

Supplementary information

Table S1. Coordinates of rebars hammered into the reef marking the start and end points and route of the stereo video surveys at 13 m and 20 m. Latitude and Longitude are in decimal degrees.

Depth (m)	Location	Latitude	Longitude
13	Rebar 1 (Start)	7.27476	134.1896
13	Rebar 2	7.27487	134.1889
13	Rebar 3	7.2749	134.1881
13	Rebar 4	7.27487	134.1872
13	Rebar 5	7.27465	134.1864
13	Rebar 6	7.27425	134.1856
13	Rebar 7	7.2737	134.185
13	Rebar 8 (End)	7.27325	134.1846
20	Rebar 1 (Start)	7.27575	134.1878
20	Rebar 2	7.27555	134.1865
20	Rebar 3	7.27514	134.1856
20	Rebar 4	7.27481	134.185
20	Rebar 5	7.27465	134.1845
20	Rebar 6 (End)	7.27439	134.1844

Table S2. Summary of monthly stereo video surveys conducted at Mutiaur.

Year	Month	Survey days
2023	February	3 days before to 4 days after new moon
2023	March	3 days before to 3 days after new moon
2023	April	2 days before to 2 days after new moon
2023	May	2 days before to 2 days after new moon
2023	June	2 days before to 2 days after new moon
2023	July	No survey due to bad weather
2023	August	2 days before to 2 days after new moon
2023	September	2 days before to 2 days after new moon
2023	October	1 day before to 2 days after new moon (1 day missed due to bad weather)
2023	November	2 days before to 2 days after new moon
2023	December	2 days before to 1 day after new moon (1 day missed due to bad weather)
2024	January	1 day after new moon (4 days missed due to bad weather and COVID)
2024	February	2 days before to 1 day before new moon (1 day missed due to bad weather)
2024	February	2 days before to 2 days after full moon

Table S3. Results of hierarchical general additive model for all survey months with all factors included as smooth terms.

Term type	Term	EDF	Ref. DF	F value	P-value
Smooth	s(Speed..cm.s.)	4.371	5.119	3.265	0.006
Smooth (random effect)	s(Month)	7.390	9.000	9.427	0.000
Smooth	s(Temperature..C.)	1.000	1.000	5.573	0.019
Smooth	s(Moon_num)	3.398	3.951	5.129	0.001
Smooth	s(Moon_num):MonthApril	2.001	2.261	2.145	0.099
Smooth	s(Moon_num):MonthAugust	1.608	1.875	0.525	0.590

Smooth	s(Moon_num):MonthDecember	5.49E-05	9.75E-05	0.016	0.999
Smooth	s(Moon_num):MonthFebruary	2.069	2.294	2.116	0.110
Smooth	s(Moon_num):MonthJune	1.514	1.768	1.710	0.273
Smooth	s(Moon_num):MonthMarch	1.003	1.006	0.288	0.595
Smooth	s(Moon_num):MonthMay	1.708	1.961	1.041	0.386
Smooth	s(Moon_num):MonthNovember	1.001	1.001	0.721	0.396
Smooth	s(Moon_num):MonthOctober	2.018	2.217	4.272	0.014
Smooth	s(Moon_num):MonthSeptember	1.000	1.000	0.286	0.593
Smooth (random effect)	s(Period,Depth_m)	8.415	9.000	14.459	0.000
Smooth	s(Tidal_height_MSL_m)	1.000	1.000	5.756	0.017
Smooth (random effect)	s(Tidal_state)	1.604	2.000	40.320	0.000

Table S4. Results of hierarchical general additive model for all survey months with month, tidal state, and period*depth included as fixed terms.

Term type	Term	Estimate	Std. Error	t value	P-value	EDF	Ref. DF	F value
Fixed	MonthAug	-0.935	0.152	-6.145	0.000	NA	NA	NA
Fixed	MonthDec	-0.428	0.140	-3.049	0.002	NA	NA	NA
Fixed	MonthFeb	-0.350	0.189	-1.857	0.064	NA	NA	NA
Fixed	MonthJun	-0.803	0.142	-5.657	0.000	NA	NA	NA
Fixed	MonthMar	-0.365	0.139	-2.618	0.009	NA	NA	NA
Fixed	MonthMay	-0.307	0.129	-2.377	0.018	NA	NA	NA
Fixed	MonthNov	-0.479	0.147	-3.255	0.001	NA	NA	NA
Fixed	MonthOct	-0.635	0.195	-3.262	0.001	NA	NA	NA
Fixed	MonthSept	-0.489	0.125	-3.928	0.000	NA	NA	NA
Fixed	Period2	-0.158	0.087	-1.812	0.071	NA	NA	NA
Fixed	Period3	0.053	0.087	0.610	0.542	NA	NA	NA
Fixed	Period4	-0.020	0.087	-0.223	0.823	NA	NA	NA
Fixed	Period5	-0.035	0.087	-0.406	0.685	NA	NA	NA
Fixed	Depth_m20	0.291	0.087	3.362	0.001	NA	NA	NA
Fixed	Tidal_stateOutgoing	-0.448	0.128	-3.499	0.001	NA	NA	NA
Fixed	Tidal_stateSlack	-0.275	0.194	-1.416	0.157	NA	NA	NA
Fixed	Period2:Depth_m20	0.133	0.122	1.084	0.279	NA	NA	NA
Fixed	Period3:Depth_m20	0.173	0.122	1.414	0.158	NA	NA	NA
Fixed	Period4:Depth_m20	0.190	0.122	1.554	0.121	NA	NA	NA
Fixed	Period5:Depth_m20	-0.371	0.122	-3.033	0.003	NA	NA	NA
Smooth	s(Speed..cm.s.)	NA	NA	NA	0.007	3.789	4.509	4.008
Smooth	s(Temperature..C.)	NA	NA	NA	0.021	1.000	1.001	5.352
Smooth	s(Moon_num)	NA	NA	NA	0.047	3.032	3.545	2.303
Smooth	s(Moon_num): Apr	NA	NA	NA	0.073	2.101	2.379	2.327
Smooth	s(Moon_num):Aug	NA	NA	NA	0.319	1.000	1.000	0.997
Smooth	s(Moon_num):Dec	NA	NA	NA	0.354	1.000	1.000	0.860
Smooth	s(Moon_num):Feb	NA	NA	NA	0.030	2.138	2.388	3.531
Smooth	s(Moon_num):Jun	NA	NA	NA	0.387	1.000	1.000	0.751

Smooth	s(Moon_num):Mar	NA	NA	NA	0.184	1.898	2.193	1.562
Smooth	s(Moon_num):May	NA	NA	NA	0.097	1.928	2.200	2.533
Smooth	s(Moon_num):Nov	NA	NA	NA	0.283	1.000	1.000	1.154
Smooth	s(Moon_num):Oct	NA	NA	NA	0.123	1.273	1.531	3.971
Smooth	s(Moon_num):Sept	NA	NA	NA	0.300	1.000	1.000	1.076
Smooth	s(Tidal_height_MSL_m)	NA	NA	NA	0.004	1.000	1.000	8.602

Table S5. Pairwise comparisons of fish density across months for all months. Contrasts are on the asinh (inverse hyperbolic sine) scale.

