Marine Mammal Observer Association






Marine Mammal Observer Association: Position Statements

The Key Issues That Should Be Addressed When Developing Mitigation Plans To Minimise The Effects of Anthropogenic Sound On Species Of Concern.

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This document has been complied by the Executive Committee of the Marine Mammal Observer Association (MMOA).

The MMOA Executive Committee contains a huge wealth of MMO experience including two Joint Nature Conservation Committee (JNCC) and Bureau of Ocean Energy Management (BOEM)/ Bureau of Safety and Environmental Enforcement (BSEE) accredited trainers, a PAM trainer, an Irish Whale and Dolphin Trust (IWDG) MMO coordinator and long established MMOs and PAM operators who are highly experienced and well respected in their field.

Current committee members are Alison Gill (Chair), Caroline Weir (Vice Chair), Carolyn Barton (Treasurer), Juliet Shrimpton (Secretary), Jacklyn Barrs, Sarah Barry, Claire Lacey, Patrick Lyne, Simon Mustoe, Heather McRae and Frances Robertson.

This document is open for consultation and the date for review is **31st March 2013.** Comments or questions regarding this document should be sent to info@mmo-association.org by this date.

Marine Mammal Observer Association Position Statements

The Marine Mammal Observer Association (MMOA) is a membership based association with the aim of bringing together and representing individuals who work commercially and professionally as Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM) Operators who implement mitigation measures to protect marine life during industry operations. The MMOA also provides information to other individuals that have an interest in MMO issues.

These position statements have been developed by the MMOA to outline our position on a number of issues relevant to the minimum standards that should be adopted for marine mammal observation, passive acoustic monitoring and mitigation to minimise the effects of anthropogenic sound on Species of Concern (SoC)[1] . **Please note that in some countries – regulatory bodies have formalised procedures and where that is the case those procedures must be strictly adhered to.** These statements may be useful for any regulatory body wishing to revise existing procedures or for government, non-government organisations and industry formulating marine mammal mitigation procedures for geographic areas where no formal regulations are in place. Throughout these documents we refer to MMOs and PAM Operators, and we use these terms in purely a mitigation context. In other words, for the specific use of these personnel during mitigation of anthropogenic sound sources rather than for research surveys or baseline monitoring surveys.

Summary of our position on key issues:

- A thorough Environmental Impact Assessment is required prior to all projects to provide the information necessary to formulate a Mitigation Plan.
- Mitigation Plans should be site, species and source specific.
- Mitigation Measures incorporated in Mitigation Plans should be based on scientific principles, in the absence of which a precautionary approach should be adopted.
- The limitations of Passive Acoustic Monitoring should be realised in order to mitigate effectively during times when Visual Monitoring is compromised.
- Only suitably qualified, experienced and dedicated personnel should be hired as Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM) Operators.
- MMO/PAM mitigation training certificates should not be the only requirement to qualify a person as an MMO or PAM Operator.
- MMO/PAM Mitigation Training Providers should not advertise their courses to be the only qualification needed to qualify a person as an MMO or PAM Operator nor should Regulators, Clients or MMO/PAM Operator Provider Companies consider certificates to be such.
- MMO Data that are to be scientifically analysed must be collected and analysed by suitably qualified personnel.
- MMO data collection should be standardised globally to create a stronger dataset.
- The publication of individual MMO data by suitably qualified MMOs should be encouraged given that permission has been granted from the Client.

[1] The MMOA defines Species of Concern (SoC) as those species which are included in the mitigation protocols implemented by MMOs and PAM Operators. Marine mammals (cetaceans, pinnipeds and sirenians) are the focal faunal groups considered by most regulators worldwide. However, the MMOA believes that other marine species warrant inclusion as SoC in many geographic regions, for example large marine species considered to be of conservation concern by the International Union for Conservation of Nature (IUCN) such as sea turtles, whale sharks, basking sharks and some species of ray.

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1. Environmental Impact Assessments and Mitigation Plans

The Marine Mammal Observer Association (MMOA) considers that the production of a comprehensive and informative Environmental Impact Assessment (EIA) and the subsequent development of a site-specific, detailed Mitigation Plan (MP) for Species of Concern (SoC) are fundamental to effective mitigation programmes. It is important that these documents are produced well in advance of a mitigation survey and that both documents are made available to the mitigation team at the start of a survey so that the processes involved in developing the MP are clearly understood by the Marine Mammal Observers (MMOs)/Passive Acoustic Monitoring (PAM) Operators. Some key points are outlined below.

Environmental Impact Assessment (EIA)

In the context of this document, the purpose of an EIA is to identify, predict, evaluate and mitigate the effects of anthropogenic sound on SoC prior to, and during, a survey using a sound source. Some regulators provide specific guidance for the development of EIAs relating to the potential environmental impacts of seismic surveys and the use of other anthropogenic sound sources. The MMOA considers that the EIA content with respect to SoC and anthropogenic sound should include the following (as a minimum):

- Information (via comprehensive reviews of published and 'grey' literature, and available datasets) on the potential and confirmed occurrence of SoC within the project area. This should include (at least) information on species presence, density, seasonal and spatial distribution, breeding periods and behaviour, where these are available. Any species of particular sensitivity should be identified, for example through assessments of SoC global and regional conservation status (such as IUCN status), local protective legislation to identify locally-important conservation priorities, and compiled information on breeding, feeding or migratory habitat which may indicate the presence of critical habitats for SoC. Where existing information on species occurrence within a project area is scarce, the establishment of baseline characterisation surveys should be considered to provide initial information on SoC occurrence on which a mitigation plan can be based and subsequent impacts identified. Given the marked seasonal variation in occurrence of many SoC within particular areas, any baseline characterisation surveys carried out should occur at the same time of year as the planned use of the anthropogenic sound source.

- Details of any environmental legislation pertinent to the protection of SoC in the project area and its implications for the mitigation programme.

- Characteristics of the source being used during the survey. These should include equipment types, amplitude (sound level) and pressure, frequency characteristics and pulse duration.

- An assessment of transmission loss around the sound source. This is commonly modelled as simple geometric spreading, either spherical (intensity falls off with distance squared) or cylindrical (intensity falls linearly with distance). However, these methods may be oversimplified in the case of loud sound sources in deeper waters, or depending on specific oceanographic conditions within a project area. Consequently, the MMOA considers that transmission loss modelling should always be site-specific and should take into account the local topography and oceanography of the project area at the time of the survey.

- Identification of, and predictions regarding, the potential impacts of the sound source on the SoC that occur in the area (bearing in mind that this will likely require separate evaluation for particular species groups, for example baleen whales, odontocetes, pinnipeds, sea turtles etc.), via a thorough literature review. With regard to anthropogenic sound, consideration should be given to:

    - The potential impacts of anthropogenic sound on the SoC occurring within the survey area. This should include both direct (e.g. tissue damage, hearing loss) and indirect (e.g. displacement of SoC or their prey species) impacts.
    - The sound levels documented to cause hearing loss and other impacts in the specific SoC found within the survey area.
    - The current 'safe sound levels' (i.e. sound levels below which exposure is unlikely to result in disturbance or injurious impacts) documented for SoC.
    - Calculations of the radius of these safe levels around the proposed sound source (taking into account actual/expected sound transmission properties within the specific survey area and pulse emission rate).
    - Conclusions on the likely impacts on individual animals and at the population level (especially considering feeding, breeding and migratory areas), based on sound exposure and overall duration of the survey.
    - An assessment of cumulative impacts where more than one operation is active simultaneously or activity is over a long period of time. Some piling construction projects may last for 2- 3 years. Note that an assessment of cumulative impacts is a requirement under some countries EIA regulations.

- A review, identification and evaluation of other potential impacts of the survey work on SoC within the survey area, for example vessel strikes, pollution and entanglement in seismic gear.

- Information on how the potential impacts on SoC identified during the EIA will be mitigated during the survey. This may take the form of a Mitigation Plan (MP) for specific high-risk impacts (e.g. a MP for sound source mitigation as described below) and additional statements regarding other impacts (e.g. the use of 'turtle guards' on seismic tail buoys to mitigate against sea turtle entrapment).

