PROJECT PROPOSAL FORM

Making the Most of Masters aims to improve collaboration between employers and universities by providing opportunities for postgraduate students to undertake work based projects as an alternative to a traditional university dissertation. Projects should address a real need within the host organisation and be beneficial to both host and student.

The Marine Alliance for Science and Technology for Scotland (MASTS), pools the majority of Scotland's marine research capacity. MASTS members provide Masters courses in a range of marine related disciplines and many of their students are keen to undertake applied projects outside of academia.

Notes on Topic Selection

A relevant academic will work with your organisation to refine your proposed topic and ensure it meets both your needs and the academic requirements of the student. Projects should typically be achievable within a 12–16 week timeframe (including writing the final report).

Your proposed project could be:

- A specific project title or topic for the student to deliver;
- A general idea of a business need which requires further development;
- A core research theme to be developed by the student into a bespoke project;
- An intended outcome for the organisation.

The level of detail you provide will determine the extent to which further discussion may be required with the relevant programme director to ensure suitability.

desk-based/data studies that will easily facilitate remote working and remote supervision are welcome, as well as in person and/or experimental based projects where appropriate.

What's Next?

Please send your completed form to the MASTS Programme Coordinator & Deputy Dean of Grad School, Dr Emma Defew (masts@st-andrews.ac.uk) before the deadline.

Following submission of the form, it will be channeled to the leaders of the various Masters programmes that operate within the MASTS community and a representative from the most relevant programme or department will get in touch to discuss the project scope, delivery and the selection of an appropriate student. If more than one student expresses an interest in your project, you will need to ensure discussions take place to enable the most suitable student to be matched with your project. The projects themselves usually won't start until May or June.

MASTS - Making the Most of Masters – Project Proposal Form

Name and address of Organisation:

HiDef Aerial Surveying Ltd.

Name of the key contact in Organisation:

Dr Laura Williamson, Dr Jack Forster

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Title of proposed project:

Comparing Inlabru and MRSea for Assessing Seabird Distribution: Investigating the Effects of Animal Density and Spatial Patterns

Project outline and intended outcomes:

Modelling the spatial distribution of seabirds is crucial for ecological research, conservation planning, and the assessment of marine biodiversity. Two statistical tools used for spatial distribution modelling are Inlabru and MRSea. Inlabru employs a Bayesian framework using integrated nested Laplace approximation (INLA) to fit complex spatial models, while MRSea uses Generalized Additive Models (GAMs) for analysing ecological data. MRSea is currently recommended by government advisors; however, a quantification of how these tools operate under different conditions has not been carried out.

The density of animals (whether a species is common or rare) and their spatial distribution patterns (clustered, dispersed, or random) can significantly influence model results. This project proposes to investigate and compare the performance of Inlabru and MRSea in modelling simulated seabird distributions, focusing exclusively on the effects of animal density and spatial distribution patterns. By doing so, the study aims to isolate the influence of basic population structure and distribution on model outcomes.

Aims and Objectives:
The key objectives are:

1. Data Simulation: Simulate seabird distribution data under various conditions of density (common vs. rare) and spatial distribution patterns (clustered, dispersed, and random), applying real-world sampling strategies.

2. Model Fitting: Fit both Inlabru and MRSea models to the simulated data
3. Comparison of Results: Evaluate and compare model results, focussing on accuracy and precision of density and population estimates.
4. Interpret Modelling Insights: Discuss the potential advantages and limitations of each approach across the range of densities and spatial distributions, and how this impacts ecological studies and conservation management.

This project will provide a detailed comparison of Inlabru and MRSea for modelling seabird distributions, focusing on how density and spatial patterns affect the results in the absence of environmental covariates. By isolating the effects of these factors, the project will offer valuable insights into the strengths and weaknesses of each modelling tool and provide guidance for ecologists and conservation practitioners in choosing appropriate methods for seabird distribution analysis.

Any additional comments e.g. details of specific disciplines required, methods to be used, travel involved, where the work would take place (i.e. at the host site or at the University), whether you foresee any Intellectual Property or confidentiality issues (and if so, what form might these take?):

This project will use simulated data, and will be using existing models. We do not foresee any IP or confidentiality issues. The student can work remotely, or can work from our Edinburgh office depending on preference. This project is suited to a student who is comfortable with the R programming language and statistical analysis, as it will involve analysis using advanced statistical techniques (e.g. Inlabru, MRSea, GAM, data simulation).

