ACOUSTIC MONITORING IN THE NORTH AND BALTIC SEA: FUTURE TASKS OF THE GERMAN MARINE ENVIRONMENTAL NETWORK – MARNET – UNDER CONSIDERATION OF THE MARINE STRATEGY FRAMEWORK DIRECTIVE

J.G. Fischer, M. Eickmeier, K. Herklotz
Federal Maritime and Hydrographic Agency (BSH), Hamburg, Germany

1 INTRODUCTION

With regard to growing acoustic impacts originated by anthropogenic underwater noise and in the context of the Marine Strategy Framework Directive (MSFD) the need for operational marine acoustic data increased significantly over the past years. Rising ocean noise levels and its associated negative influence on environmental conditions (especially to the marine life) has led the European Commission to classify ambient noise as a parameter to monitored by all European member states. The monitoring aim is to analyse and evaluate potential impacts on the environmental status as a prerequisite for acoustic noise limiting processes. Comprehensive uniform measurement data and analysing procedures are indispensable for this monitoring tasks. The paper describes an overview of existing German measurement programmes including a design of an ocean acoustic observation concept to fulfil the MSFD demands.

2 DEVELOPMENT OF AN AMBIENT NOISE MONITORING SYSTEM FOR THE GERMAN BIGHT

2.1 Monitoring

The marine monitoring network in the North and Baltic Sea (MARNET), operated by the Federal Maritime and Hydrographic Agency (BSH), is a long-term ocean observation programme at fixed monitoring stations (see Fig. 1). Main objective of these measurements is to identify the prevailing marine environmental conditions. Until now, the monitoring is focused upon the identification of the traditional hydrographic parameters (sea state, currents, physical properties of sea water, etc.). Collected oceanographic time-series date back to the early 80's. Within the context of the new demands of acoustic monitoring, the MARNET observation concept will be upgraded.

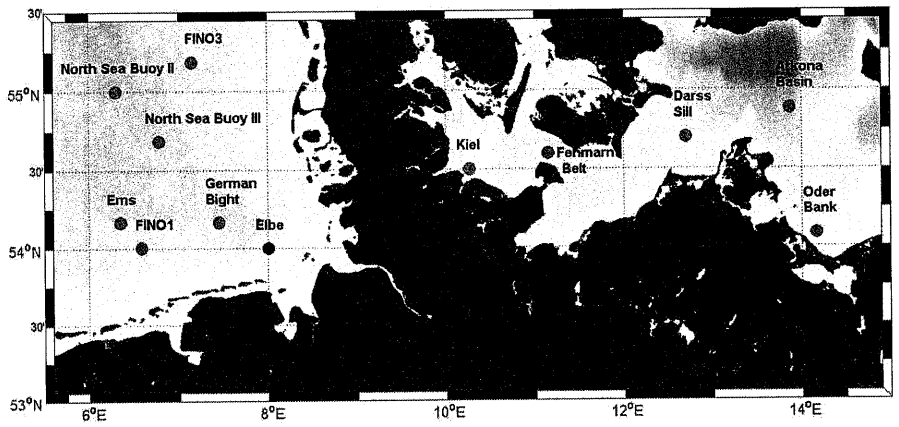

Figure 1. Map of the North and Baltic Sea. Markers indicate locations of monitoring stations. Red markers indicate station out of service.

2.2 Basic Measurements and Procedures of Noise Monitoring

The first essential step to develop an acoustic monitoring system are basic measurements of the ambient noise with following basic approach:

- Short-term shipboard measurements
- Long-term (autonomous) ocean noise recordings

The basic short-term measurements will be made during ship-surveys and will be done in two different ways. One way is to measure from the ship with one or more hydrophones, the other is to measure with stand-alone measurement systems moored at the sea-ground. The advantage of the different measurement setups is that acoustic events (see Fig.2) can be identified and data can be directly connected to the associated event. Additionally, redundant data should be available if one system fails.

Long-term measurements shall be done with an autonomous measurement system for a duration of at least three months to measure the ambient noise under different conditions (seasonal and diurnal cycles, weather, traffic etc.).

