

## **SUPPLEMENTARY FILE OUTLINE**

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## 1. SUPPLEMENTARY ANALYSES

Text S1: Details of the statistical tests mentioned in Section 2.2 on acoustic data collection.

### a. Effect of specific location on backscatter?

A pilot test was conducted to test the effect of WBAT position on acoustic measurements of fish density. In this pilot test, four WBATs were deployed at three positions (see Table S1 for coordinates), recording for 5 days (Figure S1). The results of an ANOVA test on log-transformed NASC values (Nautical Area Scattering Coefficient in  $\text{m}^2\text{nmi}^{-2}$ ) showed no significant difference in the measured backscatter between locations ( $F(3,312) = 1.69$ ,  $p = 0.17$ ).

### b. Effect of sampling interval (short vs. long) on backscatter?

Since there are no established guidelines for the minimum necessary duration of representative recordings, a combination of short and long cycles was used, with wake-up intervals of 1.5 hours. Specifically, 12 'short' and 4 'long' measurements were taken per day, with short cycles lasting minimally 72 seconds and long cycles lasting 16 minutes. This approach was chosen to enhance battery life while allowing for testing the effect of recording duration on sampling bias. To evaluate sampling bias, the longer recordings were split into 13 smaller groups and treated as independent sets of measurements. Statistical analysis, using ANOVA, showed that the mean backscatter did not differ significantly between the groups ( $p\text{-value} > 0.1$ ). This suggests that any short recording would generate the same mean backscatter as the longer recordings.

## 2. SUPPLEMENTARY FIGURES

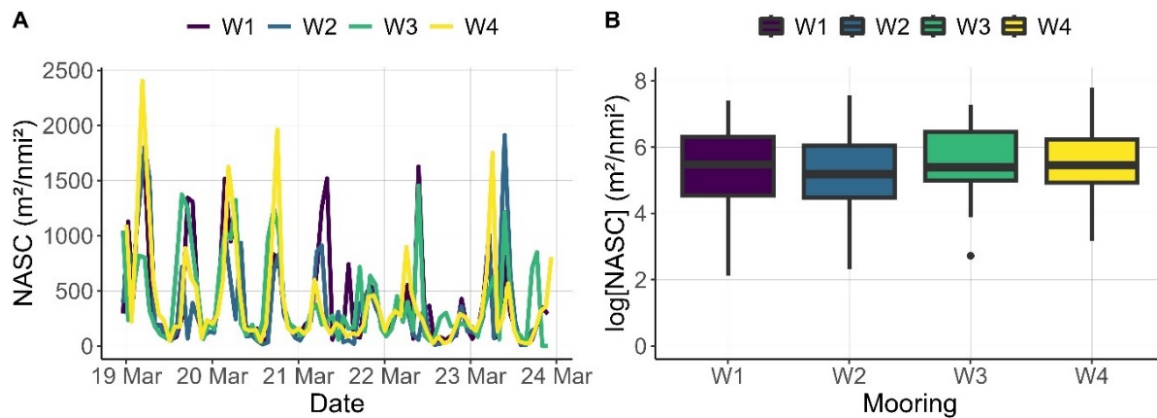


Figure S1. A) WBAT echosounders, at different positions show similar NASC values (Nautical Area Scattering Coefficient in  $\text{m}^2/\text{nmi}^2$ ) over time. The colours represent the four different WBATs, and coordinates can be found in table S1. B) Boxplots showing the distribution (i.e. minimum, 1<sup>st</sup> quartile, median, 3<sup>rd</sup> quartile and maximum) of log transformed NASC data of the 5-day period for the different WBATs. ANOVA test showed no significant difference ( $F(3,312) = 1.69$ ,  $p = 0.17$ ).

