MASTS Annual Science Meeting 2023

"Science, Sustainability and Society – valuing and protecting our marine systems"

Abstracts for MASTS Artificial Intelligence Session

11.45-13.15 on Tuesday 5th December

Estimating Interactions between Fishing and Energy Sectors in the North Sea

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Area being submitted to *Artificial Intelligence.*

Preferred presentation medium (delete as appropriate): oral.

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This study investigates the potential spatial overlap between offshore windfarm developments and fishing sectors in the North Sea combining planned areas for development with historical vessel tracking and scientific survey data #MASTSasm2023 @RobertGordonUni

Fishing has a valuable economic, social and cultural importance in Scotland. One of the most prominent areas for fishing in Scotland is in the North Sea, particularly for the pelagic fleet that is mostly concentrated in Shetland and North East Scotland. This region is a vital fishing ground, contributing to Scotland's seafood industry and global exports.

To ensure the long-term sustainability of the fishing sector, internationally coordinated scientific surveys targeting a range of species take place in this region (ICES, 2022a, 2022b). These surveys cover the same regions each year and provide a long time-series of information on biological parameters and stock size/structure for a range of important commercial stocks. These data are a key component of fisheries stock assessments which provide important advice on where quota levels should be set (e.g. ICES, 2022c).

At the same time, the North Sea is transitioning to meet ambitious Net Zero targets, which includes transitioning to clean energy sources or reducing carbon emissions (Deakin *et al.*, 2022). Hence, offshore wind, wave and tidal energies have been targeted to generate energy in a low-carbon way from sustainable and renewable sources. However, as far as we are aware, little attention has been given to the impact of these areas on the fishing sector in Scotland and on biodiversity monitoring across the region.

The aim of this study is to develop a spatial planning tool that estimates potential overlap between fishing, renewable energy and scientific surveys in the North Sea based on offshore wind farm development plans, historical vessel tracking data and data from internationally coordinated surveys. This analysis provides a clear picture of where these sectors interfere and offers insights into how they can coexist and complement each other in the future.The data considered in this study includes infrastructure, vessel tracking and survey data. The survey, environmental and offshore windfarms data have been obtained from reputable institutions, such as ICES, NSTA or Crown State Scotland. The movement and activity of the vessels have been estimated from AIS data. It is worth noting the limitations inherent to AIS data, including its susceptibility to being switched off, the challenges posed by the North Sea's High Traffic Zone (which can lead to missing or delayed signals), and the fact that it covers only approximately 25% of the Scottish fleet.

Obtained results replicate the movement patterns of vessels and the distribution of important areas of fish abundance for survey indices, based on historical data. This visual representation enhances our understanding of how these industries have evolved and can inform decision-makers, stakeholders or even the broader public about future challenges and opportunities.

Acknowledgements

All the Authors wish to thank the Net Zero Technology Centre for supporting this project.

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IMAGE ANALYSIS MADE EASY: NEW MACHINE LEARNING TOOL FOR AUTOMATIC SPECIES SURFACE AREA MEASUREMENT

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Area being submitted to (delete as appropriate): *3. Artificial Intelligence*

Preferred presentation medium (delete as appropriate): (i) oral

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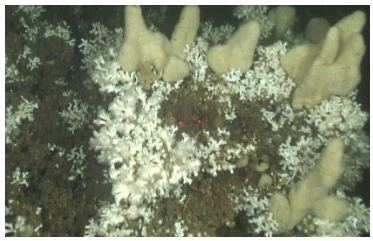
The open-source and user-friendly interactive machine learning tool RootPainter was used to efficiently develop accurate models capable of extracting deep-sea sponge surface area measurements from underwater observatory images and remotely operated vehicle video frames.



@H_Poppy_Clark

Due to advances in imaging technologies, the rate of marine video and image data collection is drastically increasing. Often these datasets are not analysed to their full potential as extracting information for multiple species, such as their presence and surface area, is incredibly time-consuming. This study demonstrated the potential of a new open-source interactive machine learning tool, RootPainter, to analyse these large marine datasets quickly and accurately. The tool was developed to measure plant roots, but here was tested on its ability to measure the presence and size of the cold-water coral reef associate sponge species, *Mycale lingua*, in two types of underwater image data: 18,346 time-lapse images and 1,420 remotely operated vehicle video frames. Corrective annotation metrics integrated with RootPainter, such as dice score and species area error, allow objective assessment of when to stop model training and reduce the need for model manual validation. Three highly accurate models were created using RootPainter, as indicated by their average dice score of 0.94 ± 0.06; model transfer and optimisation aided production of two of these models, increasing analysis efficiency from 6 to 16 times faster than manual annotation in Photoshop for time-lapse image data. Accurate presence and surface area measurements were extracted from both datasets and provided the first evidence that *M. lingua* sponge contractions can be synchronised in the deep sea. Interactive machine learning tools and model sharing have the potential to dramatically increase image analysis speeds, collaborative research, and our collective knowledge on spatiotemporal patterns in biodiversity.

