



Supplement of

Seasonal foraging behavior of Weddell seals in relation to oceanographic environmental conditions in the Ross Sea, Antarctica

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Supplementary Materials

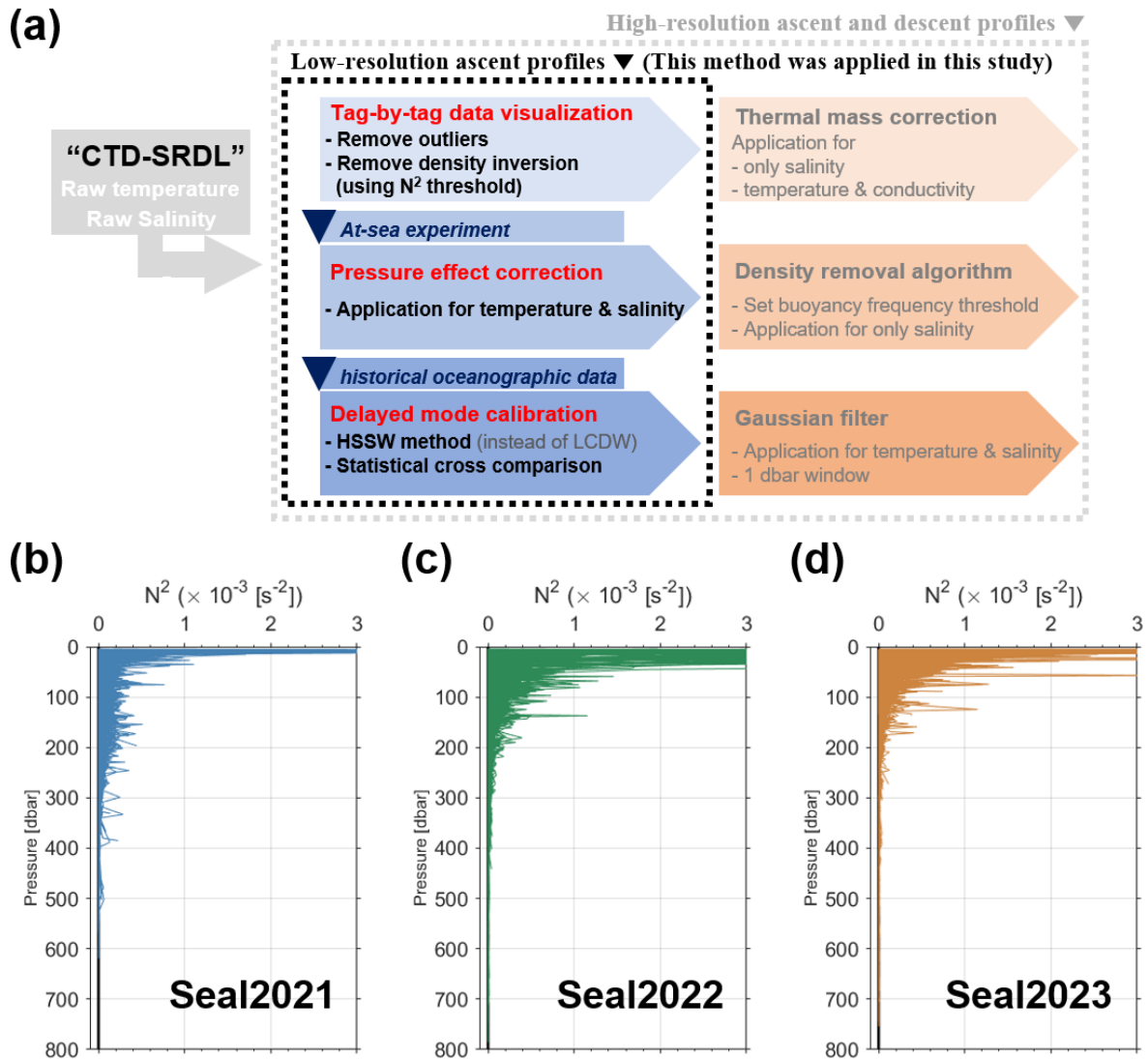
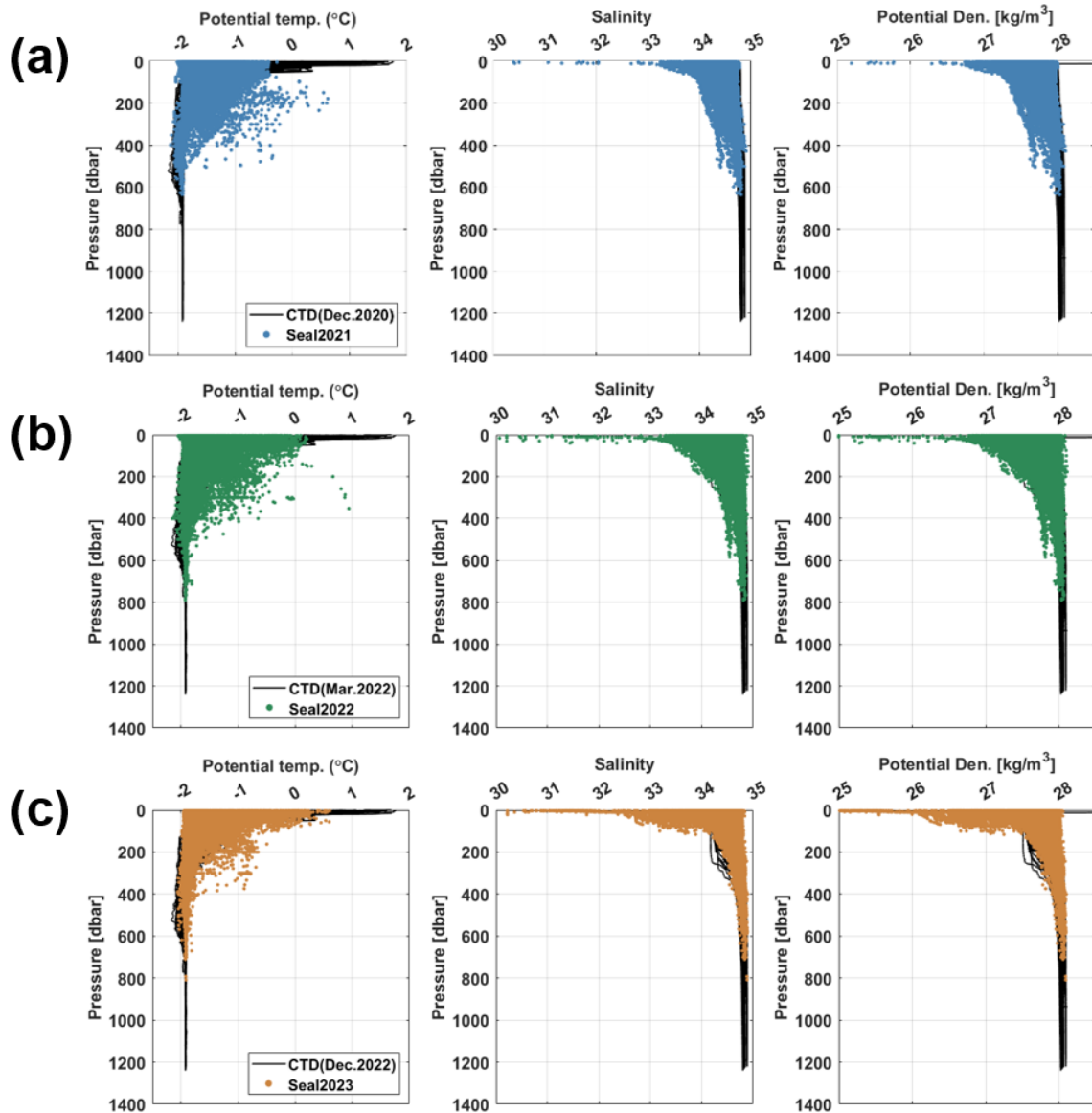


