

ENVIRONMENTAL SUSTAINABILITY OF SHORT ROTATION COPPICED POPLAR FOR REGIONAL BIO-FUELS: Monitoring Environmental Impacts



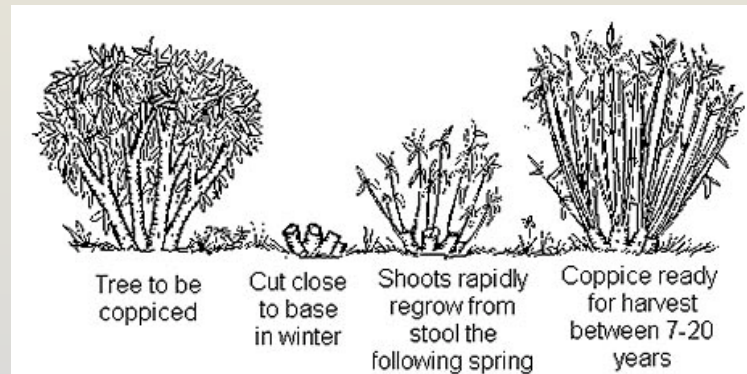
Patrick Rahilly – University of Idaho – Graduate Research Associate
Inter-mountain Forest Tree Nutrition Co-op annual meeting – April 3, 2012

Univ. of Idaho – Univ. Washington – Washington State Univ. – Green Wood Resources
Primary funding: USDA Ag and Food Research Initiative

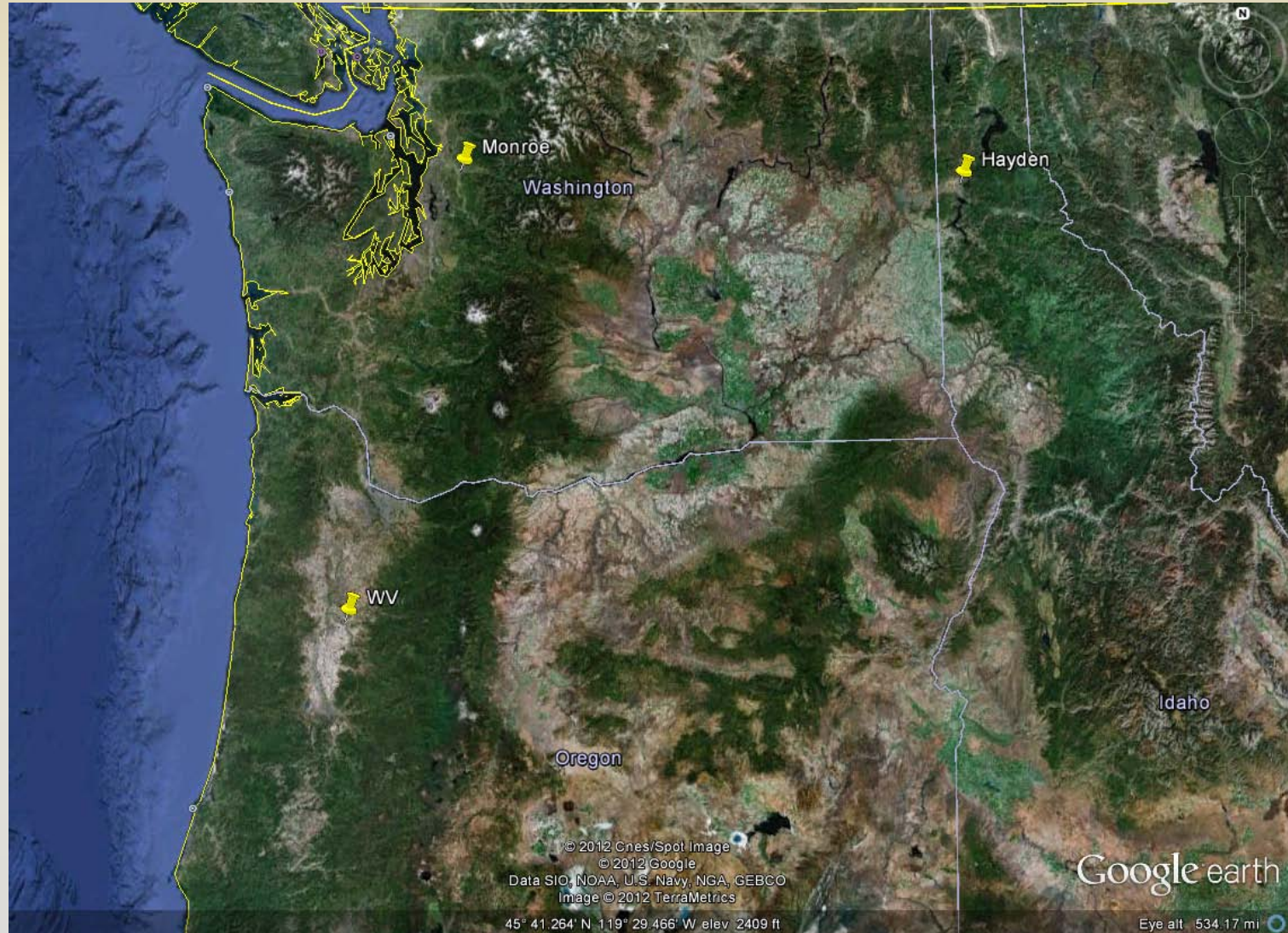
Picture: GWR Boardman Poplar Plantation – Google Earth

