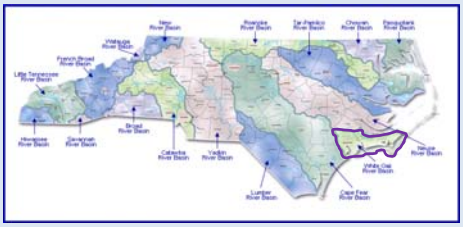
Implementation and Monitoring of Stormwater Control Measures in the Lower White Oak River Watershed, North Carolina

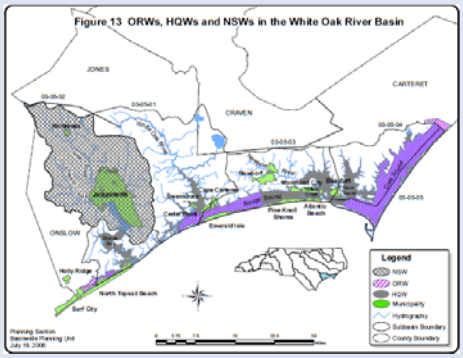
Charlie Humphrey, PhD
Interim Director, Coastal Water Resources Center
Associate Professor of Environmental Health Sciences
Humphreyc@ecu.edu
737-1479

What's Next?

- White Oak River Characteristics
- Project Goal and Objectives
- Project Methods
- Preliminary Results
- Remaining Work
- Questions

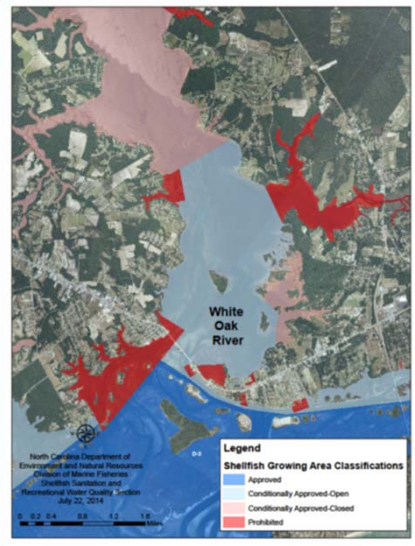
White Oak River Basin





- Entire basin within the outer coastal plain
- Drains portions of Carteret, Onslow, Craven and Jones Co.
- Croatan National Forest and Hoffman State Forest
- New, *White Oak*, Newport and North Rivers
- 10,800 ac of nutrient sensitive waters
- > 57,000 ac of outstanding resource and high quality waters used for recreation, shellfish habitat, primary nurseries

White Oak Sub-basin

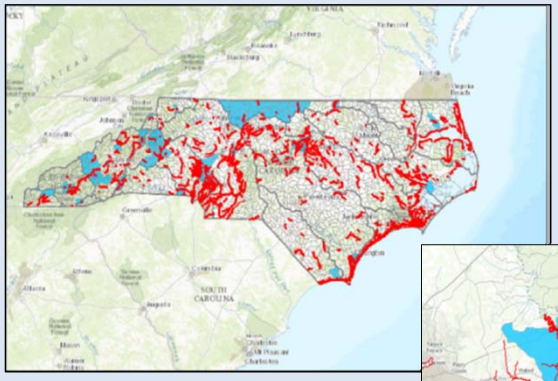


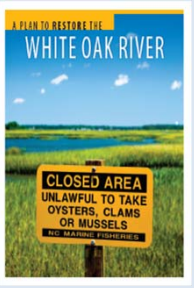
76% Forest/wetland
8% Water
2% Urban
11% crops
3% Pasture/Grass

Total area = 351 mi^2
Land area = 322 mi^2
11,032 ac of shellfish waters with > 6,900 ac impaired

