Effects of Vessel Noise on Humpback Whales

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Recall: Experiment Description and Data Generation

- Vessel approaches consisted of a typical whale-watch approach; transiting past a logging mother-calf pair at 100 m distance at slow speed
- Vessel noise was played through a transducer that was suspended from the side of the vessel to 1.5 m below the surface to mimic typical depth of propellers/shaft/exhaust of whale-watching vessels.
- The vessel noise imitation was set to different levels: control (124 dB), low (148 dB), medium (160 dB) and high (172 dB)

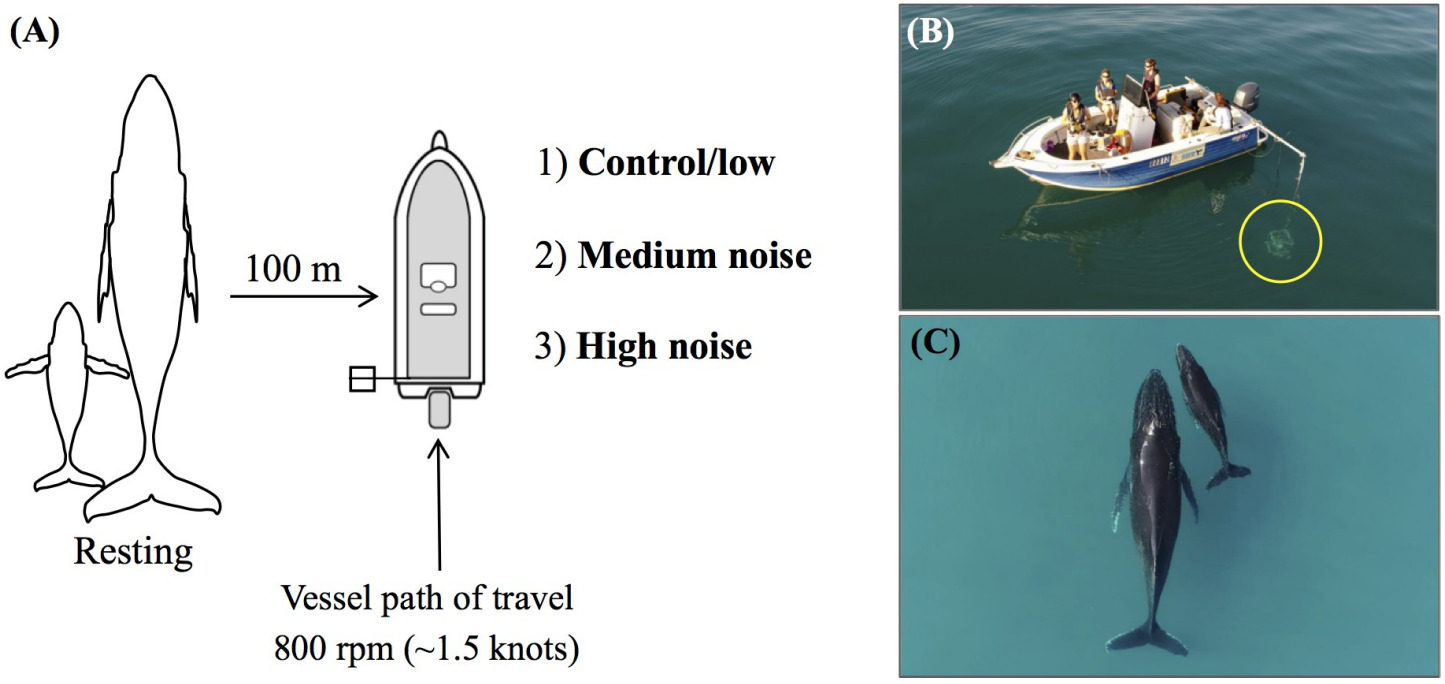


Figure 1: Experiment Design

Recall: Data

- The Data set contains 42 observations, for which there exist three entries per noise level. One before, one during and one after the whales were exposed to the synthetic vessel noises
- Three different measures were taken:
  - The respiration rate was calculated as the number of breaths per minute
  - The mean swim speed (m/s), calculated by dividing the distance traveled by the duration of a video recording
  - The proportion of time resting

