Overview of underwater anthropogenic noise, impacts on marine biodiversity and mitigation measures in the southeastern European part of the Mediterranean, focussing on seismic surveys

Ana Štrbenac, M.Sc, Stenella consulting d.o.o., Croatia

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Author: Ana Štrbenac, M.Sc. (Stenella consulting d.o.o., Croatia)

Contributions: Nicolas Entrup (OceanCare and Shifting Values), Silvia Frey, PhD (OceanCare), Sigrid Lüber (OceanCare), Lindy Weilgart, PhD (OceanCare and Dalhousie University), and Bruno Claro (OceanCare)

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List of acronyms

ACCOBAMS – Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area

ACCOBAMS FP - Focal Point of the Party to ACCOBAMS

ASCOBANS-Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas

Barcelona Convention – Convention for the Protection of the Mediterranean Sea against the pollution

Bern Convention – Convention on the Conservation of European Wildlife and Natural Habitats

CBD – Convention on Biological Diversity

CCH - critical cetaceans Habitat under ACCOBAMS

CMS – Convention on the Migratory Species of Wild Animals (Bonn Convention)

EBSA – Ecologically or Biologically Significant Marine Areas

EC – European Commission

ESPOO - Convention on Environmental Impact Assessment in a Transboundary Context

EU – European Union

GDP – Gross Domestic Product

GBIF - Global Biodiversity Information Facility

GFCM –General Fisheries Commission for the Mediterranean

ICRW - International Convention for Regulation of Whaling

ICZM – Protocol on the Integrated Coastal Zone Management in the Mediterranean, under Barcelona Convention

IMMA – Important Marine Mammal Areas

IMO – International Maritime Organisation

IUCN –International Union for Conservation of Nature

IWC – International Whaling Commission

MSFD – Marine Strategy Framework Directive

NATO – North Atlantic Treaty Organisation

NETCCOBAMS - Network on the Conservation of Cetaceans of the ACCOBAMS area

NOAA – US National Oceanic and Atmospheric Administration

OBIS – SEAMAP – Ocean Biographic Information System Spatial Ecological Analysis of Megavertebrates

RAC/SPA – Regional Activity Centre for Specially Protected Areas

SEE Med Region - South-Eastern European part of the Mediterranean Sea

SPA/BD Protocol–Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean, under Barcelona Convention

SPAMI – Specially Protected Areas of Mediterranean Importance under the SPA/BD Protocol of the Barcelona Convention

UNCLOS - UN Convention on the Law of the Sea

UNEP/MAP – Mediterranean Action Plan of the United Nations Environment Programme

WWF – World Wildlife Fund

Executive Summary

The Mediterranean Sea is one of the global biodiversity hotspots. The south-eastern European part of the Mediterranean Sea - SEE Med Region¹ - is a critical habitat for number of species, such as Cuvier's beaked whale, monk seal, and sea turtles. The Region is also rich in invertebrates. The human population is considerably large and it uses natural resources at a much higher rate than they are available in the long-run. Human pressures have negative consequences on the marine wildlife. The SEE Med Region is one of the hotspots for threatened species, with the monk seal and leatherback turtles facing extinction (IUCN category CR – Critically Endangered). The most significant threats are habitat loss and degradation, interaction with fisheries, pollution, eutrophication, disturbance (including anthropogenic noise), climate change and invasive alien species.

Maritime traffic, military exercises, seismic surveys, coastal and offshore projects are the main human activities to produce underwater noise. Since the Mediterranean is a tourist hotspot, nautical tourism is also a growing concern.

Despite the objectives agreed within the Paris Agreement to address climate change, there is still a great demand by industries for energy coming from fossil fuels. In the last decade, the extent of seismic surveys increased in the SEE Med Region, particularly in the area of the Adriatic Sea. Seismic surveys are planned to continue in the future and the areas of highest concern are the Adriatic Sea and Hellenic Trench.

The Mediterranean Sea is already heavily impacted by various threats affecting vulnerable ecosystems. Again, one of the hotspots is the northern Adriatic Sea.

Many marine organisms use sound for communication, foraging, and navigation. Anthropogenic underwater noise may have harmful effects on marine biodiversity. It may have effects such as physical damage, behavioural changes, chronic/cumulative impacts and stress. Although a knowledge gap remains regarding impacts, particularly on some species (sea turtles), certain effects are documented. One of the reasons for concern is recently published evidence of the damaging effects of seismic surveys on zooplankton. And zooplankton, together with phytoplankton, is the foundation of the marine food web upon which fish and other marine species depend.

The full extent of the impact of seismic surveys at the population level is mostly unknown, partially due to the lack of baseline knowledge about the abundance and distribution of species.

¹ For the purpose of this report SEE Med Region includes the areas of the Adriatic Sea, Ionian Sea, Strait of Sicily, Aegean Sea and northern part of the Levantine Sea.

The carrying out of seismic surveys may have implications on other economic activities, such as tourism and fisheries. Some of the SEE Med Region countries have the largest share of income from tourism contributing to GDP.

The issue of anthropogenic underwater noise and its impacts on the marine environment is already recognised at the international level, with a number of activities falling within the scope of international agreements and organisations, both those responsible for nature conservation and for various noise-producing sectors.

Guidelines on how to address, mitigate and prevent negative impacts of noise-generating activities, which include specific mitigation and management measures, are one of the most concrete outputs. Resolutions addressing concerns over underwater noise pollution, were adopted by ACCOBAMS (focussing on cetaceans) in 2010 and by CMS in 2017. The latter in particular provide guidance on how to undertake Environmental Impact Assessments (EIAs)

The EU legislation also supports the mitigation of anthropogenic noise with a number of directives and related conservation mechanisms. National legislation frameworks in the SEE Med Region are already aligned to the EU requirements or in the process of becoming so in the near future.

Knowledge about biodiversity is at the foundation of many concrete conservation efforts. Still, there is no systematic inventorying and monitoring of biodiversity in the SEE Med Region. Even baseline knowledge for cetacean biodiversity is lacking. Some initiatives, such as the ACCOBAMS Survey Project which is supposed to take place in summer 2018, should improve the state of knowledge. Stranding networks are organised in some form, to provide responses to stranding events and to record mortality.

The areas considered as internationally important as critical habitats for certain species or areas valuable for overall marine biodiversity already have significant recognition in the Region. The strongest mechanism is NATURA 2000 of the EU with appropriate assessment required for projects and plans which may have an impact on NATURA 2000 conservation objectives. However, this mechanism applies only to two cetacean species: harbour porpoise and common bottlenose dolphin and as such, do not tackle the cetacean species most sensitive to the anthropogenic underwater noise: Cuvier's beaked whale and sperm whale. On the other hand, all cetacean species are strictly protected in the EU.

With an amendment of legislation, environmental impact assessment should be implemented for seismic surveys too. Lack of data is also a challenge for good assessments as well as the general quality of studies and evaluations. Actual implementation and the effectiveness of mitigation measures are not clear. There is also a need for improved and transparent access to data, allowing to better understand the current and planned noise-generating activities in European waters.

Institutional and financial capacities are prerequisites for the implementation of any mechanisms. These are always limited, but the institutional framework exists and there are public and private funds available for implementation of conservation measures, mostly coming from the EU.

The future in the SEE Med Region could look like no seismic surveys in some sensitive areas, and strong mitigation measures in the areas where seismic surveys are allowed, as well as the employment of best available technology to reduce noise levels. Furthermore, there is a need to work on the improvement of knowledge, better communication between different stakeholders, better capacities and consequently better implementation of mitigation measures, including time and area closures, as well as the identification of "quiet zones".

In the context of seismic surveys, there is also the political question to be answered about the continued exploration and exploitation of fossil fuels, as well as risk management at exploitation sites, but these aspects are not subject to this Regional report.

1. Introduction

The increase in human activities over the last decades, such as seismic surveys for oil and gas exploitation, the use of military sonars, and maritime traffic have contributed to the rise in anthropogenic underwater noise as threat to marine biodiversity.

With adoption of the Paris Agreement to combat climate change in 2015, 195 countries have agreed on the future less dependent on fossil fuels. Still, the growing energy demand is mostly covered (86%) with the energy produced from fossil fuels (World Energy Council, 2016). However, hydrocarbon reserves are exhaustible, and oil and gas companies are in constant search for new wells. The SEE Med Region has become an area of interest in that respect in last years. At the same time, this region, as well as the entire Mediterranean Sea, represents one of the biodiversity hotspots. Finding the right balance and assuring not to threaten marine biodiversity is the challenge.

This Regional report aims to facilitate the understanding by different stakeholders of the various aspects of the anthropogenic underwater noise issue in the SEE Med Region. As such, the Report served as a basis for discussions about concrete steps towards the mitigation of impacts of anthropogenic noise in the Region, which took place at the first regional "Workshop on mitigating the impact of underwater noise on marine biodiversity with specific focus on seismic surveys in the south-eastern European part of the Mediterranean Sea" (Regional workshop) in Split, Croatia, on the 22nd and 23rd of November 2017. The workshop was organised by OceanCare in cooperation with the Natural Resources Defense Council (NRDC) and with the support of the Deutsche Bundesstiftung Umwelt (DBU).

2. Methodology

The **Geographical scope** of this report covers the southern and eastern European waters of the Mediterranean Sea, more specifically the area of the Adriatic Sea, Ionian Sea, Strait of Sicily, Aegean Sea and the northern part of the Levantine Sea – SEE Med Region (Figure 2.1). This area includes 10 Mediterranean countries: Albania, Bosnia and Herzegovina, Croatia, Cyprus, Greece, Italy, Malta, Montenegro, Slovenia and Turkey.

Data collected for preparation of the report comes mostly from the literature, reports, and other documents published by relevant experts or prepared in the scope of international/regional agreements. In addition, for some specific data, notably data about planned seismic surveys and projects with an anthropogenic underwater noise component (such as noise mapping, mitigation measures, etc.), a questionnaire was distributed to selected contacts.

One relevant, recently prepared document, which already included data on seismic surveys in the Mediterranean, is the report produced in the scope of ACCOBAMS in 2016. "Overview of the noise spots in the ACCOBAMS area – Part I, Mediterranean Sea" prepared by A. Maglio, G. Pavan, M. Castellote and S. Frey². The report was presented to the 6th Meeting of Parties organised in November 2016 in Monaco. For all the targeted activities, except marine traffic, data were collected for the period from 2005 to 2015 and the near future (period until 2020). Among all, this report contains information about planned surveys from 2015 to 2020, but it is opened to further updating. The idea of the Regional report was to update these data on seismic surveys for the SEE Med Region and, if possible, project the trend into the future compared with 2015. Hence, the starting point for data acquisition was the ACCOBAMS Secretariat, which provided data from the Overview report. In addition, ACCOBAMS focal points were contacted, as well as members of the ACCOBAMS/ASCOBANS Joint Noise Working Group and cetacean experts from Turkey.

The majority of the approached ACCOBAMS FPs and cetacean experts from Turkey responded, but few were able to actually provide data and give information about environmental projects with an anthropogenic noise component. Finally, as in the Overview report, data were mostly collected via internet, from the web pages of energy companies, authorities in charge of licensing, and from newspaper articles and therefore cannot been seen as exhaustive. This fact documents the lack of accessibility of such data, which also makes it difficult to allow proper judgements about potential cumulative effects or even duplication of activities.

The Report was opened for commenting to the participants of the aforementioned Regional workshop.

² Prepared with contribution from M. Bouzidi, B. Carlo, N. Entrup, M. Fouad, F. Leroy and J. Mueller



Figure 2.1. Geographical scope of the Report – southern and eastern part of the European waters in the Mediterranean (Source: *IUCN, 2012*)

3. Overview of the state of marine biodiversity, focussing on fauna sensitive to anthropogenic noise

3.1. General overview of the marine biodiversity in the Mediterranean Sea

The Mediterranean Sea is the largest and deepest enclosed sea in the world. Although it covers less than 1% of the world seas, it is a marine biodiversity hotspot (UNEP/MAP, 2016). Approximately 17,000 marine species occur in the Mediterranean Sea and around 20 % are endemic (Coll et al, 2010). The dominant animal species group are crustaceans (13.2%), whilst vertebrates make up 4.1%. The Aegean Sea, Strait of Sicily, and the Adriatic Sea stand out for species richness in the SEE Med Region (Figure 3.1). There is still a significant knowledge gap, but there are indications that biodiversity is even richer than previously assumed.

At the same time, the marine and coastal ecosystems are threatened, mainly from various anthropogenic sources. The most significant threats are habitat loss and degradation, interaction with fisheries, pollution, disturbance, eutrophication, climate change and invasive alien species (Coll et al, 2010, UNEP/MAP, 2012). Anthropogenic noise is considered as one form of the pollution³.



Figure 3.1. Spatially predicted patterns of species richness in the Mediterranean Sea based on the AquaMaps model (includes marine mammals, sea turtles, ray-finned fish, elasmobranchs and invertebrates) (Source: *Coll et al, 2010*)

³ As defined by the UN Convention on the Law on the Sea (UNCLOS)

3.2. Marine biodiversity related to underwater noise

The ocean environment is filled with natural sounds from animals and physical processes. Species living in this environment are adapted to these sounds, not to growing anthropogenic underwater noise. Marine mammals, sea turtles, and fish are known to be most susceptible to noise, hence the focus in this chapter is given to these groups of animals.

Humans are also a part of biodiversity, and reply on many of the species for livelihoods, while at the same time are the force that produces the greatest impacts.

3.2.1. Marine mammals

3.2.1.1. Occurrence, abundance and distribution

All marine mammals regularly encountered in the Mediterranean Sea also occur in the SEE Med Region. There are eleven cetacean (Notarbartolo di Sciara and Birkun, 2010) and one seal species – monk seal (Table 3.1). Most of them are regular inhabitants.

