NC

Nothing Compares

NORTH CAROLINA

NCSU EcoStream Conference
August 13-16, 2018
Asheville, NC

Determining the Likelihood of Detecting Change in Water Quality Resulting from Stream Restoration Practices over Mitigation Time Frames

Greg Melia and Casey Haywood
NC Department of Environmental Quality
Division of Mitigation Services

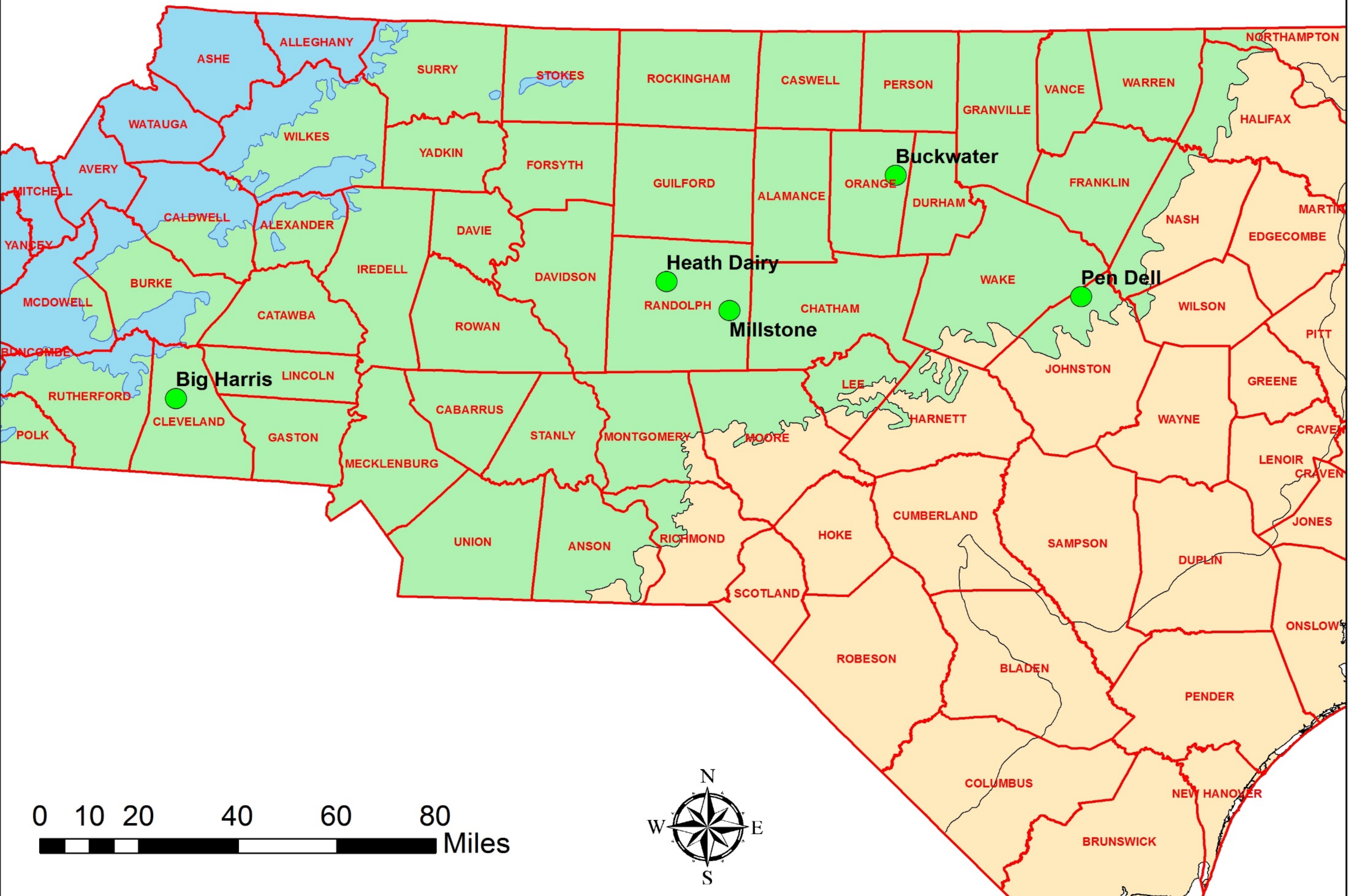
EcoStream Conference
August 13-16, 2018
Asheville, NC

