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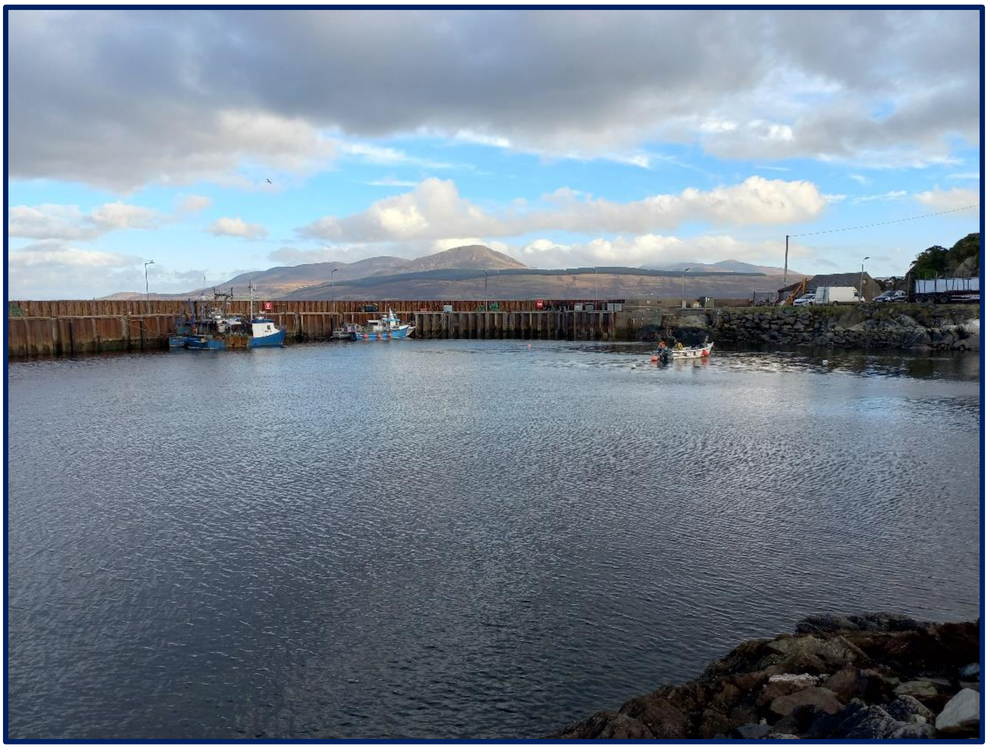
CARRADALE HARBOUR PONTOON

GEOPHYSICAL SURVEYS MARINE MAMMAL RISK ASSESSMENT



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March 2023

2293-Doc-001

Member of the Association
for Consultancy and Engineering

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and revised as follows:

REVISION STATUS INDICATOR

Page No	Date	Revision	Description of Change	Initial
	31/03/23	1	Draft Issue	GB
	03/04/23	2	Final Issue	GB

This document has been reviewed for compliance with project requirements in accordance with Wallace Stone LLP Quality Management System.

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GEOPHYSICAL SURVEYS
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GEOPHYSICAL SURVEYS
MARINE MAMMAL RISK ASSESSMENT

1. Introduction

This Marine Mammal Risk Assessment has been produced to support the European Protected Species (EPS) licence application to disturb cetaceans. The licence is required to allow geophysical surveys (specifically sub-bottom profiling) to be undertaken in the Carradale Harbour, as part of the proposed Pontoon Scheme at Carradale Harbour in the Kilbrannan Sound.

2. Proposed Hydrographic Survey Works

The Proposed Survey is being undertaken to gain information to allow accurate determination of the seabed topography and profiling of the seabed. This information would be obtained to allow accurate design of pontoon layout and inform proximity of bedrock to seabed level. It is intended to comprise a sub-bottom profiler (SBP) survey to determine the subsea geological strata and any hazards to construction. The SBP survey will be confined to the Harbour Basin covering an area of approximately 70m by 70m.

Details of the survey area is presented in Figure 2.1 with coordinates of a boundary included in table 2.1 below. The boundary line follows the harbour wall between points 3 and 4.

