LOVELAND LIVING PLANET AQUARIUM™

Stingray Behavior Project

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Outline

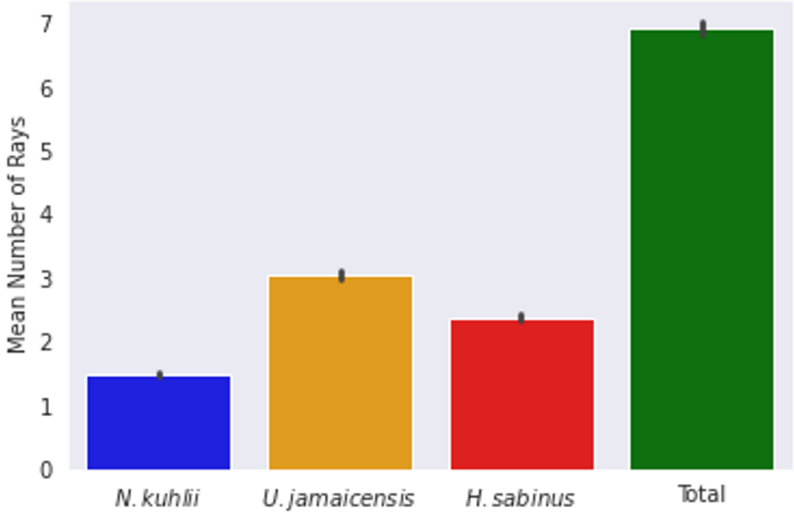
Items to be addressed:

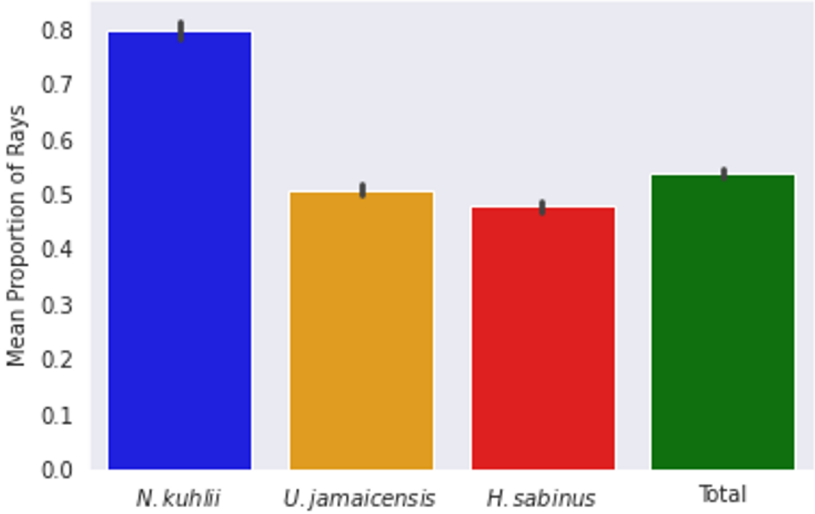
- Baseline Ray Behavior (Continuous, Instantaneous)
- Correlations Between Behaviors (Continuous, Instantaneous)
- Relationships Between Behaviors and Other Factors
- Differences Between Sampling Methods
- Suggestions

Baseline Behaviors

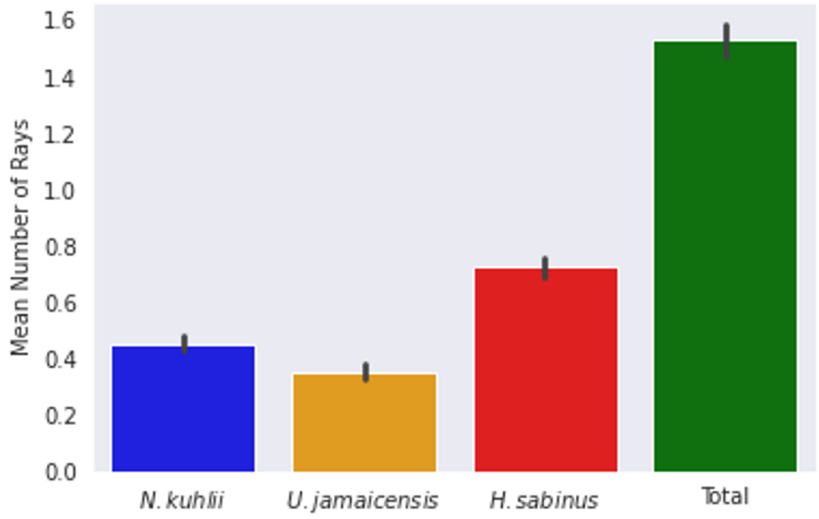
Instantaneous Data

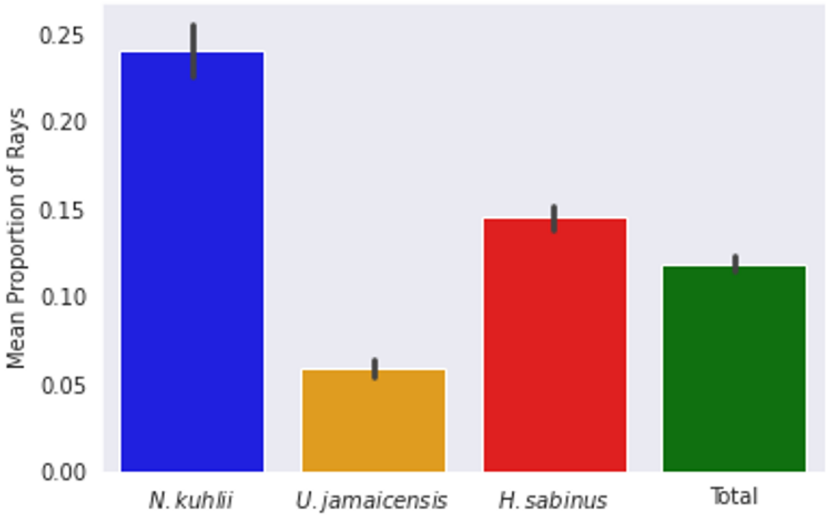
Rays In Shallow Area, Instantaneous



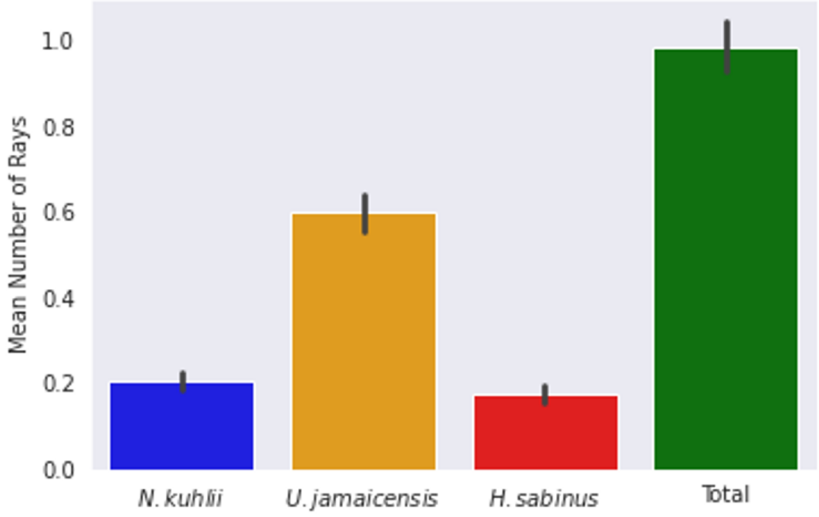


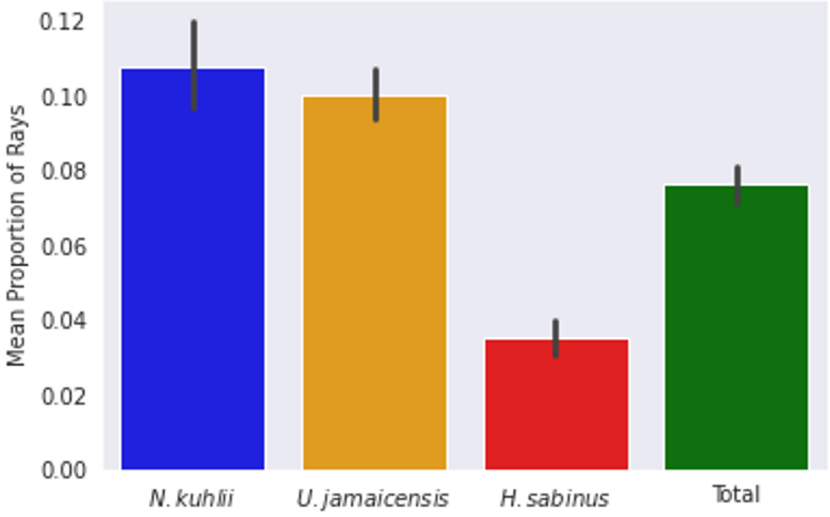
Rays Breaking the Surface, Instantaneous



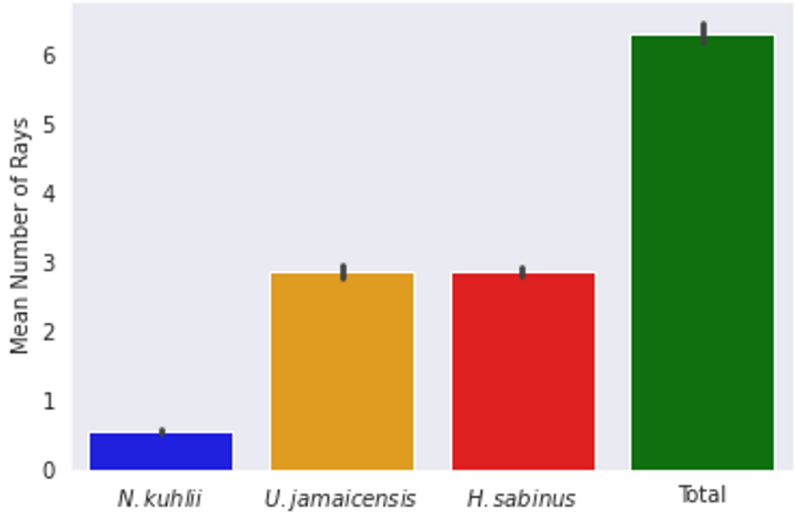


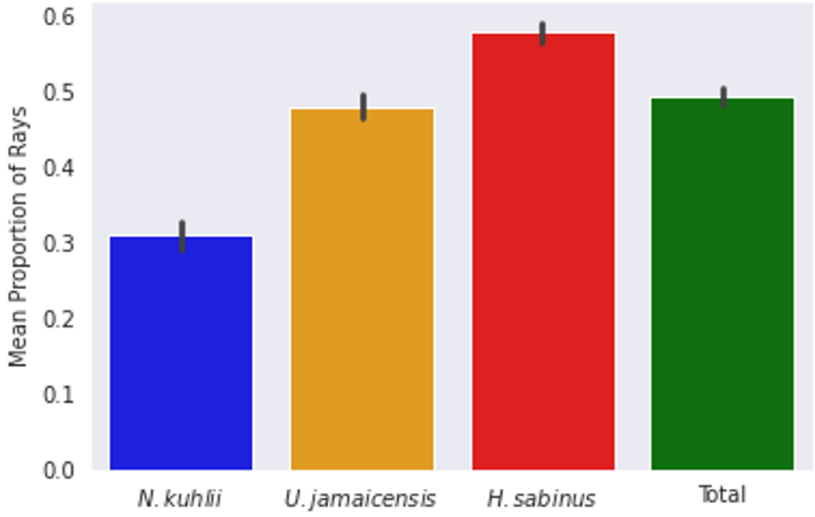
Rays Following, Instantaneous





Rays Resting at the Bottom, Instantaneous





Continuous Data

Explanation for Adjusted Means

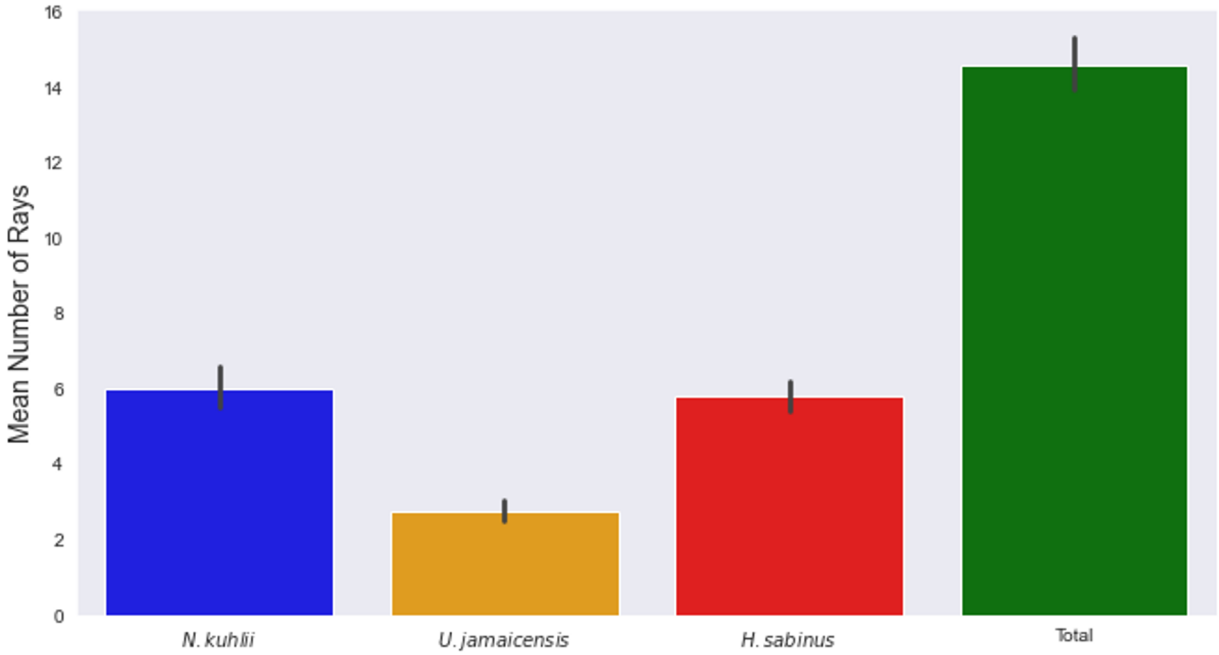
-Adjusted means on this section are calculated by dividing the raw mean by the number of stingrays per species

-Example (referring to slides 15-16)

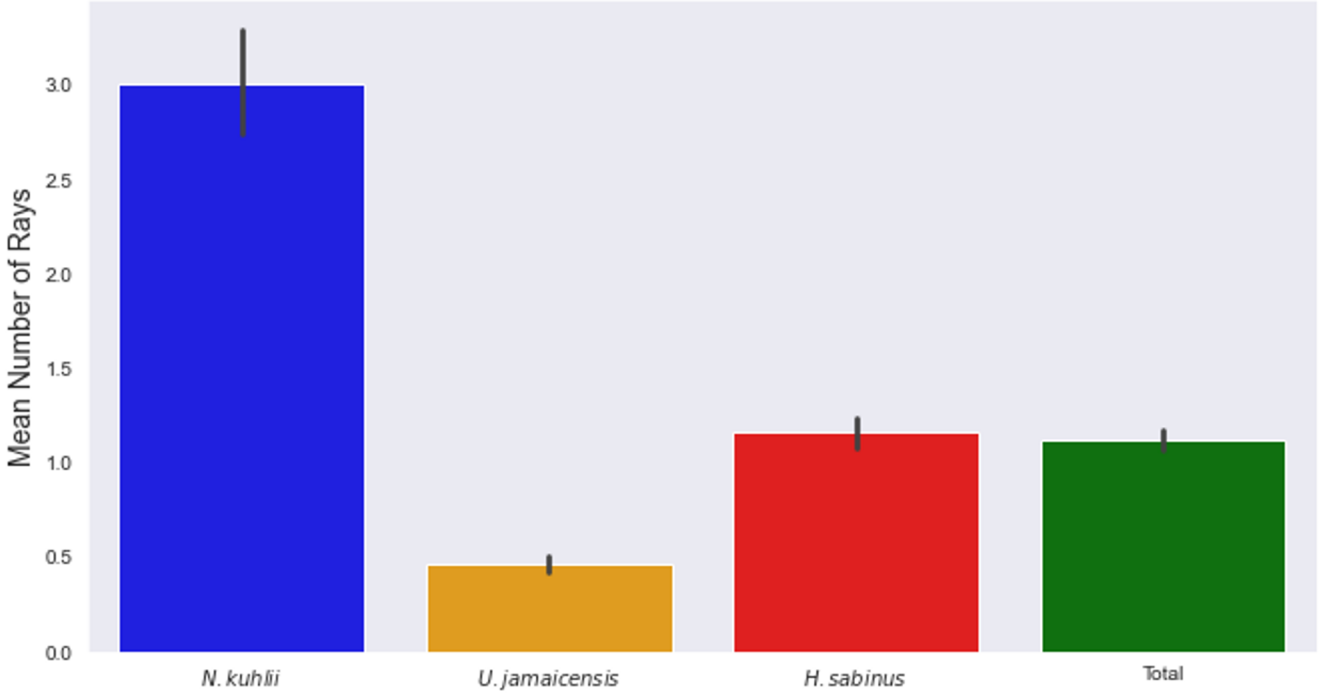
-Raw mean for Yellow Rays Following Conspecific: 3.5

-Adjusted mean for Yellow Rays Following Conspecific: 3.5 / 6 Rays = ~0.60

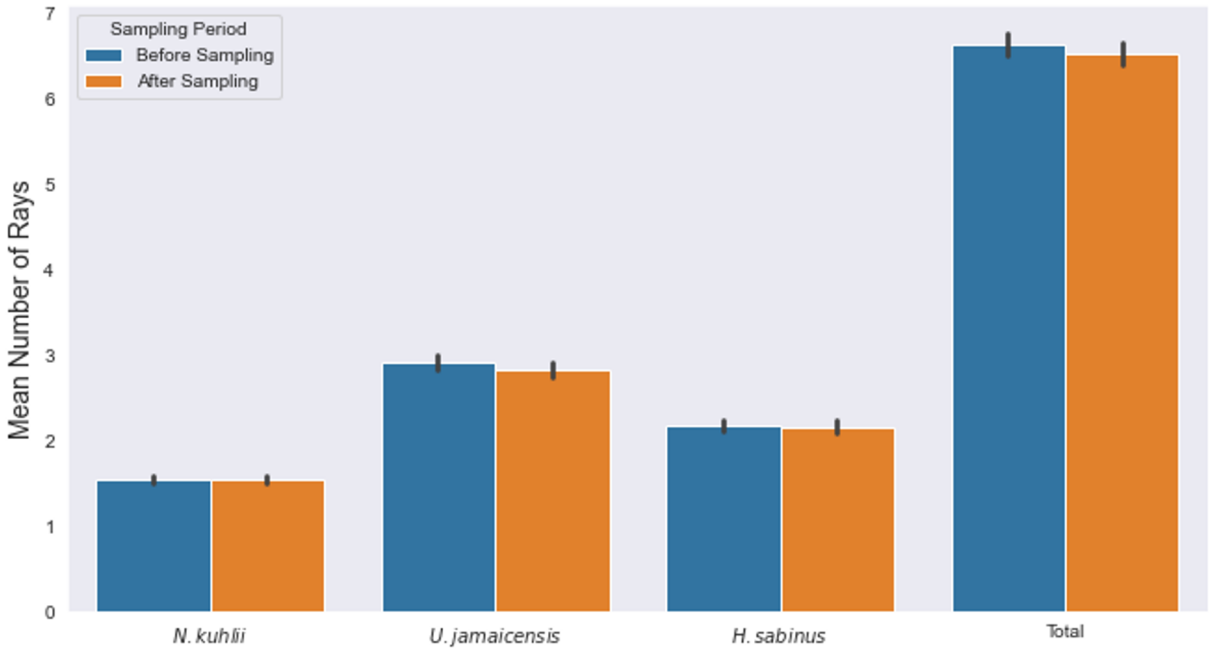
Mean Number of Rays Breaking Surface, Continuous



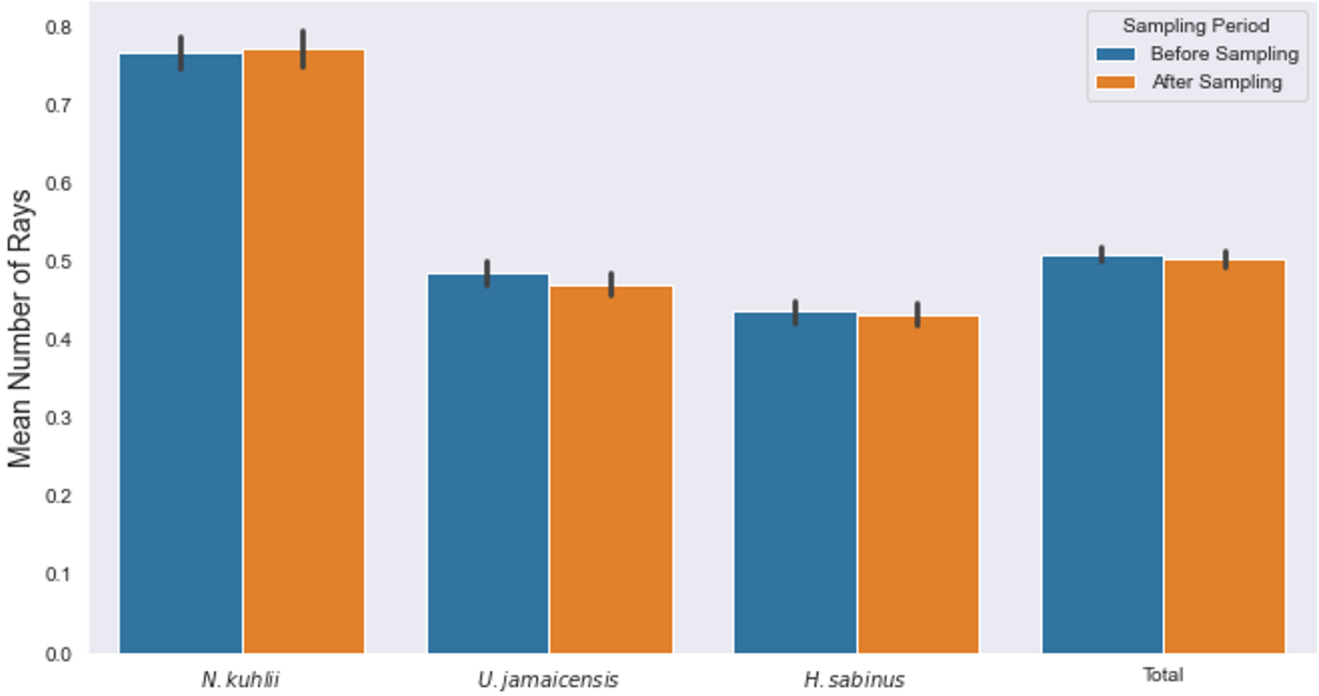
Mean Number of Rays Breaking Surface (Adjusted), Continuous



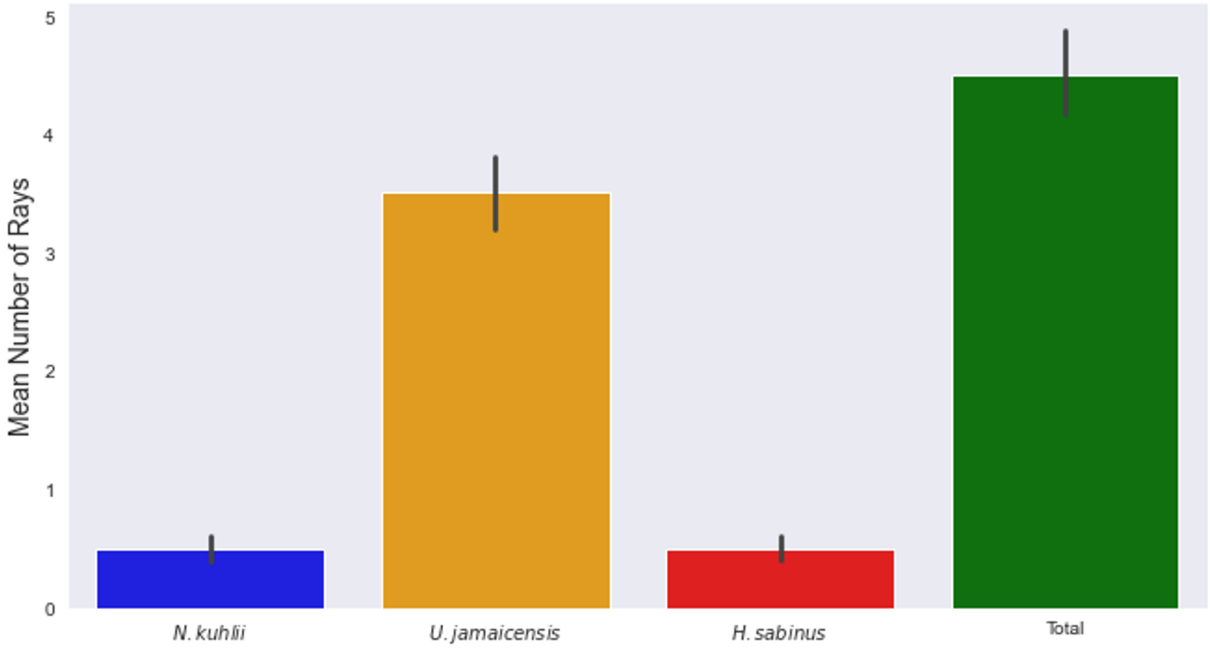
Mean Number of Rays in Shallows, Before/After Sampling



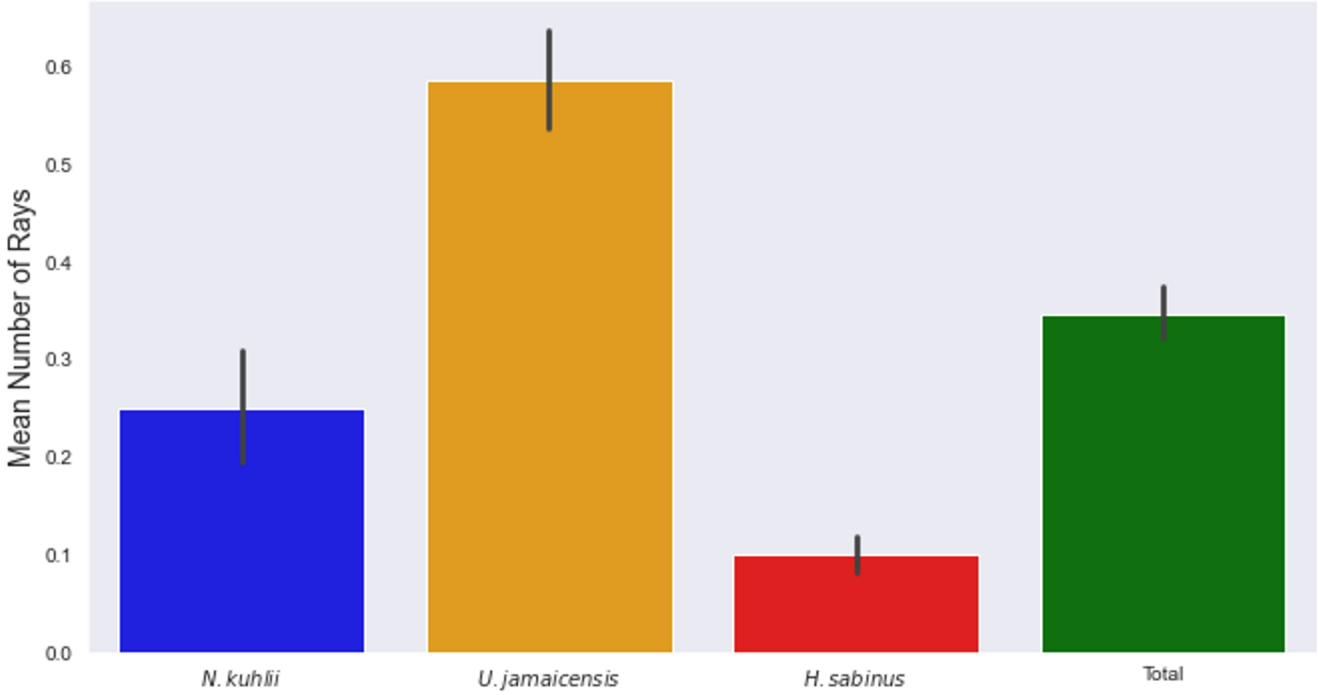
Mean Number of Rays in Shallows (Adjusted), Before/After Sampling



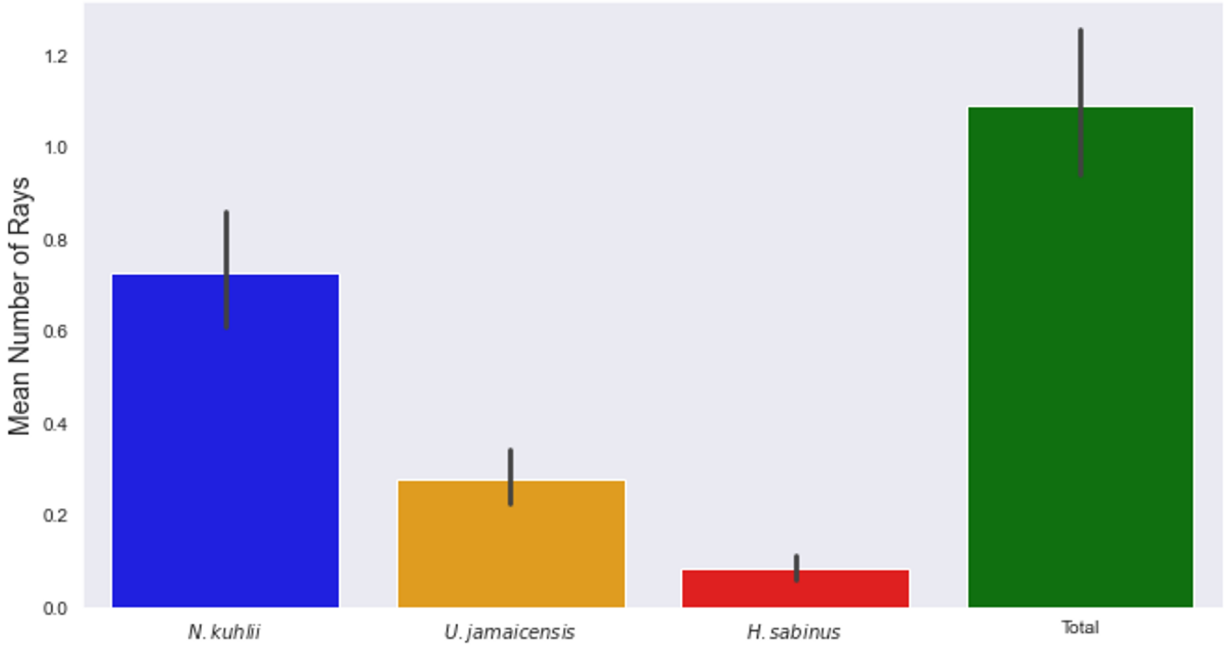
Mean Number of Rays Following Conspecific, Continuous



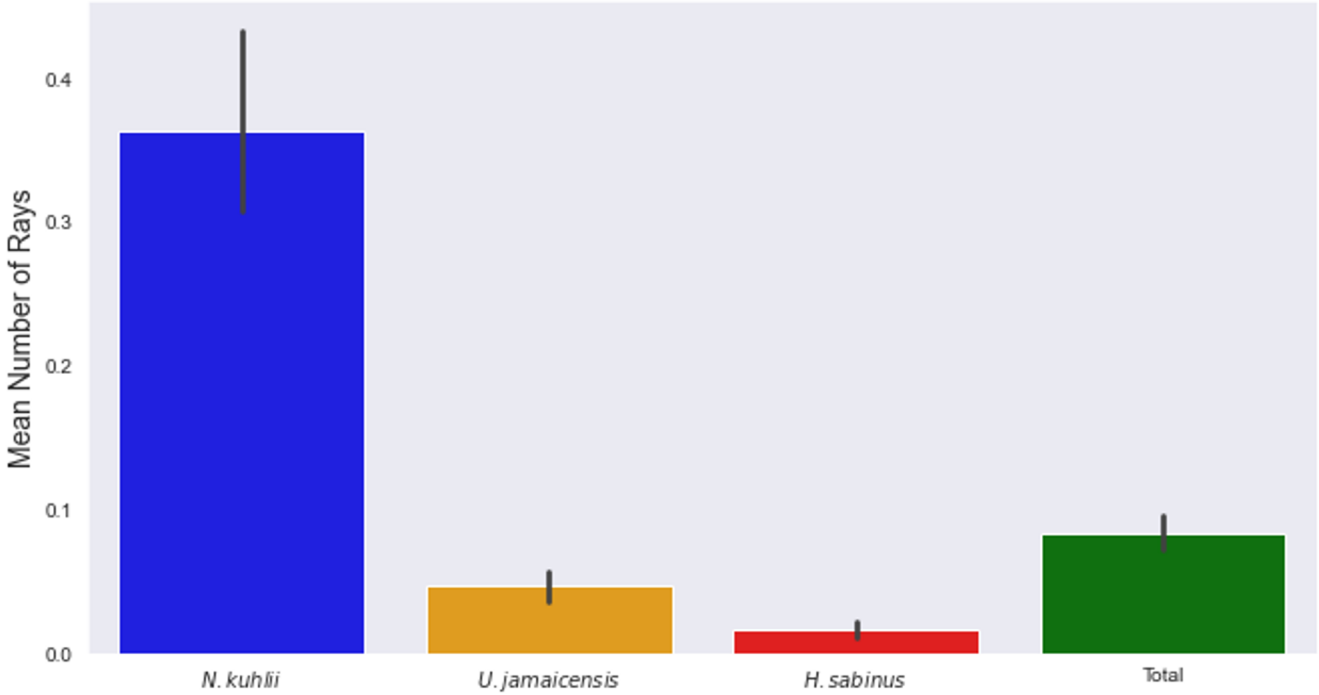
Mean Number of Rays Following Conspecific (Adjusted), Continuous



Mean Number Rays Following Different Species



Mean Number Rays Following Different Species (Adjusted)



Relationships Between Behaviors and Other Factors

A Brief Explanation of Correlation Coefficients

- Shows how closely two factors are related
- If the number is positive, when one factor increases the other increases with it
- If the number is negative, when one factor increases the other factor decreases
- If the value (positive or negative) is less than 0.3 there is little to no correlation
- If the value is between 0.3 and 0.5 there is a weak correlation
- If the value is between 0.5 and 0.7 there is a moderate correlation
- If the value is greater than 0.7 there is a strong correlation

Overall Behaviors (Instantaneous)

Correlation Matrix

	Following	Breaking the Surface	In Shallow Area	Resting at the Bottom
Following	1	0.300	0.048	-0.301
Breaking the Surface	0.300	1	0.171	-0.379
In Shallow Area	0.048	0.171	1	-0.089
Resting at the Bottom	-0.301	-0.379	-0.089	1

Overall Behaviors (Continuous)

Correlation Matrix

	Shallow	Breaking the Surface	Following Conspecific	Following Different
Shallow	1	.1217	-.046	-.006
Breaking the Surface	.1217	1	.0398	.204
Following Conspecific	-.046	.0398	1	.099
Following Different	-.006	.204	.099	1

Behavior By Species (Instantaneous)

Positive Correlations

0.414 - *U. jamaicensis* and *N. kuhlii* resting at the bottom

0.349 - *H. sabinus* and *U. jamaicensis* resting at bottom

Negative Correlations

-0.335 - *U. jamaicensis* resting at the bottom and following

-0.310 - *H. sabinus* breaking the surface and resting at the bottom
-0.386 - *U. jamaicensis* breaking the surface and resting at the bottom
-0.353 - *N. kuhlii* breaking the surface and resting at the bottom

Effects of Food Consumption and Touch Pool Attendance on Behavior (By Species)

Instantaneous

Correlations of Total Rays

	Grams food Consumed	Touch Pool Attendance	Follow	Rest	Shallow	Break
Grams food Consumed	1.000000	0.445264	-0.112471	0.017552	0.025286	0.026932
Touch Pool Attendance	0.445264	1.000000	-0.115136	0.028476	0.080733	-0.023173

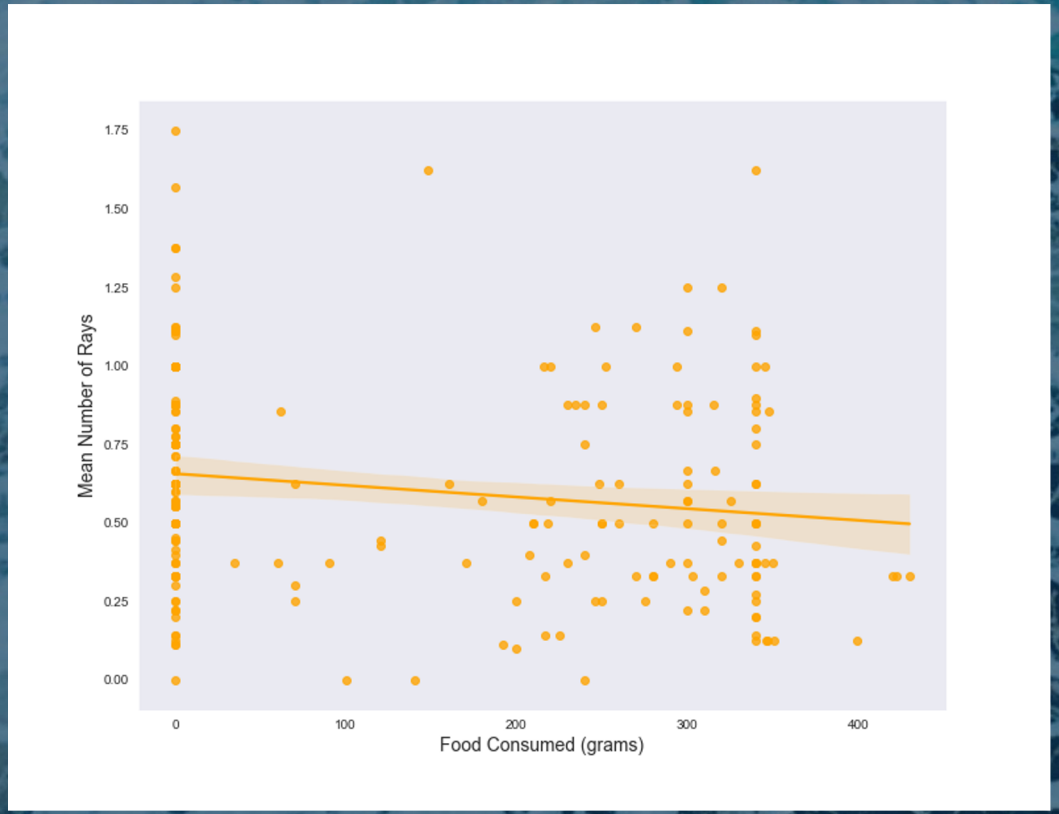
The only correlation that seems notable is the relationship between food consumed (in grams) and touch pool attendance.

Correlations of *U. jamaicensis*

	Grams food Consumed	Touch Pool Attendance	Follow	Rest	Shallow	Break
Grams food Consumed	1.000000	0.445264	-0.162436	-0.014503	0.136122	0.156622
Touch Pool Attendance	0.445264	1.000000	-0.226373	0.048956	0.249700	-0.074963

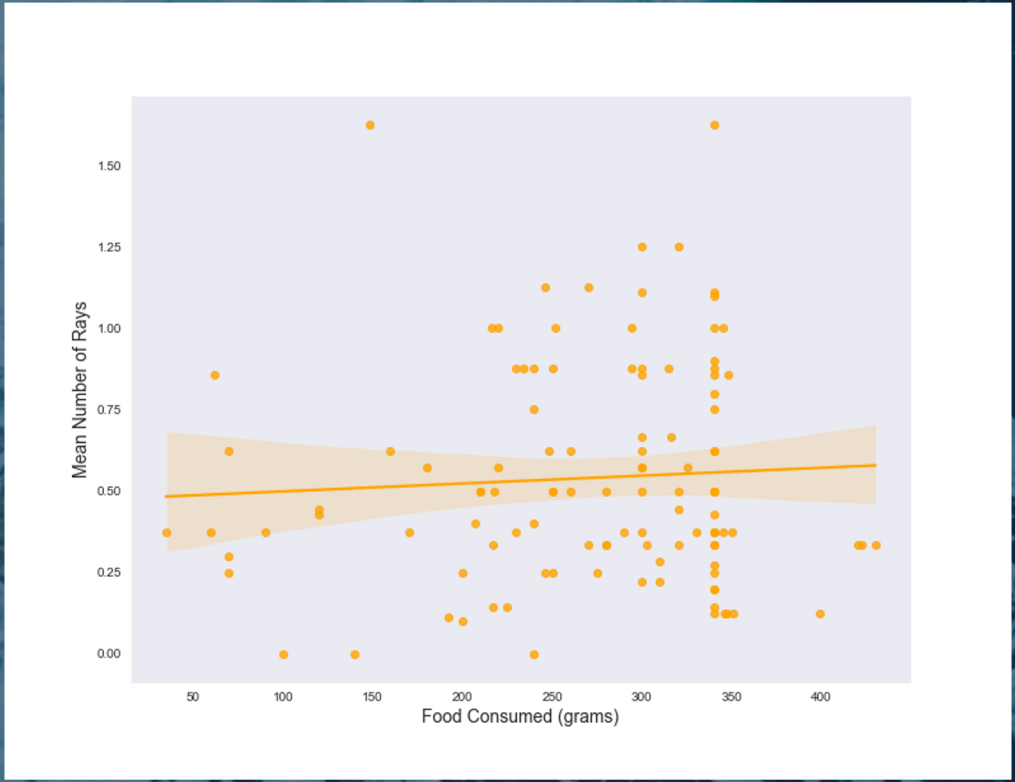
In this specific species' case we see the same general trend.

Mean *U. jamaicensis* Following Vs. Food consumption (Daily, Instantaneous)



Correlation: -0.112471

Mean *U. jamaicensis* Following Vs. Food consumption (Excluding 0's, Daily, Instantaneous) (Not good Statistical Practice)

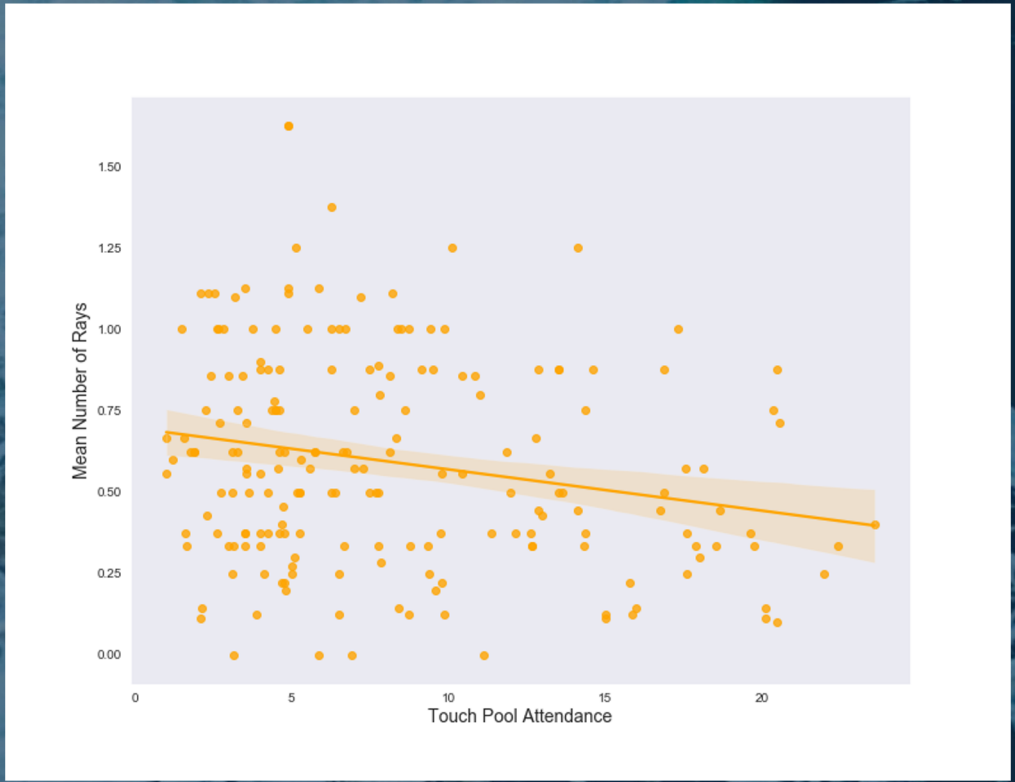


Mean *U. jamaicensis* Following Vs. Touch Pool Attendance (Daily, Instantaneous)

Correlation: -0.226373

Mean *U. jamaicensis* Following Vs. Touch Pool Attendance (Excluding 0's Daily, Instantaneous)

(Not good Statistical Practice)

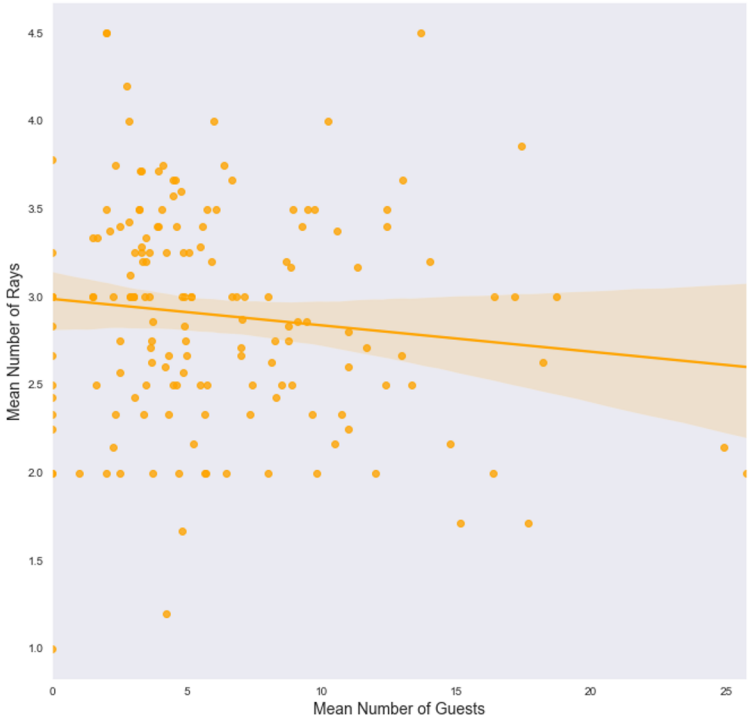


Continuous

Most Notable Correlations: *U. jamaicensis,*

	Surface Breaking	Resting (Before Sampling)	Resting (After Sampling)	Following Conspecific	Following Different Species
Min Guests	-0.21	-0.20	-0.25	-0.07	-0.13
Max Guests	-0.19	-0.20	-0.28	-0.04	-0.13

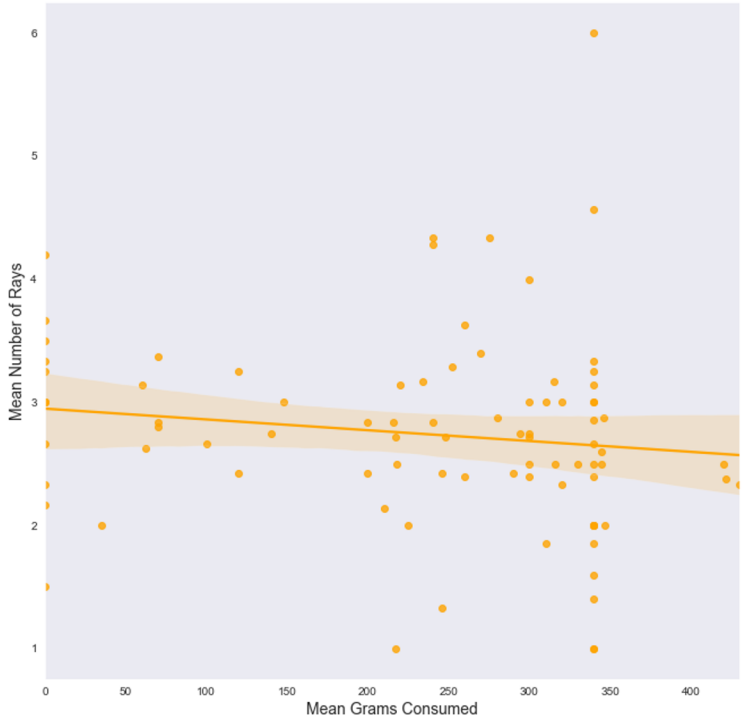
Daily Guest Attendance vs. Resting in Shallows (*U. jamaicensis,* Continuous)



Most Notable Correlations: *U. jamaicensis*

	Breaking Surface	Resting in Shallow (Before Sampling)	Resting in Shallow (After Sampling)	Following Conspecific	Following Different
Food Consumed (g)	-0.08	-0.32	-0.14	0.06	0.03

Daily Food Consumption (g) vs. Resting in Shallows (*U. jamaicensis*, Continuous)



Differences in Behavior Over Time

Daily

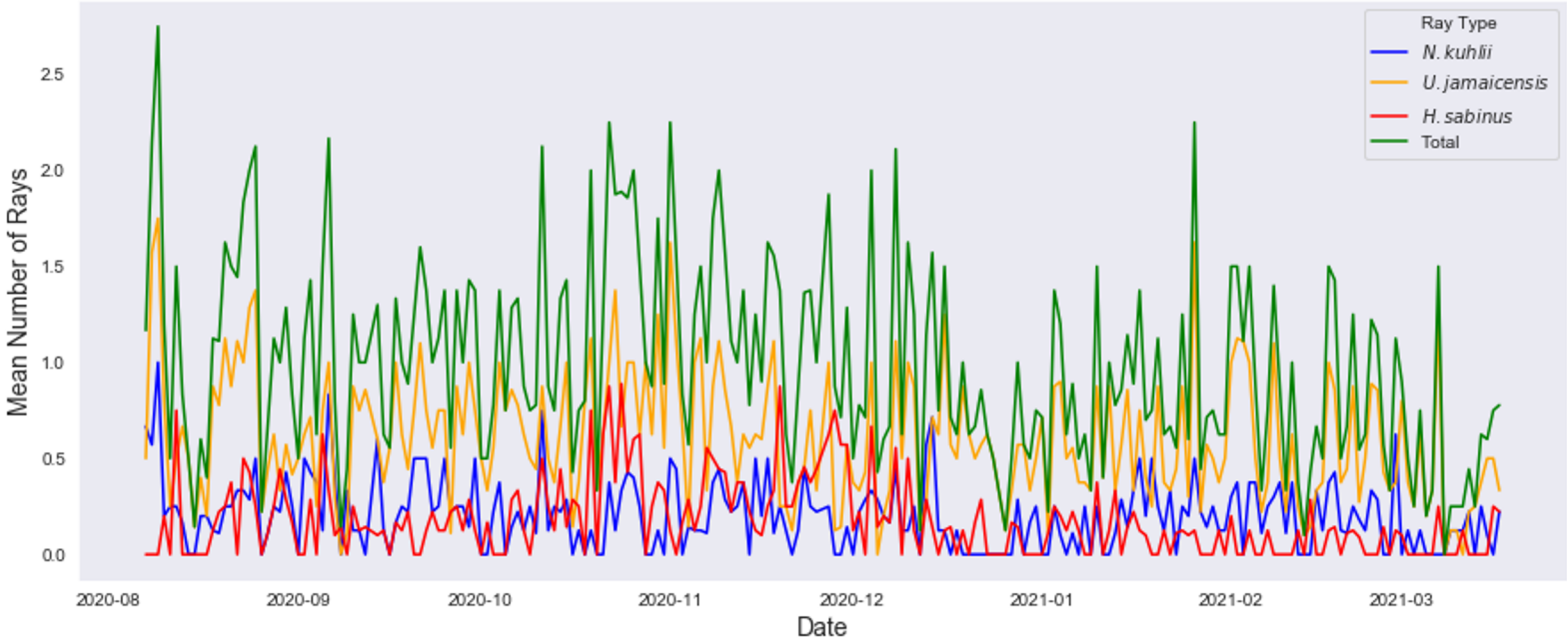
Interpretation of Instantaneous Summary Methods

- Because there were a different number of observations taken each day in instantaneous sampling, creating a sum of behaviors for each day would disproportionately weight behaviors towards days with more observations.
- To account for this fact, we divided each daily sum by the daily number of observations.
- This creates a “mean per observation” statistic that can be compared between days.
- This “mean per observation” is then divided by the number of rays of each species to obtain a “proportion per observation”.
- A similar method is taken when computing monthly means and proportions, but instead of summing totals over day and dividing by number of observations, the daily means are summed over month and divided by number of days in each month.

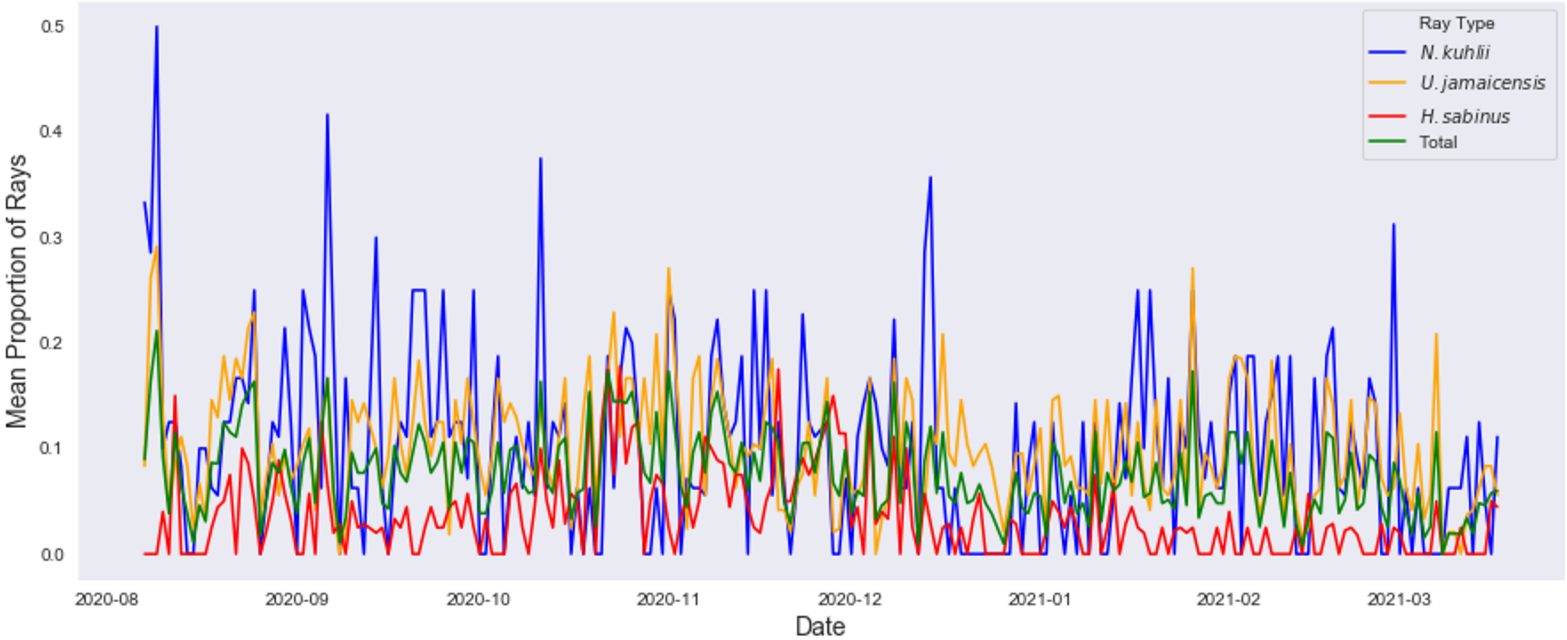
Interpretation of Continuous Summary Methods

- The “mean per observation” was calculated for Continuous in the same way as the Instantaneous
- Continuous data does cover a longer period of time and so many observations such as breaking the surface are expected to be higher than that of instantaneous
- In some cases the graphs represent the “mean number per ray across observations” (adjusted). This is simply adjusting for the different amounts of rays (For example, divide the blue ray observations by 2). These graphs will have a note at the bottom labeling them as “per ray” graphs.

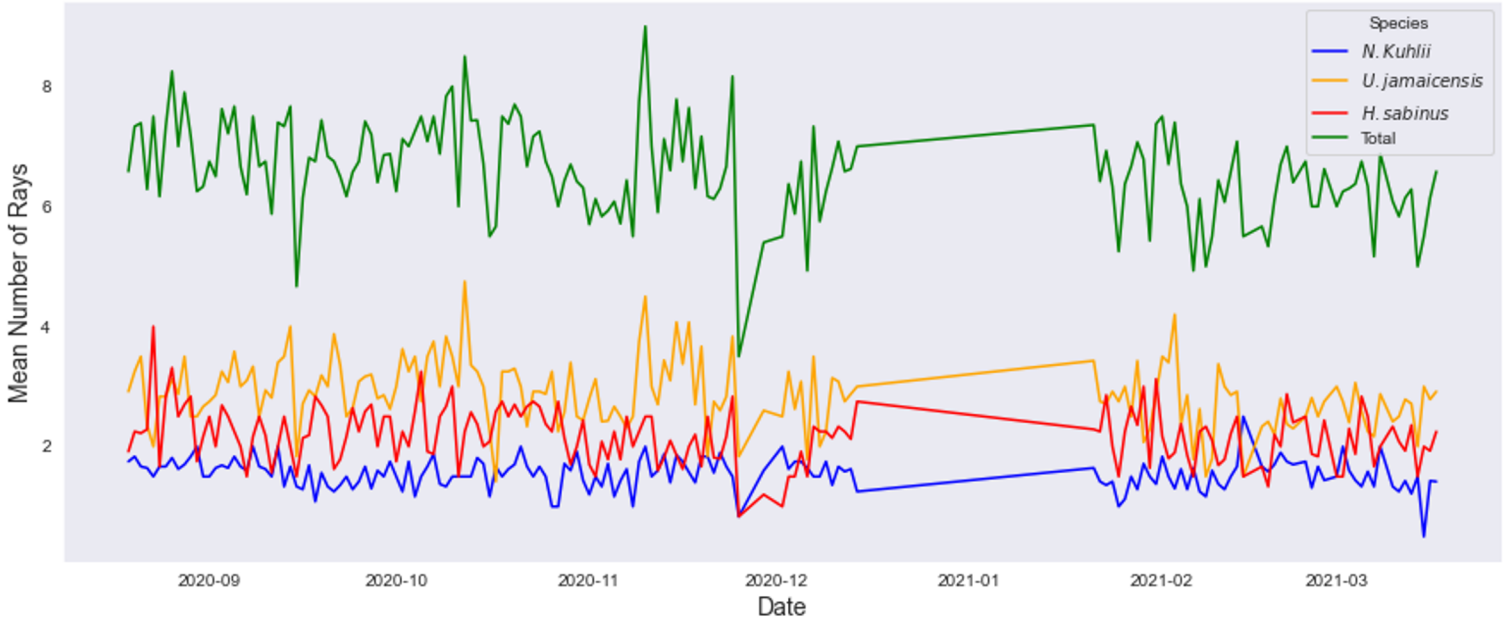
Mean Rays Following (Daily, Instantaneous)



Proportion of Rays Following (Daily, Instantaneous)

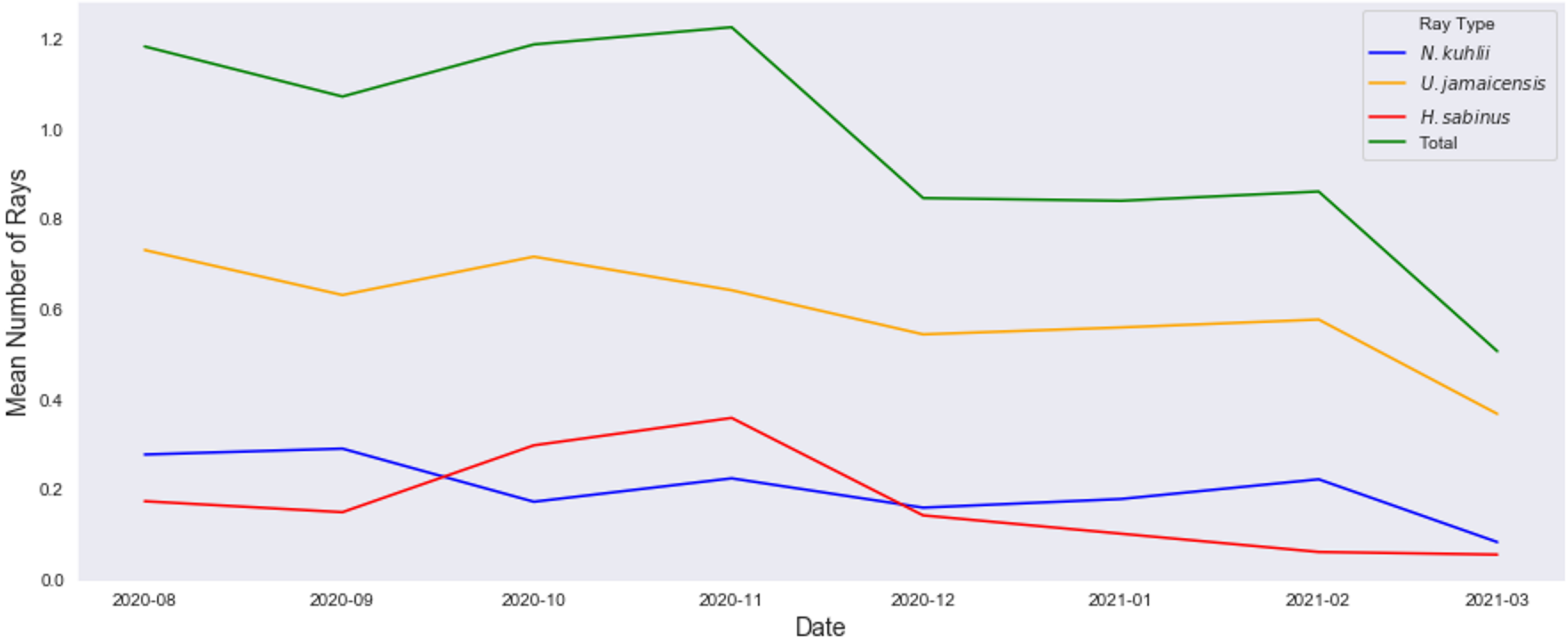


Daily Mean Number Rays Resting in Shallows, Continuous

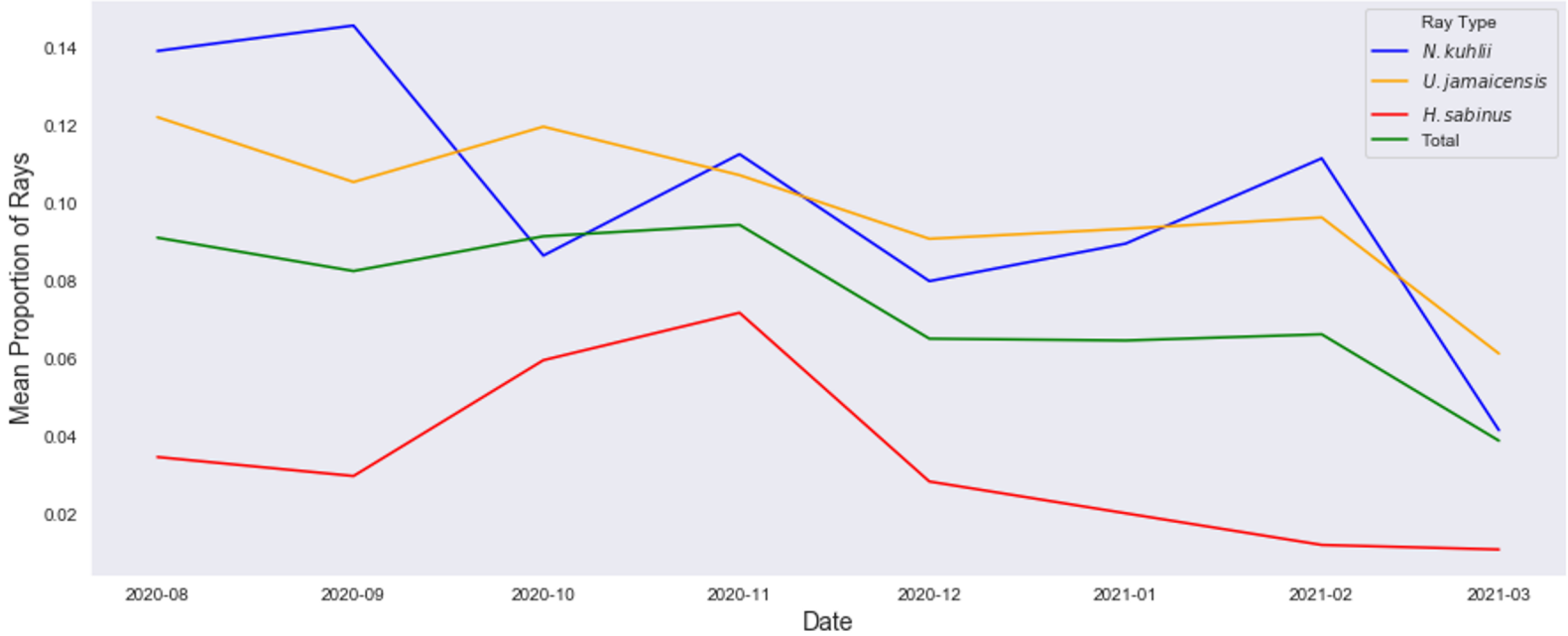


Monthly

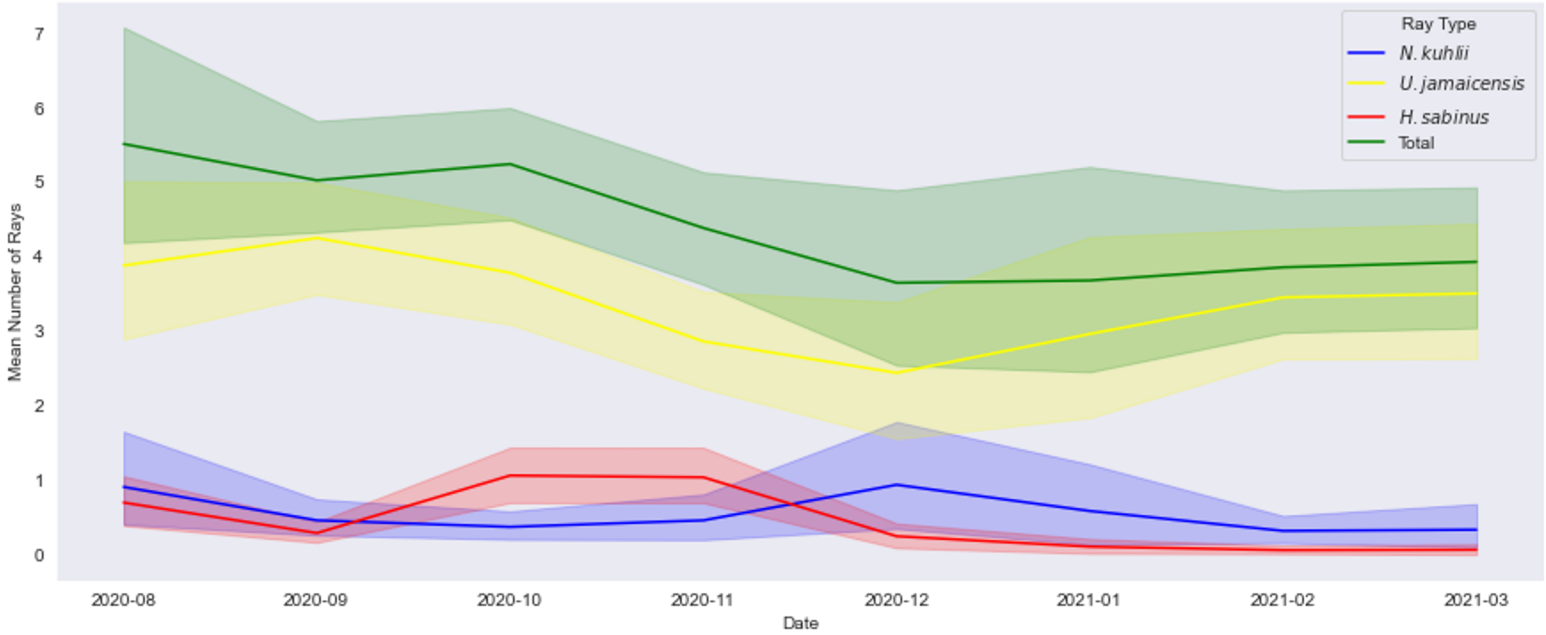
Mean Rays Following (Monthly, Instantaneous)



Proportion of Rays Following (Monthly, Instantaneous)



Mean Rays Following Conspecific (Monthly, Continuous)



Hourly

- Both ANOVA Testing and Tukey's Method suggest that there is a statistically significant difference in mean ray behavior at different time periods
- i.e. ANOVA Test (Total Rays in Shallow Area): p-value = 3.122e-67

- Despite the mean of every total ray behavior suggesting a statistically significant difference, some individual species did not exhibit statistically significant differences in some behaviors
- ANOVA Test (*N. kuhlii* in Shallow Area): p-value = 0.114
- ANOVA Test (*H. sabinus* Following): p-value = 0.061

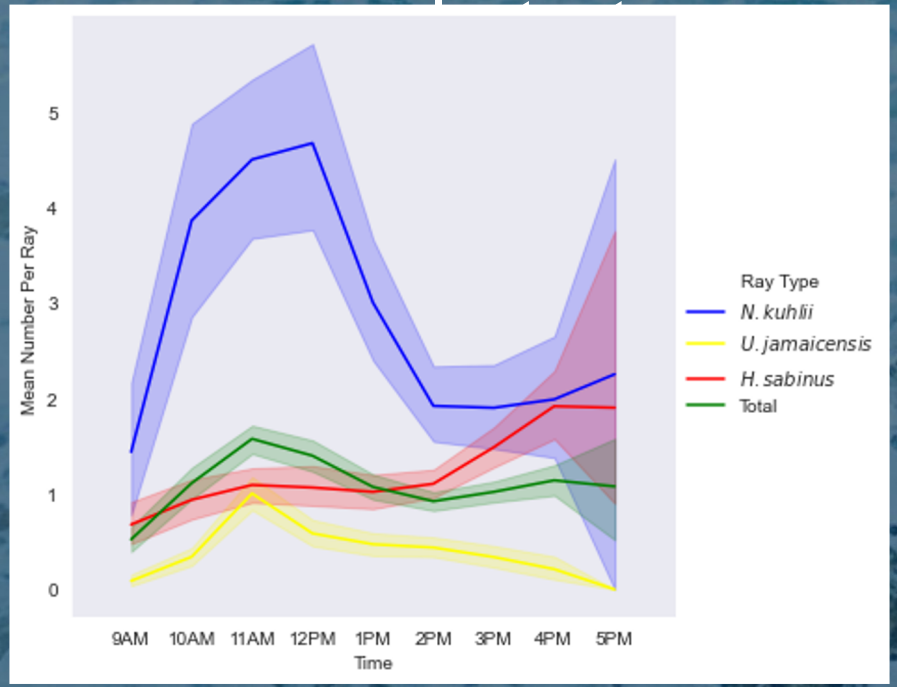
- Typically if a p-value is lower than 0.05 the difference in means is considered statistically significant

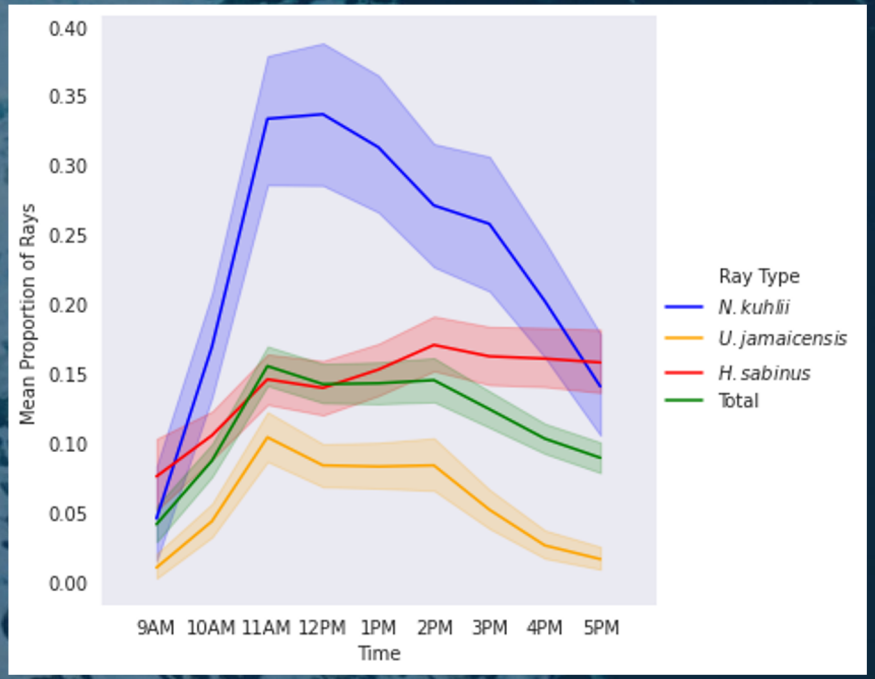
Continuous vs. Instantaneous Hourly

- Both datasets showed that there is a difference between time periods
- However, the trend across the day was slightly different for each method
- Continuous had less data for later in the day making conclusions harder

Breaking the Surface

Continuous vs.

