The challenges and complexities of impact assessment for a seismic survey in a remote coral reef environment

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Abstract

In 2007, Woodside Energy Ltd conducted a three-dimensional marine seismic survey (Maxima 3D MSS) at Scott Reef, approximately 425 kilometres north-west of Broome in Western Australia. This paper describes the challenges and complexities of impact assessment, management and mitigation as well as the regulatory approvals process for this survey. The identification and evaluation of potential impacts from the survey were primarily dealt with in an Environmental Protection Statement (EPS) under the Western Australian environmental approvals process. Engagement with a wide range of stakeholders as part of the approvals process highlighted some inherent uncertainties in the preliminary environmental impact assessment (EIA). These uncertainties were required to be addressed under Ministerial approval conditions. A plan for a field verification study, to validate impact predictions and modelling included in the impact assessment document, was developed. The field study presented major resourcing and management challenges, with the health and safety of personnel of paramount concern. At its peak, the activity involved 123 people and eight vessels operating in a remote offshore location. The challenge of maintaining safe operations, while balancing schedules and scientific and statistical rigour, was successfully met. Field results were incorporated into an adaptive management programme to ensure actual impacts during the execution of the survey did not exceed those predicted. Protection of the environment was demonstrated while enabling a business-critical activity to proceed as planned.

Background

In September 2007, Woodside Energy Ltd (Woodside) commenced a three-dimensional marine seismic survey (Maxima 3D MSS) to cover an area of approximately 362 square kilometres in both State and Commonwealth waters over Scott Reef, which is an emergent shelf atoll, situated in the Browse Basin approximately 425 kilometres north-west of Broome in Western Australia.

Acquisition of this survey was the culmination of an extremely complex and resource-intensive process that spanned a period of over 12 months. It encompassed formal regulatory approvals at State and Commonwealth levels, extensive stakeholder engagement, and a suite of research and monitoring studies to address uncertainties arising from the environmental impact assessment (EIA).

This paper does not set out to report on the results of the studies conducted in support of the Maxima 3D MSS, as these are still being collated and will be reported elsewhere. Rather, the intention is to outline the challenges and complexities faced during the impact assessment process, and to highlight some key conclusions and observations.

Regulatory approvals

The proposal to acquire the Maxima 3D MSS was referred to the Western Australian Environmental Protection Authority (EPA) by the Western Australian Department of Industry and Resources (DoIR) in August 2006. At this stage, it was unclear whether or not the proposal would have to be formally assessed under the *Environmental Protection Act 1986 (WA) (EP Act).* The EPA requested Woodside undertake a three-stage process to provide additional information concerning the potential impacts of airgun noise emissions on site-attached marine fauna, involving:

1. an analysis of the spatial distribution of received energy levels on the sea floor within and surrounding the seismic footprint as a result of the proposed operations.
2. an analysis of the relationship between the spatial distribution of received acoustic energy and the spatial distribution of benthic habitats.

3. a summary of the current state of knowledge, including the identification of knowledge gaps, with respect to the relationship between the magnitude of acoustic emissions and likely impacts on tropical marine fauna.

This process, which covered the period September to December 2006, required a comprehensive risk assessment, comprising detailed modelling of noise propagation and received sound levels, an evaluation of the use of benthic habitats as a surrogate for fish diversity, a GIS-based spatial analysis of the risk of sound exposure to different habitats, and an assessment of the significance of the potential impacts identified. Overall, the conclusion of the risk assessment was that the proposed survey was not expected to have any long-term, biologically significant impacts on the fish populations at Scott Reef (Woodside, 2007a). It also required an extensive literature review of the effects of seismic airguns and other sources of pulsed sound on marine fishes, and the commencement of stakeholder engagement that included the establishment of a technical round-table committee.

In January 2007, following assessment of the additional information provided by Woodside, the EPA determined that the proposal was to be formally assessed under the *EP Act*, and that the level of assessment required was an Environmental Protection Statement (EPS). Following release of the EPS document (Woodside, 2007a) and the statutory public review and comment period, the EPA delivered its report to the Western Australian Minister for the Environment in April 2007 (EPA, 2007). The Ministerial Statement providing approval for the survey to commence, and detailing conditions, was released at the end of August 2007 (Government of Western Australia, 2007).

