Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area, concluded under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS)

Accord sur la Conservation des Cétacés de la Mer Noire, de la Méditerranée et de la zone Atlantique adjacente, conclu sous l'égide de la Convention sur la Conservation des Espèces Migratrices appartenant à la Faune Sauvage (CMS)

Fifth Meeting of the Parties to ACCOBAMS
Tangier, 5 - 8 November 2013

08/10/2013
English
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ACCOBAMS-MOP5/2013/Doc 24

METHODOLOGICAL GUIDE:
"GUIDANCE ON UNDERWATER NOISE MITIGATION MEASURES"

Delegates are kindly invited to bring their own documents to the Meeting.
This document will be available only in electronic format during the Meeting.

Note of the Secretariat

During the last Meeting of the Parties, the Resolution 4.17 (Guidelines to address the impact of anthropogenic noise on Cetaceans in the ACCOBAMS area) was adopted with the task for the Working Group to go ahead with this issue. The composition of the Working Group was approved by the Seventh Meeting of the ACCOBAMS Scientific Committee and Yanis Souami was designated as coordinator.

The main role of the Working Group was to simplify and clarify Guidelines to facilitate their implementation by the Parties and shipping operators, in particular by providing information about mitigation technologies and management measures as well as their effectiveness and cost.

The year 2011 was dedicated to contact numerous Organisations and make them aware about the Guidelines.

A joint Working Group with ASCOBANS was created accordingly to the ACCOBAMS Scientific Committee recommendation and on the occasion of the 19th ASCOBANS Advisory Committee Meeting (19-23 March 2012).

After collecting opinion from different actors (industries, states, scientists, NGOs and others), a working platform was created in 2012 to exchange documents on noise with the view of preparing a synthesis.

The “Cluster Maritime Français”, was approached by the Coordinator of the Working Group.

During the Eighth Meeting of the Scientific Committee, it was decided to appoint a consultant for providing a bibliographic synthesis (*ACCOBAMS-MOP5/2013/Doc22: Anthropogenic noise and marine mammals: review of the effort in addressing the impact of anthropogenic underwater noise in the ACCOBAMS and ASCOBANS areas*) and consulting of noise-producers (*ACCOBAMS-MOP5/2013/Doc23: Implementation of underwater noise mitigation measures by industries: Operational and economical constraints*).

According to the decision of the Parties a Methodological guide (*ACCOBAMS-MOP5/2013/Doc24: Methodological guide: Guidance on Underwater Noise Mitigation Measures*) was prepared, thanks to a Voluntary Contribution of Monaco, by the coordinator of the Working Group. It aims to improve and facilitate the use of the Guidelines to Address the Impact of Anthropogenic Noise on Cetaceans in the ACCOBAMS Area.

The Parties will be invited to comment and take note of the document

ACCOBAMS

Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area

Methodological Guide:

Guidance on underwater noise mitigation measures

PRINCIPAUTE DE MONACO
Département des Relations Extérieures
Délégation Permanente auprès des Organismes Internationaux à caractère Scientifique, environnemental et humanitaire

This document has been realised thanks to the financial support of the Principality of Monaco

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Document prepared by Alessio Maglio (SINAY) in collaboration with the joint Working Group ACCOBAMS-ASCOBANS. This document has to be cited as: ACCOBAMS-MOP5/2013/Doc24.

FOREWORD

Underwater noise is recognised as a threat for marine wildlife and the conservation of endangered species. The ACCOBAMS Agreement has addressed the impact of underwater noise on cetacean species since 2004 through the Resolution 2.16, *Assessment and impact assessment of man-made noise*. Later, Resolution 3.10 (2007) and 4.17 (2010) were adopted, both dealing with guidelines aimed at mitigating the impact of anthropogenic noise. In particular, best practices to be employed in the ACCOBAMS area were established for each noise-producing human activity at sea and annexed to Resolution 4.17. The present guide represents a further step towards the dissemination of such mitigation procedures and towards the enhancement of their use.

BACKGROUND

For the purpose of this guide, *noise* can be defined as sound that causes negative effects. Recalling also the work carried out for the implementation of the Marine Strategy Framework Directive of the European Union, noise can be classified in two categories:

- Impulsive noise, defined as a sound emitted by a point source comprising one or more pulses of short duration and with long gaps between these pulses[1]
- Continuous noise, commonly defined as background noise without distinguishable sources[2].

Mitigation measures usually include a set of practical procedures and technological solutions aimed at reducing the environmental impact of noise-producing human activities at sea. Although both continuous and impulsive noise sources are equally concerning, this guide version only covers impulsive noise sources and its mitigation techniques. The reason of this choice is that, in the ACCOBAMS area (and in other sea areas of the European Union), regulation texts are already in place and clearly focused on impulsive noise (e.g. ACCOBAMS Resolution 4.17). The issue of continuous noise, particularly commercial shipping noise which represents the major source of continuous underwater noise, is currently being addressed by the International Maritime Organisation (IMO). Provisions for reduction of noise from commercial shipping have been drafted in 2013, with a view for approval in 2014. Future updates of this guide will address continuous noise sources as well.

[1] A deeper insight of how an impulsive sound is defined, and especially what is considered to be a *short pulse* and a *long gap*, is given in the report of the TSG Noise (Van der Graaf et al 2012)

[2] Detailed definition of underwater ambient noise can be found in Dahl et al. 2007.

