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

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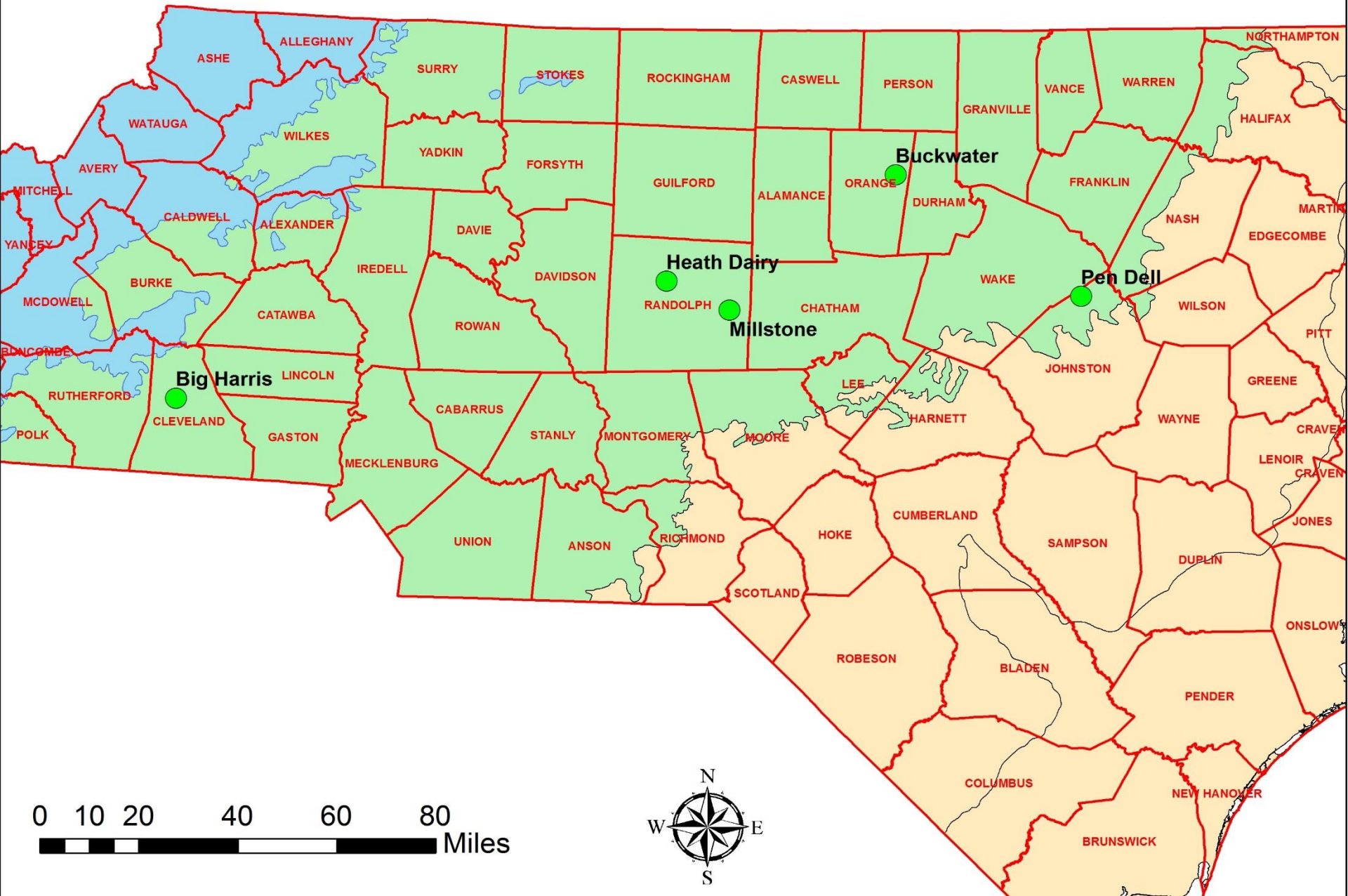
DMS WQ Sites

