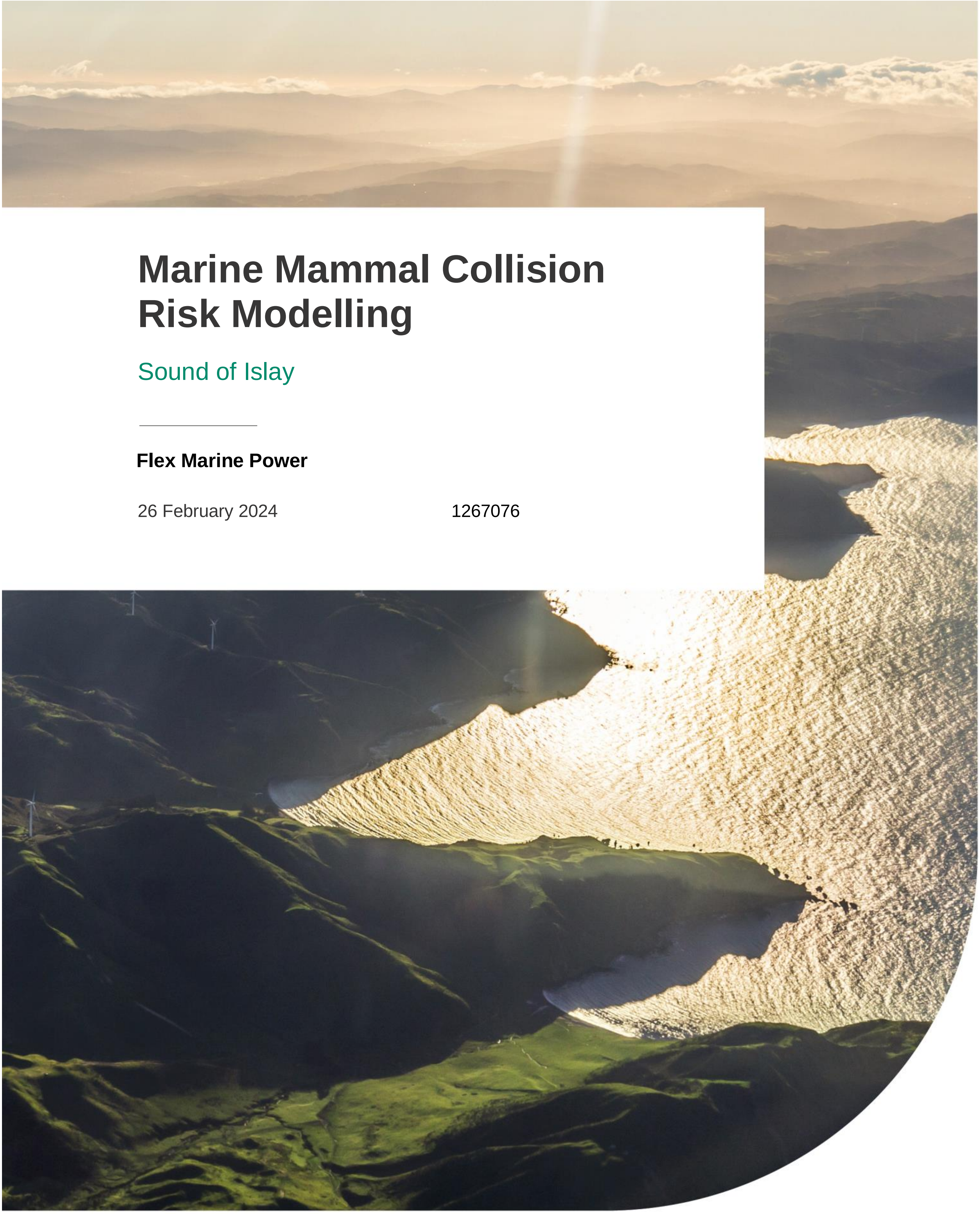
Appendix G – Marine Mammal Collision Risk Modelling.



Marine Mammal Collision Risk Modelling

Sound of Islay

Flex Marine Power

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Document history

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E	26/02/2024	Modelling updated – device depth and porpoise density

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Contents

1. Introduction

Flex Marine Power Ltd, in association with Islay Energy Trust, is proposing to develop a tidal energy generating project in the Sound of Islay. During consultation with NatureScot, it was advised that, as part of the marine licensing application, collision risk modelling should be carried out in order to assess the implications of potential collisions with the tidal device for:

- Harbour seal (*Phoca vitulina*), relating to the South-East Islay Skerries SAC [UK0030067];
- Harbour porpoise (*Phocoena phocoena*), relating to the Inner Hebrides and the Minches SAC [UK0030393]; and
- Grey seal (*Halichoerus grypus*) relating to the Treshnish Isles SAC [UK0030289].

