2012 Code of Conduct

for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations

REFERENCE DOCUMENT

Seismic survey vessel *Polarcus Alima* entering Wellington Harbour 2012. *Photo: Polarcus Ltd.*

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1. Part 1: Overview of the Code

1.1 Introduction

In February 2006 the Department of Conservation (the Department) published the *Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations* (the Guidelines) and its associated Reference Document. Subsequently in 2010, the Department contracted Blue Planet Marine to facilitate a review of the Guidelines by engaging in discussions with key stakeholders. The Department continued the review process during 2011 and developed what would become the *2012 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations* (the Code).

The Code is an operationally focused document, so it was decided that background information should be provided in a supplementary publication to be read in conjunction with it. Therefore this Reference Document supports the Code, providing context and rationale for the direction taken following the review process, as well as guidance to assist interpretation.

Both the Code and the Reference Document build upon the earlier foundation established by the 2006 Guidelines, strengthening provisions as New Zealand moves towards mandatory regulation of marine seismic survey operations throughout New Zealand continental waters.

1.2 Objectives

The primary objectives of the Code are to:

- Minimise disturbance to marine mammals from seismic survey activities
- Minimise noise in the marine environment arising from seismic survey activities
- Contribute to the body of scientific knowledge on the physical and behavioural impacts of seismic surveys on marine mammals through improved, standardised observation and reporting
- Provide for the conduct of seismic surveys in New Zealand continental waters in an environmentally responsible and sustainable manner, and
- Build effective working relationships between government, industry and research stakeholders.

1.3 Application

The Code applies to marine geophysical investigations using high-intensity acoustic seismic sources to determine the structure and composition of rock layers beneath the seafloor in New Zealand continental waters.[1] It includes both commercial and scientific studies, but it does not include low impact bathymetric (or other) marine surveying. Nor does it apply to other sources of marine noise such as underwater construction, which are covered under other legislation relevant to the coastal marine area, exclusive economic zone or extended continental shelf.

[1] For New Zealand vessels, the Code applies to seismic survey operations anywhere in the world.

1.4 Nature and duration of the Code

During the review process a general consensus emerged from the stakeholder group that New Zealand should implement mandatory measures to regulate marine seismic survey operations. The primary advantage is ensuring a transparent, level playing field with consistent application to all operators. The Department supports this in principle and continues to work towards this outcome.

However, legislative processes are complex and time-consuming; both in initial development and ongoing review. There are currently many areas of uncertainty related to the potential impacts of acoustic sources on the marine environment. Sound exposure alone may not prove to be the key determinant of potential impacts and disruption to marine mammals, with evidence emerging that 'context-based' approaches are necessary to understand the variability in animal responses to sound.[2] The actual effectiveness of mitigation measures such as soft starts is also questioned, with apparently differing responses between species and even individuals. While these uncertainties exist and research continues to build scientific understanding, the Department considers it premature to implement mandatory measures.

Therefore, the decision was made to strengthen the voluntary nature of the Guidelines by establishing an industry Code of Conduct, drafted in obligatory terms, which operators agree to treat as mandatory when adopted. In addition, such a code will be considered best practice against which the activities of non-signatories would be gauged.

The Code is an interim measure which provides opportunities not only to incorporate new scientific information, but also to test the practicality of new provisions in real world applications before they become mandatory, enforceable requirements. It also allows the time necessary to establish an entirely new training and qualifications system for observers.

After an initial three-year period, the Code will be subjected to an implementation performance review and further consideration given to establishing regulations under the Marine Mammals Protection Act 1978. The Code will remain in effect until superseded.

1.5 Adoption of the Code

The Code is open for adoption by any stakeholder in the marine seismic survey sector. While the Code is formally endorsed by the oil and gas industry representative body, the Petroleum Exploration and Production Association of New Zealand (PEPANZ), adoption and implementation is on an individual company or organisation basis.

In signing up to the Code, individuals and organisations agree to comply with the Code and treat its provisions as mandatory, on the understanding that no enforcement action is possible under the Marine Mammals Protection Act 1978 unless specific regulations are in force.

[2] See Ellison, W.; Southall, B.; Clark, C.; Frankel, A. 2011: A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. *Conservation Biology*, doi: 10.1111/j.1523-1739.2011.01803.x.

1.6 Performance of the Code

As noted at the beginning of this document, the three-year duration of the Code offers an opportunity to test the effectiveness and practicality of the provisions, both at the project planning stage and during field-based operations. Appropriate revisions and refinements can then be incorporated prior to the development of regulatory measures. In order to ensure optimum outcomes, it is critical that stakeholders provide comprehensive feedback for the Director-General to consider. Therefore, proponents, operators and observers alike should monitor performance, keeping detailed records of any issues experienced, and provide them along with suggestions for improvement at the end of each survey.

Furthermore, if any provisions create unforeseen, unavoidable practical difficulties, stakeholders are encouraged to contact the department immediately to discuss the issues and explore potential solutions.

2. Part 2: Context and interpretation of the Code

2.1 Marine Mammal Sanctuary regulations

There are six Marine Mammal Sanctuaries (MMS)[3] in New Zealand gazetted under the Marine Mammals Protection Act 1978. All but one of these MMS have associated regulations which feature various provisions related to the conduct of marine seismic surveys. The existence of the Code or its adoption by an organisation does not affect the operation of any law in force in New Zealand.

