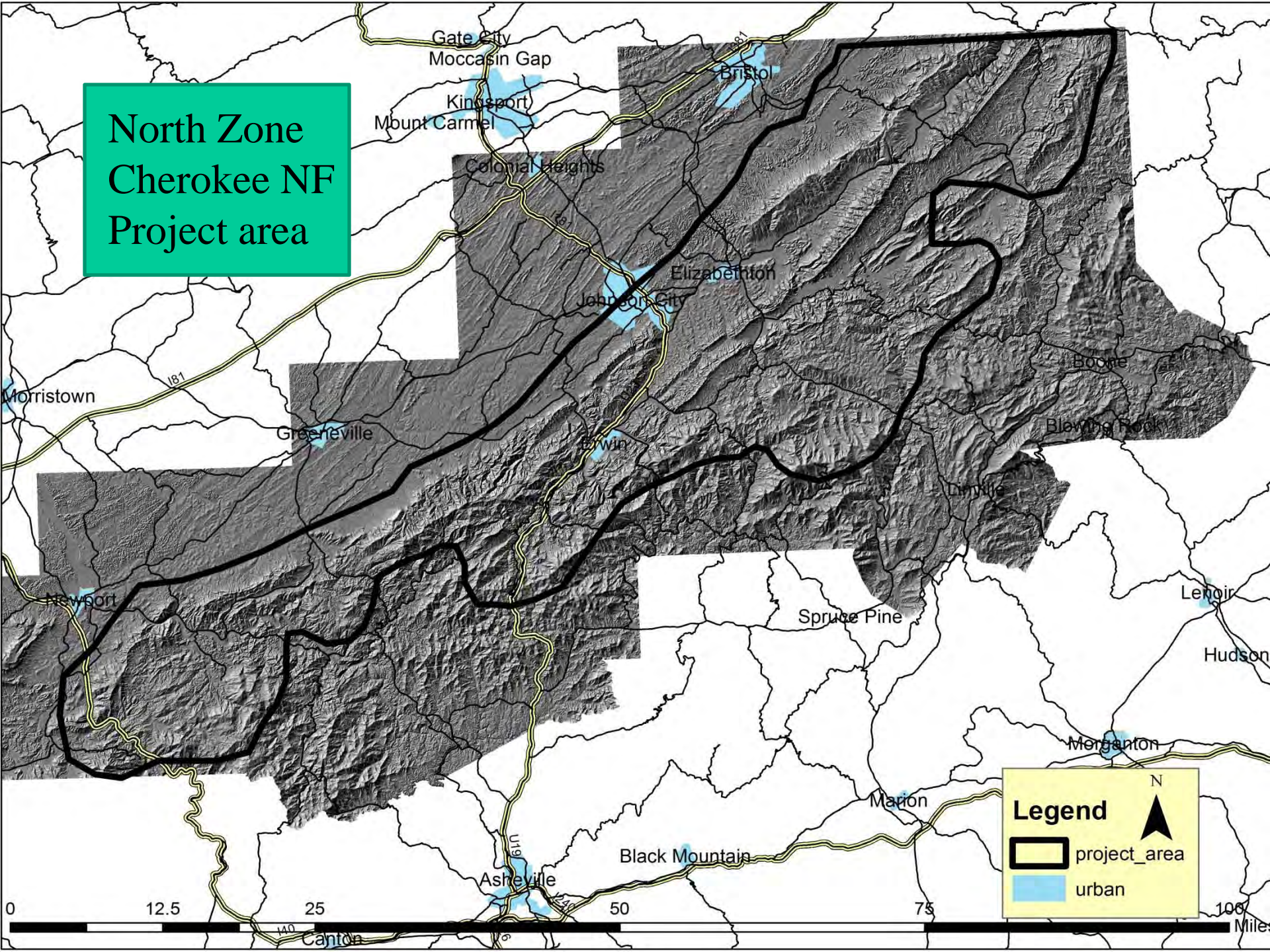
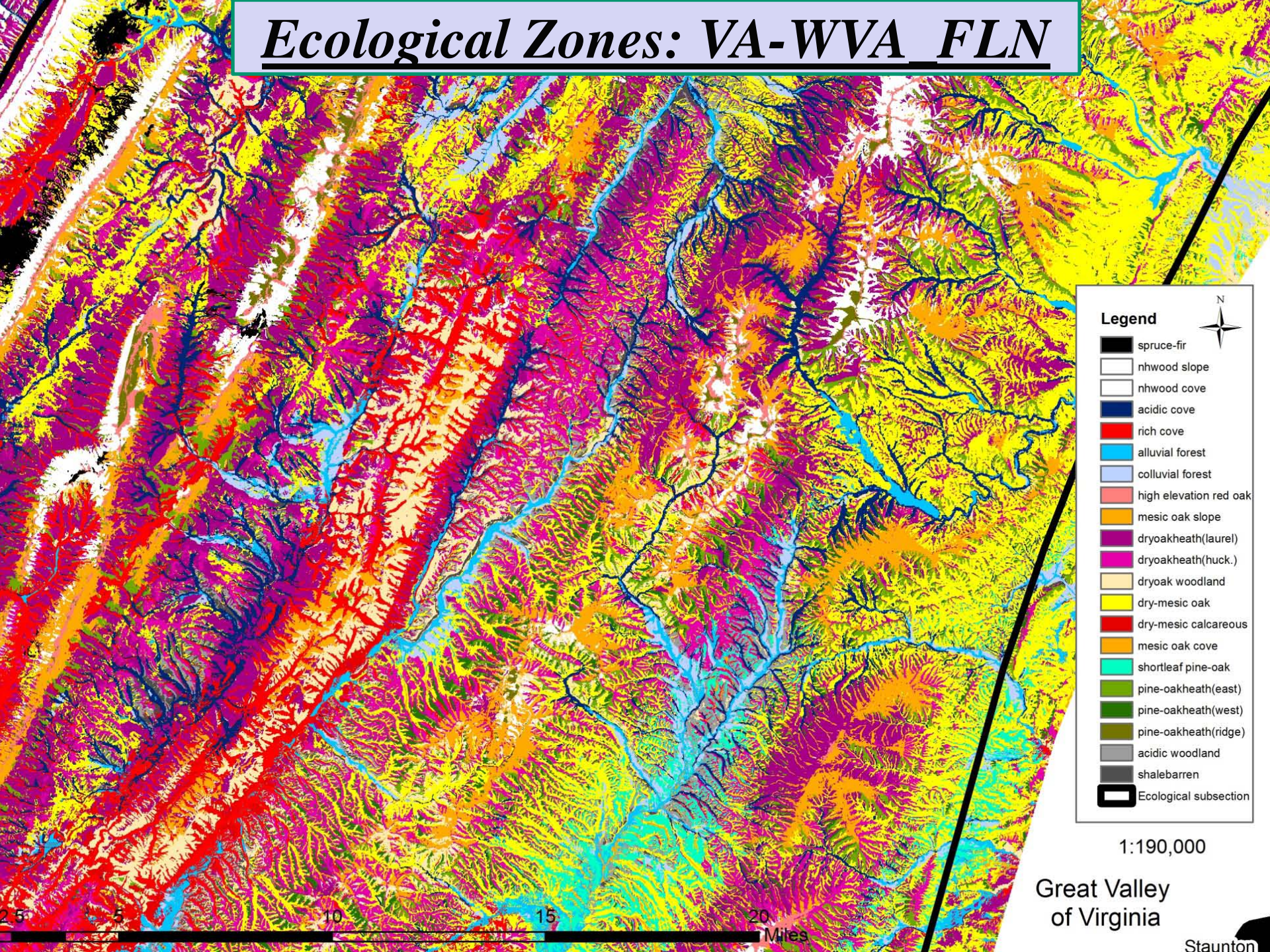


