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Turtle density around Mussau Island, Papua New Guinea: with notes on the practicality of in-water distance sampling

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SUPPLEMENTARY MATERIAL

Table S1: The rationale behind the inclusion of different variables as part of detection or density formulae within distance sampling models.

Type	Variable	Rationale
Detection	Cloud cover	Light penetration affects detectability
	Position	Observer position affects detectability
	Secchi depth	Visibility affects detectability (reef crest only)
	Visibility scale	Visibility affects detectability (inshore only)
Density	Beaufort scale	Rough waters prevent sea turtles accessing reef areas
	People	Sea turtles actively avoid people
	Season	Sea turtle density has a seasonal pattern
	Session	Sea turtle density varies between monitoring sessions
	Tide	Sea turtle density varies with tidal phase
	Village	Sea turtle density varies with study site

Table S2: Candidate models explaining sea turtle density at the reef crest transects as ranked by the Akaike Information Criterion with a small sample correction (AICc). The first component of the model equation represents the variables associated with the detection rate and the second component represents the variables associated with abundance estimation ('~1' indicates an intercept only model). Key: K = number of parameters; Δ AICc = difference between the AICc of the current model and the top ranked model; Model weight = the relative likelihood of the model; Log likelihood = maximised value of the log-likelihood function.

Model (~detection ~density)	K	AICc	Δ AICc	Model weight	Log likelihood
mod 36 ~Position ~ Beaufort scale + People + Session + Tide + Village	12	5583.84	0.00	1.00	-2779.31
mod 12 ~1 ~ Beaufort scale + People + Session + Tide + Village	11	5605.83	21.99	0.00	-2791.40
mod 35 ~Position ~ Beaufort scale + People + Season + Tide + Village	10	5618.18	34.34	0.00	-2798.67
mod 11 ~1 ~ Beaufort scale + People + Season + Tide + Village	9	5640.11	56.27	0.00	-2810.71
mod 34 ~Position ~ Beaufort scale + Season + Tide + Village	9	5737.08	153.24	0.00	-2859.19
mod 10 ~1 ~ Beaufort scale + Season + Tide + Village	8	5758.67	174.83	0.00	-2871.06
mod 9 ~1 ~ Season + Tide + Village	7	5878.16	294.31	0.00	-2931.86
mod 32 ~Position ~ Beaufort scale + Tide + Village	8	6118.71	534.87	0.00	-3051.08
mod 8 ~1 ~ Beaufort scale + Tide + Village	7	6140.28	556.44	0.00	-3062.93
mod 31 ~Position ~ Tide + Village	7	6239.87	656.03	0.00	-3112.72
mod 7 ~1 ~ Tide + Village	6	6261.63	677.78	0.00	-3124.65
mod 27 ~Position ~ Village	5	6316.97	733.13	0.00	-3153.37
mod 3 ~1 ~ Village	4	6338.61	754.77	0.00	-3165.23
mod 30 ~Position ~ Season + Tide	7	6578.23	994.39	0.00	-3281.90
mod 6 ~1 ~ Season + Tide	6	6603.59	1019.75	0.00	-3295.64
mod 29 ~Position ~ Season	5	6642.11	1058.27	0.00	-3315.94
mod 5 ~1 ~ Season	4	6666.68	1082.84	0.00	-3329.27
mod 28 ~Position ~ Tide	6	6832.30	1248.46	0.00	-3409.99
mod 4 ~1 ~ Tide	5	6857.03	1273.19	0.00	-3423.40
mod 26 ~Position ~ Beaufort scale	5	6863.88	1280.04	0.00	-3426.83
mod 2 ~1 ~ Beaufort scale	4	6887.16	1303.31	0.00	-3439.50
mod 25 ~Position ~ 1	4	6917.23	1333.39	0.00	-3454.54
mod 1 ~1 ~ 1	3	6941.22	1357.38	0.00	-3467.57
mod 33 ~Position ~ Season + Tide + Village	8	7891.95	2308.11	0.00	-3937.70
mod 48 ~Cloud cover ~ Beaufort scale + People + Session + Tide + Village	12	9023.06	3439.22	0.00	-4498.92
mod 47 ~Cloud cover ~ Beaufort scale + People + Season + Tide + Village	10	9062.11	3478.27	0.00	-4520.63
mod 24 ~Secchii ~ Beaufort scale + People + Session + Tide + Village	12	9139.13	3555.29	0.00	-4556.96
mod 51 ~Position + Secchii ~ Beaufort scale + People + Session + Tide + Village	13	9141.34	3557.50	0.00	-4556.96
mod 52 ~Cloud cover + Position + Secchi ~ Beaufort scale + People + Session + Tide + Village	14	9143.57	3559.73	0.00	-4556.96
mod 23 ~Secchii ~ Beaufort scale + People + Season + Tide + Village	10	9173.38	3589.54	0.00	-4576.27
mod 49 ~Position + Secchii ~ Beaufort scale + Session + Tide + Village	12	9175.65	3591.81	0.00	-4575.22

