Guidelines on minimising acoustic disturbance to marine fauna

1 Introduction

Seismic data are collected to obtain information on geological formations of the earth's crust. Predictions on the likely presence of hydrocarbon resources are then made based on interpretations of the seismic data. A range of energy sources are used for carrying out seismic surveys, however most surveys in Australia are carried out using airguns. The use of explosives as an energy source was abandoned because of undesirable effects on marine life and hazards to shipping and personnel.

Seismic surveys have the potential to impact on marine life such as mammals, fish, turtles, corals and other invertebrates, plankton and birds. However, research on the effects of seismic surveys on marine fauna indicates that seismic firing affects only a few faunal groups and only for a limited duration. The susceptibility of biota to seismic surveys may vary throughout the life-cycle of the fauna, as a function of their distribution, anatomy and behaviour. For those fauna identified as being more susceptible, environmentally sound operational procedures are necessary to avoid or reduce the potential impacts. This guidelines sheet summarises what is known of the impacts of seismic surveys on different groups of marine fauna, and provides information on appropriate actions that can be taken to avoid or reduce the potential impacts on susceptible groups.

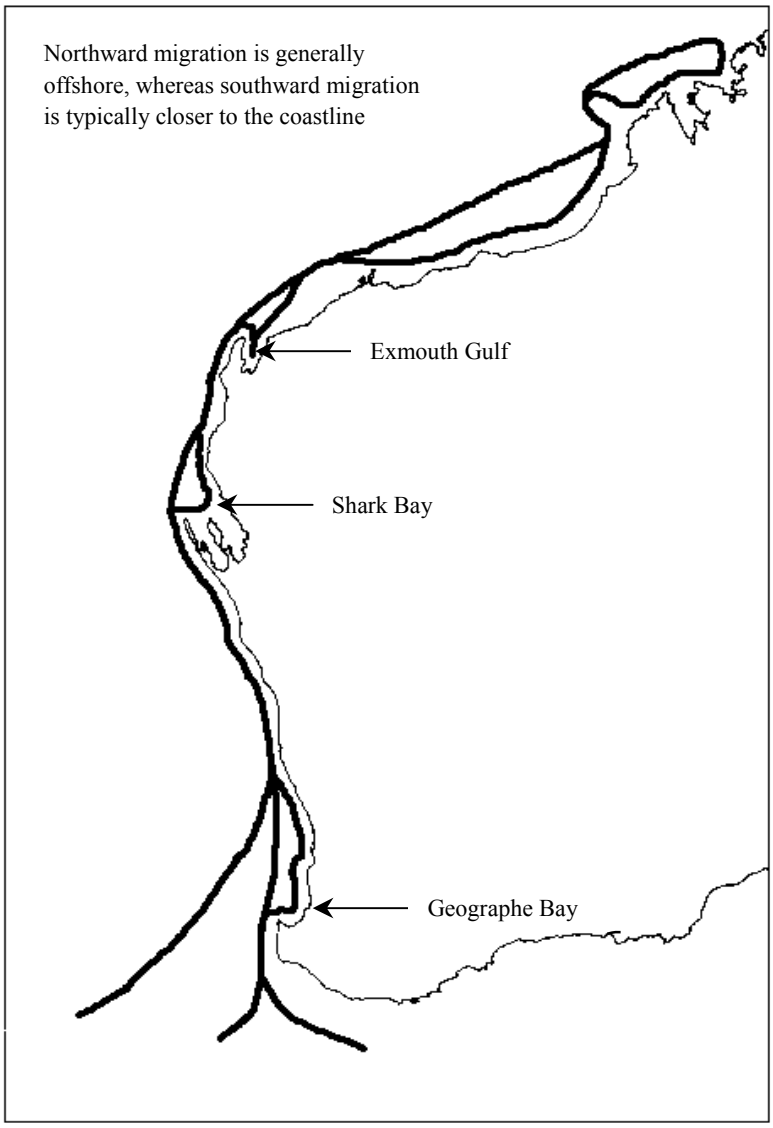
2 Whales

Toothed whales (e.g. dolphins and pilot whales) are considered to hear sound at a wide range of frequencies, from as low as 75 – 125 Hz up to 105 – 150 KHz. However, their best sensitivity under experimental conditions, has been observed at frequencies between 10 and 100 KHz. There is little overlap between the frequency ay which these smaller toothed whales hear and the predominant sound frequencies produced by seismic shots (10 – 300 Hz). The largest toothed whale, the Sperm whale, is considered to have low frequency hearing more like the baleen whales.