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


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

Station Setup and Methods

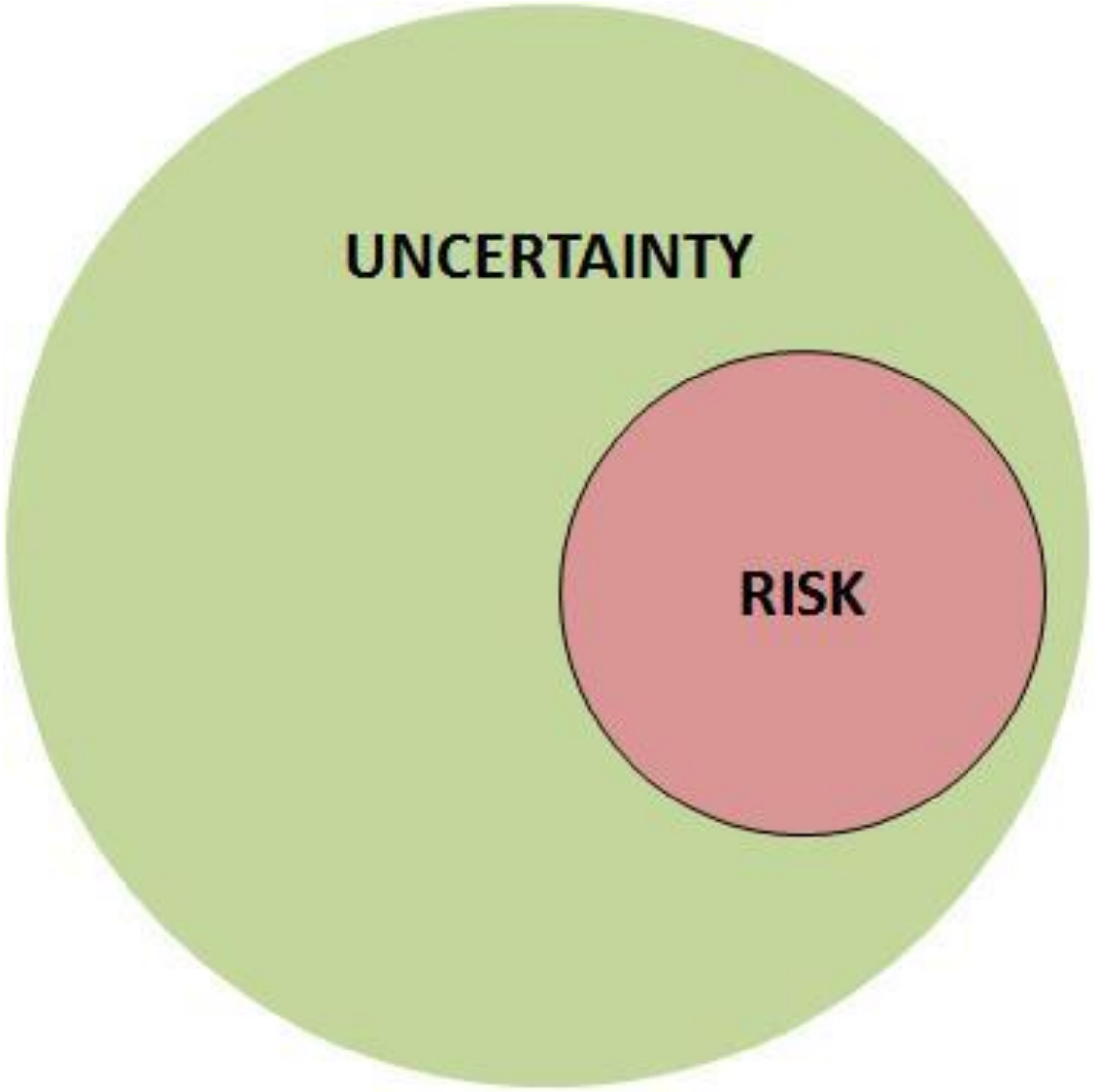
North Carolina Stream Quantification Tool

Data Collection and Analysis Manual

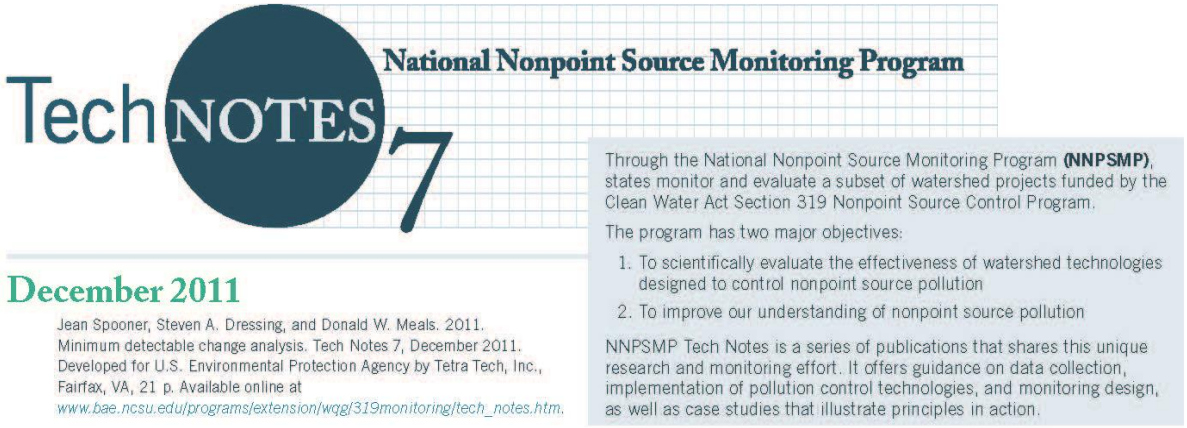
EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

