Are water quality changes detectable post stream restoration?

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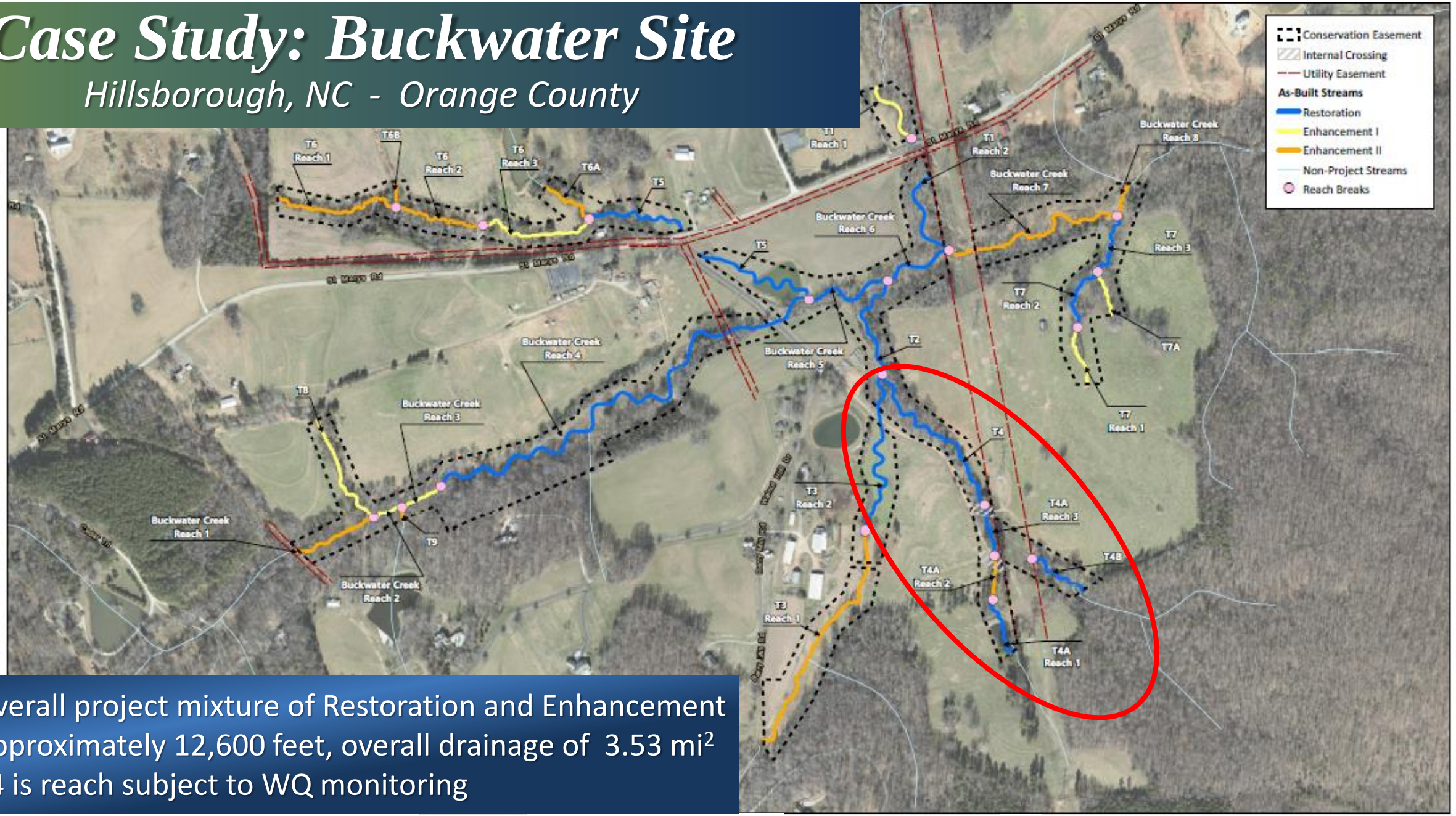
Objectives

