

Network analysis reveals multispecies spatial associations in the shark community of a Caribbean marine protected area

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Further Information on Sharks Excluded from Analyses

Of the 48 sharks tagged in BIRNM, 12 were discarded from all analyses while 3 were included only in the residency index calculation. Sharks were discarded mainly due to poor detection histories over a short period of time, which limited our ability to analyze data collected from these individuals and make confident, ecologically sound conclusions about their spatial ecology. Four of these sharks registered three or fewer detections, including one whose tag apparently was defective and registered zero detections despite being released within range of deployed receivers (T1, R2, R6, R18 in Supplement Table 1). Four more sharks registered less than 1,000 detections over eight or fewer days, with three having five or fewer days with more than one valid detection. These sharks were discarded from the analysis (R8, R17, LEM6, LEM9).

Additionally, we determined that four sharks registering less than 1,000 valid detections experienced predation mortality (LEM3, LEM7, LEM8, LEM11). Upon examining each shark's daily detection history, these sharks exhibited aberrant movements, visiting receivers that they had never used before and registering 100–200 more detections per day than previously observed. This lasted for 3–4 days before detections ceased. Since all of these sharks were young of the year or small juvenile lemon sharks between 53 and 74 cm fork length, we assume that this departure from normal behavior was actually detections registering on receivers while the tag was in the digestive tract of another, larger predator.

The remaining three sharks (LEM12, N1, R12) had detection histories of over a month but registered less than 1,000 detections overall. These sharks have low site fidelity to the array, limiting our ability to assess habitat use and draw sound ecological conclusions with network analysis, but they were included in the residency index calculation to avoid skewing this metric towards highly resident sharks. We felt it was not valid to include the other 12 sharks in the residency calculation due to their extremely limited detection histories.

Table S1. A table of all tagged sharks in this study, including species, tag type, tag power, estimated tag life, shark size, year tagged, detection history within BIRNM, and the use of each shark in further analyses. As described in the methods, sharks absent from the array for more than one hour were determined to be outside of BIRNM and the cumulative time absent along with the time at liberty was used to calculate the percent of time undetected.

Shark	Species	Tag Type	Power	Estimated Tag Life	Fork Length (cm)	Year Tagged	Number of Detections	Days Detected in BIRNM	Cumulative Time Detected in BIRNM	Cumulative Time Outside of BIRNM	% Time Undetected	Analysis Fate
T1	tiger	V16	High	3217	147	2014	2	1	0	26424	100.00	Dropped
T2	tiger	V16	High	3217	211	2015	23924	494	1515.82	15164.18	90.91	All Analyses
T3	tiger	V16	High	3217	219	2016	39411	336	2555.703	5868.297	69.66	All Analyses
T4	tiger	V16	High	3217	270	2016	34034	284	1687.066	6712.934	79.92	All Analyses
T5	tiger	V16	High	3217	220.5	2016	1429	73	114.202	8285.798	98.64	All Analyses
T6	tiger	V16	High	3217	212	2016	14519	317	884.709	7491.291	89.44	All Analyses
T7	tiger	V13	High	653	205.5	2016	3557	198	775.616	7576.384	90.71	All Analyses
R1	reef	V16	High	1741	87.5	2013	9216	82	1124.26	33363.74	96.74	All Analyses
R2	reef	V16	High	1741	101	2013	3	1	0	34488	100.00	Dropped
R3	reef	V16	High	1741	113	2013	151573	1422	16798.51	17641.49	51.22	All Analyses
R4	reef	V13	High	360	111	2013	155778	380	8876.718	267.2819	2.92	All Analyses
R5	reef	V16	High	3217	64	2014	44698	1062	3250.24	26424	89.05	All Analyses
R6	reef	V13	High	360	90	2013	0	0	0	8640	100.00	Dropped
R7	reef	V16	High	3217	83	2014	10495	173	1979.55	24420.45	92.50	All Analyses
R8	reef	V16	High	3217	94	2014	57	5	13.33	26386.67	99.95	Dropped
R9	reef	V16	High	3217	144	2014	54995	390	4999.76	21400.24	81.06	All Analyses
R10	reef	V16	High	3217	65	2014	85787	1093	9720.2	16655.8	63.15	All Analyses
R11	reef	V16	High	3217	69.5	2014	1691	17	64.33	26311.67	99.76	All Analyses
R12	reef	V13	High	360	83	2014	67	19	21.601	8930.399	99.76	Residency
R13	reef	V16	High	3217	138	2015	143624	729	10164.42	17688	63.51	All Analyses
R14	reef	V16	High	3217	115	2015	155350	734	12873.67	4934.329	27.71	All Analyses
R15	reef	V16	High	3217	103	2015	28023	714	2170.93	15637.07	87.81	All Analyses
R16	reef	V16	High	3217	99	2015	9926	233	654.89	17129.11	96.32	All Analyses

