Long-term Trends in Bacteria and Transparency at Nearshore Stations

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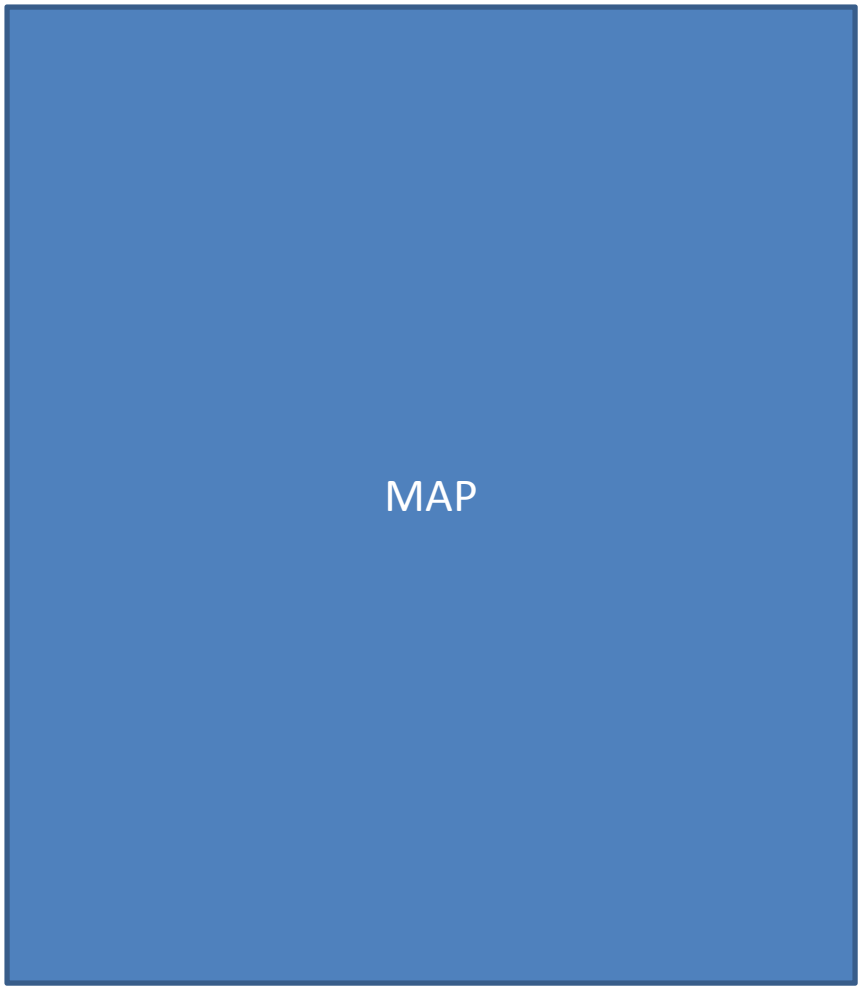
Topics

- Overview of AMP for Nearshore Monitoring
- Data Quality and Aggregation
- Statistical Concepts for Trend Analysis
- Results by Water Quality Variable
- Conclusions
- Future Recommendations

Overview of Nearshore Monitoring

- 8 Long-term Stations since 1999
- 2 Additional Stations added in 2006, 2008
- Weekly Sampling Frequency (after 2002, prior monthly)
- Sampling season May - Oct
- Additional Event and Special Sampling



Measured Variables

- Water Transparency
  - Secchi Depth: many samples “bottomed out”, used frequency < 1.2 m (4 ft – NYSDEC guidance)
  - Turbidity: closely tied to Secchi depth, more accurate measure of transparency
- Bacteria
  - Fecal Coliform: reference standard of 200 cfu/100mL at Class B sites for monthly geomean
  - E. coli: no standard