Model (~detection ~density)	K	AICc	Δ AICc	Model weight	Log likelihood
mod 50 ~Position + Secchi + Position + Cloud cover ~ Beaufort scale + Session + Tide + Village	13	9177.86	3594.02	0.00	-4575.22
mod 46 ~Cloud cover ~ Beaufort scale + Season + Tide + Village	9	9291.93	3708.09	0.00	-4636.62
mod 22 ~Secchi ~ Beaufort scale + Season + Tide + Village	9	9291.93	3708.09	0.00	-4636.62
mod 45 ~Cloudcover ~ Season + Tide + Village	8	9324.39	3740.55	0.00	-4653.92
mod 21 ~Secchi ~ Season + Tide + Village	8	9411.39	3827.55	0.00	-4697.42
mod 20 ~Secchi ~ Beaufort scale + Tide + Village	8	9673.52	4089.68	0.00	-4828.48
mod 44 ~Cloud cover ~ Beaufort scale + Tide + Village	8	9673.52	4089.68	0.00	-4828.48
mod 43 ~Cloudcover ~ Tide + Village	7	9737.53	4153.69	0.00	-4861.55
mod 19 ~Secchi ~ Tide + Village	7	9794.85	4211.01	0.00	-4890.21
mod 39 ~Cloudcover ~ Village	5	9809.84	4226.00	0.00	-4899.81
mod 15 ~Secchi ~ Village	5	9871.80	4287.96	0.00	-4930.79
mod 42 ~Cloudcover ~ Season + Tide	7	10074.62	4490.78	0.00	-5030.09
mod 41 ~Cloudcover ~ Season	5	10130.90	4547.06	0.00	-5060.34
mod 18 ~Secchi ~ Season + Tide	7	10136.82	4552.97	0.00	-5061.19
mod 17 ~Secchi ~ Season	5	10199.87	4616.03	0.00	-5094.82
mod 40 ~Cloudcover ~ Tide	6	10345.34	4761.50	0.00	-5166.51
mod 38 ~Cloud cover ~ Beaufort scale	5	10361.09	4777.25	0.00	-5175.43
mod 16 ~Secchi ~ Tide	6	10390.24	4806.39	0.00	-5188.96
mod 14 ~Secchi ~ Beaufort scale	5	10420.35	4836.50	0.00	-5205.06
mod 37 ~Cloudcover ~ 1	4	10423.56	4839.72	0.00	-5207.71
mod 13 ~Secchi ~ 1	4	10474.40	4890.56	0.00	-5233.12

Table S3: Candidate models explaining sea turtle density at the inshore transects as ranked by the Akaike Information Criterion with a small sample correction (AICc). The first component of the model equation represents the variables associated with the detection rate and the second component represents the variables associated with abundance estimation ('~1' indicates an intercept only model). Key: K = number of parameters; Δ AICc = difference between the AICc of the current model and the top ranked model; Model weight = the relative likelihood of the model; Log likelihood = maximised value of the log-likelihood function.

