Spatial Forest-Based Biomass Availability

Robert E. Froese (PI)

School of Forest Resources and Environmental Science
Michigan Technological University, Houghton, MI 49931, U.S.A.

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Executive Summary

Geospatial models were developed for the amount of growth in Michigan's forests that is net of both natural mortality and harvest removals. This metric, called *net growth after removals* (or NGAR) represents the relative accumulation or depletion of forest inventory at any given spatial location in Michigan. Where NGAR is positive there may be opportunities for additional biomass harvest, though ultimately many factors conspire to constrain the amount of NGAR that is actually available to a suitably motivated marketplace. Ultimately, if accurate data on availability and drain (current consumption) could be developed and combined with NGAR, an informative picture of opportunities for new industrial development, as well as areas where competition is already constraining current use, would be possible.

Introduction

Ultimately, many factors interact to define the amount of biomass that may be harvested from Michigan's forests. Here, the term *biomass* is used to generalize the possible suite of fiber products that harvesting may be intended to supply. These include traditional roundwood harvest for veneer, sawn lumber, and pulp and paper manufacture, as well as intensified use of roundwood and logging residues for energy production.

An analysis of forest biomass availability begins with forest inventory, where inventory is defined as both the current amount and condition of forest resources, as well as how those resources are changing. Since forests are dynamic systems, so is forest inventory; each year trees grow larger, adding wood volume to the forest, and trees die or are harvested for consumption. If the rate of tree mortality and removals is approximately equal to the rate of tree growth, then the forest inventory remains relatively constant.

Growth, mortality and removals vary spatially across the State of Michigan because of a myriad of factors. These include biophysical factors, like differences in soils, climate, and natural disturbance, as well as anthropogenious factors, like differences in land ownership, institutional behavior and management objectives. When we combine these factors, we say we can define the *availability* of forest biomass, where availability is the amount of forest biomass is available for harvest each year.

This project is the fourth in a set of tasks conceived within the Forestry Biofuel Statewide Collaboration Center (FBSCC) to address the inventory and availability of forest based biomass in the state. The overall goal in this task was to construct geospatial data sets for biomass availability for Michigan. The ultimate application is an assessment of the capacity for Michigan's forests to meet renewable energy policy goals while supporting the existing forest-based products sector.

Methods

In the FBSCC Task A1 geospatial models of inventory were constructed for Michigan (Deo et al. 2011). These models were the foundation for the data sets developed in this project. Briefly, the approach in that task was to construct a spatial model, called a mapping model, of existing ground-based inventory data collected by the USDA Forest Service, Forest Inventory and Analysis program. The mapping model relates known conditions from field samples to satellite based measurements at the same location. Then, since the satellite measurements are continuous, predictions can be made in-between the ground plots to *impute* the likely value of forest inventory attributes.

Differences were calculated between the imputed rate of forest growth and removals, in terms of merchantable cubic foot volume, in this project. This difference is termed *net growth after removals* or NGAR. The raw values of NGAR were added to the set of mapping model outputs and were embedded in a web-based information management system called the Forest Biomass Information System, or FBIS (see http://fbis.mtu.edu). This was the goal of the FBSCC Task A2 (Froese et al. 2011).

In the FBSCC Task A3, collaborators at Michigan State University analyzed past rates of timber harvest and management objectives for each of four major owner classes (GC and Potter-Witter 2011). These were: Federal, State, Industrial and Non-Industrial Private forest lands. Availability was defined as the fraction of growth that was planned for timber harvest.

The ultimate goal of this project, FBSCC Task A4, was an assessment of the capacity for Michigan's forests to meet renewable energy policy goals while supporting the existing forest-based products sector. To do this, data were required that represent forest biomass availability and demand, or drain, on the forest resource. These were the goals of the other three FBSCC Tasks A1, A2 and A3. Unfortunately, drain and availability data in a form and scale that would permit a spatial assessment were not developed in these tasks.

Spatial models of NGAR were derived by subtraction of removals from growth data at the pixel level. Because spatial error is high at the pixel scale (Deo et al. 2011), the NGAR data were generalized by smoothing using the focal statistics tool in ArcGIS 10, with a circular spatial average filter and a 2 km radius.

Results

The key product from this project is a set of spatial models of NGAR. These models are downloadable as raster (grid) data in an ESRI geodatabase format from the FBIS web site. Data are available for merchantable bolewood, in cubic feet, by major species group (softwood and hardwood). Illustrations of the two data sets are provided in Appendix 1 and Appendix 2.

Discussion

The accuracy of the NGAR data developed in this project is limited by the accuracy of the data from which they were derived, namely the imputed values of growth and removals for Michigan developed by Deo et al. (2011). Readers are encouraged to be familiar with the interpretation provided by those authors, and should review their report.

The concept of "NGAR" is intended to illustrate where, and to what degree, forest biomass is accumulating in Michigan's forests, because removals and natural mortality together are less than gross annual growth. In these areas, additional timber harvest may be possible without depleting the standing inventory, or growing stock. Limiting removals such that NGAR is no less than zero over the long term is often viewed as the most rudimentary metric of sustainable management. Otherwise, if NGAR is negative for a protracted period of time, forests are essentially being depleted.

