



Book of Abstracts

Oral Presentations

Ireland's Environment 2012:
EPA-STRIVE Research Conference

Trinity College Dublin

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About EPA Research

Science, Technology, Research and Innovation for the Environment (STRIVE) is the EPA research programme covering the period 2007 to 2013. It employs a strategic and targeted approach to protecting and improving the natural environment through the provision and accumulation of scientific research and knowledge. The programme covers the breadth of environmental issues and is structured three pillar areas:

- Climate Change & Air Quality
- Water Quality & the Aquatic Environment
- Sustainable Environment

The EPA has provided funding towards over 390 projects since 2007 and regularly hosts event to showcase findings from the programme. The sessions at today's events concentrate on three priority areas:

- Environment & Human Health (Focus on Water)
- Air Quality and Transboundary Emissions
- Biodiversity-Simbiosys Project

The Simbiosys project is led by Dr Jane Stout, TCD with partners from Queens University Belfast, University College Cork, University College Dublin. EPA provided the funding for this project which is due to complete in October 2012. The research carried out aims to quantify the impacts on biodiversity of key sectoral activities (in particular, cultivation of bioenergy crops, road landscaping and aquaculture). The work also examines role of biodiversity in providing ecosystem services including pollination, biological pest control, carbon sequestration and resistance to alien species invasion. This conference presents the key findings and outputs from the project.

ORAL ABSTRACTS

Oral Abstracts

Sectoral impacts on biodiversity and ecosystem services: introduction to the SIMBIOSYS Project

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Biodiversity and associated ecosystem services are fundamental to humanity but are increasingly threatened by human activity in a range of sectors. Globally, multi-trillion dollar values have been attributed to ecosystem services; a conservative estimate of the value of biodiversity and ecosystem services to Ireland is €2.6 billion per annum.

The SIMBIOSYS Project addressed impacts of three key sectoral activities in Ireland: cultivation of bioenergy crops, road landscaping and aquaculture. We investigated the impacts of these sectors on genetic, species and landscape biodiversity. We also investigated how sectoral activities affect the delivery of ecosystem services, including carbon sequestration, pollination, pest control via natural enemy predation and resistance to alien species invasion. To do this, we combined large-scale field-based surveys with focussed smaller-scale experiments to investigate the relationships between biodiversity and the delivery of these services.

In addition, we carried out in-depth policy-orientated reviews of these three sectors, and reviewed sectoral impacts on coastal marine ecosystems, and influences of wind farms on biodiversity and ecosystem services.

Overall, six PhD students, six Principal Investigators, three post-doctoral researchers and several other research assistants from TCD, UCD, UCC and NUIG worked directly on this integrated collaborative project which began in April 2008. Many other external collaborators were also involved, both in experimental work and as consultees on the sectoral reviews.

Findings from a range of habitats and sectors are summarised in the following abstracts and will be presented at this meeting. These findings contribute to fundamental understanding of key ecosystem processes and services, and will help to inform national policy decisions, future strategic research and management.

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Oral Abstracts

The effects of environmental context on biodiversity in agroecosystems: managing for biodiversity and ecosystem services

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Agricultural ecosystems are an important component of Ireland's biodiversity and deliver a wide range of ecosystem services. As a result of national and international policy to reduce fossil fuel use and CO₂ emissions, traditional agricultural crops are being converted to bioenergy crops. This introduces further heterogeneity in to the landscape, and there has been little research on the effects of this conversion on animals and plants and the ecosystem services that they provide. In Ireland, the most widely planted biomass crop is the perennial rhizomatous grass, *Miscanthus*. In addition, oilseed rape is grown to produce pure plant seed oil and biodiesel, and bioenergy incentives are increasing the cultivation of this crop. In this project, we used these two bioenergy crops as models to assess the effects of context (i.e. crop type) on the relationship between biodiversity and the ecosystem services that it delivers. The ecosystem services that we addressed were carbon sequestration, primary production, pollination and crop pest predation by natural enemies.

We found strong impacts of these energy crops on the biodiversity of focal groups including beetles, pollinators, and plants; however, the relationships between species richness and the ecosystem services that these groups deliver were not affected. Instead they were maintained across a range of ecological contexts at landscape scales. These results suggest that in multifunctional landscapes producing food and fuel, our ability to directly manage ecosystem services will be limited, but that by managing for biodiversity we can maintain the delivery of a wide range of different ecosystem services.

However, achieving targets of reducing biodiversity losses by 2020 and maintaining ecosystem services will require a greater understanding of aggregated impacts at the landscape-scale to ensure the sustainable development of climate change mitigation measures in Ireland.