North Zone Cherokee NF Project area



Ecological Zones: VA-WVA FLN



Legend

- spruce-fir
- nhwood slope
- nhwood cove
- acidic cove
- rich cove
- alluvial forest
- colluvial forest
- high elevation red oak
- mesic oak slope
- dryoakheath(laurel)
- dryoakheath(huck.)
- dryoak woodland
- dry-mesic oak
- dry-mesic calcareous
- mesic oak cove
- shortleaf pine-oak
- pine-oakheath(east)
- pine-oakheath(west)
- pine-oakheath(ridge)
- acidic woodland
- shalebarren
- Ecological subsection



1:190,000

Great Valley
of Virginia

Staunton

A photograph of a forest landscape. In the foreground, there is a grassy clearing with scattered brown leaves and a prominent tree stump on the left. The middle ground is filled with a dense stand of tall, thin trees, some with light-colored bark and others with darker bark. The background shows a continuation of the forest under a bright sky.

What are Ecological Zones?

Ecological zones are *units of land delineating the environment that can support a specific plant community or plant community group under historical disturbance regimes; they may or may not represent current vegetation.*

They are equivalent to LANDFIRE Biophysical Settings (BpS) that represent: *vegetation that may have been dominant on the landscape prior to Euro-American settlement. BpS are based on both the current biophysical environment and an approximation of the historical disturbance regime.* LANDFIRE = Landscape Fire and Resource Mgmt. Planning Tools Project

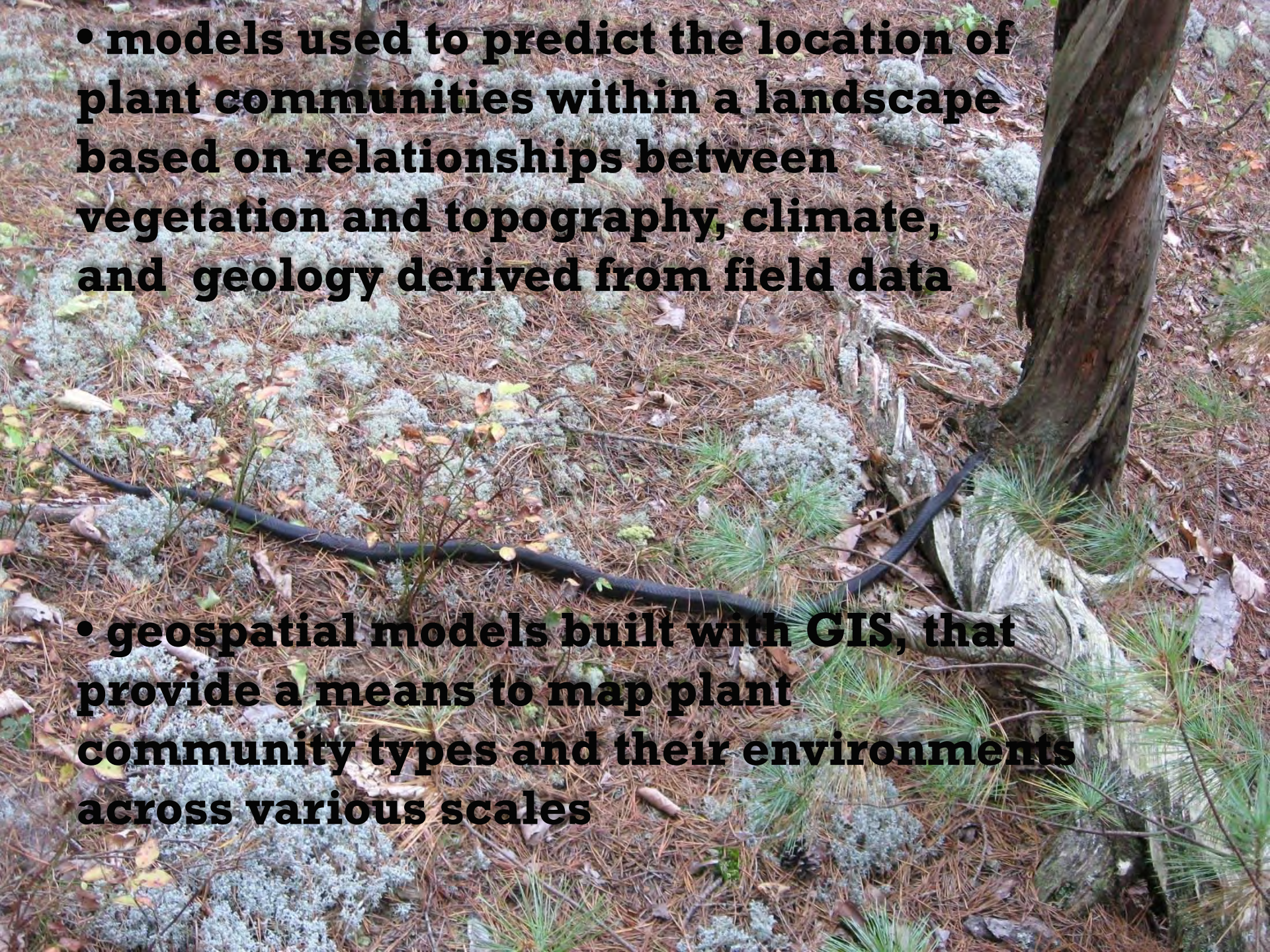
Ecological zones were mapped on 5.6 million acres in the Southern Appalachians in 2001 and revised in 2008. Map unit labels use abbreviated names of Ecological Systems (vegetation types) or more fine-scale Natural Heritage Program Natural Communities, (USDA, USFS, 2005, Southern Experiment Station).

Ecological Zones: Landscape perspective





Ecological Zones: stand perspective

A photograph of a forest floor. A black pipe or hose runs horizontally across the middle of the frame. The ground is covered with pine needles, small green plants, and patches of light-colored moss. A tree trunk is visible on the right side of the image.

- **models used to predict the location of plant communities within a landscape based on relationships between vegetation and topography, climate, and geology derived from field data**

- **geospatial models built with GIS, that provide a means to map plant community types and their environments across various scales**

United States
Department of
Agriculture

Forest Service



**Southern
Research Station**

Research Paper
SRS-41

Ecological Zones in the Southern Appalachians: First Approximation

Steve A. Simon, Thomas K. Collins,
Gary L. Kauffman, W. Henry McNab, and
Christopher J. Ulrey



Published Dec. 2005

Relationship to the National Hierarchy

Terrestrial Ecological Unit Inventory (TEUI) stratifies landscapes into repeating units based on environmental variables including climate, landform, geology, vegetation, and soils.

