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# Morlais Project Environmental Statement

## Appendix 12.2: Additional Collision Risk Assessments

### Volume III

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Appendix 12.2: Additional Collision Risk Assessments

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## GLOSSARY OF ABBREVIATIONS

CRM	Collision Risk Model
CSIP	Cetaceans Stranding's Investigation Programme
EMMP	Environmental Management and Monitoring Plan
ERM	Encounter Rate Model
ES	Environmental Statement
LAT	Lowest Astronomical Tide
m	Metre
m/s	Meters per second
MDZ	Morlais Development Zone
MU	Management Unit
MW	Mega Watt
NRW	Natural Resource Wales
SCANS	Small Cetaceans in the European Atlantic and North Sea
SNH	Scottish Natural Heritage
TWG	Technical Working Group
UK	United Kingdom

## GLOSSARY OF TERMINOLOGY

Adjusted at sea density (per m <sup>2</sup> ) [D <sub>A</sub> ]	This is a calculated field. It divides the animal density observed at the surface by the proportion estimated to be visible at the surface, to get the areal density including animals underwater at any one time.
Body width (m) [W]	Marine animals: Body width of animal. Body width is usually around ¼ of the body length.
Grey seal dive profile	Based on a study in the Pentland Firth
Harbour porpoise dive profile	Based on a study in the Sound of Sleat, Skye, using passive acoustic monitoring
Harbour seal dive profile	Based on a study in the Inner Sound, Pentland Firth
Length (m) [L]	Marine animals: Total length of animal (m) from tip to tail.
Mean blade speed relative to water (n) [v]	This is a calculated field, combining the mean tangential blade speed $v_r$ with the mean current speed $v_c$ which is parallel to the rotor axis.
Mean current speed (m/s) [ $v_c$ ]	This is the tidal current speed (in m/s) at the turbine site, averaged over the time during which the turbine is in operation, i.e. excluding slack tides or excessive tides when the turbine may be closed down.
Mean tangential blade speed (m/s) [ $v_r$ ]	This is a calculated field. Mean tangential blade speed is a mean across blade length, i.e. the blade speed in m/sec at the mid-point of the blade, relative to the hub.
Mean underwater duration of dive [ $t_u$ ]	The mean underwater duration of a dive, in seconds.
Morlais Demonstration Zone	An offshore area of 35km <sup>2</sup> within which the Project will deploy arrays of tidal devices and associated infrastructure. Defined by The Crown Estate Lease boundary, the area within which the tidal

	devices/arrays will be deployed along with associated infrastructure such as inter-array cables, export cables, marker buoys, site monitoring equipment and electrical connections to the export cables.
Observed density (per m <sup>2</sup> ) [D <sub>s</sub> ]	It is the mean number of animals, per m <sup>2</sup> , occupying the site as observed on the sea surface.
Overall dive frequency [F]	Calculated value
Proportion visible at surface	This is a calculated field.
Rotor tip minimum depth (m)	This is the depth (m) of the rotor tips when at their closest to the surface.
Rotation speed (rpm) [Ω]	The mean rotation speed of the rotors when operational, in rpm (revolutions per minute). The spreadsheet converts this to radians per second by multiplying by 2π/60
Tidal Device	A tidal energy convertor, with supporting structures, foundations and / or anchors.
Uniform dive profile	Assumes that animals are uniformly distributed between sea bottom and surface. The proportion at risk is the rotor diameter as a proportion of the sea depth.
Watch period [t <sub>w</sub> ]	In the wildlife survey from which the observed density DS was obtained, the period during which any one area of water is viewed while scanning the site.

## 1. INTRODUCTION

1. This Appendix presents additional collision risk assessments using the Encounter Rate Model (ERM) and Collision Risk Model (CRM). This is presented for information only and to provide supporting information to the assessments in **Section 12.6.4.4 of Chapter, 12 Marine Mammals (Volume I)**.

## 2. COLLISION RISK ASSESSMENTS

2. Details of the tidal device parameters used in the ERM and CRM collision risk assessments are provided in **Table 12-76 in Section 12.6.4.5.1.2 of Chapter 12, Marine Mammals (Volume I)**.
3. Details of the marine mammal parameters used in the ERM and CRM collision risk assessments are provided in **Section 12.6.4.5.1.3 of Chapter 12, Marine Mammals (Volume I)**.
4. **Table 2-1** of this Appendix illustrates the marine mammal parameters from **Table 12-77-78 in Section 12.6.4.5.1.3 of Chapter 12, Marine Mammals (Volume I)** used in the assessments presented in **Section 12.6.4.5 of Chapter 12, Marine Mammals (Volume I)**, based on the inputs to the Scottish Natural Heritage (SNH) spreadsheet following the SNH guidance for assessing collision risk between underwater turbines and marine wildlife (SNH, 2016).
5. The dive profiles were selected from the SNH (2016) spreadsheet as follows:
  - Harbour porpoise = harbour porpoise dive profile;
  - Bottlenose dolphin = uniform dive profile;
  - Risso's dolphin = uniform dive profile;
  - Common dolphin = uniform dive profile;
  - Minke whale = uniform dive profile;
  - Grey seal = grey seal dive profile (with vertical swim speed of 0.61m/s); and
  - Harbour seal = harbour seal dive profile (with vertical swim speed of 0.85m/s).



**Table 2-1 Marine mammal parameters used in collision risk assessments**

Species name					harbour porpoise	harbour seal	grey seal	minke whale	bottlenose dolphin	Risso's dolphin	common dolphin
Observed density (per m <sup>2</sup> )	D <sub>s</sub>	animals m <sup>-2</sup>			7.83E-07	5.00E-10	1.55E-07	1.700E-08	2.000E-08	3.100E-08	2.180E-07
correct for proportion underwater?					no	no	no	no	no	no	no
Proportion of animals visible at surface											
mean underwater duration of dive	t <sub>u</sub>	s			26.2	180	297	87	25.8	25.8	25.8
mean surface time	t <sub>s</sub>	s			3.9	39.5	165	3.5	3.7	3.7	3.7
overall dive frequency	F	dives s <sup>-1</sup>		1/(t <sub>u</sub> +t <sub>s</sub> )	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
watch period	t <sub>w</sub>	s	10		10.0	10.0	10.0	10.0	10.0	10.0	10.0
proportion visible at surface				1-F*max(0,t <sub>u</sub> -t <sub>w</sub> )	1.000	1.0000	1.000	1.000	1.000	1.000	1.000
adjusted at sea density	D <sub>A</sub>	animals m <sup>-2</sup>			7.83E-07	5.00E-10	1.550E-07	1.70E-08	2.00E-08	3.10E-08	2.18E-07

## 2.1. AVOIDANCE RATES FOR ONE TIDAL DEVICE OF EACH DEVICE TYPE

6. The assessment of the potential impacts and effects have been based on 98% avoidance rates for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal.
7. Avoidance rates of 0%, 50%, 90%, 95%, 98% and 99% are presented in this Appendix, as agreed with NRW at the 2<sup>nd</sup> Marine Mammal TWG in February 2019.
8. The marine mammal parameters used in the collision risk assessments are outlined in **Table 2-1** and **Table 12-77-78** in **Section 12.6.4.5.1.3** of **Chapter 12, Marine Mammals (Volume I)** and the tidal device parameters are as outlined in **Table 12-76** in **Section 12.6.4.5.1.2** of **Chapter 12, Marine Mammals (Volume I)**.
9. **Table 2-2** to **Table 2-15** present the 0%, 50%, 90%, 95%, 98% and 99% avoidance rates for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal for the ERM and CRM collision risk assessments (number of individuals per year) for one device of each device type.



**Table 2-2 Harbour porpoise ERM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Harbour porpoise									
Model	ERM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	7a
Avoidance rates										
0%	171.63	140.42	116.06	<del>236.82</del>	79.26	20.16	51.70	5.20	18.73	<del>37.60</del>
50%	85.82	70.21	58.03	<del>118.41</del>	39.63	10.08	25.85	2.60	9.37	<del>18.80</del>
90%	17.16	14.04	11.61	<del>23.68</del>	7.93	2.02	5.17	0.52	1.87	<del>3.76</del>
95%	8.58	7.02	5.80	<del>11.84</del>	3.96	1.01	2.58	0.26	0.94	<del>1.88</del>
<b>98%</b>	<b>3.43</b>	<b>2.81</b>	<b>2.32</b>	<b>4.74</b>	<b>1.59</b>	<b>0.40</b>	<b>1.03</b>	<b>0.10</b>	<b>0.37</b>	<b>0.75</b>
99%	1.72	1.40	1.16	<del>2.37</del>	0.79	0.20	0.52	0.05	0.19	<del>0.38</del>

**Table 2-3 Harbour porpoise CRM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Harbour porpoise									
Model	CRM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	
Avoidance rates										
0%	187.99	215.43	178.06	<del>104.16</del>	101.55	27.27	65.88	7.78	25.43	
50%	93.99	107.72	89.03	<del>52.08</del>	50.77	13.64	32.94	3.89	12.71	
90%	18.80	21.54	17.81	<del>10.42</del>	10.15	2.73	6.59	0.78	2.54	
95%	9.40	10.77	8.90	<del>5.21</del>	5.08	1.36	3.29	0.39	1.27	
<b>98%</b>	<b>3.76</b>	<b>4.31</b>	<b>3.56</b>	<b>2.08</b>	<b>2.03</b>	<b>0.55</b>	<b>1.32</b>	<b>0.16</b>	<b>0.51</b>	
99%	1.88	2.15	1.78	<del>1.04</del>	1.02	0.27	0.66	0.08	0.25	

CRM not applicable to device group 7a; \*CRM not updated for device type 3 as no longer in the Project Design Envelope; device type 7a also no longer in Project Description Envelope





**Table 2-4 Bottlenose dolphin ERM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Bottlenose dolphin									
Model	ERM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	7a
Avoidance rates										
0%	4.83	5.06	5.06	<del>41.66</del>	3.65	2.82	4.03	1.22	5.48	<del>0.72</del>
50%	2.42	2.53	2.53	<del>5.83</del>	1.83	1.41	2.02	0.61	2.74	<del>0.36</del>
90%	0.48	0.51	0.51	<del>1.17</del>	0.37	0.28	0.40	0.12	0.55	<del>0.07</del>
95%	0.24	0.25	0.25	<del>0.58</del>	0.18	0.14	0.20	0.06	0.27	<del>0.04</del>
<b>98%</b>	<b>0.10</b>	<b>0.10</b>	<b>0.10</b>	<b>0.23</b>	<b>0.07</b>	<b>0.06</b>	<b>0.08</b>	<b>0.02</b>	<b>0.11</b>	<b>0.01</b>
99%	0.05	0.05	0.05	<del>0.12</del>	0.04	0.03	0.04	0.01	0.05	<del>0.01</del>

**Table 2-5 Bottlenose dolphin CRM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Bottlenose dolphin								
Model	CRM								
Number of devices =	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b
Avoidance rates									
0%	6.23	7.99	7.99	<del>4.95</del>	5.47	3.21	5.94	1.60	4.79
50%	3.12	4.00	4.00	<del>2.47</del>	2.73	1.61	2.97	0.80	2.40
90%	0.62	0.80	0.80	<del>0.49</del>	0.55	0.32	0.59	0.16	0.48
95%	0.31	0.40	0.40	<del>0.25</del>	0.27	0.16	0.30	0.08	0.24
<b>98%</b>	<b>0.12</b>	<b>0.16</b>	<b>0.16</b>	<b>0.10</b>	<b>0.11</b>	<b>0.06</b>	<b>0.12</b>	<b>0.03</b>	<b>0.10</b>
99%	0.06	0.08	0.08	<del>0.05</del>	0.05	0.03	0.06	0.02	0.05

CRM not applicable to device group 7a; \*CRM not updated for device type 3 as no longer in the Project Design Envelope; device type 7a also no longer in Project Description Envelope



**Table 2-6 Risso's dolphin ERM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Risso's dolphin									
Model	ERM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	7a
Avoidance rates										
0%	7.04	7.20	7.20	<del>46.27</del>	5.28	4.01	5.81	1.74	7.82	<del>0.98</del>
50%	3.52	3.60	3.60	<del>8.14</del>	2.64	2.00	2.91	0.87	3.91	<del>0.49</del>
90%	0.70	0.72	0.72	<del>1.63</del>	0.53	0.40	0.58	0.17	0.78	<del>0.10</del>
95%	0.35	0.36	0.36	<del>0.81</del>	0.26	0.20	0.29	0.09	0.39	<del>0.05</del>
<b>98%</b>	<b>0.14</b>	<b>0.14</b>	<b>0.14</b>	<b>0.33</b>	<b>0.11</b>	<b>0.08</b>	<b>0.12</b>	<b>0.03</b>	<b>0.16</b>	<b>0.02</b>
99%	0.07	0.07	0.07	<del>0.16</del>	0.05	0.04	0.06	0.02	0.08	<del>0.01</del>

