Ecological Systems on the Cherokee National Forest: north end

Montane Pine Forest and Woodland
Below Rocky Top Gap, TN

Part 1: What are Ecological Systems
Part 2: Vegetation type mapping methods
Part 3: Process used to map Ecological Systems
Part 4: Results

Short Mt. Cherokee NF

PART 1: What are Ecological Systems

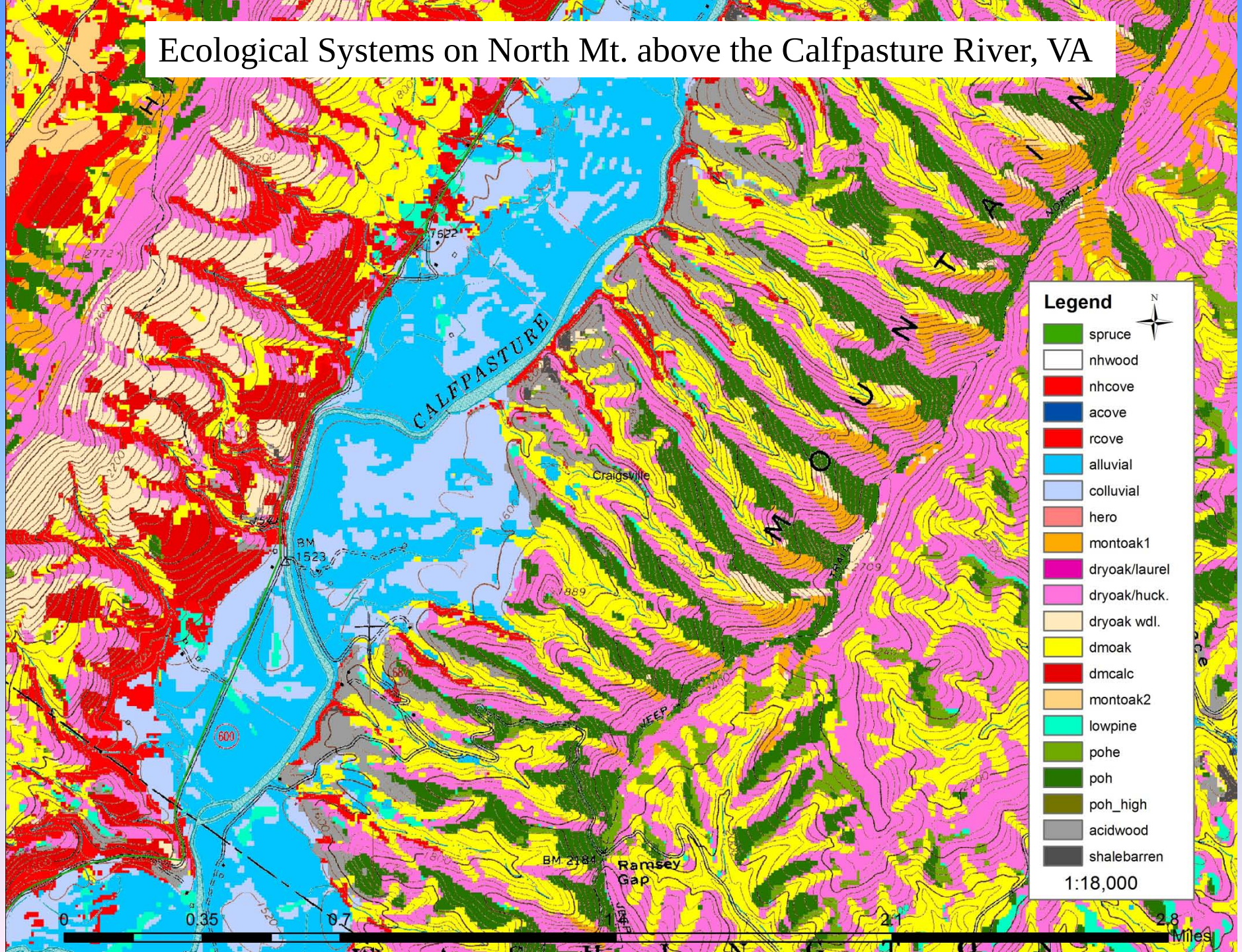
Ecological Systems are a nationally consistent set of **mid-scale** vegetation types. Mid-scale means, for example, that Rich Cove and Acidic Cove forests are aggregated into one type, the Southern and Central Appalachian Cove Forest Ecological System.

Ecological Systems are used to describe existing vegetation **and** to represent the vegetation that may have been dominant on the landscape prior to Euro-American settlement under historical disturbance regimes. Not to confuse things – but – technically, within LANDFIRE, they are used to "name" Biophysical Settings (BpS) models and map units that have been described and mapped across the entire U.S. LANDFIRE (Landscape Fire and Resource Mgmt. Planning Tools Project. USDA, USGS, FireLab, TNC, RSAC)

Ecological Systems: Landscape perspective

Jefferson NF, VA, from Steve Croy

Ecological Systems on North Mt. above the Calfpasture River, VA



Ecological Systems: stand perspective


Dry Oak / evergreen heath

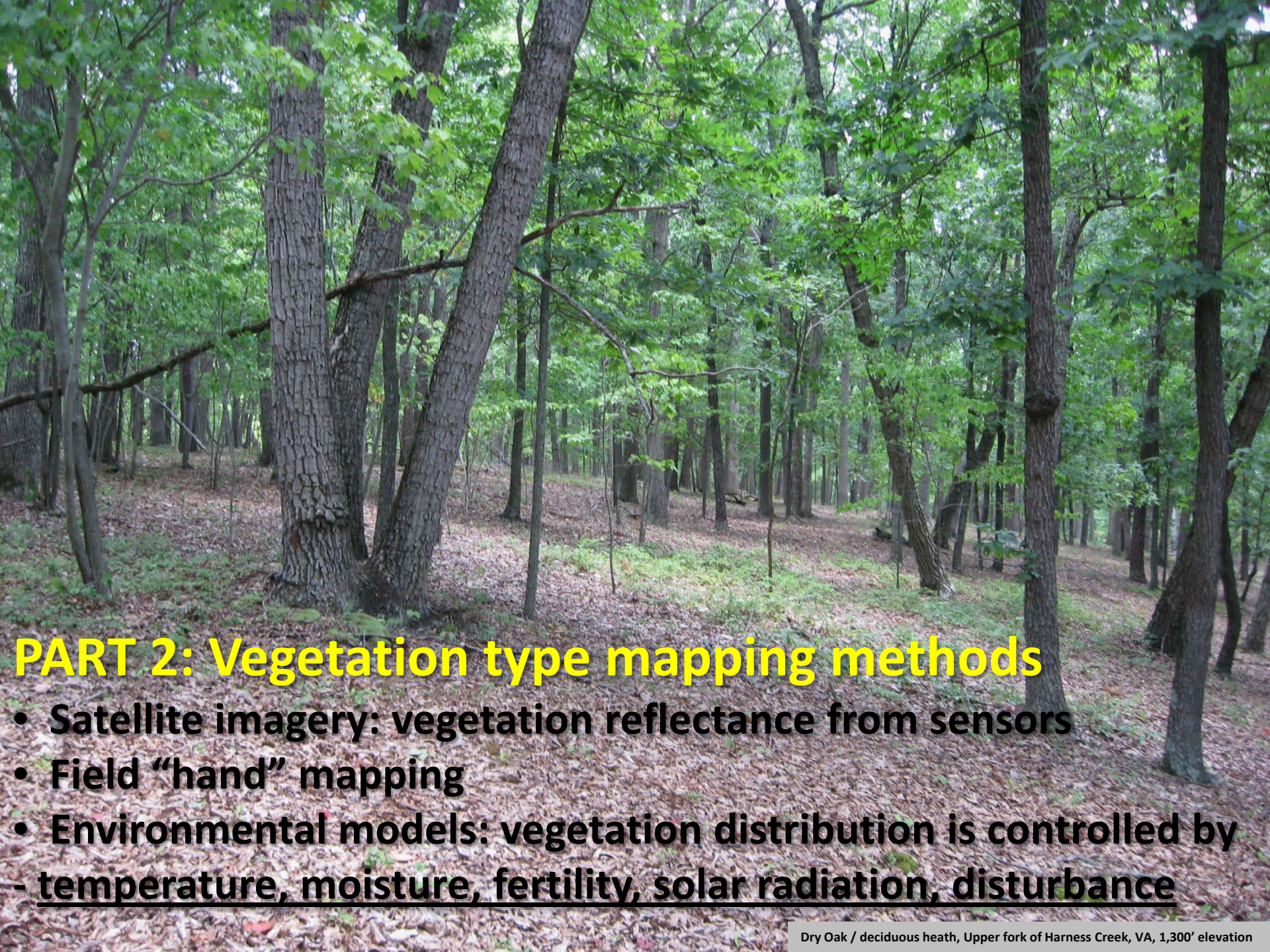

Dry Oak / deciduous heath

High Elevation Red Oak (S.&C. Appalachian Montane Oak)

