Department of Conservation
Te Papa Atawhai

Reference Document

Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations[1]

February 2006

Objective:

The purpose of this paper is to provide background information to support the Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Surveys. In particular this paper provides justification for the key recommendations in the 'Guidelines'.

Introduction:

Marine mammals depend on sound as their primary sense (Parsons and Dolman 2003a). They use sound to communicate, forage and navigate (Tyack & Clark 2000). Anthropogenic noise in the marine environment therefore has the potential to impact marine mammals adversely.

Marine seismic surveys use high intensity sound sources to determine the structure and composition of rock layers beneath the seafloor. The most common purpose of such a technique is for investigating the presence of natural resources (usually oil and gas) beneath the seafloor. For the purpose of these guidelines, 'Seismic Survey Operation' should be interpreted to mean the deliberate discharge of any acoustic source associated with the exploration for oil and gas deposits into the marine environment. Because these surveys rely on the discharge of sound into the marine environment, they could potentially affect marine mammal physiology and/or behaviour (Stone 2003). The loudest sound sources used in seismic survey operations are arrays of airguns which generate short, intense pulses of sound directed at the seafloor. The pulses are broad band, but most energy is concentrated in the 10 – 200 Hertz (Hz) frequency range, with lower energy levels in the 200 – 1000 Hz range (Goold & Fish 1998, Sodal 1999). The airguns are fired repeatedly as the ship traverses an area of interest. Depending on how many airguns are fired together, source levels range from 228 to 259 db (re 1uPa at 1m; Greene & Moore 1995). Other types of sonar, for example swath-mapping systems are sometimes used in combination with airgun surveys. The risk to marine mammals is often thought to be increased by their natural inquisitiveness - the fact that they are often attracted to human activity which often brings them into the zone where potential impacts are greatest (Parsons and Dolman 2003b).

Potential direct effects of acoustic disturbance on marine mammals can be summarised in the following categories (following Richardson et al 1995):

[1] This document should be referenced as follows: Department of Conservation. 2006. Reference Document: Guidelines for minimising acoustic disturbance to marine mammals from seismic surveys. Department of Conservation, Wellington, New Zealand.

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- Audibility (the simple fact that a sound can be heard by an individual)
- Behavioural response (this is typically avoidance of the acoustic source, or attraction to the acoustic source)
- Masking (the inability for marine mammals to hear naturally important sounds due to increased levels of anthropogenic sound in the marine environment)
- Physical effects (permanent or temporary hearing loss, discomfort or injury)

In addition the disturbance of or the reduction in prey species has also been identified as a potential indirect effect of seismic surveys (Slotte et al 2004).

The presiding legislation relating to marine mammals in New Zealand is the Marine Mammal Protection Act 1978. As there is no intent to 'take'[2] marine mammals during seismic survey operations, operators are exempt from regulation by permit under this act. For this reason the Guidelines are voluntary. If operations are to take place in the Territorial Sea (coast – 12nm) they may however, be subject to controls under the Resource Management Act 1991. Regional Councils and relevant Department of Conservation Conservancy Offices should be contacted for advice in these situations.

Marine Mammals in New Zealand

A total of 51 marine mammal species have been recorded in New Zealand waters. Below is a list of those species seen most frequently around the New Zealand coast and their national (Molloy et al 2002, Hitchmough 2002) and international (IUCN 2004) conservation status.

Table 1: Conservation status of New Zealand marine mammals

Species	Taxon	IUCN classification*	DOC threat classification	CMS listing**
Maui's Dolphin	*Cephalorhynchus. hectori maui*	EN (A1d, C1)	Nationally critical	na
Bryde's whale	*Balaenoptera edeni*	DD	Nationally critical	Appendix II
Killer whale	*Orcinus orca*	LR (cd)	Nationally critical	Appendix II
Southern right whale	*Eubalaena australis*	LR (cd)	Nationally endangered	Appendix I
Hector's dolphin	*Cephalorhynchus hectori*	EN (A1d, C1)	Nationally vulnerable	na
New Zealand sea lion	*Phocarctos hookeri*	VU (D2)	Range restricted	na
Bottlenose dolphin	*Tursiops truncatus*	DD	Not threatened	-
Dusky dolphin	*Lagenorhynchus*	DD	Not threatened	Appendix

