

Chapter 126

BIAS: A Regional Management of Underwater Sound in the Baltic Sea

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Abstract Management of the impact of underwater sound is an emerging concern worldwide. Several countries are in the process of implementing regulatory legislations. In Europe, the Marine Strategy Framework Directive was launched in 2008. This framework addresses noise impacts and the recommendation is to deal with it on a regional level. The Baltic Sea is a semienclosed area with nine states bordering the sea. The number of ships is one of the highest in Europe. Furthermore, the number of ships is estimated to double by 2030. Undoubtedly, due to the unbound character of noise, an efficient management of sound in the Baltic Sea must be done on a regional scale. In line with the European Union directive, the Baltic Sea Information on the Acoustic Soundscape (BIAS) project was established to implement Descriptor 11 of the Marine Strategy Framework Directive in the Baltic Sea region. BIAS will

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develop tools, standards, and methodologies that will allow for cross-border handling of data and results, measure sound in 40 locations for 1 year, establish a seasonal soundscape map by combining measured sound with advanced three-dimensional modeling, and, finally, establish standards for measuring continuous sound. Results from the first phase of BIAS are presented here, with an emphasis on standards and soundscape mapping as well as the challenges related to regional handling.

Keywords Marine strategy framework directive • Management • Acoustic noise • Soundscape • Acoustic standards

1 Introduction

The Marine Strategy Framework Directive (MSFD; Directive 2008/56/EC) was launched in July 2008. It treats 11 pressures that potentially have a negative effect on the marine environment, and among these is Descriptor 11 that deals with underwater noise. It is a qualitative descriptor that states that “Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.” It consists of two indicators where the first indicator addresses the distribution of loud low- and midfrequency impulsive sounds and the second deals with continuous low-frequency sound. To harmonize the implementation, the European Union established the Technical Subgroup on Underwater Noise (TSG-Noise) that has published two reports in which they have given guidelines for the descriptor and general recommendations on issues related to its implementation (van der Graaf et al. 2012; Dekeling et al. 2013). In these reports, the group proposes the

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establishment of a noise registry for bookkeeping of the impulsive noise events. It gives interpretations on how to choose thresholds and addresses issues with the scale. Finally, it gives guidance on a monitoring program. The aim of the MSFD is to achieve good environmental status (GES) by adhering to the thresholds of the indicators. In case of Descriptor 11, these are not established. It is therefore important to evaluate these indicators together, with a critical eye. Should all countries employ the same thresholds? Should a regional area establish a common grid for the spatial scale of the registry? How will member states share data? How to define GES by establishing a trend? Some of these questions were dealt with by the TSG-Noise group during 2013 and 2014. Irrespectively of their agenda, the member states were forced to implement the Descriptor and especially to have an operational monitoring system in place in mid-2014. It should be underlined that Article 6 in the Directive states that the Descriptors should preferably be dealt with on a regional level. For these reasons, the Baltic Sea Information on the Acoustic Soundscape (BIAS) project was established.

2 The BIAS Project

The BIAS project was started in September 2012, financed by the EU LIFE+ program; Sweden, Finland, Estonia, Poland, Germany, and Denmark are partners in the project. The project has five objectives: (1) to raise awareness of underwater sound in the region, (2) to implement Descriptor 11 on a regional level, (3) to assess the soundscape of the Baltic Sea by combining measurement and modeling, (4) to develop planning tools that can be used regionally, and (5) to establish regional standards and methodologies that will allow for cross-border handling of data and results.

The monitoring program will be performed by adhering to the standards that will be established in the project. Similarly, the data will be analyzed using standardized signal-processing routines. Results will be subjected to quality control and finally stored in a common data-sharing platform.

3 The Baltic Sea

The Baltic Sea is a semienclosed sea bordered by nine states. It consists of eight subcatchment areas (subbasins) and a number of harbors. The number of ships is one of the highest in Europe. It is estimated that ~2,000 sizeable ships are at sea at any time. Furthermore, several large ocean-based wind farms are planned to be erected in the Baltic Sea, which may add additional noise to the marine environment. The majority of the large ships pass the Öresund area (the Sound) or the Belt area on their way to major harbors in the Baltic Sea. The number of ships has been estimated to double by 2030 (WWF 2010), which undoubtedly will increase the pressure on the marine environment. The Baltic Sea differs from other European areas, e.g., it has an average depth of ~55 m, several large archipelagos, permanent salinity stratification

at ~90 m depth, and a complex sediment structure. Furthermore, during the summer, a thermocline develops in the surface layer. From an acoustical point of view, the Baltic Sea is a shallow-water body and thus challenging. During the summer, a sound channel is present in the upper surface, which gives rise to an extended propagation distance. Isoveli is the prevailing situation in winter, which gives rise to shorter propagation distances. Thus, winter and summer have to be treated separately. Even if the acoustical situation is complex, a joint management of underwater sound requires common methodologies. One way to proceed is to employ standards.