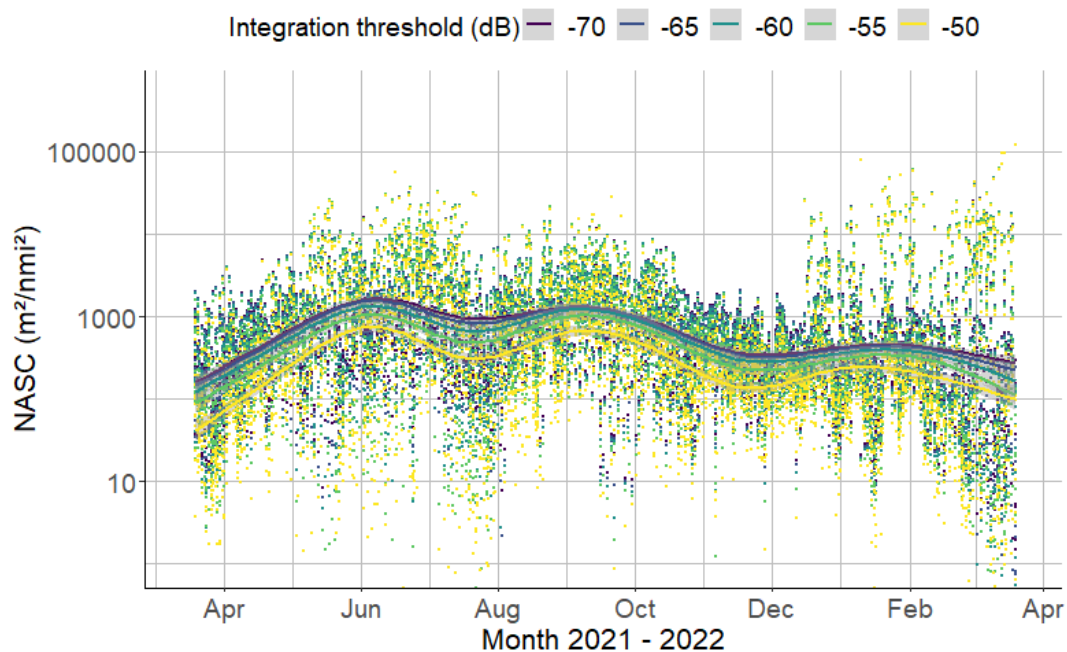


Figure S2. Fish density over the course of one year using different lower volume backscatter integration thresholds ranging from -70 to -50 dB re  $1 \text{ m}^2\text{m}^{-3}$ , represented by the different colours. The observed fish density is presented as the NASC (Nautical Area Scattering Coefficient in  $\text{m}^2/\text{nmi}^2$ ) on a logarithmic scale. The GAM smoothers show the overall trend for each threshold value.

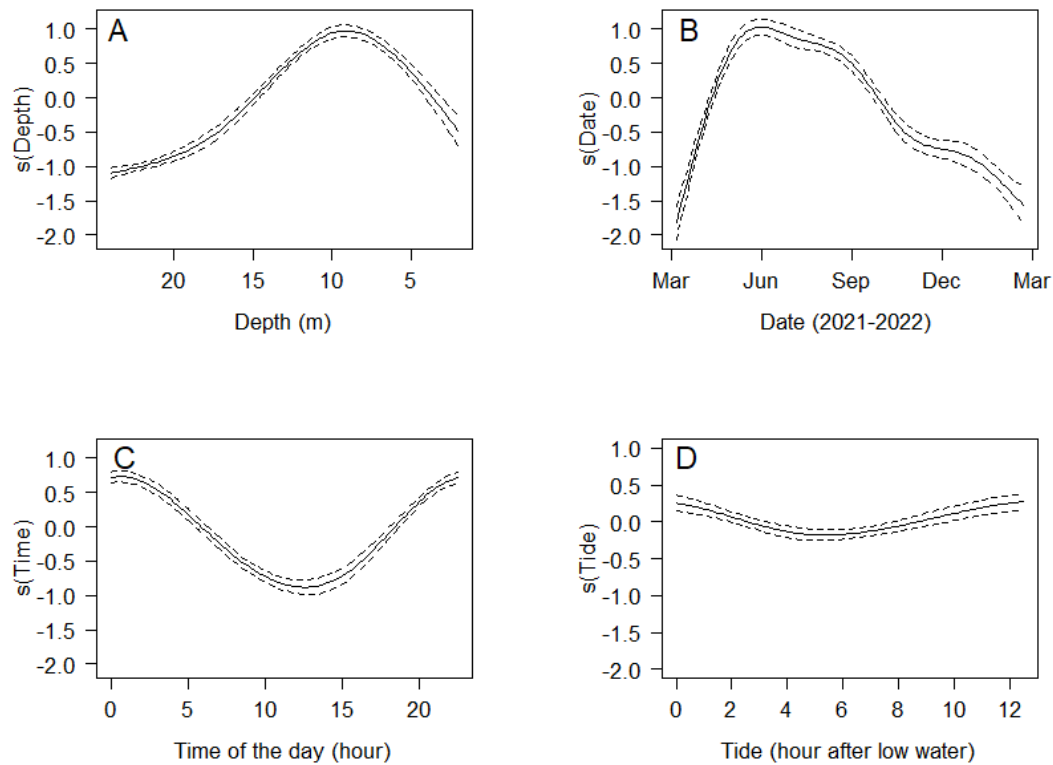


Figure S3. Smoothers of the partial effects of the GAMM showing vertical fish distribution: depth (A), date (B), time of day (C), and tidal cycle (D). The figures for the interactions are given in the main text. The y-axis presents the partial effect of the smooth terms on the NASC values (Nautical Area Scattering Coefficient in  $\text{m}^2\text{nmi}^{-2}$ ), and the dashed lines present the 95% confidence intervals.