1,815 ac monitored for aquatic life with 792 ac impaired

NC DEQ 319 Program- Approved Watershed Plans

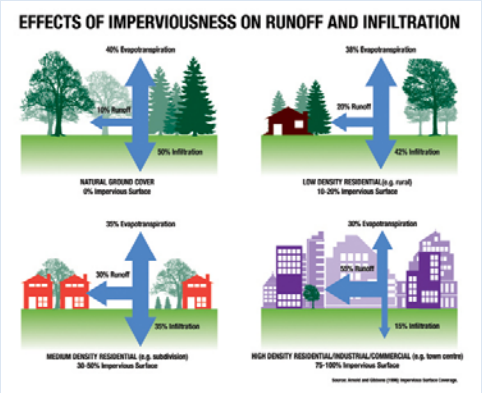




NC Coastal Federation developed White Oak Watershed Plan (2009)

Lower White Oak River Watershed Plan

- **2006 TMDL -** increased land uses significantly altered natural hydrology, pollutants quickly transported to surface waters.
- **2009 Watershed Restoration Plan-** LID techniques and stormwater control measure retrofits as viable solutions for reducing the amount of stormwater runoff entering these waters.
- Opportunity for research, education and service



Project Goal and Objectives

Goal: Improve water quality in the Lower White Oak Watershed by reducing the volume of runoff discharged to waterways during storm events

Objectives:

1) Locate sites for the installation of 12 or more stormwater BMPs
2) Develop and implement a water quality monitoring plan spanning 18 months including pre and post BMP data. Sampling includes at least 6 storm events
3) Assist with design/implementation of 12 or more stormwater BMPs
4) Assist with development of educational presentations

Lower White Oak River

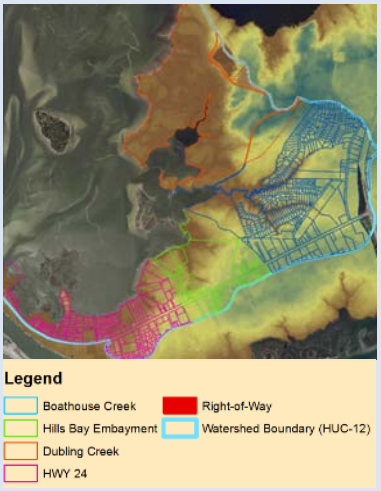


Table E.4: Existing Fecal Coliform Loading

Waterbody	Existing Load	Point Source	Nonpoint Source
Boathouse Creek	6.17×10^{11}	3.54×10^{10}	5.82×10^{11}
Dubling Creek	1.77×10^{11}	0.00	1.77×10^{11}
Hills Bay embayment	2.88×10^{10}	1.65×10^{9}	2.72×10^{10}

Table E.1: Fecal Coliform Accumulation Rates from Boathouse Creek

Land use	Loading Counts/day	Loading Percent
Wetland	7.35E+11	10.8
Pasture/Herbaceous	1.96E+11	2.9
Forest	1.51E+12	22.1
Urban	4.17E+12	61.1
NCDOT	2.19E+11	3.2
Total	6.83E+12	100

Ocean Spray Community

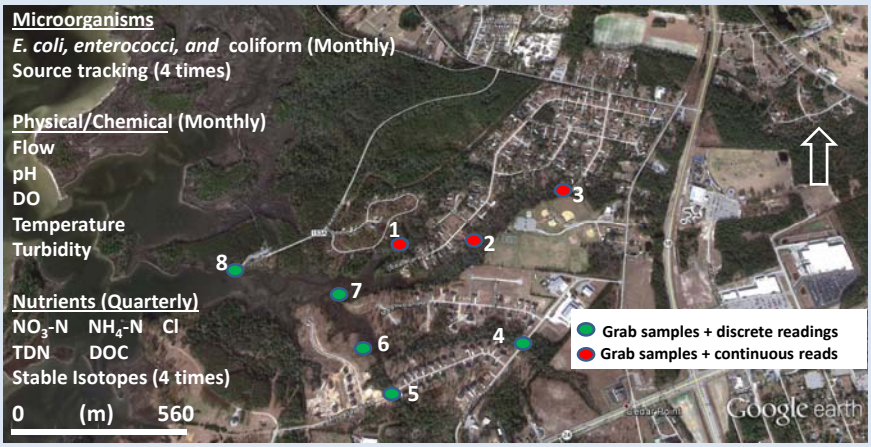
- 1980's development

Marsh Harbor Community

- Marsh Harbor
- Watershed changes
  - ~110 Forested acres converted to residential
  - Urban runoff increased
- Watershed field audits
  - Additional BMP Opportunities
  - Must meet existing stormwater management regulations