Contrast	Estimate	SE	DF	t-ratio	P-value
April - August	0.626	0.169	455.840	3.693	0.009
April - December	0.119	0.161	455.840	0.734	0.999
April - February	-0.179	0.210	455.840	-0.855	0.998
April - June	0.493	0.150	455.840	3.280	0.037
April - March	-0.039	0.147	455.840	-0.267	1.000
April - May	-0.211	0.172	455.840	-1.225	0.968
April - November	0.169	0.172	455.840	0.983	0.993
April - October	-0.261	0.187	455.840	-1.398	0.928
April - September	0.180	0.162	455.840	1.108	0.984
August - December	-0.507	0.182	455.840	-2.779	0.147
August - February	-0.805	0.126	455.840	-6.380	0.000
August - June	-0.132	0.137	455.840	-0.966	0.994
August - March	-0.665	0.132	455.840	-5.042	0.000
August - May	-0.836	0.241	455.840	-3.476	0.020
August - November	-0.456	0.206	455.840	-2.213	0.449
August - October	-0.887	0.187	455.840	-4.732	0.000
August - September	-0.446	0.172	455.840	-2.600	0.220
December - February	-0.298	0.221	455.840	-1.346	0.942
December - June	0.375	0.135	455.840	2.778	0.147
December - March	-0.158	0.174	455.840	-0.905	0.996
December - May	-0.329	0.176	455.840	-1.867	0.691
December - November	0.051	0.116	455.840	0.437	1.000
December - October	-0.380	0.166	455.840	-2.294	0.395
December - September	0.061	0.178	455.840	0.342	1.000
February - June	0.673	0.184	455.840	3.657	0.011
February - March	0.140	0.171	455.840	0.819	0.998
February - May	-0.032	0.283	455.840	-0.111	1.000
February - November	0.349	0.248	455.840	1.404	0.926
February - October	-0.082	0.219	455.840	-0.376	1.000
February - September	0.359	0.211	455.840	1.701	0.795
June - March	-0.532	0.136	455.840	-3.913	0.004
June - May	-0.704	0.192	455.840	-3.663	0.010
June - November	-0.324	0.139	455.840	-2.330	0.372
June - October	-0.755	0.169	455.840	-4.476	0.000
June - September	-0.314	0.175	455.840	-1.796	0.737
March - May	-0.172	0.212	455.840	-0.811	0.998

March - November	0.209	0.192	455.840	1.084	0.986
March - October	-0.222	0.193	455.840	-1.150	0.979
March - September	0.219	0.171	455.840	1.276	0.959
May - November	0.380	0.168	455.840	2.260	0.417
May - October	-0.051	0.195	455.840	-0.259	1.000
May - September	0.390	0.169	455.840	2.306	0.387
November - October	-0.431	0.170	455.840	-2.537	0.252
November - September	0.010	0.183	455.840	0.056	1.000
October - September	0.441	0.163	455.840	2.709	0.173

Table S6. Results of hierarchical general additive model for peak aggregation months with all factors included as smooth terms.

Term type	Term	EDF	Ref. DF	F value	P-value
Smooth	s(Speed..cm.s.)	5.178	6.180	6.969	0.000
Smooth	s(Moon_num)	3.069	3.700	8.389	0.000
Smooth	s(Moon_num):MonthApril	1.001	1.001	5.606	0.019
Smooth	s(Moon_num):MonthFebruary	1.000	1.000	12.632	0.000
Smooth	s(Moon_num):MonthMarch	1.000	1.000	7.242	0.008
Smooth	s(Moon_num):MonthMay	2.065	2.380	8.265	0.000
Smooth	s(Moon_num):MonthOctober	0.000	0.000	0.008	1.000
Smooth	s(Moon_num):MonthSeptember	1.000	1.000	11.118	0.001
Smooth (random effect)	s(Period,Depth_m)	8.164	9.000	9.891	0.000
Smooth	s(Tidal_height_MSL_m)	1.000	1.000	5.749	0.017

Table S7. Results of hierarchical general additive model for peak aggregation months with month, tidal state, and period*depth included as fixed terms.

Term type	Term	Estimate	Std. Error	t value	P-value	EDF	Ref. DF	F value
Fixed	MonthFebruary	-0.531	0.220	-2.418	0.016	NA	NA	NA
Fixed	MonthMarch	-0.624	0.169	-3.683	0.000	NA	NA	NA
Fixed	MonthMay	-0.482	0.156	-3.084	0.002	NA	NA	NA
Fixed	MonthOctober	-0.656	0.200	-3.278	0.001	NA	NA	NA
Fixed	MonthSeptember	-0.631	0.150	-4.198	0.000	NA	NA	NA
Fixed	Period2	-0.191	0.128	-1.491	0.137	NA	NA	NA
Fixed	Period3	0.150	0.128	1.170	0.243	NA	NA	NA
Fixed	Period4	0.065	0.128	0.503	0.615	NA	NA	NA
Fixed	Period5	-0.014	0.128	-0.105	0.916	NA	NA	NA
Fixed	Depth_m20	0.474	0.126	3.750	0.000	NA	NA	NA
Fixed	Tidal_stateOutgoing	-0.357	0.123	-2.909	0.004	NA	NA	NA
Fixed	Period2:Depth_m20	0.059	0.179	0.329	0.742	NA	NA	NA
Fixed	Period3:Depth_m20	0.001	0.179	0.006	0.995	NA	NA	NA
Fixed	Period4:Depth_m20	0.047	0.179	0.265	0.791	NA	NA	NA
Fixed	Period5:Depth_m20	-0.589	0.179	-3.300	0.001	NA	NA	NA
Smooth	s(Speed..cm.s.)	NA	NA	NA	0.011	1.000	1.000	6.623
Smooth	s(Temperature..C.)	NA	NA	NA	0.043	1.000	1.001	4.134

Smooth	s(Moon_num)	NA	NA	NA	0.000	4.018	4.612	7.803
Smooth	s(Moon_num):MonthApr	NA	NA	NA	0.000	2.558	2.824	6.278
Smooth	s(Moon_num):MonthFeb	NA	NA	NA	0.676	1.000	1.001	0.176
Smooth	s(Moon_num):MonthMar	NA	NA	NA	0.764	1.000	1.000	0.091
Smooth	s(Moon_num):MonthMay	NA	NA	NA	0.958	1.127	1.228	0.031
Smooth	s(Moon_num):MonthOct	NA	NA	NA	0.774	0.577	0.848	0.097
Smooth	s(Moon_num):MonthSept	NA	NA	NA	0.937	1.000	1.000	0.006
Smooth	s(Tidal_height_MSL_m)	0.001	1.105	1.189	10.48 1	0.001	1.105	1.189

Table S8. Pairwise comparisons of fish density across months for peak months. Contrasts are on the asinh (inverse hyperbolic sine) scale.