In addition, six species are visitors or vagrant in the Mediterranean where recorded in the Region: common minke whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*), false killer whale (*Pseudorca crassidens*), North Atlantic right whale (*Eubalaena glacialis*), dwarf sperm whale (*Kogia sima*), and possibly Gervais' beaked whale (*Mesoplodon europaeus*) in Turkey.

The abundance of cetaceans in the region is still mostly unknown. In the Adriatic Sea, for example, the aerial surveys implemented in 2010 and 2013 provided the first overview of the distribution of cetaceans in the entire Adriatic Sea, as well as abundance and density estimates (Fortuna, Holcer, Mackelworth (eds.), 2015). The minimum estimate for the abundance of the common bottlenose dolphin in the Adriatic Sea is 10,573 and for the striped dolphin, 41,533.

Cañadas et al. (2011) predicted densities of Cuvier's beaked whales, as one of the most sensitive cetacean species to anthropogenic noise (Figure 3.2).

The estimated total population of monk seals in the Mediterranean Sea is 350 – 450 animals, with 250 – 300 in the SEE Med Region (Lüber et al., 2015a). The SEE Med Region is a critical habitat for this species, particularly the Aegean Sea, eastern part of the Ionian Sea and northern part of the Levantine Sea (Figure 3.3). In addition, potential habitats are registered in some parts of the Croatian and Montenegrin waters of the Adriatic Sea (Mackelworth et al, 2006; Grupa sredozemna medvjedica, 2008 and Mačić et al, 2014).



Figure 3.2. Relative density of Cuvier's beaked whales predicted based on habitat modelling (1990 – 2010 data) (Source: *Cañadas et al., 2011*).



Figure 3.3. Updated (2016) distribution of the monk seal in the Mediterranean Sea (Source: ©*Schnellmann/The Monachus Guardian, 2016*)

Table 3.1. Marine mammals in the Adriatic Sea, Ionian Sea, Aegean Sea and northern Levantine Sea (SEE Med Region)⁴. Based on *Notarbartolo di Sciara and Birkun, 2010; IUCN, 2012; Panigada et al, 2017; Fortuna, C.M., Holcer, D., Mackelworth, P. (eds.) 2015. and EUNIS, 2017*

Order/Family/Scientific name	Common name (for the species)	Occurrence for the Region	Mostly found or occurred (for visitors)	IUCN Status in the Mediterranean ⁵	Conservation status under the EU Habitats Directive (based on data from 2007 – 2012)
CETACEA					
Delphinidae					
Delphinus delphis	Short beaked common dolphin	Regular	Strait of Sicily, off Malta, eastern Ionian Sea (Gulf of Corinth), Aegean Sea	Endangered (EN)	Unfavourable - bad ⁶
Globicephala melas	Long-finned pilot whale	Vagrant	One sighting of small pod in the north-west Adriatic Sea	Data deficient (DD)	-
Grampus griseus	Risso's dolphin	Regular	Eastern and western Ionian Sea, southern Adriatic	Data deficient (DD)	Unfavourable – inadequate ⁷
Orcinus orca	Killer whale	Vagrant	Single occurrence in the Ioanian Sea	Critically endangered (CR)	-
Phocoena phocoena	Harbour porpoise	Regular	Northern Aegean Sea	Endangered (EN)	Unfavourable - inadequate
Stenella coeruleoalba	Striped dolphin	Regular	Adriatic Sea, Ionian Sea, Levantine Sea, Aegean Sea? (no data)	Vulnerable (VU)	Unkown ⁸
Steno bredanensis	Rough-toothed dolphin	Regular	Eastern Levantine Sea (Cyprus)	Not evaluated (NE)	-
Tursiops truncatus	Common bottlenose dolphin	Regular	Adriatic Sea, eastern Ionian Sea, along the coasts of Sicily and Malta, southern Aegean Sea (Crete)	Vulnerable (VU)	Unfavourable - inadequate
Ziphidae					
Ziphius cavirostris	Cuvier's beaked whale	Regular	Ionian Sea, south of the Adriatic, Hellenic trench	Data deficient (DD)	Unfavourable - inadequate

⁴ Marine mammals regular in the Mediterranean

⁵ The IUCN – ACCOBAMS Red List assessments was adopted by the Meeting of Parties to ACCOBAMS in 2007 (Resolution 3.19).

⁶ Unfavourable – bad = species is in serious danger of becoming extinct (at least regionally)

⁷ Unfavourable – inadequate = a change in management or policy is required to return species in favourable status

⁸ Unknown = insufficient information available to allow asssessment

Physeteridae					
Physeter macrocephalus	Sperm whale	Regular	Ionian Sea, along the Hellenic Trench from the northern Ioanian Sea to the western Levantine Sea	Endangered (EN)	Unfavourable - bad
Balaenopteridae					
Balaenoptera physalus	Fin whale	Regular	Strait of Sicily, western Ionian Sea, southern Adriatic	Vulnerable (VU)	Unknown
PINNIPEDIA					
Phocidae					
Monachus monachus	Monk seal	Regular	Eastern part of the Ionian Sea, Aegean Sea, north-eastern part of the Levantine Sea	Critically endangered (CR)	Unfavourable - bad

3.2.1.2. Conservation status and threats

Marine mammals are mostly listed as threatened (categories CR, EN, VU) or lacking in information to assess the IUCN Red list status (Table 3.1). Two cetacean species are particularly sensitive to the anthropogenic underwater noise: Cuvier's beaked whale and sperm whale. They are assessed as Data deficient (DD) and Endangered (EN), respectively.

The SEE Med Region seems to be a hotspot for threatened marine mammals (Figure 3.4).

According to the national reports under the EU Habitats and Bird Directives for the 2007-2012 period, the conservation status of cetaceans for the Mediterranean biogeographical region is mostly unfavourable, with sperm whales, short beaked common dolphin and monk seal under threat of extinction in the region (Table 3.1).



Figure 3.4. Species richness of marine mammals in the Mediterranean Sea (left) and richness of threatened species (right) (Source: *IUCN, 2008*)

The anthropogenic underwater noise is among the major threats to the marine mammals in the Mediterranean Sea, as well as the Black Sea (Figure 3.5).



Figure 3.5. Major threats to the resident marine mammals in the Mediterranean and Black Seas (Source: *IUCN, 2012*)

3.2.2. Sea turtles

3.2.2.1. Occurrence, abundance and distribution

Three sea turtles species are regular in the Region: green turtle (*Chelonia mydas*), loggerhead turtle (*Carretta caretta*) and leatherback turtle (*Dermochelys coriacea*), but there is no evidence of nesting for the latter. Hawksbill (*Eretmochelys imbricata*) and Kemp's riddle turtles (*Lepidochelys kempi*) are considered to be vagrants (Coll et al, 2010 and IUCN, 2012). The Eastern Mediterranean is the most important area for sea turtle nesting (Figure 3.6). The aerial survey implemented in the Adriatic Sea also contributed to improvement of knowledge about sea turtles in the area, including distribution patterns and abundance (Fortuna, Holcer, Mackelworth (eds.), 2015). Loggerhead turtles are a dominant species. Probably less than 2% of observed turtles are green turtles. The minimum estimates of sea turtles in the area is 31,051.



Figure 3.6. Major nesting sites of *Caretta caretta* and *Chelonia midas* in the Mediterranean (Source: *IUCN, 2012, based on Casale and Margaritoulis, 2010*)

3.2.2.2. Conservation status and threats

According to the IUCN Red list assessment at the global level, all three regular sea turtles species are threatened; the green turtle and the loggerhead turtle are Endangered (EN), and the leatherback turtle is Critically endangered (CR). The conservation status under the Habitats Directive for loggerheads and green turtles is unfavourable to bad (EUNIS, 2017).

Main threats to the sea turtles in the marine habitats are by-catch, intentional killing and exploitation. (Casale and Margaritoulis, 2010). However, there is a growing concern about impacts of anthropogenic underwater noise (Prideaux, 2017).

3.2.3. Fish and invertebrates

3.2.3.1. Occurrence, abundance and distribution

The Mediterranean Sea harbours around 7% of the global number of marine fish species (IUCN, 2011). Of the 519 native marine fish species and subspecies, 85% are bony fish and 15%, cartilaginous fish (sharks, rays and chimaeras).

The western part of the Mediterranean is richer in number of species due to higher productivity (Figure 3.7). In the SEE Med Region the richest are coastal areas of the northern Ionian Sea (coasts of Italy and Greece). The endemic species are also more concentrated in the western part of the Mediterranean, with the Adriatic Sea standing out as endemism hot spot of the Region. The Region is also particularly rich in invertebrates (Figure 3.8). The Mediterranean Sea is also the area of distribution of the large marine fish Giant Devil Ray (*Mobula mobular*) (Notarbartolo et al, 2015). Based on the results of the 2010 and 2013 aerial surveys in the Adriatic Sea, it is estimated that over 3.000 animals are present in central and souther Adriatic Sea during summer months (Blue World, 2017). New studies also indicate importance of the Levantine basin for wintering of the species.



Figure 3.7. Species richness of native marine fish in the Mediterranean Sea (Source: *IUCN, 2011*)



Figure 3.8. Spatial predicted patterns of richness of invertebrates in the Mediterranean Sea based on the AquaMaps model (Source: *Coll et al, 2010*)

3.2.3.2. Conservation status and threats

The majority of species are assessed as Least Concerned (LC), but there are more than 8% of threatened fish species and around 29% assessed as Data Deficient (DD), which means there is still a significant knowledge gap (IUCN, 2011). Sharks and rays are among the most threatened species. Giant Devil Ray is listed as Endangered (EN). More than half of fish species are threatened by direct fishing or by-catch (Figure 3.9).



Figure 3.9. Threats to native marine fish in the Mediterranean (Source: IUCN, 2011)

Fish stocks in the Mediterranean Sea are declining significantly. A recent analysis, based on the existing data, shows that 93% of the assessed fish stocks are overexploited, and a number of them are on the verge of depletion (Piroddi et al, 2016). Furthermore, over the past 50 years the Mediterranean Sea has lost 41% of the number of marine mammals and 34% of the total amount of fish. The Western Mediterranean Sea and the Adriatic Sea have showed the largest reduction (50%) and Ionian Sea much less (8%). The major indicated driver for the change is the variability of primary production.

3.2.4. Human population

3.2.4.1. Occurrence and ecological footprint

The Mediterranean is home to around 480 million people, of which one third is concentrated in the coastal region. The population primarily inhabits urban areas. Over last 60 years, urban population growth has been increasing in all parts of the Mediterranean, from 48 to 67% (UNEP/MAP, 2016).

There is significant pressure of human population on biodiversity, which is more amplified due to geographical features of the Mediterranean Sea.

The Mediterranean ecological footprint⁹ amounts to 3 gha per capita, which means the environmental capacity is used faster than it is renewed. It is also higher than the ecological footprint on the planet (2,6 gha per capita) (UNEP/MAP, 2013) (Figure 3.10).



Figure 3.10. Global ecological footprint (Source: <u>www.footprintnetwork.org</u>, 2013)

⁹ The Ecological footprint is the measure used to access the level of consumption of available resources related to human activities and thus the level of pressure to biodiversity.

4. Anthropogenic noise

4.1. General overview of the sources of anthropogenic noise¹⁰

4.1.1. Main sources of anthropogenic noise

Maritime traffic, military exercises, seismic surveys, and coastal and offshore projects are the main human activities producing underwater noise. They produce noise of different frequency, pressure, directionality and duration (Table 4.1). All these activities are very much present in the Mediterranean Sea. In the SEE Med Region, the noise hotspots identified so far are in the northern part of the western Adriatic, parts of the northern Ionian Sea and the Strait of Sicily (Figure 4.1). In addition, one must also take into consideration that these activities may cause other problems for the environment such as pollution or they may serve as vectors for invasive alien species. There is also a higher possibility for oil spills if seismic surveys undertaken in certain areas result in drilling and exploitation activities of hydrocarbon resources, and subsequently with an increase of traffic.

Activity	Sound Intensity Level (dB re1 ìPa)	Bandwidth	Major Amplitude	Duration	Directionality
Military					
Military Low-Frequency Active Sonar	240 Peak @ 1m	<1kHz- 1khz	[unknown]	600-1,000ms	Horizontally focused
Military Mid- Frequency Active Sonar	235 Peak @ 1m	1-5kHz	[unknown]	1-2s	Horizontally focused (3 degrees down)
Continuous	182 Peak @	500Hz – 3kHz	[unknown]	18 seconds	Horizontally

Table 4.1. Noise-generating activity, sound intensity level, bandwidth, major amplitude, duration and directionality (Source: *Prideaux, 2017*)

¹⁰ The *CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities* make a specific distinction between sound and noise in the marine environment. 'Sounds' are all natural acoustic signals, and include biological (marine animals) and physical processes (earthquakes, wind, ice and rain etc). Summed together, these are understood as the ambient (non-anthropogenic) sound levels in a given area. 'Noise' is all anthropogenic acoustic signals that are in addition to the natural ambient background, except with using the technical term 'sound intensity level' which is also noise.