Model (~detection ~density)	K	AICc	Δ AICc	Model weight	Log likelihood
mod 49 ~Position + Visibility ~ Beaufort + Session + Tide + Village	13	3262.24	0.00	0.67	-1617.41
mod 52 ~Cloud cover + Position + Visibility ~ Beaufort scale + People + Session + Tide + Village	15	3263.67	1.43	0.33	-1615.89
mod 22 ~Visibility ~ Beaufort + Season + Tide + Village	10	3333.09	70.85	0.00	-1656.12
mod 48 ~Cloud cover ~ Beaufort scale + People + Session + Tide + Village	12	3350.00	87.76	0.00	-1662.39
mod 36 ~Position ~ Beaufort + People + Session + Tide + Village	12	3354.57	92.33	0.00	-1664.68
mod 12 ~1 ~ Beaufort + People + Session + Tide + Village	11	3355.18	92.93	0.00	-1666.07
mod 21 ~Visibility ~ Season + Tide + Village	9	3419.89	157.65	0.00	-1700.60
mod 47 ~Cloud cover ~ Beaufort scale + People + Season + Tide + Village	10	3440.99	178.75	0.00	-1710.07
mod 46 ~Cloud cover ~ Beaufort scale + Season + Tide + Village	9	3442.60	180.35	0.00	-1711.95
mod 20 ~Visibility ~ Beaufort + Tide + Village	9	3445.44	183.20	0.00	-1713.37
mod 11 ~1 ~ Beaufort + People + Season + Tide + Village	9	3448.48	186.23	0.00	-1714.89
mod 34 ~Position ~ Beaufort + Season + Tide + Village	9	3450.36	188.11	0.00	-1715.83
mod 10 ~1 ~ Beaufort + Season + Tide + Village	8	3450.78	188.54	0.00	-1717.11
mod 19 ~Visibility ~ Tide + Village	8	3487.14	224.90	0.00	-1735.29
mod 50 ~Position + Visibility + Position + Cloud cover ~ Beaufort scale + Session + Tide + Village	14	3497.31	235.06	0.00	-1733.83
mod 44 ~Cloud cover ~ Beaufort scale + Tide + Village	8	3501.13	238.89	0.00	-1742.29
mod 32 ~Position ~ Beaufort + Tide + Village	8	3505.51	243.26	0.00	-1744.48
mod 8 ~1 ~ Beaufort + Tide + Village	7	3506.07	243.82	0.00	-1745.82
mod 18 ~Visibility ~ Season + Tide	8	3517.03	254.78	0.00	-1750.24
mod 45 ~Cloud cover ~ Season + Tide + Village	8	3525.14	262.90	0.00	-1754.29
mod 33 ~Position ~ Season + Tide + Village	8	3532.29	270.05	0.00	-1757.87
mod 9 ~1 ~ Season + Tide + Village	7	3532.74	270.49	0.00	-1759.15
mod 43 ~Cloud cover ~ Tide + Village	7	3552.08	289.84	0.00	-1768.83
mod 31 ~Position ~ Tide + Village	7	3556.93	294.69	0.00	-1771.25
mod 7 ~1 ~ Tide + Village	6	3557.48	295.23	0.00	-1772.58
mod 24 ~Visibility ~ Beaufort + People + Session + Tide + Village	13	3565.14	302.89	0.00	-1768.85
mod 51 ~Position + Visibility ~ Beaufort + People + Session + Tide + Village	14	3565.99	303.74	0.00	-1768.17
mod 16 ~Visibility ~ Tide	7	3614.64	352.39	0.00	-1800.10
mod 42 ~Cloud cover ~ Season + Tide	7	3615.12	352.88	0.00	-1800.35

