



USDA Forest Service, Southwestern Region Terrestrial Ecological Unit Inventory (TEUI): An Integrated Approach to Mapping and Describing Ecosystems

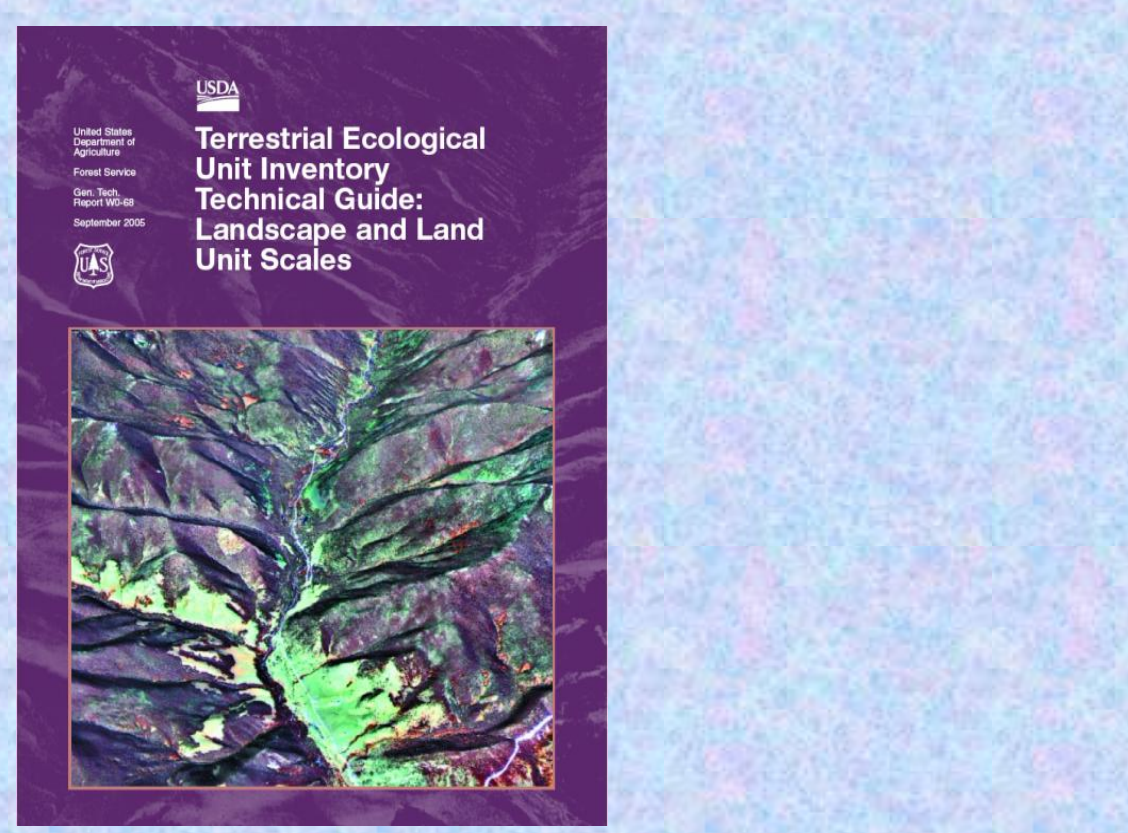
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Background

Abstract
 Historically there have been various approaches to describing, classifying and mapping ecological systems. Ecological descriptions and maps have been based mainly on vegetation or have been compiled from data of various independently conducted vegetation surveys, soil surveys and other resource efforts. We compare the similarities between the USDA-NRCS ecological site descriptions and USDA-Forest Service ecological types and map units. Commonly, soil surveys are used as the baseline polygon map to which Ecological Site Descriptions (ESD) are assigned. An ESD is assigned to a soil map unit based on a typical soil pedon. It is assumed that the ESD and soils were consistently mapped together in the soil survey project area and that the site reflects the ESD potential.

The USDA Forest Service, Southwestern Region, uses an integrated approach where ecological components (climate, soils, geology, geomorphology and vegetation) are described collectively and simultaneously at a location where the ecological type is stable, functioning, diverse and undisturbed. Ecological types are mapped and described along an environmental gradient. Climate classes have been established and described along the gradient. Soil temperature and moisture regimes have been established for each climate class through monitoring and interpretation of NOAA weather station data and are correlated to life zones. Key indicator plant species are assigned to the climate classes within life zones and diagnostic soil properties. Personnel who describe and map these ecological types are soil scientists with skills in plant taxonomy, landscape ecology, geology and geomorphology. They are also skilled in the associated protocols for data collection and digital soil mapping. Botanists, geologists, ecologists and geomorphologists are consulted and part of the quality assurance process. The resulting ecological type is from the integrated soil, plant, climate and landform data collection process. Data are collected simultaneously by the same person(s), at the same plot location, at the same time. This results in a better understanding of the cause and effect relationship among climate, soils and vegetation. This also results in a more accurate ecological site description and map.