Mitigation Plans (MPs) for Anthropogenic Sound Sources

The MP should provide the specific details of how particular impacts on SoC identified during the EIA will be mitigated during the survey. The MMOA considers that a MP should be:

- Detailed, providing unambiguous instruction on the procedures to be followed under the various circumstances that may arise during a survey (flow charts of mitigation actions are often beneficial).
- Clear and using correct, consistent and well-defined terminology throughout, to avoid any misinterpretation.
- Produced by, and reviewed by, personnel who have sufficient expertise (indicated by qualifications and previous experience with marine fauna mitigation) to make these assessments and decisions.

Due to their first-hand experience in the practicalities of implementing MPs during surveys, the MMOA recommends that experienced MMOs/PAM Operators are shown the MP prior to a project in order to highlight any discrepancy or areas that need further clarification. The MP agreed prior to the survey should be followed rigorously as a minimum standard throughout the survey and should not be subject to changes once a survey has commenced. The only exceptions should be when ambiguities in the protocols require clarification, or when additional mitigation measures are added based on unexpected faunal encounters. These changes must be approved by the relevant authority or regulator.

The information below relates specifically to MPs which aim to mitigate the impacts from an anthropogenic sound source on SoC. **Some regional regulators have existing mitigation procedures that must be adopted as a legal requirement during surveys in their waters, and those procedures should always be followed when developing a MP**. The MP should clearly describe the recommended suite of mitigation measures to be implemented by the mitigation team, in order to minimise the potential impacts of the sound source on the SoC that were identified during the EIA. This should include the following (as a minimum):

- Establishment of a mitigation zone (MZ) around the sound source.
- Procedures for the monitoring of SoC within the MZ prior to and during operations.
- The importance of hiring suitably qualified Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM) Operators.
- Use of a suite of appropriate real-time mitigation measures should a SoC be detected inside the MZ prior to and during source operations. This should also include a list of SoC for which mitigation measures will apply.
- The incorporation of additional mitigation measures to minimise the likelihood that undetected SoC are exposed to injurious levels of source activity (e.g. due to night, poor weather or the limitations of monitoring techniques). This should include a detailed outline of source start-up procedures as well as clarification on what procedures should be followed after any breaks in source activity. In the case of seismic airgun arrays this should include information on whether the system will be automated or manually-operated, details of the order in which each gun of specified volume/sound level will be added-in over time and a

graph showing cumulative volume/sound level of the array over time. This should expressly include procedures for the inclusion of ‘spare guns’ in the soft start without exceeding the normal operational volume during production and procedures for soft starts during gun tests.

- Procedures to ensure that the amount of source activity is minimised as much as possible during operations.
- Information on the communication links (and chain of command) between the mitigation team and the operators of the sound source, in order to ensure quick and well-implemented mitigation actions when animals are observed.
- Procedures for recording and reporting compliance to appropriate regulatory bodies.
- Documentation that is carefully worded to ensure that it is interpreted as mandatory rather than optional.

2. Mitigation Measures Required in a Mitigation Plan

The Marine Mammal Observer Association (MMOA) has developed some generic advice and guiding principles to follow when drafting a Mitigation Plan (MP) for Species of Concern (SoC) during surveys using anthropogenic sound sources in the marine environment. This advice is based on the MMOA's belief that nominating single generic values for mitigation zones, delay durations and soft starts is inappropriate, and instead supports the establishment of survey-specific mitigation measures based on the water depths, oceanographic conditions, sound source and SoC encountered during a particular survey. **Please note that in some geographic areas the regulatory bodies have developed a set of formalised mitigation procedures and where that is the case those procedures must be strictly adhered to.** Before developing the appropriate MP a full Environmental Impact Assessment (EIA) should have been carried out.

The Principles of Establishing Mitigation Measures for SoC

The MMOA believes that the principle adopted at the EIA stage prior to the survey (hereafter the 'Planning Principle') should be:

> **"to minimise the likelihood of potential injury or disturbance to Species Of Concern (SoC), including potential displacement of SoC from critical habitat"**

This planning principle will be achieved by identifying seasons/areas of particular importance for SoC (through the EIA and, where necessary, baseline survey work), and scheduling survey activities around those times/areas. The MMOA believes that avoidance of critical habitat is the single most important mitigation measure, and should be considered early in the survey planning process.

The MMOA believes that the principle adopted during real-time mitigation activities during a survey (hereafter the 'Mitigation Principle') should be:

> **"to minimise the likelihood that all Species of Concern (SoC) are exposed to source levels that have the potential to cause injury or death"**

This mitigation principle should then be consistently applied throughout the procedures adopted. The remainder of this document is concerned with the implementation of the mitigation principle.

More detailed advice on mitigation measures are outlined below:

Mitigation Zones (MZs)

An acceptable ('safe') level of source activity should be determined i.e. a sound level which scientific studies indicate is unlikely to be injurious to the identified SoC. The MZ will then represent the radius around the sound source within which sound levels are higher than this predetermined 'safe' level. More than one MZ may be appropriate when different species groups are being mitigated for, e.g. sea turtles, baleen whales, odontocetes and pinnipeds.

The MZ should be established by transmission loss modelling to determine the zone of influence for a particular source and activity. The MZ should be determined by the site-specific source level and by in situ measurements of local environmental conditions (e.g. water depth, seabed type, water temperature) which affect the resulting sound propagation. Where surveys are of long duration (> 1 month), MZ models should be updated regularly according to changes in localised oceanographic conditions within the site. For example, changes in water temperature and salinity are often measured regularly using T-S dips during seismic surveys and can be incorporated into updated models to calculate site-specific MZs over time.

If sound source modelling at the site of the actual project is not possible, the radius of the MZ should be determined by assuming that local conditions are optimal for sound propagation (i.e. the worst case scenario) using idealised modelled source levels and the least favourable (in terms of transmission loss) environmental conditions that are known to occur within the site. The radius of the MZ should be established based on the highest sound levels likely to be emitted by the sound source during the survey (i.e. in the case of seismic surveys, the firing of all guns simultaneously on the array and not including the spare guns – the firing of spare guns should not be carried out unless other guns are dropped out first so that production volume is not exceeded).

Monitoring of SoC Within the Mitigation Zone Prior to and During Operations

Monitoring period prior to source activity - A minimum monitoring period should be adopted prior to the initiation of a sound source to detect any SoC in the area. The duration of the monitoring period can be determined by what is known about the surfacing rates and behaviour of SoC in the area. Various mitigation procedures worldwide recommend no less than a 30 minute watch period prior to source activation and the MMOA recognises this as an acceptable minimum period.

Monitoring during source activity – The MMOA recommends that monitoring for SoC continues throughout periods of source activity, in order to collect information on potential impacts. When shut-down procedures are part of the adopted mitigation protocol (as recommended by the MMOA for sound levels considered likely to cause injury/mortality) then monitoring will be required throughout periods of source activity in order to protect SoC.

Monitoring methods – Monitoring of the MZ may comprise visual monitoring during daylight hours, passive acoustic monitoring (PAM) during all hours and night vision/ infrared techniques during hours of darkness. All monitoring methods should be assessed for their efficiency and likelihood of detecting the SoC within a particular area. Marine Mammal Observer (MMOs) and Passive Acoustic Monitoring (PAM) Operators should be positioned as near to the source as possible for effective monitoring of the MZ. The MMOA consider that the MMOs/PAM Operators should always be located on the source platform[2], unless an alternative platform has the potential to be closer to the sound source. This would be essential if the distance of the sound source from the platform compromises the ability of the MMO/PAM Operator to effectively monitor the MZ for the relevant SoC. The relative detectability of each species group should be carefully considered, since some, for

[2] Platform is defined throughout this document as any mobile or static base on which MMOs are located in order to carry out marine mammal mitigation duties. This potentially includes vessels, rigs, shore and airplanes, but most commonly-refers to vessels.

example sea turtles, may only be reliably detected within a few hundred metres of a visual observer. Consequently, a MMO located on a source platform from which the sound source is deployed several hundred metres astern (i.e. most 3D/4D seismic vessels) is unlikely to be able to reliably visually detect such fauna within the latter portion of a MZ. Where multiple sources are deployed from multiple survey platforms, a separate MZ and monitoring team are required for each source.

