Australian Government | Australian Institute of Marine Science
TOWNSVILLE | DARWIN | PERTH

27 November 2019

Committee Secretary
Environment and Communications References Committee
Department of the Senate
PO Box 6100
Parliament House
Canberra ACT 2600

Dear Committee Secretary,

The Australian Institute of Marine Science (AIMS) is pleased to make a submission to the Environment and Communications References Committee inquiry into the *Impact of seismic testing on fisheries and the marine environment*.

AIMS is a corporate Commonwealth entity established under the *Australian Institute of Marine Science Act 1972* (AIMS Act). As Australia's tropical marine research agency, it is our mission to provide the research and knowledge of Australia's tropical marine estate required to support growth in its sustainable use, effective environmental management and protection of its unique ecosystems.

To accomplish our mission, AIMS delivers independent science to help realise long-term impacts for the nation, including: (i) an improvement in the health and resilience of marine and coastal ecosystems across northern Australia, (ii) creation of economic, social and environmental net benefits for marine industries and coastal communities; and (iii) protection of coral reefs and other tropical marine environments from the effects of climate change.

Our research is focused on the priorities of our stakeholders, including Commonwealth, State and Territory governments, industry and Traditional Owners. One of our research programs helps support the '*creation of economic, social and environmental net benefits for marine industries and coastal communities*' by providing environmental baselines and condition and risk assessments required for current and future offshore oil and gas developments in north-west Australia.

AIMS has recently expanded the scope of this work. Leveraging off our expertise from doing baseline and condition/risk assessments, we are undertaking field research to better understand the impact of marine seismic surveying on sensitive species in the marine environment. We are currently examining fish and pearl oysters, and subject to the availability of additional funding, will also be studying the effect of seismic testing on plankton.

AIMS is therefore able to confidently address the impact of seismic testing on fisheries and the marine environment – with a focus predominantly on terms of reference part (a) the body of science and research into the use of seismic testing.

Yours sincerely

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Background

Determining the effect of seismic air gun pulses within the marine environment is a challenging task. These ecosystems contain an extraordinarily diverse range of species, each of which has unique biological features that could potentially result in different impacts of exposure to air gun pulses. Additionally, the physics of sound signal propagation is complex and often significantly affected by local environmental factors, such as bathymetry and seabed geomorphology. Despite these difficulties, a number of studies have examined the impacts of seismic air gun signals on fauna in both field and laboratory settings.

The results of these experiments have been the subject of recent reviews by various agencies and researchers. Geoscience Australia1 provided a summary of scientific studies investigating the impacts of low-frequency sound on marine fish and invertebrates and a critical evaluation of how these findings might be applied to the marine environment. . They found that there is often a lack of standardisation of the measurement of sound exposure, and that research on resulting impacts is often conducted during laboratory or small-scale studies. As a result, the translation of results from these experiments to real-world (i.e. commercial seismic survey) situations is complex, with limitations that need to be fully understood. In many cases, experiments had either been conducted in tanks (confounding signal characteristics and measurement accuracy) or on animals constrained in cages (possibly affecting their behaviour), and frequently with compressed air sources (simulated sources or single air guns) that were not directly comparable to the full-size air gun arrays used in commercial seismic surveys.

Limitations in our scientific understanding of the impacts of seismic exploration on marine fauna (such as those above) can result in industry and regulators applying precautionary measures in order to mitigate against potential impacts – precautionary measures which might include limiting access to locations, or changing preferred timing windows for seismic survey work. Hence, there is significant value in further research in order to provide better information to inform environmental impact assessment. Programs led by the Australian Institute of Marine Science (AIMS) are directly addressing some of the current limitations in the knowledge base. Our experiments have been designed and conducted to mimic, as far as practicable, real-world situations; thereby enhancing the utility of findings and enabling informed environmental management.

AIMS has acted as lead investigator for the conduct of two large-scale studies into the effect of marine seismic surveys: the Maxima three-dimensional (3D) marine seismic survey at Scott Reef, and the North West Shoals to Shore Research Program (NWSS). These studies are discussed below.

Maxima 3D Marine Seismic Survey at Scott Reef

The Maxima study investigated the effect of a three-dimensional marine seismic survey (Maxima 3D MSS) conducted in 2007 over approximately 360 km^2 of water in and around North and South Scott reefs on behalf of Woodside Energy Limited. These reefs lie in at the edge of the continental shelf off the coast of Western Australia, approximately 400 km north of Broome. The AIMS studies focused on assessing the effect of the Maxima 3D MSS on:

[1] AG Carroll[a], Przeslawski R[a], Duncan AC[b], Gunning M[c] and Bruce B[d]. (2017). A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. Marine Pollution Bulletin 114: 9–24.

a: National Earth and Marine Observations Branch, Geoscience Australia, GPO Box 378, Canberra ACT 2601, Australia
b: Centre for Marine Science and Technology, Curtin University, GPO Box U1987, Perth WA 6845, Australia
c: Energy Systems Branch, Geoscience Australia, GPO Box 378, Canberra ACT 2601, Australia
d: Commonwealth Scientific and Industrial Research Organisation, GPO Box 1538, Hobart TAS 7001, Australia

1. resident fish communities at six different locations on the reef slope[2]
2. scleractinian corals at eight different locations in the reef lagoon area of South Scott Reef[3].