Contrast	Estimate	SE	DF	t-ratio	P-value
April - February	-0.276	0.210	279.613	-1.314	0.777
April - March	-0.183	0.146	279.613	-1.252	0.811
April - May	-0.342	0.183	279.613	-1.871	0.423
April - October	-0.344	0.203	279.613	-1.691	0.539
April - September	-0.176	0.195	279.613	-0.901	0.946
February - March	0.093	0.178	279.613	0.520	0.995
February - May	-0.067	0.256	279.613	-0.261	1.000
February - October	-0.068	0.212	279.613	-0.320	1.000
February - September	0.100	0.207	279.613	0.483	0.997
March - May	-0.159	0.182	279.613	-0.876	0.952
March - October	-0.161	0.201	279.613	-0.799	0.968
March - September	0.008	0.189	279.613	0.040	1.000
May - October	-0.001	0.178	279.613	-0.007	1.000
May - September	0.167	0.161	279.613	1.033	0.906
October - September	0.168	0.174	279.613	0.967	0.928

Table S9. Pairwise comparisons of fish density between depths for peak months. Contrasts are on the asinh (inverse hyperbolic sine) scale.

Contrast	Estimate	SE	DF	t-ratio	P-value
Depth_m13 - Depth_m20	-0.37786	0.056888	279.6135	-6.64216	1.61E-10

Table S10. Pairwise comparisons of fish density across periods at each depth for peak months. Contrasts are on the asinh (inverse hyperbolic sine) scale.

Contrast	Depth_m	Estimate	SE	DF	t-ratio	P-value
Period1 - Period2	13	0.191	0.128	279.613	1.491	0.569
Period1 - Period3	13	-0.150	0.128	279.613	-1.170	0.768
Period1 - Period4	13	-0.065	0.128	279.613	-0.503	0.987
Period1 - Period5	13	0.014	0.128	279.613	0.105	1.000
Period2 - Period3	13	-0.341	0.128	279.613	-2.661	0.063
Period2 - Period4	13	-0.256	0.128	279.613	-1.994	0.272
Period2 - Period5	13	-0.178	0.128	279.613	-1.385	0.638
Period3 - Period4	13	0.086	0.128	279.613	0.667	0.963

Period3 - Period5	13	0.164	0.128	279.613	1.276	0.706
Period4 - Period5	13	0.078	0.128	279.613	0.608	0.974
Period1 - Period2	20	0.132	0.124	279.613	1.066	0.824
Period1 - Period3	20	-0.151	0.124	279.613	-1.217	0.742
Period1 - Period4	20	-0.112	0.124	279.613	-0.901	0.896
Period1 - Period5	20	0.603	0.124	279.613	4.852	0.000
Period2 - Period3	20	-0.284	0.124	279.613	-2.283	0.154
Period2 - Period4	20	-0.244	0.124	279.613	-1.967	0.285
Period2 - Period5	20	0.470	0.124	279.613	3.786	0.002
Period3 - Period4	20	0.039	0.124	279.613	0.316	0.998
Period3 - Period5	20	0.754	0.124	279.613	6.069	0.000
Period4 - Period5	20	0.715	0.124	279.613	5.753	0.000

Table S11. Pairwise comparisons of fish density across tidal states for peak months. Contrasts are on the asinh (inverse hyperbolic sine) scale.

Contrast	Estimate	SE	DF	t-ratio	P-value
Incoming - Outgoing	0.357	0.123	279.613	2.909	0.004