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Oral Abstracts

Impact of road landscape treatments on biodiversity within road corridors and adjacent ecosystems.

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Maintenance and development of communication and transport infrastructure is central to economic development and growth. Roadways can affect biodiversity and the delivery of ecosystem services in both negative and positive ways. Construction of roads modifies the landscape, potentially fragmenting habitats and affecting the biology of plants and animals. On the other hand, road margins/verges also provide a vegetated cover (normally maintained) along the length of the road. This may act as a corridor for flora and fauna to move around the landscape, and is considered by some to mitigate/compensate for the effects of fragmentation. However, the ecology of roadside landscapes needs to be considered in the context of adjacent land use. In addition, the ecosystem services road margins/verges deliver are poorly understood.

Prior to 2005, in Ireland, most of the road margins/verges were designed and managed to horticultural specifications, often using alien plant species and requiring high management inputs. In 2006, the publication of a Guide to Landscape Treatments for Irish Road Landscapes (National Roads Authority, 2006) heralded a change from horticultural practices to an approach based on ecological landscape design and native species. The timing of the SIMBIOSYS Project presented a unique opportunity to determine whether new landscape treatments are resulting in different or higher levels of native biodiversity in comparison with former landscape treatments, since there were parallel instances of both practices being operated between 2004 and 2007.

Investigations on road ecosystem biodiversity were carried out at landscape scale as well as across a range of species and at the molecular level. In addition, the potential for delivery of ecosystem services was assessed by investigating invasive species, pollinators and carabid beetles. Furthermore, we established a long-term, large scale road landscaping experiment which will enable future research to extend our understanding of environmental change on the biodiversity and ecosystem services of these habitats.

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Oral Abstracts

Assessing and reducing impacts of aquaculture on marine biodiversity and ecosystem functioning

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Ireland's coastal waters are very important to its society and its economy. A wide range of activities impinge on them, with potential to affect biodiversity and the provision of ecosystem services. Aquaculture is a significant industry for Ireland, particularly in remote coastal communities.

A collaborative strategic review revealed that aquaculture can influence biodiversity and ecosystem functioning and services in a number of ways. The influences considered most important in Ireland are interactions with wild fisheries resources, physical damage to or replacement of habitat, organic and nutrient enrichment, as a vector for invasive species and through interactions with seals and birds. The relative importance of these interactions depends on the environmental, economic, social, political and legislative context. Some features of the Irish aquaculture industry make its impacts generally less severe than those observed in other nations and can potentially be mitigated in a number of ways.

The role of aquaculture as a vector for potentially invasive species was a particular focus of research in SIMBIOSYS and we investigated the spread and potential impacts on biodiversity and ecosystem functioning of Pacific Oysters, *Crassostrea gigas*. Research was also undertaken into the extent and nature of impacts of nutrients and organic material derived from salmon cages.

Aquaculture occurs in many Natura 2000 sites and exerts a range of physical, chemical and biological pressures. Finding an acceptable balance between the economic and social benefits of aquaculture and the achievement of conservation objectives presents a significant challenge. Addressing this challenge effectively requires a considerable improvement in our knowledge base and recommendations will be presented for key areas of future research.

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Oral Abstracts

An assessment of carbon sequestration under Miscanthus x giganteus at different spatial scales – a case study in south east Ireland

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In recent years *Miscanthus x giganteus* has increasingly been proposed as a source of biomass for energy production in Ireland. The recent Bioenergy Scheme will support the planting of another 1400 ha of *Miscanthus* and willow. In addition to replacing fossil fuels it has been shown that growing *Miscanthus* can sequester a significant amount of carbon into soils, further mitigating carbon emission.

The aim of this study was to assess the factors influencing soil carbon sequestration at different spatial scales. A survey was conducted on 16 farms in south-east Ireland showed that soil carbon sequestration ranged from 0 to 1.75 Mg ha⁻¹ yr⁻¹. When planted on grassland soil carbon sequestration under *Miscanthus* was significantly higher than when planted on tilled land. Higher initial soil organic carbon content and a higher pH were shown to promote soil carbon sequestration. A comparison with the adjacent former land-use also showed that soil organic carbon losses due to land-use change were not significant.

A significant number of commercial *Miscanthus* plantations showed a high number of large open patches. Significantly lower carbon sequestration rates in the open patches compared to adjacent high density *Miscanthus* patches were measured (1.51 ±0.31 Mg ha⁻¹ and 2.78 ±0.25 Mg ha⁻¹, respectively). A GIS model revealed losses in carbon sequestration on a field scale with a mean reduction in soil carbon sequestration of 9.19 ±1.42 %.

