CBES

Center for BioEnergy Sustainability

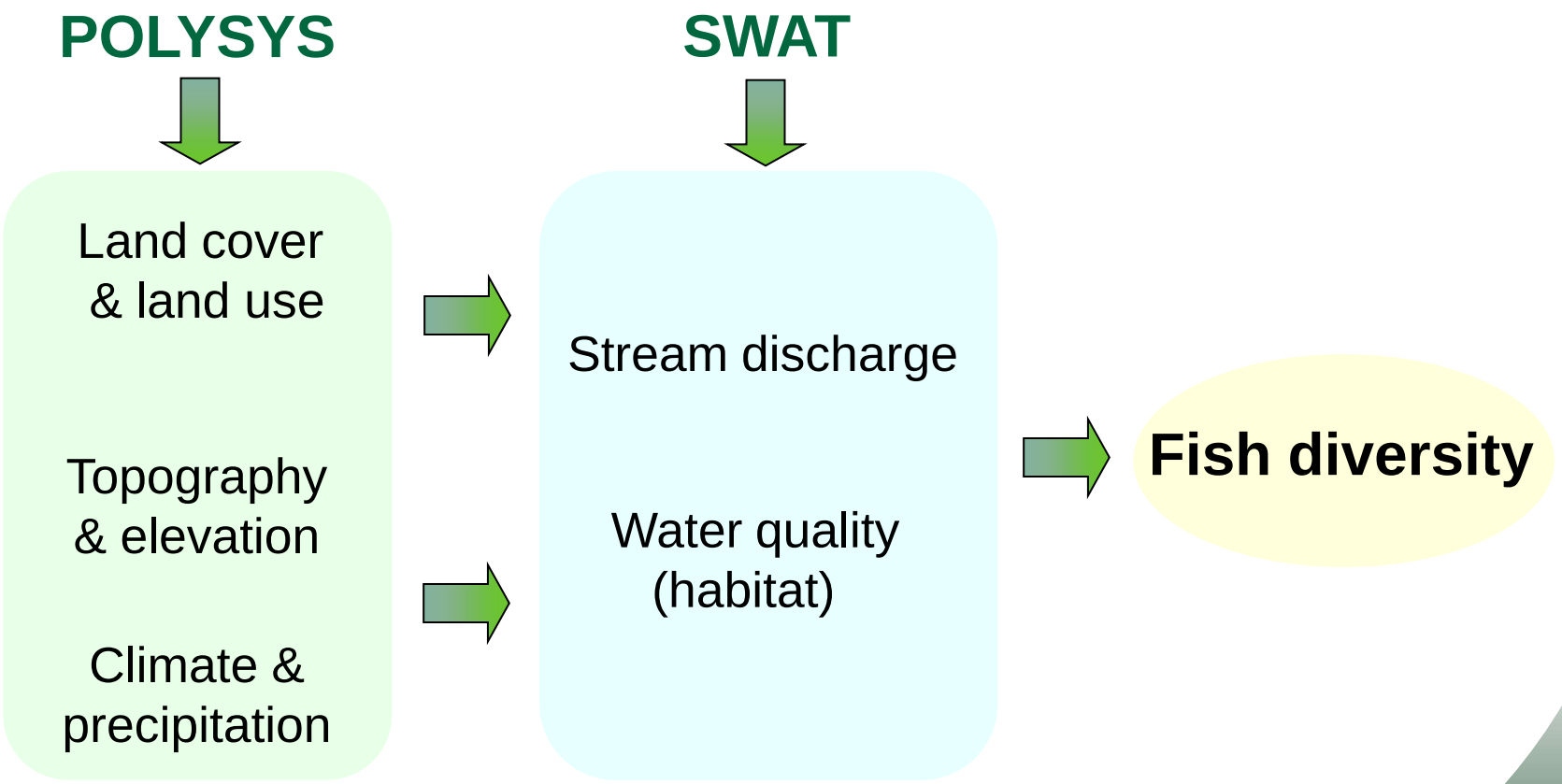
Sustainable Bioenergy from Production to Use in a series of Three Slides in Five Minutes

- Modeling Biodiversity in the Arkansas-White-Red River Basin
- Biomass Preprocessing as a Supply Chain Component
- Sustainable Energy Production Using Biological Fuel Cells
- Observations on Corn Ethanol Production and Distribution Infrastructure
- Hydrological and Geochemical Transformation of Nitrogen and Organic C in the Subsurface beneath Agricultural and Forested Ecosystems
- Logistics for a Biomass Economy

OAK RIDGE National Laboratory

Aquatic Biodiversity in the Arkansas-White-Red River Basin

Henriette Jager (PI, ESD), Latha Baskaran (ESD), Craig Brandt (BSD) and Peter Schweizer (ESD, ORISE)



Schweizer et al. 2009

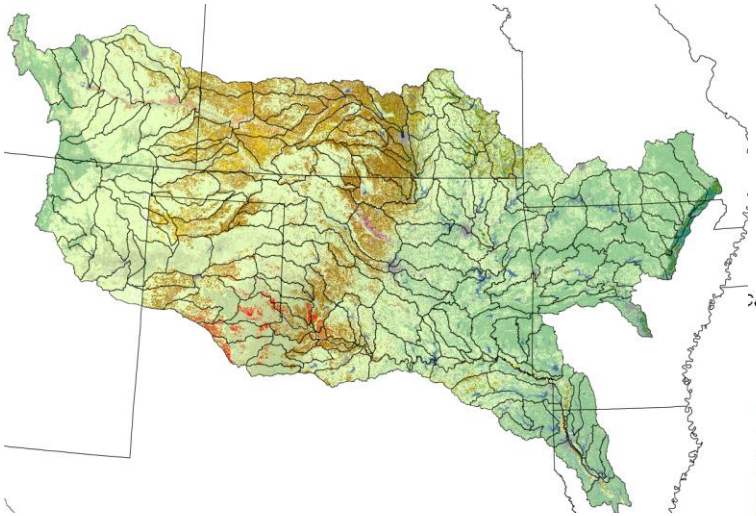
Landscapes with dedicated energy crops

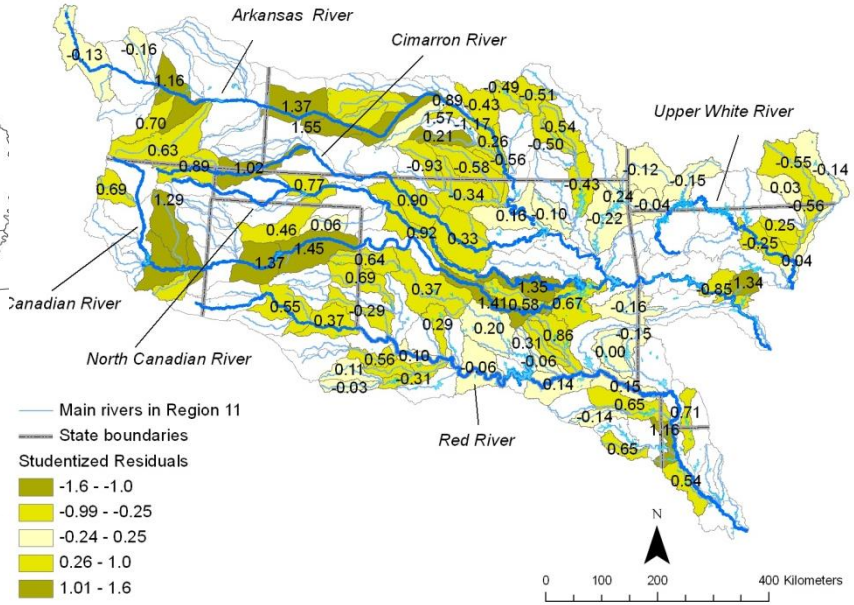
POLYSYS

- Land change projections
  - % area agriculture replaced by switchgrass

SWAT

- Integrates land change
  - Projects water quality
  - Stream discharge
  - Nutrient levels





