Report of the Marine Mammal Observer/Passive Acoustic Monitoring Requirements Technical Working Group

Part of the 2015–2016 Seismic Code of Conduct Review process

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Te Papa Atawhai

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Preface: background to the Technical Working Group

The review of the Code

In 2012, the Department of Conservation (DOC) developed a voluntary Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations ('the Code'), in consultation with international and domestic stakeholders representing industry, operators, observers and marine scientists. The Code (and its supporting reference document) aims to provide effective, practical measures to minimise the acoustic disturbance of marine mammals during seismic surveys. It was updated in 2013 after being incorporated by reference into the Exclusive Economic Zone and Continental Shelf (Environment Effects – Permitted Activities) Regulations 2013 ('the EEZ Regulations'; see SR2013/283).

At the time the 2012 Code was implemented, DOC committed to the Code being reviewed after three years. Accordingly, the review of the 2013 Code began in July 2015, with a request for feedback from numerous stakeholders (the Seismic Code Review Group; SCRG). In August 2015, this feedback was combined with that obtained during the three years since implementation.

Role of the Technical Working Groups

In August 2015, DOC established nine technical working groups (TWGs) to address the technical issues raised in the feedback and to provide expert advice on the most suitable methods for addressing them. It was intended that DOC would then draw on this advice when redrafting the Code. The TWGs were:

1. Marine Mammal Observer/Passive Acoustic Monitoring Requirements
2. Marine Mammal Observer/Passive Acoustic Monitoring Observer Data
3. Marine Mammal Impact Assessments/Marine Mammal Mitigation Plans
4. Consultation Requirements for Operators
5. Sound Propagation and Cumulative Exposure Models
6. Acoustic Ground-truthing
7. Non-Standard Surveys
8. Non-Commercial Surveys
9. Biologically Relevant Sound Levels

The work of these TWGs was supplemented by two workshops that were co-hosted by DOC in association with scientific conferences in 2015, to discuss the appropriate mechanisms to facilitate the integration of methodological and technological advances into the revised Code.

The nine TWGs worked until January 2016 to provide feedback on the issues assigned to them. This is the report of the first TWG: Marine Mammal Observer/Passive Acoustic Monitoring Requirements.

Scope of work for the Marine Mammal Observer/Passive Acoustic Monitoring Requirements TWG

Provisions of the Code pertaining to visual and acoustic monitoring lack sufficient detail. Several elements relate to required levels of training, qualifications and experience, and specified limits for hours on duty. Concerns were raised about the length of swing[1], with observers being asked to work multiple swings back-to-back (ie more than 10 weeks in a row of 12-hour days, 7 days a week). The potential for excessively long work periods for MMO or PAM operators was noted due to the long length of days and nights at different times of the year.

This TWG was asked to determine the most suitable shift lengths for marine mammal observers (MMOs) and passive acoustic monitoring (PAM) operators, as well as the total length of a day. During deliberations of duty hours, the TWG were asked to consider the time required to effectively complete non-monitoring required tasks, such as data entry, report completion, gear maintenance etc., while factoring in rest periods.

This TWG was also asked to consider if basic requirements should be implemented for the equipment used by MMOs and PAMOs. Key questions include:

- Whether all MMOs should be required to use reticulated binoculars of a certain magnification or greater
- What requirements should be established for PAM equipment and settings
- Location of PAM equipment and MMOs

The output of this TWG will be combined with that of the MMO/PAMO Data TWG to advise DOC and the Steering Group on Code elements relating to mitigation zone maintenance, animal detection, MMO/PAMO duties and reporting requirements. Advice will be delivered in the form of a report containing two or more options (where appropriate) for addressing the specific issues in this subject area in the Revised Code.

This report represents the advice from the TWG on how DOC might address the various issues in this area within the Revised Code.

Specifically, the TWG has:

1) Considered the balance between providing MMO and PAM operators for all surveys and limiting the total maximum and consecutive working hours to support their effectiveness
2) Provided suggestions for minimum standards or requirements for MMOs and monitoring equipment, including deployment periods and locations

[1] A 'swing' is the term used for a part of a survey that is completed between two scheduled port visits as limited by fuel and other supplies. In New Zealand, this is often approximately a 5-week period.

3) Provided suggestions for minimum standards or requirements for PAM operators and monitoring systems, including deployment periods and location, as well as any associated ship-noise requirements
4) Provided options for possible mechanisms to incorporate alternative monitoring or mitigation methods into the Code
5) Reviewed existing qualification, training and experience requirements for MMOs and PAM operators
6) Delivered opinions on where details of New Zealand-specific Code-related mitigation elements and reporting requirements should be included in the training process, and whether this should be a separate course from more generic MMO/PAM operator training
7) Provided opinions on the current limitations of PAM and visual observations for detecting species of concern (SoC), and calves, with consideration of handling any related uncertainty when initiating mitigation triggers (eg for shut downs)
8) Given opinions on the need for species-specific (or species-group specific) minimum standards for MMOs and PAM operators, including equipment and species-relevant settings and scan protocols
9) Considered ways to improve the estimation of distance to animal from the observer (or PAM system)
10) Provided opinions on exactly when MMO and PAM should be required, considering periods of transit, inclement weather, survey-gear maintenance, crew swaps, etc
11) Presented options to identify and deal with trained/qualified observers who perform poorly and need remedial training.

Part 1: Introduction

1. This report offers advice for addressing known Code issues related to maintaining effective MMOs and PAM

The aim of this TWG was to provide options and recommendations for revising the requirements within the Code, to improve the effectiveness of MMOs and PAM operators (and the mitigations they support) while limiting their total maximum and consecutive working hours.

The TWG was asked to consider several issues pertinent to MMO and PAM operator effectiveness. These included the:

- Length of swing and multiple back-to-back swings
- Equipment and deployment, particularly for PAM systems
- Allowance for the incorporation of new technologies
- Training and qualification for MMO and PAM personnel, observer performance and career development, and communication and reporting

The group was also asked to provide opinion and recommendations on when MMO and PAM should be required, considering periods of transit, inclement weather, survey gear maintenance, and crew swaps.

This report is structured around a number of issues that were initially raised during a workshop held on 6 August 2015. These issues have been grouped into related topics and recommendations have been provided on how DOC can address and implement the advice provided by this working group in each area.

Part 2: Fresh and effective MMOs and PAM operators

2. Shift length and fatigue management

Most of the TWG members agreed that shift length and fatigue are issues to be addressed under the Code. Effective monitoring is not possible without well-rested individuals (MMO and PAM). The current expectations under the 2013 Code result in very long shifts.[2] MMOs (including one member of this TWG) stressed that the observation hours currently expected by DOC are unrealistic, despite the current Code stating that no observer will work more than 12 hours per day. Team leaders frequently work more than this, and it is not practical to observe and monitor effectively for the amount of time currently expected. Motivation was also a concern, but the TWG was unclear on how this could be addressed under the Code.

Implementation of effective shift lengths depends on the observer team and will probably vary by survey. It is therefore unlikely that effective team management can be achieved by defining hours. There was little desire from this TWG for the Code to be overly prescriptive; however, the TWG did suggest that guidance on the options for shift management could be helpful. An easy way to alleviate some of the pressure is to require monitoring only when the source is active and/or on pre-shoot watches. However, continual monitoring gives the seismic operator more operational flexibility (provided that maximum working hours are not reached), as they will always be considered to have conducted a pre-shoot watch.

Shift length and fatigue management issues for MMOs and PAM operators are addressed in sections 2.1–2.3 below.

2.1 Marine Mammal Observers (MMOs)

It was noted that the current Code does not define 'Marine Mammal Observer'. However, the Code calls for two qualified MMOs to be on board at all times, and a minimum of one observer to be on watch during daylight hours. Where possible the Code recommends the two observers be on watch for all pre-start observation periods and other key times (which would also need to be defined, ideally in order of importance). To sustain such requirements for the entire cruise, enough MMOs must be present: a minimum number of MMO/PAM operators should be established.

An observer team with enough MMOs allows for:

- Flexible shifts
- The opportunity for observers to manage their own fatigue and that of their team members

[2] One PAM operator per 12 hours, two MMOs for all daylight hours and always on duty when the source is in the water (whether active or not).

- Effective visual observations

Some TWG members argued that one option is for the Code to require that two (2) MMOs are active at the same time, as this has been shown to improve detection rates as well as allows for less-experienced MMOs to rotate through with more experienced personnel. With two MMOs always on duty, continuous monitoring during a marine mammal sighting is possible while the other observer could perform the data entry (use of digital recorders or similar recording devices may make this point less important). While already common practice elsewhere, other members argued against adding to the standard MMO team in New Zealand as:

- Costs and health and safety exposure would increase
- Extra personnel may also not be practical, or needed on some vessels
- There could be wider implications for crew composition (by requiring others to be substituted)

Another option presented was to define the minimum number of active observers and the maximum shift length, leaving the proponent to balance these for their survey. The MMIA would dictate the practice for each project, and DOC could inform the operator when extra staffing is needed. It was noted that good fatigue management is most effective when there are enough staff to allow for adequate monitoring, although some noted that the Code may not be the appropriate mechanism for ensuring this. For example, for MMOs a maximum of 16 hours' daylight can be covered by three observers, if it was expected that two observers would always be on duty (whether the source is active or not). Three observers, for instance, would allow a maximum four-hour rotation with two observers always on duty, as well as time to fulfil other duties (eg data entry and reporting).[3]

As it stands, shift rotations are generally set by the team leader of the swing and thus may differ considerably, which risks the preferences/capabilities of other observers on the team not being taken into account. This may be particularly so for observers inexperienced in long shifts (eg where one MMO may be able to observe effectively for 4 hours, a less experienced observer may only be able to handle a 2-hour shift). Good coaching (and responsible oversight) of the team by the lead MMO will be important; this is only possible if team leaders are trained to control shift lengths to manage team fatigue. This assumes there are already sound requirements for training team leaders and their team in work ethics, and that of their team members and other personnel on the vessel. It is also important that shift-length decisions are made primarily for the observers rather than clients (ie the seismic survey company).