Terrestrial Ecological Units and Ecological Zones are fully compatible and both have the same roots, the “regionalization, classification and mapping system for stratifying the Earth into progressively smaller areas of increasingly uniform ecological potential for use in ecosystem management” (ECOMAP, 1993), although Ecological Zones are just one component in this broader scheme.

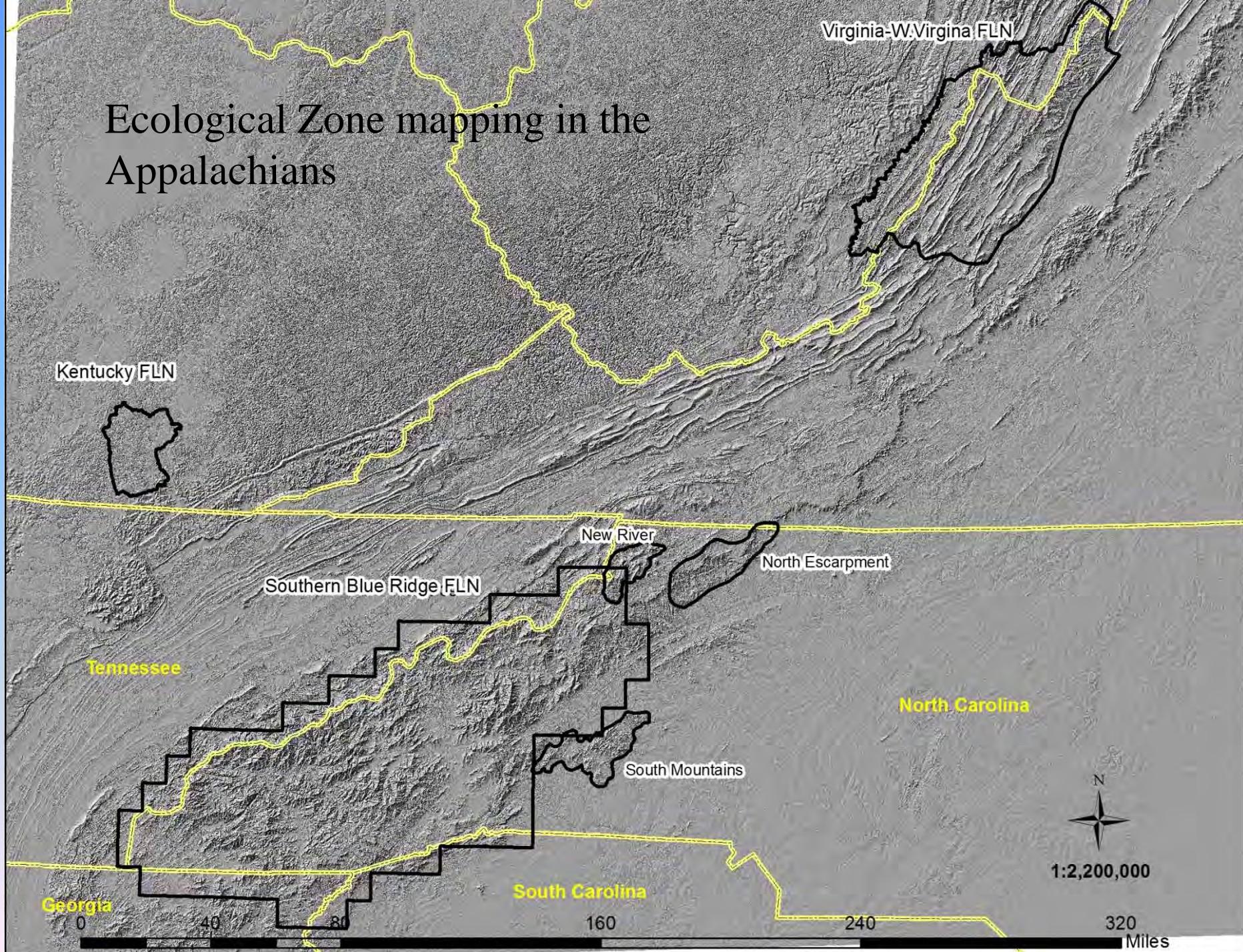
Ecological Zones are most appropriately used to characterize the potential vegetation component at the TEUI land-unit level, LT and LTP, the largest scale and most detailed levels of the National Hierarchy.

The Chattooga River Ecosystem Management Demonstration Project (1993) in South Carolina, Georgia, and North Carolina, was the first attempt at applying environmental models, like those used for developing Ecological Zones, to predict 'potential' plant community distribution across **extensive** landscapes in the Southeastern U.S. What are now termed Ecological Zones were then called "plant association predictive models" or "Potential Vegetation". In the Chattooga project, plant association predictive models were developed, under the guidance of Henry McNab (1991) – Southern Forest Service Experiment Station. These models were used in combination with soil maps to develop ecological units at different resolutions, i.e., Landtype Associations, Landtypes, and Landtype Phases.

