Forecasting Ocean Quality within the San Diego Coastal Region

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Business Problems

The ocean is a vastly important natural resource, and its health informs public health:

1. Can ocean water quality in the San Diego coastal region be better understood from a time-dependent perspective?
2. Can forecasting methods be used to reduce costs associated with direct quality measurements?

Business Objective/Tasks

- Enable dissemination of information related to ocean water quality to public policy and regulation officials
  - Examine time series machine learning models to provide accurate models of water quality parameters: salinity, pH, density, enterococci bacteria levels, etc.
  - Develop robust methods for predicting future bacterial levels, either individually or based on other parameters

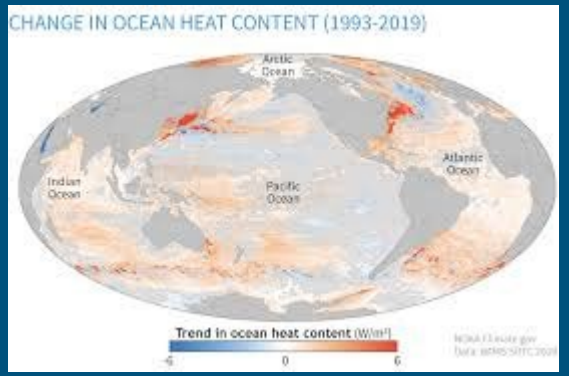
City of San Diego (2022, June 30).

Why Does Forecasting Ocean Water Quality Matter?

Ability To Support Marine Life

Beach Visitors

Health & Safety



Global Warming

(*How Is Climate Change Impacting the World's Ocean | United Nations*, n.d.)
(*Search Beach Monitoring Data | California State Water Quality Control Board*, 2022)

Rationale for Regional Split: PLOO & SBOO

Figure 1. Map of PLOO and SBOO Stations

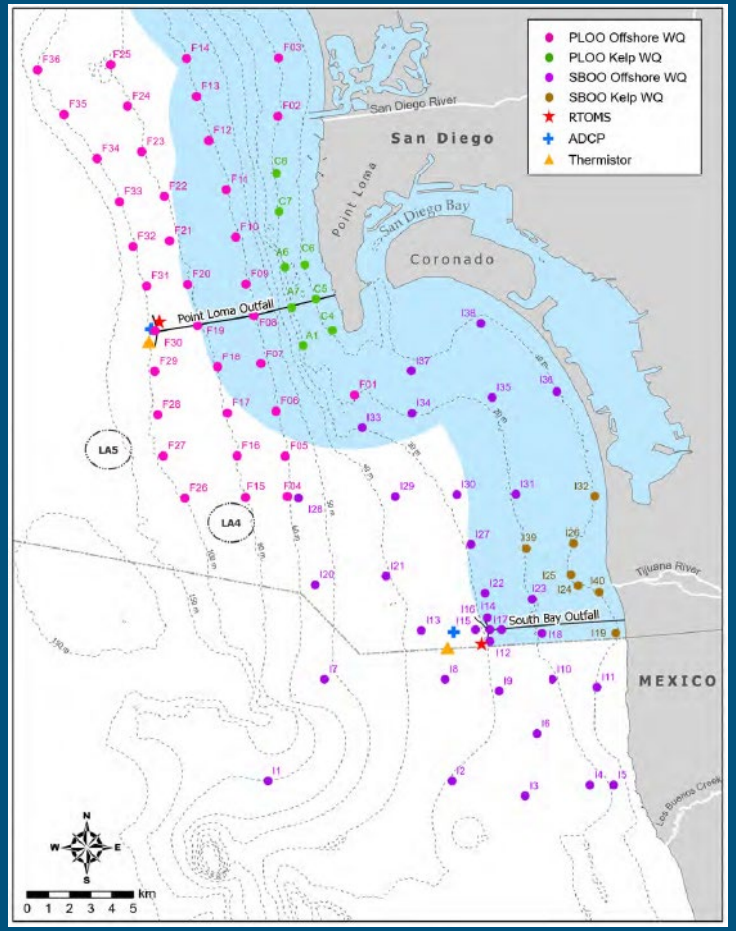
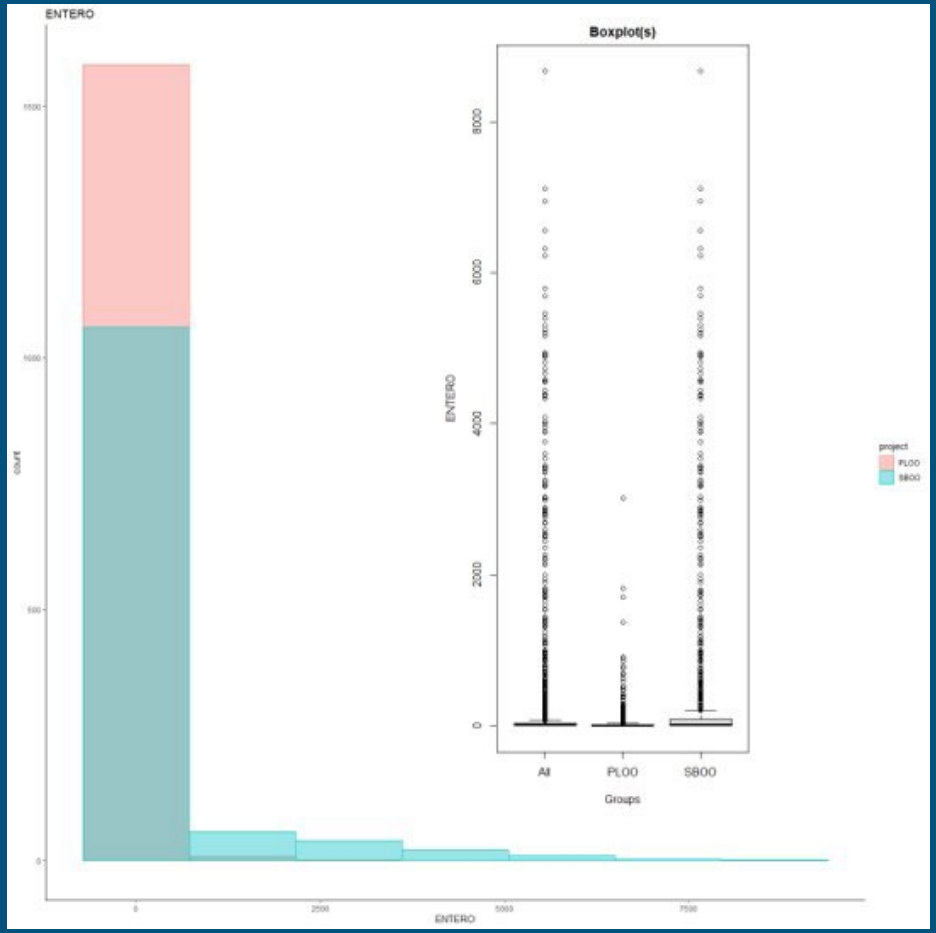


