**Minutes from on-line meetings of the DOSI Decade of Ocean Science working group**

On the 17th and 18th July 2019, the DOSI Decade of Ocean Science working group chairs held 2 open on-line meetings to discuss design criteria for the decade with the global community. The meetings were advertised via the DOSI Decade working group mailing list, the wider INDEEP/DOSI mailing list and the DSBS Slack Channel. 38 persons from 12 countries (UK, Sweden, Portugal, USA, France, Norway, Germany, South Korea, Japan, Canada, Germany and Australia) attended the meetings. At each meeting KH introduced the aims of the meeting, giving some background to the UN Decade of Ocean Science for Sustainable Development, as well as outlining the key science questions identified by the working group in the DOSI position paper (<http://dosi-project.org/wp-content/uploads/2018/05/DOSI_Decade_Position_Final-1.pdf>). KH also presented an example of a design drawn up by the Challenger Deep-Sea Special Interest Group in the context of a “new” Challenger Expedition to celebrate the 150th anniversary in 2022. The importance of a modular (or jigsaw puzzle) design was emphasised in order to maintain flexibility in funding mechanisms, and regional ownership; as well as the importance of delivering the data to answer the questions, e.g. not to be restricted by what is “logistically” possible. Attendees then discussed what they felt were the important considerations in the design of a global-scale field programme for the Decade. What follows is a summary of those discussions.

Considerations in the design of a field programme

Given the Decade is focused on sustainable development there was agreement that it would be useful to prioritise those areas of the deep-sea that are under the most anthropogenic pressure, including those predicted to change soonest under climate change forecasting. The Arctic and Southern Oceans were mentioned specifically, but also the outputs of a recent FAO report (FAO 2019) that has modelled the time of emergence of seafloor climate changes for important variables such as POC flux, dissolved oxygen, pH and temperature. With this it was recognised that it would be useful to stratify sampling across these key climate change related variables. Other key papers in this respect include Henson et al., (2016) and Long et al. (2015). It was suggested that it would also be useful to sample across a range of impact as this may help to understand shifting baselines. In addition the idea of collecting a relatively temporally dense (<10 years) global dataset would also enable us to better assess shifting baselines in future.

The importance of engaging with other UN processes and programmes was also highlighted. This engagement could take several forms. Firstly as part of the field programme design criteria we could look at the established criteria within the Convention on Biological Diversity for marine protected area (MPA) network design including uniqueness and representativity. In addition the broad scale mapping of bioregions which is related to assessing representatively (and was presented as a possible criterion by KH in the example shown) could also be used as a basis for stratification of sampling. Secondly, areas identified as Ecologically and Biologically Significant Areas (EBSAs), Areas of Particular Scientific Interest (APEIs), Vulnerable Marine Ecosystems (VMEs), Large Marine Ecosystems (LMEs), or large MPAs could be selected for inclusion in a field programme over areas not so designated where a choice between areas was possible and ecological requirements of the design could still be met. Finally, where other Decade programmes or indeed global scale programmes are also collecting data on the physical environment, we should ensure coordination spatially as far as possible without compromising the overall design, and sharing of data. For example the Seabed 2030 programme could benefit from the ability to put some biology onto bathymetry maps, while this programme could clearly benefit from high resolution bathymetry data. In addition other global field sampling initiatives such as GOSHIP (part of GOOS) and Tara may be able to offer valuable experience to the development.

It was suggested that it may be of interest from an evolutionary perspective to stratify sampling across areas of older / younger seabed, and / or to include metrics of phylogenetic diversity as well as species diversity in what is measured.

While already agreed to stratify across habitat types following the Census of Marine Life model (see DOSI Decade of Ocean Science position statement), this was again highlighted in discussions as important. Specifically in order to address connectivity of habitat types, with a design that allows us to breach the habitat silos our community tends to work in, including pelagic to benthic connectivity. The group felt this challenge could best be achieved through developing a global design with nested habitat specific designs.