Model (~detection ~density)	K	AICc	Δ AICc	Model weight	Log likelihood
mod 6 ~1 ~ Season + Tide	6	3617.76	355.52	0.00	-1802.72
mod 30 ~Position ~ Season + Tide	7	3618.26	356.02	0.00	-1801.92
mod 23 ~Visibility ~ Beaufort + People + Season + Tide + Village	11	3647.01	384.77	0.00	-1811.99
mod 40 ~Cloud cover ~ Tide	6	3665.86	403.61	0.00	-1826.77
mod 4 ~1 ~ Tide	5	3666.09	403.84	0.00	-1827.93
mod 28 ~Position ~ Tide	6	3666.72	404.47	0.00	-1827.20
mod 35 ~Position ~ Beaufort + People + Season + Tide + Village	10	3929.01	666.77	0.00	-1954.08
mod 17 ~Visibility ~ Season	6	4381.39	1119.14	0.00	-2184.53
mod 15 ~Visibility ~ Village	6	4399.36	1137.12	0.00	-2193.52
mod 14 ~Visibility ~ Beaufort	6	4423.82	1161.57	0.00	-2205.75
mod 39 ~Cloud cover ~ Village	5	4452.82	1190.58	0.00	-2221.30
mod 41 ~Cloud cover ~ Season	5	4452.92	1190.67	0.00	-2221.34
mod 29 ~Position ~ Season	5	4455.63	1193.39	0.00	-2222.70
mod 5 ~1 ~ Season	4	4455.79	1193.54	0.00	-2223.82
mod 27 ~Position ~ Village	5	4458.42	1196.18	0.00	-2224.10
mod 3 ~1 ~ Village	4	4459.51	1197.27	0.00	-2225.68
mod 38 ~Cloud cover ~ Beaufort scale	5	4480.68	1218.44	0.00	-2235.23
mod 26 ~Position ~ Beaufort	5	4482.55	1220.30	0.00	-2236.16
mod 2 ~1 ~ Beaufort	4	4482.64	1220.39	0.00	-2237.24
mod 13 ~Visibility ~ 1	5	4520.89	1258.65	0.00	-2255.33
mod 37 ~Cloud cover ~ 1	4	4570.02	1307.77	0.00	-2280.93
mod 1 ~1 ~ 1	3	4571.79	1309.54	0.00	-2282.85
mod 25 ~Position ~ 1	4	4571.83	1309.59	0.00	-2281.84

Table S4: Summary of mean sea turtle encounter rates and their standard deviation (sd).

Village	Session	Transect	mean (sea turtles km⁻¹)	sd (sea turtles km⁻¹)
Lolieng	session 1	Inshore	11.8	7.1
Lolieng	session 2	Inshore	4.0	7.0
Lolieng	session 3	Inshore	7.5	6.7
Lolieng	session 4	Inshore	5.6	10.3
Lolieng	session 1	Reefcrest	11.7	8.5
Lolieng	session 2	Reefcrest	15.2	4.8
Lolieng	session 3	Reefcrest	10.0	7.5
Lolieng	session 4	Reefcrest	23.9	10.0
Nae	session 1	Inshore	0.0	0.0
Nae	session 2	Inshore	1.5	2.6
Nae	session 1	Reefcrest	0.7	0.8
Nae	session 2	Reefcrest	3.0	2.5