It is acknowledged that there are inconsistencies between some of these regulated requirements and the provisions of the Code. In most instances the Code is more stringent, but there are some areas where the MMS regulations are stricter. In each case, the more stringent provisions will apply and proponents must check the relevant regulations if they plan to conduct surveys in any of the MMS.

The Department will work towards aligning the MMS regulations with the provisions of the Code as part of the regulatory process when mandatory measures are being developed and implemented throughout New Zealand continental waters.

2.2 Research

Internationally there is a significant amount of ongoing research into the effects of seismic survey operations on marine species and habitats, and there is a critical need to ensure it continues. While it is not anticipated that New Zealand stakeholders would duplicate international efforts, it is essential that research is conducted in our region that is relevant to our species, habitats and conditions.

For example, there are many anecdotal accounts from experienced marine mammal observers that New Zealand species of pinnipeds and common dolphins display little or no aversion to acoustic sources. As a result, stakeholders have proposed excluding such species from the provisions of the Code. This could only be considered if empirical studies prove that there are minimal physical and behavioural impacts, demonstrated over the entire range of potential seismic survey applications.

There is also scant information about the effectiveness of soft start procedures on New Zealand marine mammals as a mitigation tool. Neither is there any definitive information about the impacts of seismic surveys on beaked whales, a particularly sensitive deep-diving species encountered throughout the region.

In addition, more general research initiatives into seasonal population distributions are necessary to increase confidence in predicting sensitivities at the planning stage, as are studies on long-term, cumulative exposure effects on New Zealand species and habitats.

Operationally focused research investigating the accuracy and efficiency of onboard observations over the range of mitigation zones would also be of great value in providing assurance that the measures in the Code are both practical and effective.

[3] Auckland Islands, Banks Peninsula, Catlins Coast, Clifford and Cloudy Bay, Te Waewae Bay and West Coast North Island.

Consistent with the precautionary approach, those who undertake marine seismic surveys are responsible for demonstrating that their activities are sustainable and do not cause unacceptable harm. Therefore, the onus is on industry and science providers to use every opportunity during the three-year duration of the Code to address and report on the most significant gaps in knowledge and understanding.

Such investigations should ideally make use of independent research platforms, with robust 'before-after-control-impact' (BACI) methodologies.

If such research-focused investigations prove difficult to undertake due to the restrictive provisions of the Code, science providers should contact the Director-General to discuss potential options.

2.3 Marine mammal sensitivities

There is a range of potential impacts arising directly or indirectly from acoustic seismic sources depending on energy levels, frequencies and duration. These include:

- Physical effects:[4] trauma to body tissues (sometimes including damage resembling decompression sickness in humans), or auditory damage leading to permanent or temporary hearing loss (sometimes referred to as Permanent or Temporary Threshold Shift, PTS/TTS)
- Auditory masking: increasing background noise levels which affects an animal's ability to detect relevant sounds, such as when finding prey, navigating or in social communications
- Behavioural: causing avoidance or attraction responses, which may lead to disruption of normal functions, and
- Disturbance or reduction in prey species.[5]

While an obvious focus of the Code is minimising the physical impacts of underwater sound on marine mammals, understanding and avoiding behavioural impacts are also priorities. The clearest example is the establishment of the most stringent and precautionary mitigation zones for protection of marine mammal calves. The objective of this measure is to minimise the chances of disturbing or disrupting adult/calf pairings, due to the unpredictability of immature animals wholly dependent on a parent for survival. In addition, and as discussed in more detail later, increasing the effectiveness of observers to accurately plot animal location relative to both the vessel and the acoustic source will increase understanding of marine mammal responses to seismic surveys.

It is acknowledged that despite the range of mitigation measures included in the Code, there will always be some degree of uncertainty about the effectiveness of the provisions in minimising impacts. It is also acknowledged that the best course of action is simply to avoid conducting seismic surveys in sensitive areas. In order to address this, the Code requires a Marine Mammal Impact Assessment (MMIA) to be developed and submitted. The MMIA process ensures that all potential environmental impacts and sensitivities have been identified, and that appropriate expert advice about minimising impacts has been considered. There is a clear emphasis on avoiding operating in sensitive, ecologically important areas or during key biological periods where Species of Concern are likely to be breeding, calving, resting, feeding or migrating, or where marine mammals are present in confined waters.

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[4] Compton, R.; Goodwin, L.; Handy, R.; Abbott, V. 2007: A critical examination of worldwide guidelines for minimising the disturbance to marine mammals during seismic surveys. *Marine Policy*, doi:10.1016/j.marpol.2007.05.005.

[5] Slotte, A.; Hansen, K.; Dalen, J.; Ona, E. 2004: Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fisheries Research 67*: 143–150.

To assist in this process, the Department is involved in ongoing work to increase the utility and availability of ecological information for marine mammals in New Zealand continental waters, and in refining data on Areas of Ecological Importance (AEI) with finer scale resolution. Such information will be invaluable at the planning stage, in avoiding sensitive areas or seasons.

2.4 Acoustic source capacity vs underwater sound level

While sound intensity, frequency, duration and location are key determinants of potential impacts on marine mammals, propagation of sound underwater is a highly complex, variable process and it is beyond the scope of this document to provide a full summary.

Several jurisdictions around the world have set a maximum allowable sound level at set distances from the acoustic source, within which operations may be limited if marine mammals are present.