In conclusion, it was shown that *Miscanthus* has high carbon sequestration potential. However, this potential, as well as the effective carbon sequestration show strong local variation. Knowledge of site specific factors known to control soil carbon sequestration is therefore important to maximise this ecosystem service when growing *Miscanthus*.

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Oral Abstracts

The impacts of growing bioenergy crops on pollinators and pollination services in Ireland

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Pollination is an essential ecosystem service required by the majority of flowering plants, including many agricultural and horticultural crops. Pollinating insects, including bees, butterflies and hoverflies, are increasingly threatened by many human activities including land use change and agricultural intensification. Therefore, the conversion from conventional agriculture to the growth of energy crops in the Irish landscape has the potential to affect pollinator populations and have knock-on impacts on pollination services. By conducting large-scale field-based studies in SE Ireland, we found that growing the bioenergy crops, Miscanthus and Oilseed rape at a small scale had little impact on bumblebees, butterflies and hoverflies in comparison to conventional agriculture, but more individuals and more species of less mobile solitary bees were found in both energy crops compared with conventional crop types. More flowers for pollinators to forage on were also found in energy crops. In addition, different assemblages of solitary bee species were found in both the energy crops. In all crop types, more flowers and pollinators were found in field margins than in the centre of fields, and bumblebees searched for nests only in the margins. Energy crops may therefore be beneficial for pollinator diversity when grown at low density in a heterogeneous landscape, and field margins are particularly important. Most insects foraging in margins around winter oilseed rape fields carried large loads of Oilseed rape pollen, but very little was deposited on the stigmas of native co-flowering plants. This suggests little impact of oilseed rape on pollination of native plant species via illegitimate pollen transfer. Using genetic methods, we found that spring Oilseed rape fields provide resources for hundreds of bumblebee colonies in the Irish landscape.

Overall, we suggest that a diversity of crop types in the agricultural landscape can be beneficial for pollinating insects, and recommend appropriate conservation and augmentation of field margins and hedges as both forage and nesting resources for pollinators. As Oilseed rape is used so heavily as a resource by bees and other insects, we recommend sustainable management of this crop with limited and controlled use of pesticides. Only common pollinator species in all groups were found in the agricultural sites studied. Therefore although making agricultural regions more pollinator-friendly is vital for conservation of pollinators and the provision of pollination services, they cannot be regarded as a substitute for semi-natural areas.

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Oral Abstracts

The impacts of bioenergy crop production on ground beetles and biocontrol services.

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This research examined natural enemy diversity and the ecosystem service of natural biological control in bioenergy crops. Carabid beetles, well documented natural enemies of crop pests, were the focal taxa under examination. The impact of annual and perennial bioenergy crop production on carabid diversity was examined in a large-scale study using *Miscanthus* and Oilseed rape. Winter wheat and grass for silage were used as annual and perennial conventional crop controls. Results show that carabid diversity was significantly higher in annual crops (Oilseed rape and winter wheat) compared to perennial crops (*Miscanthus* and grass silage). Moreover, carabid community assemblages in annual bioenergy crops were significantly different from assemblages in perennial crops.

Experimental research examined the role of carabid diversity and biomass in crop pest suppression. Using the *Meligethes aeneus* - carabid - winter oilseed rape complex as a study system, the individual performance of carabid predator species, and interactions among species at low and high levels of predator biomass, in pest suppression was examined. Pollen beetle larval survival rate declined significantly as carabid predator diversity increased (a diversity effect). As predator biomass increased, larval survival rate decreased (a biomass effect). The impact of increased predator biomass outweighed the positive effect of predator diversity. These findings suggest that carabid predator biomass drives the ecosystem service of natural biocontrol.

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Oral Abstracts

Impacts of road landscape treatments on plant biodiversity within road corridors and adjacent ecosystems.

