The following supplement accompanies the article

Variation in occupancy and habitat use of *Mobula alfredi* at a major aggregation site

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Table S1. Results from the three sets of Generalised Linear Mixed-Effects Model (GLMM) analyses using the dredge function (for exploration only): (Set 1) the whole study period (2009-2012) with all environmental variables except *Sea temperature* (196 models run in total, only 20 first shown here), (Set 2) a subset of data comprising detections from October 2010 onwards when *Sea temperature* data were available (392 models run in total, only 20 first shown here), (Set 3) a subset of data comprising detections from July 2011 to integrate the hourly detection count of the '*sentinel* tag' at Severance Receiver as a fixed effect (624 models run in total, only 20 first shown here). Response variable is the presence or absence of manta rays and the random factor (1|Month/ID) designate calendar months and individual identification.

GLMM Set 1	*Diel*	*Moon*	*Wspeed*	*sex*	*Tide*	*WDir*	*Diel:Moon*	*Diel: sex*	*Diel:Tide*	*Moon:Tide*	df	logLik	AICc	delta
GLMM 1.1	+	+	+	+	+	+	NA	+	+	NA	33	-12599.3	25264.6	0.0
GLMM 1.2	+	+	+	+	+	+	NA	+	+	+	45	-12588.8	25267.8	3.1
GLMM 1.3	+	+	NA	+	+	+	NA	+	+	NA	29	-12606.8	25271.6	7.0
GLMM 1.4	+	+	+	+	+	+	+	+	+	NA	45	-12590.8	25271.6	7.0
GLMM 1.5	+	+	+	+	+	+	+	+	+	+	57	-12578.8	25271.7	7.1
GLMM 1.6	+	+	+	+	+	+	NA	NA	+	NA	30	-12606.4	25272.8	8.2
GLMM 1.7	+	+	+	NA	+	+	NA	NA	+	NA	29	-12607.6	25273.3	8.7
GLMM 1.8	+	+	+	+	+	NA	NA	+	+	NA	30	-12607.1	25274.2	9.6
GLMM 1.9	+	+	NA	+	+	+	NA	+	+	+	41	-12596.3	25274.7	10.1
GLMM 1.10	+	+	+	+	+	+	NA	+	NA	NA	24	-12613.7	25275.4	10.8
GLMM 1.11	+	+	+	+	+	+	NA	+	NA	+	36	-12601.7	25275.5	10.8
GLMM 1.12	+	+	+	+	+	+	NA	NA	+	+	42	-12596.2	25276.4	11.8
GLMM 1.13	+	+	+	NA	+	+	NA	NA	+	+	41	-12597.4	25277.0	12.3
GLMM 1.14	+	+	+	+	+	NA	NA	+	+	+	42	-12596.8	25277.7	13.0
GLMM 1.15	+	+	NA	+	+	+	+	+	+	NA	41	-12598.1	25278.3	13.7
GLMM 1.16	+	+	+	+	+	+	+	+	NA	+	48	-12591.1	25278.3	13.7
GLMM 1.17	+	+	NA	+	+	+	+	+	+	+	53	-12586.1	25278.4	13.8
GLMM 1.18	+	+	+	+	+	+	+	+	NA	NA	36	-12603.2	25278.5	13.8
GLMM 1.19	+	+	NA	+	+	+	NA	NA	+	NA	26	-12613.7	25279.4	14.8
GLMM 1.20	+	+	NA	NA	+	+	NA	NA	+	NA	25	-12614.9	25279.9	15.3

