United States
Department of
Agriculture

Nantahala and Pisgah National Forests

Draft Environmental Impact Statement

for the Proposed Land Management Plan

Appendix B:
Description of the Analysis Process

Forest Service | Southern Region | National Forests in North Carolina | R8 MB-155 B | January 2020

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Draft Environmental Impact Statement

Nantahala and Pisgah National Forests
Land Management Plan

Appendix B: Description of the Analysis Process

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In addition to the discussion in Chapter 3 itself, this appendix further describes the analysis process used for evaluations in the EIS. It includes assumptions, and a summary of tools, data used, and analysis steps by resource topic. Further information for individual analyses can be found in the project record.

Topics covered in this appendix include:

Other resource topics have their own appendix for analysis methods. For information about the ecological sustainability analysis, aquatic systems, terrestrial ecosystems and species, please see Appendix C. Information about vegetation modeling can be found in Appendix D. The Wilderness Evaluation Process is documented in Appendix E, and Wild and Scenic Rivers in Appendix F.

Air

Ambient Air Quality Data. The ozone and fine particulate matter data are from monitoring locations that meet the Environmental Protection Agency (EPA) monitoring standards for the National Ambient Air Quality Standards (NAAQS). Either the North Carolina Division of Air Quality or the EPA Clean Air Status and Trends Network (CASTNET) gathered and conducted the quality control on this ambient air data. Visibility data is gathered by the USDA Forest data (analysis of the samples is funded by the EPA) following the Interagency Monitoring of Protected Visual Environments (IMPROVE) protocols. The internet links for the data are in the figure captions in the Affected Environment.

Total Deposition Data. The total deposition estimates are derived using statistical methods for the wet and cloud deposition, and both statistical and atmospheric dispersion model estimates for the dry deposition. The methods used are described in Sullivan and others (2010) and McDonnell and others (2018).

Potential Acid Neutralizing Capacity (ANC_p) and thresholds (ANC_t). McDonnell and others (2018) describe the steady-state water chemistry model, the data used to conduct the analysis, and assumptions. Using ArcMap, calculations used spatial data from the emds_v4_073118 database found in the Critical_loads.gdb geodatabase. Additional documentation is within the metadata for the coverage.

For this EIS, the variables described by McDonnell and others (2018) for the steady-state water chemistry model (an equation) where rearranged to solve for the acid neutralizing capacity (ANC) and the potential ANC (ANC_p) assumes there is no anthropogenic effect on the catchment:

$ANC_p = (BC_{Dep} + BC_W – BC_{Up} – S_{DepNat}) / Q$

where:

ANC_p = the potential ANC without anthropogenic sulfur deposition and no timber harvests in the catchments. The unit of measure is micro-equivalents per liter (ueq/L)

BC_{Dep} = the total amount of base cations (calcium + magnesium + potassium + sodium) minus chloride. The units of measure is micro-equivalents per meter squared per year ($meq/m^2\ yr^{-1}$).

BC_W = the annual rate of base cation weathering in the soil. Units of measure are $meq/m^2\ yr^{-1}$.

BC_{Up} = the annual rate of base cation uptake by trees if the catchment has been harvested. This has been set to 0 $meq/m^2\ yr^{-1}$.

S_{DepNat} = the estimated natural deposition of sulfur from the atmosphere, which is 2.5 $meq/m^2\ yr^{-1}$.

Q = the predicted runoff (m/yr)

The ANC_p results are continuous data and the subgroup of the Planning Team chose to place the results in categories, where the ANC_t value used in any subsequent calculations used the lowest value (10, 30, 50, or 100) in the following ranges (unit of measure is ueq/L):

>=10 - <30

>=30 - <50

>=50-<100

>=100

Best Available Science

Knoepp, J. D.; Vose, J. M.; Jackson, W. A.; Elliott, K. J.; and Zarnoch, S. 2016. High elevation watersheds in the southern Appalachians: Indicators of sensitivity to acidic deposition and the potential for restoration through liming. Forest Ecology and Management. 377: 101-117.

> This peer-reviewed study relied upon repeated soil and water chemistry samples taken from one high elevation location on the Cherokee, Nantahala and Pisgah NFs. Southern Research Station staff utilized appropriate scientific methods to collect and analyze the field results. The authors discussed how timber harvesting may adversely affected base cation supplies and the range in lime application to increase soil pH.

Lawrence, G. B., and Huntington, T. G. 1999. Soil-Calcium Depletion Linked to Acid Rain and Forest Growth in the Eastern United States. USGS Water-Resources Investigations Report 98-4267. 12. https://doi.org/10.3133/wri984267

> This publication described the effects of acid deposition on forest soils and there is a delayed response in watershed improvement because there is a slow release of previously stored sulfur in the soil with a decrease in atmospheric sulfur deposition.

Lawrence, G. B.; Sullivan, T. J.; Burns, D. A.; Bailey, S. A.; Cosby, B. J.; Dovciak, M.; Ewing, H. A.; McDonnell, T. C.; Minocha R.; Quant, J.; Rice, K. C.; Siemion, J.; and Weathers, K. 2015. Acidic Deposition along the Appalachian Trail Corridor and its Effects on Acid-Sensitive Terrestrial and Aquatic Resources. Results of the Appalachian Trail MEGA-Transect Atmospheric Deposition Effects Study. Natural Resource Report NPS/NRSS/ARD/NRR—2015/996. National Park Service, Fort Collins, CO.

The report includes soil and water chemistry and dynamic modeling results for locations on the Nantahala and Pisgah National Forests. The authors reported that stream acid neutralizing capacity can decrease as much as 50 ueq/L following storm events.

McDonnell, T. C.; Sullivan, T. J.; Cosby, B. J.; Jackson, W. A.; and Elliott, K. J. 2013. Effects of Climate, Land Management, and Sulfur Deposition on Soil Base Cation Supply in National Forests of the Southern Appalachian Mountains. Water, Air, & Soil Pollution 224, no. 10: 1–18. doi:10.1007/s11270-013-1733-8.

This peer-reviewed study relied upon field data collected in the southern Appalachians, including the Nantahala and Pisgah NFs. The field data were inputs into a biogeochemistry model that has international acceptance. The methods used in the modeling analysis also has international acceptance. One of the modeling scenarios evaluated potential timber harvesting effects on soil base saturation and stream acid neutralizing capacity.

McDonnell, T. C.; Sloat, M. R.; Sullivan, T. J.; Dolloff, C. A.; Hessburn P. F.; Povak, N.A.; Jackson, W. A.; and Sams, C. 2015. Downstream warming and headwater acidity may diminish coldwater habitat in Southern Appalachian Mountain streams. PLOS One. DOI:10.1371/journal.pone.0134757.

This peer-reviewed study relied upon previously published estimates of stream acid neutralizing capacity and recently collected stream temperatures for the Southern Appalachians, including the Nantahala and Pisgah NFs. The authors utilized appropriate scientific methods for the statistical models and incorporating field results. The study identified locations on the Nantahala and Pisgah National Forests where the stream acid neutralizing capacity may be too low to support brook trout and the extent of suitable brook trout habitat if air temperatures remain the same or increases by 2 and 4 degrees Celsius.

McDonnell, T. C.; Sullivan; T. J. and Jackson, W. A. 2018. Atmospheric Deposition Effects: Modeling for Resource Management on Southern Appalachian National Forests. Final report prepared for USDA Forest Service, Asheville, NC. E&S Environmental Chemistry, Inc., Corvallis, OR. 66 pp.

This report updates a previous peer-reviewed publication using recently acquired water and soil chemistry data throughout the Southern Appalachians, including the Nantahala and Pisgah NFs. The field data were inputs into a biogeochemistry model that has international acceptance. The methods used in the modeling analysis also has international acceptance. The biogeochemistry model results provide hindcast and forecast estimates for soil base saturation and acid neutralizing capacity. Model outputs included base cation weathering estimates that were input, along with other landscape variables, to a regression model to predict base cation weathering (BCW) across the landscape. This study compiled a spatial geodatabase used in the Nantahala and Pisgah EIS. The BCW estimates along with other spatial estimates were used as inputs into the calculations conducted for the EIS. The steady state water chemistry analysis used in the report is an internationally accept method. The report also provides additional background information on how both acidification and timber harvesting effect base cation supplies.

