Irish Freshwater Sciences Association (IFSA)

Annual scientific meeting March 19th 2021

Hosted by University College Cork

Book of Abstracts

Session 1 (12 minute talks + 3 minutes questions)

10.00 Implementing Ireland's River Basin Management Plan in the Covid 19 pandemic

Fran Igoe

Southern Regional Coordinator, Local Authority Waters Programme.

The River Basin Management Plan (2018-2022) is Ireland's road map to delivering water quality targets in compliance with the EU Water Framework Directive. The Local Authority Waters Programme is a Local Authorities national shared service working on behalf of all Local Authorities to meet obligations under the River Basin Management Plan for Ireland. This includes support of the WFD governance structures set up under the plan, public and community outreach together with catchment science. All taking an evidence based approach to identifying relevant pressures. The first case of Covid 19 for Ireland was confirmed on February 29th 2020. By March 2020 significant changes to working arrangements came into place, limiting contact between workers and the public. As with other sectors, LAWPRO had to adapt to these changing conditions. This presentation outlines some of the adjustments that took place (and still evolving), opportunities that arose, setbacks and the implications for planning for the next River Basin Management Plan (2022- 2027).

10.15 Acute toxicity of the insecticide cypermethrin to three common European mayfly and stonefly nymphs

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Freshwaters are particularly vulnerable to pesticide contamination owing to their connectivity to agricultural and forestry land. We assessed the toxicity of the pesticide cypermethrin to nymphs of the common European mayflies *Baetis rhodani* and *Ecdyonurus venosus*, and the stonefly *Isoperla grammatica* in 96 h static bioassays. The 96 h median lethal concentrations (LC50s) we recorded for the three species were 0.08 µg/L, 0.15 µg/L, and 0.13 µg/L, respectively. The effective concentration (EC50), quantified as lack of escape response (implying inability to avoid drift, predation or abiotic stress), was usually 32% of the LC50s. All 96 h LC50s were lower than the highest concentrations detected in streams in the UK, and at least five times lower than the highest concentrations recorded in rivers globally. Contrasts among species were most evident at 24 h LC50, when *B. rhodani* was approximately ten times more sensitive than the other two taxa. The order of taxa sensitivity to cypermethrin in our study contrasts with their sensitivity to organic pollution in the same region, which suggests a tolerance trade-off, and thus a compounding effect of simultaneous stressors. *B. rhodani* is a key algal grazer, ubiquitous in European streams, and its decline could exacerbate algal blooms.

10.30. Impact of the 2018 European drought on microbial groundwater quality in private domestic wells: a case study from a temperate maritime climate.

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Recent research has highlighted links between climate change and groundwater quality. However, few studies have sought to explore the relationship(s) between drought conditions and groundwater quality in i) unregulated groundwater sources, or ii) temperate maritime climates. Accordingly, the current study sought to quantify the effects of the 2018 drought experienced throughout Europe on groundwater quality in Ireland via an opportunistic field study. A repeated measures sampling campaign comprised of "drought" (June/July) and "post-drought" (October/November) analyses of 74 wells was undertaken. *Escherichia coli* (*E. coli*) were present during both drought (7/74; 9.5%) and post-drought (18/74; 24.3%) sampling periods. Bivariate analyses suggest a hydrodynamic shift, with the significance of *E. coli* sources and pathways shown to change between sampling periods. More specifically, during drought conditions, septic tank density ($p = 0.001$) and local subsoil type ($p = 0.009$) were both associated with the presence of *E. coli*, while neither variable was significant during post-drought conditions. The current study is the first to provide a quantitative comparison of groundwater quality during and after a large-scale drought event in a temperate maritime climate and may be used to improve our understanding of the effects of extreme events, and develop preventative strategies going forward.

10.45. Classification of riparian delivery points for improved specification of mitigation measures

Simon Parker[1], Daire Ó hUallacháin[1], Nikki Baggaley[2], Per-Erik Mellander[1], Mark Wilkinson[2], Allan Lilly[2], Marc Stutter[2]*

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Sources and pathways by which macronutrients (nitrogen and phosphorus) and sediment enter watercourses have traditionally been classified as being either point or diffuse, with agricultural sources typically classed as the latter. Increasingly, however, the idea of diffuse pollution is being replaced with the idea of multiple point sources. Whilst previous work has sought to identify the locations of these multiple point sources (to support greater targeting of mitigation measures), little research exists describing or classifying the variety of delivery points. An element of the Smarter BufferZ project (Irish EPA-funded) aims to classify different morphologies of the delivery pathways by which water crosses from edge of field to stream to create a typology of delivery points. This applied research presents proposed supplementary DEM-based decision-support tools with examples to describe different scenarios and to demonstrate some considerations that aid in site selection and assessments of potential interventions.