2.3 Classification of noise sources

From the future measurements described in 2.2 the noise sources available in the different areas shall be identified and stored in a database together with the raw hydroacoustic signal. This database is necessary for the development of the monitoring system because event-triggered preprocessing will be implemented into the system.

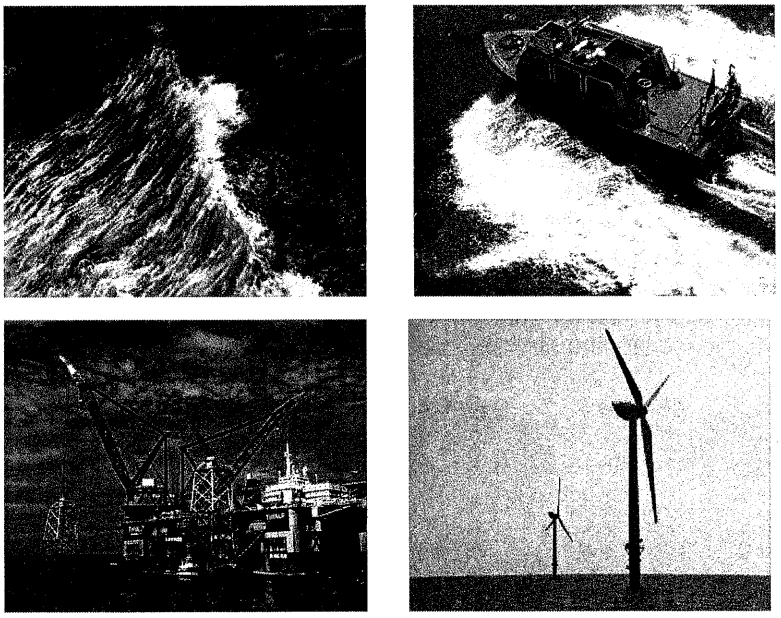

Figure 2. Examples of human and natural events that generate sound: sea state, shipping, construction work and wind park operation noise.

2.4 Requirements for a measurement set-up

Measurements of ambient noise is a challenging task because the measured sound pressure levels dominantly depend on the measurement depth, sound velocity profile and bathymetry. During this

project, a measurement set-up shall be developed with the hydrophones installed at a reasonable measurement depth for representative measurement results but with the best protection against loss due to fishery. The mechanical set-up shall not produce disturbing noise and it shall be possible to deploy and recover the system easily. See Fig. 3 (image) for a first system set-up.

Measurements and calculations regarding the propagation of the noise signals shall be done to identify the spatial arrangements of the measurement system for the best possible coverage of all regions.

2.5 Measurement concept and quality test

2.5.1 Measurement concept

It's not applicable to measure and store the noise signals the overall time, because nobody will have the resources to recalculate all the measurements later. Aim is to include a preprocessor into the measurement system with the aim of compressing the measurement data without loss of necessary information.

Research shall be done on how to compress the data most reasonable, e.g. storing 1/3 octave bands or broadband-levels like equivalent continuous sound pressure level (L_{eq}) , peak pressure level (L_{peak}) and sound exposure level (SEL). In the actual version of the MSFD only the 1/3 octave bands 63 Hz and 125 Hz shall be measured for continuous signals and the SEL or L_{peak} is necessary for impulsive sound. In our opinion, it is not sufficient to monitor the ambient noise in that way, because a lot of potentially important information will be lost. However, these reduced measurement results can be applicable for the online data-transmission.

The development of an event-triggered measurement system will be one of the main tasks because all relevant events shall be stored, but it's not necessary to store data where the conditions do not change. The event-triggered measurements shall be extended with time-triggered measurements to retrieve seasonal and diurnal changes and measurements under different weather conditions.

It's not sufficient to measure ambient noise without knowing anything about what happens in the environment of the measurement system, so further accompanying measurements shall be done like ship tracking data (AIS), hydrographic data, weather, waves etc. In the German Bight several measurement buoys/ stations (MARNET) are available from which the additional parameters can be used. However, it is only possible to use the additional information if the buoy is at a reasonable distance.