**Table 2-7 Risso's dolphin CRM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Risso's dolphin								
Model	CRM								
Number of devices =	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b
Avoidance rates									
0%	8.92	11.81	11.81	<del>6.98</del>	7.75	4.95	8.43	2.45	7.36
50%	4.46	5.90	5.90	<del>3.49</del>	3.88	2.47	4.22	1.23	3.68
90%	0.89	1.18	1.18	<del>0.70</del>	0.78	0.49	0.84	0.25	0.74
95%	0.45	0.59	0.59	<del>0.35</del>	0.39	0.25	0.42	0.12	0.37
<b>98%</b>	<b>0.18</b>	<b>0.24</b>	<b>0.24</b>	<b>0.14</b>	<b>0.16</b>	<b>0.10</b>	<b>0.17</b>	<b>0.05</b>	<b>0.15</b>
99%	0.09	0.12	0.12	<del>0.07</del>	0.08	0.05	0.08	0.02	0.07

CRM not applicable to device group 7a; \*CRM not updated for device type 3 as no longer in the Project Design Envelope; device type 7a also no longer in Project Description Envelope



**Table 2-8 Common dolphin ERM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Common dolphin									
Model	ERM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	7a
Avoidance rates										
0%	41.71	39.15	39.15	<del>83.67</del>	29.87	22.16	32.89	9.44	42.47	<del>5.04</del>
50%	20.86	19.58	19.58	<del>41.83</del>	14.93	11.08	16.45	4.72	21.24	<del>2.54</del>
90%	4.17	3.92	3.92	<del>8.37</del>	2.99	2.22	3.29	0.94	4.25	<del>0.50</del>
95%	2.09	1.96	1.96	<del>4.18</del>	1.49	1.11	1.64	0.47	2.12	<del>0.25</del>
<b>98%</b>	<b>0.83</b>	<b>0.78</b>	<b>0.78</b>	<b><del>1.67</del></b>	<b>0.60</b>	<b>0.44</b>	<b>0.66</b>	<b>0.19</b>	<b>0.85</b>	<b><del>0.10</del></b>
99%	0.42	0.39	0.39	<del>0.84</del>	0.30	0.22	0.33	0.09	0.42	<del>0.05</del>

**Table 2-9 Common dolphin CRM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Common dolphin									
Model	CRM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	
Avoidance rates										
0%	48.15	61.80	61.80	<del>36.24</del>	40.48	30.49	44.06	14.67	50.32	
50%	24.08	30.90	30.90	<del>18.12</del>	20.24	15.24	22.03	7.33	25.16	
90%	4.82	6.18	6.18	<del>3.62</del>	4.05	3.05	4.41	1.47	5.03	
95%	2.41	3.09	3.09	<del>1.81</del>	2.02	1.52	2.20	0.73	2.52	
<b>98%</b>	<b>0.96</b>	<b>1.24</b>	<b>1.24</b>	<b><del>0.72</del></b>	<b>0.81</b>	<b>0.61</b>	<b>0.88</b>	<b>0.29</b>	<b>1.01</b>	
99%	0.48	0.62	0.62	<del>0.36</del>	0.40	0.30	0.44	0.15	0.50	

CRM not applicable to device group 7a; \*CRM not updated for device type 3 as no longer in the Project Design Envelope; device type 7a also no longer in Project Description Envelope



**Table 2-10 Minke whale ERM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Minke whale									
Model	ERM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	7a*
Avoidance rates										
0%	11.81	16.91	16.91	<del>49.84</del>	9.89	8.81	11.04	4.05	18.22	<del>3.30</del>
50%	5.91	8.45	8.45	<del>24.92</del>	4.95	4.41	5.52	2.02	9.11	<del>1.65</del>
90%	1.18	1.69	1.69	<del>4.98</del>	0.99	0.88	1.10	0.40	1.82	<del>0.33</del>
95%	0.59	0.85	0.85	<del>2.49</del>	0.49	0.44	0.55	0.20	0.91	<del>0.16</del>
<b>98%</b>	<b>0.24</b>	<b>0.34</b>	<b>0.34</b>	<b>1.00</b>	<b>0.20</b>	<b>0.18</b>	<b>0.22</b>	<b>0.08</b>	<b>0.36</b>	<b>0.07</b>
99%	0.12	0.17	0.17	<del>0.50</del>	0.10	0.09	0.11	0.04	0.18	<del>0.03</del>

**Table 2-11 Minke whale CRM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Minke whale*									
Model	CRM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	
Avoidance rates										
0%	11.13	8.93	8.93	<del>12.44</del>	9.10	3.30	8.88	1.79	5.36	
50%	5.57	4.47	4.47	<del>6.22</del>	4.55	1.65	4.44	0.89	2.68	
90%	1.11	0.89	0.89	<del>1.24</del>	0.91	0.33	0.89	0.18	0.54	
95%	0.56	0.45	0.45	<del>0.62</del>	0.45	0.17	0.44	0.09	0.27	
<b>98%</b>	<b>0.22</b>	<b>0.18</b>	<b>0.18</b>	<b>0.25</b>	<b>0.18</b>	<b>0.07</b>	<b>0.18</b>	<b>0.04</b>	<b>0.11</b>	
99%	0.11	0.09	0.09	<del>0.12</del>	0.09	0.03	0.09	0.02	0.05	

CRM not applicable to device group 7a; \*device type 3 and 7a no longer in Project Description Envelope

\* minke whale have the same pcoll value for all devices, so therefore there is no change to the minke whale values with the CRM updates



**Table 2-12 Grey seal ERM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Grey seal									
Model	ERM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	7a*
Avoidance rates										
0%	27.16	23.37	23.37	<del>50.64</del>	16.99	9.99	16.11	3.94	17.72	<del>5.57</del>
50%	13.58	11.68	11.68	<del>25.34</del>	8.49	5.00	8.06	1.97	8.86	<del>2.79</del>
90%	2.72	2.34	2.34	<del>5.06</del>	1.70	1.00	1.61	0.39	1.77	<del>0.56</del>
95%	1.36	1.17	1.17	<del>2.53</del>	0.85	0.50	0.81	0.20	0.89	<del>0.28</del>
<b>98%</b>	<b>0.54</b>	<b>0.47</b>	<b>0.47</b>	<b>1.01</b>	<b>0.34</b>	<b>0.20</b>	<b>0.32</b>	<b>0.08</b>	<b>0.35</b>	<b>0.11</b>
99%	0.27	0.23	0.23	<del>0.54</del>	0.17	0.10	0.16	0.04	0.18	<del>0.06</del>

**Table 2-13 Grey seal CRM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Grey seal									
Model	CRM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	
Avoidance rates										
0%	31.57	36.70	36.70	<del>21.35</del>	23.25	13.66	21.74	6.11	19.96	
50%	15.79	18.35	18.35	<del>10.67</del>	11.63	6.83	10.87	3.05	9.98	
90%	3.16	3.67	3.67	<del>2.13</del>	2.33	1.37	2.17	0.61	2.00	
95%	1.58	1.84	1.84	<del>1.07</del>	1.16	0.68	1.09	0.31	1.00	
<b>98%</b>	<b>0.63</b>	<b>0.73</b>	<b>0.73</b>	<b>0.43</b>	<b>0.47</b>	<b>0.27</b>	<b>0.43</b>	<b>0.12</b>	<b>0.40</b>	
99%	0.32	0.37	0.37	<del>0.21</del>	0.23	0.14	0.22	0.06	0.20	

CRM not applicable to device group 7a; \*CRM not updated for device type 3 as no longer in the Project Design Envelope; device type 7a also no longer in Project Description Envelope



**Table 2-14 Harbour seal ERM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Harbour seal									
Model	ERM									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	7a*
Avoidance rates										
0%	0.07	0.07	0.07	0.14	0.06	0.04	0.06	0.02	0.05	0.00
50%	0.04	0.04	0.03	0.07	0.03	0.02	0.03	0.01	0.02	0.00
90%	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.00
95%	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
<b>98%</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
99%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table 2-15 Harbour seal CRM assessment (number of individuals / year) with different avoidance rates for one device of each different tidal device type**

Species	Harbour seal									
Model	CRM*									
Number of devices =	1	1	1	1	1	1	1	1	1	1
Device Group	1	2a	2b	3*	4	5a	5b	6a	6b	
Avoidance rates										
0%	0.08	0.11	0.10	0.06	0.08	0.06	0.07	0.03	0.06	
50%	0.04	0.06	0.05	0.03	0.04	0.03	0.03	0.01	0.03	
90%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	
95%	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	
<b>98%</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	
99%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

CRM not applicable to device group 7a; \*CRM not updated for device type 3 as no longer in the Project Design Envelope; device type 7a also no longer in Project Description Envelope

## **2.2. LESS THAN ONE BOTTLENOSE DOLPHIN SCENARIOS<sup>1</sup> FOR THE INDICATIVE COMBINATION OF DIFFERENT TYPES OF DEVICES**

10. As outlined in **Section 12.6.4.5.2 of Chapter 12, Marine Mammals (Volume I)**, the assessments are based on the indicative scenarios for the combination of different types of devices where the collision risk is predicted to be less than one bottlenose dolphin (based on the scenarios with the current maximum MW). Each stage of deployment would only progress based on these scenarios and that the regular reviewing of the monitoring and mitigation indicated that there was no increased collision risk.
11. Based on these indicative scenarios and combination of devices the first initial stage of deployment could be 18.15MW to 23.35MW.
12. It is important to note that the output of the devices (MW) used in the assessments are indicative and have been based on the current minimum rating, as a worst-case scenario and prior to deployment it is expected that the rating (MW) for the devices deployed would be higher, although the other parameters are unlikely to change. Further assessments will be conducted prior to deployment as part of the adaptive management and mitigation plan (EMMP).
13. **Table 2-16 to Table 2-29** present the 0%, 50%, 90%, 95%, 98% and 99% avoidance rates for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal for the ERM and CRM collision risk assessments (number of individuals per year) for the less than one bottlenose dolphin scenarios presented in **Section 12.6.4.5.2 of Chapter 12, Marine Mammals (Volume I)**.
14. The marine mammal parameters used in the collision risk assessments are as outlined in **Table 2-1 and Table 12-77 to 12-78 in Section 12.6.4.5.1.3 of Chapter 12, Marine Mammals (Volume I)** and the tidal device parameters are as outlined in **Table 12-76 in Section 12.6.4.5.1.2 of Chapter 12, Marine Mammals (Volume I)**.

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<sup>1</sup> Note: the less than one bottlenose dolphin scenarios have been superseded by the revised less than 0.7 bottlenose dolphin scenarios. For consistency and comparison purposes the updated CRM models were run with all the same parameters, therefore some of the results are greater than one bottlenose dolphin.



**Table 2-16 Harbour porpoise ERM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Harbour porpoise										
Model	ERM										
Number of devices =	4 (8MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	2 (2MW)	1 (1.5MW)	1 (0.3MW)	1 (1.2MW)	0	Total 12 (16.75MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a	
Avoidance rates											
0%	686.53	140.42	116.06		79.26	40.33	51.70	5.20	18.73		1138.22
50%	343.26	70.21	58.03		39.63	20.16	25.85	2.60	9.37		569.11
90%	68.65	14.04	11.61		7.93	4.03	5.17	0.52	1.87		113.82
95%	34.33	7.02	5.80		3.96	2.02	2.58	0.26	0.94		56.91
98%	13.73	2.81	2.32		1.59	0.81	1.03	0.10	0.37		22.76
99%	6.87	1.40	1.16		0.79	0.40	0.52	0.05	0.19		11.38

**Table 2-17 Harbour porpoise CRM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Harbour porpoise										
Model	CRM										
Number of devices =	3 (6MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	1 (1MW)	1 (1.5MW)	2 (0.6MW)	3 (3.6MW)	0	Total 13 (16.45MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a*	
Avoidance rates											
0%	563.96	215.43	178.06		101.55	27.27	65.88	15.57	76.29		1244.00
50%	281.98	107.72	89.03		50.77	13.64	32.94	7.78	38.14		622.00
90%	56.40	21.54	17.81		10.15	2.73	6.59	1.56	7.63		124.40
95%	28.20	10.77	8.90		5.08	1.36	3.29	0.78	3.81		62.20
98%	11.28	4.31	3.56		2.03	0.55	1.32	0.31	1.53		24.88
99%	5.64	2.15	1.78		1.02	0.27	0.66	0.16	0.76		12.44

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device, therefore ERM results included





**Table 2-18 Bottlenose dolphin ERM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Bottlenose dolphin										
Model	ERM										
Number of devices =	4 (8MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	2 (2MW)	1 (1.5MW)	1 (0.3MW)	1 (1.2MW)	0	Total 12 (16.75MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a	
Avoidance rates											
0%	19.32	5.06	5.06		3.65	5.64	4.03	1.22	5.48		49.47
50%	9.66	2.53	2.53		1.83	2.82	2.02	0.61	2.74		24.74
90%	1.93	0.51	0.51		0.37	0.56	0.40	0.12	0.55		4.95
95%	0.97	0.25	0.25		0.18	0.28	0.20	0.06	0.27		2.47
98%	0.39	0.10	0.10		0.07	0.11	0.08	0.02	0.11		0.99
99%	0.19	0.05	0.05		0.04	0.06	0.04	0.01	0.05		0.49