Vairables and Transformations

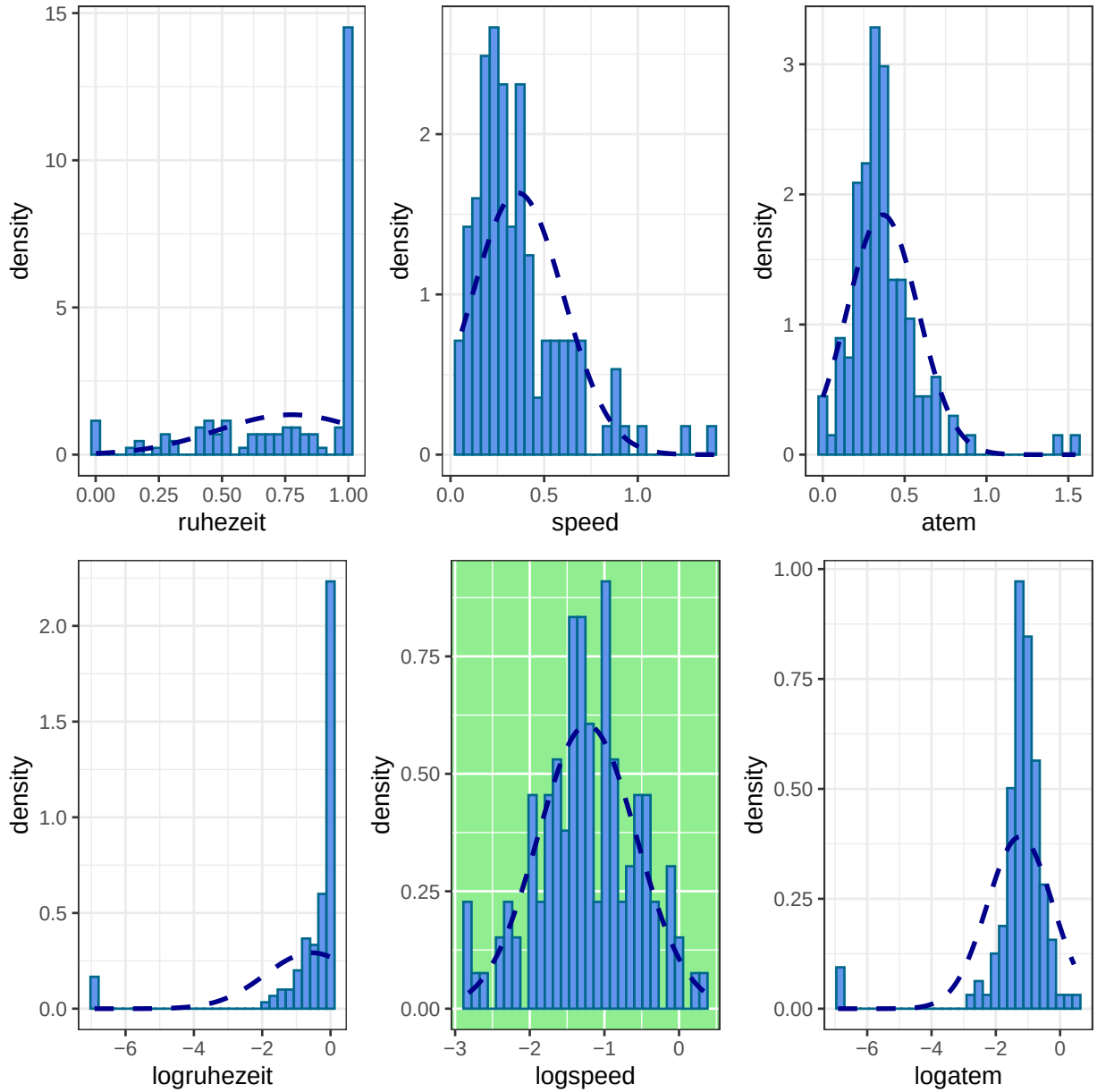


Figure 2: Variables and Transformations

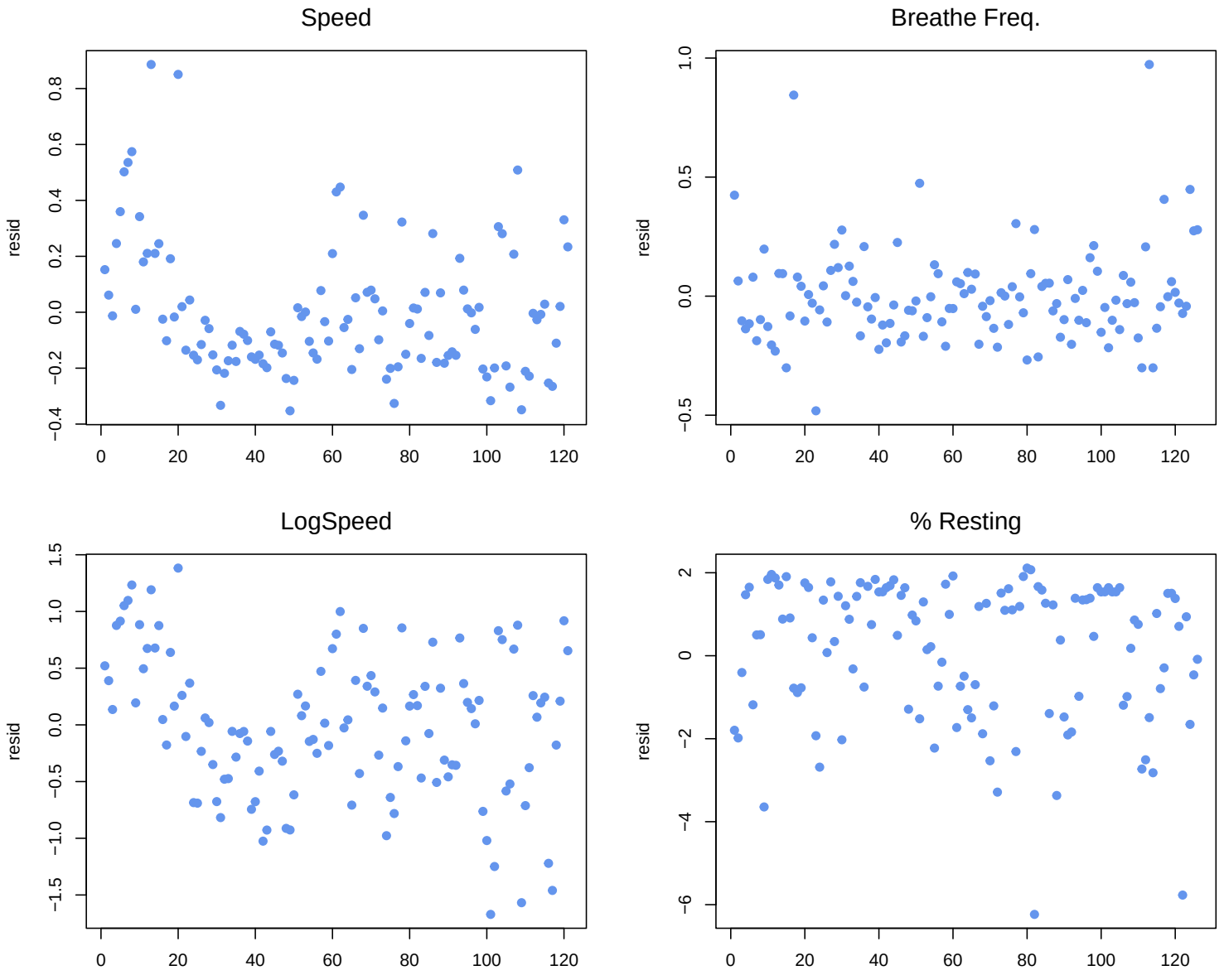
Models

- Proportion of time resting
  - Observations were weighted by the length of the observation period
  - The data used to calculate the weights was not available in the provided data set
  - Penalized quasi-likelihood (GLMM-PQL) to account for over dispersion
- Respiration rate
  - LMM
  - Estimated via restricted maximum likelihood
- Mean swim speed (m/s)
  - LMM
  - Estimated via restricted maximum likelihood
  - To account for autocorrelation within follows, the correlation was modeled with an AR1 process
- Log mean swim speed
  - LMM
  - Transformation in hopes of normally distributed residuals

