Designing Sustainable Landscapes: Biomass settings variable

A project of the University of Massachusetts Landscape Ecology Lab

Principals:

- Kevin McGarigal, Professor
- Brad Compton, Research Associate
- Ethan Plunkett, Research Associate
- Bill DeLuca, Research Associate
- Joanna Grand, Research Associate

Reference:

McGarigal K, DeLuca WV, Compton BW, Plunkett EB, and Grand J. 2017. Designing sustainable landscapes: biomass settings variable. Report to the North Atlantic Conservation Cooperative, US Fish and Wildlife Service, Northeast Region.

General description

Vegetation biomass is an effective descriptor of the net primary productivity of an ecosystem. As such, it is a fundamental component of the ecosystem's trophic dynamics. In addition, vegetation biomass is an effective proxy for the successional development (or seral stage) of vegetation following a disturbance.

Biomass is one of several ecological settings variables that collectively characterize the biophysical setting of each 30 m cell at a given point in time (McGarigal et al 2017). Specifically, biomass measures the estimated above-ground live biomass (Mg/ha) of undeveloped forested (including forested wetlands) cells in 2010 based primarily on a spectral analysis of Landsat imagery by USGS Woods Hole (**Fig. 1**).
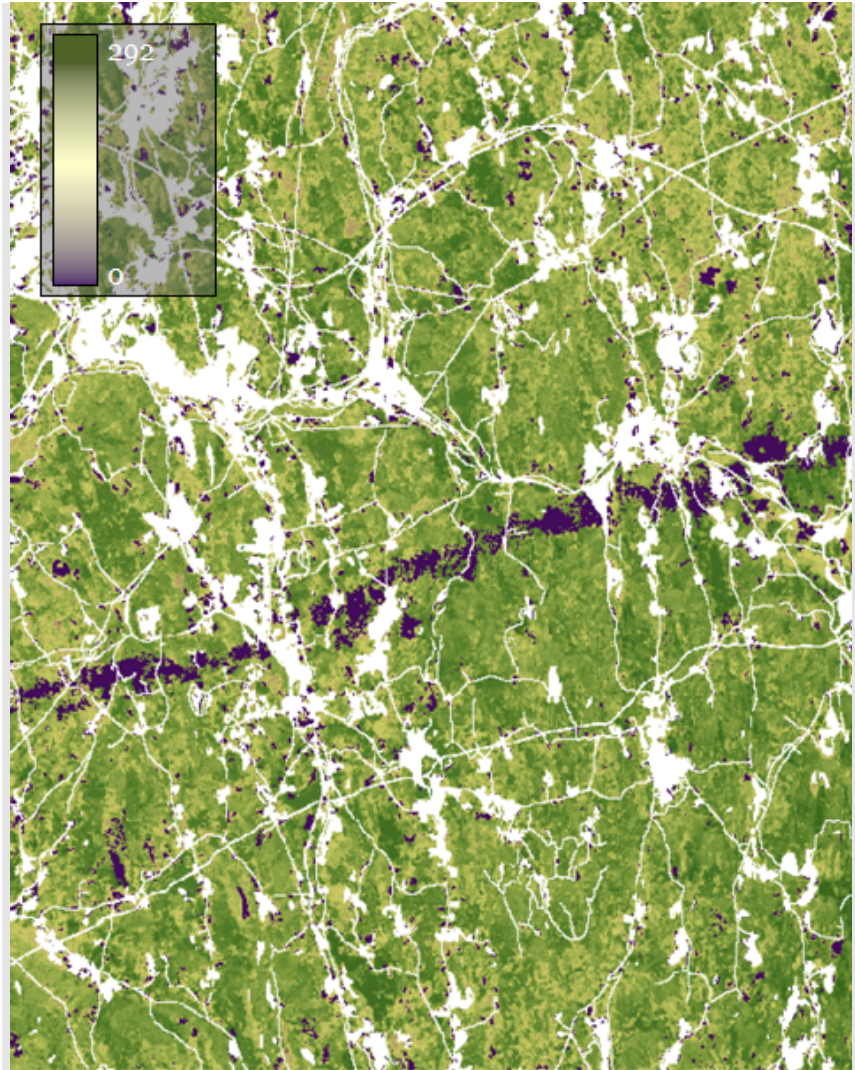

Figure 1. Above-ground live biomass (Mg/ha) in 2012 east of Springfield, Massachusetts (showing the track of the 2011 tornado). Development, roads, and other non-forested areas are shown in white.

