An approach for siting poplar energy production systems to increase productivity and associated ecosystem services

Zalesny R.S. Jr.[1], Donner D.M.[1], Coyle D.R.[2], Headlee W.L.[3], Hall R.B.[3]
[1]U.S. Forest Service, Northern Research Station, Institute for Applied Ecosystem Studies - IAES, Rhinelander, WI, USA
[2]University of Wisconsin, Department of Entomology, Madison, WI, USA
[3]Iowa State University, Department of Natural Resource Ecology and Mangement, Ames, IA, USA

Short rotation woody crops (SRWC) such as *Populus* species and hybrids (i.e., poplars) are renewable energy feedstocks that are vital to reducing our dependence on non-renewable and foreign sources of energy used for heat, power, and transportation fuels. Highly productive poplars grown primarily on marginal agricultural sites are an important component of the future energy strategy in the United States and many other countries. Poplars can be strategically placed in the landscape to conserve soil and water, recycle nutrients, and sequester carbon. Establishing poplar genotypes that are adapted to local environmental conditions substantially increases establishment success and productivity. But, it is difficult to predict field trial success in landscapes where the crop has not been previously deployed. Our overall goal is to merge our knowledge of poplar biology with large-scale spatial analysis to predefine zones of potential plant adaptation that are ecologically sustainable and economically feasible across the landscape. The project builds on SRWC research conducted at the IAES in Rhinelander, Wisconsin, USA since 1968, as well as decades of poplar genetics research in Minnesota, USA that has led to commercial poplar production on >10,000 ha in the state.

We identified in a spatially-explicit manner potential core areas within Minnesota and Wisconsin, USA for potential field testing by combining key climatic and soil properties with land ownership and use constraints. Our approach was to rank lands based on current land use (i.e., open land cover types), land ownership (private vs. public), suitability of soil for agriculture (marginal vs. prime), and economic thresholds. Because the decision to convert lands for SRWC production is an economic decision by most landowners, we incorporated soil rental rates established by the Farm Service Agency, and estimated return on corn yield by county to establish economic thresholds beyond which conversion to SRWC production is not probable. Next, we determined the range of variability (i.e., mean and variance) in climate properties (e.g., growing degree days, temperature, precipitation) and key soil properties (e.g., available water holding capacity, bulk density, pH) for the resulting land base. Additionally, we are currently using a combination of empirical data from prior regional field testing networks (see Coyle et al. – poplar database) combined with productivity models to predict establishment and long-term yield of favorable genotypes throughout the cores areas described above. We will also conduct field reconnaissance and surveys to assess the potential opportunities for maintaining soil health, water quality, and other ecosystem services, assuming poplars are tested and/or deployed within the core areas.

Our presentation will highlight the development of the GIS-based siting protocol, along with results from the productivity modeling and ecosystem services assessment. Our approach is novel in that it integrates genetics and landscape ecology to limit inputs without sacrificing sustainability or productivity of these energy feedstock production systems.

Keywords: energy security, feedstock production, *Populus*

Zalesny, Ronald S., U.S. Forest Service, Northern Research Station, Institute for Applied Ecosystem Studies - IAES, 5985 Highway K, Rhinelander, WI 54501, USA, Tel.: +715 362-1132, e-mail: rzalesny@fs.fed.us

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