear entirely to be replaced by pasture which could support grazing animals all year round. Although the other five turloughs (Rathnacreeva, 19 ha, Deerpark, 4 ha, Burren, 1 ha, Carrowreaghmony, 4 ha and the turlough in Cornfield Townland, 0.5 ha) are not due to be drained directly they may well be affected by the general lowering of water levels elsewhere in the catchments. If so they may either decrease in area or be eliminated altogether.

(V) Uplands

The vegetation of the upland areas will not be directly affected by the drainage scheme. Hazel Scrub (12 ha) on mineral soil, if cleared, may support a dry limestone grassland or if allowed to develop undisturbed may be replaced by Ash dominated woodland.

The areas in Table VII which are classed as 'probably affected' occur on benefiting land and in most cases their present vegetation will be lost in favour of agricultural grassland. The notable exceptions to this are the 0.9 hectares of open water which will be lost in favour of possibly Reedbeds and the 29.5 hectares of Coniferous Plantation which should largely remain unchanged. The 'possibly affected' areas include the remaining turloughs, which may or may not be affected by the drainage of surrounding wetlands, Bogs and Gorse Scrub classified by OPW as partially benefiting (114.1 ha) and Bogs and Gorse Scrub which are part of or directly adjoin bogs which are going to be drained (39.5 ha). Improved Wet Pasture, Wet Sedge Swards and Dry Sedge Molinia Swards may re-establish on bogs and lake margins that are not reclaimed but the extent of the areas involved are not possible to calculate. The Reedbeds around Lough

Table VII Areas of Vegetation Types Affected or Unaffected by the Proposed Drainage Scheme

Vegetation Type	Total Area	Area Probably Affected	Area Possibly Affected	Area Unaffected	Area of Possible Re-establishment
1. Lakes (Open Water)	33.5	0.9 (2.7%)	-	32.6 (97.3%)	-
2. Turloughs	77.3	48.8 (63.1%)	28.5(36.9%)	-	-
3. Bogs	340.85	115.4 (33.9%)	136.0(40%)	89.4 (26.1%)	-
4. Reedbeds	40.87	39.97(97.8%)	-	0.9 (2.2%)	0.9
5. Schoenus Marsh	22.78	22.18(96.9%)	-	0.6 (3.1%)	9.3
6. Carex elata Marsh	15.0	15.0 (100%)	-	-	2.2
7. Coniferous Plantation	55.8	29.5 (52.8%)	-	26.3 (47.2%)	-
8. Hazel Scrub & Mixed Woodland	135.0	15.0 (1.1%)	-	120.0 (98.9%)	-
9. Gorse Scrub	51.0	8.5 (16.7%)	17.6(34.5%)	24.9 (48.8%)	
10. Pasture & Arable	3298.62	-	-	3298.62(100%)	-
11. Improved Wet Pasture	308.2	280.8 (91.1%)	-	27.4 (8.9%)	
12. Lake Floodplain Pasture	36.4	36.4 (100%)	-	-	-
13. River Floodplain Pasture	55.6	46.0 (82.7%)	-	9.6 (17.3%)	-
14. Wet Sedge Swards	103.58	88.56(85.5%)	-	15.02 (14.5%)	
15. Dry Sedge Molinia Swards	45.2	35.6 (78.7%)	-	9.6 (21.3%)	
16. Dry Tall Herb	10.9	10.9 (100%)	-	-	-
17. Scraw	1.6	1.6 (100%)	-	-	-
18. Carex rostrata Marsh	3.8	0.9 (23.6%)	-	2.9 (76.4%)	-
19. Rivers and Drains	?	?	?	?	?
Catchment Area	4636.0	796.01	182.1	3657.89	?
(Percentage of Catchment)	(100%)	(17.2%)	(3.9%)	(78.9%)	?
Damaged Land Area	1166.18	796.01	182.1	188.07	
(Percentage of Damaged Land)	(100%)	(68.2%)	(15.6%)	(16.2%)	?

Areas are given in hectares

Manan and the Scraw area to the north of Ballyglass Marsh (total 2.2 ha) may be replaced by Carex elata Marsh. The Reedbeds at Lough Beg in Carrowmore North Townland (9.3 ha) may be temporarily replaced by Schoenus Marsh prior to reclamation.

The figures in brackets in Table VII show the area of the vegetation types as a percentage of the total area of the type. It should be borne in mind that according to the Corrib Mask Cost Benefit Analysis Report (Howard (41)) 11.25% of benefiting land is not expected to achieve full benefit through farmers not availing of the drainage scheme. Thus, of the 796 hectares of benefiting land in the Annies and Ballyglass catchments approximately 90 hectares can be expected not to benefit fully. The distribution of these 90 hectares is a matter of conjecture but because arterial drainage alone will have major impacts on most vegetation types this 11.25% does not mean that 90 hectares will be entirely unaffected by the scheme.

4.3.3.3. Impacts on Sites of Scientific Interest

(a) Mountpleasant School Turlough (Figure 7) Rating: National Importance

Although an attempt will be made to drain this turlough it is not certain that it will succeed (Thornton (42)). If successful the scientific interest of the area would be lost entirely. If partially successful i.e. still floods but water drains away more quickly, then the extensive Chara beds (type 2a(i)) of the semi-permanent water area are likely to be lost. This would reduce the site rating from national to local or only catchment importance. In the unlikely event of complete failure the scientific interest of the site would remain unchanged.

(b) Ballyglass Turlough (Figure 7) Rating: National Importance

As for Mountpleasant School Turlough it is not certain whether attempts to drain this area will be entirely successful. However, at the very least this turlough will dry out more in summer after drainage and thus its main distinguishing character, the swamp-like nature of the vegetation of the turlough floor (2a(iii)),will be lost. This would reduce its rating from national importance to insignificant.

(c) Ballyglass Marsh (Figure 7) Rating: Regional Importance

The drainage of Ballyglass Marsh has already been discussed in the previous section. The result of drianage and reclamation will be the complete loss of open water and Scraw vegetation from north of the road bridge and the loss of most of the Reedbeds (4a(iii)) and Carex elata Marsh to the south. The areas now occupied by open water, Scraw and Reedbed may prove to be unmanageable and may in time be replaced by wet woodland. Although wet woodland is rated more highly as a community than the types it may replace (see.Table IV) the overall diversity of the area would decline. In any case such woodland is likely to be more uniform and more species poor than the present woodland at Lough Beg. Thus the rating of Ballyglass Marsh would drop from regional to probably insignificant.

(d) Lough Beg (Figure 8) Rating: Regional Importance

The summer water level of this lake will be lowered by approximately 0.3m and much of the flow of the river running through it will be diverted to the east of the woodland. The lowering of the water level will lead to increased encroachment of the Reedbeds (4b(ii)) on the open water area although without knowing the morphology of the lake it is impossible to say to what degree this will happen. The decrease in water fluctuations and flooding will lead to decreased nutrient inputs and to acidification of the terrestrial vegetation. Thus the Carex paniculata Reedbeds will be replaced by a narrower zone of Phragmites Reedbeds (4a(ii)) and the Wet Birch Scrub ground flora will tend to become more acid. This will probably cause the loss of Ranunculus lingua from the area. Acid Birch woodland is more common than the present mesotrophic woodland and thus even without any forestry or agricultural follow up to drainage the rating of this site will drop from regional to local or less. If this area is recliamed for grassland or planted with conifers the site rating would drop to insignificant.

(e) Mullingar Bridge (Figure 9) Rating: Local Importance

Drainage, with loss of flooding and a lowering of the water table, followed by agricultural development would completely change the vegetational and geomorphological interest of the area and would reduce the site rating from local to insignificant. The water purification capacity of the area would be lost.

(f) Cloonboorhy Lough (Figure 10) Rating: Local Importance

The impact of drainage at this site has to some extent already been discussed in the previous section. In addition to the loss of a large area of its floodplain vegetation types and the restriction of its emergent Reedbeds and Carex elata Marsh, the Small Bur-reed (Sparganuim minimum) is likely to become extinct. However, as much of the interest of this site is focused on its aquatic and semi-aquatic vegetation the overall site rating would only be slightly decreased from local to catchment importance. If the summer water levels were lowered by more than 0.6 m the Reedbeds would almost entirely disappear and its site rating would then drop to insignificant.

(g) Lough Manan (Figure 8) Rating: Local Importance

The decrease in the level of Lough Manan will almost certainly eliminate the Marsh Fern (Thelypteris palustris) and with it the main reason for its local site rating. If there is any standing water left the Reedbeds (4b(i)) may re-establish on the bed of the lake. The surrounding Wet Sedge Swards and bog will dry out and may be replaced by Improved Wet Pasture, Gorse Scrub or Birch woodland. If reclaimed, however, all botanical interest of the site would be lost.

(h) Lough Beg North (Figure 11) Rating: Local Importance

Drainage of this area has also been discussed in the previous section. A lowering of the water table and elimination of flooding will cause the extinction of the Mud Sedge (Carex limosa) and Marsh Stitchwort (Stellaria palustris) from the catchments. If unreclaimed the area may develop into acid Birch woodland which, due to its size, may be of importance in terms of the catchment in the long term. If reclaimed, however, all scientific

interest in the site would be lost.

4.3.3.4 Summary of Net Effects of the Drainage Scheme

(a) Species

It was considered in Section 4.3.3.1 that the proposed drainage scheme would be responsible for the possible extinction of 13 species from the catchments, 4 of them thought to be rare (see Table 1). However, taking into account the likely evolution of vegetation in the absence of drainage (Section 4.2) 5 of these species would probably become extinct despite the proposed scheme. These are listed as follows -

Drosera anglica
Pinguicula lusitanica
Stellaria palustris
Carex limosa
Thelypteris palustris

The first 2 are associated with bogs and the main cause of their likely extinction is the continued drainage of their habitat. The second pair are found at Lough Beg North in Carrowmore North Townland and here again the main cause of their decline is existing drainage. Thelypteris palustris only occurs around Lough Manan and as this lake is likely to be overgrown naturally by vegetation in the long term so this species too will become extinct. However, it must be stated that the proposed drainage scheme will considerably accelerate the disappearance of all 5 of these species from the catchments.

The remaining 8 species are listed below -

Ranunculus lingua*
Ranunculus trichophyllus
Oenanthe fluviatilis*
Splachnum ampullaceum
Sparganuim minimum*
Carex dioica
Eleocharis palustris
Philonotis calcarea

Those marked with an asterisk are considered under Section 3.1.1 as rare or threatened. Oenanthe fluviatilis is rated as rare at a local level. All of these 8 species would be likely to survive in the catchments in the long term in the absence of the proposed drainage scheme. The probable extinction of the first 4, and the almost certain extinction of the last 4, can be solely attributable to this drainage scheme.

(b) Vegetation Types and Communities

It will be seen from Table VII that the drainage scheme will probably affect 68% of all wetlands ('damaged' land) in the catchments and possibly affect a further 15%. In most cases the existing wetland vegetation will be replaced by more man-modified grasslands. This will result in a considerable overall loss of species diversity and structural variety in the catchments as a whole. Many of the bogs, and to a lesser extent some of the river floodplain types are likely to decline and be reclaimed even without the proposed drainage scheme (see Section 4.2). However in almost all other cases the trend of evolution in the absence of drainage is towards diversification rather than uniformity and frequently replacement of one community by another rated more highly in terms of the catchment e.g. Wet Woodland (8b) replacing Reedbeds (4b(ii)) at Rinaneel Townland (see Table IV). The proposed drainage scheme will be entirely responsible for the virtual elimination of all the more highly rated communities in the catchment at present (see Table IV), notably the Polygonum amphibium/Chara spp (2a(i)) and the Carex disticha/ Menyanthes trifoliata (2a(iii)) communities of Mountpleasant School and Ballyglass Turloughs and the Wet Birch Scrub (8c) and Carex paniculata Reedbeds (4b(i)) from around Lough Beg and Lough Manan. Although no accurate figures can be given it seems probable, that even taking into account the likely evolution in the absence of drainage, the proposed scheme will be solely responsible for the loss of a large proportion of all wetland vegetation types with the possible exception of Carex rostrata Marsh, which occurs mostly outside the areas expected to be drained. Furthermore this drainage scheme will permanently exclude the possibility of re-establishment of many vegetation types, notably those of the turloughs.

(c) Sites of Scientific Interest.

The proposed drainage scheme will reduce the scientific interest and site ratings of all of the 8 sites discussed under Section 3.3. If agricultural development takes place in these areas all botanical interest will be lost and site ratings will drop to insignificant. However, two of the sites Lough Manan and Lough Beg North, are likely to loose much of their scientific interest (rare species) in the long term in the absence the proposed drainage scheme. For the remaining six the drainage scheme alone will be responsible for their destruction.

3.
~~5.~~ RECOMMENDATIONS

3.1. GENERAL RECOMMENDATIONS
~~5.1~~ ~~General Measures for Minimising Negative Impacts~~

The following discussion is of a general nature and concerns suggestions for carrying out arterial drainage works and the subsequent maintenance and agricultural development so as to minimise negative impacts on flora and fauna ~~vegetation.~~ [INSERT 7] →*

3.1.1.
~~5.1.1~~ Arterial and Field Drainage ← re wetlands

All vegetation in the river and drainage channels will be removed during dredging. ~~(In order to facilitate more rapid recolonisation of aquatic plants dredging should commence at the top of the catchments and proceed downstream to the outlets. By doing this stretches which have been dredged will receive no further disturbance from silt produced by subsequent downstream dredging, thus allowing for early recolonisation of plants.)~~ The timing of dredging activities is not an important consideration for vegetation and is more dependent upon wildlife and fisheries requirements ~~((see specialists' reports))~~. To ensure re-establishment of aquatic plants channels should not be dredged so deep as to exclude light from the bed. In one case cited by Haslam (1978) ~~(47)~~ a drain dredged to 1.5 m deep, with steep sides and water too turbid for light to reach the bed, bore no vegetation for 5 years. In large channels a steep sided trapezoid shaped bed profile should be avoided. Shallow ledges, at least on one side, should be incorporated in channel design to allow for aquatic plant development. Some meanders should be left in the river course to facilitate scour and deposition thus maintaining natural habitats. On long straight stretches meanders should be created. The same applies to riffle and pool sequences; where present they should be left, where absent they should be created. These fast flowing reaches oxygenate water and supply suitable niches for a variety of aquatic and animals plants. Where gravel beds are removed by dredging they should be replaced when works are completed.

Unnecessary removal of trees and shrubs from banks during dredging should be avoided. Tree roots, especially those of Alder (Alnus glutinosa) serve to stabilise river banks and their foliage can save channel maintenance by shading out excessive aquatic plant growth. Where bank

clearance is necessary to allow dredging machinery access to the river, it should take place on one bank only. After clearance banks should be fenced off, at least temporarily to allow vegetation to regenerate sufficiently to stabilise the substrate. Where spoil is not liekly to have a serious injurious affect on top soil it should be spread evenly over the adjoining land beyond the channel to a depth not exceedong 0.15m (Conservation and Land ~~Drainage Guidelines (48)~~). Where spoil is detrimental to agricultural practices it should be buried or heaped. Spoil disposal areas should be fenced off and reseeded and fences should be removed only when the turf can withstand grazing. Spoil mounds, especially where composed of rocks, stones or marl, should be regraded by recovering with top soil. Attempts should be made to landscape spoil mounds in harmony with surrounding topography.

~~5.1.2~~ Maintenance

Drainage channels will require occasional re-dredging and the above mentioned safeguards will again apply. Weed control is a more frequent problem and is usually achieved by either mechanical or chemical methods.

~~5.1.2.1~~ Mechanical Maintenance

The frequent use of mechanical methods of weed control over a wide area affects aquatic vegetation in two major ways. The intensive use of a drag-line or excavator, if used at intervals of 3 years or less, can cause a decline in the numbers and species of aquatic plants (Newbold, ~~(49)~~). Extensive use can reduce the number of sites from which recolonisation can occur. Weed clearance should therefore be reduced to at least 5-7 year intervals and take place in a chequer-board pattern in space and time. Where plants are used for shelter for birds and mammals cutting should not be done during critical stages of their life cycle e.g. nesting. Again cutting should be done in short stretches so that animals can find cover nearby. Plants that are non-invasive, such as ~~Reed Canary Grass~~ (Phalaris arundinacea) on channel banks, should not be cut at all. Plant debris should be removed from channels after cutting to avoid excessive oxygen depletion of the water.