Thus, this guide is thought to outline practices and existing technologies that should be used during or instead conventional maritime activities producing impulsive underwater noise. References are also included for those technologies which are very likely to become increasingly used (and market available) in the next future. According to the European Commission, the major sources of impulsive underwater noise are the following:

- Seismic surveys (airgun)
- Offshore construction (pile driving)
- Military Sonar
- Use or disposal of explosives

Further, this guide proposes the zones were spatial mitigation measures should be applied in the Mediterranean Sea, that is to say, avoiding activities having an acoustic impact on cetaceans, especially the Cuvier's Beaked whale, in such zones. These concepts have been approved by the ACCOBAMS Scientific Committee, based on the work carried out in recent years within the Scientific Committee and presented by Aguilar de Soto et al. 2013 at the conference *Effects of Noise on Aquatic Life*, held in Budapest, 11-17 August, 2013.

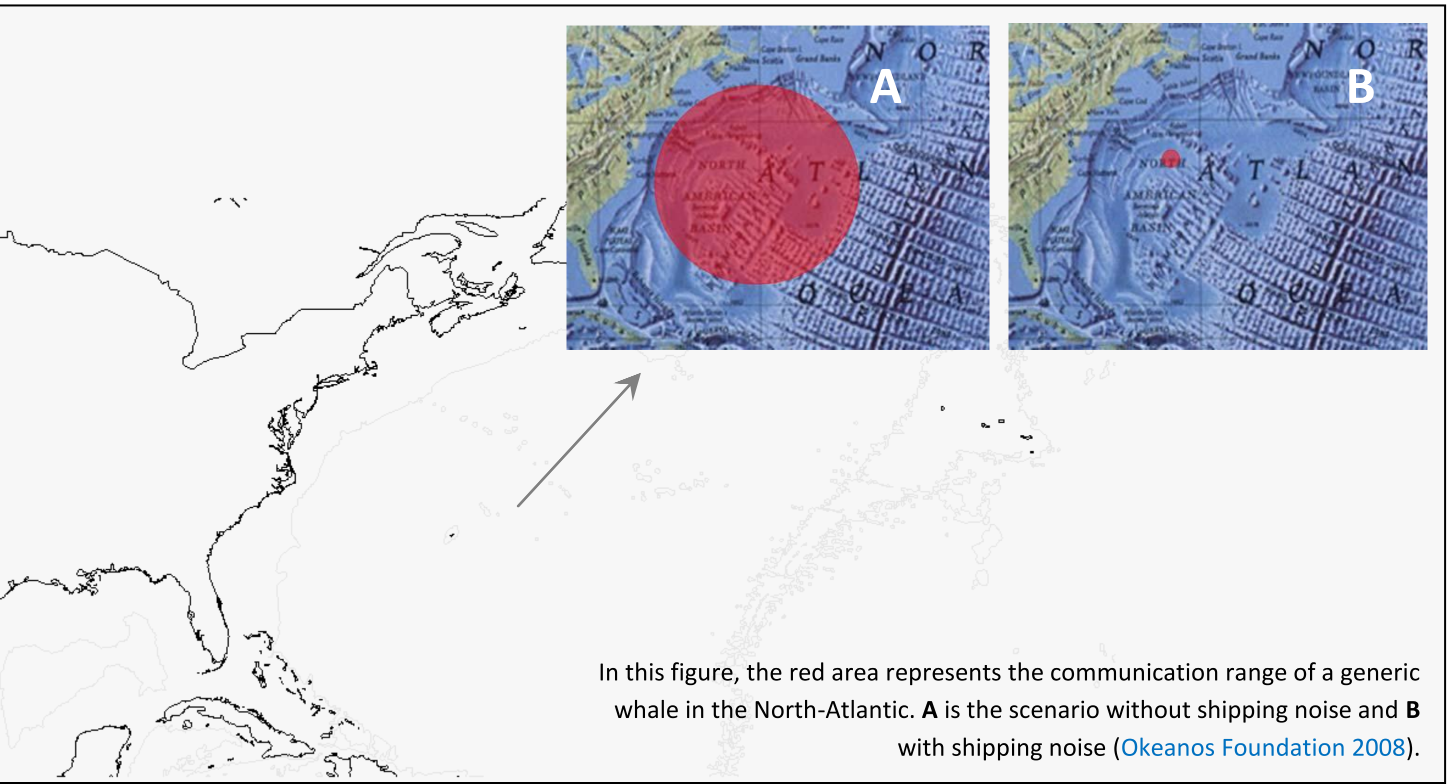
In conclusion, it is important to underline that this is thought to be a living guide and that it will be regularly updated as long as new technologies become available or new practices and procedures are established to reduce the impact of underwater noise on cetaceans.

Impulsive noise may cause negative effects of different magnitude, according to the characteristics of the noise emissions. The following table give an indicative idea about the impacts caused in both individuals/groups and populations (adapted from the work from the Convention of Biological Diversity (CBD 2012), the *Service Hydrographique et Océanographique de la Marine* (Stéphan et al. 2012) and TSG Noise (Van der Graaf et al. 2012)

EFFECT TYPE	IMPACT ON INDIVIDUALS AND GROUPS	POTENTIAL IMPACT ON POPULATIONS
NONE	Perturbation under ambient noise level or under detection threshold of species	None
	Perturbations are detected but individuals/groups show no reactions	None
BEHAVIOURAL	Perturbations are detected and animals show slight response	Low
	Individuals modify their behaviour but normal activities are not affected	Low
	Individuals modify their behaviour and stop their normal activities	Medium
PHYSIOLOGICAL	Hearing is temporarily altered	Medium/High
	Hearing is permanently damaged	High
	Tissue damages, haemorrhages	Very high
	Injuries leading directly to animal death	Very high

It should be taken into account that this table represent an important simplification of a highly more complex situation. Reaction of marine mammals to noise depends on such factors as species, individual, age, sex, prior experience with noise and behavioural state. Observed reactions to noise in marine mammals could theoretically result in impacts such as decreased foraging efficiency, higher energetic demands, less group cohesion, higher predation, decreased reproduction, and thus seriously impact the population. Moreover, animals showing no avoidance or changes in activities may still suffer important, even lethal, consequences. On the other hand, injuries or deaths of animals may not have an impact on the population if there are few relative to the size of the population (Weilgart 2007).

