

LINKING PLANT DEMOGRAPHY, ECOLOGICAL DYNAMICS AND POPULATION GENETICS ACROSS SPACE AND TIME

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Connectivity between populations is vital to the survival of extinction-prone plants, including those at risk from local environmental change, as well as pests and pathogens, with globally important implications for applied plant ecology. The metapopulation concept has become the dominant paradigm for exploring the role of connectivity in this context. However, many metapopulation models incorporate very little detail about the underlying dispersal mechanisms (demography), and measures of connectivity based on contemporary dynamics and population genetics.

Seagrass is a group of flowering plants that live in shallow sheltered areas along the UK coastline where they form dense green meadows under the sea. It is one of the most significant sources of coastal primary production and it provides a critical habitat for juvenile reef fish and commercial fisheries. During the course of a long-term study of metapopulation dynamics in the seagrass, *Zostera marina*, around the UK, we quantified demographic heterogeneity, population trends and spatial correlations within and between sampling sites. Here, we compare estimates of population connectivity inferred from these ecological dynamics with estimates of connectivity derived from a published panel of fifteen polymorphic microsatellites DNA markers. We test hypotheses on how long term declines in local seagrass populations are predicted to result in restricted genetic diversity and departure from Hardy-Weinberg equilibrium. We also explore whether spatial connectivity between local sites mitigates against population genetic changes at the broader spatial scale.

This project will aim to combine detailed measurements on individual plants with eco-evolutionary modelling and the latest population genetic and genomic approaches, to better understand the link between demography, dynamics and diversity. The over-arching goal of this study is to gain an understanding of the spatial population genetics of eelgrass, *Zostera marina*.



@AlotaibiNahaa

Marine mammals that fly: Observations of bats in coastal habitats of western Scotland

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Twitter abstract: Passive acoustic monitoring reveals regular presence of different bat species on western Scottish beaches and over adjacent coastal waters – potential for interactions with marine industry? @StevenBenjamins #MASTSasm2020

Bats (Chiroptera) represent >25% of UK mammal species and are sensitive to various human activities (JNCC & BCT 2017). Many questions still remain about aspects of bats' ecology and sensitivity to anthropogenic pressures, particularly in coastal areas. Although bats are known to traverse open water during migration (Ahlén et al. 2009) and some species occur on e.g. Orkney and the Hebrides, little is known about inshore coastal habitats' potential significance to bats in the UK. Determining if bats make use of coastal marine habitats is an essential first step in evaluating whether they might be at risk of human activities in these areas.

The present pilot study sought to investigate whether bats might be observed in coastal marine environments on the west coast of Scotland. The study used four marinised AudioMoth autonomous passive acoustic detectors to observe bats echolocating nearby (<20m from the detector). During April-September 2019 and 2020, AudioMoths mounted on 2m poles were deployed along the high tide mark on three beaches in western Argyll (Scotland), for 1-7 days. AudioMoths were also periodically placed on four floating commercial salmon farms located 87-424 m from shore for 7-21 days. Recorders were active from <1 hour before sunset to <1 hour after sunrise, and operated on a 20-50% duty cycle (1 minute on/1-4 minutes off) to preserve battery power and extend recording periods.

Approximately 480 hours of acoustic data have been collected from the various sites to date; temporal coverage varied significantly, particularly among the different fish farms, due to logistical complexities. Raw data were analysed using open source

BatClassify software to extract and classify bat echolocation calls. Calls were subsequently aggregated into Bat-Positive Minutes (BPMs) for further analysis.

Bats were detected at all beach locations and among 3 out of 4 salmon farms, between April and September. The vast majority of detections at all sites involved common and soprano pipistrelles (*Pipistrellus pipistrellus* and *P. pygmaeus*), with occasional observations of Daubenton's (*Myotis daubentonii*) and brown long-eared bat (*Plecotus auritus*). Bat detections were patchy (0-16 BPMs per day) and included single passes as well as extended BPM sequences of ≥ 10 minutes, suggesting individuals remaining in the general area; average hourly detection rates ranged up to 16 BPMs per hour in some cases. Data collected thus far indicate that, although less frequently observed in more exposed salmon farm localities, bats are regular users of coastal marine ecosystems in western Scotland, and should be considered as such when undertaking impact assessments for new or existing human activities in these environments.

Acknowledgements

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Climate impacts on the coral reefs of the Pitcairn Islands Marine Reserve in 2016

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A significant coral bleaching event observed at Ducie Atoll in the Pitcairn Marine Reserve, Pacific Ocean in 2016 was due to cold-water stress rather than warming from the 2015-2016 El Niño. #MASTSasm2020
Twitter Handle @dawson_t

The Pitcairn Islands, a UK Overseas Territory, are a group of four volcanic islands; Pitcairn, Ducie, Henderson and Oeno, located in the southern Pacific Ocean between latitudes 23° and 26° south and longitudes 124° and 131° west (Irving and Dawson 2012). In 2012, a National Geographic Pristine Seas Expedition undertook extensive diving surveys at all four islands (Friedlander *et al.* 2014). Results showed that all four islands host some of the best-preserved marine ecosystems on the planet with very high proportions of live coral compared to other tropical regions. In particular, the coral cover at Ducie, the easternmost atoll of the group was 56%, the highest cover among the Pitcairn Islands, which is remarkable given the fact that, at latitude 24°40'S, the near-shore water temperatures around the island are at the lower range of the thermal tolerance for coral reef formation. The low latitudes of the Pitcairn Islands also led to the conclusion that the coral reefs there would be resilient to global warming or El Niño climate cycles. Given the pristine nature of the marine environment in the waters around these isolated islands, in 2016, the UK Government designated a marine reserve encompassing the whole Pitcairn Islands Exclusive Economic Zone, an area of around 830,000 km² and one of the largest MPAs in the world.