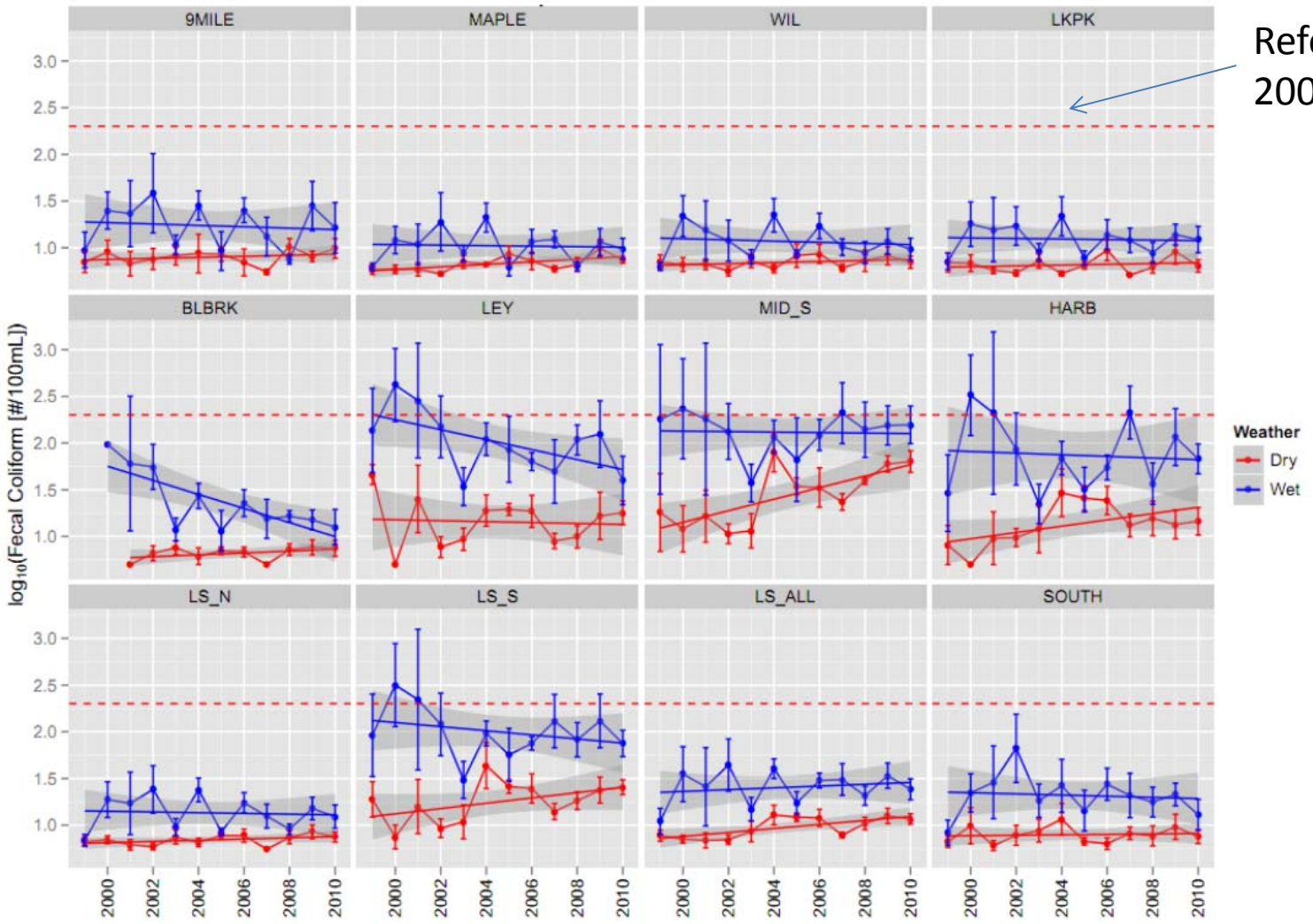
Data Aggregation

- Log-transformed to achieve quasi-normality
- Geometric Means
  - Monthly (used for Seasonal Kendall test)
  - Annual based on monthly geomeans (used for Mann-Kendall test and Linear Regression)
- Hydrologic Conditions
  - Samples categorized by dry/wet weather based on 3-day antecedent precipitation ($P_{3\text{-day}}$) of 0.2 in
- Precipitation Adjusted
  - Normalized samples to $P_{3\text{-day}}$=0.35 in using linear regression of concentration vs. $P_{3\text{-day}}$
- Lake Regions
  - Nearshore stations grouped into Northern and Southern Regions