[2] Under the Marine Mammal Protection Act 1978, 'take' includes to catch, kill, injure, attract, poison, tranquillise, herd, harass, disturb, or possess

	obscurus			II
False killer whale	*Pseudorca crassidens*	Not Listed	Migrant	-
Humpback whale	*Megaptera novaeangliae*	VU (A1ad)	Migrant	Appendix I
Pilot whale	*Globicephala sp.*	LR (cd)***	Migrant	-
Minke whale	*Balaenoptera bonarensis*	LR (cd)	Migrant	Appendix II
Dwarf minke whale	*Balaenoptera acutorostrata*	LR/nt	Not threatened	-
New Zealand fur seal	*Arctocephalus forsteri*	Not listed	Not threatened	-
Pygmy sperm whale	*Kogia breviceps*	Not Listed	Data deficient	-
Sei whale	*Balaenoptera borealis*	EN (A1abd)	Migrant	Appendix I
Blue whale	*Balaenoptera musculus*	EN (A1abd)	Migrant	Appendix I
Sperm whale	*Physeter macrocephalus*	VU (A1bd)	Migrant	-

* Key to IUCN classifications: Endangered (EN); Data Deficient (DD); Lower Risk (LR); Vulnerable (VU). For definition of qualifiers please refer to www.redlist.org

** Many migratory species are listed under the Convention on the Conservation of Migratory species of wild animals (also known as the Bonn Convention) and impacts on these species are regulated through this convention. For more information see www.cms.int. *short finned only; long finned not listed)

*** Only short finned pilot whales are listed in the IUCN red list 2004; long finned pilot whales are not listed. Both species are seen frequently in New Zealand waters.

Species of Concern:

Acoustic disturbance has the potential to affect all marine mammals – whales, dolphins and seals (for example, Malme et al 1984; Goold 1996; Harris et al 2001). For this reason most of the actions in the guidelines apply to all marine mammal species. However, the guidelines make particular reference to 'Species of Concern' for which a strong precautionary approach is recommended. For the purpose of the guidelines, 'Species of Concern' refers to:

- All whales as defined in the Marine Mammal Protection Regulations 1992: *'Whale means all species commonly known as whales; and includes baleen whales, sperm whales, beaked whales, killer whales and pilot whales.'*

- Hector's and Maui's dolphins - on the basis of specific conservation concern for these species.

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- Additional species may be recommended for inclusion by the Department of Conservation on a case by case basis as specific concerns arise[3].

The Species of Concern were chosen based on:

1. Their heightened susceptibility to acoustic disturbance and
2. Their conservation status in New Zealand waters.

These aspects are discussed for these species in further detail below.

There is good evidence to suggest that mysticete (baleen) whales are particularly susceptible to disturbance from seismic surveys. These whales are thought to be sensitive to frequencies as low as 10 Hz. Their vocalisations typically occur in the 10 to 300 Hz frequency range (Richardson et al 1995). Avoidance reactions to seismic operations have been observed repeatedly for these taxa (for example: Malme et al 1984; Richardson 1998). A number of mysticetes are also afforded a conservation status in New Zealand that is conducive to a more precautionary approach with regard to any potential disturbance (see Table 1; Molloy et al 2002).

Sperm whales are thought to have relatively good hearing at, and to be sensitive to, low frequencies (Carder & Ridgway 1990; Bowles et al 1994). They are a highly vocal species and anthropogenic noise has been linked to interruptions to and/or cessation of natural vocalisations (Watkins et al 1993; Mate et al 1994).

Sperm whales and beaked whales are both deep divers. Because of this there is some concern that significant acoustic disturbance towards the end of a deep dive may detrimentally impact on these animals as oxygen reserves may be insufficient to allow them to swim away from an unexpected intense noise (Parsons & Dolman 2003b).

Killer whales, Hector's dolphins and Maui's dolphins are all included as 'species of concern' based on their conservation status in New Zealand (see Table 1; Molloy et al 2002). Discussions on the distribution of these species are given in the following section in relation to Areas of Ecological Importance.

Areas of Ecological Importance

Operators are asked in the guidelines that special consideration be given to 'Areas of Ecological Importance'. In particular the department asks that surveys in these areas be planned in such a way to ensure that their timing will reduce the likelihood of encounters with marine mammals and particularly the species of concern. If operation in these areas is unavoidable, operators are asked to consider refraining from operating at night or using passive acoustic monitoring to 'listen' for marine mammals before operating at night. Operators intending to survey in Areas of Ecological Importance should contact the Department of Conservation at least one month prior to commencing work to discuss mitigation measures.