### 3. SUPPLEMENTARY TABLES

*Table S1.* Information about the four deployments for testing the impact of location (1 to 4), and the seven deployments (A to G) conducted during the study period. Deployment 4 is the initial phase of deployment A. Pitch and roll values varied over time owing to the dynamics of the study site, so values given here are median values per deployment period, and pitch and roll were not collected for deployments 1 to 3.

ID	Start	End	Depth (m)	WBAT	Coordinates	Pitch (°)	Roll (°)	Ping interval (s)	Sampling interval duration (s)
1	19-03-21	23-03-21	29.0	W1	052° 58,605'N 004° 45,410'E	NA	NA	0.4	Short: 72 Long: 957
2	19-03-21	23-03-21	23.0	W2	052° 58,739'N 004° 45,742'E	NA	NA	0.4	Short: 72 Long: 957
3	19-03-21	23-03-21	27.5	W3	052° 58,540'N 004° 45,877'E	NA	NA	0.4	Short: 72 Long: 957
4 A	19-03-21	15-04-21	28.5	W4	052° 58,607'N 004° 45,436'E	-7	1	0.4	Short: 72 Long: 957
B	15-04-21	20-05-21	26.5	W4	052° 58,539'N 004° 45,851'E	11	0	0.25	Short: 72 Long: 957
C	20-05-21	29-09-21	27.0	W2	052° 58,605'N 004° 45,747'E	-1	15	0.25	Short: 147 Long: 957
D	29-09-21	13-10-21	26.5	W1	052° 58,605'N 004° 45,747'E	8	-2	0.4	Short: 147 Long: 957
E	13-10-21	02-12-21	26.5	W1	052° 58,605'N 004° 45,747'E	11	-1	0.4	Short: 147 Long: 957
F	02-12-21	08-03-22	27.5	W1	052° 58,648' N 004° 45,278' E	1	1	0.4	Short: 147 Long: 957
G	08-03-22	20-03-22	26.0	W2	052° 58,607' N 004° 45,436' E	-1	10	0.4	Short: 147 Long: 957

*Table S2.* Details on the calibration of the 38 kHz transducers used in this study. Calibration was carried out in the harbour of IJmuiden (the Netherlands).

WBAT	Calibration date	Salinity (ppt)	Water temperature (°C)	38 kHz gain	Minor-axis 3dB beam angle (°)	Major-axis 3dB beam angle (°)
W1	02/03/2021	23.1	6.6	20.634	18.08	18.02
W2	24/02/2021	22.3	6.0	20.414	17.77	18.43
W3	23/02/2021	23.0	6.2	20.46	17.95	18.14
W4	02/03/2021	23.1	6.6	20.860	19.18	17.88

*Table S3.* Detection settings for automatic single target detection in Echoview.

Setting	Value
TS threshold (compensated TS) (dB re 1 m <sup>2</sup> )	-68
Pulse length determination level (dB re 1 W)	6
Minimum normalized pulse length	0.5
Maximum normalized pulse length	1.8
Maximum beam compensation (dB re 1 m <sup>2</sup> )	9
Maximum st dev. of minor-axis angles (degrees)	1.2
Maximum st dev. of major-axis angles (degrees)	1.2

Table S4. Detection settings for automatic fish school detection in Echoview.

Setting	Value
Mode	Ping time
Minimum total school height (m)	1.8
Minimum candidate length (s)	3
Minimum candidate height (m)	1.2
Maximum vertical linking distance (m)	0.5
Maximum horizontal linking distance (s)	0.5
Minimum threshold (dB)	-55

Table S5. Detection settings for automatic target track detection in Echoview.

Setting	Value
Mode	4D
Track detection algorithm gain values (range from 0-1)	
- Alpha major axis	0.5
- Alpha minor axis	0.5
- Alpha range	0.3
- Beta major axis	0.5
- Beta minor axis	0.5
- Beta range	0.3
Track acceptance	
- Minimum number of single targets per track	4
- Minimum number of pings in track	6
- Maximum gap between single targets (pings)	3