2.1.1 Mechanisms for improving effective shift-length and fatigue management for MMOs

Changes to the Code to improve shift length for MMOs (to ensure good performance) and increase observer effectiveness, should be considered. The TWG identified

[3] Such deployment protocols have been implemented elsewhere, with all-male or all-female MMO teams reducing the logistic burden on the seismic operators. However, the practicalities of deploying a three-MMO team on a smaller survey vessel would still need to be considered.

several non-exclusive options for the revision of the Code, with the most effective and practical to be progressed. Not all were supported by all members. The options are set out below.

2.1.1.1 Non-consensus suggestions

- One MMO be required at all times, with two MMOs active during certain phases when important (eg around sanctuaries, during pre-start and soft start, or when the source is active).
- As standard, three MMOs should be deployed on seismic vessels. This would allow two MMOs to be visually scanning at any given time. However, some TWG members noted this is logistically difficult on smaller vessels; they suggested that any requirement should be generally practical, or not progressed. It is more practical to provide a minimum and require more when appropriate, than to provide a higher minimum but allow fewer MMOs (with a waiver) when it is not practical.
- Two active MMOs should be required at all times, supported by a third MMO who should be responsible for data collection.
- Some TWG members noted MMOs should not work shifts longer than four hours, and for no more than 12 hours in any 24-hour period; others noted the logistical difficulties in ensuring this.
- Some TWG members suggested provisions be made for enough rest for all MMOs even in mid-summer when there are longer hours of daylight, while others suggested this would lie outside the Code.
- A shift template might be a useful guide for teams providing options on how to better organise shifts in relation to HSE and fatigue management.

2.1.1.2 Consensus recommendations

- The TWG agreed there should be flexibility for observers to take a break when the source is inactive (eg during line-turns or periods of poor weather) and when the source is likely to remain inactive for some time.[4] However, the duration of breaks will also contribute to rest quality. There are two related points:
    - This flexibility is particularly important for periods when daylight hours are long.
    - The benefit of having alert observers at critical times (eg before ramp up and during operation) outweighs collecting data during turns or longer periods where the array is not active. This cannot be stressed enough.
- The TWG agreed individual observers should be able to decide if they can work multiple swings/deployments back-to-back without a break. However, before providing flexibility, it is worth reviewing the existing dataset for trends in

[4] The BPM report noted that sources are inactive around 50% of the time.

effectiveness of observations over time to examine if how well individual perceptions of their capabilities match reality.

2.2 Passive Acoustic Monitoring operators (PAM operators)

Currently the Code calls for two PAM operators, who will generally each take a 12-hour shift to ensure that PAM systems are monitored for a full 24-hour period. Meal breaks are only possible if MMOs are available to cover for them, and only (in theory) if these MMOs have suitable training and experience to cover the PAM operators' duties.

Detection is affected by both the acoustic behaviour of marine mammals and background noise – resulting in both false positives due to misclassification of signals, and false negatives due to masking. PAM deployment and settings may also influence the capabilities of the system for detecting different species. The effectiveness of a PAM system is limited by the operator's abilities, as much as by any state of fatigue.

The 12-hour shifts expected of PAM operators are the most restrictive under the current Code, particularly for operators on overnight shifts who generally have no relief for extended periods of time. This is less the case during daylight hours when MMOs are awake and (potentially) able to relieve the on-shift PAM operator. PAM operators' most common complaint is that they cannot come off shift even during line turns – when no acoustic source is operating and no testing or soft start is immediately intended. PAM operators breach the Code even if they leave their station to go to the toilet. The Code therefore needs to address PAM operator shift lengths, to ensure PAM is being effectively implemented by the mitigation team while operators are not too fatigued.

The merits of relying exclusively on PAM at night were discussed. Although some felt PAM's limitations were overstated,[5] others felt the available evidence suggested PAM currently has a limited capacity to detect baleen whales, and can only detect high-frequency cetaceans at very close range. Despite this disagreement, if the limitations are confirmed, this would mean that many cetaceans may enter the mitigation zone at night undetected. Even if some animals respond to approaching seismic vessels by moving away, such responses are highly contextual and not universal.

Restricting shooting to daylight hours will, however, substantially disrupt operations – and increase the total amount of sound introduced, as overlaps will be needed to complete half-finished lines. It will also spread the impact over a longer period in one area and increase the risk of overlapping with other activities. These problems have unknown implications for total impact from any single survey or the cumulative impacts of human activity on the population.

[5] It was argued that PAM is currently the only technique capable of detecting marine mammals at night.

2.2.1 Mechanisms for improving effective shift-length and fatigue management for PAM operators

There were several suggestions by TWG members to address these issues.

2.2.1.1 Non-consensus suggestions

- Some TWG members consider there may be a need to restrict surveys at night to reduce risk to animals and to give PAM operators a break. Given the additional issues with PAM at this time, as discussed in sections 4 and 8, they suggested that seismic survey activity should not be allowed at any time during darkness. Other members noted the operational implications of this would be restrictive to industry, and questioned extending the overall duration of a survey.
- A suggested compromise between operational needs and the welfare both of PAM operators and of marine mammals, was to allow an operator to complete a line after sunset, provided the required pre-shoot watch and ramp-up had already been completed. In this case, an operator would not be able to initiate a new line in darkness. This is similar to the situation implemented in the Canadian Arctic for seismic surveys around feeding groups of bowhead whales. However, some TWG members strongly opposed this, due to operational restrictions and increasing the total length of time sound is present in the area.
- It was argued that allowing the PAM operator to take a 5-min break does not appreciably lower detection rates for PAM, which already has a generally low detection rate. However, others in the TWG noted that this logic was strained and that improvements in PAM may undermine this logic in the future, so it should be applied carefully.
- The number of PAM operators onboard could be increased to ensure that PAM operators can take meal and refreshment breaks without leaving the PAM system unmonitored.
- A solution to the restrictive PAM rotations could also be to use remote PAM services.
- It should be clarified that PAM operators may go off-duty when no source is operational (eg on line turns or in very bad weather). However an open line of communication should be kept with the PAM operator on duty at all times.

  Moreover, some TWG members noted that this would allow PAM operators to take breaks without affecting their monitoring and mitigation. However, as airgun inactivity can, in some cases, be unpredictable in timing and length, PAM operators may still be on duty for long durations. They also argued that, without PAM effort for periods of gun inactivity, any subsequent attempts to draw detection comparisons to assess mitigation effectiveness from the data are reduced as there is no 'control' period for comparison.

2.2.1.2 Consensus recommendations

The use of personnel fully trained in both PAM and MMO is encouraged, to allow much greater flexibility to cover shift gaps, as already stated in section 3.8.1 of the 2013 Code. The TWG also recommend all marine mammal monitoring and mitigation team staff be trained in both visual and acoustic monitoring; this would shorten PAM shifts to less than four hours by allowing staff to rotate through MMO and PAM positions. This may conflict with the current DOC requirements for trained and qualified personnel specifically for these positions – but few implementational problems are expected as many MMOs are also trained and experienced PAM operators. However, PAM operators would need to have undergone the MMO training and have sufficient experience to work in New Zealand waters.

This suggestion could be implemented by allowing short breaks of 15–30 minutes where the PAM operator is replaced by a suitably trained MMO. This may already occur on surveys in New Zealand waters; however, we would stress that any MMO team member covering the PAM operator should be trained and experienced in the specific PAM system on board.

This system would also allow PAM operators to undertake visual observations, breaking the monotony of the PAM position – refreshing team members, alleviating fatigue and mixing team duties.

A PAM operator relieved of duties by an MMO team member should remain on-call to deal with any PAM system issues.

2.3 MMO and PAM operator team size and monitoring requirements

The TWG discussed the total observer team size at length, noting the balance between the operational limitations of smaller survey vessels and the need for effective monitoring. The resulting suggestions are outlined below.

2.3.1 Non-consensus suggestions

- Some in the TWG felt that there should be at least five observers/operators on board, unless agreed otherwise with DOC, with two dedicated PAM operators and three MMOs. At least one of the MMOs should (if possible) be fully trained in PAM and capable of covering for a PAM operator.
- Others felt there should be at least four observers/operators on board, unless the pre-survey MMIA planning process determined that more observers/operators are appropriate. The team would comprise two dedicated PAM operators and two MMOs.
- While the acoustic source is active in the water, at least one qualified MMO (during daylight hours) will watch for marine mammals. Some TWG members recommended a second trained (or trainee) MMO also maintain watch during these times, while others believed this would not be necessary as standard practice.

2.3.2 Consensus recommendations

- The observers will be dedicated to detecting marine mammals, associated data collection, and instructing crew on their requirements when a marine mammal is detected within the relevant mitigation zone.
- While the acoustic source is active at least one qualified PAM operator will be on duty watch.
- Qualified MMOs and PAMOs may elect to come off watch if all the following conditions are met:
    - The MMO/PAMO has been informed the acoustic source is not active, and will remain inactive for longer than the duration of pre-start observations and ramp-up
    - The MMO/PAMO remains available to the seismic survey contractor while off watch, in case pre-start observations for testing or soft starts are needed ahead of schedule.

2.4 Fatigue management and training courses

Since fatigue is an important factor behind observer effectiveness, fatigue management should be highlighted in training (if not already) to ensure observers recognise and adapt their behaviour appropriately. This is particularly important for new and less-experienced observers. The suggested shift work templates above could be introduced during training and added to course training material so attendees are aware of appropriate shift rotations and what may work for them – rather than relying on team leader preferences.

2.4.1 Consensus recommendations

- Training courses should also stress that shift rotations and fatigue management should consider the time and effort required to enter and verify data, and compile and send reports. This is particularly important for team leads with reporting responsibilities.

Part 3: Equipment and reporting standards

3. Minimum requirements for MMOs and monitoring equipment

In this section, the TWG discusses and suggests minimum requirements for MMOs and monitoring equipment, including deployment periods and locations. Also suggested are options for improving the estimation of the distance between the animal and the observer (or PAM system). Finally, it provides opinion on the need for species (or species-group)-specific minimum standards for MMOs and PAM operators, including equipment and species-specific settings and scan protocols.

3.1 MMO equipment

MMOs should be equipped with appropriate equipment to allow them to perform their responsibilities to the highest standard.

Ensuring that MMOs have the correct equipment will probably involve a mix of prescriptive requirements (eg binoculars of a certain specification) and objective requirements (eg the ability to estimate distances within a specified accuracy). Leaning too far towards prescriptive requirements might cause problems in future as technology develops. Similarly, objective requirements will need to be linked into training and performance assessment.