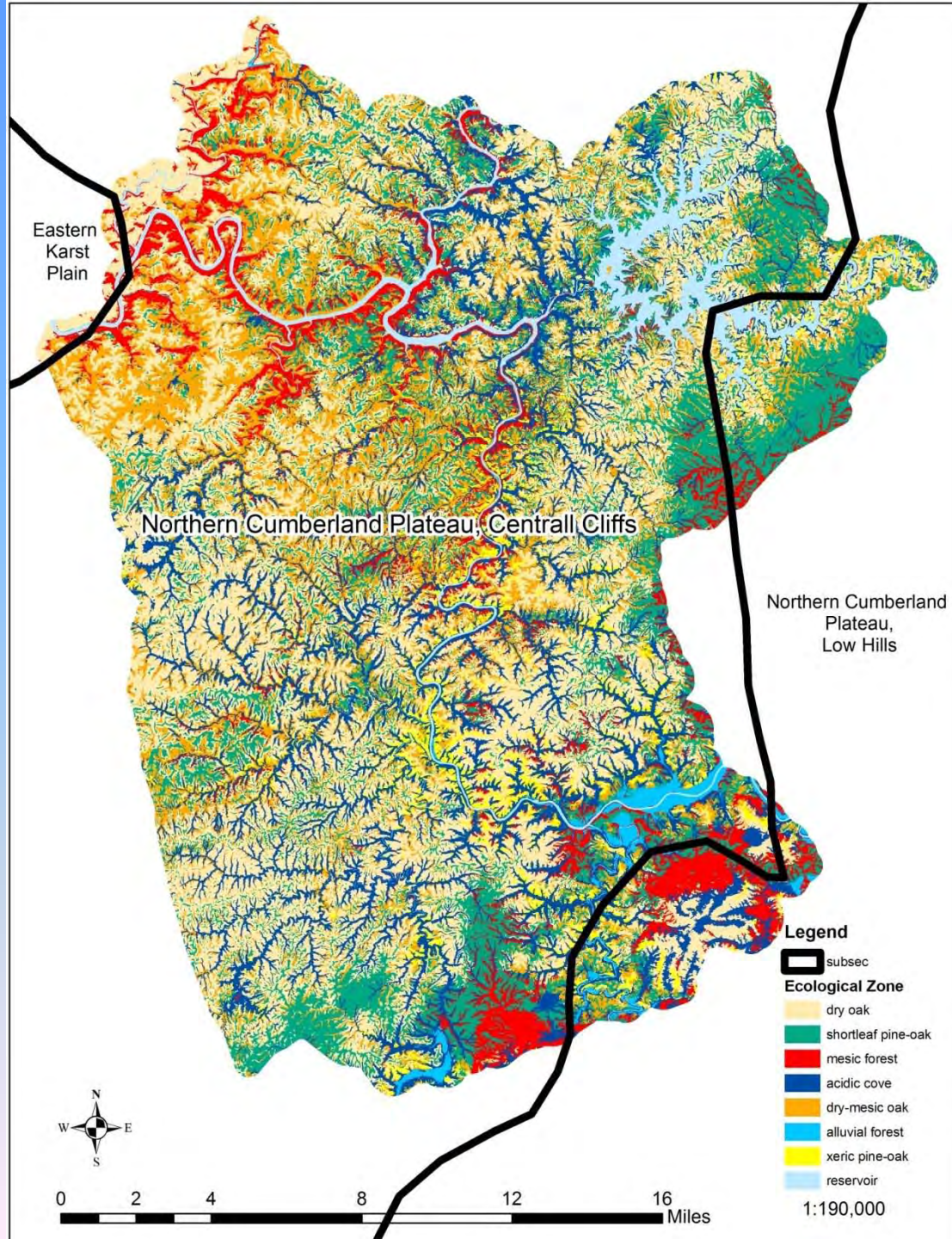
- 1999, as part of the forest planning process on the Croatan National Forest pre-settlement vegetation maps, the equivalent of Ecological Zones (Frost 1996), used to define management areas, management prescription boundaries, standards, and to set forest-wide objectives.
- 2001, the Forest Service in cooperation with the Department of Defense (DOD), Camp Lejeune Marine Corps. Base, developed an Ecological Classification System to guide conservation management decisions for their Integrated Natural Resource Management Plan (INRMP), which they continue to refer to the ECS for overall guidance on the desired future condition for specialized habitat areas (DOD 2006).
- 2001, NFsNC conducted a status review of management indicator species (MIS) habitats and population trends using Ecological Mapping to quantify the amount and distribution of plant community types that could support MIS based upon species habitat relationships (USDA 2004).
- 2004, Ecological Zones were used to identify site capability to support Eastern and Carolina Hemlock plant communities as part of a conservation area design to identify and prioritize areas for Hemlock Woolly Adelgid control (USDA 2005).
- 2005, Ecological Zones were used in the Uwharrie National Forest plan revision process to develop a map of the potential extent of Nature Serve Ecological Systems. This mapping provided the basis for the Ecological Sustainability Analysis upon which the plan was developed.
- 2005, Ecological Zones were used in a Plan amendment to evaluate the appropriateness of various MIS on the Nantahala and Pisgah National Forests (USDA, 2005).
- 2005, Ecological Zones were combined with satellite imagery to map existing vegetation on the Nantahala National Forest in a multi-year, USFS Southern Region pilot project to demonstrate a process for mid-level existing vegetation mapping suitable in the hardwood dominated forests of the Southern Region (USDA 2006).

Since the 2001 study, ecological zones have been mapped in Kentucky, and in the South Mountains, Northern Escarpment, and New River FLN landscapes in North Carolina, and in the Virginia and West Virginia FLN project area. The most recent projects to model and map ecological zones are on the remainder of GW National Forest in VA, and in the north zone of the Cherokee NF.

Ecological Zone mapping in the Appalachians



Ecological
Zones in
the
KY_FLN



Northern
High Allegheny
Mountains

Appalachian Ridges

Legend

- spruce-fir
- nhwood slope
- nhwood cove
- acidic cove
- rich cove
- alluvial forest
- colluvial forest
- high elevation red oak
- mesic oak slope
- dryoakheath(laurel)
- dryoakheath(huck.)
- dryoak woodland
- dry-mesic oak
- dry-mesic calcareous
- mesic oak cove
- shortleaf pine-oak
- pine-oakheath(east)
- pine-oakheath(west)
- pine-oakheath(ridge)
- acidic woodland
- shalebarren
- Ecological subsection



1:190,000

Great Valley
of Virginia

0 2.5 10 15 20 Miles

Staunton

Boone, NC

Southern Blue Ridge Mountains

Legend

- Spruce-fir
- High elev. red oak
- Nhwood cove
- Nhwood slope
- Acidic cove
- Rich cove
- Mesic oak-hickory
- Chestnut oak heath
- Pine-oak heath
- Dry-mesic oak-hickory
- Mixed oak heath
- Shortleaf pine-oak
- Shortleaf pine-oak heath
- Alluvial Forest
- Grassy bald
- Heath bald

1:190,000

Southern Appalachian Piedmont



Process used to develop Ecological Zones:

- **Data acquisition: identifying plant community types / ecological zones in the field (this used to take years +, now much less time),**
- **Creating digital terrain GIS database and extracting environmental data,**
- **Statistical analysis and spatial modeling,**
- **Post-processing of digital models, and**
- **Accuracy evaluation / assessment.**

Data acquisition

The Southern Appalachian Vegetation Dataset

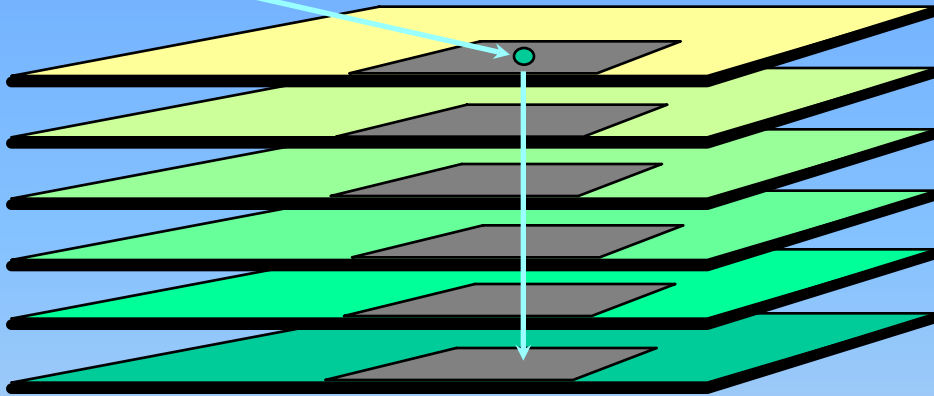
(Ulrey, Peet, and others 1999)

- *2,332 plots, mostly permanent, .05 - .1 ha. in size*
- *plant species presence, abundance*