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Ecological impacts of road construction on the wider landscape are considerable. Impacts on existing plant communities are particularly important in terms of their support and provision of ecosystem services. Road corridors crossing intensively managed agricultural land may offer potential refuge for native flora and may improve landscape connectivity. In 2006, Ireland's National Roads Authority published an updated set of guidelines for road landscaping to be implemented along new national road schemes. In 2009 we made a large scale assessment, comparing pre-guideline landscape treatments with post-guideline ones, along the N25/N22 corridor between Rosslare and Tralee. Relative plant species richness of a number of pre-guideline and post-guideline landscape treatments (including horticultural planting and natural recolonisation) was quantified, and compared with adjacent land use (agricultural fields and semi natural sites). In addition, the contribution of the seed bank to overall biodiversity was assessed in order to enhance the quality of information on biodiversity which may not have been revealed in vegetation surveys. Finally, a major limiting factor preventing the establishment of species-rich semi-natural plant communities is high soil nutrient content, which is frequently a feature of agricultural soil. Such soils were the basis of pre-guidelines landscaping and their use is discouraged under the new guidelines. Thus we assessed the nutrient status (nitrogen and phosphorous content) of soils and examined relationships with roadside plant communities. On rock-scrree road verges, there was little overall difference in the early stages of plant community development between areas planted with horticultural varieties and those left to natural recolonisation by plants. This has important implications in terms of financial cost (natural recolonisation represents a low/nil cost option) and the ultimate environmental sustainability of the landscape treatment used. The ultimate output is expected to inform those involved in the planning, design and maintenance of road schemes of a more sustainable way of creating and maintaining vegetation communities in the road corridor.

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Oral Abstracts

*Inbreeding and low levels of genetic variation in Irish roadside populations of *Crataegus monogyna* populations revealed by cpDNA and novel nuclear SSR genetic markers.*

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Woody species planted along roadsides as part of road landscaping treatments may be from common stock or be clonally propagated, and thus possess limited genetic diversity. Furthermore, many species planted along a roadside can interact with individuals of the same species in the wider landscape, resulting in gene flow between them. To assess the genetic diversity of *Crataegus monogyna* (hawthorn) in Ireland, a species often planted along roadsides, nuclear microsatellites and cpDNA markers were developed and applied to Irish populations. Samples were collected and analysed from a series of hawthorn populations along the N25/N22 road in Ireland to establish possible impacts of plantation on hedgerows, in particular effects on the molecular diversity of Irish hawthorn populations. Six sets of SSR primers were developed and successfully used to characterize a total of 125 alleles with a mean number of 20.6 alleles per locus in the Irish populations and the European controls. Eight of the nine Irish populations displayed a significant excess of homozygotes and positive fixation coefficient values (F_{is}), indicating a deficiency of heterozygotes and suggesting that the populations are inbred and displayed low genetic variability. The overall observed heterozygosity (0.475) was significantly lower than the expected value (0.751), which also is suggestive of inbreeding and a narrow genetic base of these populations. The results indicate high levels of inbreeding in hawthorn populations in Ireland, which could be a result of founder effects (planted from common stocks and/or clonally propagated), including possible effects of reproductive isolation by distance (e.g. seed dispersal systems) of populations from each other. No genetic structure was detected in comparisons between roadside planted samples and samples interior to the roads that are of more likely older provenance. This indicates that all of the studied populations likely belong to a single genepool. Overall, the results indicate that there is little genetic variation observed both between and within Irish populations of hawthorn, and that recent vs. older populations cannot be distinguished using the genetic markers employed.

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Oral Abstracts

*Into the wild: documenting and predicting the spread of Pacific oysters (*Crassostrea gigas*) in Ireland*

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Pacific oysters form invasive populations in many parts of the world, but have been farmed for over 30 years in Ireland without becoming established in the wild. However, Pacific oysters were found outside aquaculture at 18 of 69 intertidal sites during sampling in 2009. Highest densities occurred in Lough Swilly and Lough Foyle with up to 9 individuals/m² and lower densities were found in the Shannon Estuary and Galway Bay. This programme was designed to be cost-effective and repeatable and to enable assessment of factors associated with establishment of the oysters. It involved close cooperation among state agencies and universities.

Feral oysters were positively associated with the presence of hard substrata or biogenic reef, long residence times of embayments and large intertidal areas. There was also a tendency for oysters to occur in bays with aquaculture, but >500 m from it. Subsequently, effects of macrophytes and predation on post-recruitment oyster survival and growth were tested experimentally. In some cases, predation had a strong negative effect on oyster survival. Growth and condition index of oysters were slightly enhanced in the presence of macrophytes, but results were not significant.

To reconstruct the recent biological history of feral oyster populations, temporal genetic variability of farmed and wild oysters in Lough Foyle was assessed using microsatellites. Evidence was found that oysters are self-recruiting and populations are now decoupled from the closest aquaculture activities. Findings will be used to improve prediction of the further spread of Pacific oysters and to directly inform management actions.

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Oral Abstracts

The impacts of non-indigenous oysters on biodiversity and ecosystem functioning

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Invasive species have been identified as one of the major threats to biodiversity and ecosystem functioning, but the nature and magnitude of their effects may depend on the environmental context and on the abundance of the invader. Plots with increasing cover of non-indigenous oysters, *Crassostrea gigas*, were established in different estuarine habitats and assessed for biotic and functional changes.

