Forest Productivity Modeling Update - January 2003

The US Forest Service and the Missouri Department of Conservation have shown interest in modeling forest productivity for the Missouri Ozarks. This ability is significant in Missouri because many Ozark forests were historically shortleaf pine or mixed pine-oak, which are more productive given the same abiotic conditions versus the current oak-dominated vegetation types.As part of the Synergy II project, we visited Ray Hunt, an ecosystem modeler with the USDA, at his office near Washington, D.C. We discussed requirements for implementing his forest productivity model, BGC++, and he agreed to work with us to implement the model for selected areas in the Missouri Ozarks. The required abiotic input data for the model runs were collected from multiple sources (Table 1). The Mark Twain National Forest (MTNF) supplied forest stand polygon information (Figure 1, 2). These data were invaluable because they served as the basic unit within which productivity measures were calculated.

Table 1. BGC++ required parameters and source.

BGC++ Parameter	Source
Biome type	MTNF stand database
Latitude	MTNF stand database
Longitude	MTNF stand database
Soil texture	STATSGO database
Soil depth	STATSGO database
Elevation	National Elevation Dataset (NED)
Slope	NED
Aspect	NED
Biomass by species	Forest Inventory and Analysis data
Leaf Area Index by species	Cannell, 1982
Temperature	National Climate Data Center (NCDC)
Precipitation	NCDC

All data required by BGC++ was complied in an ArcView shape file to maintain the spatial link to the original forest stand polygons (Figure 3a, 3b). BGC++ expects several input files in differing formats, each as flat ACSII files. Over 64,000 polygons were evaluated by BGC++ for the MTNF. The output from BGC++ included Total Net Primary Production (NPP) (Figure 4, 5), above ground NPP (Figure 6, 7), and total allocation to stems (stem increment) (Figure 8, 9), all given in KgC/ha/yr.

MODIS/Terra Net Photosynthesis (PSN) 8-Day L4 Global data was gathered for the area coincident with the MTNF. The PSN data are measured in $KgC/m^2/8$ days. At some point the 8-day PSN data will be integrated over a year to produce an annual NPP product; to date, this product is not available. The PSN data was projected to UTM-zone 15 using the MODIS Reprojection Tool. The data were then imported to our image-processing package. A similar procedure was followed for each of the Quality Control (QC) masks. A total of 44 scenes of PSN data were processed. Image dates ranged from December 2, 2000 to January 25, 2001. All PSN data were masked using the supplied QC data. Only data that satisfied the following QC standard were included for further

processing: 1) were deemed best possible or OK, 2) used main method to calculate Fraction of Photosynthetically Active Radiation (FPAR) and Leaf Area Index (LAI) or used empirical backup method to calculate FPAR and LAI, 3) significant clouds not present, and 4) had a Confidence Quality score of very best, good, or OK. The resulting eight weeks of PSN data were merged into a single image by taking the maximum PSN value for any given pixel (Figure 10, 11).

A comparison between the modeled NPP and the MODIS derived NPP was not possible because the MODIS derived NPP data is not yet available. We did attempt to compare the modeled NPP data to the MODIS derived PSN data, but a relationship did not exist. This is most likely due to the fact that the MODIS data were collected during the winter of 2000-2001, where the BGC++ product is a yearly measure of production.