StreamMechanics

The Challenges



Optimizing Water Quality Monitoring Plans



National Nonpoint Source Monitoring Program

TechNOTES 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/wqgf/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

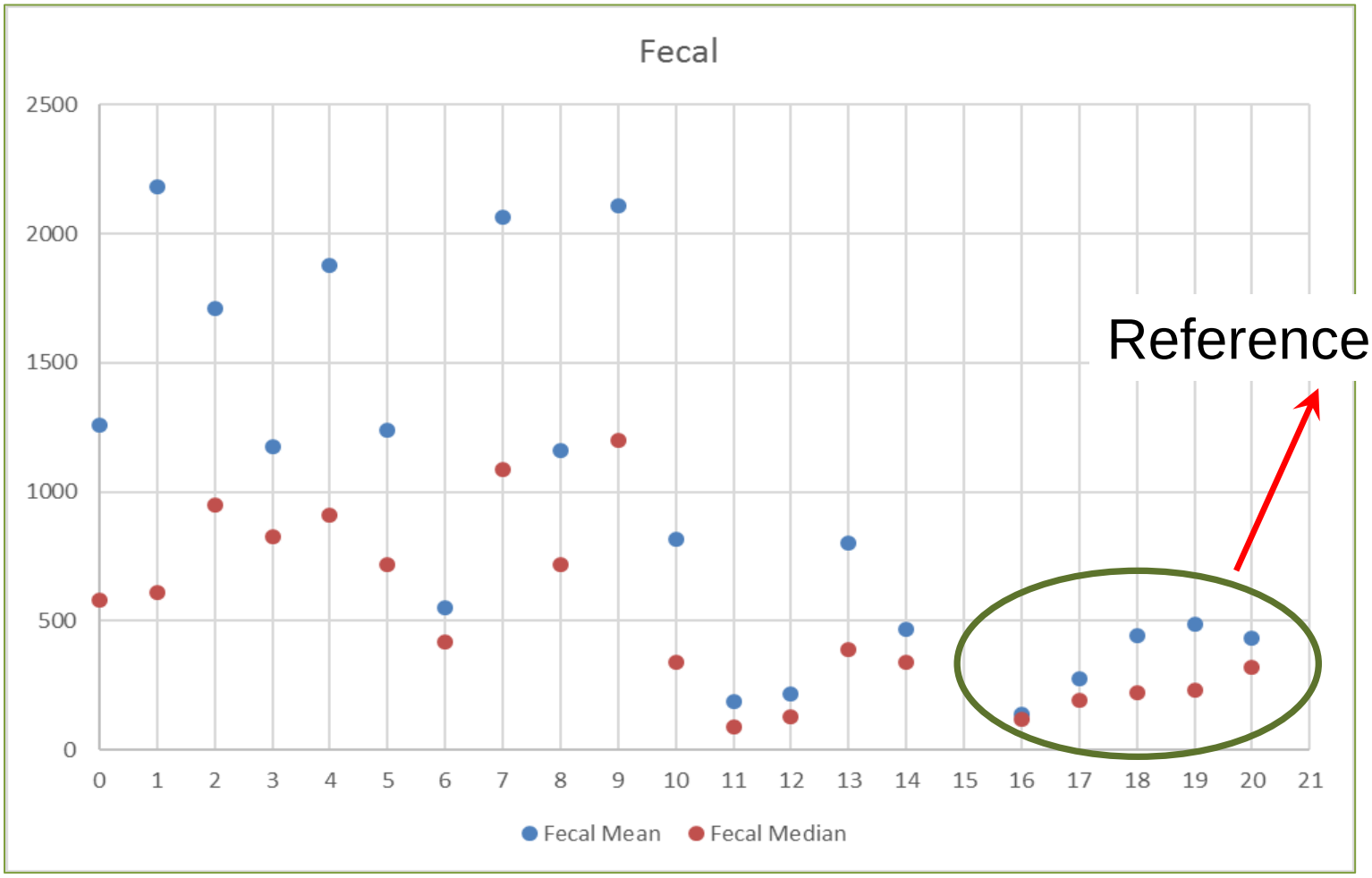
Station	0	1	2	3	4	5a	6	7	8	9	10	11	12	13	14	16	17	18	19	20
Fecal																				
Cond																				
Solids																				
NH3																				
TKN																				
NOx																				
TP																				
Macro																				
Fish																				