Two rotor sizes are under consideration to be deployed at the site. The device is expected to operate initially with a 3.28 m diameter rotor and subsequently with a 5 m diameter rotor. Both options are considered here.

2. Methods

The Encounter Rate Model (ERM) (SNH, 2016) was used to predict the number of collisions with the tidal device expected per year for harbour seal, harbour porpoise and grey seal. The ERM model is a simplified equation-based model which calculates collision rates as a function of the density of animals present at the site, the area swept by the rotor(s), and the speed of the blades, providing a standardised "order-of-magnitude" estimate of the collisions likely to occur in the absence of any factors drawing animals towards, or away from the devices (e.g. behavioural avoidance of the rotors, effects of hydrodynamic forces or attraction to the high energy flow of water through the turbines or to concentrations of fish sheltering around turbine supports). The model was run using the underwater CRM tool available on the NatureScot website (https://www.nature.scot/doc/assessing-collision-risk-between-underwater-turbines-and-marine-wildlife).

The density of animals at the site for each of the three species was calculated based on published data available in the public domain. For harbour seal and grey seal, densities within the site were calculated by scaling the UK-wide density surfaces provided by Carter *et al.* (2022) to predict the number of seals at sea within each cell of a 5 km x 5 km grid such that the combined total number of animals added up to the total of at sea animals estimated by Carter *et al*. (2022) (150,700 for grey seal and 42,800 for harbour seal). The proposed development site is contained within a single 5 km x 5 km grid cell on the Carter seal density surfaces. The predicted number of animals for this grid cell was 7.23 (3.41 – 12.95) for harbour seal and 2.89 (0.80 – 5.52) for grey seal, giving a density for the proposed development area of 0.29 (0.14 – 0.52) harbour seal per km^2 and 0.12 (0.03 – 0.22) grey seal per km^2.

For harbour porpoise, the most recent SCANS-IV density estimate for the block containing the site of the proposed development (Block CS-F, 0.201 harbour porpoise per km^2; Gilles *et al*., 2023) was used as the input density. Since confidence intervals around the density estimate are not provided, confidence intervals were calculated by assuming the same ratio of the density to the abundance for the confidence limits as for the density and abundance point estimates provided (giving confidence limits of 0.045 – 0.387 harbour porpoise per km^2). These are therefore subject to rounding error.

Since animal densities used here are already corrected for the proportion of animals not observed due to being underwater, no additional correction was required. Therefore, no correction was applied when running the ERM tool.

Proportion of animals at risk depth was then calculated using the Q2R function within the SNH tool.

Parameters associated with the size, shape and speed of the animals, the nature of the tidal channel and the specifications of the tidal device were then used to predict animal encounters with the blades. Two scenarios were considered, one representing the 3.28 m diameter rotor that will be deployed initially, and the other representing the 5 m diameter rotor that will be deployed subsequently. The predictions are assumed to represent lethal collisions in the absence of avoidance. A 98% avoidance[1] rate was then applied to predict the final number of collisions per year.

Input parameters used in the modelling are presented in Table 2.1 and Table 2.2 below.

[1] Recommended by NatureScot through correspondence on the 12/10/2021.

Table 2.1: Device and site parameters used in the modelling

Parameter	Scenario 1	Scenario 2
Rotor diameter (m)	5	3.28
Rotor minimum depth (m)*	6.45	7.30
Number of rotors	1	1
Number of blades	2	2
Rotor blade width (m)	0.604	0.330
Rotation speed (rpm)	40	56
Time not operational (%)	36	36
Mean channel depth (m)	20	20
Mean current speed (m/s)	1.75	1.75

** This parameter is used with the rotor diameter and species-specific swim depth distributions to calculate the proportion of animals swimming at rotor (risk) depth. Position of the rotor relative to the surface of the water will vary due to pitching of the device. The values used here represent the expected mean minimum depth, reflecting the average state of the device during operation.*

Table 2.2: Animal parameters used in the modelling

Parameter	Harbour porpoise	Harbour seal	Grey seal	Reference
Density (animals per km^2)	0.201 (0.045 – 0.387)	0.290 (0.140 – 0.520)	0.120 (0.030 – 0.220)	Gilles *et al*., 2023; Carter *et al*., 2022
Proportion at risk depth (3.28 m rotor)	0.23	0.09	0.03	SNH, 2016
Proportion at risk depth (5 m rotor)	0.34	0.13	0.04	SNH, 2016
Length (m)	1.48	1.41	1.86	Thompson, 2015
Body width (m)	0.32	0.34	0.42	Thompson, 2015
Swim speed (m/s)	1.4	1.8	1.8	Westgate *et al.*, 1995; Thompson, 2015
Shape factor	0.5	0.5	0.5	SNH, 2016

3. Results

Number of collisions predicted for harbour porpoise, harbour seal and grey seal using the ERM model are presented in Table 3.1, Table 3.2 and Table 3.3 below. Raw outputs are presented alongside predictions assuming different levels of avoidance (50%, 90%, 95%, 98% and 99%).