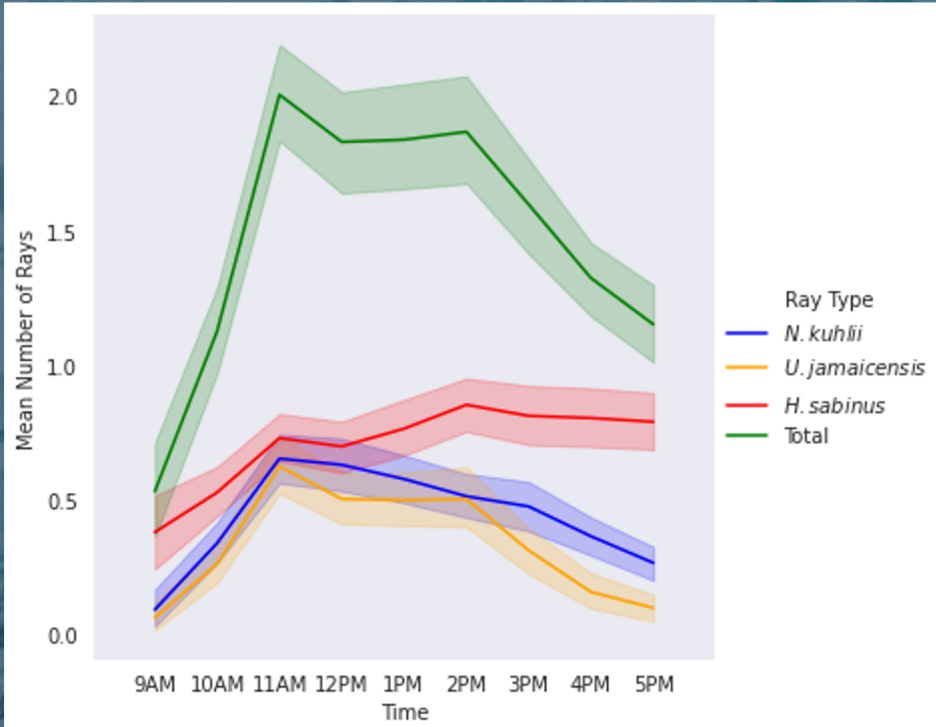


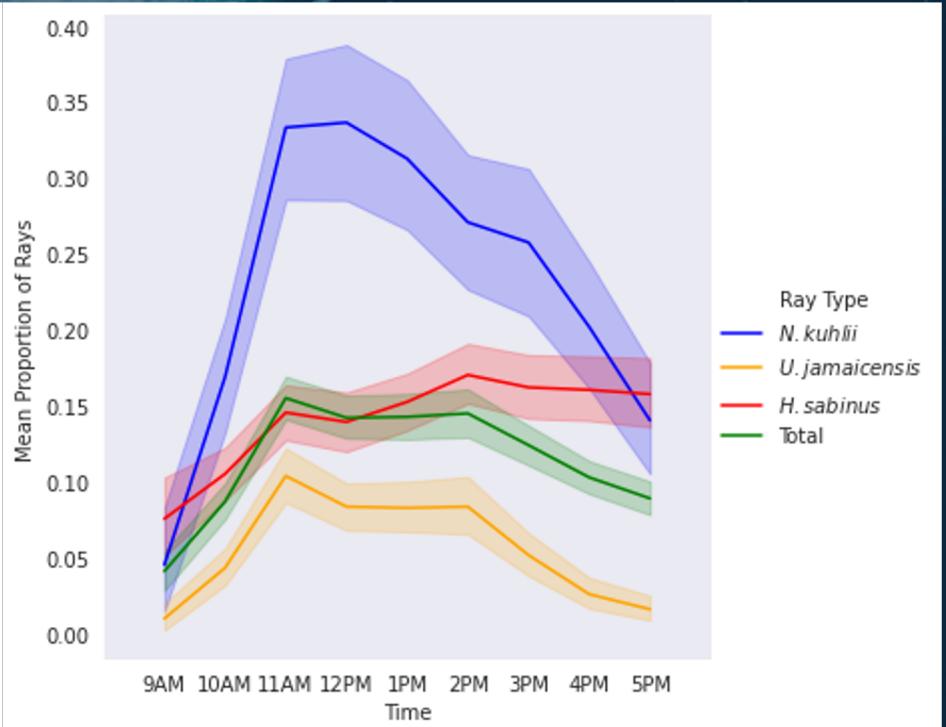


Notice that Continuous data is taken over the course of 5 minutes meaning that you shouldn't compare the y-axis numbers, just the overall trend.

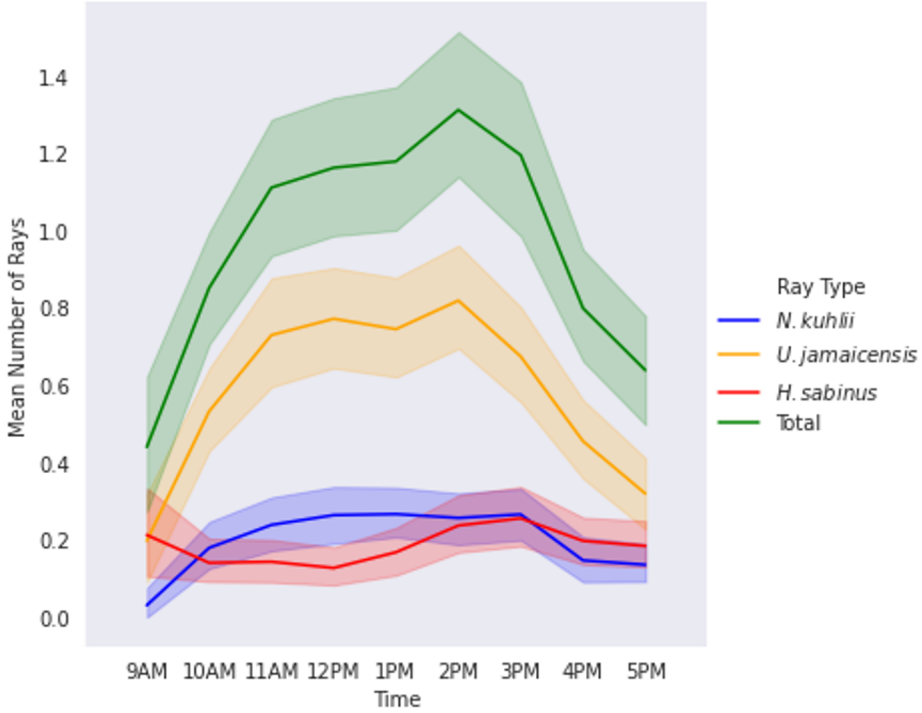
Hourly, Instantaneous Plots

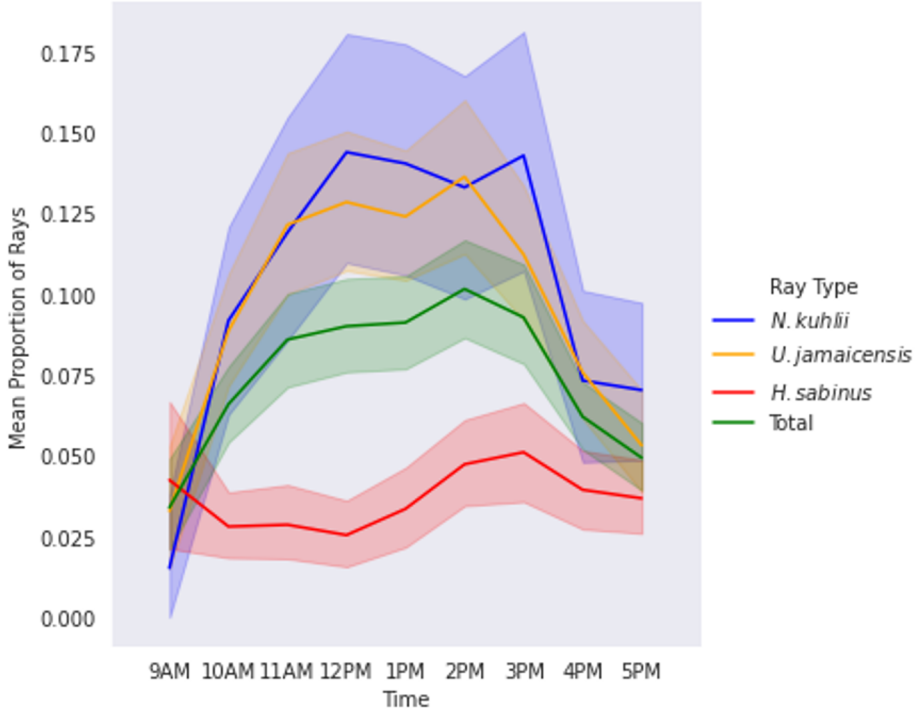
Rays Breaking the Surface (Hourly, Instantaneous)



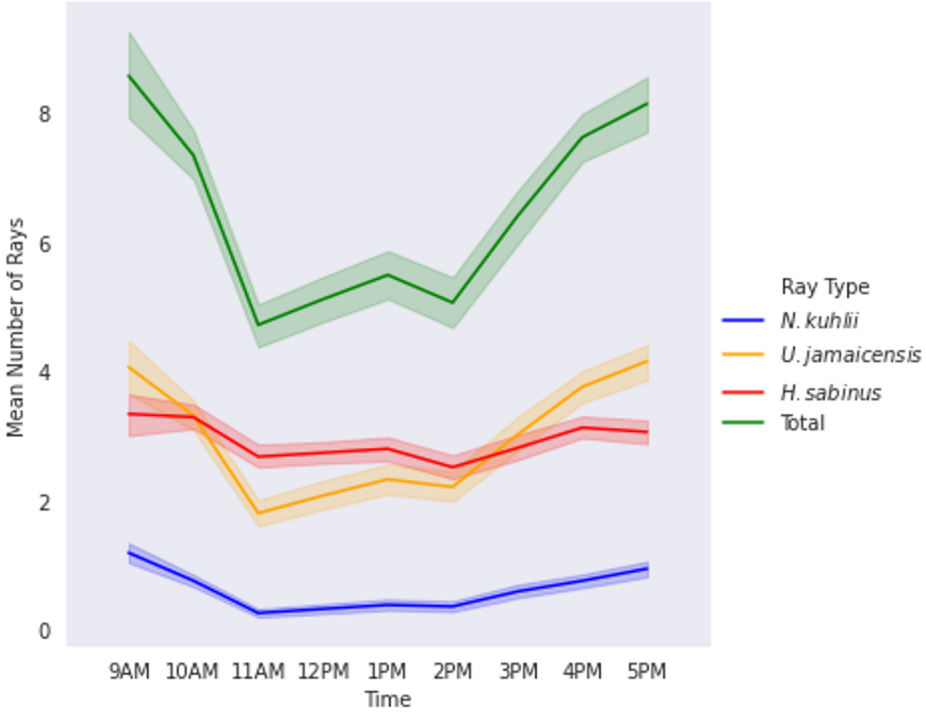


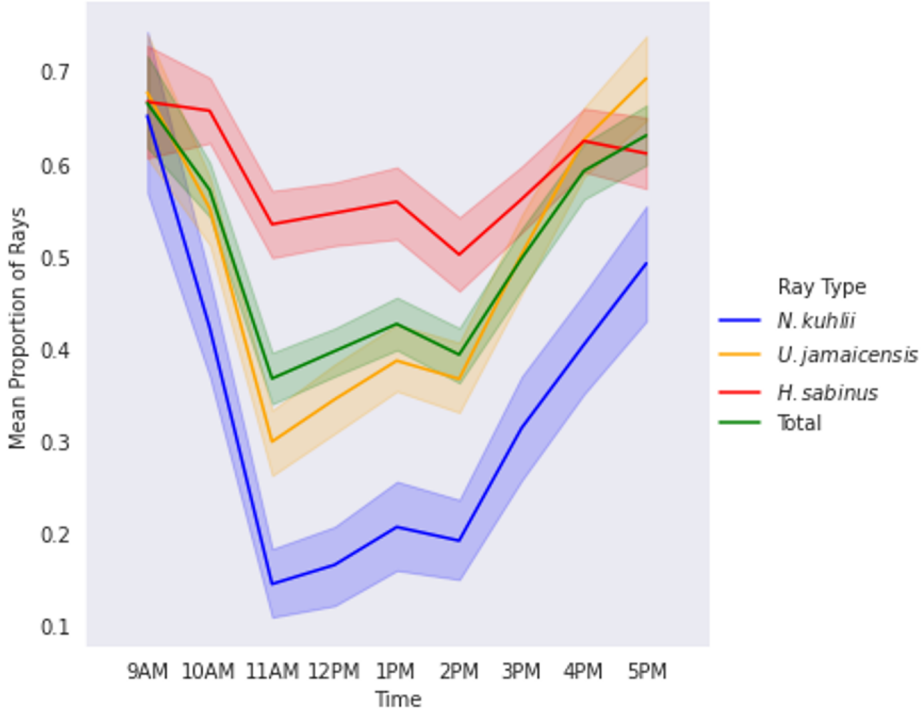
Rays Following (Hourly, Instantaneous)



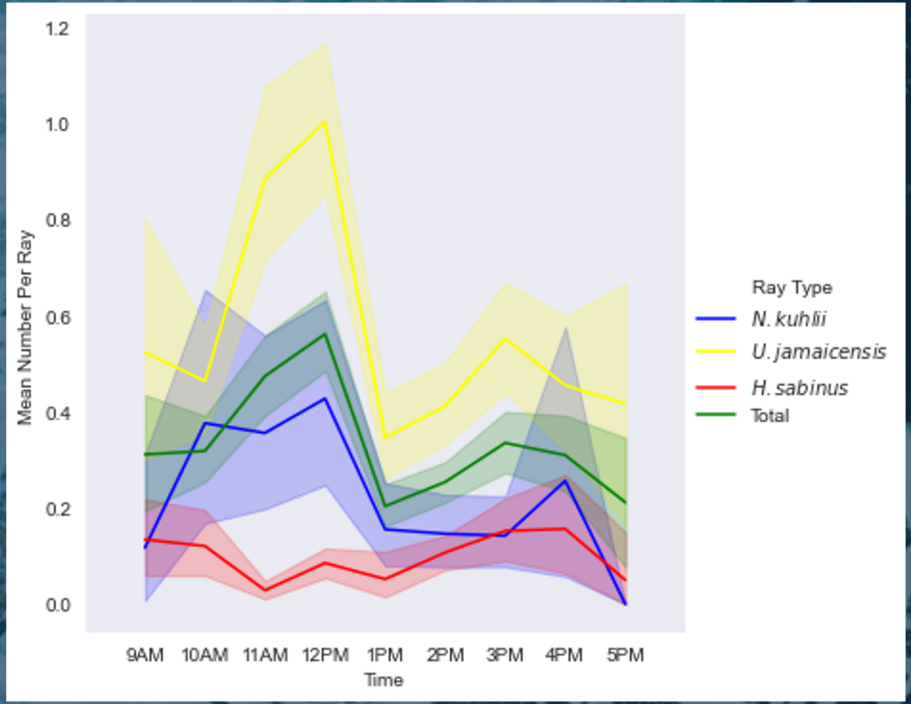


Rays Resting at the Bottom (Hourly, Instantaneous)





Rays Following Conspecific (Hourly, **Continuous**)



Following shows more variation than other variables and was harder to detect trends among continuous data (less observations than instantaneous)

Differences in Sampling Methods

Differences in Sampling Methods

<u>Continuous</u>

- Measures frequency of behavior
- A bit more detailed and therefore more useful for some behaviors (i.e. breaking the surface)
- Trends tend to be similar to instantaneous data
- Not particularly good for prediction

<u>Instantaneous</u>

- Measures amount of rays participating in a behavior
- Has more data making statistical testing more precise
- Trends tend to be similar to continuous data
- Not particularly good for prediction

Suggestions

Suggestions

- Consistency in data entry (throw out incorrect data, ensure data in same format)
- Consistency in time of data collection (amount of observations, skew in daily averages)
- Bias due to person collecting the data?

Summary

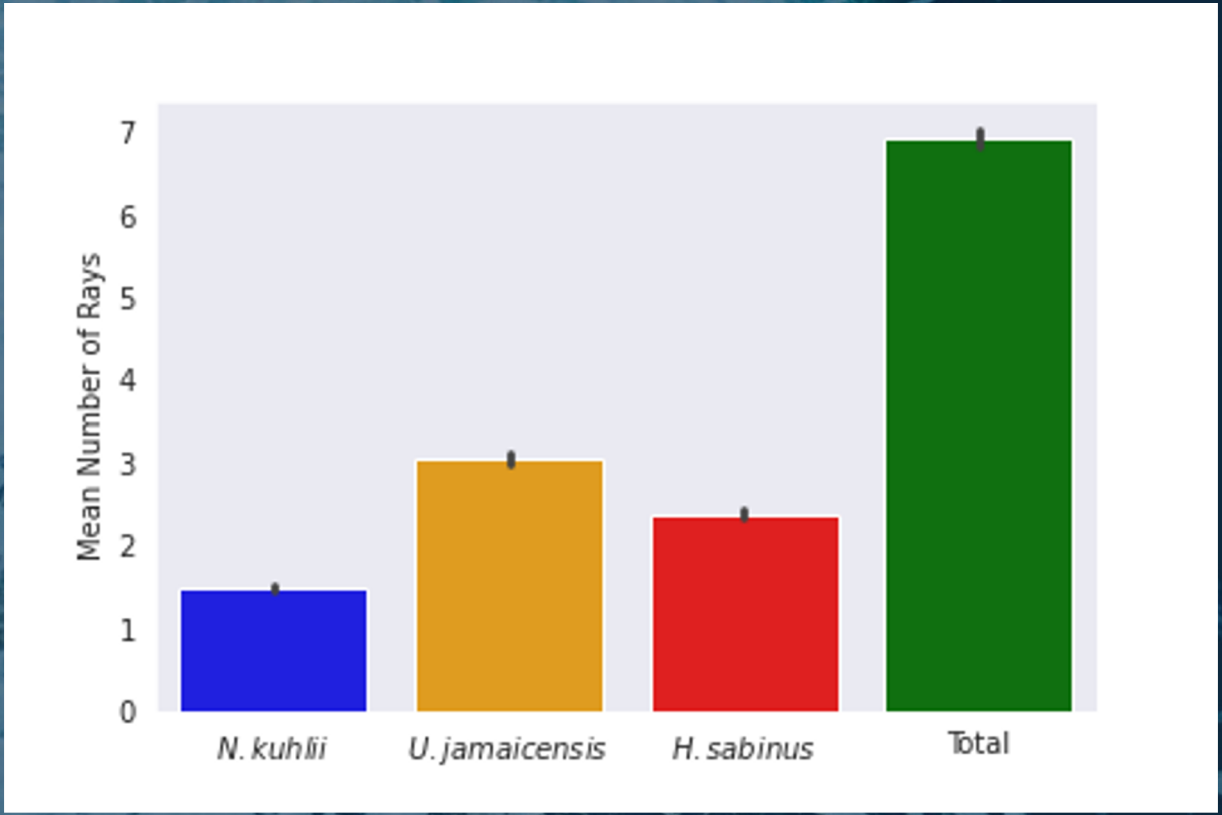
- We created plots of “baseline” behaviors
- Trends over time were hard to detect from month to month and day to day
- Different hours saw different levels of “activity” for each of the different species
- Certain species perform certain behaviors more often (*N. kuhlii* break the surface more often, *U. jamaicensis* following conspecific rays much more often)
- Instantaneous and Continuous both have advantages and disadvantages
- Having data collected at the same time each day consistently would lead to more powerful statistical analysis
- Behaviors are not highly correlated to each other, attendance, or food. There were some minor relationships between them.

Appendix

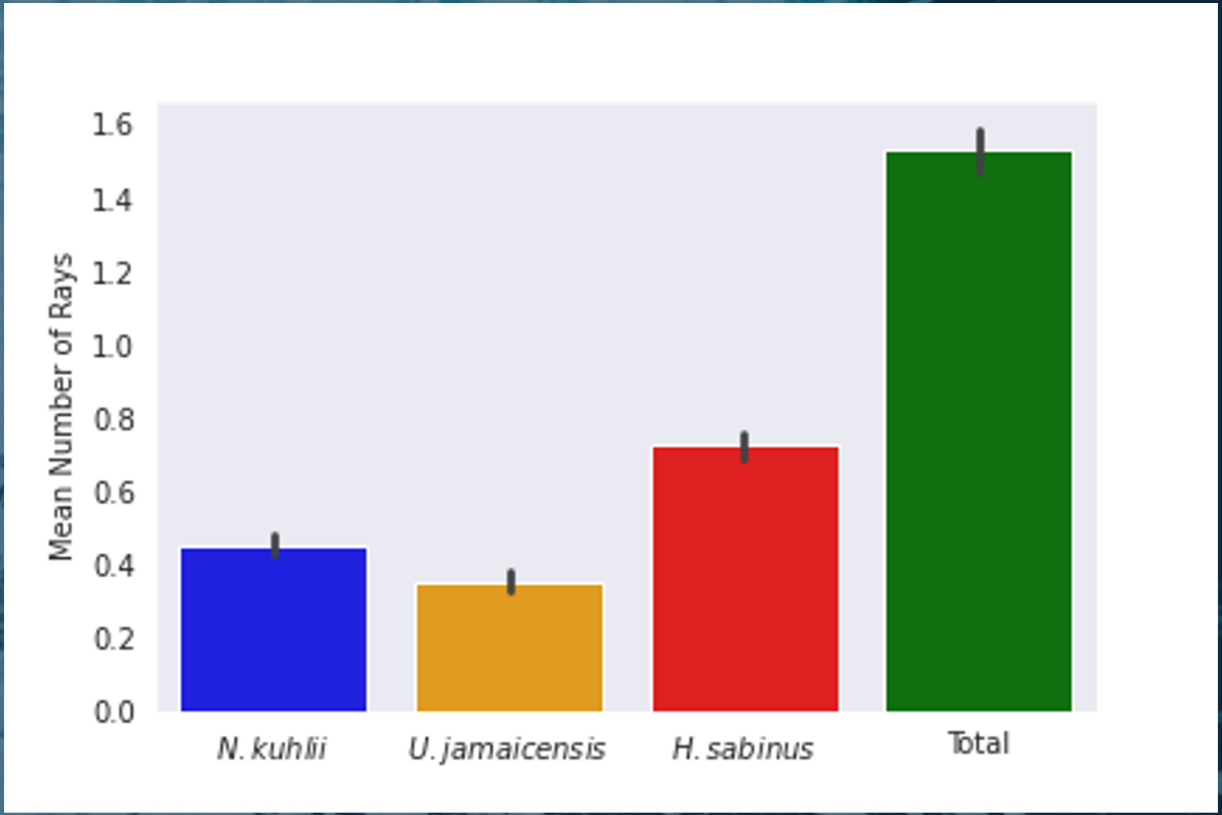
Base Data Instantaneous

Instantaneous Data

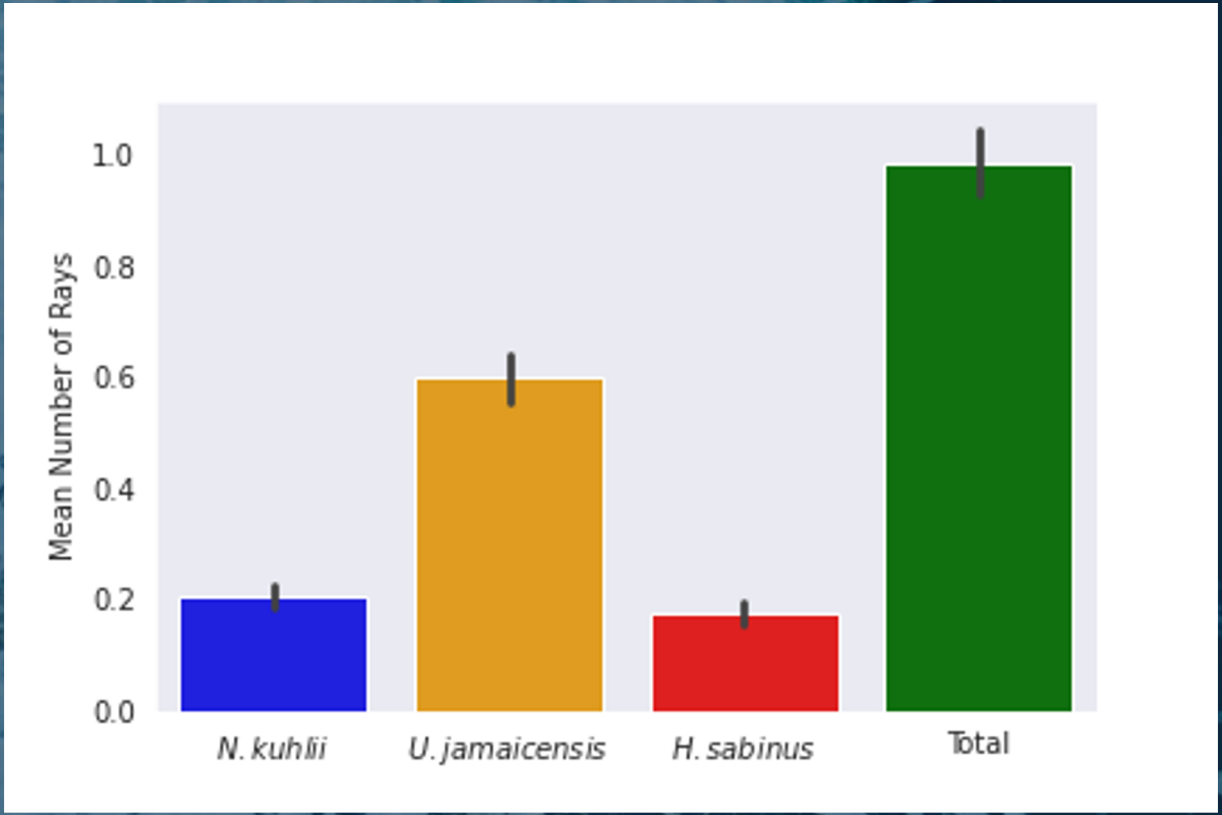
Rays In Shallow Area (Instantaneous)



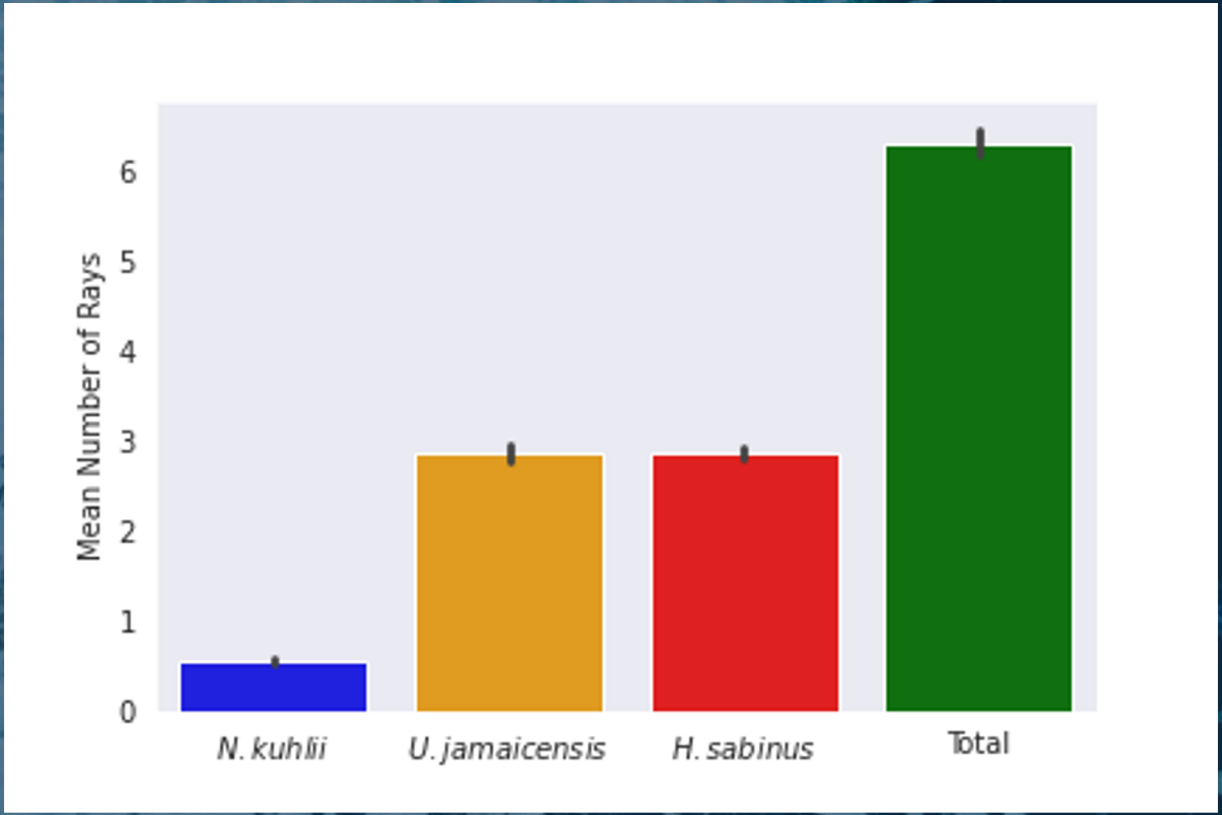
Rays Breaking the Surface (Instantaneous)



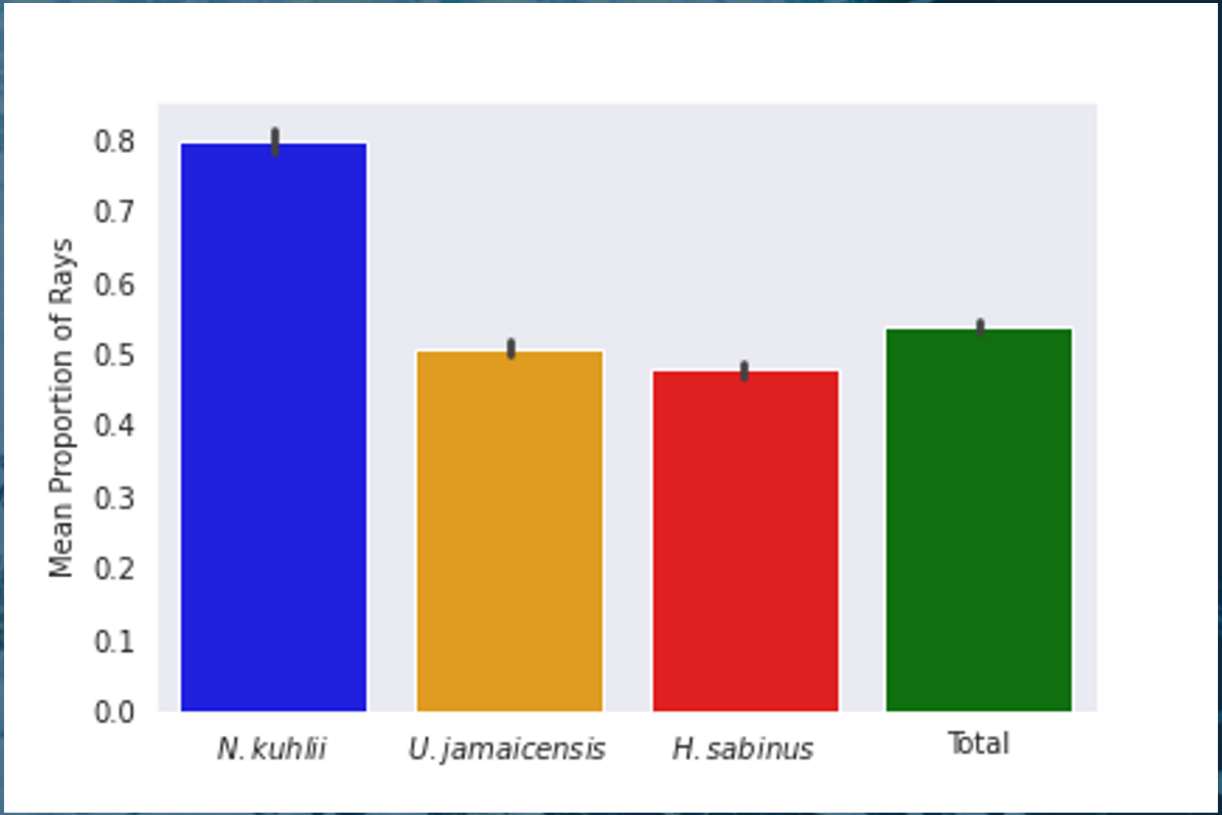
Rays Following (Instantaneous)



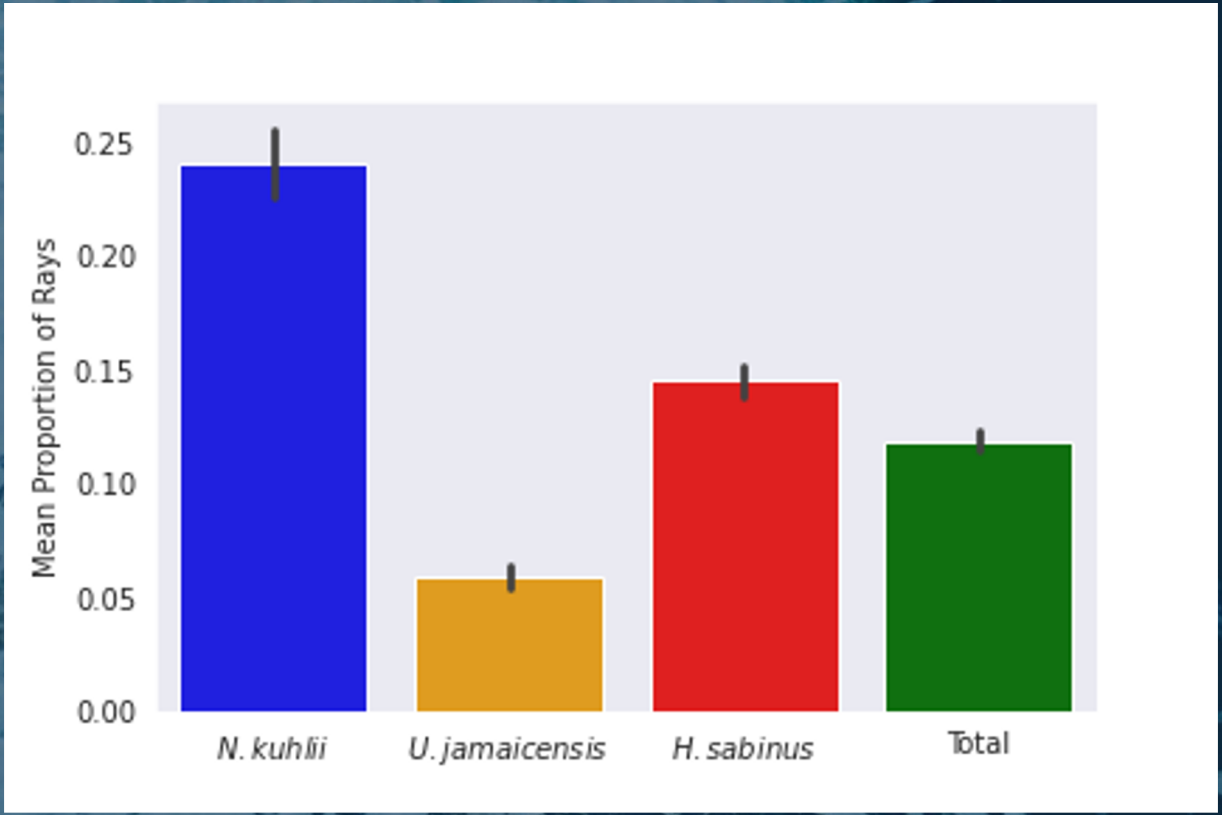
Rays Resting at the Bottom (Instantaneous)



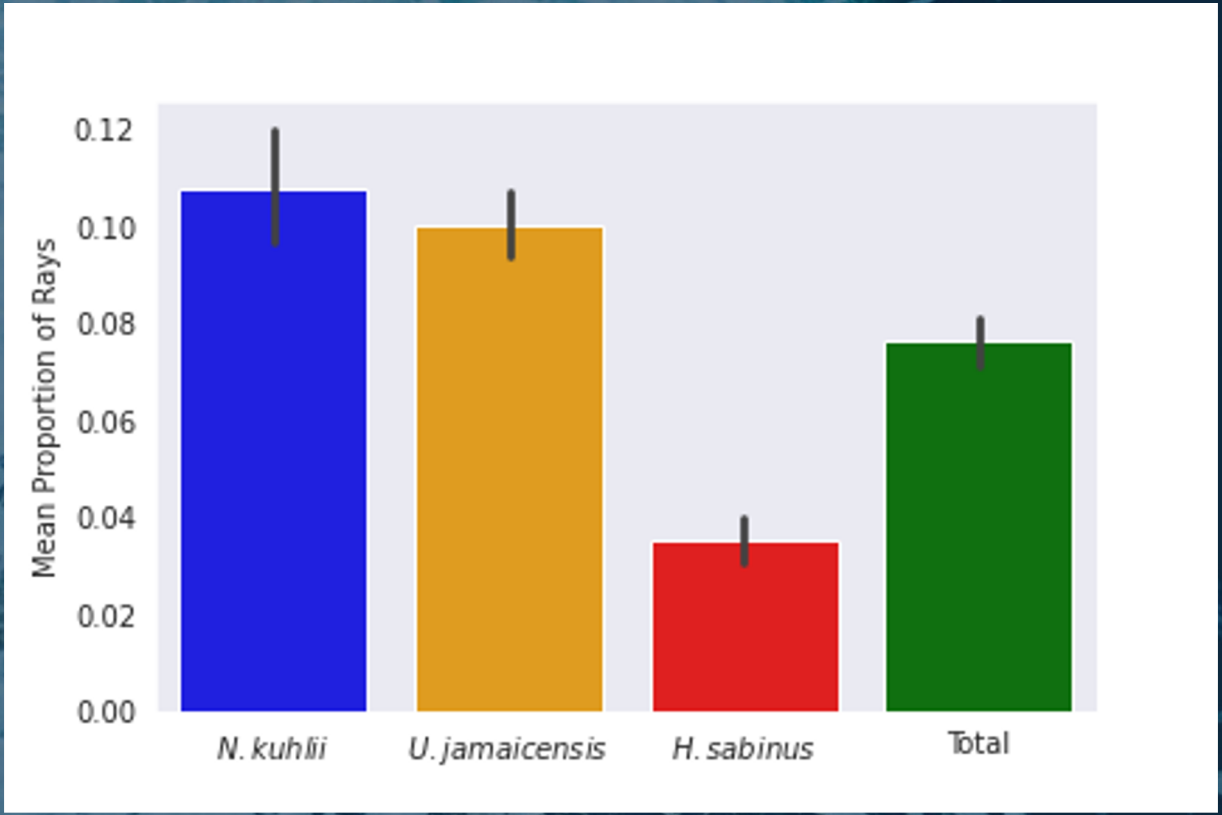
Proportion In Shallow Area (Instantaneous)



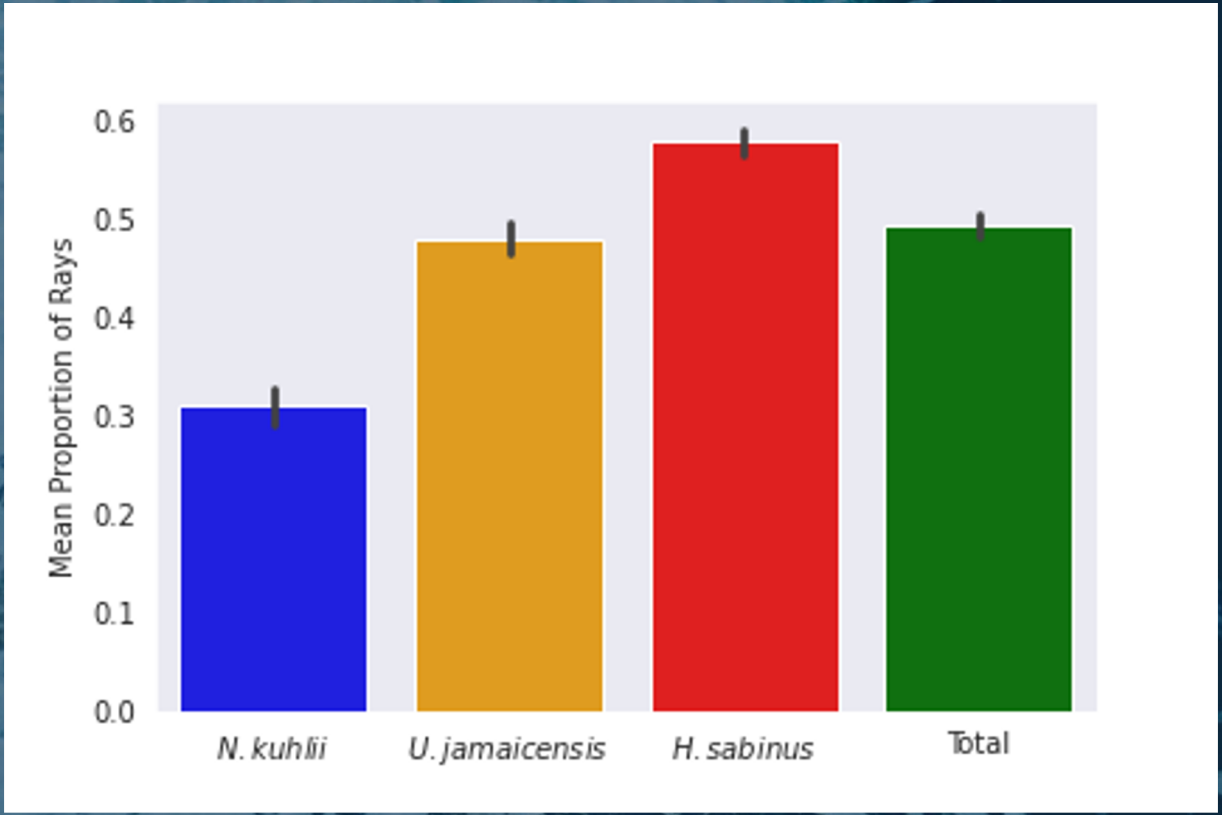
Proportion Breaking the Surface (Instantaneous)



Proportion Following (Instantaneous)

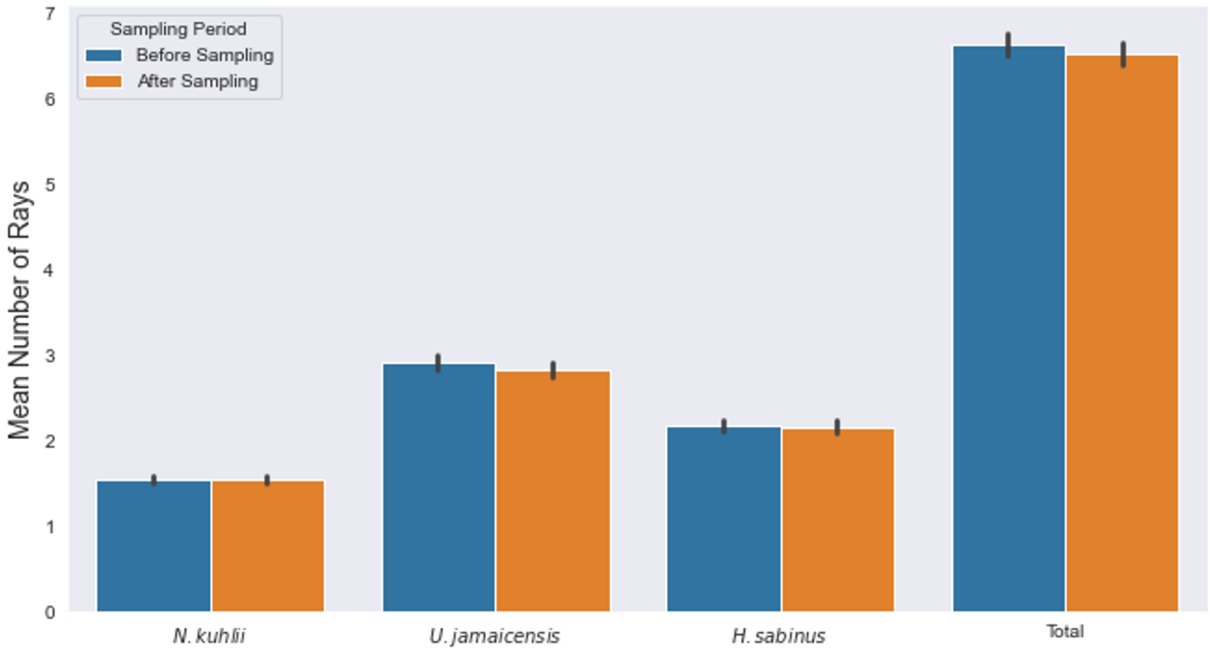


Proportion Resting at the Bottom (Instantaneous)

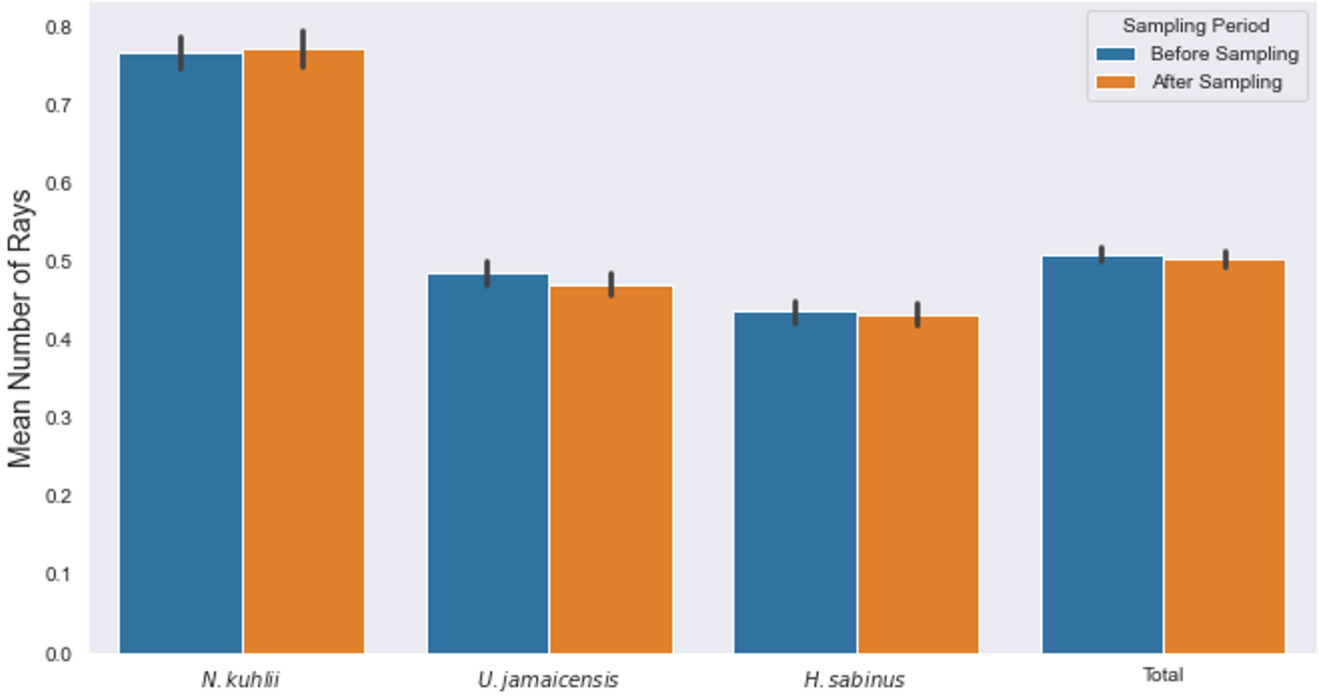


Baseline Behaviors Continous

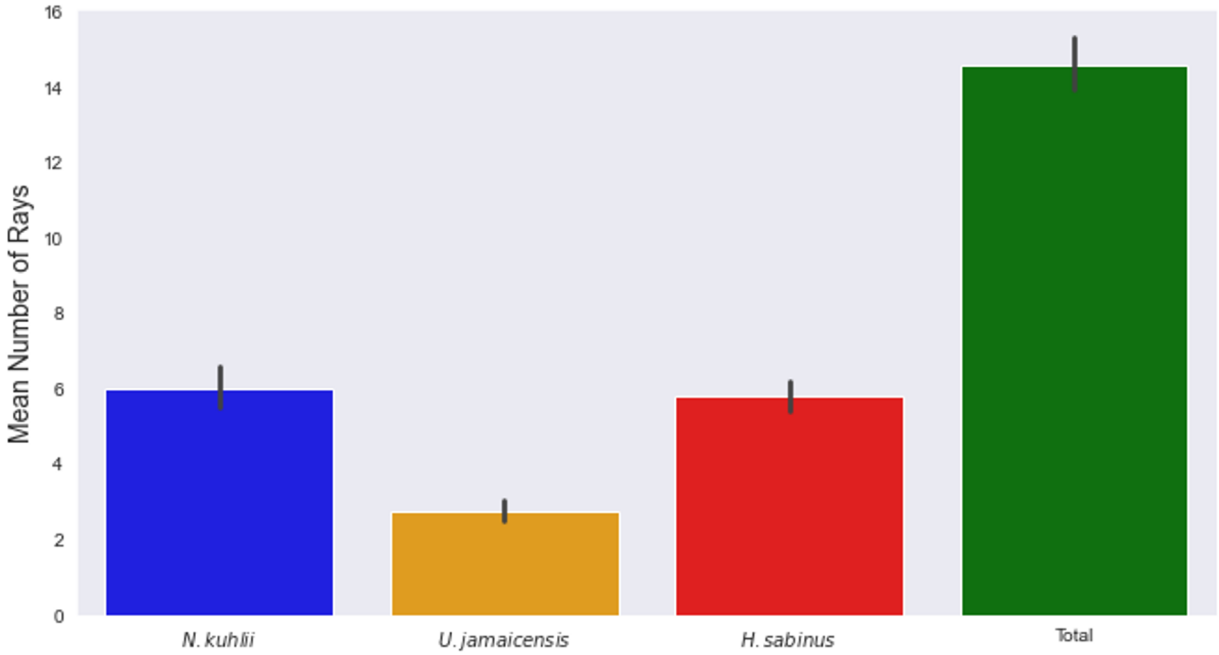
Mean Number of Rays in Shallows, Before/After Sampling



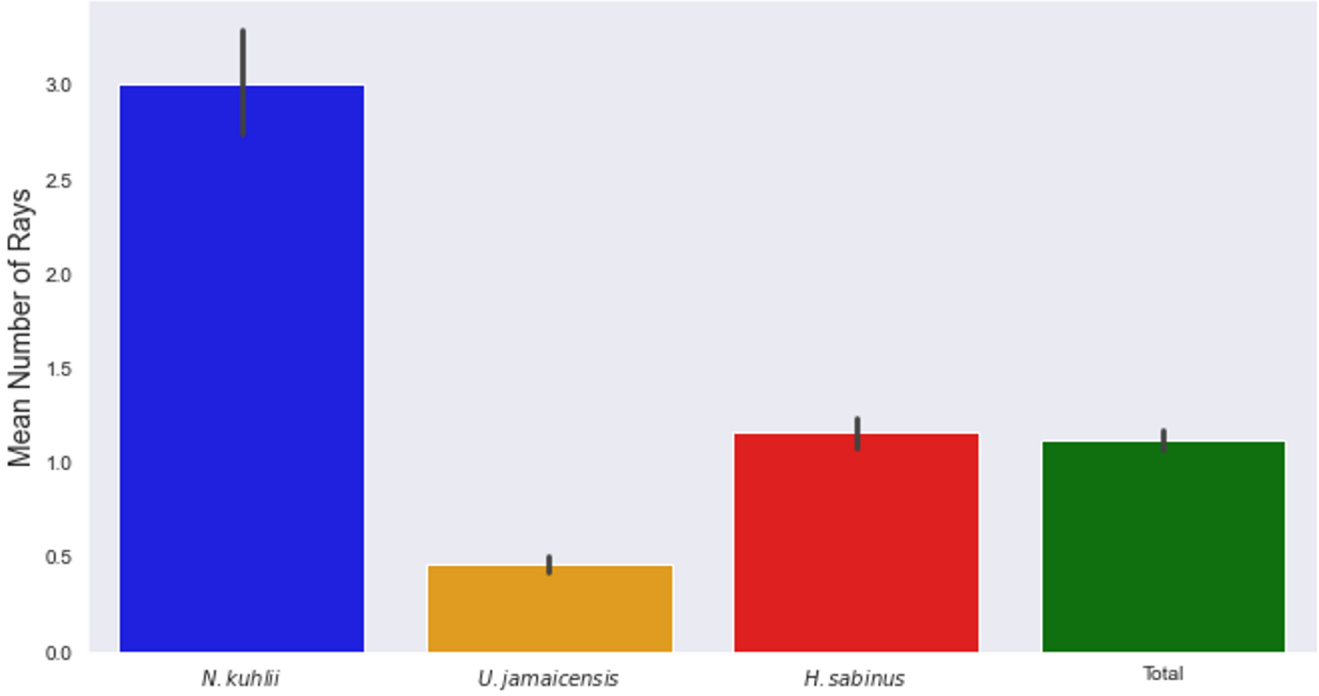
Mean Number of Rays in Shallows (Adjusted), Before/After Sampling



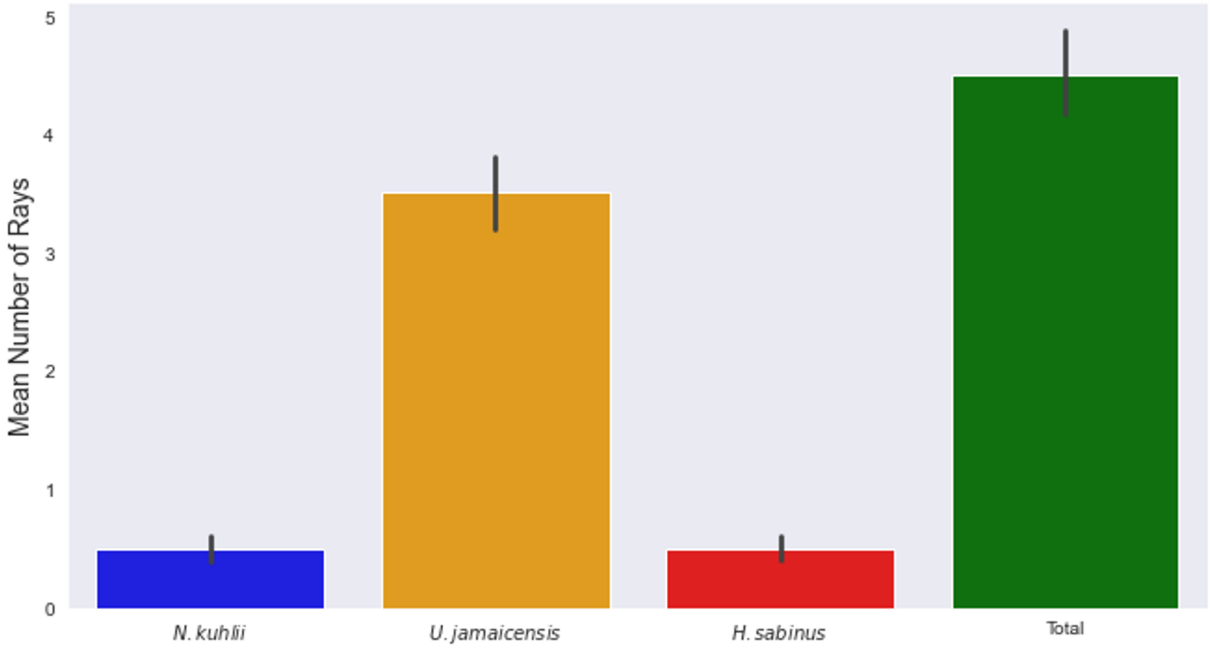
Mean Number of Rays Breaking Surface, Continuous



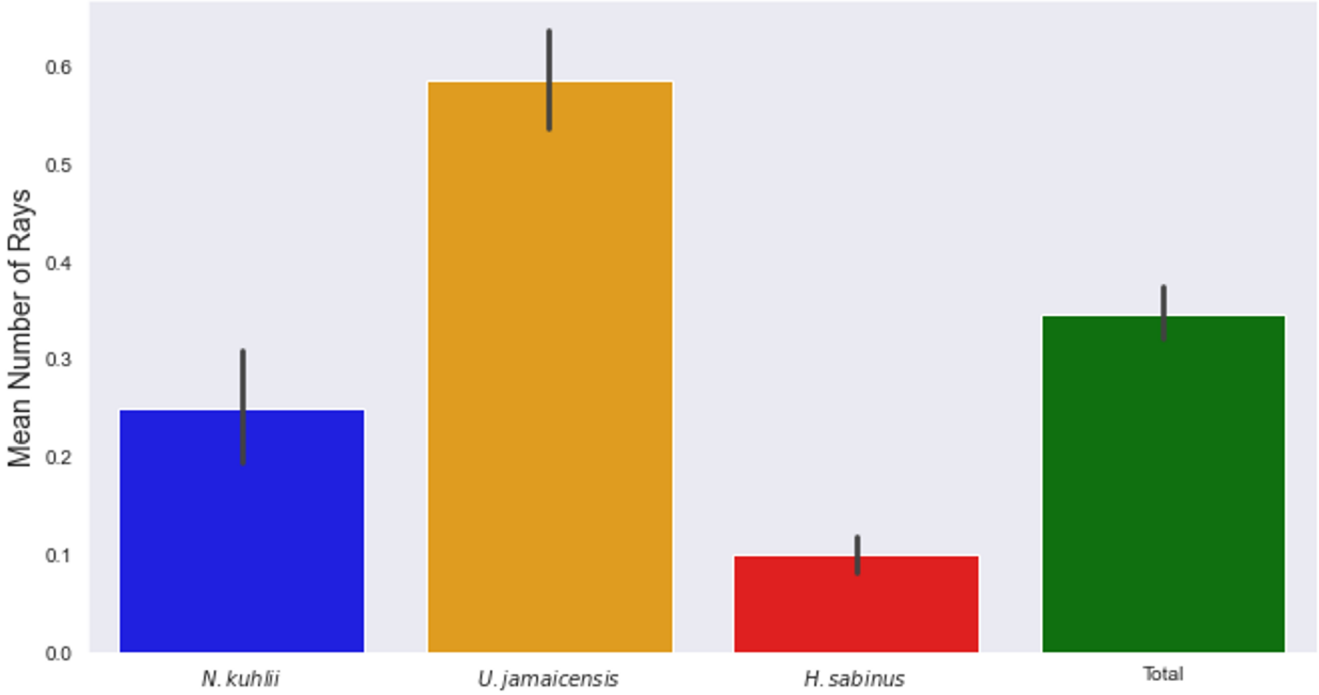
Mean Number of Rays Breaking Surface (Adjusted), Continuous