Reducing Runoff from US Forest Service Properties

Water Quality Monitoring



Monitoring Plan

Baseflow Sampling

Parameter	Frequency	Sampling Events
E. coli and Enterococci	Monthly	18
Nitrogen species	Quarterly	6
Nitrogen and Oxygen Isotopes	Twice	2
Bacterial Source Tracking	Twice	2
pH, EC, DO, Temp, Flow	Monthly	18

Storm Sampling

Parameter	Sampling Events
E. coli and Enterococci	6
Nitrogen species	6
Nitrogen and Oxygen Isotopes	2
Bacterial Source Tracking	2
pH, EC, DO, Temp, Flow	6

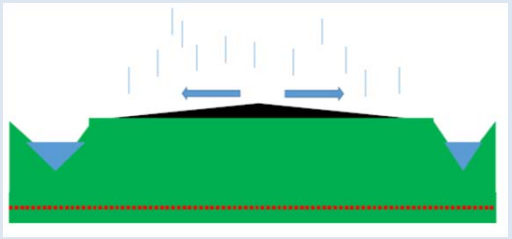
All Proposed Sampling Events (Completed)

Parameter	Events
E. coli and Enterococci	24
Nitrogen species	12
Nitrogen and Oxygen Isotopes	4
Bacterial Source Tracking	4
pH, EC, DO, Temp, Flow	24

Monitoring Volume Reduction

- Site-specific
  - Calculate runoff captured from BMPs based on contributing area, storage capacity of BMPs, and rainfall
    - Rain gauge data
    - Design specifications
- Catchment scale
  - Stream stage
    - Before, during and after storms (pre and post BMPs)

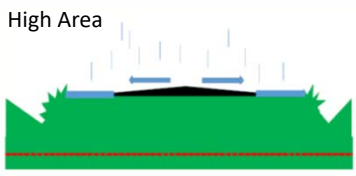
Ocean Spray Drainage



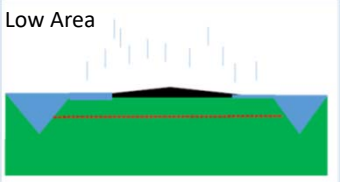
If runoff from the road is dispersed into the drainage swales throughout the neighborhood, because the soils are sandy and hydraulically conductive and the water table is below the bottom of the swale, there is great potential for the road runoff to infiltrate and stormwater pollutants to be treated.

Ocean Spray Drainage

High Area



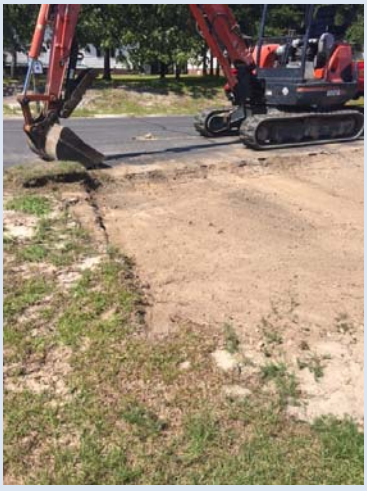
Low Area



In higher elevations, runoff flows along the edge of the road bypassing the swales and opportunity for infiltration/treatment. The stormwater runoff eventually enters in low areas, often eroding the ditch bank, and causing flooding. Groundwater is closer to the surface and there is less opportunity for treatment.

Ditch Bank Reshaping and Stabilization

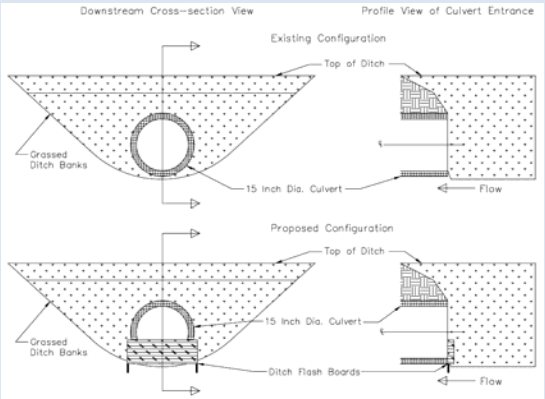
Ditch Bank Reshaping and Stabilization



Ditch Bank Reshaping and Stabilization

Ditch Bank Reshaping and Stabilization

Controlled Drainage in Neighborhoods?