Active Sonar	1m				focused	
Military Mine Counter Measures Sonar	[unknown]	100kHz- 500kHz	[unknown]	[unknown]	[unknown]	
Seismic Surveys						
Seismic Surveys	260-262 Peak to Peak @ 1m	10Hz-150kHz	10-120Hz also 120dB up to 100kHz	30-60ms	Vertically focused	
Civil High Power	Sonar					
Single Beam Sounders	240 Peak @ 1m	12kHz- 700kHz depending on the application	[unknown]	0.1ms	Vertically focused	
Sidescan Sonar	240 Peak @ 1m	12kHz- 700kHz depending on the application	[unknown]	0.1ms	Vertically focused fan spread	
Multibeam Echosounders	240 Peak @ 1m	12kHz-30kHz, 70kHz- 200kHz, 300kHz- 500kHz depending on the application	[unknown]	0.1ms	Vertically focused fan spread	
Sparkers and Boomers	204-220 _{rms} @ 1m	80Hz-10kHz	[unknown]	0.2ms	[unknown]	
Chirps	210-230 Peak @ 1m	20Hz-20kHz	[unknown]	250ms	[unknown]	
Coastal and Offsh	nore Construction	on Works				
Explosions, TNT 1-100lbs	272-287 Peak @ 1m	2Hz- ~1,000Hz	6-21Hz	<1-10ms	Omnidirectional	
Pile Driving	248-257 Peak to Peak @ 1m	20Hz-20kHz	100Hz-500Hz	50ms	Omnidirectional	
Dredging	168-186 _{rms} @ 1m	20Hz-1kHz	500Hz	Continuous	Omnidirectional	
Offshore Platforms						
Platform Drilling	150 _{rms} @1m	30Hz-40Hz	[unknown]	Continuous	Omnidirectional	
Drill Ships (including maintenance)	190 _{rms} @ 1m	10Hz-10kHz	[unknown]	Continuous	Omnidirectional	

Positioning transponders	100 _{rms} @ 2km	20kHz – 35kHz	[unknown]	Continuous	Omnidirectional	
Playback and Sound Exposure Experiments						
Ocean Tomography	165-220 Peak @ 1m	50Hz-200Hz	[unknown]	[unknown]	Omnidirectional	
Shipping and Ves	sel Traffic					
Small Vessels	160-180 _{rms} @ 1m	20Hz-10kHz	[unknown]	Continuous	Omnidirectional	
Medium Vessels	165-180 _{rms} @1m	Below 1kHz	[unknown]	Continuous	Omnidirectional	
Large Vessels	Low Frequency 180-190 rms @ 1m High Frequency 136 rms @ 700m	Low Frequency A few hundred Hz High Frequency 0.354khz- 44.8khz	[unknown]	Continuous	Omnidirectional	
Pingers	-	-	-	-		
Acoustic Navigation Beacons	160-190 Peak @ 1m	8kHz-16kHz	[unknown]	[unknown]	Omnidirectional	
Acoustic Deterrent Devices	130-135 Peak @ 1m	9kHz-15kHz	[unknown]	100-300ms	Omnidirectional	
Acoustic Harassment Devices	190 Peak @ 1m	5khz-20kHz, 30kHz- 160kHz depending on the application	[unknown]	[unknown]	Omnidirectional	
Other Noise-generating Activities						
Acoustic Data Transmission	185-196 @ 1m	18kHz-40kHz	[unknown]	[unknown]	Omnidirectional	
Offshore Tidal and Wave Energy Turbines	165-175 _{rms} @ 1m	10Hz-50kHz	[unknown]	Continuous	Omnidirectional	
Wind Turbines	90-112 _{rms} @ 110m	50Hz-20kHz	[unknown]	Continuous	Omnidirectional	



Figure 4.1. Noise hotpots in the ACCOBAMS area (Source: Maglio et al., 2016)

The Mediterranean Sea is one of the busiest area for **marine traffic**. The main routes connect the Mediterranean to the Atlantic Sea, Black Sea and Red Sea. In the SEE Med Region, the most intensive traffic density is both in the Aegean Sea and the Adriatic Sea, as well as the Strait of Sicily (Figure 4.2).



Figure 4.2. Snapshot of maritime traffic density in the Mediterranean based on the Automatic Identification System (AIS) (Source: <u>www.marinetraffic.com</u>, 2017)

When it comes to **coastal activities**, there are over 1440 harbours and ports in the Mediterranean, with high density in the northern part of the Adriatic (Maglio et al, 2016).

Offshore activities include over 200 hydrocarbon extraction wells, particularly in the Italian side of the Adriatic. Construction of offshore wind farms is approved in southern Italy and parts of Greece (in the Aegean Sea).

Available data on **military areas** for Spain, France, Italy, Greece and NATO show that these activities are concentrated in the Western Mediterranean, but they are also present in the western and southern parts of the Adriatic Sea, off the Sicily coast and in smaller parts of Greek waters (Maglio et al, 2016). However, the war in Syria shifted the military activities to the eastern part of the Mediterranean. Several military exercises were organized in the waters off Cyprus (Bender, Business Insider, 2015, CyprusMail Online, 2017).

Seismic surveys, done mostly for oil and gas exploration, are still very much present in the region (more information in Chapter 4.2.).

4.1.2. Other sources

Tourism is a very significant economic activity in the Mediterranean. However, tourist activities are seasonal, with peaks in the summer. Nautical tourism is one of the common activities, particularly in the coastal areas.

4.2. Seismic surveys

Box 1. What is a seismic survey?

A seismic survey is a form of geophysical survey widely used for oil and gas (hydrocarbon) exploration. It tries to deduce elastic properties of material by measuring their response to seismic (elastic) waves, produced by airguns (Figure 4.3). The airguns produce high-intensity, low-frequency impulsive noise at regular intervals, mostly between 10 and 300 Hz (Carroll et al., 2017). The typical discharge sound intensity level of each pulse of an air gun array is around 260-262 dB in water at 1m, peak to peak value, (260-262 dB re 1µPa @ 1m p-p) (OSPAR, 2009) every 10-15 seconds, and surveys typically run more or less continuously over many weeks (Prideaux, 2017).

Two-dimensional seismic data (2D) are usually used when searching for hydrocarbons in a relatively unexplored area, whilst three – dimensional data (3D) are used for detailed mapping in an already known area (Rafaelsen, 2006). For reservoir monitoring, so-called 4D seismic is used, which is the equivalent to repeated 3D surveys over time (Dalen, 2007).

During 2D surveys the vessel follows lines or a grid where the lines are relatively far apart (1 km or more). One noise source is used, composed of several air guns to form an air gun array and one hydrophone cable. The air gun is normally fired every 25 meters or every 10 seconds at a speed of 5 knots.

3D surveys use hydrophone cables and, usually, two sources of noise fired alternately. The surveys cover a far denser grid with grid meshes as small as 25 x 25 m. This means that the ship has to run fewer lines to cover the same area.



Figure 4.3. Scheme of an offshore seismic survey (Source: <u>www.krisenergy.com</u>)

4.2.1. Regional overview of seismic surveys

In the last decade the SEE Med Region has become an area of growing interest for exploration and exploitation of oil and gas. While, for instance, the Strait of Sicily and part of the Levantine Sea off Cyprus were surveyed since the early 2000's, in 2012 and 2013, seismic surveys extended to the areas of the Adriatic Sea and Aegean Sea (Maglio et al., 2016). Based on available data, one can conclude that significant parts of the Mediterranean Sea have been the subject of seismic surveys since 2005 (Figure 4.4).

As it stands now, all regional seas in the SEE Med, apart from the Aegean Sea, are to be subjects of future seismic surveys.

According to the available information, in addition to the planned future surveys displayed in Maglio et al., 2016, new developments emerged in the area of the southern Adriatic, off Montenegro near the border with Albania (EIA study, 2017) and south of Cyprus (ENI, 2017) (Figure 4.5). Furthermore, in the spring of 2017, Turkey launched a vessel to carry out seismic surveys northwest of Cypriot island, in the EEZ (LGC News, 2017).

As for Montenegro, the Strategic Environmental Assessment was concluded in 2016 for Programme of exploration and production of hydrocarbons in the offshore of Montenegro. Before that, the first bid round for the award of Hydrocarbons Production Concession Contracts was launched in 2013 in which 13 blocks/parts of blocks were offered (Montenegro Hydrocarbon Administration, 2016). Based on submitted offers the Government of Montenegro signed 30 years Concession Contracts for Production of Hydrocarbons (PCC) in part of Montenegrin waters for 6 blocks in September 2016 and March 2017, respectively (Milić, Glas Amerike, 2017). As a first step, implementation of 3D seismic surveys is foreseen in 2018. The EIA study¹¹ was prepared for 4 blocks and from end of September to beginning of November 2017 this study was a subject of the public consultation process (EPA, 2017). The special Commission appointed by the Director of the Environment Protection Agency of Montenegro has to assess whether the study sufficiently proved that such seismic survey would not have negative impacts to marine environment. The next bid to extend the explorations is already announced for 2019 (Milić, Glas Amerike, 2017). The southern part of the Adriatic has also been an area of interest for seismic surveys in Italian waters.

Hydrocarbons have been also explored and produced in Malta's south-eastern offshore area (Continental Shelf Department, 2017). A 3D seismic survey was carried out in the end of 2016, and collected data from is being processed and analyzed.

¹¹https://www.dropbox.com/s/f57d6lx6vy2eex6/Elabora%20o%20pricjeni%20uticaja%20na%20zivotnu%20sre dinu_EN.pdf?dl=0

The Levantine Sea has also become one of the most dynamic areas for hydrocarbons exploration and exploitation activities. In 2015 the large gas reserve was discovered in Egyptian waters close to Egypt/Cyprus border; Zohr 1 – well (Esestime et al, 2016) (Figure 4.6), which contributed to intensification of activities in the offshore area south of Cyprus, including planned 2D and 3D seismic surveys (CyprusMail online, 2017a). This case stresses the transboundary feature of the seismic surveys issue and calls for cooperation with countries beyond the SEE Med Region.



Figure 4.4. Areas of seismic surveys (licensed and implemented) in the Mediterranean from 2005 to 2015 (Source: *Maglio et al., 2016*)



Figure 4.5. Planned seismic surveys (licensed, under the application) in the wider SEE Med Region, presumably until 2020 (based on *Maglio et al., 2016* and updated with data for Cyprus and Montenegro). Prepared by Silvia Frey, PhD and Bruno Claro from OceanCare.



Figure 4.6. Map indicating the location of Zohr Discovery and complexity of hydrocarbon exploration activities in the Levantine Sea (white lines show the Spectrum 2D seismic library) (Source: *Esestime et al, 2016*)

5. Impacts of anthropogenic underwater noise on marine biodiversity, focussing on the impacts of seismic surveys

5.1. Cumulative impacts to the marine environment

No threat to marine diversity exists alone. The National Centre for Ecological Analysis used a model which overlapped the most significant human pressures on the Mediterranean marine environment with a distribution of ecosystem types of various vulnerability. It shows that the Mediterranean Sea environment is already significantly impacted (Figure 5.1). Hence, each new pressure in terms of content and spatial coverage, contributes to further degradation and losses. The analysis suggests that the Adriatic Sea is one of the most impacted areas.

In addition, species are parts of a complex trophic network. Elimination or degradation of one piece of this puzzle affects others (Figure 5.2).



Figure 5.1. Model of cumulative environmental impacts in the Mediterranean (Source: *National Centre for Ecological Analysis, 2008*. Format used in this report acquired at <u>www.grida.no</u>)



Figure 5.2. Flow diagram of the Mediterranean Sea ecosystem to illustrate linkages between various species (Source: *Piroddi et al, 2016*)

5.2. Impacts of anthropogenic noise, with a focus on seismic surveys

Sound travels approximately four times faster in seawater than in air. (Brekhovskikh and Lysanov, 2006, Au and Hastings 2009, Ross 2013). Given the characteristics of seawater as a medium, sound can covers longer distances at higher amplitude levels than in air (Nelms et al., 2016, Prideaux 2017). No wonder that many marine organisms use sound to communicate, navigate, locate food and generally sense and interpret their environment (NPWS, 2014). On the other hand, an array of human activities produce underwater noise, often at similar frequencies, which may have harmful effects on marine biodiversity.

Animals that are exposed to elevated or prolonged anthropogenic noise may experience direct injury ranging from bruising to organ rupture and death (barotrauma). This damage can also include permanent or temporary auditory threshold shifts, compromising the animal's communication and ability to detect threats. Animals can be displaced from important habitats. Finally, noise can mask important natural sounds, such as the call of a mate, the sound made by prey or a predator.

In addition, factors such as stress, distraction, confusion and panic, can affect reproduction, death and growth rates, in turn affecting the long-term welfare of populations of animals. (Southall *et al.*, 2000, Southall *et al.*, 2008, Clark *et al.*, 2009, Popper *et al.*, 2014, Hawkins and Popper, 2016, Prideaux, 2017b)

Several groups of fauna have been well researched, particularly marine mammals and fish (Figure 5.3). In the following sections an overview is given of the recorded impacts on these particular taxa, with a focus on effects from anthropogenic underwater noise produced from seismic surveys.



Figure 5.3. Proportion of scientific papers on anthropogenic noise across fauna (Source: *Williams et al, 2015*)

5.2.1. Impacts on marine mammals

There is a specificity in the auditory ability and functional frequencies for different marine mammal species (Table 5.1). Cetaceans from the region mostly operate in the mid frequencies. This overlaps with noise produced by certain anthropogenic sources (Figure 5.4).

Table 5.1. Functional frequencies of the various marine mammal species in the SEE Med Region (adapted from *NPWS, 2014 and NOAA, 2016*)

Marine mammals groups	Species in the SEE Med Region	Frequencies	
CETACEANS			
Baleen whales	Fin whale	7Hz – 22 kHz (Low frequency)	
Most toothed whales, dolphins	Sperm whale, killer whale, Cuvier's beaked whale, dolphin species	150 Hz – 160 kHz (Mid frequency)	
Certain toothed whales, porpoises	Harbour porpoise	200 Hz – 180 kHz (High frequency)	
PINNIPEDS	Monk seal	50 – 86 Hz	


Figure 5.4. Frequency range for communication between marine mammals compared with frequencies of noise produced by certain anthropogenic sources (Source: *Dalen, 2007*)

The knowledge about actual impacts of anthropogenic underwater noise from seismic surveys on marine mammals has grown considerably in recent years. Potential and known impacts may be grouped in several categories ranging from possible physical damage to indirect effects, such as noise driven shifts in availability of prey (Table 5.2).