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Title of proposed project:

Comparing Inlabru and MRSea for Modelling Real-World Seabird Distributions

Project outline and intended outcomes:

Species Distribution Models (SDMs) are valuable tools for understanding how environmental and spatial factors influence the distribution of species. In seabird conservation, accurately predicting species distributions is critical for protecting key habitats, managing Marine Protected Areas (MPAs), and informing impact assessments of offshore developments (e.g. wind farms).

This project will focus on the distribution modelling of a seabird species, such as the Common Scoter (*Melanitta nigra*), Herring Gull (*Larus argentatus*), which are both species of conservation concern in many parts of Europe. These species are known to have specific habitat preferences, and their distributions are influenced by both spatial and environmental factors such as water depth, distance to coast, and prey availability.

Two prominent statistical approaches to modelling spatial and environmental drivers of species distributions are Inlabru and MRSea. Inlabru uses a Bayesian hierarchical framework via Integrated Nested Laplace Approximation (INLA) and is highly flexible for fitting spatial models with complex structures. MRSea is built around Generalized Additive Models (GAMs), providing a simpler framework for handling spatial autocorrelation and nonlinear environmental relationships. MRSea is currently recommended by government advisors; however, a quantification of how these tools operate under different conditions has not been carried out.
Aims and Objectives:

The aim of this project is to apply and compare Inlabru and MRSea to real-world distribution data for a single seabird species, investigating how each modelling framework interprets spatial and environmental drivers of species distribution. The specific objectives are:

1. Data Collection: Obtain real-world survey data for the selected seabird species (provided) and relevant environmental covariates (e.g., water depth, distance to coast, sea surface temperature).
2. Model Fitting: Apply Inlabru and MRSea to the same dataset, fitting spatial models that incorporate environmental covariates and spatial autocorrelation.
3. Model Comparison: Compare model assumptions, outputs, and performance,

focusing on spatial predictions, model fit, and the ecological interpretation of covariate effects.

4. Assess Uncertainty and Robustness: Evaluate the uncertainty associated with each model and assess how robust they are in capturing the seabird's distribution, particularly in areas with sparse data.
5. Ecological Interpretation: Discuss the ecological significance of the model outputs and their implications for seabird conservation and management.

Any additional comments e.g. details of specific disciplines required, methods to be used, travel involved, where the work would take place (i.e. at the host site or at the University), whether you foresee any Intellectual Property or confidentiality issues (and if so, what form might these take?):

This project will use real data. We will require the student and supervisors to sign an NDA prior to access. The student can work remotely, or can work from our Edinburgh office depending on preference. This project is suited to a student who is comfortable with the R programming language and statistical analysis, as it will involve analysis using advanced statistical techniques (e.g. Inlabru, MRSea, GAM).

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Title of proposed project:

Broad-Scale Distribution Patterns and Temporal Changes Using Aerial Video Survey Data from the North Sea

Project outline and intended outcomes:

In recent years, aerial video surveys have become a prominent method for monitoring marine wildlife, providing extensive data on species distributions across large marine areas. Developers within the UK have employed aerial video surveys for over a decade to assess the populations and distribution of key species, including seabirds and marine mammals. These surveys are critical for understanding species' habitat preferences, detecting broad-scale distribution patterns, and identifying temporal changes in response to environmental and anthropogenic factors.

This project will focus on a single marine species, such as the Northern Gannet (*Morus bassanus*), Common Guillemot (*Uria aalge*), or Harbour Porpoise (*Phocoena phocoena*), each of which is of considerable conservation importance in UK waters. Gannet and guillemot are seabirds of interest due to their vulnerability to offshore developments, while harbour porpoise are a key species in marine protected areas and subject to various conservation measures.

By analysing data from aerial video surveys collected over the past decade, this study will investigate broad-scale distribution patterns and potential temporal changes in the distribution of the selected species. This research will provide insights into how the species' spatial distribution may have shifted over time, potentially in response to environmental changes, anthropogenic pressures, or natural population dynamics.

The specific objectives are:

1. Data Compilation: Collate all aerial video survey data for the selected species, covering the North Sea over the past ten years.
2. Broad-Scale Distribution Analysis: Analyse the spatial distribution of the species to identify key habitats, areas of high density, and any discernible patterns at a broad scale.
3. Temporal Changes: Investigate changes in the species' distribution through time, identifying any trends, shifts, or emerging patterns over the past decade.

4. Statistical Modelling: Use appropriate statistical models to assess the drivers of distribution patterns and temporal changes, potentially including environmental, seasonal, or anthropogenic factors.
5. Ecological Interpretation and Conservation Implications: Discuss the ecological significance of the results and explore implications for conservation management, including potential responses to marine developments or climate change.