**Table 2-19 Bottlenose dolphin CRM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Bottlenose dolphin										
Model	CRM										
Number of devices =	3 (6MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	1 (1MW)	1 (1.5MW)	2 (0.6MW)	3 (3.6MW)	0	Total 13 (16.45MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a*	
Avoidance rates											
0%	18.70	7.99	7.99		5.47	3.21	5.94	3.20	14.38		66.89
50%	9.35	4.00	4.00		2.73	1.61	2.97	1.60	7.19		33.44
90%	1.87	0.80	0.80		0.55	0.32	0.59	0.32	1.44		6.69
95%	0.94	0.40	0.40		0.27	0.16	0.30	0.16	0.72		3.34
98%	0.37	0.16	0.16		0.11	0.06	0.12	0.06	0.29		1.34
99%	0.19	0.08	0.08		0.05	0.03	0.06	0.03	0.14		0.67

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device, therefore ERM results included



**Table 2-20 Risso's dolphin ERM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Risso's dolphin										
Model	ERM										
Number of devices =	4 (8MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	2 (2MW)	1 (1.5MW)	1 (0.3MW)	1 (1.2MW)	0	Total 12 (16.75MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a	
Avoidance rates											
0%	28.18	7.20	7.20		5.28	8.02	5.81	1.74	7.82		71.25
50%	14.09	3.60	3.60		2.64	4.01	2.91	0.87	3.91		35.62
90%	2.82	0.72	0.72		0.53	0.80	0.58	0.17	0.78		7.12
95%	1.41	0.36	0.36		0.26	0.40	0.29	0.09	0.39		3.56
98%	0.56	0.14	0.14		0.11	0.16	0.12	0.03	0.16		1.42
99%	0.28	0.07	0.07		0.05	0.08	0.06	0.02	0.08		0.71

**Table 2-21 Risso's dolphin CRM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Risso's dolphin										
Model	CRM										
Number of devices =	3 (6MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	1 (1MW)	1 (1.5MW)	2 (0.6MW)	3 (3.6MW)	0	Total 13 (16.45MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a*	
Avoidance rates											
0%	26.75	11.81	11.81		7.75	4.95	8.43	4.91	22.09		98.49
50%	13.37	5.90	5.90		3.88	2.47	4.22	2.45	11.04		49.24
90%	2.67	1.18	1.18		0.78	0.49	0.84	0.49	2.21		9.85
95%	1.34	0.59	0.59		0.39	0.25	0.42	0.25	1.10		4.92
98%	0.53	0.24	0.24		0.16	0.10	0.17	0.10	0.44		1.97
99%	0.27	0.12	0.12		0.08	0.05	0.08	0.05	0.22		0.98

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device, therefore ERM results included



**Table 2-22 Common dolphin ERM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Common dolphin										
Model	ERM										
Number of devices =	4 (8MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	2 (2MW)	1 (1.5MW)	1 (0.3MW)	1 (1.2MW)	0	Total 12 (16.75MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a	
Avoidance rates											
0%	166.85	39.15	39.15		29.87	44.32	32.89	9.44	42.47		404.14
50%	83.43	19.58	19.58		14.93	22.16	16.45	4.72	21.24		202.07
90%	16.69	3.92	3.92		2.99	4.43	3.29	0.94	4.25		40.41
95%	8.34	1.96	1.96		1.49	2.22	1.64	0.47	2.12		20.21
98%	3.34	0.78	0.78		0.60	0.89	0.66	0.19	0.85		8.08
99%	1.67	0.39	0.39		0.30	0.44	0.33	0.09	0.42		4.04

**Table 2-23 Common dolphin CRM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Common dolphin										
Model	CRM										
Number of devices =	3 (6MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	1 (1MW)	1 (1.5MW)	2 (0.6MW)	3 (3.6MW)	0	Total 13 (16.45MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a*	
Avoidance rates											
0%	144.46	61.80	61.80		40.48	30.49	44.06	29.33	150.95		563.37
50%	72.23	30.90	30.90		20.24	15.24	22.03	14.67	75.48		281.69
90%	14.45	6.18	6.18		4.05	3.05	4.41	2.93	15.10		56.34
95%	7.22	3.09	3.09		2.02	1.52	2.20	1.47	7.55		28.17
98%	2.89	1.24	1.24		0.81	0.61	0.88	0.59	3.02		11.27
99%	1.44	0.62	0.62		0.40	0.30	0.44	0.29	1.51		5.63

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device, therefore ERM results included



**Table 2-24 Minke whale ERM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Minke whale										
Model	ERM										
Number of devices =	4 (8MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	2 (2MW)	1 (1.5MW)	1 (0.3MW)	1 (1.2MW)	0	Total 12 (16.75MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a	
Avoidance rates											
0%	47.25	16.91	16.91		9.89	17.62	11.04	4.05	18.22		141.89
50%	23.63	8.45	8.45		4.95	8.81	5.52	2.02	9.11		70.94
90%	4.73	1.69	1.69		0.99	1.76	1.10	0.40	1.82		14.19
95%	2.36	0.85	0.85		0.49	0.88	0.55	0.20	0.91		7.09
98%	0.95	0.34	0.34		0.20	0.35	0.22	0.08	0.36		2.84
99%	0.47	0.17	0.17		0.10	0.18	0.11	0.04	0.18		1.42

**Table 2-25 Minke whale CRM assessment\*\* (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Minke whale										
Model	CRM										
Number of devices =	3 (6MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	1 (1MW)	1 (1.5MW)	2 (0.6MW)	3 (3.6MW)	0	Total 13 (16.45MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a*	
Avoidance rates											
0%	33.40	8.93	8.93		9.10	3.30	8.88	3.57	16.08		92.18
50%	16.70	4.47	4.47		4.55	1.65	4.44	1.79	8.04		46.09
90%	3.34	0.89	0.89		0.91	0.33	0.89	0.36	1.61		9.22
95%	1.67	0.45	0.45		0.45	0.17	0.44	0.18	0.80		4.61
98%	0.67	0.18	0.18		0.18	0.07	0.18	0.07	0.32		1.84
99%	0.33	0.09	0.09		0.09	0.03	0.09	0.04	0.16		0.92

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device, therefore ERM results included

\*\*\* minke whale have the same pcoll value for all devices, so therefore there is no change to the minke whale values with the CRM updates



**Table 2-26 Grey seal ERM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Grey seal										
Model	ERM										
Number of devices =	4 (8MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	2 (2MW)	1 (1.5MW)	1 (0.3MW)	1 (1.2MW)	0	Total 12 (16.75MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a	
Avoidance rates											
0%	108.63	23.37	23.37		16.99	19.98	16.11	3.94	17.72		230.09
50%	54.31	11.68	11.68		8.49	9.99	8.06	1.97	8.86		115.05
90%	10.86	2.34	2.34		1.70	2.00	1.61	0.39	1.77		23.01
95%	5.43	1.17	1.17		0.85	1.00	0.81	0.20	0.89		11.50
98%	2.17	0.47	0.47		0.34	0.40	0.32	0.08	0.35		4.60
99%	1.09	0.23	0.23		0.17	0.20	0.16	0.04	0.18		2.30

**Table 2-27 Grey seal CRM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Grey seal										
Model	CRM										
Number of devices =	3 (6MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	1 (1MW)	1 (1.5MW)	2 (0.6MW)	3 (3.6MW)	0	Total 13 (16.45MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a*	
Avoidance rates											
0%	94.72	36.70	36.70		23.25	13.66	21.74	12.21	59.87		298.86
50%	47.36	18.35	18.35		11.63	6.83	10.87	6.11	29.94		149.43
90%	9.47	3.67	3.67		2.33	1.37	2.17	1.22	5.99		29.89
95%	4.74	1.84	1.84		1.16	0.68	1.09	0.61	2.99		14.94
98%	1.89	0.73	0.73		0.47	0.27	0.43	0.24	1.20		5.98
99%	0.95	0.37	0.37		0.23	0.14	0.22	0.12	0.60		2.99

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device, therefore ERM results included



**Table 2-28 Harbour seal ERM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Harbour seal										
Model	ERM										
Number of devices =	4 (8MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	2 (2MW)	1 (1.5MW)	1 (0.3MW)	1 (1.2MW)	0	Total 12 (16.75MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a	
Avoidance rates											
0%	0.29	0.07	0.07		0.06	0.09	0.06	0.02	0.05		0.70
50%	0.14	0.04	0.03		0.03	0.04	0.03	0.01	0.02		0.35
90%	0.03	0.01	0.01		0.01	0.01	0.01	0.00	0.00		0.07
95%	0.01	0.00	0.00		0.00	0.00	0.00	0.00	0.00		0.04
98%	0.01	0.00	0.00		0.00	0.00	0.00	0.00	0.00		0.01
99%	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00		0.01

**Table 2-29 Harbour seal CRM assessment (number of individuals / year) with different avoidance rates for indicative scenario of each type of device combined for collision risk of less than one bottlenose dolphin**

Species	Harbour seal										
Model	CRM										
Number of devices =	3 (6MW)	1 (1.5MW)	1 (1.25MW)	0	1 (1MW)	1 (1MW)	1 (1.5MW)	2 (0.6MW)	3 (3.6MW)	0	Total 13 (16.45MW)
Device Group	1	2a	2b	3	4	5a	5b	6a	6b	7a*	
Avoidance rates											
0%	0.23	0.11	0.10		0.08	0.06	0.07	0.06	0.19		0.90
50%	0.12	0.06	0.05		0.04	0.03	0.03	0.03	0.10		0.45
90%	0.02	0.01	0.01		0.01	0.01	0.01	0.01	0.02		0.09
95%	0.01	0.01	0.01		0.00	0.00	0.00	0.00	0.01		0.04
98%	0.005	0.002	0.002		0.002	0.001	0.001	0.001	0.004		0.02
99%	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00		0.01

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device, therefore ERM results included

### **2.3. LESS THAN ONE BOTTLENOSE DOLPHIN SCENARIOS FOR THE INDICATIVE MAXIMUM NUMBER OF EACH TYPE OF DEVICE FOR ONE DEVICE TYPE ONLY**

15. **Table 2-30** and **Table 2-31** present the ERM and CRM collision risk assessments (number of individuals per year and percentage of reference populations) for the less than one bottlenose dolphin scenarios for the indicative maximum number of each type of device, based on 98% avoidance rates for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal.
16. As previously outlined, it is important to note that the output of the devices (MW) used in the assessments are indicative and have been based on the current minimum rating, as a worst-case scenario and prior to deployment it is expected that the rating (MW) for the devices deployed would be higher, although the other parameters are unlikely to change. Further assessments will be conducted prior to deployment as part of the adaptive management and mitigation plan (EMMP).
17. The marine mammal parameters used in the collision risk assessments are as outlined in **Table 2-1** and **Table 12-77 to 12-78** in **Section 12.6.4.5.1.3** of **Chapter 12, Marine Mammals (Volume I)** and the tidal device parameters are as outlined in **Table 12-76** in **Section 12.6.4.5.1.2** of **Chapter 12, Marine Mammals (Volume I)**.
18. The marine mammal reference populations are presented in **Table 12-20** in **Section 12.5.10** of **Chapter 12, Marine Mammals (Volume I)**.



