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Committee Secretary
Senate Standing Committees on Environment and Communications
PO Box 6100
Parliament House
Canberra ACT 2600

Submitted online via:
https://www.aph.gov.au/Parliamentary_Business/Committees/OnlineSubmission

Thursday 21 November, 2019

Dear Sir/Madam,

Greenpeace Australia Pacific (GPAP) welcomes the opportunity to make a submission to the inquiry into the impact of seismic testing on fisheries and the marine environment.

GPAP has over one million supporters and is part of a global network tackling the world's most pressing environmental problems. We are an entirely independent, people-powered organisation and do not accept donations from governments or corporations.

Introduction

Seismic testing is a method of locating oil reserves using airguns to produce powerful blasts of noise which penetrate the ocean floor and provide data about what is under the surface. Air gun arrays are designed to produce their highest sound levels vertically downwards but they also emit considerable acoustic energy in other directions, making them a hazard for marine life.

Air gun arrays contain a horizontal plane containing up to 40 air guns depending on the testing requirements.[1] These air guns shoot a charge of compressed air down towards the ocean floor, creating an extremely high pressure pulse that penetrates the seafloor and reflects in various ways depending on the density or composition below the surface. Airgun seismic surveys are amongst the loudest sounds produced by humans. Sound travels very fast and efficiently in water. These two factors results in noise from seismic surveys being heard almost continuously in some areas for distances of over 4000 kilometres.[2] It often takes months to seismically survey an area.

[1] Duncan, A. J., 'Airgun arrays for marine seismic surveys - physics and directional characteristics', https://www.acoustics.asn.au/conference_proceedings/AAS2017/papers/p88.pdf.
[2] Weilgart, L., 'Alternative quieting technology to seismic airguns for oil & gas exploration and geophysical research', https://sustainabledevelopment.un.org/content/documents/973534_Weilgart.

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The growing body of research on the environmental effects of seismic surveying demonstrates that the current seismic testing regulation and approvals regime is inadequate. It is clear that seismic testing is harmful to marine life, and therefore to commercial fishing and other marine industries. However, the full extent of that harm is largely unknown, with research repeatedly identifying the dangers and magnitudes of impacts, despite being limited by restricted survey areas, or the duration of impact assessment.

The current approvals regime

The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) regulates offshore oil and gas exploration, including seismic testing, in Commonwealth and some state waters. NOPSEMA is required to ensure that exploration activities reduce environmental risk, with particular regard to matters protected under the Environment Protection and Biodiversity Conservation Act, to as low as reasonably practicable (ALARP).[3]

Despite this, there has not been enough research into the environmental impacts of seismic testing to assure with any degree of confidence that the probabilities of risk and magnitude of impacts are acceptable and managed. Research into the environmental effects of seismic testing on marine life is scarce. However, recent studies show that effects on marine life are more severe than previously believed.

Environmental impact assessment for seismic testing

There are three phases to conducting an environmental impact assessment on the effects of seismic testing. The first phase is collection of noise data, followed by acoustic modelling of sound transmission loss throughout the ocean, with the final phase being correlation of this measured and predicted data with effects on the environment and marine life. The data collection phase can be completed to a very high degree of accuracy thanks to technical measuring equipment. The second phase is also a straightforward process thanks to sophisticated modelling software, and typically is conducted by third-party acoustic consultants. The final phase is analysing this measured/modelled data and converting it to provide a qualitative relationship to the impacts on plant and animal species.

The first two phases of these assessments can be conducted with a high degree of accuracy. However, correlating measured and modelled data with impacts on animals and other marine life is extremely complex, and requires more research before we can identify valid restrictions and recommendations to protect the environment. On the basis of the precautionary principle,

[3] Department of the Environment and Energy, 'Environment Protection and Biodiversity Conservation Act 1999', https://www.environment.gov.au/epbc/about.

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approvals for techniques like seismic testing should be restricted until we can be certain that any approved measures will not result in harm to marine life.