4 Standards for Measuring Underwater Sound

For a comparison of results, it is vital to adhere to accepted standards. There are several attempts going on worldwide. The Netherlands, Germany, and the United Kingdom agreed on a terminology (Ainslie 2011). The American National Standards Institute (ANSI)/Acoustical Society of America (ASA) released a report (2009) that treats methodology for establishing ship signatures. The TC8 SC2 Joint Working Group of the International Organization for Standardization (ISO) is currently working on measurement standards of ships in deep water. Furthermore, the TC43 SC3 group deals with underwater acoustic terminology. However, these initiatives will not treat ambient noise, except for the terminology. Due to the present void, the BIAS project is developing standards/protocols for the measurement of ambient noise. The standards/protocols will treat the handling of sensors, handling of data, specification of sensor systems, and signal processing. The standards/protocols will include both definitions and check like lists for users to guide in the handling of sensors and data. Adhering to the standards will ensure that measurement, handling, and analysis, irrespective of user and sensor, are conducted in a standardized way. The standards/protocols will be used in the monitoring program and in the analysis of data.

5 Measurements

The focus of the first phase of the BIAS project is on measurements. One year after the start of the project, 40 sensors will be deployed in the Baltic Sea. The measurement period covers a full year and the sensors will be surfaced every third month and subsequently redeployed. There are a number of challenges related to deployments, for example, the northern and eastern regions that are covered by ice in winter and the shallowness of the Baltic Sea in combination with heavy fishing that results in a high risk to loose sensors.

Sensor positions have to be both “representative” from an acoustic point of view and chosen to minimize the risk of sensor loss. A scheme is presented here that makes use of the ship densities and special considerations. The aim is to find a representative position of the sensors, representative in the sense that the locally measured sound should characterize the trend of a larger area with significant accuracy. There are several factors that will come into play when choosing the positions, such

as shipping density, convergence/divergence of shipping lanes, depths, fishing activities, and areas of special interest. A starting point in the decision process is to make use of available information related to sound activities. Here, three consecutive steps are presented. In the first step, the annual ship passages (shipping density) at prespecified sections are established. In the second step, special areas are included, and in the final step, special considerations are made.

The annual density maps of shipping (including AIS and vessel monitoring system [VMS] data) are essential for the final positions. First, the shipping lanes, which will constitute candidates for the final sensor positions, are identified. An example is shown in Fig. 126.1 where the ship transects (not including fishing vessels) are shown for the Baltic Sea.

