2018 ASPIRE WHITE PAPER SUBMISSION

Contact Information

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Willing to Attend Workshop? Due to university commitments Murray Roberts cannot attend the workshop but Steve Ross (rosss@uncw.edu) and others from ATLAS / iAtlantic may be able to attend.

Target Name(s) Hydrothermal vents, cold-water coral and sponge grounds, submarine canyon ecosystems, deep-sea mining areas, transatlantic cold-water coral genetic connectivity

Geographic Area(s) of Interest within the North Atlantic Ocean

Northwest, North, North Central

Relevant Subject Area(s) (Indicate all that apply) Biology, Ecology, Geology, Genetics, Connectivity

Description of Topic or Region Recommended for Exploration

As Atlantic climate shifts towards generally warmer conditions with less sea ice and complex changes in overturning circulation[1], the northern parts of the Atlantic are predicted to experience great changes in productivity and faunal diversity. We therefore propose a series of sites along the northwest Atlantic (US continental slope, Northern Canada, Greenland, Iceland) and the mid-Atlantic ridge area (Azores, Brazil). The expeditions would focus on the discovery and description of cold-water coral and sponge ecosystems, hydrothermal vent fields, potential Areas of Particular Environmental Interest for seabed mining and on collecting samples to study basin-scale genetic connectivity of key taxa.

The **US continental slope** region from off Cape Lookout, North Carolina to off Cape Cod, Massachusetts, contains a remarkable diversity of physical and biological attributes. These include the Gulf Stream system, major submarine canyons composed of hard substrates and consolidated muds, hundreds of active methane seeps, extensive cold-water coral ecosystems, a major zoogeographic transition zone, extremely productive fisheries, and perhaps the richest biodiversity in the Western Atlantic. **Further exploration** in this region is important as a western Atlantic anchor point for more Atlantic basin-wide research that includes similar habitats and fauna to the north (off Canada) and to the east (off Greenland and the mid-Atlantic Ridge). Given the predominant focus of ATLAS and SponGES has been in the NE Atlantic, targeting central and western Atlantic regions also gives a more balanced geographical spread for these AORA projects and for future projects funded through the All Atlantic Ocean Research Alliance Flagship (BG-08-2018-19) to which iAtlantic is applying[2].

In the central Atlantic, the first living sample of the cold-water coral *Lophelia pertusa* from **Greenland** waters was recently discovered at 60°N, 48°W. This cold-water coral community is the only known reef in the northwest Atlantic north of 44°. Travelling south, *Lophelia* reefs are not known from Canadian waters until reaching Nova Scotia. Reef-like structures formed by living and dead *Lophelia* were identified from photographs taken in summer 2018 (CCGS *Amundsen*) at four sites 886-932 m depth, but strong currents made the area difficult to survey with a drop camera and this biogeographically important coral habitat has not been mapped. Returning to this site for **further exploration, mapping and genetic sampling** will lead to a better understanding of their connectivity at oceanic scales. We do not currently know if this site is related to western or eastern Atlantic populations, and can incorporate this analysis into ATLAS workpackage 4 'Connected Resources' led by Ifremer (France).

The **Mid Atlantic Ridge (MAR)** remains very poorly explored and there are great opportunities for new scientific discoveries building upon the 2018 discovery by ATLAS partners at the University of the Azores of the Luso vent field. Only a fraction of this area was surveyed in 2018 and samples for geology, chemistry (fluids and gases), biology and microbiology are all needed for a **complete description of this the newest active vent discovered on the MAR**. Close-by are important seamount habitats including Vulnerable Marine Ecosystems (VMEs) formed of cold-water coral gardens and sponges. Key target areas include Sarda, Farpas, Monte Alto, Voador, Cavala and Ferradura seamounts and ridges, see details in the White Paper from IMAR & OKEANUS.