McNulty, S. G.; Cohen, E. C.; Moore Myers, J. A.; Sullivan, T. J.; and Li, H. 2007. Estimates of Critical Acid Loads and Exceedances for Forest Soils across the Conterminous United States. Environmental Pollution, Air Pollution and Vegetation Effects Research in National Parks and Natural Areas: Implications for Science, Policy and Management, 149. 3: 281–92. doi:10.1016/j.envpol.2007.05.025.

This peer-reviewed publication presents the amount of nutrient base cations removed when harvesting only the bole (i.e. trunk) and bark.

Peterson, J.; Lahm, P.; Fitch, M.; George, M.; Haddow, D., and others. 2018. NWCG Smoke Management Guide for Prescribed Fire. National Wildfire Coordinating Group. Boise, ID. PMS 420-2/NFES 1279. 306 pp.

This report provides a scientific overview of how wildland fires affect air quality, and documents the current National Ambient Air Quality Standards.

Rice, K. C.; Scanlon, T. M.; Lynch, J. A.; and Cosby, B. J. 2014. Decreased Atmospheric Sulfur Deposition across the Southeastern U.S.: When Will Watersheds Release Stored Sulfate? Environmental Science & Technology 48, no. 17: 10071–78.

This peer-reviewed publication presents results from the Joyce Kilmer – Slickrock Wilderness (Nantahala National Forest). The authors estimated the release from the soil of previously stored atmospheric deposition of sulfur. The range is 2014 to 2028, with the predicted year as 2023.

Sullivan, T. J.; Cosby, B. J; Jackson, W. A; Snyder, K. U.; and Herlihy, A. T. 2010. Acidification and Prognosis for Future Recovery of Acid-Sensitive Streams in the Southern Blue Ridge Province. Water, Air, & Soil Pollution 219, no. 1–4: 11–26.

This peer-reviewed study relied upon field data collected in the southern Appalachians including the Nantahala and Pisgah NFs. The field data were inputs into a biogeochemistry model that has international acceptance. The methods used in the modeling analysis also has international acceptance. The publication describes accepted methods to estimate the total sulfur deposition from the wet, dry, and cloud/fog components. McDonnell and others (2018) provide the data sources for the southern Appalachian estimates, including the Nantahala and Pisgah NFs.

Urbanski, S. P. 2014. Wildland fire emissions, carbon, and climate: emission factors. Forest Ecology and Management. 317: 51–60.

This peer-reviewed publication provided the most recent prescribed fire emission factors for the United States and they are the most accurate, reliable, and relevant for the Nantahala and Pisgah NFs.

Climate

The affected environment is characterized based on climate and resilient landscape characteristics. Climate is analyzed based on indicators of observed and modeled climate variables (temperature and precipitation), with an emphasis on evaluating departure from historical conditions. Resilient landscape characteristics are analyzed in terms of indicators of local connectedness and landscape diversity, which is measured in relative terms to the surrounding region. Environmental consequences are discussed through a meta-analysis of peer reviewed literature describing effects on key resources, which are broadly defined around resource areas of emphasis in the LMP.

Regulatory Framework

No applicable legal or regulatory requirements or established thresholds exist for climate, climate change, or its effects on resources. The 2012 Planning Rule and Final Directives requires an assessment of climate change and integration of this information in development of plan direction that addresses ecological sustainability on national forests (36 CFR 219.8(a)(1)(iv); 36 CFR 219.6(b); Forest Service Handbook 1909.12.3; Forest Service Handbook 1909.23.1).

Methodology, Analysis Process, and Key Indicators

The affected environment is characterized based on climate and resilient landscape characteristics. Climate is analyzed based on indicators of observed and modeled climate variables (temperature and precipitation), with an emphasis on evaluating departure from historical conditions. Resilient landscape characteristics are analyzed in terms of indicators of local connectedness and landscape diversity, which is measured in relative terms to the surrounding region. Environmental consequences are discussed through a meta-analysis of peer reviewed literature describing effects on key resources, which are broadly defined around resource areas of emphasis in the LMP. Detailed descriptions of the methodology, analysis process, and key indicators are presented below.

Key indicators:

- Climate
  - Temperature – average annual daily maximum and minimum temperature
  - Temperature – number of days per year with average daily maximums greater than 90F
  - Temperature – number of days per year with average daily minimums less than 32F
  - Precipitation – average annual total precipitation
  - Precipitation – average number of dry days per year
- Landscape resilience
  - Local connectedness
  - Landscape diversity
- Environmental consequences
  - Biological diversity
  - Forest health
  - Plant communities
  - Animal communities
  - Extreme weather
  - Water resources
  - Recreation

Analysis Area and Scale

Due to the nature of climate change and its effects, this section utilizes multiple geographic and temporal scales. The geographic analysis unit is typically forest-wide, though some analyses required consideration of issues at larger or smaller geographic scales, including those that encompass the entire Southern Appalachian region. Due to the long-term effects of climate change, temporal analysis periods typically extend beyond the life of the plan with mid- or end-of-century being the most commonly used in this report, and it the scientific literature about climate change.

Data

This climate summary is based on climate models originally developed for the United Nations Intergovernmental Panel on Climate Change, downscaled by Pierce et al.[1] and available from the USDA Southeast Climate Hub's Climate by Forest tool, which is an adaptation of the National Oceanic and Atmospheric Administration's Climate Explorer.[2] The Climate by Forest tool produces graphs and tables showing historic and future projected conditions for two possible greenhouse gas emissions scenarios. [3] The climate data considered in this report are based on both historical observations and future projections:

Historic climate— For all observed data, the gray bars are plotted with respect to the 1961-1990 mean using Livneh et al. dataset.[4] The black line shows gridded historical observations.

Future climate — The modeled future climate projections are Localize Constructed Analogs (LOCA) downscaled from the Coupled Model Intercomparison Project Phase 5 (CMIP5) model realizations. This includes the hindcast (historical) and the projected (future) climate for the RCP4.5 (low) and RCP8.5 (high) emission scenarios. Each year, the range is defined by the highest and lowest model values for that year across all 32 models and the central line represents the weighted mean across all models.[5,6]

How the results are produced—The results summarized in this section represent an analysis area defined by a bounding box surrounding the Southern Blue Ridge Mountains ecological subsection (SBRM - M221Dc[7]). Data are retrieved dynamically from a NOAA-funded site at Cornell University (DeGaetano et al.[8]).

Best Available Science

These results represent the best available scientific information for evaluating climate, but limitations must be understood to make meaningful interpretations:

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[1] Pierce, D. W., D. R. Cayan, and B. L. Thrasher, 2014: Statistical downscaling using Localized Constructed Analogs (LOCA). Journal of Hydrometeorology, volume 15, page 2558-2585. http://loca.ucsd.edu/~pierce/IEPR_Clim_proj_using_LOCA_and_VIC_2016-06-13b.pdf

[2] U.S. Federal Government. 2018. U.S. Climate Resilience Toolkit Climate Explorer. [Online] https://climate-explorer2.nemac.org Accessed August 8, 2018.

[3] U.S. Forest Service. 2018. U.S. Climate By Forest (adaptation of Climate Resilience Toolkit Climate Explorer). [Online] http://climate-by-forest.nemac.org Accessed August 8, 2018.

[4] https://www.esrl.noaa.gov/psd/data/gridded/data.livneh.metvars.html

[5] Taylor K. E., Stouffer R. J., Meehl G. A. (2012): An overview of CMIP5 and the experiment design. Bulletin of the American Meteorological Society, 93, 485-498, doi:10.1175/bams-d-11-00094.1.

[6] Sanderson, B.M. and M.F. Wehner (2017): Weighting strategy for the Fourth National Climate Assessment In: Climate Science Special Report: A Sustained Assessment Activity of the U.S. Global Change Research Program [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 644-653.

[7] Keys, J.E.; Cleland, D.T.; McNab, W.H. 2007. Delineation, peer review, and refinement of subregions of the conterminous United States. Gen. Tech. Report WO-76A. Washington, DC: U.S. Department of Agriculture, Forest Service. 11 p.