Any additional comments e.g. details of specific disciplines required, methods to be used, travel involved, where the work would take place (i.e. at the host site or at the University), whether you foresee any Intellectual Property or confidentiality issues (and if so, what form might these take?):

This project will use real data. We will require the student and supervisors to sign an NDA prior to access. The student can work remotely, or can work from our Edinburgh office depending on preference. This project is suited to a student who is comfortable with the R programming language and statistical analysis, as it will involve analysis using advanced statistical techniques of the student's choice.

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Title of proposed project:

Investigating the impact of the 2022/23 Highly Pathogenic Avian Flu Virus (HPAIV) H5N1 outbreak on gannet (*Morus bassanus*) in the British Isles

Project outline and intended outcomes:

Seabird populations around the British Isles were heavily impacted by the 2022/23 HPAIV outbreak, with devastating effects on multiple seabird species such as gannet, great skua (*Stercorarius skua*) and gull and tern species (Falchieri *et al.,* 2022). Gannet were one of the most heavily affected species, and with the UK holding a large proportion of the global population, any negative impacts to UK colonies are likely to have far-reaching consequences.

The outbreak was first identified in UK colonies in 2021, although the impact to colonies seemed to be larger over the 2022 breeding season (Lane *et al.,* 2023). Since the outbreak occurred relatively recently, the effect on gannet is relatively unknown, with any attempt to describe and analyse data likely to improve existing knowledge and aid future work.

HiDef collect huge amounts of Digital Aerial Survey (DAS) data on UK seabirds every year, generally contracted by the offshore renewables industry. The survey method is particularly suited to derive species density and abundance estimates while providing additional data such as those on age, sex and behaviour.

During the HPAIV outbreak, the number of dead gannet recorded by HiDef increased considerably compared to previous years, with the cause of death presumed to be HPAI. As of yet, these data have not been analysed, therefore any analysis in terms of regional or seasonal trends and environmental conditions would be informative.

Gannet are regularly aged from HiDef footage (e.g. adult, juvenile, immature) and the proportion of each age class in the overall data can be derived. It is possible that the age structure derived for dead gannet compared to that for the rest of the observed birds will be different. Assessing differences in age structure regionally would be interesting, in addition to exploring any temporal (seasonal) variation. Potiek *et al.* (2019) present age class information for multiple seabird species in the North Sea, with something similar for gannet being able to be replicated from the HiDef data, in addition to other analyses.

If the student wishes there is potential to do much of the data manipulation/analysis in R; providing valuable skills which will be useful for future career opportunities. Two representatives from HiDef with marine biology and quantitative statistics backgrounds will co-supervise the project along with those from the partner University.

Since the impact of HPAI is still being assessed, it is likely that there may be opportunity for the student to publish in a peer-reviewed paper, if data owners are agreeable.

Falchieri, M., Reid, S.M., Ross, C.S., James, J., Byrne, A.M.P., Zamfir, M., Brown, I.H. *et al*. (2022). Shift in HPAI infection dynamics causes significant losses in seabird populations across Great Britain. *Veterinary Record Open*, 191, 294–296.

Lane, J.V., Jeglinski, J.W., Avery-Gomm, S., Ballstaedt, E., Banyard, A.C., Barychka, T., Brown, I.H. *et al*. (2023). High pathogenicity avian influenza (H5N1) in Northern Gannets: Global spread, clinical signs, and demographic consequences. *Ibis*. doi: 10.1111/ibi.13275.

Potiek, A., N. Vanermen, R.P. Middelveld, J. de Jong, E.W.M. Stienen and R.C. Fijn. (2019). *Spatial and temporal distribution of different age classes of seabirds in the North Sea. Analysis of ESAS database*. Bureau Waardenburg report 19-129. Bureau Waardenburg, Culemborg.

Any additional comments e.g. details of specific disciplines required, methods to be used, travel involved, where the work would take place (i.e. at the host site or at the University), whether you foresee any Intellectual Property or confidentiality issues (and if so, what form might these take?):

The project will likely be most suited to those with a marine biology/ecology background, although those with a quantitative background may be interested if they wish to undertake more complex analysis on the data e.g. adapting population models to assess population-level impacts (this is likely to be challenging considering the relatively short time-frame associated with the project, so prior experience with population models would be necessary).

Since the data are already available the project will be desk-based, however, HiDef have an office in Edinburgh so there will be potential to meet the team and learn more about the data collection methodology and glean support from our data scientists. Regular meetings can be set up between HiDef representatives and the student.

HiDef primarily collect highly confidential data for offshore renewables developers. To conform with client confidentiality, all data will need to be anonymised and collated to broad regions, prior to analysis. This will be done prior to the student having access to the data so no issues are expected to arise.