'Many a mickle makes a muckle': considering cumulative stressors on marine mammals

Emily Hague[1], Carol Sparling[2], Ceri Morris[3], Duncan Vaughan[4], Rebecca Walker[4], Ross M. Culloch[5], Alastair Lyndon[1], Teresa Fernandes[1], Lauren McWhinnie[1, 6]

[1]Centre for Marine Biodiversity & Biotechnology, Institute of Life and Earth Sciences, Heriot-Watt University, Edinburgh, United Kingdom – elh2001@hw.ac.uk
[2]Sea Mammal Research Unit, Scottish Oceans Institute, University of St Andrews, St Andrews, United Kingdom
[3]Natural Resources Wales, Maes y Ffynnon, Bangor, Gwynedd, United Kingdom
[4]Natural England, County Hall, Spetchley Road, Worcester, England, United Kingdom
[5]Marine Scotland Science, Scottish Government, Victoria Road, Aberdeen, United Kingdom
[6]Department of Geography, University of Victoria, Victoria, BC, V8W 3R4, Canada

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The effects of human activity can lead to multiple stressors having a cumulative impact on the environment. Cumulative Effects Assessments (CEA) formally evaluate the impacts of specific projects or activities, yet are a recognised area of significant weakness, despite being a longstanding mandatory component of the Environmental Impact Assessment (EIA) process. This is in part because knowledge of the consequences of anthropogenic impacts, and the associated thresholds, varies broadly across receptors, and understanding of how stressors interact is limited. As such, CEAs usually assess the impacts of each stressor separately, though considering stressors individually or in isolation does not indeed constitute a true assessment of their cumulative effects.

To assess the state of assessment practice within the UK, >90 CEAs considering marine mammals across eleven maritime industries were reviewed and scored using an objective framework. Marine mammals were the receptor of interest due to their high conservation value, high degree of legal protection and their vulnerability to a variety of anthropogenic disturbances which occur in UK waters.

Comparison of scores across industries and over time found a significant increase in scores over the sample period (2009-2019), though this improvement was mostly attributed to five industries (cable, large and small offshore wind farms, tidal and wave energy). On average, the aquaculture industry produced the lowest scoring CEAs, whilst the large offshore windfarm industry (> 20 turbines) produced the highest scoring CEAs, according to the scoring criteria used. There was a lack of routinely applied methodology and lack of clarity in defining the spatial and temporal scale of the CEA.

The findings raise uncertainty regarding the effectiveness of these assessments as a replicable tool to quantify and ultimately prevent significant cumulative impacts occurring. The lack of uniformity in assessment practice across industries has the potential to have conservation implications for marine mammals.

Considering the findings of the review, along with a wider review of the literature, we provide recommendations and discussion points aimed at supporting the standardisation and improvement of CEA practice. CEAs where marine mammals were the receptors were assessed here, however the recommendations are broadly applicable to CEAs conducted across the marine and terrestrial environment.

Tweet:
Many a mickle makes a muckle: how are marine mammals considered within the cumulative effects assessment process? Is this uniform across UK industries? #MASTSasm2021 @emilyhague @Lhm3Lauren @carolspaks @ceriwynmorris @becca_walker80 @planningseas @rossculloch @ILES_HWU

The Effects of Phosphate and Ocean Acidification on Coral Calcification

Elisha Hayes[1], Dr. Nicola Allison[2], Maria Cristina Castillo Alvarez[3]

[1] *Department of Earth Science: Geochemistry, The University of St. Andrews - eseh1@st-andrews.ac.uk/ elishasianhayes@outlook.com*
[2] *Department of Earth Science, The University of St. Andrews - na9@st-andrews.ac.uk*
[3] *Department of Earth Science, The University of St. Andrews - mcca1@st-andrews.ac.uk*

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Abstract

Corals produce aragonite ($CaCO_3$) skeletons that form reef systems with high biological productivity. Nutrient pollution and ocean acidification are proposed to impact coral skeleton production rates. This study investigates the role of phosphate and seawater pH on aragonite formation under biological conditions analogous to coral calcification sites. Biological analogue experiments precipitated aragonite at 25°C with 0-10μM of phosphate, at seawater pH 8.340-8.595. High phosphate concentrations and low seawater pH decrease aragonite precipitation rates by inhibiting nucleation on the provided aragonite seed. Raman spectroscopy revealed that high phosphate concentrations and low seawater pH increases the structural disorder and C-O bond lengths within aragonite. There was no evidence observed by SEM imaging to suggest that phosphate or seawater pH affects aragonite crystal morphology. The results suggest that phosphate pollution and ocean acidification will significantly reduce coral calcification rates and impact the structure of coral skeletons, which may lead to significant coral reef loss in the near future. Examining the causes of coral reef vulnerability will provide insight into possible solutions to improve coral reef resilience and survivability.