Figure 2. Entero Distributions per Project Region



City of San Diego (2022).

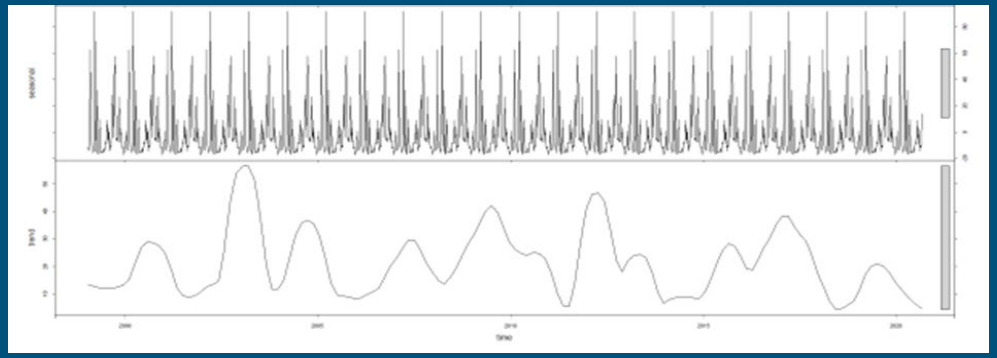
Rationale for Regional Split, cont'd

Seasonality and Trend Differences: Enterococci Bacteria Levels

Analyzing patterns like trend (up and down) and seasons (short-term cycles) help determine methods and modeling effectiveness

Figure 3.