Figure 1. Forest Biome Type, Mark Twain National Forest

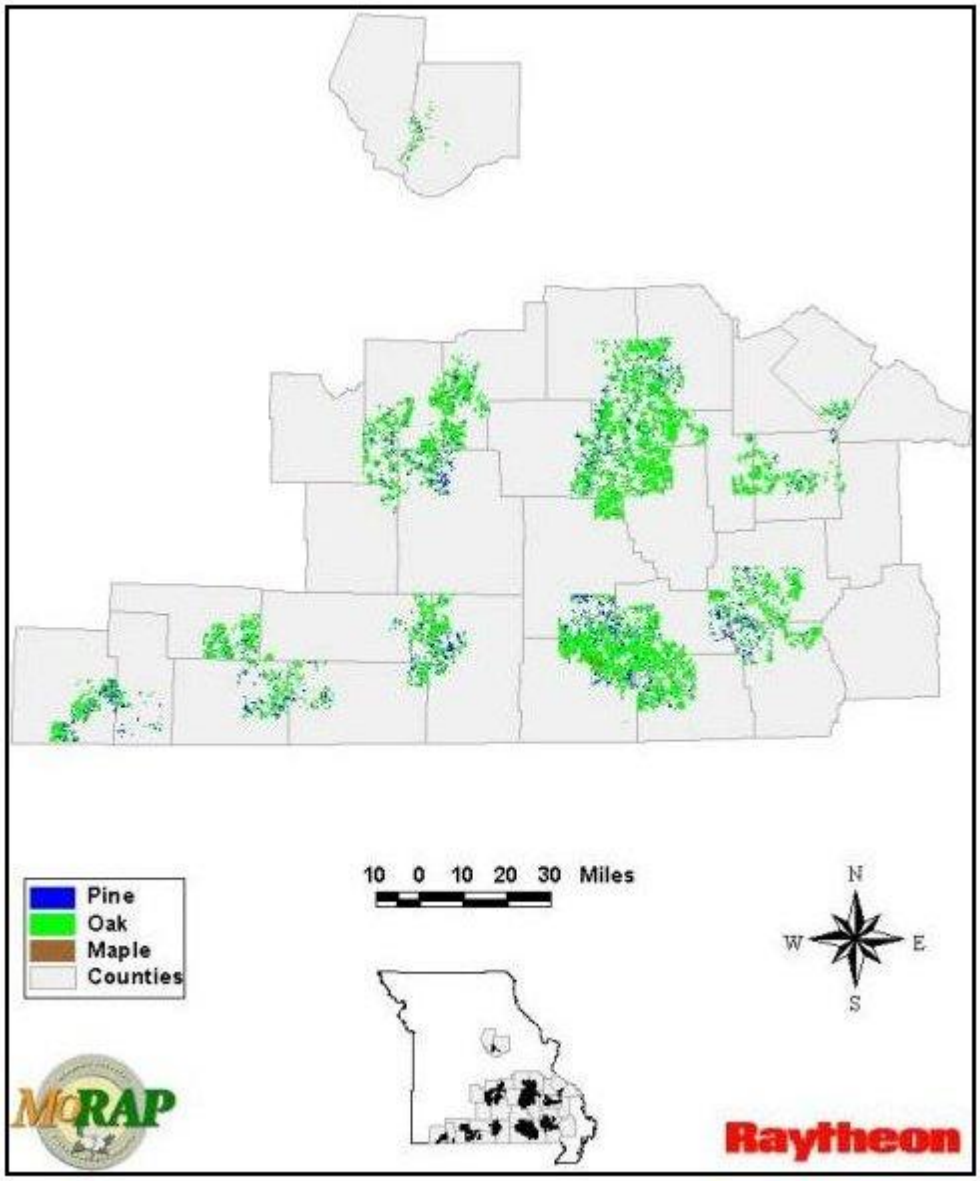

Figure 2. Forest Biome Type, Mark Twain National Forest Willow Springs District

