

# **ENVIRONMETRICS FORUM**

## **1<sup>St</sup> MEETING**

**April 25<sup>th</sup> and 26<sup>th</sup> 2018**  
**Marine Institute**

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# PROGRAM

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## DAY 1

- 10.30 am - 11.15 am, registration & coffee
- 11.15 am - 11.30 am, welcoming
- 11.30 am - 1 pm, short talks 1-6
- 1 pm - 2 pm, lunch break
- 2 pm - 3.30 pm, short talks 7-12
- 3.30 pm - 4 pm, coffee break
- 4pm - 5.15pm, short talks 13-17
- 5.15pm - 5.30pm short break
- 5.30pm - 6.15pm, long talk 1
- 7.30 pm, social dinner in Galway (to be defined)

## DAY 2

- 10 am - 10.30 am, coffee
- 10.30 am - 12.30 pm, TMB workshop
- 12.30 pm - 1.30 pm, lunch break
- 1.30 pm - 2.15 pm, long talk 2
- 2.15 pm - 2.30 pm, short break
- 2.30 pm - 3pm, meeting debriefing and next steps

### MODELLING THE EFFECTS OF MESH SIZE ON GILLNET SELECTIVITY IN THE HAKE FISHERY TO THE SOUTH AND WEST OF IRELAND

- Mikel Aristegui-Ezquibela, Marine and Freshwater Research Centre, Galway-Mayo Institute of Technology C  il  n Minto, Marine and Freshwater Research Centre, Galway-Mayo Institute of Technology
- Daragh Browne, Irish Sea Fisheries Board (BIM)
- Ron  n Cosgrove, Irish Sea Fisheries Board (BIM)
- Peter Tyndall, Irish Sea Fisheries Board (BIM)
- Daniel McDonald, Irish Sea Fisheries Board (BIM)

Recent changes to the European Common Fisheries Policy, including the Landing Obligation (LO), require a reduction in discarding. Selectivity of fishing gear has a large influence on the retention of fish of varying sizes with the potential to partly mitigate for the impacts of the LO. Here, the effects of different mesh sizes (80, 100, 120, 140mm) on the retention of hake were investigated from a gillnet selectivity trial conducted by Bord Iascaigh Mhara in the south and west of Ireland. Selectivity models for the data were compared, including: traditional logistic regression models, additive variants, alternative distributional assumptions and an exploration of the application of a recently developed multinomial catch comparison method. Considerable differences in estimated selectivity were found under fixed or varying spread normal selectivity function assumptions. Similar selectivity curves were estimated from lognormal and gamma functional forms. Results suggest that mesh sizes of 80 or 100mm caught large quantities of non-marketable fish less than 60cm length. The 120 or 140mm mesh size caught very few hake under 60cm. A multinomial catch comparison method may be more appropriate for these data than selectivity models as assumptions on geometric similarity were not fully met. We discuss the advantages and disadvantages of selectivity or catch comparison of these data and resulting inference.

*Keywords: selectivity, gillnet, modelling, multinomial, Landing Obligation*

## WHY YOU SHOULD ADD TIME SERIES DECOMPOSITION IN ADDITION TO REGULAR CORRELATIONS WHEN RECONSTRUCTING AND FORECASTING STREAM WATER TEMPERATURE

- Guillaume Bal, Marine Institute
- Ronan J. O’Sullivan, FISH-EyE Collaborative Network, School of Biological, Earth and Environmental Sciences, University College Cork
- Elvira de Eyto, Marine Institute
- Mary Dillane, Marine Institute
- Adam Kane, FISH-EyE Collaborative Network, School of Biological, Earth and Environmental Sciences, University College Cork
- Philip McGinnity, FISH-EyE Collaborative Network, School of Biological, Earth and Environmental Sciences, University College Cork
- Thomas E. Reed, FISH-EyE Collaborative Network, School of Biological, Earth and Environmental Sciences, University College Cork

