# Supplementary material for:

Sarnocinska J, Teilmann J, Balle J, van Beest FM, Delefosse M and Tougaard J (2019) Harbor

Porpoise (Phocoena phocoena) Reaction to a 3D Seismic Airgun Survey in the North Sea. Front. Mar. Sci. 6:824. doi: 10.3389/fmars.2019.00824

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| --- |
|  |
| **Figure S1.** Mean porpoise activity: the number of porpoise clicks (CPM) (first row), porpoise positive minutes (PPM) (second row), and raw data on porpoise positive buzzing minutes (BPM) (bottom row) over distance to source vessel with active airgun (left panel), SELSS (centre panel), and Leq-fastHF (right panel). |

**Table S1**. Sensitivity of C-PODs. Reported thresholds are mean values from 4 C-POD angles.

|  |  |
| --- | --- |
| C-POD ID | Threshold (dB re 1Pa pp) |
| 2200  2208  2214  2240  2243  2244  2245  2246  2248  2249  2250  2252  2443  2445 | 115  116  116  116  118  119  116  116  118  116  115  116  117  117 |

**Table S2.** Overview of data collection during three deployments. Seismic survey took place between 26 July and 5 November 2016. The total number of available days in each of the three periods (pre-survey, survey and post-survey) was 67, 98 and 134 days, respectively. During the last deployment, C-POD data collected at 100 m distance from Dagmar were used in the analysis instead of 200 m due to instrument failure and missing data.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Name | Type | Deployment position | | Water depth | Deployment | Service/recovery | End of useful data | | Recording days | |
|  |  | Lat (N) | Lon (E) | (m) |  |  | C-POD | Noise logger | C-POD | Noise logger |
| Rolf | Unmanned | 55° 36.333’ | 04° 29.671’ | 36 | 07-06-2016 | 23-08-2016 | No data | 13-08-2016 | 0 | 68 |
|  |  | 55° 36.396’ | 04° 29.608’ |  | 23-08-2016 | 24-11-2016 | 23-11-2016 | 23-11-2016 | 93 | 93 |
|  |  | 55° 36.343’ | 04° 29.675’ |  | 24-11-2016 | 22-03-2016 | 22-12-2016 | No data | 29 | 0 |
| Dagmar | Unmanned | 55° 34.589’ | 04° 36.903’ | 37 | 07-06-2016 | 23-08-2016 | 22-08-2016 | 16-08-2016 | 77 | 71 |
|  |  | 55° 34.586’ | 04° 36.728’ |  | 23-08-2016 | 24-11-2016 | 10-10-2016 | 10-10-2016 | 49 | 49 |
|  |  | 55° 34.593’ | 04° 36.897’ |  | 24-11-2016 | 22-03-2016 | 14-03-2017 | 19-12-2016 | 111 | 26 |