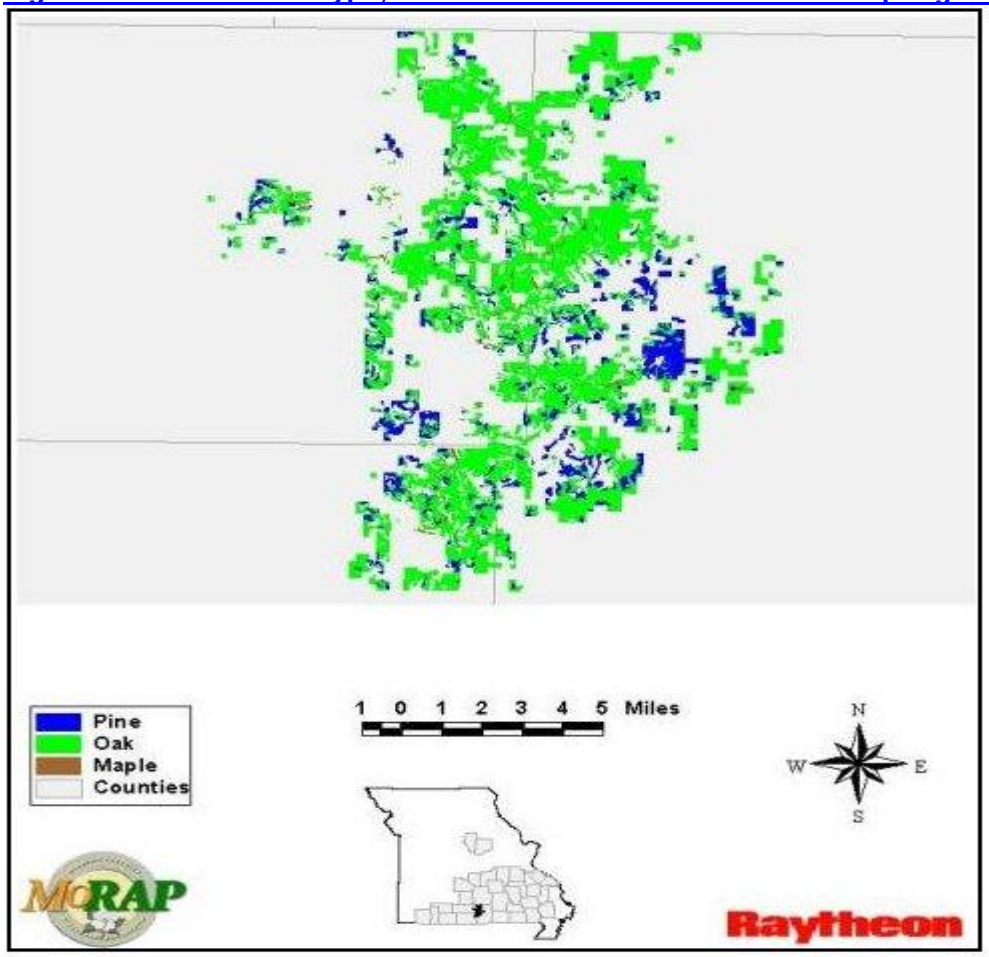

Figure 3a. BGC++ Shape File Database

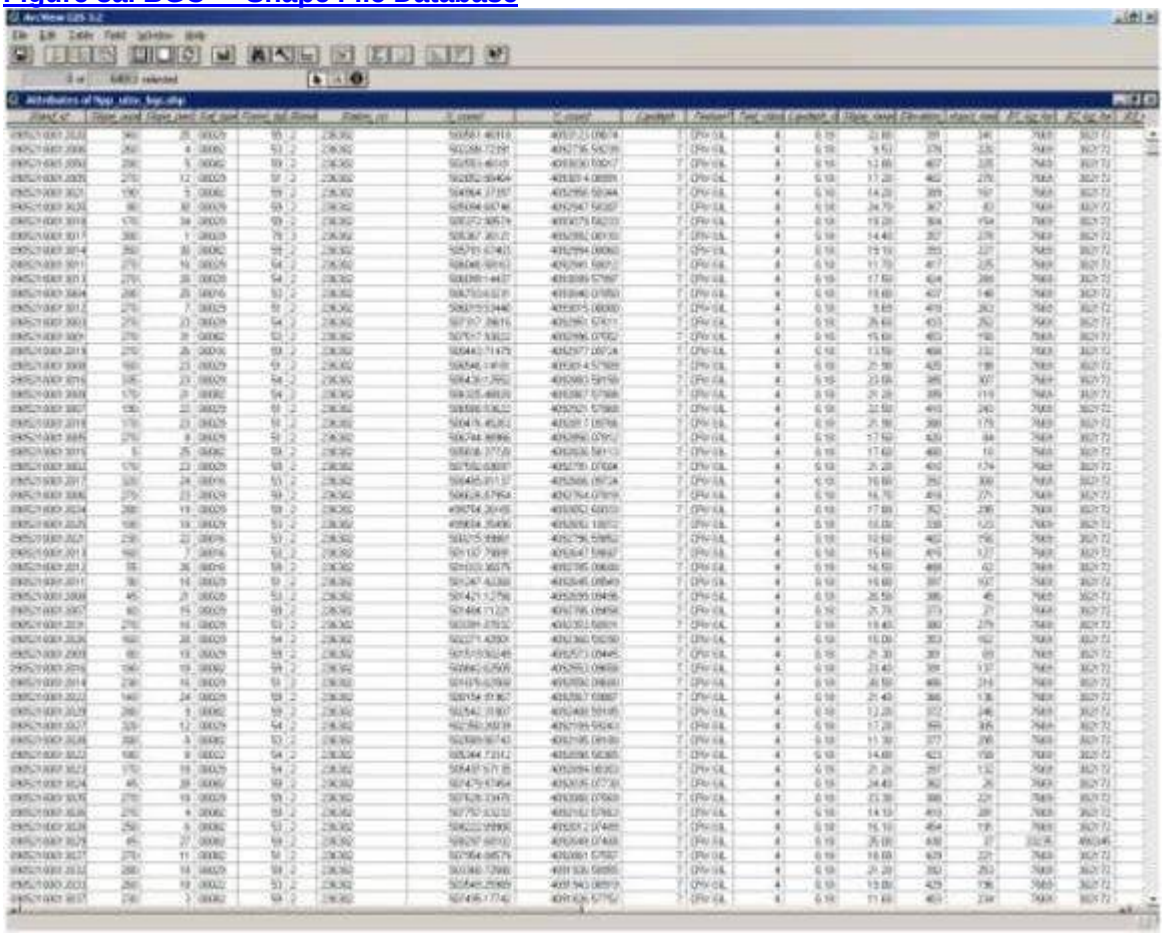

Figure 3b. BGC++ Shape File Database

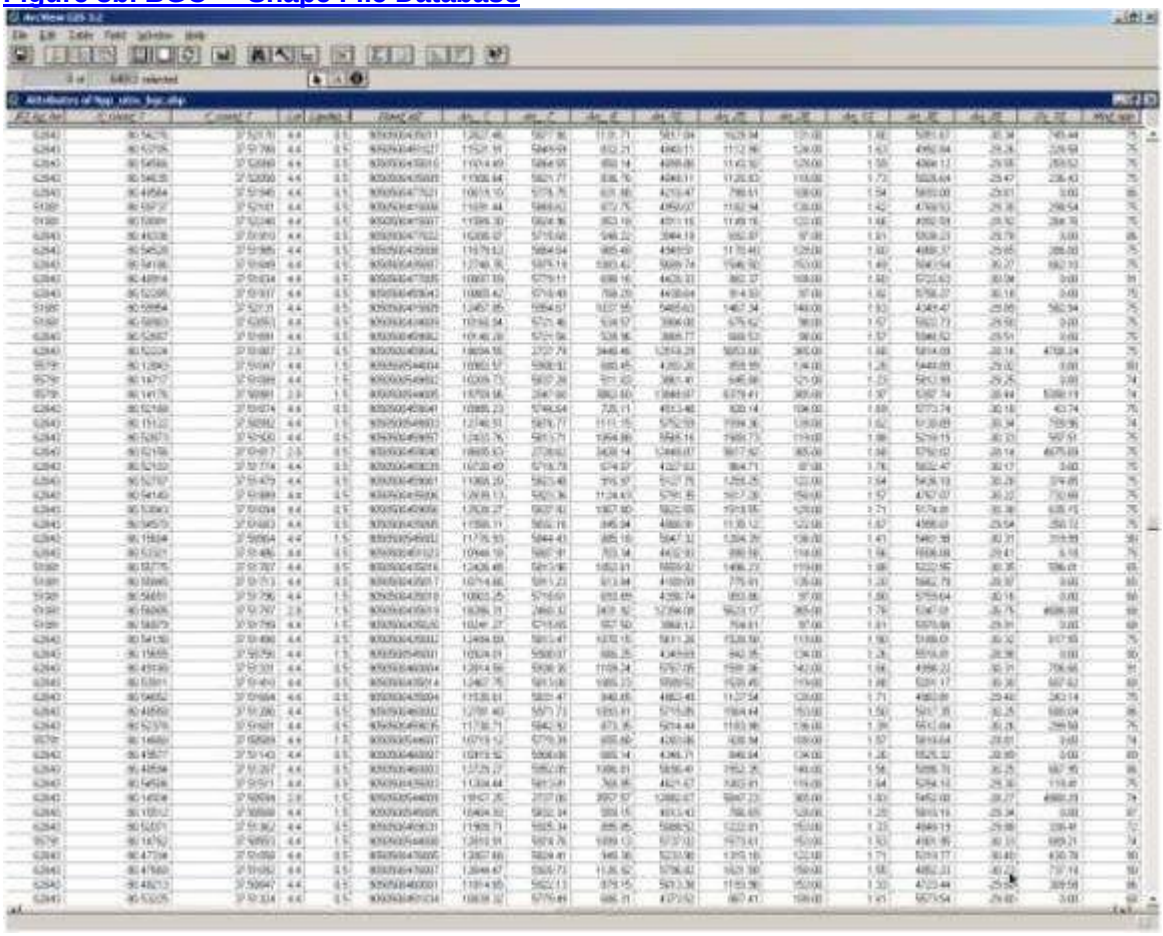