11.00. Lake dwelling pearl mussels (Margaritifera margaritifera L.) -A unique Irish phenomenon?

Kieran Cowhig, Timothy Sullivan, Simon Harrison

School of Biological, Earth and Environmental Sciences, University College Cork

The freshwater pearl mussel *Margaritifera margaritifera* is a critically endangered species. Pressures from river modification, pearl fishing, sedimentation, agriculture, and industry as well as the failure to recruit juvenile mussels, has seen the steady decline in populations across its range. Throughout the literature, habitat conditions for pearl mussels have been described to be in fast flowing, shallow

oligotrophic streams. This study highlights the discovered of pearl mussels in a lake in the south west of Ireland. The discovery challenged what we current understand about the biology of pearl mussel and questions how current conservation efforts should adapt to ensure their protection into the future. The study explores the habitat conditions of pearl mussels in a lake environment. It examines the substrate characteristics, the depth at which mussels were found, the interaction between pearl mussels and macrophytes (*Isoetes lacustris* and *Nitella sp.*) and how pearl mussel distribution and orientation varied in different areas of the lake. Within the lake pearl mussel were found to inhabit two very different habitats. One bed of mussels was found to inhabit a shallow littoral habitat while another bed was discovered in a much deeper benthic habitat. A major observation of this study was the occurrence of pearl mussel at depths up to 9m. This has not previously been described. Estimates from this study suggest that between 150,000-200,000 mussel inhabit the lake. This is a significant find with the potential for even more population discoveries in a time when pearl mussel populations are under severe threat and in decline worldwide.

11.15. Bovine faecal contamination of surface waters in a dairy-dominated catchment in SW Ireland.

Michelle Vedder, Jean O'Dwyer and Simon Harrison

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The source and fate of faecal microorganisms of bovine origin in surface waters in Ireland is poorly understood or monitored, despite their potential harm to animals and humans. The widespread contamination of running waters by agriculturally-derived organic matter, however, indicates that faecal microbial contamination follows a similar pattern. However, as for nutrients and organic matter, the source of bacterial contamination may originate from diffuse (from overland runoff) or from point sources (including direct cattle access to streams or from farmyard drainage). Knowing where such contamination arises, and why, is the vital first step in managing it effectively. This study reports an investigation into the sources of faecal indicator organisms (FIOs) in a dairy-dominated catchment in SW Ireland. The objectives were (1) to quantify the attenuation, if any, of FIOs within small drainage channels receiving direct farmyard effluent and (2) to determine the distributions, and hence origins, of FIOs within the wider catchment. We showed that FIOs were abundant along the entire length of farmyard drainage channels, despite the reported low survival and persistence of thermotolerant organisms outside of the enteric environment. Results from the catchment-wide study revealed widespread faecal contamination of surface waters from persistent farmyard drainage sources, as well as from intermittent direct deposition by cattle accessing streams.

11.30. Hydrochemical characteristics of the small stream network in Ireland

Hogan, S.C., O'Sullivan, J.J., Bruen. M., Jarvie, H.P., Bowes, M., Cox, E., and Kelly-Quinn, M.

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Recent publications have drawn further attention to the need to refocus research and management on small headwater streams to address catchment water-quality and biodiversity concerns together with the sustainable management of ecosystem services. The key contribution of this research is the characterisation of a portion of Ireland's small stream network (SSNet) based on current and historic water quality data coupled with an analysis of the influence of landscape factors. Using EPA datasets and recently collected data from 73 extensive sites, the nature and extent of nutrient water-quality status and impairment are evaluated for small streams across the major catchment typologies of Ireland. The dataset comprises 252 sites, with nutrient and geo-physical data spanning 13 years. A

total of 73% of the sites were characterised according to their physical descriptors; geology, physiography and soil type. Nutrient conditions were analysed to identify the level of compliances and exceedances Individual sites from a selection of characteristic groups were analysed to highlight changes in conditions over time using time-series graphs and to investigate possible relationships with flow conditions/precipitation events, thus gaining an improved understanding of the spatiotemporal variability of the chemical conditions of headwaters and the factors that may influence these.