However, in September 2016, the Tara Pacific expedition (2016-2018) visited Ducie Atoll and diver surveys revealed extensive bleaching of the reefs, up to 40% in places, at depths between 10-15m (Rebecca Vega Thurber, Per Comms, 26 Sept 2018). From 2015 until the middle of 2016 there was a significant El Niño event with temperature anomalies of some regions of the equatorial Pacific Ocean reaching +3.0°C - the strongest on record. The optimal temperature for the growth of coral reefs is within a range of around 23°–29°C, although some corals can tolerate water temperatures higher and lower than these limits for short periods (NOAA, 2020). Investigation of monthly Sea Surface Temperatures (SST), based on satellite data and provided by NOAA (NOAA OISST V2.1 High Resolution Dataset) with

0.25° spatial resolution, showed that for the period Sept 1981 to Dec 2019, the mean SST aggregated across the whole of the Pitcairn Marine reserve was 24.16°C with a standard deviation of 1.74°C and that at no time did the monthly SST exceed 28°C. For the period Jan 2015 to Oct 2016, the maximum monthly SST reached 27.25°C in Mar 2016, which is within the mean long-term aggregated SST ± 2 Standard deviations. However, the Sept 2016 SST dropped to 21.75°C, which is below optimal temperature conditions for coral. Following the 2015-2016 El Niño, rapid La Niña conditions emerged in July 2016, drawing up cold water from the depths of the eastern tropical Pacific and driving it westwards, creating lower than average water temperatures across the central Pacific region in Aug and Sept 2016. Examination of the NOAA daily global 5km SST data (CoralTemp Version 3.1)(Maturi *et al.*, 2017) confirmed an accumulated cold stress with daily temperature anomalies greater than 1.0°C below normal conditions for the austral winter period around Ducie Atoll, and which was likely to be the cause of the coral bleaching event.

Acknowledgements

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Analysis of bivalve larvae shell integrity and carbonate chemistry at a Scottish Coastal Observatory monitoring site

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Tweetable abstract (#MASTSasm2020): *Ocean acidification is considered a threat for calcifying plankton, including bivalve larvae of commercial importance for aquaculture and fishery industries. This work presents the first analysis on the shell integrity of pelagic bivalve larvae and its relationship with carbonate chemistry at the SCObs site at Stonehaven.*

Ocean acidification (OA) and the associated alteration to seawater carbonate chemistry is likely to have a significant impact on calcifying plankton. This group includes the pelagic larvae of bivalve species of commercial importance for aquaculture and fishery industries (e.g. mussels, oysters, scallops, etc.). Understanding the potential effects of OA on bivalve larvae is important for the assessments of economic impacts of OA, however field studies examining the relationship between carbonate chemistry and bivalve larvae are scarce.

Marine Scotland Science operates the Scottish Coastal Observatory (SCObs; <http://dx.doi.org/10.7489/1881-1>) monitoring site at Stonehaven (56 57.80N, 02 06.20W). This site is providing baseline information about the seasonality and interannual variability of carbonate chemistry as well as the plankton community in inshore Scottish waters. Temperature, salinity, nutrients, phytoplankton and zooplankton have been monitored at the site weekly since 1997. Carbonate chemistry parameters were measured between 2009-2013. This work aims to investigate the relationship between carbonate chemistry parameters and shell integrity in bivalve larvae at Stonehaven by examining specimens of archived samples from 2011-2013 using scanning electron microscopy (SEM).

SEM images revealed evidence of shell dissolution (corrosion) throughout the study period despite the seawater being supersaturated with respect to calcium carbonate. The most severe shell damage was observed during winter coinciding with periods of decreasing concentrations of carbonate. This study supports previous observations of pelagic gastropods at Stonehaven suggesting that seasonal and short-term changes in carbonate chemistry may affect the shell integrity of plankton calcifiers. These results also indicate that dissolution may appear under higher saturation values than previously assumed. This investigation provides one of the few descriptions of the variation in shell dissolution of bivalve larvae in a biological time-series, supporting the value of sustained observations on assessing the potential impacts of OA as well as providing advice to aquaculture industry.

