SURVEY OF IRISH COASTAL LAGOONS
1996 and 1998

VOLUME I Part 1

Background, Description and Summary of the Surveys

Brenda Healy

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DÚCHAS

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SUMMARY

1. Surveys of coastal lagoons in the Republic of Ireland were carried out in 1996 and 1998 by a four-member team. In total, 179 potential sites were examined and 92 lagoons were identified.

2. For purposes of this survey a lagoon is an enclosed or semi-enclosed body of brackish water with salinity generally between 1 and 30‰, and one or more lagoonal specialist species. Euhaline sites with sedimentary barriers were included if there was evidence of freshwater influence.

3. Lagoons are distributed all around the coast with the greatest concentrations in Counties Cork and Galway. Four major lagoon types were recognised based on their morphology: 23 were sedimentary lagoons, 14 rock lagoons (mainly in karst), 25 saline lake lagoons, many in peat basins, and 30 are artificial lagoons, five of which are associated with polder drainage.

4. The lagoons could be classified according to their hydrological regimes into homogenous lagoons (57) including 8 euhaline, 20 polyhaline, 11 mesohaline, and 18 oligohaline, gradient lagoons (16), and vertically stratified lagoons (5). Eight are described as "shock lagoons" and others could not be classified.

5. Lagoons range in size from <1 ha to 450 ha. Nearly half are over 5 ha and of sufficient size to be considered as sites for conservation, but a few smaller sites are also valuable. Few sites less than 1 ha are included in the national inventory except as groups of similar pools. The total area of lagoons for the Republic is estimated to be around 2500 ha.

6. Most lagoons are shallow, usually less than 3 m depth except near their outlets, but six are over 7 m and three are at least 20 m.

7. Twenty sites were selected for more intensive survey in 1996 and 19 (4 in complexes) in 1998. At least 17 others are considered worthy of further investigation. Of the lagoons surveyed, 13 are sedimentary lagoons, 5 rock lagoons, 17 saline lake lagoons and 4 are artificial lagoons.

8. All types of vegetation were sampled, including single samples of phytoplankton, and marginal stands of more than 5 m width were analysed. Records of aquatic plants include 43 taxa of phytoplankton, 63 species of non-charophyte algae, 6 charophytes and 9 vascular plants. *Chara baltica,* present in two Connemara lagoons is new for Ireland, and two rare species of *Cladophora*, *C. battersii* and *C. aegagropila* may also be new. Three charophytes are Red Data Book species for Britain and Ireland. Red algae include some species rare in Ireland.

9. Five broad macrophyte community types on soft substrates were recognised: charophyte, *Ruppia* spp, *Potamogeton pectinatus, Zostera marina,* and unattached cladophoracean communities. *Ruppia* communities, often with *Lamprothamnium*, are the most widespread benthic vegetation type, occurring over a wide salinity range. *Ruppia* was absent from only three of the sites surveyed. Characteristic communities are found below wading depth and have been under-recorded in the past.

10. Macroalgal communities on hard substrates cisisted mostly of red algae; brown algae played a minor role. Some assemblages could be equated with similar communities in Scotland, others comprised southern species and require further study.

11. Emergent stands of *Phragmites australis, Schoenoplectus tabernaemontani* or *Scirpus maritimus* are present in most lagoons. Marginal vegetation included communities of *Puccinellia maritima, Juncus maritimus, Festuca rubra, Juncus gerardii, and Eleocharis uniglumis.*

12. It was possible to classify the lagoons as ecological units in which the different vegetation units co-vary. Four lagoon types were recognised.

13. Fauna recorded at the 39 sites totalled 401 taxa, most identified to species. The number of taxa per site varied between 10 and 113, with the greatest number of species at high salinity. Only 30% of species were recorded in both years.

14. 18 of the 34 lagoonal specialist faunal species listed for Britain were recorded. . Other species which appear to be particularly frequent in Irish lagoons have been provisionally added to the list of lagoonal specialists for Ireland. The number per lagoon varied between 1 in a euhaline site and 11 in a complex of channels and pools.

15. 37 species are described as "rare" because there are few published records of them in Ireland although they may have been under-recorded. They include many of the lagoonal specialists.

16. Lagoons could be divided into five types according to the relative proportion of aquatic faunal species in eight salinity tolerance/preference classes. The proportion of species in different taxonomic groups indicated the degree of marine or freshwater influence, stability, and access for vagrants and colonisers from the sea.

17. Carabidae, Staphylinidae, and Pselaphidae (Coleoptera) were collected from shore habitats and local or rare stenotopic species used as indicators of well developed biological communities. In terms of ecotonal shore fauna, lagoons do not appear to be clearly defined habitats. Most indicators were halotolerant species of freshwater wetland rather than halobionts, indicating that salinity is not always a limiting factor.

18. Salinity regime and lagoon depth were the main environmental factors distinguishing the lagoon types. The morphology of lagoon shores, basins and inlet/outlets is only relevant to the biota in so far as it determines the salinity regime and the entry of vagrants and potential colonists. The nature of the barrier (sedimentary, peat, limestone, granite, artificial, sluiced) has little or no significance.

19. Combining the data on vegetation and aquatic fauna, five main types of lagoon could be recognised:

20. Group 1 are predominantly euhaline lagoons with a strong tidal influence. Red algae are the dominant plants, *Ruppia* are rare, the phytoplankton is marine, and the marginal vegetation consists of *Puccinellia* and *Juncus gerardii* communities. A species-rich fauna (43-113 taxa/site) resembles that of the open coast with only 1-4 lagoonal specialist species/site.

21. Group 2 are predominantly polyhaline lagoons with inlets and are characterised by *Ruppia, Lamprothamnium,* and *Zostera,* a marine phytoplankton and marginal vegetation as in Group 1. Faunal richness is generally lower (31-108 taxa) and the number of lagoonal specialists higher (4-10) than Group 1.

22. Group 3 lagoons have a range of salinity regimes. Both species of *Ruppia* occur but *R. cirrhosa* was absent from shallow systems. Faunal richness was generally low (14-30 taxa) and the number of lagoonal specialists variable (2-10, representing 6-50% of faunal taxa).

23. Group 4 are oligohaline lagoons with *Potamogeton pectinatus* common, *Ruppia* rare, a freshwater plankton, and an absence of *Juncus maritimus.* Faunal richness was somewhat higher than in Group 3 with a high proportion of insects and a good representation of lagoonal specialists (6-10 except at very low salinity).

24. Group 5 are described as 'shock lagoons' undergoing wide and rapid fluctuations in salinity due to tidal incursions. They are generally poor in resident species but may contain accidental faunal species.

25. Descriptions are provided of the habitats occurring in Irish lagoons. They include 9 aquatic habitats on soft substrates, 4 broad habitat types on hard substrates, 3 habitats with emergent vegetation, 6 marginal vegetated habitats, and 6 unvegetated habitats at lagoon margins.

26. Separate evaluations of the sites surveyed are presented for vegetation, aquatic fauna, and shore beetles. The assessments emphasise species and habitat diversity, rarity, and the occurrence of lagoonal specialists and indicator species. Geomorphology is also evaluated.

27. Combining the separate evaluations and rankings, the survey sites fall into four groups. Six top-ranking sites include the best representative examples of different lagoon types and are considered to be of international importance. A second group of 13 sites are rated as of national importance. Groups 3 and 4 are mostly average lagoons, some of which are good representative examples of *Ruppia*- or *Potamogeton pectinatus*-dominated systems. Some comparatively low-rated sites hold important populations of rare faunal species.

28. It is concluded that Ireland possesses internationally important examples of communities which may be rare in Europe, or only shared with Scotland, and some important populations of Red Data Book charophytes. Some populations of species, especially aquatic insects, could also be important, but information on their distribution is insufficient for their rarity to be assessed.

29. Ireland possesses a wide range of lagoon types, most of which are in a relatively natural state. Many of the high-ranking sites are under no immediate threats, but a few will require effective management plans and will need to be closely monitored. Additional information is needed for some of the survey sites. A number of potentially interesting lagoons have not been thoroughly surveyed.

BACKGROUND, DESCRIPTION AND SUMMARY OF THE 1996 AND 1998 SURVEYS

This section of the Report contains all the background information provided in Vol. 1 of the 1996 Report, much of it rewritten and updated. Also included is a summary of the 1996 survey and summary and discussion of the combined results of the Inventory and Site Surveys for the two years.

1. INTRODUCTION

1.1 Outline of the survey

This Report describes the results of the second part of a survey started in 1996. The first part consisted of a rapid inventory of lagoons around the coast of the Irish Republic, and surveys of 20 sites selected as possible Special Areas of Conservation (SACs). The results are described in Vols 1-3 of a Report to the National Parks and Wildlife Service (Healy *et al.* 1997a,b,c). An outline of the survey and records of flora and fauna are published in a special volume of the Bulletin of the Irish Biogeographical Society (1998).

Time did not allow all possible lagoons to be visited in 1996, and a number of further sites appeared likely to qualify as SACs. In 1998, therefore, we attempted to complete the national inventory and surveyed 16 further sites.

1.2 Previous lagoon studies in Ireland

There had been few studies of Irish lagoons prior to our survey in 1996. The only lagoons that were at all well documented for their fauna and flora were Lady's Island Lake (Healy *et al.* 1982), L. Murree (Pybus and Pybus 1980), and Furnace L. (Parker 1977, Parker and West 1978, Poole 1994). Nine lagoons in Wexford and Cork were sampled for fauna as part of an M.Sc project (Galvin 1992). A few other lagoons are well known to bird watchers. Lagoons in south Wexford have received considerable attention from geomorphologists, e.g. Carter and Orford (1980), Orford and Carter (1982), Ruz (1989), giving the impression that lagoons in Ireland are concentrated in the south-east of the country.

1.3 Purpose of the survey

The survey was undertaken to comply with the requirements of the European Union Habitats Directive (92/43/EEC) which lists lagoons as a priority habitat in Annex 1. The aims of the survey were:

- to identify all coastal lagoons in the country and provide a brief description of each
- to select a number for more intensive survey
- to survey the selected sites for information on geomorphology, hydrology, aquatic and marginal vegetation, aquatic fauna, and beetles of marginal habitats
- to evaluate the selected sites as possible candidate Special Areas of Conservation (SACs)
- to describe and evaluate the Irish lagoon resource in terms of area, lagoon types, characteristic communities, and conservation potential
- to assess the value of Irish lagoons in an international context.

1.4 Definition of lagoons

(This section is an expanded version of that in the Report of the 1996 survey, taking into account the revised classification of British sites, and a realisation of the need for a more biologically based approach to lagoon conservation.)

There is no widely accepted definition of the term "lagoon".

The word "lagoon" can have different meanings in different parts of the world and may refer to a variety of water bodies including inland saline lakes, tidal bays and freshwater ponds. A literature search using the term "lagoon" results in a high proportion of publications concerning ponds used for storage and treatment of industrial wastes. In Europe, the term is generally reserved for coastal saline lakes or enclosed bays.

The textbook definition of a lagoon is based on geomorphology

In many parts of the world, lagoons are a feature of microtidal, sedimentary coasts, and as they are often important as commercial fisheries, they have received considerable attention. Their mode of origin, and characteristic geomorphology, have given rise to the scientific definition of lagoons which appears in most textbooks. Thus Barnes (1980) describes a lagoon as "**a permanent body of shallow, brackish or salt water, separated from an adjacent sea by a barrier of sand and/or shingle but which nevertheless exchanges water with the sea**". Such systems are widespread on the east coasts of North and South America and in the Mediterranean. They have an intrinsic conservation value as endangered landforms and are particularly vulnerable to destruction due to storms, sea level rise, or human interference with coastal processes, but their biological communities are in no way unique or different from those in any other kind of enclosed brackish water.

The EU Habitats Directive definition

The Interpretation Manual of the European Union Habitats Directive (Version EUR 12), based on the CORINE classification of habitats, defined lagoons as **"expanses of shallow coastal salt water, of varying salinity or water volume, wholly or partially separated from the sea by sand banks or shingle, or, less frequently, by rocks. Salinity may vary from brackish water to hypersalinity depending on rainfall, evaporation and through the addition of fresh sea water from storms, temporary flooding by the sea in winter or tidal exchange. With or without vegetation from *Ruppietea maritimae, Potametea, Zosteretea* or *Charetea*"** (CORINE 91: 23.21 or 23.22). The Manual allowed that "salt basins and salt ponds may also be considered as lagoons, providing that they had their origin on a transformed old natural lagoon or on a salt marsh, and are characterised by a minor impact from exploitation". A revised version of the Manual (Version 15, Romão 1996) following the accession of Sweden and Finland, made further allowance for "flads" and "gloes", considered to be Baltic varieties of lagoons.

A number of lagoon-like systems, some of which can be exceptionally rich in lagoonal species, appear to remain excluded by the above definition, notably silled lakes and artificial systems.

The aim of the Habitats Directive is:

"to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies". This objective is most effectively achieved for lagoons by including in conservation programmes all types of water bodies where lagoonal conditions, species and communities are found, whatever their origin or physical structure.

A realisation of this need has brought about a shift in the definition and classification of lagoons by survey teams concerned with the selection of SACs.

British lagoon surveys of the 1980s

Prior to the Habitats Directive, surveys of lagoons on the coasts of England, Wales and parts of mainland Scotland (Barnes 1989, Sheader and Sheader 1989) distinguished two types of lagoons: **lagoons** in the strict sense i.e. with sedimentary barriers, and **saline ponds**. The latter category included brackish waters with many different origins, including human activities, such as clay pits, former salt marsh pools, and a variety of sluiced systems.

The 1996 Irish lagoon survey

The previous Irish survey included **all isolated or semi-enclosed waters which were measurably brackish or where the influence of both seawater and freshwater could be detected by observations on the biota**.

A distinction was made between **lagoons** with sedimentary or rock barriers, and **saline lakes** that included all other types, ("lake" being considered more appropriate for the larger Irish systems than the British "ponds"). The intention was to include all brackish systems while allowing for strict adherence to the Habitats Directive definition should this become necessary in the event of a legal challenge to the designation of a given site. These categories are not biologically meaningful however, and have little value for formulating a strategy for conservation of lagoonal diversity.

The selection of SACs in Britain

The UK has generally applied the definitions and criteria developed for selection of Sites of Special Scientific Interest (SSSIs) when selecting sites for designation as SACs. The original Guidelines for selection of biological SSSIs (NCC 1989) did not include intertidal habitats or significant references to lagoons. A supplement was therefore published (JNCC 1996) which provided a definition of saline lagoons in the following opening paragraph of its section dealing with lagoons: "Saline lagoons are areas of marine saline water where the concentration of salts is reduced by ground or surface freshwater input or concentrated by evaporation. Connection with the open sea is limited by sediment, shingle or rocky barriers, the degree of separation being used as a basis for the distinction of five physiographic types (based on Barnes (1988) and Sheader & Sheader (1989)). Freshwater input is usually from direct drainage from surrounding land or groundwater seepage. There is generally no major riverine input, or in cases where rivers drain into saline lagoonal systems, the lagoon basin is distinctly different from the physiographic features of an estuary (Pritchard 1967). However, there are situations where the status of a location as a saline lake (as opposed to an estuary, an arm of the sea or an enclosed bay etc) will be unclear, and any dispute about whether a site constitutes a 'saline lagoon' will be resolved by reference to a more detailed definition of saline lagoonal habitats held by country agency headquarters staff."

The above extract from the 1996 "Guidelines" has been cited in full to demonstrate the difficulties involved in defining and evaluating lagoons and the differences between the British and our own interpretations of what constitutes a lagoon. It should be noted, for example, that there is an implied assumption in the "Guidelines", (and perhaps in all British surveys) that lagoons are a special type of marine habitat, and that diversity and species richness are consequently related to the degree of tidal influence. No mention is made of the contribution made by freshwater groups or the problem of distinguishing oligohaline lagoons (5‰ or less) from freshwater lakes. It appears that many oligohaline systems have generally not been identified as lagoons in Britain, for example some of the

Norfolk Broads where salinity reaches 8‰ (Moss 1994). Sheader and Sheader (1989) admitted that insects were rarely identified during surveys in the 1980s, and most insects have since been removed from the list of lagoonal specialist species, apparently on the grounds that they also occur in brackish ditches (JNCC 1996). We have not had access to reports from other EU countries and cannot therefore comment on other interpretations of the Directive.

The present situation

The UK has had long experience in site selection for conservation and has taken the initiative in revising the CORINE classification of marine habitats through the Marine Nature Conservation Review. While the review is complete for some marine habitats, for example the intertidal (Connor *et al.* 1995), the lagoon working group has not yet produced a biotope manual. The group did, however, agree a definition of lagoons as "**marine saline systems where the normal tidal range and exchange of water are reduced by physical features, but water is continually present**" (Hiscock 1994).

In 1994, a meeting of representatives of EC Member States and DGXI met in Britain to agree procedures for selection of SACs. The agreed conclusions, set out in Brown *et al.* (1997), were subsequently endorsed by the EC Habitats Committee. One of the conclusions relevant to the present survey was that artificial areas need not be excluded from site selection.

A review of the British experience in implementing the Habitats Directive (Brown *et al.* 1997) includes a section on lagoons in which the five categories of lagoon listed in the "Guidelines" are explained, and the ten SACs selected (most are complexes of lagoons) are described. Six of these fall into the category formerly called saline ponds (lakes in Ireland). Given the close working relationship between British representatives and DGXI, it can be assumed that these will be accepted as good lagoons. On this basis, all sites identified by us as lagoons can be expected to be accepted for the purpose of the Habitats Directive, with the possible exception of oligohaline systems.

The present survey

The definition of a lagoon, and its interpretation in the field, are the same as in 1996. The classification of lagoon types has been changed, however, placing a greater emphasis on biological features and less on physical structure and origins (see later). For purposes of this survey, a lagoon is **an enclosed or semi-enclosed body of brackish water with a salinity generally between 1 and 30‰, and one or more of the lagoonal specialist species listed in Table 2.1, or one of the additional species considered to be lagoonal specialists in Ireland.** Where the salinity was <1‰ at the time of sampling, the widespread occurrence of brackishwater indicator species was taken as evidence of significant seawater influence, sufficient to identify the site as a lagoon. Similarly, the presence of a significant number of brackishwater indicator species, indicating substantial freshwater input for at least part of the time, allowed a system with full salinity (34‰) to be accepted as a lagoon. Fully marine sites with no lagoonal specialist species were generally rejected unless they possessed the geomorphological features of a true lagoon and were believed to be in a marine phase due to recent damage to the barrier. (See methods for examples.)

This interpretation differs from that adopted by the UK where oligohaline lagoons have been largely ignored, while some wholly marine systems with no lagoonal specialist species have been identified as lagoons, particularly in Scotland (Covey *et al.* 1998, Thorpe 1998). It is not clear whether the omission of many oligohaline lagoons by British surveys was deliberate, or the result of the traditional view of lagoons as marine systems. We believe the inclusion of oligohaline lagoons to be justified for two reasons. Firstly,

oligohaline waters are not listed as distinct habitats in Annex 1 of the Interpretation Manual of the Directive, although a number of species are characteristic of these conditions, e.g. the scarce charophyte *Chara canescens*, and these species are thus vulnerable. The omission is believed to be an oversight, reflecting a general neglect of this supposedly ecotonal habitat. Secondly, oligohaline lagoons represent just one phase in an evolutionary series. They may represent a final seral stage in the transition from a lagoon to a freshwater lake, or they may be the result of a recent seawater intrusion into freshwater lakes which could be destined to become 'good' lagoons if the trend continued. The national conservation strategy is to preserve a network of sites of each lagoon type in different evolutionary stages.

2. BACKGROUND INFORMATION

2.1 Characteristic features of lagoons

(This section is substantially different from that in Vol. 1 of the 1996 Report. It has been rewritten in the light of later experience and literature received during the past two years.)

2.1.1 Barriers and inlets

All lagoons are at least partially separated from the sea by some kind of barrier, either natural or man-made, which creates conditions different from those in estuaries or the open sea, and which limits colonisation and recolonisation and renewal of marine nutrients. Barriers are responsible for the variability of lagoons, perhaps their most characteristic feature, while their variable nature and topography explain many of the differences between lagoonal communities.

Sedimentary barriers. The natural, sedimentary barriers of "true" lagoons are derived primarily from offshore deposits although they may be topped by dunes of aeolian (wind-blown) sand. The barriers of north European Atlantic coasts are unusual from a world perspective in that they are composed of shingle rather than sand as in other parts of the world (Barnes 1980). This is because coarse deposits are available and because the lagoons are on meso- or macrotidal coasts, i.e. with a tidal range >2 m, where tidal energy, combined with strong wave energy due to prevailing westerly or south-westerly winds, prevents small particles settling. Elsewhere in the world, most lagoons are on low energy microtidal coasts.

On the west and south-west facing coasts of Ireland the principal components of most barriers are cobbles, stones measuring more than 6 cm whose size increases with wave force, often reaching boulder dimensions. This coarse material has its origin in glacial deposits on the sea bed which have been rolling ashore since the last ice age. However, the supply of glacial material in the sea has been steadily diminishing on Irish coasts and barriers are now transgressive, moving slowly landwards by a rolling over process. The shortage of deposits is largely responsible for the erosion problems that affect some parts of the coast (Carter and Johnston 1982). It also makes lagoons vulnerable to any human activity that further reduces the sediment supply such as dredging or gravel extraction on the coast as this may make the barriers unstable. Sedimentary barriers, especially those of sand and/or gravel, are dynamic formations that are constantly changing and they are very subject to storm damage.

Northwest European lagoons are unusual in that there is generally no outlet/inlet through the barrier, as for example in the Mediterranean and on the eastern coast of North America. Lagoon water seeps out through the barrier and seawater enters by percolation in

the same way. An outlet may form in some barriers if they are damaged or eroded or if there is a large volume of freshwater entering the lagoon that forces its way out. An intermittent outlet forms naturally in this way at Kilkeran Lake in Co. Cork when water levels are high (the barrier is sometimes also breached artificially). Some sedimentary lagoons have artificial outlets to lower their water level (see "Sluices").

Rock barriers. It is not clear what is meant by "barriers of rock" in the CORINE definition of lagoons. In Britain, it appears to have been interpreted to include that part of the land through which contact with the sea is made, i.e. the bed of the inlet/outlet. Most sills are at least partly composed of rock because currents are strong. In the 1996 survey, a rock barrier was interpreted as land separating the lagoon from the sea composed principally of rock, and the same interpretation is applied in this Report. The two lagoon types with rock barriers recognised are karst lagoons, which receive seawater through rock fissures, a process similar to percolation through sedimentary barriers, and rocky shore lagoons which are reached by the sea at spring tides or during storms.

Other types of barrier. Lagoons in the broad category called "saline lake lagoons" (see 2.2.6) are isolated from the sea by impervious land and contact with the sea is through inlet/outlets, which may be natural or artificial. Natural inlets may have various forms according to the nature of the land, bog, rocky heath, forest, agricultural and so on. Some have been modified and a few are sluiced. Artificial barriers are mostly causeways carrying roads or railways, or, less frequently, seawalls associated with land reclamation or sea defences. Many date from the middle of the last century when there was extensive road and railway construction and elaborate drainage schemes supported by the Drainage Commission (see account of Ballyteige Drainage Channels).

Sluices. Sluices allow excess water to leave the lagoon, thus alleviating flooding of farmland while preventing entry of seawater. There are two types of sluice in common use, manually controlled gates that can be raised or lowered as required, and pipes with flap valves that close by gravity. All sluices leak to some extent and flap valves frequently become jammed open by stones or damaged during storms. They act like miniature percolation barriers allowing small quantities of seawater to enter the lagoons during high tides.

2.1.2 Water level

With the exception of polder channels in which the water level is controlled by pumping, the restricted outflow from lagoons results in levels that are wholly or partly independent of tide level changes.

Inlet and silled lagoons undergo changes in water level corresponding to the spring-neap tide cycle. Levels rise before and during springs and fall before and during neaps. During and after springs, the water level in the lagoon may remain above mean tide level resulting in strong outflow currents at low tide, sometimes in the form of waterfalls.

Isolated lagoons undergo seasonal changes in water volume according to rainfall and evaporation, levels rising in winter as in isolated freshwater lakes. Often, the water level is controlled artificially to prevent flooding of farmland. In the case of lagoons with sand or shingle barriers, where such simple solutions are not feasible, the barrier may be artificially breached when the water reaches unfavourable levels. High water levels in sedimentary lagoons sometimes cause a natural outlet to form which reseals when the level falls.

2.1.3 Salinity

The word "brackish", which is part of the definition of a lagoon, is usually held to mean a mixture of freshwater and seawater, hence the scientific term mixohaline. Some authors, however, consider that in an ecological context, brackish waters are not just mixed but that the mixture is variable. Thus den Hartog (1974) defined them as "waters with an unstable salinity which results from dilution or concentration of seawater". The Venice System (1958) distinguishes the following biologically meaningful categories of brackish waters: limnetic (< 0.5‰), oligohaline (0.5-5), mesohaline (5-18), polyhaline (18-30) and euhaline (30-40). Categories between 0.5 and 30‰ are together called mixohaline.

The salinity in lagoons can be exceptionally variable, both spatially and temporally. Gradients between freshwater inflows from streams and seawater inflow are typical and usually persistent but significant short-term differences in salinity can also be observed within a scale of a few metres due to evaporation in shallow water or localised drainage from surrounding land.

Seasonal variations due to differences in rainfall between summer and winter are most noticeable in isolated lagoons and are linked to changes in water volume. The seasonal cycle has been extensively documented for Lady's Island Lake (Hurley 1997). Such changes take place gradually allowing resident organisms to adapt, but more dramatic, unpredictable events such a sea waves entering during storms or exceptional, "unseasonal" rainfall may cause abrupt changes throughout a lagoon which are less easily tolerated. Extended periods of high salinity can cause severe mortalities in otherwise mesohaline systems. Smaller lagoons with tidal inlets and substantial freshwater input may experience semidiurnal fluctuations in salinity which are wide enough to limit the diversity of the flora and fauna.

Salinity is usually somewhat lower at the water surface and often also in shallow water. Steep salinity gradients, or stratification, mainly occur in the deeper lagoons that have significant inputs of both fresh and saltwater, particularly where seawater enters over a shallow sill. However, stratification can occur in shallow waters of no more than 2 m depth where there is substantial flow of both sea- and freshwater. While stratification can be permanent in deep lagoons, e.g. Furnace L., it may be only temporary in shallow systems. There are few data on this important aspect of lagoons in Ireland.

2.1.4 Shelter

All lagoons are relatively sheltered compared with estuaries or saltmarshes in that they do not experience strong water currents except in localised areas and they tend to be protected from strong winds. The weakness of water currents may be one of the most important differences between lagoons and estuaries and may explain the restricted distribution of lagoonal specialist species.

Isolated lagoons can be almost stagnant except in the region of freshwater inflows and in this respect they are like freshwater lakes. For lagoons with outlets, there is turbulent water flowing over the sill, especially when incoming seawater meets outflowing lagoon water, but the effect is localised unless tidal streams extend into the main body of the lagoon.

Weak currents on lagoon beds can lead to anoxic conditions, especially where there is seasonal macrophyte production and accumulation of decomposing organic matter on the lagoon bed. This probably explains the poor representation of infaunal polychaetes and bivalves compared with estuaries.

2.1.5 Water chemistry

There are no data on the chemistry of Irish lagoons but it is known that processes in brackish waters generally resemble those in the sea and nutrient cycling processes are different from those in freshwater. Investigations in the Baltic and elsewhere in Europe

have revealed a pronounced change in ion ratios at a critical level of about 5‰ with the K:Na and Ca:Na ratios increasing below 8‰ with decreasing salinity (Khlebovich 1968). This level corresponds to the ecophysiological barrier of 5-8‰ dividing meso- and oligohaline water and the occurrence of marine and freshwater faunas. These chemical differences help to explain the phenomenon of the species minimum at 5-8‰ (Remane 1971). Nutrient cycling characteristics change at lower salt concentrations however. A switch in P cycling occurs at 0.3-0.8‰ with a corresponding change in species and trophic systems (Jeppeson *at al.* 1994, Moss 1994). It is apparent that there are fundamental differences between fresh and brackish waters that affect the tolerance of low salinity by brackishwater species and the occurrence of freshwater species in lagoons.

2.1.6 Aquatic vegetation

Shelter from currents and wave action allows the growth of dense swards of halotolerant macrophytes in shallow water that could not survive in turbulent or fast-flowing waters. Consequently, the physical structure of aquatic communities in lagoons resembles that of freshwater lakes rather than seashores or estuaries. The dominant taxa appear to have a wide salinity tolerance in nature and to accommodate to a certain amount of fluctuation in salt concentration, but all are to a greater of lesser extent confined to a specific salinity range, either by their physiological tolerance limits or a loss of competitiveness outside their preferred range.

Ruppia spp (tasselweeds) are the most characteristic rooted plants, occurring throughout almost the full salinity range, but they tend to be displaced by other species towards the upper and lower ends of the range. Species which are widespread in freshwaters may become common below about 5‰, while above around 25‰ marine algae appear and may be diverse and conspicuous if there are rocks for attachment. Only in inlets, however, where there is fast flowing water, do the large fucoids typical of rocky shores generally become established. Phytoplankton can be diverse and species composition undergoes seasonal change as in other ecosystems.

The most important taxa from the point of view of conservation are the Charophyceae (stoneworts) which are intolerant of nutrient enrichment and are declining throughout much of Europe. They can form dense beds on soft bottoms, and several species are lagoonal specialists and Red Data Book species. There are indications that some Chlorophyta require special types of lagoonal environments, and some species may be rare, but the *Cladophora* in particular are "difficult", and little is known of the geographic distribution or ecology of brackishwater species

2.1.7 Marginal vegetation

The extent of vegetation associated with the lagoon margins depends on the nature of the shore - rocky, stony, sandy, muddy, peaty - and the extent of water level fluctuation. A certain amount of species-poor saltmarsh is present on the shores of most lagoons, especially in regions of seawater percolation and around tidal lagoons, and there are usually beds of reeds, sedges or rushes, but these may be poorly developed if there are wide fluctuations in water level. The common swamp species appear to tolerate a wide range of salinity and shelter may be the more important limiting factor, especially for *Phragmites.*

2.1.8 Aquatic fauna

The majority of faunal species in lagoons belong to groups which are mainly marine such as polychaetes, crustaceans, prosobranchs and lamellibranchs and, at the higher salinities, bryozoans, tunicates and echinoderms, but freshwater groups such as pulmonate

gastropods and several orders of insects may be well represented, especially at low salinity. Salinity is undoubtedly the most important factor limiting species occurrence as few species can tolerate the full salinity range. All levels of salinity tolerance are represented from euhaline marine species with little tolerance of brackish conditions to limnic species characteristic of lakes. In between these extremes are species which have preferred ranges in polyhaline, mesohaline or oligohaline waters (Venice System 1958) and a contingent of euryhaline species with wide tolerance ranges. The latter are the most widely distributed and are often very abundant as most are capable of breeding within a wide range of conditions. Some are also common species of estuaries and other brackish waters, and may even live on rocky shores, while others are lagoonal specialist species (see below). Zooplankton is said to be typically sparse in lagoons.

2.1.9 Ecotonal Coleoptera

Many species of *Staphylinidae* and *Carabidae* inhabit the shores of lagoons above the water line. They occur in swards of marginal vegetation, under stones, and burrowing into bare mud and sand. A number of local species are restricted to shoreline habitats of coasts, lakes and rivers, and these have been found to be useful indicators of undegraded habitat and relatively intact ecosystems. Saldidae (Heteroptera) inhabit similar situations but no data on these were collected.

2.1.10 Lagoonal specialist species

Among the assemblage of species which inhabit brackish waters, a number are distinctly more characteristic of lagoonal habitats than of freshwater, estuaries or the sea, and are known as lagoonal specialist species (Barnes 1989). The category described by Verhoeven (1980) as inhabiting blocked brackish waters in The Netherlands and elsewhere, is broadly equivalent. A total of 43 such species has been listed by various authors for Britain (Table 2.1) but some are controversial and a number are very rare and their potential ecological range in Britain is unknown. The list has been used as a guide for the present survey but many of the species have not been recorded from Ireland while some others occur widely in other habitats. The following species have been tentatively added to the list for Ireland (Oliver and Healy 1997, Table 5): *Cordylophora caspia, Neomysis integer, Jaera ischiosetosa, J. nordmanni, Allomelita pellucida, Leptocheirus pilosus, Notonecta viridis, Plea leachi* (see Vol. IV of this report).

The number of species considered to be lagoonal specialists varies according to the author's interpretation of what constitutes a lagoon and what degree of occurrence in other kinds of brackish waters is permissible. As Barnes commented (1994) "it is likely that these specialist lagoonal forms are not lagoonal *per se* but, in respect of those of marine affinity for example, are restricted to non-tidal conditions. Their apparent lagoonal distribution pattern simply reflects the fact that along many coastlines, lagoons are the only areas of non-tidal sea water". We agree with this view. In compiling a provisional list of lagoonal specialists for Ireland (see above), the view has been taken that it is lagoonal habitats, wherever they occur, which are being characterised. Thus, brackish ditches, polder drainage channels, some upper salt marsh pools, sedimentary lagoons, rock lagoons, natural saline lake lagoons, and artificially impounded lagoons, are all variants of a habitat defined by the presence of brackish water in the range 1-30‰, a limited tidal exchange, and some shelter from strong currents and wave action, and it is these aspects of the habitat which determine the presence of lagoonal species and not the origins or topography of the systems. However, a recent reassessment of the British lists (Joint Nature Conservation Committee 1996) resulted in the removal of nearly all of the 14 species of insects previously included on the grounds that they also occur in other brackishwater habitats such as ditches.

Despite the ambiguity of their status, lagoonal specialist species help to define a lagoon and in a situation where there is doubt about whether a site should be classified as a lagoon, their presence can be decisive. "Good" lagoons, which comply fully with the definition, are healthy, and not subject to wide fluctuations in salinity, usually contain a relatively high proportion of lagoonal specialists. Although some of the species are widespread and often very abundant (*Ruppia* for example), they must all be considered vulnerable to loss of habitat as there is so little of it.

Table 2.1 Lagoonal specialist species in Britain, distinctly more characteristic of lagoon-like habitats than of freshwater, estuarine brackish waters or the sea. Compiled from Barnes (1989) and Bamber (1997), omitting *Hediste diversicolor* included by Barnes in his original list.

Cnidaria	**Insecta (cont.)**
Clavopsella navis [r]	*Agabus conspersus [r]*
Gonothyrea loveni	*Berosus spinosus [r]*
Edwardsia ivelli [r]	*Coelambus parallelogrammus [r]*
Nematosella vectensis	*Dytiscus circumflexus [r]*
Polychaeta	*Enochrus bicolor*
Armandia cirrhosa [r]	*E. melanocephalus [r]*
Almaria romijni	*Haliplus apicalis [r]*
Crustacea	*Ochthebius marinus [r]*
Lekanesphaera hookeri	*O. punctatus [r]*
Idotea chelipes	*Paracymus aeneus [r]*
Gammarus chevreuxi	**Bryozoa**
G. insensibilis	*Conopeum seurati*
Corophium insidiosum	*Victorella pavida [r]*
Palaemonetes varians	**Algae**
Paramysis nouveli	*Chaetomorpha linum*
Mollusca	**Charophyta**
Hydrobia ventrosa	*C. baltica [r]*
H. neglecta	*Chara canescens [r]*
Onoba aculeus	*C. connivens [r]*
Littorina tenebrosa	*Lamprothamnium papulosus*
Tenellia adspersa [r]	*Tolypella n. nidifica [r]*
Cerastoderma glaucum	**Angiosperms**
Insecta	*Ruppia cirrhosa*
Sigara concinna	*R.. maritima*
Sigara selecta	
S. stagnalis	

[r] rare species in Britain

2.1.11 Variability and persistence

Variability is one of the most characteristic features of lagoons. Variations in water volume, water chemistry, temperature, and especially salinity, and the consequent changes in flora and fauna, are all greater than in most other aquatic environments. The principal causes are tides, climate, and exceptional events such as storms or floods. Seasonal changes in water volume and salinity are generally tolerated by the inhabitants, which are adapted to gradual fluctuations. Daily incursions of tidal water, and the larger amounts at spring tides, have their greatest impact near the inlets and on the central lagoon bed and in the larger lagoons may hardly reach the more distant parts of the system unless there are strong winds to cause mixing. It is sudden large incursions of seawater that have the greatest effect on fauna and flora as they are unpredictable and species may be unable to adjust to such rapid changes. Small, homogeneous systems are the most vulnerable as there may be no refuge areas where sections of populations may survive. The permanent

residents of lagoons have ways of surviving major disturbance and in most cases the communities recover within a few years.

2.1.12 Productivity

Lagoons are said to be among the world's most productive ecosystems (Barnes 1980) and in many parts of the world they are exploited for fishing or shellfish culture. There are no data on productivity for Irish lagoons but it is apparent that summer growth can be rapid in some systems where the aquatic vegetation becomes luxuriant and some invertebrates, especially mysids, prawns and corixids, produce several generations in a season. High productivity is made possible by efficient recycling of nutrients in partially closed systems, supplemented by continuous or frequent renewal from the sea. In many lagoons, however, productivity may be no higher than in the open sea or in freshwater lakes, and may be severely limited if conditions are harsh or too variable.

Accumulations of decaying plant material, and a lack of effective flushing, make lagoons particularly subject to eutrophication. Blooms of phytoplankton or benthic macrophytes are frequently seen, but agricultural runoff or domestic effluents are usually suspected and unspoilt systems may be well balanced. However stagnation and deoxygenation can result naturally from excessive input of floating or wind-blown algae.

2.1.13 Species richness

Characteristically, all brackish waters, including lagoons, are poor in species compared with the open sea, and at lower salinities the fauna is generally poorer than in freshwaters. The concept of the species minimum, a critical salinity of 5-8‰ at which a minimum number of species occurs (Remane 1971, Fig. 2.1), appears to be generally true for lagoons although there are exceptions because environmental change can be more important. Attempts to correlate species richness with physical and chemical parameters of lagoons have met with only partial success. Authors generally agree that salinity is an important factor but a direct relationship has been hard to demonstrate. One possible reason may be the variability of conditions and a time lag in the response to change of the inhabitants.

2.1.14 Birds

Ireland's position on the East Atlantic Flyway, and its mild, ice-free winters, make it an important wintering area for species which breed in Arctic Canada, Greenland and Iceland and in Scandinavia and Siberia. The birds use lagoons for feeding and as sheltered roosts and a few species breed on lagoon margins and islands. It is mainly the shallower, oligohaline lagoons which attract the greatest number and diversity of birds (Tacumshin Lake, Inch Lough and Blanket Nook) as their shallow margins are ideal for waders and dabbling ducks. Lagoons sometimes attract large numbers of Mute Swans which feed on the *Ruppia* and *Potamogeton*, and almost all lagoons have at least one breeding pair. Wigeon may also be numerous where there is *Ruppia*, hence its alternative name "wigeon grass".

The Birds Directive (79/409/EEC) requires member States of the European Union to protect the most important habitats of wild birds including especially rare or vulnerable species and regularly occurring migratory species by designating suitable areas as Special Protection Areas (SPAs). Member States must take appropriate action to protect SPAs by avoiding pollution, deterioration of habitat and/or significant disturbance. Lagoons designated as SPAs, or that are part of SPAs, thus already receive the benefit of protection in this context. However, management policy does not necessarily benefit inhabitants other than birds. For example, birds which feed on invertebrates tend to be favoured by low

their prey can be most abundant, while polyhaline plants and invertebrates are less valued. There is thus a tendency to control seawater incursions.