Figure S1. Procedures for quality control of Seal-attached CTD data applied in this study. (a) Schematic procedures for quality control of two cases of CTD-SRDL data (high-resolution ascent and descent profiles and low-resolution ascent profiles; reproduced from Fig. 2 in Yoon and Lee, 2021). The quality control method for low-resolution ascent profiles (dashed black box) was applied in this study. (b) Vertical profiles of buoyancy frequency (N^2) estimated from QC completed 2021 Seal data, (c) for QC completed 2022 Seal data, and (d) for QC completed 2023 Seal data.

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Figure S2. Comparison of vertical profiles between ship-based CTD data and QC completed seal data. (a) Vertical profiles of potential temperature, salinity, and potential density for QC completed 2021 Seal data and ship-based CTD data recorded from 6 to 25 December 2020. (b) Depicts the same information as panel (a), but for seal tagging data obtained during 2022 and ship-based CTD data recorded from 15 to 19 March, 2022. (c) Depicts the same information as panel (a), but for seal tagging data obtained during 2023 and ship-based CTD data recorded from 3 to 17 December, 2022.

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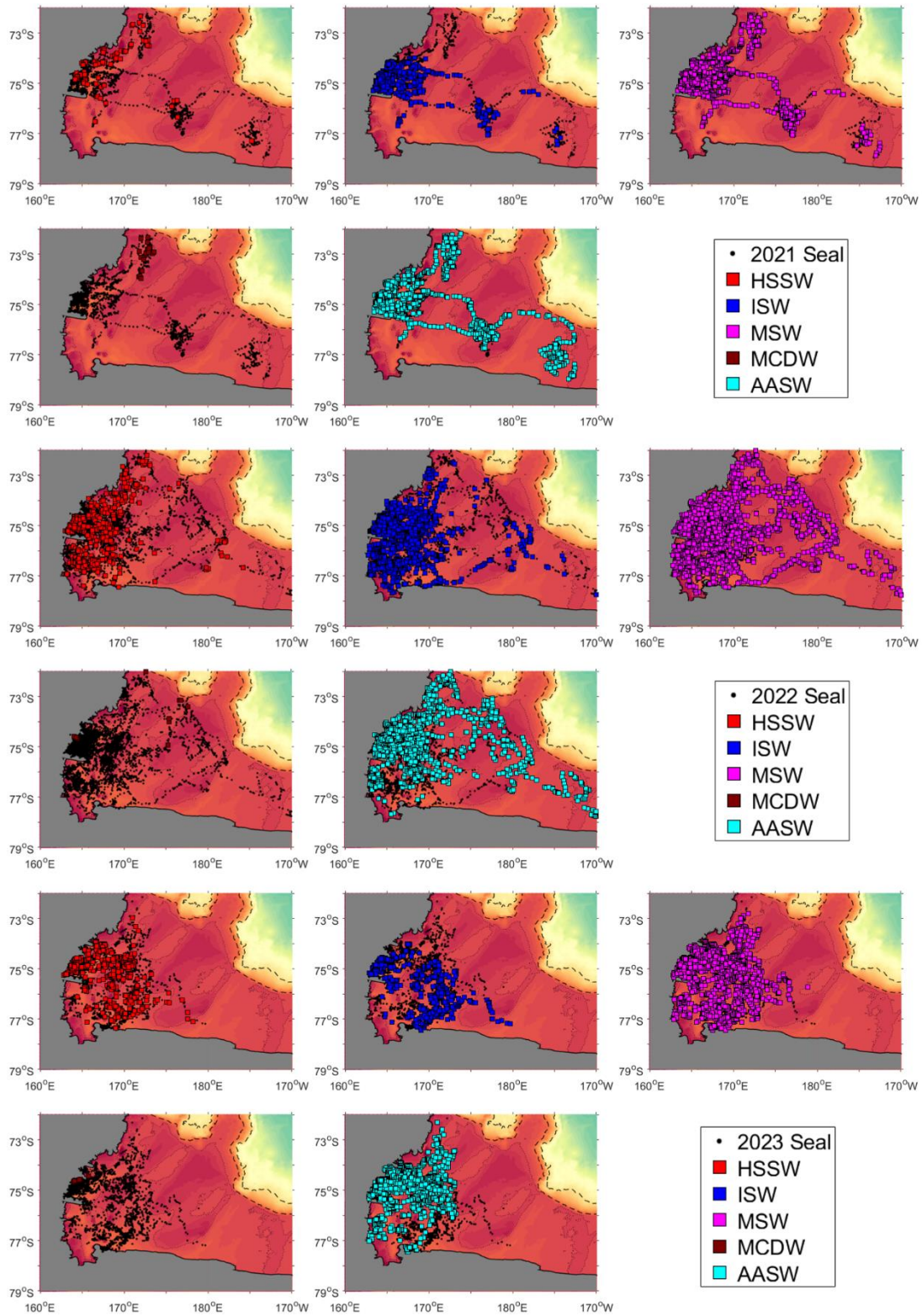
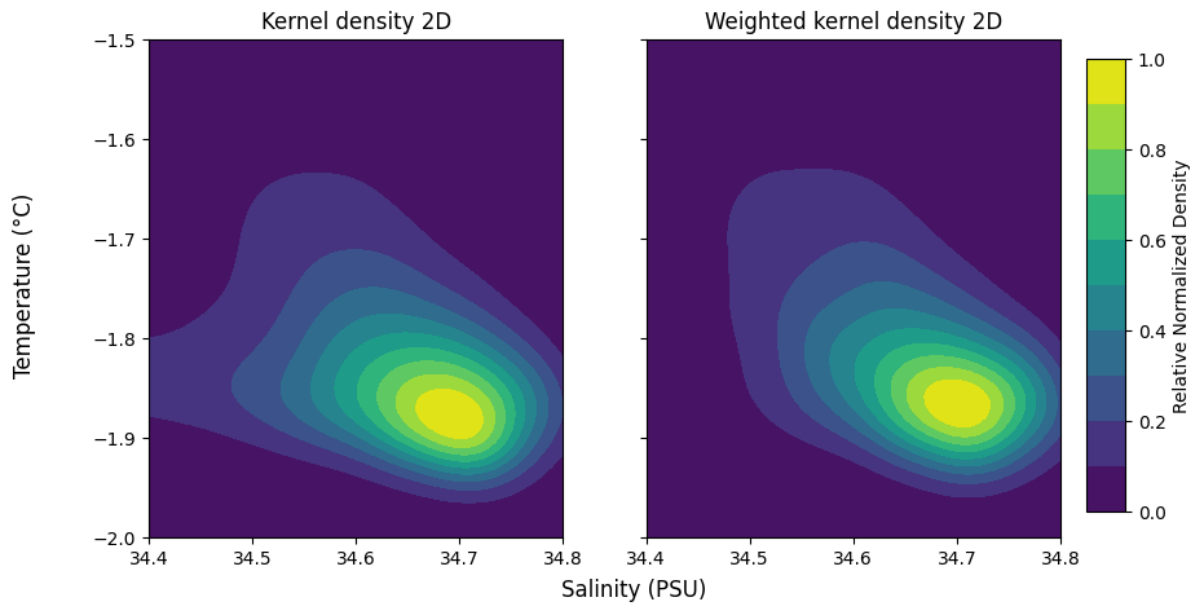
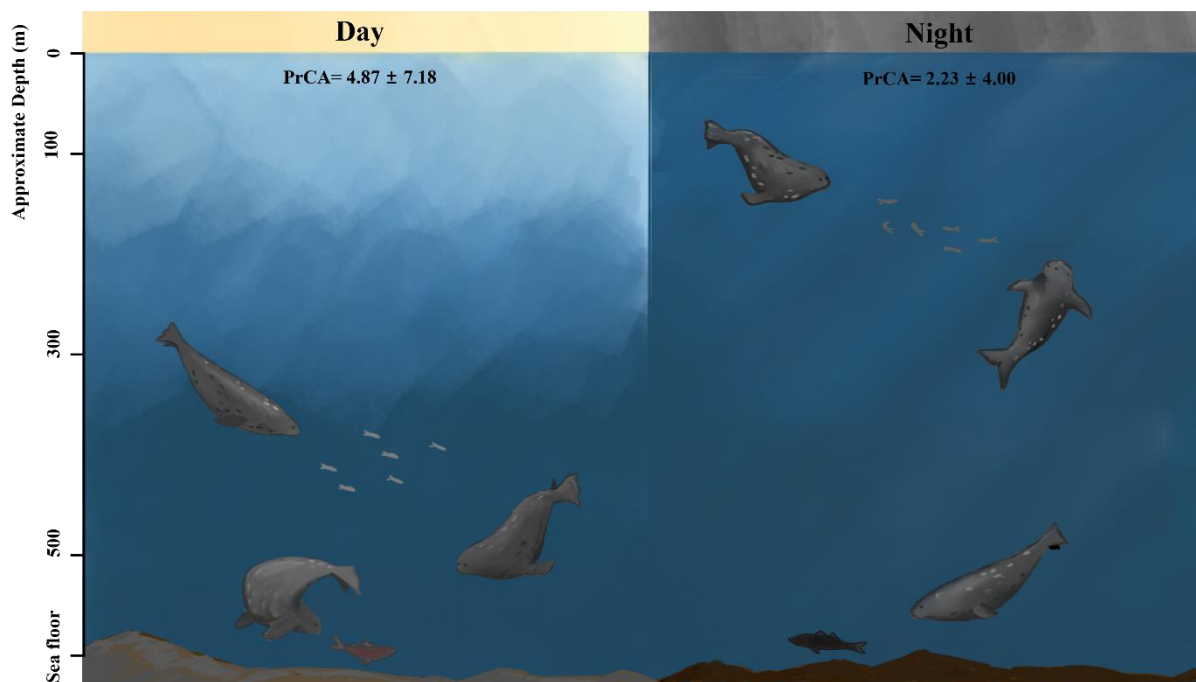