Population dynamics, catch composition and CPUE of the edible crab, *Cancer pagurus*, and European lobster, *Homarus gammarus*, in a Voluntary Marine Reserve

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Sustainability of *Cancer pagurus* & *Homarus gammarus* populations @BerwickshireMR. Information from mark/recapture, CPUE, juvenile surveys to aid baseline data to better future fishery management and national legislation. #MASTSasm2020 Twitter: @marinestation

With the nature of fishing legislation changing due to political uncertainty^{1,2}, the need for local information is essential to inform future fishery management. Focusing on the commercially important decapods, the edible crab (*Cancer pagurus*) and the European lobster (*Homarus gammarus*), this study assesses the dynamics of juvenile and adult populations from locations within the voluntary marine reserve, Catch Per Unit Effort (CPUE) and home ranges using a mark recapture method. Information on juvenile *C. pagurus* populations is not typically used in the assessment of fishery stocks, but vital to help understand how the future population will develop. Through mark/recapture assessment we can understand whether the populations situated in the Berwickshire Marine Reserve (BMR), Scotland's first voluntary marine reserve, are transient or stationery in nature. The data presented here was gained during the first two of a three-year-study, in 2018 and 2019. Weight (g), size (mm), body condition³, and sex of the decapods are recorded, as well as sea temperature (°C), dissolved oxygen (DO%), tidal height (m) and lunar phase (lighting %). This paper will present how juvenile numbers have changed over the months of 2018-2019 highlighting the difference in numbers by sex and sampling site. Female *C. pagurus* and male *H. gammarus* within the BMR travelled greater distances (7.89km and 9.02km, respectively) compared to male *C. pagurus* and female *H. gammarus*. CPUE data from 2018 to 2019 has changed for both target species. For *H. gammarus*, the CPUE increased from 0.824 to 1.84.

In contrast, the CPUE for *C. pagurus* decreased from 1.201 to 1.087. These differences in CPUE, within and between species, may be due to associated changes in recorded environmental factors. This data will provide detailed baseline information that will help to detect and evaluate future fishery impacts in the voluntary marine reserve and inform its fishery management.

Acknowledgements

We would like to thank the fishermen of the St Abbs and Eyemouth Voluntary Marine Reserve for their co-operation. The funders, The Blue Marine Foundation and FLAG, a thanks for providing the means for these projects to run for 3 consecutive years. Also, the many volunteers from St Abbs Marine Station who aided the data collection on the juvenile crab surveys and mark/recapture study, as well as, Erica Chapman and Alfie Piper for their feedback regarding this abstract.

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Exploring options for further inclusion of blue carbon in climate change policy within the framework of the IPCC

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Tweetable Abstract

Blue carbon habitats can contribute to mitigating GHG emissions on a national level but are currently underutilised and undervalued. An analysis of IPCC reports and links to policy, highlights options for greater presence and awareness of blue carbon in climate mitigation efforts.

Abstract

Climate change is one of the most significant challenges of our time, directly or indirectly impacting most aspects of day to day life. As a response to climate change, international emission reductions were determined and nations, such as the UK, individually set net zero emission targets. In order to comply with international emission targets and to reach net zero emissions, a myriad of approaches have been suggested, including the management, restoration and protection of natural carbon sinks. Coastal vegetated habitats, also known as blue carbon habitats, can make a valuable contribution to mitigating greenhouse gas emissions on a national level but are currently underutilised and undervalued. The uptake and long-term storage of carbon that characterizes these blue carbon habitats is an important ecosystem service and the protection of these sinks is a nature-based solution to climate change. As such, it is important that these sinks be included in climate change mitigation efforts at the national level. The intergovernmental panel on climate change (IPCC) is a point source of information on climate change for interested parties from science, policy and the general public and thus is a vital player influencing international and national climate change approaches and negotiation. An analysis of the links between IPCC reporting and current policy frameworks, incorporating a historical analysis of the content of previous IPCC reports, highlights options for a significantly greater presence and awareness of blue carbon within existing international climate mitigation and adaptation policy frameworks.

The effects of Electromagnetic Fields on microbial surface colonization and biofilm development

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Exposure to elevated EMF (electromagnetic field) levels can negatively effect early surface colonizing marine bacteria. Biomass, extracellular polymeric matrix and metabolic rate of marine biofilms were altered after seven days exposure to different magnetic field intensities, expected around subsea power cables. #MASTSasm2020

Introduction:

Scottish renewable energy currently has 915MW operational and 4.1GW consented offshore windfarm projects. With these large-scale developments, extensive areas of seabed could be subjected to elevated Electromagnetic field (EMF) levels emitted from subsea power cables¹. Uncertainties concerning the impacts of EMFs on marine species, particularly marine microorganisms around windfarm sites remain.

Any submerged surface in the marine environment goes through the process of “biofouling” with the formation of bacterial biofilms on macromolecular film, followed by the settlement of macrofoulers². Biofouling is a costly industrial problem; shortening the life expectancy and efficiency of submerged devices.

Subsea power cables and cable armour laid on bare substrates could serve as artificial reefs; providing refuge for commercially important species and potentially contributing to stock replenishment³. As first surface colonizers, bacterial biofilms have a critical role in facilitating the settlement of macro-invertebrates.

To assess the effects of EMF emissions on early biofouling on subsea power cables, marine biofilms were subjected to static electromagnetic fields. Microbial biofilms were developed on fiberglass mesh tiles in microcosms supplied with constant raw seawater flow. To mimic the EMFs expected to be found around HVDC (high-voltage direct current) subsea power cables, microcosms were exposed to electromagnetic fields at 3 different magnetic flux densities (0.5mT, 1.5mT and 3mT) for 7 days. Biomass was compared between treatments using crystal violet assay. The effect of EMFs on the

extracellular polymeric substance (EPS) matrix was assessed by scanning electron microscope imaging, and by measuring total carbohydrate content with phenol-sulfuric acid method. To determine changes in metabolic rate due to acute and chronic EMF exposure, spatial and temporal changes of oxygen in the biofilm tiles, were visualized with VisiSens imaging system. DNA samples were collected to analyze changes in microbial community structure and diversity.