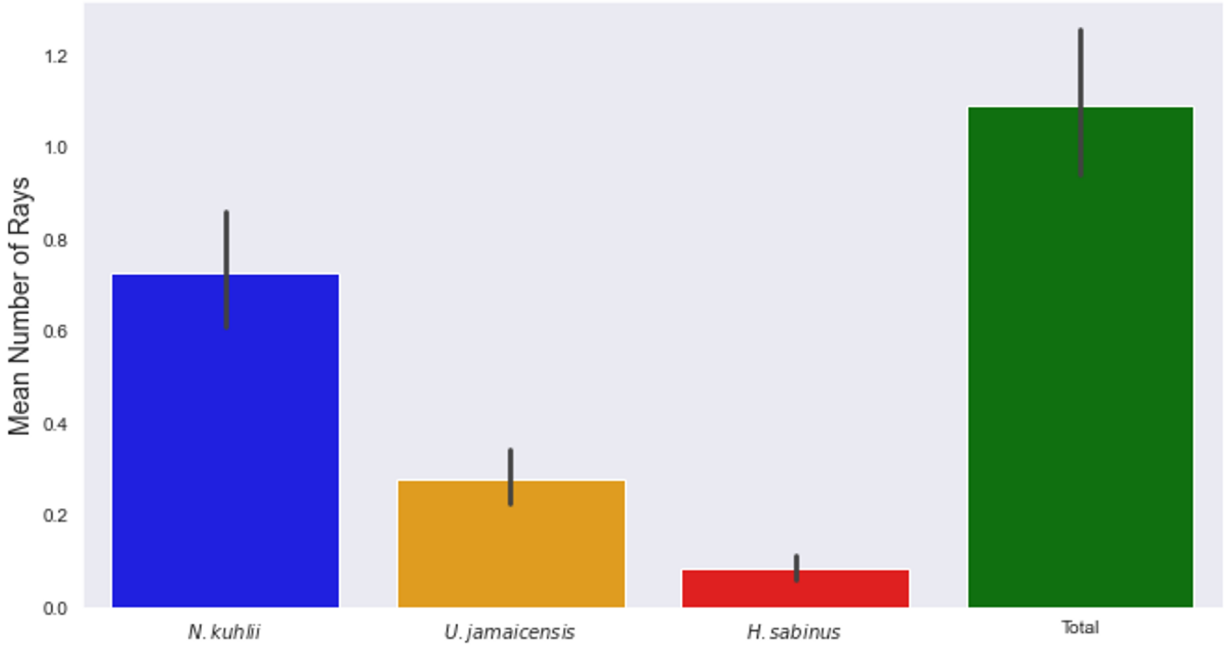
Mean Number of Rays Following Conspecific, Continuous



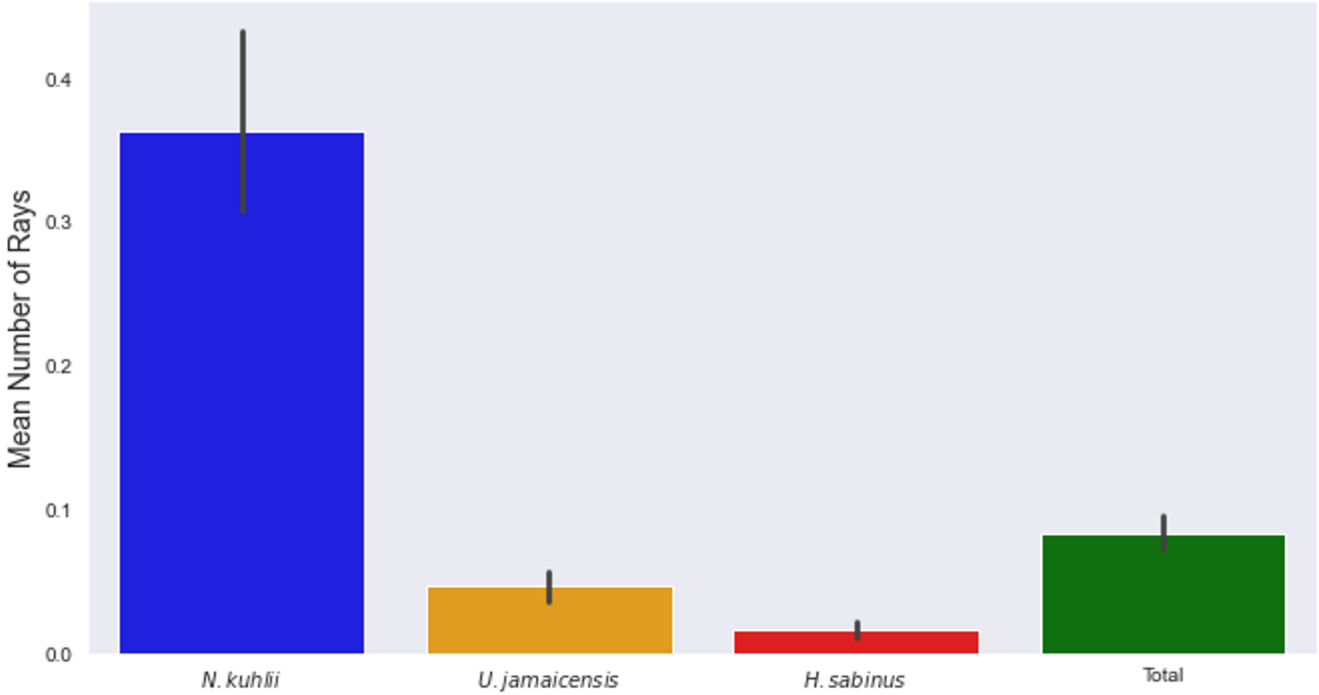
Mean Number of Rays Following Conspecific (Adjusted), Continuous



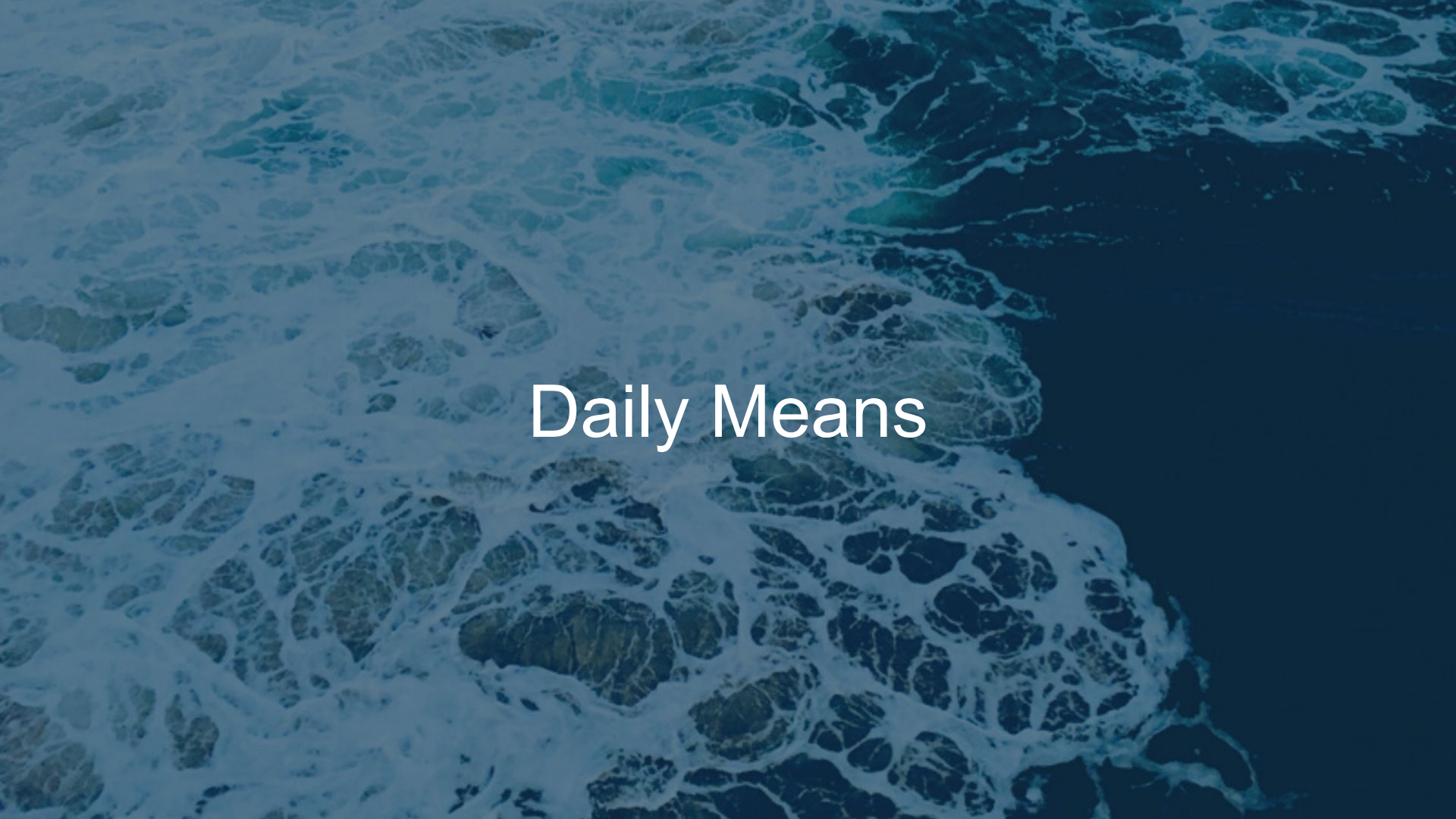
Mean Number Rays Following Different Species



Mean Number Rays Following Different Species (Adjusted)

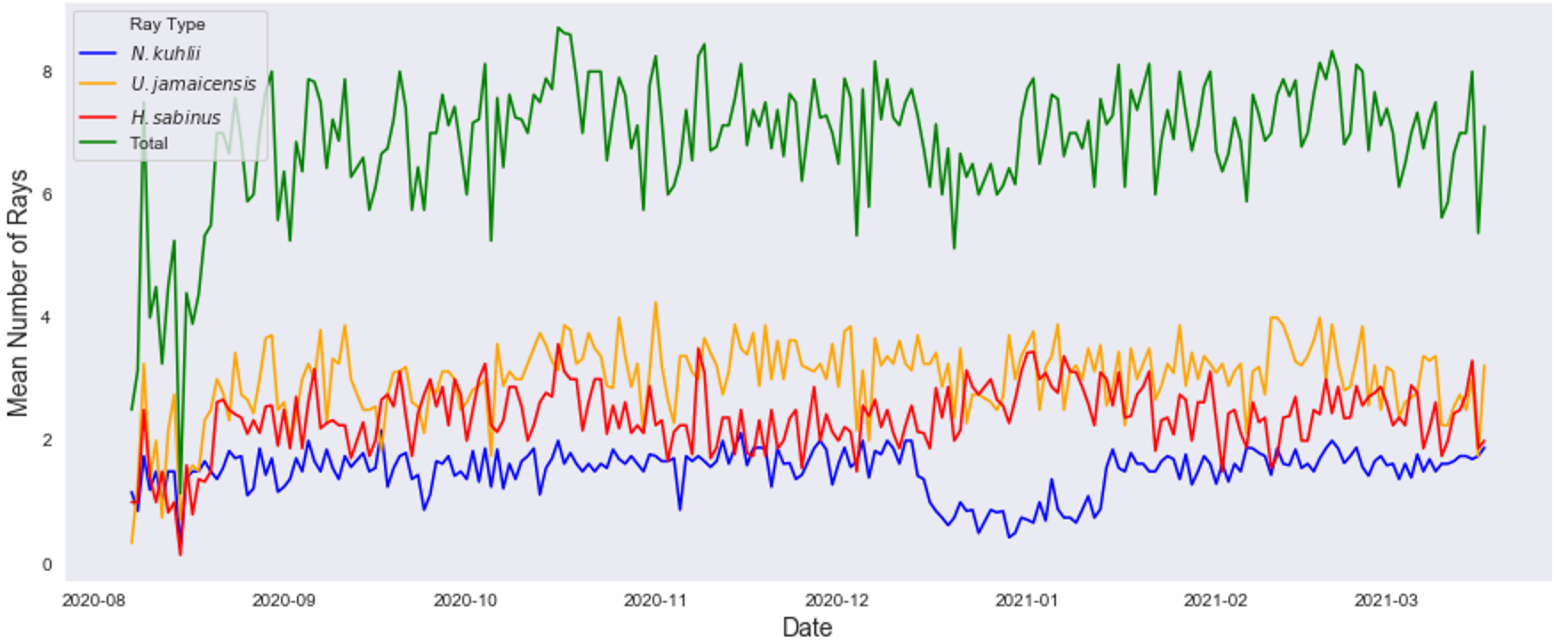


Daily Instantaneous Data

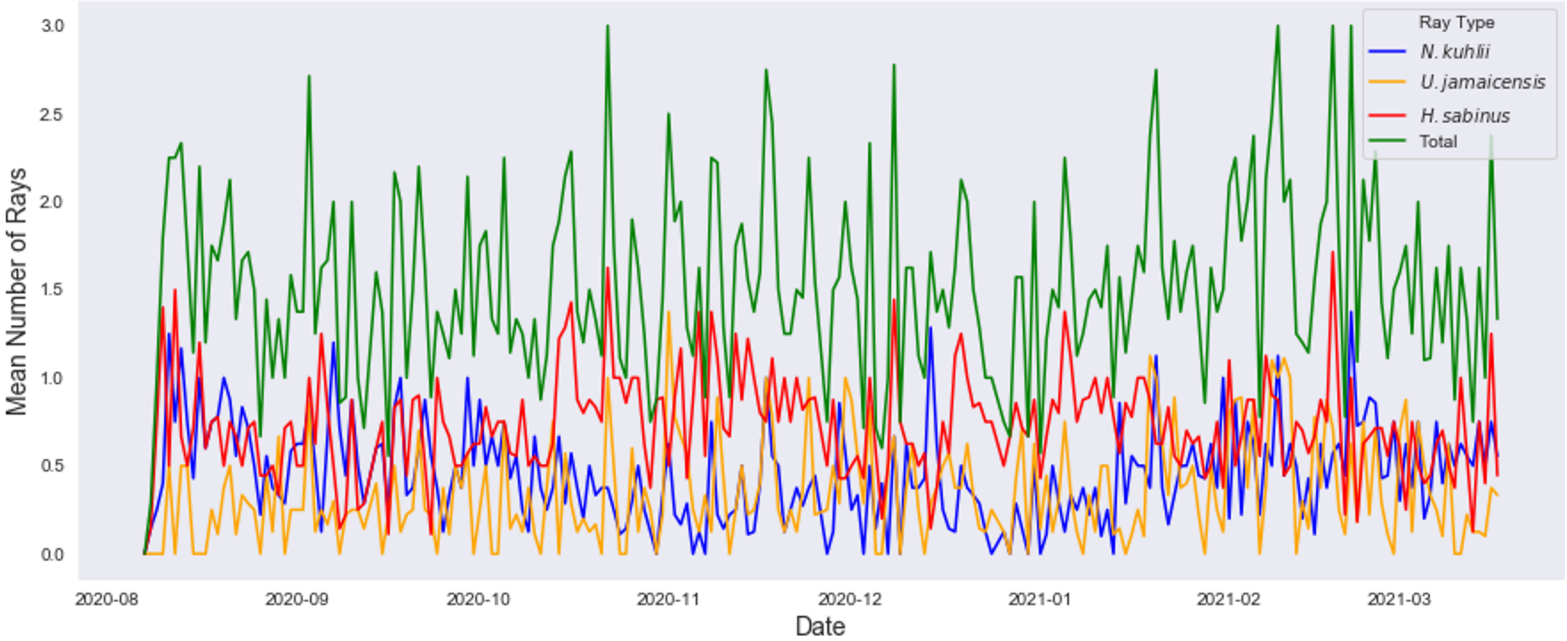


Daily Means

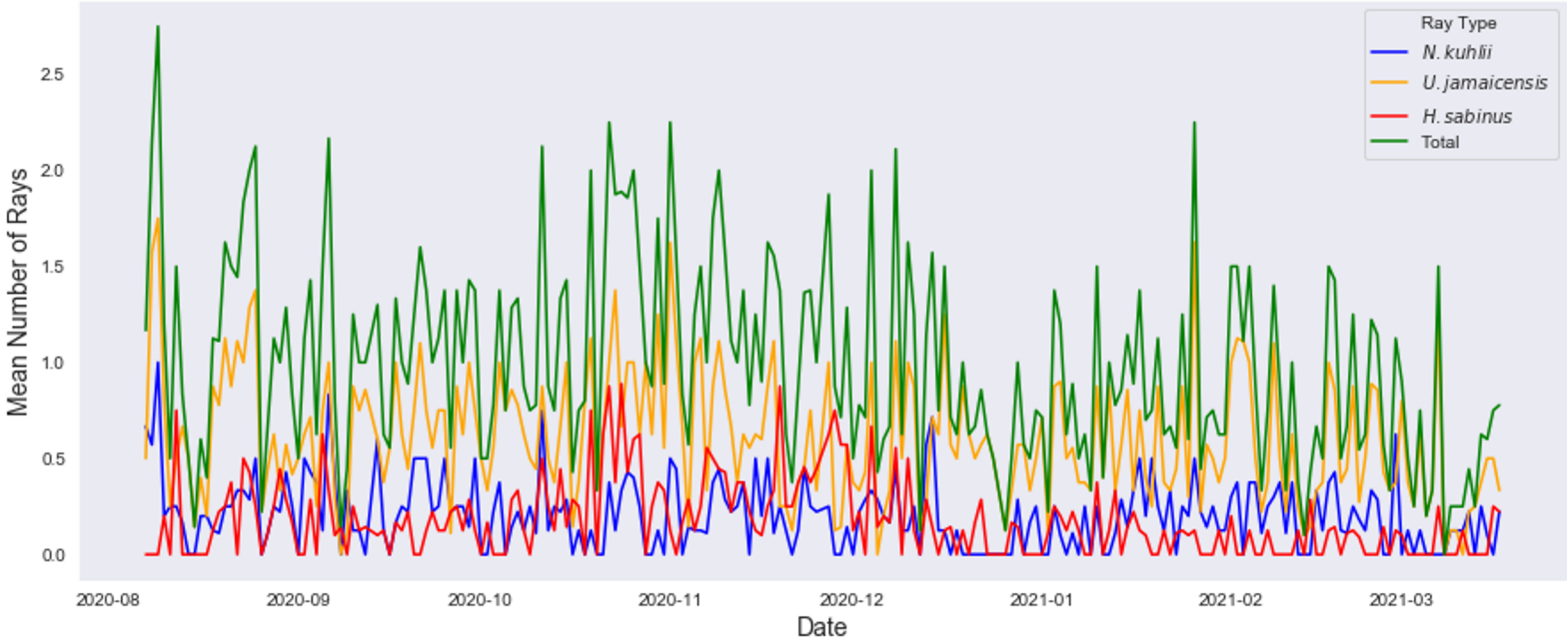
Mean Rays In Shallow Area (Daily, Instantaneous)



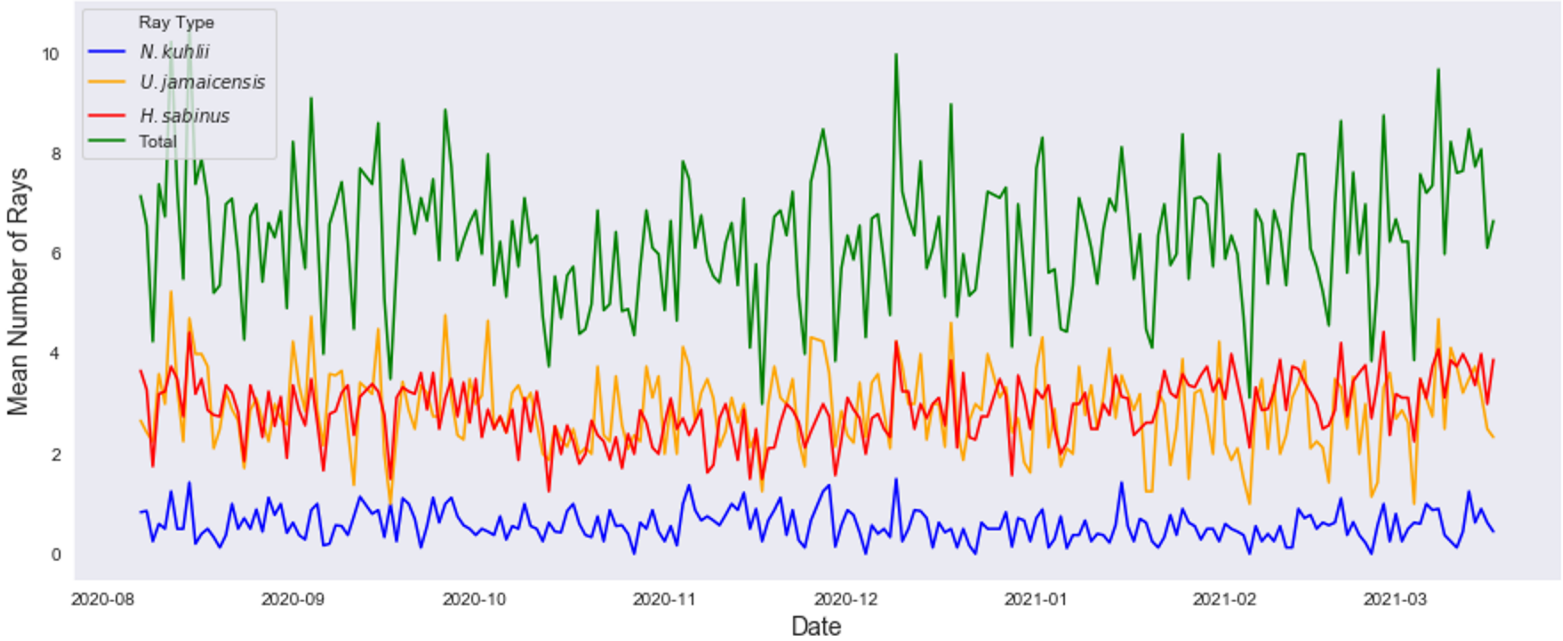
Mean Rays Breaking Surface (Daily, Instantaneous)



Mean Rays Following (Daily, Instantaneous)

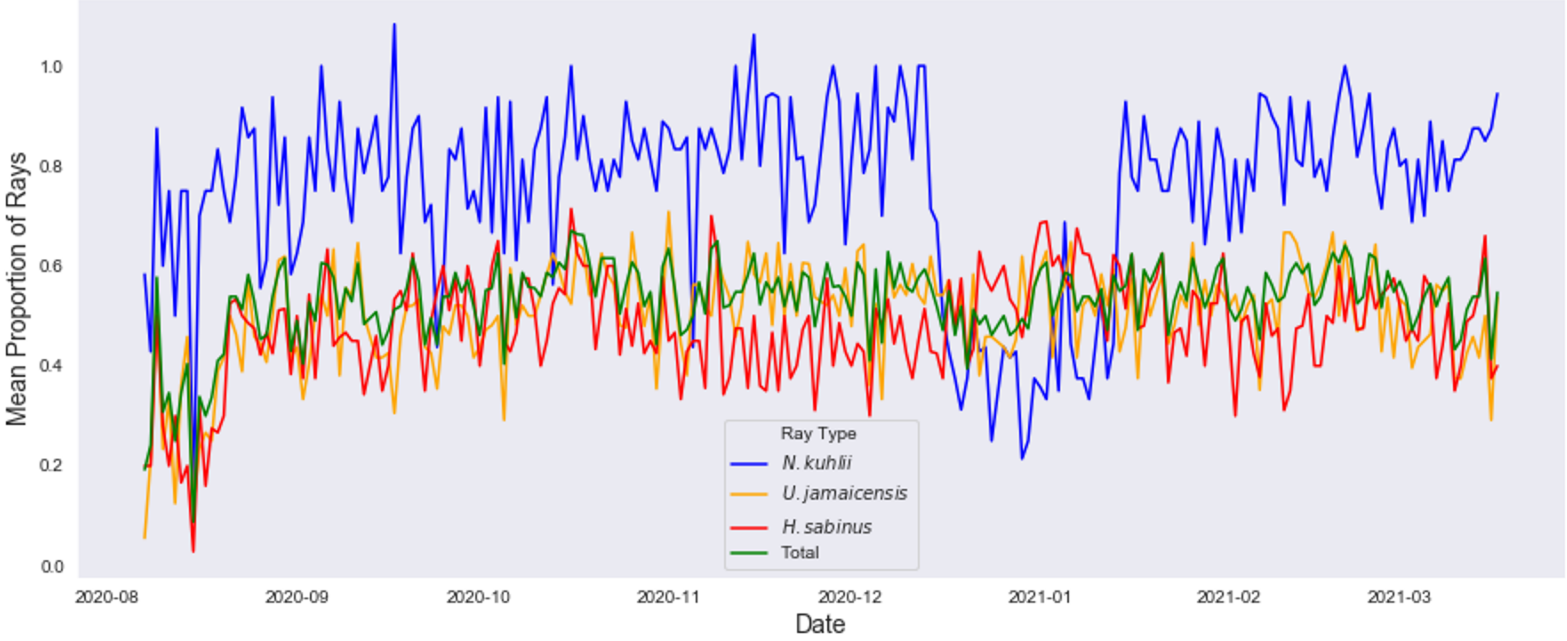


Mean Rays Resting at the Bottom (Daily, Instantaneous)

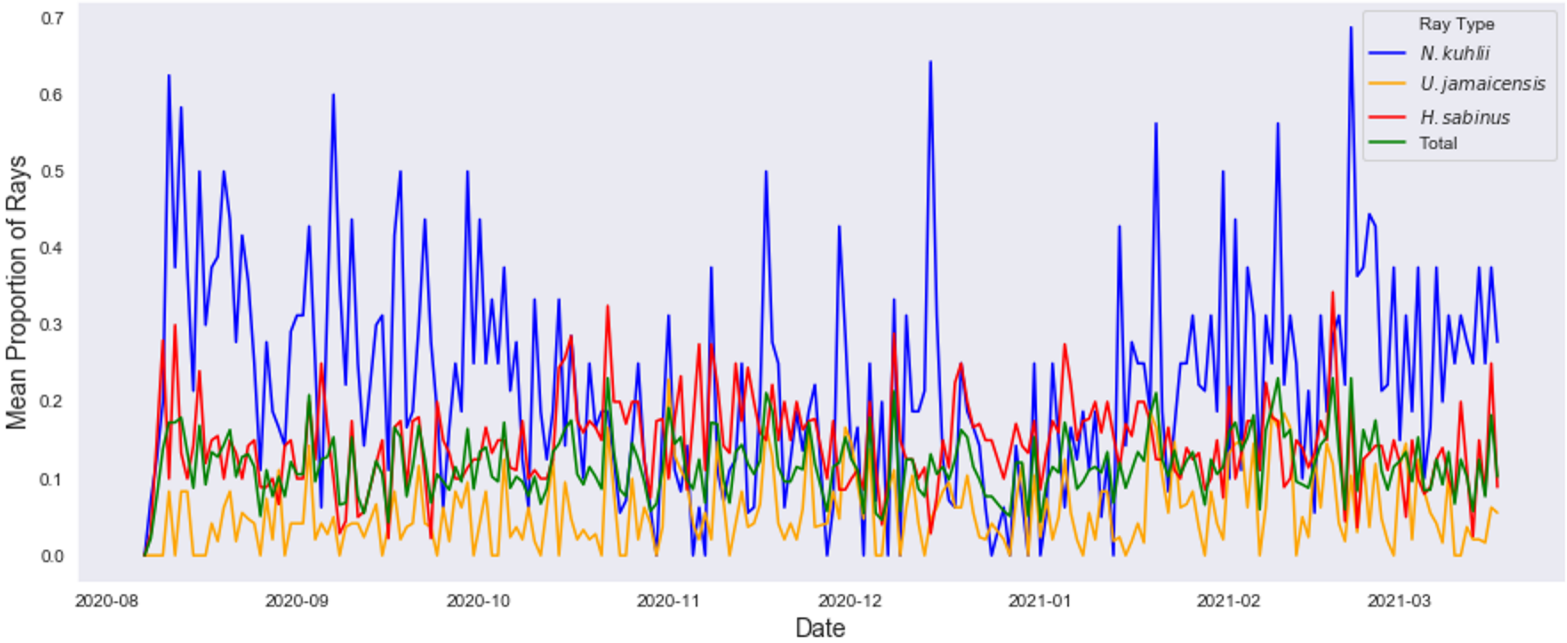


Daily Proportions

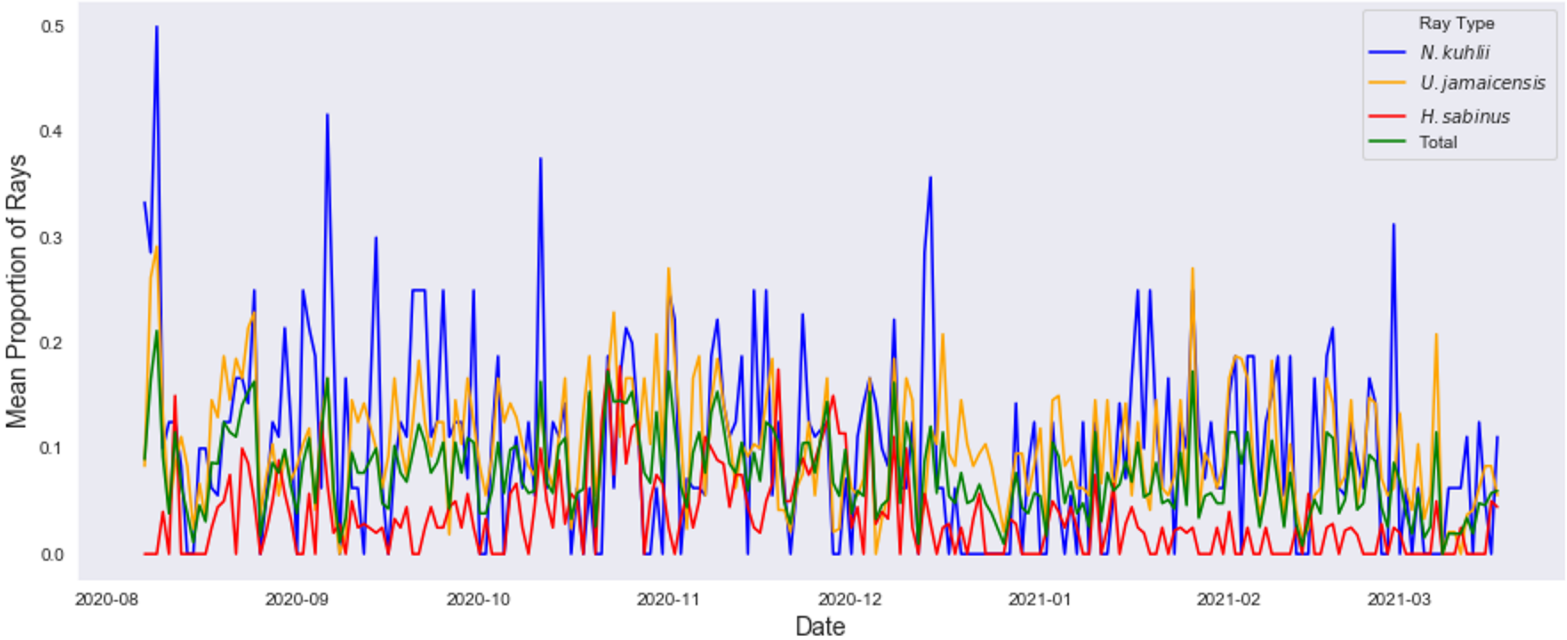
Proportion of Rays in Shallow Area (Daily, Instantaneous)



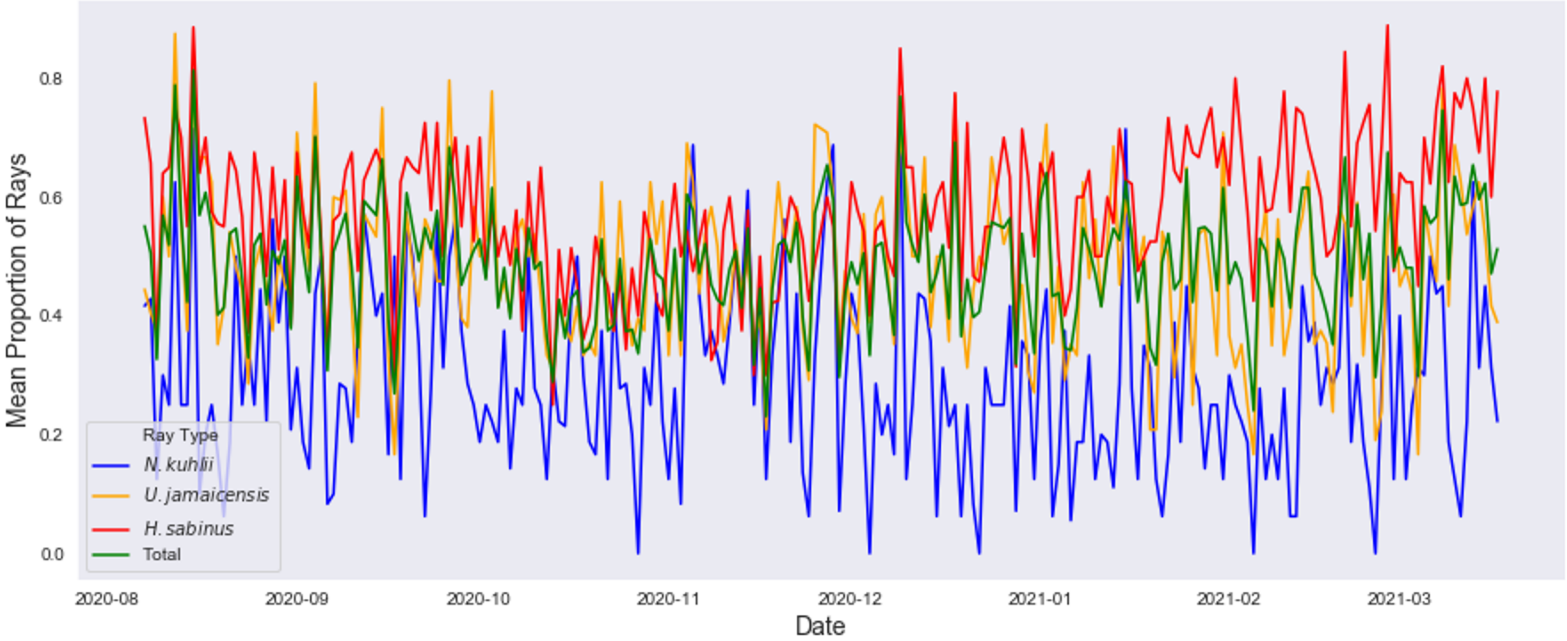
Proportion of Rays breaking the surface (Daily, Instantaneous)



Proportion of Rays Following (Daily, Instantaneous)



Proportion of Rays in Resting at the Bottom (Daily, Instantaneous)



Daily Observations vs. Food consumption

Correlations of Total Rays

	Grams food Consumed	Touch Pool Attendance	Follow	Rest	Shallow	Break
Grams food Consumed	1.000000	0.445264	-0.112471	0.017552	0.025286	0.026932
Touch Pool Attendance	0.445264	1.000000	-0.115136	0.028476	0.080733	-0.023173

The only correlation that seems notable is the relationship between food consumed (in grams) and touch pool attendance.

Correlations of U. jamaicensis

	Grams food Consumed	Touch Pool Attendance	Follow	Rest	Shallow	Break
Grams food Consumed	1.000000	0.445264	-0.162436	-0.014503	0.136122	0.156622
Touch Pool Attendance	0.445264	1.000000	-0.226373	0.048956	0.249700	-0.074963

In this specific species' case we see the same general trend.

Correlations of N. kuhlii

	Grams food Consumed	Touch Pool Attendance	Follow	Rest	Shallow	Break
Grams food Consumed	1.000000	0.445264	-0.171334	-0.032519	0.002946	-0.133245
Touch Pool Attendance	0.445264	1.000000	-0.094048	0.075522	0.010174	-0.092112

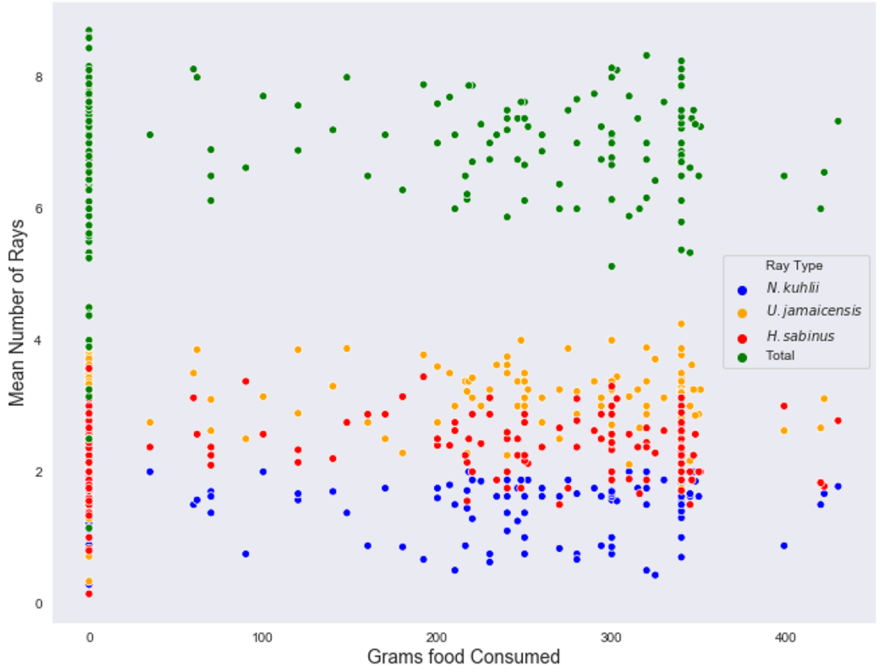
In this specific species' case we see the same general trend.

Correlations of H. sabinus

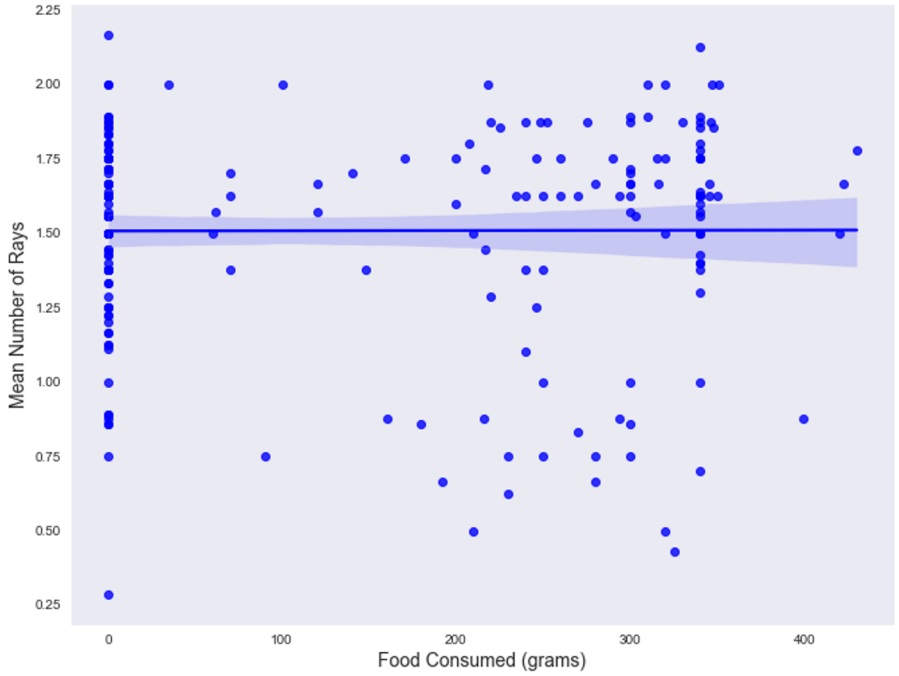
	Grams food Consumed	Touch Pool Attendance	Follow	Rest	Shallow	Break
Grams food Consumed	1.000000	0.445264	-0.101592	0.163194	0.047059	0.078487
Touch Pool Attendance	0.445264	1.000000	-0.077313	0.103668	0.363016	0.071016

In this specific species' case we see the same general trend.

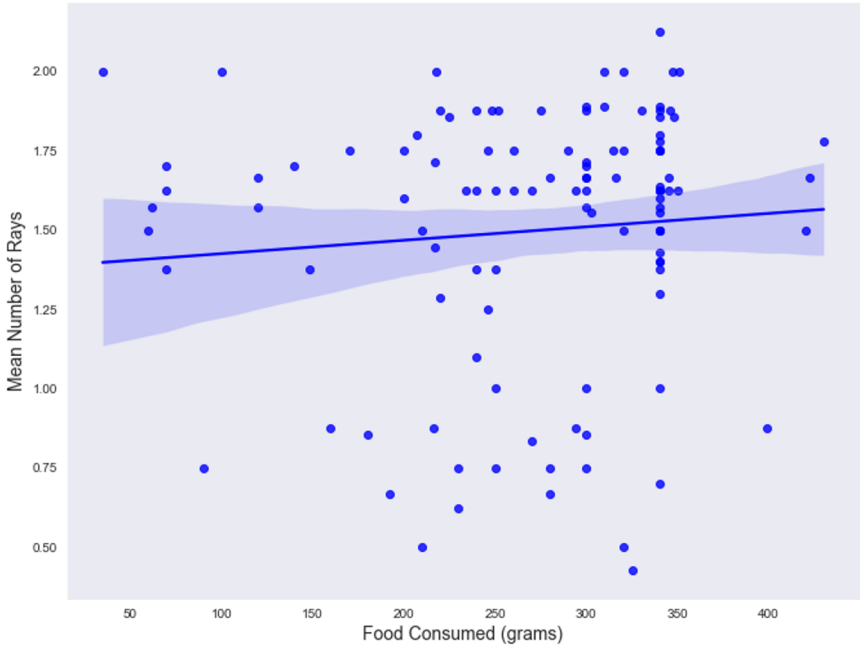
Mean Rays In Shallow Area Vs. Food consumption (Daily, Instantaneous)



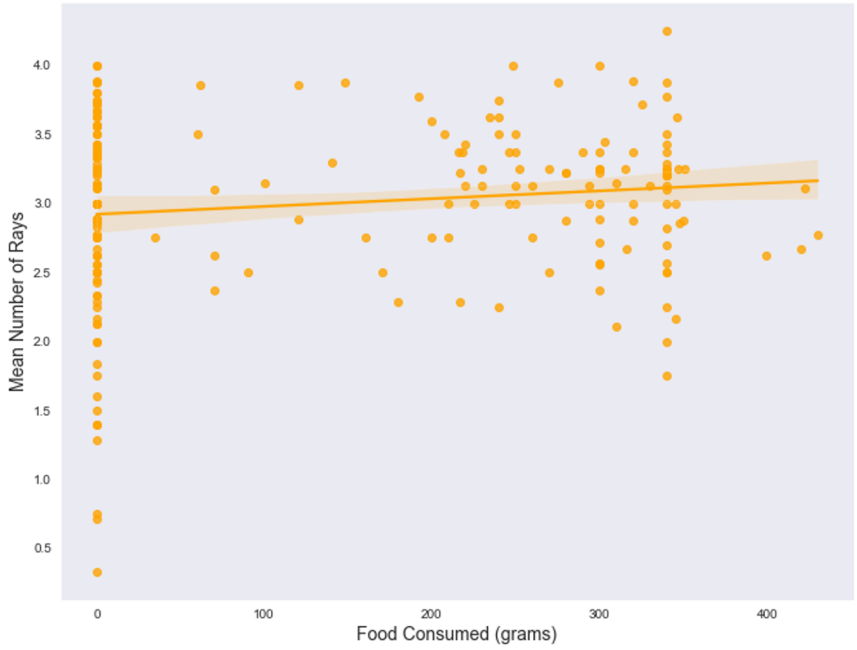
Mean N. kuhlii In Shallow Area Vs. Food consumption (Daily, Instantaneous)



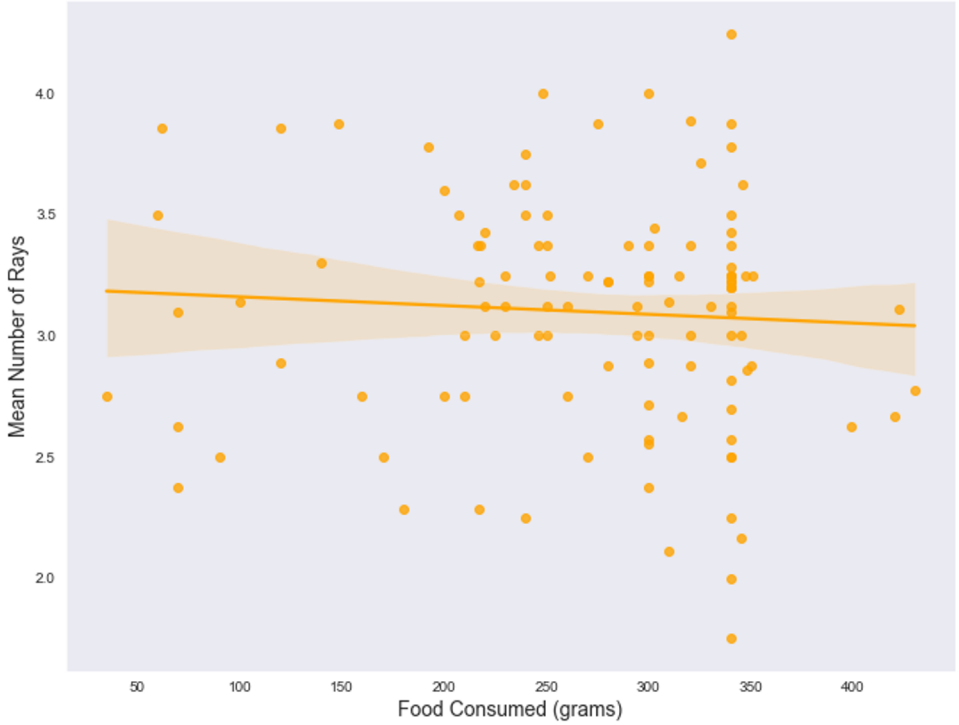
Mean N. kuhlii In Shallow Area Vs. Food consumption (Excluding 0's Daily, Instantaneous)



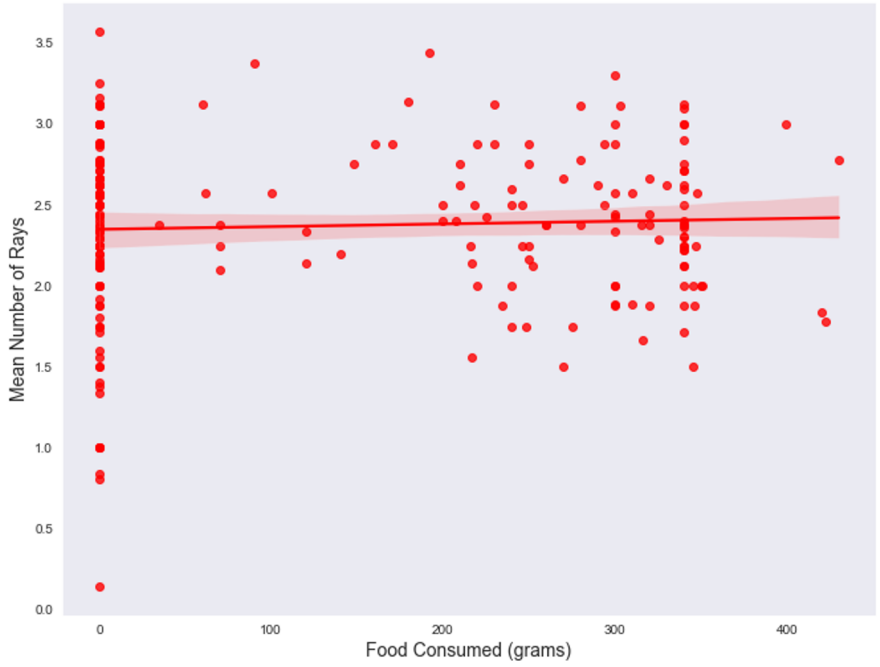
Mean U. jamaicensis In Shallow Area Vs. Food consumption (Daily, Instantaneous)



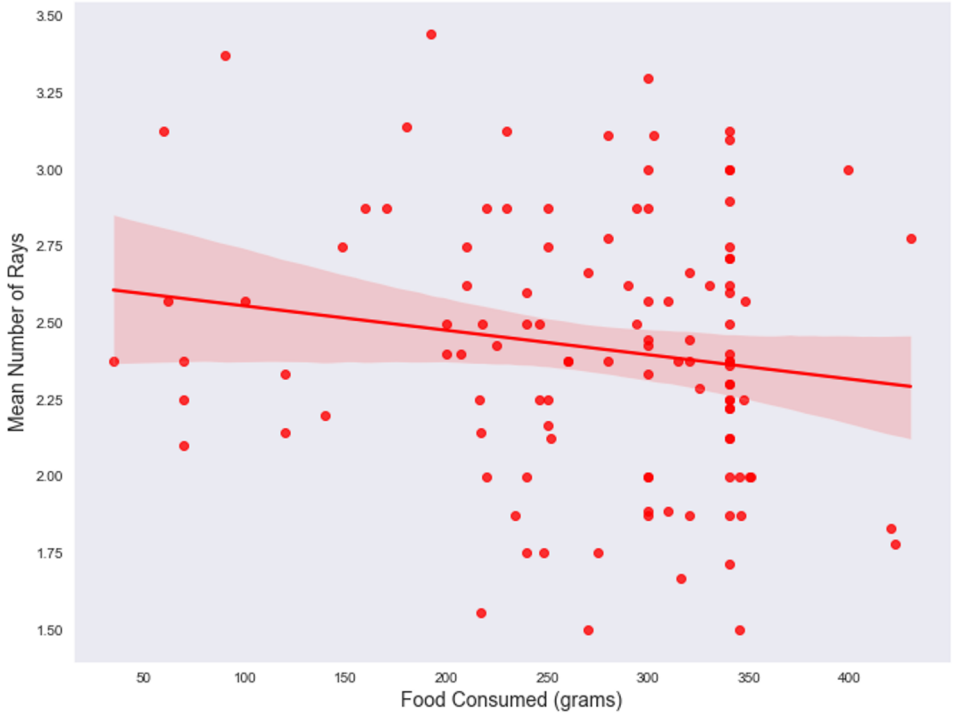
Mean U. jamaicensis In Shallow Area Vs. Food consumption (Excluding 0's, Daily, Instantaneous)



Mean H. sabinus In Shallow Area Vs. Food consumption (Daily, Instantaneous)



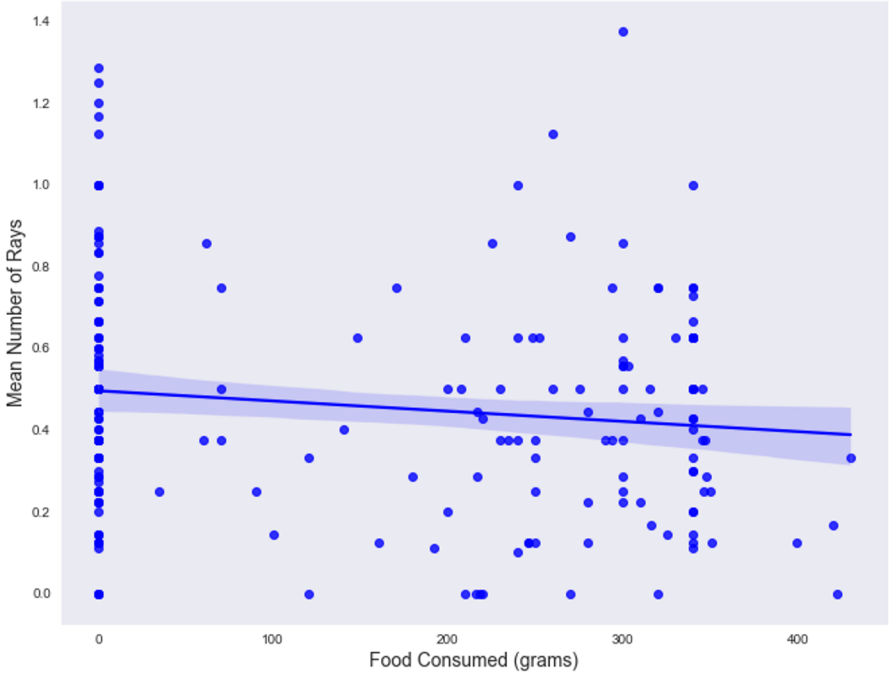
Mean H. sabinus In Shallow Area Vs. Food consumption (Excluding 0's, Daily, Instantaneous)



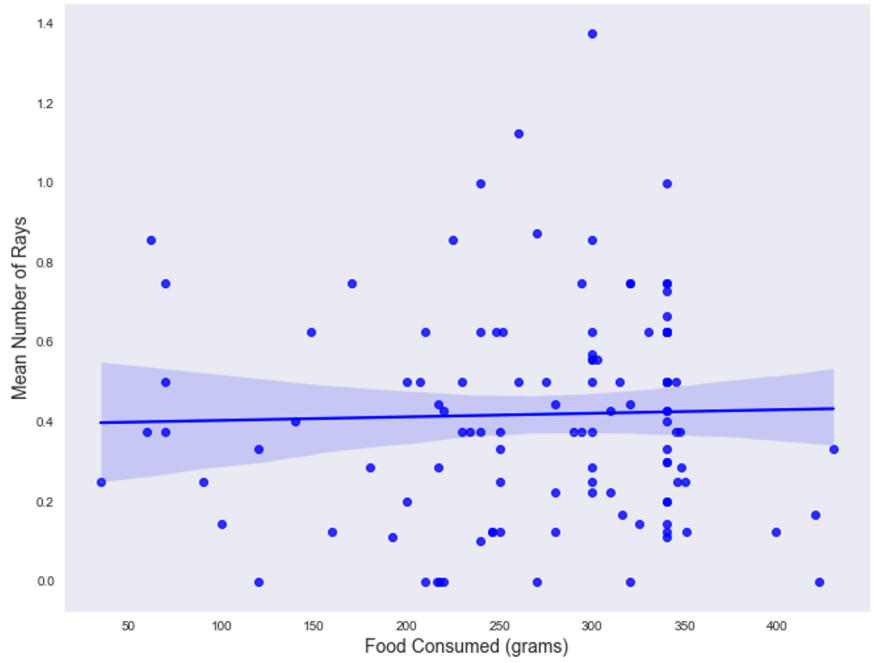
Breaking the Surface

Mean Rays Breaking the Surface Vs. Food consumption (Daily, Instantaneous)

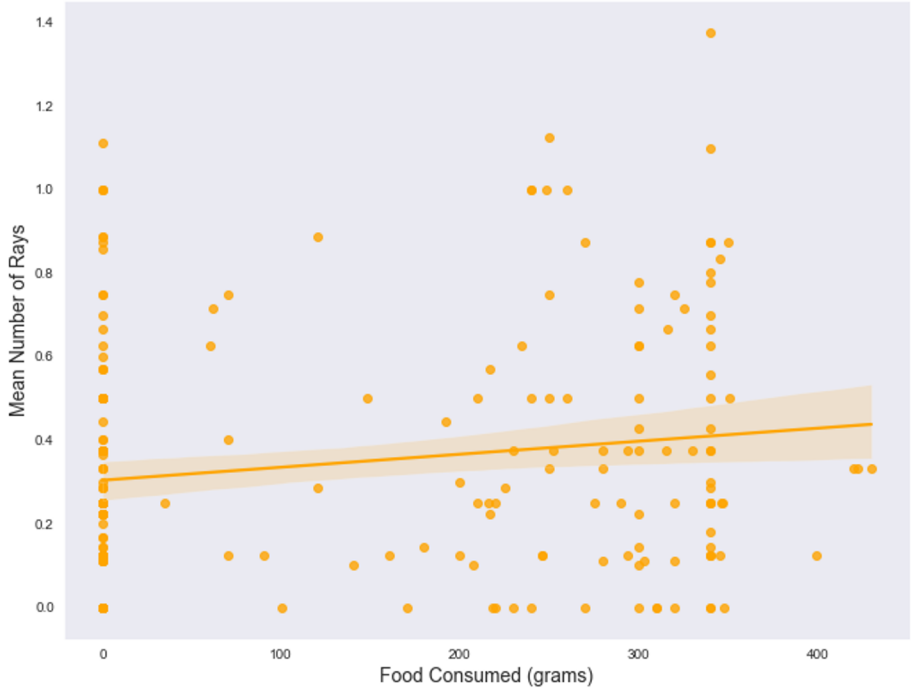
Mean N. kuhlii Breaking the Surface Vs. Food consumption (Daily, Instantaneous)



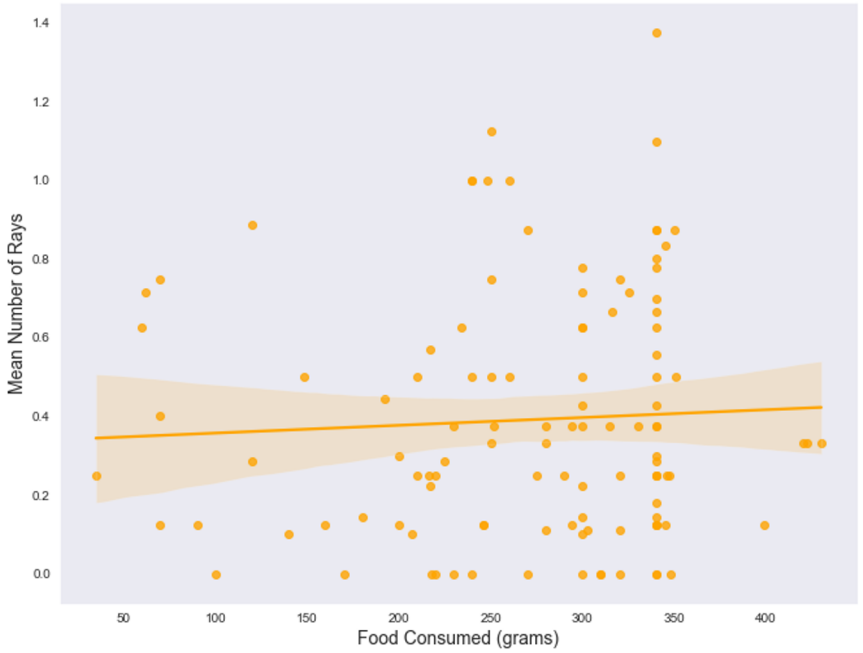
Mean N. kuhlii Breaking the Surface Vs. Food consumption (Excluding 0's Daily, Instantaneous)



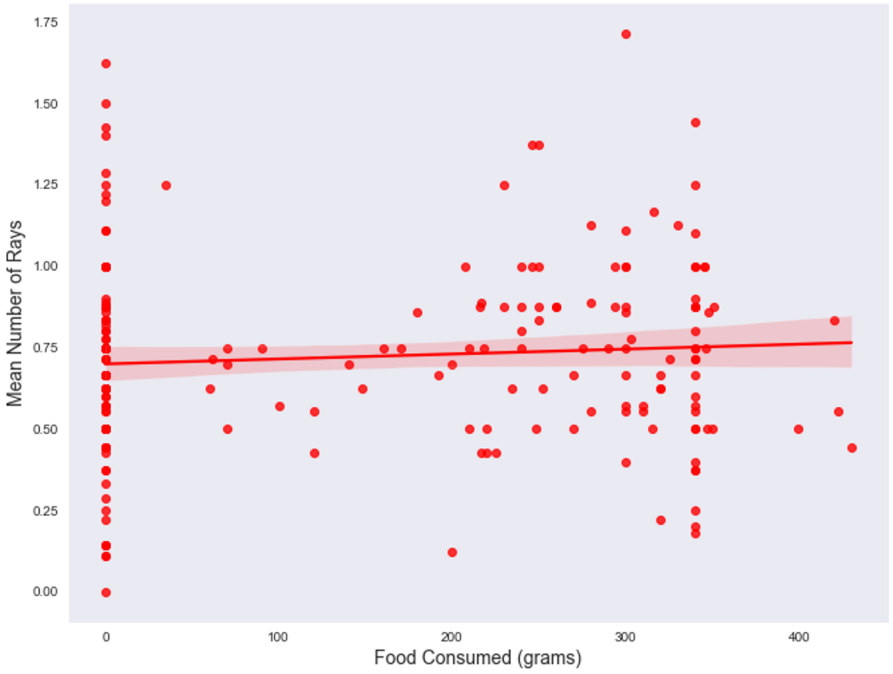
Mean U. jamaicensis Breaking the Surface Vs. Food consumption (Daily, Instantaneous)



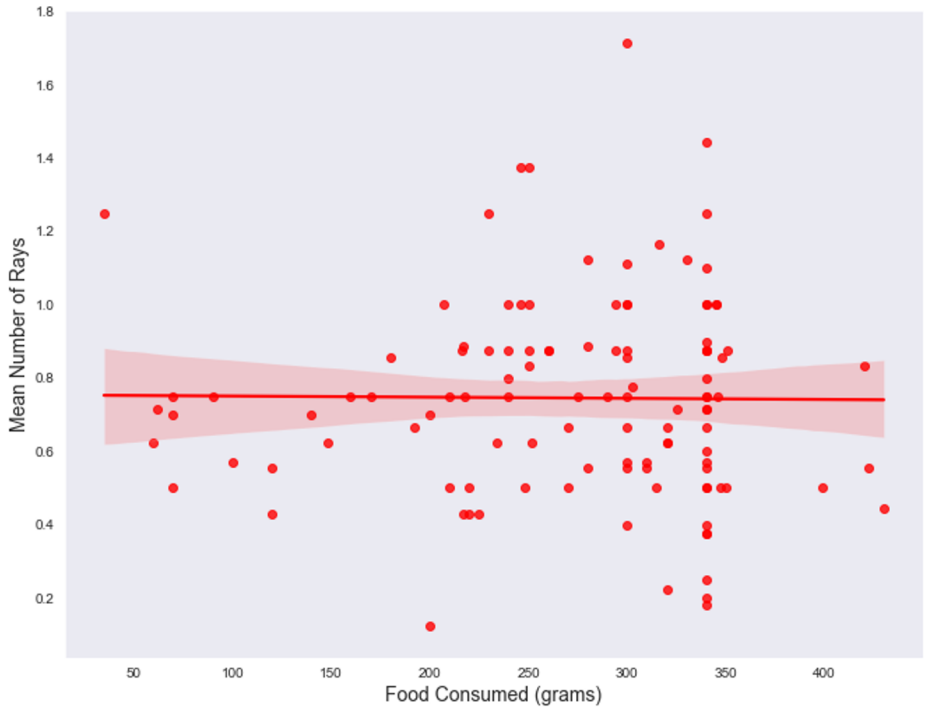
Mean U. jamaicensis Breaking the Surface Vs. Food consumption (Excluding 0's, Daily, Instantaneous)



Mean H. sabinus Breaking the Surface Vs. Food consumption (Daily, Instantaneous)



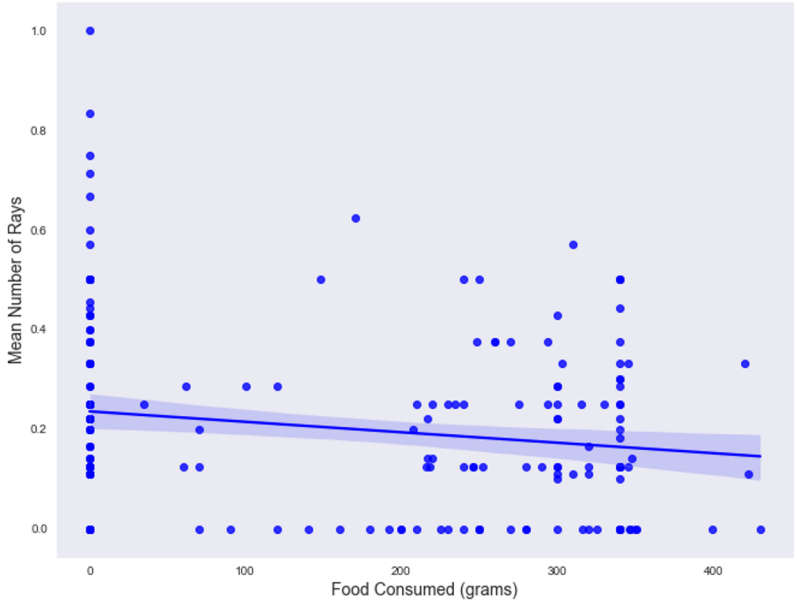
Mean H. sabinus Breaking the Surface Vs. Food consumption (Excluding 0's, Daily, Instantaneous)