5.1.2.2. Chemical Maintenance

Weed control can be attained by chemical means through the use of herbicides. Their main disadvantage is that they are less predictable in their actions than weed cutting and can have wide ranging and unforeseen side-effects. Herbicides can kill plants very quickly and serious deoxygenation of water can occur. To avoid this applications should be made in spring before the standing crop becomes too large. This however does have the disadvantage of destroying habitat, food and cover for animals at a critical stage in their life cycles. Most herbicides restrict the regrowth of the original channel flora because of the length of the phytotoxic period. Non-susceptable or resistant species then tend to colonise the vacant habitat, giving the original flora little chance of re-establishment and resulting in an impoverished and simplified flora. Care and judgement are also required to ensure that herbicides do not remove all macrophyte vegetation leaving only phytoplankton and they must not be used where water, whilst toxic, is likely to be used for domestic or agricultural drinking water.

The flora of drainage channels can be safeguarded by use of less intensive methods of mechanical maintenance and restricted use of herbicides. The British Ministry of Agriculture, Fisheries and Food (1975) (50) recommends that herbicides, where necessary, should be applied on 400 m lengths of drain alternating with 400 m lengths left untreated. In general, however, the use of herbicides should be discouraged.

5.1.2.3 Trees

The use of trees to shade out channel vegetation has many advantages over herbicides both ecologically and financially. Maintenance by trees is possible,

(a) in channels with little sediment or,

(b) channels with more sediment, requiring regular dredging, where trees can be planted on the southern bank only, or

(c) in channels where all potentially choking plants can be shaded i.e. where tree canopy covers all the channel or physical factors prevent weeds from growing in the centre of the channel.

Alders are well suited for channel maintenance because they are deciduous, allowing spring growth of river plants, and deep rooted, aiding bank stability. Alder saplings, as large as possible should be planted to provide a closed canopy to shade channel vegetation but should incorporate some light gaps to allow growth of bank vegetation. Coppicing is unncesaary unless shading is deleterious to crops.

~~5.1.3~~ 3.1.3. Agricultural Development ← no underline

After drainage the survival of a relict wetland flora, restricted mostly to drains and river channels, will depend largely upon the activities of landowners. Although there are few controls over the way in which farmers utilise their lands after arterial drainage a number of suggestions could be made through local Agricultural Advisors. Where possible unstable channel banks should be fenced off from grazing animals to avoid erosion and to allow regeneration of shrubs and trees. Erosion can also be a problem unless specific watering access points are constructed for animals. Agricultural buildings, especially where used to house livestock or store silage, should be sited well away from water courses to prevent pollution. Slurry should not be spread beside rivers. Care should be taken to exclude animals from banks where vegetation has been sprayed with herbicides or pesticides. Dumping of herbicide or pesticide containers in or near rivers should be strictly avoided.

The major long term threat to aquatic vegetation, which cannot be adequately safeguarded, is from pollution by fertilizers and livestock effluent. Although agricultural pollution is generally less severe than industrial or urban pollution it almost certainly contributes to eutrophication of lakes, rivers and drainage channels (Newbold, 1977 ~~(49)~~). ~~According to Vollenwieder (51) phosphorus levels need only increase from 0.005 to 0.1 mg/l and nitrogen levels from 0.2 to 1.5 mg/l to cause a change from ultraoligotrophic to polytrophic (polluted) water conditions. Such an increase is possible from agricultural pollution but there is as yet no evidence to support any biological changes solely attributable to this source.~~ Haslam, 1978 ~~(47)~~ regards fertilizers as potentially more hazardous pollutants than effluents because they do not come from point sources and cannot be so readily cleaned up. She states that fertilizers have only recently been added to agricultural land in large quantities in Britain and it may take several decades before

their effects on aquatic plants are known. It is therefore recommended that types of land use which require relatively low fertilizer inputs should in as far as possible, be encouraged.

5.1.4. Costs of General Measures

It is not possible to give even a crude estimate of the costs of the general measures suggested above. To obtain a reasonable estimate of costs such measures would have to be specified exactly in terms of omissions and new works and incorporated into a new design for the arterial drainage scheme. By comparing the costs and benefits of the two designs it would then be possible at least to cost those measures which directly effect the arterial drainage construction and maintenance phases. To cost those effecting the agricultural development and maintenance phases it might be necessary to actually monitor the performance of a scheme into which these recommendations had been incorporated.

5.2 Sites Recommended for Omission from the Drainage Scheme

It is recommended that the 8 sites discussed in Section 3.3 are omitted from the drainage scheme and managed as nature reserves either through acquisition or management agreements. Both Lough Beg North and Lough Manan are included in this recommendation despite the fact that natural changes could in the long term cause the extinction of the rare species they contain. If, however, these areas were properly managed such changes could be halted or would take hundreds of years to occur and would lead to such highly rated communities as Actively Growing Acid Bog (3a) or Wet Woodland (8b, 8c) with a resultant increase in their overall conservation importance.

The necessary requirements for omitting each site are discussed first followed by an examination of the costs which would be involved.

5.2.1 Requirements for Omitting Sites

(a) Mountpleasant School Turlough (Figure 7)

Area: 26.5 ha Rating: National Importance

Requirements: Swallow holes should not be opened and no channel dredging

should take place on channel number SM 100/2. A detailed hydrological study is required to ascertain the relationship between water levels and fluctuations in this turlough and ground water levels elsewhere in the catchments to see how the turlough would be affected by arterial drainage. If in fact this turlough cannot be drained there would be a saving in costs of arterial drainage and prevention of unnecessary damage to wetland vegetation. If the turlough would inevitably be affected by drainage elsewhere in the catchments and could not be conserved there would be a saving in unnecessary acquisition costs. Such a study would involve water tracing with dyes and monitoring of groundwater inputs/outputs and water level fluctuations. This would take about 18 months to complete and cost approximately £7,500, plus the use of OPW equipment and staff (Drew (24)).

(b) Ballyglass Turlough (Figure 7)

Area: 5.26 ha Rating: National Importance

Requirements: There should be no interference with the swallow hole in this turlough and no channel dredging should take place on channel number SM 100/1. A hydrological study is also required here for the same reasons discussed for Mountpleasant School Turlough. The cost is included in the price quoted for Mountpleasant School Turlough.

(c) Ballyglass Marsh (Figure 7)

Area: 15 ha + 9.7 ha Rating: Regional Importance

Requirements: No channel dredging should take place on channel number CM 5/9 from levels 89 to 100. A small embankment would be requried at the narrow southern end of the marsh to maintain high water levels. This could be built from the spoil of downstream dredging works so costs would be minimal. A brief study would be required to see if omitting Ballyglass Marsh would affect 9.7 ha of benefiting land to the east on channel number CM5/9/6 (0-4/50).

(d) Lough Beg (Figure 8)

Area: 29.5 ha Rating: Regional Importance

Requirements: No channel dredging should take place on channel number CM5/10/3. The main Annies River channel should be dug to the east of Lough Beg (CM 5/10) but care should be taken to avoid tapping the springs which feed the lake.

(e) Mullingar Bridge (Figure 9)

Area: 14.16 ha Rating: Local Importance

Requirements: No channel dredging should take place on channel number CM 5/9 from levels 34 to 49. Exempting this area would still facilitate drainage of upstream areas but approximately 3 ha of land downstream may very occasionally flood.

(f) Cloonboorhy Lough (Figure 10)

Area: 19.8 ha Rating: Local Importance

Requirements: No channel dredging should be carried out on channel number CM 5/10/5 (from levels 0-9/70) and channel number CM 5/10/1 (from levels 0-2). Omitting Cloonboorhy would still facilitate drainage of upstream areas.

(g) Lough Manan (Figure 8)

Area: 11.3 ha Rating: Local Importance

Requirements: No channel dredging should take place on channel number CM 5/10/2.

(h) Lough Beg North, Carrowmore North Townland (Figure 11)

Area: 14.16 ha Rating: Local Importance

Requirements: No channel dredging should take place on channel number

CM 5/10/1/1 from levels 42/30 to 33/40. Culverts B12 and B13 should be blocked off and channel number CM5/10/5/1 should be rerouted from B12 to B13 east of the road embankment.

5.2.2. Costs of Omission and Conservation Management

The costs of omitting an area and managing it as a nature reserve can be broken down into three basic components -

(a) the net loss or gain of benefit to the drainage scheme (OPW cost benefit analysis)

(b) the cost of compensating the landowner

(c) the cost of managing the area.

The methods for calculating the costs are outlined in Section 2.5. More details on (a) and (c) are given in Appendices 3.6 and 3.7 respectively. Management costs have been discounted over 50 years to make them comparable with the OPW cost benefit analysis figures. The cost of compensating the landowner is, for simplicity, taken to be the cost of acquiring the land rather than of reaching a management agreement with the landowner, although both methods could be used. In general the cost of acquiring the land could be regarded as the pre-drainage market value however, in this case, because the scheme has been exhibited the more realistic cost is taken to be the post-drainage market value. Both pre-and post-drainage market values are given for comparison purposes.

The overall cost for omitting and conserving each site is given in Table VIII. The total cost for omitting and conserving all 8 sites for 50 years is summarised below -

(a)	Loss of Benefit to Drainage Scheme	£304,700
(b)	Land Acquisition	£176,245
(c)	Nature Reserve Management	£ 48,014
	Total	£528,959

If the scheme had not been exhibited, and market values taken at pre-drainage prices, this total would have been reduced to £471,672. No attempt was made to estimate the value, in monetary terms, of the benefits e.g. gene pool protection, education, recreation etc. which would result from conserving these sites as no satisfactory method for doing so was available. Ignoring such benefits and regarding the land acquired as an asset the overall cost for excluding these sites would be £352,714.

Table VIII Costs (£) of Omitting and Conserving 8 Sites of Scientific Interest for 50 years

		Mountpleasant School Turlough	Ballyglass Turlough	Ballyglass Marsh	Lough Beg	Mullingar Bridge	Cloonboorhy Lough	Lough Manan	Lough Beg North	Approximate Total for all 8 sites
OPW	Losses	117,708	25,594	114,500	129,810	70,935	91,156	48,492	63,399	661,600
Cost Benefit	Savings	43,822	15,080	63,259	45,790	91,764	46,774	16,951	33,487	359,900
Analysis	Net Total	73,886	10,514	51,241	84,020	-20,829**	44,382	31,541	29,912	304,700
Present	Pre-drainage	26,658	5,297	24,873	42,096	14,259	19,938	6,954	20,979	118,958*
Market Value	Post-drainage	39,988	7,937	37,272	59,609	21,367	29,878	10,096	29,707	176,245*
Management Costs		10,732	2,130	6,075	2,025	6,601	9,922	4,576	5,953	48,014
Total Cost		124,606	20,581	94,588	86,045*	7,139	84,182	46,213	65,572	528,959

* Market Value of Lough Beg not included as land already owned by Department of Fisheries and Forestry

** Net saving of £20,829 by omitting Mullingar Bridge.

5.3 MONITORING

5.3.1 Objectives of a Monitoring Program

A monitoring program should be carried out to follow the changes in vegetation brought about by the arterial drainage scheme, and to verify the predictions made in this report. This should have two major objectives, firstly to follow and quantify the spatial changes in vegetation types throughout the catchments and secondly to identify the impacts of separate drainage scheme activities within each vegetation type. For the purpose of this discussion it is assumed that in most cases field drainage, either marginal or underdrainage, will be followed by agricultural development i.e. ploughing, reseeding, fertiliser etc. The two have been classed together as 'land reclamation' and thus three main environmental states are envisaged post-drainage; (i) areas not drained, (ii) areas with arterial drainage but not fully reclaimed and (iii) areas with arterial drainage plus full reclamation. From the vegetation point of view full reclamation can be regarded as a cutoff point where semi-natural vegetation is replaced by strongly man-modified vegetation.

5.3.2 Suggested Methods

Monitoring should take place at a frequency comparable to the rate at which benefiting land is expected to attain full benefit (Howard (41)). The following sample frequency is suggested, where negative and positive numbers represent respectively years prior to and post arterial drainage work completion:

-1, +1, +3, +5, +8, +12, +20.

In order to avoid the necessity of carrying out a complete ground survey in each sample year it is recommended that vegetation maps should be largely based upon false colour infra red aerial photographs. These should be flown each sample year at around the same time, preferably August or September, and photographs printed to a scale of 1:10,000. It will be necessary to redraw the existing pre-drainage Vegetation Map (Figure 5) from such aerial photographs to enable correlations to be established between aerial photographs and vegetation types and to serve as a base line for future monitoring. It may be necessary to use colour enhancement techniques to aid vegetation mapping and to identify changes in vegetation

between sampling periods.

In conjunction with aerial photography some sampling of vegetation on the ground will be required. Sampling techniques should be standardised and it is recommended that the Braun-Blanquet approach (Westhoff & van der Maarel (7)) be used to enable vegetation composition and structure to be quantified and compared. Data should be computerised to aid comparison. Permanent sample plots should be set up in each vegetation type, the siting of which will depend upon the nature of the habitat, the area of vegetation type and upon the expected drainage schemes impacts. The main drawback of using permanent sample plots is the lack of control over management ie. grazing, fertiliser etc. Information regarding inputs and management practices will depend upon the co-operation of the land-owners on whose land the sample plots are located. Ideally for each vegetation type 6 plots would be sited in areas not due to be drained, 6 in areas arterially drained but not expected to be fully reclaimed and 6 in areas fully reclaimed. This ideal is unattainable however for the following reasons. Firstly, many of the vegetation types are limited in area and distribution. Secondly several vegetation types are restricted to areas of benefiting land and do not occur elsewhere in the catchments on lands not due to be drained. Thirdly, although the location of lands not affected by the scheme is known there is no accurate way of predicting which arterially drained lands will not be fully reclaimed. This introduces an element of chance in the siting of certain plots. This lack of control over management in permanent plots will mean that only the overall effects of arterial drainage and land reclamation activities will be detectable. The impacts of individual activities such as moling, pipe laying, fertiliser inputs, increasing livestock density etc. would require more carefully controlled conditions.

The following sampling regime for the catchments is suggested:

(a) The eight sites recommended for omission, whether conserved or not, are of special botanical importance and should be sampled and mapped in detail (39 plots). These areas encompass considerable vegetational variation and are likely to be particularly sensitive to changes brought about by the drainage scheme.

(b) Lakes and Turloughs, where a drop in water levels may cause relocation of vegetation zones, should be sampled by transects. Lough Carra and its shoreline should be sampled near the river outlets (32 plots).

(c) Bogs and Gorse scrub, which are widespread and considerably disturbed by turf cutting, should be sampled by large area plots. Changes in patterns of turf cutting and distribution and cover of Gorse Scrub or Birch woodland, which correlate with drier conditions, could be monitored by aerial photographs (9 plots).

(d) Improved Wet Pasture, River Floodplain Pasture, Wet Sedge Swards and Dry Sedge Molinia Swards, which are widespread and cover a large area are most likely to encompass the range of drainage impacts i.e. not drained, arterial drainage only and fully reclaimed. These types should be sampled accordingly by siting a large number of plots in each type (70 plots).

(e) Isolated Reedbeds, Schoenus Marsh, Carex elata Marsh, Carex rostrata Marsh, Dry Tall Herb and Wet woodlands, which are limited in area and have a scattered distribution should be sampled by siting plots in each area where the vegetation types occur. (20 plots).

(f) Pasture and Arable, which are not on benefiting land, and Coniferous Plantation, in which changes, if any, will only occur in growth rates, need not be sampled. Growth rates of conifers would in any case be monitored by the Forest and Wildlife Service.

(g) A number of plots should be sited in spoil disposal and bank clearance areas to monitor changes in vegetation (10 plots).

(h) The effects of arterial and field drainage and their maintenance on the vegetation of drainage channels should be monitored by sampling selected representative stretches of channel types i.e. canal-like reaches, riffle and pool sequences, deep regraded stretches and drains. Total species lists, abundance values and microhabitats should be recorded for each sample (10 sample stretches).

This comes to a sum total of 190 permanent plots and sample stretches. In addition to change in vegetation, ecological factors (soils and water) should also be monitored. It is recommended that soil samples be taken from each terrestrial and semi-terrestrial plot in each sample year and analysed for N, P, K and Ca. To accurately monitor hydrological changes water tables should be measured in each plot at least every month, especially during the first years after drainage. Water samples from the selected drainage channels and lakes including L. Carra should also be taken at monthly intervals. These should be analysed for major plant nutrients, major ions, BOD, pH, silt and turbidity. Water quality monitoring could be carried out in co-operation with a fisheries monitoring program.

5.3.3 Costs

The costs for such a monitoring program at current prices amounts to £152,075. This can be broken down as follows:-

	Per sample year		Total cost
Colour aerial photography	£5,000	x 7 =	£ 35,000
Salaries * - Fieldwork	£4,400	x 7 =	£ 30,800
Desk work	£2,935	x 7 =	£ 20,545
Expenses	£2,330	x 7 =	£ 16,310
Soil Analysis	£1,590	x 7 =	£ 11,130
Water Table Monitoring	£2,170	x 7 =	£ 15,190
Water collection and analysis	£3,300	x 7 =	£ 23,100
	£21,725	x 7 =	£152,075

*Salaries are based on those of the Forest and Wildlife Service and were doubled to take into account costs for backup facilities, insurance, pensions etc. Equipment costs have not been included.