Global warming is one of the main threats to wildlife, with a broad range of impacts at individual, population, community and ecosystem levels. Locally forecasting and subsequently mitigating the impact of climate change requires long-term biological records together with historical and forecasted environmental time series. Air temperature, rainfall and downscaled climate change are easily accessible by ecologists. On the contrary, time series of stream water temperature are usually short, incomplete, and forecasts are not readily available. Although reconstructing and forecasting stream temperature by modelling the direct correlation between air and water temperatures over time is appealing due to this method’s simplicity and apparent good performance, it can be inherently biased as it does not discriminate between and link together the different components of the times series: long term trends, seasonality and daily variations. During this talk, we will first illustrate the caveats to standard correlations. Then, we will present how the additive decomposition of water temperature and time series of associated covariates, together with a correlative approach, can be used to circumvent the issues surrounding the use of direct correlations. Applications of this generic approach implemented within a Bayesian framework will be presented to illustrate both its fitting and forecasting performances.

*Keywords: water temperature, climate change, Bayesian modelling, forecasting uncertainty, air temperature, water discharge*

## AN EM ALGORITHM TO ESTIMATE INTER-ANNUAL VARIATION IN FISH GROWTH FROM LENGTH-FREQUENCY DATA

- Luke Batts, MFRC, Galway-Mayo Institute of Technology
- C  il  n Minto, MFRC, Galway-Mayo Institute of Technology
- Hans Gerritsen, Marine Institute
- Deirdre Brophy, MFRC, Galway-Mayo Institute of Technology

Fish growth is a fundamental component of many commonly used fisheries stock assessment techniques. Obtaining accurate estimates of growth parameters can be key to the reliability of these assessments. Analysis of length frequency distributions from surveys is one well known method for obtaining growth parameter estimates and is often used where other methodologies are not practical or feasible. Length frequency distributions were modelled using mixture models, where the means of the components (normal distributions within the mixture model) were constrained to follow a re-parameterised von Bertalanffy growth function. An Expectation- Maximisation (EM) algorithm with an adapted M step was used to find maximum likelihood parameter estimates iteratively. The methodology incorporates bivariate random effects into the model. This allows for inter-annual variation in the first and final components for each year, accommodating some of the natural variation that occurs in spawning and growth of fish. Cohorts of fish are then grown through the years, according to the cohort specific random effects on the means of the first and final components and an overall growth rate. Testing on two fish species, haddock (*Melanogrammus aeglefinus*) and white-bellied anglerfish (*Lophius piscatorius*), we were able to successfully model and identify cohorts, as well as obtaining reasonable estimates of growth parameters. As often found, estimation is sensitive to starting values. Unrealistic parameter values (that give reasonable component means) are occasionally estimated - methods used to treat these cases are discussed.

*Keywords: EM algorithm, length frequency analysis, inter-annual growth variability*

## COUPLING SEASONAL WEATHER FORECASTS WITH LONG TERM ECOLOGICAL DATA TO INFORM WATER MANAGEMENT

- Elvira de Eyto, Marine Institute
- Eleanor Jennings, Dundalk Institute of Technology

Water resources are closely dependent on the services supplied by ecosystems that maintain both water quantity and quality. Climate Extreme Events (CEE), like heat waves, droughts and floods, stress ecosystems and compromise their capacity to provide key services related to water. This implies huge economic and social impacts, which are expected to be even more relevant in the future. There has been limited development of solution-oriented tools integrating climate services (CS) and ecosystem impacts modelling for efficient adaptation to CEE. Here, we present the initial work of the WATExR project, which aims to integrate state-of-the-art seasonal climate predictions and water quality simulations, enabling efficient decision making and adaptation of water resources management to an increasing frequency of CEE. The work will be carried out in seven representative catchments across Europe. In each case study, WATExR will build an original, standardized modelling workflow system programmed as a QGIS plug-in. The Irish case study is based in the Burrishoole catchment, Co. Mayo, where the Marine Institute manage one of the key index sites in the north Atlantic for diadromous fish stocks. As a stakeholder in this project, the MI seeks to couple fish production and phenological models with seasonal forecasts to aid management and conservation goals.