However, it is as challenging to model, predict and measure underwater sound levels relative to distance from an acoustic source, as it is to interpret results. As such there can be significant variability, uncertainty and inconsistency. This is compounded by the variety of different sound measurement units (e.g. peak pressure, root mean squared, sound exposure level) that can be employed depending on application, none of which can be directly compared. In addition, scientific understanding of the effects of underwater sound on marine mammals is inconclusive and continually evolving, so using sound criteria to determine mitigation measures is fraught with difficulty.

Therefore, for the purposes of the Code a more practical and easily implemented solution was sought by stakeholders. Despite its acknowledged limitations, it was decided that the physical capacity of the acoustic array (the total volume, expressed in litres or cubic inches, of all acoustic sources involved) would primarily determine the level of mitigation measures applicable to survey operations. Based on the clear demarcation of acoustic source capacity, three levels have been established:

- Level 1: the most stringently controlled for high-energy seismic surveys, with the largest mitigation zones and highest number of observers required
- Level 2: less stringent measures reflecting reduced risk of potential impacts from lower energy seismic surveys, mainly reflected in smaller mitigation zones, and
- Level 3: where seismic survey energy output is so low that no significant impacts are expected. Level 3 surveys are specifically excluded from the provisions of the Code.

It should be noted that it is common practice for acoustic source operators to have equipment redundancy in the array, with between 25–50% (by airgun volume) spare capacity. This allows operations to continue efficiently in the event that individual airguns malfunction. For this reason, acoustic source arrays are measured by their 'operational capacity' to determine the appropriate level.

Consideration of underwater sound levels is still an important factor, and is provided for both inherently in the radii of the mitigation zones and in the MMIA process where seismic surveys are being planned in AEI or MMS, as discussed later in this document.

2.5 Mitigation zones

Mitigation zones that should provide protection over the range of marine mammal sensitivities described earlier have been developed and agreed with the stakeholder group.

- Within the Level 1 and 2 mitigation zones for Species of Concern[6] with calves, it is intended that behavioural impacts will be reduced as far as possible within operational constraints (based on available behavioural response criteria).
- Within the Level 1 and 2 mitigation zones for both Species of Concern and for Other Marine Mammals, the intent is also focused on progressively reducing the potential for physiological trauma (based on available injury criteria).

The maximum distance of 1.5 km for Species of Concern with calves in Level 1 surveys is primarily related to the maximum distance an observer on board the source vessel could discern an adult/calf pairing under optimal sighting conditions (though such observations in excess of even of 1 km may still be very challenging). It is acknowledged that sound may travel far beyond this distance, but for practical purposes this is considered the limit of reliable observations in routine operating conditions.

As has been noted, there are many difficulties and much variability with using sound criteria to determine the size of mitigation zones. This can cause confusion in both interpretation and application, and there are particular problems when trying to identify relevant research to inform the decision-making process. However, recent scientific studies have been drawn upon in part to give some degree of confidence that in addition to being practical for observers to monitor effectively, the mitigation zones set in the Code will provide precautionary protection in most circumstances.

The received levels presently defined by the USA National Marine Fisheries Service (NMFS) as safety criteria for pinnipeds and cetaceans[7] are 190 and 180 dB referenced to 1 µPa root mean squared (RMS) respectively, with 160 dB referenced to 1 µPa RMS identified as the level above which there is likely to be behavioural disturbance. Compton et al (2007) recommends the latter as a preferable boundary for minimising disturbance, but acknowledges the difficulty of implementation given the distances from source required to achieve that threshold. Sound exposure level (SEL) is becoming more commonly used, and research should focus its effort on these issues. Unpublished research[8] from a recent Curtin University study indicates that for large acoustic source arrays (<3250 cubic inches), the maximum SEL is approximately 165 dB re 1 μPa^2-s at 1 to 1.5 km, and the maximum SEL measured at 200 m of large source arrays is approximately 174 dB re 1 μPa^2-s. These SELs are below the behavioural response/injury criteria (171/186 dB re 1 μPa^2-s respectively) for the most sensitive marine mammal group for in-water sound.[9] Hence, for both Level 1 and 2 surveys, the mitigation zones for all marine mammals provide an operational margin for larger arrays than those tested in the recent study.

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[6] Species of Concern, as listed in Schedule 2 of the Code, includes all New Zealand cetacean species except common and dusky dolphins, plus the New Zealand sea lion.

[7] High Energy Seismic Survey Team, 1999, High energy seismic survey review process and interim operational guidelines for marine surveys offshore southern California, California State Lands Commission and The United States Minerals Management Service Pacific Outer Continental Shelf Region.

[8] McCauley, R. 2012: pers. comm., Centre for Marine Science and Technology, Curtin University, Perth, W.A.

[9] Southall, B.; Bowles, A.; Ellison, W.; Finneran, J.; Gentry, R.; Greene Jr., C.; Kastak, D.; Ketten, D.; Miller, J.; Nachtigall, P.; Richardson, W.J.; Thomas, J.; Tyack, P. 2007: Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals 33*: 411–522.

2.6 Sound transmission loss modelling

The mitigation zone distances identified in the previous section should be considered minimums under the Code. Where particular sensitivities have been identified (such as key biological periods or shallow/enclosed waters), additional mitigation measures could include extending the radii of the zones and deploying additional observers on other vessels and possibly aircraft, or reducing power to ensure that sound levels are kept within limits that protect the various marine mammal species expected to be encountered. Operation in shallow waters could result in much larger mitigation zones being needed due to reduced transmission loss in shallow depths, but this is a highly complex area as temperature, salinity and seafloor structure and topography are also influencing factors.