Table 2.1 Co-ordinates of SBP survey boundary

Point	Latitude	Longitude
1	55º 35.541’ N	5º 27.744’ W
2	55º 35.577’ N	5º 27.748’ W
3	55º 35.577’ N	5º 27.700’ W
4	55º 35.541’ N	5º 27.671’ W
5	55º 35.541’ N	5º 27.674’ W

Figure 2.1 SBP survey boundary

2.1 Geophysical Survey Equipment and Method Statement

Aspect Land & Hydrographic Surveys Ltd will conduct combined bathymetric and geophysical surveys. With regards to bathymetric surveys, a frequency of 400kHz will aim to be used throughout the survey period to provide the highest data resolution possible. In instances where the frequency of the system is required to be altered based on the local conditions of the site (i.e. dense sediment layers or the presence of seaweed / kelp that can mask the signals), it is envisaged that the system will operate at a frequency above 275kHz.

A geophysical survey of the area will be undertaken to determine the depth of sediment overlay and rockhead profile, otherwise known as sub-bottom profiling. The sub-bottom profiling will be conducted utilising seismic reflection techniques and an acoustic boomer sub- bottom system. The outputs will seek to determine the depths to all significant seismic reflectors, particularly those that can be correlated to changes in geological strata but will not quantify any strata (i.e. till, gravel, sand, mud, etc.). This is required to inform the design options for the new facilities.

The entire system will be mounted on a catamaran towed behind the vessel. The survey lines will be at 10m line spacing over the proposed area, with 20m spaced cross lines. The acoustic boomer system will consist of an insulated metal plate and rubber diaphragm adjacent to a flat wound electrical coil, mounted on a towed catamaran. A short duration, high power electrical pulse, generated by the shipboard power supply and capacitor banks, will discharge to the electrical coil and the resultant magnetic field explosively repels the metal plate, generating a broad band acoustic pressure pulse in the water column. The frequency of this pulse is in the range 400Hz to 14kHz, with most of the energy being directed vertically downward at a maximum output of 300 joules per pulse.

Acoustic boomers for use in geophysical surveys and sub-bottom profiling typically have a source level of 212 dB re 1 µPa @ 1 m (SPLpeak) with a 200J pulse energy, and 215 dB re 1 µPa @ 1 m (SPLpeak) with a 300J pulse energy (Applied Acoustics, 2010).

The SBP survey will entirely undertaken with the boundary of the harbour walls.

2.2 Actions Requiring Licensing

Under the Habitats Directive it is an offence to deliberately capture, injure or kill an EPS (including all cetaceans), deliberately disturb an EPS or damage or destroy a breeding site or resting place of an EPS (see Section 2). Therefore, this application and associated risk assessment are submitted in relation to the potential for geophysical survey activities, as described above, to disturb an EPS.

2.3 Assessment of Alternatives

2.3.1 Do Nothing

The key driver for the project is to improve the operating conditions for operators of MOWI work boats using Carradale Harbour and provide shared mooring space for the local residents/fishermen. The pontoon provides safe access as an alternative to the use of harbour ladders, or ropes to lower kit on board boats etc, with direct boat access from a pontoon significantly improved overall.

There are no historic ground investigation or sub-bottom profiling survey records of the Carradale Harbour that could be used to inform the design of the pontoon scheme. Bathymetric and geophysical surveys are essential for effective project design, safety and appropriate determination of project risks. Therefore, the ‘Do Nothing’ option has not been considered further.

2.3.2 Alternative Survey Techniques

As Multibeam Bathymetry will not be detectable by marine mammals, and therefore will not result in any risk of injury or disturbance to marine mammals, no alternatives for these techniques need to be considered.
With regard to geophysical surveys, the only way to obtain the required resolution of surface ground conditions in the Carradale Harbour, without the use of Sub-bottom Profiling, would be to undertake an extremely detailed geotechnical investigation. This would include taking a series of marine boreholes within the harbour, which would result in extended survey durations and more likely, more repeated disruptions to marine mammals. In addition, this option would require extended closure of the harbour and not be financially viable.

This option is not justified by the increased risk posed to marine mammals, impact on local community with harbour closure and is financially unviable.