*Keywords: Climate forecasts, extreme events, diadromous fish*

## SPECIES DISTRIBUTION MODELING USING BIOLOGICAL RECORDS DATA: THE EFFECT OF UNEVEN SAMPLING IN IRISH NATIONAL BIODIVERSITY DATA CENTRE DATASETS

- Willson Gaul, University College Dublin
- Paul Caplat, Queen's University Belfast
- Mark Emmerson, Queen's University Belfast
- Lupe Leon Sanchez, Queen's University Belfast
- Tomás Murray, National Biodiversity Data Centre
- Dinara Sadykova, Queen's University Belfast
- Hannah White, University College Dublin
- Jon Yearsley, University College Dublin

Opportunistic biological records datasets, such as those held by the National Biodiversity Data Centre (NBDC), can be successfully used in species distribution modeling. However, spatially uneven sampling is expected to introduce bias into models, especially when the intensity in sampling effort is correlated with important environmental gradients. We first describe the geographic and environmental sampling biases present in NBDC records. We then use simulations to test the effect on model performance of varying amounts of spatial sampling bias using several species distribution modeling methods. The different intensities of spatial bias used for simulation scenarios are empirically derived from the NBDC datasets, giving simulation results that can directly inform the use of NBDC datasets for species distribution modeling.

*Keywords: biological records, spatial bias, species distribution model, citizen science, virtual ecology*

## A STOCK ASSESSMENT MODEL FOR ANGLERFISH USING THE ASSESSMENT FOR ALL (A4A) FRAMEWORK.

- Hans Gerritsen, Marine Institute

The a4a model is an age-based fisheries stock assessment model; it based on the standard Baranov catch equation and tuned with survey indices of abundance. A large number of age-based stock assessment models exist, but a4a has very low parametrization requirements and is easy to specify. There are 5 submodels (specifying: fishing mortality at each age and year; the initial age structure; recruitment; catchability of the abundance indices and observation variance). Each of these submodels are specified using R linear model formulas e.g. for GLMs, GAMs etc. This opens the possibility of using the linear modelling tools available in R. Monkfish are a tricky species to assess; they are difficult to age; males and females have very different growth rates and possibly different natural mortality; two similar species are often reported together in the landings records. However they have one thing going for them: the recruitment success varies very strongly from year to year, resulting in very strong and very weak cohorts that can be tracked over time.

Earlier this year, the International Council for the Exploration of the Sea (ICES) accepted an a4a assessment model for white anglerfish in the Celtic Sea and Biscay. This is the first 4a4 assessment that will be used to set advised Total Allowable Catches (TACs). It is also the first robust age-based assessment for anglerfish.

*Keywords: fisheries, stock assessment, anglerfish*

## PICTURE VS PLAYGROUND: VALUING COASTAL AMENITIES

- Tom Gillespie, , NUI Galway

The aim of this paper is to determine the effect of proximity to coastline features, amenities and sea views on housing prices in Ireland using hedonic price modelling. The paper investigates if having a ‘picture’ of the coast via a window in a house adds more to the value of the property than having access to the coast for recreational purposes. The analysis uses a rich dataset of 0.5 million real estate listings, both sales and rental, in Ireland since 2006. The paper also uses geographic information systems (GIS) modelling to determine distances to coastal features as well as 3D spatial modelling techniques to develop a unique and novel measurement system for a house’s view of the sea. The results of the modelling exercise suggest that proximity to Blue Flag beaches have a significant price effect and that increasing a property’s vertical angle of view of the sea by 1 degree is associated with a 1.8% positive price effect. Being within 100 meters of the coast with a wide sea view corresponds to a 26% positive price effect. Sea views are found to have a greater price effect than proximity to the coastal amenities suggesting that households value the aesthetic quality of the coast over having access to it for recreational purposes in Ireland. Finally, the impact of coastal amenities on housing prices was found to display a counter-cyclical trend when compared with the housing market cycle.

