Supplementary material to “Variation in echolocation tactics with depth and sea state but not naval sonar exposures in sperm whales” In prep. for Marine Mammal Science, 2021

Noise measurements

Ambient noise measurements were attempted in order to validate the field-estimated sea state as a proxy covariate for ambient noise conditions. To do this, acoustic data were extracted from 25 ms duration clips, 10 ms prior to each regular click train start. Based on an exploratory analysis, the 25 + 10 ms gap was determined to be a sufficiently short time period to exclude tagged whale clicks in the measurement. The shortest gaps in clicking were associated with regular click trains that followed buzzes without a pause. The clips were high-pass filtered using an 8^{th} order Butterworth with a cut-off frequency of 2 kHz (a steep filter was used to minimize the effect of received sonar and flow noise on the measurements, while incorporating energy near the sonar band). The filtered data were then measured root-mean square pressure, NL_{rms} (dB re 1 μPa).

To quantify whether and how sea surface noise might influence ambient noise conditions measured at the animal, the NL_{rms} noise metric was modelled in a gaussian GAMM. The model was fitted with smooth covariates for depth, mean vertical speed and fluke rate for the click train, sea state, SEL_{sp}_CAS and SEL_{sp}_PAS. Sea state and depth were allowed to interact non-linearly (as above, using the ti-specification). The covariates were specified maximum 3 knots each, except for depth (max 5).

In the full model for NL_{rms}, fluke rate and ti(sea state, depth) interaction were not supported at the 5% level. The model was therefore re-fitted without these covariates. The resulting model explained 25% of the response data (Fig. S14); without sea state, the adjusted R^2 was 20%, suggesting sea state captured around 5% of the variation in the response data; a similar difference was found for depth (5.5%). The effects included smooths for vertical velocity (F=1.7, p=0.006), depth (F=17.0, p<0.001), sea state (F=11.5, p<0.001), SEL_{sp}_CAS (F=214, p<0.001) and SEL_{sp}_PAS (F=22.5, p<0.001) (Fig. S15). The difference between sea state 2.5 and 4 equated to an estimate difference of 1 dB in NL_{rms}. The difference was the same (to 1^{st} decimal place) up to 2000 m depth. When sea state was held constant (Beaufort = 3) and depth increased from 100 m to 1000 m, NL_{rms} decreased by 2.7 dB.

GAMM analysis further details

Log-transformed Duration, ODBA and CR (Table 2) were specified as normal distributions and with identity links, which helped model convergence and compliance with residual distributional assumptions compared to specifying the untransformed data as Gamma-distributed. Buzz and pause presence/absence were modelled as binomial response variables, with a logit link. Stroke rate was specified a Poisson distribution (with ‘quasi’ option to allow for over-dispersion) and ICI a Gamma distribution, both with a log-link. Serial correlation within each deployment was modelled using the first-order autoregressive (AR1) structure.

Depth was fitted as a smooth covariate. The maximum number of knots in the smooth was set to 5 *a priori* to avoid over-fitting while allowing biologically feasible complexity such as multiple prey layers.

All received level covariates SEL_{sp} were set to zero during baseline and had the lowest observed value (69 dB) subtracted for SEL measured during exposures. To represent the different masking potential from the two different duty cycles, SEL_{sp}_CAS and SEL_{sp}_PAS were set to zeros (same as baseline) during PAS and CAS exposures, respectively. To represent a single cut-off for spatial masking release, modified covariates $SEL_{sp,\ facing}$, SEL_{sp}_CAS_{facing} and SEL_{sp}_PAS_{facing} were set to zero, same as baseline (equivalent to received SEL of 69 dB, as above), when the angle to the sonar source was greater than 90 degrees. In addition to the linear interaction terms, more flexible nonlinear interactions were considered (using the "ti" specification in mgcv which allows separate main and interaction effects, with maximum number of knots = 3).

The support for each smooth and parametric covariate was assessed using Wald or Wald-like tests (summary.gam function within mgcv). Smooth covariates were fitted with thin-plate regression splines with shrinkage (bs="ts"), allowing the automatic removal of the terms when they didn't gain support.

Table S1. Summary of tested models. B represents the baseline model structure s(Depth, k=5) + SeaState + SeaState:Depth + SeaState:surface_angle

No.	Model structure
1	B + NS + SEL_{sp} + SEL_{sp}:sonar_angle
2	B + NS + $SEL_{sp,\ facing}$
3	B + NS + SEL_{sp}_CAS + SEL_{sp}_PAS + SEL_{sp}_CAS:sonar_angle + SEL_{sp}_PAS:sonar_angle
4	B + NS + SEL_{sp}_CAS_{facing} + SEL_{sp}_PAS_{facing}
5	B + NS + ti(SEL_{sp}) + ti(SEL_{sp},sonar_angle)
6	B + NS + ti(SEL_{sp}_CAS) + ti(SEL_{sp}_CAS,sonar_angle) + ti(SEL_{sp}_PAS) + ti(SEL_{sp}_PAS,sonar_angle)
7	state + s(Depth) + SeaState + SeaState:Depth
8	s(Time since start of exposure) + s(SEL_{sp})
9	Lombard full model (further details below)
10	Lombard null model for sea state, mp_1 specified < 0 (further details below)
11	Lombard null model for sonar, sp_1 specified < 0 (further details below)
12	Lombard full model with additional linear covariate representing inspection range

Right-hand censored model structure

The model specified the linear predictor for AOL_{zp} as $y_i = \alpha_w + mp_i*(1 - mr_i) + sp_i*(1 - sr_i) + \varphi*\varepsilon_{(i-1)}$, where mp_i and sp_i represent masking potential and mr_i and sr_i masking release from sea state and sonar exposures, respectively, for observation i and whale w. Tag deployments were included both as fixed effect (α_w, above) and random effect ($AOL_i \sim Gaussian(y_i, \tau_w)$). The serial correlation parameter φ was estimated as a multiplier to the residual from previous time step $\varepsilon_{(i-1)}$. The masking potentials were specified $mp_i = mp_1*log10(SeaState_i)$ and $sp_i= sp_1*SEL_{sp,i}$ where mp_1 and sp_1 are estimable coefficients. Masking release from sea state was specified as $logit(mr_i) = c + mr_1*depth_i + mr_2*surface\_angle_i$ where c was fixed at -10, and mr_1 and mr_2 were estimable coefficients. Similarly, masking release from sonar was specified as $logit(sr_i) = c + sr_1*sonar\_angle_i$ where the intercept c was fixed at -10, and sr_1 was an estimable coefficient. The fixing of the intercept at a small negative value assumes no masking release when covariate values are zero (whale at sea surface and facing the sonar source at angle of zero).

In the full model (Model 9, Table S1), coefficients for masking release (mr_1, mr_2, sr_1) were only allowed positive values (i.e., depth, surface angle and sonar angle were allowed to decrease, not increase, the effect of sea state and sonar on AOL_{zp}). Initial values were drawn randomly from the prior distributions. Parameter convergence was assessed by monitoring trace histories (24,000 iterations with 12,000 burn-in for three chains) and the Brooks-Gelman-Rubin diagnostic (Brooks & Gelman, 1998). The model goodness-of-fit was assessed by the coefficient of determination ($R^2=1 – (SS_{res}/SS_{tot})$) calculated over the nonclipped (noncensored) values.

The full model showed slow mixing and bimodal posteriors when the prior for masking potential of sea state noise (*mp1*) was allowed to take on either negative or positive values (uniform or Gaussian priors). Positive values represented the expected direction according to a Lombard effect. Positive-valued Gamma priors were therefore specified, with the caveat that non-zero posteriors no longer had the simple interpretation as support for the coefficient. Instead, two null models were fitted where either the coefficient for masking potential from sea surface (mp_1) (Model 10, Table S1) or sonar (sp_1) (Model 11, Table S1) were specified as negative, with otherwise identical Gamma priors. The resulting models showed sufficient mixing and unimodal posterior distributions (Fig. S14).

Supplementary data and R code

Data and R code are provided at https://github.com/Saana-I/MaskingIndicators to replicate the exploratory (1_visualization.R), GAM regression (2_GAM_analysis.R) and Lombard effect analyses (3_Lombard_nimble_fit.R). To run the Lombard effect analysis, place the nimble model scripts (3_Lombard_nimble_model.R, 3_Lombard_nimble_model_null1.R, 3_Lombard_nimble_model_null2.R) in your R workspace.

The datasets include “atab”, which consists of the regular click and buzz trains, and “etab”, which lists the start and end times of each exposure. Both are stored in “Supplement_data.Rd”. For convenience, atab is also provided as a csv file. The variables included in atab include tag deployment ID (“ind”), seconds from tag-on (“sfromtot”), GMT time, duration, audit label (RC = regular click, BUZZ = buzz train), notes/comments on the audit, duration of the following pause (pausedur) and label of the following audit (nextLabel). Experimental set up is summarized by the variables Focal (true/false whether the tag deployment was the focal whale in the experiment), ExposureType (“BP”= baseline or post-exposure, “NS” = no-sonar, and “CAS”, “HPS”, “MPS” = continuous, high-level and medium-level sonar), SL (source level), ExposureTime (how long the animal has been exposed in a given session, in minutes), NS (no-sonar, true or false), and SELmax and SELcum (maximum single-ping SEL and cumulative SEL over the session, respectively). “Angle” is the sonar angle and “VAngle” the surface angle.

Figures

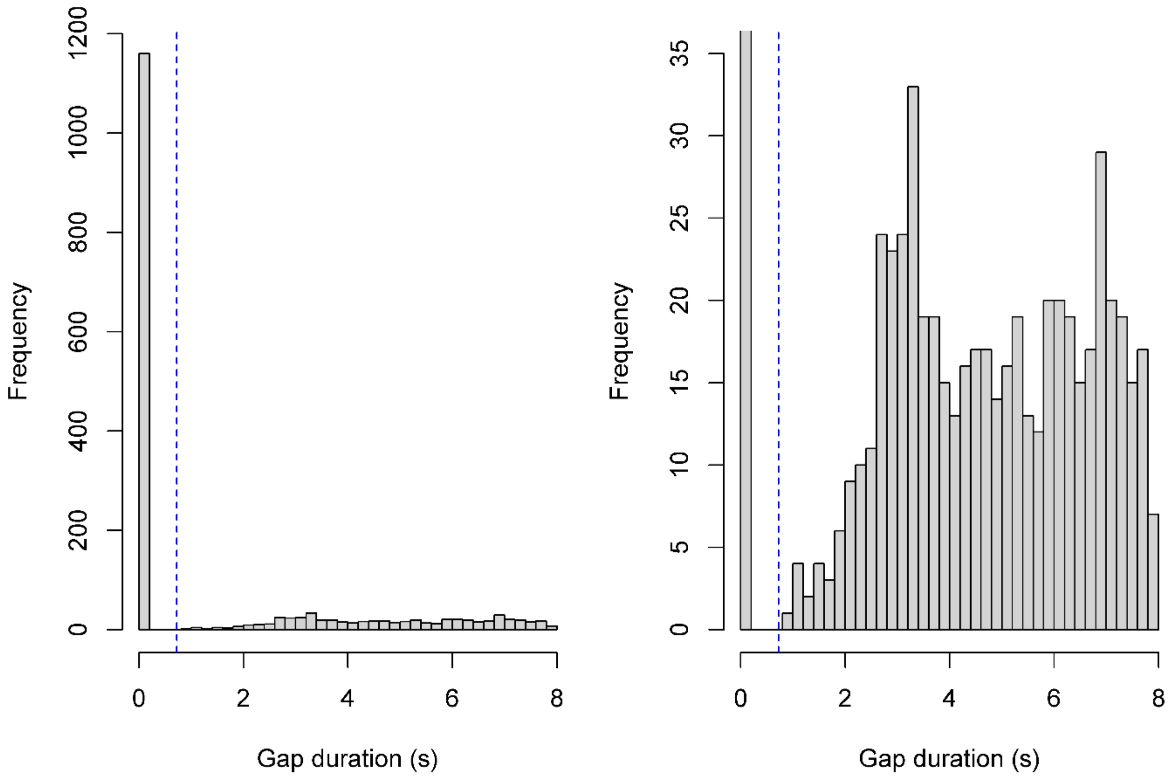

Figure S1. Histogram of gap durations between buzzes and the following click trains. Blue dashed line shows the median first ICI of regular click trains (0.76 s).