Unlike toothed whales, baleen whales (e.g. Humpback whales, Right whales), are believed to have sensitive hearing at low frequencies, inferred from their anatomical characteristics. Baleen whales produce underwater sounds at frequencies ranging from 12 Hz up to 8 KHz, although predominantly below 1 KHz. There is considerable overlap between the frequencies of sounds produced by baleen whales and frequencies produced by seismic shots, and the potential for disturbance of baleen whales from seismic survey activities is considered higher than the potential for disturbance of toothed whales. Behavioural responses including changes in respiration rates and avoidance of the seismic vessel have been observed. Sudden turning on of the seismic source can elicit a startle response, even with the whale up to 3 km from the source. However, the startle response is not observed with continual firing of the source.

Most baleen whales in WA are humpback whales who migrate annually along the western Australian coast to breef and calf, northbound whales migrating further offshore than southbound whales (Figure 1). Because humpbacks have a relatively narrow migratory route, and spend extended periods in certain areas to breed and calf (Table 1), seismic operations conducted across the migration route during the period of migration or in the calving grounds are likely to cause disruption. Seismic operations should not be carried out in areas listed in Table 1 during the whale calving and resting periods.

Figure 1 Inferred migration routes of Humpback whales (Jenner & Jenner, 1998)



Humpback whales can also be expected to be encountered outside the shown migratory paths which are representative only of the main migratory body during peak season at each area.

The periods for resting and calving shown in Table 1 are estimated peak migration periods. Actual timing of annual migration may vary by several weeks between years.

Table 1 Location and estimated period of humpback whales activity in Western Australia. (Jenner and Jenner, *pers. comm.*).

Known important locations	Duration			Importance of area
	September	October	November	
Campden Sound and adjacent areas				Calving area
Exmouth Gulf				Resting area with calves
Shark Bay				Resting area with calves
Geographe Bay				Resting area with calves

The following guidelines provide recommended procedures to minimise the impact of seismic activity on whales. These guidelines may be complimentary to existing operator procedures, or may be used as the basis for sound whale encounter procedures in the absence of existing procedures. The Environmental Protection and Biodiversity Conservation Act 1999 provides the legislative basis for these guidelines and must be complied with. Under this Act, it is an offence to interfere with any whale. The guidelines are described below and illustrated in Figure 2.

The guidelines include (but are not be limited to):

