DMAD - Marine Mammals Research Association

It is too Loud Now!

The ignored consequences of noise pollution in the Mediterranean Sea

A Guide on What Seismic is, its Denied and Ignored Consequences and How These can be Minimised

Contents:

"Precautionary principle enables a rapid response to be given in the face of a possible danger to human, animal or plant health, or to protect the environment. In particular, where scientific data do not permit a complete evaluation of the risk, recourse to this principle may, for example, be used to stop distribution or order withdrawal from the market of products likely to be hazardous."

European Commission, 2000.

It is too Loud Now!

There are no quiet locations left in the entire Mediterranean and the level of human-generated noise from the oil and gas industry, military and shipping, has doubled in intensity every decade within the past 60 years. Yet, we are still slow to take actions to minimise this human-generated disturbance to an environment that provides oxygen and food to us, and additionally contains many valuable resources. Many countries blame the absence of protective measures on "not having enough proof of damage to their marine environment", even though human-made noise is identified as a pollutant and threat in the Marine Strategy Framework Directive that was adopted more than a decade ago.

Further, the negative consequences of loud and impulsive noises have already been documented for at least 30 marine mammal species, 66 fish species, and 36 invertebrate species (1).

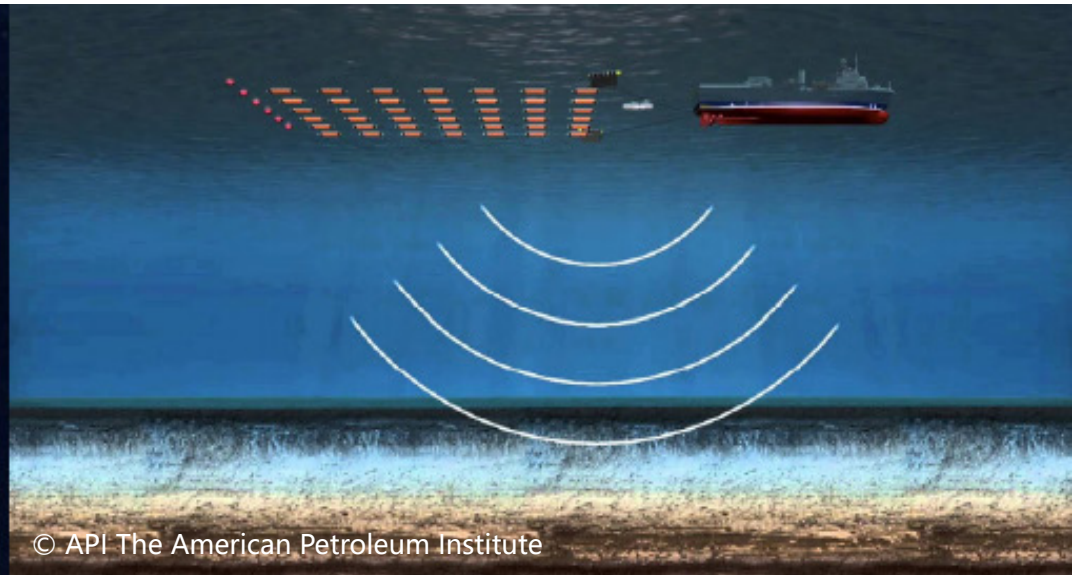
"There is no room for excuse now! We have to act now! The future is not under the sea bed, what is above is priceless!"

Offshore Hydrocarbon Research Activities

Offshore hydrocarbon exploration activities, specifically seismic surveys are often associated with the generation of loud and impulsive sound levels that can disperse great distances in the marine environment. Seismic surveys use airguns arrays, attached to streamers behind seismic vessels which emit high-intensity, low frequency pulses that are vertically directed towards the seafloor. The airguns generate low frequency sounds generally below 250Hz with 90% of this energy normally emitted below 140Hz, however, the pulses can reach frequencies of up to 20 kHz (2;3).