R17	reef	V16	High	3217	106	2016	208	3	9.833	8414.167	99.88	Dropped
R18	reef	V16	High	3217	132	2016	2	1	0	8424	100.00	Dropped
N1	nurse	V13	High	360	99	2013	409	72	23.197	8904.803	99.74	Residency
N2	nurse	V16	High	3217	104	2014	25273	476	2621.87	23778.13	90.07	All Analyses
N3	nurse	V16	High	3217	102	2014	2581	63	289.33	26134.67	98.91	All Analyses
N4	nurse	V13	High	360	107	2013	28065	261	2801.971	5838.029	67.57	All Analyses
N5	nurse	V16	High	3217	162	2014	8910	107	480.63	25871.37	98.18	All Analyses
N6	nurse	V16	High	3217	131	2015	20422	122	1212.76	16619.24	93.20	All Analyses
N7	nurse	V16	High	3217	111	2015	49475	738	4003.7	14260.3	78.08	All Analyses
N8	nurse	V16	High	3217	116	2015	23064	252	2520.88	15311.12	85.86	All Analyses
N9	nurse	V16	High	3217	180	2015	166522	667	7304.43	10503.57	58.98	All Analyses
N10	nurse	V16	High	3217	179	2015	188651	712	8631.36	9176.64	51.53	All Analyses
N11	nurse	V16	High	3217	122	2016	32730	347	1995.204	6428.796	76.32	All Analyses
LEM1	lemon	V16	High	1741	126	2013	174130	1,435	22,064.33	12,335.67	35.86	All Analyses
LEM2	lemon	V16	High	1741	116	2013	182684	1437	19690.51	14797.49	42.91	All Analyses
LEM3	lemon	V9	Low	685	74	2015	134	8	20.01	14619.99	99.86	Dropped
LEM4	lemon	V13	High	653	78	2016	1043	130	122.31	11301.69	98.93	All Analyses
LEM5	lemon	V16	High	3217	80	2016	2434	6	82.746	8341.254	99.02	All Analyses
LEM6	lemon	V13	High	653	53	2016	430	5	56.886	8367.114	99.32	Dropped
LEM7	lemon	V13	High	653	54	2016	635	11	43.973	8164.027	99.46	Dropped
LEM8	lemon	V13	High	653	53	2016	884	8	26.917	8349.083	99.68	Dropped
LEM9	lemon	V13	High	653	56	2016	315	8	23.226	8256.774	99.72	Dropped
LEM10	lemon	V16	High	3217	148	2016	76670	349	6225.841	2174.159	25.88	All Analyses
LEM11	lemon	V13	High	653	53	2016	551	32	81.463	8126.537	99.01	Dropped
LEM12	lemon	V13	High	653	55	2016	715	16	116.276	8259.724	98.61	Residency