| Skjold | Manned | 55° 31.760' | 04° 54.641' | 40 | 06-06-2016 | 24-08-2016 | 22-08-2016 | Not deployed | 78 | 0 |
|  |  | 55° 31.799' | 04° 54.629' |  | 24-08-2016 | 24-11-2016 | 09-11-2016 | Not deployed | 78 | 0 |
|  |  | 55° 31.759' | 04° 54.635' |  | 24-11-2016 | 22-03-2016 | 22-03-2017 | Not deployed | 119 | 0 |
| Halfdan B | Manned | 55° 32.141' | 05° 01.992' | 45 | 06-06-2016 | 24-08-2016 | 22-08-2016 | Not deployed | 78 | 0 |
|  |  | 55° 32.152’ | 05° 01.963' |  | 24-08-2016 | 24-11-2016 | 23-11-2016 | Not deployed | 92 | 0 |
|  |  | 55° 32.144' | 05° 01.972' |  | 24-11-2016 | 22-03-2016 | 22-03-2017 | Not deployed | 119 | 0 |
| Dan F | Manned | 55° 28.508' | 05° 06.722' | 46 | 06-06-2016 | 23-08-2016 | No data | 22-08-2016 | 0 | 78 |
|  |  | 55° 28.504' | 05° 06.739' |  | 23-08-2016 | 24-11-2016 | 06-11-2016 | 06-11-2016 | 76 | 76 |
|  |  | 55° 28.466' | 05° 06.548' |  | 24-11-2016 | 22-03-2016 | 22-03-2017 | 06-02-2017 | 119 | 75 |
| Kraka | Unmanned | 55° 24.087' | 05° 04.945' | 47 | 06-06-2016 | 23-08-2016 | 22-08-2016 | 17-08-2016 | 78 | 73 |
|  |  | 55° 24.096' | 05° 04.963' |  | 23-08-2016 | 23-11-2016 | 23-11-2016 | 23-11-2016 | 93 | 93 |
|  |  | 55° 24.086' | 05° 04.900' |  | 23-11-2016 | 22-03-2016 | 22-03-2017 | 04-02-2017 | 120 | 74 |
| Regnar | Closed well-head | 55° 23.097' | 05° 13.705' | 47 | 07-06-2016 | 24-08-2016 | 22-08-2016 | 22-08-2016 | 77 | 77 |
|  |  | 55° 23.105' | 05° 13.698’ |  | 24-08-2016 | 23-11-2016 | 02-10-2016 | 02-10-2016 | 40 | 40 |
|  |  | 55° 23.097' | 05° 13.705' |  | 23-11-2016 | 22-03-2016 | 21-12-2016 | Not deployed | 29 | 0 |
| Ref.2 | No structures | 55° 18.334' | 05° 22.741' | 44 | 06-06-2016 | 23-08-2016 | 22-08-2016 | Not deployed | 78 | 0 |
|  |  | 55° 18.246’ | 05° 22.772’ |  | 23-08-2016 | 23-11-2016 | 05-11-2016 | Not deployed | 75 | 0 |
|  |  |  |  |  | 23-11-2016 | 22-03-2016 | No data | Not deployed | 0 | 0 |
| Ref. 1 | No structures | 55° 26.339' | 05° 30.373' | 49 | 06-06-2016 | 23-08-2016 | 22-08-2016 | 22-08-2016 | 78 | 77 |
|  |  | 55° 26.290’ | 05° 30.370' |  | 23-08-2016 | 23-11-2016 | 04-10-2016 | 04-10-2016 | 43 | 42 |
|  |  |  |  |  | 23-11-2016 | 22-03-2016 | No data | No data | 0 | 0 |