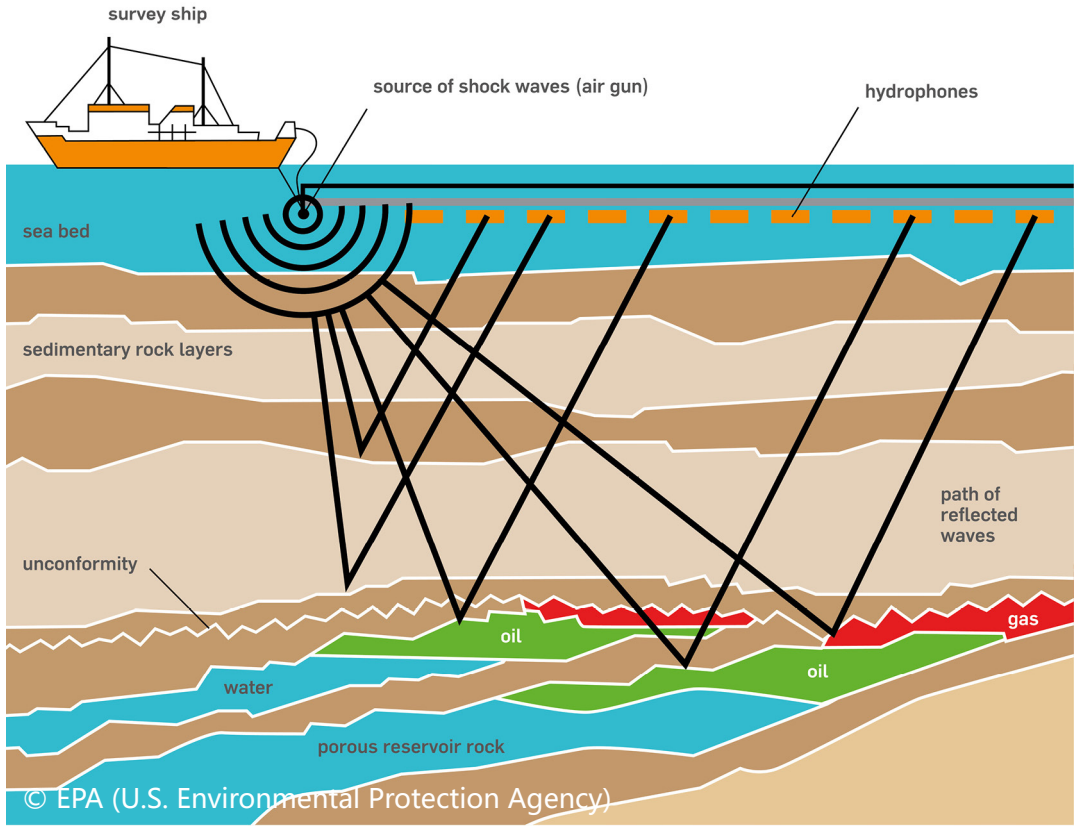
The generated sound typically lasts several milliseconds and is repeated every 10 to 15 second, often 24 hours a day and for several weeks in the same area (2). The reflection of the pulses from the seafloor reaches sensors on the hydrophone arrays and are transmitted to the computers to map the structures below the surface of the sea floor in order to identify potential hydrocarbon resources in the area (4).

The characteristics of these impulsive, high energy and low frequency waves causes disturbance to marine fauna from the bottom to the top of the food chain and the effect range can stretch long distances (2), although, the level of impact is negatively correlated with the distance from the source and with every 10-fold increase in distance, sound levels reduce by 20 and 10 dB in deep and shallow water, respectively (2). Further, the size of the airgun array being used plays a critical importance on the response, with larger airgun arrays resulting in a greater likelihood of impact (5).



This sudden noise in the environment causes physical damage to the species, as well as masking or changing their important behaviours. Marine animals use sound for critical life functions such as foraging, avoiding predators, communication, navigation, and reproduction. Leaving no quiet zones for animals can result in dire consequences and due to the seriousness of this topic, there has been more research focusing on the effects of human noise on marine mammals within the last decades (6,7,8).

"Our seas do not provide us a closed, controlled laboratory environment. Despite the difficulties in measuring the effect of loud noise on individuals or populations, specifically the long-term impacts on long-lived animals, a wide range of marine taxa has shown concerning negative outcomes as a result of human sound. This ranges from larva mortality to injuries and behavioural masking in the ocean's giants. These numerous examples should be enough evidence to implement precautionary measures for the protection of our marine environment and the "richness" that it holds."



Known Effects of Seismic Surveys on Species

Despite the main defence of the seismic industry being that their "no existing research that proves the negative effects of loud and impulsive sounds on marine fauna", there are numerous records which demonstrate its adverse effect on invertebrates, fish, and marine mammal species. While mortalities and injuries occur closer to the air-gun array, behavioural responses and masking can occur at much lower received sound levels, and thus in larger areas (9).

Even though behaviour responses may occur at larger spatial scales with lower severity, if there is a prolonged period of seismic activity, the population level effects of disturbance are likely to be of more significance than the individual injuries observed (2).