Where survey operations are planned in AEI or MMS, sound transmission loss modelling must be a component of the MMIA. This is a process by which the potential sound levels generated by specific acoustic source configurations can be modelled and predicted over the range of physical environmental conditions expected during the survey.

The transmission distance of sound in seawater is determined by a combination of geometric spreading loss and an absorptive loss proportional to the sound frequency. The sound intensity decreases with distance from the sound source. Generally, the decrease in sound intensity ranges between $1/r$ (r = distance from the source) and $1/r^2$ (spherical spreading), depending on the characteristics of the sound source location and transmission paths. Due to the wave properties of sound and propagation conditions, waves from single and multiple sources can converge, reflect from the sea surface and sea floor, and can add to or cancel each other. Numerical modelling of sound transmission loss for seismic source arrays requires calculation of spreading, attenuation and wavefield interactions for each source in the array.

The results of such modelling should give an indication of the relative distances from the acoustic source over which 171 dB re 1 μPa^2-s SEL (behaviour criteria) and 186 dB re 1 μPa^2-s SEL (injury criteria) could be expected. Depending on the outcomes, if these levels are predicted to occur at greater distances than the relevant mitigation zones (Species of Concern with calves and Other Marine Mammals respectively), then additional mitigation measures such as just described must be discussed with the Department and considered for implementation.

2.7 Use of mitigation acoustics during line turns

The use of acoustic sources as mitigation is sometimes employed with the intent of continuing to exclude marine mammals during line turns, though it is unclear if there is sufficient evidence to draw any conclusions about the effectiveness of this practice. However, the objective of this Code is to reduce noise in the marine environment as much as practically possible.

Therefore proponents are strongly discouraged from using acoustic sources for mitigation purposes during line turns if practically possible, and instead to shut down at the end of a line and reactivate the acoustic source according to the applicable soft start procedures and pre-start observations. If it is considered to be necessary to employ acoustic sources for mitigation purposes during line turns only, power output should be limited to the maximum required to effectively ensonify the largest mitigation zone. Proponents must discuss and agree options with the Department as part of the MMIA process.

If acoustic sources are employed for mitigation purposes, it is important to collect appropriate data to monitor effectiveness.

2.8 Pre-start observations

During the review process several submissions proposed extending pre-start observation times to account for deep-diving species with extended subsurface durations. However, seismic survey vessels typically acquire data at a speed of around 5 knots, and will attain this speed for some distance in the approach to a survey line in order to keep the acoustic source and streamers positioned correctly. In 30 minutes at this speed the survey vessel would cover a significant distance of around 20 km. Extending the pre-start observation period does not provide any additional certainty that animals will actually be detected in the active survey area prior to activating the acoustic source.

The minimum 30-minute period stipulated is considered sufficient for the purposes of the Code in most circumstances,[10] especially when combined with Passive Acoustic Monitoring.

2.9 Incorporation of Passive Acoustic Monitoring

Passive Acoustic Monitoring (PAM), when used in conjunction with visual observations, has been shown to increase detections of marine mammals by between five to eight times, with significant numbers of animals heard but never seen.[11]

There are of course limitations, chief amongst them being that performance is entirely dependent on equipment, configuration and the expertise of the operator. It also relies on cetaceans actually vocalising, which can be variable between species or even among individuals, and results can vary enormously depending on the frequencies that each species uses. Variation can also occur due to environmental conditions. However, high quality, properly designed and optimised arrays with experienced operators can reliably detect many vocalising cetaceans over the range of mitigation zones[12] established in the Code. This could add significant value at a fraction of the total operating costs of a typical Level 1 survey.

The objective of making PAM a requirement of Level 1 surveys, and providing incentive for its use in Level 2 surveys through reduced pre-start observation requirements, is to facilitate greater investment in and use of the technology across the sector. Over time this will inevitably increase the accuracy, reliability and availability of PAM systems, as well as building the experience and expertise of operators.

Use of PAM technology in New Zealand continental waters is dependent on systems being designed specifically for acoustic detections over the range of vocalisation frequencies for New Zealand cetacean species. This includes both the frequency responses of the hydrophone elements and the (sound) data acquisition card technology. The hydrophone elements must be capable of monitoring the vocalisation frequencies of New Zealand cetacean species from 1 Hz–180 kHz, while the data acquisition card technology (sound

[10] For operations in AEI where particular sensitivities have been identified (such as the presence of deep-diving species with extended submerged periods), there is scope to consider deployment of additional observation platforms at the beginning of a survey line which could provide for increased pre-observation periods.

[11] Gillespie, D.; Chappell, O.P. 1998: Automated cetacean detection and monitoring. Chapter 8.1: pp. 1–6 in: Tasker, ML; Weir, C. (Eds): Proceedings of the seismic and marine mammals workshop, London 23–25 June.

[12] For species using ultra-high frequencies for echolocation, it may not be possible for current PAM technologies to detect cetaceans beyond a few hundred metres, even in optimum operating conditions.

cards) should be capable of sampling twice that, i.e. 360 kHz.[13] This range is sufficient to cover the highest frequency echolocation 'clicks' of Hector's and Maui's dolphins (>125 kHz) and bottlenose dolphins (>150 kHz), all of which are Species of Concern.