Acknowledgements

We would like to thank EASTBIO DTP, the BBSRC and iAtlantic for supporting this research.

Remote sensing and machine learning helps quantify spatial variation in bird communities in response to human recreation.

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Area being submitted to: *Artificial Intelligence*

Preferred presentation medium: oral presentation

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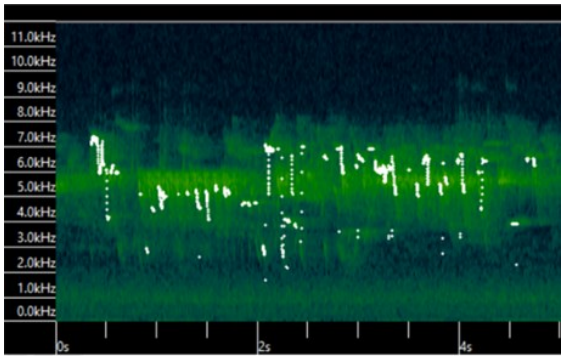
Tweetable Abstract:
@AmberCowans on using machine learning methods to process audio data at #MASTSasm2023 🎤💻 Come along for some insights on how false-positive modelling of continuous AI output can help solve ecological problems.

Abstract:



Combining AI tools with remote-sensed data has the potential to revolutionize biodiversity monitoring, where passive collection and efficient processing of large amounts of species detection data can be used to explore species-habitat relationships. A feature of AI classification is relatively high false-positive rates, which is a potential source of bias in ecological models. Therefore, new methods are required for robust ecological inferences from classification data. In this talk, I show how machine learning algorithms can be used to identify bird species from their natural vocalizations. I then demonstrate how modelling the continuous confidence scores regularly produced by classification algorithms can help us understand the role of human recreation in driving spatial variation in bird communities in Scotland. Finally, I explore the sensitivity of ecological inference to temporal recording schedules, providing guidance on how to optimize recorder deployment and study design.

Acknowledgements

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Cold-water coral cover in the Darwin Mounds Special Area of Conservation, the impact of image annotator bias in machine learning

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Area being submitted to (delete as appropriate): *3. Artificial Intelligence*

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How does human bias impact machine learning predicted estimates of the Essential Ocean Variable (EOV) cold-water coral cover in Scotland's oldest offshore marine protected area? How can we reduce this variability to improve our cover estimates? Find out more @ #MASTSasm2023.

Seabed cover estimates are a commonly applied and recommended Essential Ocean Variable (EOV) for several habitat forming marine taxa (Levin et al., 2019). They can be derived from non-destructive seabed image surveys by drawing around the observed objects of interest, such as cold-water coral colonies, with a mask. This process is known as instance segmentation. Manual instance segmentation is a time-consuming process and small objects of interest may be omitted or difficult to draw around, introducing bias when extracting size and areal cover data. We can automate instance segmentation using supervised machine learning, but the performance of trained networks is impacted by the quantity and quality of the manually created training data.

We demonstrate the impact of training data quality using a case study on the instance segmentation of cold-water coral colonies from seafloor images collected in the Darwin Mounds Special Area of Conservation – Scotland's oldest offshore Marine Protected area (MPA) – in 2019 with the autonomous underwater vehicle *Autosub6000* carrying the BioCam imaging system (Thornton et al., 2021).

Eleven human users annotated the same 96 seafloor images for living cold-water coral colonies (*Desmophyllum pertusum* and *Madrepora oculata*), and these images were then used to train, validate, and test Mask R-CNN instance segmentation (He et al. 2020). Using different user annotations as training data produced different coral colony predictions, creating uncertainty in coral cover estimates. This uncertainty was driven by annotator

size selectivity bias and omission of masks for small colonies. We then reduced annotator data variability using several methods: (i) generating masks for colonies that were not drawn by users, and (ii) by combining multiple user annotations to create new training data, using three different techniques: (a) masks drawn by a mix of users with no overlap, (b) average consensus masks, and (c) heatmap masks. Variability in coral cover estimates was reduced by generating masks with a modelled colony size based on users' drawn masks and further reduced by combining user masks to create new training datasets.