GLMM Set 2	*Diel*	*Moon*	*ST*	*Wspeed*	*sex*	*Tide*	*WDir*	*Diel: Moon*	*Diel: sex*	*Diel: Tide*	*Moon: Tide*	df	logLik	AICc	delta
GLMM 2.1	+	+	+	+	+	+	+	+	+	+	+	61	-5580.3	11283.0	0.0
GLMM 2.2	+	+	+	+	+	+	NA	+	+	+	+	58	-5583.5	11283.2	0.3
GLMM 2.3	+	+	+	+	NA	+	+	+	NA	+	+	57	-5586.3	11286.9	3.9
GLMM 2.4	+	+	+	+	NA	+	NA	+	NA	+	+	54	-5589.5	11287.2	4.2
GLMM 2.5	+	+	+	+	+	+	+	+	+	+	NA	49	-5594.8	11287.8	4.9
GLMM 2.6	+	+	+	+	+	+	NA	+	+	+	NA	46	-5597.8	11287.8	4.9
GLMM 2.7	+	+	+	+	+	+	+	+	NA	+	+	58	-5585.8	11287.9	5.0
GLMM 2.8	+	+	+	+	+	+	NA	+	NA	+	+	55	-5589.0	11288.2	5.2
GLMM 2.9	+	+	+	NA	+	+	+	+	+	+	+	57	-5587.8	11289.8	6.9
GLMM 2.10	+	+	+	+	+	+	NA	NA	+	+	+	46	-5599.2	11290.5	7.5
GLMM 2.11	+	+	+	+	+	+	NA	+	+	NA	NA	37	-5608.2	11290.6	7.6
GLMM 2.12	+	+	+	+	+	+	+	NA	+	+	+	49	-5596.3	11290.9	7.9
GLMM 2.13	+	+	+	+	+	+	+	+	+	NA	NA	40	-5605.4	11290.9	8.0
GLMM 2.14	+	+	+	+	+	+	NA	+	+	NA	+	49	-5596.6	11291.4	8.5
GLMM 2.15	+	+	+	+	NA	+	+	+	NA	+	NA	45	-5600.7	11291.6	8.6
GLMM 2.16	+	+	+	+	NA	+	NA	+	NA	+	NA	42	-5603.7	11291.6	8.7
GLMM 2.17	+	+	+	+	+	+	+	+	+	NA	+	52	-5593.7	11291.7	8.7
GLMM 2.18	+	+	+	+	+	+	+	+	NA	+	NA	46	-5600.2	11292.6	9.6
GLMM 2.19	+	+	+	+	+	+	NA	+	NA	+	NA	43	-5603.2	11292.6	9.6
GLMM 2.20	+	+	+	NA	NA	+	+	+	NA	+	+	53	-5593.6	11293.5	10.5

GLMM Set 3	*Diel*	*Moon*	*ST*	*Sen*	*Wspeed*	*sex*	*Tide*	*WDir*	*Diel:Moon*	*Diel: sex*	*Diel: Tide*	*Moon: Tide*	df	logLik	AICc	delta
GLMM 3.1	+	+	+	+	+	+	+	+	+	+	+	+	65	-3012.8	6156.4	0.0
GLMM 3.2	+	+	+	+	+	NA	+	+	+	NA	+	+	61	-3017.0	6156.6	0.3
GLMM 3.3	+	+	+	+	+	+	+	+	+	+	+	NA	53	-3025.6	6157.7	1.3
GLMM 3.4	+	+	+	+	+	+	+	+	+	NA	+	+	62	-3016.7	6158.1	1.7
GLMM 3.5	+	+	+	+	+	NA	+	+	+	NA	+	NA	49	-3030.0	6158.3	2.0
GLMM 3.6	+	+	+	+	+	+	+	+	+	+	NA	NA	44	-3035.1	6158.4	2.1
GLMM 3.7	+	+	+	+	+	+	+	+	+	NA	+	NA	50	-3029.7	6159.7	3.4
GLMM 3.8	+	+	+	+	+	NA	+	+	+	NA	NA	NA	40	-3039.9	6160.1	3.8
GLMM 3.9	+	+	+	+	+	+	+	+	+	+	NA	+	56	-3023.9	6160.2	3.8
GLMM 3.10	+	+	+	+	+	NA	+	+	+	NA	NA	+	52	-3028.5	6161.5	5.1
GLMM 3.11	+	+	+	+	+	+	+	+	+	NA	NA	NA	41	-3039.6	6161.5	5.2
GLMM 3.12	+	+	+	+	+	+	+	+	+	NA	NA	+	53	-3028.2	6162.9	6.5
GLMM 3.13	+	+	+	+	+	+	+	NA	+	+	+	+	62	-3019.4	6163.5	7.1
GLMM 3.14	+	+	+	+	+	NA	+	NA	+	NA	+	+	58	-3023.5	6163.5	7.1
GLMM 3.15	+	+	+	+	+	+	+	NA	+	+	NA	NA	41	-3040.9	6164.0	7.7
GLMM 3.16	+	+	+	+	+	+	+	NA	+	+	+	NA	50	-3031.9	6164.1	7.8
GLMM 3.17	+	+	+	+	+	NA	+	NA	+	NA	+	NA	46	-3036.0	6164.4	8.1
GLMM 3.18	+	+	+	+	+	+	+	NA	+	NA	+	+	59	-3023.2	6164.9	8.5
GLMM 3.19	+	+	+	+	+	NA	+	NA	+	NA	NA	NA	37	-3045.6	6165.4	9.0
GLMM 3.20	+	+	+	+	+	+	+	NA	+	NA	+	NA	47	-3035.7	6165.8	9.4