Impact	Effects on animal
Mortality	Death from damage sustained during noise exposure
Injury to tissues; disruption of physiology	Damage to body tissue, e.g internal haemorrhaging, disruption of gas- filled organs like the swim bladder, consequent damage to surrounding tissues
Damage to the auditory system	Rupture of accessory hearing organs, damage to hair cells, permanent threshold shift, temporary threshold shift
Masking	Masking of biologically important sounds including sounds from conspecifics
Behavioural changes	Interruption of normal activities including feeding, schooling, spawning, migration, and displacement from favoured areas
	These effects will vary depending on the noise level and distance

able 5.2. Potential impacts of noise exposure	(Source:	Hawkins and	Popper,	2016)
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5.2.2. Impacts on sea turtles

Sea turtles are highly migratory, moving periodically within the marine environment and into the terrestrial environment to forage and breed (Godley et al, 2010).

The effects of anthropogenic noise from seismic surveys on sea turtles is much less researched than those on marine mammals (Figure 5.3). Still, some knowledge exists. Research on the majority of the sea turtles occurring in the SEE Med region shows that they are able to detect sounds of low frequencies, which overlap with the low frequency noise of seismic airguns (Nelms et al, 2016). Similar to marine mammals, noise from airguns potentially cause physical damage, hearing damage, behavioural change, chronic impacts, and stress (Popper et al., 2014), as well as entanglement in the equipment (Nelms et al., 2016). According to McCauley et al. (2000), a typical airgun array operating in the depths between 100 and 120 m could impact the behaviour of sea turtles at 2 km and cause avoidance at around 1 km. Hearing thresholds of sea turtles are still unknown.

5.2.3. Impacts on fish and invertebrates

Fish are also able to detect sound. The sensitivity to certain frequencies varies in different fish species. For instance, the cartilaginous fish (sharks, rays), which lack gas-filled air bladders, are highly sensitive to low frequency sound (approximately 20 to 1,500 Hz) (Myrberg, 2001; Casper, 2013). Fish with swim bladders are more susceptible to physical injury such as barotrauma (Popper et al., 2014). Invertebrates have structures which enable detection of sound waves in their immediate vicinity (Kaifu et al., 2008). Besides sea turtles, sharks and rays are very under-represented in anthropogenic noise impact studies (Weilgart, 2017).

Seismic surveys may have physical, behavioural, physiological, and catch rate effects on both fish and invertebrates (Carroll et al, 2017). Again, a reduction in fish availability has effects on cetaceans and other species in the food web.

For fish, there are few actual data about physical injuries caused by seismic surveys. Behavioural changes are better known, although often based on experiments in laboratories. These show both negative and positive impacts. There is a lack of knowledge about masking of natural sounds by seismic surveys, as well as effects on biological and physiological processes (Carroll et al, 2017).

Some commercial fish catch was reduced up to 80% due to noise (Weilgart, 2017). However, there is contradictory evidence regarding the impacts of seismic surveys, in particular (Carroll et al., 2017). For invertebrates, no effects on catch rates have been detected so far (Carroll et al., 2017). It should also be noted that most of the research has been carried out outside of the Mediterranean region.

Recent studies show that widely used marine seismic survey air gun operations negatively impact zooplankton (McCauely et al., 2017). In addition, it is also documented that anthropogenic noise such as ship noise even affects DNA integrity of mussels (Kight & Swaddle, 2011, Wale et al., 2016). These impacts can cause reduced growth, reproduction, and immune response.

5.3. Impacts on regional populations

There is a lack of knowledge about actual impacts of anthropogenic noise in general at the population level in the Mediterranean Sea, let alone about the impacts of seismic surveys. One of the primary reasons is a lack of baseline knowledge about the abundance and distribution of species. On the other hand, even if certain baseline knowledge exists, it is difficult to correlate seismic surveys with recorded mortality. In the Croatian part of the Adriatic Sea, for example, a 2D seismic survey was implemented at the end of 2013/beginning of 2014. The recorded mortality of cetaceans in the Adriatic Sea, as well as sea turtles in the Croatian part of the Adriatic, increased in 2014 when compared to 2013, for about 24% for each group of species (Fortuna, Holcer, Mackelworth (eds., 2015 and Jelić et al., 2017). It may be a consequence of the increased monitoring effort under the IPA Adriatic NETCET project (2012 - 2015), as well as the stranding of sperm whales in the second half of 2014. It should be noted that due to the bad conditions of the carcasses, it was difficult to determine the cause of mortality. However, interaction with fisheries was the most common recorded cause, as well as mechanical injuries of sea turtles (Fortuna, Holcer, Mackelworth (eds.), 2015 and Jelić et al., 2017). There was no proven link to seismic surveys, though one should consider that this would be difficult to demonstrate. On the other hand, there was a case in the western Mediterranean Sea when it was suspected that seismic surveys caused atypical mass strandings of sperm whales (ACCOBAMS SC10, 2015).

5.4. Socio – economic impacts

The consumption of energy is fundamental to modern society and the main source are fossil fuels. Although the burning of fossil fuel and the resulting climate change have resulted in a shift of focus to renewable sources of energy, according to the International Energy Agency, in 2040, oil and gas will probably meet half the global growing energy needs (OECD, IEA, 2016). A healthy environment is a requirement for human existence and economic activities. The Mediterranean Sea could be viewed as an arena of competition for space and resources. For example, the Mediterranean is a known tourist hot spot. Concerns have been raised by many stakeholders not exclusively relating to seismic surveys per se, but in reaction to the general hydrocarbons exploration and exploitation activities and possible negative events. Oil spills, as one of possible consequences, would put not just marine biodiversity at risk but also other interests, such as tourism and fisheries, at least in some areas.

This issue was raised during debates about seismic surveys and possible future oil exploitation in Croatia, especially as the Croatian economy depends significantly on tourism. The share of travel and tourism contribution to the GDP in Croatia is among the highest in Europe – 24,7%, followed by other countries in the region – Montenegro, Cyprus, and Greece (Figure 5.4). Any oil spill in a semi-enclosed area such as the Adriatic Sea, may be the end of tourism in the region, at least for some time. The central part, as well as the entrance to the Adriatic Sea are already indicated as hotspots of possible oil spills, which is related to transport of hydrocarbons (UNEP/MAP, 2012) (Figure 5.5). In addition, there is a potential to develop wildlife based tourism in the SEE Med Region.

Another activity to consider is fisheries. Fish stocks are already significantly depleted and there are documented impacts of noise from seismic surveys on fish stocks and zooplankton.

TRAVEL & TOURISM'S TOTAL CONTRIBUTION TO GDP		2016 % share
29	Croatia	24.7
31	Montenegro	22.1
34	Cyprus	21.4
40	Greece	18.6
65	Bulgaria	12.8
67	Slovenia	12.6
68	Turkey	12.5
73	Italy 11.1	
	European Union	10.2
	World	10.2
101	Bosnia-Herzegovina	9.2
120	Czech Republic 7.8	

Figure 5.4. Contribution of travel and tourism to GDP (Source: WTTC, 2017)



Figure 5.5. Possible oil spills detected by satellites (Source: *UNEP/MAP, 2012*. Format used in this report acquired at <u>www.grida.no</u>)

5.5. Future areas of potential impacts on marine biodiversity

The possibility of impacts from seismic surveys in the SEE Med region could be foreseen when planned seismic surveys are viewed in the context of the areas identified as important for marine biodiversity. Parts of the Adriatic Sea and Hellenic trench are the areas of overlap of strongest marine biodiversity and planned seismic surveys (Figures 5.6. a to d).









Figure 5.6. Planned seismic surveys in the context of different international/EU level modes of spatial protection a) EBSAs, b) IMMAs c) ACCOBAMS CCH, d) NATURA 2000 (protected area boundaries provided by IMMAs Task Force of the IUCN, ACCOBAMS and acquired from the web). Prepared by Silvia Frey and Bruno Claro from OceanCare.

6. Existing mechanisms for the mitigation of negative impacts of anthropogenic underwater noise

6.1. Legislation framework and policy documents

The international and national communities have recognised the issue of anthropogenic underwater noise, which is reflected in the respective legislative frameworks and strategic documents. These frameworks represent the legal basis for further concrete conservation mechanisms and measures.

6.1.1. International level

Global and regional environment/biodiversity conservation **agreements** have addressed anthropogenic noise by adopting a number of decisions and resolutions. The main global agreement for biodiversity conservation is the Convention on Biological Diversity (CBD). Other relevant conventions are more specific in their scope. The Bonn Convention or Convention on Migratory Species (CMS) is focused on conserving and protecting of species within their whole life cycle. In fact, Cuvier's beaked whale in the Mediterranean Sea has been listed in both CMS's Appendices (endangered migratory species and migratory species conserved through Agreements) by the 11th Conference of Parties in 2014, because the scientists had identified the connection between atypical mass strandings of Cuvier's beaked whales and intense anthropogenic underwater noise.

International Convention for the Regulation of Whaling (ICRW) with the International Whaling Commission (IWC) focuses on cetaceans, with anthropogenic underwater noise issue predominantly discussed by IWC's Scientific and Conservation Committees. But the sectorial international organisations such as the General Fisheries Commission for the Mediterranean (GFCM), the International Maritime Organization (IMO) have also started to address anthropogenic noise.

In the Mediterranean area specifically, most relevant are the ACCOBAMS Agreement (cetaceans) of the Bonn Convention; the Barcelona Convention with several protocols, including the SPA/BD Protocol (marine species and habitats) and Protocol on Integrated Coastal Management (ICZM Protocol); and GFCM (fisheries). The Bern Convention is particularly relevant for countries that are not members of the European Union, due to the fact that the provisions and objectives of the Bern Convention are implemented into European Union legislation via the EU's Habitats Directive.

The Convention on Environmental Impact Assessment in a Transboundary Context (ESPOO Convention) and its Protocol on Strategic Environmental Assessment (SEA) should also be mentioned in relation to the transboundary environmental impact assessment.

The majority of the SEE Med countries are signatories or parties to these agreements.

In 2015 the world leaders adopted the United Nation's Global 2030 Agenda for Sustainable Development with 17 Sustainable Development Goals (SDG). This Agenda should shape national development plans over the next 15 years. The particular attention has been given to the issue of the anthropogenic noise. Among all, the detrimental effect of ocean noise on fish and fisheries was identified as a problem and remedy actions were proposed (UN, 2017).

The main global biodiversity conservation specific **strategic document** is the *Strategic Plan for Biodiversity 2011-2020 (Aichi targets)*, adopted in the scope of the CBD. Its counterpart at the pan-European level is the *Pan-European 2020 Strategy for Biodiversity*. The *Strategic Action Programme for the Conservation of Biological Diversity (SAP BIO)* in the Mediterranean Region was launched in 2004 by RAC/SPA. The strategic action objectives include, above all, reducing negative impacts on biodiversity.

The ACCOBAMS Strategy 2014-2023 was developed and adopted by Parties in 2013. In the scope of the Strategy overall objective, 10 supportive specific objectives were identified and linked to the Aichi targets and targets of the EU Biodiversity Strategy to 2020. The overall objective is to improve the current conservation status of cetaceans and their habitats in the ACCOBAMS area.

One of the specific objectives is the reduction of human pressures, with activities proposed to address the issue of anthropogenic noise, mostly by identifying, mapping, and monitoring sources of noise, as well as updating the mitigation guidelines.

6.1.2. EU level

The Habitats Directive, Marine Strategy Framework Directive (MSFD), Environmental Impact Assessment Directive (EIA Directive) and Strategic Environmental Impact Directive (SEA Directive) are the most relevant parts of the EU *acqui communitaire* which addresses nature conservation and anthropogenic underwater noise. In addition, there is a new Directive on Maritime Spatial Planning, which aims at balanced use of already competitive maritime areas. This Directive obliges all EU countries to develop maritime spatial plans by 2021.

The most important directives to point out are the Habitats Directive and MSFD. The aim of the Habitat Directive is to ensure Favourable Conservation Status (FCS) of some 220 habitats and approximately 1000 species of European interest, listed in the Directive's Annexes. Above all, the Directive stipulates setting up of a network of protected sites - NATURA 2000 - across the European Union. Marine species listed on Annex II of the Directive are the species which are conservation objectives of specific NATURA 2000 sites. These are all sea turtle

species, but only two cetacean species; the common bottlenose dolphin and harbour porpoise.

Such a listing is reflection of species related information coming predominantly from the northern European waters, as there is only one population of harbour porpoise in the Mediterranean Sea, and the common bottlenose dolphin is more abundant than many other species in this region.

For effectiveness of NATURA 2000, the Directive requires adequate management of the sites together with application of the appropriate assessment mechanism.

Cetacean species most sensitive to the anthropogenic noise are not listed as "NATURA 2000 species". However, all cetacean species are strictly protected in the EU both within and outside NATURA 2000 sites (listed on Annex IV of the Habitats Directive).

The MSFD aims to achieve Good Environmental Status (GES) of the EU marine waters and beyond by 2020. GES is measured through 11 descriptors, including the ones on ambient and impulsive noise (Descriptor 11).

The contents of the directives will be further elaborated on in Chapter 6.3.

The *EU Biodiversity Strategy to 2020* is the main **strategic document** for biodiversity conservation. It was adopted in 2011 by the European Commission, taking into account globally set Aichi targets. The first of six major targets is full implementation of the Birds and Habitats Directives.

The EC also adopted the EU Strategy for the Adriatic and Ionian Region (EUSAIR). The main pillars are blue growth, environmental quality, sustainable tourism and connecting the region.

6.1.3. National level

All SEE Med countries have in place a **national nature conservation legislation** framework.

As members of the EU, Croatia, Cyprus, Greece, Italy and Malta had to harmonise their national legislation with the EU's. Albania, Bosnia and Herzegovina, Montenegro and Turkey are non-members of EU.