## CLUSTERING TO IDENTIFY COHERENT MARINE REGIONS

- Mark Johnson, NUI Galway

In an ideal world, a discipline may be considered to have a core set of methods that are well understood and applied by all. This probably is not the case for any field, but is certainly not true for ecology. We may have passed ‘peak ANOVA’ but it is likely that issues identified by Underwood and Hulbert, among others, are still occurring in the literature. Some points about the tools used can be drawn from the Dynamic Ecology blog. This short talk will illustrate some applications of techniques to spatial data in fisheries, biological oceanography and biogeography, with particular reference to clustering to identify coherent regions.

*Keywords: cluster, autocorrelation*



## ADAPTIVE MANAGEMENT FOR THE RECOVERY OF THE HIGHLY THREATENED CURLEW IN IRELAND: ASSESSING CONSERVATION MANAGEMENT, POPULATION DYNAMICS AND LAND USE CHANGE

- Seán B.A. Kelly, UCD School of Agriculture & Food Science, University College Dublin
- Anita Donaghy, BirdWatch Ireland
- Barry J. McMahon, UCD School of Agriculture & Food Science, University College Dublin

Populations of Eurasian Curlew *Numenius arquata* are declining across the species' entire range, from the British Isles to Russia. This trend reflects the current global decline of wader (shorebird) populations. In recent decades, breeding populations of Curlew in Ireland have declined by 86% and contracted in range by 78%. With fewer than 150 breeding pairs remaining, Curlew represents one of Ireland's most pressing conservation concerns. In 2017, the National Parks & Wildlife Service began implementing a Curlew Conservation Programme aimed at conserving remaining pairs and promoting population recovery. Complementary to this, our research programme aims to inform optimal management for breeding Curlew in terms of on-the-ground management and national policy. Combining data on Curlew breeding productivity, land use, predation threat and predator control, our research will assess the efficacy of the existing conservation programme to determine if and how it can be improved. Using current data on breeding productivity, we will also model future Curlew population dynamics under various management scenarios. We will determine minimum productivity thresholds required to maintain or grow populations and the minimum viable population for Ireland. Furthermore, combining data on land use and the occurrence of breeding pairs, we aim to assess the impacts of land use change in recent decades on the decline of breeding Curlew in Ireland. These analyses will inform evidence-based conservation management and influence policy for the benefit of Curlew and other ground-nesting birds of conservation concern.

*Keywords: Conservation management, ground-nesting birds, Curlew, land use change, population dynamics, adaptive management*

## DISENTANGLING THE RELATIONSHIPS BETWEEN PLANT TRAITS, ENVIRONMENTAL CONDITIONS AND DEMOGRAPHIC STRATEGIES.

- Ruth Kelly, School of Natural Sciences, Trinity College Dublin
- Yvonne Buckley, School of Natural Sciences, Trinity College Dublin

A key assumption of the use of 'functional traits' in plant ecology is that these traits can be used to predict the fitness of species in terms of demographic rates and population performance. Thus, functional traits are often used to make predictions about how species will respond to environmental change, and about their capacity to recover following catastrophic events. However, the link between functional traits and demographic rates across plant species is by no means fully understood. Whilst associations between individual plant traits and vital rates have been previously demonstrated, these relationships explain relatively little of the observed variation in vital rates across species and environments.

Our research differs from previous work by focusing on the association between multivariate 'trait syndromes' and complete demographic strategies (i.e. combined schedules of growth, survivorship and reproduction) across a global suite of plant species. Using a multivariate modelling framework we assess the extent to which life-history parameters derived from matrix population models can be predicted by combinations of plant traits and their relationship with the environment.

This talk will focus on the application of modern multivariate approaches to understanding the relative influences of multiple multivariate drivers on population performance, whilst accounting for the inherent phylogenetic structuring of species data. Given the inherent complexity of ecological systems, we suggest that these multivariate modelling approaches are an invaluable tool-set for addressing a wide range of environmental research questions.

