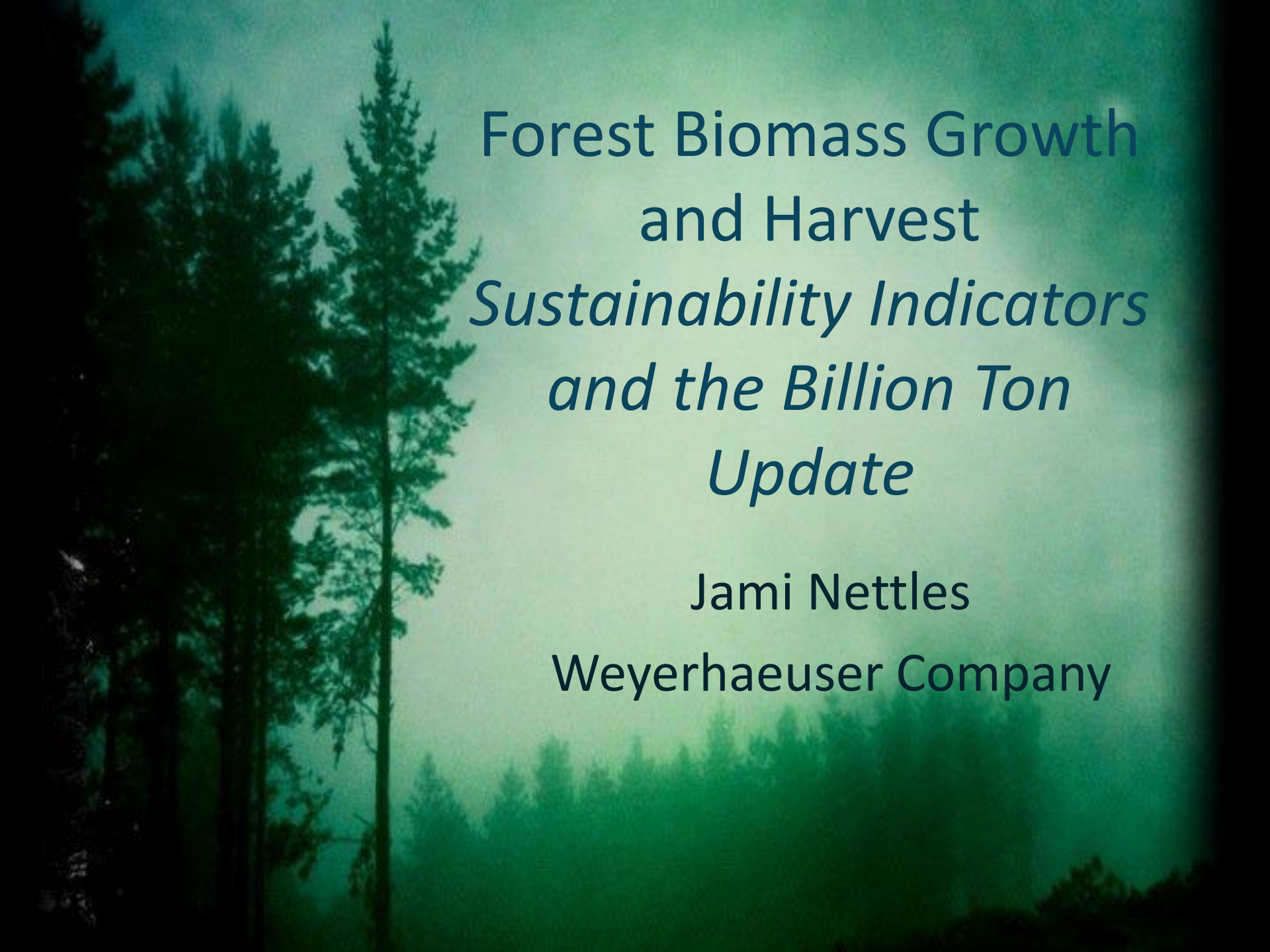


Forest Biomass Growth and Harvest *Sustainability Indicators and the Billion Ton Update*

Jami Nettles

Weyerhaeuser Company

Sustainability Research

- The presentation is a small sample of our work
- The results included are preliminary
- There are a wide number of colleagues, cooperators and students involved that are not explicitly credited
- Please contact me for further information on any aspect of these studies

Biomass Sustainability Research Strategy

Comprehensive look at the environmental aspects of biofuel operations in commercial pine plantations

- Biodiversity
- Carbon Life Cycle Analysis
- Hydrology
- Soil Productivity/Sustainability

Forest biomass sources

Uncertainty in feedstock production practices led us to include a range of operational options in our study design. Evaluating multiple production options will provide a more complete assessment of the general sustainability of forest biomass feedstock development.