Montane Northern Red Oak-Chestnut Oak (slope type)

Montane Northern Red Oak-Chestnut Oak (cove type)

Dry-mesic Oak (Southern Appalachian Oak)

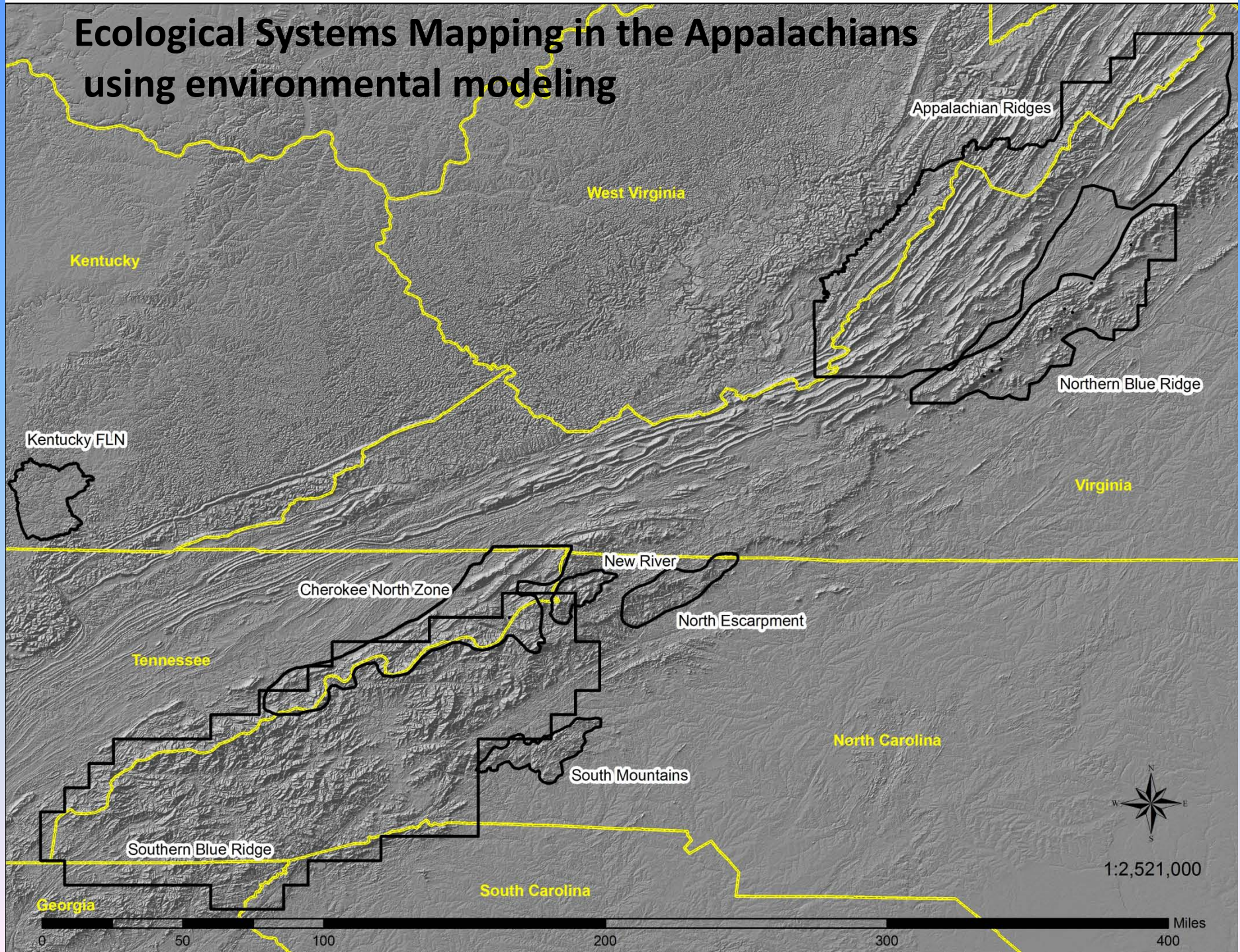


PART 2: Vegetation type mapping methods

- Satellite imagery: vegetation reflectance from sensors
- Field “hand” mapping
- Environmental models: vegetation distribution is controlled by

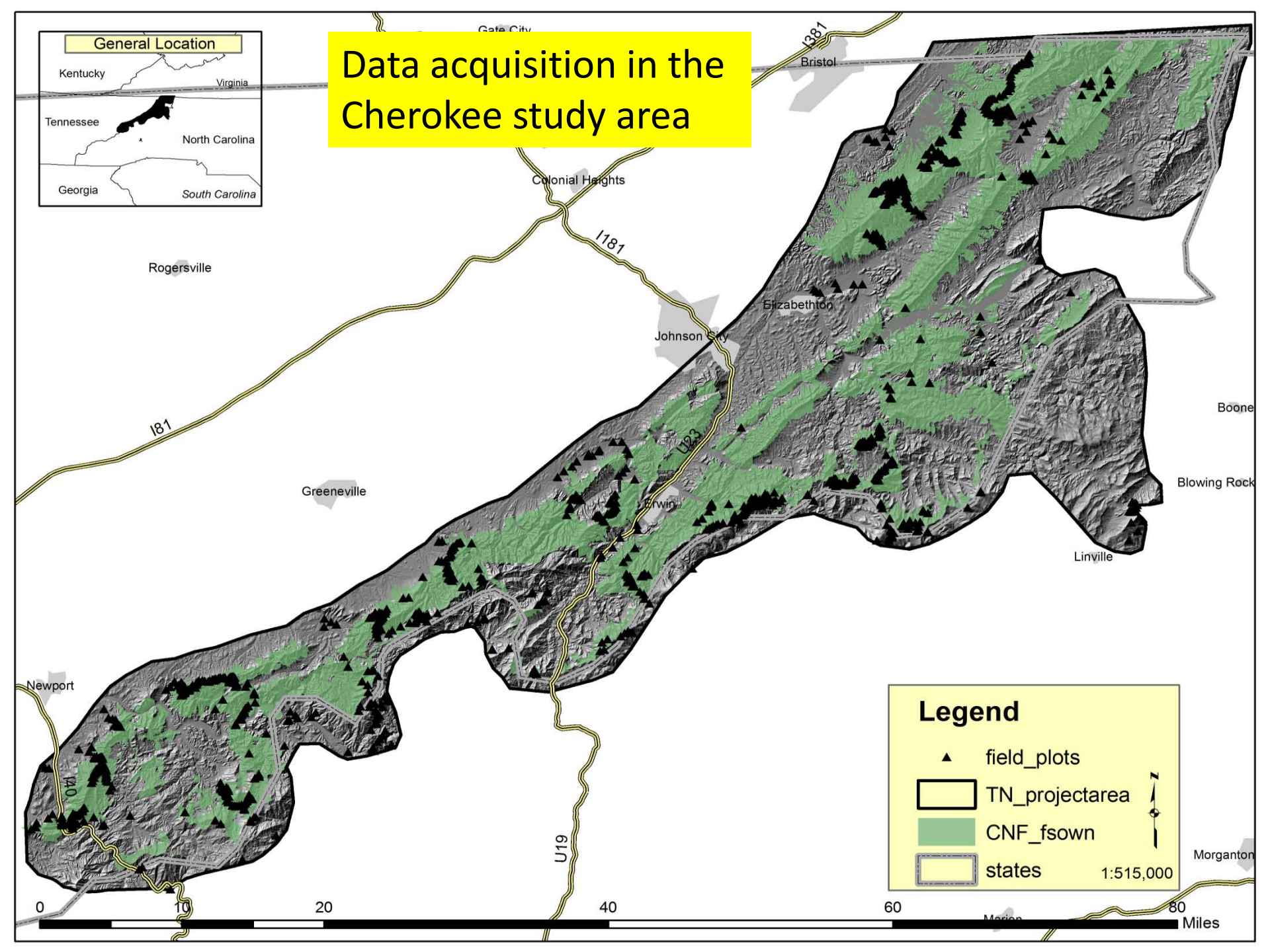
- temperature, moisture, fertility, solar radiation, disturbance

Dry Oak / deciduous heath, Upper fork of Harness Creek, VA, 1,300’ elevation


Ecological Systems Mapping in the Appalachians using environmental modeling
Appalachian Ridges
West Virginia
Kentucky
Northern Blue Ridge
Kentucky FLN
Virginia
New River
Cherokee North Zone
North Escarpment
Tennessee
North Carolina
South Mountains
Southern Blue Ridge
South Carolina
Georgia
1:2,521,000
Miles
0
50
100
200
300
400