The following lagoons are designated as SPAs: Broadmeadow Water, Lady's Island Lake and its islands Inish and Sgarbheen, Tacumshin Lake, L. Gill, and Inch L. Other larger SPAs containing lagoons are the Wexford Wildfowl Reserve (North Slob channels), Inishbofin (L. Bofin), Inishkea Islands (Doon L.), Balasadare Bay (Portavaud E. and Tanrego 1 and 2), Tory Island (Loch O Theas), and L. Swilly (Blanket Nook and Inch L.). Some other SPAs are adjacent to lagoons e.g. The Raven and Ballyteige Burrow.

2.3 Classification of lagoons

2.2.1 Textbook classification

Textbooks generally deal only with sedimentary lagoons that are natural formations and classified according to their mode of origin (e.g. Barnes 1989). Only a few Irish lagoons can fitted into these types.

2.2.2 Early British surveys

Two types of lagoon were recognised in surveys undertaken in the 1980s, i.e. prior to the Habitats Directive: lagoons and saline ponds. The distinction was emphasised by the publication of two separate reports (Barnes 1989, Sheader and Sheader 1989).

2.2.3 The 1996 Irish survey

For this survey, four types of lagoon were distinguished: sedimentary lagoons, rock lagoons, natural saline lakes ("lake" being considered more appropriate for the larger Irish systems that the British "ponds"), and artificial saline lakes. The first two types corresponded to our interpretation of the Habitats Directive, while the last two appeared to fall outside the definition. The types have no ecological significance, and there is a danger that the use of the word "lake" suggests that these types are not really lagoons.

2.2.4 UK revised classification

The UK devised a new classification that was more ecologically meaningful. Five types were recognised according to the degree of marine influence (Joint Nature Conservation Committee 1996, Brown *et al.* 1997):

1. *Isolated lagoons* – receiving seawater by limited groundwater seepage or overwash;
2. *Percolation lagoons* – receiving seawater by percolation through the barrier;
3. *Sluiced lagoons* – ingress and egress of water modified by human mechanical interference;
4. *Silled lagoons* – rocky basins with a sill between HWS and LWS;
5. *Lagoon inlets* – with a permanent connection with the sea, any sill is sublittoral.

Species richness is said in general to increase from isolated lagoons to lagoon inlets. The classification has been applied to candidate SACs. It has the added advantage over the previous subdivision into lagoons and saline ponds in that the word "lagoon" is used for all categories, thus making it clear that all are considered to be true lagoons.

The disadvantage of this classification is that it takes no account of the degree of freshwater influence, or, in the case of silled lagoons and lagoon inlets, the length and width of the inlet that can act as a filter of potential marine colonists.

2.2.5 Classification based on biological characteristics

As yet there is no accepted classification of lagoonal habitats. A "Working draft of a classification of marine biotopes for isolated saline waters in Scotland" (Covey and Thorpe

1994) is too severely limited by the small geographic area on which it was based to be generally applicable in Ireland, although a number of the habitats described have been identified during the present survey.

No attempt has so far been made to identify and classify Irish lagoonal biotopes, and only a preliminary analysis is included in this report.

2.2.6 Classification based on geomorphology and topography

A classification based on barriers and inlets has limited ecological meaning but is not without merit and is the easiest to apply to systems that have been only superficially examined. A hierarchical classification with three levels is used in this Report to provide a preliminary description of lagoons e.g. in tables listing lagoons and their general characteristics. (Tables 4.1 and 4.2).

Level 1 – main category of lagoon (sedimentary, rock, saline lake, artificial)
Level 2 – type of barrier and mode of seawater entry
Level 3 – details of barrier or inlet.

The classification is summarised in Table 2.2. Eleven morphological types are distinguished:

1. **Isolated sedimentary lagoons** – receiving small amount of seawater by percolation through a sand/gravel or shingle barrier, or by overwash at spring tides or during storms. Salinity is generally low to medium and salinity gradients are usual in large systems. Colonisation from the sea severely limited.
2. **Inlet sedimentary lagoons** – tidal, with high or variable salinity. Colonisation from the sea unrestricted. Salinity varies according to freshwater inflow.
3. **Sluiced sedimentary lagoons** – generally old lagoons that have evolved into freshwater lakes but artificial sluiced outlets allow entry of seawater. Mostly oligohaline.
4. **Karst lagoons** – receiving seawater principally through rock fissures. Salinity varies.
5. **Rocky shore lagoons** – pools in the supralittoral zone of rocky shores, reached by seawater at spring tides and/or during storms. This type differs from silled lagoons by the sill being at or above HWS.
6. **Inlet peat lagoons** – a special type of inlet lagoon with a long inlet through peat with vertical banks. Usually high salinity because freshwater input slow.
7. **Silled lagoon** – inlet rocky, seawater entering at high tide. The salinity depends on the height of the sill relative to tide level and the amount of inflowing freshwater.
8. **Sluiced saline lake lagoon** – coastal lake with natural outlet, but sluiced. Low salinity unless the sluice malfunctions.
9. **Artificial inlet lagoon** – artificial barrier with bridged inlet. Tidal. Salinity depends on freshwater inflow.
10. **Artificial sluiced lagoon** - artificial barrier with sluiced inlet or narrow pipe that severely restrict inflow of seawater.
11. **Artificial pumped lagoon** – water level controlled by pumping, conditions stable.

The eleven types reflect the nature of the landscape and the history of land use in the area but they have limited value for predicting the biota.

Table 2.2. Classification of lagoons based on geomorphology and seawater entry. The main lagoon types are underlined.

Sedimentary lagoons	Isolated sedimentary lagoon	sand/gravel barrier cobble barrier
	Inlet sedimentary lagoon	sand/gravel barrier cobble barrier
	Sluiced sedimentary lagoon	wide barrier
Rock lagoons	Karst lagoons	isolated other sources of seawater
	Rocky shore lagoons	overwash
Saline lake lagoons	Inlet peat lagoons	natural outlet, unsilled
	Silled lagoons	natural outlet, may be modified
	Sluiced saline lake lagoons	natural outlet, obstructed
Artificial lagoons	Artificial inlet lagoons	bridged inlet
	Artificial sluiced lagoons	sluiced outlet piped outlet
	Artificial pumped lagoons	pumped outlet

2.2.7 Classification based on hydrology and salinity regime

Aspects of salinity are probably the most important factors determining the nature of lagoonal communities. A classification based on the relative importance of seawater and freshwater input is therefore likely to be a good predictor of lagoonal communities. A classification into nine hydrological lagoon types (Table 2.3) describes lagoons in terms of homogeneity, salinity gradients and stability of conditions. Lagoon size is recognised as a contributing factor to the salinity regime and salinity gradients; depth appears to be less important but this aspect needs further investigation. The nine types are used to define lagoons in Tables 4.1 and 4.2 listing Irish lagoons and their characteristics. Together with morphological type, and some information on substrate, (rock, sand, peat etc.), the hydrological classification could predict some of the characteristic features of lagoonal biota. To what extent this approach is successful is discussed in 5.8 of this Volume.

Table 2.3. Classification of lagoons based on hydrology and salinity regime.

Homogeneous lagoons, generally small, stable, some seasonal variation

- Euhaline, small freshwater inflow
- Polyhaline, larger freshwater inflow
- Mesohaline, freshwater and seawater inflows moderate
- Oligohaline, small seawater inflow

Lagoons with salinity gradients, larger, fairly stable, seasonal variations

- Large seawater + freshwater inflows both important
- Small seawater inflow, localised, horizontal gradient
- Small freshwater inflow, localised, horizontal gradient
- Vertical gradients or stratified

Lagoons with wide temporal fluctuations, freshwater and tidal inflows, unstable*

- This category corresponds to the "shock habitats" of den Hartog (1974).

2.3 Historical, oceanographic and human factors

(This section is reproduced from the section "Environmental factors" in the Report of the 1996 survey, with only minor changes.)

- geology, geomorphology and post-glacial history of the coastline;
- oceanographic influences (tidal range, wave force, storm frequency and magnitude);
- climate, especially rainfall and wind speed;
- sea-level changes;
- coastal erosion;
- threats from exploitation, pollution, coastal defence projects and land reclamation.

2.3.1 The Irish Coastline

The Republic has nearly 6500 km of coastline (including islands and estuaries up to the first bridge) of which sedimentary shores represent a considerable proportion. The greatest proportion of beaches is found in counties Wexford, Kerry, Mayo and Donegal (Martin *et al.* 1974). The present day coastline is strongly influenced by glacial and post-glacial history. Only the north of the country, roughly north of a line from Dublin to Limerick (Fig. 2.2), and the mountains of the south-west, were covered by the last glaciation, the position of the southern border of the ice sheet corresponding to a tilt-line, south of which the sea level has been rising over the past 17,000 years while to the north of the line there has been some isostatic land rise (Carter 1992). This tilting of the land mass has had its most obvious effect on the landscape of the south-west where valleys in rock with roughly E-W trending folds have been drowned to give a very dissected coast. The effects of the dominant formative influences on coastal geomorphology are summarised in Fig. 2.2.

The west and south-west coasts are predominantly rocky and the high energy Atlantic waves have segmented the coastline into a series of headlands and rock-bound embayments. Sandy beaches are confined to sheltered bays and are mostly short. A feature of the north-west, (Galway, Mayo and Donegal) is the widespread occurrence of machair, a formation associated with evenly distributed rainfall (238-248 rain days), strong winds throughout the year (annual average reaches 7 m/s) and cool temperatures, characteristics which also favour the persistence of shallow lakes in the moist areas (Bassett and Curtis 1985). In contrast, the south-east comprises a low-lying glaciated plain where a series of stream catchments between Bray in N. Wicklow and Cullenstown in W. Wexford became blocked behind barriers of gravel, or sand and gravel, to form extensive areas of marshland with lagoons (Carter *et al.* 1984). All of this land was subjected to drainage schemes during the 19th century, however, and today only a few lagoons remain more or less intact, the remainder being reduced to relict systems.

Barrier systems, which characteristically separate sedimentary lagoons from the sea, occur where there is a supply of material. Extensive sand or gravel barriers are found on the east and south-east coasts and those in Co. Wexford are well documented (Carter and Orford 1980, Carter and Johnston 1982, Orford and Carter 1982, Carter *et al.* 1984, Ruz 1989). Much less is known about the western shores where spits and bars tend to be shorter and situated in relatively sheltered areas. Only a few western lagoon barriers have been investigated by geomorphologists, chiefly in Clare and south Mayo (Delaney and Devoy 1995, Devoy *et al.* 1996). Barriers occurring between W. Cork and N. Donegal are generally composed of shingle (particles >6 mm in diameter), with cobbles (6-25 mm) usually dominant. Cobble barriers are often described as "boulder bars".

Most Irish barriers are to some extent transgressive, especially those of the south-east, due to low sediment supply. They remain relatively stable in the face of wave attack. Seaward seepage through gravel and shingle barriers is usually sufficient to prevent the formation of inlets and sediment transport is mainly onshore (Orford and Carter 1984).

2.3.2 Oceanographic influences

The spring tidal range over most of the Irish coast is between 3 and 5 metres (meso-macrotidal) with the highest in parts of the west (Fig. 2.3). Only on the north Wexford coast (and in Co. Antrim) is the range less than 2 m i.e. microtidal, a regime which often favours lagoon formation.

Differences between wind force and wave height, and therefore wave energy, between east and west coasts also have important consequences for coastal formations. The west coast receives long period Atlantic swell waves approaching from the west or south-west with median wave heights of 1.5-3.0 m. Frequent cyclonic depressions also produce large waves, especially toward the north. On the south coast, there is a marked east-west gradient in median wave height which falls to < 1 m in the Irish sea. In the west of the country, both wave height and wind speed can be greater than anywhere else in western Europe. Maximum wave heights (averaging once in 50 years) (Fig. 2.5) are 30-35 m on the west coast, diminishing from west to east along the south coast and falling to 17-18 m on the east coast (Couper 1983). In the west, inshore breakers on rocky coasts commonly exceed 8 m in height (Carter 1992). Tidal current speeds, on the other hand, are greater in the east (Fig. 2.4) where longshore currents have formed a series of spits and barriers.

2.3.3 Climate

Rainfall. The average annual rainfall (1951-1980) varies between 750 mm in the east and 1500 mm in coastal areas of the west (Fig. 2.6). (Rainfall >2000 mm is confined to mountain districts.) The monthly average is highest in December-January and lowest in February-June (Rohan 1986).

The number of rain days (days on which 0.2 mm or more are measured) vary between 190/yr near east and south east coasts and about 250/yr in places near the west coast (Rohan 1986).

Temperature. Mean daily air temperatures in coastal areas remain above 5°C throughout the Irish Republic (Fig. 2.7) and frosts are rare. Ice may form occasionally on saline waters but is of short duration.

Wind. South, south-west or west winds predominate throughout the country (Fig. 2.8). Maximum wind speeds reach over 50 m/s on parts of the west coast, decreasing eastward (Fig. 2.9). Mean annual wind speeds range from 8.1 m/s at Malin Head to 5.2 m/s at Dublin and the mean number of days with gales follows a similar pattern (Table 2.2). These trends are reflected in variations in wave height.

Evaporation and humidity. Class A pan values for evaporation from a water surface range from 650 to 800 mm/yr at coastal stations There are no clear regional differences. Annual mean values of relative humidity at noon are 75-80% on all parts of the Irish coast.

Table 2.4 Wind speed data (m/s) for seven coastal stations (from Rohan 1986)

	Annual mean hourly wind speed	Annual mean number of days with gales	Annual max. 10 min. wind speed
Malin Head	8.1	57.4	34.5
Belmullet	6.7	29.2	34.0
Galway	5.0	-	-
Valentia	5.6	10.7	29.9
Roches Point	6.3	32.0	31.9
Rosslare	5.9	12.1	26.8
Dublin Airport	5.2	7.0	25.2

Future climate trends. While there is still uncertainty as to whether or not the enhanced greenhouse effect will affect global climate, current models indicate a likely rise of global mean temperature of about 0.3°C per decade (Houghton *et al.* 1990). Other predictions for the north-east Atlantic include an increase in precipitation in winter (McWilliams 1992) and increases in wind speed and storm frequency. Measurements of ocean waves in Britain in the past 25 years suggest that there has been a substantial increase in wave height in the north-east Atlantic (Carter and Draper 1988) and it appears likely that the trend will continue.

2.3.4 Sea-level change

Sea level has been rising worldwide since the last glaciation due to rising global temperature resulting in thermal expansion and ice-melt. Northern regions are also experiencing isostatic rebound following the decline of ice-sheets. Global warming has caused a global sea-level rise of 1-2 mm/yr since the end of the 19th century.
Recent Irish tide gauge records indicate that sea level is rising at a rate of 0.2 mm/yr at Dublin, is stationary at Belfast and is falling by as much 2.4 mm/yr at Malin Head, Donegal (Carter and Johnston 1982, Carter 1992). These regional differences are explained by isostatic "tilting" of the land mass following retreat of the ice sheet after the last glaciation. The sheet only extended over the northern half of the country, roughly to a line between Dublin and Galway. Near the tilt line there has been little observable change in sea level while the rate of land uplift increases northward. Evidence from Castlemaine Harbour and Cork Harbour, however, suggests a sea level rise of only 0.8-1.1 mm/yr over the last 2000 years which is close to the eustatic global trend (Carter *et al.* 1989) and therefore may not be due to isostatic sinking of the land. The coastal scenery of the south-west is typical of a drowning landscape. In the south-east, where shores are mainly sedimentary, rising sea-level is associated with severe coastal erosion and enhanced transgression of barriers.

Rising sea level on southern coasts will have a direct effect on coastal lagoons by increasing the incidence of flooding by seawater, erosion of barriers, and damage to barriers caused by destructive storm surges. Indirect effects will include the redistribution of coastal sediments, and an increase in the urgency of coastal protection schemes. Reclaimed land will be particularly vulnerable. Barriers are likely to transgress landward more rapidly and mobile gravel beaches would be subject to major changes (Carter 1992). The flood control systems currently in use will become steadily less effective.

An increase in the rate of global warming and therefore sea level rise, due to the greenhouse effect, is not yet proven. The Intergovernmental Panel on Climate Change considered that unequivocal detection of an enhanced greenhouse effect would not be possible until at least the year 2000 (Houghton *et al.* 1990).

2.3.5 Coastal erosion

Low sediment supply means that coastal erosion is taking place on most parts of the Irish coast and is affecting about 25% of the shoreline (Carter and Johnston 1982). The most serious problems are experienced on sedimentary coasts, particularly Dublin, Wicklow and Wexford. Port developments, sediment extraction and recreational activities are adding to the problem of coastal protection.

2.3.6 Threats to coastal lagoons

True lagoons are transient features that would eventually evolve into freshwater lakes and eventually fill in if the barrier remains stable, or become fully tidal if the barrier is partially destroyed or if the sea-level rises. Some changes to lagoons that may be perceived as threats are thus caused by natural phenomena, but human activities can accelerate or alter natural trends. Any project that alters the supply of sediment to barriers, such as sand or gravel extraction, pier extension or upstream coastal protection schemes, may have far-reaching consequences for lagoons in the area.

Many lagoons, and natural or semi-natural saline lakes, are threatened by land reclamation projects, and some have been drained in recent years. The commonest form of pollution is nutrient enrichment from fertiliser or slurry application on surrounding land, overflowing slurry tanks, silage, and sewage leaks from septic tanks. Cattle herds can also cause significant enrichment, especially in small water bodies. The impact of enrichment on lagoonal communities depends mainly on the flushing rate and systems with outlets are less vulnerable to adverse effects. Small, shallow systems are particularly susceptible.

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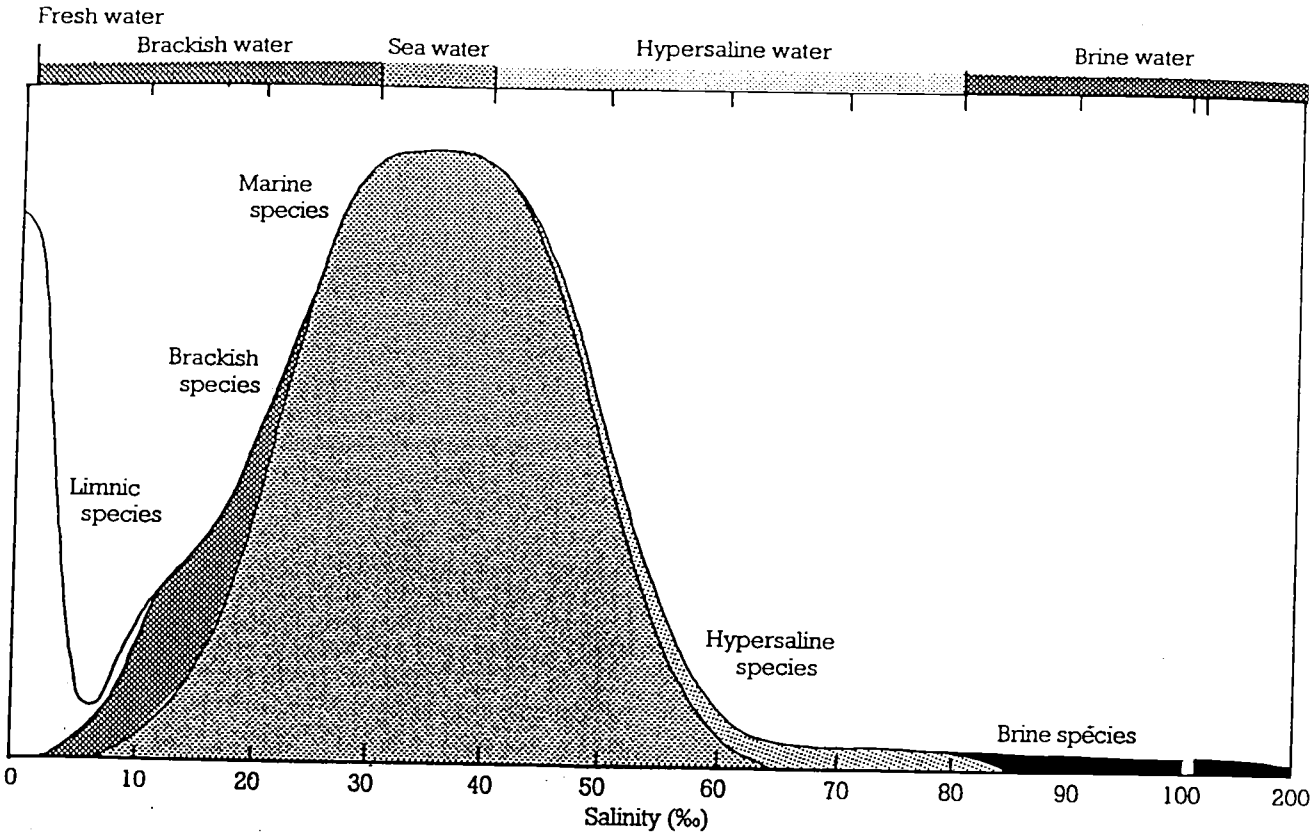

Fig. 2.1 Relative number of species of aquatic invertebrates inhabiting fresh, brackish, sea, hypersaline or brine water. (From Davidson *et al.* 1991, derived from Kinne 1971)

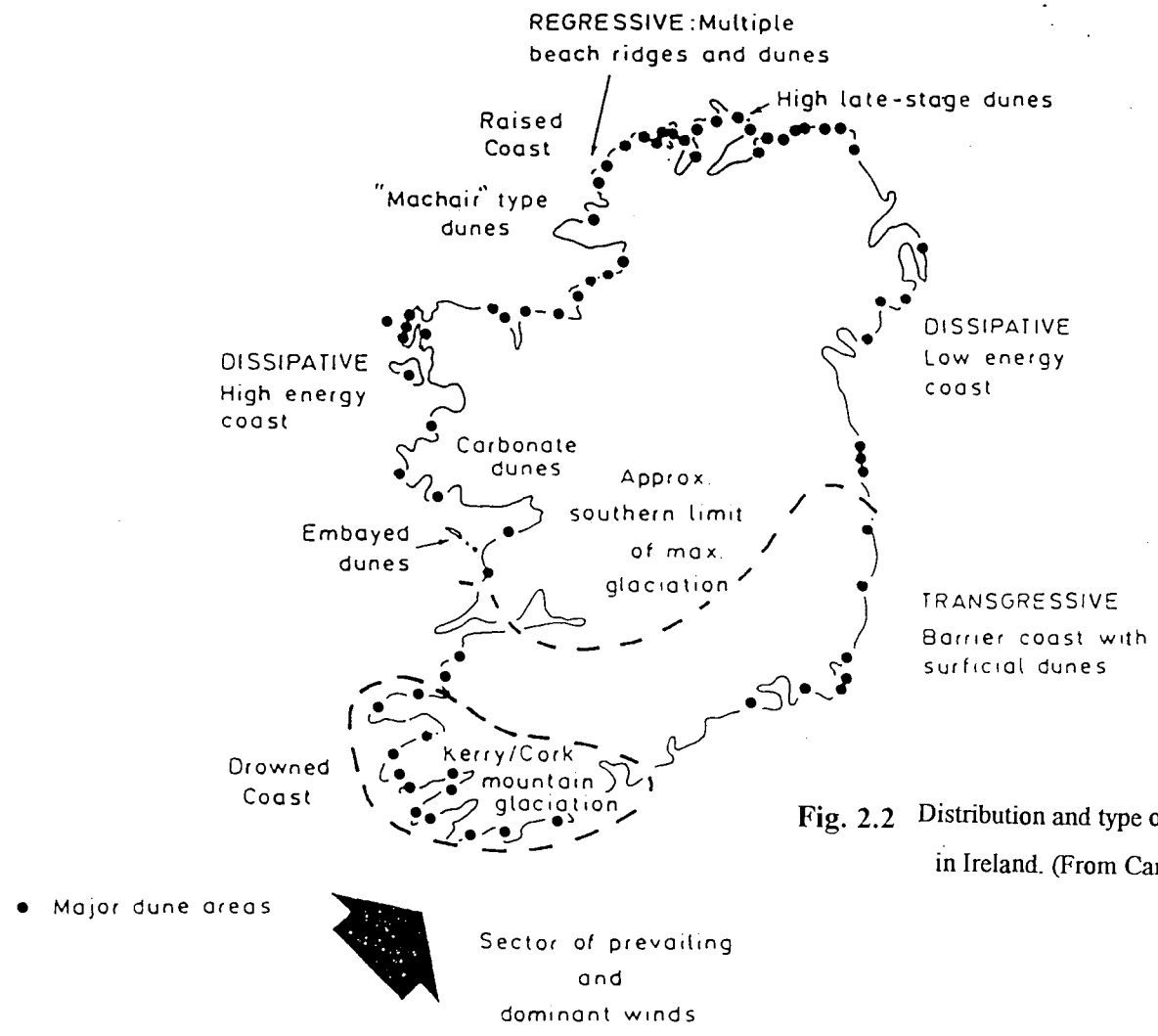

Fig. 2.2 Distribution and type of coastal formations in Ireland. (From Carter 1990)

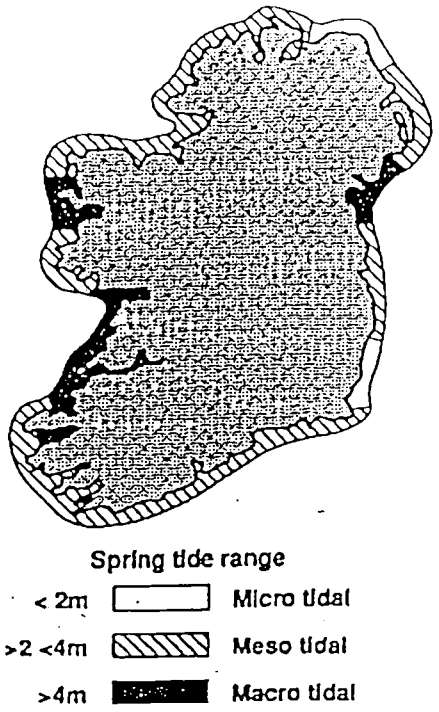

Fig.2.3 Tidal ranges around the Irish Coast (form Carter 1992)

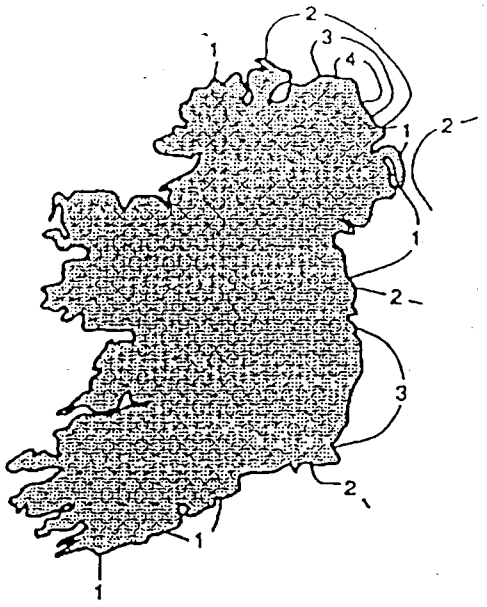

Fig.2.4 Maximum tidal current velocities (m/s) at mean spring tides (from Carter 1992)

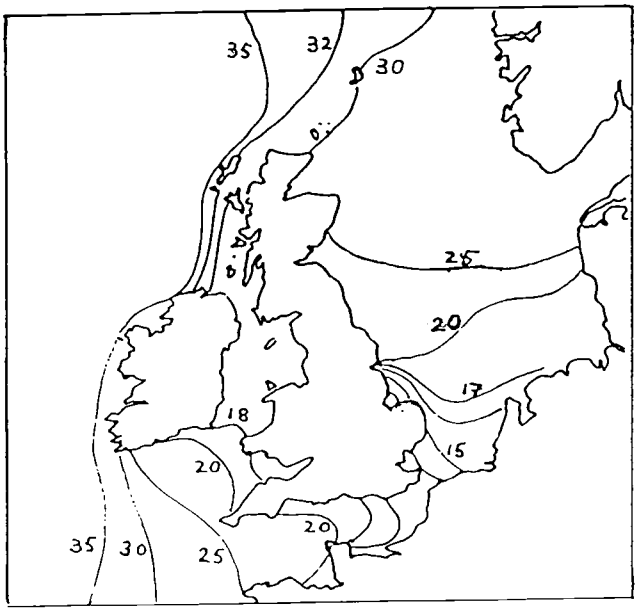

Fig. 2 5 Wave heights on Irish and British coasts (maximum occurring once in 50 years) (from Couper 1983)

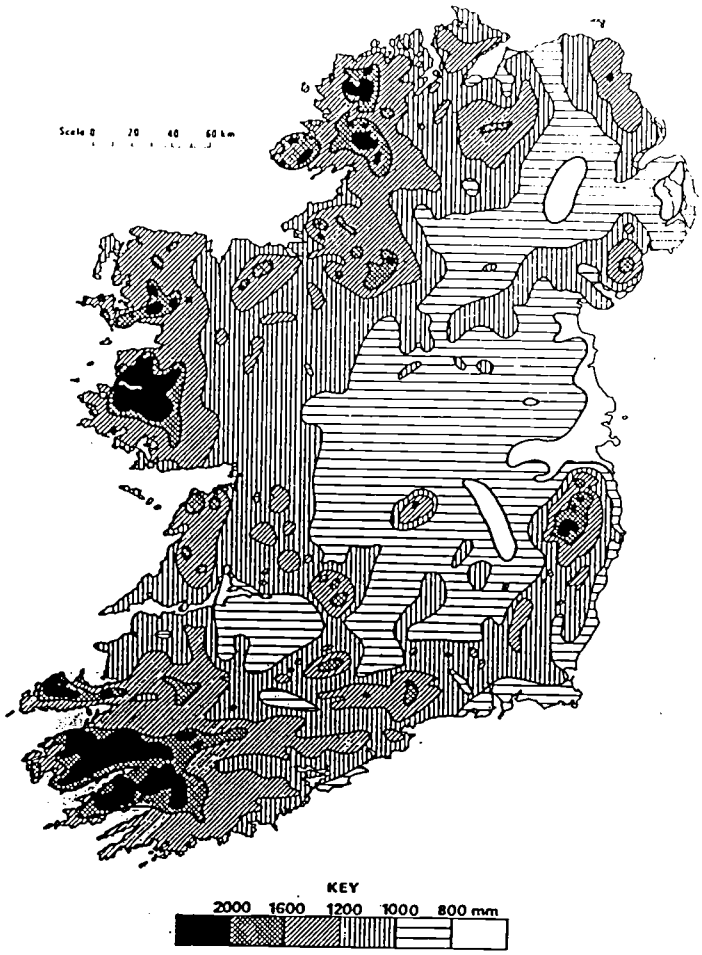

Fig. 2 6 Average annual rainfall 1951-1980 (from Rohan 1986)

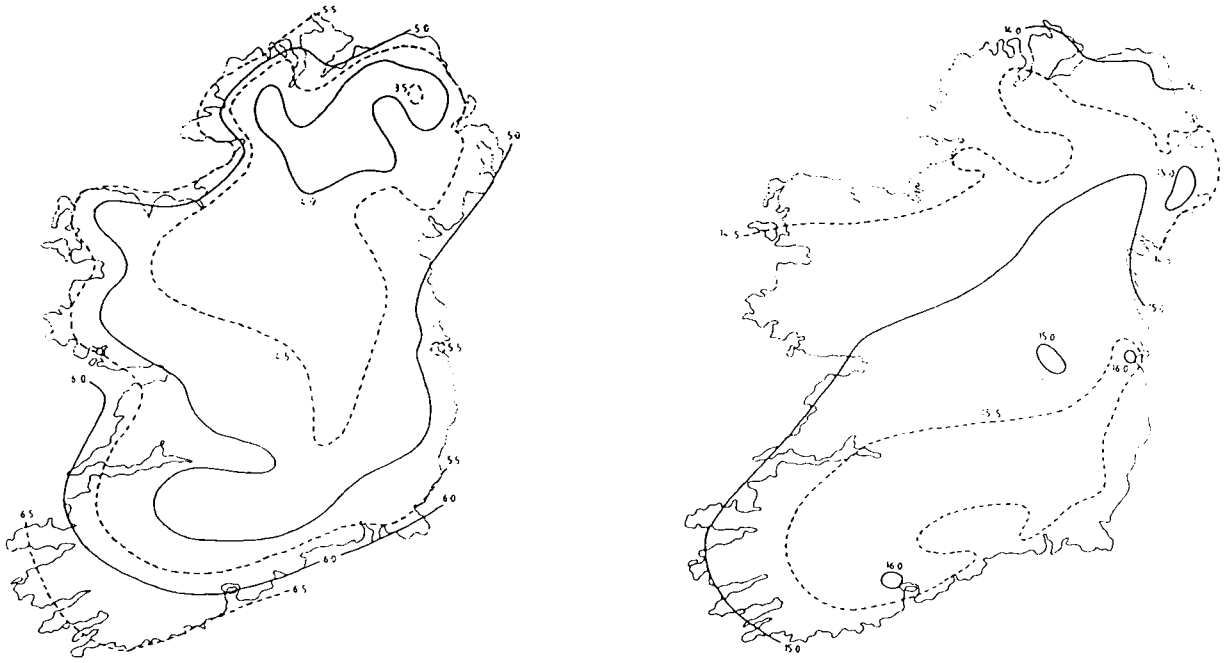

Fig. 2.7a Mean daily air temperature (°C) January 1951-1980. (reduced to mean sea level)

Fig. 2.7b Mean daily air temperature (°C) July 1951-198' (reduced to mean sea level)

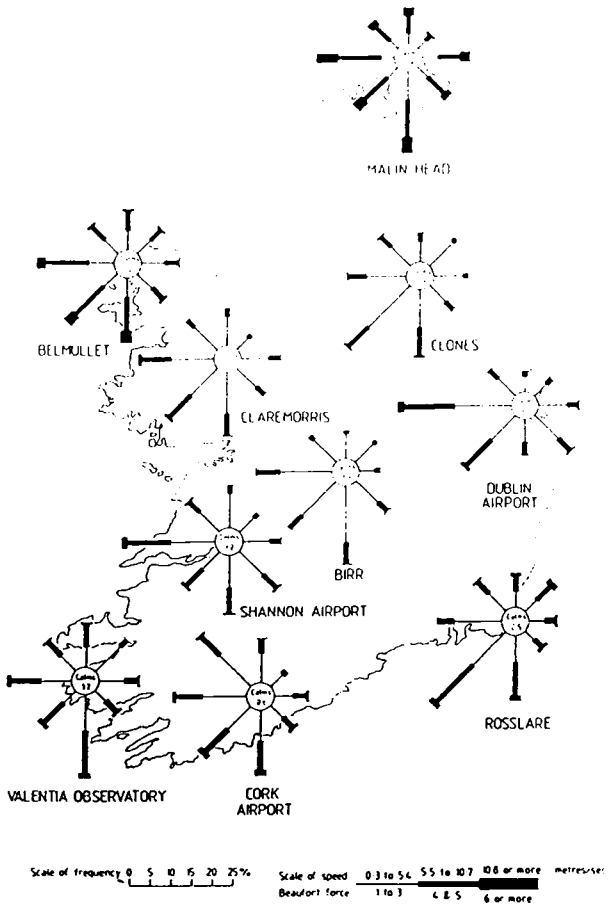

Fig. 2.8 Frequency of simultaneous occurrence of specified ranges of wind speed and direction. (from Rohan 1986)

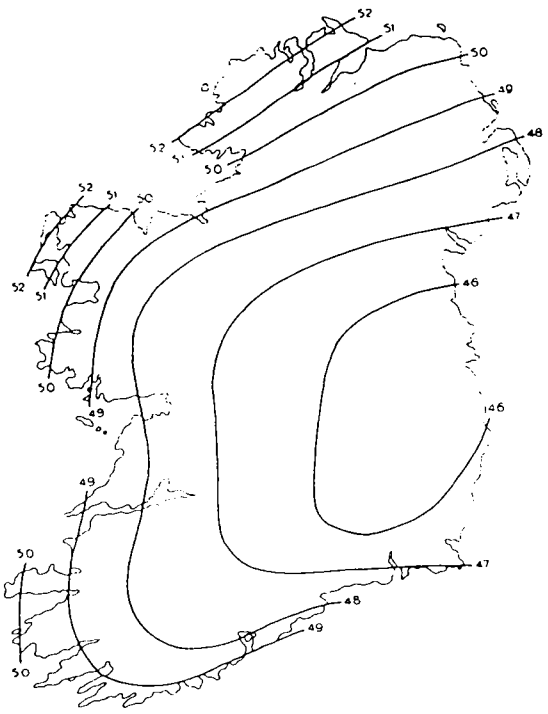

Fig. 2.9 Maximum wind speed (m/s) in a gust with a return period of 50 years (from Rohan 1986)

3. DESCRIPTION OF THE 1996 AND 1998 SURVEYS

3.1 Description of the 1996 survey

3.1.1 Programme

The survey in 1996 consisted of two phases, (1) compilation of an inventory of lagoons on the coast of the Republic and selection of 20 sites for further study, and (2) site surveys of the selected lagoons. The survey was carried out by a four-member team specialising in vegetation, aquatic fauna and Coleoptera. Brief visits to sites were made between 11 June and 7 July and site surveys were carried out from mid July to the first week of October.

3.1.2 Identification of lagoons

Potential sites were identified chiefly from OS 1:50 000 maps (Discovery Series), with additional information from aerial photographs and colleagues. Maps of some important areas had not been published in time for the survey, notably Cork Harbour, the Shannon Estuary, and Galway Bay.

Isolated lakes were considered to be saline if the salinity was 1‰ or more or if certain indicator species were present. Indicators of marine influence in waters that were fresh at the time of sampling were:

Algae; *Enteromorpha*

Plants: *Ruppia* spp., *Scirpus maritimus,* and salt-marsh plants on the shore. The presence of salt-sensitive species such as water-lilies and water lobelia was taken to indicate permanently freshwater.

Fauna: mysids, *Palaemonetes varians.*

Tidal waters were considered to be brackish if the salinity was <33‰ or if certain indicators of brackish conditions were present. Indicators of freshwater influence in waters of salinity >33‰ at the time of sampling were:

Algae: *Chaetomorpha linum, Fucus ceranoides*

Plants: *Ruppia* spp, charophytes, *Phragmites*

Fauna: *Cerastoderma glaucum, Hemiptera, Coleoptera*

Fully saline waters, i.e. with a salinity of 34‰ or more, were included even when no brackish species could be found, if they displayed the topographical features of a true lagoon, namely shallow water, a sedimentary barrier, and restricted tidal flow.

3.1 3 Names of sites

The names and spellings are those shown on the recent 1:50 000 Ordnance Survey maps (Discovery Series) when available. Alternative names used locally or shown on other maps, and also Irish names, are given at the beginning of each site description. Grid references are for the centre of the lagoon.

3.1.4 Brief surveys of lagoons

Description of the site and sampling of fauna and flora were completed in 1-2 hours. For most lagoons, only a part of the site could be investigated and observations were generally concentrated near the inlet where this was easily accessible. Notes were made on topography of the lagoon and surrounding land with particular attention to the barrier and inlet, and the position of freshwater inflows. Observations on aquatic vegetation and fauna were confined to water of wading depth. Fauna was collected by net sweeps, sediment sieving and searches of hard substrates for sessile and cryptic species. Some preliminary

collecting of marginal beetles was done at promising sites, and pitfall traps were laid at sites likely to be selected for more intensive survey.

