Possible Approach to amend Decision 2010/477/EC

Descriptor 11: Energy, including underwater noise

Author	Version	Date
Milieu	V1	23.05.2014
Mark Tasker	v2 draft (taking account of D. Connor suggestions)	15 July 2014
Mark Tasker	v3 draft; new text in Part 2	24 July 2014
Mark Tasker	v4 draft, accommodating MAAx3, RL, VP, JP, FTx2, MA, RD comments,	1 September 2014
Mark Tasker	v5 responding to comments from Germany, RD, MC, RL	27 September 2014
Mark Tasker	v6 responding to comments from TG Noise, Germany (per Andrea Weiss), Nicolas Entrup (on behalf of the International Fund for Animal Welfare, Marine Conservation Society, Natural Resources Defense Council, OceanCare, Whale and Dolphin Conservation), CEDA, France and comments during the January 2015 cross-cutting workshop in Copenhagen	30 January 2015
Mark Tasker	v7 responding to comments from Germany (per Maria Boethling) and Netherlands (René Dekeling, Niels Kinneging, Sandra van der Graaf)	16 March 2015
Mark Tasker	v7.1 taking account of late comments on v5 (sic) by David Connor received 17 March	18 March 2015
René Dekeling	v8 based on discussion in WG GES, and written comments received from Oceancare, Germany, Spain and UK	3 June 2015

This document on the possible approach to amend Decision 2010/477/EC for Descriptor 11: Energy, including underwater noise, is based on an document presented by TG Noise (version 7) to the CIS WGGES meeting in April 2015.

During the WGGES meeting various participants made further comments on the document. The meeting agreed that these comments should be reflected in a new version of the document (version 8). The comments have been added to the manual to show potential options and have been included without further consultation with TG Noise. The comments have been added with no consideration of the relative importance of the issues raised, compared to the previous version (version 7) of the document.

Descriptor 11; Energy, including underwater noise

Title of Descriptor

Good Environmental Status for Descriptor 11: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

Approach

General approach to version 8 of the Manual

Work on this manual which provides advice for the review of the Commission Decision on indicators of Good Environmental Status started in 2014. The Technical Group on Noise of the MSFD CIS (TG Noise) provided technical advice (via ICES) on the current review by the Commission of their Decision, using the 'Manual' (based on a standard template). The first main drafts of the Manuals were considered by the higher level EU working group WG-GES last year, and comments were invited on these Manuals.

A "cross-cutting" workshop was held in January 2015 to deal with issues common to several or all indicators. Following receipt of the comments and the workshop outcomes, a draft version 7 was made of the Descriptor 11 Manual. Further guidance was received from the Commission/DG Environment in relation to issues where there was not agreement in relation to comments received. In those cases, the issue was to be noted and referred upwards for resolution further on in the European process. Therefore, next to version 7 of the Manual, an 'Unresolved Issues' document was provided.

In the March 2015 meeting of WG GES, version 7 of the Manual was discussed in the meeting of WG GES. It was suggested that the current version did not sufficiently reflect comments of a number of Member States/stakeholders, that the decription of the use of the precautionary principle was not consistent with the report of the cross-cutting issues workshop (which was not available when version 7 was drafted) and explicit mention should be made of resolutions of international agreements (e.g. CBD). Therefore TG Noise was requested to come with a new version. That task was taken up, aiming for a new version that would address the different concerns of all parties concerned, noting that:

1. In the 2014 meeting of WG GES, MSCG and MD, TG Noise advised that initiating actual monitoring of current indicators should be a priority, and the view of TG Noise was that this is generally accepted as main priority;
2. Monitoring of underwater noise should be done in such a way that it is future proof;
3. As explained by the Commission during WG GES, when implementing monitoring, Member States have some freedom (flexibility), but minimum standards should be met;
4. The scope of the Manual is to provide guidance on criteria to determine GES, and at this stage TG Noise cannot advise on concrete targets and such advice will therefore not be part of this Manual.

For this new version, comments received after WG GES (of which some had been sent in an earlier stage) were reviewed and where possible taken over. The main unresolved issues/needed choices are mentioned in this document and not, as in the earlier version, (only) mentioned in an unresolved issues document; although that previous way of working was as requested, this implied that the Manual alone did not provide complete description of the discussion that was held or was still ongoing.

Definition of the Descriptor

There are many kinds of anthropogenic "**energy"** that human activities "**introduce"** into the marine environment including sound, light, other electromagnetic fields, heat and radioactive energy. Energy inputs can occur at many scales of both space and time. To date the main focus of the Member States in their approach to Descriptor 11 has been on sound (noise when it becomes a problem). In the context of the Marine Strategy Framework Directive, radioactivity is considered as a property of a hazardous substance, not as an 'energy'.

"**Underwater noise**" is defined as anthropogenic sounds which may be of short duration (e.g. impulsive such as from seismic surveys and piling for wind farms and platforms, as well as explosions) or long lasting (e.g. continuous such as dredging, shipping and energy installations). These can affect marine species in different ways. Species that are exposed to noise may be adversely affected over a short time-scale (acute effect) or a long time-scale (permanent or chronic effects). Adverse effects may be both physiological and behavioural and range from subtle (e.g. temporary harm to hearing, behavioural effects) to obvious (in the worst case, death).