Our results showed that static EMFs expected around subsea power cables affect early biofilm formation, in a field intensity dependent manner. Biomass and total carbohydrate content of biofilm tiles exposed to 1.5mT and 3mT EMFs were significantly lower than sham and 0.5mT exposed tiles. Two-dimensional mapping of oxygen concentrations revealed altered metabolism of biofilm tiles, after acute and chronic exposure to 3mT magnetic field intensity.

To further understand the underlying mechanism of static EMF effects on early biofilm formation, long-term field experiments and *in situ* magnetic field measurements around HVDC subsea power cables will be required.

Acknowledgements

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Regional Scale Mapping of Sedimentary Carbon Using Multibeam Data

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Marine sediments are long-term stores of organic carbon (OC) that is derived from atmospheric carbon dioxide (CO₂) via natural biological processes. Sediments bury, and essentially remove, this carbon over geological timescales (Berner, 2003) and this process provides a climate regulation service (Raven and Falkowski, 1999). To improve our understanding of how much carbon (C) is stored in marine sediments, knowing where to look is a key factor. Spatial mapping of sedimentary OC is developing quickly (Smeaton and Austin, 2019; Legge et al., 2020) in response to requirements to improve carbon-stock estimates within the marine environment (Luisetti et al., 2019). However, data for sedimentary carbon over large areas is a limiting factor in producing accurate estimates.

The seabed is routinely mapped using acoustic multibeam echosounders (MBES) with backscatter intensity acting as a proxy for substrate type. A recent pilot study undertaken within a sea loch on the west coast of Scotland demonstrated the use of MBES data as a novel methodology to spatially predict the distribution of sedimentary OC over a heterogeneous seabed, and, to estimate a surface standing stock of OC (Hunt et al., 2020).

To extend the application of this approach, we have taken an existing MBES dataset collected from a dynamic coastal setting, and apply a similar methodology to determine the likely spatial distribution of sedimentary OC. The Moray Firth, on the east coast of Scotland, is an estuary with multiple riverine inputs that opens out into the northern North Sea. A ground-truthing campaign of sediment grabs was conducted in 2019 across the MBES backscatter footprint. Sediment samples have undergone particle size and elemental analysis for carbon. The objective of this study is to understand the potential of using MBES backscatter, bathymetry, and derivative variables that characterise seabed terrain, to spatially map sedimentary OC in a dynamic coastal environment. This type of approach may help to improve our ability to spatially predict sedimentary OC at a

regional scale and could have applications in seabed planning and management strategies.

Hello? Is it sedimentary #bluecarbon you're looking for? Can multibeam systems help to improve spatial mapping of marine #sediment organic carbon on a regional scale? We show preliminary results from the Moray Firth, Scotland. #marinespatialplanning #MASTSasm2020

Acknowledgements

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Assessing the effects of tidal stream marine renewable energy on seabirds: A conceptual framework

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Adverse effects from #tidal turbines on #seabirds are hard to measure. There are many survey methods out there, but which to choose? Presenting: A framework to guide survey method selection for quantifying effects of tidal turbines on seabirds. #MASTSasm2020.

Marine renewables, including tidal energy devices, are increasingly being deployed across the world in an effort to combat climate change [1]. Where such devices overlap with marine wildlife there are concerns about adverse effects, in particular collision and displacement [2]. The UK is a particularly illustrative example as it holds ca. 50% of Europe's tidal energy resource and contains numerous tidal development sites yet is also home to internationally important seabird populations whose breeding colonies are often in close proximity to said sites [3, 4]. Therefore, in order to ensure sustainable deployment of tidal energy devices, there is a need to quantify any adverse effects on seabirds.

There are numerous established and novel survey methodologies to gather data on seabird behaviour in areas of strong tidal currents. These include land-based vantage point surveys, boat-based surveys, aerial or UAV surveys, active acoustic monitoring, underwater digital imagery, marine radar, and bird-borne tracking. Guidelines on how best to deploy these in the explicit context of effects from tidal energy devices are, however, lacking [5]. We therefore developed a conceptual framework to aid in the choice of survey method(s) for this purpose. Collision risk and displacement, as multi-dimensional and complex effects, were broken down into primarily spatio-temporal and behavioural components, at different scales. A literature review subsequently conducted within the context of this framework allowed for current knowledge to be synthesized, knowledge gaps to be highlighted, and suitability of method to effect measured to be identified.

The framework and survey method suitability categorization are presented here. Key findings include the need for more focused research into close-range (<100m) overlap with and behavior around devices as well as the environmental variables underlying seabird use of tidal stream environments. The combination of complementary methods is also merited, which calls for continued interdisciplinary collaboration. Finally, progress on quantifying effects from tidal energy devices will allow research to move towards robust assessment of impacts on marine wildlife.

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Spatio-temporal trends in different components of demersal fish biodiversity in the North Sea

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Tweetable Abstract: Temporal trends in fish species richness (R) in the North Sea show increase in overall R and increase Lusitanian (warm water) fish R . Warming in the North Sea could be leading to changes in fish community composition presenting difficulties for fisheries.