Figure 4. BGC++ Total Net Primary Productivity, Mark Twain National Forest

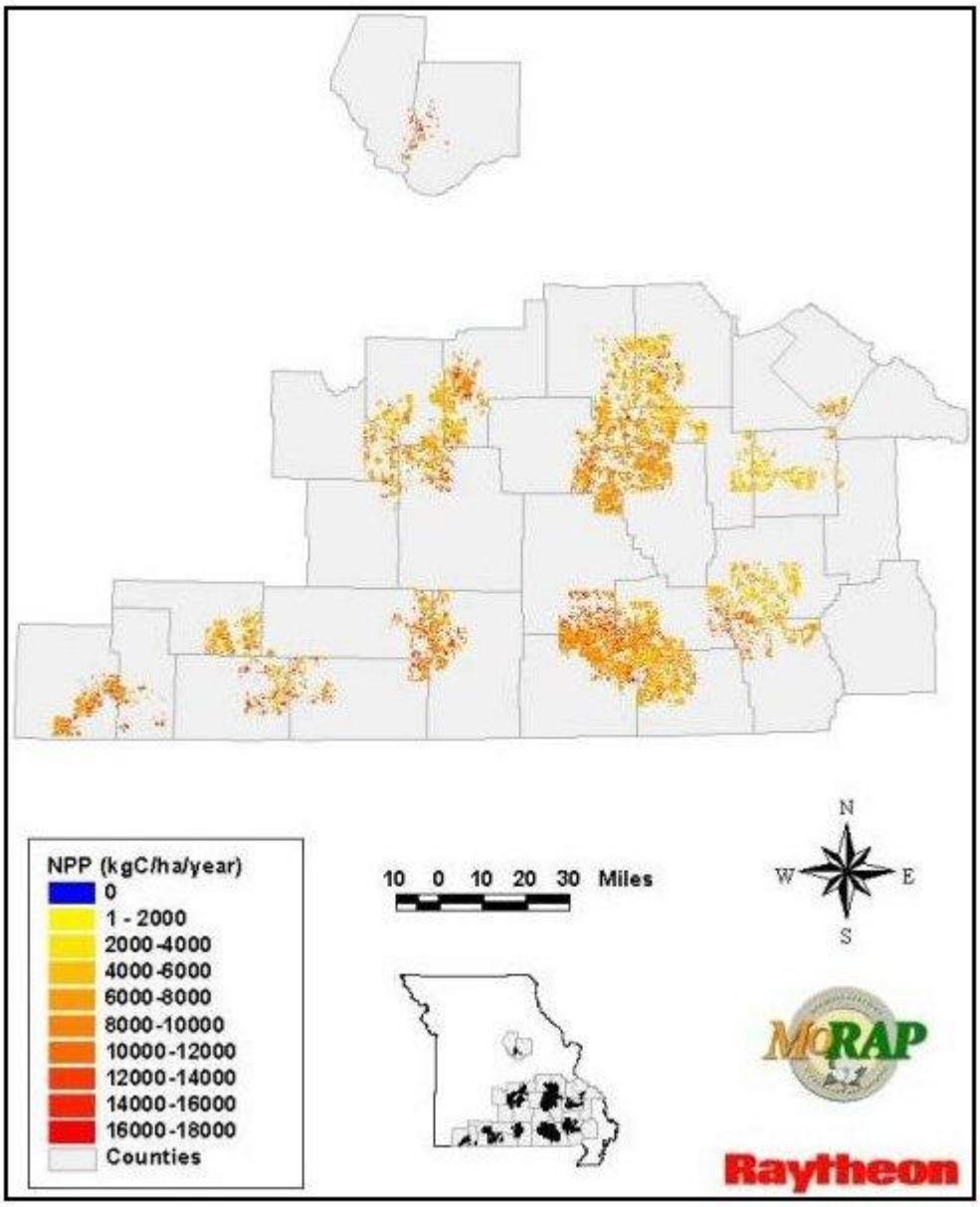

Figure 5. BGC++ Total Net Primary Productivity, Mark Twain National Forest Willow Springs District