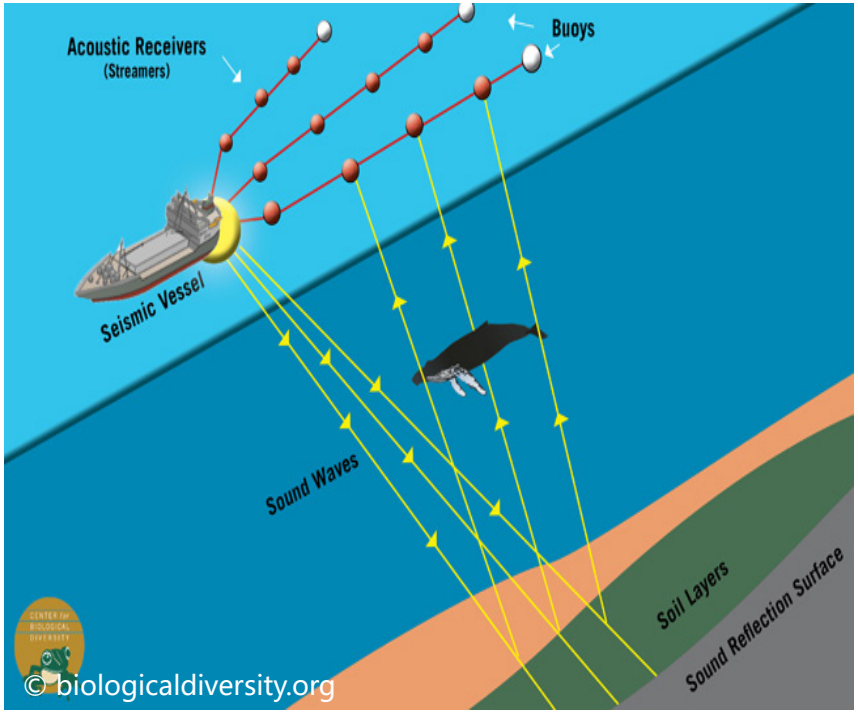


Table 1. Summary of documented negative impacts associated with seismic practices from the bottom to the top of the marine food chain.

Negative Impacts	Invertebrates	Fish	Marine Mammals
Reduce in growth and reproduction[12,13,14,15,16,17]	X	X	
Larva mortality[12,13,14,16,1,17,18]	X	X	
Physical abnormalities[19,20,21,22,23]	X	X	X
Hearing damage[19,24,25,26,27,28,29]		X	X
Slow growth rate[12,13]	X	X	
Behavioural alterations and masking	X	X	
Stress[16,20,21,30,31,32,33]	X	X	X
Mortality[12,1,34,35,36]	**X**	**X**	**X**
Injuries[37,38,39,40,41,42,43]	**X**	**X**	**X**

"To our knowledge, brown shrimps, lobsters, snow crabs, eels, cod, haddock, rockfish, herring, sand eel, blue whiting and clownfish altered their normal physical and behavioural patterns in response to noise disturbance. Some of these are economically valuable species and these changes resulted in a 40-80% decline on their catch rate (10,11)".

Considering the economic importance of fisheries both regionally and globally, an 80% decline in catch should not only create concern for marine fauna from an ecological point of view but also for the economic growth of the countries concerned.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Marine Mammals

Marine mammals are top predators of the marine environment and as a result of their presence, they impact biologically rich habitats due to their role in nutrient flow, and thus are named "marine engineers".

"Yet, more than 30 of 90 marine mammal species have been documented as vulnerable to disturbance from noise. The level of threats stretches from behavioural modifications to mortality and mass stranding events."

The top predator species of the marine ecosystem, such as the beaked whale, long whale, gray whale, bowhead whale, humpback whale, harbour porpoises, wildebeest, grouse, and seals, may experience **death, mass stranding, injury, or injury when exposed to sudden and high-energy noise sources. Cases of abandonment, behavioural change have been recorded (2).**

The Documented Negative Evidences

1. Dolphins have been observed fleeing from the area if airguns are active within 1km (38,39,40,41).

2. Harbour porpoises were left with damage to be hearing (23) and were documented engaging in shallower and shorter dives if the seismic vessel was between 400-700m (42).

3. It is estimated that 29% (10-62%) of whales within approximately a 1 km proximity of the seismic survey would experience hearing damage (18).

4. Almost 50% of stranded dolphins have been shown to have profound hearing loss, implying that impaired hearing could have led to their stranding/entanglement (25).