Scale was an issue that the group felt needed to be considered carefully in the design from both a spatial and temporal perspective. Scale could be considered in a very numeric context (sampling at 1m, 1km, 10km, 100km etc as shown in the example given) or we could consider spatial scales in a mapping context sensu Greene et al. (1999), who described megahabitats, macrohabitats, meso habitats etc. Consideration would also need to be given to the scales at which the environment varies for example seamount and abyssal habitats vary on different scales, and the design would need to accommodate / capture this. This issue also applies in a pelagic context where meso-scale oceanographic features such as meso-scale eddies and fontal systems represent important habitat for pelagic species yet large scale water mass structure is also important. In terms of temporal scale what is measured should be stratified over short temporal scales e.g. tidal cycles where possible to provide fine scale temporal data. Larger scale temporal data will need to be the focus of a monitoring / experimental field element to the Decade plans to be discussed later.

It was recognised that pelagic systems have different drivers to benthic systems and so the criteria for design may need to be adapted. However the importance of bentho-pelagic coupling was stressed and therefore the need for “vertical” as well as “horizontal” transects in any design. Stratification by depth was seen as important as the environment changes much more in the vertical than the horizontal.

In terms of area of focus it was agreed that working in both areas beyond national jurisdiction and within nations exclusive economic zones was desirable, and that it was most important to have a design to answer the questions, ignoring political boundaries. That said, there is a need for understanding of transboundary issues in order to achieve sustainable use, and therefore where there were options of different spatial sampling regimes that equally met the design criteria, those that included transboundary sampling would be preferable.

Finally it was recommended that the design criteria are documented and clearly understandable, such that regional adaptations can be made that still satisfy the design criteria, but enable regional concerns to be taken into consideration. Essentially that we aim to produce a “blueprint” that can be followed by the community.

Other points arising

Several important points were made about the operation of a field programme, which are not directly related to design criteria but we note here for future discussions. It was suggest that the field programme should have a coordination and communication platform, such that as the decade progresses the community can see which pieces of the jigsaw puzzle have already been completed and what is left to do. It was also suggested that a pilot module might be sensible in order to tease out operational flaws prior to wider role out of the programme. It was suggested that the different pieces (modules) of the field programme could be prioritised in terms of urgency, and resources directed to the most urgent areas first where possible. Following the publication of the design, we could look to see if parts of it could be fulfilled by industry and actively engage others to participate.

There was general agreement that a core set of sampling should be defined together with the methods that should be used to undertake sampling and preserve specimens. The Census of Marine Life have produced documents that could be drawn on for this purpose to avoid duplication of effort, and Woodall et al. (2018) have defined some key variables. It was recognised that different biological compartments may require different research cruises to sample them, for example it is logistically challenging to undertake ROV work and trawling on the same cruise. Therefore the design needs to be able to operate in a modular way in terms of sampling of biological compartments. It may be desirable to have a few sites at which a greater level of sampling is achieved, and have a list of priority taxa (indicator taxa) that are focused on first in terms of processing of samples following research cruises.

There will need to be a clear protocol on the archiving of physical specimens and data, and processes for obtaining fair and open access to both. Storing of samples that may have future use with innovations in technology, should also be anticipated and planned-for.

The issue of technology used to sample / survey came up both in terms of use of novel technology (AUVs, AI, robotics), and ensuring cheaper more accessible technology is sought such that a wide range of nations can participate. This issue will be discussed in future meetings.

Next steps

The next steps are for a small team of the willing to draft a design for the field programme, taking all points raised into consideration. We suggest a 2 day workshop to 1) discuss, agree and document criteria, 2) produce draft designs for each habitat type (abyss, trench, seamount, canyon, slope, chemosynthetic), 3) modify designs to ensure global coherence, 4) submit drafts to the community for comment. We have submitted an application to the DSBS to fund a physical workshop, however this could also be achieved via an online meeting. Each habitat specific team will require as a minimum a person with expert knowledge of the habitat system, a person with good GIS skills, a person with a strong macro-ecology background / statistical design knowhow. The team would also benefit from the presence of senior researchers with experience of large programme design.

The time line must fit with that outlined by the UN’s Decade of Ocean Science roadmap. Below we give a proposed Gantt chart for this aspect of the Deep-Sea Decade Project. The actions in orange are those set down in the road map. Proposed wider project steering group meetings are also shown. This steering group is envisioned to be the team identified in a SCOR proposal that we are awaiting a decision on.



**References**

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