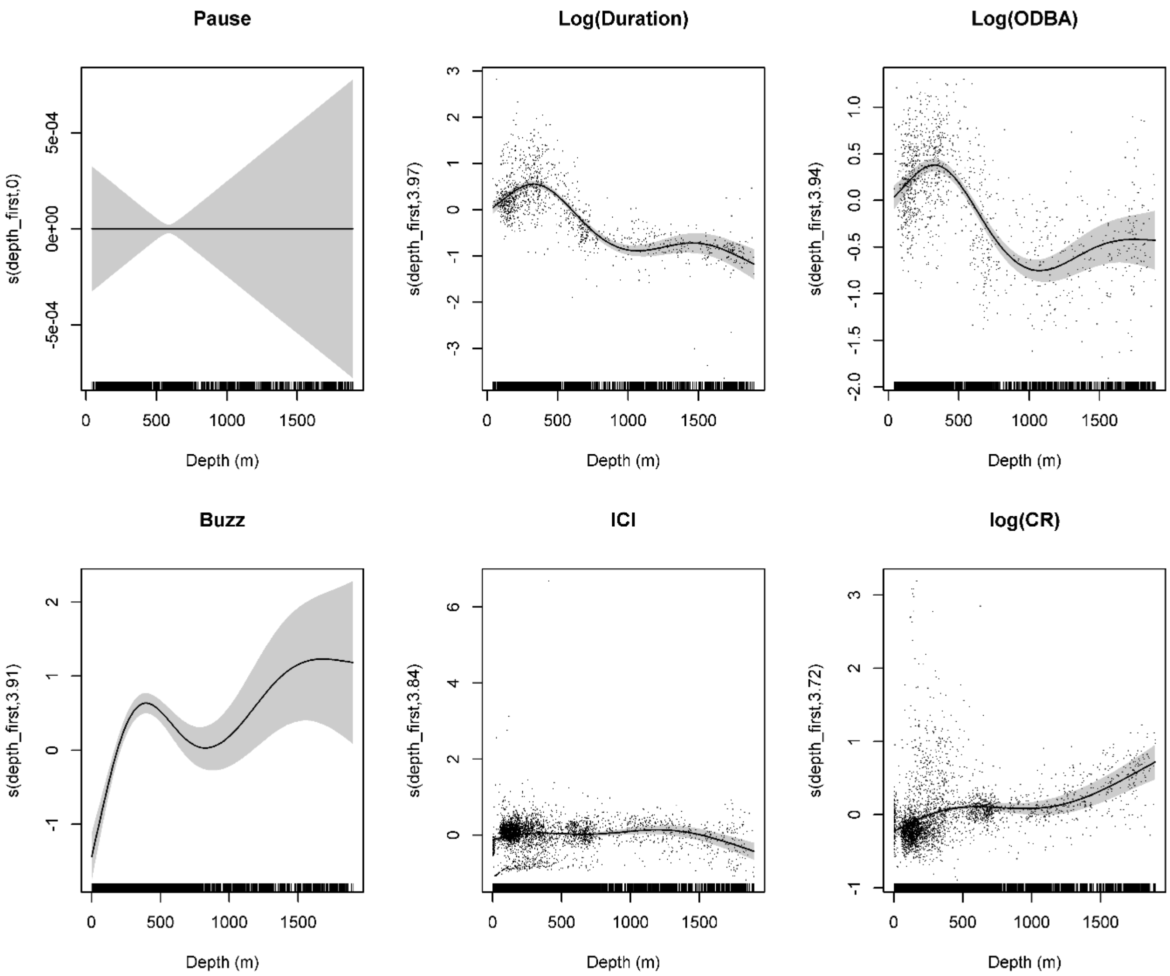

Figure S2. Partial smooths for depth in non-exposure models for Pause, Log(Duration), Log(ODBA), Buzz, ICI and log(CR).

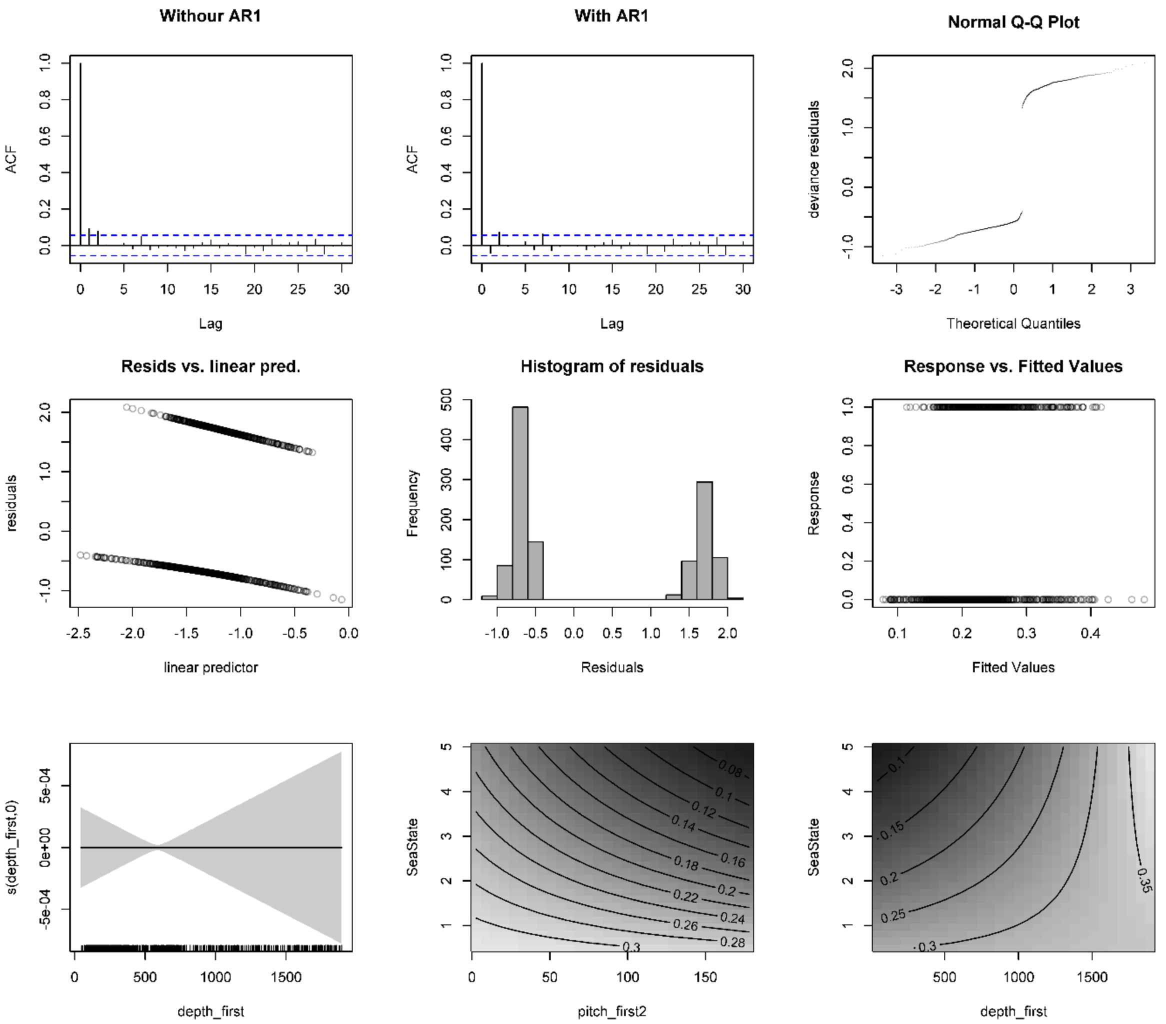

Figure S3. Model diagnostics and estimates for non-exposure model for Pause. Depth is labelled as "depth_first", surface angle is labelled as "pitch_first2". ACF = autocorrelation function, AR1 = 1st-order autoregressive correlation structure. Bottom panels shown the component smooth function for depth (left), and the model predictions for the sea state interactions, with darker colour indicating a lower value. For the model predictions, depth was fixed to its median value.

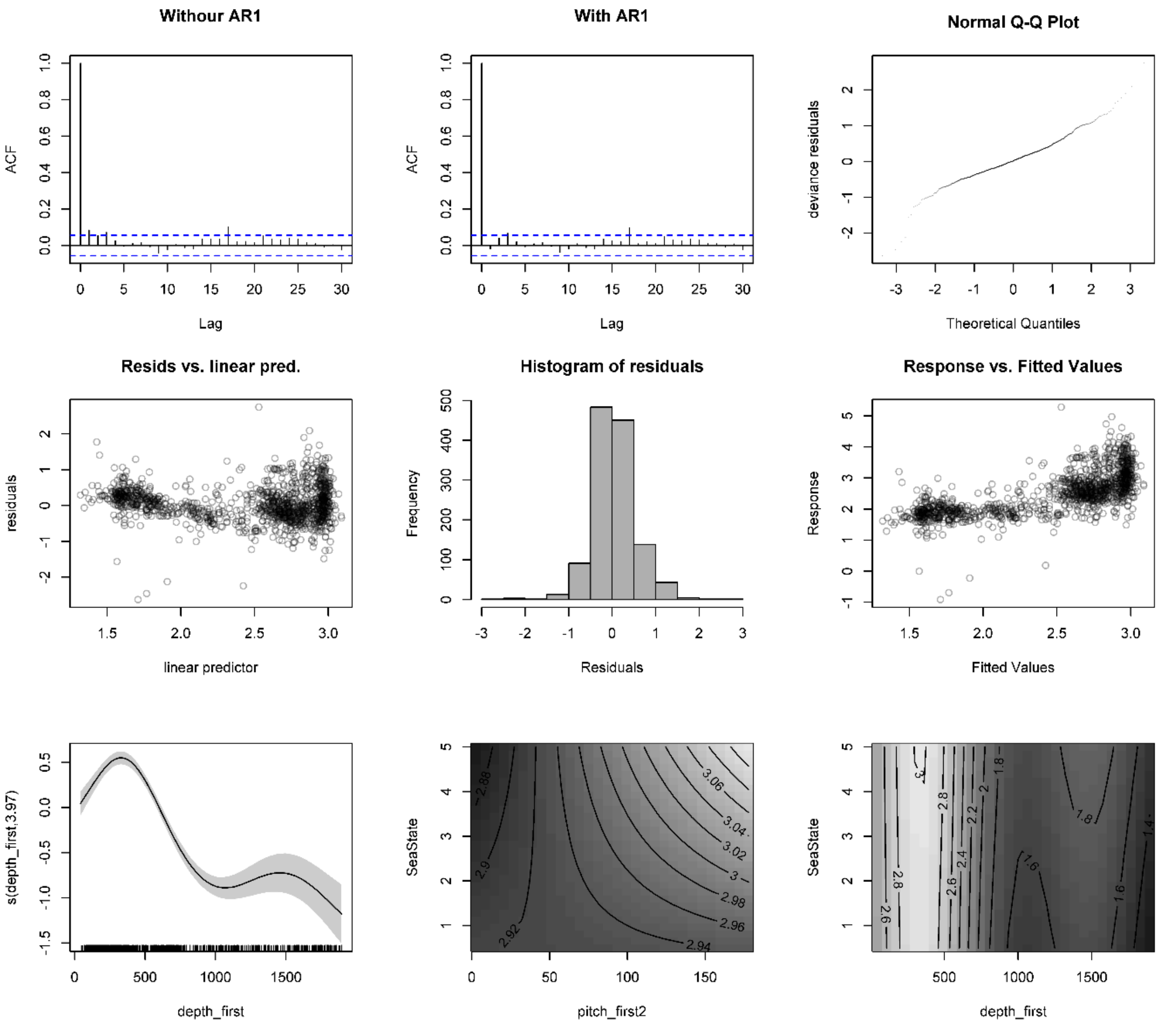

Figure S4. Model diagnostics and estimates for non-exposure model for Log(Duration). Depth is labelled as "depth_first", surface angle is labelled as "pitch_first2". ACF = autocorrelation function, AR1 = 1^{st}-order autoregressive correlation structure. Bottom panels shown the component smooth function for depth (left), and the model predictions for the sea state interactions, with darker colour indicating a lower value. For the model predictions, depth was fixed to its median value.

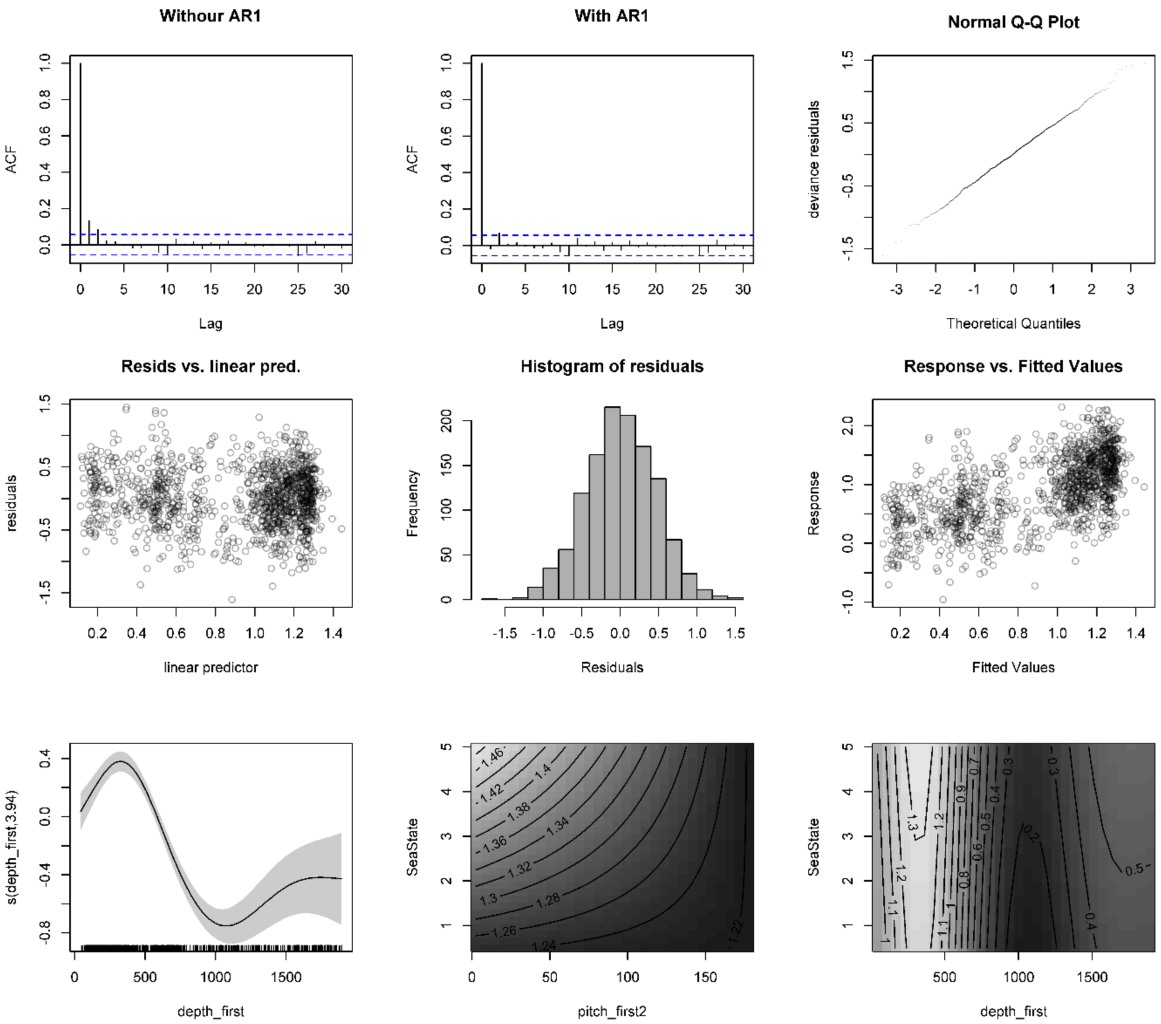

Figure S5. Model diagnostics and estimates for non-exposure model for Log(ODBA). Depth is labelled as "depth_first", surface angle is labelled as "pitch_first2". ACF = autocorrelation function, AR1 = 1st-order autoregressive correlation structure. Bottom panels shown the component smooth function for depth (left), and the model predictions for the sea state interactions, with darker colour indicating a lower value. For the model predictions, depth was fixed to its median value.