Abbreviations: *WSpeed*=wind speed, *WDir*=wind direction, *ST*= *Sea temperature*, *Sen*= *sentinel*, df= degree of freedom, AIC= Akaike's Information Criterion, NA= predictor not included, '+' = predictor included

Table S2. Output of the GLMM set 1 with greatest support with significant effect of environmental variables in comparison to the intercept (GLMM 1.1). Intercept includes: Diel-Night, WDir-W, Tide – Ebb and sex-F .

*Pres~ Diel phase * sex + Diel phase * Tide phase + ns(Moon) + WDir + ns(WSpeed)+ (1|Month/Manta ID)*

Fixed variables	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-4.670	0.218	-21.385	>0.01
Diel - Sunrise	2.203	0.136	16.210	>0.01
Diel - Day	2.274	0.098	23.299	>0.01
Diel - Sunset	0.941	0.183	5.127	>0.01
Wdir - N	0.237	0.078	3.031	>0.01
Wdir - E	0.079	0.076	1.044	0.30
Wdir - S	0.161	0.072	2.227	0.03
ns(*moon illum*, df = 4)1	-0.552	0.106	-5.217	>0.01
ns(*moon illum*, df = 4)2	0.266	0.092	2.899	>0.01
ns(*moon illum*, df = 4)3	0.729	0.134	5.440	>0.01
ns(*moon illum*, df = 4)4	-0.396	0.071	-5.580	>0.01
ns(*WSpeed*, df = 4)1	-0.099	0.122	-0.814	0.42
ns(*WSpeed*, df = 4)2	-0.299	0.104	-2.877	>0.01
ns(*WSpeed*, df = 4)3	-0.674	0.282	-2.388	0.02
ns(*WSpeed*, df = 4)4	-0.174	0.108	-1.603	0.11
Sex - M	-0.492	0.244	-2.012	0.04
Tide - Low	0.467	0.131	3.562	>0.01
Tide - Flood	0.563	0.109	5.153	>0.01
Tide - High	0.251	0.140	1.788	0.07
Diel - Sunrise:*Tide* - Low	-0.608	0.204	-2.975	>0.01
Diel - Day:*Tide* - Low	-0.312	0.144	-2.166	0.03
Diel - Sunset:*Tide* - Low	-0.499	0.260	-1.921	0.05
Diel - Sunrise:*Tide* - Flood	-0.699	0.166	-4.205	>0.01
Diel - Day:*Tide* - Flood	-0.506	0.120	-4.207	>0.01
Diel - Sunset:*Tide* - Flood	-0.751	0.215	-3.497	>0.01
Diel - Sunrise:*Tide* -High	-0.302	0.206	-1.468	0.14
Diel - Day:*Tide* - High	-0.312	0.154	-2.027	0.04
Diel - Sunset:*Tide* - High	-0.645	0.277	-2.332	0.02
Diel - Sunrise:*Sex* - M	-0.008	0.137	-0.058	0.95
Diel - Day:*Sex* - M	0.139	0.102	1.364	0.17
Diel - Sunset:*Sex* - M	0.598	0.172	3.483	>0.01