3.1.5 Selected site surveys

The 20 sites selected for further study were distributed along south and west coasts from Wexford to Donegal (Table 3.1).

Table 3.1. Sites selected for survey in 1996, listed in clockwise order from Co. Wexford to Co. Donegal.

	Name	County	Nearest town or village	OS Grid Reference	Discovery Map No.
1	Lady's Island Lake	Wexford	Rosslare	T 099065	77
2	Tacumshin Lake	Wexford	Rosslare	T 050065	77
3	Kilkeran Lake	Cork	Rosscarbery	W 338344	89
4	Lissagriffin Lake	Cork	Crookhaven	V 775265	88
5	Farranamanagh Lake	Cork	Kilcrohane	V 830378	88
6	Drongawn Lough	Kerry	Sneem	V 731640	84
7	Lough Gill	Kerry	Castlegregory	Q 606142	70/71
8	Cloonconeen Pool	Clare	Carrigaholt	Q 836497	63
9	Lough Donnell	Clare	Quilty	R 002707	57
10	Lough Murree	Clare	Ballyvaughan	M 255119	51
11	Aughinish Lagoon	Clare	Kinvarra	M 286134	51
12	Bridge Lough	Galway	Kinvarra	M 342128	(52)*
13	Lettermullen Pool	Galway	Lettermullen	L 827213	44
14	Loch Tanaí	Galway	Costelloe	L 950305	45
15	Lough Aconeera	Galway	Kilkieran	L 875369	44
16	Mill Lough	Galway	Carna	L 755331	44
17	Corragaun Lough	Mayo	Killadoon	L 748698	37
18	Roonah Lough	Mayo	Killadoon	L 755765	37
19	Furnace Lough	Mayo	Newport	L 965975	31
20	Durnesh Lake	Donegal	Ballintra	G 878695	11

* Not published at time of writing

Surveys consisted of 2-4 day sampling sessions depending on the size of the lagoon and ease of access.

Environmental factors. Salinity was measured at all aquatic sampling stations by means of a hand-held refractometer accurate to 1‰. The substrate in shallow water was recorded at faunal sampling stations. Water depth, and details of the barrier and inlet, were recorded during faunal sampling.

Vegetation. Observations of aquatic vegetation were mainly confined to water of wading depth but a grapnel was used to collect deeper samples. Two types of recording were used:

(1) Qualitative shore-based surveys during walks around the shore and in shallow water. Species occurrence and the extent of the main vegetation types were recorded. At some of the larger sites it was not possible to walk the complete shoreline.

(2) Quantitative sampling in transects perpendicular to the shore at intervals around the lagoon. Transects were sampled from shallow water through emergent and marginal vegetation to adjacent habitat. Cover/abundance and frequency values were recorded in quadrats or relevés and the vegetation types classified into NVC communities (except for aquatic vegetation for which no classification was published).

Aquatic fauna. Faunal samples were collected by a combination of sweep-netting, sieving of sediment, and close inspection of stones and vegetation for about an hour at each station. Perspex light-traps were left overnight at some stations, and fyke nets were used at

appropriate stations when water depth (and the presence of otters) allowed. Material collected was preserved in 70% alcohol, except for fyke net catches which were released alive.

Marginal beetles. Five sampling methods, all standardised by area or time, were used according to habitat type and weather: (1) suction sampling in transects of standard area; (2) pitfall traps with ethylene glycol as preservative; (3) cobbles turned within 0.5-2 m from the water margin; (4) flotation of substrate samples where burrow casts were observed; (5) search of bare soil (<50% vegetation cover) during warm weather without rain.

Further details of sampling methods and procedures are given in the site survey reports (Healy *et al.* 1997, Vol. 3, Parts 1-20).

3.1.6 Summary of the 1996 survey

(1) Among 99 potential sites visited, 50 were identified as lagoons and a further 6 were known to qualify. Time did not allow all potential sites to be visited and up to 50 further sites were considered to be worth visiting in the future, a number of them on islands.
(2) Ireland posesses a wide range of lagoon types, most of which are in a relatively natural state. Karst lagoons may be unique in Europe, and rocky peat lagoons with silled inlets may be confined to this country and Scotland.
(3) Irish lagoons are, on average, larger than those in Britain where few of the 166 recorded (Bamber *et al.* 1992, Smith & Laffoley 1992, Davidson *et al.* 1991) are >10 ha. The area of the 20 lagoons surveyed was 1-450 ha with a mean of 73 ha. The total Irish lagoon resource was estimated to be about 2800 ha.
(4) Salinities ranged from nearly freshwater to hypersaline with a range of 0-40‰.
(5) All but one of the 20 selected sites were recommended for proposal as SACs and 14 have since been designated as proposed candidate sites, either as lagoons or as parts of larger complexes of habitats.
(6) Species records in the 20 selected sites included 53 aquatic plants (including algae), 248 aquatic invertebrates and fish, and 209 Carabidae and Staphylinidae. One charophyte was a new Irish record, and several invertebrates could be new records.
(7) The number of aquatic taxa per lagoon varied between 15 and 69 with a mean of 34.2. This figure was much higher that that recorded during surveys in Britain and The Netherlands. The most important determinants of species richness were area, habitat diversity, salinity regime, and the presence of rocks.
(8) *Ruppia* spp occurred in most sites and were found to be useful indicators of lagoonal conditions. *Chara baltica* in L. Aconeera was a new Irish record. *Lamprothamnium papulosum* was recorded at four sites, and *Chara canescens* at three sites. Both are Red Data Book species listed as 'vulnerable' for Ireland.
(9) The aquatic fauna resembled that of British lagoons but some species were distinctly more frequent and a number of British species were not recorded. Insects appeared to be far more frequent than in Britain. Amphipoda, Hemiptera and aquatic Coleoptera were of particular interest for their diversity and apparent ecological preferences. All three groups included species believed to be rare.
(10) The total number of lagoonal specialist species was 19, including 6 plants and 13 invertebrates. The number in each lagoon varied between 1 and 11. The list of lagoonal specialists needs to be revised for Ireland but a reliable list can not be produced until more is known about the ecology of brackish species here.

(11) Fifteen species of marginal Coleoptera were identified as indicator species characterising well-developed habitat, but only nine were known to be halophilous or halotolerant. On the whole, species were more characteristic of freshwater wetland than saline soils, with many halotolerant species not recorded, indicating that soil salinity is not always a limiting factor.

3.1.7 Limitations of the 1996 survey

(1) Time limits did not allow all potential lagoons to be visited and the inventory was thus incomplete.
(2) Restriction of sampling to wading depth may have resulted in a failure to collect or identify certain important species, notable charophytes, or to recognise water stratification or salinity gradients.
(3) Some groups were not identified to species, either because material needed to be identified while alive, or because taxonomic expertise was not available. Groups affected include Turbellaria, Nemertea, Diptera (larvae) and green algae.
(4) Restriction of the survey to summer and autumn did not allow the full range of conditions in lagoons to be assessed. The effect on water levels and salinity of winter rains and storms is unknown.
(5) A shortage of information on the occurrence of brackishwater species in Ireland, and their ecological range, made it difficult to determine their rarity or assess their value as indicator species.
(6) The absence of an experienced geomorphologist/hydrologist on the survey team made it hard to evaluate the sites as landforms, or to predict future trends or identify potential threats.
(7) More sites needed to be sampled to provide a data set large enough for an analysis which might identify communities or species characteristic of particular lagoon types or environmental conditions. A number of lagoons not surveyed were believed to be of scientific interest and potentially capable of supplying the needed information.

3.2 Description of the 1998 survey

3.2.1 Programme and procedures

The programme, procedures and sampling methods were essentially the same as in 1996, with the following changes:

Identification and naming of sites. Maps of Cork Harbour, the Shannon Estuary, and Galway Bay were available and allowed identification of a number of previously unknown small sites. Marine charts were also used. Sites in the Gaelteacht are described in this report under their Irish names except for Loch Chonaortha and Loch an Mhuilinn for which the English names Lough Aconeera and Mill Lough, used in the 1996 survey, have been retained

Criteria for designation as lagoon. In general, the criteria were the same as in 1996 (see 3.1.2), but drawing on previous experience, the presence of *Ruppia* was taken to be diagnostic. Sites without *Ruppia* were considered to be lagoons if the salinity was at least 1‰. If they were dominated by marine algae, they were only accepted as lagoons if tidal exchange appeared sufficiently limited to allow brackish conditions to persist in some areas of the system, or if it appeared likely that the marine phase was recent or transitory.

Sampling. An important improvement on previous procedures has been the investigation of the lagoon bed at all depths (except for a few deep sites) by snorkelling. This enabled recognition of extensive beds of charophytes and other algae beyond wading depth. Samples of vegetation brought to the surface provided additional faunal material.

Salinity measurement. A conductivity meter gave more accurate readings and a 5 m cable made it possible to record salinity gradients to this depth and to recognise stratification.

Taxonomic expertise. The expertise and experience of the team's botanist greatly increased our ability to recognise distinct habitats and the conditions in which they occur. The identification of *Cladophora* species is particularly important.

3.2.2 Selection of survey sites

Nineteen sites were chosen in Counties Wexford, Cork, Galway and Donegal (Table 3.2), i.e. areas of the country with the greatest concentration of lagoons. Four are on islands. Three were studied as part of a single unit (the L. Fhada complex), and Cara na gCaorach was briefly investigated as an adjunct to L. Cara Fionnla.

Sites were selected according to their perceived scientific value with preference for the following:

- Sites in complexes interdependent on each other and capable of designation as single large SACs
- Karst lagoons
- Sites in Donegal, under-represented in 1996.

Ballyteige drainage channels were chosen because although they are artificial, the system is diverse, is adjacent to a pcSAC and an SPA, and has potential for lagoon habitat creation.

Table 3.2 Sites selected for survey in 1998. Loch an Ghadaí and the upper pools were studied as part of the L. Fhada complex. Cara na gCaorach was sampled briefly as part of Cara Fionnla.

Lagoon	County	Map No.	Grid ref.	Nearest town or village
Ballyteige drainage channels	Wexford	77	T 9506	Kilmore Quay
Kilmore Lake, Whiddy Is.	Cork	85	V 8548	Bantry
Loch Mór	Galway	51	L 9802	Inis Oírr
Loch Phort an Chorrúch,	Galway	51	L 8511	Árainn
Loch an Chara	Galway	51	L 8810	Árainn
Loch Fhada	Galway	45	L 9330	Cheathrú Rua Thuaidh
L. Fhada upper pools	Galway	45	L 9531	Cheathrú Rua Thuaidh
Loch an Ghadaí	Galway	45	L 9330	Cheathrú Rua Thuaidh
Loch an Aibhnín	Galway	45	L 9431	Muiceanach idir Dha Sháile
Loch Cara Fionnla	Galway	45	L 9628	Casla
(Cara na gCaorach)	Galway	45	M 9631	Cinn Mhara
Loch an tSáile	Galway	45	L 9539	Scriob
Lough Athola	Galway	44	L 6348	Clifden
Lough Bofin	Galway	37	L 5265	Inishbofin
Maghery Lough	Donegal	1	G 7209	Dunglow
Sally's Lough	Donegal	1	B 7216	Burtonport
Kincas Lough	Donegal	1	B 7920	Kincaslough
Moorlagh	Donegal	1	B 7919	Annagary
Inch Lough	Donegal	6	C 3427	Buncrana

4. SUMMARY OF THE LAGOON INVENTORY

4.1 New lagoons identified

A total of 68 new potential sites were visited by at least one member of the team, bringing the total number of sites examined to 179 (Table 4.1). Among 192 sites considered, 13 have not been visited, in most cases because it seemed unlikely that they would prove to be brackish. Time and weather did not allow visits to two island sites: Doon L. on Inishkea North, and an un-named lake on Inishirrer in Co. Donegal. Some information on Doon L. has since been obtained from a colleague. The Inishirrer lagoon was seen from a boat to have the appearance of a classical lagoon with a cobble barrier. A few small sites, mainly in the region of Cork Harbour, have not been inspected but we believe that few lagoons of importance >1 ha now remain to be investigated.

The addition of 36 new sites (including Doon L. and Inishirrer L.) brings the total number of lagoons for the country to 92 (Table 4.2, Fig. 4.1).

4.2 Regional distribution of the main lagoon types

Lagoons are found on nearly all parts of the Irish coast but for different reasons. Certain types are concentrated in regions where geology, geomorphology, post-glacial history, climate and human activities have favoured their formation (Table 4.3, Fig. 4.1).

Table 4.3. Regional distribution of the four main type of lagoon (sedimentary, rock, saline lake and artificial).

	Sedim. lag.	Rock lag.	Saline lake lag.	Artif. Lag.	**Total**
Louth-Wicklow	0	0	0	2	**2**
Wexford	2	0	0	3	**5**
Cork	5	0	0	17	**22**
Kerry	1	0	1	0	**2**
Clare	3	2	0	1	**6**
Galway	4	12	16	2	**34**
Mayo	4	0	1	1	**6**
Sligo	1	0	1	2	**4**
Donegal	3	0	5	3	**11**
Total	**23**	**14**	**24**	**31**	**92**

Louth-Wicklow

The region is mostly overlain by rich deposits of glacial drift. The greater part of the coast consists of sand or shingle beaches, often backed by sand dunes, and with spits at river mouths in north Co. Dublin. The southern part of the east coast from just north of Wicklow to Wexford once consisted of a series of stream catchments, each with a coastal barrier which in many cases impounded a lagoon (Carter *et al.* 1984). All of these were drained in the 19th century and there are no natural lagoons on this coast at the present time. Two artificial lagoons, a small one on a golf course near Greenore and the large Broadmeadow Water, were creating by construction of railway embankments.

South-east Wexford

Long stretches of the coast are occupied by gravel-based barrier systems topped with sand dunes providing ideal conditions for lagoon formation. Lady's Island Lake and Tacumshin Lake, lying behind a south coast barrier, are classic examples of percolation lagoons, and barrier dynamics here have been well studied. Lady's Island Lake, which is periodically breached, has a rich flora and fauna and is the only Irish lagoon to have been

studied over a long period (Healy 1997). The former Ballyteige Lough, lying behind the Ballyteige Burrow west of Kilmore Quay, was once a large brackish inlet but was partly drained during the mid 19th century to create polders from which water is pumped out. Similar polders form the North and South Slobs which replace former mud flats and salt marshes in Wexford Harbour (Rowe and Wilson 1966). The broad drainage channels of these three sites constitute lagoonal habitats with relatively constant conditions.

Waterford-East Cork

No significant lagoons remain in this region. The former Ballycotton Lagoon is now open to the sea and tidal and the supply of local sediment appears to be inadequate for maintenance of the original barrier.

Cork Harbour

The present large harbour is actually a drowned river valley (Carter 1992). Brackish wetlands may once have been widespread around its shallow margins but most have been reclaimed and the area is highly industrialised so that no completely natural lagoons remain. A number of artificial lagoons have been created, however, some inadvertently during road construction, others deliberately as reservoirs or cooling ponds. The largest is Rostellan Lake which is slightly brackish and important for waterfowl. Lough Beg, cut off from an arm of Cork Harbour, is a private bird reserve. The site at Ahanesk, south of Midleton, is perhaps the most interesting but has not been properly investigated.

The South-west

The Armorican fold system of West Cork and Kerry, consisting of Old Red Sandstone interspersed with shales and other sedimentary rocks, forms a series of south-west trending ridges separated by valleys which became flooded to form rias during post-glacial times. Natural lagoons are not numerous but are of many different types. The largest sedimentary lagoon is Lough Gill, a shallow lake on a sandy tombolo on the north Kerry coast. It is a good example of a late stage lagoon evolving into a freshwater lake and its present mildly brackish state is due to the presence of an artificial sluiced outlet. Kilkeran Lake on the south coast has a sandy barrier that is periodically breached, sometimes naturally, sometimes artificially to relieve flooding. Reenydonagan Lough, and Kilmore Lough on Whiddy Island, lie in Bantry Bay which contains Ireland's most southerly drumlins. Both have cobble barriers but the Kilmore barrier is partly destroyed and the lagoon now appears to be in a marine phase. Farranamanagh Lake is a good example of a sedimentary lagoon with an inlet in which wide fluctuations in salinity limit the fauna and flora. The only silled saline lake lagoon in the region, Drongawn Lough, is completely natural and unspoiled.

Partly because of its indented coastline, the south-west contains the greatest concentration of artificial lagoons in the country, most having been formed when roads were constructed across bays and inlets. The best of these is Lissagriffin Lough.

Clare-South Galway

The region includes the karstic Burren limestone in the north, and shales and sandstone overlain by peat and gleys in the south. Two interesting lagoons lie in the southern sector. Cloonconeen Pool near Loop Head is a peat lagoon which may have formed in a peat cutting. It has a low cobble barrier on a peat base which extends into the intertidal zone where there is a drowned forest. Lough Donnell is one of the best examples of a western percolation lagoon although it has an artificial outlet. It is noteworthy for the height and length of its barrier and the extent of seawater percolation. The karst lagoons of

the Burren, south Galway and the Aran Islands are of special interest and show a wide diversity of topography and hydrology. All receive at least some seawater through subterranean fissures and some may show tidal fluctuations in water level. The most important karst lagoon is Lough Murree which contains two species of endangered charophytes. The nearby Aughinish lagoon is also in karst but is unusual in having a tidal inlet through rock as well as a cobble barrier. Loch Mór on Inis Oírr reaches over 20 m in depth and is oligohaline, while lagoons on Inis Maan and Árainn (Inis Mór) are small and shallow with various salinity regimes. All but one of the Aran lagoons were rather poor in species. A number of small, isolated karst lagoons also occur on the mainland south of Kinvarra.

Connemara, Co. Galway

This severely glaciated region includes the area of Galway granite in the south and metamorphic rocks in the north. The drowned coastline is deeply indented with many sheltered bays, and long sea inlets that often penetrate far inland. The landscape is mostly rocky blanket bog with numerous lakes, some of which have outlets to the sea. The region is rich in silled and inlet lagoons. A group of interconnecting lakes in the south of the region (Loch Fhada, Loch an Ghadaí, Loch an Aibhnín and Loch Tanaí), and the neighbouring Loch Cara Fionnla and Loch Cara na gCaorach, are particularly important for their rich and interesting plant communities which include a rare charophyte, and the presence of some faunal species possibly rare in Ireland. The rock lagoon on Lettermullen contains a similar community and has a remarkable diversity for such a small pool. Further north, Lough Athola has an unusual outlet consisting of a network of salt marsh creeks in peat which empty over a sill onto a rocky shore. Other important saline lakes are Loch an tSaile, a large, complex inlet lagoon managed as a salmonid fishery, and Salt Lake, a deep silled lagoon with rapids which has attracted some attention for its interesting fauna which includes some rare nudibranchs and a serpulid reef. Three largish sedimentary lagoons with cobble barriers, Ballyconeely Lough which is sluiced, Lough Anillaun with an open inlet under a road, and Lough Bofin which is isolated, are appear to be poor in species but the latter contains plentiful *Lamrothamnium papulosum*.

Mayo-Sligo

The coast of Mayo from Killary Harbour northwards to Clew Bay, Achill Island and the Mullet peninsula is mostly low-lying with widespread drift deposits. The mainly sandy coast is highly dynamic and subject to both gradual changes and storm damage. The majority of lagoons are in machair, which depends for its development on wind-blown sand, and most former lagoons are now in a late evolutionary phase having filled with sand so that they are above or beyond the influence of the sea and have become freshwater lakes. Some have mysids or other brackishwater invertebrates, which may be relict populations, but *Ruppia* is always absent. The most important remaining sedimentary lagoon is Corragaun Lough which has undergone changes in shape and position of the inlet since the 1950s. Roonah Lough on the same coast, was an oligohaline lagoon in 1996 but now appears to be open to the sea and tidal due to storm damage. The only important saline lake lagoon is Furnace Lough, a large, deep, stratified lagoon sheltered between rocky hills and moraines which is an important salmonid fishery but has a relatively poor invertebrate fauna for its size.

Donegal

This region has a varied geology and many different coastal formations and lagoon types. Glaciation has produced drift-covered coastal plains with drumlins and vast quantities of sand which have given rise to active dune systems and extensive tracts of

Fanad region, former sedimentary lagoons are now too far from the coast to be influenced by the sea. Land uplift in the region may have accelerated the filling and accretion processes. Five natural saline lakes, with sills or artificial outlets and a range of depths and salinity regimes, are found in and south of the Rosses, a mountainous region with outcropping Rosses granite. They include Maghery Lough which is the only lagoon in Donegal containing *Lamprothamnium papulosum*. There is a small sedimentary lagoon on the bleak Tory Island. Two artificial lagoons on the east side of Lough Swilly were created to receive drainage water pumped from extensive polders. Both are important for waterfowl.

4.3 Some sites rejected

Some sites showing the topographical characteristics of lagoons or lagoon-like systems were rejected for various reasons.

L. Atalia, Galway City. This was ignored in 1996 on the basis of local advice but was inspected in 1998. Very soft mud in areas likely to be brackish prevented proper investigation. Although brackish conditions may persist in some areas, a significant intertidal zone was exposed at low tide.

Dawros Beg, Co. Galway. A small bay cut off from the sea by a high wall allows entry and exit of water through a narrow opening. There is obviously a limited tidal range on a given day but there appeared to be no significant freshwater input and no evidence of brackish conditions.

Termoncarragh L., Mullet Peninsula. The main drainage channel was slightly brackish and contained *Ruppia* and some brackishwater invertebrates but there was no evidence of marine influence in the lake itself.

Cross L., Mullet Peninsula. This was accepted as a lagoon in 1996, but after reinvestigating in 1998 it was rejected, mainly on the grounds that *Ruppia* was absent. Although obviously a former lagoon, it is probably now unlikely to be reached by seawater.

Bunduff L., Co. Sligo. Classified as a doubtful lagoon in 1996. It was revisited and a search was made for *Ruppia* but none was found. The lake is thus considered to be in a freshwater phase but could become a lagoon following storm-induced changes to the barrier.

Shanaghan L., Co. Donegal. In spite of localised salinity of 4‰ and the presence of mussel shells and *Jaera nordmanni*, the fauna and flora indicated that marine influxes are rare. Three of the four *Potamogeton* present are strictly freshwater species.

Table 4.1 Complete list of known and possible lagoons visited in 1996 and 1998, and some unseen. Sites identified as lagoons in grey. * visited for the first time in 1998.

	Grid ref.	Morphological type	Salinity (ppt)	Area (ha)	Comments
Co. Louth					
Greenore Golf Course*	J 0810	Artificial lag. sluiced?	4	ca 2	
Dublin					
Broadmeadow Water	O 2147	Artificial lag. with inlet	3-33	280	
Wicklow					
Broadlough	T 3096	Tidal inlet	seawater		Too tidal, not lagoon
Kilkoole	T 3016	Saltmarsh channels and pools	seawater		Too tidal, not lagoon
Wexford					
North Slob channels	T 0723	Artificial lag., pumped	11-24	50	
South Slob, Coal channel	T 0718	Artificial lag., pumped	3	50	
Lady's Island L.	T 0906	Sedimentary lag., isolated	18-24	350	
Tacumshin L.	T 0506	Sedimentary lag., pipes	0-?	450	
Ballyteige channels	T 9506	Artificial lag., pumped	0-29	8+	
Waterford					
Tramore	X 5801	?	?	5	Not visited
Wood Pt. Blackwater R.*	X 0084	?	?	4	Not lagoon
Lackaroe, Blackwater R.*	X 0782	Blocked tidal creek	13	6	
Cork					
Youghal mudlands*	X 1079	Artificial lag., sluiced	13	2	
Ballymacoda*	X 2472	Salt marsh	-	-	Salt marsh
Ballycotton Lagoon	W 9865	Former sedimentary lagoon	seawater	-	No longer a lagoon
Shanagarry*	W 9967	Saltmarsh creek	seawater	-	Salt marsh
Ahanesk*	W 8771	Artificial lag., sluiced	16-34	2	
Aghada (2)		Cooling ponds?	?	-	Not visited
Rostellan L.	W 8766	Artificial lag., pipe	4-35	50	
Cuskinny L.	W 8367	Artificial lag., sluiced?	22-27	4	
Slatty Bridge, Fota Is.	W 8072	Artificial lag., sluiced?	11-24	2	
Raffeen, Ringaskiddy*	W7564	Artificial lag., sluiced?	33	4	
L. Beg, Curraghbinny	W 7762	Artificial lag., sluiced	(0-10)	2	
Clashroe, Oysterhaven*	W7050	Artificial lag., sluiced	6-25	5	
Ballinclashet, Oysterhaven*	W 6950	Tidal creek	18	1.5	
Kinsale Marsh	W 6349	Artificial lag., sluiced	30-35	12	
Garrettstown, Kinsale*	W 5943	Saline lake lagoon	0-10	?	
White's Marsh, Inchydoney	W 3939	Artificial lag., pipe	37	2	
Muckruss L.	W 3839	Artificial lag., pipe	40	1	
Kilkeran L.	W 3334	Sedimentary lag., isolated	1-2	20	
Rosscarbery	W 2936	Artificial lag., inlet	14-24	20	
Blind Harbour	W 2031	Artificial lag., inlet	(34) tidal	8	
Toormore L.	V 8430	Artificial lag., pipes	40	1-2	
Lissagriffin L.	V 7726	Artificial lag., inlet	3-30	15	
Farranamanagh L.,	V 8337	Sedimentary lag., inlet	1-27	4	
Reen Pt. pools	V 8839	Sedimentary lag., isolated	high	1(all tog)	
Kilmore L. Whiddy Is.	V 8548	Sedimentary lag., inlet	26-32	6.5	
Reenydonagan L.	V 0051	Sedimentary lag., pipe	12-25	25	
Kerry					
Drongawn Lough, Sneem	V 7364	Saline lake lag., silled	10-30	11.5	
Lough Currane, Waterville	V 5165	Freshwater lake	fresh	-	Not lagoon
Lough Gill	Q 6014	Sedimentary lag., sluiced	0-5	144	
Akeragh L.	Q 7526	Former lagoon	dry	-	Drained
L. Naparka, Castlegregory	Q 6217	Dune slack?	fresh?	-	Not lagoon

Table 4.1 (cont.

	Grid ref.	Morphological type	Salinity (ppt)	Area (ha)	Comments
Limerick					
Mungret*	R 5455	Freshwater lake, (clay pit)	fresh	80	Not lagoon
Muckinish Pt.*	R 5057	Freshwater lake, (clay pit)	fresh	25	Not lagoon
Aughinish Is.	R 2853	Artificial lake	fresh?	10	Not lagoon? (not visited)
Clare					
Shannon Airport Lagoon	R 3562	Artificial lag., sluiced	13	2	
Scattery Is.	Q 9752	Tidal inlet?	tidal	-	Degraded, not lagoon
Cloonconeen Pool	Q 8349	Sedimentary lag., isolated	8-35	7	
Farrihy Lough, Kilkee	Q 9164	Probably freshwater lake	?	-	Not visited
Doonbeg Lough	Q 9665	Partly blocked tidal estuary	-	-	Not lagoon
Lough Donnell	R 0070	Sedimentary lag., inlet	2-6	25	
Muckinish Lough	M 2708	Karst lagoon	14	1	
Lough Luirk	M 2808	Turlough, nearly dry	fresh?	-	Not lagoon
Lough Murree	M 2511	Karst lagoon	10-27	13	
Aughinish Lagoon	M 2813	Sedimentary lag., inlet	31-40	8	
Galway					
L. Mor, Inis Oirr*	L 9802	Karst lagoon	1-10	7	
L. Ceann Gainamh, Inis Meain*	L 9506	Turlough, nearly dry	fresh	-	Not lagoon
Port na Cora Iochs, Inis Meain*	L 9306	Karst lagoon	4-15	<1	
L. na gCadhan, Inis Meain*	L 9406	Karst lagoon	2	<1	
L. Amurvy, Árainn*	L 7711	Karst lagoon	17, 2	1	
L. Dearg, Arainn*	L 8012	Karst lagoon	15-30	4	
L. Phort an Chorrúch, Arainn*	L 8511	Karst lagoon	1-5	4	
L. an Chara, Arainn*	L 8810	Karst lag., sluiced	8-25	5	
L. an tSaile, Arainn*	L 8808	Karst lagoon	16-34	<1	
Bridge L., Knockakilleen	M 3412	Artificial lag., sluiced	30-38	4	
Tawin Is. (2)*	M 3119	tidal inlets	tidal	-	Not lagoons (too tidal)
Doorus lakes*	M 3512	Karst lagoon	1-?	all<1?	
Rincarra Peninsula	M 3716	Karst lagoon	>30	<1	
Ardfry Point*	M 3320	Karst lagoon	12	1	
Ardfry pool*	M 3521	Artificial lag. Inlet	22	1	
Rinvile (Turreen) L.*	M 3623	Saline lake lag., sluiced	?-27	3	
L. Atalia, Galway City*	M 3025	Silled inlet	7-10 (ebbing)	-	Too tidal?
Mutton Island*	M 2923	Tidal inlet	seawater	-	Not lagoon
Hare Island*	M 3123	Tidal inlet	seawater	-	Not lagoon
Renmore L., Galway City*	M 3125	Sedimentary lag., isolated	10	<1	
Rusheen Bay, Barna*	M 2623	Tidal inlet	-	-	Not lagoon
L. Faddacrussa*	L 9628	Saline lake lag., inlet, peat	17	1	
Lettermullen Pool	L 8221	Rocky shore lagoon	(28) 34-35	<1	
L. an Mhuillin*	L 8623	Freshwater lake	fresh	-	Not lagoon
Keeraunagark Bay	L 9722	Tidal bay with weir	seawater	-	Too tidal, not lagoon
L. an Oileainin*	L 9331	Freshwater lake	fresh	-	Not lagoon
L. Fhada upper pools*	L 9531	Saline lake lag., indirect inlet, peat	13-33	2	
Loch an Ghadaí*	L 9330	Saline lake lag., indirect inlet, peat	3-10	5	
Loch Fhada*	L 9330	Saline lake lag., indirect inlet, peat	8-25	8	
L. Tanaí	L 9530	Saline lake lag., indirect inlet, peat	11-32	11	
Loch an Aibhnín*	L 9431	Saline lake lag., silled, peat	18-27	55	
L. ui Chadhain*	L 9628	Freshwater lake	fresh	-	Not lagoon
L. Cara Fionnla	L 9628	Saline lake lag., indirect inlet, peat	0-30	15	
Cara na gCaorach*	M 9631	Saline lake lag., inlet, peat	0-20	60	
L. Nafurnace	L 9736	Freshwater lake	fresh	-	Not lagoon

Fig. 4.1 (cont.)

	Grid ref.	Morphological type	Salinity (ppt)	Area (ha)	Comments
Loch Doire Bhanbh*	L 9638	Saline lake lag., pipe	?	1.5	
L. an tSáile	L 9539	Saline lake lag., silled	0-15	90	
L. Inverbeg	L 9139	Freshwater lake	fresh	-	Not lagoon, sill too high
L. Invermore	L 9039	Freshwater lake	fresh	-	Not lagoon, sill too high
Lough Aconeera	L 8837	Saline lake lag., silled	0-14	26	
Flannery Bridge	L 8635	Tidal inlet	seawater	-	Not lagoon
L. Nageeron	L 7532	probably freshwater lake	fresh?	-	Not visited
Mill Lough	L 7832	Saline lake lag., silled	2-34	6	
Toombeola Bridge	L 7544	Blocked river mouth	fresh	-	Not lagoon
L. Naneeve	L 8038	Not known	-	-	Not visited
Loch na gCaor	L 7531	Freshwater lake	fresh	-	Not lagoon
L. Ateesky	L 7831	Tidal inlet	33	-	Not lagoon
L. Keeraun	L 7832	Saline lake lag., silled (isolated)	3	1	
Ballyconneely Lough	L 6244	Sedimentary lag. sluiced	0-5	20	
Bunowen (several)	L 6041	Not known	?	small	Not visited
Doonloughan L.	L 5744	Former lagoon?	fresh	-	Not lagoon
Lough Athola	L 6348	Saline lake lag., silled	6-33	11	
Ballinaboy L.	L 6647	Freshwater lake	fresh	-	Slight marine influence
Salt Lake	L 6649	Artificial lagoon?, inlet	(4) 16-35	50	
Fahy L., Omey Is.	L 5655	Former sedimentary lagoon	fresh	-	Machair lake
Aughrusbeg L.	L 5658	Freshwater lake	fresh	-	Not lagoon
Lough Anillaun	L 6158	Sedimentary lag., inlet	fresh	15	
Rusheenduff L.	L 6763	Former sedimentary lagoon	fresh	-	Cobble barrier, not lagoon
Dawros Beg*	L 6758	Artificial sea pool	38-39	4	No freshw. Not lagoon
Lough Bofin, Inishbofin*	L 5265	Sedimentary lag. isolated	13-33	8	
Mayo					
Doovilra L.	L 7567	Former sedimentary lagoon?	fresh	-	Not lagoon
Dooaghtry L.	L 7470	Freshwater lake (pers. comm.)	fresh	-	Not lagoon
Corragaun Lough	L 7570	Sedimentary lag., inlet	0-32	10	
Cross L., Killadoon	L 7475	Former sedimentary lagoon	fresh	-	Cobble barrier, not lagoon
Roonah Lough	L 7677	Sedimentary lag., inlet	0-2	55	
L. Cahasy	L 7578	Former sedimentary lagoon	fresh	-	Cobble barrier, not lagoon
L. Baun	L 7579	Former sedimentary lagoon	fresh	-	Cobble barrier, not lagoon
L. Polimore	L 7479	Former sedimentary lagoon	fresh	-	Cobble barrier, not lagoon
Murrisk N.*	L 9283	Freshwater lake	fresh	-	Not lagoon
Murrisk S.*	L 9282	Freshwater lake	fresh	-	Not lagoon
L. Duff	L 9382	Probably freshwater lake	fresh?	-	Tide did not allow access
Annagh L. Westport Bay	L 9583	Not known	?	-	Not visited
Westport House L.	L 9884	Freshwater lake	fresh	-	Not lagoon
Furnace Lough	L 9797	Saline lake lag., silled	0-22	125	
L. Feeagh	L 9698	Freshwater lake	fresh	-	Not lagoon
Keel L., Achill	F 6405	Former sedimentary lagoon	fresh	-	Too far from sea
Sruhill L.	F 6504	Former sedimentary lagoon	fresh	-	Too far from sea
L. Nakeeroge, Achill	F 5708	probably freshwater lake	fresh?	-	Not visited
L. Nakeeroge, Annagh Strand	F 5907	probably freshwater lake	fresh?	-	Not visited
L. Nambrack, Achill	F 7009	Former sedimentary lagoon	fresh	-	Too far from sea
L. Doo, Achill	F 7109	Former sedimentary lagoon	fresh	-	Too far from sea
Sruhill L.	F 7208	Tidal inlet	seawater	-	Not lagoon
Dooniver Lough, Achill	F 7307	Sedimentary lag., sluiced	fresh	3	
Inishbiggle (several)	F 7406	Not known	fresh?	-	Not visited
Drumsleed	F 7611	Freshwater lake	fresh	-	Not lagoon
Feorinyeo Bay, Mullet Pen.	F 6423	Freshwater lake	fresh	-	Not lagoon

Table 4.1 (cont.)

	Grid ref.	Morphological type	Salinity (ppt)	Area (ha)	Comments
Cross L., Mullet Pen.	F 6430	Former sedimentary lagoon	fresh	110	Slight marine influence
Doon Lough, Inishkea N Is.	F 5623	Sedimentary lag., isolated?	fresh?	1.5	Lagoon?
Termoncarragh L.*	F 6634	Freshwater lake	fresh	45	Brackish outlet, not lagoon
Cartoon Lough, Killala Bay	G 2032	Artificial lag., pipe?	36	4	
Sligo					
Bunduff L.	G 7155	Former sedimentary lagoon	fresh	-	Slight marine influence
L. Gill	G 7235	Freshwater lake	fresh	-	Not lagoon
Portavaud E, Ballysadare Bay*	G 5834	Sedimentary lag., inlet	33	5	
Portavaud W*	G 5834?	Saline lake lag., pipe	25	1	
Tanrego 1*	G 6228	Saline lake lag., pipe	25-30	1	
Tanrego 2*	G 6129	Saline lake lag., pipe	13-16	2.5	
Leitrim (none identified)					
Donegal					
Durnesh Lough	G 8870	Sedimentary lagoon, sluiced	0-7	83	
Shanahan L.*	G 7091	Freshwater lake	0-4	8	Not lagoon, but slightly salt
Sheskinmore L.*	G 7096	Freshwater lake	fresh	25	Not lagoon
Clooney L.	G 7299	Freshwater lake	fresh	-	Not lagoon
Maghery Lough	G 7209	Saline lake lag., silled	15-27	19	
L. Scalpacore, Cruit Is.*	G 7221	Freshwater lake	fresh	-	Not lagoon
Toberkeen L.	G 7510	Freshwater lake	fresh	-	Not lagoon
Loch O Dheas, Tory Is.*	G 8446	Sedimentary lag.	5	1	
Loch O Thoir, Tory Is.*	G 8645	Freshwater lake	fresh	-	Not lagoon
Drumnatinny	G 9234	?	?	-	Not visited
L. Meela	B 7313	Freshwater lake	fresh	-	Not lagoon, inlet brackish
Sally's Lough	B 7216	Saline lake lag., silled	28-35	6	
Kinkas Lough	B 7920	Saline lake lag., silled	2-31	6	
Mullaghderg L.	B 7620	Freshwater lake	fresh	-	Not lagoon
Carnboy L.	B 7823	Freshwater lake	fresh	-	Not lagoon
Inishirrer Is.	B 7829	Sedimentary lag., isolated	-	3	
Gola Is.*	B 7627	Freshwater lake	fresh	-	Not lagoon
Derrybeg (3)	B 8025	Saline lake lags., isolated?	11	1	Salt marsh?
Moorlagh	B 7919	Saline lake lag., sluiced	0-30	10	
Corganniver Glebe	B 9936	Sandhill pools	?	Small	Not visited
Dunfanaghy New Lake	C 0035	Freshwater lake	fresh	-	Not lagoon
Melmore L.	C 1243	Former sedimentary lagoon?	fresh	-	Not lagoon
Lackagh River, Glen Lough	C 0930	River Estuary	fresh	-	Not lagoon
Rosapenna	C 1138	Freshwater lake	fresh	-	Not lagoon
Moss L., Carrickart*	C 1338	Freshwater lake	fresh	-	Not lagoon
Carrick Beg L.*	C 1536	Artificial lag., percolation	22	2	
Back Lough	C 1835	Tidal bay	seawater	-	Not lagoon
Rinmore L.*	C 1946	Freshwater lake	fresh	-	Not lagoon
Wee Sea	C 1939	Tidal bay	seawater	-	Not lagoon
Kindrum L.	C1843	Freshwater lake	fresh	-	Not lagoon
Rinboy L., Fanad	C 1744	Freshwater lake	fresh	-	Not lagoon
Eelburn Loughs, Fanad	C 1944	Freshwater lake	fresh	-	Not lagoon
Kinny L. Fanad	C 2044	Freshwater lake	fresh	-	Not lagoon
Maghera-Dromann, Fanad	C 2045	Freshwater lake	fresh	-	Not lagoon
Shannagh L.	C 2145	Freshwater lake	fresh	-	Not lagoon
Maghera More, M'cunningham*	C 2312	Tidal mud flats	seawater	-	Not lagoon
Blanket Nook Lough	C 3119	Artificial lag., sluiced	10-20	40	
Inch Lough	C 3427	Artificial lag., sluiced	1-8	160	
Isle of Dooagh	C 3952	Former sedimentary lagoon	dry	-	Drained, not lagoon

Table 4.2 Lagoons identified 1996-1998. Salinities at the time of sampling, previous measurements in brackets. Blue – surveyed in 1996, red – surveyed in 1998, green – worth further investigation

	Grid ref.	Area (ha)	Morphological type	Hydrological type	Salinity (ppt)	Comments
Louth						
1 Greenore Golf Course	J 0810	ca 2	Artificial lag. sluiced?	Oligohahaline	4	Little known
Dublin						
2 Broadmeadow Water	O 2147	280	Artificial lag. Inlet	Gradient, sea>fresh	3-33	Polluted
Wexford						
3 North Slob channels	T 0723	50	Artificial lag., pumped	Gradient, sea+fresh	11-24	Good fauna. Worth further study
4 South Slob channels	T 0718	50	Artificial lag. pumped	Gradient, sea<fresh	3	Mainly fresh. Search for charophytes?
5 Lady's Island L.	T 0906	350	Sedimentary lag. Isolated	Gradient, sea+fresh	18-24	Periodically breached
6 Tacumshin L.	T 0506	450	Sedimentary lag., pipes	Gradient, sea<fresh	0-?	Partly drained
7 Ballyteige channels	T 9506	8+	Artificial lag. pumped	Gradients, sea+fresh	0-29	Percolation through dunes
Waterford						
8 Lackaroe, Blackwater R.	X 0782	6	Artificial lagoon, inlet	Gradient?	13	Inlet from estuary
Cork						
9 Youghal mudlands	X 1079	2	Artificial lag. sluiced	probably gradient	13	Former saltmarsh?
10 Ahanesk	W 8771	2	Artificial lag. sluiced	gradients	16-34	Worth revisiting
11 Rostellan L.	W 8766	50	Artificial lag. pipe	Gradient, sea<fresh	4-35	Mainly oligohaline
12 Cuskinny L.	W 8367	4	Artificial lag. pipe	Polyhaline	22-27	Wildfowl reserve, average.
13 Slatty Bridge, Fota Is.	W 8072	2	Artificial lag. sluiced?	Gradient, sea+fresh	11-24	Linear system, poor
14 Raffeen, Ringaskiddy	W 7564	4	Artificial lagoon sluiced?	Polyhaline	33	Part of golf course
15 L. Beg, Curraghbinny	W 7762	2	Artificial lag. sluiced	Oligohaline	(0-10)	Private bird reserve. Surveyed
16 Clashroe, Osterhaven	W7050	5	Artificial lag. sluiced?	Oligo-mesohaline	6-25	Worth sampling
17 Kinsale Marsh	W 6349	12	Artificial lag. sluiced	Polyhaline	30-35	Threatened by development
18 Garrettstown, Kinsale	W 5943	?	Artificial lagoon	Oligohaline	0-10	Former salt marsh channels
19 White's Marsh, Inchydoney	W 3939	2	Artificial lag. pipe	Polyhaline	37	Very shallow
20 Muckruss L.	W 3839	1	Artificial lag. pipe	Polyhaline	40	Very shallow
21 Kilkeran L.	W 3334	20	Sedimentary lag. isolated	Oligohaline	1-2	Occasionally breached
22 Rosscarbery	W 2936	20	Artificial lag. sluiced?	Gradient. sea>fresh	14-24	Poor
23 Blind Harbour	W 2031	8	Artificial lag. sluiced?	Euhaline	(34) tidal	Poor
24 Toormore L.	V 8430	1-2	Artificial lag. sluiced?	Euhaline	40	Peaty
25 Lissagriffin L.	V 7726	15	Artificial lag. sluiced?	Gradient, sea+fresh	3-30	Poor flora, average fauna
26 Farranamanagh L.,	V 8337	6	Sedimentary lag. Inlet	"Shock lagoon"	1-27	Poor flora and fauna
27 Reen Pt. pools	V 8839	1(all tog)	Sedimentary lag. isolated	mainly polyhaline	high	Worth sampling

Table 4.2 (cont.)