The seismic source used for the Maxima 3D MSS was a 2055 cubic inch (33.67 L) dual air gun array towed behind a commercial seismic survey vessel (*MV Veritas Voyager*) with one 'shot' released every 18.75 m (time interval of approximately 8 seconds).

A census of the fish community was conducted at six locations at Scott Reef both before and after the survey. The census included small site-attached demersal (fish) species belonging to the family Pomacentridae and larger, roving demersal species belonging to other families of reef fishes. These data were combined with a decade of historical data on patterns of fish diversity and abundance (collected previously by AIMS) to assess the impact of the seismic survey.

In this study, there was no measurable effect of the Maxima 3D MSS on the diversity or abundance of the coral reef-associated fish community in shallow water at Scott Reef. Similarly, for individual species that were likely to be affected by seismic surveys, (particularly territorial species belonging to the family Pomacentridae), there was no evidence of direct or indirect mortality from sub-lethal effects.

These results are consistent with other studies[4] conducted in the Scott Reef lagoon during the Maxima 3D MSS, where fish communities were exposed to sound exposure levels far greater than those experienced by fish communities inhabiting the reef slope. For instance, during caged-fish experiments, where the closest cage was approximately 45 m from the center line of the seismic air gun pass in approximately 5 m of water, fish suffered no mortality or soft tissue damage. Permanent or temporary hearing threshold shifts were also not observed in fish in any of the cages.

The lack of a measurable direct effect of the Maxima 3D MSS on the Scott Reef fish community was likely due to a number of contributing factors. At the most basic level, although exposure to intense sound can be lethal to fishes[5], the majority (99%) of reef slope habitat was exposed to sound exposure level[6] of less than 187 dB re 1 mPa^2.s. This was far below levels expected to cause direct mortality. The effect of the Maxima 3D MSS was clearly non-lethal and there was no statistical evidence of an impact on either diversity or abundance of fish communities associated with the reef slope in shallow water.

The coral study[7], was the first to examine possible effects of a seismic survey on coral reef communities *in situ*. The existence of extensive and comparable areas of coral habitat at the Scott Reefs facilitated robust assessment of damage to coral. In a pilot study, seismic activity was restricted to a single line across comparable habitats. The full Maxima 3D MSS was then conducted across the entire lagoon, with coral assessment sites subject to a gradient of exposure to seismic acoustic signals. No damage to dominant species of coral was visible in both the

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[2] Results published in: I Miller and E Cripps (2013). Three dimensional marine seismic survey has no measurable effect on species richness or abundance of a coral reef associated fish community. Marine Pollution Bulletin 77: 63–70

[3] Published in: Andrew Heyward, J Colquhoun, E Cripps, D McCorry, M Stowar, B Radford, K Miller, I Miller, C Battershill. (2018) No evidence of damage to the soft tissue or skeletal integrity of mesophotic corals exposed to a 3D marine seismic survey. Marine Pollution Bulletin 129(1):8 - 13

[4] Woodside, 2007. Maxima 3D Seismic Survey: Scott Reef. Final Adaptive Management Program. Woodside Energy Ltd, Perth, Western Australia, Australia, 29 pp.; Hastings, M.C., Miksis-Olds, J., 2012. Shipboard assessment of hearing sensitivity of tropical fishes immediately after exposure to seismic air gun emissions at Scott Reef. In: Popper, A.N., Hawkins, A.D. (Eds.), Effects of Noise on Aquatic Life. Springer Science and Business Media, New York, pp. 239–243.

[5] Keeven TM and Hempen GL (1997). The environmental effects of underwater explosions with methods to mitigate impacts. US Army Corps of Engineers. https://semspub.epa.gov/work/01/550560.pdf

[6] Sound pressure level (SEL) is a decibel measure of sound intensity over a specified time period referenced to one micro-Pascal

[7] Refer to footnote #2

pilot study and full survey. Repeat surveys before and immediately after the initial pilot study also found no visible evidence of any immediate physiological damage or stress response by corals.

It is possible that seismic surveys might impact corals through structural damage to the calcareous (calcium carbonate) skeleton, damage to soft tissues or behavioral responses. It is known that scleractinian corals can suffer skeletal and tissue damage from the physical effects of hydro acoustic force[8] if the received peak-to-peak pressure[9] exceeds ≈260 dB re 1 µPa. However, this is an extremely high energy level for a seismic signal and well beyond real-world situations.

North West Shoals to Shore Research Program

In 2017, AIMS entered into an agreement with Quadrant Northwest Pty Ltd (Quadrant) (now Santos Energy) for the North West Shoals to Shore (NWSS) Research Program. This research focusses on improving baseline information for sensitive systems and species through four major themes. Of particular relevance to this inquiry, the Program Theme *Marine Noise Monitoring and Impacts* examines the impacts of seismic activities on pearl oysters and demersal fishes.