Use of Suitably Qualified Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM) Operators

Monitoring should only be conducted by independent, experienced and dedicated MMOs and PAM Operators. The MMOA consider that, in this context, experience should reflect both field expertise with marine mammals (in order to develop detection and identification skills) and suitable training courses (in order to develop proficiency with implementing mitigation procedures and completing data forms). Please see the MMOA Position Statement – *Marine Mammal Observer (MMO) Qualifications* and *Passive Acoustic Monitoring (PAM) Operator Qualifications* - for further guidance. An assessment should be made of how many MMOs and PAM Operators are required to provide the necessary mitigation monitoring, allowing sufficient rest periods for fatigue. As a rule, a MMO/PAM Operator should not be expected to work more than the standard 12 hr work per day of other seafarers. Additionally, since visual observations require a high level of concentration, the MMOA recommends that a MMO team should be organised such that no MMO works for more than 2 hr solid followed by a break of at least 1 hour.

Appropriate Real-time Mitigation Measures Should a SoC be Detected Inside the MZ Prior to and During Source Operations

Species of concern inside the mitigation Zone (MZ) - If a SoC is detected (visually or acoustically) within the MZ prior to source activation, commencement of the source should be delayed until such time that the animals depart the MZ. If it is unclear whether an animal has departed the MZ, an additional "buffer" time should be added to ensure a high likelihood that the animal is no longer in proximity to the sound source. Due to the limitations of passive acoustic monitoring (see Position Statement – Passive Acoustic Monitoring) it is very unlikely that a PAM operator, during the hours of darkness, will be able to determine when SoC have left the MZ (with the only possible exception being the ability to track vocalising sperm whales) and adding buffer times will be a standard procedure throughout night-time operations. Vessel speed, and the behaviour and swimming speeds of specific SoCs, should be considered to determine the likely length of time for a safe distance to be established. Different buffer times may be required according to the species groups being mitigated for, e.g. sea turtles, baleen whales, odontocetes or pinnipeds.

If a SoC is detected (visually or acoustically) within the MZ while a sound source is active, the source should be shut down until such time that the animals depart the MZ (see above for circumstances where it is unclear whether an animal has departed the MZ). The source should resume using a soft start procedure (see below).

Some regulators worldwide do not adopt shut down procedures, based on a unproven "common sense" principle that animals that opt to approach a sound source voluntarily, are choosing to do so at their own risk and consequently do not require mitigation. This principle has also been adopted as 'best practice' in the mitigation plans for surveys in some geographic areas where no formal regulator guidance is in place. However, there is no scientific basis for the assumption that animals entering a mitigation zone (which has previously been defined as an injurious zone) 'voluntarily' while a source is active, are somehow less susceptible to impacts. This may particularly be the case when young, sensitive animals are accompanying adults and are involuntarily exposed to high sound levels. Finally, some SoC, for example sea turtles basking at the surface for metabolic purposes, may not have sufficient mobility to move away appropriately from an approaching sound source. The MMOA believes that mitigation plans should aim to "**minimise the likelihood that all species of concern are exposed to source levels that have the potential to cause injury or death**" and therefore supports shutting down a sound source whenever a SoC enters the MZ for whatever reason.

The Incorporation of Additional Mitigation Measures to Minimise the Likelihood that Undetected SoCs are Exposed to Injurious Levels of Source Activity (e.g. due to night, poor weather or the limitations of monitoring techniques).

Adopt a ramp-up or soft start procedure[3] - The aim of the soft start is to initiate the source at the lowest possible sound level and gradually increase power over a pre-defined time period to reach the operational sound level. This procedure is intended to allow animals to depart the immediate vicinity of a sound source prior to being exposed to potentially injurious levels of sound. The soft start must commence at a sound level which does not have the potential to cause injury. If the source cannot be started at a sufficiently low (i.e. 'safe') power level, then an alternative method, such as deploying specially designed acoustic alarms, should be adopted. Acoustic alarms should be designed to cover the frequency ranges of all SoC and should also be activated gradually.

The duration of a soft start should be sufficient to allow an animal to move to a safe distance before full power is achieved. The behaviour and swimming speeds of the SoC should be considered to determine the length of time that it takes for an animal to move to a safe distance. Consideration should be given to situations when full soft starts might not be necessary – for example when testing low-power single airguns at source levels below those that are considered injurious.

In the case of seismic airgun arrays, the airgun soft start procedure should be automated wherever possible to avoid operator inconsistencies in start-up techniques. Seismic contractors should have, and follow, detailed protocols for the order in which each gun of specified volume/sound level is added-in over time and a graph showing cumulative volume/sound level of the array over time. This should expressly include procedures for the inclusion of 'spare guns' in the soft start (without exceeding normal operational volume during production) and procedures for soft starts during gun tests.

[3] The terms 'ramp-up' and 'soft start' refer to the same operational procedure where a sound source is initiated at its lowest sound level and gradually increases in sound level over time to reach the desired operational level. The terms are used by different regulatory bodies worldwide and are inter-changeable. We use 'soft start' throughout the remainder of this document.

For other surveys utilising sound sources, such as pile driving, military sonars and explosives, it is important to have pre-determined and detailed soft start procedures in place for all equipment that produces high-amplitude sound with the potential to cause injury to SoC.

Breaks in Source activity – Technical issues with equipment sometimes result in a "break in source activity" during surveys, where the sound source is temporarily shut down for maintenance. Various regional guidelines stipulate permitted short lengths of time within which a source can resume at full power following such a break in activity. If the source does not resume within that period of time, a soft start must be carried out prior to resuming the survey. Determining an appropriate length of time for a permitted break in source activity (i.e. where a soft start is not required on source resumption) should take account of:

- Whether the MMO and PAM Operators can be certain that the MZ was free of SoC (i.e. whether they were on watch, whether it was night or day, the detectability and mobility of the SoC).
- The speed of the platform and how far it has moved since shutting down.

The MMOA believes that in most cases a precautionary approach to mitigation should not permit breaks in source of activity of more than 5 minutes without requiring a soft start. This is particularly the case for SoC of low detectability such as sea turtles. The MMOA does not support resuming at full volume following a break in source activity if no visual watch for SoC was being maintained throughout the break by a MMO (i.e. at night or in poor visibility). This procedure should only be utilised during occasional, unexpected incidences of technical issues with source activity; it should not be a routine method of avoiding a subsequent soft start.

Noise records – The MMOA is aware that noise records of (usually) 1 or 2 minutes duration are routinely carried out during seismic surveys, prior to the start of each line. This involves shutting down the source and then resuming at full power. The routine occurrence of noise records should be acknowledged and specifically included within Mitigation Plans. The mitigation team should maintain a watch for SoC throughout the duration of noise records in case animals are observed within the MZ during the break in firing and mitigating actions are required. The duration of noise records should be kept to the minimum possible, and these should not be carried out and included within the duration of the soft start.

Use of a mitigation source - The practice of keeping sound sources active at reduced power in-between operations (for example during seismic survey line changes) is sometimes adopted by regulators or included in mitigation plans where no formal regulations are in place. This is called the "minimum source" or mitigation source", and is intended as a 'common sense' approach to warn animals of the location of a sound source. There is no currently-available scientific evidence that "mitigation sources" are effective at deterring animals from the vicinity of an active source (indeed, there is equally the potential for attraction of animals towards low power sound sources). Consequently, the MMOA recommends that careful consideration should be given before adopting this unproven technique, particularly given the significant amount of additional sound that will be emitted into the marine environment as a result.

Minimising Source Use and Levels

Best practice should include both minimising overall use of the sound source throughout the survey and using the lowest practicable sound levels. The sound source should be switched off whenever the survey is not in production mode. Testing of sound sources should be kept to an absolute minimum. Start-up of the sound source (including soft start) should be run as close to the start of operations as is possible. The use of a mitigation source in between operations is discouraged until scientific evidence is available to support the procedure.

Communication Links

It is important to clarify the communication links (and chain of command) between the mitigation team and the operators of the sound source, in order to ensure quick, clear and well-implemented mitigation actions when animals are observed.

The mitigation team should have direct contact with personnel operating source equipment so that delays and shutdowns are executed immediately. The MMOA recommends that the use of handheld radios (as opposed to intercom systems) is vital (especially for MMOs, who are likely to be outside on deck during pre-shoot watches) to ensure that mitigation guidance is swiftly conveyed to the operations crew whilst allowing the observer to continue to monitor the animals. A sufficient number of handheld radios should therefore be made available to the MMOs and PAM Operators at all times.

Recording and Reporting Compliance to Appropriate Authorities

Prior to any project it should be determined how compliance with mitigation measures is to be reported to the appropriate authorities. What data are to be collected and how this is to be recorded should be determined from the outset. The data recording protocol will then need to be passed onto on any appropriate authority for assessment.