	Grid ref.	Area (ha)	Morphological type	Hydrological type	Salinity (ppt)	Comments
28 Kilmore L. Whiddy Is.	V 8548	6.5	Sedimentary lag. inlet	Euhaline	26-32	In a marine phase
29 Reenydonagan L.	V 0051	25	Sedimentary lag., pipe	Gradient, sea+fresh	12-25	Worth further sampling
Kerry						
30 Drongawn Lough, Sneem	V 7364	20	Saline lake lag. silled	Polyhaline	10-30	Deep (18 m), rich
31 Lough Gill	Q 6014	144	Sedimentary lag. sluiced	Oligohaline	0-5	Shallow. *Chara canescens*
Clare						
32 Shannon Airport Lagoon	R 3562	2	Artificial lag. sluiced	Mesohaline	13	Worth further sampling
33 Cloonconeen Pool	Q 8349	7	Sedimentary lag. isolated	Poly-euhaline	35	Barrier overwashed. Drowned forest
34 Lough Donnell	R 0070	25	Sedimentary lag. inlet	Oligohaline	2-6	Tidal water flushed by river
35 Muckinish Lough	M 2708	1	Karst lag.	Mesohaline	14	200 m from sea
36 Lough Murree	M 2511	13	Karst lag.	Mesohaline (polyhaline)	10-27	Rich flora, becoming eutrophic
37 Aughinish Lagoon	M 2813	8	Sedimentary lag. inlet	Euhaline	31-40	Silled inlet + cobble barrier. In karst
Galway						
38 L. Mor, Inis Oirr	L 9802	7	Karst lag.	Oligohaline	1-10	Deep (25 m). Poor
39 Port na Cora lochs, Inis Meain	L 9306	<1	Karst lag.	Oligohaline, mesohaline	4-15	poor
40 L. na gCadhan, Inis Meain	L 9406	<1	Karst lag.	Oligohaline	2	poor
41 L. Amurvy, Arainn	L 7711	1	Karst lag.	Oligohaline, mesohaline	17, 2	poor
42 L. Dearg, Arainn	L 8012	4	Karst lag.	Polyhaline	15-30	poor
43 L. Phort an Chorruch, Arainn	L 8511	4	Karst lag.	Oligohaline	1-5	Cobble barrier, eutrophic
44 L. an Chara, Arainn	L 8810	5	Karst lag. sluiced	Mesohaline (polyhaline)	8-25	Fauna good
45 L. an tSaile, Arainn	L 8808	<1	Karst lag.	Polyhaline	16-34	Open grikes
46 Bridge L., Knockakilleen	M 3412	4	Artificial lag. sluiced	Euhaline	30-38	Shallow, eutrophic.
47 Doorus lakes (4)	M 3512	all<1?	Karst lag.	various	1-22	Small, isolated
48 Rincarna Peninsula	M 3519	<1	Karst lag.	Euhaline	?	Shingle barrier
49 Ardfry Point	M 3320	1	Karst lag.	Mesohaline	12	Shingle barrier
50 Ardfry pool	M 3521	1	Artificial lag. Inlet	Polyhaline	22	Former fish pond
51 Rinvile (Turreen) L.	M 3623	3	Saline lake lag.	Polyhaline	?-27	Worth further sampling
52 Renmore L., Galway City	M 3125	<1	Sedimentary lag. isolated	Mesohaline	10	Eutrophic
53 L. Faddacrussa	L 9628	1	Saline lake lag., inlet, peat	Mesohaline	17	Salt marsh pool
54 Lettermullen Pool	L 8221	1	Rocky shore lag.	Euhaline (polyhaline)	(28) 34-35	Rich, interesting
55 L. Fhada upper pools	L 9531	2	Saline lake lag., indirect inlet, peat	Mesohaline, polyhaline	13-33	Seawater by overwash

4.4 Occurrence of lagoon types

Morphological types

The geomorphology and topography of the sites is summarised in Table 2.4. The number of lagoons in each of the 11 categories suggested in Section 2.2.6 is shown in Table 4.4.

Table 4.4 Representation of morphological lagoon types

Sedimentary lagoons	(21)		
Isolated		8	
Inlet		8	(2 with artificial inlets)
Sluiced		5	
Rock lagoons	(16)		
Karst		14	
Rocky shore		2	
Saline lake lagoons	(21)		
Inlet in peat		7	
Silled		10	
Sluiced		4	
Artificial lagoons	(28)		
Inlet		6	
Sluice/pipe		19	
Pumped		3	
Unclassified	(23		

A few lagoons did not fit easily into the above categories, generally because they were of mixed origin.

Cloonconeen Pool is a peat lagoon without rocks but with a cobble barrier. It is classified as an isolated sedimentary lagoon because the barrier is formed of material from offshore.
Aughinish L. is in karst and has an extensive cobble barrier, but also a tidal inlet emptying onto a rocky shore. This "mixed" lagoon has been classified as an inlet sedimentary lagoon because the inlet is the main source of salts and colonists.
Loch Phort Chorrúch is in karst but has a cobble barrier without inlet. As the main source of salts appears to be through rock fissures, it is classified as a karst lagoon.
L. Faddacrussa, and one of the Cork sites classified as a saline lake lagoon, were associated with salt marshes and could qualify as saltmarsh pools. Their fauna and flora were too poor for a distinction to be made.
Lochs Fhada, an Ghadaí and the upper pools form a complex connected by inlets which drain into L. an Aibhnín. Their channels are described as "indirect". The main source of salts appears to be overwash from a salt marsh into the upper pools. However, colonisation of L. Fhada is more likely to be from L. an Aibbnín. L. Tanaí also drains into L. an Aibbnín through an indirect inlet.
L. Athola has a mixed inlet, part peat and part a rocky sill. Functionally, it is a silled lagoon.
Ahanesk and Carrick Beg. These artificial lagoons have no specially designed outlet but water percolated through the cracks in the sea wall. The are classified as sluiced.

Hydrological types

The hydrological classification of the 92 lagoons (where possible) is given in Table 4.5. Most aspects of the hydrological regime could be recognised during the initial brief

visits but the presence of vertical gradients, dependent to some extent on depth, could not be determined, and shock lagoons were not identified.

Table 4.5 The occurrence hydrological types among 92 lagoons

Homogeneous lagoons	(57)	
Euhaline		8
Polyhaline		20
Mesohaline		11
Oligohaline		18
Gradient lagoons	(16)	
Horizontal gradient sea > fresh		2
Horizontal gradient sea + fresh		6
Horizontal gradient sea < fresh		3
Vertical + horizontal gradients		5
Shock lagoons	(8)	7
Unclassified	(9)	

Ballyteige has been subdivided into three distinct components for this analysis. L. Bofin is included with the shock lagoons, with some hesitation, based on the high salinity recorded in summer 1996 contrasting with 3‰ recorded in March 1999. The nine sites unclassified are those for which there is insufficient information.

It is obviously difficult to decide on the dominant salinity regime of a lagoon based on a few observations, especially when they are confined to summer. Where recorded salinities overlap two categories, the lower one has been chosen because it is assumed that salinities are likely to be lower in winter. The lower category was also preferred for sites sampled at spring tides when the salinity could have been unusually high.

4.5 Lagoon size

Lagoon sizes were estimated from maps and are not necessarily accurate. The size of some small sites may be overestimated. Estimates for some sites given in the 1996 Report are revised.

A greater number of small sites were included in the 1998 survey. Many of these are in karst and were included because they were considered to be of special interest. Although a high proportion of the lagoons included in the national list are small (Fig. 4.2), the proportion is smaller than in the British survey (see Smith and Laffoley 1992), and nearly half are over 5 ha and of sufficient size to be considered as sites of conservation value.

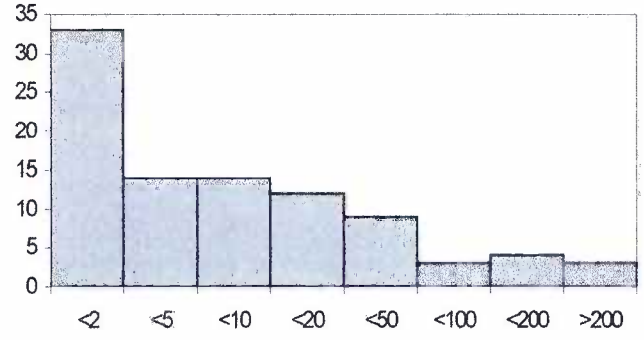

Fig. 4.2 Proportion of lagoons in eight size categories (ha).

Table 4.2 (cont.)

	Grid ref.	Area (ha)	Morphological type	Hydrological type	Salinity (ppt)	Comments
85 Sally's Lough	B 7216	6	Saline lake lag., silled	Poly-euhaline	28-35	*Cladophora battersii*
86 Kinkas Lough	B 7920	6	Saline lake lag., silled	Horiz. & vert. gradients	2-3	Inlet partly artificial. Stratified.
87 Inishirrer Is.	B 7829	3	Sedimentary lag., isolated	?	-	Not visited
88 Derrybeg (3)	B 8025	1	Saline lake lags., isolated?	Mesohaline	11	Salt marsh pools. Not sampled
89 Moorlagh	B 7919	10	Saline lake lag., sluiced	"Shock lagoon" vert. grad.	0-30	Shock lagoon, poor-average
90 Carrick Beg L.	C 1536	2	Artificial lag., sluiced	Polyhaline	22	Worth further sampling
91 Blanket Nook Lough	C 3119	40	Artificial lag., sluiced	Meso-polyhaline	10-20	Worth further sampling
92 Inch Lough	C 3427	160	Artificial lag., sluiced	Gradient, sea<fresh	1-8	Best oligohaline lag. *Chara canerscens*

4.6 Depths

Depth measurements are only available for the 39 sites surveyed and a few others. Most lagoons are, by definition, shallow, regardless of origin. The average depth for most is 2-3 m. A few are even shallower and where the substrate is firm a wide area of the lagoon bed can be easily prospected. One karst lagoon, and a few saline lake lagoons, reached depths greater than 5 m:

Drongawn L. – 18 m
L. Mór –at least 20 m
L. Fhada – 7 m
L. an tSáile – 14 m
Salt Lake – at least 20 m
L. Furnace – 21 m

4.7 Sites worthy of further investigation

In addition to the 36 sites surveyed as potential SACs in 1996 and 1998, at least 17 others are considered worthy of investigation (coloured green in Table 4.2). Among these, Doon L., Inishkea, and Inishirrer are unknown and may turn out to be poor in species like most other western island sites. Salt Lake near Clifden has been independently investigated and is known to be interesting and worthy of SAC status. The North Slob in Wexford has been surveyed for aquatic fauna by at least three investigators in recent times and has been shown to contain a rich fauna including rare species. The flora needs to be resurveyed. Other potentially valuable sites include five large lagoons, South Slob, Rostellan L., Reenydonagan L., Ballyconneely L., and Blanket Nook. Reenydonagan appeared highly eutrophic, however, and the S. Slob may be mainly freshwater. Shannon Airport Lagoon, although artificial, contained well-developed aquatic vegetation, including charophytes and a diversity of insects. Among the remaining sites, the most interesting appeared to be Ahanesk and Garretstown in Co. Cork, Rinvile L. in Co. Galway, and Carrick Beg in Co. Donegal.

4.8 References (Sections 3-4)

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Rowe, D. and Wilson, C.J. 1996. High skies – low lands. An anthology of the Wexford Slobs and Harbour. Duffry Press, Dublin. 363 pp.

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5. SUMMARY OF RESULTS OF THE 1996 AND 1998 SURVEYS

In this section, results of the 1998 site surveys are combined with those for 1996, giving a sample set of 39 sites when the L. Fhada complex is split into its three main components and Cara na gCaorach is included. Comparison between these lagoons and the total 92 for the country shows to what extent they are representative.

5.1 Geographic distribution of the survey sites

The sites are spread around the country from Wexford to Donegal (Table 5.1). Nearly half are in Co. Galway where most of the karst lagoons are situated and where there is the greatest concentration of saline lake lagoons. Comparison with Table 4.3 shows that Cork sites are poorly represented relative to the total identified. This is because the majority are artificial.

Table 5.1 Distribution of the lagoon types surveyed.

	Sedimentary lags.	Rock lags.	Saline lake lags.	Artificial lags.	Total
Wexford	2	0	0	1	3
Cork	3	0	0	1	4
Kerry	1	0	1	0	2
Clare	3	1	0	0	4
Galway	1	4	11	1	17
Mayo	2	0	1	0	3
Donegal	1	0	4	1	6
Total	13	5	17	4	39

5.2 Lagoon area

Fig. 5.1 shows that selection of survey sites favoured the larger lagoons with only one (Lettermullen Pool) less than 2 ha, and all but one (Broadmeadow Water – polluted) of lagoons over 50 ha included. Other lagoons >20 ha not surveyed were the North Slob (quite well known), South Slob (mainly freshwater), Rostellan L. (very low salinity), Rosscarbery (poor), Reenydonagan (eutrophic), Ballyconneely L. (thought to be very low salinity), Salt Lake (sufficient information available), and Blanket Nook (artificial, similar to Inch L.).

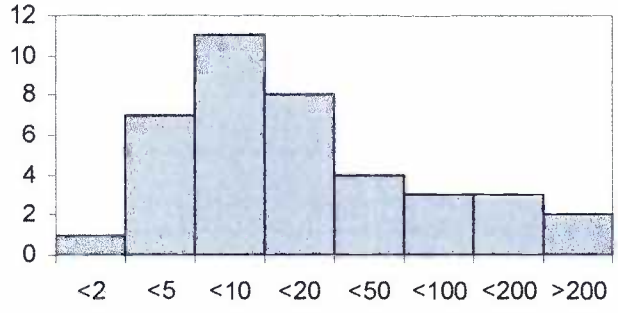


Fig. 5.1 Frequency of eight categories of lagoon area (ha) for 39 sites surveyed in 1996 and 1998.

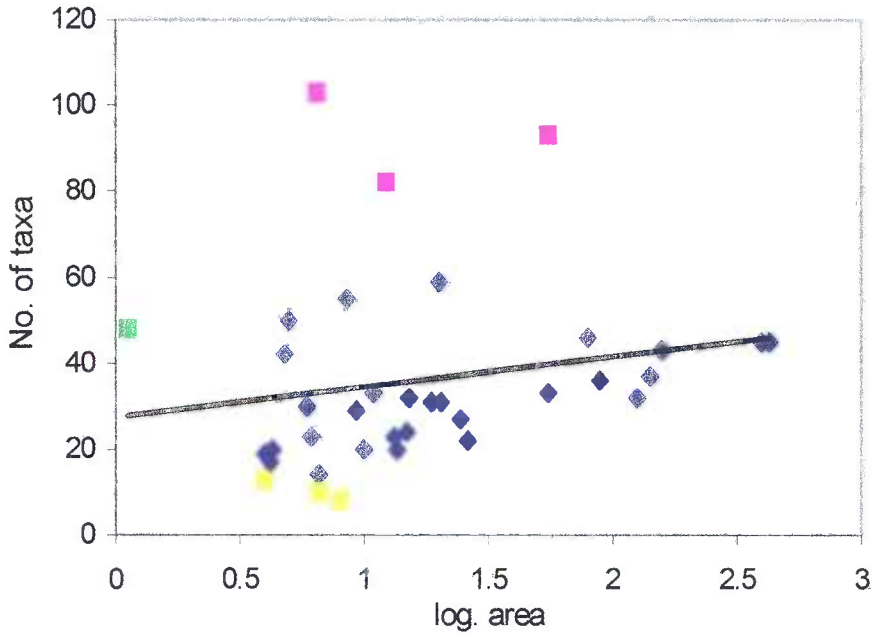


Fig. 5.2 Species area relationship (aquatic fauna) for 36 lagoons. Pink = saline sites (Kilmore, Aibhnín, Athola), green = Lettermullen, yellow = Bofin and Mór and Chorrúch.

A species area relationship is barely detected for aquatic fauna (Fig. 5.2) and is complicated by the effects of high salinity and easy access for species from the open coast. Four sites with exceptionally rich faunas in relation to their size are all euhaline or polyhaline, and in the case of Kilmore, Aibhnín and Athola, experience frequent tidal flow. A similar effect of high salinity might be demonstrated for plants with red algae making an increasingly important contribution to species numbers with increasing salinity. Three sites with exceptionally poor faunas (Mór, Chorrúch and Bofin) are on islands and may be less accessible for potential colonists. The number of species in some of the larger lagoons may be underestimated because sampling effort was not proportional to the size of the lagoon.

5.3 Lagoon morphological types

Comparison between the proportion of morphological types among the survey sites (Table 5.2) and those for the 92 Irish lagoons (Table 4.4) shows that representatives of all types were surveyed. The number of sedimentary lagoons surveyed is roughly proportional to their occurrence, but although 16.8% of the total number of lagoons were classified as rock lagoons, mostly the interesting karst lagoons (Table 4.3), this type formed only 12.8% of those surveyed. However, many are too small to be of conservation value. Saline lakes are exceptionally well represented with 17 out of a possible 21 surveyed, while only four out of a possible 26 artificial sites were surveyed. The selection of many saline lake lagoons has proved justified because many of these have been rated highly in the final evaluation.

Table 5.2 Representation of morphological lagoon types among the survey sites

Sedimentary lagoons	(13)
Isolated	4
Inlet	6
Sluiced	3
Rock lagoons	(5)
Karst	4
Rocky shore	1
Saline lake lagoons	(17)
Peat	7
Silled	9
Sluiced	1
Artificial lagoons	(4)
Inlet	1
Sluiced	2
Pumped	1

5.4 Lagoon hydrological types

Comparison between Tables 5.3 and 4.5 shows that all but one of the recognised hydrological regimes are represented among the survey sites. The omission is the type with horizontal gradient dominated by seawater. The high proportion of shock lagoons and those with vertical gradients may be because these are hard to recognise without a proper survey and could have been overlooked among the sites not surveyed. The poor representation of mesohaline lagoons was noted for the 1996 survey. There appear to be relatively few good examples of this regime in the country.

Table 5.3 Representation of hydrological lagoon types among the survey sites

Homogeneous lagoons	(22)
Euhaline	5
Polyhaline	7
Mesohaline	2
Oligohaline	8
Gradient lagoons	(9)
Seawater > freshwater	0
Seawater + freshwater	2
Seawater < freshwater	2
Vertical and horizontal	5
Shock lagoons	7

It needs to be stressed that the lagoons are classified according to observations made in summer and both higher salinities (due to storms) and lower salinities (due to rainfall) might be expected in winter. During most of the 1998 survey period, water levels were exceptionally high due to heavy rainfall and surface salinities may have been unusually low.

5.5 Summary of vegetation surveys (text partially from Roden, Volume III)

All types of aquatic vegetation have been investigated, and marginal stands of more than 5 m width have been analysed.

5.5.1 Species records

Records from aquatic habitats include 43 taxa of phytoplankton, 63 non-charophyte algae (61 identified to species) from hard substrates, and 6 charophytes and 9 vascular plants from soft substrates. Over 160 species of plants have been identified from emergent and marginal communities. Species lists and tables of species occurrence are given in Volume III.

Some of the algae are believed to be rare or local, although in the case of the more "difficult" Chlorophyta, they are probably under-recorded. *Cladophora battersii* and *C. aegagropila* are known from few localities in Western Europe, the large populations identified during this survey are therefore important. Some of the red seaweeds are southern species which may be near the northern limit of their range. These have not been recorded from Scotland, the only other area of Western Europe where lagoons similar to those in which the species occur in Ireland are found. Their occurrence here in lagoons is thus of interest.

5.5.2 Lagoonal specialist species

Among lagoonal specialist plants listed by Barnes (1989) and others, only *Chara connivens* and *Tolypella nidifica* were not found. *Chara connivens* has not been recorded in Ireland since 1970 (Stewart and Church 1992). There may be some doubt about its status as a lagoonal specialist as it frequently occurs inland. The only record of T. nidifica in Ireland from the North Slob has since been found to be an error. *Cladophora battersii* is added as a lagoonal specialist characterising deep water soft substrates in high salinity.

5.5.3 Communities

Plankton

Plankton, more than any other plant community, changes in species composition over each year. Therefore the single samples analysed in this study represent only a partial picture. Three elements can be distinguished, i) species of coastal sea water, ii) species known to favour brackish conditions and iii) freshwater species. As might be expected species distributions reflect water salinity. The diversity of brackish water dinoflagellates, especially in the genus *Prorocentrum*, is most interesting as these species are seldom encountered, probably due to infrequent sampling (Dodge 1982). Equally, the very distinctive species *Stephanosphaera pluvialis* in Loch an Ghadai was unexpected. It is more usually a species of rainwater pools in limestone karst in Ireland, (Roden 1979).

Further analysis of the planktonic flora of the sites is beyond the scope of this report, but the ecological role of plankton in lagoons should not be overlooked. Extremely dense blooms of dinoflagellates and other species were found at several sites, to the extent that lagoon water was very noticeably more turbid than fresh or seawater. This cloudiness accounts in part for the poor light at depth in some lagoons and the consequent restriction of macrophyte growth. A possible explanation is that lagoons are places where sea and freshwater mix. Algal growth in the former is known to be nitrogen limited while the in the latter it is phosphorus limited. Intermediate water may benefit from an adequate supply of both nutrients.

Benthic macrophytic vegetation on soft sediments

In nearly all cases species diversity is low with less than 5 species recorded in

most samples. The distributions of the dominant species are related to salinity and depth (Fig. 5.3). The vegetation can be divided into five broad categories (for further details see "Habitats" 5.8, and Volume III):

Charophyte communities
Potamogeton pectinatus communities
Ruppia sp. communities
Zostera marina communities
Unattached cladophoracean algal communities.

The categories greatly extend the habitat divisions recognised by Covey and Thorpe (1994) for Scotland where these soft substrate communities may be less well developed or have not been identified.

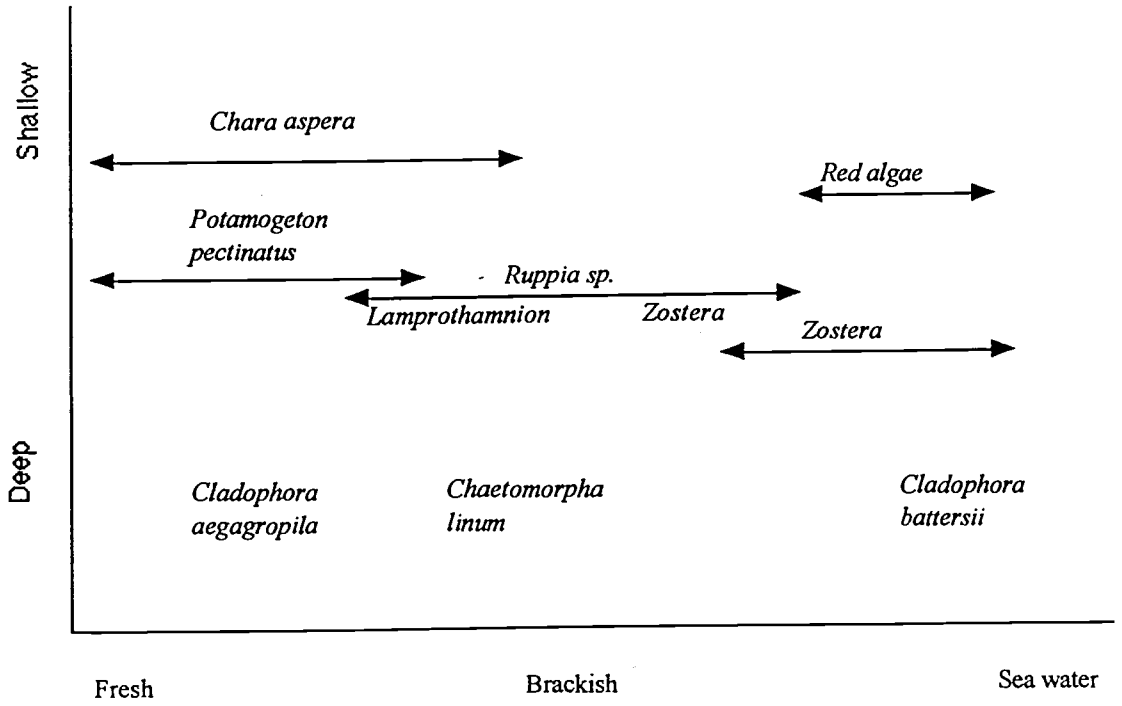


Fig. 5.3. Distribution of the more important species of macrophyte in relation to depth and salinity in the lagoons studies.

Benthic communities on hard substrates

Only high salinity lagoons in rock basins have an extensive algal flora. Hard substrates were dominated by red algae but the number of sites at which they were found was small and the communities were less clearly defined. Insufficient work was carried out to rigorously define the macro-algal communities present but it was possible to define an outline of them. Some could be equated with similar

communities in Scotland; others were dominated by southern species and may occur in lagoonal habitats on more southerly European coasts.

The most noticeable feature of the macroalgal communities was the minor role played by brown algae (Phaeophyceae). Several *Fucus* were recorded but these rarely formes extensive beds as on rocky shores. Only *Fucus ceranoides* was at all frequent.

Vegetation of lagoon margins

All the lagoons described in this report had some form of halophytic vegetation bordering their shores. The extent of this vegetation was determined in large part by the nature of the lagoon in question. Lagoons formed in rock basins tend to have steep cliff like shores with a rapid transition from lagoonal communities to terrestrial communities. Lagoons with shores of sand, peat or mud have more gradual transitions and larger areas of marginal vegetation. As the lagoons have a wide range of salinities, marginal vegetation ranges from halophytic vegetation such as salt marsh to freshwater marsh and grassland. The limit of marginal vegetation was arbitrarily defined as the point at which halophile or coastal plants disappeared.

Irish coastal vegetation has been studied intensively by a number of ecologists (e.g. Wymer 1984, Sheehy Skeffington and Wymer 1991, Curtis and Sheehy Skeffington 1998) and a framework of associations has been defined in accordance with the Zurich Montpellier method. Wymer (1984) gives a comprehensive account of salt marsh communities and the results of this survey are interpreted with reference to his work.

The marginal vegetation is divided into the following broad categories;

Puccinellia communities
Juncus maritimus communities
Festuca rubra communities
Juncus gerardii communities
Eleocharis communities
Phragmites, Schoenoplectus and *Scirpus* communities.

Details if these formations and their subdivisions are given under "Habitats" (5.8) and in Volume III.

Wymer's classification of Irish salt marsh communities (1984) provides an adequate framework for most of the marginal communities encountered in this survey. The present data differs in two significant ways:

i) Communities which Wymer found to occur at the top of tidal salt marshes are found close to the waters edge in the case of lagoons. The communities of the lower salt marsh e.g. Salicornietum strictae did not occur while the Puccinellietum was poorly developed and confined to the more saline lagoons.

ii) The lagoonal communities differed from tidal marshes in having fewer halophile species such as *Aster tripolium*, and additional non halophile species for example *Potentilla anserina* were more common.

5.5.4 Lagoon types based on vegetation

A large number of vegetation units have been described in this survey for planktonic, benthic, emergent and marginal vegetation. The various tables in Vol. III show that these communities replace each other as salinity varies. The vegetation types in the different habitats can be correlated, thus high salinity lagoons have red algal communities on rock faces and are bordered by Puccinellietum communities,

while the *Potentilla anserina-Juncus gerardii* community borders lagoons with stands of *Potamogeton pectinatus* and a predominantly freshwater phytoplankton. These correlations are obviously not absolute but they demonstrate that it is possible to classify lagoons as ecological units in which the different vegetation units co-vary.

It is possible to sub divide the lagoons based on the presence of certain vegetation types in the littoral, sub littoral and lagoon margins. The 16 lagoons studied are divided into four types. While little sublittoral data are available for the 1996 sites, the remaining data are sufficient to see if these sites can be included in this scheme.

1) Lagoons with little or no *Ruppia*, with red algal communities on exposed rock, *Cladophora battersii* at depth on mud and marginal vegetation with Puccinellietum, Juncus gerardii typicum and *Blysmus* communities. Marine phytoplankton.
Kilmore, Aughinish, Athola and Sally's.

2) Abundant *Ruppia* with *Zostera* and *Lamprothamnion papulosum*, red algae on exposed rock, marginal communities and plankton as in (1).

Drongawn, Lettermullen, Tanai, Aibhnín, Maghery. The lower basin of Loch an tSáile is a possible inclusion on the basis that *Zostera* occurs.

3) *Ruppia* and *Lamprothamnium* common, red algae very poor or absent, *Fucus, Cladophora* and *Enteromorpha* on rock, Pure stands of *C. linum* at depth, *Chara aspera* occasional, Puccinellietum or Juncetum gerardii typicum rare or absent, *Juncus maritimus* and *Potentilla anserina* variant common in marginal vegetation. This large group is divided into two subgroups.

i) very shallow, without *R. cirrhosa*. Lissagriffin, Cloonconeen, Donnell, Bridge, Corragaun, Roonagh, Moorlagh

ii) deeper, >1m, with *R. cirrhosa*. Farranamanagh, Cara Fionnla, Loch Fhada, an Ghadaí, Mill Lough, Lough Bofin, Kincas. Lady's Island can be included in this group but it is so large that several different communities may occur.

Lough Murree and the east basin of Loch an tSáile are transitional to group 4 as some *P. pectinatus* occurs.

4) *Potamogeton pectinatus* common , *Ruppia* occasional or absent, no *Lamprothamnium, Chara aspera* or *C. canescens* occasional, *Enteromorpha* and *Cladophora* on rock, *Fucus* rare or absent. Marginal vegetation includes *Eleocharis* communities, *P. anserina* variant, no *Juncus maritimus*.

Tacumshin, Kilkeran, Lough Gill, Mór, Chara, Chorrúch, an tSáile, Aconeera, Furnace, Durnish, Inch. This group can be sub-divided with Inch, Tacumshin and Gill having *Zanichellia*, and *Chara canescens*. All are large shallow lagoons. Loch an tSáile upper and middle basin, Aconeera and Furnace are all deep stratified lakes in rock basins with very diverse communities including *Chara baltica* in two of the three sites.

Ballyteige is not classified.

When the data sets are combined in this way, new insights into the distribution of species and vegetation types become obvious. For instance *Cystoseira foeniculaceus* is found in two of the four Group 1 lagoons, (it also occurs in an unsurveyed lagoon in inner Galway Bay).

As Hatch and Healy have already noted (1998) the *Zostera-Lamprothamnium-Ruppia cirrhosa* community is only found in south Connemara, giving the lagoons in this area an exceptional importance.

The Group 3 lagoons are sub-divided into shallow and deep. The constant presence of *R. maritima* in the shallow group suggests that the benthic vegetation of these lagoons belong to Verhoeven's Ruppietum maritimae. In the deeper lagoon group, the supposedly rare *Lamprothamnium* occurs in seven of the ten sites, a search of Mill Lough and even Farranamanagh might reveal further populations. The common occurrence of *R. cirrhosa* suggests that a *R. cirrhosa/Lamprothamnium* community is widespread in suitable lagoons.

In Group 4, the co-occurrence of *Zannichellia, Chara canescens* or *Ruppia maritima* in four large shallow lagoons suggests that a community including these species occurs in Irish lagoons. There was insufficient data from the Inch survey alone to define this association. *Chara baltica* was found in two of the three deep, stratified, low salinity lagoons, while *Cladophora aegagropila* occurred in one. These most unusual sites are unlikely to occur commonly in western Europe, their conservation value is great. As all three are large, further underwater exploration is desirable. The calcareous algal nodules in An Loch Mór are unique but further information is needed before their importance can be determined. The remaining small, shallow low salinity lagoons seem of less value.

5.6 Summary of the aquatic fauna surveys (text partially from Oliver, Volume IV)

5.6.1 Species records

A total of 401 taxa were recorded during the two surveys, with 245 recorded at the 20 sites surveyed in 1996 and 294 at 16 sites in 1998. The total for 1996 differs from that stated by Oliver and Healy (1998) as several taxa such as *Ligia, Petrobius,* and *Asellus* are not included in this analysis as they are not considered to be truly aquatic, although the same could be argued for several of the Coleoptera species. Other Insecta were also not included in this figure as they refer to previous records and were not actually collected during the survey.

The greater number of species recorded in fewer lagoons in 1998 is explained by greater number of euhaline sites (Kilmore, Athola, Sally's) while the exceptional L an Aibhnín which yielded 107 taxa compared with a maximum number of 69 in Drongawn in 1996. Greater sampling effort and accumulated experience are not believed to have contributed significantly, except for a few groups, mainly the polychaetes and copepods parasitic in ascidians. No species unique to deep benthos were added as a result of occasional sampling in deeper water in 1998.

Not only the total numbers but the proportions in each taxonomic group also differed between surveys (Table 5. 4). More annelid species were recorded in 1998 than in the previous survey. This may be partly explained by greater expertise in identification but also by the fact that sites with large areas of soft marine sediments were included (Kilmore L, L. Athola and Sally's L.). The total number of Insecta is approximately the same for both surveys but fewer Coleoptera were recorded in 1996, possibly due to the higher incidence of rainfall, stronger winds and lower temperatures. On the other hand, the total number of Diptera was greater partly because for the first time a specialist identified many of the Chironomid specimens but also possibly because more pupal exuviae were collected.

Many of the taxa recorded were records of single specimens or small colonies at only one site, but the difference in the lists between the two years is quite striking. Only 137 taxa out of the total 401 were recorded in both years (approx. 30%).

The number of taxa per site varied considerably from only 10 at L. Bofin to 113 at Kilmore L. (see Fig. 5.3). Higher total numbers were recorded at Kilmore, Aibhnín and Athola, partly reflecting the more marine nature of these three sites, although relatively high numbers of species were also recorded at freshwater sites such as Lady's Island L., Tacumshin L. and Durnesh L.

Table 5.4

	Taxa	Lag. sp.	Insecta	Crustacea	Mollusca	Annelida	Pisces
1996	246	22	80	47	47	18	21
1998	294	20	73	59	50	38	14
Total	401	25	113	75	65	46	25

5.6.2. Commonly occurring species

The most frequent species taken in 1998 were somewhat different from those recorded in 1996, reflecting the more saline conditions (Table 5.5).

Table 5.5. The most commonly occurring species in 36 survey sites (number of sites).
* denotes lagoonal specialist species.

	1996+1998 (36)	1996 (20)	1998 (16)
Chironomidae (larvae)	34	19	15
Anguilla anguilla	33	17	16
Gasterosteus aculeatus	31	19	12
Palaemonetes varians	27	16	11
Carcinus maenas	26	16	10
Pomatoschistus microps	24	13	11
Potamopyrgus antipodarum	24	14	10
Gammarus duebeni	24	12	12
**Neomysis integer*	24	15	9
Pleuronectes flesus	21	13	8
**Jaera nordmanni*	20	8	12
**Conopeum seurati*	20	6	12
Ischnura elegans	19	10	9
Crangon crangon	17	8	9
Melita palmata	16	7	9
Praunus flexuosus	16	7	9
Gammarus zaddachi	16	7	9
**Lekanesphaera hookeri*	15	8	7
Arenicola marina	15	9	6
**Sigara stagnalis*	14	9	5
Corophium volutator	14	6	8
**Cerastoderma glaucum*	13	7	6
Hediste diversicolor	13	8	5
Hydrobia ulvae	13	4	9
**Idotea chelipes*	12	4	8
Mytilus edulis	12	5	7
Sigara dorsalis	10	8	2
Mugilidae	12	8	4
**Hydrobia ventrosa*	12	7	5
**Enochrus bicolor*	10	6	4
Corixa panzeri	10	6	4

5.6.3. Rarity

The rarity of invertebrate species in Ireland is hard to assess because there have been few systematic surveys, and brackish fauna in particular has been under-recorded. The 37 species described as 'rare' in this report include some for which there are few previous records but which are widespread in lagoons e.g. *Enochrus bicolor* and *Conopeum seurati).* They must continue to be regarded as rare because their habitat is rare. About a third of all the 'rare' species are beetles. Aquatic beetles have received some attention in recent years (Foster *et al.* 1992), but few brackish localities have been sampled. The Northern Ireland lake survey included several brackish and coastal sites and the occurrence and habitat of the species collected (Nelson *et al.* 1997, 1998) has served as a basis for the ecological classification of species collected during our surveys. However, some species apparently rare or absent in the north are southern species which may be frequent in the south. Similarly, some northern species, e.g. the amphipod *Gammarus chevreuxi*, common in Durnesh L. are known from the north but not recorded in the south (Costello *et al.* 1989) and may be genuinely rare here.