Trend Analysis Concepts

- Parametric Test
  - Linear regression of annual geomean vs. year
  - Slope represents change in concentration over time
  - Significance of trend depends on significance of slope being different from zero
- Non-parametric
  - Mann-Kendall: change in annual geomeans over time based on ranks
  - Seasonall Kendall: variation of Mann-Kendall where test first applied to individual months, then combined as overall trend test

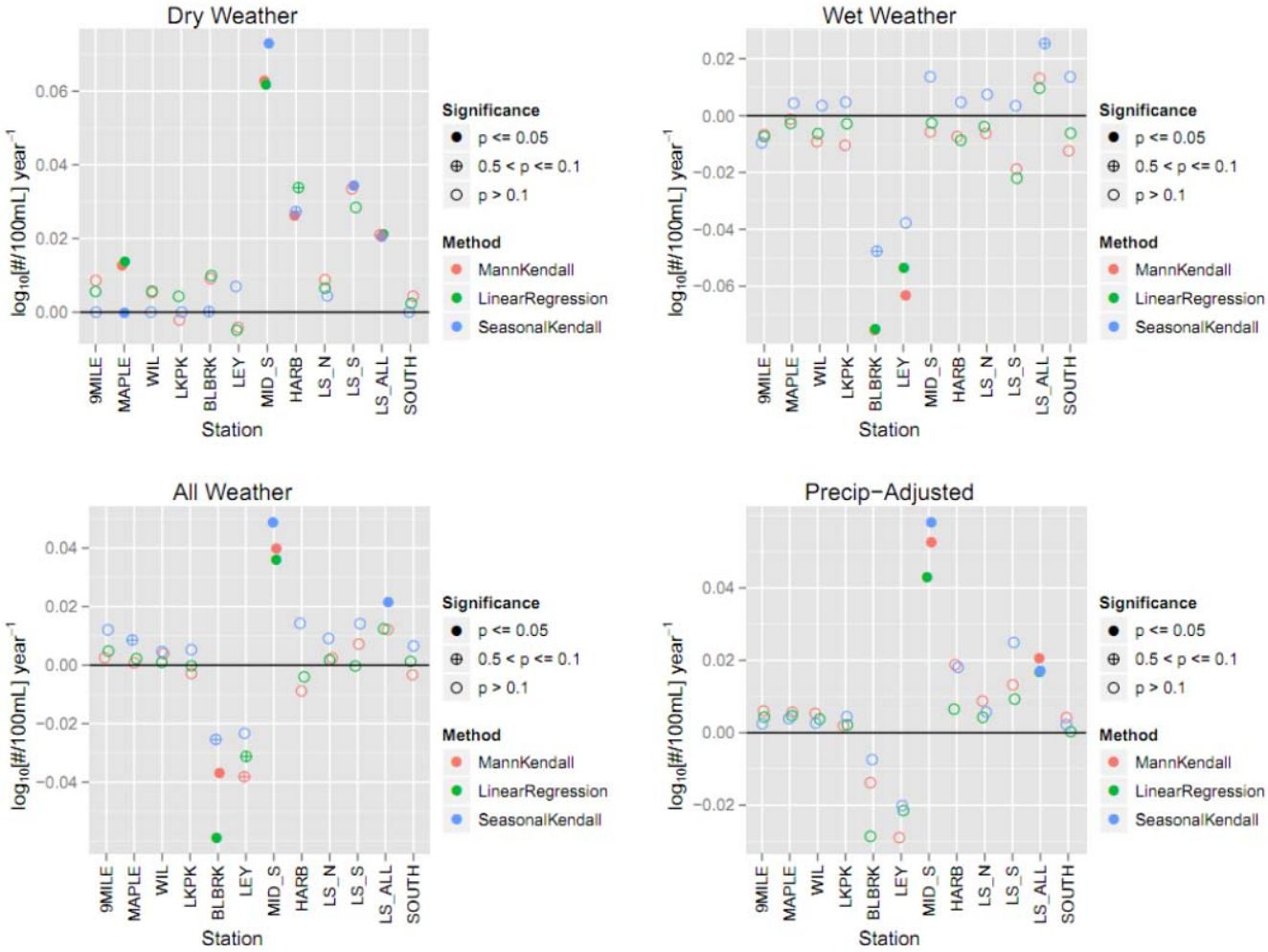
Annual Geomean – Fecal Coliform



Reference Criteria:
200 cfu/100mL

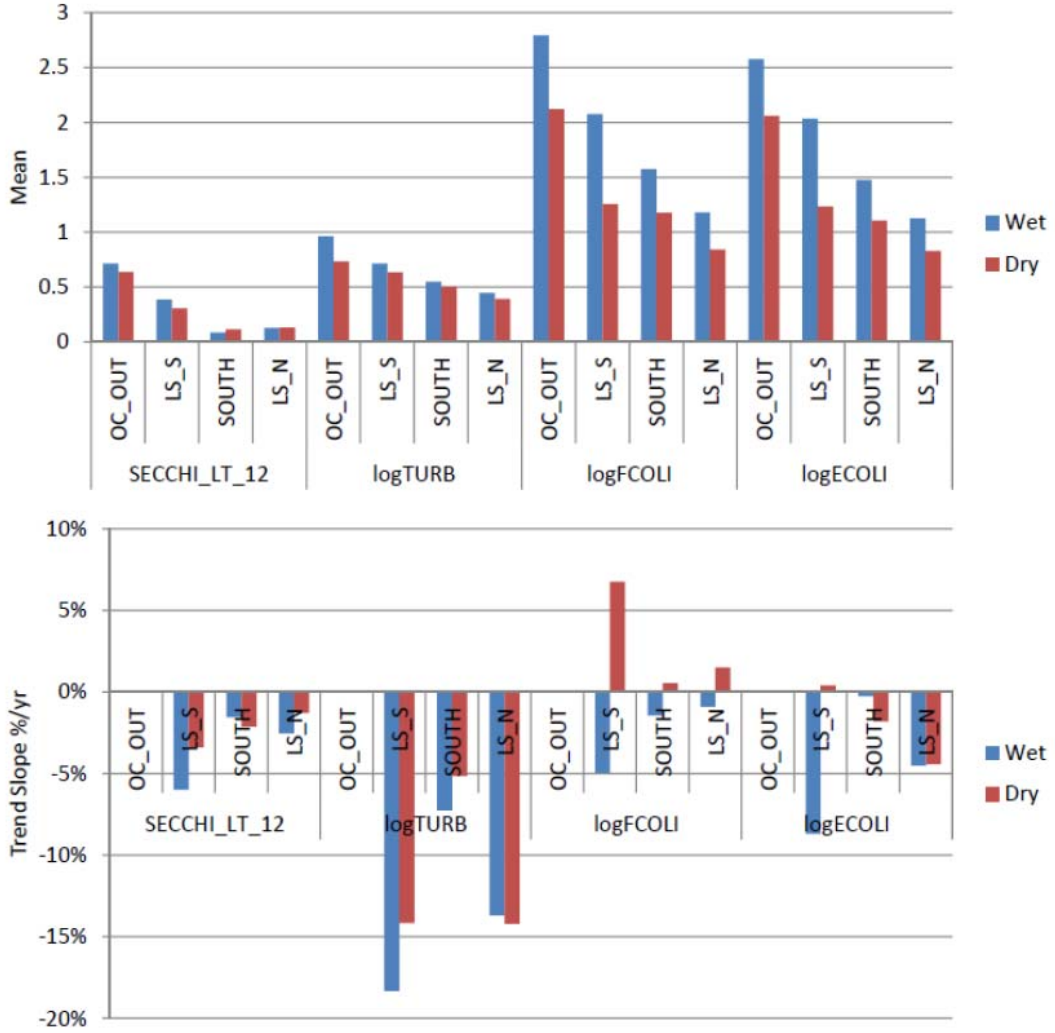
Legend: Time series of annual geometric mean fecal coliform at each site for dry (red) and wet (blue) weather. Error bars denote +/- 1 standard error based on standard deviation of monthly geomeans. Trend lines are linear regressions with 95% confidence intervals.