Figure S3. The oceanographic information obtained from the Seal-attached CTDs is spatially represented for 2021, 2022 and 2023. The 2021, 2022, and 2023 information is displayed above, in the middle, and below, respectively. Each color represents a different water mass.



25 **Figure S4. Kernel Density Plots of Dive Behavior in TS Diagram.** (a) The kernel density plot of water temperature and salinity for each dive illustrates the dive distribution in the TS diagram. (b) The weighted kernel density plot is where the density is weighted by the number of PrCA (Prey Capture Attempts) events for each dive. Both plots are based on data collected from seal-attached CTD sensors, which provide temperature, salinity, and PrCA data for each dive. The density was highest around a salinity of 34.7 PSU and a temperature of -1.85 °C for both sides. Kernel densities were min-max normalized in each plot, respectively.

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35 **Figure S5.** Schematic summary of diel changes in diving behaviors. During the day, pelagic preys may move to deeper waters, consequently increasing in the diving depth of Weddell seals, with a higher proportion of benthic dives observed. PrCA values are presented as mean ± standard deviation. Note: The high variability of PrCA events results in SD values being larger than the mean values.

Table S1. Metadata for captured Weddell seals. In the zoletil volume, “None” indicates that the seals were deployed with no anesthesia. Blanks mean that no

Identification	Age	Sex	Body Length (m)	Capture Date	Logger Type	Tagged Part	Administered dose of Zoletil 50 (ml)
329	Adult	F	2.60	2021-02-16	CTD-SRDL	back	None
330	Adult	M	-	2021-02-16	CTD-SRDL	back	None
333	Adult	F	2.00	2021-02-18	CTD-SRDL	head	5
334	Adult	M	2.20	2021-02-19	CTD-SRDL	head	5
335	Adult	M	2.00	2021-02-19	CTD-SRDL	head	5
344	Adult	M	2.50	2021-02-19	CTD-SRDL	head	5
337	Adult	F	2.50	2021-02-20	CTD-SRDL	head	5
343	Adult	M	2.40	2021-02-20	CTD-SRDL	head	5
345	Adult	F	2.10	2021-02-21	CTD-SRDL	head	5
346	Adult	F	2.30	2021-02-22	CTD-SRDL	head	5
347	Adult	M	2.30	2021-02-23	CTD-SRDL	head	5
348	Adult	M	1.90	2021-02-23	CTD-SRDL	head	5
349	Adult	M	2.30	2021-02-24	CTD-SRDL	head	5
350	Adult	F	2.20	2021-02-24	CTD-SRDL	head	4
351	Adult	F	2.50	2021-02-25	CTD-SRDL	head	5
352	Adult	M	2.40	2021-02-25	CTD-SRDL	head	5
353	Adult	F	2.40	2021-02-26	CTD-SRDL	head	5
354	Adult	F	2.50	2021-02-27	CTD-SRDL	head	5
369	Adult	F	2.20	2021-02-27	CTD-SRDL	head	5
G5	Adult	M	2.60	2021-03-04	CTD-SRDL with GPS	back	3.5
G2	Adult	F	2.50	2021-03-04	CTD-SRDL with GPS	back	3.5
G3	Adult	F	2.40	2021-03-04	CTD-SRDL with GPS	back	3.5
G4	Adult	F	2.40	2021-03-07	CTD-SRDL with GPS	back	3.5