Abbreviations: W=West, E= East, N= North, S=South; WDir=wind direction, moon illum= moon illumination, WSpeed=Wind speed, M= male, ns= natural spline

Table S3. Output of the GLMM set 2 with greatest support with significant effect of environmental variables in comparison to the intercept (GLMM 2.2). Intercept includes: *Diel*-Night, *Tide* – Ebb and sex-F

[*Pres~ Diel phase**ns(*Moon illumination*) + *Diel phase*Tide phase*+ ns(*Moon illumination*)**Tide phase*+ *Diel*Sex* + *ns*(*WSpeed*)+ ns(*ST*)+(1|*Month/Manta ID*)]

Fixed effects	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**
(Intercept)	-3.73	0.46	-8.17	>0.01
Sex - M	-0.59	0.36	-1.66	0.10
Diel - Sunrise	2.13	0.43	4.98	>0.01
Diel - Day	1.92	0.23	8.45	>0.01
Diel - Sunset	0.48	0.70	0.68	0.50
ns(*moon illum*, df = 4)1	1.29	0.40	3.22	>0.01
ns(*moon illum*, df = 4)2	0.25	0.36	0.68	0.50
ns(*moon illum*, df = 4)3	-0.39	0.58	-0.68	0.50
ns(*moon illum*, df = 4)4	0.26	0.30	0.87	0.38
ns(*WSpeed*, df = 4)1	-0.08	0.17	-0.48	0.63
ns(*WSpeed*, df = 4)2	-0.62	0.16	-3.99	>0.01
ns(*WSpeed*, df = 4)3	-0.86	0.40	-2.14	0.03
ns(*WSpeed*, df = 4)4	-0.04	0.13	-0.29	0.77
Tide - Low,	0.31	0.27	1.15	0.25
Tide - Flood,	0.90	0.23	3.87	>0.01
Tide - High,	0.01	0.30	0.05	0.96
ns(*Sea temperature*, df = 4)1	-0.48	0.26	-1.81	0.07
ns(*Sea temperature*, df = 4)2	0.66	0.32	2.02	0.04
ns(*Sea temperature*, df = 4)3	-1.41	0.58	-2.42	0.02
ns(*Sea temperature*, df = 4)4	-2.15	0.45	-4.75	>0.01
Diel - Sunrise:ns(*moon illum*, df = 4)1	-0.83	0.67	-1.24	0.21
Diel - Day:ns(*moon illum*, df = 4)1	-1.59	0.37	-4.31	>0.01
Diel - Sunset:ns(*moon illum*, df = 4)1	-0.77	1.04	-0.74	0.46
Diel - Sunrise:ns(*moon illum*, df = 4)2	-0.40	0.54	-0.74	0.46
Diel - Day:ns(*moon illum*, df = 4)2	0.77	0.34	2.27	0.02
Diel - Sunset:ns(*moon illum*, df = 4)2	-0.44	0.75	-0.58	0.56
Diel - Sunrise:ns(*moon illum*, df = 4)3	-0.58	0.76	-0.76	0.44
Diel - Day:ns(*moon illum*, df = 4)3	0.58	0.53	1.08	0.28
Diel - Sunset:ns(*moon illum*, df = 4)3	0.24	1.11	0.21	0.83
Diel - Sunrise:ns(*moon illum*, df = 4)4	-0.38	0.41	-0.93	0.35
Diel - Day:ns(*moon illum*, df = 4)4	-0.98	0.27	-3.59	0.00
Diel - Sunset:ns(*moon illum*, df = 4)4	0.31	0.52	0.59	0.55
ns(*moon illum*, df = 4)1:*Tide* - Low	-0.76	0.46	-1.67	0.09
ns(*moon illum*, df = 4)2:*Tide* - Low	-0.18	0.40	-0.44	0.66
ns(*moon illum*, df = 4)3:*Tide* - Low	0.54	0.60	0.90	0.37
ns(*moon illum*, df = 4)4:*Tide* - Low	-0.09	0.31	-0.28	0.78
ns(*moon illum*, df = 4)1:*Tide* - Flood	-1.32	0.39	-3.38	>0.01
ns(*moon illum*, df = 4)2:*Tide* - Flood	-0.27	0.32	-0.83	0.41
ns(*moon illum*, df = 4)3:*Tide* - Flood	0.26	0.52	0.50	0.62
ns(*moon illum*, df = 4)4:*Tide* - Flood	-0.37	0.27	-1.37	0.17
ns(*moon illum*, df = 4)1:*Tide* - High	-0.16	0.48	-0.33	0.74
ns(*moon illum*, df = 4)2:*Tide* - High	-0.08	0.43	-0.19	0.85
ns(*moon illum*, df = 4)3:*Tide* - High	0.95	0.66	1.44	0.15