**Table 2-30 Marine mammal ERM assessment (number of individuals / year and % of reference population) with 98% avoidance for less than one bottlenose dolphin scenarios for the indicative maximum number of each type of device type**

Tidal device category	1	2a	2b	3*	4	5a	5b	6a	6b	7a*
Number of Devices	10 (20MW)	9 (13.5MW)	9 (11.25MW)	4 (4MW)	13 (13MW)	17 (17MW)	12 (18MW)	40 (12MW)	9(10.8MW)	69 (6.9MW)
Harbour porpoise	34.33	25.28	20.89	4.74	20.61	6.86	12.41	4.16	3.37	51.89
	0.03%	0.02%	0.02%	0.00%	0.02%	0.01%	0.01%	0.004%	0.003%	0.05%
Bottlenose dolphin	0.97	0.91	0.91	0.93	0.95	0.96	0.97	0.97	0.99	0.99
	0.24%	0.23%	0.23%	0.24%	0.24%	0.24%	0.24%	0.25%	0.25%	0.25%
Risso's dolphin	1.41	1.30	1.30	1.30	1.37	1.36	1.40	1.39	1.41	1.35
	0.02%	0.01%	0.01%	0.01%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%
Common dolphin	8.34	7.05	7.05	6.69	7.77	7.53	7.89	7.55	7.65	6.92
	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
Minke whale	2.36	3.04	3.04	3.99	2.57	3.00	2.65	3.24	3.28	4.55
	0.01%	0.01%	0.01%	0.02%	0.01%	0.01%	0.01%	0.01%	0.01%	0.02%
Grey seal	5.43	4.21	4.21	4.05	4.42	3.40	3.87	3.15	3.19	7.69
	0.09%	0.07%	0.07%	0.07%	0.07%	0.06%	0.06%	0.05%	0.05%	0.13%
Harbour seal	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01
	0.03%	0.03%	0.02%	0.02%	0.03%	0.03%	0.03%	0.03%	0.02%	0.01%

\* device type 3 and 7a no longer in Project Description Envelope





**Table 2-31 Marine mammal CRM assessment (number of individuals / year and % of reference population) with 98% avoidance for less than one bottlenose dolphin scenarios for the indicative maximum number of each type of device type**

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b	7a*
Number of Devices	7 (14MW)	11 (16.5MW)	11 (13.75MW)	10 (10MW)	9 (9MW)	27 (27MW)	9 (13.5MW)	55 (16.5MW)	18 (21.6MW)	N/A
Harbour porpoise	26.32	47.39	39.17	<del>20.83</del>	18.28	14.73	11.86	8.56	9.15	N/A
	0.03%	0.05%	0.04%	<del>0.02%</del>	0.02%	0.01%	0.01%	0.01%	0.01%	
Bottlenose dolphin	0.87	1.76	1.76	<del>0.99</del>	0.98	1.73	1.07	1.76	1.73	N/A
	0.22%	0.44%	0.44%	<del>0.25%</del>	0.25%	0.44%	0.27%	0.44%	0.43%	
Risso's dolphin	1.25	2.60	2.60	<del>1.40</del>	1.40	2.67	1.52	2.70	2.65	N/A
	0.01%	0.03%	0.03%	<del>0.02%</del>	0.02%	0.03%	0.02%	0.03%	0.03%	
Common dolphin	6.74	13.60	13.60	<del>7.25</del>	7.29	16.46	7.93	16.13	18.11	N/A
	0.01%	0.02%	0.02%	<del>0.01%</del>	0.01%	0.03%	0.01%	0.03%	0.03%	
Minke whale	1.56	1.96	1.96	<del>2.49</del>	1.64	1.78	1.60	1.96	1.93	N/A
	0.01%	0.01%	0.01%	<del>0.01%</del>	0.01%	0.01%	0.01%	0.01%	0.01%	
Grey seal	4.42	8.07	8.07	<del>4.27</del>	4.19	7.37	3.91	6.72	7.18	N/A
	0.07%	0.13%	0.13%	<del>0.07%</del>	0.07%	0.12%	0.07%	0.11%	0.12%	
Harbour seal	0.01	0.025	0.023	<del>0.04</del>	0.014	0.030	0.012	0.032	0.023	N/A
	0.02%	0.05%	0.05%	<del>0.02%</del>	0.03%	0.06%	0.02%	0.06%	0.05%	

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device; \*device type 3 and 7a no longer in Project Description Envelope

## 2.4. INDICTIVE 30MW OF EACH TYPE OF DEVICE

19. It is currently proposed that the Morlais tidal arrays would be installed in phases, with up to 30MW for each type of device.
20. **Table 2-32** and **Table 2-33** present the ERM and CRM collision risk assessments (number of individuals per year and percentage of the reference populations) for 30MW of each device type, based on 98% avoidance rates for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal. The results are summarised in **Table 2-34**.
21. As outlined in **Section 12.6.4.5.1.2 of Chapter 12, Marine Mammals (Volume I)**, these scenarios would only be developed once the monitoring and mitigation indicates that the collision risk would be less than one bottlenose dolphin.
22. The marine mammal parameters used in the collision risk assessments are as outlined in **Table 2-1** and **Table 12-77 to 12-78** in **Section 12.6.4.5.1.3 of Chapter 12, Marine Mammals (Volume I)** and the tidal device parameters are as outlined in **Table 12.74** in **Section 12.6.4.5.1.2 of Chapter 12, Marine Mammals (Volume I)**.
23. The marine mammal reference populations are presented in **Table 12-20** in **Section 12.5.10 of Chapter 12, Marine Mammals (Volume I)**.



**Table 2-32 Marine mammal ERM assessment (number of individuals / year and % of reference population) with 98% avoidance for 30MW of each tidal device type**

Tidal device category	1	2a	2b	3*	4	5a	5b	6a	6b	7a*	Total
Number of Devices	15	20	24	30	30	30	20	100	25	300	N/A
<b>Harbour porpoise</b>											
30MW	51.49 (0.05%)	56.17 (0.05%)	55.71 (0.05%)	<del>142.09</del> (0.14%)	47.55 (0.05%)	12.10 (0.01%)	20.68 (0.02%)	10.41 (0.01%)	9.37 (0.009%)	<del>225.62</del> (0.22%)	N/A
<b>Bottlenose dolphin</b>											
30MW	1.45 (0.37%)	2.02 (0.51%)	2.43 (0.61%)	<del>7.00</del> (1.76%)	2.19 (0.55%)	1.69 (0.43%)	1.61 (0.41%)	2.44 (0.61%)	2.74 (0.69%)	<del>4.34</del> (1.09%)	N/A
<b>Risso's dolphin</b>											
30MW	2.11 (0.02%)	2.88 (0.03%)	3.46 (0.04%)	<del>9.76</del> (0.11%)	3.17 (0.04%)	2.41 (0.03%)	2.33 (0.03%)	3.47 (0.04%)	3.91 (0.04%)	<del>5.89</del> (0.07%)	N/A
<b>Common dolphin</b>											
30MW	12.51 (0.02%)	15.66 (0.03%)	18.79 (0.03%)	<del>50.20</del> (0.09%)	17.92 (0.03%)	13.30 (0.02%)	13.16 (0.02%)	18.88 (0.03%)	21.24 (0.04%)	<del>30.08</del> (0.05%)	N/A
<b>Minke whale</b>											
30MW	3.54 (0.02%)	6.76 (0.03%)	8.12 (0.03%)	<del>29.90</del> (0.13%)	5.94 (0.03%)	5.29 (0.02%)	4.43 (0.02%)	8.10 (0.03%)	9.11 (0.04%)	<del>19.79</del> (0.08%)	N/A
<b>Grey seal</b>											
30MW	8.15 (0.14%)	9.35 (0.16%)	11.22 (0.19%)	<del>30.37</del> (0.51%)	10.19 (0.17%)	6.00 (0.10%)	6.44 (0.11%)	7.87 (0.13%)	8.86 (0.15%)	<del>33.42</del> (0.56%)	N/A
<b>Harbour seal</b>											
30MW	0.02 (0.04%)	0.03 (0.06%)	0.03 (0.07%)	<del>0.08</del> (0.17%)	0.04 (0.08%)	0.03 (0.05%)	0.02 (0.04%)	0.04 (0.08%)	0.02 (0.05%)	<del>0.02</del> (0.05%)	N/A

\* device type 3 and 7a no longer in Project Description Envelope



**Table 2-33 Marine mammal CRM assessment (number of individuals / year and % of reference population) with 98% avoidance for 30MW of each tidal device type**

Tidal device category	1	2a	2b	3*	4	5a	5b	6a	6b	7a*	Total
Number of Devices	15	20	24	30	30	30	20	100	25	N/A	N/A
<b>Harbour porpoise</b>											
30MW	56.40 (0.05%)	86.17 (0.08%)	85.47 (0.08%)	<del>62.50</del> (0.06%)	60.93 (0.06%)	16.36 (0.02%)	26.35 (0.03%)	15.57 (0.01%)	12.71 (0.01%)	N/A	N/A
<b>Bottlenose dolphin</b>											
30MW	1.87 (0.47%)	3.20 (0.81%)	3.84 (0.97%)	<del>2.97</del> (0.75%)	3.28 (0.83%)	1.93 (0.49%)	2.38 (0.60%)	3.20 (0.81%)	2.40 (0.60%)	N/A	N/A
<b>Risso's dolphin</b>											
30MW	2.68 (0.03%)	4.72 (0.05%)	5.67 (0.06%)	<del>4.19</del> (0.05%)	4.65 (0.05%)	2.97 (0.03%)	3.37 (0.04%)	4.91 (0.06%)	3.68 (0.04%)	N/A	N/A
<b>Common dolphin</b>											
30MW	14.45 (0.03%)	24.72 (0.04%)	29.66 (0.05%)	<del>21.75</del> (0.04%)	24.29 (0.04%)	18.29 (0.03%)	17.62 (0.03%)	29.33 (0.05%)	25.16 (0.04%)	N/A	N/A
<b>Minke whale</b>											
30MW	3.34 (0.01%)	3.57 (0.02%)	4.29 (0.02%)	<del>7.47</del> (0.03%)	5.46 (0.02%)	1.98 (0.008%)	3.55 (0.02%)	3.57 (0.02%)	2.68 (0.01%)	N/A	N/A
<b>Grey seal</b>											
30MW	9.47 (0.16%)	14.68 (0.24%)	17.62 (0.29%)	<del>12.84</del> (0.21%)	13.95 (0.23%)	8.19 (0.14%)	8.69 (0.14%)	12.21 (0.20%)	9.98 (0.17%)	N/A	N/A
<b>Harbour seal</b>											
30MW	0.02 (0.05%)	0.04 (0.09%)	0.05 (0.10%)	<del>0.04</del> (0.07%)	0.05 (0.10%)	0.03 (0.07%)	0.03 (0.05%)	0.06 (0.12%)	0.03 (0.06%)	N/A	N/A

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device; \*CRM not updated for device type 3 as no longer in the Project Design Envelope

**Table 2-34 Summary of number of individuals (and % of reference population) that could be at risk of collision with operational tidal devices at Morlais for 30MW scenarios (based on updated CRM and removing devices 3 and 7a from the Project Design Envelope)**

Species	Magnitude for 30MW scenarios ERM and CRM
Harbour porpoise	<b>9.4-86.2 individuals (0.009-0.08% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact</b>
Bottlenose dolphin	<b>1.5-3.84 individuals (0.37-0.97% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01% to more than 1% of the reference population anticipated to be exposed to effect). <b>Magnitude reduced to medium, with removal of device 7a</b>
Risso's dolphin	<b>2.1-5.7 individuals (0.02-0.06% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact</b>
Common dolphin	<b>12.5-29.7 individuals (0.02-0.05% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact</b>
Minke whale	<b>2-9.1 individuals (0.01-0.04%)</b> Potential permanent effect with <b>low to medium</b> magnitude (0.001-1% of the reference population anticipated to be exposed to effect). <b>No change to overall medium magnitude</b>
Grey seal	<b>6-17.6 individuals (0.1-0.29% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact</b>
Harbour seal	<b>0.02-0.06 individuals (0.04-0.12% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact</b>

## 2.5. INDICTIVE 40MW OF EACH TYPE OF DEVICE

24. It is currently proposed that the Morlais tidal arrays would be installed in phases, with up to 40MW for the first phase. It is currently unknown the different types and number of the different devices that could be deployed for the 40MW scenario, therefore an assessment has been conducted based on 40MW of each device type.
25. **Table 2-35** and **Table 2-36** present the ERM and CRM collision risk assessments (number of individuals per year and percentage of the reference populations) for 40MW of each device type, based on 98% avoidance rates for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal. The results are summarised in **Table 2-37**.

26. As outlined in **Section 12.6.4.5.1.2 of Chapter 12, Marine Mammals (Volume I)**, these scenarios would only be developed once the monitoring and mitigation indicates that the collision risk would be less than one bottlenose dolphin.
27. The marine mammal parameters used in the collision risk assessments are as outlined in **Table 2-1 and Table 12-77 to 12-78 in Section 12.6.4.5.1.3 of Chapter 12, Marine Mammals (Volume I)** and the tidal device parameters are as outlined in **Table 12.74 in Section 12.6.4.5.1.2 of Chapter 12, Marine Mammals (Volume I)**.
28. The marine mammal reference populations are presented in **Table 12.20 in Section 12.5.10 of Chapter 12, Marine Mammals (Volume I)**.