5.6.4. Lagoonal specialists

The emphasis placed on lagoonal specialist species in this report recognises their rarity as being more ort less confined to a priority, endangered habitat. Many are eurytopic species, common and often abundant in a wide range of lagoon types, while others, which must be considered more vulnerable, require more specific environments. A few species not on British lists were present in several lagoons although there were few previous records of them in Ireland. Examples are *Leptocheirus pilosus, Allomelita pelucida, Notonecta viridis* and *Plea leachi.* These were added provisionally to the list of lagoonal specialists for Ireland (Oliver and Healy 1998). Investigations in other brackish habitats such as salmarshes and sheltered estuaries will show whether their inclusion was justified.

Six out of the 13 'rare' beetles recorded were considered to be lagoonal specialists by Barnes (1989). Beetles could thus be important when evaluating Irish lagoons. However, their mobility and dependence on favourable climatic conditions mean that their continuing presence in a given lagoon is uncertain. Also, they were generally collected in low numbers. Heteroptera, on the other hand, while also capable of flying, were usually more abundant and are probably more constant inhabitants of the localities where they were recorded. *Notonecta viridis* and *Plea leachi* have been recorded on several occasions at Tacumshin and Ballyteige and are presumably permanent residents. The dense population of the rare lagoonal specialist *Sigara selecta* In L. Chara, only the second known locality in Ireland, is therefore important. Insects received little attention during British surveys, thus their status as lagoonal specialist species in Britain is largely unknown.

5.6.5. Faunal assemblages in relation to salinity

Given the wide range of conditions represented by the lagoons surveyed, the relatively small number of sites, and the high proportion of species occurring only once or twice, it is doubtful whether many distinct assemblages of species characterising given sets of environmental conditions could be identified from the present data. Time did not allow a multivariate analysis to be attempted. Nevertheless, some patterns of species occurrence can be recognised. In the following

analysis, only the number of species in each of the salinity tolerance/preference classes recognised in the site surveys, and one additional category, are considered, and no attempt is made to single out indicator species. The classes are:

1. Euhaline, marine species – more or less stenohaline, not known to be tolerant of reduced salinity;
2. Euhaline-polyhaline species – marine species known to tolerate a degree of reduced salinity, including a number of common intertidal species;
3. Poly-mesohaline species – brackishwater species, characteristic of polyhaline waters and the upper mesohaline range, i.e. about 15-30 ‰;
4. Euryhaline species – brackishwater species with wide salinity tolerance, occurring throughout almost the full salinity range;
5. Meso-oligohaline species – brackishwater species characterising the middle to lower salinities, i.e. about 2-15;
6. Oligohaline-limnetic species – brackishwater species also extending into freshwaters;
7. Limnetic-brackish species – freshwater species known to tolerate low levels of salt; including species described as "coastal";
8. Limnetic species – species normally considered to be strictly inhabitants of freshwater.

While the majority of species could be classified with relative ease, a few were more difficult:

(a) Brackishwater species occurring over a wide salinity range but not as wide as euryhaline species were classified into Classes 3 or 5 according to their relative frequency in the upper or lower range.
(b) Marine species recorded in more than one brackish lagoon but not recorded in the literature as tolerating brackish conditions were put into Class 2.
(c) Freshwater species occurring in several oligohaline sites but not mentioned in the available literature as surviving in brackish water were placed in Class 7. While the occurrence of marine species in brackish waters is quite well documented, less information is available for freshwater species.
(d) Species for which a decision was particularly difficult are omitted.

Fig. 5.4 shows the proportion of species in each class recorded at the 36 survey sites in the form of bar charts. L. Fhada and Ballyteige channels have been subdivided into their obviously different components. The charts are grouped into five lagoon types according to their profiles, although in some cases the placement is somewhat arbitrary. Obviously there are factors other than salinity that govern species occurrence, but some general trends emerge.

Type 1. (Fig. 5. 4a).

Lagoons with sea inlets, regular tidal flushing, and minor inflows of freshwater. Salinity high, fairly stable.

Fauna: Species rich (47-111 spp, + Ballyteige 3), dominated by euhaline marine species, especially near inlets, and a high proportion of Class 2. A good proportion are sessile species (sponges, hydroids, anemones, serpulid polychaetes, bryozoans, tunicates and some infaunal species), indicating stable conditions. The presence of brackishwater species distinguishes these assemblages from those of the open coast. In the case of Kilmore L. the proportion is low and this site is therefore atypical (or not a lagoon). The proportion is relatively high for L an Aibhnín where the salinity is somewhat lower.

The profile for Ballyteige 3 differs from the others. This is not considered to be a typical lagoonal habitat because currents are strong.

Type 2 (Fig 5.4b)

Lagoons with high salinity but narrow, long, or silled inlets that restrict tidal flow and a greater input of freshwater than in Type 2.

Fauna: Medium to low species richness (18-37 spp). Profiles of irregular shape with a low proportion of euhaline species, indicating either restricted access for colonists or salinity that is too low or fluctuates; those that occur are frequently transient pelagic species. Fauna dominated by classes 2 and 4.

Type 3 (Fig. 5.4c)

Lagoons with salinity gradients and a diversity of habitats. Access for marine colonists restricted or erratic, significant freshwater inflows.

Fauna: Medium species richness (15-37 spp). Profiles broad, including species from most classes, but euryhaline forms dominant constituting at least a third of species.

Type 4 (Fig. 5.4d)

Poor lagoons (for fauna), either stressed by fluctuating condition ("shock lagoons") or with low habitat diversity,

Fauna: Species poor (9-23 spp), freshwater species rare or absent, euryhaline species dominant (35-75% of species). Three of the sites in this category are on islands for which opportunities for colonisation may bereduced.

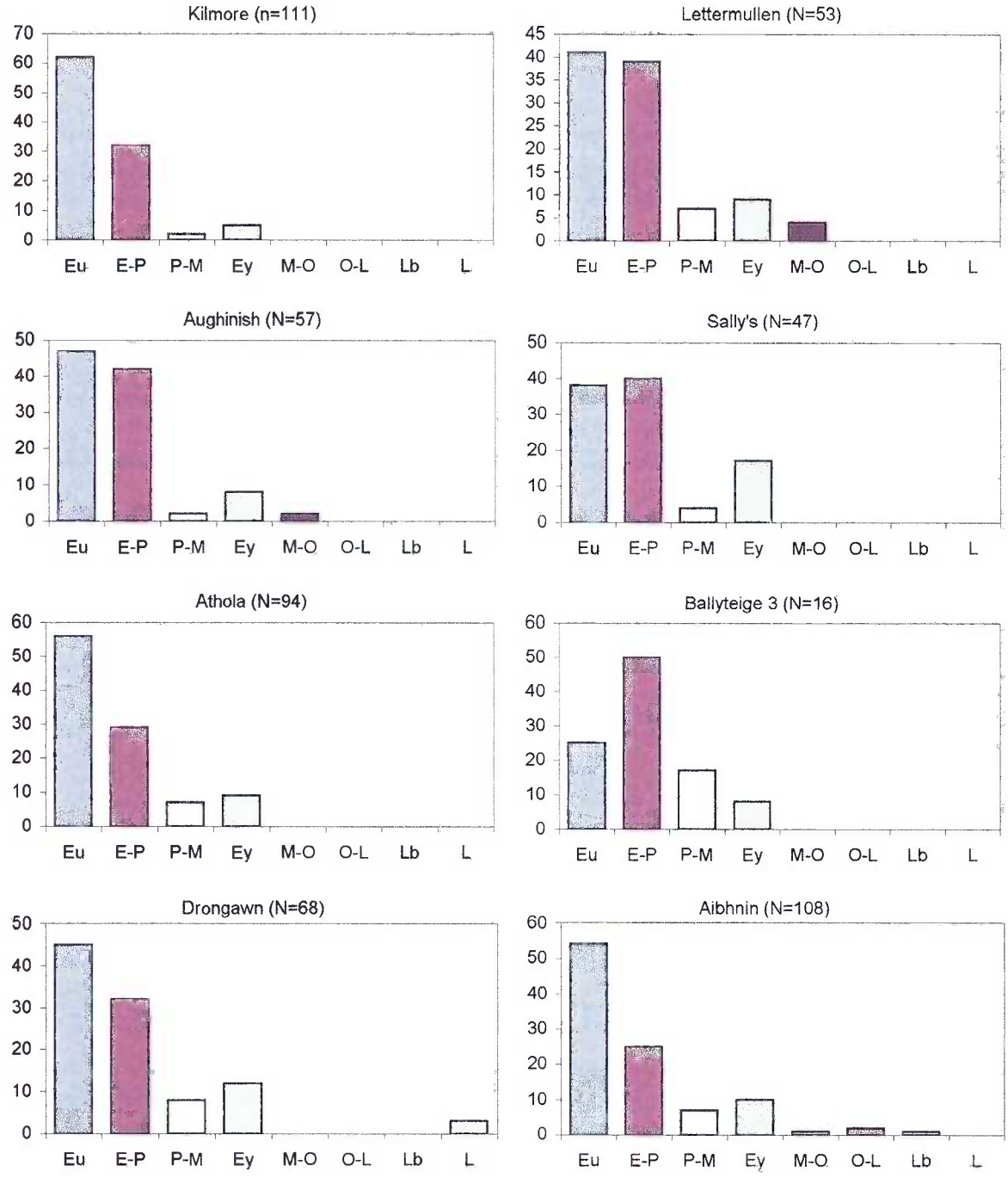
Type 5 (Fig. 5.4e)

Oligohaline lagoons with small influxes of seawater. Stable.

Fauna: Medium to high species richness (23-51 spp). Systems dominated by freshwater and oligohaline species, but usually with a significant proportion of euryhaline species distinguishing these sites from freshwater lakes. Two large sites (an tSáile and Tacumshin) have broad spectra and might be included in Type 2.

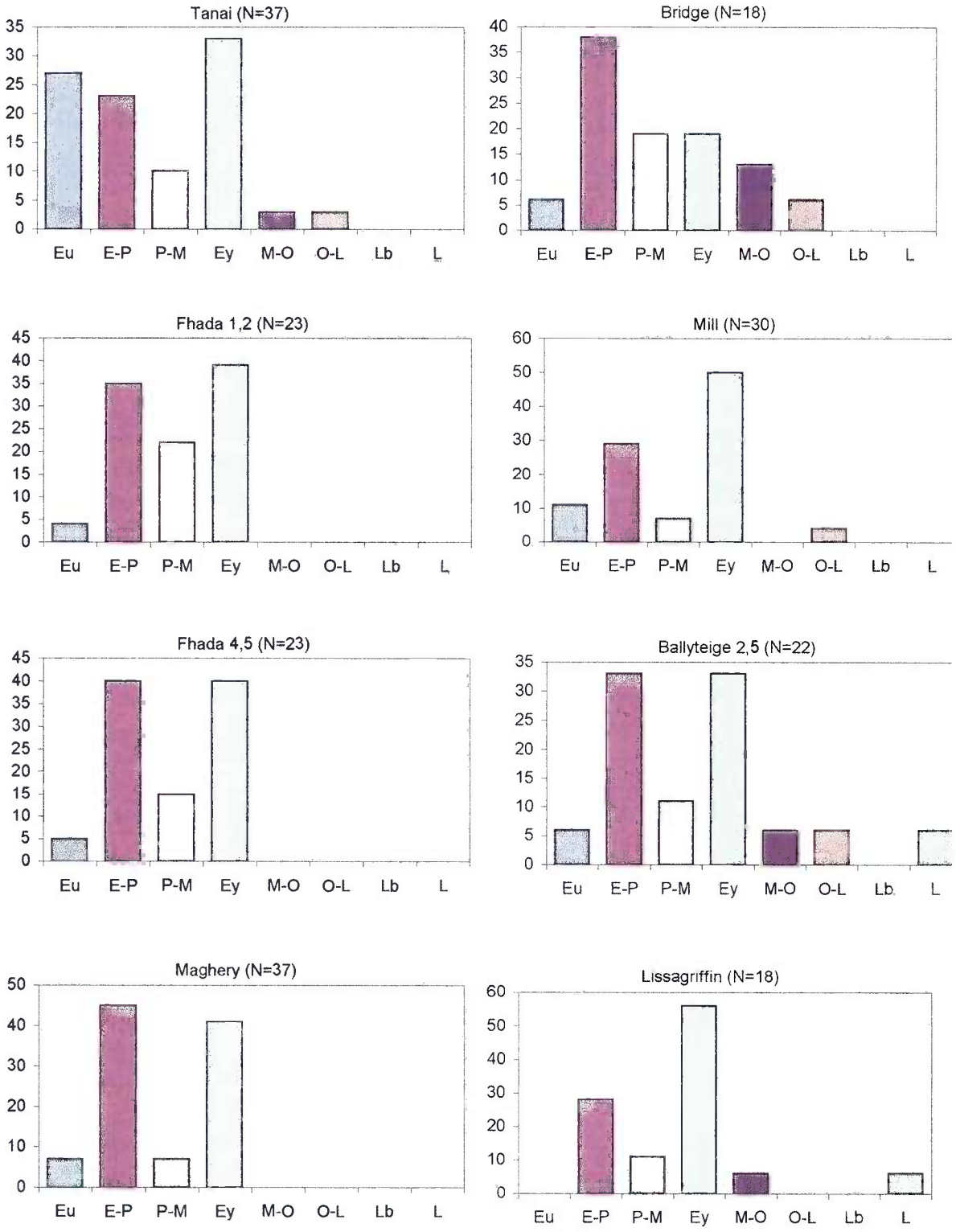
Within each of the main types, sub-types can be recognised according to the predominant salinity regime.

Fig. 5.4a. TYPE 1. Proportion of species in 8 salinity tolerance classes.



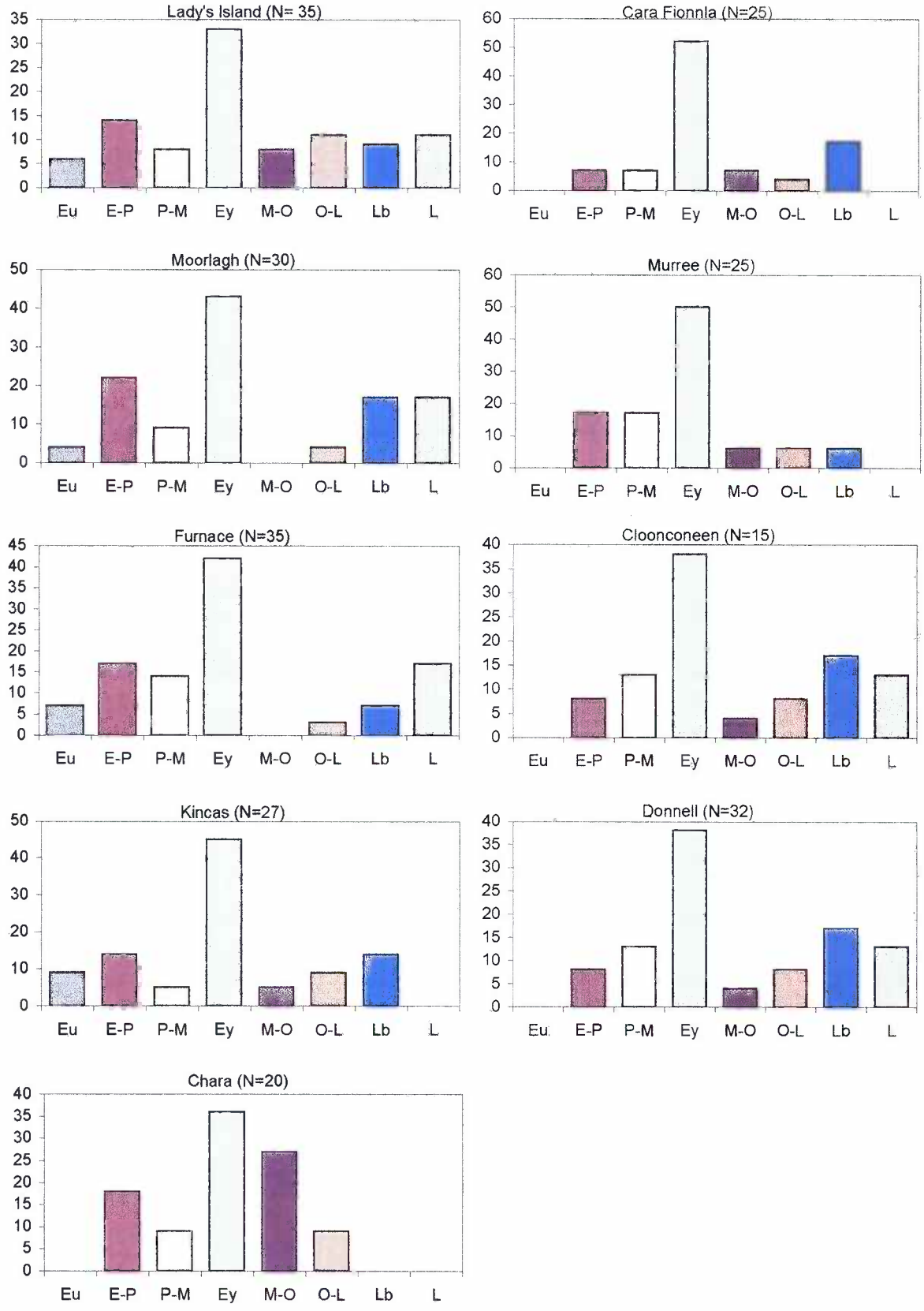
Eu - marine, euhaline; E-P = eu-polyhaline; P-M = poly-mesohaline; Ey = euryhaline; M-O = meso-oligohaline; O-L = oligohaline-limnetic; Lb = limnetic-brackish; L = limnetic.

Fig. 5.4b. TYPE 2. Proportion of species in 8 salinity tolerance classes.



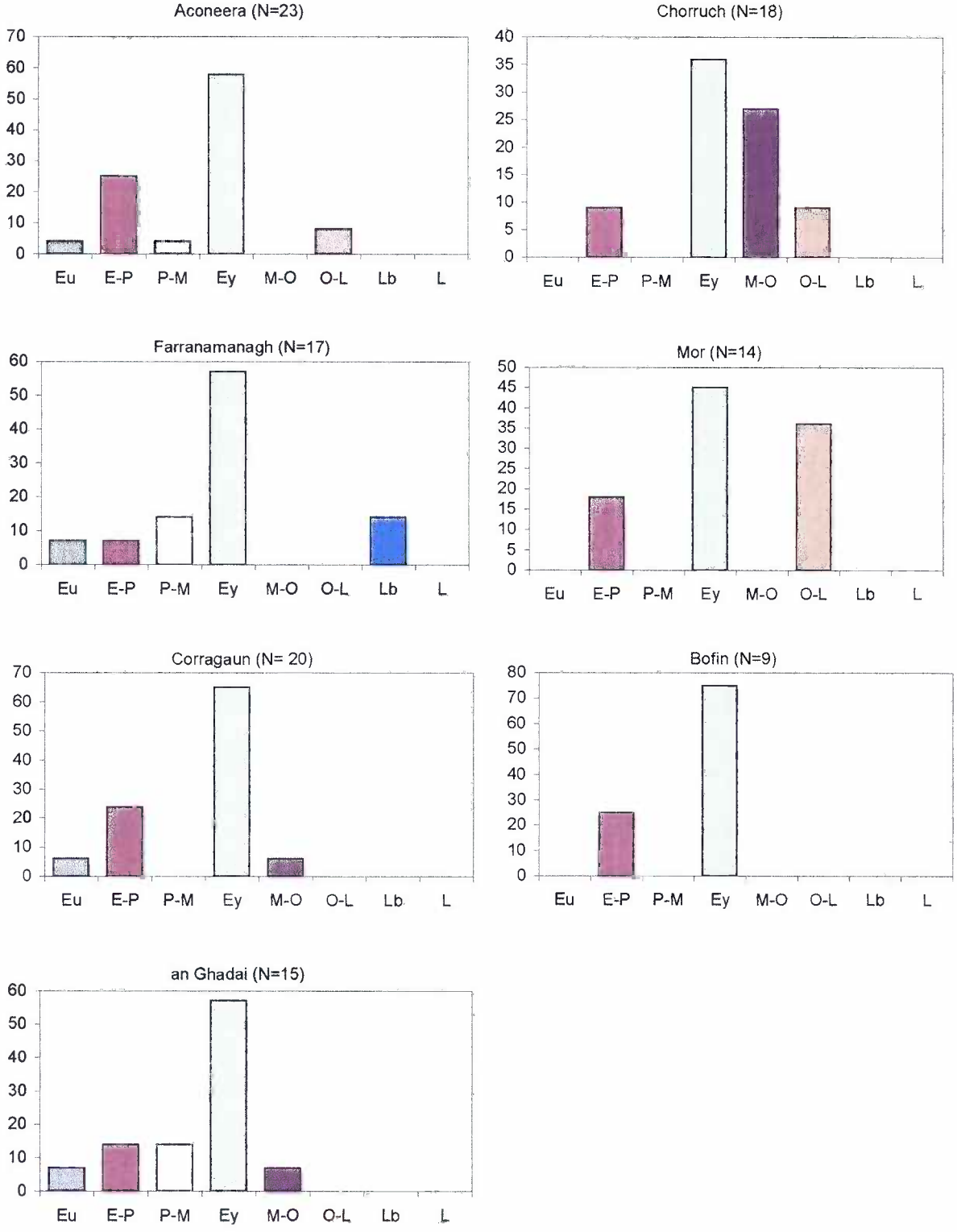
Eu - marine, euhaline; E-P = eu-polyhaline; P-M = poly-mesohaline; Ey = euryhaline;
M-O = meso-oligohaline; O-L = oligohaline-limnetic; Lb = limnetic-brackish; L = limnetic.

Fig. 5.4c. TYPE 3. Proportion of species in 8 salinity tolerance classes.



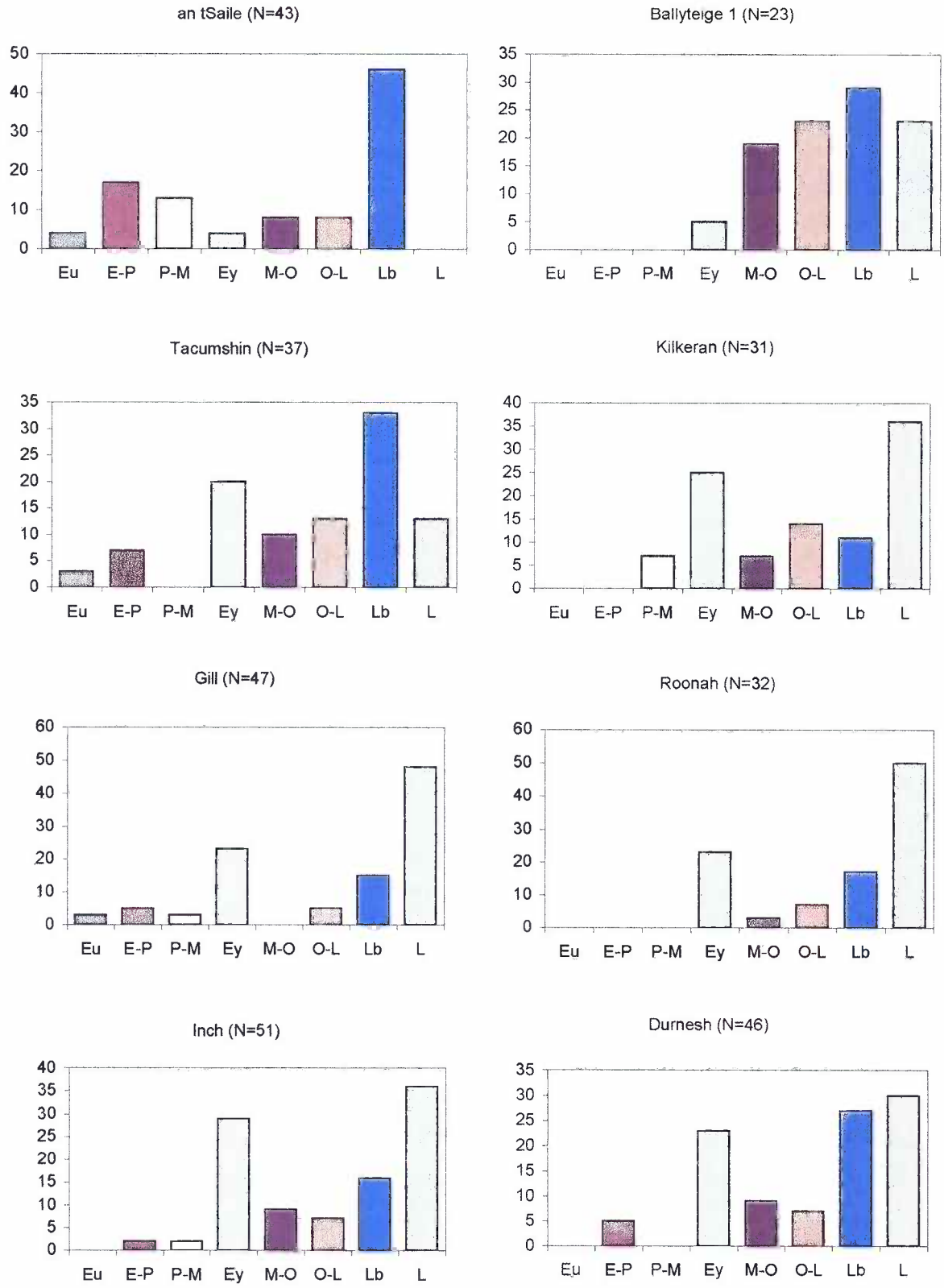
Eu - marine, euhaline; E-P = eu-polyhaline; P-M = poly-mesohaline; Ey = euryhaline; M-O = meso-oligohaline; O-L = oligohaline-limnetic; Lb = limnetic-brackish; L = limnetic.

Fig. 5.4d. TYPE 4. Proportion of species in 8 salinity tolerance classes.



Eu - marine, euhaline; E-P = eu-polyhaline; P-M = poly-mesohaline; Ey = euryhaline; M-O = meso-oligohaline; O-L = oligohaline-limnetic; Lb = limnetic-brackish; L = limnetic.

Fig. 5.4e. TYPE 5. Proportion of species in 8 salinity tolerance classes.



Eu - marine, euhaline; E-P = eu-polyhaline; P-M = poly-mesohaline; Ey = euryhaline; M-O = meso-oligohaline; O-L = oligohaline-limnetic; Lb = limnetic-brackish; L = limnetic.

5.6.6. Proportion of taxonomic groups

The proportion of the different taxonomic groups changes with salinity, e.g. insects replacing crustaceans as the salinity falls, but it is also influenced by other factors such as substrate type, the nature and abundance of vegetation, ease of access for colonists etc. A great deal can be deduced about a given site by examining its taxonomic profile without identifying all taxa to species or knowledge of their salinity tolerances. It is sufficient to know how many species are in each group.

In Fig. 5.5 (a-e) the proportion of species in each of the ten major groups is shown as bar charts. Characteristic profiles reflect combinations of environmental factors such as salinity, stability, presence of hard substrate, easy access from the sea, and habitat diversity (often related to lagoon size).

Type A (Fig. 5.5a)

Euhaline or polyhaline sites with tidal inlets, little freshwater entering, stable. Rocks present, at least near the inlet.
Fauna: Species-rich (51-111 spp), with a wide spectrum of groups, including sessile forms such as sponges, hydroids, anemones, serpulid polychaetes, barnacles, bryozoans, and tunicates, which are dependent on stable conditions. Annelids and molluscs well represented, two or more species of echinoderms.

This type corresponds to Type 1 based on salinity tolerance and the same lagoons are represented.

Type B (Fig. 5.5b)

Lagoons with salinity gradients, frequently stratified due to both seawater and freshwater incursions, moderately stable. Usually with a diversity of habitats.
Fauna: Less diverse than Type A (23-43 spp). Tidal waters introduce transient pelagic or mobile benthic marine species (jellyfish, mysids, prawns, starfish, fish). A high proportion of crustaceans (at least 20%), and usually of molluscs. Two or more species of tunicates usually present indicating fairly stable conditions.

This type corresponds partly to Type 2 based on salinity tolerance.

Type C (Fig 5.5c)

Lagoons with fluctuating conditions ("shock lagoons"), freshwater and seawater influxes both important, but with a greater influence of seawater..
Fauna: Low faunal diversity (9-30 spp). Crustaceans dominant (at least 40%), fish relatively important, molluscs and sessile forms poorly represented.

Type D (Fig. 5.5d)

Lagoons characterised by few opportunities for colonisation from the sea, conditions fairly stable, various salinity regimes. A poorly defined group.
Fauna: Moderately diverse (15-38 spp). Two sub-types, one dominated by crustaceans, the other by crustaceans and insects, corresponding to different salinity regimes.

The atypical Ballyteige 3 site is included here but is obviously a type on its own, dominated by annelids requiring appropriate substrates and oxygenated water. The high proportion of fish in Lady's Island may be due to recent breaching of the barrier that allowed entry of active pelagic species.

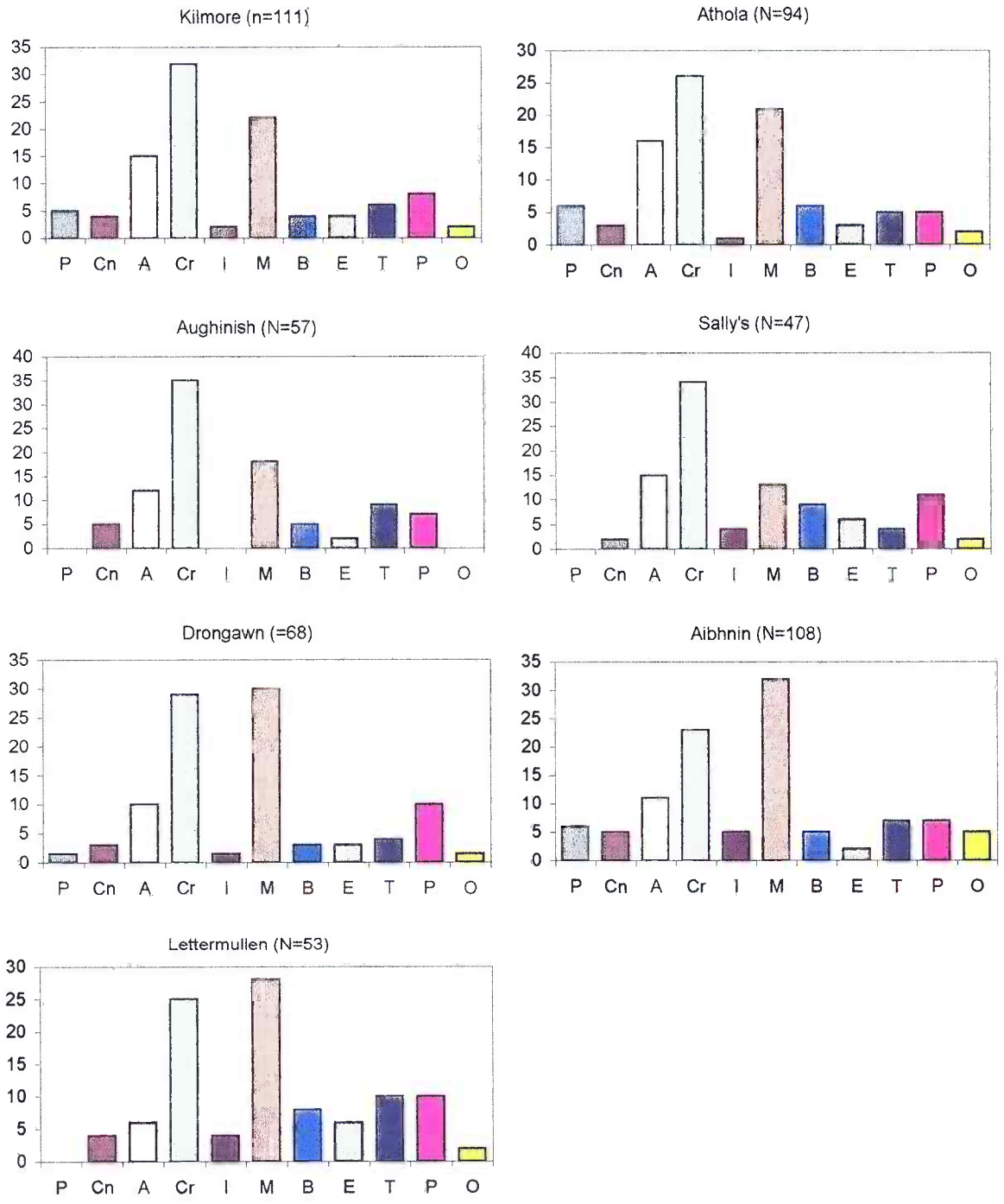
Type E (Fig. 5.5e)

Oligohaline lagoons, marine influence limited, seawater flushed out. Stable.
Fauna: Moderately rich (13-53 spp), dominated by insects (45-80%).

This type corresponds to Type 5 based on salinity tolerance.

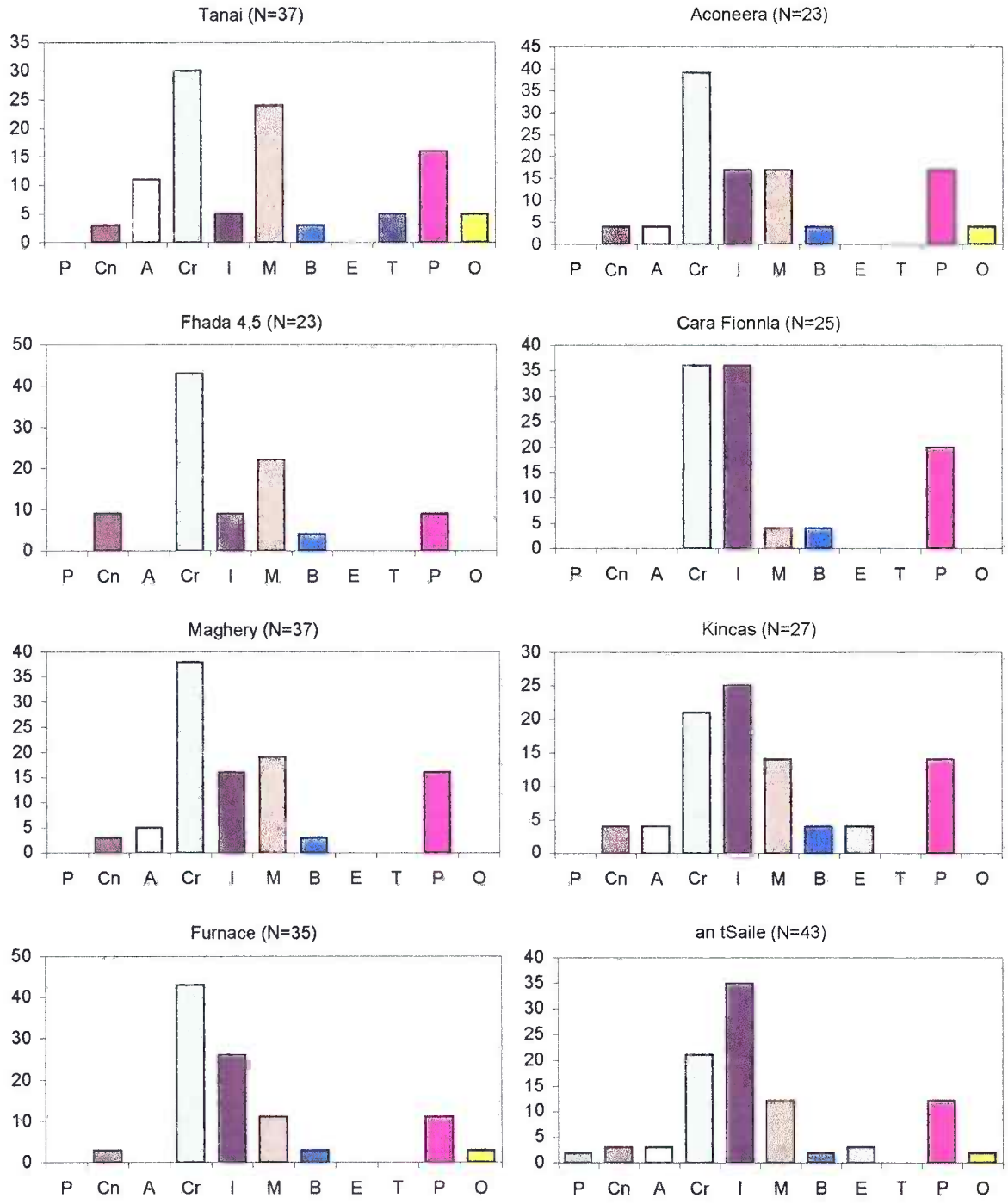
The types are not clearly defined but the groupings serve to demonstrate the type of information that taxonomic profiles can provide. Particularly useful is the presence of marine groups that indicate either stability or ease of colonisation.

Fig. 5.5a TYPE A. Proportion of species in taxonomic groups.