Effects on biodiversity were mostly context-dependent: biodiversity increased with increasing cover of *C. gigas* in mud-flats, but was unaffected or reached a threshold and decreased with the highest level of cover in mussel-beds and boulder-fields. A key grazer, *Littorina littorea*, an invasive barnacle, *Elminius modestus* and macro-algae *Fucus vesiculosus* were facilitated by *C. gigas* regardless of the habitat. Establishment of the honeycomb worm, *Sabellaria alveolata*, was inhibited by *C. gigas* at any cover in boulder-fields and effects were due to the physical structure as well as the biological activities of *C. gigas*.

Several processes involved in nutrient cycling were altered, but responses were non-linear with regards to the cover of oysters. Community respiration was greatest in plots with the highest cover of *C. gigas*, likely due to an increase in microbial activity. Fluxes and turnover rates of ammonium were greatest at medium cover of *C. gigas* in mud-flats and mussel-beds, but for silicate they increased with increasing cover of oysters in mud-flats but decreased at the greatest cover of oysters in mussel-beds.

This research has shown that *C. gigas* can alter biodiversity and nutrient cycling, and may therefore affect ecosystem services including aquaculture.

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Oral Abstracts

Extent of influence of salmon farms on benthic communities and trophic structure

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The extent of salmon farming's influence on the environment and the uptake of particulate and dissolved effluents by benthic organisms was assessed using community structure and stable isotope analyses. Sediment cores were collected along two directions (perpendicular to (T1) and in the direction of (T2) the main residual current) at 0, 25 and 200 m from two salmon farms (Millstone and Cranford) located in Mulroy Bay, Republic of Ireland. In addition, fouling communities were collected on artificial substrates, which were placed for 2 months at 1 m depth at the same distances.

The extent of measurable change in benthic communities depended on residual current direction. At both farms, communities living below the cages had low diversity, and were dominated by opportunistic species. Variation in isotopic signatures of the food sources was sufficient to identify variation in the organisms' diet. Intra-specific variation in isotopic value in benthic invertebrates was mostly explained by distance from cages. Organisms collected beneath the cages were depleted in $\delta^{13}\text{C}$ as compared to individuals collected at 200 m. A shift in $\delta^{13}\text{C}$ was observed in species present at more than one distance, including *Malacoceros fuliginosus*, *Nephtys hombergii*, Nematoda and *Anthoptera balii*. Fouling communities collected on artificial structures, mainly composed of tunicates (*Asciella aspersa*) showed higher $\delta^{15}\text{N}$ value at fish cage sites compare to 200 m sites. The study demonstrated that fish effluents were assimilated and became a food source for native organisms with repercussions for trophic structure. Sedimentary and fouling organisms, potential sinks for fish effluents, may play an important role in the carrying capacity of ecosystems for aquaculture.

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Oral Abstracts

Sustainable development of wind energy in Ireland – consequences for biodiversity and ecosystem services.

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In response to climate change, the EU has set a target to achieve 20% of energy from renewable sources by 2020. Consequently, Ireland has set targets of 40, 10 and 12% of energy coming from renewable sources for electricity, transport and heat, respectively. Wind energy is expected to contribute to over 90% of these targets given Ireland's large onshore and offshore wind potential, with over 2000 MW of installed capacity to date. However, the potential impacts of these wind farm developments on Ireland's biodiversity remain largely unquantified. To maximise effectiveness, wind farms ideally should be sited in open, exposed areas where mean wind speeds are high, with developments most suited to upland, coastal and offshore areas. This means that a wide range of species and habitats of high conservation value are or will be potentially influenced by wind energy developments. Results of the strategic review of the literature highlight little published information on impacts of wind developments on Ireland's biodiversity and ecosystem services. The international literature suggests that birds (onshore and offshore), bats (onshore), marine mammals are the species that are most vulnerable to the direct impacts of wind turbines. Habitats (particularly peatland, heath, upland, coastal and marine habitats in Ireland) are directly influenced, predominantly during the construction phase and through longer term habitat loss. No studies to date have focused on impacts on the provision of ecosystem services or the indirect impacts of wind farms on habitats and species. Habitat ecological and physical integrity, habitat fragmentation and the facilitation of invasive species remain largely under researched. Long term sustainability of the sector will be dependent on quality research, appropriate monitoring, greater consideration of cumulative impact assessments facilitated by clearer guidance, and appropriate spatial planning. Our spatial analyses reveal the extent to which wind resources and current and future wind farm developments overlap with habitats and species of conservation value. We put forward recommendations on the sustainable future planning and management of wind farms in Ireland, helping ensure the direct benefits of green house gas emission reduction are maximised without compromising the protection of biodiversity in Ireland.