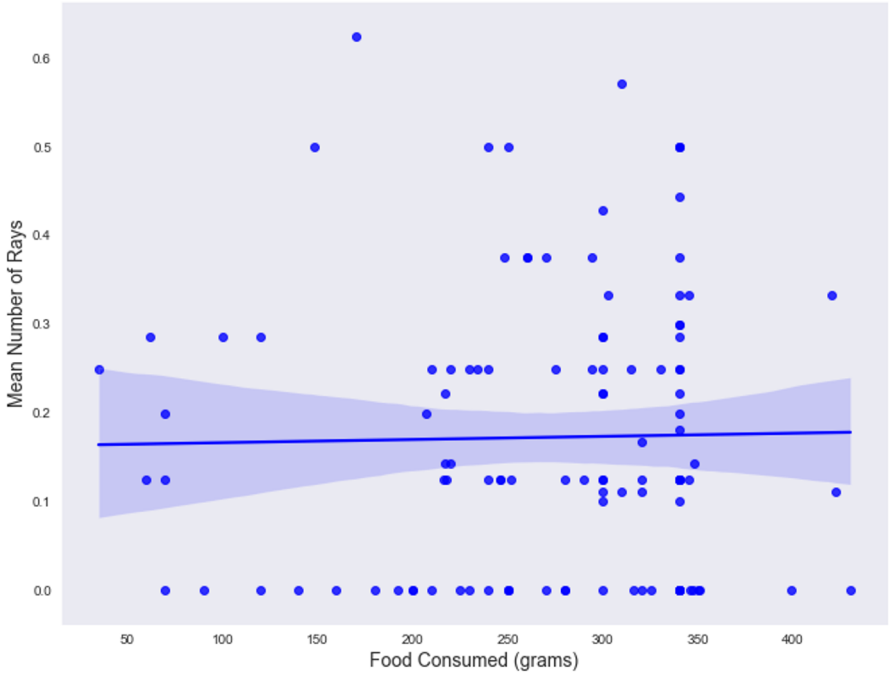
Following

Mean Rays Following Vs. Food consumption (Daily, Instantaneous)

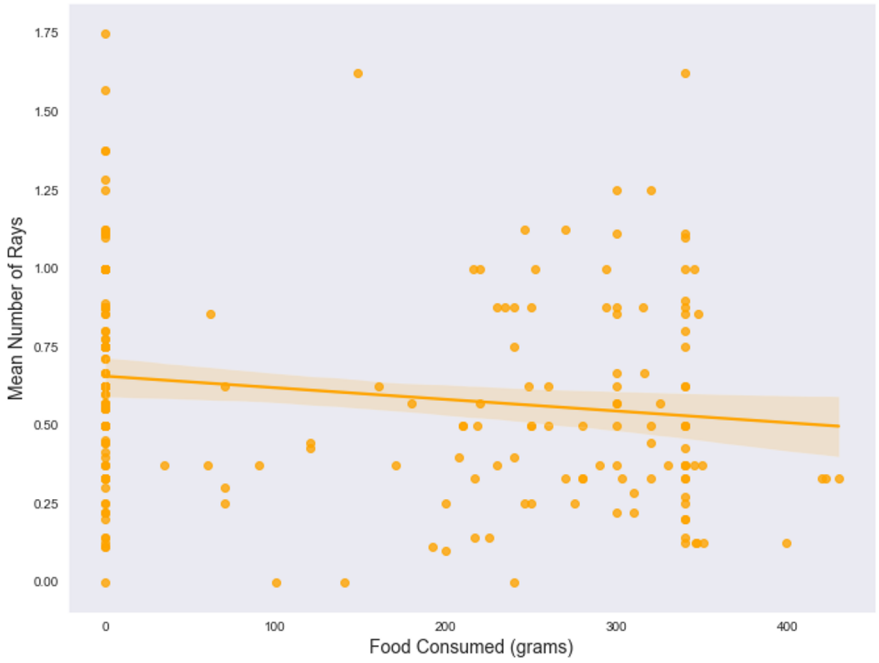
Mean N. kuhlii Following Vs. Food consumption (Daily, Instantaneous)



Mean N. kuhlii Following Vs. Food consumption (Excluding 0's Daily, Instantaneous)

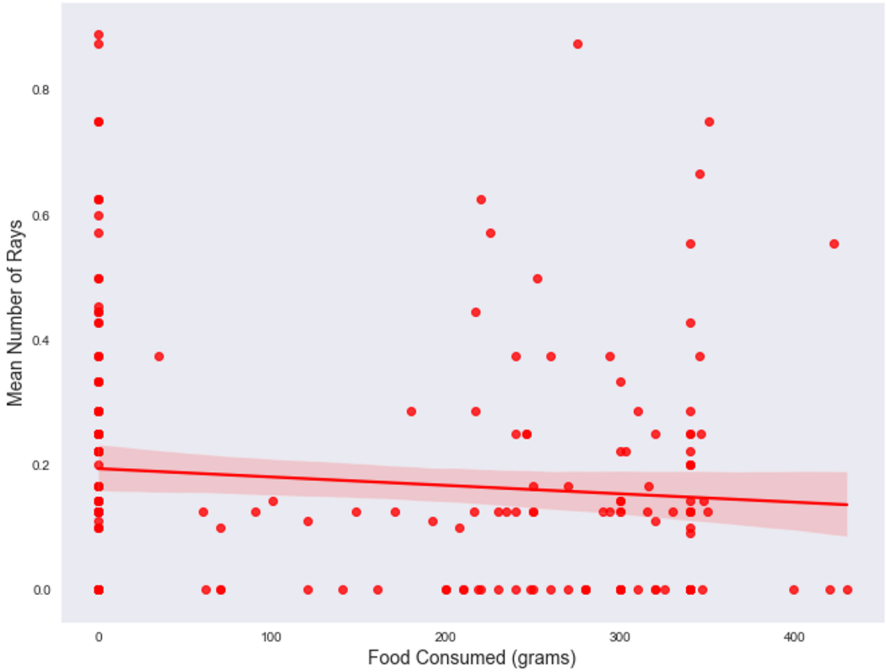


Mean U. jamaicensis Following Vs. Food consumption (Daily, Instantaneous)

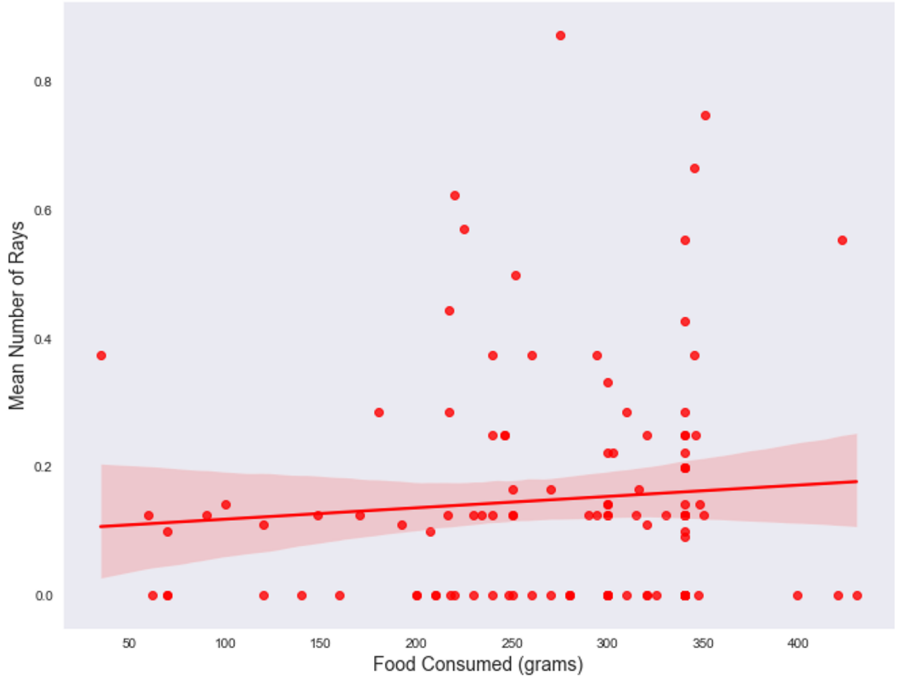


Mean U. jamaicensis Following Vs. Food consumption (Excluding 0's, Daily, Instantaneous)

Mean H. sabinus Following Vs. Food consumption (Daily, Instantaneous)

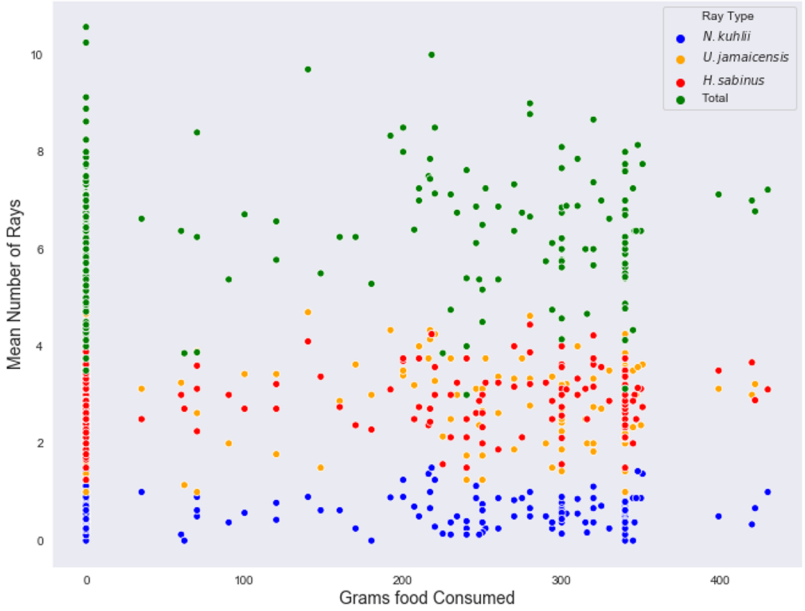


Mean H. sabinus Following Vs. Food consumption (Excluding 0's, Daily, Instantaneous)

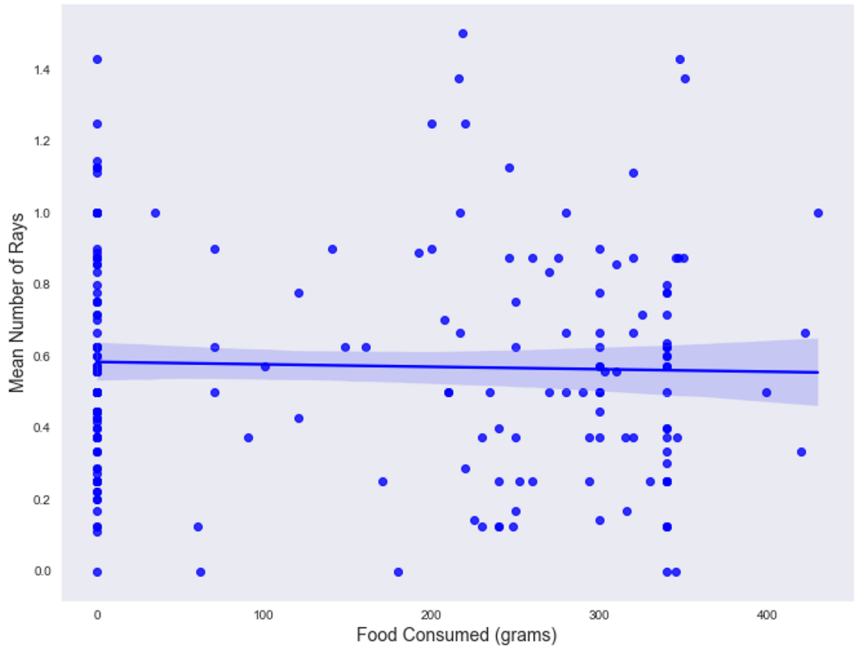


Resting at the Bottom

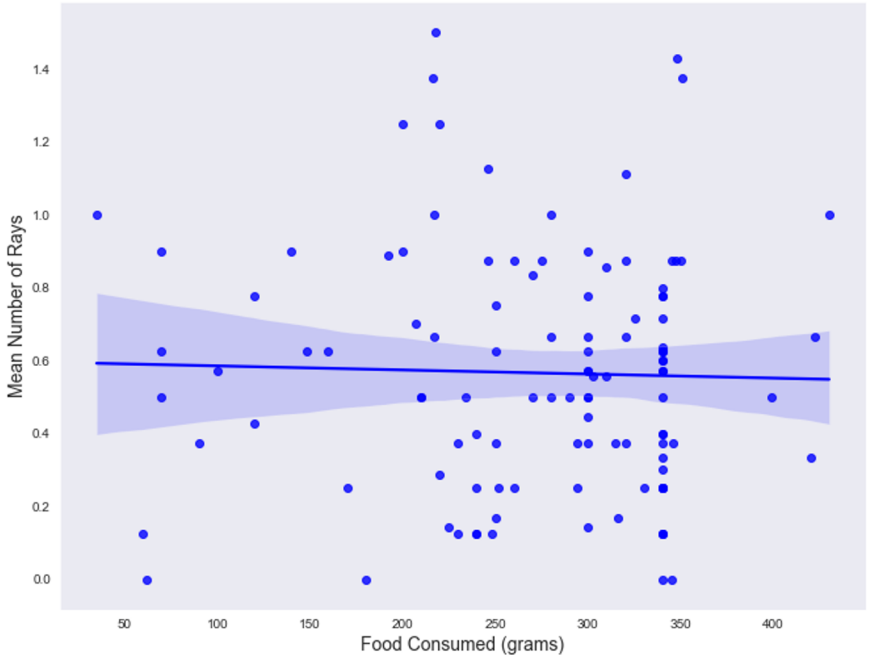
Mean Rays Resting at the Bottom Vs. Food consumption (Daily, Instantaneous)



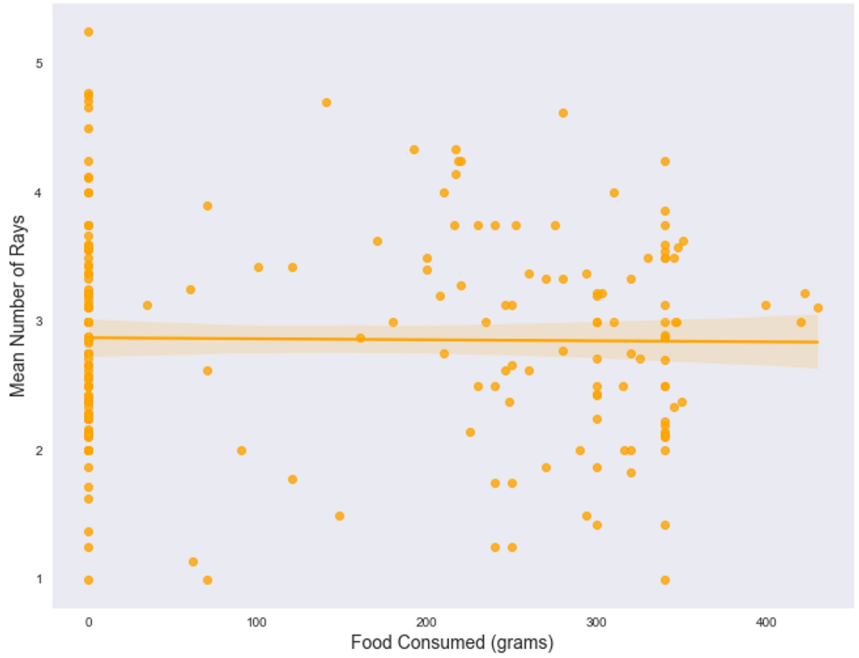
Mean N. kuhlii Resting at the Bottom Vs. Food consumption (Daily, Instantaneous)



Mean N. kuhlii Resting at the Bottom Vs. Food consumption (Excluding 0's Daily, Instantaneous)

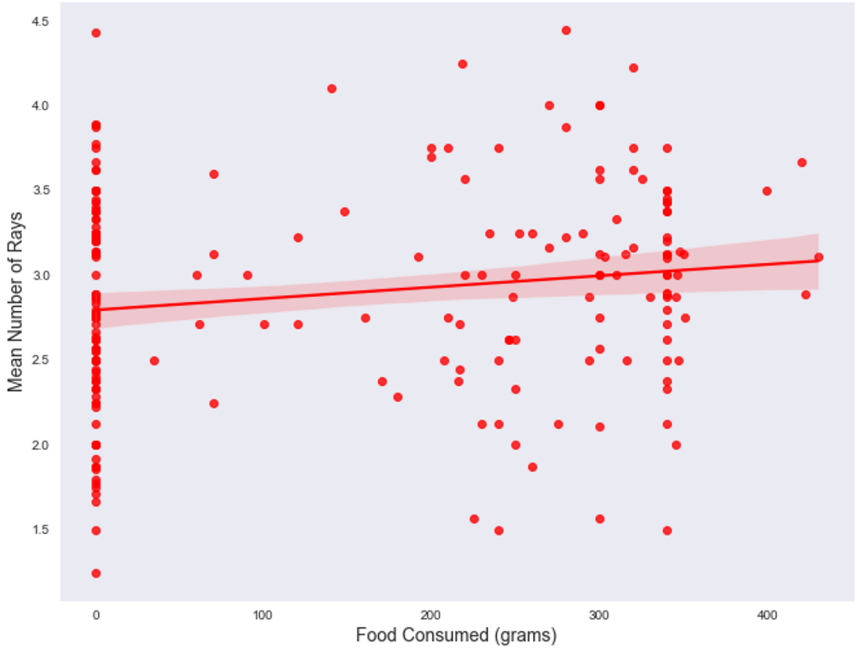


Mean U. jamaicensis Resting at the Bottom Vs. Food consumption (Daily, Instantaneous)

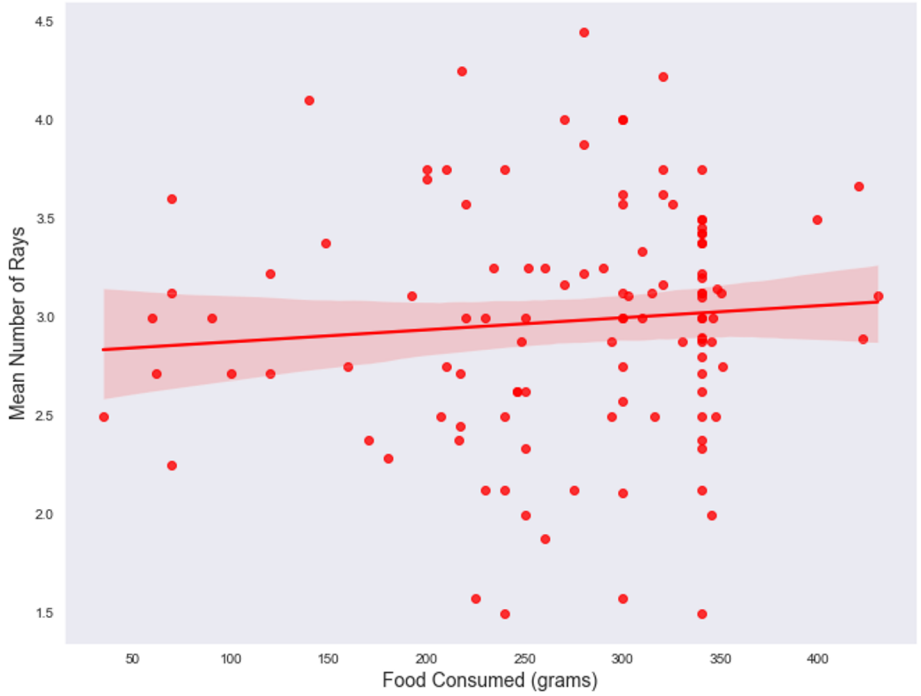


Mean U. jamaicensis Resting at the Bottom Vs. Food consumption (Excluding 0's, Daily, Instantaneous)

Mean H. sabinus Resting at the Bottom Vs. Food consumption (Daily, Instantaneous)

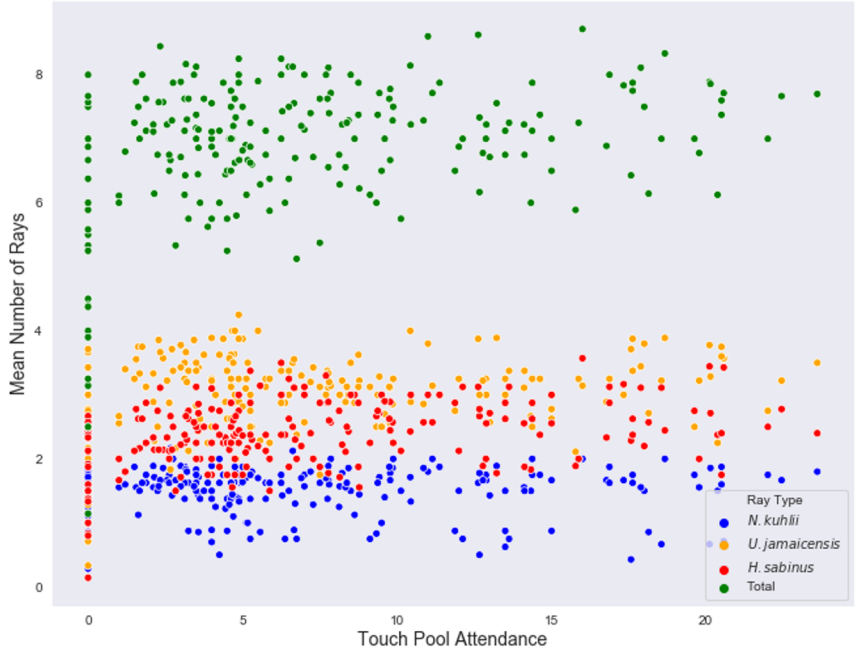


Mean H. sabinus Resting at the Bottom Vs. Food consumption (Excluding 0's, Daily, Instantaneous)

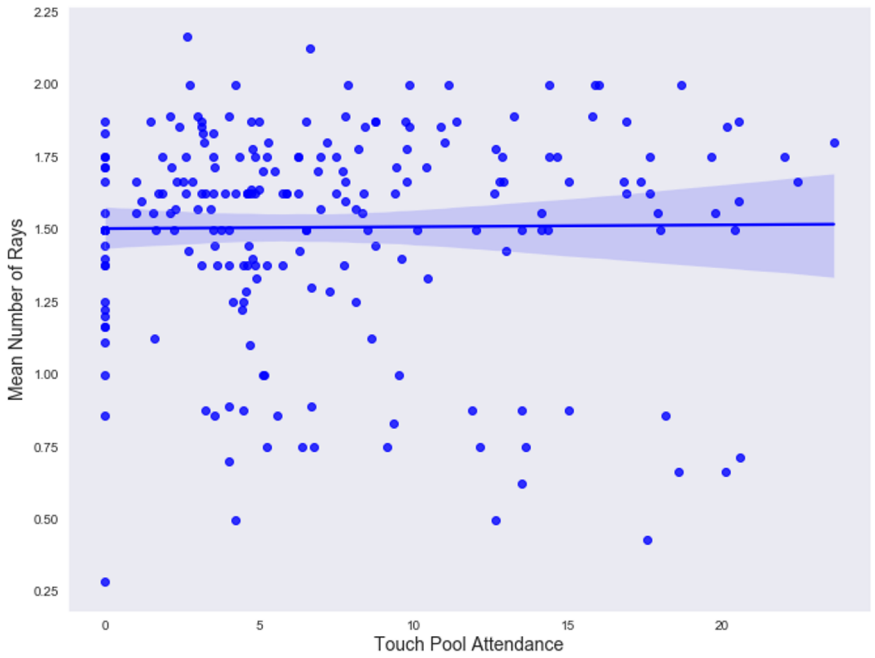


Daily Observations vs. Touch Pool Attendance

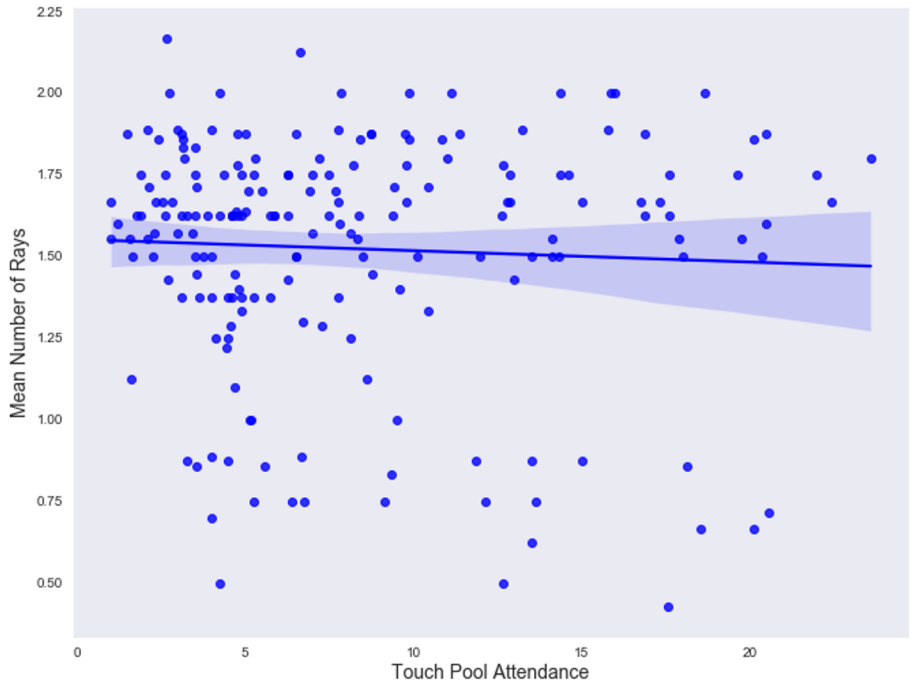
Mean Rays in Shallow Area Vs. Touch Pool Attendance (Daily, Instantaneous)



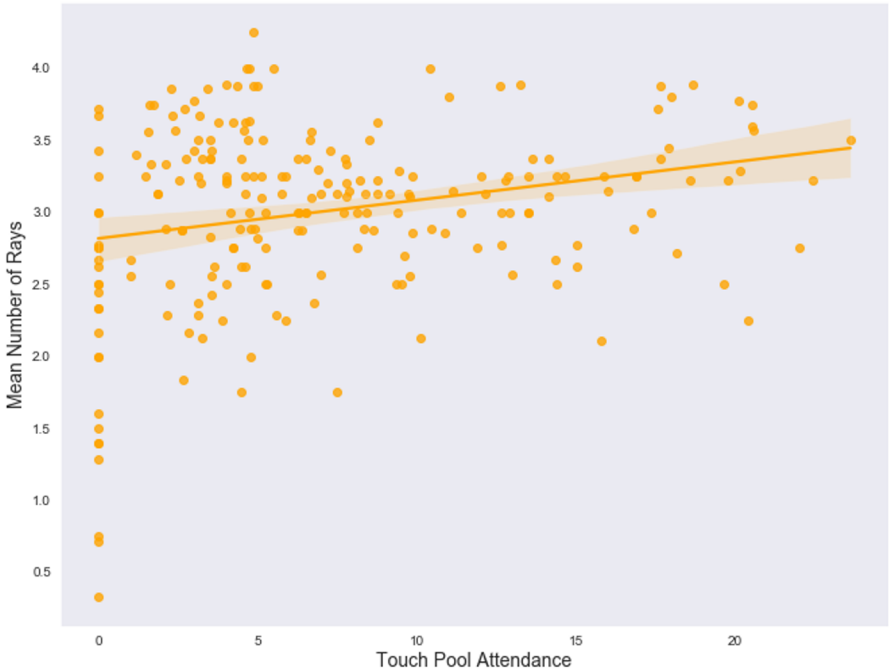
Mean N. kuhlii in Shallow Area Vs. Touch Pool Attendance (Daily, Instantaneous)



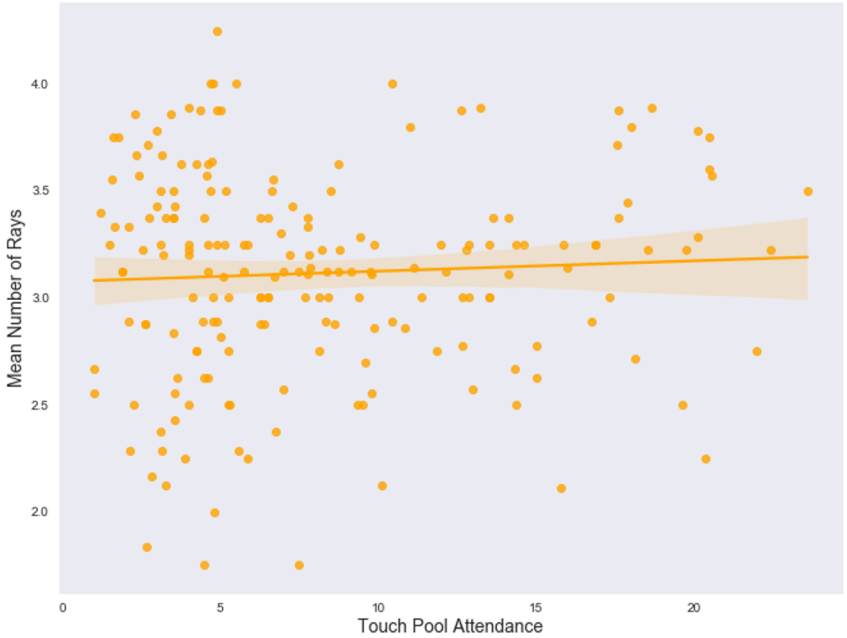
Mean N. kuhlii in Shallow Area Vs. Touch Pool Attendance (Excluding 0's Daily, Instantaneous)



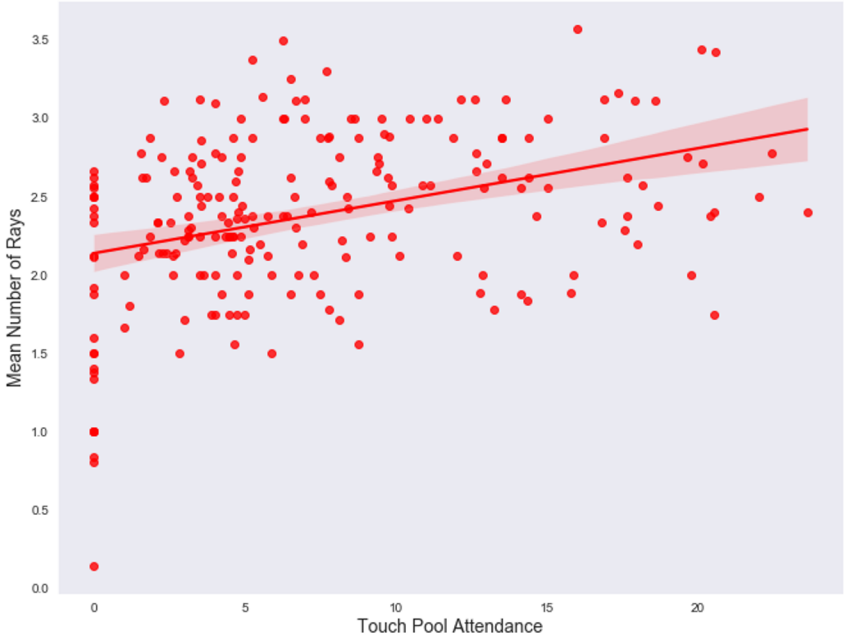
Mean U. jamaicensis in Shallow Area Vs. Touch Pool Attendance (Daily, Instantaneous)



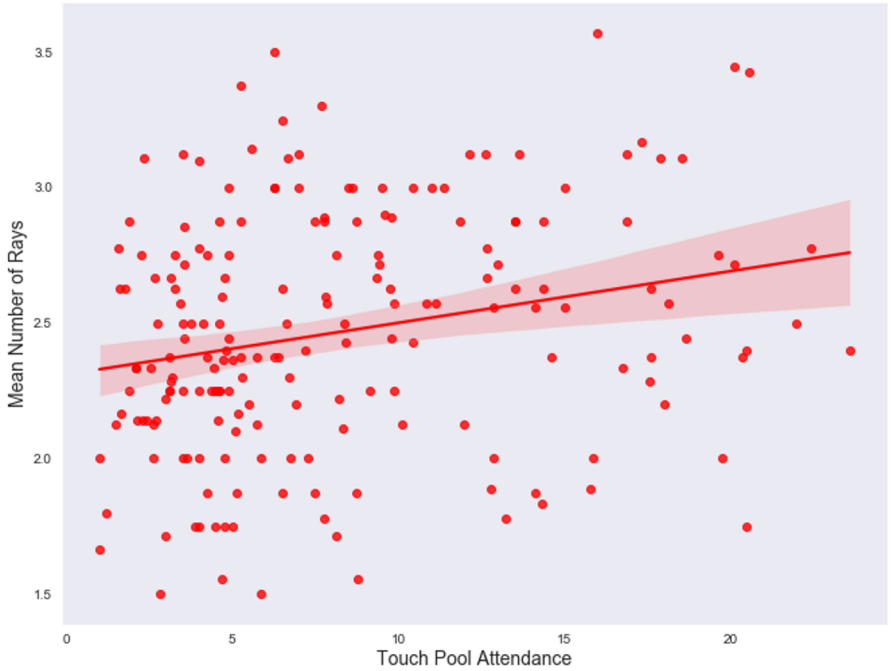
Mean U. jamaicensis in Shallow Area Vs. Touch Pool Attendance (Excluding 0's Daily, Instantaneous)



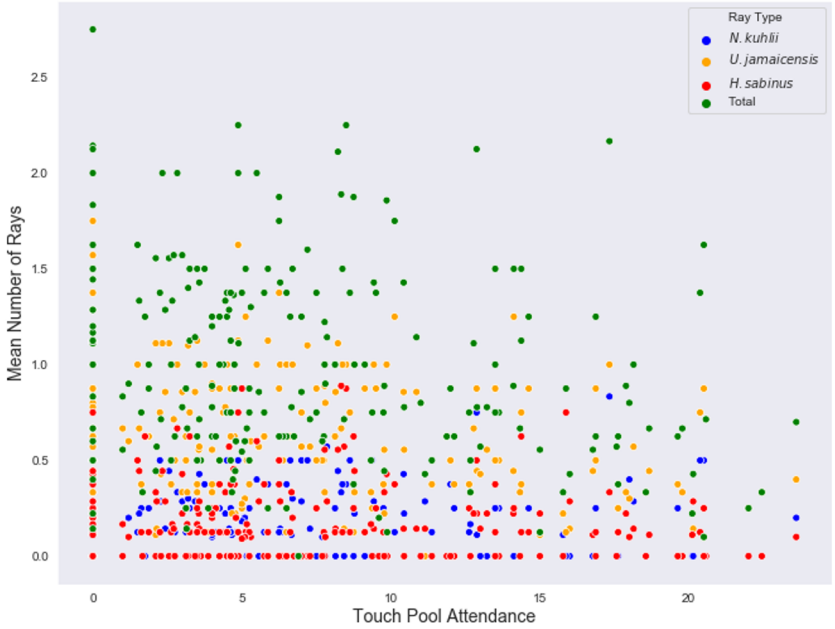
Mean H. sabinusin in Shallow Area Vs. Touch Pool Attendance (Daily, Instantaneous)



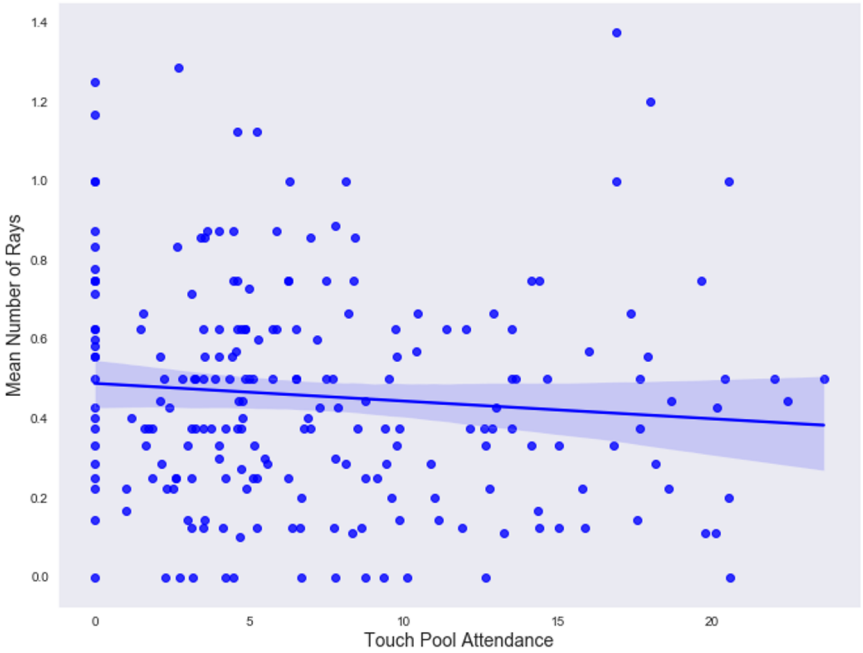
Mean H. sabinusin in Shallow Area Vs. Touch Pool Attendance (Excluding 0's, Daily, Instantaneous)



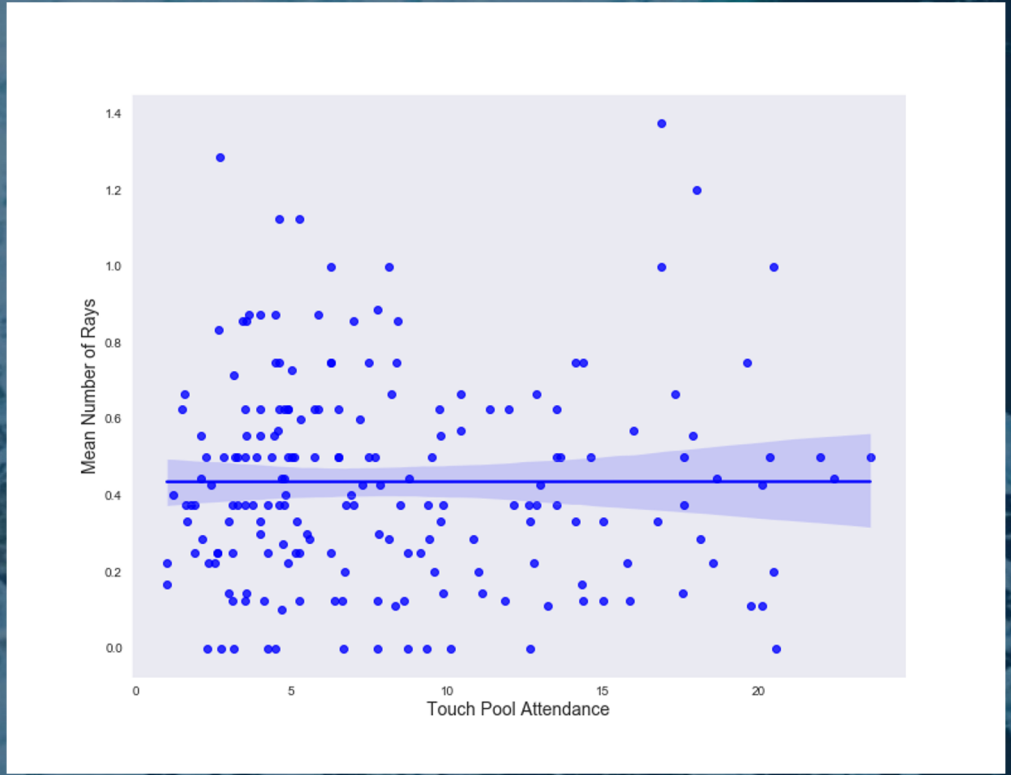
Mean Rays Breaking the Surface Vs. Touch Pool Attendance (Daily, Instantaneous)



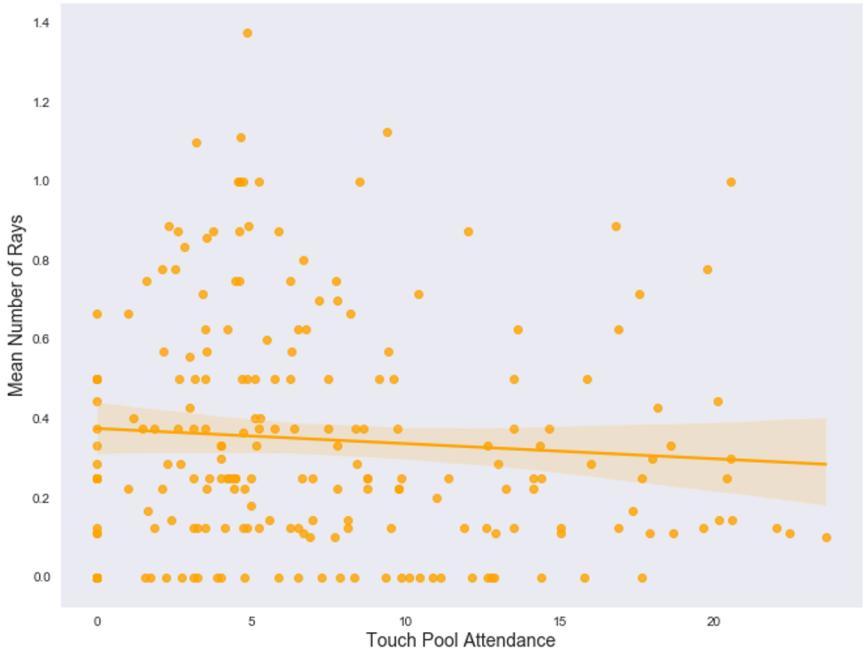
Mean N. kuhlii Breaking the Surface Vs. Touch Pool Attendance (Daily, Instantaneous)



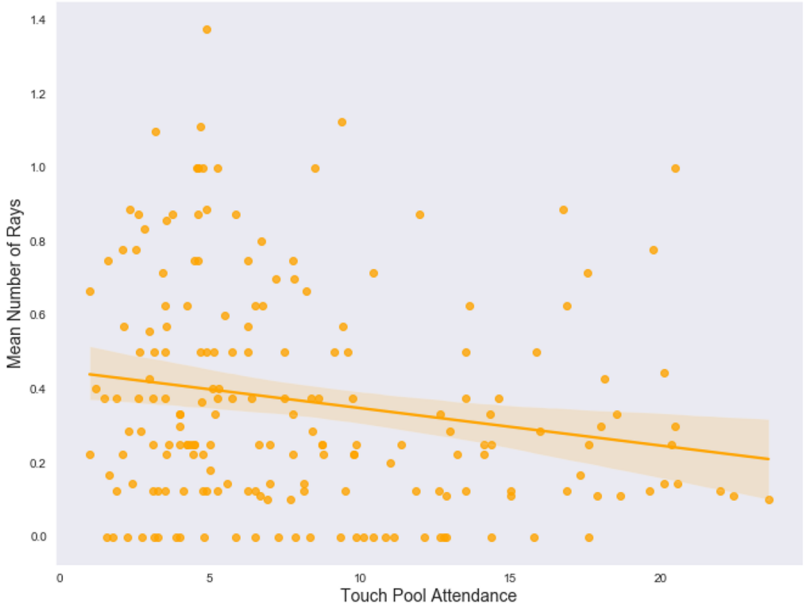
Mean N. kuhlii Breaking Surface Vs. Touch Pool Attendance (Excluding 0's Daily, Instantaneous)



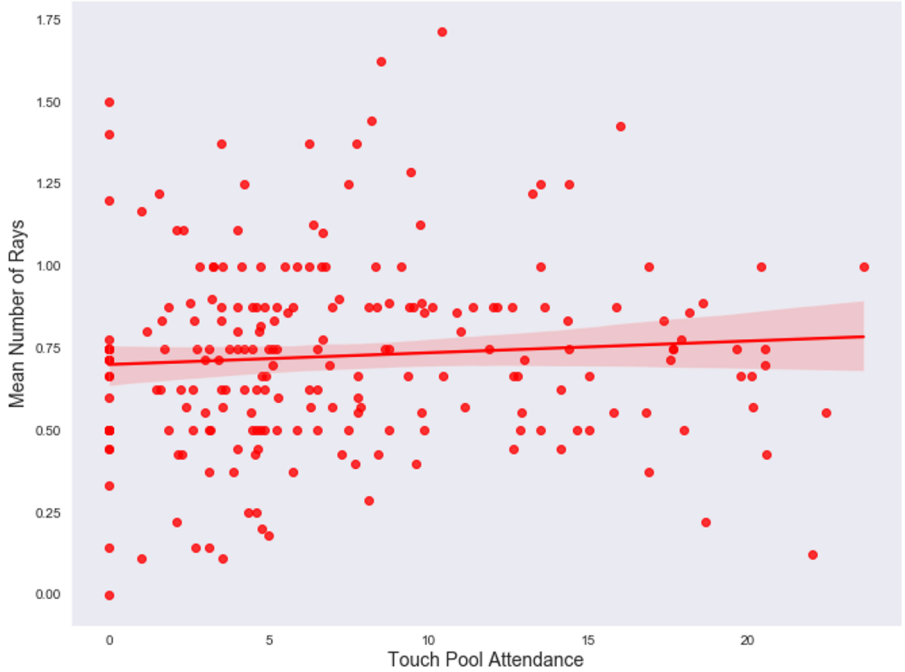
Mean U. jamaicensis Breaking the Surface Vs. Touch Pool Attendance (Daily, Instantaneous)



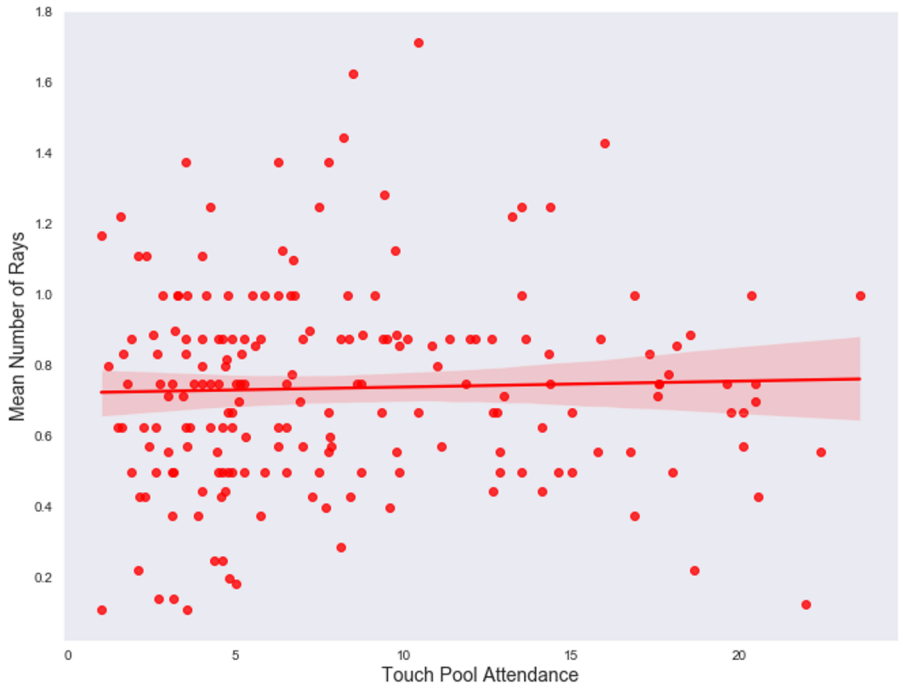
Mean U. jamaicensis Breaking the Surface Vs. Touch Pool Attendance (Excluding 0's Daily, Instantaneous)



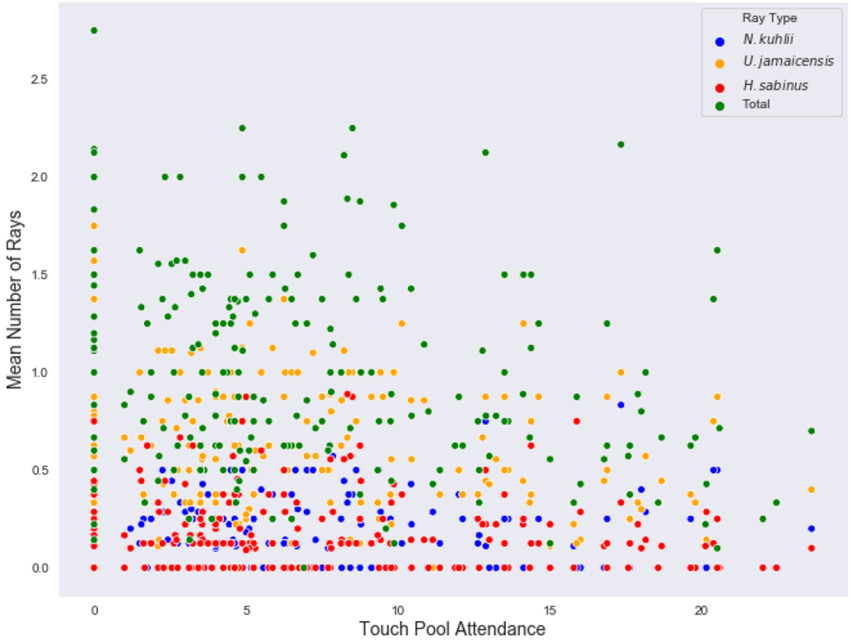
Mean H. sabinusin Breaking the Surface Vs. Touch Pool Attendance (Daily, Instantaneous)



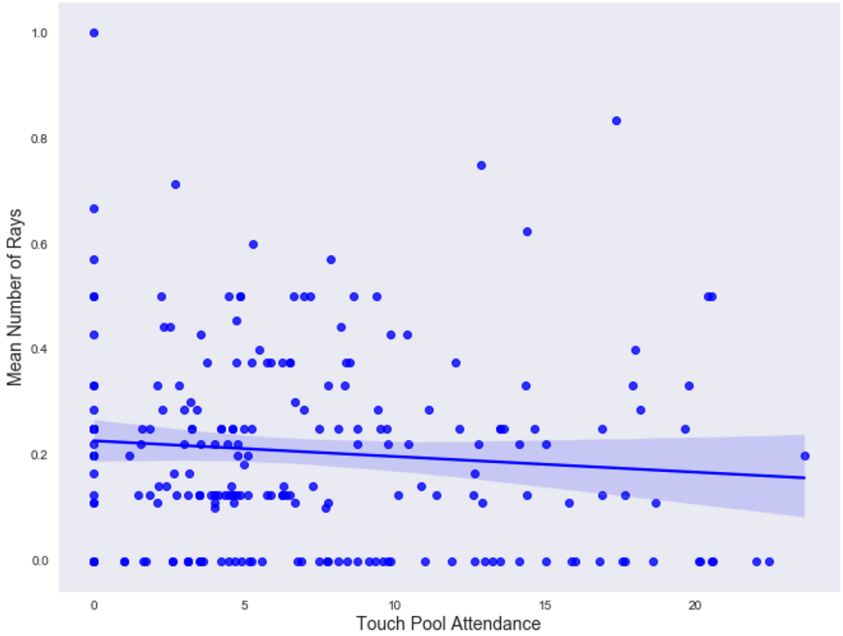
Mean H. sabinusin Breaking the Surface Vs. Touch Pool Attendance (Excluding 0's, Daily, Instantaneous)



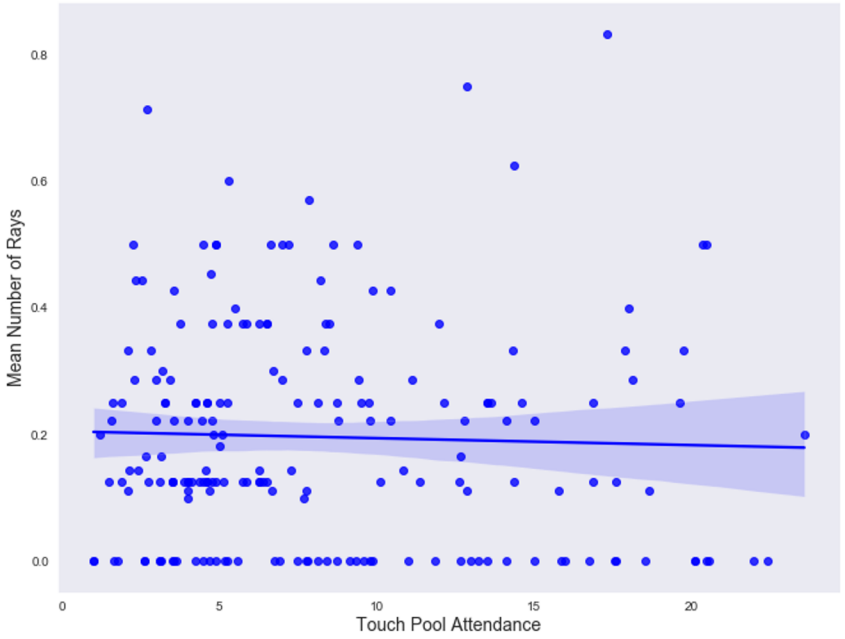
Mean Rays Following Vs. Touch Pool Attendance (Daily, Instantaneous)



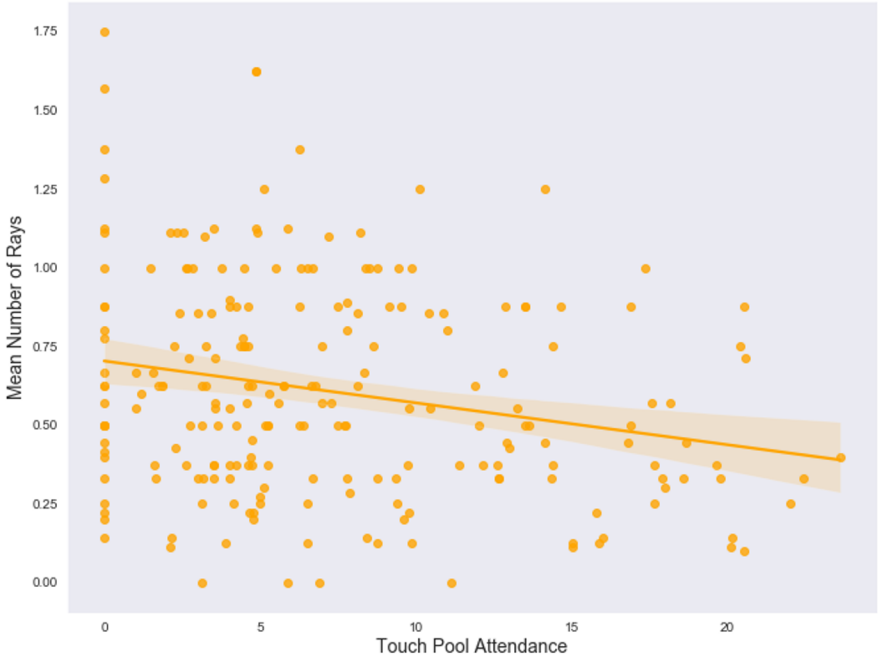
Mean N. kuhlii Following Vs. Touch Pool Attendance (Daily, Instantaneous)



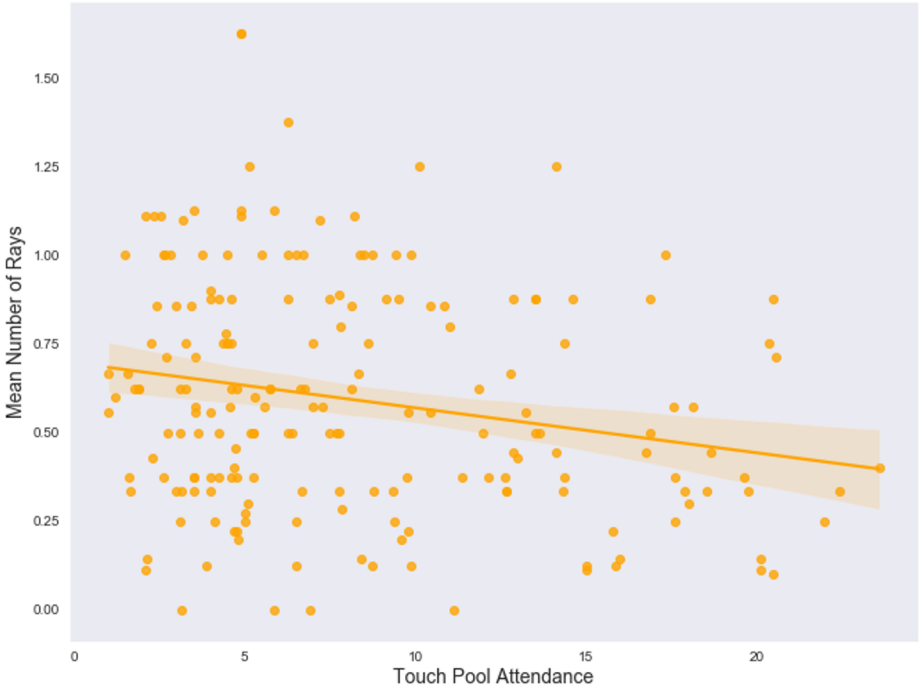
Mean N. kuhlii Following Vs. Touch Pool Attendance (Excluding 0's Daily, Instantaneous)



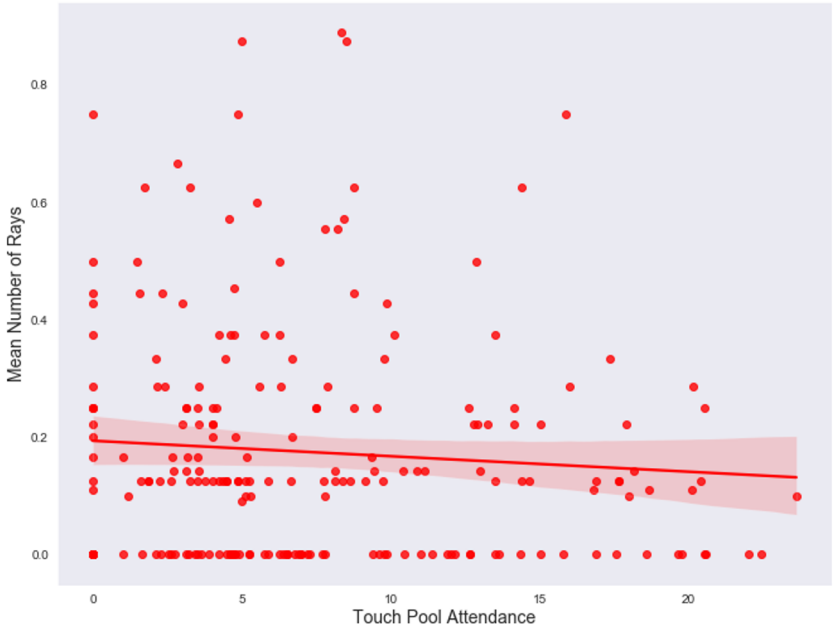
Mean U. jamaicensis Following Vs. Touch Pool Attendance (Daily, Instantaneous)



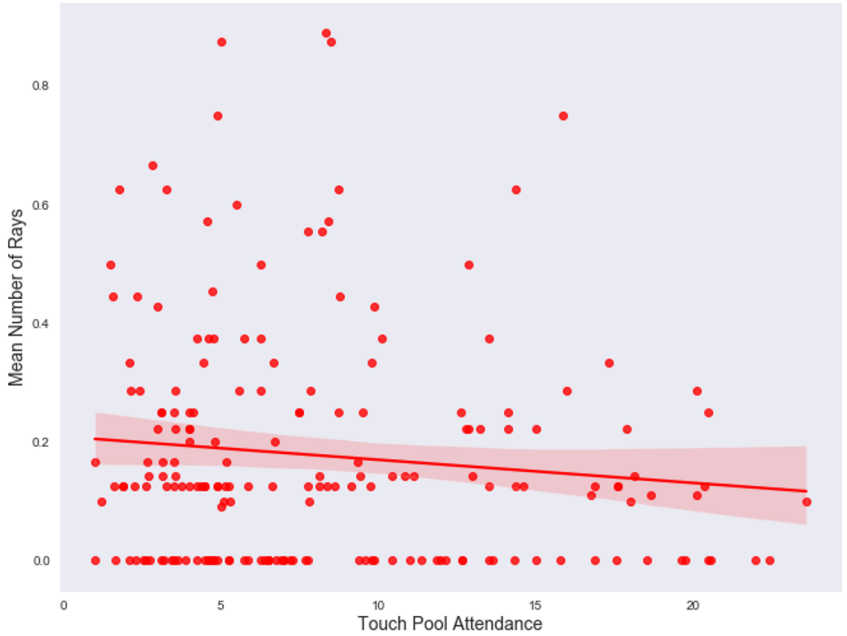
Mean U. jamaicensis Following Vs. Touch Pool Attendance (Excluding 0's Daily, Instantaneous)



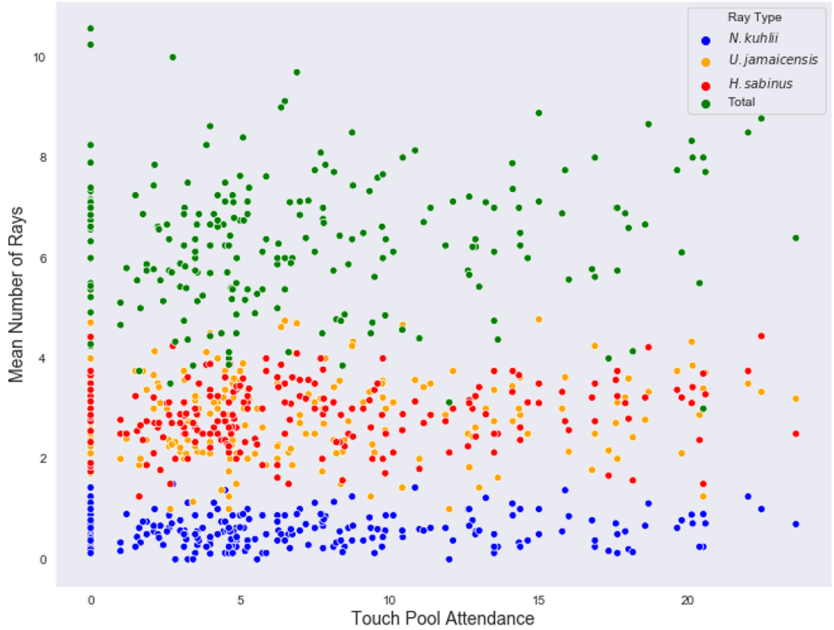
Mean H. sabinusin Following Vs. Touch Pool Attendance (Daily, Instantaneous)



Mean H. sabinusin Following Vs. Touch Pool Attendance (Excluding 0's, Daily, Instantaneous)

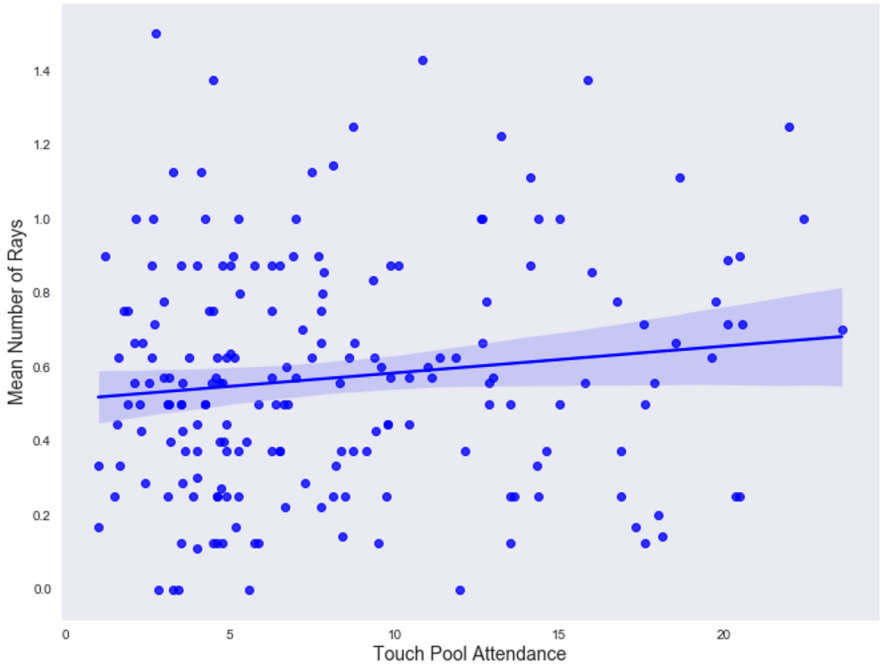


Mean Rays Resting at the Bottom Vs. Touch Pool Attendance (Daily, Instantaneous)