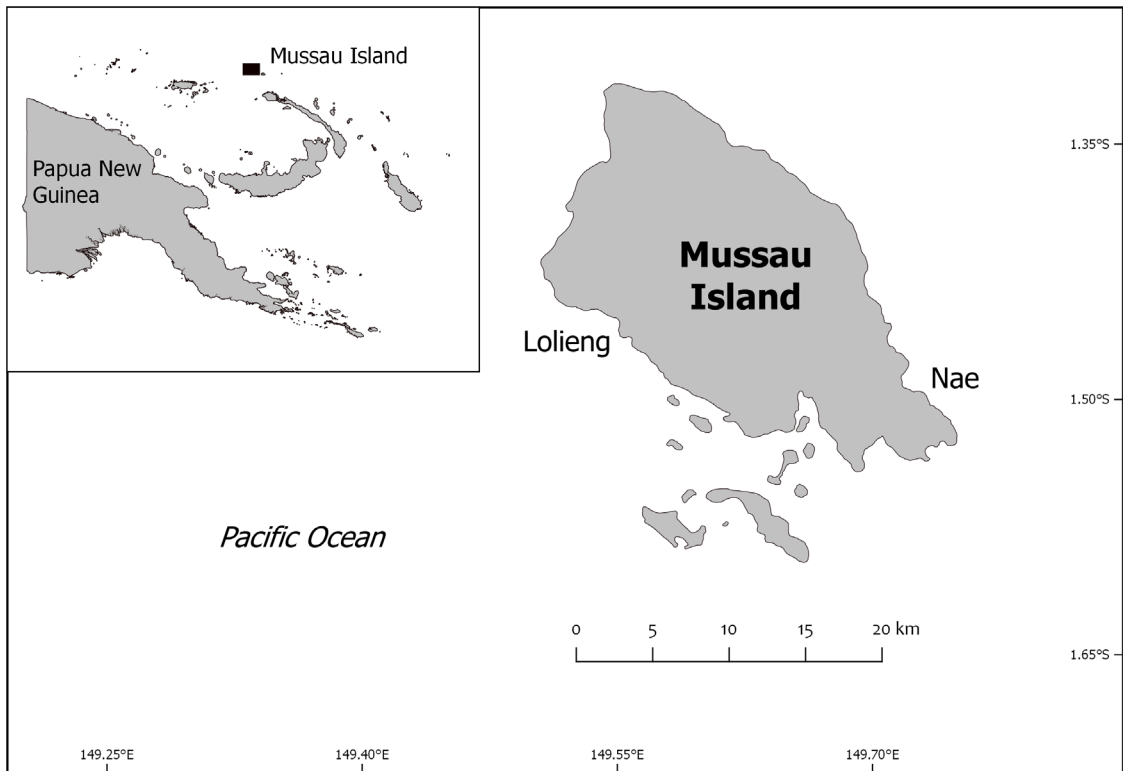


Fig. S1: Study site locations, Mussau Island, Papua New Guinea.

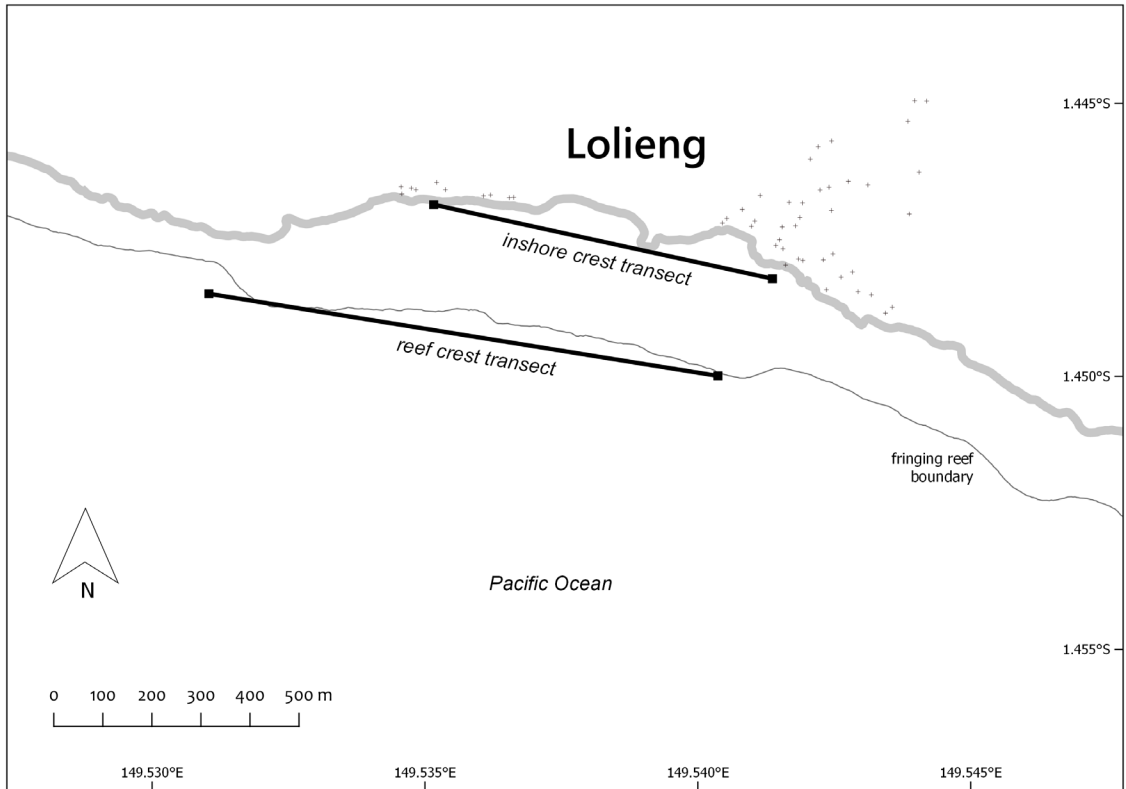


Fig. S2: Study site location: detail Lolieng, Mussau Island.