Based on industry and observer feedback, the Department is confident that optimally configured and operated PAM systems can significantly increase detections of vocalising cetaceans. Further, the Department considers that incorporation of performance-based PAM—with standards clearly articulated in the Code—is sufficient to allow seismic surveys to continue operating in poor sighting conditions.

However, it is recognised that the technology has not yet been developed to the stage of absolute reliability in all circumstances, and its incorporation is based on the best endeavours of suitably qualified and experienced operators.

2.9.1 Best practice recommendations

While not a requirement of the Code, it is highly recommended that vessel self-noise assessments are undertaken during mobilisation. This is in order to optimise PAM array configuration according to the specific noise characteristics of the vessel and equipment involved, and to refine expectations for distance/bearing estimations for New Zealand cetacean species during the survey. Copies of any vessel self-noise assessment reports should be included with the summary trip report.

The use of internationally recognised, industry standard, PAMguard[14] software is also strongly recommended best practice.

2.9.2 PAM alternatives

It is acknowledged that PAM is not the only technology available that can augment visual observations by increasing detection rates of marine mammals. Though PAM has some limitations, and its application is still being developed and refined, it is recognised as the most advanced technology that is commercially available and its practical operational value has been demonstrated when configured correctly and a skilled operator is employed. However, proponents may propose alternative technologies for consideration by the Director-General, providing they can demonstrate with confidence that the substitution will perform at least as well as—if not better than—the best available PAM systems without significantly increasing negative impacts on marine mammals. Such alternatives could also be considered to supplement PAM and MMO observations.

2.10 Qualified observers: performance, training and standards

If observer experience alone is relied upon as an indicator of capability, there is a danger that there could be significant variability in the accuracy of observations and utility of data records. Observers are responsible for decisions that have significant impacts on operations, so it is critical that robust and defensible methods are employed. Furthermore, without an understanding of basic navigational principles, valuable information about animal responses to seismic survey operations could be overlooked. For example, if vessel movement is not accounted for appropriately, marine mammal reactions as indicated by movement relative to the acoustic source could be completely misinterpreted.

[13] Sampling range determined in accordance with Nyquist Theorem.

[14] PAMguard is open source software, developed as world standard and supported by E&P Sound and Marine Life Joint Industry Programme (JIP) of the International Association of Oil and Gas Producers.

The primary purpose of requiring qualified observers onboard is to ensure operational compliance with the mitigation measures specified in the Code. However, an objective of the Code is to increase knowledge of marine mammal behaviour by acquiring verifiable data through robust observational techniques. Therefore, the focus is not just on compliance, but also on science, where every survey is seen as an opportunity to build understanding about New Zealand marine mammals. In order to achieve this, observer performance needs to be standardised and competence demonstrated.

Therefore, as a separate initiative supporting implementation of the Code, the Department is involved in ongoing work with stakeholders to develop and review observer training and competence standards. Performance is outcome-based, so that experienced observers can simply demonstrate competence rather than having to complete unnecessary training.

In addition, there is a requirement for qualified observers to have 12 weeks' relevant sea-time in New Zealand continental waters, in order to gain experience with identification and behaviour of the region's particular species.

The Department recognises that this could initially cause resourcing bottlenecks, and as a result has implemented interim measures (see below) which add a degree of flexibility if difficulties are experienced sourcing suitably qualified observers. It is anticipated that as the number of qualified observers increases throughout the three-year duration of the Code, resourcing will not be an issue by the time mandatory regulations are considered.

Standardising the reporting format for observers to record and submit marine mammal sighting and behaviour information is a critical element to ensure that data utility is maximised. Linked with the training initiative, the Department is also working with stakeholders to develop user-friendly observer reporting datasheets which include all information relevant to the Code. The initial outcome of this work is an Excel-based template that will be subject to continuing refinement throughout the duration of the Code, based on feedback from observers using the reporting form in operational conditions.

In addition, the Department is undertaking a review of its marine mammal database system, and there is ongoing work to develop spatial planning resources to support effective marine resource management processes.

2.10.1 Interim provisions for training and experience

It is recognised that allowance needs to be made for newly trained observers or those without experience in New Zealand continental waters to gain the 12 weeks' sea-time required to be considered qualified observers. In such instances, providing an agreement is in place for an appropriately qualified observer to act in a mentoring capacity to a trained observer for the duration of a voyage, it is acceptable for there to be one qualified observer and one trained observer in each observation role (MMO/PAM) on board.

It is also acknowledged that the new observer requirements may create resource or training bottlenecks for surveys being planned in New Zealand continental waters after the Code is implemented. To minimise impacts, for the first 12 months after this Code comes into effect, MMO with 3 years' professional experience and a minimum of 12 weeks' relevant international sea-time may be engaged if no other suitable qualified observer is available. To reflect the limited availability of suitably qualified and experienced PAM operators, for the entire duration of the Code, PAM operators with 3 years' professional experience[15] and a minimum of 12 weeks' relevant international sea-time may be engaged if no other suitable qualified observer is available.

[15] Due to the relatively recent emergence of PAM technology, it may prove difficult to locate suitable operators with 3 years' experience. In such circumstances, the proponent should contact the Director-General to discuss possible alternative options.

Such observers will still be expected to perform to the standards outlined in this section, and their inclusion should be supported by provision of current curriculum vitae and professional references that demonstrate suitable experience, qualifications, training and abilities.

