RESULTS FOR BEST FIT (TEST A)

Supplemental Results for talk #73: An Individual-Based Model of Basking Sharks in Ireland

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Table of Contents

Overview

The settings in Table 1 were identified as the best fit by the preliminary tests.

50 trials were repeated for each submodel under the same settings (Table 1), and the results of each trial averaged. Tests were conducted with 100 and 200 sharks in the model. Each day, the model counts Total Aggregations (*all* aggregations of 2 or more sharks) and conduct 20 random Pseudo Sighting Reports (any sighting of one or more sharks). Pseudo Sighting Reports are meant to simulate public sightings reports. Model results were compared to sightings data from the Irish Basking Shark Group and Irish Whale and Dolphin Group (IBSG/IWDG).

Table 1: Parameter settings for Test A

Threshold_Zp	3E+12
Sense-Distance	10
Swim-Speed	9
Cal_%	17
Other_Zp_%	17
Friend_Min	5
No_Eat_Min	14
Return-Season	20

Preliminary testing identified that these model settings result in model output that is most comparable to the real world data.

Kolmogorov-Smirnov Tests

Repeat trials were compared together to test consistency of model results. Total Aggregations were compared, to determine the percentage of trials that were significantly different from each other.

Table 2: Kolmogorov-Smirnov Results for Test A

	Total Aggregations		Pseudo Sightings	
	100 sharks	200 sharks	100 sharks	200 sharks
Food/Social	68.00	74.45	1.71	0.00
Food	58.78	38.53	0.49	0.00
Social	0.00	0.00	0.00	0.00
Random	0.00	0.00	0.00	0.00

The percentage of trials (out of 50 trials) that were significantly different than other repeat trials is reported.

Total Number of Aggregations

Table 3: Average Number of Shark Aggregations and Pseudo Sighting Reports for 50 trials Under Settings for Test A.

	Total Aggregations		Pseudo Sightings Reports	
	100 sharks	200 sharks	100 sharks	200 sharks
Food/Social	1806	4099	110	208
Food	1712	3925	111	227
Social	143	568	88	170
Random	165	629	87	172

Total number of aggregations throughout the entirety of the model run (1982-2018). Pseudo Sightings reports include any shark "sighted" during a random sample of 20 patches, including single sharks, while Total Aggregations only count groups of two or more sharks, but count *all* aggregations in the model each day.

Average Aggregation Size Per Month

All 50 trials were averaged together. The average size of aggregations per month was calculated, then the data was normalized via min-max normalization. The model results compared to the data from IBSG/IWDG and the Mean Error (ME), the mean absolute error (MAE), and the root mean square error (RMSE) were calculated.

The normalized data was also graphed onto time series and box plots for qualitative comparisons.

ME/MAE/RMSE

Table 4 Comparison of Average Aggregation Size Per Month (Total Aggregations; 100 sharks)

	Inishowen			All of Ireland		
Submodel	ME	RMSE	MAE	ME	RMSE	MAE
Food/Social	0.15	0.23	0.17	0.14	0.22	0.16
Food	0.25	0.33	0.27	0.24	0.31	0.25
Social	0.38	0.48	0.39	0.36	0.45	0.36
Random	0.34	0.46	0.36	0.32	0.43	0.33

Total aggregations (average across 50 trials) compared to IBSG/IWDG sightings. Data was normalized via min-max normalization. Total aggregations counts groups of two or more sharks. Results are compared to IBSG/IWDG data from the model area (Inishowen) and all of the IBSG/IWDG data (All of Ireland).

Table 5 Comparison of Average Aggregation Size Per Month (Pseudo Sighting Reports; 100 sharks)

	Inishowen			All of Ireland		
Submodel	ME	RMSE	MAE	ME	RMSE	MAE
Food/Social	0.14	0.22	0.17	0.12	0.21	0.15
Food	0.19	0.27	0.21	0.16	0.25	0.19
Social	0.27	0.32	0.29	0.25	0.30	0.27
Random	0.28	0.33	0.29	0.25	0.30	0.27

Pseudo Sighting Reports (averaged across 50 trials) compared to IBSG/IWDG sightings. 20 random patches are sampled per day, and all shark sightings (including single sharks) are reported. Data was normalized via min-max normalization. Results are compared to IBSG/IWDG data from the model area (Inishowen) and all of the IBSG/IWDG data (All of Ireland).

Table 6: Comparison of Average Aggregation Size Per Month (Total Aggregations; 200 sharks)

	Inishowen			All of Ireland		
Submodel	ME	RMSE	MAE	ME	RMSE	MAE
Food/Social	0.10	0.18	0.13	0.08	0.18	0.12
Food	0.25	0.30	0.26	0.23	0.28	0.24
Social	0.62	0.70	0.63	0.61	0.68	0.61
Random	0.58	0.67	0.58	0.56	0.65	0.57

Total aggregations (averaged across 50 trials) compared to IBSG/IWDG sightings. Data was normalized via min-max normalization. Total aggregations counts groups of two or more sharks. Results are compared to IBSG/IWDG data from the model area (Inishowen) and all of the IBSG/IWDG data (All of Ireland).

Table 7: Comparison of Average Aggregation Size Per Month (Pseudo Sightings Reports; 200 sharks)

	Inishowen			All of Ireland		
Submodel	ME	RMSE	MAE	ME	RMSE	MAE
Food/Social	0.07	0.16	0.11	0.05	0.15	0.10
Food	0.14	0.21	0.17	0.12	0.20	0.15
Social	0.38	0.43	0.39	0.36	0.41	0.37
Random	0.43	0.48	0.44	0.41	0.45	0.42

Pseudo Sighting Reports (averaged across 50 trials) compared to IBSG/IWDG sightings. 20 random patches are sampled per day, and all shark sightings (including single sharks) are reported. Data was normalized via min-max normalization. Results are compared to IBSG/IWDG data from the model area (Inishowen) and all of the IBSG/IWDG data (All of Ireland).

