

7th
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Abstracts



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abstracts

Paper-1

A hydrographic and mathematical model of Killybegs Harbour, Co. Donegal

Brendan O'Connor

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Killybegs Harbour was the focus of a detailed marine survey during the latter half of 1996 as part of an on going project to develop a water treatment system for the town and its industries. Hydrographic data were collected using tide poles, continuous and direct recording current meters, drogues, dye releases and probes. Samples were also collected for analyses of water and sediment quality. Some of these data were used to validate a two dimensional depth integrated mathematical model of the harbour. Results of the field work show the inner Harbour to have very low current speeds throughout the tidal cycle and over the spring and neap tides. This is reflected in low recordings from the current meters and the tracks of the drogues. The model predicts similar low velocities in the Harbour.

The paper will present results from the marine survey and some output from the model. The reasons for low current velocities in an area which is very close to such a high energy, oceanic system as Donegal Bay is discussed.

Paper-2

The shallow seafloor environment between Portstewart and the Giants Causeway

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¹ Environmental Studies, University of Ulster, Coleraine

² Geological Sciences, University of Maine, USA.

The north coast and inner shelf of Ireland is exposed to energy inputs from high energy Atlantic swell waves and tidal currents which accelerate as the tidal wave propagates through the North Channel. Shelf and coastal sediment is derived from reworking of relict glacial deposits and contemporary terrigenous sediment supply is minimal.

Recent investigations of the shallow seafloor between Portstewart and the Giants Causeway reveal the existence of several distinct sea floor facies defined on the basis of sediment texture and bedform morphology. These facies may be linked to the prevailing energy regimes.

An inner swell-dominated facies comprising planar sand without surface bedforms typifies the innermost shelf to depths of about 15 m. Seaward this is succeeded by a gravel lag exhibiting occasional current lineations. Further seaward, the shelf is typified by asymmetrical sand waves (amplitude 4-5m) which indicate net easterly sediment transport. The presence of gravel in the troughs of these sand waves suggests they form a thin mobile veneer.

A localised series of large sand ridges (12m amplitude) indicate net westerly sediment transport. These features are interpreted as composite structures formed in a bedload parting zone generated by tidal current eddies at coastal structural offsets.

Geomorphological and sedimentological investigations of the sea floor are a neglected element in coastal studies in Ireland. They provide the potential to elucidate the link between beach and nearshore sedimentation and the nature of shelf sediment dispersal.

Paper-3

Stable carbon isotopic apportionment of individual polycyclic aromatic hydrocarbons in sediments from marine and estuarine environments

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Much interest has recently focused on the quantitative apportionment of multiple sources of organic contaminants in natural aquatic systems. Polycyclic aromatic hydrocarbons (PAH) are of great interest in this regard because in addition to their suspected toxic and carcinogenic properties, they also have a wide range of potential natural and anthropogenic sources. Here we present the results of a study where the primary source inputs of PAH to sediments of a Harbour and Estuary are quantitatively assessed using a combination of molecular abundance and carbon isotope measurements of individual (4- and 5-ring) PAH. Mass balance calculations using a simple two-component mixing model show that approximately 50 to 80% of the PAH input to the Harbour sediments is of combustion origin, and likely dominated by vehicular emissions. Direct petrogenic contribution, possibly crankcase oil, accounts for the remaining 20 to 50 % of the total PAH input. PAH inputs to the Estuary seemed to be predominately of wood combustion origin but the presence of an unidentified isotopically depleted PAH source was also apparent.

Paper-4

A national survey of coastal lagoons

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¹ Department of Zoology, University College, Dublin

² Terrascope Environmental Consultancy, Riverstick, Co. Cork

³ Sherkin Island, Co, Cork

A variety of coastal saline lagoons and lakes occur around our coast but few have been studied. Here, as elsewhere in Europe, natural lagoons continue to disappear as a result of natural processes and drainage. Consequently, the EU Habitats Directive lists coastal lagoons as a high priority for conservation.

We were commissioned by the National Parks and Wildlife Service to compile an inventory of saline lagoons in the Republic and to give a scientific evaluation of those identified. 143 potential sites were identified from maps, 98 were visited, and 50 sampled. Among 55 which qualified as saline lagoons on the basis of their geomorphology or evidence of brackish conditions, 26 were identified as natural lagoons, 11 as other types of natural saline lake, and 18 were artificially created by the construction of roads or railways, or sea walls to prevent tidal flooding. Some unusual types may be unique to Ireland e.g. lagoons in karst limestone and those with peat barriers.

Twenty sites were selected for more intensive study of their vegetation, aquatic fauna, and marginal Coleoptera. Some interesting communities have been described and a number of rare plant and animal species identified.

Paper-5

The first reported isolation of a microalgal virus from Irish coastal waters and its preliminary characterisation

E. Mortimer & J.W. Patching

Martin Ryan Marine Science Institute, University College, Galway

Indigenous marine viruses are presently receiving considerable attention due to reports of their high abundance and hypotheses concerning their role in the marine food web. To date, viruses have been isolated for twelve species of marine microalgae covering seven genera. In this study, tangential flow technology was employed for the isolation of a novel virus from Galway Bay water which acts

as a specific pathogen of the unicellular green flagellate *Pyramimonas orientalis* (Prasinophyceae). Electron-micrographs of infected cells showed structural damage and the presence of viral particles. The virus was shown to possess a hexagonally shaped structure 60-80 nm in diameter and a dsDNA genome. Future work will involve sequencing the DNA polymerase gene of the virus with the ultimate aim of developing a specific nucleic acid based probe. This will provide a means of monitoring environmental levels of the virus and identifying the importance of its role in the life-cycle of *Pyramimonas orientalis*.

Paper-6

Influence of intertidal oyster trestles on the abundance of meiofauna

Hanne Skjaeggstad & Pat Boaden

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Shellfish are suspension feeders and their culture, unlike that of fish, does not require a food input in excess of the natural plankton supply. However, shellfish culture still has the potential to affect the local environment considerably, for example through alteration of the sedimentation regime, addition of faecal material and the cropping of food resources.

An experiment was set up to identify effects of intertidal oyster (*Crassostrea gigas*) culture on the immediate benthic environment by comparison of common sediment parameters and meiofaunal abundance at control and experimental sites. The sites were studied seasonally for a year and relationships between meiofaunal abundance and physico-chemical and biological factors.

Oyster trestles were found to increase the redox potential while reducing the pH and the chlorophyll *a* and organic carbon content. Trestles also caused a decrease in mean grain size and silt content, resulting in less well sorted sediment than at the control site and an excessively peaked (leptokurtic) distribution. Meiofaunal numbers were also lower under trestles than at control sites.

Using a stepwise method of linear regression it was shown that changes in meiofaunal abundance were best explained by changes in sediment redox potential, temperature and silt content.

Paper-7

Observations on the biology of the parasites of smelt *Osmerus eperlanus* (L.) in the Shannon system

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The smelt *Osmerus eperlanus* is an indigenous anadromous fish in Ireland, Concerns here have been expressed about the current status of the species, which has declined in many other European countries and little is known of its biology in this country, A spawning population of smelt was sampled by electrofishing in the lower Shannon in March, 1994. Details of the age structure, growth rates of the population will be presented. The metazoan parasites of the Shannon smelt were investigated. A relatively rich species assemblage, comprising 10 species was recorded. An analysis of the variation in smelt parasite infracommunities will be presented and infection parameters will be related to the smelt diets and migratory habits.

Paper-8

The diatom genus *Pseudo-nitzschia* and its distribution in southern and southwestern coastal waters of Ireland

C. Cusack, R.C.T. Raine & J.W. Patching

Martin Ryan Marine Science Institute, University College, Galway

Interest in the planktonic diatom genus *Pseudo-nitzschia* (Peragallo) has grown over the past ten years, following the identification of certain species as the causative agents of potentially fatal amnesic shellfish poisoning (ASP) in humans. So far, studies on the distribution of *Pseudo-nitzschia* in Irish waters have been hindered by difficulties in identification. The light microscope does not reveal morphological structures required to identify *Pseudo-nitzschia* to species level.

This paper reports on a taxonomic survey of *Pseudo-nitzschia* which was carried out in coastal and shelf waters to the South and Southwest of Ireland. Both light and electron microscopy were employed. At least five *Pseudo-nitzschia* species have been identified, *P. pungens*, *P. fraudulenta*, *P. seriata*, *P. delicatissima* and *P. pseudodelicatissima*. Species identification was confirmed using transmission electron microscopy of cleaned valves. Three of these species have been reported to produce domoic acid (an ASP toxin) in cultures.

The presence of these potentially toxic species in Irish waters signals a need for more detailed phytoplankton monitoring in the vicinity of intensive shellfish farming than is usually performed.

Paper-9

Assessing size and shape of pacific oysters using image analysis techniques

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In recent years increased production of pacific oysters (*Crassostrea gigas*) has led to competition between growers reducing market prices. Oyster farmers must become more aware of the quality of their product, in terms of growth, meat content and shell shape, if they are to remain competitive. Measurement of oysters in the field is a slow and laborious process using callipers or measuring grids. Sample size and number of parameters measured are often determined more by the time available between tides than statistical requirements.

C-Mar in collaboration with the Marine Institute, Wexford Organisation for Rural Development and Bannow Bay and Barlough Oyster Growers have developed a method of quickly measuring and assessing the shape of large quantities of oysters, using computer based image analysis techniques. Oysters are videoed in the field, and the images analysed later in the laboratory. In excess of 100 measurements per minute may be taken using this technique, providing information on both shell size and shape for each stage of cultivation. This allows the farmer to develop husbandry techniques that improve quality and ensure the best price for the product.

Paper-10

Shannon estuary: heavy metal free?

Caitríona O'Leary

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Although data on heavy metals have been published for a number of Irish east coast sites, only once off studies existed for the Shannon estuary prior to the present study. The metal levels studied were Al, Fe, Zn, Mn, Cr, Co, Cu and Ni. Comparison of heavy metals values in *Fucus vesiculosus* and sediment samples with the corresponding metal levels in *Mytilus edulis* show that an increase in metal levels in the sediments did not lead to a similar increase in *M. edulis* except on a few occasions. The levels of Fe and Al in *M. edulis* were higher than those of the other metals studied and there were occasional flushes of Cr through the estuary. Considerable variation existed between the levels of the different metals bioaccumulated by the organs of *M. edulis*. The best all-round indicators of the

metals studied, based on consistency of results when compared between sites and seasons were *M. edulis*, *Cerastoderma edule*, and *Nucella lapillus*. Species specific metal accumulation was observed in a number of cases, e.g. levels of Zn in *N. lapillus* were significantly different to all other species and *C. edule* was a specific accumulator of Ni. The overall trend in metal levels was one of stability with the occasional high level. The Shannon estuary is not suffering from any concerning degree of heavy metal pollution with respect to the above mentioned metals. This paper provides data on heavy metals from the Shannon estuary, its status on a national and international basis and future recommendations.

Paper-11

Bacteriological studies on mid-Atlantic ridge hydrothermal plumes

D. O'Brien, D.Eardly, M. Carton & J.W. Patching

Martin Ryan Marine Science Institute, University College, Galway

Some results of studies on microbial biomass, activity and community structure within the neutrally buoyant plumes of deep ocean hydrothermal vents are reported. As most members of natural microbial communities are unculturable, molecular methods were used to assess microbial community structure. Using the polymerase chain reaction, phylogenetically informative 16S ribosomal RNA genes from both the Archaeal and the Bacterial domains were isolated from environmental samples obtained by *in situ* filtration both within and outside plumes. Representative clone libraries were then created from these amplification products. Initial probing and sequencing analysis of portions of these libraries have been completed. All archaeal clones obtained gave positive signals on probing with either a crenarchaeotal (thermophiles, halophiles) specific probe or a euryarchaeotal (methanogens) specific probe. Activity measurements were carried out on water samples incubated under both surface and *in situ* pressures to determine the degree of adaptation of populations to the plume environment. We have also used scanning electron microscopy coupled with X-ray microanalysis to examine the composition of particulates recovered from plumes and the nature of bacteria/particle associations within the plumes. Particles rich in iron, manganese, copper and zinc were observed.

Paper-12

Harmful species introduced by shipping

Dan Minchin

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Harmful species can be transferred either on ships hulls or within the ballast water and sediments used to stabilise ships while at sea. Following the usage of tri-butyl-tin (TBT) antifouling paints, in the early 1970's, the amount of fouling has been considerably reduced. The area of most concern, however, is the movement of ballast water in ships. Ballast tanks on ships are very large and can enable a wide range of taxa to be easily transported from distant loading areas to areas beyond their natural range. There are many species being transferred and inoculated into new regions daily throughout the world with consequences for ecosystems, fisheries, aquaculture and human health. There is particular concern over the movements of dinoflagellates, whose cysts are durable and are known to occur in ballast sediments. Populations of some species have appeared, over the last twenty years, in areas where historically they were unknown.

There is agreement on the need to eliminate or reduce further unwanted species movements. This must be regulated by the shipping industry in consultation with marine scientists. The International Maritime Organisation (IMO) issued a set of guidelines for the reballasting of the ballast tanks over deep water in the ocean as well as precautionary measures to reduce risks at the time of ballasting. Disinfection of water in ballast tanks is a difficult matter to achieve because of the large volumes involved, but ultimately the risk of exotic movements will remain until such a time when all organisms in ballast waters and sediments can be practically destroyed.

Ireland is likely to acquire a number of exotic species that have become established elsewhere in Northern Europe. Studies of shipping patterns for the main port areas may greatly aid in reducing the risk of exotic introductions by learning of the highest risk routes and developing plans to reduce the viability of harmful exotic species.

Paper-13

The quality status of the Celtic Seas: a new assessment of Ireland's marine ecosystems

R G V Boelens

Marine Institute, c/o Forbairt Laboratory, Shannon Town Centre, Co Clare

The first in-depth review of knowledge of the seas around Ireland will be completed in 1998. It will focus on changes and trends over the past 20 years, both natural and Man-made. Work is well underway in reviewing scientific reports and publications on all facets of the physics, chemistry and biology of coastal and shelf-sea areas westwards of the UK mainland to the Atlantic 200m depth contour (Celtic Seas). The stimulus for this major undertaking is a decision within the OSPAR Convention (Northeast Atlantic) that the condition of the seas from the Arctic to the Azores will be assessed between now and the year 2000. Accordingly, the Marine Institute has set up a dedicated QSR (Quality Status Report) office in Shannon to work with its UK counterpart in preparing a report on that part of the region known as the Celtic Seas. The paper outlines the scope and content of the report, the main issues to be addressed and highlights key scientific considerations in assessing marine environmental quality. It encourages Irish scientists to contribute data and research findings relevant to the QSR.

Paper-14

Phylogenetic analysis of a microbial mat at a hydrothermal vent system on the mid-Atlantic ridge

M.W. Carton, D. O'Brien, D. Eardly & J. W. Patching

Martin Ryan Marine Science Institute, University College, Galway

Total genomic DNA was extracted from a microbial mat sampled near a deep sea hydrothermal vent located at the Azores Triple Junction of the mid-Atlantic Ridge. The mat consisted of filamentous tufts visible to the naked eye and was attached to rocks and the surface of mussels (*Bathymodiolus*) in the vicinity of warm seeps. Water emitted by these seeps was known to contain significant quantities of methane and reduced sulphur compounds. Two universal PCR primers were used to amplify an approximately 900 bp portion of the 16SrRNA gene from the genomic DNA. The resultant PCR products were cloned into the plasmid vector pBGS8 and sequenced. Although universal PCR primers were used, the clones were identified as Eubacterial in origin, and were closely related (though not identical) to the Beggiatoacea, a group capable of autotrophic metabolism when supplied with reduced sulphur compounds.

Paper-15

The potential of Strangford Lough for commercial scallop (*Pecten maximus*) cultivation: scallop spat collection techniques and settlement patterns

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Strangford Lough is a large marine Lough located on the east coast of Co Down. Research has been in progress here since May 1995 to assess the potential of the Lough to support scallop (*Pecten maximus*) cultivation. Ongrowing trials with scallops of different age-groups have been conducted over a two year period to compare growth at several sites around the Lough. Cultivation equipment and techniques are also being tested in an attempt to ascertain the most suitable ongrowing strategy for Strangford Lough. Spat collectors deployed in Strangford Lough during the summer and autumn of 1995 and 1996 received a very small settlement of king scallops (*Pecten maximus*) and a relatively larger settlement of queen scallops (*Aequipecten opercularis*). A trial on spat collector design in Mulroy Bay, Co Donegal, compared the efficiency of spat collector bags composed of various combinations of readily available materials. Spatfall of both king and queen scallops was greatest on traditional onion bags containing white "Netlon" filling.

Paper-16

Implications for air quality in landfill sites arising from volatile organic compounds associated with leachate collection

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The levels of volatile organic compounds (VOC) emitted from landfill sites has elicited concern recently due to the toxicological implications for workers and neighbouring residents. Part of the requirements of a modern landfill management programme is the collection of leachate to prevent the pollution of surface and ground waters. Prior to the release of landfill leachate to the aquatic environment, biological treatment is used to reduce the organic loading of this discharge. In this paper, which is the first study of VOC in landfills in Ireland, evidence is presented for the deterioration of ambient air quality associated with leachate collection in a co-disposal landfill facility which received both municipal and industrial non-hazardous waste. A comparative study that targeted two cells of a landfill, with and without leachate collection, revealed persistent elevated levels of hazardous compounds in the ambient air at the cell with a leachate pool. VOC levels were 5-13 times higher than the expected values for a typical rural location and included 1,1,1-trichloroethane ($< 27.7 \mu\text{g}/\text{m}^3$), tetrachloroethene ($< 100 \mu\text{g}/\text{m}^3$) and toluene ($< 308 \mu\text{g}/\text{m}^3$). However, benzene constituted a potential health hazard with 75% of these samples containing levels in excess of guideline limits and with a maximum recorded level of $166 \mu\text{g}/\text{m}^3$.

Paper-17

The effect of nitrate on biological nutrient removal systems

Donal Mulkerrins, Clodagh Jordan & Emer Colleran

Environmental Research Unit, Dept. of Microbiology, University College Galway

Eutrophication of lakes and slow flowing rivers is becoming a very serious problem, resulting in over-abundant growth of algae and macrophytes. Both phosphate and nitrogen are limiting factors for biological growth in natural waters. E.U. legislation requires a more strict control of the levels of nitrogen and phosphate being released into natural waters. Although Biological Nutrient Removal systems are a well established technology on mainland Europe, this is not the case in Ireland.

To obtain biological phosphate removal using activated sludge, the sludge must be recirculated through anaerobic and aerobic phases. Phosphate accumulating bacteria utilise their polyphosphate store, as an energy reserve which enables uptake and storage of substrates anaerobically. The stored substrate is metabolised under aerobic conditions which release energy for "luxury" uptake of phosphate. Nitrogen removal may also occur in such systems, if an anoxic zone is incorporated between the anaerobic and aerobic phases.

The presence of nitrate in the anaerobic zone prevents phosphate release which is a necessary prerequisite for phosphate uptake in the subsequent aerobic zone. This leads to a deterioration of the phosphate removal efficiency. The adverse effects of nitrate on biological phosphate removal is well documented in the literature. However, methods to overcome this inhibitory effect of nitrate are not well documented. This study found that a considerable improvement in the phosphate removal efficiency occurs if the phosphate load to the system is increased temporarily prior to returning to the original influent phosphate values.

Paper-18

A critical assessment of solid waste management in a large university, within the framework of Irish and international waste management

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Waste generated in Trinity College Dublin is similar to that which would be produced in a small town with an associated industrial estate: distinct areas of the College generate domestic, commercial and industrial type wastes.

Using a variety of methods, including waste characterisation, questionnaires, waste auditing, and examining existing waste disposal records, it was possible to calculate the quantity and character of municipal solid waste from the college in the course of a year. Waste production for the College is equivalent to 68 kilogrammes per student.

Appropriate waste management techniques for this waste were proposed. Under this scheme, 29% of the waste stream will be diverted from landfill, the current rate is 2%.

Proposals from the study addressed:

- internal policies on waste management in TCD,
- policy with regard to educational and similar institutional wastes at a national level, and
- international consideration of waste from educational sources.

Those proposals addressed to Trinity College included:

- amendments to the waste collection and disposal systems with a cost saving of over £37,000 per annum,
- a framework within which a waste management plan for the College could be drafted, and
- a recommendation to guide purchasing policy in the College.

Paper-19

Trials on advanced sewage sludge treatment

John Bartlett

Fehily Timoney Weston, Centre Park House, Centre Park Road, Cork

A series of trials were carried out at Killarney WTP on the suitability of certain technologies for the treatment of extended aeration sewage sludges (EAS). The objective was to produce sludge which met the criteria of the Use of Sewage Sludge in Agriculture Directive and which produced sludge suitable for recycle in agriculture.

The technologies examined were Thermophilic Aerobic Digestion (TAD), and Alkaline Stabilisation. Raw and product sludges were analysed for a comprehensive range of chemical, physical and biological parameters.

TAD was found to successfully treat EAS, significantly reducing total solids, volatile solids, volume and effectively pasteurising the sludge. It was found to be an economic system for EAS.

Alkaline stabilisation also successfully treated the sludge within the meaning of the Directive, but was significantly less economic for EAS (it is an economic system for primary sludge).

Paper-20

Anaerobic treatment of phenol and related organics

Thérèse Mahony & Emer Colleran

Environmental Research Unit, Dept. of Microbiology, University College, Galway

Anaerobic treatment is increasingly being applied to wastewaters emanating from the chemical industry. The successful treatment of chemical-containing wastewaters may be influenced by the ability of anaerobic bacteria to degrade a series of related chemicals which may appear in the influent wastewater periodically. Laboratory-scale, upflow anaerobic hybrid reactors were used to assess the substrate range of anaerobic methanogenic consortia. A control reactor was seeded with anaerobic biomass which had not been exposed to aromatic substrates. A test reactor was seeded with biomass which had previously been exposed to a phenol-containing influent. The reactors were operated over a 400 day period, with the test reactor being exposed to sequential introduction of sodium benzoate, p-cresol, salicylate and p-hydroxybenzoic acid. The data obtained suggested that a seed sludge with a competence for phenol degradation did not possess an endogenous capacity for degradation of related aromatic chemicals. After varying lag-phases, competent degradative populations for the test related aromatics was shown to develop in the test reactor. Data will be presented on threshold levels of recalcitrant chemical concentration, toxicity and maximum acceptable loading rates.

Paper-21

Constructed wetlands for waste water treatment: the case of Ballymaloe House, Midleton, Co Cork

Feidhlim Harty

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My paper is on the topic of constructed wetlands for wastewater treatment and one such system at Ballymaloe House, Shannagary, Midleton, Co. Cork. The wetland was built in 1993 for this purpose. The growth of the guest house meant that the existing septic tank was no longer able to cope with the waste load fed into it.

Constructed wetlands are man-made wetlands which are specially designed for the treatment of wastewater. A careful selection of plants and specially designed substrate provide the right biological environment for cleansing and reoxygenating the water. These wetlands are modelled on natural wetlands but are designed to achieve optimum treatment efficiencies.

The paper will discuss Constructed Wetlands for wastewater treatment, their use in Ireland and specifically their use at Ballymaloe house.

Paper-22

Phytoremediation potential of plant species from the Silvermines area, Co. Tipperary

Maria Steinborn & John Breen

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Phytoremediation uses plants which are native or have adapted to metalliferous soils and that can bioaccumulate high metal concentrations into their dry matter. It has been proposed that such plants can be grown under intensive conditions and harvested, thus creating a possible method of soil metal decontamination.

In February 1995, (following preliminary site observations), five abundant plant species were chosen for lead, copper and zinc analyses from an abandoned lead mine in the Silvermines area. Corresponding soil samples were also taken and analysed for lead, copper and zinc concentrations. Of the five plant species chosen for analysis - *Rhynchospora alba*, *Teucrium scorodonia*, *Hylocomium splendens*, *Primula vulgaris* and *Succisa pratensis*, only *Rhynchospora alba* and *Hylocomium splendens* were found to have phytoremediation potential with respect to lead, while *Teucrium scorodonia* appeared to have phytoremediation potential with respect to zinc.