*Keywords: Botany, demography, functional traits, multivariate analyses, environmental filtering*

## INCLUDING UNCLASSIFIED INDIVIDUALS IN SEX-SPECIFIC LIFE-HISTORY MODELS

- C  il  n Minto, Marine and Freshwater Research Centre (MFRC), Galway-Mayo Institute of Technology
- John Hinde, School of Mathematics, Statistics and Applied Mathematics, National University of Ireland
- Rui Coelho, Portuguese Institute for the Ocean and Atmosphere (IPMA)

Estimating sex-specific life-history models typically proceeds by fitting to individuals recorded as male or female. Yet, for many animal species sex may not be apparent until the onset of maturation. As a result, sex-specific life-history models are often only fit to known-sex individuals that occupy a limited region of the fitting space. This results in biased parameter estimates. We propose an alternative approach whereby the sex of the unclassified individuals is treated as a classification problem to be estimated simultaneously with the sex-specific life-history models.

*Keywords: Dimorphism, EM algorithm, missing data, partial classification*

## PROGNOS: PREDICTING IN LAKE RESPONSES USING HIGH FREQUENCY NEAR REAL TIME MODELS

- Tadhg Moore, Dundalk Institute of Technology
- Elvira de Eyto, Marine Institute
- Mary Dillane, Marine Institute
- Don Pierson, Uppsala University
- Eleanor Jennings, Dundalk Institute of Technology

Lakes and reservoirs are under continuous pressure from urbanization and agricultural intensification, and from changes in climate, including an increasing occurrence of extreme climatic events. These pressures can reduce water quality by promoting the occurrence of nuisance algal blooms and higher levels of dissolved organic carbon (DOC), two issues that can substantially increase the costs for water treatment. To monitor such changes in water quality, automated high frequency (HF) monitoring systems are increasingly being adopted for lake and reservoir management across Europe. These HF data are mostly used to provide near real time (NRT) information on the present lake state. An even more valuable tool for water management, however, would be to use HF data to run computer models that forecast the probability of a change in lake state in the coming weeks or months. In PROGNOS, we will develop an integrated approach that couples HF lake monitoring data to dynamic water quality models to forecast short-term changes in lake water quality. This will potentially provide a greater window of opportunity over which to make water quality management decisions, and will increase the value of HF monitoring data, ensuring that their potential to guide water quality management is fully realized. This project will promote innovative solutions for water-related challenges across Europe. It will develop, demonstrate and disseminate forecast based adaptive management solutions for two specific water quality threats: nuisance algal blooms and the production disinfection by-products from DOC. The technology demonstrated here has the potential to transform water management and foster the growth of European companies that specialize in adaptive water management and water quality forecasting systems. The project consortium includes expertise from European sites that have been involved in the forefront of HF monitoring systems since the late 1990s, expertise in modelling algal blooms and DOC levels, and expertise in assessing societal benefits from changes in water management.

*Keywords: Water Quality, Modeling, High Frequency Monitoring, Dissolved Organic Carbon*

## BUILDING ON THE FLOOD PLAINS

- Thomas McDermott , NUI Galway

In this paper we study how much construction has taken place on coastal flood plains in the US in recent decades, in which locations, and why. Coastal areas offer many advantages and attract concentrations of economic activity, but some parts of the coast are particularly prone to flooding, and as sea levels rise so too will the flood risk. As Kydland and Prescott (1977) discuss in their Nobel Prize winning contribution, this flood risk is partly borne by taxpayers. In recent years the Federal government paid tens of billions of dollars of subsidies, in the form of investment in flood defenses, subsidized insurance, and recovery assistance in the aftermath of floods. These costs are likely to increase further over time; the US Atlantic and Gulf coasts experienced some of the fastest rates of local sea level rise in the world during the 20th century, and this trend is expected to significantly raise the frequency and severity of floods. To make matters worse, the National Flood Insurance Program suffers from a number of deficiencies, and is widely thought to underestimate flood risk, with the result that payouts have exceeded premiums and large debts have accumulated. Of particular concern is the flood risk mapping process, which affects flood insurance premiums, and does not account for anticipated future changes in risk. To study these issues, we use high resolution data from the National Oceanic and Atmospheric Administration. These include data on land cover change from 1996-2010, based on satellite imagery, combined with official maps of current flood risk and detailed maps showing areas expected to be inundated for various levels of future sea level rise. These allow us to study the rates of development in particularly risky parts of the US coast across time and space, and to investigate some of their causes.