- Thompson River (1976-78. T. Wentworth)
- High Elevation Red Oak (1978. J. Delapp & T. Wentworth)
- Great Smoky Mts. (1980. P. White)
- Black and Craggy Mts (1984. D. Mcleod)
- Ellicot Rock (1990-91. K. Patterson)
- Craggy Mountains (1991. C. Ulrey)
- Steels Creek (1992. C. Ulrey)
- Grandfather-Roan (1995. B. Peet)
- Chattooga Basin (1995. S. Simon)
- Linville Gorge (1995. C. Newell)
- Nantahala Mountains (1995-96. B. Peet)
- Montane Cedar Hardwoods (1996 C. Small)
- Kelsey Tract (1996. S. Roberts)
- Shining Rock (1996. Claire Newell)
- Winesprings (1996, McNab & Simon)
- Joyce Kilmer-Slickrock (1997. Claire Newell)
- Great Smoky Mts. TNC (1997-98. K. Patterson & C. Ulrey)
- Highlands Area - PULSE (1997. B. Peet)
- Chimney Rock & Hot Springs PULSE (1998. B. Peet)

Ecological Zone modeling

Known Location (point)



Spatial Data Layers

Elevation

Precipitation

Aspect

Relative slope position

Slope

Geology (and 20 others)

$f(x) \rightarrow$ *statistical function**

*= Predicted distribution
map*

* e.g. Maximum Entropy, Logistic regression, Discriminant analysis

From "Assessment and Mapping of Vegetation Communities in the Shenandoah National Park, John Young, USGS

Importance of environmental variables in predicting ecological zone occurrence (21 different zones) in the VA_WVA FLN.

| Environmental variable | % of models using this variable |
|--|---------------------------------|
| Limestone lithology | 52 |
| Elevation above streams | 43 |
| Valley position | 43 |
| Elevation | 38 |
| Distance to high average annual snowfall areas | 38 |
| Non-acidic shale lithology | 33 |
| Acidic shale lithology | 33 |
| Distance to Rivers | 33 |
| Sandstone lithology | 29 |
| Relative slope position | 29 |
| Elevation above rivers | 29 |
| Slope steepness | 24 |
| Distance to Streams | 24 |
| Aspect (cosine) | 19 |
| Aspect (raw) | 19 |
| Average annual precipitation | 19 |
| Landform index | 19 |
| Surface curvature perpendicular to slope | 14 |
| Surface profile curvature roughness | 10 |
| Local relief | 10 |
| Surface curvature overall | 5 |
| River influence | 5 |
| Yearly solar radiation | 5 |
| Growing season solar radiation | 0 |
| Terrain relative moisture index | 0 |
| Surface curvature parallel to slope | 0 |

Identified 12 Nature Serve Ecological Systems, 21 Ecological Zones in the VA_WVA FLN

Central and Southern App. Spruce-Fir Forest

Appalachian (Hemlock)-Northern Hardwood {2 ecozones}

Central and Southern Appalachian Montane Oak

Southern and Central Appalachian Cove Forest {2 ecozones}

Southern Appalachian Oak Forest {2 ecozones}

Northeastern Interior Dry-Mesic Oak Forest {2 ecozones}

Allegheny-Cumberland Dry Oak Forest and Woodlands {3 ecozones}

Central Appalachian Dry Oak-Pine Forest (in part)

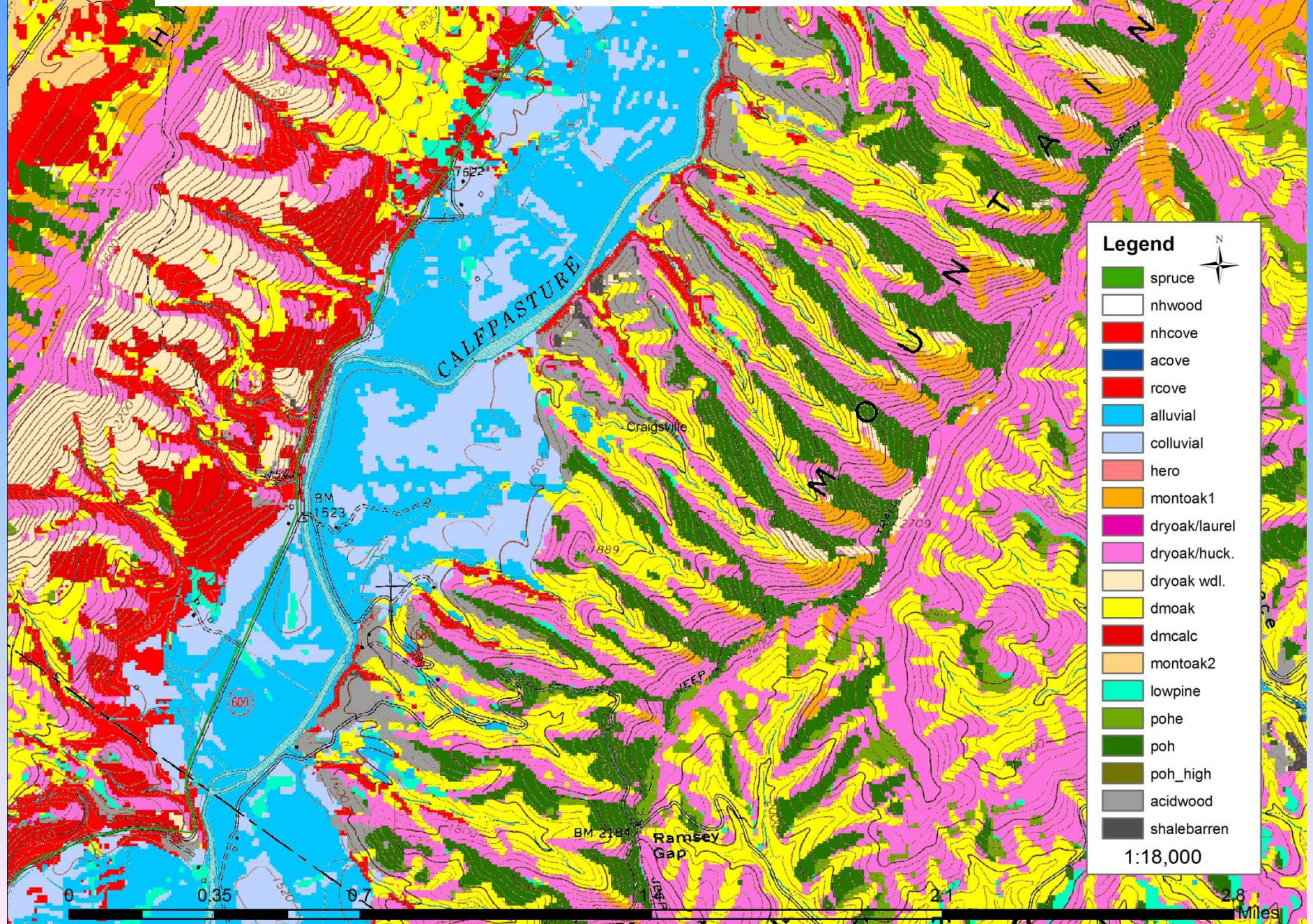
Southern Ridge & Valley / Cumberland Dry Calcareous Forest

Southern Appalachian Montane Pine Forest and Woodland {3 ecozones}

Southern Appalachian Low-Elevation Pine

Appalachian Shale Barrens {2 ecozones}

Ecological zones on North Mt. above the Calfpasture River



Legend

- spruce
- nhwood
- nhcove
- acove
- rcove
- alluvial
- colluvial
- hero
- montoak1
- dryoak/laurel
- dryoak/huck.
- dryoak wdl.
- dmoak
- dmcalc
- montoak2
- lowpine
- pohe
- poh
- poh_high
- acidwood
- shalebarren