FULL PROJECT OVERVIEW:

- Short rotation coppice hybrid poplar for Non-Food Based Bio-Fuels in the Pacific North West
- Green Wood Resources: plant, manage, and harvest plantations
- ZeaChem: cellulosic fermentation process for bio-fuels – ethanol, jet-fuel, diesel, etc.
- 2 – 3 year growth cycles
- Planted in spring
- 5 year study



PROJECT SITE LOCATIONS and HISTORY:



QUESTION OF SUSTAINABILITY:

Forest Sustainability

"Sustainability: A state or process that can be maintained indefinitely. The principles of sustainability integrate three closely interlined elements-the environment, the economy and the social system-into a system that can be maintained in a healthy state indefinitely."

(British Columbia Forest Service)

ENVIRONMENTAL IMPACTS:

Question of Sustainability:

- Impact on soil quality and site health?
 - Soil physical and chemical parameters
 - Soil biota: fungus, bacteria – ratios
 - Enzyme activity
- Impact on water quality and soil conservation?
 - Erosion
 - off-site transport of nutrients and Ag chemicals
- Carbon balance and soil carbon accumulation?
- Comparison of environmental conditions of poplar and adjacent Ag-lands (not productivity)

OBJECTIVES: assessing sustainability

Comparing conditions of adjacent field and Poplar plantations

- Soil Quality: assess conditions before, during, and after harvest of first rotation at three locations
- Assess soil erosion and off-site transport of nutrients and agricultural chemicals
- Biologic Response: assess enzyme activity and total microbial biomass & ratios (Fungus : Bacteria)
- Monitor carbon balance and greenhouse gas flux
- Modeling: erosion models, isoprene emissions, net carbon gain
- Literature reviews pertinent to project