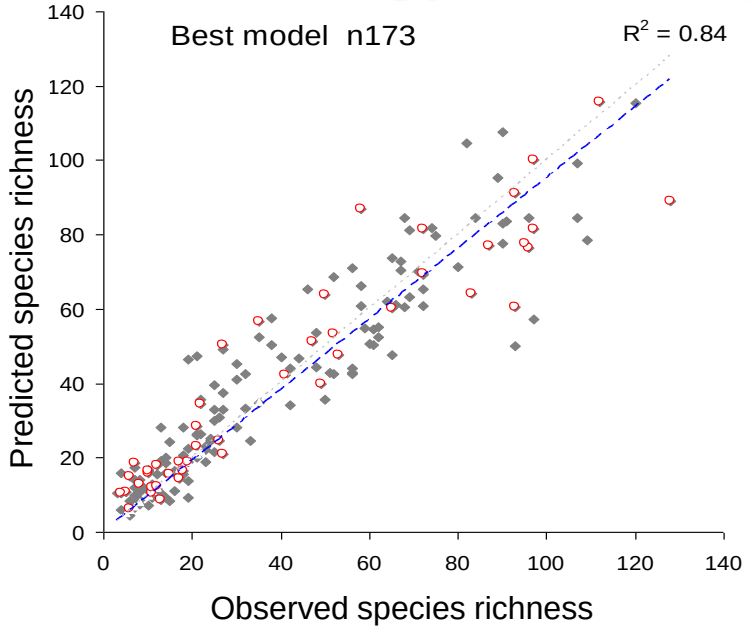
Schweizer et al. 2009

Project biodiversity under future bioenergy landscape

Water quality parameter from SWAT
Integrates land cover changes

Poisson regression and information theoretic approach for model selection

Best-fit model $r = 0.92$ in validation subset
candidate set performed similarly well



Applications

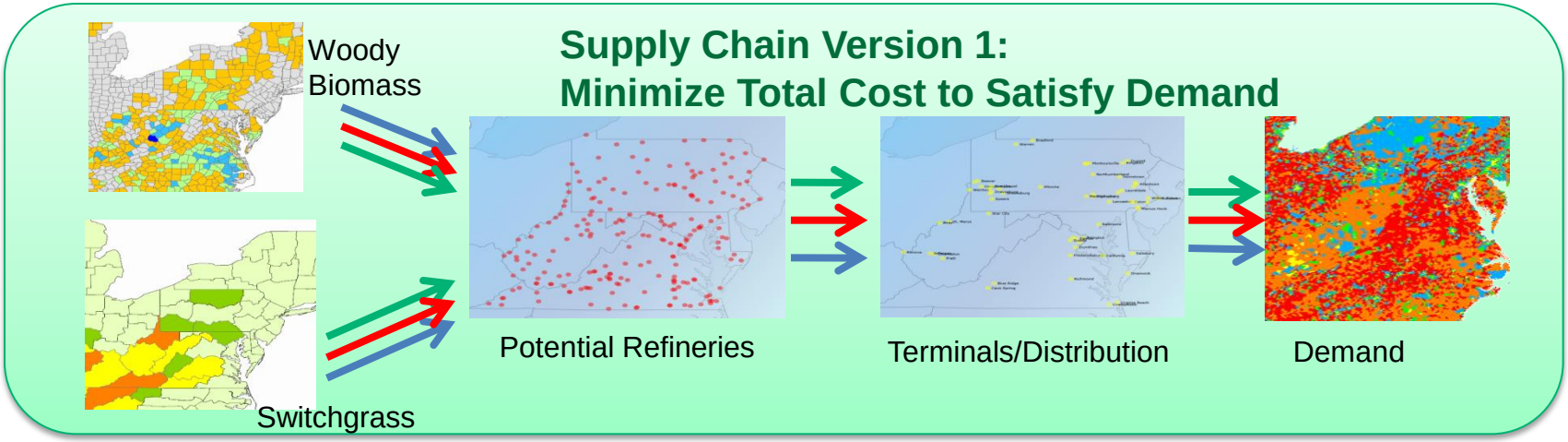
Project species richness in
future energy crop landscape(s)

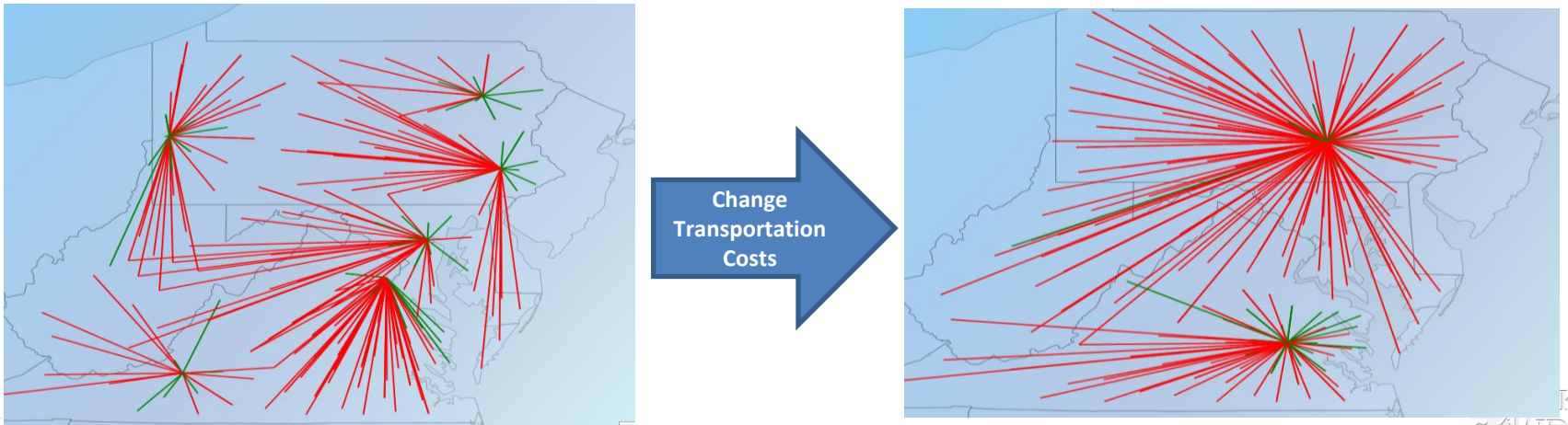
N-Species projected for energy crop landscape
- N-Species in present landscape
= anticipated changes in biodiversity