Paper-23

Efficient biological nutrient removal from wastewater streams in the Irish food industry

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One of the key environmental problems for the Irish food industry is the treatment of large volume wastewater streams, containing nitrogen and phosphorus compounds, which are the primary causes of river eutrophication. The current use of chemicals for phosphate removal by chemical precipitation could be reduced by the successful incorporation of biological nutrient removal (bnr), including enhanced biological phosphate removal (ebpr). Ebpr exploits the biochemical properties of *Acinetobacter* and related strains to accumulate high amounts of phosphate when cultured under altering anaerobic and aerobic conditions. The objective of the present study is to develop an efficient bnr- system, which can be incorporated into existing treatment plants. A semi continuous system with sequencing batch reactors (sbr) has been chosen for the lab scale set up. Activated sludge, obtained from a typical food industry treatment plant without ebpr initially showed the presence of micro-organisms, performing anaerobic orthophosphate release and aerobic "luxury uptake". Characteristic concentration profiles associated with ebpr were not observed when the activated sludge was exposed to a typical food industry waste water fortified with short chain fatty acids (scfa) in the semi continuous system and further batch tests did not indicate the presence of ebpr micro-organisms. A pure-culture batch test with *Acinetobacter lwoffii*, a typical bacterium found in existing ebpr systems, produced characteristic ebpr concentration changes. Inoculates of the strain led to release of phosphate in the anaerobic regime in a semi continuous system, but the following uptake in the aerobic regime did not result in excessive phosphate removal. Introduction of a synthetic wastewater and an anoxic regime in the lab scale process induced ebpr capability with "luxury" phosphate uptake, after a period of acclimatization, without inoculum.

This work was part funded by the Department of Agriculture Food and Forestry Dublin, under the Food Industry Sub Programme of the EU Structural Funds 1994-9.

Paper-24

Water purification using treated peat

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The feasibility of utilising peat as a filter medium for the purification of wastewater and the removal of iron from groundwater was examined.

Peat was pretreated by bitumen extraction with various solvents and by steam treatment. These peats were then compared with untreated peat. An optimum particle size of 1-2mm was established experimentally for filtration purposes. Untreated peat was found to be an excellent filter medium for general water purification, reducing B.O.D. by 95%, C.O.D. by 80%, and coliform content by >99%. Debituminising the peat was found to double the peat's capacity to adsorb low concentrations of ferrous iron from solution. This was attributed to increased porosity, as seen in S.E.M.'s which resulted in greater availability of active sites, greater hydrophilicity due to the removal of waxes and other hydrophobic groups, and an increased amount of carboxylic functional groups. Debituminised peat was also found to be physically harder which is advantageous in its use as a filter medium as it will not compress as easily as untreated peat. Steam treating the peat at 121°C at 15 lbs/sq. inch pressure for one hour reduced its capacity to adsorb ferrous iron due to hydrolysis of functional groups.

Functional group analysis of organic matter derived from peat revealed that the COOH/OH ratio of the peat is very important for iron adsorption, and that the greater this ratio the greater the amount of iron that can be adsorbed per gram of peat.

Increasing the pH of the ferrous solution was found to increase the amount of ferrous iron adsorbed by the peat. Intraparticle diffusion of the ferrous solution was found to become rate

controlling after one hour contact time with untreated peat, and after three hours contact time with debituminised peat.

Regeneration of the peat filters following iron adsorption was accomplished using mineral acids and salts. Subsequent iron adsorption was enhanced following regeneration. Iron was recovered as a mixture of ferrous salts on evaporating the used regenerating solutions.

Paper-25

Recovery of chromium from tannery effluents using a redox-adsorption approach

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Adsorption isotherms for sodium and chromium uptake from aqueous solutions onto Amberlite resin were prepared. Adsorption of each cation followed the Langmuir model. In aqueous solutions containing both chromium and sodium as the only cationic species, it was found that with increasing initial concentration of sodium, the trivalent chromium uptake on the resin decreased substantially. To overcome this difficulty, a four step redox-adsorption system has been developed for removal of trivalent chromium from tannery effluents. The initial step involves oxidation of the trivalent chromium to the hexavalent form. Step two removes the sodium by ion-exchange. Step three reduces the hexavalent chromium back to its initial cationic trivalent form and the final step removes the trivalent chromium by ion-exchange. Each step in the process has been assessed using batch and flow mode for simulated and actual tannery effluents.

Key Words: adsorption isotherm, chromium, redox, tannery effluent

Paper-26

Engineered containment systems for solid and liquid waste treatment storage and disposal facilities

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This paper will initially set out the major changes in design approach to engineered containment of waste over the last ten years, and what is driving the radical rethink on containment design both national and international.

The impact of the proposed Landfill Directive on the whole approach to containment design for all types of waste facilities. Following on from this a brief examination of some of the various containment design solutions and materials. Particular attention will be paid to the use of synthetic membranes in modern design solutions; their history, strengths and weaknesses. The role and purpose of Construction Quality Assurance in waste containment engineering will be developed.

The paper will finish with an examination of some case histories where the good and bad use of modern containment solutions provides the opportunity for learning and improvement of design and installation skills and techniques.

Paper-27

Healthcare waste management: the Irish experience

Claire McQuade

The talk will be broken down into a series of subtitles:

- a) Definition of healthcare waste as used by the Irish Department of Health. What is healthcare risk waste?
- b) Principles of healthcare waste management: to include reduction; segregation and replacement.
- c) Legislation dealing with healthcare waste both in an Irish and European context.
- d) Historical record of the Irish healthcare waste industry: from use of small scale on-site incinerators to present day export of waste; examination of the government tender for alternate technologies and its results and implication.
- e) Waste Management Bill (June 1996) and how it affects the Irish healthcare industry.
- f) Waste auditing and Ireland; comparison of Ireland and the European experience.
- g) Present trends in the Irish healthcare industry and future implication of government policy.

Paper-28

Favourable geological / hydrogeological settings for landfill sites in Ireland

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Ireland is better endowed than many countries in settings suitable, on geological/ hydrogeological grounds, for the siting of landfills. The high costs of lining sites, and the uncertainties as to the durability of artificial liners over the longer term, and the long term degradation behaviour of landfilled waste encapsulated in liner/capping systems, makes it unwise to ignore the possibilities of locating sites, which take advantage of the natural characteristics of the geological setting.

The critical parameters for suitable sites are depth to the water table and thickness of overburden. Although much of central and western Ireland is underlain by limestones, which due to karstification may represent important aquifers, suitable thicknesses of low permeability clay-rich overburden can provide acceptable aquifer protection. Whilst upland and lowland sites each have their advantages and disadvantages, upland areas are typically less populated, more secluded and composed of poorer quality land. In addition the water table is usually at greater depth in upland areas. It is, however, possible through engineering design and operation to compensate for shallow water tables in lowland sites.

Paper-29

Pseudomonas genetically modified for the degradation of PCBs and resistance to mercury: development of bacterial inoculants for bioremediation

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Rhizosphere bacteria such as fluorescent *Pseudomonas* are ecologically adapted to colonise and compete in the soil rhizosphere environment. Expanding the metabolic potential and heavy metal resistance of such bacteria to degrade pollutants (in soil) may prove to be a useful bioremediation strategy.

The pathway for the degradation of biphenyl (BP) and the metabolism of polychlorinated biphenyl (PCBs) was introduced into *P.fluorescens* F113, using the transposable element TnPCB (which

contains the bph operon) to construct the genetically modified strain F113pcb. To further expand the degradative potential of F113pcb, the toluene degradative (Tol) pathway was introduced by transfer of the toluene TOL plasmid pWVO. The resulting strain could now grow on BP and benzoic acid.

In order to realise the potential of rhizosphere based bioremediation, it is important to take note of other compounds in polluted soil which may limit the survival of the inoculant. Heavy metal contamination, in particular, mercury, is common in polluted ecosystems. Therefore we introduced genes encoding the mer (mercury resistance) operon into F113pcb with a view to engineering inoculant strains resistant to this heavy metal.

Expression of the bph recombinant genes can be detected in the rhizosphere which suggests considerable potential for manipulating the rhizosphere for the bioremediation of pollutants in soil.

Key words: bioremediation, genetically modified bacteria, PCBs, mercury, rhizosphere, gene expression.

Paper-30

Location and evaluation of potential landfill sites in west Cork

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Various methods of study were employed to locate the potentially most suitable landfill sites, within a specified area in West Cork. This process included an initial screening stage, which consisted of the assembly of all available information, to produce a topographical, geological, and depth to both bedrock and water table maps. These maps were then used in conjunction to assess the suitability of potential landfill sites in the study area. Once identified, the potential sites were subject to geophysical survey and hydrogeological investigation. The geophysical surveys comprised of both electromagnetic (EM) and electric methods, to provide reconnaissance of the underlying geological structure. A preliminary hydrogeological survey was completed, using information obtained from on-site bore holes and measurements acquired from surrounding domestic water wells.

Paper-31

The application of genetic probe technology in landfill bacteria studies

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Studies to characterise, enumerate and/or assess activity of the important groups of landfill bacteria are hampered by lack of an established technology. Culture techniques e.g. plate counts and most probable numbers are likely to give biased results as only a small percentage of microorganisms are culturable and an important microbial group may be missed. Palmisano *et. al.* (1993) estimated that less than 1% of total bacteria determined by microscopic techniques were culturable. Therefore in order to gain an understanding of microbial activities in landfills genetic probe techniques are being developed.

Extraction of DNA from landfill waste is based on methods developed for extraction from soils and sediments however with different associated problems. The presence of humics do not appear to pose problems as is the case with extraction of DNA from soils whereas the presence of high quantities of polysaccharides do complicate the extraction of good quality DNA from waste.

Possible methods include cell extraction followed by cell lysis, alternatively the cells lysing procedure may be applied to the waste sample then DNA extracted directly. Different cell lysis techniques include sonification, freeze/thaw and mechanical disruption, all give different results in terms of quality and quantity of DNA extracted.

Previous studies using environmentally derived DNA have taken three basic approaches. Firstly a semi-quantitative diversity based using denaturing gradient gel electrophoresis to separate bands of DNA from different species based on sequence variation (Silvey & Blackall 1995). A second approach by Hiraishi *et. al.* (1995), in a study of anaerobic sludges, has been to determine species

variation based on DNA fragment length produced by restriction enzyme digestion. Alternatively environmentally derived DNA has been used in several studies to design probes for use in In-situ hybridisation studies (Amann *et. al.* 1995)

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Paper-32

An environmental assessment of Rossmore landfill site, Carrigtwohill, Co Cork and monitoring of trace metal contamination around Rossmore peninsula (Part 1)

C. Butler & A. Allen

University College Cork

The introduction of new controls on landfilling has resulted in the use of synthetic lining materials (geomembranes) for groundwater protection at sites where local geology is insufficient protection.

Rossmore landfill site is located on Rossmore Island, approximately 1.5 km south-east of Carrigtwohill, Co Cork. Artificial containment of waste was recently engineering to replace the pre-existing landfill practice of 'disperse and attenuate' of landfill leachate at the site. Research has been initiated to identify the risk of contamination to the river channel, the groundwater of the island and the Middleton syncline aquifer on the mainland from landfill leachate.

Geologically, the site is inappropriately located in an area of Lower Carboniferous (semi-karst) limestone which has been locally quarried for commercial use. The sub-base of both containment cells are placed above a (1.5m) gravel attenuation layer beneath a quarried, fissured bedrock floor. In the event of leakage, the thin, permeable overburden material and weathered, fractured limestone is likely to be ineffective in attenuating leachate that enters the groundwater flow. The fissure flow of the limestone is also likely to accommodate rapid leachate migration from the waste to the (shallow) groundwater table.

Paper-33

An environmental assessment of Rossmore landfill site, Carrigtwohill, Co Cork and monitoring of trace metal contamination around Rossmore peninsula (Part II)

C. Butler, J. Twomey & A. Allen

University College Cork

Rossmore landfill site is located 1.5 km south-east of Carrigtwohill, Co Cork, on Rossmore island. Rossmore is situated in an environmental sensitive area of the North Channel, in the Upper Cork Harbour. Since the 1970's, the river channel has been a long-established oyster bed and the large spatting ponds on Brink Island depend upon the water quality of the river. Research was concerned with the mobility and concentration of particular trace metals Fe, Pb, Cu, Zn, Cr, Ni, Mn, Cd through soils and bedrock and their potential as pollutants to the channel from landfill leachate.

Groundwater from shallow (monitoring) boreholes and sediment from Rossmore bay and at various locations along the coastline were sampled. Both species *F. vesiculosus* and *A. nodosum* of the brown algae were also collected for tissue-analysis. The metal concentration in all samples remain within E.R.U (natural) levels yet dramatic increases especially from the toxic elements of Cd and Pb were obtained in contrast to former results of a previous survey (in 1991). The trace metals Mg and Fe were an reliable indication of leachate contamination and were comparable higher in areas of close proximity to the landfill of solid waste (at Rossmore Bay) and the sludge disposal (near Brick Island).

Paper-34

Groundwater protection in the Dower Spring catchment, Co. Cork

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The Dower Spring, Co. Cork, represents a significant natural resource. The spring derives its water from the surrounding area which is underlain by Devonian mudstones and sandstones and Carboniferous limestones. A regionally important aquifer has developed in the clean limestones due to karstification and past tectonism. Consequently, the groundwater within the aquifer is inherently vulnerable to pollution due to point recharge and rapid flow velocities. Glacial depositions offer varying amounts of protection to the groundwater, the sand and gravels gives little while the till is somewhat more effective. Water quality is good but bacteriological pollution is occurring.

Protection of this resource from pollution is essential and it can be achieved through the implementation of a groundwater protection scheme. A protection scheme was prepared for the Dower Spring catchment using the Geological Survey of Ireland methodology. Owing to the karstic nature of the aquifer, the usual method of defining the inner protection area by a 100-day time of travel radius proved inappropriate. An alternative method of delineating this area using limestone lithology and the development of karst features was implemented.

Paper-35

An evaluation of the extent to which Irish environmental impact assessments take groundwater issues into account.

Susan O'Shea & Catherine Coxon

Environmental Sciences Unit, Trinity College Dublin

This paper discusses the extent to which Irish environmental impact assessments take groundwater issues into account. Groundwater is part of the hydrogeological cycle and is recharged by water which infiltrates the unsaturated zone. Contaminants present on the land surface may be carried by the percolating water and finally enter the groundwater causing pollution. Approximately 25% of water abstractions in Ireland are from groundwater and certain areas are dependant on groundwater as a source of supply. Therefore it is vital that the groundwater components of environmental impact assessments for developments with the potential to affect groundwater are carried out by suitably qualified experts.

Research was undertaken to determine the extent of the research in all EISs submitted since January 1995 for developments with the potential to affect groundwater. In addition a selection of EISs relating to piggeries, quarries and holiday developments, submitted since January 1992, were evaluated. In conjunction with the analysis of the groundwater components of these EISs, a questionnaire was circulated to a number of hydrogeological experts working in Ireland. This determined the proportion of Irish EISs involving hydrogeological experts and the experts' opinions on the appropriate scale of their involvement in EISs for piggeries, quarries and holiday developments. These results were compared with the actual extent of the groundwater research determined in the EIS evaluations.

Paper-36

A colloidal survey of deep and shallow groundwater in (urban/rural) Nottingham, U.K.

Carol Butler

University of Birmingham

The transport and migration of contaminants through groundwater can be enhanced in the presence of mobile colloids. Research has been initiated to identify the colloidal populations and the contaminants sorbed on to colloidal particles within the Nottingham Triassic sandstone aquifer. Samples of both deep (industrial) and shallow (residential) boreholes located in both rural and urban areas were investigated. Sampling of natural colloids and seeding of groundwater with artificial colloids has been performed using methodologies developed from previous research within the Birmingham Triassic sandstone.

The majority of the colloids, found in the samples, were composed of silica oxides, aluminosilicates and CaSO₄ particles. Contaminants associated with these colloids include Mg, Fe, Al, Zn, Ti and Cd in deep boreholes. Shallow sites contain mainly organics: inorganic particles also present probably derived from the weathering of minerals of the soil and matrix of the bedrock. Heavy metals are rare, although traces of Al and Ti were observed in groundwater from shallow boreholes. Bacteria cultured on agar nutrient-based plates confirmed their presence in groundwater. Gram-negative, rod-shaped, motile (mainly) bacteria dominated, and the *Streptomyces* sp. is common in many of the samples.

Groundwater in the Nottingham area has very distinctive colloidal populations which could prove useful as tracers to contaminant sources.

Paper-37

Observation of the risk of ivermectin use in fish farming

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Ivermectin use is widespread in Ireland, as a therapeutic treatment in the control of lice infestations of farmed Atlantic salmon. Considerable controversy exists, particularly in Scotland, over its use in aquaculture. This was highlighted by a recent article in the *New Scientist*, 7th September 1996, entitled "Salmon farmers win licence to kill". Every chemotherapeutic, whether for human or animal consumption, is lethal at some concentration and the scarcity of published scientific literature, dealing with ivermectin use in aquaculture, leaves many such claims standing on very thin ground. Virtually no relevant data currently exists in relation to ivermectin usage in farmed Atlantic salmon at sea. Data will be presented on the LC50 and acute toxicity of ivermectin in Atlantic salmon held in sea water, along with other data which helps elucidate the "real risks" associated with the use of ivermectin i.e. the environmental impact on non target species and the health risk associated with the consumption of ivermectin residues.

Paper-38

Ecotoxicological assessment of three selected pesticides used in the Irish mushroom industry

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Pesticides are widely used in the mushroom growing industry. Once the mushrooms have been harvested, the mushroom compost on which they were growing has to be disposed of. This spent mushroom compost (SMC) has many desirable properties for use in soil amendment. However there may be problems with its disposal due to the potential presence of pesticide residues. In Ireland,

250,000 tonnes of SMC is produced annually. To date there has been no systematic ecotoxicological assessment of pesticides in Irish SMC. In this paper, some of the ecotoxicological effects of the three most commonly used pesticides in the Irish mushroom industry, i.e. Diazinon, Prochloraz, and Diflubenzuron will be presented. The ecotoxicological effects studied include *Lemna minor*, *Selenastrum capricornutum*, *Allium cepa*, and *Pseudomonas fluorescens*. An understanding of the ecotoxicity of these pesticides is essential to ensuring the safe disposal of SMC.

Paper-39

The determination of tumour promoting cyanobacterial toxins in Irish lakes

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Toxic blooms of cyanobacteria have been reported in lakes, ponds and reservoirs throughout the world. The most abundant cyanobacterial toxins are the microcystins and they have been implicated in many incidences of animal deaths due to their acute hepatotoxicity. Toxic cyanobacteria are a hazard to human health, primarily due to the chronic development of primary liver cancer in humans exposed to sub-acute doses of these toxins in drinking water. Recently, microcystins have been found to be potent inhibitors of protein phosphatases, 1 and 2A, and this accounts for their high toxicity. It is expected that the regulatory limit for these toxins in potable waters will be <1 µg/L and therefore sensitive analytical methods for the screening of freshwaters are required. Screening for toxins in bloom material was routinely carried out using a lethal mouse bioassay but this is insufficiently sensitive for water analysis and this assay has been banned in several European countries. We report the determination of microcystins using highly sensitive methods based on the inhibition of protein phosphatases. This quantitative enzyme bioassay was applied in the first study of hepatotoxic cyanobacteria in Irish freshwaters. Furthermore, microcystins were isolated from three Irish lakes and their identities confirmed using a new chemical derivatisation method linked with electrospray mass spectrometry.

Paper-40

Marine phytoplankton blooms and diarrhoeic shellfish toxicity

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The main acute toxic effect of diarrhoeic shellfish poisoning (DSP) toxins is a severe gastroenteritis and this is probably due the potent protein phosphatase inhibitory activity of these toxins. The aim of this work was to elucidate the nature of the toxic DSP compounds present in shellfish in Ireland and to utilise sophisticated analytical techniques to study the dynamics of intoxication by phytoplankton blooms. Chemical methods for DSP toxin detection such as high-performance liquid chromatography (HPLC) with fluorescence detection, or liquid chromatography coupled with mass spectrometry (LC-MS-MS), have been shown to be valuable analytical tools in characterising toxin profiles in phytoplankton and shellfish. Four diarrhoeic shellfish poisoning (DSP) toxins, DTX-1, okadaic acid (OA) and its isomers, DTX-2 and DTX-2B, were determined. The latter toxins can only be obtained as pure reference standards by isolation from Irish mussels and phytoplankton. Gradient HPLC, using a polymeric bonded phase, successfully separated the four toxins that were derivatised with two fluorimetric reagents thus enhancing the reliability of identification. The development of a new bioassay for detecting DSP toxins, utilising the pure enzyme, protein phosphatase 2A, is nearing completion. A relationship between water temperature fluctuation, phytoplankton blooms and toxicity in shellfish was established.

Paper-41

Effects of phenyltins on microalgae

H.M. Mooney & J.W. Patching

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Triphenyltin (TPhT) at concentrations in the nM to μ M range inhibits gross photosynthesis and respiration by the diatom *Skeletonema costatum* (Greville) Cleve and the chlorophyte *Dunaliella tertiolecta* (Butcher). In general *D. tertiolecta* is more resistant to the effects of phenyltins than *S. costatum*. Both species are more resistant to diphenyltin than triphenyltin.

Batch and chemostat-grown cells of *S. costatum* and *D. tertiolecta* exposed to levels of triphenyltin known to inhibit their respiration and photosynthesis were examined using transmission electron microscopy. Following short exposure times, ultrastructural abnormalities occurred at the organelle level. Exposure of growing cultures of *D. tertiolecta* to TPhT resulted in a 45% increase in monounsaturated fatty acids with a concomitant decrease in total PUFA's. This effect was not observed with *S. costatum*.

Comparison of our results with levels of organotins which have been observed by others in Mediterranean coastal waters indicates that levels of TPhT found in some marine environments could influence phytoplankton composition and dynamics.

Paper-42

Resistance to organotins amongst indigenous benthic bacteria

S. Kavanagh & J.W. Patching

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Sediment bacteria isolated from sites in Galway Bay and Killary Harbour were examined for their sensitivity to Tri-, di- and monosubstituted butyltins, methyltins and phenyltins. As has been reported in other studies, there was a tendency for toxicity to decrease in the order tri > di > monosubstituted organotins: Tributyltin and dibutyltin at a concentration of 8.4 μ M, inhibited 77% and 70% of isolates respectively, whereas 20% of isolates could grow in the presence of 280 μ M monobutyltin. No correlation appeared to exist between environmental organotin levels and the sensitivity of the bacterial population. Multiple antibiotic and metal resistances have been reported for organisms exhibiting resistance to tributyltin. Antibiotic and metal resistance profiles of those isolates resistant to all organotins used and those sensitive to all organotins used, were examined. Although both types of isolate were found to exhibit multiple antibiotic and metal resistances, the resistance spectrum was larger amongst the organotin resistant isolates. These isolates were also investigated for the presence of plasmids as involvement of plasmids in tributyltin resistance in bacteria has been reported. The gram reaction of isolates was compared with their resistance spectra. As had been noted previously, gram-positive bacteria tended to be more sensitive to organotins than gram-negative bacteria.

Paper-43

The identification of neurotoxins from cyanobacteria and marine phytoplankton

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A new analytical protocol has been developed for the determination of the cyanobacterial neurotoxin, anatoxin-a. Anatoxin-a was readily converted into a highly fluorescent derivative and HPLC analysis gave good linear calibrations with a remarkable detection limit of 20 pg per injection. Following the first identification of anatoxin-a in Irish freshwaters, this toxin was implicated as the causative agent in incidents of fatal canine neurotoxicosis. Thus, there had been regular reports of deaths to dogs in Caragh Lake, Kerry where the causative organism was a benthic cyanobacterium (*Oscillatoria*). This toxin was also recently identified in Lough Derg, Tipperary, following similar rapid deaths of two young dogs that exhibited neurotoxic poisoning. The biodegradation products of anatoxin-a can also be studied using this new HPLC method and this supplies additional information concerning historic toxin levels.

Paralytic Shellfish Poisoning (PSP) toxins have been reported in mussels from Belfast Lough but they had not previously been identified in the Republic of Ireland. However, following a phytoplankton bloom of *Alexandrium tamarense* in Cork Harbour in 1996, gonyotoxins (GTX2 and GTX3) were identified in wild mussels (<360µg/100g) and cultivated oysters (<88µg/100g). HPLC methods were employed to show that the toxin profile was remarkably simple when compared to the profiles found during PSP incidents in other countries.

Paper-44

Expression of stress proteins in cultured cells, a measure of heavy metal toxicity

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The stress response is a reaction of cells to diverse metabolic, chemical and physical stress conditions, including hypothermia, heavy metal toxicity and mechanical trauma. It entails the rapid synthesis of a suite of proteins called stress proteins. These proteins have been shown to be highly conserved and have been found in organisms as diverse as bacteria, molluscs and humans. This study aims to develop a cell culture assay that uses stress proteins as a sub-lethal measure of toxicity. Synthesis of stress proteins in Normal Rat Kidney (NRK) cells in response to cadmium chloride was investigated by one dimensional sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE) according to the procedure of Laemmli and proteins detected by silver staining. At sub lethal levels of cadmium chloride (> 5mg/l) typical stress protein induction patterns were detected, with a decrease in the overall synthesis of normal cellular proteins. This study is ongoing and future work will look at the effect of longer exposure periods and will look for the same effect on different cell lines and in response to different toxic stimuli.

