Are There Technological Alternatives to Airguns for Oil and Gas Exploration to Reduce Potential Noise Impacts on Cetaceans?

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2 Introduction

Seismic airgun surveys, used to find oil and gas deposits underneath the ocean floor, produce loud, sharp impulses that can raise noise levels substantially over large areas. These surveys can last months, and the noise they produce is virtually ubiquitous in some areas of the world's oceans. Though noise impacts on marine life (fish, marine mammals, and even invertebrates) from seismic surveys are well documented, the biological relevance of these impacts on wild populations remains controversial among the various stakeholders. Rather than address the controversy or evaluate the evidence for or against an impact, the purpose of a workshop held in Monterey, California, in 2009, was to examine quieter, potentially less harmful technologies that might be able to, at least partially, replace airguns.

Supported by the Okeanos Foundation, a multi-disciplinary group of geophysical scientists, seismologists, biologists, and regulators met to find ways to make marine seismic surveys quieter. The participants agreed that marine life would benefit from a quieter ocean. This is their consensus report.

3 Findings and Recommendations

The most effective acoustic mitigation remains not exposing marine life (i.e., through avoidance) to additional anthropogenic noise.

- Regulators together with the hydrocarbon and seismic survey industry should reduce sound levels to the lowest practicable and/or use alternative technologies to reduce noise exposure.
- Impulsive sources like airguns have the potential to physically impact marine life because of the sharp rise times and high peak pressures of airguns. Behavioural effects are also possible even at large distances from the airguns.

3.1 Airguns

- Airgun design can be optimized to reduce unwanted energy.
    - Imaging deep geological targets requires a low frequency (<200Hz) acoustic source. Currently seismic airguns produce broad-band acoustic energy (>200Hz) and in directions (both inline and horizontal to the plane of interest) that are not of use. Thus, unnecessary acoustic energy (noise) should be reduced through array, source, and receiver design optimization.
    - Lower source levels could be achieved through better system optimization, i.e. a better pairing of source and receiver characteristics, and better system gain(s). For example, new receiver technologies, such as fiber optic receivers, may allow the use of quieter sources through a higher receiver density and/or a lower system noise floor.

3.2 Use of alternative technologies with airguns and/or instead of airguns

Controlled sources generally put the same level of geophysically useable energy into the water as impulsive sources like airguns, but over a longer period of time, and a resulting lower peak sound level, i.e. they are quieter. For example, for a rough calculation in the near-field, a 1 s oscillatory/vibrator/projector pulse puts the same level of geophysically useful energy into the water as an airgun's 10 ms pulse, but is 100 times quieter, resulting in a 10,000 fold reduction in the area of ensonification. These sources include technologies such as the electro-mechanical modern marine vibrator, low frequency acoustic projector (driving cylinder, e.g. LISA, a low frequency electromagnetic transducer system), the solid state piezoceramic Helmholz resonator (e.g. The Naval Research Laboratory's DTAGS), and other non-impulsive, oscillating sound sources. Furthermore, controlled sources can produce sound over the frequency range desired, generating signals that can be specifically designed to minimize the impact on marine mammals and maximize geological interpretability (e.g. pseudo-random sequences).

Controlled sources, by using a sweep rather than an impulse, can reduce the amplitude (peak levels) by 30 dB by spreading out the energy over time. The use of pseudo noise (PN) sequences could reduce the acoustic footprint further (perhaps by an additional 20 dB/Hz by spreading out frequencies over time), but more research is needed to fully understand how to implement these sequences in an effective and optimized way.

- In certain situations and with certain non-airgun source types, placing the sources and/or receivers near or on to the sea floor can reduce the required source level, as well as the amount of sound that needs to travel through the water column. For example, marine vibrators can operate close to the seabed and accomplish increased penetration relative to shallow towing.
- A controlled source offers improved receiver optimization possibilities compared to airguns. For instance, a combination of fiber optic sensors with a reduced bandwidth seismic source, such as a marine vibrator, may make the most optimal use of these technologies.
- Front-loading the exploration workflow with the use of silent technologies (e.g., Controlled Source Electromagnetics / 3D Electromagnetics, gravity, gravity gradiometry, etc.) could optimize the exploration process and require less sound. For instance, if 2D airgun surveys followed by quieter technol-

ogies (e.g. 3D CSEM) do not show promising targets, proceeding with 3D seismic surveys may not be worthwhile. Conversely, one may optimize 3D seismic activities based on the results from 2D seismic and 3D CSEM.

- Technologies such as marine vibrators, microseismic monitoring (passive seismic), and fiber optics could reduce the need for 4D airgun surveys, used to monitor the movement of oil or gas in an exploited reservoir over time.
- Regulators and/or the seismic and hydrocarbon industries should fund or undertake research into impacts on marine animals of alternative technologies.
- While some airgun alternative technologies are available now or in the next 1-5 years, an increase in R&D funding for alternative exploration technologies will accelerate development and expand the application window. Governments should encourage the development and use of alternative technologies in an environmentally sensitive manner through both regulatory changes and additional funding to regulatory bodies, scientists, and engineers.

4 Coordination / Incentives

- Governments should discontinue programs that discourage the utilization of non-airgun technologies. Rather, they should develop incentives for any environmentally beneficial alternative technologies.
- The academic geophysical community should be encouraged to research quieter alternatives to airguns, with the aid of government and/or industry funding.
- Regulators should encourage and help fund research and development of quieter, alternative sources and their impact assessments.

Acknowledgements: This is based on the Report of the Workshop on Alternative Technologies to Seismic Airgun Surveys for Oil and Gas Exploration and their Potential for Reducing Impacts on Marine Mammals (2010) Monterey, Calif., USA, 31 Aug.–1 Sept., 2009. Okeanos Foundation. 29+iii pp. Availa-

ble from: http://www.sound-in-the-sea.org/download/AirgunAlt2010.pdf Thanks also to Andrew Wright (Co-Organizer), Sarah Dolman, Jo Hastie, Michael Jasny, Tanja Winkler, and, especially, Dieter Paulmann.