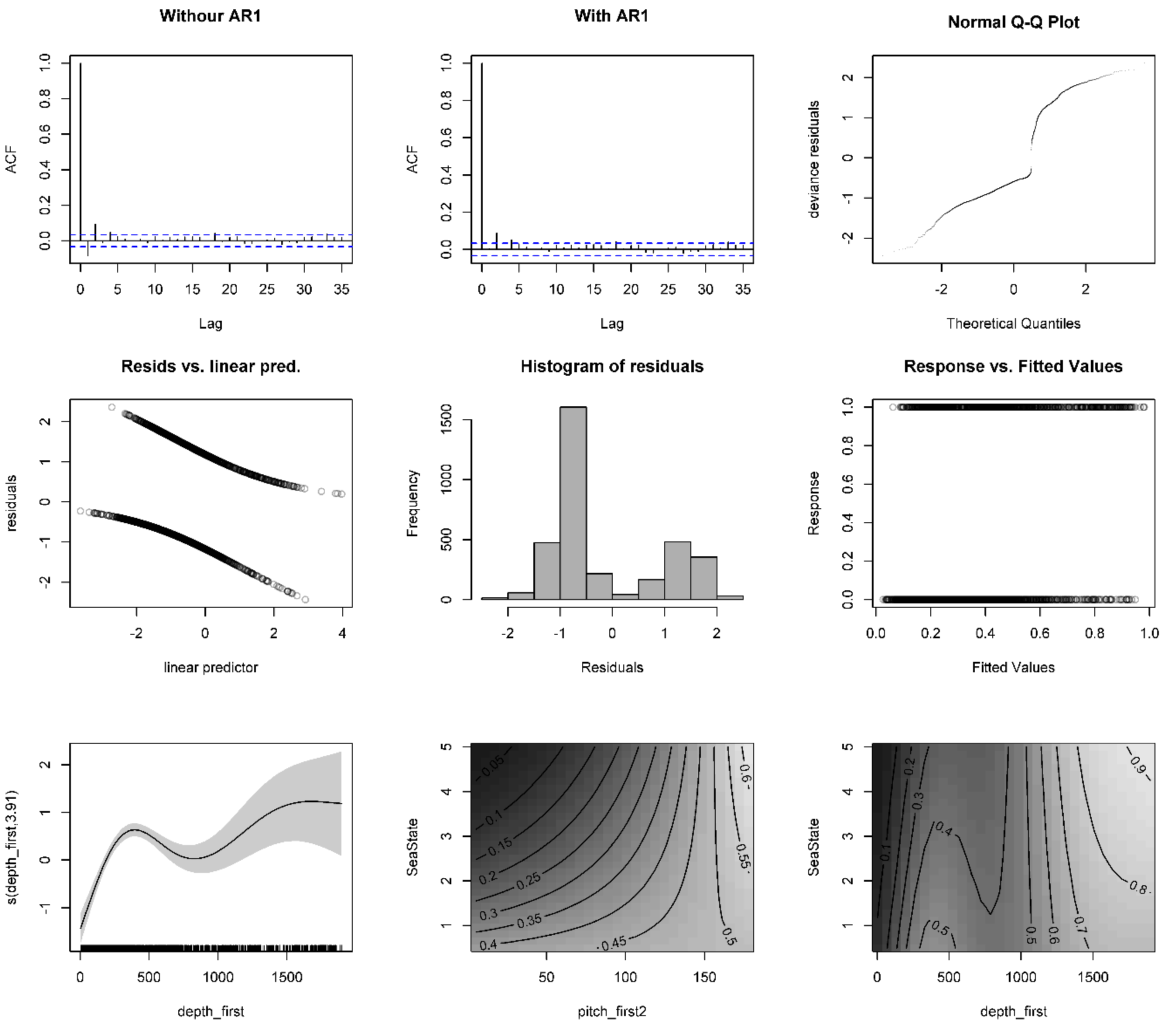

Figure S6. Model diagnostics and estimates for non-exposure model for Buzz. Depth is labelled as “depth_first”, surface angle is labelled as “pitch_first2”. ACF = autocorrelation function, AR1 = 1st-order autoregressive correlation structure. Bottom panels shown the component smooth function for depth (left), and the model predictions for the sea state interactions, with darker colour indicating a lower value. For the model predictions, depth was fixed to its median value.

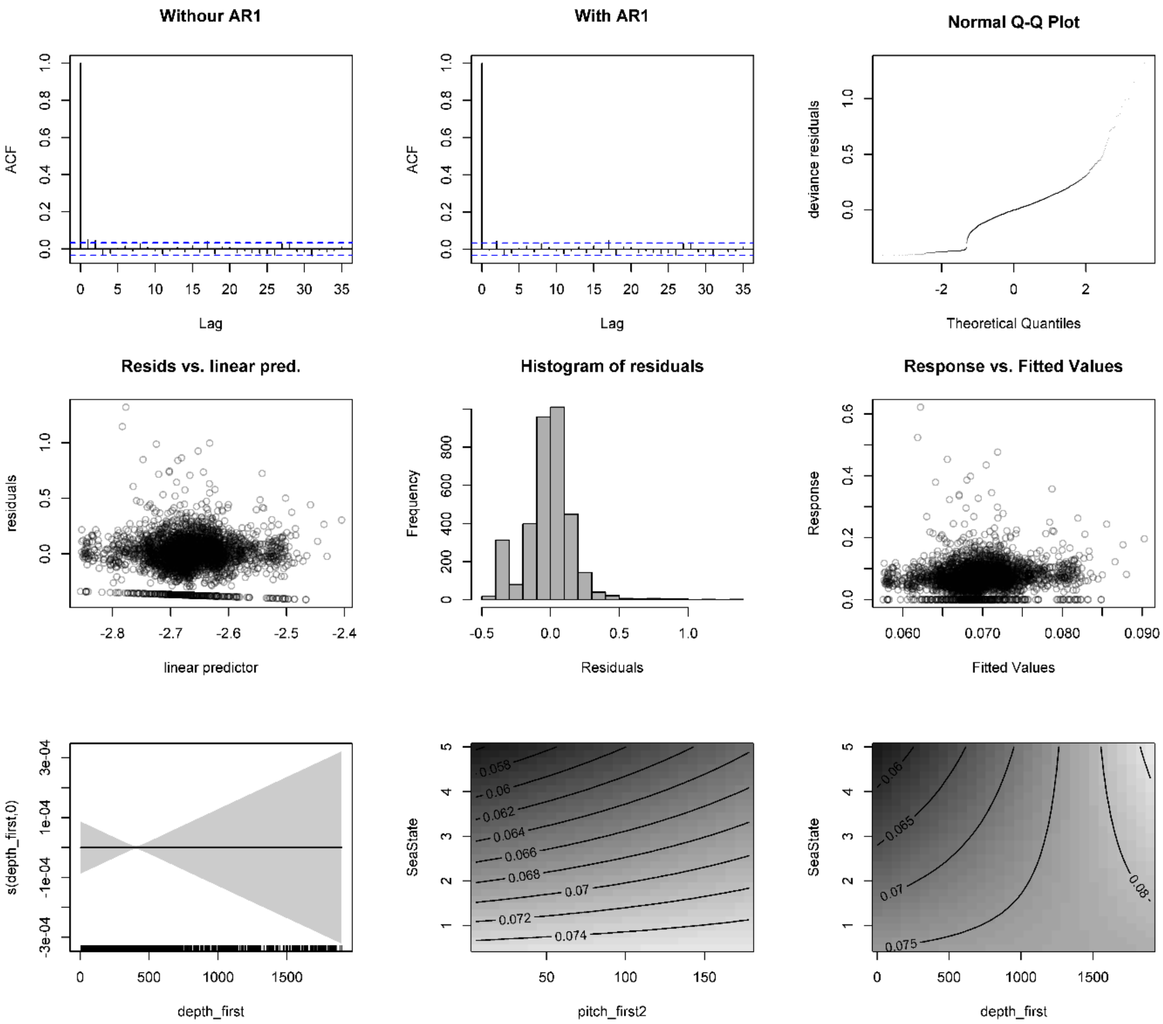

Figure S7. Model diagnostics and estimates for non-exposure model for fluke stroke rate ("fluker", per second). Depth is labelled as "depth_first", surface angle is labelled as "pitch_first2". ACF = autocorrelation function, AR1 = 1st-order autoregressive correlation structure. Bottom panels shown the component smooth function for depth (left), and the model predictions for the sea state interactions, with darker colour indicating a lower value. For the model predictions, depth was fixed to its median value.

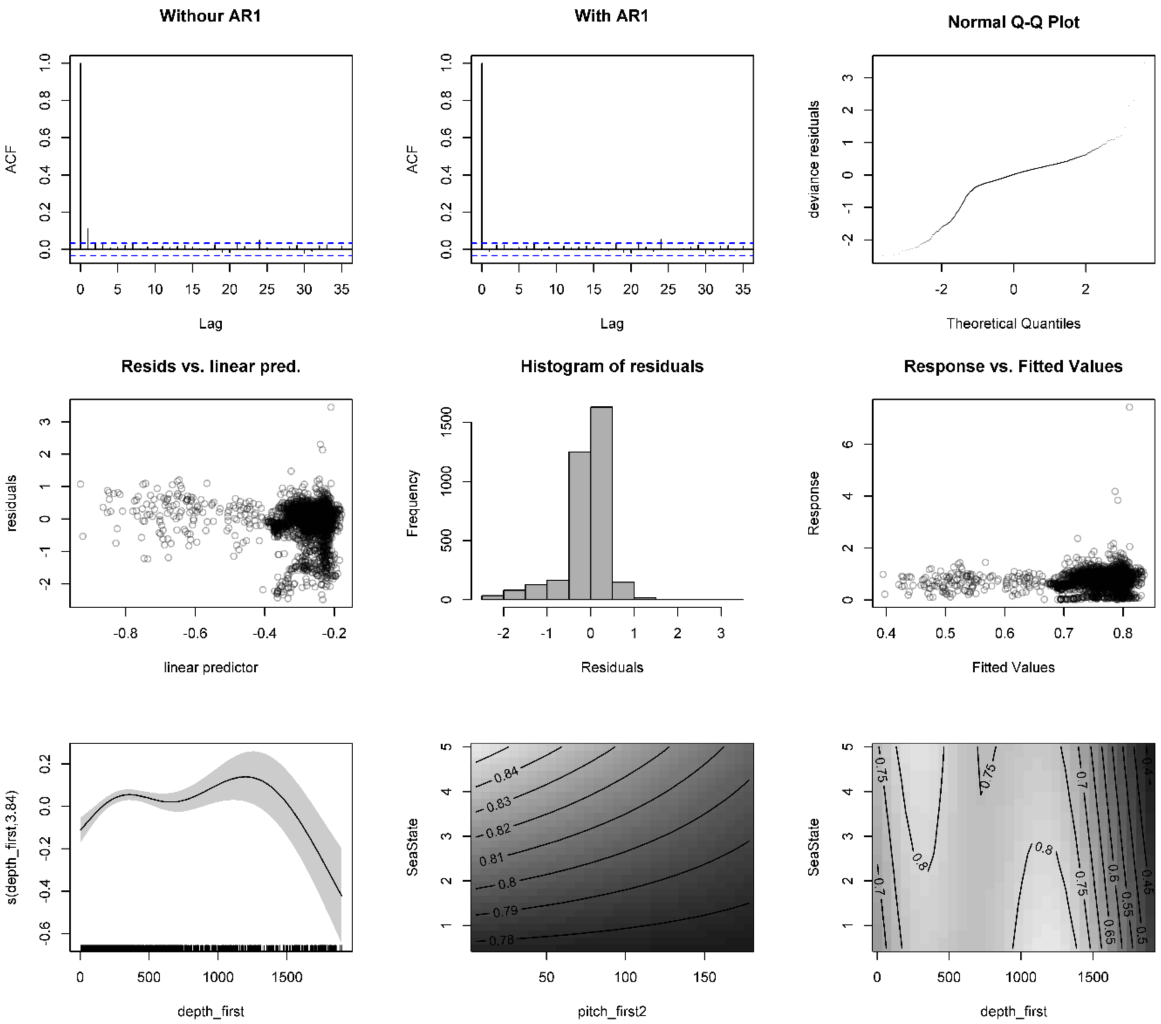

Figure S8. Model diagnostics and estimates for non-exposure model for ICI. Depth is labelled as "depth_first", surface angle is labelled as "pitch_first2". ACF = autocorrelation function, AR1 = 1st-order autoregressive correlation structure. Bottom panels shown the component smooth function for depth (left), and the model predictions for the sea state interactions, with darker colour indicating a lower value. For the model predictions, depth was fixed to its median value.

