

Supplementary Information

Satellite tracking reveals sex-specific differences in the geographical and vertical habitat use of whale sharks, *Rhincodon typus*, in the Eastern Indian Ocean.

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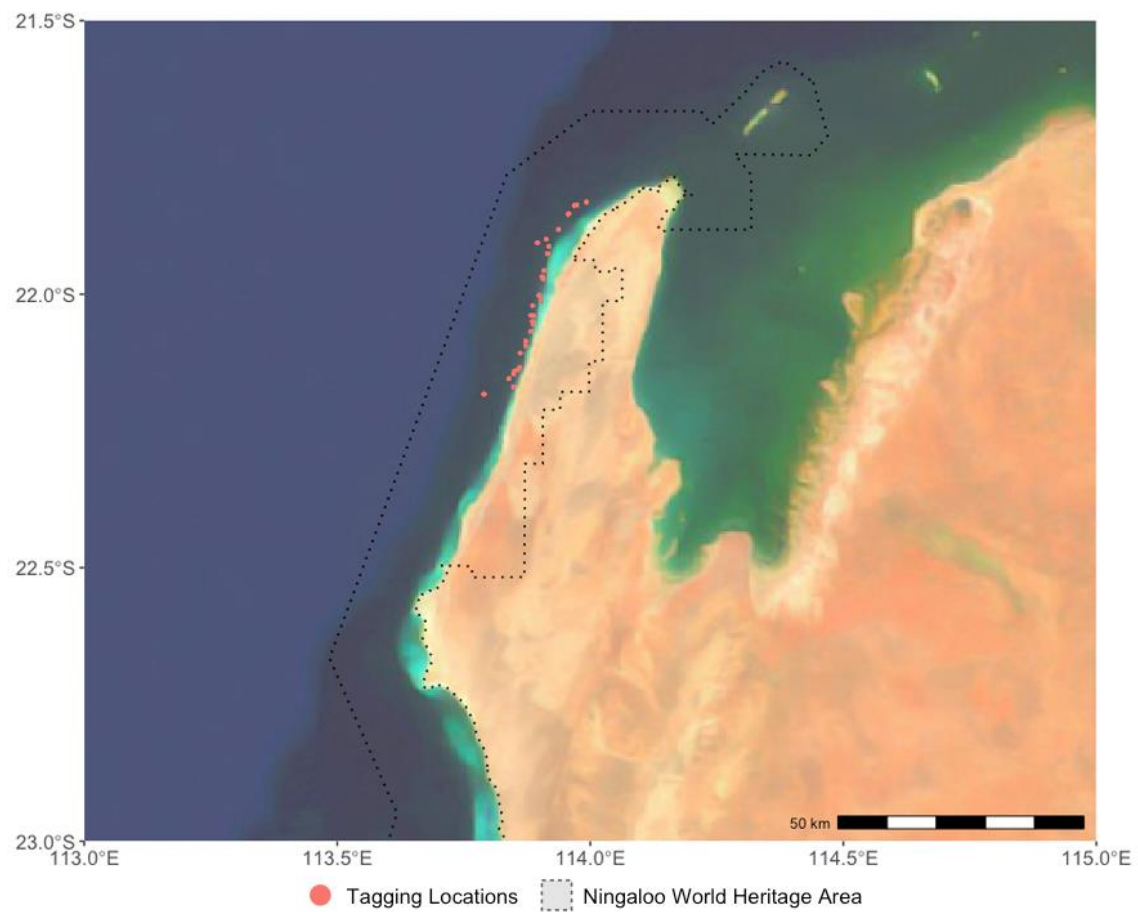
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Supplementary Fig. 1 Locations of satellite tag deployments on individual whale sharks

Supplementary Table 1 Summary of satellite tag deployments on whale sharks at Ningaloo Reef. WSID = Whale Shark ID. TL = Total Length (m). Adult = N – No calcified claspers or <8 m female, Y – Yes based on visual of calcified claspers, U – Unsure but TL >8m. Sat. Fixes = Number of satellite position fixes. Return = Month of return migrations to Ningaloo Reef