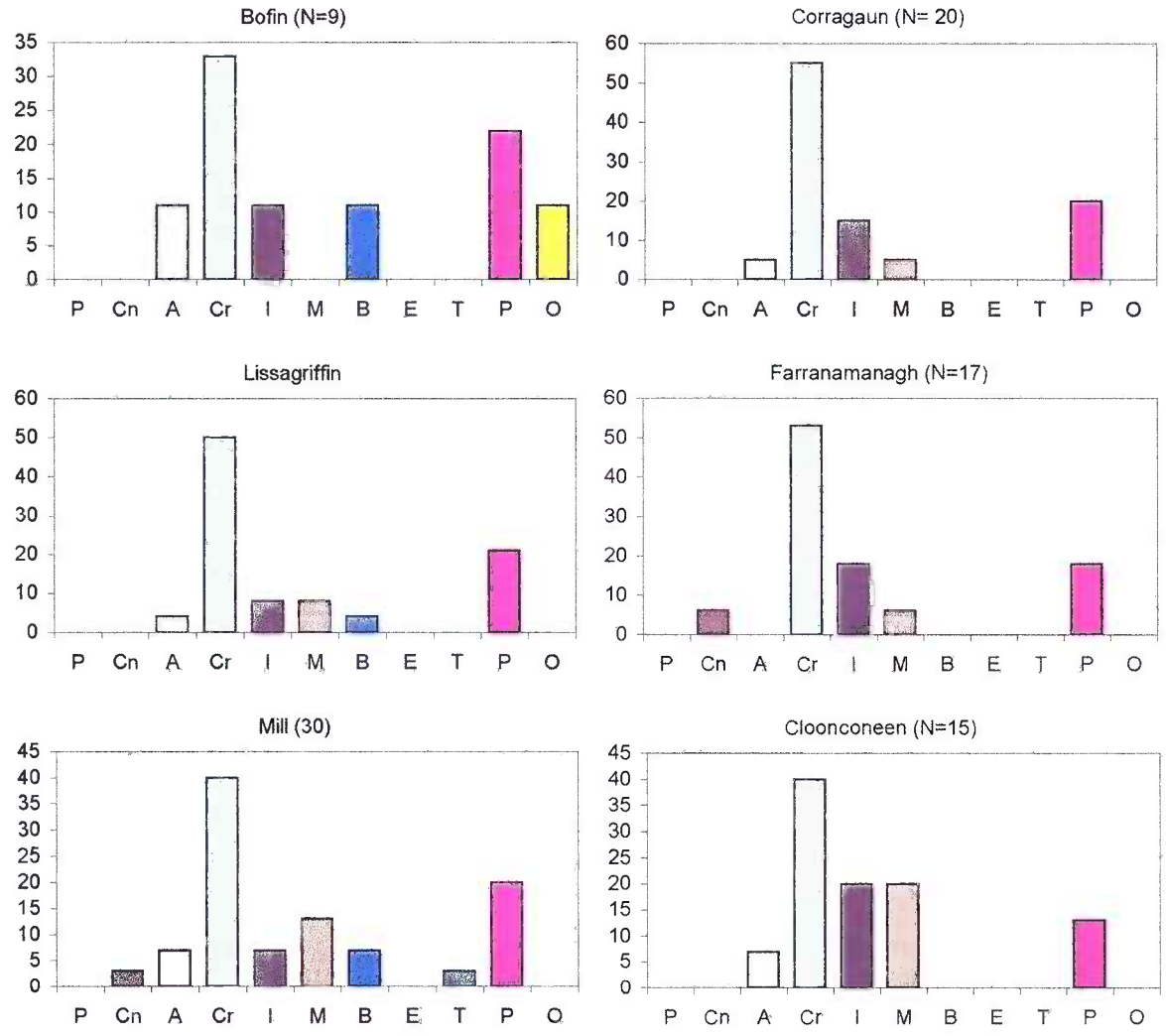
P- Porifera, Cn- Cnidaria, Cr- Crustacea, I- Insecta, M- Mollusca, B- Bryozoa, E- Echinodermata, T- Tunicata, P- Pisces, O- Others.

Fig. 5.5b TYPE B. Proportion of species in taxonomic groups.



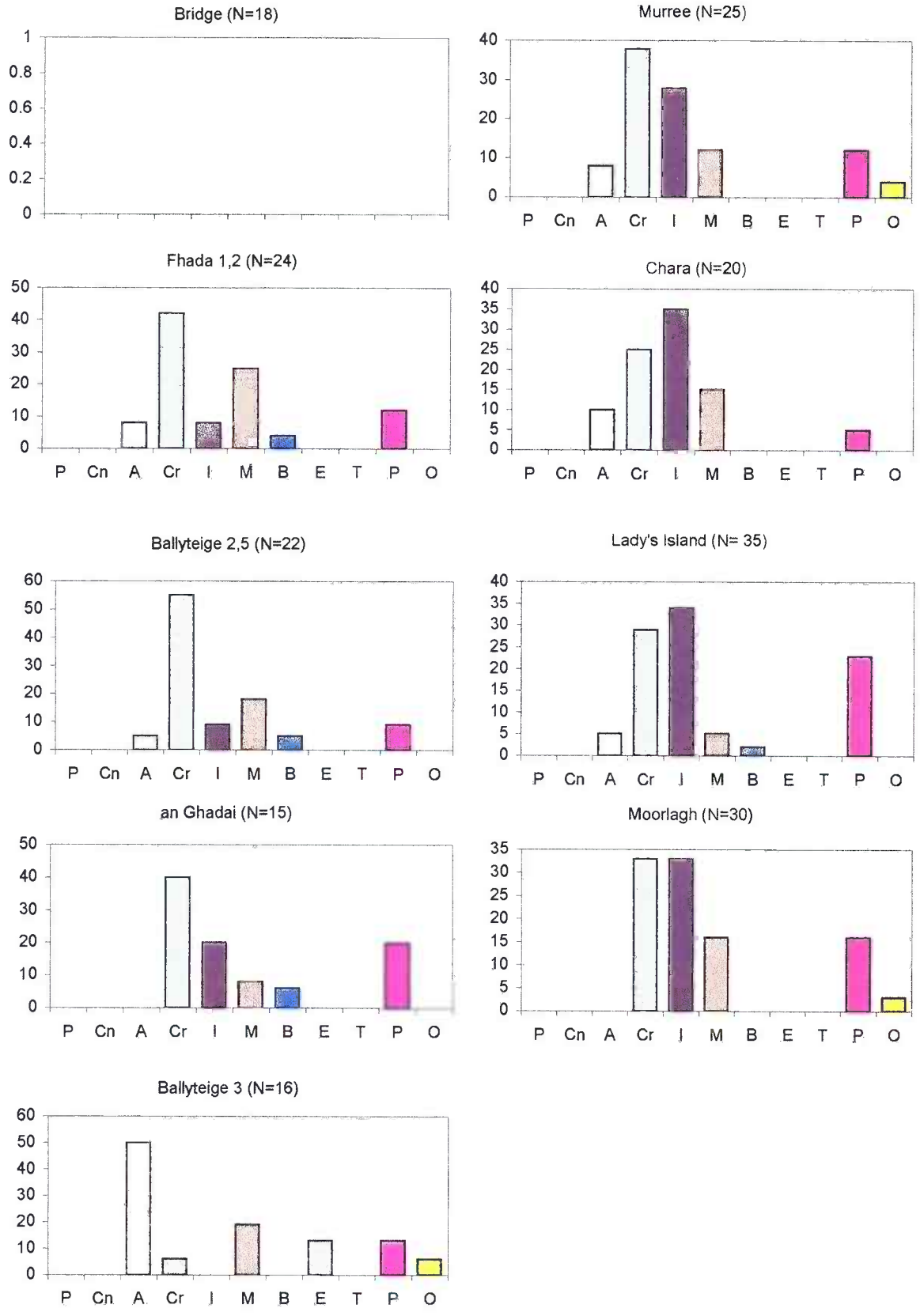
P- Porifera, Cn- Cnidaria, Cr- Crustacea, I- Insecta, M- Mollusca, B- Bryozoa, E- Echinodermata, T- Tunicata, P- Pisces, O- Others.

Fig. 5.5c TYPE C. Proportion of species in taxonomic groups.



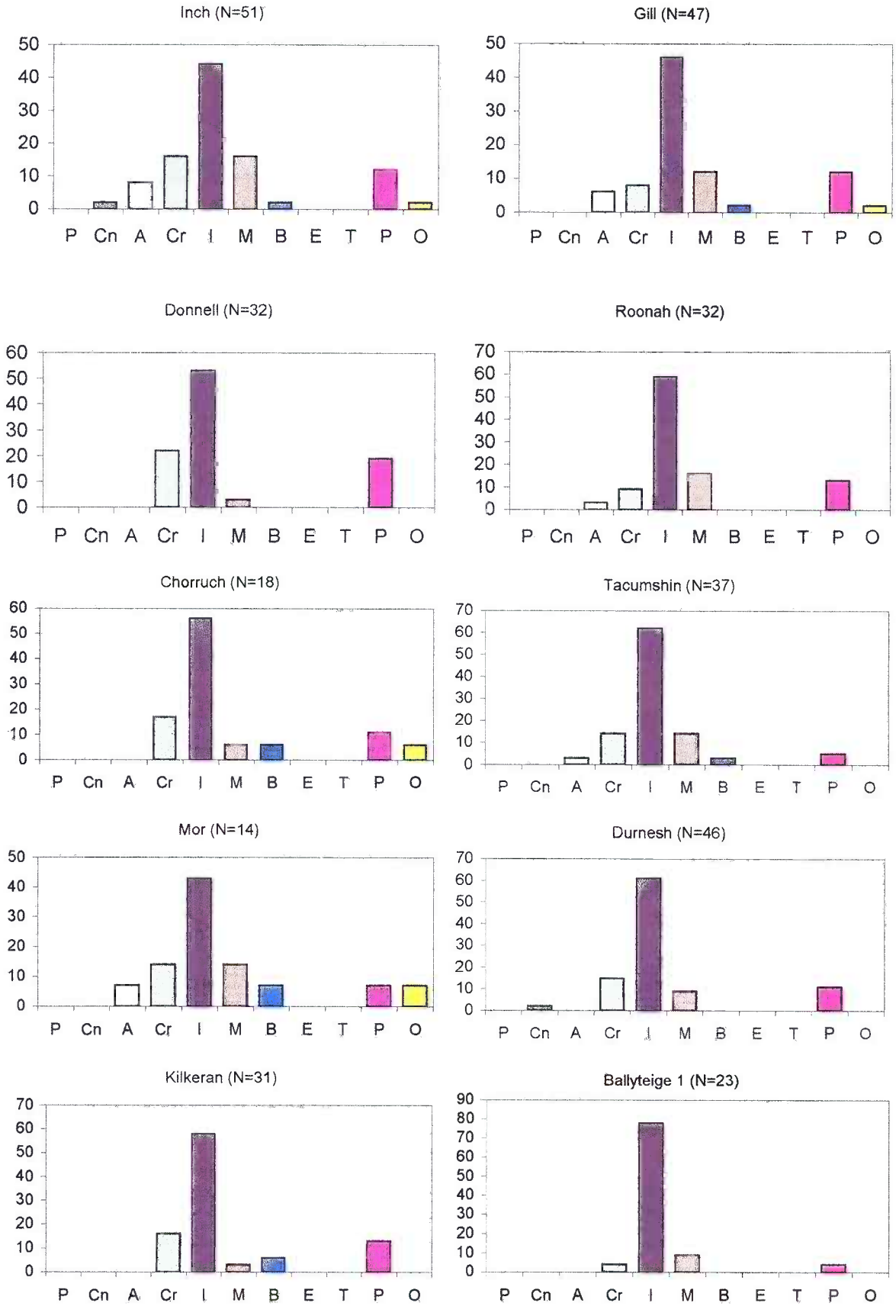
P- Porifera, Cn- Cnidaria, Cr- Crustacea, I- Insecta, M- Mollusca, B- Bryozoa, E- Echinodermata, T- Tunicata, P- Pisces, O- Others.

Fig. 5.5d TYPE D. Proportion of species in taxonomic groups.



P- Porifera, Cn- Cnidaria, Cr- Crustacea, I- Insecta, M- Mollusca, B- Bryozoa, E- Echinodermata, T- Tunicata, P- Pisces, O- Others.

Fig. 5.5e TYPE E. Proportion of species in taxonomic groups.



P- Porifera, Cn- Cnidaria, Cr- Crustacea, I- Insecta, M- Mollusca, B- Bryozoa, E- Echinodermata, T- Tunicata, P- Pisces, O- Others.

5.7 Summary of surveys of shore Coleoptera (text partially from Good, Vol. V)

In total, 104 species of staphylinid, 41 species of carabid and five species of pselaphid were recorded from the sixteen sites sampled. Five species of staphylinid, and five species of carabid were considered indicators of well-developed habitat. Sites were divided into five types of lagoon or saline lake, based on the geomorphology of the barrier and the type of shore substrate. These were: (1) sand barrier lagoons/drains (only one site, which was drained); (2) shingle barrier lagoons; (3) peat shore saline lakes; (4) karst lagoons; and (5) estuary impoundments.

In total, three local stenotopic species were recorded from sea rush swards in the six Camus Bay sites (Cara na gCaorach - Cara Fionnla inlet, L. an Aibhnín, L. an tSáile, L. Cara Fionnla, L. Fhada, L. Tanaí). Of these, only *Stenus lustrator* was a recurring species at many of the 12 saline lake peaty shores dominated by *J. maritimus*, surveyed in 1996 and 1998. *Philonthus fumarius* is a coastal marsh species, but it was only represented by a single individual (at L. Tanaí). *Stenus opticus* is a bog species, and only occurred where the lake shore graded into well-developed intact blanket bog (also at L. Tanaí). The L. Tanaí site was directly adjacent to intact ungrazed blanket bog, and this was the likely source of indviduals of *Stenus opticus* and *Stenus incrassatus* which may have subsequently bred in the *J. maritimus* and *A. stolonifera* swards. These swards were flooded during the summer of 1998, and may therefore only be an accessory habitat for these species, which are exploited during years of little disturbance by flooding.

The potential of Juncea maritimi swards on irregularly flooded peat as a habitat for stenotopic staphylinids and pselaphids, suggested by Good and Butler (1998) based on results from L. Tanaí, has, therefore, not been borne out by further investigation. This contrasts with the results of the aquatic fauna and flora (Oliver, 1999, Roden, 1999), but perhaps this is not surprising. Peat/saline water ecotones are a relatively recent phenomenon, following long periods of bog growth (which only began c. 5 000 BP) and subsequent rises in sea levels. The structure of the Connemara landform with its continuous supply of lakes and bays to the rising and falling sea, however, would have allowed continuous colonisation by aquatic species adapted to brackish conditions for a much longer time period.

5.8 Classification of lagoons based on biota

The four broad categories of lagoon based on vegetation (see 5.5.4) can serve as a basis for an initial classification. The scheme recognises the presence or absence of benthic macrophyte species and communities, together with the broad type of phytoplankton (marine, brackish, freshwater) and characteristic marginal communities. Although no similar classification has been attempted for fauna, some aspects of faunal occurrence can be linked with these groupings.

Group 1 (Kilmore, Aughinish, Athola, Sally's) is dominated by red algae, *Ruppia* are rare or absent, phytoplankton is marine and the marginal vegetation consists of Puccinellietum, Juncetum gardii typicum and the *Blysmus* communites. All are predominently euhaline lagoons with a strong tidal influence, regardless of origin or shape. Hard substrates for attachment of algae and sessile invertebrates are present. The four examples fall into the faunal Types 1 (based on salinity tolerance), and Type A (based on taxonomic groups) (see bar charts, Figs 5.4 and 5.5). The number of faunal species/lagoon is high, (47-113) and the proportion of lagoonal specialists low (2-10%). The fauna resembles that of the open coast. Most algal communities are different from

those on the open coast, however.

Group 2 (Drongawn, Lettermullen, Tanaí, Aibhnín, Maghery) have *Ruppia*, *Lamprothamnium*, and (usually) *Zostera*, marine phytoplankton, and marginal vegetation as in Group 1. Conditions are predominently polyhaline. All sites have inlets (temporary for Lettermullen) but access for colonists and conditions for their survival are less favourable than for Group 1. The fauna is dominated by polyhaline species with a high proportion of molluscs.The number of species is somewhat lower than in Group 1 (31-93) and the proportion of lagoonal specialists higher (7-24%). Drongawn, Lettermullen and Aibhnín are placed in faunal Types 1 and A, while Tanaí and Maghery stand out as different, with fewer species and are in Types 2 and B.

Group 3 are lagoons with *Ruppia* and *Lamrothamnium* common, a more brackish phytoplankton, and the marginal vegetation typical of Groups 1 and 2 absent. Two subdivisions are distinguished:

i shallow water systems without *Ruppia cirrhosa* (Lissagriffin, Cloonconeen, Donnell, Bridge, Corragaun, Roonah, Moorlagh);

ii deeper waters with *Ruppia cirrhosa* present (Farranamanagh, Ghadaí, Fhada, Cara Fionnla, Mill, Bofin, Kincas and parts of Lady's Island. Murree and an tSáile which have some *Potamogeton pectinatus*, are transitional to Group 4.

The subdivision appears to have no significance for the fauna which does not separate out into distinct groups. Deeper water was rarely sampled, however. The fauna in both sub-groups is moderate to poor (14-30 species), with a variable, but potentially high proportion of lagoonal specialists (6-50%)

This large group includes 14-17 sites, nearly half of all the lagoons surveyed, and spans a wide range of geomorphology and hydrological regimes. *Ruppia* communities appear to tolerate considerable fluctuation in salinity. Faunal diversity varied from moderate to poor and communities were characterised by a predominance of euryhaline species tolerating a wide range of conditions, absence of limnetic and limnetic-brackish species and a small proportion of insects relative to crustaceans. The exception to these generalisations is Roonah which was oligohaline and according to the fauna is classified into Types 5 and E with insects dominant. Other sites are placed in Types 3-4 and C-D. As mentioned in 5.6, these categories can be somewhat arbitrary.

Group 4 includes lagoons in which *Potamogeton pectinatus* is common and *Ruppia* is rare or (rarely) absent, with a freshwater plankton and absence of *Juncus maritimus*. Conditions are oligohaline, isolated from the sea by complete barriers or sluiced outlets. Equivalent faunal categories are Types 5 and E, with moderate to poor faunal richness, dominated by limnetic and limnetic-brackish species with insects outnumbering all other groups.

The communities of Group 4 lagoons are quite distinct although a wide range of lagoon morphological types are included. Two sub-groups can be distinguished by their benthic flora:

i shallow lagoons with *Chara aspera, C. canescens* and *Zannichellia palustris* (Tacumshin, Gill, Inch)

ii deep stratified systems with diverse communities (an tSáile, Aconeera, Furnace). *Chara baltica* was present at two of these sites.

There were no obvious differences in the fauna of the two sub-types. The number of species/lagoon was 23-51, i.e. rather higher than for Group 3, and the proportion of lagoonal specialists 11-25% except for L. Gill where only 2?37 spp were lagoonal specialists.

Group 5 This group is added with some hesitation to accommodate 'shock lagoons' which undergo wide and rapid changes in salinity as a result of regular tidal flow or occasional storm surges. This type of lagoon is not distinguished on the basis of vegetation but the unstable conditions can severely limit the fauna. The following examples are included in faunal Types 3-4 and C-D: Lissagriffin, Farranamanagh, Corragaun, and Moorlagh, and possibly Mill, Bofin and Kincas. They are characterised by rather low species numbers (10-30) and average numbers of lagoonal specialists (6-22%). Recorded taxa frequently include transient accidentals thus the number of resident species may be lower and the proportion of lagoonal specialists among them may be generally higher.

Conclusions

1. It is apparent that the morphology of the lagoon shores and basins is only relevant to the biota in so far as it determines the salinity regime and the entry of accidental invaders and potential colonists, and provides habitats for deep or shallow water communities. The nature of the barrier and inlet/outlet (sediment, peat, limestone, granite, artificial, sluiced) appears to have little or no significance.
2. It is the prevailing salinity that generally determines the types of plant community present. The hydrological classification of lagoons suggested in 4.3 and Table 5.3 is therefore meaningful in this context and can be predictive.
3. *Ruppia* communities, often with *Lamprothamnium* in the sublittoral, are the most widespread. They appear to tolerate a wide range of salinities although they may succumb to sudden changes. Rhizomes and resistant spores could allow full regeneration of damaged swards. Common faunal species may survive in refuges to repopulate lagoons following mortalities. In this way, both vegetation and fauna can be persistent and short-term changes in salinity regimes need not necessarily endanger established communities.
4. Species richness is greatest at high salinity and in lagoons with salinity gradients. Areas of higher richness can occur near freshwater and seawater inlets, increasing the diversity of the larger lagoons. The extra dimension of depth adds to the diversity of the vegetation in some lagoons.

5.9 Lagoonal habitats

The habitats described below were identified primarily by plant communities. While characteristic faunal assemblages associated with these communities can to some extent be recognised, in general, faunal species are much less reliable indicators of environmental conditions than plants; they are less constant and almost none are faithful to any given community. Long-lived sedentary species are considered here to be the most useful but there are few such species in oligohaline and mesohaline waters. At higher salinities, however, where sessile marine taxa can invade lagoons, their presence is taken to indicate stable conditions within recognisable ranges. Examples are sponges, anemones, hydroids, serpulid polychaetes, barnacles, bryozoans, and tunicates.
The codes allocated to the different communities/habitats are provisional only.

5.9.1 AQUATIC HABITATS

It appears that depth rather than substrate determines the limits of aquatic plant communities, together with salinity. The diversity of habitats is therefore partly

dependent on the profile of the lagoon bed.

Correspondence with habitats described for Scottish lagoons (Covey and Thorpe 1994) is given where similarities can be recognised. The prefix OB for these indicates that they were described from obs, the name used in Scotland for silled saline lakes like most of those in Connemara.

Habitats on soft substrates

AS1 *Cladophora-Enteromorpha* communities at the water's edge

Cladophora vagabunda and other opportunistic chlorophyte species growing on stones and rocks in very shallow water. Ephemeral growths, dying and becoming bleached as a result of high temperatures or falling water levels. Together with floating *Enteromorpha and Cladophora* which is washed ashore, they form decaying or drying mats that provide moisture and food for faunal species. Corresponding to OB12 of Covey and Thorpe: "littoral mats of ephemeral green algae".
Associated species: Isolated salt marsh plants such as *Salicornia*, or freshwater marsh plants e.g. *Littorella.*
Fauna: *Jaera nordmanni, Ligia oceanica, Orchestia gammarella, Littorina saxatilis, Ochthebius* spp, *Cercyon* spp, Saldidae.
Sites: Widespread, present in some areas on the shores of most lagoons.

Floating rafts of ephemeral *Enteromorpha* or *Cladophora* were not closely investigated and are not treated as a separate habitat.

AS2 Charophyte communities in shallow water

Species of *Chara* in water 0.5-1.5 m in depth, usually on sand or gravel, at salinities <10‰.
Dominant plants: *Chara aspera, C. baltica, C. canescens, C. virgata.*
Associated species: filamentous green algae often entangled, *Potamogeton pectinatus, Ruppia* spp, *Zanichellia palustris, Myriophyllum spicatum.*
Fauna: *Neomysis integer, Gammarus zaddachi, G. duebeni, Lekanesphaera hookeri, Palaemonetes varians, Jaera nordmanni, J. ischiosetosa, Ischnura elegans, Potamopyrgus antipodarum,* Trichoptera, Heteroptera, especially *Sigara dorsalis* and *Corixa praeusta*, and aquatic beetles. In stable systems at very low salinity, freshwater molluscs such as *Lymnaea peregra, Pisidium* spp, *Sphaerium* spp may be present. *Idotea chelipes* absent. There are no diagnostic species. *Neomysis, Palaemonetes* and *Jaera nordmanni* can live in freshwater lakes. *Lekanesphaera hookeri* and *G. zaddachi* are perhaps the most reliable indicators of brackish conditions at very low salinity.
Sites: Very shallow oligohaline lakes: Tacumshin, Gill, Durnesh, Roonah, Inch.
Shores of stratified lakes: Fhada, an tSáile, Aconeera, Furnace, Kincas.

AS3 *Potamogeton pectinatus* communities

Potamogeton pectinatus in single species stands, or dominant in multispecies stands, in muddy or peaty substrates or in limestone grikes, generally in salinities <10‰. A variant of *P. pectinatus*, possibly var. flabellatus, was present in 20‰ at an tSáile and Maghery. Covey and Thorpe recognise a biotope OB32 as "brackish mud with *Potamogeton pectinatus*".
Associated species: *Myriophyllum spicatum, Ruppia, Potamogeton berchtoldi, P. polygonifolius.* Unattached *Enteromorpha* or, less frequently *Cladophora*, often present.
Fauna: As for the *Chara* community, but with a greater diversity of heteropterans and beetles. *Lekanesphaera hookeri* almost constant, sticklebacks often abundant.

Cordylophora caspia occasionally present. *Idotea chelipes* absent.
Sites: The dominant community in Mór, Kilkeran, and the Bunargate pool at Lady's Island. Significant populations in parts of Tacumshin, Chorrúch, Cara Fionnla, an tSáile, Aconeera, Durnesh, Inch. Absent from Donnell and Roonah where the salinity during sampling was very low throughout, suggesting that extended periods of higher salinity occur in these lagoons. Also absent as a distinct community in Gill.

***Potamogeton* and *Ruppia* in mixed stands**

Mixed stands are recognised as a transitional rather than a distinct community. Their presence generally indicates oligo-mesohaline conditions in the range 3-13‰. In situations where the stands occur, e.g. at Murree, Aconeera and Inch, some faunal species of higher salinity may be present, e.g. *Cerastoderma glaucum, Conopeum seurati, Pomatoschistus microps. Idotea chelipes* present and often abundant.

AS4 *Ruppia* communities

Both *Ruppia* species can occur over almost the whole salinity range but *R. maritima* tends to be found in shallow water and *R. cirrhosa* in deeper water. However, transitional stands are very common and as species could not always be identified with certainty, no attempt is made to distinguish associations. The variety var. *brevirostris* occurred in two very different habitats: low salinity stagnant water at Inch, and high salinity flowing water at Ballyteige. An atypical community was found at Corragaun. A community of *Ruppia* with *Chaetomorpha* was distinguished but its ecology is not clearly defined. Covey and Thorpe group all *Ruppia* communities from Scottish lagoons into a single biotope OB31 but state that considerable variation occurs.
Associated species: *Potamogeton pectinatus* (see above), *Chaetomorpha, Cladophora.*
Fauna: Given the wide salinity range of this community, oligo- meso- and polyhaline species can all occur. Species distinguishing the community from the P. pectinatus one are: *Idotea chelipes, Enochrus bicolor*, and meso-polyhaline species such as *Praunus flexuosus, Hydrobia ventrosa, Corophium volutator, Crangon crangon, Arenicola marina* and *Hediste diversicolor.*
Sites: This is the most widespread and characteristic community in Irish lagoons, absent only from Loch Mór and the two most saline sites investigated, Kilmore and Aughinish, and represented by small stands only in Kilkeran and Athola. *Ruppia* was more important than *P. pectinatus* in the apparently oligohaline lagoons Donnell and Roonah.

AS5 *Ruppia-Lamprothamnium* communities

This association occurred in a wide range of salinities, generally in polyhaline waters, 15-30‰, at depths >1 m (except in Ghadaí), below the *Ruppia* stands. *Ruppia cirrhosa* was identified at four out of the seven sites and may be the constant species in this community. Although *L. papulosum* occurs in the Outer Hebrides, no equivalent biotope is listed by Covey and Thorpe.
Associated species: *Chaetomorpha, Cladophora, Enteromorpha.*
Fauna: Few samples were obtained because the sites were usually too deep. No species distinguishing this community from the previous one can be recognised, but heteropterans and beetles were rare or absent, and there was a greater proportion of polyhaline species.
Sites: Murree (with *P. pectinatus* and *Chara canescens*), Ghadaí, Fhada, Cara Fionnla, an tSáile, Bofin, Maghery. The community occurred in seven out of the 10 deeper sites and it is suggested that it may be widespread in suitable lagoons.

AS6 *Zostera-Ruppia* communities

Communities of *Zostera marina* with *Ruppia cirrhosa* were confined to an area of south Connemara at depths >1 m, generally 1.5-3 m, in salinities 14-25‰. Covey and Thorpe describe a *Zostera* biotope OB30 from Scottish lagoons.
Associated species: *Lamprothamnium* at three out of the four sites, *Spermathocnus paradoxus, Chaetomorpha linum.*
Fauna: *Gonothyraea loveni, Laomedea angulata, Caprella acanthifera, Tanais dulongi, Akera bullata, Scaphander lignarius, Callopora lineata, Ascidiella aspersa, Ciona intestinalis, Clavelina lepadiformis.*
Sites: Lettermullen, Tanai, Aibhnín, an tSáile.

AS7 *Chaetomorpha* communities

A wide-ranging community forming a layer of *Chaetomorpha linum* on the lagoon bed at 1-4 m, generally >2 m, especially in stratified lagoons, but it may extend into shallower water. The algae form a deep layer of unattached masses over soft substrates which tend to be anoxic.
Associated species: *Cladophora* species.
Fauna: In the few samples from depth, the fauna resembled that of the *Cladophora* communities described below. In shallow water, characteristic species were *Idotea chelipes, Limapontia depressa,* and *Littorina tenebrosa.*
Sites: Drongawn, Ghadaí, Fhada, an tSáile, Aconeera, Sally's, Kincas. A shallow water example in Bridge. The full extent of this community is not known owing to the lack of information on some of the deeper lagoons surveyed in 1996. It could be expected to occur in Mill and Furnace.

AS8 *Cladophora* deep water communities

Two species formed dense carpets on the floor of three lagoons, mainly in >3 m, but sometimes extending into shallower water. *Cladophora battersii* occurred in 28-33‰ and *C. aegagropila* in 10-12‰. Both are rare, or possibly under-recorded. They form an unattached layer of characteristic balls over anoxic silt.
Associated species: *Chaetomorpha linum.*
Fauna: *Acanthopleura ballii, Platynereis dumerili, Scoloplos armiger, Corophium volutator, Ampithoe ramondi, Onoba aculeus, Cerastoderma glaucum, Musculus discors, Amphipholis squamata, Leptosynapta inhaerens.*
Sites: *C. battersii* at Athola and Sally's, *C. aegagropila* at an tSáile.

AS9 Soft mud without vegetation

The central bed of most lagoons is occupied by a layer of soft silt often with a white film of *Begiattoa*. No faunal species have been identified from this habitat.

Habitats on hard substrates

Rocks were present in silled inlets and formed significant parts of the shoreline of many lagoons. Only at high salinities, however, were algae important enough for distinct communities to be recognised. Three such lagoons were surveyed in 1996 and five in 1998. Hard peat can also sometimes support a community of algae and fauna.

Roden distinguishes eight algal communities, differing in faunal richness and species composition (see Vol. III of this report). However, most are not sufficiently widespread to allow the conditions in which they occur to be fully defined. Furthermore, as the different communities were not distinguished during faunal sampling, it is not possible to recognise associations between faunal species and algal communities. Only

three broad algal communities are distinguished below, dominated by red, brown, and green algae.

AH1 Red algal communities

Four different communities were distinguished, all on rocks in shallow water of >20‰.

A species-poor community with *Phyllophora pseudoceranoides, Chondrus crispus, Hildebrandia* sp. *Cladophora rupestris* and entangled *Chaetomorpha linum*. (Aibhnín, Fhada, Sally's, Maghery). This resembles the biotope OB24 of Covey and Thorpe described as "hard substratum with algal turf including *Phyllophora pseudoceranoides*.

A richer variant with *Furcellaria lumbricalis* dominant. (Aibhnin, Maghery, Sally's). It may be related to biotope OB23 of Covey and Thorpe described as "bedrock and boulders with *Polyides/Furcellaria*".

An even richer flora with *Laurencia obtusa, Chyllocladia verticillata, Chondria dasyphylla*, and *Cladophora pellucida*. These species all have a southern range. (Aibhnín).

A distinctive community of southern species with *Chondrocanthus acicularis* and *Pterocladia capillaris*. (Athola)

Other species: A total of 44 species has been recorded from these communities, most of them Rhodophyta.

Fauna: The fauna collected from the sites where these communities were found included species living in and on the algae, on and under the rocks, in the substrate between them, and the mobile fish and crustaceans swimming around them. Together they constitute by far the most diverse assemblage occurring in lagoons. Most are common species of the open coast, including species of rocky shores where adaptations for reduced salinity are common. As on boulder sea shores, the fauna was particularly rich where rocks lay on coarse substrates rather than anoxic muddy sand.

Sites: Drongawn, Kilmore, Lettermullen, Fhada, Aibhnín, Athola, Maghery, Sally's.

AH2 Brown algal communities

The characteristic brown seaweed of brackish waters is *Fucus ceranoides* which grows in clumps on scattered rocks in shallow water and does not form a true community in lagoons. It is abundant and well developed at the entrance to the inlet from Camus Bay to Cara Fionnla and Cara na gCaorach.

Fauna: No species are particularly associated with this fragmented habitat. The community corresponds to OB154 of Covey and Thorpe described as "sublittoral zone of *Fucus ceranoides*".

Sites: Lissagriffin, Farranamanagh, Bridge, Tanaí, Cara Fionnla, an tSáile, Aconeera, Mill, Moorlagh.

Pelvetia canaliculata formed a narrow band just above mean water level at Athola. Fucoids were present in Drongawn and Fhada. Elsewhere, brown seaweeds were generally confined to inlets where there was fast-flowing water. They included *Fucus vesiculatus, F. serratus, Ascophyllum nodosum, Chorda filum*, and occasional *Laminaria*.

Fauna: As inlets have not been thoroughly investigated, being thought not to be strictly part of the lagoons, no faunal lists have been compiled. Casual observations indicate an impoverished rocky shore fauna with mussels usually present.

AH3 Green algal communities

A species-poor community of *Cladophora* and *Enteromorpha* species grows on rocks in low salinity water. Below about 1 m *Chaetomorpha linum* may also be present.

Corresponding to OB19 of Covey and Thorpe "boulders and bedrock with filamentous green algae.
Fauna: Few species live among the algae, the most frequent is *Potamopyrgus antipodarum* with *Littorina saxatilis* and *Hydrobia ventrosa* at somewhat higher salinity.

AH4 Submerged compact peat

Submerged cliffs. Some green algae may be present but the most conspicuous organisms are tunicates, especially *Ascidiella aspersa* and *Clavelinia lepadeformis*.
Sites: Athola (inlet).

Habitats with emergent vegetation

Stands of tall reeds or sedges were a conspicuous feature of many lagoons, often as single species stands but sometimes in mixed, possibly transitional communities. They are considered here as aquatic communities because flooded areas were sampled for aquatic fauna.

Aquatic fauna was most diverse in *Phragmites* which can grow in deeper water.

AE1 ***Phragmites*** **beds** were extensive at Tacumshin, Kilkeran, Lissagriffin, Gill, Donnell, Mill and Durnesh, Kinkas, and were present in smaller but significant areas at Lady's Island, Mór, Cara Fionnla, an tSáile, Bofin, Corragaun, Furnace, Maghery, Sally's and Inch.
AE2 ***Scirpus maritimus*** **stands** were extensive at Tacumshin, Chara, Donnell, Murree, and Chorrúch, and formed smaller stands at Lady's Island, Kilkeran, Lissagriffin, Farranamanagh, Gill, Bofin, Corragaun and Roonah.
AE3 ***Schoenoplectus tabernaemontani*** **stands** were distinguishable by the presence of freshwater species and were extensive at some low salinity sites: Tacumshin, Donnell, an tSáile, Durnesh and Inch, and were present as smaller stands at Lady's Island, Kilkeran, Lissagriffin, Farranamanagh, Aconeera, Corragaun, Roonah and Maghery.

Fauna: Sampling for fauna in dense beds was inefficient and most collections included fauna from nearby open water. Differences between stands of the three vegetation types cannot be distinguished. The decaying leaf bases of *Phragmites* sometimes contained dipteran larvae and oligochaetes and provided a substrate for sessile species such as the lagoonal bryozoan *Conopeum seurati*. Species of *Gerris* (water skaters) are often frequent in sheltered open areas among reeds (and also among rocks), and mysids and prawns tend to swarm near emergent plants.

5.9.2 MARGINAL HABITATS

Marginal vegetation

All the lagoons investigated had some form of halophytic vegetation bordering their shores, the extent and nature of which depended on the geomorphology of the lagoons and their salinity. Gently sloping shores have gradual transitions between vegetation types and they occupy larger areas, while peat lagoons generally have vertical banks, usually with outcrops of rock on the shore, and narrow vegetation zones. The five main lagoon types distinguished by Good in Volume V of this Report (sand barrier, shingle barrier, peat shore, karst, and estuary impoundments) display characteristic marginal habitats.

Non-halophytic vegetation is briefly described in the Site Reports. In 1996, transects through the transition zones were recorded, but their fauna was not investigated and is not discussed here.

TV1 *Puccinellia* communities

The examples identified correspond to the armerietosum sub-association of the Puccinellietum maritimae association (Wymer 1984). The community had a very limited distribution at the water's edge of the most saline lagoons and in seepage zones.
Sites: Cloonconeen, Donnell (seepage sites), Aughinish, Bridge, Aibhnín, Athola, Corragaun, Sally's.

AV2 *Juncus maritimus* communities

These are species-poor variants of the more typical upper salt marsh association but in most lagoons the community occurs at the water's edge.
Three types were identified: (i) with *Armeria*, (ii) with *Festuca rubra*, (iii) with *Agrostis stolonifera*.
Sites: One of the commonest marginal communities. Relevés in 1998 at Fhada, Aibhnín, an tSáile, Athola; also present at Drongawn, Cloonconeen, Lettermullen, Tanaí, Cara Fionnla, Aconeera, Mill, Corragaun, Furnace, Maghery, Sally's, Moorlagh. Extensive stands surround Cara na gCaorach and the inlet leading to Cara Fionnla (Cinn Mhara salt marsh).

TV3 *Festuca rubra* communities

Swards of *Festuca rubra*, resembling the association described by Wymer (1984), with some associated species, occur locally around several lagoons
Sites: Ghadaí, an tSáile, Sally's, Moorlagh.

TV4 *Juncus gerardii* communities

Small swards containing *Juncus gerardii, Glaux maritima* and *Agrostis stolonifera* were common around most of the sites. Four variants were distinguished: (i) with *Potentilla anserina*, (ii) with *Samolus valerandii*, (iii) with *Plantago maritima*, corresponding to the typical association (Wymer 1984), (iv) with *Blysmus rufus*, corresponding to the Blysmetum rufi association described by Wymer (1984) in higher salinity lagoons.
Sites: Lady's Island, Tacumshin, Farranamanagh, Murree, Bridge, Chara, Chorrúch, Aibhnín, Cara Fionnla, an tSáile, Athola, Bofin, Maghery, Sally's, Kincas, Inch

TV5 *Eleocharis* communities

Eleocharis uniglumis with *Agrostis stolonifera*, sometimes mixed with *Eleocharis palustris* and halophytic species such as *Triglochin maritimum, Glaux maritima* and *Plantago maritima*, occurred at a number of western lakes. Three variants could be distinguished: (i) with *Leontodon autumnalis* in drier conditions, (ii) with *Juncus articulatus* in wetter conditions, (iii) more open vegetation in which *Agrostis stolonifera* is rare, at the edge of less saline lagoons.
Sites: Mór, Ghadaí, Aibhnín, Cara Fionnla, an tSáile, Athola, Bofin, (Roonah, Furnace – *E. palustris*).

TV6 Open halophyte communities

Open communities of pioneer halophytes near the water's edge, subject to frequent flooding by lagoon water. Species recorded include *Sueda maritima, Spergularia marina, Glaux maritima, Triglochin maritima, Salicornia* sp and *Spartina*..
Sites: Lady's Island, Tacumshin, Cloonconeen, Donnell, Aughinish.

Unvegetated habitats

TG1 Sand flats

Sites: Lady's Island, Tacumshin, Lissagriffin, Donnell, Corragaun, Roonah, Durnesh, Inch.

TG2 Stony shores

Sites: Kilmore, Chorruch, Farranamanagh, Drongawn, Murree, Tanai, Mill, Bofin, Furnace.

TG3 Stranded plant debris

Material includes algal mats, *Potamageton* and *Ruppia* and remains of reeds and sedges.

Sites: Lissagriffin, Gill, Murree, Aibhnin, Maghery.

TG4 Peat banks

Peat tends to be eroded to form vertical banks with an overhang where plant roots bind the surface. The lower parts of the banks provide a habitat or refuge for some aquatic species such as *Hediste diversicolor* which burrows into the peat, and *Littorina saxatilis, Orchestia gammarella, Lekanesphaera hookeri* and Hydrobiidae which find refuge in existing cracks and erosion cavities.

Sites: Drongawn, Cloonconeen, Connemara saline lake lagoons, Corragaun, Furnace, Moorlagh.