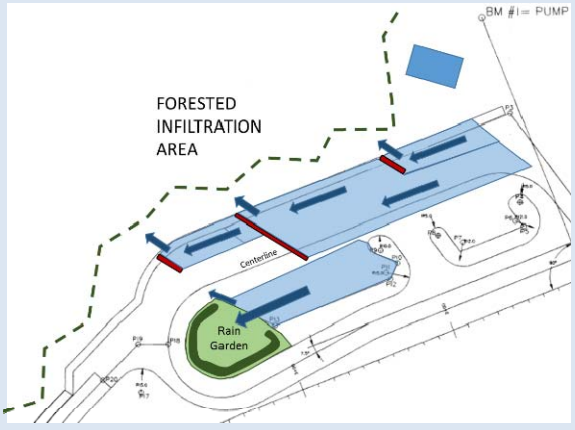


Controlled Drainage

Controlled Drainage

Controlled Drainage

US Forest Service Boat Ramp



- Divert parking area drainage into forested areas for infiltration & rain garden
- USFS agreeable as long as soils will accommodate infiltration

Rain Garden Installation

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Rain Garden Installation

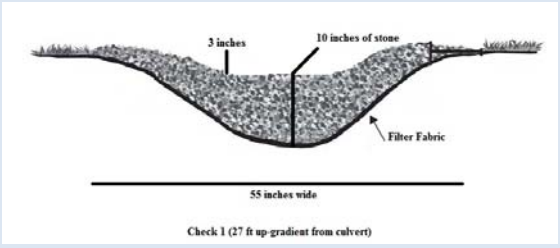
Rain Garden at Work

Walkway Renovation

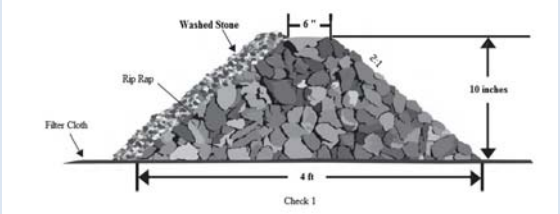
Walkway Renovation

Rock Check Dams

Rock Check Dams



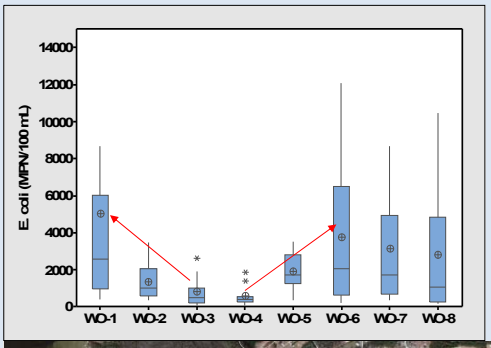
Check 1 (27 ft up-gradient from culvert)



Check 1

Rock Check Dams

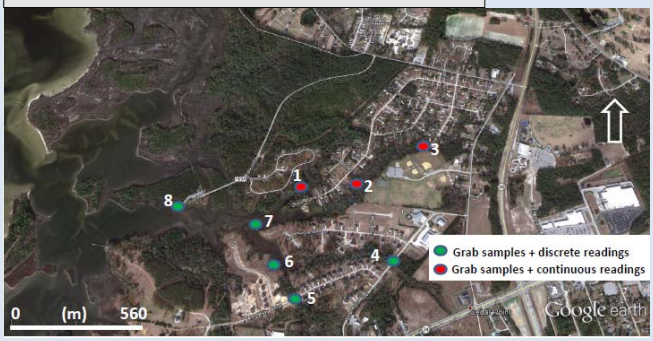
Preliminary Water Quality Monitoring Results