The term "**level**", as used in the MSFD Annex I and in relation specifically to underwater noise, is taken in a wide sense not only to describe sound pressure levels but also other features of sound (such as the degree of its spatial and temporal distribution).

Most commercial activities entailing high noise levels which affect relatively broad areas of sea are executed under regulated conditions subject to a licence. There is some variation in the degree to which commercial activities are subject to a licence between Member States, and where activities are subject to licensing there is variation about including emissions of underwater noise. Unlike chemical pollution, noise does not persist in the environment. Thus, if the source of noise is reduced, the amount of noise energy in the water is immediately lowered. There have been very few studies of long-term changes in levels of underwater noise in the oceans. Several studies, all in the north-east Pacific Ocean, suggest that there was a 10 dB increase in offshore marine ambient noise in the 10-50 Hz range during the last 35 years of the 20th century, attributed primarily to increases in commercial shipping traffic[1]. Although these findings need to be verified for European waters, human activities, including shipping, pile-driving and seismic surveys, have changed marine soundscapes not only in deeper waters but also in coastal areas, and the consequences for ecosystems are uncertain[2]. Despite a continuing increase in the number of ships worldwide, it is not known whether ambient noise levels at these frequencies continue to increase; there are probably differences between different regions, not only levels but also in trends. There is no knowledge of changes in ambient noise level in European waters, but lacking evidence that ships and piling have become drastically quieter, it can be assumed that if these activities are increasing, noise levels are likely also increasing.

Linkages with existing relevant EU legal requirements, standards and limit values

[1] Andrew, R. K., Howe, B. M., Mercer, J. A., & Dzieciuch, M. A. (2002). Ocean ambient sound: comparing the 1960s with the 1990s for a receiver off the California coast. Acoustics Research Letters Online, 3: 65-70.
McDonald, M. Hildebrand, J. and Wiggins, S. 2006. Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California. Journal of the Acoustical Society of America, 120: 711-718.

[2] Merchant, N.D., Pirotta, E., Barton, T.R., Thompson, P.M. Monitoring ship noise to assess the impact of coastal developments on marine mammals. Marine Pollution Bulletin 78 (2014) 85-95.

In 2011, JRC identified that "there are no methodological standards available within the framework of European or international conventions relevant to Descriptor 11"[3].

The non-binding European Commission Guidelines for the establishment of the Natura 2000 network in the marine environment[4] consider noise as a source of pollution that affects the marine environment and biodiversity. The guidelines identify several sources of underwater noise pollution, including the propeller and machinery noise of ships. Member States need to regulate such-noise generating activities in accordance with the provisions of the Habitats Directive if they are likely to have significant effects on protected features in Natura 2000 sites or on species strictly protected as listed in Annex IV, including cetaceans.

The work at EU level is coordinated by the **Technical Group on Noise** of the MSFD CIS (TG Noise) for further development of Descriptor 11 Noise/Energy, noting that for issues related to defence or national security (e.g. military sonar), implementation of the MSFD is a national responsibility.

Linkages with international and RSC norms and standards

Pursuant to the United Nations Convention on the Law of the Sea (**UNCLOS, 1982**), there are general duties to protect marine biodiversity (including marine mammals) and prevent, reduce and control pollution "from any source". The Convention defines "pollution of the marine environment" as "the introduction by man, directly or indirectly, of substances of or energy into the marine environment, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities." As a form of energy, the introduction of sound (and other forms of energy) falls under the definition of pollution of the marine environment contained in the UNCLOS and most relevant regional instruments.

Additionally, several international conventions, such as the **UN Convention on Migratory Species (CMS**) and its daughter agreements, recognise underwater noise, including noise from shipping, as a potential threat to marine species and confirmed the need for limitation of harmful underwater noise; CMS resolution 10.24 a.o. recommends the adoption of Best Available Techniques (BAT) and Best Environmental Practice (BEP) and encourages Parties to integrate the issue of anthropogenic noise into the management plans of marine protected areas (MPAs) where appropriate.[5].

Of the regional agreements made under the framework of CMS, **ACCOBAMS** (Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area) and **ASCOBANS** (Agreement on the Conservation of Small Cetaceans in the Baltic, North East Atlantic, Irish and North Seas) have a joint Working Group that addresses underwater noise in order to ensure the best possible advice is generated for the Parties on the topic. ACCOBAMS has adopted Resolution 4.17 (Guidelines to address the impact of anthropogenic noise on cetaceans in the ACCOBAMS area).

In the **Convention on Biological Diversity** Decision ~~XI/18 A~~ XII/23 of 2014 governments are encouraged to take appropriate measures… to avoid, minimize and mitigate the potential significant adverse impacts of

[3] Piha, H and Zampoukas, J. 2011. Review of Methodological Standards Related to the Marine Strategy Framework Directive Criteria on Good Environmental Status, JRC. Available at: http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/16069/1/lbna24743enn.pdf
[4]European Commission 2007. Guidelines for the establishment of the Natura 2000 network in the marine environment. Application of the Habitats and Birds Directives. Available at: http://ec.europa.eu/environment/nature/natura2000/marine/docs/marine_guidelines.pdf
[5] Convention on Migratory Species/UNEP/CMS/Resolution 10.24- Further steps to abate underwater noise pollution for the protection of cetaceans and other migratory species. Adopted by the Conference of the Parties at its Tenth Meeting (Bergen, 20-25 November 2011). Available at http://www.ascobans.org/sites/default/files/document/AC19_7-07_CMS_Res10-24_UnderwaterNoise_1.pdf

anthropogenic underwater noise on marine and coastal biodiversity. A series of actions are proposed including specific research into species and sound sources, developing/transferring quieter technologies, combining acoustic and habitat mapping, utilising spatio-temporal management, conducting impact assessments, considering thresholds and standardizing metrics and sound measurements.