Research treatments:

- Harvest residue
- Understory – planted or natural
- Intercropped energy crop
- Dedicated energy crop

Southeastern Biomass Research

Important Sustainability Indicators

Biomass production has the potential to influence a variety of ecological attributes of forest ecosystems; these include effects on:

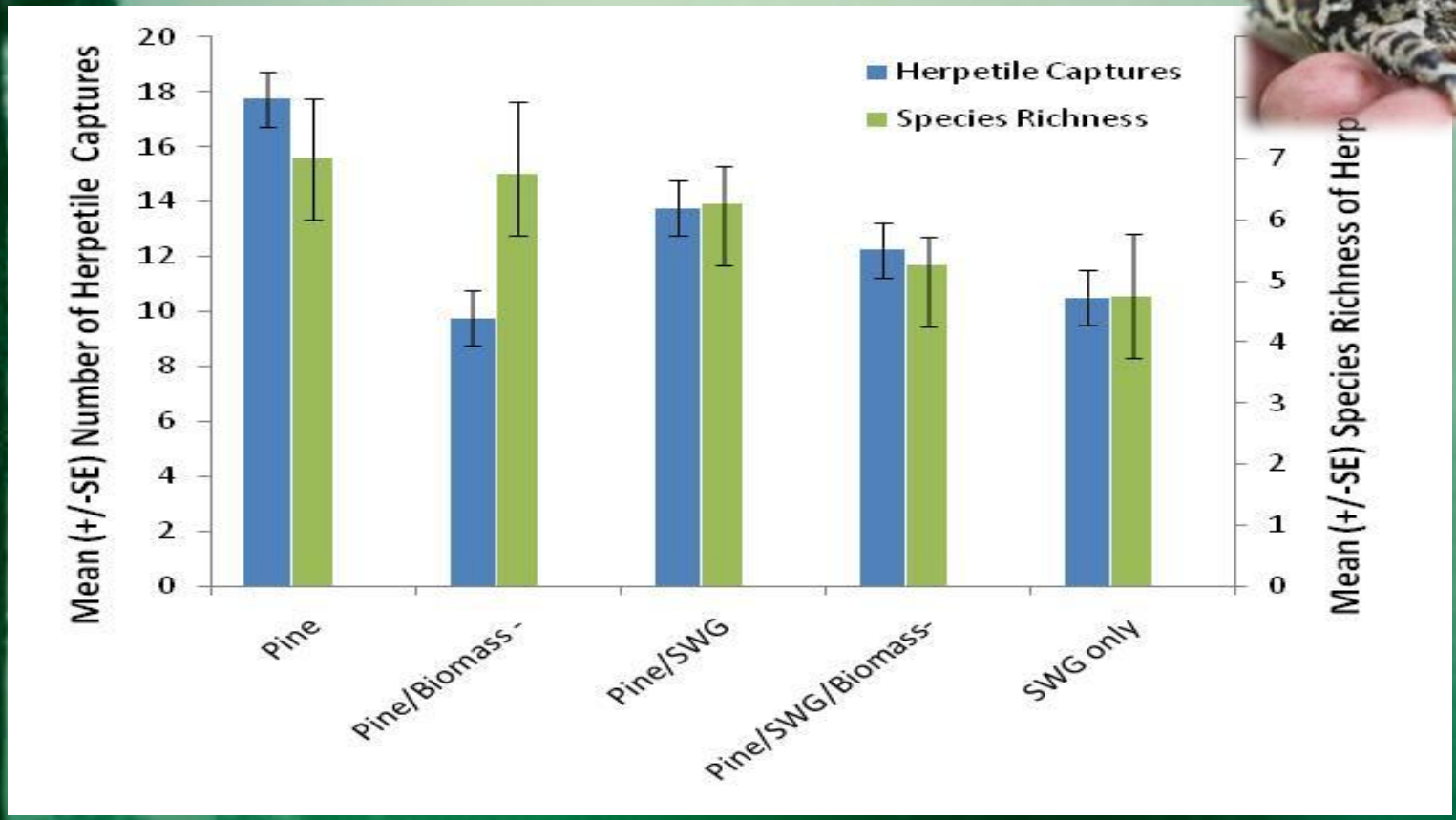
- Biodiversity
- Carbon Life Cycle Analysis
- Hydrology
- Soil Productivity/Sustainability