[8] DeGaetano, A.T., W. Noon, and K.L. Eggleston (2014): Efficient Access to Climate Products in Support of Climate Services using the Applied Climate Information System (ACIS) Web Services, Bulletin of the American Meteorological Society, 96, 173–180

Accuracy and precision— One may assess model performance by comparing model reconstructions of the historical period with historical observations. For this evaluation, the envelope of model realizations used to reconstruct historical conditions aligned very well with the gridded historical observations themselves (Figure 1 and 2). The same models that produced accurate historical reconstructions were used to develop climate projections based on specific emissions pathways. By using results from multiple models (i.e., model agreement/uncertainty), this analysis incorporates a diversity of scientific approaches to modeling the climate system. This analysis is agnostic about how best to represent the physics of the coupled ocean and atmosphere, its sensitivity to greenhouse gases, and resultant climate changes that emerge at a regional level or at the scale of analysis used here. The methods used here are not concerned with examining precise conditions in a specific year in the future. Instead, we analyze a weighted average of model results to provide general guidance about trends and trajectories that are well-supported by modeling studies.

The accuracy of model results relates most closely to future emissions, which themselves will be determined by future human decisions. Human decisions about greenhouse gas emissions cannot be accurately modeled, so the Climate by Forest tools adopts two emissions pathways that are frequently used in climate science.

Each interpretation section in this report addresses these characteristics of accuracy and precision. There are other limitations of these data that are inherent to the systems, models, and assumptions used to develop them that are not readily assessed, but should be considered contextually as these are considered alongside other sources of information, including findings from peer-reviewed literature and local expertise.

Reliability—The results presented in this report are based on peer-reviewed science being widely applied within the National Climate Assessment. [9]

Relevance—Relevance is assessable through geographic and indicator considerations. The Climate by Forest tool summarizes results at the ecological subsection scale, which is not perfectly coincident with the boundaries of our area of interest (i.e., NPNFs), but given the coarseness of the climate data and other sources of uncertainty, the selected subsection (Southern Blue Ridge Mountains – M221Dc) provides a representative sample that can be reasonably applied to the area of interest as a whole and represents areas that, at least historically, have similar climates. While there are additional climate variables that are relevant to the mission and operations of the NPNFs, the selected attributes cover the major physical variables of temperature and precipitation and give sufficient insight into potential influences on resources and management activities.

[9] https://science2017.globalchange.gov/downloads/

Carbon

Regulatory Requirements

No applicable legal or regulatory requirements or established thresholds exist for management of forest carbon or GHG emissions. The 2012 Planning Rule and Final Directives requires an assessment of baseline carbon stocks and a consideration of this information in management of the national forests (Forest Service Handbook 1909.12.4).

Data

The affected environment section summarizes the Forest Carbon Assessment for the Nantahala and Pisgah NFs (Dugan and McKinley 2018). The carbon assessment draws largely from two recent U.S. Forest Service reports: the Baseline Report (USDA Forest Service 2015) and the Disturbance Report (USDA Forest Service, in review). Together they provide the best available quantitative assessment of forest carbon stocks, harvested wood products stocks, and the factors that influence carbon dynamics on the N-PNF. The primary sources to evaluate potential future conditions and the impacts of climate change on forest carbon dynamics were the Resource Planning Act (RPA) assessment (USDA Forest Service 2016) and a regional vulnerability assessment (McNulty et al. 2015). These reports incorporate advances in data and analytical methods and collectively represent the best and most relevant scientific information available for the Nantahala and Pisgah NFs. These resources were explicitly selected for their consistent reliance on Forest Inventory and Analysis (FIA) data, which contains statistically valid sampling of ground-truthed monitoring data. They also use validated (peer-reviewed) modeling tools that integrate current remotely sensed and high-resolution products (e.g., Healey et al. 2018) with FIA data (Dugan et al. 2017; Dugan and McKinley 2018).

Key indicators:

- Carbon pools (carbon stocks) and carbon uptake
- Natural and human-caused influences on carbon stocks and carbon uptake

Scale

The spatial scale of this analysis includes the forested lands of the Nantahala and Pisgah National Forests (NPNFs). The NPNFs was administratively combined with the Uwharrie and Croatan National Forests to form a single administrative unit, the National Forests in North Carolina (NFs in NC). Therefore, some of the model results presented here, including estimates of carbon stocks and impacts of disturbances and other factors, are available only for combined NFs in NC or at the regional scale. The Nantahala and Pisgah NFs accounts for about 80 percent (about one million acres) of the forested area in the NFs in NC. [10] Thus, the available information is a reasonable representation of the carbon trends and factors impacting carbon on the Nantahala and Pisgah NFs.

Relative to the contribution of all the world's forests to carbon flux, the influence of the NPNFs is extremely small, so a meaningful analysis at the global scale is not practical. However, national and regional factors related to forests' influence on carbon dynamics are included here to provide context for the nature of the local effects of Nantahala and Pisgah NFs.

[10] This estimate is derived from the most recent FIA survey data available in FIA EVALIDator (https://apps.fs.usda.gov/Evalidator/evalidator.jsp).

The temporal scale for analyzing carbon socks and emissions focuses on the expected lifespan of the plan (10-15 years). However, this report includes analysis and discussion beyond this expected lifespan to provide context for potential forest carbon dynamics and factors influencing these dynamics in the future. Considering factors beyond the plan period is important because this plan covers only part of the life cycle of the forest.

The Forest Service is committed to using the best available information to support management decisions. In general, this means relying upon sources that are data-driven, locally calibrated, and consistent over both time and space. However, estimates of future carbon stocks (i.e., stored carbon) and their trajectory over time remain unclear because of uncertainty from the multiple interacting factors that influence carbon dynamics. These factors include environmental changes and changes in climate that affect the health, productivity, and diversity of forests. Although advances in research have helped to account for and document the relationship between GHG and global climate change, it remains difficult to reliably simulate observed temperature changes and distinguish between natural or human causes at smaller than continental scales (IPCC 2007).

Fire

Fire Prioritization Analysis Methods

Ecological Need

Our intent was to develop a model to determine the highest ecological need for recurrent fire. The following steps were incorporated to develop the highest ecological need across the landscape.

- We utilized the six most fire adapted ecozones modeled across the southern Appalachians: Pine-Oak/Heath, Shortleaf Pine-Oak, Dry Oak, Dry-Mesic Oak, Dry-Mesic Oak, High Elevation Red Oak, and Mesic Oak.
- On a grid system of 30 by 30 foot pixels the modeled ecozone was weighted with a value based on its fire return interval with a greater value to those types with the shorter fire return interval. The values given are as follows:

Ecozone	Maintenance Return Interval	Weighting
Shortleaf Pine	3-7	6
Pine Oak Heath	3-7	6
Dry Oak	7-12	4
Dry-Mesic Oak	15-20	2
High Elevation Red Oak	20-25	1
Mesic Oak	23-27	1

- A neighborhood analysis was completed via spatial analyst across a 100 acre area to derive the sum of all the weighted values within any individual neighborhood. It was decided to use 100 acres as the neighborhood size to represent the smaller burn blocks. While average prescribed burns are 5-6 times larger than 100 acres, this process provides flexibility to aggregate larger blocks with adjacent similar burn priorities as well as identifies smaller areas with a great need to burn.

- For the 100-acre neighborhood analysis there are 4840 pixels. Thus the summed value for any single neighborhood could vary from 0 within an area with none of the above fire adapted ecozones to 29,040 for a 100-acre block with only pine-oak/heath or shortleaf pine-oak or a combination of the two.
- This analysis was completed across the Nantahala-Pisgah National Forest as well as all lands within the surrounding ecozone modeled area.
- A map of the neighborhood analysis was created with the raster classified and symbolized by the following categories:

Fire Need	100 Acre Block Value	Map Color
Moderately High	10,000 - 12,500	Yellow
High	12,500 - 17,500	Brown
Very High	17,500-29,040	Red

- The map, see attached pdfs, visually displays across the landscape where the greatest need for maintenance or restoration of fire adapted plant communities.

Community Protection

The objective is to identify the national forest lands in western North Carolina where risks of wildfire could threaten local communities. We considered several methods to estimate these lands and landed on the following approach.