The MMOA recommends that data collection during mitigation surveys should be standardised according to established protocols. For example, a set of standardised electronic MMO and PAM data forms have been developed by the E&P Sound and Marine Life Joint Industry Programme (JIP) (www.soundandmarinelife.org), a body affiliated with the International Association of Oil and Gas Producers (OGP). The data forms have been frequently revised following extensive feedback from MMOs and PAM Operators working in the field, and are recommended for a global standard. These forms have been adopted by the Joint Nature Conservation Committee in the United Kingdom and can be found online at: http://jncc.defra.gov.uk/page-1534

3. Passive Acoustic Monitoring

The Marine Mammal Observer Association (MMOA) recommends that Passive Acoustic Monitoring (PAM) equipment supplied for marine mammal mitigation purposes should comprise (at least) the following components:

- An appropriate length of cable to deploy the hydrophone elements at a suitable distance from engine noise in order to be effective. At least one spare cable is recommended in case damage is incurred during deployments.
- Hydrophone elements with the correct frequency range for the Species of Concern (SoC). This may mean multiple elements with differing frequency sensitivities.
- Sound cards (and back up drivers) with the appropriate sampling rate for the SoC and full instructions on their configuration.
- Pairs of hydrophones elements for each frequency range needed in order to provide bearing information for tracking animals.
- Full details of separation distances of each pair of hydrophone elements for bearing determination.
- GPS for tracking vocalisations (needed for range and bearing determination).
- Calibrated depth sensor and full instructions on configuration.
- Filtering system for unwanted noise and full instructions on configuration.
- Professional noise cancelling headphones (with battery charger and spare batteries).
- Appropriate software for real time monitoring which shows bearing and range to the animals and species classification, where possible.
- Every component of the PAM equipment in duplicate (including the smallest connectors) in case of equipment failures.
- Full detailed manual of assembly and calibration.
- Full inventory of contents.
- Properly labelled shipping containers and reels.
- 24 hr. support from the PAM equipment provider for technical problems and configuration advice.

Using PAM alongside visual monitoring by Marine Mammal Observers (MMOs) greatly improves the possibility of certain marine mammal species being detected, such as harbour porpoises and sperm whales which vocalise frequently and distinctively. However, clients, regulators and PAM Operator provider companies should be aware of several inherent limitations with the use of PAM for mitigation purposes. These points are vital to understand when considering whether PAM is suitable for use as a sole monitoring method during darkness or other periods of limited visibility (i.e. whether it has a reasonable likelihood of reliably detecting the SoC present within a site).

Passive Acoustic Monitoring (PAM) has the following limitations:

- Many potential SoC will not be detected using PAM equipment because they do not produce vocalisations, only vocalise above water or vocalise only infrequently, for example sea turtles, sirenians, whale and basking sharks, and many species of pinniped. Even cetacean species may not vocalise all the time and may pass close to a PAM system but remain undetected. For example, minke whales in the north Atlantic are known to be very difficult to detect acoustically on their summer feeding grounds, and many MMOs/PAM Operators will attest to having visually observed dolphins close to a platform without detecting them acoustically.
- Limited ability to detect baleen whale vocalisations due to the fact that PAM equipment used for mitigation purposes is usually deployed astern of large commercial vessels and in proximity to continuous low frequency engine noise. Propeller noise (together with water noise and the low frequency sound emitted by the airguns (or other sound source) themselves) masks low frequency biological signals and renders the detection of baleen whale vocalisations virtually impossible using the currently-available PAM systems.
- In cases where baleen whales are occasionally detected, for example singing humpback whales, the nature of these vocalisations, which travel over many kilometres, make it very problematic to determine range and bearing using current equipment and a PAM Operator may be unable to say with any level of reliability whether an animal is within a MZ or not.
- Species that vocalise at high frequencies will not be detected beyond short distances. For example, the reliable detection range for harbour porpoise signals is approximately 200-300m. Therefore, a harbour porpoise may be present in the outer region of a MZ (.e.g. 300-500m from the source) but not detected by a PAM system.
- The vocal repertoires of many marine mammal species are poorly-described or unknown.
- Many marine mammal vocalisations, particularly the echolocation click trains produced by odontocetes, are directional in nature and not easily detected by PAM equipment if the animals are facing away from the hydrophone. For example, bow-riding dolphins are often undetected by PAM systems which are deployed astern, while harbour porpoises (which often show avoidance reactions to platforms) will not be detected when swimming away from a vessel's track line.
- Range determination is only possible for some species through the tracking of bearing information over time, using the timing of signals arriving at pairs of hydrophone elements deployed at known distances from the ship's stern and the ship's GPS position. Current PAM systems with simple pairs of hydrophones are often inadequate at providing suitable bearing information for range determination. In the majority of cases, the current PAM systems used during mitigation surveys do not provide adequate range Information to allow a PAM Operator to determine whether an animal is inside or outside of the MZ. Furthermore, accurate range estimation using current software relies on a hydrophone being deployed in a straight line and at set distances astern of the vessel. It is usually the case during pre-shoot mitigation watches that the vessel is engaged in a slow turn between seismic lines, and consequently the hydrophone will also be angled and curved to one side of the vessel track line causing inaccuracies in range estimation.

The MMOA believes that PAM equipment can be used with reasonable effectiveness during mitigation for some cetacean species, in particular:

(1) The harbour porpoise and other specific small odontocetes (e.g. porpoise species and *Cephalorhynchus* dolphins) known to emit regular high-frequency echolocation clicks. If these clicks are detected then animals can almost certainly be concluded to be within a few hundred metres of the PAM system, making them a good candidate for PAM-based mitigation.
(2) The sperm whale, which emits very regular clicks throughout its dives and embarks on dives of long duration which make it a less suitable species for visual tracking. The clicks of sperm whales are distinctive, regular and by their nature are amongst the most likely sounds to provide good bearing and range estimation using the currently-available software.

However, aside from these species, the MMOA believes that the use of PAM equipment for mitigation purposes for other SoC should not be considered to represent a reliable sole method but rather should be supplementary to other mitigation measures.

PAM Detections and Noise Samples

To date, PAM recordings made during mitigation surveys, or noise sample records for quality assessments (i.e. to gauge water noise and masking and determine how effective the PAM system was likely to be at detecting marine mammals in practice), are not being collated by regulatory bodies. The MMOA recommends that the use of PAM during every mitigation project should be objectively assessed for detection rates, to determine whether acceptable signal-to-noise ratios are achieved for mitigation purposes and to test the sound quality of the PAM system. The effectiveness of PAM for marine mammal mitigation purposes cannot be assessed without understanding the acoustic environment that the systems are being deployed in and the corresponding likelihood of detecting an animal.

Submission of PAM Data to Regulatory Bodies

It is not currently a requirement for recordings of PAM detections to be submitted to a regulatory body. However, the MMOA believes that this is desirable in order to:

- Assess the likelihood of acoustic detection for different SoC.
- Provide a means of checking and validating the species identification of acoustic detections recorded.
- Provide a means of assessing the mitigation decisions made based on particular acoustic detections (i.e. double-checking of range and bearing information or amplitude).
- Provide opportunity for acoustic analysis research.

At present, PAM data is not checked or verified and its effectiveness in mitigation surveys (in terms of equipment functioning properly, adequate ambient noise levels for making detections, the number and species of detections made, the provision of adequate range and bearing information and the consequent implementation of mitigation decisions) has not been examined.

Training for PAM Operators

A PAM Operator needs to be able to assemble (and sometimes repair) PAM equipment, deploy it (from a variety of platforms) safely, maximise the signal-to-noise ratio for the detection of marine mammals (and other SoC), configure PAM software with respect to monitoring screens and hardware settings (including for range and bearing information), identify acoustic signals and track bearing information to determine range (if possible). PAM is therefore a technical skill that needs thorough prior training and much experience at sea to accomplish. Please see the MMOA's Position Statement - *Passive Acoustic Monitoring (PAM) Operator Qualifications* - for more information on this subject.

