Restoration Needs Analysis in Nantahala and Pisgah National Forests

An Assessment of Potential Active Restoration in Departed Forest Ecosystems

Marissa Ponder

marissa.ponder@gmail.com

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ABSTRACT

Nantahala and Pisgah National Forests are renowned for scenic vistas, unique plant communities, and biodiversity. Within this region are 11 forest ecosystems managed under the 1994 Amended Land Management Plan (LMP). This analysis follows a prior ecological departure analysis of Nantahala and Pisgah forest ecosystems that compared each ecosystem's current forest structure to its historical Natural Range in Variation (NRV). The purpose of this analysis is to identify forest condition classes that are significantly contributing to ecological departure as well as provide restoration opportunities. This analysis engaged local partners through verifying results of the ecological departure analysis and synthesizing potential active restoration techniques. In total, this analysis identified over 270,000 acres as in need of active restoration, mostly residing within the mid to late closed forest condition classes. This study indicates that there is currently a need to increase active restoration efforts through management activities such as prescribed burning.

INTRODUCTION

The Southern Blue Ridge (SBR) ecoregion is renowned for scenic vistas, unique plant communities, and is a biodiversity hot spot. The ecoregion covers a five-state region from Virginia to Georgia, encompassing a wide range of natural communities, and physical variation in the form of elevations, landforms, and geologies. Residing within the SBR, Nantahala and Pisgah National Forests comprise one third of the 3.2 million acres of National Forest land in the SBR ecoregion. These forests are currently managed under the 1987 Land Management Plan (amended in 1994). Prior to the current LMP, these forests experienced contentious management decisions. The forest ecosystems in Nantahala and Pisgah National Forests are the result of past natural and human disturbances (Vose, 2013).

These forests have experienced a varied history of fire management beginning with Native American burns which encouraged open canopies and oak regeneration (Brose, Schuler, Van Lear, & Berst, 2001). During the early 20th century, forest management emphasized high levels of timber extraction with clearing of large tracts of land. Additionally this landscape experienced a reduction in fire, as fire suppression became the main strategy for forest fire management. Insect and diseases have also contributed to altering forest composition. Some of the more notable and large-scale outbreaks have been the chestnut blight, hemlock wooly adelgid, and pine bark beetles. The chestnut blight significantly altered the landscape through the rapid death of trees giving way to open space for other species to move in. The forest structure and composition seen today is largely a result of natural historical events and management practices. For example, fire suppression in highly fire-adapted systems has resulted in a closing of the canopies; such is evident in species with a fire return interval of less than 20 years being the most departed systems (Kelly, 2013). These alterations have caused concern among wildlife biologists, botanists, hunters, and conservationists. As a result, forest ecosystems in Nantahala and Pisgah National Forests have high understory shrub density, declining populations of oak species, and closing canopies. The US Forest Service (USFS) is tasked with not only grappling with the consequences of past management practices but will face new challenges, such as climate change, increased human and natural disturbances, and habitat fragmentation, which require landscape-level conservation and restoration efforts.

Natural Range in Variability (NRV) has emerged as a tool for managers to incorporate into restoration and land management planning (Landres, Morgan, & Swanson, 1999). NRV are reference conditions which describe how forest condition classes (seral class and canopy cover) for an ecosystem were influenced by disturbance and succession prior to European settlement (Haugo et al., 2014; Keane, Hessburg, Landres, & Swanson, 2009; Landres et al., 1999). NRV is a tool managers can use in restoration for setting management goals as it provides a framework for improving our understanding of an ecosystem (Haugo et al., 2014; Landres et al., 1999). It is particularly useful in systems where anthropogenic change has altered ecological systems as it highlights forest conditions that are a result of these changes. For example in the Nantahala and Pisgah National Forests the current overabundance of late closed forest conditions is a reflection of early 1920's timber harvests followed by large-scale fire suppression. NRV aims to increase understanding of an ecosystem by evaluating the historical driving processes of a system and how these processes influence current conditions. This analysis follows a prior ecological departure analysis of Nantahala and Pisgah forest ecosystems that compared each ecosystem's current forest structure to its historical Natural Range in Variation (NRV) (Kelly 2013).

Currently the USFS is revising its Land Management Plan (LMP) for Nantahala and Pisgah National Forests, which governs how the agency will manage these forests for the next 15-20 years. This legislatively mandated revision is a collaborative process that provides opportunities for stakeholders to recommend plan direction and management-area designations. Beyond the Nantahala-Pisgah LMP revision, federal forest management across the nation has shifted toward emphasizing ecological restoration (USDA 2012, USDA Forest Service 2012). This national shift in management goals aims to reverse habitat degradation, which likely resulted from long-term fire suppression, widespread disease outbreaks, and intensive land management practices (Haugo & Welch, 2013; Haugo et al., 2014).

The ecological departure analysis of Nantahala and Pisgah National forests identified five systems as greatly departed from their NRV values (Kelly 2013). This restoration needs analysis is an extension of the ecological departure analysis as it seeks to evaluate the drivers of departure within each ecosystem and identify potential management interventions. The goal of this analysis is to develop a framework that provides information on where active restoration is most needed across the Nantahala and Pisgah National Forests. As the LMP revision is a collaborative process this report and resulting data analysis will be submitted in hopes of documenting a need for change in the new Plan. The purpose of this analysis is to:

- Identify forest conditions driving the most departed forest ecosystems
- Verify results of the ecological departure analysis through expert review
- Synthesize potential active restoration techniques

The goal of this analysis is to use the above processes to document and spatially map where active restoration is most needed for each ecosystem and cumulatively across these systems in Nantahala and Pisgah National Forests. Active management is defined as a management intervention with the goal of restoration and can vary from prescribed burning to mechanical thinning. Several assumptions are inherent in this restoration needs analysis. All systems may require some level of restoration, but this analysis focuses solely on restoring forest structure; analyses of forest species composition, invasive species management, or wildlife habitat could yield a very different list of forest systems in need of restoration. The hope is that as these forests transition toward their historical range in variation the ability for them to function as a system and have increased resiliency will follow. Additionally, this analysis focuses on forest conditions classes requiring active management on federally managed forests because of the potential to leverage management changes in the LMP revision process.

Study Area

This restoration needs analysis examines approximately 765,872 acres of Nantahala and Pisgah National Forests (Figure 1). The Grandfather Ranger District of Pisgah National Forest is excluded from this analysis, as it was not modeled in the ecological departure analysis due to insufficient LiDAR data. Nantahala and Pisgah National Forests contain 11 forest ecosystems. Within this region, these ecosystems vary across their predicted fire return intervals, disturbance history, timber management, and topographic gradients.