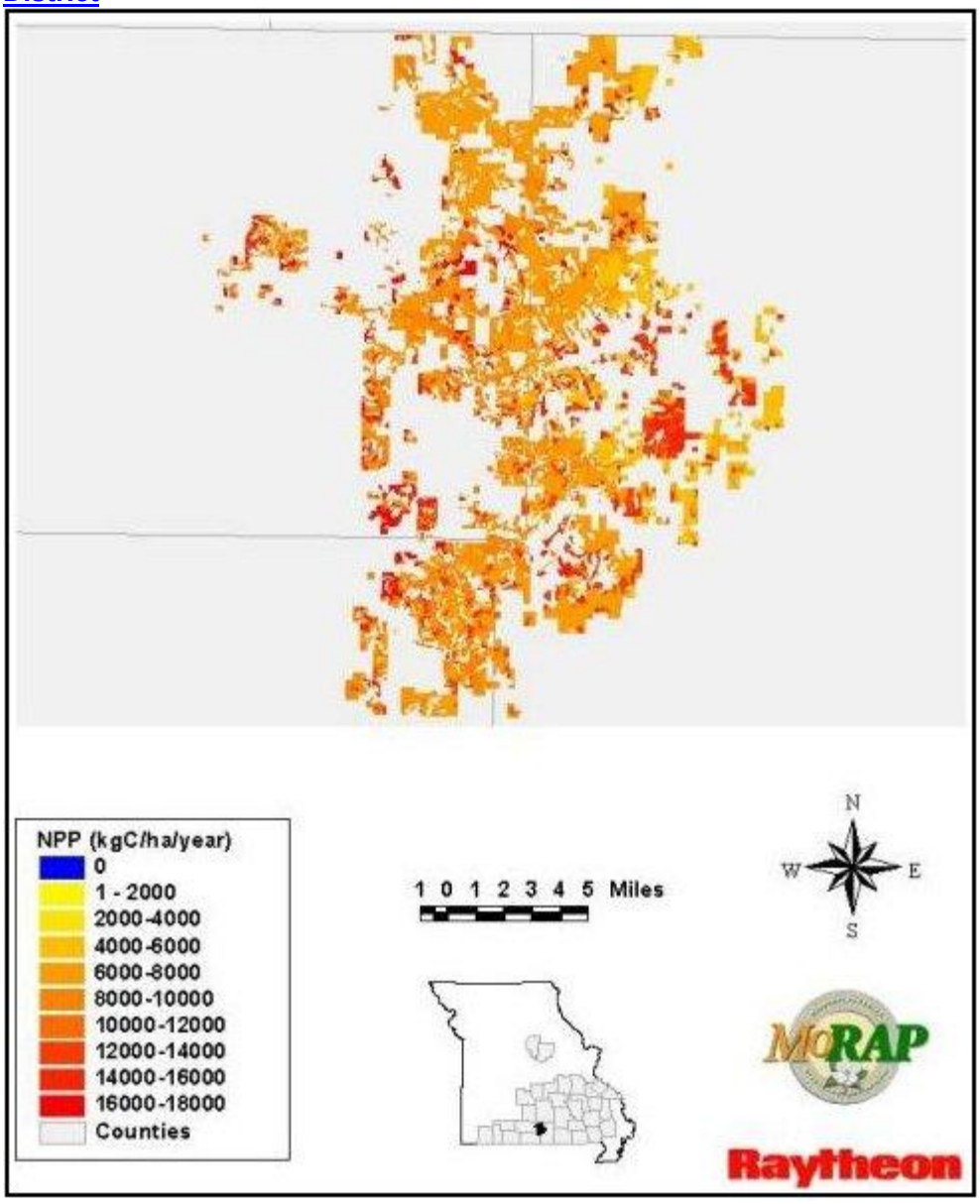

Figure 6. BGC++ Above-Ground Net Primary Productivity, Mark Twain National Forest