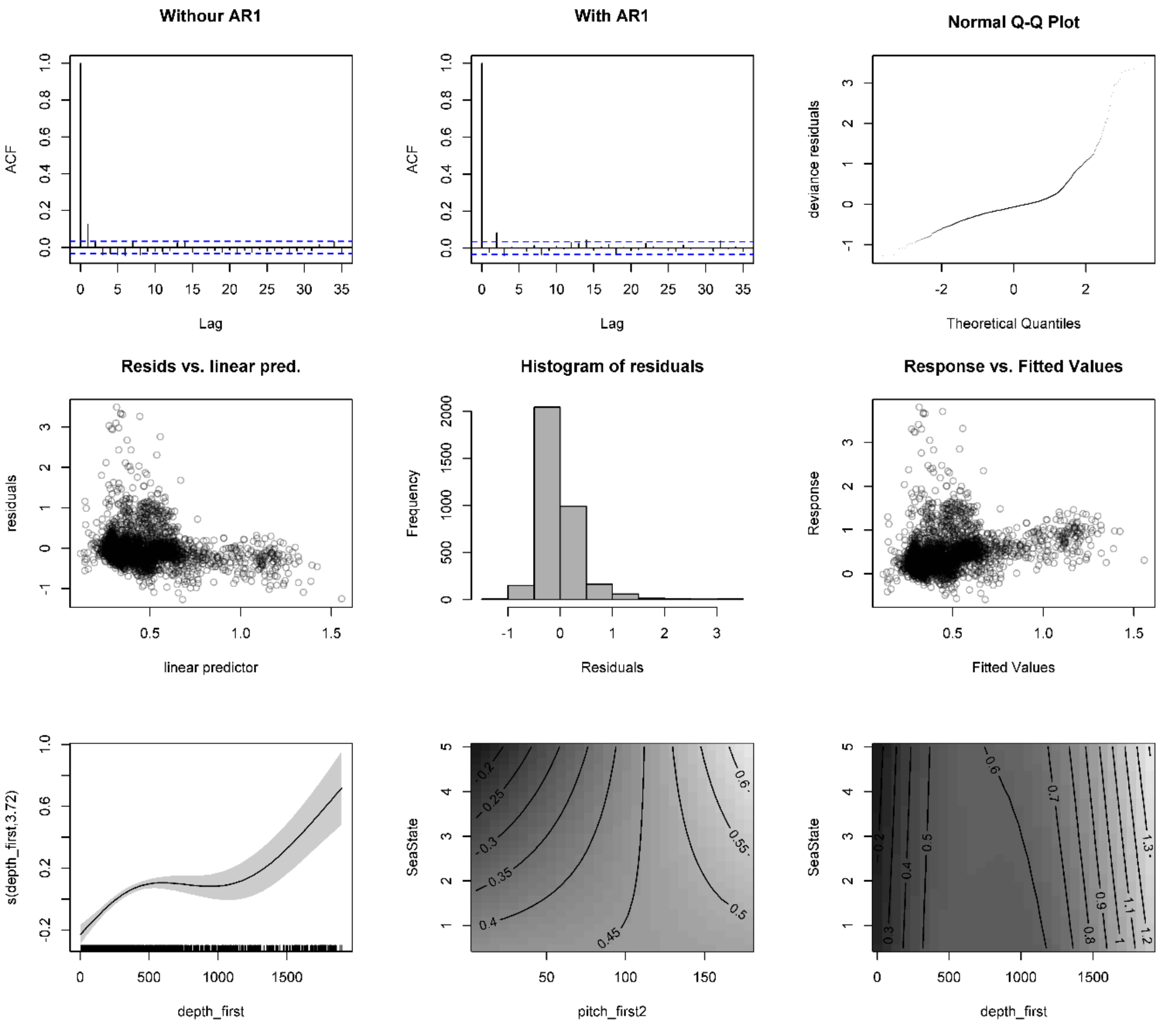

Figure S9. Model diagnostics and estimates for non-exposure model for log(CR). Depth is labelled as "depth_first", surface angle is labelled as "pitch_first2". ACF = autocorrelation function, AR1 = 1st-order autoregressive correlation structure. Bottom panels shown the component smooth function for depth (left), and the model predictions for the sea state interactions, with darker colour indicating a lower value. For the model predictions, depth was fixed to its median value.

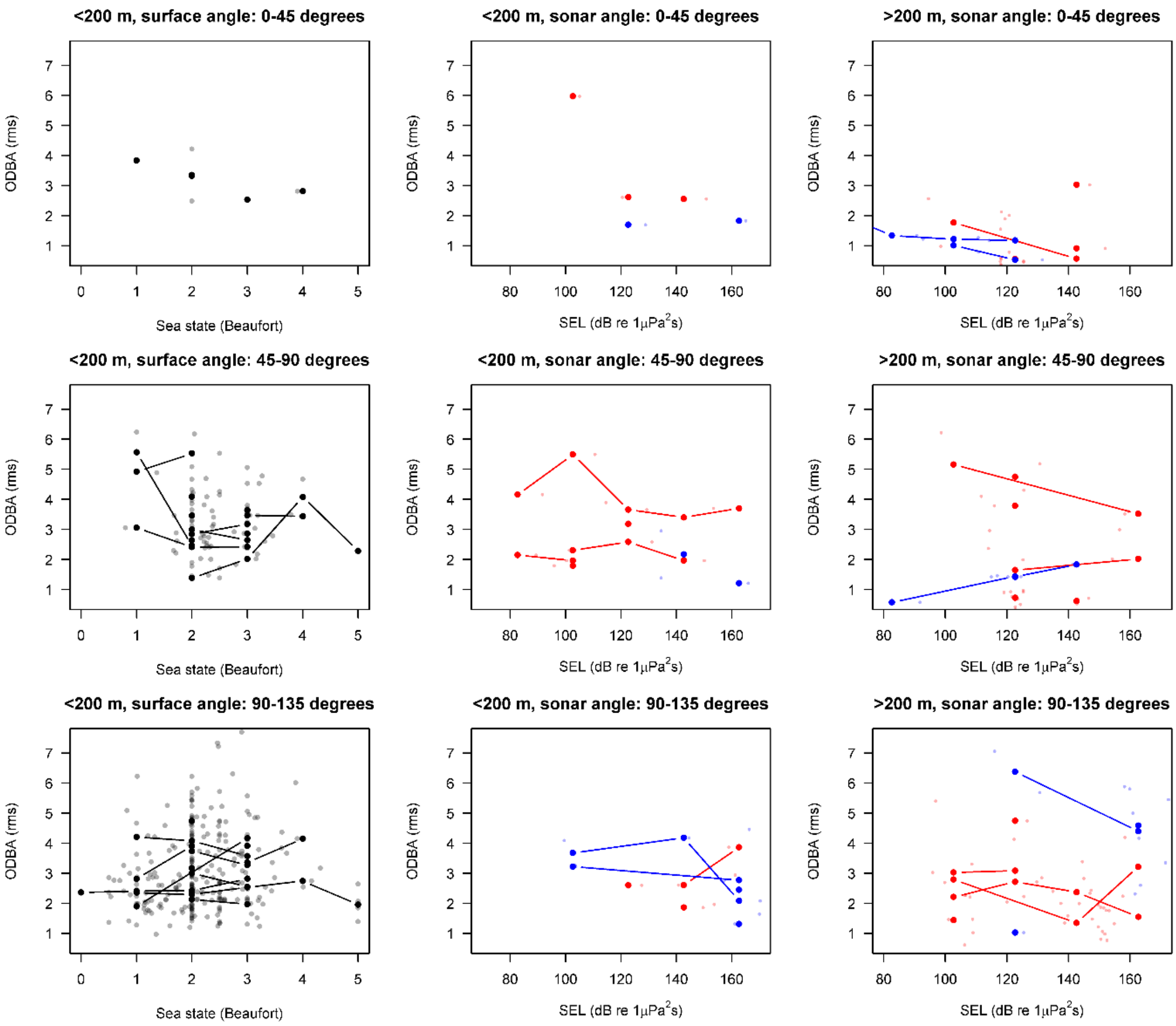

Figure S10. Root-mean square ODBA of buzzes within each tag deployment (connected lines) as a function of sea state and received sound exposure level (SEL) from exposures, at different depths, surface and sonar angle (Blue = CAS continuous active sonar, Red = PAS pulsed active sonar). Transparent symbols show raw dat, solid symbols averages within sea state and SEL bins.

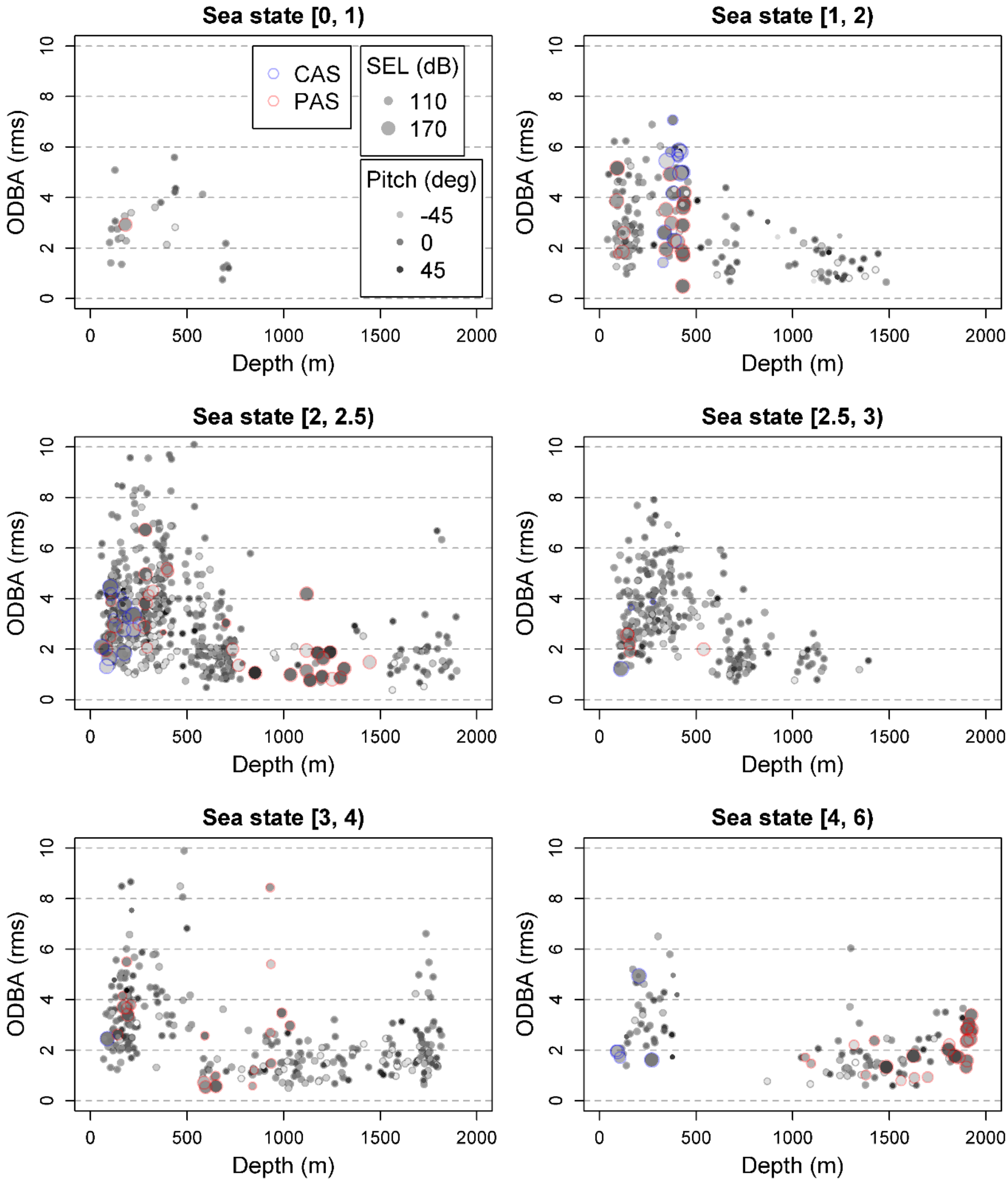

Figure S11. Root-mean-square of ODBA of buzzes at different sea states and pitch angles both during exposure and non-exposure periods (CAS = continuous active sonar, PAS = pulsed active sonar).