5. Bottlenose dolphins and grey whales showed a 50% decline in their foraging activity when the noise level increased only 15-20dB (38,43).

6. Nearly 250 adult male fin whales stopped singing during a seismic survey that lasted several months with an adverse impact on their breeding success (16).

7. Sperm whales were reported to temporarily avoid the waters of seismic survey locations (44).

8. Beaked whales were reported mass-stranded, caused by naval sonars in the range of 2.6 to 14kHz (45,46).

9. 75 melon-headed whales were stranded after entering a shallow tidal estuarine which occurred at the same time as a survey by a vessel using high-powered 12kHz multibeam echo sounding equipment (47).

Stranding Cases of Marine Mammals in Turkey

Since 2015, there have been over 60 seismic activities that have taken place within the Turkish Mediterranean Sea and Black Sea, with surveys increasing after 2017. From the Mediterranean waters of Turkey alone, up to 20 specimens were reported as stranded, with the majority of them being beaked whales. Of those stranded, two beaked whales and one minke whale which were stranded showed physical damage frequently associated with loud noise (49,50). Except for these two cases, although no study on noise has been carried out, more than 60 seismic activities have taken place in the Mediterranean and Black Seas since 2015, and the number of seismic activities has reached its peak since 2017.

Why and How Should We Reduce Noise?

"Turkey has signed several national and international conventions on marine environmental protection from the Barcelona and Bern Convention to the ACCOBAMS and as such is committed to resolutions regarding seismic surveys, including the environmental assessment and mitigation process."

Mitigation measures can be followed to "avoid, minimise, restore and offset" damage to the marine environment. Avoidance is the most effective method and consists of avoiding overlap in space and time between the seismic survey and animals (48). The solution is simply: surveys should be scheduled when populations are absent or in low numbers.

1. High-frequency sounds created during activities are of no importance for research and these sounds can be prevented from reaching the sea,
2. Producing only the sounds necessary for the activity,
3. Having a Marine Mammal Observer (MMO) and a Passive Acoustic Observer (PAM) on the platform during seismic activity, thus ensuring that there are no marine mammals in the area.

Restoration and offsetting are not well applied in the marine environment due to the difficulty in quantifying impacts. Offsetting is generally identified as initiation or funding of conservation programs focused on either risk reduction or habitat protection (2).

How to mitigate the negative consequences of seismic operations on marine fauna?

1. Tracklines of seismic vessels in close proximity to the shore should be placed to avoid the animals becoming trapped in bays and/or canyon systems. Lines may require starting close to the shore and moving away, or require shoreline monitoring from headlands and/or by the chase vessel by MMOs (Marine Mammal Observers) or a combination of all these measures. ACCOBAMS (2016a) resolution 4.17 states mitigation should ;
"Adapt the sequencing of seismic lines to account for any predictable movements of animals across the survey area and avoid blocking escape routes".

2. The size of the Exclusion Zone (EZ) must be determined by modelling (ACCOBAMS (2016) resolution 4.17). Shutdown determined through this method should then be implemented as part of the mitigation strategy. Shutdown for "vulnerable" species as required under ACCOBAMS (2016a) resolution 4.17 should be implemented anywhere in the monitored area and "vulnerable" species must be defined clearly in the Environmental Assessment phase.

3. A soft start procedure should be determined in the Environmental Assessment phase and should generally follow industry recommended best practice with 6 dB stepped increases (IOGP, 2017). This must then be followed and recorded during the survey for verification afterwards.

4. At least one MMO should be on duty during all survey daylight hours and one PAM (Passive Acoustic Monitoring) operator should be on duty at all times during the seismic surveys, these should be ACCOBAMS trained ideally (ACCOBAMS resolution 6.18 (2016b);
"Cetacean observers and bio-acousticians in charge of the monitoring programme must be qualified and experienced, with suitable equipment ". Therefore, evidence of training and experience should be sought.

5. The environmental assessment should be completed to avoid sensitive zones and times such as breeding periods in order to minimise impacts.

6. Careful recording of all sightings/detections and proximity to the source should be completed to provide data for research. MMOs and PAM operators should all have previous experience with species likely to be encountered.

7. Any non-compliance and mitigation actions, such as delay or shutdowns, should be reported within 24 hours to the regulator.

8. Measures should be put in place for the rapid post mortem analysis of any animals stranded during or after the seismic surveys.

9. Mitigation measures should be extended to monk seals (critically endangered) and green (endangered) and loggerhead (endangered) turtles.

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