Figures

Total Aggregations

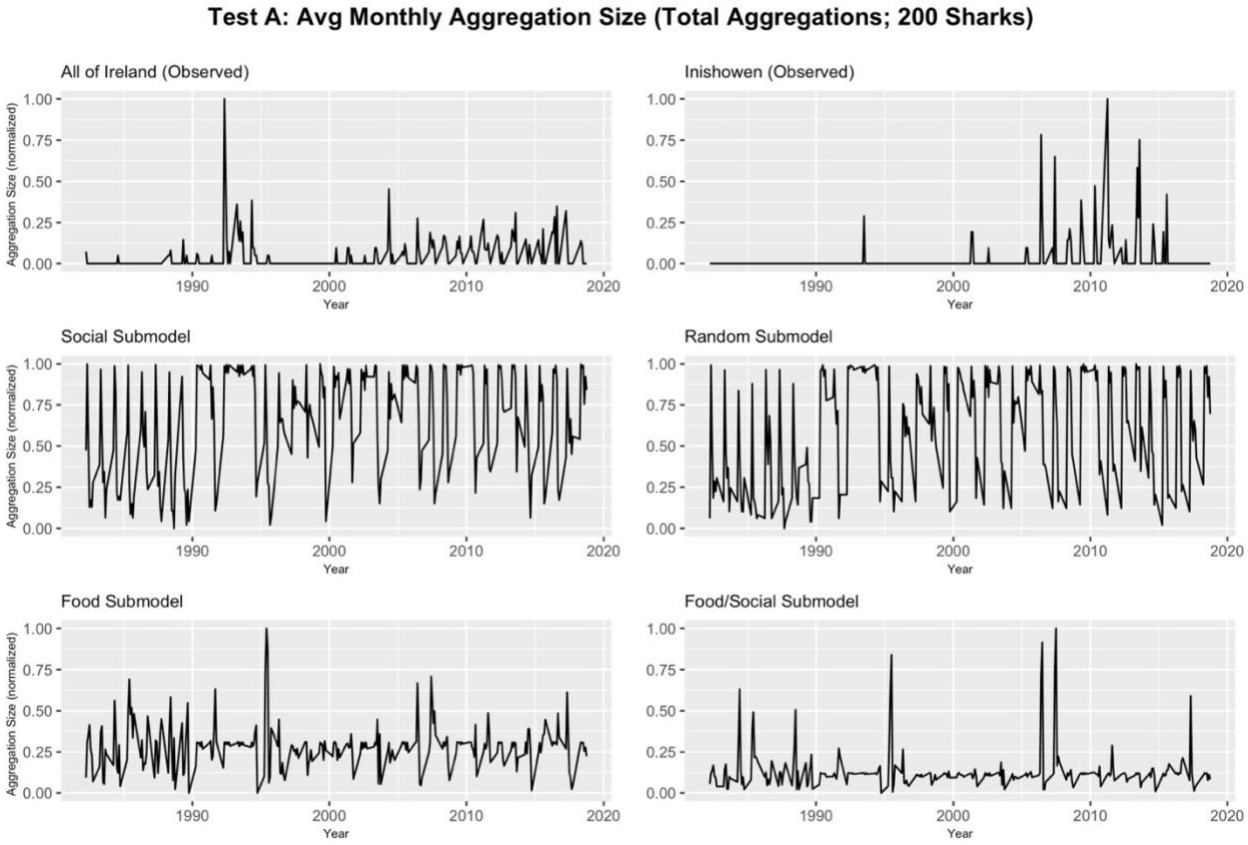

Figure 1: Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Total Aggregations include all groups of two or more sharks. The average size of aggregations per month were calculated and normalized. This test contained a maximum of 200 sharks.

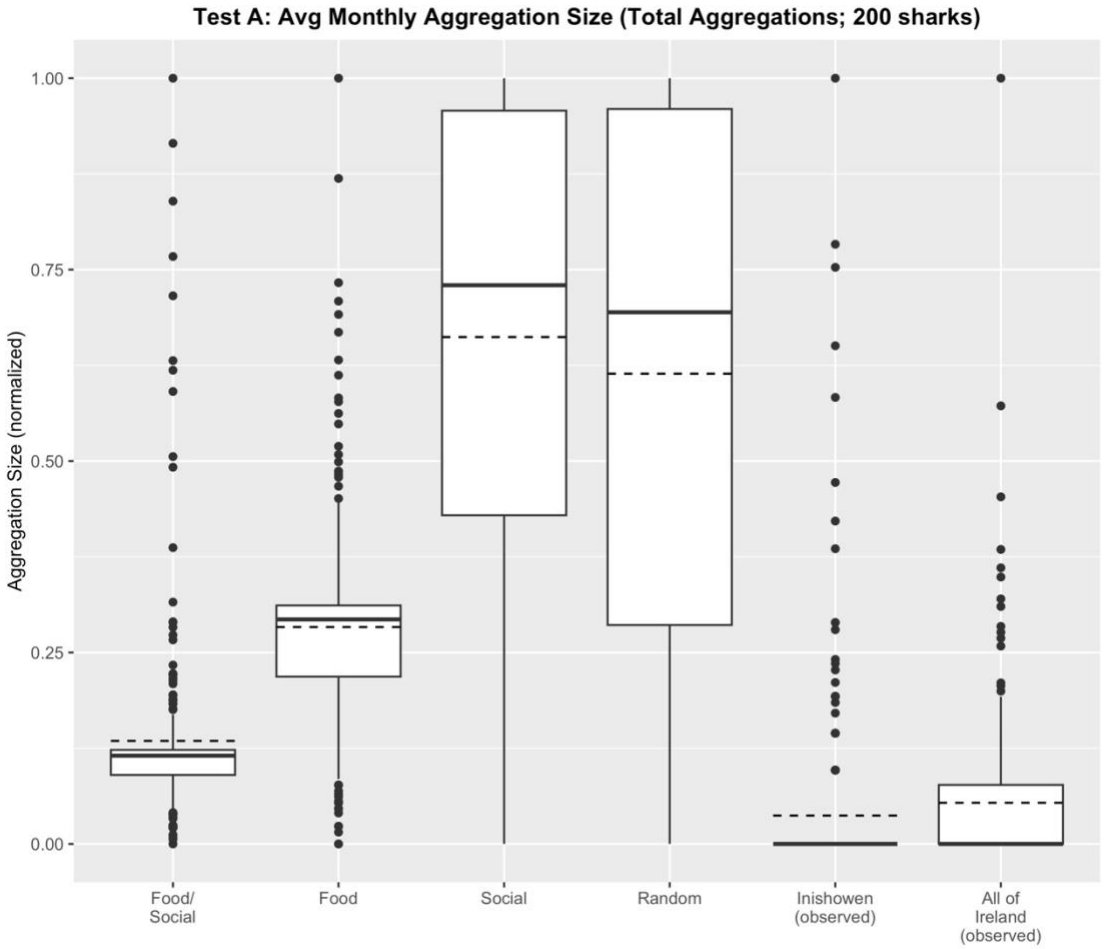

Figure 2: Boxplot comparing the average of 50 submodel trials to IBSG/IWDG data. Total Aggregations include all groups of two or more sharks. The average size of aggregations per month were calculated and normalized. This test contained a maximum of 200 sharks.

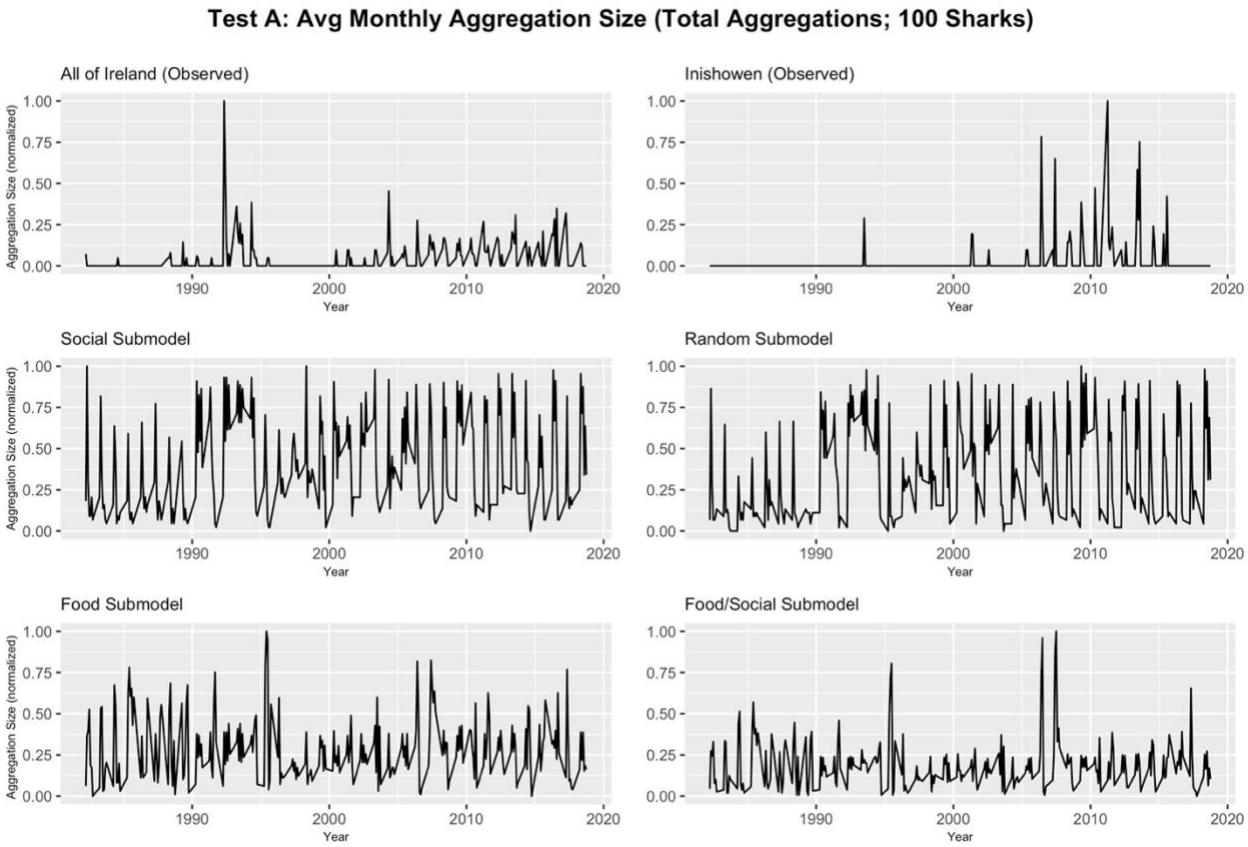

Figure 3 Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Total Aggregations include all groups of two or more sharks. The average size of aggregations per month were calculated and normalized. This test contained a maximum of 100 sharks.