Trend Slopes – Fecal Coliform



Legend: Slopes and significance of parameter and non-parametric trend tests for each station and weather condition. Symbols denote significance: hollow – not significant, crossed – moderately significant, filled – highly significant. Colors denote test method: red – Mann-Kendall of annual geomean, green – Linear Regression of annual geomean, blue - Seasonal Kendall of monthly geomean.

Summary of Trend Slopes (%/yr)



Trend Slopes = percent of long-term geometric mean per year (% of weekly values per year for Freq Secchi < 1.2 m)
Onondaga Creek Outlet Site (OC_OUT) wes sampled in 2008-2010 (trends not tested).
Stations sorted in south-north direction. LS_N = northern nearshore; LS-S = southern nearshore; SOUTH = South Deep.

Summary of Trend Slopes (%/yr)

Summary of Trend Analysis Results Trend Slopes in Percent Per Year May-September 1999-2010

		Freq. of Secchi Depth < 1.2 m				Turbidity				Fecal Coliform Bacteria				E. Coli Bacteria			
Site	Description	Dry	Wet	All	Adj	Dry	Wet	All	Adj	Dry	Wet	All	Adj	Dry	Wet	All	Adj
9MILE	Ninemile Creek	-2	-2	-2	-2	-13	-12	-13	-12	1	-2	1	1	-5	-4	-6	-5
MAPLE	Maple Bay	-2	-2	-2	-2	-13	-13	-14	-13	3	-1	1	1	-1	-4	-2	-2
WIL	Wilkenson	-1	-2	-1	-1	-14	-12	-13	-13	1	-1	0	1	-4	-5	-4	-4
LKPK	Lake Park	-1	-3	-2	-2	-14	-13	-14	-14	1	-1	0	0	-6	-6	-7	-7
BLBRK	Bloody Brook	-7	-3	-3	-2	-17	-18	-18	-17	2	-16	-13	-6	-5	-14	-11	-5
LS_N	All Northern Sites	-1	-3	-2	-2	-14	-14	-14	-14	2	-1	0	1	-4	-4	-5	-4
LEY	Ley Creek	-4	-7	-7	-6	-16	-19	-17	-16	-1	-12	-7	-5	-2	-13	-9	-7
MID_S	Mid South	-3	-5	-3	-3	-13	-19	-16	-15	15	-1	9	10	3	-6	0	1
HARB	Harbor Brook	-3	-6	-5	-5	-13	-17	-15	-14	8	-2	-1	2	1	-2	-2	0
LS_S	All Southern Sites	-3	-6	-5	-5	-14	-18	-16	-15	7	-5	0	2	0	-9	-4	-2
LS_ALL	All Lakeshore	-2	-3	-3	-2	-14	-15	-15	-14	5	2	3	4	-2	-5	-4	-3
SOUTH	South Deep	-2	-2	-2	-2	-5	-7	-5	-5	1	-1	0	0	-2	0	-1	-1

Significance levels Decreasing p < .05 p < .10 Increasing p<.05 p<.10 Trend Analysis Method: LinearRegression

Trend Slopes expressed as % of values < 1.2 m per year for Secchi and % of long-term geometric mean for turbidity and bacteria

Dry/Wet samples classified based upon 3-day antecedent precipitation at Hancock Airport <> 0.2 inches

Adj. = All data adjusted for correlations with antecedent rainfall by linear regression before performing trend analysis.

Conclusions

- Water clarity is improving lake-wide
- Bacteria decreasing under wet weather at Ley Creek and Bloody Brook
  - CSO and stormwater controls
- Bacteria increasing under dry weather at Mid-South and Harbor Brook
  - Reduced chlorination at WWTF
- Multiple trend detection methods generally agree and lead to robust analysis

Recommendations

- Similar trend analyses at tributary sites
- Update AMP Statistical Framework to include nearshore data
- Refinement of wet/dry weather criteria
- Analysis of individual storm events
- Update AMP Statistical Framework software to utilize new methods for trend detection