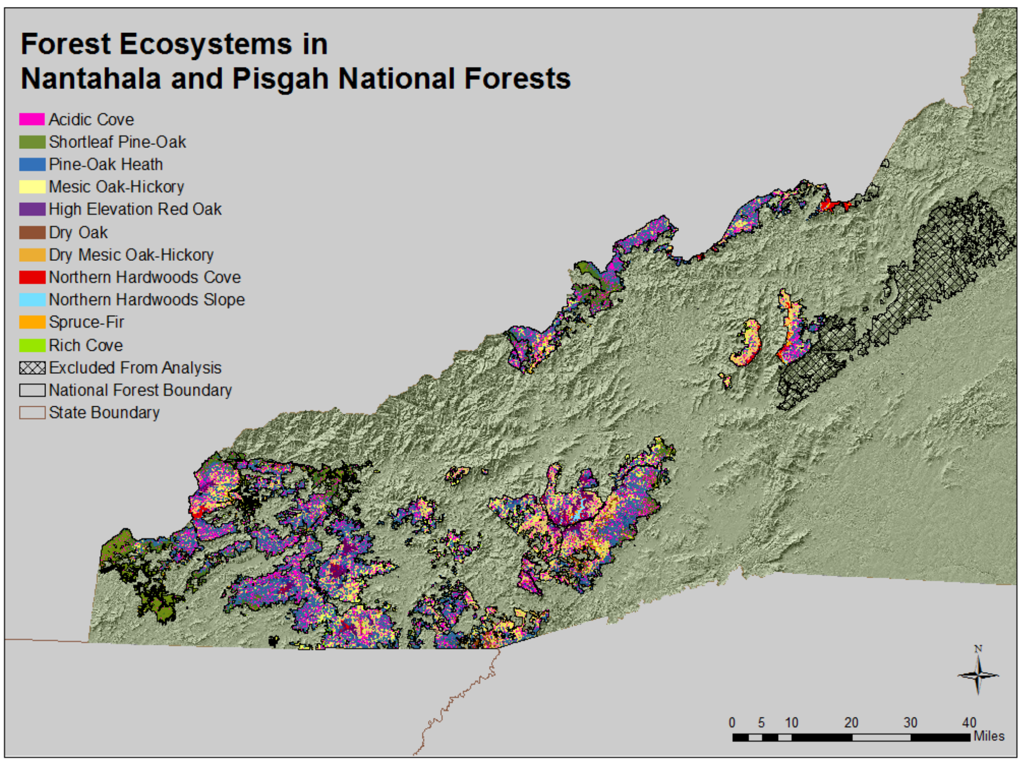

Figure 1. Map of ecosystems in Nantahala and Pisgah National Forests. The ecosystem boundaries have been visually exaggerated for display purposes.

ECOLOGICAL DEPARTURE ANALYSIS

The ecological departure analysis was modeled after the eCAP methodology developed by The Nature Conservancy. This analysis contrasted current forest structure with historical NRV values in 11 ecosystems and determined the overall departure of each system from its historical distribution. J. Kelly (2013) used NRV values derived from LANDFIRE BioPhysical Settings models and calculated current forest structure.

Calculating Natural Range in Variation

A Natural Range in Variation (NRV) is calculated using a BioPhysical Settings (BpS) model, which is a spatially explicit, multiple pathway model which seeks to estimate the distribution of forest seral and canopy cover classes by incorporating pre-European settlement rates for disturbances and succession. These rates are estimated through a literature review and expert analysis which are updated as new information becomes available (Haugo et al., 2014). The resulting NRV of a BpS does not represent a single moment in time yet it is an approximation of an equilibrium condition which is estimated through running the BpS models multiple times (Haugo et al., 2014). It is important to note that like all model outputs, NRV values are estimates and contain varying levels of error. Additionally the use of NRV values in the ecological departure analysis and this analysis recognizes that forests are not static and that these systems do not have a single set of optimal conditions. Rather, it recommended that the goal of using NRV should be to identify a range of conditions that restores sufficient forest function.

Estimating Current Forest Structure

A data set was provided by Josh Kelly of Western North Carolina Alliance (Kelly 2013). The resulting dataset contained more than 100 GIS layers separated by ecosystem type, canopy cover, and shrub height. These layers were created by processing 2005 LiDAR data and USFS stand data into raster files before conversion to shapefiles. This conversion decreased acreage at least 5%. All enumerated acreage estimates in this report refer to estimates from the raster datasets, however, the map figures refer to the shapefile layers. Additionally, the following definitions were used to define forest conditions:

- Closed canopy: >60% canopy cover or an open canopy in mid – old growth seral classes with a high shrub density
- Open canopy: ≤60% canopy cover and a low shrub density
- High shrub: > 50% shrub density
- Low shrub: ≤ 50% shrub density

Estimating Ecological Departure

Departures from current conditions were calculated by comparing current proportion of seral classes to the reference condition (NRV) predicted with the Biophysical settings models. The following equation was used to calculate the departure:

$$100\% - \sum_{i=1}^{n} \min\{Current_i, NRV_i\}$$

The analysis identified five systems as having poor ecosystem health, which was defined as having a system departure greater than 66%. The results of this study provide ecological departure by forest ecosystem (Table 1).

Table 1. Ecological departure by ecosystem. Excerpted from Kelly 2013.

Forest Ecosystem	System Departure (%)
Dry Oak	84
Pine-Oak Heath*	83
Shortleaf Pine-Oak*	83
Dry Mesic Oak-Hickory	70
Mesic Oak-Hickory	70
High Elevation Red Oak	63
Rich Cove	54
Acid Cover	55
Spruce-Fir*	34
Northern Hardwoods Cove*	6
Northern Hardwoods Slope*	3

* Old growth seral classes were not analyzed in the BpS models therefore they were not included in the ecological departure analysis.

FOREST RESTORATION NEEDS ANALYSIS

The restoration needs analysis follows the ecological departure analysis by evaluating the drivers of departure in each system. Many of the methods in this analysis were modeled after similar analyses, particularly the work of the Clearwater Basin Collaborative in Idaho (Haugo and Welch 2013; Haugo et al. 2014). The intent of identifying the forest conditions causing overall system departure is to identify forest condition classes where there is the potential for active management interventions. This analysis followed a four-step process, which included:

- Classifying management interventions
- Identifying forest conditions driving departure
- Mapping of ecosystems identified as most in need of active restoration
- Verifying results of restoration needs analysis with expert review

Potential Management Interventions

Forests are dynamic systems which when undisturbed by natural or human events naturally age from an early successional class through old growth. At each seral stage these forests are susceptible to natural disturbances such as a lighting strike setting fire and altering forest conditions. Land managers can alter forest succession through management decisions. When a decision is made to extinguish a wildfire, it likely will result in a more closed canopy. Identifying where and how managers can intervene and transition forest seral classes is illustrated below (Figure 2).

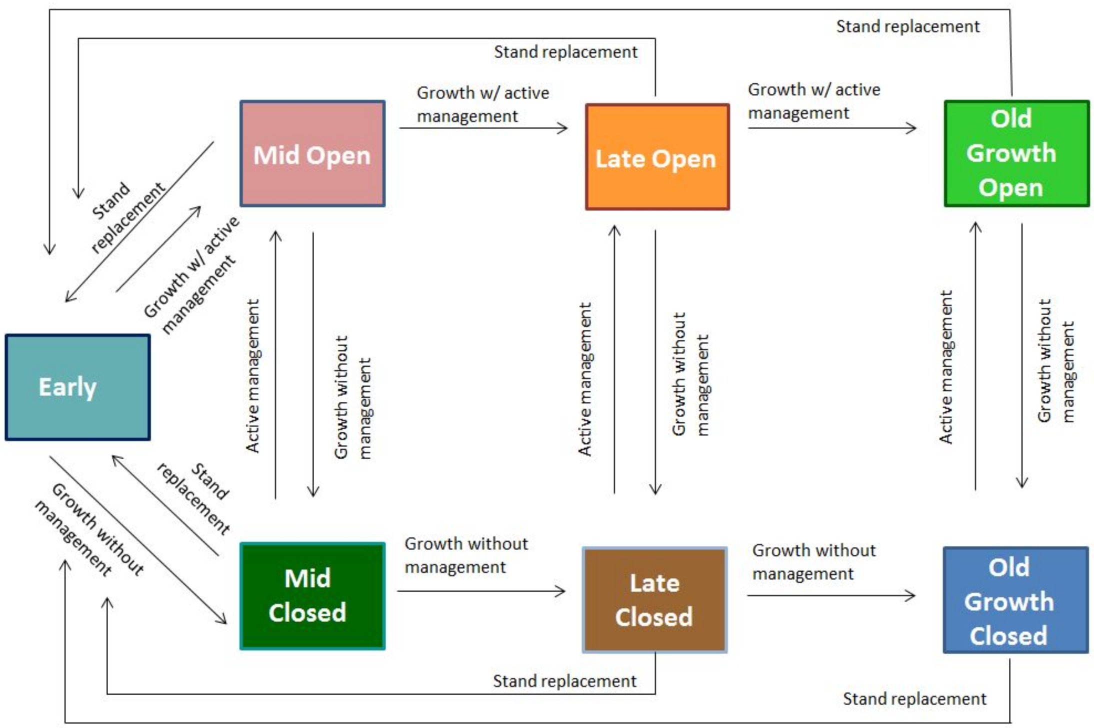

Figure 2. Forest class transitions for active and passive management.