Furthermore, it is worth noting that for a broad range of marine mammals, masking effects (on communication, navigation, prey/predator detection etc.), caused by rising continuous noise levels are likely to have an increasingly prevalent impact on a longer term (Pavan 2010). The following picture shows an example of the predicted decreased communication range for baleen whales, owing to increases in ambient noise due to shipping (Okeanos Foundation 2008).



In this figure, the red area represents the communication range of a generic whale in the North-Atlantic. **A** is the scenario without shipping noise and **B** with shipping noise (Okeanos Foundation 2008).

TERMS and DEFINITIONS

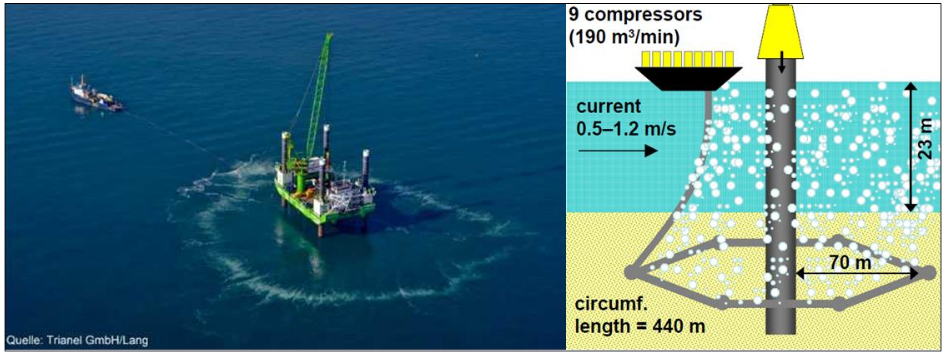
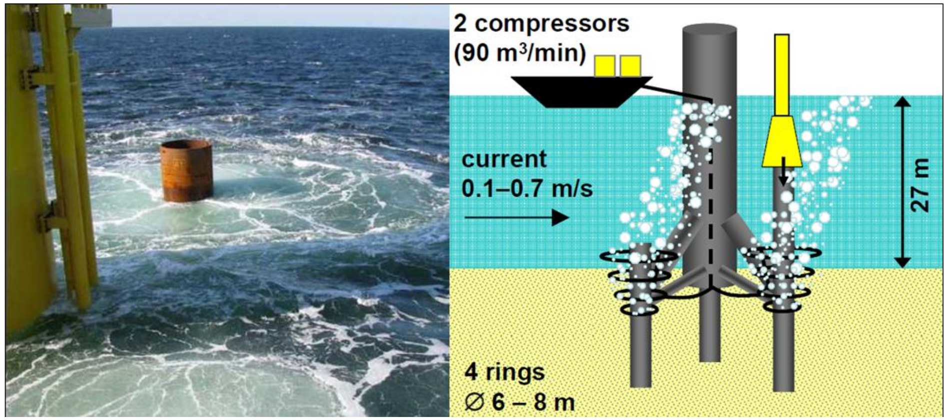
ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and the contiguous Atlantic area
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
AMD	Acoustic Mitigation Devices. This terminology is employed to include all devices which use acoustics as a means of mitigating interactions between cetaceans and human activities. Usually AMDs encompass Acoustic Deterrent Devices (ADD), developed for cetaceans, and Acoustic Harassment Devices (AHD), conceived for seals.
EIA	Environmental Impact Assessment.
EZ	The Exclusion Zone is defined as the area within which no animals must be present during noise emissions. An individual or a group entering this zone trigger the application of mitigation procedures/practices. The extent of the EZ should be determined on the basis of a scientific approach, i.e. by means of sound propagation modelling verified in the field. The limit of the EZ should be set following existing science on safe/harmful exposure criteria. However, such criteria are controversial and hence a precautionary approach should can be employed.
LFAS/MFAS	Low- and Mid-Frequency Active Sonar employed during military exercises
LACS	Low level Acoustic Combustion Source. A proposed alternative to the seismic airgun. More details are provided in the section *ALTERNATIVE TECHNOLOGIES*.
MMO	Marine Mammal Observers are experienced observers employed to visually detect the presence of marine mammals within a defined zone. Animals can be spotted by the naked eye or by means of appropriate binoculars
MV	Marine Vibroseis. Vibroseismic source employed thus far for inland seismic exploration. Extension of this technology to maritime exploration is underway. More details are given in the section *ALTERNATIVE TECHNOLOGIES*;
PAM	Passive Acoustic Monitoring signifies the activity of recording continuous underwater sound by means of hydrophones. Several configurations exist to set up a PAM system. Marine mammal detection by means of towed PAM systems (as used by PAM operators during seismic exploration) is only one of the possible ways of PAM monitoring.
SEL	Sound Exposure Level. It is a measure of the accumulated sound energy over a defined period of time.
SPL	Sound Pressure Level. It is a measure of the pressure of a sound.