Breeding, feeding, resting and migrating have been identified as important behaviours during which marine mammals are particularly vulnerable to

[3] For example some concern is also held for populations of bottlenose dolphins in some areas of New Zealand.

disturbance (Environment Australia 2001). This is especially so for whales and dolphins accompanied by calves (McCauley et al 2000).

For some species there is sufficient data to indicate that these behaviours take place in typically localised areas. Where this depth of knowledge is available we have provided specific detail about the areas that should optimally be avoided during seismic surveys to minimise risk to animals. For many species this depth of understanding is lacking and areas and times to avoid are therefore less prescriptive. Research continues in this field, hence it is envisaged that these areas of ecological importance will evolve as our knowledge of marine mammal distribution and behaviour in New Zealand waters increases. The following descriptions should form the basis for planning when and where surveys should/should not be undertaken to minimise impacts on 'species of concern'.

Table 2 illustrates areas that are considered of 'Permanent Ecological Importance'. Table 3 indicates migration routes of whales and additional areas that are considered of 'Seasonal Ecological Importance' and need only be avoided for the time period specified.

Table 2- Areas of 'Permanent' Ecological Importance

Description of Area	Latitude range	Species of concern	Reference to explanatory notes
Kaipara Harbour – New Plymouth	36º30'S - 39º4'S	Maui's dolphin	1
Kahurangi Point – Jackson Head Oamaru – Port Underwood Long Point – Chaslands Mistake	40º46'S - 43º58'S 41º21'S - 45º07'S 46º15'S – 46º38'S	Hector's dolphin	2
Kaikoura	42º10'S – 42º50'S	Sperm whales Beaked whales	3
Hauraki Gulf	36º00'S – 37º00'S	Bryde's whales	5b
Bay of Plenty East Coast Northland Chatham Rise	36º45'S - 37º45'S 34º40'S - 35º50'S 43º00'S - 44º25'S	Beaked whales	4
Southern New Zealand	45º45'S – 52º40'S	NZ sea lions & southern right whales	6 5a

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Table 3- Areas of 'Seasonal' Ecological Importance

Description of Area	Latitude range	Species of concern	Season of concern	Reference to explanatory notes
East Coast / Hawkes Bay Cook Strait Otago Southland / Stewart Is	37º30'S – 39º40'S 41º00'S - 41º35'S 45º20'S - 46º05'S 46º40'S – 47º15'S	Southern right whales	May – Oct (for all areas)	5a
Central New Zealand East & West Coasts North Island	40º50'S - 42º45'S 35º00'S – 38º00'S	Humpback whales	May – Aug Sept - Dec	5c

Please note: The majority of marine mammal sightings that contribute to the information presented above have been relatively coastal. However, limited data is available with regard to offshore distributions. For this reason the offshore boundaries of the Areas of Ecological Importance have not been specified and we ask that precautions be taken throughout the extension of the EEZ.

Explanatory notes:

1. Maui's dolphins

Maui's dolphins (previously known as North Island Hector's dolphins) are the northern subspecies of the Hector's dolphin. Maui's dolphins are endemic and are found only off the west coast of the northern half of the North Island (Kaipara Harbour to New Plymouth - 77% of all sightings occur between Manukau Harbour and Port Waikato. Slooten et al 2005). Grave concern is held for the long-term survival of this subspecies, with recent estimates of population size indicating that there are only around 110 individuals left (Slooten et al in press). They have a coastal distribution, with all sightings to date within 4 nm of the coast (Slooten et al 2005). Some seasonal changes in distribution are apparent with dolphins being found further from shore during the winter months (Slooten et al 2005). The conservation of this sub-species is of utmost importance to the department (Suisted and Neale 2004). For its future survival, anthropogenic impacts on Maui's dolphin must be eliminated.

2. Hector's dolphins

This small endemic coastal dolphin species is restricted to the South Island of New Zealand. Here three genetically distinct populations have been identified (Pichler 2002); West Coast South Island (c. 5400 individuals), east coast South Island (c. 1900 individuals), and south coast South Island (c. 100 individuals; Dawson et al 2004). This species is most frequently seen close inshore, and distribution is more dispersed in winter than in summer. At Banks Peninsula the

offshore distribution extends further (to at least 18nm offshore in winter; Rayment et al 2005) than off the South Island west coast, where the furthest offshore sighting from aerial surveys to date is 6nm (Rayment et al 2003).