## ESTIMATING THE VALUE OF GOOD ENVIRONMENTAL STATUS IN THE EUROPEAN ATLANTIC REGION

- Daniel Norton, NUI Galway

Using a combination of the contingent valuation method (CVM) and value transfer (VT), the value of the benefits associated with the achievement of good (marine) environmental status (GES) as specified in the EU MSFD for Atlantic member states is estimated. The increased use and availability of geographical data means that many VT exercises now include spatial elements such as allowing for substitute sites, distance decay and population density. This paper explores the manner in which distance decay is modelled and the appearance of the modifiable area unit problem (MAUP) when population density is included as an explanatory variable. These issues can have a large effect on a VT estimate.

## "UNLOCKING THE ARCHIVE" - USING ADVANCED STATISTICAL TECHNIQUES TO INVESTIGATE DRIVERS OF ATLANTIC SALMON AND EUROPEAN EEL GROWTH.

- Louise Vaughan, Marine Institute / Galway-Mayo Institute of Technology
- Deirdre Brophy, Galway-Mayo Institute of Technology
- Niall O'Maoileidigh, Marine Institute
- Russell Poole, Marine Institute
- C  il  n Minto, Galway-Mayo Institute of Technology

Investigations of both intrinsic and extrinsic drivers of fish growth require detailed long-term datasets. The Newport Research Facility (NRF) holds an extensive collection of Atlantic Salmon scales and European Eel otoliths collected as part of national and international monitoring programmes. The NRF has been monitoring the Burrishoole Catchment for over 55 years and detailed meteorological data is available over this time period. The "Unlocking the Archive" project aims to develop advanced statistical techniques to analyse these datasets efficiently and in doing so build capacity for future research endeavour. More specifically it aims:

- To use scale growth trajectories from Atlantic Salmon to investigate declines in marine growth and survival and potential climate impacts.
- Relate patterns in annual growth increments of European eel to temperature, productivity and meteorological conditions within the Burrishoole catchment.

Available datasets will be reviewed and built upon. Time series data of fish growth and environmental conditions will be combined and analysed to make inferences on how individuals and populations respond to environmental change. Results from the "Unlocking the Archive" project will be used to develop recommendations for future management plans of Atlantic Salmon and European Eel.

*Keywords: Atlantic Salmon, European Eel, Climate Change, Fish Growth,*

## BIODIVERSITY AND RESILIENCE AT THE MACRO-SCALE

- Hannah White, University College Dublin
- Dina Sadykova, Queen's University Belfast
- Paul Caplat Queen's, University Belfast
- Willson Gaul, University College Dublin
- Tomas Murray, National Biodiversity Data Centre
- Lupe Leon Sanchez, Queen's University Belfast
- Mark Emmerson, Queen's University Belfast
- Jon Yearsley, University College Dublin

Investigating the resilience of ecosystem functions is vital for informing management so that we can adapt to minimise the impact of ongoing environmental change on ecosystem functioning. It has been established that biodiversity promotes resilience at local scales. Studying this relationship at larger scales could enable the investigation of landscape biodiversity effects on resilience, however, this has proved problematic due to the challenges of measuring both biodiversity and resilience at large spatial scales. Using remotely-sensed data allows us to obtain time-series data of a vegetation index (EVI) at these large scales and can be used to quantify multiple components of resilience. We present methods to calculate the resistance, variability and recovery (three components of resilience) of a particular ecosystem function, productivity, across the island of Ireland. We use a temporal moving window algorithm on EVI anomalies to account for seasonal cycles and noise within the community-level measure of productivity which can be used to identify periods of environmental perturbations. The relationship of resilience with biodiversity was investigated using biological recordings data of vascular plants to estimate species richness using statistical methods to account for variation in recorder effort. Although investigating resilience and biodiversity at large scales presents unique challenges with regards to the spatial and temporal accuracy of the data, using statistical methods to account for these show that the biodiversity-resilience relationships previously observed at small, experimental scales are maintained at large spatial scales.