Carbon

Volatilized nutrients.
Organic decomposition

effluent biosolids

Harvest

litter fall



surface runoff erosion

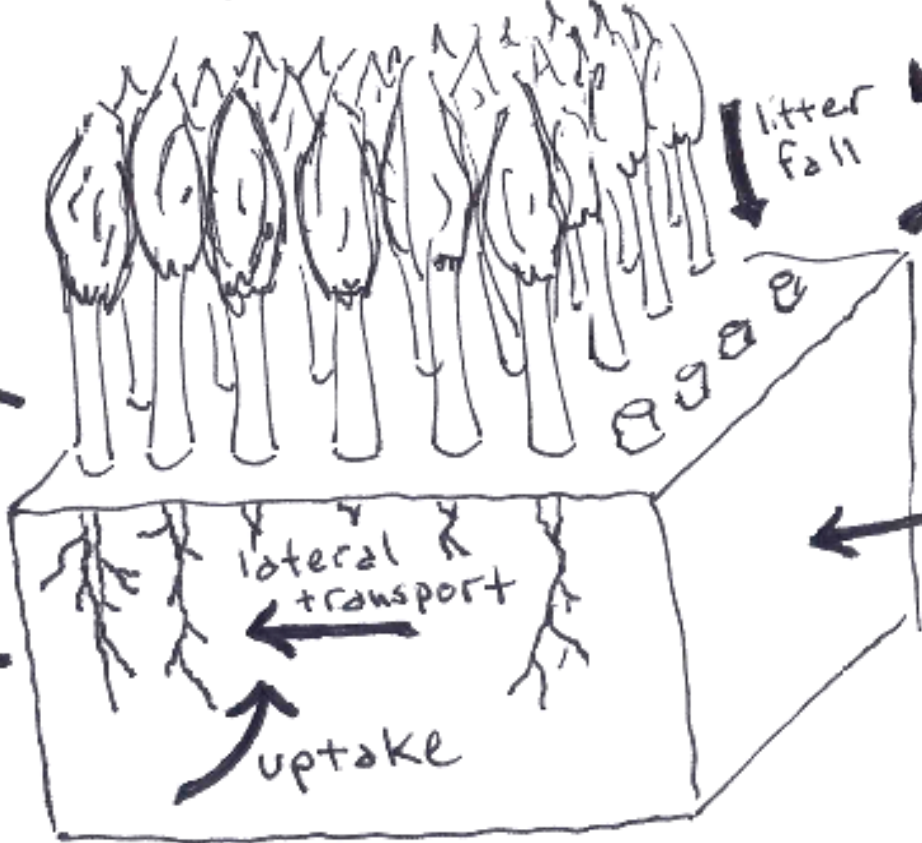
lateral losses

lateral transport

uptake

lateral inputs

leaching



HYPOTHESES:

Poplar plantations – vs – past site management

- Impact on soil quality/health
 - Physical and chemical parameters will improve
 - Fungus : Bacteria ratios will favor Fungus
 - Enzyme function will increase
- Water quality and soil conservation
 - Comparative during establishment – improving over time
 - Less nutrient loss over time
- Soil carbon accumulation
 - Organic carbon and soil organic matter will greatly increase

IMPACT ON SOIL QUALITY:

HOW WILL POPLAR PLANTATIONS AFFECT SOIL QUALITY?

Soil Quality (SQ):

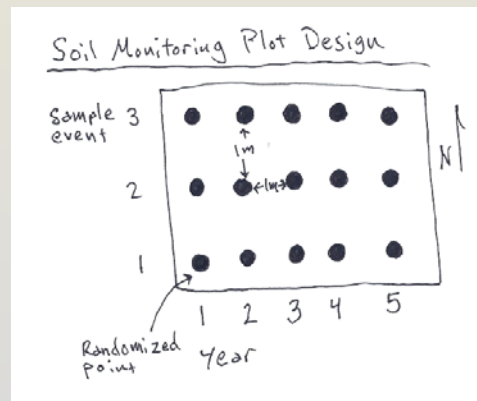
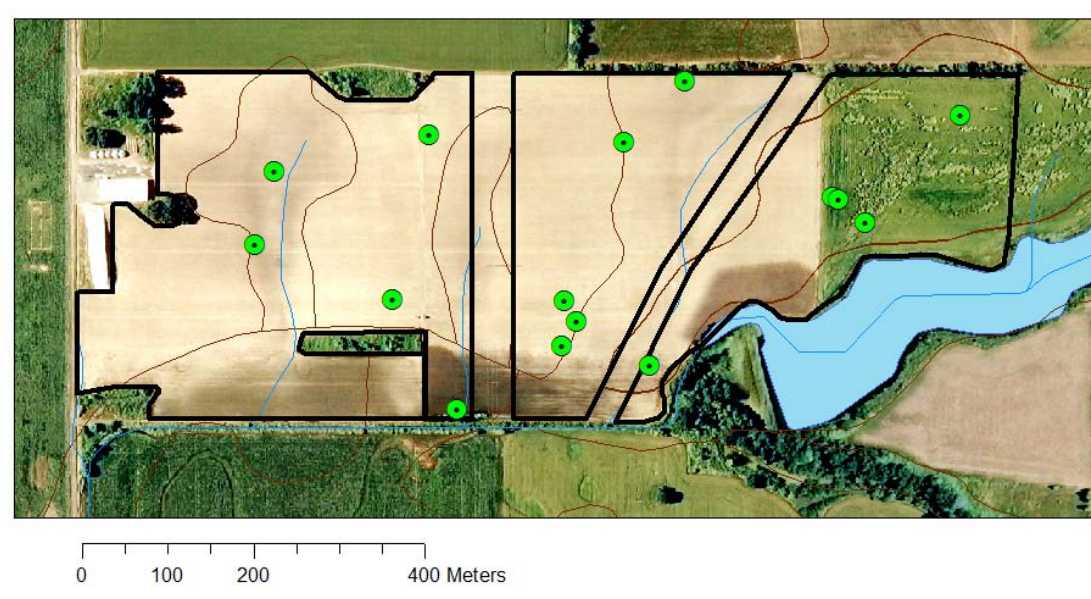
‘the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation’
(Karlen et al., 1997).