3. Sperm whales

Sperm whales are deep divers and can remain submerged on for up to 90 minutes however their average dive times are 44 minutes and 39 minutes for summer and winter respectively (Jaquet et al 2000). The guidelines suggests a pre-start up observation period of 30 minutes, so a sperm whale submerged in the direct vicinity could go un-noticed during pre-start visual observations, and hence inadvertently be affected by seismic operations. Sperm whales are known to be resident off Kaikoura (Childerhouse et al 1995) therefore any surveys in this area are likely to meet with suggested additional requirements from the department, for instance extended pre-start observations. Seismic and swath mapping surveys have previously created widespread temporary changes in sperm whale behaviour at Kaikoura which have in turn affected the commercial 'whale-watching' industry (DOC, unpublished data). We ask that operators advise DOC and consult with whale-watch companies at least one month before operating in this area.

4. Beaked whales

Beaked whales range in size from 3.7 – 9.7 m (Baker 1999). These animals are shy and inconspicuous at sea and they spend much of their time submerged on deep dives. They may be particularly vulnerable to high energy downward-directed seismic pulses, especially at depths where they are already physiologically compensating for predictable pressure changes (US Department of the Interior 2004). Acoustic disturbance from naval sonar exercises has been implicated in several beaked whale stranding events overseas (Frantzis 1998; Degollada et al 2003). Beaked whales may be more susceptible to anthropogenic acoustic disturbance than other marine mammal species. Beaked whales are rarely observed at sea and use sonar signals that are ultrasonic (>20 kHz; Dawson et al 1998; Johnson et al 2004) making documentation of their presence difficult. For this reason, particular effort should be made to make sightings in areas where beaked whales are likely to be present. Any information (including photographs) of these species would be gratefully received by the Department of Conservation. No specific data is available regarding distribution for these species, although they are generally considered to inhabit waters depths of greater than 1000 metres. Stranding records indicate that they may be concentrated in the following regions: Bay of Plenty/East Cape; offshore Chatham Rise, and off the east Coast of Northland (Anton van Helden, Te Papa, pers. comm.).

5. Mysticete whales – (baleen whales)

Mysticete whales include the following species common to New Zealand waters: southern right whales, Bryde's whales, blue whales, fin whales, humpback whales, minke whales (two species) and sei whales. Overseas studies have identified mysticete whales as being the most prone to disturbance from seismic operations as the frequencies over which they communicate overlap directly with acoustic profiles of seismic surveys (US Department of the Interior 2004).

5a. Southern right whales

In light of the evidence that mysticete whales are more prone to acoustic disturbance and given the conservation status (critically endangered: Hitchmough 2002) of southern right whales, the department is concerned about the impact that seismic surveys could potentially have on this species. Southern right whales are seen around the mainland coastline from May to October each year (Patenaude 2003). During this time the whales tend to move north into warmer, sheltered coastal waters to calve. Sighting data suggests that the East Coast/Hawke's Bay region may be an important breeding ground for this species (Patenaude 2003). This species is also frequently sighted in waters off Southland, Otago and through Cook Strait during the migration and breeding period (Department of Conservation unpublished data). Evidence suggests that there may be only 30 individuals left in the New Zealand mainland population (Patenaude 2003).

5b. Bryde's whales

There is a lack of published literature on this species in New Zealand. Bryde's are seen most frequently in the Hauraki Gulf, but also occur along the East Coast up to and including the Bay of Islands. Evidence suggests a degree of residence in the Hauraki Gulf, especially in the outer gulf area (Alan Baker, pers comm.). These whales are more abundant in the Gulf over winter months when they are observed feeding on aggregations of prey. Bryde's whales are often found in association with common dolphins as they both utilise the same aggregations of prey species.

5c. Humpback whales

These whales undertake an annual migration through New Zealand waters between summer feeding grounds in the Antarctic and winter breeding grounds in the tropics. Generally they travel north up the East Coast of the South Island then on through Cook Strait before heading offshore during May to August (Gibbs & Childerhouse 2000). The southern migration takes place between September and December) when they travel down both coasts of the North Island.

6. New Zealand sea lions

New Zealand sea lions are classified as 'range restricted' (Hitchmough 2002) because over 95% of breeding for the species now occurs within a restricted area of the New Zealand subantarctic. Historically breeding sites were located in several regions around the New Zealand mainland (Childerhouse & Gales 1998). Little research has been conducted to date to assess the impacts of underwater noise on seal species. However, available research suggests that seal species are relatively tolerant of, or able to habituate to seismic disturbance and that hearing in seals, especially fur seals and sea lions, is poor at low frequencies (Pidcock et al 2003). Hence this species and other seal species have not been identified as 'species of concern' in the guidelines, yet observations of the behaviour of seals and sea lions in the vicinity of survey vessels should be recorded.

