Chapter 145
WODA Technical Guidance on Underwater Sound from Dredging

Frank Thomsen, Fabrizio Borsani, Douglas Clarke, Christ de Jong, Pim de Wit, Fredrik Goethals, Martine Holtkamp, Elena San Martin, Philip Spadaro, Gerard van Raalte, George Yesu Vedha Victor, and Anders Jensen

Abstract The World Organization of Dredging Associations (WODA) has identified underwater sound as an environmental issue that needs further consideration. A WODA Expert Group on Underwater Sound (WEGUS) prepared a guidance paper in 2013 on dredging sound, including a summary of potential impacts on aquatic biota and advice on underwater sound monitoring procedures. The paper follows a risk-based approach and provides guidance for standardization of acoustic terminology and methods for data collection and analysis. Furthermore, the literature on dredging-related sounds and the effects of dredging sounds on marine life is surveyed and guidance on the management of dredging-related sound risks is provided.

Keywords World organization of dredging associations (WODA) • Dredging • Noise • Marine mammals • Fish
1 Introduction

Covered by a number of regulatory frameworks and processes, including the EU Marine Strategy Framework Directive, underwater sound has also been identified by the Central Dredging Association (CEDA) as an issue that needs further consideration. Thus, in 2011, a CEDA Working Group on Underwater Sound (WGUS) was founded and published a position paper on underwater sound in relation to dredging (CEDA 2011). The paper received a great deal of attention from both within and outside CEDA. Based on the previous achievement, a World Organization of Dredging Associations (WODA) Expert Group on Underwater Sound (WEGUS) was established. The task of the WEGUS was to extend the previous achievements to a broader international audience and to provide a guidance paper on dredging sound, a review of impacts on aquatic biota, and advice on underwater sound-monitoring procedures (WODA 2013). Some key results from the paper are summarized here.

2 A Risk-Based Approach to Sound in Relation to Dredging

WODA recommends following a risk-based process in assessing sound-related impacts from dredging (see, for example, Boyd et al. 2008; Fig. 145.1). This will result in a more systematic approach to acoustic impact studies. With regard to risk
identification, it is advised to use an appropriate framework whereby risks can be divided into the categories of masking, response, temporary (TTS) or permanent (PTS) threshold shift, and injury (see Richardson et al. 1995). However, it is important to recognize that these impact zones are partially overlapping and are not simply related to distance between the source and the exposed organisms. Consideration must be given to the fact that the physiological effects are related to the dose of exposure, which also involves the duration of the impact (Southall et al. 2007). Physiological effects could potentially occur at sound pressure levels (SPLs) that do not cause a behavioral response if the exposure duration is sufficiently long.

For the exposure assessment, standardization of acoustic terminology is a prerequisite (see WODA 2013). It is easy to misuse the many different notations of underwater sound and make comparisons based on inconsistent decibel values. Great care must be taken in any reference to inferred SPLs based on the source strength and the distance between the source and the observation location. The underwater sound distribution should be described using underwater acoustic models supported by empirical field data to the fullest extent practical.

With regard to the characterization of dredging sounds, progress is being made and a lot more is known now than some years ago. Dredging sounds can be associated with sediment excavation, propulsion of dredging vessels during transport, and dredged material placement. A given project may involve one or more of four basic types of dredgers: cutter suction dredger, trailing suction hopper dredger, grab dredger, and backhoe dredger. Sound sources associated with different types of hydraulic and mechanical dredge processes can be very manifold (Fig. 145.2). Very detailed measurements on a number of trailing suction hopper dredgers have been performed. Information on grab and backhoe dredgers has become available as well. Existing data indicate that source levels associated with most dredging processes are generally comparable with those of merchant ships, with the exception of

Fig. 145.1 Overview of the risk-based approach to investigate sound-related risks
Elevated levels of noise generated by gravel extraction (de Jong et al. 2010; Robinson et al. 2011; Reine et al. 2012a, b). Despite an increased knowledge of dredging sounds, we do not yet have a complete understanding of acoustic emissions from dredging because not all sources that are shown in Fig. 145.2 are covered and measurements are still not fully standardized. Looking at the receptor organisms, it is necessary to define the population that will be subject to the sound exposure. This, however, is very challenging due to variability in population estimates (Thomsen et al. 2011).

One remaining key challenge is the dose-response assessment, i.e., the assessment of the relationship between the properties of the received sound and the effects that it has on marine life. Metrics other than overall dose in terms of the cumulative sound exposure level (SEL) may also be relevant for the physiological effects (e.g., peak sound pressure, rise time, kurtosis), but data confirming such effects are lacking. Behavioral effects are usually related to the SPL for a stated averaging time (either the duration of the transient signal or a “long-term” average for ambient sound). Results from studies investigating the effects of sound on marine mammals, fish, and other aquatic life are, to date, highly equivocal. Some cetaceans have been observed avoiding areas of dredging activity on a temporal basis (reviewed by Richardson et al. 1995 and a recent study by Diederichs et al. 2010). No peer-reviewed information exists about the effects of dredging-induced sound on seals or fish.

Fig. 145.2  Sound sources for main dredger types
Due to the above uncertainties, risk characterization and the management of risks related to the dredging sound are challenging. It is clear that the dredging sound has the potential to impact aquatic life, and it is assumed that most of these impacts would concern disruption of communication due to masking or alteration of behavior patterns. Cumulative and long-term exposures leading to TTS have to be considered, at least for marine mammals (Kastelein et al. 2012), although PTS or other auditory injuries are unlikely. If the assessment concludes that there is a high risk of an adverse effect, the risk management could involve mitigation measures. OSPAR (2009) identified several options including technical and operational ones. One very effective sound-mitigation measure might simply be adequate maintenance of the dredge plant, including lubrication and repair of winches, generators, propulsion components, and other potential sources, because well-maintained dredgers are much less likely to be “loud” dredgers. The WODA advice is to identify, assess, and manage the risk following the framework outlined above. In conclusion, assessments of dredging sound-induced impacts may require different approaches depending on the organisms and effects of concern and the type and location of the project.

Acknowledgments  Technical guidance was provided by the World Organization of Dredging Associations (WODA), which consists of three independent professional associations: the Central Dredging Association (CEDA) serving Europe, Africa and the Middle East; the Eastern Dredging Association (EADA) serving the Asian and Pacific regions; and the Western Dredging Association (WEDA) serving the Americas. The three associations are nonprofit organizations dedicated to the exchange of knowledge and information related to dredging, navigation, hydraulic engineering, and construction. We are very grateful for the logistical support of the WODA Expert Group on Underwater Sound (WEGUS) meetings and in the finalization of the paper. We are especially grateful to Anna Csiti for her tremendous support throughout our work.

References


OSPAR (2009) Overview of the impacts of anthropogenic underwater sound in the marine environment. OSPAR convention for the protection of the marine environment of the North-East Atlantic. Available at www.ospar.org