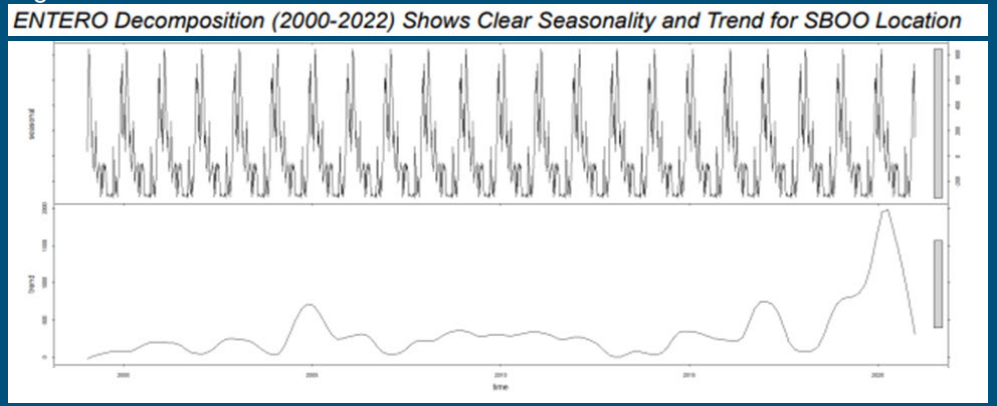
ENTERO Decomposition (2000-2022) Shows Clear Seasonality Element for PLOO Location



- Trend: Consistent up and down
- Season: Less clumping, with 2 distinct peaks; jagged lows following highs

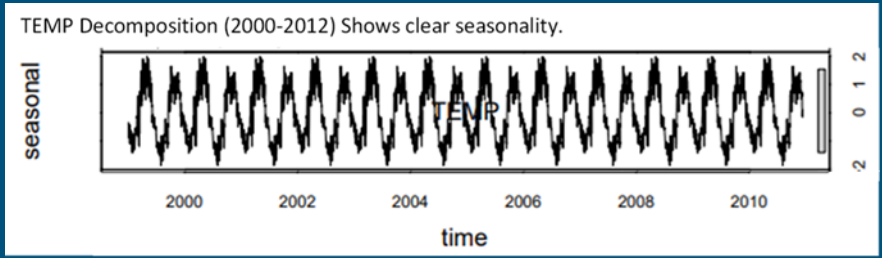
Figure 4.

ENTERO Decomposition (2000-2022) Shows Clear Seasonality and Trend for SBOO Location



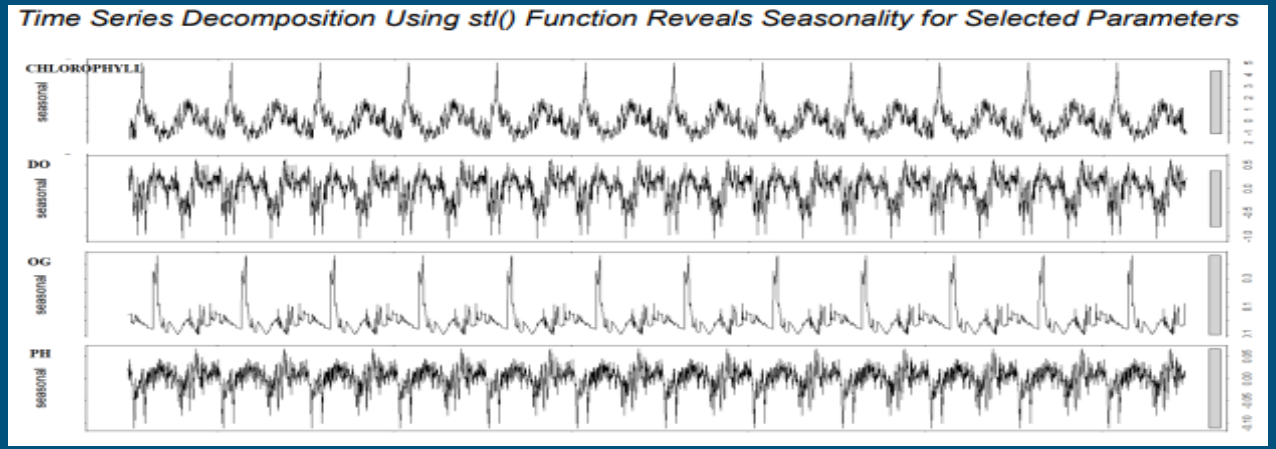
- Trend: Short peaks until last few years with a large up then down
- Season: More of stair-stepping pattern, as opposed to stark ups then downs

Figure 5.



- Seasonal patterns in most of the parameters.
- Temperature follows the calendar seasons

Figure 6.



Seasonality Measures

Findings

- Measures of **pH**, **density**, and **salinity** contributed significantly to modeling entero levels when used as predictors
- **Point Loma Ocean Outfall (PLOO):**
  - In testing, no models of individual parameters did consistently better than the seasonal naive model (i.e., predicting last season values as this season's)
- **South Bay Ocean Outfall (SBOO):**
  - For majority of individual features, two of the three models performed better than a naïve one

Findings, cont'd

- When looking at entero alone, marked difference between prediction capabilities at PLOO vs. SBOO
- Most likely due to the complexity of natural environment parameter fluctuation, predictions were inconsistent across parameters and models
- Test window did not always reflect long-term (cyclical) nature of the data

Figure 7.