The proposal for the Maxima 3D MSS was also referred to the Commonwealth Department of Environment and Water Resources (now the Department of Environment, Water, Heritage and the Arts) in July 2006 under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).* A similar parallel process to the State approvals followed, with final Commonwealth approval received on 11 September 2007 (DEWR, 2007). Final State environmental clearances came through on 14 September 2007. The pre-survey field verification study (see below) started on schedule one day later.

Stakeholder engagement

Woodside maintains a proactive approach to engaging stakeholders in key activities, which was aligned with the requirements of the regulatory approvals process through two levels of stakeholder engagement:

- The establishment of a technical round-table committee to assist in the risk assessment process. This committee was composed of representatives from the WA Department of Environment and Conservation (DEC), DoIR, DEWR, WA Department of Fisheries, WA Museum, Curtin University Centre for Marine Science and Technology (CMST), Australian Institute of Marine Science (AIMS), URS Australia and WWF.
- Engagement of additional relevant stakeholders as part of the EPS process. This involved discussions with a number of individuals and non-governmental organisations (NGO), including RecFishWest, Kimberley Marine Tourism Association, Kimberley Professional Fishermen's Association, Environs Kimberley, and the Conservation Council (WA). A number of organisations provided formal submissions on the draft EPS, and 127 issues raised by stakeholders were addressed in the final EPS document.

Early engagement of relevant stakeholders through the technical round-table committee provided significant benefits. It ensured Woodside's assessment was fully informed by stakeholder concerns and was a key factor in demonstrating to the EPA that an EPS level of assessment was appropriate for this proposal - typically this level of assessment is applied to proposals where a formal public review period may be unnecessary because the proponent has adequately consulted with stakeholders. It also meant that a number of the key government, scientific and NGO stakeholders were already well-versed in the highly complex technical aspects of the project, in advance of the release of the final EPS.

EIA uncertainties

In spite of the comprehensive risk assessment undertaken, uncertainties still remained concerning actual versus predicted impacts from airgun noise emissions on tropical marine fish and corals. As a result, the conditions of Ministerial approval required the completion of a preliminary field verification study at Scott Reef (Phase I), to verify predictions of impacts on fish and coral communities, as well as to verify the minimum airgun array size consistent with successful seismic data acquisition. Following the completion of Phase I, the data acquisition phase (Phase II) could be undertaken. This requirement was addressed via the development and implementation of a Draft Adaptive Management Programme (with approval prior to Phase I), and a Final Adaptive Management Programme (completion required prior to Phase II) (Woodside, 2007b). Details of the adaptive management approach are provided in another paper at the IAIA 2008 conference (Grebe *et al.*, in press).

The Ministerial Statement also required the development and implementation of the following:

- Cetacean Monitoring Plan (Woodside, 2007c);
- Non-Indigenous Marine Species Management Plan (Woodside, 2007d);
- Fish Monitoring Programme (Woodside, 2007e);
- Oil Spill Contingency Plan; and
- Coral spawning monitoring.

Woodside prepared an Environment Plan, in accordance with regulatory requirements, that incorporated all of the environmental management elements listed above. Additional commitments to limit the potential for environmental impacts included:

- no seismic acquisition during coral-spawning periods and inside of buffer zones during peak turtle nesting times;
- the presence of continuous daylight marine mammal/fauna observations on the seismic vessel and support vessel during the Phase I and Phase II surveys; and
- the exclusion of seismic data acquisition in buffer zones of 400 metres distance from the outer reef edge and 800 metres from the reef inside the lagoon of south Scott Reef.

Field verification study

The field verification study comprised a suite of monitoring activities the EPA required to be conducted *in situ* in the southern lagoonal waters of Scott Reef. The study included the exposure of faunal communities to airgun noise emissions using the survey vessel and seismic array proposed for the full Phase II part of the Maxima 3D MSS. Over 20 scientific specialists, with expertise in underwater sound, coral reef ecology and reef fish biology, designed and executed unique scientific investigations relating to the impact of seismic surveys on a coral reef environment.