@IeuanJ24

The effects of fisheries on biodiversity have been well studied, however, relatively little research has gone into the potential effects of biodiversity on fisheries. This may be particularly important for the fishing industry in the North Sea due to the introduction of the landing obligation in 2019 as areas with higher biodiversity may be characterised by higher levels of bycatch where selectivity by gear cannot reduce bycatch. Generally, trends in biodiversity are thought to be decreasing. However, in some marine environments, biodiversity has been increasing over the recent years. Recent studies have shown that biodiversity in the North Sea has increased over the last 30 years. However, it is difficult to disentangle the effects of increasing sea temperatures and improvements in fisheries management over the period on biodiversity. Traditional measurements of species richness provide no information on how community composition may have changed over the period studied. Increases in species richness, R , can still be achieved even if species which were previously well established in the study area were lost over the period if enough species have colonised the area. Therefore, to attempt to separate the effects of both fishing and sea temperature, biodiversity components are proposed. By breaking biodiversity down into component parts, we look to create a simple way to isolate the different factors of ocean warming and changes in fisheries management. Using commercial species R , R_c , the effects of fisheries on biodiversity will be isolated. By examining and comparing changes in biodiversity of faunal groups (Lusitanian, R_L , and Boreal, R_b) designated by thermal preference the effects of climate change will be explored. To evaluate changes in different biodiversity components in the North Sea, data from the North Sea International Bottom Trawl Survey was used for both quarter 1 and quarter 3 between 1991 and 2019.

An increase in average R of around 3 was found between 1991-2019 for both quarter 1 and quarter 3, though this increase was not linear. No real increase was detected in R_c over the study period although R_c was not consistent during that time. R_L increased by ~ 2 over the study period, whereas, R_b showed a slight decrease of ~ 0.5 in quarter 1 and an increase of ~ 0.8 in quarter 3. Temporal patterns in R and R_L follow a similar trajectory and the increase in R seem largely driven by increases in R_L suggesting that warmer temperatures are a large driver for recent increases found by other studies. The increase in R_b in quarter 3 is more surprising however, though could be due to better management of migratory species such as herring. Further research to quantify the spatio-temporal patterns of biodiversity components will be conducted to investigate the hypothesis that boreal species will be forced northward by warming oceans and Lusitanian species have increased at the entry points to the North Sea. Trends in species evenness measures will also be investigated.

Acknowledgements: Thanks to the SUPER DTP and NERC for making this project possible through their funding. Thanks go to my supervisors and both the University of Aberdeen and Marine Scotland for their assistance throughout this project.

Detection of DNA damage in sea urchin coelomocytes with fast micromethod

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Area being submitted to : 5. Marine Science Technologies & Methodologies

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#MASTSasm2020: Development, optimisation, and validation of an alternative method for DNA damage detection, using sea urchins as model organisms with comparative results from 3 different species, and preliminary results with enzyme incubation to target specific lesions of damage

Twitter: @Fengjia

Sea urchins are a valuable ecotoxicological model as they are common in coastal marine environments and there are a wealth of genetic and molecular tools available for experimentation. The commonly used method for DNA damage detection in ecotoxicology is the comet assay. While it has many advantages, it is also very time-consuming and it depends on single cell suspensions and requires only fresh tissues. Schröder (2006) described another method for DNA damage measurement called the fast micromethod. With the ability to work with fresh or frozen cells and extracted DNA, it is an alternative to the comet assay. However, it is not yet used in many studies, and more evidence is needed to fully validate it as an effective method for DNA damage detection. This study uses sea urchin coelomocytes of *Paracentrotus lividus*, *Echinus esculentus* and *Psammechinus miliaris* to standardize the fast micromethod for measuring concentration-dependent response curves of DNA strand breaks to hydrogen peroxide (concentrations ranging 0.1-10mM), commonly used in wild aquaculture for cleaning or sea lice treatment, and to compare DNA susceptibility between species and individuals. The fast micromethod works by means of alkaline unwinding (pH13) with PicoGreen fluorescent dye and kinetic readings of 20 minutes of fluorescence as dsDNA unwinds to ssDNA. The method is based on a 96-well plate format, which allows large sample size and it is time efficient, under 3 hours for the base method and under 4-5 hours with the added lesion-specific enzyme incubation step. The results calculate a strand scission factor (SSF) to show concentration response curves for H₂O₂ where increasing damage is determined as H₂O₂

concentration increases, and a similar trend was found in all three species of sea urchins. The SSF for the highest concentration (10mM) is 0.15±0.06 for *P. lividus*, 0.15±0.08 for *P. miliaris* and 0.28±0.07 for *E. esculentus* (mean±s.e.m., n=7 individuals for each species). The differences of DNA susceptibility between species may be explained by their natural geographical differences and warm and cold-water distributions. The results indicate higher DNA damage in *E. esculentus*, potentially because they are at their thermal limits. In addition, preliminary results with added Fpg and EndoIII enzyme incubation step show promising ability to increase DNA lesion-specificity and differentiate between oxidized purine or pyrimidine bases. The results show that the fast micromethod is a sufficient method to detect differences of damage in separate species and individuals, making it an efficient DNA damage detection method for ecotoxicological studies. Preliminary results with added enzyme incubations indicated that with further optimisation, it is a valid method for differentiation of various oxidative damage with lesion-specific enzymes.