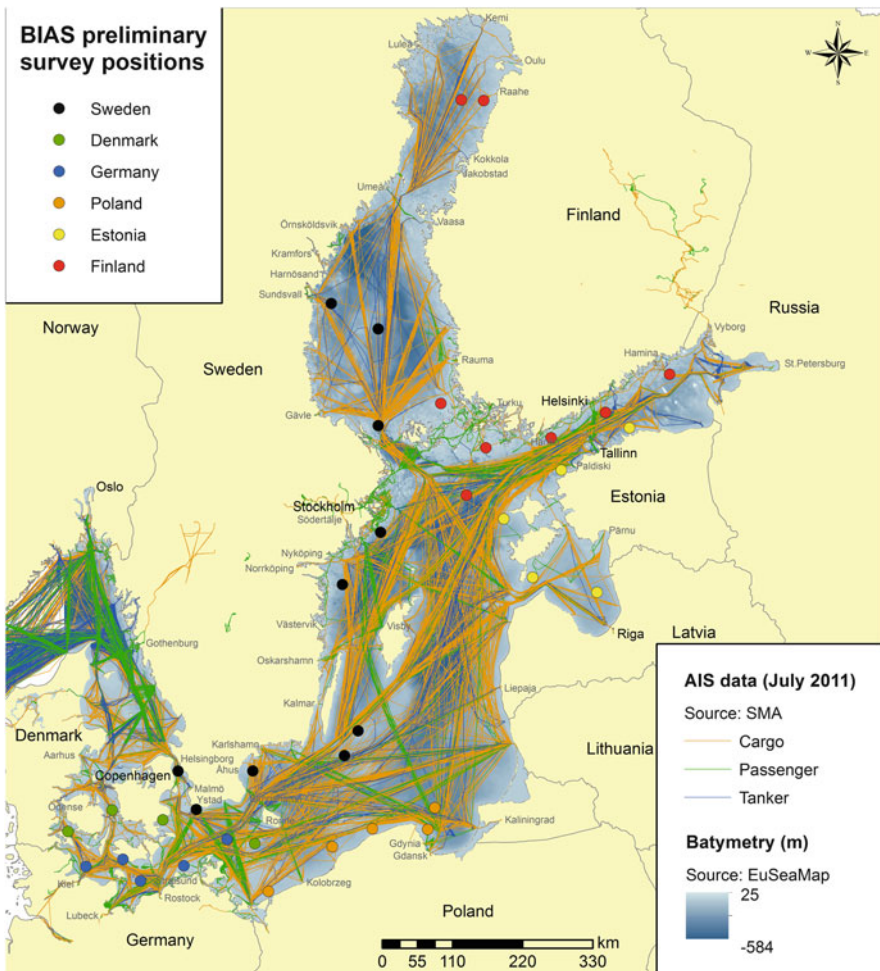


Fig. 126.1 Ship traffic in July 2011 at the major transects in the Baltic Sea. *Color of the lines indicates type of ship. Colored dots show the planned deployment positions*

It should be stressed that the density can change due to shipping lanes diverging or converging. The second step is to sort the lanes in density (passage) order, thereby obtaining a ranking list. A final sorting is done by dividing the shipping densities in the list into quartiles. The 25% quartile (Q1) of low shipping density is classified as minor shipping lanes. The shipping lanes falling above the 75% quartile (Q3) are classified as heavy shipping lanes and the rest as medium shipping lanes.

Depending on the number of deployed sensors, special areas may be included in the observational program. Marine reserves, Nature 2000 areas, dedicated areas with little or no industrial activity, and “potential silent areas” are examples of special areas. The final decision of their inclusion in the observational program depends on the number of sensors and the importance of the areas. When the final positions are established, special concern should be given to the nearby area of the positions. Information on fishing activities might be used to avoid a loss of sensors due to unwanted trawling events, which are normally done at low speeds (<6 kn). By establishing the trawling activities in the region, for example, by using VMS data, the areas to be avoided can be identified. If necessary, the position can be adjusted to an area with lower fishing frequency, thereby minimizing the probability of loss due to trawling (see Fig. 126.1). If feasible, the final position can be adjusted to a position nearby a shipwreck, which normally is avoided by fishers. Some of the acoustic sensors will be located in areas where stationary oceanographic monitoring systems (or other structures) are located. Care has to be taken, however, to avoid that the platform-generated noise does not adversely affect the performance of the acoustic sensors. It should be underlined that sediment properties (related to attenuation of sound) in an area can vary on a relatively short spatial scale as well as the vertical properties (sound profile). If possible, the final position should be on a location where the sediment and depth are representative for the area. The final BIAS project positions are shown in Fig. 126.1. The close vicinity to the Sea of Åland deployment is shown in Fig. 126.2. It should be noted that the fishing activities are restricted to certain areas.

6 Modeling

One of the aims of the BIAS project is to produce soundscape maps of the Baltic Sea. There are several reasons for making soundscape maps. First, they give valuable information on the spatial distribution. Second, they extend measured values to the whole sea. Third, they can be used to interpret the obtained results. This will also be valuable in year-to-year comparisons where, for example, a slight shift of a traffic lane will appear as an increase or decrease in sound levels. Finally, the modeling will be used for reducing the number of sensors. It cannot be assumed that the managing authorities will continue this extended observational program after the BIAS project ends. By then, using model results, the minimum required number of sensors and their positions will be established.