Schweizer et al. 2009

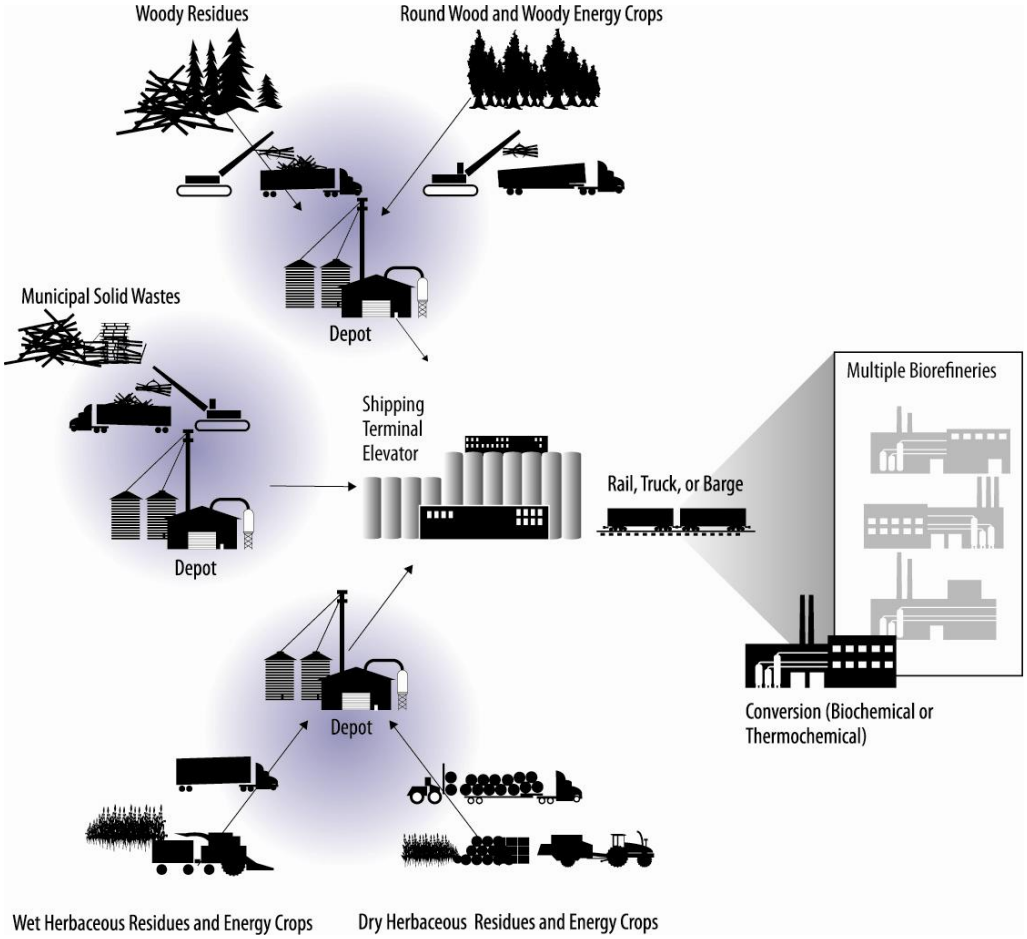
Evolution and Optimization of the Biofuel Supply Chain

Michael Hilliard, Ingrid Busch, Randy Curlee, Mike Schultze,
Rebecca Hartman-Baker, Neil Thomas, Ike Patterson





PreProcessing as a Supply Chain Step

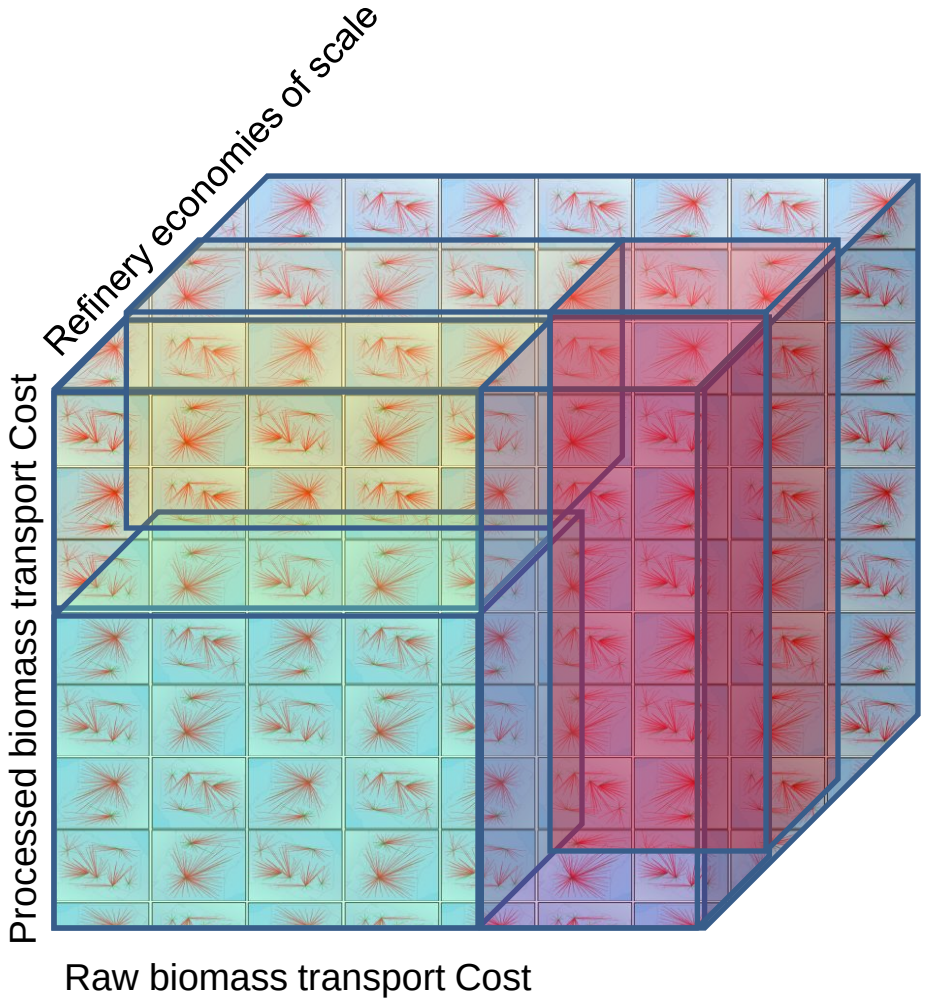


Supply Chain Model

- Two new types of locations/processes
- Transportation cost structures for biomass in multiple forms
- Refinery costs and economies of scale using pre-processed vs. "raw" biomass
- "Solutions" have unique configurations

Uniform-Format Solid Feedstock Supply System: A Commodity-Scale Design to Produce an Infrastructure-Compatible Bulk Solid from Lignocellulosic Biomass. April 2009

A Potential High-performance Computing Approach to Analysis



- Solutions are configurations not single numbers
- Goal: Insight, identification of critical factors
- Run multiple to provide a 3-D (or higher) environment for visualizing relationships
- Identify change points in the parameter space