Some parameters that define SQ:

- Nutrients
- pH
- CEC
- Microbial Biomass/Activity: fungus, bacteria, function
- Organic matter, organic matter, organic matter!!!
- Bulk Density

SOIL MONITORING PLOTS AND SAMPLING:

- ArcGIS random generated plot locations:
- Monitoring plot sampling matrix
 - Year 1, event 1 = randomized point
 - Located by sub-foot GPS
 - 1 m X 1 m spacing
- Sampling depths
 - All parameters: 0 – 6 inches
 - Carbon and Nitrogen only:
10 – 14 in, 18 – 22 in, 26 – 30 in,
34 – 38 in, 42 – 46 in
- Year 1, event 1 is prior to plantation establishment
- 3 sampling events/year staggered evenly over the growing season



- Nutrients
- pH, buffer pH
- CEC, % base saturation
- bulk density
- Microbial Biomass; fungus, bacteria, enzyme activity
- Organic matter and total organic carbon.

IMPACT ON SOIL/NUTRIENT CONSERVATION & WATER QUALITY:

Agricultural settings – biggest concern is Eutrophication of water bodies from Nitrogen and Phosphorous

In Pac. NW – big problem is siltation of gravel beds and aggradation of streams – concern of fisheries and flood management

Soil Loss = Production Loss! ...and degradation of ENV.

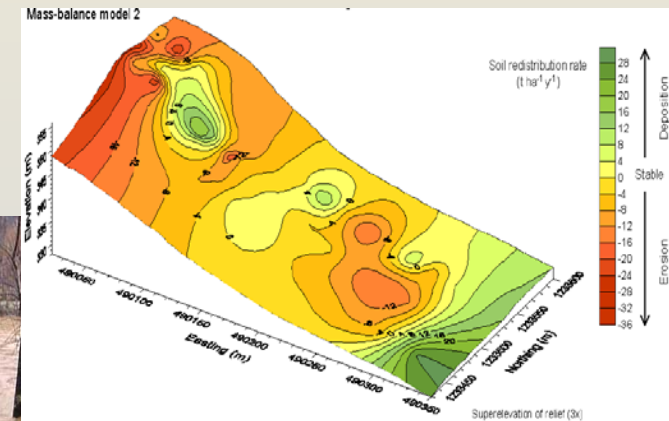
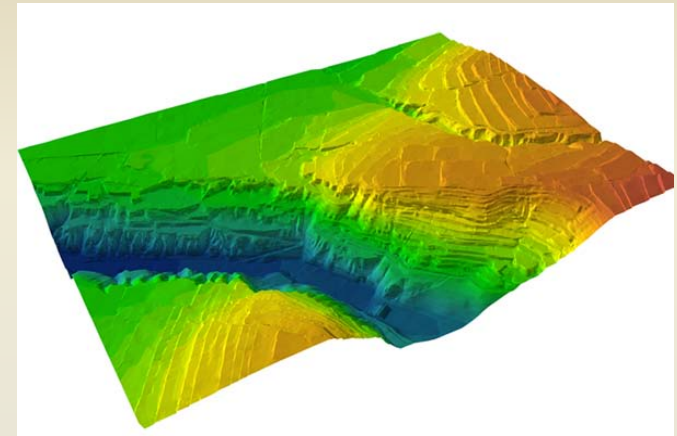
How does establishment of poplar plantations compare to traditional agricultural practices?

SOIL EROSION & CONSTITUENT TRANSPORT: PLAN OF ATTACK.



