The Threat Posed by Ocean Noise Pollution to Europe's Cetaceans

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"Whales and dolphins live in an acoustic world, which they primarily perceive by listening. But we are filling their homes with noise pollution. It is important to their health and survival that we significantly reduce noise in the ocean."
Nicolas Entrup

Introduction

The oceans are an acoustic world: marine mammals live in a medium through which sound propagates extremely well. This explains the dependence of many marine animals on acoustics for navigation, hunting, reproduction and communication. Cetaceans are highly adapted physiologically and behaviourally to use sound (Tyack and Miller, 2002). As humans increasingly use sound underwater in our attempts to efficiently navigate, explore and exploit the seas, ocean noise pollution has become recognised as an issue of major significance and concern and a primary focus of marine mammal research over the last two decades (Simmonds *et al*., 2014). This has resulted in some relevant legislation, regional and international policy decisions, and associated guidance. Most current mitigation efforts are directed at reducing the risk of injury from exposure to intense noise, although the effectiveness of such mitigation measures in terms of risk reduction has rarely been quantified. Longer-term chronic impacts of noise, including disturbance or masking of sounds critical for feeding and reproduction, have received substantially less attention.

Several substantive reviews have considered ocean noise pollution in recent years (for example, Richardson *et al*., 1995; Simmonds *et al*., 2004; Hildebrand, 2005; Jasny, 2005; Weilgart, 2007; and Simmonds *et al*., 2014). The available evidence shows how noise can have a variety of deleterious effects on cetaceans, including:

- reducing communication ranges and obscuring sounds of interest (a process known as masking);
- disrupting reproductive behaviours;
- adversely affecting energetic budgets through interference with foraging and increased travel;
- excluding animals from certain important habitats;
- inducing chronic stress responses;
- causing temporary or permanent loss of hearing sensitivity;
- inducement of physical injury; and,
- in certain instances, causing mortality.

Research on beaked whales has demonstrated that intense noise events can have impacts at the population level (Weilgart, 2007), and noise pollution is also now appreciated to be creating widespread effects impacting many different marine species (Weilgart, 2018). Whilst many marine animals have evolved to cope with and, indeed, use sound, including the many natural sounds in the marine environment, human activities are now a major source of noise throughout many parts of the world's oceans increasing direct impacts as well as cumulative effects.

Ocean noise sources generated by human activities can be divided into two main categories: ambient, continuous noise and intense, impulsive noise (Hildebrand, 2005; Simmonds *et al*., 2014). Ambient and continuous noise mainly relates to vessel traffic, including commercial shipping and passenger ferries as well as leisure boats. Continuous noise can also be produced from drilling in oil and gas operations or some construction. Intense impulsive noise includes seismic airgun arrays for oil and gas exploration, military, research, fisheries and civil powered sonars; industrial and construction noise (notably from pile-driving for offshore wind farms); acoustic deterrent and harassment devices (used predominantly to deter marine mammal predators from fisheries and aquaculture facilities); and loud noises used in some scientific experiments. The impact of different noise sources may vary according to marine habitat. Coastal areas with heavy shipping and/or industrial activities may be most heavily affected by chronic noise pollution. However, the distinctions between continuous and impulsive noise are not necessarily perfect, as some impulsive noise can become continuous over larger distances and in certain conditions. Chronic noise can cause chronic impacts, such as masking, but also acute impacts such as hearing damage. Powerful noise sources can cause acute impacts, for example the loud noise made by seismic surveys or military sonars, but the impacts can be long-lasting, even up to a year or more after the noise has ceased, at least in invertebrates (Day *et al*., 2017; Fitzgibbon *et al*., 2017; Day *et al*., 2019).

Chronic noise

Commercial shipping is of great economic importance, providing an efficient means of transporting large quantities of goods and materials, and it is also the principal source of low frequency (5–500 Hz) background noise in the

world's oceans. Studies undertaken relating the output from large ships to the characteristics of the vessel, and using measurements from more than 1,500 ships, found a linear relationship between source level and speed of most ship classes, with sound levels increasing by around 1 dB per knot of speed (Veirs *et al*., 2016). Container ships had the highest source levels. The dataset also showed that the loudest 15% of ships contribute the majority of the sound energy from shipping (Veirs *et al*., 2018). Leaper and Renilson (2012) estimated that the noisiest 10% of vessels (those that are 6.8 dB or more over the average) contribute to 48-88% of the total acoustic footprint (the sea area over which the ship noise increases the background noise over a certain level). Shipping traffic is not uniformly distributed, and this affects chronic noise pollution. The major commercial shipping lanes follow particular routes to minimise the distance travelled. Dozens of major ports and "mega-ports" handle the majority of the traffic, but hundreds of small harbours and ports host smaller volumes of traffic. There is also a related issue of collisions between shipping and cetaceans, which is causing growing concern (see box on ship strikes below).