The MMOA emphasises that the skills required to work effectively as mitigation PAM Operator are difficult to acquire through short training courses, and require practical time at sea. Consequently, the MMOA recommends that organisations hiring PAM Operators for mitigation surveys seek to use personnel with proven previous field expertise with marine mammal acoustics. The MMOA does not promote the use of inexperienced PAM personnel as trainees offshore unless those persons are "extra" to the required number of experienced PAM Operators needed to cover 24 hr mitigation (i.e. trainees should be supplementary to, and learning from, the mitigation team, rather than working as part of it). The MMOA recommends that persons seeking acoustic monitoring experience achieve this by attending training courses or by joining voluntary or dedicated research projects (paid or otherwise).

4. Marine Mammal Observer (MMO) Qualifications

The Marine Mammal Observer Association (MMOA) emphasises that a Marine Mammal Observer (MMO) mitigation training certificate should *not* be the only requirement to qualify a person as a MMO on a mitigation survey. A MMO requires *all* of the following skills to be able to complete their job professionally and competently:

- **Good vision (with or without corrective aids) –** provided by medical documentation of recent eye test.
- **A good attitude to conducting watches of concentrated effort, often for long days and several consecutive weeks** - evidence of work experience where this has been proven such as previous (non-seismic) surveys at sea or long periods in the field conducting surveys or monitoring work. Attitude/enthusiasm can also be determined via feedback from previous employers or colleagues
- **Ability and experience to identify the specific SoC known to occur within the region of the survey and for which mitigation measures apply** - evidence of previous experience of researching marine mammals at sea or working as a naturalist guide at sea or conducting paid or voluntary cetacean surveys or work at sea where marine mammal experience has been achieved incidentally – i.e. fisheries observers and other marine researchers. This experience should be of an appropriate length of time to have gained the skills to be competent at identifying marine mammal species – MMOA recommends this to be at least 20 weeks in an area where a range of marine mammal species are encountered. In areas where mitigation is being applied to other SoC (e.g. sea turtles), then a MMO should be selected who has proven field experience with the specific SoC in question.
- **Ability to make accurate estimates of range at sea** - through prior at-sea experience during research or voluntary surveys or theoretical training through appropriate training courses.
- **An understanding of the mitigation requirements of the area or project** - through appropriate training from a regulator approved training course or from client/employer created training courses.
- **Ability to make decisions quickly and to convey the necessary mitigation information to the crew concisely, politely, objectively and firmly** - personnel working as a MMO should be independent and should have the character and confidence to make correct mitigating decisions under pressure. Such characteristics could be gauged via feedback from previous employers or colleagues.
- **Experience of recording data in a scientific and accurate manner** – through a formal academic qualification or through work experience where this was achieved (in the latter case references should be sought).
- **Experience of assimilating data, basic data analysis and writing reports** – through a formal academic qualification or through work experience where this was achieved (in the latter case references should be sought).
- **Ability to work in a team and communicate well** - such characteristics could be gauged via feedback from previous employers or colleagues.

- **Aspire to improve their skills as an MMO and to further their knowledge** – belong to a professional body such as the MMOA or other appropriate professional body where information and code of practice is promoted. Attend training courses and refreshers to improve knowledge and skill.

A Client hiring MMOs for a mitigation survey through a MMO provider company (personnel agency) should request this standard of MMO qualification in order to promote a professional standard in their environmental objectives.

Benefits of Hiring Professional MMOs with all of the Above Skills

The MMOA emphasises that the use of MMOs who meet the above professional standards is likely to confer a number of benefits for the clients of mitigation surveys, both in terms of proving compliance with mitigation requirements and maintaining a positive environment on-board the platform. These potential benefits include:

- Client confidence in meeting environmental requirements.
- A professional working attitude by the MMO on board the platform, ensuring courteous interactions with crew, appropriate chains of command are followed and good cooperation is achieved when mitigation measures are required.
- Early detection of SoC in the field and the experience to gauge the behaviour and direction of particular animals and request early mitigation responses that may avoid disruption to the survey.
- Accurate identification of SoC to species level which ensures that species-specific mitigation measures are implemented correctly and potentially avoids erroneous mitigation measures that may be costly to the survey.
- Ability (based on previous experience and correct use of field equipment) to make good distance estimates, which may avoid unnecessary disruption to the survey.
- Collection of standardised, high-quality data that serves to prove compliance with mitigation requirements and may additionally contribute to robust scientific analysis.
- Knowledge and experience to answer questions that arise during the survey, and to guide the crew through the required mitigation measures clearly and concisely to avoid error and confusion.

5. Passive Acoustic Monitoring (PAM) Operator Qualifications

The Marine Mammal Observer Association (MMOA) emphasises that a Passive Acoustic Monitoring (PAM) training certificate should *not* be the only requirement to qualify a person as a PAM Operator. A PAM Operator requires *all* of the following skills to be able to complete their job professionally and competently:

- **Good hearing** - provision of medical documentation of a recent hearing test.
- **A good attitude to conducting monitoring periods of concentrated effort, often for long days and several consecutive weeks** - evidence of work experience where this has been proven such as previous (non-seismic) surveys at sea or long periods in the field conducting surveys or monitoring work. Attitude/enthusiasm can also be determined via feedback from previous employers or colleagues
- **Ability and experience to identify a range of marine mammal acoustic signals** - previous experience of PAM for marine mammals at sea or conducting paid or voluntary cetacean surveys where PAM was adopted. This experience should be of an appropriate length of time to have gained the skills to be competent at identifying marine mammal acoustic signals and interpreting acoustic software – the MMOA recommends this to be at least 20 weeks during which time a range of marine mammal species should have been encountered.
- **Ability to assemble, deploy and configure PAM equipment to optimise signal-to-noise ratio** – previous experience of PAM for marine mammals at sea or conducting paid or voluntary cetacean surveys where PAM was adopted. Attendance of appropriate training courses with instruction on assembly and deployment of specific PAM equipment/software.
- **Ability to interpret acoustic software for detection and range estimation (where possible)** – Previous experience as described above. Attendance on a course to be instructed on PAMGUARD or other suitable software.
- **An understanding of the mitigation requirements of the area or project** -through appropriate training from a regulator approved training course or from client/employer created training courses.
- **Ability to make decisions quickly and to convey the necessary mitigation information to the crew concisely, politely, objectively and firmly** - personnel working as a PAM operator should be independent and should have the character and confidence to make correct mitigating decisions under pressure. Such characteristics could be gauged via feedback from previous employers or colleagues.
- **Experience of recording data in a scientific and accurate manner** – through a formal academic qualification or through work experience where this was achieved (in the latter case references should be sought).
- **Experience of assimilating data, basic acoustic data analysis (i.e. familiarity with producing and interpreting spectrograms) and writing reports** – through a formal academic qualification or through work experience where this was achieved (in the latter case references should be sought).

- **Ability to work in a team and communicate well** - such characteristics could be gauged via feedback from previous employers or colleagues.
- **Aspire to improve their skills as a PAM Operator and to further their knowledge** – belong to a professional body such as the MMOA or other appropriate professional body where information and code of practice is promoted. Attend training courses and refreshers to improve knowledge and skill.

A Client hiring PAM Operators through a MMO and PAM provider company (personnel agency) should request this standard of PAM qualification in order to promote a professional standard in their environmental objectives.

Benefits of Hiring Professional PAM Operators with all of the Above Skills

The MMOA emphasises that the use of PAM Operators who meet the above professional standards is likely to confer a number of benefits for the clients of mitigation surveys, both in terms of proving compliance with mitigation requirements and maintaining a positive environment on-board the platform. These potential benefits include:

- Client confidence in meeting environmental requirements.
- A professional working attitude by the PAM Operator on board the platform, ensuring courteous interactions with crew, appropriate chains of command are followed and good cooperation is achieved in the event that mitigation measures are required.
- Accurate identification of SoC acoustic signals which ensures that species-specific mitigation measures are implemented correctly (for species that can be positively-identified to species level using acoustic methods) and potentially avoids erroneous mitigation measures that may be costly to the survey.
- Ability (based on previous experience and correct calibration of acoustic equipment) to make good distance estimates to acoustic signals (where equipment permits), which may avoid unnecessary disruption to the survey.
- Collection of standardised, high-quality acoustic data that serves to prove compliance with mitigation requirements and may additionally contribute to robust scientific analysis.
- Knowledge and experience to answer questions that arise during the survey, and to guide the crew through the required mitigation measures clearly and concisely to avoid error and confusion.