*Keywords: resilience, macroecology, productivity*

## ASSOCIATING METEOROLOGY WITH THE EMISSION CHARACTERISTICS OF THE FUNGAL SPORES RESPONSIBLE FOR ASH DIEBACK DISEASE

- Jon Yearsley (UCD)
- Volkmar Timmermann (NIBIO, Norway)
- Paul Burns (University of Exeter, UK)

*Hymenoscyphus fraxineus* is the fungal pathogen responsible for ash dieback disease. The disease was observed in Poland in 1992. It spread rapidly across Europe and was first detected in Ireland in October 2012. The spread of ash dieback disease can be broken down into three stages: emission of spores from an infected site, airborne dispersal of spores, infection of a new tree stand. In this talk we focus on the meteorological characteristics that influence the quantity and timing of the spore emissions from an infected stand of ash trees. We analyse hourly counts of *H. fraxineus* spore concentrations from an infected ash stand near As (Norway) from the summers of 2009, 2010 and 2011. We use general linear models and generalised additive models to associate meteorological variables with the time of the daily peak spore concentration and the total daily spore emissions from 70 days of observations. We discuss preliminary findings and issues of collinearity, model selection and temporal autocorrelation.

### TRACKING ECOLOGICAL PERTURBATIONS THROUGH STABLE ISOTOPE ANALYSIS

- A.L Jackson, School of Natural Sciences, Trinity College Dublin
- Q Yang, School of Natural Sciences, Trinity College Dublin
- I Donohue, School of Natural Sciences, Trinity College Dublin

Ecosystem-based approaches that consider more than just the target species are becoming the norm in the management of harvested ecosystems such as fisheries or forestry. Indeed, the approach is growing in popularity for managing and restoring impacted ecosystems in general. A major challenge we face is collecting sufficient data on the non-target (or less charismatic) species in order to elaborately describe the dynamics of the wider community and to judge our management strategies. Monitoring directly the abundances of all the species in the community in response to perturbations such as harvesting (but more generally to any perturbation) is the ideal, but likely impossible, approach. Stable isotopes move through ecological communities and are predictably altered by key trophic ecological processes of consumption and assimilation. Using a mathematical framework of Lotka-Volterra community dynamics coupled with models of stable isotope dynamics, we show that the effects of perturbations are theoretically detectable in the stable isotope data alone. This opens up the possibility that, with further understanding and validation, resource-efficient stable isotope analysis could be deployed to act as a near-real-time method for monitoring impacted systems at community or ecosystem scales.

*Keywords: population dynamics, food webs, stable isotopes*

## INTEGRATING GIS AND MODELLING APPROACHES FOR PRECISE ASSESSMENT OF ORGANIC CARBON STOCKS AND CHANGES IN IRISH AGRICULTURAL SOILS

- M.I. Khalil, UCD School of Biology & Environmental Science and Earth Institute, University College Dublin
- B.A. Osborne, UCD School of Biology & Environmental Science and Earth Institute, University College Dublin