3. Marine Mammal and Basking Shark Baseline

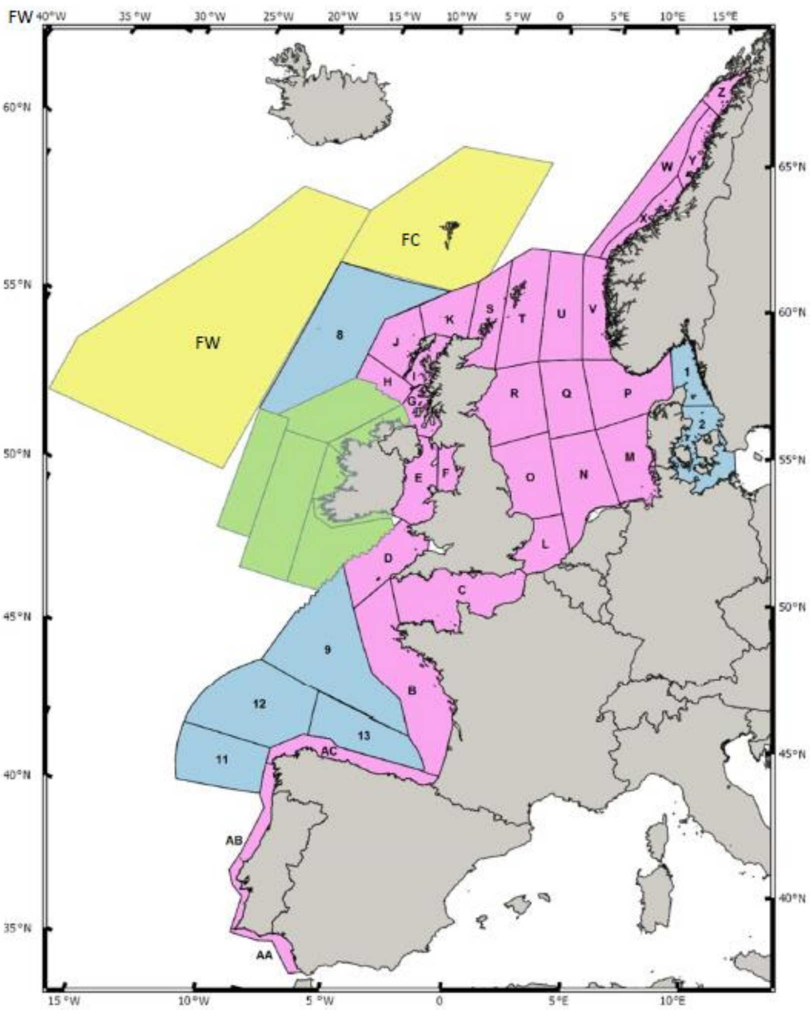
All UK cetacean species are listed under Annex IV of the European Habitats Directive and Schedule 2 of the Habitat Regulations 1994 as EPS, which has been transposed into Scottish Law through the Wildlife and Countryside Act 1981 and The Conservation (Natural Habitats, &c.) Regulations 1994. Specifically, Regulation 39 (1) of the Habitats Regulations 1994, makes it an offence to deliberately or recklessly kill, injure, harass, or disturb an EPS.

3.1 Cetaceans

A series of large scale surveys for Small Cetaceans in European Atlantic waters and the North Sea (SCANS) waters was initiated in 1994 in the North Sea and adjacent waters. The programme was repeated in 2005 (Hammond et al., 2013) (SCANS-II) and again in 2016 (SCANS-III) (Hammond et al., 2017). Data from SCANS III has been used to identify key areas of importance for relevant cetacean species in relation to Carradale Harbour.

SCANS surveys were conducted in the summer and therefore data are representative of summer distributions only. However, it is understood that the densities of cetaceans around the British Isles are likely to be highest during this season (Hammond et al., 2017). The abundances presented are therefore considered to represent the worst-case of the maximum number of individuals potentially affected. A breakdown of the SCANS-III survey blocks is shown in Figure 4.1. The proposed survey area is located within Block G.