Three types of management categories were considered in this analysis:

- *Active*: An intentional management action is taken to alter the current forest condition. For example, overstory thinning results in opening forest canopy and is considered active management.
- *Passive*: Restoration occurs through natural succession.
- *Active & then Passive*: An active management intervention occurs at least once and then natural succession follows. For example if a system needed to transition from late closed to old growth open an active management intervention would be necessary to open up the canopy as well as time for the seral class to age.

Identification of Systems Most In Need of Restoration

The ecological departure analysis provided acreage and percentage of the system separated by seral class, canopy cover, and shrub height. While the ecological departure analysis considered a system departure, greater than 66% to be in poor ecosystem health this analysis evaluated any system which had greater than a 60% cumulative departure. Six systems were identified as most in need of restoration:

- Dry Oak
- Pine-Oak Heath
- Shortleaf Pine-Oak
- Dry Mesic Oak Hickory
- Mesic Oak-Hickory
- High Elevation Red Oak

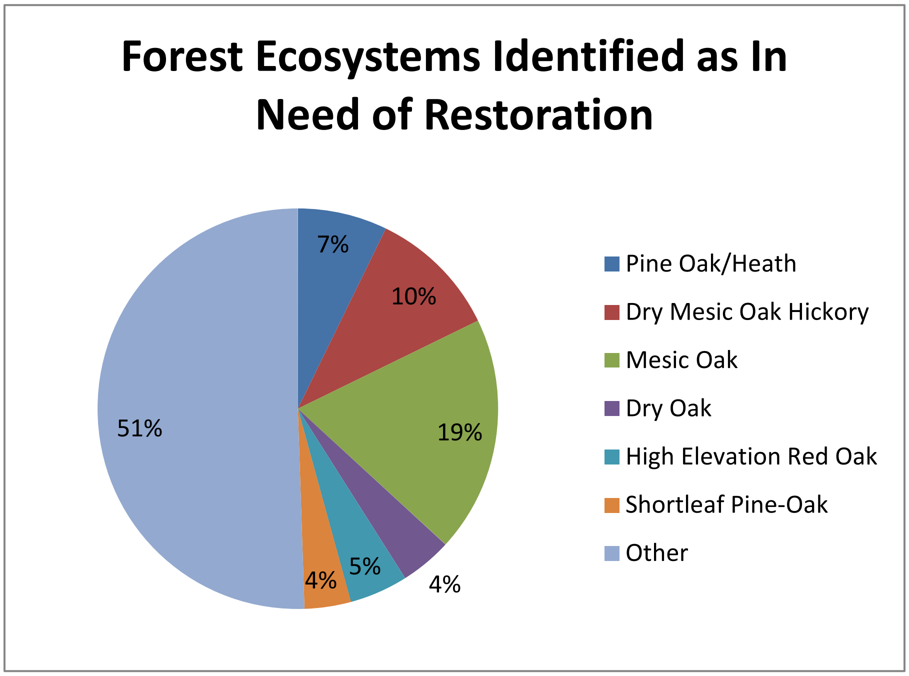

Figure 3. Forest ecosystems identified as most in need of structural restoration (excludes Grandfather Ranger District).

These six systems cumulatively cover approximately half of Nantahala and Pisgah National Forests (Figure 3). Within these systems, each individual forest condition class was evaluated for its contribution to the system's overall departure. Forest condition classes are defined as the unique combination of seral class and canopy cover (e.g. late seral closed). Any forest condition which had greater than 5% departure was designated as in need of evaluation at the partner meeting. The following information was then classified for each forest condition:

- deficit or overabundance of acres in relation to NRV
- the required active, passive, or active and then passive management to transition ecosystem toward NRV (i.e prescribed fire or thinning)

Each of these systems required primarily active restoration to return the system closer to its NRV. The general trend of mid-closed or late-closed being over abundant emerged as well as a general lack of old growth open. The results of this analysis were compiled for use in a geospatial mapping of forest condition classes contributing to departure. These maps were accompanied by their statistical information in spreadsheet form for evaluation by local experts at a partnership meeting.

GIS Analysis

Geospatial analysis software (ArcGIS 10.1) was utilized in evaluating the spatial distribution of each forest ecosystem (ESRI 2012). ArcGIS is a mapping software which allows users to create maps and use geographic data to evaluate spatial relationships. This software is a powerful tool that allows one to perform large-scale analysis such as this one of the Nantahala and Pisgah National Forests. The ~120 shapefiles separated by ecosystem type, canopy cover, and shrub height were combined into 11 shapefiles, one for each system. A custom python script was used to dissolve, add attribute information, and combine each system into a single shape file. Forest condition classes contributing to a system's departure that could be reduced through active management were identified. A custom GIS tool was used to query for these attributes and combined them into a separate shape file for each forest ecosystem. This resulted in maps of each ecosystem showing where there is a need for active restoration which were presented at a partner engagement meeting.

Partner Engagement

The results of identifying areas for active restoration and subsequent maps were presented at an all-day partnership meeting in Asheville, NC on January 28, 2014. The meeting was attended by 13 state, federal, and non-profit organizations. The meeting objectives were to:

- share with and receive feedback from partners on the in-progress restoration needs analysis
- collect information on restoration priorities and to prioritize the top forested systems in need of restoration
- to develop a realistic goal for restoration of the highest prioritized systems for the next 20 years

In general participants were interested in overarching themes within each system rather than detailed NRV values. This was to be expected as it is recommended that NRV values be used to *guide* restoration efforts. It became apparent rather quickly that restoration of these forests would need to extend beyond the life of the next LMP. A few individuals suggested that the USFS consider using Landscape Forecasting models similar to those done on the Cherokee National Forest. Overall, participants agreed that the analysis successfully identified the overarching drivers of departure in each forest ecosystem. Results of a geospatial analysis of each ecosystem as well as information gleaned from this meeting are presented by system below.

RESULTS OF IDENTIFYING ACTIVE RESTORATION

An overabundance of mid-closed and/or late-closed forest conditions and a need for active restoration was documented in this analysis and confirmed by expert opinion at the partnership meeting (Table 3). Forest condition classes with an overabundance were all classified as needing active restoration and/or active restoration followed by passive restoration. The results presented here focus solely on the active portion of restoration as the passive stage will extend beyond the current LMP. Time plays an important role in the long-term restoration goals of these systems. For example in systems like Mesic Oak Hickory with an overabundance of the late-closed stage and a deficit of old growth open, reducing the overabundant class will temporarily cause a large increase in late-open until it ages to old growth-closed. Cumulatively 270,254 acres of active restoration is needed in order to restore forest condition classes with an overabundance back to their NRV values (Table 4).

It is important to reiterate that the goal has never been to return all six of these systems to their NRV. However, NRV values are helpful in identifying drivers of departure and the results of this analysis show overwhelmingly that in all six systems mid-closed and late-closed forest condition classes are excessive. Each of these six systems have at least half their successional distribution residing within the late closed forest condition class.

Table 3. Percentage of forest condition classes in mid closed and late closed for each ecosystem.

	Proportion of System	
Forest Ecosystem	**Mid Closed**	**Late Closed**
Pine Oak Heath	14.77%	76.59%
Shortleaf Pine Oak	27.58%	57.81%
Dry Oak	16.90%	66.40%
Dry Mesic Oak Hickory	16.75%	68.83%
Mesic Oak Hickory	22.36%	56.37%
High Elevation Red Oak	17.40%	56.20%

An overview of each ecosystem is provided below and compiles the results of the restoration needs analysis as well as information obtained at the partnership meeting. The presentation of these results is meant to ignite conversation about what is obtainable over the next 20 years during the life of a new Land Management Plan for the Nantahala and Pisgah National Forests. Additionally geospatial data was distributed to partners to allow them to determine how and where they would like restoration to occur.

Table 4. Acreage and percentage of each forest ecosystem requiring active restoration.