Biodiversity

Key Indicators

- Plant diversity
- Habitat structure
- Forage quality, (e.g., deer browse)
- Animal response
  - Birds
  - Pollinators
  - Small mammals

Early Results Lenoir 1 - Herpetiles



Carbon Life Cycle

Key Indicators

- GHG emissions from biomass crop establishment and cultivation (e.g., fertilization, other chemical treatments)
- GHG emissions associated with biomass harvest and transport
- Changes in C stocks in soils and aboveground
  - Carbon sources through stable isotope analysis
  - CO_2 Efflux

Soil Stability and Site Productivity

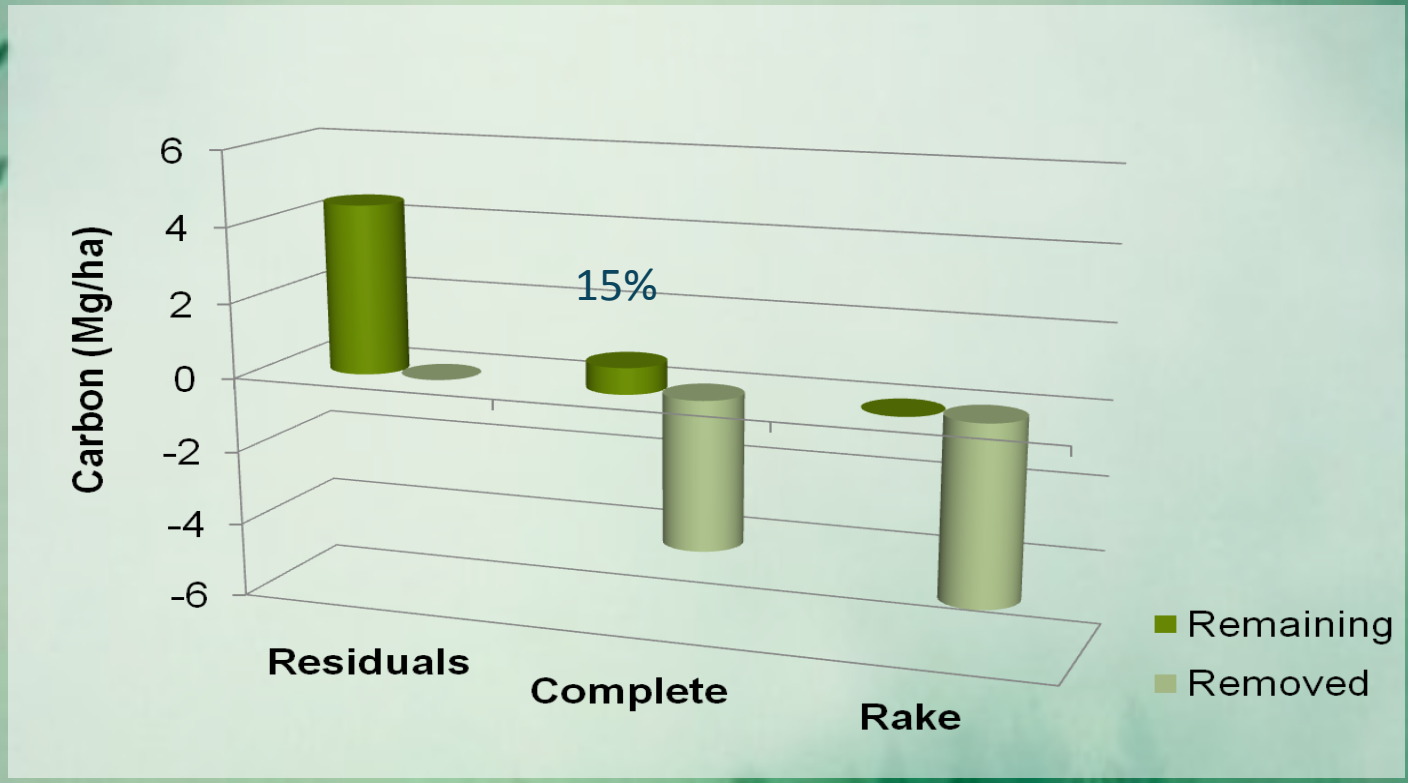
Key Indicators

- Soil Compaction
- Soil Composition
  - Nutrient analysis
  - Microbial activity
- Organic matter retention
- Carbon
  - Carbon sources through stable isotope analysis
  - CO_2 Efflux
- Productivity
  - pine tree diameter and heights
  - biomass yield by type