Key words: Stress response, cell culture assay, toxicity

Paper-45

Smoking control in restaurants: a questionnaire study of patrons' knowledge and attitudes regarding the Tobacco Regulations 1995

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The 1995 Tobacco Regulations require 50% of the seating area in restaurants to be designated non-smoking with a proviso that this may be reduced where an approved ventilation system is incorporated. Seven out of ten Irish adults are non-smokers and previous research has demonstrated a mis-match in consumer demand and availability regarding "non-smoking" accommodation in restaurants. Restaurateurs are reluctant to provide no-smoking accommodation, oblivious to the potential demand, which may not be manifesting itself in the marketplace. The purpose of the study was to investigate possible reasons for this.

A questionnaire study of 190 restaurant patrons from six randomly chosen restaurants in Galway was undertaken to determine knowledge attitudes and demographic profile of the restaurant-going public. The restaurants were chosen from a census of restaurants in the Galway County Borough area. Categorisation into three distinct categories, determined by the cost of dining was undertaken prior to selection. One restaurant from each category was surveyed mid-week and the other was surveyed at the weekend.

The study found that restaurant clients are predominantly from the upper social classes and prevalence of smokers is lower as a consequence than that for the population as a whole. Even accounting for recreational smoking - occasional smoking in a social setting - non-smokers will usually outnumber smokers in the majority of restaurants by two to one. Non-smokers are not selective enough in seeking non-smoking accommodation and a lack of knowledge of the regulations was highlighted.

Health promotion initiatives are necessary at national and local level to heighten awareness of the latent demand for no-smoking accommodation and to transform this demand into a commercial reality.

Paper-46

Resilience and resistance of macroinvertebrate communities following a flood disturbance

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This study investigates the recovery of macroinvertebrate communities following two major Spring floods of two different catchments (i.e. forestry and moorland) in Co. Cork. Particular objectives were to compare recovery rates between streams in the two different catchments and to investigate whether recovery rates of macroinvertebrate communities were affected by the distance from the headwater. Two methods were used to investigate recovery rates following the floods:

1. Natural substrates: 0.1m² samples of natural substrate taken at random over a fifty metre stretch.
2. Artificial substrates: This consisted of substrate trays filled with clean (i.e. no macroinvertebrates) substrate that were dug into streams following the floods.

Small scale localised disturbances were also examined using artificial substrate trays which were placed in both catchments during a period of non-flooding.

The results of these methods were then compared to investigate the usefulness of artificial substrates as a measure of macroinvertebrate recovery in freshwater flood research.

Preliminary results suggest that macroinvertebrate communities recover more rapidly from localised flooding than from a widespread flooding event and that artificial substrates are not as accurate as the natural sampling in monitoring macroinvertebrate recovery from flood.

Paper-47

Ecological assessment of Irish lakes

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There are more than 5000 lakes in Ireland. The character of these lakes is primarily influenced by the geology of the catchment and anthropogenic influences within the catchment. Chemical data on 30 lakes (March-October 1996) will be presented. The lakes were chosen to reflect the diversity of Irish lakes. This work forms part of a larger project which will produce a methodology for the Ecological Assessment of Irish Lakes.

Chlorophyll a concentrations ranged from <1 µg/l to 177 µg/l. Total phosphorus concentrations ranged from <3 µg/l to 572 µg/l. Total nitrogen concentrations ranged from 0.29 mg/l to 4.50 mg/l. The most eutrophic lakes were located in the north midlands and the most oligotrophic were located in the west of Ireland. The large seasonal and inter-lake variation in colour (<3 to 200 PtCo units) appears to be due to catchment nature and landuse. There was a poor relationship between Secchi disc readings and chlorophyll a concentrations due to interference by colour. pH readings ranged from 4.60 to 9.17.

Paper-48

Spatial scale and the aggregation of stream macroinvertebrates

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It is widely accepted that macroinvertebrates in streams have aggregated spatial distributions. The majority of research on macroinvertebrate distribution has been based on sampling of the substrate or manipulative field experiments. Most studies have attempted to explain the observed patterns of abundance in relation to abiotic variables. An alternative approach is taken here, based on the study of the aggregation of invertebrates associated with ephemeral patchily distributed resources. The distribution of macroinvertebrates colonising artificial leaf packs is investigated at different spatial (several metres to 2km) and temporal (2 and 4 weeks) scales. All major taxa were intraspecifically aggregated though the level of aggregation varied as scale decreased. Interspecific associations were rare on most occasions however at the largest spatial scale they were not uncommon. The influence of heterogeneity in the environmental variables measured for each pack (e.g. accumulated detritus and sediment, leaf mass, flow and depth) was considered but the invertebrates did not appear to respond in a predictable manner to the microhabitat variations. The observed distribution patterns are discussed in relation to the Aggregation Model of Coexistence.

Paper-49

Longitudinal variation in freshwater pearl mussel density in relation to river habitat

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The freshwater pearl mussel population in 1.6km of the river Bandon at Dunmanway, Co Cork was censused as part of an Environmental Impact Assessment of a flood relief scheme. This section of river includes a proposed Special Area of Conservation.

Ninety-five cross-sections (2.5-3 metres wide) were taken. All mussels touching each cross-section were counted and various habitat parameters were recorded. The total population was estimated as 14 000 individuals and four juveniles were found. Population densities on individual cross-sections displayed large variation. This variation is analysed in relation to models of aggregation and habitat parameters.

Paper-50

Burren patch dynamics

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Patch dynamics is becoming of increasing interest in relation to conservation issues. This study attempts to assess the patch dynamics of Burren vegetation. As the flora of the Burren is a unique mixture of arctic-alpine and Mediterranean species, it is important that we understand the patch dynamics so that these floral elements can be maintained in the future. These vegetation patches, found on the open karst limestone may be of vital conservation interest due to their changing nature, particularly the smaller patches which may be more vulnerable to perturbations such as soil erosion and grazing pressure.

One hundred patches of vegetation were measured in an area south of Mullach Mór within the Burren National Park. A patch was defined as an area of vegetation totally surrounded by bare limestone. The area of each patch was recorded. All flowering and non-flowering (e.g. ferns and bryophytes) species were noted along with their percent cover. In addition, habitats present within each patch were noted e.g. grassland, tall shrub, dwarf shrub, rubble and gryke and their percent cover estimated. The height of the vegetation was taken into account within each habitat type and also aspect and slope of each patch. Presence or absence of grazing by cattle and goats was recorded by the existence of faeces in the patch.

Data are analysed with CANOCO (Canonical Correspondence) and results are presented. Whether patches studies are establishing or being eroded is one of the questions we hope to address with these data.

Paper-51

Natural regeneration within the Crom oakwoods, Co. Fermanagh

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The Crom lowland oakwoods, on the shores of Upper Lough Erne, Co. Fermanagh, represent one of the largest surviving blocks of semi-natural woodland in Ireland. Recent biological and historical surveys reveal ecological continuity in time, despite selective felling during the Napoleonic and the two World Wars. Little is known, however, about tree regeneration within the Crom oakwoods or their response to recent changes in conservation management.

This paper presents the results of a field survey of one of the least disturbed woodland areas within Crom demesne. Following a policy of selective felling by the National Trust in 1993, changes in seedling density and composition within ten canopy gaps were recorded over time. Tree species invasion and herbivorous predation were examined. Results indicate that grazing pressure by fallow deer (*Dama dama*) is the single most important factor affecting oak (*Quercus robur*) and ash (*Fraxinus excelsior*) seedling density, although the effects of herbivory may be reduced by an understorey of *Rubus fruticosus*. Invasion by sycamore (*Acer pseudoplatanus*) was recorded in some of the canopy gaps.

Paper-52

Do Island floras change? A resurvey of the islands of Lough Corrib after an eighteen year interval

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Uninhabited islands are the natural counterparts of man made nature reserves, as both are bounded fragments of larger vegetation types. Consequently the Island Theory of Biogeography proposed MacArthur and Wilson in 1967, has been of great interest to conservation biologists. Central to the theory is that species number on an island is a balance between colonization and extinction, but useful measurements of these processes require long time intervals between surveys. Here I present the results of two surveys of the wooded islands of Lough Corrib made in 1974 and 1992. Species extinction and colonization occurred and extinction, as expected, was greater on smaller islands. However a number of observations suggest that species turnover is not rapid.

i) Some of the Corrib islands are less than 200 years old. The group of species with populations on these islands has a different species area curve than the group of species confined to older islands. This difference is difficult to understand in terms of extinction and colonization

ii) Extinction was exclusively the fate of rare or marginal species, the bulk of the flora was not affected.

iii) Most of a small group of species recorded in 1802, still persist. Low species turnover rates imply that smaller areas can still maintain or conserve a group of species and data from the Corrib islands support this hypothesis.

Paper-53

The effect of macrofaunal activity on soil organic matter decomposition in forestry ecosystems

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It is suggested in the Century model (Parton *et al.* 1987) that, given similar climatic conditions, carbon loss will be up to 20% slower on the surface than below ground. One of the main reasons for the apparent differences in immobilisation of nutrients by microbial biomass is the relative abundance of fungal to bacterial decomposers. Parton *et al.* (1987) also suggest that carbon flow between the various pools of the model will be influenced by silt/clay content resulting in greater stabilisation of organic matter in passive and slow pools with increasing silt/clay content.

Earthworms ingest and bury considerable amounts of structural plant material and intimately mix this organic material with soil particles. It is expected therefore that earthworms will greatly influence the timing, release and flow of organic matter between various pools of SOM.

Two long term field experiments (ca. 2 years) were conducted to test the general hypothesis that macrofaunal activity can influence patterns of plant litter decomposition and carbon dynamics in forestry systems.

In the first experiment, surface and buried litter bag treatments containing unshredded oak leaves (> 4 mm) plus soil, shredded oak leaves plus soil (< 2 mm) and casts (comminuted litter and ingested soil) of the earthworm *Lumbricus terrestris* were used to assess the impact of burial, shredding and faunal comminution processes on organic matter decomposition.

In the second experiment, cast (organic matter 10.3%) plus earthworms (*Aporrectodea caliginosa*, *Lumbricus terrestris*), cast alone and uningested soil and litter (control) were added (as a surface horizon) to perspex cylinders containing a 'base' soil depleted in organic matter (1%). As surface organic matter was incorporated into lower 'base' soils, the influence of cast production on carbon stabilisation and/or mineralisation was examined by analysing treatments for changes in C associated with various fine earth fractions (silt/clay).

Earthworm casts (surface or buried) reduced fluctuations in MC in comparison with other treatments (fig 3). In both experiments earthworm casts (surface and buried) retained a higher proportion of OM than other treatments (fig. 4). This would suggest that mineralization of nutrients is taking place at a slower rate in earthworm casts. Martin (1991) similarly concluded that endogeic earthworm populations significantly reduce the decomposition rate of soil organic matter in subtropical savanna ecosystems. These results extend this hypothesis of a reduced decomposition rate to temperate anecic earthworms. Preliminary findings from both experiments suggest that this stabilisation is due to a combined reduction in both respiration and leaching of carbon. Studies are ongoing on quantifying these variations for modelling purposes.

Paper-54

Birds of coniferous forests in Munster

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This work forms part of a COFORD-funded project examining forest location and enhancement strategies for biodiversity, in relation to bird and fish populations (cf. abstract by Lehane *et al.*). Baseline data on bird populations and diversity are being collected throughout the year at a range of forest compartments, and related to parameters including tree species, tree age, and size and shape of forest plot. Fieldwork in the first year of the project has focused on *Coillte* forest compartments comprised of 30- to 45-year old stands of the seven conifer species most frequently planted in Munster, using point-count methodology. Preliminary data will be presented on the breeding and wintering bird assemblages, and their relationship to floristic and structural features of the forests studied.

Paper-55

Aphodius dung beetle assemblage stability at different spatial and temporal scales

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Little is known about the degree of spatial and temporal stability of north temperate dung beetle communities. We have analysed the *Aphodius* assemblage at four spatial scales: geographical, regional, local and between-field and at three temporal scales: inter-annual, seasonal and between-day. There was a similar level of variability at the regional, local and between-field spatial scales and the inter-annual temporal scale, inferring some degree of spatio-temporal stability at these scales. Assemblages were as variable at the smaller between-field scale compared to the local scale. At the seasonal scale, species are strongly segregated. Hence, quite marked variability in assemblage structure is evident over the year, which exceeds variability from one year to the next. At the daily scale, species abundances within a field displayed high variability, but there was relatively little variability in assemblage structure. Between-field variability in assemblage structure may be promoted by the temporal variability in resource availability which arises in rotational grazed pastures.

Paper-56

Should spraint surveys be used to assess otter habitat use?

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There has been widespread use of spraint surveys to assess otter habitat use, yet the validity of assuming a relationship between the importance of habitat features and marking behaviour is still questioned in published literature. This study aimed to address this problematic issue and elucidate what, if any, relationship exists between marking levels and habitat type. Spraint surveys were carried out on a number of Northern Irish river systems and multivariate techniques were employed to relate a range of stream and bank characteristics to marking intensity. Because of difficulties created by highly intercorrelated habitat variables, sites similar in habitat were grouped using ordination. The resulting axes scores were used to examine the relationships between broad categories of habitat and both spraint presence/absence and spraint/spraint site frequency. Generally, few significant relationships were observed. There was little indication that marking was consistently absent from particular habitat types. The variation in spraint/spraint site frequency explained by the habitat variables was very low. Limitations associated with the habitat data in this study are acknowledged, but it is contended that, given the great intraspecific variations in otter ecology, caution should be exercised in using spraint surveys alone to predict and assess habitat use.

Paper-57

Withdrawn

Paper-58

The BIODDEPTH experiment: an analysis of the role of biodiversity in ecosystem function

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The accelerating loss of biodiversity globally is of grave concern to biologists and ecologists for a number of reasons. Extinction is intrinsically undesirable, but what effect is it having on ecological processes and ecosystem function? BIODDEPTH (Biodiversity and Ecological Processes in Terrestrial Herbaceous Ecosystems), an EU Project funded under the Environment and Climate programme attempts to address this question, in a novel way by experimentally investigating the impacts of reducing biodiversity on ecosystem structure and processes.

Empirical experiments carried out in the Ecotron controlled environment facility at the Centre for Population Biology at Silwood Park, UK, have shown that productivity is reduced at lower species diversities. To test this result at the field level, concurrent experiments have been set up this year along two intersecting transects across Europe including Ireland, UK, Portugal, Switzerland, Germany, Sweden and Greece, using grassland communities as a template for manipulation. Appropriate plant species have been chosen for each region and are grown singly and in mixtures across a range of diversity of species and functional groups. Ecological parameters measured include productivity, decomposition, nutrient turnover and light interception. The species used are a combination of grasses, herbs and legumes which form different functional groups within grassland habitats. In addition, the influence of plant diversity on invertebrate communities is also being examined.

Several hypotheses have emerged to predict the effect of species loss on ecosystem function (e.g. river, redundant, idiosyncratic, null). These experiments, over the next three years, will aim to clarify this effect across a range of environmental parameters within the European context.

Paper-59

Minimum phosphorus requirements for herbage production in the spring

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Phosphorus from agriculture is one of the sources of pollution of surface waters in Ireland. However, phosphorus plays an important role in the grass growth, especially under cold conditions, in spring. This is also the time that grass has an increased value for farmers because of the scarcity. The objectives of this field experiment were to examine the effect of amount and application date of phosphorus fertiliser on spring herbage production and to determine the minimum soil phosphorus concentration required at which a phosphorus application is economic. Phosphorus fertiliser (superphosphate, 16% water soluble P) was applied at three rates (0, 15 and 45 kg P ha⁻¹), at two application dates (end-October 1995 and mid-February 1996), on four sites (3 locations) with different soil P concentrations: 2, 4, 6 and 18 ppm P (Morgan's). Herbage was harvested on three occasions, at the end of March, April and May 1996. Phosphorus fertiliser did have an effect on spring herbage production at the three sites with the lowest soil phosphorus concentration. Significant yield increases of 6 to 30 kg DM ha⁻¹ per kg applied phosphorus ha⁻¹ were obtained (at 15 kg P ha⁻¹). In most cases there was no significant difference between 15 and 45 kg ha⁻¹. Phosphorus application date did not affect the yield.

Paper-60

Assessing farm pollution trends from chemical and biological water quality monitoring and recorded pollution statistics

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This paper compares agricultural pollution incidents recorded in two river catchments in Northern Ireland since 1990 with a parallel water quality monitoring programme of streams in these catchments using a chemical classification and biotic indices. Such streams are generally not included in national water quality monitoring programmes which focus on larger rivers, yet they are the most susceptible to agricultural pollution. Overall numbers of farm pollution incidents have declined in Northern Ireland since 1990 and this decline was reflected in improvements in stream water quality derived from the Fisheries Ecosystem classification which employs BOD, ammonium and dissolved oxygen measurements. Improvements were most apparent for ammonium and dissolved oxygen. However the number of pollution incidents in individual catchments was a poor indicator of water quality in the

two catchments, as the catchment with substantially better water quality had the larger number of pollution incidents. Improvements in water quality since 1990 were also evident from the BMWP invertebrate biotic index. However many streams continued to produce relatively low index values, particularly with respect to the ASPT index. While the most severe pollution incidents associated with silage effluent has evidently declined, chronic low-level pollution from farm yards and buildings may be continuing to the extent that it poses a significant water quality problem in these catchments.

Paper-61

Phosphorus recommendations for grazing systems

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Movement of phosphorus from agricultural soils into water bodies is being blamed for some of the deterioration in water quality in recent years. There is now little doubt that soils with excessively high soil P levels can lead to loss of P via overland flow following heavy rainfall events. There is no scientific evidence that there are agronomic response to P above Morgans P of ten. Attention has focused on recommendations for P in agricultural systems and this paper concentrates on P recommendations for grazing. Once a target soil fertility level has been attained P fertiliser regimes can be based on replacement of P that is removed in product be it milk, meat or wool. The target soil fertility level is dependent on stocking rate. At stocking rates of 2.5 L.U./ha and upwards (intensive systems) soil P levels need to be in the region of 6- 10 (Morgan's extract). In more extensive systems, P levels can be somewhat lower soil P levels of 4-6. The offtakes of P can vary dramatically with stocking rate. In dairying, some 5 kg P are removed at stocking rate of 1.0 L.U./ha, while some 15 kg P and removed when the stocking rate is 3.0 L.U./ha.

Paper-62

Soil properties and related factors on organic farms

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The objective of this study is to analyse a broad range of soil and farm properties in the light of productivity in organic grassland. Random soil samples from thirty selected organic grassland farms in Counties Limerick and Clare are being analysed in the laboratory for pH, CEC, organic carbon, compactability, bulk density, aggregate size and stability. In twenty farms evaluated to date the values for physical and locational properties vary widely while values for organic carbon and bulk density are acceptable, and aggregate properties excellent. Among those farms Biomass Carbon and Biomass N, arginase and urease activities and polysaccharide content are similar however microbial counts for TVC, urease, amylase, protease, cellulase and exopolysaccharides producers vary considerably. The results to date show that it is possible to rate the farms in terms of soil quality on the basis of measured physical and chemical parameters, while biological quality comparisons are less clear. In the study so far, productivity has been measured solely as livestock units per hectare and has not correlated significantly with any of the soil properties tested. Productivity of all thirty farms in the study is being more thoroughly explored through a detailed questionnaire and interview of farmers in regard to inputs, management and farm outputs. Herbage production will be evaluated in a sample of farms. Roles of the measured soil and farm properties to organic grassland productivity will be evaluated through statistical analysis. It is envisaged that key contributory factors will be identified as indicators of organic production potential.

Paper-63

Development of a recreation management model using GIS (Geographical Information Systems) to assess the vulnerability of soils and landscapes to erosion due to amenity usage

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Amenity usage, in particular walking, is now an environmental problem facing the outdoor recreation manager. Ireland's upland soils and vegetation are revealing extensive erosional deterioration. This problem is likely to grow as more people are participating in various outdoor recreational activities than ever before.

This study is working towards the development of appropriate management strategies that can improve the carrying capacity of areas facing recreational pressure. The erosion problem set is constantly changing due to changing social and environmental conditions and so no solutions can be immediately offered. Instead, the study approach has been process orientated and considers how upland systems operate and the causal links within the system so that solutions are carefully developed, analysed and implemented.

The National Parks of Wicklow, Killarney and Connemara are being studied using the open systems approach to help identify causal relationships and to isolate the critical variables involved. This can better predict the impact of resource allocation decisions and adjust strategies to minimize impact prior to implementation. Assessments of recreational patterns, ecosystem function and damage are based on spatially distributed data recorded at a variety of spatial and temporal scales. Using geographical information system (G.I.S.) technology this data can be more effectively analysed so that the status and impact of recreation can be understood.

Paper-64

Landscape hierarchies in Northern Ireland: a GIS-centred approach to glacial resource inventory and assessment

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The last (late Devensian) glaciation has left a strong signature on Northern Ireland's landscapes. Glacial processes have formed distinctive landscapes on regional to local scales. Landscapes can be identified through remotely-sensed and field-based observations of glacial landform and sediment distributions and characteristics. A hierarchical schema is used to model the relationships between landscapes of different scales. Location-specific landscape data are addressed using unique codes that break regional-scale landscapes into their constituent local-scale landscapes. The hierarchical model is used to automate the inventory process using a Geographical Information System (GIS) and relational database to integrate data on glacial sediment bodies, sediment exposures, ecologically important areas and archaeological features. Recording and assessing glacial landscapes in a spatial systems context using GIS can be used as the basis for a range of landscape management, planning and protection applications, such as geological conservation.

Paper-65

Woodland recreationists' views on woodlands and their functions: a preliminary report

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Woodlands in Ireland are often promoted only for their value as standing timber crops, but many other functions - nature conservation, recreation, contribution to landscape, simply existing, grazing and shelter for domestic livestock, and private cutting for poles or firewood are also important. A comprehensive survey is currently being carried out in five woodlands in the vicinity of Galway. Under study are broadleaf, coniferous, and mixed woodlands managed for various coats, but all are used to some degree for recreation. People using the woodlands are being surveyed throughout the year, as are other Galway residents in their homes to compare their views on usage. Preliminary data from people interviewed in the woodlands during the summer and autumn of 1996 (n = 152) indicates that they are of the opinion that there is insufficient woodland in Ireland; they generally prefer broadleaf or mixed woodlands; and they list nature conservation, recreation, simply existing, and contribution to landscape as the most important functions of woodland. Commercial timber production is only tolerated for economic reasons. Respondents generally prefer to see a managed, mixed age woodland with > 50% older trees, > 50% native trees, and think that Irish woodlands should be expanded with the planting of broadleaf trees.

Paper-66

Maximising the ecological diversity of industrial cutaway peatlands

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The industrial exploitation of Ireland's peatlands by Bord na Mona will see the disappearance of most of the larger raised bogs within the next forty years. Some of the 80,000 hectares in Bord na Mona production will be suitable for agriculture and afforestation, but the estimates of how much land will be suitable for these purposes have been substantially revised downwards in recent years. It is now accepted that much of the industrial cutaway will be available for recreational, amenity and conservation developments.

In contrast with agricultural and forestry use of cutaway, little research was devoted in the early years of planning to the ecological potential of cutaway bog. The study introduced in this presentation seeks to devise practical methodologies for maximising the ecological potential of cutaway bog.

The present paper describes an early exercise in this study, focusing on the raised bog at Killaun and Ballywilliam in County Offaly. It the ecological situation at present - before development by Bord na Mona and then outline a procedure for facilitating that the cutaway bog can achieve the maximum in terms of ecological diversity. The paper will also briefly review the potential of remote sensing imagery in the mapping and evaluation of peatland habitats.

Paper-67

Measuring chlorophyll content of Irish lakes using airborne spectrometry

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A three year programme to monitor Irish Lakes through airborne spectrometry and colour video imagery began in 1995. Aircraft can fly and monitor up to 100 lakes a day, where conventional methods can manage only 10 easily accessible lakes. The Portable Multispectral Spectrometer (PMS) is mounted in conjunction with a colour video camera, in a Cessna 172. PMS measures the sun/sky light and the light reflected up from the ground, the ratio of these is the reflectance.

Presented here are spectrometric and lake sample data from the 1995/96 campaigns. This data set has been used to construct a model of the way light interacts with the lake and its constituents, such as; algae (which contain chlorophyll), suspended sediment, dissolved organic matter, in order to produce a reflectance spectra. The modelled reflectance is compared with the measured reflectance, and the inputs altered until the two spectra matched. Thus the final set of inputs represent the constituents in the observed lake. This inverse retrieval technique, gives acceptable chlorophyll 'a' retrieval in the range 4-100µg/l.