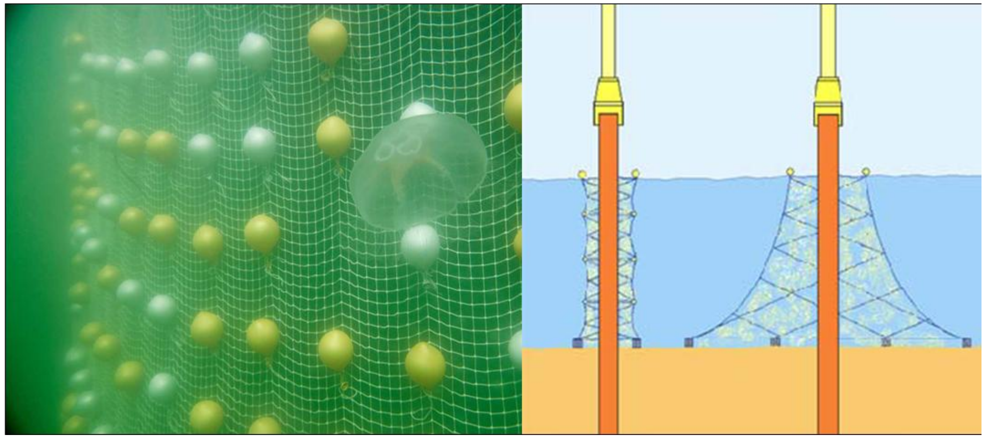
ACCOBAMS

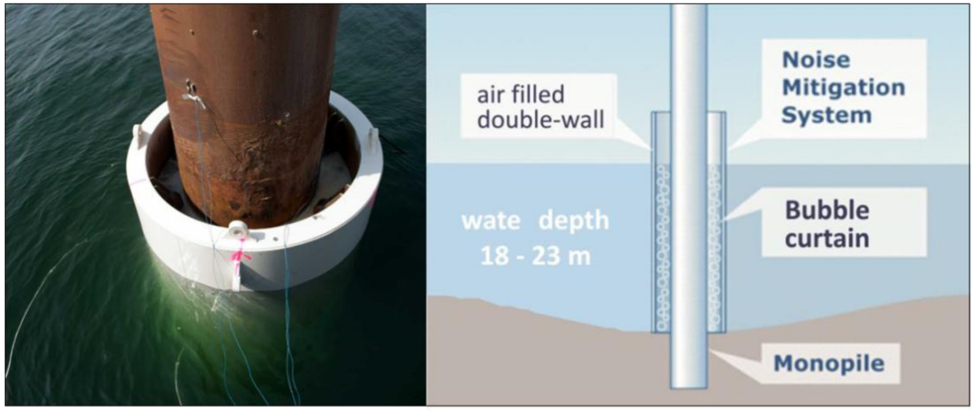
NOISE MITIGATION FRAMEWORKS

NOISE MITIGATION TECHNOLOGIES

This following table aims to provide an overall view of mitigation technologies with some examples of the achievable noise reduction. Values presented in the table are broadband values and come from experiences carried out to reduce impact piling noise. Differences in the pile diameter and hammer size for each experience do not allow a direct comparison of the noise reduction efficiency between techniques. Further details can be found in Koschinski and Lüdemann, in prep.

MITIGATION TECHNOLOGY	NOISE REDUCTION	"RELEVANT" ACTIVITIES	
Big Air Bubble Curtain. A large bubble curtain consists of a hose with drilled holes, supplied with compressed air. The hose is placed on the sea bed and the air escaping from the holes forms the bubble screen. (Photo : Trianel GmbH/Lang ; reference : Verfuß & Jülich 2012, Koschinski & Lüdemann in prep)	Single bubble curtain : - 12 dB (SEL), 14 dB (peak) - 11 dB (SEL) 15 dB (peak) Double bubble curtain : - 17 dB (SEL), 21 dB (peak)	Pile driving (p. 15) Drilling (p. 15) Dredging (p. 15) Use or disposal of explosives (p. 16)	
Little Air Bubble Curtain A little bubble curtain can be customized and placed much closer to the noise source than the big bubble curtain. It may consist of a rigid frame placed around the source. Several configurations are possible. (Reference : Verfuß & Jülich 2012, Koschinski & Lüdemann 2013)	Several tests : - 12 dB (SEL), 14 dB (peak) - 11-13 dB (SEL) - 4-5 dB (SEL) - 14 dB (SEL), 20 dB (peak)	Pile driving (p. 15) Drilling (p. 15) Dredging (p. 15)	