11.45. Decline of the White-clawed Crayfish population of the River Suir catchment

Pascal Sweeney. Consultant.

The River Suir catchment formerly supported a high population of white-clawed crayfish (*Austropotamobius pallipes*). In 2017, crayfish plague (*Aphanomyces astaci*) was detected in the lower reaches of the main channel, from where it spread upstream. Data collected at sites throughout the Suir catchment in 2020 is compared with data collected at the same sites in Summer 2017, when crayfish plague was limited to the downstream end of the catchment. Available data from earlier surveys are also examined. While, historically, crayfish were found down to tidal waters at Carrick-on-Suir, by August 2017 crayfish plague had wiped out the population from Clonmel downstream but crayfish were found to be still present at 37 other sites in the catchment. In Summer 2020, crayfish were found at only three Suir catchment sites: one on the main channel and two well up small tributaries. It is hoped that, after crayfish plague here has died out in the wider catchment, the remnant populations in the small tributaries will survive to allow natural re-colonisation. Re-assessment of these remnant populations in coming years is planned.

Session 2 (7 minute talks + 3 minute questions)

14.00. Destroyed, Not Defeated: Ireland's Legacy of Aquatic Pollution

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Historical pollution events can leave a lasting impact on the freshwater environment, long after the inputs have ceased. Pollution can persist as legacy contamination within the sediment of the waterbody, and can continue to contribute to contemporary water quality issues decades or more later. Water quality monitoring does not typically consider this class of pollution, outside of obvious cases where monitoring has been informed by a known historical occurrence. However, the contribution of legacy contamination is far too important to ignore. In this symposium contribution, we investigate the legacy contamination aspect of water quality status. We offer an overview of the concept of legacy pollution, and its potential impacts in the context of Irish freshwaters. Finally, we apply an existing methodology to perform an exploratory analysis of the hypothesized contribution of legacy phosphorous inputs to contemporary phosphorous concentrations in Irish waterways. This analysis demonstrates how contemporary inputs could be the lesser contributor to ongoing water quality issues, and highlights the need for a greater appreciation of Ireland's legacy of historical contamination.

14.10. Crustacean zooplankton taxa specific grazing experiments in Lough Feeagh, a temperate dystrophic lake.

Maria Calderó Pascual[1], Elvira de Eyto[2], Kemal Ali Ger[3] and Valerie McCarthy[1]

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Linking freshwater zooplankton communities to ecosystem functioning is crucial given their central trophic position in aquatic food webs. Quantifying specific phytoplankton prey and herbivorous zooplankton grazer interactions is essential to understanding shifts in planktonic community structure and dynamics. In comparison to clear water, phytoplankton dominated lakes, less is known about specific grazing impacts on natural planktonic communities in dystrophic lakes, where heterotrophic energy dynamics may be very important. Therefore, in this work we designed *in-situ* zooplankton taxa specific grazing experiments with natural freshwater planktonic communities from Lough Feeagh, a temperate dystrophic lake situated on the northwest Atlantic coast of Ireland. Preliminary results differentiate between calanoid and cyclopoid ingestion rates ($ngC_{prey} \cdot grazer^{-1} \cdot h^{-1}$) of dominant phytoplankton prey taxa during September 2020. Consistent with other studies, calanoids had relatively higher ingestion rates of ciliates, *Cryptomonas* and colonial diatoms such as *Tabellaria fenestrata* and *Asterionella formosa*, previously described as high-quality food cells. In contrast, for cyclopoids, maximum ingestion rates were observed for the cyanobacteria *Oscillatoria,* which is rarely present in large biomass in this lake. Despite generally low phytoplankton and ciliate concentrations compared to other lake types, neither zooplankton taxa took advantage of the relatively dominant

small diatoms such as *Cyclotella* or Chlorophyta cells. These observations suggest that calanoid and cyclopoid taxa have variable food preferences, at least in circumstances there is high food availability for primary consumers such as in early autumn. Future experiments aim to target other important crustacean taxa which appear seasonally in Feeagh, such as *Daphnia* and *Diaphanosoma,* to better understand their role in ecosystem functioning of this temperate dystrophic lake.