Soil Compaction

- No negative effects on soil compaction due to “extra” entries of heavy equipment required for biomass removal, site preparation, and mechanical planting of switchgrass.
- Soil compaction will be evaluated every year to determine if the annual harvests of switchgrass significantly increases soil strength.

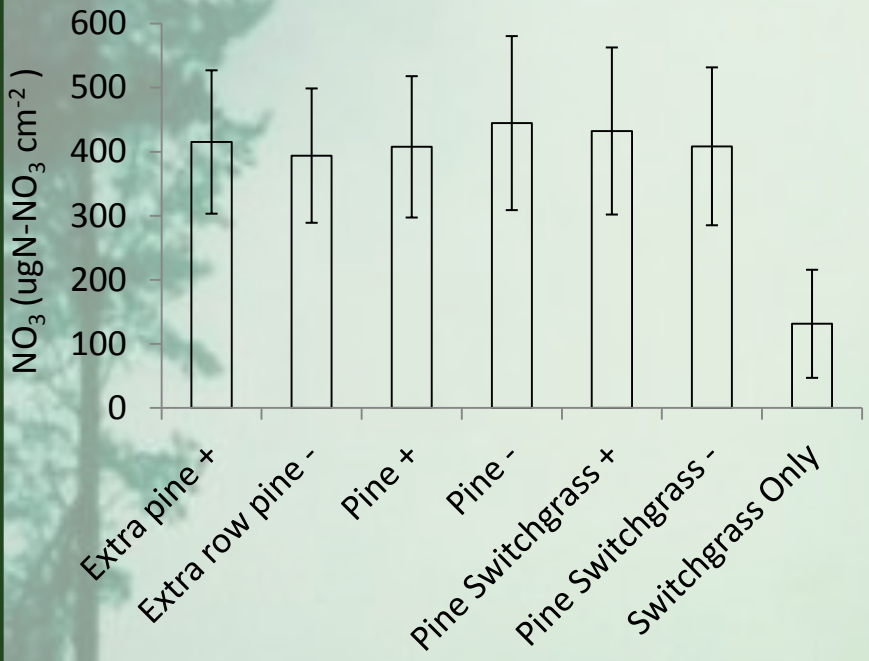
Organic Matter Retention



- Even with “complete” removal of biomass there was still 15% of the CWD material left on the site.

(Beauvais 2010)