Policy Direction



Official protocol for conducting Terrestrial Ecological Unit Inventory (Winthers et al., 2005).

Provides for a standardized method to define, delineate, and describe terrestrial ecological sites (Caudle et al., 2010).

Table 1. Descriptive and total interpretive elements by protocol.

Descriptive and Interpretive Data Elements of Ecological Unit Inventory	
USDA Forest Service - Southwest Region - Terrestrial Ecological Unit Inventory	USDA Natural Resource Conservation Service - Ecological Site Description
Map Unit Legend	Ecological Site Characteristics - small color photographs
Map Symbol: two or three digit number	Site type: type of site - rangeland, forest land, etc.
Map Unit Component: decimal number	Site Name: Name and Precipitation Zone (in)
Soil Name/Miscellaneous Area: Soil Taxonomic Name (family or subgroup) common name	Identifies plant community by taxonomic name and common name
Climate: soil depth, soil surface texture, rock, soil surface texture, other unique soil properties	Site ID: consists of eleven digits both numerical and alpha characters
Phonetic Class, gradient, life zone (number), sub-step	Major Land Resource Area: Three digit number and name
Vegetation Symbol: Name (color symbol) of the Potential Natural Vegetation category	Major Land Resource Area: Three digit number and name
Soil/Composition/Climate/Kind of Map Unit: slope-range as a % composition as % climate as descriptive term	Physiographic Features
Kind of map unit - descriptive term	A brief description of the location-elevation-landscape position, landform of the ecological site
Map Unit Setting and Properties	Landform: identifies landform (common name) may include more than one landform
Map Symbol: two or three digit number	Elevation: identifies a minimum and maximum elevation (ft)
Map Unit Name: Soil Taxonomic (family/subgroup) Climate Class (step/sub-step) Soil Phase (soil depth/surface texture)	Slope: identifies a minimum and maximum slope (%)
PNV Taxon (series/subseries) Climate Class Map Unit Kind/Slope Range expressed as a percent	Water Table Depth: identifies a minimum and maximum water table depth (in)
Setting: narrative form	Flooding
Describes location of each major ecological type and identifies the landform for each ecological type (MAP unit)	Frequency: identifies a minimum and maximum flood frequency
Timing period (range of months) and the amount of precipitation received (% MAAT degree - degree C)	Duration: identifies a minimum and maximum flood duration
Mean snowfall and snow accumulation (cm). Freeze-free period (expressed in days). Elevation (range in)	Pooling
Polychrome shape and size (range in/feet). Stream channel type and drainage pattern.	Depth: identifies a minimum and maximum pooling depth (in)
Map Unit Symbol and Component	Frequency: identifies a minimum and maximum pooling frequency
Landscape Features: hierarchical	Duration: identifies a minimum and maximum pooling duration
Site Geomorphology	Basal Class: identifies a minimum and maximum runoff class
Geomorphic Process	Aspect: Descriptive term
Landscape Term	Climate Features: narrative and table form
Landform	A narrative discussion on the major climate properties. Range in annual precipitation (in), winter/summer ratios, period, precipitation intensity (descriptive term), duration, direction, and area from which the storm events originate are discussed. Snowfall amounts and depth (in), time periods of snowfall events, humidity and discussed. Average annual air temperatures (F). Time of year as mentioned when daytime air temperatures are the highest and when free temperatures occur.
Element Landform	
Common Landform	
Parent Material	
Kind	
Origin	

Table 2. Number of data elements, by category, for ecological site descriptions by protocol.

	USDA-FS, SW		
	USDA-FS, TEUI #	Region TEUI #	USDA-NRCS, ESD #
Soils	50	15	16
Vegetation	97	87	97
Geomorph/Geol	17	18	3
Climate	3	19	6
Total	167	139	122

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Table 3. A comparison of ecological type and ecological site description (ESD) classification and mapping methods. The comparison is made using Winthers et al. (2005) and USDA-Natural Resources Conservation Service (1997, amended 2003).