2.10.2 Training providers and observer courses

In conjunction with stakeholders the Department has developed a high level model curriculum for MMO and PAM operator training courses (see Appendix 1). Observers successfully graduating from training courses that are structured according to the model curriculum are expected to be able to demonstrate competency in each specified area as a minimum, and as such would be considered 'trained observers' for the purposes of the Code.

Though the Department will not be involved in official accreditation of educational organisations, it will review course material developed by established training providers for MMO and PAM operators in the context of the standards articulated in the Code. Training providers are encouraged to submit comprehensive descriptions of course content, assessment/examination processes, personnel involved, resources and equipment, for confidential evaluation. The Director-General will subsequently indicate whether such courses are considered suitable and adequate to ensure observer competencies that are consistent with requirements of the Code, and whether the experience and qualifications of those directly involved with training are acceptable for the role.[16]

As part of the recognition process, the Department reserves the right to nominate a relevant member of staff to attend any observer training courses in order to evaluate content and delivery. The Department will meet any necessary travel costs, though training providers are expected to make space freely available on their observation courses for such evaluation purposes. The Department also reserves the right to review training provider records related to administration and assessment/examination processes of recognised observer courses at any time.

Details of recognised courses will be published on the Department of Conservation website.

[16] It is essential that tutors have relevant scientific/technical background according to the modules they are presenting. At least one person with significant experience working in an observational capacity offshore, such as lead MMO/PAM operator or equivalent, should be available to offer practical perspectives from direct, personal experience.

3. Acknowledgements

3.1 Stakeholder participation

The Department of Conservation would like to thank all those individuals and organisations who took the time to provide submissions and contribute to the review process. We are especially grateful to those who participated in the various working and review groups for their significant efforts.

The Department would also like to specifically acknowledge the following participants:

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Carolyn Barton, Observer Training Specialist, UK

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Appendix 1: Observer training courses—Model curriculum

1. Background

It is expected that two separate courses would be developed depending on whether candidates were seeking to become marine mammal observers (MMO) or Passive Acoustic Monitoring (PAM) operators. These would feature common areas for both categories of observer as well as more detailed requirements for each discipline. However, since the two roles are complementary it is important that any person acting in a particular observational capacity (either MMO or PAM) should have an understanding of the basic concepts of each other's discipline. Therefore, the MMO course needs to include a theoretical module with key introductory information about PAM operation, and vice-versa. Candidates seeking to qualify as both MMO and PAM operators would not need to repeat common modules; indeed, training providers may opt to develop integrated courses that provide full instruction in each discipline.

It is anticipated that the time requirements for these courses could be of the order of two weeks. Courses must include relevant practical instruction in field conditions, with formal assessment of competency through examination, and may potentially be conducted anywhere in the world providing relevant standards are met.

Where appropriate, theoretical subject matter could be taught and assessed online or by other remote learning in advance of the practical components. This could facilitate more convenient, cost-effective and timely educational processes.

For experienced observers, it may only be necessary to demonstrate competence through the examination process. This could be enhanced by development of an intensive workshop of comparatively limited duration (1–3 days), completed immediately prior to examination.

1.1 Tuition staff

It is important that those responsible for delivery of training have relevant qualifications, background and experience in relation to the components they are teaching.

This is particularly relevant for subjects related to observer duties and performance. Those engaged to provide training in these areas should be able to demonstrate significant offshore experience, as lead MMO/PAM operator or equivalent.

1.2 Training objectives

The objective of these observer training courses is to ensure that trained observers can meet the standards articulated in the Code when they are engaged in their respective professional capacities on marine seismic surveys. The relevant standards are as follows.

2. Observer standards in the Code

Those successfully completing observer training courses and passing the assessment process are expected to be able to perform to the following standards as a minimum.

2.1 MMO standards

The standards for being considered a trained marine mammal observer include demonstrating proficiency in the following areas as minimum requirements:

- Understanding mitigation and reporting requirements under the Code
- Measuring distance, true speed and direction of travel of marine mammals and vessel movement
- Navigation (e.g. true vs magnetic north, course vs heading)
- Plotting positions of marine mammals in relation to vessel and acoustic source
- Detection and identification of New Zealand marine mammal species, and behaviour/activity assessment
- Understanding relevant aspects of seismic survey operations

While engaged in observation duties onboard seismic survey vessels, qualified marine mammal observers are expected to be able to use the following tools effectively:

- Reticle binoculars and/or sextant for medium- to long-range (>500 m) distance determinations
- Measuring sticks (in addition to sextant or reticle binoculars) for short-range distance determinations
- Angle boards and compass for bearing determinations from vessel
- GPS to record vessel coordinates accurately and download track logs

2.2 PAM operator standards

The standards for being considered a trained PAM operator include demonstrating proficiency in the following areas as minimum requirements:

- Understanding mitigation and reporting requirements under the Code
- Optimised deployment, and configuration of PAM equipment to ensure effective detections of cetaceans for mitigation purposes
- Detection and identification of vocalising species or cetacean groups
- Measuring distance and bearing of vocalising cetaceans while accounting for vessel movement
- Navigation (e.g. true vs magnetic north, course vs heading)
- Plotting positions of cetaceans in relation to vessel and acoustic source
- Understanding relevant aspects of seismic survey operations

3. Subject area headings and content

Training courses should enable prospective MMO and PAM operators to demonstrate competence in the following areas (not appearing here in any particular order) according to the standards articulated in the Code, as a minimum.

