SURVEY OF IRISH COASTAL LAGOONS 1998
V. SHORE FAUNA : CARABIDAE, STAPHYLINIDAE AND PSELAPHIDAE (COLEOPTERA)

Contents

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Summary of 1996 and 1998 Surveys

1. Soil invertebrates represent a large proportion of the biodiversity of Ireland. Shore habitats can be important habitats for soil invertebrates. This is because the communities which occur there are adapted to a variety of flooding regimes, sediment textures, winter storms, fluctuating temperatures, and, in the case of coastal lagoons, variations in soil salinity. In consequence, a wide variety of species occurs in the various shore micro-environments, many being involved in the decomposition of accumulations of organic matter, such as reed litter, seaweed, algal mats and other organic debris, and others being predators of herbivorous insects and mites.

2. The beetle (Coleoptera) families Carabidae (ground-beetles), Staphylinidae (rove-beetles) and Pselaphidae are well represented in shore habitats, and together account for approximately 5% of the total land and freshwater fauna and flora in Ireland. They are used here as indicators of the ecological development of shore habitats of Irish lagoons. Sites with two or more indicator species, given the standard sampling intensity used at each site, are considered to have potential conservation value.

3. Twenty-two indicator species were recorded from 36 lagoons and saline lakes. Eleven sites are concluded to have significant potential conservation value for their shore habitats and invertebrate communities. These were Lady's Island Lake (Co. Wexford), Kilkeran L. (Co. Cork), L. Gill (Co. Kerry), Cloonconeen, L. Donnell, L. Murree (Co. Clare), L. Aconeera, L. Tanaí, L. Port Chorrúch (Co. Galway), Durnesh L., and Inch L. (Co. Donegal).

4. Seven habitat features of conservation value which are found at lagoons were recognised: marsh soils, partially vegetated sandy shores, stagnant saline silty shores with dense algal growth, lagoon outflow beach sandflats, grassy sandy lakeshores used for loafing by waterbirds, peat shores with a Juncea maritimi vegetation adjacent to wet *Sphagnum* bog, and overwashed decaying seaweed on lagoon barriers.

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Abstract

Fifteen coastal lagoons or saline lakes, and one reclaimed polder channel with saline springs, were sampled for Staphylinidae and Carabidae on the south and west coasts of Ireland during 1998, continuing an earlier survey of twenty sites in 1996. A total of 104 species of staphylinid, 41 species of carabid and five species of pselaphid were recorded, of which five carabid and four staphylinid species were considered indicators of ecologically well-developed shoreline habitats (i.e. containing many local or rare specialist species). Sites where such habitats were indicated as occurring were Loch Port Chorrúch (Aran Is, Co. Galway) and Inch Lough (Co. Donegal). Three types of habitat of potential conservation value were recognised in 1998: grassy, sandy lake shores used for loafing by waterbirds, overwashed decaying seaweed on lagoon barriers, and stagnant saline silty shores with dense algal growth.

Introduction

Soil invertebrates represent a large proportion of the biodiversity of Ireland. Shore habitats can be important for a number of soil invertebrate communities. This is because the communities which occur there must be adapted to a variety of flooding regimes, sediment textures, winter storms, fluctuating temperatures, and, in the case of coastal lagoons, variations in soil salinity. In consequence, a wide variety of species occur in the various shore microenvironments, many being involved in the decomposition of accumulations of organic matter (reed litter, seaweed, algal mats and washed up organic debris), and others being predators of herbivorous insects and mites.

The beetle (Coleoptera) families Carabidae (ground-beetles), Staphylinidae (rove-beetles) and Pselaphidae are well represented in shore habitats, and together account for nearly 6% of the total land and freshwater fauna and flora in Ireland. They are used here as indicators of the ecological development of shore habitats of Irish lagoons and saline lakes.

The shore fauna (Staphylinidae and Carabidae) sampled from nineteen coastal lagoons or saline lakes on the south and west coasts of Ireland in 1996 were reported in Good and Butler (1998). The results of sampling a further sixteen Irish sites in 1998 are reported here. The Pselaphidae sampled from all sites are also included.

Methods

The sites are described in more detail elsewhere in this report. Lough Mór (Inis Oírr, Aran Is.) possessed a rocky shore with little habitat for shore Coleoptera, and no Staphylinidae or Carabidae were discovered in a search of c. 100 stones on the south-east shore of the lake. This site was not further investigated. Lough Cara Fionnla receives seawater via a long bayhead inlet, which widens into two lakes along its course from the salt marsh area near its mouth. This brackish inlet was also sampled, although not one of the areas selected as part of the set of sites surveyed for aquatic groups.

Details of sites and sampling are summarized in Tables 1 and 3. The sampled areas were generally those most influenced by seawater, because the emphasis of the survey was marine. These areas were mostly associated with the barrier and outer parts of the lagoon or lake shores; the inflow marshes were not sampled. Four sampling methods were used : (1) Suction sampling using a Stihl® BR 400 suction apparatus, mounted on the operator's back. This machine (referred to as an 'S-vac' to distinguish it from the 'D-vac' suction sampler) has a

suction pipe of 58 mm diameter (0.0026 m^2 surface area). Six subsamples within a defined vegetation type of 100 x 1.5 sec. 'sucks' per subsample were taken at each site, resulting in a total area of 1.56 m^2 covered. Because the hand-held pipe was shaken when the apex of the pipe was in the vegetation, a larger area (c. 2 m^2) was effectively sampled. (2) Six plastic cup pitfall traps with undiluted ethylene glycol (commercial anti-freeze) as preservative. (3) Ground search turning cobbles (n = 30 / sample). (4) Flotation of beetles in sand or soil in a bucket of water, in areas of potentially suitable *Bledius* habitat (16 samples of c. 100 cm^2 x 8 cm depth) (see Good in press). An equivalent sampling effort was used at each site, except where suitable microhabitats were not available for ground search or flotation.

Species were selected as indicators of well-developed habitat if : (1) they have a restricted habitat preference to the types of microhabitat associated with the lagoon shores; and, (2) they are reported in the literature as being local or rare, from which it is assumed that they are less likely to survive in historically degraded ecosystems. By 'well-developed habitat' it is meant that the ecosystem is sufficiently undisturbed by human activity to allow it to retain many local or rare stenotopic species. The presence of two or more indicator species, likely to breed in the shoreline habitats sampled, is considered an indication of habitat quality (see Good and Speight, 1991).

Nomenclature of Coleoptera follows Anderson *et al.* (1997). Plant nomenclature follows Webb *et al.* (1996). Voucher specimens of a number of species have been deposited in the National Museum of Ireland, and other species have been retained in the author's collection.

Salinity measurements were taken using a portable salinity refractometer, calibrated using distilled water. All measurements were taken in surface water (50 - 100 mm depth).

Results

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 (Table 2). Sites were divided into five types of lagoon or saline lake, based on the geomorphology of the barrier and the type of shore substrate (Table 3). 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. Results for each site are given under these categories below.

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1. SAND BARRIER LAGOONS/DRAINS

The classic site for this category of lagoons is Lady's Island Lake in Co. Wexford (Healy, 1997; see Good and Butler (1998) and Oliver and Healy (1998) for ecotonal shore and aquatic Coleoptera, respectively). Five sites in this category were surveyed in 1996 (Good and Butler 1998), but only one site (Ballyteige Channels) was surveyed in 1998, and this had been drained for agricultural land in the 19th century.

1.1. Ballyteige Channels (Co. Wexford)

This site consists of polder channels and a shallow drain system behind a sand dune, through which saline water percolates at high spring tides. It includes *Carex* flats which flood with brackish water, and pools with salt-marsh vegetation, and is hydrologically part of large area (c. 4 km^2) of reclaimed agricultural land drained by deep channels with accumulating water pumped over a sea wall.

Three areas were selected for sampling:

(1) A c.0.3 ha flat sandy area between a drain and main channel, with *Carex* spp. (incl. *C. extensa*), *Glaux maritima, Plantago maritima*, and sparse grasses. The salinity of the adjacent drain was 29‰ (23 vii 1998).

(2) The bank of drain with *Bolboschoenus maritimus*, draining to a main channel. The bank vegetation consisted of *Juncus maritimus, Juncus gerardii*, sparse *Bolboschoenus maritimus, Plantago maritma, Triglochin maritima, Agrostis stolonifera* and *Centuarium* sp. Drain-water salinity was 24‰ (22 vii 1998).

(3) The sandy margin of wide shallow flooded drain nearest to the sand dunes, with *Schoenoplectus lacustris* ssp.*tabernae-montani, Bolboschoenus maritimus* and *Ruppia* sp. in standing water. Drain-water salinity was 11‰ (22 viii 1998, after rain).