The NWSS Program leverages AIMS' extensive knowledge of, and experience in, marine ecosystems of the North West Shelf, our world-class research facilities including the *Research Vessel Solander* in north west Australia, and our existing capability and experience in working with the offshore petroleum industry. It is the first time in Australia that a commercial seismic vessel with full seismic air gun array has been dedicated for use in a controlled and real-world experiment.

Experiments in the *Marine Noise Monitoring and Impacts* theme examine the effects of seismic survey operations on fish and pearl oysters. The work has been funded by direct contributions from Quadrant (now Santos Energy) and in-kind support from AIMS and other research and industry groups. AIMS's contribution is approximately 25 percent of the total project cost.

A large emphasis has been placed on consultation throughout the study. An experimental plan was developed in an iterative process, with stakeholder involvement, commencing in July 2017. Meetings to discuss the experiment design were held with a variety of stakeholders, including: fishing industry businesses and representative bodies, Indigenous and environmental groups, the WA Department of Primary Industries and Regional Development, the Australian Petroleum Production and Exploration Association (APPEA) science working group, the International Association of Geophysical Contractors, geophysical contractors, petroleum exploration and production companies, Curtin University and University of Tasmania.

A draft experiment design based on consultation outcomes was prepared and distributed to stakeholders in advance of a two-day workshop held on 23-24 January 2018, hosted by AIMS. The workshop was attended by 30 stakeholder representatives. AIMS developed the final experimental plan for studies into the effect of seismic surveys on demersal fishes and pearl oysters based on the workshop outcomes, in consultation with its scientific collaborators.

In September 2018, AIMS conducted two large-scale experiments to determine the effects on fish and pearl oysters (*Pinctada maxima*) using a dedicated commercial seismic vessel.

[8] Hastings, M.C., 2008. Effects of sound on shallow coral reefs and predicted effects for the Gigas seismic survey in and around North Scott Reef Lagoon. Sinclair Knight Mertz Pty Ltd, Adelaide (14 pp.).
[9] Peak to peak pressure is a measure of range in pressure between the most negative pressure and the most positive pressure of the signal

The fish study was located 90 km off the Pilbara coast. Researchers tagged red emperor (*Lutjanus sebae*), which are commercially important and an indicator species for other demersal fish, and tracked their movement via two arrays of acoustic receivers before, during and after exposure to the seismic survey. Additionally, the demersal fish community was monitored using Baited Remote Underwater Video Systems to document relative abundance, length distribution and species composition.

Findings are expected to be released in the second quarter of 2020 and will determine whether seismic surveys displace fishes from the survey area. If so, it will quantify ranges and timeframes over which this occurs and the ranges from seismic survey source at which any displacement and/or behavioral responses can no longer be detected.

The pearl experiment was conducted close to Broome in 20-35 m water depths and involved setting out more than 10,000 pearl oysters in groups of about 1200 at different distances of up to six km from the seismic vessel operation. After being exposed to the seismic sound, a selection of the oysters were sampled for condition, physiology and growth over a six-month period. Others were seeded to test if exposure to seismic sound affects the ability of the oyster to produce market quality pearls.

The pearl oyster study will determine whether seismic surveys impact the mortality of oysters and, if so, the ranges and time period over which this occurs. The study will also determine whether seismic survey operations adversely impact the ability of pearl oysters to produce market quality pearls at the same rate as un-exposed shell.

The knowledge and understanding of the magnitude of effect of seismic surveys on commercially important fisheries and pearl oysters is critical for resource management. This has particular relevance in northwest Australia, where oil and gas exploration around high-value commercial fisheries has been prevalent for many years and will continue into the future. Information gained from this study will provide the foundation for evidence-based environmental resource management.

Conclusions

As a marine research agency with a mission that includes delivering economic, social and environmental net benefits for marine industries, AIMS is motivated to help reduce the uncertainties faced by industry during exploration for offshore oil and gas and to answer related questions posed by the commercial fishing industry.

We have made a start in this area with our work on the NWSS Research Program, which we look forward to publicly reporting when the work is completed by mid-2020.

AIMS' research into the effects of seismic surveys on marine ecosystems or individual species has required the integration of multi-disciplinary (biology, ecology, physics) expertise to conduct controlled experiments that correspond directly to real-world situations. These were designed in consultation with resource and environmental managers and stakeholders in order to better address their needs and knowledge gaps. By following this process, our NWSS Research Program will soon produce definitive answers to some of the present uncertainties that surround the use of seismic surveys in marine environments.

Our research assists the Australian offshore resources industry to continuously improve environmental management of its exploration activities. We have addressed impacts to some key species of commercial interest, however, much work remains to be done. AIMS' informed position is that examination of the impacts of seismic testing on plankton is now one of the most important future directions for research.