3.1 New Zealand law and requirements of the Code

1. Marine Mammals Protection Act 1978
2. Marine Mammal Sanctuaries
3. Primary objectives of the Code:
    - Minimise disturbance to marine mammals from seismic survey activities
    - Minimise noise in the marine environment arising from seismic survey activities
    - Contribute to the body of scientific knowledge on the physical and behavioural impacts of seismic surveys on marine mammals through improved, standardised observation and reporting
    - Provide for the conduct of seismic surveys in New Zealand continental waters in an environmentally responsible and sustainable manner, and
    - Build effective working relationships between government, industry and research stakeholders
4. Key features of the Code:
    - Recognition of three levels of surveys depending on scale and potential effects determined by the notified operational capacity of the acoustic source array
    - Specific mitigation measures for Level 1 and 2 surveys for marine mammal groups according to sensitivity, with three defined 'mitigation zones'
    - Increased focus on notifications of surveys to provide for pre-survey planning engagement with departmental officials
    - Requirements for Marine Mammal Impact Assessments (MMIA) covering entire operational area to be submitted to the Director-General
    - Sound transmission loss modelling required as part of the MMIA for operations in Areas of Ecological Importance or Marine Mammal Sanctuaries, with scope for additional mitigation measures as specified by the Director-General
    - Requirement for two qualified and independent MMO, and two qualified and independent PAM operators, on all Level 1 surveys
    - Requirement for two qualified MMO on all Level 2 surveys
    - Requirements for operating in poor sighting conditions or at night, or in new areas within the survey
    - Provisions for marine mammal observations at all times while the acoustic source is in operation
    - Limitation of individual observer effort to 12 hours in any 24-hour period
    - Development of observer training, performance and reporting standards
    - Expanded recording and reporting requirements, including data on all marine mammal observations, regardless of location
    - Recommendation to consider impacts on other marine species and habitats at the planning stage, and to record observations where possible
    - Prohibition on the use of explosives as acoustic sources, and
    - Focus on industry responsibility for research
5. Application of the Code, New Zealand continental waters
6. Acoustic source capacity vs underwater sound

3.2 Trained vs qualified observers

1. 12 weeks' New Zealand experience
2. Mentoring
3. Interim provisions

3.3 Role of the qualified observers

1. Compliance and science (noting the primary purpose of ensuring operational compliance with the Code)
2. Effective communications between observers and crew (establishing within the 'Chain of Command', agreeing detection/mitigation procedures with Party Chief or other seismic crew and between MMO/PAM)
3. Briefings
4. Authorities
5. Duties
6. Effort
7. Working with and positively influencing crew
8. Alternative deployment in fleet
9. Crew observations
10. Standardised data collection
11. Mitigation zones
12. Pre-start observations (new location, good vs poor sighting conditions/night)
13. Delayed starts and shutdowns
14. Reporting
15. Managing commercial pressures and onboard conflicts
16. Maintaining MMO effort during safety drills
17. Professional behaviour

3.4 New Zealand marine mammal species

1. Taxonomy
2. Identification
3. Distribution
4. Ecology
5. Habitats
6. Behaviour (including guidance on defining behaviour and understanding variability)
7. Marine mammal acoustics
8. Sensitivities to acoustic disturbance
9. Areas of Ecological Importance and possible additional mitigation measures[17]
10. Operational issues (Species of Concern and Other Marine Mammals)

[17] Further measures may include, for example, additional observers or observation platforms, aerial observation, acoustic source power restrictions, extending pre-start observations for deep-diving species, deployment of static PAM equipment in sensitive areas, or designing the survey so as to avoid trapping marine mammals in confined areas such as narrow, constricted seaways.

3.5 General seismic operations overview

1. Purpose of seismic surveying
2. Terminology
3. Types of survey (2D, 3D, 4D, OBS, VSP)
4. Operational procedures and equipment
5. Testing (e.g. drop, bubble)
6. Ramp up/soft start procedures
7. Line turns/mitigation guns
8. Onboard systems (e.g. RobTrack, Orca, among others) and interpretation of data displays (e.g. navigation screens)
9. Chain of Command onboard (including necessity of establishing communication protocol between qualified observers and Party Chief or other appropriate crew)

3.6 Vessel health and safety

(This module is a not intended to replicate any areas that would normally be included in offshore survival or emergency training required by industry for offshore operations, such as BOSIET or STCW.)

1. Overview of vessel operations
2. Personal safety
3. Emergency procedures
4. Personal protective equipment
5. High voltage systems (for PAM operations)
6. Industry requirements for appropriate offshore survival and medical fitness certificates
7. Writing, reviewing and modifying risk assessments and procedure documents

3.7 Navigation

1. Basic vessel navigation principles (heading, course, true speed etc)
2. Compass use (including magnetic deviation and variation)
3. Positions in relation to moving vessel and acoustic source
4. GPS use, format, units, downloading (track logs) and accounting for GPS antenna position in relation to acoustic source
5. Plotting positions, projections, track logs, transferring true plots to report form

3.8 Weather and environmental conditions

1. Sighting conditions (outlining potential effects on ability to observe/detect marine mammals, and relevance of collecting information of direct relevance to data use)
2. Beaufort sea state
3. Cloud cover
4. Swell/wave height (for the purposes of the Code, crest to trough)
5. Wind strength
6. Visibility

3.9 Visual observations

(This module must be in comprehensive detail for MMO course, though only a conceptual outline is required for PAM course. The MMO course must include practical instruction in vessel-based field operating conditions, with ground-truth testing of participant distance/bearing estimations.)