Acknowledgements

I would like to thank my supervisors Helena, Kim, and Ted for their guidance.

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Moroccan lagoons: Current environmental issues and Environmental Conservation Measures of marine resources

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Lagoons play a fundamental role in Morocco in view of hydrologic and biogeochemical cycles, maintaining biodiversity, and a wide range of socio-economic activities are distributed around them. However, due to the great pressure to which these ecosystems are subjected, usually generated by the growing anthropogenic activities around them, it is essential to implement monitoring plans based on sound scientific approaches to detect past and recent environmental changes.

In this study, we conduct a diagnostic comparison of previous investigations that have documented the potential contamination by metals in the sediments of five Moroccan lagoons. The diagnostic comparison showed a moderate and severe affection of Nador, Oualidia, and Sidi Moussa lagoons by Fishing, aquaculture, tourism, and industrial activities, which is clear by the high concentration of toxic trace elements such as As, Cd and Cr in lagoon sediments (MEJJAD et al, 2020).

The on-going study is providing a diagnostic comparison about the contamination level changes in these vital areas, and it highlights the need of implementing new environmental politics for preserving these lagoons as a storehouse for biodiversity, which offers main ecosystem services.

Tweetable abstract: The continued increase of many identified and unidentified human activities nearby the coastal environment can harm the fauna, flora, and human health.

My twitter handle : @NezhaGeology

The bi-gradational contourite sequence and climatic signals: a geostatistical assessment

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Are you a student? Yes

The contourite depositional system in the of Gulf of Cadiz is made up of multiple bi-gradational sequences, throughout the Quaternary interval in particular, that coarsen-upward then fine-upward, typically over 0.5-5 m of section. The repetition of sequences over hundreds of metres is a common feature of contourite drifts everywhere and leads to two unsolved questions:

(1) Is there a regular cyclicity and, if so of what duration?

(2) What are the primary controls on the development of such sequences?

U1386 and U1387 are two of the sites drilled during IODP Expedition 339 and are both influenced by the warm Mediterranean Outflow Water. Around 120 and 130 sequences, respectively, have been measured at these sites, within the upper 420 m of section, spanning from the mid-Pleistocene to Present. Biostratigraphic control shows more or less continuous sedimentation at average rates of 35 cm/ka and 25 cm/ka, respectively. Sequences comprise 3-7 layers separated by gradational contacts, but with marked variation in thickness and complexity, both vertically and laterally at all sites.

A geostatistical approach was applied to both assess and interpret the cyclicity pattern, using cluster analysis, autocorrelation, frequency analysis, and spectral analysis. A transition probability function assesses how the sediments change upwards. The highest transition probability occurs from mud to silty mud layers, and from silty mud to mud layers. This indicates the dominance of a 3-layer-sequence (mud – silty mud – mud), which is commensurate with a low-energy muddy drift, and less common 4-7 layer sequences.

There is an average sequence thickness of around 3 m at both sites U1386 and U1387, which equates to an average duration of 8.66 ka and 12.06 ka, respectively, but only a very irregular cyclicity.

The cross-correlation function shows a moderate to good correlation between these two sites that are just 4 km apart.

Based on sequence duration and frequency at Sites U1386 and U1387, and the average sedimentation rates (as above), the contourite succession studied can be divided into four stages:

(1) a high frequency of sequences during the past 350 ka

(2) a lower frequency of sequences from 350-700 ka

(3) a high frequency of sequences from 700-1000 ka ago

(4) a relatively high frequency of cycles from over 1Ma.

Whereas the thickness of each sequence is highly variable, the frequency of occurrence is closely related to drift evolution stages and to fluctuation in the strength of the Mediterranean Outflow Water. Our detailed analysis suggests that the two principal controls on contourite sequences are variation in bottom current strength and sediment supply, both of which have a complex interaction with climate.

Pre and Post COVID-19 Lockdown effect on saltpan encroachment of a Ramsar Site: Sambhar Salt Lake, India

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Emergence of COVID-19 has emphasized that destruction of ecosystem leads to destruction of human. Ecosystem that protects us have been altered allowing pathogens including corona viruses. Wetlands are diverse ecosystems in which slight alteration puts enormous impact on socio-ecological, physio-chemical and economical aspects. India had longest lockdown from 24 March 2020 to 30 May 2020.

Current study is conducted its impact on the largest saline wetland of India, Sambhar Salt Lake. History states this lake originated from Tethys Sea 2000 years back when Himalaya emerged and the sea receded to Arabian Sea leaving its bed as Indian Thar desert. Though it has been a Ramsar site since 23 March 1990 along with an Important Bird Area, it does not come under any protected area network of India. It used to be critical habitat of 289 migratory birds species coming from West Pacific Flyway, East-Asian Australasian Flyway, and the Central Asian Flyway that have now reduced to only 31 species as per our joint bird census report with Asian Water Census volunteers.

The lake delivers services and functions like ground water recharge, halophytes, halophiles, salt, and livelihood, which are being ignored, and planned to set up world's largest solar park, film city, increase tourism activities, vehicle-testing sites and a Bollywood hub. Legally, up to 3km buffer area it

comes under eco-sensitivity zone but threats like illegal saltpans and extraction of ground water, reduction in surface water level, reduction in migratory birds, halophiles and halophytes.