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

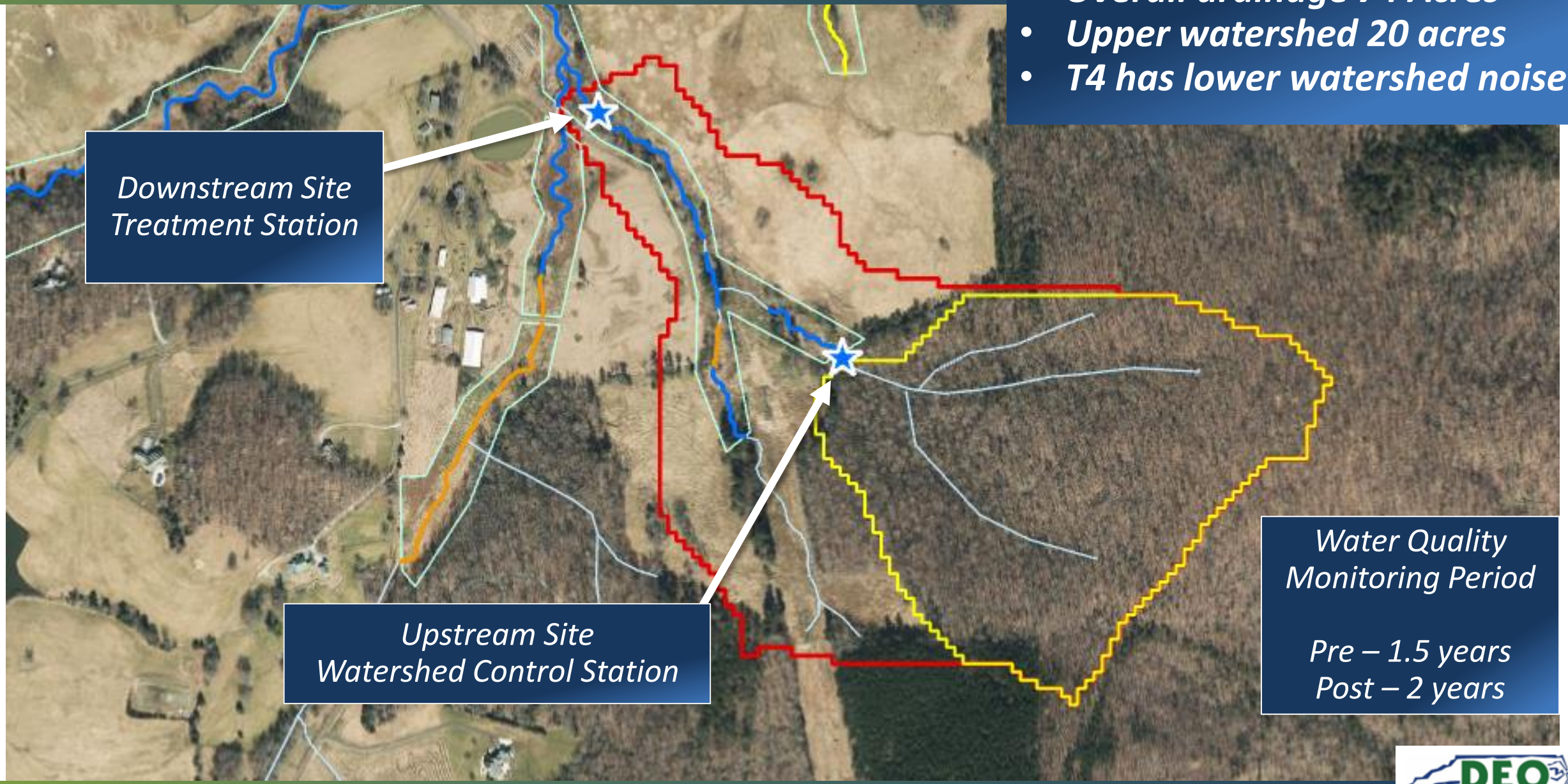
Hillsborough, NC - Orange County



- Overall project mixture of Restoration and Enhancement
- Approximately 12,600 feet, overall drainage of 3.53 mi^2
- 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*



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

Photo Courtesy of: Wildlands Engineering

Livestock

Was the main lateral drainage in Reach T4.

Buckwater Stressors: Reach T4

Photo Courtesy of: Wildlands Engineering

Eutrophic Pond

Drains into Reach T4.

Buckwater Stressors: Reach T4

Photo Courtesy of: Wildlands Engineering

Floodplain Disconnection

ReachT4 was incised.

Water Quality Station Setup

Water Quality Station Setup and Methods

Why use an ISCO autosampler?

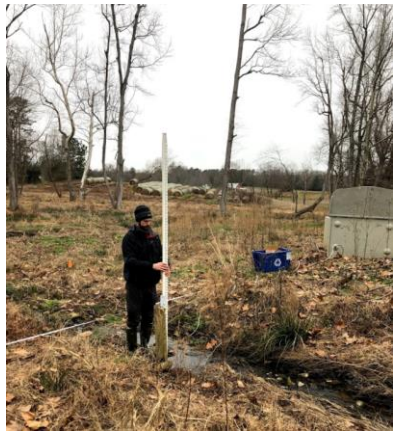
- Avoid storm chasing
- Samples programed to collect as flow proportional composite sample in base or storm flow conditions.
- Discharge calculated based on site specific rating curve derived from weir equations or dilution gauging.
- Integrates precipitation and stage data.

