# Theme session K

## Introducing man-made structures in marine systems: assessing ecological effects, knowledge gaps and management implications

Conveners: Silvana Birchenough (Cefas, UK), Jennifer Dannheim (AWI, Germany), Furu Mienis (NIOZ, Netherlands)

**Summary**

The recent need for energy generation has instigated the introduction of a large variety of man-made structures (MMS, thereafter) across soft sediment areas, resulting in modification of marine ecosystems. The nature of these structures varies across areas, from oil and gas installations, anchored buoys, ship wrecks, pipelines and more recently an exponential addition of renewable energy structures. Overall effects resulting from these MMS are expected to differ across marine systems, as they will depend largely on the footprint created by these added substrates. Since the effects are likely influenced by the detailed characteristics (e.g. type of structure, hydrodynamics) of the marine environment in which these systems may operate.

Large offshore MMS such as oil and gas installations, and wind turbines span the entire water column, thus connecting surface layers with the seafloor sediments, and consequently differ from seafloor restricted natural and man-made hard substrate (e.g. pipelines, ship wrecks). Offshore structures can alter biodiversity with direct consequences on ecological processes and resulting in direct modification of overall functioning over different scales. Furthermore, these structures provide habitat for a fouling community, often new to offshore regions, potentially serve as stepping stones for range-expanding (non-indigenous) species, provide habitat and shelter for marine (fish) species, and alter biological and biogeochemical processes in the water column and at the seafloor, either directly (e.g. scouring, organic matter export from piles) or indirectly (e.g. closure or displacement of fisheries).

This theme session was conducted on days 3 and 4 of the ICES Annual Science Conference, over a four-hour slot. The session was mainly attended by researchers and scientific advisors, directly working on understanding the direct effect of MMS. A total of approximately 15 participants, were present over the two days. The session featured a total of 12 presentations and 9 posters.

On the first day, the session welcomed contributions, mainly dealing with research to understand the likely effects of offshore structures on marine systems, including direct effects on organisms and ecosystems and giving a detailed view of the processes influencing these systems. The research focused on the main ecological effects and likely repercussions for community structure and functioning. On the second day, the contributions presented were focused on ecosystem level effects, modelling approaches, new tools for monitoring effects, challenges associated with scale patterns, direct applications based on Environmental Impact Assessments, cumulative effects frameworks and future challenges associated with the introduction of MMS.

The overall messages from the session were:

- There was consensus from the different presentations, that the evidence suggests that the overall understanding from the effects associated to the introduction of MMS is

"*complicated*". There is a clear need for Transatlantic research cooperation to distill common effects, long-term effects and biological responses that until now, still generate several levels of uncertainty;

- The issue of understanding changes and responses in connection to different SCALES, in which these processes operate, was discussed across several presentations. Although, some relevant knoweldge exists, there is still a lack of clear understanding with regards to the issue of scales over connectivity, footprint of the structures and larger ecosystem level effects (e.g. food web effects and the differences observed in the efficiency with which the energy and biomass from these sytems is captured and consumed);
- Depending on the factors relevant to different MMS, several targeted studies will need to consider temporal, spatial, depth and density of structures to fully document observed and expected ecological responses;
- There is a clear need to undertake studies taking multidisciplinary approaches, where a combination of processes, linkages between processes and species responses are tested and fully-documented;
- Benefits of increased collaboration between industry and science were highlighted. Some examples, promoting data sharing, *in-situ* experiments and data acquisition can help to test, validate and study in greater detail ecological responses and processes;
- Research has provided some initial insights into the responses resulting from the introduction of MMS (e.g. reef-effect, contaminants, stepping stone theory, biodiversity and functional changes), but clearly, there are still many responses and processes that will need investigation;
- Clear benefits can be obtained by combining experiments/tools, field data, modelling approaches and overall validation. These types of approaches can provide a detailed set of cause-effect responses from MMS studies;
- Some research centred on the development of indicators, some good examples included primarily hydrocarbons and macrozoobenthos;
- Further research, helping to document the likely effects and footprint resulting from different types of MMS across marine systems, can help to understand the zonation patterns of the colonising fauna inhabiting the structures as well as community types in surrounding areas;
- There is a need to disseminate wider ecological research to inform the decision making-processes. This type of communication can help to promote a cost-effective strategy across multi-sectors;
- Further studes, helping to disentangle natural vs anthropogenic changes, are needed to provide further understanding of the observed effects of these MMS and to support additional studies looking at future scenarios and interaction of pressures across MMS.

This theme session provided a good opportunity for communication between scientists and advisors working directly on the effects resulting from the introduction on MMS. There were clear benefits from developing the framework for research and advice on environmental effects associated with these developments. Based on the issues raised there are clear opportunities to explore better integration of science and decision making.