

Introduction:

The ability to estimate Net Ecosystem Production (NEP) for the Greater Yellowstone Ecosystem (GYE) is critical for understanding how changes in fire frequency and pattern may affect the carbon balance across the landscape. Estimates of above and belowground biomass for lodgepole pine (*Pinus contorta* var. *latifolia* (Engelm. Ex Wats.) Critchfield) forests are essential components for determining NEP for the GYE, because 80% of the overstory forest vegetation within Yellowstone National Park is lodgepole pine (Despain 1990). These estimates may then be extrapolated to the current landscape in order to estimate Net Primary Production (NPP) and NEP at very broad scales.

ALLOMETRIC MODEL DEVELOPMENT, AND BIOMASS ALLOCATION PATTERNS OF LODGEPOLE PINE IN THE GREATER YELLOWSTONE ECOSYSTEM

Rick Arcano and Dan Tinker
Department of Botany, University of Wyoming



Objectives:

- 1.) Develop above and belowground allometric equations for mature lodgepole pine trees of the GYE.
- 2.) Determine the effect of stand density and age on biomass allocation patterns of the GYE.

Hypotheses:

- 1.) Allometrics will be different from other studies due to differences in vegetation, substrate, precipitation, and temp.
- 2.) Biomass allocation patterns will differ between stand densities and tree ages. More biomass has been shown to be allocated to roots in more dense stands (Pearson et al. 1984; Litton et al. 2003; Turner et al. in press). More biomass will be allocated to bole production relative to foliage production in older trees (Ryan et al. 1997; Jackson and Chittenden 1981; Gower et al. 1995).

Results and Discussion:

In all regression analyses, a non-linear power function ($Y = aX^b$), where Y = total root biomass, and X = diameter at breast height (DBH), and a and b are parameters, provided the best predictive models. Combining all three stands ($n = 24$ trees), 96% of the variance in total root biomass was explained by DBH alone. Individual predictive models were also developed for each of the three individual stands. For the two young stands, one sparse (725 trees/ha, $n = 5$ trees) and the other dense (2524 trees/ha, $n = 14$ trees), R^2 values for the individual models were 0.92 and 0.97, respectively. For the older stand (150-165 years old, $n = 5$ trees) DBH explained 92% of the variance in total root biomass. Finally, when combining the two younger stands into a single predictive model ($n = 19$ trees) to examine the effect of stand age on DBH as a predictor of total root biomass, the R^2 for the combined model was 0.98, while combining the two sparse stands ($n = 10$ trees) to examine density effects on the model produced an R^2 of 0.87.

Although the variance in total root biomass was well explained by DBH for all stands combined ($R^2 = .96$), this is not the best model for predicting total root biomass at the landscape scale. Instead, models incorporating stand age and density into the analysis are better suited for landscape scale applications. The stand-age model that grouped the two young stands ($R^2 = 0.98$) was a better model for predicting total root biomass from DBH in the GYE than the stand-density model, where the R^2 of combined low-density stands was only 0.87. However, all of these models illustrated that DBH is an excellent predictor of total root biomass across ages and densities. Also, future models using DBH and other predictive variables will be developed for predicting root biomass as well as for aboveground components of tree biomass (tree bole, foliage, branches).

Conclusions:

- A non-linear power function best fit the data for all regression analyses thus far.
- Dbh was a strong predictor of total root biomass >10 mm for all models.
- Inclusion of all 3 stands spanning ages and densities was an excellent model for predicting total root biomass with dbh, but may not be well suited for extrapolation to the landscape.
- Stand-age was a better model for predicting total root biomass with dbh than stand density.

Future Work:

- More analyses for evaluating dbh as a predictor of other tree biomass components (tree bole, foliage, and branches) are in progress.
- More analyses using many predictive variables (total height, sapwood area, etc.), including multi-variate analyses.
- Determination of biomass allocation patterns for lodgepole pine.

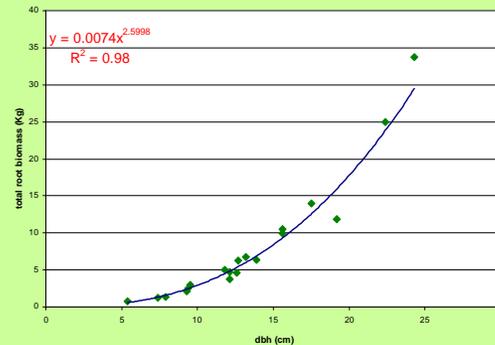


Figure 1: Relationship between dbh and total root biomass in two young (50-65 yrs. Old) stands on the Targhee N.F. in Inland Park, ID within the Greater Yellowstone Ecosystem

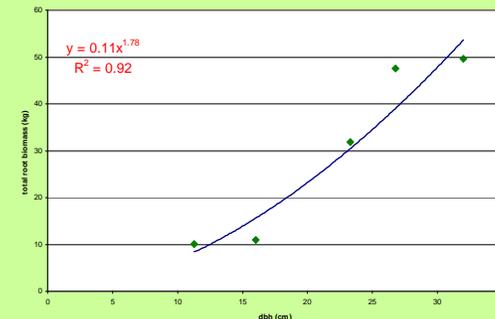


Figure 2: Relationship between dbh and total root biomass (>10mm diameter) for an older (150-165 yrs. Old) stand east of Ashton, ID on the Targhee N.F. within the Greater Yellowstone Ecosystem

Methods:

We examined how lodgepole pine allometrics and biomass allocation patterns differed with stand density and age. Allometrics were developed in three stands in the GYE. We examined three stands where two were young, one of which was dense (50-65 yrs old, 2452 trees/ha) and the other sparse (50-65 yrs old, 725 trees/ha), while the other stand was older and also sparse (150-165 yrs old, 674 trees/ha). Roots were harvested from 15 trees in the dense stand, while 5 were harvested from each sparse stand due to larger tree size, which coincided with much larger root systems. Only one older stand was sampled, because densities of lodgepole pine stands tend to converge as they age (Kashian et al. in review). All tree components were harvested in the summer of 2004. Subsamples for moisture content were taken from each component (roots, bole, etc.) to determine the dry weight of the entire component from each tree by developing a dry:wet ratio from drying of each subsample. A non-linear power function ($Y = aX^b$, where Y = total root biomass (Kg), X = diameter at breast height, and a and b are parameters) regression was used to assess the ability of DBH to predict total root biomass.



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