ISCO autosampler

ISCO rain gauge

Water Quality Station Setup and Methods

Cross-section



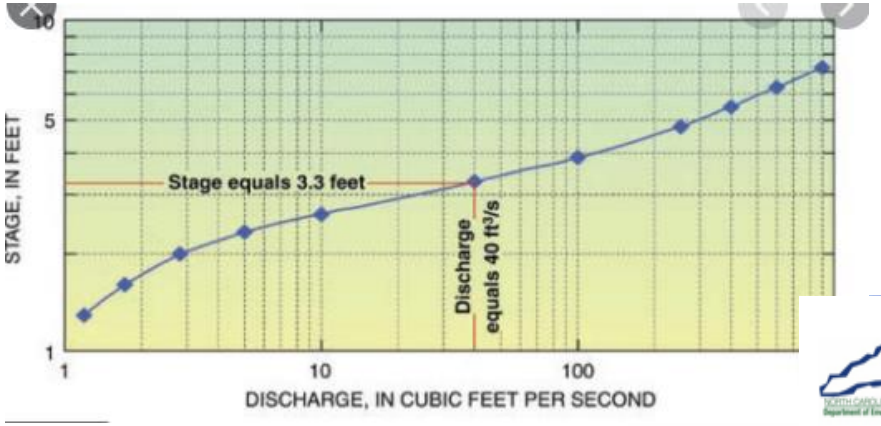
Install stage plate

Secure sampling equipment

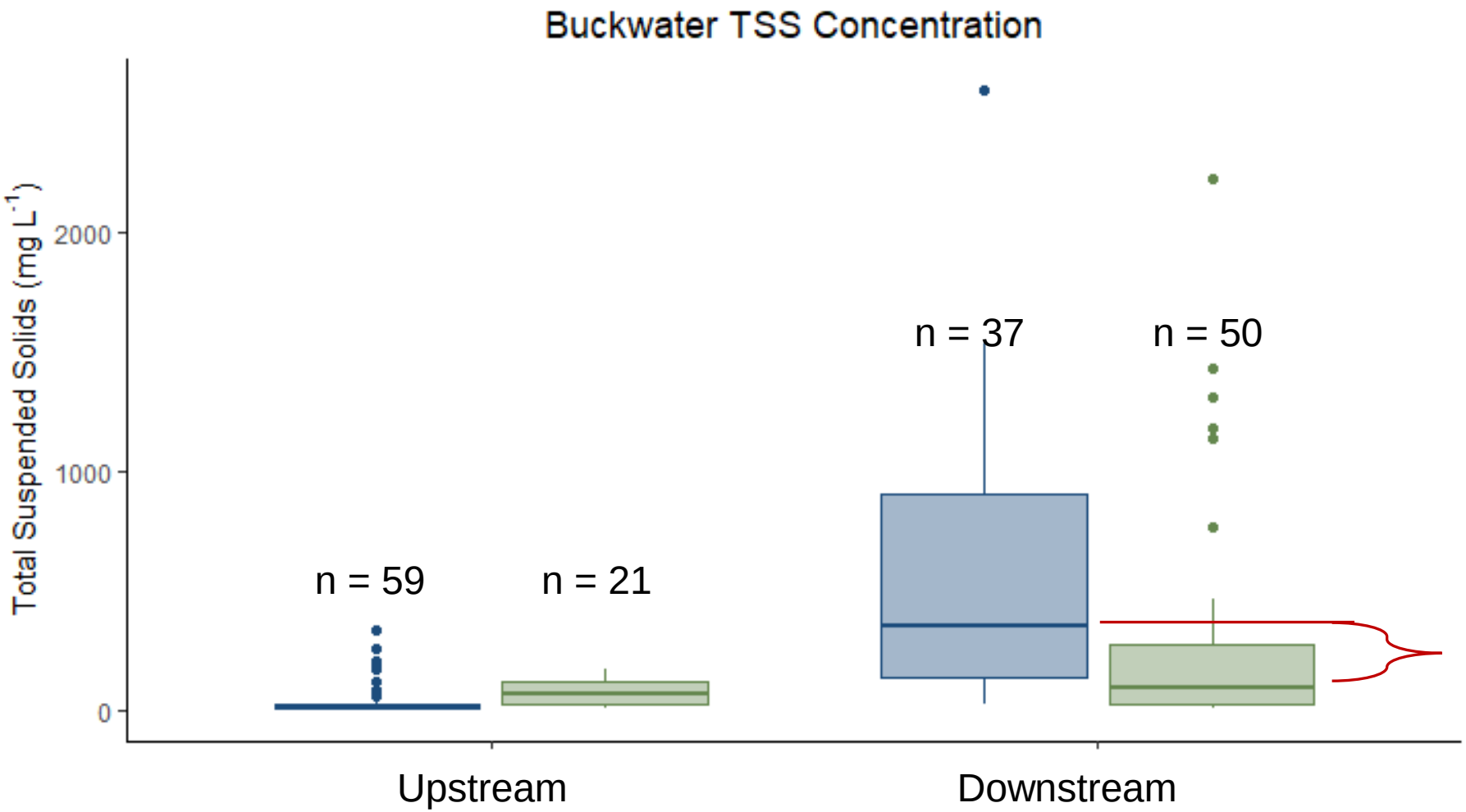
Install ISCOs

Program ISCOs

Site specific rating curve

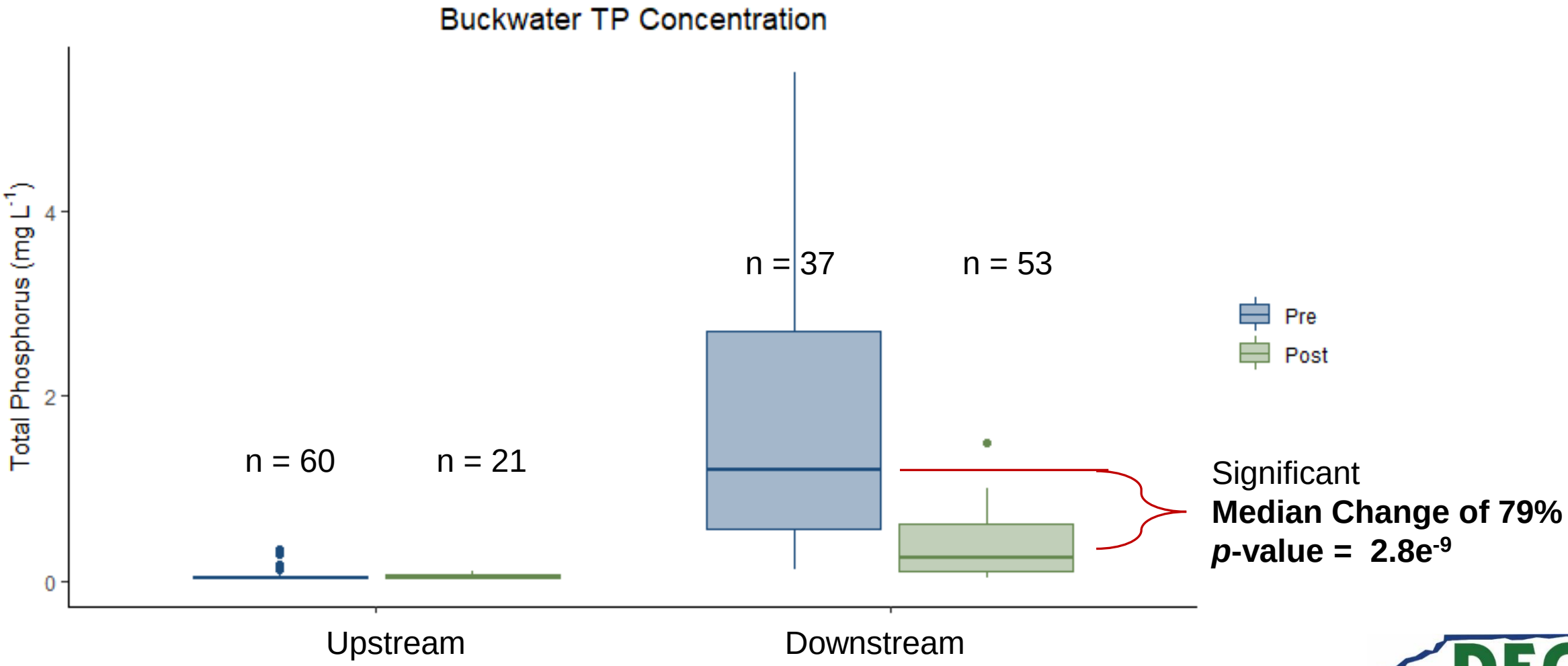