[1] Thornalley et al. (2018) Anomalously weak Labrador Sea convection and Atlantic overturning during the past 150 years. Nature 556: 227-230

[2] http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/bg-08-2018-2019.html

In addition, beyond national jurisdiction the International Seabed Authority (ISA) has issued three **exploration contracts for deep-sea mining** for polymetallic sulphides PMS along the MAR[3]. To manage exploration contracts, the ISA has listed the MAR as a priority area for developing Regional Environmental Management Plans (REMPs)[4]. For a REMP to have effective conservation measures as part of the spatial planning for deep-sea mining, there needs to be sufficient environmental baseline information. The section of the MAR immediately south of the current block of exploration contracts (extending from Vema Transform Fault at 10°N to the Brazilian EEZ around Saint Peter and Saint Paul Archipelago) has been little explored and the environmental baseline here is poorly characterised. Understanding the faunal communities along this section of the MAR and their connectivity to the rest of the MAR would provide vital context for the potential impact of deep-sea mining between 10°N and the Azores EEZ. One of the conservation measures used in ISA REMPs are **Areas of Particular Environmental Interest** (APEIs). Suggestions have recently been made for optimal APEI placement along the MAR, with the network of proposed APEIs being centred on APEIs placed at the Romanche Transform Fault and the Vema Transform Fault[5]. Exploration around the Vema Transform Fault heading south along the MAR towards the Brazilian Saint Peter and Saint Paul Archipelago would help to confirm Vema as an anchor for APEI placement. Exploration here would also **identify further areas with special fauna and habitats** along the MAR that could be considered for inclusion in APEIs.

Studying the **genetic connectivity** of widespread reef framework-forming corals *Lophelia pertusa* and *Madrepora oculata* is necessary to reveal patterns of genetic connectivity at the North Atlantic scale. This work is grounded in larval distribution modelling and connectivity analyses completed through the ATLAS project. The underlying VIKING20 hydrographic model outputs, Lagrangian particle tracking modelling and connectivity analysis approach can be developed with other species to create testable hypotheses on population relatedness, co-evolution, speciation etc. For example, it is presently unclear whether *L. pertusa* and *M. oculata* species are actually the same species since recent genome scan analysis point toward the possible occurrence of several taxa of *Madrepora* in the Eastern Atlantic. Important stepping stones may be coral habitats from Iceland, Greenland and the Azores, although our knowledge of their distribution on Atlantic seamounts and abyssal plains is much less advanced that on margins and canyons. Thus, sampling in Northern Canada, Greenland as well as along the MAR, would allow examination of hypotheses of (1) ongoing or resolved **speciation** among taxa present on both sides of the Atlantic and (2) if common taxa are confirmed, the present-day **connectivity** of populations distributed along ridge and across the Atlantic.

Relevant Partnerships (If Applicable)

This white paper has been prepared by the University of Edinburgh drawing primarily on discussions within the ATLAS (2016-2020) and iAtlantic consortia and the team writing the IMAR & OKEANUS white paper at the University of the Azores, Portugal[6]. During its preparation email discussions were also held between the ATLAS, SponGES, CHONe and DEEPSEARCH communities and we look forward to developing collaborations to maximise the benefits of any ASPIRE partnerships that arise from these White Papers. At the time of writing the iAtlantic consortium was finalising its bid for a €10.6M project to produce an integrated assessment of Atlantic marine ecosystems. If funded, iAtlantic would run 2019-2023 and would complete a programme of work in both North and South Atlantic including several focal regions addressed in this White Paper. iAtlantic also includes an extensive **capacity building plan** that would greatly benefit from telepresence expeditions allowing collaborators across Argentina, Brazil, South Africa, Namibia, Angola, Senegal, Canada, the USA and Europe to be engaged with the work offshore and participate actively in the missions. Both the ATLAS and iAtlantic consortia include significant partnerships with offshore industries and we would look to capitalise on this to make any baseline research directly relevant to economic activities in the Atlantic (e.g. via ATLAS WP5 'socioeconomics' and WP6 'maritime spatial planning).

[3] https://www.isa.org.jm/deep-seabed-minerals-contractors?qt-contractors_tabs_alt=1#qt-contractors_tabs_alt

[4] International Seabed Authority (2018) Preliminary strategy for the development of regional environmental management plans for the Area. *ISBA/24/C/3*.

[5] Dunn DC & Van Dover CL *et al.* (2018) A strategy for the conservation of biodiversity on mid-ocean ridges from deep-sea mining. *Science Advances* 4:eaar4313

[6] Contributions to this White Paper were received from Sophie Arnaud-Haond (Ifremer), Rachel Boschen-Rose (Seascape), Lea-Anne Henry (UEDIN), Ellen Kenchinton (DFO), Steve Ross (UNCW), Telmo Morato (IMAR-UAz), J Murray Roberts (UEDIN) and Bodil Wesenberg Lauridsen (Geo Survey Denmark)