Forest Ecosystem	Total Current NF Area	Total Amount Requiring Active Restoration	
	Acres	Acres	%
Pine Oak Heath	55,439	46,213	83%
Shortleaf Pine Oak	28,760	23,054	80%
Dry Oak	32,079	24,904	78%
Dry Mesic Oak Hickory	80,532	54,825	68%
Mesic Oak Hickory	146,097	98,800	68%
High Elevation Red Oak	35,999	22,458	62%
TOTAL	**378,906**	**270,254**	

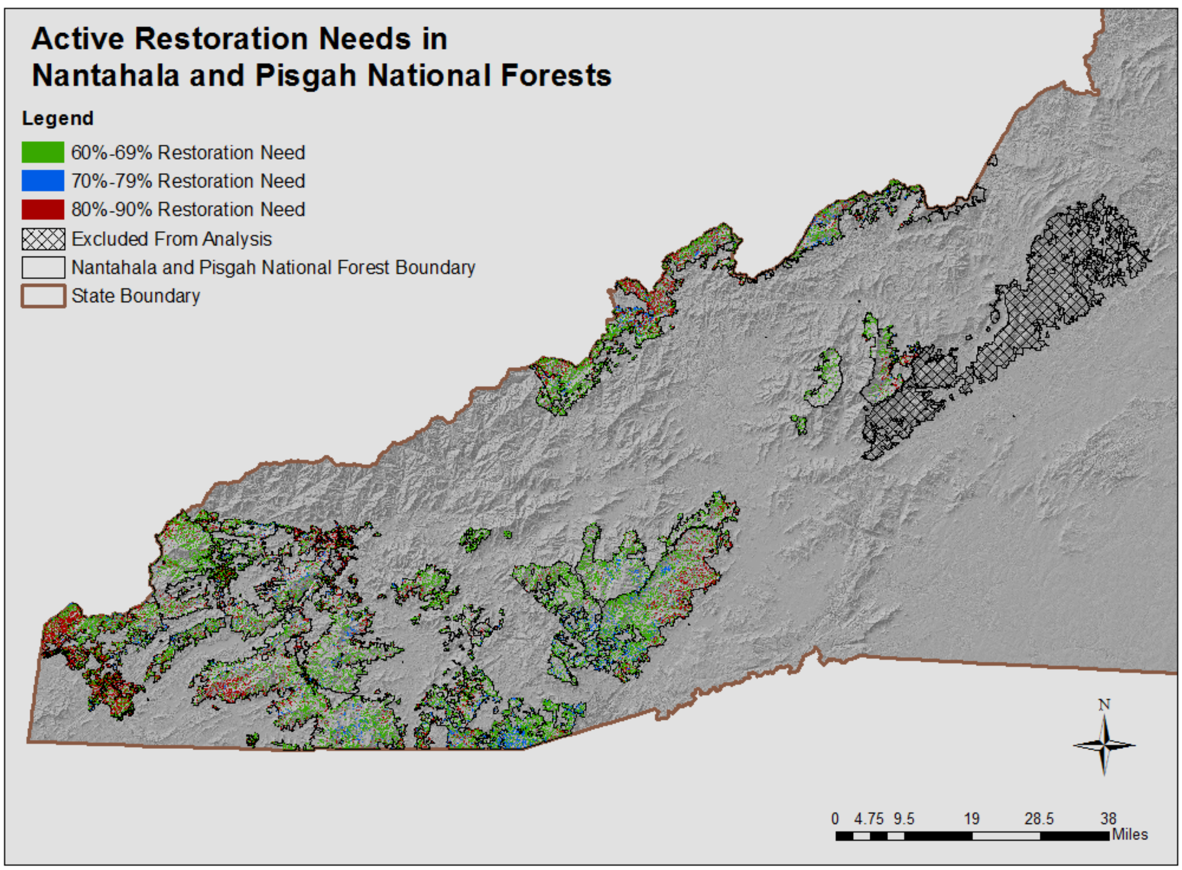

Figure 4. The areas identified show the relative percent of each system that needs to be restored.

Pine Oak Heath

Pine Oak Heath was identified in this analysis as having the greatest proportion (83%) of the system requiring active restoration (Figures 5 & 6). The distribution of forest condition classes show that the overabundance of late-closed is the largest forest condition class, thus requiring the most active restoration. Experts when showed this chart commented that there is a possibility that the 2005 LiDAR data does not accurately portray the late-closed category. A large outbreak of native pine bark beetles occurred in the early 2000s and many dead trees were possibly still standing when LiDAR data was collected. Attention was also drawn to the high shrub density of this system (55%) as well as a loss of seed trees in this system. Partners agreed that this system has been neglected but provides the opportunity for an aggressive fire program. Mechanical thinning and prescribed burning were both considered viable management tools for opening up canopy cover and reducing the amount of late-closed. Encroachment of white pine was presented as an additional management challenge for restoration. This system serves as an example where partners may not agree on the exact NRV value predicted by BpS models at 5% for late-closed, yet all agreed that 76% of this system was too high.

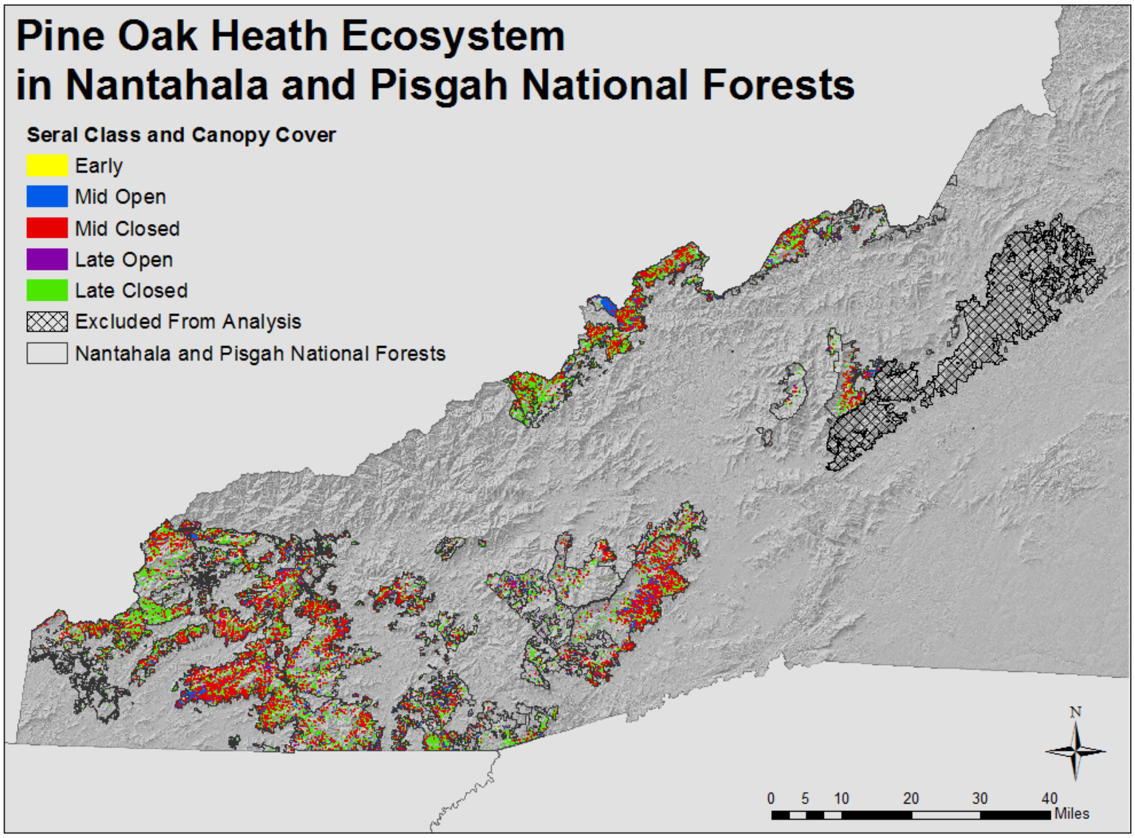

Figure 5. Distribution of forest conditions classes in the Pine Oak Heath ecosystem. The forest condition class boundaries have been visually exaggerated for display purposes.