DMS WQ Sites

Project	County	# Reaches	Param	Storm	Base
Heath Dairy	Randolph	2	F,N,S,M	Y	Y
Millstone	Randolph	2	F,N,S,M	Y	Y
Millstone	Randolph	1	F,N,S	Y	Y
Pen Dell	Johnston	1	F		Y
Buckwater	Orange	1	F,N,S	Y	Y
Big Harris	Cleveland	5	F,N,S	Y	Y
Big Harris	Cleveland	8	M		Y

F – Fecal; N – Nutrients; S – Total Suspended Res; M–Macrobenthos

DMS WQ Sites



Buckwater
Heath Dairy
Pen Dell
Millstone
Big Harris
ASHE
ALLEGHANY
SURRY
STOKES
ROCKINGHAM
CASWELL
PERSON
GRANVILLE
VANCE
WARREN
NORTHAMPTON
HALIFAX
WATAUGA
WILKES
YADKIN
FORSYTH
GUILFORD
ALAMANCE
ORANGE
DURHAM
FRANKLIN
NASH
MARTIN
EDGECOMBE
AVERY
MITCHELL
YANCEY
CALDWELL
ALEXANDER
IREDELL
DAVIE
DAVIDSON
RANDOLPH
CHATHAM
WAKE
WILSON
PITT
BURKE
MCDOWELL
CATAWBA
ROWAN
JOHNSTON
GREENE
BUNCOMBE
LINCOLN
RUTHERFORD
CLEVELAND
POLK
GASTON
CABARRUS
STANLY
MONTGOMERY
LEE
HARNETT
MOORE
WAYNE
CRAVEN
LENOIR
MECKLENBURG
CUMBERLAND
JONES
UNION
ANSON
RICHMOND
HOKE
SAMPSON
DUPLIN
SCOTLAND
ONSLOW
ROBESON
BLADEN
PENDER
COLUMBUS
NEW HANOVER
BRUNSWICK
0 10 20 40 60 80
Miles
N
W
E
S

Station Setup and Methods

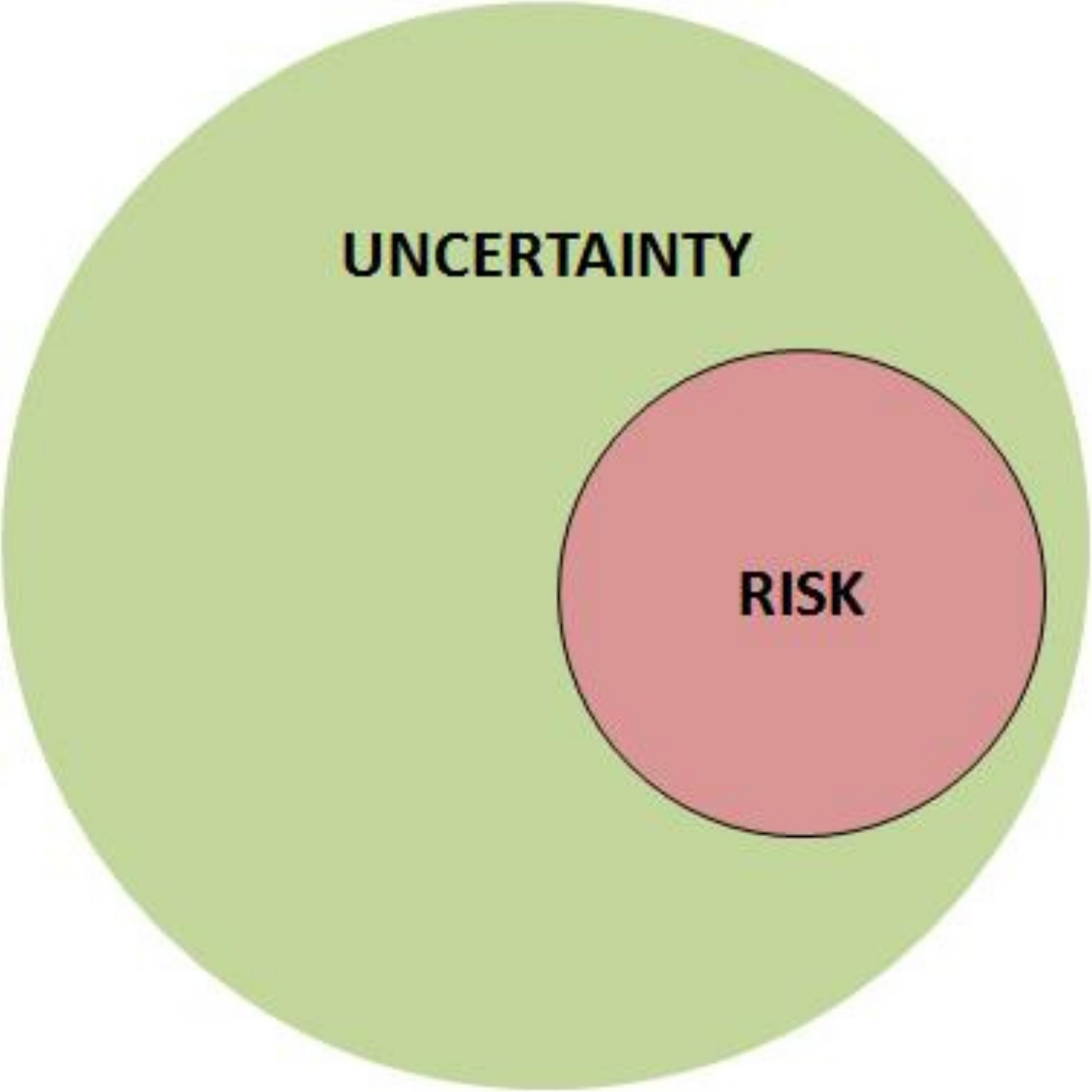
North Carolina Stream Quantification Tool