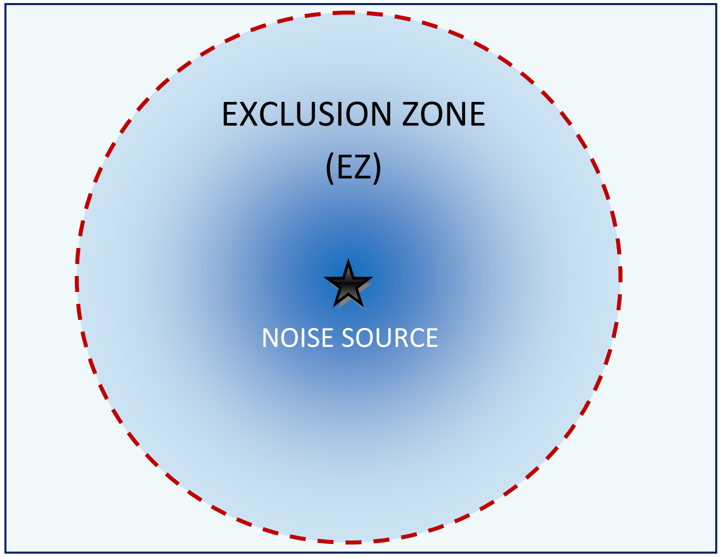
Hydro Sound Damper. This technology consists of fishing nets with small balloon filled with gas and foam - tuned to resonant frequencies- fixed to it. It can be applied in different ways. (Photo: Patrice Kunte; Reférence: Verfuß & Jülich 2012, Koschinski & Lüdemann 2013)	4 - 14 dB (SEL)	Pile driving (p. 15) Drilling (p. 15) Dredging (p. 15) Use or disposal of explosives (p. 17)	
Cofferdam. The cofferdam consists of a rigid steel tube surrounding the pile. Once the pile is stabbed into the cofferdam, the water is pumped out (Photos: Kurt Thomsen; Reference: Verfuß & Jülich 2012, Koschinski & Lüdemann 2013)	up to 22 dB (SEL) and 18 dB (Peak)	Pile driving (p. 15) Drilling (p. 15)	

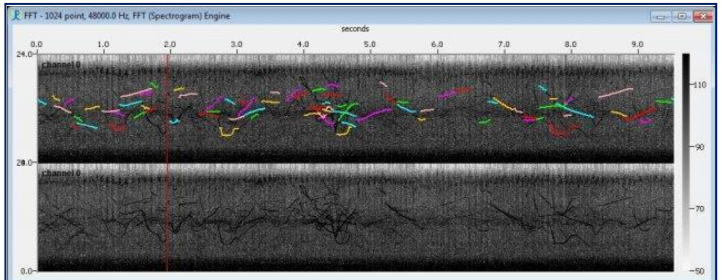
Noise Mitigation Screen. The NMS is a double layered screen, filled with air. Between the pile and screen there is a multi level and multi size bubble injection system. (Photo: Patrice Kunte; Reference: Verfuß & Jülich 2012, Koschinski & Lüdemann 2013)	5 – 20 dB reduction (SEL)	Pile driving (p. 15) Drilling (p. 15)	
BEKA_shells - Double steel wall with polymer filling - Inner and outer bubble curtain - Acoustic decoupling (vibration absorber) (Photos: Patrice Kunte; Reference: Verfuß & Jülich 2012, Koschinski & Lüdemann 2013)	6-8 dB (SEL)	Pile driving (p. 15) Drilling (p. 15)	

ALTERNATIVE TECHNOLOGIES	EMISSIONS	RELEVANT ACTIVITIES	REFERENCES/COMMENTS
Drilled foundation Drilling can be done within a concrete pile. The drill head can be placed outside the pile if there is resistance. The pile will sink within the drilled hole	Not information available	Any activity that would require pile driving (offshore wind farms, harbour extensions, bridges etc.)	(North Sea Foundation 2012, Verfuß 2012, Koschinski & Lüdemann 2013)
Vibro-drilling. Vibro-drilling combines a vibrator tandem PVE and a drill head in one unit. The pile is driven into the sea floor by vibrating. Drilling is applied when there is resistance with vibrating	Less than 130 dB @ 750 m expected (not measured yet)	Any activity that would require pile driving (offshore wind farms, harbour extensions, bridges etc.)	(North Sea Foundation 2012, Verfuß 2012, Koschinski & Lüdemann 2013)
Concrete Gravity Foundations. These structures are reinforced, self buoyant concrete structures. They are towed to a site and directly placed to the seabed.	No emissions	Any activity that would require pile driving (offshore wind farms, harbour extensions, bridges etc.)	(North Sea Foundation 2012, Verfuß 2012, Koschinski & Lüdemann 2013)
Bucket foundation. A bucket foundation is a large steel caisson which is founded in the seabed by suction pumps. The water is pumped out of the cavity underneath the caisson. The vacuum in combination with the hydrostatic pressure makes the caisson penetrate into the seabed up to its final depth	Very low noise expected (not measured yet)	Any activity that would require pile driving (offshore wind farms, harbour extensions, bridges etc.)	(North Sea Foundation 2012, Verfuß 2012, Koschinski & Lüdemann 2013)
Marine Vibroseis (MV). Hydraulic and electromechanical MVs can be towed in the same configuration as airgun arrays or operated in a stationary mode much like land vibrators; MV's will have lower source signal rise times, lower peak pressures, and less energy above 100 Hz	Source Level : 203 dB re 1µPa; 6-100 Hz	Seismic surveys (p. 16)	System from Geokinetics licenced for shallow water available mid 2014 (CSA Ocean Sciences Inc. 2013, Weilgart 2013, Castellote, pers. comm.)
Low level Acoustic Combustion Source (LACS) The LACS system is a combustion engine producing long sequences of acoustic pulses at a rate of 11 shots/s with low intensity at non-seismic (>100 Hz) frequencies. The system is suitable for shallow-penetration, towed-streamer seismic surveys or vertical seismic profiling	Source Level : 218 dB re 1µPa Peak-to-Peak	Seismic surveys (p. 16)	Market available (Askeland et al. 2009, CSA Ocean Sciences Inc. 2013)