WSID	Sex	TL	Adult	Tag Type	Tag Date	Days at Liberty	Sat. Fixes	Track Length (km)	Return
143675*	F	7.5	N	SPLASH	1/6/2015	9	10	355.4	-
143678	M	5	N	SPLASH	26/6/2015	38	96	2066.8	-
143674*	U	4.5	N	SPLASH	26/6/2015	42	140	768.3	-
161737	F	3.8	N	SPOT	1/6/2016	62	14	371.8	-
161736	M	3.8	N	SPOT	1/6/2016	180	194	1830.9	-
143669	F	5.5	N	SPLASH	1/6/2016	119	345	1254.3	-
161733	F	4	N	SPOT	2/6/2016	76	60	1881.5	-
143677	F	7	N	SPLASH	2/6/2016	220	55	3931.8	-
161734	F	5	N	SPOT	2/6/2016	102	135	1035.8	-
143670	M	7	N	SPLASH	2/6/2016	56	118	1316.4	-
161735	M	9	Y	SPOT	3/6/2016	91	135	937.0	-
163470†	F	7	N	SPLASH	7/7/2016	206	501	7079.5	Dec
163471†	M	6	N	SPLASH	7/7/2016	296	53	4871.1	Oct
36295	M	8.1	U	SPLASH	5/6/2017	324	151	2286.0	Mar
36324	M	8	N	SPLASH	5/6/2017	250	298	2917.9	Aug
161731	M	7.5	N	SPOT	5/6/2017	340	231	5978.3	Sep
161730	F	8	U	SPOT	6/6/2017	33	122	460.3	-
161729	F	7.1	N	SPOT	6/6/2017	40	94	516.0	-
36293	M	9	Y	SPLASH	6/6/2017	97	58	925.3	-
161727	M	8.7	Y	SPOT	7/6/2017	14	53	132.7	-
36309	F	8	U	SPLASH	8/6/2017	232	154	4001.0	Nov
36325	M	8.9	N	SPLASH	8/6/2017	152	334	3110.6	-
161732	M	8.3	N	SPOT	10/6/2017	141	204	4729.2	-
57818†	M	9.3	Y	miniPAT	4/6/2018	12	14	71.3	-
57827	F	9.1	U	SPLASH	6/6/2018	86	81	3230.0	-
57822	F	7.1	N	SPLASH	8/6/2018	13	11	382.6	-
57825	F	6.4	N	SPLASH	10/6/2018	22	60	522.3	-
57824	F	6.5	N	SPLASH	10/6/2018	159	298	6259.5	Aug
57829†	M	8.7	Y	SPLASH	10/6/2018	310	161	6515.1	Dec
57821	F	6.6	N	SPLASH	12/6/2018	127	409	4320.0	-
57828†	M	6.5	N	SPLASH	13/6/2018	280	406	6896.1	Jan
57826	F	7.6	N	SPLASH	13/6/2018	325	93	2817.3	-
57830	M	9.2	Y	SPLASH	13/6/2018	50	169	765.4	-
57823	M	8.7	U	SPLASH	13/6/2018	108	277	4366.3	-
57819†	F	7.6	N	miniPAT	13/6/2018	22	26	605.4	-

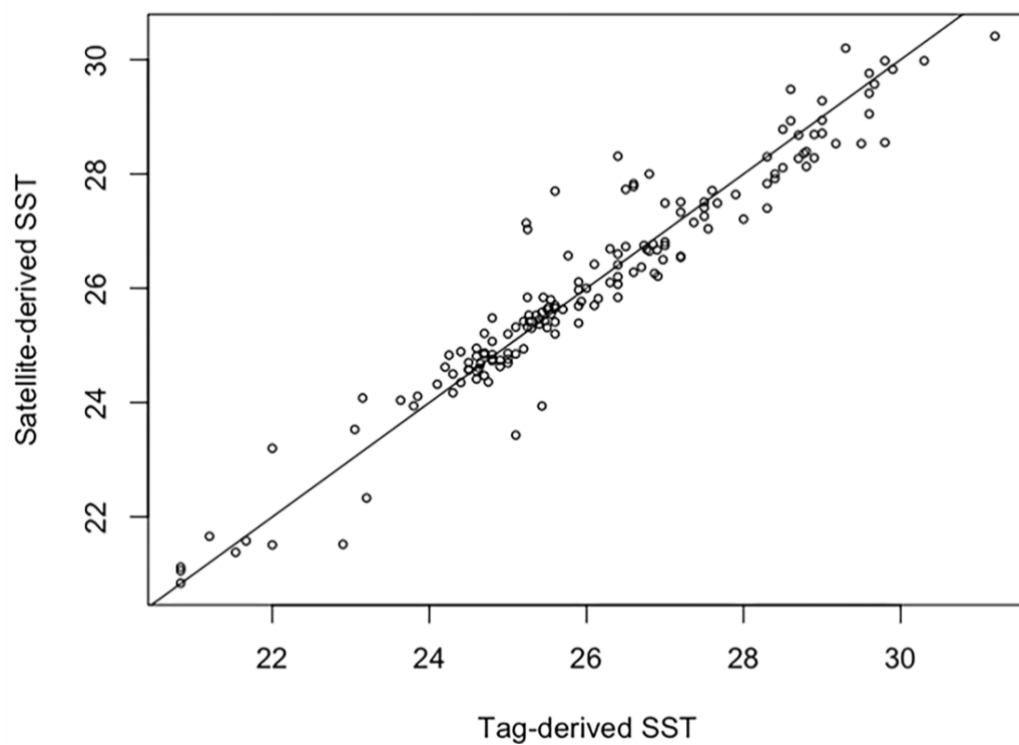
* Tags that were excluded from further analysis