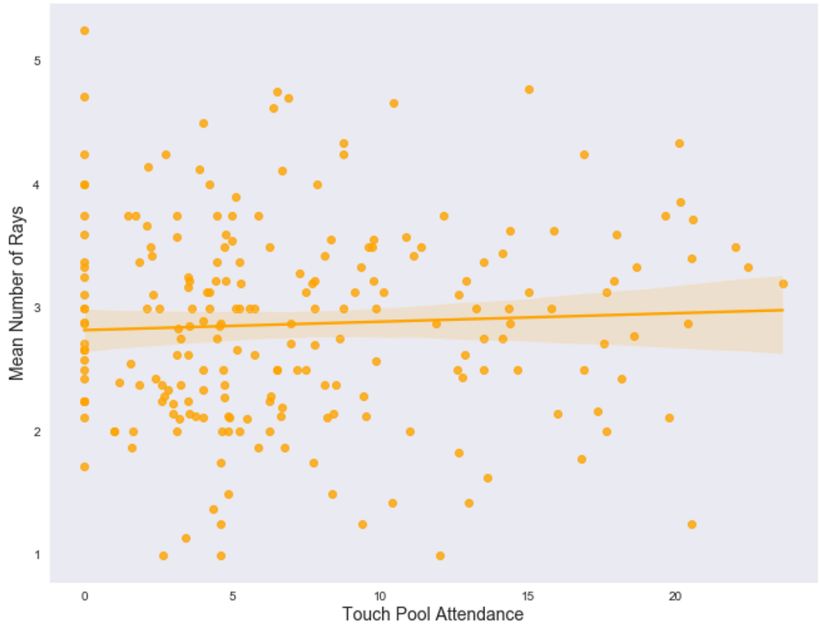


Mean N. kuhlii Resting at the Bottom Vs. Touch Pool Attendance (Daily, Instantaneous)

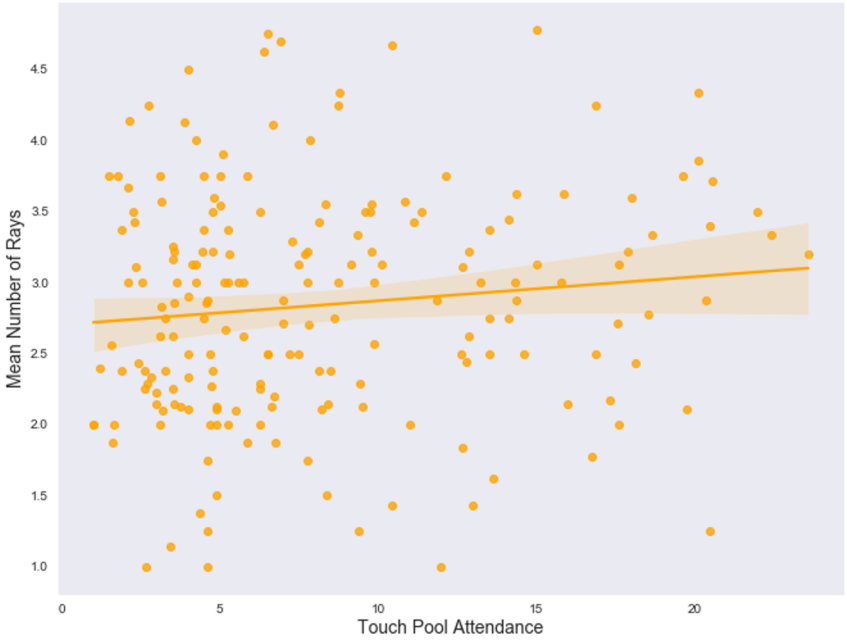
Mean N. kuhlii Resting at the Bottom Vs. Touch Pool Attendance (Excluding 0's Daily, Instantaneous)



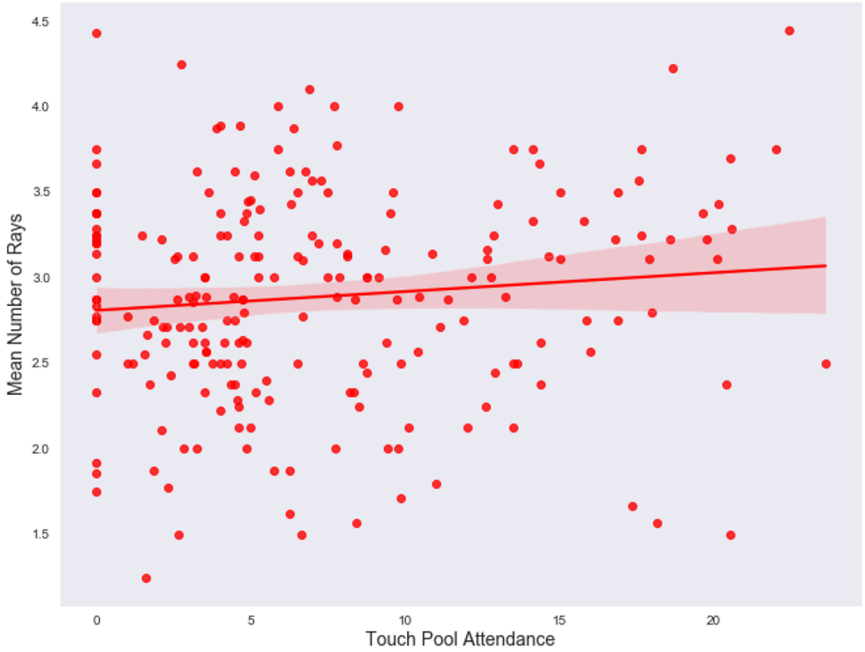
Mean U. jamaicensis Resting at the Bottom Vs. Touch Pool Attendance (Daily, Instantaneous)



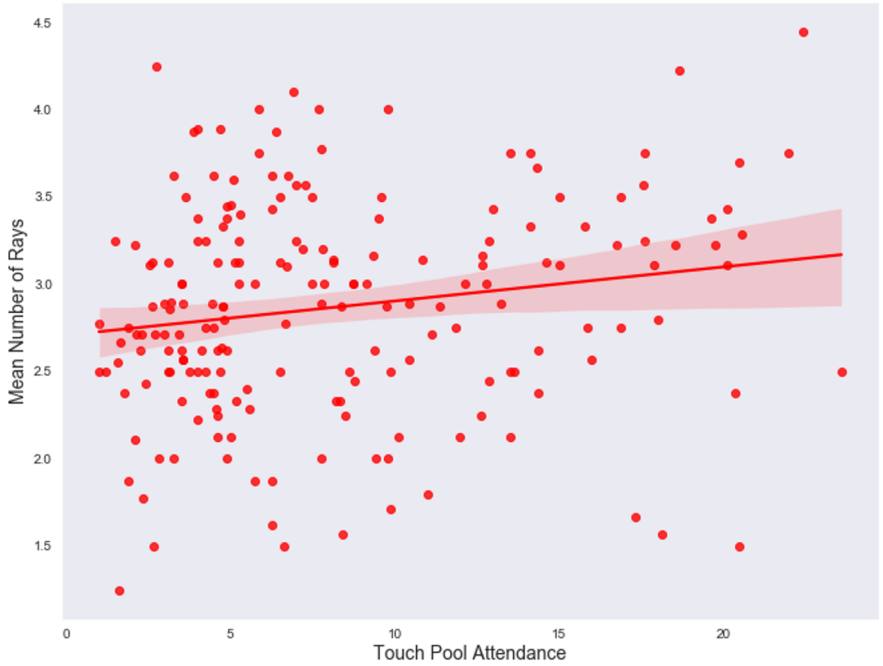
Mean U. jamaicensis Resting at the Bottom Vs. Touch Pool Attendance (Excluding 0's Daily, Instantaneous)



Mean H. sabinusin Resting at the Bottom Vs. Touch Pool Attendance (Daily, Instantaneous)

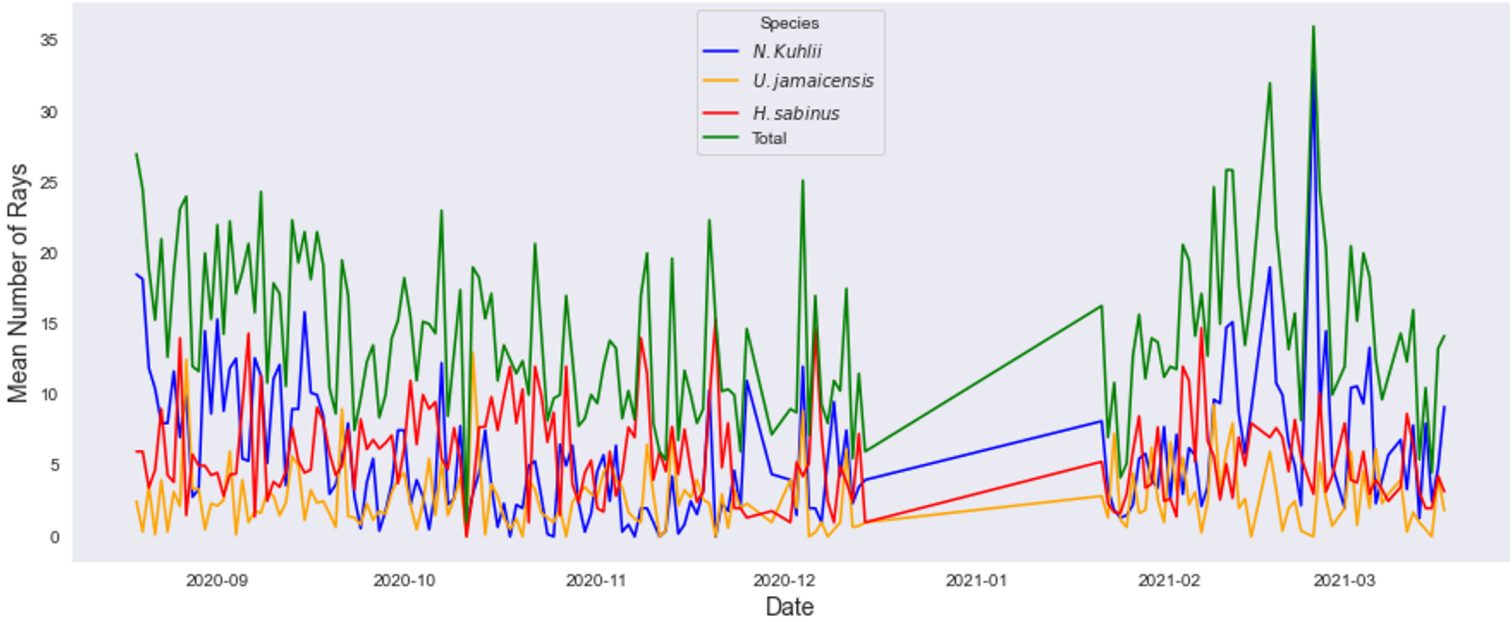


Mean H. sabinusin Resting at the Bottom Vs. Touch Pool Attendance (Excluding 0's, Daily, Instantaneous)

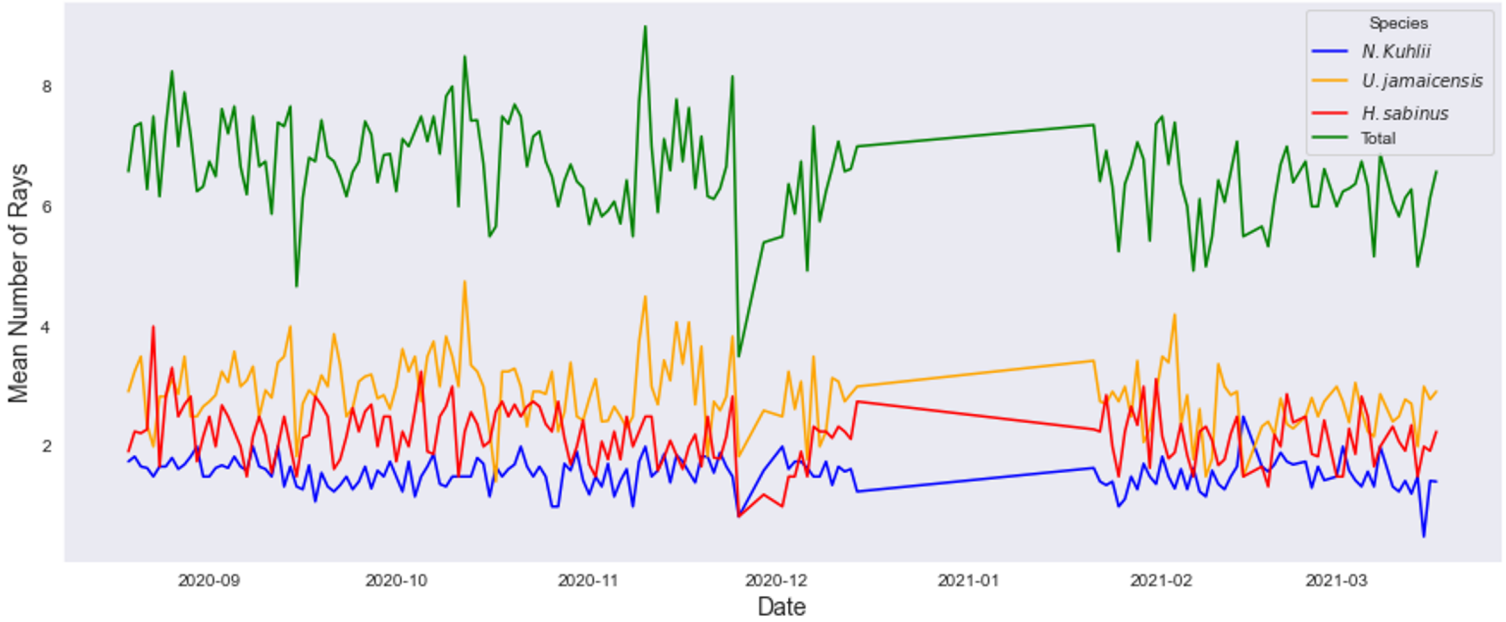


Daily Continuous Data

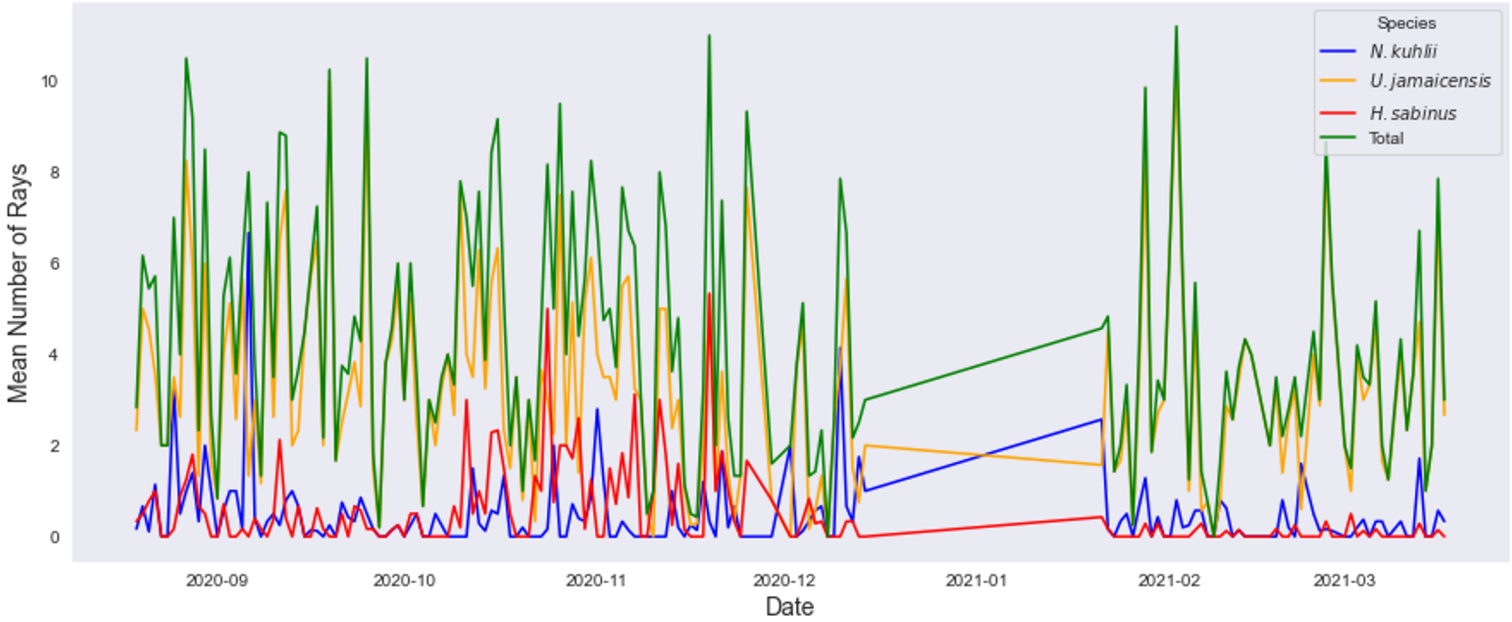
Daily Mean Surface Breaks, Continuous



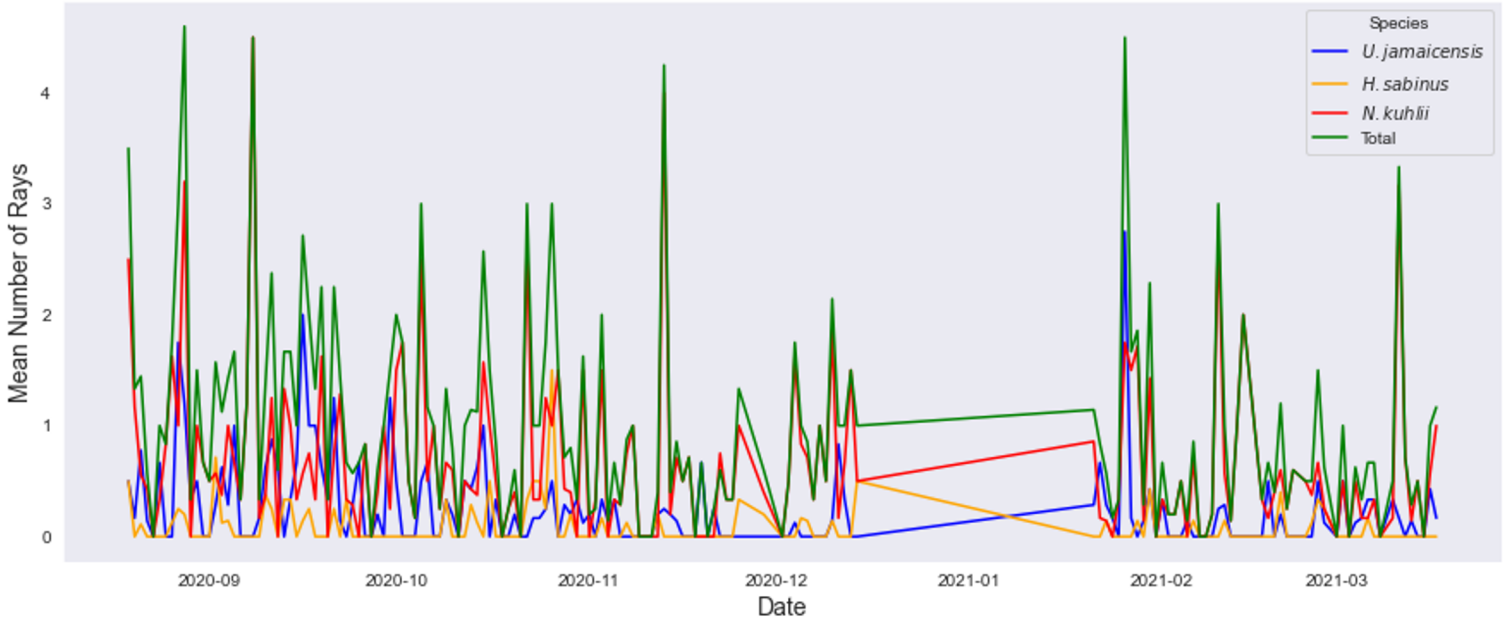
Daily Mean Number Rays Resting in Shallows, Continuous



Daily Mean Rays Following Conspecific, Continuous



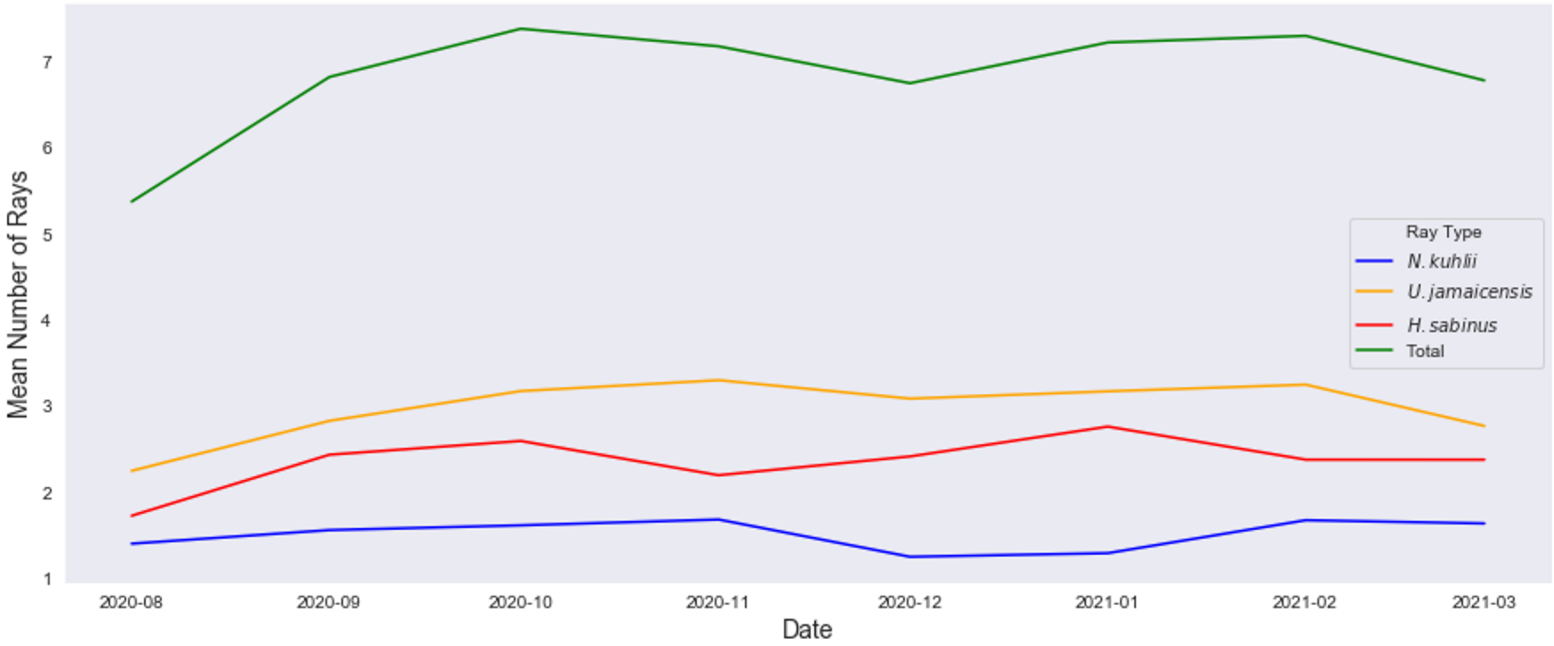
Daily Mean Rays Following Different Species, Continuous



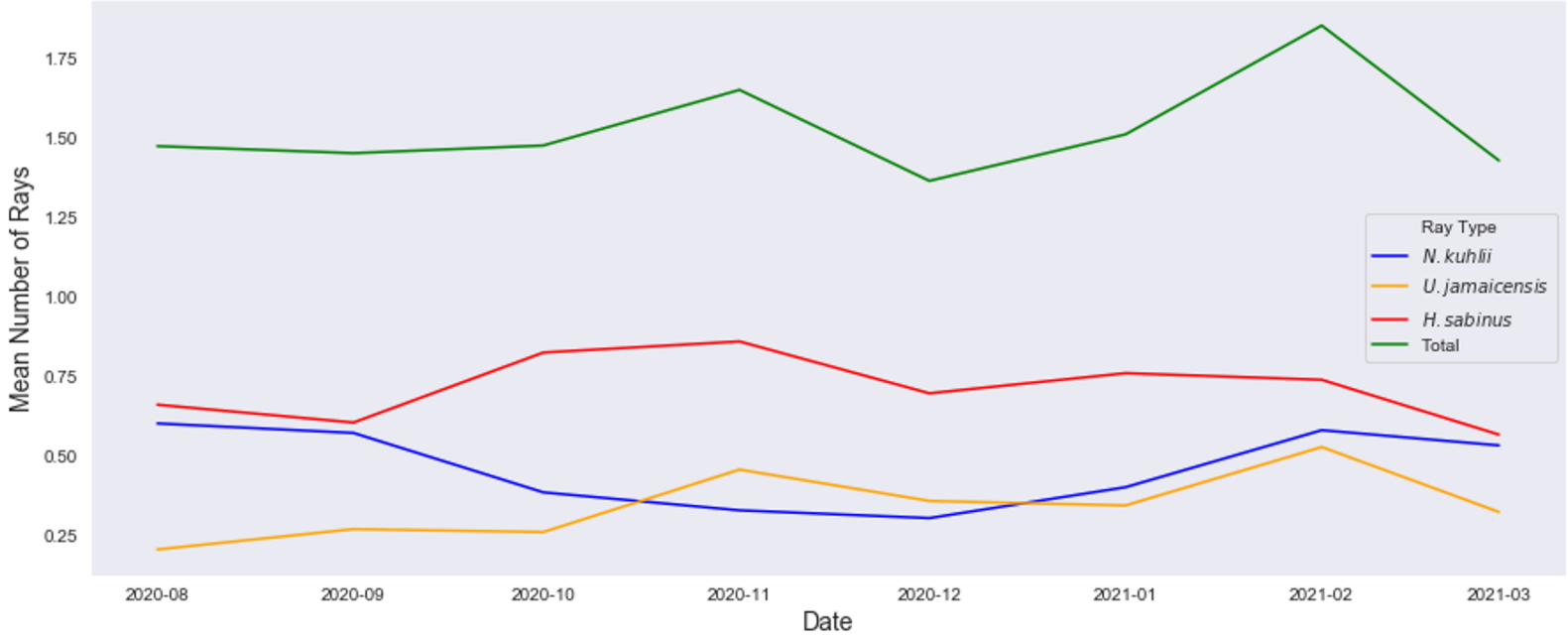
Monthly Instantaneous Data

Monthly Means

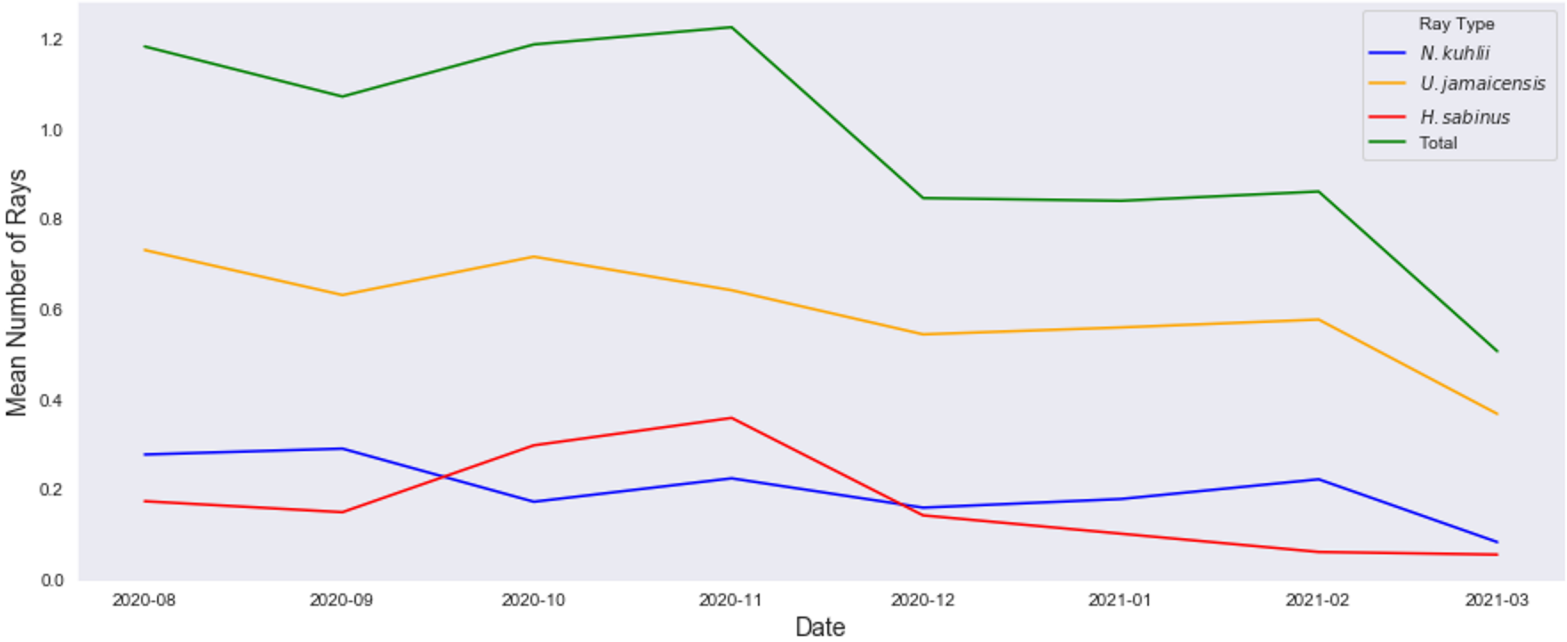
Mean Rays In Shallow Area (Monthly, Instantaneous)



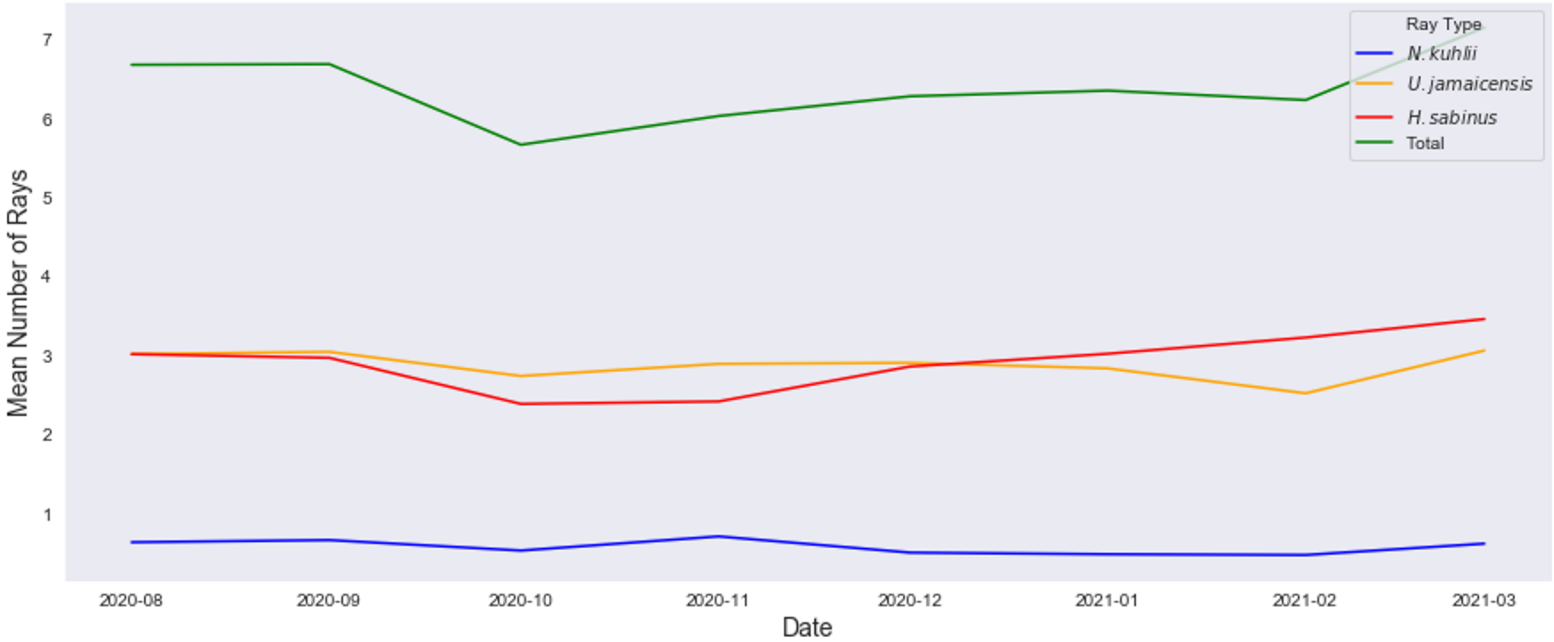
Mean Rays Breaking the Surface (Monthly, Instantaneous)



Mean Rays Following (Monthly, Instantaneous)

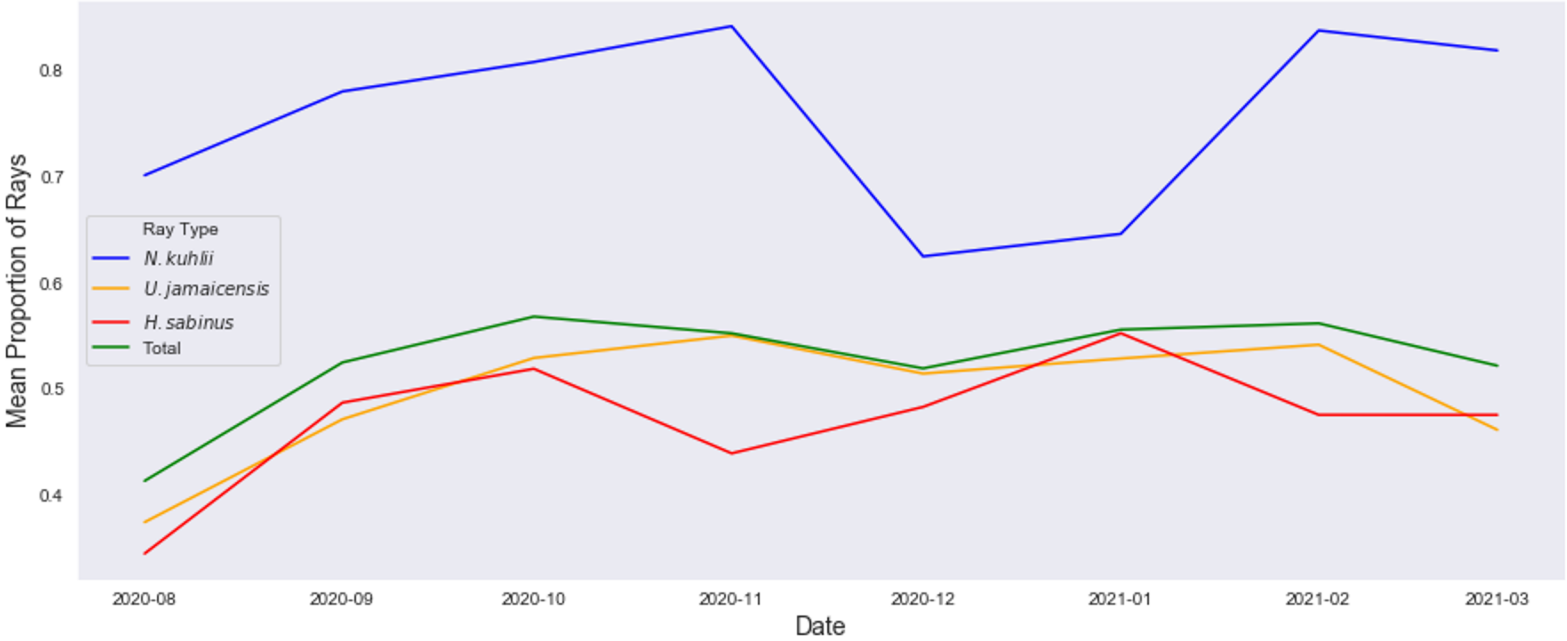


Mean Rays Resting at the Bottom (Monthly, Instantaneous)

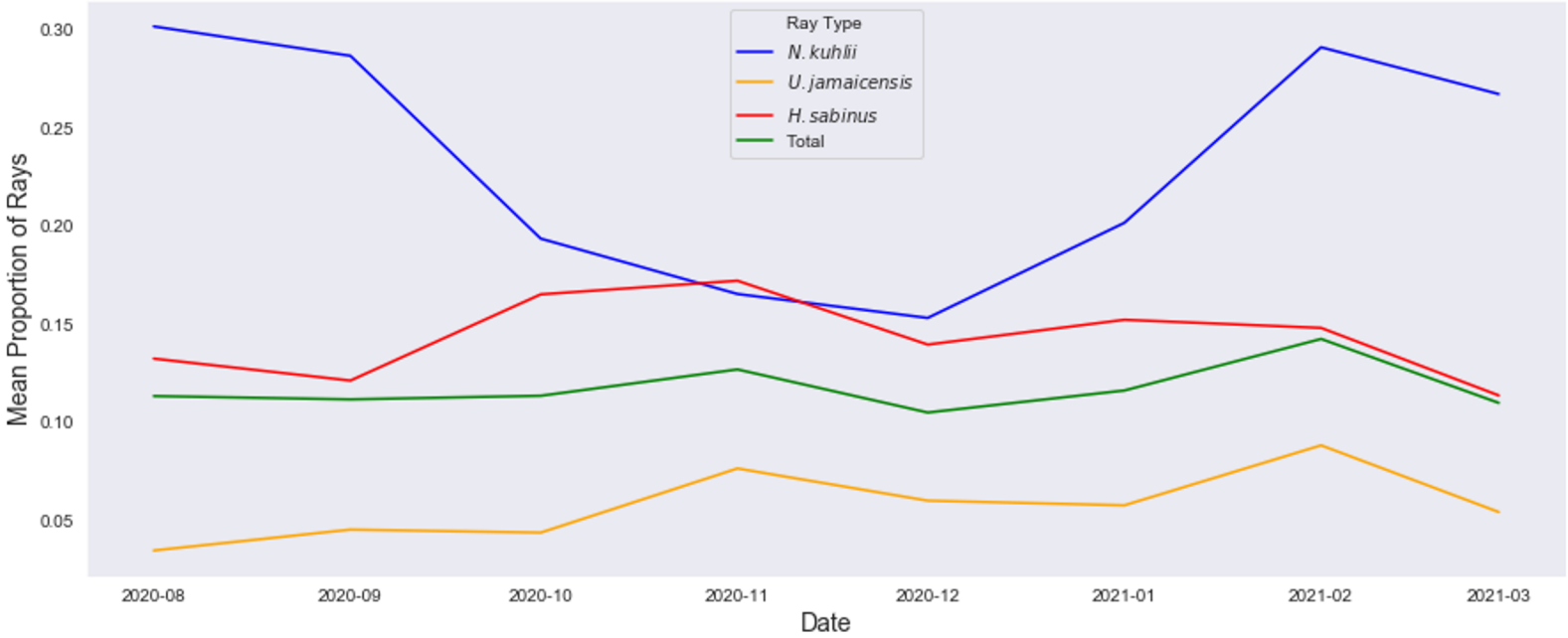


Monthly Proportions

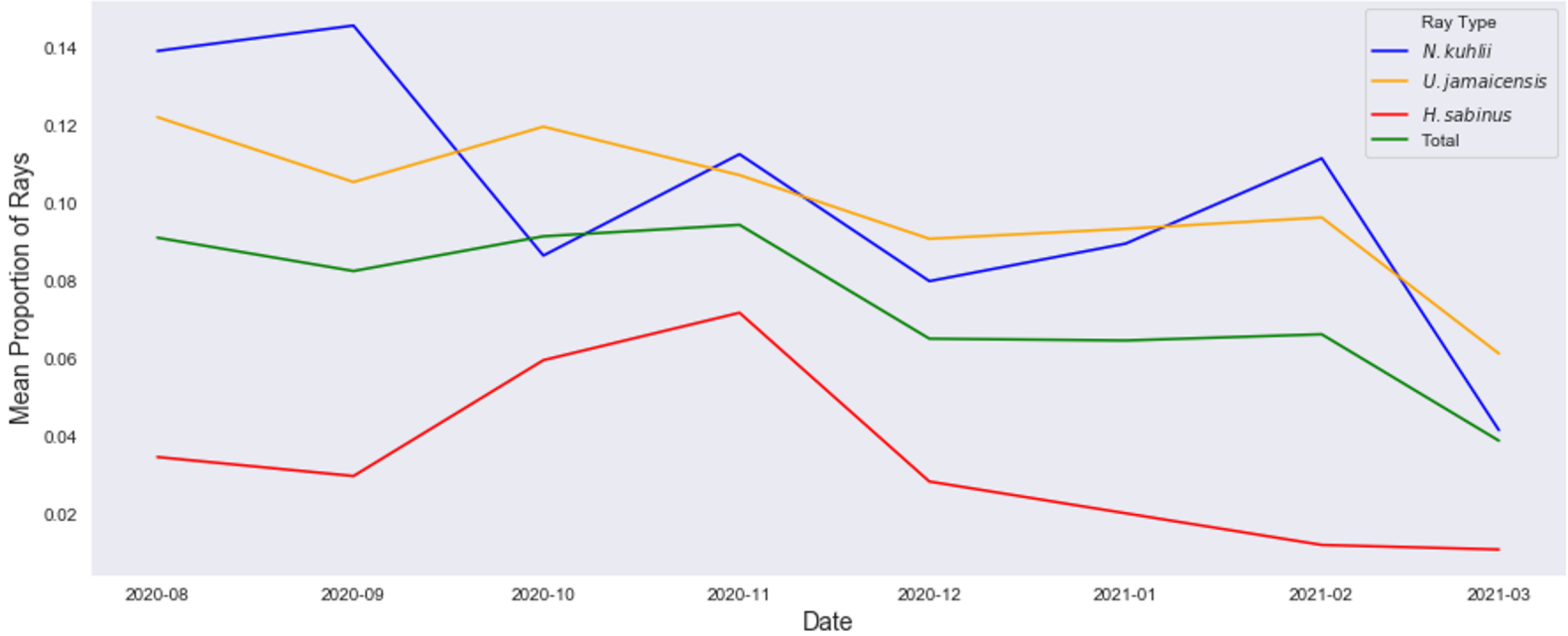
Proportion of Rays in Shallow Area (Monthly, Instantaneous)



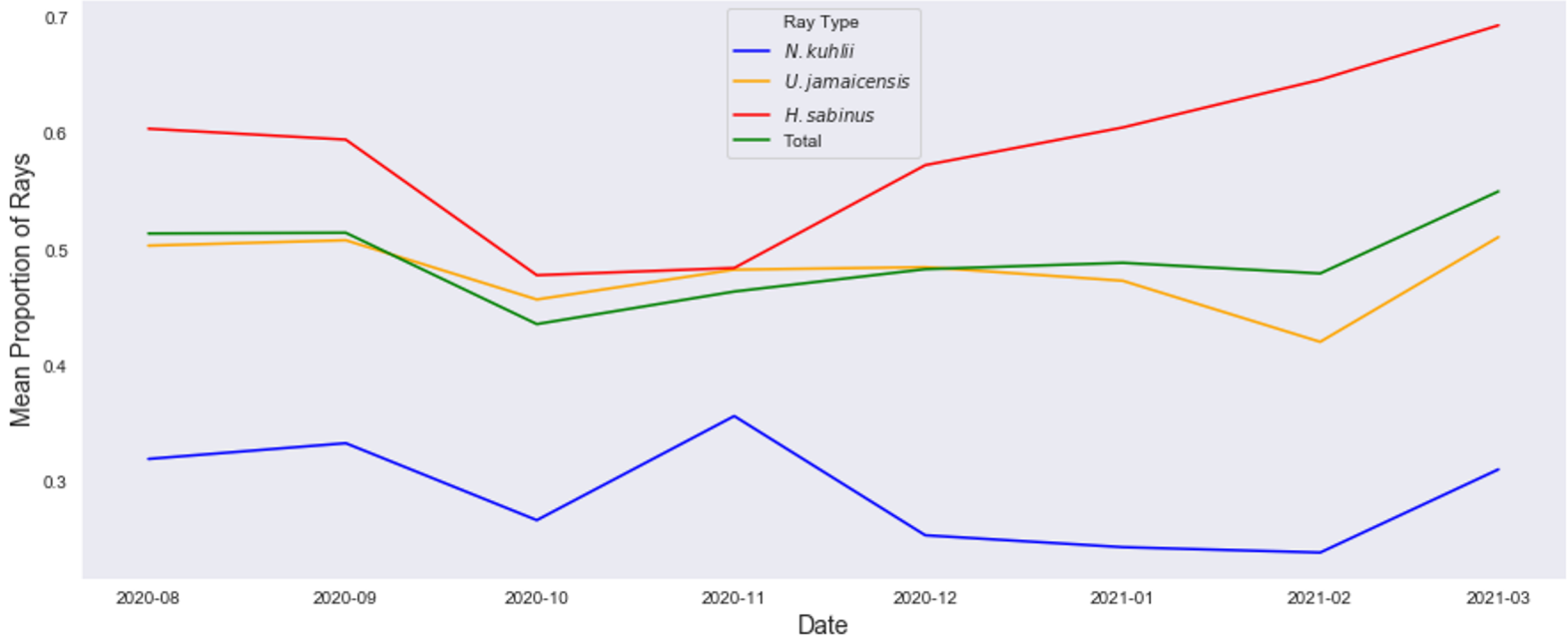
Proportion of Rays Breaking the Surface (Monthly, Instantaneous)



Proportion of Rays Following (Monthly, Instantaneous)



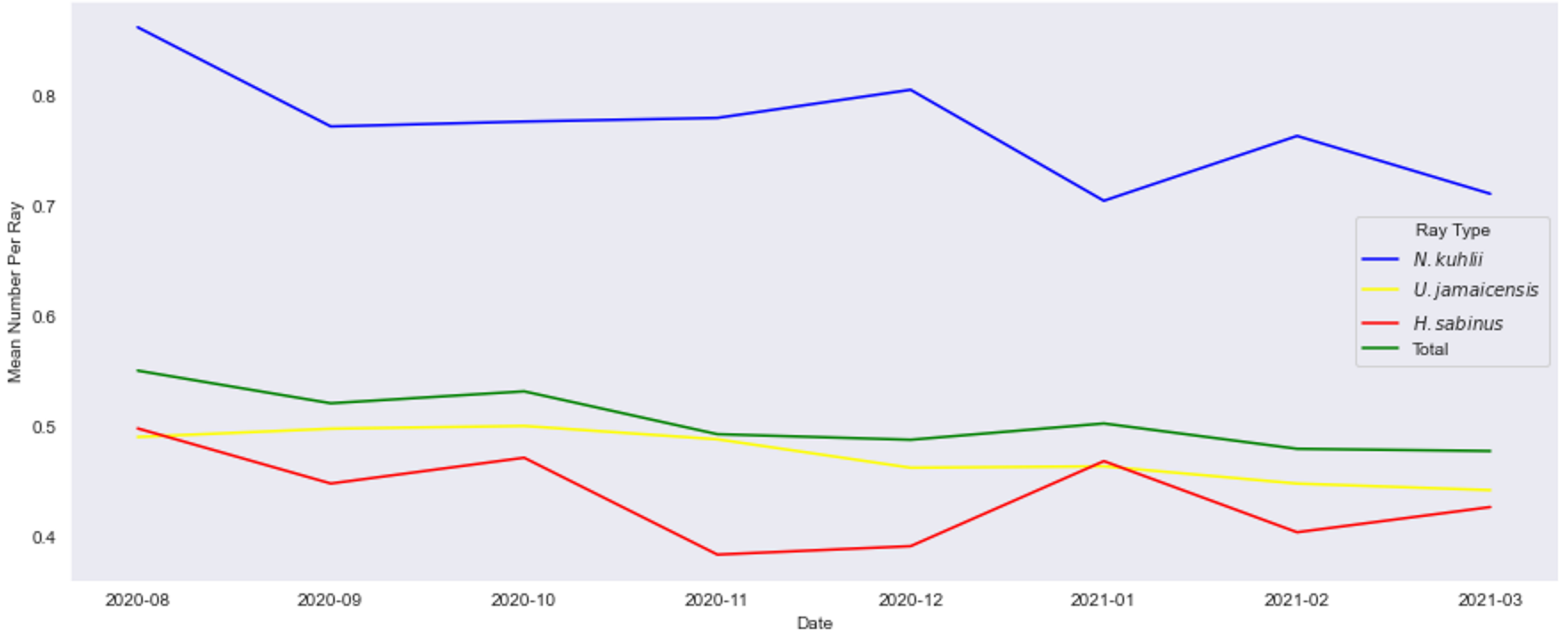
Proportion of Rays Resting at the Bottom (Monthly, Instantaneous)



Monthly Continuous Data

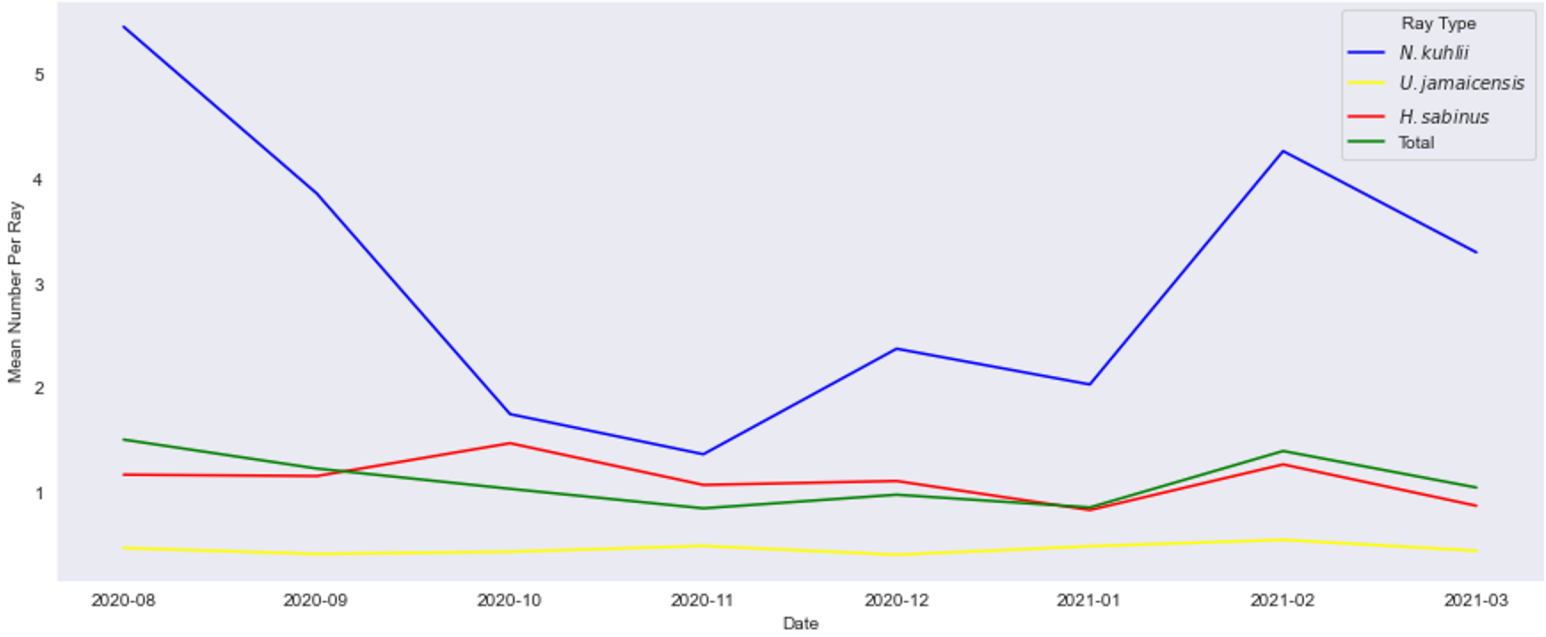
The charts that have a note at the bottom saying “per ray” are showing the amount of the behavior seen per ray (so for example, taking the total amount observed of a blue ray breaking the surface during a time period and dividing that by 2)

Mean Rays in Shallow Area (Monthly, Continuous)



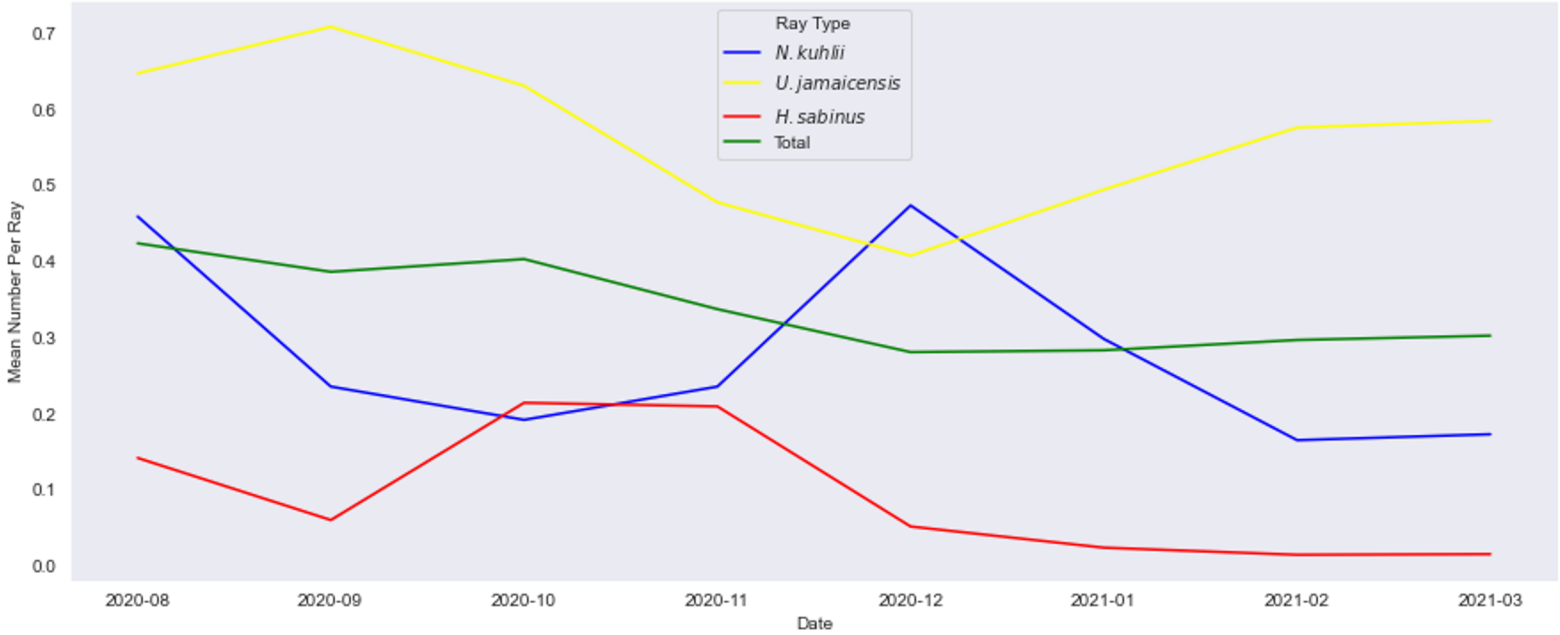
*This is the per ray observations (to compare across groups). It is the average between the before and after measurements.

Mean Rays Breaking the Surface (Monthly, Continuous)



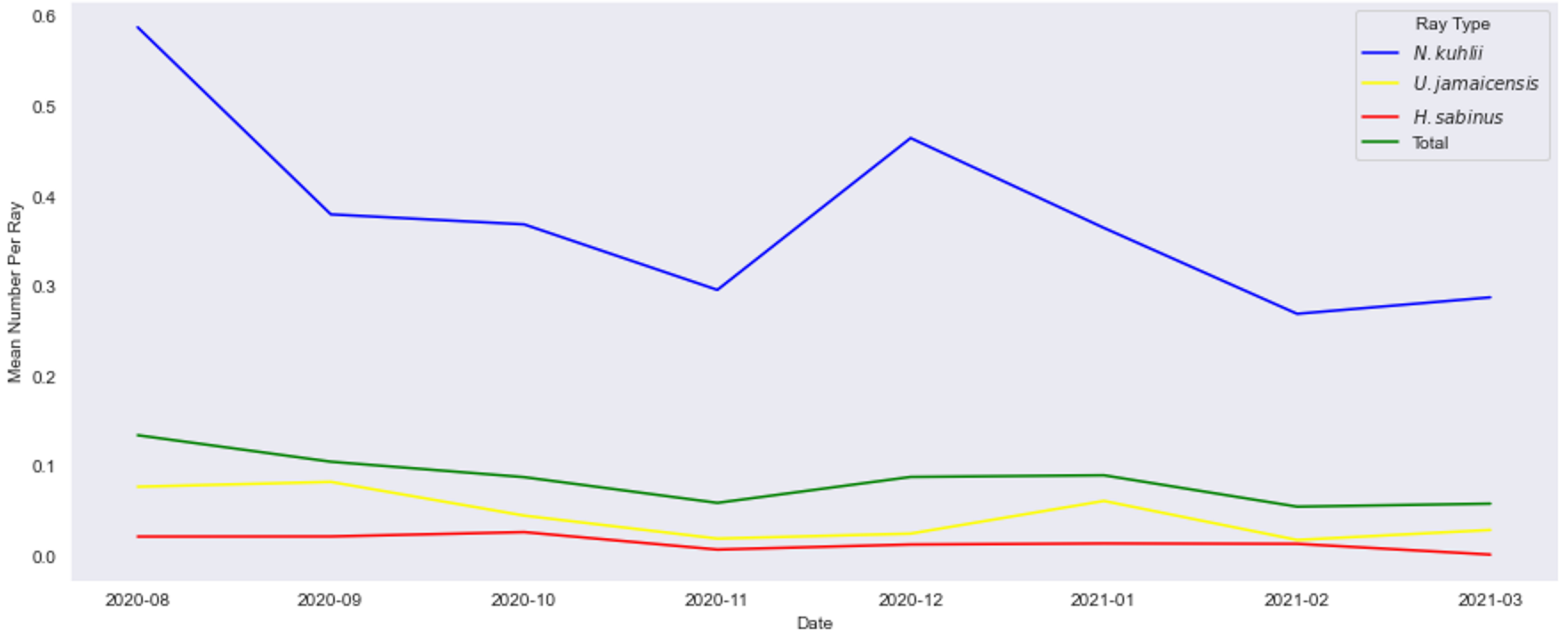
*This is the per ray observations (to compare across groups)

Mean Rays Following Conspecific (Monthly, Continuous)



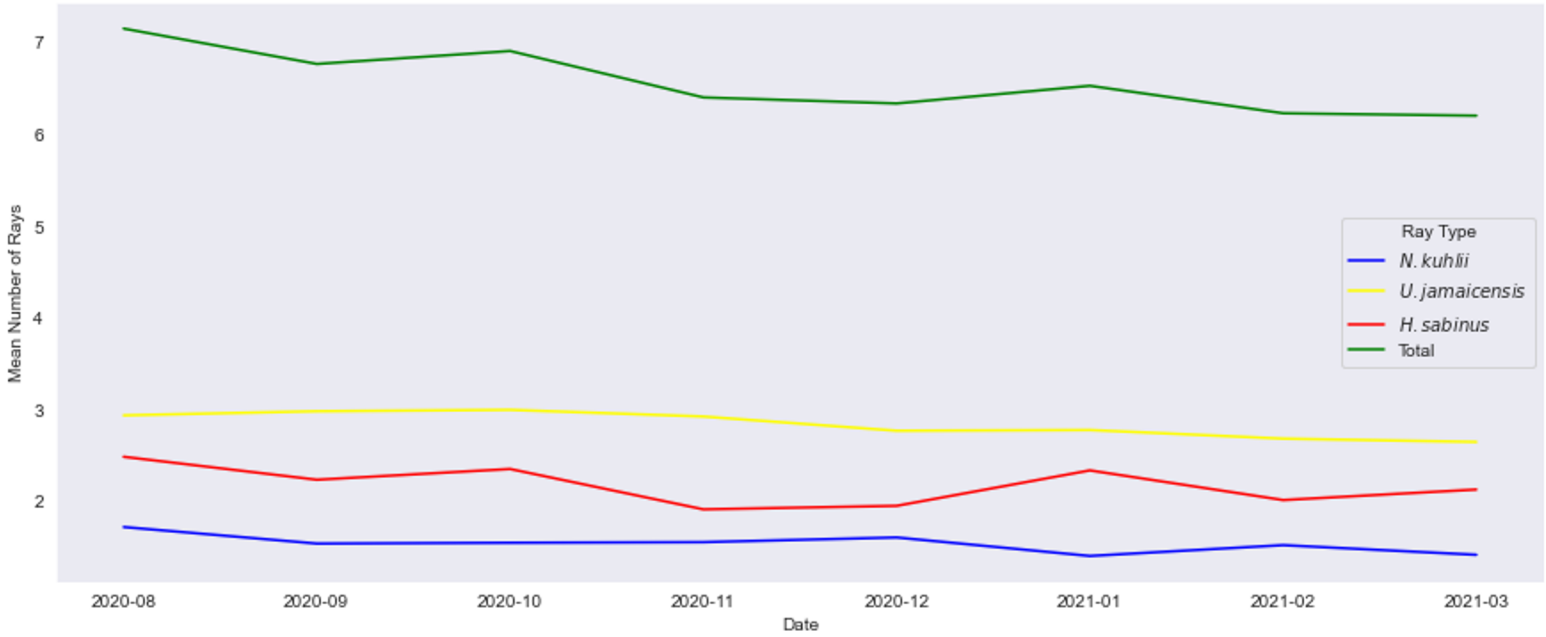
*This is the per ray observations (to compare across groups)

Mean Rays Following Different (Monthly, Continuous)

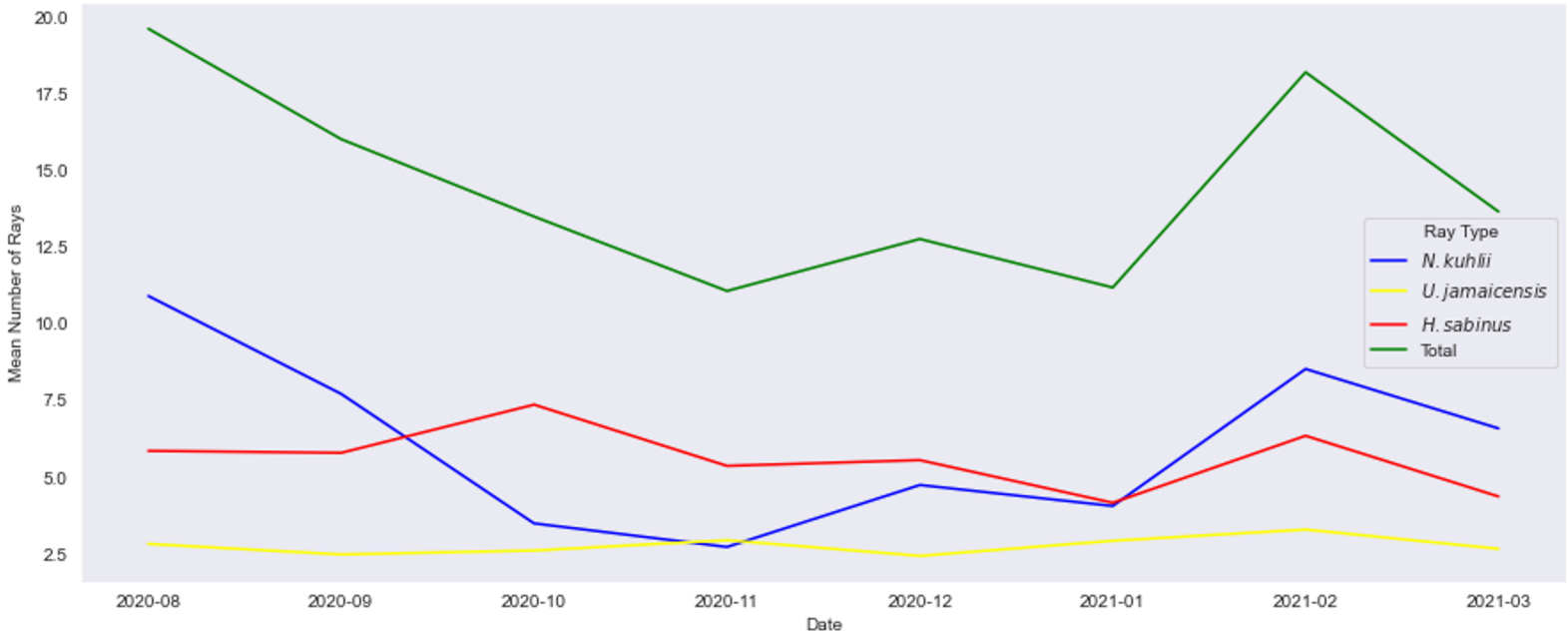


*This is the per ray observations (to compare across groups)