6. Marine Mammal Observer (MMO) and Passive Acoustic Monitoring (PAM) Mitigation Training Standards

The Marine Mammal Observer Association (MMOA) considers that mitigation training courses are a crucial component of implementing effective mitigation measures at sea, and has the following advice regarding the content and provision of training courses for MMOs and PAM Operators.

MMO and PAM Mitigation Training Courses

A MMO or PAM mitigation training certificate should *not* be the only requirement to qualify a person as a MMO. MMO and PAM mitigation training courses should only act as a supplementary qualification for a person who already has the appropriate academic and marine mammal field experience to work as a MMO or PAM Operator. The MMOA note that mitigation training course providers should *not* advertise their courses to be the only qualification needed to become a MMO or PAM Operator, and nor should regulators, clients or MMO and PAM Operator providers consider mitigation training certificates to be such.

MMO and PAM mitigation training courses should serve to provide new MMOs and PAM Operators with the necessary knowledge to enable them to perform appropriately in a mitigation role and to be aware of their duties and responsibilities while implementing mitigation measures.

MMO and PAM Mitigation Training Course Content (Generic Components)

In some countries regulatory bodies have formalised training requirements and where that is the case those requirements must be strictly adhered to. Additionally, the MMOA recommends that all mitigation training courses worldwide should include the following generic components:

- The importance of sound to marine mammals.
- The potential effects of anthropogenic sound on marine mammals and other SoC (if applicable) including acoustic criteria used to define zones of disturbance and injury.
- Visual monitoring techniques, including methods for range estimation (MMO courses).
- Field identification (visual or acoustic) of marine mammal and other SoC (if applicable) – noting that course attendees should already have some practical experience with identifying relevant species or seek to gain this after attending the course and prior to mitigation work.
- The mitigation procedures being used in the geographic region.
- Soft start principles, procedures and monitoring.
- Mitigation Zones.
- An understanding of the industry operations that require MMOs.
- The role of the MMO:
    - Attending project start-up meetings.
    - Monitoring for marine mammals and other SoC (if applicable).

- Monitoring of compliance with mitigation procedures (i.e. compliant source operations).
- Mitigating for SoC inside mitigation zones prior to operations, during soft start (if applicable) and during full power operations (if applicable).
- Scenarios that may arise and how to deal with these.
- Interaction with industry personnel and procedures in place.
- Recording MMO and/or PAM data and compliance reporting.
- Chains of command on-board industrial platforms.

Additional MMO and PAM Mitigation Training Course Content (Specific to Geographic Area)

Where regulatory bodies have formalised training requirements those requirements must be strictly adhered to. Elsewhere, the MMOA recommends that mitigation training courses for specific geographic areas should include the following components:

- Understanding the background and development of the adopted mitigation procedures and their legislative framework.
- Consent and permitting process of the procedures prior to projects.
- Specific explanation of the mitigation procedures for the geographic area.
- Identifying species likely to be in the geographic area.
- Discussing specific project data collection if applicable.

Specific PAM Operator Mitigation Training (Theory and Software Training)

- Basic theoretical principles of sound.
- Recognition of different types of SoC vocalisations.
- Discussion of types of unwanted ambient noise and masking problems.
- Components of PAM equipment – cables, hydrophone elements, sound cards, filtering systems, depth sensors, laptops and software – assembly, deployment and calibration.
- Discussion of deployment scenarios and examples.
- Principle components of PAM software – displays and the need for project-specific configuration.
- Specific software training – e.g. PAMGuard – practical instruction in creating configurations and basic settings relating to hardware used and method of deployment.
- Discussion of bearing determination and the problem of ranging acoustic signals.

Specific PAM Operator Mitigation Training (Assembly and Deployment)

PAM training is only complete when a person has learnt how to assemble PAM equipment and deploy it in a safe and sufficient way to maximise the detection of vocalising animals. A range of PAM equipment is currently marketed to industry and so prospective PAM Operators if possible should visit as many PAM providers as possible to practice assembling equipment. Experience of at-sea deployment is hard to gain as there is a lack of practical training courses worldwide offering this

facility. No PAM Operator should take sole responsibility on an offshore mitigation job without having some prior deployment experience. They could gain such experience from joining research groups or voluntary groups who carry out acoustic monitoring work, attend a PAM training course offering at-sea deployment experience or work on an offshore mitigation project alongside an experienced PAM Operator (in addition to the required number of experienced PAM Operators needed to provide 24 hr. mitigation) for a probationary period.

MMO and PAM Mitigation Training Course Instructors

The responsibility for determining who provides MMO and PAM mitigation training courses falls with the regulator for the geographic region in question. However, the MMOA believes that the following criteria should be met by people wishing to act as MMO or PAM mitigation training course providers:

- Must demonstrate that an instructor has good presentation and teaching skills.
- Be able to compile clear, interesting and professional training material such as PowerPoint presentations, training manuals and practical interactive sessions.
- Have an extensive background in visual and/or acoustic marine mammal survey techniques and species identification.
- Be knowledgeable with respect to the effects of noise on marine mammals.
- Have experience of responsibility as a lead MMO in a wide range of offshore industrial operations. If the course is aimed at mitigation during seismic surveys, then the Instructor should have first-hand experience of working on several survey types such as site surveys, VSP, OBC, 2D/3D and 4D surveys. If the course covers additional operations such as pile driving or explosive work then the instructor should also have had the experience of working as a MMO on such projects.

7. Marine Mammal Observer (MMO) and Passive Acoustic Monitoring (PAM) Operator Providers

The Marine Mammal Observer Association (MMOA) believes that a MMO and PAM Operator provider company should:

- Provide only suitably-qualified and appropriately-referenced MMOs and PAM Operators
- Have a comprehensive understanding of worldwide mitigation requirements and the ability to recognise the skills needed to be competent and professional MMOs, preferably with personal experience in working commercially as an MMO/PAM operator.
- If supplying PAM equipment and PAM Operators have the appropriate knowledge of PAM equipment and understand its limitations in the field (and make potential Clients aware of these limitations from the outset).
- Draw up proper legal contracts with their MMOs and PAM Operators, including the timing and duration of each project, the day rates and payment schedule, travel and visa arrangements and all other logistical and contractual considerations.
- Cover all insurance required by an MMO or PAM Operator to work on industry projects, and be transparent in what a MMO/PAM Operator is covered for and what they need to arrange for themselves.
- Provide the MMO and PAM Operator with the correct documentation prior to the project for clarification (e.g. Environmental Impact Assessment, DECC consent, Environmental Management Protocols etc).
- Recommend sufficient numbers of MMOs and PAM Operators to a Client to cover the mitigation required for the project.
- Be able to check MMO and PAM reports for quality purposes.
- Respect the independent nature of MMO/PAM reports and inform individual MMOs and PAM Operators who have authored a report of any changes made to that report before it is submitted to the Client.

8. Marine Mammal Observer (MMO) and Passive Acoustic Monitoring (PAM) Data Collection and Analysis

Using Suitably Qualified MMOs and Thorough Methodology

The Marine Mammal Observer Association (MMOA) maintains that to maximise the value of data collected during mitigation surveys, it is essential for MMOs and PAM Operators to be suitably qualified, experienced and dedicated. Any data that are to be scientifically analysed need to have been collected using a structured, standardised methodology and then should be fully assessed for data quality before analysis can begin. Meaningful analyses should only include data collected by people with proven species identification skills, an appreciation for the necessity for correctly recording effort status and weather conditions, and good distance estimation skills. Using inexperienced persons and individualised data collection methodologies will lessen scientific credibility.

Use of Photographs to Improve MMO Data Quality

MMO data is of superior quality if photographs of each sighting are collected and stored (bearing in mind that it is not possible to photograph every sighting because animals are often seen briefly or at distance or in inclement weather conditions). The collection of supporting images allows later independent-verification of the sightings, especially in terms of species identification. This is particularly important in areas where little information exists of marine mammal distribution. The MMOA encourages Clients to specifically request MMOs who are able to take good-quality photographs during sightings to maximise the quality of the data being collected and their subsequent use for scientific purposes.

Collating PAM Detection Recordings and Noise Samples

Retaining and collating recordings of PAM detections and samples of noise is not a widespread requirement with regulators. The MMOA encourages Clients to specifically request that recordings of every PAM detection are made and stored during a survey, so that independent-verification of the data can occur at a later time and the use of the data be maximised. This process will also facilitate assessment of the signal-to-noise ratio and other recording parameters experienced during PAM surveys with a view to assessing the likely potential for detections to have occurred on the system.