G1	Adult	M	2.40	2021-03-07	CTD-SRDL with GPS	back	3.5
553	Adult	M	1.80	2022-02-15	CTD-SRDL	head	5
551	Adult	F	1.85	2022-02-16	CTD-SRDL	head	4
552	Adult	M	1.85	2022-02-17	CTD-SRDL	head	4
G605	Adult	M	1.90	2022-02-18	CTD-SRDL with GPS	back	4
547	Adult	M	1.90	2022-02-22	CTD-SRDL	head	4
387	Adult	M	2.20	2022-02-23	CTD-SRDL	head	4.5
549	Adult	F	2.00	2022-02-23	CTD-SRDL	head	4
581	Adult	M	2.30	2022-02-24	CTD-SRDL	head	5
G606	Adult	M	1.70	2022-02-24	CTD-SRDL with GPS	back	3.5
580	Adult	M	2.05	2022-02-28	CTD-SRDL	head	4
582	Adult	F	1.80	2022-02-28	CTD-SRDL	head	3.5
430	Adult	M	2.20	2022-03-01	CTD-SRDL	head	4
426	Adult	M	2.15	2022-03-04	CTD-SRDL	head	4
427	Adult	F	2.20	2022-03-04	CTD-SRDL	head	4
583	Adult	M	2.00	2022-03-04	CTD-SRDL	head	4
548	Adult	F	2.00	2022-03-05	CTD-SRDL	head	4
584	Adult	F	2.15	2022-03-06	CTD-SRDL	head	5
386	Adult	M	2.15	2022-03-06	CTD-SRDL	Head	4.5
592	Adult		1.87	2023-01-30	CTD-SRDL	head	5
608	Adult	F	2.3	2023-01-31	CTD-SRDL	head	5
603	Adult	M	2.1	2023-01-31	CTD-SRDL	head	5
772	Adult	F	2.08	2023-01-31	CTD-SRDL	head	4
457	Adult	M		2023-02-01	CTD-SRDL	head	3
320	Adult	M	1.82	2023-02-02	CTD-SRDL	head	3.5
376	Adult	F	2.2	2023-02-02	CTD-SRDL	head	4
324	Adult	F	1.97	2023-02-04	CTD-SRDL	head	4
654	Adult	F	2.18	2023-02-04	CTD-SRDL	head	4
590	Adult	M	1.8	2023-02-04	CTD-SRDL	head	3.5
451	Adult		2.26	2023-02-04	CTD-SRDL	head	5

368	Adult	M	1.95	2023-02-04	CTD-SRDL	head	5
550	Subadult	M	1.7	2023-02-04	CTD-SRDL	head	2
690	Subadult	M	1.68	2023-02-04	CTD-SRDL	head	2
735	Adult	F	2	2023-02-05	CTD-SRDL	head	5
602	Adult	M	2	2023-02-05	CTD-SRDL	head	5
693	Adult	F	2.15	2023-02-05	CTD-SRDL	head	5
782	Adult	M	2.1	2023-02-05	CTD-SRDL	head	5
692	Adult	M	2.1	2023-02-05	CTD-SRDL	head	5
601	Adult	M	2.05	2023-02-05	CTD-SRDL	head	5
773	Adult	F	2.4	2023-02-05	CTD-SRDL	head	5
694	Adult	M	2.1	2023-02-05	CTD-SRDL	head	5