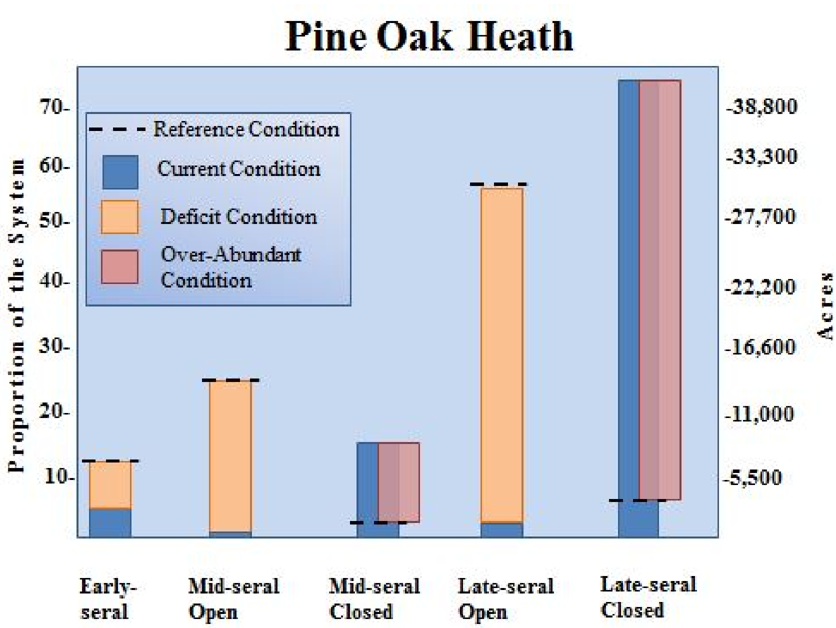

Figure 6. Comparison of current forest condition classes to their predicted reference condition in the Pine Oak Heath ecosystem.

Shortleaf Pine Oak

Shortleaf Pine Oak had a significant portion of the system (~57%) residing within late-closed (Figures 7 & 8). Similar to Pine Oak Heath, there was a concern that many of the late-closed captured by 2005 LiDAR might be misrepresentative of the total amount of living trees due to pine beetle infestations. This was echoed in comments by experts concerning a need for a better understanding of actual species composition and current conditions. Partners worried that there is an encroachment of hardwoods into this system and that restoration of this system will take a considerable amount of time. Complicating the long-term success of this system is that Shortleaf is fickle in seed production with about a 30-year timeframe on seed life. Partners were concerned as they have not seen much regeneration within this system and several noted the establishment of early seral forest would require plantings.

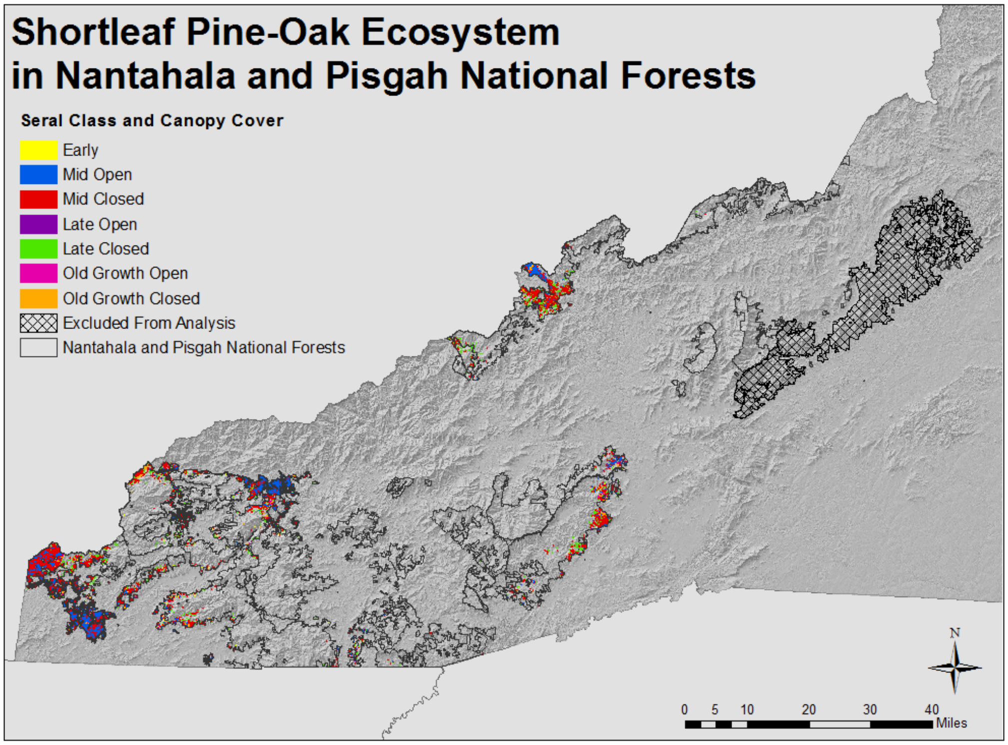

Figure 7. Distribution of forest conditions classes in the Shortleaf Pine Oak ecosystem. The forest condition class boundaries have been visually exaggerated for display purposes.

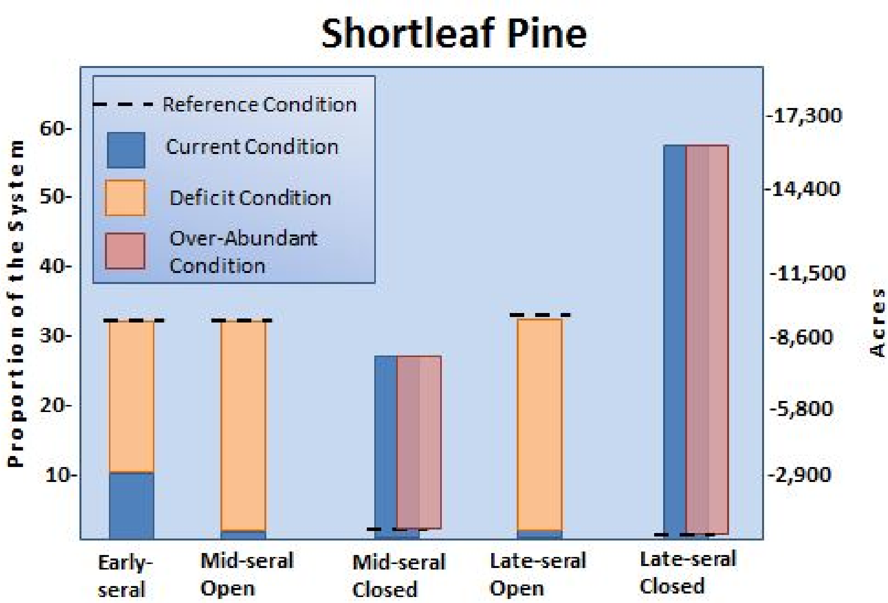

Figure 8. Comparison of current forest condition classes to their predicted reference condition in the Shortleaf Pine Oak Heath ecosystem.

Dry Oak

This system ranked third in the ecological departure analysis as the most departed with 66% of current forest conditions residing within late-closed and only 0.2% in old growth open (Figures 9 & 10). Several partners commented that the exact NRV values for closed canopy conditions across seral classes might be too low. Despite these concerns, all agreed that this system has an excess of closed canopy. Several challenges for restoration include a very high shrub density, overabundance of scarlet oaks, and need for a fire program with frequent burns. Experts stressed the need to balance prescribed fire intensity and frequency with oak regeneration. Many felt that in the beginning fire intensity would need to be higher in order to reduce the overabundance of evergreen shrubs. One advantage this ecosystem had over others was it has been resistant to encroachment of maple trees due to dry conditions.