(Below water level, high salinity peat lagoons often have a typical assemblage of tunicates, especially *Ascidiella aspersa* and *Clavelina lepadiformis*, e.g. the Athola inlet.)

TG5 Earth banks

Eroding earth banks are similar to peat banks and have a similar infauna. Sloping earth banks in seepage areas may have a covering of *Vaucheria* (Ballyte eige).

Sites: Lady's Island, Ballyteige, Farranamanagh, Furnace.

TG6 Bedrock and boulders with maritime lichens

Not investigated.

Cryptic fauna includes maritime taxa such as *Petrobius* and *Ligia*.

Sites: Drongawn, Tanai, Athola, Corragaun.

6. EVALUATION AND RANKING OF THE SURVEY SITES

The 36 survey sites are evaluated separately for vegetation, aquatic fauna, and Coleoptera of marginal habitats. The different approaches and methods used are explained in the following sections.

6.1 Vegetation (C. M. Roden)

6.1.1 Assessment of sites surveyed in 1998

In the Natura 2000 project it is suggested that sites be assessed in terms of Habitats and species present. Habitats are judged in terms of representivity, relative surface, and conservation potential, while species are judged in terms of population size and conservation potential. In this assessment I have adapted this scheme to the needs of the present survey.

Based on the analysis of the survey data the following communities are recognized. Asterisks indicate communities that are best developed at lagoonal sites. Others are closely related to more widespread communities in Ireland.

Marginal vegetation
i) Puccinellietum
ii) *Juncus maritimus* communities
iii) *Juncetum gerardii* typicum
iv) *J.gerardii/ Potentilla/anserina* community*
v) *J.gerardii/Samolus valerandii* community*
vi) *Eleocharis* communities
vii) *Festuca rubra* communities
viii) *Blysmus rufus* communities

Emergent vegetation
Communities of:
i) *Phragmites australis*
ii) *Schoenoplectus tabernaemontani*
iii) *Scirpus maritimus*

Benthic vegetation; soft sediments
i) Charophyte communities*
ii) *Potamogeton pectinatus* communities
iii) Monogeneric *Ruppia* sp. communities*
iv) *Ruppia/Lamprothamnium* communities*
v) *Ruppia/Lamprothamnion/Zostera* community*
vi) *Ruppia/Zostera* communities*
vi a) *Chaetomorpha linum* communities*
vi b) *Cladophora aegagropila**
*Cladophora battersii**

Benthic communities on rock
i) Red algal communities*?
ii) *Fucus* sp. *Enteromorpha* sp.
iii) *Cladophora, Enteromorpha*

Plankton communities are not included in this analysis

In this assessment vegetation is scored as follows:

Presence of a community =1

Presence of an * community=2

Total area of each * community ; <1 ha=1, <5ha =2, >5=3.

Rarity is scored for in the following manner: community present at <2 sites=2, at <4 sites=1.

As the *communities showed little damage due to human interference, habitat condition or degradation is not scored.

Flora

Most of the species encountered are widespread and are known not to be rare. A number however are confined to brackish habitats. As their presence enhances the conservation value of the lagoon they are scored in the assessment. In addition a small number of algae are both confined to lagoons and thought to be very rare, either nationally or on a European basis.

Cladophora battersii has not been identified previously as a lagoon specialist but its two confirmed populations in the U.K. include the Loch Maddai lagoon in North Uist and the Fleet in Dorset, It has also been recorded in the past from the Vadills lagoon in the Shetlands.It is also recorded from a single French Lagoon. Prof. C. Van den Hoek states "I do think indeed that *C. battersii* deserves to be a protected species. It is quite rare, and it probably characterizes (but this should be investigated) an ecologically rather narrow (not very eutrophied and not extremely variable as to salinity) lagoonal habitat. I have seen myself 8 collections of the species from Eire, Britain, France and the Adriatic".

C. aegagropila has a somewhat more widespread distribution. Burrows reports that the plant has been found recently in brackish habitats in the Orkney Islands and South Uist. Prof.. Van den Hoek states that it is common in the Gulf of Bothnia in the Baltic. However it also occurs in certain freshwater lakes.

Lagoonal species

Ruppia maritima var brevirostris
Ruppia maritima,
Ruppia cirrhosa,
Chara baltica
Chara canescens
Lamprothamnium papulosum
Cladophora aegagropila?
Cladophora battersii
Chaetomorpha linum

An underlined species is scored 2 as these are believed to be rare, while a more widespread lagoonal species is scored 1. As most of these species form vegetational units, scoring for population size simply duplicates the vegetational score.

The results of this semi-quantitative ranking (Table 6.1) show that the two largest and most diverse lagoons, Loch a tSáile and Loch an Aibhnín have the highest score, while the essentially marine Kilmore Lake has the lowest. Lough Athola is in my opinion under ranked because the scoring system takes no account of differences in red algal communities. The unique red algal vegetation in Lough Athola is possibly very unusual, while that of Maghery and Sally's Lough, which rank higher than Lough Athola, is poor.

For this reason I would rank Lough Athola above these two sites. For similar reasons the difference in score between Loch an Aibhnín and Loch a tSáile probably overstates their difference in conservation value, but this does not affect their ranking

Table 6.1. Assessment of sites studied in 1998

	number of communities	number of * communities	area < 1 ha	area < 5 ha	area > 5 ha	No. of lagoonal species	No. of * species	rarity	VALUE
Loch an tSaile	12	6	2	2	2	5	3	3	50
Loch an Aibhnin	9	4		1	3	4	1	3	37
Inch Lough	10	4	2		2	2	2		32
Loch Fhada	11	4	2	2		3	1		30
L. Cara Fionnla	9	4	2	2		3	1		28
Sally's Lough	10	4	3	1		3	1	4	32
Maghery Lough	6	3	1	2		3	1	1	23
Lough Athola	7	3	2	1		2	1	4	25
Lough Bofin	6	2	1	1		3	1		18
Kincas Lough	7	3	3			2			18
Loch Phort Chorruch	7	2	1	1		2			16
Loch an Chara	5	2	2			2			13
Ballyteige	1	1		1		3	1		12
Loch Mor	7	1	1			0			10
Moorlagh	5	1		1		1			10
Kilmore Lake	0	0	0						0

6.1.2 Overall ranking of the 1996 and 1998

The final part of this project is to combine the results of the present survey with sites those of the 1996 survey undertaken by Mr. Pat Hatch, in order to present an overall ranking of Irish lagoons for conservation purposes. Such a comparison is difficult as the 1996 survey was directed towards littoral and marginal vegetation, while the present survey laid most emphasis on the sublittoral vegetation. This problem is somewhat reduced as in 1998 it proved possible to visit some of the 1996 sites and to briefly examine the sublittoral vegetation. This additional data is now presented, before an attempt is made to produce a complete ranking.

Drongawn Lough. (2/10/1998)

Underwater observations: Only the area inside the entrance sill was examined. The lake water was reasonably clear without strong evidence of stratification. Inside the sill the sides of the lake consist of steeply shelving exposed rock. The rocky slope was followed down to at least 6m depth where a gently sloping bare muddy floor was encountered but there was no sign of *Beggiatoa* at this depth as in Loch Fhada. Exposed rock near the surface was covered in red algal communities with *Polyides rotundus*, *Chondrus crispus*,

depth on sand or gravel a band of *Ruppia cirrhosa* was found. This band thinned with depth and at 3m gave way to dense stands of *Chaetomorpha linum* and *Cladophora* sp. (not *battersii*). This band in turn gave way to bare mud at about 6m.

Lough Gill (2/10/1998)

A small area in the north east of the lake was examined, including a dense stand of *Phragmites australis* and shallow open water. Two unusual plants were found in the reedswamp, *Ceratophyllum demersum* and *Aster lanceolatus*. The former is a uncommon native species while the latter is a scarce introduction from North America. The open water was extremely shallow with patches of *Ruppia cirrhosa* in an unusual small form but with the characteristic very long flower or fruit peduncules reaching the water surface. Two charophytes were found; abundant *Chara aspera* and occasional patches of *Chara canescens*. The latter species was not found in 1996 but had been recorded from Lough Gill at the start of the century. Both species, like *R. cirrhosa*, were dwarf forms about 2-4cm high.

Loch Aconeera (26/8/1998)

Underwater observations: The water in this lake is visibly stratified at a depth of about 4m. Water clarity is moderate to good. The deepest point reached was about 6m. Here a muddy floor with outcropping rock had empty shells of *Mytilus edulis, Mya arenaria* and *Cerastoderma glaucum* on the surface. Rare plants of *Chondrus crispus* grew on rock. Along the thermocline occasional *Aurelia aurita* were seen, these specimens were larger than those found in Loch Fhada. At about the level of the thermocouple dense stands of *Chaetomorpha linum* were found on rock and sand. The upper part of the lake floor consisted of very large glacial boulders (like Loch a tSáile) resting on bedrock, mud or sand. A band of *Ruppia (cirrhosa* ?) occurred above the *C. linum* at about 2-3m. Extremely dense stands of *Potamogeton pectinatus* were found near the shore. Above this zone at 1m *Chara baltica, Ruppia maritima and P. pectinatus* were seen.

Roonah Lough (/10/1998)

This site was visited briefly but the lake appeared very different from the description of 1996. The exit to the sea seemed very large and much of the lake floor was exposed, as the tide was out. It seems possible that the barrier has been breached or widened since the 1996 survey which reported that Roonagh was a low salinity lagoon.

Several other sites were briefly examined using chest waders but no new species or vegetation types were added to the 1996 descriptions. Sites include Tacumshin, Farranamanagh, Lough Muree, Mill lough, Lettermullen pool, Corragaun and Durnesh. However one site which was not chosen to be surveyed in 1998 is of interest as its flora resembles that of Corragaun Lough as described in Verhoeven (1980). Ballyconneely Lough, Co. Galway which was briefly visited on 14/9/1998 had a flora which included *Ruppia maritima, Potamogeton pectinatus, Chara aspera, Chara vulgaris* var. *longibractea, Chara hispida, Scirpus maritimus* and *Schoenoplectus tabernaemontani*. Like Corragaun Lough, Ballyconneely is a shallow lake on sand. It was the only site seen in 1998 with this particular flora.

A comparison method

It has been shown that the different communities that combine to make up the total vegetation of each lagoon co vary, mainly in response to salinity changes. It is possible to sub divide the lagoons based on the presence of certain vegetation types in the littoral, sub littoral and lagoon margins. The sixteen lagoons studied are divided into four types:

1) Lagoons with little or no *Ruppia*, with red algal communities on exposed rock, *Cladophora battersii* at depth on mud and marginal vegetation with Puccinellietum, Juncus gerardii typicum and *Blysmus* communities. Marine phytoplankton.

2) Abundant *Ruppia* with *Zostera* and *Lamprothamnium papulosum*, red algae on exposed rock, marginal communities and plankton as in (1).

3) *Ruppia* and *Lamprothamnium* common, Red algae very poor or absent, *Fucus, Cladophora* and *Enteromorpha* on rock, Pure stands of *C. linum* at depth, *Chara aspera* occasional, Puccinellietum or Juncetum gerardii typicum rare or absent, *Juncus maritimus* and *Potentilla anserina* variant common in marginal vegetation.

4) *Potamogeton pectinatus* common, *Ruppia* occasional or absent, no *Lamprothamnium*, *Chara aspera* or *C. canescens* occasional, *Enteromorpha* and *Cladophora* on rock, *Fucus* rare or absent. Marginal vegetation includes *Eleocharis* communities, *P. anserina* variant, No *Juncus maritimus.*

While little sublittoral data is available for the 1996 sites, the remaining data is sufficient to see if these sites can be included in this scheme.

Group 1 lagoons includes Kilmore, Aughinish, Lough Athola and Sally's Lough.

Group *2* includes Drongawn, Lettermullen Pool, Loch Tanaí, Loch an Aibhnín, Maghery. The lower basin of Loch a tSáile is a possible inclusion on the basis that *Zostera* occurs.

Group 3 which is large is divided into two subgroups. Only *R. maritima* has been recorded from group (i) while *R. cirrhosa* has been recorded from (ii).
(i) very shallow. Lissagriffin, Cloonconeen, Lough Donnell, Bridge Lough, Corragaun, Roonagh, Moorlagh
(ii) >1m. Farranamanagh, Cara Fionnla, Loch Fhada, Loch an Ghadaí, Mill Lough, Lough Bofin, Kincas. Lady's Island can be included in this group but it is so large that several different communities may occur. Lough Murree and the east basin of Loch an tSáile are transitional to group 4 as some *P. pectinatus* occurs.

Group 4. Tacumshin, Kilkeran, Gill, Mór, an Chara, Phort Chorrúch, an tSáile, Aconeera, Furnace, Durnesh, Inch. This group can be sub-divided with Inch, Tacumshin and Lough Gill having *Zanichellia*, and *Chara canescens*. All are large shallow lagoons. Loch an tSáile upper and middle basin, Lough Aconeera and Furnace Lough are all deep stratified lakes in rock basins with very diverse communities including *Chara baltica* in two of the three sites.

Ballyteige is not classified.

When the two data sets are combined , new insights into the distribution of species and vegetation types become obvious. For instance *Cystoseira foeniculaceus* is found in two of the four Group 1 lagoons, (it also occurs in an unsurveyed lagoon in inner Galway Bay).

As Hatch and Healy have already noted (1998) the *Zostera / Lamprothamnium / Ruppia cirrhosa* community is only found in south Connemara, giving the lagoons in this area an exceptional importance.

The Group 3 lagoons are sub-divided into shallow and deep. The constant presence of *R. maritima* in the shallow group suggests that the benthic vegetation of these lagoons belong to Verhoeven's Ruppietum maritimae. In the deeper lagoon group, the supposedly rare *Lamprothamnium* occurs in seven of the ten sites, a search of Mill Lough and even Farranamanagh might reveal further populations. The common occurrence of *R. cirrhosa* suggests that a *R. cirrhosa/Lamprothamnium* community is widespread in suitable lagoons.

In Group 4, the co-occurrence of *Zannichellia*, *Chara canescens* or *Ruppia maritima* in four large shallow lagoons suggests that a community including these species occurs in Irish lagoons. There was insufficient data from the Inch survey alone to define this association. *Chara baltica* was found in two of the three deep, stratified, low salinity lagoons, while *Cladophora aegagropila* occurred in one. These most unusual sites are unlikely to occur commonly in western Europe, their conservation value is great. As all three are large, further underwater exploration is desirable. The calcareous algal nodules in An Loch Mór are unique but further information is needed before their importance can be determined. The remaining small shallow low salinity lagoons seem of less value.

As similar data are not available from each lagoon, even a semi-quantitative ranking system is impossible, but in the following lists I attempt to rank in order of importance the sites included in the four major groups.

Group 1. Athola, Sally's, Aughinish, Kilmore. High salinity sites including examples of *Cladophora battersii*, red algal communities and *Cystoseira foeniculaceus*.

Group 2. Lough Aibhnín and Lough Tanaí are linked and should be treated as one unit along with the linked Lough Fhada complex, Lettermullen, Drongawn, Maghery. Includes examples of *Zostera/Lamprothamnium/Ruppia cirrhosa* community and very diverse seaweed communities. If the Loch Fhada complex is added, an even greater variety of communities is covered.

Group 3 (i). These lagoons are very poor botanically and it is impossible to suggest a rank order, they should be assessed solely on zoological or geological grounds, though some should be conserved. Ballyconneely Lough, which has a flora which resembling that given by Verhoeven (1980) for Corragaun Lough, would rank ahead of any of the listed sites as an example of a shallow lagoon with *Ruppia maritima*.

Group 3 (ii). Lady's Island (given the huge area of the sublittoral in this site, further survey is necessary to see if as yet undescribed vegetation also occurs), Murree, Cara Fionnla (further exploration of the channel and lakes leading to the sea may increase the value of this site), Bofin, Kincas, Farranamanagh, Mill Lough.
Examples of charophyte communities, *Ruppia cirrhosa/ Lamprothamnium papulosum* community and *Chaetomorpha linum* stands in deeper water.

Group 4. Lough Gill, Tacumshin, Inch, Durnesh. All four sites are important for *Chara canescens* populations and *Zanichellia/Ruppia* communities.
Loch an tSáile, Furnace, Aconeera. Important for *Chara baltica*, stratification and sub-halocline brackish communities.
An Loch Mór, (important as palaeoecology site and possibly interesting calcareous algae)
Kilkeran, an Chara, Phort Chorruch,

Combining these data I would group the 36 sites in the following conservation categories:

First	Second	Second (cont.)
Loch an Aibhnín	Athola	Sally's
Loch Tanaí	Lettermullen Pool	Drongawn
Loch Fhada complex	Murree	Maghery
Lady's Island,	Gill	Ballyconneely?
Loch an tSáile,	Inch	Cara Fionnla
Tacumshin	Furnace	Bofin
	Aconeera	Kincas
		Durnesh

Sites in the first category are considered to be of international importance, those in the second category of national importance.

The vegetation of the remaining 16 sites does not appear to be of exceptional interest.

6.2 Aquatic fauna (G.A. Oliver)

Numerical evaluation scheme for aquatic fauna of lagoons.

This scheme aims to assess sites chiefly on the basis of lagoonal fauna i.e. their faunal richness in terms of total number of taxa recorded, specialist species, and interesting or rare species, and proportion of the lagoon that is regarded as "good habitat for fauna". The intention is to introduce an objective element into the evaluation process as well as clarifying the relative importance placed on the different criteria.

Two analyses are provided; the first dealing exclusively with fauna and the second with modifications added according to size and habitat quality. The scores allotted to fauna are objectively based on numbers of species, although the list of lagoonal specialists both in Britain and Ireland and the rarity of many of the species involve some quite subjective assessments as information concerning ecology and occurrence is often incomplete. Estimates of diversity based on standard diversity indices are time-consuming and outside the scope of this project, and in any case would be of limited value without information on seasonal and annual variations in presence and abundance. Lagoonal conditions and populations are notoriously subject to unpredictable change although this may not be a feature of all lagoons. Typical causes are the tendency of some lagoonal species to produce summer blooms, mortalities due to sudden influxes of seawater or exceptionally high temperatures in shallow water, and random colonisations due to floods, storms or the malfunctioning of sluices.

The following criteria are used in order to rank the 36 sites surveyed:

1) Faunal richness

A maximum of 10 points based entirely on the total number of taxa recorded at each site.

Rating:	0-9 spp	1	60 -69 spp	6
	10 -19 spp	2	70 -79 spp	7
	20 -29 spp	3	80 -89 spp	8
	30 -39 spp	4	90 -100 spp	9
	40 -49 spp	5	>100 spp	10

2) Number of lagoonal specialist fauna listed in Britain

Scored according to the number of lagoonal specialist species recorded at the site, listed for Britain (Table 1.1). Presence of high numbers of these species is believed to

indicate lagoonal and relatively stable conditions and be a good predictor of survival of the lagoonal fauna in the long term. (9 is the maximum number recorded at any one site during the two surveys).

3) Number of lagoonal specialist fauna listed in Ireland

Scored according to the number of additional species proposed as lagoonal specialists in Ireland (Table 1.2) that are recorded at the site which are not listed in Britain. The list for Ireland includes most of those listed in Britain but some species on the British list either do not occur in Ireland or appear to differ in ecology such that they are not useful indicators of lagoonal conditions. Some additional species not listed in Britain are proposed as lagoonal specialists in Ireland but this list is still tentative and some species may prove to be less specialised to lagoonal habitats than believed. (5 is the maximum number recorded at any one site during the two surveys).

4) Interesting or rare fauna

Scored according to the number of species believed or known to be rare, although care must be taken with this score as populations may be ephemeral and information on most faunal groups in Ireland is insufficient for a reliable judgement on rarity to be made. For these reasons many of the species believed to be rare are referred to as "interesting". On the other hand, in some cases, species that are indeed rare may not have been recognised as such. (7 is the maximum number recorded at any one site during the two surveys)

5) Faunal Diversity

Scored according to the number of ecological categories, based on salinity regimes from limnic to marine that are present at the site. In cases when only one species is present in a category it is ignored. (7 is the maximum number of categories recognised)

6) Size of the lagoon

Scored according to the number of hectares of open water. Obviously, the size of a lagoon can vary considerably with fluctuations in water level and for this reason estimates of size can vary considerably in the literature. For this survey, estimates of size are based on a combination of information from O.S. maps, aerial photographs and field work. Large size generally implies stability and habitat diversity. (8 is the maximum number of points scored)

Rating:		
	< 1 ha	0
	1-2	1
	3-5	2
	6-20	4
	21-50	5
	51-100	6
	>100	8

7) Quality of lagoonal habitat

Scored from 1 to 4 according to the percentage of lagoon which is considered to be rich habitat, regardless of type. For example, L. an Aibhnín would score 4 points as 100% of the lagoon is considered to be of "good" habitat for fauna, whereas L. Bofin and Kilmore L. only score 1 as 75% of these lagoons appears to be largely devoid of animal life.

Analysis 1 is based on the first 5 criteria which relate directly to fauna and result in a value referred to as Score 1.
Analysis 2 includes the first five criteria (Score 1) relating to fauna plus the final two criteria relating to size and habitat quality which give a combined score referred to as Score 2.

Table 6.2 shows a summary of the data on which the evaluation is based

Table 6.2 Scores for evaluation of 36 lagoons based on number of taxa, lagoonal specialists for Britain, lagoonal specialists for Ireland, rare species, ecological diversity of the species, size of lagoon and proportion available to fauna. Score 1 based on fauna alone (first five columns), score 2 based an all criteria (all columns).

	Taxa	Lag sp Br	Lag sp Ir	Rare Sp	divers	size	hab	Score 1	Score 2
1.1 Lady's Island L.	4	8	2	5	5	8	3	24	35
1.2 Tacumshin L.	5	7	3	5	3	8	1	23	32
1.3 Kilkeran L.	3	3	3	4	3	4	3	16	23
1.4 Lissagriffin L.	3	4	3	4	4	4	1	18	23
1.5 Farranamanagh L.	2	1	3	1	4	2	4	11	17
1.6 Drongawn L.	7	3	1	3	3	4	3	17	24
1.7 L. Gill	5	1	1	1	4	8	4	12	24
1.8 Cloonconeen Pool	2	6	1	1	4	4	4	14	22
1.9 L. Donnell	3	2	3	1	5	5	3	14	22
1.10 L. Murree	3	4	2	4	5	4	3	18	25
1.11 Aughinish Lag.	6	1	0	2	3	4	4	12	20
1.12 Bridge L.	2	7	0	4	3	2	3	16	21
1.13 Lettermullen Pool	5	5	0	4	4	0	4	18	22
1.14 L. Tanaí	4	8	0	4	4	4	4	20	28
1.15 L. Aconeera	3	4	2	1	3	5	3	13	21
1.16 Mill L.	3	4	2	2	4	4	3	15	22
1.17 Corragaun L.	2	3	2	2	4	4	2	13	19
1.18 Roonah L.	4	1	1	1	3	6	2	10	18
1.19 Furnace L.	4	3	5	6	5	8	2	23	33
1.20 Durnesh L.	5	3	3	2	4	6	4	17	27
2.1 Ballyteige chans.	6	8	3	6	7	2	3	30	35
2.2 Kilmore L.	10	1	1	6	4	4	1	22	27
2.3 L. Mór	2	2	1	1	4	4	1	10	15
2.4 L. Phort Chorrúch	2	3	1	2	4	2	3	11	17
2.5 L. an Chara	2	6	2	5	4	2	4	19	25
2.6 L. Fhada complex	4	8	2	3	5	4	4	22	30
2.7 L. an Aibhnín	10	9	1	7	5	6	4	32	42
2.8 L. Cara Fionnla	3	3	2	1	5	4	4	14	22
2.9 L. an tSaile	4	5	2	2	7	6	3	21	29
2.10 L. Athola	9	5	2	3	4	4	4	23	31
2.11 L. Bofin	1	0	1	0	2	4	2	4	10
2.12 Maghery L.	3	4	3	2	6	4	4	18	26
2.13 Sally's L.	5	4	0	3	4	2	3	16	21
2.14 Kincas L.	3	2	3	2	7	4	3	17	24
2.15 Moorlagh	3	3	3	0	7	4	4	16	24
2.16 Inch L.	5	5	3	4	5	8	4	22	34

Table 6.3 Ranking of 36 surveyed lagoon sites. Score 1 based on fauna (first five columns in Table 6 2); Score 2 based on all criteria in Table 6.2.

score 1		score 2	
32	Aibhnín	42	Aibhnín
30	Ballyteige	35	Lady's Island
24	Lady's Island	35	Ballyteige
23	Tacumshin	34	Inch
23	Furnace	33	Furnace
23	Athola	32	Tacumshin
22	Kilkeran	31	Athola
22	Inch	30	Fhada
22	Fhada	29	an tSáile
20	Tanaí	28	Tanaí
20	an tSáile	27	Kilkeran
19	Chara	27	Durnesh
18	Murree	26	Maghery
18	Maghery	25	Murree
18	Lissagriffin	25	Chara
18	Lettermullen	24	Moorlagh
17	Kincas	24	Kincas
17	Durnesh	24	Gill
17	Drongawn	24	Drongawn
16	Sally's	23	Lissagriffin
16	Moorlagh	23	Kilmore
16	Kilmore	22	Mill
16	Bridge	22	Lettermullen
15	Mill	22	Donnell
14	Donnell	22	Cloonconeen
14	Cloonconeen	22	Cara Fionnla
14	Cara Fionnla	21	Sally's
13	Corragaun	21	Bridge
13	Aconeera	21	Aconeera
12	Phort Chorrúch	20	Aughinish
12	Gill	19	Corragaun
12	Aughinish	18	Roonah
11	Farranamanagh	17	Phort Chorrúch
10	Roonah	17	Farranamanagh
10	Mór	15	Mór
4	Bofin	10	Bofin

Comments on the 36 sites

1.1 Lady's Island Lake, Co. Wexford.

Lady's Island Lake is a large (350 ha), **natural sedimentary lagoon** and one of the largest and, possibly, one of the best examples of a percolation lagoon in the whole of Europe.

The aquatic faunal community during stable periods comprises a characteristic assemblage of brackishwater species, a high proportion of which are specialist lagoonal species. A strong N-S salinity gradient and a wide range of substrate types explains the high level of species richness reported in this and other surveys. This is not always apparent, however, because the community undergoes wide fluctuations in species composition and abundance due to breaching.

The aquatic fauna was rich with 44 taxa recorded of which 10 are lagoonal specialists and 5 are interesting species.

Based on fauna alone the lagoon scores highly in both rankings due to the relatively high species number, large number of lagoonal specialists, wide range of ecological categories and size of the lagoon.

Interesting species:

Notonecta viridis, Enochrus bicolor, Cercyon sternalis, Cymbiodyta marginella Conopeum seurati

Conclusion: Exceptional conservation value.

1.2 Tacumshin Lake, Co. Wexford.

Tacumshin Lake is a large (430 ha) **natural sedimentary lagoon** and one of the largest and best examples of a true lagoon in Ireland and Europe. However drainage attempts have greatly reduced the value of the site.

The aquatic fauna was rich with 45 taxa recorded of which 10 are lagoonal specialists and 5 are interesting species. The assemblage typifies a low salinity lagoon with a consistently high input of freshwater, and few opportunities for colonisation from the sea.

Based on fauna alone the lagoon scores highly in both rankings due to the relatively high species number, large number of lagoonal specialists and rare species. It rates highly for the size of the lagoon but this score is lowered by the fact that drainage has reduced the open water area considerably.

Interesting species: *Notonecta viridis, Plea leachi, Octhebius marinus, Cercyon sternalis, Enochrus halophilus*

Conclusion: Exceptional conservation value.

1.3 Kilkeran Lake, Co. Cork.

Kilkeran Lake is a 20 ha **natural sedimentary lagoon** lying behind sand dunes with an artificial channel to the sea. It is a good example of its type but has suffered from eutrophication. It is probably the best example in the south west of Ireland of a lagoon with a sand/gravel barrier.

For such a small lake, the aquatic fauna appears to be diverse with 30 taxa recorded of which 6 are lagoonal specialists and 4 are interesting species.

Based on fauna alone the lagoon scores in the mid-range in both rankings due to the relatively low species number, low number of ecological categories and small size.

Interesting species: *Hydrometra gracilenta* (possible first Irish record but awaiting confirmation), *Notonecta viridis, Allomelita pellucida, Helophorus fulgidicollis* (possible first Irish record but awaiting confirmation)

Conclusion: High conservation value.

1.4 Lissagriffin Lake, Co. Cork.

Lissagriffin Lake is a 15 ha **artificial lagoon** created by construction at the head of a tidal inlet. The lagoon lies behind sand dunes and it is possible that at one time in the past it was a sedimentary lagoon.

The aquatic fauna appears to be low with only 26 taxa recorded but 7 are lagoonal specialists and 4 are interesting species.

Based on fauna it scores in the mid-range on the first analysis which is much higher than expected but this is due to the relatively high number of lagoonal specialists and interesting species. It scores lower on the second analysis due to small size and the relatively small area of 'good' habitat.

Interesting species: *Allomelita pellucida, Cercyon sternalis, Enochrus bicolor, Ochthebius punctatus*

The fact that the lagoon is very shallow, presumably due to silting-up, and much of it is dry for parts of the tidal cycle lower the value of the site considerably.

Conclusion: Medium conservation value.

1.5 Farranamanagh Lake, Co. Cork.

Farranamanagh Lake is a small (4 ha), **natural sedimentary lagoon** with a cobble barrier and natural inlet in an area of natural beauty.

The aquatic fauna is poor, with only 16 taxa recorded. However, 4 species are regarded as lagoonal specialists and 1 **are** interesting species.

Based on fauna the lagoon is ranked low due to low species number and small size, but this is considered to be an under-evaluation, as the site is a very good example of a small sedimentary lagoon in good condition lying in an area of natural beauty.

Interesting species: *Allomelita pellucida*

Conclusion: Medium conservation value.

1.6 Drongawn Lough, Co. Kerry.

Drongawn Lough is a 12 ha **saline lake lagoon** with a shallow highly constricted tidal inlet. The lagoon is in virtually pristine condition in an area of great natural beauty.

The aquatic fauna is rich, with 69 taxa recorded, of which 4 are lagoonal specialists and 3 are interesting species.

Based on fauna the lagoon is ranked in the upper mid-range of scores on the fist analysis based on large species number but most of these are upper salinity range species and proportionately few are lagoonal specialists. In the second analysis it scores slightly lower due to its relatively small size and the fact that because it is so deep not all of the lagoon is considered to be "good" habitat for fauna.

Interesting species: *Jaera forsmani, Erichthonius difformis, Lembos longipes*

The fauna of the lagoon is probably under-recorded as the a diving survey would be required to do it justice. However, it still ranks quite highly and is an excellent example of a completely natural saline lake lagoon in an almost perfect state of preservation. As a lagoon, it is a very good example of its type, probably similar to the Scottish "obs".

Conclusion: High conservation value.

1.7 Lough Gill, Co. Kerry.

Lough Gill is a large (150 ha) **natural sedimentary lagoon** in a "classical position" (Guilcher and King, 1961), lying between two sedimentary barriers forming a tombolo.

The fauna is quite rich and diverse and lies in the poly-mesohaline to limnic range. A total of 49 taxa were recorded, but although many of the species recorded are regarded as euryhaline, only 2 are lagoonal specialists. One species is of particular interest.

The predominance of freshwater species and the fact that neither of the lagoonal specialists was abundant casts some doubt upon the acceptance of the lake as a true lagoon based on the fauna alone. Salinity levels are controlled by management of the sluice and weir. Water analyses at UCD show the undeniable presence of seawater within the lagoon despite the fact that it is widely regarded as being completely fresh.
Interesting species: *Cercyon sternalis*

Based on fauna the lagoon is ranked very low in the first analysis, as. despite the relative richness and diversity, there are very few lagoonal specialists or interesting species. In the second analysis it scores much higher due to large size and the fact that all of the lagoon is considered "good" habitat for fauna.
Conclusion: High conservation value.
However, whether or not the lake can be conserved as a lagoon depends on management and the persons responsible for management decisions.

1.8 Cloonconeen Pool, Co. Clare.

Cloonconeen Pool is a small (7 ha) **natural sedimentary lagoon** with a cobble barrier superimposed on peat.

The fauna of the lagoon is poor, with only 15 taxa recorded, but 7 of these are regarded as lagoonal specialists and one is an interesting species.
Interesting species: *Enochrus bicolor*

Based on fauna the lagoon is ranked in the lower mid-range due to the very low number of taxa, only one interesting species and small size of the lagoon. This is considered to be an under-evaluation, however, as the series of pools is a very good example of an unusual type of lagoonal habitat in peat with a percolation barrier.
Conclusion: High conservation value.

1.9 Lough Donnell, Co. Clare.

Lough Donnell is a 25 ha **natural sedimentary lagoon** with a high cobble barrier and unsluiced artificial outlet pipe through which seawater can enter.

The fauna is relatively poor for the size of the lagoon **34 taxa** and although it is moderately diverse with species in the range limnic to marine and 5 are lagoonal specialists, none are particularly abundant and only one is considered interesting.
Interesting species: *Notonecta viridis*

Based on fauna Lough Donnell ranks in the lower mid-range due to the low number of taxa and interesting species recorded. It gains a slightly higher rank in the second analysis due to size of the lagoon, although it is very shallow and much of the bed of the lake is exposed at times, making it unsuitable for permanent residence to most fauna. The lagoon might be greatly improved if the outlet was sluiced and water levels allowed to remain higher.
Conclusion: Low conservation value based on fauna.

1.10 Lough Murree, Co. Clare.

Lough Murree is a 13 ha **rock lagoon** with no surface connection with the sea. The lake has formed in limestone bedrock on which a cobble barrier has been deposited on the coastal side of the lagoon.

The fauna is relatively poor, with only 27 taxa recorded. However, quite a wide range of ecological categories are present from poly-mesohaline to limnic, 6 species are lagoonal specialists, and 4 are considered interesting.
Interesting species: *Jaera ischiosetosa, Enochrus bicolor, Littorina "tenebrosa", Megasternum obscurum*

Records from the past indicate a less saline regime, at periodically, with at least two other lagoonal specialists reported and a generally "healthier" community. The lake appears to suffer from eutrophication problems.

Based on fauna the lagoon ranks in the upper mid-range of scores due to the relatively high number of lagoonal specialists, rare species and diversity of ecological groups. Ranking in the second analysis is lowered slightly by the relatively small size of the lagoon and the fact that most of the central area is covered with a thick layer of anoxic mud.

The lagoon is an excellent example of a karstic rock lagoon despite the apparent deterioration of the site.

Conclusion: High conservation value.

1.11 Aughinish Lagoon, Co. Clare.

Aughinish Lagoon is a small (8.5 ha) **natural sedimentary lagoon** with a cobble barrier and a natural tidal inlet.

It is an unusual lagoon in that it is situated in karstic limestone and may receive seawater through underground fissures, as well as through the inlet and through or over the barrier but the fact that it becomes hypersaline suggests that water in the lagoon is isolated at least periodically.

The fauna is rich with 57 taxa recorded but almost entirely marine. Only one species is regarded as a lagoonal specialist, a rare species which occurred in low numbers.

Interesting species: *Gammarus chevreuxi, Ochthebius auriculatus*

Based on fauna the lagoon ranks very low due to the lack of lagoonal specialists, rare species and general low diversity, despite the relative richness of the site. It is a very interesting lagoon geomorphologically and faunistically but as a representative site for lagoonal fauna it is not of any great value.

Conclusion: High conservation value, but not as a lagoon.

1.12 Bridge Lough, Co. Galway.

Bridge Lough is a small (4 ha) **artificial saline lagoon** formed by construction of a causeway carrying a road across a tidal inlet. The lagoon is very shallow and appears to suffer from eutrophication problems.

The fauna is relatively poor, with only 22 taxa recorded but 7 lagoonal specialists and 4 interesting species. However, access to most of the lagoon was denied and the site may be under-recorded.

Interesting species: *Enochrus bicolor, Ochthebius punctatus, Conopeum seurati*
Cercyon littoralis

Based on fauna the lagoon ranks in the lower mid-range of scores due to the high number of lagoonal specialists and interesting species, despite the low values for richness and diversity. In the second analysis it scores even lower due to the small size of the lagoon and the fact that much of the bed of the lagoon is covered with a thick layer of anoxic mud and not regarded as "good' habitat for fauna.

Conclusion: Medium-Low conservation value.

1.13 Lettermullen Pool, co. Galway.

Lettermullen Pool is a small (1 ha) **natural rock lagoon.** It could also be described as a large supra-littoral rock pool with a rock barrier and receiving seawater by occasional overwash.

The fauna is rich, with 52 taxa recorded in quite a wide range of ecological groups, with 5 lagoonal specialists and 4 interesting species. Two additional lagoonal specialists were recorded in July 1990 when salinity was slightly lower.

Interesting species: *Laomedea angulata, Enochrus bicolor, Littorina "tenebrosa" Conopeum seurati*

Based on fauna the lagoon ranks in the upper mid-range as a result of number of species, lagoonal specialists, rare species and diversity. The ranking is lowered in the second analysis due to its small size.

Although the lagoon is small, it is an excellent example of its type with a rich and interesting fauna.

Conclusion: High conservation value.

1.14 Loch Tanaí, Co. Galway.

Loch Tanaí is an 11 ha **natural saline lake** formed in peat with a long, possibly artificial, tidal channel connecting it to L. an Aibhnín and Camus Bay (See Site 2.7 in this section and Section 4.7).

The fauna is quite rich with 37 taxa recorded from the marine to euryhaline groups and including 8 lagoonal specialists and several rare or interesting species.

Interesting species: *Enochrus bicolor,Littorina "tenebrosa",Conopeum seurati Syngnathus typhle*

Based on fauna the lagoon ranks in the top ten sites in the country due to faunal richness and diversity, number of lagoonal specialists and interesting species. In the second analysis it rates slightly lower due to its small size, although it actually forms part of a complex with several other Connemara sites.

The lagoon is an excellent example of a saline lake lagoon situated in peat with a rich and interesting fauna.

Conclusion: High conservation value.

1.15 Lough Aconeera, Co. Galway.

Lough Aconeera is a quite large (26 ha) **natural saline lake** with a narrow tidal inlet under a road bridge. It is uncertain how natural this inlet is, as it is certainly modified by the bridge and the road along the south shore has been raised to avoid flooding.

The fauna is relatively poor with only 25 taxa but dominated by euryhaline species with 6 lagoonal specialists. Only one species is possibly rare.

Interesting species: *Conopeum seurati*

Based on fauna the lagoon ranks low in the first analysis due to low species number, diversity and rarity of the species. In the second it ranks very slightly higher due to size but much of the deeper, central parts of the lake consist of large granite boulders and coarse sand, and are not considered to be "good" habitat for fauna.

Conclusion: Low conservation value but this is considered an under-evaluation.

1.16 Mill Lough, Co. Galway.

Mill Lough is a small (6 ha) **natural saline lake** with a narrow tidal inlet, modified to some extent by a road bridge. It is very much like a smaller version of L. Aconeera.

The fauna is quite rich with 30 taxa recorded The dominant group are euryhaline and 6 of the species are lagoonal specialists but there is a far greater marine element in this lagoon compared with L. Aconeera. Two species are considered interesting.

Interesting species:

Conopeum seurati,Cercyon littoralis

Based on fauna, the lagoon ranks in the lower mid-range in the first analysis and slightly higher in the second, despite its small size and the fact that only 75% of the lake is considered to be "good" habitat.

Conclusion: Medium conservation value.

