Ecomath for the North Zone of Cherokee National Forest: A Randomized Approach to Determining Forest-Wide Fire Priorities Based on Ecological Factors

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Executive Summary

"Ecomath" is a term coined for the prioritization of prescribed fire developed by participants in the Southern Blue Ridge Fire Learning Network. Previous versions of Ecomath have evaluated and ranked existing and potential prescribed fire units that were delineated by the presence of control lines, which had operational benefits, while only evaluating a minority of the land base open to management and using a non-randomized study design. In this study, all Forest Service ownership on the North Zone of Cherokee National Forest was evaluated in randomized fashion by using the UTM Grid to produce kilometer square land units that were scored for ecological factors. Like previous versions of Ecomath, the factors used to score each unit area included the ecological zones present, fire dependent rare species present, fire dependent rare communities, and priority habitat types. The result is a shapefile of all North Zone Forest Service Ownership with a unique score for each square kilometer section of the UTM Grid. The score for each area is intended to be used in identifying priorities for future fire planning and management on Cherokee National Forest.

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Introduction

In the early 20th century, fire prevention became one of the core missions of the U.S. Forest Service, despite an understanding by Gifford Pinchot that fire had an important role in the ecology of many forests (Pinchot, 1899). Late in the 20th century, scientific evidence began to mount that fire suppression and exclusion were causing major and undesirable effects on forests in the Southern Appalachians (Nowacki & Abrams 1992, etc.). The 2004 RLRMP for Cherokee National Forest includes goals on reintroducing fire to the Southern Appalachian landscape and the implementation of the 2004 Forest Plan has made Cherokee National Forest among the leading land management agencies as far as prescribed fire implementation, and the North Zone of Cherokee National Forest now regularly applies fire to more than 10,000 acres of land annually to accomplish goals of wildfire prevention, ecological restoration, and maintenance of pine and oak forests.

Beginning in 2010, a group of stakeholders formed a committee, led by the Tennessee Chapter or The Nature Conservancy, to advance ecological restoration and vegetation management on the North Zone of Cherokee National Forest. This effort was dubbed the Cherokee National Forest Landscape Restoration Initiative. Part of the initiative was to create maps of the potential natural vegetation, or Ecozones (used interchangeably with term ecosystems), present on the North Zone. These maps were intended to be a resource for land managers in the restoration of the major ecosystems on the North Zone, including activities such as fire.

Also in 2010, the Central Escarpment Landscape of the Southern Blue Ridge Fire Learning network began a project to prioritize all potential prescribe fire units on the Grandfather Ranger District of Pisgah National Forest based on ecological considerations. This project inspired several other versions of Ecomath, including a version for the North Zone of Cherokee National Forest in May of 2011. These early versions were seen as useful by fire managers, but were biased by limiting the analysis to pre-selected fire units.

In 2015, The Nature Conservancy contracted the author of this report to complete a new Ecomath analysis for the North Zone. The design criteria for this study were that it: 1) Include Forest Service and stakeholder input in assigning priorities to model components; 2) Prioritize the ecological need for fire of the entirity of the North Zone of Cherokee National Forest and adjacent conservation lands; and 3) Use a methodology that was randomized.

Methods

Two meetings were organized to set the parameters for this version of Ecomath. The first meeting, on June 8th, 2015 determined the components of the GIS model and a second meeting on November 13th provided a chance for Forest Service staff and stakeholders to provide feedback on the results on the GIS model before it was finalized. See Table 1 for a list of the model components of the Ecomath model. Model components chosen include the acreage of fire adapted forest types, the acreage of regenerating forest previously created through wildfire and prescribed fire, the presence of shortleaf pine stands, the presence of rare communities identified in the 9.F Management area of the 2004 RLRMP, and the presence of two fire dependent rare species, *Fothergilla major* and *Thermopsis fraxinifolia*. The variable weight given to various forest types (or ecozones) was based on research specific to those vegetation types in the southern Appalachians. Various authors investigating the historical fire return interval of Southern Appalachian yellow pine forests report average return intervals of 3 – 7 years (Aldrich et al. 2010; Flatley et al. 2013; Flatley et al. 2015). Studies in Southern Appalachian oak forests are not as numerous nor as precise in dating fires, however, various studies have a range of reported mean fire return intervals from 9 years (McEwan et al. 2013) to "<35 years" (

Table 1: Model Components for North Zone of Cherokee NF Ecomath

Component	Attribute	Score	Max Score per Polygon	Notes
Yellow Pine Ecozones (including Montane and Low Elevation Pine)	Acres	Acres	162	Given the highest weight based on historical fire return interval of 3-7 years
Dry Oak Forest Ecozone	Acres	Acres x .75	140	Oak forest fire return interval of 9-24 years and dry oak forest assumed to have the most frequent fire
Dry-Mesic Oak Forest Ecozone	Acres	Acres x .5	94	Intermediate to dry oak forest and mesic oak forest
Montane Oak Forest Ecozone	Acres	Acres x .25	49	Lowest fire return interval of at least 24 years is 4x longer than yellow pine Ecozones
Regeneration from fire	Acres	Acres x .5	75	An uncommon structural class on Cherokee National Forest, more common in fire prone Ecozones
Wildfire History	# of Wildfires since 1990	5 points per fire	25	Used as a surrogate for future wildfire risk
Shortleaf Pine Stands	Presence	20	20	Shortleaf pine is a priority forest type