In total, eight species of carabid and twenty-one species of staphylinid were recorded, none of which are regarded as indicator species (Tables 4 and 5).

The *Pogonus* species could not be satisfactorily determined as either *chalceus* or *littoralis*. For the purposes of this report, it is assumed to be the commoner species (*chalceus*) which, although stenotopic and halobiont, has been relatively frequently recorded in Ireland and has not therefore been regarded as an indicator species.

An extra pitfall trap sample from a *Bolboschoenus maritimus* sward (S950053, drain water salinity 4‰ on 22 vii 1998), adding a further 17 species (Tables 4A and 5A), did not produce any indicator species.

2. SHINGLE BARRIER LAGOONS

Two shingle barrier lagoon sites were surveyed in 1998. Results from four previously surveyed sites were reported in Good and Butler (1998).

2.1. Lough Bofin (Inisbofin, Co. Galway)

This shingle barrier lagoon, facing north-north-west into the Atlantic ocean, has heavily grazed sheep pasture and eroded till and rock shores with shores of peat with *Juncus gerardii*, etc. on its south-west margin. There is also a reed-bed at the freshwater inlet. Restricted drainage to the sea is likely to result in frequent fluctuations in water level.

Two areas were selected for sampling:

(1) A narrow (c.2m) band of *Juncus gerardii* dominated vegetation with *Glaux maritima*, *Potentilla anserina*, *Plantago maritima*, sparse *Agrostis stolonifera*, and *Leontodon autumnalis*, on peaty soil near the shingle barrier. Standing water salinity offshore was 9-10 ‰.

(2) As above, but with denser cover with higher density of *Agrostis stolonifera*. (These two sampling subsites were close to each other because they were considered to represent the best examples of shore habitat, in comparison to other more eroded or disturbed (by flooding) areas.

In total, two species of carabid, nine species of staphylinid and one species of pselaphid were recorded, none of which are regarded as indicator species (Tables 6 and 7). The extent of ecotonal shore habitat was limited at this site, and flooding of the shore appears to occur regularly.

2.2 Kilmore Lake (Whiddy Is., Co. Cork)

This site has a wide central inflow channel, which allows seawater entry with most tides. The shores are narrow with rocky shores, eroded clay loam with cobbles and narrow clay loam banks with grasses and sedges, and narrow reedbeds.

Five areas were selected for sampling.

(1) A narrow (c.1-2m) till bank (probably clay loam) with *Arenaria maritima*, *Puccinellia* sp., *Carex extensa*, etc., covered at high spring tides.

(2) As above, but with *Juncus maritimus*, salt-marsh grasses and sedges; mink (*Mustela vison* Schr.) spraints were present in this area.

(3) An area of shore exposed at neap tide with cobbles on fine-textured sediment in a narrow relatively sparse stand of *Phragmites australis*.

(4) As above, but with a sandy substrate.

(5) An area of *Fucus*/*Phragmites*/leaf-litter storm debris on the inner shore, up to 25 cm thick in patches.

Three species of carabid and eleven species of staphylinid were recorded, one of which, *Aepus marinus*, is regarded as an indicator species (Tables 8 and 9). Ten of the 14 species are

characteristic marine littoral species, and many may have originated as colonists from the surrounding open coast (numbers of dispersing individuals were found floating on the water surface).

Aepus marinus is local halobiont species of a westerly distribution in Great Britain. Its range is limited from Norway to Brittany (Luff, 1998), and it is absent from Denmark, Germany and the Benelux coasts (Lucht, 1987; Hansen, 1996). It is probably local in Ireland (Luff, 1998); Johnson and Halbert (1902) described as locally common at the beginning of this century. *A. marinus* is a stenoptopic species of intertidal rocky seashores (Lindroth, 1974), occurring in coarse sand or gravel (Hyman and Parsons, 1992).

Myrmecopora sulcata was represented at Kilmore Lake by a single specimen. It keyed out as *M. lohmanderi* Bernh., using Scheerpeltz (1972). *M. lohmanderi* is restricted to the Baltic Sea and south-eastern North Sea. However, the external characteristics of these two species overlap, the genitalia are indistinguishable, and they are probably one species (Lohse, 1989).

3. PEAT SHORE SALINE LAKES

This was the most frequent type of site surveyed in 1998. Results from five previous sites were reported in Good and Butler (1998).

3.1. Lough an tSáile (Co. Galway)

This site consists of a series of three bayhead saline lakes with an outflow channel to Screeb Bridge and Aibhainn Scríbe, with rock, boulder, peat and till cliffed shores, in a blanket bog and heath landscape.

Four areas were selected for sampling:

(1) A small area of c. 0.5 ha ungrazed grass bank shore of the outflow channel above the bridge, with *Agrostis stolonifera, Juncus maritimus, Festuca rubra*, etc. and sheltered from the west by rock outcrops and heath.

(2) As above but less sheltered.

(3) An area of gently sloping granite rocky shore with thin peat and coarse sand in patches, covered by a *Fucus* and *Enteromorpha* mat. Offshore (0.5 m) salinity was 0 ‰ (7 vii, 17 ix 1998).

(4) An area of cobbles and boulders on sand/silt shore below c. 1m high peat cliff with boulders, heath and bog vegetation.

Eleven species of carabid, eighteen species of staphylinid and three species of pselaphid were recorded, one of which, *Stenus lustrator*, is regarded as an indicator species (Tables 10 and 11).

Prior to the first coastal lagoon survey (1996) there were three Irish records of *Stenus lustrator* (Anderson, 1984), which appears to be local in Europe (Horion, 1963). The species

is tyrphophilous (associated with peat), but also occurs on marshy shores and flood meadows, according to Koch (1989). The pre-1996 Irish records are from bogs (Anderson, 1984), and the species appears to be characteristic of lagoons and saline lakes with well-developed peat shore habitat, being recorded from eight sites in the 1996 and 1998 survey.

3.2. Lough Athola (Co. Galway)

This is a partially tidal lagoon with a rock barrier, rocky and peaty shores, with areas of *Juncus maritimus* and salt-meadows.

Five areas were selected for sampling:

(1) An area (c. 0.4 ha) dominated by *Juncus maritimus*, *Agrostis stolonifera*, *Festuca rubra*, *Leontodon autumnalis*, *Plantago maritima*, *Glaux maritima*, and with occasional plants of *Phragmites australis*, *Armeria maritima* and *Triglochin maritima*, grading down to salt-marsh with *Armeria maritima* and *Salicornia* sp. The area was not recently grazed, but probably spring or winter grazed by cattle.

(2) An area of saline meadow on peat which was drained to the lake by creeks and dominated by *Blysmus rufus* with *Triglochin maritima*, *Plantago maritima*, *Juncus gerardii*, and sparse *Agrostis stolonifera.*

(3) An area of saline meadow with c. 0.5 m high peat cliffs at the margin of a creek.

(4) As above, but near the rock barrier to the sea on salt-marsh; these cliffs had deeper sides (c. 1m).

(5) An area of shore with granite cobbles and large pebbles on coarse sand/peat, which is covered during spring tides. This area also had *Juncus* litter and fibrous algal mats in places.

In total, five species of carabid, ten species of staphylinid and two species of pselaphid and one species of heterocerid were recorded (also one species of heterocerid), one of which, *Stenus lustrator* (see 3.1 above) is regarded as an indicator species (Table 10 and 11).

3.3. Loch an Aibhnín (Co. Galway)

This is a large saline lake with a rocky channel to the sea, a small tidal response, and fluctuating but high surface water salinity (up to 31‰). The lake shore has eroded cliffed peat margins, boulders and outcropping rock, especially on the exposed eastern shore, but also has extensive areas of *Juncus maritimus* and *Agrostis stolonifera* on the more sheltered northern and western shores. Peat cuttings are evident in the surrounding bog, and the gradient between land and sea is steeper on the western than on the eastern shore. *Zostera* wrack was present on the northern shore after gales.

Three areas were selected for sampling:

(1) An area of moderately to heavily grazed *Juncus maritimus*, *Agrostis stolonifera* and *Festuca rubra* dominated sward on peat below the outflow from L. Tanaí. There are extensive (c. 0.5 ha) areas of this type of shore vegetation in the vicinity. The area is grazed by sheep and cattle.
(2) An area of ungrazed *Agrostis stolonifera, Festuca rubra* and *Juncus maritimus* dominated sward on a small peat bank isolated from the surrounding peat (and livestock) by narrow (c. 1m width) flooded cuttings.
(3) An area of *Zostera marina* wrack, with a lesser amount of *Fucus vesiculosus*, in the early stages of decomposition on a sheltered (from north and west) shore on granite rock and shallow peaty soil. The water salinity immediately (0.5 m) offshore was 31‰ (12 viii 1998).