Acute noise

Seismic exploration uses high-intensity sound to examine the Earth's crust, mainly in pursuit of fossil fuel deposits. To a lesser extent, it is also used by researchers to gather other geological information. Arrays of airguns are deployed and fired with precise timing to produce a coherent pulse of sound (Hildebrand, 2005). Oil industry airgun arrays typically involve twelve to forty-eight individual guns, towed about 200m behind a vessel, and produce source levels as high as 260 dB peak re 1 µPa at 1 m output[1] (Hildebrand, 2009). Except for nuclear and chemical explosions, this is probably the loudest human-caused underwater noise. Noise from a single seismic airgun survey, used to locate oil and gas deposits under the sea floor, can blanket an area of over 300,000 km^2, raising background noise levels 100-fold (20 dB), continuously for weeks or months (IWC, 2005, 2007). In 2015, Nowacek *et al*., highlighted the fact that technological improvements and economic market forces in petroleum and natural gas exploration had extended the spatial and temporal reach of seismic surveys, notably into higher latitudes and deeper waters, during most months of the year. They emphasised that this may have acute, cumulative, and chronic effects on marine organisms and noted that this expansion also raised issues about overlapping jurisdictions and governance. They gave the Mediterranean and north-eastern North Atlantic as examples and suggested the creation of an international regulatory instrument to try and better manage seismic surveys. However, as far as we are aware, this idea has not been further developed.

Sonar systems use acoustic energy to probe the ocean itself "looking" at objects within the water column, at the sea bottom, or within the underlying sediment. Active sonar emits high-intensity acoustic energy and receives reflected and/or scattered energy. A wide range of sonar systems are in use by civilian and military interests. Sonar systems are described as low-frequency (100 Hz - 1 kHz), mid-frequency (1–20 kHz), and high-frequency (>20 kHz) (Hildebrand, 2005). Military sonars generally cover a broader frequency range with higher source levels than civilian sonars and are operated during both training exercises and combat. Low-frequency active (LFA) sonars are used for submarine tracking over scales of many hundreds to thousands of kilometres. Mid-frequency tactical antisubmarine warfare (ASW) sonars are designed to detect submarines over several tens of kilometres.

Offshore industries can produce both acute noise, for example pile-driving during construction, and chronic noise, for example sounds produced by machinery on off-shore platforms and the noise produced by vessels or helicopters servicing offshore activities. Simmonds and Brown (2010) looked at the offshore marine renewables industry (wind farms, submerged turbines and other energy generating devices) in UK waters. They noted its rapid expansion and a lack of understanding of possible impacts on cetaceans, emphasising the desirability of countries coordinating their construction activities to try and limit noise pollution.

[1] Loudness (also called sound pressure level, or SPL) is measured in logarithmic units called decibels (dB). The intensity of a sound wave with a pressure of 1 microPascal (µPa) is the reference intensity for underwater sound. The logarithmic nature of the decibel scale means that each 10 dB increase is a ten-fold increase in intensity. A 20-dB increase is a 100-fold increase in intensity, and a 30-dB increase is a 1000-fold increase in intensity.

International engagement with noise pollution

Growing awareness led to efforts to engage with this issue starting in the 1990s to 2000s (Simmonds *et al*., 2014). One of the first, and perhaps the most widely recognised, signs that loud noise was causing problems for marine life came from a number of very unusual live strandings of beaked whales (in some cases, different species stranding at the same time). For example, there was a spate of these in the Spanish Canary Islands between 1982 and 1989. These were linked to military exercises offshore (Simmonds and Lopez-Jurado, 1991). Other similar stranding events followed, as did considerable investigation (e.g. Jepson *et al*., 2003; Fernández *et al*., 2005). The International Whaling Commission's (IWC) Scientific Committee commented that "there is now compelling evidence implicating military sonar as a direct impact on beaked whales in particular" (IWC, 2004)[2]. The Spanish government imposed a moratorium on naval exercises in the waters of the Canary Islands in 2004 and these stranding events have not reoccurred there since (Fernández *et al*., 2013), pointing to a significant conservation success following this precautionary action.

Further to the association between strandings and loud noise sources becoming widely recognised alongside other lines of evidence, the significance of ocean noise pollution has been increasingly acknowledged by several international and regional conventions. Examples include the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) and the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS). Both have considered the threat posed by ocean noise in some detail and passed relevant resolutions, including the 2007 ACCOBAMS "Guidelines to address the impact of anthropogenic noise on marine mammals in the ACCOBAMS area"[3].

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) has also been highly proactive on this issue (CMS, 2020). Among other things, Cuvier's beaked whales (*Ziphius cavirostris*) in the Mediterranean Sea were added to Appendix I of CMS in 2014, and this was, in part, as a reaction to concerns about the impacts of noise on their relatively small and isolated populations[4]. (ACCOBAMS had passed a Resolution calling for strict protection of this species in the Mediterranean the year before[5].) In 2017, CMS also agreed to the "CMS Family Guidelines on Environmental Impact Assessment for Marine Noise Generating Activities" (CMS, 2017).