Paper-68

Revegetation of metal mine tailings using *Glyceria fluitans*

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Low nutrient content, high metal concentrations, and poor water retention are characteristics of metal mine tailings. Revegetation of tailings under upland conditions can be difficult and can cause pollution problems due to dispersion of dust. An alternative approach is revegetation under wetland conditions using metal tolerant wetland plants. This would also reduce wind erosion.

Glyceria fluitans found growing in the tailings pond of an abandoned lead-zinc mine in Glendalough, Co. Wicklow, was considered a suitable species for revegetation purposes.

In greenhouse experiments, two populations of *Glyceria fluitans*, one from a metal contaminated and the other from a non-contaminated site, were grown successfully on mine tailings with a high zinc content. These plants have also been grown on alkaline zinc mine tailings in an outdoor microcosm experiment with and without fertiliser treatment. Results indicate that *Glyceria fluitans* can be established on zinc mine tailings, regardless of origin, with minimal fertiliser treatment.

Paper-69

Rehabilitation of abandoned metalliferous mine spoil at Avoca mines using sewage sludge as an ameliorant

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Co-disposal of wastes to reduce their individual environmental impact is a fundamental part of environmental management. The land disposal of sewage sludge to add organic matter and nutrients and improve the success of mine waste revegetation is an example. The results of a trial of sewage sludge as an ameliorant for the revegetation of acid-generating metalliferous mine spoil near Avoca, Co. Wicklow, funded by the EU LIFE programme, are presented. The issues addressed are: (1) sludge-derived metal, nutrient and pathogen contamination of surface and ground-water; (2) food-chain metal availability; (3) sludge application alternatives for rehabilitated mine spoil; (4) selected

spoil cover versus capillary barriers as rehabilitation options, and (5) vegetation establishment and its long-term sustainability at Avoca.

Paper-70

Mining and the environment - a case study of Arcon Mines Ltd.

K. McNair, D. Waugh & S. Hickey

Arcon Mines Ltd, Galmoy, Co. Kilkenny

Arcon Mines Ltd, Galmoy, Co. Kilkenny is the first new Zinc/lead mine in Ireland in over twenty years. The Environmental Impact statement (E.I.S) submitted as part of Arcons planning permission was one of the most comprehensive ever produced in the State. Planning permission, atmospheric and effluent discharge licences were granted by the local authority in 1994. Planning and licence conditions applied to the mine include extensive environmental monitoring and control requirements covering the construction, operation and post closure phases of the mine.

Many of the conditions in the discharge licences are based on commitments made by Arcon in the E.I.S and set new standards in environmental monitoring and control for the Irish mining industry. These include the installation of an automated "real time" environmental monitoring system covering noise, climatological, vibration, water and effluent discharges. The extent of the commitment to environmental protection is apparent in the elaborate monitoring programmes covering all aspects of the natural environment. In addition Arcon has installed a regional water supply scheme and a stream augmentation system.

Arcon Mines Ltd is an example of an environmentally sound modern mining development that allows for protection of the environment both for the present and into the future.

Paper-71

Leveraging public perception - a systems perspective of the mining industry

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In the past mining companies have made some enormous mistakes with regard to their environmental impacts but it must be remembered that usually the companies were acting with the best knowledge and technology available at that time. Now the body of knowledge about mining and the environment has substantially grown and the impacts of mining on the environment are more controllable and predictable.

However, the environmental problems left by mining operations in the past are still very much a problem today, many years after the mines have been abandoned. As the mining companies have become more conscious of the growing public opposition and influence they have also become more fearful of allowing any information about their environmental impacts into the public domain.

The objective of this paper is to use the tools and techniques of systems thinking and system dynamics to examine how mining companies can - through more open interaction with the public - improve the image of their industry.

Paper-72

Measurement of air pollutants in Dublin city using differential optical absorption spectroscopy

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It is now well established that high levels of air pollutants can cause significant adverse health effects, while other consequences such as vegetation damage and building deterioration have also been characterised. In order to improve air quality in Europe the European Commission have issued a number of directives with regard to acceptable levels of a range of pollutant species such as SO₂, NO₂ and O₃. Monitoring of these compounds together with volatile organic compounds (VOCs) is necessary to provide improved pollution warnings to those who are sensitive to air pollutants as well as providing valuable data for environmental planning. Major sources of VOCs in the atmosphere include automobile exhaust emissions, solvent evaporation and emissions from the chemical and petroleum industry. Concern has recently been expressed about the presence of benzene in urban air arising from the use of unleaded petrol. In order to provide information for urban planning, e.g. traffic systems, it is imperative for urban areas to have sophisticated pollution measuring systems.

An investigation of Dublin's air quality has recently got underway with the commissioning of an OPSIS long path UV system, based on the principle of differential optical absorption spectroscopy (DOAS). This state of the art open-path system has been set up at DIT, Kevin St. to monitor a variety of criteria pollutants over pathlengths ranging from 400m to 1km. The pollutants of interest are SO₂, NO₂, O₃, benzene and toluene. The conventional methods of fluorescence (SO₂), chemiluminescence (NO_x), ultraviolet absorption (O₃) and gas chromatography (VOCs) are being operated in conjunction with the OPSIS system. Interpretation of the results is carried out based on the known chemistry and meteorology and intercomparisons are made between the different monitoring methods operated at this site and by other monitoring agencies.

Paper-73

A passive sampler for measuring gaseous ammonia, the Willems-badge

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Gaseous emissions of ammonia (NH₃) from agricultural activities are known to effect low-nutrient ecosystems due to deposition. Therefore in recent times much attention has been paid to monitoring ambient air concentrations of ammonia. In this paper a new passive sampling method is presented to monitor ammonia. It does not need electricity and is reliable in different weather conditions. Exposure times can be varied from 1 hour to 1 week depending on the ambient concentration level. Concentrations of ammonia have been monitored for one year at 4 sites in Ireland using sampling times of 1 week. The method has been shown to be reliable at the low concentration levels at these sites and results were used to estimate dry deposition fluxes. Currently the method is being tested for long sampling times, e.g. one month, in order to provide a cheap way of finding an annual average concentration level. In the Netherlands the method has also been used to investigate the emissions of ammonia, which shows the Willems-badge to be a multi-functional sampling method.

Paper-74

An investigation into the relationship between concentrations of nitrogen oxides in the atmosphere at a site in Dublin and mesoscale and synoptic meteorological observations

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Occurrences of high concentrations of air pollutants are not usually the result of increased emissions but of meteorological conditions that inhibit dispersal of the pollutants. A study was carried out to investigate the affects of meteorological conditions on atmospheric nitrogen oxide (NO_x (nitrogen oxide and nitrogen dioxide)) concentrations at a site in Dublin. NO_2 is a secondary pollutant that is formed when NO is oxidised. NO is created when fuel is combusted at high temperatures. The main source of NO_x at the measurement site was traffic. The measurement site was at Rathmines, Dublin, one of the main commuter routes into the city. Data used in the study (meteorological conditions and hourly NO_x concentrations) were compiled from hourly records for the years 1988-1992. The research identified wind speed, air pressure and wind direction as the most important mesoscale meteorological parameters for understanding the behaviour of extreme NO_x concentrations in Dublins air. Daily, weekly and seasonal variation in NO_x concentrations were observed. The work also highlighted the importance of the role played by general synoptic weather conditions over local climatic effects, in extreme events. Examination of the synoptic meteorological information inferred that significant quantities of NO_x pollution was transported to Ireland from sources in Britain and Europe.

The relationship between daily mean mesoscale meteorological observation and daily mean NO_2 measurements at Rathmines was examined. A multiple regression model was constructed to estimate daily NO_2 concentrations. The model used daily mean wind speed, wind direction and the previous days mean NO_2 concentration to estimate daily mean NO_2 concentrations. The model has a R^2 (adjusted) value of 72.6%.

Finally, the possibility of building a model to forecast high concentrations of NO_2 in Dublin was evaluated and some recommendations were made.

Paper-75

PM_{10} concentration measurements in Dublin city

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Mass concentration of ambient particulate matter with an aerodynamic diameter less than $10\mu\text{m}$ (PM_{10}) are reported for a range of sites in Dublin City. PM_{10} gravimetric mass concentration measurements are made with low flow Partisol 2000 air samplers using an impaction type PM_{10} inlet and 47mm diameter glass fibre filters. In addition, much finer time resolution mass measurements (minimum sampling frequency of 30 minutes) are made using a tapered element oscillating microbalance (TEOM) PM_{10} mass monitor. These PM_{10} mass concentrations methods are also compared with mass concentration inferred using the standard black smoke method. Analysis of the ambient mass concentration data with reference to traffic density and meteorological influences are presented. Results for the first six months of 1996 show that the average PM_{10} values vary from site to site with the highest average recorded at the Dublin city centre site and the lowest at one of the suburban sites. Intercomparison between PM_{10} and black smoke mass concentrations show that the relationship is site specific. Statistical analysis between PM_{10} levels and car traffic number show a positive correlation while a weak negative correlation is found between PM_{10} levels and rainfall amount, wind speed and air temperature.

We wish to acknowledge the Environmental Protection Agency, and the Department of the Environment, through the European Regional Development fund for support of this work.

Paper-76

Baseline survey of VOCS in Dublin city

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¹ TMS Environment Ltd

² Environmental Health Unit, Dublin Corporation

A comprehensive survey of Volatile Organic Compounds (VOC's) in ambient air in Dublin city has been underway since August 1995 and is scheduled for completion in December 1996. The project involves sampling and analysis of VOC's at 20 locations in Dublin city. This paper will present an outline of the strategy used for the implementation of the survey, and will include a discussion of the VOC's selected for inclusion in the monitoring programme, criteria for selection of sampling and analysis strategies, selection of sampling sites for inclusion in the survey and a detailed review of the strategies developed for analysis of the VOC's at the trace levels encountered in ambient air. The project is part funded by the Environmental Protection Agency under the Environmental Monitoring, R&D Sub-Programme of the Operational Programme for Environmental Services 1994 - 1999.

Paper-77

Peroxy radical reactions of atmospheric interest

Eoin Collins

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Large quantities of organic compounds are emitted into the atmosphere as a result of anthropogenic and biogenic processes. These emissions lead to a complex array of chemical and physical transformations resulting in effects such as photochemical air pollution. Laboratory studies indicate that the oxidation of organic compounds in the atmosphere occurs by a series of free radical reactions. Mechanistic studies identify peroxy radicals, e.g. RO₂, as key intermediates in these processes. These radicals are also involved in the formation of NO₂ and peroxyacetyl nitrate which are components of photochemical smog.

This study is concerned with the peroxy radicals which are formed in the atmospheric oxidation of halogenated alkanes and various ethers.

Paper-78

Kinetics and mechanisms for the reactions of OH Radicals with esters and carbonates

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Oxygenated organic compounds have increasing application as water soluble solvents and fuel additives. The effects of releases of these species into the atmosphere on tropospheric ozone and formation of other secondary pollutants may be of some concern. Reaction with the OH radical is the principal fate of these compounds in the atmosphere. Product studies on the OH radical and Cl atom initiated oxidation of a series of diethers show that esters and carbonates are formed in high yield. Preliminary rate constant data for the reactions of OH radicals with a series of esters and carbonates have been obtained using both a laser photolysis technique and a conventional relative rate method. The results yield estimates of the atmospheric lifetimes of these compounds. Mechanistic studies have also been carried out to provide structure-reactivity information on the reactions and to establish their eventual oxidation products.

Paper-79

Radon exposures in Irish showcaves

Jack Madden

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Radon is a natural radioactive gas which is classified as a Class A carcinogen by the International Agency for Research on Cancer (IARC). The principal adverse health effect arising from the inhalation of radon gas and radon decay products is lung cancer.

As part of its assessment of occupational exposure to radon the Radiological Protection Institute of Ireland (RPII) has been conducting surveys of radon gas and radon decay product concentrations in Irish showcaves since 1993.

Area monitoring of underground radon concentrations was conducted using passive Cr-39 alpha track detectors and active measurements of both radon gas and radon decay product concentrations were carried out at selected points along the tourist routes.

Individual assessments of the radiation doses to the cave guides during the working hours spent underground were also carried out using personal radon dosimeters.

The results of all radon monitoring and dose assessments for the cave guides together with the implications for speleologists and the general public will be presented and discussed.

Paper-80

Atmospheric deposition in Ireland

Julian Aherne, Roel van den Beuken & Edward P. Farrell

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This research describes the strategy used to map the atmospheric deposition of the major ions in precipitation for Ireland on a national scale. The preliminary maps of deposition load have been produced by combining interpolated maps of average annual concentrations, for approximately 30 point measurements, with an interpolated map of long-term average annual rainfall volume, based on approximately 600 points. The resultant maps will be used as inputs to the critical loads mapping programme which is currently being funded by the Irish Environmental Protection Agency. The use of these maps within the critical loads programme will also be discussed. All images are stored in a raster (grid or pixel) based Geographic Information System (GIS). The images consist of 200,000 by 1 km² pixels in 500 rows by 400 columns, registered to the Irish national grid.

Paper-81

Ambient aerosol characteristics at Mace Head on the west coast of Ireland

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This paper presents results of a number of measurements performed on the ambient aerosol at Mace Head atmospheric research station on the west coast of Ireland between June and August 1996. The remote measuring site receives for between 50%-60% of the time air which has a back-trajectory origin over the North Atlantic Ocean (marine air mass). It also receives air from an easterly direction (continental air mass) which is more polluted. Results of the measurements from both types of air masses are presented. Aerosol size distributions, in the size range 0.5 to 30 μm , were recorded using a TSI (model 3310A) aerodynamic particle sizer spectrometer. Measurements of mass concentration of particulate carbon aerosol using an aethalometer and of cloud condensation nuclei (CCN) for both air mass conditions are also presented. Basic meteorological parameters were measured under both marine and continental air mass conditions and their influences on the aerosol characteristics are also discussed.

Paper-82

Kinetic studies of the reaction of OH radicals with ethers

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Polyfunctional oxygenated compounds have increasing application as water soluble solvents and fuel additives. The effects of releases of these species into the atmosphere on tropospheric ozone and formation of other secondary pollutants may be of some concern. Relatively few studies have been carried out on the reactions of hydroxyl radicals with organic compounds containing more than one functional group, although some data are available in the literature for OH radical reactions with polyfunctional oxygen-containing species. Rate data for the reactions of OH radicals with various polyalcohols, polyethers and hydroxyethers have been reported. The reported rate coefficients indicate that these compounds appear to show enhanced reactivity compared to that expected from rate data obtained for molecules containing only one functional group. The purpose of this work was to determine rate constant data for the reaction of OH radicals with various diethers and hydroxy ethers using both a laser flash photolysis technique and a conventional relative rate method. The results yield estimates of the atmospheric lifetimes and provide structure-reactivity information on the reactions.

Paper-83

The decomposition of ammonia over copper on alumina catalysts

Teresa Curtin

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Odours and air quality are of growing concern in the present day. Already various efforts have been made to reduce the levels of hazardous air pollutants emitted from both mobile and stationary sources. In the agricultural sector, many problems concerning effluents and odours have arisen as a direct influence of intensive farming, a problem that will have to be tackled in the future. The volatile substances associated with odour concentration are thought to consist primarily of ammonia, SO₂, H₂S and various VOCs. For this reason, the initial step in this investigation was to develop a catalyst that would decompose ammonia into water and nitrogen.

Copper impregnated on alumina was found capable of decomposing ammonia into nitrogen and water in the presence of oxygen. The reaction is thought to proceed in two steps. In the first step, ammonia is oxidised to NO in the presence of oxygen. The NO then combines with unreacted ammonia to form nitrogen, similar to the deNO_x reaction. The reaction was studied over CuO/Al₂O₃ catalyst of varying copper loadings. CuO/Al₂O₃, prepared using Cu(NO₃)₂ presented the best overall activity. Introducing SO₂ into the reactant stream converts the CuO/Al₂O₃ into CuSO₄/Al₂O₃. The formation of this sulphate species seems to have a negative influence on the ammonia decomposition activity.

Paper-84

Electricity and sustainable development

Donagh O'Mahony

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This paper will examine the challenges presented by increasing energy use in Ireland and the future role of the Electricity Supply Industry in contributing to the goal of Sustainable Development. The following will be discussed: electricity use in the context of national total energy use, unique characteristics of the Irish electricity supply system, constraints and options in moving towards a sustainable national energy system, future role of electricity in efforts to stabilise national CO₂ emissions. Projections based on conventional wisdom will be shown to be unsustainable.

Paper-85

Side scan sonar investigations in Lough Neagh, Northern Ireland

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Recent mapping of the bed of Lough Neagh provides new information on the nature, origin and distribution of lake bed sediments and of the impact of human activities upon the lake floor.

In general the lake comprises a nearshore littoral facies that is dominantly sandy or composed of eroded bedrock or glacial deposits. This is typically barred or planar. The inner sand facies passes, often without marked change of slope, into unconsolidated muds which dominate most of the Lough floor. At various localities are areas of low relief which represent the wave-planed remnants of glacial deposits. These are characterised by coarse gravel and boulder surfaces. Although some of these features exhibit positive relief (islands in the Lough are their less eroded equivalents), others pass laterally into mud without marked topographical change.

These preliminary investigations suggest the entire lake floor to be a wave-planed surface formed through erosion of highs in a pre-existing relict glacial topography and deposition of eroded material in depressions. This material has been sorted such that muds are deposited below wave base and sands have been transported to the contemporary shoreline. No firm conclusion can be reached at present as to whether planation of the lake floor is a contemporary process or is linked to former (lower) lake levels.

Human activities on the Lough comprise fishing and sand extraction. Fishing activities produce a range of distinctive drag marks on the lake bed, usually associated with dragging net anchors. These are usually confined to distinct areas close to the sand-mud interface. Suction dredging of the sand deposits has produced a distinctive lake floor morphology characterised by deep (up to 5m) circular depressions which, when abandoned, provide foci for mud deposition in the nearshore zone.

Paper-86

Withdrawn

Paper-87

Estuarine waterfowl ecology and the design of environmental impact studies

Tom Gittings

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Estuarine waterfowl display complex spatial and temporal patterns of intra-site distribution and habitat selection. For example:

- * low tide usage of a site is not necessarily related to high tide usage
- * temporal patterns of usage by feeding and non-feeding birds of the same species may be different
- * peak usage of a site may occur at intermediate tidal states
- * spatiotemporal patterns may vary between neap and spring tides

This paper presents some data from sites in southwest Ireland collected during environmental impact assessments and discusses the implications for the design of baseline EIA studies.

Paper-88

Risk perception and fear reduction

Janet Heeran

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People are inherently suspicious of that which they do not understand, so unless communication is entered into, claim and counter-claim will mount and conflict is likely to arise. Risk perception is central to people's reactions to developments, and unless they accept a project, it is likely to be dogged by protests.

The public is bombarded with environmental information from many sources. These opinions often clash in their findings and make it difficult for non-experts to make a decision. Thomas (1990) points out that "what is seen as a disaster by one may be regarded as an opportunity by another" (p.37). If those who disseminate information (scientists, lawyers, states, developers) believe a development to be an opportunity, the public will find it difficult to counter their arguments (Milne, 1996). The position is even more unclear when the scientists are paid by vested interests (Wynne and Mayer, 1993, p.35).

This talk explores some of the reactions to these realities. Will those who make the rules by which society operates be consumed by their own contradictions? (Beck, 1995, p.172) Will governments give the public more opportunities to give voice to their fears and challenge the solutions offered by "experts"? What opportunities exist for including the public in decisions about their environment?

References:

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Paper-89

Making Irish environmental legislation work. Practical experience and recommendations for improvements

Simon White

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In this presentation I would like to start by explaining who we are and why we exist. This will lead me to show why we researched the system that the Irish Government has in operation in order to contend with Environmental concerns. I wish to praise the positive aspects of the system recently deployed and show how we support its general thrust. Then I intend to explain the nature of the difficulties we have encountered in the system, how we found even greater difficulty in bringing all this to the attention of the people who have the ability to remedy the situation.

I will try to demonstrate how in our view, the system in practice, is bringing about the very situation it was supposedly designed to avoid.

Finally I will put forward our ideas as to how the system can be improved and list the actual amendments that we see as necessary to bring this about, and I intend to appeal for support from all the concerned environmentally aware persons in lobbying in every effective quarter to have the Legislation amended.

Paper-90

Tangible and intangible costs and benefits associated with implementing environmental management systems

Simon Stringer

36 Deramore Ave, Belfast, BT7 3ER

This paper will examine the costs and benefits, both hidden and tangible, associated with implementing an environmental management system (EMS). The costs are related to human resources and training, capital costs and costs to the environment. The benefits are primarily short term fiscal benefits, competitive advantage leading to longer term business stability, better relations with the regulatory authorities and stakeholders. The thesis considers why any organisation should implement an EMS and where the effort should be directed and aspects of the social responsibilities that organisations are now being charged with.

A questionnaire was sent to a variety of commercial and service oriented bodies spanning a wide range of activities from the heavily regulated chemical sector to the 'self regulating' local authorities. These organisations operate in Ireland, Northern Ireland and the UK. The responses are suitable for indicating the readiness and ability of organisations to meet the current environmental challenges. The statistical relevance is limited by the number of industries and companies that have implemented an EMS and the number of respondents.

The paper closes by looking at the future for the environment within a world driven by international, national and local trade. It examines the relevance of EMS in this world and where the most likely developments are going to take place. Jacques Santer, President of the European Commission, said in 1995 "environmental policies need to be robust and justifiable on cost and benefit grounds", but they cannot be the only considerations for long term global stability. Other factors include a need for the revision of personal values and an integration of the players' disparate requirements.

Paper-91

Monitoring the changes in semi-natural habitat in relation to agricultural grassland and forestry in the Sperrins AONB, Northern Ireland using satellite imagery

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Satellite imagery, whilst not providing the detailed information yielded by field survey, can provide quantitative information on land cover change over large areas, relatively quickly and cheaply. A thematic map of land cover has been produced for the Sperrins Area of Outstanding Natural Beauty (AONB) from a 6 band Spring 1989 Thematic Mapper (TM) image. Three groups of land cover types were mapped: semi-natural vegetation, agricultural grassland and coniferous woodland. Area estimates for these groups were in close agreement with field survey estimates derived from a sampling programme stratified by multivariate land classification. A 5% systematic (grid) sample of pixels independent of the training data showed that agricultural grassland was classified with an accuracy of 90%. Similarly estimates of coniferous woodland from image processing and field survey were in close agreement with 85% of coniferous woodland pixels correctly classified. Changes in the distribution of agricultural grassland and coniferous woodland mapped from satellite imagery may therefore indicate which parts of the countryside are losing semi-natural vegetation. This information may assist government planners and countryside managers in formulating and adopting coherent strategies for countryside management.

Paper-92

Conservation and aquaculture - what are the conflicts?

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² National Parks and Wildlife Service, 51 St Stephens Green, Dublin 2.

This paper will address both the conflicts between conservation and aquaculture and the positive side of aquaculture for conservation in Ireland. It will look at species currently being cultivated and those which are likely to be cultivated in the future. The ways in which the impacts can be mitigated and some of the conflicts resolved will be discussed.

Paper-93

Continuous emissions monitoring systems for power stations

Brendan Barry

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Legislation is already in place world-wide which requires electricity producers to monitor, record and report stack emissions on a continuous basis.

EC Directive 88/609/EEC, which is implemented in Ireland in the form of "Air Pollution Act 1987 (Combustion Plant) Regulations", 1992, is a driving force behind the current need for Continuous Emissions Monitoring Systems (CEMS) in ESB. The EPA in Ireland has the responsibility and authority to ensure compliance through the introduction of Integrated Pollution Control Licensing. Other forces include the need for corporate emissions cap management.

There are many different types of CEMS technology available and numerous manufacturers of each type. CEMS is a relatively new concept in most countries and the technology is still in a developing stage. A comprehensive review of the legislation, available technologies and international experiences in CEMS was undertaken by ESB. This paper introduces the key issues arising out of this review.

Time and expense were saved by adopting a centrally driven uniform approach to the procurement of this equipment. The main provisions involved in selecting, installing, maintaining and operating a CEMS are discussed and an insight is given as to how these provisions were incorporated into a generic Purchase Specification for all of ESB Power Generation CEMS requirements.

Paper-94

Evaluating Ireland's wave energy resources

Kenneth Kingston, Brian Holmes & Noel Murphy

Hydraulics and Maritime Research Centre, University College, Cork

As part of the State's Marine Research Measures Programme (1994 - 1999), the Hydraulics and Maritime Research Centre is carrying out an investigation into the wave energy resources available along the western seaboard of Ireland. The accurate knowledge of wave climate characteristics in various water depths is of fundamental importance to this and many other coastal studies. Few actual reliable measurements exist to assist in decision making processes. At present, 3rd generation wind-wave development models are reasonably accurate for predicting seastates at deep water locations. However, it is in shallow (<50m) coastal regions where wave transformation phenomena become important, that the prediction of wave climate characteristics is of more interest with regards to the evaluation of waves and their effects.