14.20. The Citizen Science Stream Index – a novel, simple, biomonitoring protocol for non-experts

Brendan McSorley, Tim Sullivan, Simon Harrison

School of Biological, Earth and Environmental Sciences, University College Cork

Despite several decades with the European Nitrates and Water Framework Directives, the water quality of many of Ireland's river and lakes remains stubbornly unsatisfactory. The cause is largely due to inputs of nutrient-rich organic matter of agricultural and municipal origin. Despite this depressing state of affairs, the vast majority of Ireland's waterways - especially smaller streams - are not routinely monitored in terms of water quality. A spatially-extensive biomonitoring programme involving non-expert citizens would provide valuable data on how - and where - streams are being polluted. It would also give citizens a much greater stake in the quality and health of the streams in their neighbourhood. Current biomonitoring protocols – even those targeted at non-experts – tend to require advanced levels of taxonomic expertise, which are likely to discourage citizens from engaging in the important issue of local stream water quality. Here we report on the development of a Citizen Science Stream Index (CSSI) – a simplified macroinvertebrate biomonitoring protocol, based on a small number of commonly occurring, easily identifiable and distinct taxa that are strong indicators of clean or polluted waters. We show that despite the basic nature of the protocol, it relates well to other more complex and established schemes. We believe that the CSSI can be a practical and important tool in the effort to improve water quality in Ireland.

14.30. An ecosystem service-based decision-support tool for river basin management

Marcin R. Penk, Michael Bruen, Christian Feld, Jasper Kenter, Mike Christie, Jay Piggott, Mary Kelly-Quinn

University College Dublin, Ireland

Freshwaters contribute a disproportionately high level of ecosystem services, including cleaner water for consumption and food production, flooding mitigation as well as places for recreation and appreciation of nature. However, freshwater ecosystems are among the most degraded and threatened, undermining these services. The ecosystem services framework can be a useful management tool to facilitate a focus on targets, both in terms of pressure mitigation and ecosystem services enhancement that are of direct interest to policy makers, managers and stakeholders who are concerned with river health. We developed an evidence-based decision-support tool for Ireland's rivers using a Bayesian Belief Network model linking individual stressors to a selection of desired ecosystem service outcomes (focusing on wildlife value, water quality, and angling) through biotic and abiotic cause-and-effect chains. We have applied this model to three case study catchments: Dodder, Suir and Moy, to demonstrate the benefits associated with a reduction of various stressors in different settings. Using these case studies we demonstrated that the individual and interactive effects of globally pervasive freshwater stressors can be related in a relatively simple way to changes to ecosystem services. We then show how this facilitates a dialog with a variety of stakeholders about appropriate management options.

14.40. Advances from the Hydromussel Project: Integrating remote sensing into freshwater pearl mussel conservation and management

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Extreme low flow conditions, such as those occurring during droughts, are among the most serious threats to Irish Freshwater Pearl Mussel (FPM, *Margaritifera margaritifera*, LINNAEUS 1758) populations. A key aspect to build up the resilience of these populations is to promote long-term water storage and its slow release to buffer for potential extreme low flow periods. Using indices derived from remote sensing (RS), we aim to identify spatio-temporal patterns associated to different landcover-types that provide insights into specific hydrometeorological states and fluxes such as near-surface soil moisture and evapotranspiration. Time series have been produced for 27 FPM-relevant catchments and five RS-derived indices, with cloud cover being a serious limiting factor of image usability. Initial analysis at different spatial scales show promising results that should be of use to environmental managers and conservation practitioners to better manage and support the recovery of Irish FPM populations.

14.50. Developing an ecologically informative hydromorphological classification of Irish small streams.

Edward Cox[1], Michael Bruen[2], Angela Gurnell[3], Sinead Hogan[2], Jeremy J. Piggott[5], Mary Kelly-Quinn[1]

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Hydromorphological setting and condition are increasingly recognised as crucial to the functioning of river ecosystems. So, knowledge of the natural physical structure for a given geomorphic setting is an important tool for effective environmental management, particularly for small streams (first and second order rivers) which comprise approximately 75% by length of the Irish river network. However, little physical habitat scale information exists for these rivers in Ireland. In this study the hydromorphology of 42 minimally impacted headwaters across Ireland was assessed using the multi-scale Modular River Physical Survey (MoRPh) method developed for English rivers. Rivers were surveyed at three scales: module (length 10 m), sub-reach (50 m), reach (1+km). At the reach-scale-we found that the Irish headwaters studied subdivide into six indicative geomorphic types, although most were either classified as 'confined bed-rock' or 'step-pool' types. Preliminary module and sub-reach scale analysis supports subdivision of 'step-pool' rivers according to their substrate and geomorphic-habitat features, potentially providing a more ecologically informative classification of Irish small streams.