† Tags that included geolocation estimates from light-level data

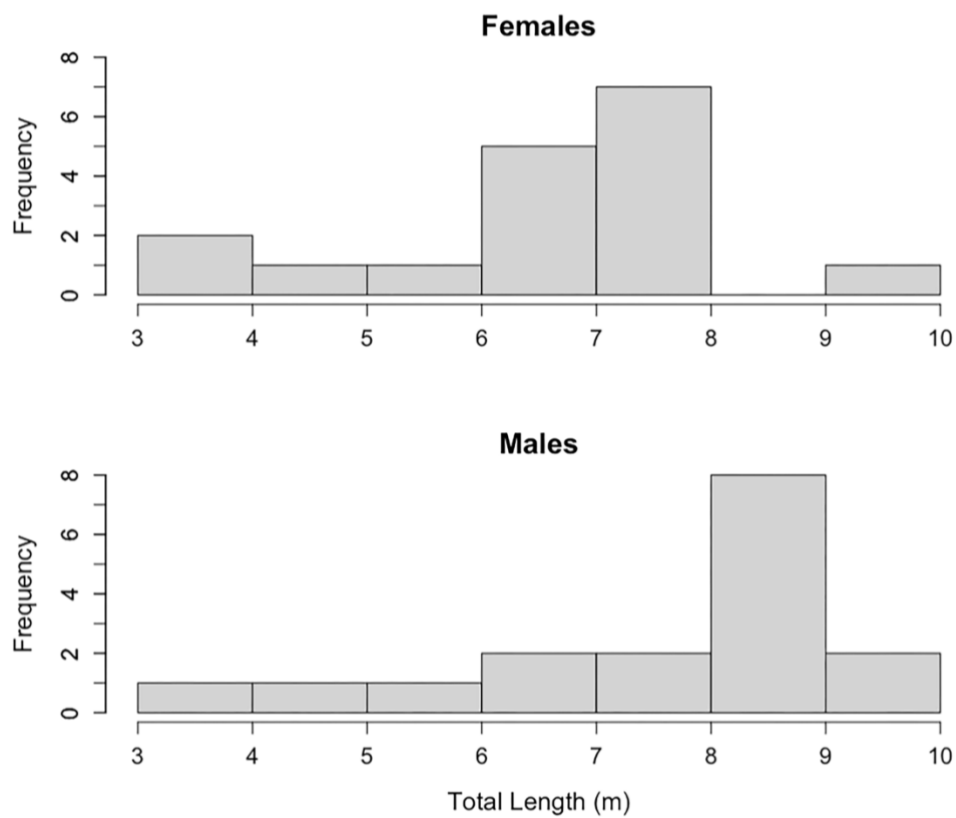
Supplementary Table 2 Summary of depth and temperature data reported by satellite tags deployed on whale sharks. WSID = Whale Shark ID, * indicates excluded tags. Data Source: Time Series = Summarised time series depth data (10-minute), Histogram = Summarised time at depth and temperature data (24-Hour), PDT = Profiles of Depth and Temperature (24-Hour). SST = Sea Surface Temperature (24-Hour). Data Days = Number of days of data