Funded via the Marine Institute, the HMRC is developing a methodology to produce acceptable shallow water wave climate characteristics using existing empirical wave climate transformation packages. This paper highlights the various problems associated with determining the inshore wave energy levels from offshore wave climate records which then have to be incorporated in the working model. These problems include interpretation of directionality of the wave climate and shadow zones

in the nearshore region as well as numerical interpretation of bathymetric influences on the wave energy propagation. The use of climate statistics rather than full spectral information is also considered. The solutions adopted and their verification are then outlined.

Keywords: wave energy levels, wave transformation, directionality, shadow zones.

Paper-95

Emissions from two compression ignition engines running on mineral and rape seed oil based fuels

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Emissions of carbon monoxide, carbon dioxide, oxygen, exhaust opacity, and engine performance were measured upon

(1) A 1.4 litre turbo charged Elsbett powered Volkswagen Transporter, running on cold pressed, filtered to 25 microns, unprocessed rape seed oil, compared with running on mineral fuel oil.

(2) A 2.4 litre naturally aspirated Toyota Dyna, running on rape methyl ester compared with running on mineral fuel oil.

Emissions of carbon monoxide were found to be generally, higher with the mineral fuel oil (peak value 0.27%) than with the rape methyl ester (peak value 0.25%) used in the Toyota Dyna, however with the Elsbett engine running on unprocessed rape seed oil the carbon monoxide emissions were significantly higher than that of the mineral fuel oil (peak values of 0.29% and 0.19% respectively). The emissions of carbon dioxide were similar for both vehicles and for both fuels (typically 11% - 14%), whereas oxygen emission was found to be greater with the oil seed rape based fuels (typically 2.5% - 3.5%) than with the mineral fuel (typically 0.5% - 2.5%), for both vehicles.

Exhaust opacity was found to be significantly greater for the mineral fuel oil (typically 40 - 80 Hartridge smoke units) than the oil seed rape based fuels (typically 20 - 60 Hartridge smoke units), in the case of the Toyota Dyna running on rape methyl ester the exhaust smoke output was approximately half that of the mineral based fuel.

Paper-96

The vapour phase Beckmann rearrangement over solid acids

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ϵ -Caprolactam is an important intermediate in the manufacture of synthetic fibres. Its production is normally carried out in the liquid phase using oleum as a catalyst. Although highly selective, this process suffers from many disadvantages related to corrosiveness and formation of ammonium sulphate byproduct. Owing to these limitations, the production of ϵ -Caprolactam in the gas phase offers many advantages such as single step, clean and cheaper production.

Following from this a specific range of solid acids have been studied for the Beckmann Rearrangement of cyclohexanone oxime to ϵ -caprolactam over a fixed bed microreactor. ZSM-5 zeolite was the most successful catalyst tested. Varying activities and selectivities to the lactam were observed depending on the type of solid acid used. Other products observed included cyclohexanone, 5-cyanopent-1-ene and aniline. The acids were characterised for their surface acidity by FTIR spectroscopic analysis of preadsorbed pyridine. Coke formation was noted from the commencement of reaction which eventually led to loss in activity. The loss in activity was directly related to the total concentration of hard Bronsted acid sites. It was observed that the rearrangement is largely controlled by the intensive factor of Bronsted acidity and that the reaction is orbital controlled and said to follow Pearsons concepts of acidity where the soft base cyclohexanone oxime prefers to react with the soft Bronsted acid sites.

Paper-97

Catalytic destruction of volatile organic compounds on platinum/zeolite

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A range of platinum catalysts supported on zeolites have been tested for the catalytic destruction of volatile organic compounds (VOC's) in air. A range of zeolites were selected as supports including ZSM-5, HY, and β -Zeolite in their acidic and sodium forms and the results compared with a conventional Pt/Al₂O₃ catalyst. Typically catalysts were prepared by ion exchange using Pt(NH₃)₄Cl₂·H₂O as the platinum source. Catalysts typically contained 0.5 to 2 wt% platinum and dispersions, as measured by hydrogen chemisorption, were in the range 39-65%. Toluene, one of the prime indoor VOC's, originating from paints, adhesives and combustion products was selected and fed to the reactor in the concentration range 200-5000ppm, with O₂ at 12 vol%. Typical W/F values were 0.03-0.24g s/ml.

Some typical conversion-temperature plots are shown in Figure 1 for toluene conversion over Pt/Al₂O₃, Pt/ZSM-5, Pt/HY and Pt/ β -Zeolite.

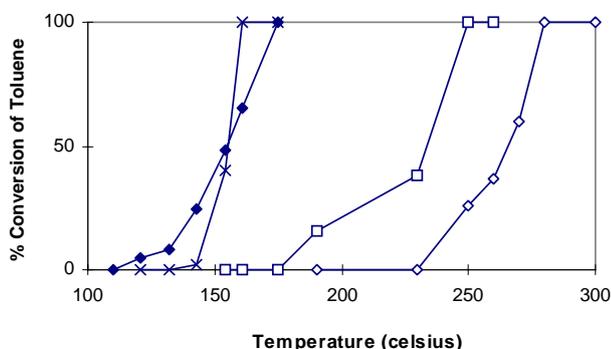


Figure 1: Conversion of Toluene over Pt/Al₂O₃ (□), Pt/ZSM-5 (◆), Pt/HY (◇) and Pt/ β -zeolite (×). W/F=0.12g s/ml, P_{toluene}= 5000ppm, P_{O₂} = 12 vol %.

Typically in our reaction conditions full conversion of toluene could be achieved over Pt/ZSM-5 and Pt/ β -zeolite below 170°C, but for every catalyst studied some coke formation was observed, with up to 10wt% coke on the catalysts after extended operation. X-ray diffraction and hydrogen chemisorption measurements indicate that platinum dispersion did not change during testing. The measured dispersions, which indicate that amount of the platinum resides outside the zeolite micropores, and the fact that the accumulated coke did not seriously deactivate the Pt/Zeolite catalysts, indicates that the active component of the catalyst is the platinum deposited on the external surface of the zeolites. Reasons for the differing activity of Pt/Zeolite and Pt/Al₂O₃ are discussed.

Paper-98

Semi-refined rapeseed oil (SRO) as a diesel fuel extender for agricultural equipment

Kevin Mc Donnell

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The renewed interest in environmentally compatible fuels has led to the choice of rapeseed oil as the main alternative to diesel fuel in Europe.

The objective of this research was to produce an economic and high quality non-esterified rapeseed oil suitable for use as a diesel fuel extender. This was achieved by acidified hot water degumming combined with filtration to five microns. This rapeseed oil was designated as a Semi Refined Oil (SRO) and can only be used as a diesel fuel extender.

A unique method for assessing injector fouling was developed which has the advantage of enabling a very rapid engine test cycle to be used. A Fouling Index (FI) based on the ratio between the fouled injector orifice area compared with a clean injector orifice area was developed which enabled the fouling propensity of various fuel blends to be correlated. This showed that injector orifice blocking increases with increasing SRO inclusion rates.

SRO proved to be a suitable diesel fuel extender, at inclusion rates up to 25 %, when used with direct injection combustion systems. Power output was reduced by c. 0.06% for every 1% increase in SRO inclusion rate, and brake specific fuel consumption (BSFC) increased by c. 0.14% per 1% increase in SRO inclusion rate.

It was concluded that SRO can be used as a diesel fuel extender in unmodified direct injection diesel engines. The only practical difference observed in this study is that the injectors require more frequent servicing compared with diesel operation. The technology for producing SRO is relatively simple and hence offers the possibility of small, locally based, production units as well as economic mass production units.

Paper-99

Effect of steam on very active alumina-based catalysts for the selective catalytic reduction of NO by propene in excess oxygen

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Introduction: Due to the deleterious effects of NO_x on nature and human health, the control of emission from power plants or automobiles is currently of great concern. An effective way of removal of the NO_x present in oxygen- and water-containing effluents is Selective Catalytic Reduction (SCR) by NH_3 ; however, this displays some drawbacks associated with NH_3 transportation and also NH_3 slip to the atmosphere. Much research work has been carried out recently regarding the possibility of using as a reductant either CH_4 , widely available and often already used in power plants as a fuel, or C_3H_6 , usually found in most diesel exhausts. However, no viable catalyst has been found for these reactions due to the detrimental effect of water on most of the materials investigated. The present work reports an investigation of a series of metals supported on alumina which have proved to be very active for the SCR of NO by propene [1]. It also examines the effect of the addition of 12vol.% of water to the gas stream on the behaviour of the catalysts.

Experimental: A plug flow reactor operated at atmospheric pressure was used with a feed of $0.1\% \text{NO} + 0.1\% \text{C}_3\text{H}_6 + 5\% \text{O}_2$ in helium. Water was added using a syringe pump. The NO_x were analysed using a gas-cell fitted in a FT-IR spectrometer. A nitrogen balance of 100% was assumed in order to obtain the N_2 concentrations.

Results: The catalysts reported here were the best formulations for the SCR of NO by propene obtained using a series of metal-promoted alumina, zirconia and ZSM-5 materials tested in our laboratory. The conversions of NO and C_3H_6 and the yield of N_2 , N_2O and NO_2 obtained using a dry feed over Al_2O_3 -supported Ag, Ni, Co and In are reported Figure 1 at their respective temperatures of maximum NO conversion (T_{max}). The metal loading on the Al_2O_3 (source and surface area given in brackets) were: 0.3wt.% Co (Akzo, $248\text{m}^2\text{g}^{-1}$), 3wt.% Ni (Rhone Poulenc,

115m²g⁻¹), 1.2wt%Ag (Alcan, 148m²g⁻¹) and 0.8wt.%In (Akzo, 248m²g⁻¹). All these Al₂O₃-based materials exhibit significant NO conversion at the high space velocity used; this is comparable to the space velocity encountered in car exhausts, with selectivities to dinitrogen of around 90% at T_{max}. The silver formulation proved to be the most effective, displaying the highest maximum conversion of NO at the lowest temperature. An optimum loading of ca. 0.01g of silver per 100m² of the Al₂O₃ was found. The addition of 12vol.% of water induced a significant loss of activity (ca. four-fold loss for all formulations) with a shift of T_{max} towards higher temperatures (Figure 2). The yields of N₂ obtained are nevertheless high, the most active catalyst still being the formulation containing silver which exhibits N₂ as the only product at its T_{max}. We are currently examining the effect of SO₂, present in typical diesel exhaust gases, on the behaviour of these catalysts.

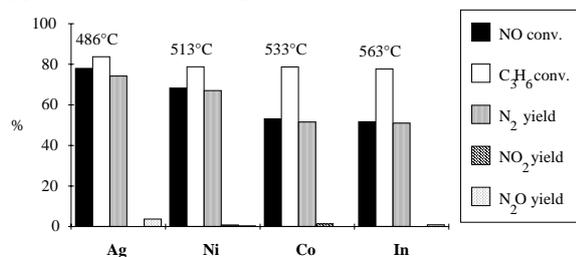


Figure 1. Catalytic activity at the given values of T_{max} of promoted alumina in a dry feed for the SCR of NO by propene in excess oxygen (GHSV= 100000h⁻¹).

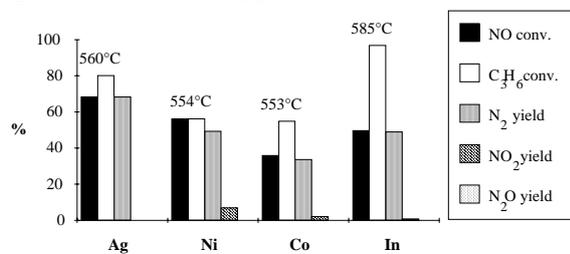


Figure 2. Catalytic activity at the given values of T_{max} of promoted alumina in a wet feed (12vol.% H₂O) for the SCR of NO by propene in excess oxygen (GHSV= 25000h⁻¹).

Reference

1. R. Ukropec, C. Stapleton and J.R.H. Ross, poster presented at the 11th ICC, Baltimore 1996.

Paper-100

The role of oxygen in photocatalysis

B.R.Eggins, J.A.Byrne, F.L.Palmer, H. Coleman, B. Kelly & P.J.K. Robertson

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When illuminated with UV-A light TiO₂ becomes a powerful catalyst capable of completely oxidising organic pollutants present in water. The photoexcited TiO₂ catalyses the electron transfer from a reducing species (pollutant) to an oxidising species present at the surface. The oxidant normally used is dissolved oxygen which is readily available in air. However it has been suggested that the reduction of oxygen is rate limiting. If oxygen acts only as an electron acceptor the process should be enhanced by the addition of a species with a more kinetically favorable reduction reaction.

TiO₂ has been used both in suspension reactors and as a photoanode material in a two compartment photoelectrochemical cell. The rate of degradation of model pollutants has been compared in the presence or absence of oxygen, or with the addition of metal ions as alternative electron acceptors. The results suggest that the role of oxygen is more complex than simply that of an electron acceptor in the degradation of aromatic pollutants.

Paper-101

The effects of vegetation and land-use change on soil development at Uragh, Co. Kerry

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Two toposequences of soils were studied, one under semi-natural woodland at Uragh, Co. Kerry and a second from an adjacent cleared site, to elucidate the effects of land use change on soil development. Pollen analysis, supported by ^{14}C dating, was used to reconstruct the vegetation history of the non-wooded site, and confirmed historical documentary evidence that this clearance occurred *ca.* 350 years BP. Reduced interception and curtailed nutrient cycling by the vegetation in the open site since then have caused a deterioration in soil structure and quality. Oak wood clearance has resulted in changes in ground flora and increased water fluxes. The increase in effective precipitation has caused greater acidification and podzolisation in well drained areas, and has resulted in increased gleisation in the poorly drained areas. The accumulation of surface organic material, evident in many of the non-wooded soils, with or without the development of an iron-pan, is a precursor to the development of blanket peat.

Paper-102

Anthropogenic influence and soil development in semi-natural oakwoods in the marginal uplands of Ireland

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The relationships between semi-natural oak woodlands and the podzolic nature of their soils were investigated at fourteen semi-natural oakwood sites. Nine non-wooded sites located in similar environments were also studied to further characterise the oakwood soils. Historical records and palynological data were used to evaluate vegetation/soil dynamics and land-use history. Chemical and physical analyses were used to evaluate pedogenic processes, especially in relation to podzolisation and hence, acidification.

Physical attributes differentiated wooded soils from non-wooded soils more than their chemical properties. There were appreciable amounts of mobile organically-complexed and inorganic, poorly crystalline iron, especially in the spodic upper B horizons of most sites. This suggests that podzolisation was, and continues to be, a dominant process in virtually all the soils studied. Podzolisation may have been initiated by the presence of *Pinus* and episodic natural and/or anthropogenic fires. Anthropogenic influence, especially through clearance, fire, pastoralism and woodland management was critical in accelerating podzolisation at most of these sites. Though podzolisation is still the dominant soil process at the wooded sites, the presence of oak seems to retard podzolisation compared to non-wooded sites.

Paper-103

Potassium levels in a forest ecosystem influenced by drought: Ballyhooly, Co. Cork - the EXMAN project

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Current climate change predictions indicate that over the next twenty years Ireland may experience summer droughts followed by storm events. The effects of such droughts and subsequent rewetting on the biogeochemical status of forest ecosystem soils and waters has been studied as part of the EU-wide EXMAN (EXperimental MANipulation of forest ecosystems) Project. The primary

focus of the study in Ireland has been to investigate the influence of periodic drought and rewetting on nitrogen mineralisation and nitrification.

More recently high levels of potassium have been observed in soil waters after drought and rewetting over a three year period at a Norway Spruce (*Picea Abies.*) stand at Ballyhooly Co Cork. Is potassium being leached from the ecosystem under such climatic conditions and will it be a significant problem if current climate predictions are correct?

The paper presents the results of three successive years' investigations at the site.

Paper-104

Effects of clearfelling in blanket peatland forests on surface water quality for salmonid fisheries

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Large-scale mechanised clearfelling of conifer plantations on blanket peatland sites is under way in western Ireland. Significant effects on water quality for salmonid fish are possible, including silting of gravel used for hatching eggs, as well as impacts on the chemistry of streamwater, particularly during high-water episodes. This project considers the mechanisms of impact initiation, and aims to separate effects of the cutting of trees alone from the activities of the machines used in the operation, and of concentrations of their activities near timber stacking areas. The method employs collection of surface runoff water from catchments ranging in scale from a few square metres to over a hundred hectares. The range includes paired experimental catchments at the 1 ha scale, to allow a direct comparison of the clearfell-only effects. Larger catchments give the opportunity to assess the export from the forest to the downstream ecosystems of suspended and dissolved substances, and the contribution of point sources within the catchment to the total catchment export. Intensive monitoring of paired and nested catchments is under way in Cloosh Valley Forest in Connemara. It is planned to extend the study to a selection of peatland catchments around Ireland for shorter-term monitoring during clearfelling operations under a broader range of conditions. The project will contribute to the development and refinement of Forest Service guidelines for forest managers on prevention of unsustainable forest management practices.

This project is funded by COFORD, the Council for Forest Research and Development, and is supported by Coillte Teoranta.

Paper-105

Seasalt deposition and its impact on soils in a maritime environment

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Atmospheric deposition in maritime regions is dominated by seasalt (NaCl) which reaches the vegetation and land surfaces through wet, dry and occult deposition. The molar sodium (Na^+):chloride (Cl^-) ratio in seawater provides a fingerprint in precipitation characterising a marine influence. Although a marine influence can be detected at great distances from the sea, it decreases rapidly with increasing distance from the coast.

As forest canopies intercept dry and occult deposition, deposition to the forest floor is usually greater than in the open. This is most pronounced in even-aged coniferous plantations, but it is a phenomenon common to all forest stands.

The potential of seasalts to induce short-term acidification in surface waters is well documented. High salt inputs during storm events result in the displacement of hydrogen (H^+) and aluminium (Al^{+3}) from the exchange complex of the soil by Na^+ and possibly Mg^{2+} in the precipitation. This is essentially a temporary phenomenon, but the restoration of equilibrium may take a long time, particularly on soils of low hydraulic conductivity.

Evidence for the salt effect in Irish soils is presented together with time sequences for sodium:chloride ratios in a forest ecosystem on blanket peatland. Episodic variation in the sodium:chloride ratio and the activity of sodium on the cation exchange complex are currently being investigated.

Paper-106

The establishment of a long-term ecological network in Ireland

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The impact of environmental change, whether of human or natural origin, is of major importance to the conservation of natural resources, the maintenance of biodiversity and sustainable development. Long-term ecosystem monitoring is an essential tool used to improve our understanding of the structure of ecosystems and the processes which control their stability.

An Irish monitoring network is currently being established. Initially, a small number of sites will be considered for inclusion. At this stage, emphasis is being laid on natural and semi-natural sites, which have existing funding or installations. All members of the scientific community are encouraged to co-operate in the establishment of the network by providing information on individual sites in which they are currently engaged in research relevant to long-term monitoring.

At present, the Forest Ecosystem Research Group in UCD is co-ordinating the network and an *ad hoc* committee consisting of the primary national agencies responsible for environmental monitoring and other scientific experts has been established to oversee this work.

Brackloon Wood, a semi-natural oakwood near Westport, Co. Mayo will be the prototype site in the network. Support has been received from the National Council for Forest Research and Development (COFORD), which will allow the scope of monitoring to be broadened to include floral and faunal components, and to develop links with existing national and international networks.

Paper-107

Nutrient and heavy metal leaching associated with the addition of animal slurry to forest soil

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Previous studies carried out by our group have indicated that nitrification and nitrate leaching play significant roles in acidification, the stripping of base cations and the mobilisation of aluminium in forest soils. Elevated atmospheric inputs of nitrogen, either as ammonium or nitrate, accelerated these processes. In this study, we examine the effects of adding animal manures to forest soils. The responses of leachate chemistry and heavy metal mobilisation are compared with the responses to atmospheric inputs and to spreading the manures on grassland.

Paper-108

Distribution and range expansion of the grey squirrel in Ireland

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The grey squirrel was introduced to Ireland c. 1912, at Castle Forbes, Co Longford. Queen's University, Belfast and Trinity College Dublin are undertaking red and grey squirrel distribution surveys in Northern Ireland and the Republic of Ireland, respectively. Four previous surveys in 1960s and 1970s are compared with the results of the recent surveys. Future expansion of the grey squirrel is predicted on the basis of expansion rates and resistance to dispersal due to topographical features.

Paper-109

The river Shannon brown trout management programme

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The Brown Trout Management Programme (1995-1998) is funded by the Electricity Supply Board. The key objective of the programme is the assessment of the brown trout fisheries in the river Shannon catchment in terms of utilisation and catch. During the period 1995-1996 the status of brown trout (*Salmon trutta* L.) in this area was examined using (1) brown trout production and mean biomass models for the geographic area under consideration, (2) monitoring of angler catches, and (3) adult salmonid census stations located in the lower Shannon and on selected afferent streams in the mid Shannon region. In general, catch rates reported by anglers and numbers of trout ascending the selected afferent streams during 1995 and 1996 were found to be lower than predicted. Although the relationship between trout abundance and angler's catch is not fully understood at this time, the relatively low numbers of trout entering the index streams to spawn is of concern. Significant numbers of trout ascended through the census station located at Ardnacrusha hydro-electric station during this period but it is unknown whether these movements were directional or accidental. Current management strategies and options for stock enhancement are outlined.

Poster-1

Immobilisation of TiO₂ powder for the treatment of polluted water

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TiO₂ is most efficient used as an aqueous suspension because it has a large surface area available for reaction with pollutants. However suspension reactors require that the catalyst be removed from the treated water prior to discharge. This may not be feasible in industrial situations because microfiltration would be required to remove the catalyst due to its small particle size. Alternatively the catalyst may be immobilised onto a suitable support substrate.

In this work a commercial form of TiO₂ was coated onto various solid support substrates using an electrophoretic method. The coated substrates were heat treated to improve adhesion of the catalyst to the support. The photocatalytic efficiency of the coatings were compared with respect to the degradation of phenol in aqueous solution. The photocatalytic efficiencies of the coatings were not markedly dependent on either the support substrate or the annealing temperature. XPS and SEM/EDX analysis of the films showed no significant differences between the various samples.

Poster-2

Land spreading of spent mushroom compost

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Spent mushroom compost (SMC) is the mushroom compost remaining after the final mushroom harvest. It contains organic matter and soluble plant nutrients. It is a valuable source of nutrients and it acts as a soil conditioner. SMC has traditionally been spread on land due to its fertiliser properties. However current SMC management practices in Co. Monaghan are cause for concern as almost 50% of it is dumped (Carlton, O. (ed.) 1993). Thirty two percent of the Irish mushroom industry is located in Co.Monaghan (Twohig, D (ed.) 1992) so a large quantity is being dumped. Nearly 77% of the county's lakes currently are classed as eutrophic and hypereutrophic compared with 20% nationally. The average annual phosphorus surplus in the county is 28 kg/ha (Carlton, O. (ed.) 1993).

A fully randomised grassland field experiment was commenced in March 1996 on a surface water Gley of loam texture in Monaghan. Three applications of SMC are being used. In addition three ages of SMC; fresh, aged for 6 months, and aged for 12 months are being used. Grass dry matter yield, chemical and physical soil properties are being measured.

A series of pot experiments is being carried out also. Surface soil samples from three Co. Monaghan soils are being used; soil taken from the same location as the grassland field experiment, an acid brown earth of silt loam texture and a surface water Gley of sandy loam texture. These three soils were incorporated with SMC at a rate equal to the highest rate in the grassland field experiment. The same ages of SMC as in the grassland field experiment are being used. Available phosphate, electrical conductivity levels, pH, and bulk density are being measured.

References

- Carlton, O. (ed.) 1993. *Monaghan Agricultural Waste Management Study - summary report*. Teagasc, Dublin.
Twohig, D (ed.) 1992. *Horticultural Crop Census 1989/1991*. Teagasc, Dublin.

Poster-3

Effect of cheese whey application on soil and drainage water properties in grassland soils

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The dramatic increase of farmhouse cheese production in Ireland has led to the problem of cheese whey disposal. The objective of this study was to assess the value of whey as a cheap fertiliser alternative, while taking into consideration its potential for environmental pollution.

Cheese whey was applied out-of-doors to 160 soil columns at rates equivalent to 0 (W1), 40 (W2), 80 (W3) and 160 (W4) m³/ha/year. Applications were made at regular intervals over two growing seasons. Two soils of contrasting agricultural significance were compared and there were 20 replications of each soil/whey combination. Five of the twenty replications (i.e. 40 soil columns) were dismantled at 6 monthly intervals and a range of physical and chemical soil parameters measured at six depths. Drainage water from columns was collected and analysed for nitrite nitrogen, nitrate nitrogen, ammonium nitrogen and orthophosphate once per month. Grass was cut on all columns on 3 occasions per growing season and herbage dry matter production determined.