Likewise, in 2008, the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) added "noise from commercial shipping and its adverse impacts on marine life" to its work. Subsequently, in 2014, "Guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life" were approved by the MEPC[6]. OSPAR (the Convention for the Protection of the Marine Environment of the North-East Atlantic) and CBD (the Convention on Biological Diversity) have also reviewed the issue in recent years (Simmonds *et al*., 2014).

The European Union's (EU) Marine Strategy Framework Directive (MSFD) (2008/56/EC)[7] explicitly requires consideration of underwater noise in the determination of Good Environmental Status (GES) by its member states, and two noise-related indicators have been defined in the Directive: one for intense sounds of short duration such as sonar, seismic surveys and pile driving (including as used to establish the foundations of wind farms), and one for chronic, low-frequency noise associated primarily with shipping.

In addition, various guidelines to help address noise impacts have been proposed. The most well-known of these have probably been the guidelines proposed by Southall *et al*. (2007). Their guidance is focused on Temporary Threshold

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[2] In the years that followed, efforts were made to elucidate the mechanisms that were leading to strandings and death and, at the time of writing, it seems most likely that in many instances deeper diving cetaceans become incapacitated when exposure to loud noise causes them to change their dive pattern and develop decompression sickness, as in the case of divers with the 'bends', when bubbles of gas form in their tissues (see e.g. Jepson *et al*., 2003; Fernandez *et al*. 2005).

[3] https://www.accobams.org/wp-content/uploads/2016/06/ACCOBAMS_MOP3_Res.3.10.pdf

[4] The proposal for the inclusion of this population on Appendix 1 can be found here: https://www.cms.int/sites/default/files/document/Doc_24_1_1_Prop_I_1_Ziphius_cavirostris_%28Cuvier%27s_Beaked_Whale%29_EU.pdf

[5] Resolution 5.13 Conservation of Cuvier's beaked whales in the Mediterranean. Available here: https://www.accobams.org/wp-content/uploads/2016/06/ACCOBAMS_MOP5_Res.5.13.pdf

[6] MEPC.1/Circ.8337. April 2014

[7] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056

Shift (temporary hearing loss) and Permanent Threshold Shift (permanent hearing loss) which are physical impacts. They did not extend to behavioural responses, which are more difficult to understand and mitigate against.

Based on the outputs of the relevant international fora, we believe that the following general principles are widely agreed:

1. Measures should be taken to avoid, minimise and mitigate adverse impacts of anthropogenic underwater noise on marine and coastal biodiversity;
2. Environmental Impact Assessments (EIAs) that take underwater noise into consideration should be conducted;
3. Consideration should be given to noise pollution in management plans for marine protected areas and other critical habitat areas;
4. Further research to help better understand impacts and the effectiveness of mitigation should be conducted; and
5. Best Available Techniques (BAT) and Best Environmental Practice (BEP) should be further developed and applied. Weilgart (2019) gives some guidance on this for three noise sources (shipping, seismic airguns, and pile driving).

The Mediterranean Sea – 'A Special Study'

Thanks to the support of ACCOBAMS, a special report on noise hotspots in the Mediterranean Sea was published in 2016 (Maglio *et al.*, 2016). The Mediterranean is the largest and deepest semi-enclosed basin in the world and a major reservoir of marine and coastal biodiversity, including eleven cetacean species. The report considered the area between the Strait of Gibraltar and the Bosphorus: in other words, the whole of the Mediterranean but not the adjacent waters. It considered the position of 1,446 harbours, 228 drilling platforms, 52 wind farm projects, 830 seismic exploration areas, a number of military areas, and 7 million vessel positions. The authors found an average of around 1,500 vessels present in the area at any time, with areas of heaviest traffic levels mainly in the northern and western part of the basin and in Greek waters. The dataset also demonstrated a significant increase in seismic exploration activities, some of the loudest noise sources in the marine environment, during the period considered. The area covered by seismic surveys increased from 3.8% to 27% of the Mediterranean between 2005 and 2013.

The authors found that certain areas were exposed to multiple noise-producing human activities: the Italian part of the Adriatic Sea, the Strait of Sicily, the French Mediterranean from the Côte d'Azur to the Gulf of Fos, the Gulf of Valencia, the north-eastern part of Corsica, the higher Ionian Sea, and the coast of Campania. They compared these hot spots with key cetacean habitat areas and identified potential areas of conflict in the Ligurian Sea, the Strait of Sicily and the northern part of the Hellenic Trench. Whilst the authors stressed that their report should be seen as a "first rough review" of the real situation in the Mediterranean Sea, this kind of compilation of information serves to illustrate where noise is concentrated and may be a particular problem for cetaceans. It would be good to see this work extended and other areas in Europe similarly considered.

Specific noise issues in European waters

Shipping

International shipping transports more than 80% of global trade around the world[8] and this is set to increase[9]. European waters are exposed to intense shipping traffic, attracted by large ports, such as Rotterdam, Antwerp and Hamburg (Figure 1). The Mediterranean Sea connects the Atlantic and the Indian Oceans, as well as providing entry to the Black Sea, making the Strait of Gibraltar and the Suez Canal areas of particularly heavy shipping. The intensity of cargo and tanker shipping in the Mediterranean is shown in Figure 2.