- Use the Southwrap data layer for risk assessment; WUI_Risk. This layer uses a 30m x 30m pixel size and assign a risk rating to each pixel based on housing density and flame length. The values range from -9 to 0, where -9 is the highest risk and -1 is the lowest risk, and 0 is no risk.
- Region 8 Staff produced a High Risk Map by selecting Gridcodes -9 through -6 and then buffered the areas out 3 miles. This is considered the wildland urban interface and called NC_High_Risk_WUI_3mo_Buffer on the map product.
- An estimate of priorities for national forest lands to be in a condition that protects adjacent communities was made using a refinement of the Southwrap data. A neighborhood analysis using a moving circular window of a three mile radius and the focal statistic function that summed the Southwrap risks numbers and assigned a value to each pixel based on the combined risks within the window.
- The national forest ownerships were extracted from this layer. The summed values for the pixels classified into five classes using the natural breaks classification method. The five categories of risks are: very high, high, moderately high, moderate, and low. This classification used the “jenks natural breaks” to determine breakpoints.
- A visual check of how well the protection status was made using a layer from Ward & Shipley (R8 Fire) of polygons with high risk factors (-9 to -6). There were several high risk areas immediately adjacent to areas classified as “low”. To compensate for this, the breakpoint from moderate to low was adjusted in order to classify more lands as “moderate”. This classification of national forest lands now appears consistent with Southwrap and Region 8 assumptions.
- The raster layer was converted to polygons and acreages were determined for each category and mapped.

- The refinements for NF ownerships are estimated as follows:

(Note: Adjustments made to the moderate and low breakpoints are shown below. The assumption made for the adjustment: If the lands are with the WUI and High Risk polygons were adjacent to lands classified as "low," these lands should be reclassed as "moderate."

NF Lands Risk Rating	Acres	Map Color
Very High	4467	Red
High	58513	Orange
Moderately High	181333	Yellow
Moderate	726263 (385228 ac previous)	Blue
Low	72484 (413520 ac previous)	Gray

Aquatic Systems

See Appendix C

Terrestrial Ecosystems

See Appendix C

Species

See Appendix D

Old Growth

Data Sources

The analyses for the Designated Old Growth Network used spatial layers to derive the figures and tables in Chapter 3. An overview of these spatial data follows.

- Alt A: The large and medium patches in the existing OG network were examined and refined to clean the data best. Small patches on each ranger district were accumulated. The small patches were then combined into one layer with large and medium patches. This layer became the basis of comparison among the alternatives from the existing designated OG network.
- Alt B: This layer is the designated OG network (Alt A) excluding the 6 patches as described in Alternative B (Chapter 3). Patches were modified in order to provide the needs for other resource conditions, and that, the patches may have been designated without consideration of the entire OG network.
- Alt C: This layer has the designated OG Network (Alt A) combined with an inventory provided by Mountain True during the revision process (NGO Inventory). The NGO inventory was integrated with Alt A network by dissolving any overlap among the patches.

- Alt D: This layer has the designated OG network (Alt B) combined with a partial dataset of the NGO inventory. The partial NGO inventory was integrated with Alt B network by dissolving any overlap among the patches.
- Ecozones_Elim_1ac : This is the spatial layer of the ecozones modified to eliminate polygons that were less than 1 acres in size by using the eliminate command that would integrate the small acreages with adjacent polygons of larger sizes.
- Vegetation: This geodatabase has the Forest Service Vegetation layer updated to year 2017 with information relevant to the plan revision, with special emphasis on the analyses in Spectrum.

Methods to Derive Figures and Tables: Refer to Chapter 3 Designated OG Network

The modeled amount of older forest conditions under continued current management compared with the upper and lower range of desired conditions from the modeled Natural Range of Variation

> This figure uses the output summaries from Spectrum for Alternative A to plot estimated ages by 10 planning periods. The purpose of this figure is to show that the NP forests are in an early-to-mid-periodic recovery transition from the past logging activity but rapidly progressing toward older forest conditions.

Map of mature forest trending toward old across the Nantahala and Pisgah NFs

> This figure is a spatial depiction of moving toward older forest conditions, derived by using FSVegSp age classes and advancing in age in 20 years and 50 years without harvest management activity and regardless of any designated OG network in place.

Estimates of the old growth successional class by ecozone over time

> This figure is an extended version of figure 50 (above) and derived by intersecting the Ecozone layer with FSVeg layer and advancing the age classes 10 years and 50 years. The 10 year and 50 year plan periods are consistent with assumptions used in the Terrestrial Ecosystem analyses and shows that most systems exceed NRV in 50 years (without active management.)

NRV Estimates of Desired Old Growth Conditions on the Nantahala and Pisgah NFs

> The derivation of this table is documented in more detail in the project record for the estimation of the natural range of variation (NRV) (See Terrestrial Ecosystems). The purpose of this table is to show the relative amounts of each ecozone that would be in old growth conditions using assumptions for NRV estimates.

Designated Old Growth Network by Patch Size (Acreage and Number) by Alternative

> This table summarizes the amount and number of patches in the Designated OG Network to compare alternatives using the layers for Alt(s) A, B, C, and D (above). The summary statistics used to compare alternatives are found in the project record under Des_Old Growth_Alts_comparisons.xls.

Old Growth Trending Landscapes by Patch Size (Acreage and Number) by Alternative

> The amount and location of developing old growth conditions would likely be higher than just considering the Designated OG Network because resulting conditions within several management areas would likely trend toward old growth. The OGT landscapes were derived by using the dissolve command for those areas (below) in each alternative, and then summarizing the statistics by

amount and size of patches. The summary statistics can be found in the project record under OG_Landscape A_analysis.xlsx.

Sources: Shapefiles for Alternatives A, B, C and D; and then dissolved using the following areas for larger patch sizes.

- Designated Old Growth Small, Medium, and Large Patches
- Backcountry Management Area
- Special Interest Areas Management Area
- Research Natural Areas Management Area
- Wilderness Study Areas & Recommended Wilderness Management Area
- Roan Mountain Management Area except for Grassy Balds management portions
- Inventoried Roadless Areas (incorporated into Backcountry in Alternatives B, C, and D)

Ecozone Representation for Designated OG Network and OGT Landscapes

The Ecozone layer was intersected with the layers used to derive Tables 25 and 26 (above) to estimate the degree of ecozone representation by alternative in both the Designated OG Network and OGT landscapes. Summary statistics are found in the project record.

Elevation of Designation OG Network and OGT Landscape

An elevation layer was intersected with the layers used to derive tables above to estimate the degree of elevation representation by alternative in both the Designated OG Network and OGT landscapes.

Rare Species Occurrences within the Designated OG Network and OGT Landscapes

A Rare Species occurrences layer was intersected with the layers used to derive tables above to estimate the degree of distribution of rare species by alternative in both the Designated OG Network and OGT landscapes. Note: the data source is considered sensitive information and not available for public distribution.

Unique Habitat Occurrences in Designated OG Network and OGT Landscapes

A Unique Habitats layer was intersected with the layers used to derive Tables 25 and 26 (above) to estimate the degree of distribution of unique habitats by alternative in both the Designated OG Network and OGT landscapes. Note: the data source is considered sensitive information and not available for public distribution.

Number of Ecozones and Elevation Change by Patch Size (Sample of Patches)

To get an estimate of topographic diversity, which can indicate the degree of biological diversity across a landscape, a sample of patch sizes was taken across the ranger districts. Ecozones are reasonable indicators of topographic diversity because geophysical features are used to derive ecozones (Source: 3rd Approximation, Simon). This was not a random sample, but instead, a stratified targeted sample to include a range of patch sizes across a range of ranger districts. As shown in the table, large patch sizes offer a much higher degree of topographic diversity (and inferred biological diversity) compared with smaller patches.

Number of Patches in the Designated OG Network and the OGT Landscapes by Alternative. The table has a section for each patch type: Large +, Large, Medium, and Small

A Ranger District layer was intersected with the layers used to derive tables above to estimate the degree of ecozone redundancy by alternative in both the Designated OG Network and OGT landscapes. Summary statistics are found in the project record. Ranger districts were used as the landscape size for measuring redundancy because they are sufficiently large and they are also where project level decisions on future OG networks occur.

Standards for Considering Old Growth Characteristics at the Project Level

This table is a comparison of standards by alternative that apply to projects for future old growth and shown for the reader's convenience.

Plan and Project Patch Designation Summary from the Existing Plan

This table shows the effect of implementing the standard in the current plan on the Designated OG Network. It is an accounting of what has occurred over the 20+ years of implementing the current plan standard during project design. While all patch sizes have been incorporated, more small patches are designated than medium patches and few large patches during project planning.

Ecozone Representation for All Patches by Patch Size in Designated OG Network (Alt A)

This table was derived by intersecting the Ecozone layer with Alt A Designated OG Network. It is different from Table 27 because it shows the patch size distribution by ecozone type.