Whey application affected ($P \leq 0.001$) the total concentration in drainage water of all nitrogen measurements on all dates from 13.11.93 to 6.5.94 inclusive. No significant ($P \leq 0.05$) differences were observed for orthophosphate during this period or for nitrogen measurements from 7.6.94 to 18.7.95 inclusive. Concentrations showed the following pattern on almost all occasions: W4>W3>W2>W1.

The effects of soil, whey application and depth on the measured soil parameters reduced in significance with time.

Poster-4

Petrel distribution around Ireland

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There are nine species of petrel (Procellariiformes) found in offshore waters around Ireland. While four of these breed in Ireland, only one species, the fulmar (*Fulmarus glacialis*), is resident. This group of seabirds is pelagic and may feed far offshore even during the breeding season. Petrels such as Manx shearwaters and storm petrels are very difficult to census at breeding sites because they nest in burrows often on remote islands and return to the colonies at night. As petrels spend most of their lives at sea, it is important to study their offshore distribution.

The Seabirds at Sea Team (Joint Nature Conservation Committee) has undertaken detailed seabird surveys in waters around Ireland between 1994 and 1996. Surveys are carried out from various vessels including research vessels, Irish Naval Service vessels and ferries, using standardised counting methods. This paper reports distribution patterns of petrels and how they change throughout the year.

Poster-5

Oyster rearing in Brittany

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No abstract available

Poster-6

Urban oasis: Apple Tree Court

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No abstract available

Poster-7

Water resources in Afghanistan

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Poster-8

Envirotech and EMS for SMEs

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No abstract available

Poster-9

Urban parks and local Agenda 21

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No abstract available

Poster-10

Exclusive mechanisms *versus* tolerant mechanisms - how plants survive in metal contaminated soil

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Although metals are essential to plant growth- some metals are needed more than others. Soils which contain high concentrations of toxic metals such as lead, zinc and copper can affect the growth of the plant considerably. Despite this fact, soils which contain high metal concentrations are not devoid of plant life. Plants can grow on these toxic soils by one of two ways - either they prevent the metal from entreing their tissues (exclusive mechanisms) or they have an internal mechanism that causes the metal to be harmless to the plant (tolerance mechanisms).

In January and February 1995, an abandoned mining site in the Silvermines area was investigated and the five most abundant plant species growing in the area were analysed for their lead, copper and zinc concentrations. The immediate soil in which the samples were growing was also analysed for the same metals.

Upon analysis, it was noted that soil metal concentrations were higher than 'normal' soil metal concentrations. (This was to be expected due to the site chosen for analyses). When metal concentrations analysed from the site were compared to normally encountered plant metal concentrations, abnormally high plant zinc and lead concentrations were observed. Although such concentrations are known to prevent plant growth, no such toxicity was visible in the sampled area, thus indicating resistance through tolerance of the metals in question. Of the two fundamental metal tolerant syndromes which have been reported, only the zinc/ cadmium/ lead syndrome appeared to be present in the Silvermines area.

Poster-11

Grey seal (*Halichoerus grypus*) / fisheries interactions in Irish waters: research intentions

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This work forms part of an EU (DG-XIV) / BIM funded project to investigate the affect that seals have on fisheries in Irish waters.

The physical interactions between seals and inshore fisheries will be investigated using radio tagging, diet analyses and a new technique utilising high resolution sonar. The reproductive rates and age structure of the population will be examined and methods of marking individual animals for future recognition will also be investigated.

The grey seal is a definitive host of the nematode *Pseudoterranova decipiens*. Intermediate hosts include different commercially important fish species and several invertebrates. A study of infection and prevalence of the worms in different seal populations will be conducted along with investigations of the physiological impact that the worm has on infected fish. Economics of removal of worms and the identification of invertebrate hosts will be undertaken.

This diet of the grey seal will be investigated by critically evaluating the currently available methods of pinniped diet analysis (e.g. digestive tract content, protein and fatty acid analyses) and applying them to a real population. This project also aims to use appropriate technology to qualify some of the current assumptions upon which pinniped diet and foraging behaviour are based.

Poster-12

The wildlife implications of wide-spaced agroforestry systems

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Northern Ireland is the least wooded region in Europe, having only 6% of its total land area under trees. Recent changes in land use policy and increased environmental awareness, have led to a reappraisal of the role of agroforestry in the UK.

Given the relatively small mean farm size of 25ha, it is unlikely that there will be a large scale change of land use to woodland in NI, therefore, alternative means of introducing trees to farms must be found. The integration of trees and pasture in a silvopastoral system, whereby livestock graze between widely spaced, protected broad-leaved trees, is one appropriate option.

In the mid 1980's, a forum to consider a research strategy for UK agroforestry was inaugurated and a National Network Experiment established. Two network sites have been established in NI, an upland site at Broughshane, Co. Antrim, and a lowland site at Loughgall, Co. Armagh. The output of pasture, stock and trees, the ecological interactions and the resultant impact of the system upon the environment, is currently being measured.

The aim of this work is to define some of the underlying ecological processes in operation within silvopastoral systems, which might affect the wildlife component. Achievement of this will occur by intensively monitoring some of the interactions which occur between tree, sward and stock. These implications will have an effect upon birds, invertebrates, small mammal and soil fauna populations. Changes in these variables will be monitored over time and in relation to changes in both sward and canopy structure.

Poster-13

The assessment of the environmental impact of mining on geological media

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This research focused on the study of the impact of mining activity on the geological environment, and the drawing up of guidelines for Environmental Impact Assessment (EIA) in relation to geological media.

The main sources of environmental impact are associated with mine dewatering operations, creation of large volume of solid and liquid waste, and the generation of potential pollutants in ground water, rock and soil. Major environmental concern may arise in relation to contamination of water, soil and the atmosphere with heavy metals and sulphur compounds, especially acid mine drainage (AMD). Being a by-product of the oxidation of metal sulphides, AMD may present a source of environmental pollution both during the life of a mine and also after mine closure. Modern mine technologies allow prevention of a majority of environmental problem.

This study aims to provide mine management and other interested parties with information on potential environmental impacts and hence create the basis for appropriate choice in mining technology. For EIA to be successful, first, data collection must be complete and accurate, and, second, the interpretation of these data must be full and sound. Within the EIA report, the Environmental Impact Statement (EIS), collection and interpretation of data are the main basis for the prediction of potential environmental impacts and hence the choice of preventive measures. The data

to be collected and the geological area to be considered are described in the Guidelines for Environmental Impact Assessment. The Guidelines also describe in a general way relevant aspects of mining.

The Guidelines are presented in the form of a computerised information package, to be used with Microsoft Windows. The standard Windows software was used to structure the Guidelines, and the usual help guidance is available.

Poster-14

Earthbank ecology

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Earthen banks are a common field boundary feature in agricultural systems in Ireland. They make up almost 20% of the total of recorded field boundary types in N. Ireland, as recorded in the Northern Ireland Countryside Survey (NICS) of 1992, undertaken by the University of Ulster.

In a field study of earthbank ecology, carried out during the summer of 1996, 150 earthbanks were sampled. The vegetation composition and structure of earthbanks is described. Variation is analysed in relation to the composition of adjacent grassland parcels and associated farming practices.

Poster-15

The effects of human activity on the behaviour of brent geese and wigeon on Strangford Lough, Co Down, Northern Ireland

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Numbers of overwintering Wigeon on Strangford Lough have declined from a maxima of 20,000 in the 1970s to less than 2,000 at present, whereas Pale-bellied Brent geese, which occupy similar habitats, have not suffered a similar decline. Human activity has increased around the Lough in recent decades and this has been proposed to have contributed to the decline of Wigeon which is considered to be less tolerant to disturbance than Brent geese. The present study assesses the types of human activity on Strangford Lough and their effect on Brent geese and Wigeon. The effectiveness of wildlife refuges was also evaluated. Results confirm that Brent geese are more tolerant to human activity than Wigeon. Wigeon reacted at greater distances from anthropogenic activity than Brent geese, were more likely to fly greater distances and less likely to return to their former location. Human disturbance was particularly damaging to birds because they were normally disturbed while feeding which is already limited by tidal state. The most common form of human activity was people walking. It was concluded that disturbance would have contributed to the decline of Wigeon in Strangford Lough, although is not the only factor involved.

Poster-16

Heavy metal loads in biota from the Shannon estuary

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Metal levels of Al, Fe, Zn, Mn, Cr, Co, Cu and Ni were analysed in molluscs from the Shannon estuary from 1991 to 1994. Seaweed and sediment metal levels were also taken for comparative purposes. Prior to this study no long term biomonitoring studies were carried out in the estuary. A representative sample of this data will be presented to provide an overview of the current overall trends in metal levels in the estuary.

Poster-17

Monitoring of forest ecosystems in Ireland

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Forest decline is not, as yet, a serious problem in Ireland. Thus, we are in the enviable position of being able to monitor the health status of the Irish forest ecosystems in a relatively unpolluted environment, and to collect baseline data and conditions in relatively healthy forests. In 1988, the Forest Ecosystem Research Group (FERG) of the Department of Environmental Resource Management, University College Dublin established a monitoring plot at Ballyhooly, Co. Cork. In 1991, we extended this monitoring to a further three forest plots, namely Brackloon, Co. Mayo, Cloosh, Co. Galway and Roundwood, Co. Wicklow. Precipitation throughout Ireland has a strong marine influence. Inputs of both sodium and chloride are high in Ireland, particularly in the west of the country. Proton and nitrate inputs are highest at the Roundwood site, while there is a net consumption of protons and nitrogen at the two western sites, Brackloon and Cloosh. Concentrations of nitrate in the soil water are extremely low at Brackloon and Cloosh. Ammonium inputs at Ballyhooly are significant.

Sulphate inputs are similar at all four plots and the concentrations are significantly augmented in throughfall and stemflow. A much higher proportion of the sulphate is of non-seasalt origin at the Roundwood site.

Forest health results indicate a generally low level of discoloration and defoliation at the four forest plots.

Poster-18

Biological indicators used to determine the distribution of TBT within Bantry Bay

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1. In Bantry Bay 66 stations were examined from June to July 1996 for imposex in the dogwhelk *Nucella lapillus* and 28 of these for intersex in the periwinkle *Littorina littorea*. Highest values were recorded close to contamination sources such as piers and moorings.
2. In Castletownbere Harbour, where there are high levels of TBT in sediments, some dogwhelk populations have become extinct. Dogwhelks close to this Harbour had high levels of imposex, this declined with distance from source. Similar trends were seen in *Littorina littorea* using intersex values. Contamination at Bantry, Glengarriff, Leahill and Black Ball Harbour was lower.
3. The low level of imposex and intersex within Bantry Bay (outside of Bere Haven Sound) may be due to residual flow of water through the Bay and periodic exchanges with shelf water from an area of upwelling near the Bay entrance.

4. Levels of TBT in water, as determined by imposex and intersex, are unlikely to cause significant effects in aquaculture or potential aquaculture projects within the Bay, except in and immediately adjacent to Castletownbere Harbour.

Poster-19

Lake management models - assessing and reconstructing lake oxygen regimes using chironomid larvae

Zoë Ruiz

University of Ulster

Successful lake ecosystem management requires long term data so that baseline conditions and natural variation within the system can be determined. From these, anthropogenically related changes can be discerned and likely future scenarios can be modelled. Such long term water quality data may be reconstructed using the remains of living organisms preserved in the lake sediments: species assemblages at different depths in the sediment indicate lake conditions over many centuries.

Although regimes of some water quality parameters such as pH have been reconstructed using, for example, diatom remains, that of the most vital property - dissolved oxygen concentration (DOC) - has not. Non-biting midge or chironomid larvae are good indicators of dissolved oxygen conditions in lakes and their remains are preserved in lake sediments. By modelling contemporary chironomid community response to some aspect of DOC (and other water quality parameters e.g. total phosphorous), and analysing the species composition of the chironomid subfossils in lake sediments this project aims, using recently developed weighted averaging regression and calibration techniques, to quantitatively reconstruct DOC and water quality over the last 100 - 150 years in a set of 30 small lakes in Northern Ireland.

Poster-20

The ecology of the natterjack toad in south-west Ireland

Liza Keane

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The natterjack toad (*Bufo calamita* Laurenti), Ireland's only toad and rarest amphibian, is legally protected under Appendix IV of the Habitats Directive and Appendix II of the Bern Convention. Published work on the species in Ireland is very limited, emphasising the need for further research. This project examines the toad's life cycle, from breeding to hibernation, and the factors that affect these processes. Demographic information is being related to a range of habitat characteristics, including breeding pond topography, and vegetation types in the surrounding habitat. The age structure of the population is being assessed by skeletochronology, and diet preference is being determined by using a combination of stomach flushing, sweep-netting and pitfall trapping.

Poster-21

Natural resource and landscape study of the River Lee catchment

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The Lee Valley is a catchment area of 1,200.km². A baseline study has been undertaken on the natural unit of the catchment, in terms of its natural resources and landscapes. Initially an inventory of landscape and natural resources was made. Baseline data on geology, soils, vegetation, archaeology, natural heritage areas etc. were compiled into a geographical information system (GIS).

Landscape, in the sense of physical, cultural, historical, visual and ecological elements of an area, is being examined and classified in the catchment in terms of selected landscape attributes and formative processes. This will lead to a landscape ecological study of connectivity between natural heritage areas (NHAS) and other elements in the catchment.

Natural resources of the Lee Valley are being defined in terms of the Functions of Nature (De Groot, 1992), i.e. the goods and services which nature provides for human utilisation. An economic value is being assigned for these functions, leading to an assessment of sustainability of resource use in the catchment area.

Poster-22

Farm pollution trends in Northern Ireland, 1987-1995

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Agricultural pollution incidents in Northern Ireland declined by 51% between 1987 and 1995. This decrease reflected a 77.6% reduction in silage related incidents which declined steadily since 1987. In contrast, non-silage related pollution incidents showed no consistent trend and were 22% greater in 1995 than in 1987. The downward trend in silage related incidents in Northern Ireland closely matches an increase in the percentage of wilted silages. As wilting increases silage dry matter content and reduces effluent volumes, the potential pollution hazard from silage declined between 1987 and 1995.

Pollution trends in Northern Ireland have been broadly similar to those in England & Wales. The maximum fine for causing pollution increased from C2,000 to £20,000 in 1992 and 1994 in England & Wales and Northern Ireland respectively. This increase did not have a noticeable effect on pollution numbers in either region. In addition, farm pollution trends in a number of river catchments in Northern Ireland targeted for pollution advice did not differ from the area as a whole.

A breakdown of pollution causal factors shows reductions in excess of 50% in the categories for leaking silos and leaking and overflowing tanks but incidents attributed to no collection facilities increased markedly. This increase most likely reflects a change in detection policy as it is unlikely that the number of farms without waste handling facilities increased since 1987.

Poster-23

The ecology of artificial lakes on cutover bog

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As an attempt to utilise abandoned cutaway raised bog, Bord na Móna has recently created a number of wetlands in the Irish midlands. These shallow lakes have been created over the past decade by allowing exploited cutaway fields to flood. The poster deals with the history and significance of these lakes and describes baseline studies carried out at three lakes, a study of the Entomostracan populations of 3 small waterbodies, detailed invertebrate studies at several lakes and elucidation of the feeding patterns in these lakes through studies of invertebrate and vertebrate predation (damselfly larvae and sticklebacks).

Poster-24

A critical investigation of the groundwater ubiquity score for pesticide risk assessment to freshwater lakes

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It is important to understand the behaviour of chemicals, especially contaminants e.g. trace organics, in freshwater. One group of trace organic compounds are the pesticides which are an essential element of modern agriculture in Northern Ireland. Pesticides are also used in areas from forestry to the domestic garden. The European Community Drinking Water Directive requires that the concentrations of individual pesticides in drinking water supplies must not exceed 0.1µg/l (0.5µg/l for total pesticides). Of particular concern is the movement of pesticides to the aquatic environment through runoff and leaching. We need methods to assess these risks and the Groundwater Ubiquity Score (G.U.S.) has recently been proposed as a risk assessment tool for groundwaters.

The project objective is to investigate the suitability of the G.U.S. as a method for assessing the risks to freshwaters from pesticides. Evaluation of the accuracy of the G.U.S. prediction will be carried out using data gathered from analysis of fresh water environments, i.e. lake sediment cores which give an indication of historical input trends, and water, using Gas Chromatography-Mass Spectroscopy (GC-MS) analysis and Liquid Chromatography (LC) analysis in conjunction with the knowledge of the chemical processes in freshwater lakes and sediments.

Poster-25

Storing and querying karst information in Microsoft ACCESS databases

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Carboniferous limestones form the bedrock over more than half the area of the Republic of Ireland. Knowledge on the degree and extent of karstification of the limestones is limited or non-existent in many areas of the country. More information is urgently required for a number of important reasons. A two year TCD/GSI project has been initiated to accumulate more information, data being gathered from maps and literature, local authorities, academic institutions, exploration and consulting companies. The information shall be stored in a 'Karst database' (a customised version of Microsoft ACCESS) which has been designed specifically for the project. The database can be queried to enable a better understanding of karst in the country. This query function permits the user to utilise the information to answer questions such as: "List all springs in a specified area which have a large discharge and a rapid response to rainfall and occur in a lowland topographic setting on the Waulsortian stratigraphic unit." Graphical representation of this information may be obtained as the database is connected to an AutoCAD terminal. A second 'Bibliography database' has also been created to store titles of literature on karst in Ireland. This information may also be queried using the basic ACCESS query tools. These databases are located in the Groundwater section, Geological Survey of Ireland.

Poster-26

Biological monitoring of the west Fermanagh and Erne Lakeland Environmentally Sensitive Area in Northern Ireland

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Northern Ireland has five Environmentally Sensitive Areas, covering 20% of the agricultural land area- A monitoring programme was established in 1992, to evaluate the impact of ESA designation and to provide baseline data on the wildlife value of target habitats. Plant, invertebrate and bird data were recorded on participant and non participant farms.

Habitats monitored in the West Fermanagh and Erne Lakeland ESA in 1993, included wet grasslands, hay meadows, limestone grasslands, unimproved and improved grasslands. Plant species cover was recorded. Hedgerows and field margins were also monitored. Site information such as grazing and current management practices were recorded from all habitats.

Carabid beetles and spiders were monitored as indicators of biological change. Classification and ordination of invertebrate data indicated distinct ground beetle communities associated with specific habitats. Information on the distribution and status of important carabid species such as *Carabus clatratus* has been collected and this may prove to be a useful indicator species on wet grassland habitats.

Multivariate analyses described the habitats by vegetation and species groups. Species lists and indicator species will be used to help quantify changes in the long term monitoring programme. The West Fermanagh and Erne Lakeland ESA was re-monitored in 1996, revisiting 30-40% of sites stratified by their vegetation type. Information on results from the original baseline monitoring will be presented and the classification of the habitats outlined.

Poster-27

Landscape monitoring in Northern Ireland's Environmentally Sensitive Areas

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Landscape monitoring was carried out in all five Environmentally Sensitive Areas in Northern Ireland during 1995. Land cover elements such as grassland, field boundaries, historical features were recorded from random 25 hectares squares in all ESAs, at a sampling intensity of 1.5%-2.0% by ESA area. PC ARC/INFO and ArcView were used for mapping, data retrieval and calculating estimates of land cover for the entire ESA.

Habitats were initially classified according to DANI ESA guidelines. Details of habitat subtypes such as species-rich and species-poor, were based on indicator and common plant species, identified from the biological monitoring programme (1994/1995).

Landscape monitoring of the Environmentally Sensitive Areas has initially provided baseline estimates of land cover resources, such as wet grassland, limestone grassland, hay meadows and field boundaries in the ESAs. Predictions of the areas of habitats targeted by the ESA scheme will prove valuable to both the ESA scheme promoters, planners and monitoring team.

The landscape monitoring of all five ESAs will be repeated in 1998. This will provide the initial broad evaluation of the ESA scheme, after three years. These results, in conjunction with the biological monitoring and historical monitoring results will help assess the overall effectiveness of the ESA scheme and where necessary help redefine management guidelines.

Poster-28

Estimation of *Nephrops norvegicus* biomass in the Irish Sea from research vessel surveys and hatchery studies

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Biomass of mature female *Nephrops* in the western Irish Sea has been estimated at 8,000 - 12,000t in 1982 and 1985, based on larval surveys. Fishing pressure is increasing with catches around 6,000t per year. It is important for management of this valuable resource that the actual level of fishing mortality is established.

Larval surveys offer the best means of estimating potential stocks, but potential and realised fecundity along with larval mortality must be assessed to attain sufficient accuracy and precision in estimates.

The objectives of this project are to establish a protocol for estimating *Nephrops* biomass by using the annual larval production method, and to investigate those aspects of the biology of *Nephrops*, which have most influence on the accuracy of this method. Ovigerous females are being held in the QUB Marine Laboratories, to monitor egg loss and larval production. Larvae will be transferred to rearing tanks and reared under different temperature regimes.

Information on larval survival and egg loss from adult *Nephrops* held in culture will make a valuable contribution to the understanding of *Nephrops* biology, and will significantly improve stock assessment and the quality of management advice.

Poster-29

Dairying in the rural environmental protection scheme

N. Culleton & J. Murphy

Teagasc, Johnstown Castle, Co. Wexford

The rural environment protection scheme was launched by the Government and the E.U. to help landowners farm their land in what is perceived to be an environmentally friendly manner. The severest limitation from an intensive point of view is the restrictions on nitrogen usage. A total of 260 kg N is the maximum amount of N allowed. This is composed of organic and inorganic nitrogen. The ceiling on organic N is 170 kg/ha. A dairy cow is deemed to produce 85 kg N/annum meaning that the maximum permissible stocking rate is 2 LU/ha. The balance of the N (90 kg) can be supplied from inorganic sources. Work at Johnstown was aimed at designing a system of farming that could carry 2 LU/ha within these nitrogen restrictions. The main limitations that were observed were a) length of the winter, it is difficult to make sufficient silage for longer than 140 day winter, b) concentrates fed over winter, it becomes easier to carry this stocking rate if meals fed exceed 500 kg/cow/year, c) silage yield, it is imperative that 5-6 t of silage DM/ha be harvested in late May/early June. The system designed involved only 1 cut of silage, that received normal N rates, spreading slurry in March. Using N for early grass and depending on white clover from June onwards.

Poster-30

Fertilisers for *Fraxinus excelsior* in the establishment phase

N. Culleton

Teagasc, Johnstown Castle, Co. Wexford

The work reports on the effects of adding nitrogen, and varying rates of phosphorus, potassium and lime to a recently planted stand of *Fraxinus excelsior* L. planted into a lowland fertile mineral soil at Johnstown Castle, Co. Wexford. The site is a moderately well drained loam over a clay loam. Phosphorus and potash values were 8.5 and 100 mg/kg soil, respectively and pH was 6.0. The mean height of trees at planting was 101cm and after 6 years growth mean tree height was 483cm. Mean tree diameter at 30 cm above ground at the planting stage was 12.1mm and after 6 years growth was 55 mm at 1.3 m above ground. Adding a range of N, P and K fertilisers and lime did not consistently

improve height increases or tree diameters in the 6 years of the establishment phase. The mean N, P, K, and Ca concentrations of the leaves were recorded twice annually. Mean values in N, P, K and Ca content of leaves in August were 2.5%, 0.19%, 0.91% and 1.9% respectively. There were no consistently significant differences between treatments. It is concluded that there was no need to add fertiliser in the establishment phase of *Fraxinus excelsior* when planting in a relatively fertile lowland site.

Poster-31

Windows of opportunity for spreading slurry

N. Culleton, W.E Murphy & O. Carton

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Dairy cows produce 315 litres of slurry per week during the winter months. The storage required to store this slurry using roofed slatted tanks will vary from 5.8m³ for a 16 week winter to 9.4m³ for a 26 week winter. The ideal management is to have sufficient storage capacity to keep all the slurry and spread on the land during the grazing season, when the plants can utilise the nutrients. The slurry should be returned to the silage ground where it was produced. In practice farm systems, the windows for spreading are quite narrow. The first opportunity is to spread slurry before closing for first cut silage in early April. In many years, this is not possible because land is too wet to hold slurry spreading equipment. The second opportunity is to spread after the first cut is harvested, and before the grass regrowth is too advanced. The third option is to spread after the second cut. These management options assume that farmers have adequate storage capacity for the entire winter. Unfortunately, many farmers do not have this facility. Such farmers have 3 choices, sell off surplus stock (not practical); build extra storage capacity, or spread slurry in the winter months. The second choice is the most desirable, and will be essential in the long term, more research is needed on low cost slurry storage options. Work at Johnstown Castle has show that the meteorological and soil conditions did exist at Johnstown Castle on odd occasions in most winters that allowed limited amounts of slurry spreading during winter. However careful planning and a very strict code of practice are required, and all other options should be exhausted before considering this option. In the short term this may provide some solutions, but in the long term complete winter storage should be provided, if the risk of water pollution from slurry is to be avoided.