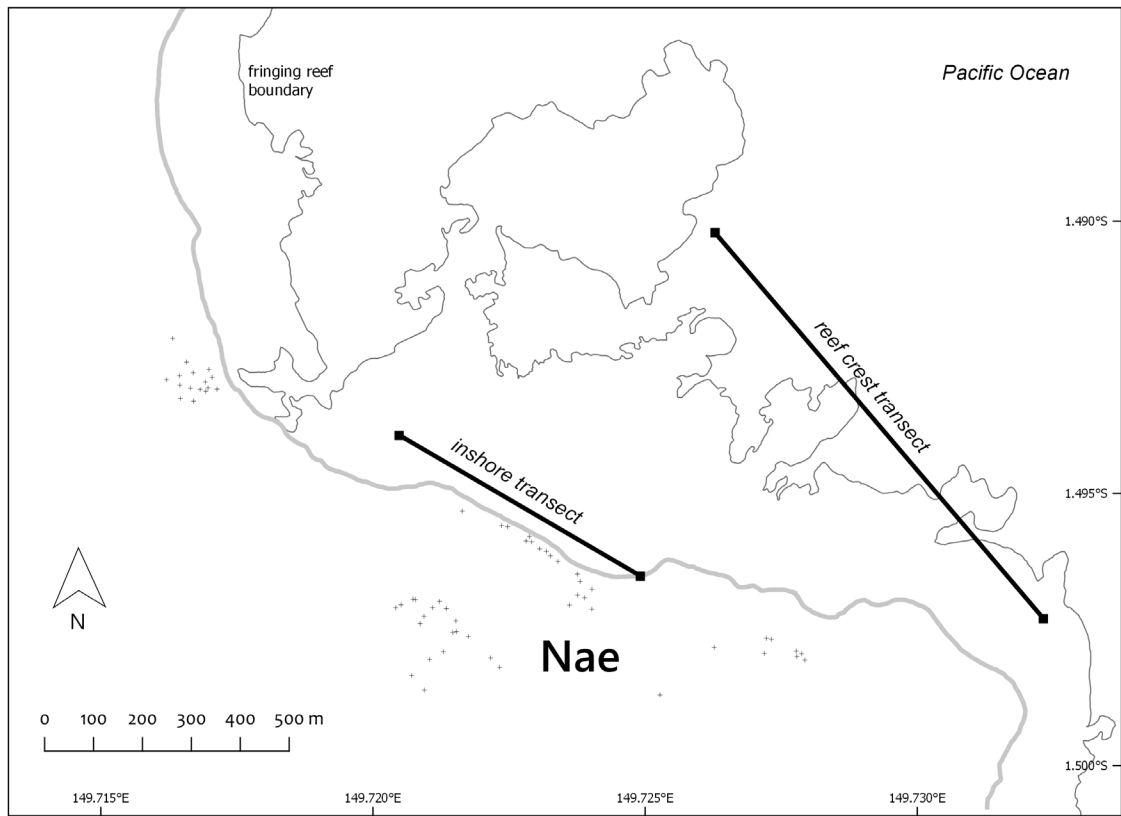


Fig. S3: Study site location: detail Nae, Mussau Island.