Fixed effects	Estimate	Std. Error	z value	Pr(>|z|)
ns(*moon illum*, df = 4)4:*Tide* - High	-0.65	0.35	-1.89	0.06
Diel - Sunrise:*Tide* - Low,	-0.26	0.31	-0.85	0.40
Diel - Day:*Tide* - Low,	-0.19	0.21	-0.93	0.35
Diel - Sunset:*Tide* - Low,	0.24	0.48	0.50	0.61
Diel - Sunrise:*Tide* - Flood,	-1.03	0.34	-2.99	>0.01
Diel - Day:*Tide* - Flood,	-0.60	0.16	-3.64	>0.01
Diel - Sunset:*Tide* - Flood,	-0.88	0.60	-1.47	0.14
Diel - Sunrise:*Tide* - High,	-0.31	0.37	-0.84	0.40
Diel - Day:*Tide* - High,	-0.47	0.21	-2.21	0.03
Diel - Sunset:*Tide* - High,	0.03	0.52	0.06	0.95
Sex - M:*Diel* - Sunrise,	0.25	0.19	1.28	0.20
Sex - M:*Diel* - Day,	0.26	0.14	1.88	0.06
Sex - M:*Diel* - Sunset,	0.79	0.24	3.28	>0.01

Abbreviations: W=West, E= East, N= North, S=South; *WDir*=wind direction, *moon illum*= *moon illum*ination, WSpeed=Wind speed, M= male, ns= natural spline

Table S4. Output of the GLMM set 3 with greatest support with significant effect of environmental variables in comparison to the intercept (GLMM 3.5). Intercept includes: *Diel*-Night, *WDir*-W and *Tide* – High

[*Pres~Diel phase**ns(*Moon illumination*)+ *Diel phase*Tide phase + WDir+* ns(*WSpeed*)+ ns(*ST*)+ns(*sentinel*)+ (1|*Month/Manta ID*)]