Amount of MA Group 1 and MA Groups 3 and 4 Along With Percent in Designated OG Network by Geographic Area for Alternative B

This table was derived by aggregating the management area groups by geographic area (Alt B only) because the standard in Alt B emphasizes the potential designation of future OG in MA Groups 3&4 by considering lands broadly across geographic areas. The summary shows opportunities for future potential old growth designation in both MA Group 1 as well as MA Group 3&4.

Ecozone Representation for all Patches by Patch Size in Designated OG Network (Alt D)

This table was derived by intersecting the Ecozone layer with Alt D Designated OG Network. This table was derived to investigate what the effect of deleting some patches (from the existing network), but yet, adding patches from the NGO inventory would have on ecozone representation. This is a starting point for future old growth designation, that would only be allowed where ecozones are underrepresented or not redundant.

All Lands Analysis by Patch Size by Alternative

This table provides an estimate for how much older forests could accrue on lands in ownerships other than the national forests. It is assumed that the following landowners tend to manage for natural forested conditions with natural disturbances as the prevailing disturbance regime. There were discussions with personnel from separate land trusts and the NC Natural Heritage Program to derive appropriate parcels. To derive this layer, the following lands were aggregated, and any overlapping lines were dissolved to form larger patches across the landscape. Larger patches would enhance topographic and biological diversity. Summary statistics are found in OG_LandscapeA_analyses.xlsx.

- Regional land trusts including (2018 Managed Areas layer from the NC Natural Heritage Program)
    - Mainspring Conservation
    - Highlands Cashiers land trust
    - Conserving Carolina
    - Southern Appalachian Highlands Conservancy
    - Foothills Conservancy
- North Carolina land trusts (See above)
    - The Conservation Trust of North Carolina (Beetree watershed)
- National land trusts (See above)
    - The Nature Conservancy
    - The Conservation Fund
- North Carolina State Parks Dedicated Nature Preserves
- North Carolina Wildlife Commission NC Natural Heritage Natures Preserves
- North Carolina Forest Service Dedicated Nature Preserves
- North Carolina Plant Conservation Program Preserves
- Adjacent National Forests (Sumter, Chattahoochee, and Cherokee) Wilderness
- Adjacent Cherokee NF Inventory Roadless Areas

All Lands Analysis by Patch Size Numbers by Alternative, Patch Sizes Connecting to the Appalachian Trail or in (Parentheses) to Different Wild and Scenic Corridors

> Connecting old growth patches can enhance the function of providing corridors for species movement and disbursement. The corridors of the Appalachian Trail and Wild and Scenic rivers are relatively narrow in comparison with large patches, but provide pathways for connecting patches. This table was derived by overlaying the Appalachian Trail and Wild and Scenic river management areas with the All Lands layer (above) and determining the number of patches intersecting by each of these corridors.

Cultural Resources

Site density is a factor of determining the number of sites within a set number of acres. The result is determined by dividing the number of recorded sites into the total number of acres inventoried and surveyed at the professionally and legally complete level. This ratio reflects the number of acres that were surveyed to locate each site. The average site density for the Nantahala and Pisgah National Forests is 1 site located per 27.6 acres surveyed based upon current total acres surveyed (87,137) and total sites recorded (3152) to date.

Predictive modelling is a process to determine or estimate the number of sites expected or likely to be encountered and recorded within a given project area. Basically, predictive modelling compares the most common landscape variables associated with similar type sites across a similar landscape to project and estimate the number of sites located on a given acreage. The variables most often used are landform (topography), land slope and distance to water along with stream rank or order. Generally, flatter areas with higher stream orders would be considered highest probable site locations. There are some exemptions of course, for uncommon or rare site types, as well as for the differences found between pre-contact and contact period sites and historic and transportation and industrial type sites, an example of the latter being mines. These site types are most often referenced and found through archival research and land use documents.

Previously, topographic maps and aerial photographs were the most reliable sources used to determine topographic conditions and features including the common site location variables. However, data availability has greatly improved and its accuracy tremendously increased with the advent and development of LiDAR, Light Detection and Ranging. Landscape imagery and mapping detail with very high resolution is available and has dramatically enhanced topographic landscape analyses.

LiDAR data has been used to determine Management Area acreage site location probability based upon the associated variables. Coupled with known site locations potential impacts upon projected sites can be determined in order to compare effects of alternatives.

Recreation

Recreation Opportunity Spectrum

The desired Recreation Opportunity Settings for each management area was calculated through the use of GIS analysis. The foundation of this work started with the Nantahala and Pisgah National Forests ROS Inventory, which was completed in 2014 and followed the National ROS Inventory Mapping Protocol. As the ROS Inventory was mapped based on the physical, social, and managerial settings prior to the completion of management area mapping under the new Nantahala-Pisgah Forest Plan Revision, this data needed to be updated to reflect the desired conditions for the new management areas.

The first step to create the ROS desired conditions map was to update the Inventory to reflect land that was acquired after the Inventory was completed. Following this, the updated ROS Inventory was intersected with the management areas mapped across each alternative and new acreage counts were calculated; this was performed using the Intersect tool in GIS, which calculates the geometric intersection of multiple feature classes. The output dataset calculated the number of acres of each ROS setting by management area, which was used to describe the ROS desired conditions across all management areas.

Transportation and Access

To evaluate the amount of new road construction needed annually, numbers were reviewed from the ten-year period between 2001 and 2011, during which 12.5 miles of new system roads were constructed. With continued implementation of Alternative A, 6.0 total additional miles of road will likely be needed annually, including 1.2 miles of new road prism construction, 1.9 miles of existing road prism added to the system, and 2.6 miles of temporary road construction that is decommissioned after use.

Road decommissioning would also be expected to continue at existing rates. From 2001 to 2011, 20.7 miles of road were obliterated. Given this, about 2.1 miles of decommissioning would be expected to continue annually under continuation of Alternative A.

Projected miles of total road construction for the action alternatives are based on SPECTRUM modeling which estimated lands currently available and required for future vegetation management activities, the current transportation network, and operability criteria.

To accomplish Tier 1 objectives, it is assumed that current trends for transportation system management activities continue, where 6.0 total additional miles of road will likely be needed annually, including 1.2 miles of new road prism construction, 1.9 miles of existing road prism added to the system, and 2.6 miles of temporary road construction that is decommissioned after use. These roads would be constructed predominately to meet the needs of vegetation management and administrative-only use, where approximately 41 percent of all new roads added to the system will be Maintenance Level 2 and closed to the public, thereby limiting motor vehicle use, maintenance requirements, costs, and impacts to other resource areas.

Then, to accomplish Tier 2 objectives, additional road construction would be required, as shown in the Table below, assuming consistent needs annually over the modeling time period.

Table 1. Estimated Miles of Additional Road Construction Needed to Accomplish Tier 2 Objectives

	Alt B	Alt C	Alt D
Total additional miles	5.4 miles	6.0 miles	5.3
Additional Total Miles of NFS Roads as New Corridor (annual)	1.1	1.2	1.0
New System Road on Existing Corridors (annual)	1.7	1.9	1.7
Additional Miles of Temporary Roads (annual)	2.6	2.9	2.6

Modelling projections show limited difference between action alternatives in terms of total projected road construction mileage. The primary difference between alternatives would be priorities for road construction location and road decommissioning sites based on management area direction. The Matrix and Interface MAs are the management areas most permissible in terms of new system road construction and it can be assumed that those are the management areas where most new system road construction would occur in support of management activities and providing recreational access to the Forests.

Historically, 20 percent of new system road construction occurs on new corridors, and 80 percent occurs as temporary roads or new system roads on existing corridors. Existing corridors are typically non-system, unauthorized road corridors that may have been used as temporary roads on past projects and remain on the landscape (unobliterated). Most new road mileage would consist of temporary roads not to be included in the Forest transportation atlas. All action alternatives include plan direction to remove temporary roads from service by decommissioning at the conclusion of the project. decommissioning activities would vary based on site specific needs, but could include removing drainage structures, access points, culverts, and signs, and restoring vegetation, contours, and natural drainage patterns.

Wilderness

See Appendix E for documentation of the Wilderness Evaluation Process.

Wild and Scenic Rivers

See Appendix F fore documentation of the Wild and Scenic River evaluation process.