Shut down distances:

The shut down distances that are recommended in the guidelines and the rationale behind them are presented below.

1 km for species of concern

The guidelines recommend that operators shut down air guns during full acquisition if 'Species of Concern' come within 1 km of the power source. It is generally accepted that noise levels below 180 dB re 1 µPa (rms) are unlikely to cause any loss of hearing (temporary or permanent) or physiological damage to cetaceans (URS Australia 2004). Based on vessels operating 2000-3000 cubic inch arrays at full power, several studies indicate that the 180 dB re 1 µPa (rms) threshold correlates well with a 1 km distance in most scenarios (URS Australia 2004).

1.5 km for groups containing calves

The department recommends, for species of concern, that if a cow/calf pair or a group containing calves approaches within 1.5 km of the power source during full acquisition that the gear is shut down. Evidence suggests that groups containing calves are more susceptible to disturbance than other individuals (McCauley et al 2000). The 1.5 km shut down distance in this scenario serves to provide heightened protection to these vulnerable groups in an effort to minimise not only the likelihood of hearing loss or physiological damage, but also any significant behavioural responses that could have a potential negative effect on the energy budget of a calf or lactating female.

The department recognises that species identification may be difficult at this distance, but we are confident that the majority of 'species of concern' will be detectable. Detecting and identifying dolphin species at this distance is likely to be a challenge; however, both Hectors and Maui's dolphins, the only dolphin species formally included as 'species of concern' have a relatively coastal distribution (Slooten et al 2005; Rayment et al 2005) hence the likelihood of encountering these dolphins during offshore surveys is low.

Data Collection:

The Department has asked that operators keep a record of all marine mammal sightings made during surveys on the recording forms provided. The department intends to use the observation information that you provide on these forms to; 1. enhance our general knowledge of marine mammal distribution and behaviour in New Zealand waters, and 2. investigate the effect of seismic surveys on marine mammals in New Zealand.

Notes on detecting the presence of marine mammals:

- Operators should allow at least 30 min for sightings to be made prior to commencement of any air gun discharge;
- The detection rate for marine mammals decreases with increasing sea state. Search effort should reflect this;
- Observations should be made from a high vantage point with a clear all round view;
- The surrounding sea should be first scanned slowly with the naked eye and then slowly with binoculars. This should be repeated continuously throughout the 30 minute period;
- Dolphins and porpoises typically surface 2-3 times per minute to breathe. Dive times and surface behaviour are more erratic when they are feeding, but most dives are unlikely to exceed 5 minutes. Large whales surface less often and may remain submerged for longer periods (typical dive duration for mysticete whales is 5-10 minutes, and 40 – 50 minutes for sperm whales);

- Surface splashing may provide a cue to the presence of marine mammals, although in seas rougher than sea state 2, marine mammal splashes may be difficult to detect;
- Blows of large whales are typically quite obvious as vertical plumes of fine white mist. Blows can be difficult to detect in strong winds and in areas of sun glare;
- Some species of marine mammals may be attracted to boats and may accompany a vessel for some time. If possible check over the bow of the ship during observation periods in an attempt to detect marine mammals close to the vessel that may not be visible from the normal vantage point;
- Feeding seabirds can sometimes indicate the presence of marine mammals, as they often target the same groups of schooling prey. Any flocks of birds should be checked for the possible association with marine mammals;
- An oily slick at the sea surface can also signify the presence of marine mammals, these slicks, or 'footprints', are created when marine mammals dive.
- The reflection of sun off a whale's shiny body can also often be used as a means of detection.

ADDITIONAL USEFUL INFORMATION

Converting kilometres to nautical miles:

To convert kilometres into nautical miles divide kilometres by 1.852. Eg 100 km = 54 nm.

Determining distance of marine mammals from vessel:

1. First you need to establish the angle of the marine mammal below the horizon. This can be done by either:

   a. Using reticle-equipped binoculars, or;
   b. Using a sextent – some prior training required

2. Once you know this angle, standard formulae that account for the Earth's curvature, refraction and the known height of eye of the observer can be used to calculate range. The standard tables and formula needed to carry out these calculations can be found in Norie's Nautical Almanac.

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