Poster-32

Mechanisms of trace metal contaminant transport in lakes

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Elevated trace metal concentrations have been proven to contribute to problems in human haematological, renal and central nervous systems. Anthropogenic activities are the major source of trace metal input to aquatic systems.

Little is known about the processes governing the soluble metal concentrations, distribution of metals in lakes, and the nature of the solid phases by which metals are removed from the water column. This study examines the competing processes of wave-driven horizontal mixing and particle sedimentation, the residence time and distribution coefficients of individual metals and the influence of kinetics on sedimentation of metals on settling particles.

Particulates were collected fortnightly by means of sediment traps in Lough Neagh for one year and an automatic time series sediment trap was used for closer time interval sedimentation measurements. The sediment and accompanying water samples were analysed for copper, lead, zinc and cadmium by graphite furnace atomic absorption and phosphorus was analysed by solution spectrometry. Associated data, including wind speed and direction, river inflow and phytoplankton productivity were also collected. Initial results show that sedimentation rates vary between traps around the lake. This variation is probably due to wind driven water movements and is seasonally dependant.

Poster-33

Effects of Kerry cattle on the vegetation of a *Molinia*-dominated blanket bog in Killarney, County Kerry

F. Dunne & G.J. Doyle

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Blanket peatlands on the north-facing slopes of Mangerton mountain, within the Killarney National Park, have become dominated by *Molinia caerulea* with the consequent reduction in other common peatland species. Literature sources indicate that blanket bog species are replaced by *Molinia* where there are changes in land use practices. In Killarney, changes in grazing and burning regimes are thought to have influenced this shift towards *Molinia* dominance.

Relevés were taken in an area that had been grazed by Kerry Cattle for four summers and in other areas that were cattle grazed for only one summer. These were compared with relevés from similar vegetation communities that had not been grazed by cattle. Grazing by Kerry Cattle causes a change in species composition and vegetation structure. Some species increase in frequency and cover while others show a decrease or are eliminated from areas with sustained cattle grazing. Although the frequency of occurrence of *Molinia* remains unchanged, it is reduced in cover and some *Molinia* tussocks are completely destroyed.

Poster-34

A technique for obtaining 3-dimensional structural images of non-coherent particulate material (milled peat) by *in situ* impregnation

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Milled peat is a loose, non-coherent porous medium and has a typical particle size of 5-10 mm and a network of macro, meso and micro pores (>100µm, 100-30µm and 30µm). By preparing stained blocks and thin sections detailed image analysis can be used to examine the material architecture and the nature of the particle and pore size distributions. In the field, sample areas (10 x 6 cm) were impregnated slowly with a fast curing epoxy resin that had been mixed with an ultra - violet dye. After 24 hours the sample was removed as a solid block and taken to the laboratory where it was cut in the vertical plane to give two samples of equal size. A further impregnation with slow curing resin under vacuum yielded two blocks that could be sliced several times in any orientation (one vertical and one horizontal slice were considered initially). The slices were lapped and cleaned prior to being digitised for examination of the pore structure. The combination of multiple 2-dimensional images can be used to build up a 3-dimensional picture of the peat block. The techniques described is applicable to any non-coherent porous material where undisturbed samples of the structure are required.

Poster-35

Continuous measurements of total gaseous mercury at Mace Head, Ireland

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Since September 1995 continuous measurements of total gaseous mercury with 5 min time resolution are carried out at Mace Head, Ireland. The Mace Head field research station, operated by the Atmospheric Physics Research Group at University College Galway, is located on the west coast of Ireland, approximately 88km west of Galway city, near Carna, Co. Galway (53° 19' N; 9° 54' W). The station has a clean sector zone between 180° and 300°, with open access to the Atlantic ocean,

representing background conditions for atmospheric mercury and other trace gases. More than 50 % of the incoming air masses have been in this sector for the years 1990 to 1994.

A Tekran Model 2537A Mercury Vapour Analyzer was installed at Mace Head in September 1995. Sampling intervals are variable and were set to 5 min. The instrument has an autocalibration cycle which was set to 25 hours using an internal permeation source. Additionally, the instrument is calibrated manually every two to three months by injecting 20 µl of Hg-saturated air with a syringe. The instrument was intercalibrated with other automated analysers and manual methods as well during an international field intercomparison exercise in September 1995 which was carried out at this site.

Average Hg-concentrations in "clean-sector- air masses" are in the range of 1,5 ng m⁻³. High concentrations of up to 8 ng m⁻³ have been detected during other periods. Data sets for atmospheric mercury concentrations in clean air masses and more continentally influenced air mass respectively will be presented.

Poster-36

Alternative technologies to dispose of healthcare waste

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Waste to Energy is the premiere Irish healthcare waste collection and disposal company. It is contracted to dispose of the majority of countries healthcare waste. At present this waste is disposed of by export to the UK and incineration thereafter.

However the government has opened a tendering system which when complete will operate a Irish healthcare waste disposal option. Waste to Energy was one of the eight companies which has completed the, first round of tendering. The tendering was open to all European countries.

By early January 1997 the tendering system should be over and the successful candidate confirmed. It is hoped that by summer-autumn 1997 the new technology will be in operation.

Waste to Energy would welcome this opportunity to disclose its alternative technology to the colloquium. This is a Non-Burn technology with recycling aspects, and should be of interest to all attending.

Poster-37

Detection of TBT contamination in Dublin Bay using four snail indicators

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Tri-butyl-tin (TBT) is used as a biocide in ships' antifouling paints, to reduce the drag caused by fouling organisms and was also formerly used on pleasure craft and on salmon-cage netting. In 1987 a bye-law prevented the use of this substance on vessels under 25m and on other structures, with few exceptions. There has been a significant reduction in the levels of contamination since 1987 in areas of salmon farms and small boat activity as measured in 1993. In areas of shipping, however, there was a general increase in contamination. Studies in Cork Harbour, Killybegs and Castletownbere Harbours over 1994-96 indicated that contamination remains high in these areas. In the two fishing harbours contamination in sediments near to the berthage areas was high.

Dublin Bay has a number of sources of TBT contamination, but because it is a shallow bay with a 3m tidal range much of this is rapidly dispersed. A plume of contaminated water extends in a north-

easterly direction from Dublin Port, the main area of contamination. The TBT is sourced from a dry dock facility and from 4,000+ ships entering the port each year. Contamination from Dun Laoghaire, a ferryport, and Howth, a fishing port, is also rapidly dispersed. The snails *Nucella lapillus*, *Littorina littorea*, *Hydrobia ulvae* and *Buccinum undatum* were used as biological indicators by means of imposex and intersex (only in *L. littorea*) and provided base line data up to March/April 1996. Sexual changes take place in female snails at low levels of contamination and these may be used to quantify the relative concentrations of TBT in sea water. In areas of high contamination female dogwhelks die because a vas deferens seals the vagina so that the eggs cannot be released. Due to the resultant mortality the females become poorly represented in regions close to sources and some populations expire. In areas of higher contamination the winkle can survive; and because it is more tolerant of high TBT levels it is a useful species for mapping.

Poster-38

The ecotoxicology of heavy metals in the estuarine ecosystem

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Increasing emphasis is being placed upon chemical analysis of sediments to determine the distribution and concentration of toxic chemicals in aquatic environments. The resulting data are often used to characterise chemical accumulations, including delineation of 'hotspots'. These data alone, however, provide no information regarding the possible biological associations. Therefore, direct ecotoxicity testing is required.

This study sets out to investigate the effect of heavy metal contamination in estuarine sediments on the fauna (both vertebrate and invertebrate) and includes the development of a direct-phase sediment toxicity test using the tellinid bivalve mollusc, *Scrobicularia plana* (da Costa). This species is a deposit feeder and in direct contact with contaminated and uncontaminated sediments. Intrinsic to this study is the elucidation of the sensitivity of *S. plana* to heavy metals compared to the sensitivity of other estuarine fauna in order to ascertain its potential as a bioindicator.

Direct-phase sediment toxicity tests are currently being carried out using sediments collected from the Colligan Estuary, Dungarvan, Co. Waterford where previous research has indicated sediment contamination from a tannery plant. Chemical analysis of the sediments were undertaken including heavy metals (Cr, Pb, Zn, Cu), sediment grain size, pH, Eh and organic carbon.

Keywords: *Scrobicularia plana*; Direct-phase sediment toxicity tests; estuaries; heavy metals.

Poster-39

Alderwoods in south Cork

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Alder woodlands were examined as part of a project that will define a baseline of vegetation in South Cork, centred on the Kinsale hinterland. To date 430 vegetation samples or relevés have been collected, which include descriptions of higher plants, bryophytes and lichens. The vegetation was classified according to the Braun-Blanquet method of phytosociology. Soil samples were analysed for pH, % waterloss, Ca, Mg, Na, K, total N, total P, Cu, Zn and Sn.

The specific aims of the alderwood study were to provide (a) comprehensive descriptions and classification of alder woodlands in the area, based on a subset of seventy relevés, (b) to examine the plant/soil interactions, and (c) to explore the possibility that such plant communities might be used to monitor environmental impacts in the area.

Phytosociological analysis indicated that woodlands dominated by *Alnus glutinosa* belonged to the Alnetea glutinosae or alder woodland class. The majority of alder woodlands had significant elements from the Querco-Fagetea (Oak-Beech class), suggesting that they were transitional communities, possible part of a successional sequence from alder woodland ⇒ oak woodland. The

edaphic features also reflected such a sequence, passing from wet \Rightarrow dry, high pH \Rightarrow low pH, high nutrient levels \Rightarrow low nutrient levels.

Future work will involve providing comprehensive vegetation classification for the Kinsale region. By relation such information to point sources of environmental impact in the region, an assessment of the potential as pollution monitors of individual species and of plant communities may be possible.

Poster-40

Vegetation and soil characteristics of damaged Atlantic blanket bogs

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The Atlantic blanket bogs of the Connemara region of County Galway are an important feature of the landscape of western Ireland. These ecosystems are currently threatened by several types of anthropogenic activity. Overgrazing by sheep is now a well-known problem. The recent upsurge in ecotourism has increased trampling damage, while evolving mechanisation has altered the pattern of domestic peat cutting and extended the harvesting impact.

Both intact and damaged sites were surveyed for their vegetation composition and soil physical and chemical properties. This comparison led to an understand of the specific effects of the various forms of damage. Grazing and trampling were found to have similar impacts: (a) in altering the vegetation structure; (b) in eradicating some typical bog species and (c) allowing a specific suite of species to invade damaged areas. Machine damaged sites were found to have a larger number of colonising species than the other damaged areas.

The soil nutrient analyses indicate that nitrogen and phosphorus levels are higher and sodium and potassium levels are lower in the damaged sites, by comparison with the levels characteristic of peat from undamaged areas.

The correlations between the vegetation and soil analyses will provide a scientific understanding of the impacts of human activity on these sensitive habitats and contribute to the preparation of realistic management plans for the future of these areas.

Poster-41

Soil nutrient status of Irish sand-dune systems

Karen Gaynor & Gerry Doyle

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Sand-dune systems are known to be poor in organic matter and plant nutrients including nitrogen, phosphorus and potassium. While dunes along the East coast of Ireland tend to consist of siliceous sands, many along the West coast have a higher content of shell fragments, producing a more calcareous soil. The porous nature of the sediment leads to leaching of these valuable nutrients to the water-table. As a result, dune slacks tend to have higher levels of nutrients than the rest of the dune systems. Variation in nutrient levels throughout the dune system is reflected in the composition and structure of the plant communities.

The work described here, forms part of a countrywide survey of the vegetation and edaphic features of sand-dune systems. To date 700 relevés have been collected, together with some 500 soil samples from representative sites. The results presented provide comparisons in edaphic features (pH, % carbon, % carbonates, sodium, calcium, magnesium, potassium, nitrogen and phosphorus) between (a) a selection of dune systems from a variety of geographical locations, and (b) sub-habitats within a number of individual dune systems.

Poster-42

Comparative analysis of plasmid and chromosomally mediated arsenic resistance

David Ryan & Emer Colleran

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Plasmid encoded metal resistances were widespread in bacterial species even before the emergence of resistance to most antibiotics. Resistance to metals is often mediated by transport of the metal out of the cell via plasmid-encoded efflux transport proteins. Two such plasmids which encode arsenic resistance have been characterised.

The arsenic resistance operon of the *Staphylococcus aureus* plasmid, pI258, consists of three genes, *arsR*, *arsB*, and *arsC*, while that of the *Escherichia coli* plasmid, R773, consists of five genes, *arsR*, *arsD*, *arsA*, *arsB*, and *arsC*. The *arsR* gene in both strains encodes a repressor protein with 30% homology between the, amino acids. The *arsB* gene encodes a transmembrane α helix protein with 58% homology between the strains, while the *arsC* gene encodes for a reductase in both organisms, but the homology is only 19%. The transport system in R773 includes an extra gene, *arsA*, which determines an arsenic stimulated soluble ATPase. Finally *arsD* in the R773 operon encodes a secondary regulatory protein that functions separately from the repressor *arsR*. R478 is an IncH12 plasmid encoding arsenic resistance. Plasmids of the H incompatibility group are large conjugative plasmids that encode multiple antibiotic and heavy metal resistance, IncH plasmids are of interest because of their common association with pathogenic enterics. M125 is a pre-antibiotic era *Morganella morganni* strain encoding high levels of chromosomally mediated arsenic resistance.

This poster describes a series of colony hybridization experiments carried out under varying stringency conditions using an αP^{32} labelled *ars* determinant isolated from the IncH12 plasmid, R478. Previous studies have shown that, while R478 encodes resistance to arsenate and arsenite, these determinants appear to be unrelated to the *arsABC* genes from the IncF1 plasmid, R773. The probe was used to examine the relatedness of various arsenic resistance determinants both chromosomally and plasmid encoded.

Poster-43

Thermophilic anaerobic digestion of a sulphate containing molasses based wastewater

Sean Pender & Emer Colleran

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Traditionally, energy requiring aerobic biological purification processes have been employed to remove organic pollutants from wastewaters. In recent years, however, attention has focused on anaerobic digestion, which, in addition to being a net producer of usable energy, also generates far less biomass than the equivalent aerobic processes. A number of medium and high strength wastewaters can act as substrates for thermophilic anaerobic treatment as they are discharged at high temperatures. Thermophiles have higher metabolic rates, thereby allowing the digestion time to be substantially reduced.

This poster describes the start up and operation of laboratory scale thermophilic (55°C) digesters for the treatment of a molasses-based wastewater. The effects of sulphate addition to the digesters is shown, as well as the loading rates which are applicable to the system. The development of the metabolic activity of the sludges over time is also illustrated, prior to, and following sulphate addition. Results obtained during the study indicate that sulphate addition was detrimental to successful thermophilic treatment of the wastewater under study and that acetate removal was the step most affected as a result. Sulphate addition to mesophilic digesters treating an identical wastewater did not result in a similar reduction in reactor performance. Results also illustrate that mesophilic digestion of the wastewater under study achieves greater COD removal efficiency than thermophilic treatment in the absence of sulphate at the loading rates applied.

Poster-44

An investigation into the environmental impacts of sheep dips

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Sheep are attacked by a variety of debilitating parasites, including the sheep scab mite, which is highly contagious. Organophosphate insecticides are used to kill these pests, the majority of sheep still been annually dipped in these chemicals. Water samples were taken from rivers and ponds adjacent to sheep dip tanks at three sites from around the country, and were analysed for organophosphates. Diazinon was found in all samples, with high levels being recorded at site 3 where dip was escaping from the tank and directly into the water. Organophosphates also pose a health hazard to humans. Farmers are exposed to organophosphates while dipping and also while handling sheep after dipping. Organophosphates can be adsorbed by inhalation or through the skin. A growing number of farmers are now speaking out about how their lives have been ruined by organophosphate exposure. It is essential to educate farmers to wear proper protection equipment (PPE) while dipping. A survey of a small group of Irish farmers was carried out, and revealed that a large proportion (32%) wore no PPE at all; 32% were even unaware of the potential danger of dips. The survey also revealed that 27% of farmers disposed of their spent dip in a careless fashion; 27% emptying it on to surrounding soil and 9% emptying it directly into a drain or stream

Poster-45

An interesting muricid from the Irish Sea

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Nucella Roding (1797) is a genus of predatory mollusc (snail) of rocky sea shores. The type species *Nucella lapillus* is found in the North Atlantic.

Dog whelks display much variation in shape, size and colour. Some 974 enclaves of *Nucella lapillus* were studied by Crothers(1985) and the overall adult mean shell length was 27.4mm. Mean shell lengths of individual enclaves ranged from 17.0mm to 47.6mm.

American dog whelks are small, populations usually have a mean shell length of 30.0mm. In Europe, Spanish and Portuguese dog whelks also tend to be small. Populations of large form dog whelks(those which exceed 40.0mm.) have been recorded from Scottish, English and Welsh waters. They tend to occur on the lower shore or sub-tidally and have been recorded to 40m.

During September 1996, a number of snails were collected on a BIOMAR cruise with the Lough Beltra in Dublin Bay. These have been identified as *Nucella lapillus*. These snails were collected from 98m. in the Codling Deep. The largest of these snails measures 62.7mm. The length and aperture height of these shells do not conform with 'normal' *Nucella* figures.

This presentation figures shell variability within this and other populations of the large form of *Nucella lapillus* from various localities in England, Scotland and Wales.

Poster-46

The fauna of Rogerstown Estuary

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Rogerstown Estuary is a small tidal bay approximately five miles north east of Swords, Co. Dublin. The estuary is extremely shallow, with 90% drying out at low tide. The Dublin to Belfast railway line dissects the estuary, separating approximately 30% of the area to the west.

The North side of the inner estuary is utilised as a municipal tip (Balleally tiphead), presently covering 50% of this section. In addition to this tiphead, the Lusk sewage effluent outfall enters the estuary on the east side of the railway viaduct, running parallel to the railway line from the north shore. This facility, which passes through a septic tank before entering the receiving waters serves approximately 3 000 people.

During the period, August-October, 1996 a faunal survey was carried out in the intertidal zone of this estuary. This survey included infaunal analysis (collected using quadrats), analysis of pelagic and epi-benthic fauna (nets) and hand searches of algae and stones at each station for sessile fauna.

Approximately 40 taxa were recorded. This presentation details station localities and the taxa collected.

Poster-47

Analysis of waste degradation in existing landfills

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A new waste degradation project has been initiated at U.C.C. in which currently operating and decommissioned landfills will be sampled in order to investigate the characteristics of the partially degraded refuse and their associated omissions. Landfills with various geographic/topographic, climatic and geological/hydrogeological settings will be sampled using a recently purchased hollow stem auger system, which allows undisturbed solid samples to be taken. Leachate samples will also be collected from the same borehole for laboratory analysis, and various leachate characteristics such as pH, temperature, conductivity, dissolved oxygen, and salinity will be measured down the borehole. Similarly, landfill gas will be analysed for methane, carbon dioxide and oxygen, also in situ, using an infra-red gas analyser. Waste of different ages will be sampled and physically assessed, and moisture contents, volatile solids and cellulose/lignin ratios determined. Leachate will be analysed mainly for VFA's, COD, BOD and a range of metals. It is hoped that differences in degradation rates related to climatic/hydrogeological setting of the landfill sites may emerge. The ultimate objective of the project is to delineate the parameters that control degradation of waste in landfills. Preliminary results of a pilot project on a small landfill in West Cork will be presented.

Poster-48

Constructed wetlands for effluent treatment

Niall Clements

University of Ulster

This project examines the potential of constructed wetlands to remove pollutants such as phosphate, nitrate, nitrite and ammonia. The overall aim of the study is to understand the processes of removal and therefore adjust conditions within wetland design to optimise removal. Particular attention is being paid to alternative bed media capable of phosphate absorption; laterite and red mud have been concentrated on as both display the potential to remove phosphate from solution. The microbiology of constructed wetlands is relatively under studied and this project is attempting to investigate in detail the microbes involved in the production of nitrogen gas through denitrification.

Poster-49

The GC-MS determination of organic contaminants in industrial effluents using solid phase microextraction

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A new rapid sampling technique, solid phase micro-extraction (SPME), was applied to the determination of volatile organic compounds (VOC) in wastewater discharges. Environmentally significant samples, typical of those subject to regulatory control, were examined and included discharges from treatment plants of pharmaceutical, petrochemical and municipal sewerage facilities. Analysis was performed using gas chromatography - mass spectrometry (GC-MS) following sampling using headspace or immersion SPME. After extraction, the SPME device was transferred to the GC for thermal desorption 220°C for 2 minutes. A methyl silicone column (50 m x 0.20 mm, 0.5 µm layer thickness) was used with helium as carrier gas. Using a temperature program of 40-200°C the organic components were determined within a mass range of $m/z = 30-400$ in EI mode.

Fused silica fibres, coated with either poly(dimethylsiloxane) or poly(acrylate) were examined to determine VOC which included chloroform, saturated carboxylic acids, alkylbenzenes, phenol, benzonitrile and benzofuran. For most samples, headspace SPME was preferred to immersion SPME with detection limits varying from 2 - 80 ng/ml and satisfactory relative standard deviations of 2.7 - 9.3 %. In a comparative study, SPME was found to be equivalent to the purge-and-trap technique for screening wastewaters for VOC and significantly better than direct headspace sampling.

Poster-50

Identification of the diarrhoeic toxin, dinophysistoxin-2, in the marine phytoplankton, *Dinophysis acuta*

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Diarrhoeic shellfish poisoning (DSP) poses serious problems, both to human health and to the shellfish industry, due to the marked increase of the syndrome in many parts of the world. The profile of DSP toxins found in Irish shellfish is unique in that the rare dinophysistoxin-2 (DTX-2) is often predominant with lower levels of okadaic acid (OA). The observation of elevated levels of DTX-2 in mussels followed shortly after the presence of high cell counts of the marine phytoplankton, *Dinophysis acuta*, in the cultivation areas, thus providing circumstantial evidence that this phytoplankton is the primary source of DTX-2. Since this class of phytoplankton has resisted attempts at cultivation unialgal samples (22-100 cells) of wild *D. acuta*, which were harvested in Ireland, were obtained by picking individual cells from a microscope slide. Analysis by fluorimetric high-performance liquid chromatography (HPLC) found OA ($58 \pm 7 \times 10^{-12}$ g/cell) and DTX-2 ($78 \pm 14 \times 10^{-12}$ g/cell). The DSP toxins in the phytoplankton were confirmed using micro HPLC with tandem mass spectrometric (μ HPLC-MS-MS) analysis of the free toxins and μ HPLC-MS of the derivatised toxins with an IonSpray (IS) interface, coupled to an atmospheric pressure ionisation (API) source. These studies confirmed, for the first time, that *Dinophysis acuta* was the progenitor of DTX-2 in shellfish in Ireland.

Poster-51

Interception of seasalt by coniferous and broadleaved woodland in a maritime environment in Western Ireland

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Atmospheric deposition in maritime regions is dominated by seasalt (NaCl). As the forest canopy intercepts dry and occult deposition, throughfall concentrations and usually fluxes also, are greater than in precipitation. This is most pronounced in even-aged coniferous monoculture, but it is a phenomenon common to all forest stands.

We present here, the results of four year's monitoring in two forest stands, one coniferous, one broadleaved, in a maritime region of western Ireland. All important cations and anions in the ecosystem are measured at regular intervals. Only sodium and chloride are reported here.

Interception of water by the dense pine plantation at Cloosh is, as expected, much higher than by the open broadleaved stand. However, perhaps because of the high stand density, stemflow represents an unusually high proportion (23%) of the total load of water to the forest floor. By contrast, stemflow in the broadleaved stand is insignificant.

Deposition of seasalt, as represented by Na^+ , to the forest floor (throughfall and stemflow combined) is almost equal at the two stands. This is remarkable given the deciduous nature of the Brackloon stand and the low interception of water by the canopy. In Cloosh, stemflow again contributes a high proportion of the total deposition of Na^+ .

The weekly data emphasise the enormous fluctuation which occurs in seasalt deposition as result of storms. In both stands, Na^+ in throughfall is highest in winter. The impact of a major storm on January 5th of that year is illustrated in the deposition of Na^+ in the period when compared with the four year annual average load.

The extreme peaks in seasalt deposition in maritime environments has implications for the base saturation of soils and may result in the transfer of acidity from the soil to surface waters.