To address these issues, this study analyzed soil salinity indices using satellite data of 1989, 1998, 2008, 2014, 2019 and 2020 in the absence of ground observations to picturize impact of lockdown due to COVID-19 on the ecosystem. Results state that salinity has decreased over the years until 2019 however, the lake has revived during lockdown.

Results state that the lake is full of water; soil salinity has increased indicating its unique halophiles and halophytes revived into the lake. Once again, lake is ready to welcome its rich biodiversity if there is least human interference. It is concluded that lake has naturally restored itself without human intervention.

Keywords: Geospatial Indices, Migratory birds, Ramsar site, Saline soil, Salinity, Wetland

Tweetable Abstract

India's largest saline wetland was on the verge of extinction due to illegal salt mining, however due to COVID-19 lockdown the lake has again revived. Its saline soil and water ready to welcome its rich biodiversity.

Twitter handle: @Rajashree0609

Bringing decades of environmental monitoring and research to a wider audience: innovative public engagement strategies

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Are you a student? (Delete as appropriate): No.

Abstract

For over four decades Shetland Oil Terminal Environmental Advisory Group (SOTEAG) has continued to look after the interests of the environment around Shetland's Sullom Voe Terminal and Port. It is recognised as a pioneering world-class model of integrated coastal management based on its independent scientific monitoring and expert advice.

SOTEAG works to preserve Shetland's natural heritage, but also to share with the rest of the world its experience of environmentally responsible industrial activity in a distinctive cultural setting and sensitive natural environment. The Sullom Voe Terminal is one of the biggest and most complex of its kind in Europe, with a high operational turnover, and as a result there is the potential for large and irreparable risks to the surrounding environment. SOTEAG's monitoring provides an ongoing 'health check' at Sullom Voe by evaluating the amount and significance of change and advising The Sullom Voe Association Ltd. whether remedial action is required.

In recent years SOTEAG has added to this responsibility and has been committed to morphing decades of environmental monitoring and research into meaningful public engagement. These activities transform detailed reports and statistics into accessible, hands on activities for a range of ages and abilities.

How knowledge is generated and consumed has seen massive changes in recent years. Public engagement not only enriches and animates work, it ensures that the public is part of a two-way conversation, involving the exchange and application of knowledge, with the goal of generating mutual benefit. It is therefore essential that you not only understand your purpose but that you understand your audience and their needs.

Once you have chosen who you will be engaging with, and why you are engaging, the appropriate method becomes clearer, and therefore SOTEAG uses a range of platforms when engaging with the public. Public engagement has been adopted to enhance the work SOTEAG has been doing for over four decades. The activities also aim to increase awareness of the knowledge and skills required to monitor the environment on Shetland, in potentially hazardous conditions. This interaction between interested stakeholders is essential to build on public understanding. Public engagement helps to inspire learning, learn from others, change attitudes or behaviour and respond to social needs. SOTEAG aims to continue to work with a variety of audiences and partners to share good practice.

Tweet #MASTSasm2020

SOTEAG: Bringing decades of Shetland based environmental monitoring and research to a wider audience through public engagement

Twitter handle: @SOTEAG1

Acknowledgements

The Sullom Voe Association Ltd for funding SOTEAG's environmental monitoring program.

To what extent are marine protected areas in the Irish Sea equitably governed and managed? A case study approach.

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Are you a student? Yes.

IMarEST student member number: 8089291

It is not enough to simply designate a protected area; according to the Convention on Biological Diversity's Aichi Target 11, these sites should be governed and managed effectively and equitably. Equitable (i.e. fair and inclusive) conservation is vital to ensuring effective protection of natural resources while maintaining human well-being, yet equity tends to be overlooked in protected area assessments. Equity issues arise when protected areas have a disproportionate effect on stakeholder groups and this can influence biological conservation outcomes. The Site-level Assessment for Governance and Equity (SAGE) toolkit was developed by the International Institute for Environment and Development (IIED) to address the gap in equity assessments and is currently in the pilot-testing phase. Based on the three dimensions of equity (recognition, distribution, and procedure), SAGE contains Likert-scale questions to assess good governance by evaluating how different stakeholder groups perceive their protected area's legitimacy and management and to what extent they feel included in decision-making. Irish Sea marine protected areas (MPAs) were the first marine sites selected to test out this new tool, the other protected areas being largely terrestrial. Three MPAs in Great Britain, Northern Ireland, and the Republic of Ireland were selected to assess equitable governance and management in the Irish Sea. Quantitative data from SAGE is complemented by qualitative data from online survey comments and semi-structured interviews with stakeholders to understand the impact MPA management has on stakeholders and assess the overall equitable governance and management of Irish Sea MPAs. The transboundary nature of two of these MPAs (the Solway Firth and Carlingford Lough) also allows for a comparison of the effect of different governance and management approaches on

equity to identify gaps and highlight best practices.

PhD candidate @ConstanceSCHERE from @KCLGeography discusses how to assess equity in Irish Sea marine protected areas and shares early results from Strangford Lough in Northern Ireland. #MASTSasm2020.

@ConstanceSCHERE

The full abstract should be submitted to masts@st-andrews.ac.uk, in an editable format, by **16:00 Monday 31st August 2020**.