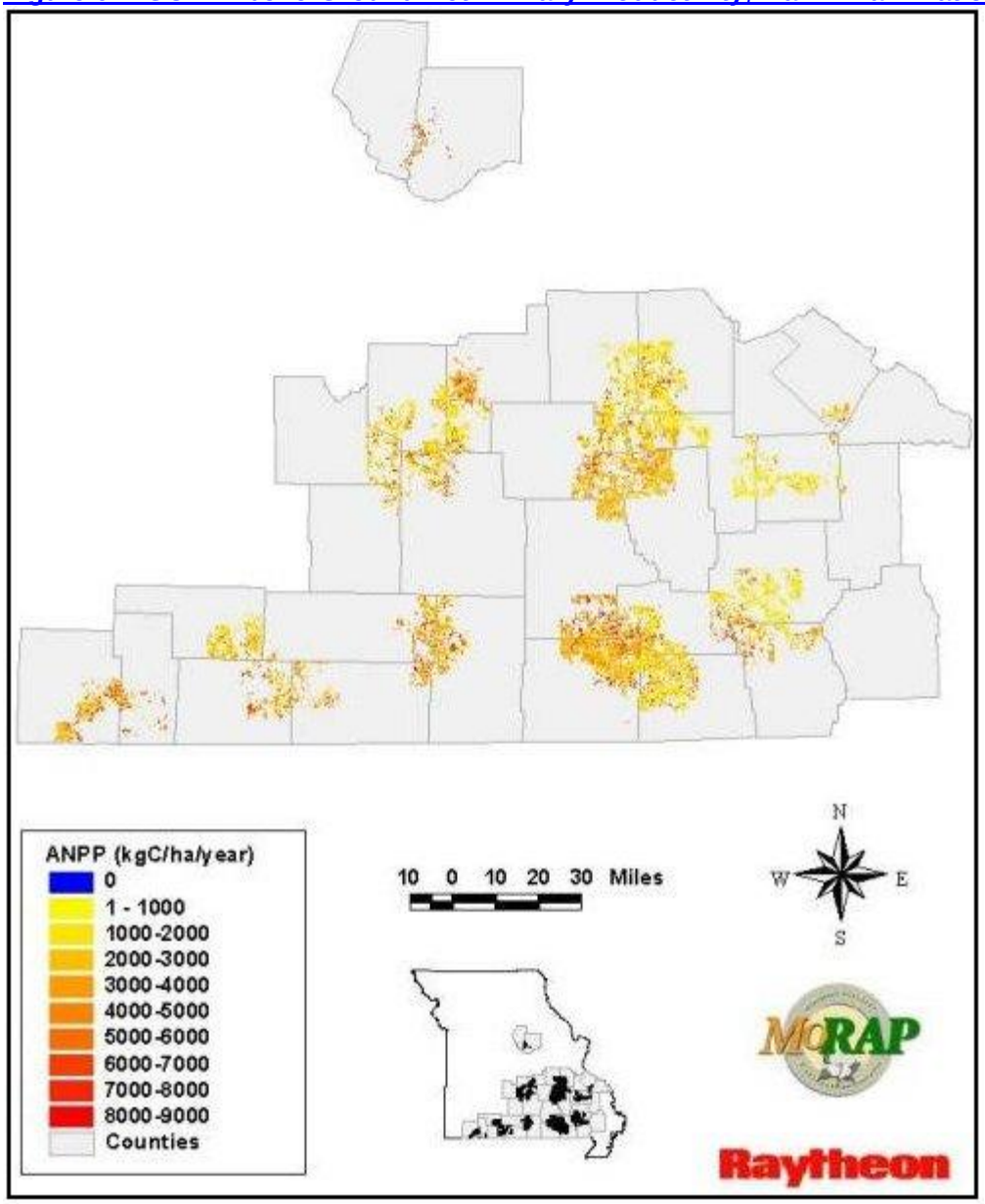

Figure 7. BGC++ Above-Ground Net Primary Productivity, Mark Twain National Forest Willow Springs District