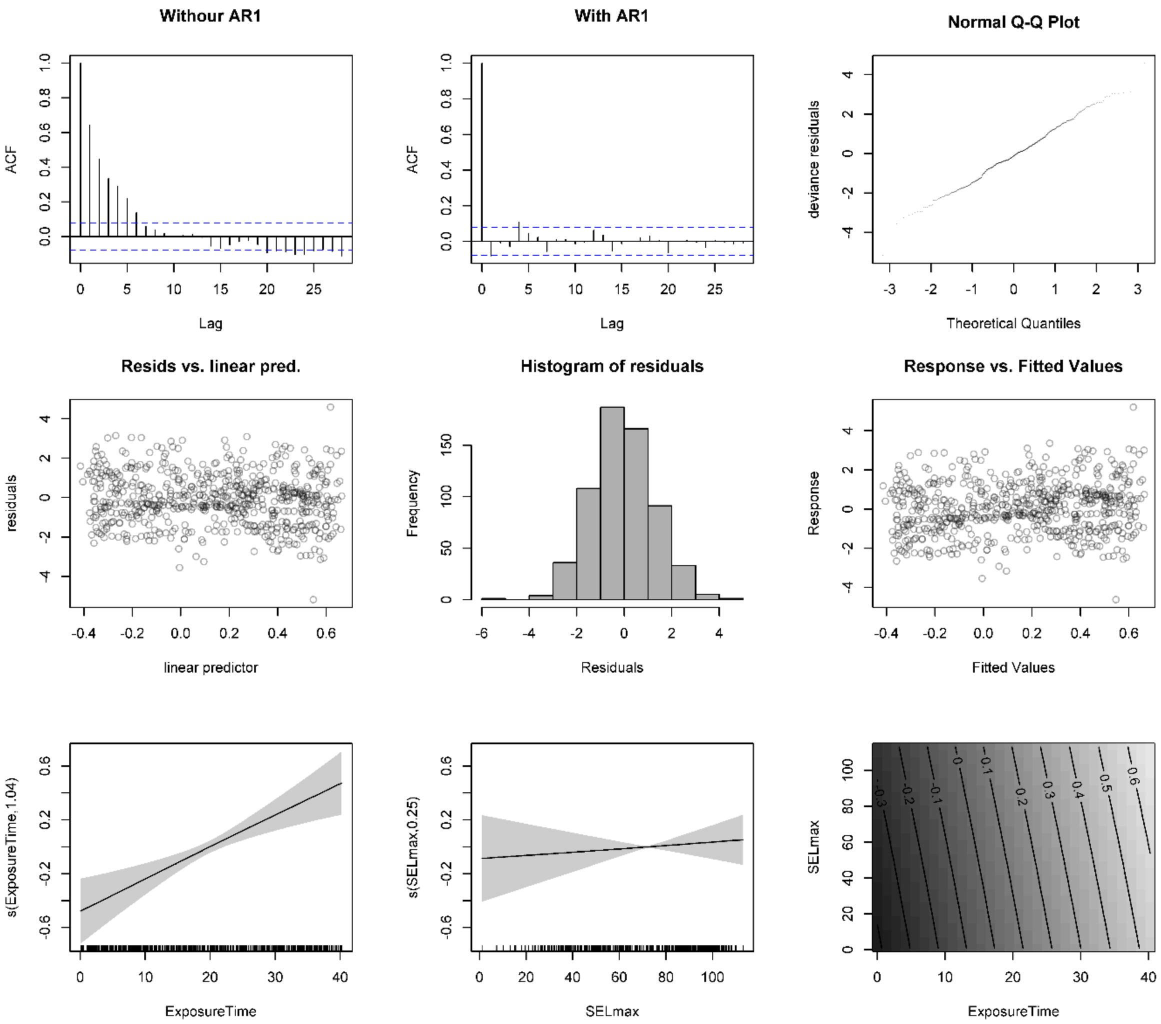

Figure S12. Model diagnostics and estimates for log(sonar angle proportion). ExposureTime = time since start of no-sonar or sonar exposure. ACF = autocorrelation function, AR1 = 1st-order autoregressive correlation structure. Bottom panels show the component smooth functions (left, middle) and model predictions (right) at the log-scale.

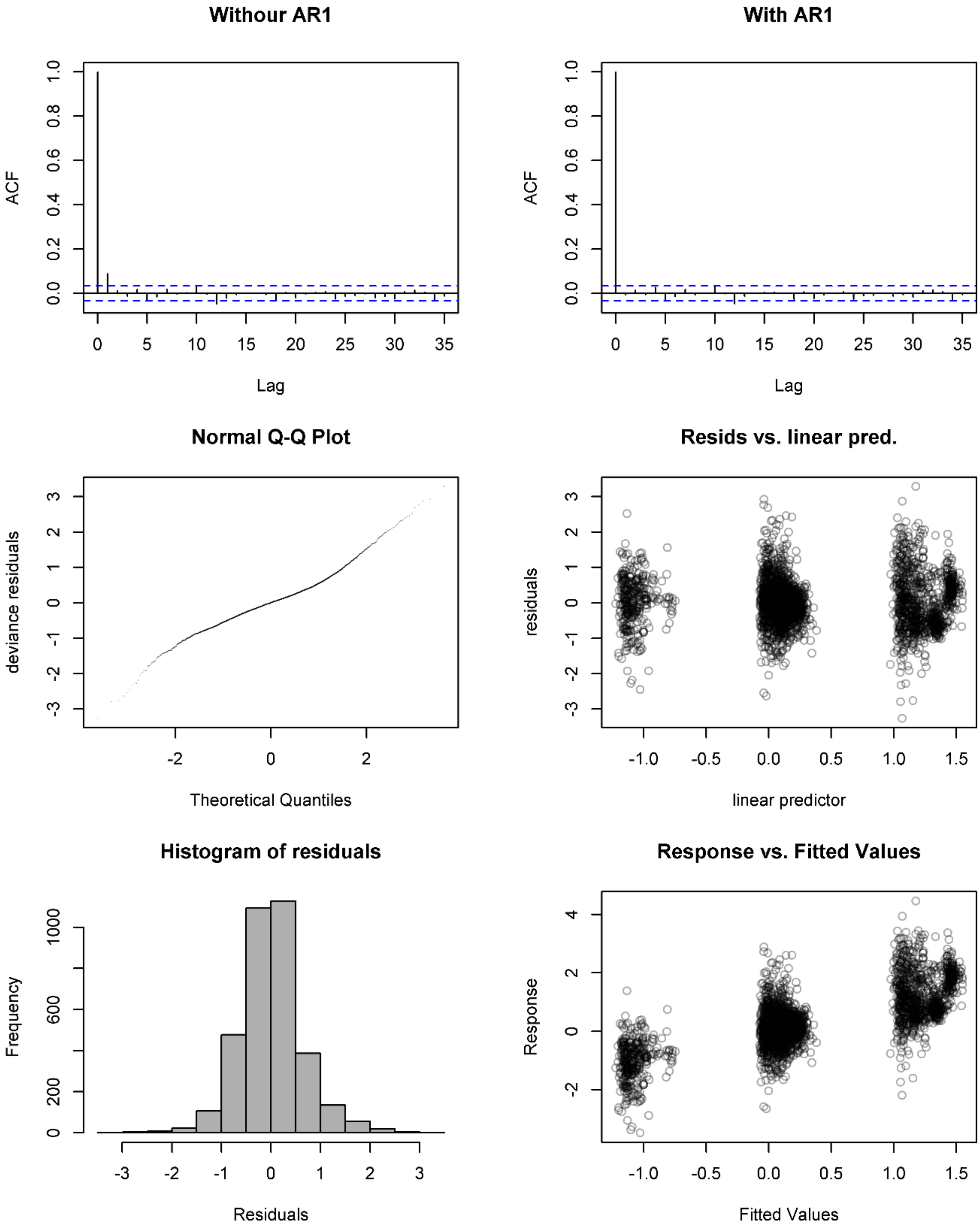

Figure S13. Model diagnostics and estimates for log(surface angle proportion). ACF = autocorrelation function, AR1 = 1st-order autoregressive correlation structure. Bottom panels shown the component smooth functions (left, middle) and model predictions (right) at the log-scale.

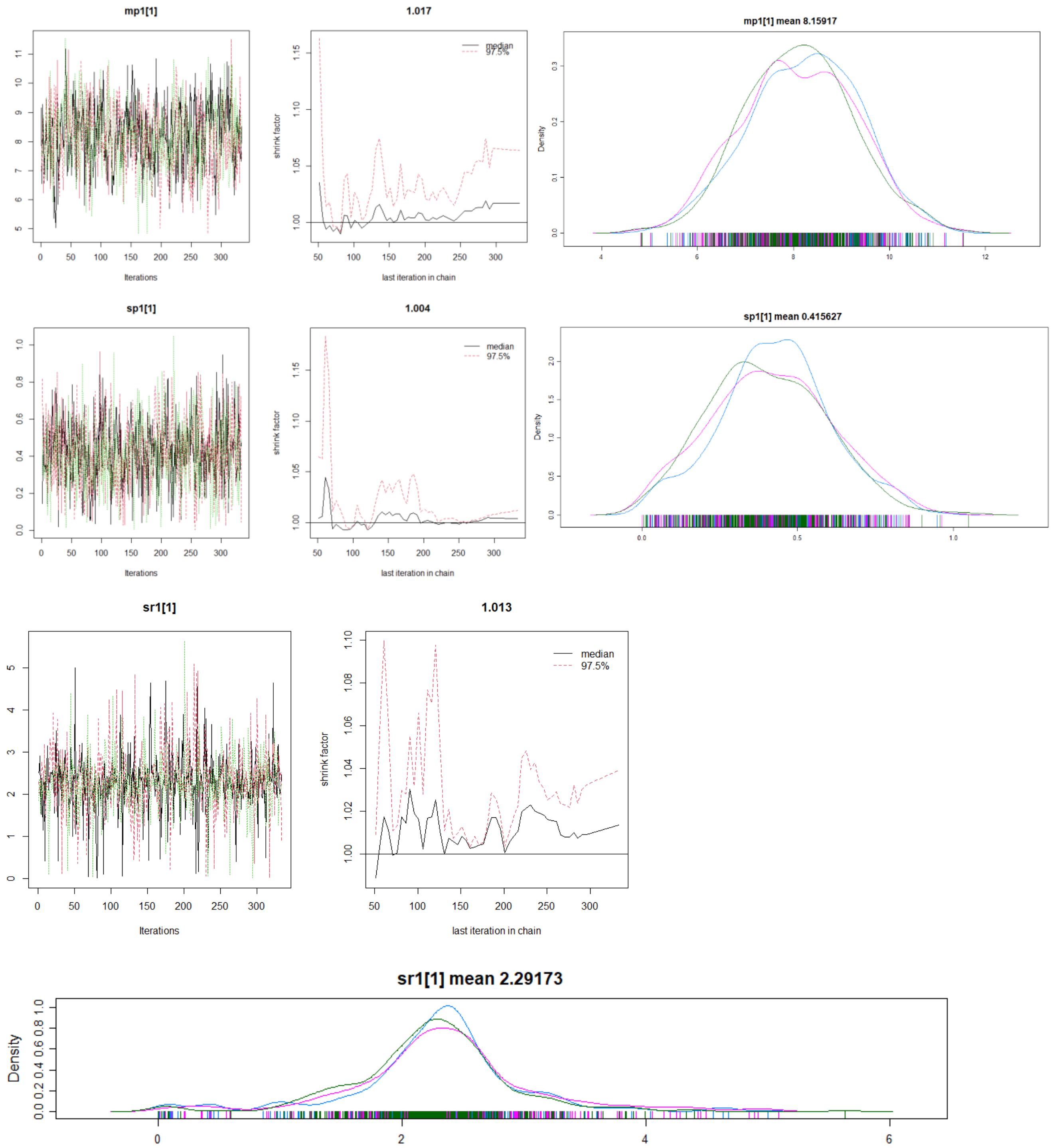

Figure S14. Posterior trace histories and Gelman-rubin diagnostics for the key parameters of the full AOL_{zp} model (Model 9, Table S1). mp1 = masking potential from sea state, sp1 = masking potential from received SEL, sr1 = masking release from sonar angle.

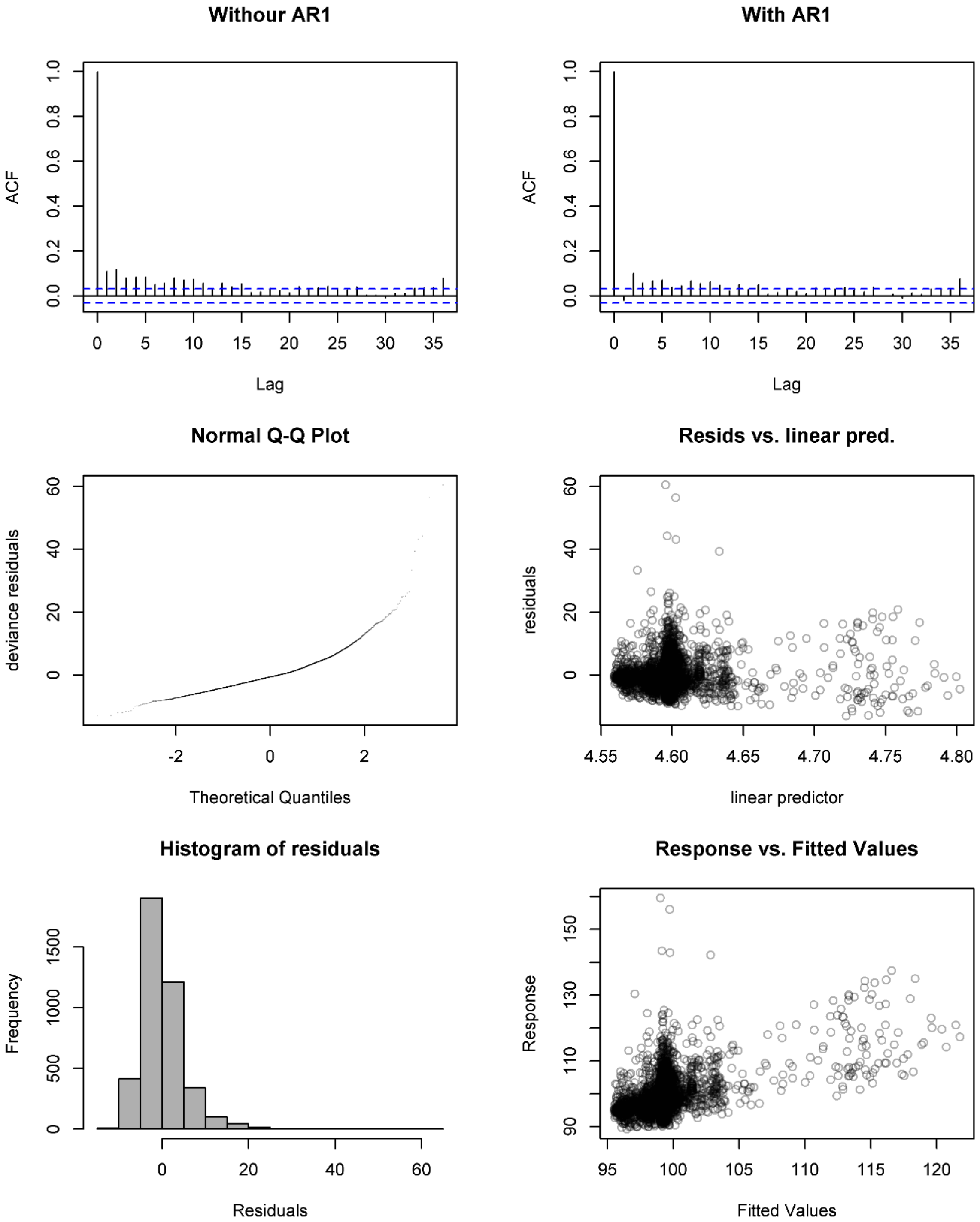

Figure S15. Model diagnostics for the pre-train noise metric (SPL_{rms}).