Data Collection and Analysis Manual

EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

StreamMechanics

The Challenges



Optimizing Water Quality Monitoring Plans

National Nonpoint Source Monitoring Program

Tech NOTES 7

December 2011

Jean Spooner, Steven A. Dressing, and Donald W. Meals. 2011. Minimum detectable change analysis. Tech Notes 7, December 2011. Developed for U.S. Environmental Protection Agency by Tetra Tech, Inc., Fairfax, VA, 21 p. Available online at *www.bae.ncsu.edu/programs/extension/wqg/319monitoring/tech_notes.htm.*

Through the National Nonpoint Source Monitoring Program **(NNPSMP)**, states monitor and evaluate a subset of watershed projects funded by the Clean Water Act Section 319 Nonpoint Source Control Program.

The program has two major objectives:

1. To scientifically evaluate the effectiveness of watershed technologies designed to control nonpoint source pollution
2. To improve our understanding of nonpoint source pollution

NNPSMP Tech Notes is a series of publications that shares this unique research and monitoring effort. It offers guidance on data collection, implementation of pollution control technologies, and monitoring design, as well as case studies that illustrate principles in action.

Minimum Detectable Change Analysis

MDC = Allows you to estimate the amount of change necessary to support statistically reliable change detection. This is based on the variability observed in the parameters distribution.