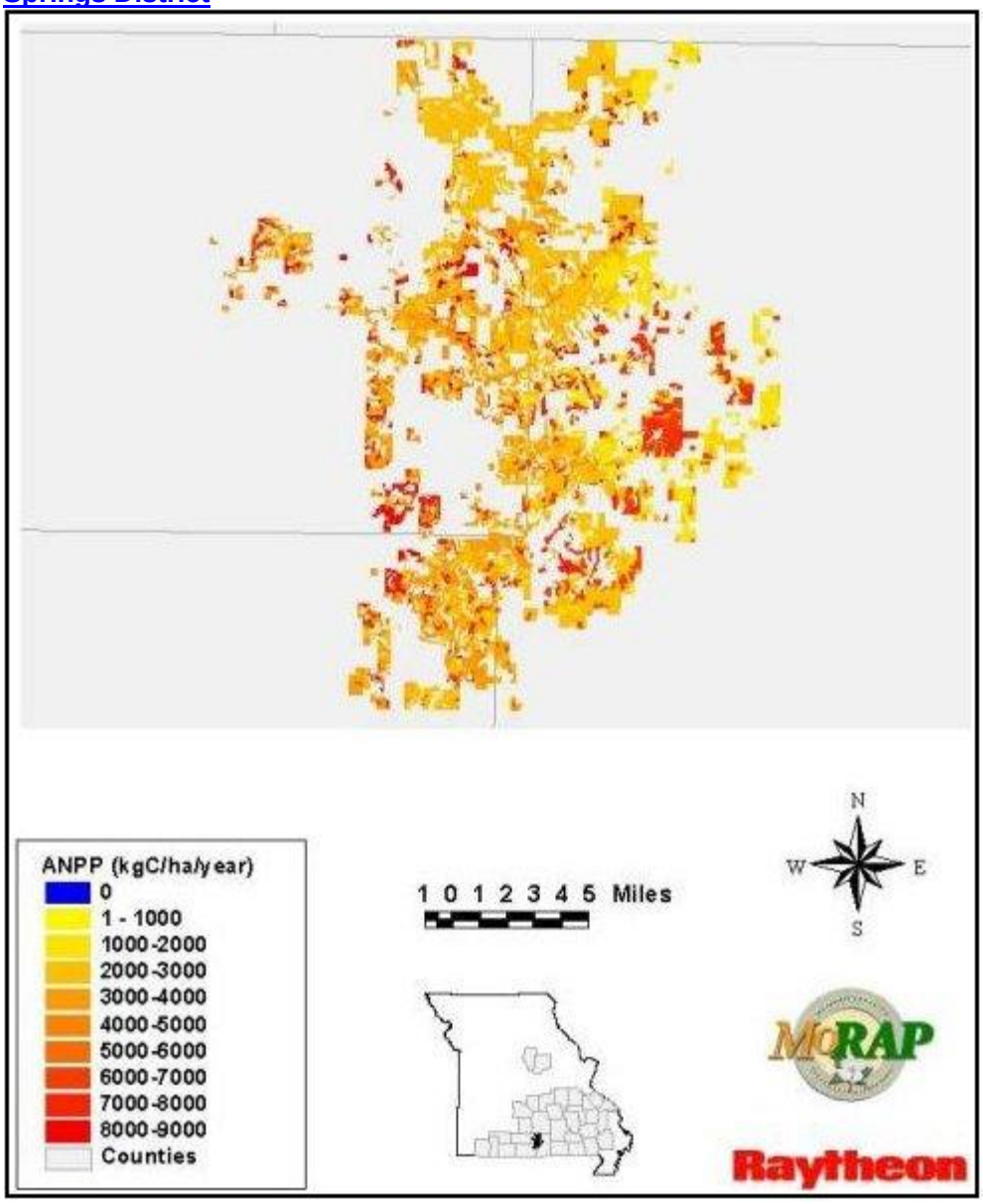

Figure 8. Total Allocation to Stems, Mark Twain National Forest

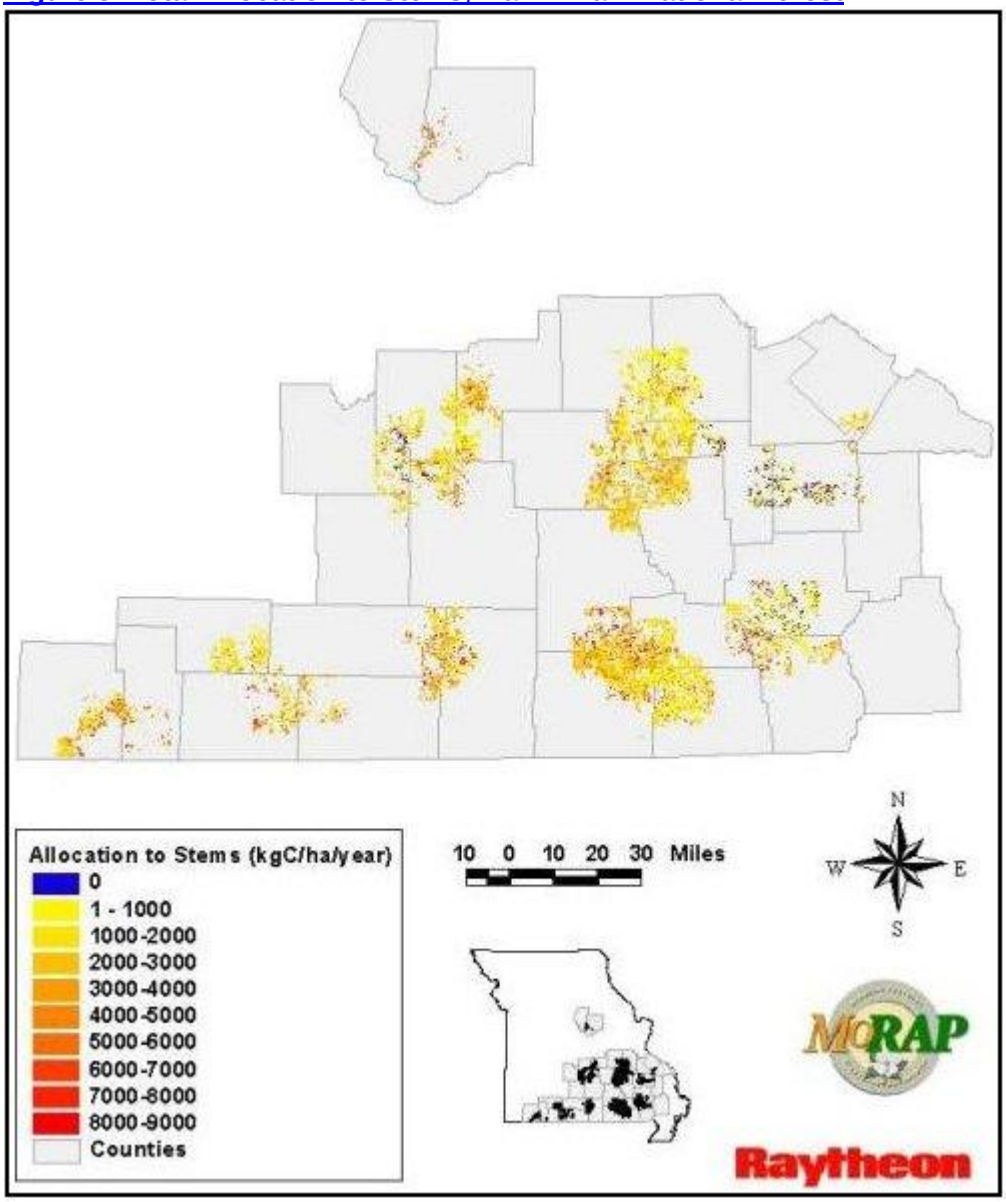

Figure 9. Total Allocation to Stems, Mark Twain National Forest Willow Springs District

