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Enterococci in St. Johns County Coastal Waters: Site Comparison, Diurnal Variability, and Environmental Impacts

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Introduction:

Enterococcus is a genus of bacteria found in the digestive tracts of humans & other animals. Because of its association with gastrointestinal illness in humans, enterococcus is used as the fecal indicator bacteria criterion for marine & estuarine surface waters. High levels of enterococcus are potentially associated with inputs of untreated wastewater and/or septic tank leakage into estuaries. While the Florida Depart of Health conducts regular monitoring of enterococci levels along populated beaches in Saint Johns County during summer months, much less is known about the daily variability of these counts & the environmental factors these enterococci may be associated with.

Methods:

Phase 1:
- Water sampling 3 times a day, once a week, for 3 weeks
- Samples were collected & brought back to the lab
- 90 mL of DI water & 10 mL of sample were mixed with the IDEXX reagent powder, poured into an IDEXX pouch, sealed & labeled. Duplicates were processed.
- All samples were labeled & left to incubate for 24 hours & then held under UV light for analysis.

Phase 2:
- 1 large sample of low salinity & 1 large sample of ocean water was collected & brought back to the lab.
- The 2 samples were mixed into a 7-sample salinity gradient & split into 3 sets to be tested in natural light, UV light, & Dark samples conditions.
- The light & dark samples were taken to the marina & tied to a line in dive bags. The UV samples were placed in the UV chamber. All samples were incubated for 6 hours & then removed for processing.
- All samples were processed the same as phase 1 using IDEXX equipment & the UV chamber for results.

Hypothesis:

Phase 1: Enterococcus levels would be highest at sunrise due to a lack of UV exposure overnight.
Phase 2: Enterococcus levels would be lowest in the samples only exposed to UV light due to UV being used as a sanitation measure to kill bacteria.
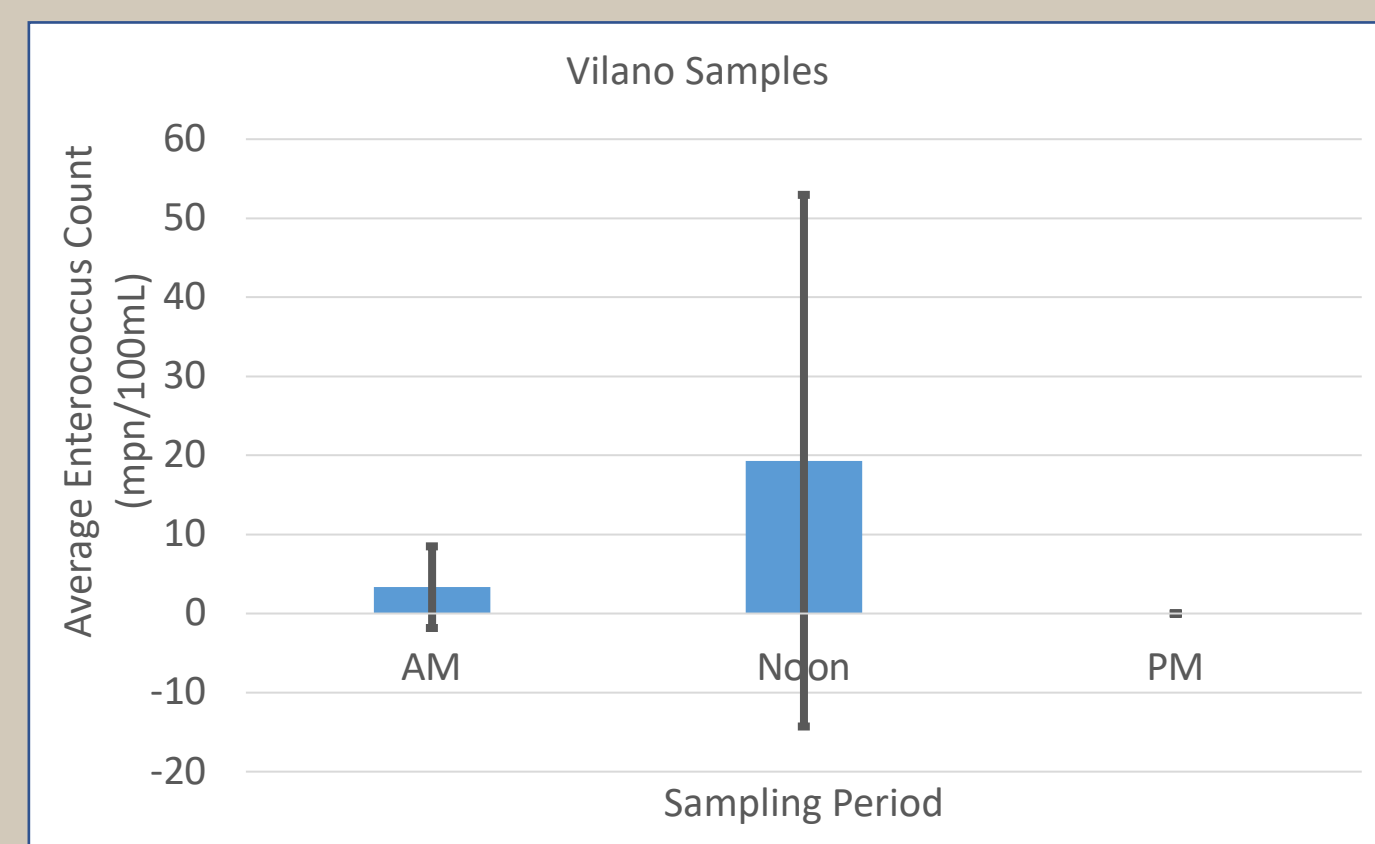
Results & Statistical Analysis:

Figure 1 - Vilano Samples: This graph shows the average bacteria count for the Vilano Beach sample sight each time of day. The vertical lines show the error margins for each sampling period.

Figure 2 - St. Augustine Samples: This graph shows the average bacteria count for the St. Augustine Beach sample sight each time of day. The vertical lines show the error margins for each sampling period.
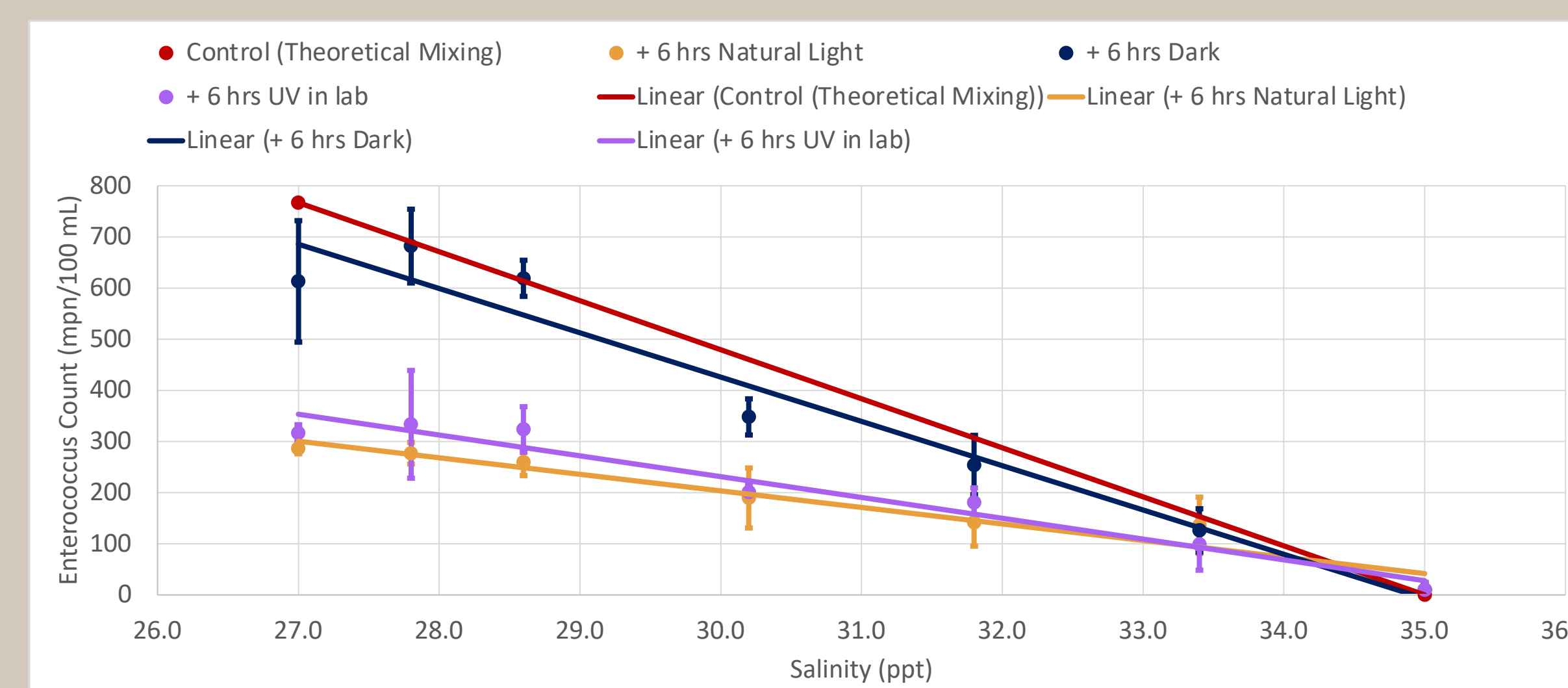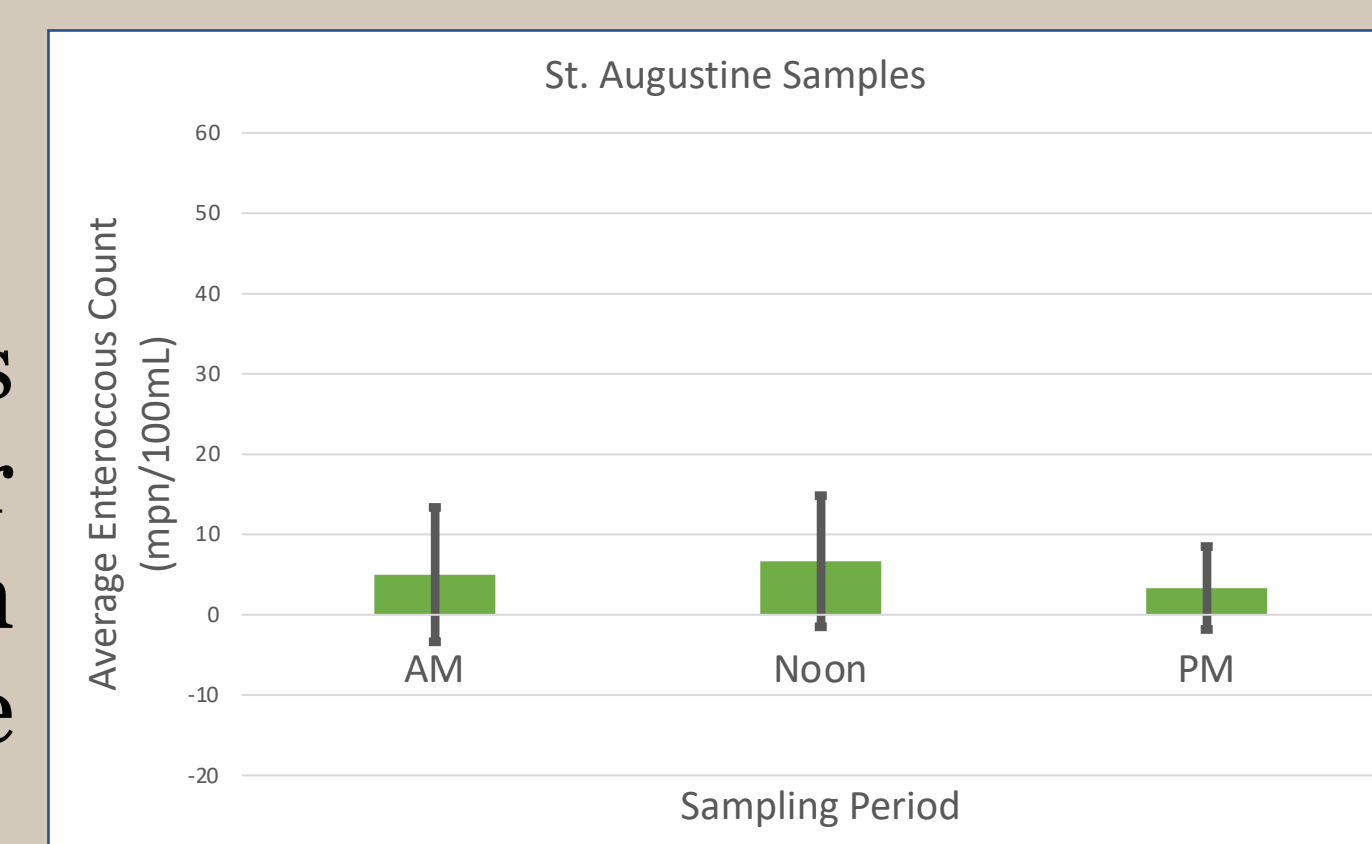