Optimizing Water Quality Monitoring Plans

Big Harris Pre-con Water Quality Monitoring Scope

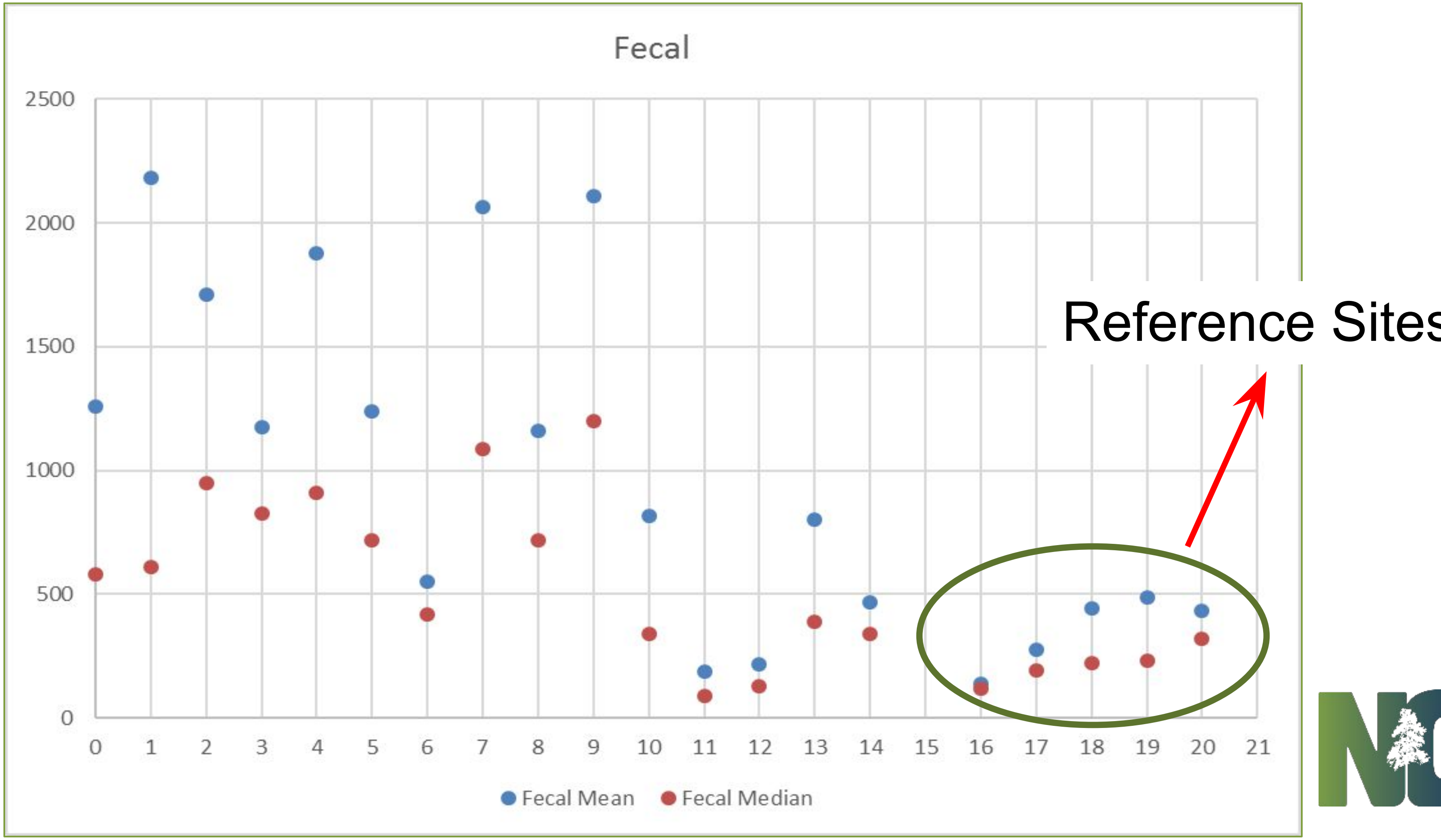
Station	0	1	2	3	4	5a	6	7	8	9	10	11	12	13	14	16	17	18	19	20
Fecal	green	yellow	yellow	green	green	green	green	yellow	green	green	yellow	green	green	yellow	green	green	yellow	green	green	green
Cond	green	yellow	yellow	green	green	green	green	yellow	green	green	yellow	green	green	yellow	green	green	yellow	green	green	green
Solids	green	yellow	yellow	green	green	green	green	yellow	yellow	yellow	yellow	green	green	yellow	green	green	yellow	green	green	green
NH3	green	yellow	yellow	green	green	green	green	yellow	green	green	yellow	green	green	yellow	green	green	yellow	green	green	green
TKN	green	yellow	yellow	green	green	green	green	yellow	green	green	yellow	green	green	yellow	green	green	yellow	green	green	green
NOx	green	yellow	yellow	green	green	green	green	yellow	green	green	yellow	green	green	yellow	green	green	yellow	green	green	green
TP	green	yellow	yellow	green	green	green	green	yellow	green	green	yellow	green	green	yellow	green	green	yellow	green	green	green
Macro	green	green		green	green	green	green		green	green	green			green	green	green	green	green	green	green
Fish	green			green	green	green	green	green		green	green			green	green		green		green	

Baseflow	green
Base and Stormflow	yellow

Optimizing Water Quality Monitoring Plans

Criteria and Analyses Applied to Pre-con Data

- ❑ Are the existing levels of concern?



Optimizing Water Quality Monitoring Plans

Criteria and Analyses Applied to Pre-con Data

- MDC values ≥ 50% were considered too high

Example : Variability in data pre-construction data for TSS at station 4 produced an MDC of 81%.