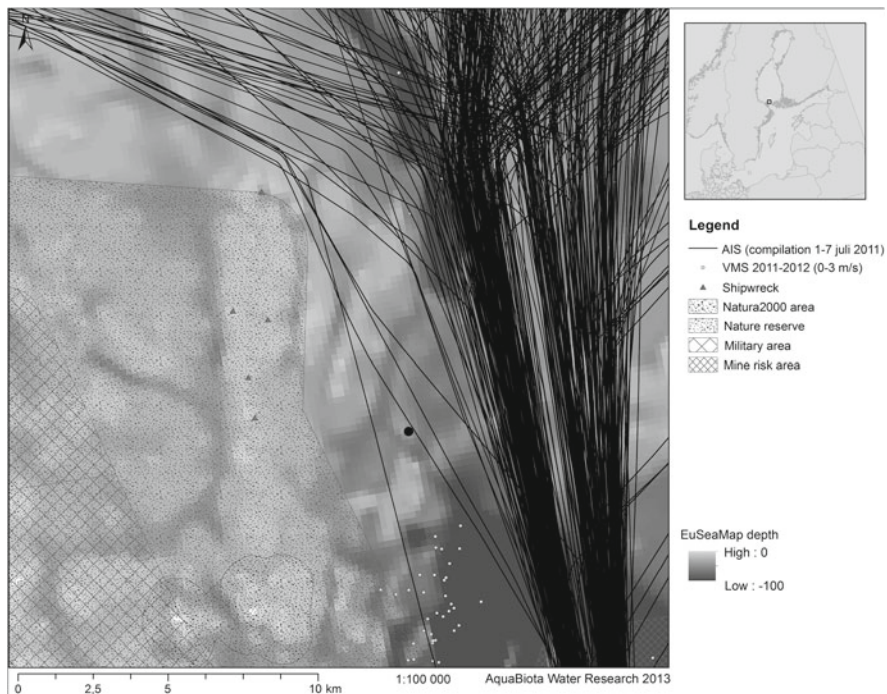


Fig. 126.2 Underwater acoustic measurements in the Sea of Åland in July 2011. Chart shows ship traffic as *black lines*. *White dots* show position of the fishing vessels (speed <6 kn). *Large black dot* is position of the acoustic sensor and triangles show ship wrecks

7 Quality Assurance

To ensure that the data and results are intercomparable and reliable, a quality-control system will be developed where quality assurance (QA) protocols will play a central role. This activity is closely related to the standards where guidelines are given on the handling of sensors, handling of data, and signal processing. By following the standards, the quality will be met, which the QA protocol will certify. An important aspect is to facilitate the reanalysis of data. The TSG-Noise group recommends that sound pressure levels and sound exposure levels be established. However, they do not rigorously define these quantities. Furthermore, we have to foresee that in the future new acoustic quantities will be of interest. It is, therefore, likely that a reanalysis has to be done. A too often occurring situation is that data cannot be reused due to lack of essential information, such as filter thresholds, tapering function, or even sampling rate. The QA protocols will ensure that full knowledge exist on sensors, data handling, and data processing and thus will allow for reanalysis of old data. The second reason for implementing QA protocols is to make cross-border comparison possible.

Underwater sound is likely to affect regions that are divided between different countries. Management of sound will, by its nature, involve several countries and it will be necessary to cooperate in managing the activity or the area. Here, an important requirement is that data are comparable. It is important to avoid situations when the same sea area is classified differently according to the noise level of neighboring countries.

8 End Products

To efficiently manage underwater sound in the Baltic Sea on a regional level, a number of tools will be developed. In the BIAS project, a regional registry will be established to handle impulsive noise according to the TSG-Noise group's recommendations. The BIAS project recommendation is to use International Council for the Exploration of the Sea (ICES) rectangles for spatial area for the Baltic Sea. This has the advantage that sound, fish, and mammals are dealt with on the same grid. A stock increase or decrease can thereby be correlated. To avoid double bookkeeping, a protocol will be used that uniquely identifies a sound event in the registry. A geographic information system (GIS)-based planning tool will be developed both for keeping track of the trend and for the soundscape map. This tool will be interactive and have a graphical user interface (GUI) that presents the prevailing sound situation. The tool will further be able to supply the present noise levels and the measure/modeled trend of a specific location. It will thus be possible to use the tool not only for now casting but also for forecasting. This feature is essential when traffic lanes are to be moved or when new offshore infrastructures are planned that will add noise to an already noisy environment.

9 Challenges

Establishing standards is not a task for an individual project but for an international organization. Still, the BIAS project has to be a forerunner due to the tight time plan that was decided by the European Commission. Even if the standards will be used internally, the BIAS project will deliver a recommendation of standards to the Baltic Sea member states at the project end. Establishing standards is a rather tedious and cumbersome process that aims for both consensus and acceptance. Thus, the BIAS project standards should be regarded as an interim solution that can be used as a starting point for an international group.

The aim to store data in a common data-sharing platform has shown to be unrealistic. Several of the Baltic Sea states have shown concerns in publishing acoustic data or even to share data between member states due to security reasons. The consequence is that the storing of data as well as the analysis will be done on a national level. This status makes a regional reanalysis problematic because it will require a request

to several countries that might be turned down due to lack of financing or time. This also highlights the importance of using standards. The data and processing techniques of other countries will have to fulfill a comparable set of standards, especially when the reanalysis is done.

Finally, there are as many opinions on “tools” as there are managers. To compile sometimes conflicting demands will be a challenge. We will hopefully be able to report on the outcome in a future paper.

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