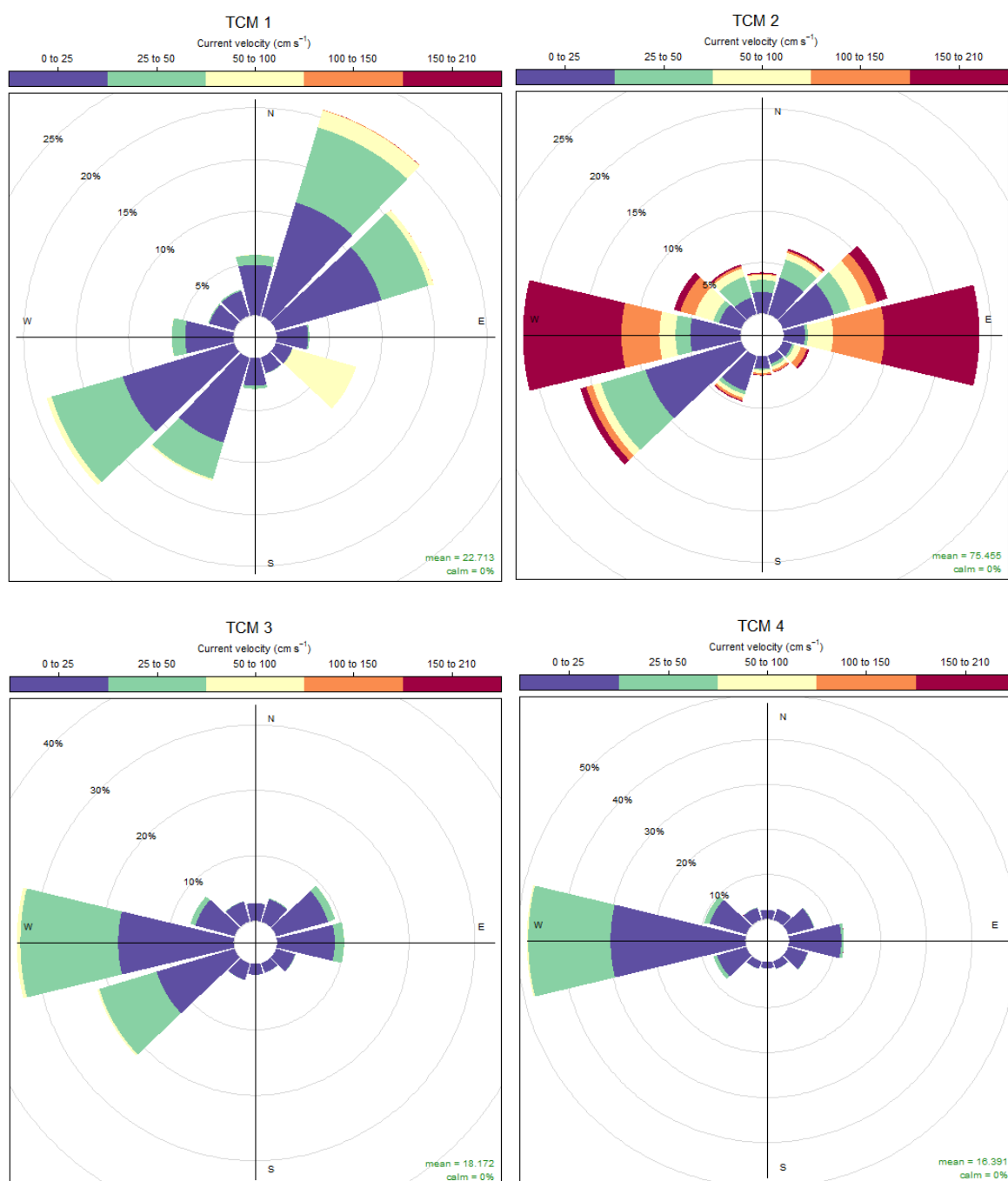


Figure S1. Current velocity collected using four tilting current meters (TCMs) deployed at Mutiaur across the survey period from April 2023 to March 2024 at TCM 1 and TCM 2 and from February 2023 to March 2024 at TCM 3 and TCM 4.

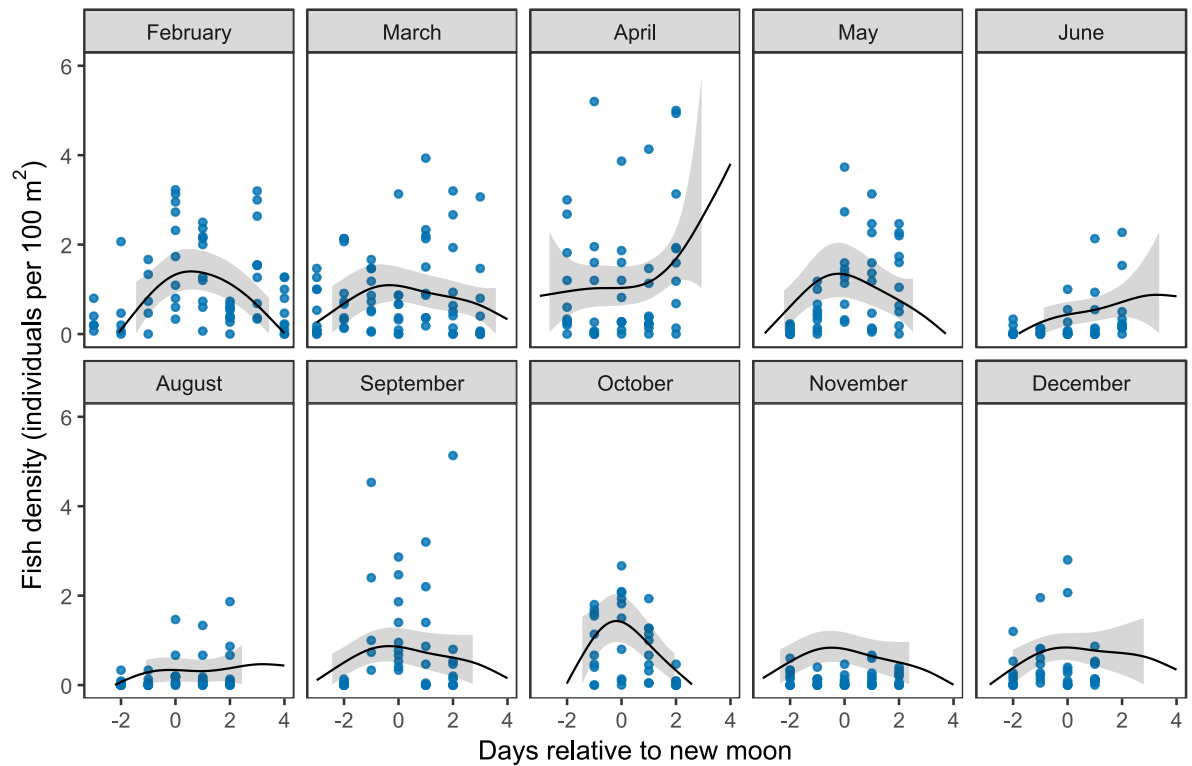


Figure S2. Relationship between density of Longnose Emperors at Mutiaur across days relative to the new moon (0) in each survey month. Observed fish density is shown by blue points and predicted fish density is shown by black lines with credible intervals shown by grey area. The survey was not completed in July 2023 due to bad weather and data from January 2024 was removed as only one day was surveyed.