**Table 2-35 Marine mammal ERM assessment (number of individuals / year and % of reference population) with 98% avoidance for 40MW of each tidal device type**

Tidal device category	1	2a	2b	3*	4	5a	5b	6a	6b	7a*	Total
Number of Devices	20	27	32	40	40	40	27	134	34	400	N/A
<b>Harbour porpoise</b>											
40MW	68.65 (0.07%)	75.83 (0.07%)	74.28 (0.07%)	189.46 (0.18%)	63.41 (0.06%)	16.13 (0.02%)	27.92 (0.03%)	13.95 (0.01%)	12.74 (0.01%)	300.82 (0.29%)	N/A
<b>Bottlenose dolphin</b>											
40MW	1.93 (0.49%)	2.73 (0.69%)	3.24 (0.82%)	9.33 (2.35%)	2.92 (0.74%)	2.26 (0.57%)	2.18 (0.55%)	3.27 (0.82%)	3.73 (0.94%)	5.74 (1.45%)	N/A
<b>Risso's dolphin</b>											
40MW	2.82 (0.03%)	3.89 (0.04%)	4.61 (0.05%)	13.02 (0.15%)	4.22 (0.05%)	3.21 (0.04%)	3.14 (0.04%)	4.65 (0.05%)	5.31 (0.06%)	7.85 (0.09%)	N/A
<b>Common dolphin</b>											
40MW	16.69 (0.03%)	21.14 (0.04%)	25.06 (0.04%)	66.93 (0.12%)	23.89 (0.04%)	17.73 (0.03%)	17.76 (0.03%)	25.30 (0.04%)	28.88 (0.05%)	40.11 (0.07%)	N/A
<b>Minke whale</b>											
40MW	4.73 (0.02%)	9.13 (0.04%)	10.82 (0.05%)	39.87 (0.17%)	7.91 (0.03%)	7.05 (0.03%)	5.96 (0.03%)	10.85 (0.05%)	12.39 (0.05%)	26.38 (0.11%)	N/A
<b>Grey seal</b>											
40MW	10.86 (0.18%)	12.62 (0.21%)	14.95 (0.25%)	40.49 (0.67%)	13.59 (0.23%)	7.99 (0.13%)	8.70 (0.14%)	10.55 (0.18%)	12.05 (0.20%)	44.56 (0.74%)	N/A
<b>Harbour seal</b>											
40MW	0.03 (0.06%)	0.04 (0.08%)	0.04 (0.09%)	0.11 (0.23%)	0.05 (0.10%)	0.03 (0.07%)	0.03 (0.06%)	0.05 (0.11%)	0.03 (0.06%)	0.03 (0.06%)	N/A

\* device type 3 and 7a no longer in Project Description Envelope



**Table 2-36 Marine mammal CRM assessment (number of individuals / year and % of reference population) with 98% avoidance for 40MW of each tidal device type**

Tidal device category	1	2a	2b	3*	4	5a	5b	6a	6b	7a*	Total
<b>Number of Devices</b>	<b>20</b>	<b>27</b>	<b>32</b>	<b>40</b>	<b>40</b>	<b>40</b>	<b>27</b>	<b>134</b>	<b>34</b>	<b>400</b>	<b>N/A</b>
<b>Harbour porpoise</b>											
40MW	75.20 (0.07%)	116.33 (0.11%)	113.96 (0.11%)	<del>83.33</del> <del>(0.08%)</del>	81.24 (0.08%)	21.82 (0.02%)	35.57 (0.03%)	20.86 (0.02%)	17.29 (0.02%)	N/A	N/A
<b>Bottlenose dolphin</b>											
40MW	2.49 (0.63%)	4.32 (1.09%)	5.11 (1.29%)	<del>3.96</del> <del>(1.00%)</del>	4.37 (1.10%)	2.57 (0.65%)	3.21 (0.81%)	4.28 (1.08%)	3.26 (0.82%)	N/A	N/A
<b>Risso's dolphin</b>											
40MW	3.57 (0.04%)	6.37 (0.07%)	7.56 (0.09%)	<del>5.59</del> <del>(0.06%)</del>	6.20 (0.07%)	3.96 (0.05%)	4.55 (0.05%)	6.58 (0.07%)	5.01 (0.06%)	N/A	N/A
<b>Common dolphin</b>											
40MW	19.26 (0.03%)	33.37 (0.06%)	39.55 (0.07%)	<del>28.99</del> <del>(0.05%)</del>	32.38 (0.06%)	24.39 (0.04%)	23.79 (0.04%)	39.30 (0.07%)	34.22 (0.06%)	N/A	N/A
<b>Minke whale</b>											
40MW	4.45 (0.02%)	4.82 (0.02%)	5.72 (0.02%)	<del>9.95</del> <del>(0.04%)</del>	7.28 (0.03%)	2.64 (0.01%)	4.79 (0.02%)	4.79 (0.02%)	3.64 (0.015%)	N/A	N/A
<b>Grey seal</b>											
40MW	12.63 (0.21%)	19.82 (0.33%)	23.49 (0.39%)	<del>47.08</del> <del>(0.28%)</del>	18.60 (0.31%)	10.93 (0.18%)	11.74 (0.20%)	16.36 (0.27%)	13.57 (0.23%)	N/A	N/A
<b>Harbour seal</b>											
40MW	0.03 (0.06%)	0.06 (0.12%)	0.07 (0.13%)	<del>0.05</del> <del>(0.10%)</del>	0.06 (0.13%)	0.04 (0.09%)	0.04 (0.07%)	0.08 (0.16%)	0.04 (0.09%)	N/A	N/A

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device; device type 3 and 7a no longer in Project Description Envelope





**Table 2-37 Summary of number of individuals (and % of reference population) that could be at risk of collision with operational tidal devices at Morlais for 40MW scenarios**

<b>Species</b>	<b>Magnitude for 40MW scenarios ERM and CRM</b>
<b>Harbour porpoise</b>	<b>12.7-116.3 individuals (0.01-0.11% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact.</b>
<b>Bottlenose dolphin</b>	<b>2-5.1 individuals (0.5-1.29% of MU)</b> Potential permanent effect with <b>medium to high</b> magnitude (0.01% to more than 1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact.</b>
<b>Risso's dolphin</b>	<b>2.8-7.6 individuals (0.03-0.09% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact.</b>
<b>Common dolphin</b>	<b>16.7-39.6 individuals (0.03-0.07% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact.</b>
<b>Minke whale</b>	<b>2.6-12.4 individuals (0.01-0.05%)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact.</b>
<b>Grey seal</b>	<b>8-23.5 individuals (0.13-0.39% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of impact.</b>
<b>Harbour seal</b>	<b>0.03-0.08 individuals (0.06-0.16% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect). <b>No change to magnitude of effect.</b>



## 2.6. INDICTIVE 240MW FULL BUILD SCENARIO

29. It is currently proposed that the Morlais tidal arrays would be installed in phases up to 240MW.
30. **Table 2-38** and **Table 2-39** present the ERM and CRM collision risk assessments (number of individuals per year and percentage of the reference populations) for indicative 240MW full build scenario with different numbers of each device type, based on 98% avoidance rates for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal. The results are summarised in

31. **Table 2-40.**
32. As outlined in **Section 12.6.4.5.1.2 of Chapter 12, Marine Mammals (Volume I)**, these scenarios would only be developed once the monitoring and mitigation indicates that the collision risk would be less than one bottlenose dolphin.
33. The marine mammal parameters used in the collision risk assessments are as outlined in **Table 2-1 and Table 12-77 to 12-78 in Section 12.6.4.5.1.3 of Chapter 12, Marine Mammals (Volume I)** and the tidal device parameters are as outlined in **Table 12-76 in Section 12.6.4.5.1.2 of Chapter 12, Marine Mammals (Volume I)**.
34. The marine mammal reference populations are presented in **Table 12.20 in Section 12.5.10 of Chapter 12, Marine Mammals (Volume I)**.



**Table 2-38 Marine mammal ERM assessment (number of individuals / year and % of reference population) with 98% avoidance for indicative 240MW scenario**

<b>Tidal device category</b>	<b>1</b>	<b>2a</b>	<b>2b</b>	<b>3</b>	<b>4</b>	<b>5a</b>	<b>5b</b>	<b>6a</b>	<b>6b</b>	<b>7a</b>	<b>Total</b>
<b>Number of Devices</b>	<b>30</b>	<b>20</b>	<b>33</b>	<b>0</b>	<b>30</b>	<b>0</b>	<b>20</b>	<b>50</b>	<b>25</b>	<b>50</b>	
<b>Harbour porpoise</b>											
240MW scenario	154.47 (0.15%)	56.17 (0.05%)	76.60 (0.07%)	0	47.55 (0.05%)	0	20.68 (0.02%)	5.20 (0.005%)	9.37 (0.009%)	37.60 (0.04%)	<b>407.6440 (0.39%)</b>
<b>Bottlenose dolphin</b>											
240MW scenario	4.35 (1%)	2.02 (0.51%)	3.34 (0.84%)	0	2.19 (0.55%)	0	1.61 (0.41%)	1.22 (0.31%)	2.74 (0.69%)	0.72 (0.18%)	<b>18.19 (4.58%)</b>
<b>Risso's dolphin</b>											
240MW scenario	6.34 (0.07%)	2.88 (0.03%)	4.75 (0.05%)	0	3.17 (0.04%)	0	2.33 (0.03%)	1.74 (0.02%)	3.91 (0.04%)	0.98 (0.01%)	<b>26.09 (0.30%)</b>
<b>Common dolphin</b>											
240MW scenario	37.54 (0.07%)	15.66 (0.03%)	25.84 (0.05%)	0	17.92 (0.03%)	0	13.16 (0.02%)	9.44 (0.02%)	21.24 (0.04%)	5.01 (0.01%)	<b>145.81 (0.26%)</b>
<b>Minke whale</b>											
240MW scenario	10.63 (0.045%)	6.76 (0.03%)	11.16 (0.05%)	0	5.94 (0.03%)	0	4.42 (0.02%)	4.05 (0.02%)	9.11 (0.04%)	3.30 (0.01%)	<b>55.36 (0.24%)</b>
<b>Grey seal</b>											
240MW scenario	24.44 (0.4%)	9.35 (0.16%)	15.42 (0.26%)	0	10.19 (0.17%)	0	6.44 (0.11%)	3.94 (0.07%)	8.86 (0.15%)	5.57 (0.09%)	<b>84.21 (1.40%)</b>
<b>Harbour seal</b>											
240MW scenario	0.06 (0.12%)	0.03 (0.06%)	0.05 (0.09%)	0	0.04 (0.08%)	0	0.02 (0.04%)	0.02 (0.04%)	0.2(0.05%)	0.004 (0.01%)	<b>0.25 (0.49%)</b>



**Table 2-39 Marine mammal CRM assessment (number of individuals / year and % of reference population) with 98% avoidance for indicative 240MW scenario**

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b	7a*	Total
Number of Devices	30	20	33	0	30	0	20	50	25	50	
Harbour porpoise											
240MW scenario	169.20 (0.16%)	86.17 (0.08%)	117.52 (0.11%)	0	60.93 (0.06%)	0	26.35 (0.03%)	7.78 (0.01%)	12.71 (0.01%)	37.60 (0.04%)	518.26 (0.50%)
Bottlenose dolphin											
240MW scenario	5.61 (1.41%)	3.20 (0.81%)	5.27 (1.33%)	0	3.28 (0.83%)	0	2.38 (0.60%)	1.60 (0.40%)	2.40 (0.60%)	0.72 (0.18%)	24.45 (6.16%)
Risso's dolphin											
240MW scenario	8.02 (0.09%)	4.72 (0.05%)	7.79 (0.09%)	0	4.65 (0.05%)	0	3.37 (0.04%)	2.45 (0.03%)	3.68 (0.04%)	0.98 (0.01%)	35.68 (0.41%)
Common dolphin											
240MW scenario	43.34 (0.08%)	24.72 (0.04%)	40.79 (0.07%)	0	24.29 (0.04%)	0	17.62 (0.03%)	14.67 (0.03%)	25.16 (0.04%)	5.01 (0.01%)	195.59 (0.35%)
Minke whale											
240MW scenario	10.02 (0.04%)	3.57 (0.02%)	5.89 (0.03%)	0	5.46 (0.02%)	0	3.55 (0.02%)	1.79 (0.01%)	2.68 (0.01%)	3.30 (0.01%)	36.26 (0.15%)
Grey seal											
240MW scenario	28.42 (0.47%)	14.68 (0.24%)	24.22 (0.40%)	0	13.95 (0.23%)	0	8.69 (0.14%)	6.11 (0.10%)	9.98 (0.17%)	5.57 (0.09%)	111.62 (1.86%)
Harbour seal											
240MW scenario	0.07 (0.14%)	0.04 (0.09%)	0.07 (0.14%)	0	0.05 (0.10%)	0	0.03 (0.05%)	0.03 (0.06%)	0.03 (0.06%)	0.004 (0.01%)	0.32 (0.64%)

\*CRM not applicable for vertical blade of cross-flow multi-rotor floating type device, therefore ERM results included for 240MW scenario

**Table 2-40 Summary of maximum number of individuals (and % of reference population) that could be at risk of collision with operational tidal devices at Morlais for 240MW scenario**

<b>Species</b>	<b>Magnitude for 240MW scenario ERM and CRM</b>
<b>Harbour porpoise</b>	<b>408-518 individuals (0.4-0.5% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect).
<b>Bottlenose dolphin</b>	<b>18.2-24.5 individuals (4.6-6.2% of MU)</b> Potential permanent effect with <b>high</b> magnitude (more than 1% of the reference population anticipated to be exposed to effect).
<b>Risso's dolphin</b>	<b>26.1-35.7 individuals (0.3-0.4% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect).
<b>Common dolphin</b>	<b>145.8-195.6 individuals (0.26-0.35% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect).
<b>Minke whale</b>	<b>36.3-55.4 individuals (0.15-0.24% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect).
<b>Grey seal</b>	<b>84.2-111.6 individuals (1.4-1.9% of MU)</b> Potential permanent effect with <b>high</b> magnitude (more than % of the reference population anticipated to be exposed to effect).
<b>Harbour seal</b>	<b>0.25-0.32 individuals (0.5-0.6% of MU)</b> Potential permanent effect with <b>medium</b> magnitude (0.01-1% of the reference population anticipated to be exposed to effect).