Ultimately, we used the average consensus masks of all 11 users to create a reference dataset and to infer live coral cover over the full 29-hectare extent of the western Darwin Mounds survey area (20,281 individual seafloor images). The cold-water corals of the Darwin Mounds have suffered significant impact from historic demersal trawling (Huvenne et al., 2016) and are the primary focus of the site's conservation objectives - maintain or restore the extent and distribution of cold-water coral habitat. The potential for fully autonomous surveys of the site and the automated generation of cold-water coral seabed cover EOV data offers an effective and efficient means to appropriately monitor the status of this and other offshore MPAs.

Acknowledgements

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Optimising drone image acquisition for AI species identification and counting of cliff nesting seabirds

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Tweet

Optimising remote image acquisition for AI detection and counting needs to be carefully considered. When dealing with sensitive species and habits there are practical, legal, welfare and ethical considerations that need to be taken into account @ #MASTSasm2023.

The remote acquisition of images and video using drones is of increasing interest as a means of undertaking population surveys of a range of species. Coupled to AI analyses, the process of identifying and counting the abundance of target species will increase the amount and quality of data available to monitor populations – particularly in difficult to reach habitats. Establishing protocols and workflow pipelines to standardise these survey approaches is required, particularly when dealing with sensitive species and habitats, where stringent legal protections are in place and welfare and ethical considerations must be taken into account.

The work presented here, will outline progress that has been made by an interdisciplinary team at the University of St Andrews who are attempting to inform the development of an operational framework for undertaking drone surveys and AI analysis of cliff nesting seabird colonies.

We will document both the current processes required to undertake such research, suggest possible improvements and outline some of the approaches that are being developed to optimise and standardise image acquisition and survey design as a precursor to the training of AI algorithms.

The need for accurate site-specific digital elevation maps and surface maps as foundations for pre-programming survey flights will be explored. The minimum image resolution required for reliable species identification and how this relates to the drone camera specifications and ultimately limitations on distance to subject and area to be surveyed. Integrating these physical parameters with knowledge of bird behaviour and the propensity for disturbance caused by the drone will also be discussed.

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Identifying delphinid species by their whistles and clicks: A new acoustic classifier for the British Isles

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Our new ML acoustic classifier is the first to identify British and Irish delphinid by their whistles and clicks. Combining information in this way shows improved accuracy. The classifiers are freely available through a Python-based application. Please get in touch for more info!
@KleynTristan

Abstract
Passive acoustic monitoring has gained popularity as a cost-effective approach for surveying delphinid occurrence in the Northeast Atlantic but remains hindered by the lack of a dependable method for identifying species by their vocalizations. We address this gap by presenting a new acoustic classifier that uses machine learning to classify delphinid vocalizations to species for this region. We developed separate random forest models for whistles and echolocation clicks that leverage the collective decisions of many decision trees to predict the species category. These models were trained on an extensive dataset comprising 69 acoustic features extracted from over 10,000 vocalizations manually detected from visually verified single-species recordings of the seven commonly occurring species in British and Irish waters *(Delphinus delphis, Grampus griseus, Globicephala melas, Lagenorhynchus acutus, Lagenorhynchus albirostris, Orcinus orca,* and *Tursiops truncatus)*. Our method predicts species identity of delphinid encounters by training separate click and whistle classifiers, combining predictions from both to inform overall encounter prediction that is 71.3% accurate for seven species. Accuracy in classifying individual clicks and whistles varies between encounters at standard deviations of 23% and 28%, respectively, which describe the spread in likelihood of delphinid encounters being classified correctly. *Grampus griseus* exhibited the lowest overall accuracy at 30.0%, while *Lagenorhynchus albirostris* demonstrated the highest accuracy, reaching 93.0%. To facilitate broader application and accessibility, we have made these classifiers available through an open-source Python-based application, which is freely accessible for use via GitHub.

Acknowledgments
We would like to thank the Hebridean Whale & Dolphin Trust, Galway-Mayo Institute of Technology, and Phil Hammond and Doug Gillespie of the Sea Mammal Research Unit for helping to support our classifier development by contributing a generous amount of visual-acoustic data to the project.