High MDC (low probability of reliable change detection)

	TSS mg/L
MDC	11.86
MDC%	81

Optimizing Water Quality Monitoring Plans

Criteria and Analyses Applied to Pre-con Data

- ❑ Opportunity to address the bulk of the stressors.
- ❑ Representation by another station.

The application of these criteria and the analyses performed on the pre-con data converted the scope from this…

Optimizing Water Quality Monitoring Plans

Big Harris Pre-con Water Quality Monitoring Scope

Station	0	1	2	3	4	5a	6	7	8	9	10	11	12	13	14	16	17	18	19	20
Fecal	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow	Baseflow
Cond	Baseflow	Base and Stormflow	Base and Stormflow	Baseflow	Baseflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Baseflow
Solids	Baseflow	Base and Stormflow	Base and Stormflow	Baseflow	Baseflow	Baseflow	Baseflow	Base and Stormflow	Base and Stormflow	Base and Stormflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Baseflow
NH3	Baseflow	Base and Stormflow	Base and Stormflow	Baseflow	Baseflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Baseflow
TKN	Baseflow	Base and Stormflow	Base and Stormflow	Baseflow	Baseflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Baseflow
NOx	Baseflow	Base and Stormflow	Base and Stormflow	Baseflow	Baseflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Baseflow
TP	Baseflow	Base and Stormflow	Base and Stormflow	Baseflow	Baseflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Base and Stormflow	Baseflow	Baseflow	Baseflow
Macro				Baseflow		Baseflow	Baseflow			Baseflow	Baseflow			Baseflow	Baseflow					
Fish				Baseflow		Baseflow	Baseflow			Baseflow	Baseflow			Baseflow	Baseflow					

Baseflow	(green)
Base and Stormflow	(yellow)

Optimizing Water Quality Monitoring Plans

Big Harris Post-con Water Quality Monitoring Scope

Station	2	3	5a	6	8	9	10	13	14		
Fecal										Base and Storm	
Cond										Baseflow	
Solids										Stormflow	
NH3											
TKN											
NOx											
TP											
Macro											
Fish											

Optimizing Water Quality Monitoring Plans

Criteria and Analyses Applied to Pre-con Data

- ❑ Data driven.
- ❑ Technically Sound
- ❑ ~50% cost-scope reduction between pre and post
- ❑ Optimized.

Questions that Need to be Addressed

How do we arrive at appropriate performance standards and optimize post-construction sampling plans?

DMS Monitoring Plan and Objectives

Project	County	# Reaches	Param	Storm	Base
Heath Dairy	Randolph	2	F,N,S,M	Y	Y
Millstone	Randolph	2	F,N,S,M	Y	Y
Millstone	Randolph	1	F,N,S	Y	Y
Pen Dell	Johnston	1	F		Y
Buckwater	Orange	1	F,N,S	Y	Y
Big Harris	Cleveland	5	F,N,S	Y	Y
Big Harris	Cleveland	8	M		Y