5.4 Requirements for Further Research

5.4.1 Aerial Photography

Aerial photographs are a potentially valuable aid to vegetation mapping and could be used effectively for surveying and monitoring the vegetational impacts of drainage. A study to assess their accuracy and limitations

could be quite easily carried out on the vegetation of the Annies and Ballyglass catchments, as so much information already exists, and could form part of the suggested monitoring program to study the effects of drainage. Aspects to be investigated should include the possibility of producing vegetation maps from aerial photographs using, if necessary, image enhancement techniques. The results of such a study would be of use in many fields of physical planning as well as to nature conservation.

5.4.2 Turloughs

Insufficient data on the ecology and distribution of turloughs in the country led to difficulties in the evaluation of the turloughs in the Annies and Ballyglass catchments. As turloughs are apparently restricted to Ireland and are rapidly disappearing due to drainage a study aimed at identifying the physical and biological factors which characterise them needs to be instigated soon. This should include a comprehensive survey of all the remaining turloughs to examine their distribution, range and variation. This would enable realistic evaluations and conservation decisions to be made.

5.4.3 Classification, Inventory and Evaluation of Wetlands

There is a fundamental lack of up to date information on the status, ecology and distribution of Irish wetland vegetation. This made itself apparent in the present study when attempting to evaluate species, communities and sites of scientific interest in the catchments. Wetlands are so rapidly disappearing in Ireland, most especially due to drainage, that there is an urgent need for a systematic classification, inventory and evaluation of all those remaining. This is essential if the impacts of drainage are to be realistically assessed.

A widely acceptable classification system is required to accurately define ecosystem and habitat types on a European scale. The system employed for the present study (Cowardin et al (16)), which was developed for the United States, uses geographical Provinces for the first level of division and physical factors for subsequent dichotomies. A similar approach could be developed for Europe, using the Council of Europe's phytogeographical Domains i.e. Boreal, Atlantic, Subatlantic, Central European and

Mediterranean (Council of Europe (54)) as the first level of division, physical factors for the second and, going a stage further, using Braun-Blanquet (Westhoff and van der Maarel (7)) phytosociological associations as a third. This would enable comparison of wetlands at national and European levels and help to put national conservation priorities in a European perspective.

A systematic and up-dated inventory of wetland species, communities and sites of scientific interest is needed to keep pace with the rate of land reclamation and development. Considerable emphasis should be placed on the importance of basic field survey work. Data should be collected in a standardised format and stored in an easily accessible and modifiable form on computer. This information should be organised at both national and international levels with the aim of providing an integrated biological databank facility. The need for inventory and a computer-based data handling system are stressed in the recommendations of the IBP's experimental study of conservation sites (Clapham et al (55)).

Evaluation of wetlands is directly dependant on classification and inventory. An attempt was made to develop a systematic approach towards site selection and site rating. Selection and rating criteria should be clearly defined and as objective as possible. Larson (44) puts forward an evaluation system for wetlands in the United States, largely for ornithological purposes, which uses numerical scores for clearly stated criteria. Helliwell (45) suggests methods for evaluating wildlife resources and attempts to attach notional monetary values on them. Van der Maarel (46) goes even further and investigates the possibilities of integrating ecological principles into physical land use planning. However, as yet there is no widely accepted methodology for evaluating natural biological resources. Without a standardised method evaluation will remain subjective and the impacts of drainage on wetlands will not be accurately assessed.

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APPENDIX 3.1

Site Selection Criteria used by An Foras Forbartha

(1) Naturalness

No part of our countryside today is untouched by the hand of man or his grazing animals and the concept of natural vegetation is not tenable for any sizeable area. For example, a good proportion of the Irish flora and fauna has been introduced by man (about 25 per cent of flowering plants and 35 per cent of mammals) and these organisms have integrated themselves into the pre-existing communities. Research is gradually revealing the types of community that developed before the coming of man and the degree to which an area approximates to this state is one of its most important values.

(2) Richness or diversity

This applies both to the number of species in a community and to the number of communities in an area. The most natural examples of any community have all available niches filled by the species most suited to them. They are thus species-rich relative to that community type in general. Variation in communities within the site is also relevant. Apart from it being more interesting to see several different communities in an area, provided each of them is developed properly, it is clearly better to choose one site with a range of variation rather than two or three separate but homogeneous ones.

(3) Rarity

The variability of environmental factors means that the extremes of any gradient, say of grazing or wetness, are found only occasionally. Rare combinations of factors give rise to rare habitats which may be indicated by rare species or unusually large numbers of a common one. Rarity for its own sake can be over-rated but the exceptional habitat or species may reveal a widespread truth that is otherwise difficult to see. It is an important

element in conserving the full range of variation of natural communities.

(4) Typicality

The typicality of an area is at least as important as rarity for planning and conservation where lands are being reserved in the long-term for the sake of their natural communities. If most of the examples of a habitat are going to be destroyed or greatly modified, it is important to retain some of those at the centre of the variation as well as at the extremes.

(5) Size

In a changing environment subject to intensification of use, size is of the utmost importance. A large enough area will prevent outside influences from modifying the feature of value. All conservation sites should be surrounded by a buffer zone in which these influences can be absorbed without affecting the heartland. Nutrient-poor sites, such as bogs and wetlands in general, are especially sensitive to interference in this way.

(6) Scientific research

All other things being equal, the existence of scientific records adds to the value of an area. They will make subsequent work easier and more revealing and they may allow an estimate of change over time to be made. Time is an environmental factor that cannot easily be simulated by experiment.

(7) Accessibility and education

These criteria on their own are not of great importance as almost any area can be made accessible if it is so desired and used for education. However, they may be useful in choosing between otherwise similar sites.

APPENDIX 3.2

An Foras Forbartha 4-Point Rating Scale

The importance of each area is indicated in terms of the following categories:

International Importance

1. Only area of its type in Europe.
2. One of a few such localities in Europe.
3. One of a natural series in Europe.
4. Recognised international importance.
5. Specialised educational importance.

National Importance

1. Only area of its type in Ireland.
2. One of a few such localities in Ireland.
3. One of a natural series in Ireland.
4. Recognised national importance.
5. General or specialised educational importance.

Regional Importance

1. Only area of its type in province.
2. One of a few localities in Ireland.
3. One of a natural series in region.
4. Fine example of its kind.
5. General or specialised educational importance.

Local Importance

1. Only area of its type in county.
2. One of a few localities in province.
3. Fine example of its kind.
4. General educational importance.

APPENDIX 3.3

Explanation of Terms used in Table VI:

1. Whether the scientific interest of a site is threatened.

2(a) If a site contains a rare species, whether that species is thought to be declining, expanding or static in Ireland.

2(b) Whether the plant communities of a site are thought to be declining, expanding or static in Ireland.

2(c) Whether a site type (e.g. habitat type as defined by Cowardin et al (10) is thought to be declining, expanding or static in Ireland.

3(a) If a site contains a rare species, the number of sites already conserved in Ireland containing the same species.

3(b) The number of sites already conserved in Ireland containing the same communities (Poore and Gryn-Ambroes (43)).

3(c) The number of sites already conserved in Ireland containing the same site types (See 2c).

4. If, taking into account criteria 1-3 above, a site is worth considering for conservation.

5. Whether the scientific interest of a site can be maintained in the long term.

6(a) Whether a site contains species that are rare at catchment, local, regional, national or international levels.

6(b) Whether a site contains communities that are rare at catchment, local, regional, national or international levels.

6(c) Whether the site type is rare at catchment, local, regional, national or international levels.

6(d) Whether the site contains geomorphological phenomena that are rare at catchment, local, regional, national or international levels.

7(a) The number of species recorded from a site.

7(b) The number of communities recorded from a site.

8(a) Whether other sites of scientific interest containing the same communities occur in the vicinity (the importance of proximity of wetland sites to each other is discussed by Larson (44) whose rating system implies that proximity is an important factor where sites are less than a half mile (.8 km) apart or if hydrologically connected up to 3 miles (4.8 km) apart).

8(b) Whether other sites of scientific interest of the same site type occur in the vicinity.

8(c) Whether other sites of scientific interest containing different communities occur in the vicinity.

8(d) Whether other sites of scientific interest of different site type occur in the vicinity.

9. The rating of a site on the basis of its size in comparison to similar site types in the catchment, county, province, country or world (the evaluation of size as a factor for conservation is discussed by Helliwell (45)).

10. As defined by van der Maarel (46) and classified in terms of natural, near-natural, semi-natural, agricultural, near-cultural and cultural.

11(a) The rating of a site on the basis of its potential importance to research workers in the county, province, country or world (suggestions for estimating research values of sites of scientific interest are put forward by Helliwell (45)).

11(b) The rating of a site on the basis of its potential importance to students from schools, colleges or field centres in the catchments, county, province, country, or world, (suggestions for estimating general educational values are also put forward by Helliwell (45)).

12. Overall site rating in terms of Local, Regional, National or International importance estimated by taking into account ratings and scores for criteria 7-12.

APPENDIX 3.4: List of Species Recorded during Survey

- = probably decline
+ = probably expand
N = probably not affected
E? = possible extinction from catchment
E = probable extinction from catchment.

Species	Frequency	% Frequency	Impact of Drainage
Carex panicea	165	57	-
Agrostis stolonifera	162	56	-
Succisa pratensis	152	52	-
Calliergon cuspidatum	147	51	-
Hydrocotyle vulgaris	133	46	-
Juncus articulatus	132	45	-
Filipendula ulmaria	131	45	-
Mentha aquatica	130	45	-
Molinia caerulea	130	45	-
Holcus lanatus	124	43	N
Potentilla erecta	120	41	-
Carex nigra	108	37	-
Ranunculus flammula	107	37	-
Galium palustre	107	37	-
Anthoxanthum odoratum	106	36	-
Ranunculus acris	103	35	+
Carex flacca	103	35	N
Potentilla anserina	102	35	-
Juncus effusus	98	34	-
Senecio aquaticus	91	31	-
Lythrum salicaria	83	28	-
Leontodon autumnalis	81	28	N
Trifolium repens	80	27	+
Ranunculus repens	74	25	+
Plantago lanceolata	74	25	+
Cirsium dissectum	74	25	-
Prunella vulgaris	73	25	N
Trifolium pratense	67	23	+

Species	Frequency	% Frequency	Impact of Drainage
Cynosurus cristatus	67	23	+
Cirsium palustre	66	22	-
Parnassia palustris	64	22	-
Eriophorum angustifolium	63	21	-
Carex lepidocarpa	62	21	-
Rhytidiadelphus squarrosus	61	21	-
Cardamine pratensis	61	21	-
Festuca rubra	61	21	N
Angelica sylvestris	60	20	-
Menyanthes trifoliata	58	20	-
Briza media	56	19	N
Carex rostrata	53	18	-
Cerastium fontanum	52	18	+
Lotus corniculatus	51	17	N
Triglochin palustris	51	17	-
Phragmites australis	51	17	-
Calluna vulgaris	49	17	-
Agrostis tenuis	49	17	N
Centaurea nigra	48	16	+
Schoenus nigricans	47	16	-
Luzula multiflora	45	15	-
Anagallis tenella	44	15	-
Equisetum fluviatile	41	14	-
Pseudoscleropodium purum	40	13	N
Erica tetralix	39	13	-
Carex echinata	38	13	-
Pedicularis palustris	37	12	-
Campylium stellatum	34	11	-
Juncus bulbosus	34	11	-
Thuidium tamariscinum	32	11	N
Potentilla palustris	32	11	-
Hylocomium splendens	30	10	-
Caltha palustris	30	10	-
Juncus conglomeratus	30	10	-
Carex disticha	30	10	-

Species	Frequency	% Frequency	Impact of Drainage
Scorpidium scorpioides	29	10	-
Drepanocladus revolvens	28	9	-
Iris pseudacorus	27	9	-
Rumex acetosa	26	9	N
Carex hostiana	26	9	-
Vicia cracca	25	8	N
Narthecium ossifragum	24	8	-
Sphagnum subnitens	23	8	-
Hypnum jutlandicum	23	8	N
Equisetum palustre	23	8	-
Salix atrocinerea	23	8	-
Myrica gale	23	8	-
Polygonum amphibium	23	8	-
Bellis perennis	23	8	+
Lolium perenne	23	8	+
Carex demissa	23	8	-
Nasturtium officinale agg.	21	7	-
Linum catharticum	20	6	+
Hypochoeris radicata	20	6	+
Festuca arundinacea	20	6	-
Pinguicula vulgaris	19	6	-
Lemna minor	19	6	-
Dicranum scoparium	18	6	-
Drosera rotundifolia	18	6	-
Myosotis scorpioides	18	6	-
Dactylis glomerata	18	6	+
Glyceria fluitans	18	6	-
Ctenidium molluscum	17	5	-
Sagina procumbens	17	5	-
Ulex europaeus	17	5	-
Festuca pratensis	17	5	N
Scirpus lacustris	17	5	N
Cladonia portentosa	16	5	-
Calliergon giganteum	16	5	-

Species	Frequency	% Frequency	Impact of Drainage
Valeriana officinalis	16	5	-
Juncus subnodulosus	16	5	-
Carex pulicaris	16	5	-
Sphagnum palustre	15	5	-
Aulacomnium palustre	15	5	-
Lathyrus pratensis	15	5	N
Epilobium palustre	15	5	-
Sparganium erectum agg.	15	5	N
Juncus inflexus	15	5	-
Leucanthemum vulgare	14	4	+
Echinodorus ranunculoides	14	4	-
Sieglingia decumbens	14	4	N
Carex elata	14	4	-
Apium nodiflorum	13	4	N
Potamogeton natans	13	4	N
Poa pratensis	13	4	+
Epilobium parviflorum	12	4	-
Epilobium obscurum	12	4	-
Utricularia vulgaris	12	4	-
Taraxacum officinale	12	4	+
Fissidens adianthoides	11	3	-
Climacium dendroides	11	3	-
Pleurozium schreberi	11	3	-
Potamogeton coloratus	11	3	-
Deschampsia cespitosa	11	3	-
Phalaris arundinacea	11	3	-
Cratoneuron filicinum	10	3	-
Rubus fruticosus agg.	10	3	-
Samolus valerandi	10	3	-
Myosotis laxa	10	3	-
Cirsium vulgare	10	3	+
Alisma plantago-aquatica	10	3	-
Juncus acutiflorus	10	3	-
Elecocharis palustris	10	3	-

Species	Frequency	% Frequency	Impact of Drainage
Carex diandra	10	3	-
Carex ovalis	10	3	N
Fontinalis antipyretica	9	3	N
Brachythecium rutabulum	9	3	+
Calypogeia mullerana	9	3	N
Lophocolea bidentata	9	3	N
Salix repens	9	3	-
Betula pubscens	9	3	N
Alnus glutinosa	9	3	-
Crataegus monogyna	9	3	+
Galium verum	9	3	N
Galium saxatile	9	3	-
Epipactis palustris	9	3	-
Poa trivialis	9	3	N
Phleum pratense	9	3	+
Peltigera canina	8	2	N
Nuphar lutea	8	2	N
Polygala serpyllifolia	8	2	N
Knautia arvensis	8	2	N
Achillea millefolium	8	2	+
Senecio jacobea	8	2	+
Scirpus setaceus	8	2	-
Carex paniculata	8	2	-
Bryum pseudotriquetrum	7	2	-
Plagiomnium undulatum	7	2	N
Preissia quadrata	7	2	-
Riccardia multifida	7	2	-
Selaginella selaginoides	7	2	-
Salix aurita	7	2	-
Hypericum pulchrum	7	2	N
Veronica beccabunga	7	2	-
Cirsium arvense	7	2	+
Leontodon taraxacoides	7	2	-
Lemna trisulca	7	2	N
Juncus bufonius	7	2	-

Species	Frequency	% Frequency	Impact of Drainage
Chara hispida	6	2	N
Chara his. v.h.f. polyacantha	6	2	N
Leucobryum glaucum	6	2	-
Pteridium aquilinum	6	2	N
Hippuris vulgaris	6	2	-
Apium inundatum	6	2	-
Callitriche obtusangula	6	2	N
Odontites verna	6	2	N
Leontodon hispidus	6	2	+
Sparganium emersum	6	2	-
Dactylorhiza maculata	6	2	-
Chara his. v.h.f. rudris	5	1	N
Rhytidiadelphus triquetrus	5	1	N
Cephalozia connivens	5	1	N
Osmunda regalis	5	1	N
Blechnum spicant	5	1	N
Stellaria graminea	5	1	N
Lychnis flos-cuculi	5	1	-
Veronica scutellata	5	1	-
Rhinanthus minor	5	1	N
Utricularia minor	5	1	N
Plantago maritima	5	1	-
Pilosella officinarum	5	1	N
Carex hirta	5	1	-
Chara glob. v.h.f. virgata	4	1	N
Chara vulgaris	4	1	-
Campylopus introflexus	4	1	N
Mnium hornum	4	1	N
Riccardia pinguis	4	1	-
Equisetum arvense	4	1	N
Polygonum persicaria	4	1	+
Prunus spinosa	4	1	N
Hypericum tetrapterum	4	1	-
Hedera helix	4	1	N
Conopodium majus	4	1	N