Part 3: Process used to map Ecological Systems, i.e., environmental modeling

- **Data acquisition: identifying plant community types / ecological zones / ecological systems in the field**
- **Creating digital terrain GIS database (spatial data layers) and extracting environmental data,**
- **Statistical analysis and spatial modeling,**
- **Post-processing of digital models, and**
- **Accuracy evaluation / assessment.**


General Location
Kentucky
Virginia
Tennessee
North Carolina
Georgia
South Carolina
Data acquisition in the Cherokee study area
Gate City
Bristol
I381
Colonial Heights
I181
Rogersville
Elizabethton
Johnson City
I81
Boone
Greeneville
U23
Erwin
Blowing Rock
Linville
Newport
I40
U19
Morganton
Legend
field_plots
TN_projectarea
CNF_fsown
states
1:515,000
0
10
20
40
60
80
Miles

Spatial data layers

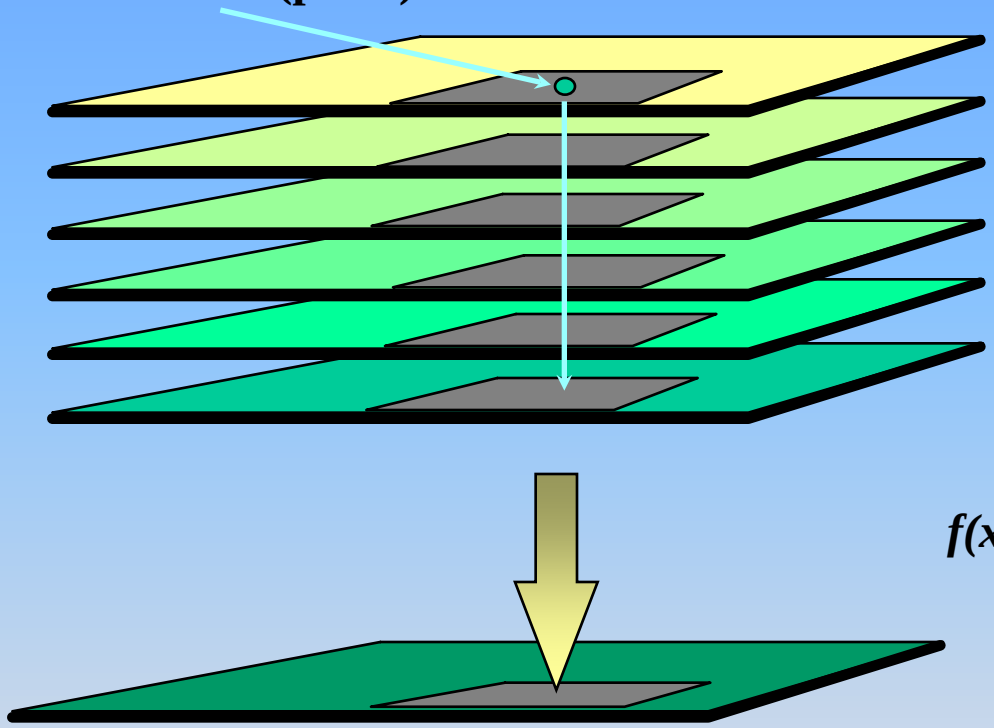
Importance of environmental variables in predicting Ecological System occurrence on the Cherokee National Forest: north end

Environmental variable	% of models
Elevation	65
Distance to mafic-silicate rocks	59
Local relief	47
Difference in elevation from the nearest river	47
Distance to carbonaceous-sulfidic rocks	41
Distance to carbonate-bearing rocks	35
Relative slope position (broader scale)	35
Difference in elevation from the nearest stream	35
Distance to closest river	29
Relative slope position (finer scale)	29
Average annual precipitation	24
Distance to closest stream	24
Aspect cosine	18
Valley position	18
Aspect in degrees	16
Landform index	12
Terrain shape index	12
Slope steepness	12
Distance to siliciclastic rocks	12
Landform10 (surface shape 10x10 neighborhood)	6
Landform30 (surface shape 30x30 neighborhood)	6
Solar radiation during the entire year	3
Surface curvature (all directions)	-
Surface curvature perpendicular to slope direction	-
Surface curvature in the direction of slope	-
Surface curvature roughness	-
Slope length	-
Solar radiation during the growing season	-
Terrain relative moisture index	-

[1/] percent of all models where variable made at least a 5% contribution to the prediction gain

Process: Ecological Systems modeling

Known Location (point)



Spatial Data Layers

Elevation
Precipitation
Aspect
Relative slope position
Slope
Geology (and 24 others)

f(x)* → *statistical function*

= Predicted distribution Ecological Systems map

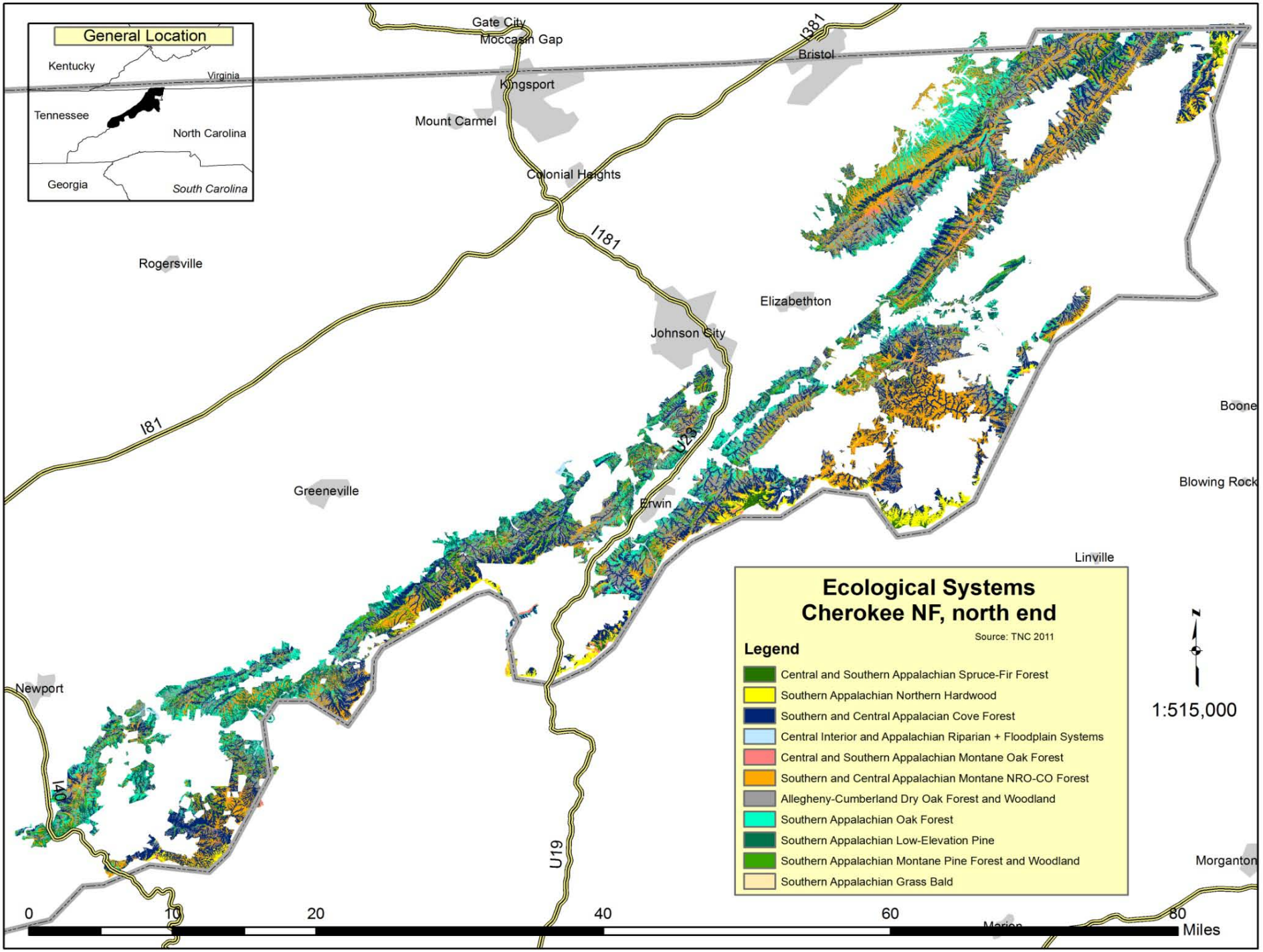
* e.g. Maximum Entropy, Logistic regression, Discriminant analysis