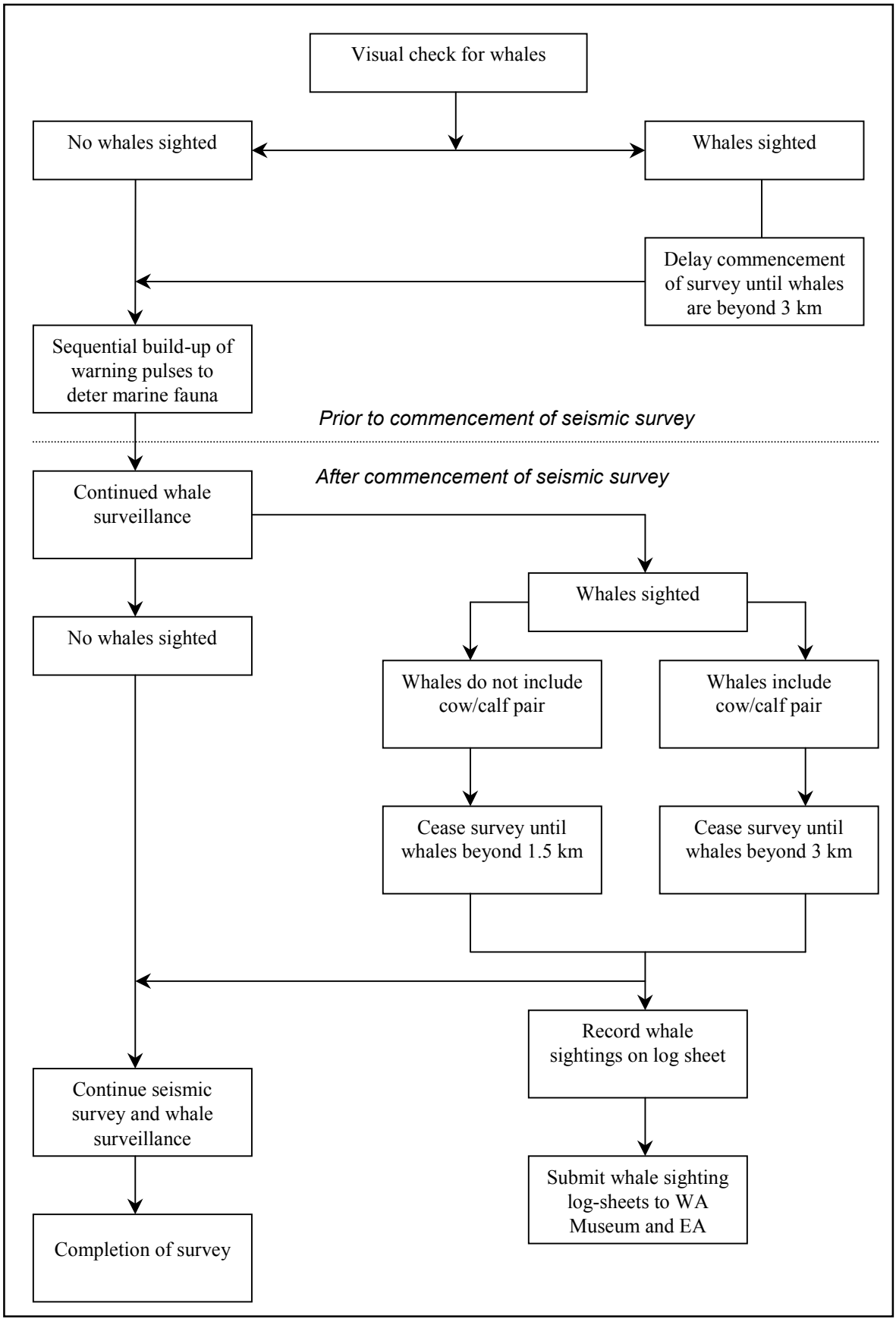
- Seismic survey activities should not be carried out in areas of known whale activity during migration and breeding periods (Figure 1, Table 1). The timing, location and potential impacts on Humpback whales should be identified in the Environmental Management Plan for the activity.
- Prior to commencement of survey operations, a visual check for the presence of whales. Indicators of whale activity may be in the form of blows and surface activity resulting in large splashes. Seismic activity should not begin unless whales are a minimum distance of 3 km from the seismic vessel.
- A sequential build-up of warning pulses should be made to deter and warn marine fauna immediately before commencement of seismic activity. This may involve a gradual increase in the number of air-guns fired over a 5-10 minute period.
- A whale watch should be maintained during the warning sequence to establish the presence or absence of whales within 3 km of the vessel.
- During operations. a whale watch should commence if any whale comes within 3-5 km of the operating seismic vessel.
- The seismic vessel should cease operations if whales are observed within 3 km (for cow/calf pairs) or 1.5 km (other whales excluding cow/calf pairs). Seismic operations should not re-commence until the whales are beyond these specified distances.
- All whale observations should be recorded on observation log sheets (available from CALM), and submitted to: Dr. John Bannister, Western Australian Museum, Francis St. Perth, and the Biodiversity Group, Environment Australia.

The differentiation between cow/calf pairs and other whales is made because cow/calf pairs are more susceptible to disturbance and displacement by seismic operations. Furthermore, individual whales (particularly competitive breeding bulls) may deliberately investigate the seismic source or undertake passing manoeuvres which take them close to the operating seismic survey. For these whales, a distance of 1.5 km to the source is recommended before ceasing operations.

Although 38 of the world's 80 species have been positively sighted and identified cetaceans off the Western Australian coast, there is little information regarding the location of important habitats for these cetaceans. Seismic vessels encountering any group of large cetaceans at sea are encouraged to complete a sighting sheet and submit it to Dr. John Bannister, Western Australian Museum.

The DoIR would like to acknowledge the assistance of R. McCauley, K.C.S and M-N Jenner in developing these guidelines.

Figure 2 Flowchart of whale encounter procedures



3 Dugongs

Dugongs occur in shallow tropical waters, typically in water depths less than 5 m, in areas where there are extensive seagrass meadows. Seismic surveys typically have less effect on marine fauna in shallow waters due to the lower lateral propogation of the noise; with the airguns angled downwards, most of the shot immediately penetrates the seabed. Dugongs have hearing with the greatest sensitivity in the 1-2 KHz range, and thus higher than the typical range of seismic surveys, and thus dugongs are likely to have a low sensitivity to seismic shots.

Dugongs generally calve in shallow tropical waters (< 1 m deep), between August and September, although may calve as late as December. In these shallow waters where there is extensive seagrass, there is a greater likelihood of encountering dugongs during seismic surveys, and between August and December there is a further likelihood of causing distrubance during the breeding and calving season. Although the effects of seismic surveys is largely speculative, as a precautionary approach it is advisable to avoid carrying out seismic surveys in shallow coastal areas with extensive seagrass meadows between the months of August and December. Further information on dugong breeding activities and locations should be sought from CALM before any seismic survey activity is carried out.