The Scientific Committee of the **International Whaling Commission (IWC)** has been considering the issue of underwater sound for more than a decade. At its 2008 meeting the Scientific Committee endorsed a reduction target in the contribution of shipping to ambient noise levels in the 10-300 Hz range by 3dB in 10 years and by 10 dB in 30 years relative to current levels; at this moment, this proposal for a target from this advisory body has not been taken over in a formal IWC resolution.

The International Convention for the Prevention of Pollution From Ships **MARPOL** (73/78) only defines pollution in terms of introduction of 'substance' and not 'energy'. At **IMO** level, in October 2008, based on a proposal by the United States, the IMO added "Noise from commercial shipping and its adverse impact on marine life" as a high priority item to the work programme of its Marine Environment Protection Committee (MEPC). In 2014, the MEPC approved Guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life, recognising that underwater noise radiating from commercial ships may have both short- and long-term negative consequences on marine life.

The BIAS project in the Baltic Sea region is developing a common methodology for measuring acoustic data. In the **HELCOM** Initial Holistic Assessment (HELCOM 2010) the impact of noise was assessed using a 4-level indicator system and identified noise as "other physical disturbance": level 1 indicates that the noise is audible to biota; level 2 indicates that masking of communication occurs; level 3 indicates an avoidance reaction; and level 4 indicates physiological impacts. Level 1 and 2 were considered relevant for the major part of the Baltic Sea area at this time. The indicators are being considered for HELCOM Coreset II.

Currently, no **OSPAR** Contracting Party has incorporated noise into any permanent monitoring programme[6]. In 2009, the OSPAR Commission considered an overview document on the effects of man-made underwater noise on marine life and in its core part documented the effects of sound from human activities on marine life. The OSPAR QSR 2010 also considers the negative effects of anthropogenic underwater noise. The ambient noise indicator (11.2.1) is a (priority) candidate indicator; in 2014 the OSPAR Commission decided that the impulsive noise indicator (11.1.1) was sufficiently developed and was accepted as common indicator (for all OSPAR areas).[7] An OSPAR working group (ICG Noise), co-working with ICES, has developed a proposal for an impulsive noise registry that would be managed by ICES and could become operational in 2015/2016; for one (sub)region, a proposal was made for a **joint** ambient noise monitoring programme, but at this stage there is no agreement on funding this programme and it is not likely to be operational in time to contribute to the OSPAR 2017 Intermediate Assessment.

Underwater noise has yet to be addressed by either the **Barcelona** or the **Bucharest Conventions**, but a proposal has been submitted for a basin wide strategy for monitoring (see further on).

Definition of GES

The energy descriptor is primarily a 'pressure' descriptor. This largely means that if GES is to be achieved, the introduction of energy should not compromise the achievement of GES for marine species (as covered

[6] MSFD Advice Manual and Background document on Good environmental status - Descriptor 11: Underwater noise, 2012
[7] OSPAR 14/21/1-E, Summary Record of the Meeting of the OSPAR Commission (OSPAR) of 23-27 June 2014

under Descriptors 1, 3 and 4). In its report published in February 2012, TG Noise made an analysis and provided a number of recommendations with regards to methodological standards and possible threshold values to be used for impulsive sound (indicator 11.1.1) and continuous low frequency noise (indicator 11.2.1); in the report published in 2014 TG Noise suggested possible use of the data for impulsive noise to decide whether GES is reached or not, and identified further steps needed, of which establishing knowledge how displacement affects a species at the population level is a priority topic. Currently there is much international effort directed at obtaining improved information on population effects, both from military funded research on the effects of sonar, and from research aimed at characterising the effects of offshore wind energy, e.g. the PCoD and DEPONS projects. Modelling and risk assessment tools are available that can provide a high level of detail, e.g. mapping the areas where thresholds may be exceeded by noise generating activities. Using this approach an update of the assessment of the marine environment (e.g. the OSPAR 2017 Intermediate Assessment) may well be possible, at least for some well studied species as harbour porpoises.

For ambient noise, TG Noise concluded that even if information on actual trends and levels would become available by monitoring, much greater understanding of the relationship between the environmental pressure caused by ambient noise and the state of the ecosystem is still needed before GES can be understood and a target can be set for indicator 11.2.1.

The "climate sensitivity" for D11 (or criteria/indicators)

Descriptor 11 is not directly climate sensitive but climate related issues might affect this descriptor. The increase in atmospheric levels of CO_2 not only results in atmospheric climate change but also in ocean acidification, and an increase in sea surface temperature. It has been claimed that the acidification of marine waters could potentially increase the propagation range of underwater noise[8][9] which effect would make the ocean noisier, with biological impacts e.g. on the behaviour of marine mammals. However, additional physically-based analyses indicate that the problem seems unlikely to be significant[10][11]. Seasonal variations in sea surface temperature (and possibly of water stratification) have been proposed as an explanation of observed seasonal cycles in the amplitude of ambient noise in the frequency range 25 Hz to 50 Hz[12]. While this link requires further investigation, if confirmed, it has implications for long term trends: specifically, a long term increase in sea surface temperature would result in a corresponding *decrease* in expected deep water ambient noise on a global scale, partly compensating for the increase expected due to increased shipping[13]. Such changes would apply to the propagation of both 'natural' and anthropogenic underwater sound. As can be seen, there is no certainty about the overall effects of climate change on the transmission of underwater sound.