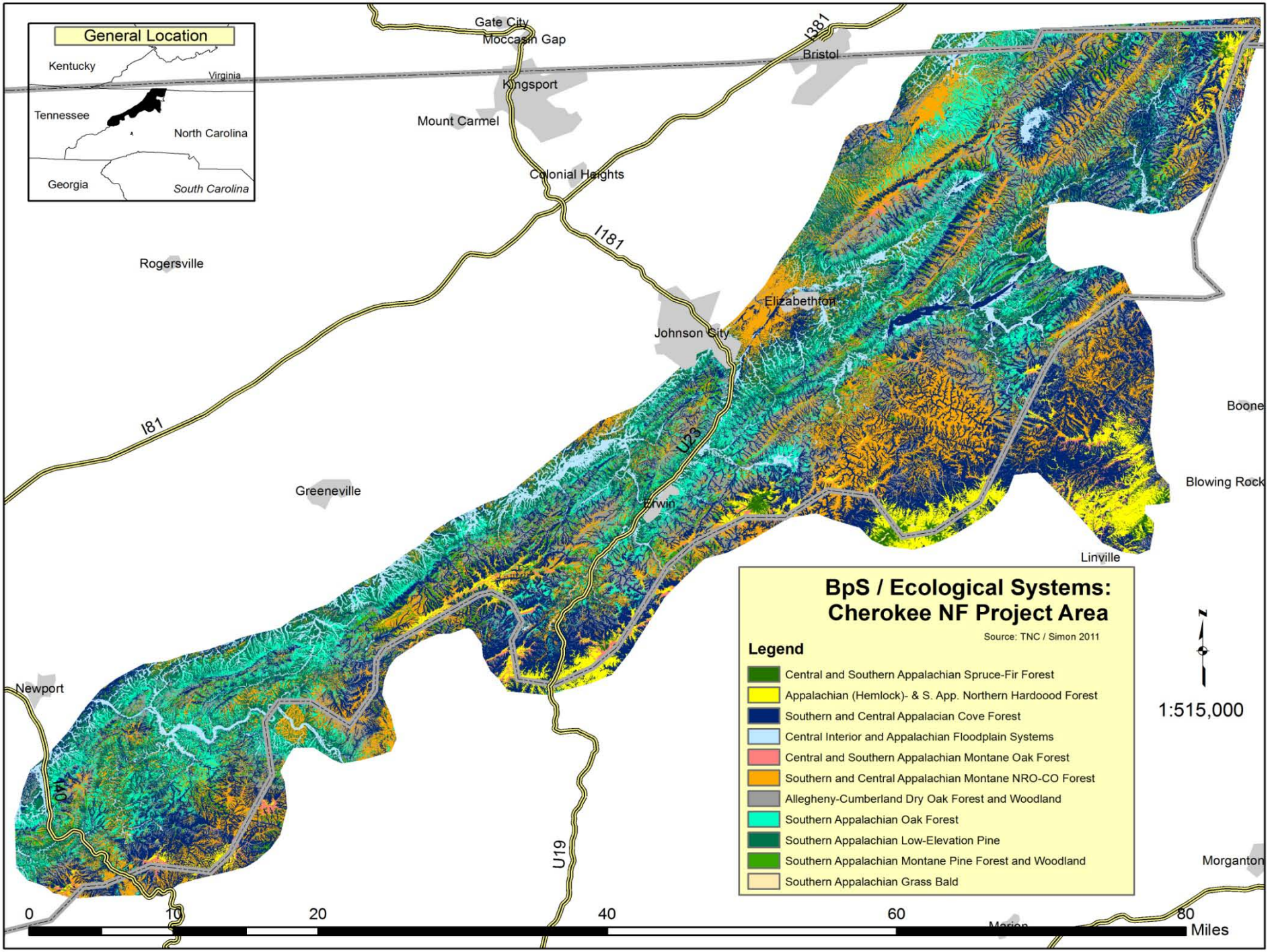
From "Assessment and Mapping of Vegetation Communities in the Shenandoah National Park", John Young, USGS

Part 4: Results

Identified 12 Ecological Systems (TNC - Nature Serve), 18 Ecological Zones on the Cherokee National Forest: north end

Central and Southern App. Spruce-Fir Forest
Southern Appalachian Northern Hardwood {2 ecozones}
Central and Southern Appalachian Montane Oak
Southern and Central Appalachian NRO-CO Forest {3 ecozones}
Southern and Central Appalachian Cove Forest {3 ecozones}
Southern Appalachian Oak Forest
Allegheny-Cumberland Dry Oak Forest and Woodlands {2 ecozones}
Southern Appalachian Montane Pine Forest and Woodland
Southern Appalachian Low-Elevation Pine
Central Interior and Appalachian Floodplain System
Central Interior and Appalachian Riparian Systems
Southern Appalachian Grass and Shrub Bald


General Location
Kentucky
Virginia
Tennessee
North Carolina
Georgia
South Carolina
Gate City
Moccasin Gap
Bristol
Kingsport
Mount Carmel
Colonial Heights
I381
I181
Rogersville
Elizabethton
Johnson City
I81
Greeneville
Erwin
Boone
Blowing Rock
Linville
Newport
I40
U19
U23
Morganton
Marion
Ecological Systems
Cherokee NF, north end
Source: TNC 2011
Legend
Central and Southern Appalachian Spruce-Fir Forest
Southern Appalachian Northern Hardwood
Southern and Central Appalacian Cove Forest
Central Interior and Appalachian Riparian + Floodplain Systems
Central and Southern Appalachian Montane Oak Forest
Southern and Central Appalachian Montane NRO-CO Forest
Allegheny-Cumberland Dry Oak Forest and Woodland
Southern Appalachian Oak Forest
Southern Appalachian Low-Elevation Pine
Southern Appalachian Montane Pine Forest and Woodland
Southern Appalachian Grass Bald
N
1:515,000
0
10
20
40
60
80
Miles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Erwin
Blowing Rock
Linville
Newport
I40
U19
Morganton
Marion
BpS / Ecological Systems:
Cherokee NF Project Area
Source: TNC / Simon 2011
Legend
Central and Southern Appalachian Spruce-Fir Forest
Appalachian (Hemlock)- & S. App. Northern Hardoood Forest
Southern and Central Appalacian Cove Forest
Central Interior and Appalachian Floodplain Systems
Central and Southern Appalachian Montane Oak Forest
Southern and Central Appalachian Montane NRO-CO Forest
Allegheny-Cumberland Dry Oak Forest and Woodland
Southern Appalachian Oak Forest
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N
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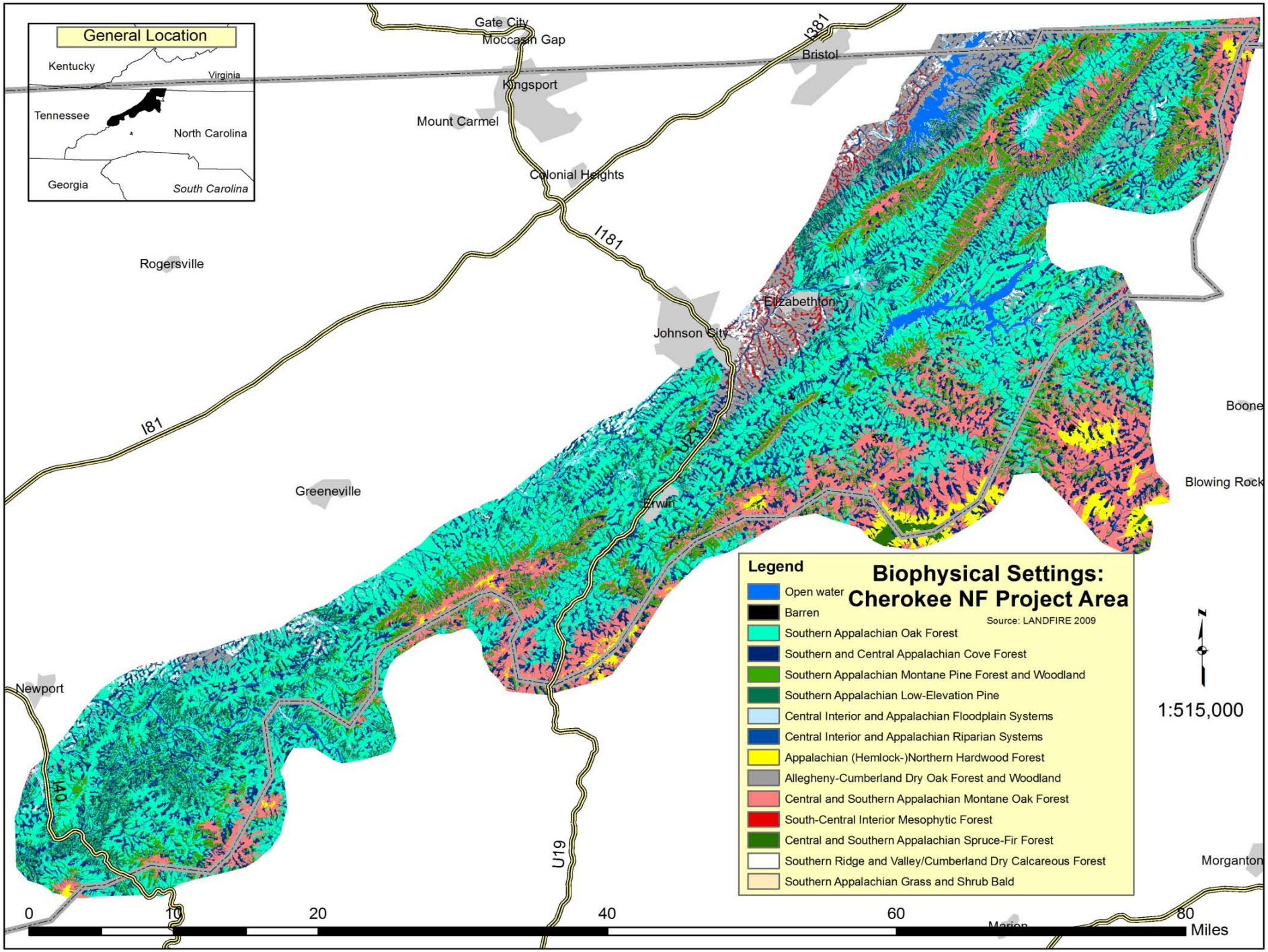
Miles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Gate City
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Elizabethton
Johnson City
I81
U23
Boone
Blowing Rock
Greeneville
Erwin
Newport
I40
U19
Morganton
Marion
Legend
Biophysical Settings:
Cherokee NF Project Area
Source: LANDFIRE 2009
Open water
Barren
Southern Appalachian Oak Forest
Southern and Central Appalachian Cove Forest
Southern Appalachian Montane Pine Forest and Woodland
Southern Appalachian Low-Elevation Pine
Central Interior and Appalachian Floodplain Systems
Central Interior and Appalachian Riparian Systems
Appalachian (Hemlock-)Northern Hardwood Forest
Allegheny-Cumberland Dry Oak Forest and Woodland
Central and Southern Appalachian Montane Oak Forest
South-Central Interior Mesophytic Forest
Central and Southern Appalachian Spruce-Fir Forest
Southern Ridge and Valley/Cumberland Dry Calcareous Forest
Southern Appalachian Grass and Shrub Bald
N
1:515,000
0
10
20
40
60
80
Miles

