Seismic Surveys in Complex Environments – Analysing the Variability of Exclusion Zones with Field Measurements and Models

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The sound intensity introduced in the marine environment by offshore industry and commercial shipping has greatly increased in the last few decades. The scientific evidence of the potential negative effects of current underwater sound levels has encouraged regulatory agencies to establish and redefine mitigation strategies, in order to minimise the impact on marine animals. Seismic surveys can be especially damaging because they use loud sources during extended periods and over large areas.

The Sound Source Verification methodology (SSV) maps the sound field produced by an acoustic source in water, using a combination of models and field measurements (Heath and Wyatt, 2014). The mapped sound levels are eventually used to estimate the exclusion zones: areas around the source where the sound levels exceed a particular threshold with proved impact on marine species. The SSV procedure consists of three main stages: 1) *Pre-survey modelling*, where modelled exclusion zones are provisionally implemented in the mitigation plan, until field measurements are available; 2) *Sound field mapping*, carried out by different deployment techniques and sampling methods; 3) *Model validation and refinement*, where the pre-survey model is verified and updated based on field measurements. The SSV is a very powerful tool to define exclusion areas that are truly representative of each operational and environmental situation, as shown in several deployments (Jiménez et al., 2015).

The way regulations specify how exclusion zones should be determined varies from country to country: some use specific distances from the source whilst others use threshold levels (Erbe, 2013). The lack of regulatory agreement, along with the necessity for limited, simple exclusion zones which can be practically monitored, might lead to oversimplifications. Exclusion zones can show large variations in shape and coverage, by effect of bathymetry (e.g. shallow water and varying slopes), environmental conditions (e.g. freshwater or colder water intrusions), source and receiver positions or hearing sensitivity of the animal. The exclusion zone approach is a key part of the mitigation strategy, and as such special effort must be put on creating methods to accurately calculate these zones and effectively integrate them in the survey mitigation plan.

We show, through measurements and models, the effects on the exclusion zones of some of the main environmental and biological factors: bathymetry, geology, receiver depth, hearing response and sound level metric. These analyses are complemented with recommendations on the cases where additional exclusion zones should be defined.

References

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