Sustainable Energy Production Using Biological Fuel Cells

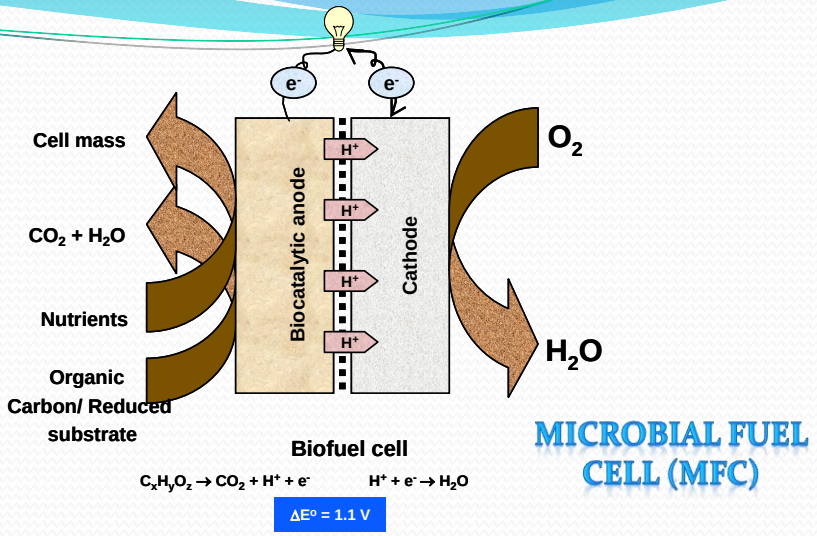
Abhijeet P. Borole

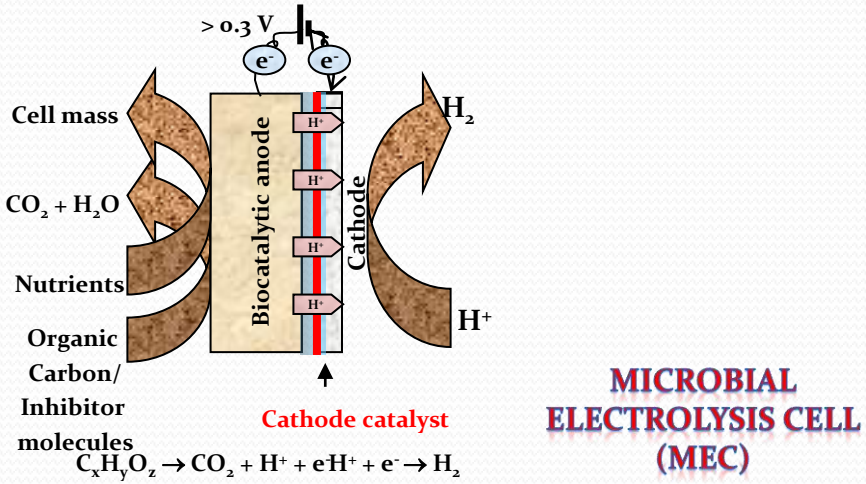
Biosciences Division

Oak Ridge National Laboratory, Oak Ridge, TN

Biological fuel cells

- Microbial fuel/electrolysis cells
- Electricity or hydrogen production
- Sustainability
  - Fuel resource: organic waste, biomass
  - Catalyst: Microbes, enzymes (no Pt, metal), regenerable
  - Electrodes : Graphite-based (plentiful)
  - Product: CO2 (C neutral), water





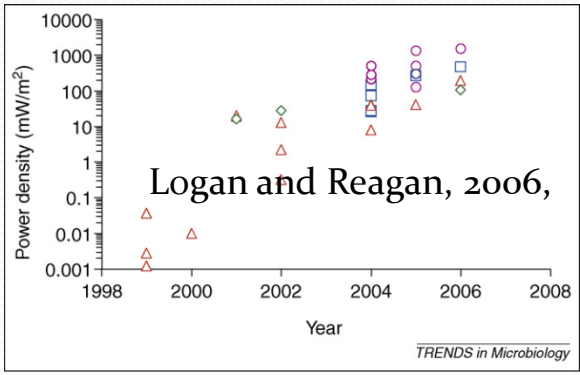
[1] Borole, et.al., 2009, **J. Power Sciences**., Integrating Engineering Design Improvements with Exoelectrogen Enrichment Process to Increase Power Output from Microbial Fuel Cells, 191, p520.

MFC/MEC Technology

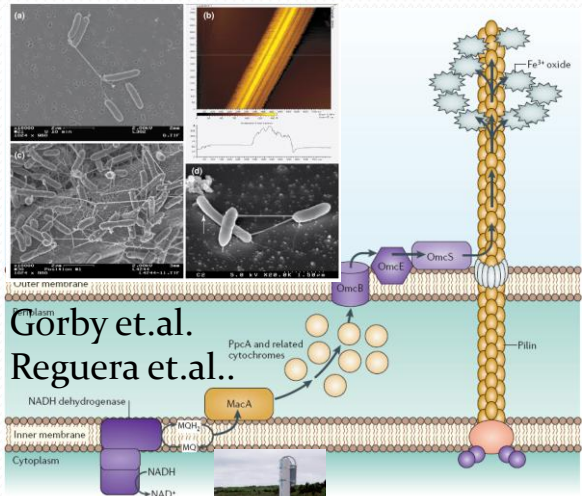
- Increase in power density from 1 to 2000 mW/m² in 5 years.
- Discovery of biological nanowires and concept of direct electron transfer.
- Deployment of MFCs for harvesting power from sea-floor – *First application*.
- Current interest
  - Improving power densities (at larger scale) and energy conversion efficiency
  - Conversion of complex organic matter, e.g., wastewater
  - Understanding direct electron transfer mechanism and microbe-electrode interactions
  - Diversification into multiple areas of 'bioelectrochemical systems', e.g. Electro-fuels production.
- Work at ORNL
  - Biocatalyst and engineering optimization

Integration of MFC engineering design parameters and biological enrichment process:

Power density > 5000 mW/m² (0.5 kW/m³)



Logan and Reagan, 2006,



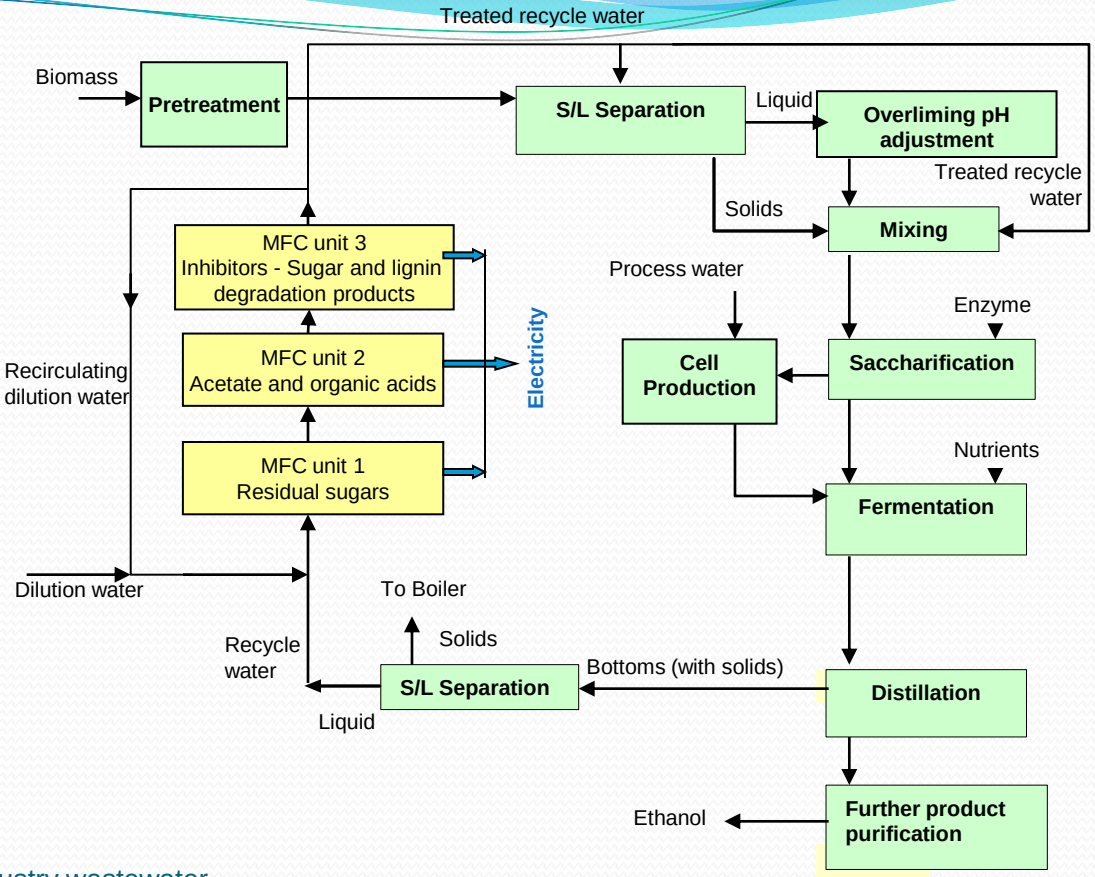
Gorby et.al.
Reguera et.al..