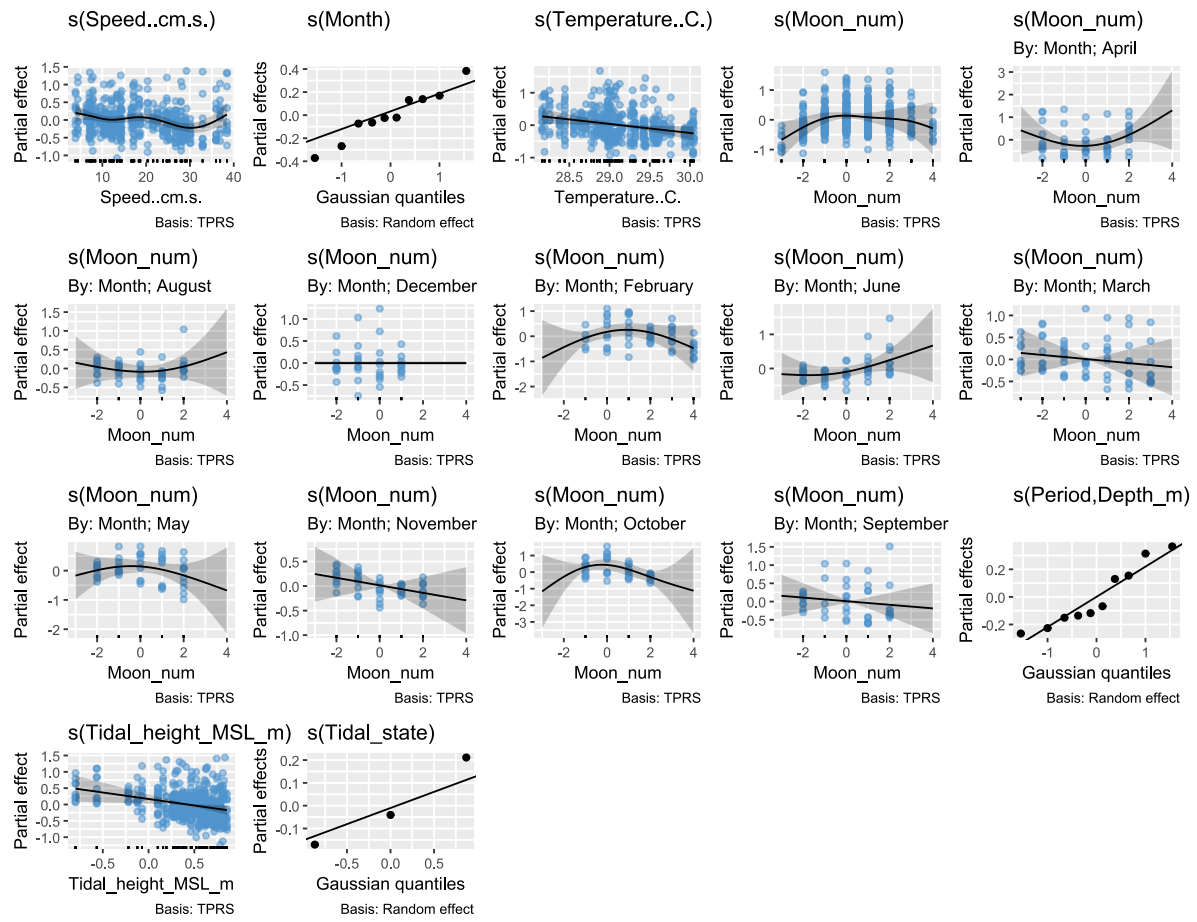


Figure S3. Partial effects plots for the smooth terms of the hierarchical general additive model including all months with all factors included as smooth terms. Partial effects of each term are represented by black lines or points, and blue points represent partial residuals.

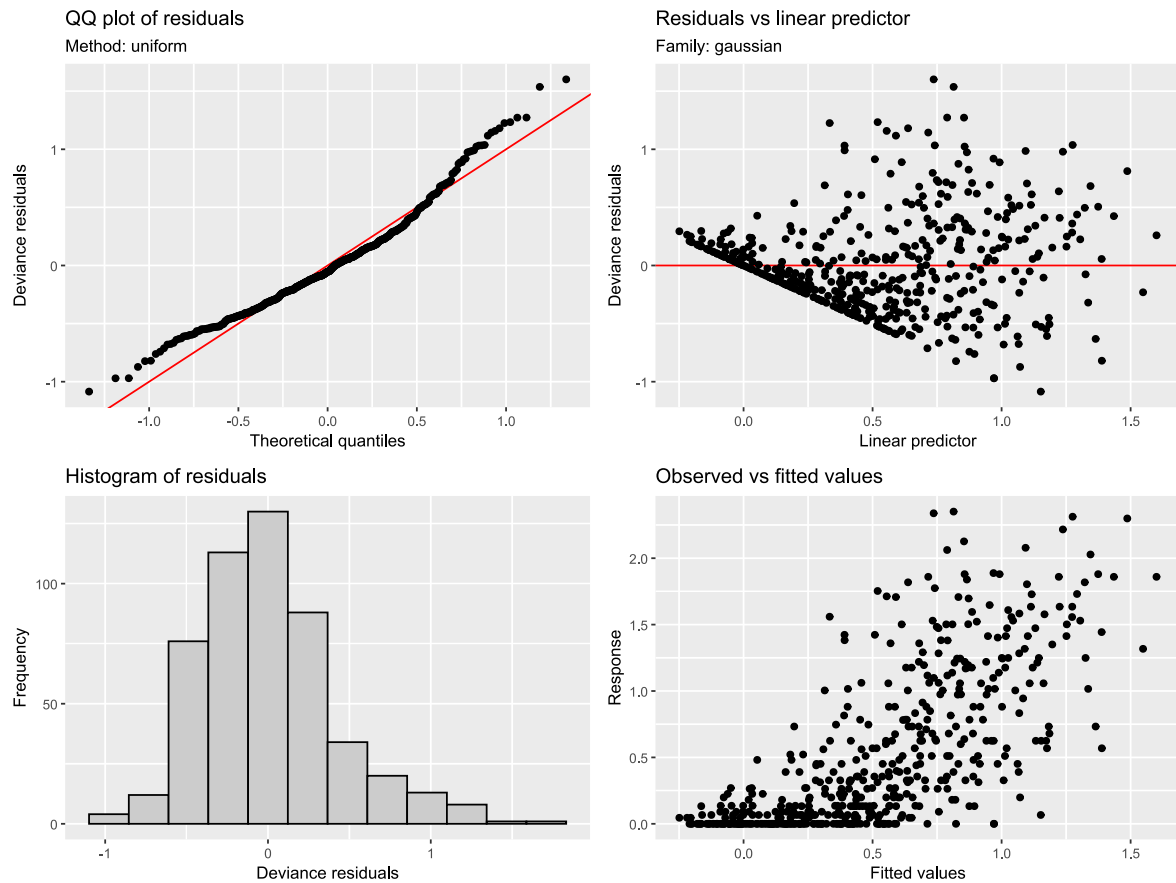


Figure S4. Diagnostics plots for the hierarchical general additive model including all months with all factors included as smooth terms.

