

Blue Build & Biosecurity: *Incorporating ecological science into marine infrastructure to minimize colonisation by invasive species.*

Supervisors:

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Project Background and Rationale:

Urbanisation of our oceans is happening at an exponential rate^{9,10}, leading to increasing demands on coastal ecosystem services and functions, including expanding installations of marine artificial structures driven by aquaculture, oil extraction, coastal defence and renewable energy (see review in⁹), creating a network of coastal and offshore artificial structures. While, coastal defences, ports and harbors have historically converted wetlands into hard-structure shorelines, new or novel habitats are being created from marine installations located in seabed areas previously devoid of hard structure¹⁰. Research has shown that invasive non-native species (INNS) favour artificial over natural structures^{11,12}. This expanding network built environments are facilitating a 'stepping-stone' expansion or 'jump dispersal' of INNS^{13,14}, across greater distances than ever before⁹. The global economic impacts of terrestrial and marine invasive species are estimated at USD 1.4 trillion annually (5% of the global economy), in the UK the annual estimate is £1.7 billion¹⁵. The threat of invasive species within Europe has been highlighted as a priority action in policies at all levels from national to global, including the Convention of Biological Diversity Strategic Plan for Biodiversity 2011-2020 (Aichi Target 9). Over the next decade, the 'ocean urbanisation' process will continue unabated, particularly in energy-rich offshore environments. Over 7,500 wind turbines are either on-line, under construction or consented in Europe and many tidal and wave projects are rapidly progressing towards commercial-scale deployments (see review in¹⁶). The full scale of marine infrastructure related INNS is under-appreciated as environmental reviews and permitting for projects typically do not account for cumulative impacts of time and space. Currently, no studies on the consequences of infrastructure on INNS and ecosystem alterations have integrated both ecological and policy analysis. While 'green build' is an emerging ecologically positive engineering design concept for buildings on land, a similar logic of 'blue build' is needed for marine built environments. This PhD project on the current knowledge of INNS ecology and distribution patterns and policies related to marine installations will contribute to nascent efforts in integrating biosecurity into our coastal recreation, energy and defense structures in the UK and beyond.

Key Research Questions:

We hypothesise that UK policy is promoting the installation of multiple marine structures, which are creating novel habitats, without understanding the cumulative implications that this will have on the widespread dispersal of INNS. The specific objectives of this project are to;

- Identify key aspects of the siting and structures of marine installations that favour the settlement of INNS.
- Review representative brown field and new coastal and offshore developments to determine when in the project cycle if/ when INNS are considered.
- Review local to global policies in mitigation of INNS dispersal and settlement from a policy and ecological perspective on the spread and establishment of INNS.
- Assess the changing scale of impacts resulting from the spread and establishment of INNS on cumulative marine installations over space and time.
- Identify ways to improve biosecurity at 'blue build' sites (marine installations) across a representative spectrum of environmental settings.

- Provide recommendations for existing and future marine installations based on above for relevant local, national and global authorities and stakeholders.

Methodology and Timetable

Months 1-12 (UoE): Literature review of INNS status of various marine installations (e.g. different scales, ecological settings) in UK/ EU. Involvement of questionnaires, interviews. Identification of potential marine installations for further case studies (site locations and policy processes) in UK. Data acquisition on INNS distribution through major EU datasets (e.g., AQUANET, DAISIE). Review of policy context and economic drivers for marine installations and INNS taking into account local, regional and international horizons. **Months 12–24 (SAMS):** Develop preliminary criteria of which ecological conditions can optimize biosecurity (i.e., preventing the establishment of INNS), based on selective site visits and pilot interviews. Verification of criteria by field based work, including site surveys, manipulative experiments using settlement panels, questionnaires and interviews additional settlement panels. **Months 24 – 42 (UoE or SAMS):** Analysis of results and additional fieldwork, completion of recommendations for existing and future marine installations and policy guidance. Write thesis and publish findings in high profile peer-reviewed journals.

Training: A comprehensive training programme will be provided, comprising specialist scientific training and generic transferable professional skills. For example, through this project, UoE will lead on Policy and networking with academic and policy makers (UK and EU). Training in meta-analysis, policy document analysis, information management. SAMS will lead on: Identification and INNS survey expertise; statistical analysis software (in house), marine related dialogue and discussions.

Requirements:

This PhD is best suited to a student with and benthic marine-coastal ecological science training, but with an interest in policy processes and engineering designs.

Further reading and references:

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- 9 Mineur, F. et al. (2012). *Ocean Mar Biol Ann Rev* **50**, 187-232.
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