Buckwater Reach T4 – Total Suspended Solids



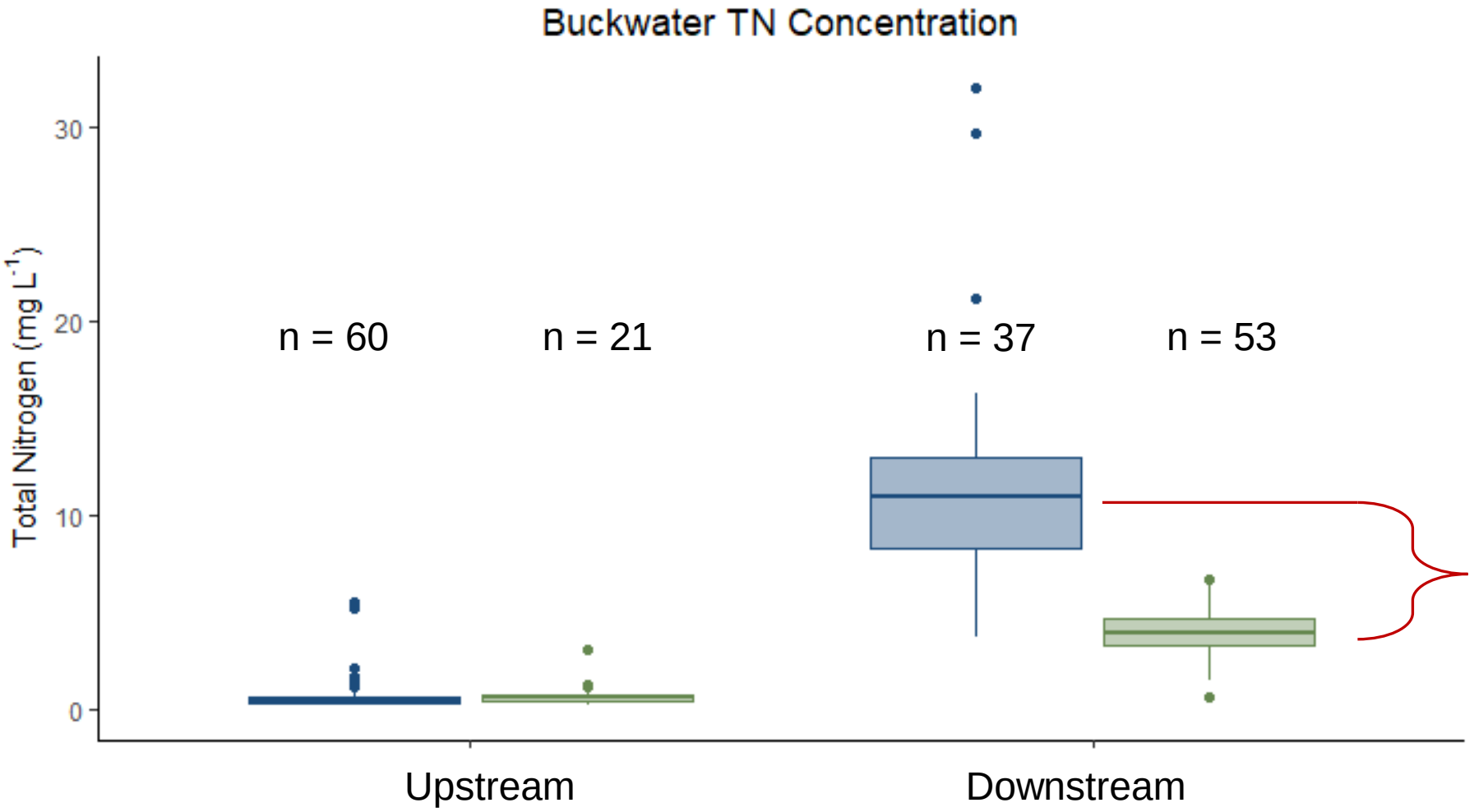
Significant
Median Change of 74%
***p*-value = 6.8e^{-5}**

Buckwater Reach T4 – Total Phosphorus



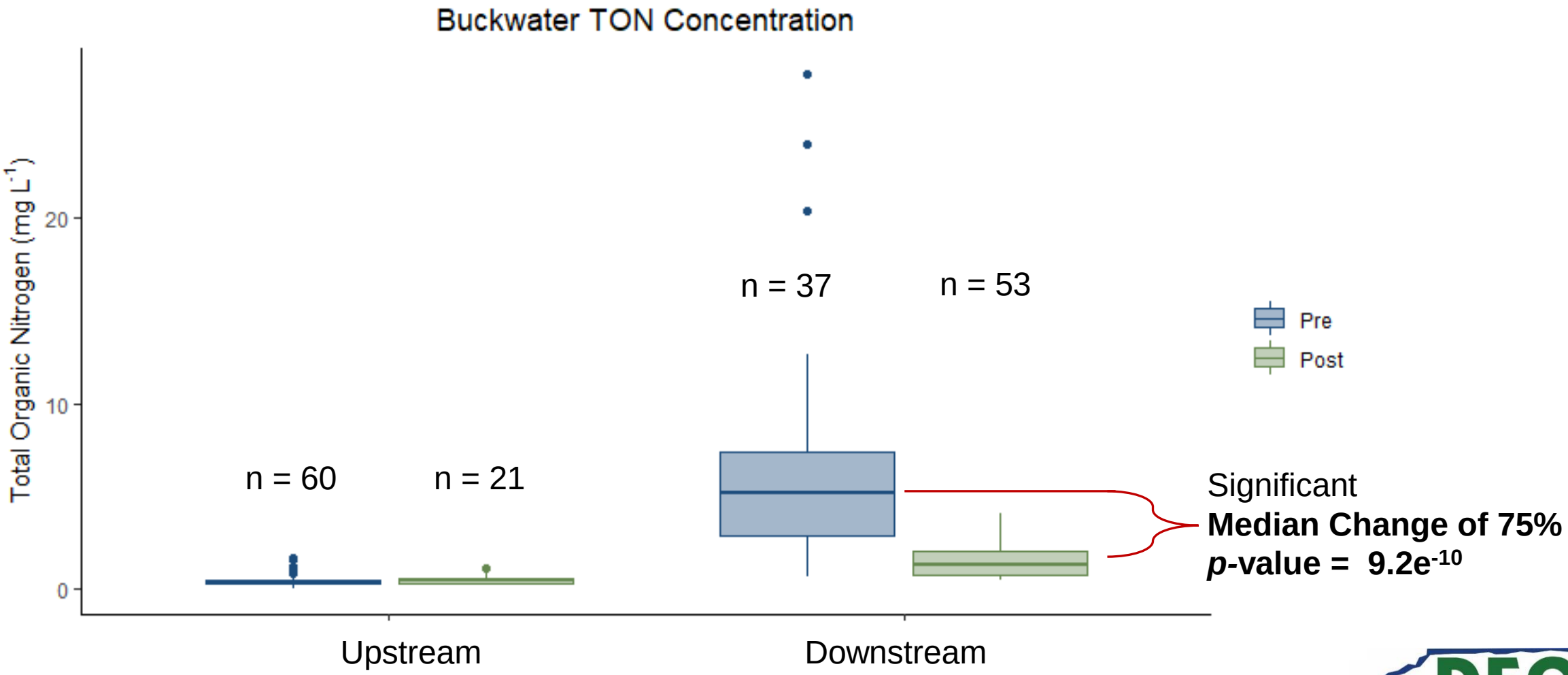
Significant
Median Change of 79%
***p*-value = 2.8e^{-9}**