Minerals and Energy

Analysis - Leasable Minerals

Estimated range of potential ground disturbance of leasable mineral activity during the 15 year of Revised Plan

The first step to estimate the potential ground disturbance for leasable mineral activity during the 15 years of the Revised Plan was to access the permitted mines website of the North Carolina Division of Energy, Mineral and Land Resources (DEMLR) and sort the data for the 18 counties with the Nantahala and Pisgah NFs lands (North Carolina Division of Energy, Mineral and Land Resources, 2018). The data for the 18 counties then was sorted for permitted mines for minerals on non-federal lands that would be hardrock leasable minerals on National Forest System lands. The 18 counties total 4,795,099 acres includes 1,042,797 of NFS lands and 3,752,302 of non-NFS lands. The permitted mines for hardrock type minerals are all on non-NFS lands and total 7,005 acres. The 7,005 acres of permitted mines is less than 1/5th of one percent (0.186%) of the 3,752,302 of non-NFS lands.

The second step is to make an estimate of ground disturbance during the 15 years of the Revised Plan for the NFS lands that would not be in an existing or potential mineral withdrawal under each alternative. For most of the Nantahala and Pisgah NFs, 1/5th of one percent of the area is used to estimate the upper end of potential ground disturbance for leasable mineral development (mines). This estimate is conservative considering that 1) mine permitting on non-NFS lands is less burdensome than on NFS lands, 2) NC DEMLR permitted acres (7,005 acres) is larger than NC DEMLR bonded acres (1,133 acres) because the permitted acres includes buffers. For the portion of the Forest with Backcountry, AT, SIAs and EIAs where road construction is severely restricted or not allowed, 1/20th of one percent of the area is used to estimate the upper end of potential ground disturbance for leasable minerals development (mines). The total acres of potential ground disturbance for leasable mineral development (mines) is increased by 5% to estimate mineral exploration that would be outside of, and in addition to, exploration within the area of mineral development (mines).

The lower end of potential ground disturbance for leasable minerals is 0 acres. Under the current Forest Plan so far there has been no ground disturbance for leasable minerals. Also, under all alternatives the private sector would initiate proposals for leasable mineral exploration or development. If, for whatever reason, the private sector would not initiate any proposals on the N&P NFs during the 15 years of the plan, then the lower end of potential ground disturbance would be 0 acres.

Gaps in Data

Assessing the potential impact of Forest Plan alternatives on leasable mineral resources has major gaps in data compared with assessing potential impacts on surface resources. Surface resources, like vegetation, are accessible at the earth's surface, and so, the Forest has an inventory of vegetation, including timber, across the one million acres of the Nantahala and Pisgah NFs. But leasable mineral resources in the earth's subsurface are not readily accessible, and so, the Forest does not have an inventory of leasable mineral resources beneath the one million acres of the Nantahala and Pisgah NFs.

In the 1970's and early 1980s the U.S. Geological Survey conducted mineral potential studies of Wilderness and Wilderness Study Areas (WSA) designated by Congress in the Eastern Wilderness Act of 1975. These decades-old studies would need to be updated in light of 1) changes in the types of minerals needed to meet 21st century demands for critical minerals, 2) advances in mineral prospecting and exploration technology, 3) advances on mineral deposit modeling, 4) advances in mineral extraction and processing. These mineral potential studies which are the most detailed mineral studies on the Forest are in Wilderness and Wilderness Study Areas in which leasable mineral exploration and development are not allowed. If up-to-date and detailed mineral potential studies were available for the hundreds of thousands of acres of Forest outside the Wilderness and WSA, it would be useful information to integrate into the Revised Plan process. The lack of up-to-date and detailed mineral potential studies comparable to the USGS studies of Wilderness and WSA is in contrast to the modern inventories of surface resources used in the Revised Plan process.

Even if up-to-date mineral potential studies for the entire Forest were available, mineral potential is not an inventory of mineral resources in the vast subsurface beneath the Forest. A timber inventory would sample for the physical presence of trees, and then, for sufficient timber volume to be considered as a commercial timber stand. Similarly, a mineral resource inventory would sample for the physical presence of ore grade mineralization, and then, for sufficient ore volume to be considered as a commercial mineral deposit. The available information that is closest to this type of mineral resource inventory is the Mineral Resources Data System (MRDS) which has mineral site records including present and past mines, prospects, and occurrences along with related geologic, commodity, and deposit information (U.S. Geological Survey, 2013a). The MRDS has about 200 records of mineral sites on the Nantahala & Pisgah NFs. However, the vast majority of these records are pre-1960 prospects or small mines which ceased production. The MRDS data is very useful because it does have records of the physical presence of mineralization as well as some mineral deposits that in the historic past were commercial mineral deposits. The MRDS provides valuable data that could be used as part of designing a mineral resource inventory project, that is, an exploration project.

But the MRDS is not a mineral resource inventory of commercial mineral deposits on the one million acres of the Nantahala and Pisgah NFs comparable the timber inventory of commercial timber stands.

The lack of a mineral resource inventory on the N&P NFS comparable to timber and other surface resource inventories puts mineral resources at great disadvantage in considering trade-offs between alternatives and in assess effects on mineral resources vs effects on surface resources. Commercial mineral deposits on the N&P NFs are scarce, hidden beneath the earth's surface, and hard to discover.

Mineral exploration and development would occupy relatively small portions of the N&P NFs (less than a fraction of 1% of the N&P NFs). If the locations of the undiscovered mineral deposits were known, then the Revised Plan alternatives could be designed to consider and accommodate mineral exploration and development on less than a fraction of 1% of the N&P NFs.

But the locations of scare, undiscovered mineral deposits are not known. Mineral deposits suitable for commercial development may occur at any depth in the subsurface. A comprehensive inventory of mineral resources for any one site would require drilling and core sampling to at least 10,000 feet depth below ground surface. Mineral deposits vary in lateral extent, and some valuable mineral deposits may have a lateral extent of a few hundred feet or less. So, in order to responsibly manage the federal mineral estate, large areas of the N&P NFs would need to be available to search for the few needles in a haystack. The first stages of the search covers large areas and involves little or no ground disturbance, such as desktop analyses of existing geologic data and new mineral deposits models; reconnaissance surveys and sampling; and geophysical surveys. The next stage of the search narrows down to selecting one or more sites for subsurface exploration such as drilling or trenching. It is at this stage that the mineral company would apply for a BLM prospecting or exploration permit. If the exploration is successful, then the mineral company would apply for a BLM mining permit. Even though hundreds of thousands of acres of the N&P NFs would be available to search and explore, the potential ground disturbance from mineral exploration and development of scarce mineral deposits would be less than a fraction of 1% of the N&P NFs.

The Forest Service Mineral Program Policy includes: Ensure the integration of mineral resource programs and activities with the planning and management of renewable resources through the land and resource management planning process, recognizing that mineral development may occur concurrently or sequentially with other resource uses. Ideally, the Plan Revision would provide the flexibility and allow the adaptation needed to accommodate discovery of valuable mineral deposits. The Forest Service provides such flexibility and adaptation for surface resources, for example, if a T&E species or a heritage resource is discovered in an area, then the management for the area would be adjusted to accommodate the T&E species or heritage resource. Whether the Revised Plan components are sufficient to provide the flexibility and allow the adaptation needed to responsibly manage the federal mineral estate is unclear and uncertain.

Best Available Scientific Information - Leasable Minerals

Source of mineral resource information used include the North Carolina Geological Survey, North Carolina Division of Energy, Mineral and Land Resources, and U.S. Department of Interior agencies such as U.S. Geological Survey and Bureau of Land Management.

Analysis - Renewable Energy

The analysis used spatial data in a GIS project. The analysis used information from the 2005 report by the National Renewable Energy Laboratory (NREL) and U.S. Forest Service that identifies and evaluates the potential for solar and wind energy resource development on NFS lands, including the NFS lands in North Carolina (National Renewable Energy Laboratory Report, 2005). The analysis used wind speed at 50 m and Wind Power Class 4 and above as high potential areas for wind energy as was used by the 2005 NREL report.

The analysis used the areal distribution of Management Areas in the current Plan and action alternatives based on Forest Service GIS spatial data.

Best Available Scientific Information - Renewable Energy

Sources of information used include the 2005 report by the National Renewable Energy Laboratory (NREL) and U.S. Forest Service that identifies and evaluates the potential for solar and wind energy resource development on NFS lands, including the NFS lands in North Carolina (National Renewable Energy Laboratory Report, 2005). Sources include more recent information from the National Renewable Energy Laboratory on 80 m wind speed in North Carolina. Other data sources include the U.S. Energy Information Administration.