In total, two species of carabid, nine species of staphylinid and one species of pselaphid were recorded, none of which are regarded as indicator species (Tables 12, 13 and 14).

3.4. Loch Cara Fionnla (Co. Galway)

This is a bayhead saline lake surrounded by heath on glacial deposits with rock outcrops and boulders. The lake inlet has a partial rock barrier. The lake shore is of exposed granite rock, boulders, cobbles and pebbles and peat cliffs. The inlet has a small area (c.0.2 ha) of ungrazed grass, and there are *Phragmites* and *Schoenoplectus* beds at the inflow to the lake.

Two areas were selected for sampling:
(1) The ungrazed grass bank of the outflow channel which is on peat, with *Agrostis stolonifera, Festuca rubra,* and *Juncus gerardii* grading into rough grassland with *Molinia caerulea*, etc. The area is flooded at high spring tides.
(2) The bank of a pool (with *Schoenoplectus lacustris* ssp.*tabernae-montani*) on wet peat with a relatively sparse cover (c. 70%) of *Plantago maritima, Carex* sp., *Anagalis tenella, Leontodon autumnalis, Hydrocotyle vulgaris, Cochlearia officinalis, Agrostis stolonifera* and *Eleocharis* sp., grading into *Schoenus nigricans* and *Molinia caerulea* dominated vegetation. The pool was fed by a peat flush (with *Drosera officinalis*, etc.).

Three species of carabid, fourteen species of staphylinid and two species of pselaphid were recorded, one of which, *Stenus lustrator* (see 3.1 above), is regarded as an indicator species (Tables 12 and 14).

3.5. Cara na gCaorach inlet (Co. Galway) (see map in Robinson 1990)

This is a bayhead inlet to Loch Cara Fionnla, with a causeway bridge at the tidal outlet, via a series of lakes to Cara Fionnla. Submerged rocks, exposed at low tide provide partial constrictions to water flow at Cara na gCaorach and at the townland boundary between Cinn Mhara and Leitir Mucú. Unlike the Loch an Aibhnín area to the west, this area is flatter with more ecotone between bog and saline lake. As a result there are extensive (several ha.) areas of

Juncus maritimus and *Agrostis stolonifera* dominated vegetation, grading into salt marsh at the seaward end.

Two areas were selected for sampling:

(1) Swards of *Agrostis stolonifera, Festuca rubra* and *Juncus maritimus*, and of *Agrostis stolonifera* and *Juncus gerardii* on peat, grading patchily into typical salt-marsh vegetation. The daily tidal range is c. 1 m. Offshore (0.5 m) salinity was 20‰ (26 ix 1998).

(2) An area of *Agrostis stolonifera, Festuca rubra* and *Juncus maritimus*, grazed by horses and sheep. There is less tidal range in this area than above, and there is no associated salt-marsh vegetation. The offshore salinity was 12‰ (26 ix 1998).

In total, one species of carabid, seven species of staphylinid and one species of pselaphid were recorded, one species of which, *Stenus lustrator* (see 3.1 above), is regarded as an indicator species (Tables 12 and 14). Pitfall traps were generally unproductive; one extra set of six traps (L962295) had no representative of these three groups at all.

3.6. Lough Fhada (Co. Galway)

This is a bayhead saline lake with a granite outcrop, boulder and till shores and scoured peat cliffs. The peat shores at either end of the lake have *Juncus maritimus* and peat shore pastures. The western end was heavily grazed.

Two areas were selected for sampling:

(1) A stand (c. 0.12 ha) of *Juncus maritimus* with *Triglochin maritima* and *Cochlearia officinalis*, grading into heath pasture with sparser *J. maritimus, Festuca rubra, Eriophorum* sp., *Agrostis stolonifera, Plantago maritima*, and occasional *Danthonia decumbens* and *Molinia caerulea*. Areas of higher peat supported *Erica* and *Calluna* heath. The salinity of pool water in this area was 3‰ (11 viii 1998).

(2) An area of *Juncus maritimus* grading into a grass-dominated sward on the southern sheltered bay of the lake, although with more irregular, and in places, more sloping topography. This area was similar in vegetation structure and composition to that sampled at L. Tanaí in 1996, but less sheltered from the west. The immediate hinterland consisted of heath rather than intact blanket bog and with most of the sward in standing water at the time of sampling and probably more susceptible to flooding than L. Tanaí because of the greater water level fluctuation that would be associated with L. an Aibhnín.

A total of two species of carabid, nine species of staphylinid and two species of pselaphid were recorded, one of which, *Stenus lustrator* (see 3.1 above) is regarded as an indicator species (Tables 12 and 14).

3.7. Kincas Lough (Co. Donegal)

This is a saline lake, with an artificial channel inlet/outlet, with rock/boulder shores and peaty shores with reed-beds, sedgebeds and marsh with *Sphagnum, Menyanthes*, etc. The lake is relatively sheltered.

Two areas were selected for sampling.

(1) An area of *Carices, Eriophorum* sp. and *Eleocharis* sp. on peaty cobble/boulder shore with *Phragmites australis* in standing water.

(2) An area of *Phragmites australis* and *Juncus maritimus* (sparse cover) in standing water grading into *Juncus gerardii, Triglochin maritima, Cochlearia officinalis, P. australis* and carices on peat, with *Pteridium aquilinum, Osmunda regalis, Calluna vulgaris*, and *Erica* sp. heath vegetation inland.

In total thirteen species of carabid, twenty species of staphylinid and one species of pselaphid were recorded, none of which are regarded as indicator species (Tables 15 and 16).

3.8. Maghery Lough (Co. Donegal)

This is a saline lake with a sluiced causeway barrier. The shores on the exposed side (especially the east shore) are of eroded rock. Those on the sheltered side have pasture and an extensive reed-bed on peaty soil.

Three areas were selected for sampling:

(1) A narrow (c 0.4 m) strip of shore vegetation with *Juncus gerardii*, grasses, *Glaux maritima, Juncus maritimus, Plantago maritima* and *Triglochin maritima*, on a peaty soil with boulders, and with a small (c. 0.25 m) cliff to the standing lake water. Salinity offshore was 4‰ (2 vii 1998).

(2) A dense tall reedbed (*Phragmites australis*) on peaty soil with probable otter (*Lutra lutra*) tunnel tracks with deep compacted shaded reed litter. Standing water was present only in the outer part of the reed-bed; the salinity of this water was 22‰ (2 vii 1998).

(3) An area of wet reed and rush litter debris on coarse sand, on the northern shore.

Nine species of carabid, twenty-seven species of staphylinid and one species of pselaphid were recorded, one of which, *Atheta aquatilis*, is regarded as an indicator species (Tables 15 and 16).

Atheta aquatilis was only recently recorded as Irish, from Lynn Lagoon, Larne Lough in Co. Antrim (Anderson *et al.*, 1997). It is local in Britain (Hyman and Parsons, 1994), and uncommon in Central Europe and Scandanavia (Palm, 1970; Benick and Lohse, 1974). It is a stenotopic species restricted to moss and litter in flooded shaded habitats, springs, flushes and wet woodland (Palm, 1970; Koch, 1989; Hyman and Parsons, 1994).

3.9. Moorlagh (Co. Donegal)

This is a saline lake with a causeway and artificial sluice barrier, with eroded rock and boulder shores, and shores of peat cliff. There is an area of ungrazed *Juncus maritimus* sward on the west shore. The water level appears to fluctuate frequently.

Two areas were selected for sampling:

(1) An area (c. 0.3 ha) of ungrazed *Juncus maritimus, Agrostis stolonifera, Festuca rubra, Triglochin maritima, Juncus gerardii, Plantago maritima*, etc., with a slightly raised bank of *Festuca*, other grasses, *Leontodon autumnalis* and *Trifolium repens* before a c. 1m peat cliff into standing water of the lake. This graded inland into wet grassland and heath. Offshore (0.5 m) salinity was 0 ‰ (4 viii 1997).

(2) A small, flat, duck loafing area c. 1m offshore with *Juncus maritimus, J. gerardii, Cochlearia officinalis, Glaux maritima, Plantago maritima, Agrostis stolonifera, Senecio palustris*, etc. Inland from this area was pasture, with *Eriophorum* sp., *Juncus effusus, Molinia caerulea*, etc. Duck and swan droppings were frequent. Offshore (0.5 m) salinity was 0 ‰ (4 viii 1997).

A total of eight species of carabid, eighteen species of staphylinid and three species of pselaphid were recorded, none of which are regarded as indicator species (Tables 15 and 16).

3.10. Sally's Lough (Co. Donegal)

This is a saline lake, with an artificial inlet/outlet channel, mostly with rock/boulder shores and an area of peat shore with reed-beds and pasture near the outlet channel. Much of the reed-bed was utilized by cattle and partially flooded at the time of sampling.