**Table S3**. Output of the generalized additive mixed effect models predicting CPM, PPM and BPM/PPM as a function of distance to the active source vessel. The model forms the analytical basis for Figure 3 (left panel).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Fixed effect | CPM | | PPM | | BPM/PPM | |
| β | SE | β | SE | β | SE |
| (Intercept) | 2.216 | 0.185 | -1.336 | 0.133 | -1.8866 | 0.309 |
| Smooth term | edf | F-value | edf | F-value | edf | F-value |
| s(distance to seismic vessel) | 3.999 | 6628.000 | 2.963 | 46.300 | 2.936 | 27.4200 |
| Random effect | Var | Residual | Var | Residual | SD | Residual |
| Station ID (N = 6) | 0.455 | 1.000 | 0.325 | 1.000 | 0.752 | 1.000 |
| Temporal correlation | Phi | | Phi | | Phi | |
| corAR1 | 0.231 | | 0.538 | | 0.264 | |

**Table S4.** Output of the generalized additive mixed effect models predicting CPM, PPM and BPM/PPM as a function of SELSS. The model forms the analytical basis for Figure 3 (centre panel).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Fixed effect | CPM | | PPM | | BPM/PPM | |
| β | SE | β | SE | β | SE |
| (Intercept) | 2.008 | 0.132 | -1.523 | 0.060 | -2.106 | 0.438 |
| Smooth term | edf | F-value | edf | F-value | edf | F-value |
| s(SELSS) | 3.982 | 294.200 | 1.000 | 10.210 | 2.309 | 5.832 |
| Random effect | Var | Residual | Var | Residual | SD | Residual |
| Station ID (N = 6) | 0.265 | 1.000 | 0.088 | 1.000 | 0.855 | 1.000 |
| Temporal correlation | Phi | | Phi | | Phi | |
| corAR1 | 0.212 | | 0.518 | | 0.229 | |

**Table S5**. Output of the generalized additive mixed effect models predicting CPM, PPM and BPM/PPM as a function of Leq-fastHF. The model forms the analytical basis for Figure 3 (right panel).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Fixed effect | CPM | | PPM | | BPM/PPM | |
| β | SE | β | SE | β | SE |
| (Intercept) | 1.989 | 0.139 | -1.544 | 0.054 | -1.935 | 0.433 |
| Smooth term | edf | F-value | edf | F-value | edf | F-value |
| s(Leq-fastHF) | 2.989 | 754.200 | 3.251 | 8.461 | 2.370 | 4.777 |
| Random effect | Var | Residual | Var | Residual | SD | Residual |
| Station ID (N = 6) | 0.279 | 1.000 | 0.071 | 1.000 | 0.845 | 1.000 |
| Temporal correlation | Phi | | Phi | | Phi | |
| corAR1 | 0.211 | | 0.514 | | 0.228 | |

**Table S6**. The amount of variation in the data explained (R2adj) by the generalized additive mixed effect models with distance from source vessel, SELSS and Leq-fastHF as predictor variables of CPM, PPM and BPM/PPM..

|  |  |  |  |
| --- | --- | --- | --- |
| Acoustic measure | R2adj = variation explained by the model | | |
| Distance | SELSS | Leq-fastHF |
| CPM | 0.132 | 0.028 | 0.052 |
| PPM | 0.255 | 0.142 | 0.244 |
| BPM/PPM | 0.136 | 0.117 | 0.106 |

**Table S7**. Output of the generalized linear mixed effect models predicting CPM, PPM and BPM /PPM experimental area and seismic period. The model forms the analytical basis for Figure 5.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Fixed effects | CPM | | PPM | | BPM/PPM | |
| β | SE | β | SE | β | SE |
| (Intercept) | -2,829 | 0,545 | -6,670 | 0,455 | -7214 | 0,306 |
| Experimental blocka |  |  |  |  |  |  |
| Before-impact | 0,027 | 0,448 | -0,117 | 0,399 | 2964 | 0,342 |
| During-control with airguns off | 0,924 | 0,187 | 0,658 | 0,108 | 0,792 | 0,265 |
| During control with airguns on | 0,781 | 0,206 | 0,078 | 0,127 | 0,658 | 0,312 |
| During impact with airguns off | 1,673 | 0,436 | 1,009 | 0,398 | 1621 | 0,341 |
| During impact with airguns on | 1,579 | 0,437 | 0,432 | 0,400 | 1648 | 0,347 |
| After-impact | 1,530 | 0,446 | 0,819 | 0,406 | 0,766 | 0,343 |
| Hour of the day | -0,047 | 0,007 | -0,013 | 0,006 | -0,129 | 0,008 |
| Hour of the day^2 | 0,002 | 0,003 | 0,001 | 0,003 | 0,008 | 0,001 |
| Julian day | 0,024 | 0,003 | 0,028 | 0,002 | 0,039 | 0,003 |
| Julian day^2 | -0,036 | 0,001 | -0,004 | 0,003 | -0,010 | 0,003 |
| Random effect | Var | SD | Var | SD | Var | SD |
| Station ID (N = 9) | 0,556 | 5,949 | 0,541 | 0,542 | 0,357 | 0,182 |

a Reference = Control-Before