2.5.2 Quality test

The installation of the measurement system for at least three month does not allow for cleaning or testing the system itself. To assure that the system works correct until the end of the measurement campaign, quality checks are scheduled at least every two months. These quality checks will be performed with a calibrated hydrophone deployed at a defined distance to the monitor system. The calibrated hydrophone sends a frequency sweep to the system and after recovering the quality of the system could be recalculated.

2.6 Online-Data-Transmission

The hydroacoustic data will be transmitted to the laboratory on a hourly basis. This makes it possible to check if the measurement systems still work and to have a quick look at the ambient noise immediately and not after the system will be recovered and the data will be processed. The measurement data will be transferred from the measurement system to a buoy or a fixed station using an underwater modem or a cable. Via satellite connection the data will be transfered onshore (see Fig 3).

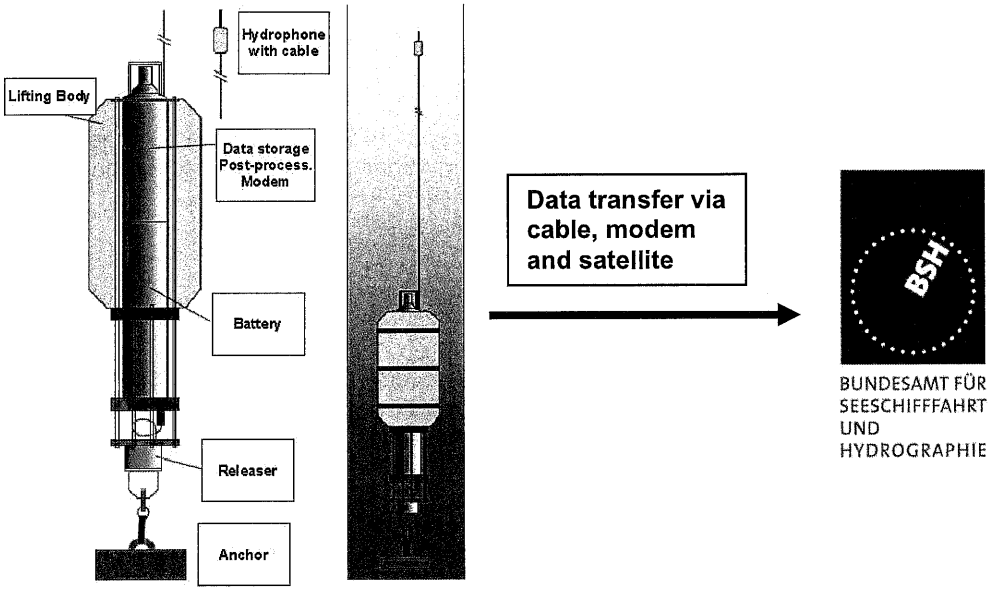

Figure 3. Sketch of measurement set-up (adapted from design drafts of the "Evologics company", www.evologics.com) and data transfer.

3. OVERVIEW

Preliminary monitoring schedule:

- Tests for operational acoustic monitoring
  - short- and long-term measurements for identification of noise sources and to get information of noise distribution within different regions
- Classification of noise sources
  - database of different acoustic signals for pre- and postprocessing of data

  With collected experience and knowledge
- Development of observation concept and measurement set-up
- Design and development of preprocessing algorithms
- Monitoring
- Reporting

4. FURTHER PROJECTS

In context of underwater acoustic measurements and prediction the BSH is involved in different projects.

- Project Hyprowind
  This project includes the retrieval of realistic underwater scenarios and forecast modeling for wind farm construction noise in the German part of the North Sea, as well as measurements for the verification of the models.

- Project: Standardization of the underwater noise from wind farms
  Standardization of measurements and predictions in consideration of noise propagation during construction and operation phases of offshore wind farms.

- Project Bias (Baltic Sea Information on the Acoustic Soundscape)
  Development of common methodology in measuring ocean acoustic data and integration of this data with environmental data into sound-maps (distribution of sound -"soundscape"-) .