Two areas were selected for sampling:

(1) A narrow (several m) pasture margin on peat with *Juncus gerardii, Festuca rubra, Plantago maritima, Glaux maritima*, and *Triglochin maritima* grading to grassland inland and with *Armeria maritima* sward towards the open water.

(2) A moderately dense reed-bed on peat with *Phragmites australis, Juncus gerardii, Armeria maritima, Glaux maritima, Plantago maritima* and *Aster tripolium*, but with sparser plant cover (bare areas occurring) than at subsite 1. More frequent flooding occured at this second subsite.

A total of eight species of carabid, thirteen species of staphylinid and two species of pselaphid were recorded, none of which are regarded as indicator species (Tables 15 and 16).

4. KARST LAGOONS

Lough Murree is the most well known lagoon in the karst area of North Clare and South Galway. Results from Lough Murree and two other previously surveyed sites were reported in Good and Butler (1998). Two karst lagoon sites were surveyed in 1998.

4.1. Loch An Chara (Aran Is., Co. Galway)

This is a karst lagoon with a sand causeway /barrier at one end, but it is also fed and drained via grykes. It was drained in the past but has now extensively revegetated with *Bolboschoenus maritimus*. The shore ecotone was mostly relatively abrupt (at the time of sampling) from grassland to *B. maritimus* in standing water. The area floods to the roadway in winter, according to a local landowner.

Two areas were selected for sampling:

(1) A relatively sparse sward of *Agrostis stolonifera. Juncus gerardii, Glaux maritima, Triglochin maritima*, and sparse *Bolboschoenus maritima*, 2-8 m wide, between *B. maritima* in standing water offshore, and limestone grassland (*Trifolium pratense, Centaurea nigra, Juncus articulatus*, etc.) inshore. The area had been grazed, but not very recently. Offshore (0.5 m) salinity was 12 ‰ (16 ix 1998).

(2) An area similar to that above, but with a more dense sward with insignificant *B. maritimus*.

A total of five species of carabid and eleven species of staphylinid were recorded, none of which are regarded as indicator species (Tables 17 and 18).

4.2. Loch Port Chorrúch (Aran Is., Co. Galway)

This is a coastal brackish lagoon with a shingle barrier and subterranean or subaquatic karst channel connections to and from the sea. Overtopping of the barrier also occurs. There is little apparent tidal response, but the water level fluctuates seasonally. The lake shore has organic-rich silty and sandy margins, and pasture shores grazed by cattle. There are some *Bolboschoenus maritimus* stands and more extensive *Phragmites australis* beds.

Four areas were selected for sampling:

(1) A sward of *Agrostis stolonifera* and *Potentilla anserina* with sparse *Bolboschoenus maritima, Carex obtrubae, Elymus sp.* and *Phragmites australis*. This lies between the shingle barrier and *Phragmites* in standing water, and is sheltered to the south-east by a stone wall. Offshore (0.5 m) salinity was 2‰ (27 viii 1998).

(2) An area of *Bolboschoenus maritimus* with *Potentilla anserina* and *Agrostis stolonifera*, on c. 50 mm sand over organic sediment near the outflow stream from the shingle barrier.

(3) An area of shore with single cobbles on sand/silt, near *Bolboschoenus maritimus* stands in water.

(4) An area of the cobble / pebble shingle barrier with overwash seaweed debris and a small fraction of sand supporting 50 - 100% cover of Chenopodiaceae.

Four species of carabid and twenty-eight species of staphylinid were recorded, two of which are regarded as indicator species (Tables 17 and 18).

Brundinia meridionalis was recorded new to Ireland in the 1996 survey, from three coastal lagoons on the Co. Clare coast. Although it is not listed in Hyman and Parsons (1994) as rare

or notable in Great Britain, it appears to be rare or local in many parts of Europe (Porta 1926, Palm 1970, Benick & Lohse 1974, Mahler 1987, Koch 1989). *B. meridionalis* is a halophilous species, recorded from tidal refuse and silty soils on the coast and also on inland saline soils in Austria and other countries (Steel 1953, Koch 1989). Tidally undisturbed lagoons with stagnant water are favoured by this species - relatively large populations were recorded on organic-rich soils with dense algal growth at three lagoons in the 1996 survey.

Heterothops binotatus is known from the coasts of the northern Palaearctic; it is mostly halobiont in its occurrence, and local in the North and Baltic Seas (Horion, 1965). While it was not recorded from France by Coiffait (1974), it is not listed as notable in Great Britain by Hyman and Parsons (1994). It is recorded from a number of sites in Ireland (Johnson and Halbert, 1902; Owen, 1997). It is a stenotopic species (Koch, 1989), occuring in decomposing wrack and shoreline detritus with weed and grass growth (Fowler, 1888; Horion, 1965), and was found in this habitat at L. Phort Chorrúch.

5. ESTUARY IMPOUNDMENTS

Only one site (Inch Lough) was surveyed in this category in 1996 and 1998.

5.1. Inch Lough (Co. Donegal)

This is a large saline lake formed from a doubly impounded island arm of Lough Swilly estuary, with causeway sluice doors allowing seawater ingress, and with a pumped inflow from a large reclaimed area of agricultural land. The site supports large numbers of breeding and wintering waterfowl (the site is designated as an SPA). There is extensive freshwater marsh and wet pasture.

Two areas were selected for sampling:

(1) An area of lightly-grazed pasture shore (c. 7 m width; flooded at high water) used as a loafing area by swans and waterfowl (many swan droppings were present), with *Potentilla anserina, Plantago major, Glaux maritima, Juncus gerardii* and *Agrostis stolonifera.* Offshore (0.5 m) salinity was 8‰ (5 vii 1998).

(2) An area of shelly sandy beach with a sparse (c. 50%) cover of *Agrostis stolonifera, Poa* sp. and *Juncus bufonius* grading into dense *Agrostis stolonifera, Potentilla anserina, Plantago major, Senecio palustris*, etc. The sediment was organic-rich, and offshore (0.5 m) salinity was 4‰ (5 vii 1998). The amplitude of water fluctuations was high in spring and summer 1998.

A total of thirteen species of carabid and thirty-seven species of staphylinid were recorded, four of which are regarded as indicator species (Tables 19 and 20).

Bembidion bipunctatum is a halotolerant shore species, occurring inland and in coastal shingle and brackish water pools (Koch 1989, Hyman and Parsons 1992). It is widespread but local in Great Britain (Hyman and Parsons 1992), and recorded from Ireland (Speight *et al.* 1982). It

occurs from North Africa to west Siberia, and is common at least in northern Germany, although rarer further west (Freude 1976).

Bembidion aeneum is a stenotopic halobiont species, occurring in the salt spray zone above the upper shore and near brackish pools (Koch 1989). Although it is not listed as rare or notable in Great Britain (Hyman and Parsons 1992), and is listed as Irish without annotation by Speight *et al.* (1982), it is local in Britain and Ireland according to Lindroth (1974).

Pelophila borealis has been recorded from several sites in Ireland (Luff, 1998), but is only recently recorded in Britain from north-eastern Scotland, Orkney and Shetland (Hyman and Parsons, 1992). It is a northern Holarctic species and is not known as native in Central Europe (Freude 1976). Restricted to wet silty substrates on lentic water margins (Hyman and Parsons 1992). Lott and Bilton (1991) only record it from turloughs and Lough Gash.

There are few Irish records of *Philonthus furcifer*, a species not recorded from Great Britain (Lott and Foster 1990, Lott and Bilton 1991). It is rare in Europe, and is restricted to marshy shores (Horion 1965).

Discussion

Two (Inch Lough, Loch Port Chorrúch) of the sixteen sites sampled in 1998 had significant potential conservation value for their shore invertebrate fauna, based on the Carabidae, Staphylinidae and Pselaphidae recorded (Table 22). Of the 36 sites sampled in both 1996 and 1998, eleven sites had significant potential conservation value (three sand barrier lagoons, two shingle barrier lagoons, two karst lagoons, two peat shore saline lakes, one drumlin lagoon, and one estuary impoundment) (Table 22). Most indicator species were freshwater wetland or coastal wetland (i.e. halotolerant) species, rather than halobiont species (Table 22). The likely reasons for this are discussed in Good and Butler (1998).

There were seven recognisable microhabitats at the eleven sites with significant potential conservation value (see Table 23). 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 (Table 22). The 1998 survey also included proportionally more sites with high salinities, approaching fully marine conditions, but only three halobiont/halophilous indicator species (*Aepus marinus*, *Brundinia meridionalis*, *Heterothops binotatus*; Table 2) were recorded. While weather conditions were considerably wetter than in 1996, this did not affect relative trap catches at sandy sites (Inch, Ballyteige, etc.). Whether it affected samples on peat shores can only be tested by sampling the same area(s) in a different year. Nevertheless, it is to be expected that more than one indicator species would have occurred in the total combined sample from all 1998 peat shore sites.