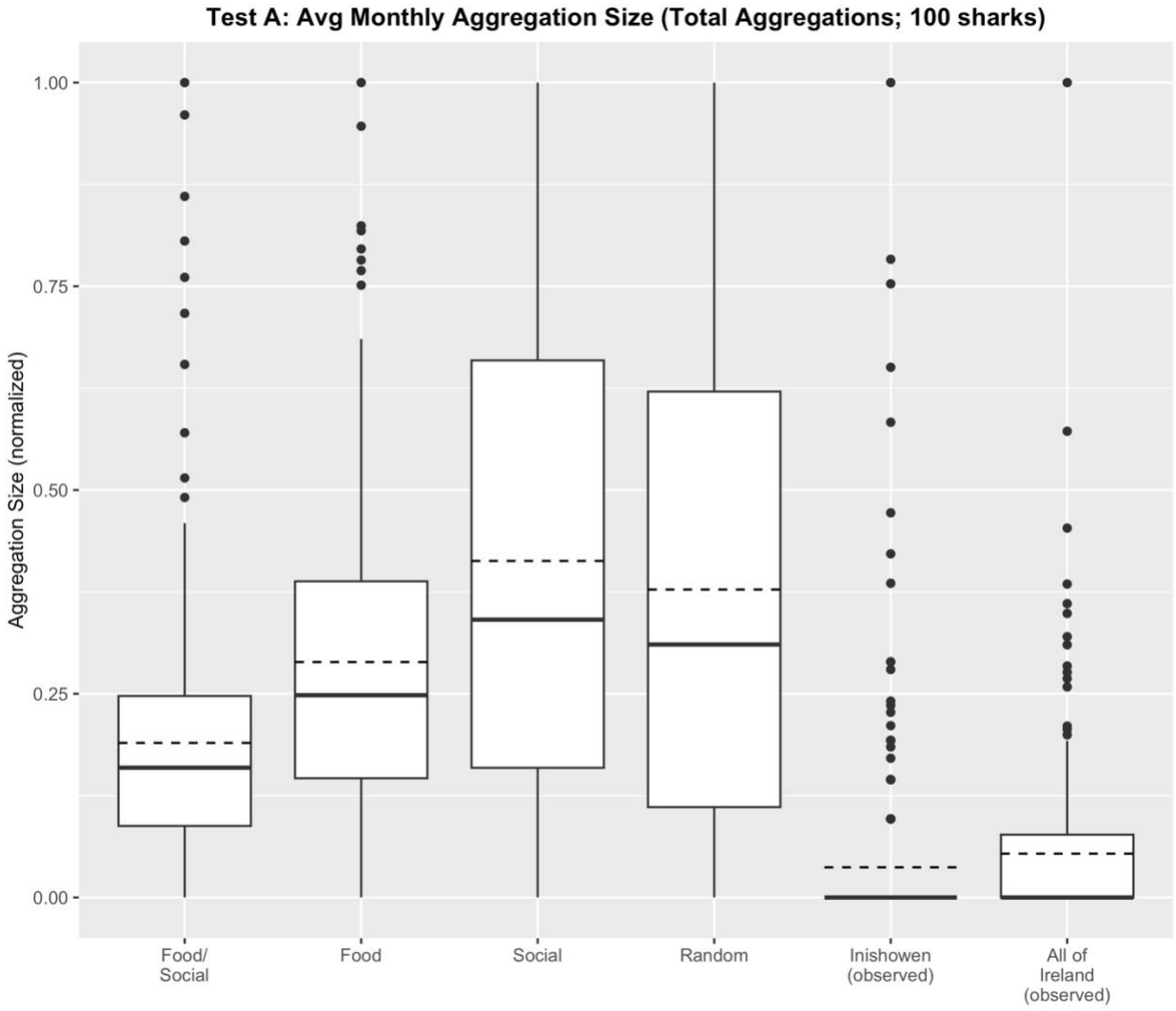

Figure 4 Boxplot comparing the average of 50 submodel trials to IBSG/IWDG data. Total Aggregations include all groups of two or more sharks. The average size of aggregations per month were calculated and normalized. This test contained a maximum of 100 sharks.

Pseudo Sighting Reports

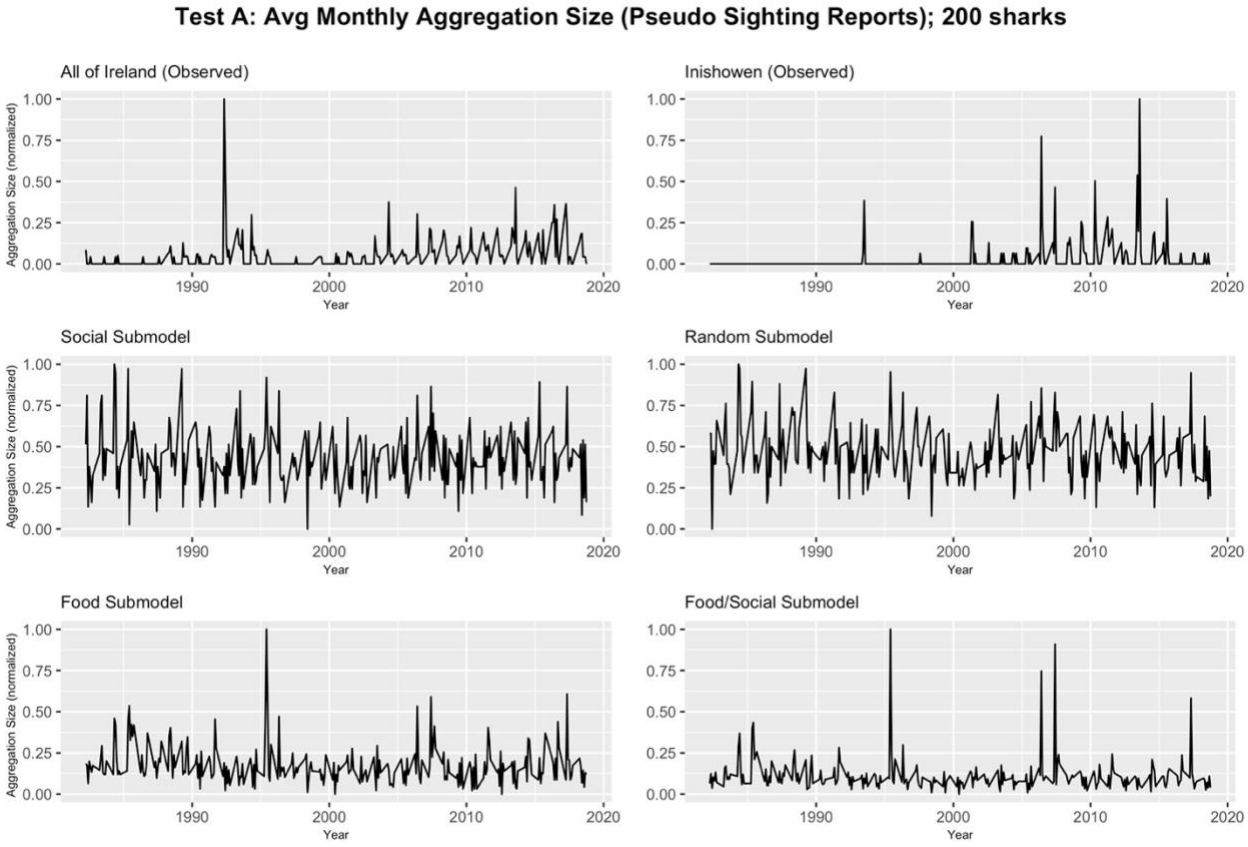

Figure 5: Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Pseudo Sighting Reports result from a random sample of 20 patches each day. These reports include single sharks as well as groups of sharks (with the number of sharks in each group recorded). The average size of aggregations per month were calculated and normalized. This test contained a maximum of 200 sharks.