1:18,000



2.8 Miles



Pine-Oak Heath (westslope)



Dry Oak / huckleberry



Dry-mesic Oak Forest



Montane (mesic) Oak Forest



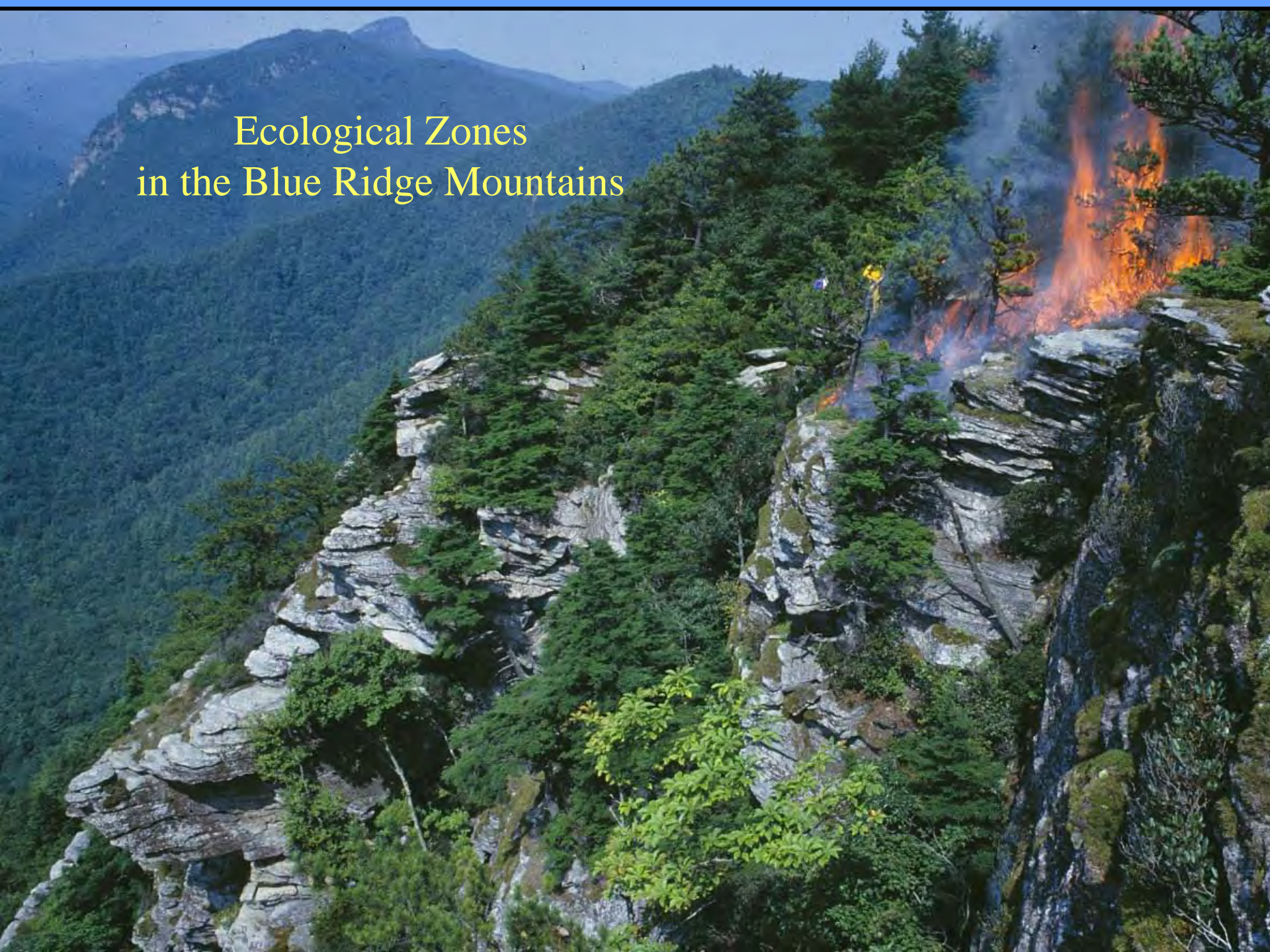
High elevation Red Oak

| Comparison of ecological zone accuracy across the Southern Blue Ridge (SBR), Kentucky FLN, and the VA_WVA FLN | | | | | | |
|---|-----------------------------|--------------|------------|--------------------|-------------------|---------------|
| Ecological zone | Northern Escarpment SBR_FLN | Kentucky FLN | VA_WVA FLN | South Mts. SBR_FLN | New River SBR_FLN | Other SBR_FLN |
| Size of area (acres-rounded) | 233,000 | 278,000 | 1,900,000 | 217,000 | 95,000 | 5,600,000 |
| | Percent correct | | | | | |
| Grassy Bald | - | - | - | - | - | 30 |
| Heath Bald | - | - | - | - | - | 19 |
| Spruce-Fir | - | - | 96 | - | - | 53 |
| N. Hardwood Slope | - | - | 87 | - | - | 70 |
| N. Hardwood Cove | - | - | 100 | - | 63 | 23 |
| Acidic Cove | 93 | 87 | 82 | 63 | 96 | 66 |
| Rich Cove | 100 | 92 | 77 | - | 75 | 51 |
| Alluvial Forest | 91 | 81 | 82 | 100 | - | 56 |
| Colluvial Forest | - | - | 85 | - | - | - |
| High Elev. Red Oak | 73 | - | 74 | - | 71 | 75 |
| Mesic Oak-Hickory | 83 | - | 85 | 67 | 80 | 43 |
| Mixed Oak Heath | 83 | - | - | - | - | 36 |
| Chestnut Oak Heath | - | 83 | 82 | 59 | 0 | 27 |
| Dry-Oak / Huckberry-Vacc. | - | - | 71 | - | - | - |
| Dry-Oak Woodland | - | - | 72 | - | - | - |
| Dry-Mesic Oak | 73 | 77 | 89 | 62 | - | 27 |
| Dry-Mesic Calcareous Forest | - | - | 80 | - | - | - |
| Montane Oak Cove | - | - | 94 | - | - | - |
| Shortleaf Pine-Oak | - | 80 | 87 | 100 | - | 66 |
| Pine-Oak Heath (eastside) | - | - | 64 | - | - | - |
| Pine-Oak Heath (westside) | 93 | - | 89 | - | - | 58 |
| Pine-Oak Heath (ridges) | - | 79 | 82 | - | - | - |
| Shortleaf P-O Heath | - | - | - | - | - | 58 |
| Acidic Woodland | - | - | 87 | - | - | - |
| Shale Barren | - | - | 80 | - | - | - |
| OVERALL | 86 | 82 | 82 | 64 | 61 | 52 |
| Most fire-adapted group | 98 | 95 | 98 | 89 | 86 | 83 |