Acknowledgements

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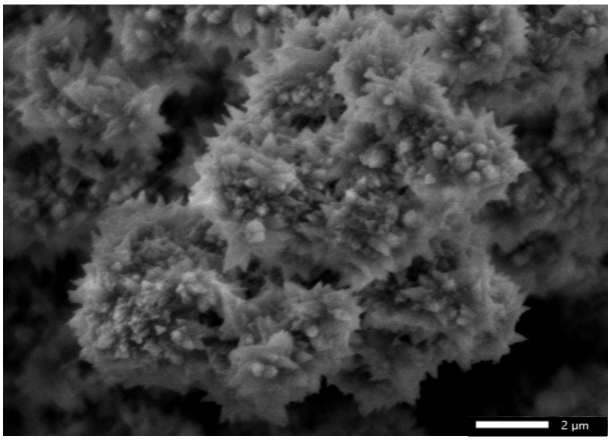
'Tweetable' Abstract

We precipitated aragonite in vitro under conditions analogous to tropical coral calcification sites and added phosphate. Phosphate reduced precipitation rates and affected $CaCO_3$ structures suggesting coastal phosphate pollution is detrimental to coral reef building. #MASTSasm2021



Review on Effect of Noise pollution in Ocean Environment

Balavignesh P[1], Brathikan V M [2], Janarthanan Venkatachalam [3]

[1] *UG 2nd year student, Department of Mechanical engineering* – balavignesh20020904@gmail.com
[2] *Incharge-student research cell* – brathikan@gmail.com
[3] *Researcher-student research cell* – vjaansens@gmail.com

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Abstract-Human exploration and improvements in marine developments have led to urbanization in the ocean, which resulted in the creation of anthropogenic noise pollution. The source of sounds in the ocean are mainly of two types, biotic, and abiotic sounds.

The biotic sounds are produced by the aquatic species for the purpose of communication, mate detection and identifying prey. The abiotic sounds are classified into anthropogenic and natural background sounds. The anthropogenic sounds interfere with the biotic sounds through which the animals communicate with each other. It results in misperception among marine organisms. This anthropogenic sound results in marine noise pollution.

The sources of marine noise pollution include construction and working of various offshore plants. The sounds from dredging, pile driving for offshore windfarms, seismic air guns and sonar creates a huge impact on the life of marine organisms.

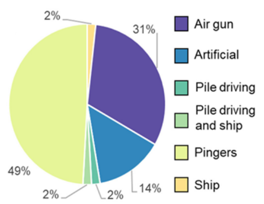

Fig. 1. Sources of noise pollution in the ocean

Marine noise pollution has become a serious threat to the life of aquatic organisms. Anthropogenic noise pollution causes both physiological and psychological damages to aquatic organisms. The major effects are increased heartbeat rate which indicates increased stress level, alteration in swimming speed and direction, difficulty in finding prey and mate, behavioral alterations, and acoustic masking.

There are solutions available to reduce or eliminate marine noise pollution. They are usage of electric motors and speed reduction and regular maintenance of vessels, instead of using seismic air guns, a hydraulic and electromagnetic vibrator can be used and developing bubble curtains and muffling for pile driving.

The primary focus of this review paper is to showcase the drastic efforts of marine noise pollution and suggest some solutions and hence save the marine ecosystem.

Keywords-acoustic masking, noise pollution effects, noise pollution types, solutions, source of sounds in the ocean.

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A question of realism: stressor impacts on biofilm in the lab and field

James E V Rimmer[1], Andrew J Blight[2] and David M Paterson[3]

[1] *Scottish Oceans Institute, School of Biology, University of St Andrews – jr49@st-andrews.ac.uk*
[2] *Scottish Oceans Institute, School of Biology, University of St Andrews – ajb34@st-andrews.ac.uk*
[3] *Scottish Oceans Institute, School of Biology, University of St Andrews – dp1@st-andrews.ac.uk*
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Biofilms are the photosynthetic base of many intertidal systems, but we have only a limited understanding of how they respond to the increasing array of anthropogenic stressors, especially in natural habitats. Experiments were conducted to measure impacts and bridge the gap from lab to field #MASTSasm2021