3.1.1 Reticule binoculars

All MMOs should be equipped with reticule binoculars. Such binoculars are easily available, cost effective and a tested method to estimate distances at sea. Binoculars in use should not be prescribed, but should meet minimum standards, eg binoculars should include a built-in compass and 0.5-mil reticule spacing. Observers should also ensure their binoculars are suitable for work in New Zealand – which has considerable variation in magnetic declination, increasing from North to South across the EEZ.

The correct use of reticule binoculars should be covered during training, especially for new and less-experienced observers. In-field assessment and verification should also be performed during rotations to make sure observers are correctly estimating angles to, and ranges of, sightings. These field tests can be incorporated into regular shifts where observers test their distance estimation abilities with inanimate objects such as other vessels, tail-buoys etc. Estimates may be verified with cooperation of the bridge crew and their radar systems. These test sessions should be documented in project report appendices. Regular field tests should also serve to check that compasses built into binoculars (which are susceptible to magnetic interference from electronic equipment on the survey vessel) are functioning correctly. Alternatively, an angle board can be used.

3.1.2 Range sticks and clinometers

Some argued that range sticks should be discouraged due to variable accuracy and other issues. Others noted that this has not been very well assessed and would be worth researching, as many MMOs still rely on range sticks. Either way, some TWG members noted that they may still be required for assessing distance to near-by animals as reticule binoculars are only functional within a given angle from the horizon. Similarly, the horizon might not be visible due to distant weather, land, or for some other reason.

Another useful tool for estimating distance is a clinometer: observers can calculate pre-survey distance ranges according to angle, once the height of the eye (ie at the observation position) above sea level is known. This can be easily done once for each location prior to the start of the first shift. This will allow an observer to be able to immediately know if a sighting is within the mitigation radii or not. Actual angles can be plugged into computer software to calculate the accurate distance measurements, even after the fact.

3.1.3 MMO position

The position of the MMO on the vessel is often overlooked, but crucial to effectiveness. However, the best position for an MMO to perform at their best is vessel-specific, and often dictated by prevailing environmental conditions. Observers must use common sense; they should be outside as much as possible, with a good view of the mitigation zone(s) – the flying bridge is often a great observation position. For their own safety, they should also try to stay in shade and out of the radar beam as much as possible.

3.1.4 Software aids and other new methods

The new Code, while requiring a tested method of distance estimation, should also allow for – and encourage testing of – new and emerging distance estimation and detection technologies; the Code should be future-proofed.

Software that helps observers to initiate mitigation measures quickly and efficiently should be encouraged. Software that has not previously been used effectively for mitigation purposes would need to be trialled. Examples of such software are discussed below. Note that the use of the examples below does not indicate TWG endorsement.

3.1.4.1 VADAR Sea (Visual & Acoustic Detection and Ranging at Sea)

VADAR Sea is software that converts compass and reticule readings into real-time positioning of the sighting to the source. Sightings can also be mapped in real time in relation to the source, allowing for appropriate figures to be easily incorporated into reports.

A caveat of using a system like VADAR Sea is that observers would need to access the software at their point of observation, and would presumably have to take their eyes off the sighting. This serious limitation could be addressed by a team response to the

sighting: for example, data are loaded into the software by a second MMO (if a laptop running the software is available at the observation position).

Other more technical options might include:

- Integrating inclinometers and GPS into binoculars that automatically transmit information to the datasheet. Distance estimation in mitigation actions should be available instantly at the observation position without distracting from the sighting, and any methods for instantaneous mitigation decisions need to encompass this.
- To improve data entry, there was a recommendation that data should be recorded in the field to a digital recorder, or similar recording device for later entry into the spreadsheets.
- An alternative for real-time data entry is to use hand-held computers with internal GPS and a Microsoft Windows operating system (like the Trimble ones). However, the TWG noted the importance of establishing distance to the animal in real-time, while all other information can be retrieved later when off duty.

3.1.4.2 RADES (Real-time Automated Distance Estimation at Sea)

RADES software (in development by Seiche) addresses many of the above challenges. Trials have shown the software to assess distance to objects, relative to a source, with consistent accuracy. Using this technology may allow for more robust decision-making regarding position of an animal within a mitigation zone.

Available as an iPad app, RADES uses the orientation data provided by Apple's CoreMotion SDK sensor. Alternatively, it is integrated into a camera HD/Thermal Imaging camera system. On an iPad the software can be used in real-time by MMOs while the sighting is being observed in the view-finder. Multiple mitigation zones can be overlaid around the centre of the source. The interface allows the operator to enter height information, capture images and zoom. Relevant information such as species-specific shutdown policies can also be displayed onscreen without the MMO taking their eyes off the sighting. RADES tracks the horizon for stabilisation and has algorithms for haze removal and image clarity. It can be combined with inertial units (digital inclinometers) to determine distance in foggy conditions (where no horizon is visible).

3.1.5 Recommendations for MMO equipment and protocols

The TWG recommends that MMOs should have a minimum toolkit suitable for work in the southern hemisphere. A comprehensive kit would include:

- Distance table(s) – specific to project vessel/sighting platform(s) and mitigation zones
- Reticule binoculars, with compass
- A real-time system for estimating actual position of marine mammals from seismic source (eg reticule binoculars)

- A DSLR camera with telephoto lens and ability to take several frames per second of at least 7.2, but preferably 10-15, megapixels
- An angle board (even if binoculars are required to have in-built compasses as they can suffer from magnetic interference from the vessel)
- A hand-held GPS that logs tracks (ideally linked to a laptop, and that shows position in real time – PAM systems already log a ship's GPS track and this data should be made available to the MMO)
- A laptop, with access to Microsoft Word or other software essential for data entry
- An additional means to back up data
- A note book
- A digital recorder/tablet or similar for in-field data entry
- A marine mammal ID guide
- DOC reporting forms
- A copy of the Marine Mammal Impact Assessment (MMIA) and the Marine Mammal Mitigation Plan (MMMP)
- A copy of the Code and the associated Reference Document
- UHF hand-held (or otherwise easily accessible) radio transmitters, or other means of communicating among MMOs/PAMOs while moving around the ship

The TWG also recommended that:

- MMOs conduct observations from outside when possible, and from a high vantage point (eg the flying bridge) with a 360-degree view of the mitigation zone. All MMOs/PAMOs should be able to communicate immediately, if necessary, through radio transmitters.
- MMOs should be able to observe from a suitable place inside when environmental conditions dictate; such monitoring should be noted in the final reports.
- The Code is made flexible to allow for the testing and use of new mitigation technologies that may improve distance estimation and mitigation decision-making.
- Sextants not be required. Their use was discussed as a means of distance estimation; however, they were dismissed due to the time required to use them in the field. Likewise, no distance should be estimated with the naked eye alone.

4. Minimum requirements for PAM operators and systems

This section suggests minimum standards or requirements for PAM operators and monitoring systems, including deployment periods and location, as well as any associated ship-noise requirements.

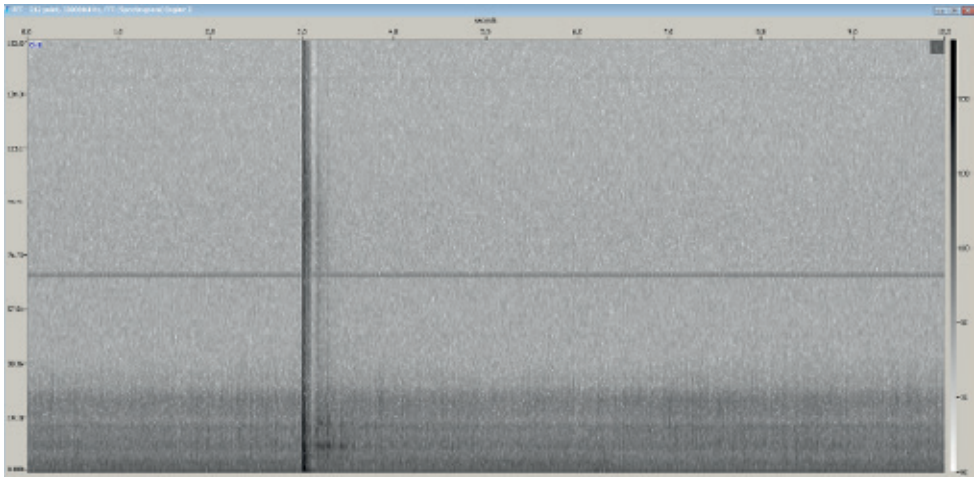
4.1 PAM system standards

The current Code states that PAM systems must be able to detect cetaceans at distances of 1 km (Level 2 surveys) and 1.5 km (Level 1 surveys). The background document further states that ship noise has to be assessed in order to optimise the system. For obvious reasons, neither document provides an absolute target to be met, nor do they state how and for what species the 1 km and 1.5 km targets must be checked.

There are two difficulties in addressing this:

- There is no absolute standard to measure the performance of PAM against; this is true for all the available detection technologies and methods – as well as for visual observation.
- There are many variables in the set-up of PAM that prevent consistent assessment across different projects (see **Spectrograms 1** and **2** for examples). Effective PAM deployment depends on several factors where effectiveness requires configurations that are specific to each survey: vessel capabilities, other gear deployed, PAM operator competence, etc.