REAL-TIME MITIGATION PRACTICES

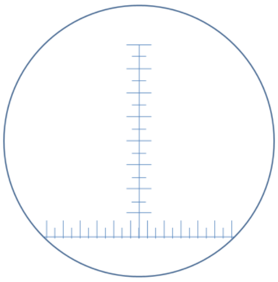
Mitigation protocols	RELEVANT ACTIVITIES
Use of Acoustic Mitigation Devices (AMD) - Prior to the beginning of the work, AMD should be used to drive away groups or individuals of marine mammals - Only AMDs allowed in the ACCOBAMS area are to be employed (see ACCOBAMS Resolution 4.9, 2010 for cetacean devices)	Pile driving/Drilling/Dredging (p. 15) Use or disposal of explosives (p. 17)
Soft start protocol - Noise emissions should begin at low power, increasing gradually until full power is reached - The soft start procedure should be of 20 min duration at least	Pile driving/Drilling/Dredging (p. 15) Seismic surveys (p. 16) Use or disposal of explosives (p. 17) Sonar (p. 18)
Visual monitoring protocol - Dedicated and independent Marine Mammal Observers (MMO) should watch the Exclusion Zone (EZ) for 30 min before the beginning the soft start procedure (120 min for highly sensitive species). - The soft start procedure should be delayed if cetaceans enter the EZ - Continuous watch should be kept for the entire duration of noise emission - The activity should be stopped (or powered down) if cetaceans enter the EZ - In case of a halt in noise, a new 30 min watch should be kept without animals in the EZ before re-starting noise emissions (120 min for highly sensitive species)	Pile driving/Drilling/Dredging (p. 15) Seismic surveys (p. 16) Use or disposal of explosives (p. 17) Sonar (p. 18)
Acoustic monitoring protocol - Acoustic monitoring should be used to alert the observers (MMO) to the presence of cetaceans - Continuous acoustic monitoring should be performed for the entire duration of the noise emission - If activities are carried out at night or during bad weather conditions, acoustic monitoring is to be used as the main monitoring tool - In such conditions, noise emissions should be stopped, or powered down, if acoustic detections of cetaceans occur	Pile driving/Drilling/Dredging (p. 15) Seismic surveys (p. 16) Use or disposal of explosives (p.17) Sonar (p.18)





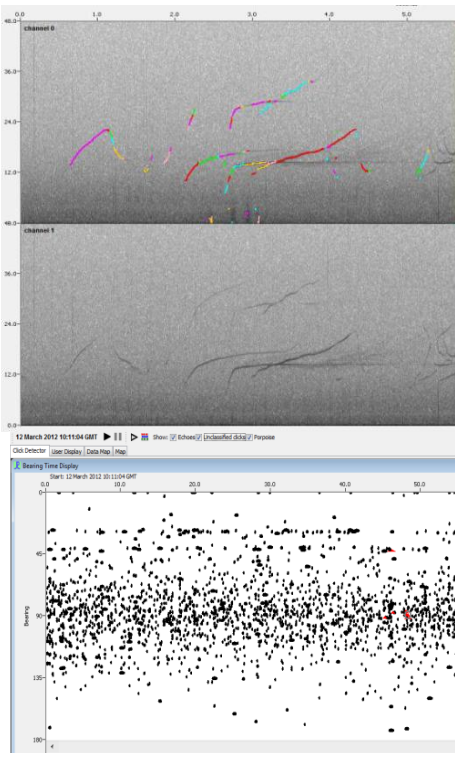
Marine Mammal Observers (MMO)

- The MMO should be equipped with distance measuring binoculars and a standard "Cetacean Sighting Form" made available by ACCOBAMS
- At least two MMOs should be onboard seismic vessels operating in the ACCOBAMS area, observing the survey zone continuously. Shifts should never exceed 2 hours and MMOs must be able to rest between shifts.



Three tasks have to be systematically fulfilled:

- Monitoring the area implementing mitigation measures whenever necessary (cf visual monitoring protocol)
- In addition, the MMO must collect abundance, distribution and behavioural data throughout the survey. This task has to be performed both during seismic acquisition and transit
- Reporting



Passive Acoustic Monitoring (PAM)

PAM equipment should be able at least to detect and localise cetaceans. The following software tools are suggested. PAM operators should be experienced bio-acousticians, familiar with the vocalisations of cetaceans in a determined area.

SOFTWARE	MORE INFOS AND/OR DOWNLOAD
PAMGUARD	http://www.pamguard.org/
SEAPRO & PAM WorkStation	http://www-3.unipv.it/cibra/seapro.html
ISHMAEL	(Mellinger 2001)
RAINBOWCLICK	http://www.marineconservationresearch.co.uk/
WHISTLE	www.ifaw.org

GUIDANCE TO MITIGATE THE ACOUSTIC IMPACT OF MAN-MADE IMPULSIVE NOISE

PILE DRIVING/DRILLING/DREDGING

Pile driving is a conventional technique employed in many coastal and offshore constructions, such as wind farms, offshore platforms, harbour extensions etc. The growth of the wind energy sector caused a great increase in the use of this technique both in coastal and offshore environments. Other sources, like drilling and dredging, may be cause for concern, although these techniques are not as intense as impact pile driving.

Source level	*228 dB re 1µPa m (Peak) or* *243 – 257 dB re 1µPa m (P-to-P)*
Bandwidth	*20 Hz – 20 kHz*
Major amplitude	*100 Hz – 500 Hz*
Duration	*50 ms*
Directionality	*Omnidirectional*

ref: CEDA 2011; OSPAR 2009

Conventional impact pile driving should not be used in the Areas of Special Concern for Beaked whales (p.19), where strict measures need to be applied.