Table 3.1: Predicted annual collision rate for harbour porpoise at different avoidance rates (Values in bold represent the avoidance rate recommended for use by NatureScot)

Avoidance rate	Scenario 1 (5 m diameter rotor)	Scenario 2 (3.28 m diameter rotor)
0%	11.31 (2.53 - 21.77)	6.11 (1.37 - 11.76)
50%	5.65 (1.27 - 10.88)	3.05 (0.68 - 5.88)
90%	1.13 (0.25 - 2.18)	0.61 (0.14 - 1.18)
95%	0.57 (0.13 - 1.09)	0.31 (0.07 - 0.59)
98%	**0.23 (0.05 - 0.44)**	**0.12 (0.03 - 0.24)**
99%	0.11 (0.03 - 0.22)	0.06 (0.01 - 0.12)

Table 3.2 Predicted annual collision rate for harbour seal at different avoidance rates (Values in bold represent the avoidance rate recommended for use by NatureScot)

Avoidance rate	Scenario 1 (5 m diameter rotor)	Scenario 2 (3.28 m diameter rotor)
0%	6.32 (3.05 - 11.34)	3.20 (1.55 - 5.74)
50%	3.16 (1.53 - 5.67)	1.60 (0.77 - 2.87)
90%	0.63 (0.31 - 1.13)	0.32 (0.15 - 0.57)
95%	0.32 (0.15 - 0.57)	0.16 (0.08 - 0.29)
98%	**0.13 (0.06 - 0.23)**	**0.06 (0.03 - 0.11)**
99%	0.06 (0.03 - 0.11)	0.03 (0.02 - 0.06)

Table 3.3: Predicted annual collision rate for grey seal at different avoidance rates (Values in bold represent the avoidance rate recommended for use by NatureScot)

Avoidance rate	Scenario 1 (5 m diameter rotor)	Scenario 2 (3.28 m diameter rotor)
0%	0.92 (0.23 - 1.69)	0.56 (0.14 - 1.02)
50%	0.46 (0.12 - 0.84)	0.28 (0.07 - 0.51)
90%	0.09 (0.02 - 0.17)	0.06 (0.01 - 0.10)
95%	0.05 (0.01 - 0.08)	0.03 (0.01 - 0.05)
98%	**0.02 (<0.01 - 0.03)**	**0.01 (<0.01 - 0.02)**
99%	0.01 (<0.01 - 0.02)	0.01 (0 - 0.01)

4. Discussion

The ERM modelling provides a standardised approach to generate indicative "order of magnitude" predictions of the number of collisions of marine mammals with the tidal device expected over a year (SNH, 2016). The model does not incorporate any attraction of animals towards the device, as there are no data available to quantify any such effects. However, it is important to note that the high energy flow of water through the turbine may prove attractive to marine mammals, which might result in increased collision risk. In contrast, the model also assumes that all encounters result in fatality. However, some encounters will be contact with peripheral parts of the animal and/or with slow-moving central parts of the turbine and such encounters would likely result in no, or only very minor injury to the animal (SNH, 2016).

The Potential Biological Removal (PBR) value is widely used as a method of calculating whether anthropogenic mortality is consistent with the population reaching or exceeding a target population. For seal species the PBR value for West Scotland Seal Management Unit (SMU) was compared with the worst-case scenario of predicted annual collisions for both species. For harbour seal, the worst-case scenario presented here (0.13 harbour seals for the 5 m diameter rotor) constitutes just 0.014% of the allowable take suggested by the PBR (936; Morris *et al.*, 2022[2]). For grey seal the worst-case scenario (0.02 grey seals for the 5 m diameter rotor) constitutes just 0.002% of the allowable take suggested by the PBR (933; Morris *et al*., 2022).

For harbour porpoise, the site lies within the West Scotland cetacean Management Unit (MU). The population estimate for harbour porpoise within the West Scotland MU is 28,936 (21,140 – 39,608) (IAMMWG, 2023). The worst-case scenario for harbour porpoise (0.23 fatalities per year for the 5 m diameter rotor) represents just 0.001% of the total population within the West Scotland MU.

The percentage of the reference population estimated for harbour porpoises and percentage of PBR levels for seal species which have the potential for collision is less than 1% for the three species assessed. Therefore, collision risk is unlikely to have an adverse effect on the species' populations.

[2] These are the PBRs for 2023. The 2024 PBRs are not yet available (http://www.smru.st-andrews.ac.uk/scos/scos-reports/ checked 26/02/2024 - the SCOS 2023 Interim Advice was available but not the full report).

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