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Baseline

Italy introduces pre and post operation monitoring phases for offshore seismic exploration activities

C. Fossati[a,*], B. Mussi[b], R. Tizzi[b], G. Pavan[a], D.S. Pace[b,c]

[a] CIBRA, Department of Earth and Environment Science, Pavia University, CONISMA, Rome, Italy
[b] Oceanomare Delphis Onlus, Via Gino Marinuzzi 74, Rome, Italy
[c] Department of Environmental Biology, Sapienza University of Rome, Italy

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ABSTRACT

Concern is growing that marine fauna can be affected by noise such as naval sonar, pile driving or geophysical surveys, among others. Literature reports a variety of animal reactions to human noise (from apparently null or negligible to strong). However, conclusive results on its effects on marine mammals at individual and population level are still lacking. In 2015, the Italian Environmental Impact Assessment Commission mandated seismic operators apply a standard scientific protocol comparing marine mammal presence before, during, and after offshore seismic survey. For 60 days before and after the survey, marine mammals are monitored using visual and acoustic methods. One or more acoustic autonomous recorders, depending on area size, must also be deployed throughout the three phases for continuous monitoring. Consistent data gathered from many surveys will enable robust statistical analysis of results. Diffusion of this monitoring method internationally would improve the study of far-reaching, intense, low frequency noise.

The concern that man-made noise can affect marine fauna has increased over the years, mainly within the context of Navy sonars and seismic surveys by the oil and gas industry. Anthropogenic underwater noise is now recognized as a worldwide concern. The worry regarding its potential direct or indirect disturbance, as well as evidence of negative effects on a variety of marine organisms, has increased over the past few years (Peng et al., 2015; Williams et al., 2015). Possible consequences range from auditory masking (Erbe et al., 2016), physiological damages (Aguilar de Soto and Kight, 2016; Henderson et al., 2008), metabolism modification (Lagardére, 1982), to embryogenesis hindering (Aguilar de Soto et al., 2013) and behavioral alterations (e.g. increased alertness, temporary avoidance behavior, habitat abandonment, modification of group structure or activity state, cessation of feeding or socializing, vocal changes (Southall et al., 2007; Weilgart, 2013)).

Such effects are species-specific and individuals at different life stages may show variations in their susceptibility to anthropogenic noise. Considering the wide range of impacts on marine fauna, noise pollution may not only pose a great threat to single marine organisms but may also affect the composition, and subsequently the health and functions of the ecosystem (Peng et al., 2015).

The literature regarding marine mammals and noise is relatively limited and inconclusive, apart from a few demonstrations of cause-effect relationships between sonars and beaked whales (e.g. Richardson et al., 1995; Tyack, 2009). Any firm generalizations and statements should be made with caution. There is still little known of the long-term and cumulative effects of noise exposure and synergistic human-generated stressors (Pine et al., 2014; Williams et al., 2015; Maglio et al., 2015). In other words, the biology of “disturbance” and the long term effect of noise on the health of marine mammals, on their prey species and on all marine fauna and processes is not yet well understood.

The oil and gas offshore exploration industry, as well as geophisical research institutions, typically rely on arrays of airguns, which are towed behind ships and release intense shots of compressed air into the water about once every 10–20 s. Although most of the energy from these acoustic “shots” is directed downward to the seafloor (to explore its structure for hydrocarbon reserves or geological features), its low frequency components can travel thousands of kilometers from the source (Nieukirk et al., 2012). In addition, high frequency components with a significant amount of the energy may travel outwards and be heard kilometers away (Hermannsen et al., 2015). Even if recent studies report that marine seismic surveys may represent a considerable source of ocean noise pollution in terms of overall energy and spatiotemporal ranges of influence (Nowacek et al., 2015), the environmental problems created by these noise bouts are not fully understood and the effects of

* Corresponding author.
E-mail address: claudio.fossati@unipv.it (C. Fossati).

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offshore seismic exploration on the marine environment is still under debate (Castellote and Llorens, 2016). A number of scientific articles report observations of either no impact or heavy impact on fish, mollusks, crustaceans and echinoderms (see Carroll et al., 2017 for a review). As often occurs when dealing with biology, the significant variability of ecological, social and behavioral conditions as well as different environmental scenarios, makes it hard to find a "one size fits all" conclusion. As for marine mammals, many authors (e.g. Gordon et al., 2004; Weilgart, 2013) report some degree of disturbance, ranging from minor behavioral changes to noteworthy responses. Sperm whales (*Physeter macrocephalus*) in the Gulf of Mexico apparently showed no reaction to airguns except for a statistically not significant decrease in foraging activity (Miller et al., 2009). Male fin whales (*Balaenoptera physalus*) ceased singing for weeks to months during a seismic survey, recommencing singing in hours or days after the survey ended (IWC, 2007). Harbor porpoises (*Phocoena phocoena*) have been observed to engage in strong avoidance responses of up to fifty miles from an array (Bain and Williams, 2006) and, off the coast of Brazil, seismic surveys have been linked to the long-term loss of marine mammal biodiversity (Parente et al., 2007). Considering these diverse results, assessing the effects of airguns on marine mammals (and marine life in general) and managing the risks that seismic surveys can pose at individual, population and ecosystem level is extremely challenging, in particular regarding the long-term effects which are hard to see and evaluate. The international scientific community is asking for a more comprehensive approach (CBD, 2012; UNEP-DEPI/MED WG.408/Inf.11, 2015) to address knowledge gaps on the impact of seismic exploration on the marine environment.