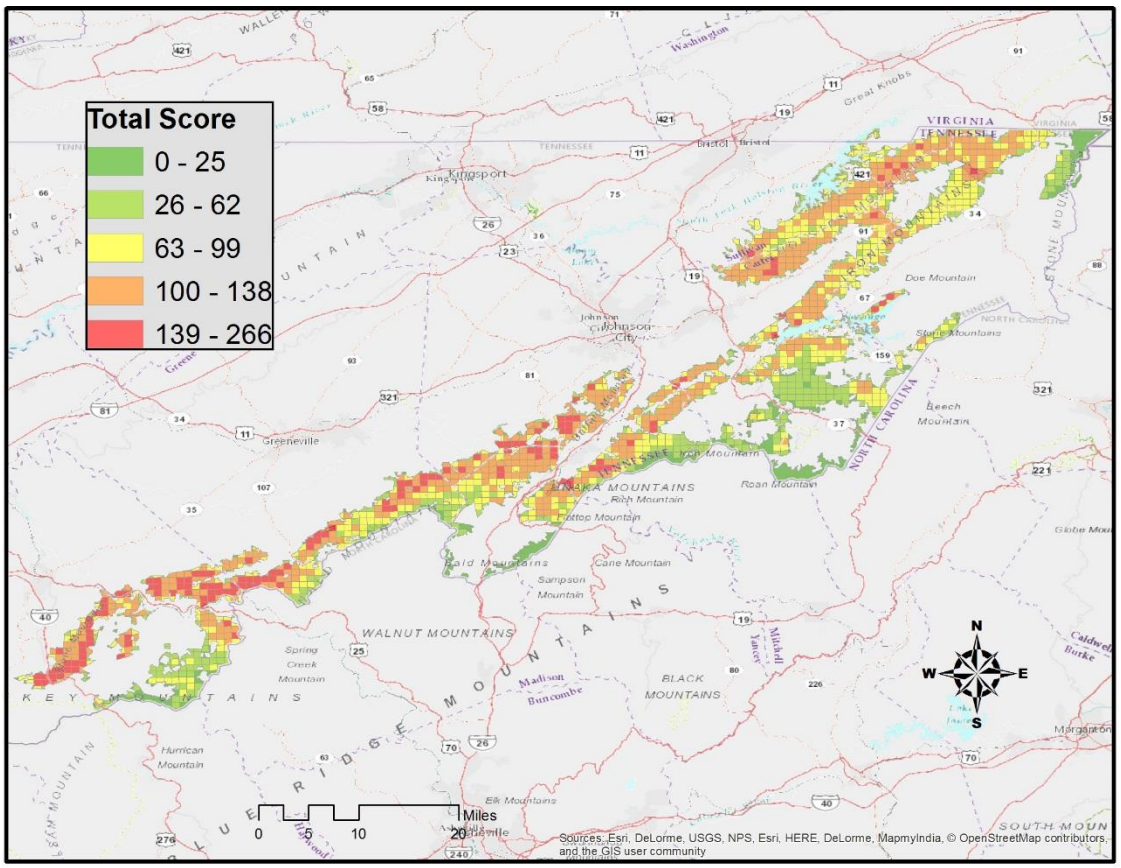
Rare Species	Presence	Occurrences x 6	24	Some rare species require fire for persistence
9.F Rare Fire Communities	Presence	25	25	Rare communities are important reservoirs of biodiversity

In the GIS portion of the exercise, each component was intersected with 2,316 UTM Grid squares and scored based on the weighting listed in Table 1. The tabulate intersect tool was used repeatedly to accomplish this analysis with the results of each intersect being added to the attributes of the final Ecomath shapefile.

Results

The range of scores for the 2,316 UTM Grid squares was 0 – 266. The highest scoring polygons cluster towards lower elevations with greater proportions of pine and oak forest. Many of these polygons are on or near the boundary with private land (see Figure 1). The lowest scoring polygons are generally situated at higher elevations near the North Carolina state line. The drivers of the model were consistent with the intent of the model design in that ecosystem type and acreage were the largest drivers of the model, with acres of forest regenerating from fire being the next greatest influence, and all other model components having roughly equivalent influence on the scoring of polygons with maximum scores in the range of 20-25 points.

