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SMRU Ltd Technical Note:

Seagreen Noise Impact Assessment – quantification of animals within dBht contours using spatially explicit animal density data

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- **Shapefiles for dBht contours were supplied by Subacoustech Environmental Ltd**
- **Piling scenarios assessed:**
  - Alpha GM1 (driven 2m WC)
  - Bravo GM1 (driven 2m WC)
  - Alpha GM3 (drive-drill-drive 2m ML)
  - Bravo GM1 (drive-drill-drive 2m ML)
  - Alpha GM1 (driven 2m WC) and Bravo GM1 (driven 2m WC)
  - Alpha GM3 (drive-drill-drive 2m ML) and Bravo GM1 (drive-drill-drive 2m ML)
  - Alpha GM3 (drive-drill-drive 2m ML) and Inch Cape ML
  - Alpha GM3 (drive-drill-drive 2m ML) and Neart na Gaoithe ML
  - Alpha GM3 (drive-drill-drive 2m ML) and Inch Cape ML and Neart na Gaoithe ML
- **Density surfaces used:**
  - Seals – at-sea density surfaces for both species presented in FTOWDG seal baseline report (Sparling et al 2011)
  - Harbour porpoise – DMP analysis (Mackenzie, Donovan and Kidney 2012)
  - Bottlenose dolphins – density surface presented in Quick & Cheney (2011)

- **Calculation approach used for seals and harbour porpoises:**
  - dBht shapefiles – all polylines were converted into polygons and the area of each polygon was calculated
  - For cumulative scenarios (resulting in multiple dBht contours), where contours overlapped with each other, a new single dBht polygon was created covering the full extent of all polygons.
  - For each scenario dBht polygon(s) and density surfaces were overlaid in GIS (ArcGIS 9.3).
  - Firstly the number of animals within the 90 dBht contour was calculated for each scenario: a query was run in GIS to select all grid cells from the density surface which had their centre point inside the 90 dBht polygon.
  - The predicted abundance in all selected cells was summed to give total predicted abundance over all selected grid cells.
  - This abundance was divided by the total area of all selected grid cells to give average predicted density over selected grid cells.
  - This density was multiplied by the area of the 90 dBht polygon to calculate the predicted abundance of animals within the 90dBht contour.
  - It is assumed 100% these animals are displaced entirely from the area[1].

[1] This value, and corresponding value of 65% for the 75 dBht contour was taken from behavioural dose response curve presented in Thompson et al (2011) which was created from data on acoustic detections of harbour porpoises during piling at Horns Rev wind farm (Brandt et al 2011).

- Secondly the number of additional animals within the 75 dBht contour was calculated. The process above was repeated using the 75 dBht contour polygons to calculate the total abundance of animals within the whole 75 dBht contour.
- The total number of animals already predicted to be displaced from the 90 dBht contour were subtracted from this total abundance – the result is equivalent to the number of animals predicted to be within the 75 dBht contour but outside the 90 dBht contour.
- It is assumed that 65% of these animals are displaced entirely from the area.
- Therefore the total number of animals calculated to be displaced from the area is the sum of all animals predicted to be within the 90 dBht contour plus 65% of the animals predicted to be between the 90 dBht contour and the 75 dBht contour.

- **Calculation approach used for bottlenose dolphins**
  - Only the multisite cumulative scenarios had any overlap between the dBht contours and the bottlenose dolphin density surface. There was only overlap with the 75 dBht contours.
  - The extent of the overlap between the 75 dBht contours and the density surface was quantified in terms of area (km^2).
  - The area of overlap was multiplied by the average density to provide a predicted abundance in the area of overlap.
  - It is assumed that 65% of these animals are displaced from the area.

- **Limitations and caveats:**
  - The density surfaces used represent averages across space and time, there is likely to be both spatial and temporal variation in the distribution and abundance of animals.
  - The density surface for bottlenose dolphins is relatively crude and simply represents an estimate of the abundance of animals using the Tay and St Andrews Bay area divided uniformly over the surveyed area. It is highly likely that dolphins will occur outside of this range.
  - Restriction to only two dBht contours is a relatively crude approach – this could be refined by the inclusion of a higher resolution of dBht contours and application of the dose response curve across all of the contours.
  - The proportion of animals predicted to respond within each contour is based on data from harbour porpoises, bottlenose dolphins and seals may be more or less sensitive.
  - The probability of response is likely to be highly context specific, and the duration of any response is currently uncertain.
  - These predictions don't have any temporal component i.e. they don't take into account duration of piling.