1.17 Corragaun Lough, Co. Mayo.

Corragaun Lough is classified as a **natural sedimentary lagoon** with a completely natural tidal inlet. However, this stretch of coastline is subject to dynamic changes in sedimentation patterns, and the lagoon appears to have silted up and reduced in size and depth considerably. This is presumably due to sand from the coastal dunes being blown inshore but may also be partly due to siltation from the inflowing freshwater streams. The lagoon is now small and very shallow and separated from the sea by a longer, sinuous tidal channel.

The fauna is poor with only 23 taxa recorded, but 5 species are lagoonal specialists and 2 are interesting species.

Interesting species:

Ochthebius punctatus,Megasternum obscurum

Based on fauna, Corragaun ranks low in the first analysis, despite the number of lagoonal specialists and 2 interesting species, and even lower in the second due to small size and the fact that much of the bed of the lagoon either is exposed during neap tides or is covered with a thick, mobile layer of peaty, anoxic soft sediments.

Faunistically, the lagoon is not of very great interest but it is an interesting example of a type of sedimentary lagoon "in decline" and forms part of a dynamic complex of lagoon types on this part of the coast.

Conclusion: Low conservation value for fauna during survey but could easily change character and is an important part of a complex.

1.18 Roonah Lough, Co. Mayo.

Roonah Lough is a large (55 ha) **natural sedimentary lagoon** with a cobble barrier and apparently natural inlet, although this may partly be due to deliberate breaching and has certainly been "repositioned" recently.

The fauna is moderately rich with 35 taxa recorded and dominated by limnic and euryhaline species but with only 2 lagoonal specialists and 1 species of any apparent interest.

Interesting species: *Aplexa hypnorum*

Based on fauna, Roonah Lough ranks as one of the lowest sites of the 36 surveyed, as despite the relative richness, there are very few species typical of lagoons or of particular interest. The size of the lagoon does not help to improve this ranking.

Geomorphologically, the site is a good example of a sedimentary lagoon but faunistically it did not appear to be of any great interest during the survey. However, this stretch of coastline is subject to dynamic changes in sedimentation patterns, and it forms part of a complex of interesting lagoon types. It appears that, since the survey, a storm caused damage to the barrier and the lagoon has changed from being largely freshwater to much more tidal in character.

Conclusion: Low conservation value for fauna during survey but could easily change character and is an important part of a complex.

1.19 Furnace Lough, Co. Mayo.

Furnace Lough is a large (125 ha), and in places deep **saline lake lagoon** with two natural inlets either side of an island, modified with weirs.

The fauna is relatively rich with 35 taxa recorded, including 8 species regarded as lagoonal specialists and 6 interesting or rare species.

Interesting species: *Allomelita pellucida, Jaera ischiosetosa, Lembos longipes, Leptocheirus pilosus, Megasternum obscurum, Conopeum seurati*

Based on fauna, the lagoon ranks in the mid-range based on faunal richness, diversity, number of lagoonal specialists and rare species. In the second analysis it ranks much higher due to large size.

Lough Furnace is an excellent example of a large, stratified saline lake lagoon with a relatively rich and very interesting fauna.

Conclusion: High conservation value.

1.20 Durnesh Lough, Co. Donegal.

Durnesh Lough is a large (85 ha) **sedimentary lagoon** of an interesting type, in that the barrier is composed partly of drumlins and partly high sand dunes with the remnants of a cobble barrier in places. It is unclear how natural the lagoon is, as there is now an artificial channel and pipe running under the sand dunes and the brackish nature of the lagoon may be due entirely to the artificial outlet which allows a certain amount of seawater to enter. According to local information, the lagoon previously drained from an area further north and the channel was cut to alleviate flooding.

The fauna of the lagoon is rich, with 48 taxa recorded, largely due to the high number of limnic Coleoptera, but 6 of the species are lagoonal specialists and 2 are interesting. The most notable feature of the lagoon is the dense population of a rare amphipod.

Interesting species: *Cordylophora caspia, Gammarus chevreuxi*

Based on fauna, the lagoon ranks in the mid-range on the first analysis due to richness and number of lagoonal specialists and the upper mid-range on the second due to large size and the fact that the entire lagoon is regarded as "good" habitat for fauna.

Conclusion: High conservation value.

2.1 Ballyteige drainage channels, Co. Wexford.

Ballyteige drainage channels are regarded as the remnants of a **sedimentary lagoon** for the purposes of this survey. The channels lie behind a sedimentary barrier, through which seawater percolates, in an area formerly occupied by an area of open water known as Ballyteige Lake, which was either a freshwater lake or true lagoon. The channels themselves, which have an open water area of approximately 5 ha, are artificial and were cut in order to drain the lake and a seawall was constructed to prevent seawater entering this previously tidal area. However, it now enters from a different direction.

Sampling stations represent a complex of lagoonal habitats as salinity varies considerably on different stretches of the channels.

Fauna of the area is surprisingly rich and diverse, with 60 taxa recorded from limnic to marine groups, and including an exceptional 11 lagoonal specialists and several interesting species and an interesting community of *Leptosynapta inhaerens* and *Amphipholis squamata.*

Interesting species: *Notonecta viridis, Plea leachi, Enochrus bicolor, Megasternum obscurum,Conopeum seurati, Rhantus suturalis.* (*Agabus conspersus* - collected in 1991).

Based on fauna, and despite its small area of water (5 ha), Ballyteige ranks as one of the top three lagoonal sites in the country due to faunal richness, diversity, number of lagoonal specialists and interesting species.

Although the site is largely artificial, it is undoubtedly of great value faunistically and has the added advantage of great potential for creation of artificial lagoons of different depths and salinities.

Conclusion: Exceptional conservation value.

2.2 Kilmore Lake, Co. Cork.

Kilmore Lake is a small (6 ha) **natural sedimentary lagoon** with a low cobble barrier. According to local information, the barrier was damaged at the time when the oil terminal was being constructe and the lagoon is now almost entirely marine.

The fauna of the lagoon is extremely rich, with the highest number of taxa recorded (113) out of all 36 sites surveyed and several interesting species. However, it is dominated almost entirely by marine or marine/polyhaline species, with very few euryhaline species and only 2 lagoonal specialists.

6Interesting species: *Jaera forsmani, Lembos longipes,Cercyon depressus,C. littoralis Phallusia mamillata, Styela clava*

Based on fauna, the lagoon ranks in the top ten sites of the country in the first analysis, due to the high number of taxa and interesting species. In the second analysis, it ranks lower due to small size and the fact that the fauna is largely restricted to a narrow peripheral belt and a larger area near the inlet. Much of the bed of the lagoon is covered with athick layer of soft, mobile and anoxic sediments.

As a result of the faunal survey, Kilmore Lake has to be regarded as of high conservation value, despite the fact that it is not a good representative of a lagoonal community. The situation could possibly be improved by restoration of the barrier.

Conclusion: High conservation value, though possibly not as a lagoon.

2.3 Loch Mór, Co. Galway.

Loch Mór is an entirely natural **rock lagoon** situated in karstic limestone with no surface connection to the sea. It is a unique type of lagoon, very deep (approx. 25 m) with limestone escarpments along much of the shoreline.

The fauna is extremely poor with only 15 taxa recorded, 3 of which are regarded as lagoonal specialists and only one is of particular interest. Environmental conditions in the lagoon would appear to be relatively stable and the paucity of fauna may be due to an "island effect", compounded by the fact that there is no surface connection with the sea and no large amount of surface freshwater entering the lagoon.

Interesting species: *Conopeum seurati.*

Based on fauna, the lagoon ranks as the second lowest of the 36 sites surveyed. However, it is an exceptional example of what appears to be a unique type of coastal lagoon and the faunal ranking is a gross under-evaluation of the site.

Conclusion: Low conservation value based on fauna, but an excellent example of an apparently unique type of lagoon.

1.4 Loch Phort Chorrúch, Co. Galway.

Loch Phort Chorrúch is a small (4 ha) **natural sedimentary lagoon** situated in karstic limestone, with a long, unbroken, cobble barrier. The lagoon is shallow and appears to suffer eutrophication, at least periodically.

The fauna of the lagoon is relatively poor, with only 19 taxa recorded, of which 4 species are lagoonal specialists and only 2 species are of particular interest.

Interesting species: *Enochrus bicolor,Conopeum seurati*

Based on fauna, the lagoon ranks low due to the general paucity of fauna, lagoonal specialists and interesting species. Although the bed of the lagoon is basically limestone pavement, it is overlain in many areas by a thick layer of soft, mobile and anoxic sediment, a generally hostile environment to most fauna.

Although faunistically the lagoon is rated low, geomorphologically it is a good example of a sedimentary lagoon.

Conclusion: Low conservation value based on fauna, but geomorphologically it is a good example of a sedimentary lagoon.

2.5 Loch an Chara, Co. Galway.

Loch an Chara is a small (5 ha) **saline lake lagoon** in karstic limestone. The formation of the lagoon is uncertain. Seawater appears to enter from a tidal spring at the north end and a malfunctioning sluice system at the south end. Historically, it seems that tidal water entered from the south but this is now blocked by a road.

Faunistically, the lagoon is not rich as only 22 taxa were recorded, although it seems that at least 3 others occurred in the recent past, but 8 species are lagoonal specialists and 5 are rare species, most notably the extremely abundant corixid.
Interesting species: *Jaera ischiosetosa, Sigara selecta, Enochrus bicolor,Ochthebius punctatus, Megasternum obscurum*

Based on fauna, the lagoon ranks in the top ten sites in the country in the first analysis. It ranks lower in the second analysis due to its small size.

Although the lagoon is not impressive geomorphologically, it is by far the best example of a lagoonal community in the Aran Islands and one of the best in the country.
Conclusion: High conservation value.

2.6 Loch Fhada complex, Co. Galway.

The Loch Fhada complex comprises a series of **saline lake lagoons** of different sizes, depths and salinities with a total open-water area of approximately 15 ha.

The fauna of the whole complex is rich and diverse, with 38 taxa recorded from meso-oligohaline to marine groups, of which 10 species are lagoonal specialists and 3 are interesting species.
Interesting species: *Jaera forsmani,Littorina "tenebrosa",Conopeum seurati*

Based on fauna, the complex as a whole ranks as one of the top three sites in the country due to faunal richness, diversity and number of lagoonal specialists. It ranks slightly lower in the second analysis due to its relatively small size.
Conclusion: Exceptional conservation value.

2.7 Loch an Aibhnín, Co. Galway.

Loch an Aibhnín is a large (55 ha), shallow **saline lake lagoon** with a narrow, silled inlet. The lagoon lies in a sparsely populated area and is in an almost perfect state of preservation.

The fauna of the lagoon is extremely rich and diverse, with 107 taxa recorded, of which 10 are lagoonal specialists and 7 are interesting species.
Interesting species: *Gonothyraea loveni, Jaera forsmani, Cercyon littoralis, Littorina "tenebrosa",Conopeum seurati, Lembos longipes, Enochrus bicolor*

Based on fauna, the lagoon ranks as the highest of all sites surveyed. Not only is it rich and diverse, with a high number of lagoonal specialists and rare species, but it is a large site in almost completely natural condition.
Conclusion: Exceptional conservation value. Undoubtedly one of the best sites in the country.

2.8 Loch Cara Fionnla, Co. Galway.

Loch Cara Fionnla is a 13.5 ha **saline lake lagoon** with a narrow tidal inlet that runs through Cara na gCaorach and the Kinvarra saltmarsh to Camus Bay.

The fauna of the lagoon is relatively poor, with only 26 taxa recorded, of which 5 are lagoonal specialists but only one species appears to be of any great interest.
Interesting species: *Conopeum seurati*

Based on fauna, the lagoon ranks in the lower mid-range as despite the low number of species, the community is quite diverse and "lagoonal" in that a large proportion of the species are either brackish or lagoonal specialists.

The lagoon is an interesting example of the type but faunistically not impressive. It does, however, form part of a complex with other lagoons in this part of Connemara and forms part of a continuum of lagoonal habitat through Cara na gCaorach to Camus Bay.
Conclusion: Medium conservation value.

2.9 Loch an tSaile, Co. Galway.

Loch an tSaile comprises a series of 2 **saline lake lagoons** with an upper freshwater lake which was not included in the survey. The lagoons are large, covering a total open-water area of approximately 90 ha, and receive tidal water through a narrow, silled inlet, modified to some extent by a road bridge.

The fauna of the lagoons is quite rich and very diverse, with 43 taxa recorded from limnic to marine groups, reflecting the wide range of salinity regimes within the lagoons. A total of 7 species are regarded as lagoonal specialists and at least 3 species are interesting:
Interesting species:

Megasternum obscurum (1996), *Littorina "tenebrosa", Conopeum seurati*

Based on fauna, the lagoon ranks in the top ten sites of the country due to faunal richness, diversity, number of lagoonal specialists and size.
Conclusion: High conservation value.

(N.B. Mention should also be made of the small pool referred to as Doire Bhanbh, which although not connected to L. an tSáile, contains a very interesting lagoonal fauna and should be included in any conservation efforts concerning L. an tSaile).

2.10 Lough Athola, Co. Galway.

Lough Athola is a 10 ha **saline lake lagoon** with a narrow, silled inlet which is of special interest as it runs through eroded peat.

The fauna of the lagoon is extremely rich but mostly in the poly/mesohaline to marine range. 7 species are regarded as lagoonal specialists, however, and 3 species areconsidered of interest. 93 taxa
Interesting species: *Jaera ischiosetosa, Leptocheirus pilosus, Conopeum seurati*

Based on fauna, the lagoon ranks high and one of the top ten in the country. This ranking is largely due to the number of marine species present. The fauna is similar in many respects to Kilmore L. except that more lagoonal specialists were recorded in L. Athola. Both sites appear to be more typical of the open coast and it may be that both sites are lagoons "in decline" through purely natural processes.

The lagoon is a good example of a saline lake lagoon, situated in peat and at the marine end of the range of salinity types.
Conclusion: High conservation value, although as a lagoonal habitat it may be short-lived.

2.11 Lough Bofin, Co. Galway.

Lough Bofin is a small (8 ha) **natural sedimentary lagoon** with an impressive cobble barrier.

The fauna of the lagoon is extremely poot, with only 10 taxa recorded, only one species regarded as a lagoonal specialist, and none are considered rare or interesting. There is even some doubt about the one lagoonal specialis (*Jaera nordmanni*) as it is only a proposed specialist for Ireland, awaiting further information concerning ecological requirements.

Based on fauna, the lagoon ranks lowest of the 36 surveyed. The paucity of species is possibly due to either, or a combination of, the "island effect", extreme variations in salinity regime creating a "shock system" and perhaps periodic anoxia due to decaying algae washed into the lagoon during storms.

The lagoon is an excellent example of a sedimentary lagoon geomorphologically, but faunistically it is extremely poor.

Conclusion: Low conservation value.

2.12 Maghery Lough, Co. Donegal.

Maghery Lough is a 19 ha **saline lake lagoon** with a modified and sluiced outlet.

The fauna of the lagoon is moderately rich, with 32 taxa recorded from limnic to marine groups. Three additional species were recorded in 1996. A total of 7 species are regarded as lagoonal specialists and 2 are considered to be of interest.

Interesting species: *Jaera ischiosetosa, Conopeum seurati*

Based on fauna, the lagoon ranks highly, in the upper mid-range due to the relatively high number of lagoonal specialists and ecological categories. None of the species are particularly abundant, apart from the thriving population of *Mya arenaria*, but the lagoon is a good example of its type with a diverse lagoonal community.

Conclusion: High conservation value.

2.13 Sally's Lough, Co. Donegal.

Sally's Lough is a 10 ha **saline lake lagoon** with a narrow inlet running through a small gorge in the rock. It is uncertain how natural this lagoon is, as according to local information, it was formerly a freshwater lake and the channel was cut through the rock to alleviate flooding and this caused the lake to become brackish.

The fauna is rich, with 49 taxa recorded, but mostly marine or marine-polyhaline. There is a significant brackish element to the fauna, however, and 4 of the species are regarded as lagoonal specialists. 3 species are considered to be of particular interest.

Interesting species: *Ampithoe ramondi,Lembos longipes,Conopeum seurati*

Based on fauna, the lagoon ranks in the mid-range as, despite the apparrent richness, diversity and number of lagoonal specialists is relatively low. In the second analysis it ranks even lower due to relatively small size and the fact that much of the central area is covered with a thick layer of anoxic soft sediment, which is not a "good" habitat for most fauna.

The lagoon in many respects is similar to Kilmore L. and L. Athola but with fewer marine species.

Conclusion: Medium conservation value.

2.14 Kincas Lough, Co. Donegal.

Kincas Lough is a small (6 ha) **saline lake lagoon** with an unsluiced artificial outlet. It is uncertain how natural the brackish nature of the lagoon is, as according to local information, the outlet was deepened to alleviate flooding and this allowed seawater to enter the formerly freshwater lake.

The fauna of the lake appears moderately rich, with 27 taxa recorded, of which 5 species are regarded as lagoonal specialists and 2 are interesting species. The lagoon appears to to be highly "enriched" and at least two species are regarded as indicators of eutrophic conditions.

Interesting species: *Cordylophora caspia,Conopeum seurati*

Based on fauna, the lagoon ranks surprisingly highly, in the mid-range due to the number of lagoonal specialists and the diversity of the fauna. Many of the fauna are recorded as single specimens, however, and this ranking may be an over-evaluation.

The lagoon is an example of a small saline lake with a brackish community but not generally considered very highly.
Conclusion: Medium conservation value based on fauna but this is considered to be an over-evaluation.

2.15 Moorlagh, Co. Donegal.

Moorlagh is a 10 ha **saline lake lagoon** with an artificial barrier formed by a causeway and road bridge and a natural outlet modified with sluices.

The fauna appears to be relatively rich, with 29 taxa recorded from limnic to marine groups, but most of the species were recorded from the extreme ends of the lagoon, either where a small river enters or at the tidal inlet. Fauna in the main body of the lagoon is much poorer and many of these species are highly mobile and able to enter and/or leave fresh or seawater freely. 6 of the species are regarded as lagoonal specialists but only one species is of interest and that was recorded previously in 1996 and not found during the present survey.
Interesting species: *Jaera ischiosetosa* (1996)

Based on fauna, the lagoon ranks surprisingly highly, in the mid-range due to the number of lagoonal specialists and the diversity of the fauna. Many of the fauna recorded are not typical of the main body of the lagoon, however, which is much poorer. The lagoon appears to undergo extreme variations in salinity regime and there are relatively few species that are permanent residents.

The lagoon is an example of a small, shallow saline lake lagoon and faunistically is not impressive.
Conclusion: Medium conservation value based on fauna but this is considered to be an over-evaluation.

2.16 Inch Lough, Co. Donegal.

Inch Lough is a large (160 ha) **artificial saline lagoon** created by impounding a tidal area between the mainland and Inch Island between two embankments.

The fauna is rich and diverse, with 53 taxa recorded from limnic to poly-mesohaline groups and including 8 lagoonal specialists and 4 interesting species.
Interesting species: *Cordylophora caspia, Hygrotus novemlineatus, Aplexa hypnorum Conopeum seurati.*

Based on fauna, the lagoon ranks among the top three sites of the 36 surveyed due to faunal richness, diversity, number of lagoonal specialists and interesting species and finally size.

The lagoon is an excellent example of an artificial lagoon with a rich and varied fauna and a lagoonal community equivalent to a natural lagoon. Despite the fact that it is artificial, it is one of the very best lagoonal habitats for fauna in the country.
Conclusion: Exceptional conservation value.

Summary

In conclusion, Table 6.4 summarises the conservation value of the aquatic fauna of the sites surveyed with an emphasis on lagoonal communities and brackish water species.

Table 6.4 Conservation value of the sites surveyed, based on lagoonal fauna

Exceptional	High	Medium	Low
Lady's Island L.	Kilkeran L.	Lissagriffin L.	L. Donnell
Tacumshin L.	Drongawn L.	Farranamanagh L.	L. Aconeera
Ballyteige	Cloonconeen Pool	L. Gill	Corragaun L.
L. Fhada complex	L. Murree	Aughinish L.	Roonah L.
L. an Aibhnín	Lettermullen	Bridge L.	L. Mór
Inch L.	L. Tanaí	Mill L.	L. Phort Chorrúch
	Furnace L.	L. Cara Fionnla	L. Bofin
	Durnesh L.	Sally's L.	
	Kilmore L.	Kincas L.	
	L. an Chara	Moorlagh	
	L. an tSáile		
	L. Athola		
	Maghery L.		

6.3 Shore Coleoptera (J. A. Good)

Approximately 8.5% of the total number of recorded species (7.9% in 1996, 9.3% in 1998) were classed as indicator species (including the Pselaphidae recorded in 1996, see Table 6.5). The total number of species recorded at a site is not a useful measure of its potential conservation value because a large number of these species may not be associated with the characteristic habitats of the site (e.g. grassland species, opportunistic or vagrant species). Equally, the relative abundance of any one species is highly dependent on the sampling methods and conditions at the time of sampling, and may be misleading as regards conservation value. Furthermore, there is too little accurate information on the Irish status of nearly all soil invertebrates to depend on rare species as reliable indicators of conservation value. Using British rarity classes is also open to question because many wetland species (e.g. *Blethsia multopunctata)* are more frequent in Ireland. Rare species also tend to be just that: rare, and without intensive or targeted sampling are often missed in extensive surveys such as this. It must also be remembered that the objective of conservation of invertebrate habitats is species-rich characteristic communities which are vulnerable to human-induced disturbance, not rare species, of which Ireland has notably few in any case. Finally, while listed lagoonal specialists may be used for aquatic invertebrate evaluation, the only carabid, staphylinid or pselaphid which might fit this category is, in the author's opinion, *Brundinia meridionalis.*

Eleven of the 36 lagoonal sites surveyed were considered to have significant conservation value for their shore invertebrate fauna, based on recorded Carabidae, Staphylinidae and Pselaphidae. Seven types of habitat of potential conservation value were recognised at the surveyed lagoons. None of these could be regarded as exclusively lagoonal, and probably occur in other habitat types. Three of these were microhabitats associated with freshwater lakes (marshes, waterbird loafing areas, sandy shores), two were associated with coastal environments (shingle with overwashed seaweed, sandflat beaches) and two were associated with upper salt-marsh zones (*Juncus/Agrostis* with wet bog, silty stagnant saline shores). It may well be that lagoonal processes provide better examples of many or all of these microhabitats, but only comparative surveys of other coastal habitats can verify this.

The high proportion of peat shore saline lakes in the 1998 survey must partly account for the relatively poor set of site ratings for sites sampled in that year, when compared to 1996. The 1998 survey also included proportionally more sites with high salinities, approaching fully marine conditions, but only one halobiont indicator species (*Aepus marinus*) was recorded.

It is important to emphasise that rating a site as 'significant' does not confer any conservation status on that site. It is merely stating that the microhabitat present is indicated to contain a well-developed characteristic biological community; conservation status requires a further decision as to the scarcity or value of the microhabitat type.

Table 6.5 Coastal lagoon sites rated for conservation importance according to interpretation of ecotonal Coleoptera (Carabidae, Staphylinidae, Pselaphidae) sampled in 1996 and 1998. See methodolology section for explanation of interpretation.

Categories : None , low, significant, exceptional.

Significant refers to sites reaching a status that is worth conserving, in terms of their ecotonal fauna.

Site	Conservation value	No. indicator species	No. freshwater or coastal wetland species	No. halobiont species
Cloonconeen Pool	Significant	2	1	1
Durnesh Lake	Significant	3	2	1
Inch Lough	Significant	4	4	0
Kilkeran Lake	Significant	2	2	0
Lady's Island Lake	Significant	3	3	0
Lough Aconeera	Significant	2	2	0
Loch Port Chorrúch	Significant	2	0	2
Loch Tanaí	Significant	2	2	0
Lough Gill	Significant	2	2	0
Lough Murree	Significant	2	1	1
Ballyteigue Slob	Low	0		
Cara na gCaorach Inlet	Low	1		
Drongawn Lough	Low	1		
Faranamanagh Lake	Low	1		
Kilmore Lake	Low	1		
Lissagriffin Lake	Low	1		
Loch an Aibhnín	Low	0		
Loch an tSaile	Low	1		
Loch Athola	Low	1		
Loch Cara Fionnla	Low	1		
Loch Fhada	Low	1		
Lough Donnell	Low	2		
Maghery	Low	1		
Tacumshin Lake	Low	1		
An Loch Mór (Inis Oírr)	None	-		
Aughinish Lagoon	None	0		
Bridge Lough	None	1		
Corragaun Lough	None	0		
Kincas Lough	None	0		
Lettermullen Pool	None	-		
Loch an Chara (Árainn)	None	0		
Lough Bofin	None	0		
Lough Furnace	None	0		
Mill Lough	None	0		
Moorlagh	None	0		
Roonah Lough	None	1		
Sally's Lough	None	0		

6.4 Summary evaluation based on biological criteria

In Table 6.6 the 36 sites surveyed in 1996 and 1998 are ranked in the first column according to their estimated value for vegetation as the plant species and communities are believed to be more permanent, and to reflect the predominant environmental conditions more faithfully, than fauna. Faunal species tend to vary seasonally and from year to year depending on weather. Sites are rated 3 or 2 for vegetation and 0 for sites considered to have no special value. L. Mór is rated as 1 on the basis of its calcareous nodules. Rank 1 includes the best representatives of each of the main lagoon types distinguished by their vegetation; Rank 2 contains the next best examples. Faunal assessments are rated 3-0 according to their rating in Table 6.2: sites with scores >22 = 3, 16-22 = 2, 12-15=1, <12=0. The value for L. Athola which is considered to have been overvalued, has been lowered. Four ranks are used for Coleoptera: exceptional, significant, low, and none. However, no site was rated as exceptional. Sites with significant habitats for shore fauna are scored 2, sites with low habitat value = 1.

Three of the sites in Rank 1 are interconnected, Aibhnín, Fhada and Tanaí. It is recommended that they form a single conservation unit. L. Cara Fionnla in the same area is not ranked as highly but if Cara na gCaorach and the tidal inlet are included with it, together with the adjoining Cinn Mhara saltmarsh, another important conservation area could be formed.

Comments on the combined evaluations

Assessments of vegetation and aquatic fauna emphasise habitat diversity and lagoonal specialist species and are partly dependent on size of the lagoon and topographical complexity. The evaluation of shore habitats based on ecotonal beetles emphasises habitat quality. At some sites only shallow water vegetation was investigated and these lagoons could be upgraded if interesting deep water communities were discovered. Low values for shore fauna at some sites are due to the lack of appropriate vegetation, generally where the shores are steep and/or rocky.

Ranks 1 and 2 are similar for vegetation and aquatic fauna in spite of the difficulties involved in assessing fauna on the basis of single sets of samples in one season, and in one year. It is in Ranks 3-4 that disagreement becomes apparent. However, only two sites, Bofin and Ballyteige, have contradictory evaluations, Bofin being rated highly for *Lamprothamnium* while the fauna is very poor, and Ballyteige for faunal diversity, number of lagoonal specialists and rare insect species, but with uninteresting vegetation. Rank 4 consists mainly of *Ruppia* sites with few other plant species present. Factors contributing to high scores for fauna at these sites include habitat diversity (e.g. in lagoons with salinity gradients), a range of marginal vegetation types, high species richness in high salinity sites, and possibly a warmer, drier climate in the south of the country.

Rankings show some interesting regional patterns. Two areas of the coastline contain some of the most important lagoons: southeast Wexford for its well-documented percolation lagoons, and Connemara, particularly the Camus Bay area, for its saline lake lagoons in peat. A high proportion of notable insect species in the Wexford lagoons, and also in some Cork sites, suggests that climate may play a part in determining the richness of these lagoons. The aquatic fauna of the North Slob channels is also known to be rich. The Connemara lagoons are notable for the diversity of their plant communities and the richness of their fauna. L. an Aibhnín is undoubtedly the best high salinity lagoon in the country for aquatic fauna. Unlike the Wexford lagoons, these peat lagoons are largely untouched by human activities and under no immediate threats. In contrast to the Wexford and Connemara regions, Donegal proved somewhat disappointing. Only Inch L. with its important population of *Chara canescens,* oligohaline species of insects and molluscs, and

well-developed marginal habitats could be rated highly. The cooler wetter climate may be one factor limiting faunal diversity in the north.

Table 6.6 Final ranking of the 36 sites.

		Vegetation	Aquatic fauna	Shore fauna	Total
Rank 1	Lady's Island	3	3	2	8
	Aibhnín	3	3	1	7
	Tanaí	3	2	2	7
	Tacumshin	3	3	1	7
	Fhada	3	2	1	6
	An tSáile	3	2	1	6
Rank 2	Inch	2	2	2	6
	Murree	2	2	2	6
	Durnesh	2	2	2	6
	Athola	2	2	1	5
	Furnace	2	3	0	5
	Maghery	2	2	1	5
	Drongawn	2	2	1	5
	Sally's	2	2	1	5
	Aconeera	2	1	2	5
	Gill	2	1	2	5
	Lettermullen	2	2	-	4
	Kincas	2	2	0	4
	Cara Fionnla	2	1	1	4
Rank 3	Bofin	2	0	0	2
	Ballyteige	0	3	1	4
Rank 4	Kilkeran	0	2	2	4
	Kilmore	0	2	1	3
	Cloonconeen	0	1	2	3
	Lissagriffin	0	2	1	3
	Chorrúch	0	1	2	3
	Moorlagh	0	2	0	2
	Chara	0	2	0	2
	Bridge	0	2	0	2
	Mill	0	2	0	2
	Donnell	0	1	1	2
	Farranamanagh	0	1	1	2
	Corragaun	0	1	0	1
	Aughinish	0	1	0	1
	Mór	1	0	0	1
	Roonah	0	0	0	0

Karst lagoons, in spite of their supposed different water chemistry, showed no particular features to distinguish them from other lagoon types, although the calcareous algal nodules in L. Mór are believed to be unique to brackish lakes in limestone. In general, the karst lakes tended to be rather poor and only L. Murree was rated highly. Most karst lakes are some distance from the sea and therefore unlikely to experience sudden changes in salinity so more developed vegetation and fauna were expected. The exception

is L. Phort Chorrúch which is affected by sea overwash. L. Murree is occasionally reached by overwash waves but the amounts are probably insignificant. The fact that all the karst lagoons investigated except L. Murree were on islands (including a number only briefly surveyed) may explain their poverty. Among the Aran lagoons, only L. Chara contained a moderately rich fauna and a good representation of lagoonal specialist species. Poor fauna was also a feature of L. Bofin (and L. Ó Dheas on Tory Island) so an island effect must be suspected.

As mentioned in the 1996 Report, some western areas are rich in former sedimentary lagoons in various evolutionary stages. Most of the examples on Achill Island, and virtually all of the coastal lakes in the Fanad region of Donegal, appear to have filled in as a result of sand accretion and land rise and are now too far from the coast for brackish conditions to persist. The south Mayo coast, however, remains dynamic. Both of the brackish lagoons surveyed in 1996 (Corragaun and Roonah) have changed their character dramatically in recent years, therefore lakes near the coast which were fresh when sampled could become brackish following storm-induced changes to the barrier. Historical data on repeated sand movements in this area indicate persistent retreat and barrier breakdown (Devoy *et al.* 1996). Although individually these lagoons score low in Table 6.6, as a series which includes all evolutionary stages they could form an interesting conservation unit.

Representativity

In order to conserve a representative selection of Irish lagoons, they need to be chosen from a range of lagoon types. Ranking within the five lagoon Groups identified according to vegetation (see 6.1) is shown in Table 6.7. Highly rated examples occur in four of the five groups but not in Group 3a lagoons (shallow water *Ruppia* communities without *R. cirrhosa*) which are characteristically poor. Some of the larger lagoons might be divided into regions characterised by different vegetation types e.g. Lady's Island and An tSáile.

Table 6.7 Ranking of sites within lagoon types based on vegetation. (Ratings as in Table 6.6. Loch an tSáile contains several vegetational groups; the rating is for the lagoon as a whole)

Group 1		Group 2		Group 3a		Group 3b		Group 4	
Athola	5	Aibhnín	7	Lissagriffin	3	Lady's Island	8	Tacumshin	7
Sally's	5	Tanaí	7	Cloonconeen	3	Fhada complex	6	An tSáile	(6)
Kilmore	3	An tSáile	(6)	Donnell	2	Murree	6	Durnesh	6
Aughinish	1	Drongawn	5	Moorlagh	2	Cara Fionnla	4	Inch	6
		Maghery	5	Bridge	2	Kincas	4	Gill	5
		Lettermullen	4	Corragaun	1	Mill	2	Aconeera	5
				Roonah	0	Bofin	2	Furnace	5
						Farranamanagh	2	Kilkeran	4
								Ballyteige	4
								Chorrúch	3
								Chara	2
								Mór	1

The lagoon Groups in Table 6.7 are characterised chiefly by salinity regime and depth but the predominant salinity sometimes varied widely within a Group (e.g. 3a) resulting in greater differences in aquatic fauna between sites than was apparent for vegetation. As salinity regime appeared to be the predominant factor influencing aquatic fauna, a division of the sites according to their hydrological regimes is also shown (Table 6.8).

Table 6.8 Ranking of sites within lagoon hydrological types. (Ratings as in Table 6.6.)

Poly-euhaline		Predominantly mesohaline		Wide salinity gradient		Predominantly oligohaline		'Shock lagoons'	
Aibhnín	7	Murree	6	Lady's Island	8	Tacumshin	7	Cara Fionnla	4
Tanaí	7	Aconeera	5	Fhada complex	6	An tSáile	6	Farranamanagh	2
Athola	5	Kincas	4	Furnace	5	Durnesh	6	Mill	2
Maghery	5	Chara	2	Ballyteige	4	Inch	6	Bofin	2
Sally's	5			Lissagriffin	3	Gill	5	Moorlagh	2
Drongawn	5					Kilkeran	4	Corragaun	1
Lettermullen	4					Chorrúch	3		
Kilmore	3					Donnell	2		
Cloonconeen	3					Mór	1		
Bridge	2					Roonah	0		
Aughinish	1								

6.5. Non-biological criteria

Lagoon size

The size of a lagoon is an important contributing factor to habitat diversity. Lagoon area is included in the evaluation of sites for aquatic fauna:

Rating:	< 1 ha	0	1-2	1
	3-5	2	6-20	4
	21-50	5	51-100	6
	>100	8		

Size is to a large extent recognised in the emphasis placed on habitat diversity by the scoring systems for both vegetation and aquatic fauna. Almost all the larger Irish lagoons have been rated highly on biological criteria and all are in the top 20.

Geomorphology

The textbook definition of a lagoon is based on geomorphology, and the Habitats Directive largely depends on the same definition. In this survey, a more biological approach has been adopted but the value of lagoons as unique landforms should not be ignored. Lagoons with sedimentary barriers are considered to be the most valued, not only because they most closely conform to the widely recognised definition of lagoons, but because they are the most vulnerable to destruction due to storm damage and changes in sedimentation patterns. Lagoons lost in this way are unlikely to be replaced. In Europe, silled saline lake lagoons are believed to be unique to Ireland and Scotland, and the Irish ones appear to be richer in lagoonal species and communities than the Scottish ones. They are thus internationally important. Karst lagoons may be unique to Ireland in Europe. Most are the equivalent of anchialine pools, i.e. land-locked saline pools receiving seawater through fissures, tunnels or caves (Holthuis 1973), which are common in some other parts of the world, particularly the Middle East, Hawaii and the Caribbean. Loch Mór, in spite of its poor flora and fauna, has special features which could be important for its conservation.

Information on geomorphological features of the lagoons surveyed is given in the summary descriptions of the 36 sites under Aquatic Fauna (Section 6.2), and in the

individual site reports (Vol. 1 Part 2, 1999, and Vol. II, 1997). The following scores are used for rating sites in Table 6.9:

Sedimentary lagoons	natural –	5
	breached -	4
	artificial outlet –	1-2
Karst lagoons	natural -	4
	sluiced -	2
Saline lake lagoons	natural -	3
	sluiced -	2
Artificial lagoons		0
	special features	1

Documentation and research

Before our surveys, only five Irish lagoons had been the subject of published scientific work which included aquatic fauna and flora. These sites are all in the top two ranks of our final evaluation. Our investigations in the Connemara lagoons have already alerted one research group to the potential of these sites and periwinkles in Lettermullen Pool and L. an Aibhnín are being studied as part of an international research programme.

The following scores are used in Table 6.9:

Several publications - 4
One publication or more than 1 report – 3
Important ongoing research project - 2
A single report or minor research project – 1

NB Reports and publications based on the 1996 survey are not included.
Reports and minor theses are available for a few other lagoons not surveyed

Ornithological importance

Three of the seven sites in the top rank (Lady's Island, Tacumshin, and Inch) are the most important lagoons for waterfowl in the country, and all are SPAs. Although some other sites lie within, or adjacent to, SPAs, notably Ballyteige, none are in themselves of sufficient importance for birds to warrant raising the ranking of the lagoons significantly.

Table 6.9 Evaluation of the 36 lagoons based on non-biological criteria

	Size	Geomorphology	Documentation	Total
Lady's Island	8	4	4	16
Tacumshin	8	3	3	14
Furnace	8	3	3	14
Roonah	6	5	0	11
Kilkeran	4	4	2	10
Gill	8	1*	1	10
Murree	4	4	2	10
Bofin	4	5	1	10
Corragaun	4	5	1	10
Aughinish	4	5	0	9
Mór	4	4	1	9
Aibhníin	6	3	0	9
An tSáile	6	3	0	9
Inch	8	0	0	8
Kilmore	4	4	0	8
Cloonconeen	4	4	0	8
Donnell	5	3	0	8
Farranamanagh	2	5	0	7
Drongawn	4	3	0	7
Chorrúch	2	4	1	7
Fhada	4	3	0	7
Tanaí	4	3	0	7
Cara Fionnla	4	3	0	7
Aconeera	5	2	0	7
Athola	4	3	0	7
Durnesh	6	2	0	8
Mill	4	2	0	6
Maghery	4	2	0	6
Kincas	4	2	0	6
Moorlagh	4	2	0	6
Ballyteige	2	1*	1	4
Lissagriffin	4	0	0	4
Lettermullen	0	3	1	4
Chara	2	2	0	4
Sally's	2	2*	0	4
Bridge	2	1*	0	3

* Ballyteige – artificial system but seawater percolation through a natural barrier
L. Gill – artificial outlet but formerly a natural sedimentary lagoon
Sally's L. – formerly a freshwater lake, but now functioning as a saline lake lagoon
Bridge L. –barrier is artificial but the lagoon is in a karst basin

6.6 Conservation of lagoons not surveyed

Time did not allow all potentially valuable lagoons to be surveyed. Brief visits indicated that 14 further sites are worth consideration. The following are likely to be of most interest and require further investigation:

North Slob Channels – Known to contain a rich and interesting aquatic fauna; *Ruppia and Zostera* present, *Chara canescens* recorded. Oligo-polyhaline.

South Slob Channels – Large area, several charophytes recorded. Oligohaline-fresh.

Rostellan L. – Artificial barrier. Large, (about 50 ha), oligohaline. Dense aquatic vegetation.
Reenydonagan L. Sedimentary lagoon, sluiced. About 25 ha, predominantly mesohaline, eutrophic.
Salt Lake – Large (about 50 ha) saline lake lagoon. Deep. Interesting fauna. Not surveyed because adequate information already available.
Ballyconeely L. – Sluiced sedimentary lagoon, about 20 ha, oligohaline. Unusual aquatic vegetation.
Blanket Nook – Large (about 40 ha). Similar to Inch L. but more saline.

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