Baseflow	
Base and Stormflow	

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

- Proposed restoration treatment(s) for reach(s) represented by sampling have the opportunity to address the main stressors

Example: Constraints or landowners will not permit stabilization of ephemeral gullies that are producing the bulk of the sediment load. Does it make sense to expect meaningful TSS reductions?

Optimizing Water Quality Monitoring Plans

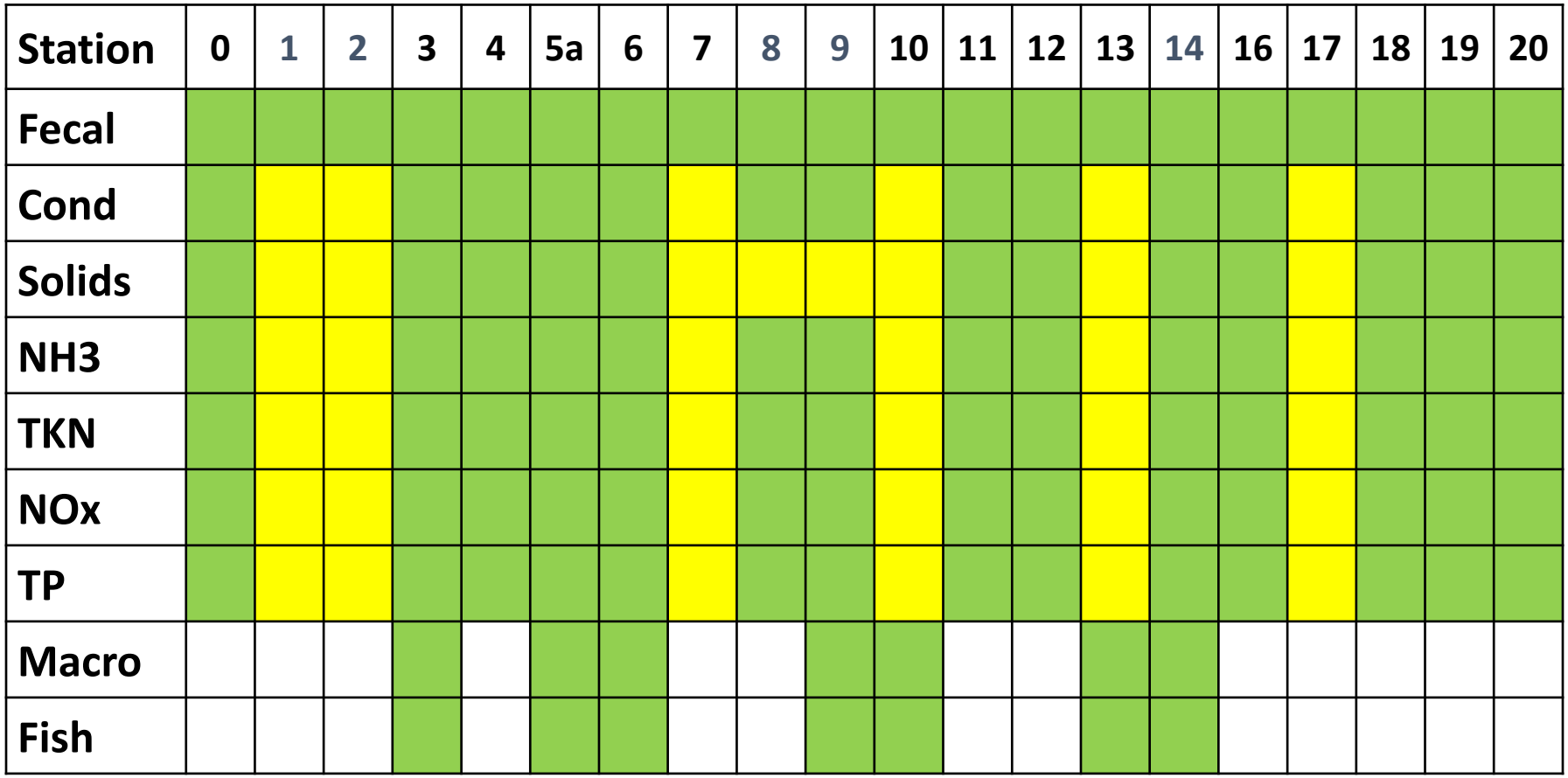
Criteria and Analyses Applied to Pre-con Data

- Pre-con data indicates one or more other stations will adequately represent the station that was dropped.