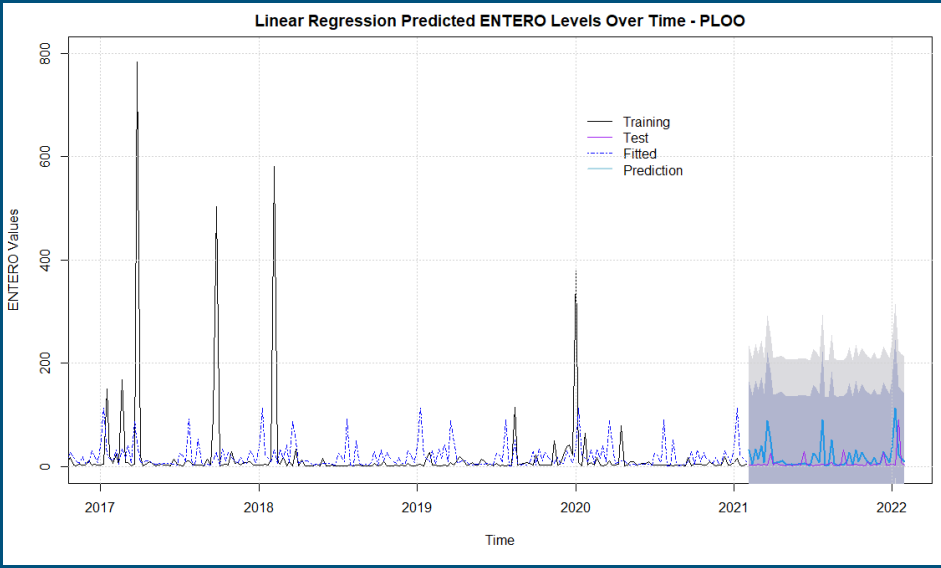
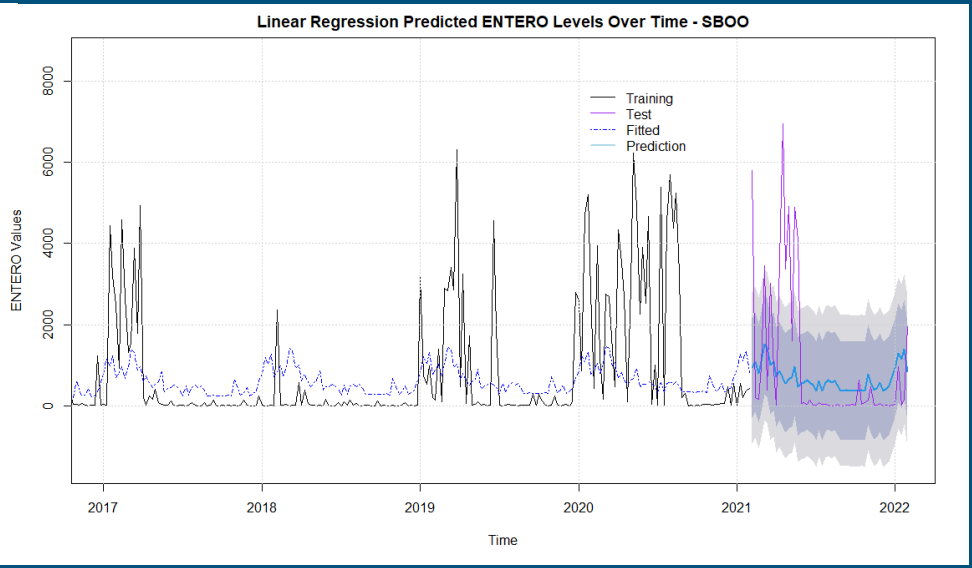