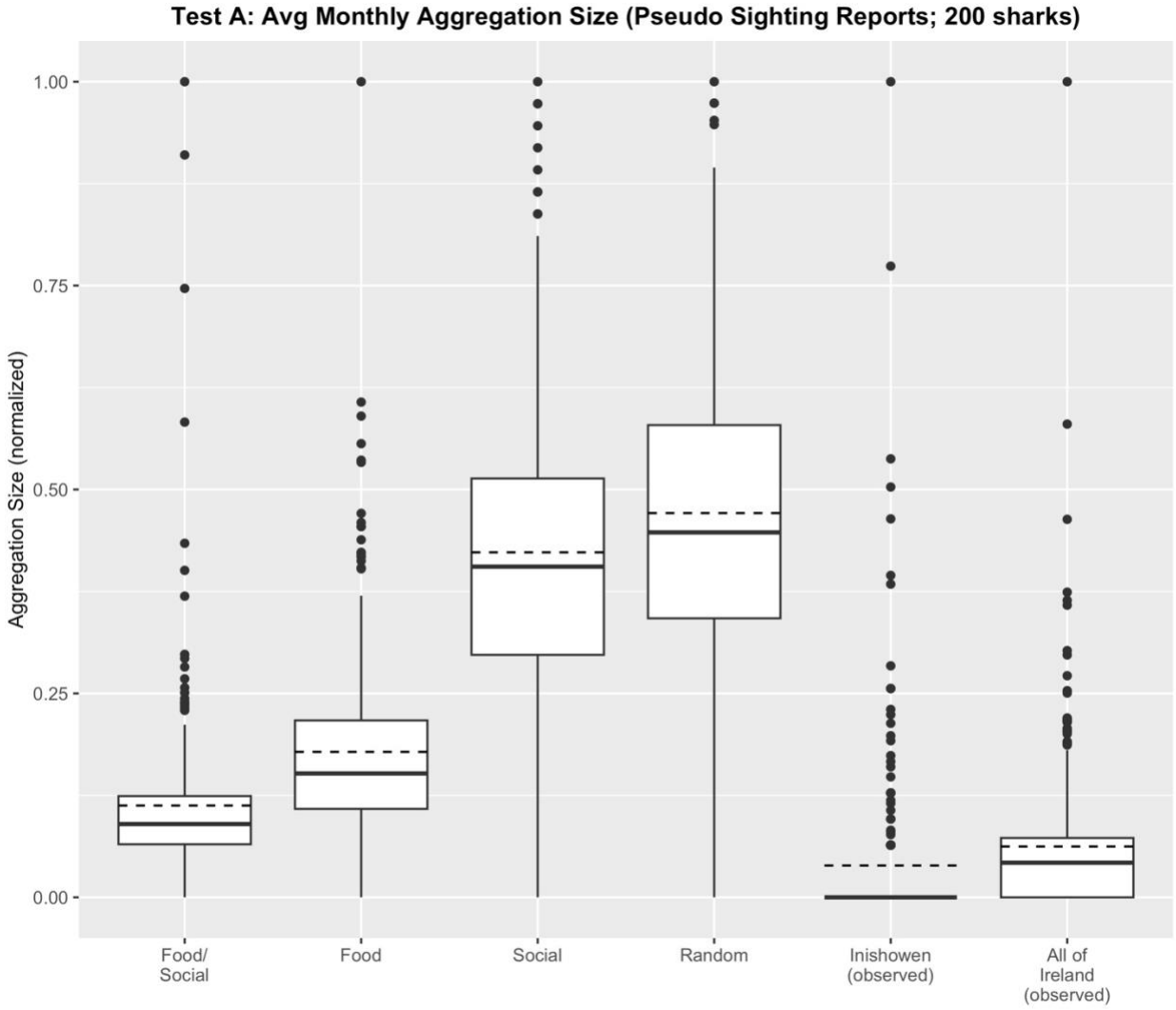

Figure 6: Comparison of 50 trials (averaged together) each submodel Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Pseudo Sighting Reports result from a random sample of 20 patches each day. These reports include single sharks as well as groups of sharks (with the number of sharks in each group recorded). The average size of aggregations per month were calculated and normalized. This test contained a maximum of 200 sharks.

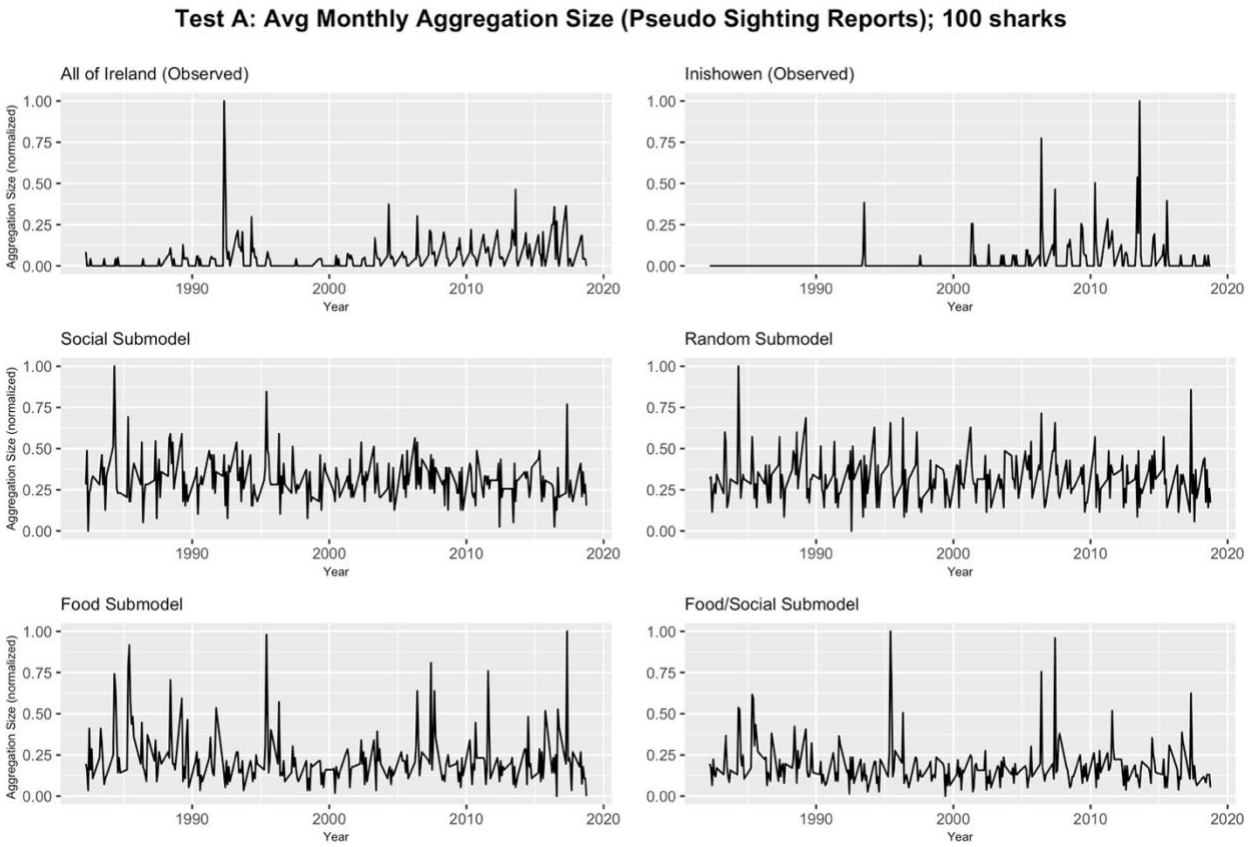

Figure 7 Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Pseudo Sighting Reports result from a random sample of 20 patches each day. These reports include single sharks as well as groups of sharks (with the number of sharks in each group recorded). The average size of aggregations per month were calculated and normalized. This test contained a maximum of 100 sharks.