WSID	Sex	Days at Liberty	Data Source	Data Days	Depth Range (m)	Temperature Range (°C)
143675	F	9	Time Series	3	3.5 – 213.5	-
			Histogram	6	0 – 200	22 – 28
			PDT	6	0 – 200	17.2 – 26.4
143678	M	38	Time Series	7	2 – 1427.5	-
			Histogram	38	0 – 1800	10 – 28
			PDT	19	0 – 888	5.4 – 34
			SST	18	-	24.2 – 27.6
143674	U	42	Time Series	4	2 – 143	-
			Histogram	9	5 – 300	18 – 26
			PDT	5	0 – 864	5.6 – 25.2
161736	M	180	Histogram	40	-	16 – 28
			SST	41	-	24 – 26
143669	F	119	Time Series	10	0.5 – 209	-
			Histogram	42	0 – 400	18 – 28
			PDT	27	0 – 312	13 – 26.4
			SST	27	-	23.3 – 26
161733	F	76	Histogram	15	-	16 – 30
			SST	14	-	24.5 – 28.5
143677	F	220	Time Series	4	3 – 328.5	-
			Histogram	16	0 – 800	10 – 30
			PDT	12	0 – 768	6.4 – 29.8
			SST	12	-	25.1 – 29
143670	M	56	Time Series	12	1 – 322	-
			Histogram	46	0 – 1200	10 – 28
			PDT	57	0 – 1056	5 – 26.8
			SST	56	-	24.6 – 26.7
161735	M	79	Histogram	29	-	16 – 28
			SST	39	-	19 – 25.1
143672*	F	22	Time Series	6	0.5 – 92	-
			Histogram	11	0 – 150	24 – 28
			PDT	11	0 – 88	4 – 25.5
163470	F	206	Time Series	37	0.5 – 1648.5	-
			Histogram	82	0 – 1800	10 – 34
			PDT	81	0 – 1624	3.4 – 31
			SST	77	-	23.7 – 31
163471	M	296	Time Series	22	0.5 – 1290.5	-
			Histogram	38	0 – 1800	10 – 30
			PDT	40	0 – 1288	4.4 – 31.9
			SST	39	-	21.9 – 29
36295	M	324	Time Series	10	0.5 – 397.5	-
			Histogram	9	0 – 150	22 – 30
			PDT	13	0 – 192	21.8 – 30.8
			SST	13	-	25.1 – 29.2
36324	M	250	Time Series	20	1 – 184	-
			Histogram	75	0 – 800	10 – 28
			PDT	79	0 – 464	9.4 – 29
			SST	78	-	21.8 – 26.1
161729	F	40	Histogram	12	-	16 – 28
			SST	23	-	19.3 – 27.8
36293	M	97	Time Series	4	0.5 – 153	-
			Histogram	7	0 – 1200	10 – 28