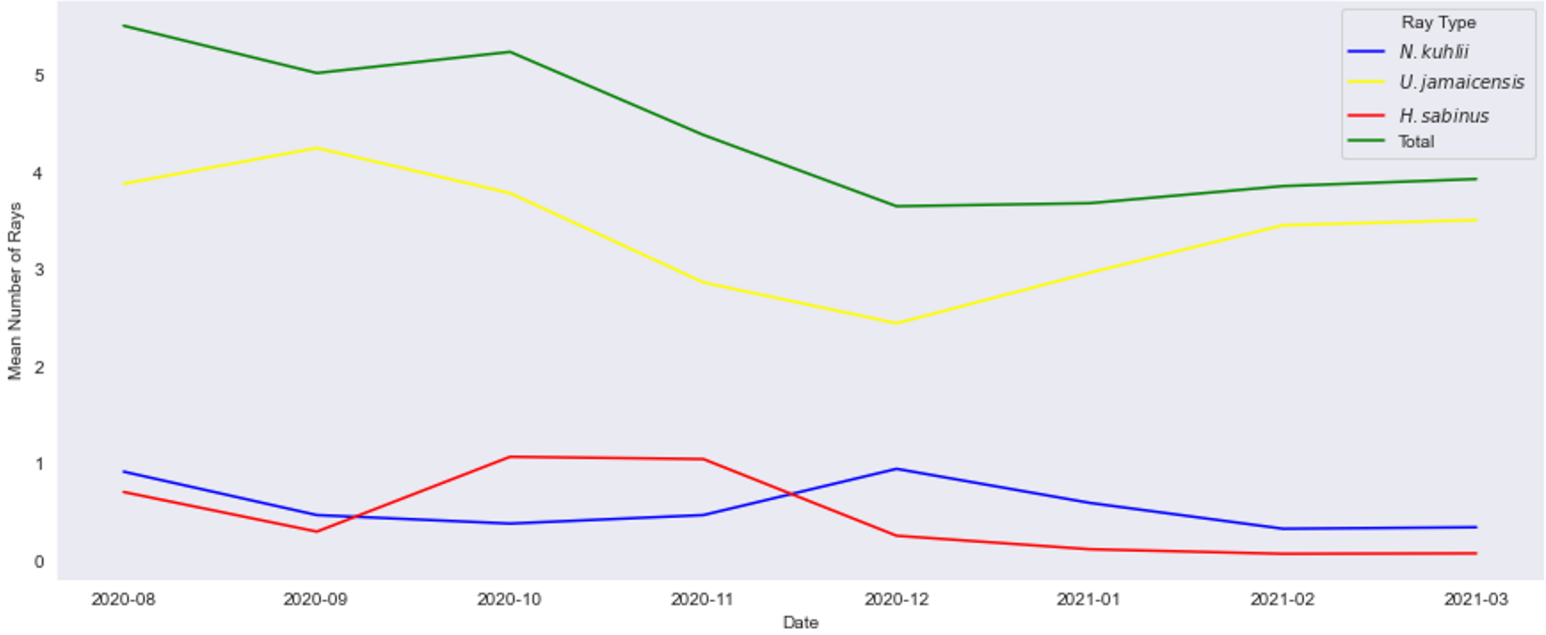
Mean Rays in Shallow Area Total (Monthly, Continuous)



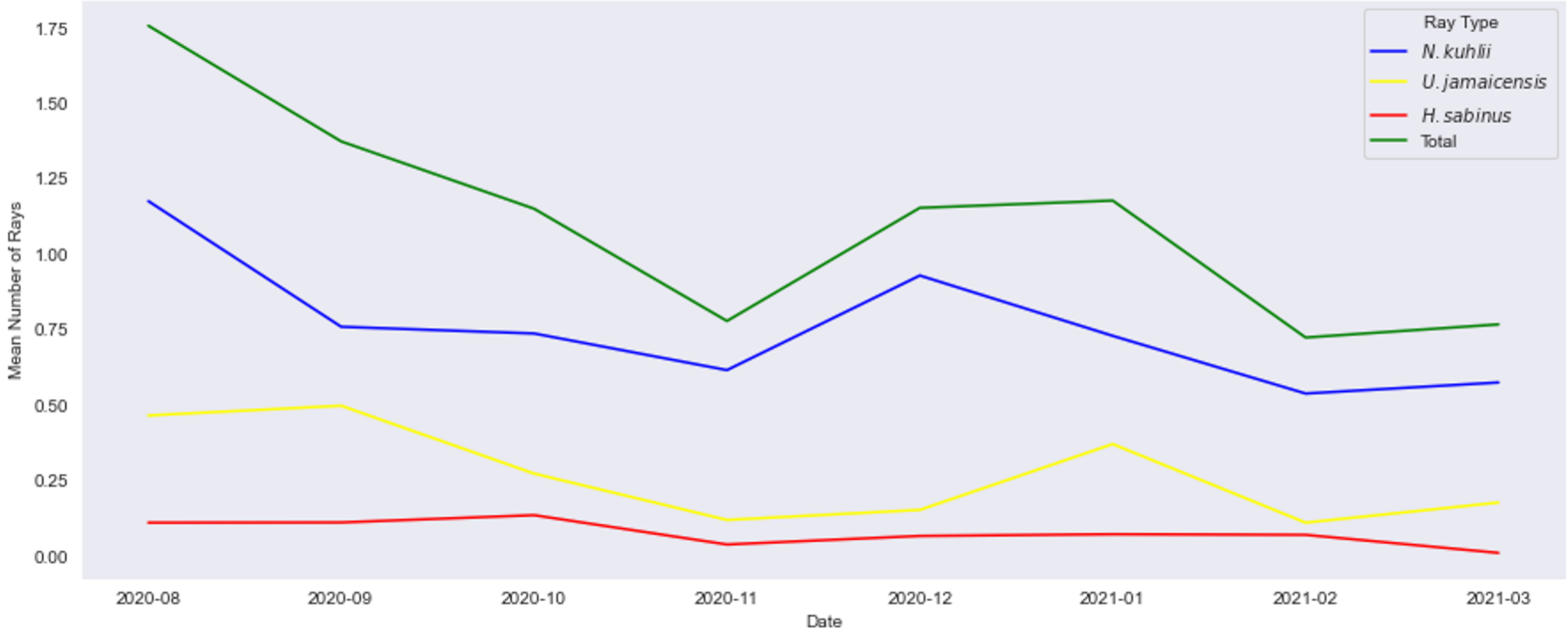
Mean Rays Breaking the Surface Total (Monthly, Continuous)



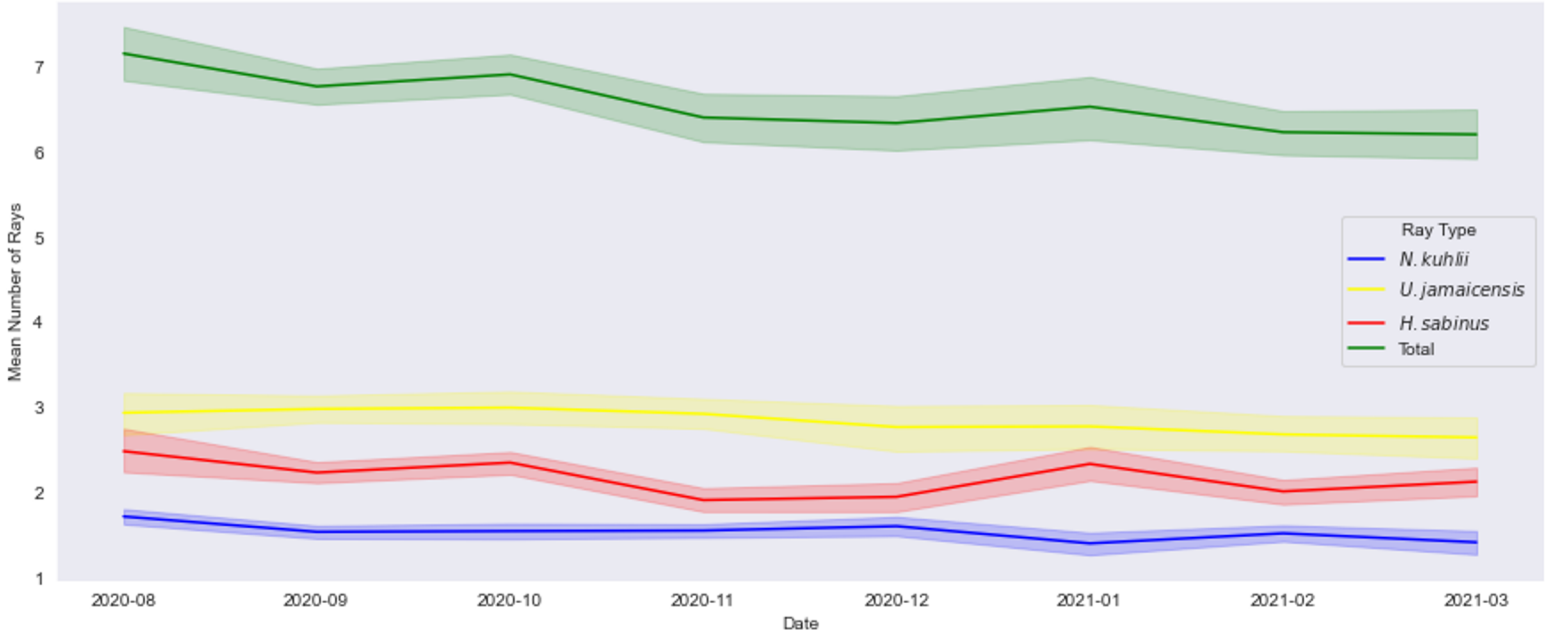
Mean Rays Following Conspecific Total (Monthly, Continuous)



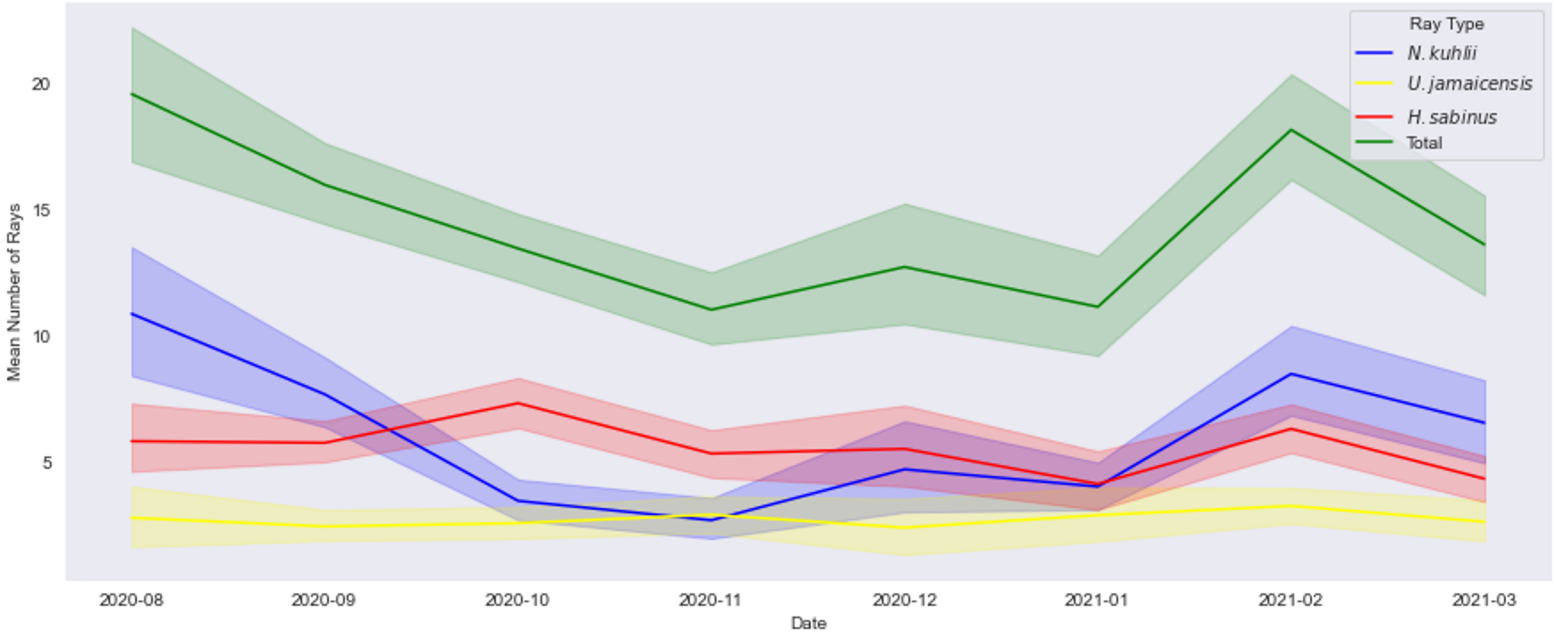
Mean Rays Following Different Total (Monthly, Continuous)



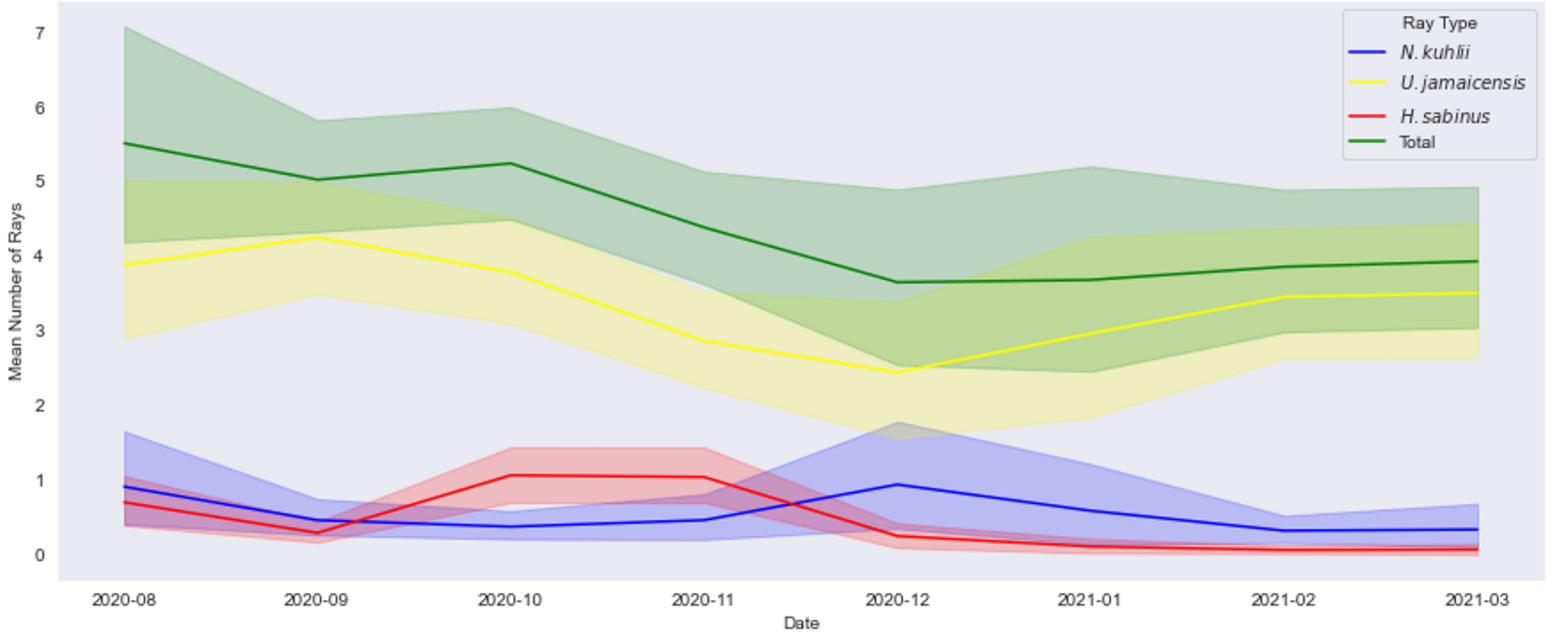
Mean Rays in Shallow Area Total w/ Errors (Monthly, Continuous)



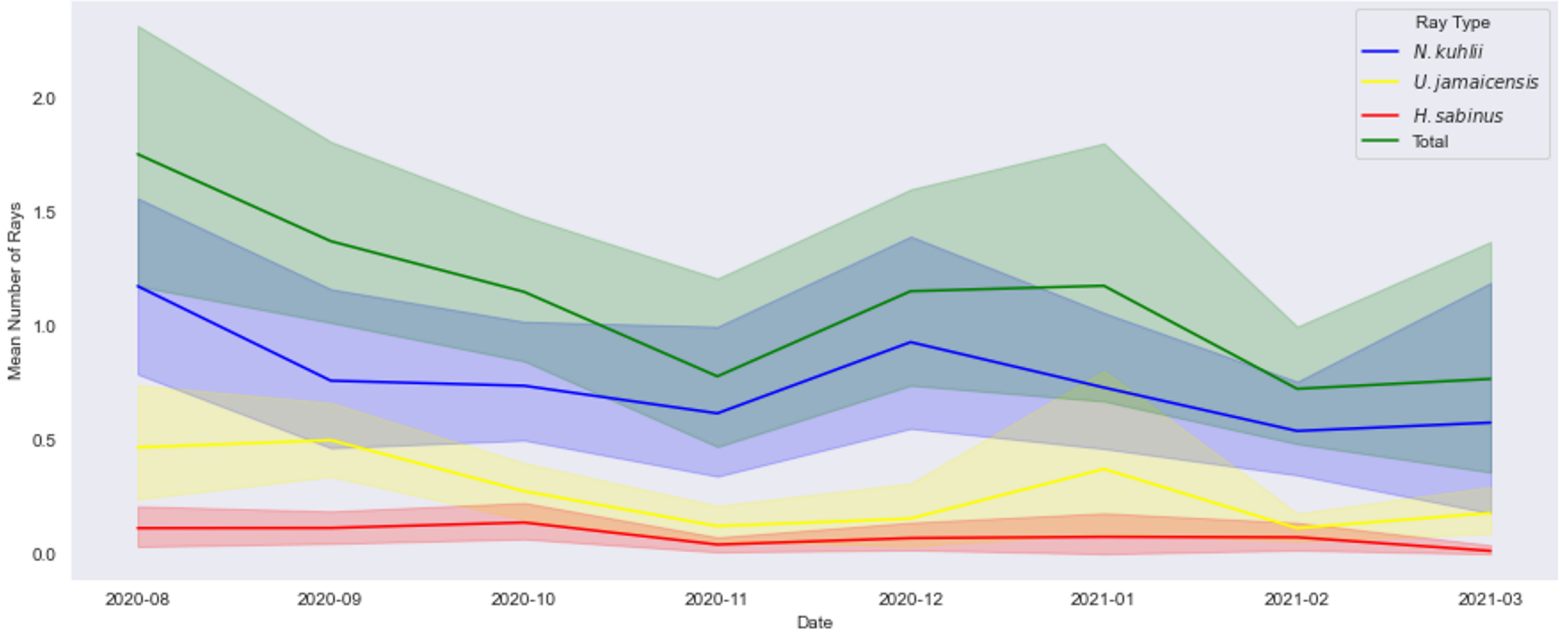
Mean Rays Breaking the Surface Total w/ Errors (Monthly, Continuous)



Mean Rays Following Conspecific Total w/ Errors (Monthly, Continuous)

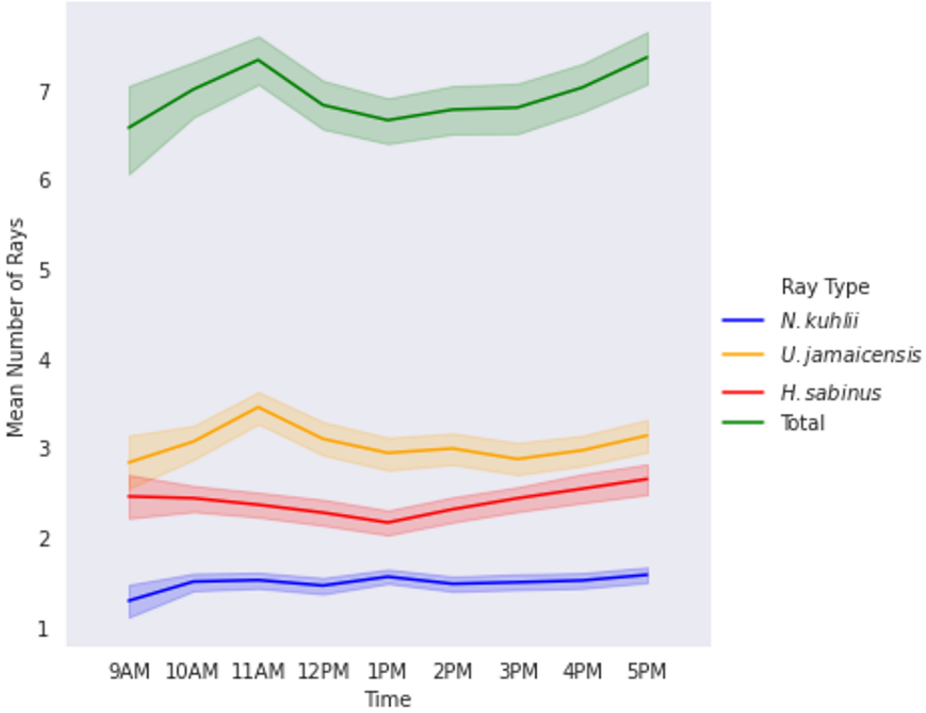


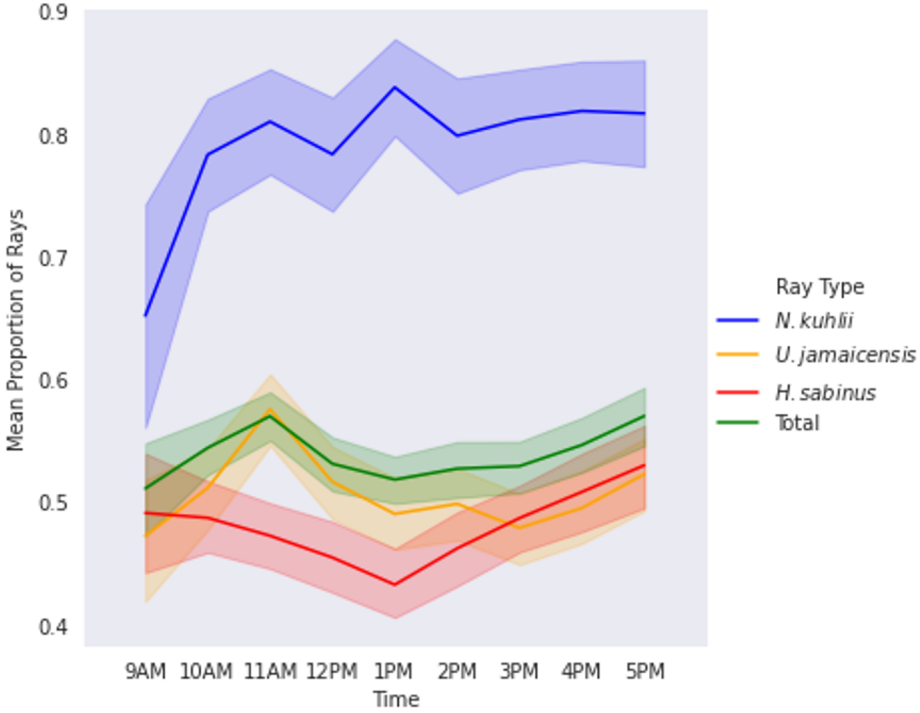
Mean Rays Following Different Total w/ Errors (Monthly, Continuous)



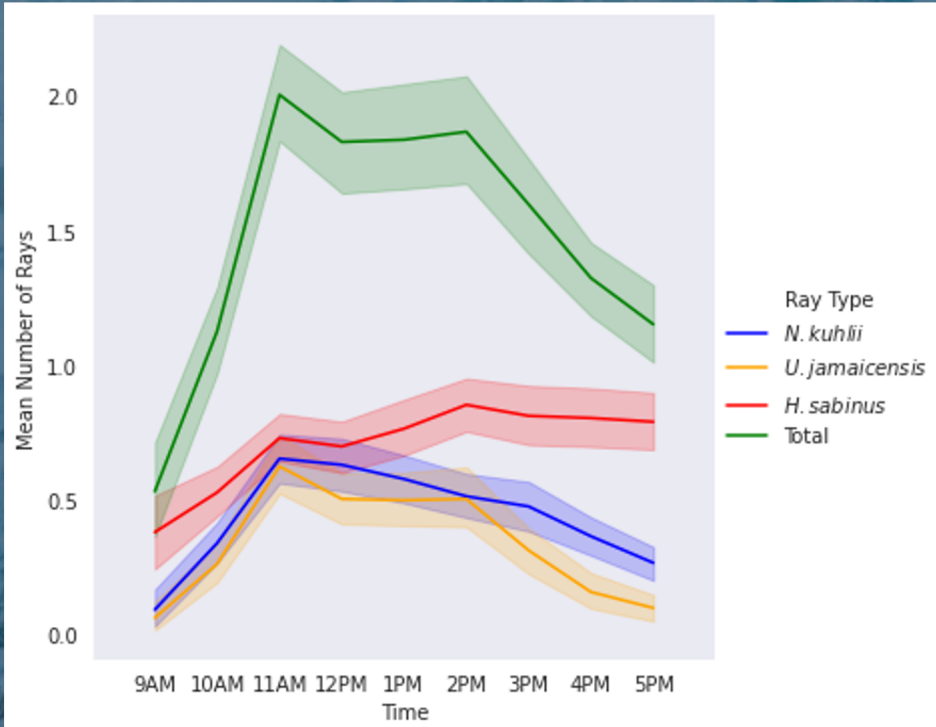
Hourly Instantaneous Data

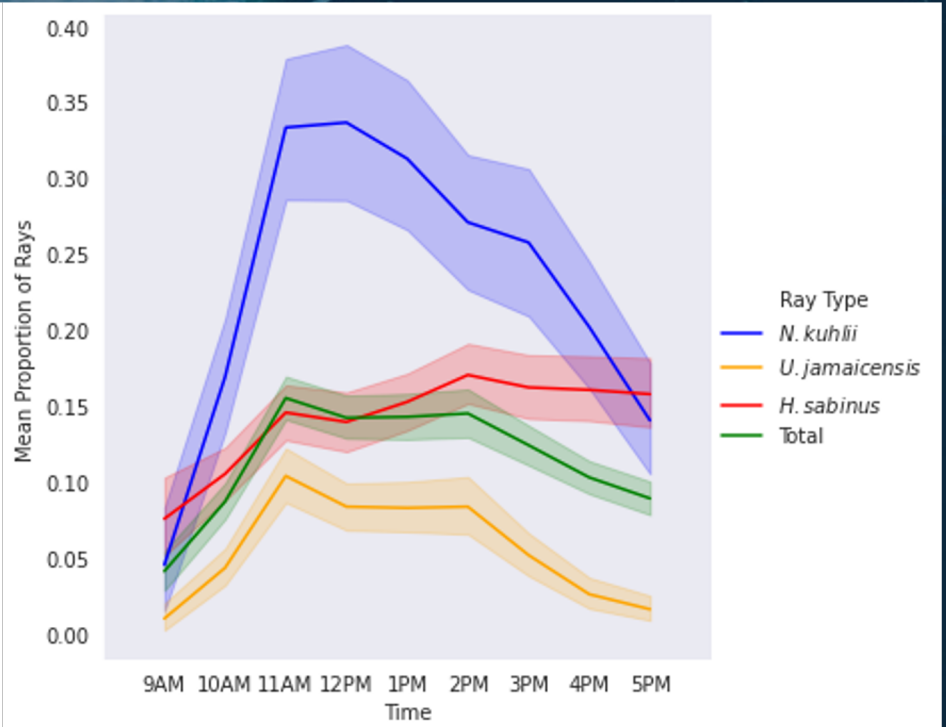
Rays In Shallow Area (Hourly, Instantaneous)



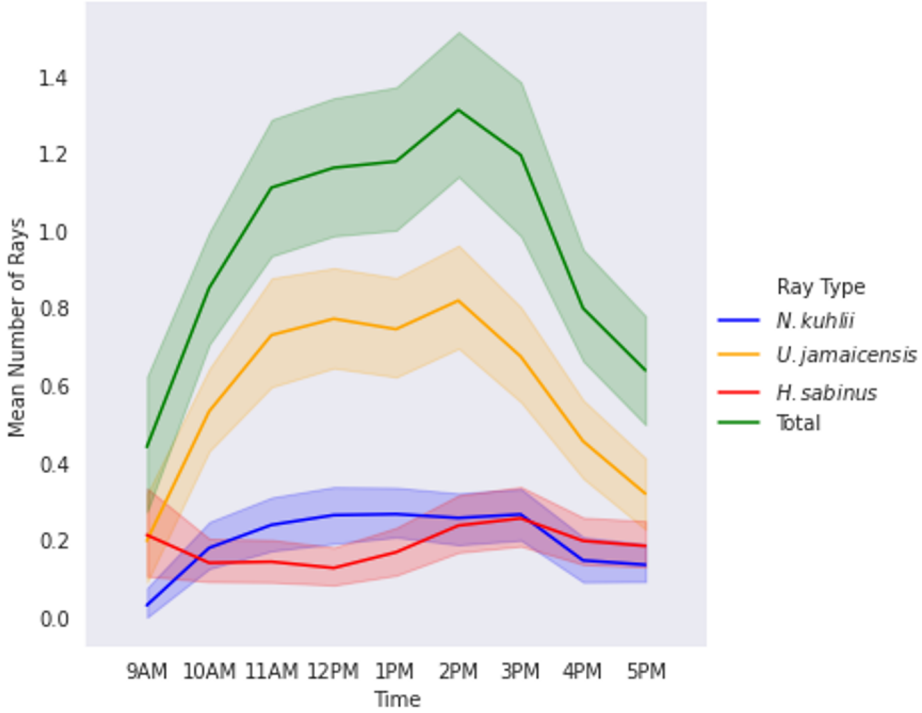


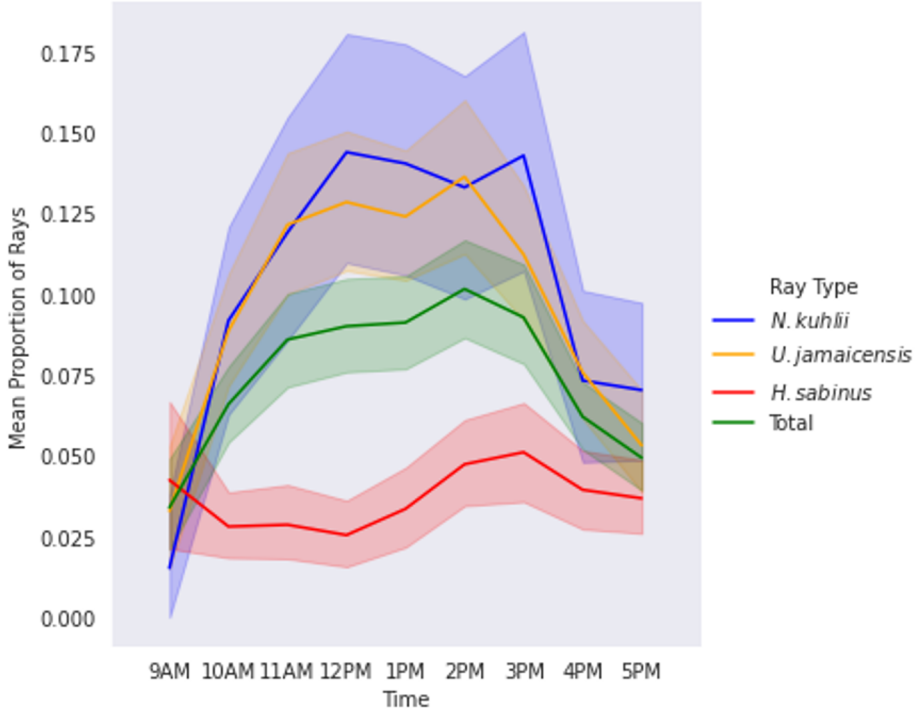
Rays Breaking the Surface (Hourly, Instantaneous)



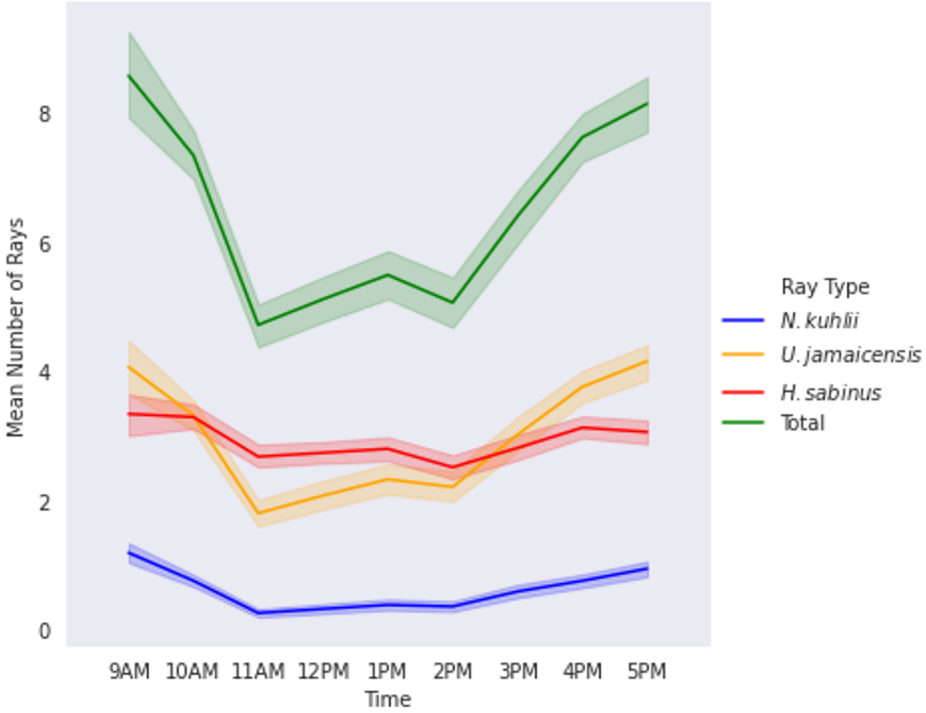


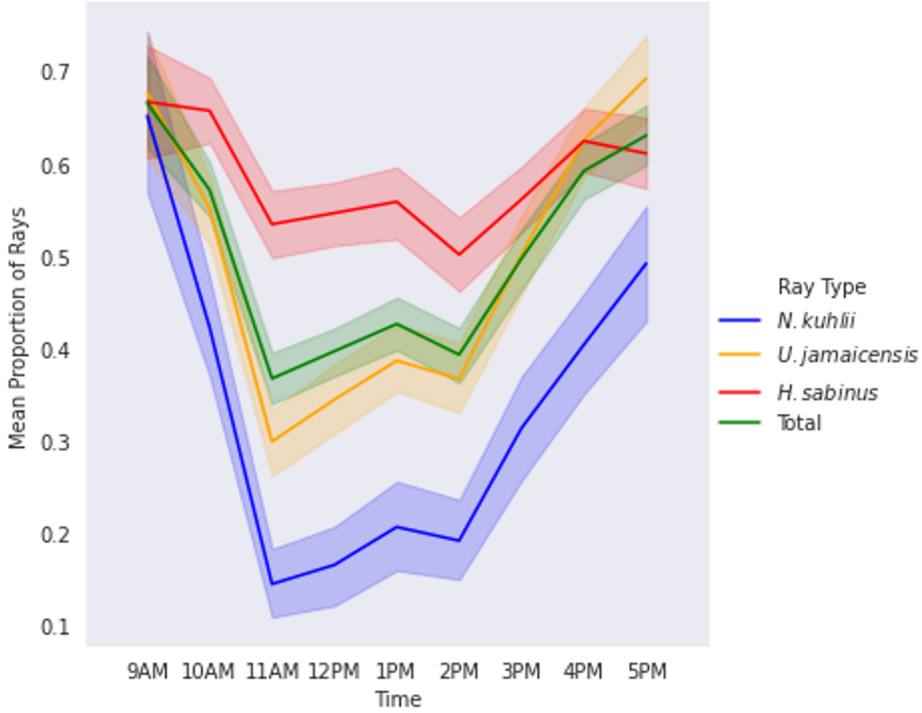
Rays Following (Hourly, Instantaneous)





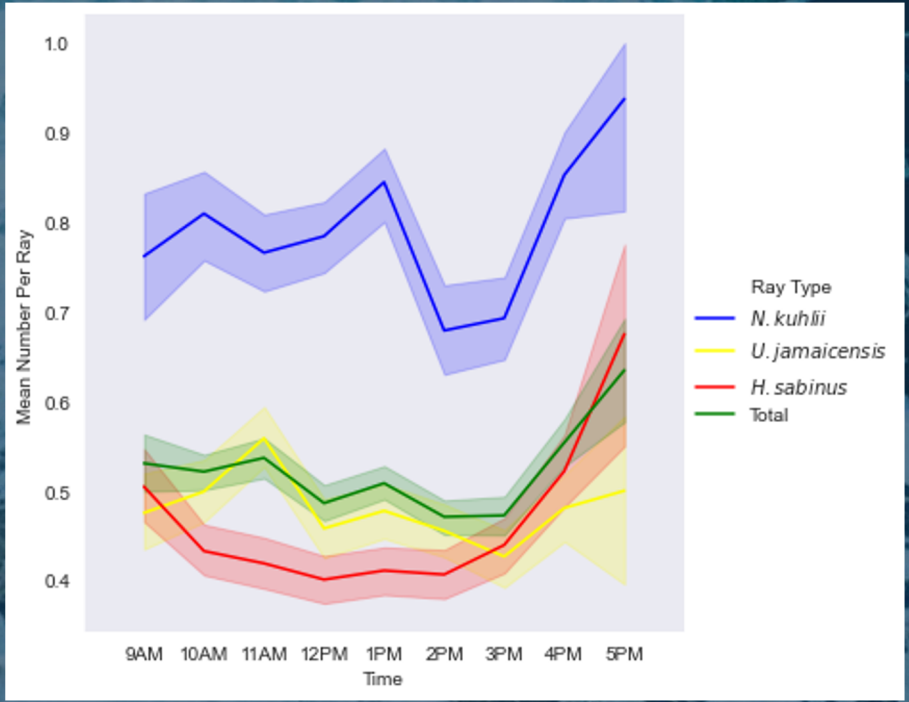
Rays Resting at the Bottom (Hourly, Instantaneous)





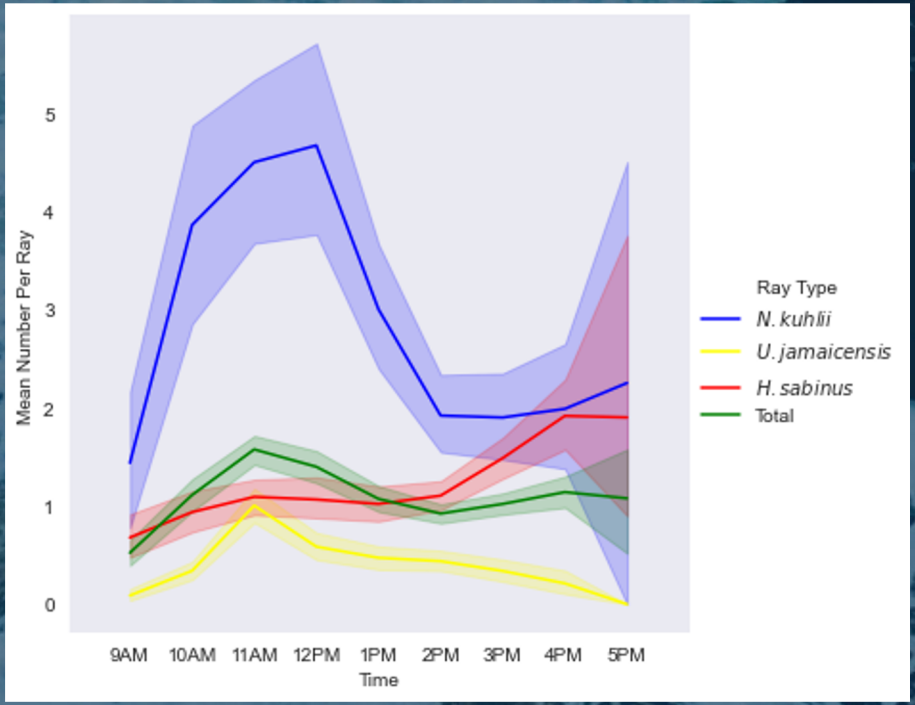
Hourly Continuous Data

Rays In Shallow Area (Hourly, Continuous)



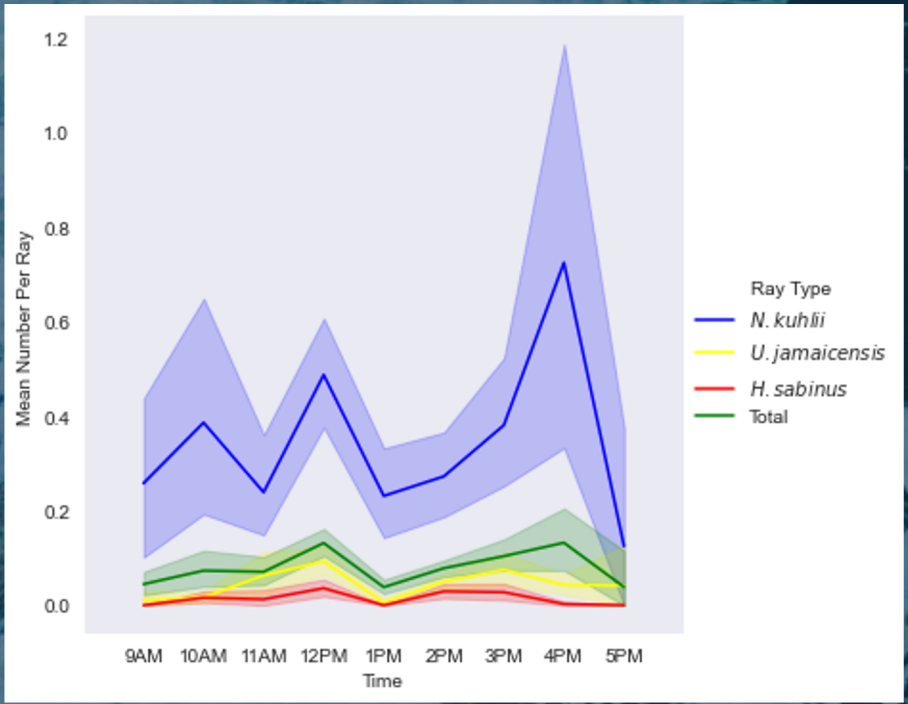
*This is the per ray observations (to compare across groups). It is the average between the before and after measurements.

Rays Breaking the Surface (Hourly, Continuous)



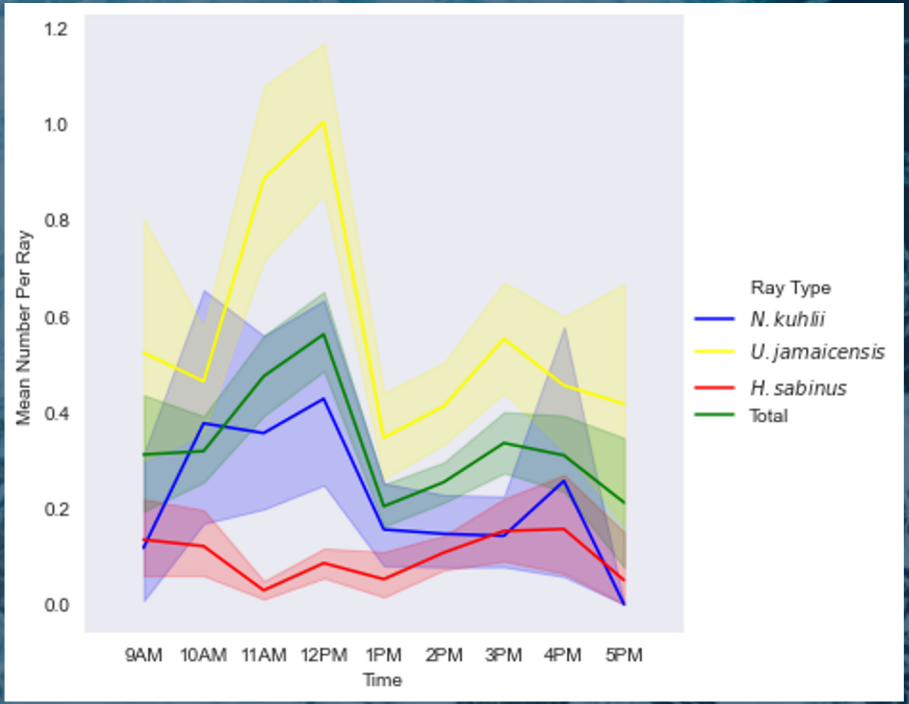
*This is the per ray observations (to compare across groups)

Rays Following Different Species (Hourly, Instantaneous)



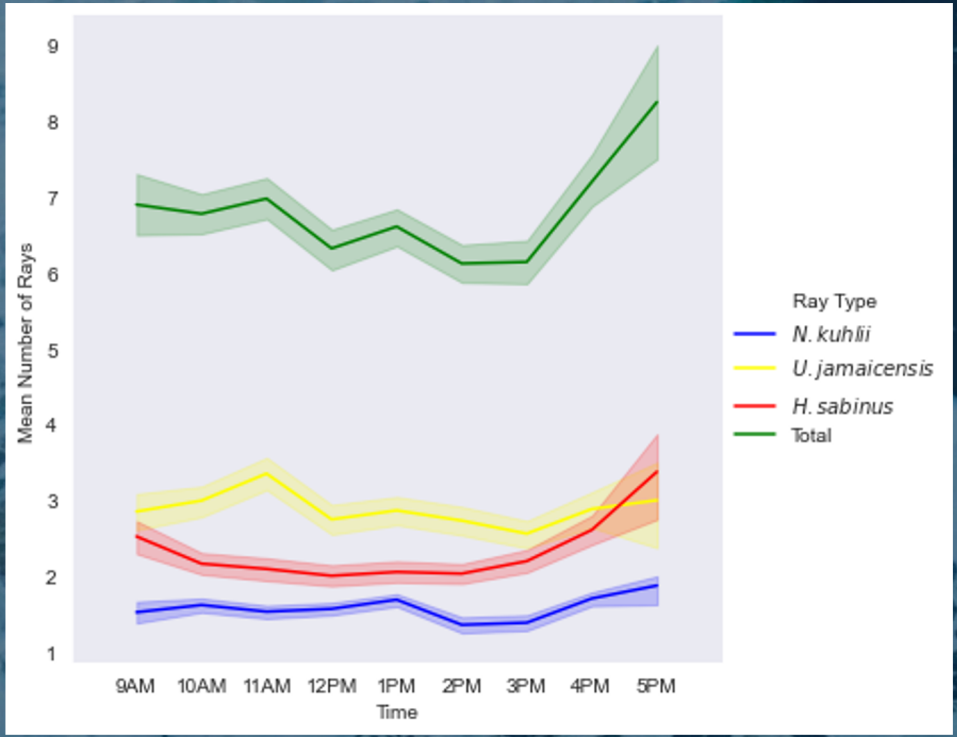
*This is the per ray observations (to compare across groups)

Rays Following Conspecific (Hourly, Instantaneous)

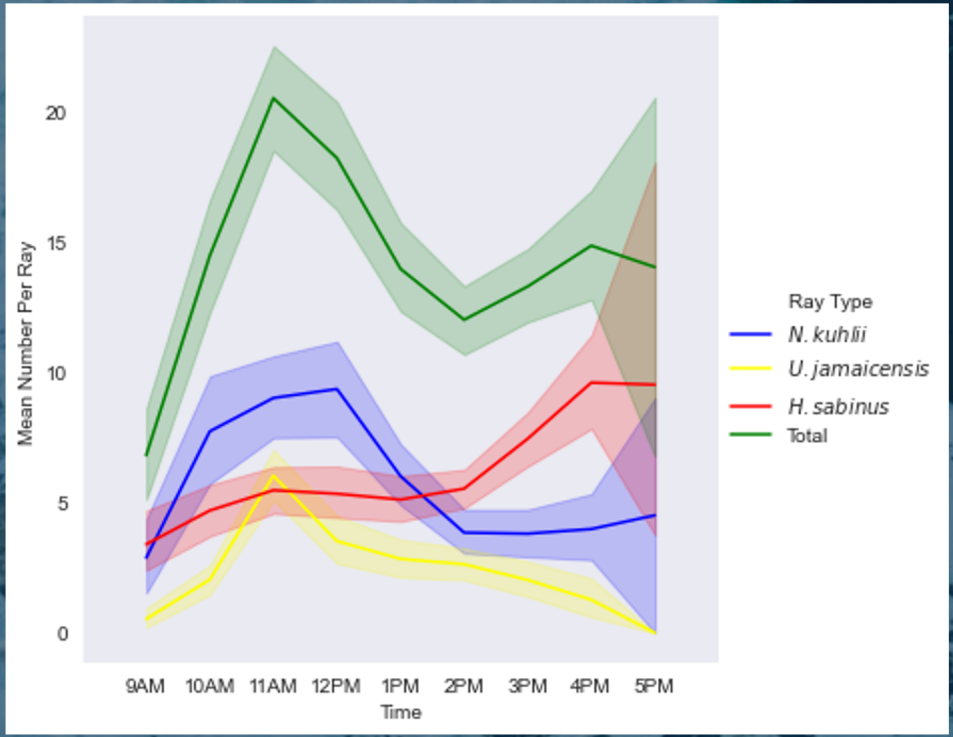


*This is the per ray observations (to compare across groups)

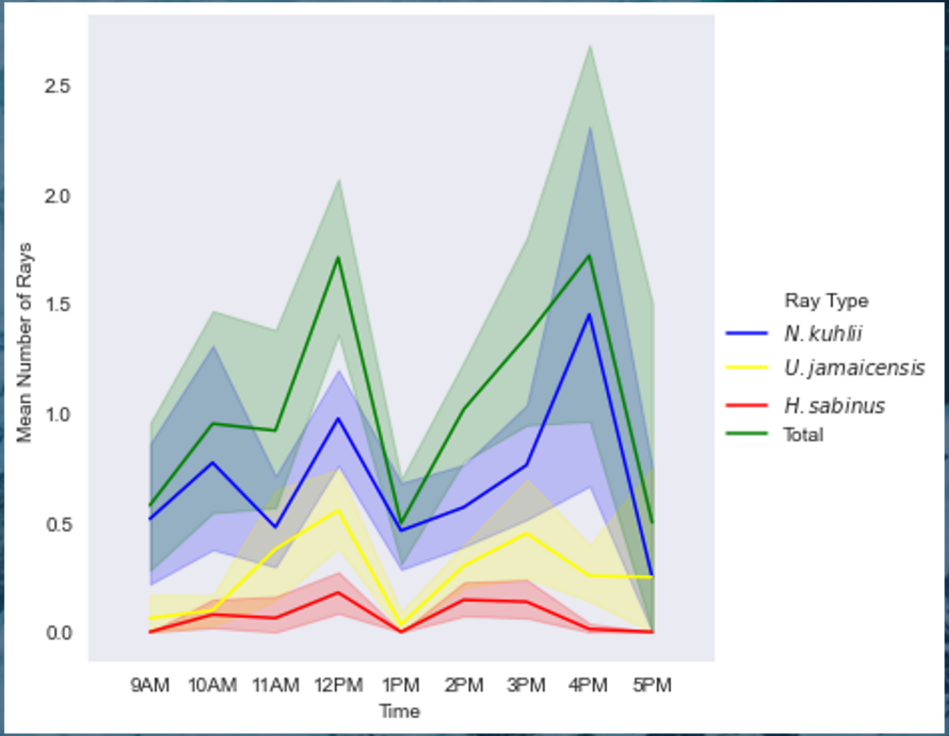
Rays In Shallow Area Total (Hourly, Continuous)



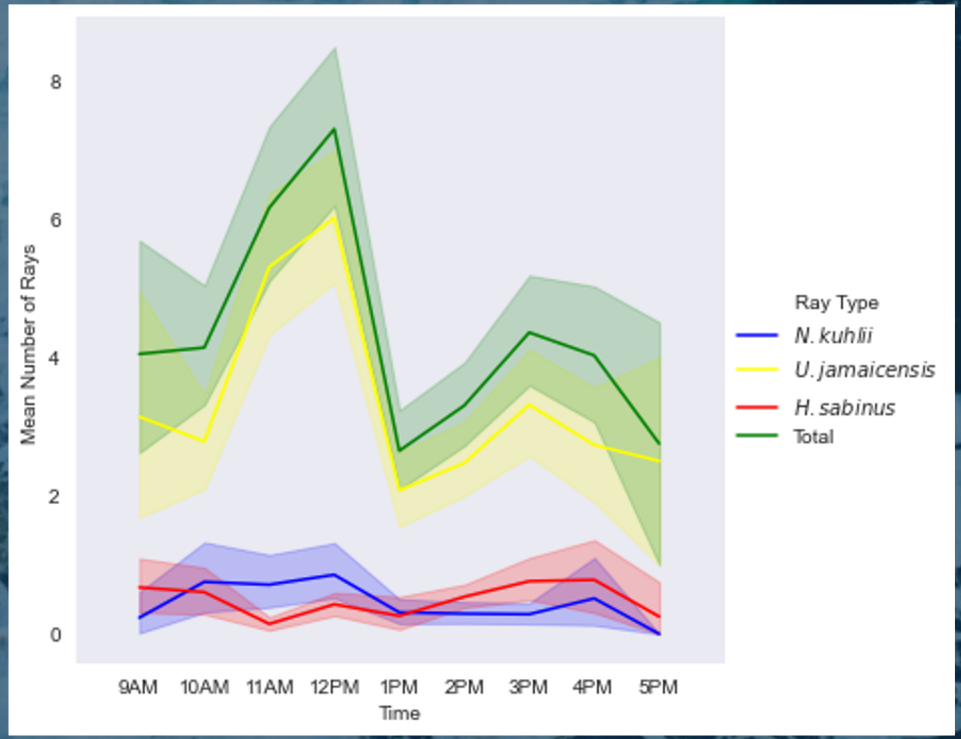
Rays Breaking the Surface Total (Hourly, Continuous)



Rays Following Different Species Total (Hourly, Instantaneous)



Rays Following Conspecific Total (Hourly, Instantaneous)

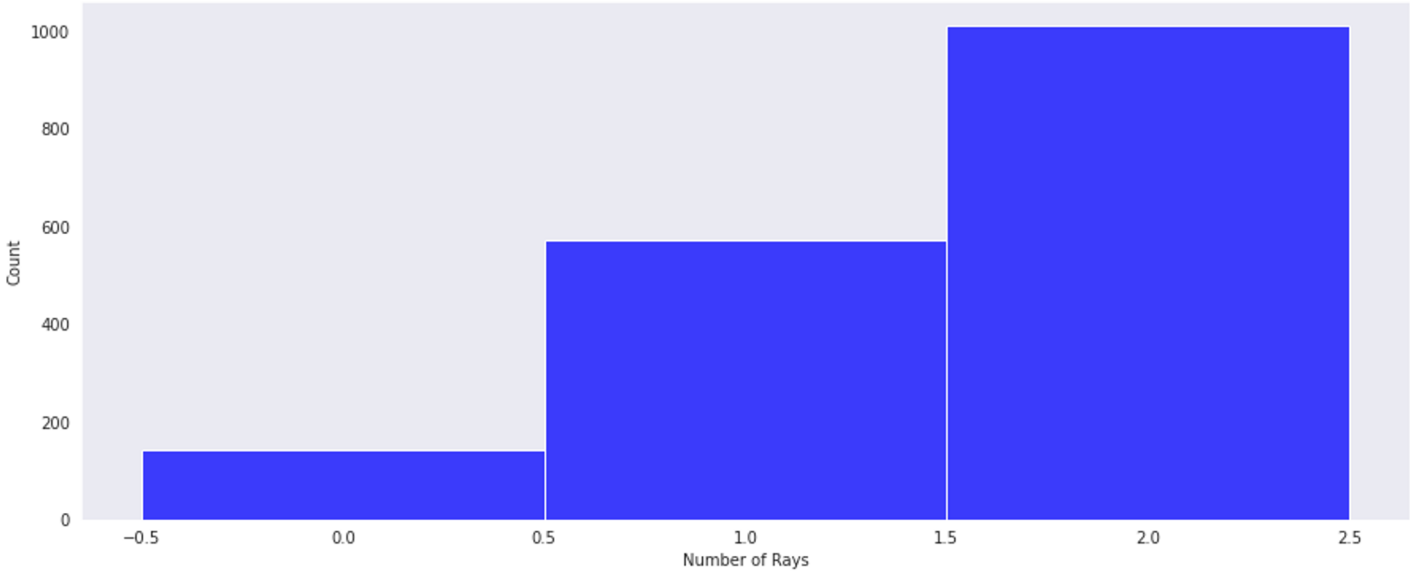


Base Behavior Histograms
(Frequency Counts, Instantaneous)

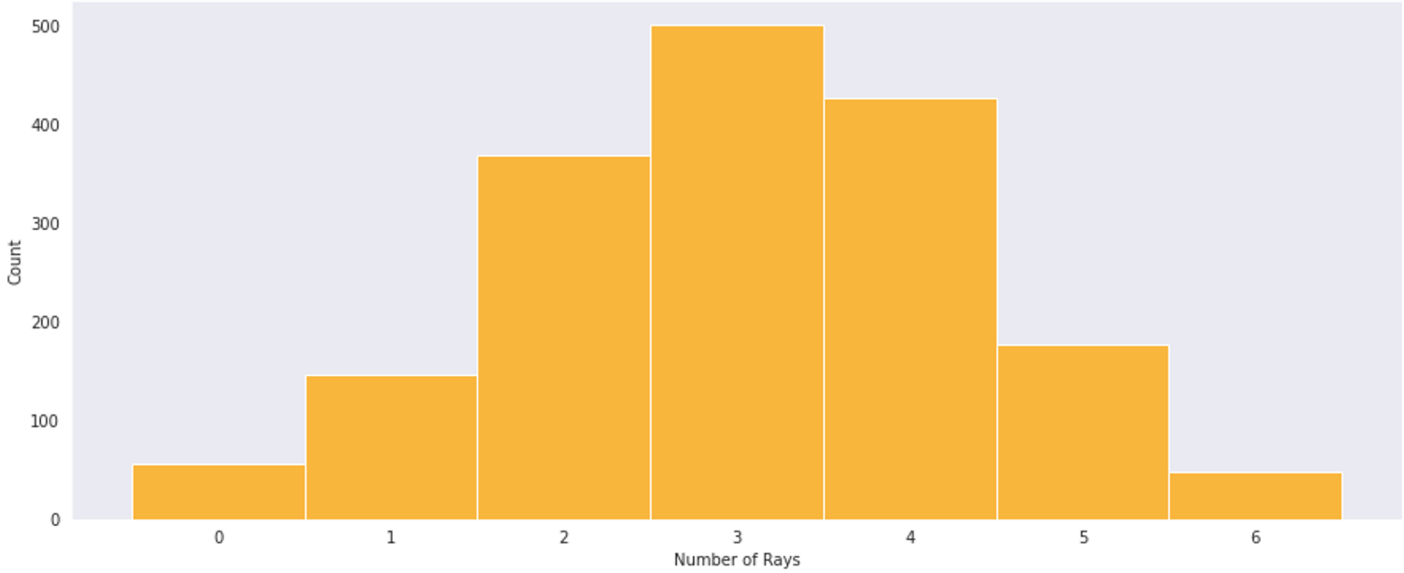
Rays in Shallow Area Histograms

(Instantaneous)

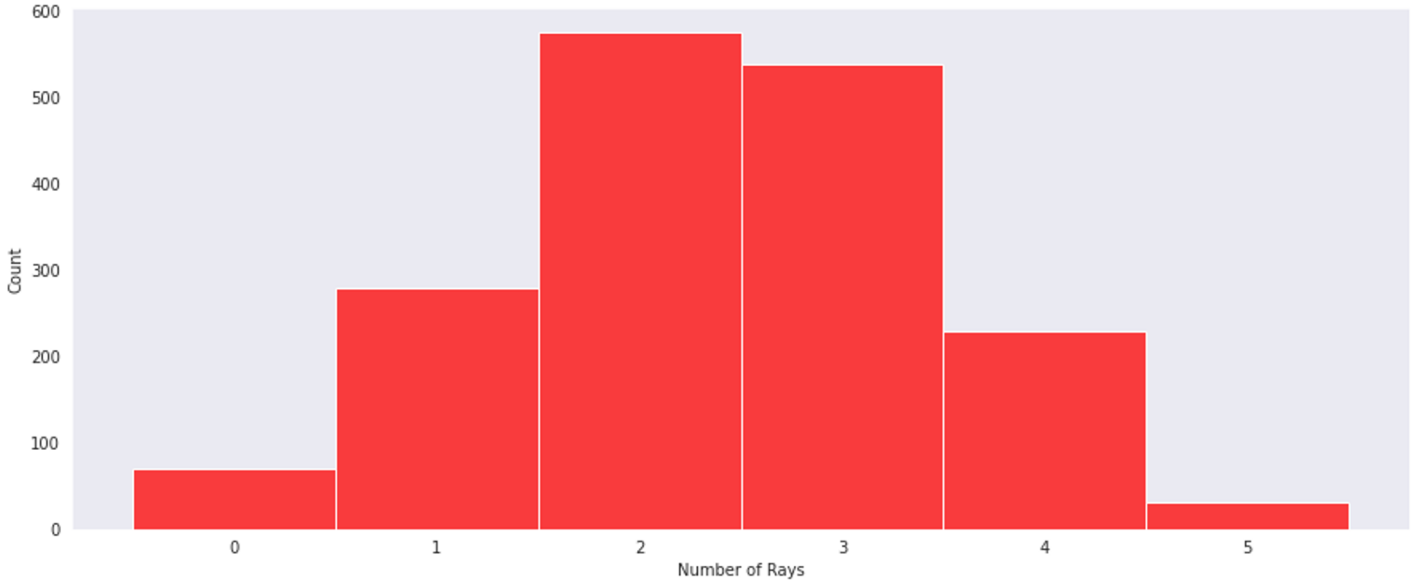
N. kuhlii in Shallow Area (Instantaneous)



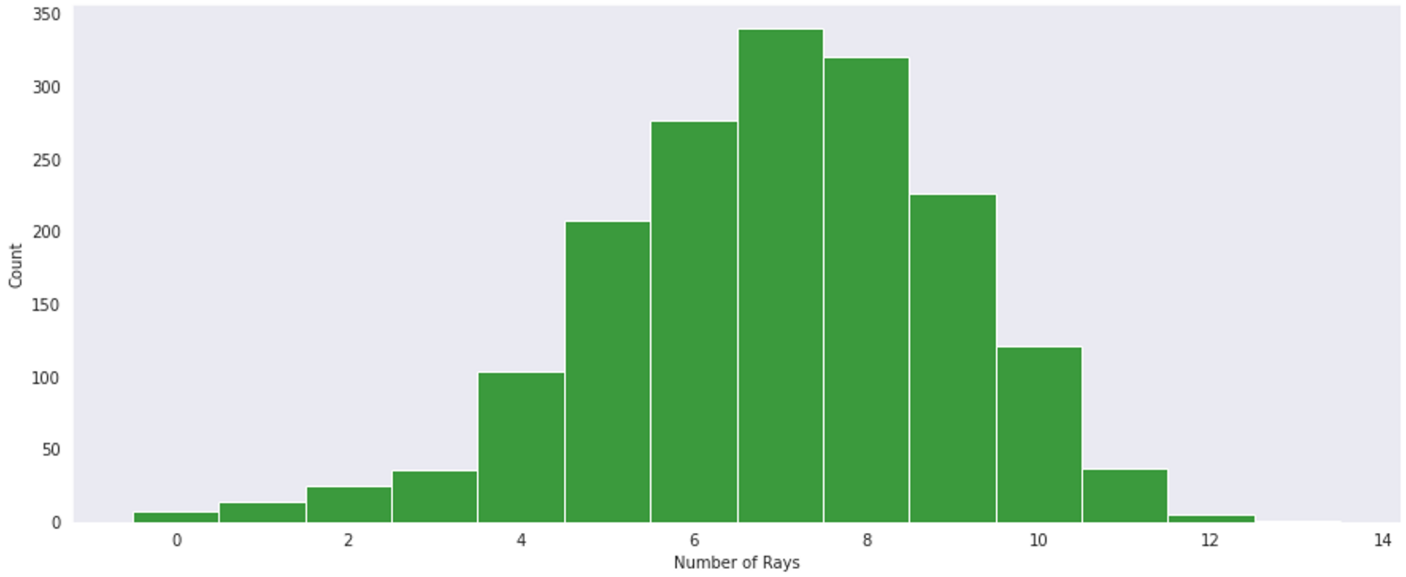
U. jamaicensis in Shallow Area (Instantaneous)



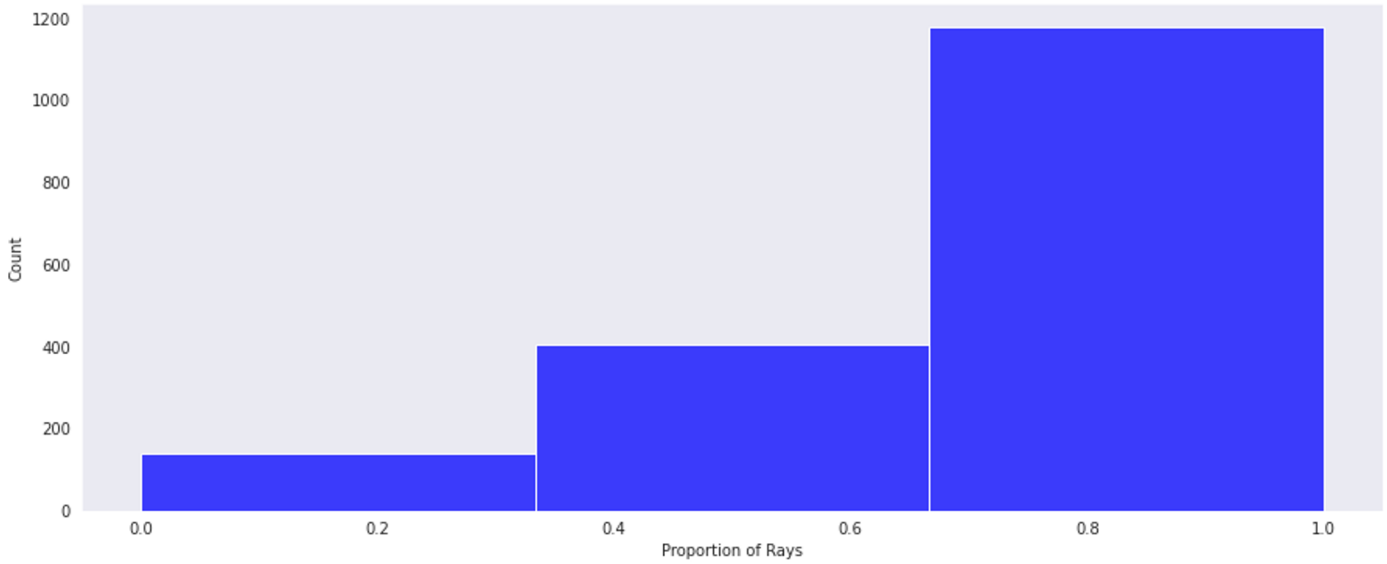
H. sabinus in Shallow Area (Instantaneous)