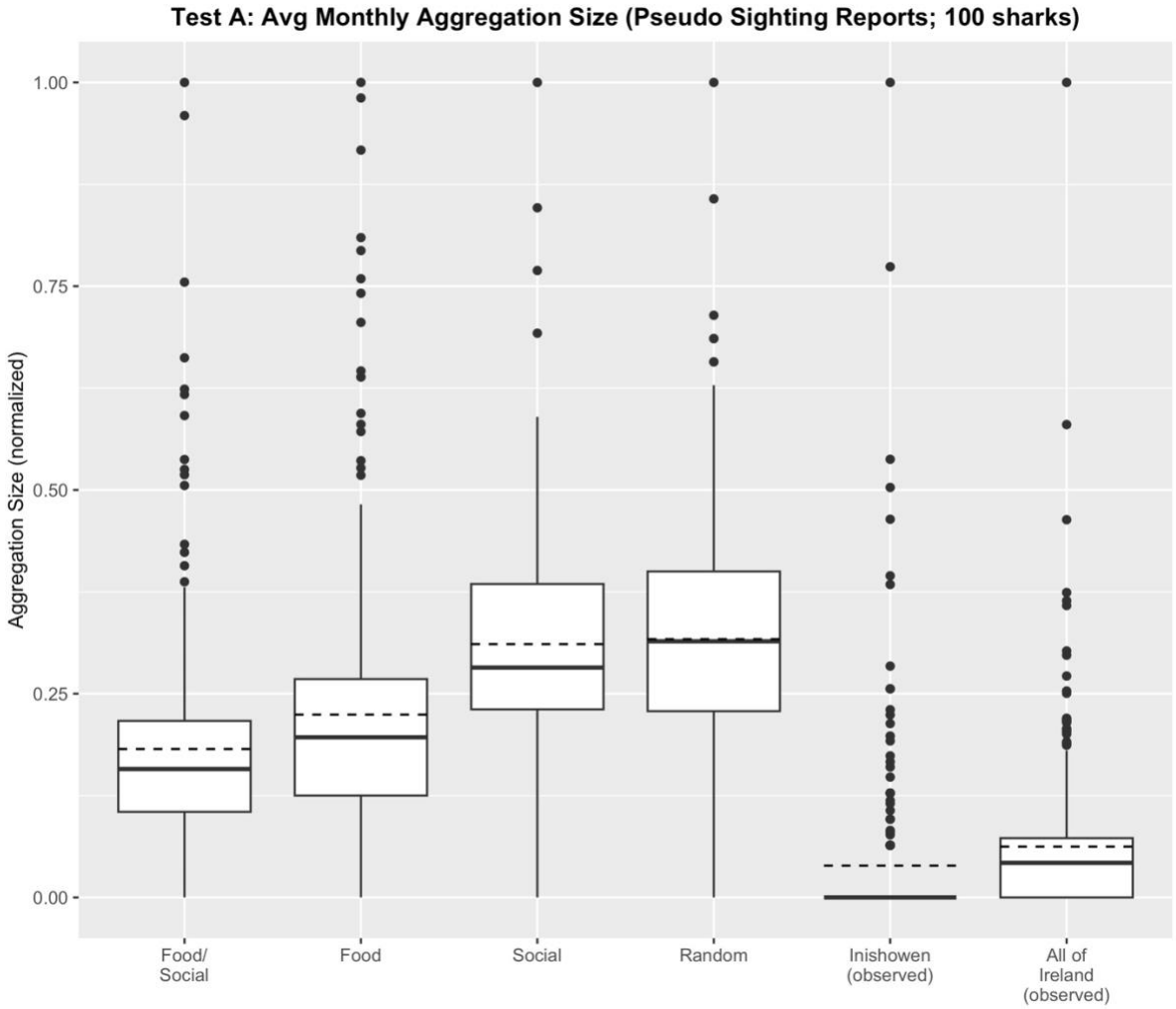

Figure 8 Comparison of 50 trials (averaged together) each submodel Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Pseudo Sighting Reports result from a random sample of 20 patches each day. These reports include single sharks as well as groups of sharks (with the number of sharks in each group recorded). The average size of aggregations per month were calculated and normalized. This test contained a maximum of 100 sharks.

Average Number of Aggregations Per Month

All 50 trials were averaged together. The average number of aggregations per month was calculated, then the data was normalized via min-max normalization. The model results compared to the data from IBSG/IWDG the Mean Error (ME), the mean square MAE (Mean absolute error) and the root mean square error (RMSE) were calculated.

The normalized data was also graphed onto time series and box plots for qualitative comparisons.

RMSE/ME/MAE

Table 8: Comparison of Average Number of Aggregations Per Month (Total Aggregations; 200 sharks)

	Inishowen			All of Ireland		
Submodel	ME	RMSE	MAE	ME	RMSE	MAE
Food/Social	0.03	0.16	0.06	0.00	0.17	0.08
Food	0.02	0.15	0.05	-0.01	0.16	0.07
Social	0.27	0.39	0.28	0.25	0.36	0.26
Random	0.16	0.24	0.17	0.13	0.21	0.16

Total aggregations (averaged across 50 trials) compared to IBSG/IWDG sightings. Data was normalized via min-max normalization. Total aggregations counts groups of two or more sharks. Results are compared to IBSG/IWDG data from the model area (Inishowen) and all of the IBSG/IWDG data (All of Ireland).

Table 9: Comparison of Average Number of Aggregations Per Month (Pseudo Sightings Reports; 200 sharks)

	Inishowen			All of Ireland		
Submodel	ME	RMSE	MAE	ME	RMSE	MAE
Food/Social	0.11	0.18	0.13	0.06	0.19	0.13
Food	0.11	0.20	0.13	0.07	0.21	0.14
Social	0.23	0.28	0.24	0.18	0.27	0.22
Random	0.27	0.31	0.27	0.22	0.29	0.25

Pseudo Sighting Reports (averaged across 50 trials) compared to IBSG/IWDG sightings. 20 random patches are sampled per day, and all shark sightings (including single sharks) are reported. Data was normalized via min-max normalization. Results are compared to IBSG/IWDG data from the model area (Inishowen) and all of the IBSG/IWDG data (All of Ireland).

Table 10: Comparison of Average Number of Aggregations Per Month (Total Aggregations; 100 sharks)

	Inishowen			All of Ireland		
Submodel	ME	RMSE	MAE	ME	RMSE	MAE
Food/Social	0.01	0.14	0.04	-0.02	0.15	0.06
Food	0.01	0.14	0.04	-0.02	0.15	0.06
Social	0.26	0.37	0.27	0.23	0.34	0.25
Random	0.15	0.22	0.16	0.12	0.20	0.15

Total aggregations (averaged across 50 trials) compared to IBSG/IWDG sightings. Data was normalized via min-max normalization. Total aggregations counts groups of two or more sharks. Results are compared to IBSG/IWDG data from the model area (Inishowen) and all of the IBSG/IWDG data (All of Ireland).

Table 11 Comparison of Average Number of Aggregations Per Month (Pseudo Sightings Reports; 100 sharks)

	Inishowen			All of Ireland		
Submodel	ME	RMSE	MAE	ME	RMSE	MAE
Food/Social	0.14	0.21	0.16	0.09	0.21	0.15
Food	0.11	0.19	0.13	0.07	0.20	0.13
Social	0.17	0.22	0.19	0.13	0.22	0.17
Random	0.21	0.25	0.22	0.17	0.24	0.20

Pseudo Sighting Reports (averaged across 50 trials) compared to IBSG/IWDG sightings. 20 random patches are sampled per day, and all shark sightings (including single sharks) are reported. Data was normalized via min-max normalization. Results are compared to IBSG/IWDG data from the model area (Inishowen) and all of the IBSG/IWDG data (All of Ireland).