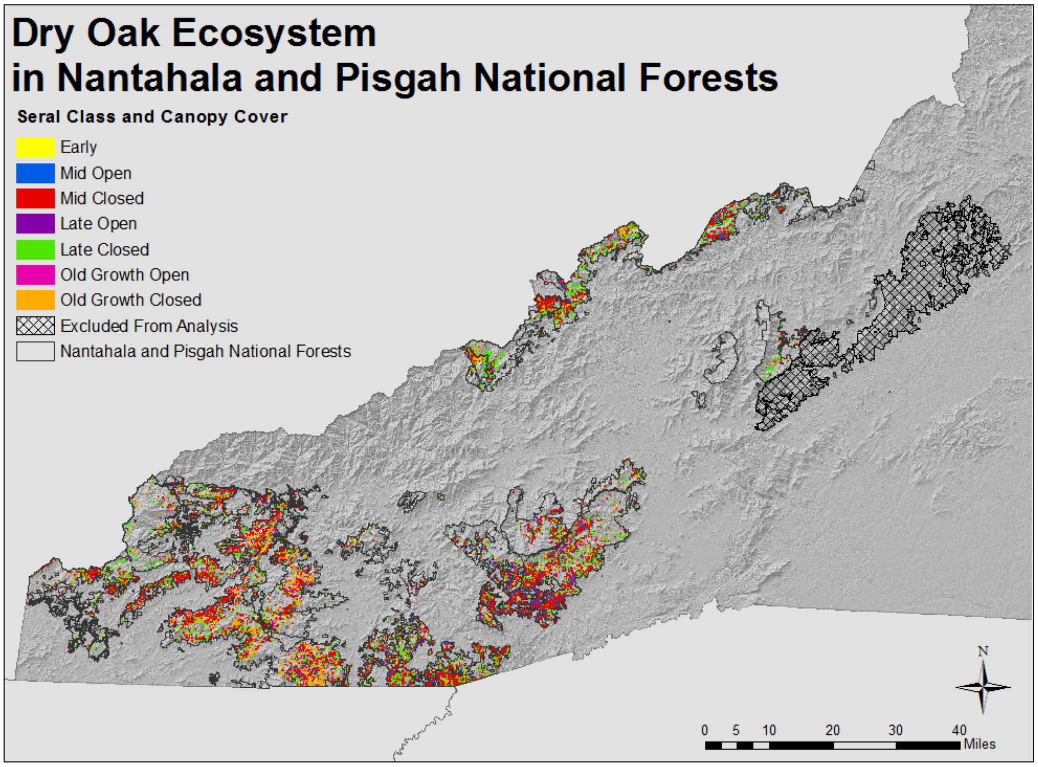

Figure 9. Distribution of forest conditions classes in the Dry Oak ecosystem. The forest condition class boundaries have been visually exaggerated for display purposes.

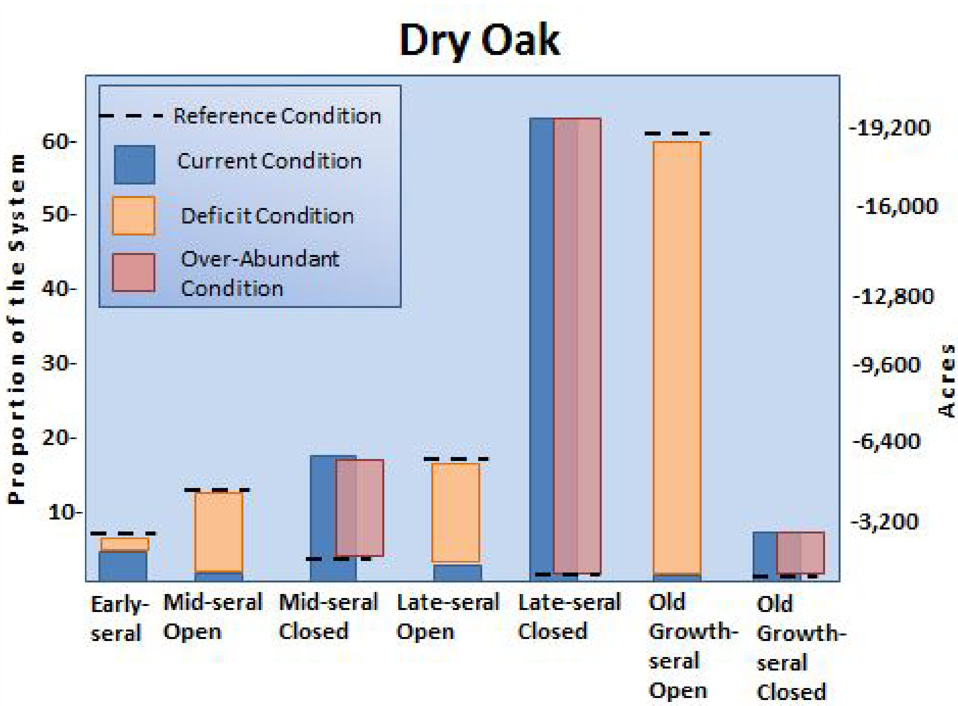

Figure 10. Comparison of current forest condition classes to their predicted reference condition in the Dry Oak ecosystem.

Dry Mesic Oak Hickory

When partners were presented with information on this system's departure all agreed that this system identified the major structural restoration needs (Figures 11 & 12). The discussion of a need for species composition was considered a key component in order to successfully restore this system. Many participants were concerned with the level of mesic species currently in the late age class as well as their establishment in the understory. It was mentioned that if no management actions are taken that this system will have a major loss of Oak and transition to a mostly mesic forest. Information gleaned on the accuracy of the current amount of early aged forest revealed that it will be transitioning to mid seral soon. This age distribution likely resulted from an old cutting cycle (~20 years). While many did not agree on the amount of old growth open compared to old growth closed suggested by NRV values (20x more), there was major concerns over the lack of old growth regardless of canopy openness. Partners were concerned regarding the ecological implications of having nearly 66% of the system in late-closed. Resulting from this discussion was the notion that while we may not be able to accelerate time to transition much of the late to old growth, expanding the types of silviculture practices could help compensate. More specifically mocking gap, structure and patch dynamics of old growth through over story canopy management could be used in conjunction with a long-term plan to transition toward more old growth.

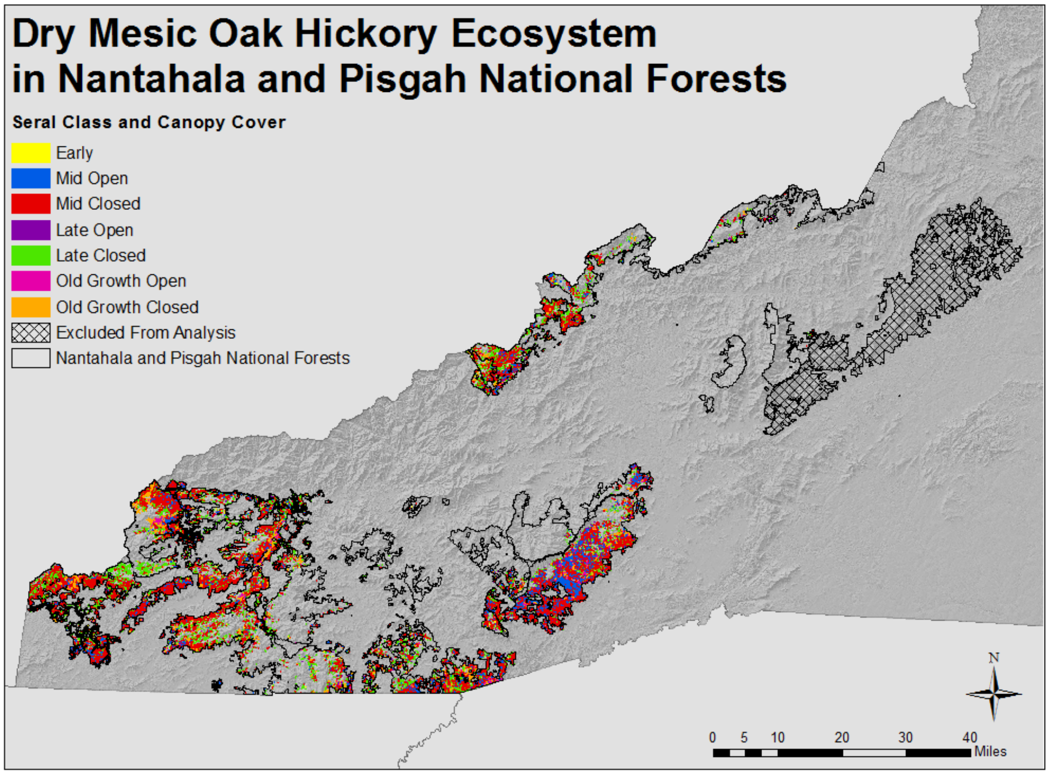

Figure 11. Distribution of forest conditions classes in the Dry Mesic Oak Hickory ecosystem. The forest condition class boundaries have been visually exaggerated for display purposes.

