Electronic Supplementary Material for: High rates of vessel noise disrupt foraging in wild harbour porpoises (*Phocoena phocoena*)

Electronic Supplementary Material includes three tables, three figures and a video.

Table S1. Overview of foraging buzz data for the full deployments, i.e. prior to exclusion of time intervals dominated by rain, splashing and loud transients (see Methods and table 2), from the seven porpoises included in the study. Night was assumed to start after the civil dusk, i.e. when the sun was >6 degrees below the horizon. The proportion of buzz-positive minutes in the subset of data selected for analysis (table 2) were reflected in these full datasets, with the exception of porpoises hp14_226b and hp13_170a, where the proportion of buzz-positive minutes was 8-15% lower, and porpoise hp16_264a where the proportion was 15% higher.

animal ID	hp12_272a	hp12_293a	hp13_102a	hp13_170a	hp14_226b	hp15_117a	hp16_264a
total buzz count	1856	1381	3408	1222	3232	906	383
number of minutes after recovery period	1068	982	1359	858	1140	721	651
buzz-positive minutes	422 (39.5%)	553 (56.3%)	649 (47.8%)	493 (57.5%)	764 (67.0%)	409 (56.7%)	215 (33.0%)
daytime buzz-positive minutes	90 (22.1%)	94 (25.8%)	151 (18.1%)	346 (49.8%)	461 (65.8%)	311 (63.2%)	88 (13.8%)
night-time buzz-positive minutes	332 (50.3%)	459 (74.3%)	498 (94.9%)	147 (90.2%)	303 (69.0%)	98 (42.8%)	157 (67.7%)

Table S2. Average noise levels in 0.5-s and 1-min time windows for data included in the analysis (i.e. without time intervals dominated by rain, loud transients etc., see Methods). The 0.5-s TOL averages are for periods with audible propulsion noise (purple in figure 2). The 1-minute TOL averages are for all minutes that scored positively for presence of vessel noise. The results are given as maximum, TOL_{90}, TOL_{50} and TOL_{10} noise levels (i.e. noise levels exceeded for 90, 50 and 10% of the time, respectively).

animal ID	hp12_272a	hp12_293a	hp13_102a	hp13_170a	hp14_226b	hp15_117a	hp16_264a
TOL@16 kHz (dB re 1µPa rms) in 0.5 s							
TOL_{90}	78	79	76	81	77	77	77
TOL_{50}	82	84	79	85	82	82	81
TOL_{10}	86	93	87	90	89	91	92
Max	100	125	107	108	107	111	119
TOL@16 kHz (dB re 1µPa rms) in 1 min							
TOL_{90}	81	82	78	83	81	80	79
TOL_{50}	84	86	81	88	87	84	83
TOL_{10}	87	96	90	92	91	93	92
Max	97	120	105	102	105	108	118

Table S3. Results of permutation test for differences in total buzz duration and buzz count for minutes with and without high vessel noise levels. Significant values are highlighted in bold.