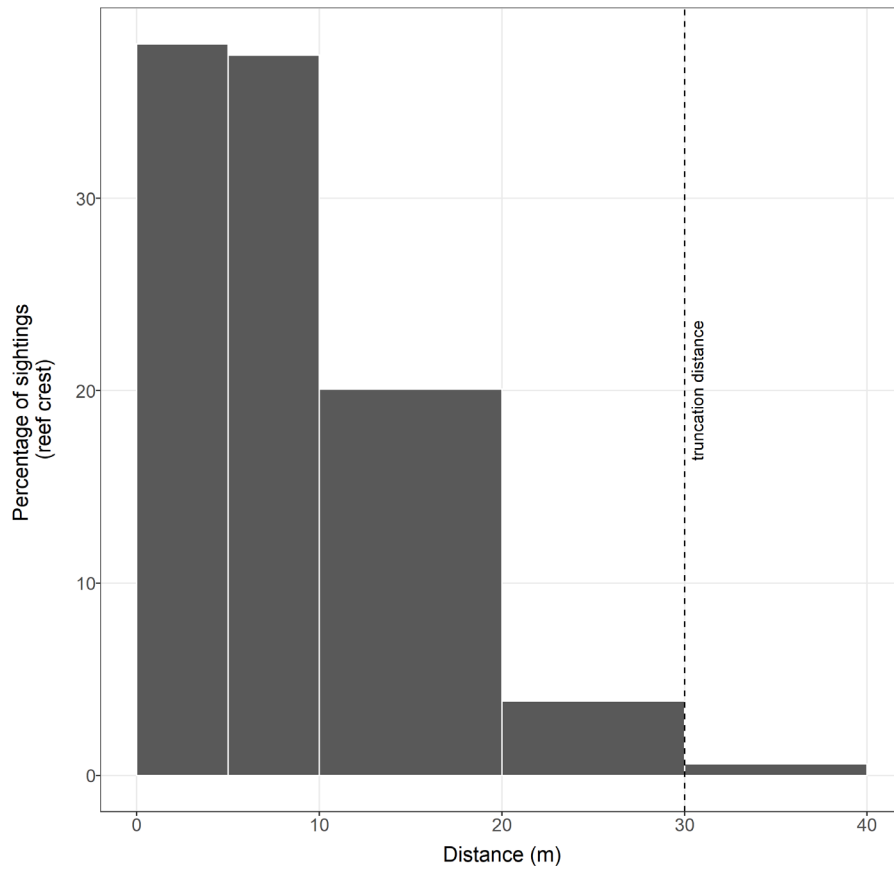


Fig. S4: Percentage of sightings seen at each distance interval at the reef crest transects. Distances > 30 m were removed from the analysis (truncated).

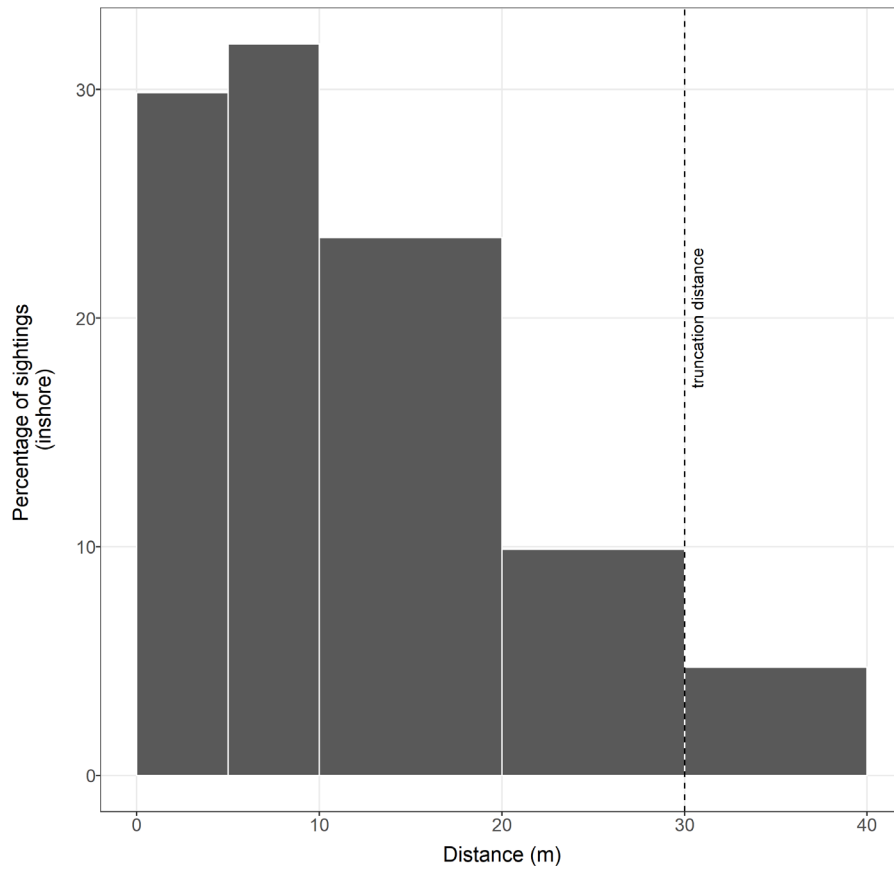


Fig. S5: Percentage of sightings seen at each distance interval at the inshore transects. Distances > 30 m were removed from the analysis (truncated).