Figure 4.1 Area covered by SCANS-III



From a review of the data in SCANS-III and of the sightings recorded by the Hebridean Whale and Dolphin Trust Sightings Map (HWDT 2022), there are four cetacean species, which are anticipated to be in the region. These species are:

- harbour porpoise (Phocoena phocoena);
- bottlenose dolphin (Tursiops truncatus);
- short-beaked common dolphin (Delphinus delphis); and
- minke whale (Balaenoptera acutorostrata).

3.1.1 Harbour Porpoise

The harbour porpoise is one of the most common marine mammal species recorded in north-western European shelf waters (Reid et al., 2003). Harbour porpoises are found in relatively inshore waters throughout the northern hemisphere. They are widespread throughout coastal regions of the Scottish waters and seen year-round. The number of harbour porpoises in Hebridean waters is amongst the highest in Europe (HWDT, 2023).

In the last 5 years (since Jan 2018), 9 sightings records of harbour propoises have been identified in the middle of the Kilbrannan Sound, with 70 sightings in total in the Kilbrannan Sound (HDWT, 2023).

Table 4.1 shows the SCANS III data for Harbour Porpoise within block G.

Table 4.1 Harbour Porpoise density and abundance estimates from the SCANS-III survey in block G

Block	**Density (groups /km^2)**	**Mean group size**	**CV (mean group size)**	**Density (Animals /km$^{2)}$**	**CV**	**Abundance**	**CL low**	**CL high**
G	0.221	1.52	0.094	0.336	0.428	5087	1701	10386

3.1.2 Bottlenose Dolphin

Bottlenose dolphins (Tursiops truncatus) are present in UK waters all year round and can often be seen close to shore. In the last 5 years (since Jan 2018), 19 sightings records of bottlenose dolphins have been identified in the middle of the Kilbrannan Sound, with 29 sightings in total in the Kilbrannan Sound (HDWT, 2023). The nearest sighting was recorded approximately 200m from the entrance to Carradale Harbour (HWDT, 2023).

Table 4.2 shows the SCANS III data for Bottlenose Dolphin within block G.

Table 4.2 Bottlenose Dolphin density and abundance estimates from the SCANS-III survey in block G

Block	**Density (groups /km^2)**	**Mean group size**	**CV (mean group size)**	**Density (Animals /km$^{2)}$**	**CV**	**Abundance**	**CL low**	**CL high**
G	0.0125	9.67	0.44	0.1206	0.682	1824	0	4474

3.1.3 *Short-beaked Common Dolphin*

Off western Scotland, common dolphins are generally summer visitors with sightings peaking between May and October, when food is most abundant however, since 2014 common dolphins have been reported in every month of the year (HWDT, 2023).

SCANS III surveys have no data for common dolphin within Block G with no sightings recorded.

In the last 5 years (since Jan 2018), 3 sightings records of common dolphins have been identified in the middle of the Kilbrannan Sound, with 11 sightings in total in the Kilbrannan Sound (HDWT, 2023). The nearest sighting was recorded approximately 1km from the entrance to Carradale Harbour (HWDT, 2023).

3.1.4 *Minke whale*

The annual movement patterns of minke whales are not fully understood but they are thought to make a general migration between tropical breeding grounds in the winter, and colder feeding regions during the summer. Minke whales are frequently seen in coastal and inshore waters around the Hebrides from April to October. (HDWT, 2023)

In the last 5 years (since Jan 2018), 1 sighting record of a Minke Whale was identified in the middle of the Kilbrannan Sound, with 15 sightings in total in the Kilbrannan Sound (HDWT, 2023). The nearest sighting was recorded from Carradale town so would presume the sighting could have been less than 500m from shore (HWDT, 2023).

Table 4.4 Minke Whale density and abundance estimates from the SCANS-III survey in block G

Block	Density (groups /km^2)	Mean group size	CV (mean group size)	Density (Animals /km$^{2)}$	CV	Abundance	CL low	CL high
G	0.0203	1.33	0.25	0.0271	0.7	410	0	1259

3.2 Cetacean Baseline Summary

The likelihood of occurrence for each species in the Kilbrannan Sound, density estimates retrieved from the SCANS III report, and the estimated group size based on the information retrieved from sightings data are summarised in Table 4.5.