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Oral Abstracts

Assessing the impact of waste water treatment plant effluent on norovirus contamination in shellfisheries

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Norovirus (NoV) is the leading cause of viral gastroenteritis worldwide. Filter feeding bivalve shellfish such as oysters can accumulate NoV when grown in areas impacted by human faecal waste. Such shellfish present a significant health risk when consumed raw. We investigated the fate of NoV during wastewater treatment (WWT) and the impact of wastewater effluent on oysters using real-time reverse transcription quantitative PCR (RT-qPCR). We also used FRNA bacteriophage as an indicator organism for NoV during WWT and compared an infectivity assay with an RT-qPCR. Results from the study indicate;

- The mean NoV reduction during secondary WWT was $<1 \log_{10}$ genome copies 100ml^{-1} respectively as judged by RT-qPCR.
- NoV concentrations in oysters correlated with NoV concentrations in wastewater showing a strong seasonal trend.
- RT-qPCR detected both infectious and non-infectious FRNA bacteriophage particles.
- Using the FRNA bacteriophage infectivity assay as a model secondary WWT was demonstrated to reduce virus concentrations by $2 \log_{10}$ pfu 100ml^{-1} . UV disinfection reduced virus concentrations by an additional $2 \log_{10}$ pfu 100ml^{-1} .
- A significantly greater ratio of infectious FRNA bacteriophage to non-infectious FRNA bacteriophage was present in untreated wastewater compared with treated effluent.

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Oral Abstracts

The real-time prediction of coastal water quality ensuring the protection of public health in Ireland and Wales

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The Revised Bathing Water Directive (rBWD) that came into operation last year provides for monitoring and classification of bathing water quality in the European Union. The rBWD sets stricter standards than the previous Directive: an 'Excellent' qualification under the rBWD is twice as stringent than the previous 'Guideline' standard. These stricter standards obviously have implications for the classification of Irish bathing waters, which may result in the loss of blue flag status in a number of instances. The rBWD recognises that short-term pollution may affect the overall qualification of a bathing water, and therefore provides a provision that up to 15% of samples may be discounted in a four year assessment period. However, discounting is dependent on that short-term pollution is predicted. A retrospective analysis of Irish bathing water sites shows that discounting is not a trivial exercise: when applied it results in a 25% increase in the number of bathing waters classified as 'Excellent'. The Smart Coasts project, funded under the EU Interreg IVa programme is aimed at developing tools to predict bathing water quality using a multidisciplinary approach involving hydrological and microbiological methods combined with state of the art information technology. A particular powerful tool in this project is the use of microbial source tracking, which allows for the identification of both the biological and geographical origin of faecal contamination. The combination of these methodologies will result in a predictive model for faecal contamination allowing discounting of samples for bathing water assessment.

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Oral Abstracts

Cryptosporidium monitoring of Ireland's waters

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Cryptosporidium is a ubiquitous parasite affecting a wide range of animals including humans. Studies have found that *Cryptosporidium* is quite widespread in the aquatic environment and poses a significant threat to public health in Ireland as several recent waterborne outbreaks have shown. Since 2004, cryptosporidiosis is a notifiable disease in humans and it has shown that Ireland has one of the highest reported incidence rates in Europe with between 8.7 and 14.4 cases/100,000 population a year. *Cryptosporidium* oocysts pose a challenge to water treatment processes because of its small size and resistance to disinfection processes. Contamination of the aquatic environment with *Cryptosporidium* spp. oocysts, which are not infectious to susceptible human hosts, further contributes to the difficulties in assessing the risk to public health from waterborne oocysts. Genetic fingerprinting of isolates of *Cryptosporidium* to species or even sub-species level has provided much greater insight into the two main species (*C. parvum* and *C. hominis*) within the human population and has the potential to provide new insights into the transmission of disease and in identifying species-specific risk factors and for the control of risk. There is a strong case for adopting the strategy of typing all isolates in future.

Results from a pilot testing scheme from five local authorities with water supplies on the EPAs remedial action list will be presented. This work was undertaken at the *Cryptosporidium* reference laboratory established at the Central Veterinary Laboratory on the Backweston research campus in Celbridge, Co Kildare. The laboratory received INAB accreditation to ISO 17025 for the enumeration of *Cryptosporidium* oocysts concentrated by IDEXX filters in April 2012.