[8] Hester, K. C., Peltzer, E. T., Kirkwood, W. J., and Brewer, P. G. 2008. Unanticipated consequences of ocean acidification: A noisier ocean at lower pH. Geophysical Research Letters 35, L19601.

[9] Ilyina T, Zeebe RE, Brewer PG (2010) Future ocean increasingly transparent to low-frequency sound owing to carbon dioxide emissions. Nature Geoscience 3: 18-22.

[10] Reeder, D.B. and Chiu, C.-S. 2010. Ocean acidification and its impact on ocean noise: phenomenology and analysis. Journal of the Acoustical Society of America 128 Express Letters 137-143. DOI: 10.1121/1.3431091.

[11] Joseph, J.E., Chiu, C.-S. 2010. A computational assessment of the sensitivity of ambient noise level to ocean acidification. Journal of the Acoustical Society of America 128: Express Letters 144-149.

[12] Ainslie, M.A. 2013. Periodic changes in ambient noise: possible causes and implications for long term prediction. In 1st International Conference and Exhibition on Underwater Acoustics. pp 655-662.

[13] Ainslie, M. 2012. Potential causes of increasing low frequency ocean noise levels. In Proceedings of Meetings on Acoustics, 12: 070004. Acoustical Society of America.

Results of the Article 12 assessment (incl. in depth assessment)

Descriptor

A total of fifteen Member States (MS) have defined GES at descriptor level and according to MSFD Annex I whilst five MS have not defined GES for underwater noise. All MS who have defined GES for D11 have used different approaches. In addition the definitions provided appear to have been based on different interpretations (in some cases mistranslations) of the 2010 Commission Decision. Two MS provided a definition of GES that was a copy or very similar to that provided in Annex I of the MSFD. Three MS included threshold values in their definition. In addition to underwater noise, one MS included also other forms of energy in their definition, and identified them as light, electromagnetism and changes in temperature. One MS reported an elaborate GES definition, stating that GES is achieved when the abundance, mortality risk and communication behaviour of sensitive species is not affected by underwater noise.

Criteria

Eleven MS have included the criteria provided in the Commission Decision 2010/477/EU although a few MS did not make use of both criteria or did not differentiate clearly between them, or. provided a GES definition that was not or only roughly in line with the definitions as provided in the Commission Decision.

Indicators

Not all MS applied the indicators as provided in the Commission Decision. At indicator level, only two MS have included details as specified in the Commission Decision.

Regional coherence descriptor

Although the limited development of the GES definitions by most MS could provide an opportunity to achieve a high level of regional coherence, in the North-east Atlantic and Baltic coherence was assessed as low and in the Mediterranean as moderate. Neither of the Black Sea MS defined GES for Descriptor 11.

MS good practices

Three MS have provided threshold values, meaning that the other definitions are all qualitative. One MS specifically mentions in their GES definition other forms of energy, namely, emission of light, other electromagnetic fields and heat.

Analysis of the current text of the Decision

- **Criteria to be kept in the Decision, in accordance with the mandate provided by the Directive**

The following two Criteria are clearly the operative part of the Commission decision and should be kept, but see below for improvements in wording to remove ambiguities, and options how these criteria could be further developed/adapted.

11.1. Distribution in time and place of loud, low and mid frequency impulsive sounds

— Proportion of days and their distribution within a calendar year over areas of a determined surface, as well as their spatial distribution, in which anthropogenic sound sources exceed levels that are likely to entail significant impact on marine animals measured as Sound Exposure Level (in dB re 1µPa 2.s) or as

peak sound pressure level (in dB re 1µPa peak) at one metre, measured over the frequency band 10 Hz to 10 kHz (11.1.1)

11.2. Continuous low frequency sound

— Trends in the ambient noise level within the 1/3 octave bands 63 and 125 Hz (centre frequency) (re 1µPa RMS; average noise level in these octave bands over a year) measured by observation stations and/or with the use of models if appropriate (11.2.1).

- **Recommended improvements to wording of Criteria**

Indicator 11.1.1. **Distribution in time and place of loud, low and mid frequency anthropogenic impulsive sounds.** TSG Noise noted (van der Graaf et al. 2012) that the current Commission Decision of Indicator 11.1 is not unambiguous, and there is a need for an explanation as to how it should be interpreted. TSG Noise (Dekeling et al. 2014b) therefore defined "impulsive" in this context as including all sounds of duration less than 10 seconds and recommends improving Indicator 11.1.1 to:

The proportion of days and their distribution within a calendar year, over geographical locations whose shape and area are to be determined, and their spatial distribution in which either the monopole energy source level (in units of dB re 1 µPa² m² s*), or the zero to peak monopole source level (in units of* dB re 1 µPa m*) of impulsive anthropogenic sound sources, measured over the frequency band 10* Hz *to 10* kHz*, exceeds a value that is likely to entail significant impact on marine animals (11.1.1).*

It has to be noted that for some sources (notably pile driving) it will be difficult to determine a 'monopole source level', and in the register as set up now (based on TG Noise guidance) other options to characterize sources are given. This is likely sufficient to use the data in an assessment.