Albania, Montenegro, and Turkey are EU candidate countries and Bosnia and Herzegovina a potential candidate. Among them, only Montenegro started accession negotiations in 2012. Albania has already transposed most of the Habitats Directive provisions into national legislation, followed with Montenegro (data for Birds Directive only, in process for Habitats Directive) and Bosnia and Herzegovina (Vasiljević, Pokrajac, Erg (ed.), 2017). However, due to the complex situation in Bosnia and Herzegovina, nature conservation is regulated by laws adopted at an entity (regional) level, without integration at the national level. There are also efforts to harmonise Turkish national legislation with the EU.

National Biodiversity/Nature Protection **Strategies** and Action Plans (NBSAPs) are the main nature conservation policy documents and the principal instruments for implementing the Convention on Biological Diversity at the national level. All SEE Med countries have adopted at least one of the National Biodiversity Strategies and Action Plans.

6.1.4. Other strategic documents

Several strategies for the conservation of specific species or groups of species exist at the regional level.

RAC/SPA developed Action plans for the conservation of cetaceans, sea turtles and monk seals in the Mediterranean Sea, adopted in the framework of the Barcelona Convention.

Strategies on the conservation of sea turtles and cetaceans in the Adriatic Sea 2016 – 2025 were prepared under the NETCET project. These two strategies were prepared by stakeholders with an affiliation to nature conservation and without official adoption of the documents. Still, it was an attempt to harmonise conservation efforts at the Adriatic Sea level. One of the identified objectives is to reduce the impact of threats to cetaceans and sea turtles with several actions to address the issue of anthropogenic noise.

6.2. Mitigation guidelines

The standardized guidelines to address the impacts of anthropogenic noise are being produced in the frameworks of several international agreements.

The most relevant for the region have been ACCOBAMS Guidelines, adopted by the 4th Meeting of Parties in 2010 as an integral part of the Resolution 4.17. The Guidelines include a number of measures for the mitigation of impacts of anthropogenic underwater noise on cetaceans from various sources, including seismic surveys and airgun uses. A need for the precautionary principle is stressed, as well as a need for the undertaking of an EIA before granting approval for noise-producing activities.

In addition, the increase of seismic activities in the ACCOBAMS area has called for Marine Mammal Observers (MMO) of high quality in knowledge, experience and performance. As a result, a certification system for highly qualified MMOs was developed and adopted by the 6th Meeting of Parties in 2016--Resolution 6.18. It includes elements such as adequate training, development of standard formats for data collection, certification of MMOs and periodical renewal of their status, as well as a requirement to certified MMOs to report after each mission at sea.

The CMS Parties adopted Resolution 10.24 in 2011, which promotes development of mitigation guidelines. Resolution on Adverse Impacts of Anthropogenic Noise on Cetaceans and Other Migratory Species was adopted at the 12th Conference of Parties (COP 12) of the CMS in October 2017, and endorsed the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities¹².

The Guidelines were developed through two comprehensive consultation processes that extended over a full year. The Guidelines provide advice to decision-makers to assess negative impacts of anthropogenic noise from various sources before approvals to proceed are granted. This information also supports informed mitigation programmes to be designed. The EIA Guideline for each anthropogenic noise-generating activity should be used together with appropriate modules on species and impact from the Technical Support Information, and adjusted to regional and domestic circumstances. When assessing the environmental impacts of seismic surveys (air gun and alternative technologies) the Guidelines provide detailed information about several areas that should be considered, including full descriptions of the research area, equipment to be used and activity; independent, scientific modelling of noise propagation loss; species impact; mitigation and monitoring plans, reporting plans; as well as consultation and independent review (Annex I). Croatia also prepared an expert basis for national guidelines for mitigation of impacts of anthropogenic noise on marine mammals and sea turtles. Development of such guidelines was the requirement of the EC coming from the EU pilot opened due to possible noncompliance with the EU legislation of an implemented 2D seismic survey in Croatian waters. The guidelines are expected to be adopted by the relevant authority.

6.3. Conservation mechanisms and measures

6.3.1. Inventorying, monitoring, and threat assessments

Knowledge about the state of marine biodiversity is fundamental for conservation actions and a timely response to emerging issues. This knowledge is acquired through inventorying and monitoring of both biodiversity and threats, proper data management and threat status assessments. All these actions are also required for the implementation of the aforementioned international, EU and national legislation, as well as associated progress/implementation reporting.

However, current efforts are still not systematic and sufficient. There is even a lack of baseline knowledge about large, charismatic species like cetaceans. For example, information about abundance and distribution exists only sporadically in some areas, such as the Cres- Lošinj area in northern Adriatic (Croatia). Recently, with the launching of aerial

¹² http://www.cms.int/en/document/annex-adverse-impacts-anthropogenic-noise-cetaceans-and-other-migratory-species

surveys, more knowledge is being acquired in areas such as the Adriatic Sea and Strait of Sicily. The "ACCOBAMS Survey Initiative" project, with a field survey planned for the summer of 2018, will be the first comprehensive survey of the abundance and distribution of cetaceans in the Mediterranean Sea which should shed more light on the state of cetaceans in the area. The LIFE EUROTURTLES project should give more insight into populations of loggerhead and green turtles in the SEE Med region and propose conservation measures.

Knowledge about threats and their impacts is also limited. There are stations to measure ambient noise in some areas of the Region. Furthermore, the first overview of noise sources and noise hotspots was given in the scope of ACCOBAMS. There is also an effort to establish a Mediterranean impulsive noise register (ACCOBAMS SC11 Report, 2017). The idea of register was initiated by the MSFD, expanded to the Mediterranean Sea area through the Ecosystem Approach Initiative led by the UNEP/MAP Barcelona Convention. Finally, the responsibility for register's establishment was given to ACCOBAMS (ACCOBAMS MOP6, 2016).

The actual status of species can be identified through the IUCN Red List Assessment or the conservation status under the Habitats Directive. For cetaceans specifically, the assessment in the ACCOBAMS area together with the IUCN was made in 2006 and the following will be implemented after the ACCOBAMS survey.

Availability of data is an issue. Global and regional species datasets exist, such as OBIS-SEAMAP or GBIF. The NETCCOBAMS platform is being established in the framework of ACCOBAMS. A significant amount of data about noise sources is available via the web, but there is no central place for these data. Also, there is an issue of confidentiality regarding implemented seismic surveys.

6.3.2. Stranding networks

A timely response to stranding events may mitigate mortality and help injured animals to recover. In addition, information about any recorded mortality may give certain insights into threats.

Countries in the SEE Med Region have some form of operational stranding networks. These also include recovery and rehabilitation centres, mostly for sea turtles (Figure 6.1). According to the 2016 ACCOBAMS national reports, organised national stranding networks for cetaceans exist only in Croatia, Greece, Italy and Slovenia. During implementation of the NETCET project, contacts were established between various participants involved in the stranding networks of the Adriatic Sea. It was also proposed to organise the Adriatic Emergency Team in the future (Štrbenac (ed.), 2015).

There is an ongoing effort to fill all recorded data about cetacean mortality into a unique Mediterranean database: MEDACES, hosted by University of Valencia.



Figure 6.1. Overview of rehabilitation centres for sea turtles (red), first-aid centres (blue) and informal or temporary facilities (green) in the Mediterranean. (Source: *MEDASSET, 2017*)

6.3.3. Protection of areas

The oldest mechanism for the conservation of biodiversity is the use of protected areas. In the Mediterranean Sea and SEE Med region there are areas of international, EU and national designations which are either recognised as important habitats for marine biodiversity or are legally and functionally protected.

SPAMIs are areas designated for the conservation of species and habitats under the SPA/BD protocol and they already require certain management in place. EBSAs are special areas identified under the scope of the CBD to support a healthy marine environment. The IUCN's IMMAs for marine mammals is a tool to ensure conservation of the most valuable habitats of marine mammals, either through the designation of protected areas or some other means of conservation. ACCOBAMS's CCHs are valuable areas for cetaceans and the ACCOBAMS Parties are asked for designation of these areas in one of the protected areas categories. However, all these international recognitions of important areas are a "soft" conservation mechanism and mostly without actual management structures.

Nevertheless, there are areas protected in national categories, more or less adjusted to IUCN categories. These areas, particularly national parks, have been managed by special legal entities established for that purpose.

The spatial protection mechanism with most weight in terms of functionality is NATURA 2000. NATURA 2000 is established in the marine part of the EU countries of the SEE Med Region, but not in all countries. Croatia still has a scientific reserve for sea turtles, which means the establishment of NATURA 2000 for sea turtles requires better knowledge.

Although the management of NATURA 2000 is challenged, there is one mechanism which contributes to actual implementation of NATURA 2000 and that is appropriate assessment (more information in Chapter 6.3.4).

Furthermore, fishery regulated areas could also contribute to the implementation of conservation measures. Fishery restricted areas (FRS) are established under the GFCM to protect deep sea habitats and essential fish habitats (EFH) (FAO, 2017). The majority of them are located in the SEE Med Region: in the northern Ionian Sea, Strait of Sicily and south of Cyprus. Similar areas are designated at a national level too. In Italy for example, Biological resource Protection Areas (BPAs; *Zone di Tutela Biologica*) are established with commerical and recreational fisheries prohibited. The largest such area in the Adriatic is the Pomo/Jabuka pit area in the central Adriatic with a surface area of over 2,200 km² (Fortuna, Holcer, Mackelworth (ed.), 2015). At the 41st session of the GFCM in October 2017, this area is also recognised as FRS.

The majority of the areas with some form of international designation in the SEE Med Region include the northern and southern Adriatic, parts of the Strait of Sicily, the Hellenic Trench and parts of the Aegean Sea. The northern Levantine Sea is identified as an EBSA (for more information see Figure 5.6. a to d.

In addition, establishment of "quite zones" was proposed at the 10th Meeting of the ACCOBAMS Scientific Committee, as possible solution to mitigate negative impacts of anthropogenic noise to some of the most sensitive species (Lüber et al, 2015b). In order to ensure functionality of "quite zones", it was recommended to establish four Specially Protected Areas of Mediterranean Importance under Barcelona Convention (SPAMI), covering critical habitats of the Cuvier's beaked whale and monk seal in the Mediterranean Sea (Figure 6.2).



Figure 6.2. Proposed "quite zones" in the Mediterranean Sea (Source: Lüber et al, 2015b)

6.3.4. Environmental and nature impact assessments

Environmental and nature impact assessments (ENIA) are powerful tools to prevent or mitigate impacts of human intrusions into the environment. These assessments should be made initially at the strategic level and then at the level of particular projects/activities.

SEAs, EIAs and appropriate assessments (since they apply only to NATURA 2000 sites) are carried out in EU countries.

In 2015 Italy introduced a specific approach for obtaining permits for oil and gas exploration in its waters. Namely, Environmental Impact Assessment Commission of the Ministry of Environment mandated seismic surveys operators to apply standard scientific protocol, which includes monitoring of marine mammal presence 60 days before and after the survey, as well as during the survey (Fossati et al, 2017). The EIA is used in the non-EU countries. However, EIAs for seismic surveys started to be implemented recently. Specifically, after some debate, the EIA Directive was amended in 2015 so as to enable application of its mechanism to seismic surveys.

There are still some limitations and challenges with adequate implementation of ENIAs. In the appropriate assessment specifically, the focus is only on NATURA 2000 species and they do not include the most sensitive species of cetaceans, such as Cuvier's beaked whale.

Furthermore, the quality of environmental impact assessment studies is questionable (Wright *et al* 2013, Prideaux and Prideaux 2015).

Lack of and availability of data is also an issue. Although the main principle of the ENIAs is that the proponents (who usually commission the preparation of the study) prove that their project would not harm the environment and as such, should acquire data in the absence of already existing information. The interpretation of data is also a challenge, particularly the cumulative impacts.

Once the project is improved and mitigation measures are prescribed, there is an issue of surveillance as to whether these measures are properly implemented and are they actually effective.

Defensible EIAs, representing the Best Available Techniques and Best Environmental Practice, should provide regulators with decision-making certainty by ensuring appropriate transparency, natural justice, independent peer-review and appropriate consultation. Each of these elements complements and supports the others. (Prideaux, 2017).

6.4. Institutional and financial capacities

Implementation of existing mechanisms requires good institutional, individual and financial capacities. All SEE Med countries have established a certain institutional framework both for nature conservation and energy sectors. In principle, it includes governmental and local authorities and agencies, non-governmental organisations, the scientific community and private companies. As already mentioned, countries also join regional and international organisations. Human capacities are always an issue, as well as lack of communication and cooperation between different stakeholders at all levels.

Public funding, such as funding coming from the EU and national budgets, seems to be more in focus when it comes to implementation of conservation measures. However, there is a question whether private funding should overtake a part of the financial burden, particularly due to the fact that many problems for biodiversity and nature in general arise from the activities implemented by private companies. National budgets are also very limited and the majority of the countries is not able to adequately finance implementation of conservation mechanisms and measures. There are many requirements coming from the EU legislation and strategies, hence the EU provides a good share of the funding in the Region. Some of the EU funding possibilities include transboundary programmes like INTERREG, LIFE or Structural and investment funds, for which allocation is negotiated bilaterally between countries and the EC. QuiteMed is a recently started regional project, supported by EC – DG Environment. This project aims to improve coherence and comparability as regards Descriptor 11 of the MSFD through cooperation between Mediterranean Sea basin countries. The project will focus on methodologies and best practices for underwater noise monitoring and a joint register of impulsive noise. SEE Med countries are significantly involved, with five out of nine project partners (from Croatia, Greece, Italy, Malta and Slovenia).

There are also several projects with a noise mapping and mitigation component in the application procedure for funding from the Italian-Croatian INTERREG.