@JEV_Rimmer

Coastal systems lie at the interface between the land and sea and are generally the most easily accessed and utilised marine environments for a range of industrial and recreational purposes. This is exemplified in many estuarine systems, which often are bordered by areas of urbanisation for historic or contemporary reasons due to the access they provide to adjacent marine systems and inland areas of habitation, industry, and/or agriculture. Estuaries also play an important ecological role as habitats for migratory birds and fishes, adding to the perceived intrinsic and recreational value of the system. However, an extensive (and growing) array of anthropogenic pressures have the potential to manifest deleteriously (Gunderson et al., 2016), perhaps most insidiously through the interactions of stressors which are present at levels considered individually safe, or at least sublethal. At the base of many estuarine food webs are the microphytobenthos (MPB), an autotrophic assemblage which include diatoms and cyanobacteria which can form visible biofilms in depositional intertidal sediments. The MPB are not only important primary producers, but also play a key role in ecosystem engineering through the reduced erosion of sediments by the exudation of EPS (extracellular polymeric substances) (Chen et al., 2017). However, we have only a limited understanding of how these assemblages respond to stressor exposure, particularly multiple stressor exposure. We conducted a series of experiments using a tidal mesocosm system to assess the response of MPB to glyphosate exposure, a common industrial and commercial herbicide, as well as to nanoparticles of TiO_2, which are found in an extensive range of products. Both chemicals can be detected in watercourses and are known to chemically interact (Ilina et al., 2017), and therefore serve as a case study for interactions which may manifest at a biological level. Experiments were then conducted in the field at the Eden Estuary (Fife), to investigate the extent to which laboratory findings can be extrapolated to the real environment, as it was expected that the scale and features of a natural system would buffer to some extent against negative impacts which arise in a more confined microenvironment. Findings indicate a clearly negative impact of the herbicide on MPB biomass, but a negative impact of TiO_2 only at intermediate levels of the herbicide, hinting at an interaction effect.

Acknowledgements

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Taking a fish-eye view – how do marine species encounter anthropogenic electromagnetic fields (EMFs)?

Zoë L. Hutchison[1], David Secor[2], Peter Sigray[3], John W. King[4], Andrew B. Gill[5]

[1] *School of Biology, University of St Andrews, St Andrews, UK – zlh1@st-andrews.ac.uk*
[2] Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD, USA
[3] *KTH, Royal Institute of Technology, Sweden*
[4] *Graduate School of Oceanography, University of Rhode Island (URI), USA*
[5] *Cefas – Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, UK*

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Are you a student? No.
Twitter: @hutch1son_z

Understanding the effects of electromagnetic fields (EMFs) on receptive species requires combining knowledge on the EM source, the EM environment and critically how the species encounters the EMF; a function of species' sensory biology, life history, and movement ecology.

Effective assessment of the outcome of interactions between a receptor species and an anthropogenic pressure requires the consideration of several factors, namely the characteristics of the pressure, the biological factors that influence the receptor and the local context. Electromagnetic fields (EMFs) are an anthropogenic pressure that is associated with subsea cable electricity transmission and has risen in interest because of the significant installation of, and future plans for offshore wind (and other marine power generation), and extensive transmission cable networks in coastal and offshore waters. The EMF emitted by a cable depends on the transmission type (DC or AC), the materials used, and the power applied to the cable. There are several taxa that are receptive to either the magnetic or electric field components (or both) and they vary in their biological characteristics, sensory biology, life history, and movement ecology. Whilst a species may be receptive to EMFs, it is the context with which it encounters the EMF that is critical to take into account. This means that the cable properties, the animal of interest and the local EM environment (e.g. the geomagnetic field) should all be considered together.

Cables are commonly buried in or laid on the seabed (with protection) and present EMF emissions to species inhabiting the benthic zone. However, future plans include floating devices which have cables in the water column (i.e. dynamic cables) which will introduce EMFs into the pelagic zone too. This means that the cable properties, orientation to and inclination of the local geomagnetic field, and the spatial extent and intensity of the cable EMF needs to be considered at biologically relevant scales in three-dimensions. We present a framework which takes the vantage point of the receptor species to properly contextualise the potential effects of EMF on the receptor. We further exemplify this approach with a study of American eels (*Anguilla rostrata*) encountering the EMF of the Cross Sound Cable (CT, USA), on their outward migration to sea.

The existing knowledge base is based on a diverse range of laboratory and field approaches, which whilst incrementally improving knowledge now needs to be integrated to speed up the filling of key knowledge gaps, which will be particularly useful for improving assessments and models of future scenarios. Implicit in the framework is a systematic and consistent approach to measuring and modeling alternating EMFs and accounting for cable properties and local environmental characteristics to assist with assessing the response from the perspective of the receptor. Acquiring such knowledge will enable better translation of EMFs, their effects and encounter context, into impact assessments to inform appropriate management where necessary.

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