4 Turtles

The presumed effects of seismic surveys on turtles are mostly speculative. Threshold noise levels from seismic survey shots that are likely to cause either pathological damage or disturbance are not known. Only one study has documented the avoidance of air gun shots by turtles; avoidance occurred at a distance of 30 m with an airgun firing at a pressure of 1373 KPa at an interval of 15 s. Turtle hearing is most sensitive in the frequency range of 100 – 700 Hz, and therefore overlaps with the most common sound frequencies produced by seismic air guns. Thus, it is likely that turtles would be able to hear seismic activities for a considerable distance from the source of the shots, and would experience some disturbance.

The greatest potential for disturbance is likely to occur when surveys are run over mating grounds, or across migratory routes if the surveys are carried out for protracted periods. It is advisable to check with CALM regarding the migratory routes and breeding areas before conducting seismic surveys. In areas of turtle mating, nesting and hatching, it advisable to avoid conducting seismic exploration programs in shallow waters in known turtle rookery beaches during their nesting season. Nesting seasons differ between turtle species and between nesting locations.

5 Fish

The effects of seismic surveys on fish are generally observed to be transitory, except at close range. Seismic shots are known to elicit a startle response in fish, resulting in a movement away from the source of the noise, and changes in schooling behaviour. Behavioural changes are observed to cease during the exposure period, sometimes within minutes of commencement of surveying, indicating habituation to the noise. Fish are considered to have good low frequency hearing and so are likely to be able to hear seismic shots for up to several kilometres from the source. Disturbance of fish is believed to cease at noise levels below 180 dB re 1μPa. Although there is some evidence to suggest that seismic surveys may cause physical damage to fish, for example to the auditory system, there is no evidence of direct mortality resulting from seismic shots. The noise intensity that would result in mortality or other pathological effects has not been quantified.

Fish species which from breeding aggregations are likely to be more susceptible to disturbance by seismic shots if the survey is carried out at the time when breeding activities are occurring. Mortality of fish larvae in the plankton is considered to be insignificant compared with stochastic factors that cause natural mortality to fish larvae. In the absence of definitive information on the magnitude and duration of the influence of seismic survey operation on fish, it would be prudent to check with Fisheries Western Australia to determine the known fish breeding grounds and their seasonality prior to carrying out seismic surveys. Such identification of the known breeding area and timing of breeding seasons should be included in the Environmental Management Plan for the proposed activity.

6 Invertebrates (including coral and plankton)

A wide variety of invertebrates are sensitive to low frequency (10 – 150 Hz) hydroacoustic disturbances (particle motion, whether induced by sound waves or other sources), e.g. jelly fish and comb jellies, brittle stars, crustaceans, arrow worms, octopus and squid. This frequency range overlaps with the frequency range produced by seismic shots, so it is likely that invertebrates will perceive seismic shots. However, a number of studies have revealed that effects of airgun shots on invertebrates are limited to a transient alarm response, e.g. tail-flicks of lobsters, siphon closing in ascidians. The DoIR has prepared a guidelines sheet dealing with seismic surveys in Western Australian rock lobster fishing grounds, however the focus of these guidelines is to minimise interference of seismic surveys with fishing activities.

Most invertebrates have a pelagic or planktonic phase in their lifecycle and the mortality of plankton has been observed at close range (within 5 m) of the source of the seismic shot. The effects of seismic surveys are considered to be inconsequential given the size of planktonic populations and their high natural mortality rate resulting from stochastic events. Although it is unlikely that seismic exploration using air guns would have a significant effect on coral larvae, CALM should be consulted prior to commencing seismic surveys, to obtain information on coral spawning and settlement periods.

7 Contacts

ORGANISATION	TITLE	BUSINESS PHONE NUMBER	FAX NUMBER
Department of Industry and Resources *Petroleum Division*	Manager Environment	(08) 9222 3142	(08) 9222 3799
Department of Conservation and Land Management *Environmental Protection Branch (Como Office)*	Environmental Officer	(08) 9334 0388	(08) 9367 9913
Department of Conservation and Land Management	District Manager		
Fisheries Western Australia	Management Officer Fish Habitat	(08) 9482 7324	(08) 9482 7389
Australian Petroleum Production and Exploration Association (APPEA)	Director (Western Australia)	(08) 9321 9775	(08) 9321 9778