Understanding potential harm to marine life

The hearing abilities of marine species — including the detection of sound, frequency discrimination, sound source localisation, and auditory processing at both the inner ear and the auditory centres in the brain — are poorly understood. This lack of information also extends to how marine fauna respond to sound in the wild, how this affects their behaviour, and how this might change during development and over the lives of individual species. What we do know is that the auditory sensitivity of each species varies greatly, as do results with variations in individual size, sex and differences in life history or conditioning.[4] The currently used Auditory Evoked Potential (AEP) method of categorising temporary and permanent shifts in hearing as well as behavioural changes has often been criticised, and there is broad scientific consensus that standardised testing approaches need to be developed to be able to effectively collaborate research between individual studies.[5]

The main research priority should be to measure the hearing abilities of a wider range of species using audiometry. The second should be to measure the responses from individual species to acoustic disturbances such as seismic air gun blasts. Finally, a collaborative and multidisciplinary approach should be taken to combine all the different data and information sources to provide a valid roadmap of the ecological effects of seismic testing. The current approval system and procedures are built on stacking assumptions, and introducing many uncertainties at each level of the assessment. This regularly results in highly uncertain, superficial assessments that give the impression that they have been written largely to ‘tick the box’ required by regulation instead of providing meaningful insights.

Data on hearing capabilities exist for only around 100 of the 27,000 or more existing species of fish.[6] The hearing capabilities of fish, whale, and shark species on which we have data vary so greatly that it is not credible to generalise from those examples or extrapolate to estimate physical damage or hearing threshold shifts on other, unstudied species. Biological specialisations that enhance hearing vary among different species. Instead, research needs to be conducted on individual species which have dense populations in areas where seismic testing is proposed.

Little is known about the long-term effects of seismic testing on marine fauna behaviour or the effects of cumulative exposure to loud sounds. There is limited research on effects on fauna

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[4] Hawkins, A.D. (1981) ‘The Hearing Abilities of Fish’, in Tavolga W.N., Popper A.N., Fay R.R. (eds) *Hearing and Sound Communication in Fishes. Proceedings in Life Sciences*. Springer, New York.
[5] Sisneros et al., ‘Comparison of Electrophysiological Auditory Measures in Fishes’, http://www.kmaruska.biology.lsu.edu/Maruska%20and%20Sisneros%202016.pdf.
[6] Popper et al., ‘Effects of Sound on Fish’, https://www.nrc.gov/docs/ML1434/ML14345A573.pdf.

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beyond immediate effects following exposure. Lagardere demonstrated that noise only 30dB above ambient levels for 3 months resulted in both decreases in growth rate and reproductive rate in certain marine species.[7] Changes continued for up to a month following the termination of the signal. A different, concerning study, based on exposure to a pure sound tone at 180dB peak for one hour, found that, while no damage was evident in the animals in the 24-hours following exposure, if the animals were kept alive for four days following exposure, damage became evident in varying degrees.[8] McCauley et al. investigated the effects of exposure to the sounds of a seismic air gun on Australian pink snapper.[9] The animals were exposed to varying levels of seismic gun emissions at different distances, and then were kept alive for different time intervals after exposure. The results very clearly showed extensive damage to sensory hair cells of the ear. The extent of damage increased with the post-exposure period up to at least 58 days: the maximum survival interval described.

A more recent study assessed the effects of seismic testing on zooplankton.[10] Its findings showed that airgun exposure significantly decreased zooplankton abundance, and increased the mortality rate from a natural level of 19% per day to 45% per day (on the day of exposure). These impacts were observed to the maximum assessed range of 1.2km from the testing location. The conclusions in that study stated there is an urgent need to conduct further studies to mitigate, model and understand potential impacts on plankton. Such a stark change in daily plankton mortality rate would have a huge impact on marine ecosystems, as plankton is the major food source for a huge number of species. This is all the more concerning considering that the testing was only conducted to 1.2km from the noise source, while acoustic modelling has shown that highly elevated noise persist at levels in the order of 160dB at 4km away, and 140dB at around 10km away. It is likely, therefore, that the radius of this impact is much larger than suspected, with heavy consequences to our marine ecosystems, the foundation of which is the plankton at the core of this study.

The above examples suggest that damage from exposure to sound takes some time to become apparent and appear to be found at long distances from the site of individual seismic testing blasts. Considering that the decibel levels experienced from seismic testing are higher and of greater duration, the longer term effects on all other species of fish and marine fauna is likely to be severe. The effects on commercial fishing in particular may be more devastating in the long-term than we realise. What is also clear is that the majority of studies conducted on hearing

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[7] Lagardere (1982), 'Effects of ambient noise on the metabolic level of Crangon Crangon', https://www.jstor.org/stable/24815069?seq=1#page_scan_tab_contents.
[8] Hastings et al., 'Effects of low-frequency underwater sound on hair cells of the inner ear and lateral line of the teleost fish Astronotus ocellatus', https://www.ncbi.nlm.nih.gov/pubmed/8819864/.
[9] McCauley et al., 'Management and monitoring of fish spawning aggregations within the west coast bioregion of western Australia', http://www.fish.wa.gov.au/documents/research_reports/frr187.pdf.
[10] McCauley, R., Day, R., Swadling, K.M., Fitzgibbon, Q., Watson, R. and J. Semmens (2017) "Widely used marine seismic survey air gun operations negatively impact zooplankton", *Nature Ecology & Evolution* 1: 1-8.