Lovley et.al.,
Tender et.al

[2] Borole, et.al., 2009, **Biochem. Engg. J.**, Improving power production from acetate-fed microbial fuel cells via enrichment of exoelectrogenic organisms in continuous flow systems, 48, 71-80.

Biorefineries

- Need significant volume of water (Water: EtOH = 10:1)
- Impact of MFCs on ability to reuse water, specifically for *high solids loading (> 20% solids) cellulosic biochemical conversion process.*
- Results:
  - Demonstrated removal of furfural, HMP, phenolics, acetate, and residual sugars to enable water recycle.
  - Estimated amount of electricity production = 2.5 MW (70 million gallon plant)[3].
  - Improving energy recovery from biomass and conversion efficiency.
- 650 biorefinery plants by 2022 – DOE mandate
- 21 billion gallons of biofuels



Other applications:

Energy production from organic waste, e.g., food industry wastewater
Produced water treatment
Bioelectrochemical power with simultaneous environmental remediation.

Benefits of MFC/MEC Technology

Water reuse
Sustainable energy production
Waste utilization

[3] Borole, et.al., 2009, **Biotechnol for Biofuels**., Controlling accumulation of fermentation inhibitors in biorefinery process water using Microbial Fuel Cells, April 2009, on line.

Acknowledgements: ORNL LDRD Program for funding.

Observations on Corn Ethanol Production and Distribution Infrastructure

Steven Peterson

Geographic Information Sciences and Technology Group

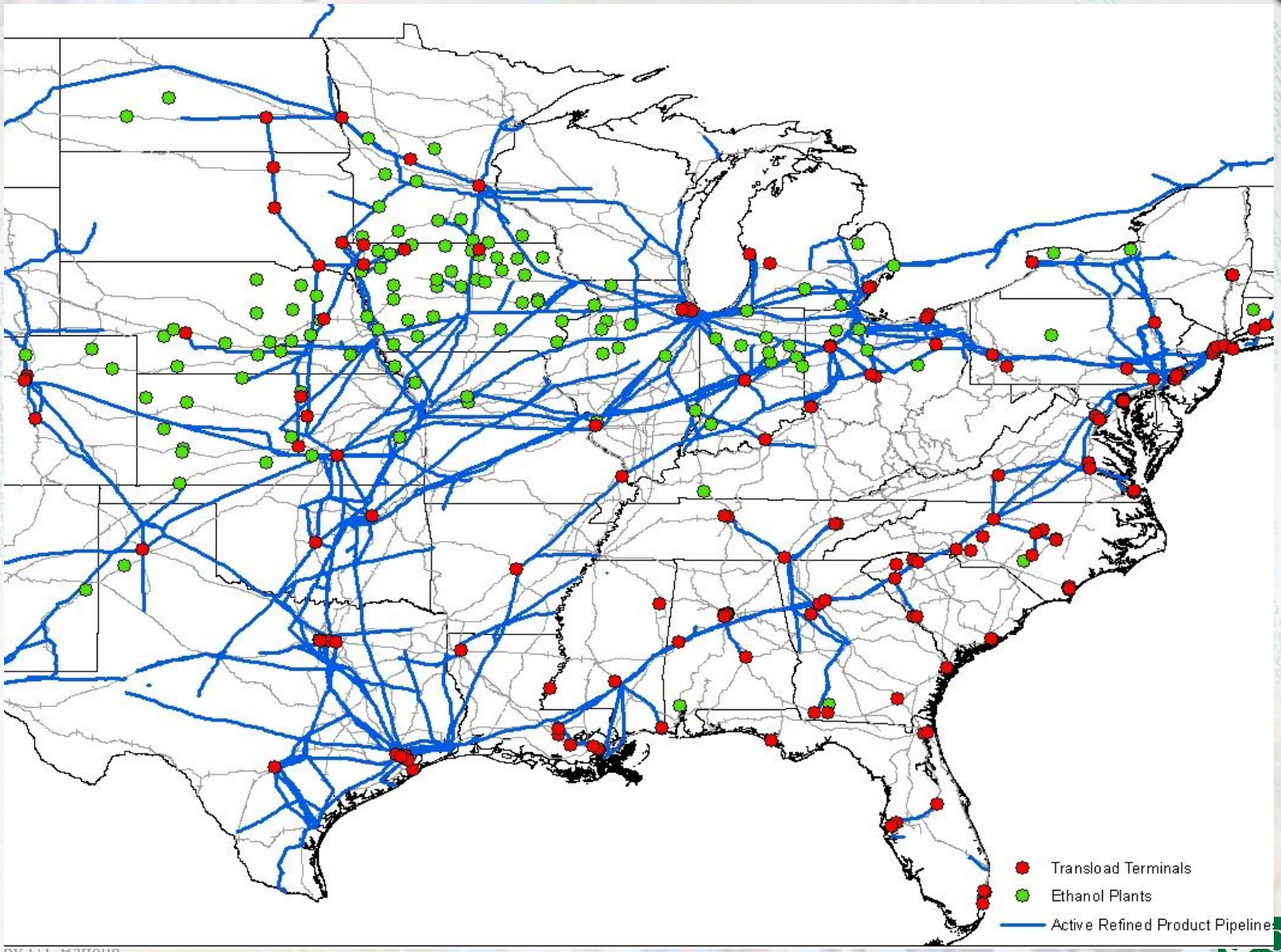
U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Infrastructure Interface

Geographic Information Science and Technology



The Problem

Geographic Information Science and Technology

- For biofuels/bioenergy, distribution and transportation systems are critical
- For distribution and transportation systems, biofuels/bioenergy are not critical
  - *Energy* **is** critical for transportation systems
    - As **fuel** for diesel-electric locomotives, maritime vessels, barges and trucks
    - As **cargo** –
      - Oil is often transported by pipelines and then on/off-loaded to/from ships
      - Coal provides the largest source of tonnage shipped by railroads and accounts for 25-30% of revenue for the largest (Class I) railroads
      - Project cargo for wind energy production often moves by rail
      - Power plant equipment, especially nuclear, often moves by rail and barge
      - Ethanol is a small component (less than 1% of volume) but was the fastest growing business segment – either as agricultural product, energy, or chemical