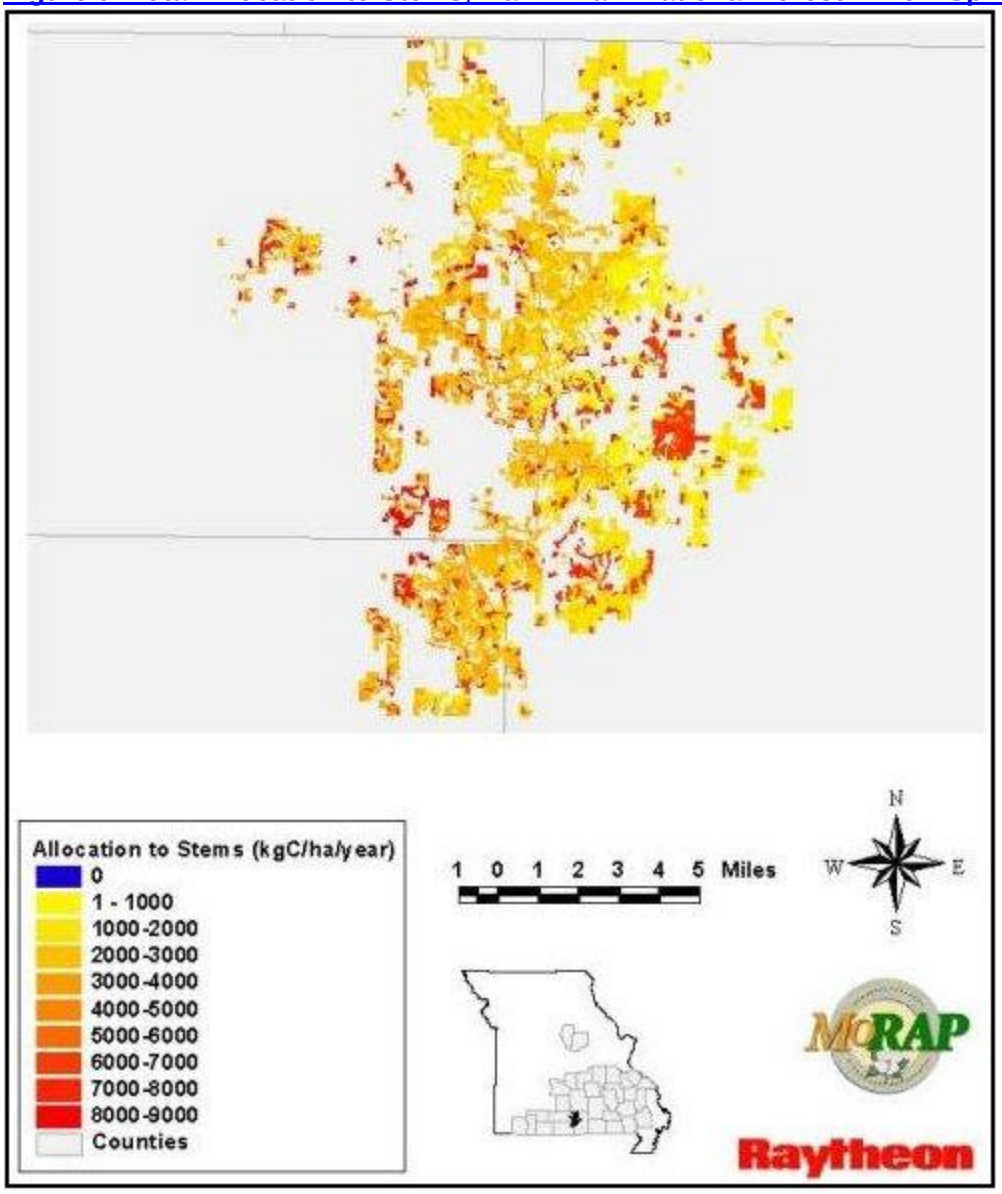

Figure 10. MODIS Net Photosynthesis, Mark Twain National Forest

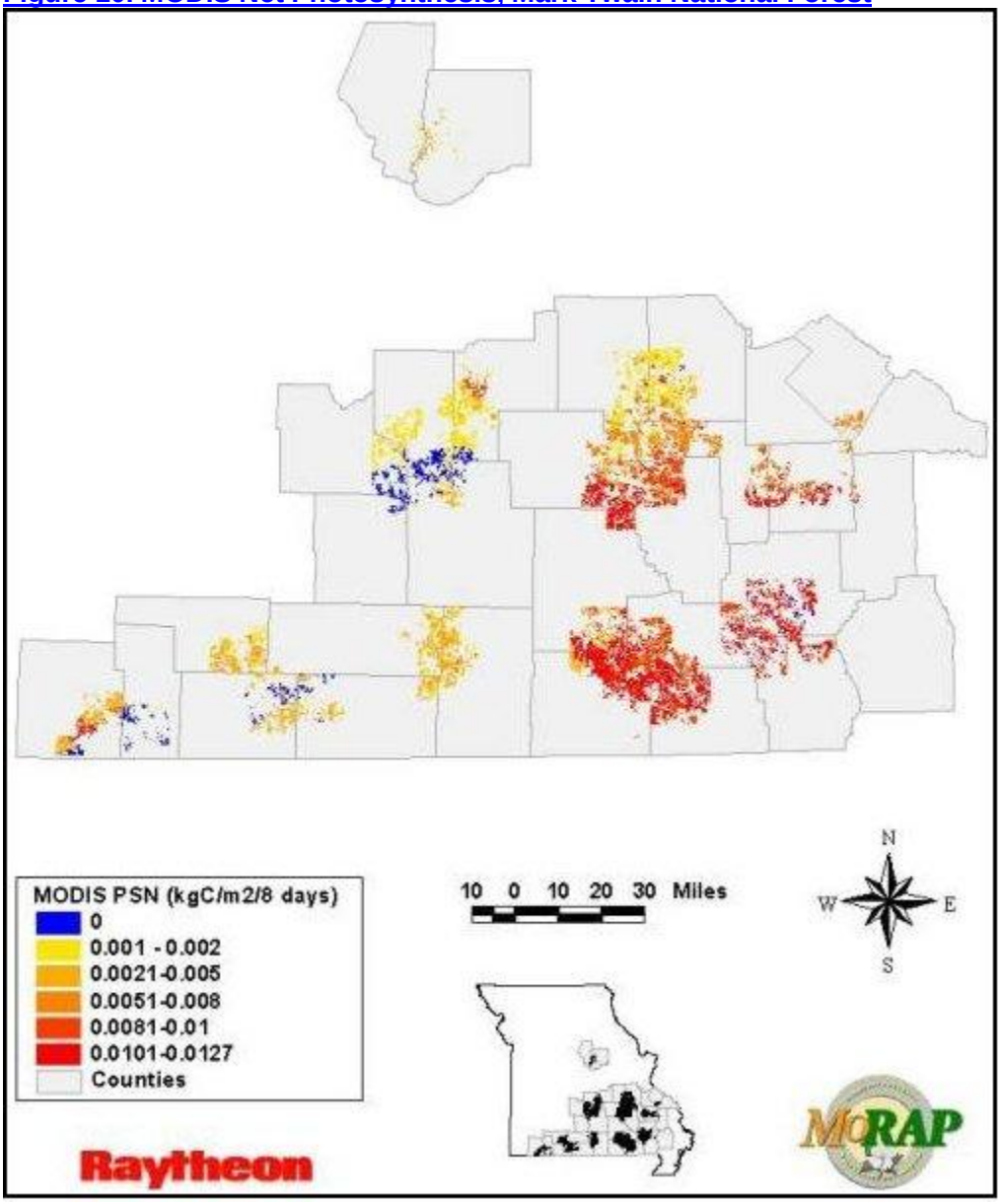

Figure 11. MODIS Net Photosynthesis, Mark Twain National Forest Willow Springs District