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and physical damage to fish to date may be invalid, as they focus on the immediate effects of exposure to sound.

The poor state of our knowledge and the very limited data available can be seen from the work of Hamernik and Qui,[11] and Hamernik et al.[12] Both studies found that there was no correlation between energy metrics of a sound, the temporary and permanent hearing threshold shifts, and outer ear hair cell loss for exposures that contained high level transient sources (impacts or noise bursts). These studies conclude that it is premature to provide any guidance on exposure levels that could cause hearing threshold shifts in any fish species based on research exposing species to pure tonal noise sources rather than specifically the noise in question. The same concerns apply to extrapolating between different species, or between any animals for that matter.

The rate at which sound levels change are important in assessing the potential effects of exposure to transient sounds on marine and land animals.[13] Impulsive sounds such as those from seismic testing arise from a rapid release of energy, and the characteristics of such a sound pulse are extremely damaging. Due to the nature of seismic surveying, these sound blast pulses being repeated with such high frequency in order to obtain geographical information are the worst possible type of noise source with respect to physical damage to marine fauna. The repeated pulses cause very large gradients in sound energy, and the effects of these on marine physical features are clear.[14]

Any future investigations must not only examine immediate mortality of seismic airgun pulses on marine fauna, but rather they need to consider longer term effects on physiology, behaviour, life-cycle and population, as well as effects on fauna at greater distances from the source.

It is important to note that there are a number of substitute technologies on the market, such as the Aquavib Marine Vibrator and the Vibroseis systems. Both of these products, as well as other similar competitors to seismic testing, use the same type of technology and have been used successfully for land-based seismic exploration for years. Instead of using a sharp onset 'pulse', these alternate technologies use the same energy levels but spread over a longer period, thus

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[11] Hamernik, Roger & Qiu, Wei (2002) 'Energy—independent factors influencing noise-induced hearing loss in the chinchilla model', *The Journal of the Acoustical Society of America*, 110: 3163-8, 10.1121/1.1414707.
[12] Hamernik et al., 'The use of Kurtosis-adjusted cumulative noise exposure metric in evaluating the hearing loss risk for complex noise', https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4844558/.
[13] Johnson and Robinson, 'The loudness of sonic booms heard outdoors as simple functions of overpressure and rise time', https://www.sciencedirect.com/science/article/abs/pii/0022460X71906286; Amernik and Hsueh (1998), 'Impulse noise: Some definitions, physical acoustics and other considerations'. *The Journal of the Acoustical Society of America*. Volume 90.
[14] Popper et a.l, 'Rethinking sound detection by fishes', https://www.sciencedirect.com/science/article/pii/S037859550900313X.

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removing the high peak pressure of airguns. This dramatically reduces the two sound characteristics that are thought to be the most injurious to living tissues.[15]

Deficiencies in environment planning and NOPSEMA approval conditions

Seismic testing approval applications have been rejected by NOPSEMA in the past on a range of grounds. A prominent example is Asset Energy's application for its Baleen 2D HR Seismic Survey off the New South Wales coast, which was submitted in July 2017. The six page long list of reasons for refusal included:

- No details being provided on how soft starts of seismic pulses will be implemented
- Failing to demonstrate that the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable
- Not assessing the impacts from cumulative sound exposure from the seismic source
- Not demonstrating how compliance will be monitored for the EPS 'Use of dedicated Marine Fauna Observer (MFO)' and 'Trained crew members to assist MFO as required' components.
- No details being provided on the training and experience of MFOs

A further, stark example can be seen in PGS Australia's February 2017 subjective approval for seismic testing in the Great Australian Bight. Approval conditions stipulated by NOPSEMA included, for example, that:

> 'The petroleum activity may only be carried out in a manner that ensures no injury to pygmy blue whales (*Balaenoptera musculus*); or interference with foraging behaviours of pygmy blue whales in the foraging biological important area (BIA), including no displacement from foraging areas.'[16]

Of course it is impossible to ensure no injury to the species in question, as it cannot be guaranteed that observers will spot a pygmy whale or be able to ascertain whether it has been injured. The approval condition in question is, therefore, practically meaningless and open to abuse by the proponent. These are simply two examples from a much wider field.