In total, three local stenotopic species were recorded from peat shore *Juncus maritimus* swards in the six Camus Bay sites (Cara na gCaorach inlet, L. an Aibhnín, L. an tSáile, L. Cara Fionnla, L. Fhada, L. Tanaí). Of these, only *Stenus lustrator* was a recurring species at the 12 saline lake peat shores dominated by *J. maritimus*, surveyed in 1996 and 1998. (This species occurred in almost salt-marsh conditions in the Cara na gCaorach inlet, and was included as a halotolerant indicator species on this basis, although it was not considered so by Good and Butler (1998). Thus, the rating for L. Aconeera has increased since the 1996 survey.) *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). As mentioned above, 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* (and other bog species; see Table 10, Good and Butler 1998) 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 and Healy 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.

In terms of their ecotonal shore fauna, lagoons do not appear to exist as clearly defined habitats like deciduous woodlands or calcareous fens. But then neither do raised bogs, in the sense that they contain invertebrate communities characteristic of *Sphagnum* mosses rather than of raised bog. The conservation value of lagoons and saline lakes, for ecotonal soil biota, must therefore be seen in the context of coastal wetland habitat rather than coastal lagoonal habitat *per se*. Inch Lough provides a good illustration. It is a recently formed site, where no previous lagoon or saline lake occurred. Lough Swilly estuary doubtless provided the source populations of the indicator species recorded in 1998 (two of these species were recorded in the L. Foyle/L. Swilly area by Buckle (1900)). Inch Lough must therefore be viewed as a particularly good example of the type of coastal wetland/shore habitat occurring in Lough Swilly, rather than as an entity in itself. The exceptions are sites with a strong marine influence (e.g. Kilmore Lake) where the fauna forms part of a larger marine shore habitat outside of the lagoon.

Use of indicator species for conservation evaluation

Appoximately 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 21). 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 dependant 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 a reliable indicator of conservation value. Using British rarity classes is also open to question, because many wetland species (e.g. *Blethsia multipunctata*) 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*.

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TABLE 1. Details of sites and sampling of coastal lagoons and saline lakes in 1998. Generic abbreviations: *J.* - *Juncus; J. mar.* - *Juncus maritimus; J. ger.* - *Juncus gerardii; P. ans.* - *Potentilla anserina; B.* - *Bolboschoenus*. Each sampling area is identified by a grid reference.

Site	Grid ref.	Vegetation	Method	Sampling date
An Loch Mór, Inis Oírr	L990020	Stones with	Ground search	30 August 1998
(Co. Galway)		*Enteromorpha*		
Ballyteige Channels	S953048	*Carex, Glaux*	S-vac	22 August 1998
(Co. Wexford)			Pitfall traps	23 July - 22 August 1998
	S937064	*Juncus, Agrostis*	Pitfall traps	22 July - 22 August 1998
	S953049	*Schoenoplectus*	Ground search	22 August 1998
Inch Lough	C342226	*Juncus, Agrostis*	S-vac	19 September 1998
(Co. Donegal)			Pitfall traps	5 July - 6 August 1998
	C351229	*Agrostis*	Pitfall traps	5 July - 6 August 1998
Kilmore Lake (Whiddy Is.)	V956488	Salt marsh bank	Pitfall traps	24 August - 11 September 1998
(Co. Cork)			Sieve samples	24 August 1998
	V957481	Salt marsh grass	Pitfall traps	24 August - 11 September 1998
	V957489	*Phragmites* shore	Ground search	24 August 1998
	V959490	Storm wrack	Sieve samples	11 September 1998
Kincas Lough	B750197	Sedge shore	S-vac	4 August 1998
(Co. Donegal)			Pitfall traps	3 July - 5 August 1998
	B751196	*J. gerardii*	Pitfall traps	3 July - 5 August 1998
Loch an tSáile	L951383	*Agrostis/J. mar.*	S-vac	2 September 1998
(Co. Galway)			Pitfall traps	17 September - 17 October 1998
	L951383	*Agrostis/J. mar.*	Pitfall traps	17 September - 17 October 1998
	L951384	Shore wrack	Ground search	7 July 1998
	L962394	Cobble shore	Ground search	17 September 1998

Lough Athola	L628483	*Agrostis/J. mar.*	S-vac	3 September 1998
(Co. Galway)			Pitfall traps	3 - 25 September 1998
	L626482	*Blysmus*	Pitfall traps	3 - 25 September 1998
	L626483	Peat creek cliffs	Flotation	25 September 1998
	L623483	Peat pool cliffs	Flotation	25 September 1998
	L629482	Rock crevices	Ground search	25 September 1998
Loch an Aibhnín	L949308	*Agrostis/J. mar.*	S-vac	17 August 1998
(Co. Galway)			Pitfall traps	17 August - 16 September 1998
	L945321	*Agrostis/J. mar.*	Pitfall traps	12 August - 3 September 1998
	L944320	*Zostera* wrack	Sieve samples	12 August 1998
Lough Bofin (Inisbofin)	L523656	*J. gerardii*	S-vac	29 August 1998
(Co. Galway)			Pitfall traps	29 August - 19 September 1998
			Pitfall taps	29 August - 19 September 1998
Loch Cara Fionnla	L963292	*Agrostis/Festuca*	S-vac	18 August 1998
(Co. Galway)			Pitfall traps	18 August - 16 September 1998
	L963285	Peat pool shore	Pitfall traps	18 August - 16 September 1998
Cara na gCaorach inlet	L957317	*Agrostis/J. mar.*	S-vac	18 August 1998
(Co. Galway)			Pitfall traps	16 September - 7 October 1998
	L962313	*Agrostis/J. mar.*	Pitfall traps	26 September - 7 October 1998
Loch an Chara (Árainn)	L885100	*Agrostis/J. ger.*	S-vac	26 August 1998
(Co. Galway)			Pitfall traps	26 August - 16 September 1998
	L884099	*Agrostis/J. ger.*	Pitfall traps	26 August - 16 September 1998
Loch Fhada	L944310	*Agrostis/J. mar.*	S-vac	11 August 1998
(Co. Galway)			Pitfall traps	11 August - 3 September 1998
	L945311	*Agrostis/J. mar.*	Pitfall traps	11 August - 3 September 1998
Loch Port Chorrúch	L856111-857112	*Agrostis/P. ans.*	S-vac	27 August 1998
(Árrain, Co. Galway)			Pitfall traps	24 June - 27 August 1998
	L856110	*B. maritimus*	Pitfall traps	24 June - 27 August 1998

		Cobble/silt shore	Ground search	23 June 1998
	L855110	Overwash wrack	Sieve samples	27 August 1998
Sally's Lough	B714164	*J. gerardii*/grass	S-vac	4 August 1998
(Co. Donegal)			Pitfall traps	3 July - 4 August 1998
	B715165	*P australis/J ger*	Pitfall traps	3 July - 4 August 1998
Maghery Lough	B722095	*J.gerardii*/grass	S-vac	4 August 1998
(Co. Donegal)			Pitfall traps	2 July - 4 August 1998
	B721092	*Phragmites* bed	Pitfall traps	2 July - 4 August 1998
			Sieve samples	4 August 1998
	B723096	Flood debris	Sieve samples	2 July 1998
Moorlagh	B788186	*J mar.*/grass	S-vac	16 August 1998
(Co. Donegal)			Pitfall traps	4 July - 4 August 1998
		Festuca cliff	Flotation	3 August 1998
	B791186	Duck-loafing area	Pitfall traps	4 July - 4 August 1998

TABLE 2. Indicator species recorded from coastal lagoons and saline lakes in 1998. Soil salinity preference / tolerance derived from Horion (1963-67), Lindroth (1974), Koch (1989) and Hyman and Parsons (1994); see text also. 'Freshwater' refers to habitat in association with freshwater; 'halophilous' to species which have a preference for saline soils; 'halotolerant' to species which occur on both saline and non-saline soils.

Species	Total no.	Sites	Soil salinity preference / tolerance
STAPHYLINIDAE			
Atheta aquatilis (Thoms.)	3	Maghery L.	Freshwater
Brundinia meridionalis (Muls. Rey)	1	L. Phort Chorrúch	Halophilous
Heterothops binotatus (Grav.)	2	L. Phort Chorrúch	Halobiont
Philonthus furcifer Renk.	1	Inch Lough	Freshwater
Stenus lustrator Er.	44	L. Cara Fionnla, Cara na gCaorach inlet, L. Fhada, L. an tSaile, L. Athola.	Freshwater, halotolerant
CARABIDAE			
Aepus marinus (Ström)	2	Kilmore L.	Halobiont
Bembidion aeneum Germ.	27	Inch Lough	Freshwater, halophilous
Bembidion bipunctatum (L.)	2	Inch Lough	Freshwater, halotolerant
Pelophila borealis (Payk.)	2	Inch Lough	Freshwater

TABLE 3. Types of coastal lagoon and saline lake based on barrier and shore substrate characteristics. See Healy and Oliver (1998) for general classification and definitions of lagoons and saline lakes. Shore substrate refers to representative substrate sampled, and does not cover all substrates present at a site.