Item of Comparison	Ecological Type	Ecological Site
Land Classification System References	-FSM 1940, FSM 2060, FSH 2090 -Terrestrial Ecological Unit Inventory Technical Guide: Landscape and Land Use Planning and Analysis Levels (Winthers et al. 2005) -National Hierarchical Framework of Ecological Units (Cleland et al. 1997)	-Agriculture Handbook 260, Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin (USDA-Natural Resources Conservation Service 2006) -National Range and Pasture Handbook (USDA-Natural Resources Conservation Service 1997, amended 2003) -National Forestry Manual (USDA-Natural Resources Conservation Service 1998)
Classification System Hierarchy Levels	Ecological Unit Hierarchy Levels: Ecoregion, Subregion (Section, Subsection); Landscape; Landtype association (LTA); Landscape (LT); Landtype phase (LTP). http://databases.fs.fed.us/other_resources/conservation.html , accessed 7 December 2008	Land Resource Region (LRR); Major Land Resource Area (MLRA); Land Resource Unit (LRU) (not used in all states, or modified by each state); Ecological Site. http://databases.fs.fed.us/other_resources/conservation.html , accessed 7 December 2008
Basic Unit of Classification	Ecological type: a category of land with a distinctive (that is, recognizable) combination of landscape elements. The elements making up an ecological type are climate, geology, geomorphology, soils, and potential natural vegetation. Ecological types differ from each other in their ability to produce vegetation and respond to management and natural disturbances (Winthers et al. 2005).	Ecological site: a distinctive kind of land with specific soil and physical characteristics that differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation, and in its ability to respond similarly to management actions and natural disturbances.
Vegetation Dynamics	Serial states and/or seral community types describe vegetation community change and successional processes. State-and-transition models can be accommodated in Terrestrial Ecological Unit Inventory (TEUI) (see p. 28 in Winthers et al. 2005), and efforts are underway to implement it.	State-and-transition models integrate responses to management and natural disturbances.
Ecosystem Classification and Mapping Differentiation Criteria	Potential natural vegetation - soil factors (including soil taxonomy) = abiotic site factors (geology, geomorphology, climate) All contribute to understanding inter-relationships among environmental settings needed to understand ecosystem responses and develop management interpretations. Potential natural vegetation is used as a reference to capture site capabilities.	Historic Climax Plant Community - Soil Series or Series Phase. Abiotic and soil factors are considered up front and incorporated into soil series or soil series phases in soil mapping.

Table 4. Crosswalk of Valles Caldera National Preserve (VCNP) TEUI Veg. Classes With MLRA48 ESDs & Muldavin VCNP Veg. Classes.

Veg Structural Class	Alliance Group	Muldavin VCNP Mapped Veg Class	TEUI Subseries Veg Class	NRCS ESD R084A
Forest	Rocky Mt. Spruce Fir	Spruce-Fir Forest & Woodland Dry	Pine	Pine White/Pine
		Spruce-Fir Forest & Woodland Moist	Pine/Abies/Pine	Pine/Abies/Pine
	Rocky Mt. Aspen Forest	Aspen Forest & Woodland Dry	Pine/Abies/Pine	Pine/Abies/Pine
		Aspen Forest & Woodland Moist	Pine/Abies/Pine	Pine/Abies/Pine
	Rocky Mt. Mixed Conifer	Mixed Conifer Forest & Woodland Dry	Abies/Pine/Pine	Pine/Abies/Pine
		Mixed Conifer Forest & Woodland Moist	Abies/Pine/Pine	Pine/Abies/Pine
		Blue Spruce Pinyon Pine	Pine/Abies/Pine	Pine/Abies/Pine
		Blue Spruce Pinyon Pine	Pine/Abies/Pine	Pine/Abies/Pine
	Rocky Mt. Ponderosa Pine	Ponderosa Pine Forest & Woodland	Pine	Pine
		Ponderosa Pine Forest & Woodland	Pine	Pine
Shrublands	Rocky Mt. Montane Shrubland	Gambel Oak-Mixed Montane Shrubland	Quercus/Grass	Quercus/Grass
		Upper Montane Grassland	Quercus/Grass	Quercus/Grass
	Rocky Mt. Montane Grassland	Upper Montane Grassland	Quercus/Grass	Quercus/Grass
		Lower Montane Grassland	Quercus/Grass	Quercus/Grass
		Montane Wet Meadows	Quercus/Grass	Quercus/Grass
		Montane Wetland	Quercus/Grass	Quercus/Grass
	Herbaceous Veg	Montane Wet Meadows	Quercus/Grass	Quercus/Grass
		Montane Wetland	Quercus/Grass	Quercus/Grass
		Montane Wet Meadows	Quercus/Grass	Quercus/Grass
		Montane Wetland	Quercus/Grass	Quercus/Grass

Table 5. Vegetation crosswalk of ESDs MLRA 39-New Mexico and the Gila NF TEUI Veg. Classes.