Analysis - Energy Requirements and Depletable Resource Requirements

The method to determine energy requirements and depletable resource requirements was to use available FS data that provided a basis for estimates of energy requirements and depletable resource requirements.

Estimates of mineral materials requirements (crushed rock aggregate, rip rap, etc.) to construct and maintain roads, developed recreation sites, trailheads, and other facilities were based on information from Forest Engineering Staff.

Gaps in Data (Energy Requirements and Depletable Resource Requirements)

There is a lack of data on fossil fuel consumptions required for major parts of the Forest recreation program. Fossil fuels are consumed to construct, operate and maintain the Forest recreation infrastructure spread across 1.1 million acres of mountainous terrain. The Forest accomplishes this recreation workload using not only Forest labor, vehicles, and equipment but also a variety of other means using non-Forest labor, vehicles and equipment, such as:

1. The Forest issues service contracts to provide and maintain public access along hundreds of miles of roads and trails and associated bridges, and to construct, operate and maintain campgrounds, horse camps, boat launches, waterfalls access facilities, trailhead parking lots, restrooms, and other recreation infrastructure.
2. The Forest has Participating Agreements with a variety of organizations which supply labor, vehicles and equipment to construct, operate and maintain the recreation infrastructure.
3. The Forest issues Special Use Permits to outfitters guides, concessionaires, and others who supply labor, vehicles and equipment for recreation services.
4. The Forest has Volunteer Programs for individuals and organizations who supply labor, vehicles and/or equipment to construct and maintain recreation infrastructure and provide recreation services.

There also is a lack of data on fossil fuel consumptions required for other Forest activities such as, 1) prescribed fire operations, 2) wildfire suppression, 3) helicopters and fixed wing aircraft used in fire management, insects and disease surveillance and monitoring, and flood and wind storm damage assessments, 4) in-State and out-of-State transportation of fire fighters from FS and other agencies to fight wildfires on the Forest.

Best Available Scientific Information - Energy Requirements and Depletable Resource Requirements

Sources include available FS data that provided a basis for quantitative estimates of energy requirements and depletable resource requirements. Fossil fuel consumption for recreation on the Nantahala and Pisgah NFs is based on estimates using numbers of visits and mileage travelled in the FY 2008 and FY 2013 Forest’s Visitor Use Reports as part of National Visitor Use Monitoring (USDA-Forest Service).

Vehicle fuel economy data is based on:

Sivak, M. and Shoettle, B., 2017, On-road fuel economy of vehicles in the United States: 1923-2013, Report No. SWT-2017-5, March 2017, University of Michigan Sustainable Worldwide Transportation, pp10. http://umich.edu/~umtriswt/PDF/SWT-2017-5.pdf

Analysis - Reserved and Outstanding Mineral Rights

The data used to assess the subsurface ownership is a GIS subsurface layer and shapefile (NC_Nat_Psg_Surface-Subsurface_Rights) obtained from R8 RO on June 7, 2013.

For the Nantahala & Pisgah NFs the subsurface ownership shapefile has an attribute table listing 205 tracts with outstanding or reserved mineral right where there is less than 100% federal mineral ownership. For the 205 tracts, the attribute table column for recorded acres (deed acres) has a total 125,714 acres.

In ArcMap, a calculation was made to determine the GIS acres for each of the 205 tracts. A column of these GIS acres was added to the attribute table. The GIS acres of subsurface ownership have a total of 102,523 acres. The GIS acres total of 102,523 acres is 23, 191 acres less than the recorded acres total of 125,714 acres.

The potential effects (referred to a “dual potential effects on surface management and private mineral rights operations”) would be most adverse in management areas where roads are prohibited or severely restricted, such as in Recommended Wilderness areas or Inventoried Roadless Areas. An indicator of the potential for conflict is the degree of restrictions or prohibitions that the alternatives place on roads or federal leasable minerals. The alternatives vary in the extent to which they create dual potential effects on surface management and private mineral rights operations.

Gaps in Data (Reserved and Outstanding Mineral Rights)

One possible explanation for this difference is that the reserved or outstanding mineral rights on some tracts may apply only to part of tract. There are multiple tracts where the difference between recorded acres and GIS acres is greater than 1,000 acres. The existing information is insufficient to provide a reasonable estimate on the extent of current subsurface ownership Forest-wide. This lack of reliable information affects not only consideration of private mineral rights (subsurface ownership; reserved and outstanding mineral rights) but also consideration of federal mineral ownership on the tracts with unclear or unresolved mineral rights status. It likely would be time-consuming and costly, particularly if attorney’s opinion is sought, to remedy the insufficient information for the entire Forest. However, verifying the subsurface ownership status would be less time consuming for the limited number of tracts in Recommended Wilderness subject to ROR in Alternatives B and D.

Best Available Scientific Information - Reserved and Outstanding Mineral Rights

The analysis used the Forest Service GIS subsurface ownership data which is based on FS Lands Status records of tracts subject to reserved and outstanding mineral rights at the time of tract acquisition. Verification of the accuracy or currency of the FS Lands Status records is beyond the scope of the analysis. Verification of the accuracy or currency of the FS Lands Status records is conducted on a case-by-case basis when needed as part of Plan implementation.

Social and Economic Resources

Spatial and Temporal Context for Effects Analysis

The economic analysis area consists of 18 counties in western North Carolina that are adjacent to, or in the immediate vicinity of the Nantahala and Pisgah NFs. These 18 counties are Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Graham, Haywood, Henderson, Jackson, Macon, Madison, McDowell, Mitchell, Swain, Transylvania, Watauga, and Yancey. The largest counties, in terms of land area, are Buncombe, Burke, Haywood, Macon, and Swain County all with more than 500 square miles. Cherokee, Graham, Jackson, Macon, McDowell, and Transylvania Counties have the greatest number of National Forest System acres.

The revised Land Management Plan (LMP) temporal boundaries is 20 years so the effects are expected to last for at least 20 years or until a revised LMP is available or amendments are created.

Socioeconomic Indicators

Social and economic characteristics of the analysis area are described by the following indicators. Many of these indicators will then be used to explain the effects of the alternative management scenarios. For example, estimates of job and income contributions to the local economy by alternative are one way to understand socioeconomic impacts of different management alternatives on the local economies surrounding the Nantahala and Pisgah NFs.

- Demographics: Population, Age
- Economy: Income, Median Earnings, Non-labor Income, Employment, Unemployment
- Public Values
- Benefits to People: Ecosystem Services

Economic Methodology

Economic impact analysis estimates the role of NFS resources, uses, and management activities on employment and income in the communities that surround the Nantahala and Pisgah NFs.

Economic contribution to the 18-county analysis area was estimated with input-output analysis using the IMPLAN (IMpact analysis for PLANing) modeling system (MIG 2016). The modeling system allows the user to build regional economic models of one or more counties for a particular year and estimates the economic consequences of activities, projects, and policies on a region. IMPLAN uses Forest Service data on expenditures and resource uses to estimate the economic consequences of Forest Service management. Quantitative inputs (e.g., animal unit months, recreation visits, and Forest Service and Department of Interior payments to counties) were obtained from Forest Service program areas for this analysis. The model for this analysis used the 2016 IMPLAN data, which is the latest available dataset.

Input-output analysis represents linkages between sectors in an economy. IMPLAN not only examines the direct contributions from the analysis area but also indirect and induced effects. Indirect employment and labor income effects occur when a sector purchases supplies and services from other industries in order to produce their product. Induced effects are the employment and labor income generated as a result of spending new household income generated by direct and indirect employment. For example, visitors to FS managed land spend money on accommodation and food. Accommodation and food service businesses buy supplies from other businesses. The employees of these firms spend their earnings on a variety of goods and services. These transactions result in direct, indirect, and induced effects, respectively, in the regional economy.

Potential economic impacts are assessed using the model, and therefore results, are specific to the analysis area chosen. Results for individual forests and grasslands in an area cannot simply be summed together to get meaningful regional or state contribution results because of overlapping economic areas of influence. Similarly, results cannot be easily disaggregated into smaller analysis units as appropriate analysis areas must be evaluated. The 18-county analysis area used in this analysis follows that selected and presented in the assessment. (Assessment, 2014).