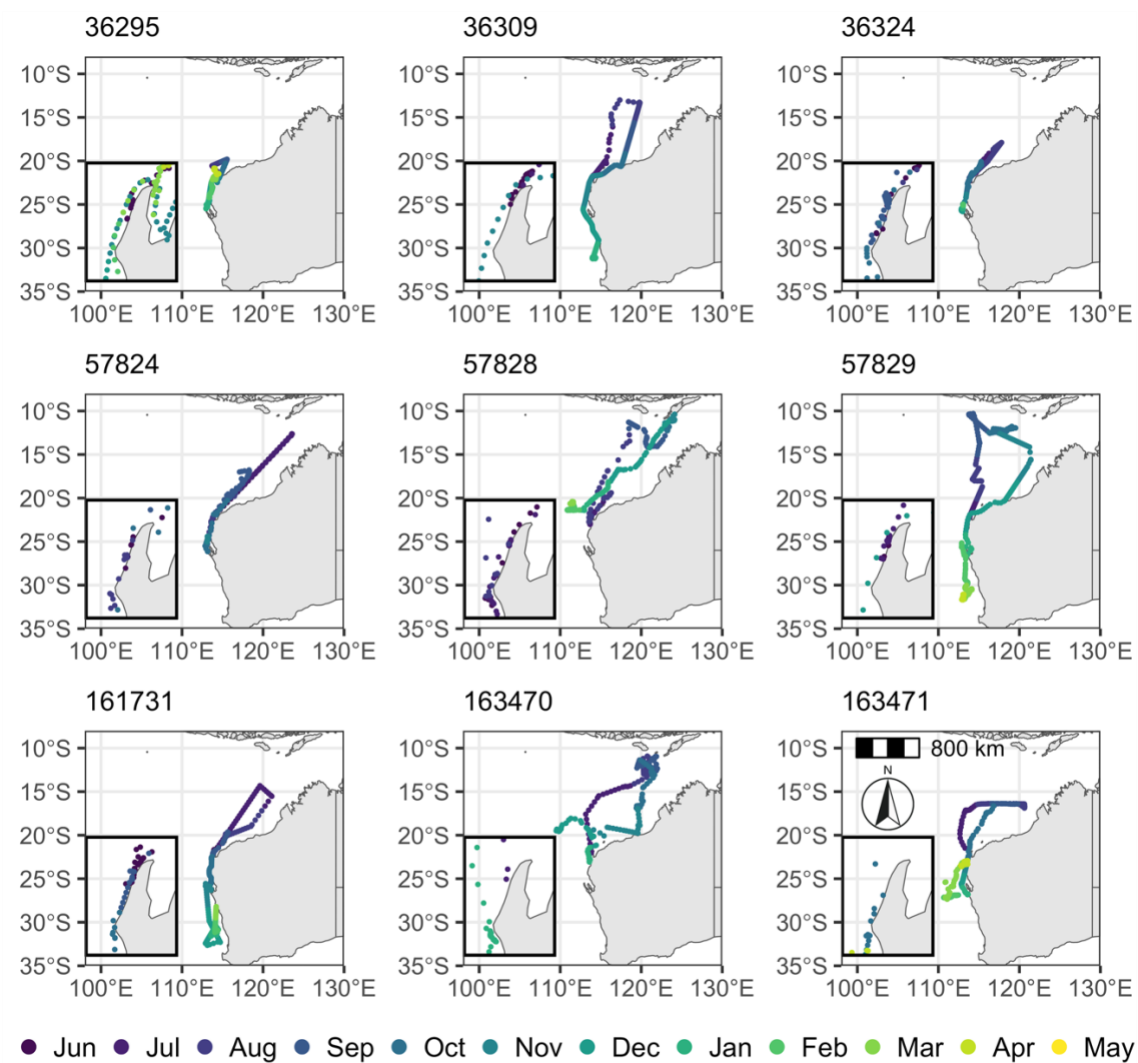
161727	M	14	PDT	8	0 – 240	15.6 – 26.5
			SST	7	-	24.3 – 26.2
			Histogram	9	-	22 – 30
			SST	13	-	24 – 27.6
36309	F	232	Time Series	25	0.5 – 1576	-
			Histogram	101	0 – 1800	10 – 30
			PDT	92	0 – 1832	2.4 – 29.4
			SST	93	-	21.8 – 29.4
36325	M	152	Time Series	10	0.5 – 336.5	-
			Histogram	21	0 – 800	10 – 28
			PDT	17	0 – 456	8.8 – 26.3
			SST	19	-	24.7 – 26.1
161732	M	141	Histogram	66	-	10 – 32
			SST	53	-	22.5 – 29.2
57818	M	12	Time Series	4	0.5 – 85	-
			Histogram	4	0 – 200	26
			PDT	4	0 – 72	4 – 25.9
			SST	5	-	20.3 – 25.9
57827	F	86	Time Series	14	0.5 – 870	-
			Histogram	9	0 – 1800	6 – 32
			PDT	15	0 – 1296	4.4 – 27.5
			SST	17	-	25 – 27.5
57822	F	13	Time Series	2	0.5 – 62.5	-
			Histogram	1	0 – 100	20 – 34
			PDT	2	0 – 80	19.4 – 32.4
			SST	2	-	26
57825	F	22	Time Series	5	0.5 – 161	-
			Histogram	22	0 – 200	20 – 28
			PDT	23	0 – 192	18.4 – 26.1
			SST	22	-	24.2 – 26
57824	F	159	Time Series	33	0.5 – 1105.5	-
			Histogram	142	0 – 1200	6 – 30
			PDT	160	0 – 1104	4.6 – 28.4
			SST	159	-	20.5 – 28.7
57829	M	310	Time Series	42	1 – 1906	-
			Histogram	284	0 – 2000	3 – 34
			PDT	310	0 – 1904	2.2 – 31.1
			SST	281	-	20.4 – 31.1
57821	F	127	Time Series	12	0.5 – 345.5	-
			Histogram	45	0 – 1800	6 – 28
			PDT	38	0 – 1696	3.2 – 26.6
			SST	38	-	24.4 – 26.6
57828	M	280	Time Series	42	0.5 – 1188.5	-
			Histogram	271	0 – 1800	6 – 36
			PDT	280	0 – 1320	4.2 – 32.6
			SST	296	-	22.4 – 31.7
57826	F	325	Time Series	2	1 – 247	-
			Histogram	11	0 – 400	15 – 30
			PDT	6	0 – 136	15.2 – 27.6
			SST	7	-	23 – 25.3
57830	M	50	Time Series	11	0.5 – 202	-
			Histogram	48	0 – 400	15 – 26
			PDT	49	0 – 368	12.8 – 25.7
			SST	48	-	24.3 – 25.6
57823	M	108	Time Series	11	0.5 – 179.5	-
			Histogram	51	0 – 800	10 – 30
			PDT	44	0 – 656	7 – 27.8
			SST	45	-	24.4 – 27.8
57819	F	22	Time Series	6	0.5 – 322	-
			Histogram	6	0 – 400	16 – 26
			PDT	6	0 – 296	4 – 25.4
			SST	6	-	25.1 – 25.6