Buckwater Reach T4 – Total Nitrogen



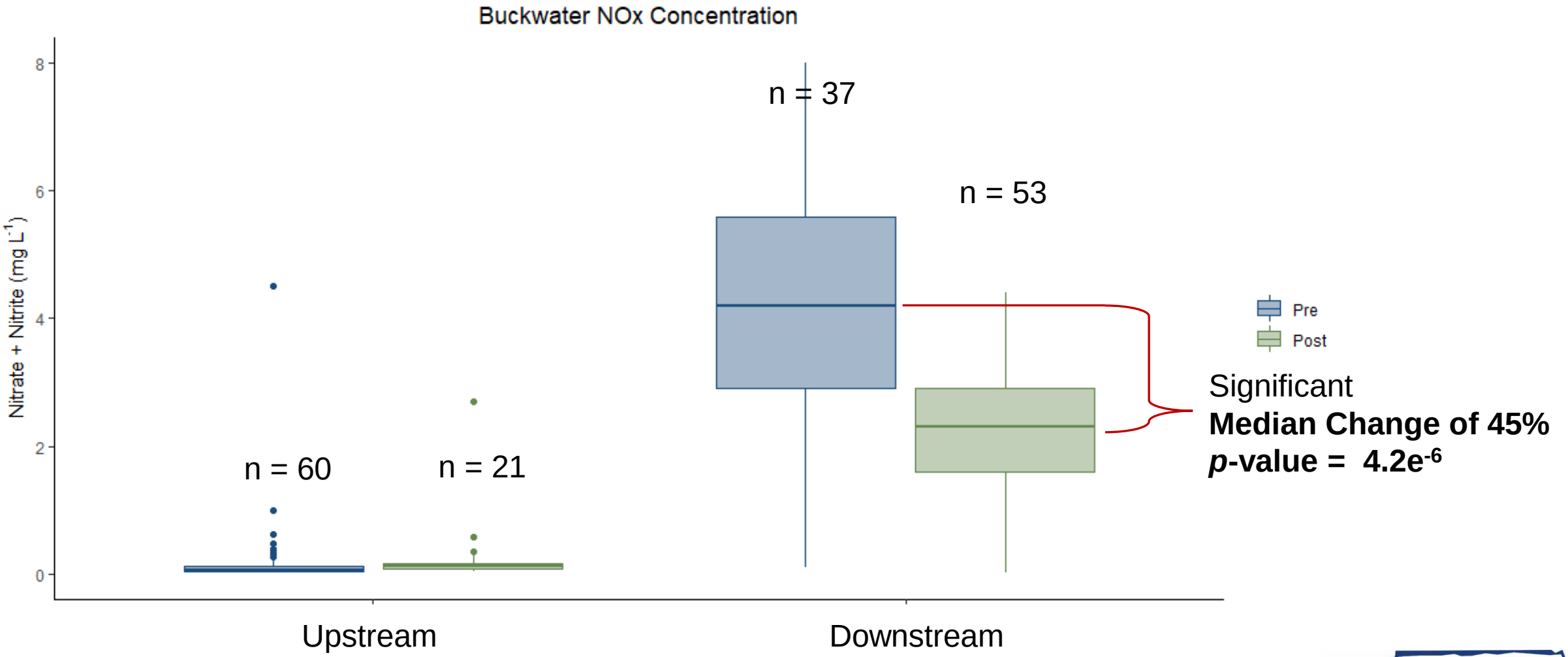
Significant
Median Change of 64%
***p*-value = 1.2e^{-13}**

Buckwater Reach T4 – Total Organic Nitrogen



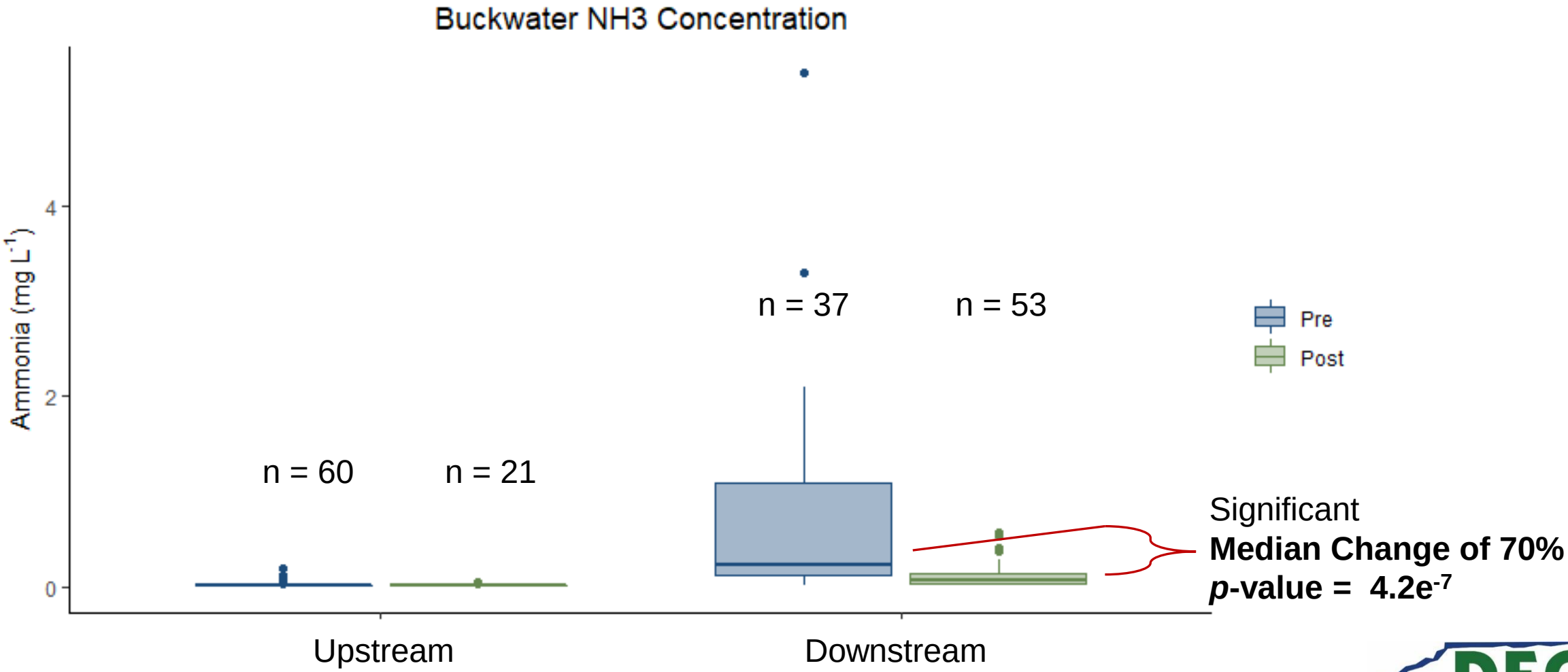
Significant
Median Change of 75%
***p*-value = 9.2e^{-10}**