Site	Barrier	Shore substrate	Lagoon shore class
Ballyteige Channels	Sand (drained)	Sand	Sand barrier drains
Inch Lough	Causeway / sluice	Sand / loam	Estuary impoundments
Kilmore Lake	Shingle	Clay loam / cobbles	Cobble barrier lagoon
Kincas Lough	Narrow inlet	Peat	Peat shore saline lake
Loch an tSaile	Narrow inlet	Peat	Peat shore saline lake
Lough Athola	Narrow inlet	Peat	Peat shore saline lake
Loch an Aibhnín	Narrow inlet	Peat	Peat shore saline lake
Lough Bofin	Shingle	Peat	Cobble barrier lagoon
Loch Cara Fionnla	Narrow inlet	Peat	Peat shore saline lake
Cara na gCaorach inlet	Narrow inlet	Peat	Peat shore saline lake
Loch an Chara	Shingle / karst	Silt / sand	Karst lagoon
Lough Fhada	Narrow inlet	Peat	Peat shore saline lake
Loch Port Chorrúch	Shingle / karst	Silt / sand	Karst lagoon
Maghery Lough	Causeway / sluice	Peat	Peat shore saline lake
Moorlagh	Causeway / sluice	Peat	Peat shore saline lake
Sally's Lough	Narrow inlet	Peat	Peat shore saline lake

TABLE 4. Staphylinidae from a sand barrier polder channel/drain system at Ballyteige Channels (Co. Wexford). Indicator species are marked with an asterisk.

Anotylus rugosus (Fab.)	2
Astenus lyonessius (Joy)	1
Atheta amplicollis (Muls. Rey	2
Bledius limicola Tott.	18
Mycetoporus splendidus (Grav.)	3
Oxypoda umbrata (Gyll.)	1
Paederus fuscipes Curt.	3
Philonthus cognatus Steph.	2
Philonthus laminatus (Creutz.)	1
Quedius schatzmayri Grid.	1
Sepedophilus nigripennis (Steph.)	2
Stenus brunnipes Steph.	5
Stenus canaliculatus Gyll.	8
Stenus clavicornis (Scop.)	3
Stenus fulvicornis Steph.	3
Stenus juno (Payk.)	1
Stenus ossium Steph.	1
Tachyporus dispar (Payk.)	4
Tachyporus hypnorum (Fab.)	1
Tachyporus pusillus Grav.	1
Xantholinus longiventris Heer	1

TABLE 5. Carabidae from a sand barrier polder channel/drain system at Ballyteige Channels (Co. Wexford). Indicator species are marked with an asterisk.

Agonum marginatum (L.)	1
Dyschirius globosus (Herbst)	11
Dyschirius leudersi Wag.	1
Elaphrus cupreus Dufts.	1
Loricera pilicornis (Fab.)	2
Pogonus chalceus (Marsham)	1
Pterostichus melanarius (Ill.)	1
Pterostichus niger (Schal.)	17

TABLE 4A. Extra pitfall trap samples of Staphylinidae from a sand barrier polder drain with *Bolboschoenus maritimus* at Ballyteige Channels (Co. Wexford). Indicator species are marked with an asterisk.

Anotylus rugosus (Fab.)	2
Atheta amplicollis (Muls. Rey	145
Atheta fungi (Grav.)	2
Atheta graminicola (Grav.)	15
Atheta laticollis (Steph.)	1
Calodera aethiops (Grav.)	2
Carpelimus corticinus (Grav.)	3
Falagrioma thoracica (Steph.)	1
Geostiba circellaris (Grav.)	13
Mycetoporus splendidus (Grav.)	3
Oxypoda elongatula Aubé	3
Philhygra elongatula (Grav.)	5
Philhygra melanocera (Thoms.)	1
Philhygra volans (Scriba)	2
Philonthus cognatus Steph.	1
Philonthus laminatus (Creutz.)	2
Sepedophilus nigripennis (Steph.)	1
Staphylinus dimidiaticornis Gemm.	149
Stenus brunnipes Steph.	7
Stenus canaliculatus Gyll.	3
Stenus clavicornis (Scop.)	20
Stenus fulvicornis Steph.	5
Stenus juno (Payk.)	2
Stenus nanus Steph.	1
Tachinus signatus Grav.	33
Tachyporus dispar (Payk.)	2
Xantholinus longiventris Heer	3

TABLE 5A. Extra pitfall trap samples of Carabidae from a sand barrier polder drain with *Bolboschoenus maritimus* at Ballyteige Channels (Co. Wexford). Indicator species are marked with an asterisk.

Amara plebeja (Gyll.)	1
Bembidion mannerheimi Sahlb.	25
Carabus granulatus L.	26
Pterostichus melanarius (Ill.)	36
Pterostichus niger (Schal.)	64

TABLE 6. Staphylinidae and Pselaphidae from shingle barrier lagoon shores at Lough Bofin in Connemara (Co. Galway). Indicator species are marked with an asterisk.

Atheta amplicollis (Muls. Rey)	3
Cordalia obscura (Grav.)	1
Euaesthetus bipunctatus (Ljungh)	3
Reichenbachia juncorum (Leach)	5
Stenus boops Ljungh	1
Stenus brunnipes Steph.	2
Stenus canaliculatus Gyll.	8
Stenus cicindeloides (Schall.)	4
Stenus juno (Payk.)	23
Stenus tarsalis Ljungh	8

TABLE 7. Carabidae from from shingle barrier lagoon shores at Lough Bofin in Connemara (Co. Galway). Indicator species are marked with an asterisk.

Pterostichus niger (Schall.)	1
Pterostichus diligens (Sturm)	1

TABLE 8. Staphylinidae from a shingle barrier lagoon shore at Kilmore Lake (Whiddy Is., Co. Cork). Indicator species are marked with an asterisk.

Atheta vestita (Grav.)	8
Bledius limicola Tott.	23
Cafius fucicola Curtis	3
Cafius xantholoma (Grav.)	6
Dinaraea angustula (Gyll.)	1
Emplenota obscurella (Grav.)	2
Gabrius trossulus (Nordm.)	2
Halobrecta flavipes Thoms.	18
Myrmecopora sp.	3
Omalium laeviusculum Gyll.	12
Xantholinus glabratus (Grav.)	1

TABLE 9. Carabidae from a shingle barrier lagoon at Kilmore Lake (Whiddy Is., Co. Cork). Indicator species are marked with an asterisk.

Aepus marinus (Ström) *	2
Cillenus lateralis Samouelle	1
Trechus obtusus Er.	1

TABLE 10. Staphylinidae and Pselaphidae from saline lake peat shores in Connemara (Co. Galway): Loch an tSaile and Lough Athola. The same sampling techniques and effort were used at each site. Indicator species are marked with an asterisk.

	L. an tSaile	L. Athola
Aleochara brevipennis Grav.	1	-
Atheta fungi (Grav.)	1	-
Brachygluta fossulata (Reich.)	31	-
Brachygluta helferi (Schm.)	138	129
Cordalia obscura (Grav.)	1	-
Encephalus complicans Kirby	6	-
Lesteva sicula Er.	2	-
Ocypus olens (Müll.)	1	1
Olophrum fuscum (Grav.)	1	-
Oxypoda elongatula Aubé	1	-
Reichenbachia juncorum (Leach)	44	4
Rugilus erichsoni (Fauvel)	1	-
Sepedophilus nigripennis (Steph.)	12	8
Stenus bimaculatus Gyll.	5	-
Stenus brunnipes Steph.	1	3
Stenus clavicornis (Scop.)	4	1
Stenus fulvicornis Steph.	3	2
Stenus impressus Germ.	10	2
Stenus juno (Payk.)	9	-
Stenus lustrator Er. *	19	19
Stenus nitidiusculus Steph.	1	-
Bledius limicola Tott.	-	9
Drusilla canaliculata (Fab.)	-	4
Stenus fuscipes Grav.	-	1

TABLE 11. Carabidae and Heteroceridae from saline lake peat shores in Connemara (Co. Galway): Loch an tSaile and Lough Athola. The same sampling techniques and effort were used at each site. Indicator species are marked with an asterisk.