Indicator 11.2.1. **Continuous low frequency anthropogenic sound** There has been some variation in the understanding of the terminology surrounding the complex issue of underwater sound and its effects. TSG Noise (van der Graaf et al. 2012) therefore defined the terms used in Indicator 11.2.1.

- **Trends:** the Oxford Dictionary defines 'trend' as 'general direction in which something is developing or changing'. Following this, 'trend' refers to year-to-year (or longer) changes in ambient noise levels.
- **Average noise level:** TSG Noise realised that the term 'average noise level' is not unambiguous; there are different methods to establish a value for an average that are all correct, but lead to different values. TSG Noise recommended defining 'average noise level' as 'average of the squared sound pressure', since this definition is robust to changes or differences in the duration of individual time samples.
- **Use of models:** Measurements are considered essential to ground-truth models. The use of models can strengthen analyses by, for instance, addressing bias introduced by the variability of the spatial distribution of human pressure, and by the natural variability of the environment, and to extend the results of monitoring to poorly or uncovered areas.

Based on these points, TSG Noise recommended improving Indicator 11.2.1 to:

Trends in the annual average of the squared sound pressure associated with ambient noise in each of two third octave bands, one centred at 63 Hz and the other at 125 Hz, expressed as a level in decibels, in units of dB re 1 µPa*, either measured directly at observation stations, or inferred from a model used to interpolate between or extrapolate from measurements at observation stations.*

TG Noise did not regard these recommended changes as adding any burden to the process of implementing MSFD, but they should ensure further clarity and help ensure that Member States do not vary in their understanding of the indicators.

The choice of the 63 Hz and 125 Hz bands (as initially proposed in 2010 by Task Group 11, see Tasker et al. 2010) was based on monitoring the contribution of shipping to ambient noise. The use of (only) these two frequencies has been discussed in (a.o.) the TG Noise, and there have been suggestions to add additional frequencies, and restricting monitoring to these two frequencies has been criticized by (e.g.) Oceancare.

In the BIAS project it was decided that next to the two MSFD bands, the 2 kHz third octave band would be monitored, being more representative for hearing of sensitive species. Initial results of the BIAS project indicate that part of the shipping in the Baltic Region emits noise in a wider (higher) band. No concrete results have been published at this stage.

In the proposal made for a ambient noise monitoring strategy for the North Sea, made by the OSPAR ICG Noise (and which was accepted by the OSPAR EIHA committee as formal OSPAR Guidance)[14], it was suggested that there was no clear benefit monitoring outside the range of 10 Hz to 1 kHz, suggesting (based on a modelled sound map) that in the North Sea the contribution of shipping noise above 1 kHz would be small compared to natural sources.

In a proposal made in the context of the Ecosystems Approach (EcAp) initiative, as implemented in the framework of the Barcelona Convention, a proposal was made for a basin-wide strategy for underwater noise monitoring in the Mediterranean. The proposed strategy on noise monitoring (which is based on the TG Noise monitoring guidance (Dekeling et al. 2014a,b,c)) recommends several adaptations for the Mediterranean case[15]. Next to the two present frequency bands, other frequencies have been proposed based on bio-acoustical properties of key marine mammal species of the Mediterranean, i.e. the fin whale, the sperm whale and the Cuvier's beaked whale. At this stage it is not clear whether the monitoring strategy will be implemented as proposed.

In a scientific workshop organized with support of the International Whaling Commission in Leiden, The Netherlands, in 2014, it was suggested that one third octave bands in the range of 10-1000 Hz should be covered when making sounds maps[16]. If this suggestion were followed, the MSFD frequency bands would be covered on a wider scale and (part of) this advice can be used to align efforts in North America and the EU, but this is a significant extension of the Commission Decision.

[14] Snoek, R.C., Ainslie, M.A., Prior, M.K., Van Onselen, E., Ambient noise monitoring strategy and joint monitoring programme for the North Sea-Part I: monitoring strategy ambient noise, OSPAR document EIHA 15/5/7 Add.1-E, 2015

[15] Achieving underwater noise regulation through an ecosystems-based approach: the "Mediterranean strategy on Underwater Noise Monitoring" Maglio, A., Pavan, G., Castellote, M., Salivas, M., Descroix-Comanducci, F., OCEANOISE 2015, Vilanova y la Geltrú, Barcelona, 2015

[16] International Whaling Commission, Joint workshop report: Predicting sound fields- global soundscape modelling to inform management of cetaceans and anthropogenic noise, 15-16 April 2014, Leiden, The Netherlands

With the information available at this stage, **TG Noise cannot provide one agreed advice** on the inclusion of an option for monitoring concrete additional frequency bands. The following considerations are relevant:

- There is agreement that monitoring should become operational as a priority, to enable assessments and setting concrete targets;
- Monitoring additional frequencies will increase the cost to some extent and thus may delay implementation of monitoring, and some MS have indicated that the initial focus should be on the present two frequency bands;
- For the longer term, decisions made on any monitoring programme need to be robust, in that sense that options remain to adapt or extend monitoring programmes in a cost-effective way, the programmes should be 'future-proof'. TG Noise itself suggested that MS should consider covering a wider frequency band (10 Hz to 20 kHz) in the measurements, and potentially in analysis, and so extending the knowledge base;
- The present frequencies are relevant to characterize shipping, the dominant source of continuous low frequency noise in many regions;
- Other frequencies may be more relevant for biota, e.g. lower frequencies for baleen whales, higher frequencies for toothes whales.