### 3. ENVIRONMENTAL PARAMETERS

#### 3.1. WATER DEPTH

29. Water depths across the Morlais Development Zone (MDZ) reach over 72m Lowest Astronomical Tide (LAT) in the northwest of the site, with an average depth across the main site of approximately 40m LAT. All depths in this section are based on LAT.
37. Water depths and tidal resource vary across the MDZ. The eight indicative deployment zones are located in parts of the MDZ that support stronger tidal resource, while also offering a range of depth parameters. Across Zones 1, 2 and 3 water depths are mainly between 30m and 40m, with some deeper areas of 40-45m, whilst within the majority of Zones 4, 5, 6 and 7 the water depth is generally 30-35 m.
35. The water depths in the collisions risk assessments are as outlined in **Table 12-76** in **Section 12.6.4.5.1.2 of Chapter 12, Marine Mammals (Volume I)**. These water depths were based on the most likely water depths at the different deployment zones that the different types of tidal devices would be deployed, as summarised in **Table 3-1**.

**Table 3-1 Water depth for tidal devices used in marine mammal collision risk (ERM and CRM) assessments**

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b	7a
Position in water column	Surface	Surface	Mid-water	Surface	Surface	Seabed	Seabed	Seabed	Seabed	Surface
Description	Twin-rotor floating	Multiple-rotor buoyant platform	Multi-rotor buoyant mid water	Multiple-rotor buoyant platform	Spar buoy	Seabed mounted single rotor	Seabed mounted single rotor	Seabed mounted single rotor	Three-rotor seabed mounted platform	Cross-flow multi-rotor floating
Median water depth (m)	42.5	40	40	30	45	43	43	40	40	40
Rotor tip minimum depth (m)	3.2	5	10	5	6	23	14	26	30	1

36. The additional assessments in this section determine the potential effect of water depth on the collision risk assessments, based on a minimum water depth of 25m (with the exception of device type 4 and 5b which was assessed for a minimum depth of 30m to take into account the rotor diameter) and maximum water depth of 50m for all devices.
37. The rotor tip minimum depth was adjusted, if required, to take into account the change in water depth. The minimum water depths and rotor tip minimum depth used in the additional collision risk assessments are presented in **Table 3-2**. The maximum water depths and rotor tip minimum depth used in the additional collision risk assessments are presented in **Table 3-3**.
38. The marine mammal parameters used in the collision risk assessments are as outlined in **Table 2-1** and **Table 12-77 to 12-78** in **Section 12.6.4.5.1.3 of Chapter 12, Marine Mammals (Volume I)** and the other tidal device parameters are as outlined in **Table 12-76** in **Section 12.6.4.5.1.2 of Chapter 12, Marine Mammals (Volume I)**.

**Table 3-2 Minimum water depth for tidal devices used in additional collision risk (ERM and CRM) assessments**

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b	7a
Position in water column	Surface	Surface	Mid-water	Surface	Surface	Seabed	Seabed	Seabed	Seabed	Surface
Description	Twin-rotor floating	Multiple-rotor buoyant platform	Multi-rotor buoyant mid water	Multiple-rotor buoyant platform	Spar buoy	Seabed mounted single rotor	Seabed mounted single rotor	Seabed mounted single rotor	Three-rotor seabed mounted platform	Cross-flow multi-rotor floating
Minimum water depth (m)	25	25	25	25	30	25	30	25	25	25
Rotor tip minimum depth (m)	3.2	5	10	5	3	10	4	15	25	1

**Table 3-3 Maximum water depth for tidal devices used in additional collision risk (ERM and CRM) assessments**

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b	7a
Position in water column	Surface	Surface	Mid-water	Surface	Surface	Seabed	Seabed	Seabed	Seabed	Surface
Description	Twin-rotor floating	Multiple-rotor buoyant platform	Multi-rotor buoyant mid water	Multiple-rotor buoyant platform	Spar buoy	Seabed mounted single rotor	Seabed mounted single rotor	Seabed mounted single rotor	Three-rotor seabed mounted platform	Cross-flow multi-rotor floating
Maximum water depth (m)	50	50	50	50	50	50	50	50	50	50
Rotor tip minimum depth (m)	3.2	5	10	5	6	30	20	36	35	1

39. **Table 3-4** and **Table 3-5** present the ERM and CRM collision risk assessments (number of individuals per year) for median, minimum and maximum water depth, based on 98% avoidance rates for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal.
40. The results indicate that for some species changing the water depth for some device types can increase the potential collision risk, while for other it can lower the potential collision risk. Therefore, this will be further assessed prior to deployment, based on the types of devices and actual water depth at deployment location, as part of the Environmental Management and Monitoring Plan (EMMP).





**Table 3-4 Comparison of median, minimum and maximum water depths for marine mammal ERM assessment (number of individuals / year) with 98% avoidance for one device of each device type**

Tidal device category		1	2a	2b	3	4	5a	5b	6a	6b	7a
Number of Devices											
Species	Water depth	1	1	1	1	1	1	1	1	1	1
Harbour porpoise	Median	3.43	2.81	2.32	4.74	1.59	0.40	1.03	0.10	0.37	0.75
	Minimum	3.94	4.59	3.84	7.84	2.41	1.84	2.55	0.49	2.22	0.34
	Maximum	3.26	2.85	1.74	3.55	1.65	0.26	0.81	0.06	0.30	0.59
Bottlenose dolphin	Median	0.10	0.10	0.10	0.23	0.07	0.06	0.08	0.02	0.11	0.01
	Minimum	0.16	0.16	0.16	0.37	0.11	0.10	0.12	0.04	0.18	0.02
	Maximum	0.08	0.08	0.08	0.19	0.07	0.05	0.07	0.02	0.09	0.01
Risso's dolphin	Median	0.14	0.14	0.14	0.33	0.11	0.08	0.12	0.03	0.16	0.02
	Minimum	0.24	0.23	0.23	0.52	0.16	0.14	0.17	0.06	0.25	0.03
	Maximum	0.12	0.12	0.12	0.26	0.09	0.07	0.10	0.03	0.13	0.02
Common dolphin	Median	0.83	0.78	0.78	1.67	0.60	0.44	0.66	0.19	0.85	0.10
	Minimum	1.42	1.25	1.25	2.68	0.90	0.76	0.94	0.30	1.36	0.16
	Maximum	0.71	0.63	0.63	1.34	0.54	0.38	0.57	0.15	0.68	0.08
Minke whale	Median	0.24	0.34	0.34	1.00	0.20	0.18	0.22	0.08	0.36	0.07
	Minimum	0.40	0.54	0.54	1.59	0.30	0.30	0.32	0.13	0.58	0.11
	Maximum	0.20	0.27	0.27	0.80	0.18	0.15	0.19	0.06	0.29	0.05
Grey seal	Median	0.54	0.47	0.47	1.01	0.34	0.20	0.32	0.08	0.35	0.11
	Minimum	0.55	0.14	0.30	0.66	0.32	0.38	0.32	0.22	0.99	0.11
	Maximum	0.67	0.58	0.65	1.42	0.40	0.10	0.22	0.03	0.15	0.11
Harbour seal	Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



**Table 3-5 Comparison of median, minimum and maximum water depths for marine mammal CRM assessment (number of individuals / year) with 98% avoidance for one device of each device type**

Tidal device category		1	2a	2b	3	4	5a	5b	6a	6b
Number of Devices		1	1	1	1	1	1	1	1	1
Species	Water depth	1	1	1	1	1	1	1	1	1
Harbour porpoise	Median	3.76	2.37	1.96	2.08	2.12	0.25	1.22	0.07	0.17
	Minimum	4.31	3.88	3.24	3.45	3.22	1.14	3.01	0.34	1.03
	Maximum	3.57	2.40	1.47	1.56	2.20	0.16	0.96	0.04	0.14
Bottlenose dolphin	Median	0.12	0.09	0.09	0.10	0.11	0.04	0.10	0.02	0.05
	Minimum	0.21	0.14	0.14	0.16	0.16	0.06	0.15	0.03	0.08
	Maximum	0.11	0.07	0.07	0.08	0.10	0.03	0.09	0.01	0.04
Risso's dolphin	Median	0.18	0.13	0.13	0.14	0.15	0.05	0.15	0.03	0.08
	Minimum	0.30	0.20	0.20	0.22	0.23	0.09	0.21	0.04	0.12
	Maximum	0.15	0.10	0.10	0.11	0.14	0.04	0.13	0.02	0.06
Common dolphin	Median	0.96	0.67	0.67	0.72	0.82	0.27	0.80	0.13	0.40
	Minimum	1.64	1.07	1.07	1.16	1.23	0.47	1.14	0.21	0.64
	Maximum	0.82	0.53	0.53	0.58	0.74	0.23	0.68	0.11	0.32
Minke whale	Median	0.22	0.18	0.18	0.25	0.18	0.07	0.18	0.04	0.11
	Minimum	0.38	0.29	0.29	0.40	0.27	0.11	0.25	0.06	0.17
	Maximum	0.19	0.14	0.14	0.20	0.16	0.06	0.15	0.03	0.09
Grey seal	Median	0.63	0.39	0.39	0.43	0.47	0.12	0.39	0.06	0.17
	Minimum	0.64	0.12	0.26	0.28	0.45	0.23	0.39	0.15	0.46
	Maximum	0.78	0.49	0.55	0.60	0.55	0.06	0.27	0.02	0.07
Harbour seal	Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Maximum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

### 3.2. CURRENT SPEED

41. The current speed in the collisions risk assessments are as outlined in **Table 12.74** in **Section 12.6.4.5.1.2** of **Chapter 12, Marine Mammals (Volume I)**. The current speed was based on the mean current speed that the tidal devices would be operating at the MDZ, as summarised in **Table 3-6**.
42. It is important to note that the tidal devices have a minimum and maximum current speed at which they operate, and this has been used to calculate the mean current speed used in the ES assessments.

**Table 3-6 Current speed for tidal devices used in marine mammal collision risk (ERM and CRM) assessments**

Tidal device category	1	2a	2b	3	4	5a	5b	6a	6b	7a
Position in water column	Surface	Surface	Mid-water	Surface	Surface	Seabed	Seabed	Seabed	Seabed	Surface
Description	Twin-rotor floating	Multiple-rotor buoyant platform	Multi-rotor buoyant mid water	Multiple-rotor buoyant platform	Spar buoy	Seabed mounted single rotor	Seabed mounted single rotor	Seabed mounted single rotor	Three-rotor seabed mounted platform	Cross-flow multi-rotor floating
Mean current speed (m/s)	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
Rotation speed (rpm)	8.71	18	18	26.7	10.1	7.5	7.5	22	22	13.6
Mean tangential blade speed (m/s)	4.56	4.71	4.71	3.5	7.14	2.95	5.11	5.76	5.76	1.78
Mean blade speed relative to water (n)	4.81	4.95	4.95	3.81	7.30	3.31	5.33	5.96	5.96	2.34

43. The additional assessments in this section determine the potential effect of increased current speed on the collision risk assessments, based on a worst-case scenario for a mean current speed of 1.77m/s and adjusting the related parameters, as outlined in **Table 3-7**.
44. It is important to note that the mean current speed is the most appropriate parameter to use as the maximum operating current speed would only be applicable for a relatively short period of the tidal cycle.
45. The marine mammal parameters used in the collision risk assessments are as outlined in **Table 2-1** and **Table 12-77 to 12-78** in **Section 12.6.4.5.1.3** of **Chapter 12, Marine Mammals (Volume I)** and the other tidal device parameters are as outlined in **Table 12-76** in **Section 12.6.4.5.1.2** of **Chapter 12, Marine Mammals (Volume I)**.
46. **Table 3-8** and **Table 3-9** present the ERM and CRM collision risk assessments (number of individuals per year) for current speeds of 1.52m/s and 1.77m/s, based on 98% avoidance rates for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal.

47. The results indicate that for some species changing the current speed and related parameters for some device types can increase the potential collision risk, while for other it can lower the potential collision risk. Therefore, this will be further assessed prior to deployment, based on the parameters of devices to be deployed in relation to current speed, as part of the Environmental Management and Monitoring Plan (EMMP).