Data Gaps and Analytical Needs

- Network routing analysis
- Specific, validated geolocations of distribution infrastructure elements
  - Connections between rail/barge systems and the pipeline system
- Determination of
  - Spatial patterns of production and distribution
  - Market linkages
  - Infrastructure and potential critical vulnerabilities

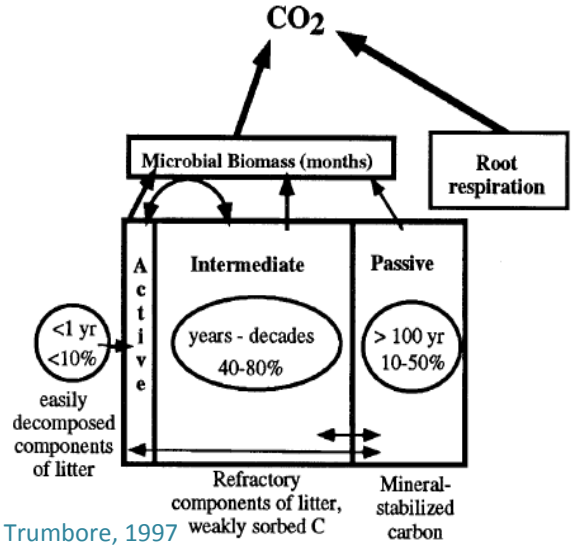
Hydrological and geochemical transformation of nitrogen and organic C in the subsurface beneath agricultural and forested ecosystems

Melanie Mayes

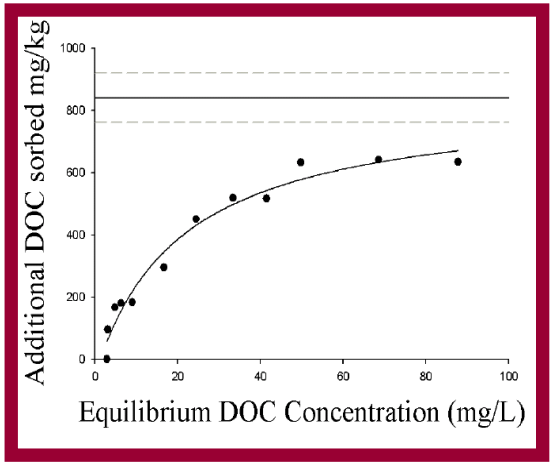
Oak Ridge National Laboratory

Regional Scale Assessment of Passive Soil Potential

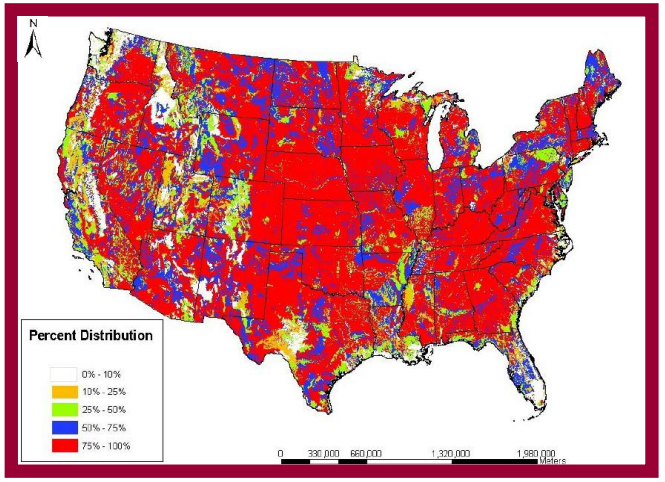
Sorption of Dissolved Organic C (DOC)



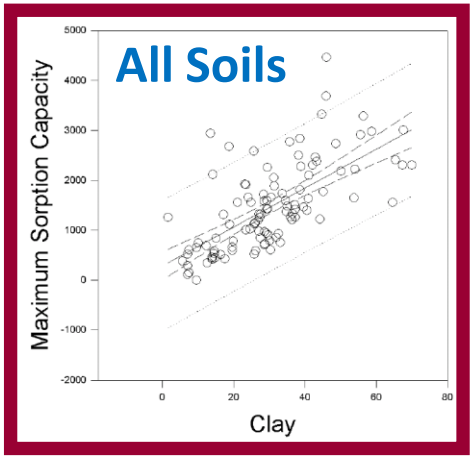
Trumbore, 1997

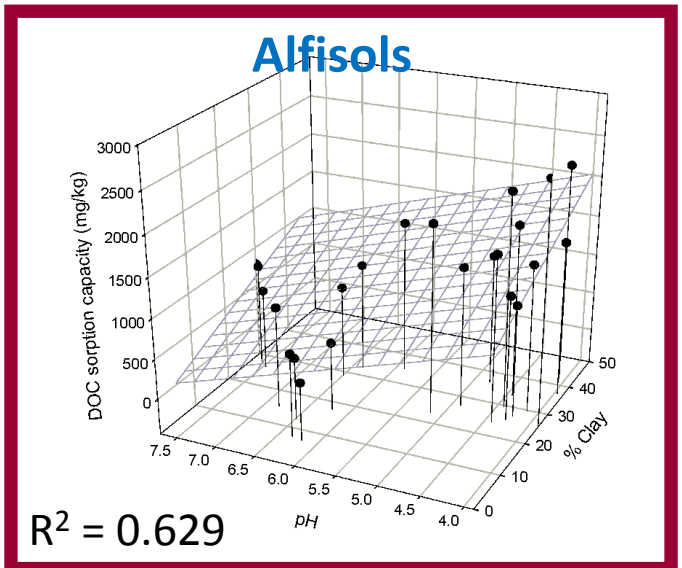


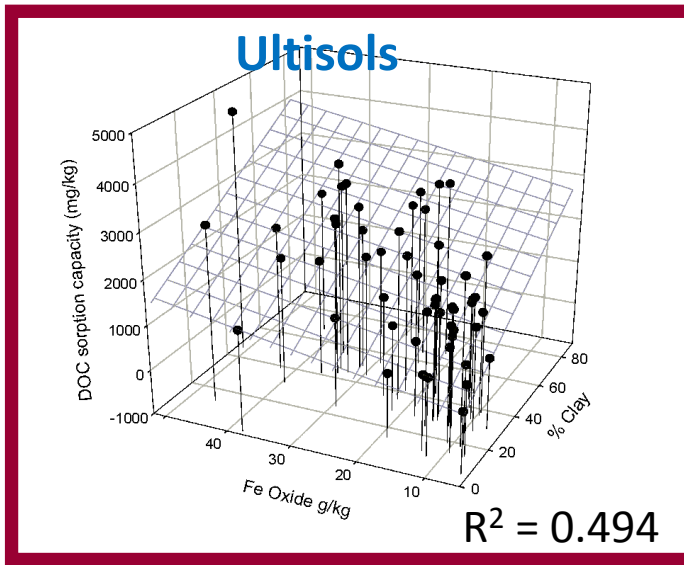
Areal Coverage of Soil Database Great Groups