Figures

Total Aggregations

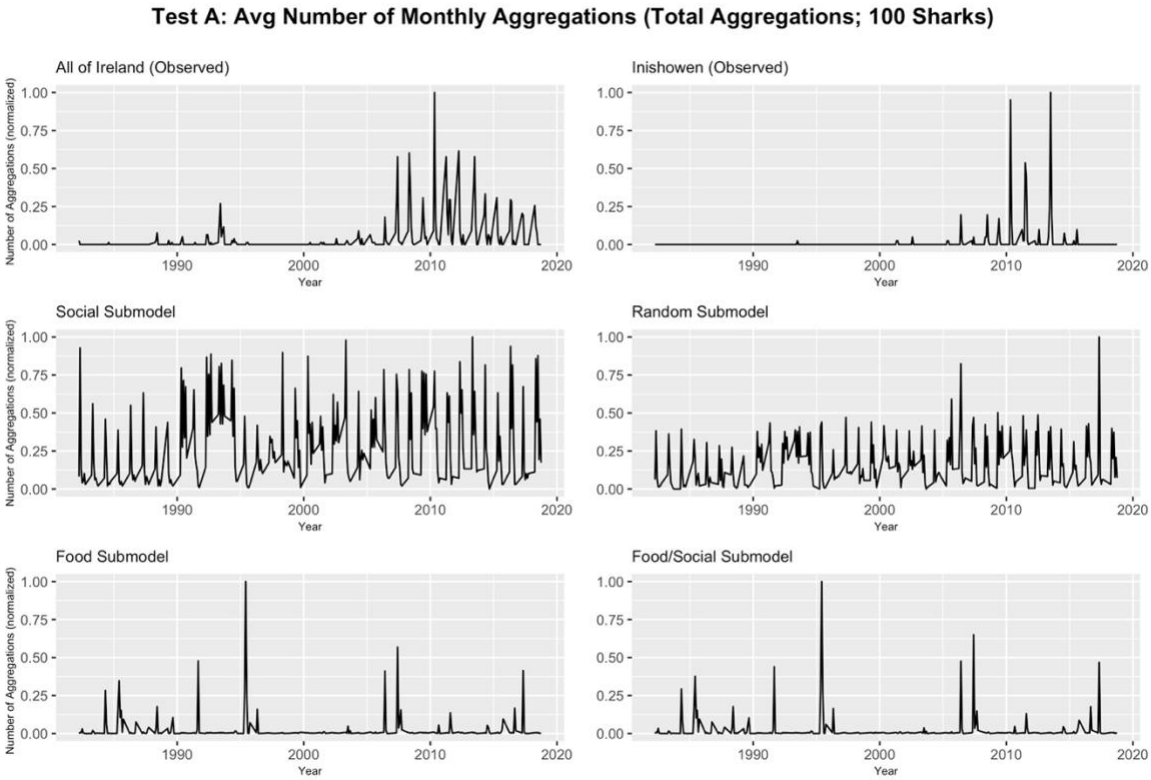

Figure 9: Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Total Aggregations include all groups of two or more sharks. The average number of aggregations per month were calculated and normalized. This test contained 100 sharks.

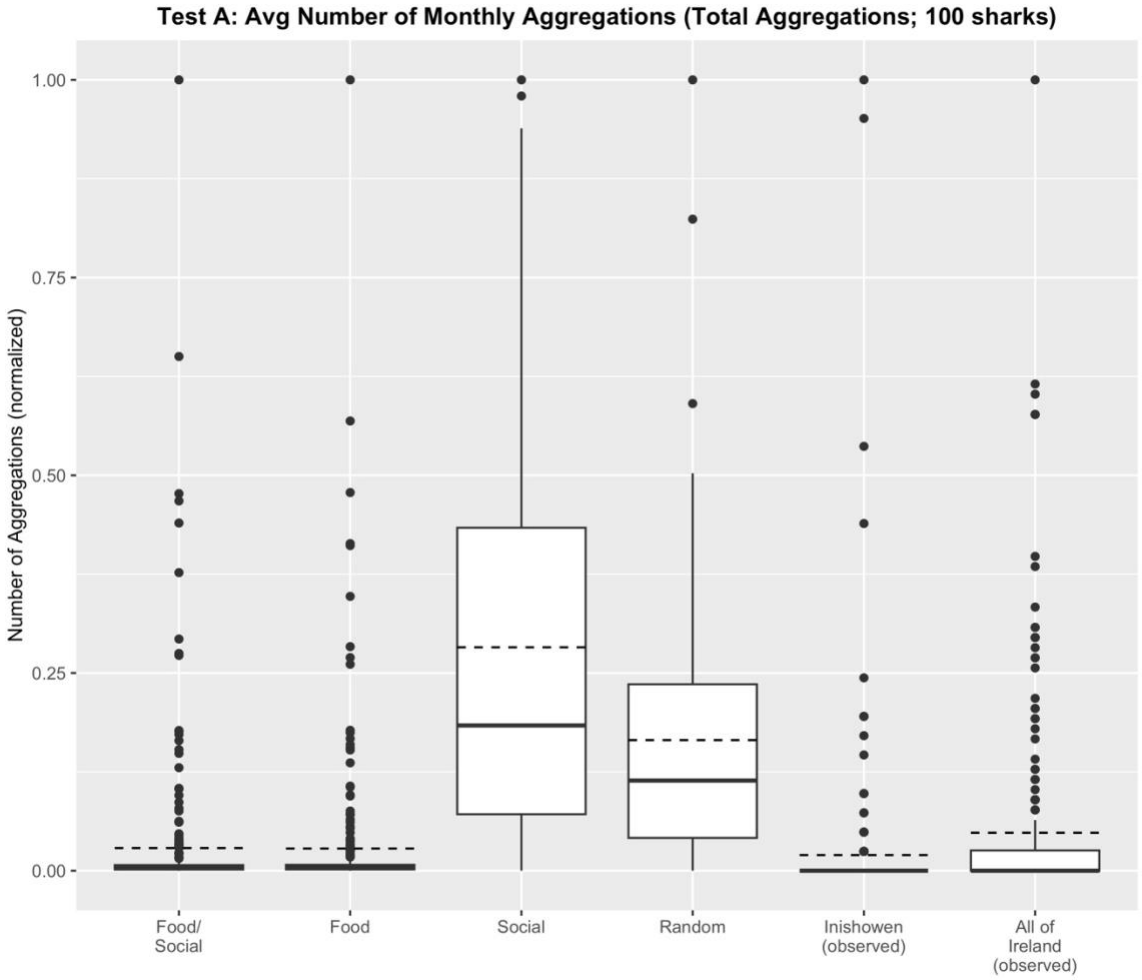

Figure 10 Boxplot comparing 50 trials (averaged together) each submodel to IBSG/IWDG data. Total Aggregations include all groups of two or more sharks. The average number of aggregations per month were calculated and normalized. This test contained a maximum of 100 sharks.

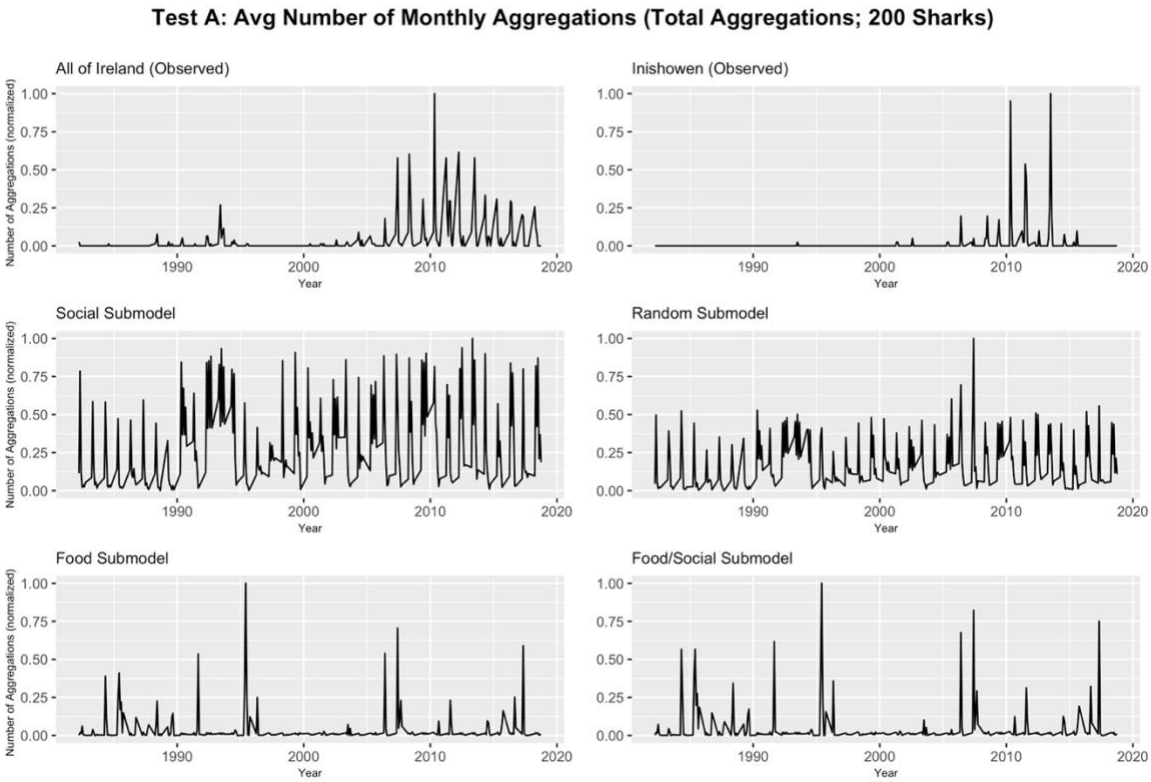

Figure 11: Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Total Aggregations include all groups of two or more sharks. The average number of aggregations per month were calculated and normalized. This test contained 200 sharks.