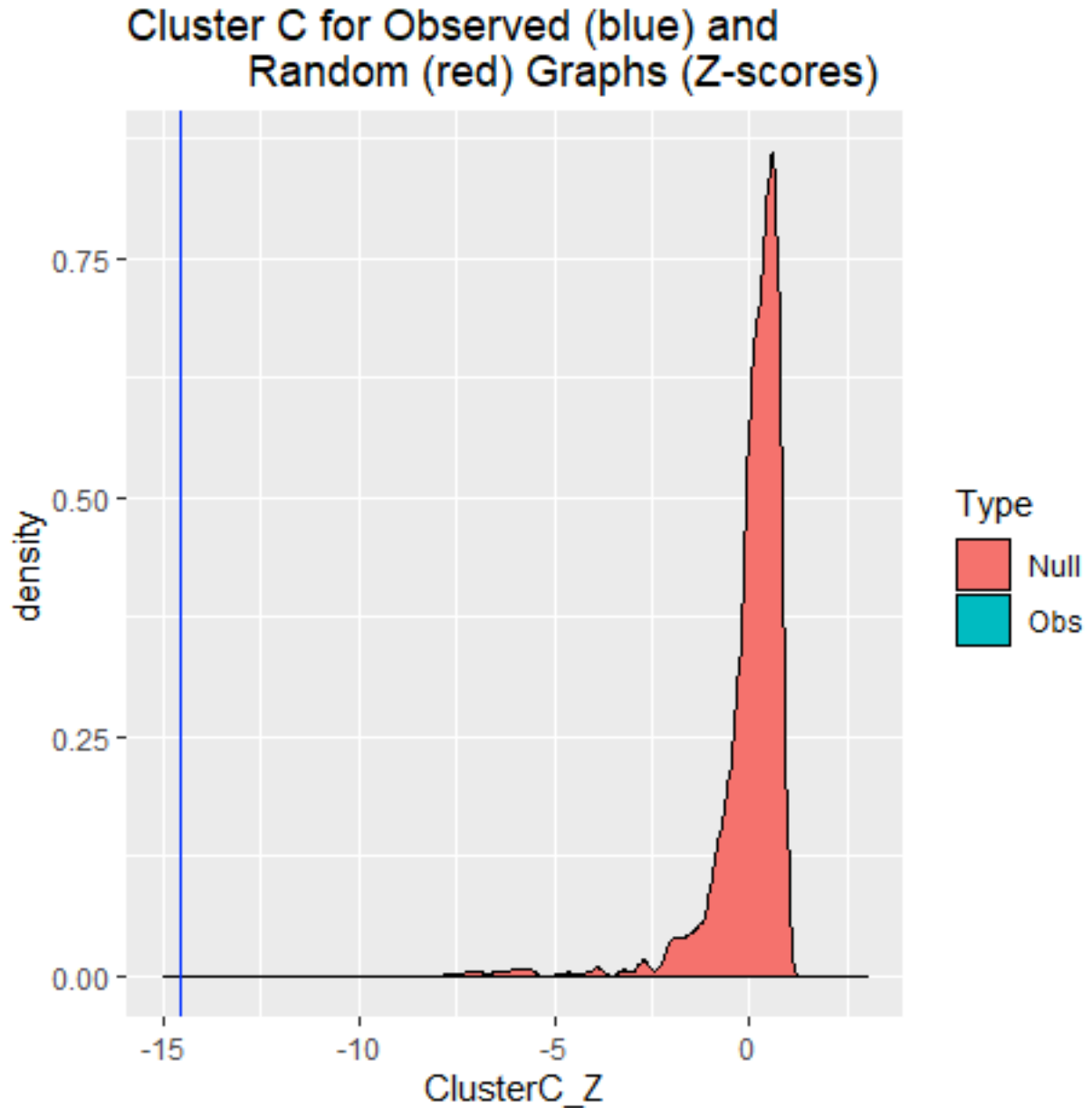


Fig. S1. Results of the comparison of our observed bipartite network to 1,000 randomly generated networks on a z-score scale. The blue vertical line is the clustering coefficient value for the observed network, while the red distribution are the values generated by the null models. Our observed network was significantly different from the nulls so we proceeded with network analyses.