Mitigation Framework for pile driving, drilling and dredging	
Planning phase (expected outcomes of the EIA)	1. Review the presence of cetaceans in the candidate periods for the works and carry out or fund research where the information is non-existent or inadequate 2. Select periods with low biological sensitivity 3. Use sound propagation modelling results, verified in the field, to define the extension of the exclusion area (EZ) 4. Plan the lowest practicable source power 5. Consider alternative technologies (p. 10) 6. Plan Noise Mitigation Technologies in case no alternatives are possible (p. 7-8-9)
Real-time mitigation practices (p. 12)	1. Use Acoustic Mitigation Devices prior to the beginning of the work 2. Use the soft start protocol 3. Use the visual monitoring protocol* 4. Use the acoustic monitoring protocol*
Post-activity	1. Detailed reporting of real-time mitigation**

* PAM and MMO equipment (p. 14)

** Detailed reports of the mitigation activity should follow a standard form made available by ACCOBAMS


BOEM, 2013

The airgun is presently the most employed technology for carrying out marine seismic exploration. Such surveys are pervasive worldwide, in shallow and deep water as well as in coastal or offshore environments.

Source level*	*220 – 262 dB re 1µPa m (P-to-P)*
Bandwidth	*5 Hz – 100 kHz*
Major amplitude	*10 Hz – 120 Hz*
Duration	*10 – 100 ms*
Directionality	*Downwards*

ref: CEDA 2011; OSPAR 2009

Seismic surveys should not take place in the Areas of Special Concern for Beaked whales (p.19), where strict measures need to be applied.

Mitigation Framework for seismic surveys	
Planning phase (expected outcomes of an EIA)	1. Consider the adoption of alternative technologies (p. 10) 2. Review the presence of cetaceans in the candidate periods for the survey and carry out or fund research where the information is non-existent or inadequate 3. Define no-survey zones (biological reserves, especially protected areas etc.) 4. Select periods with low biological sensitivity 5. Use sound propagation modelling to define the extent of the exclusion area (EZ)
Real-time mitigation practices (p. 12)	1. Use the visual monitoring protocol* 2. Use the acoustic monitoring protocol* 3. Use the soft start protocol
Post-activity	1. Detailed reporting of real-time mitigation**

* PAM and MMO equipment (p. 14)
** Detailed reports of the mitigation activity should follow a standard form made available by ACCOBAMS

Underwater detonations may occur for the disposal of explosives or may be planned during maritime construction, e.g. to fragment rock prior to dredging. This is the loudest source of underwater noise and need to be treated with particular care.

Underwater detonations should not be used in the Areas of Special Concern for Beaked whales (p.19), where strict measures need to be applied.

Source level (0.5 – 50 kg)	*272 - 287 dB re 1µPa m (Peak)*
Bandwidth	*2 Hz – 1 kHz*
Major amplitude	*6 Hz – 21 Hz*
Duration	*1 – 10 ms*
Directionality	*Omnidirectional*

ref: CEDA 2011; OSPAR 2009

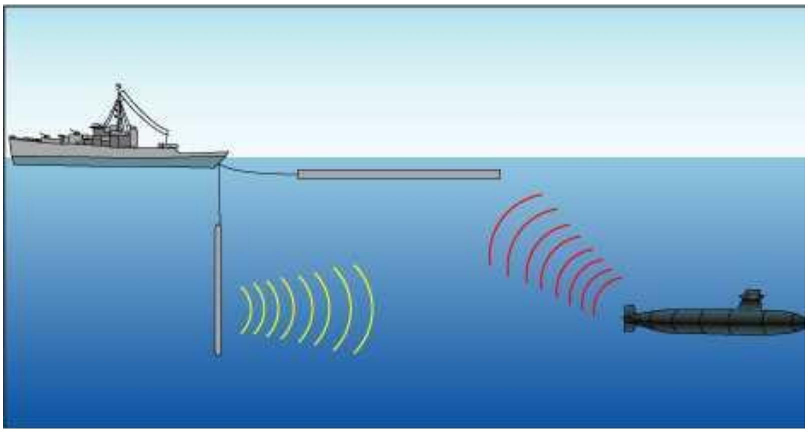
Mitigation Framework for use or disposal of explosives	
Planning phase (expected outcomes of the EIA)	1. Review the presence of cetaceans in the candidate periods for the work and fund research if information is inadequate 2. Select periods with low biological sensitivity 3. Use sound propagation modelling results to define the extent of the exclusion area (EZ) 4. Plan the lowest practicable charge
Noise Mitigation Technologies	1. Use noise mitigation technologies: • Big Air Bubble Curtain (p. 7) • HydroSound Damper net (HSD-net, p. 8)
Real-time mitigation practices (p. 12)	1. Use Acoustic Mitigation Devices prior to the work 2. Use the soft start protocol (small charges prior to operational charges) 3. Use the visual monitoring protocol 4. Use the acoustic monitoring protocol
Post-activity	1. Detailed reporting of real-time mitigation*

* PAM and MMO equipment (p. 14)

** Detailed reports of the mitigation activity should follow a standard form made available by ACCOBAMS

ACCOBAMS

SONAR USE



Low-, mid- and high frequency active sonars (LFAS, MFAS, HFAS) are employed during military exercises as well as during academic and industrial surveys, such as fish stock estimations and bathymetric surveys. Especially, low- and mid-frequency naval sonars are of great concern given the mass stranding events of cetaceans linked in space and time with military exercises and need to be addressed with particular care

High-powered active sonar should not be used in the Areas of Special Concern for Beaked whales (p.19), where strict measures need to be applied.