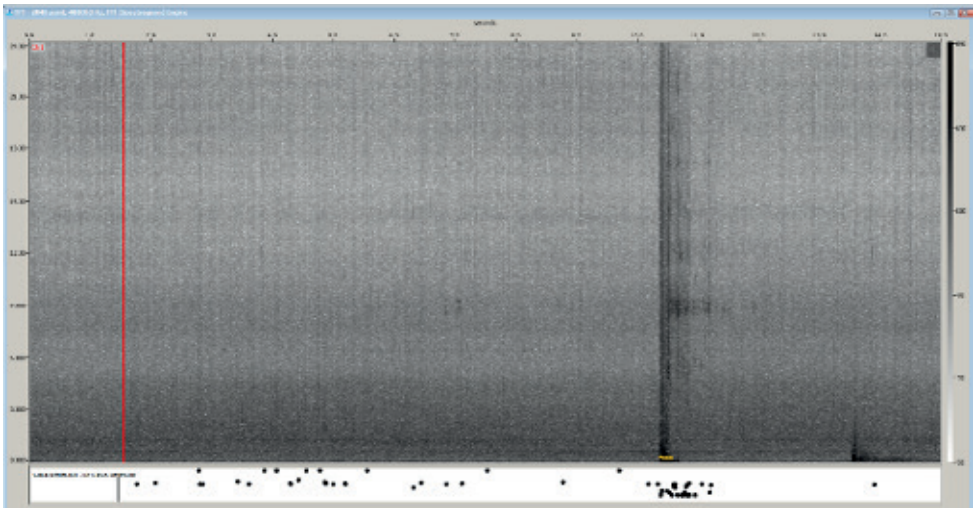
Spectrogram 1:



In this first spectrogram, the Y axis shows spectrum frequency range from 0–155 kHz. Time is shown on the X axis (10 s). The horizontal well-defined dark line half way shows an unfortunate electrical interference; the vertical dark line shows a shot of the airguns at full power, which ranges from zero to beyond the top limit of the spectrogram (even though this is commonly referred as 'low frequency' because most energy is at low freq.) This spectrogram is used to visually monitor and detect the frequency range of dolphin echolocation clicks at higher frequencies as well as having a broader range of visualising the sound being monitored. On this setup, the elements are about 200 m astern, 20 m

before the guns and at 27 m depth (while guns are at 8 m). The swell is about 2 m and the wind speed is about 11 kn, meaning good conditions and not much background noise from the ocean surface.

Spectrogram 2:



Spectrogram 2 reads the same way as spectrogram 1, although the frequency range on the Y axis is from 0–24 kHz, encompassing the whole spectrum of the vessel noise seen on the Spectrogram 1. Note the seismic shot (vertical black line) and the echo from the seafloor at lower frequencies about 3 seconds later (~2,250 m water depth). This one is used to detect both whistles, echolocation clicks, and (supposedly) low frequency tonal sounds (possible, but limited). Although difficult to see at this moment, the ship's echo sonar can be seen as a shade that is highlighted by the circle.

The greatest problem in deploying PAM is minimising noise from the ship itself (rather than the seismic source – which can be 'removed' with software such as PAMGuard's Seismic Veto function). It may be worth considering:

- Deploying longer hydrophone cables to increase signal-to-noise ratio (as achieved by the Whale Watcher and Quiet Seas systems), and to provide more flexibility in sensor separation (eg for low-frequency detection).
- Source-Tow PAM, which deploys the hydrophone section directly behind the seismic source, removing deployment complications. It also has the significant advantage of placing the PAM sensors in the centre of the mitigation zone. Such systems can be connected through the airgun umbilicals, but depend on the availability of spare wires and/or good-quality wires. Wireless links direct-to-vessel are also emerging.

Although PAM deployment is considered briefly in the MMIA process there is likely room for improvement. The current Code is vague on how it expects PAM systems to be optimised – this should be considered early in a project's planning stages, ideally with the seismic contractor/vessel operators involved. Early consideration of PAM systems will help ensure appropriate PAM systems are provided and suitably deployed for each project. Any deployment must consider seismic equipment spread

(especially from a noise and entanglement perspective) and environmental conditions (eg currents that might carry hydrophone cables over seismic cables and lead to entanglement) for the duration of the project.

A competent PAM operator (ie someone who knows the correct software settings) is as important as the hardware itself. The 'Rolls Royce' of PAM equipment will not monitor effectively if the operator does not understand Nyquist frequencies and sampling rates. The quality of training ultimately determines whether PAM equipment is deployed and monitored effectively; this further reinforces the need for as much hands-on classroom tuition and field practice in MMO and PAM training as possible. Field components were noted to be especially important in training PAM operators.

4.1.1 Consensus recommendations for PAM systems, deployment and operation

The TWG recommended:

- DOC (as the main audience) undertakes a study of PAM performance. At present there is no prescribed standard against which the performance of PAM systems can be measured. This is a weakness of all detection methods currently implemented for mitigation. Any study of PAM performance requires survey reports to better document PAM systems, settings and deployment methods – this should be a minimum requirement for reporting (see section 7.2).
- A review of PAM deployment methods in New Zealand be undertaken to determine the most effective deployment strategies for the region, given local species and conditions. Such a review will enable DOC to make informed recommendations regarding future PAM deployments.
- The Code should **not** prescribe equipment/model type or modes of deployment at this time. The TWG suggested the Code provides a minimum set of functional requirements that PAM systems should meet. It would then be the client's responsibility (through their PAM provider) to ensure their chosen system meets these requirements. Alongside this the Code could:
    - Include general guidance on PAM system deployment and operation, particularly with reference to meeting the requirements of the Code (as detailed in section 4.1). Successful PAM deployments are often detailed in project reports, and effective deployment methods should be shared with PAM system providers to ensure they can provide system-specific recommendations also. There are also published examples providing general guidance on the deployment and operation of PAM systems (eg Todd et al. 2015).
    - Stress generic considerations, such that PAM deployment locations and configurations should be selected carefully, to optimise the signal-to-noise ratio (avoiding the noisiest locations, eg turbulence and cavitation immediately aft of the propeller) and minimise risks of entanglement and damage to the hydrophone cable.
- PAM operators be suitably trained and experienced in the specific PAM system employed.

TWG members also encourage DOC (as well as regulators and industry around the world) to:

- Provide on-going support to the development and improvement of PAM system technologies. This includes ongoing research into improved automated classifiers and the potential to integrate PAM systems into seismic streamers. Testing and (potentially) introduction of these systems, alongside conventional PAM, should be encouraged.

  Sensors already contained within seismic streamers have recently been developed for use in marine mammal monitoring, and these are now maturing into field trials phase. This has the advantage of removing additional equipment deployed in the water, reducing the number of deployments and possibility of entanglement. However:

  - Built-in sensors may not be suited to this in terms of frequency range (for detection) and separation (for localisation). The technologies developed to date have favoured an automated detection approach with a simple user interface. No raw sound data is received. As a result, performance verification is inherently difficult. This is especially relevant to the trigger rate: high sensitivity = too many mitigation actions; low sensitivity = possible exposure.
  - The sensors trail the mitigation zone, sometimes substantially, making detections at the leading edge of the mitigation zone difficult. They often do not involve an operator to make judgement calls in cases where the automatic detection classification is doubtful and performance verification extremely difficult.
- Require/instigate good assessments of PAM systems so that their effectiveness and capabilities meet DOC's requirements.

4.1.2 The unresolved issue of PAM deployment location

There were conflicting opinions on the best solution for deploying PAM systems. Deployment near the rear of the seismic vessel makes PAM susceptible to engine noise, prompting suggestions that PAM systems should be deployed from a small vessel independent of the source vessel. However, PAM was first used on seismic surveys from chase boats and the drawbacks of this forced the move to the source vessels. The benefits of PAM being deployed from the source vessel is that the PAM array is usually (but not always, given the large size of some arrays) closer to the airgun array, although this does indeed present a trade-off with detection ability.

PAM systems deployed from chase vessels must determine if detections are within the mitigation zone, especially if the chase vessel is positioned in front of the source vessel. However, deployment from a chase vessel would enhance marine mammal detectability in large mitigation zones. If PAM systems are deployed from a chase vessel, proper distance from the chase and seismic vessel should be established according to the mitigation zone. The chase vessel's principal role, therefore, might be to provide 'scoping ahead', specifically for baleen whales, to trigger response by MMOs or an Infrared system onboard the source vessel. This would require an array

(perhaps an extended array), but not necessarily an operator.[6] Also, a PAM system deployed from a chase vessel can be used for ground-truthing of sound transmission loss modelling in the field, prior to operations. It may also be useful to conduct PAM and visual monitoring from a chase vessel when operations move into a new location. However, the benefits of this are uncertain and it would require multiple PAM arrays and vessel-to-vessel transfers, which are generally not favoured due to health and safety risks. A chase vessel may also be impractical given the current 24-hour PAM requirements. The chase vessels also have other 'support vessel' duties and likely cannot remain in a viable PAM location indefinitely.

Another consideration is the use of PAM with new sound sources, especially continuous sources such as marine vibroseis. When marine vibroseis are used instead of airgun arrays, mitigation zones are expected to decrease substantially due to lower source levels and non-pulse signals, so there should be less need for PAM deployments from a chase vessel. Mid and high-frequency signals from vocalising odontocetes should be detectable even when marine vibroseis are active. PAM is likely to be even less effective in detecting baleen whale calls than it is during an airgun survey, as the source's low-frequency sounds will mask these calls for more of the time during a marine vibroseis survey (because the duty cycle is higher). However, actual detection rates of baleen whales, with PAM systems deployed from either the source or chase vessel, are very low due to vessel noise – even during airgun surveys.

4.2 Verifying PAM capabilities

It was noted that, for objective-based requirements to be implemented for PAM, it would be necessary to verify the capabilities of PAM systems (and observers) once deployed.

Verifying the capabilities of PAM deployment methods in the field could be a lengthy/costly process; this is perhaps better addressed prior to commencing a survey or through a focussed study. This is challenging because PAM system performance is survey-specific (partly due to the environmental conditions during the survey), but simple verification trials are possible. These would include calibrated transmissions of real-world recorded emissions from the chase vessel. A suite of emissions could be used to represent different types of cetaceans, even though previous experience has revealed challenges with reliability and amplitude of low-frequency sound source play backs.

On each survey there should at least be some comparison and analysis of PAM detections relative to MMO detections. Considerable caution should be used in comparing this data however, especially as MMO data has its own limitations (ie many reports from seismic surveys around the world show PAM detections outnumbering MMO sightings by a significant margin – although the opposite has been shown to be true in the data collected in New Zealand to date (Childerhouse et al. 2016).

[6] The technology exists for inter-vessel linked real-time PAM by radio transmission (effective for several kilometres).

4.2.1 Consensus recommendations

The TWG recommended:

- An in-depth study of PAM system performance by an independent party (a non-PAM equipment manufacturer) be carried out, to test different PAM systems before they are even approved (potentially by DOC) for use in New Zealand. This is long overdue.
- An in-depth study of the effectiveness of PAM relative to MMOs (globally, but also in New Zealand) is also overdue. Consideration of relative performance – of ideal research conditions compared to real-world performance in the industrial conditions on board a seismic vessel – needs to be taken into account.
- Some form of capacity verification for PAM systems. Members acknowledged that such efforts should also be practical, and realised that pre-survey assessment may not allow for the system to be adequately tested under expected survey conditions.
- DOC consider requiring analyses of chosen PAM systems on a project-specific basis. This would go some way to ensuring that the chosen system can achieve the requirements laid out in the Code (including those PAM requirements recommended in **section 4.1.1**) for the project on which it will be deployed. This is particularly important where detection distances for high-frequency species might be limited to ~300 m due to sound transmission (not necessarily equipment) limitations.