In 2015 the European Commission adopted the 2014 – 2020 Programme for Cross-border Cooperation in the Mediterranean Sea basin within the European Neighbourhood Instrument (ENI CBC Med). The first call for standard projects has been launched in mid-2017 (ENPI CBC Med, 2017). Cyprus, Greece, Italy and Malta are eligible countries from the SEE Med Region.

7. Possible future actions for the prevention/mitigation of the negative impacts of anthropogenic noise from seismic surveys

The ideal future for the SEE Med Region would be one without impacts of anthropogenic underwater noise from seismic surveys on the marine environment. This could be achieved under two scenarios; Scenario 1 - no seismic surveys are implemented in the Region from now on, Scenario 2 - some areas are defined to be excluded from any seismic survey and in areas where seismic surveys are possible, their permission is subject to a strict ENIA, application of best available technology and implementation of strong mitigation mechanisms.

Scenario 1 is self-explanatory, hence the Scenario 2 will be elaborated in more details.

Several related sets of actions could be considered in further discussions, starting from improvement of the knowledge base, seismic survey-free zones, to better communication and cooperation between various stakeholders.

The already mentioned Regional Workshop organised and hosted by OceanCare, NRDC and in cooperation and with the support of the DBU in November 2017 is a good case in this regard. Bringing together a wide array of participants, including representatives from governmental institutions, intergovernmental organizations (IGOs), industry stakeholders and non-governmental organizations (NGOs), the Workshop agreed on a set of 16 Recommendations (See Annex 2), paying tribute to the demand of such workshops and the inherent need for multi-stakeholder collaboration and communication.

• Improved knowledge

Baseline knowledge should be acquired for species already known as sensitive to noise, including knowledge about abundance and distribution, as well as knowledge about threats. This may include:

- Collecting baseline information about targeted species,
- Development of sensitivity maps, produced as a basis for maritime spatial planning, SEA and ENIAs (using as an example the work done with Cuvier's beaked whales),
- Setting up of systematic monitoring schemes,
- Setting up an inventory and monitoring of anthropogenic underwater noise, also building on existing initiatives in the framework of ACCOBAMS (f.e. establishment of the functional impulsive noise register)

- Exploration of impacts of seismic surveys on least known species, particularly sea turtles, as well as cumulative effects,
- Setting up monitoring of effectiveness of proposed/implemented mitigation measures,
- Setting up functional stranding networks in all SEE Med countries and at regional levels.

• No seismic surveys zones

Some areas, already known to be sensitive (for example due to geographical features or the presence of sensitive species) should be considered as seismic survey-free zones. These zones could be designated through establishment of protected areas or by using other mechanisms, such as offshore maritime spatial planning. In addition, the attempts to stop granting licences for seismic surveys already exist in the Mediterranean area (f.e. in France) (Dearden, Independent, 2017).

• Improved implementation of existing conservation mechanisms

Many mechanisms are already in place, but their implementation is an issue. This may be improved if:

- Capacities to perform adequate ENIAs for seismic surveys are increased in all phases; from the preparation of studies, to evaluations by the governmental agencies, implementation of mitigation measures, and effectiveness monitoring (the latter in case the investment is approved),
- Non-EU countries set up the appropriate assessment framework.
- Management plans for the NATURA 2000 areas and nationally designated areas encompassing sensitive areas addressing the noise issue in general. The seismic survey issue is handled for NATURA 2000 through appropriate assessments.

• New mitigation measures

Are seismic surveys the only way to explore for oil and gas? With intensive technology development, are there other, more clean options? Even 3dB decrease in source level throughout the survey is better than any visual mitigation (Leaper et al, 2015). Hence, new technologies and solutions should be sought. Indeed, aforementioned UN Sustainable Development Agenda calls for new technologies and innovation as a part of solution to minimise ocean noise. Parties to CMS and ACCOBAMS adopted similar decisions in recent years, committing themselves to such policy. Particularly promising is Marine Vibroseis, a quieter option to seismic airguns, sparing particularly the high-frequency hearing cetaceans such as beaked whales and dolphins (Weilgart, 2013; Duncan et al., 2017).

• Better communication between stakeholders at all levels

Communication between stakeholders coming from different sectors and backgrounds is crucial for all efforts towards the mitigation of negative impacts on the marine environment. This communication should be improved within particular countries, but also at the Regional level. Special regional workshops could be one of the tools or this topic could be discussed in the framework of other regional initiatives/events. They are also a good opportunity to exchange knowledge and experience. Project-driven cooperation could be an even stronger mode of communication.

• Improved capacities (human, institutional, financial)

Good capacities also contribute to better implementation of the existing and emerging mechanisms. This may be achieved in a way that:

- Existing financial options are used better, e.g. through implementation of joint projects or similar efforts.
- Institutional and individual capacities are improved through training on a specific topic, such as the already indicated implementation of the ENIAs, functional stranding networks, etc. The benefit of the existing initiatives should be used, such as training of the MMOs under the ACCOBAMS high quality certification system.

8. References

- 1. Abdul Malak, D. *et al.* (2011). Overview of the Conservation Status of the Marine Fishes of the Mediterranean Sea. Gland, Switzerland and Malaga, Spain: IUCN. vii + 61p.
- 2. ACCOBAMS 6th Meeting of Parties (MOP 6) (2016). Progress report of a noise demonstrator: Development of demonstrator of a Mediterranean impulsive noise register managed by ACCOBAMS. Monaco
- 3. ACCOBAMS Report of the 11th Meeting of the Scientific Committee (2017). Monaco
- 4. Au, W.W.L. and Hastings, M.C. (2009). Principles of Marine Bioacoustics. New York: Springer Science and Business Media
- 5. Bender, J. (2015). Russia is moving into the eastern Mediterranean for naval exercises. Business Insider. <u>http://www.businessinsider.com/russia-is-moving-into-the-eastern-mediterranean-for-naval-exercises-2015-9</u>
- 6. Brekhovskikh, L.M. and Lysanov, Y.P (2006). Fundamentals of Ocean Acoustics: Edition 3'. New York: Springer Science and Business Media
- 7. Blue World Institute. Giant Devil Ray. Downloaded on 03 December 2017. https://www.blue-world.org/conservation/species/devil-ray/
- Cañadas, A., Fortuna, C., Pulcini, M., Lauriano, G., Bearzi, B., Cotte, C., Raga, J. A., Panigada, S., Politi, E., Rendell, L., B-Nagy, A., Pastor, X., Frantzis, A. & Mussi, B. (2011). Accobams collaborative effort to map high-use areas by beaked whales in the Mediterranean. In: 63 Scientific Committee Meeting of the International Whaling Commission, Tromso, Norway: International Whaling Commission.
- 9. Carroll, A.G., Przeslawski, R., Duncan, A., Gunning, M., and Bruce, B. (2017). A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. Mar. Poll. Bull. 114(1): 9-24.
- 10. Casale, P. & Margaritoulis, D. (2010) Sea turtles in the Mediterranean: distribution, threats and conservation priorities. Gland, Switzerland: IUCN/SSC Marine turtle specialist group.
- Casper, B.M., Halvorsen, M.B., Matthews, F., Carlson, T.J., Popper, A.N. (2013). Recovery of barotrauma injuries resulting from exposure to pile driving sound in two sizes of hybrid striped bass. PLoS One, 8, Article e73844,

- Clark C.W., Ellison W.T., Southall B.L., Hatch L., Van S., Parijs A.F., Ponirakis D. (2009). Acoustic Masking in Marine Ecosystems as a Function of Anthropogenic Sound Sources. Paper submitted to the 61st IWC Scientific Committee (SC-61 E10).
- Coll M, Piroddi C, Steenbeek J, Kaschner K, Ben Rais Lasram F, Aguzzi J, et al. (2010) The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. PLoS ONE 5(8): e11842. <u>https://doi.org/10.1371/journal.pone.0011842</u>
- Continental Shelf Department of Malta. Oil and Gas Exploration. Downloaded in November 2017. https://continentalshelf.gov.mt/en/Pages/Oil-and-Gas-Exploration.aspx
- Cuttelod, A., García, N., Abdul Malak, D., Temple, H. and Katariya, V. 2008. The Mediterranean: a biodiversity hotspot under threat. In: J.-C. Vié, C. Hilton-Taylor and S.N. Stuart (eds). *The 2008 Review of The IUCN Red List of Threatened Species*. IUCN Gland, Switzerland. 13 p.
- 16. CyprusMail Online (2017a). "Block 11 looks extremely positive", gas expert says. http://cyprus-mail.com/2017/03/09/block-11-looks-extremely-promising-gas-expertsays/
- 17. CyprusMail Online (2017b). Turkish miltiary exercises. <u>http://cyprus-mail.com/2017/04/19/turkish-military-exercises/</u>
- Dalen, J. (2007). Effects of seismic surveys on fish, fish catches and sea mammals. Report for the Cooperation group - Fishery Industry and Petroleum Industry. Report no.: 2007-0512. Norway. 30 p.
- 19. Dearden, L. (2017). France to ban all new oil and gas exploration in renewable energy drive. Independent. http://www.independent.co.uk/news/world/europe/france-ban-new-oil-gas-exploration-stop-granting-licences-macron-hulot-renewable-energy-drive-a7806161.html
- 20. Duncan, A.J., Weilgart, L.S., Leaper, R., Jasny, M., and Livermore, S. (2017). A modelling comparison between received sound levels produced by a marine Vibroseis array and those from an airgun array for some typical seismic survey scenarios. Mar. Poll. Bull. 119: 277–288.
- 21. ENI's activities in Cyprus (2017). <u>https://www.eni.com/enipedia/en_IT/international-presence/europe/enis-activities-in-cyprus.page</u>
- 22. ENPI CBC Med (2017). http://www.enpicbcmed.eu/enicbcmed-2014-2020
- 23. Environmental Impact Assessment study for the 3D Geophysical Survey in offshore Montenegro (2017). Prepared for ENI Montenegro BV.

https://www.dropbox.com/s/f57d6lx6vy2eex6/Elabora%20o%20pricjeni%20uticaja% 20na%20zivotnu%20sredinu EN.pdf?dl=0

- 24. Environment Protection Agency of Montenegro (EPA) (2017). http://www.epa.org.me/images/eia/enimontenegrobv2009.pdf
- 25. Esestime, P., Hewit, A., Hodgson, N. (2016). Zohr A newborn carbonate play in the Levantine Basin, East Mediterranean. First Break, Vol.34 : 87-93
- 26. EUNIS Database (2017).eunis.eea.europa.eu
- 27. Fortuna, C.M., Holcer, D., Mackelworth, P. (eds.) 2015. Conservation of Cetaceans in the Adriatic Sea. 135 p. Report produced under WP 7 of the NETCET project, *IPA Adriatic* Cross-border Cooperation Programme.
- 28. Fossati, C., Mussi, B., Tizzi, R., Pavan, G., Pace, D. S. (2017). Italy introduces pre and post operation monitoring phases for offshore seismic exploration activities. Marine Pollution Bulletin. http://dx.doi.org/10.1016/j.marpolbul.2017.05.017
- 29. Global Footprint Network (2017). <u>http://www.footprintnetwork.org/</u>
- Godley, B.J., Barbosa, C., Bruford, M., Broderick, M., Catry, M., Coyne, M.S., Formia, A., Hays, G.C., Witt, M.J. (2010). Unravelling migratory connectivity in marine turtles using multiple methods. J. Appl. Ecol., 47: 769-778
- Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M. P., Swift, R., and Tompson, D. 2004. A review of the effects of seismic surveys on marine mammals. Mar. Technol. Soc. J. 37(4): 16–34.Halper, S.B., Walbridge, S., Selkoe, K., A., Kappel, C. V., Micheli, F., D'Argos, C., A Global Map of Human Impact on Marine Ecosystems (2008). Science. Vol. 319, Issue 5865: 948-952
- 32. Grupa Sredozmena medvjedica (2008). Stručno djelo za analizu podatka o rasprostranjenosti morskih špilja , staništa s Dodatka I Direktive o staništima (kod 8330) i viđenja sredozemne medvjedice *(Monachus monachus)*, vrste s Dodatka II Direktive o staništima u Jadranu (Croatian only). Analysis prepared for the Croatian State Institute for Nature Protection.
- 33. Hawkins A.D. and Popper A.N.(2016). Developing Sound Exposure Criteria for Fishes. The Effects of Noise on Aquatic Life II. New York. Springer:431-439.
- 34. IUCN (2012). Marine mammals and sea turtles of the Mediterranean and Black Seas. Gland, Switzerland and Malaga, Spain. IUCN. 32 p.
- 35. Jelić, K, Jeremič, J., Mahečić, I., Maričević, A. (2017). Izvješće o provedbi Protokola za dojavu i djelovanje u slučaju pronalaska uginulih, bolesnih ili ozlijeđenih strogo zaštićenih morskih životinja (morski sisavci, morske kornjače, hrskavične ribe) za razdoblje od 2010. do 2015. godine (Croatian version only). Hrvatska agencija za okoliš i prirodu. Zagreb. 54 p.