	NAVAL SONAR	ACADEMIC and INDUSTRIAL SONAR
Source level	*235 dB re 1µPa m (Peak, LFAS)* *223 – 235 dB re 1µPa m (Peak, MFAS)*	*203 – 240 dB re 1µPa m (rms)*
Bandwidth	*100 Hz – 500 Hz (LFAS)* *2 kHz – 8 kHz (MFAS)*	*1 kHz – 400 kHz*
Major amplitude	*3.5 kHz (MFAS)*	*Various*
Duration	*6s – 100s (LFAS)* *0.5s – 2s (MFAS)*	*0.2 ms – 100 ms*
Directionality	*Horizontally focused*	*Depends on sonar type*

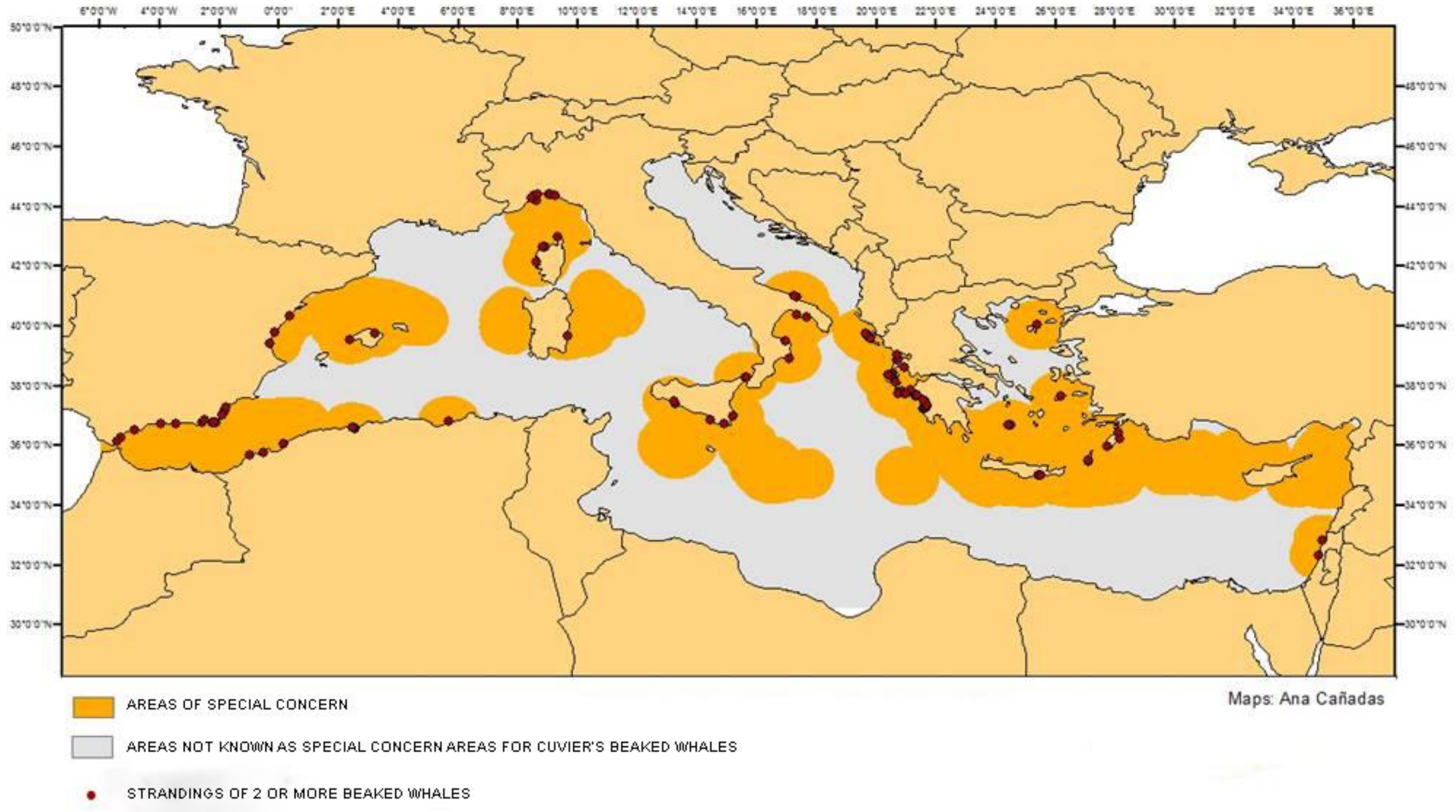
ref: (CEDA 2011; Lurton and Antoine 2007; OSPAR 2009)

Mitigation framework for military and civil sonar use	
Planning phase (expected outcomes of an EIA)	1. Review the presence of cetaceans in the candidate periods for the survey/exercise and fund research if information is inadequate 2. Define no-exercise zones (biological reserves, especially protected areas etc.) 3. Define buffer zones 4. Select periods with low biological sensitivity 5. Use sound propagation modelling to define the extent of the exclusion area (EZ)
Real-time mitigation practices (p. 12)	1. Use the visual monitoring protocol* 2. Use the acoustic monitoring protocol* 3. Use the soft start protocol
Post-activity	1. Detailed reporting of real-time mitigation**

* PAM and MMO equipment (p. 14)

** Detailed reports of the mitigation activity should follow a standard form made available by ACCOBAMS

AREAS OF SPECIAL CONCERN FOR BEAKED WHALES



CITED LITERATURE

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