**Table 3-7 Increased current speed and related parameters used in additional collision risk (ERM and CRM) assessments**

<b>Tidal device category</b>	<b>1</b>	<b>2a</b>	<b>2b</b>	<b>3</b>	<b>4</b>	<b>5a</b>	<b>5b</b>	<b>6a</b>	<b>6b</b>	<b>7a</b>
Position in water column	Surface	Surface	Mid-water	Surface	Surface	Seabed	Seabed	Seabed	Seabed	Surface
Description	Twin-rotor floating	Multiple-rotor buoyant platform	Multi-rotor buoyant mid water	Multiple-rotor buoyant platform	Spar buoy	Seabed mounted single rotor	Seabed mounted single rotor	Seabed mounted single rotor	Three-rotor seabed mounted platform	Cross-flow multi-rotor floating
Mean current speed (m/s)	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77	1.77
Rotation speed (rpm)	8.71	30	30	18	11.3	9	8	22	22	13.6
Mean tangential blade speed (m/s)	4.56	7.85	7.85	3.5	7.99	3.53	5.45	5.76	5.76	1.78
Mean blade speed relative to water (n)	4.89	8.05	8.05	3.81	8.18	3.95	5.73	6.03	6.03	2.34



**Table 3-8 Comparison of mean and increased current speed for marine mammal ERM assessment (number of individuals / year) with 98% avoidance for one device of each device type**

Tidal device category		1	2a	2b	3	4	5a	5b	6a	6b	7a
Number of Devices											
Species	Current speed	1	1	1	1	1	1	1	1	1	1
Harbour porpoise	Mean (1.52m/s)	3.43	2.81	2.32	4.74	1.59	0.40	1.03	0.10	0.37	0.75
	Increased (1.77m/s)	3.43	4.59	3.80	3.39	1.77	0.47	1.10	0.10	0.37	0.75
Bottlenose dolphin	Mean (1.52m/s)	0.10	0.10	0.10	0.23	0.07	0.06	0.08	0.02	0.11	0.01
	Increased (1.77m/s)	0.10	0.16	0.16	0.17	0.08	0.07	0.09	0.02	0.11	0.01
Risso's dolphin	Mean (1.52m/s)	0.14	0.14	0.14	0.33	0.11	0.08	0.12	0.03	0.16	0.02
	Increased (1.77m/s)	0.14	0.23	0.23	0.24	0.12	0.09	0.12	0.03	0.16	0.02
Common dolphin	Mean (1.52m/s)	0.83	0.78	0.78	1.67	0.60	0.44	0.66	0.19	0.85	0.10
	Increased (1.77m/s)	0.83	1.27	1.27	1.23	0.67	0.52	0.70	0.19	0.85	0.10
Minke whale	Mean (1.52m/s)	0.24	0.34	0.34	1.00	0.20	0.18	0.22	0.08	0.36	0.07
	Increased (1.77m/s)	0.24	0.54	0.54	0.76	0.22	0.20	0.23	0.08	0.36	0.07
Grey seal	Mean (1.52m/s)	0.54	0.47	0.47	1.01	0.34	0.20	0.32	0.08	0.35	0.11
	Increased (1.77m/s)	0.54	0.76	0.76	0.75	0.38	0.23	0.34	0.08	0.35	0.11
Harbour seal	Mean (1.52m/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Increased (1.77m/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



**Table 3-9 Comparison of mean and increased current speed for marine mammal CRM assessment (number of individuals / year) with 98% avoidance for one device of each device type**

Tidal device category		1	2a	2b	3	4	5a	5b	6a	6b
Number of Devices		1	1	1	1	1	1	1	1	1
Species	Water depth									
Harbour porpoise	Mean (1.52m/s)	3.76	2.37	1.96	2.08	2.12	0.25	1.22	0.07	0.17
	Increased (1.77m/s)	3.90	2.46	2.04	2.16	2.20	0.26	1.27	0.08	0.18
Bottlenose dolphin	Mean (1.52m/s)	0.12	0.09	0.09	0.10	0.11	0.04	0.10	0.02	0.05
	Increased (1.77m/s)	0.13	0.09	0.09	0.10	0.11	0.04	0.11	0.02	0.05
Risso's dolphin	Mean (1.52m/s)	0.18	0.13	0.13	0.14	0.15	0.05	0.15	0.03	0.08
	Increased (1.77m/s)	0.18	0.13	0.13	0.14	0.16	0.05	0.15	0.03	0.08
Common dolphin	Mean (1.52m/s)	0.96	0.67	0.67	0.72	0.82	0.27	0.80	0.13	0.40
	Increased (1.77m/s)	0.99	0.69	0.69	0.75	0.85	0.28	0.82	0.14	0.41
Minke whale	Mean (1.52m/s)	0.22	0.18	0.18	0.25	0.18	0.07	0.18	0.04	0.11
	Increased (1.77m/s)	0.26	0.21	0.21	0.29	0.21	0.08	0.21	0.04	0.12
Grey seal	Mean (1.52m/s)	0.63	0.39	0.39	0.43	0.47	0.12	0.39	0.06	0.17
	Increased (1.77m/s)	0.65	0.41	0.41	0.44	0.48	0.12	0.40	0.06	0.17
Harbour seal	Mean (1.52m/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Increased (1.77m/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## 4. MARINE MAMMAL PARAMETERS

### 4.1. BODY LENGTH AND WIDTH

48. **Table 4-1** outlines the marine mammal dimensions, based on the SNH guidance (SNH, 2016), used for the collision risk assessment, as presented in **Table 12-77** of **Section 12.6.4.5.1.3** of **Chapter 12, Marine Mammals (Volume I)**. Where possible the values from the SNH guidance (SNH, 2016) were used, as this was a peer-reviewed data source and it also allows, if required, comparison with other collision risk assessments. Where data was not provided bottlenose dolphin, Risso's dolphin and common dolphin these were determined based on Cetacean Stranding's Investigation Programme (CSIP) stranding records from Wales and data collected by Marine Environmental Monitoring (1994-2017).

**Table 4-1 Marine mammal dimensions used in the Morlais collision risk assessments**

Species	Length (m)	Effective radius/body width (m)	Source
Harbour porpoise	1.48m	0.32m	SNH (2016); Thompson (2015)
Bottlenose dolphin	2.57m	0.64m	Calculated from Welsh stranding data (1994-2017)
Risso's dolphin	2.36m	0.59m	Calculated from Welsh stranding data (1994-2017)
Common dolphin	1.77m	0.44m	Calculated from Welsh stranding data (1994-2017)
Minke whale	8.8m	2.2m	SNH (2016); Horwood (1990)
Grey seal	1.86m	0.42m	SNH (2016); Thompson (2015)
Harbour seal	1.41m	0.34m	SNH (2016)

49. In addition, stranding data from around the Welsh (1994-2017) and UK (2005-2015; including Welsh data) coastline were assessed for all species to determine the mean, maximum, minimum and median values for body length and effective radius/body width (**Table 4-2** and **Table 4-3**).
50. It should be noted that there can be biases and limitations in stranding data, for example, there could be the potential to be an increased representation of very young, sick, and (to a lesser extent) very old animals (i.e., they are representative of the age structure of deaths rather than the age structure of the living population) and towards animals living or moving through coastal waters.
51. Taking into account the body length and effective radius/body width, UK and Welsh stranding data a range of potential values were determined (**Table 4-4**) and assessed for any potential effects on the collision risk assessments.
52. The other marine mammal parameters used in the collision risk assessments are as outlined in **Table 2-1** and **Table 12-77 to 12-78** in **Section 12.6.4.5.1.3** of **Chapter 12, Marine Mammals**

**(Volume I)** and the tidal device parameters are as outlined in **Table 12.74** in **Section 12.6.4.5.1.2** of **Chapter 12, Marine Mammals (Volume I)**.

53. **Table 4-5** and **Table 4-6** present the ERM and CRM collision risk assessments (number of individuals per year) for different body length and effective radius/body width, based on 98% avoidance rates for harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, minke whale, grey seal and harbour seal.
54. The marine mammal parameters will be further reviewed and assessed prior to deployment, based on the latest information and guidance, as part of the Environmental Management and Monitoring Plan (EMMP).

**Table 4-2 Marine mammal dimensions from Welsh stranding data (1994-2017)**

Species	Parameter	Length (m)	Effective radius/body width (m)
<b>Harbour porpoise (n=1,038)</b>	Maximum	2.51	0.63
	Minimum	0.39	0.10
	Mean	1.22	0.30
	Median	1.23	0.31
<b>Bottlenose dolphin (n=38)</b>	Maximum	3.53	0.88
	Minimum	1.07	0.27
	Mean	2.57	0.64
	Median	2.90	0.73
<b>Risso's dolphin (n=15)</b>	Maximum	3.25	0.81
	Minimum	1	0.25
	Mean	2.37	0.59
	Median	2.43	0.61
<b>Common dolphin (n=124)</b>	Maximum	2.4	0.6
	Minimum	0.61	0.15
	Mean	1.77	0.44
	Median	1.85	0.46
<b>Minke whale (n=4)</b>	Maximum	8.8	2.2
	Minimum	2.43	0.61
	Mean	4.68	1.17
	Median	3.75	0.94
<b>Grey seal (n=92)</b>	Maximum	2.25	0.56
	Minimum	0.6	0.15
	Mean	1.37	0.34
	Median	1.22	0.30

**Table 4-3 Marine mammal dimensions from UK stranding data (2005-2015)**

Species	Parameter	Length (m)	Effective radius/body width (m)
<b>Harbour porpoise (n=854)</b>	Maximum	1.89	0.47
	Minimum	0.69	0.14



Species	Parameter	Length (m)	Effective radius/body width (m)
	Mean	1.24	0.31
	Median	1.21	0.30
<b>Bottlenose dolphin (n=33)</b>	Maximum	3.41	0.85
	Minimum	1.28	0.32
	Mean	2.45	0.61
	Median	2.60	0.65
<b>Risso's dolphin (n=18)</b>	Maximum	3.08	0.77
	Minimum	1.31	0.33
	Mean	2.36	0.59
	Median	2.31	0.58
<b>Common dolphin (n=216)</b>	Maximum	2.62	0.66
	Minimum	0.73	0.18
	Mean	1.83	0.46
	Median	1.86	0.47
<b>Minke whale (n=26)</b>	Maximum	8.35	2.09
	Minimum	3.13	0.78
	Mean	5.20	1.30
	Median	4.74	1.19

**Table 4-4 Marine mammal dimensions used in additional collision risk assessments based on SNH (2016) guidance, Welsh (1994-2017) and UK (2005-2015) stranding data**

Species	Parameter	Length (m)	Effective radius/body width (m)	Data source
<b>Harbour porpoise</b>	ES	1.48	0.32	SNH (2016)
	Maximum	2.51	0.63	Welsh data
	Minimum	0.39	0.10	Welsh data
	Mean	1.22	0.30	Welsh data
	Median	1.23	0.31	Welsh data
<b>Bottlenose dolphin</b>	ES (mean)	2.57	0.64	Welsh data
	Maximum	3.53	0.88	Welsh data
	Minimum	1.07	0.27	Welsh data
	Mean	2.45	0.61	UK data
	Median	2.90	0.73	Welsh data
<b>Risso's dolphin</b>	ES (mean)	2.36	0.59	Welsh data
	Maximum	3.25	0.81	Welsh data
	Minimum	1	0.25	Welsh data
	Mean	2.36	0.59	UK data
	Median	2.31	0.61	UK data
<b>Common dolphin</b>	ES (mean)	1.77	0.44	Welsh data
	Maximum	2.62	0.66	UK data

Species	Parameter	Length (m)	Effective radius/body width (m)	Data source
	Minimum	0.61	0.15	Welsh data
	Mean	1.83	0.46	UK data
	Median	1.85	0.46	Welsh data
<b>Minke whale</b>	ES	8.8	2.2	SNH (2016)
	Maximum	8.8	2.2	Welsh data
	Minimum	2.43	0.61	Welsh data
	Mean	5.20	1.30	UK data
	Median	4.74	1.19	UK data
<b>Grey seal</b>	ES	1.86	0.42	SNH (2016)
	Maximum	2.25	0.56	Welsh data
	Minimum	0.6	0.15	Welsh data
	Mean	1.37	0.34	Welsh data
	Median	1.22	0.30	Welsh data
<b>Harbour seal</b>	ES	1.41	0.34	SNH (2016)
	No UK or Welsh stranding data			



**Table 4-5 Comparison of body dimensions for marine mammal ERM assessment (number of individuals / year) with 98% avoidance for one device of each device type**