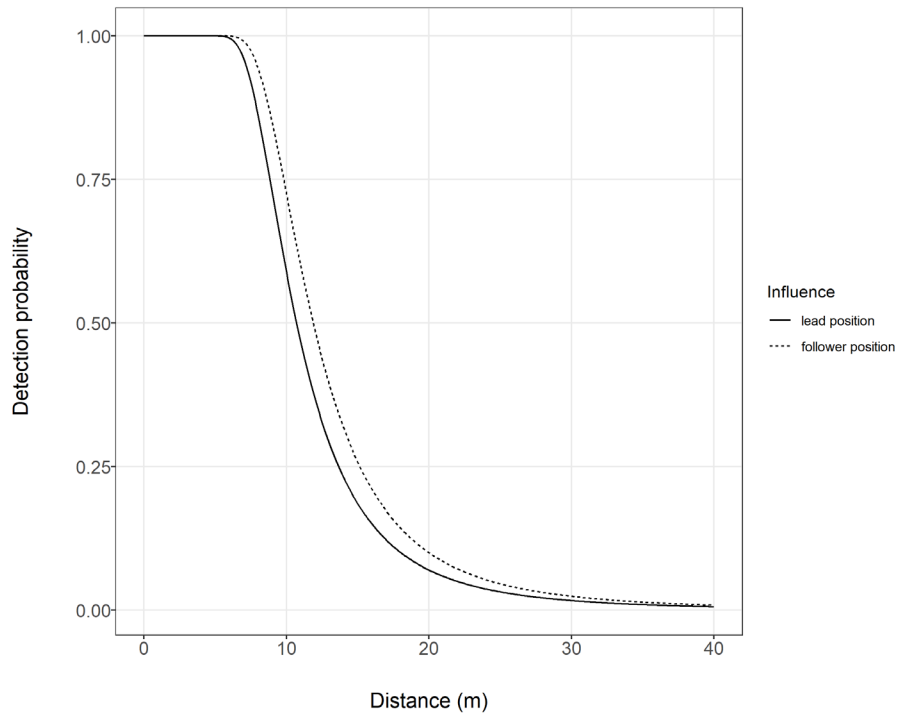


Fig. S6: The influence of observer position on detection probability at the reef crest transects predicted by the top ranked model: $\sim Position$ (detection) $\sim Beaufort\ scale + People + Session + Tide + Village$ (detection).

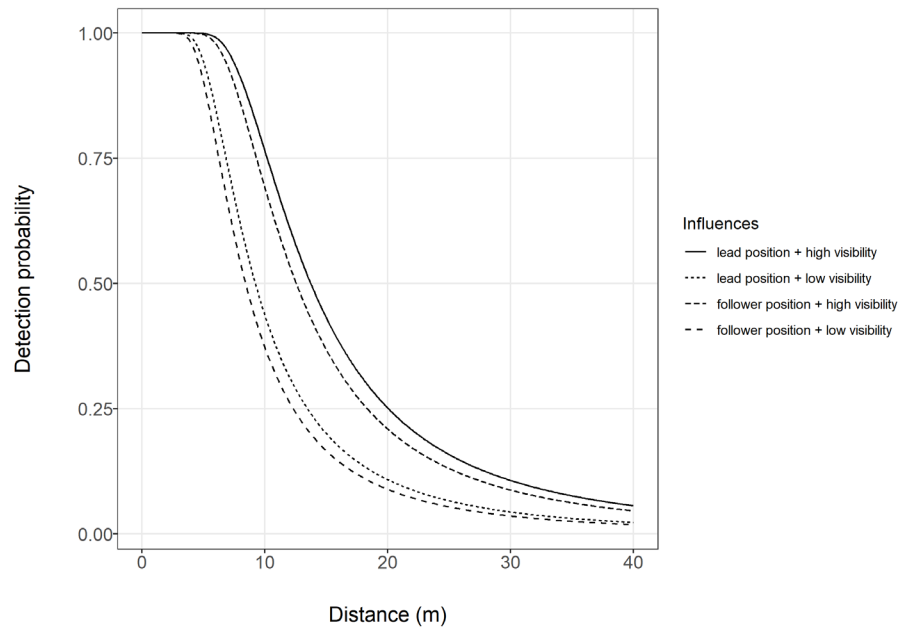


Fig. S7: The influence of observer position and visibility on detection probability at the inshore crest transects predicted by the top ranked model: $\sim Position + Visibility$ (detection) $\sim Beaufort\ scale + Session + Tide + Village$ (density)