Use and interpretation of this layer

Biomass, along with all the other settings variables, is used in the calculation of ecological distance and resistance in the derivation of the resiliency metrics in the context of the broader assessment of ecological integrity (see technical document on integrity, McGarigal et al 2017). Biomass is also used in many of the representative species landscape capability

models as a proxy for seral stage (see technical document on species, McGarigal et al 2017). This settings variable metric relies of several assumptions which affect it use and interpretation:

- The initial (2010) biomass distribution is distinctly bimodal, with modes at very low biomass and moderately high biomass, and this pattern is consistent across all ecoregions, although it is more pronounced in some (e.g., Cumberlands and Southern Ridge and Valley) than others (e.g., Central Appalachian Forest). The low biomass mode is likely due to a combination of confounded factors. In part, this mode may reflect a real pulse of high-severity disturbances during the past couple of decades (e.g., due to increased forest cutting). However, it may also reflect GIS errors in the creation of the initial biomass layer. Indeed, there is good evidence for the latter resulting from disagreement between the forest cover mask used to create the initial biomass layer (Kellndorfer et al 2013) and the DSL forest cover mask (see DSLland document, McGarigal et al 2017). Unfortunately, it is difficult to discern between these two possible sources for the cause of the low biomass mode.

- To derive Biomass, we used the Woods Hole NACP Aboveground National Biomass and Carbon Baseline Data V.2 (Kellndorfer et al. 2013) estimate of biomass and updated it with the High-Resolution Global Maps of 21st-Century Forest Cover Change (Hansen et al. 2013) and forest succession models to generate the 2010 biomass raster (see below for details). Thus, the final biomass settings variable reflects the integration of several models. As such, it is not going to match reality perfectly, especially at the level of an individual 30 m cell. Consequently, our biomass layer is best interpreted as a "fuzzy" estimate that becomes more reliable with increasing spatial resolution.

Derivation of this layer

The derivation and statistical evaluation of the biomass settings variable in the context of the disturbance and succession model is described in detail elsewhere (see technical document on disturbance and succession , McGarigal et al 2017). Briefly, we derived the 2010 biomass layer as follows:

1) To begin, we used the Woods Hole NACP Aboveground National Biomass and Carbon Baseline Data (NBCD) V.2 (Kellndorfer et al. 2013) estimate of above-ground live biomass for the year 2000 derived from Landsat imagery;

2) Next, we converted biomass to expected stand age based on a fitted regression model for the corresponding ecosystem group (using Forest Inventory and Analysis, FIA, plot data to fit the model) that describes biomass change as a function of stand age and a suite of ecological settings variables (growing degree days, growing season precipitation, soil pH, soil depth and soil available water supply). Note, any biomass value that exceeded the predicted value for stand age = 220 years (the maximum observed stand age in the FAI dataset) was assigned a stand age of 220;

3) Next, we advanced stand age forward to 2012 (for consistency with the Hansen et al. data, see below) by adding 12 years to stand age;

4) Next, we set stand age to the age since disturbance based on the High-Resolution Global Maps of 21st-Century Forest Cover Change (Hansen et al 2013) for stand-replacing disturbances occurring between 2000-2012. For example, a cell that was disturbed in 2005 would have an age of 7, whereas an undisturbed cell would have the predicted age in 2000 plus 12 years from step 3; and

5) Lastly, we applied the appropriate regression model for the corresponding ecosystem to convert the adjusted stand ages in 2012 to predicted biomass.

This process resulted in a map of predicted above-ground live biomass for 2012, which we considered as the baseline condition in 2010. Note, we deemed the two-year difference between the estimated biomass in 2012 and our baseline year of 2010 for the landscape change, assessment and design (LCAD) model as trivial.

GIS metadata

This data product is distributed as a geotiff raster (30 m cells). Cell values range from 0 (no above-ground live biomass) to a maximum of 292 Mg/ha. Nonforested cells were assign a nodata value.

Literature Cited

Hansen MC, Potapov PV, Moore R, Hancher M, Turubanova SA, Tyukavina A, Thau D, Stehman SV, Goetz SJ, Loveland TR, Kommareddy A, Egorov A, Chini L, Justice CO, and Townshend JRG. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November). Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

Kellndorfer J, Walker W, Kirsch K, Fiske G, Bishop J, LaPoint L, Hoppus M, and Westfall J. 2013. NACP Aboveground Biomass and Carbon Baseline Data, V. 2 (NBCD 2000), U.S.A., 2000. Data set. Available on-line [http://daac.ornl.gov] from ORNL DAAC, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/1161

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