Table 1. Predicted displacement of harbour seals at sea

Scenario	Abundance within 90dBht contour	Abundance between 90 and 75 dBht contours	Total animals displaced
Alpha GM1 (driven 2m WC)	51	94	112
Bravo GM1 (driven 2m WC)	38	76	88
Alpha GM3 (drive-drill-drive 2m ML)	44	85	99
Bravo GM1 (drive-drill-drive 2m ML)	28	71	74
Alpha GM1 (driven 2m WC) & Bravo GM1 (driven 2m WC)	56	90	115
Alpha GM3 (drive-drill-drive 2m ML) & Bravo GM1 (drive-drill-drive 2m ML)	50	83	104
Alpha GM3 (drive-drill-drive 2m ML) & IC ML	91	92	151
Alpha GM3 (drive-drill-drive 2m ML) & NNG ML	56	133	142
Alpha GM3 (drive-drill-drive 2m ML) & IC ML & NNG ML	96	94	156

Table 2. Predicted displacement of grey seals at sea

Scenario	Abundance within 90dBht contour	Abundance between 90 and 75 dBht contours	Total animals predicted to be displaced
Alpha GM1 (driven 2m WC)	398	1226	1195
Bravo GM1 (driven 2m WC)	465	975	1099
Alpha GM3 (drive-drill-drive 2m ML)	367	950	985
Bravo GM1 (drive-drill-drive 2m ML)	424	770	924
Alpha GM1 (driven 2m WC) & Bravo GM1 (driven 2m WC)	542	1247	1353
Alpha GM3 (drive-drill-drive 2m ML) & Bravo GM1 (drive-drill-drive 2m ML)	534	933	1140
Alpha GM3 (drive-drill-drive 2m ML) & IC ML	625	1889	1853
Alpha GM3 (drive-drill-drive 2m ML) & NNG ML	624	2157	2027
Alpha GM3 (drive-drill-drive 2m ML) & IC ML & NNG ML	809	1983	2098

Table 3. Predicted displacement of harbour porpoises

Scenario	Abundance within 90dBht contour	Abundance between 90 and 75 dBht contours	Total animals predicted to be displaced
Alpha GM1 (driven 2m WC)	104	722	573
Bravo GM1 (driven 2m WC)	112	835	655
Alpha GM3 (drive-drill-drive 2m ML)	67	627	474
Bravo GM1 (drive-drill-drive 2m ML)	83	694	534
Alpha GM1 (driven 2m WC) & Bravo GM1 (driven 2m WC)	164	861	724
Alpha GM3 (drive-drill-drive 2m ML) & Bravo GM1 (drive-drill-drive 2m ML)	114	752	603
Alpha GM3 (drive-drill-drive 2m ML) & IC ML	217	610	613
Alpha GM3 (drive-drill-drive 2m ML) & NNG ML	161	769	661
Alpha GM3 (drive-drill-drive 2m ML) & IC ML & NNG ML	257	687	704

Table 4. Predicted displacement of bottlenose dolphins

Scenario	Abundance within 90dBht contour	Abundance between 90 and 75 dBht contours	Total animals predicted to be displaced
Alpha GM1 (driven 2m WC)	0	0	0
Bravo GM1 (driven 2m WC)	0	0	0
Alpha GM3 (drive-drill-drive 2m ML)	0	0	0
Bravo GM1 (drive-drill-drive 2m ML)	0	0	0
Alpha GM1 (driven 2m WC) & Bravo GM1 (driven 2m WC)	0	0	0
Alpha GM3 (drive-drill-drive 2m ML) & Bravo GM1 (drive-drill-drive 2m ML)	0	0	0
Alpha GM3 (drive-drill-drive 2m ML) & IC ML	0	28	18
Alpha GM3 (drive-drill-drive 2m ML) & NNG ML	0	49	32
Alpha GM3 (drive-drill-drive 2m ML) & IC ML & NNG ML	0	67	44

Summary

- For seals and harbour porpoises, more animals were predicted to be displaced during drive only scenarios compared to drill-drive; this is due to the higher blow energies (and thus louder strikes) employed during the drive only scenarios.
- For both species of seal, more animals were predicted to be displaced during piling at alpha compared to piling at bravo. This is because the contours centred on alpha overlap to a greater extent with higher density areas inshore and closer to haul out sites. For harbour porpoises the opposite was true.
- For harbour seals and harbour porpoises more animals were predicted to be displaced during piling concurrently at Inch Cape and Alpha (Firth of Forth), compared to piling concurrently at Neart na Gaoithe and Alpha (Firth of Forth). For grey seals and bottlenose dolphins the opposite was true.
- For bottlenose dolphins none of the Firth of Forth only scenarios resulted in any overlap between the dolphin density surface and dBht contours. However given the relatively crude way that the density surface was created, this must be treated with caution and displacement is possible outside of this defined area.
- For all of these species, piling concurrently at all three sites resulted in the highest predicted displacement. However, the increase in predicted displacement was not a linear increase with the number of concurrent piling operations; in fact the increase in predicted displacement was relatively small in some cases. For example the increase in predicted displacement for harbour seals between piling at a single location (Alpha) and piling at two locations (Alpha and Bravo) was only 3% despite a doubling in piling activity. Similarly, the increase in predicted displacement for harbour seals between piling at two sites (Alpha and IC) and piling at three sites (Alpha, IC and NNG) was 4%.
- This has implications for the temporal aspects of piling at several locations (both within a single site and cumulatively at different sites). If potential displacement is the key concern, as long as the degree of spatial overlap between concurrent piling operations can be maximised, it may be better to carry out multiple piling operations to allow construction in a shorter space of time rather than a longer period of subsequent single piling operations.

References

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