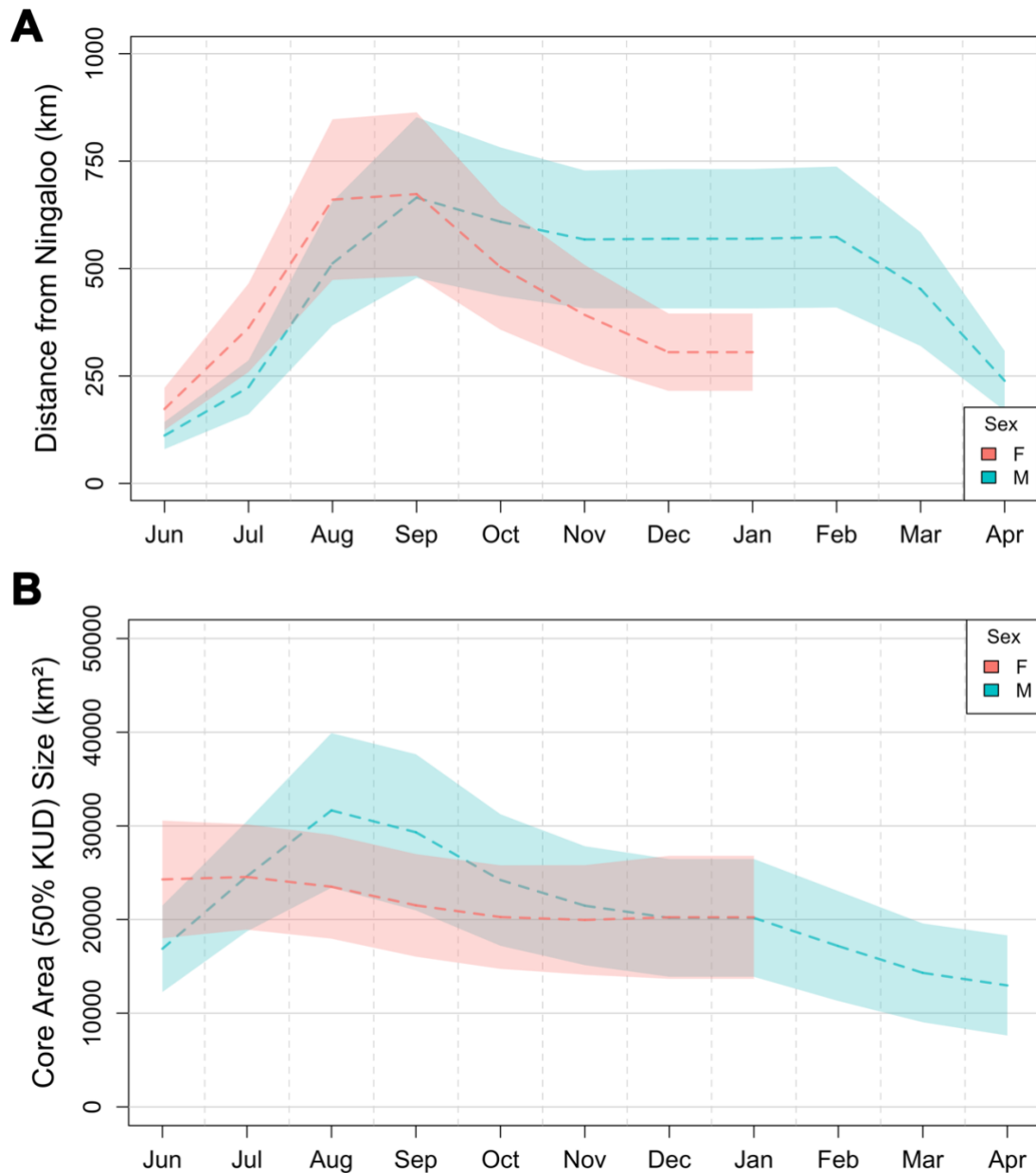
Supplementary Fig. 2 Comparison of Sea Surface Temperature (SST, °C) collected from Wildlife Computers tags with satellite-derived SST records extracted with daily locations