Fixed effects	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**
(Intercept)	-3.46	0.73	-4.74	>0.01
Diel - Sunrise	1.99	0.43	4.59	>0.01
Diel - Day	1.44	0.32	4.48	>0.01
Diel - Sunset	1.32	0.71	1.86	0.06
WDir - N	0.52	0.17	2.97	>0.01
WDir - E	0.23	0.17	1.39	0.17
WDir - S	0.18	0.16	1.10	0.27
ns(*moon illum*, df = 4)1	-0.01	0.44	-0.01	0.99
ns(*moon illum*, df = 4)2	0.72	0.39	1.86	0.06
ns(*moon illum*, df = 4)3	0.65	0.61	1.06	0.29
ns(*moon illum*, df = 4)4	-0.68	0.31	-2.16	0.03
ns(*WSpeed*, df = 4)1	0.35	0.26	1.35	0.18
ns(*WSpeed*, df = 4)2	-0.41	0.24	-1.72	0.08
ns(*WSpeed*, df = 4)3	-0.05	0.61	-0.08	0.94
ns(*WSpeed*, df = 4)4	-0.59	0.25	-2.39	0.02
Tide - Ebb,	-0.49	0.23	-2.14	0.03
Tide - Low,	0.02	0.25	0.09	0.93
Tide - Flood,	0.40	0.21	1.89	0.06
ns(*Sea temperature*, df = 4)1	-1.45	0.31	-4.75	>0.01
ns(*Sea temperature*, df = 4)2	0.97	0.43	2.25	0.02
ns(*Sea temperature*, df = 4)3	-2.81	0.73	-3.83	>0.01
ns(*Sea temperature*, df = 4)4	-2.80	0.61	-4.59	>0.01
ns(*sentinel*, df = 4)1	0.33	0.37	0.89	0.38
ns(*sentinel*, df = 4)2	0.06	0.26	0.23	0.81
ns(*sentinel*, df = 4)3	-1.03	0.88	-1.17	0.24
ns(*sentinel*, df = 4)4	0.06	0.47	0.14	0.89
Diel - Sunrise:ns(*moon illum*, df = 4)1	-0.26	0.94	-0.28	0.78
Diel - Day:ns(*moon illum*, df = 4)1	-1.64	0.51	-3.24	>0.01
Diel - Sunset:ns(*moon illum*, df = 4)1	0.46	1.54	0.30	0.76
Diel - Sunrise:ns(*moon illum*, df = 4)2	-0.61	0.68	-0.90	0.37
Diel - Day:ns(*moon illum*, df = 4)2	0.23	0.45	0.51	0.61
Diel - Sunset:ns(*moon illum*, df = 4)2	-1.52	1.02	-1.49	0.14
Diel - Sunrise:ns(*moon illum*, df = 4)3	-2.16	0.95	-2.27	0.02
Diel - Day:ns(*moon illum*, df = 4)3	-0.01	0.69	-0.02	0.98
Diel - Sunset:ns(*moon illum*, df = 4)3	-1.08	1.44	-0.75	0.45
Diel - Sunrise:ns(*moon illum*, df = 4)4	-0.59	0.54	-1.09	0.28
Diel - Day:ns(*moon illum*, df = 4)4	-1.53	0.37	-4.18	>0.01
Diel - Sunset:ns(*moon illum*, df = 4)4	0.57	0.78	0.74	0.46
Diel - Sunrise:*Tide* - Ebb,	0.39	0.48	0.81	0.42

Abbreviations: W=West, E= East, N= North, S=South; *WDir*=wind direction, *moon illum*= *moon illum*ination, WSpeed=Wind speed, M= male, ns= natural spline

Table S5. Relative variable importance for each GLMM set based on the sum of Akaike weights over all models including the explanatory variable: (1) the whole study period (2009-2012) with all environmental variables except *Sea temperature*, (2) a subset of data comprising detections from October 2010 onwards when *Sea temperature* data were available, (3) a subset of data comprising detections from July 2011 to integrate the hourly detection count of the '*sentinel* tag' at Severance Receiver as a fixed effect.

GLMM set 1	Importance	Number of containing models
Diel phase	1.00	156
Moon phase	1.00	144
Tidal phase	1.00	144
Wind Direction	0.99	98
Diel:Tide	0.99	60
sex	0.99	124
Diel:sex	0.97	52
Wind speed	0.97	98
Moon:Tide	0.19	56
Diel:Moon	0.05	60

GLMM set 2	Importance	Number of containing models
Diel phase	1.00	312
Moon phase	1.00	240
Sea temperature	1.00	156
Tidal phase	1.00	240
Wind Speed	0.98	156
Diel:Moon	0.98	120
Diel:Tide	0.97	120
Moon:Tide	0.90	96
sex	0.89	208
Diel:sex	0.82	104
Wind Direction	0.54	156

GLMM set 3	Importance	Number of containing models
Diel phase	1.00	624
Moon phase	1.00	480
Sea temperature	1.00	312
Wind Speed	1.00	312
Tidal phase	1.00	480
Sentinel	1.00	312
Diel:Moon	1.00	240
Wind Direction	0.96	3012
Diel:Tide	0.79	240
sex	0.65	416
Moon:Tide	0.60	192
Diel:sex	0.48	208