[8] http://www.imo.org/en/About/Pages/Default.aspx
[9] https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=2563

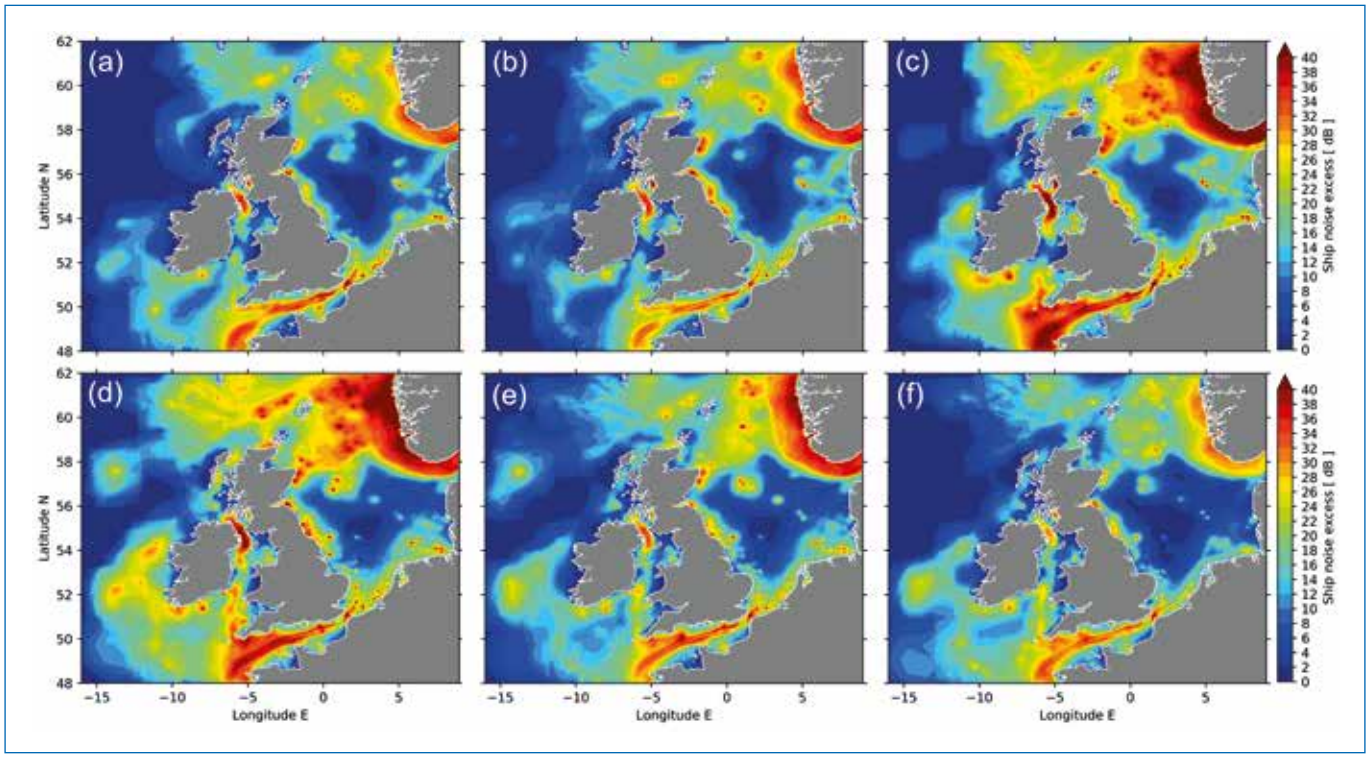

Figure 1. Median broadband ship noise excess (ship noise levels above wind) for selected months in 2017. *(a) January (b) March (c) May (d) July (e) September (f) November (From Farcas et al., 2020).*