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Oral Abstracts

Emerging pollutants from health establishments

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Health care services are much more intensive now than 2 to 3 decades ago. Increased intensity is related to technological advances that allow for substantial improvement in quality and duration of life and changes in societal expectations around ageing, death and dying. Health care service delivery has a major environmental footprint including energy, disposable products and devices, pharmaceutical products and water. In general health care waste is much more effectively controlled now than formerly. In relation to management of health care wastewater however there has been little change in recent decades. Pharmaceutical agents are specifically engineered to have biological impacts at low concentrations. They are increasingly designed to resist rapid metabolic degradation so as to reduce the frequency of drug administration. For many medications including antibiotics, cytotoxic chemotherapeutic agents and endocrine active drugs significant quantities (in some cases up to 90%) of the dose of drug administered to a patient is subsequently excreted in biologically active form in urine and faeces. Although pharmaceutical contamination of the environment through wastewater is also an issue for the wider community health care facilities are a special case because of the variety of and the concentration of pharmaceuticals consumed. Most hospitalized patients are taking multiple pharmaceutical agents. For example about 1 in 3 will be consuming antibiotics at any time and annual consumption of antimicrobial agents in hospitals is in Kg quantities. Hospitals are also foci for high levels of antibiotic resistant bacteria. Many of these resistant bacteria are also shed in faeces and enter the wastewater stream. Throughout much of Europe hospital wastewater streams containing pharmaceutical agents and antimicrobial resistant bacteria joins general municipal wastewater without specific pre-treatment. In Ireland such waste generally receives at least secondary treatment before discharge into the environment although globally this is far from universal. Concentrations of antibiotics and probably most pharmaceutical entering the environment from this source are not likely to be associated with acute human toxicity. It is much more difficult to assess the possible effects of persistent low level environmental contamination with antibiotics and other pharmaceutical agents on human health and the impact of such contamination on microbial biodiversity, including selection of antibiotic resistant bacteria. It is appropriate to consider the need for measures to reduce the environmental footprint of health care facilities by developing specific standards for management of clinical wastewater. A more complex challenge is to consider ways to assess the overall sustainability of current trends in health care delivery in terms of the balance between individual health benefit achieved against the potential adverse ecological and population health impact of this approach to health care.

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Oral Abstracts

Priority Substances in Waters

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Many knowledge gaps exist in relation to managing priority substances and priority hazardous substances in Irish Waters. This information is needed to enable compliance with WFD reporting requirements. A risk-based model of expected pollutants has been developed based on inputs to municipal wastewater treatment plants from a variety of sources with a variety of population equivalents. Notably this project focussed on wastewater treatment facilities however, the impact of non-licensed sources like golf-courses, hospitals, airports, restaurants etc., on priority hazardous substances arising from rainfall run-off can also be significant. The research involved a large sample number, analysed for priority and hazardous substances. Samples were collected monthly throughout the project and also at higher frequency during wet and dry periods. The output of the risk-based model identifies the likely occurrence of groups of priority substances based on WWTP population equivalent and usage and this approach can be applied to other locations in Ireland and assist in informing a monitoring programme for WFD.

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Oral Abstracts

The impacts of transboundary air pollution on acid sensitive lakes in Ireland

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Atmospheric pollution can adversely affect the natural environment leading to significant impacts on both biodiversity and ecosystem services. As a consequence, during the last two decades international policies have focused on reducing emissions of transboundary air pollutants. This research asked 'what is the impact of transboundary air pollution on Irish ecosystems' and 'how have they responded to changes in atmospheric deposition'. To answer these questions' extensive surveys of upland lakes were carried out, in addition a network of lake catchments were established in upland regions to evaluate the levels of heavy metals, mercury and persistent organic pollutants in the Irish environment, and their relation to transboundary air pollution. The long arduous hikes to mountain tops have further provided new insights on the impacts of sea salt episodes and the importance of these systems as sources of greenhouse gases.

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Oral Abstracts

A New Approach to Bioaerosol Monitoring in Ireland

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Primary Biological Aerosols Particles (PBAPs) are fragments of biological material emitted or suspended directly from the biosphere to the atmosphere. PBAPs represent a significant fraction of the total aerosol burden and the different types can include viruses (0.01–0.3 μm), bacteria (0.1–10 μm), fungal and fern spores (1–30 μm), plant pollen (5–100 μm), and fragments of animal and plant matter. All human activity is affected in some way by the roles of such viruses, bacteria, spores, and pollen: well-known adverse effects include the promotion of health allergies, the spreading of diseases to humans or agricultural crops, and their roles as agents of terrorism.