The conclusion at this stage is that, in general, there is consensus that the present indicators should be kept; there is **no consensus** whether additional frequency bands should be chosen, and if so, which frequency bands would be most appropriate. A practical solution could be that the option to include monitoring other bands in (sub)regions is included in either a new Comission Decision, or in additional guidance provided by the Commission, RSC-committees or TG Noise. The approach taken in the BIAS project (to investigate monitoring other frequencies) should be repeated in new initiatives so that relevance of other frequency bands can be confirmed parallel to monitoring present frequency bands. This would be consistent with the requirement in MSFD article 11-1 that monitoring programmes should be compatible within marine regions or subregions. The choice to include other bands would then still be for MS cooperating in a region, formally they would not be obliged by the CD to include other bands.

- **Explicative text**

The following part of the Decision provides explanation on the scope of the Descriptor, broadening to include other forms of energy. If not covered by the criteria or indicators, such information is not really necessary in the Commission Decision and may lead to confusion as to whether it should be addressed or not (but see consideration under 'Proposals for new criteria (including other topics than noise) not yet covered', below, related to new criteria other forms of energy).

Together with underwater noise, which is highlighted throughout Directive 2008/56/EC, other forms of energy input have the potential to impact on components of marine ecosystems, such as thermal energy, electromagnetic fields and light.

- **To be taken out of the Decision and included in guidance**

The following part of the Decision could be taken out as it constitutes guidance for assessment methodologies of underwater noise (but it should be noted that some parties preferred to keep this text within the Decision):

At the current stage, the main orientations for the measurement of underwater noise have been identified as a first priority in relation to assessment and monitoring subject to further development, including in relation to mapping. Anthropogenic sounds may be of short duration (e.g. impulsive such as from seismic surveys and piling for wind farms and platforms, as well as explosions) or be long lasting (e.g. continuous such as dredging, shipping and energy installations) affecting organisms in different ways. Most commercial activities entailing high level noise levels affecting relatively broad areas are executed under regulated conditions subject to a licence. This creates the opportunity for coordinating coherent requirements for measuring such loud impulsive sounds.

If it chosen to keep this guidance in the Decision, TG Noise can make an update/improvement.

Conclusions (part I):

- Redrafting of the Criteria will make them unambiguous but not change any actions or burden on Member States.
- Monitoring or registering of underwater noise has been very limited to date, resulting in a lack of available data on which to base recommendations. Starting monitoring of the existing indicators should have priority.
- There is no general consensus on monitoring additional frequency bands for continuous noise; validation of the need for monitoring additional frequency bands should have priority.
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- Further research on the effects of the introduction of all forms of energy, including sound, into the marine environment is still needed.
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Part II

GES criteria (in accordance with Art. 9.3)

- Proposal to combine criteria.

There is no proposal to combine criteria.

- GES boundaries defined according to limit values.

As noted above, three Member States included threshold values for the emission of sound in their definitions of GES relevant to Indicator 11.1.1. Such values apply mainly to certain individual activities in the waters of those Member States and aim to protect certain sensitive species. Such values have not been discussed by TG Noise and do not account for the cumulative effects of exposure to underwater noise. Further work is required in order to be able to better quantify and understand the phrase *"…likely to entail significant impact on marine animals"* whether in relation to individual or cumulative impacts of underwater sound. There are, at present, no clear links between pressure and state responses of underwater noise that would allow clear boundaries or thresholds to be set for either Indicator 11.1.1 or 11.2.1.

In January 2015 a meeting on 'cross-cutting issues' was held in Copenhagen at ICES. In this meeting the use of 'maximum acceptable levels of pressures in the marine environment' to provide a proxy of GES was discussed; the use of 'acceptable pressure levels' was seen as useful when the relation between pressure and impacts was known, but for pressure like litter (D10) and underwater noise (D11), because of the limited scientific understanding of impacts, it was suggested that setting precautionary pressure levels might be the only feasible option at present.

The monitoring guidance provided by TG Noise also discussed setting targets when there was insufficient knowledge, and concluded that the use of trend-based targets could be used (e.g. a downward or non-increasing trend) in line with the precautionary principle.

Whether a (precautionary) target is based on an 'acceptable pressure level' or is a trend-based target, the absence of data on levels and trends of both impulsive and ambient noise would make it difficult at present to define and/or to validate any concrete target. The initiation of actual monitoring of both impulsive and ambient noise therefore remains essential to enable verifying any target, and was identified as priority in the November 2014 TG Noise progress report (Dekeling et al. 2014d). If the pressure indicators on underwater noise are to be clearly linked to Good Environmental Status then it will also be necessary to be coherent with any thresholds set in the state indicators (e.g. D1). Underwater noise is not the only pressure on marine species and ecosystems and plainly its significance may vary depending upon other pressures on those species and ecosystems.

- Proposals for new criteria (including other topics than noise) not yet covered

Options for additional criteria have been discussed within TG Noise and are explained below. There are no **agreed** proposals for new criteria.