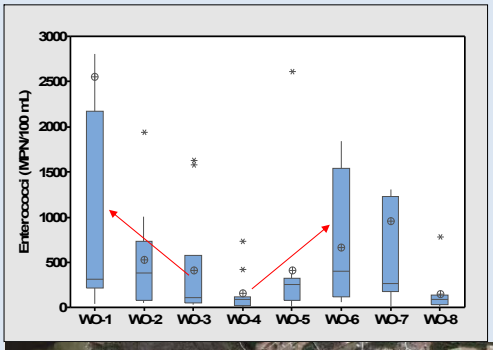


E. coli Trends

E. coli concentrations increase as flow moves downstream

All geom. mean concentrations > 126 MPN/100 mL and >10% values exceeded 410 MPN/100 mL

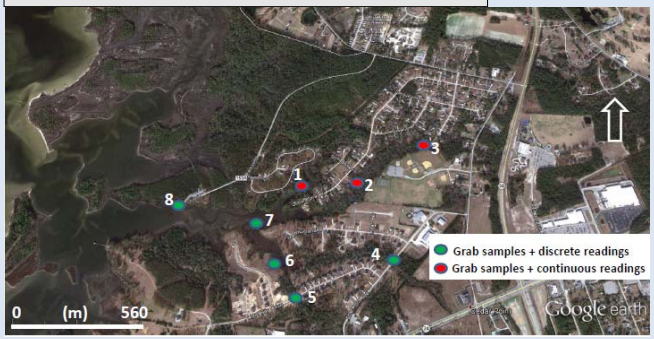


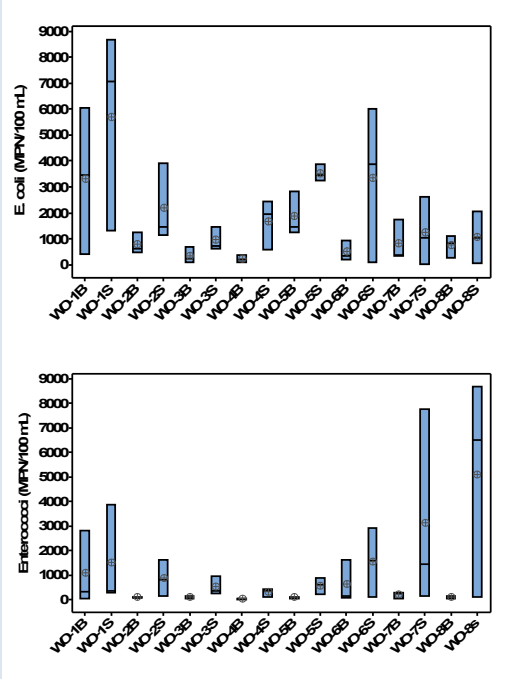


Enterococci Trends

Enterococci concentrations increase as flow moves downstream

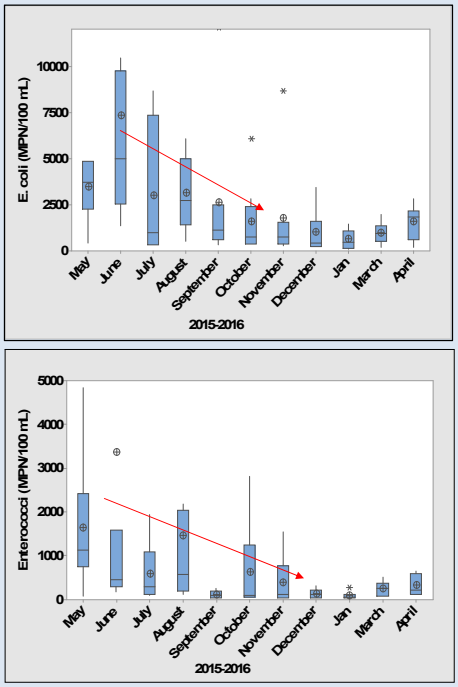
All geom. mean concentrations > 35 MPN/100 mL and >10% values exceeded 130 MPN/100 mL