Buckwater Reach T4 – Nitrate + Nitrite



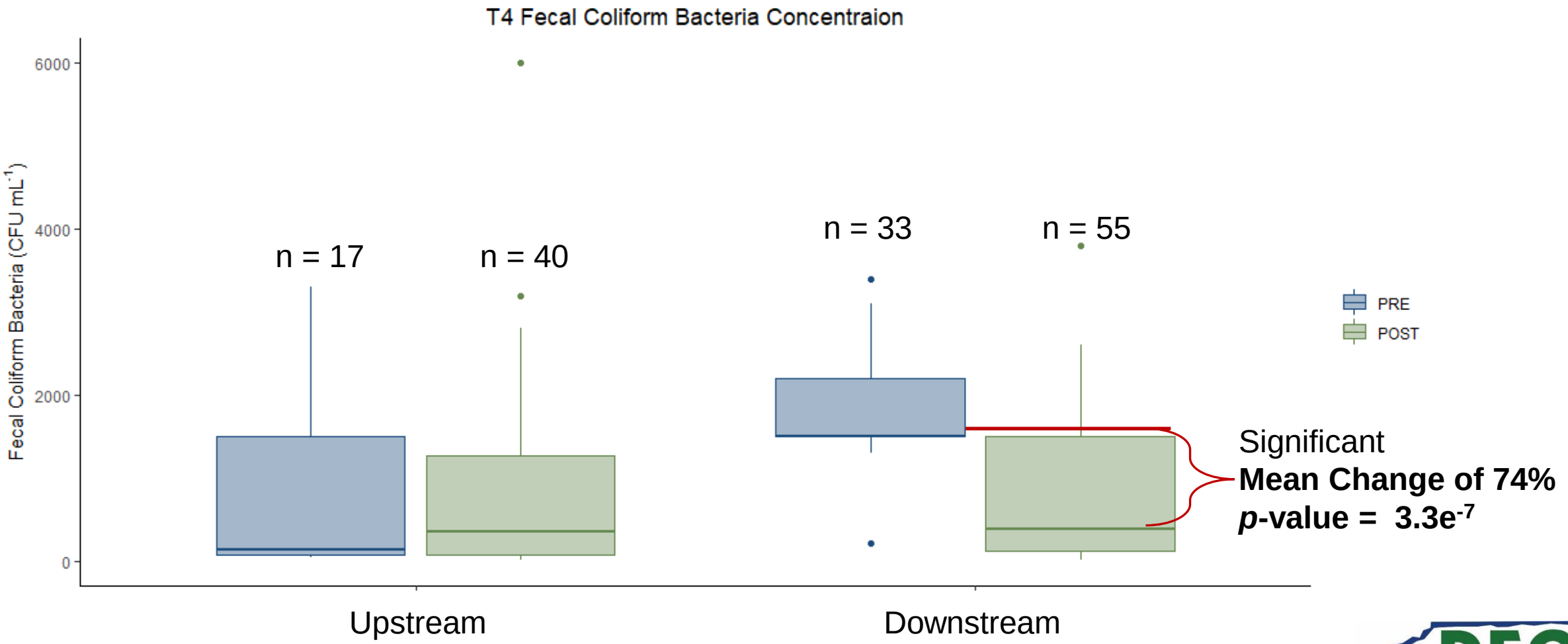
Significant
Median Change of 45%
***p*-value = 4.2e^{-6}**