Supplementary Fig. 3 Length frequency histogram of tagged male and female whale sharks



Supplementary Fig. 4 Tracks of whale sharks that made return migrations to Ningaloo Reef (inset map) after migrating further than 300 km from the tagging location. Coloured points show the months of the year of locations obtained after tagging annually in June and July. The Whale Shark ID is shown at the top of each panel (see Supplementary Table 1)



Supplementary Fig. 5 (A) Predictions of distance from Ningaloo Reef for female (red) and male (blue) whale sharks, derived from the best Generalised Additive Model (GAM) (Table 3a). **(B)** Predictions of the monthly 50% Kernel Utilisation Distribution (KUD) area sizes (km²) for female (red) and male (blue) whale sharks, derived from the best GAM (Table 3b). Lines and shaded regions indicate the predicted values and standard errors for each month.

Supplementary Table 3 Summary of the Core (50% KUD) and Total (95%) area sizes (km²) of individual whale sharks tagged at Ningaloo Reef, throughout their entire deployments

WSID	Sex	Adult	Days at Liberty	Core Area (km ²)	Total Area (km ²)
161729	F	N	40	12025	54725
161730	F	U	33	14075	65450
161734	F	N	102	21125	71650
143669	F	N	119	13075	76150
57822	F	N	13	25700	84975
57825	F	N	22	21475	85475
161737	F	N	62	15525	90625
57819	F	N	22	41725	127200
161733	F	N	76	87650	328350
57826	F	N	325	29600	325575
57824	F	N	159	95975	378825
36309	F	U	232	140050	524825
57827	F	U	86	147100	586325
143677	F	N	220	116950	588225
163470	F	N	206	133975	668700
57821	F	N	127	107775	564525
Mean Core/Total Area (km ²)	F	-	-	63987.5	288850.0
57818	M	Y	12	9400	37025
161727	M	Y	14	9300	37175
143670	M	N	56	23575	81675
57830	M	Y	50	18675	85775
161735	M	Y	91	25675	90050
36293	M	Y	97	30425	100800
161736	M	N	180	34225	118850
36295	M	U	324	40875	139900
36324	M	N	250	41650	181825
36325	M	N	152	43400	193425
143678	M	N	38	119250	404550
57823	M	U	108	60775	434750
163471	M	N	296	102275	471850
161731	M	N	340	102325	490425
161732	M	N	141	65200	572400
57828	M	N	280	106375	578875
57829	M	Y	310	176950	761575
Mean Core/Total Area (km ²)	M	-	-	59432.3	281230.9

Supplementary Table 4 Aggregated Time at Depth (TAD) data reported by satellite tags deployed on whale sharks. TAD Bin = Time at Depth (m), Weighted Mean = mean TAD weighted by number of tags and days of data, Weighted SE = Weighted Standard Error, Rescaled Mean = Weighted mean rescaled to 100% across all TAD bins