Comparison of the extent and accuracy of TNC 2011 Ecological Systems and LANDFIRE 2009 Ecological Systems

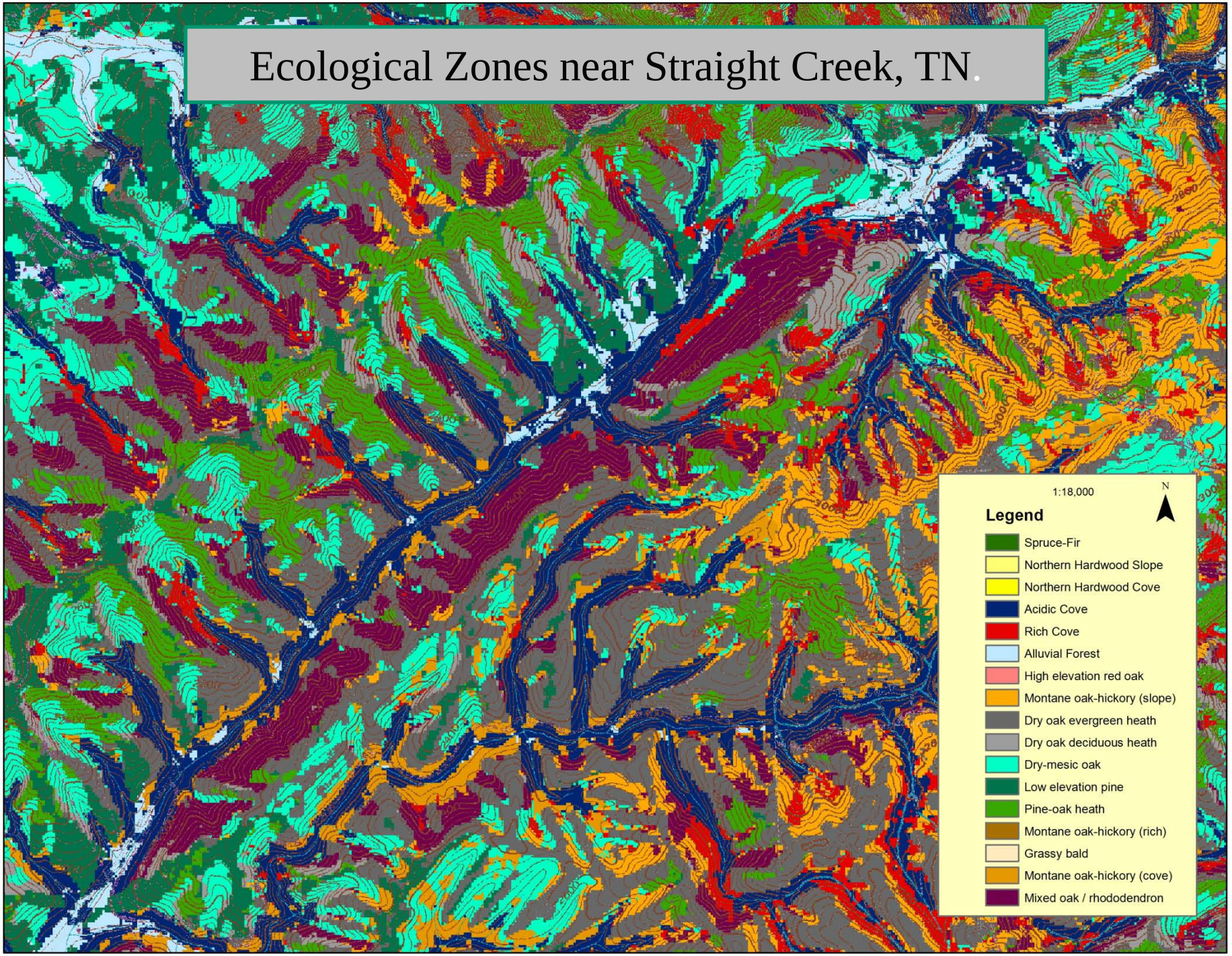
		TNC 2011			LANDFIRE 2009		
map code	Ecological Systems	USFS acres	% of total	accuracy allplots	USFS acres	% of total	accuracy allplots
27	Southern Appalachian Grass and Shrub Bald	63	0.0	100%	42	0.0	50%
1	Central and Southern Appalachian Spruce-Fir Forest	2,236	0.7	89%	674	0.1	31%
2	Southern Appalachian Northern Hardwood	11,639	3.4	88%	4,167	1.2	28%
4	Southern and Central Appalachian Cove Forest	102,977	30.0	91%	43,127	12.5	20%
6	Central Interior and Appalachian Riparian Systems	2,083	0.6	100%	30,662	8.9	62%
23	Central Interior and Appalachian Floodplain Systems	464	0.1	100%	1,151	0.3	39%
98	Reservoirs and Ponds	117	0.03	--	443	0.1	--
8	Central and Southern Appalachian Montane Oak	4,136	1.2	79%	52,996	15.4	36%
9	Southern and Central Appalachian Red Oak-Chestnut Oak	67,712	19.7	82%			
13	Southern Appalachian Oak Forest (DRY-MESIC OAK)	40,765	11.9	84%	130,000	29.9	64%
10	Allegheny-Cumberland Dry Oak Forest and Woodland	65,880	19.2	79%	8,508	2.5	5%
16	Southern Appalachian Low-Elevation Pine	23,821	6.9	87%	10,845	3.2	15%
18	Southern Appalachian Montane Pine Forest and Woodlands	21,837	6.4	81%	60,539	17.6	20%
	Barren-Rock/Sand/Clay	--	--	--	302	0.0	
	South-Central Interior Mesophytic Forest	--	--	--	122	0.0	
	Southern Ridge and Valley/Cumberland Dry Calcareous Forest	--	--	--	142	0.0	
	TOTAL	343,721	100.0	86%	343,721	100.0	30%