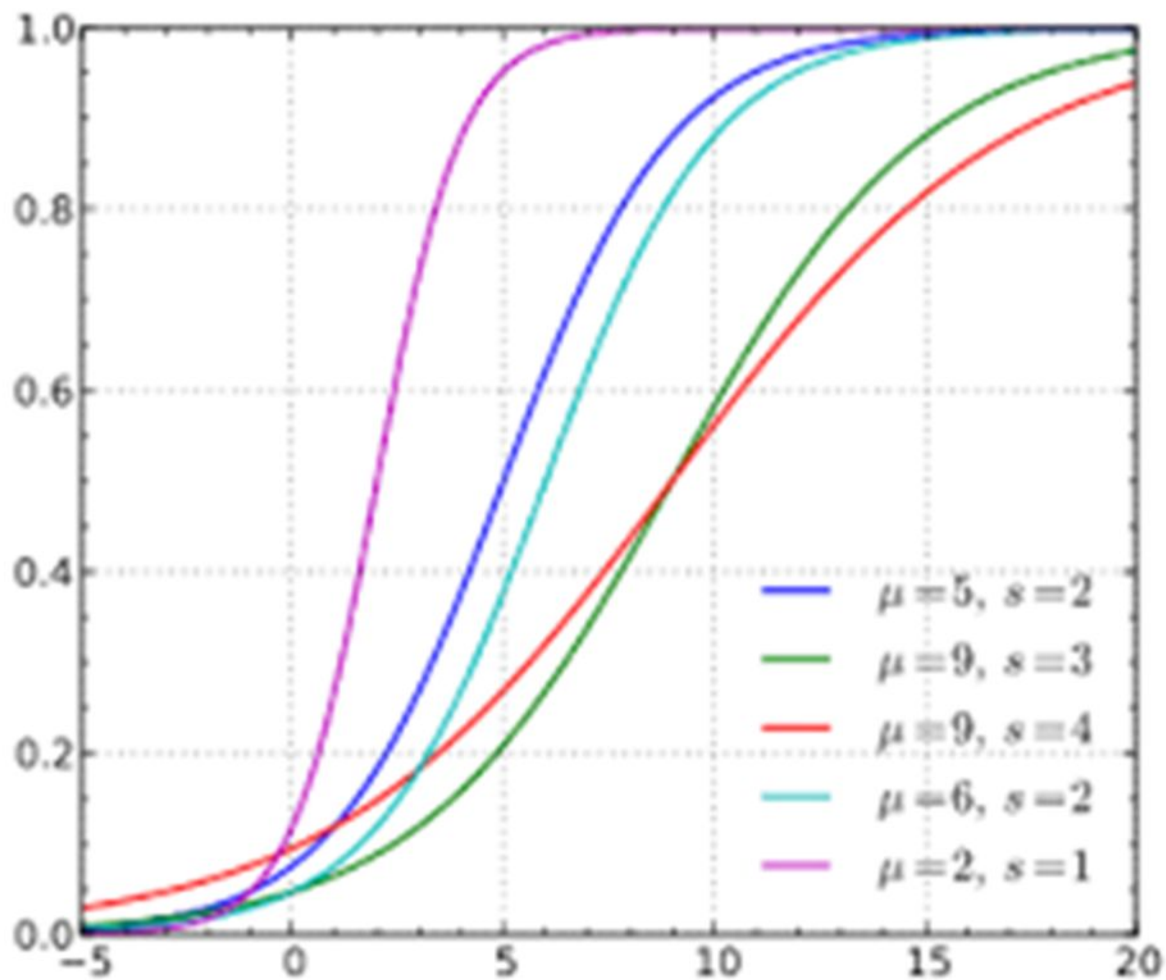
F – Fecal; N – Nutrients; S – Total Suspended Res; M–Macrobenthos

Heath Dairy – NCSU (D.E. Line) larger reach showed storm load reductions ranging from 41 to 67% for nutrients and solids. Smaller reach only demonstrated reductions in NH3/4

DMS Monitoring Plan and Objectives

Multivariate Logistic Regression Model

Take the data set of 30 or so reaches and regress against the 3 or 4 most influential explanatory variables



$$\ln[Y/(1-Y)] = a + b_1X_1 + b_2X_2 + b_3X_3 \ldots$$

DMS Monitoring Plan and Objectives

- **Objective 3**

Use the same data to augment/calibrate existing models and tools to improve their predictive capability hopefully reducing the need for direct measurement.

Acknowledgements and Citations

- Casey Haywood –DMS
- Jamie Blackwell – NCSU and DMS.
- Dan Line - NCSU
- Jean Spooner - NCSU
- DMS Management.

Jean Spooner, Steven A. Dressing, and Donald W. Meals. 2011. Minimum detectable change analysis. Tech Notes 7, December 2011. Developed for U.S. Environmental Protection Agency by Tetra Tech, Inc., Fairfax, VA, 21 p.

Daniel E. Line 2015. Effects of Livestock Exclusion and Stream Restoration on the Water Quality of a North Carolina Stream. ASABE Vol. 58(6): 1547-1557

Terziotti, Silvia, Capel, P.D., Tesoriero, A.J., Hopple, J.A., and Kronholm, S.C., 2018, Estimates of nitrate loads and yields from groundwater to streams in the Chesapeake Bay watershed based on land use and geology: U.S. Geological Survey Scientific Investigations Report 2017–5160, 20 p., https://doi.org/10.3133/sir20175160.

DMS S&A Website

https://deq.nc.gov/about/divisions/mitigation-services/dms-science-data