Table 4.5 Cetacean Baseline Summary

Species	**Likelihood of Occurrence**	**Density Estimate per km2 (SCANS III)**
Harbour Porpoise	Very likely	0.336
Bottlenose Dolphin	Possible/Occasionally	0.1206
Short-Beaked Common Dolphin	Possible/Occasionally	NA
Minke Whale	Possible/Occasionally	0.0271

3.3 Other Marine Species

3.3.1 *Basking Shark*

Basking sharks can be found around the full extent of the UK coastline but are most frequently observed around the west coast of Scotland, the south-west of England, Wales, and the Isle of Man (Witt et al., 2012). The Sea of the Hebrides on the west coast of Scotland provides conditions that attract large numbers of sharks each summer. Sightings of basking shark are however rare in the Kibrannan Sound with only 1 sighting recorded in the last 5 years (since Jan 2018), (HDWT, 2023).

Basking sharks lack gas-filled cavities such as swim bladders and are regarded as having low sensitivity to underwater sound (Popper et al., 2014). Therefore, the species has been scoped out of the underwater sound assessment, as the potential impact to basking shark from underwater sound disturbance is not considered to be a concern.

3.3.2 *Seals*

Seals are not listed as Annex IV EPS species under the Habitats Directive however, both common and grey seals are included in Annex II, meaning that their core habitat must be protected under the Natura 2000 Network and managed in accordance with their ecological requirements. Under the Marine (Scotland) Act 2010, it is an offence to kill, injure or take a seal, as well as to harass a seal, deliberately or recklessly, at a significant haul out site.

4. Impact Assessment

4.1 Cetacean Hearing Sensitivity

To reflect the different hearing sensitivities of cetacean species, Southall et al. (2019) classified marine mammals into functional hearing groups. These groups are shown in Table 5.1, together with the species in each category most likely to be in the vicinity of the survey area.

Table 5.1 Hearing sensitivity of relevant cetaceans

Cetacean Hearing Group	Relevant Cetaceans	Estimated Auditory Bandwidth
Low Frequency	Minke whale	7 Hz to 35 kHz
High Frequency	Bottlenose dolphin and common dolphin	150 Hz to 160 kHz
Very High Frequency	Harbour porpoise	275 Hz to 160 kHz

As mentioned in section 3 the proposed sub-bottom profiling equipment produces a noise source with a frequency pulse in the range 400Hz to 14kHz, therefore within the auditory bandwidth of the relevant cetaceans.

4.2 Impact Threshold Criteria

Southall et al. (2019) presents acoustic injury onset-thresholds for both unweighted sound pressure level peak criteria (SPLpeak) and cumulative (i.e., more than a single sound impulse) weighted sound exposure level criteria (SELcum). This is presented as the received level thresholds which onset permanent threshold shift (PTS), where unrecoverable hearing damage may occur, and temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur for marine mammal species.

Table 5.2 presents the Southall et al. (2019) criteria for the onset of PTS and TTS thresholds for peak sound pressure level SPL_{peak} and cumulative sound exposure SEL_{cum} when considering impulsive noise sources.

Table 5.2 PTS and TTS thresholds for marine mammals

	PTS		**TTS**	
Cetacean Hearing Group	**SPL_{peak} (dB re 1 µPa)**	**SEL_{cum} (dB re 1 µPa^2s)**	**SPL_{peak} (dB re 1 µPa)**	**SEL_{cum} (dB re 1 µPa^2s)**
Low Frequency	219	183	213	168
High Frequency	230	185	224	170
Very High Frequency	202	155	196	140

4.3 Risk of Acoustic Injury

The SBP survey will be undertaken within Carradale Harbour and be enclosed by the Harbour walls to the west and partly to the north, which will shield the majority of noise transmission into the Kilbrannan Sound.

The risks of acoustic injury to marine mammals from sub-bottom profiling have been assessed based on existing literature surrounding the effects of seismic surveys on marine mammals.