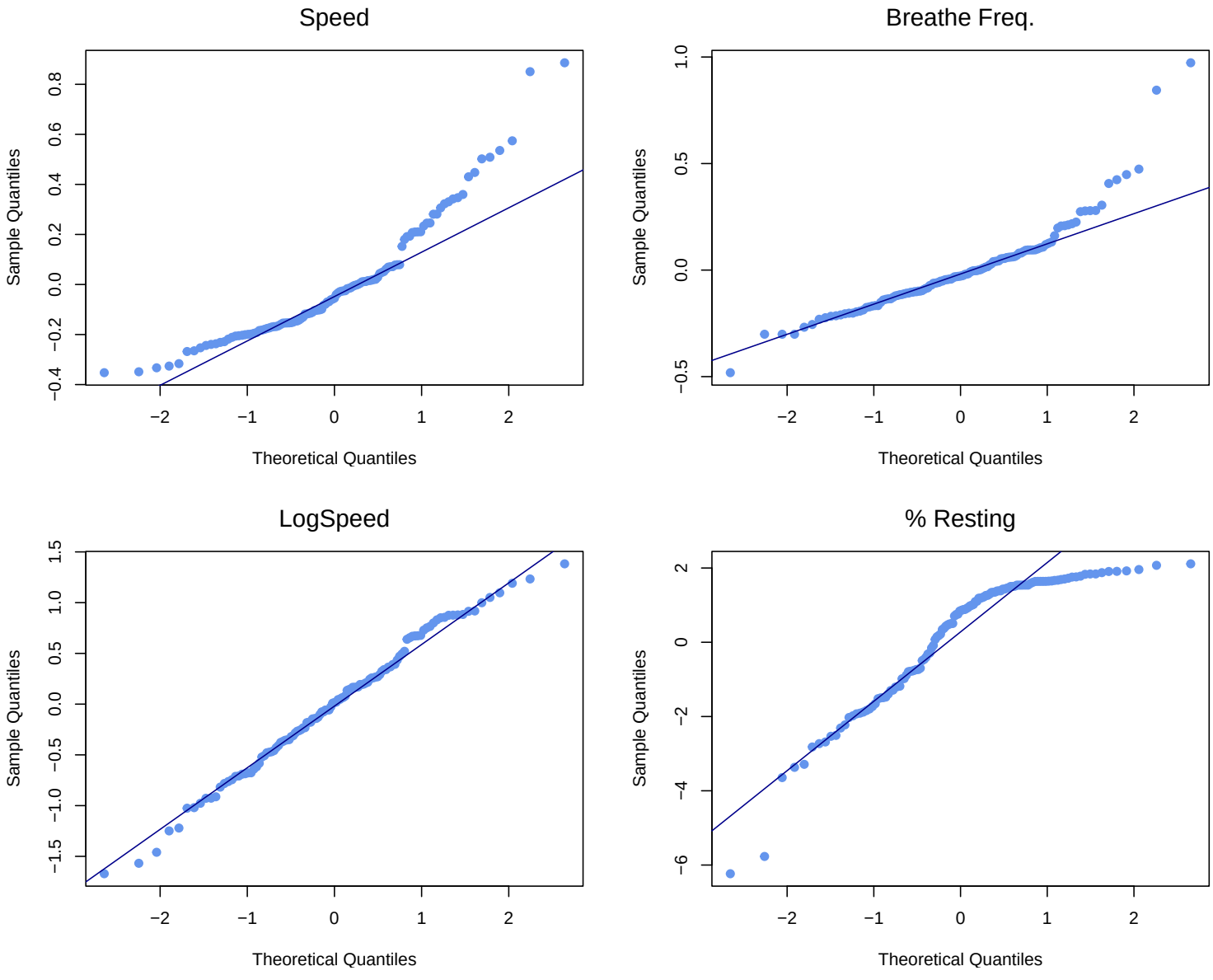
Model details	**Model**
Proportion.time.logging ~ treatment*phase + (1|Individual), weights	GLMM-PQL
Respiration.rate (breaths min^{-1}) ~ treatment*phase + (1|Individual), method="REML"	LMM
Mean.swim.speed (m s^{-1}) ~ treatment*phase + (1|Individual), corr, method="REML"	LMM