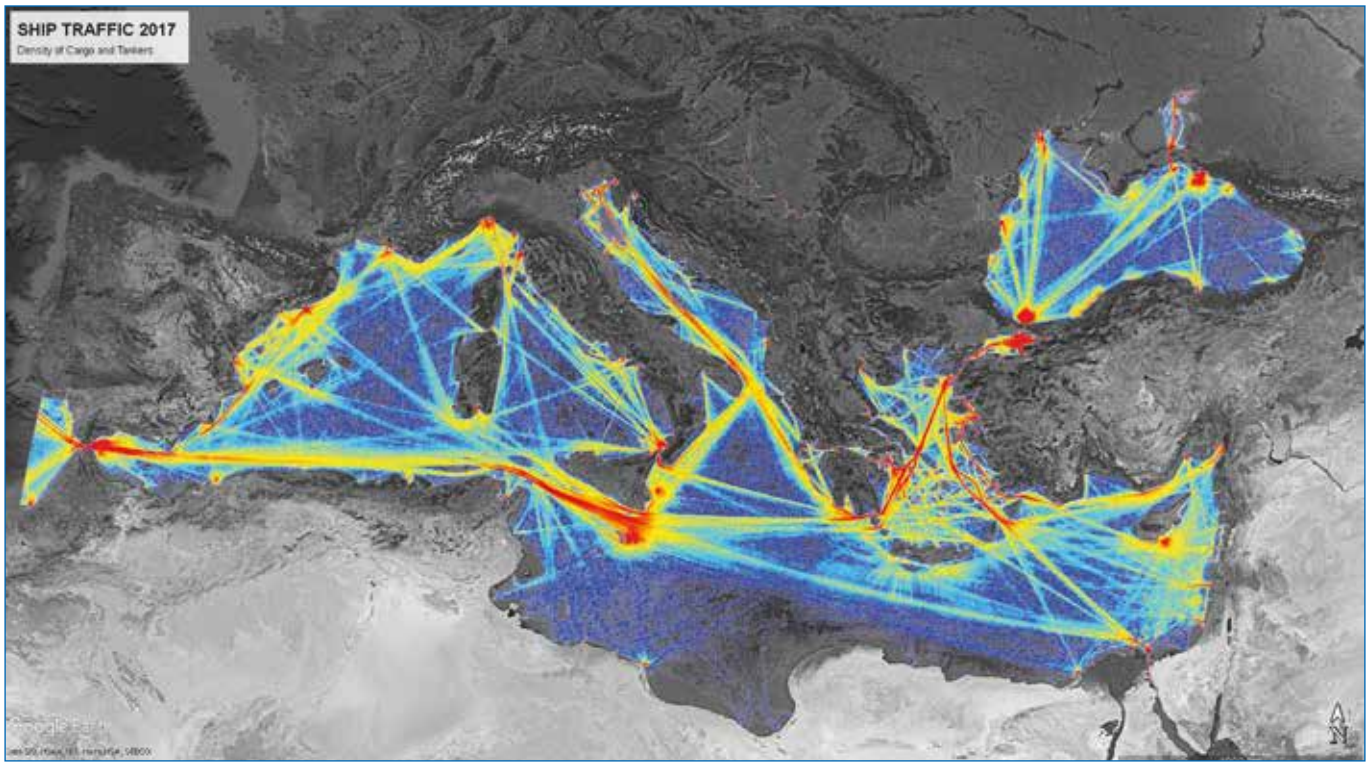

Figure 2. Density of cargo and tankers in the Mediterranean, 2017 *(From ACCOBAMS and IUCN Joint SSC/WCPA Marine Mammal Protected Areas Task Force, 2018 and Maglio et al., 2016).*

In addition to introducing significant noise into the marine environment, major impacts of maritime transport also include:

i. operational, accidental or intentional pollution, including the release of oil, litter, and hazardous and noxious substances, including toxic gases and particulates such as sulphur oxides (SOx) and nitrogen oxides (NOx), as well as greenhouse gas emissions; and
ii. the introduction of non-indigenous species through ballast waters.

As noted above, noise emissions generated by shipping are mainly produced by larger vessels, and there is also a relationship between noise level and speed. The IMO approved Guidelines in 2014 designed to reduce noise emissions[10].

Additionally, Leaper (2019) recently explored the links between ship speed, ship strikes, greenhouse gas emissions and noise. His modelling shows that a modest 10% speed reduction across the global fleet, estimated to reduce overall greenhouse gas emissions by around 13% could also reduce the total sound energy from shipping by around 40% and could potentially reduce overall ship strike risk by around 50%. A 20% reduction in speed could lead to a reduction of noise emissions from shipping by around 67%.

Vancouver Fraser Port – A model to be replicated

The Vancouver Fraser Port Authority, British Columbia, Canada, has developed the Enhancing Cetacean Habitat and Observation (ECHO) Program to develop mitigation measures that will lead to a quantifiable reduction in threats to whales because of shipping activities[11]. This programme includes research on changes in the underwater noise emitted as a result of voluntary ship slowdown measures and avoidance of cetacean habitat. For instance, comparisons are made between the loudest and quietest ships to determine the causes of these differences based on vessel design characteristics.

In 2019, 82% of large commercial ships participated in the slowdown and reduced underwater noise intensity by half[12]. Vehicle carriers, cruise ships and container vessels slowed to 14.5 kts or less through the water; and bulkers, tankers, ferries and government vessels to 11.5 kts or less. In 2018, the slowdown was to 15 kts and 12.5 kts for the same vessel categories. The participation rate was 87% vs. 61% in 2017. The slowdowns produced a 15% reduction in affected whale foraging time in 2018 and a 22% reduction in 2017. In 2017, mean speed reductions were 2.1 kts for bulk/general cargo ships and as high as 7.7 kts for container ships. This produced a 44% reduction in noise intensity.