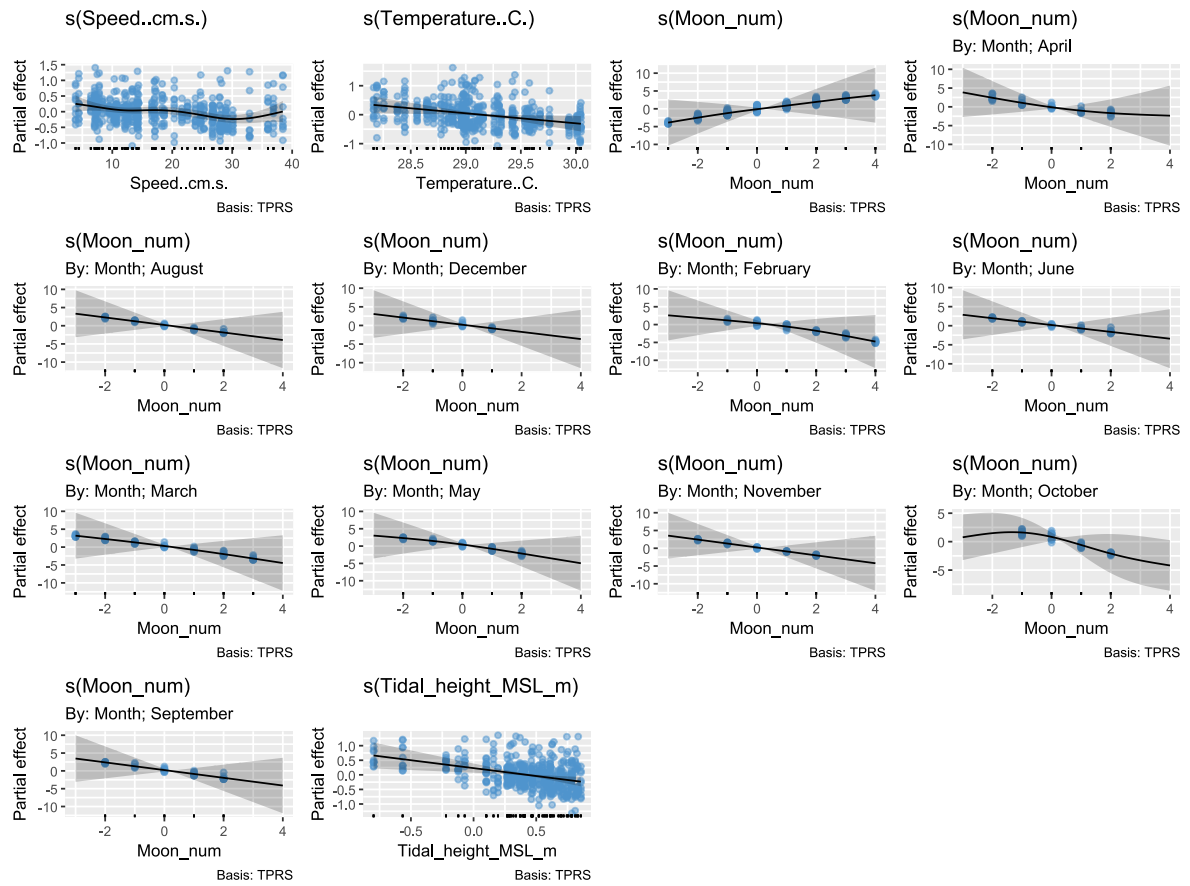


Figure S5. Partial effects plots for the smooth terms of the hierarchical general additive model including all months with month, tidal state, and period*depth included as fixed terms. Partial effects of each term are represented by black lines or points, and blue points represent partial residuals.

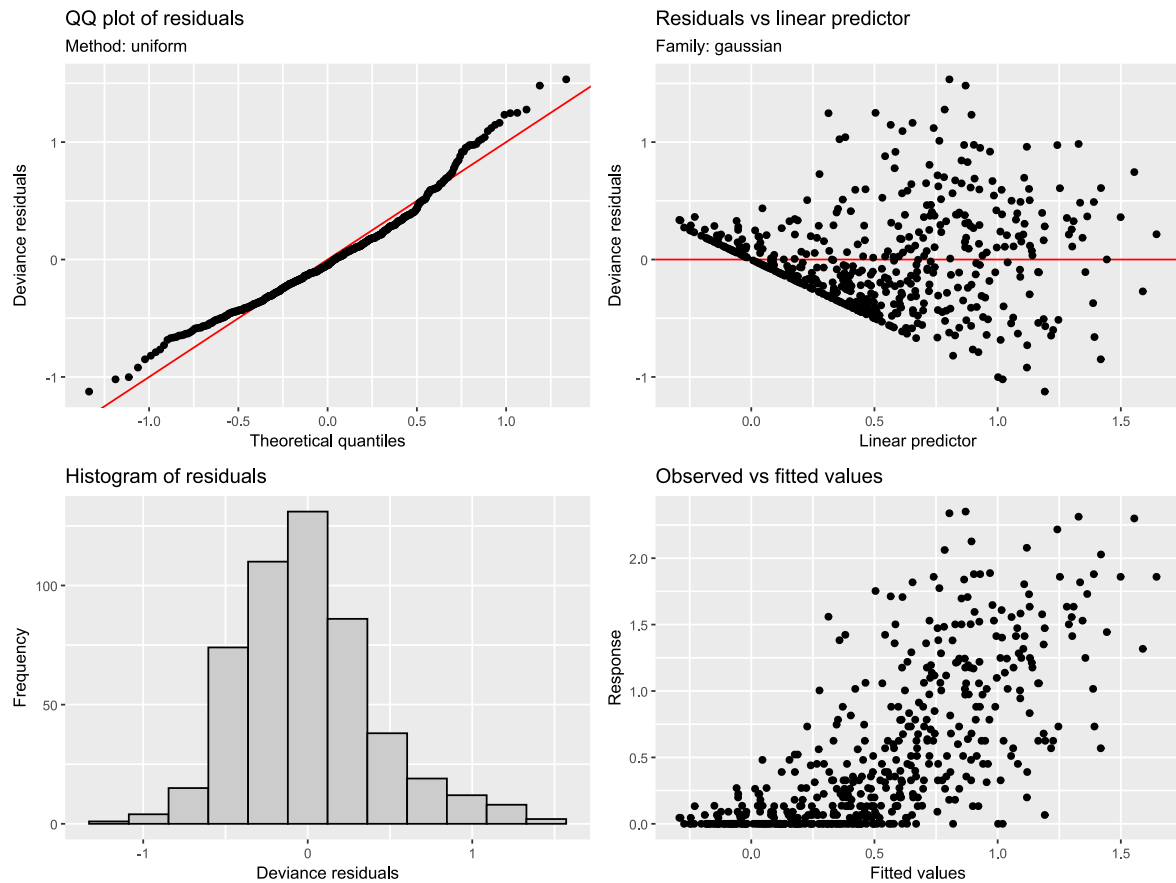


Figure S6. Diagnostics plots for the hierarchical general additive model including all months with month, tidal state, and period*depth included as fixed terms.