Poster-52

Rate constants and hydroxyl radical yield for the gas-phase reactions of ozone with a series of dialkenes

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Ozone is reactive towards various classes of unsaturated organic compounds in the atmosphere most noticeably alkenes and terpenes. Ozone-alkene reactions are of particular interest since these reactions have a significant impact on chemical transformations in the troposphere, providing mutual sinks for both ozone and alkenes and concomitantly serving as a source of partially oxidised compounds and radical species. For several years hydroxyl radicals have been implicated as playing a major role in the chemistry of ozone-alkene reactions. Recent studies suggest that under atmospheric conditions OH radicals are formed in O_3 -alkene reactions often in close to unit yield. However there are still significant uncertainties concerning the reaction mechanism and the products formed in gas-phase O_3 -alkene reactions.

Terpenes, compounds containing one or more C=C bonds, are emitted in significant quantities from vegetation. Until recent years it was believed that they played little part in the chemistry of the atmosphere. However if ozone-terpene reactions result in a significant source of free radicals then their role in tropospheric chemistry may be greater than generally believed.

The aim of this study is to look at the reaction of ozone with isoprene (2-methyl-1,3-butadiene) and related conjugated dienes in order to determine the rate constants and OH radical yields for reaction with ozone. These compounds act as prototypes for terpenes and a full understanding of these reactions will enable a structure activity relationship to be developed.

Poster-53

Reactions of chlorine atoms with aromatic compounds

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Reaction with OH radicals is believed to be the dominant loss process for aromatic compounds in the troposphere [1]. However, it has recently been suggested that Cl atoms may play a significant role in the gas phase degradation of volatile organic compounds in marine air masses [2]. Measurements of the ambient concentrations of alkanes [3] and alkyl nitrates [4] in the lower troposphere during the Arctic springtime also provide evidence for the importance of Cl atom reactions in the atmosphere. A growing body of evidence from field experiments, laboratory studies and model calculations suggest that, in addition to HCl, highly reactive chlorine-containing species, such as Cl₂, HOCl and ClNO₂ also volatilise from sea salt aerosol in the marine boundary layer. Subsequent photolysis of these compounds may provide relatively high levels of Cl in various regions of the troposphere.

This work involves kinetic studies on the reaction of Cl atoms with a series of aromatic compounds, the results of which give structure-activity relationships for the reactions. Studies of the products formed from the reaction of Cl atoms with aromatic compounds provides evidence for possible reaction mechanisms.

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Poster-54

The internet as an environmental resource

Bernadette O'Regan & Richard Moles

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The Internet is many things to many people. The objective of this poster is to share the presenter's experience regarding the use of the Internet as an environmental and general academic resource.

The paper begins with some general ideas on what the Internet is (and is not) and how to get access to it. It goes on to discuss the Internet as a passive information resource, reviewing some of the major environmental web sites. The next level of involvement is to actively use the Internet as a sounding board for your own academic work. This can take the form of sourcing, and subscribing to, one or more online mailing list or discussion groups. Alternatively, you can create your own web site and invite others to comment on your work. In this respect the presentation culminates on issues associated with the development and maintenance of a world wide website called Mine Line - dedicated to fostering a systems perspective of the mining industry.

Poster-55

Environmental impact statements for the mining industry

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When it is decided that a proposed mining development requires an Environmental Impact Assessment, the scope of the study is determined, after which the Environmental Impact Statement is prepared. This poster presents a set of guidelines outlining the information to be contained in Environmental Impact Statements specifically prepared for the mineral extraction industry in Ireland and designed to be used in conjunction with the Batneec Guidance note, Draft Guidelines and Advice Notes on Current Practice, issued by the Environmental Protection Agency.

Presently over 50% of the surface area of Ireland is under licence for exploration. These guidelines are provided as an aid to fostering small mining developments - as recommended by The National Minerals Policy Review Group.

Poster-56

The identification and amelioration of the impacts of clearfelling operations on aquatic systems in Ireland

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Research outside Ireland has shown that clearfelling of forestry can have major impacts on aquatic systems, through changes in hydrology, temperature regime, nutrient levels, sedimentation and changes in the balance between allochthonous and autochthonous inputs to rivers. These changes can in turn have direct and indirect effects on stream biota. At present, the forestry industry in Ireland is expanding rapidly and not only in terms of planting but also in the rate and area of tree felling. However, very little scientific information is available on possible effects of clearfelling on streams in Ireland. This COFORD-Coillte funded project aims to gain more information on the potential environmental impact of clearfelling in Irish catchments by investigating the impact of clearfelling at a large number of sites throughout Munster. For each clearfell site sampling is carried out both spatially and temporally at different sampling stations along the stream and variables monitored relate to water quality, stream habitat and stream fauna (both macroinvertebrates and fish). By studying the impacts of clearfelling under a range of conditions and clearfell practices this project will try to determine with which techniques and under what conditions any possible adverse impacts of clearfelling on aquatic ecosystems may be minimised.

Poster-57

Forest location and enhancement strategies in relation to salmonid fish in Munster

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Over the period 1995-98, this COFORD-funded project is collecting baseline (and some experimental) data on the populations and ecology of salmonids in relation to plantation forestry at a wide range of sites in Munster. (See abstract by Walsh et al. for a parallel study of birds in relation to forestry.) A major aspect of the study involves assessment of population densities and biomass of salmonids in relation to altitude and levels of catchment afforestation, with particular reference to buffered catchments. A stratified random sample of 63 sites (usually 30-m stretches of stream) were electrofished in spring 1996, and again in autumn 1996. Additional sites will be sampled in 1997-98, with some replication of sites to control for longer-term temporal trends. Preliminary data on densities and biomass of fish in relation to altitude and catchment afforestation categories will be presented.

Poster-58

Using GC-MS/Combustion/IRMS to determine the 13C/12C ratios of individual hydrocarbons produced from the combustion of biomass materials - application to biomass burning

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The coupling of a quadrupole mass spectrometer to a gas chromatograph / combustion / isotope ratio mass spectrometer (GC-MS/C/IRMS) allows simultaneous mass spectral detection and isotope ratio analysis of individual compounds separated on a single column. This significantly enhances the ability to identify and assess the purity of individual compounds in complex organic mixtures, which in turn reduces the uncertainty associated with determining the isotopic composition of individual compounds. Here we describe the application of a GC-MS/C/IRMS to determine the $\delta^{13}C$ of individual aliphatic and aromatic compounds produced from the pyrolysis of a variety of biomass materials in controlled laboratory experiments. The results of these studies may serve as a means of determining past biomass fire origin, frequency and intensity (e.g., C3 forest vs. C4 grassland). The results may also be of value in assessing past climatic conditions since biomass burning has been shown to be an important source of greenhouse and other chemically active gases over the past few decades.

Poster-59

Mapping critical loads for Ireland: progress to date

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In recent years pollutant loads of sulphur and nitrogen have been described in terms of critical loads. The basis of this concept focuses on the link between emissions and ecosystem response. It indicates the maximum level of pollution which is compatible with the sustainability of ecosystems and the maintenance of environmental quality.

Critical loads have become a well established element within the work programme of the UNECE Convention on Long-Range Transboundary Air Pollution. Since January 1996 the Irish Environmental Protection Agency have been funding a three year project titled "Determination and mapping of critical loads for sulphur and nitrogen and critical levels for ozone in Ireland" under the Environmental Monitoring R&D Sub-programme.

The progress to date in mapping critical loads for Ireland is discussed in this poster. As well as contributing to the ongoing emissions reduction strategies, this research will have other applications, such as identifying sensitive ecosystems and quantifying their tolerance to specific pollutants.

Poster-60

Gaseous SO₂ measurements with passive samplers at forest sites

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Although the mean concentration level of sulfur dioxide (SO₂) has decreased all over Europe in recent years, it is still the most significant pollutant in relation to acid deposition to many nature areas in Ireland. SO₂ has been intensively measured in areas where concentrations are generally high, close to emissions sources such as power plants, using advanced techniques. In this research project the aim is to apply a sampling technique appropriate to monitor the much lower concentration level in remote

nature areas. A passive sampling technique, the Willems-badge, is especially adjusted for this purpose. The effect of different exposure times is investigated in a field comparison studies. Unlike other passive sampling methods the detection limit of the Willems-badge is very low and it can function without the use of a reference method in different outdoor circumstances. The passive sampler does not need electricity and is an inexpensive technique. The final goal is to fit in the passive sampling with the forest ecosystem monitoring program.

Poster-61

Shells of dog whelks (*Nucella lapillus*) from two shores with different levels of TBT contamination

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TBT (tributyltin) was formerly used as an antifouling agent in marine paints. It causes major interference with the breeding process of molluscs, including imposex in some species, including *Nucella lapillus*, whereby females develop a penis. The incidence of imposex can be used as an indicator of TBT contamination.

By referring to previous work (Minchin *et al. Marine Pollution Bulletin*, 30: 633, 1995, and personal communication) two shores near Cork harbour were chosen which had high incidence (Fountainstown, Irish Grid W 789 578) and low incidence (Garrettstown, W 595 446) of imposex, suggesting different contamination levels of TBT. Both shores had similar exposure on the Ballantine Exposure scale. Sixty specimens of *N. lapillus* were collected in January 1996 from the same tidal level of each shore using the "rule of twelfths". In the laboratory a range of standard morphometric measurements were made and shell strength was measured on an Astron tensometer. Significant differences, between shores, both in morphometrics and strengths may be due to level on the shore (the same in this case), shore exposure (both shores had similar Ballantine scale values), or, TBT. The results are preliminary in nature and need to be carried out at further sites to elucidate the factors involved.

Poster-62

Management priorities for the River Nore (Ireland) to conserve the pearl mussel, *Margaritifera durrovensis*

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The River Nore in south-east Ireland is the only location for the freshwater pearl mussel *Margaritifera durrovensis* (closely related to both *M. auricularia* and *M. margaritifera*). The Nore also contains all of the freshwater species in Ireland (six species of fish and one crustacean) listed as in need of protection in the European Union 'Habitats' Directive. Since 1991, our studies have assessed the abundance and distribution of the pearl mussel and the quality of the river as a mussel habitat. The river Nore suffers from nutrient enrichment, and in places bank erosion has led to river bed siltation. Mussels are confined to the main channel of the river Nore, no juvenile mussels have been recorded, and the population is considered threatened with extinction. In the Nore, mussels are most abundant under the shade of trees beside the river bank, and least abundant where filamentous algae cover the river bed. This suggests that even localised river bank management (e.g. fencing, tree planting) may improve habitat conditions. There are a variety of authorities, organisations and individuals who must be co-ordinated to utilise existing resources to improve the river quality. This would have benefits for both nature conservation of freshwater and riparian species, and angling and tourism amenities. It may also benefit land owners through provision of advice on land and soil

nutrient management. Such an initiative in river management would be pioneering in Ireland, and break the ground for similar work in other rivers.

Poster-63

Landform replication in quarries - an example of basalt landscapes in Northern Ireland

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Designed quarry production faces are dissimilar from natural escarpments with respect to their physical characteristics, ecological diversity and position in the landscape. Modern basalt quarries in Northern Ireland are characterized by unbroken bare faces, standing water, scree blast piles and a general absence of vegetation. In contrast, natural scarps occur on a smaller scale, provide a range of ecological niches in morphologically diverse terrain, and are more aesthetically pleasing components of the landscape.

Of 306 possible sites in Northern Ireland, 99 were identified as being essentially unmodified (semi-natural). Semi-natural escarpments have been found to consist of an assemblage of specific morphological elements. Ten such elements have been identified; 5 or 6 of these occurring on almost all locations. Analysis of assemblages of morphological elements through site mapping and photography has enabled a quantitative model of semi-natural escarpments to be produced.

The aim is to examine the physical and ecological characteristics of natural basalt scarp landforms. Identifying these and the processes operating on them can lead to the potential re-creation of these more natural appearances in abandoned quarries. Former quarry basins will therefore contribute to, rather than detract from, overall landscape character.

Poster-64

Groundwater protection of a sand and gravel aquifer

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Protection of the sand and gravel aquifer west of Letterkenny town, Co. Donegal is essential as this groundwater resource is to augment a public drinking water supply that will meet the needs of Letterkenny town into the next century. The aquifer is a glacial outwash deposit in a river valley of between 2 and 10 of clean sands and gravels overlying metamorphic schists. The stratigraphy of the Quaternary deposits is highly complex due to the chaotic mode of deposition during and after the last glaciation. This results in a complex groundwater system and groundwater chemistry. 4-10m of estuarine silts overlie the gravel aquifer close to Letterkenny town, where the aquifer is semi-confined. 2-8m of silts and sands overlie the aquifer to the west.

The Geological Survey of Ireland Groundwater Protection Scheme methodology was applied to the aquifer. It aims to protect groundwater from existing and new potentially polluting activities by assessing the vulnerability of groundwater to pollution, by applying zones for both the resource as a whole and the source (wellheads) and finally by applying codes of practice to manage potential sources of pollution within these zones. Vulnerability categories were assigned and Source and Resource Protection Zones were delineated. The GSI scheme was adapted to the sand and gravel aquifer and this paper describes the adaptations.

Poster-65

Detection and quantification of supplemental phytase activity in animal feed

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Selected microbial enzymes may be added to animal feed in order to promote a number of nutritional and other goals, including the reduction of the pollutive effect of animal excreta. The enzyme phytase (EC 3.1.3.8) exhibits significant potential in this regard. 60-80% of the phosphorous present in cereal grains used to manufacture animal feeds is present in the form of phytic acid (myo-inositol-hexaphosphate). Phytic acid - phosphate is biologically unavailable to monogastrics (e.g. pigs and poultry) as the monogastric digestive tract is virtually devoid of the enzyme phytase, which hydrolyses phosphate groups from the core inositol ring structure. Thus a very significant proportion of the phosphorous in animal feed is excreted by monogastrics, contributing greatly to the pollutive effect of animal slurry. Supplementation of monogastric animal feed with microbially-derived phytases has been shown to ameliorate this effect by conferring on the animal the digestive capacity to degrade phytic acid. Incorporation of phytase in monogastric animal feed thus has the potential to substantially reduce environmental phosphate pollution, particularly in the area of intensive (monogastric) animal production. A suitable assay system capable of detecting and quantifying phytase once added to feed is required for regulatory and quality control purposes. We describe an assay, based upon radial diffusion of enzyme through a substrate-containing gel, which is capable of detecting and quantifying phytase when incorporated into animal feed at typical industrial inclusion levels.

Poster-66

Metabolism of mono-chlorophenols by a mixed microbial community

Alan Farrell & Brid Quilty

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Chlorinated phenols are xenobiotics of serious environmental concern, due to their usage in the production of pesticides, herbicides and disinfectants. They may also be found in effluents resulting from pulp and paper manufacture, and may be formed during chlorination of wastewaters. Chlorophenols pose an environmental risk because of their acute toxicity and relative persistence to degradation. Hence, their complete elimination from the environment is desirable. Several aerobic bacteria have been shown to completely degrade chlorophenols, through chlorocatechols, with dehalogenation taking place after ring cleavage via an ortho- pathway. However, degradation of chlorophenols may result in the production of coloured, toxic by-products following meta- cleavage of chlorocatechols.

The present study is concerned with the metabolism of mono-chlorophenols by a commercially produced, mixed microbial community, which has been designed to degrade a range of substituted aromatic compounds. Metabolism was monitored using a variety of methods, degradative pathways were established and intermediates typical of these pathways were identified. These studies have shown that under standard conditions, in aerobic batch cultures, metabolism of chlorophenols is due to meta- cleavage. With modification of these conditions, it is hoped that metabolism may be directed towards the more productive ortho- pathway.

Poster-67

Fat degradation by microorganisms

John Fleming & Brid Quilty

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Processing of animals and animal products produces large quantities of fat as waste. Fats such as tallow have high specific BOD's, and are usually solid at waste-treatment temperatures. If fat is not removed from a waste stream, it interferes with the treatment of this waste. It is therefore necessary that some preliminary treatment is used to remove fats and prevent them reaching the aeration tanks, in the waste-treatment systems and the receiving waters.

To date, the most common methods of removing fats from wastewater are physico-chemical methods before the biological stage. This can take the form of a fat trap or a flotation unit (e.g. Dissolved Air Flotation (DAF) unit). These methods are, however, prone to shock overloading, allowing fats to enter the biological stage of treatment.

As a preliminary step to developing a microbiological fat system, the ability of some microorganisms to biodegrade fat was assessed. These organisms were isolated from waste-water and activated sludge obtained from a commercial rendering operation which produces large quantities of fat-containing waste. The most efficient organisms have been identified as mycelial fungi and yeasts. The ability of these organisms to degrade solid fat under specified conditions was assessed.

Poster-68

A pilot study into the effects of clearfelling on nutrient losses and sustainability

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The Forest Ecosystem Research Group has been intensively monitoring the chemistry of a Norway spruce forest stand (planted 1939) in Castleblagh Wood, Ballyhooly Co. Cork, since late 1988. Six years of measurements were completed in 1994, sufficient to make realistic estimates of the size of and variation in atmospheric inputs to this stand. The site had been monitored considerably less intensively throughout 1995. The stand was clearfelled by Coillte Teoranta in October 1995.

This project was designed to monitor the impacts of clearfelling and replanting on nutrient cycling, water quality and the sustainability of the forest resource. Emphasis is placed on the quality of water leaving the forest, the potential pollution impact and the long-term sustainability of the resource. It is anticipated that following the clearfelling of the forest stand, the nutritional status of the site will be affected by losses of nutrients to surface waters and to groundwater. Nutrient pools will be influenced by the decomposition of organic matter including crop residues (lop and top). Preliminary results indicate that the concentration of nitrate in soil water has increased significantly.

Funded by the Forest Service through the back-up measures of the Forestry Operational Programme.

Poster-69

Carbon dioxide emissions in blanket peatland forest, Cloosh Valley, Connemara

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Northern peatlands occupy some 346 million hectares and play an important role in the global climate. They release considerable amounts of methane and sequester large amounts of carbon dioxide. In Europe 15 million hectares of peatlands have been drained for forestry. Research interest has grown about the impact of peatland drainage on the carbon balance and the role of peatland forests in the global climate.

This poster describes research being carried out in Cloosh Valley Forest, Connemara to investigate some of these impacts. Carbon dioxide emissions are being monitored across a range of sites, open peatland, recently afforested, mature forest and recently clearfelled. During measuring campaigns the water table level is measured at all sites and it is planned to constantly monitor the soil temperature at a small number of sites. This will enable CO₂ emissions to be modelled and estimates of the annual CO₂ flux to be calculated based on soil temperature measurements. Other elements of the project are, (i) a litter bag experiment to assess the rate of decomposition and nutrient leaching at all sites, and (ii) controlled laboratory studies using cores of peat to assess the quantitative impact of water table depth and soil temperature on CO₂ emissions.

Poster-70

Estimation of evapotranspiration in small forested peatland catchments using the water balance method and its comparison with potential evapotranspiration values by Penman-Monteith equation

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Evapotranspiration is important as a term in the hydrological cycle, eg in soil water and ground water balances and in salinisation. There are a number of equations which give an approximate value of evapotranspiration and the most commonly used equation is the Penman-Monteith equation. In this study the Penman-Monteith equation method will be compared with the water balance equation method. Field values for the water balance equation were collected at small forested peatland catchments in Connemara (Cloosh valley). Here the parameters in the water balance equation will be measured and evapotranspiration will be calculated directly. The ET_p value obtained will then be compared with the values obtained from the Penman-Monteith equation. The difference in the ET_p values is taken as the error. This error may provide a modifier term for application of the Penman-Monteith equation to such sites.

Acknowledgement: Data for this study were supplied by the Forest Ecosystem Research Group, ERM Dept, UCD from COFORD project 3-3-95.

Poster-71

Impact of seasalt deposition on cation exchange processes and proton transfer in a forested peatland

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Atmospheric deposition in maritime regions is dominated by seasalts. It has been found that the impact of storm events is very pronounced in western Ireland. Seasalt deposition events may have an effect on soil ion exchange processes in these regions and induce short-term acidification in soil water and in surface waters. The experiment was carried out in a stand of *Sitka Spruce*, on deep blanket peatland, at Cloosh valley forest, Co. Galway. The preliminary results have shown that Mg and Na comprised more than 50% of total exchangeable cations and over 90% of base cations in the forested peatland, except in the O horizon. In general, the CEC decreased with the peat depth. The concentration of exchangeable Fe was contrary to the general trend and increased with depth. There were no significant variations of exchangeable cations during 10 successive months of measurement. It is suggested that the significant changes in exchangeable cations in forested peatlands occur only after major storm events.

Poster-72

Quantitative effects of macrophyte growth on hydraulic efficiency during and immediately after summer rains

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Since the Rio Summit many governments have professed themselves interested in biodiversity. This has manifested itself in the UK as a desire to increase habitat diversity on those river systems which have been subjected to channelization in the past. This manifestation has resulted in two major river restoration projects in England in the last five years, and a couple of smaller ones in N. Ireland, one of which is centred on campus here at UUC. One of the major problems associated with river restoration is trying to find a balance between the ecologically sound (and the aesthetically pleasing) and the hydraulically efficient aspects of a river channel. The balance required is one which allows the development of many different ecological niches, while maintaining hydraulic efficiency. What effect does the planting of aquatic macrophytes and channel re-adjustment have on the hydraulic efficiency of a river channel?

The poster will contain, as well as some before-and-after photographs of the stream in question, some preliminary results of the quantitative effects of macrophyte growth on hydraulic efficiency during and immediately after summer rain storms, and, perhaps, how this can be mitigated against by proper planning of the channel re-adjustments.

Poster-73

Environmental Protection Agency: Assessment of the sensitivity of estuarine and coastal waters to eutrophication due to nutrient inputs, with reference to Dublin Bay and adjacent coastal areas

Peter Cunningham

Environmental Protection Agency

This poster will be based on a recently completed examination of data collected by EPA over the last four years.

Poster-74

Electromagnetic treatment of water

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Scale formation is normally associated with divalent metal ions such as calcium, magnesium and silica present as sulphates, carbonates and phosphates in water. As the solubility product of each component species is exceeded due to changes; in concentration by evaporation or freezing, increases in temperature or changes in pH, metal salts precipitate as small colloidal particles. Scale formation proceeds through the processes of crystal nucleation followed by crystal growth. The formation of scale on heat transfer surfaces, equipment walls, in pipelines, etc. presents a common and frequently serious industrial problem. It is estimated that the build-up of scale in industrial water systems costs British industry over £600 million each year¹. Traditionally chemical based products were employed in the prevention and removal of scale deposits. However, with growing environmental awareness, industries are increasingly moving toward cleaner, greener options.

The EIDS Fluid Treatment System manufactured by ZPM Europe Ltd is an innovative clean technology for the prevention of scale which operates by the emission of selected Radio Frequency directly into the water through the patented Energy Interface Delivery unit. The technology is designed to retain scale forming ions in solution until they eventually precipitate out as larger particles² with a reduced propensity to form scale deposits. The precipitated charged colloidal particles interact with the electric field of the radio frequency signal modifying the nature of the surface charges (hence the zeta potential), thereby altering the crystal growth characteristics^{3,4}. Results from laboratory experiments and industrial trial sites are presented.

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Poster-75

Sodium, magnesium, iron and lead levels in Irish honey, including an urban / rural comparison

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Sodium, magnesium, iron and lead levels were determined in fifteen samples of Irish honey using both flame and graphite furnace atomic absorption techniques. Both wet digestion and dry ashing preparation was used and comparative results will be presented. Since the samples formed part of a larger study (M.F. Coffey, *The sources of pollen, nectar and surplus honey using melissopalynology and the multivariate classification of honeys*. PhD thesis, University of Limerick, 1995), the floristic sources of the honey is known. Sodium levels had a mean of $33.1\mu\text{g/g}$ though this value may be subject to interference with potassium. Magnesium levels had a mean value of $13.4\mu\text{g/g}$. The mean value of iron was $2.21\mu\text{g/g}$, similar to values reported in American honeys; dark honey samples had higher values of iron. Lead had a low mean value of $0.09\mu\text{g/g}$. There was no significant difference (Student's *t* test) between rural and urban samples.

Poster-76

The use of Chironomidae (Diptera) as biological indicators in Lough Neagh

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Many of the Chironomid species found in Lough Neagh have a world wide distribution, and have been used as biological indicators of water quality. This poster describes their use as indicators in Lough Neagh over the past twenty years, and how these results compare with those of other studies.

A comparison is made between the contemporary Chironomid fauna of the Lough and the fauna present in the 1970's. Despite a reduction in phosphate loading from point sources to the Lough in the 1980's, the composition of the fauna has remained fairly constant. Data from the profundal area of the Lough (5 - 25 metres of overlying water) are compared for 1975 and 1995. Calculation of biotic indices for these sites shows that Lough Neagh does not appear to conform to published limits.

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