Early Results

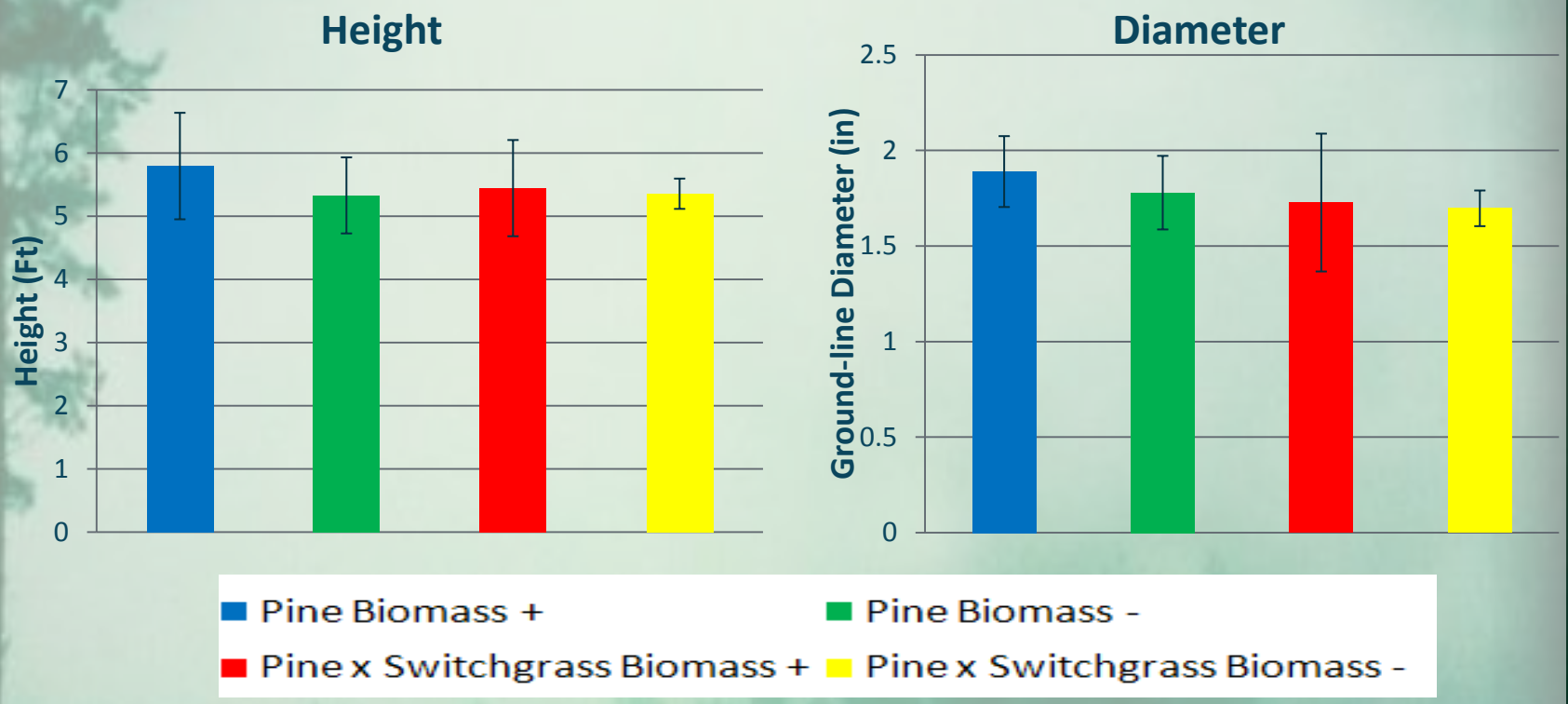


Cumulative Nitrogen
July 2009 - July 2010

+ indicates treatments in which residuals were left in the interbed space.
– indicates treatments in which all residuals were removed from the interbed space.
NOTE: This graph represents the bedded region only and does not include NH_4 .

- The switchgrass only treatment resulted in significantly reduced available nitrogen (N) over the past year
  - There is a trend of reduction of inorganic N (NH_4 and NO_3) at every sampling period *(data not shown)*

2-year Tree Productivity



- There was no effect of intercropping or biomass removal on tree productivity (height or diameter).

Hydrology

Key Indicators

- Water quality
  - Sediment
  - Nutrients
- Water volume
  - Water yield
- Aquatic biology
  - Aquatic macroinvertebrates
  - Crayfish specifically

Hydrology

Key Indicators

- Multi Scale Modeling
  - Plant-level
    - Water use
    - Nutrient cycling
  - Operational
  - Regional
    - Water volume
    - Water quality

Early Results - Intercropping

- Soil moisture –
  - Intercropped sites have higher soil moisture than natural understory
- Groundwater – Lenoir 1 (small scale)
  - No difference between pine/biofuel treatments
- Sediment Survey (operational)
  - Roughly 1 riparian incursion/100 ha – these very of low significance
  - Forest practices very protective and no inherent incursions

Billion Ton Study Update

- Address concerns of maximum rate of harvest and residual removal
- Realistically distribute the effects of forest scenarios into models for water quality and quantity.
- Complement our models of biodiversity and soil effects to understand the effects of more intensive practices across the southeast

Project Sponsors

- Current research initiated by Catchlight Energy, a joint venture of Chevron and Weyerhaeuser Company
- Additional funding
  - Weyerhaeuser Company
  - US Department of Energy
  - NCASI
  - North Carolina Biofuels Center

Cooperators

- NC State University
- US Forest Service
- NCASI
- Mississippi State University
- Roanoke College
- Virginia Tech
- Gainesville State College
- University of Alabama, Bham
- Yale University
- Duke University
- University of NC, Greensboro
- Eastern Carolina University