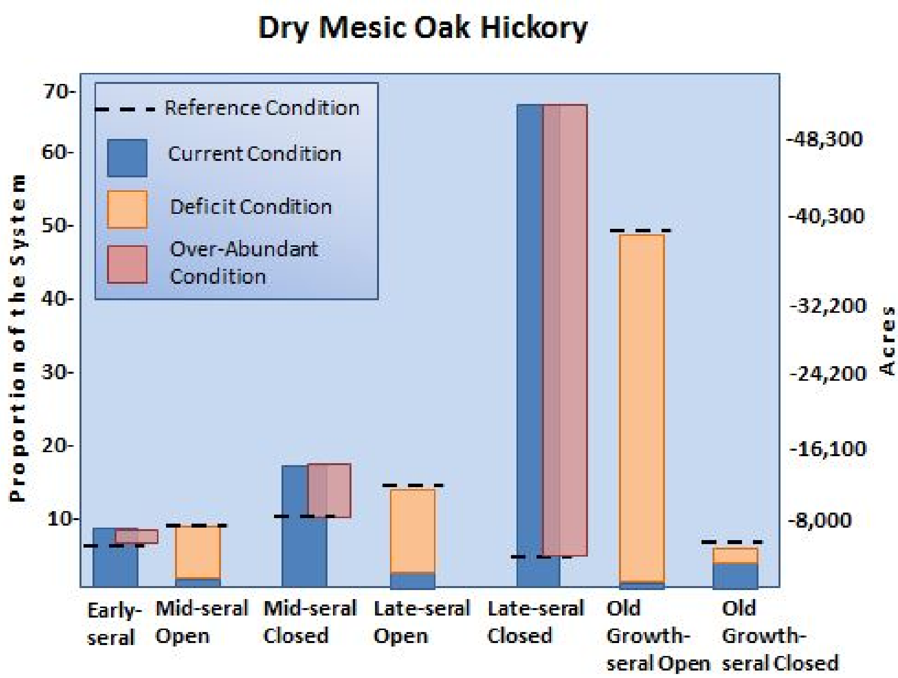

Figure 12. Comparison of current forest condition classes to their predicted reference condition in the Dry Mesic Oak Hickory ecosystem.

Mesic Oak Hickory

Mesic Oak Hickory is overall a very productive forest ecosystem with its current forest composition containing a large portion of mid-closed and late-closed, cumulatively ~78% of the system (Figures 13 & 14). While partners mentioned that this system, like others would benefit from more detailed information regarding species composition, many mentioned that the current late-closed forest captured by the 2005 LiDAR data might actually be dominated by tulip poplar rather than characteristic vegetation. Active restoration in this system is complicated by the nature of this system's presence along steep slopes. In regards to the early age class, not only is it below the NRV, many felt that the early forest predicted by LiDAR is near aging to mid. Additionally oak plantings are another key component such that there is a need for their establishment post canopy opening.

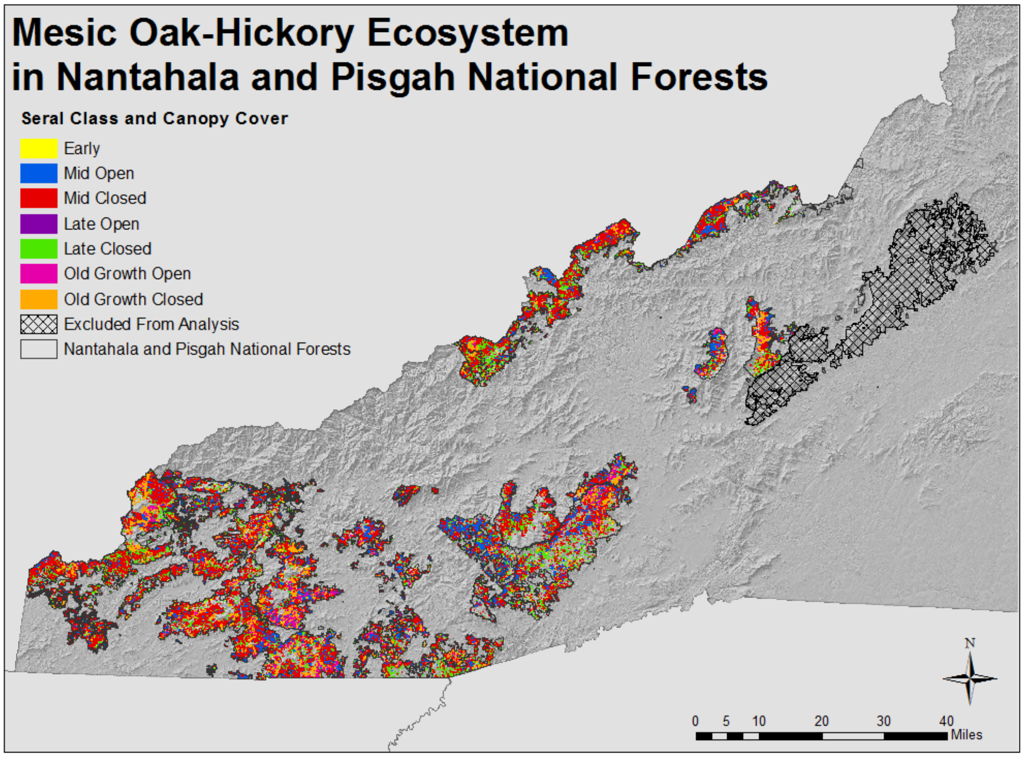

Figure 13. Distribution of forest conditions classes in the Mesic Oak Hickory ecosystem. The forest condition class boundaries have been visually exaggerated for display purposes.

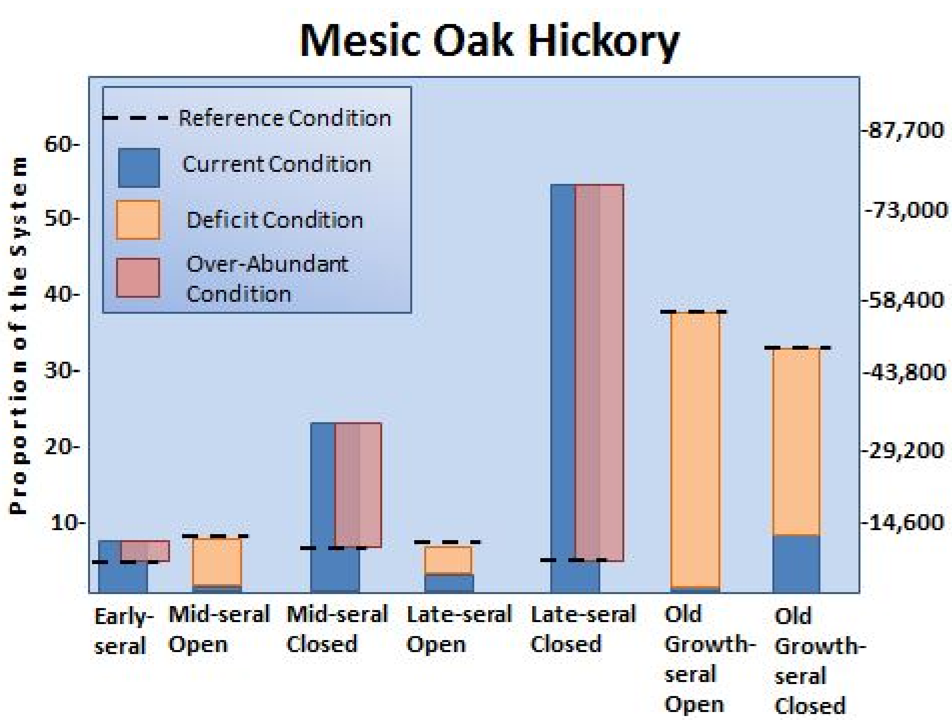

Figure 14. Comparison of current forest condition classes to their predicted reference condition in the Mesic Oak Hickory ecosystem.