Species	Frequency	% Frequency	Impact of Drainage
Plantago major	4	1	+
Typha latifolia	4	1	-
Dactylorhiza incarnata	4	1	-
Poa annua	4	1	N
Arrhenatherum elatius	4	1	+
Cladium mariscus	4	1	-
Chara glob. v.a.f curta	3	1	N
Sphagnum capillifolium	3	1	-
Polytrichum commune	3	1	-
Atrichum undulatum	3	1	N
Breutelia chrysocoma	3	1	N
Ulota crispa	3	1	N
Eurhynchium praelongum	3	1	+
Pellia epiphylla	3	1	N
Frullania tamarisci	3	1	N
Rumex crispus	3	1	N
Rumex conglomeratus	3	1	N
Rumex sanguineus	3	1	N
Rumex obtusifolius	3	1	N
Sagina nodosa	3	1	-
Ranunculus lingua	3	1	E?
Geum urbanum	3	1	N
Hypericum perforatum	3	1	N
Myriophyllum verticillatum	3	1	N
Myriophyllum spicatum	3	1	N
Fraxinus excelsior	3	1	N
Stachys palustris	3	1	-
Veronica catenata	3	1	N
Bidens cernua	3	1	-
Listera ovata	3	1	-
Dactylorhiza fuchsii	3	1	N
Agrostis canina	3	1	N
Alopecurus geniculatus	3	1	-
Scirpus cespitosus	3	1	-
Carex binervis	3	1	-
Sphagnum papillosum	2	0	-

Species	Frequency	% Frequency	Impact of Drainage
Sphagnum cuspidatum	2	0	-
Sphagnum auriculatum auricu.	2	0	-
Sphagnum auriculatum inunda.	2	0	-
Plagiomnium elatum	2	0	-
Plagiomnium rostratum	2	0	-
Philonotis calcarea	2	0	E
Ulota phyllantha	2	0	N
Amblystegium riparium	2	0	-
Eurhynchium striatum	2	0	N
Hypnum cupressiforme	2	0	N
Odontoschisma sphagni	2	0	-
Thelypteris palustris	2	0	E
Ranunculus trichophyllus	2	0	E?
Drosera anglica	2	0	E?
Sorbus aucuparia	2	0	N
Medicago lupulina	2	0	+
Polygala vulgaris	2	0	-
Viola riviniana	2	0	N
Viola canina	2	0	N
Circaea lutetiana	2	0	N
Heracleum sphondylium	2	0	N
Daucus carota	2	0	N
Erica cinerea	2	0	N
Centaurium erythraea	2	0	N
Thymus drucei	2	0	N
Veronica anagallis-aquatica	2	0	-
Pinguicula lusitanica	2	0	E?
Utricularia intermedia	2	0	-
Campanula rotundifolia	2	0	N
Solidago virgaurea	2	0	N
Antennaria dioica	2	0	N
Carlina vulgaris	2	0	N
Sonchus arvensis	2	0	N
Potamogeton praelongus	2	0	N
Poa subcaerulea	2	0	N

Species	Frequency	% Frequency	Impact of Drainage
Festuca ovina	2	0	N
Alopecurus pratensis	2	0	+
Nardus stricta	2	0	N
Eleocharis quinqueflora	2	0	E
Rhynchospora alba	2	0	N
Carex dioica	2	0	E
Sphagnum contortum	1	0	-
Sphagnum rubellum	1	0	-
Ditrichum flexicaule	1	0	N
Ceratodon purpureus	1	0	N
Campylopus paradoxus	1	0	N
Barbula reflexa	1	0	N
Barbula cylindrica	1	0	N
Cinclidotus fontinaloides	1	0	-
Schistidium apocarpum	1	0	N
Splachnum ampullaceum	1	0	E?
Bryum capillare	1	0	N
Rhizomnium punctatum	1	0	N
Plagiomnium affine	1	0	-
Neckera pumila	1	0	N
Neckera complanata	1	0	N
Thuidium delicatulum	1	0	N
Rhynchostegium riparioides	1	0	-
Hypnum cupressiforme lacun.	1	0	N
Rhytidiadelphus loreus	1	0	N
Conocephalum conicum	1	0	N
Pellia endiviifolia	1	0	N
Metzgeria furcata	1	0	N
Lepidozia setacea	1	0	-
Calypogeia sphagnicola	1	0	-
Lophozia ventricosa	1	0	-
Leiocolea badensis	1	0	N
Tritomaria exsectiformis	1	0	-
Solenostoma triste	1	0	N
Mylia anomala	1	0	-

Species	Frequency	% Frequency	Impact of Drainage
Plagiochila asplen. major	1	0	N
Chiloscyphus pallescens	1	0	N
Cephalozia bicuspidata lamm.	1	0	N
Diplophyllum albicans	1	0	N
Scapania aspera	1	0	N
Scapania gracilis	1	0	-
Radula complanata	1	0	N
Lejeunea ulicina	1	0	N
Dryopteris filix-mas	1	0	N
Dryopteris dilatata	1	0	N
Polypodium vulgare	1	0	N
Corylus avellana	1	0	N
Stellaria holostea	1	0	N
Nymphaea alba	1	0	N
Thalictrum minus	1	0	N
Potentilla sterilis	1	0	N
Fragaria vesca	1	0	N
Lathyrus montanus	1	0	N
Oxalis acetosella	1	0	N
Geranium robertianum	1	0	N
Ilex aquifolium	1	0	N
Epilobium montanum	1	0	N
Anthriscus sylvestris	1	0	N
Berula erecta	1	0	-
Oenanthe fluviatilis	1	0	E?
Vaccinium myrtillus	1	0	N
Lysimachia vulgaris	1	0	-
Primula vulgaris	1	0	N
Primula veris	1	0	N
Blackstonia perfoliata	1	0	N
Galium boreale	I	0	N
Teucrium scorodonia	1	0	N
Ajuga reptans	1	0	N
Veronica chamaedrys	1	0	N
Veronica serpyllifolia	1	0	N

Species	Frequency	% Frequency	Impact of Drainage
Achillea ptarmica	1	0	N
Potamogeton polygonifolius	1	0	N
Arum maculatum	1	0	N
Sparganium minimum	1	0	E
Orchis mascula	1	0	N
Festuca gigantea	1	0	N
Sesleria caerulea	1	0	N
Bromus ramosus	1	0	N
Trisetum flavescens	1	0	N
Eriophorum vaginatum	1	0	N
Carex vesicaria	1	0	-
Carex limosa	1	0	E
ADDITIONAL SPECIES			
Stellaria palustris	-	-	E
Carex lasiocarpa	-	-	-
Chara delicatula	-	-	N
Sorbus hibernica	-	-	N
Rhamnus cathartica	-	-	N
Quercus robur	-	-	N
Quercus petraea	-	-	N
Ulmus glabra	-	-	N
Sambucus nigra	-	-	N
Acer pseudoplatanus	-	-	N
Aesculus hippocastanum	-	-	N
Pinus sylvestris	-	-	N
Pinus contorta	-	-	N
Picea abies	-	-	N
Picea sitchensis	-	-	N

APPENDIX 3.5 - Vegetation Analysis

Vegetation Type 1. Lakes - total area (open water) 33.5 ha

Community 1a Profundal Zone

Cowardin Classification	-	Ecosystem : lacustrine Subsystem : profundal nonvegetated Class : bottom Subclass : fine Habitat : permanently flooded, fresh, alkaline.
Phytosociology	-	devoid of vegetation
Distribution	-	Lake beds below photic level found in the larger lakes Cloonboorhy, Carrownacon North and South and Loughs Frank. Isolated pockets of deep water also occur in Lough Carra.
Substrate	-	Marl/Mud
Management	-	None

Community 1b - Lower Infralittoral Zone

Cowardin Classification - Ecosystem: lacustrine/palustrine
Subsystem: littoral
vegetated

Class: submergent/floating leaved/submergent wetland
Subclass: algal/vascular
Order: mineral
Habitat: permanently flooded, fresh, alkaline.

Phytosociology - Charion asperae alliance. Submerged vegetation of oligo - to mesotrophic water composed principally of species of Characeae, usually in monodominant stands. Widespread in Europe and in Ireland at local, regional and national levels.

Potametum lucentis association. Submerged vegetation in 1-5 m deep, open water exposed to wind and wave action. Occurs in central, eastern and southern Europe and probably widespread in Ireland at local, regional and national levels.

Potameto nupharetum association. Floating leaved vegetation found in boreal and maritime parts of Europe and probably widespread in Ireland at local, regional and national levels.

Sample Number - 266, 278 (see Figure 4).

Average Number of Vascular Plants per Sample - 3

Dominant species - Potmogeton praelongus, P. lucens, Nuphar lutea, Chara ruderis.

Associated species - Sparganium emersum, Myriophyllum verticillatum.

Structure - Submerged aquatic community in 2.5 - 3.5m (-7) of water. Floating leaves of Nuphar lutea occur close to the reedbeds with a cover of 40%. Bryophytes absent. The extent of this zone varies with the angle of slope of the substrate and exposure to wave action but usually

occurs as a narrow band 2-3m wide in deeper waters beyond the Scirpus lacustris zone (4a(i)). To some extent this zone integrades with the Scirpus lacustris zone.

Distribution - Found in the three larger lakes Cloonboorhy, Carrownacon North and Carrownacon South and in Loughs Frank and probably also occurs in the smaller lakes Lough Beg, Lough Manan and in the lake at Rinaneel Townland. In Lough Carra restricted to sheltered areas or to water from 2.5 - 7.0 m deep.

Substrate - Soft marly mud.

Management - None

Comments - Generally poorly developed in the lakes of the catchments due to their morphology and restricted in Lough Carra due to exposure.

Community 1c Plankton

Not examined.

Vegetation Type 2. Turloughs - total area 77.3 ha.

Community 2 a(i) Polygonum amphibium/Chara spp

Cowardin Classification - Ecosystem: palustrine (?)
vegetated

Class: submergent/floating leaved/emergent wetland
Subclass: algal/vascular
Order : mineral
Habitat: semi-permanently flooded.

Phytosociology - Possibly in the Hydrocotylo-baldellion alliance (Baldellio-littorelletum). Mesotrophic to oligotrophic with periodic alterations between wet and dry phases. Distribution unknown.

Sample Number - 25, 26, 27.

Average Number of Vascular plants per sample - 7

Dominant Species - Polygonum amphibium, Apium inundatum, Chara spp, Calliergon giganteum, Drepanocladus revolvens.

Associated Species - Equisetum fluviatile, Potamogeton natans.

Structure - A mixture of emergent, floating and submerged vegetation. Chara species most abundant with cover 100% and in the case of Mountpleasant School Turlough co-dominant with bryophytes Calliergon giganteum and Drepanocladus revolvens.

Distribution - Confined to the semi-permanent calcareous waters of Mountpleasant School, Slishmeen and Rathnacreeva Turloughs.

Substrate - Marl

Management - None

Comments - Best developed and most extensive in Mountpleasant School Turlough.

Community 2a(ii) Carex rostrata/Glyceria fluitans

Cowardin Classification - as for 2a(i)

Phytosociology - probably in the Glycerio-sparganion alliance. Vegetation of the contact zone between land and water where the water table may fluctuate to allow both aquatic and terrestrial plants to intermingle; in relatively stable fertile habitats. Distribution unknown, probably widespread but decreasing due to drainage.

Sample Number - 248, 249, 251, 254, 255.

Average Number of Vascular plants per Sample - 16.4

Dominant Species - Carex rostrata, Glyceria fluitans.

Associated Species - Nasturtium officinale Agrostis stolonifera, Equisetum fluviatile, Eleocharis palustris.

Structure - Tall (40 cms) Carex rostrata dominated community in up to 50 cms of water (in summer) with floating leaves of Glyceria fluitans and Polygonum amphibium and emergent Equisetum fluviatile and Eleocharis palustris. Cover of herbs 50-60%. Bryophytes poorly developed, mainly Calliergon cuspidatum.

Distribution - Found in the semi-permanent water areas of Burren, Carrowreaghmony and Deerpark Turloughs.

Substrate - Marl/Mineral.

Management - Subject to grazing during prolonged dry conditions when open water levels recede.

Comments - The presence of Glyceria fluitans and Nasturtium officinale indicate more eutrophic conditions than in the Chara dominated turloughs. This may be due to a

greater proportion of the inflowing water being derived from direct run-off in the smaller turloughs while spring water inputs predominate in the larger turloughs. It is thought that direct run-off water would contain more nutrients and being less extremely calcareous that such nutrients, especially phosphours, would be more readily available.

Community 2a(iii) Carex disticha/Menyanthes trifoliata

Cowardin Classification - Ecosystem: palustrine
vegetated
Class: emergent wetland
Order: mineral
Habitat: semi-permanently flooded, fresh, mineral rich, alkaline.

Phytosociology - probably in the Magnocaricion alliance. Vegetation dominated by large sedges in eu- to mesotrophic water on soft organic or mineral substrates. Often in a zone around open water behind reedswamps. May be related to Caricetum rostratae but is more eutrophic. Occurs throughout Europe but in Ireland distribution unknown.

Sample Number - 321

Average Number of Vascular plants per Sample - 30

Dominant Species - Carex disticha, Menyanthes trifoliata, Equisetum fluviatile, Utrichularia vulgaris agg.

Associated Species - Hippuris vulgaris, Caltha palustris

Structure - An extensive homogeneous marsh vegetation forming a quaking scraw in places. Water up to 30 cms deep (in summer) with Carex disticha and Menyanthes trifoliata emergents, cover 50%, and Utrichularia vulgaris agg. and Lemna trisulca submerged, cover 60%. Bryophytes poorly developed, mainly Calliergon giganteum. Flooded margins of turlough towards outlet dominated by Ranunculus trichophyllus, Eleocharis palustris, Alisma plantago-aquatica and Apium inundatum.

Distribution - Found only in Ballyglass Turlough.

Substrate - Mineral/mud.

Management - Apparently none. Possibly light grazing around drier margins.

Comments - A well developed community with similarities to the Carex rostrata Marsh type (18). This turlough appears to drain northwards into Mountpleasant School Turlough through a swallow hole which lies on the upper rim of the turlough basin. The lower levels are permanently waterlogged and are probably eutrophic for the same reasons suggested for the other small turloughs.

Community 2b Flooded Pasture

Cowardin Classification - Ecosystem : palustrine
vegetated
Class : emergent wetland
Order : mineral
Habitat : temporarily flooded, fresh, alkaline.

Phytosociology - In the Agropyro-rumicion crispi alliance and probably the Ranunculo -potentilletum association. Both natural and anthropogenic vegetation of disturbed ground and unstable habitats, consisting of rhizomatous and stoloniferous hemicryptophytes; in habitats with extremes of wetness and dryness.

Sample Number - 24, 28, 250, 252, 253, 256, 257.

Average Number of Vascular plants per sample - 15.7.

Dominant Species - Potentilla anserina, Agrostis stolonifera, Carex panicea, Carex nigra, Hydrocotyle vulgaris.

AssociatedSpecies - Galium palustre, Filipendula ulmaria, Carex hirta, Ranunculus repens, Mentha aquatica.

Structure - Low (5 cms) grazed grass/sedge swards, cover 65-85%. Bryophytes poorly developed, cover 10%, mainly Fontinalis antipyretica and Cinclidotus fontinaloides (on rocks and trees). Chara species present in this zone in Mountpleasant School Turlough, cover 20%.

Distribution - Most extensively developed on the temporarily flooded margins of Mountpleasant School, Slishmeen and Rathnacreeva Turloughs and to a lesser extent at Burren, Carrowreaghmony, Deerpark and Ballyglass Turloughs. Also occurs at the small turlough in Cornfield Townland in the extreme south of the Ballyglass catchment.

Substrate - Mineral/Marl

Management - Heavily grazed and poached during summer.

Comments - This vegetation type intergrades with grass dominated pasture above high water mark through a transitional zone marked by the presence of Juncus bulbosus, Leontodon autumnalis and Trifolium repens.

Vegetation Type 3. Bogs - total area 340.85 ha

Community 3a - Actively Growing Acid Bog Areas

Cowardin Classification - Ecosystem: palustrine
vegetated
Class : moss/lichen wetland
Order : organic
Habitat : saturated, fresh, acid

Phytosociology - Calluno - sphagnion papillosi alliance. Vegetation of deep, waterlogged peat (acid pH 3.2 - 4.2). This area is in the transition from Erico- sphagnetum magellanici (raised bog) to Pleurozio purpureae-Ericetum tetralicis (atlantic blanket bog) associations. It contains more blanket than raised bog elements but this may be due to disturbance. The Erico- sphagnetum magellanici occurs in the Atlantic sector of Europe and is now rare.