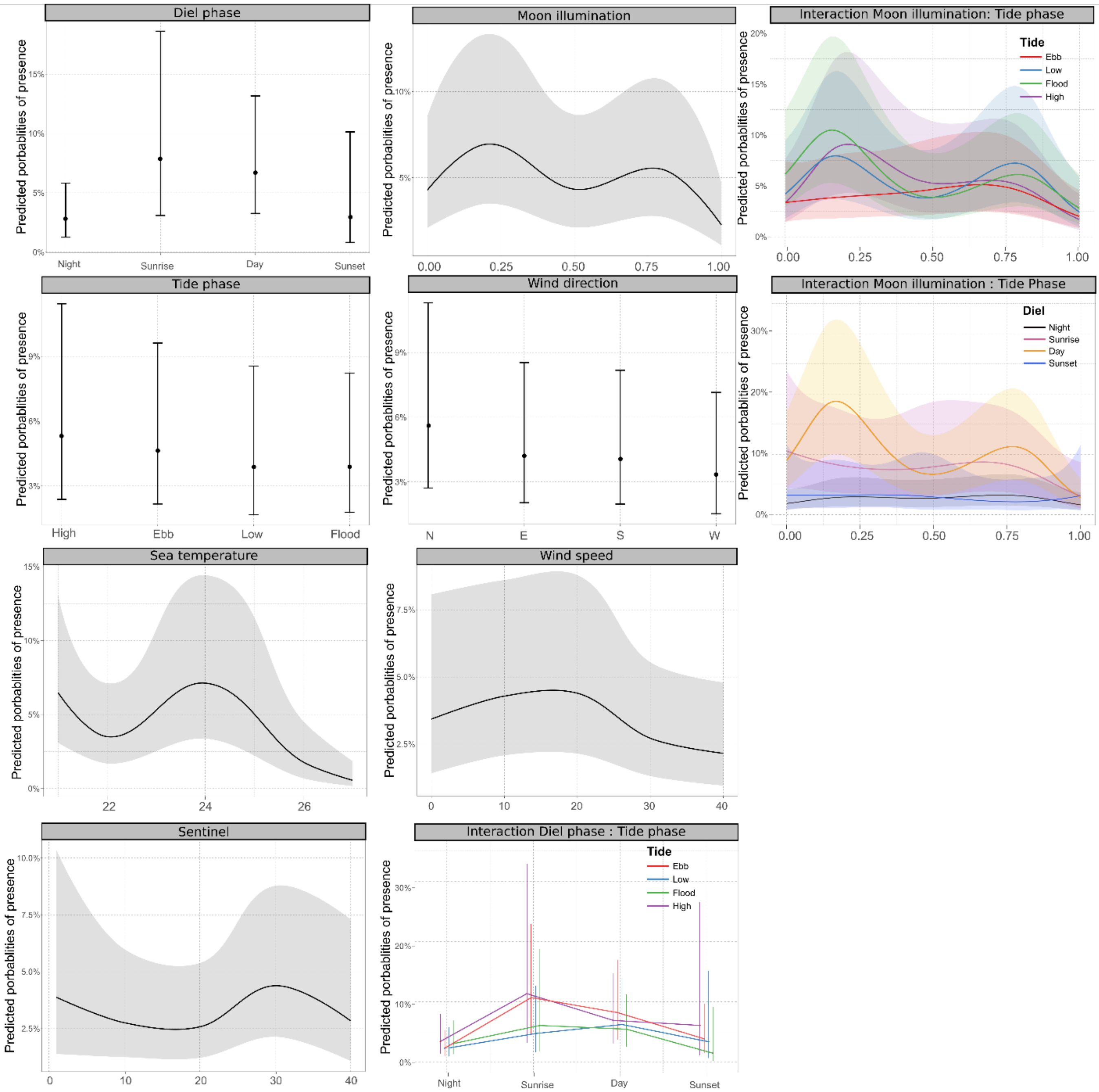

Figure S1. Marginal effects of predictors on the presence of reef manta rays at LEI from the best-fit generalised linear mixed effects model for each environmental variable retained in GLMM Set 3 (GLMM 3.5) using AICc score and the principle of parsimony *[Pres~Diel phase*ns(Moon illumination)+ Diel phase*Tide phase+ ns(Moon illumination)*Tide phase+ WDir+ ns(WSpeed)+ ns(ST)+ns(sentinel)+ (1|Month/Manta ID)]*. Grey-shaded areas represent the 95% confidence interval.