High Elevation Red Oak

High Elevation Red Oak forests had the least cumulative amount of forest in need of active restoration with 62% of the system requiring active management in late-closed and mid-closed classes (Figures 15 & 16). However overall this system is extremely closed with only 6% falling into the open category across all seral classes. This system historically contained a healthy Chestnut population which many felt supported the notion that this system overall was quite open. Partners mentioned that there were concerns regarding the accuracy of the BpS models. However, all agreed that there is an overabundance of mid- and late-closed classes as well as a need for active restoration. These forests had the highest proportion of old growth compared to the other systems in this analysis with growth comprising 17% of the system. When experts were presented with this information, they mentioned that the natural occurrence of this system at high elevations might have prevented timber harvest.

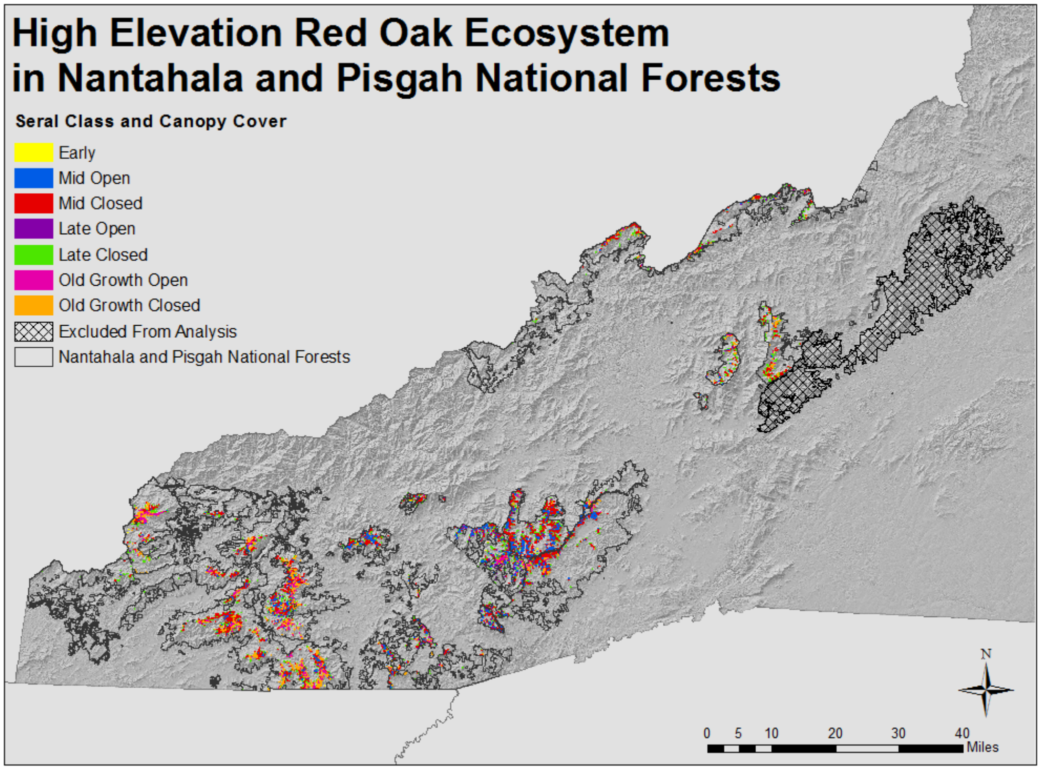

Figure 15. Distribution of forest conditions classes in the High Elevation Red Oak ecosystem. The forest condition class boundaries have been visually exaggerated for display purposes.

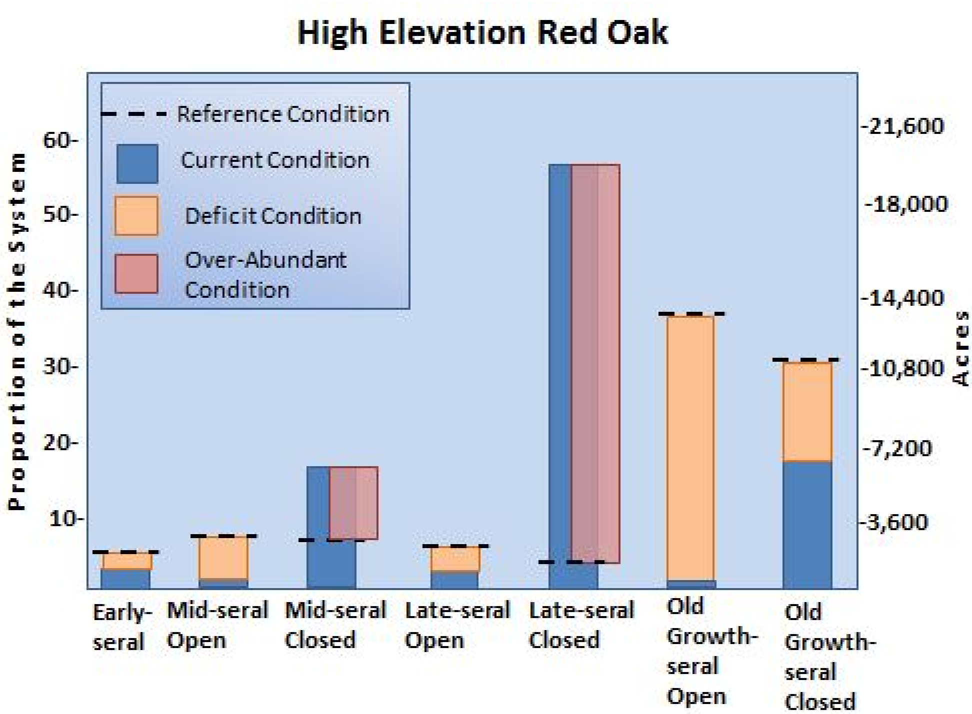

Figure 16. Comparison of current forest condition classes to their predicted reference condition in the High Elevation Red Oak ecosystem.

DISCUSSION

This restoration needs analysis focused on identifying broad goals for structural restoration of forest ecosystems in Nantahala and Pisgah National Forests. The same assumptions which apply to the proceeding ecological departure analysis are inherited in this analysis. Caution is recommended when evaluating the results as error is introduced in LiDAR measurements, ecozone mapping, and in generating NRV values. However even when one considers these sources of error this analysis utilizes the best available science and techniques for addressing structural restoration. Despite these margins of error, large trends, such as an overabundance of late-closed forest condition classes still stand out as a major structural restoration need.

When soliciting feedback on this project from partners and experts two common needs emerged. First, many were curious as to where restoration should occur across 1.1 million acres. Secondly, the need for more detailed species composition arose. More detailed species composition information was a clear message during the partner engagement meeting especially as a need for large-scale restoration planning in this region. Obtaining accurate species composition data allows land managers to identify areas of uncharacteristic vegetation and prioritize restoration accordingly. For example, areas identified as having uncharacteristic vegetation may be more suited for restoration practices that send a seral class back to early. On the other end of the spectrum if a system with an overabundance of late closed has intact characteristic vegetation then management activities should focus on transitioning it to the appropriate old growth canopy classification.

Many participants agree that active restoration efforts need to focus on transitioning the over abundant late-closed forest condition toward old growth. However, it is important to note that while many agree with this, there is concern surrounding the quality and quantity of early seral habitat. While early successional habitat does not have the same deficit of forest compared to old growth, the quality, size, and configuration of this seral class may not be meeting the needs of wildlife species. Others brought up concerns of invasive species and diseases affecting forest ecosystems, with hemlock wooly adelgid clearly causing large-scale disturbance. While this analysis does not address the answers to these questions, it has furthered the dialogue amongst stakeholders. The geospatial data from this analysis has been compiled, distributed and is available for public use.

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