Economic Analysis Spreadsheet Tool (FEAST) (USFS 2018) developed by the U.S. Forest Service Inventory and Monitoring Institute in Fort Collins, Colorado. This tool uses a Microsoft Excel workbook as an interface between user inputs and data generated using the IMPLAN input-output modeling system (MIG 2016).

The FEAST analysis assesses the economic impacts of the resource outputs projected under each alternative. Resource outputs in this context are the amount of a resource (forest products, AUMs, recreation visits, etc.) that would be available for use under each alternative.

Regional economic impacts are estimated based on the assumption of full implementation of each alternative. The actual changes in the economy would depend on individuals taking advantage of the resource-related opportunities that would be supported by each alternative. If market conditions or trends in resource use were not conducive to developing some opportunities, the economic impact would be different from the estimates in this analysis.

Social Methodology

Forest management and planning issues are most often presented in terms of commodity uses (tangible goods), rather than by the peoples' interests and values (intangible goods) towards natural resources (Rolston and Coufal 1991). Therefore, in many cases, social indicators are described in terms of the effects that result from changes to natural resources. For example, changes in resource availability can potentially result in changes in the amount and quality of available resources, such as recreation hiking trails. However, according to Brown and Reed (2000) the less tangible interests and values of people are often the driving force behind forest planning and management debate.

Describing the Social Impacts of the forest plan includes understanding the values or interests held by individuals or groups that are affected by or interested in natural resource issues (stakeholders). Stakeholders base their desires in FS resources, resource uses, and management actions on the interests and values they hold. Oftentimes these values are put forth as an individual's or group's focus of interest, the basis for the agenda they bring forth, and/or determines what an individual or group finds valuable in contributing to their quality of life. Social impacts use potentially affected stakeholder groups to reflect the concerns of stakeholders and potential effects to them.

There is considerable complexity involved in understanding the interests and values of stakeholders; in part, due to the fact that individuals and groups can embrace multiple interests. At times these interests can be in conflict with each other and it is up to that individual or group to prioritize their interests in order to address the natural resource issue. Therefore, the social impacts of the analysis area are based on the interaction of the identified interests with estimated changes to resource availability and uses. Indicators, such as acres, have been identified to help guide the assessment of values. The analysis is primarily qualitative. However, quantitative measures, such as acres available for recreation are referenced, as appropriate.

The framework for the social analysis employs generalities. Area residents and Nantahala and Pisgah NFs visitors have diverse preferences and values that may not be fully captured in the description of social consequences. Nevertheless, the general categories are useful for assessing social impacts based on particular forest-related interests.

Additional Assumptions for the Economic Impact Analysis

Resource specialists projected annual resource outputs based on the best available information and professional judgment. The purpose of the social and economic analysis is to compare the relative impacts of the alternatives. Changes in use levels were estimated using professional judgment. However, actual changes in use are difficult to predict.

Recreation Economics

Total annual recreation visits obtained from the National Visitor Use Monitoring Program (NVUM)[11] suggest more than 4 million recreational visits annually to Nantahala and Pisgah NFs NF (Table 2). Recreation visits are distributed among visitor types according to the patterns observed on the entirety of the National Forest of North Carolina—the primary sampling unit for NVUM. The distribution of visitor type (i.e., local or non-local visitor) and use type (e.g., was the visit wildlife-related?) are used to estimate visitor spending (Table 3). Average visitor expenditures by type are reported for the entirety of the National Forests of North Carolina and were obtained from the NVUM program (White 2017). Wildlife and fish-related visits—this includes hunting, fishing and wildlife viewing as the primary activity during the visit—is reported separately since the Forest Service has a variety of policies and management efforts aimed at conserving wildlife habitat and wildlife populations. Although the analysis of this plan revision did not require it, this would allow reporting of outcomes related to these investments. In this analysis, separate reporting allows the relative contribution of this visit type to be illustrated.

Table 2. Annual Recreation Visits

Segment	Non-Local Visitors			Local Visitors			Total Annual Visits
	Day	Over-night on FS	Over-night off FS	Day	Over-night on FS	Over-night off FS	
Non-Wildlife Related	363,928	181,964	473,107	2,511,105	109,178		3,639,283
Wildlife Related[A]	19,886	7,954	39,772	310,219	15,909	3,977	397,717
Share of Total Visits	10%	5%	13%	70%	3%	>1%	4,037,000

[A] Wildlife and fish-related recreation includes viewing wildlife, fishing, and hunting as the primary activity during visit.
Source: USFS, 2018

[11] The National Visitor Use Monitoring survey provides estimates of national forest visitation, sampling visitors at four site types, including wilderness sites. Approximately one-third of visitors sampled completed a survey about their spending behavior related to their national forest visit. Information gathered through the National Visitor Use Monitoring survey is used to develop estimates about recreation on national forests such as the number of forest visits, participation in recreation activities, spending profiles for visit types (day/overnight, local/nonlocal), and the economic contribution of national forest recreation on local communities (Hjerpe, Holmes and White, 2017). The economic contribution of recreation visitors, along with other programs, to the Nantahala and Pisgah NFs is presented in the effects analysis.

Table 3. Spending Profiles by Trip Segment Type, Dollars Per Party Trip

Segment Spending Profiles	Non-Local Visitors			Local Visitors		
	Day	Overnight on FS	Overnight off FS	Day	Overnight on FS	Overnight off FS
Non-Wildlife Related	$76.19	$396.45	$801.20	$24.98	$180.52	$293.73
Wildlife Related	$76.73	$300.93	$566.17	$45.34	$220.28	$208.70

Source: White, 2017

The economic impact analysis examines the economic significance of outdoor recreation on the Nantahala and Pisgah NFs to the analysis area economy and includes the effects of spending by all visitors, both those who reside in the analysis area and those who do not. The analysis shows the size and nature of economic activity associated with these recreational experiences to show contribution to the local economy.

Minerals Economics

Currently a minerals materials contract for crushed stone exists on Nantahala and Pisgah NFs. The five year contract allows the purchaser to buy and extract up to 250,000 short tons/year of crushed stone at $.20/ton. This contract has been renewed several times. The quantities removed are not expected to differ between alternatives. However, in practice the actual quantity extracted varies from year to year.

Timber Economics

The timber analysis examined economic activity of stumpage flowing through logging companies, sawmills, firewood sales, and other wood products. Baseline information on the average annual volume (cubic feet) cut and estimates of harvests anticipated under the alternatives were provided by the Nantahala and Pisgah timber specialist based on vegetation modeling (see the terrestrial ecozone section of the EIS for more). Table 4 provides the estimated annual forest product volumes available, by alternative. Details of how these numbers were developed may be found in the Forest Plan timber calculations suitability appendix (Plan Appendix B).

The economic impact analysis used the average across action alternatives of the estimated annual forest product volumes. Estimated differences across alternatives given these modeling approaches is minimal and actual resource use will fluctuate based on local and global market conditions. Therefore, an average was used to represent the economic significance of the timber program, showing the size and nature of the economic activity associated with action alternatives. This allows comparison to the no action alternative, as well as other resource programs on the forest, and avoids implying there are meaningful differences across alternatives.

The direct effects were estimated using direct response coefficients developed from a national Timber Mill Survey conducted by the University of Montana's Bureau of Business and Economic Research (Sorenson et al, 2016[12]). These timber response coefficients are broken into multi-state regions and are considered more accurate than those available from IMPLAN. The indirect and induced effects were generated by the IMPLAN model.

[12] Sorenson, C., C. Keegan III, T. Morgan, C. McIver, M. Niccolucci. 2016. Employment and Wage Impacts of Timber Harvesting and Processing in the United States. Journal of Forestry, 114(4) 474-482.

Table 4. Estimated Annual Forest Product Volumes, by Alternative

Forest Product	Alternative A	Alternative B		Alternative C		Alternative D	
	Tier 1	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2
Harvest-Softwood Sawtimber (CCF)	3,657	7,948	12,530	7,310	12,403	7,914	12,515
Harvest-Softwood Pulp (CCF)	386	9,468	15,134	8,695	15,018	9,420	15,127
Harvest-Hardwood Sawtimber (CCF)	8,858	11,109	31,513	11,291	32,412	11,092	31,238
Harvest-Hardwood Pulp (CCF)	2,280	14,642	42,775	14,915	43,739	14,558	42,479
Posts (CCF)	54						
Fuelwood (CCF)	1,310	1,640	1,640	1,640	1,640	1,640	1,640

Source: Nantahala and Pisgah NF resource specialists.