Sample Number - 5

Average Number of Vascular plants per Sample - 13

Dominant Species - Sphagnum subnitens, Sphagnum capillifolium, Eriophorum angustifolium, Molinia caerulea.

Associated Species - Narthecium ossifragum, Drosera rotundifolia, Rynchospora alba, Sphagnum auriculatum var. auriculatum, Sphagnum palustre, Sphagnum papillosum.

Structure - Hummocky terrain dominated by Sphagnums and Eriophorum angustifolium. Herb layer 30 cms, cover 30-80%. Bryophytes well developed, cover 90%. Water table just below ground surface.

Distribution - Limited to the remaining wet, acid areas. Most widespread on the Carrowmore North Townland bog in the northeast of the Annies catchment.

Substrate - Acid peat.

Management - Peat cutting and grazing by sheep.

Comments - Limited in extent in the two catchments as a whole. The presence of such species as Pteridium aquilinum, Salix atrocinerea, and Campylopus introflexus amongst this type indicates considerable disturbance by drainage and probably by burning.

Community 3b Bog Pools

Cowardin Classification - Ecosystem: palustrine
vegetated

Class: submergent beds/emergent wetland
Subclass: algal/vascular
Order: organic
Habitat: permanently flooded, fresh, acid/circumneutral.

Phytosociology - contains elements of the Phragmition, Magnocaricion, Rynchosporion albai, Caricion curto-nigrae alliances and the Charetea fragilis class. This type of habitat is widespread in Ireland but decreasing due to reclamation.

Sample Number - 8, 75.

Average Number of Vascular plants per Sample .- 10.5.

Dominant Species - Carex rostrata, Utrichularia intermedia, Potamogeton polygonifolius, Sphagnum cuspidatum.

Structure - Usually more or less rectangular pools of open water, depth up to 50 cms, formed by peat cutting. Phragmites autralis is an occasional emergent species. The sides of the pools are frequently colonised by the bryophytes Riccardia pinguis, Riccardia multifida, Campylium stellatum and Bryum pseudotriquetrum and the insectiverous Drosera rotundifolia and Pinguicula vulgaris. The Royal Fern Osmunda regalis was occasionally seen by the edges of pools.

Distribution - Widespread throughout both catchments.

Substrate - Usually peat but often cut down to fen peat or marl.

Management - None

Comments - The calcicole species such as Drepanocladus revolvens, Campylium stellatum, Riccardia pinguis and Charas etc. indicate relatively high pH conditions, possibly where pools have been cut down to fen peat or where there is ground water influence.

Community 3c Dry Ridges

Cowardin Classification - non-wetland or as 3b

Phytosociology - Calluno-ulicetea class, possibly belonging to the Sarothamnion scopariae alliance. On dry edges of drained or burned bogs. Euatlantic, widespread in Ireland on acid soils or thin peat.

Sample Number - 33, 52, 74, 77, 84, 88, 93, 122, 124, 217.

Average Number of Vascular plants per Sample - 13.8

Dominant Species - Calluna vulgaris, Molinia caerulea, Carex panicea, Hypnum jutlandicum, Cladonia portentosa.

Associated Species - Erica tetralix, Ulex europaeus, Potentilla erecta, Sphagnum subnitens.

Structure - Dry ridges between cutaway areas dominated by dwarf shrubs of Calluna vulgaris ranging in height between 5-50 cms depending on grazing and burning. Cover is variable, between 10-90%. The ferns Pteridium aquilinum, Osmunda regalis and Blechnum spicant, are occasional associates. Herb layer is dominated by Molinia caerulea and Carex panicea with some Potentilla erecta with a generally low cover of around 20%. Bryophytes are often abundant with cover often in excess of 90%, dominated by Sphagnum species and Hypnum jutlandicum. Lichens are also well developed, predominantly the species Cladonia portentosa, with cover values up to 60%.

Distribution - Widespread throughout both catchments

Substrate - Peat

Management - Occasional burning and grazing by sheep

Community 3d Molinia Dominated Areas

Cowardin Classification - as for 3b

Phytosociology - intermediate between the Cirsio-molinietum association (unmanured wet meadows on poor soils which dry out in summer) and the Calluno-ulicetea shrub heathland class. The Cirsio-molinietum association has a boreo-atlantic distribution but is rare in Germany and the Benelux countries. It's distribution in Ireland is unknown but probably widespread.

Sample Number - 37, 51, 54, 55, 60, 78, 98, 126, 131, 167, 202, 203, 207, 218.

Average number of Vascular plants per Sample - 16.9.

Dominant Species - Molinia caerulea

Associated Species- Succisa pratensis, Calluna vulgaris, Erica tetralix, Cirsium dissectum, Anthoxanthum odoratum, Carex panicea, Potentilla erecta.

Structure - Often a hummocky or tussocky terrain dominated by Molinia caerulea with Succisa pratensis and Potentilla erecta as the more frequent associate species. Height of herb layer up to 30 cms, cover 85%. Bryophytes and lichens poorly developed and usually absent.

Distribution - Widespread throughout both catchments. The most extensive areas occur to the north of the former Lough Beg in Carrowmore North Townland bog.

Substrate - Peat

Management - Grazed by sheep and probably frequently burned.

Comments - The species Calluna vulgaris and Erica tetralix are often present in small quantities in this community but are probably suppressed by burning and grazing.

Community 3e Areas cut down to Fen Peat or Marl

Cowardin Classification - Ecosystem: palustrine
vegetated
Class: emergent/shrub wetland
Order: organic/mineral
Habitat: saturated, seasonally flooded, fresh, alkaline/acid.

Phytosociology - Cirsio dissecti - Schoenetum nigricantis association with sometimes Myricetum gale association (Myrica gale dominated vegetation of the laggs and cutaways of raised and blanket bogs). The Circio-Schoenetum association occurs in western France and Britain and is widespread in Ireland but decreasing rapidly due to reclamation.

Sample Number - 11, 31, 53, 59, 61, 65, 69, 73, 76, 83, 89.

Average Number of Vascular plants per Sample - 16.1.

Dominant Species - Schoenus nigricans, Carex lepidocarpa, Carex panicea, Campylium stellatum

Associated Species - Eriophorum angustifolium, Carex nigra, Myrica gale, Pinguicula vulgaris.

Structure - A low tussocky vegetation dominated by Schoenus nigricans often in association with dwarf shrubs (30 cms) of Myrica gale. The herb layer is low (20 cms) and mostly comprised of sedges, predominantly Carex lepidocarpa. Herb cover, including the dominant tussocks of Schoenus nigricans is often up to 70%. Bryophytes are well developed, cover from 20-60%, most commonly the fen species Campylium stellatum, Drepanocladus revolvens, Preissia quadrata and sometimes Scorpidium scorpioides in the occasional pool of open water.

Distribution - Widespread but local and not very extensive.

Substrate - Fen peat or marl.

Management - Probably grazed by sheep

Comments - A not very well defined community but encountered frequently enough to warrant description. Myrica gale is sometimes dominant and may replace Schoenus nigricans in more acid conditions as in the case of the bog north of the lower reaches of Annies River in Rinaneel Townland.

Vegetation Type 4 Reedbeds - total area 40.87 ha.

Community 4 a(i) Scirpus lacustris

Cowardin Classification - Ecosystem: lacustrine/palustrine
Subsystem: littoral
vegetated
Class: emergent wetland
Order: mineral/(organic)
Habitat: permanently flooded, fresh, alkaline.

Phytosociology - Scirpo- phragmitetum association.
Vegetation of tall helophytes, mostly poor in species, often monodominant; in stagnant or slightly running water 0.2 - 3m deep. Widespread in Europe and in Ireland.

Sample Number - 267, 269, 279.

Average Number of Vascular plants per sample - 4.7

Dominant Species - Scirpus lacustris, Nuphar lutea.

Associated Species: Chara ruderis, Chara aculeata, Chara delicatula, Myriophyllum verticillatum.

Structure - Occurs as a narrow band (1-3m) in approximately 2m of water at the margins of the lakes. Emergent Scirpus lacustris ranges in height from 1-1.5m above water level. Submerged vegetation dominated by Chara species with a height of 20cms and cover from 20-60%. Floating leaves of Nuphar lutea occur. This vegetation type merges with the Lower Infra-littoral zone described under Lakes 1b, in deeper water and with the Phragmites australis community, described below, in shallower water.

Distribution - Occurs to varying extents on most of the lakes in the catchments but is apparently absent from Lough Beg. Sparsely developed on Lough Carra.

Substrate - Muddy marl.

Management - None.

Comments - The extent of this community is dependent upon exposure to wave action and the slope of lake shore. It is best developed around Cloonboorhy Lough but is restricted in extent around the Carronnacon Loughs.

Community 4a(ii) Phragmites australis

Cowardin Classification - as for 4a(i)

Phytosociology - Scirpo-Phragmitetum association (see 4a(i)) transition to Caricetum elatae association (see 4a(iii)).

Sample Number - 72, 114, 115, 268.

Average Number of Vascular plants per sample - 7

Dominant Species - Phragmites australis, Carex rostrata, Chara ruderis, Chara aculeata, Chara delicatula.

Associated Species - Carex elata, Chara desmacantha, Chara vulgaris, Fontinalis antipyretica.

Structure - Lake margin vegetation in 0.3-1.5 m standing water. Phragmites australis is usually dominant ranging in height from 1-2.5m. The associated species vary depending on the exposure of the shoreline. In sheltered areas the associated emergents may include Cladium mariscus and Carex lasiocarpa as well as Carex rostrata and Carex elata. Sheltered shore submergents include Utrichularia intermedia, Utrichularia vulgaris agg., Myriophyllum verticillatum, Sparganium emersum and a variety of Chara species. Submergent cover can vary from 25-40%. In exposed shore locations Phragmites australis becomes sparse and associated species may consist only of submerged Charas with a low cover value.

Distribution - Occurs to some extent around all of the lakes in the catchments but is best developed on Cloonboorhy Lough. The larger lakes, Cloonboorhy and Carrownacon North and South show marked differences in the developemnt of this community between sheltered and exposed shorelines.

Substrate - Marl or marly peat.

Community 4a (iii) *Carex elata*

Cowardin Classification - Ecosystem: palustrine
vegetated
Class : emergent wetland
Order : mineral
Habitat : semi-permanently flooded, fresh, alkaline.

Phytosociology - Caricetum elatae association. Vegetation dominated by sedges in eu- to mesotrophic water on soft organic or mineral substrates. Often in a zone around open water behind reedswamps of the alliance Phragmition. Distribution unknown but probably widespread in Ireland.

Sample Number - 41, 42, 43.

Average Number of Vascular plants per sample - 15.3

Dominant Species - *Phragmites australis*, *Carex elata*.

Associated Species - *Menyanthes trifoliata*, *Utrichularia spp* , *Chara spp* , *Filipendula ulmaria*, *Valeriana officinalis*.

Structure - Large tussocks (1m tall) of *Carex elata* with associated semi-terrestrial species *Filipendula ulmaria* and *Valeriana officinalis* interspersed with pools of open water (5-20cms deep) with tall (2m) emergent *Phragmites australis* and aquatic submergent Utrichularia and Chara species (cover 50-100%).

Distribution - Occurs south of the road bridge in the northern part of the former Ballyglass Lough.

Substrate - Marl

Management - None

Comments - Represents an early stage in the successional development from shallow lake to fen. Similar communities occur in places around the margins of Cloonboorhy and Carrownacon Loughs where Carex elata may grow with Phragmites australis.

Community 4b (i) *Carex paniculata*

Cowardin Classification - Ecosystem: palustrine
vegetated
Class : emergent/shrub wetland
Order : organic
Habitat : seasonally flooded, fresh, circum-neutral/alkaline.

Phytosociology - Caricetum paniculatae association with elements of the Alnion glutinosae alliance (fen vegetation dominated by *Alnus glutinosa* on waterlogged, neutral to acid peat). Widespread in Europe, probably once frequent in Ireland but now decreasing due to drainage and reclamation.

Sample Number - 70, 71, 85, 86.

Average Number of Vascular plants per sample - 7.3

Dominant Species - *Salix atrocinerea*, *Carex paniculata*, *Phragmites australis*, *Myriophyllum sp.*

Associated Species - *Alnus glutinosa*, *Betula pubescens*, *Filipendula ulmaria*, *Valeriana officinalis*, *Lemna trisulca*.

Structure - A swamp with transitions to woodland dominated by *Salix atrocinerea* with *Alnus glutinosa* and *Betula pubescens* growing to 6m in height. Large tussocks of *Carex paniculata* grow to 2m in height with areas of open water, 30cms deep, in between occupied by emergent *Phragmites australis* (2m in height) and submergent *Myriophyllum sp.* and *Lemna trisulca*.

Distribution - Occurs only around Lough Beg amidst a coniferous forest plantation and to a lesser extent on the northern margin of Lough Manan.

Substrate - Silty peat.

Management - Former attempts to plant conifers in this community have failed and at present there appears to be no management.

Comments - This community has a very restricted distribution both within the catchments and within the country as a whole. This sort of swamp reed bed is dependent on fluctuation high water levels and some nutrient enrichment from lake or stream flooding. The rare Marsh Fern, Thelypteris palustris, occurs in this community around Lough Manan.

Community 4b (ii) Carex nigra/Galium palustre

Cowardin Classification - as for 4b (i)

Phytosociology - Scirpo- Phragmitetum association transition to Magnocaricion alliance (sedge dominated). Vegetation of fresh to slightly brackish, still or gently flowing water, in sheltered places. Distribution unknown but probably widespread in Europe and in Ireland.

Sample Number - 35

Average Number of Vascular plants per sample - 15.

Dominant Species - Phragmites australis, Carex nigra, Galium palustre

Associated Species - Ranunculus lingua, Carex flacca, Menyanthes trifoliata, Mentha aquatica, Equisetum fluviatile.

Structure - Extensive Phragmites australis dominated reedbed. Height of reeds 2.5m, cover 80%. The ground flora is dominated by Carex nigra with Carex flacca (to 1m tall) and Galium palustre. The water table is at or near the ground surface, the wettest areas having an abundance of Menyanthes trifoliata and Equisetum fluviatile. Scattered bushes of Salix atrocinerea and some poorly growing Fraxinus excelsior also occur.

Distribution - Occurs only on the north bank of the Annies River, near the outlet, in Rinaneel Townland.

Substrate - Silty peat

Management - None

Comments - One of the largest (8 hectares) and certainly the most dense stand of Phragmites australis in the

catchments. This reedbed may be of relatively recent origin. Some evidence that the area was formerly a bog is provided by the 1837 Ordnance Survey 6 inch maps and by the presence of isolated Calluna vulgaris and Sphagnum dominated ridges within the reedbed. The reeds may have developed on cutaway bog that has become flooded through lack of maintainance of mid 19th century drainage channels. The continued existence of the present vegetation is dependent upon high water levels and occasional flooding by the Annies River bringing in nutrients. A small lake surrounded on the northern shore by Cladium mariscus occurs amidst the reedbed.

Community 4c Schoenus nigricans/Molinia caerulea

Cowardin Classification - Ecosystem : palustrine
vegetated
Class: emergent wetland
Order: organic
Habitat: seasonally flooded, fresh, alkaline.

Phytosociology - Scirpo-Phragmitetum association (4a(i))transition to Cirsio dissecti - Schoenetum nigricantis association (5).

Sample Number - 13, 19, 22, 23, 91, 95, 174, 208, 209, 210, 211, 232, 233, 235, 240, 245.

Average Number of Vascular plants per sample - 18.6.

Dominant Species - Schoenus nigricans, Molinia caerulea, Carex lepidocarpa, Campylium stellatum.

Associated Species - Phragmites australis, Carex nigra, Carex rostrata, Succisa pratensis, Angelica sylvestris, Filipendula ulmaria, Equisetum fluviatile, Scorpidium scorpioides, Chara hispida.

Structure - Often a tussocky vegetation dominated by Schoenus nigricans and/or Molinia caerulea and Carex lepidocarpa, to a height of 40 cms. Phragmites australis is generally sparse with a cover of around 10% and ranging in height from 1-2 m. Bryophytes are well developed between tussocks, the most abundant species being Campylium stellatum, Drepanocladus revolvens and Scorpidium scorpioides. The latter species is found together with Chara hispida in the occasional patches of open water that occur between tussocks.

