Are water quality changes detectable post stream restoration?

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WRRI, Raleigh NC. March 23 – 24, 2022
Objectives

Insight based on our current findings in relation to our objectives 1 & 3:

1. Provide case examples of water quality response to restoration.

2. Gain understanding the relative efficacy of different practices

3. Gain understanding of the time frames of improvement & their sustainability.

4. Utilize data collected to potentially calibrate current models in use in mitigation plans.

5. Gain an understanding of the reach and watershed attributes that inform the detection of change in water quality to help refine stated mitigation plan goals (i.e. examine a Gradient of “signal to noise”)

Case Study: Buckwater Site

Hillsborough, NC - Orange County

- Overall project mixture of Restoration and Enhancement
- Approximately 12,600 feet, overall drainage of 3.53 mi²
- T4 is reach subject to WQ monitoring
Buckwater Site: Reach T4

- Project reach length 820 ft.
- Overall drainage 74 Acres
- Upper watershed 20 acres
- T4 has lower watershed noise

Water Quality Monitoring Period
Pre – 1.5 years
Post – 2 years
Reach T4 Watershed Characteristics

- Watershed above upper WQ station is completely forested.
  - This is a low watershed noise case example.

- 30 ac. of the entire 74 ac. watershed had stressors.
  - 68% of the stressors were within the treatment area.

What were some of the major stressors to the watershed?
Buckwater Stressors: Reach T4

Livestock

Was the main lateral drainage in Reach T4.

Photo Courtesy of: Wildlands Engineering
Buckwater Stressors: Reach T4

Eutrophic Pond
Drains into Reach T4.

Photo Courtesy of: Wildlands Engineering
Buckwater Stressors: Reach T4

Floodplain Disconnection
Reach T4 was incised.

Photo Courtesy of: Wildlands Engineering
Water Quality Station Setup
Water Quality Station Setup and Methods

**Why use an ISCO autosampler?**

- Avoid storm chasing
- Samples programmed to collect as flow proportional composite sample in base or storm flow conditions.
- Discharge calculated based on site specific rating curve derived from weir equations or dilution gauging.
- Integrates precipitation and stage data.

ISCO rain gauge

ISCO autosampler
Cross-section
Install stage plate
Secure sampling equipment

Install ISCOs
Program ISCOs

Site specific rating curve
Buckwater Reach T4 – Total Suspended Solids

Total Suspended Solids (mg L\(^{-1}\))

**Buckwater TSS Concentration**

- **Upstream**: n = 59
- **Downstream**: n = 37

Significant Median Change of 74%

\(p\)-value = 6.8e\(^{-5}\)
Buckwater Reach T4 – Total Phosphorus

**Buckwater TP Concentration**

- **n = 37**
- **n = 53**

- **n = 60**
- **n = 21**

**Significant Median Change of 79%**

- **p-value = 2.8e-9**
Buckwater Reach T4 – Total Nitrogen

Significant Median Change of 64%
p-value = 1.2e^{-13}

Total Nitrogen (mg L^{-1})

Upstream: n = 60
Downstream: n = 21

Upstream: n = 37
Downstream: n = 53
**Buckwater Reach T4 – Total Organic Nitrogen**

**Significant Median Change of 75%**

$p$-value = 9.2e-10

- Upstream: n = 60
- Downstream: n = 53

- Pre
- Post

**Buckwater TON Concentration**

Total Organic Nitrogen (mg L\(^{-1}\))
**Buckwater Reach T4 – Nitrate + Nitrite**

Significant Median Change of 45%

\[ p\text{-value} = 4.2 \times 10^{-6} \]

Upstream: \[ n = 60 \]

Downstream: \[ n = 53 \]

\[ n = 21 \]
Buckwater Reach T4 – Ammonia

Significant Median Change of 70%

$p$-value = $4.2 \times 10^{-7}$
Reach T4 – Total Fecal Coliform Bacteria

Significant Mean Change of 74%  
*p-value = 3.3e^{-7}*

$n = 17$  
$n = 40$  
$n = 33$  
$n = 55$
Buckwater Site: Reach T3 (Fecal Only)

- 1,336 project linear feet
- Overall drainage 141 acres
Reach T3 – Total Fecal Coliform Bacteria

Significant Median Change of 53%
p-value = 0.0015

T3 Fecal Coliform Bacteria Concentration

Upstream

Downstream

n = 33
n = 40
n = 34
n = 51
**Summary of Results**

- Buckwater Reach T4 demonstrated a low watershed noise case study with reductions in nutrients and suspended solids:
  - 64 – 79% reduction in all pollutants in the post sampling compared to pre-construction conditions.
  - 45% reductions for Nitrate and Nitrite (NO$_2$/NO$_3$).
  - Decreased concentrations and variability of nutrients and solids in post restoration conditions.
    - Attributed to stream reconnect, vegetated buffers, cattle exclusion.

- **Significant reduction in fecal coliform (53 – 70% reduction) due to cattle exclusion at both reach T3 and T4.**
Moving Forward

Goals we are still working towards:

- Include projects with different levels of signal to noise.
- Examine effects of different restoration treatments?
- Calculate and compare discharge and loads.
- Analyze change in hydrologic residence times.
DMS Water Quality Dashboard

https://ncdms.shinyapps.io/DMS_Data_Dashboard/?ga=2.244140805.1888177155.1629207544-1820359697.1629207544
DMS Water Quality Dashboard
Acknowledgements

DMS Science & Analysis

- Periann Russell
- Greg Melia
- Joe Famularo
- Lin Xu

DMS Mitigation Provider:

- Wildlands Engineering, Inc.
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https://deq.nc.gov/about/divisions/mitigation-services