  Such analyses could be performed during the first days of a survey by assessing the system setup, ambient noise levels, ship noise levels and sound propagation parameters. It would also help relax the current requirement to cover 1 Hz – 180 kHz, which is not easily achievable with a single PAM system.

  However, very careful thought would be needed before any action is taken following a discovery (eg through 'ground-truthing') that PAM, or another detection system, was performing below requirements in the field. Clear upfront rules reduce the risk of under-performance. Meanwhile, field-testing using a mobile source (perhaps on a chase boat) at three frequencies during normal PAM deployments over the next few years might provide more information upon which to base management decisions in future.

4.3 Mechanisms for incorporating alternative monitoring or mitigation methods into the Code

As stated above, DOC intends (if possible) to build provisions into the Code that would allow alternate methods to be approved for use, on a trial or permanent basis. Several of the above recommendations on PAM requirements may offer a starting point for ways to incorporate alternative monitoring or mitigation technologies into the Code.

New technologies currently face much higher requirements to prove their effectiveness than the commonly-used PAM and MMO methods. However, the working group acknowledges that objective requirements are needed to ensure that a new system or technology meets the requirements of the Code.

These provisions would need to be able to differentiate between an 'additive' technology to be used alongside MMOs and PAM, versus a 'replacement' technology that might supplant one or the other.[7] If the latter is desired, the new technology should be required to demonstrate it is equally effective at detecting marine mammals as the method it will replace.

The use of novel and developing technologies would require advanced training and perhaps additional operational personnel for mitigation and monitoring teams.

4.3.1 New technologies with potential

Some alternate technologies are very promising – such as IR imaging, which takes advantage of the fact that all marine mammals must surface to breathe. This technology is promising for large whales detected at distances beyond even conservative safety zones. Trials with IR systems suggest they have good automated detection algorithms, including distance from source estimations. They can also be used to assess and document behavioural reactions of individuals or groups of animals.

Other systems that might be considered involve the use of unmanned aerial vehicles (UAVs). This rapidly developing technology could be an important complementary mitigation tool. Current UAVs used in combination with image processing technologies (such as that used in RADEs or IR imaging, both mentioned above), have huge potential. Real-time and archival data recording, from a birds-eye view with defined and more accurate mitigation zones, is now feasible, allowing better assessments of animal movements relative to a sound source. UAVs are already autonomous and can handle varying weather conditions, with battery systems allowing for 20–25 minute flight times. These systems could potentially be used for pre-observations as well as shutdown situations.[8]

While there is still much research and development required for many of the new mitigation technologies, industry is likely to adopt such techniques in the future. Most vessels will soon have UAVs in their toolkits, as they are a cost-effective way to reduce risk of operational jobs, such as checking surface gear. These developing technologies should therefore also be encouraged for the purposes of impact mitigation.

Using more environmentally-benign alternatives to airgun arrays, such as marine vibroseis, should also be encouraged. As discussed above, this technology has a lower peak amplitude, slower rise time and significantly less energy above 100 Hz, which will likely lead to fewer acute impacts. However, the longer duty cycle means that other impacts may remain a concern.

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[7] Some TWG members noted that PAM, at least during the daytime, was already an 'additive' technology above the use of MMOs.

[8] However these flight durations are arguably a bit short for pre-observations or shutdowns.

5. Communication and reporting

5.1 Communication

Issues around lines of communication were briefly discussed. For example, there is some confusion in the Code about which agency should be contacted (DOC or the Environmental Protection Authority – the EPA) and whether observers should be allowed to contact their client/employer in advance of contacting regulators. It was agreed that further advice and guidance on this issue would be useful.

5.1.1 Lines of communication should be established at the outset of a project

This includes communication with the client, MMO agency, DOC and personnel onboard the vessel(s). When these lines of communication are established the requirements of the mitigation team should be discussed. Clients need to be made aware that MMOs and PAM operators may be required to contact DOC. This can be covered in the permit/planning phase and during the kick-off meeting to ensure personnel on board the vessel are aware of requirements from the beginning. MMOs and PAM operators should then be able to communicate with DOC without problems.

MMOs and PAM operators need to know exactly how they should contact DOC for various queries or concerns (eg via phone or email depending on urgency, what phone number or email address should be used, is there a specific person who may know more about their survey, etc).

Given the confined working/living environments of offshore works, personnel are generally expected to resolve issues personally and professionally. MMOs and PAM operators should be able to approach the client representatives (reps) aboard vessels with any concerns about non-compliance with the Code. For this to happen comfortably, clients need to inform their client reps ahead of seismic surveys that, at first, reps will act as intermediaries to resolve concerns locally. Contacting DOC should only occur after discussions with reps, as good relations aboard vessels should encourage respect between the crew and MMOs/PAM operators – and therefore compliance with the Code.

While seismic operators should not be determining if non-compliance has occurred, MMOs and PAM operators could (and should) request additional information so the observer can report the potential non-compliance properly. This should also carry forward into final reports.

5.2 Final reports

Observers who write final reports must be recognised and respected as the authors. Therefore, they must be fully involved in the revision process of their reports in partnership with the agency. Any changes made to reports must be in consultation with the report's author(s) (the lead MMO in many cases). This will help ensure reports to the regulatory agency are accurate. Reports could be made publicly available – as in Ireland and with 90-day reports in the US.

5.2.1 Report content and layout

Currently MMO final reports are often merely summaries, lacking sufficient information on sightings/detections, effort, PAM set up, MMO observation protocols etc. This seems like a waste and the reports should be available to researchers for reviews, environmental assessment preparation, and other activities.

Although reports should meet a minimum standard, content should not be too prescribed so authors do not leave out important information. Reports should at least include:

- Full sighting/detection lists
- Details on effort
- Details on PAM systems, settings and deployments (often missing from reports to date)

Effort data should include information on rotations and shift lengths. Detections (both visual and acoustic) should (at a minimum) be summarised in the body of the report, with the raw data included in tabulated form in the appendices. This is helpful to those using the reports in future, even if these data are (or will be) available in a database or on the data forms. Similar data on PAM detections should likewise be included in reports. At the least, data should be suitably summarised and in a form to allow further analyses if the observers themselves are not able to perform basic quantitative summaries and comparisons of the data.

Ideally, agencies should work with observers after the project to perform suitable reporting. Reports should include a brief analysis of the sightings as previously mentioned. There is significant value in understanding the detection rate at different source statuses (full power, soft start, pre-start observations and source not active). The Blue Planet Marine (BPM) report (Childerhouse et al 2016) included in this review process could be used to highlight the areas of reports that are often lacking.

Part 4: Observer training and performance

6. Requirements for observer training, qualifications and experience

In this section the TWG reviews existing qualification, training and experience requirements for MMOs and PAM operators. It also provides views on:

- Where details of New Zealand's Code-related mitigation elements and reporting requirements should be included in the training process
- Whether this should be a separate course from more generic MMO/PAM operator training.

The group had numerous suggestions for improvements that might be made to observer (MMO or PAMO) training, certification, assessment, and professional development. Comments made it clear that stakeholders were uncertain about the observer role, and how observers' responsibilities were balanced between monitoring for mitigation purposes and monitoring for scientific data-gathering purposes.

6.1 Mitigation v. science: clarifying the MMO role

Some TWG members indicated concern, particularly among MMOs working in New Zealand waters, that observers are distracted from monitoring by the need to complete sighting data forms. Thus there is some concern surrounding whether observers on vessels are there to implement mitigation or to collect data. The argument followed that deployment of observers for mitigation or data collection for scientific purposes (such as that collected for marine mammal surveys) are two different things.

The primary purpose (and first responsibility) of MMOs is to mitigate the source. Accordingly, it is more important to note, for example, when an animal moves into a mitigation zone and initiates a shutdown, rather than spend time determining the exact distance to an animal. For example, an observer might note before their shift that the edge of the mitigation zone is 2.5 reticules from the horizon at a given angle of detection. Repeating this across a few (eg five) angles will allow them to quickly decide if mitigation action is needed prior to a precise distance determination.

However, other TWG members noted that any assessment of mitigation effectiveness requires the collection of scientifically valid data. Data collection for mitigation and scientific endeavour are thus not actually in opposition. Seismic surveys represent platforms of opportunity, and collection of any data (in addition to mitigation-related information) should be encouraged. Good data collection practices must be covered in observer training. All data must be collected in a scientifically-robust manner that is understood by the data collectors – not all of whom will have scientific backgrounds. Data collected during periods of source inactivity (eg outside the survey

area, or on line changes) must be recorded to the same level as data collected while the seismic source is active. The importance of accurate effort logs should be emphasised in the Code. However, additional data collection for scientific purposes should not interfere with mitigation requirements, nor add to the responsibilities of MMOs in such a way as to lead to undue fatigue.

Any data collected in a scientifically robust way should be made available for analysis.[9] Currently the most important data include:

- Distance to vessel/guns (at first sighting and subsequently)
- Location
- Airgun activity (including how long the source had been active at the time of sighting)
- Date
- Time of day (local time, not including daylight saving)
- Taxonomic classification to the lowest taxonomic level species (if identifiable)
- Group size and composition (including minimum and maximum number of individuals)
- Group activity state (eg travel, forage, social, rest)
- Sighting conditions (sea state, glare, cloud cover, overall visibility score etc) at start of watch and any subsequent changes in conditions (including loss of light)
- Observer name
- Observation start and end time – important for assessing the effects of fatigue over time
- Reticled binocular characteristics
- Height of the observation point
- Number of reticles
- Animal and vessel bearing (over a series of observations during the same sighting)
- Vessel speed
- Depth, sea temperature and salinity if available
- Acoustic and visual match
- Comments

Consideration also needs to be given to data standards, eg Darwin Core, OBIS, etc.

[9] The issue of what data are required to ideally both a) fulfil mitigation responsibilities and b) support subsequent assessments of mitigation and monitoring programs (as well as answer other questions surrounding, for example, species presence in survey areas) is covered in the report from the Marine Mammal Observer/Passive Acoustic Monitoring Observer Data TWG.