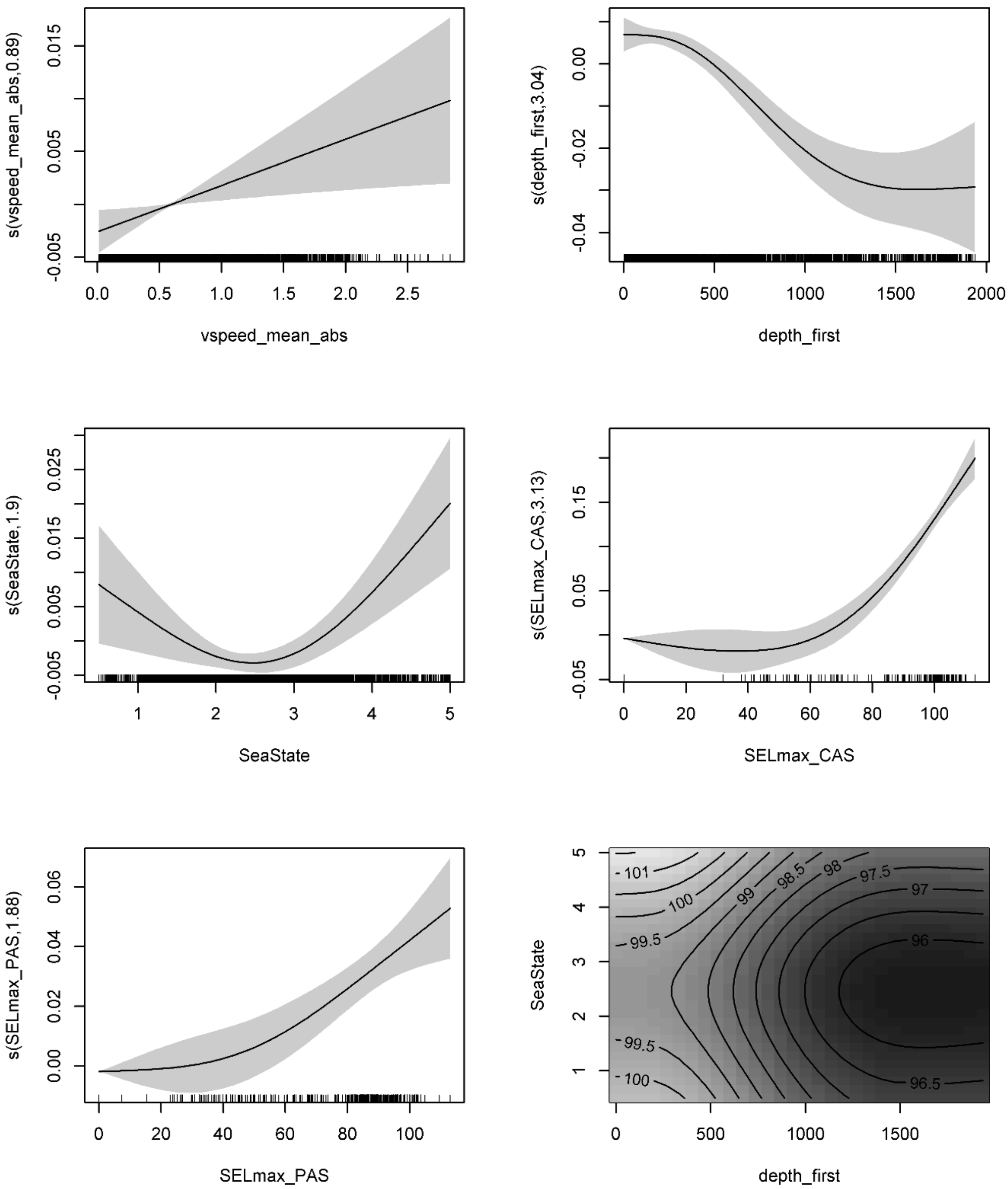

Figure S16. Smooth estimates for the pre-train noise metric (SPL_{rms}). vspeed_mean_abs = mean vertical speed during the click trian. Bottom-right contour plot shows model predictions at response scale.

Table S2. Mean and standard deviation (in brackets) calculated across tag deployment means during different Beaufort sea states (SS; baseline/post-exposure data) and experimental conditions. Note that the values include variation due to dive depth (bottom row) and received SEL; please see Table 4 for the summary statistics excluding data from > 500 m.

Data	Variable	SS ≤ 2	SS 3	SS ≥ 4	No-sonar	MPAS	HPAS	CAS
Buzzes	Pause (%)	47.3 (31)	30 (29.7)	18.3 (25.8)	38.7 (33.9)	52.2 (35.8)	34.6 (30.1)	14.7 (17.3)
	Duration (s)	17.1 (6.8)	16.8 (6.3)	12.3 (7.2)	15.6 (7.8)	13.8 (6.1)	15.7 (7.7)	16 (5.6)
	ODBA (unitless)	2.92 (0.78)	3.31 (0.94)	2.6 (1.14)	2.99 (1)	2.71 (1.08)	2.72 (0.9)	2.99 (1.4)
Regular click trains	Buzz (%)	26.8 (12.3)	28.8 (12.2)	36.5 (22)	29.5 (8.5)	23.1 (21)	27.2 (22.3)	22.9 (10.5)
	AOL * (dB)	182.4 (5.5)	178.8 (6.9)	176.6 (10.5)	181.4 (5.9)	179.9 (7.2)	179.4 (8.8)	179.5 (8.4)
	Stroke rate (/min)	4.3 (1.1)	4.1 (0.7)	4.3 (0.2)	4.4 (0.8)	4.2 (0.7)	4.1 (1.5)	3.8 (0.7)
	ICI (s)	0.86 (0.25)	0.75 (0.11)	0.79 (0.15)	0.81 (0.08)	0.8 (0.16)	0.79 (0.24)	0.75 (0.18)
	CR (/s)	1.43 (0.31)	1.88 (0.5)	2.44 (0.99)	1.68 (0.56)	1.68 (0.45)	1.69 (0.58)	1.64 (0.52)
	Surface angle (°)	107.2 (20.7)	100.6 (3.2)	103.1 (1)	102.3 (10.6)	97.8 (8.4)	96.7 (12)	101 (7.1)
	Sonar angle (°)	98.9 (14.4)	92.1 (22.9)	107.4 (15.5)	97.2 (34.8)	91.2 (33.3)	96.5 (41.9)	97 (36.5)
	Depth (m)	283 (164)	351 (370)	701 (776)	353 (371)	362 (342)	388 (461)	226 (208)

* Clipped values included

Table S3. Full exposure models and associated Wald- or Wald-like tests. Note that parametric estimates (Est) are given at link scale, and for smooth covariates, estimated degrees of freedom (EDF) are provided instead. SE = standard error.

Model	Response	Covariates	Est/EDF	SE	t-value	p-value
1	buzz	(Intercept)	-0.418	0.206	-2.029	0.042
	buzz	SeaState	-0.739	0.100	-7.393	0.000
	buzz	NS	-0.002	0.178	-0.014	0.989
	buzz	SELmax	-0.010	0.004	-2.257	0.024
	buzz	SeaState:surface_angle	0.004	0.000	10.398	0.000
	buzz	SeaState:depth_first	0.000	0.000	3.385	0.001
	buzz	SELmax:sonar_angle	0.000	0.000	1.558	0.119
	buzz	s(depth_first)	3.917	4.000	32.522	0.000

2	buzz	(Intercept)	-0.442	0.205	-2.152	0.031
	buzz	SeaState	-0.731	0.100	-7.322	0.000
	buzz	NS	0.009	0.178	0.050	0.960
	buzz	SELmax2	-0.007	0.003	-2.607	0.009
	buzz	SeaState:surface_angle	0.004	0.000	10.408	0.000
	buzz	SeaState:depth_first	0.000	0.000	3.326	0.001
	buzz	s(depth_first)	3.916	4.000	32.574	0.000
3	buzz	(Intercept)	-0.424	0.207	-2.051	0.040
	buzz	SeaState	-0.736	0.100	-7.356	0.000
	buzz	NS	-0.003	0.178	-0.015	0.988
	buzz	SELmax_CAS	-0.003	0.008	-0.404	0.686
	buzz	SELmax_PAS	-0.012	0.005	-2.356	0.019
	buzz	SeaState:surface_angle	0.004	0.000	10.382	0.000
	buzz	SeaState:depth_first	0.000	0.000	3.392	0.001
	buzz	SELmax_CAS:sonar_angle	0.000	0.000	0.039	0.969
	buzz	SELmax_PAS:sonar_angle	0.000	0.000	1.762	0.078
	buzz	s(depth_first)	3.917	4.000	32.543	0.000
4	buzz	(Intercept)	-0.444	0.206	-2.160	0.031
	buzz	SeaState	-0.730	0.100	-7.309	0.000
	buzz	NS	0.009	0.178	0.050	0.960
	buzz	SELmax_CASF	-0.005	0.005	-1.036	0.300
	buzz	SELmax_PASF	-0.008	0.003	-2.440	0.015
	buzz	SeaState:surface_angle	0.004	0.000	10.399	0.000
	buzz	SeaState:depth_first	0.000	0.000	3.336	0.001
	buzz	s(depth_first)	3.916	4.000	32.594	0.000
5	buzz	(Intercept)	-0.426	0.206	-2.070	0.039
	buzz	SeaState	-0.750	0.100	-7.512	0.000
	buzz	NS	0.002	0.178	0.014	0.989
	buzz	SeaState:surface_angle	0.004	0.000	10.433	0.000
	buzz	SeaState:depth_first	0.000	0.000	3.406	0.001
	buzz	s(depth_first)	3.918	4.000	32.809	0.000
	buzz	ti(SELmax)	0.829	2.000	2.388	0.016
	buzz	ti(SELmax,Angle)	0.000	4.000	0.000	0.854
6	buzz	(Intercept)	-0.326	0.238	-1.367	0.172
	buzz	SeaState	-0.827	0.119	-6.937	0.000
	buzz	NS	-0.091	0.193	-0.472	0.637
	buzz	SeaState:surface_angle	0.005	0.000	9.638	0.000
	buzz	SeaState:depth_first	0.000	0.000	3.860	0.000
	buzz	s(depth_first)	3.896	4.000	23.706	0.000
	buzz	ti(SELmax_CAS)	0.128	2.000	0.074	0.283
	buzz	ti(SELmax_CAS,Angle)	0.000	4.000	0.000	0.528
	buzz	ti(SELmax_PAS)	0.607	2.000	0.776	0.110
	buzz	ti(SELmax_PAS,Angle)	0.000	4.000	0.000	0.507
7	CR_log	(Intercept)	0.499	0.053	9.368	0.000
	CR_log	SeaState	-0.080	0.019	-4.159	0.000
	CR_log	NS	0.001	0.039	0.034	0.973

