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## 10 RECOMMENDED MITIGATION MEASURES

This Chapter provides a summary of the recommended mitigation measures as suggested in Chapter 9. These are discussed below in terms of temporal, spatial and operational mitigation measures.

### 10.1 TEMPORAL MITIGATION

The seismic survey should be scheduled considering the sensitivity of the various environmental and social components within the proposed survey area. When planning the timing of the seismic operation it is important to avoid periods of high activity of sensitive marine life (eg whale migration and turtle breeding seasons) and peak tourism seasons (such as periods when diving and recreational fishing is conducted).

#### 10.1.1 *Avoidance of Baleen Whale Migrations and Turtle Nesting*

The seismic surveys will, as far as possible, be planned to coincide with periods when migratory cetaceans move out of Mozambican waters (ie from June to November baleen whales tend to be migrating south to their summer feeding grounds in Antarctic waters). The peak whale calving/ breeding season in Mozambique waters is between August and October and the seismic survey is planned to be finalised before the start of August.

In addition, sea turtles have nesting grounds at Vamizi (close to Pemba) where peak nesting periods occur in January and August, and on Macaloe Island (Quirimbas Archipelago) where nesting is likely in May and December. These two locations are outside of the survey area and the timing of nesting is outside the proposed seismic survey dates of June and July.

#### 10.1.2 *Avoidance of Peak Tourism activities (diving, recreational fishing)*

The seismic surveys will as far as possible be planned out of the peak tourism seasons (December/January, Easter (March/ April),and June/ August) and out of the periods when visitors arrive specifically to see humpback whales and their calves in the area (June to October). At a minimum, the period of August to October (peak whale watching season for baleen whales) will be avoided.

As soon as PCMRB has the finalised seismic survey plan it will be communicated to tourism operators via the channels defined in the

Communication Plan (including other key stakeholders and governmental tourism institutions). The information will include details on the timing and location of each survey line and how they may impact dive operators, fishing charters and other recreational activities.

## 10.2 *SPATIAL MITIGATION*

An exclusion zone for whales will be maintained whereby seismic airguns will not be started, or they will be shutdown, if a whale is observed within 500 m of the seismic survey vessel. This zone will need to be increased to 1 km where the bathymetry indicates steep sloping seabed so as to reduce the acoustic impact on whales which may take refuge in these areas.

Spatial mitigation can also be applied with the use of exclusion or buffer zones around sensitive areas to restrict the seismic vessel from operating in those areas. A 1,500 m exclusion or buffer zone is proposed for coral reef areas to reduce the potential for mortality of fish associated with these reefs. Coral reefs areas are recognised as important areas for tourism (diving, snorkelling and fishing) and for artisanal fishing.

## 10.3 *OPERATIONAL MITIGATION FOR BIOPHYSICAL ISSUES*

Operational mitigation is mitigation management carried out during the operational phase of the project. The types of mitigation used to reduce the impact on marine mammals and other marine fauna include:

- soft starts;
- Marine Mammal Observers (MMOs);
- passive acoustic monitoring (PAMs);
- exclusion zones;
- use of chase boats for “herding”;
- communication with marine mammal researchers in the region;
- waste management; and
- emergency response procedures.

Each of the above mitigation measures is discussed in detail below. The implementation of the first four mitigation methods will be guided by the following references:

- JNCC Guidelines for Minimising Acoustic Disturbance of Marine Mammals from Seismic Surveys (JNCC, 2009);

- HESS Interim Operational Guidelines for High-Energy Seismic Surveys off Southern California (HESS, 1999);
- MacCauley *et al.*, 2000;
- SCAR *ad hoc* Group on Marine Acoustic Technology and the Environment (2002);
- Cummings and Brandon, 2004;
- Scripps Institute of Oceanography, 2007;
- Australian Government – Department of Environment and Water Resources 2007;
- APPEA 2006;
- Compton 2007;
- McCauley *et al* 2000;
- IBAMA 2003; and
- Joint Nature Conservation Committee, 2009.

In general, the levels of acoustic firing intensity and pressures used during the seismic survey should be restricted to the minimum required to obtain the necessary results from the seismic acquisition survey.

### 10.3.1 *Implementation of “Soft-start” or “Ramp Up” Procedures*

Soft starts will be used as a mitigation measure to reduce potential impacts on fish, turtles, whales and dolphins.