The monitoring work consisted of:

- shallow water fish diversity and abundance (underwater visual census);
- coral monitoring (drop-camera transects);
- deep-water fish diversity and abundance analysis using baited and unbaited remote underwater video (BRUVs and RUVs);
- collection of fish samples for:
    - pathology studies (e.g. gross damage to non-auditory tissues)
    - physiological studies – otolith analysis (hair cell damage), and fish hearing threshold analysis (auditory brainstem response - ABR)
- subsurface equipment:
    - sound loggers (validation of sound propagation and noise exposure modelling)
    - fish exposure cages
    - RUVs (behavioural responses)
- fish school location (sonar transects).

The field verification study presented major resourcing and management challenges, with the safety of personnel being of paramount concern. At its peak, the study involved 123 people, from a variety of organisations, including: Woodside; SKM-ERM environmental consultancy; CMST; AIMS; Blue Planet Marine; Pearl Sea Coastal Cruises; the Australian National University; Pennsylvania State University; the Northern Territory Department of Fisheries; and eight vessels operating in a

remote offshore location. The challenge of maintaining safe operations, whilst balancing schedules and scientific and statistical rigour, was successfully met.

Key outcomes from the field verification study were:

- successful, world-first execution of fish ABR measurements conducted onboard a vessel at sea;
- the identification of a new hearing specialist fish species (verified with anatomical studies);
- no hearing impacts (temporary or permanent threshold shift) found in fish after exposure to airgun emissions;
- no evidence of coral damage or fish mortality caused by airgun emissions;
- the observed impacts were less than initially modeled and predicted in the EIA;
- the DEC was able to provide approval for Woodside to continue with the Phase II survey, with no additional monitoring or mitigation requirements; and
- excellent health and safety performance for such a large operation - no injuries/incidents.

In February 2008, Woodside released a compliance report that summarised the information collected during the Phase I and Phase II surveys, and demonstrated compliance with the conditions and commitments made during the approval process (Woodside, 2008).

Ongoing monitoring

The Ministerial conditions required a level of ongoing monitoring after the end of the Phase II (seismic data acquisition) survey, to further the scientific understanding of any potential longer term effects of noise exposure on fish communities following a seismic survey. This ongoing monitoring includes additional post-seismic survey studies of reef fish diversity and abundance (with a first post-survey study at Scott Reef conducted by AIMS in January 2008), plus an investigation into the time-related sequence of damage to, and repair of, auditory hair-cells of fish exposed to noise emissions during the Phase II survey (undertaken by CMST). These hair cell experiments continued for a period of three months following the initial exposure to airgun emissions.

Conclusions

Key conclusions and observations resulting from this impact assessment process are:

- Uncertainties in the actual versus predicted impacts in the EIA led to considerable delays to regulatory approvals for the Maxima 3D MSS – the original proposed timing for the survey was November 2006; this then slipped to January-March 2007, and then to May-June 2007; actual acquisition of the survey commenced in September 2007, more than 12 months after the proposal had originally been referred to the EPA.
- It is estimated that the total cost to Woodside and its joint venture participants in the Browse LNG Development Project resulting from the impact assessment process, field studies and compliance with the conditions of the Ministerial Statement exceeds A$8 million, which is a significant proportion of the overall cost of the seismic programme.
- This probably represents the most comprehensive and complex field investigation of the environmental impacts of seismic airgun noise on an offshore, tropical reef environment conducted anywhere in the world to date.
- This is the first time that a monitoring programme has incorporated all of the key aspects in relation to the potential impacts of seismic airgun emissions on fish and coral communities i.e. simultaneous/combined use of sound loggers, visual transects (diver and drop-camera), behavioural observations using baited and unbaited remote underwater video, physiological studies examining hair cell damage and auditory brainstem response, pathological examination of non-auditory tissues, and fish school location using sonar.
- It is expected that the results of the monitoring will make a significant contribution to reducing the uncertainty around the potential impacts of airgun emissions on fish.
- This process clearly illustrates the benefits of early stakeholder engagement in building relationships, and in ensuring open and transparent communication and a

cooperative approach between the proponent, government, the scientific community and NGOs.

- The impact assessment and field studies can be successfully used to ensure that seismic airgun emissions of the magnitude used during the acquisition survey can meet environmental protection requirements and will not result in unacceptable impacts on sensitive shallow water marine ecosystems such as Scott Reef.

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