The Port's EcoAction Program, launched in 2007, offers discounts on harbour dues to vessels that voluntarily reduce their noise emissions. Depending on how quiet ships are, they can earn up to 47% off the basic harbour due rate. The number of qualifying vessels has steadily increased over the years, to reach 986 in 2019. Shore power installations for cruise and container ships have also cut down noise and air emissions. The Prince Rupert Port Authority has a similar programme to financially reward quieter ships[13].

Such port strategies could be replicated in European ports both for cetaceans and their prey (fish and invertebrates) which is also largely noise-sensitive.

[10] https://www.imo.org/en/MediaCentre/HotTopics/Pages/Noise.aspx
[11] https://www.portvancouver.com/environmental-protection-at-the-port-of-vancouver/maintaining-healthy-ecosystems-throughout-our-jurisdiction/echo-program/
[12] https://www.portvancouver.com/wp-content/uploads/2020/08/ECHO-Program-2019-voluntary-vessel-slowdown-in-Haro-Strait-and-Boundary-Pass-final-report.pdf
[13] https://www.portvancouver.com/environment/air-energy-climate-action/marine/

Military noise

Noise produced by military activities is a sensitive issue because it relates to matters of national security. Nonetheless, in 2004, the European Parliament adopted a Resolution calling on Member States to adopt a "Moratorium on the deployment of high-intensity active naval sonars until a global assessment of their cumulative environment impact on marine mammals, fish and other marine life has been completed"[14]. However, apart from the Spanish ban on activities around the Canary Islands, no other government, as far as we are aware, has taken action. Perhaps understandably, there is little information publicly available about the extent of military noise. Maglio *et al.* (2016) for example, reported that data on the spatial extent of military areas were only available for four Mediterranean countries (Spain, France, Italy and Greece) and this covered almost 18.2% of sea surface in the Mediterranean Sea.

There is also debate about how to interpret EU law in this matter. Article 2.2 of the EU's MSFD states that "This Directive shall not apply to activities the sole purpose of which is defence or national security"[15]. It also adds "Member States shall, however, endeavour to ensure that such activities are conducted in a manner that is compatible, so far as reasonable and practicable, with the objectives of this Directive."

In 2010, the Parties to ACCOBAMS, adopted Resolution 4.17[16] agreeing to "Guidelines to address the impact of anthropogenic noise on cetaceans in the ACCOBAMS area". These Guidelines include specific recommendations for "military high power sonar", including that "*Sonar surveys should be planned so as to avoid key cetacean habitat and areas of cetacean density, so that entire habitats or migration paths are not blocked, so that cumulative sonar sound is limited within any particular area, and so that multiple vessels operating in the same or nearby areas at the same time are prohibited.*"

In 2018, further to an atypical mass stranding of beaked whales that occurred between the 31st of March and 10th of April 2014 on Crete, the ACCOBAMS Follow-Up Committee (an independent tool of the Agreement which is used to review compliance by Parties) concluded that "it is likely that the atypical mass stranding of beaked whales … was the result of the military exercises taking place from 31 March to 10 April 2014, in which Greece was also involved"[17]. It invited Greece "to provide information to the ACCOBAMS Secretariat about how the Guidelines annexed to the Resolution 4.17 have been implemented after 2014 till now". This conclusion was endorsed by the 7th Meeting of the ACCOBAMS Parties in 2019.

Searching for oil and gas

In December 2015, the Paris Agreement, the first-ever universal and legally binding global climate change agreement, was adopted. Its objective was to limit global warming to well below 2°C and to pursue efforts to limit it to 1.5°C compared to pre-industrial levels. We believe that all European countries have ratified the Agreement, except Turkey. Meeting the objectives of the Agreement requires a transition away from burning fossil fuels, but the continued search for new hydrocarbon resources in European waters stands in stark contrast to this objective. To date, France is one of the few European countries that has clearly banned exploration for new hydrocarbon resources in its waters.

The threat from loud noise to cetaceans is now widely recognised, as outlined above, yet hydrocarbon exploration continues in European waters, including very deep areas, some of which are likely of critical importance to sensitive whale species, such as beaked whales (Bernaldo de Quirós *et al.*, 2019), sperm whales (*Physeter macrocephalus*) and others. There is also no comprehensive overview of previously undertaken and planned seismic activities in European waters. Instead, the approach is rather fragmented.

[14] European Parliament resolution on the environmental effects of high-intensity active naval sonars; 28 October 2004 – Strasbourg. https://www.europarl.europa.eu/sides/getDoc.do?reference=B6-2004-0089&type=MOTION&language=EN&redirect

[15] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056

[16] This resolution was updated in 2019 by Resolution 7.13

[17] Report of the Second Meeting of the ACCOBAMS follow up committee. Monaco, 5-6 March 2018. ACCOBAMS-FC2/2018/Doc 14

For the Northeast Atlantic, an analysis reviewing impulsive noise-generating activities between 2015 and 2017 summarised that seismic airgun surveys have been the dominant noise source (67%- 83% of annual impulsive noise activity) in the region, although a decline of 38% was reported during this period. Pile driving, as well as explosions and employing active sonar devices, were reported to increase. The authors interpret the documented decline in seismic surveys to be due to an "exceptional strategic survey conducted in UK waters in 2015/16", as well as "due to the low oil price over this period" (Merchant *et al*., 2020).