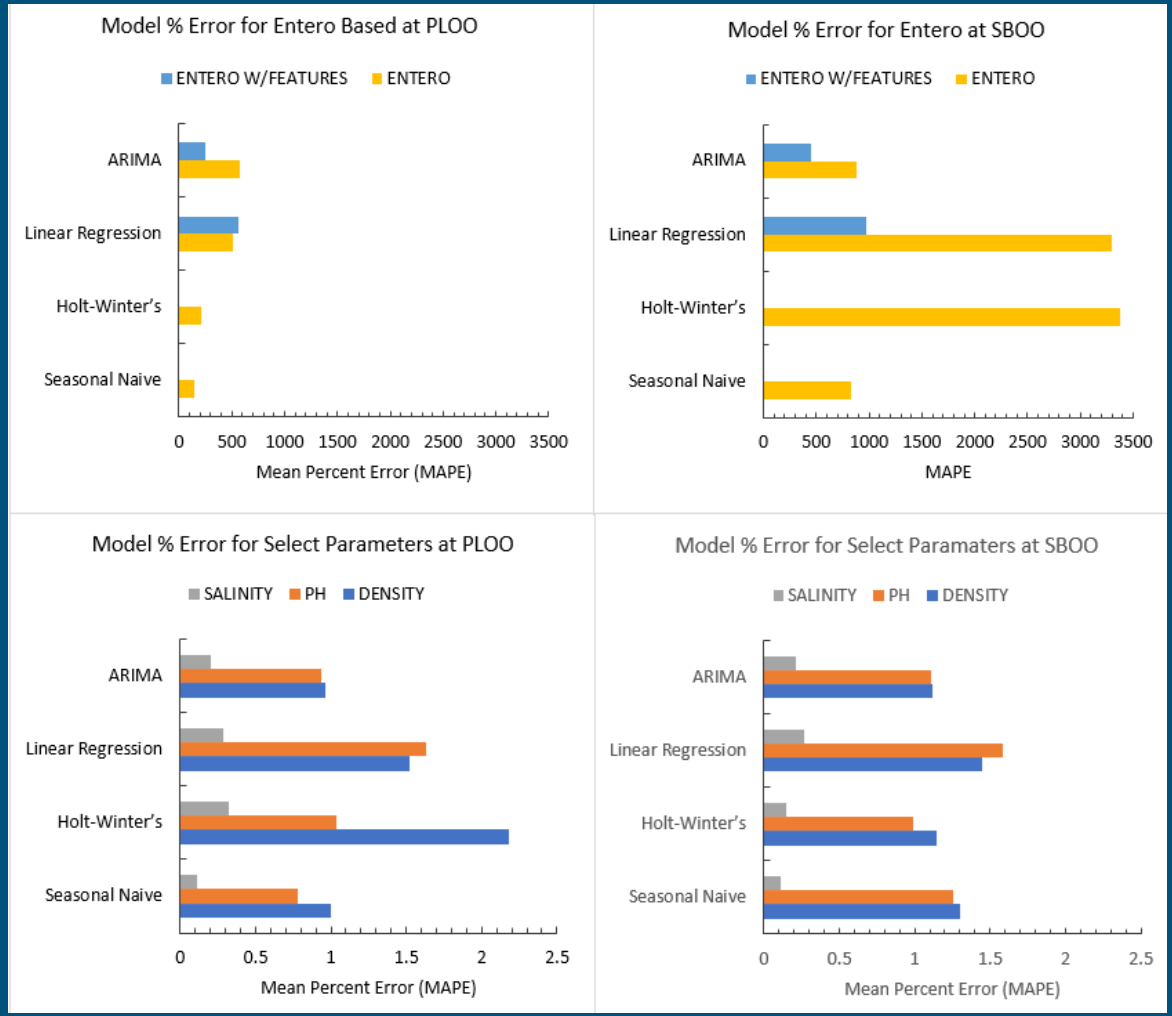
Figure 8.



Findings, cont'd

- ARIMA model has potential
- Need to determine best way to include external variables
- Need more methods refinement

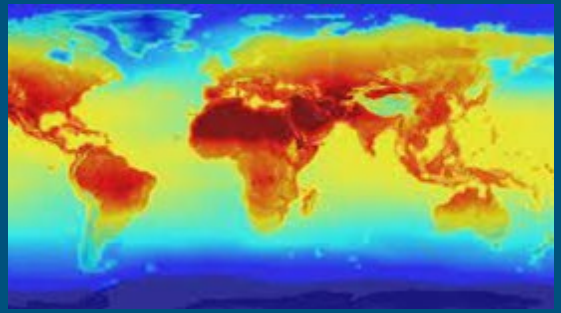
Figure 9.



Solution/Call to Action/Next Steps

Forecasting Refinement

Design and Develop Beach Health & Safety Warning



Contributions to Global Warming Studies

Thank you!

References:

- City of San Diego (2022, June 30). *2020-2021 Biennial receiving waters monitoring and assessment report for the Point Loma and South Bay ocean outfalls*. https://www.sandiego.gov/sites/default/files/compressed_2020-2021_biennial_receiving_waters_monitoring_report_0.pdf
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- *How is climate change impacting the world's ocean | United Nations*. (n.d.). the United Nations. Retrieved December 9, 2022, from https://www.un.org/en/climatechange/science/climate-issues/ocean-impacts