animal ID	hp12_293a						hp13_102a			hp13_170a	hp14_226b	hp15_117a			hp16_264a		
threshold, TOL @16 kHz (dB re 1µPa rms)	96	99	102	105	108	111	96	99	102	96	96	96	99	102	96	99	102
high-noise minutes (exposure time)	80 (8.8%)	39 (4.3%)	25 (2.8%)	15 (1.7%)	9 (1%)	5 (0.6%)	15 (1.3%)	8 (0.7%)	5 (0.4%)	5 (1.6%)	6 (0.9%)	33 (4.7%)	15 (2.1%)	7 (1%)	22 (4.3%)	15 (2.8%)	12 (2.2%)
low-noise minutes	717						1050			276	650	570			442		
buffer minutes	110	151	165	175	181	185	95	102	105	25	34	97	115	123	29	36	39
high-noise mean (max) total buzz duration min^{-1} (s)	3.53 (34.96)	3.75 (34.96)	2.66 (13.92)	3.43 (13.92)	3.06 (13.92)	5.5 (13.92)	0	0	0	9.83 (17.80)	2.01 (9.63)	8.01 (27.81)	8.74 (25.45)	7.80 (25.45)	0	0	0
low-noise mean (max) total buzz duration min^{-1} (s)	3.70 (39.59)						4.51 (39.86)			10.38 (59.91)	7.04 (43.48)	3.79 (36.28)			2.42 (45.89)		
p-value for buzz duration min^{-1} (two-sided)	0.859	0.898	0.429	0.973	0.901	0.450	**0.001**	**0.007**	**0.045**	0.966	**0.031**	**0.002**	**0.010**	0.137	**0.017**	0.074	0.145
high-noise mean (max) buzz count min^{-1}	1.61 (10)	1.5 (8)	0.88 (5.5)	1 (5.5)	1.17 (5.5)	2.1 (5.5)	0	0	0	2.30 (4)	0.92 (3)	2.39 (8.5)	2.8 (8.5)	1.93 (5.5)	0	0	0
low-noise mean (max) buzz count min^{-1}	1.49 (12)						2.87 (16)			1.99 (14)	2.84 (23.5)	1.08 (7)			0.30 (7)		
p-value for buzz count min^{-1} (one-sided)	0.727	0.531	**0.046**	0.180	0.349	0.789	**0.001**	**0.004**	**0.022**	0.676	**0.022**	1	1	0.941	**0.008**	**0.037**	0.073