MMO and PAM Data Analysis

Analysis of the data collected during mitigation surveys should be carried out by individuals/organisations that have a full understanding of the limitations of current MMO and PAM datasets. Datasets collected by multiple personnel of varying skill levels are inherently subject to wide variation in standards. Although this variation can be minimised to some extent through the

use of standardised data collection methods and data forms, bias in detection rates and identification skills between observers is an acknowledged and fundamental issue for all large marine mammal surveys, and will be especially the case in large MMO/PAM datasets where data may originate from several hundred observers. Meaningful analyses are reliant on having an understanding of the varying quality of MMOs and PAM Operators being hired on projects and the limitations this creates (for example, the ability to account for inter-observer variation during analysis). An assessment of which data are of scientific value can only be achieved if the data are accompanied by detailed descriptions of the methodology used, by supporting information allowing independent-verification (i.e. photographs or acoustic recordings) and an indication of whether the data were collected by dedicated, experienced and qualified MMOs and PAM Operators.

Collating MMO and PAM Datasets Worldwide

The MMOA supports the standardisation of data collection methods and the data forms used to record data worldwide, in order to improve the value of global datasets. MMO and PAM data forms in an electronic form have been developed by the E&P Sound and Marine Life Joint Industry Programme (JIP) (www.soundandmarinelife.org), a body affiliated with the International Association of Oil and Gas Producers (OGP). The data forms have been frequently revised following extensive feedback from MMOs and PAM Operators working in the field. The MMOA encourages the adoption of these forms with their guidance notes, where appropriate, to improve the standardisation of MMO data worldwide. These forms have been adopted by the Joint Nature Conservation Committee in the United Kingdom and can be found online at: http://jncc.defra.gov.uk/page-1534

In summary to maximise the value of MMO data for scientific purposes the data must be:

- Collected by suitably qualified and experienced MMOs and PAM Operators.
- Collected using a standardised methodology (e.g. through the use of JIP-funded MMO data forms).
- Quality-controlled by assessing the experience of the MMO or PAM Operator and by validating data (i.e. through the use of photographs and acoustic recordings).
- Accompanied by photographs and acoustic recordings whenever possible for each visual or acoustic detection.
- Analysed by individuals/organisations that have a full understanding of how MMO and PAM data are collected, have been collected in the past and what the limitations are.

The potential uses of MMO data for scientific research purposes have resulted in some MMOs seeking permission from the Client to publish their own data from work on seismic survey vessels. The MMOA encourages this practice. Please refer to the statement - The Use of Marine Mammal Observer (MMO) data for Scientific Publications – for further information.

9. The Use of Marine Mammal Observer (MMO) Data For Scientific Publications

Potential Scientific Uses of MMO Data

Seismic surveys[4] often occur in areas where little is known about the occurrence of marine mammals and other marine wildlife of conservation concern (e.g. sea turtles, whale and basking sharks, seabirds). This includes some large geographic regions where little scientific research has been carried out (e.g. the eastern tropical Atlantic off the west coast of Africa and large parts of the Indo-Pacific region), but also includes the deep, offshore waters around many continents (since for logistical reasons most marine mammal research worldwide has been focussed on coastal species inhabiting near shore, easily-accessible waters). Consequently, seismic survey vessels can potentially operate as a 'platform of opportunity' from which to collect valuable data on the occurrence of marine mammals (and other fauna) for scientific research purposes.

The potential uses of MMO data for scientific research purposes (including specific examples of peer-reviewed scientific papers published by MMOs from their own work on seismic survey vessels and having undergone a data permission process with the Client) may include:

- Documenting new range states for species, e.g. beaked whales (Weir, 2006a); Clymene dolphins (Weir, 2006b), Fraser's dolphins (Weir et al., 2008); whale sharks (Weir, 2010), killer whales (Weir et al., 2010), *Mobula* rays (Weir et al., 2010).
- Documenting unusual sightings/behaviours, e.g. rough-toothed dolphins in Gabon (de Boer, 2010a).
- Describing species morphology/taxonomic forms, e.g. common dolphins in Angola (Weir and Coles, 2007).
- Describing species composition, seasonality and distribution[5], e.g. sea turtles off Angola (Weir et al., 2007); cetaceans off Gabon (de Boer, 2010b); cetaceans around Montserrat in the Caribbean (Weir et al., 2011); cetaceans in the eastern tropical Atlantic (Weir, 2011).
- Calculating species density[5], e.g. minke whales in the North Sea (de Boer, 2010c).
- Assessing species habitat preferences[5], e.g. cetaceans off Angola and Gabon (Weir et al., 2012).
- Analysing the potential impacts on species from airgun activity, e.g. cetaceans off Angola (Weir, 2008a), pilot whales in Gabon (Weir, 2008b).
- Describing the vocalisations of species recorded on PAM systems (no examples from seismic surveys to date).

[4] This document refers to seismic surveys which remain the most frequently-used platform for MMOs carrying out industry-related mitigation work. However, MMOs work from a range of additional platforms (e.g. rigs, drill ships, pipe-laying barges, military frigates, decommissioning platforms) and this document also applies to data collected during those surveys.

[5] The MMOA acknowledges that publishing information certain information (e.g. distribution, density and abundance estimates, habitat preferences) from platforms that are emitting high-amplitude sound is always subject to limitations arising from the unknown responses of animals to the sound source. Such limitations should always be described in a transparent manner and accounted for in analyses wherever possible.

Suitability of MMO Data for Scientific Analysis

It should be clearly understood that the use of MMO data for scientific purposes is very different from its use during a standard mitigation role. While all data collected on seismic survey vessels comprises mitigation data, not all of it is suitable for scientific analysis. A MMO working in a standard mitigation role may have only basic field identification skills (mitigation does not require species-specific identification in many cases) and lack the background in, and understanding of, rigorous standardised data collection.

The collection of data that is suitable for scientific analysis is reliant on the use of experienced and dedicated MMOs who are meticulous about the collection and coding of field data and have sufficient expertise with the fauna in question to correctly identify animals in the field. Datasets where species identification is questionable, or where the basic information required to perform effort-related analyses (e.g. on-effort watch duration, location, airgun activity and associated environmental data recorded accurately and at regular, short intervals) is lacking or inaccurate, are unlikely to be suitable for scientific purposes. Consequently, for data to be useful in a scientific context, the following are usually required:

- The use of a MMO who is experienced, dedicated, motivated and understands the importance of accurate data collection and data coding
- The use of a MMO with proven experience in reliable field identification of the species of interest within the study area
- The routine collection of additional data to support the species identifications recorded in the field, so that independent verification of the data can be performed when necessary. This might include acoustic recordings of the species, or photographs of sightings[6]. It should be noted that many species (for example, dolphins of the *Stenella* genus and whales of the genus *Mesoplodon*) are very similar in external appearance and behaviour, and observers require significant levels of field experience to reliably distinguish between such species in the field (such experience may require several years of intensive survey work in an area to achieve). Photographic verification is therefore a standard method of verification used by the scientific community, and has even greater importance for MMO datasets (where sightings are often distant and seen briefly).
- Depending on the analyses being carried out, the collection of high-quality supporting effort data. This requires (as a minimum):
    - The collection of GPS positions at sufficiently-small intervals (≤1 hr intervals on 3D/4D surveys; every few minutes where turns between lines are acute, i.e. on site surveys) to reliably recreate the track of a seismic vessel (i.e. through turns) to show the location of survey effort
    - Accurate logging of airgun use and related effort data

[6] It is acknowledged that it is not always possible to photograph every sighting at sea. However, for scientific purposes it should be routine for MMOs to attempt to photograph sightings whenever possible and for the best images from each sighting to be logged as supporting data. Verification of the identification of animals at sea is essential when describing new species range states or documenting rare/unusual species or occurrences. In many cases, due to the high potential for confusing cetacean species in the field, such information would not be accepted by the scientific community without supporting data.

- Accurate logging of environmental data, especially Beaufort sea state (which is known to be a very important factor influencing the detection rate of marine fauna). It is recommended that where imprecise sea state codes are the requirement on mitigation data forms (e.g. the JNCC forms) that precise Beaufort sea state data are collected additionally by the MMO for scientific use (this may also apply to visibility and swell height).