Comparison of Ecological Zone accuracy across the CNF, GW, Kentucky FLN, and the Southern Blue Ridge (SBR) study areas based on intersection of classified data (field data) with modeled map units (ECOLOGICAL ZONES ARE USED TO DEFINE ECOLOGICAL SYSTEMS)

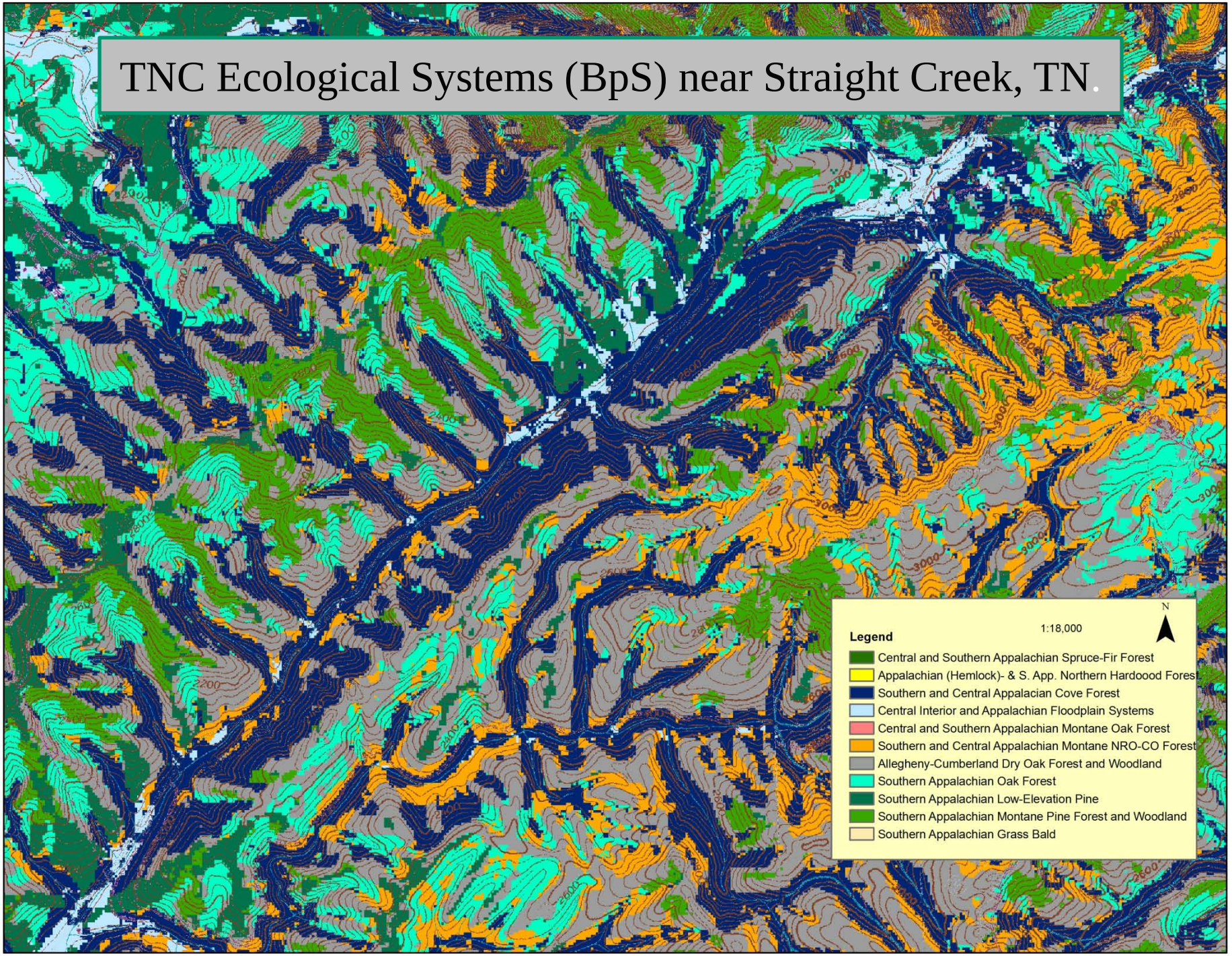
Ecological Zone	Cherokee NF North end	George Washington NF		Kentucky FLN	Northern Escarp. SBR	South Mts. SBR	Other SBR
		Appalachian Ridges	Blue Ridge				
Size of area (acres-rounded)	1,021,600	3,761,700	1,026,200	278,000	233,000	217,000	5,600,000
	Percent correct based on field data points						
Grassy Bald	100	-	-	-	-	-	30
Heath Bald	-	-	-	-	-	-	19
Spruce-Fir	86	89	-	-	-	-	53
N. Hardwood Slope	88	86	81	-	-	-	70
N. Hardwood Cove	71	89	100	-	-	-	23
Acidic Cove	83	83	90	87	93	63	66
Spicebush Cove	-	-	71				
Rich Cove [1/]	76	82	82	92	100	-	51
Alluvial Forest	92	67	94	81	91	100	56
Floodplain	-	78	-				
High Elevation Red Oak	79	86	84	-	73	-	75
Montane Oak Rich	100	77	68				
Montane Oak Cove	66	79	-	-	-	-	-
Montane Oak Slope [2/]	85	72	80	-	83	67	43
Colluvial Forest	-	70	-	-	-	-	-
Dry-Mesic Oak	78	84	90	77	73	62	27
Dry-Mesic Calcareous Forest	-	81	-	-	-	-	-
Dry Oak Evergreen Heath [3/]	75	66	73	83	-	59	27
Dry Oak Deciduous Heath	75	65	71	-	-	-	-
Mixed Oak Heath	76	-	-	-	83	-	36
Low Elevation Pine [4/]	85	90	91	80	-	100	66
Shortleaf P-O Heath	-	-	-	-	-	-	58
Pine-Oak Heath (eastside)	-	82	-	-	-	-	-
Pine-Oak Heath (westside) [5/]	82	77	83	-	93	-	58
Pine-Oak Heath (ridges) [6/]	-	59	-	79	-	-	-
Pine-Oak Shale Woodland	-	89	-	-	-	-	-
Shale Barren	-	83	-	-	-	-	-
Alkaline Woodland	-	92	-	-	-		
Mafic Glade and Barren	-	-	91				
OVERALL	80	77	80	82	86	64	52
Most fire-adapted group	94	97	98	95	98	89	83

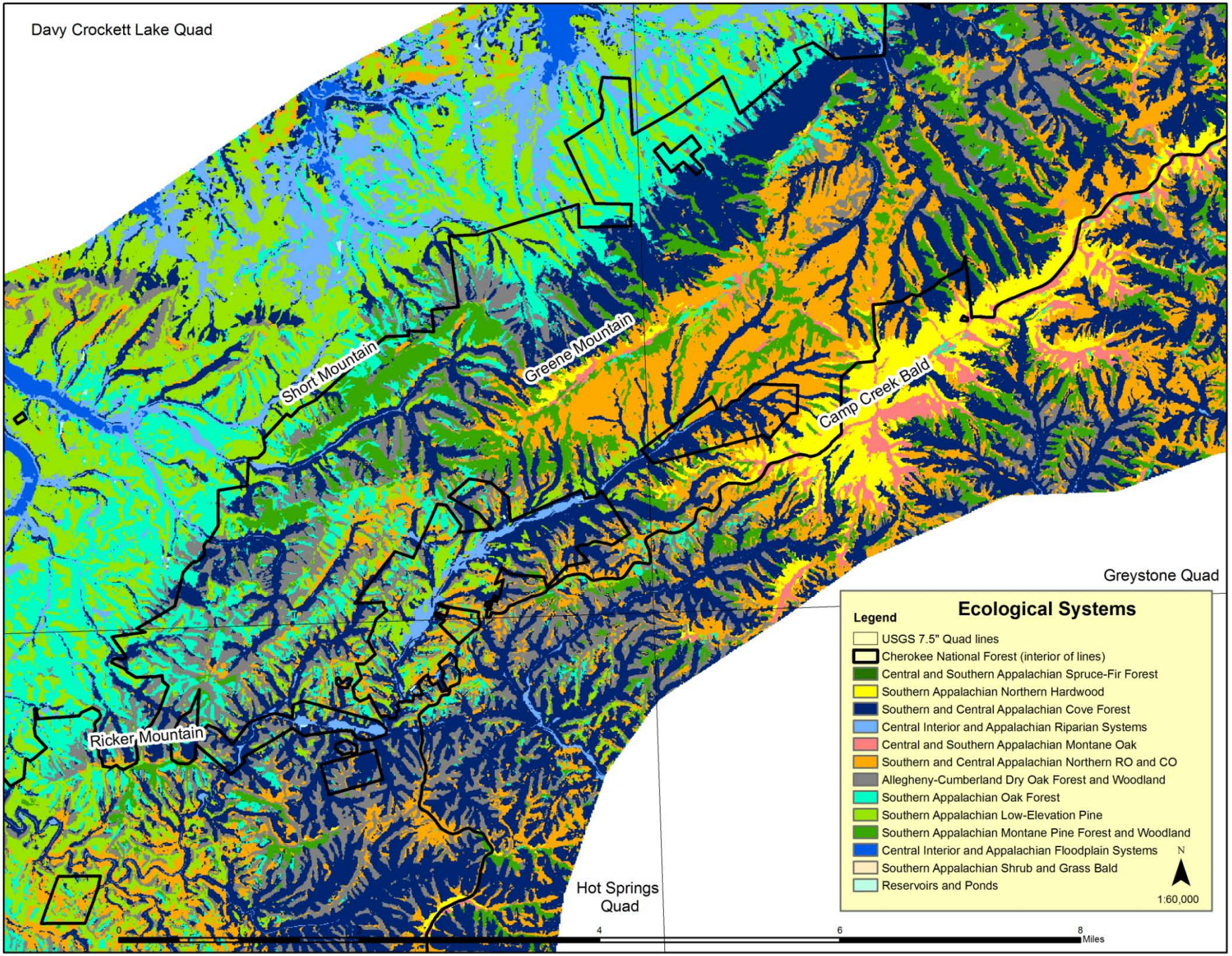
[1/] Mesic Forest in Kentucky, [2/] typical Montane_submesic Oak [3/] Chestnut Oak in SBR, [4/] Shortleaf Pine-Oak in SBR, [5/] typical POH, [6/] "Xeric Pine-Oak" in Kentucky