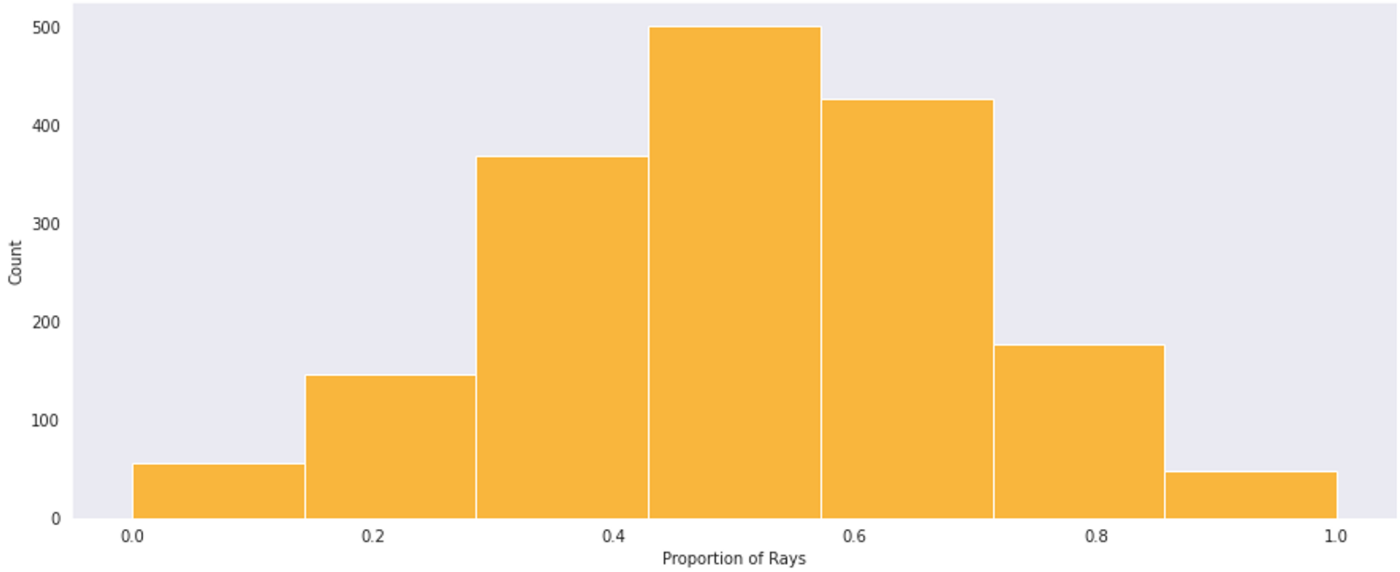
Total Rays in Shallow Area (Instantaneous)



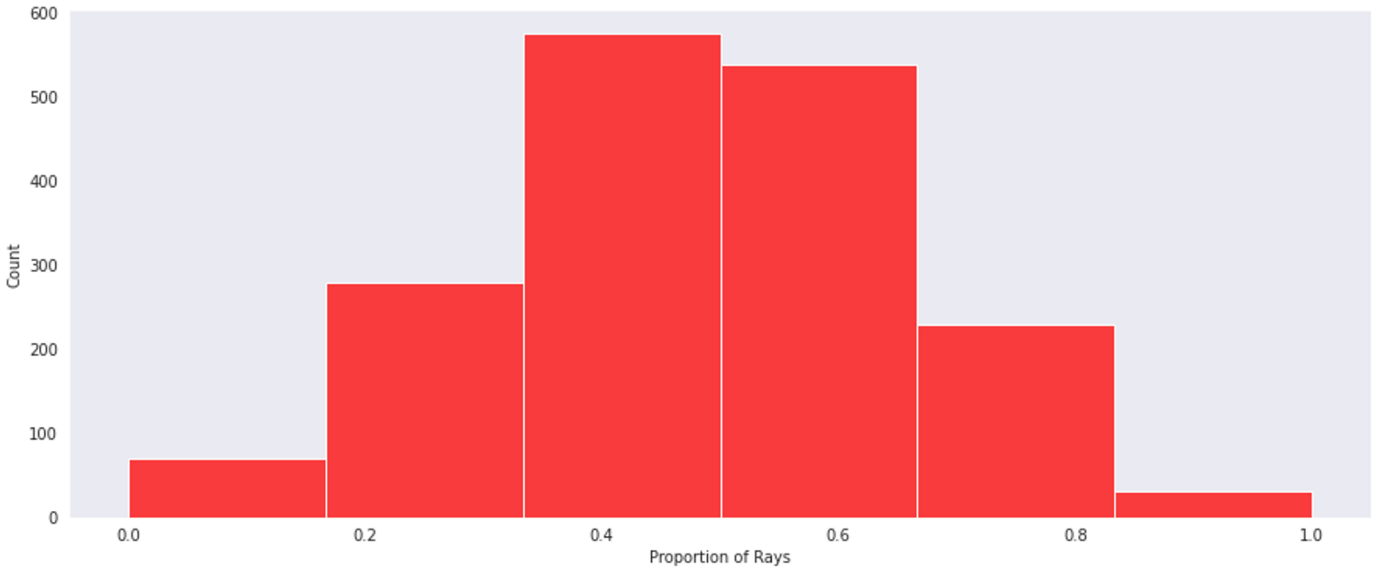
Proportion of *N. kuhlii* in Shallow Area (Instantaneous)



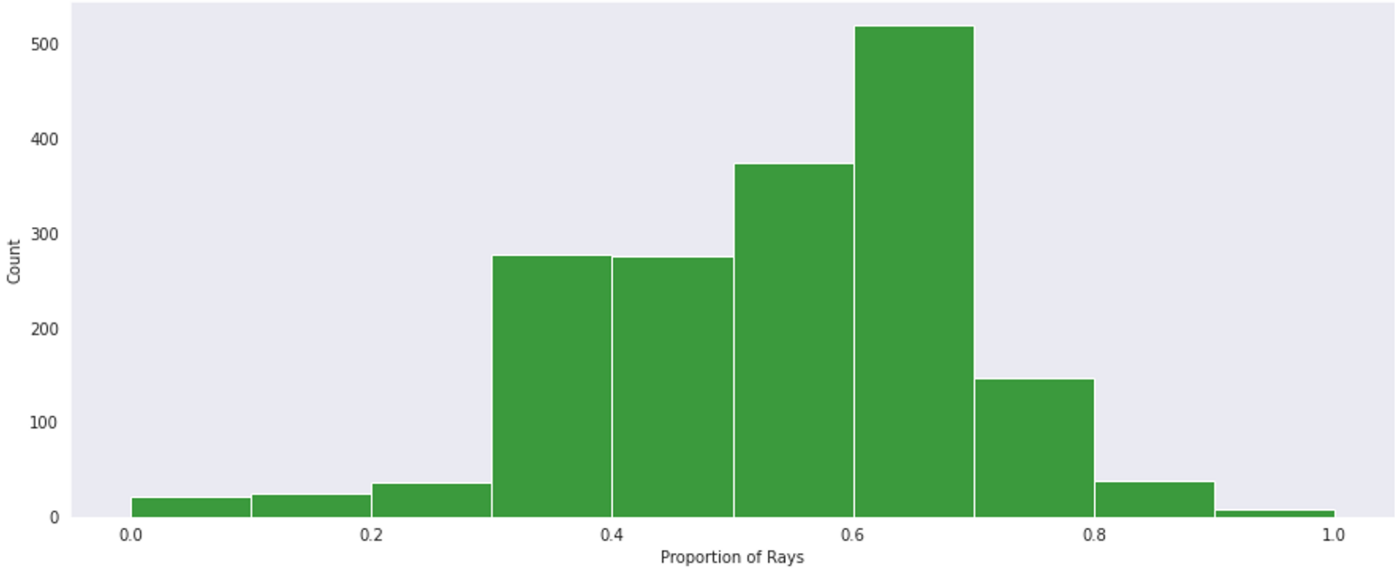
Proportion of *U. jamaicensis* in Shallow Area (Instantaneous)

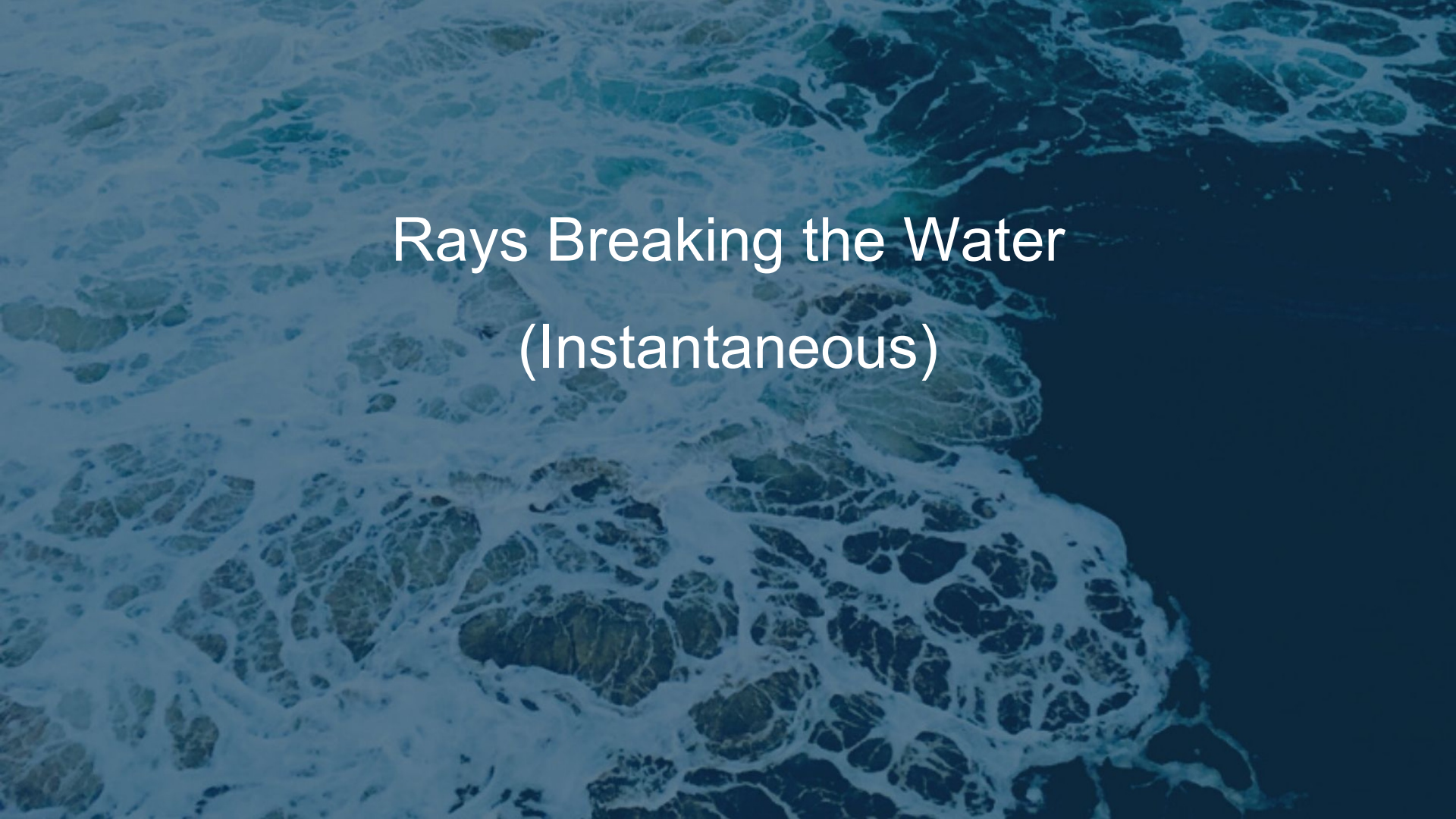


Proportion of *H. sabinus* in Shallow Area (Instantaneous)



Proportion of Total Rays in Shallow Area (Instantaneous)

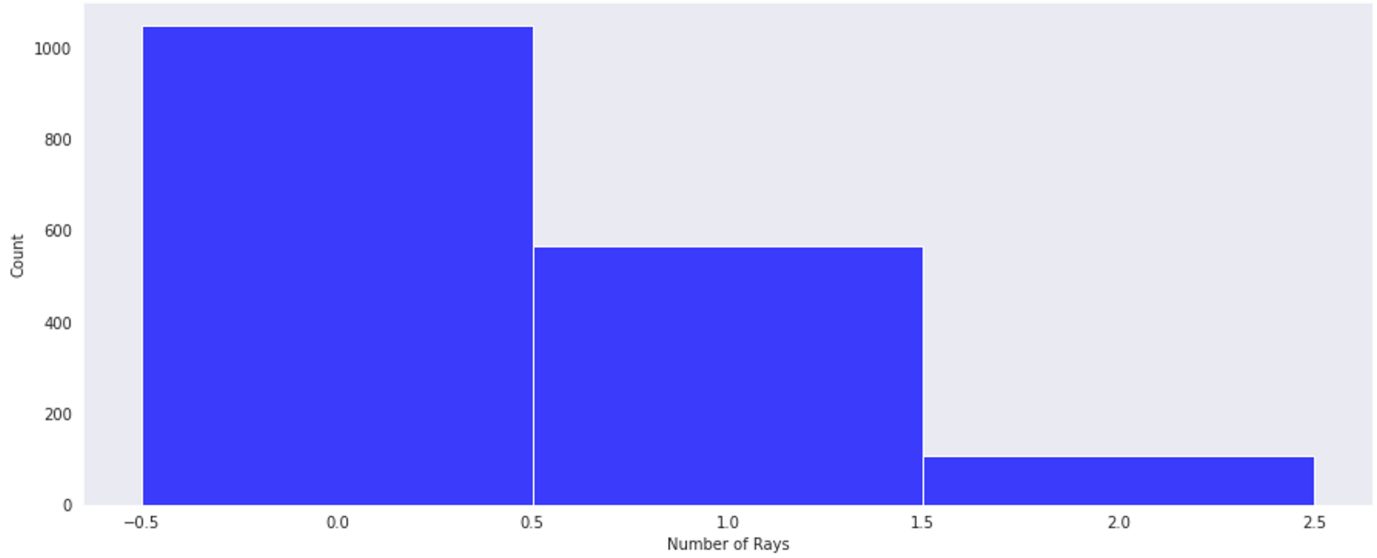




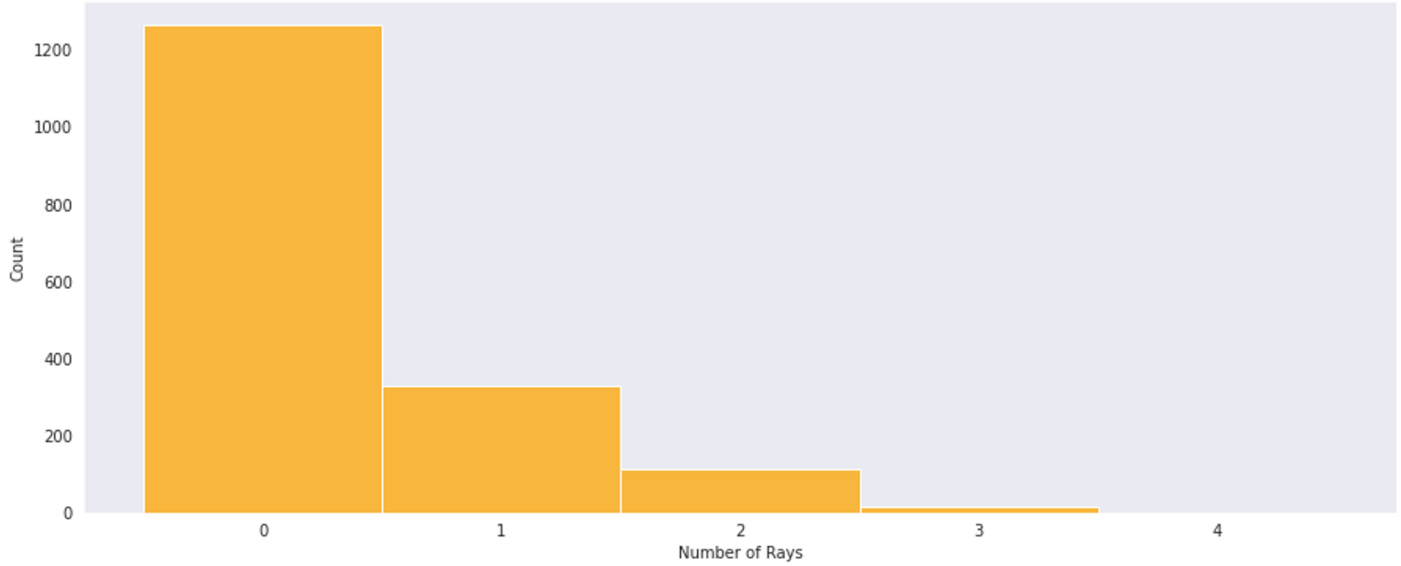
Rays Breaking the Water

(Instantaneous)

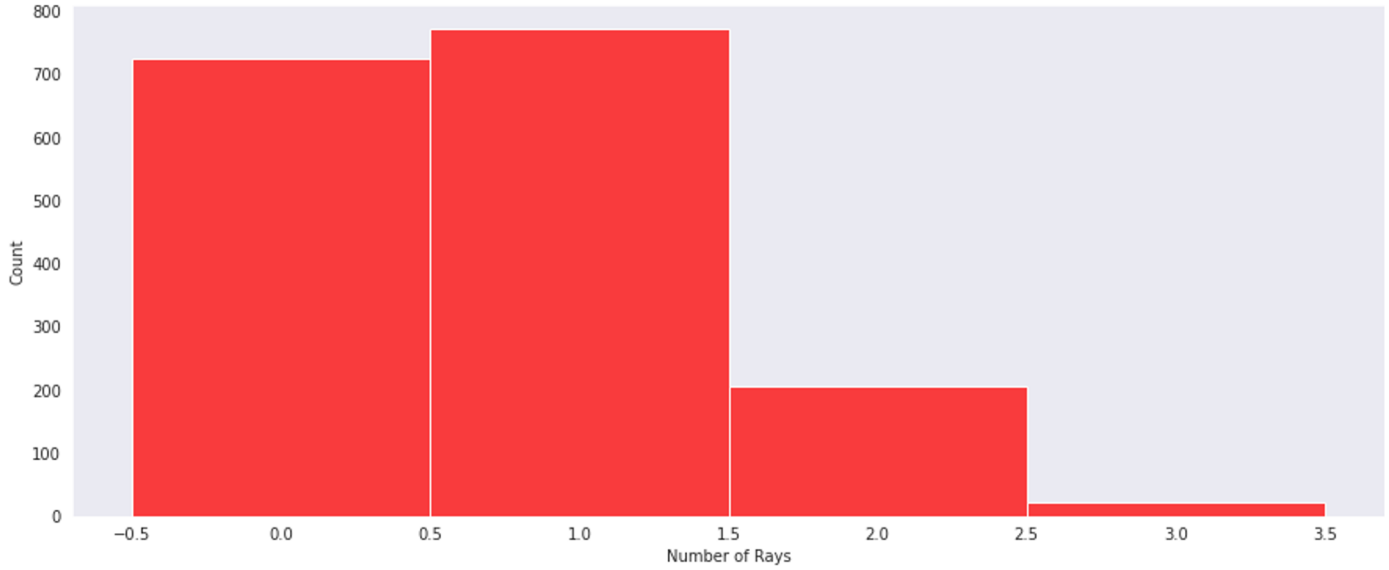
N. kuhlii Breaking the Surface (Instantaneous)



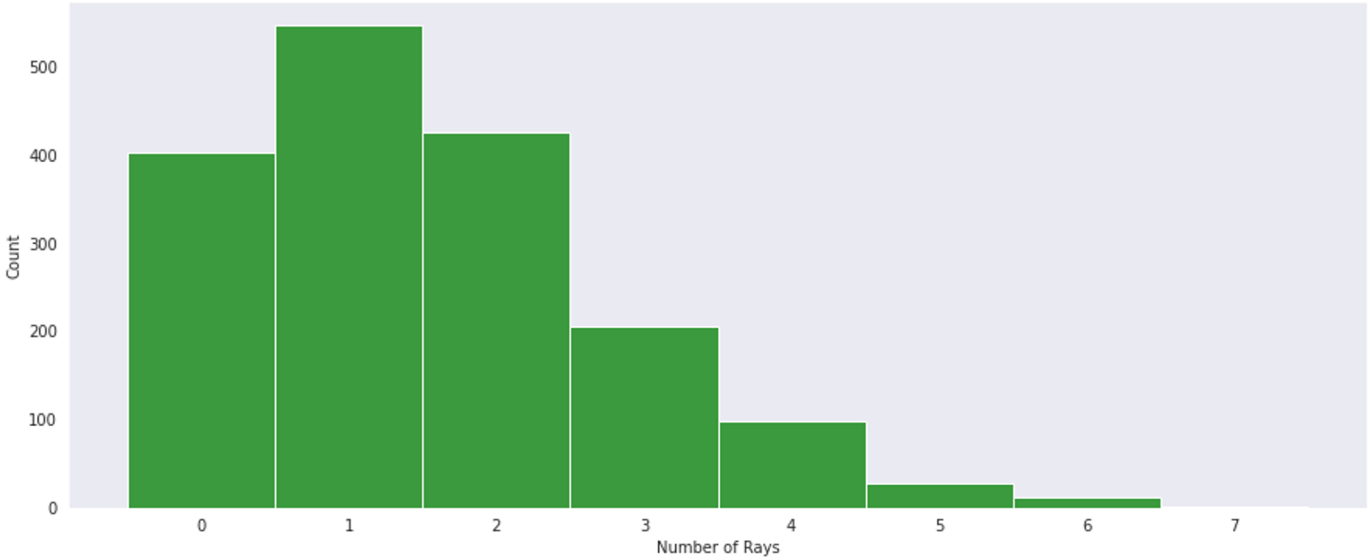
U. jamaicensis Breaking the Surface (Instantaneous)



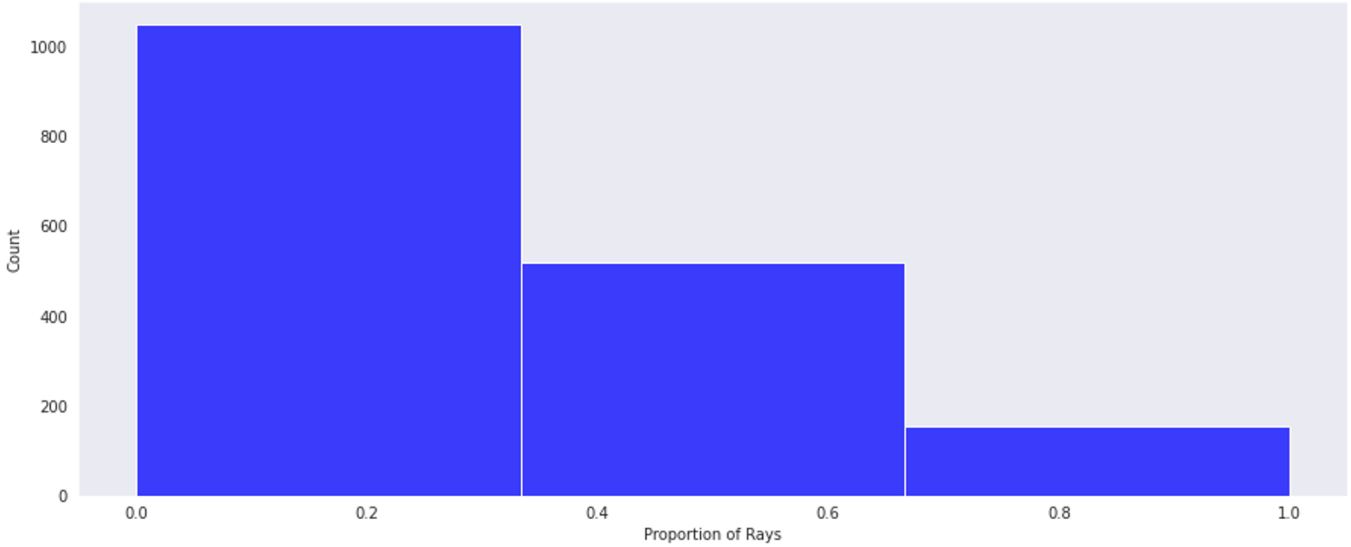
H. sabinus Breaking the Surface (Instantaneous)



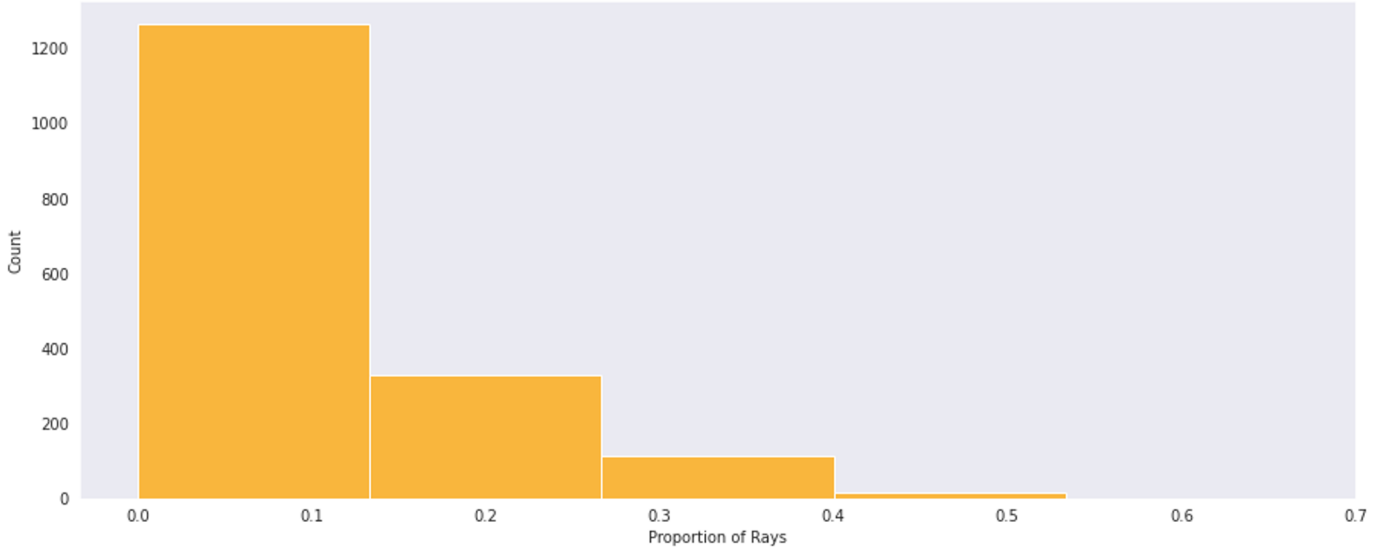
Total Rays Breaking the Surface (Instantaneous)



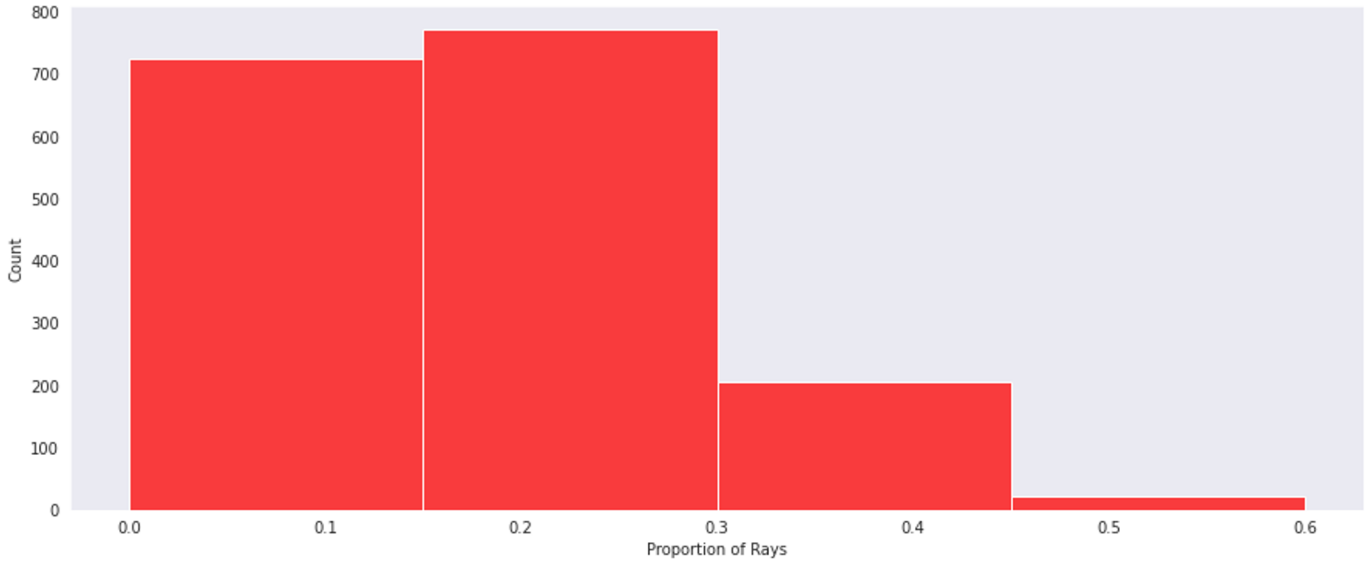
Proportion of *N. kuhlii* Breaking the Surface (Instantaneous)



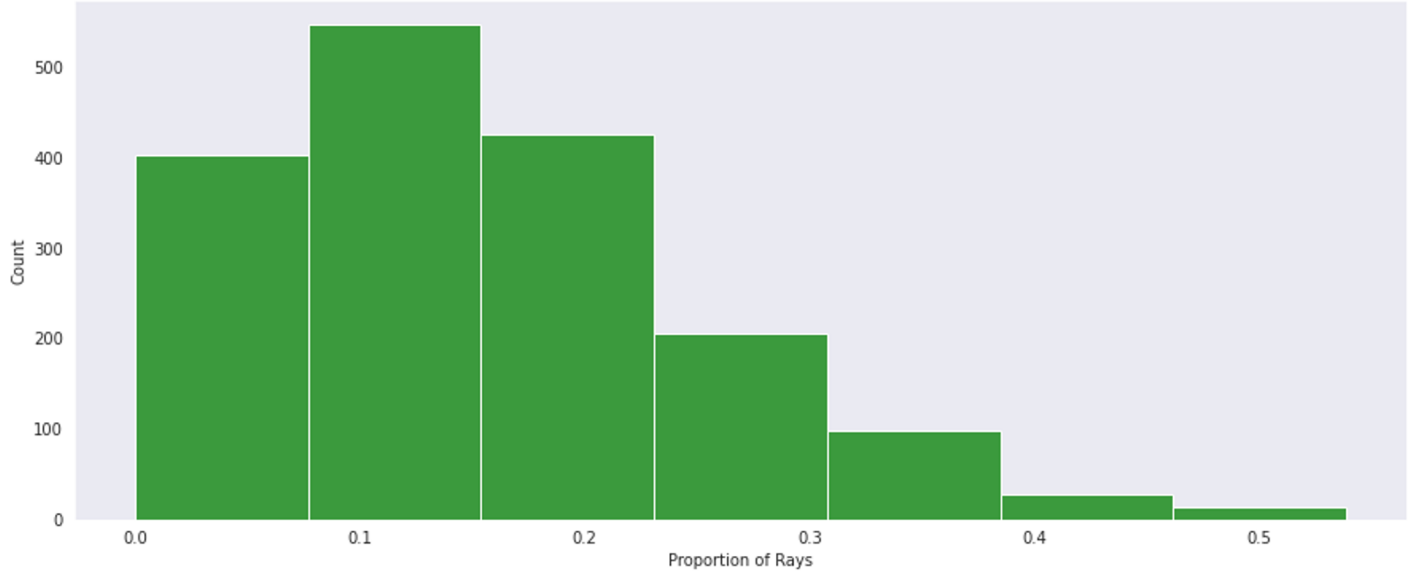
Proportion of *U. jamaicensis* Breaking the Surface (Instantaneous)

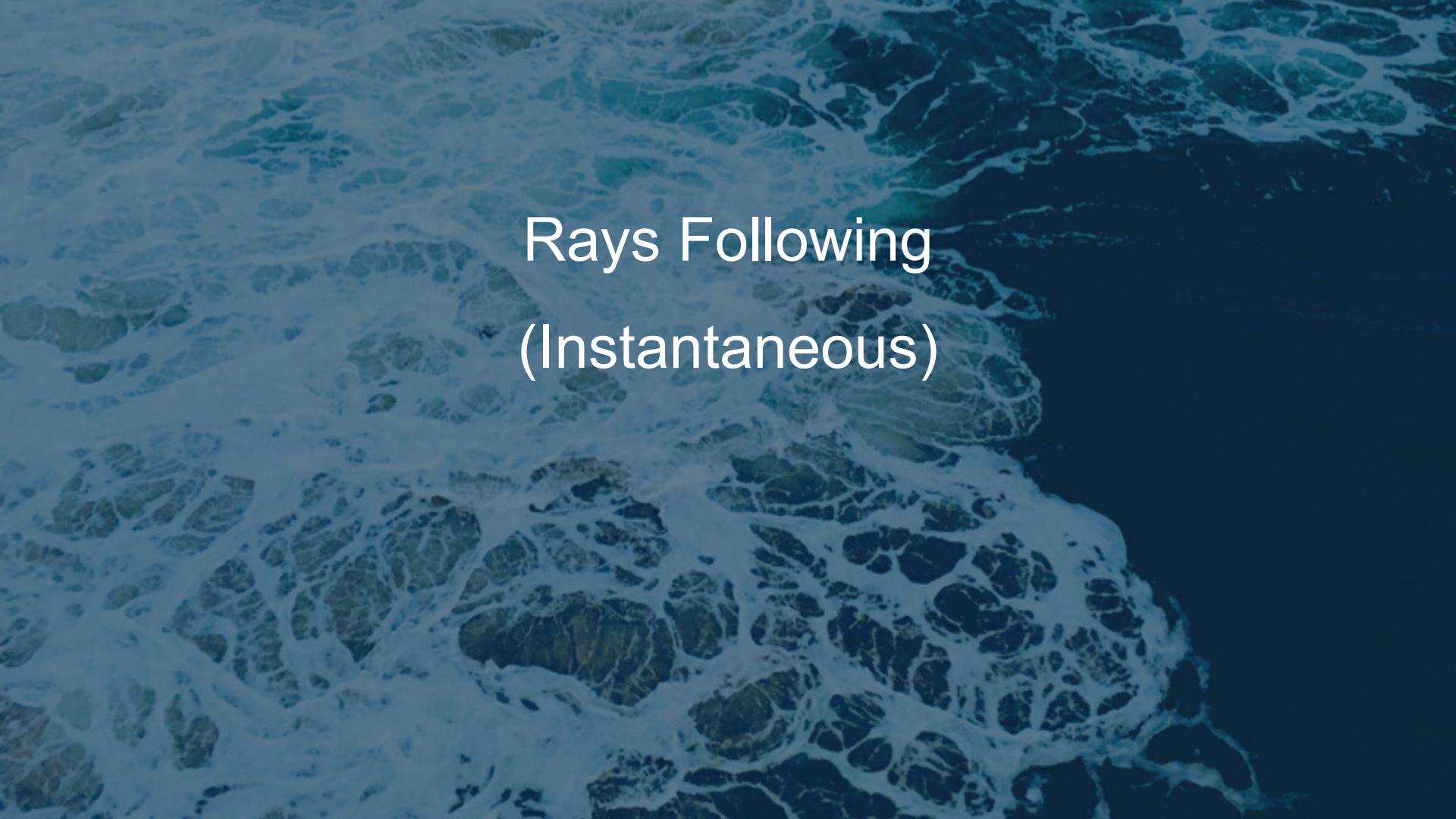


Proportion of *H. sabinus* Breaking the Surface (Instantaneous)



Proportion of Total Rays Breaking the Surface (Instantaneous)

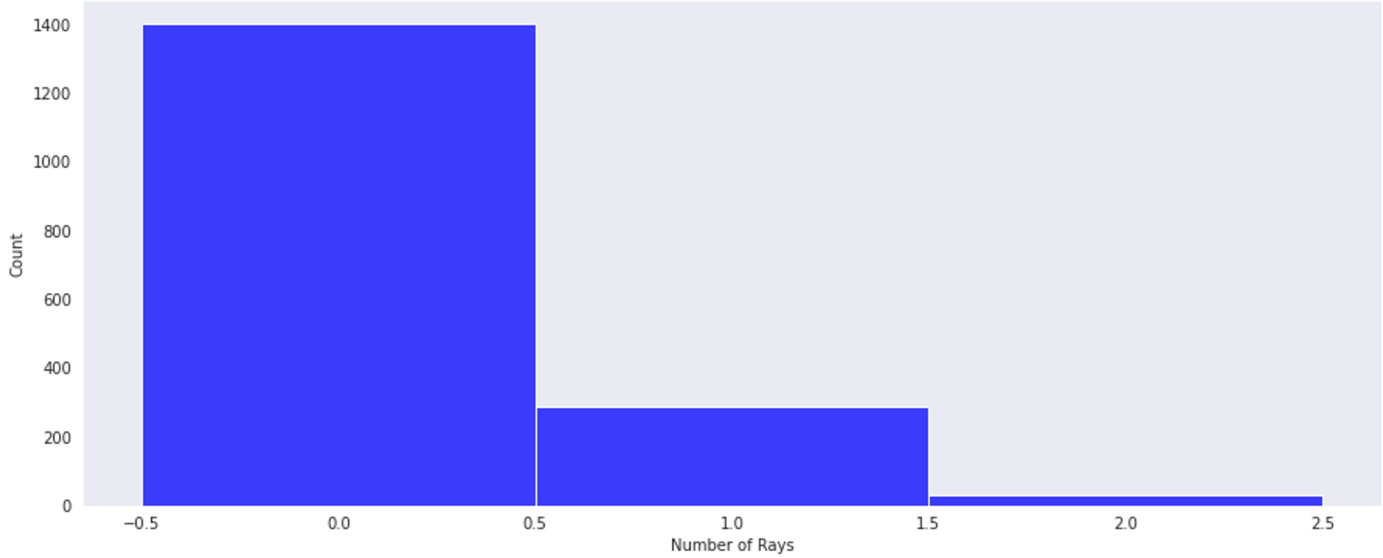




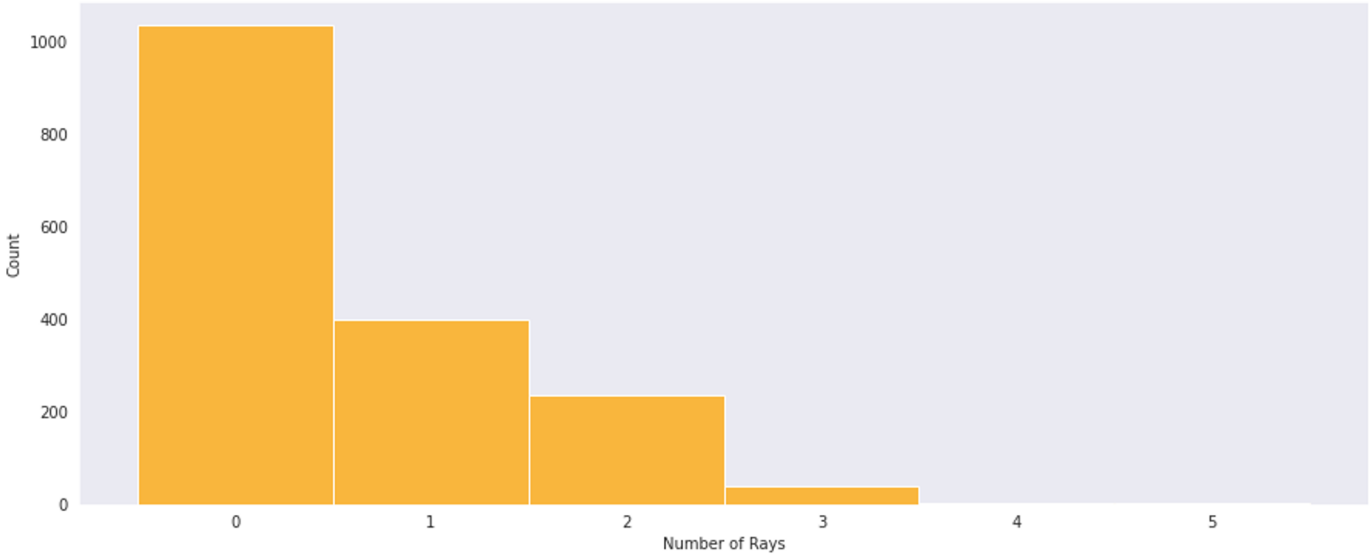
Rays Following

(Instantaneous)

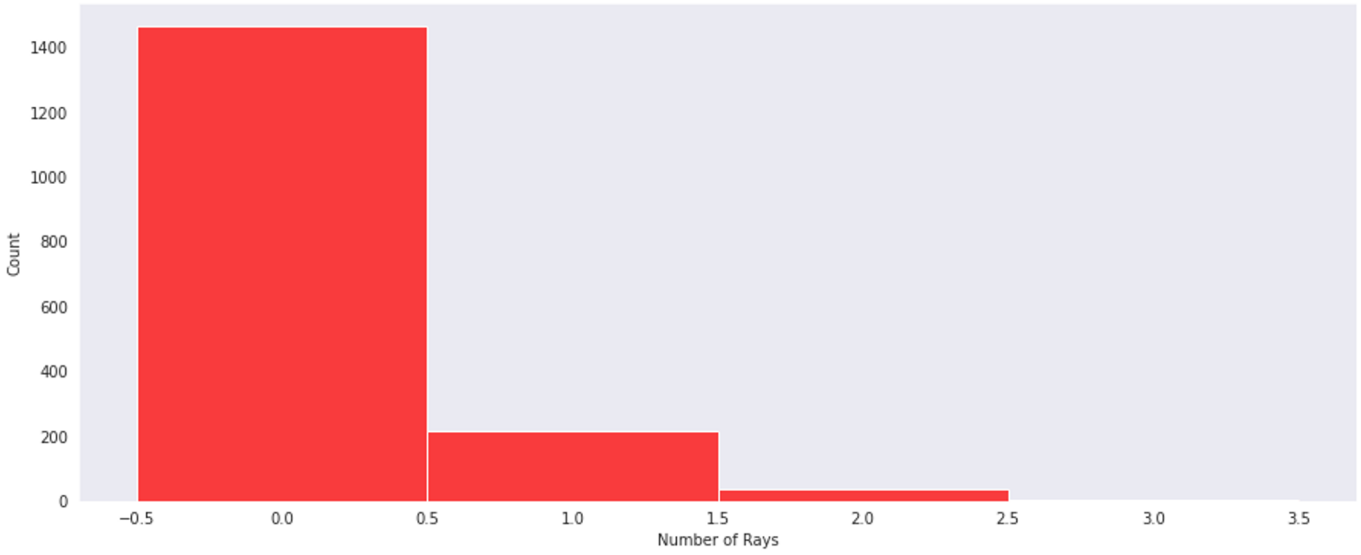
N. kuhlii Following (Instantaneous)



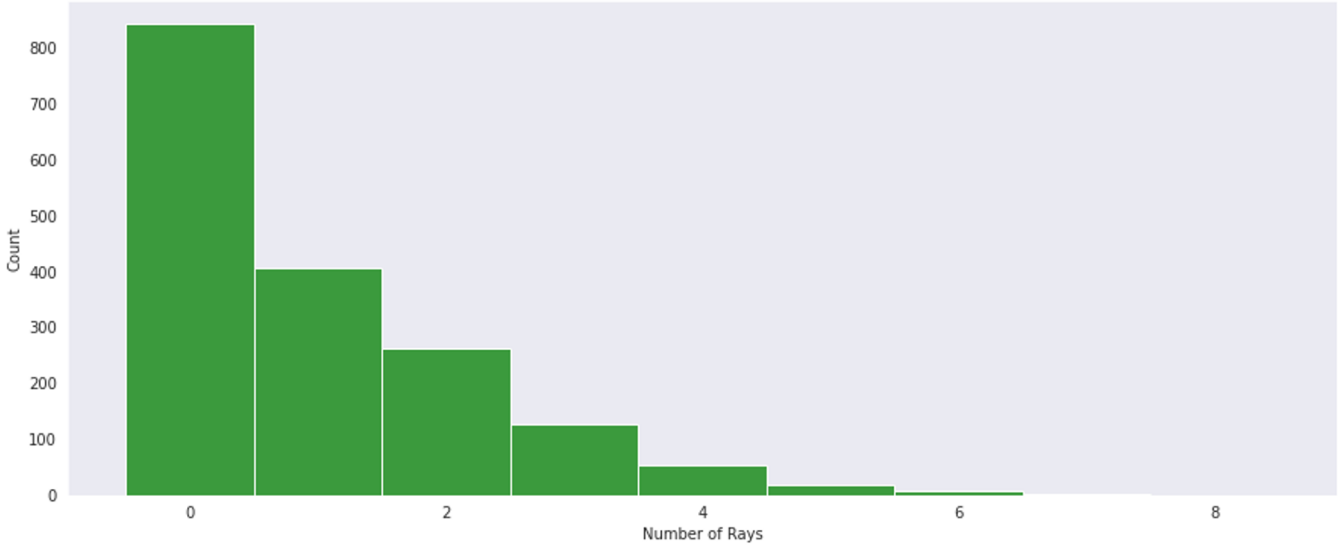
U. jamaicensis Following (Instantaneous)



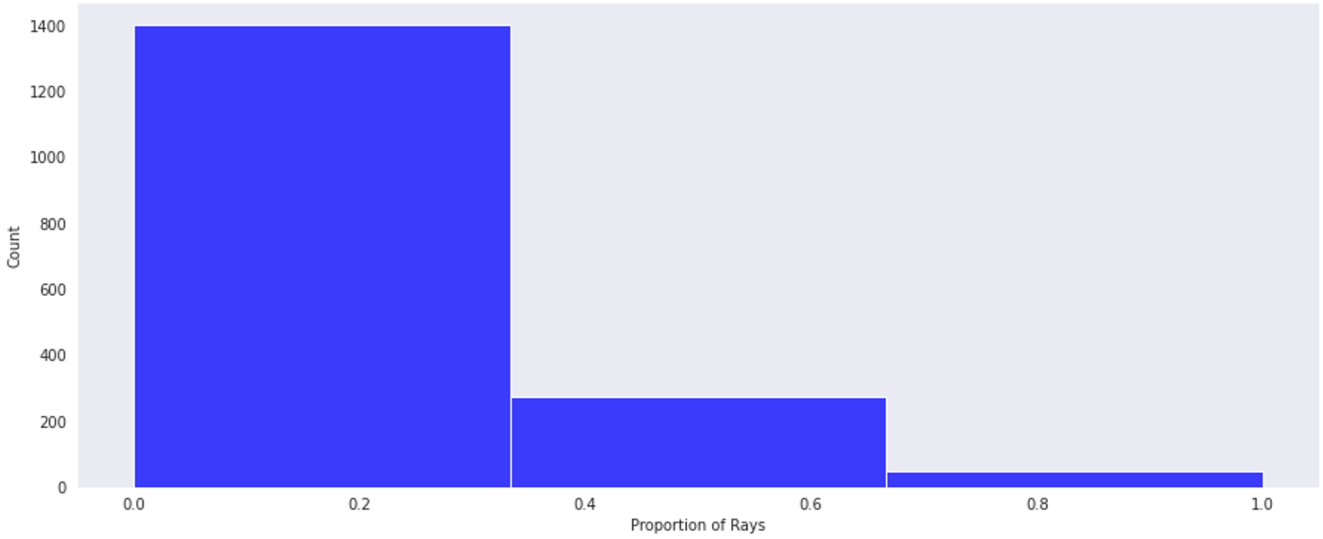
H. sabinus Following (Instantaneous)



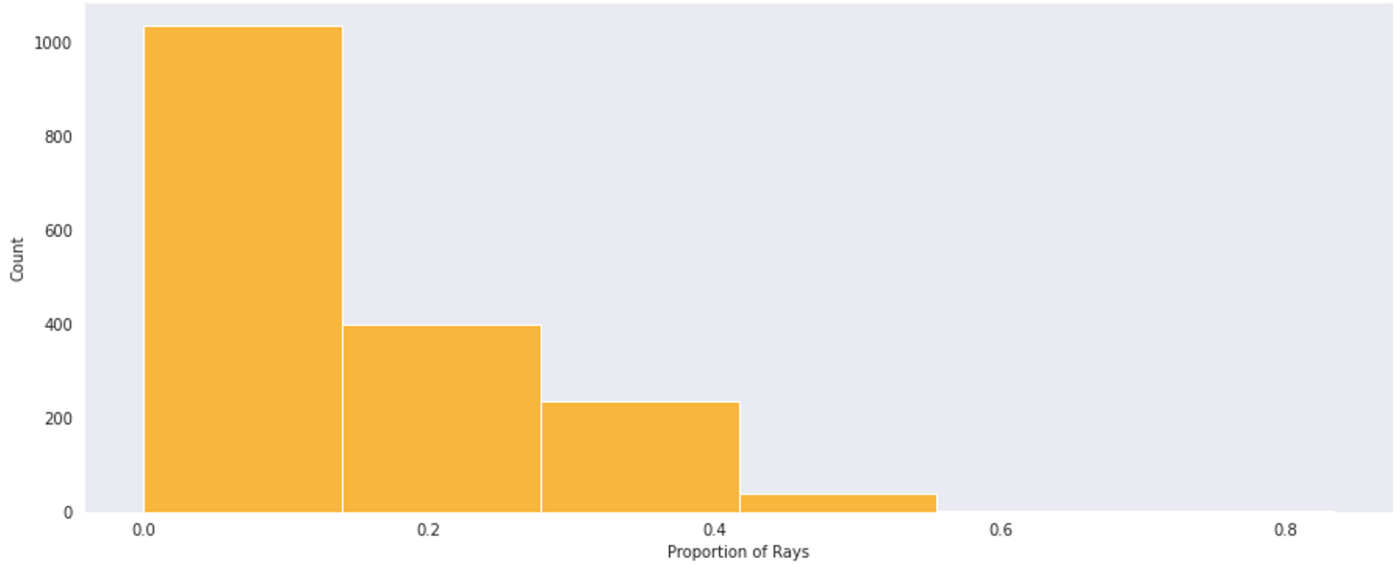
Total Rays Following (Instantaneous)



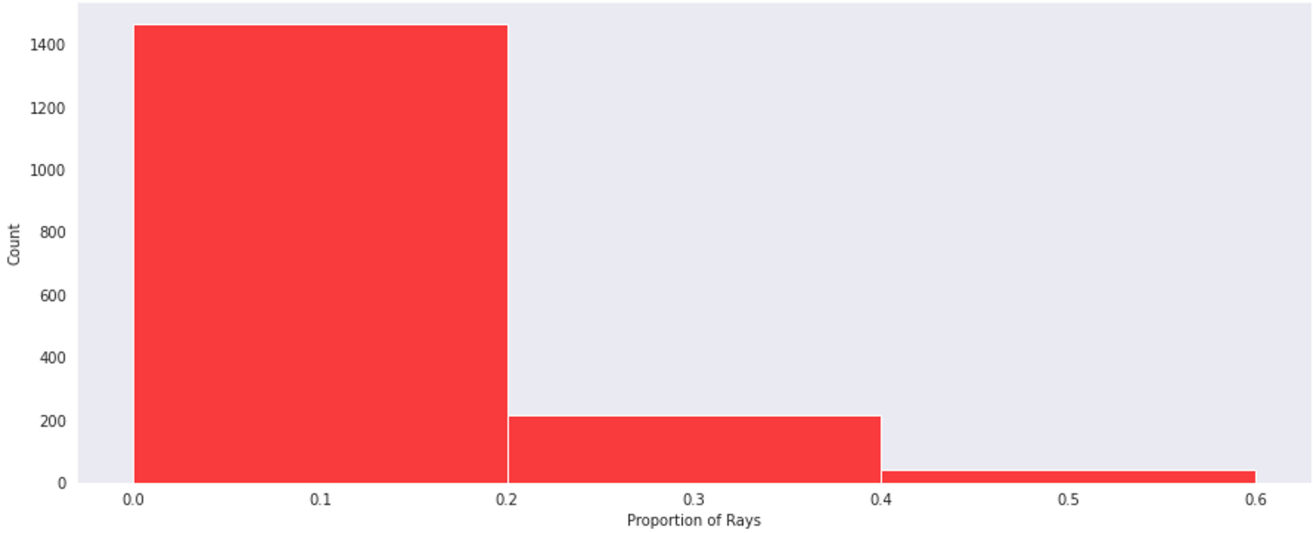
Proportion of *N. kuhlii* in Shallow Area (Instantaneous)



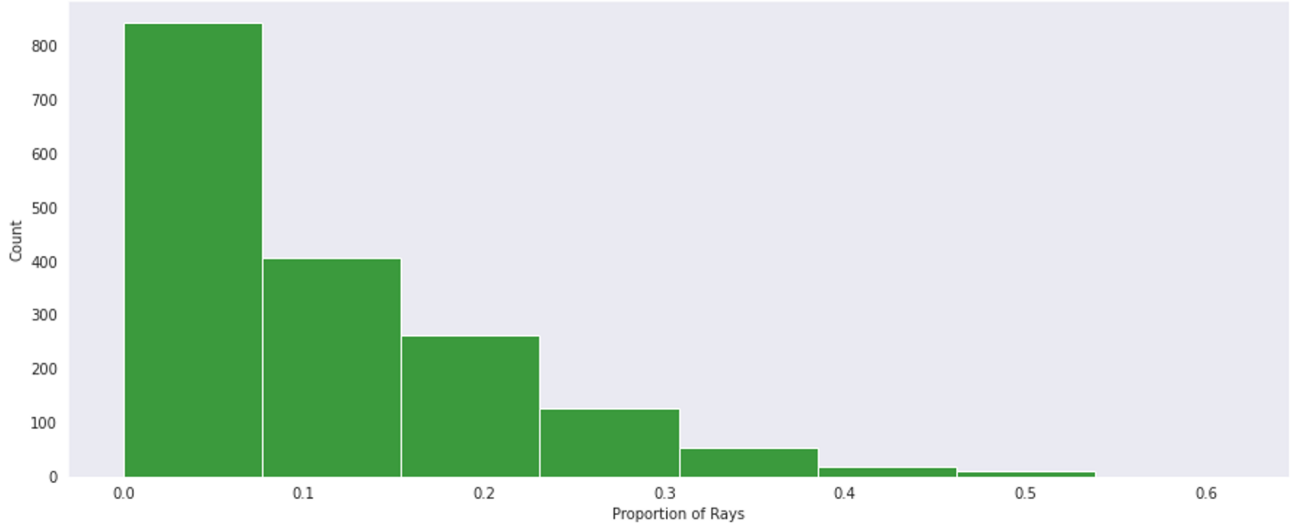
Proportion of *U. jamaicensis* Following (Instantaneous)



Proportion of *H. sabinus* Following (Instantaneous)



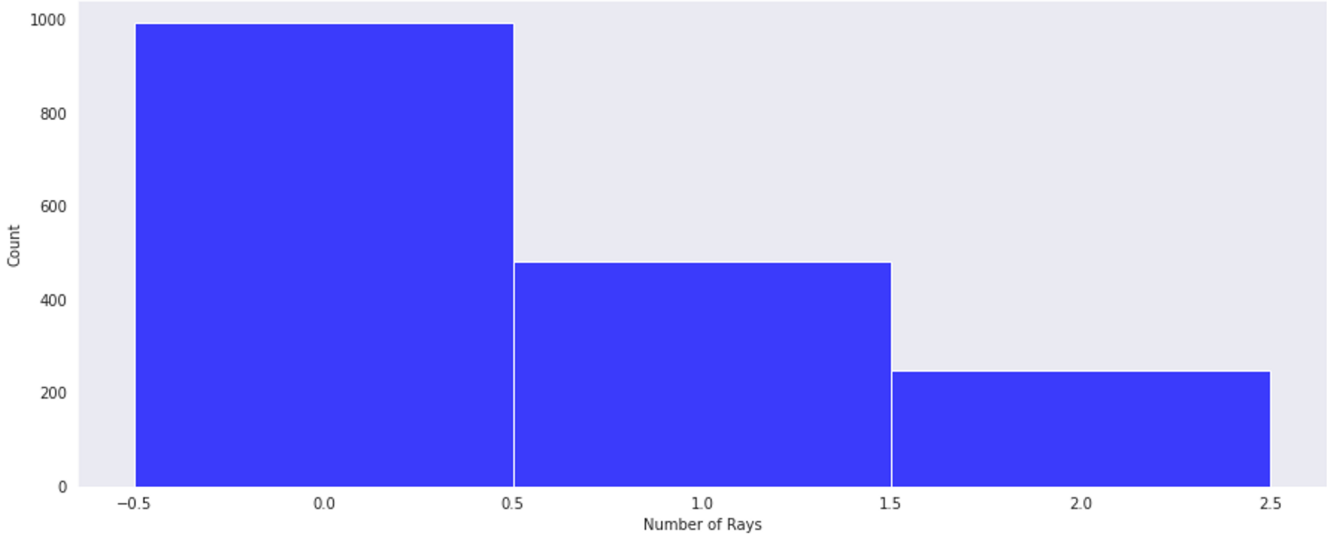
Proportion of Total Rays Following (Instantaneous)



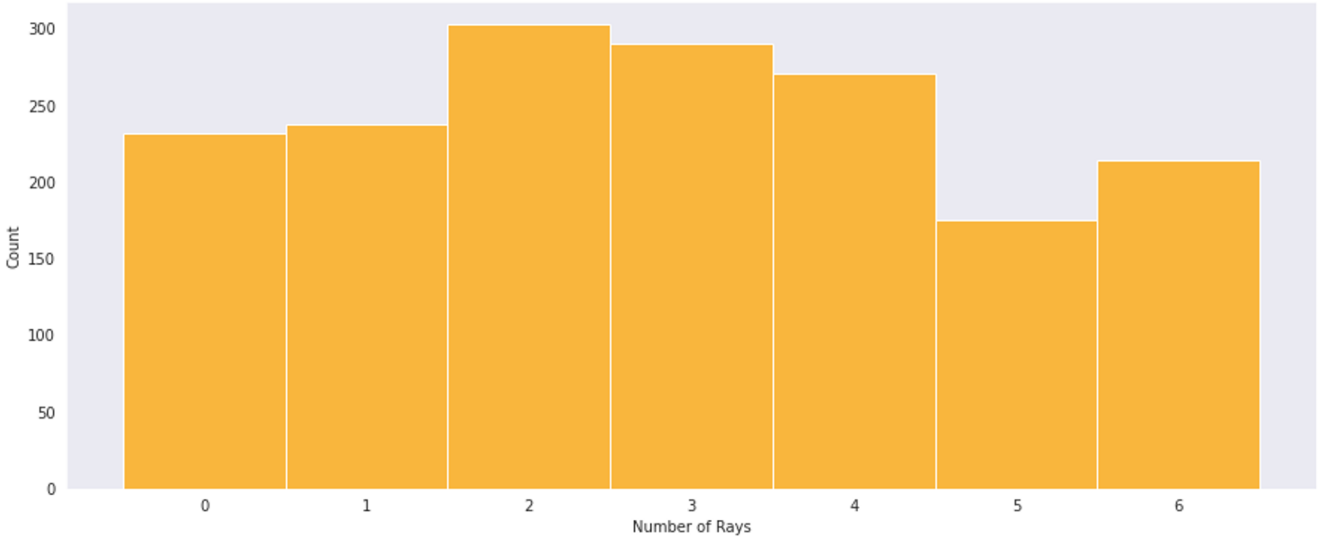
Rays Resting at the Bottom

(Instantaneous)

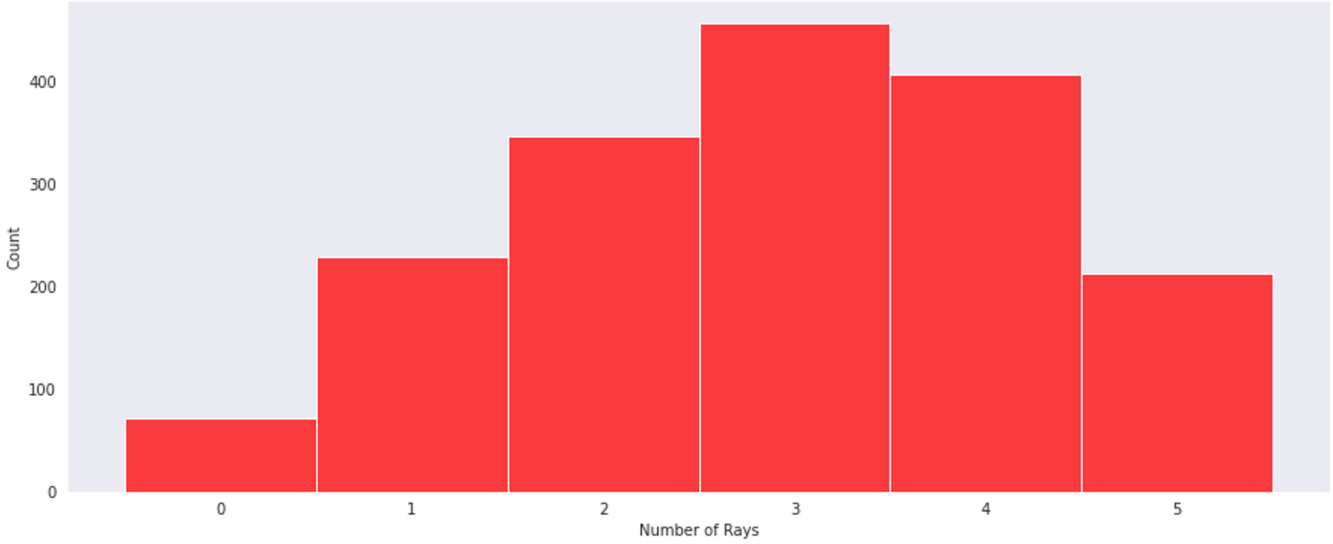
N. kuhlii Resting at the Bottom (Instantaneous)



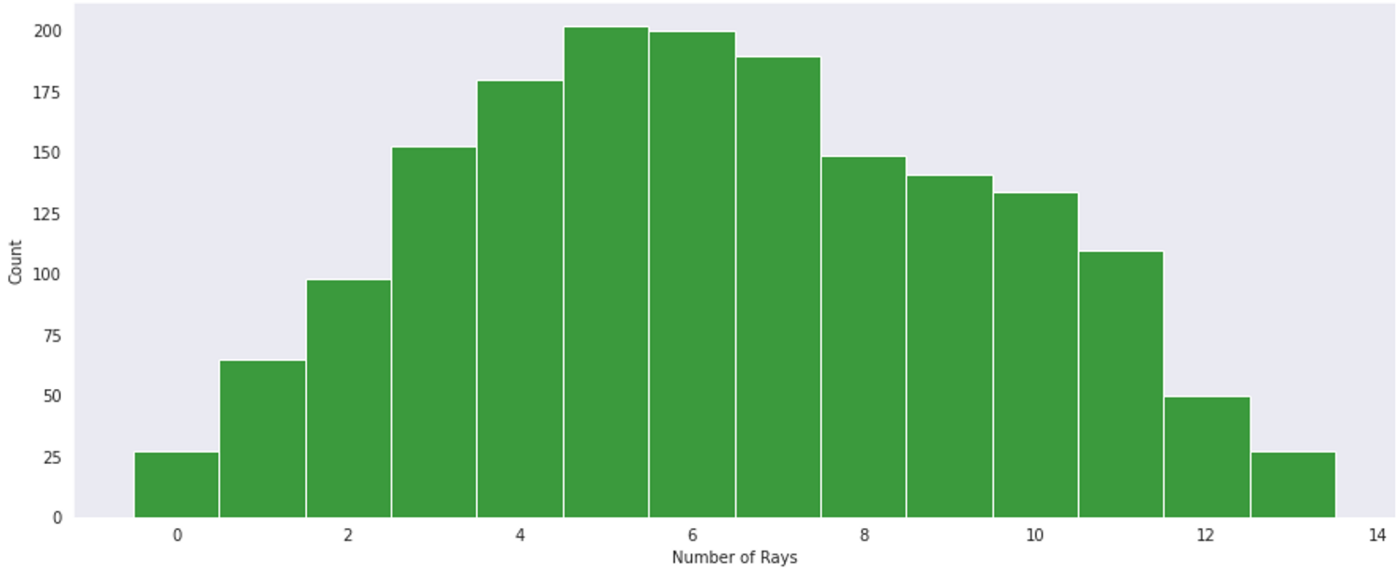
U. jamaicensis Resting at the Bottom (Instantaneous)