Figure 1: Overview of Ecomath scores for the North Zone of Cherokee National Forest



Discussion

Models are inherently approximations of reality, and none are completely true. The authors of this model are aware of the assumptions imbedded within it, as well as the fact that the entire enterprise of conservation is value laden. We conserve what we value, be it clean water, wildlife populations, biodiversity, scenery, or even outdoor experiences. All of the model components chosen were chosen because they are valued by Cherokee National Forest and its stakeholders, and even within those value judgements, attempts were made to be as objective as possible. For example, the scores for the various fire adapted Ecozones were weighted based on the scientific evidence for their historic, pre-fire suppression, fire return intervals. Occurrence-based factors were weighted so as to contribute significantly to the overall score up to 10% of the maximum, but not to overwhelm the influence of other components.

While this version of Ecomath breaks the North Zone into 2,316 individual polygons, reviewers noted that some highly fire adapted areas, like the south slope of White Rock Mountain, are not prioritized by this model. A future version of this model is intended to be developed that increases the number of polygons by at least four fold, with the intent of creating a more fine-

grained tool. For the time being, a prioritization model based on square kilometer polygons (247 acres) will help to refine fire planning and management on the North Zone.

The Ecomath model is intended to be a tool for prioritizing fire management on the North Zone of Cherokee National Forest. By consulting the shapefile when mapping new prescribed fire units, Forest Service staff and partners will have a tool to validate judgements on where efforts should be focused in the future.

Attribute Table Glossary

Hero_Acres – acres of the High Elevation Red Oak Ecozone in each polygon

MontaneOak_Sl – acres of the High Elevation Red Oak Ecozone in each polygon

MOakRichA – acres of the Montane Oak – Rich Ecozone in each polygon

MontOakCov – acres of the Montane Oak Cove Ecozone in each polygon

All_Montan – acres of all Montane Oak Ecozones, including HERO, in each polygon

Dry_Oak_Ever – acres of the Dry Oak Evergreen Heath Ecozone in each polygon

Dry_Oak_Dec – acres of the Dry Oak Deciduous Heath Ecozone in each polygon

AllDryOak – acres of combined Dry Oak Ecozones in each polygon

DMOH_Acres – acres of Dry-Mesic Oak Hickory Ecozone in each polygon

LowPineOak – acres of the Low Elevation Pine-Oak Ecozone in each polygon

POH_Acres – acres of the Pine-Oak/Heath (or Montane Pine) Ecozone in each polygon

All_Yellow – combined acres of the Low Elevation Pine-Oak and Pine-Oak/Heath Ecozones in each polygon

MontOakSco – the score resulting from the combined acreage of Montane Oak Ecozones in each polygon

DMOH_Score – the score resulting from the Dry-Mesic Oak Ecozone in each polygon

Dry Oak Scor – the score resulting from the combined Dry Oak Ecozones in each polygon

Ypine_Scor – the score resulting from the combined yellow pine Ecozones in each polygon

EcoZ_Score – the score resulting from the combined acreages of all fire adapted ecozones within each polygon

Wildfire_Hi – the total number of wildfires in each polygon since 1990

WildFScore – the score resulting from all wildfire occurrences within each polygon since 1990

Shortleaf – the score resulting from the presence or absence of known shortleaf pine stands in each polygon

Regen_Acre – the score resulting from the number of acres of regenerating forest divided by two in each polygon

MA9F_Pres – the score resulting from the presence or absence of fire adapted rare communities in each polygon

EO_Count – the number of fire dependent rare species element occurrences in each polygon

EO_Score – the score resulting from the number of element occurrences in each polygon

Total_Scor – the total score from all model components in each polygon

Area_Score – the total score divided by the unit area

Works Cited

Abrams, Marc D. 1992. "Fire and the Development of Oak Forests. Bioscience." May 1992.

Aldrich, Serena R; Lafon, Charles; Grission-Meyer, Henri; DeWeese, Georgina; and Hoss, Jennifer. 2010. "Three Centuries of Fire in Montane Pine-Oak Stands on a Temperate Forest Landscape." Applied Vegetation Science.

Flatley, William T., Charles W. Lafon, Henri D. Grissino-Mayer, and Lisa B. LaForest. 2013. "Fire History, Related to Climate and Land Use in Three Southern Appalachian Landscapes in the Eastern United States." *Ecological Applications: A Publication of the Ecological Society of America* 23 (6): 1250–66.

McEwan, Ryan W; Cooper, Adrienne; Hruska, Amy; Pederson, Neil; Taylor, Josh, and Robert Watts. 2013. "Fire and Gap Dynamics over 300 Years in an Old-Growth Temperate Forest." Applied Vegetation Science.

Pinchot, Gifford. 1899. "The Relation of Forests and Forest Fires." Fire Ecology Volume 7, Issue 3. 2011

Wade, D.D.; Brock, B.L.; Brose, P.H. [and others], 2000. "Wildland Fire in Ecosystems: Effects of Fire on Flora - rmrs_gtr042_2.pdf." 2016. Accessed June 16.