Extent of Ecological Zones in the VA_WVA FLN

| Code | Ecological Zone | Total Study Area | | USFS and other Conservation Land | | Private Land | |
|------|---------------------------|------------------|-------|----------------------------------|------|--------------|------|
| | | acres | % | acres | % | acres | % |
| 1 | Spruce | 17,387 | 0.9 | 6,931 | 0.6 | 10,456 | 1.2 |
| 2 | Northern Hardwood | 64,324 | 3.2 | 49,885 | 4.5 | 14,439 | 1.6 |
| 3 | Northern HW Cove | 68,154 | 3.4 | 34,010 | 3.1 | 34,114 | 3.8 |
| 4 | Acidic Cove | 136,087 | 6.8 | 72,138 | 6.6 | 62,949 | 7.2 |
| 5 | Rich Cove | 120,079 | 6.0 | 46,253 | 4.2 | 73,826 | 8.3 |
| 6 | Alluvial Forest | 44,653 | 2.2 | 10,001 | 0.9 | 34,652 | 3.9 |
| 7 | Colluvial Forest | 74,022 | 3.7 | 6,662 | 0.6 | 67,360 | 7.6 |
| 8 | High Elevation Red Oak | 11,675 | 0.6 | 8,776 | 0.8 | 2,899 | 0.3 |
| 9 | Montane Oak Slopes | 119,346 | 6.0 | 92,660 | 8.4 | 26,686 | 3.0 |
| 10 | DryOak-Mt.laurel | 339,559 | 17.1 | 210,727 | 20.8 | 128,832 | 14.4 |
| 11 | DryOak-Huckleberry-Vacc. | 170,970 | 8.6 | 128,848 | 11.7 | 42,122 | 4.7 |
| 12 | DryOak-Woodland | 67,607 | 3.4 | 40,366 | 3.7 | 27,241 | 3.1 |
| 13 | Dry-mesic Oak | 431,333 | 21.7 | 230,932 | 21.0 | 200,401 | 22.5 |
| 14 | Dry-mesic Calcareous | 50,257 | 2.5 | 14,240 | 1.3 | 36,017 | 4.0 |
| 15 | Montane Oak Coves | 33,538 | 1.5 | 15,994 | 1.5 | 17,544 | 2.0 |
| 16 | Low Elevation Pine | 39,692 | 2.0 | 12,458 | 1.1 | 27,234 | 3.1 |
| 17 | Pine-Oak Heath Eastside | 59,824 | 3.0 | 42,101 | 3.8 | 17,723 | 2.0 |
| 18 | Pine-Oak Heath Westside | 44,184 | 2.2 | 32,066 | 2.9 | 12,118 | 1.4 |
| 19 | Pine-Oak High Elev. Ridge | 8,352 | 0.4 | 5,476 | 0.5 | 2,876 | 0.3 |
| 20 | Acidic Woodland | 60,245 | 3.0 | 23,818 | 2.2 | 36,427 | 4.1 |
| 21 | Shale Barren | 31,214 | 1.2 | 12,835 | 1.2 | 18,379 | 2.1 |
| | TOTAL | 1,992,502 | 100.0 | 1,097,177 | 55.1 | 895,325 | 44.9 |
| 1-6 | Least fire-adapted | 450,684 | 22.6 | 219,218 | 20.0 | 231,466 | 25.9 |
| 7-21 | Most fire-adapted | 1,541,818 | 77.4 | 877,959 | 80.0 | 663,859 | 74.1 |

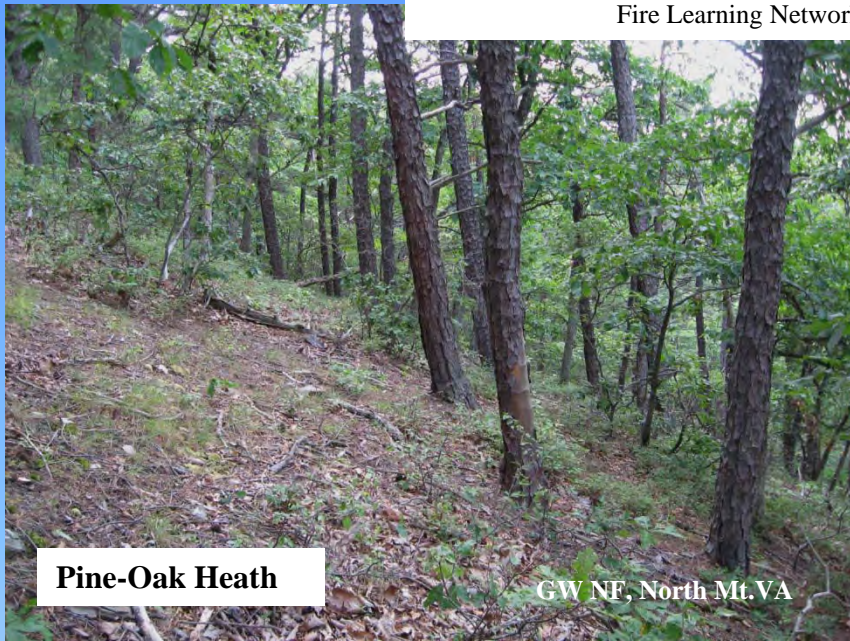
Ecological Zones
in the Blue Ridge Mountains



A photograph of a forest with many thin, vertical tree trunks and a dense, green undergrowth of shrubs. The text is overlaid in the center.

What Plant Communities Are Fire Adapted?

Fire-adapted plant communities identified by the Southern Blue Ridge
Fire Learning Network (FLN) Partners in 2008



Pine-Oak Heath

GW NF, North Mt. VA



Shortleaf Pine-Oak

Chattahoochee NF, GA.