Figure 3: Sprogis et al. Supplementary file 2

Residual Diagnostics I



Residual Diagnostics II



Results: speed ~ I(treatment) * I(szenario)

- Sprogis et al. report: within high noise treatments, swim speed increased significantly from before to during vessel approaches ($\alpha = 0.05$)

	Value	Std.Error	DF	t-value	p-value
(Intercept)	0.339	0.068	73	5.019	0.000
I(treatment)Medium	-0.080	0.095	39	-0.838	0.407
I(treatment)High	0.013	0.092	39	0.139	0.890
I(szenario)During	-0.013	0.066	73	-0.201	0.841
I(szenario)After	0.037	0.067	73	0.546	0.587
I(treatment)Medium:I(szenario)During	0.057	0.094	73	0.611	0.543
I(treatment)High:I(szenario)During	0.183	0.090	73	2.027	0.046
I(treatment)Medium:I(szenario)After	0.055	0.093	73	0.594	0.554
I(treatment)High:I(szenario)After	0.026	0.093	73	0.283	0.778

Results: logspeed ~ I(treatment) * I(szenario)

	Value	Std.Error	DF	t-value	p-value
(Intercept)	-1.231	0.183	73	-6.725	0.000
I(treatment)Medium	-0.328	0.258	39	-1.272	0.211
I(treatment)High	-0.018	0.250	39	-0.072	0.943
I(szenario)During	-0.108	0.171	73	-0.631	0.530
I(szenario)After	0.082	0.204	73	0.404	0.688
I(treatment)Medium:I(szenario)During	0.342	0.242	73	1.415	0.161
I(treatment)High:I(szenario)During	0.508	0.233	73	2.175	0.033
I(treatment)Medium:I(szenario)After	0.268	0.283	73	0.945	0.348
I(treatment)High:I(szenario)After	0.020	0.281	73	0.070	0.944

Results: atem ~ I(treatment) * I(szenario)

- Sprogis et al. report: within the high treatments, the respiration rate from before to during vessel approaches increased significantly ($\alpha = 0.05$)

	Value	Std.Error	DF	t-value	p-value
(Intercept)	0.349	0.057	78	6.132	0.000
I(treatment)Medium	-0.023	0.079	39	-0.290	0.774
I(treatment)High	-0.016	0.078	39	-0.208	0.836
I(szenario)During	-0.064	0.076	78	-0.851	0.397
I(szenario)After	0.067	0.076	78	0.890	0.376
I(treatment)Medium:I(szenario)During	0.142	0.105	78	1.352	0.180
I(treatment)High:I(szenario)During	0.302	0.103	78	2.921	0.005
I(treatment)Medium:I(szenario)After	-0.095	0.105	78	-0.899	0.371
I(treatment)High:I(szenario)After	-0.098	0.103	78	-0.946	0.347

Results: ruhezeit ~ I(treatment) * I(szenario)

- Sprogis et al. report: within high noise treatments, the proportion of time resting from before to during vessel approaches decreased significantly ($\alpha = 0.05$)

	Value	Std.Error	DF	t-value	p-value
(Intercept)	2.381	0.623	78	3.821	0.000
I(treatment)Medium	-0.787	0.786	39	-1.000	0.323
I(treatment)High	-0.350	0.809	39	-0.433	0.668
I(szenario)During	-0.027	0.810	78	-0.033	0.974
I(szenario)After	-1.023	0.706	78	-1.449	0.151
I(treatment)Medium:I(szenario)During	-0.775	0.979	78	-0.792	0.431
I(treatment)High:I(szenario)During	-1.506	0.991	78	-1.519	0.133
I(treatment)Medium:I(szenario)After	0.714	0.910	78	0.785	0.435
I(treatment)High:I(szenario)After	-0.341	0.911	78	-0.374	0.709