	CR_log	SELmax	-0.001	0.001	-1.814	0.070
	CR_log	SeaState:surface_angle	0.001	0.000	8.096	0.000
	CR_log	SeaState:depth_first	0.000	0.000	0.938	0.348
	CR_log	SELmax:sonar_angle	0.000	0.000	1.294	0.196
	CR_log	s(depth_first)	3.714	4.000	22.491	0.000
8	CR_log	(Intercept)	0.498	0.053	9.357	0.000
	CR_log	SeaState	-0.080	0.019	-4.172	0.000
	CR_log	NS	0.003	0.039	0.068	0.946
	CR_log	SELmax2	-0.001	0.000	-1.604	0.109
	CR_log	SeaState:surface_angle	0.001	0.000	8.132	0.000
	CR_log	SeaState:depth_first	0.000	0.000	0.931	0.352
	CR_log	s(depth_first)	3.713	4.000	22.533	0.000
9	CR_log	(Intercept)	0.498	0.053	9.329	0.000
	CR_log	SeaState	-0.080	0.019	-4.174	0.000
	CR_log	NS	0.001	0.039	0.030	0.976
	CR_log	SELmax_CAS	-0.001	0.001	-0.416	0.678
	CR_log	SELmax_PAS	-0.002	0.001	-1.936	0.053
	CR_log	SeaState:surface_angle	0.001	0.000	8.091	0.000
	CR_log	SeaState:depth_first	0.000	0.000	1.005	0.315
	CR_log	SELmax_CAS:sonar_angle	0.000	0.000	0.329	0.742
	CR_log	SELmax_PAS:sonar_angle	0.000	0.000	1.277	0.202
	CR_log	s(depth_first)	3.714	4.000	22.537	0.000
10	CR_log	(Intercept)	0.498	0.053	9.361	0.000
	CR_log	SeaState	-0.080	0.019	-4.171	0.000
	CR_log	NS	0.003	0.039	0.069	0.945
	CR_log	SELmax_CASF	-0.001	0.001	-1.102	0.271
	CR_log	SELmax_PASF	-0.001	0.001	-1.202	0.230
	CR_log	SeaState:surface_angle	0.001	0.000	8.132	0.000
	CR_log	SeaState:depth_first	0.000	0.000	0.922	0.357
	CR_log	s(depth_first)	3.713	4.000	22.518	0.000
11	CR_log	(Intercept)	0.499	0.053	9.382	0.000
	CR_log	SeaState	-0.082	0.019	-4.267	0.000
	CR_log	NS	0.003	0.039	0.065	0.948
	CR_log	SeaState:surface_angle	0.001	0.000	8.151	0.000
	CR_log	SeaState:depth_first	0.000	0.000	0.954	0.340
	CR_log	s(depth_first)	3.716	4.000	22.552	0.000
	CR_log	ti(SELmax)	0.562	2.000	0.642	0.131
	CR_log	ti(SELmax,Angle)	0.000	4.000	0.000	0.382
12	CR_log	(Intercept)	0.496	0.053	9.301	0.000
	CR_log	SeaState	-0.081	0.019	-4.227	0.000
	CR_log	NS	0.003	0.039	0.068	0.946
	CR_log	SeaState:surface_angle	0.001	0.000	8.136	0.000
	CR_log	SeaState:depth_first	0.000	0.000	0.997	0.319
	CR_log	s(depth_first)	3.716	4.000	22.699	0.000
	CR_log	ti(SELmax_CAS)	0.000	2.000	0.000	0.629
	CR_log	ti(SELmax_CAS,Angle)	1.307	4.000	0.798	0.088

	CR_log	ti(SELmax_PAS)	0.676	2.000	1.046	0.079
	CR_log	ti(SELmax_PAS,Angle)	0.000	4.000	0.000	0.376
13	duration_log	(Intercept)	2.458	0.083	29.559	0.000
	duration_log	SeaState	-0.046	0.042	-1.105	0.269
	duration_log	NS	0.080	0.075	1.062	0.288
	duration_log	SELmax	0.003	0.002	1.586	0.113
	duration_log	SeaState:surface_angle	0.000	0.000	1.206	0.228
	duration_log	SeaState:depth_first	0.000	0.000	1.402	0.161
	duration_log	SELmax:sonar_angle	0.000	0.000	-1.922	0.055
	duration_log	s(depth_first)	3.968	4.000	86.529	0.000
14	duration_log	(Intercept)	2.454	0.083	29.591	0.000
	duration_log	SeaState	-0.043	0.042	-1.026	0.305
	duration_log	NS	0.082	0.075	1.089	0.276
	duration_log	SELmax2	0.000	0.001	0.339	0.735
	duration_log	SeaState:surface_angle	0.000	0.000	1.212	0.226
	duration_log	SeaState:depth_first	0.000	0.000	1.295	0.196
	duration_log	s(depth_first)	3.967	4.000	84.903	0.000
15	duration_log	(Intercept)	2.460	0.083	29.661	0.000
	duration_log	SeaState	-0.048	0.042	-1.153	0.249
	duration_log	NS	0.081	0.075	1.078	0.281
	duration_log	SELmax_CAS	-0.005	0.004	-1.401	0.161
	duration_log	SELmax_PAS	0.005	0.002	2.536	0.011
	duration_log	SeaState:surface_angle	0.000	0.000	1.287	0.198
	duration_log	SeaState:depth_first	0.000	0.000	1.353	0.176
	duration_log	SELmax_CAS:sonar_angle	0.000	0.000	1.273	0.203
	duration_log	SELmax_PAS:sonar_angle	0.000	0.000	-2.851	0.004
	duration_log	s(depth_first)	3.968	4.000	86.928	0.000
16	duration_log	(Intercept)	2.448	0.083	29.552	0.000
	duration_log	SeaState	-0.038	0.042	-0.911	0.363
	duration_log	NS	0.083	0.075	1.103	0.270
	duration_log	SELmax_CASF	-0.006	0.003	-2.234	0.026
	duration_log	SELmax_PASF	0.002	0.001	1.463	0.144
	duration_log	SeaState:surface_angle	0.000	0.000	1.266	0.206
	duration_log	SeaState:depth_first	0.000	0.000	1.095	0.274
	duration_log	s(depth_first)	3.967	4.000	84.945	0.000
17	duration_log	(Intercept)	2.453	0.083	29.563	0.000
	duration_log	SeaState	-0.041	0.042	-0.985	0.325
	duration_log	NS	0.081	0.075	1.087	0.277
	duration_log	SeaState:surface_angle	0.000	0.000	1.156	0.248
	duration_log	SeaState:depth_first	0.000	0.000	1.295	0.195
	duration_log	s(depth_first)	3.968	4.000	86.118	0.000
	duration_log	ti(SELmax)	0.000	2.000	0.000	0.718
	duration_log	ti(SELmax,Angle)	0.905	4.000	0.541	0.095
18	duration_log	(Intercept)	2.455	0.083	29.573	0.000
	duration_log	SeaState	-0.043	0.042	-1.036	0.300
	duration_log	NS	0.082	0.075	1.098	0.272

	duration_log	SeaState:surface_angle	0.000	0.000	1.134	0.257
	duration_log	SeaState:depth_first	0.000	0.000	1.372	0.170
	duration_log	s(depth_first)	3.959	4.000	87.146	0.000
	duration_log	ti(SELmax_CAS)	0.000	2.000	0.000	0.501
	duration_log	ti(SELmax_CAS,Angle)	0.000	4.000	0.000	0.535
	duration_log	ti(SELmax_PAS)	0.000	2.000	0.000	0.783
	duration_log	ti(SELmax_PAS,Angle)	1.358	4.000	1.428	0.017
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19	fluker	(Intercept)	-2.589	0.058	44.472	0.000
	fluker	SeaState	-0.057	0.023	-2.446	0.014
	fluker	NS	0.053	0.054	0.983	0.326
	fluker	SELmax	0.000	0.001	-0.442	0.659
	fluker	SeaState:surface_angle	0.000	0.000	0.857	0.391
	fluker	SeaState:depth_first	0.000	0.000	3.282	0.001
	fluker	SELmax:sonar_angle	0.000	0.000	-0.058	0.954
	fluker	s(depth_first)	0.000	4.000	0.000	0.170
					-	
20	fluker	(Intercept)	-2.591	0.058	44.591	0.000
	fluker	SeaState	-0.057	0.023	-2.455	0.014
	fluker	NS	0.057	0.054	1.051	0.293
	fluker	SELmax2	0.000	0.001	-0.486	0.627
	fluker	SeaState:surface_angle	0.000	0.000	0.879	0.380
	fluker	SeaState:depth_first	0.000	0.000	3.277	0.001
	fluker	s(depth_first)	0.000	4.000	0.000	0.144
					-	
21	fluker	(Intercept)	-2.590	0.058	44.395	0.000
	fluker	SeaState	-0.056	0.023	-2.415	0.016
	fluker	NS	0.053	0.054	0.976	0.329
	fluker	SELmax_CAS	0.002	0.002	1.323	0.186
	fluker	SELmax_PAS	-0.002	0.001	-1.341	0.180
	fluker	SeaState:surface_angle	0.000	0.000	0.818	0.414
	fluker	SeaState:depth_first	0.000	0.000	3.296	0.001
	fluker	SELmax_CAS:sonar_angle	0.000	0.000	-1.626	0.104
	fluker	SELmax_PAS:sonar_angle	0.000	0.000	0.970	0.332
	fluker	s(depth_first)	0.000	4.000	0.000	0.166
					-	
21	fluker	(Intercept)	-2.593	0.058	44.589	0.000
	fluker	SeaState	-0.056	0.023	-2.440	0.015
	fluker	NS	0.056	0.054	1.046	0.296
	fluker	SELmax_CASF	0.001	0.001	0.880	0.379
	fluker	SELmax_PASF	-0.001	0.001	-1.217	0.224
	fluker	SeaState:surface_angle	0.000	0.000	0.845	0.398
	fluker	SeaState:depth_first	0.000	0.000	3.390	0.001
	fluker	s(depth_first)	0.000	4.000	0.000	0.140
					-	
22	fluker	(Intercept)	-2.591	0.058	44.604	0.000

	fluker	SeaState	-0.057	0.023	-2.489	0.013
	fluker	NS	0.056	0.054	1.040	0.298
	fluker	SeaState:surface_angle	0.000	0.000	0.878	0.380
	fluker	SeaState:depth_first	0.000	0.000	3.287	0.001
	fluker	s(depth_first)	0.000	4.000	0.000	0.149
	fluker	ti(SELmax)	0.340	2.000	0.258	0.218
	fluker	ti(SELmax,Angle)	0.000	4.000	0.000	0.811
23	fluker	(Intercept)	-2.590	0.058	-44.614	0.000
	fluker	SeaState	-0.058	0.023	-2.510	0.012
	fluker	NS	0.058	0.054	1.067	0.286
	fluker	SeaState:surface_angle	0.000	0.000	0.889	0.374
	fluker	SeaState:depth_first	0.000	0.000	3.289	0.001
	fluker	s(depth_first)	0.000	4.000	0.000	0.140
	fluker	ti(SELmax_CAS)	0.000	2.000	0.000	0.559
	fluker	ti(SELmax_CAS,Angle)	0.000	4.000	0.000	0.314
	fluker	ti(SELmax_PAS)	0.000	2.000	0.000	0.285
	fluker	ti(SELmax_PAS,Angle)	0.000	4.000	0.000	0.242
24	ICI_first	(Intercept)	-0.339	0.049	-6.937	0.000
	ICI_first	SeaState	0.030	0.019	1.613	0.107
	ICI_first	NS	0.028	0.037	0.743	0.458
	ICI_first	SELmax	0.001	0.001	1.172	0.241
	ICI_first	SeaState:surface_angle	0.000	0.000	-1.073	0.283
	ICI_first	SeaState:depth_first	0.000	0.000	-0.089	0.929
	ICI_first	SELmax:sonar_angle	0.000	0.000	-0.119	0.905
	ICI_first	s(depth_first)	3.816	4.000	16.571	0.000
25	ICI_first	(Intercept)	-0.338	0.049	-6.879	0.000
	ICI_first	SeaState	0.031	0.019	1.636	0.102
	ICI_first	NS	0.023	0.037	0.611	0.541
	ICI_first	SELmax2	0.000	0.000	1.019	0.308
	ICI_first	SeaState:surface_angle	0.000	0.000	-1.168	0.243
	ICI_first	SeaState:depth_first	0.000	0.000	0.039	0.969
	ICI_first	s(depth_first)	3.813	4.000	15.855	0.000
26	ICI_first	(Intercept)	-0.338	0.049	-6.885	0.000
	ICI_first	SeaState	0.030	0.019	1.636	0.102
	ICI_first	NS	0.028	0.037	0.759	0.448
	ICI_first	SELmax_CAS	-0.001	0.001	-1.191	0.234
	ICI_first	SELmax_PAS	0.002	0.001	2.178	0.029
	ICI_first	SeaState:surface_angle	0.000	0.000	-1.055	0.292
	ICI_first	SeaState:depth_first	0.000	0.000	-0.231	0.818
	ICI_first	SELmax_CAS:sonar_angle	0.000	0.000	1.391	0.164
	ICI_first	SELmax_PAS:sonar_angle	0.000	0.000	-0.901	0.368
	ICI_first	s(depth_first)	3.811	4.000	16.236	0.000
27	ICI_first	(Intercept)	-0.337	0.049	-6.850	0.000
	ICI_first	SeaState	0.031	0.019	1.641	0.101
	ICI_first	NS	0.023	0.037	0.624	0.533