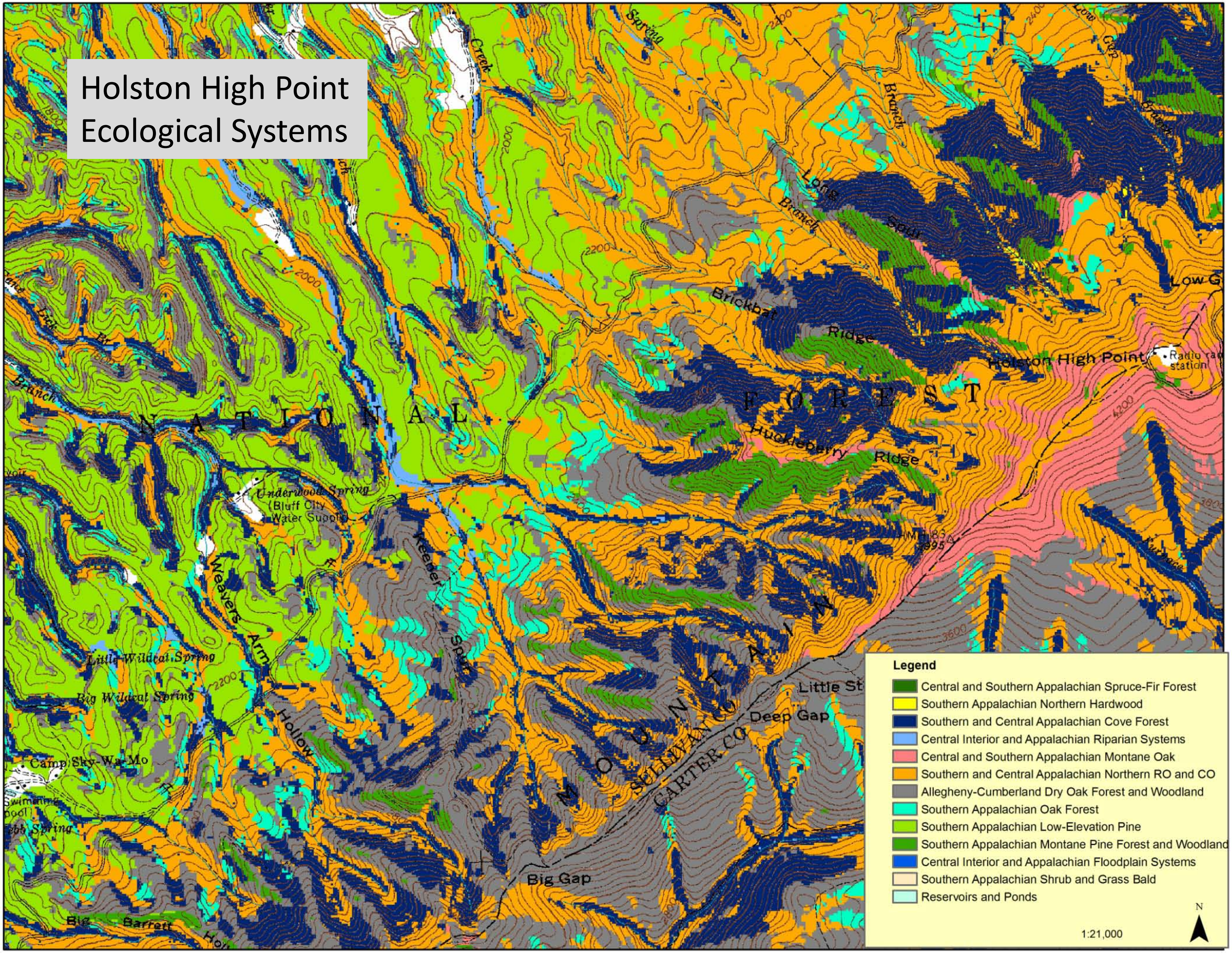
Ecological Zones near Straight Creek, TN.

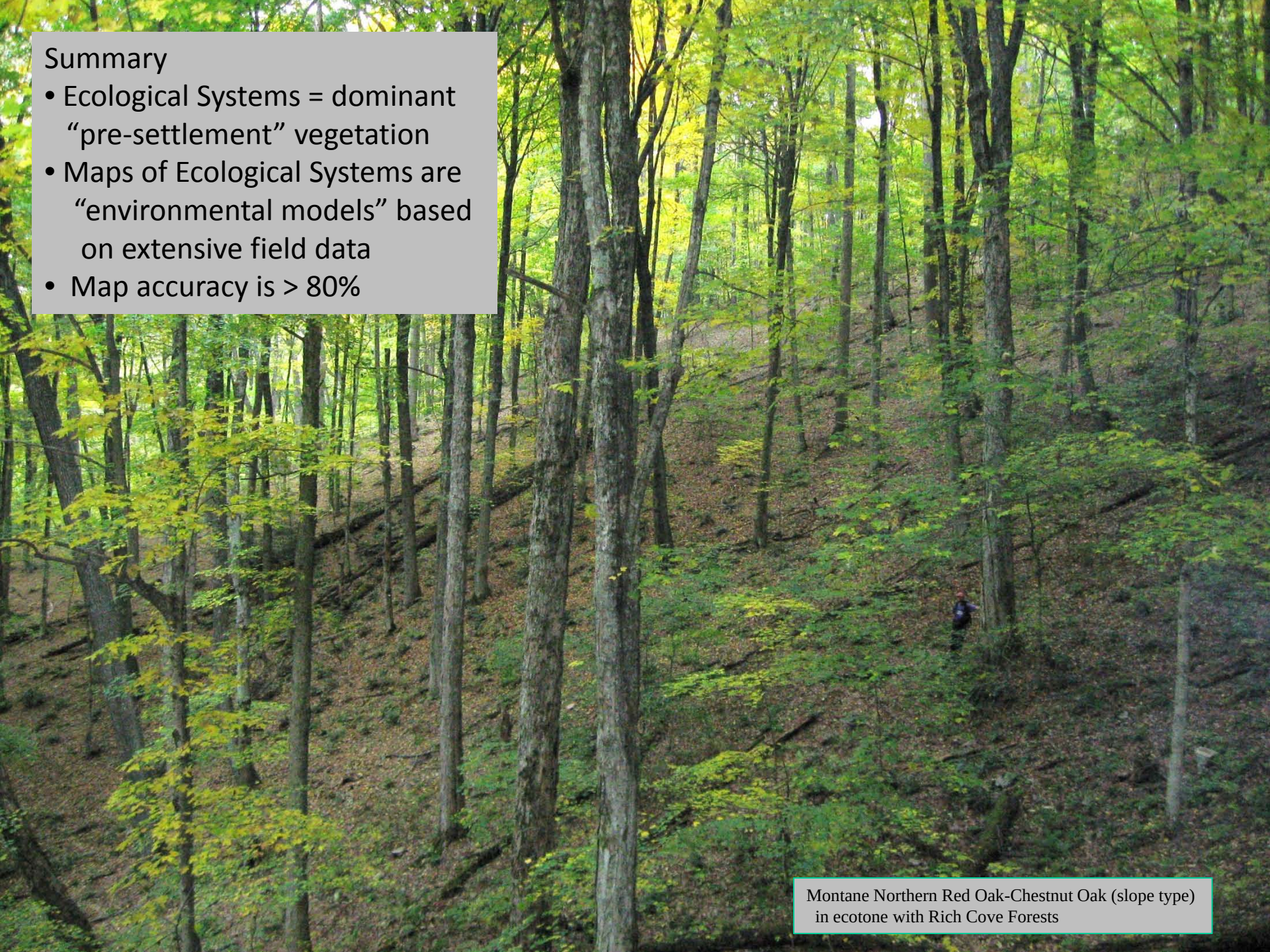


TNC Ecological Systems (BpS) near Straight Creek, TN.