As noted above, most of these data are required for mitigation actions, so should be recorded anyway. Effort-related data are not always recorded in a systematic fashion and this is something that should be addressed – probably through training courses. However, even with more systematic effort, reporting MMOs should not suffer undue fatigue; if anything, better effort reporting helps keep observers alert and aware of changes in sighting conditions.

Overall it is important to address how the data are collected – this relates back to data collection protocols and how data are recorded. Observer courses should contain elements of training in good data collection protocols, as well as the reasoning for the collection of the data.

Regardless of purpose, the current form-filling and data entry requirements of the Code are labour-intensive.[10] If DOC decides to maintain a scientific approach, the amount of data collection required provides further impetus for the inclusion of additional team members as recommended in **section 2**. Extra MMO team members have the potential to allow for two observers to be on duty while the source is active. A two-member observation team allows for one MMO to undertake data entry once an animal is detected – allowing instantaneous data entry as a sighting (and potentially mitigation action) occurs. Such systems are often employed on dedicated marine mammal surveys.[11]

That said, it was suggested that great value might be found in DOC encouraging MMOs to undertake snapshot bird counts within a defined radius (say 500 m), once or maybe twice per day, with identification to the lowest level possible. This would be easy, interesting, and potentially very scientifically useful. Many MMOs would happily do this, potentially offering information on changes on seabird densities offshore. However, others noted that without a formalised transect (which is labour intensive) its usefulness would be limited by the MMOs' ability to identify species. In contrast, it was suggested that data on sea turtle presence could be easily and effectively collected without much extra effort.

6.2 Certification

Observers need to be more formally certified, so that they can demonstrate their status and suitability. However, simply being certified for completing a course does not demonstrate that an observer has the required experience and expertise for the job in hand. DOC:

- Could issue certificates or other formal documents for this purpose. Such documents should include date of issue and the status of the observer.
- Should review the CVs of MMOs and PAM operators who do not hold a New Zealand certificate to prove their credentials and expertise and the agency must make a case for these individuals. DOC would then decide the outcome.

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[10] They also often cannot be achieved without stress in a 12-hour shift – supported in confidence from experienced lead MMOs in New Zealand.

[11] For example, the SCANS II surveys in and around the North Sea and NMFS marine mammal surveys in US waters.

6.3 Training levels and requirements

TWG members noted that two different observer status levels exist in New Zealand: trained and qualified. Both have been through a training course, and the qualified observers have at least 12 weeks' experience as an MMO or PAM operator in New Zealand. There are also two sets of training courses in New Zealand: short and long courses. The former is for 'experienced' observers only (those with at least 12 weeks' experience as an MMO/PAMO), while the latter is open to any candidate.

There are two key issues here: short v. long courses, and defining 'trained' and 'qualified'.

6.3.1 Short v. long courses

Some TWG members find the current system of long and short training courses, where there are different requirements for different people, problematic and confusing. As it stands, the present system of two courses appears to allow for MMOs with no marine mammal experience to be considered trained and, after 12 weeks in a mitigation role in New Zealand waters, qualified.

Thus the review of the current Code provides a good opportunity to also review the training requirements for observers working in New Zealand waters. As detailed above, the issue of experience needs to be clarified by DOC, particularly regarding training courses as those with appropriate experience outside of mitigation should be recognised. Some TWG members felt that, regardless of course length marine mammal experience should be a prerequisite for attending any MMO/PAM training course.

6.3.2 Trained v. qualified

The issue of whether an observer is qualified to work in New Zealand waters relates mainly to experience levels, and the TWG assumed that DOC seeks to have experienced observers in charge of mitigation. Observers should preferably have experience on the job, as well as demonstrated experience in wider marine mammal field biology. For example, the Marine Mammal Observer Association (MMOA) has set the following criteria for MMO and PAM operator full membership status:

- Individuals have worked as a professional MMO and/or PAM operator, implementing mitigation measures during industry operations on at least two occasions in the previous five years.
- Completion of appropriate MMO and/or PAM training.
- Recent personal development in marine mammal identification and behaviour – whether this was during other employment (eg during fisheries work) or outside of any professional commitments.[12] Alternatively, persons who have worked for 20 weeks or more as an MMO and/or PAM operator will qualify as having relevant

[12] For example: voluntary surveys/guiding, holidays whale-watching, organising boat trips to see marine mammals, etc.

experience. This experience must include regular sightings/detections of several marine mammal species.

Individuals must be able to demonstrate they meet these criteria, in their CV.

Another issue with the current system is the 12-week requirement for an observer to be considered qualified to work in New Zealand waters. Simply stating that observers must have 12 weeks' experience in a mitigation role in New Zealand should not determine an observer's qualification. This requirement does not address:

- Observers with little additional marine mammal expertise in marine mammal observation and behaviour
- Low sighting rates during those 12 weeks
- Observers with years studying marine mammals in New Zealand (or elsewhere), yet without relevant experience to work in a mitigation role. While mitigation experience is useful, observers with years of field-based marine mammal observation, identification and behaviour experience can acquire it fairly quickly.

The skills of detecting and identifying marine mammals also do not vary by region – these skills depend on the overall experience and skills of the observer. This should be recognised by DOC – directly relevant experience, knowledge and skills should count towards qualification as an observer in New Zealand waters. This is the only way to ensure competent people can work as observers, and should emphasise the importance of experience and skills. DOC may be restricting themselves by limiting the Code to only those observers who have local knowledge/or mitigation experience. DOC may be better to require at least one member of the MMO team to have local experience.

The current requirements related to the two-tier course system and who can undertake which course is another area that DOC should address. Currently those individuals, regardless of their expertise (marine mammal, acoustic etc.) who have not spent 12 weeks on a seismic survey vessel may only take the long course for 'beginners'. This results in extremely experienced individuals holding the same certification as those with no prior marine mammal experience. This makes little sense if DOC is keen on seeing only skilled individuals working as MMO and PAM operators in their waters.

6.4 Refresher courses

The TWG considered that refresher courses should be required. As well as providing training on Code revisions, refresher courses allow a focus on practical skills (eg identify and address bad habits), new technologies or methodologies, as well as data collection and reporting responsibilities. Refresher courses would also be opportunities for experienced observers to learn from each other and address 'lessons learned' from their respective jobs.

Such courses would also provide an opportunity for direct feedback. Experienced MMO and PAM operators rarely discuss issues and potential solutions to real-life/job

experiences, even though opportunities exist.[13] Potential solutions, and information on the effectiveness of mitigation methods, should be reported straight to DOC.

However, some members of the TWG noted that 'observing' is a profession and thus the onus should be on observers to deliver their skills and knowledge to a required standard. Such self-improving observers should be encouraged. It is also the more engaged individuals who are likely to take refresher courses, particularly to continue their professional development.

6.4.1 Options for refresher courses in place of full training

Other members of this TWG noted that there are limitations with the 'use it or lose it' approach. The current downturn in the seismic survey industry has resulted in fewer job opportunities and lower day rates, likely leading to a loss of experienced observers and discouragement for new entrants.

To address this, a couple of options were proposed:

- Observers who have not worked in New Zealand for a period of time (eg five years) could have the option to take a refresher course rather than having to attend a full training course again.
- 'Reset the clock' for MMO/PAM operators who were formerly trained and practised in New Zealand waters and who take a refresher course, irrespective of time away from the profession Candidates can achieve their former status (including 'lead' status), if they can demonstrate competence.

These options would permit flexibility without compromising standards or discouraging new blood. Some members noted a total lack of consideration of time away from the profession could undermine effective mitigation zone monitoring; this particular option was therefore discouraged.

For options like these to be viable, DOC needs to ensure that any refresher course is worth taking. There are now many online options for refresher courses allowing for participants to interact (eg the courses offered over Coursera (https://www.coursera.org/), while keeping attendance costs down and allowing observers to refresh their knowledge regularly. Other online options may be as simple as allowing individuals to complete a course on their own schedule. However, bad field/practical habits may not be fixed easily in this way.

MMO/PAM operators in the TWG generally supported refresher courses as a way to be 'on top of things' before going to sea. However, they noted the refresher course would only be as good as the level of 'difficulty' or the design of the course itself. While all agreed that any refresher can only be beneficial, there was mixed opinion on a specific requirement to take such courses at regular intervals, especially if it required money and time. Accessibility to the Code and the MMIA/MMMP documents for review prior to a survey at home is much cheaper and could be undertaken by professionals, although not every MMO/PAM operator would do this.

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[13] Such as within teams while on a survey, going back to their trainers to discuss issues and/or seek solutions, and on internet forums such as that available to full members of the MMOA.

Other MMO/PAM operators felt that regular refresher courses should be mandatory (eg every three years), provided they were available online at minimal cost and were not simply a 'box ticking' exercise. More substantial courses could then be instigated by DOC whenever it considers that there has been considerable change in the Code, or critical advances in technology.

6.4.2 Recommendations for refresher courses

It was noted that it's taken time, work and money to set up training courses, and that it will take as long to set up a proper, useful ongoing assessment process. The cost for training courses is borne by MMOs and MMO suppliers, but ongoing assessment should be a regulator's role and funded by them.[14] the TWG therefore recommended that any refresher courses should be accessible through online platforms, to give individuals flexibility in completing the course and to reduce costs.

However, if the regulator did not adopt the recertification role, the TWG noted that:

- DOC should provide a list of the types of content it wants reassessed. This would have to be updated when the Code is revised, or when new methodologies or technologies are introduced, etc.
- Training providers should be informed of changes so they can update existing courses/assessments (presumably this already takes place). This could be done via the DOC website so that changes (and interpretation of them) are clear. DOC should also specify if updated courses will need to go through an approval process again.

6.4.3 Alternative options to refresher courses

It was suggested that an alternative to refresher courses would be for course instructors to be responsible for informing their past students if substantial changes to the Code are made. However, this was deemed unmanageable, and would not deal with those lacking in on-the-water experience.

Like any survey-specific deviations from the Code, wider changes will be recorded in the MMIA/MMMP, which would in any case act as a refresher document for DOC requirements for MMO/PAM operators. MMIA/MMMPs should be provided to MMOs/PAM operators in advance of the survey and MMOs/PAM operators should be required to read these to keep informed of changes to regulation. They could therefore take the place of refresher courses. However, it was noted that refresher courses should be planned following extensive Code updates. Also, there would be no way to verify that the documents had been reviewed before the MMO/PAM operator went to sea.

