An Improved Volume, Biomass, Carbon, and Thermochemical Database for Major US Tree Species

Justification: Forest biomass and carbon are closely related and are estimated from the same underlying data. These estimates are demanded for bioenergy, greenhouse gas, and traditional wood supply purposes. Historically, the forest biomass focus was on the merchantable part of the stem. This historical focus has now extended to whole tree biomass. There is also a need to separate whole tree biomass into components such as the bole, branches, twigs, and leaves. Furthermore, there is a need to understand the thermochemical characteristics of tree species given their potential use for bioenergy. Because of the historical focus on the merchantable stem and the expense of conducting the requisite felled tree studies, there is a lack of data available to characterize thermochemical properties and to develop flexible biomass models in a consistent fashion nation-wide.

Approach: The Forest Inventory and Analysis program is currently funding an effort to build a database of appropriate data to develop these flexible biomass models. This effort includes university, industry, and non-governmental organization partners as well as other federal partners. There are several phases to this effort, (1) Identify and obtain relevant biomass and taper data from legacy studies. (2) Conduct felled tree studies to fill in gaps in legacy biomass data. (3) Conduct thermochemical characterization on trees used in the felled tree studies. (4) Develop a system of equations for whole tree and component biomass.

Expected results: A primary outcome is the development of nationally-consistent models to predict tree volume/biomass/carbon that explicitly incorporate the relationships between these attributes as determined from study data. The models should also account for any systematic trends in tree allometry, wood density, and biomass component allocation across the landscape. In addition to spatial variation, within-tree trends in wood density can also be described. Also, of considerable interest will be the national-scale observed field data as well as the associated physical, chemical, and thermochemical properties obtained from lab analyses that can support additional research endeavors.

Phases:

Legacy data: Felled tree studies are expensive, time-consuming, and the only way to get combined biomass and stem taper data. Numerous felled tree studies have been conducted and published. A substantial effort is underway to obtain data from existing felled tree studies in electronic format. To date, data from 55 legacy studies has been obtained. This includes combined biomass and taper data for 838 trees across 23 species and biomass only data for 6745 trees across 107 species.

Felled tree studies: There are various knowledge gaps associated with legacy data, primarily the small geographic scope of individual studies and limited data on large-sized trees. Filling these gaps is necessary to understand how tree form and biomass allocation varies among species and across environmental gradients. Felled tree data are being collected by six university partners (Oregon State Univ., Virginia Tech, Univ. of Georgia, Univ. of Maine, Michigan State Univ., Univ. of Montana), with emphasis on the top 20 species (by volume) in the East and top 10 species in the West. To date, approximately 500 trees have been felled and measured.

Thermochemical characterization: The applicability of the woody biomass database becomes more robust when there is a link to utilization potential. Thus, trees sampled for the woody biomass volume database will also be sampled for physical, chemical, and thermochemical characterization and thus their efficacy as a bioenergy feedstock. Analyses will focus on density, ash content, heating value, fixed carbon, volatile matter, and chemical composition (organics and inorganics).

Model development: Flexible modeling approaches that fit the identified needs will be extracted from the current literature base and expert opinion. These models should be applicable for both excurrent and decurrent tree forms. Recent advances in taper-based approaches, such as the varying centroid method, and the further development and application of pipe model theory provide new methods that may be compared with other techniques like component ratio methods and "seemingly unrelated regression" that ensures additivity. The model development phase should also employ modern techniques that account for issues such as heterogeneity of residual variance and lack of independence among observations.

Timeline: Considerable time and expense are needed to assemble the requisite data sets, particularly the felled tree information and associated data from the lab analyses. Thus, the first three phases comprise the majority of the project. The model development phase will occur in tandem with the first three phases, as available data can be used to evaluate various modeling frameworks, assess model uncertainty, and provide guidance on sample sizes needed to attain precision goals. The rate of progress for these phases is largely dependent on available funding. Currently, the FIA program is providing the sole monetary support for the project. Future funding will depend on the overall FIA budget and the importance of the project in relation to other research needs of the program. At the current level, it is expected the project will be completed in 2020. This timeline would shorten considerably if the FIA program had a substantial increase in project funding or funds/other contributions from external partners. The timeline may lengthen (i.e., beyond 2020) if FIA remains the primary funding source and current commitments to the project cannot be maintained.

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