Davy Crockett Lake Quad
Short Mountain
Greene Mountain
Camp Creek Bald
Greystone Quad
Ricker Mountain
Hot Springs Quad
Ecological Systems
Legend
USGS 7.5" Quad lines
Cherokee National Forest (interior of lines)
Central and Southern Appalachian Spruce-Fir Forest
Southern Appalachian Northern Hardwood
Southern and Central Appalachian Cove Forest
Central Interior and Appalachian Riparian Systems
Central and Southern Appalachian Montane Oak
Southern and Central Appalachian Northern RO and CO
Allegheny-Cumberland Dry Oak Forest and Woodland
Southern Appalachian Oak Forest
Southern Appalachian Low-Elevation Pine
Southern Appalachian Montane Pine Forest and Woodland
Central Interior and Appalachian Floodplain Systems
Southern Appalachian Shrub and Grass Bald
Reservoirs and Ponds
N
1:60,000
0
4
6
8
Miles


Holston High Point
Ecological Systems
Legend
Central and Southern Appalachian Spruce-Fir Forest
Southern Appalachian Northern Hardwood
Southern and Central Appalachian Cove Forest
Central Interior and Appalachian Riparian Systems
Central and Southern Appalachian Montane Oak
Southern and Central Appalachian Northern RO and CO
Allegheny-Cumberland Dry Oak Forest and Woodland
Southern Appalachian Oak Forest
Southern Appalachian Low-Elevation Pine
Southern Appalachian Montane Pine Forest and Woodland
Central Interior and Appalachian Floodplain Systems
Southern Appalachian Shrub and Grass Bald
Reservoirs and Ponds
N
1:21,000
NATIONAL FOREST
Holston High Point
Brickbat Ridge
Huckleberry Ridge
Long Branch
Underwood Spring
(Bluff City
Water Supply)
Little Wildcat Spring
Big Wildcat Spring
Camp Sky-Wa-Mo
Big Gap
Deep Gap
SULLIVAN CO
CARTER CO



Summary

- Ecological Systems = dominant "pre-settlement" vegetation
- Maps of Ecological Systems are "environmental models" based on extensive field data
- Map accuracy is > 80%

Montane Northern Red Oak-Chestnut Oak (slope type) in ecotone with Rich Cove Forests

United States
Department of
Agriculture

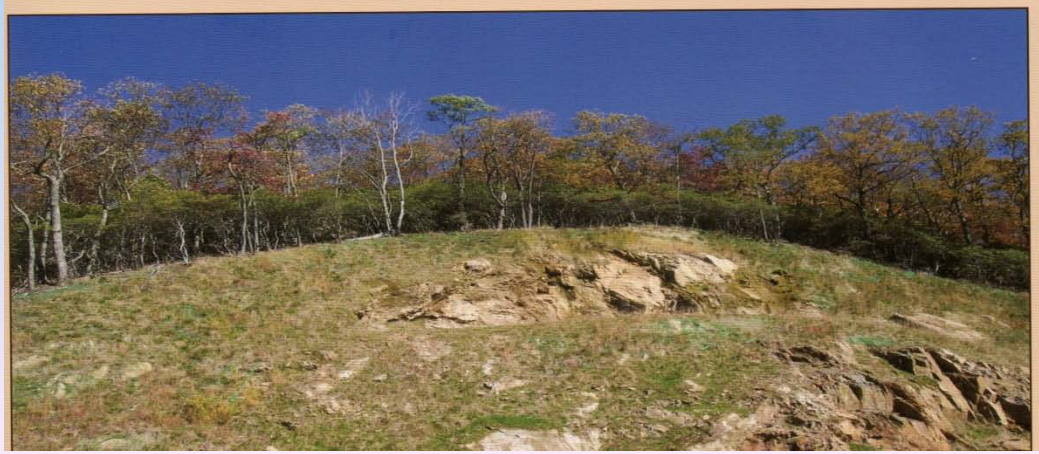
Forest Service

**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

Table 6: Mean values for environmental variables that describe temperature, fertility, moisture, and insolation gradients within TNC Ecological Systems / BpS. (some values are rounded).

		Temp.	Fertility (distance in 1,000s ft. to lithogeochemical type) [1/]				Moisture, Temperature, Radiant Energy, and Fertility[2/]						
map code	Ecological System	ELEV. ft.	GEO1	GEO2	GE03	GEO4	SLOPE	VPOS	RPOS	ASP	SOL	TSI	SDIF
27	Balds	5,780	46.7	0	9.7	46.7	13	2	4	.08	16.3	4.3	660
1	Spruce-Fir	5,140	30.0	6.9	4.5	24.9	37	20	19	.06	14.8	4.4	270
2	Northern Hardwood	4,410	31.9	10.1	2.0	27.1	46	32	35	.45	12.8	-3.2	220
4	Cove	2,790	13.2	36.5	0.5	8.4	42	53	64	.18	12.7	-10.2	70
6	Alluvial Forest	1,510	4.0	44.9	1.5	1.9	13	88	67	-.23	13.4	-6.8	7
8	Montane Oak 1	4,320	16.8	26.7	0.07	8.8	31	15	7	-.08	15.2	11.9	420
9	Montane Oak 2 (new)	3,170	13.6	46.1	0.5	8.6	36	38	35	.16	13.5	-1.1	150
13	Sourhern App. Oak	2,250	7.1	55.0	1.5	1.4	34	40	36	-.01	13.6	-2.7	115
10	Dry Oak	2,610	4.5	53.1	0.3	1.6	43	46	19	.01	13.3	7.2	185
16	Low Elevation Pine	1,990	3.9	42.7	0.5	1.1	24	47	18	-.07	14.0	11.0	260
18	Montane Pine	2,680	6.2	44.7	0.2	2.5	46	35	11	-.32	16.3	4.3	660

[1/] Geo1 = Carbonate-bearing rock, Geo2 = Mafic-silicate rock, Geo3 = Siliciclastic rock, Geo4 = Carbonaceous-sulfidic rock. [2/]Slope in percent, VPOS = valley position (100 = valley bottom, 0 = major ridge top), RPOS = relative slope position (100 = bottom of slope, 0 = top of secondary or major ridge), ASP = cosine of aspect (smaller = more south, larger = more north), SOL = solar radiation (unit watt hours per square meter in millions), TSI = terrain shape index (land surface shape, negative numbers are degree of concavity, positive numbers are degree of convexity), SDIF = difference in elevation above the nearest stream (ft).

Table 9. Extent of TNC Ecological Systems in the project area and within Cherokee National Forest ownership

map code	Nature Serve Ecological System (derived from Ecological Zones)	Total acres	% of total	USFS acres	% of total
1	Central and Southern Appalachian Spruce-Fir Forest	7,215	0.7	2,236	0.7
2	Southern Appalachian Northern Hardwood Forest	47,675	4.7	11,639	3.4
4	Southern and Central Appalachian Cove Forest	317,847	31.1	102,977	30.0
23	Central Interior and Appalachian Floodplain Systems	22,488	2.2	464	0.1
6	Central Interior and Appalachian Riparian Systems	40,544	4.0	2,083	0.6
8	Central and Southern Appalachian Montane Oak	13,920	1.4	4,136	1.2
9	Southern and Central Appalachian Red Oak-Chestnut Oak	165,788	16.2	67,712	19.7
13	Southern Appalachian Oak Forest	108,470	10.6	40,765	11.9
10	Allegheny-Cumberland Dry Oak Forest and Woodland	123,144	12.1	65,880	19.2
16	Southern Appalachian Low-Elevation Pine	126,948	12.4	23,812	6.9
18	Southern Appalachian Montane Pine Forest and Woodlands	33,505	3.3	21,837	6.4
27	Southern Appalachian Grass and Shrub Bald	622	0.1	63	0.0
98	Reservoirs and Ponds	13,413	1.3	117	0.0
	TOTAL	1,021,579	100.0	343,721	100.0