Buckwater Reach T4 – Ammonia

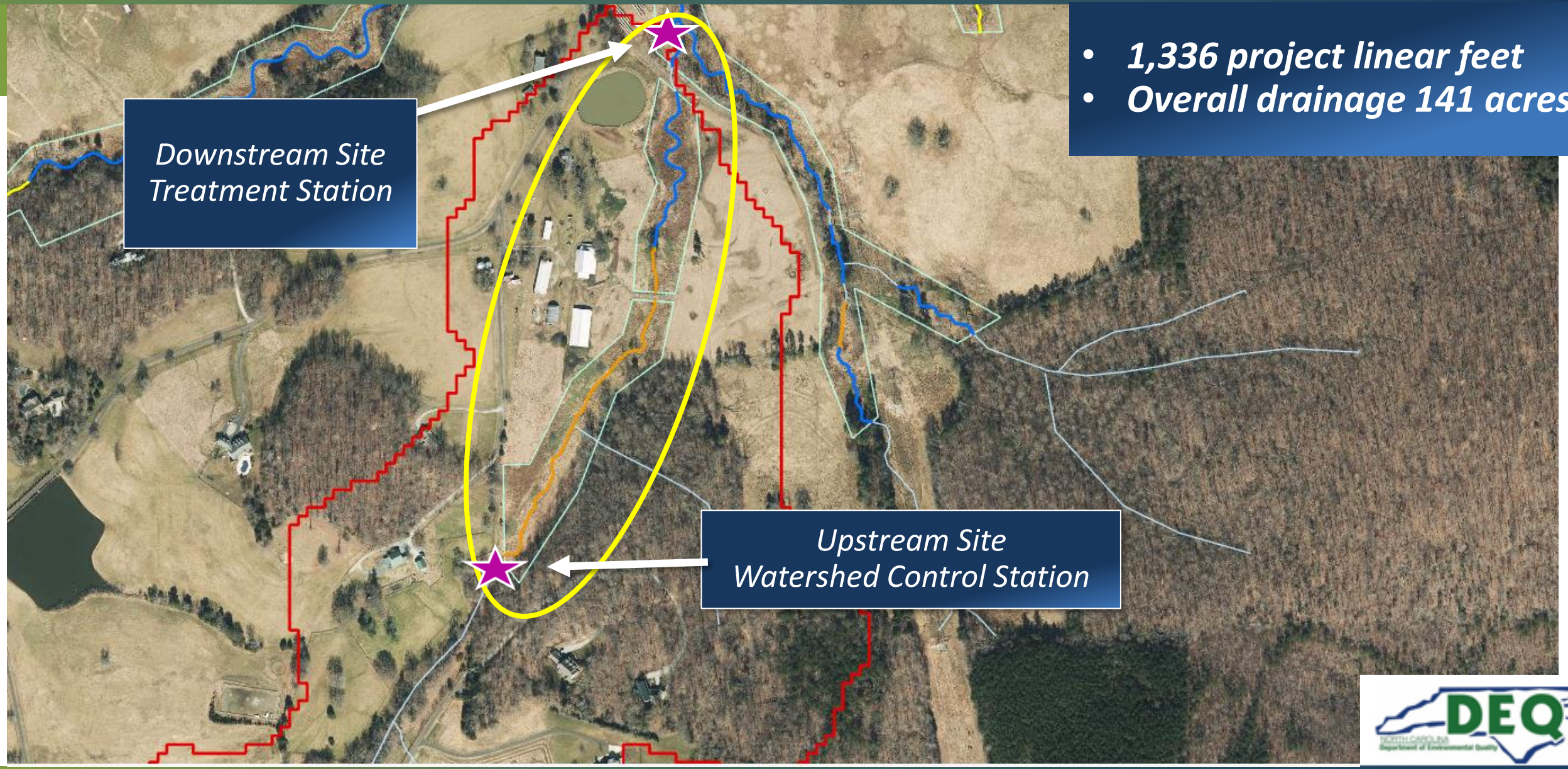


Significant
Median Change of 70%
***p*-value = 4.2e^{-7}**

Reach T4 – Total Fecal Coliform Bacteria

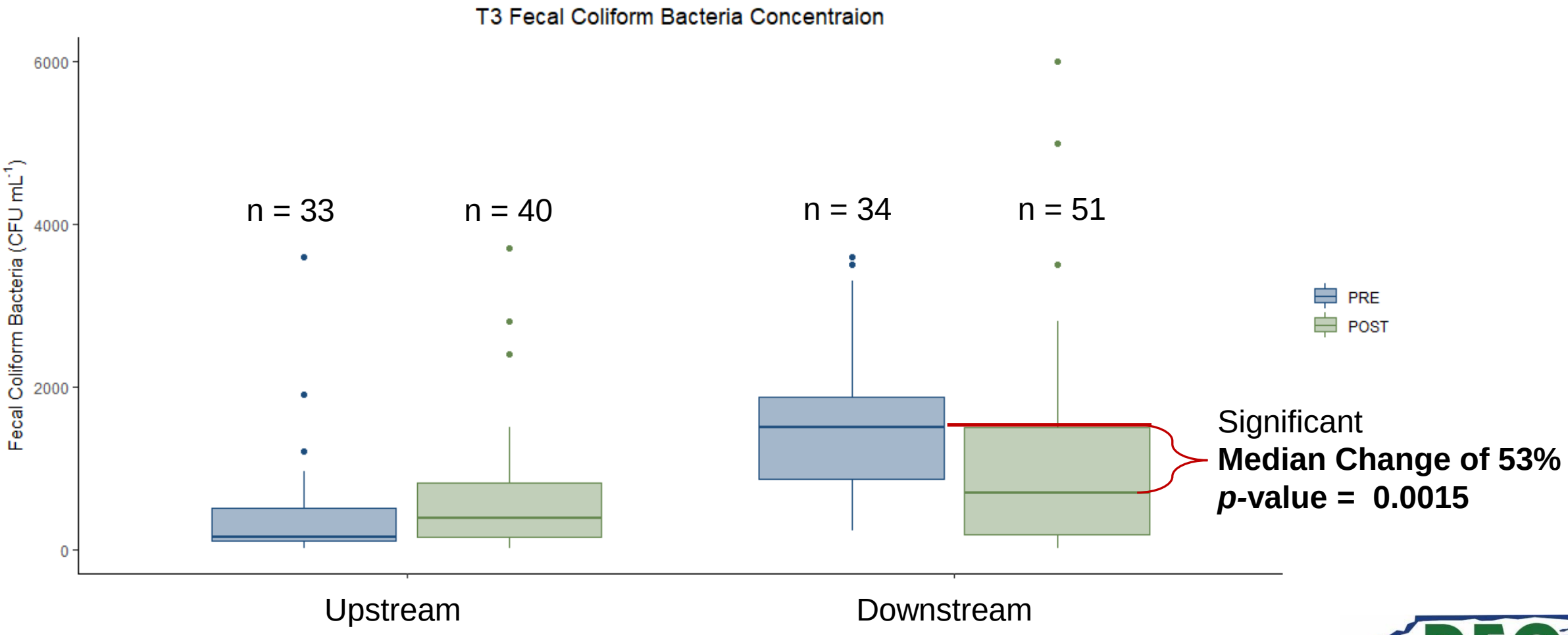


Buckwater Site: Reach T3 (Fecal Only)