Maglio *et al*. (2016) reviewed a dataset of 830 seismic activities in the Mediterranean Sea, demonstrating a significant increase of seismic exploration activities. These covered 3.8% of the Mediterranean's surface in 2005 and 27% in 2013. These are likely to be minimum figures, as no datasets were available for some states. Additionally, there are "more than two hundred offshore oil and gas platforms […] active in the Mediterranean. With new discoveries of large fossil fuel reserves and explorations in the region, this figure is set to increase".[18] Hydrocarbon exploration and exploitation in the Hellenic Trench has been especially controversial in recent years and, in 2019, dozens of scientists and conservation organisations called on the Greek government for immediate and effective protection of this region[19]. ACCOBAMS has also been calling for protection of this area.[20]

Continued seismic activities in the Mediterranean are unlikely to be in line with the Noise Guidelines adopted by Parties to ACCOBAMS concerning the protection of whale species in the Mediterranean and Black Seas, which require that, in principle, intense noise-generating activities shall "avoid cetaceans' key habitats and marine protected areas, define appropriate buffer zones around them and consider the possible impact of long-range propagation"[21]. The Guidelines include a specific section for seismic surveys and airgun uses which states "seismic surveys should be planned so as to avoid key cetacean habitat and areas of cetacean density, so that entire habitats or migration paths are not blocked". Most European waters range states have also supported the adoption of the 2017 CMS Family Guidelines to undertake Environmental Impact Assessments prior to noise-generating activities, but exploration and exploitation activities for hydrocarbon resources continue in most jurisdictions.

Exceptions to such hydrocarbon activities are France and, also, Spain where, in recent years, many applications for permits to undertake seismic surveys have been withdrawn by the applicant or rejected by authorities due to concerns over the impact on marine biodiversity.

In the 2019 'Reduce the Noise' report[22], four conservation organisations reviewed at least 13 Programmes of Measures by EU Member States to reach GES within their waters, as required by the MSFD, and concluded that for reducing underwater noise levels this binding objective will not be met. This appears to be little different for Non-EU-Member European States.

Conclusions

The chronic and acute impacts of anthropogenic noise on cetaceans in European waters is of concern and, as with other forms of pollution, reducing input at source will be the most effective way of reducing impacts. Impacts on sensitive species can also be reduced by temporal or spatial separation. Marine spatial planning, following a science-based protected area approach, including the definition of buffer-zones, can be used to provide guidance towards noise exclusion zones and quieting regions.

Given the many sources of noise, consideration also needs to be given to their cumulative and synergistic effects and to managing them collectively. Underwater noise is also a transboundary issue, and international cooperation

[18] https://wedocs.unep.org/bitstream/handle/20.500.11822/28627/19wg468_21_eng.pdf?sequence=1&isAllowed=y
[19] https://www.wwf.gr/images/pdfs/Resolution_text_ENG.pdf
[20] (Resolution 3.22. Marine Protected Areas for Cetaceans; Area of Special Importance for the Sperm Whale; (16) southwest Crete and the Hellenic Trench; Resolution 4.15. MPAs of Importance for Cetacean Conservation; Resolution 6.24. New Areas of Conservation of Cetacean Habitats)
[21] RESOLUTION 4.17 GUIDELINES TO ADDRESS THE IMPACT OF ANTHROPOGENIC NOISE ON CETACEANS IN THE ACCOBAMS AREA. Available here: https://www.accobams.org/wp-content/uploads/2016/06/ACCOBAMS_MOP4_Res.4.17.pdf
[22] https://www.oceancare.org/wp-content/uploads/2019/01/Report_Reduce-the-Noise_190124.pdf

and coordination are required to address it. Reducing habitat degradation arising from noise pollution will also give species and populations more resilience to face the myriad of other non-acoustic threats that they now face.

The international community needs to meet the United Nations' (UN) Sustainable Development Goals (SDGs) – of particular relevance here are SDG13 to combat climate change, and SDG14 which focuses on the health of oceans. These are central to marine conservation efforts in the face of ocean noise pollution. SDG1 (related to human livelihoods) and SDG2 (related to food security) are also highly relevant because noise pollution in the seas also threatens these aspects. Additionally, in Europe, there are the objectives set under the Paris Agreement, as well as by the EU to achieve GES for its waters. All of these objectives mean that it would make sense for decision-makers to phase out exploration activities (i.e. seismic airgun surveys) for new hydrocarbon sources, one of the loudest human-made noises.

By reducing speed, the shipping sector can contribute most cost-effectively to reducing the environmental impact of shipping, including ocean noise and ship strikes. Furthermore, port policies will play a major role in creating incentives towards speed reduction schemes. Ocean noise-generating activities should also be subject to robust and transparent EIAs, as agreed by the Parties to CMS. Military activities, in particular manoeuvres and activities in peacetime, should follow the environmental and species conservation provisions recognised nationally, regionally and internationally.