	L. an tSaile	L. Athola
Agonum albipes (Fab.)	1	-
Agonum fuliginosum (Panz.)	2	-
Bembidion assimile (Gyll.)	1	-
Bembidion mannerheimi Sahlb.	7	9
Carabus granulatus L.	1	-
Dromius linearis (Ol.)	3	1
Elaphrus cupreus Dufts.	1	-
Ocys harpaloides (Serv.)	1	-
Pterostichus strenuus (Panz.)	1	-
Pterostichus melanarius (Ill.)	6	-
Pterostichus niger (Schall.)	40	3
Carabus problematicus Herbst	-	1
Heterocerus fossor Kies.	-	7

TABLE 12. Staphylinidae and Pselaphidae from saline lake peat shores in the Camus Bay area of Connemara (Co. Galway): Loch an Aibhnín; L. Fhada; Cara na gCaorach inlet; L. Cara Fionnla. The same sampling techniques and effort were used at each site, with the exception of L. an Aibhnín where *Zostera* shore refuse was sieved. Indicator species are marked with an asterisk.

	Aibhnín	Fhada	Cara na gCaorach	Cara Fionnla
Atheta aquatica (Thoms.)	1	-	-	-
Brachygluta helferi (Schm.)	21	7	24	1
Drusilla canaliculata (Fab.)	3	-	-	2
Paederus fuscipes Curt.	9	-	8	-
Sepedophilus nigripennis (Steph.)	1	1	1	-
Stenus brunnipes Steph.	1	1	-	1
Stenus juno (Payk.)	3	1	-	-
Stenus ossium Steph.	1	-	-	-
Euaesthetus bipunctatus (Ljungh)	-	5	-	7
Reichenbachia juncorum (Leach)	-	3	-	43
Stenus clavicornis (Scop.)	-	2	-	-
Stenus fulvicornis Steph.	-	1	-	5
Stenus fuscipes Grav.	-	2	-	-
Stenus lustrator Er. *	-	2	2	2
Stenus nitidiusculus Steph.	-	1	-	1
Atheta vestita (Grav.)	-	-	2	-
Cordalia obscura (Grav.)	-	-	1	7
Tachyporus dispar (Payk.)	-	-	1	1
Xantholinus longiventris Heer	-	-	1	-
Atheta amplicollis (Muls. Rey)	-	-	-	1
Oxypoda elongatula Aubé	-	-	-	3
Quedius fulginosus (Grav.)	-	-	-	1
Quedius molochinus (Grav.)	-	-	-	1
Stenus tarsalis Ljungh	-	-	-	2
Tachyporus nitidulus (Fab.)	-	-	-	1

TABLE 13. Staphylinidae from *Zostera* debris on the seaward shore of Loch an Aibhnín, Connemara (Co. Galway).

Atheta vestita (Grav.)	25
Omalium laevisuculum Gyll.	27

TABLE 14. Carabidae from saline lake peat shores in the Camus Bay area of Connemara (Co. Galway): Loch an Aibhnín; L. Fhada; Cara na gCaorach inlet; L. Cara Fionnla. The same sampling techniques and effort were used at each site, with the exception of L. an Aibhnín where *Zostera* shore refuse was sieved. Indicator species are marked with an asterisk.

	Aibhnín	Fhada	Cara na gCaorach	Cara Fionnla
Bradycellus harpalinus (Serv.)	1	-	-	-
Dyschirius globosus (Herbst)	3	-	-	-
Bembidion mannerheimi Sahlb.	-	1	-	-
Pterostichus niger (Schall.)	-	1	-	5
Bembidion assimile Gyll.	-	-	1	-
Loricera pilicornis (Fab.)	-	-	-	1
Notiophilus palustris (Dufts.)	-	-	-	1

TABLE 15. Staphylinidae and Pselaphidae from saline lake peat shores at Maghery Lough, Sally's Lough, Kincas Lough and Moorlagh (Co. Donegal). The same sampling techniques and effort were used at each site, with the exception of Maghery where shore debris and *Phragmites* litter was sieved. Indicator species are marked with an asterisk.

	Maghery	Sally's	Kincas	Moorlagh
Aleochara lanuginosa Grav.	1	-	-	-
Anotylus rugosus (Fab.)	1	-	-	-
Atheta aquatilis (Thoms.) *	3	-	-	-
Atheta fungi (Grav.)	1	-	-	7
Atheta graminicola (Grav.)	1	-	-	-
Bryaxis bulbifer (Reich.)	1	-	-	-
Cordalia obscura (Grav.)	1	1	-	-
Gyrohypnus angustatus Steph.	1	-	-	-
Lathrobium boreale Hochhuth	1	-	1	-
Lathrobium terminatum Grav.	5	-	2	-
Lesteva sicula Er.	17	-	-	-
Myllaena brevicornis (Matth.)	3	-	-	-
Myllaena infuscata (Kr.)	1	-	-	-
Olophrum fuscum (Grav.)	1	-	-	3
Olophrum piceum (Gyll.)	1	-	-	-
Oxypoda elongatula Aubé	1	-	-	1
Philonthus varians (Payk.)	1	-	-	-
Quedius maurorufus (Grav.)	10	-	-	-
Quedius nitipennis (Steph.)	3	-	-	-
Rugilus erichsoni (Fauv.)	1	-	-	-
Staphylinus dimidiaticornis Gemm.	16	18	8	-
Stenus bimaculatus Gyll.	6	-	-	-
Stenus brunnipes Steph.	3	-	6	1
Stenus clavicornis (Scop.)	3	6	-	-
Stenus juno (Payk.)	1	-	2	3
Tachinus marginellus (Fab.)	1	-	-	-
Tachinus signatus Grav.	5	27	-	4
Xantholinus linearis (Ol.)	1	-	-	-
Aloconota gregaria (Er.)	-	1	-	-
Amischa analis (Grav.)	-	1	-	-
Atheta amplicollis (Muls. Rey)	-	3	-	13
Atheta celata (Er.)	-	1	-	-
Ocypus aeneocephalus (DeGeer)	-	2	-	-
Philonthus cognatus Steph.	-	2	-	-
Philonthus laminatus (Creutz.)	-	5	-	-
Pselaphus heisei Herbst	-	1	-	1
Quedius fuliginosus (Grav.)	-	2	1	-
Reichenbachia juncorum (Leach)	-	1	-	3
Xantholinus longiventris Heer	-	2	-	-

	Maghery	Sally's	Kincas	Moorlagh
Bryaxis bulbifer (Reich.)	-	-	2	23
Carpelimus corticinus (Grav.)	-	-	1	-
Dinaraea angustula (Gyll.)	-	-	1	-
Euaesthetus bipunctatus (Ljungh)	-	-	1	-
Gabrius coxalus (Hochh.)	-	-	1	-
Mycetoporus splendidus (Grav.) agg.	-	-	1	-
Lathrobium brunnipes (Fab.)	-	-	1	-
Ocypus olens (Müll.)	-	-	1	-
Othius punctulatus (Goeze)	-	-	1	-
Stenus canaliculatus Gyll.	-	-	7	-
Stenus fulvicornis Steph.	-	-	3	8
Stenus impressus Germ.	-	-	1	21
Stenus nitens Steph.	-	-	1	-
Stenus nitidiusculus Steph.	-	-	1	7
Tachyporus dispar (Payk.)	-	-	1	9
Gabrius trossulus (Nordm.)	-	-	-	1
Geostiba circellaris (Grav.)	-	-	-	2
Othius angustus Steph.	-	-	-	1
Quedius nemoralis Baudi	-	-	-	1
Stenus cicindeloides (Schall.)	-	-	-	1
Stenus pusillus Steph.	-	-	-	1
Tachyporus nitidulus (Fab.)	-	-	-	1

TABLE 16. Carabidae from saline lake peat shores at Maghery Lough, Sally's Lough, Kincas Lough and Moorlagh (Co. Donegal). The same sampling techniques and effort were used at each site, with the exception of Maghery where shore debris and *Phragmites* litter was sieved. Indicator species are marked with an asterisk.