<u>Other forms of energy:</u>

TG Noise has developed a paper on "criteria for criteria" to allow consideration of other introductions of energy than those included so far. TG Noise has proposed that these "criteria for criteria" would be

adopted, and could be applied when other forms of energy introduction will be considered. There appears to have been little further research beyond that reviewed by TG11 (Tasker *et al*. 2010) so it seems unlikely at this time that TG Noise's recommendations will differ from those of TG11; but is should be noted that additional information will become available at short notice (mid-2015) by the EU funded MarVEN-project, and with this information, using the 'criteria for criteria' an advice can be given on suitability of indicators for other forms of energy; at this stage **no** information is available to substantiate an EU-wide indicator. This has been reported earlier in the November 2014 progress report of TG Noise (Dekeling et al., 2014d). At present, **no criteria for other forms of energy** are proposed.

Other indicators of noise:

High frequency impulsive noise

In the initial advice that formed the basis of the present Commission Decision (Tasker et al. 2010) another possible noise indicator on high frequency impulsive noise was suggested, acknowledging that scientific evidence for adverse effects was limited. Over the last years, no additional evidence has become available suggesting impact at a large scale and it has not been brought up as priority issue. Further research providing information on the (scale of) effects of high frequency sound remains necessary **before this can be considered** as new indicator.

Impact indicator

The present indicators are both 'pressure indicators'. There has been discussion on the need for additional impact indicators, as for most GES descriptors both pressure as impact indicators are available.

NGO Oceancare mentioned the need for an impact indicator, and suggested a number of steps that need to be taken to assess impacts of noise (evaluation of effects on biota; weighting of the effects; cumulative interpretation (using maps).

Germany also proposed the use of an impact indicator and earlier this year provided a text proposal[17] but this proposal has not been discussed or agreed on in TG Noise or with other stakeholders. The present proposal should be further discussed and developed.

In the TG Noise monitoring guidance, it was noted that pressure indicators (and pressure targets) may be used if a clear understanding of the relationship between pressure, state and impact exists. The Netherlands have indicated that methodologies are available so that the information collected using the present impulsive noise indicator (11.1.1) can be used to determine impact, using recently developed tools enabling an exposure assessment using noise maps[18] (the methodology has similarities with the approach proposed by Oceancare). Although parts of this methodology need further development and validation, such methodology probably will enable use of the present pressure indicator in assessing GES; this will be further evaluated by the OSPAR ICG Noise, contributing to the OSPAR 2017 Intermediate Assessment.

The interim conclusion is that a concrete **impact indicator cannot** be proposed at this stage, but it should also be noted that the present pressure indicator for impulsive noise probably can be used to assess impact in the future. If it would be decided that a separate impact indicator is needed, it could be a priority

[17] Indicator 11.3.1. Impact indicator: In sensitive areas or/and at sensitive times only a certain number (or percent) of animals belonging to a regional population of a sensitive species should be effected by anthropogenic impulsive underwater sound.

[18] De Jong, C.A.F., Binnerts, B., Heinis, F., Modelling of impact pile driving noise for assessing the impact on marine animals, OCEANOISE 2015, Vilanova y la Geltrú, Barcelona, 2015

topic for the work programme of TG Noise, but even then it is uncertain that an impact indicator will be sufficiently developed in time.

- Link to possible future EEA indicator

There are no known future EEA indicators.

GES methodological standards (in accordance with Art. 9.3)

There are no proposals to change the standard for defining GES. Further research is required to define the relationship between the introduction of underwater energy and the effects on the state of the environment.

Standardised methods for monitoring for comparability (in accordance with Art. 11.4)

- Proposals for specifications which aim at improving comparability of monitoring results on the basis of JRC / ICES / RSCs inventories and Article 12 findings linked to proposed criteria.

Dekeling et al. (2014a,b,c) provides comprehensive guidance to standardise registration of the location of the distribution in time and place of loud, low and mid frequency impulsive sounds and the monitoring of continuous low frequency sound. In order to assess the usability of the TG Noise Monitoring Guidance for Member States and to identify common problems preventing effective monitoring of underwater noise, in 2014 a questionnaire was developed by the Commission, and sent to Member States; TG Noise has analysed the results and responses received.; although all EU Member States have indicated (in 2014) that they plan to implement a register for impulsive noise and intended to set up monitoring ambient noise, both based on the TG Noise guidance, no RSC or individual Member State has implemented full monitoring of impulsive or ambient noise at this moment.

Standardised methods for assessment for comparability (in accordance with Art. 11.4 GES)

- Proposals for specifications which aim at improving comparability of assessment results on the basis of general guidance prepared by Deltares taking account of JRC / ICES / RSCs inventories and Article 12 findings linked to proposed criteria.

If Member States followed the monitoring guidance provided by TG Noise (Dekeling 2014a,b,c) then assessment results should be comparable. Part of this guidance recommends an integrated approach between Member States that would involve the establishment of noise registers for Regional Seas, and the collective design of an ambient noise monitoring system to represent each Regional (or possibly sub-Regional) Sea. Such approaches would undoubtedly be more efficient and cost-effective than for each Member State to establish its own monitoring system. TG Noise is attempting to determine if there are any particular practical barriers to Member States working collectively, with early indications being that long-term (non project) funding mechanisms being likely to be one issue (e.g. how would costs of long-term monitoring be shared equitably and in a guaranteed way between relevant Member States).