- 36. Kaifu, K., Akamatsu, T., Segawa, S. (2008). Underwater sound detection by cephalopod statocyst. Fisheries Science. 74: 781-786
- 37. Kight, C., and Swaddle, J. (2011). How and why environmental noise impacts animals: an integrative, mechanistic review. Ecol. Lett. 14: 1052–1061.
- 38. KrisEnergy (2017). www.krisenergy.com
- 39. Leaper, R., Calderan, S., Cooke, J (2015). A Simulation Framework to Evaluate the Efficiency of Using Visual Observers to Reduce the Risk of Injury from Loud Sound Sources. Aquatic Mammals 41 (4): 375-387
- 40. LGC News (2017). Turkeybegins seismic surveys offshore Cyprus today. http://www.lgcnews.com/turkey-begins-seismic-surveys-offshore-cyprus-today/#, https://www.dailysabah.com/business/2017/07/17/turkish-seismic-vessel-tocontinue-surveys-in-mediterranean
- 41. Lüber, S., Frey, S., Prideaux, M., Prideaux, G. (2015a). Protecting Cuvier's beaked whale and Mediterranean monk seal critical habitat from anthropogenic noise in the Mediterranean Sea. OceanCare, Switzerland
- 42. Lüber, S., Frey, S., Prideaux, M., Prideaux, G. (2015b). Creating "quite zones". Protecting Cuvier's beaked whale and Mediterranean monk seal critical habitat from anthropogenic noise in the Mediterranean Sea, OceanCare, Switzerland
- 43. Mackelworth, P., Holcer, D., Wiemann, A., Rako, N., Fortuna, C. (2006). Izvještaj o istraživačkim aktivnostima provedenim s ciljem utvrđivanja mogućih boravišta sredozemne medvjedice (*Monachus monachus*) u području Kvarnera i Kvarnerića u 2006 (Croatian only). Report prepared by Blue World Institute for the Croatian State Institute for Nature Protection
- 44. Mačić, V., Panou, A., Bundone, L., Varda, D. (2014). Contribution to the knowledge of rare and endangered habitats marine caves (Montenegro, South East Adriatic Coast). Poster presentation at the 1st Mediterranean Symposium on the conservation of the dark habitats (Portorož, Slovenia, 31st October 2014)
- 45. Maglio, A., Pavan, G., Castellote, M., Frey, S. (2016). Overview of the noise spots in the ACCOBAMS area Part I, Mediterranean Sea. An ACCOBAMS report, Monaco, 44 p.
- 46. Marine Traffic (2017). www.marinetraffic.com
- 47. Mediterranean Association to Save the Sea Turtles (2017). http://www.medasset.org/our-projects/Sea-Turtle-Rescue-Map/
- 48. McCauley, R., Day, R.D., Swadling, K.M., Fitzgibbon, Q.P., Watson, R.A., and Semmens, J.M. (2017). Widely used marine seismic survey air gun operations negatively impact zooplankton. Nature Ecology & Evolution 1: 1-8.

- 49. Milić, P. (2017). CG: Počinje intenzivno istraživanje nafte i gasa. Voice of America (Glas Amerike). <u>https://www.glasamerike.net/a/crna-gora-nafta-</u> <u>istrazivanje/3767735.html</u>
- 50. Montenegro Hydrocarbon Administration (2016). http://www.mha.gov.me/vijesti/167283/Vlada-Crne-Gore-usvojila-Tenderskudokumentaciju-za-prvi-tender-u-podmorju-Crne-Gore.html
- 51. Myrberg, A. A, Jr (2001). The acoustic biology of elasmobranchs. Environmental Biology of Fishes 60: 31-45
- 52. NCEAS (2008). A map of cumulative human impacts on Mediterranean marine ecosystems. (WWW) National Center for Ecological Analysis and Synthesis, University of California. http://globalmarine.nceas.ucsb.edu/mediterranean/
- Nelms, S.E., Piniak, W.E.D., Weir, C.W., Godley, B.J. (2016). Seismic surveys and marine turtles: An underestimated global threat? Biological Conservation. Vol.193: 49-65
- 54. NOAA (2016). Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commerce, NOAA. NOAA Technical Memorandum. NMFS-OPR-55, 178 p.
- 55. Notarbartolo di Sciara, G., Birkun, A., Jr (2010). Conserving whales, dolphins and porpoises in the Mediterranean and Black Seas: an ACCOBAMS status report, Monaco. 212 p.
- 56. Notarbartolo di Sciara, G., Serena, F., Mancusi, C. (2015). *Mobula mobular*. The IUCN Red List of Threatened Species 2015: e.T39418A48942228. Downloaded on 03 December 2017.
- 57. NPWS (2014). Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters. Department of Arts, Heritage and Gaeltacht. 52 p.
- 58. OSPAR(2009). Overview of the impacts of anthropogenic underwater sound in the marine environment OSPAR Commission: Publication number 441/2009.
- 59. Panigada, S., Donovan, G., Druon, J-N, Lauriano, G., Pierantonio, N., Pirotta, E., Zanardelli, M., Zerbini, A., Notarbartolo do Sciara, G. (2017). Satellite telemetry on Mediterranean fin whales, working towardsidentification of critical habitats and focussing on mitigation measures. Scientific Reports 7: 3365
- 60. Piroddi, C., Coll, M., Liquete, C., Macias, D., Greer, K., Buszowski, J., Steenbeek, J., Danovaro, R., Christensen, V. (2016). Historical changes of the Mediterranean Sea ecosystem: modelling the role and impact of primary productivity and fisheries changes over time. Scientific Reports. 7:44491

- Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B., Løkkeborg, S., Rogers, P.H., Southall, B.L., Zeddies, D.G., Tavolga, W.N. (2014). Sound exposure guidelines for fishes and sea turtles A Tech. Rep. Prep. by ANSI-Accredited Stand. Comm. S3/SC1 Regist. with ANSI
- 62. Prideaux G. (2017) Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessments for Marine Noise-generating Activities, CMS, Bonn
- 63. Prideaux, G. and Prideaux, M. (2015). Environmental impact assessment guidelines for offshore petroleum exploration seismic surveys. *Impact Assessment and Project Appraisal*. published online December 2015.
- 64. Rafaelsen, B. (2006). Seismic resolution (and frequency filtering). University of Tromso. <u>https://folk.uio.no/hanakrem/svalex/E-learning/geophysics/Seismic resolution.pdf</u>
- 65. Ross, D. (2013). Mechanics of Underwater Noise. New York: Elsevier/Pergamon Press
- 66. Schnellmann, M./The Monachus Guardian (2016). Updated distribution map of the Mediterranean monk seal. http://www.monachusguardian.org/factfiles/image/ms_dist_map_2016.html
- 67. Southall B.L., Bowles A.E., Ellison W.T., Finneran J.J., Gentry R.L., Greene Jr C.R., Kastak D., Ketten D.R., Miller J.H., Nachtigall P.E., Richardson W.J. (2008). Marine mammal noise-exposure criteria: initial scientific recommendations. Bioacoustics 17(1-3): 273-275.
- 68. Southall B.L., Schusterman R.J., Kastak D. (2000). 'Masking in three pinnipeds: Underwater, low-frequency critical ratios.' The Journal of the Acoustical Society of America 108(3): 1322-1326.
- 69. Štrbenac, A. (ed.) (2015). Strategy on the conservation of cetaceans in the Adriatic Sea for the period 2016 2025. Document produced under the NETCET project, IPA Adriatic Cross-border Cooperation Programme. 28 p
- 70. <u>United Nations Sustainable development knowledge platform (2017). Sustainable</u> <u>Development Goals. https://sustainabledevelopment.un.org/sdgs</u>
- 71. UNEP/MAP (2016). Mediterranean Strategy for Sustainable Development 2016-2025. Valbonne. Plan Bleu, Regional Activity Centre. 83 p.

- 72. UNEP/MAP (2012). State of the Mediterranean Marine and Coastal Environment. UNEP/MAP Barcelona Convention. Athens. 92 p
- 73. UNEP/MAP (2013). Mediterranean Strategy for Sustainable Development follow up. Plan Bleue
- 74. Vasilijević, M., Pokrajac, S., Erg, B. (eds.) (2017). State of Nature Conservation Systems in South-Eastern Europe. Gland, Switzerland and Belgrade, Serbia: IUCN Regional Office for Eastern Europe and Central Asia (ECARO)
- 75. Wale, M.A., Briers, R.A., Bryson, D., Hartl, M.G.J., and Diele, K. (2016). The effects of anthropogenic noise playbacks on the blue mussel *Mytilus edulis*. Marine Alliance for Science & Technology for Scotland (MASTS) Annual Science Meeting, 19-21 October. <u>http://www.masts.ac.uk/media/36069/2016-abstracts-gen-sci-session-3.pdf</u>
- 76. Weilgart, L. (2017). The Impact of Ocean Noise Pollution on Fish and Invertebrates, OceanCare, Switzerland and Dalhousie University, Canada
- Weilgart, L. 2013. Alternative quieter technologies to seismic airguns for collecting geophysical data. In: von Nordheim, H., Maschner, K., and Wollny-Goerke, K. (Eds.) Proceedings of the 3rd International Conference on Progress in Marine Conservation in Europe 2012. BfN-Skripten 339: 127-134. <u>http://www.bfn.de/0502_skripten.html</u>
- 78. Williams, R., Wright, A.J., Ashe, E., Blight, L.K., Bruintjes, R., Canessa, R., Clark, C.W., Cullis-Suzuki, S., Dakin, D.T., Erbe, C., and Hammond, P.S. (2015). Impacts of anthropogenic noise on marine life: publication patterns, new discoveries, and future directions in research and management. Ocean & Coastal Management 115: 17-24.
- 79. World Energy Outlook 2016 Executive Summary. OECD/IEA (International Energy Agency). France. 13 p
- 80. World Energy Resources (2016). World Energy Council. 1028 p
- 81. World Travel and Tourism Council (2017). Travel & Tourism., Economic Impact 2017 Croatia. 24 p
- Wright A.J., Dolman S.J, Jasny M., Parsons E.C.M., Schiedek D., Young S.B. (2013). Myth and momentum: a critique of environmental impact assessments. J Environ Prot. 4:72–77.

Annex I. The EIA Guideline for Seismic Survey – extraction from the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise-generating Activities

VI. EIA Guideline for Seismic Surveys (Air Gun and Alternative Technologies)

This EIA Guideline should be used in combination with the appropriate modules on species and impact from the **Technical Support Information** (B.1-12, C and D) as required for individual regional and domestic circumstances.

Component	Detail	
Description of area	 Detail of the spatial extent and nature of the survey – including seabed bathymetry and composition, description of known stratification characteristics and broad ecosystem descriptions – as well as the spatial area that will experience anthropogenic noise, generated by the proposed survey, above natural ambient sound levels Detail of the typical weather conditions and day length for the area during the proposed activity period Identification of previous and simultaneous activities, their seasons and duration in the same or adjoining areas, existence and location of any 	
Description of the	 Explanation of all survey technologies available (including low-noise or 	
equipment and activity	noise-free options) and why the proposed technology has been chosen. If low-noise options have not been chosen, an explanation should be provided	
·	about why these technologies are not preferred	
	 Description of the survey technology including: 	

Modelling of noise propagation loss	• Detail of independent, scientific modelling of noise propagation loss in the same season/weather conditions as the proposed activity accounting for local propagation features (depth and type of sea bottom, local propagation paths related to thermal stratification, SOFAR or natural channel characteristics) from point source out to a radius where the noise levels		
	 Detail of independent, scientific modelling of noise propagation loss in the same season/weather conditions as the proposed activity accounting for local propagation features (depth and type of sea bottom, local propagation paths related to thermal stratification, SOFAR or natural channel characteristics) from point source out to a radius where the noise levels generated are close to natural ambient sound levels Identification and mapping of proposed species exclusion zones and description of how noise propagation into these zones will be minimized, taking into consideration the local propagation features 		
Species impact	 generated are close to natural ambient sound levels Identification and mapping of proposed species exclusion zones and lescription of how noise propagation into these zones will be minimized, aking into consideration the local propagation features General: a. Identification and density of species likely to be present that will experience sound transmission generated by the proposed activity above natural ambient sound levels. Calculated from this, the extent of the impact zones, and the number of animals affected by the activity. a. Specification of the type of impact predicted (direct and indirect) as well as direct and indirect impacts to prey species b. Information on the behaviour of each species group, and the ability to detect each of the species for mitigation purposes (e.g. for marine mammals this will include diving behaviour, vocal behaviour, and conspicuousness when at the surface). For each species group, also detail of the following (refer to module B species summary): a. Specific habitat components considered ii. presence of critical habitat (calving, spawning, feeding grounds, resting bays etc.) c. Scientific assessment of impact: i. exposure levels ii. total exposure duration 		

Component	Detail
	iii.determination of precautionary safe/harmful exposure levels (direct impact, indirect impact and disturbance) that account for uncertainty and avoids erroneous conclusions
Mitigation and	Detail of:
Mitigation and monitoring plans	 Detail of: Scientific monitoring before the survey to assess baselines, species distribution and behaviour to facilitate the incorporation of monitoring results into the impact assessment Scientific monitoring programmes, conducted during and after the survey, to assess impact, including noise monitoring stations placed at specified distances Transparent processes for regular real-time public reporting of survey progress and all impacts encountered Most appropriate methods of species detection (e.g. visual/acoustic) and the range of available methods, and their advantages and limitations, as well their practical application during the activity. Impact mitigation proposals: 24-hour visual or other means of detection, especially under conditions, sea spray or fog) establishing exclusion zones to protect specific species, including scientific and precautionary justification for these zones soft start and shut-down protocols protocols in place for consistent and detailed data recording
	and operations)
	down mitigation protocols
	vi. spatio-temporal restrictions
	 Quantification of the effectiveness of proposed mitigation methods

Reporting plans	• Detail of post operation reporting plans including verification of the effectiveness of mitigation, and any shut-down procedures occurring and reasons why	
Consultation and	 Description of consultation, prior to EIA submission; 	
independent review	a List of stakabolders consulted	
independent review	a. List of stakeholders consulted	
	b. Detail of information provided to stakeholders, opportunities	
	given for appropriate engagement and the timeframe for feedback	
	 Explanation of what amendments and changes have been made. 	
	to the proposed survey in response to the comments, queries	
	to the proposed survey in response to the confinents, queries,	
	requests and concerns	
	 Explanation of which comments, queries, requests and concerns 	
	have not been accommodated and why	
	 Description of independent review of draft EIA: 	
	a. Detail of the independent reviewers (species experts) including	
	a. Detail of the independent reviewers (species experts) including	
	b. Description of the comments, queries, requests and concerns	
	received from each reviewer	
	c. Explanation of what amendments and changes have been made	
	to the proposed survey in response to the comments queries	
	requests and concerns	
	requests and concerns	
	 Explanation of which comments, queries, requests and concerns 	
	have not been accommodated and why	

Annex II. Recommendations agreed at the Workshop hosted by OceanCare, NRDC and in cooperation and with the support of the DBU in November 2017 in Split, Croatia.