Sex	Onshore /Offshore	TAD Bin (m)	Number of Days	Number of Tags	Weighted Mean	Weighted SE	Rescaled Mean
F	offshore	0 - 10	206	9	48.02	17.11	45.49
F	offshore	11 - 20	204	9	8.35	6.28	7.91
F	offshore	21 - 40	204	9	11.84	6.64	11.21
F	offshore	41 - 60	204	9	10.13	6.33	9.59
F	offshore	61 - 100	204	9	13.71	10.63	12.98
F	offshore	101 - 200	184	9	5.44	7.77	5.15
F	offshore	201 - 400	188	8	3.29	5.87	3.11
F	offshore	401 - 800	92	6	2.36	3.90	2.24
F	offshore	801 - 1200	22	5	1.17	0.88	1.11
F	offshore	1201 - 1800	12	4	1.28	0.46	1.21
M	offshore	0 - 10	480	9	41.58	20.69	38.78
M	offshore	11 - 20	480	9	8.40	6.58	7.84
M	offshore	21 - 40	480	9	14.66	9.50	13.68
M	offshore	41 - 60	477	9	10.85	7.45	10.12
M	offshore	61 - 100	457	8	13.87	12.17	12.94
M	offshore	101 - 200	405	8	8.14	9.85	7.60
M	offshore	201 - 400	384	9	5.29	8.36	4.93
M	offshore	401 - 800	171	8	1.68	2.55	1.57
M	offshore	801 - 1200	44	5	1.05	0.60	0.98
M	offshore	1201 - 1800	28	4	1.26	0.76	1.17
M	offshore	1801 - 2000	8	1	0.43	0.26	0.40
F	onshore	0 - 10	267	9	42.00	20.96	39.22
F	onshore	11 - 20	268	9	13.62	10.63	12.72
F	onshore	21 - 40	268	9	18.39	12.04	17.18
F	onshore	41 - 60	262	9	11.44	9.22	10.69
F	onshore	61 - 100	216	9	13.25	12.74	12.37
F	onshore	101 - 200	119	9	8.38	11.77	7.83
M	onshore	0 - 10	460	10	39.44	19.74	36.46
M	onshore	11 - 20	461	10	12.46	9.53	11.52
M	onshore	21 - 40	461	10	19.94	10.84	18.44
M	onshore	41 - 60	441	10	12.76	9.31	11.80
M	onshore	61 - 100	380	10	13.29	14.06	12.28
M	onshore	101 - 200	204	10	10.29	11.15	9.51

Supplementary Table 5 Aggregated Time at Temperature (TAT) data reported by satellite tags deployed on whale sharks. TAT Bin = Time at Temperature (°C), Weighted Mean = mean TAT weighted by number of tags and days of data, Weighted SE = Weighted Standard Error, Rescaled Mean = Weighted mean rescaled to 100% across all TAT bins

Sex	Onshore/ Offshore	TAT Bin (°C)	Number of Days	Number of Tags	Weighted Mean	Weighted SE	Rescaled Mean
F	offshore	0 - 10	71	6	11.01	14.00	6.34
F	offshore	11 - 22	191	10	22.25	24.37	12.81
F	offshore	23 - 24	211	10	19.08	23.40	10.98
F	offshore	25 - 26	207	11	34.21	30.63	19.70
F	offshore	27 - 28	153	10	32.34	30.23	18.62
F	offshore	29 - 30	36	4	39.09	24.32	22.51
F	offshore	31 - 32	7	1	15.54	13.30	8.95
F	offshore	33 - 36	2	1	0.15	0.05	0.09
M	offshore	0 - 10	167	8	8.50	11.72	5.26
M	offshore	11 - 22	416	11	25.13	27.59	15.57
M	offshore	23 - 24	434	11	14.84	21.86	9.19
M	offshore	25 - 26	433	12	30.57	31.24	18.94
M	offshore	27 - 28	339	11	40.11	30.11	24.85
M	offshore	29 - 30	153	5	31.79	22.48	19.69
M	offshore	31 - 32	41	2	9.38	12.10	5.81
M	offshore	33 - 36	5	2	1.12	1.56	0.69
F	onshore	0 - 10	23	4	6.63	8.78	2.95
F	onshore	11 - 22	144	10	48.94	41.44	21.82
F	onshore	23 - 24	188	11	38.34	34.78	17.09
F	onshore	25 - 26	241	11	53.56	38.90	23.88
F	onshore	27 - 28	88	9	44.64	34.60	19.90
F	onshore	29 - 30	30	7	31.88	28.86	14.21
F	onshore	31 - 32	1	1	0.30	0.00	0.13
M	onshore	0 - 10	17	5	6.25	8.47	2.85
M	onshore	11 - 22	210	15	38.11	39.48	17.36
M	onshore	23 - 24	434	15	38.46	36.77	17.52
M	onshore	25 - 26	487	15	62.72	36.32	28.58
M	onshore	27 - 28	181	11	41.14	34.68	18.74
M	onshore	29 - 30	52	6	30.66	22.73	13.97
M	onshore	31 - 32	6	1	2.13	2.40	0.97