DOC should (where possible) advise existing qualified and trained individuals, as well as training providers, that changes have been made to the Code. DOC should also make it generally known that such changes have taken place, through its website and

[14] Some TWG members suggested this might be a task for the EPA's audit and compliance section, which can recover costs.

those of the relevant MMOs. A periodical newsletter was not deemed appropriate, mainly due to its cost and the resulting delay in implementation of Code changes.

Important changes to the Code could be disseminated via:

- DOC and EPA websites/newsletters/list servers could list the changes – and probably should as a matter of course
- Observers on DOC's list could be directed to the updates
- MMIAs and MMMPs: these must include the latest info and can be used on a case-by-case basis for observers to stay updated
- Observers on a particular survey must know the MMIA and any accompanying MMMP

However, the TWG stressed that these options would address changes to the Code, but not the need to refresh observers' skills (including methodologies and reporting), nor provide for skill reassessments.

6.5 Suggested training structure

Taking these discussions into account, the TWG noted that those with biological experience may be using the role as a stop-gap to more academic employment, while others with less experience initially may be more motivated in the position. In contrast, the less academically inclined may amass field experience, which improves detection rates and increases correct species identification. Further discussions surrounded the need to bring concerned iwi into the process in an appropriate way. To resolve these issues, most of the TWG[15] suggested:

- Biological experience (which would need to be defined) should not be a prerequisite for undertaking the full DOC MMO course.
- Vessel time must be conducted at a later time to achieve certification – if not possible during the initial training due to adverse weather conditions.
- Upon completing the MMO course, an individual becomes a trainee MMO.
- Trainee MMOs must be deployed accompanied by qualified MMOs.
- Trainee MMOs must complete a certain period as an MMO (perhaps one month) and receive favourable reviews from their lead MMO(s) to progress to the level of trained MMO.
- Trained MMOs can be deployed in a team of three MMOs with one other trained MMO.
- Trained MMOs must complete 12 weeks as an MMO, receive favourable reviews from their lead MMO(s), and pass a test to become a qualified MMO. The test should be online to make the process easier for them.

[15] However, some TWG members noted they had not had time to consider the operational implications of the above proposal, and did not endorse the procedure.

- DOC may extend training periods as judged suitable for either trainee or trained MMOs, based on lead MMO reports.
- DOC may also require MMOs to recertify early, based on lead MMO reports.
- Qualified MMOs can act as lead MMOs only if they have at least 12 weeks of experience with the New Zealand Code, have received leadership training/coaching, and some training in data analysis and report writing.
- MMOs with training coming from other countries should undertake a short DOC MMO course and complete the related test to enter the process as a trained or qualified MMO, according to their field experience. Courses should be online so applicants do not need to travel to New Zealand prior to deployment. Incoming MMOs at trained level can count their foreign experience at 50% in pursuit of qualified status. Incoming MMOs at qualified level require a favourable report from their first lead MMO regarding their knowledge and implementation of the New Zealand Code. DOC may otherwise require them to retake the course and test.
- All MMOs should be required to take regular refresher courses (every three or four years) to maintain their qualifications. These should be online courses (potentially in addition to in-person courses) to make renewal easier. Such courses would allow observers to stay up to date with the latest developments. MMOs may do this anyway, but this could be a way of formally recognising it and contributes to an observer's CPD.
- Qualified MMOs should be encouraged to undertake PAM training to help alleviate PAM operator fatigue.
- An introduction to the data collected under the New Zealand Code, especially the rationale behind it, should be included in both long and short courses. Both courses should also highlight fatigue management within training.

A similar process was also suggested for PAM operators, based on their acoustic experience.

7. Observer professional development and dealing with poor performances

This section provides options for identifying and dealing with trained/qualified observers who perform poorly and need remedial training.

There needs to be discretion in the Code relating to performing to an acceptable professional and personal standard. Thus there is a need to identify whether observers are performing to the expected standard and remedy any faults, if needed. It was agreed that under the current scheme it is difficult to determine whether deficiencies exist. TWG members suggested that observers who need remedial training might be detected via multiple means, including review of datasheets, assessment of skills in the field, and peer review. It was further suggested that 'good' observers currently use various ways to test their skills (ie around distance estimation) in the field, and self-check that they are working at a high level. Some of these methods might be formalised and applied more widely.

7.1 Observer performance

Often, poorly-performing MMO and PAM operators may have inadequate training and/or experience. The best place to address bad habits or skill deficiencies is in the field; the lead observer should take a role in this, even though it may be the lead with bad habits or deficiencies. The system currently expects the lead to be experienced and qualified for that position, based on their CV. However, the suggestion was made (albeit without agreement) that a governmental observer should accompany seismic surveys: (a) in sensitive areas always; and (b) in other locations periodically, to oversee activities and MMO performance.

In some cases observers may not team players, and may not be keen to address their deficiencies. There must be a method to address their issues, or at least identify them and their deficiencies. Ideally the contractor should be the point of contact for MMOs/PAM operators, and should also be answerable to the regulatory agency (as well as their client). However, in practice many MMOs/PAM operators do not want to 'rock the boat' and do not raise concerns with their contractor (or if they do often little happens). Observers should therefore have a line of direct contact to DOC, who can then feed back to the contractor.

As MMO/PAM operators are typically freelance, companies probably have less incentive to look out for their contractors than their full-time staff. This is not likely something that DOC could easily address; however, DOC could survey MMO suppliers at the end of every trip for feedback on each observer, although a potential conflict of interest was noted here. Observers would need to give approval for this beforehand, to address confidentiality concerns.

Professional standards go beyond the practical requirements of the Code – issues surrounding personal conduct must also be considered. These include not only conduct that is non-negotiable (eg safety, drug use, harassment, etc.), but also an individual's ability to work in a team. For example, a vessel master is required to be a

'fit and proper' person in order to hold their ticket – a similar definition could apply to observers.

7.1.1 Recommendations on how to assess and address observer performance

The TWG recommends that:

- In-field performance assessments be encouraged, if not required. DOC would have to outline the types of activities it recognises, and put methods in place to verify that observers undertake these assessments. Examples of in-field performance assessments are:
    - Validation of distance estimation (as summarised in **section 3.1**) – International Whaling Commission (IWC) sighting surveys have standard validation experiments that are undertaken on every survey (all observers estimate distance to objects of known range – blindly). This should be done on the way to the operational area, overseen by the team leader and included in the final report.
    - Data verification in the field by team members, to identify and address potential issues in data collection and recording in real time.
    - Exercises where observers have to fill in a dummy reporting form, acoustically identify/localise species, etc. This would be best done in transit or prior to departure.
    - Data recording and comparison by two MMOs on duty together (including sightings of marine mammals – although this would require restructuring of DOC reporting forms). Preferably this might occur when the source is inactive. If the source is active, it could be better for one MMO to watch the marine mammals while the other records data.
    - An online exam for the Code that observers could take prior to departure on a survey. Such a test could also be offered to client reps and seismic leads on a survey, to ensure that all understand the requirements of the Code. However, if this was to be done prior to each survey the test would need to be changed frequently.
- Post-survey data analysis that highlights insufficiencies in submitted data. It should initially be carried out by the MMO/PAMOs who collect the data, and who should be required to generate a standard analysis of the data collected. For example, a) distance of first sighting for those that led to mitigation action; b) number of sightings/hr made while source was at full power – plus other key periods such as pre-start observations, soft start and source inactive. To achieve this, perhaps MMOs should be paid for an extra two days' work on top of their hitch (as long as it is a full hitch).
- Observers should have direct reporting capabilities to the contractor or DOC, to identify (and hopefully resolve) severe issues in the field.
- Observers should be able to submit confidential peer reviews of their fellow team members. Should an observer be subject to reoccurring reports (from MMO leads,

MMO suppliers, etc.), there should be an option to revoke their observer status in New Zealand waters. With a certification system in place, this would be as straightforward as revoking their certificate. However, there must also be checks within the system to ensure that an observer is not being unfairly targeted; although this would be difficult to implement, A possible solution could be for an unidentified governmental observer to periodically accompany seismic surveys to oversee activities and MMO performance.

- MMOs could be suspended if they are found to be perjuring.

TWG members stressed that implementing these suggestions should not increase workloads unrealistically. Accordingly, the team should decide when and where such activities are undertaken, and assessment activities should be performed prior to the start of the survey, during periods of bad weather or during periods when the sound source is inactive.

7.2 Continuing professional development (CPD)

Ongoing opportunities for observers' professional development were seen as worthwhile, in addition to the review of training and performance above. These could include

- Refresher training
- Training in new technologies
- Sharing of 'lessons learned'
- Training in analysis methods and report writing, and expertise gained on the water
- Tips for increasing consistency and efficacy of in-field performance

Ongoing professional development must be encouraged. This may be done, as suggested in section 6, in the form of prerequisites for training courses and certification/review by DOC. Agencies should be the places to drive the importance of CPD in their observers – those observers who demonstrate continual work to develop and diversify their skills should be the ones put forward for work.

There are many opportunities for observers to develop their skills, eg membership of professional organisations such as the MMOA or The Institute of Marine Engineering Science and Technology (IMarEST). Refresher courses (See section 6.4) could be made mandatory, and this is probably the easiest method of ensuring observers are up to date. Other online courses should be encouraged, and course completion should be recognised by both the agencies and the regulators. Observers should also be encouraged to train in new technologies – agencies may be well placed to involve their observers in field trials for new mitigation technologies. This would reduce the (often prohibitive) costs for observers, and build relationships and commitment between agencies and their observers.

Part 5: Monitoring species of concern and other considerations

8. Limitations of PAM and visual methods for detection of species of concern and calves

This section provides opinion on the current limitations of PAM and visual observations for detecting SoC and calves. It gives options for dealing with any related uncertainty regarding initiating mitigation triggers (eg for shutdowns).

8.1 Detection effectiveness

The TWG generally noted that it is very difficult (or impossible) to accurately differentiate most small dolphin species by their whistles/clicks in real-time PAM mitigation. One cannot detect presence of calves with PAM either. As the common dolphin is not a SoC (no shut downs, only delays), and is the most common dolphin in New Zealand waters, PAMOs may be unwilling to shut the source down at night if they detect whistles within the 1,000-m mitigation zone (as they may be common dolphins), even though another species may actually be present.[16]

Equally, visual detection of calves over 1,500 m in real time mitigation is not realistic for small animals. This is often only possible by analysing photographs after the fact and when the animals are at high speed and porpoising or breaching. For large whales it may be possible, depending on weather conditions and other factors.