Ship strikes

An issue closely related to ocean noise is ship strikes, meaning collisions between cetaceans and ship propellers or any other part of a vessel. In resolution 7.12 SHIP STRIKES, ACCOBAMS recently reiterated its concerns about the effects of ship strikes on large whales, such as fin (*Balaenoptera physalus*) and sperm whales. It noted that the only effective mitigations to avoid serious injury and death of cetaceans from ship strikes at present are (a) avoidance by ships of areas or times with a high density of whales, including the establishment of shipping lanes or non-shipping zones, and (b) speed reductions in such areas or times, slowing ships down to speeds below 10-12 knots. The resolution also identified some high risk areas including the Hellenic Trench, the Strait of Gibraltar, the Pelagos Sanctuary, the area south west of the island of Crete, around the Balearic Islands, between Almeria and Nador, at the eastern side of the Alborán Sea, and the Strait of Sicily.

Recommended actions

Policy

- An immediate ban on the search for new oil and gas deposits in the seabed in European waters;
- Mandatory application of the CMS Guidelines on EIAs prior to noise-generating activities;
- The development of best-available quieting technologies and legislation covering the use of these technologies;
- Europe should take a leading role in devising a global strategy that seeks to reverse the trend of rising ocean noise levels and supports the incorporation of measures to manage ocean noise in international agreements and in the negotiations leading up to such agreements within the UN system;
- Agreement should be reached on a European-wide shipping and port policy for the reduction of ocean noise, including incentive programmes (e.g. reducing port fees) for quieter ships and the promotion of operational noise-reducing measures, such as speed reductions, within the IMO. These actions also have other environmental health benefits (e.g. the reduction of greenhouse gases);
- The assessment of cumulative impacts of all activities in the ocean, including climate change, through multi-sectoral strategies for countries' energy, environmental and blue economy policies;
- The removal of subsidies for the oil and gas industry and the use of public money in line with the objectives of the 2015 Paris Agreement on Climate Change; and
- Research into the socioeconomic effects of ocean noise on marine life.

Management measures

- Time-area closures to minimise contact with cetaceans and other marine life, especially during sensitive seasons;
- The identification of and establishment of noise exclusion zones and alternative shipping routes, including the designation of noise buffer zones around sensitive habitats, using science-based protected area approaches as guidance, as well as the establishment of 'quiet zones' in Important Marine Mammal Areas (IMMAs), Natura 2000 protected areas and Ecologically or Biologically Significant Marine Areas (EBSAs);
- Application of the precautionary approach, including by carefully assessing all future ocean noise-generating activities and ensuring the use of BAT and BEP for any approved activities. Regulators must require operators to demonstrate that they are not using sources that are more powerful than necessary and at unnecessary frequencies; and
- Compilation of a list of past, present and future impulsive noise-generating activities through a registry in order to share data amongst stakeholders for the ultimate purpose of establishing noise budgets and limits for regions.

Private sector

- Work towards the development and application of quieting technologies by various noise-generating industries;
- The shipping sector should reduce speed as a measure to reduce noise emissions, whilst also, by this action, contributing to the achievement of climate goals;
- There should be a general commitment to imposing quieting measures and to the SDGs, in particular Goal 14, on the conservation and sustainable use of the oceans, seas and marine resources, which seeks to prevent and significantly reduce marine pollution.

Science

- Whilst further research is clearly needed to better understand the details and mechanisms of the impacts of noise on marine life, this research should not delay mitigation and remedial action to curb underwater noise pollution;
- Provision of scientifically sound and independent advice that guides the establishment of 'quiet zones' and assists with the prioritisation of efforts;
- Assistance in the compilation of a list of past, present and future impulsive noise-generating activities through a registry, sharing data amongst stakeholders for the ultimate purpose of establishing noise budgets and limits for a region;
- Assistance in assessing the appropriateness of BAT and BEP as well as their effectiveness in mitigating noise;
- Acoustics experts should take part in and lead research on the temporal and spatial distribution of sensitive species, as well as the spatial distribution of their suitable habitats for better planning and mitigation; and
- Studies should be extended to include consideration of the impacts of ocean noise on fish, invertebrates, and catch rates and the overall ecosystem, as well as associated socioeconomic effects.

Public

- Whilst there is a growing awareness by the general public of noise pollution, a wider appreciation of the sensitivity of cetaceans to noise should also be generated by appropriate educational initiatives;
- Everyone using echo sounders/fish finders/sonar and motor-driven vessels should recognise that they are introducing noise pollution into the seas and oceans that may affect the ability of cetaceans to perceive their environment and communicate with each other. Sonar should only be used when necessary:
- Great care should be taken when sailing or motoring around these animals, they should not be chased and whale and dolphin watching guidelines should be followed; and
- Local communities should be encouraged to work towards preventing and significantly reducing ocean noise.

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