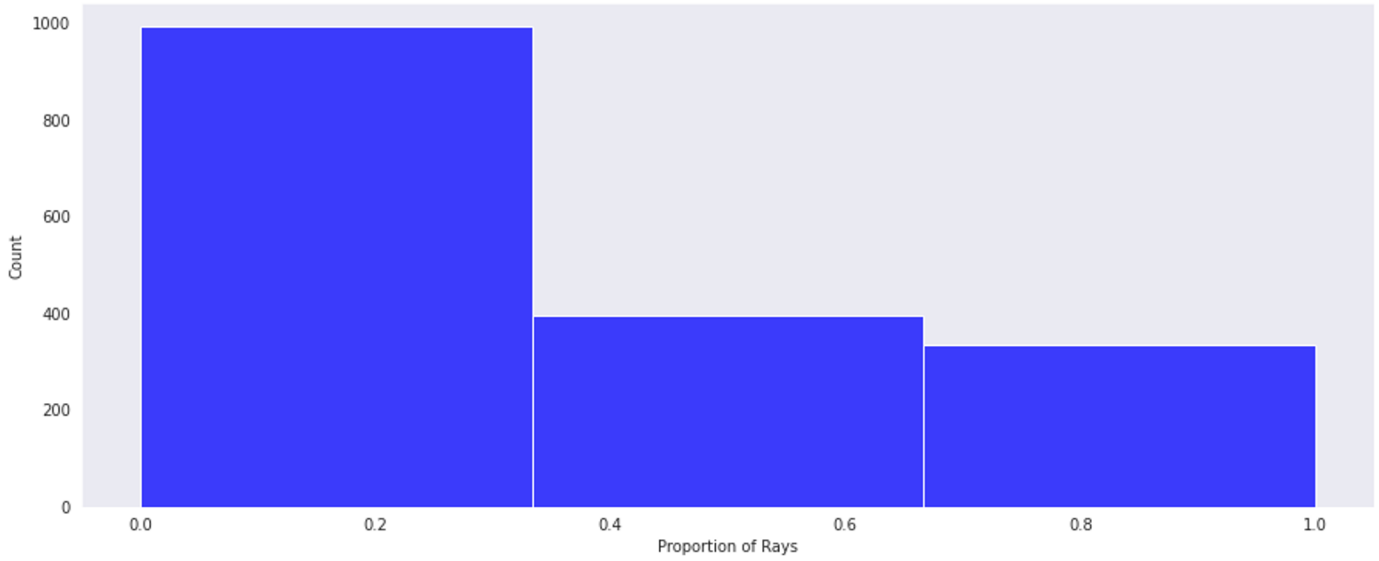
H. sabinus Resting at the Bottom (Instantaneous)



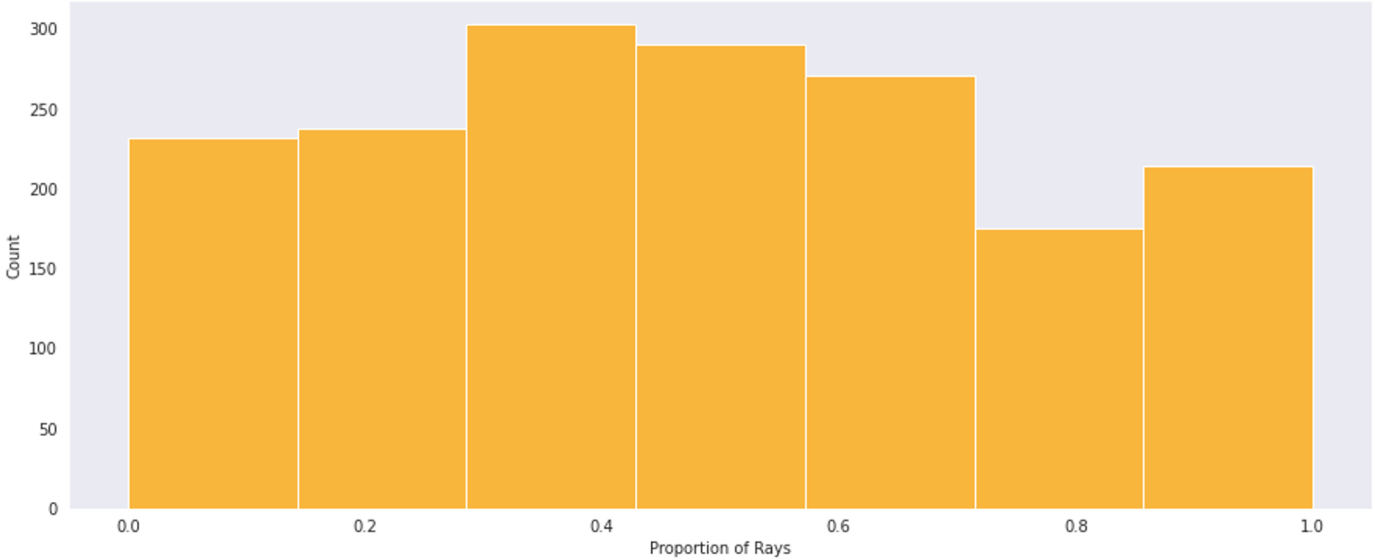
Total Rays Resting at the Bottom (Instantaneous)



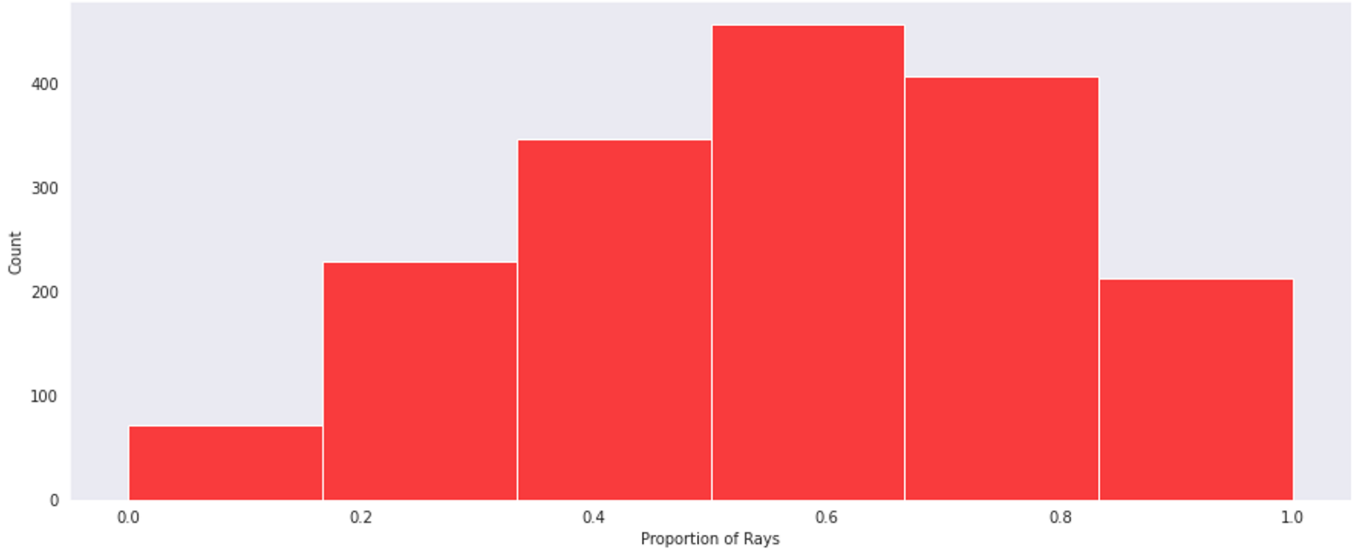
Proportion of *N. kuhlii* Resting at the Bottom (Instantaneous)



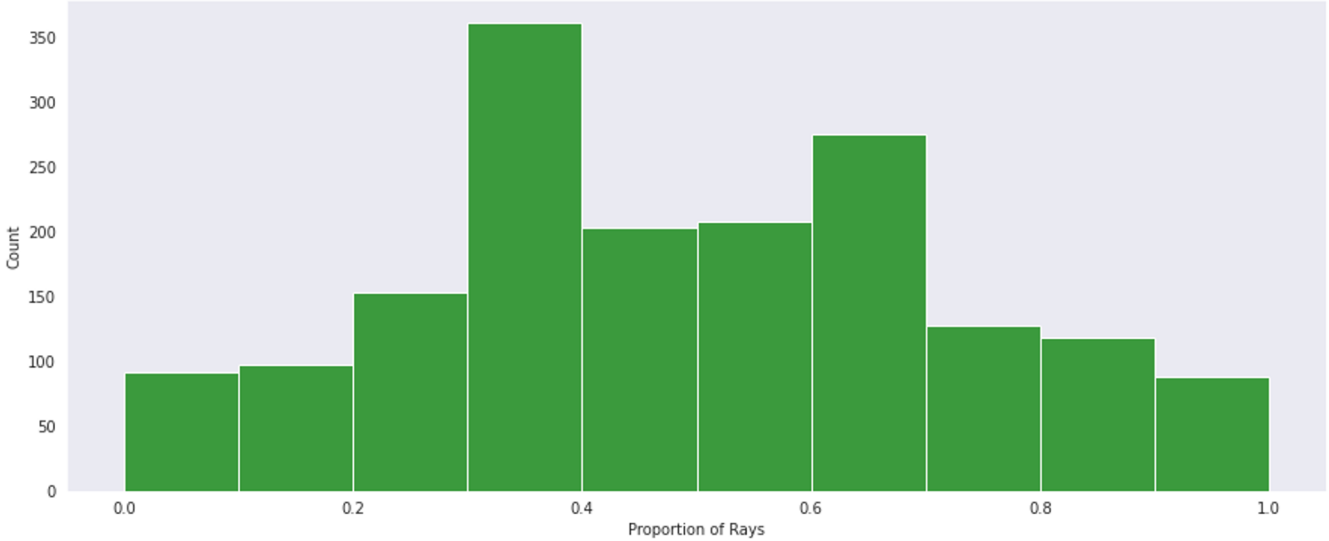
Proportion of *U. jamaicensis* Resting at the Bottom (Instantaneous)



Proportion of *H. sabinus* Resting at the Bottom (Instantaneous)

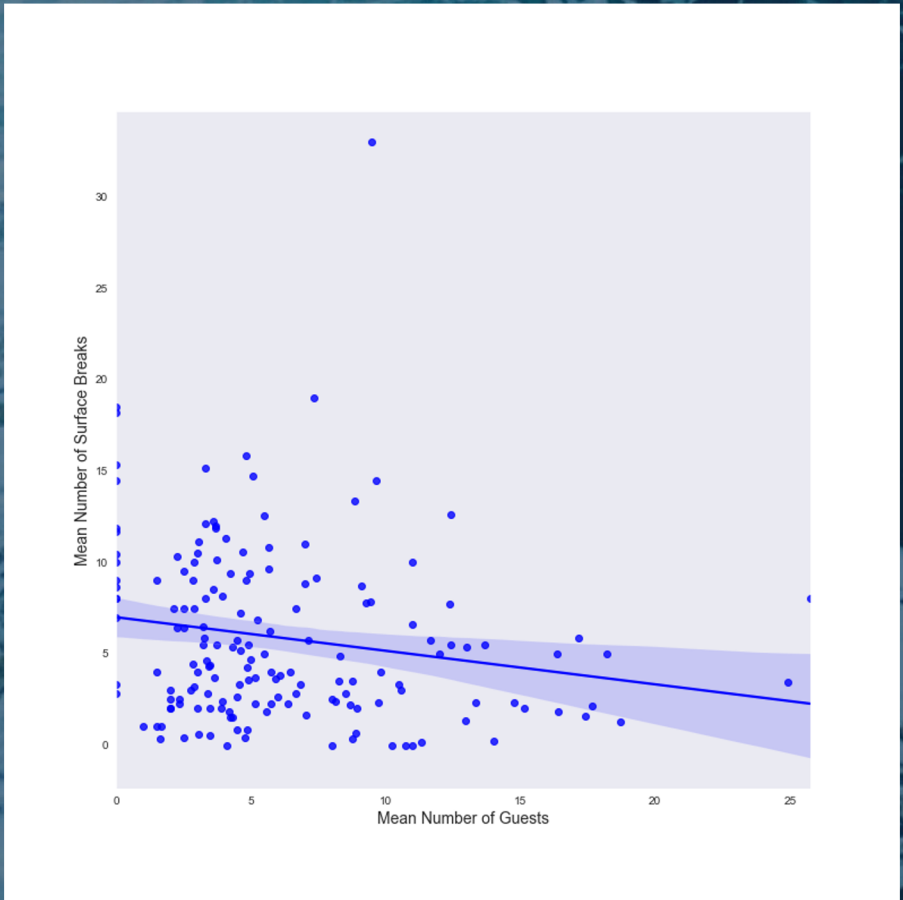


Proportion of Total Rays Resting at the Bottom (Instantaneous)

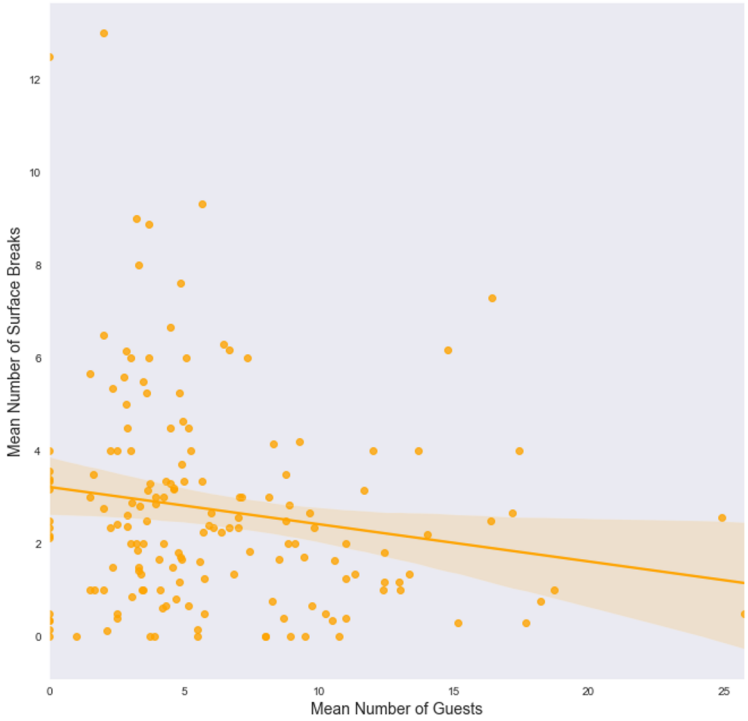


Guest Attendance vs. Surface Breaks (Continuous)

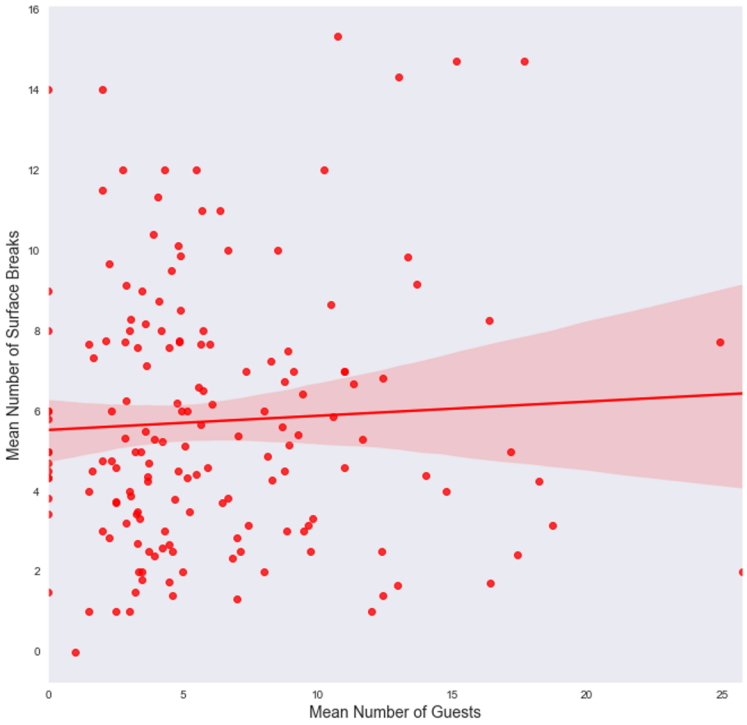
Daily Guest Attendance vs. Surface Breaks (*N. kuhlii*, Continuous)



Daily Guest Attendance vs. Surface Breaks (*U. jamaicensis,* Continuous)

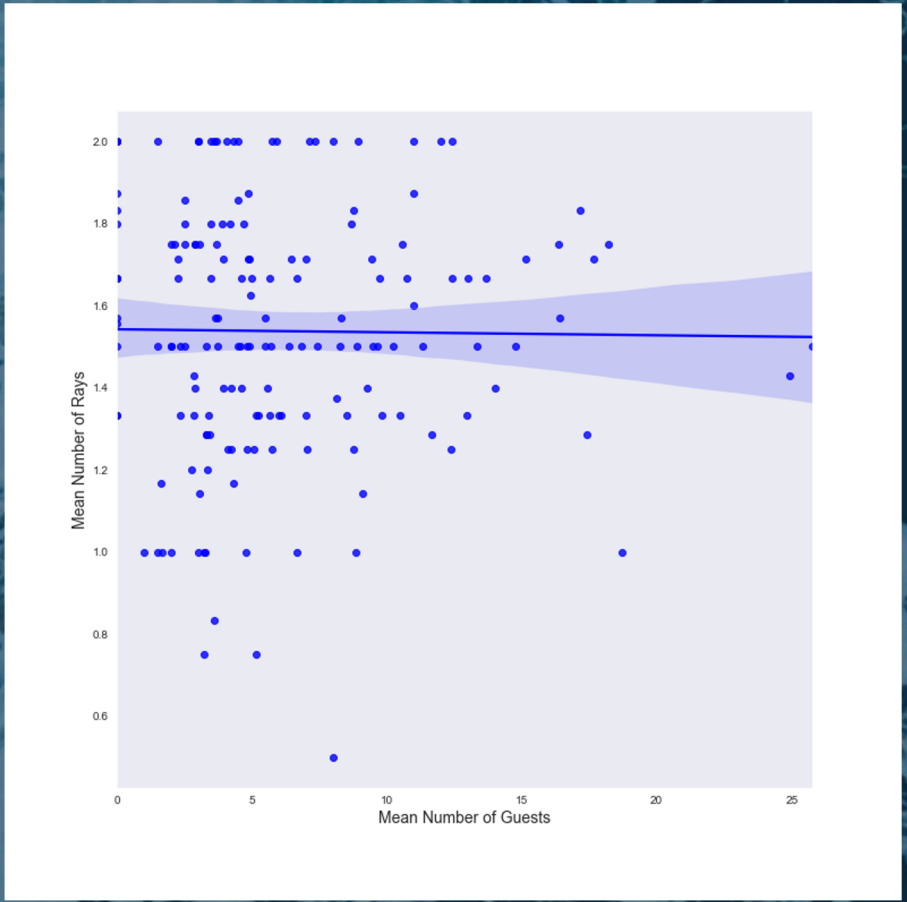


Daily Guest Attendance vs. Surface Breaks (*H. sabinus*, Continuous)

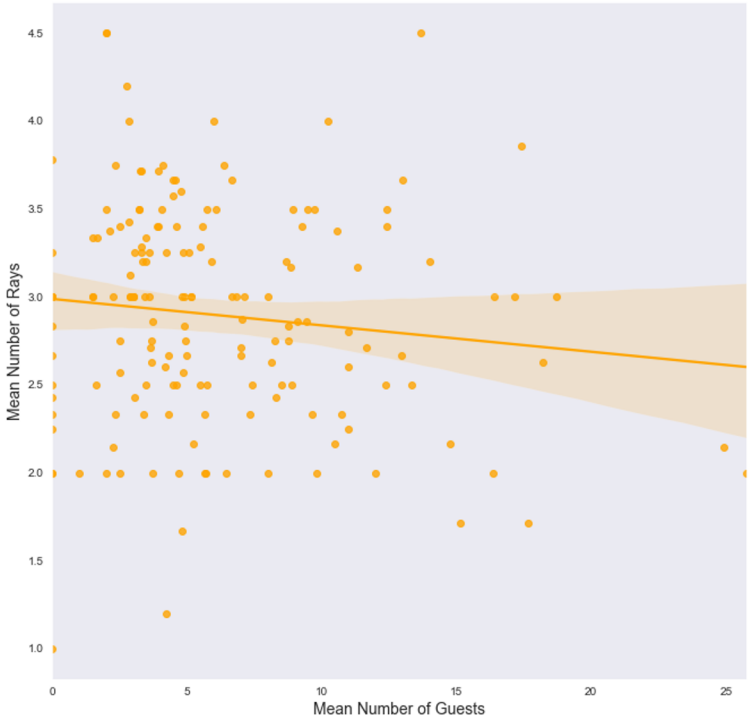


Guest Attendance vs. Resting in Shallows (Continuous)

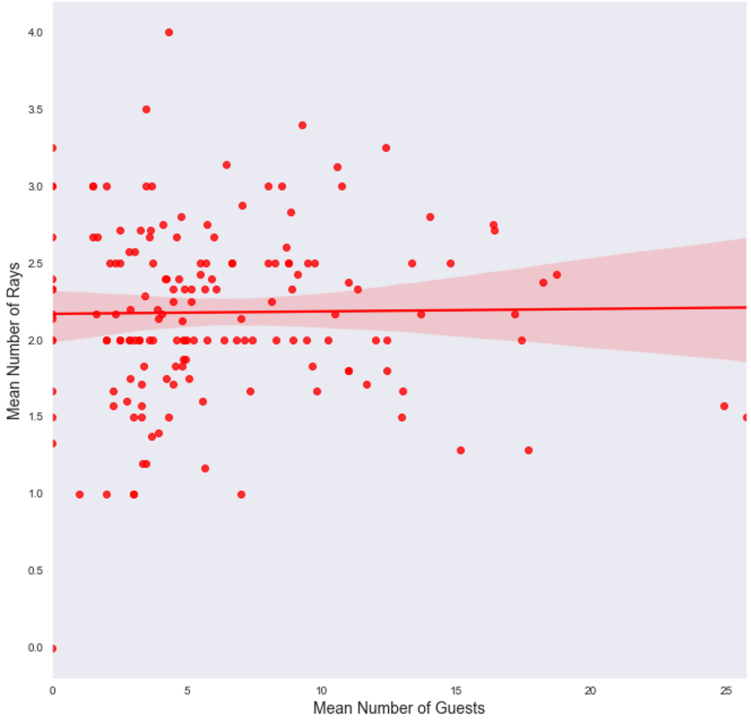
Daily Guest Attendance vs. Resting in Shallows (*N. kuhlii*, Continuous)



Daily Guest Attendance vs. Resting in Shallows (*U. jamaicensis,* Continuous)

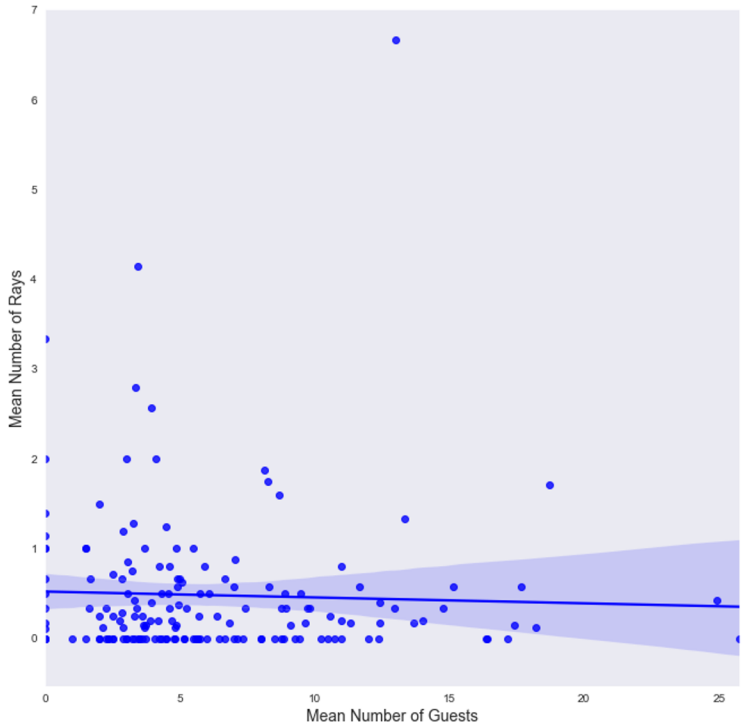


Daily Guest Attendance vs. Resting in Shallows (*H. sabinus*, Continuous)

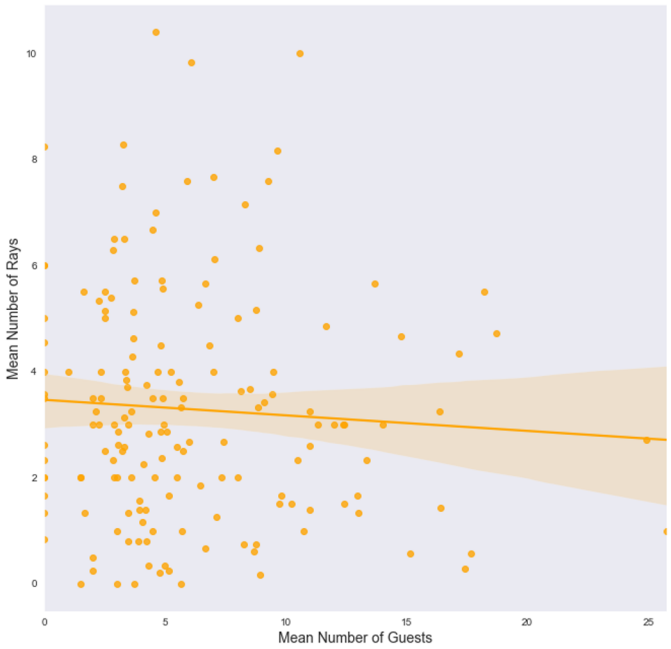


Guest Attendance vs Conspecific Following (Continuous)

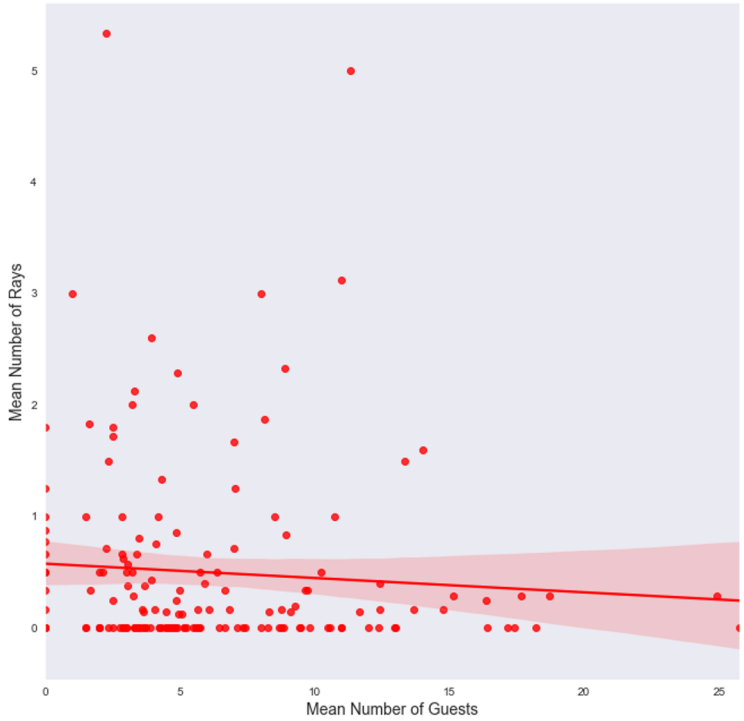
Daily Guest Attendance vs. Following Conspecific (*N. kuhlii*, Continuous)



Daily Guest Attendance vs. Following Conspecific (*U. jamaicensis,* Continuous)

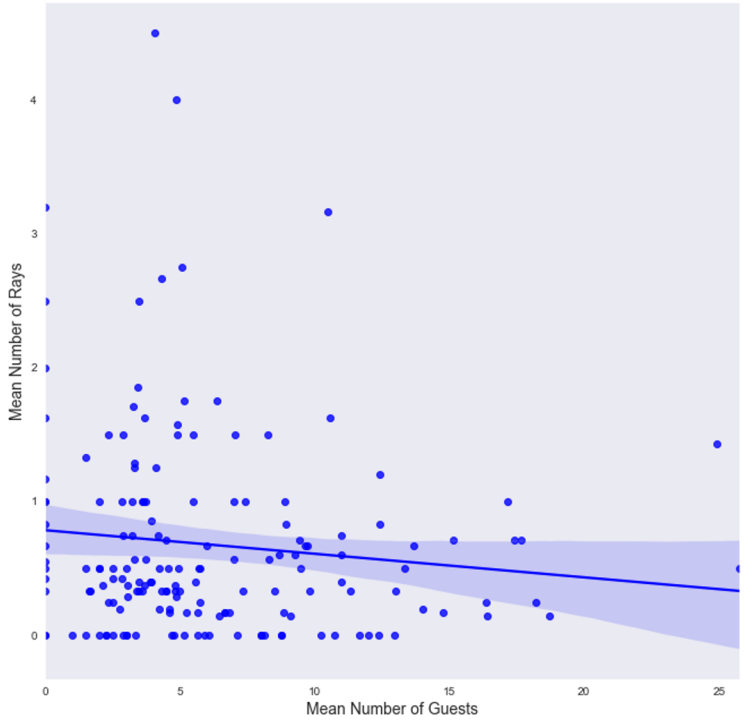


Daily Guest Attendance vs. Following Conspecific (*H. sabinus*, Continuous)

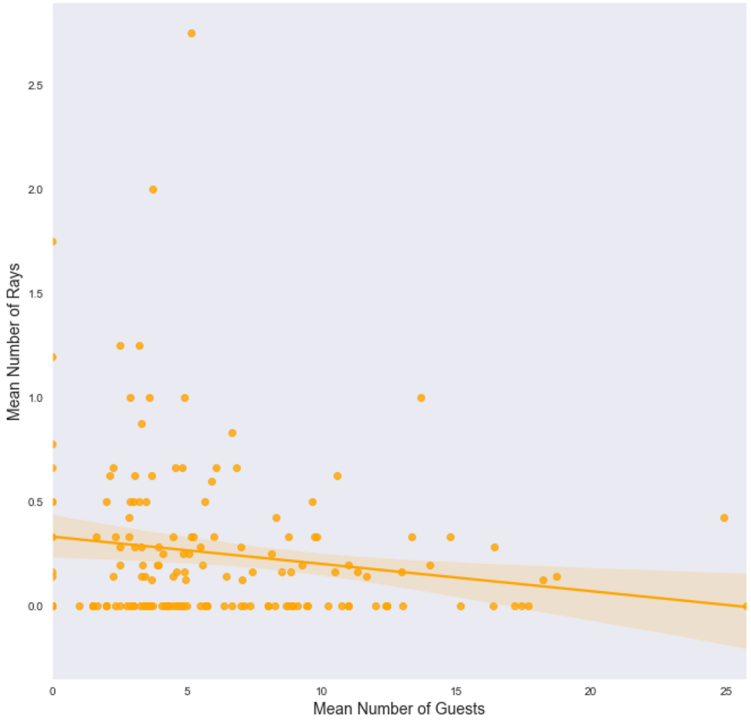


Guest Attendance vs Following Different Species (Continuous)

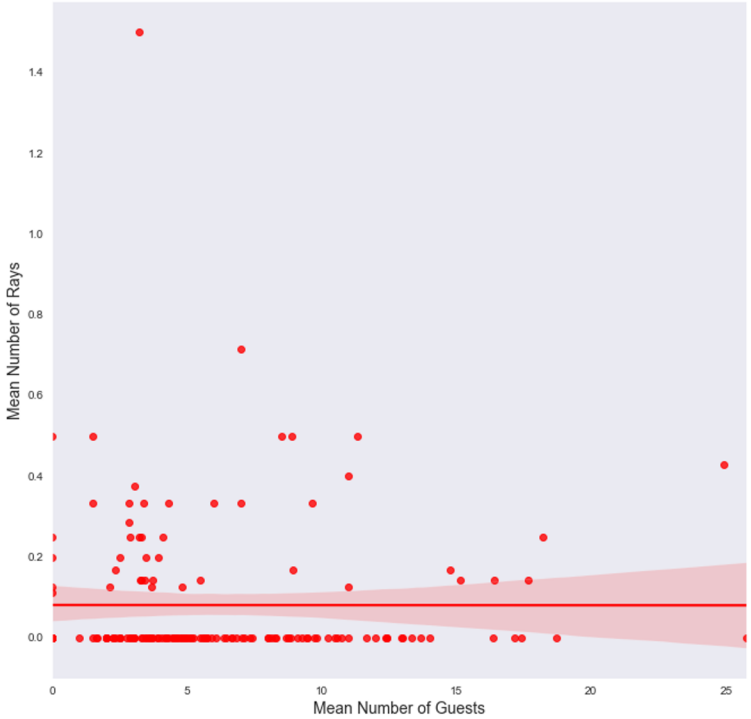
Daily Guest Attendance vs. Following Different Species (*N. kuhlii*, Continuous)

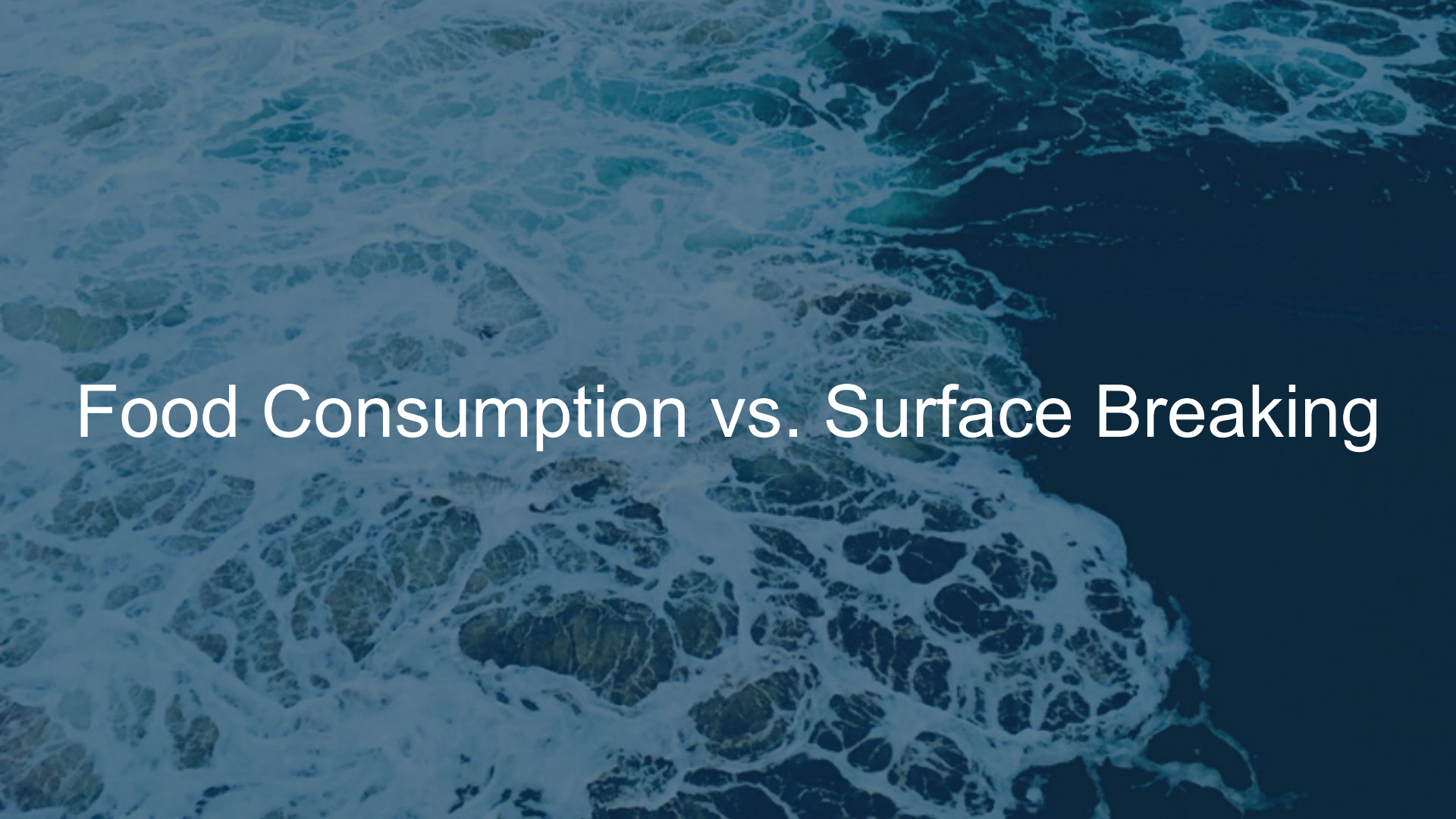


Daily Guest Attendance vs. Following Different Species (*U. jamaicensis,* Continuous)



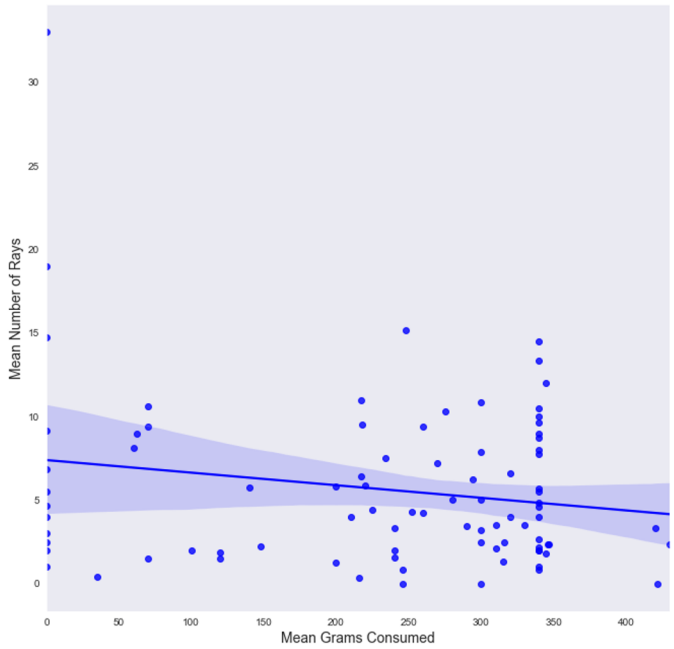
Daily Guest Attendance vs. Following Different Species (*H. sabinus*, Continuous)



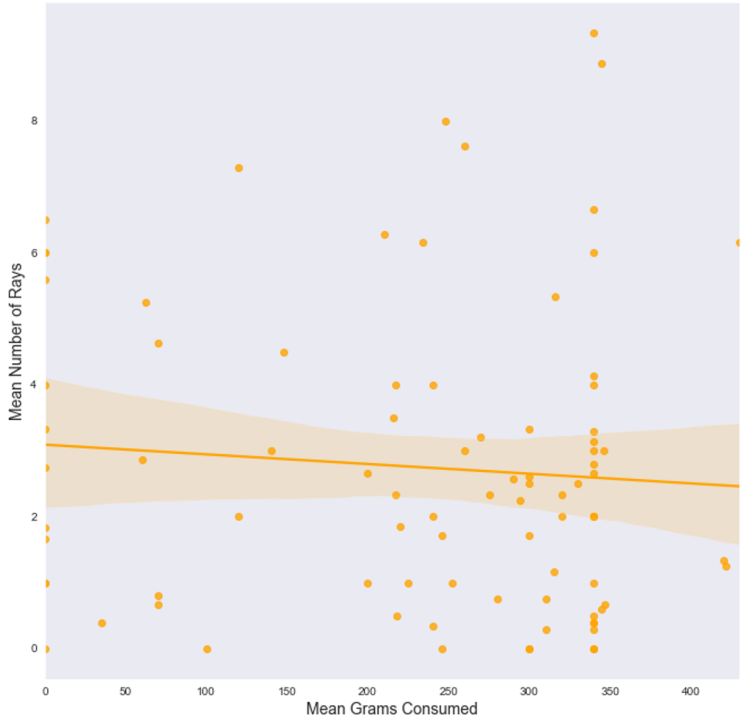


Food Consumption vs. Surface Breaking

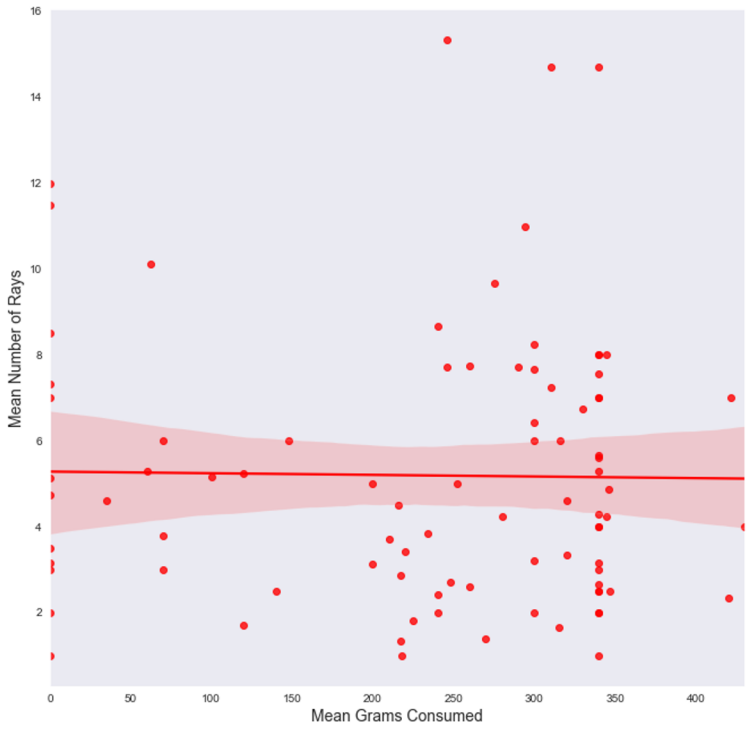
Daily Food Consumption (g) vs. Surface Breaks (*N. kuhlii*, Continuous)



Daily Food Consumption (g) vs. Surface Breaks (*U. jamaicensis,* Continuous)

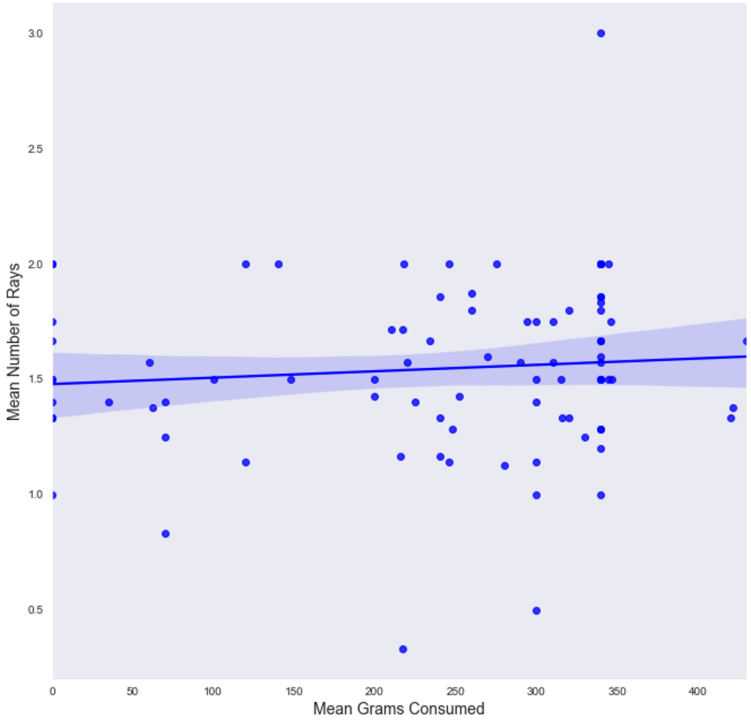


Daily Food Consumption (g) vs. Surface Breaks (*H. sabinus*, Continuous)

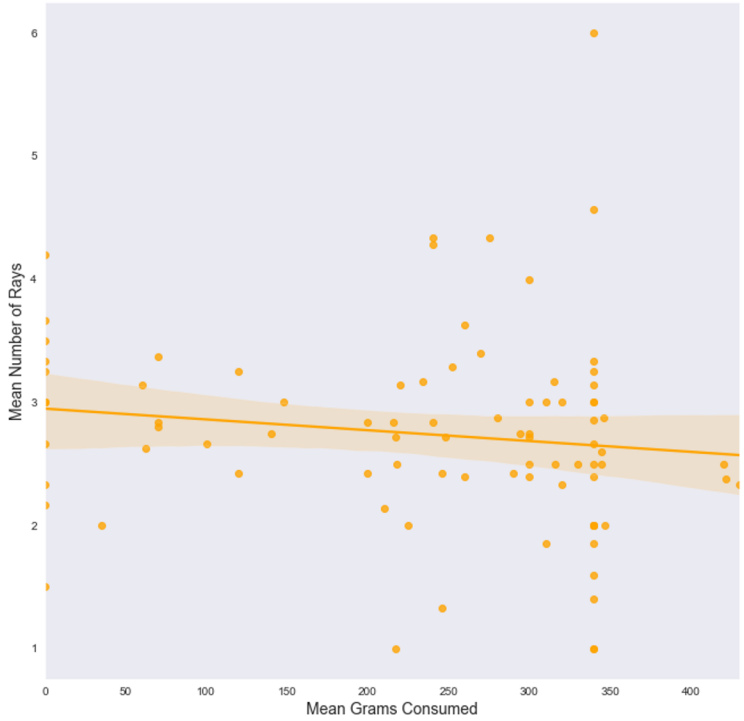


Food Consumption vs. Resting in Shallows

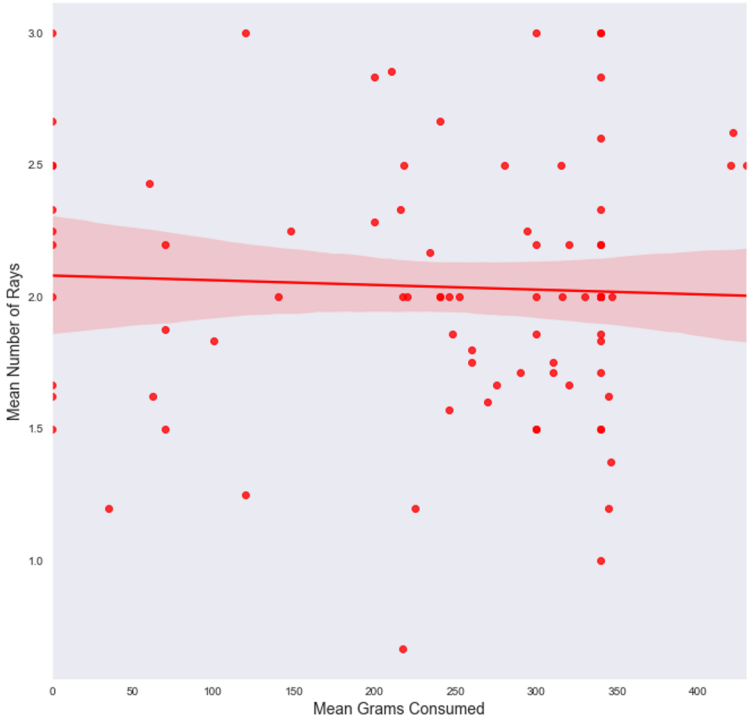
Daily Food Consumption (g) vs. Resting in Shallows (*N. kuhlii*, Continuous)



Daily Food Consumption (g) vs. Resting in Shallows (*U. jamaicensis*, Continuous)

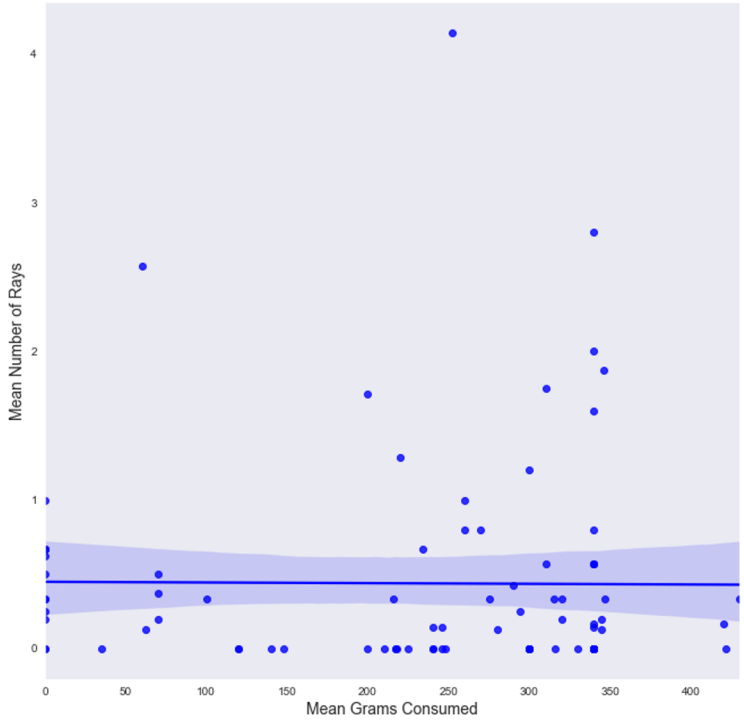


Daily Food Consumption (g) vs. Surface Breaks (*H. sabinus*, Continuous)

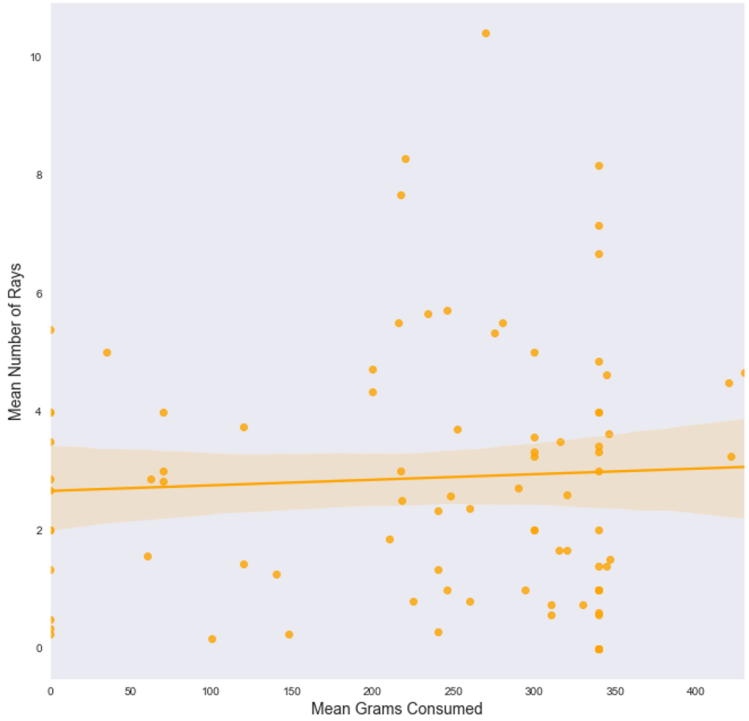


Food Consumption vs. Conspecific Following

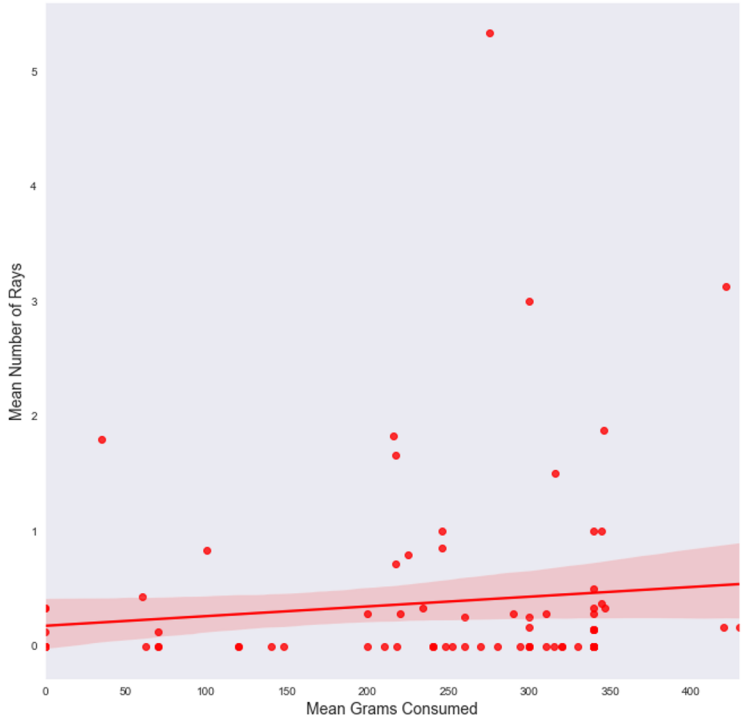
Daily Food Consumption (g) vs. Following Conspecific (*N. kuhlii*, Continuous)



Daily Food Consumption (g) vs. Following Conspecific (*U. jamaicensis*, Continuous)

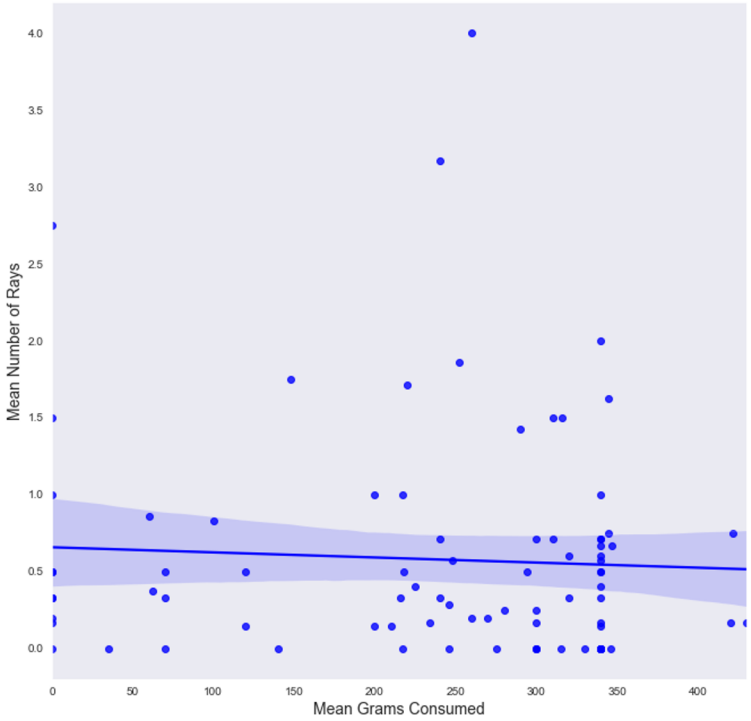


Daily Food Consumption (g) vs. Following Conspecific (*H. sabinus*, Continuous)

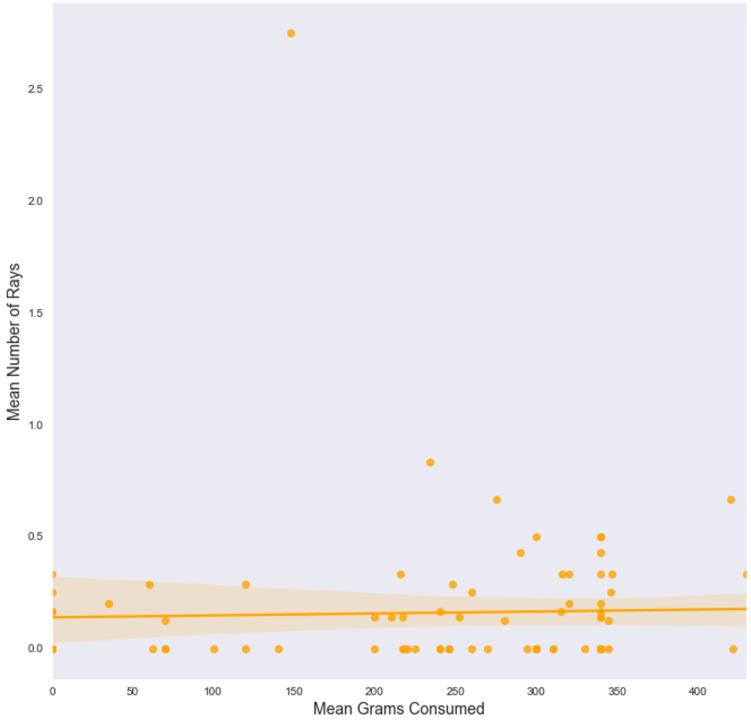


Food Consumption vs. Following Different Species (Continuous)

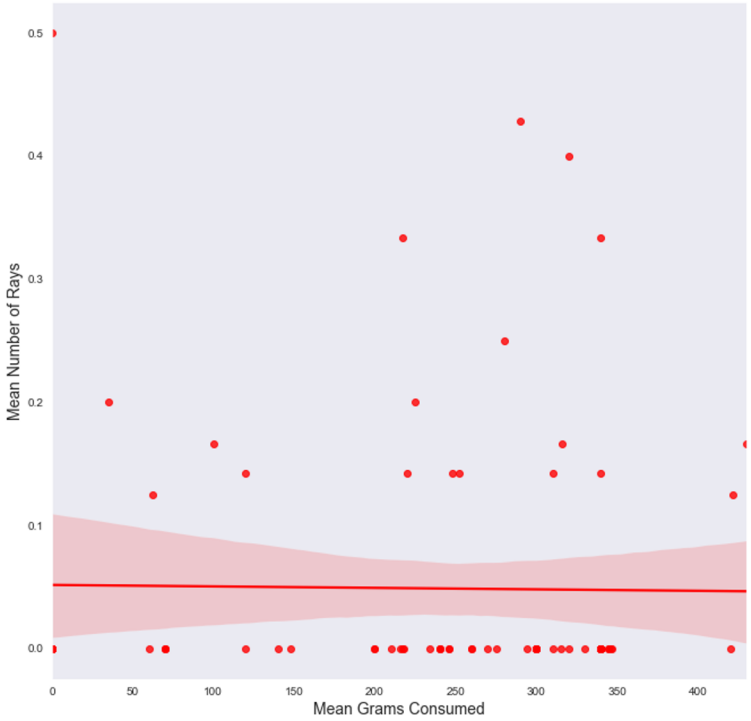
Daily Food Consumption (g) vs. Following Different Species (*N. kuhlii*, Continuous)



Daily Food Consumption (g) vs. Following Different Species (*U. jamaicensis,* Continuous)



Daily Food Consumption (g) vs. Following Different Species (*H. sabinus*, Continuous)



Correlation Heatmaps for Guest Attendance vs Behaviors

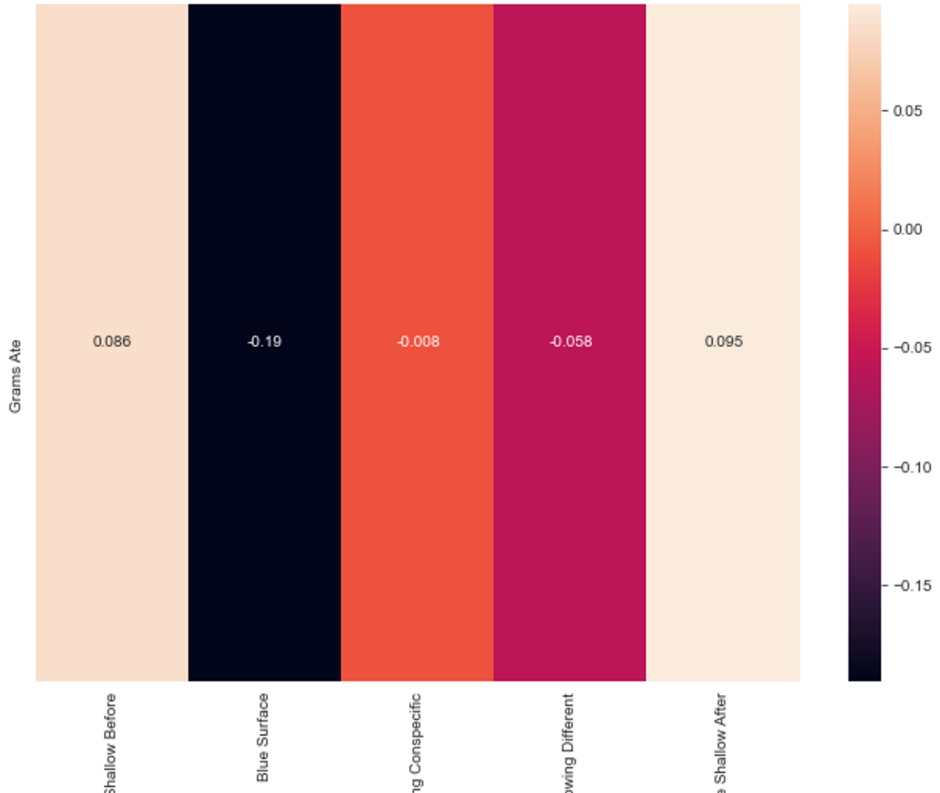
Correlation Heatmap for Guest Attendance vs. Ray Behaviors (*N. kuhlii*, Continuous)

Correlation Heatmap for Guest Attendance vs. Ray Behaviors (*U. jamaicensis*, Continuous)

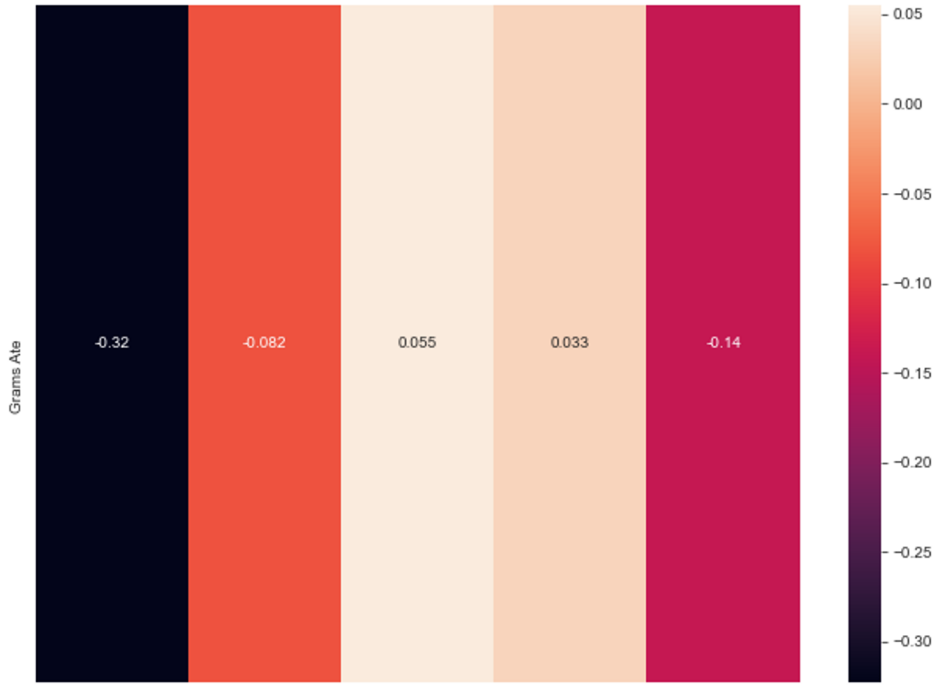
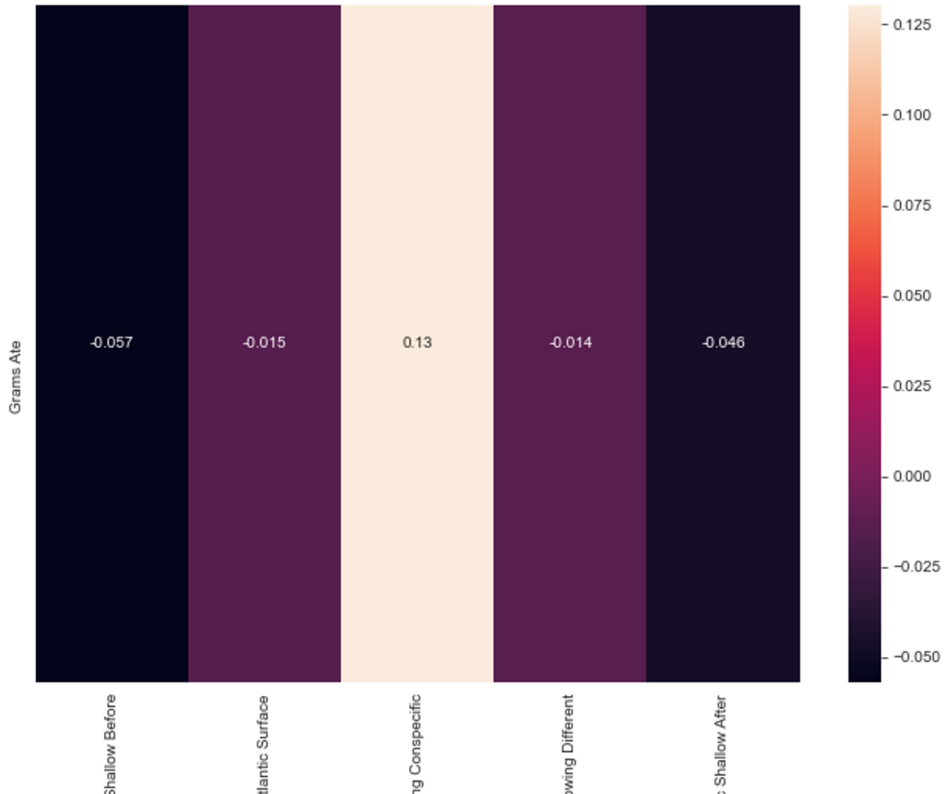
Correlation Heatmap for Guest Attendance vs. Ray Behaviors (*H. sabinus*, Continuous)

Correlation Heatmaps for Food Consumption vs Behaviors

Correlation Heatmap for Guest Attendance vs. Ray Behaviors (*N. kuhlii*, Continuous)



Correlation Heatmap for Food Consumption vs. Ray Behaviors (*U. jamaicensis*, Continuous)



Correlation Heatmap for Guest Attendance vs. Ray Behaviors (*H. sabinus*, Continuous)