1. Standards in the Code
2. Watch-keeping (including use of optimum vantage points with unimpaired vision, scanning techniques, right-to-left observation method, detection procedures, fatigue management, avoiding distractions)
3. Sextants (lightweight plastic Davis Mark 15 or alloy Astra IIIB recommended as minimum for operational use in field conditions)
4. Reticle binoculars (including 'mil' scale standardisation)
5. Measuring sticks
6. Eye estimations
7. Angle boards and compass use
8. Accounting for height of observer
9. Accounting for distance to acoustic source
10. Estimating mitigation zone boundaries on the water in relation to the acoustic source
11. Thermal imaging and high resolution digital photography[18]
12. Other technologies[19] (including practical limitations, e.g. laser range-finders, infra-red)
13. Use of marine mammal identification keys
14. Recording initial and subsequent behaviour
15. Benefits of using dedicated hand-held GPS units to assist visual observations

3.10 PAM operations

(This module must be in comprehensive detail for PAM course, though only a conceptual outline is required for MMO course. The PAM course must include practical instruction on at least one PAM array[20] deployed from a vessel in field operating conditions.)

1. Standards in the Code
2. Importance of bioacoustician training and experience in system design and set-up
3. Static and towed systems
4. Array design (appropriate broadband element frequencies, relevant sound data acquisition frequencies for New Zealand species, Nyquist Theorem)
5. Single vs multiple strings
6. Redundancy
7. Left/right ambiguity
8. Commercially available systems (e.g. Seiche, MSeis, Vanishing Point, Ocean Science Consulting, outlining operational features, specifications and differences)
9. Deployment and optimisation (in relation to specific circumstances of vessel and seismic array)

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18 May be theory only.

19 May be theory only.

20 A theoretical introduction to the key functional/operational characteristics of the range of common, commercially available equipment is required. However, reflecting the practical difficulties of providing access to multiple technologies, competency need only be demonstrated on a single system deployed from any suitable vessel.

10. Calibration and testing
11. Software (notably industry standard PAMguard recommended, but also IFAW, Ishmael, RavenPro, Logger, others as appropriate) including practical instruction on key features
12. Operation
13. Detections (monitoring, software-aided)
14. Acoustic sample analysis and filtering
15. Saving data (techniques to assist operations, automatic saving, buffering, or for reporting purposes)
16. Identification of species or cetacean groups
17. Distance/bearing estimation (including factors affecting variability) and plotting positions
18. Calibrating detections with visual observations
19. Watch-keeping (including 'listening' techniques, detection procedures, fatigue management, distraction management, maintaining focus on detections)
20. PAM alternatives
21. Limitations of PAM technology
22. Simulation-modelling software
23. Importance of ongoing training
24. Vessel self-noise assessment
25. Pre-survey planning (clearly define objectives of PAM, determine species of particular interest/concern, identify appropriate mitigation zone performance expectations, determine process for calling for a PAM-initiated shutdown)

3.11 Recording and reporting

1. The standardised New Zealand report form (Excel-based)
2. Units
3. Determination of 'confidence' in identification (underlining need for realistic assessment of certainty, and resisting the tendency/pressure to assign a positive identification without having high confidence)
4. Operations
5. Effort
6. Recording sightings 'On-survey' (while acoustic source is in the water in the operational area) and 'Off-survey' (at any other times)
7. Marine mammal sightings
8. Other sightings
9. Differentiating data on New Zealand fur seals for practical efficiency
10. Acoustic source activities, including exceeding notified operational capacity
11. Generating pivot tables within the standard New Zealand report form for daily, weekly and trip reporting (opportunities, functions and advantages)
12. Submission of summary trip report
13. Submission of raw data sheets

14. Requirement to inform DOC immediately if higher numbers of cetaceans/Species of Concern encountered than indicated in Marine Mammal Impact Assessment
15. Reporting non-compliance (both immediate requirements and in the summary trip report)
16. Communicating with Department of Conservation to ascertain correct measures in instances of ambiguity or uncertainty
17. Maintaining personal records/log books for training, qualifications and sea-time (signed off by vessel masters)

3.12 Assessment/examination

1. Demonstration of competence in all above areas
2. Trained observers recognised for results of 75 per cent and above
3. Reassessment procedures for those initially scoring less than 75 per cent
4. Certification/personal log book stamp

3.13 General observer issues

(Optional module, but seen as potentially adding significant value.)

1. Living and working offshore (practical advice for life onboard a commercial vessel, e.g. facilities on board, shop, gym, laundry, library, luggage weight limits, internet access, communications to shore)
2. Appropriate personal conduct on board
3. Other potential observer roles outside the scope of the Code (non-seismic activities, e.g. pile driving, offshore renewable energy projects, navy sonar testing, well head removal and use of demolition explosives)
4. Benefits of joining a professional industry association for ongoing support, mentoring, professional/career development. Key benefits may include:
    - Providing a means for employers to identify observers
    - Representation of member interests to industry
    - Working with regulators to represent member interests
    - Providing a platform to bring independently working observers together as community, where experienced observers can discuss or highlight any issues they encounter, give or seek advice from other members, and for networking
    - Providing a central information directory for resources such as research papers, guidelines, PAM, or training courses to support observation work