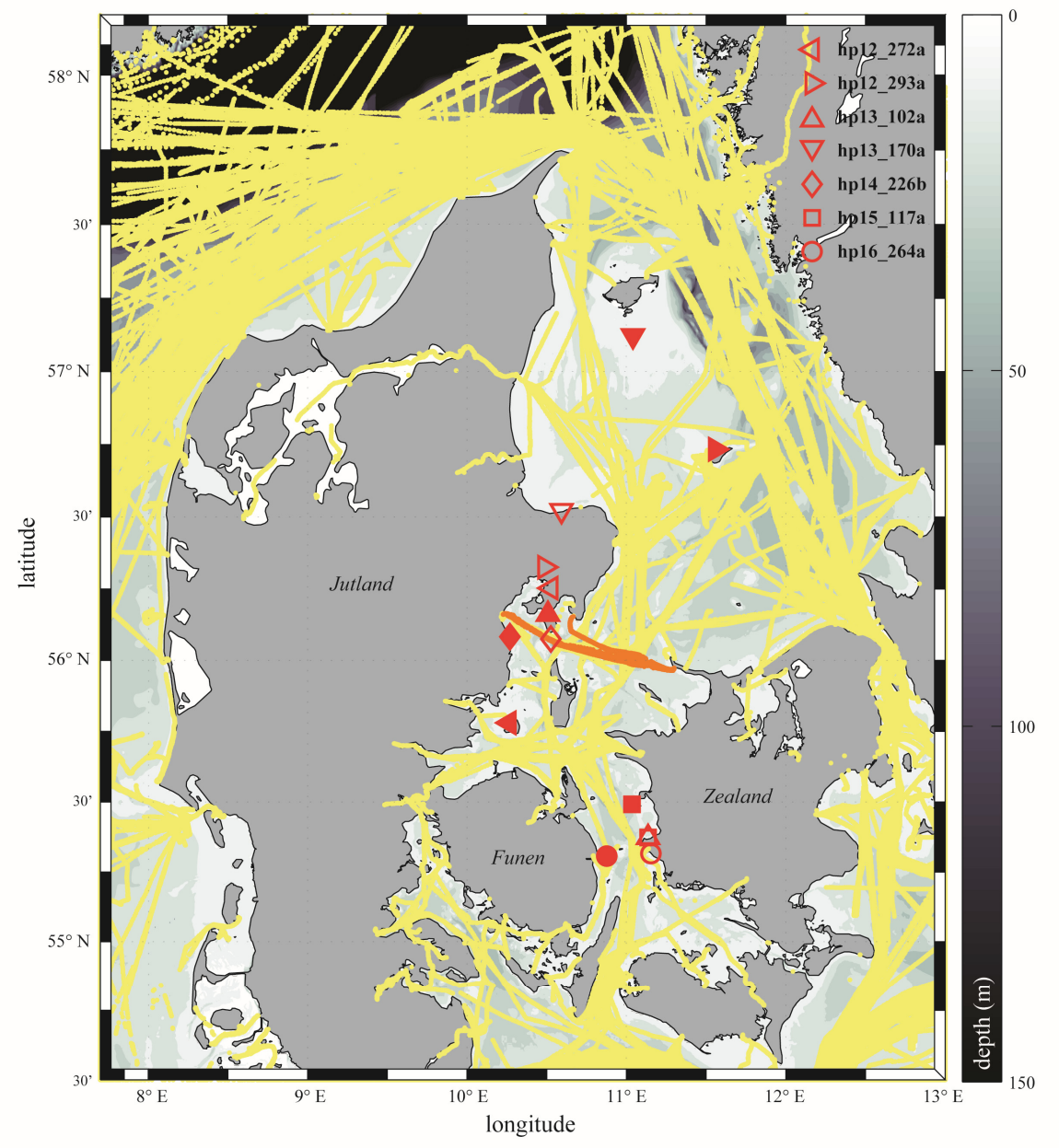

Figure S1. Bathymetry map (source: http://portal.emodnet-bathymetry.eu) of the study area showing tag deployment (red, unfilled) and recovery (red, filled) positions for the seven harbour porpoises. Three tags were deployed, and one recovered at the same location (red filled triangle for hp13_102a); their markers are shifted vertically for clarity. The map is overlaid with Automatic Identification System (AIS) data (data extracted by Jakob Tougaard, Aarhus University) for the duration of the hp12_293a tag recording (yellow circles; see also table 1, figure 1). The routes of fast passenger ferries sailing between the Jutland Peninsula and the island of Zealand are highlighted in orange. Datum: WGS84; projection: Mercator. Note that small, fast-moving and high-frequency noise generating boats are not required to carry an AIS transmitter and are therefore not included in the map.

Figure S2. Noise levels as a function of acceleration-based measure of activity (see Methods) for eight third-octave bands. Each row (**a-g**) represents recordings from one animal. The data points show 0.5-s averages and match the time categories in figure 2, i.e. (1) baseline (outside of foraging, vessel noise exposure, or possible vessel noise exposure; blue) and (2) during prey pursuit outside of periods of vessel noise exposure (orange). Time intervals dominated by rain (see e.g. figure 1) or loud transients were excluded for all measurements. The estimates are overlaid with kernel density curves computed over 128x128 square grid. TOLs correlate positively with activity in most animals with activity-dependent flow noise dominating the low-frequency third-octave bands, but the effect decreases with frequency. To avoid large contributions of flow noise to the TOL measurements, especially during highly energetic pursuits of prey, we chose the 16-kHz third-octave band.