Distribution	-	Most extensively developed on the site of the former Lough Beg in the Carrowmore North Townland but also occurs to the north of Loughs Frank and in isolated patches throughout the catchments.
Substrate	-	Fen peat or marl.
Management	-	None
Comments	-	A rather heterogeneous and variable community representing a transitional stage in fen development. The Lough Beg infill is probably the best example of this community in the catchments. The Mud Sedge, Carex limosa and the Marsh Stitchwort, Stellaria palustris have their only stations in the catchments at this site.

Vegetation Type 5 Schoenus Marsh - total area 22.78 ha

Cowardin Classification - Ecosystem: palustrine/lacustrine vegetated
Class: emergent wetland
Order: mineral/organic
Habitat: seasonally flooded flats, fresh, alkaline.

Phytosociology - Cirsio-dissecti - Schoenetum nigricantis association. Rich fen vegetation. Occurs in western France and Britain. Widespread in Ireland but decreasing rapidly due to land reclamation.

Sample Number - 19, 23, 36, 49, 97, 101, 103, 117, 175, 178, 205, 206, 225, 230, 231, 243.

Average Number of Vascular plants per Sample - 19.5.

Dominant Species - Schoenus nigricans, Carex lepidocarpa, Campylium stellatum

Associated Species - Carex panicea, Molinia caerulea, Succisa pratensis, Scorpidium scorpioides.

Structure - Tussocky terrain of Schoenus nigricans to 60 cms in height and cover of 60% with bryophytes well developed especially Campylium stellatum and Scorpidium scorpioides and occasionally also Preissia quadrata and Riccardia pinguis. Herb cover is usually low at less than 15% and the water table is generally at or slightly above ground level.

Distribution - Widespread but mostly in the Annies catchment. Occurs on marl or marly peat where peat has been removed for turf as in the Carrowmore North Townland bog or on marl around lakes as at Cloonboorhy and Carrownacon.

Vegetation Type 6 — Carex elata Marsh - total area 15 ha

Cowardin Classification

Ecosystem : palustrine vegetated
Class : emergent wetland
Order : mineral
Habitat : semi-permanently flooded, fresh, alkaline.

Phytosociology - Caricetum elatae association, sedge dominated vegetation (see 4a (iii)). Distribution unknown but probably widespread in Ireland.

Sample Number - 44, 46, 47.

Average Number of Vascular plants per sample - 14

Dominant Species - Carex elata, Menyanthes trifoliata, Chara spp

Associated Species - Juncus articulatus

Structure - At its most extreme this community is characterised by very low species diversity with Carex elata forming large tussocks over 1m in height. Areas of open water 20cm deep occur between tussocks which are dominated by Chara species (100%) and occasionally abundant Menyanthes trifoliata.

Distribution - Extensively developed on the site of the former Ballyglass Lough but also occurs as a marginal band of vegetation backing reedbeds at Cloonboorhy and Carrownacon South.

Substrate - Marly mud

Management - None

Comments - A transition stage in fen development particularly well exemplified at Ballyglass Lough.

Vegetation Type 7 — Coniferous Plantation - total area 55.8 ha

Cowardin Classification - Ecosystem : palustrine vegetated
Class : forested wetland
Subclass : evergreen
Habitat : temporarily flooded, fresh, alkaline/acid (farmed).

Phytosociology - not examined. Widespread vegetation.

Dominant Species - Picea abies, Pinus contorta, Pinus sylvestris, Picea sitchensis.

Structure - Conifers planted since the early 1950's with small amounts of Fraxinus excelsior, Alnus glutinosa, and Acer pseudoplatanus. Heights of conifers range to 12m. Yield classes range from 8 for Picea abies and Pinus contorta on thin peat over marl to 22 for Pinus sylvestris on mineral soil. The ground flora is severely impoverished or absent.

Distribution - On the site of a former estate woodland at Towerhill Demesne.

Substrate - Peat, silty peat and mineral.

Management - By Forest and Wildlife Service.

Vegetation Type 8 Hazel Scrub and Mixed Woodland - total area 135 ha.

Community 8a Hazel Scrub

Cowardin Classification - Mostly non wetland.

Ecosystem	: palustrine (in part) vegetated
Class	: shrub/forested wetland
Subclass	: deciduous
Order	: mineral
Habitat	: saturated/temporarily flooded, fresh alkaline.

Phytosociology - Corylo-Fraxinetum subassociation typicum. Species rich damp Hazel-Ash woodland. Widespread in Britain and Ireland but fragmentary.

Sample Number - 14

Average Number of Vascular Plants per Sample - 25

Dominant Species - Corylus avellana, Prunus spinosa, Crataegus monogyna, Fragaria vesca, Oxalis acetosella, Rhytidiadelphus triquetrus, Eurhynchium striatum.

Associated Species - Rubus fruticosus, Circaea lutetiana, Potentilla sterilis, Geranium robertianum, Arum maculatum, Fraxinus excelsior.

Structure - Corylus avellana and Crataegus monogyna woodland with closed canopy at 4m and cover 85%. Understorey dominated by shrubs of Prunus spinosa (2m high) and occasional clumps of Rubus fruticosus. Herb layer poorly developed with a cover of less than 20%. Bryophytes well developed with cover from 30-60%, mostly Rhytidiadelphus triquetrus and Eurhynchium striatum with Ulota crispa, Radula complanata and Frullania tamarisci common as epiphytes on the trees.

Distribution - The most widespread type of semi-natural woodland in this part of County Mayo. Occurs most extensively in the catchments in the south-east of the Ballyglass in Creggarve Townland. Also occurs extensively two miles north-west of Cloonboorhy Lough in Catford Townland. Smaller pockets of this community are found scattered throughout both catchments.

Substrate - Usually on thin mineral soil over limestone, often with limestone boulders strewn around, or on limestone pavement.

Management - Usually heavily grazed by cattle, sometimes coppiced.

Comments - Considerable species diversity amongst the herbs and bryophytes. If left would develop the climax community for this region (Moore (36)).

Community 8b Alder Wood

Cowardin Classification - Ecosystem: palustrine
vegetated

Class: forested wetland
Subclass: deciduous
Order: organic
Habitat: saturated/temporily flooded, fresh, circumneutral.

Phytosociology - probably Carici remotae-Fraxinetum association. Occurs in western and central Europe and probably widespread in Ireland but fragmentary and declining due to reclamation and grazing.

Sample Number - 149

Average number of Vascular plants per sample - 23

Dominant Species - Alnus glutinosa, Rubus fruticosus, Prunus spinosa, Circaea lutetiana, Geum urbanum, Ranunculus repens, Thuidium tamariscinum, Eurhynchium striatum.

Associated species - Crataegus monogyna, Fraxinus excelsior, Angelica sylvestris, Epilobium montanum, Agrostis stolonifera, Mentha aquatica, Pellia epiphylla, Plagiomnium undulatum.

Structure - Alnus glutinosa woodland with some Fraxinus excelsior to about 10 m, cover 55%. Shrub layer dominated by Prunus spinosa (4m tall), cover 20% and undershrub by Rubus fruticosus to 70 cms, cover 40%. Herb layer mostly of Circaea lutetiana and Ranunculus repens, height 30 cms, cover 30%. Bryophytes, mainly Thuidium tamariscinum and Eurhynchium striatum, cover 30%, leaf litter cover 15% and bare soil 15%.

Distribution	-	Restricted to Carrowslattery Townland in the southern part of the Ballyglass catchment. A similar but less well developed community occurs in small amounts amongst the coniferous plantation.
Substrate	-	Silty peat
Management	-	The small wood at Carrowslattery Townland is currently being felled for land clearance.
Comments	-	This community is probably subject to occasional flooding.

Community 8c — Wet Birch Scrub

Cowardin Classification - Ecosystem: palustrine
vegetated
Class: forested wetland
Subclass: deciduous
Order: organic
Habitat: seasonally flooded, fresh, circumneutral.

Phytosociology - transitional between Alno-Salicetum cinereae association and the Alnion glutinosae alliance. Fen woodland on very shallow, neutral to acid peat, or mineral soil, frequently waterlogged. The Alnion glutinosae alliance is widespread in Europe, frequent in Ireland but generally poorly developed. The Alno-salicetum cinereae association is Atlantic to Subcontinental but its distribution in Ireland is unknown.

Sample Number - 87

Average Number of Vascular plants per sample - 22.

Dominant Species - Betula pubescens, Salix atrocinerea Alnus glutinosa, Rubus fruticosus, Carex paniculata, Filipendula ulmaria, Agrostis stolonifera, Holcus lanatus.

Associated Species - Sorbus aucuparia, Ilex aquifolium, Crataegus monogyna, Phragmites australis, Lythrum salicaria, Calliergon cuspidatum.

Structure - Betula pubescens, Salix atrocinerea and Alnus glutinosa dominated woodland from 5-7m tall, cover 65% with large tussocks of Carex paniculata (1.5m tall) and grassy open areas with Rubus fruticosus, Filipendula ulmaria, Agrostis

stolonifera and Holcus lanatus. Herb layer to 30 cms, cover 40%. Bryophytes poorly developed, mostly Calliergon cuspidatum and Rhytidiadelphus triquetrus, cover 10%.

Distribution - Occurs around Lough Beg and southwards from the lake along the Annies River to the Mill Bridge at Clooneencarra. Restricted to this one area in the catchments and possibly rare in the county.

Substrate - Peat

Management - Attempts at afforestation with conifers in this area failed. At present no management.

Comments - This community is dependant upon high water levels and periodic flooding.

Vegetation Type 9. Gorse Scrub - total area 51 ha.

Cowardin Classification - mostly non-wetland
Ecosystem: palustrine (in part) vegetated
Class: shrub wetland
Subclass: evergreen
Order: organic
Habitat: saturated, fresh, acid.

Phytosociology - Ulici-Ericion cinereae alliance. Euatlantic gorse heathland, widespread in Ireland.

Sample Number - 204

Average Number of Vascular plants per sample - 12.

Dominant Species - Ulex europaeus, Molinia caerulea

Associated Species - Calluna vulgaris, Agrostis tenuis, Potentilla erecta, Succisa pratensis.

Structure - Ulex europaeus dominated scrub ranging in height from 1-2.5m and in cover from scattered bushes to 100%. Ground flora beneath shrubs absent but in open areas between bushes dominated by Molinia caerulea, height to 70cms, cover 50%. Bryophytes poorly developed or absent.

Distribution - Widespread throughout both catchments and usually though not always associated with the drier areas of bog. Most extensively developed in the Lissalacaun Townland in the north of the Ballyglass catchment.

Substrate - Peat or mineral.

Management - Lightly grazed by cattle and sheep.

Vegetation Type 10 Pasture and Arable total area 3,300 ha.

Community 10a Pasture

Cowardin Classification - Non-wetland

Phytosociology - Centaureo- Cynosuretum subassociation typicum. Moderate quality pastures rich in weeds and poor yield grasses, extremely common and widespread in Ireland.

Sample Number - 300,302,303,306,307,308,309.

Average Number of Vascular Plants per sample - 12.1

Dominant species - Lolium perenne, Agrostis tenuis, Holcus lanatus, Trifolium repens, Dactylis glomerata, Cynosurus cristatus.

Structure - Agricultural grassland, usually grazed pasture. Herbs 5-10 cms tall, cover 50-90%. Bryophytes poor or absent, where present predominantly Eurhynchium praelongum and Brachythecium rutabulum.

Distribution - The dominant vegetation type of the catchments occupying approximately 71% of the total area.

Substrate - Mineral soil, mostly Brown Earths and Grey Brown Podzolics of limestone origin.

Management - Mostly grazed by cattle and sheep and occasionally by horses and donkeys.

Comments - Locally variable in species composition depending on management activity i.e. reseeding, fertilizer application etc.

Community 10b

Arable

Not sampled but certainly very limited in extent (probably less than 2% (60 hectares) of the currently available agricultural land). From casual observation the main crops appear to be barley and potatoes with some vegetable production (cabbage, onions, etc.).

Vegetation Type 11 Improved Wet Pasture - total area 308.2 ha.

Cowardin Classification - Ecosystem : palustrine
vegetated
Class: emergent wetland
Order : organic
Habitat : saturated, fresh, circumneutral.

Phytosociology - Senecioni - Juncetum acutiflori and Junco acutiflori-Molinietum associations.. Grassland vegetation of wet soils, where rainfall exceed 1000mm per year. On poorly drained soils or sometimes developed on cutover peat. The European distribution of these associations is not known but in Ireland they appear to be widespread.

Sample Number - 16, 20,21,29,48,50,56,57, 66, 67,79,80,90,92,94,104 121,123,127,128,130,131,144,145,150,152,153,154, 155,156,157,158,159,168,170,171,172,173,176,177, 179,180,181,182,183,184,186,187,191,196,197,198, 199,214,216,219,222,224,226,237,242.

Average Number of Vascular plants per sample - 25.1

Dominant Species - Juncus effusus, Agrostis stolonifera, Calliergon cuspidatum, Ranunculus acris, Senecio aquaticus, Carex panicea, Trifolium repens.

Associated Species - Cirsium palustre, Ranunculus repens, Cynosurus cristatus, Potentilla anserina, Filipendula ulmaria.

Structure - Juncus effusus usually dominant and forming large tussocks up to 80cms in height. Herb layer between tussocks usually grazed and poached ranging from 5-30cms in height with a cover of from 80-100%. Bryophyte diversity very low, mostly the species Calliergon cuspidatum which is often abundant.

Distribution - Widespread throughout both catchments but tending to occur most extensively in the upper reaches of the drainage network.

Substrate - Mostly peat or silty peat.

Management - Grazed mostly by cattle but characteristically poorly managed pasture.

Comments - A rather broad vegetation category encompassing a wide variety in species composition caused by differing management activities and intensities. The better managed areas may contain little or no Juncus effusus and a predominance of grasses whilst the less managed areas may have Juncus effusus completely dominant with very low grass cover. Some transitional areas, with an abundance of sedge species are also included in this type.

Vegetation Type 12 Lake/Floodplain Pasture - total area 36.4 ha

Cowardin Classification - Ecosystem : palustrine vegetated
Class : emergent wetland
Order : organic
Habitat : temporarily/seasonally flooded, fresh, alkaline.

Phytosociology - probably Carici nigrae- Juncetum articulati and/or Junco acutiflori- Molinietum associations (11). The former is a small sedge vegetation of poorly drained soils. The distribution of Carici nigrae- Juncetum articulati in Europe is unknown but in Ireland occurs around lake shores and wet dune hollows and is probably frequent. The Junco acutiflori- Molinietum is widespread in Ireland.

Sample Number - 16,17,18,100,102,107,108,109,110,116,120.

Average Number of Vascular plants per sample - 22

Dominant Species - Calliergon cuspidatum, Agrostis stolonifera, Carex nigra, Carex panicea, Juncus articulatus.

Associated Species - Galium palustre, Filipendula ulmaria, Prunella vulgaris, Potentilla anserina, Leontodon autumnalis.

Structure - Herb layer usually grazed and poached, height 15-20cm cover 75-85%. Bryophyte species diversity is low but Calliergon cuspidatum is frequently very abundant in this community with a cover ranging from 20-80%.

Distribution - Occurs around the flooded margins of Cloonboorhy and Carrownacon Loughs and to a lesser extent around Loughs Frank.

Substrate - Marly Peat

Vegetation Type 13. River Floodplain Pasture total area 55.6 ha

Cowardin Classification - Ecosystem: palustrine
vegetated
Class: emergent wetland
Order: organic/mineral
Habitat: seasonally flooded, fresh, alkaline/ circumneutral.

Phytosociology - Glycerio-Sparganion alliance possibly the Filipendulo-Iridetum pseudacori association. Vegetation of the banks of small streams and ditches which may dry out in summer. Occurs in western and central Europe and frequent in Ireland but decreasing.

Sample number - 135, 136, 137, 138, 146, 147, 192, 193, 194,195, 212, 213, 215.

Average Number of Vascular plants per sample - 21.1

Dominant Species - Agrostis stolonifera, Carex nigra, Hydrocotyle vulgaris, Calliergon cuspidatum.

Associated Species - Potentilla anserina, Glyceria fluitans, Nasturtium officinalis, Ranunculus repens, Ranunculus flammula, Senecio aquaticus, Iris pseudacorus, Galium palustre, Carex disticha, Juncus articulatus, Caltha palustris, Polygonum amphibium.

Structure - Variable depending upon grazing pressure. The less intensively grazed areas tend to be those which are more permanently flooded and in these situations Iris pseudacorus, Nasturtium offininalis and Caltha palustris may become dominant forming a tall (80 cms) herb layer as at Kilskeagh Townland, west of Mullingar Bridge. In less frequently

flooded situations species such as Glyceria fluitans, Agrostis stolonifera and Carex nigra may predominate. Bryophytes are usually poorly developed or absent but at some sites Calliergon cuspidatum was abundant.

Distribution - Found along the flooded margins of drains, ditches and rivers throughout both catchments. The most extensive and best developed example of this type occurs at Kilskeagh Townland, west of Mullingar Bridge.

