Using RUSLE2 to Model Soil Erosion Potential for Shrub Willow

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Shrub Willow

- Potential applications in heating, electricity, and transportation fuels in the northeastern US
- Similar composition to other hardwoods facilitates mixing with forest residues
- Potential to sequester carbon in root systems (Pacaldo et al. 2012)

Soil Health and Erosion

- Soil health must be maintained over the production cycle, including:
 - Aggregate stability
 - Root health
 - Soil organic matter and carbon
 - Cation exchange capacity
 - D pH
 - Water holding capacity
- All factors can be negatively impacted by water-driven soil erosion, the removal of topsoil by rainfall and runoff.

Willow Biomass - Crop Production Cycle



Soil Erosion Impact of Perennial Energy Crop Production

- Tillage only occurs in the first year, surface disturbance every three years
- For perennial woody biomass crops, studies have shown improved:
 - Soil carbon (Blanco-Canqui 2010, Kahle et al. 2005, Tolbert et al. 2002); mixed results, either increase or no change
 - Aggregate stability (Blanco-Canqui 2010)
 - Water infiltration and soil porosity (Kahle et al. 2005)

Motivation

- Biomass Crop Assistance Program for willow in northern NY
- Natural Resource Conservation Service (NRCS) models soil erosion from potential sites
- Current willow vegetation file based on limited data
- Interest in thresholds for soil type and slope and the impact of cultivar on erosion

RUSLE2

- Widely used empirical soil erosion model
- Predicts average annual soil loss from water erosion and calculates Soil Conditioning Index (SCI)
 - SCI is a measure of change in soil organic matter
- Can be used to compare different managements (e.g. different cultivars, fall or spring site preparation)

RUSLE2

$\square A = R^*K^*L^*S^*C^*P$

- A: average annual soil loss (Mg/ha or tons/ac)
- R: rainfall erosivity
- K: soil erodibility
- L&S: field length and slope
- C: cover management (vegetation and management)
- P: support practices (cover crops, contour farming)

Cover Management Factor

- Vegetation file (over crop lifetime):
 - Canopy fall height
 - Root biomass in top 4 inches of soil
 - % Canopy cover
 - % Live ground cover
 - Yield
- Management file (over crop lifetime):
 - Site preparation and planting
 - Harvesting and regrowth

Developing a Vegetation File

- 2013 growing season May through November
- Data collected using chronosequence approach
- Three cultivars: SV1, SX64, and Fish Creek
- Parameters for vegetation file: canopy fall height, live ground cover, canopy cover, and root biomass in the top 4 inches of soil
- Leaf area index data was also collected, but is not a part of the vegetation file.







SX64 – 2 yr shoots, 6/12/13



SV1 – 2 yr shoots, 6/12/13

Wolcott-2 yr shoots, 6/12/13

Example: Middlebury, VT (3 yr shoots, 7 yr roots)



Management File

Date	Operation	
10/5/0	Sprayer, post-emergence	
10/15/0	Plow	
10/15/0	Disk	
5/7/1	Sprayer, post-emergence	
5/14/1	Disk	
5/15/1	Plant	
5/17/1	Sprayer, pre-emergence	

Results

- Low average values over the entire rotation (23 years)
 - □ Using a 6% slope, 150 feet long hillside
 - Silt loam soil type
 - Standard fall site preparation
 - T-value: 6.7 Mg/ha/yr (3 t/ac/yr)
 - Fish Creek: 1.75 Mg/ha/yr
 - SX64: 1.70 Mg/ha/yr
 - SV1: 1.53 Mg/ha/yr
 - SCI: ~1 for all cultivars

Results - Effect of Cultivar

Fish Creek had consistently the highest erosion (3% higher than SX64 under default conditions).

■ Yield \rightarrow aboveground biomass \rightarrow dead ground cover

Results – Erosion by Year

Highest erosion in the first year (fall site prep through the following fall)



Results – Spring Site Preparation

Date	Operation
10/5/0	Sprayer, post-emergence
5/7/1	Sprayer, post-emergence
5/14/1	Plow, moldboard
5/14/1	Disk, offset, heavy
5/15/1	Planter, transplanter
5/17/1	Sprayer, pre-emergence

Results – Effect of Soil Type

Soil Type	Fish Creek	SX64	SV1	
Clay	0.36	0.35	0.32	
Clay loam	0.90	0.87	0.79	
Loam	1.56	1.51	1.37	
Silt	2.38	2.32	2.08	
Silt Loam	1.75	1.70	1.53	
Silty Clay	0.63	0.61	0.56	
Silty Clay Loam	1.11	1.08	0.98	
No sandy types included – too well drained for willow				

Results – Effect of Slope



Further Research

- Adaptation of RUSLE2 to perennial woody crops
- Data collection on growth characteristics for different sites over a wider geographic area
- Empirical measurements of erosion to compare to the model

References

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Thank you! Questions?

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