Ultimately it is essential that NGAR data be combined with realistic models of likely availability to estimate the true resource management potential. There are areas in Michigan where NGAR will be completely inaccessible to the wood or biomass products market, because landowners have no intention of ever permitting harvesting. Clear examples are parks and protected areas, but also National Forest lands, because there is now a long history of timber harvest on National Forests at far less than ASQ (Annual Sale Quantity) levels in approved forest management plans.

Similarly, it is essential that NGAR be paired with a realistic model of drain, or current harvest consumption, by the wood products and energy sectors. Without this pairing it will be difficult to determine the locations within Michigan where supply and demand are such that new opportunity for forest utilization, and development of e.g. bioenergy facilities, exist. It will remain equally difficult to estimate where competition is already significant enough that current facilities are under pressure to obtain adequate raw material.

Literature Cited

Deo, R.K., R.E. Froese and M.J. Falkowski. 2011. Geospatial forest inventory models for Michigan. *Final report submitted to Michgan Economic Development Corporation*. Michigan Technological University, Houghton MI. 24 pp.

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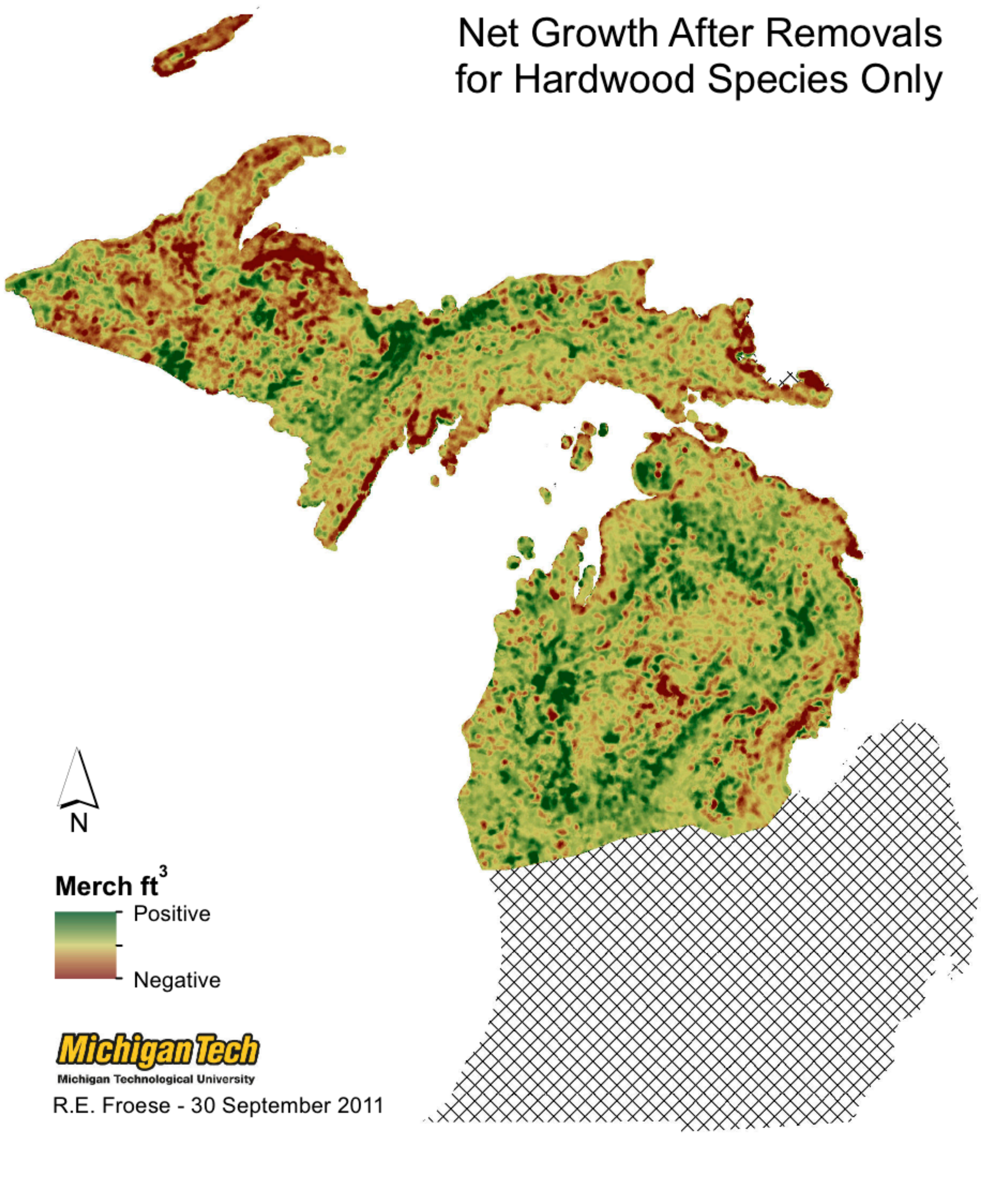
GC, S. and K. Potter-Witter. 2011. Michigan timber available to harvest. Michigan State University, Department of Forestry. 10 pp. Available at: http://fbis.mtu.edu/caveats.pdf (accessed 30 September 2011).

Appendix 1 Net Growth After Removals for Hardwood Species



Appendix 2 Net Growth After Removals for Softwood Species