The nature of the environment plan criteria and process is itself a cause for concern, entirely apart from the extent to which individual proponents comply with it. The environmental plan acceptance criteria are riddled with grey areas, rather than just black and white requirements,

[15] Southall et al., 'Marine mammal noise-exposure criteria: Initial scientific recommendations', https://www.researchgate.net/publication/24264860_Marine_mammal_noise-exposure_criteria_Initial_scientific_recommendations.
[16] NOPSEMA (2017), 'Decision notification: Duntroon multi client 3D and 2D marine seismic survey environment plan', https://docs.nopsema.gov.au/A548192.

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further drawing attention to the fact that not enough is known to set strict regulations on the issue of seismic testing.

The regulations provide eight acceptance criteria against which NOPSEMA must assess each environment plan.[17] Two of the acceptance criteria at the core of the concerns raised in this submission are that:

- The environment plan demonstrates that the environmental impacts and risks of the activity will be reduced to as low as reasonably practicable.
- The environment plan demonstrates that the environmental impacts and risks of the activity will be of an acceptable level.

Despite NOPSEMA's publication of guidance notes on what 'as low as reasonably practicable' and 'acceptable level' mean, the interpretation of these criteria remains largely subjective. As discussed above, there is not enough data available to confirm the adequacy of the acceptance criteria in assessing impacts. Environmental plans for seismic testing — including the Baleen survey by Asset Energy,[18] the North-west Australia 4D survey by Woodside Energy,[19] and the Sauropod 3D Marine seismic survey by 3D Oil Limited[20]) — are riddled with high-level statements such as 'care will be taken where reasonably practicable' and negative effects being 'unlikely' to cause significant issues. As noted in this submission, the impacts of seismic testing on marine life are likely to be far worse than expected based on current research, mandating a more precautionary approach.

Recommendations

Seismic testing is used widely in the oil and gas subsurface exploration industry. However, it is increasingly clear that the threat of harm to marine life and ecosystems posed by seismic testing has been significantly underestimated in the scarce research that has been published on the topic. Australian marine ecosystems should not be treated as informal test subjects for long term negative effects of current seismic testing approaches under a business as usual approach: there are too many potential risks of severe negative impacts.

Greenpeace Australia Pacific therefore recommends that:

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[17] NOPSEMA, 'Assessment Process', https://www.nopsema.gov.au/environmental-management/environment-plans/.
[18] Asset Energy, 'Baleen 2D HR Seismic Survey Environmental Plan', https://www.nopsema.gov.au/assets/epdocuments/A591778.pdf.
[19] Woodside Energy Ltd, 'North-west Australia 4D Marine Seismic Survey Environment Plan', https://docs.nopsema.gov.au/A684137.
[20] 3D Oil Limited, 'Sauropod 3D Marine Seismic Survey (WA-527-P), https://docs.nopsema.gov.au/A700258.

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1. A moratorium on subsurface seismic testing be enacted in Australia, pending further research on its impacts, based on the latest scientific techniques
2. Were a broad moratorium prove impossible to enact, that seismic testing should be banned in known habitats or migratory paths of protected species, as defined under the EPBC Act, including the entirety of the Great Australian Bight
3. Where subsequent approvals are given, that the proponent be required to explore and employ alternative technologies which demonstrate a lower decibel footprint in order to minimise any impacts on marine fauna and ecosystems
4. That any project approvals process require the proponent to show how they have addressed the guidelines on environmental impact assessment provided by the Convention on Migratory Species of Wild Animals[21]
5. Further independent research on the impacts of seismic testing be funded by the federal government to assist in these efforts

If you require any further information on this submission, please do not hesitate to contact Greenpeace Australia Pacific via the details below.

Yours Sincerely,

Attila Szabo
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[21] Prideaux G. (2017) 'Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessments for Marine Noise-generating Activities', *Convention on Migratory Species of Wild Animals,* https://www.cms.int/sites/default/files/basic_page_documents/CMS-Guidelines-EIA-Marine-Noise_TechnicalSupportInformation_FINAL20170918.pdf.