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



Baseflow	
Base and Stormflow	

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

- **Overarching Goal of DMS Plan**.

  Provide information and data resources to the mitigation/restoration community that will assist practitioners in making decisions about the inclusion of water quality goals and performance standards at the reach scale and to augment models and tools with quality data.

  This will reduce the need for direct measurement of water quality in the long run.

DMS Monitoring Plan and Objectives

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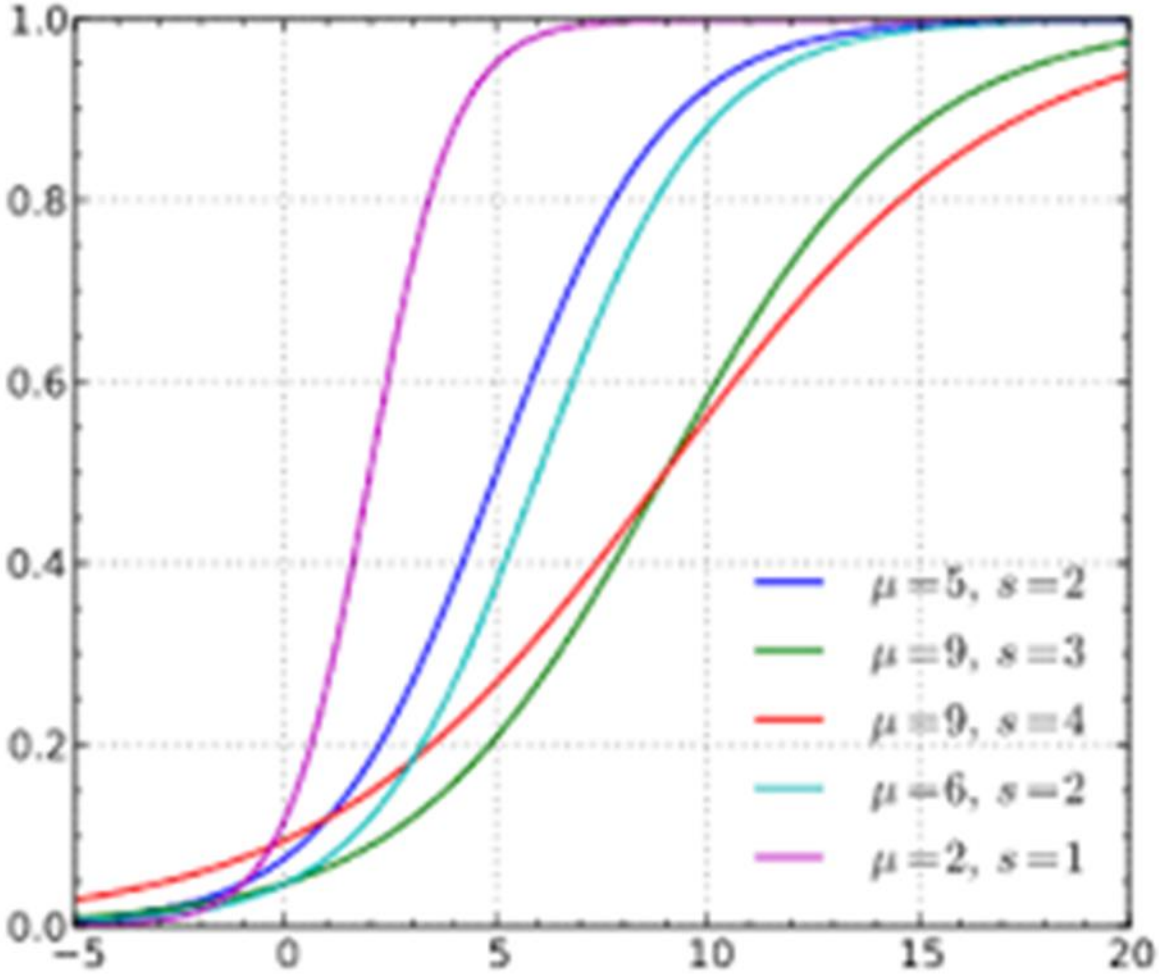
F – Fecal; N – Nutrients; S – Total Suspended Res; M–Macrobenthos

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 given its challenges.

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