Soil Properties relate to DOC Sorption Capacity

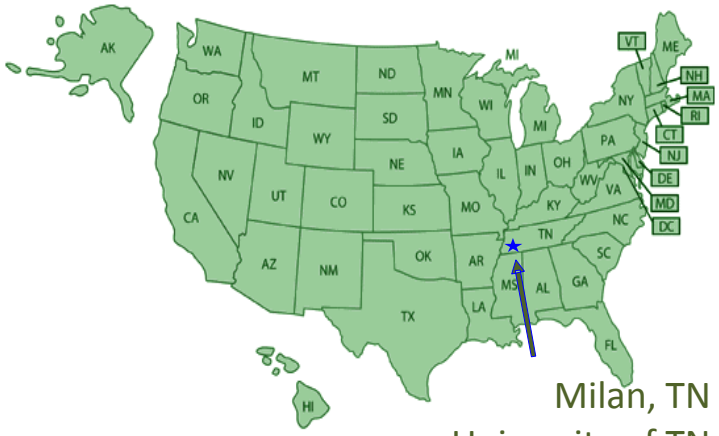




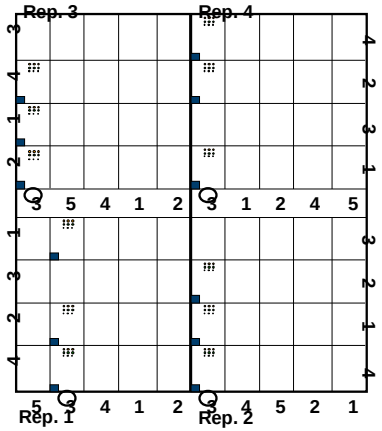


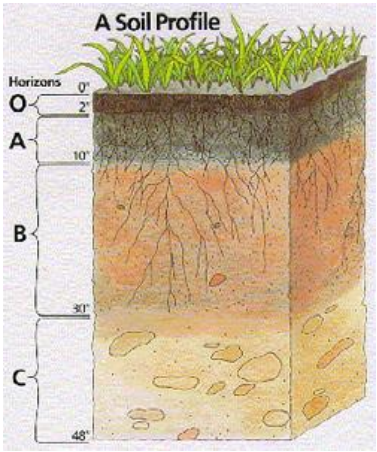
Katherine Heal
Craig Brandt
me

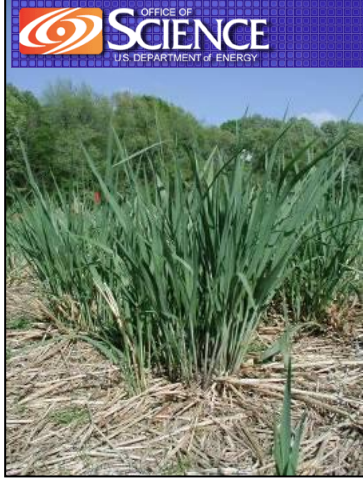
Soil Water Quality beneath Switchgrass



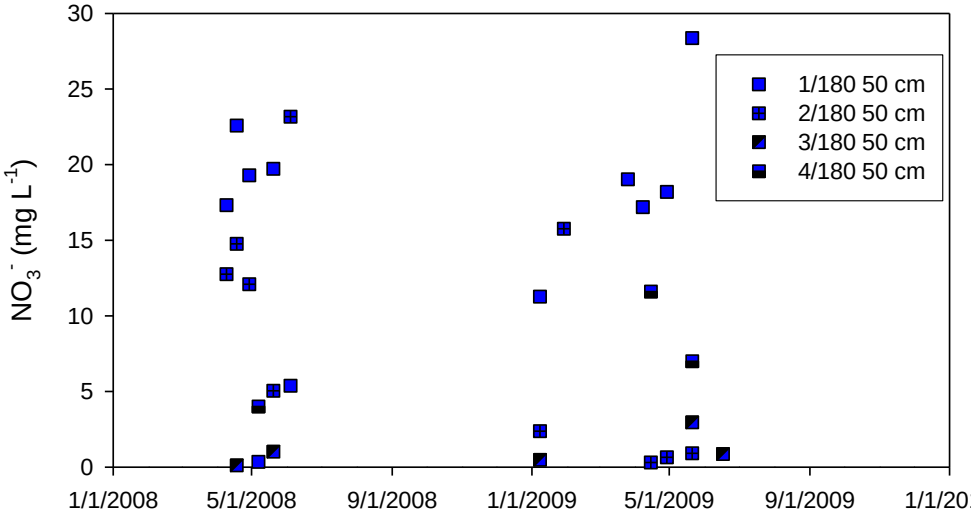
Milan, TN
University of TN



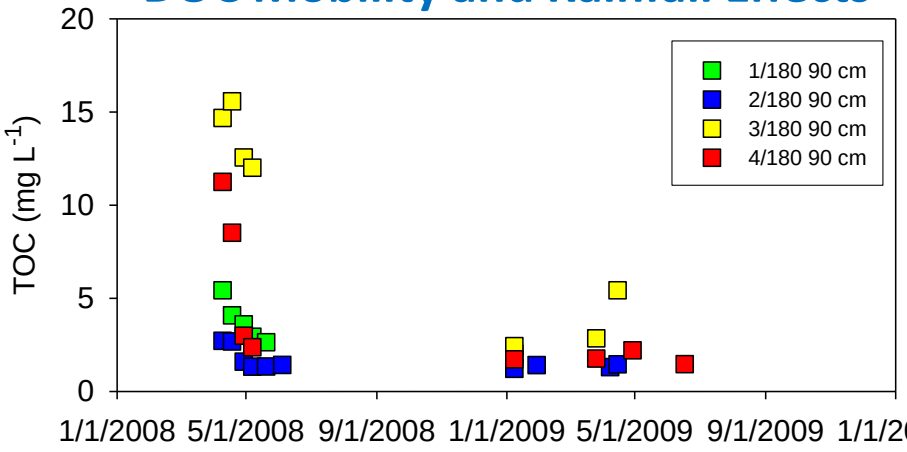




Soil Water Quality and Fertilization



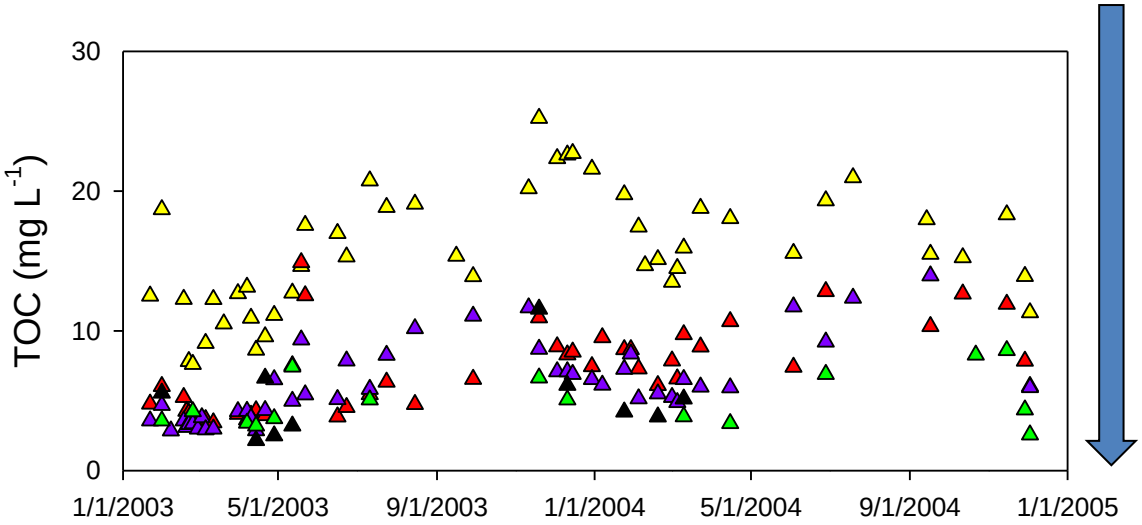
DOC Mobility and Rainfall Effects



Jana Phillips
Jonathan Reagan
Don Tyler

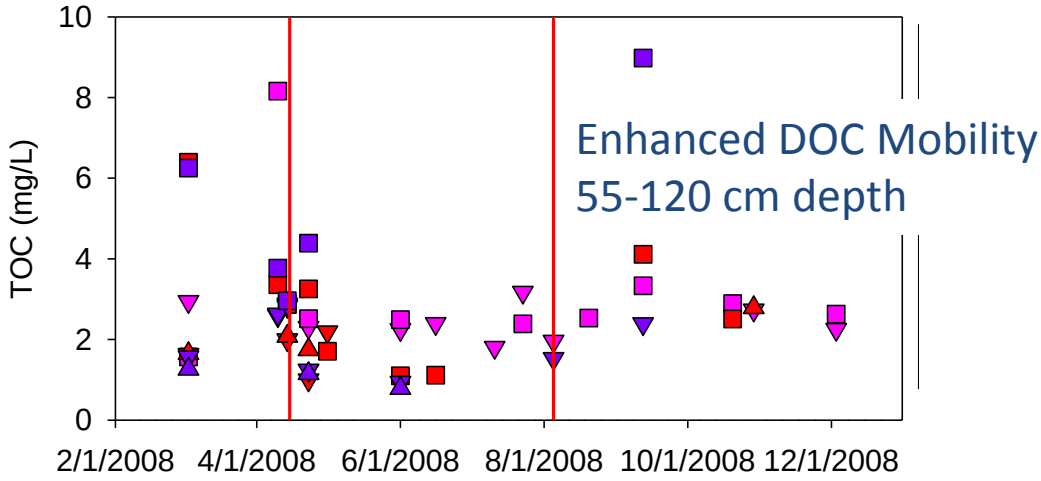
DOC Mobility in Forested Ecosystem

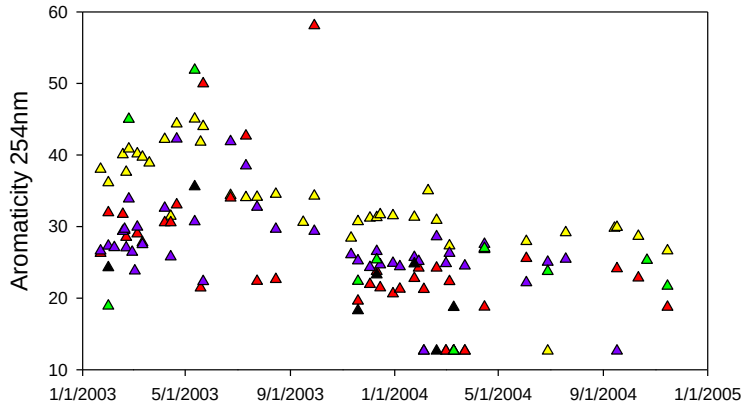
Long-term Monitoring of Instrumented Pedons at Walker Branch and Melton Branch, ORNL



Chemical Changes in DOC w/depth