The traditional method for determining ambient concentrations of PBAPs has been by impaction/collection followed by manual counting/identification under an optical microscope. The overall process is time-consuming, labour intensive and requires considerable expertise for success. Project BioCheA has employed a new on-line technique for PBAP (pollen, fungal spores and bacteria) detection, counting and identification in a variety of settings including laboratory and field. The instrumentation is based on measuring the intrinsic fluorescence of PBAP using UV flash-lamps for excitation, and also using laser scattering for optical size and “shape” measurements of the individual particles.

The results subsequently obtained for PBAP such as Yew pollen, *Aspergillus fumigatus*, *Penicillium* and *Pseudomonas aeruginosa* will be discussed in terms of the future likely applications of WIBS to real-time bioaerosol monitoring of waste/compost/contaminated water supplies and also indoor environments.

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Oral Abstracts

Emissions from small scale combustion installations

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Emissions of particulate matter (PM), and oxides of nitrogen (NO_x), are a significant source of air pollution across Europe. These pollutants impact negatively on air quality at local level, and at a continental level via transboundary air pollution. Although emissions from large point sources are monitored and controlled, considerable uncertainty surrounds estimates of emissions from transport and other distributed combustion sources. The ETASCI project set out to establish better quantitative estimates of NO_x and PM emissions from these “small combustion installations” (SCI) in Ireland.

This presentation will focus on emissions from residential sources, and particularly on emissions from gas-, oil-, or wood-pellet-fired boilers. A two-step approach was adopted. First, real-world duty-cycle data was obtained for appliances of each type, by monitoring their usage throughout a heating season. A representative duty cycle for each appliance type was derived from analysis of this data, and then imposed on similar appliances installed in a purpose-built experimental test facility. Emissions of NO_x and PM over each phase of the duty cycle were then measured, and emissions factors (EF) determined for each appliance under typical Irish operating conditions.

Currently, estimates of emissions from this source are based on emission factors compiled by the European Monitoring and Evaluation Program (EMEP). The EF observed by ETASCI were found to be significantly lower than those published in the EMEP Guidebook – by a factor of two in the case of NO_x, and by an order of magnitude in the case of PM. Operating mode was found to be a significant factor only when estimating PM emissions from a wood-pellet boiler. Finally, a single weighted-average emission factor that accounted for all possible boiler operating modes was calculated for use when compiling new emission inventories.

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Oral Abstracts

Air pollution in Small Towns in Ireland

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Introduction

Traditionally air pollution measurements have been made at large urban centers, there is a gap in our knowledge as to what air pollution levels are like in smaller towns. We selected 4 towns, Navan (no coal ban, has natural gas supply), Tralee (coal ban, no natural gas), Letterkenny and Killarney (no coal ban and no natural gas).

Methods

Measurements of particulate matter at each location was undertaken, due to finish monitoring in June 2012, the parameters measured were PM₁₀, PM_{2.5}, Black Smoke (BS) and a chemical analysis of the samples for Benzo-a Pyrene (BaP) was also undertaken. Support from local HSE staff at each location was vital to the success of the project, they checked the samplers and changed filters when required

Results

Town	A	B	C	D	Dublin
PM_{2.5}					
Average	14	7	14	5	11
Max	62	47	51	53	51
PM₁₀					
Average	46	11	19	22	14
Max	313	62	53	203	48
BS					
Average	15	5	5	4	4
Max	32	34	25	21	32

Units all μgm^{-3} (note these are interim data, as the full year of data collection is not complete at the time of submission of this abstract)

Conclusions

The levels in some of these smaller towns are a cause for concern, and in particular they are higher than Dublin. Initiatives are required to improve the air quality in smaller towns in Ireland, source identification is an important aspect.

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Oral Abstracts

Development of a volcanic ash forecasting model

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The Eyjafjallajökull volcano located in the south of Iceland erupted on 20th March 2010. During a number of eruptive phases a large volcanic ash plumes rising up to 10 km were observed. The spread of ash from the erupting volcano closed much of Irish and European air traffic for over a week over fears of the effect on jet engines of the ash. The development of a robust and accurate forecasting model was shown to be critical in order to minimise the economic disruption from these events. The work described here outlines the development, validation and automation of an atmospheric dispersion model (REMOTE Regional Model with Tracer Extension) for accurate and timely volcanic ash forecasting, as well as assessing future risk scenarios and air quality implications. Future model developments in the measurement network in order to facilitate better forecasts are also discussed

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