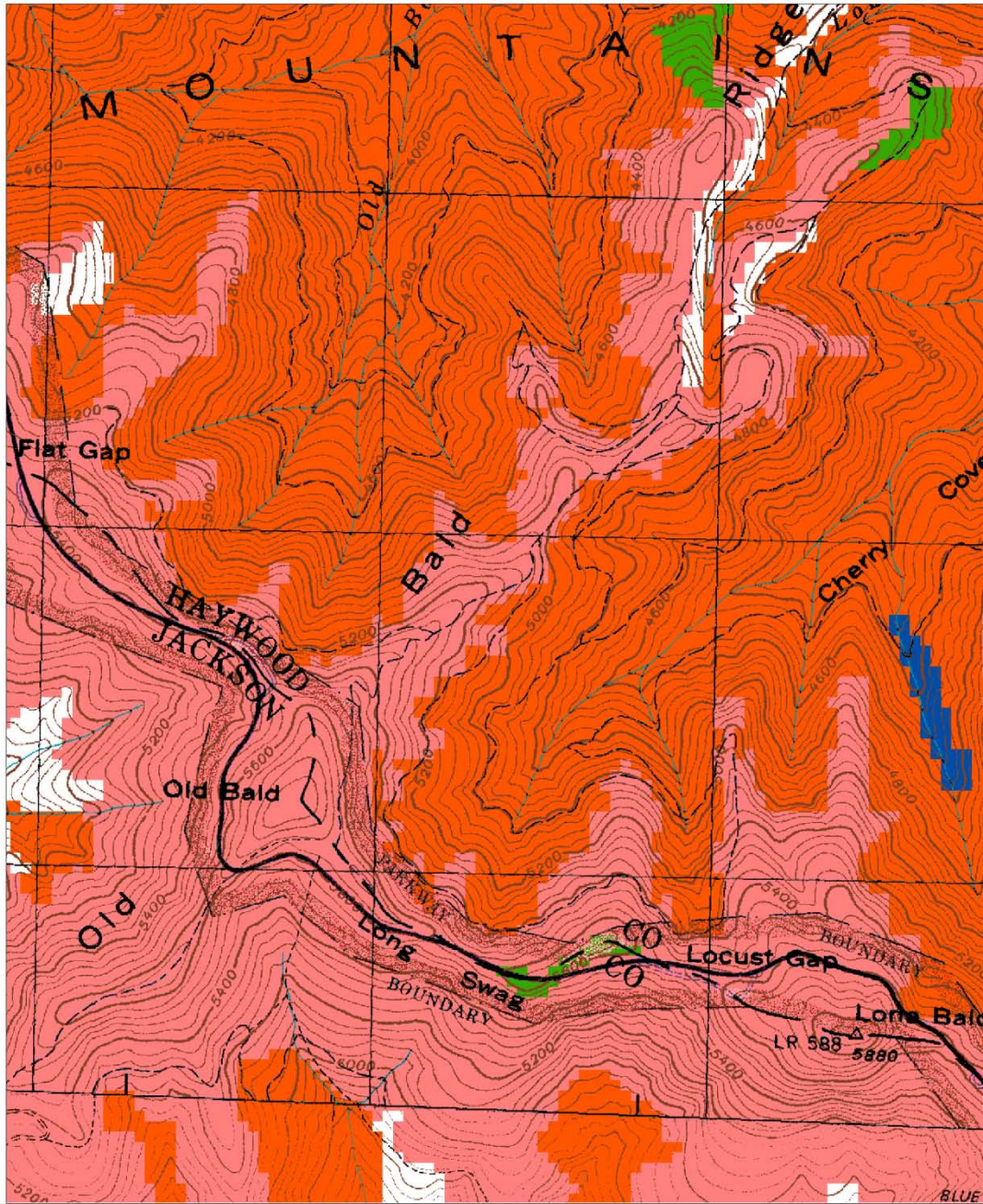
High elevation Red Oak

GW NF, Shenandoah Mt. VA



Mesic (montane) Oak

South Mts. NC



1st Approximation
Ecozones:
Waynesville WS

June 2008

Legend

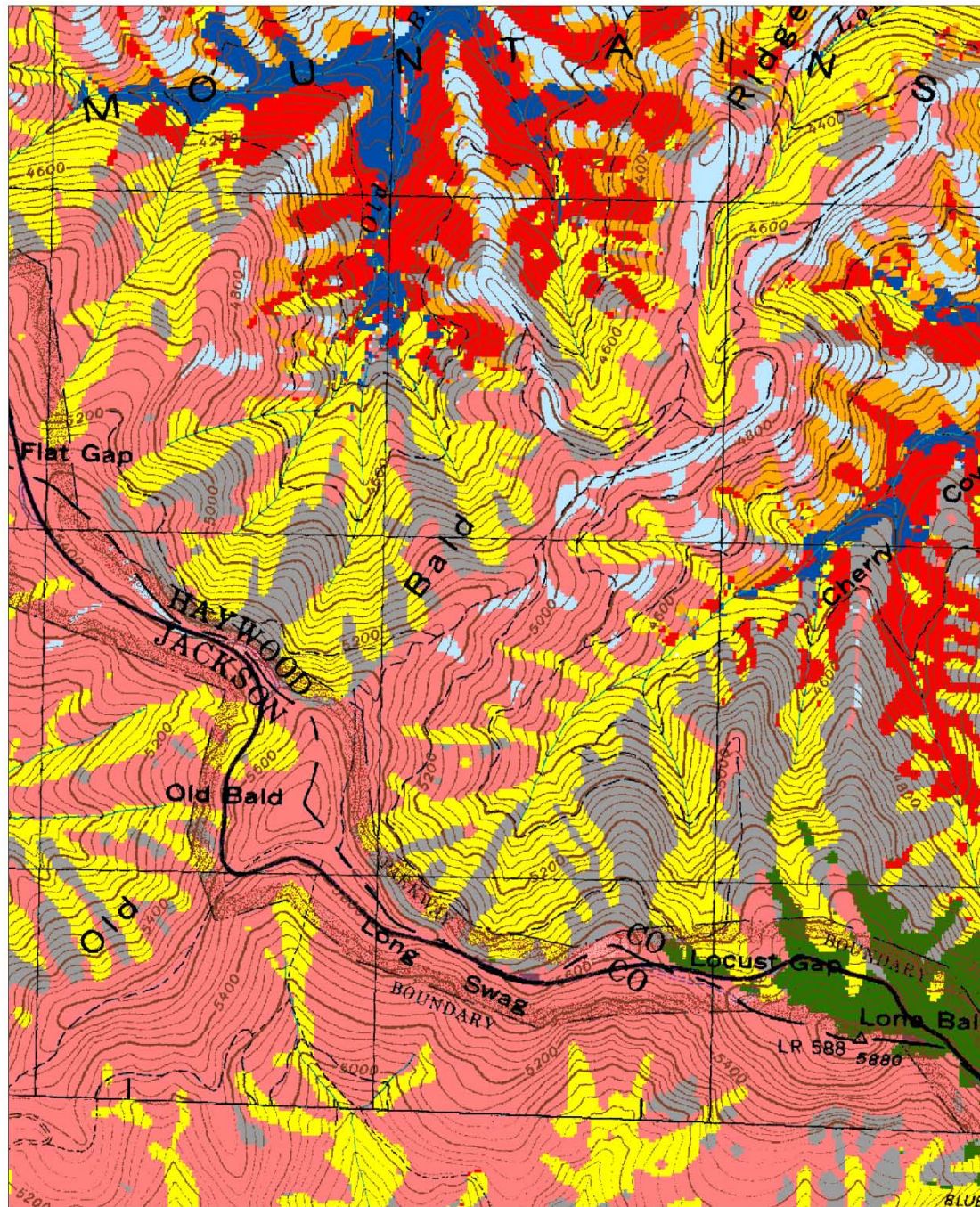
1ST_ECOZONE

- Acidic Cove
- ChestnutOakHeat
- Dry-MesicOakHic
- HighElevRedOak
- MesicOakHickory
- NorthernHWood
- PitchPine-OakHe
- RichCove
- Shortleaf Pine-
- Spruce-Fir
- WP-OakHeath



1:5,912

1 inch equals 492.702302 feet



2nd Approximation
Ecozones:
Waynesville WS
(local knowledge
method)

June 2008

Legend

- Spruce-fir
- High elevation red oak
- Northern hardwood cove
- Northern hardwood slope
- Acidic cove
- Rich cove
- Mesic oak-hickory
- Chestnut oak heath
- Pine-oak heath
- Dry-mesic oak-hickory
- Mixed oak heath
- Shortleaf pine-oak
- Shortleaf pine-oak heath
- Alluvial forest
- Grassy gald
- Heath bald



1:5,912

1 inch equals 492.702302 feet