No noise modelling has been undertaken for sub-bottom profilers for this survey However, results from noise modelling undertaken for other assessments indicate that the potential impact on marine mammals from a sub-bottom profiler will be limited in extent.

A comparison of the likely source levels from sub-bottom profiling with the impulsive unweighted SPLpeak levels determined by Southall et al. (2019) (Table 4.2), identified that PTS and TTS levels for HF cetaceans including Short-Beaked Common Dolphin are not exceeded. The source levels at both 200J and 300J pulse energies of 212 dB re 1 µPa and 215dB re 1 µPa respectively, exceed the levels which could cause both PTS and TTS in Harbour Porpoise. Noise levels, however, drop quickly over short distances with non-directional noise sources of the higher level dropping to below the unweighted SPLpeak TTS levels for porpoise within 20m of the source.

As such it is highly unlikely that the peak noise levels will give rise to auditory injury to marine mammals. However, the cumulative effects of repeated impulse noise events also need to be considered.

With respect to bottlenose dolphins, no hearing threshold shifts have been measured when exposed to seismic airguns, even at high source levels (196 to 210 dB re 1 µPa SPLpeak and unweighted 193 to 195 dB re 1 µPa2s SELcum) (Finneran et al., 2015). When considering the likely species to be present in the Kilbarran Sound during geophysical surveys (see Section 4.2), the lack of hearing threshold shifts identified for bottlenose dolphins can also be assumed for short-beaked common dolphins at similar source levels, as the ranges of best hearing for both species are similar within the HF hearing group.

With regards to VHF cetaceans, Kastelein et al. (2017) indicated that TTS onset thresholds of 188 dB re 1 µPa2s SELcum persisted for harbour porpoise when exposed to 10 consecutive shots fired from seismic airguns at a range of up to 1.3km in deep water (Hermannsen et al., 2015). In shallow waters, where sound propagation is limited, other studies indicated that TTS could be induced in a porpoise at 350m by exposing it to 100 airgun pulse with a weighted SEL of 164 dB re µPa2s (Lucke et al., 2009; Hermannsen et al., 2015). It is important to note however, that in each study, estimates were based under a conservative assumption that the porpoise would remain stationary.

There are no comparative studies available for Minke Whales.

As part of the geophysical survey proposed for Carradale Harbour, the acoustic boomers utilised as part of sub-bottom profiling will be more directed towards the seafloor than seismic airguns, coupled with the shallow nature of the environment, and enclosure by harbour walls, the sound will attenuate much more rapidly and thereby reduce the ensonified zone (Southall et al., 2007). It is therefore assumed that the risk of TTS for harbour porpoise during geophysical surveys will be synonymous with those described in Lucke et al. (2009) and Hermannsen et al. (2015) (~ 350m). Estimates of PTS for harbour porpoise are unavailable but will persist at shorter distances from the noise source.

4.4 Risk of Disturbance

When considering the risks of disturbance to marine mammals from seismic surveys, short- term responses have not resulted in broad-scale displacement (Thompson et al., 2014). Despite this, observed reductions of echolocation activity could be indicative of change in foraging or social behaviour (van Beest et al., 2018). Results have indicated that harbour porpoise remaining in seismic survey impact areas reduced their echolocation activity by 15% during the seismic survey (Pirotta et al., 2013) and the probability of detecting vocalisations when porpoises were present increased with distance from the source vessel, suggesting that probability vocalising was dependent upon received noise intensity (Pirotta et al., 2013).

Few disturbance events are likely to have significant effects to the energetic status of a porpoise, (Wisniewska et al., 2018), particularly when surveys are conducted in shallow waters where sound cannot propagate as far. In addition, where surveys are not frequently repeated, the risks of chronic disturbance which impact upon an individual's ability to survive, breed, reproduce or raise young, are limited.

Although few empirical data persist in the UK for impacts on HF cetaceans (such as short- beaked common dolphin), studies elsewhere indicate that small cetaceans (including harbour porpoise) have a tendency to swim away at speed (Stone, 2003) from seismic airguns, or tend to avoid seismic survey vessels when airguns are firing at a distance of up to ~1km (Moulton & Miller, 2005; Moulton & Holst, 2010; Pirotta et al., 2013). However, as sub-bottom profiler sounds are more directed towards the seafloor, they will attenuate much more rapidly thereby reducing the ensonified zone (Southall et al., 2007). As such, disturbance ranges are likely to be much less than 1km.