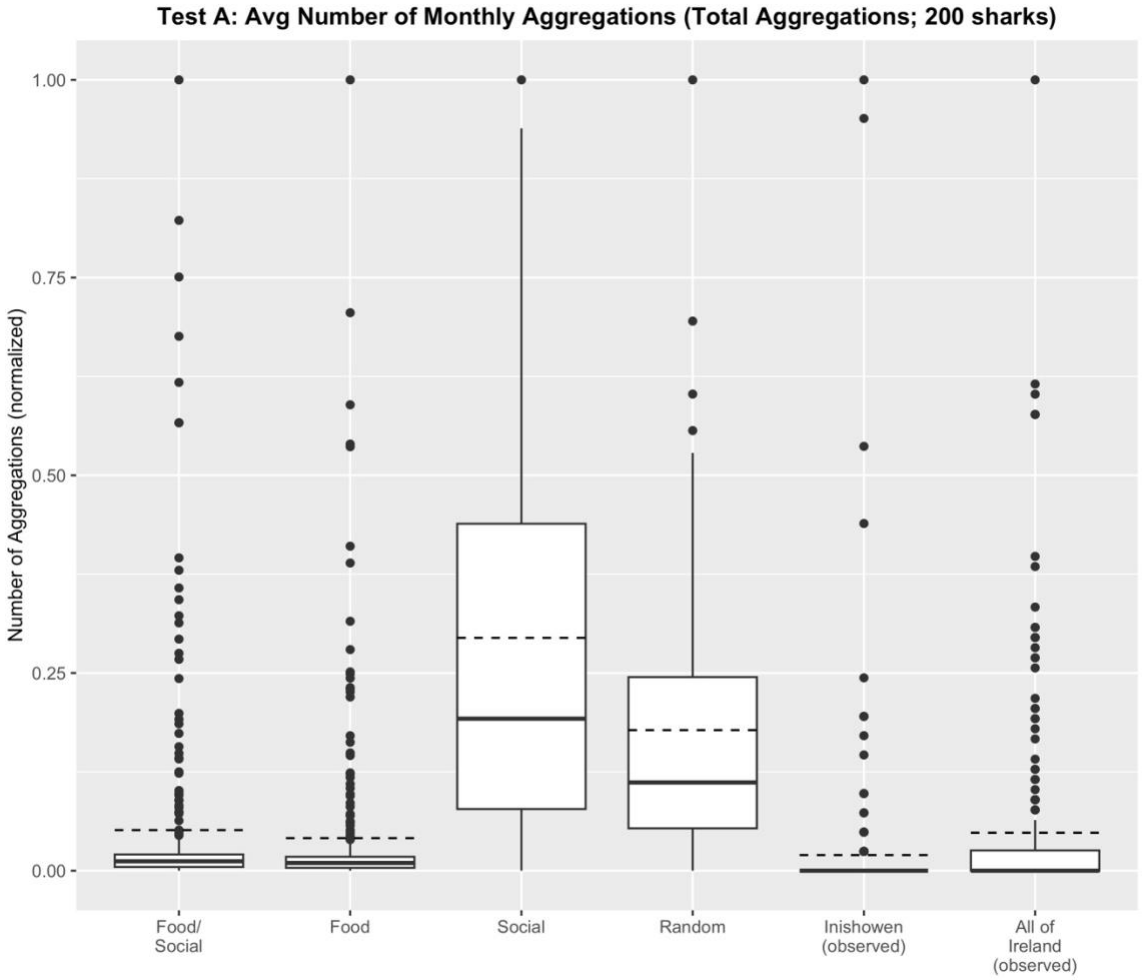

Figure 12 Boxplot comparing 50 trials (averaged together) each submodel to IBSG/IWDG data. Total Aggregations include all groups of two or more sharks. The average number of aggregations per month were calculated and normalized. This test contained a maximum of 200 sharks.

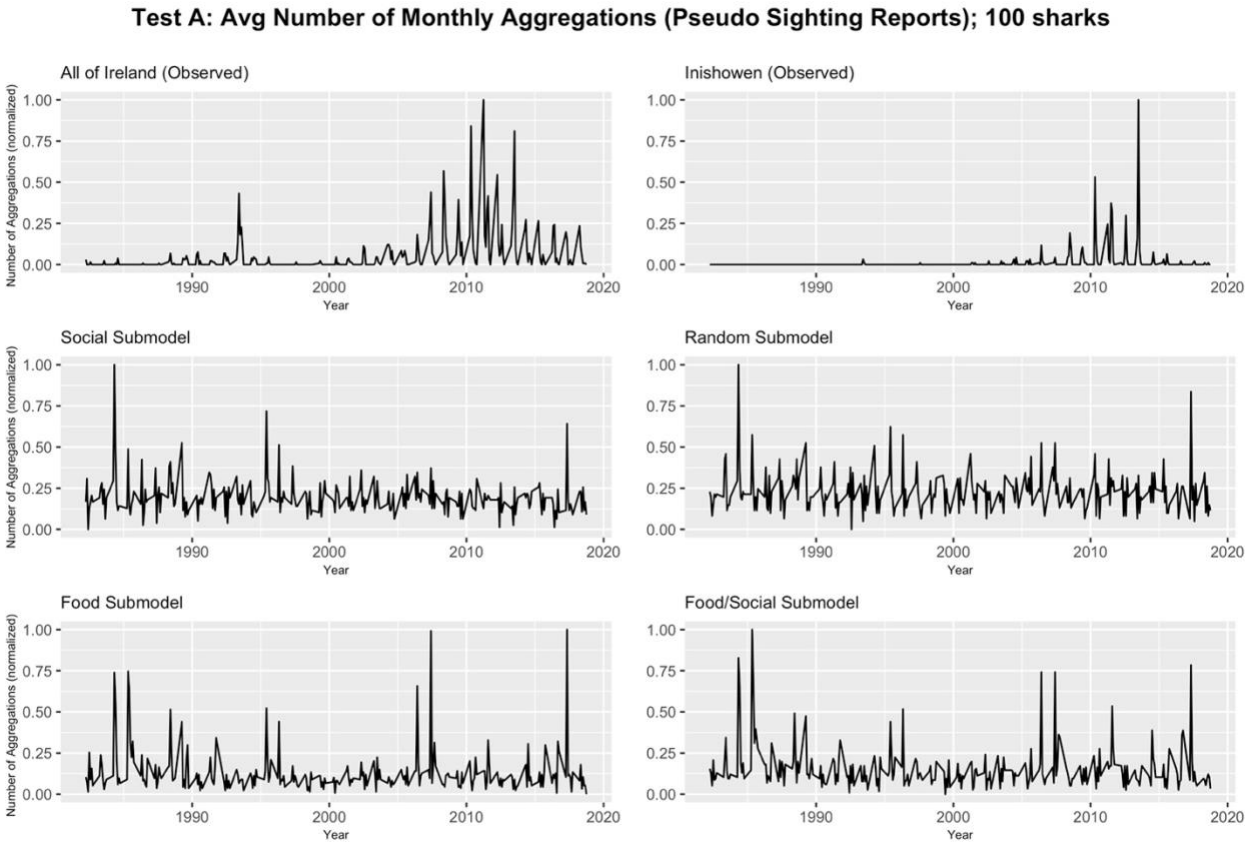

Figure 13 Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Pseudo Sighting Reports result from a random sample of 20 patches each day. These reports include single sharks as well as groups of sharks (with the number of sharks in each group recorded). The average number of aggregations per month were calculated and normalized. This test contained a maximum of 100 sharks.