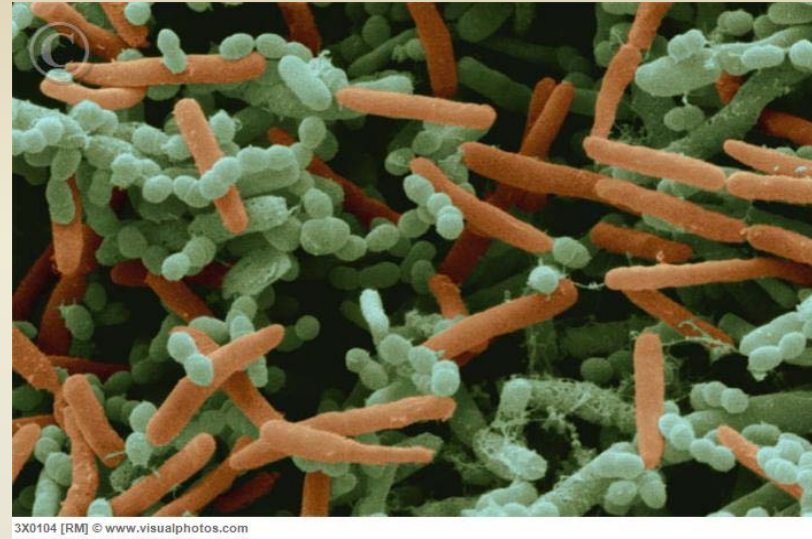
SOIL EROSION & CONSTITUENT TRANSPORT: PLAN OF ATTACK.

- DEM/MICRO-TOPO MAPPING (ground based)
- DEFINE DRAINAGE BASINS
- INSTAL STANDARD CONTRACTUAL WEIR
- INSTAL AUTO-SAMPLER EQUIPED WITH DEPTH/PRESURE TRANSDUCER FOR STORM EVENT SAMPLING
- EROSION MODELS: RUSLE 3D – WEPP



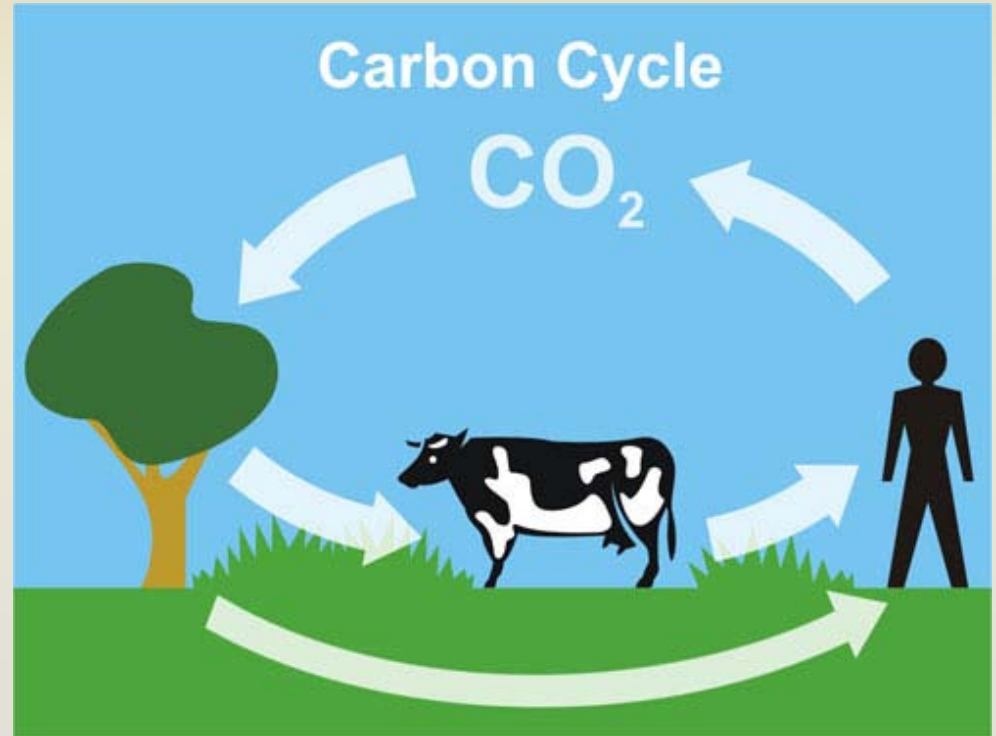
BIOLOGIC RESPONSE:

- Total microbial biomass
 - Substrate induced respiration
- Anti-fungal and Anti-bacterial inhibitors
 - Defines fungus : bacteria ratio
- Enzymes activity
 - Gives idea of microbes present
 - Peroxidase – lignin decomp
 - Phenol oxidase – lignin decomp
 - Chitanase – chitin decmop
 - Acid Phosphatase – phosphorous
 - β - glucosidase – cellulose decomp



CARBON BALANCE:

- Field measurements
 - GHG flux
 - Soil OM, Carbon
 - Destructive poplar growth
 - Above-ground below ground allometric associations and estimations
- Modeling
 - 3PG
 - Life Cycle assessment (LCA)
- Comparisons to Ag fields





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