The Paris Agreement emphasises enhanced mitigation measures, reducing GHG assessment uncertainties, better quantified sinks, and the tailored use of different offsetting mechanisms. The SOC pool has the potential to act as a major source or sink of GHGs. Due to the lack of spatially explicit activity data, Ireland is mainly using the IPCC Tier-1 methodology for inventory reporting. To attain Tier-2, data generated previously through overlaying land use (LU) and soil maps using ArcGIS were reprocessed to develop depth-distribution models and pedotransfer functions ( $R^2=0.53-1.00$ ) for estimation of SOC concentrations and bulk densities. Then, databases/maps for two soils and a historical agricultural LU (2000-2014) were overlaid to categorize key LUs on mineral, organo-mineral and organic soils. Empirical approaches and IPCC default density change factors (DCFs, %) were applied to calculate SOC density/stock ( $\text{SOC}_{\text{U+03C1}}$ ) and their changes. The range of  $\text{SOC}_{\text{U+03C1}}$  was in the order, rough grazing (R)>grassland (G)>rotation/ley (GT)>tillage (T), and was highest in the organic soils. For the 0-30cm soil layer, the  $\text{SOC}_{\text{U+03C1}}$  ( $\text{t-C-ha}^{-1}$ ) measured in 2006 was 242 (R), 207 (G), 162 (GT) and 80 (T). The reference year (1990) value ( $\text{SOC}_{\text{U+03C1}}^{\text{ref}}$ ), predicted using two-phase models, was 238 (R), 198 (G), 166 (GT) and 99 (T),  $\text{t-C-ha}^{-1}$ . Based on the  $\text{SOC}_{\text{U+03C1}}^{\text{ref}}$  values, G and R were sinks, whilst T and GT were sources. The DCFs overestimated the  $\text{SOC}_{\text{U+03C1}}$  change by 42-156% and the corrected one for the four LUs combined, over 25 years, was 0.23, 0.42 and 0.53  $\text{t-C-ha}^{-1} \text{ yr}^{-1}$  for the 0-10, 0-30 and 0-100cm layers. The corresponding national agricultural SOC<sub>0-100</sub> measured in 2006 were 316, 838 and 1679 Tg. An estimated potential of offsetting GHGs through SOC sequestration was 24, 59 and 106% of the total emitted from Irish agriculture. The findings imply that the integrated approaches can provide robust estimates of  $\text{SOC}_{\text{U+03C1}}$  and their changes overtime.

*Keywords: GIS, Empirical modelling, SOC density/stocks, agricultural land uses, Ireland*



## MACROALGAE MODELLING FOR NUTRIENT LOAD ALLOCATION IN THE TOLKA ESTUARY

- Joseph V. McGovern, Ryan Institute/Department of Civil Engineering, NUI Galway
- Stephen Nash, Ryan Institute/Department of Civil Engineering, NUI Galway
- Michael Hartnett, Ryan Institute/Department of Civil Engineering, NUI Galway

CANCELLED

The occurrence of macroalgae blooms in the intertidal zone of estuaries subjected to nutrient enrichment from point and diffuse pressures is a persistent issue nationally and internationally. In response to the issue, modelling and management tools are necessary to determine the conditions which may lead to restoration of good status.

A pre-existing high resolution finite difference hydrodynamic, solute transport and water quality model has been adapted to include macroalgae growth and decay, alongside the existing trophic status parameters of pelagic chlorophyll\_a as a proxy for phytoplankton, inorganic N and P and dissolved oxygen. Macroalgae growth has been modelled as a function of temperature, tissue N and P, salinity, bed stress and proximity to an upper bed capacity limit, whilst macroalgae decay comprises a baseline rate and a DO stress component. The resultant model was applied to the system comprising the Tolka estuary and the adjoining Liffey estuary and Dublin Bay.

Here, we compare the results of high resolution water quality model with results generated by applying the DCPM tool (Aldridge et al., 2010), developed for the UK Environment Agency, to the same system.

*Keywords: Macroalgae, eutrophication, growth model, nutrient load allocation*

# TMB WORKSHOP

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## WHAT IS TMB AND WHAT CAN IT DO FOR ME

Template Model Builder is an exciting analytical tool for fitting high-dimensional, potentially non-linear statistical models. Inspired by ADMB, TMB is written in C++ and automatically differentiates the objective function, thus providing gradients that result in fast and stable optimization. This workshop will provide a practical introduction to TMB for ecological modelling, including a hands-on tutorial.)

## TMB SETUP

Please install TMB on your laptop before the workshop. Information on installation can be found here:

[https://github.com/nwfsc-assess/geostatistical\\_delta-GLMM/wiki/Steps-to-install-TMB](https://github.com/nwfsc-assess/geostatistical_delta-GLMM/wiki/Steps-to-install-TMB)

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