	Maghery	Sally's	Kincas	Moorlagh
Agonum thoreyi Dej.	76	2	1	-
Bembidion mannerheimi Sahlb.	3	2	6	2
Elaphrus cupreus Dufts.	1	-	5	1
Leistus fulvibarbis Dejean	1	-	-	-
Leistus terminatus (Hellw.)	1	-	-	-
Loricera pilicornis (Fab.)	1	-	-	-
Pterostichus diligens (Sturm)	6	-	1	3
Pterostichus niger (Schal.)	1	-	-	-
Pterostichus nigrita (Payk.)	2	-	1	-
Agonum fuliginosum (Panz.)	-	5	2	-
Harpalus rufipes (DeGeer)	-	1	-	-
Notiophilus palustris (Dufts.)	-	1	1	-
Pterostichus crenatus (Dufts.)	-	5	3	-
Pterostichus strenuus (Panz.)	-	1	-	4
Pterostichus versicolor (Sturm)	-	1	-	-
Abax parallelepipedus (Pil. & Mit.)	-	-	1	-
Carabus granulatus L.	-	-	4	-
Dromius linearis (Ol.)	-	-	6	-
Pterostichus melanarius (Ill.)	-	-	1	-
Pterostichus minor (Gyll.)	-	-	1	-
Agonum albipes (Fab.)	-	-	-	6
Dromius melanocephalus Dej.	-	-	-	1
Nebria brevicollis (Fab.)	-	-	-	1
Ocys harpaloides (Serv.)	-	-	-	3

TABLE 17. Staphylinidae from karst lagoon shores at Loch an Chara and Loch Port Chorrúch (Aran Is., Co. Galway). The same sampling techniques and effort were used at each site, with the exception of L. Port Chorrúch where barrier overwash litter was sieved. Indicator species are marked with an asterisk.

	Loch Port Chorrúch	Loch an Chara
Amischa analis (Grav.)	1	-
Anotylus rugosus (Fab.)	4	-
Atheta amplicollis (Muls. Rey)	17	1
Atheta clientula (Er.)	6	-
Atheta fungi (Grav.)	1	-
Atheta graminicola (Grav.)	22	1
Atheta orbata (Er.)	1	-
Atheta vestita (Grav.)	1	-
Brundinia meridionalis (Muls. Rey) *	1	-
Carpelimus corticinus (Grav.)	1	3
Cordalia obscura (Grav.)	15	-
Gabrius nigritulus (Grav.)	23	-
Gyrohypnus fracticornis (Müll.)	5	-
Heterothops binotatus (Grav.) *	2	-
Mycetoporus splendidus (Grav.)	5	-
Quedius maurorufus (Grav.)	7	-
Rugilus orbiculatus (Payk.)	1	-
Sepedophilus nigripennis (Steph.)	2	1
Stenus brunnipes Steph.	1	3
Stenus canaliculatus Gyll.	25	131
Stenus clavicornis (Scop.)	14	4
Stenus fulvicornis Steph.	9	3
Stenus juno (Payk.)	8	1
Stenus ossium Steph.	12	-
Tachinus signatus Grav.	49	-
Tachyporus nitidulus (Fab.)	1	-
Xantholinus jarrigei Coiffait	3	-
Xantholinus longiventris Heer	5	-
Stenus cicindeloides (Schall.)	-	5
Stenus nanus Steph.	-	1

TABLE 18. Carabidae from karst lagoon shores at Loch an Chara and Loch hort Chorrúch (Aran Is., Co. Galway). The same sampling techniques and effort were used at each site, with the exception of L. Port Chorrúch where barrier overwash litter was sieved. Indicator species are marked with an asterisk.

	Loch Port Chorrúch	Loch an Chara
Bembidion assimile Gyll.	5	-
Bembidion mannerheimi Sahl.	3	-
Demetrias atricapillus (L.)	1	-
Pterostichus strenuus (Panz.)	2	-
Dyschirius globosus (Herbst)	-	1
Elaphrus cupreus Dufts.	-	1
Pterostichus niger (Schall.)	-	3
Pterostichus nigrita (Payk.)	-	1
Pterostichus crenatus (Duft.)	-	1

TABLE 19. Staphylinidae from an impounded estuarine inlet lagoon shore at Inch Lough (Lough Swilly, Co. Donegal). Indicator species are marked with an asterisk.

Aloconota gregaria (Er.)	3
Amischa analis (Grav.)	1
Anotylus rugosus (Fab.)	2
Atheta amplicollis (Muls. Rey)	5
Atheta graminicola (Grav.)	6
Atheta zosterae (Thoms.)	1
Encephalus complicans Kirby	1
Gabrius coxalus (Hochh.)	1
Lesteva sicula Er.	1
Omalium laeviusculum Gyll.	1
Oxypoda exoleta Er.	1
Philhygra elongatula (Grav.)	1
Philhygra melanocera (Thoms.)	1
Philonthus carbonarius (Grav.)	6
Philonthus cognatus Steph.	13
Philonthus concinnus (Grav.)	1
Philonthus furcifer Renk. *	1
Philonthus laminatus (Creutz.)	19
Sepedophilus nigripennis (Steph.)	1
Staphylinus dimidiaticornis Gemm.	1
Stenus boops Ljungh	1
Stenus brunnipes Steph.	7
Stenus canaliculatus Gyll.	7
Stenus cicindeloides (Schall.)	12
Stenus clavicornis (Scop.)	1
Stenus formicetorum Mannh.	3
Stenus fulvicornis Steph.	22
Stenus juno (Payk.)	4
Stenus melanopus (Marsh.)	4
Stenus nanus Steph.	4
Stenus picipes Steph.	16
Stenus similis (Herbst)	4
Tachinus laticollis Grav.	1
Tachinus signatus Grav.	15
Tachyporus dispar (Payk.)	1
Tachyporus obtusus (L.)	1
Tachyporus tersus Er.	3

TABLE 20. Carabidae from an impounded estuarine inlet lagoon shore at Inch Lough (Lough Swilly, Co. Donegal). Indicator species are marked with an asterisk.

Agonum dorsale (Pont.)	1
Agonum marginatum (L.)	13
Agonum muelleri (Herbst)	6
Amara plebeja (Gyll.)	1
Bembidion aeneum Germ. *	27
Bembidion bipunctatum (L.) *	2
Bembidion mannerheimi Sahlb.	1
Bembidion tetracolum Say	4
Carabus granulatus L.	4
Loricera pilicornis (Fab.)	3
Pelophila borealis (Payk.) *	2
Pterostichus diligens (Sturm)	1
Pterostichus nigrita (Payk.)	11

TABLE 21. Pselaphidae from sites surveyed in 1996. Indicator species are marked with an asterisk. Site abbreviations: Acon. - L. Aconeera; Cloon. - Cloonconeen; Dron. - Drongawn L.; Durn. - Durnesh L.; Farra. - Farranamanagh L.; Kilk. - Kilkeran L.; Lady's - Lady's Is. L.; Liss. - Lissagriffin L.; Tacum. - Tacumshin L.; Tanaí - L. Tanaí. Indicator species are marked with an asterisk.

	Acon.	Cloon.	Dron.	Durn.	Farra.	Kilk.	Lady's	Liss.	Tacum.	Tanaí
Brachygluta helferi (S.-Göbl)	27	1	3	9	-	-	-	-	-	1
Bryaxis bulbifer (Reich.)	-	-	-	-	2	-	-	-	-	1
Pselaphus heisei Herbst	-	-	-	5	-	-	-	-	-	1
Trissemus impressa (Panzer) *	-	-	-	11	-	-	-	-	-	-
Reichenbachia juncorum (Leach)	7	-	-	-	4	-	-	1	-	1
Rybaxis longicornis (Leach)	-	-	-	-	-	26	3	-	4	-

TABLE 22. Coastal lagoon sites rated for potential 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 potentially worth conserving as national examples of the habitat type for their soil fauna.

Site	Conservation value	No. indicator species	No. freshwater or coastal wetland species	No. halobiont species
Cloonconeen	Significant	2	1	1
Durnesh Lake	Significant	4	3	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 Donnell	Significant	2	2	0
Lough Gill	Significant	2	2	0
Lough Murree	Significant	2	1	1
Ballyteige 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		
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		

TABLE 23. Microhabitats represented at sites with significant potential conservation value (see Table 22). Microhabitat abbreviations: Marsh - Saturated soils with high organic matter content, and with dense vegetation cover; Loaf. - Shores used for loafing by swans and waterbirds with faecal enriched soils; Sandy - Partially vegetated sandy shores; Bog - *Juncus / Agrostis* swards near blanket bog with wet *Sphagnum*; Overw. - Interior of shingle barriers with deep decayed seaweed supporting Chenopodiaceae; Beach - Beach sandflats maintained by lagoon outflow; Silty - Stagnant saline silty shores with dense filamentous algal growth.

Site	Microhabitat						
	Marsh	Loaf.	Sandy	Bog	Overw.	Beach	Silty
Cloonconeen	+	-	-	-	-	-	+
Durnesh Lake	+	-	-	-	-	+	-
Inch Lough	-	+	-	-	-	-	-
Kilkeran Lake	+	-	+	-	-	-	-
Lady's Island Lake	-	+	+	-	-	-	-
Lough Aconeera	-	-	-	+	-	-	-
Loch Port Chorrúch	-	-	-	-	+	-	+
Loch Tanaí	-	-	-	+	-	-	-
Lough Donnell	+	-	+	-	-	-	-
Lough Gill	+	-	+	-	-	-	-
Lough Murree	+	-	-	-	-	-	+