Tidal device category		1	2a	2b	3	4	5a	5b	6a	6b	7a
Number of Devices		1	1	1	1	1	1	1	1	1	1
Species	Parameter	1	1	1	1	1	1	1	1	1	1
Harbour porpoise	<b>ES</b>	<b>3.43</b>	<b>2.81</b>	<b>2.32</b>	<b>4.74</b>	<b>1.59</b>	<b>0.40</b>	<b>1.03</b>	<b>0.10</b>	<b>0.37</b>	<b>0.75</b>
	Maximum	4.66	4.47	3.70	8.36	2.34	0.62	1.53	0.17	0.60	1.34
	Minimum	2.19	1.20	0.99	1.47	0.81	0.19	0.53	0.04	0.16	0.22
	<b>Mean</b>	<b>3.13</b>	<b>2.41</b>	<b>1.99</b>	<b>3.90</b>	<b>1.40</b>	<b>0.35</b>	<b>0.91</b>	<b>0.09</b>	<b>0.32</b>	<b>0.62</b>
	Median	3.14	2.43	2.00	3.94	1.40	0.35	0.92	0.09	0.32	0.62
Bottlenose dolphin	<b>ES</b>	<b>0.10</b>	<b>0.10</b>	<b>0.10</b>	<b>0.23</b>	<b>0.07</b>	<b>0.06</b>	<b>0.08</b>	<b>0.02</b>	<b>0.11</b>	<b>0.01</b>
	Maximum	0.12	0.14	0.14	0.34	0.10	0.08	0.11	0.03	0.15	0.02
	Minimum	0.06	0.05	0.05	0.09	0.04	0.03	0.04	0.01	0.05	0.01
	<b>Mean</b>	<b>0.09</b>	<b>0.10</b>	<b>0.10</b>	<b>0.22</b>	<b>0.07</b>	<b>0.05</b>	<b>0.08</b>	<b>0.02</b>	<b>0.10</b>	<b>0.01</b>
	Median	0.10	0.11	0.11	0.27	0.08	0.06	0.09	0.03	0.12	0.02
Risso's dolphin	<b>ES</b>	<b>0.14</b>	<b>0.14</b>	<b>0.14</b>	<b>0.33</b>	<b>0.11</b>	<b>0.08</b>	<b>0.12</b>	<b>0.03</b>	<b>0.16</b>	<b>0.02</b>
	Maximum	0.18	0.20	0.20	0.47	0.14	0.11	0.15	0.05	0.21	0.03
	Minimum	0.09	0.07	0.07	0.13	0.06	0.04	0.06	0.02	0.08	0.01
	<b>Mean</b>	<b>0.14</b>	<b>0.14</b>	<b>0.14</b>	<b>0.33</b>	<b>0.11</b>	<b>0.08</b>	<b>0.12</b>	<b>0.03</b>	<b>0.16</b>	<b>0.02</b>
	Median	0.14	0.14	0.14	0.32	0.10	0.08	0.11	0.03	0.15	0.02
Common dolphin	<b>ES</b>	<b>0.83</b>	<b>0.78</b>	<b>0.78</b>	<b>1.67</b>	<b>0.60</b>	<b>0.44</b>	<b>0.66</b>	<b>0.19</b>	<b>0.85</b>	<b>0.10</b>
	Maximum	1.06	1.12	1.12	2.58	0.81	0.62	0.89	0.27	1.21	0.16
	Minimum	0.54	0.36	0.36	0.61	0.32	0.22	0.35	0.09	0.39	0.04
	<b>Mean</b>	<b>0.85</b>	<b>0.81</b>	<b>0.81</b>	<b>1.73</b>	<b>0.61</b>	<b>0.46</b>	<b>0.67</b>	<b>0.19</b>	<b>0.87</b>	<b>0.10</b>
	Median	0.86	0.81	0.81	1.75	0.62	0.46	0.68	0.20	0.88	0.11
Minke whale	<b>ES</b>	<b>0.24</b>	<b>0.34</b>	<b>0.34</b>	<b>1.00</b>	<b>0.20</b>	<b>0.18</b>	<b>0.22</b>	<b>0.08</b>	<b>0.36</b>	<b>0.07</b>
	Maximum	0.24	0.34	0.34	1.00	0.20	0.18	0.22	0.08	0.36	0.07
	Minimum	0.08	0.08	0.08	0.19	0.06	0.05	0.07	0.02	0.09	0.01
	<b>Mean</b>	<b>0.14</b>	<b>0.18</b>	<b>0.18</b>	<b>0.48</b>	<b>0.12</b>	<b>0.10</b>	<b>0.13</b>	<b>0.04</b>	<b>0.20</b>	<b>0.03</b>
	Median	0.13	0.16	0.16	0.43	0.11	0.09	0.12	0.04	0.18	0.03
Grey seal	<b>ES</b>	<b>0.54</b>	<b>0.47</b>	<b>0.47</b>	<b>1.01</b>	<b>0.34</b>	<b>0.20</b>	<b>0.32</b>	<b>0.08</b>	<b>0.35</b>	<b>0.11</b>
	Maximum	0.61	0.55	0.55	1.25	0.39	0.23	0.37	0.09	0.42	0.14
	Minimum	0.34	0.21	0.21	0.35	0.17	0.09	0.17	0.03	0.16	0.04
	<b>Mean</b>	<b>0.46</b>	<b>0.36</b>	<b>0.36</b>	<b>0.74</b>	<b>0.27</b>	<b>0.16</b>	<b>0.26</b>	<b>0.06</b>	<b>0.27</b>	<b>0.08</b>
	Median	0.44	0.33	0.33	0.66	0.26	0.14	0.24	0.06	0.25	0.07



**Table 4-6 Comparison of body dimensions for marine mammal CRM assessment (number of individuals / year) with 98% avoidance for one device of each device type**

Tidal device category		1	2a	2b	3	4	5a	5b	6a	6b
Number of Devices		1	1	1	1	1	1	1	1	1
Species	Parameter	1	1	1	1	1	1	1	1	1
Harbour porpoise	<b>ES</b>	<b>3.76</b>	<b>2.37</b>	<b>1.96</b>	<b>2.08</b>	<b>2.12</b>	<b>0.25</b>	<b>1.22</b>	<b>0.07</b>	<b>0.17</b>
	Maximum	6.10	3.96	3.27	3.67	3.41	0.41	1.97	0.12	0.29
	Minimum	1.44	0.89	0.74	0.75	0.82	0.09	0.47	0.03	0.07
	<b>Mean</b>	<b>3.21</b>	<b>2.02</b>	<b>1.67</b>	<b>1.77</b>	<b>1.81</b>	<b>0.21</b>	<b>1.04</b>	<b>0.06</b>	<b>0.15</b>
	Median	3.23	2.04	1.68	1.79	1.82	0.21	1.05	0.06	0.15
Bottlenose dolphin	<b>ES</b>	<b>0.12</b>	<b>0.09</b>	<b>0.09</b>	<b>0.10</b>	<b>0.11</b>	<b>0.04</b>	<b>0.10</b>	<b>0.02</b>	<b>0.05</b>
	Maximum	0.17	0.12	0.12	0.14	0.14	0.05	0.14	0.02	0.07
	Minimum	0.06	0.04	0.04	0.04	0.05	0.02	0.05	0.01	0.02
	<b>Mean</b>	<b>0.12</b>	<b>0.08</b>	<b>0.08</b>	<b>0.09</b>	<b>0.10</b>	<b>0.03</b>	<b>0.10</b>	<b>0.02</b>	<b>0.05</b>
	Median	0.14	0.10	0.10	0.11	0.12	0.04	0.12	0.02	0.06
Risso's dolphin	<b>ES</b>	<b>0.18</b>	<b>0.13</b>	<b>0.13</b>	<b>0.14</b>	<b>0.15</b>	<b>0.05</b>	<b>0.15</b>	<b>0.03</b>	<b>0.08</b>
	Maximum	0.24	0.17	0.17	0.20	0.20	0.07	0.20	0.03	0.10
	Minimum	0.08	0.06	0.06	0.06	0.07	0.02	0.07	0.01	0.03
	<b>Mean</b>	<b>0.18</b>	<b>0.13</b>	<b>0.13</b>	<b>0.14</b>	<b>0.15</b>	<b>0.05</b>	<b>0.15</b>	<b>0.03</b>	<b>0.08</b>
	Median	0.18	0.12	0.12	0.14	0.15	0.05	0.14	0.02	0.07
Common dolphin	<b>ES</b>	<b>0.96</b>	<b>0.67</b>	<b>0.67</b>	<b>0.72</b>	<b>0.82</b>	<b>0.27</b>	<b>0.80</b>	<b>0.13</b>	<b>0.40</b>
	Maximum	1.39	0.98	0.98	1.10	1.17	0.39	1.14	0.20	0.59
	Minimum	0.41	0.28	0.28	0.29	0.36	0.12	0.35	0.06	0.17
	<b>Mean</b>	<b>0.99</b>	<b>0.69</b>	<b>0.69</b>	<b>0.75</b>	<b>0.84</b>	<b>0.28</b>	<b>0.82</b>	<b>0.14</b>	<b>0.41</b>
	Median	1.00	0.70	0.70	0.76	0.85	0.28	0.83	0.14	0.42
Minke whale	<b>ES</b>	<b>0.22</b>	<b>0.18</b>	<b>0.18</b>	<b>0.25</b>	<b>0.18</b>	<b>0.07</b>	<b>0.18</b>	<b>0.04</b>	<b>0.11</b>
	Maximum	0.22	0.18	0.18	0.25	0.18	0.07	0.18	0.04	0.11
	Minimum	0.10	0.07	0.07	0.08	0.09	0.03	0.08	0.01	0.04
	<b>Mean</b>	<b>0.20</b>	<b>0.15</b>	<b>0.15</b>	<b>0.19</b>	<b>0.17</b>	<b>0.06</b>	<b>0.17</b>	<b>0.03</b>	<b>0.09</b>
	Median	0.19	0.14	0.14	0.17	0.16	0.06	0.16	0.03	0.09
Grey seal	<b>ES</b>	<b>0.63</b>	<b>0.39</b>	<b>0.39</b>	<b>0.43</b>	<b>0.47</b>	<b>0.12</b>	<b>0.39</b>	<b>0.06</b>	<b>0.17</b>
	Maximum	1.54	0.98	0.98	1.08	1.14	0.30	0.95	0.14	0.20
	Minimum	0.26	0.16	0.16	0.16	0.19	0.05	0.16	0.02	0.07
	<b>Mean</b>	<b>0.49</b>	<b>0.30</b>	<b>0.30</b>	<b>0.32</b>	<b>0.36</b>	<b>0.09</b>	<b>0.30</b>	<b>0.04</b>	<b>0.13</b>
	Median	0.44	0.27	0.27	0.29	0.33	0.08	0.27	0.04	0.11

## 4.2. DENSITY ESTIMATES

55. The density estimates used in the collisions risk assessments for Risso's dolphin, common dolphin and minke whale were based on the SCANS-III survey data (Hammond *et al.*, 2017), therefore for consistency the density estimates for harbour porpoise and bottlenose dolphin from the SCANS-III surveys have also been assessed (**Table 4-7**).

**Table 4-7 Harbour porpoise and bottlenose dolphin density estimates**

Species	ES assessment	SCANS-III survey
Harbour porpoise	0.783/km <sup>2</sup> West Anglesey (SEACAMS; Appendix 12.1)	0.239/km <sup>2</sup> SCANS-III Block E (Hammond <i>et al.</i> , 2017)
Bottlenose dolphin	0.02/km <sup>2</sup> Area from Anglesey to Cardigan Bay (Feingold and Evans, 2013)	0.008/km <sup>2</sup> SCANS-III Block E (Hammond <i>et al.</i> , 2017)

56. The other marine mammal parameters used in the collision risk assessments are as outlined in **Table 2-1** and **Table 12-77 to 12-78** in **Section 12.6.4.5.1.3** of **Chapter 12, Marine Mammals (Volume I)** and the tidal device parameters are as outlined in **Table 12-76** in **Section 12.6.4.5.1.2** of **Chapter 12, Marine Mammals (Volume I)**.
57. **Table 4-8** and **Table 4-9** present the ERM and CRM collision risk assessments (number of individuals per year) for the harbour porpoise and bottlenose dolphin density estimates, based on 98% avoidance rates.
58. The values used in the collision risk assessments in **Section 12.6.4.5.2** of **Chapter 12, Marine Mammals (Volume I)** are robust and the most suitable values to use. However, the marine mammal density estimates will be further reviewed and assessed prior to deployment, based on the latest information and guidance, as part of the Environmental Management and Monitoring Plan (EMMP).



**Table 4-8 Comparison of harbour porpoise and bottlenose dolphin density estimates for marine mammal ERM assessment (number of individuals / year) with 98% avoidance for one device of each device type**

Tidal device category		1	2a	2b	3	4	5a	5b	6a	6b	7a
Number of Devices		1	1	1	1	1	1	1	1	1	1
Species	Density Estimate	1	1	1	1	1	1	1	1	1	1
Harbour porpoise	ES	3.43	2.81	2.32	4.74	1.59	0.40	1.03	0.10	0.37	0.75
	SCANS-III	1.05	0.86	0.71	1.45	0.48	0.12	0.32	0.03	0.11	0.23
Bottlenose dolphin	ES	0.10	0.10	0.10	0.23	0.07	0.06	0.08	0.02	0.11	0.01
	SCANS-III	0.04	0.04	0.04	0.09	0.03	0.02	0.03	0.01	0.04	0.01

**Table 4-9 Comparison of harbour porpoise and bottlenose dolphin density estimates for marine mammal CRM assessment (number of individuals / year) with 98% avoidance for one device of each device type**

Tidal device category		1	2a	2b	3	4	5a	5b	6a	6b
Number of Devices		1	1	1	1	1	1	1	1	1
Species	Density Estimate	1	1	1	1	1	1	1	1	1
Harbour porpoise	ES	3.76	2.37	1.96	2.08	2.12	0.25	1.22	0.07	0.17
	SCANS-III	1.15	0.72	0.60	0.64	0.65	0.08	0.37	0.02	0.05
Bottlenose dolphin	ES	0.12	0.09	0.09	0.10	0.11	0.04	0.10	0.02	0.05
	SCANS-III	0.05	0.04	0.04	0.04	0.04	0.01	0.04	0.01	0.02

## **5. REFERENCES**

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