Soft starts have become standard practice in seismic surveys around the world. They are used when seismic sources have been silent for a period of time and are about to be started. Soft starts involve a gradual increase of seismic energy over a period of time rather than commencing immediate full level firing. This procedure is intended to allow any marine mammals, fish or turtles that are close to the array to move away before they are exposed to emissions at full power.

Soft starts will be practised throughout the seismic survey in Rovuma Basin. Prior to the start of seismic shooting, sound levels will be increased gradually by 6 dB per minute over a period of at least 20 minutes. Initiation of seismic firing should only begin after marine mammal observers (MMOs) have confirmed that the visual area around the vessel to a distance of 500 m (ie within the exclusion zone) has been clear of all marine mammal and turtle species for at least thirty minutes.

Seismic sources will be shut down during turning of the vessel at the completion of each seismic line and soft starts will be practised prior to commencement of the next seismic line. This is especially important for lines

starting and ending in shallow waters along the coast (western end of survey area) where the more sensitive habitats occur. In addition, if the acoustic transmission is interrupted anywhere along a seismic line and not re-initiated for a period of 5 minutes or more, a 20 minute soft start procedure will be undertaken before restarting data acquisition.

If a marine mammal or a marine turtle is observed within the 500 m exclusion zone around the seismic vessel during the survey, the seismic source should be shut down and only be restarted when the exclusion zone is clear and a soft start procedure followed.

The efficacy of the soft start procedure as a mitigation measure for fish and dugongs has not been evaluated. The territoriality of certain reef fish may override flight responses due to noise stress. While for dugongs, the efficacy of soft starts is unknown and based entirely on the assumption that animals will flee from an approaching sound source.

### 10.3.2 *Marine Mammal Observers (MMOs)*

Qualified and independent Marine Mammal Observers (MMOs) will be used during the seismic survey. The MMOs will undertake daylight observations from the seismic vessel at all times during the seismic survey and record responses of all marine mammals (and turtles) to seismic activity, including distance from the vessel, swimming speed and direction and obvious changes in behaviour and displacement or attraction. It is important that the identification and the behaviour of the animals are recorded accurately along with seismic energy levels at the time of the observation. Furthermore MMOs should:

- record the timing of all soft starts undertaken during the seismic survey and details of pre-firing marine animal observation regimes; and
- have experience in both cetacean (and turtle) identification, and observation techniques; in particular, the MMOs need to have experience identifying and differentiating between the different species of baleen and toothed whale species.

Seismic shooting will be terminated when obvious changes to cetacean behaviours are observed from the survey vessel, or animals are observed within the 500 m exclusion zone around the seismic vessel. Conservative safety distances are defined by received sound pressure levels of 180dB re 1  $\mu$ Pa (rms) for baleen and sperm whales and 210 dB re 1  $\mu$ Pa (rms) for toothed

whales <sup>(1)</sup>. Once seismic source levels are known, the safety distances should be calculated using transmission loss models and verified on site.

The ability of MMOs to observe marine fauna is severely restricted at night and under poor weather conditions. It is recommended that data from daylight sightings be used to estimate likelihood of whales in the area at night. High daytime densities of sensitive species within the exclusion zone may require the termination of night time surveys until such time as the daily sighting densities decrease.

Due to the high cost of stop-start seismic operations, it is recommended that the decision to terminate firing be made by the contractor/ operator based on advice from the MMO with regard to the presence of marine mammals in the vicinity of the seismic vessel. It is mandatory that MMOs provide full reporting of all seismic termination decisions (including the behaviour and distance of marine mammals at the time) in a daily close out report to authorities.

The use of suitably qualified MMOs on board the seismic vessel to search for dugongs ahead of the survey vessel is not deemed an effective mitigation measure. No observations can be carried out at night and even in good sighting conditions the probability of observers sighting dugongs is low and it is likely that these animals would only be observed from the seismic vessel when they were well inside the 500 m exclusion zone. Any dugongs sighted in the vicinity of operating seismic vessels should result in immediate termination of firing of airguns regardless of distance to the animals. Only once the direction of movement and speed of the animal has been determined, and it is outside the 500 m <sup>(2)</sup> radius of the sound source, will the surveys proceed.