Substrate - Silty peat or mineral.

Management - Often heavily grazed.

Comments - This type of vegetation is dependant upon high water levels and nutrient input through flooding of drains, ditches and rivers.

Vegetation Type 14 Wet Sedge Swards - total area 103.58 ha

Cowardin Classification - Ecosystem: palustrine
vegetated
Class: emergent wetland
Order: organic/mineral
Habitat: temporarily/seasonally flooded, fresh, acid-alkaline.

Phytosociology - probably Carici nigrae - Juncetum articulati (12) and/or Junco acutiflori - Molinietum associations. The latter association occurs in unmanured wet meadows on poor soils which dry out somewhat in summer. The distribution of the Carici nigrae - Juncetum articulati association in Europe is not known but in Ireland occurs around lake shores and wet dune hollows and is probably frequent. The Junco acutiflori - Molinietum is widespread in Ireland.

Sample Number - 30, 32, 34, 39, 45, 58, 63, 64, 68, 96, 99, 111, 118, 119, 125, 142, 148, 160, 162, 166, 200, 220, 221, 227, 228.

Average Number of Vascular plants per sample - 23.9

Dominant Species - Carex panicea, Carex flacca, Molinia caerulea, Cirsium dissectum, Calliergon cuspidatum.

Associated Species - Juncus articulatus, Mentha aquatica, Hydrocotyle vulgaris, Holcus lanatus, Succisa pratensis, Ranunculus flammula, Potentilla erecta.

Structure - Usually ungrazed sedge meadows (height 30-40 cms, cover 90%) dominated by Carex panicea and Carex flacca and frequently, though not always, by Carex lepidocarpa, Carex nigra, Carex hostiana, Carex echinata and Carex pulicaris. Other

frequent associates, which occasionally are dominant, include Molinia caerulea, Cirsium dissectum, Succisa pratensis, Potentilla erecta, Hydrocotyle vulgaris, Juncus articulatus and Mentha aquatica. Bryophyte species diversity is usually poor but the species Calliergon cuspidatium is usually present and occasionally covers 20%.

Distribution - Widespread throughout both catchments.

Substrate - Peat or marly peat.

Management - Poor pasture, occasionally heavily grazed.

Comments - This type of vegetation occurs mostly on drained bog margins, perhaps where pH is slightly higher and may be subject to flooding.

Vegetation Type 15. Dry Sedge Molinia Swards - total area 45.2 ha

Cowardin Classification - Ecosystem: palustrine
vegetated
Class: emergent wetland
Order: organic/mineral
Habitat: saturated (temporarily flooded?), fresh, acid?

Phytosociology - Junco acutiflori-Molinietum transition to Centaureo-Cynosuretum subassociation juncetosum. Moderate quality pastures rich in weeds and grasses of low agricultural value on deep, imperfectly drained, often gleyed soils derived from limestone. Probably widespread in Ireland.

Sample Number - 82, 105, 113, 129, 132, 133, 134, 143, 161, 163, 165, 169, 185, 188, 190, 201, 238, 244.

Average Number of Vascular plants per sample - 29.8

Dominant Species - Molinia caerulea, Carex panicea, Carex flacca, Anthoxanthum odoratum, Festuca rubra, Succisa pratensis, Cirsium dissectum.

Associated species - Potentilla erecta, Holcus lanatus, Agrostis tenuis, Trifolium pratense, Ranunculus acris, Calliergon cuspidatum.

Structure - Usually ungrazed species rich meadows dominated by the grasses Molinia caerulea, Anthoxanthum odoratum, Festuca rubra and the sedges Carex panicea and Carex flacca. Herb layer 30-60cms high, cover 95-100%. Bryophytes are poorly developed, where present predominantly Calliergon cuspidatum. The herbs Plantago lanceolata and Centaurea nigra are also quite frequently found in association with this type and in several sites attained dominance.

Distribution	-	Widespread throughout both catchments usually on the drier bog margins.
Substrate	-	Peat, mineral.
Management	-	Usually ungrazed meadows.
Comments	-	A species diverse type generally drier than the Wet Sedge Sward type. Usually found on peat, often near the peat/mineral transition, and probably occasionally flooded.

Vegetation Type 16 Dry Tall Herb - total area 10.9 ha

Cowardin Classification - Ecosystem: palustrine
vegetated
Class: emergent wetland
Order: organic
Habitat: temporarily flooded fresh, circumneutral.

Phytosociology - Filipendulion alliance. Seldom grazed or mown tall grassland vegetation of continuously wet areas along rivers, streams and ditches on humus and mineral rich soils where organic matter is deposited. Distribution unknown, probably widespread in Ireland and decreasing rapidly.

Sample Number - 38, 81,140, 141, 164.

Average Number of Vascular plants per sample - 23.4

Dominant Species - Filipendula ulmaria, Carex flacca, Agrostis stolonifera, Festuca arundinacea.

Associated species - Lythrum salicaria, Phalaris arundinacea, Carex disticha, Valeriana officinalis.

Structure - A tall dense vegetation from 50-150 cms high, cover 100% forming a hummocky or tussocky terrain. Bryophytes poorly developed or absent.

Distribution - Limited in extent and generally not well developed in either catchment. Where it does occur it is confined to the lower reaches of the rivers. Perhaps the best example of this type is found west of the road bridge over the Ballyglass River near the outlet.

Substrate - Peat or silty peat.

Management - None.

Comments - This type of community is probably related to the River Floodplain type in that it requires some nutrient input from flooding but it generally occurs in areas with a slightly lower water table and is probably only occasionally flooded.

Vegetation Type 17 Scraw - total area 1.6 ha.

Cowardin Classification - Ecosystem : palustrine vegetated
Class : emergent wetland
Order : organic
Habitat : semi-permanently flooded/saturated, fresh, alkaline.

Phytosociology - Scirpo- phragmitetum association (4a (i)) transition towards Caricetum elatae association (6). Probably widespread in Ireland but decreasing.

Sample Number - 40.

Average Number of Vascular plants per sample - 20.

Dominant Species - Menyanthes trifoliata, Sparganium erectum, Scirpus lacustris, Equisetum fluviatile, Hippuris vulgaris.

Associated Species - Carex elata, Alisma plantago-aquatica, Apium nodiflorum, Agrostis stolonifera.

Structure - A floating mat of vegetation forming a quaking scraw. Herbs 30-70cms tall, cover 100%. Bryophytes absent.

Distribution - Only occurs to the north of the road bridge at Ballyglass Marsh.

Substrate - Mud

Management - None

Comments - A transitional vegetation type overgrowing shallow open water.

Vegetation Type 18 Carex rostrata Marsh - total area 3.8 ha

Cowardin Classification - Ecosystem : palustrine vegetated
Class : emergent wetland
Order : organic/mineral
Habitat : semi-permanently flooded fresh, alkaline.

Phytosociology - Caricetum rostratae and Caricetum lasiocarpae associations. The former is a base - poor swamp vegetation usually found along the contact zone between quaking areas and more terrestrial communities. The latter is a mesotrophic vegetation, usually confined to the waterlogged marginal areas around fens. Found in northern, central and western Europe and probably frequent in Ireland.

Sample Number - 223,318.

Average Number of Vascular plants per sample - 19

Dominant Species - Carex rostrata, Eriophorum angustifolium, Menyanthes trifoliata, Chara globularis, Chara hispida var. major.

Associated Species - Potamogeton coloratus, Carex nigra, Carex lasiocarpa, Equisetum fluviatile, Utrichularia vulgaris.

Structure - Marsh area under 50cms of water with Carex rostrata the dominant emergent (50cms high, cover 50-70%) and Chara species the dominant submergent (Cover 15-80%). Bryophytes mainly Calliergon giganteum and Scorpidium scorpioides (cover 10%).

Distribution - As scattered isolated patches in the north of the Ballyglass catchment.

Vegetation Type 19 Rivers and Drains

Cowardin Classification - Ecosystem : riverine
Subsystems : high gradient/low gradient reaches
Class : pools/riffles/bottom/submergent/floating-leaved/emergent wetland
Subclass : fine/course/rock/algal/vascular
Order : mineral
Habitat : semipermanently/permanently flooded, fresh, alkaline/circumneutral, channelised.

Phytosociology - Glycerio- Sparganion alliance, probably Apio-Veronicetum beccabungae association occurring in drains which tend to dry out in summer. Distribution unknown but probably frequent in Ireland. Apion nodiflori alliance, probably Apio- sietum association occurring in clear, eutrophic, mostly calcareous or slightly brackish, running water. Occurs in Mediterranean and Atlantic Europe and possibly common in Ireland. Potameto- . Nupharetum association occurring in slow flowing river stretches. Possibly widespread in Ireland. Charion asperae alliance on marl substrates, widespread in Irealand.

Sample Number - 271,272,273,274,275,276,277,282,283,284,285, 286,287,288,289,290,291,292,293,294,295,296, 297,298,299.

Average Number of Vascular plants per Sample - 8.3.

Dominant Species - Apium nodiflorum, Nasturtium officinalis.

Associated Speices - Sparganium erectum, Mentha aquatica, Callitriche obtusangula, Glyceria fluitans, Hippuris vulgaris Lemna minor, Potamogeton natans, Equisetum fluviatile.

Structure - Vegetation of drains and ditches frequently dominated by Apium nodiflorum and Nasturtium officinalis with Glyceria fluitans. Myosotis scorpioides and Mentha aquatica on mineral soils. Drains sometimes dominated by Chara hispida, C. ruderis, C. aculeolata and other Chara spp on marl substrate. Faster flowing riffle/pool and deep regraded stretches usually devoid of vegetation but sometimes with Apium nodiflorum, Fontinalis antipyretica and Rynchostegium riparioides. Slower flowing reaches near the outlets often choked with vegetation, particularly by submergent Apium nodiflorum and Nasturtium officinalis, emergent Sparganium erectum, Hippuris vulgaris and Alisma plantago-aquatica and floating leaved Nuphar lutea and Potamogeton natans.

Distribution - Drain and ditch vegetation common throughout both catchments, particularly the upper reaches. Riffle/pool sequences well developed at Mullingar Bridge and above Lough Beg. Deep regraded stretches found downstream of Loughs Frank and Carrownacon South and elsewhere. Slow flowing canal-like stretches confined to the lower reaches of both rivers. For a more detailed description of riverine morphology see hydrobiologist's report.

Substrate - Extremely variable from bare rock, boulders, gravels, silt, peat to marl.

Management - Mostly channalised in the 1850's. Little maintenance at present except for a limited amount of weed cutting.

Comments - The river system in these catchments has been strongly man-modified. Macrophyte vegetation

APPENDIX 3.6

Breakdown of Savings and Losses of Benefit by Omitting 8 Sites of Scientific Interest (Supplied by OPW)

Savings (£)	Mount-pleasant School Turlough	Ballyglass Turlough	Ballyglass Marsh	Lough Beg	Mullingar Bridge	Cloonboorhy Lough	Lough Manan	Lough Beg North	Approx-imate Total
Arterial Drainage Scheme	6,972	5,634	24,341	5,937	64,395	16,175	2,862	13,315	139,600
Field Drainage	7,729	1,534	7,204	8,604	4,130	5,775	3,296	4,130	42,400
A.D. Maintenance	6,045	2,655	8,756	5,932	8,474	6,610	1,469	3,559	43,500
F.D. Maintenance	2,771	550	2,582	3,084	1,480	2,070	1,181	1,480	15,200
Target Group Investment	13,470	2,674	12,555	14,995	7,198	10,065	5,744	7,198	73,900
Widening and Spoil	1,640	326	1,529	1,826	876	1,226	699	876	9,000
Fertilizers	2,388	474	2,226	2,658	1,276	1,784	1,018	1,276	13,100
Existing Maintenance	2,807	1,233	4,066	2,754	3,935	3,069	682	1,653	20,200
Total	43,822	15,080	63,259	45,790	91,764	46,774	16,951	33,487	356,900
Losses (£)									
Increase in Income	91,122	18,087	84,933	101,436	48,690	68,084	38,856	48,690	499,900
Saving in Maintenance	5,739	2,521	8,314	5,632	8,045	6,275	1,394	3,379	41,300
Saving in Purchases	219	43	204	243	117	163	93	117	1,200
A.D. Scheme	15,257	3,028	14,220	16,984	8,152	11,400	6,506	8,152	83,700
A.D. Maintenance	3,530	1,550	5,113	3,464	4,948	3,859	858	2,078	25,400
Field Drainage	1,367	271	1,274	1,522	730	1,021	583	730	7,500
Buildings	474	94	442	527	253	354	202	253	2,600
Total	117,708	25,594	114,500	129,810	70,935	91,156	48,492	63,399	661,600

APPENDIX 3.7

Costs for Management Programs

	Present Cost for 8 sites per year
Inspector Grade III for 1 week	£367
Forester in Charge for 2 weeks	£693
Ranger for 6 weeks	£1356
	£2416

Discounted @ 3½% for 50 years = £58,685 per 8 sites per 50 years
= £ 405 per ha for 50 years

FIGURE 1

MAP OF ANNIES AND BALLYGLASS CATCHMENTS

Reduced from 6 Inch (1:10,560) Ordnance Survey Maps (Mayo, Sheets 90, 100 & 110, 1931 Edition) to approximately 2½ Inches to a Mile (1:25,000)

——— Catchment Boundary

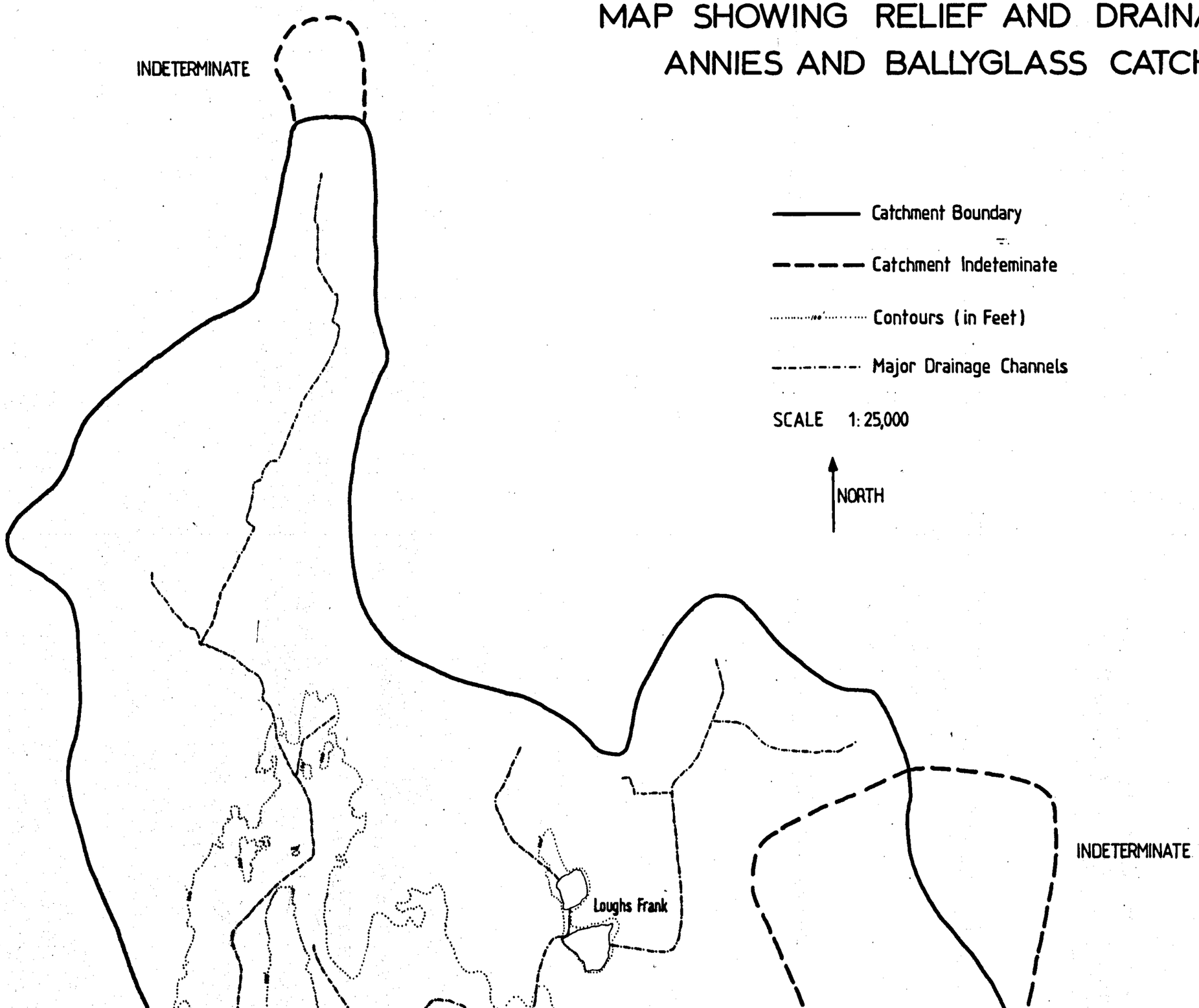
– – – – Catchment Indeterminate

NORTH

SCALE 1:25,000

FIGURE 2

MAP SHOWING RELIEF AND DRAINAGE ANNIES AND BALLYGLASS CATCHMENTS



Catchment Boundary

Catchment Indeteminate

Contours (in Feet)

Major Drainage Channels

SCALE 1: 25,000

NORTH

INDETERMINATE

Loughs Frank

Cloonboorty

Carrownacon North

ANNIES

Carrownacon South

Lough Beg

Lough Manan

BALLYGLASS

Rinaneel Tld.