Figure 3 - Lab Experiment Samples: This graph shows the results of statistical tests from phase 2 samples. Statistically, there is no difference between the dark samples & the control or between the natural light & UV light samples.

Figure 4 - ANCOVA: This graph shows the statistical differences among the sampling parameters for the beach water samples.

ANCOVA - Enterococcus (mpn/100 ml)

	Sum of Squares	df	Mean Square	F	p
Salinity (ppt)	874559	1	874559	664.1	<.001
Treatment	206028	3	68676	52.2	<.001
Treatment ※ Salinity (ppt)	164610	3	54870	41.7	<.001
Residuals	26336	20	1317		

Figure 5 - Post Hoc Comparisons: This graph shows the statistical differences among the sampling parameters for the lab experiment samples.

Post Hoc Comparisons - Treatment

Comparison						
Treatment	Treatment	Mean Difference	SE	df	t	p_tukey
Light	Dark	-193.0	19.4	20.0	-9.95	<.001
	UV	-23.3	19.4	20.0	-1.20	0.634
	Control	-241.5	19.4	20.0	-12.45	<.001
Dark	UV	169.7	19.4	20.0	8.75	<.001
	Control	-48.5	19.4	20.0	-2.50	0.091
UV	Control	-218.2	19.4	20.0	-11.25	<.001

Discussion:

Phase 1: The results from phase 1 showed that there was little variation among the sample times & sample sites. The bacteria counts remained low throughout the sampling period. There was 1 outlier in a noon sample from Vilano, which could be from sediment in the sample or from the bottle not being shaken prior to mixing with DI water & reagent.

Phase 2: The results from our lab experiment showed that the dark samples followed the theoretical mixing trend closer than the natural & UV light samples. The samples exposed to light factors had a decrease in bacteria count by almost ½ of the predicted mpn. In this lab experiment, the UV & natural light had no statistical difference & our hypothesis was rejected.
Our results suggest that enterococcus presence at our sites is low & that natural light is as efficient as UV light in reducing enterococcus counts.

Acknowledgments:

We would like to extend a thank you to Dr. Matt Brown & Dr. Madeleine Doiron for their guidance throughout the semester. Without either of you, this project wouldn't have been possible.

Sources:

Campos, C. J. A., Kershaw, S. R., & Lee, R. J. (2013). Environmental Influences on Faecal Indicator Organisms in Coastal Waters and Their Accumulation in Bivalve Shellfish. Estuaries and Coasts, 36(4), 834–853. http://www.jstor.org/stable/23484862. R Core Team (2021). R: A Language and environment for statistical computing. (Version 4.1) [Computer software]. Retrieved from https://cran.r-project.org. (R packages retrieved from MRAN snapshot 2022-01-01). The jamovi project (2022). jamovi. (Version 2.3) [Computer Software]. Retrieved from https://www.jamovi.org.