Rational and technical background for proposed revision

- Justification and technical background justifying the above proposals.

For further background justifying this advice (next to what is summarised above) – further detail can be found in the TG11 and TG Noise reports (Tasker et al. 2010, Van der Graaf et al. 2012, Dekeling.et al. 2014).

Conclusions (part II):

- No new indicator is proposed for other forms of energy at this stage.
- A new indicator for high frequency impulsive noise is not considered a priority.
- There is no agreed impact indicator available at this stage, but the present pressure indicator for impulsive can be used in the (near) future to describe impact.

Other related products (e.g. technical guidance, reference in common understanding document)

Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.H., André, M., Borsani, J.F., Brensing, K., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Pajala, J., Redman, P., Robinson, S.P., Sigray, P., Sutton, G., Thomsen, F., Werner, S., Wittekind, D., Young, J.V., 2014. Monitoring Guidance for Underwater Noise in European Seas, Part I: Executive Summary, JRC Scientific and Policy Report EUR 26557 EN, Publications Office of the European Union, Luxembourg, 2014, doi: 10.2788/29293

Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.H., André, M., Borsani, J.F., Brensing, K., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Pajala, J., Redman, P., Robinson, S.P., Sigray, P., Sutton, G., Thomsen, F., Werner, S., Wittekind, D., Young, J.V., 2014. Monitoring Guidance for Underwater Noise in European Seas, Part II: Monitoring Guidance Specifications, JRC Scientific and Policy Report EUR 26555 EN, Publications Office of the European Union, Luxembourg, 2014b, doi: 10.2788/27158

Dekeling, R.P.A., Tasker, M.L., Van der Graaf, A.J., Ainslie, M.A, Andersson, M.H., André, M., Borsani, J.F., Brensing, K., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Pajala, J., Redman, P., Robinson, S.P., Sigray, P., Sutton, G., Thomsen, F., Werner, S., Wittekind, D., Young, J.V., 2014. Monitoring Guidance for Underwater Noise in European Seas, Part III: Background Information and Annexes, JRC Scientific and Policy Report EUR 26556 EN, Publications Office of the European Union, Luxembourg, 2014c, doi: 10.2788/2808

Reference Documents

Tasker, M.L., Amundin, M., Andre, M., Hawkins, A., Lang, W., Merck, T., Scholik-Schlomer, A., Teilmann, J., Thomsen, F., Werner, S. and Zakharia, M. 2010. Marine Strategy Framework Directive. Task Group 11 Report, Underwater noise and other forms of energy. European Union and ICES. 58pp.

Van der Graaf, A.J., Ainslie, M.A., André, M., Brensing, K., Dalen, J., Dekeling, R.P.A., Robinson, S., Tasker, M.L., Thomsen, F., Werner, S. 2012. European Marine Strategy Framework Directive - Good Environmental Status (MSFD GES): Report of the Technical Subgroup on Underwater noise and other forms of energy.

Dekeling, R.P.A., Tasker, M.L., Ferreira, M., Ainslie, M.A, Anderson, M.H., André, M., Borsani, J.F., Box, T., Castellote, M., Cronin, D., Dalen, J., Folegot, T., Leaper, R., Mueller, A., Pajala, J., Peterlin, M., Robinson, S.P., Thomsen, F., Vukadin, P., Young, J.V, Progress Report on Monitoring of Underwater Noise. 3rd Report of the Technical Group on Underwater Noise (TG Noise). November, 2014d.

Descriptor

Descriptor 11: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

Together with underwater noise, which is highlighted throughout Directive 2008/56/EC, other forms of energy input have the potential to impact on components of marine ecosystems, such as thermal energy, electromagnetic fields and light. Additional scientific and technical progress is still required to support the further development of criteria related to this descriptor including in relation to impacts of introduction of energy on marine life, relevant noise and frequency levels (which may need to be adapted, where appropriate, subject to the requirement of regional cooperation). At the current stage, the main orientations for the measurement of underwater noise have been identified as a first priority in relation to assessment and monitoring subject to further development, including in relation to mapping. Anthropogenic sounds may be of short duration (e.g. impulsive such as from seismic surveys and piling for wind farms and platforms, as well as explosions) or be long lasting (e.g. continuous such as dredging, shipping and energy installations) affecting organisms in different ways. Most commercial activities entailing high-level noise levels affecting relatively broad areas are executed under regulated conditions subject to a licence. This creates the opportunity for coordinating coherent requirements for measuring such loud impulsive sounds.

11.1. Distribution in time and place of loud, low and mid frequency impulsive sounds

— Proportion of days and their distribution within a calendar year over areas of a determined surface, as well as their spatial distribution, in which anthropogenic sound sources exceed levels that are likely to entail significant impact on marine animals measured as Sound Exposure Level (in dB re 1µPa 2.s) or as peak sound pressure level (in dB re 1µPa peak) at one metre, measured over the frequency band 10 Hz to 10 kHz (11.1.1)

11.2. Continuous low frequency sound

— Trends in the ambient noise level within the 1/3 octave bands 63 and 125 Hz (centre frequency) (re 1µPa RMS; average noise level in these octave bands over a year) measured by observation stations and/or with the use of models if appropriate (11.2.1).