Workshop on mitigating the impact of underwater noise on marine biodiversity with specific focus on seismic surveys in the southeastern European waters in the Mediterranean Sea

Recommendations for mitigating the impact of underwater noise on marine biodiversity in the south eastern European waters in the Mediterranean Sea

An important workshop on 'Mitigating the impact of underwater noise on marine biodiversity with specific focus on seismic surveys in the south eastern European waters in the Mediterranean Sea' took place November 22-23, 2017 in Split, Croatia. The workshop participants discussed the complexity of underwater noise management and mitigation, and developed a series of sixteen priority Recommendations to improve the conservation and protection of marine wildlife in south eastern European waters from the threat of marine noise pollution.

The workshop was attended by 65 participants from 15 countries (see Annex 1), representing various stakeholder groups. They ranged from governmental institutions, such as ministries, nature protection, conservation, and energy agencies, to international organizations, including multilateral, regional, environmental agreements and regional fisheries bodies, to scientists and civil society organisations. All participants attended in their private or observer capacity and, while their participation was welcomed, it was understood that the recommendations stemming from the workshop should not be regarded as entailing any legal or policy expectations on their organisations.

The following 16 Recommendations represent the agreed outcomes of the workshop.

Government regulators, industry and stakeholders are urged to, as appropriate:

Recommendation 1: A Precautionary Approach

Apply a precautionary approach (for instance, incorporating into national legislation, strategies) to future activities that have the potential or are known to have harmful effects on the marine environment,

Recommendation 2: UN Open-ended Informal Consultative Process on the Oceans and the Law of the Sea

Ensure, to the maximum extent possible, that the 19th Meeting of the UN Open-ended Informal Consultative Process on the Oceans and the Law of the Sea (ICP or UNICPOLOS) in June 2018 addresses the various sources of ocean noise pollution, and provides guidance as well as a clear plan for mitigation actions that can be taken by all involved stakeholders.

Recommendation 3: Noise Budget

Explore the concept of a noise budget/threshold for the south eastern European waters in the Mediterranean Sea, in line with the threshold values required under the Marine Strategy Framework Directive (MSFD).

Recommendation 4: Cumulative Impacts

Address the cumulative impacts of all activities in the ocean, including climate change, through multi-sectoral strategies for countries' energy, environmental and blue economy policies, especially through the Maritime Spatial Plans to be developed by the EU Member States by 2021¹.

¹ Directive 2014/89/EU of the European parliament and of the council of 23 July 2014 establishing a framework for maritime spatial planning



Workshop on mitigating the impact of underwater noise on marine biodiversity with specific focus on seismic surveys in the southeastern European waters in the Mediterranean Sea

Recommendation 5: Strategic Environmental Assessments (SEAs) and Environmental Impact Assessments (EIAs) Make full use of national multi-sectoral Strategic Environmental Assessments (SEAs) conducted by governments, before any areas are opened for licensing applications to the oil and gas industry.

SEAs and Environmental Impact Assessments (EIAs), which are the assessments specific to proposed activities, should take into account all available information on the potential impact on species, habitats and other marine users (for instance, including the presence of marine mammal habitat as indicated by the identification of scientific advice, such as Important Marine Mammal Areas), as well as legislative and non-legislative commitments that are in place (including, the EU Habitats Directive and MSFD, for example), and should include the opportunity for meaningful and comprehensive public comment.

The information contained in SEAs and EIAs, as well as all collected data should be transparent and available to all stakeholders (for instance, tourism, fisheries), including civil society, in accordance with applicable regulations. Information about past, present and planned noise-generating activities should be submitted to national noise registries and remain publicly accessible, in perpetuity.

Recommendation 6: The CMS Noise EIA Guidelines

Transpose the Convention on Migratory Species (CMS) on Environmental Impact Assessment for Marine Noisegenerating Activities² (CMS Noise EIA Guidelines) into national legislation or species management plans, bearing in mind the context of the national legal structures, and use the CMS Noise EIA Guidelines as a standardized format to detail what is expected of applicants and assessment milestones. The CMS Noise EIA Guidelines should be adapted and improved according to national expert advice, and with multi-sectoral involvement. If countries don't have a legal basis to adopt guidelines, prescribing the development of such guidelines can be a useful tool.

Recommendation 7: Limiting Number and Time Frames of Seismic Surveys

Limit the number and time frames for seismic surveys to avoid the seasonal presence of vulnerable species and the duplication of surveys. States should make full use of the Convention on Environmental Impact Assessment in a Transboundary Context (ESPOO mechanisms) for transboundary consultations. A transparent overview of planned seismic activities should be promoted (for example, by making full use of the MSFD noise registry), to avoid duplication of seismic surveys, and improve transboundary consultation.

Recommendation 8: Best-available Quieting Technologies

Promote the development and mandate the use of best-available quieting technologies, such as *Marine Vibroseis*, by means of regulatory pressure and requiring operators to demonstrate they are not using sources that are more powerful than necessary and at unnecessary frequencies. This should be a component of each EIA and apply throughout the survey. What is considered necessary should be subject to independent review, as detailed in the CMS Noise EIA Guidelines.

Recommendation 9: Previous, Simultaneous, On-going, and Planned Activities

Take into account previous, simultaneous, on-going, and planned activities in the same or adjoining areas to consider potential cumulative or synergistic impacts, and assess the effectiveness of mitigation measures and monitoring activities for operational reviews prior, during and post-operation, ensuring monitoring results are publicly accessible, as detailed in the CMS Noise EIA Guidelines.

³ http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0052



Workshop on mitigating the impact of underwater noise on marine biodiversity with specific focus on seismic surveys in the southeastern European waters in the Mediterranean Sea

Recommendation 10: Review of SEAs and EIAs

Ensure adequate review of SEAs and ElAs, to maintain a transparent separation of science and politics, and avoid conflicts of commercial interest. This principle is detailed within the CMS Noise ElA Guidelines and supports the provisions in EU Directive 2011/92/EU as amended by 2014/52/EU³. Adequate time needs to be scheduled for all stages of the assessment, including the review process and comprehensive public consultation.

Recommendation 11: Spatial and Area Based Management

Develop and update integrated maps showing all IMMAs and marine protected areas as identified by competent bodies and organizations (for instance, national authorities, ACCOBAMS, CBD, GFCM, UNEP-MAP, NATURA 2000, IMMAs, EBSAs, and others) to facilitate spatial and area based management, and to ensure all species and habitats of conservation concern identified by these bodies have equal and appropriate recognition according to their conservation goals.

Recommendation 12: Subsidies

Remove subsidies for the oil and gas industry and spend public money in line with the objectives of the 2015 Paris Agreement on Climate Change.

Recommendation 13: Monitoring Survey Areas

Ensure the data on the occurrence and distribution of noise-sensitive species required for strategic maritime spatial planning is provided through inventories (for example, Areas of Interest for Important Marine Mammal Areas, Ecologically or Biologically Significant Marine Areas (EBSAs), and GFCM Fisheries Restricted Areas) to prioritise where to focus effort, and monitor survey areas where there is a lack of knowledge about the occurrence and distribution of noise-sensitive species and habitats.

Recommendation 14: Best Available Technology and Best Environmental Practice

Prepare a global report on the Best Available Technology (BAT) and Best Environmental Practice (BEP) for the mitigation of underwater anthropogenic noise, and make available to all government agencies, interested stakeholders and civil society in the regions in question, as a supplement to the CMS Noise EIA Guidelines.

Recommendation 15: Knowledge Transfer

Knowledge exchange and information-sharing should take place at the national level (multi-sectoral involvement) and regional level (between different countries in the region), and through an open-access independent scientific network focused on sharing data and monitoring ocean noise in the Mediterranean. The NETCCOBAMS⁴ platform developed by ACCOBAMS could be used as a tool for this.

Recommendation 16: Training and Capacity

Address the lack of training and capacity (for instance Marine Mammal Observers (MMOs), Passive Acoustic Monitoring, etc.) in the region, by making use of existing initiatives, such as the ACCOBAMS's accreditation system for high-quality MMOs, to significantly raise awareness and build support for reducing noise in the marine environment.

December 2017

The 2-day workshop was organised and hosted by OceanCare and NRDC, international nature conservation organisations, and was technically and financially supported by the Deutsche Bundesstiftung Umwelt (DBU).

⁴ http://www.netccobams.com/
ANNEX 1: Underwater Noise Workshop Participants

Last Name	First Name	Position/Institution	Country
Alexiadou	Paraskevi	Pelagos Cetacean Research Institute	Greece
Ameri	Michele	UN Division for Ocean Affairs and the Law of the Sea	Italy
Bataković	Milena	Agency for Environmental and Nature Protection	Montenegro
Bernal	Miguel	General Fisheries Commission for the Med. of the FAO (GFCM)	Spain
Bravo	Carlos	Alianza Mar Blava	Spain
Carić	Dr Hrvoje	Institute of tourism	Croatia
Carpentieri	Serena	Legambiente Onlus	Italy
Čižmek	Hrvoje	Marine Explorers Society 20000 leagues	Croatia
Čović	Radosav	Hydrocarbons Administration of Montenegro	Montenegro
D'Amato	Leonora	Environment and Resources Authority	Malta
Dinkelmeyer	Andreas	International Fund for Animal Welfare (IFAW)	Germany
Dobrinić	David	Croatian Hydrocarbon Agency	Croatia
Domel	Claudia	Deutsche Bundesstiftung Umwelt (DBU)	Germany
Đurović	Mirko	Director of the Institute of Marine Biology	Montenegro
ElHaweet	Alaa Eldin	Arab Academy for Science, Technology & Maritime Transport (Egypt)	Egypt
Entrup	Nicolas	OceanCare/NRDC	Austria
Ferri	Nicola	General Fisheries Commission for the Med. of the FAO (GFCM)	Italy
Frey	Silvia	OceanCare	Switzerland
Frisch-Nwakanma	Heidrun	UNEP/CMS Secretariat	Germany
Holcer	Draško	Blue World Institute	Croatia
Janković-Mišnić	Jasmina	Environmental Protection Agency Montenegro	Montenegro
Jelenić	Ivana	Ministry of Environment and Energy	Croatia
Jelić	Katja	Croatian Agency for the Environment and Nature	Croatia

Last Name	First Name	Position/Institution	Country
Jeremić	Jasna	Croatian Agency for Environment and Nature	Croatia
Kandić	Milica	Green Home	
Knežević	Jelena	UN Environment/Mediterranean Action Plan	Montenegro
Kramer	Brigitte	Freelance journalist (Germany)	Germany
Kruss	Aleksandra	CNR Marine Institute Venice, Italy	Poland
Leaper	Russell	International Fund for Animal Welfare (IFAW)	United Kingdom
Lüber	Sigrid	OceanCare	Switzerland
Mackelworth	Peter	Blue World Institute	United Kingdom
Madricardo	Dr Fantina	Consiglio Nazionale delle Ricerche - Istituto di Scienze Marine	Italy
Maglio	Alessio	SINAY	Italy
Matea	Spika	Udruga Sunce	Croatia
Mateja	Gazic	Ministry of environmetantal protection	Croatia
Medenica	Nikola	Environmental protection Agency (EPA) of Montenegro	Montenegro
Micallef	Tamara	Environment and Resources Authority	Malta
Michaelides	Savvas	Department of Fisheries and Marine Research, Cyprus	Cyprus
Müller	Johannes	OceanCare/NRDC	Germany
Nenadović	Tina	Gardline Geosurvey Ltd. Marine Wildlife and Environmental Dpt.	Croatia
Nikolić	Vedran	European Commission, DG Environment	Croatia
Notarbartolo di Sciara	Giuseppe	Tethys Research Institute	Italy
Panigada	Simone	ACCOBAMS	Italy
Panou	Aliki	Archipelagos - environment and development	Greece
Pavan	Gianni	University of Pavia	Italy
Pilikou	Maria	Legal Advisor - International Law of the Sea	Cyprus
Radojčić	Dušica	Association Green Istria	Croatia

Last Name	First Name	Position/Institution	Country
Radonjić	Dina Skarep	Hydrocarbons Administration of Montenegro	Serbia
Radović	Ilija	Environmental protection Agency (EPA) of Montenegro	Montenegro
Raičević	Nikola	Environmental Protection Agency (EPA) Montenegro	Montenegro
Rako Gospić	Nikolina	Blue World Institute	Croatia
Risch	Denise	Scottish Association for Marine Science	Germany
Ritter	Fabian	Whale and Dolphin Conservation Society (WDC)	Germany
Schneider	Daniela	Croatian Agency for Environment and Nature	Croatia
Sekovski	Ivan	Priority Actions Programme / Regional Activity Centre (PAP/RAC)	Croatia
Sijan	Milena	Moderation	Croatia
Šimunović	Vedran	Udruga Val	Croatia
Širović	Dr. Ana	Scripps Institution of Oceanography	Croatia/USA
Štrbenac	Ana	Stenella consulting d.o.o.	Croatia
Summer	Lisinka	OceanCare	Austria
Tomac	Luka	Zelena akcija / FoE Croatia	Croatia
Tomić	Zoran	Greenpeace CEE in Croatia	Croatia
Vaniček	Dr Vlatka	Director of Sector of Environmental Protection	Croatia
Varda	Dušan	Mediterranean Center for Environmental Monitoring - MedCEM	Serbia
Weilgart	Linda S.	Dalhouy University, Department of Biology	USA and Germany