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Table S2 Error metrics for kriging estimates of salinity and temperature (2021-2023)

Year	Temperature (ME)	Temperature (RMSE)	Temperature (MAE)	Salinity (ME)	Salinity (RMSE)	Salinity (MAE)
2021	0.0012	0.1859	0.1131	0.0001	0.1107	0.0766
2022	0.0022	0.1496	0.0846	0.0001	0.1297	0.0891
2023	0.0054	0.1764	0.1073	0.0004	0.1883	0.1111

ME: Mean Error, RMSE: Root Mean Squared Error, MAE: Mean Absolute Error.

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Table S3. Comparison of models predicting prey capture attempts using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values

AIC	BIC	Explanatory Variable (Fixed effects)
129327.5	129435.5	WM_f+Benthic+D_Month_f
129331.3	129448.3	WM_f+Benthic+Sex+D_Month_f
129333.9	129459.9	WM_f+Benthic+D_Month_f+C_Year
129337.5	129472.5	WM_f+Benthic+Sex+D_Month_f+C_Year

129503.5	129575.4	WM_f+Benthic
129507.6	129588.6	WM_f+Benthic+Sex
129510.9	129600.9	WM_f+Benthic+C_Year
129514.9	129613.9	WM_f+Benthic+Sex+C_Year
129817.9	129916.9	WM_f+D_Month_f
129818.3	129899.2	Benthic+D_Month_f
129821.6	129911.6	Benthic+Sex+D_Month_f
129821.8	129929.7	WM_f+Sex+D_Month_f
129823.3	129922.3	Benthic+D_Month_f+C_Year
129823.6	129940.6	WM_f+D_Month_f+C_Year
129826.7	129934.7	Benthic+Sex+D_Month_f+C_Year
129827.3	129953.2	WM_f+Sex+D_Month_f+C_Year
129935.7	129980.7	Benthic
129939.4	129993.4	Benthic+Sex
129941.8	130004.8	Benthic+C_Year
129945.6	130017.5	Benthic+Sex+C_Year
130013.6	130076.6	WM_f
130017.9	130089.8	WM_f+Sex
130020.6	130101.6	WM_f+C_Year
130024.6	130114.6	WM_f+Sex+C_Year

130434	130505.9	D_Month_f
130437.4	130518.3	Sex+D_Month_f
130438.2	130528.2	D_Month_f+C_Year
130441.7	130540.6	Sex+D_Month_f+C_Year
130551.5	130596.5	Sex
130553.4	130607.4	C_Year
130557.2	130620.1	Sex+C_Year

Table S4. Comparison of models predicting diving depth using AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) values

AIC	BIC	Explanatory Variable (Fixed effects)
711620.3	711719.3	Sex+D_Month_f+C_Year
711625.3	711715.3	D_Month_f+C_Year
711632.2	711713.2	Sex+D_Month_f
711637.2	711709.2	D_Month_f
711744.3	711807.3	Sex+C_Year
711749.3	711803.2	C_Year
711757	711802	Sex

50 **Table S5 The best model for prey capture attempts (PrCA) including interaction term between julian date and dive type**
 The comparison of AIC values revealed that Water mass and interaction term between julian date and dive type are important variables for predicting PrCA.

$$\log(\text{PCA_BTM} + 1) \sim \text{Water Mass} + \text{Dive Type} * \text{Julian date} + (1|\text{IID}) + \text{corAR1}(1|\text{IID})$$

<i>Predictors</i>	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	1.28	1.08 – 1.47	<0.001

Water Mass [ISW]	-0.09	-0.26 – 0.09	0.327
Water Mass [MSW]	-0.09	-0.26 – 0.08	0.315
Water Mass [AASW]	-0.4	-0.57 – -0.23	<0.001
Dive Type [Benthic]	-0.15	-0.21 – -0.09	<0.001
Julian date	-0.0032679	-0.00304957– -0.00348623	<0.001
Dive Type [Benthic] × Julian Date	0.0033987	0.00365321– 0.00314419	<0.001
N IID	44		
<hr/>			
Observations	59675		
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