Acknowledgements

This work was supported by the Economic and Social Research Council [ES/P000703/1]. The authors would like to thank the Strangford Lough & Lecale Partnership, the Solway Firth Partnership, and all the local groups and organisations that have been instrumental in the recruitment of participants for this study.

A multivariate approach to determining factors of natural and artificial reef assemblages: Implications for biodiversity and marine renewable energy

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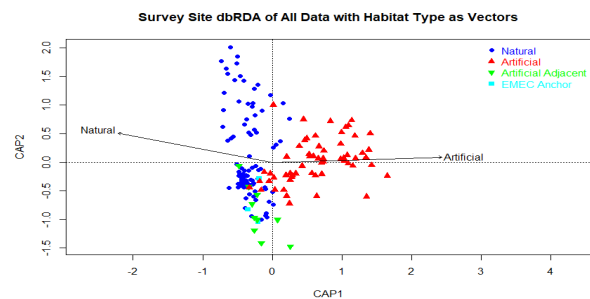
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Increased development of Marine Renewable Energy projects will dictate a larger range of artificial reefs systems through their mooring solutions on the benthic habitat. These artificial reef systems will be subject to greater variance of environmental factors as technology in this sector progresses. Environmental factors impact on their biological community compositions and therefore on local, regional and global biodiversity. To gain better understanding of how these factors may impact on future planning and management policy of marine renewable developments, data from 176 habitat surveys with specific environmental factors (Age, Size, Isolation, Substrate, Depth and Current) in Scapa Flow were analysed.

Survey data were split between Natural, Artificial and adjacent to Artificial reef systems. Artificial and Natural reefs exhibited significant differences in assemblage characteristics (β -diversity) whilst sites adjacent to artificial reefs also proved to be distinct in their makeup from both types of reef listed prior. Depth and current proved to be significant factors for all surveys except current for natural reef assemblages. Artificial reefs showed significant differences due to substrate type; wood, steel and concrete. Age and length of the artificial reef systems did not determine species compositions on the artificial structures themselves but did prove significant in structuring adjacent assemblages. Possible correlations of blue carbon species and sites adjacent to artificial structures were observed.

Future development of marine renewable resources should therefore be concerned with an increased spatial variability in where these projects can be developed, with additional regard for the substrate type used in mooring solutions to best mitigate against damage to environmental health whilst bolstering potential benefits to ecosystem services.



Tweetable abstract - @jacksheehy12

Future development of marine renewable resources should address the increase in spatial variability of where these structures can be installed, and regard for the substrate type used in mooring solutions to best mitigate against damage to environmental health whilst bolstering potential benefits to ecosystem services.

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Acoustic localisation reveals fine-scale movements of harbour porpoises around salmon farms in Scotland

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Tweet: What do #porpoises get up to around #fishfarms in #Scotland? #Acoustic localisation provides a first look into fine-scale movements of these small #cetaceans around farm infrastructure. #MASTSasm2020 @tex_sim

Aquaculture requires space in habitats often frequented by cetaceans. Interactions with aquaculture facilities and practices may represent a trade-off between costs and benefits to fitness. Aquaculture may provide foraging opportunities (Bonizzoni et al., 2013), but also cause habitat displacement (Watson-Capps & Mann, 2005), and possibly increase entanglement risk (Díaz López & Bernal Shirai, 2007).

In Scotland, few studies have examined interactions between cetaceans and aquaculture, despite >200 Atlantic salmon farms distributed throughout the west coast, northern and western islands, which host some of the highest densities of harbour porpoise (*Phocoena phocoena*) in Europe. The discrete surfacing behaviour of harbour porpoises make them challenging to observe in the wild. Therefore, the present study aimed to use acoustic localisation approaches to visualise the fine-scale movements of the harbour porpoise around active salmon farms to assess the suitability of this technique at salmon farms and to understand how porpoises might make use of farm infrastructure.

A linear vertical multi-hydrophone array was deployed at two active salmon farms on the west coast of Scotland for one week each during May and October 2019. A cetacean click detector (C-POD) was simultaneously deployed during the experiments. Large volumes of acoustic data were collected by the hydrophone array during the two monitoring periods (>8 TB), therefore porpoise click trains were initially located within C-POD data to guide subsequent analysis of the array data. Using custom MATLAB script, the Time of Arrival Difference (TOAD) between porpoise echolocation clicks detected by each of the hydrophone elements allowed the depth

and distance of the vocalising animal from the array to be calculated. Click characteristics such as amplitude, and individual click waveforms were also calculated. Partial dive tracks were visualised, indicating that porpoises closely approached and swam amongst fish farm infrastructure at both sites during array deployment.

These results indicate that hydrophone arrays can be an effective method for Passive Acoustic Monitoring (PAM) of porpoises' movements and behaviour around fish farms. Localisation of porpoises around fish farms provides a greater insight into the nature of porpoise and aquaculture interactions in Scotland, and the impacts that may result from close proximity to the industry.

Acknowledgements

This research is jointly funded by the Scottish Association for Marine Science (SAMS), the Marine Alliance for Science and Technology for Scotland (MASTS) and NatureScot. Dr. Koblitz was supported by a MASTS Postdoctoral and Early Career Researchers Exchanges (PECRE) grant.

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