Urea Fertilizer

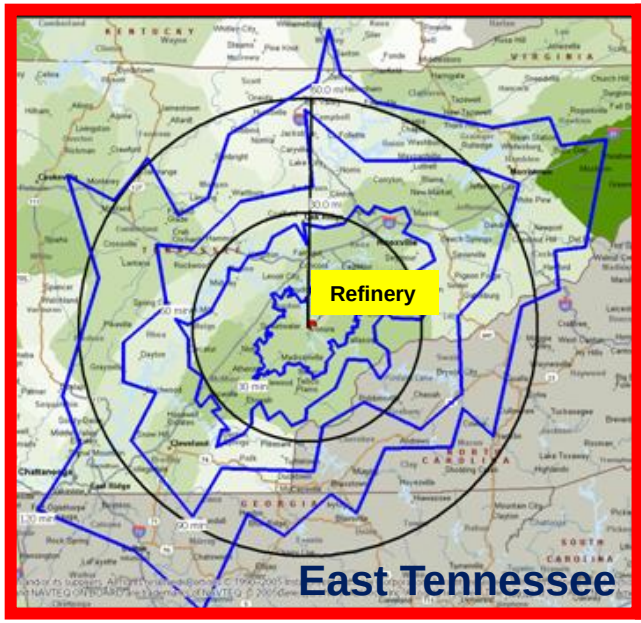




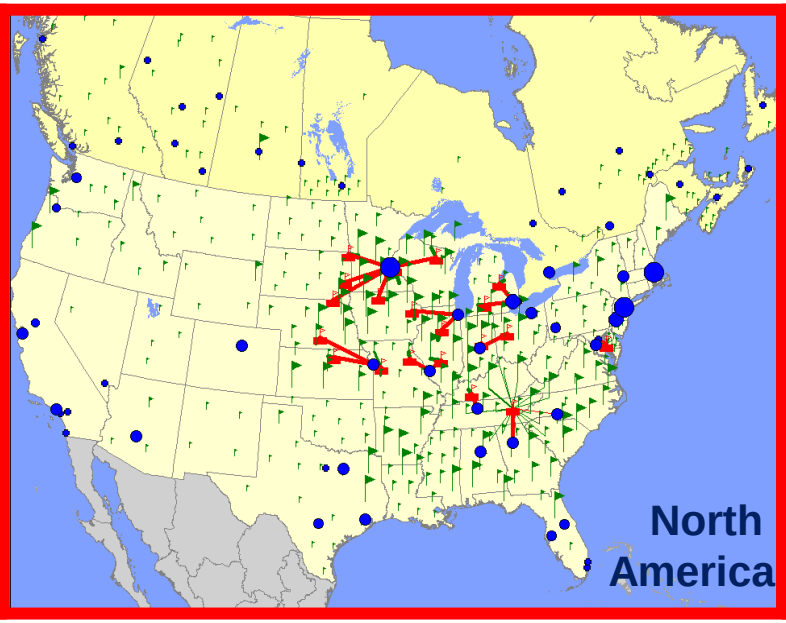
Jana Phillips
Jonathan Reagan

Logistics for a Biomass Economy

Examples of our projects:



Inbound Travel Mapping



Cellulosic Sites North America

Outbound Markets

www.stratag.org/Bioworks-Report

Strata G

www.stratag.org

Logistics for a Biomass Economy

Ideas for the future:

Strategic SRWC

Closed-loop Systems

Electrified Short-Line Rail

StrataG

www.stratag.org

Logistics for a Biomass Economy

About StrataG:

Services

- Business
- Engineering
- Science
- Technology
- Waste Mgt. & Transportation

Locations

Core Values

- We Care
- Integrity
- Service
- Quality
- Safety
- Innovation
- Attitude
- Outreach

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