- *1,336 project linear feet*
- *Overall drainage 141 acres*

Reach T3 – Total Fecal Coliform Bacteria



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 reachT3 and T4.*

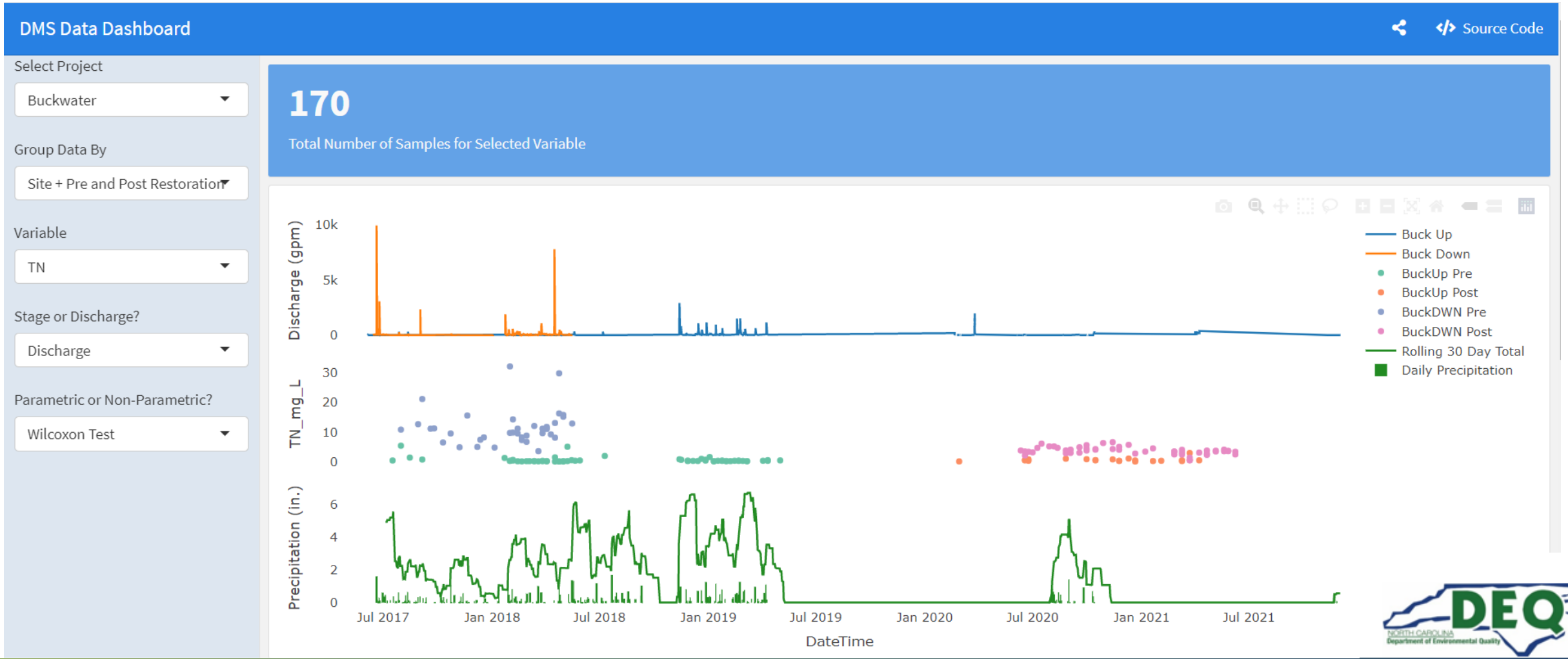
Moving Forward

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

DMS Data Dashboard

Source Code

Select Project

Buckwater

Group Data By

Site + Pre and Post Restoration

Variable

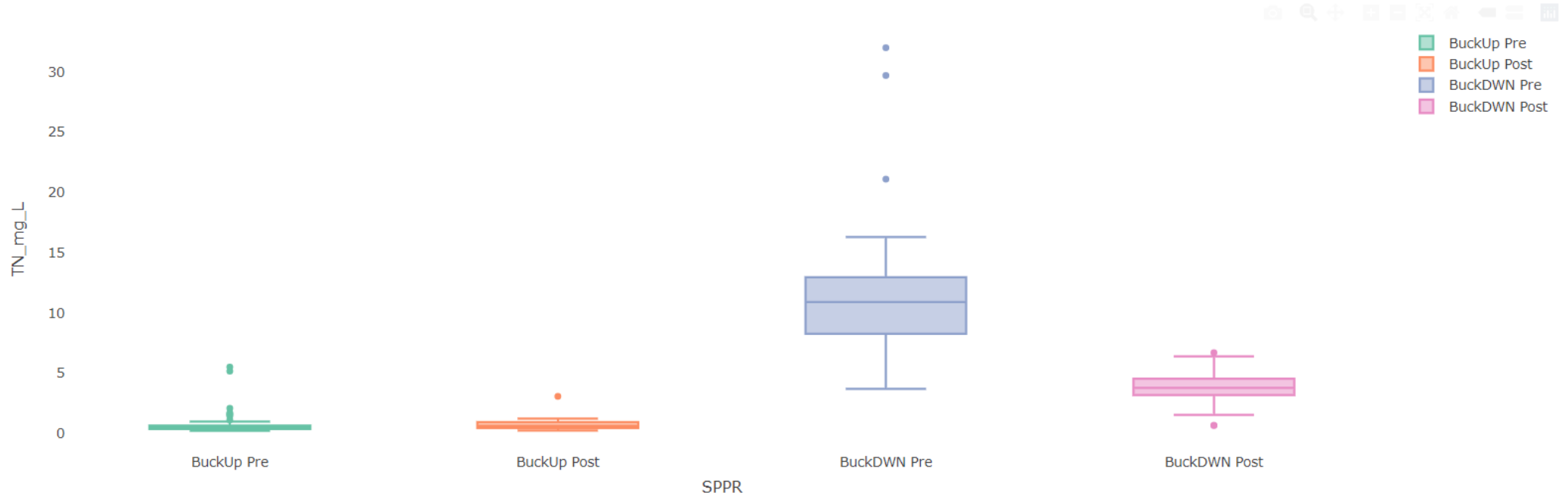
TN

Stage or Discharge?

Discharge

Parametric or Non-Parametric?

Wilcoxon Test



Show 10 entries

Search:

	Variable	Group A	Group B	n Group A	n Group B	Test Statistic	P Values
1	TN_mg_L	BuckDWN Post	BuckDWN Pre	65	37	53.5	5.5e-14
2	TN_mg_L	BuckDWN Post	BuckUp Post	65	22	1094.5	1.47e-10
3	TN_mg_L	BuckDWN Post	BuckUp Pre	65	61	2941.5	6.82e-17
4	TN_mg_L	BuckDWN Pre	BuckUp Post	37	22	814	1.86e-10

Acknowledgements

DMS Science & Analysis

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

DMS Mitigation Provider:

- Wildlands Engineering, Inc.

Questions?

Email: Danielle.Mir@ncdenr.gov

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