The 1,500-m mitigation zone is theoretically sound, but only seems to complicate real-time mitigation. The Code needs to be simplified.

Members noted that, based on analysis of observer data collected so far (Childerhouse et al 2016), some species are more difficult to detect, particularly by PAM. Most PAM detections are of odontocetes (dolphins and toothed whales), which vocalise at higher frequencies and are thus easier to differentiate from background noise. Baleen whales are therefore detected less often with PAM than would be expected based on visual observations. It was noted that there have been no shutdowns for baleen whales purely on the basis of acoustic detections. This implies that baleen whales are moving into the mitigation zones undetected at night.

It was also discussed that deep-diving marine mammal species (such as beaked whales) are quite difficult to detect via visual or acoustic means, due to short intervals at the surface and infrequent vocalisations. TWG members noted that these species are sensitive to acoustic disturbance. In particular, concern was expressed whether the 30 minute pre-start observation procedures were sufficient to mitigate the risk to these species, given the above notes.

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[16] Although it is noted that dusky dolphins are not known to whistle.

8.1.1 Recommendations for improving detection effectiveness and pre-start observations

PAM is limited by several factors (marine mammals are not always vocalising, lack of knowledge of sounds produced, variable detection range between species, masking of lower frequencies by vessel noise, etc). However, PAM offers the considerable advantage over MMO of allowing observations at night.

Despite this, Leaper et al (2015) suggests that there is a reduction in mitigation efficiency by up to 50% at night (depending on daylight hours). In areas where SoC are expected, operations may therefore be limited to periods of good visibility, as in Canada.

With these points in mind, the TWG recommends:

- New technologies under development might usefully address concerns surrounding detection effectiveness in future; the revised Code should be flexible enough to take advantage of them.
- An extended pre-start observation period may be warranted in deep water areas where animals are more likely to dive for extended periods. However, some TWG members cautioned that:
    - Sensitive deep-divers displaying avoidance behaviours (probably beaked whales) may do so at a distance beyond observers' detection range.
    - If the purpose of increasing pre-start monitoring periods is to account for deep-diving species, the pre-watch periods would have to be increased to account for the durations of species' dives. This is not practical as consistent pre-start monitoring periods of over two hours would be required for every acoustic source used for some species (particularly beaked whales). The vessel would also cover approximately 10 nm in this time.
    - For pre-start observations,
    - a minimum of two observers should be on watch (any lead MMO likely already ensures this).
    - It would be more effective to monitor the area where the seismic source will be activated, rather than four or more kilometres away during the run-up to start of line. Using a chase vessel may allow longer observation time within the start-up area, although they are not always available. The TWG agreed this topic should be revisited, and they should advise on appropriate mitigation methods. However, ultimately no resolution was reached.
    - Mitigation actions timeframes need to match increased pre-watch durations. For instance, there is no point increasing pre-watches if observers cannot implement a mitigation action until 30 minutes before starting the guns. Mitigations must, however, remain relevant to the movement of the vessels and mammals.

Despite the recommendations above some TWG members noted that the most effective way to mitigate impacts of seismic sounds on beaked whales is to avoid important habitats altogether. Studies have shown that monitoring will detect less

than 2% of whales in a ship's path (particularly for long-diving beaked whale species; Barlow and Gisiner 2006, Leaper et al. 2015). It was also noted that beaked whales are often reported as dolphins, especially if MMOs are not familiar with the species.

8.2 Pre-start procedures for start-up in new locations, in poor sighting conditions

TWG members flagged this as a problematic area, as 'new location' is not defined in the current Code. Members were also concerned with the requirement for a 2-hour monitoring period from a moving vessel, as well as the pre-start requirements that treat SoCs and other marine mammals differently. As the Code is currently written it is not clear if the requirements achieve the desired goals for start-ups in new locations.

The question was also raised for DOC about why starting in a 'new survey area' is treated different from any other start-up, as the focus of current mitigation is the area immediately surrounding the vessel in any case. Some suggested the rule could be removed without loss of protection, as it was additional and unnecessary complex.

The TWG suggested a proper assessment of the efficacy of monitoring for marine mammals tens of kilometres away from the start-up location– it is not clear if a 2-hour survey can realistically indicate marine mammal occurrence when actually arriving at a new location. This method of surveying on the way to a new location also does not address the issue of 'clearing' the new location for seismic operations, because little (if any) time will be available to monitor the new area.

MMOs and/or PAM operators may detect animals at any point on the way to the new area. It should be noted that a seismic survey vessel travelling at 4.5 kn (its approximate speed when towing a streamer spread) would travel around 16.7 km in 2 hours. Thus any animals detected at the beginning of the 2-hour period would be at least 16 km away from the operational area and associated mitigation zones. Ideally DOC should therefore require that monitoring be focussed on the area around the start-up location.

The only rationale the group could see for the 2-hour monitoring requirement was that it ensures mitigation zones are cleared should seismic survey contractors want to test single guns, gun clusters and (potentially) entire arrays.[17] Such testing usually takes place before commencing a soft start for the first line of the survey. If this is the intention of the Code, then it should be clarified.

The current Code suggests that if a SoC is detected within the survey's mitigation zones during the 2-hour survey period, prior to arriving at a new location, then start-up of operations would be delayed. However, this suggests that a start-up of potentially over 15 km away from where the animal was sighted would be delayed, which some TWG members suggested made little sense from a mitigation perspective. If this is the case, then it would need to be clarified within the Code.

[17] It was noted, however, that a full gun test requires its own pre-watch.

The TWG did not support increasing the pre-observations to account for deep-diving species as it was deemed to lack scientific support. Instead, the TWG noted (without consensus) that the most effective mitigation measure for beaked whales would be to avoid important habitats – particularly given the difficulties in detecting them visually or via PAM, and the lack of evidence for the efficacy of ramp-up. Similar measures should be recommended for sensitive areas for other species (breeding, feeding and migration).

8.2.1 Suggestions for pre-start monitoring requirements for new survey areas

While the TWG recommends that this section be re-assessed and re-written by DOC to clarify the requirements and specific terms (eg new location), there was no consensus on what changes should be made. Various members of the TWG suggested that:

- 'New location' be defined as a position at least a given distance (TBA) from the last position of acoustic source use, based against a defined number of days (number TBA) since that acoustic source use took place. For example, a 'new location' could be defined as 'Any place within the operational area in which acoustic source operations of any sort have not taken place within a 20 km radius of within the previous 48 hrs.'
- The additional requirements for new areas could be removed entirely.
- A team of MMOs (and potentially PAM operators) be deployed on an independent chase vessel to specifically survey the new start-up area prior to the arrival of the source vessel, if DOC has a specific concern regarding marine mammal occurrence (ie SoCs) within a new operating area. Knowledge of species present may be required for identifying SoCs, which would require experienced and trained MMO/PAM operators to survey the area.

  However, other members noted that the MMIA addresses the expected presence of marine mammals within an operational area, and believed that sending a boat to pre-survey a new area is unnecessary. This is because the source will not be active when starting in a new operational area, and if marine mammals are present they should be detected and identified by the MMOs. Safety concerns for personnel in small boats, especially offshore, were also noted. Finally, concern was expressed over the potential for a survey to be delayed if the pre-survey cannot be conducted (due to things like weather).
- Greater emphasis be placed on the use of PAM[18] for monitoring transit to,[19] and within, new operation areas. Extra MMOs would not improve detection rates when sighting conditions are poor, especially for inconspicuous species such as beaked whales.

[18] As it is currently the only available tool for meeting monitoring requirements during periods of poor visibility.

[19] As is currently dictated in the Code through the 2-hour survey provision.

- Surveys be suspended during periods of low visibility as no improvements to PAM will a) detect animals that are not vocalising, or b) recognise sounds masked by the source vessel.

9. Listing species of concern

The reference document to the Code defines SoC as all New Zealand cetaceans (except common and dusky dolphins), plus the New Zealand sea lion, and it would be easier if the Code clearly stated this too. The current list of SoC includes all baleen whales and beaked whales known to occur in New Zealand waters (10 species of baleen whale and 12 species of beaked whale) as well as 13 other odontocete species including sperm whale, dwarf and pygmy sperm whales, killer whales, pilot whales and melon-headed whales. The list also includes the New Zealand sea lion.

It was also noted that some species known to exist in New Zealand waters (albeit infrequently) are not on the list of SoC, and should be added. These include:

- Risso's dolphins (*Grampus griseus*) – which, while rare in New Zealand waters, are deep divers.
- The spade-toothed beaked whale (*Mesoplodon traversii*). The first stranding of these whales occurred in New Zealand, indicating this extremely rare species might occur in New Zealand waters.

Turtles are common in parts of the New Zealand EEZ with four species found, thus turtles should also warrant a mitigation policy. Cetacean mitigation policy is not appropriate for sea turtles; one suggestion is to include in the Code a specific turtle mitigation action – for example, a shutdown at 200 m using a 10-shot turtle pause or a shutdown with a soft start.

While the TWG agrees that marine turtles deserve a mitigation policy, there was no consensus whether the Code is the right place to do this, as the Code would need to be extended beyond its current focus on marine mammals.

9.1 Suggestions for improving the species of concern list

There was a suggestion that the list could be simplified – for example it might be easier to list only those species that are NOT on the list. If a specific list of SoC is necessary, it could simply list all baleen and beaked whales, and then further list the other odontocete species and sea lion.

The TWG generally agreed the data sheets should be amended to incorporate better species groups and nesting. If varying responses are being given for similar circumstances the options could be explained in detail in the 'Key to Categories' tab in the excel forms. This process may help clarify why some options were given in the first place.

One possibility would be for DOC to adopt some existing international standard, such as the IWC standard, or the Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) codes.

10. Other points discussed

The TWG supports analysis of the existing sightings data, to provide a better basis for assessing the efficacy of PAM in real-world seismic operations.

Discussions on appropriate actions when acoustic detections are judged as likely to be within mitigation zones (but not actually localised by the system) needs to be held by DOC and the EPA outside of Code review.

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