Baseflow and Stormflow Trends: Bacteria Concentrations

Stormflow bacteria concentrations elevated relative to baseflow

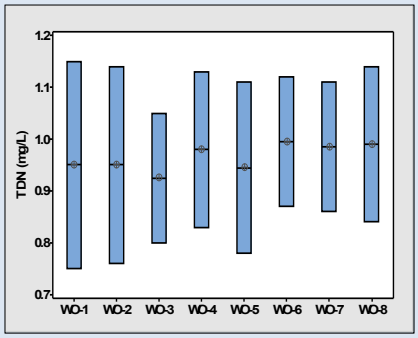


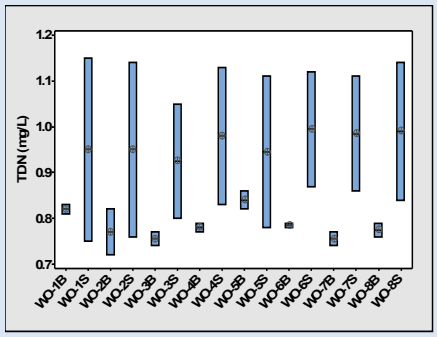
Seasonal Trends: Bacteria Concentrations

Warmer months typically higher concentrations, colder months typically lower concentrations

Nitrogen Trends

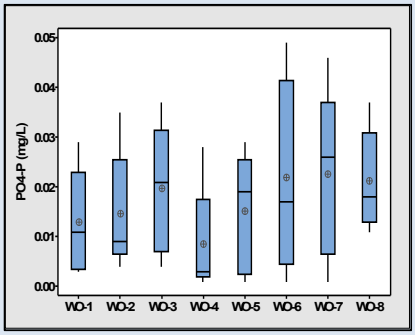
Stormflow concentrations elevated relative to baseflow.

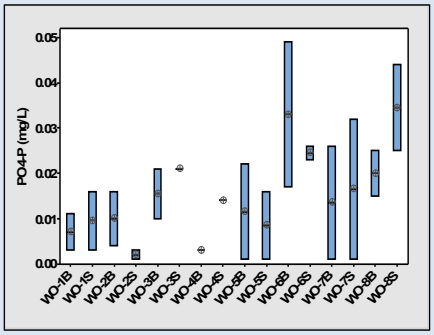


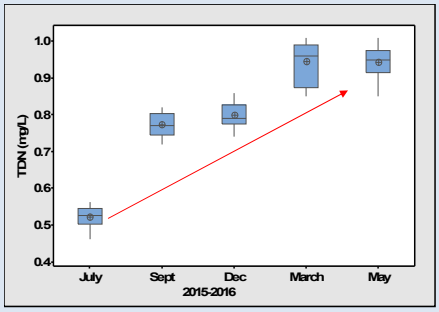


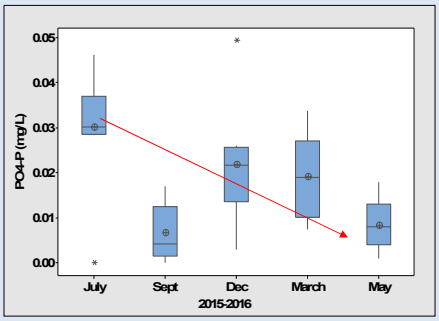
Phosphate Trends

Stormflow concentrations elevated relative to baseflow.









Nutrient Concentrations: Temporal Trends?

Stormwater Runoff Reductions?






Summary

- Lower White Oak River impaired due to elevated bacteria concentrations, portions of WO watershed are nutrient sensitive
- Nutrient and bacteria concentrations and loads increase during storm events
- Goal of project was to improve water quality by reducing volume of urban runoff during storms
- Stormwater control measures including a rain garden, ditch modifications and stabilizations, controlled drainage, check dams were installed to reduce runoff during storms
- Monitoring will continue and pre and post BMP data will be compared

Future Work

- Communicate with CF regarding volunteers in Marsh Harbor for downspout disconnects and rain gardens/water harvesting
- Culvert to divert drainage to forested area in campground on USFS property (in progress)
- Comparison of pre and post BMP flow during storms
- Comparison of pre and post BMP water quality
- Source tracking data for nitrate and indicator bacteria
- Educational outreach, presentations, and report

Acknowledgements

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Questions?