### 10.3.3 *Passive Acoustic Monitoring*

Passive acoustic monitoring (PAM) uses hydrophones to monitor underwater sound. Many marine mammals are highly vocal and their presence may be detected using hydrophones. Odontocetes (toothed whales) use a bio-sonar system, emitting a series of clicks and sensing objects by interpreting the resulting echoes, and dolphins also communicate using whistling sounds. Mysticetes, or baleen whales, make deep and long sounds that are referred to

(1) OGP/IAGC, 2003

(2) Although the Australian guidelines state that observations will begin at least 30 minutes prior to use of high energy acoustic sources, with particular focus on a 3 kilometres radius around the survey vessel, a 500 m radius is recommended as per the JNCC. The 3 km radius as recommended by the Australian guidelines is currently under review and is likely to be changed to 500 m in line with the JNCC guideline.

as songs or moans and these sounds fall almost exclusively within the frequency range of the maximum energy of seismic survey noises (slightly higher frequencies for humpback whales; 100 Hz and 4 kHz).

Sperm whale vocalisations, dolphin echo-location clicks and dolphin whistles are emitted so frequently that the detection of these noises using PAM may be used as a reliable indication of the presence of these animals, at ranges of up to two kilometres <sup>(1)</sup>. However, baleen whales (eg minke and humpback whales) are much less easy to detect using PAM as their vocalisation is linked to specific behaviour, such as mating and is therefore restricted to certain times, areas and mainly to males. Their sounds may also be masked by the noise of the vessel engines. The efficacy of PAM in detecting dugongs is also entirely unknown as these mammals are not known to produce consistent sounds for communication.

The use of PAM for monitoring marine mammal sounds from the survey vessel, particularly if such monitoring can provide distance and bearing of the animals, may assist with management of marine mammal issues during night time or low visibility conditions.

Monitoring using PAM requires that animals be vocalising, and Gordon *et al.* (2003) list a number of advantages of acoustic monitoring over visual monitoring including:

- 24 hour per day monitoring not limited by sea conditions or daylight;
- the acoustic detection range of PAM often exceeds the visual range of MMOs;
- many species are audible for longer periods while they are underwater compared to the brief moments on the sea surface; and
- data collection can be automated, although real-time decisions based on PAM data may require constant monitoring.

The use of PAM is encouraged by the JNCC Guidelines <sup>(2)</sup> as it is recognised that this is the only technique that is effective during conditions of poor visibility and during the hours of darkness. It is therefore recommended that the use of this technology be investigated and used to some extent in order to develop the understanding and effectiveness of PAM. PAM should be carried out as a complementary mitigation action to visual monitoring by MMOs. Note that the MMOs must be trained in the operation of PAMs and the interpretation of PAM data.

(1) Janik, 2000 and Rasmussen et al, 2006

(2) JNCC, 2004



#### 10.3.4 *Enforcement of Exclusion Zones*

A conservative safety distance is defined by received sound pressure levels of 180 dB re 1  $\mu$ Pa (rms) for baleen whales and sperm whales and 210 dB re 1  $\mu$ Pa (rms) for toothed whales. A conservative exclusion zone for marine mammals (and turtles) is typically defined as 500 m radius from the seismic source, and is based on acoustic modelling of the potential for the temporary alteration of the hearing sensitivity (TTL).

An exclusion zone of 500 m radius from the seismic source will be designated for the monitoring of marine mammals and turtles from the seismic vessel during the PCMRB survey. If animals are observed within the exclusion zone, the seismic source will be shut down and the marine animals will be observed until they are outside the zone. Restart of seismic source will follow soft start procedures (if shut down for 5 minutes or more), including making sure that marine mammals and turtles have not been seen in the exclusion zone for a period exceeding 20 minutes.

#### 10.3.5 *“Herding” using Chase Boats*

Previous seismic surveys have involved the use of chase boat to “herd” approaching marine mammals away from the seismic operation. The value of such “herding” is questionable as it is doubtful that it would be more effective than the avoidance stimulus of the seismic sound. Furthermore, it is probable that the cetaceans would only be detected visually once they were within the zone of influence of the seismic noise. The use of herding is also not recommended for dugongs.

#### 10.3.6 *Waste Management*

A detailed Waste Management Plan will be developed to deal with all wastes generated on the seismic vessel. Management actions will be included for the following waste types:

- Liquid effluents including deck drainage, drainage from machine spaces and sewage;
- Kitchen and other solid wastes; and
- Hazardous wastes.

All wastes will be handled according to OGP Waste Management Guidelines (No2.58/196, 1993), the International Convention for the Protection of Pollution from Ships MARPOL 73/78 and relevant Mozambican legislation.