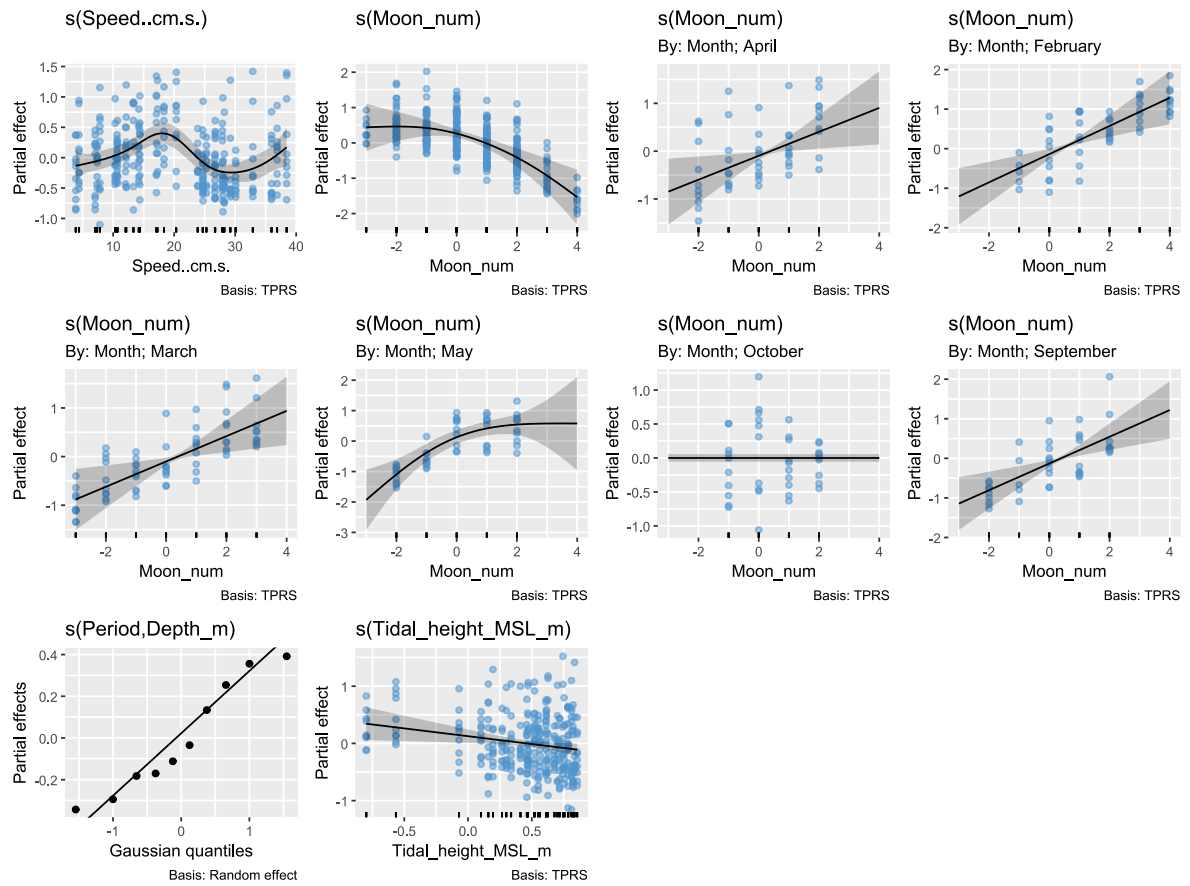


Figure S7. Partial effects plots for the smooth terms of the hierarchical general additive model including peak months with all factors included as smooth terms. Partial effects of each term are represented by black lines or points, and blue points represent partial residuals.

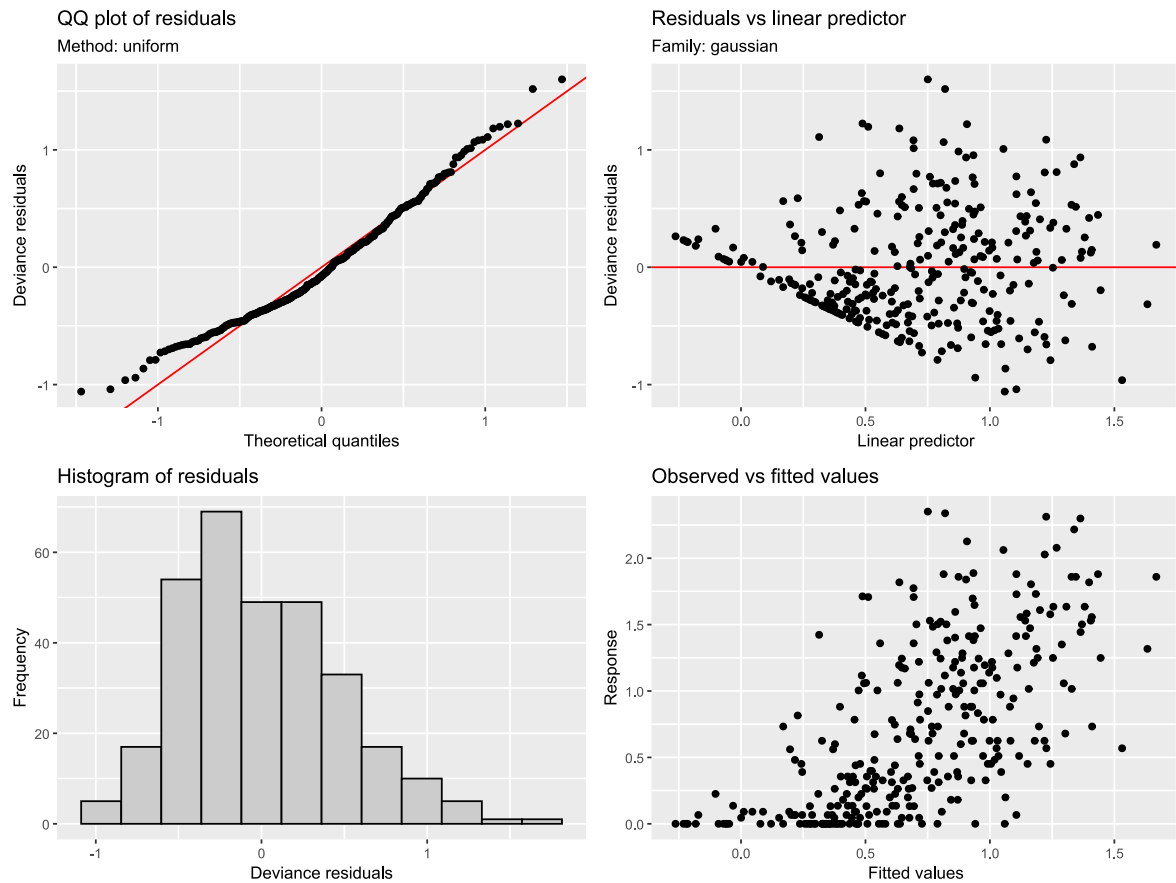


Figure S8. Diagnostics plots for the hierarchical general additive model including peak months with all factors included as smooth terms.