4.5 Summary of Impacts

With reference to SCANS III the following densities of relevant cetaceans has been determined in table 5.3. As survey works are contained within Carradale Harbour the affected area has conservatively been estimated as a semi-circle with 1 km radius.

Table 5.3 Estimated number of the species within 1 km of the survey area

Species	**Density Estimate per km2 (SCANS III)**	Estimated Number within Impact Area
Harbour Porpoise	0.336	0.53
Bottlenose Dolphin	0.1206	0.19
Short-beaked Common Dolphin	NA	
Minke Whale	0.0271	0.04

On the basis of the SCANS III density estimates and sightings recorded by HWDT there is a low probability of their being cetaceans present during the short timescales of the sub-bottom profiling works. Also taking account of the short disturbance ranges, the shielding effects of the harbour walls, and lack of regular surveys the chances of geophysical surveys causing effects at a level to impact upon an individual's ability to survive, breed, reproduce or raise young are highly unlikely for all marine mammal receptors.

5. Marine Mammal Mitigation Plan

5.1 Mitigation Strategy

The mitigation measures outlined are based on the Joint Nature Conservation Committee’s (JNCC) Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from geophysical surveys (JNCC, 2017).
Mitigation Strategy. In order to minimise potential impacts to marine mammals, the survey vessels will adhere to the provisions of The Scottish Marine Wildlife Watching Code (SMWWC). It should be noted that the standard Joint Nature Conservation Committee (JNCC) geophysical survey protocol is designed for offshore waters which have typically deeper waters (JNCC, 2017) and therefore the mitigation has been adapted as appropriate for geophysical surveys within the confines of Carradale Harbour.

5.2 Visual Monitoring Protocols

Marine mammal observations during daylight, good visibility and sea states less than 4, will be conducted visually by an MMO based on the acoustic survey vessel. The MMO’s vantage point will be located at a high position on the vessel, and afford the MMO clear all-round visibility of the mitigation zone. The vantage point will also be in a safe location; away from machinery, ropes, high power transmitters etc., and provide some protection from the prevailing conditions. The MMO will be equipped with 7x50 magnification binoculars.

The MMO protocol is outlined below:

1. The Survey Party Chief will inform the MMO of the intention to commence acoustic survey operations, at least 40 minutes prior to arrival at the Start of Line (SoL) position.
2. The MMO will commence a continuous watch of a 500m zone around Carradale Harbour using binoculars, at least 30min before the intended arrival at the SoL.
3. If marine mammals are observed the MMO will advise the Survey Party Chief, so that measures can be taken to minimise the impacts of any potential delays on the survey operations.

4. When the vessel is arriving at the SoL and 30min pre-watch is complete the Survey Party Chief will ask the MMO whether acoustic survey operations can commence.
    - If the 500m mitigation zone around the survey vessel has been clear of marine mammals for at least 20min, the MMO will give permission to commence acoustic survey operations.
    - If marine mammals have been observed inside the mitigation zone within 20min, the MMO will delay acoustic survey operations until at least 20min after the last sighting within the mitigation zone.

6. Conclusions

This report has demonstrated that the proposed geophysical survey within Carradale Harbour, through the adoption of effective and proportionate mitigation measures, poses no risk of acoustic injury to marine mammals. Due to the highly directional nature of the survey methodology, the shallow water depth, boundary of harbour walls, and limited extent and duration of the surveys, it is very unlikely that disturbance will be significant to individual animals or at a population level. An EPS licence is required to be sought however, as marine mammals may experience some short-term, instantaneous disturbance outwith the mitigation zone.

Alternative techniques have been considered for Sub-bottom Profiling which comprises the geophysical survey, however, none exist which do not add extended timescales to the duration of the current methodologies. Extended timeframes to the surveys are not justified by the risks to marine mammals.

This document therefore supports the application for an EPS Licence to Disturb Cetaceans for geophysical surveys.

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