In order to reduce the possible adverse effects of airguns on marine mammals who rely heavily on acoustics for their life (short and long range communication, echolocation, environment sensing), a coordinated effort among industries, governments, scientists, and environmental organizations is needed. The majority of oil and gas companies (and some Navies) has implemented mitigation protocols based on "best practices" and/or precautionary approaches. Among these, the ACCOBAMS (Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea, and Contiguous Atlantic Area) and JNCC (Joint Nature Conservation Committee) guidelines for civil and industrial activities, and CMRE (Centre for Maritime Research and Experimentation, La Spezia, IT) for Navy operational activities (Ryan, 2009) are commonly used to design operational monitoring and mitigation procedures. Unfortunately, these protocols are not standardized yet. Some require prior studies to identify species in the investigated area and define Exclusion Zone sizes (according to local oceanographic conditions and source characteristics), whereas others operate on fixed values regardless of the airgun array size and oceanographic conditions. In general, these protocols list a series of actions to be taken by specialized personnel (Marine Mammals Observers and Passive Acoustic Monitoring operators) to reduce exposure of marine mammals to potentially dangerous noise levels during the active phase of seismic surveys. Critical readings of these guidelines (Wright and Cosentino, 2015) and review of results have already been published (Stone, 2015). Nowacek et al. (2015) suggested ways to assess appropriate impact thresholds while stressing the importance of baseline data as a key aspect of reaching scientifically reliable conclusions about the risks to marine life from seismic surveys. They pointed out that the process for permitting surveys must take these data into account and be adjusted accordingly, perhaps even paused while such information is gathered. Further scientific data are then necessary to understand the effectiveness of the mitigation procedures in reducing direct impacts on animals and to understand if presence, behavior, and habitat use of marine mammals in the area are altered by the seismic surveys. If yes, we need to know to which extent this alteration occurs, at which stage of the seismic activity, and how long it takes to resume the original situation.

The Italian Ministry of Environment (MATTM) ratified a number of agreements (CBD, Habitat Directive, Bonn Convention, CITES, Barcelona Convention for the Protection of the Marine Environment, IWC etc.) and subscribed to other pacts such as ACCOBAMS and Pelagos Sanctuary. Through these treaties, MATTM is committed to the conservation of cetacean populations by issuing regulations that promote the systematic implementation of "best practices" by offshore industry and other operators, aimed at preventing, mitigating and minimizing noise impact on animals.

In 2015, the Environmental Impact Assessment Commission of the Italian MATTM, in charge of releasing permits for oil and gas exploration in Italian waters, issued new criteria for obtaining such permits. Documents detailing these rules (in Italian) are available online at http://www.va.minambiente.it/it-IT. The most innovative advance is the mandatory request for "before and after" seismic survey observation phases in addition to mitigation practices during the airgun surveys. These two supplementary monitoring periods are specifically intended, and must be consequently designed, for the gathering of information on marine mammals' presence, density, and distribution, before and after the seismic survey in the interested area. In particular, MATTM requests companies to plan and execute an *ante* and a *post* seismic cruise survey with the following characteristics:

- The surveys, at least 60 days long each, must include a visual and acoustic investigation of the whole area following a grid with maximum 10 nautical miles spacing between each leg.
- Qualified passive acoustic monitoring (PAM) operators and experienced marine mammal observers (MMO) with a strong scientific background must be in charge of data collection.
- In the meantime, calibrated acoustic (bottom or surface) autonomous recorders must be deployed with a maximum spacing of 20 nautical miles to cover the entire area. They must be active for the whole period (*ante*, *during*, and *post operation*) with a recording duty cycle of at least 25% of the time.
- Data on visual encounters and acoustic contacts with marine mammals must be provided to MATTM at least monthly through a detailed reporting system. Data will be made public on the MATTM website.
- During the seismic survey mitigation procedures must be adopted (MATTM requires companies to provide certified operators with solid background and to consider both JNCC and ACCOBAMS recommendations).

These innovative elements, which have never appeared in this form in other legislations, represent an important opportunity to investigate the possible consequences of seismic surveys on the presence, distribution and behavior of cetaceans.

The Italian MATTM requires that oil and gas companies submit a detailed "Monitoring and Mitigation Plan" for the verification of compliance with the new law. In this respect, a detailed plan must be presented for approval to obtain permission for the entire operation (pre-survey acoustic/visual monitoring, seismic survey mitigation procedures, post-survey acoustic/visual monitoring). This document (available on http://www.va.minambiente.it/it-IT) must include:

- bibliographic review of the available information for the given operation area to evaluate data on the marine mammals local community,
- acoustic modeling of the sound source according to local oceanographic conditions to calculate 180 dB and 160 dB exclusion zones,
- before and after study phase details (acoustic and visual equipment, data collection protocol etc.),
- mitigation protocol details.

The resulting data will be extremely valuable. The combination of visual and acoustic surveys along with long-term data from sonobuoys (that must remain operative for all three phases) will provide a

relatively accurate description of marine mammals' presence in the study area along with a detailed description of the airgun activity and of any other possible man-made noise that may occur. Systematic observations of possible variations in presence, distribution, and behavior of encountered animals in respect to the different phases of the study will cast new light on this still controversial subject. The new system will improve knowledge for future actions (modification of seismic survey outlines, tuning of mitigation procedures). The “before” phase data will allow the recording of the presence of critical species in advance (deep divers and sensitive species such as beaked whales) or the existence of densely populated areas, thus improving in situ mitigation's effectiveness. Moreover, scientific data collected during the monitoring and mitigation phases (stored and made public by the MATTM through a dedicated database) could allow us to deepen our knowledge of the impact of the seismic surveys on the marine environment and provide guidance for future endeavours.

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