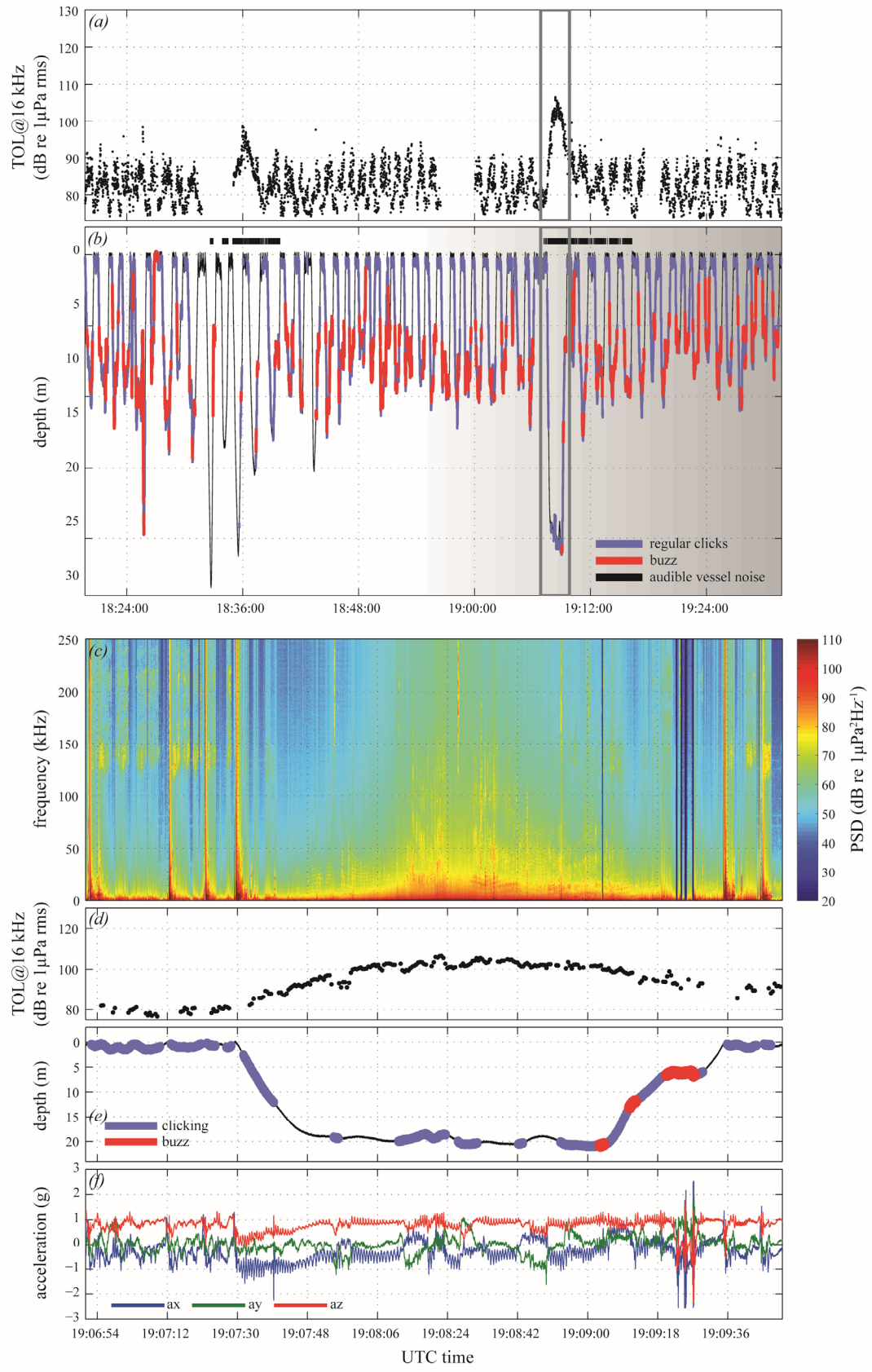

Figure S3. Diving and foraging behaviour of porpoise hp14_226b around the time of passage of a fast ferry. Panels (c-f) are a close-up of the period delineated by the grey vertical lines in (a-b). (**a, d**) 16-kHz

third-octave band levels (0.5-s trimmed mean averages over 1-ms measurements; see Methods). (**b, e**) Dive profile (black) with the time during which the porpoise produced regular and buzz clicks marked in blue and red, respectively. The thick black lines above the profile show the time with audible vessel noise in the recordings. The characteristic of the noise recorded around 18:36 suggests another fast ferry passage, albeit at a greater distance or at a lower speed. Gray shading marks the civil twilight. (**c**) Spectrogram composed of power spectral densities (PSDs) in 1-Hz bands. For ease of interpretation, clicks of the tagged porpoise were removed from the recording. (**f**) Acceleration.

Video S1. Related to figure 3. Behavior of porpoise hp12_293a around the time of passage of a presumed fast ferry.

UPPER PANEL: Spectrogram composed of power spectral densities (PSDs) in 1-Hz bands. The broadband vertical bands indicate noise when the porpoise surfaces. The narrow vertical lines at above 120 kHz are clicks produced by the tagged animal and its calf.

LOWER PANEL: Approximate three-dimensional path of a harbour porpoise estimated by dead reckoning using pressure, accelerometer and magnetometer data recorded by the DTAG-3. The track is colour-coded by root-mean-squared (RMS) minimum specific acceleration (MSA), a proxy for activity, in 0.5-s windows. The track has been displaced by 5 m relative to the water surface, to better show the movements of the porpoise during the vessel noise exposure.