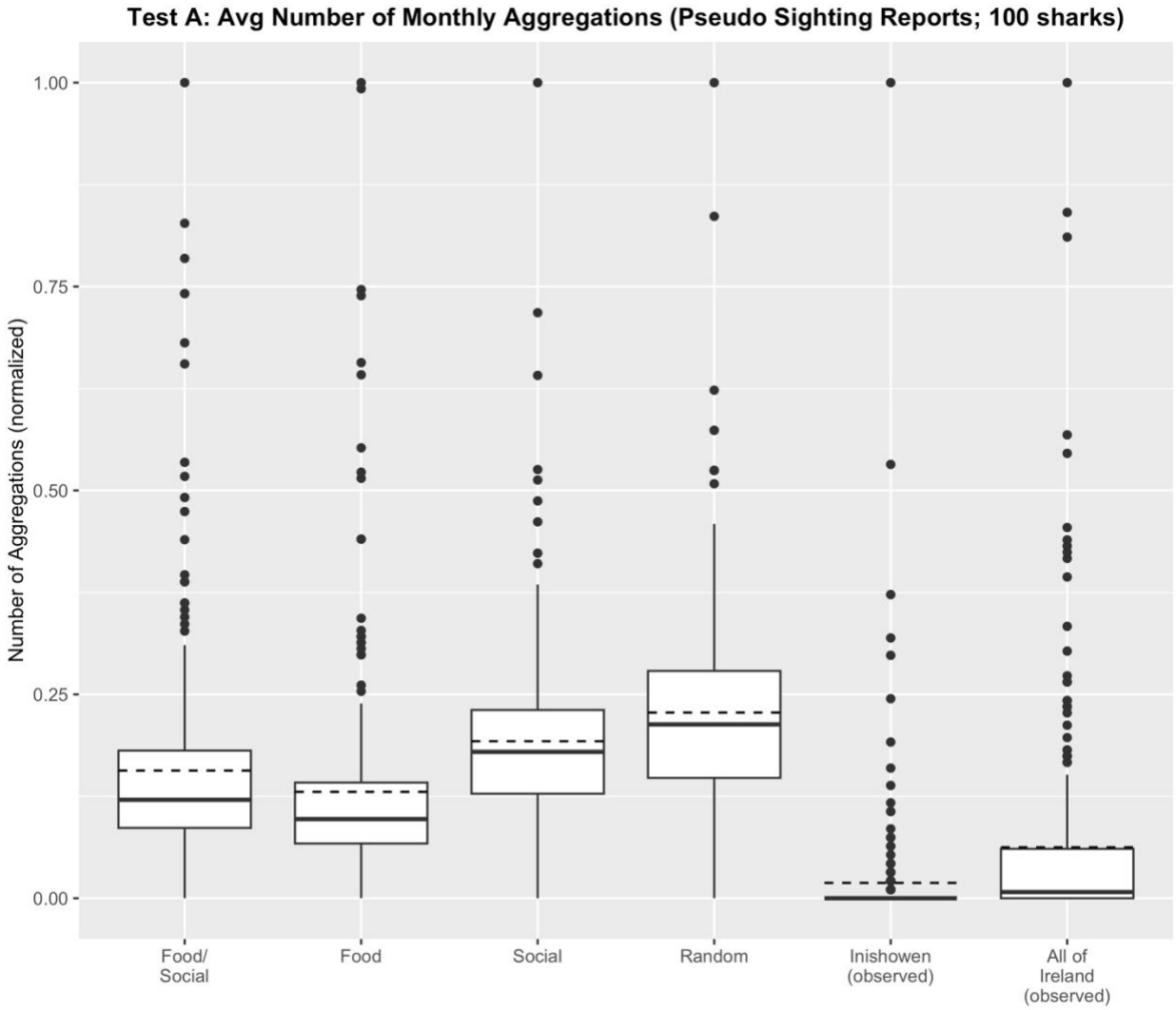

Figure 14 Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Pseudo Sighting Reports result from a random sample of 20 patches each day. These reports include single sharks as well as groups of sharks (with the number of sharks in each group recorded). The average number of aggregations per month were calculated and normalized. This test contained a maximum of 100 sharks.

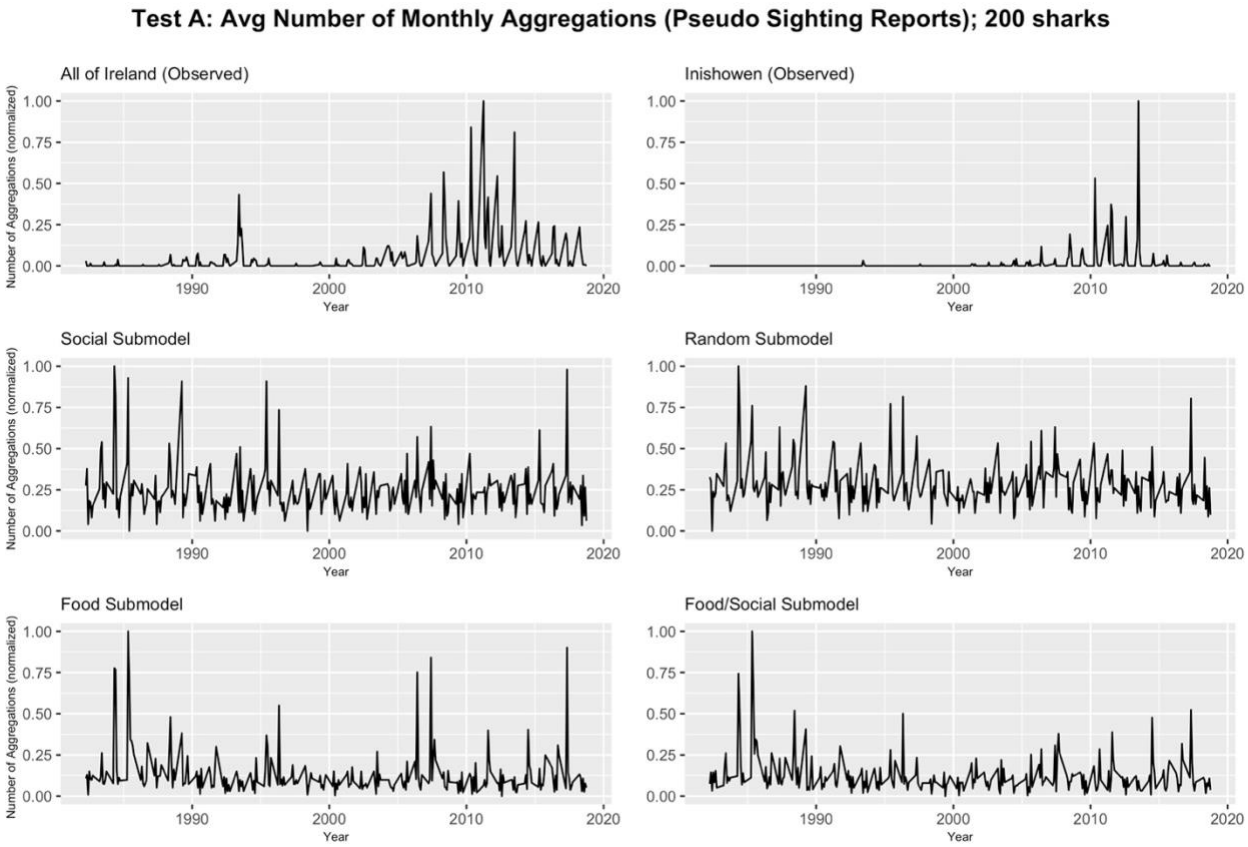

Figure 15 Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Pseudo Sighting Reports result from a random sample of 20 patches each day. These reports include single sharks as well as groups of sharks (with the number of sharks in each group recorded). The average number of aggregations per month were calculated and normalized. This test contained a maximum of 200 sharks.

Figure 16 Comparison of 50 trials (averaged together) each submodel to IBSG/IWDG data. Pseudo Sighting Reports result from a random sample of 20 patches each day. These reports include single sharks as well as groups of sharks (with the number of sharks in each group recorded). The average number of aggregations per month were calculated and normalized. This test contained a maximum of 200 sharks.