15.00. Multiple-stressor effects of climate change drivers on the ecosystem functioning of streams in New Zealand impacted by deposited fine-sediment.

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Freshwater ecosystems are under continued pressure from multiple stressors. These can negatively impact freshwater communities and ecosystem processes, and can interact to produce unexpected ecological outcomes. Predicted future climatic changes are expected to exacerbate the negative effects of stressors and place further pressure on freshwater ecosystems with an additional amalgam of stressors. This study investigated the individual and combined effects of climate change (temperature variation, flow velocity variation [due to changes in precipitation], and increased CO_2) and deposited fine-sediment on stream ecosystem processes (respiration, decomposition) in Otago, New Zealand. This study used the ExStream System (an experimental stream mesocosm system comprising of 128 circular stream channels). Cotton strips and leaf packs were placed in each channel to study respiration and decomposition (mass loss and tensile strength). Respiration, mass and tensile strength were measured for 128 cotton strips and analysed. Preliminary analyses show that there were significantly lower rates of respiration in channels enriched with carbon dioxide. However, there were no significant differences in mass or tensile strength between treatments and the control. This result suggests that increased carbon dioxide impacts certain hydrochemical conditions which could potentially impact stream communities and other ecosystem processes.

15.10. The potential for offline water retention areas to attenuate floods and entrained water quality in an agricultural mini-catchment.

Darragh Murphy, John Weatherill, Simon Harrison

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Agricultural catchments are affected by elevated loadings of nutrients and suspended solids, channelization of low-order streams and the presence of complex networks of sub-surface drainage. Such hydrological and biological aspects of agricultural landscapes have the combined effects of inducing both chronic and flood-driven surges of nutrients and suspended solids to receiving water bodies. While legislation such as the Nitrates Directive and the Water Framework Directive may achieve some degree of reduction in the flux of water quality pressures to receiving streams, rivers and lakes, water quality continues to degrade nationally at a worrying level. Temporary offline retention of surface water is known to reduce downstream flood risk and to encourage the deposition of suspended solids and biological uptake of labile nutrients such as Soluble Reactive Phosphorus (SRP) and Dissolved Organic Carbon (DOC). The current study, conducted on a mixed-use, privately owned, farm in Co. Cork, is investigating the potential for offline water retention areas to attenuate floods and entrained water quality pressures. Chemical and hydrological data are being collected from a low-order stream within the farm as it is diverted and temporarily retained on forested and rye-grass dominated retention areas.

15.20. An investigation of change in macroinvertebrate community structure in the littoral zone of Lough Feeagh over a 48 year period.

Emma Drohan[1], Elvira de Eyto[2], Eleanor Jennings[2], Valerie McCarthy[1]

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Lough Feeagh, located within the Burrishoole catchment Co. Mayo is a dystrophic lake which has been the subject of numerous long-term studies with a network of *in-situ* sensors deployed across the catchment measuring a range of variables in near real time since 2003. However, despite this monitoring network within the Burrishoole system, the shallower waters along the littoral zone of Lough Feeagh have received less focus. The littoral zone is structurally and functionally an important part of most lakes as it influences the movement and processing of material as it flows from terrestrial ecosystems into the lake, this can impact both physical and biological processes through the pelagic zone. This study aims to investigate changes in macroinvertebrate community structure in the littoral zone of Lough Feeagh through the analysis of historical data from three surveys carried out over a 48-year period. A decline in species diversity indices was observed between 1971 and 1994, with a subsequent increase in 2019, however, a reduction in species evenness and spatial diversity indicates a shift in community structure from the 1970s to the present day. Examining changes in macroinvertebrate community structure over time will provide information on impacts of catchment changes to the littoral zone with potential implications for ecosystem function.

15.30. Comparing preliminary results from a palaeo-envionmental study of Lough Feeagh and past studies in the Burrishoole Catchment, Co. Mayo

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An 8m long sediment core was extracted from Lough Feeagh, a large freshwater lake in the Burrishoole catchment County Mayo. Preliminary geochemical and chronological analysis have been conducted including stratigraphic descriptions and measurements of organic matter (Loss On Ignition LOI550), wet density and dry weight. Other cores from both Lough Feeagh and Lough Furnace have been taken from the Catchment, which presents an opportunity to investigate the relationship of long-term organic matter differences at different points in the Catchment. These other cores, while much shorter than the core taken from this project, offer valuable insight into the organic and carbon intake into the lake sediments at different parts of the Catchment.