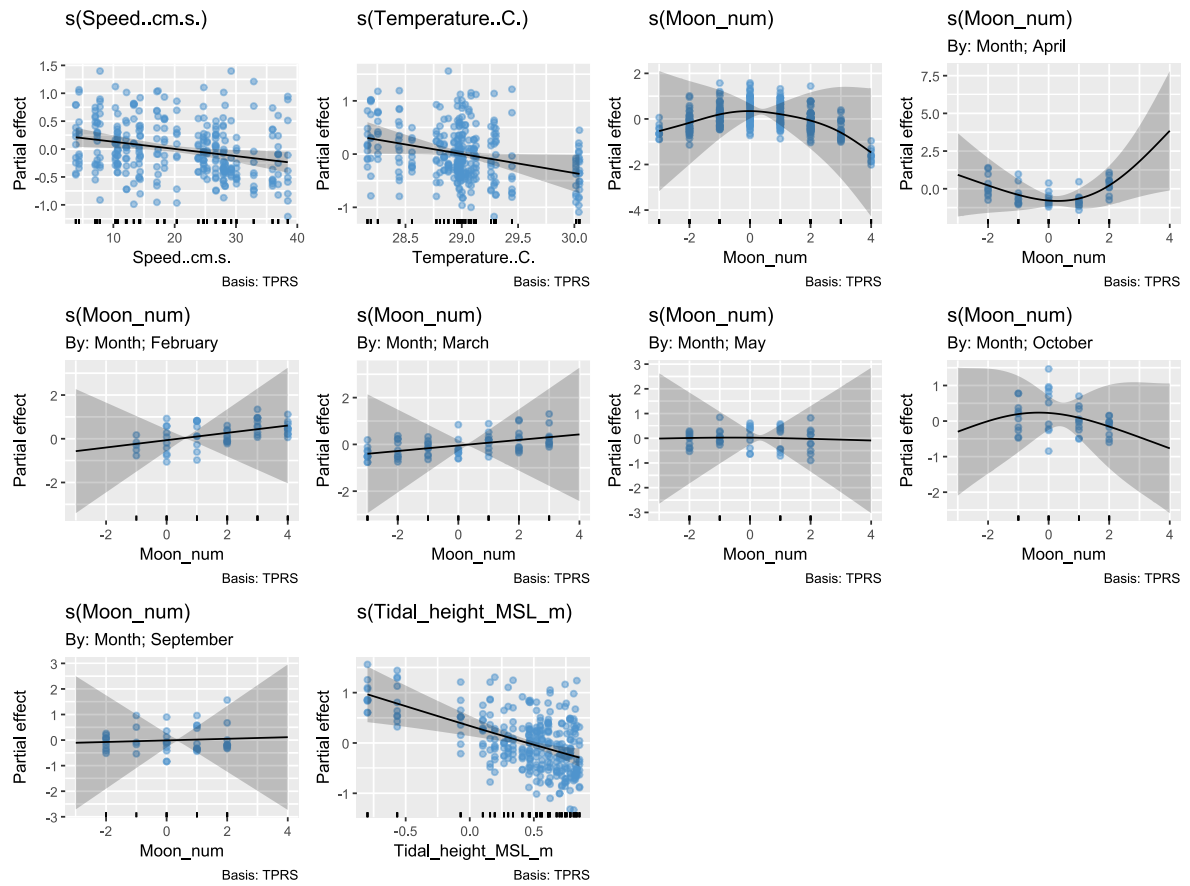


Figure S9. Partial effects plots for the smooth terms of the hierarchical general additive model including peak months with month, tidal state, and period*depth included as fixed terms. Partial effects of each term are represented by black lines or points, and blue points represent partial residuals.

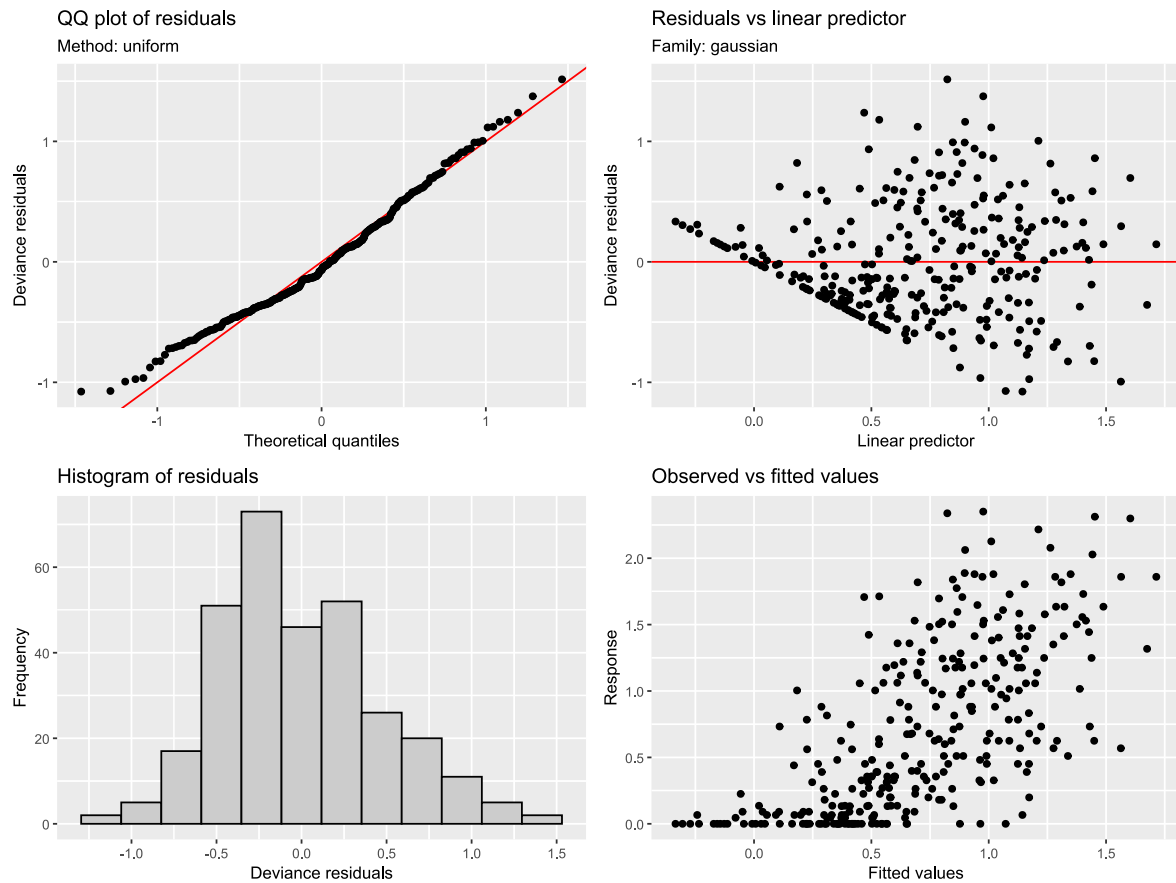


Figure S10. Diagnostics plots for the hierarchical general additive model including peak months with month, tidal state, and period*depth included as fixed terms.