Water Quality Monitoring of Maryland's Tidal Waterways

UMBC REU Site: Interdisciplinary Program in High Performance Computing

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Chesapeake Bay

- Home for more than 3,600 species, including 2,700 plant species alone
- Valuable commercial and recreational resource
- Maryland Department of Natural Resources (DNR) monitors various parameters such as dissolved oxygen, turbidity and chlorophyll.

Courtesy - Maryland DNR Eyes on the Bay webpage

Overview

Our research determined areas of water quality concern and is split into two projects:

Project 1

- Compute and compare failure rates for the stations
- Assess stations' statuses using the Wilcoxon Signed-Rank Test
- Perform a simulation to assess the validity of the above test
- Rank the stations using multiple comparison tests

Project 2

- Conducted trend analyses for nutrients at five stations in the Corsica River

To complement our research, we have developed a data-driven software in R to analyze and display results in a GUI.

This poster covers Project 1.

References and Acknowledgments

- Technical report for Project 1 , Project 2, and GUI: HPCF–2012–12 `www.umbc.edu/hpcf` > Publications.
- For more information on the data, visit the Eyes on the Bay website `www.eyesonthebay.net`
- Technical Report for the Bayesian Ranking Method: HPCF–2011–11 `www.umbc.edu/hpcf` > Publications.
- REU Site: `www.umbc.edu/hpcreu`, funded jointly by NSF and NSA
- DNR, UMBC, HPCF, CIRC

Ranking

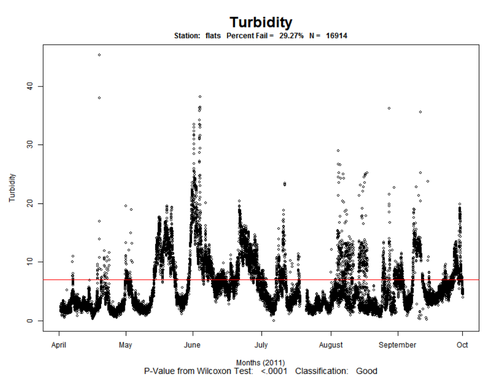
Oxygen (5mg) — Ranks of monitoring stations with respect to percent failure: the Tukey Test (TT), the Bonferroni Test (Bonf), Benjamini–Hochberg Method (BH), and the Bayesian Ranking Method (BRM).

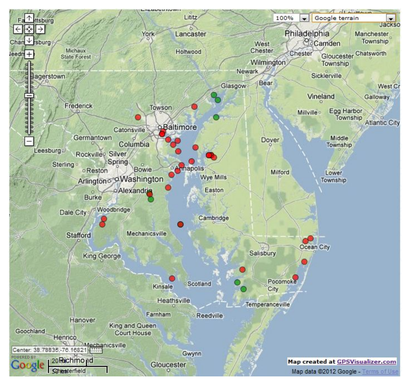
Station Name	% Fail	TT	Bonf	BH		BRM
				% Fail	Mean	
Betterton	0	1	1	1	1	1
Havre de Grace	0	2	1	1	2	2
Flats	0.0001	3	1	3	3	3
⋮	⋮	⋮	⋮	⋮	⋮	⋮
Little Monie	0.8021	36	36	36	36	36
Masonville (bottom)	0.8040	37	36	36	37	37
Goose (bottom)	0.8981	38	38	38	38	38

Ranking

- Ranking methods used multiple comparison tests to control for Type I error
  - Tukey's Test (proportion)
  - Bonferroni (proportion)
  - Bayesian Ranking
  - Benjamini–Hochberg (mean, proportion)
- Benjamini–Hochberg was most useful because it showed ties in the ranking without being too conservative

Stations' Statuses





Picture to the left is an example of the skew in some of the parameters and the picture to the right shows the stations' statuses utilizing the Wilcoxon test on the log-transformed data with the Benjamini-Hochberg rejection method.

Simulation and Adjustment

- Test Statistic: $\mathrm{S} = \left| \sum_{i=1}^{m} \left[R_i \cdot \mathrm{sign}(x_i - thresh) \right] \right|$
  where R_i = rank of $|x_i - thresh|$
- The Wilcoxon Signed-Rank Test assumes the data is symmetric. For non-symmetric data, the True Type 1 Error may be inflated.
- Our simulation study (using $\Gamma(\alpha, \beta)$ to cover a wide range of skewness values) shows that log-transformation substantially reduces the Type I Error.
- Utilized the Benjamini-Hochberg method to control for the familywise Type I Error.