Lough Carra

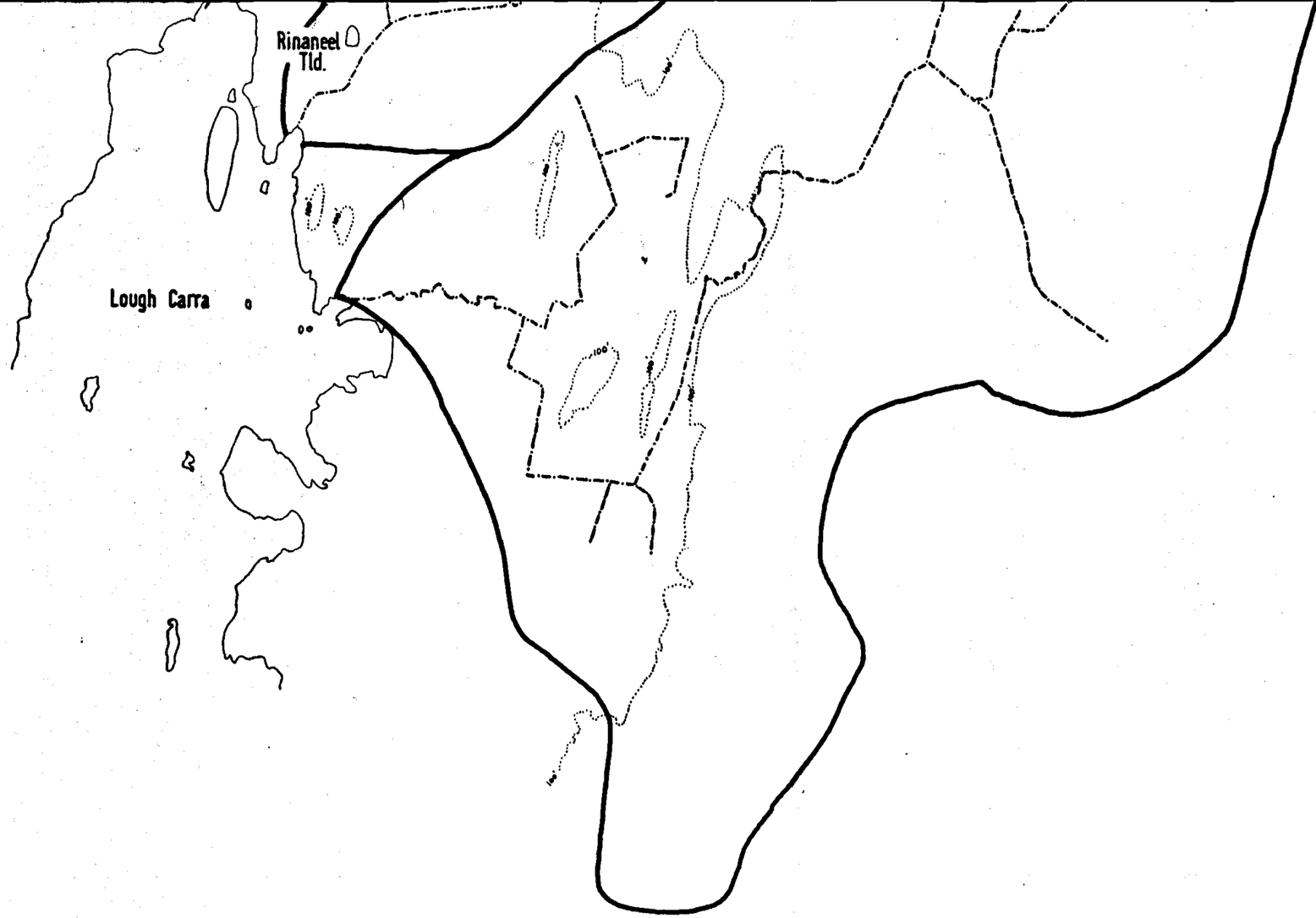
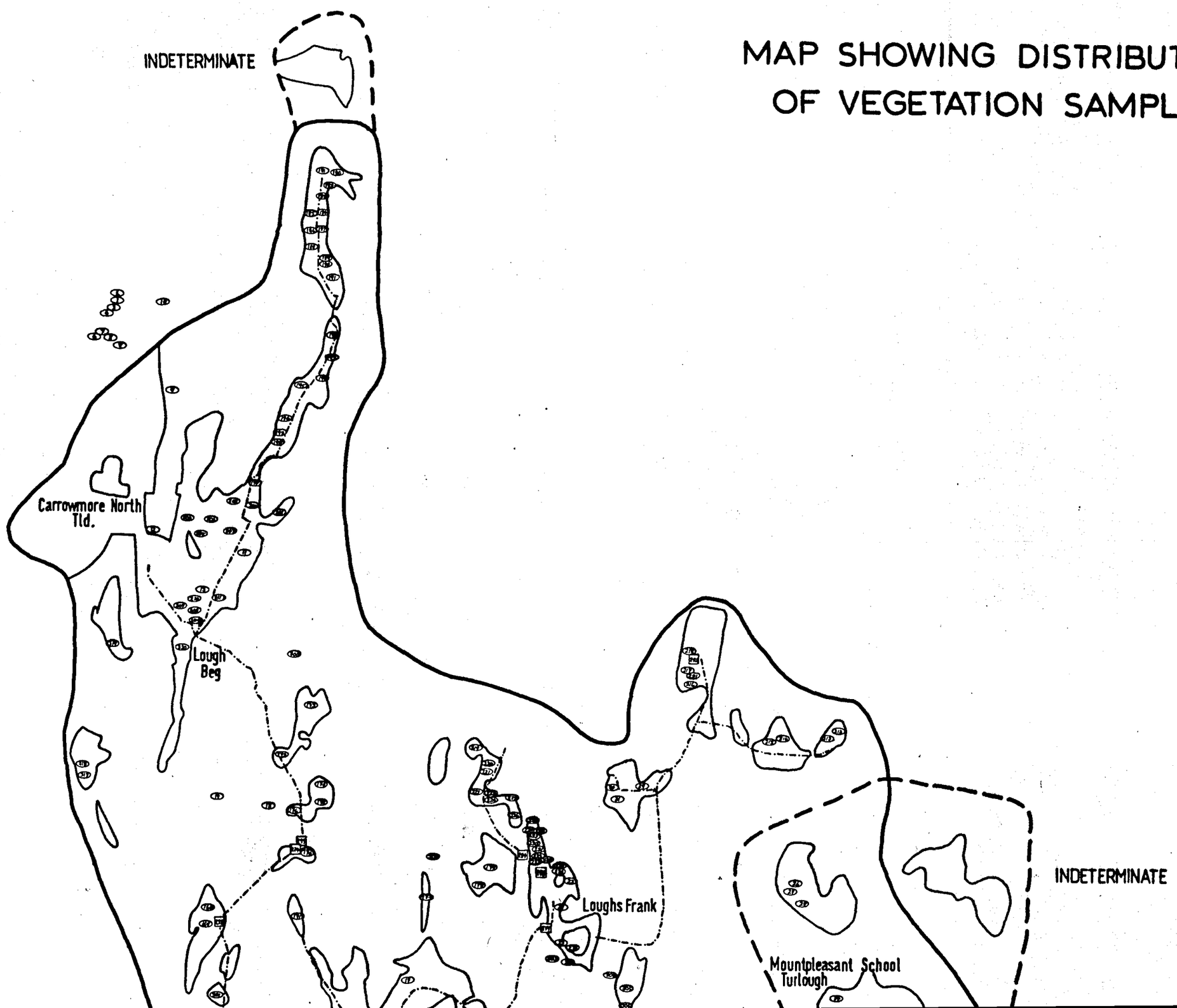
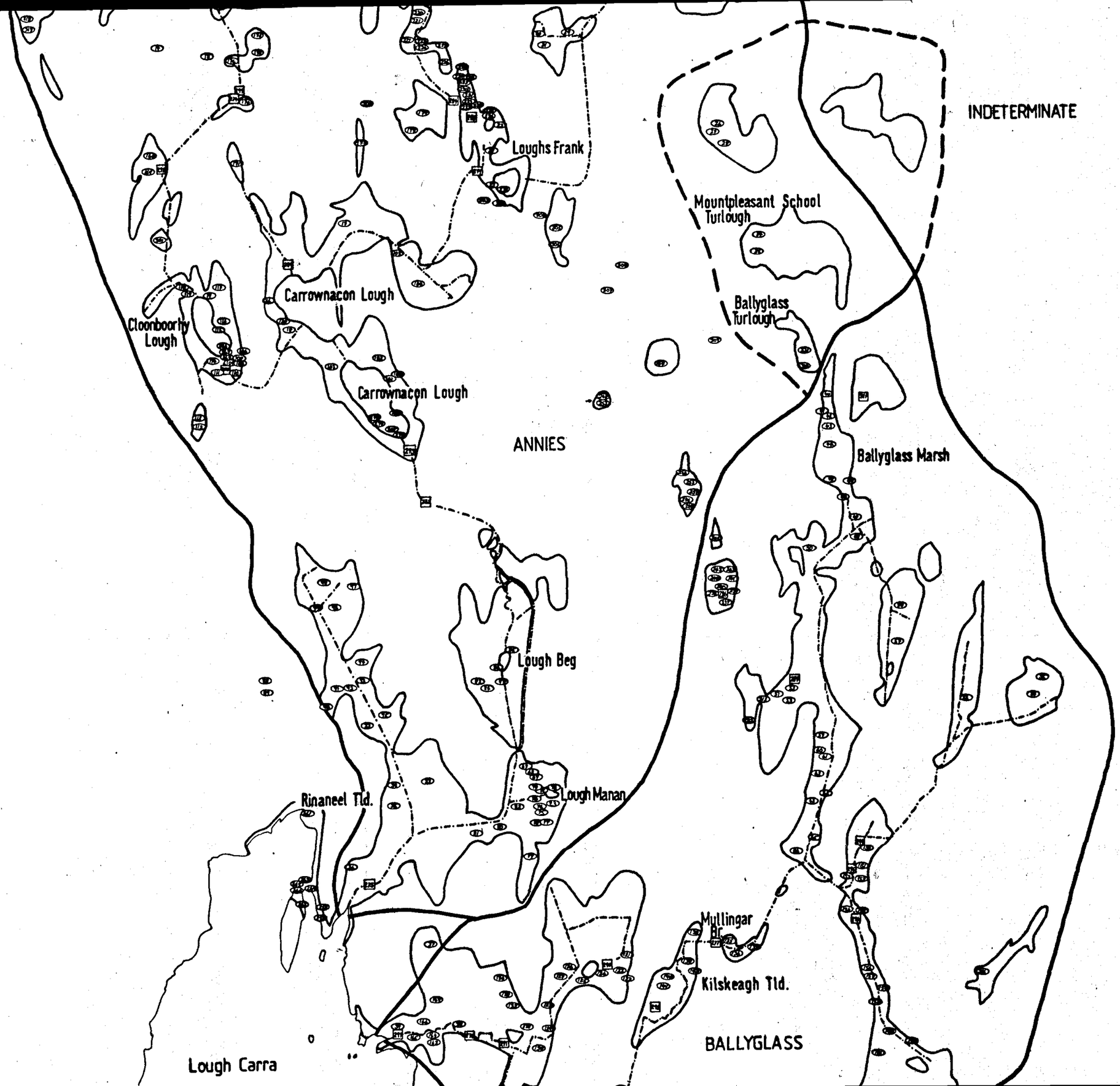
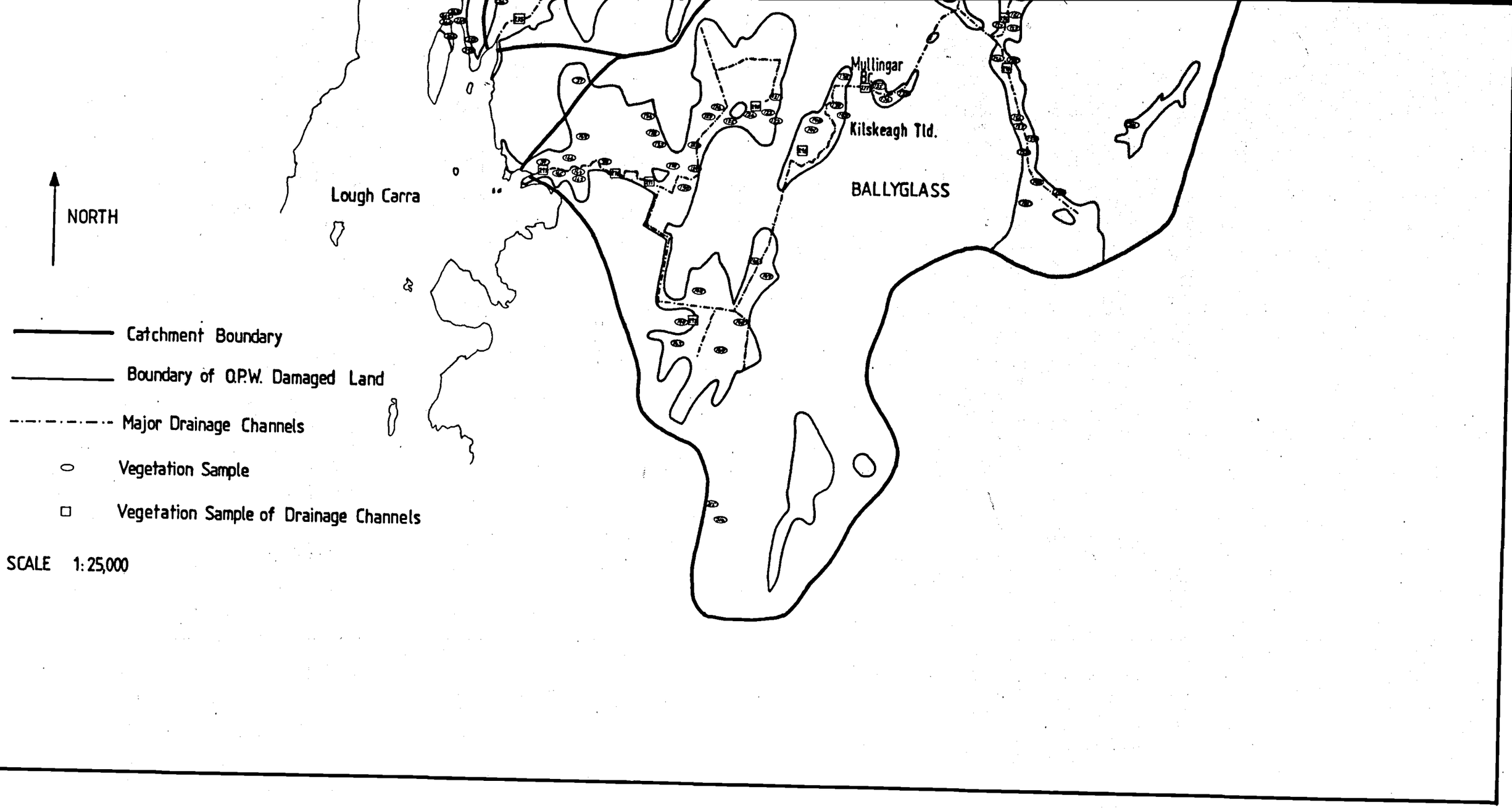

Rinaneel Tld.
Lough Carra

FIGURE 4

MAP SHOWING DISTRIBUTION OF VEGETATION SAMPLES




INDETERMINATE
Loughs Frank
Mountpleasant School Turlough
Ballyglass Turlough
Carrownacon Lough
Cloonboorly Lough
Carrownacon Lough
ANNIES
Ballyglass Marsh
Lough Beg
Lough Manan
Rinaneel Tld.
Mullingar Br.
Kilskeagh Tld.
BALLYGLASS
Lough Carra


Multingar Br.
Kilskeagh Tld.
BALLYGLASS
Lough Carra
NORTH
Catchment Boundary
Boundary of O.P.W. Damaged Land
Major Drainage Channels
Vegetation Sample
Vegetation Sample of Drainage Channels
SCALE 1:25,000