	ICI_first	SELmax_CASF	-0.001	0.001	-0.794	0.427
	ICI_first	SELmax_PASF	0.001	0.001	1.766	0.077
	ICI_first	SeaState:surface_angle	0.000	0.000	-1.145	0.252
	ICI_first	SeaState:depth_first	0.000	0.000	-0.030	0.976
	ICI_first	s(depth_first)	3.809	4.000	15.551	0.000
28	ICI_first	(Intercept)	-0.334	0.049	-6.839	0.000
	ICI_first	SeaState	0.030	0.019	1.637	0.102
	ICI_first	NS	0.027	0.037	0.719	0.472
	ICI_first	SeaState:surface_angle	0.000	0.000	-1.092	0.275
	ICI_first	SeaState:depth_first	0.000	0.000	-0.074	0.941
	ICI_first	s(depth_first)	3.815	4.000	16.455	0.000
	ICI_first	ti(SELmax)	0.851	2.000	2.766	0.011
	ICI_first	ti(SELmax,Angle)	0.000	4.000	0.000	0.839
29	ICI_first	(Intercept)	-0.332	0.049	-6.749	0.000
	ICI_first	SeaState	0.031	0.019	1.662	0.097
	ICI_first	NS	0.027	0.037	0.716	0.474
	ICI_first	SeaState:surface_angle	0.000	0.000	-1.116	0.264
	ICI_first	SeaState:depth_first	0.000	0.000	-0.228	0.819
	ICI_first	s(depth_first)	3.815	4.000	16.340	0.000
	ICI_first	ti(SELmax_CAS)	0.000	2.000	0.000	0.737
	ICI_first	ti(SELmax_CAS,Angle)	0.000	4.000	0.000	0.130
	ICI_first	ti(SELmax_PAS)	0.907	2.000	4.646	0.001
	ICI_first	ti(SELmax_PAS,Angle)	0.983	4.000	0.521	0.121
30	odba_log	(Intercept)	0.923	0.074	12.553	0.000
	odba_log	SeaState	0.007	0.039	0.189	0.850
	odba_log	NS	0.093	0.072	1.300	0.194
	odba_log	SELmax	-0.003	0.002	-2.047	0.041
	odba_log	SeaState:surface_angle	0.000	0.000	-1.998	0.046
	odba_log	SeaState:depth_first	0.000	0.000	1.060	0.289
	odba_log	SELmax:sonar_angle	0.000	0.000	1.904	0.057
	odba_log	s(depth_first)	3.937	4.000	68.070	0.000
31	odba_log	(Intercept)	0.919	0.073	12.503	0.000
	odba_log	SeaState	0.010	0.039	0.263	0.793
	odba_log	NS	0.092	0.071	1.296	0.195
	odba_log	SELmax2	-0.003	0.001	-2.591	0.010
	odba_log	SeaState:surface_angle	0.000	0.000	-2.036	0.042
	odba_log	SeaState:depth_first	0.000	0.000	1.048	0.295
	odba_log	s(depth_first)	3.939	4.000	70.222	0.000
32	odba_log	(Intercept)	0.925	0.074	12.548	0.000
	odba_log	SeaState	0.005	0.039	0.121	0.904
	odba_log	NS	0.094	0.072	1.316	0.188
	odba_log	SELmax_CAS	-0.008	0.003	-2.339	0.019
	odba_log	SELmax_PAS	-0.002	0.002	-1.137	0.256
	odba_log	SeaState:surface_angle	0.000	0.000	-1.963	0.050
	odba_log	SeaState:depth_first	0.000	0.000	1.112	0.266
	odba_log	SELmax_CAS:sonar_angle	0.000	0.000	2.418	0.016

	odba_log	SELmax_PAS:sonar_angle	0.000	0.000	0.869	0.385
	odba_log	s(depth_first)	3.937	4.000	68.184	0.000
33	odba_log	(Intercept)	0.915	0.074	12.439	0.000
	odba_log	SeaState	0.014	0.039	0.356	0.722
	odba_log	NS	0.093	0.071	1.302	0.193
	odba_log	SELmax_CASF	-0.008	0.003	-3.192	0.001
	odba_log	SELmax_PASF	-0.002	0.001	-1.327	0.185
	odba_log	SeaState:surface_angle	0.000	0.000	-2.002	0.046
	odba_log	SeaState:depth_first	0.000	0.000	0.882	0.378
	odba_log	s(depth_first)	3.939	4.000	69.801	0.000
34	odba_log	(Intercept)	0.925	0.074	12.570	0.000
	odba_log	SeaState	0.006	0.039	0.167	0.867
	odba_log	NS	0.096	0.072	1.346	0.179
	odba_log	SeaState:surface_angle	0.000	0.000	-1.948	0.052
	odba_log	SeaState:depth_first	0.000	0.000	0.965	0.335
	odba_log	s(depth_first)	3.938	4.000	67.880	0.000
	odba_log	ti(SELmax)	0.000	2.000	0.000	0.322
	odba_log	ti(SELmax,Angle)	0.883	4.000	0.350	0.205
35	odba_log	(Intercept)	0.922	0.074	12.473	0.000
	odba_log	SeaState	0.007	0.039	0.181	0.856
	odba_log	NS	0.098	0.071	1.380	0.168
	odba_log	SeaState:surface_angle	0.000	0.000	-1.921	0.055
	odba_log	SeaState:depth_first	0.000	0.000	0.963	0.335
	odba_log	s(depth_first)	3.960	4.000	67.738	0.000
	odba_log	ti(SELmax_CAS)	0.000	2.000	0.000	0.333
	odba_log	ti(SELmax_CAS,Angle)	1.423	4.000	1.169	0.039
	odba_log	ti(SELmax_PAS)	0.000	2.000	0.000	0.410
	odba_log	ti(SELmax_PAS,Angle)	0.000	4.000	0.000	0.838
36	pause	(Intercept)	-1.300	0.651	-1.997	0.046
	pause	SeaState	0.206	0.214	0.965	0.335
	pause	NS	0.049	0.377	0.129	0.897
	pause	SELmax	0.000	0.009	0.048	0.962
	pause	SeaState:surface_angle	-0.002	0.001	-2.412	0.016
	pause	SeaState:depth_first	0.000	0.000	-0.391	0.696
	pause	SELmax:sonar_angle	0.000	0.000	-0.043	0.966
	pause	s(depth_first)	0.725	4.000	0.661	0.050
37	pause	(Intercept)	-1.300	0.650	-1.999	0.046
	pause	SeaState	0.206	0.213	0.967	0.334
	pause	NS	0.048	0.377	0.128	0.898
	pause	SELmax2	0.000	0.006	-0.022	0.982
	pause	SeaState:surface_angle	-0.002	0.001	-2.414	0.016
	pause	SeaState:depth_first	0.000	0.000	-0.389	0.697
	pause	s(depth_first)	0.729	4.000	0.669	0.049
38	pause	(Intercept)	-1.300	0.655	-1.983	0.048
	pause	SeaState	0.208	0.215	0.968	0.333
	pause	NS	0.043	0.374	0.114	0.909

	pause	SELmax_CAS	-0.036	0.033	-1.091	0.276
	pause	SELmax_PAS	0.007	0.010	0.722	0.471
	pause	SeaState:surface_angle	-0.002	0.001	-2.278	0.023
	pause	SeaState:depth_first	0.000	0.000	-0.598	0.550
	pause	SELmax_CAS:sonar_angle	0.000	0.000	0.877	0.381
	pause	SELmax_PAS:sonar_angle	0.000	0.000	-0.421	0.674
	pause	s(depth_first)	0.750	4.000	0.710	0.046
39	pause	(Intercept)	-1.322	0.654	-2.021	0.043
	pause	SeaState	0.218	0.214	1.020	0.308
	pause	NS	0.048	0.376	0.128	0.898
	pause	SELmax_CASF	-0.042	0.045	-0.939	0.348
	pause	SELmax_PASF	0.003	0.007	0.416	0.677
	pause	SeaState:surface_angle	-0.002	0.001	-2.386	0.017
	pause	SeaState:depth_first	0.000	0.000	-0.492	0.623
	pause	s(depth_first)	0.746	4.000	0.702	0.046
40	pause	(Intercept)	-1.300	0.650	-2.000	0.046
	pause	SeaState	0.206	0.213	0.968	0.333
	pause	NS	0.048	0.376	0.128	0.898
	pause	SeaState:surface_angle	-0.002	0.001	-2.415	0.016
	pause	SeaState:depth_first	0.000	0.000	-0.391	0.696
	pause	s(depth_first)	0.730	4.000	0.671	0.049
	pause	ti(SELmax)	0.000	2.000	0.000	0.988
	pause	ti(SELmax,Angle)	0.000	4.000	0.000	0.378
41	pause	(Intercept)	-1.289	0.650	-1.984	0.047
	pause	SeaState	0.190	0.211	0.897	0.370
	pause	NS	0.038	0.376	0.102	0.918
	pause	SeaState:surface_angle	-0.002	0.001	-2.382	0.017
	pause	SeaState:depth_first	0.000	0.000	-0.326	0.744
	pause	s(depth_first)	0.680	4.000	0.584	0.058
	pause	ti(SELmax_CAS)	0.529	2.000	0.562	0.146
	pause	ti(SELmax_CAS,Angle)	0.000	4.000	0.000	0.595
	pause	ti(SELmax_PAS)	0.001	2.000	0.000	0.349
	pause	ti(SELmax_PAS,Angle)	0.000	4.000	0.000	0.542

Table S4. Posterior mean, median, SD, and 95%credible interval estimates for the full and nulls models for apparent output levels (AOL). Note that the covariates were expressed in tens of dB (SEL), tens of degrees (sonar/surface angle), and 100s of metres (dive depth), and so the corresponding covariates are given at that scale. Highlighted rows show the appropriate comparisons with the null models for sea state (Null model 1) and sonar (Null model 2).

Model	Variable	Description	Mean	Median	SD	95% lower	95% upper	CRI width
Full	b0[1]	Individual-average intercept	181.8	181.7	4.2	173.9	191.1	17.2
	b0_tau[1]	Inter-individual precision in intercept	0.01	0.00	0.00	0.00	0.01	0.0
	mp1[1]	Masking potential from log10(sea state)	8.16	8.20	1.15	**5.95**	**10.42**	4.5
	mr1[1]	Masking release from depth (x 100 m)	1.22	1.35	0.46	0.23	1.85	1.6
	mr2[1]	Masking release from surface angle (x 10 deg)	0.70	0.69	0.06	0.62	0.82	0.2
	phi[1]	Serial correlation parameter	0.29	0.29	0.02	0.25	0.32	0.1
	sp1[1]	Masking potential from received SEL (x 10 dB)	0.42	0.41	0.19	**0.05**	**0.79**	0.7
	sr1[1]	Masking release from sonar angle (x 10 deg)	2.29	2.31	0.72	0.43	3.90	3.5
Null 1	b0[1]	Individual-average intercept	184.1	184.1	4.1	176.0	192.9	16.9
	b0_tau[1]	Inter-individual precision in intercept	0.01	0.01	0.00	0.00	0.01	0.0
	mp1[1]	Masking potential from log10(sea state)	2.51	2.31	1.71	**0.09**	**6.46**	6.4
	mr1[1]	Masking release from depth (x 100 m)	1.09	1.11	0.68	0.04	2.33	2.3
	mr2[1]	Masking release from surface angle (x 10 deg)	0.88	0.37	0.84	0.01	2.42	2.4
	phi[1]	Serial correlation parameter	0.28	0.29	0.02	0.25	0.32	0.1
	sp1[1]	Masking potential from received SEL (x 10 dB)	0.49	0.49	0.18	0.13	0.83	0.7
	sr1[1]	Masking release from sonar angle (x 10 deg)	2.21	2.20	0.51	1.29	3.34	2.1
Null 2	b0[1]	Individual-average intercept	181.9	181.8	4.3	174.1	190.5	16.4
	b0_tau[1]	Inter-individual precision in intercept	0.01	0.00	0.00	0.00	0.01	0.0
	mp1[1]	Masking potential from log10(sea state)	8.32	8.28	1.16	6.06	10.55	4.5
	mr1[1]	Masking release from depth (x 100 m)	1.19	1.29	0.46	0.11	1.88	1.8
	mr2[1]	Masking release from surface angle (x 10 deg)	0.70	0.69	0.06	0.61	0.82	0.2
	phi[1]	Serial correlation parameter	0.29	0.29	0.02	0.26	0.32	0.1
	sp1[1]	Masking potential from received SEL (x 10 dB)	0.06	0.03	0.17	**0.00**	**0.17**	0.2
	sr1[1]	Masking release from sonar angle (x 10 deg)	1.37	0.85	1.69	0.04	6.89	6.9

The censored regression model code for Nimble

```
nimbleCode({

  #model{

  ## Likelihood

  for(j in 2:N) { # loop across data

    # Observation model
    isCensored[j] ~ dinterval(zpeak0[j], censorLimitVec[j])
    zpeak0[j] ~ dnorm(y[j] + phi[1]*epsilon[j-1], tau.cor[ID[j]])

    # Serial correlation in predictor
    epsilon[j] <- (zpeak0[j] - y[j]) #- phi[1]*epsilon[j-1]

    # Linear predictor
    y[j] <- b0_ID[ID[j]] + mp[j]*(1-mr[j]) + sp[j]*(1-sr[j])

    # Masking potential
    mp[j] <- mp1[1]*log10_SeaState[j]

    # Masking release (proportion)
    logit(mr[j]) <- -10 + mr1[1]*depth_first[j] + mr2[1]*surface_angle[j]

    # Masking potential from sonar
    sp[j] <- sp1[1]*SELmax[j]

    # Masking release from sonar
    logit(sr[j]) <- -10 + sr1[1]*sonar_angle[j]

  }

  ## 1st time step

  for(j in 1) {

    # Observation model
    isCensored[j] ~ dinterval(zpeak0[j], censorLimitVec[j])
    zpeak0[j] ~ dnorm(y[j], tau.cor[ID[j]])

    # Serial correlation in predictor
    epsilon[j] <- (zpeak0[j] - y[j])

    # Linear predictor
    y[j] <- b0_ID[ID[j]] + mp[j]*(1-mr[j]) + sp[j]*(1-sr[j])

    # Masking potential
    mp[j] <- mp1[1]* log10_SeaState[j]
```

```
  # Masking release (proportion)
  logit(mr[j]) <- -10 + mr1[1]*depth_first[j] + mr2[1]*surface_angle[j]

  # Masking potential from sonar
  sp[j] <- sp1[1]*SELmax[j]

  # Masking release from sonar
  logit(sr[j]) <- -10 + sr1[1]*sonar_angle[j]

}

## Priors

for(k in 1:NW) {
  tau.cor[k] <- tau[k]#/(1-phi[1]*phi[1])
  tau[k] ~ dgamma(1, 1)
  b0_ID[k] ~ dnorm(b0[1], b0_tau[1])
}

phi[1] ~ dunif(-1,1)
b0_tau[1] ~ dgamma(1, 1)
b0[1] ~ dunif(100, 200)

mp1[1] ~ dgamma(1, 1)   # log10(Sea state)

mr1[1] ~ dgamma(1, 1)    # masking release f(depth)
mr2[1] ~ dgamma(1, 1)    # masking release f(surface_angle)

sp1[1] ~ dgamma(1, 1)   # CAS/PAS

sr1[1] ~ dgamma(1, 1)    # masking release f(sonar_angle)

})
```