Benefits of Publishing MMO Data

Currently, there are large amounts of potentially-useful data being collected by MMOs worldwide that are not being made accessible to researchers and consequently amount to 'lost data'. The MMOA seeks to encourage publication of appropriate MMO datasets (see above conditions) so that data are available to scientists and, ultimately, feedback into the conservation of marine fauna worldwide.

For the MMO - Using the data collected during seismic surveys is a method of contributing to science and, in the long-term, to the potential conservation of marine species. Scientific publications are also a great addition to a CV, illustrating enthusiasm, dedication, competence and a genuine interest in the topic.

For the Client - Making MMO data accessible for scientific purposes demonstrates Client interest and support for the environment and furthering scientific knowledge, and releasing such data is likely to be of benefit to species conservation. There are no obvious disadvantages to releasing data, assuming protocols are established and followed (see below).

For Conservation - Species conservation is reliant on knowledge of when and where a species occurs. This basic information is often lacking, particularly for mobile marine species, and in deep-offshore and poorly-studied regions (where seismic survey vessels may provide a unique opportunity for data collection). The example scientific publications provided above demonstrate how basic data on species occurrence, distribution, taxonomy, behaviour, density and habitat preferences can be provided by MMO data, with obvious conservation implications.

Protocols for Releasing MMO Data

It is important for all parties concerned that protocols relating to the release, and subsequent use, of MMO data are established at an early stage in discussions. The publication of MMO datasets is still relatively rare, and there are no predefined standardised protocols in place to follow. The procedure will be survey-specific, requiring direct discussions between Client and MMO, and in some cases also the personnel agency providing the MMO to the Client. Ultimately, the Client of a survey owns any data collected, and it is essential that a MMO receives the Client's express permission before releasing/publishing any data. This may otherwise violate client confidentiality and result in a breach of contract.

Clients should establish from the outset exactly what their data will be used for, which data will be used, what the intended output will be (e.g. conference presentation, scientific paper) and how they

will be acknowledged. Clients should be aware that any published data (e.g. a journal paper) will subsequently be in the public domain, and may be referred to in other scientific papers and used elsewhere. Consequently, the Client should have the opportunity to view and comment on both a draft paper (prior to submission to a journal) and the final version of the paper (if accepted for publication). Permission to use the data should include clauses to this effect, so that Client approval is expressly required prior to submission and final publication. This eliminates any risk of information being published that the Client deems to be confidential or otherwise sensitive.

A MMO wishing to publish data from seismic surveys should appreciate that environmental datasets are often considered sensitive and should seek to ensure that the process is carried our courteously and as transparently as possible. This will particularly be the case for data concerning potential impacts of airgun activity on marine fauna, and a MMO should clearly state whether or not airgun impacts will be considered within the proposed paper. The MMOA recommends that (as a minimum) a MMO should inform the Client of:

- The aims/objectives of using the data (providing a working title and a synopsis of likely content).
- Exactly which data will be included.
- Where they intend to publish the data.
- How the Client will be acknowledged.
- At which stages the Client will be contacted to approve the paper content.

The MMOA also emphasises that in instances where permission to publish is refused then a MMO should remain courteous, professional and accept that decision.

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10. The Conduct of Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM) Operators during Offshore Operations

This section is aimed at providing guidance to MMOs and PAM Operators (hereafter the 'mitigation team') on their conduct during offshore operations. It is also aimed at providing guidance to MMO/PAM providers and Clients regarding the personnel they hire.

Knowledge of Regulatory Requirements

The mitigation team have a duty to ensure they are familiar with all documentation outlining mitigation procedures (including regulatory guidelines and/or those conditions specified in project approvals and permits) prior to the project start. They should ensure they always have this documentation to hand and consult it regularly. On arrival at the platform or at the start up meeting, the mitigation team should provide a short summary of the mitigation requirements to the key personnel on the platform. They should be able to answer questions quickly and confidently about the mitigation procedures without having to refer back to the documentation.

Diligent Observation/Monitoring

The mitigation team should always ensure they will be on time for their watches. They should perform their observation and monitoring duties to the best of their abilities. At all times during their watches they should remain diligent. MMOs should have professional binoculars (good light gathering ability, waterproof, suitable magnification for scanning at sea, wide field of view and range estimation ability is recommended) which they should use to scan the mitigation zone, and adjacent waters, regularly. It is the MMO's responsibility to ensure that they are aware of any specific requirements with regard to what type of binoculars are required for the country they are working in (for example, some countries require the use of reticulated binoculars). Data recording should be prompt and observations resumed as soon as possible. PAM Operators should remain at their station and remain wholly focused on monitoring PAM software and listening to acoustic signals.

Recording Data and Species Identification

The mitigation team should be diligent in the recording of data. All entries should be as accurate as possible and without subjectivity. They should have appropriate identification books/cameras if applicable to aid them with species determination. The MMOA emphasises that species identifications should *never* be guessed at - this practice does not benefit anyone and renders the data unreliable and unfit for data analysis. The lowest definite category of identification should be adopted as the formally reported species identification at all times. In other words 'definite dolphin species' is more appropriate than 'possible bottlenose dolphin', although the latter can also be noted in the Comments column. The MMOA stresses that no pressure should be placed on the mitigation team to always make a positive species identification. On the contrary, this is often not possible due to the nature of marine fauna and the often challenging viewing conditions at sea.

Accurate Range Determination

The mitigation team should estimate range as accurately as is possible given the prevailing conditions. MMOs should have suitable equipment (reticulated binoculars, inclinometers or range sticks) to determine range and PAM Operators should have sufficient knowledge to interpret PAM software to determine range (when the software permits).

Use of Handheld Radios

The mitigation team should use handheld radios in accordance to the platforms protocol (i.e. using the platforms working channel and following radio good practice). They should remember that communications must be kept to the minimum and that instructions must be clear and decisive. They should always check that their radios are charged and on the correct channel, and should not compromise communication by listening to loud music. They should not have disputes over the radio.

Taking Mitigating Actions

The mitigation team should adhere strictly to the mitigation procedures determined prior to the project. They should advise on mitigation actions in a clear, concise and polite manner to the platform's crew, and ensure that measures are implemented swiftly.

Non-compliance

In any cases of non-compliance the mitigation team should adhere to the communication protocol established by the Client. They will remain calm, professional and respectful in these situations. For transparency the mitigation team should log in detail the sequence of events of any non compliance in case future disputes arise.

Reporting

The mitigation team should report honestly and concisely the details of their observation/monitoring effort, weather conditions, gun activity, sightings/acoustic detections and the platform's adherence to the mitigation procedures determined prior to the project. Reports should be submitted within the agreed timeframe.

Respect Data Confidentiality

The mitigation team should be aware that they are working for an operation with sensitive data and will respect this. No information should be distributed without following the correct reporting protocol determined prior to the project.

Respecting Safety Policies

During certain operations or exercises on the platform the mitigation team should be aware that they may be required to wear Personal Protective Equipment (PPE) or be excluded from areas. They should select their work area within appropriate safety boundaries. If they are unsure about any activity or workspace they should ask the Captain, Chief Officer or Party Manager first. The mitigation team are aware that they are expected to attend safety drills and any safety meetings when requested. If they need to be exempt from these because they must be on watch, they will clear this first with the Captain or Chief Officer.

Appropriate Dress

The mitigation team should dress appropriately for their role. This means in cold climates they should have appropriate warm and waterproof clothing for observation outside. In warm climates they should wear suitable clothing and sunscreen to avoid sunburn.

Remain Professional at all Times

Even when the mitigation team are off watch they will act professionally. They will consider the close working environment on-board the platform. They will not distract other crew members from their duties and will be aware that people may be asleep during the day and that they may need to be quiet in certain areas of the platform.

Being Part of a Team

The mitigation team may be working as part of a MMO team. The mitigation team will respect the person who has been assigned to lead this team and the duties they have to perform. They will be supportive at all times. The mitigation team should also be aware that for the period of time they are on the platform they are also part of the platforms crew and on board community.

Aspire to Improve their Knowledge and Professionalism

The mitigation team will seek to improve their skills and knowledge of their profession. If possible, they will join a professional affiliation such as **The Marine Mammal Observer Association** (www.mmo-association.org) and attend training courses to update their knowledge and expertise when possible. They will keep up-to-date with developments and publications regarding marine mammals and noise. Their skill as an MMO will be enhanced by the knowledge of how operations work on the platform – and they will make an effort to learn more about wider offshore operations.