NRCS ESD	Gila NF TEUI
F039XA001NM-Forestland (PSME-POTRS/QUGA-RONE/POFE)	POTRS/RONE
F039XA002NM-Forestland (PIPO-PSMEG/QUGA-CEMO2/POFE)	QUGA/RONE
F039XA003NM-Forestland (PIED-JUSC2/QUGA/BOGR2)	PSMEG/PIPOS/QUGA
F039XA004NM-Forestland (PIPOS-JUDE2/QUGR3/FEAR2)	PIPO/QUGA
F039XA007NM-Forestland (PIPOS-PIED/MUM-BOCU)	PIED/JUDE2/QUGA
	PIPOS/JUDE2/QUGR3
	PIPOS/JUDE2
	PIPOS/FEAR2
	PIPOS/MUMO
	PIPOS/BOGR2

Methods

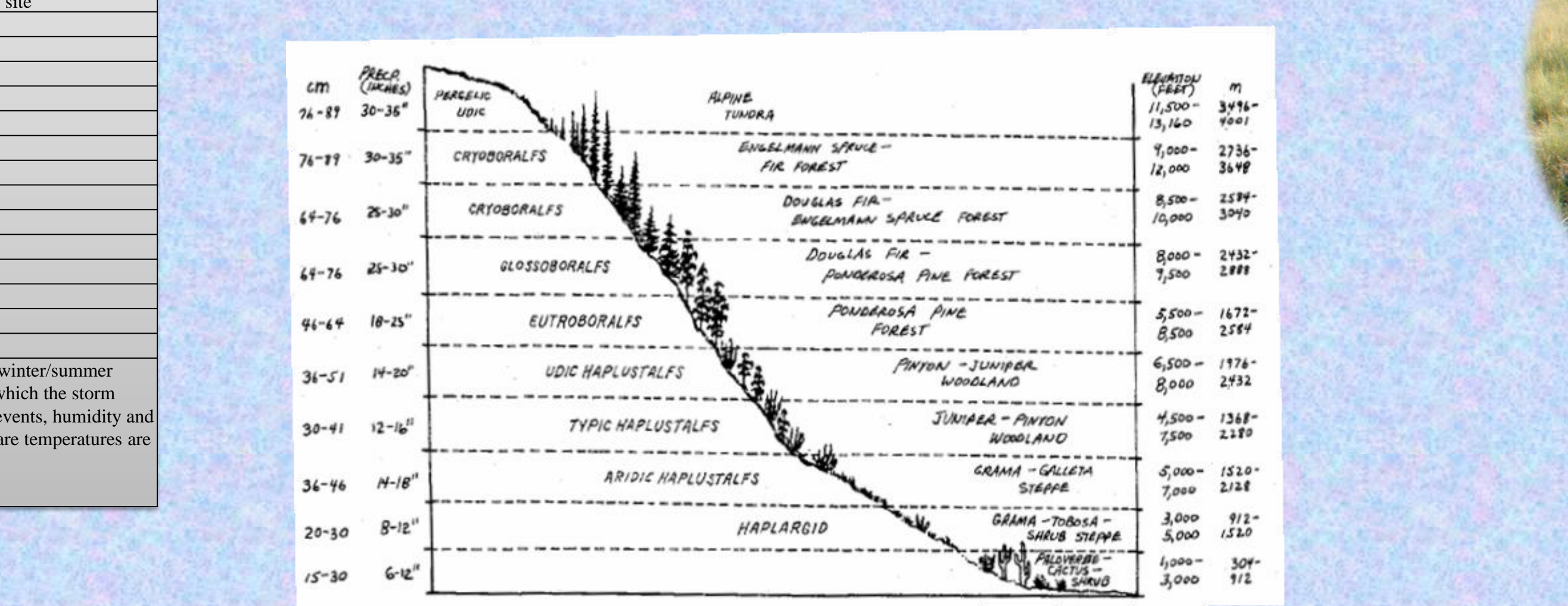


Figure 1. 'Altitude sequence' of soils and vegetation in New Mexico (Jenny, 1980).

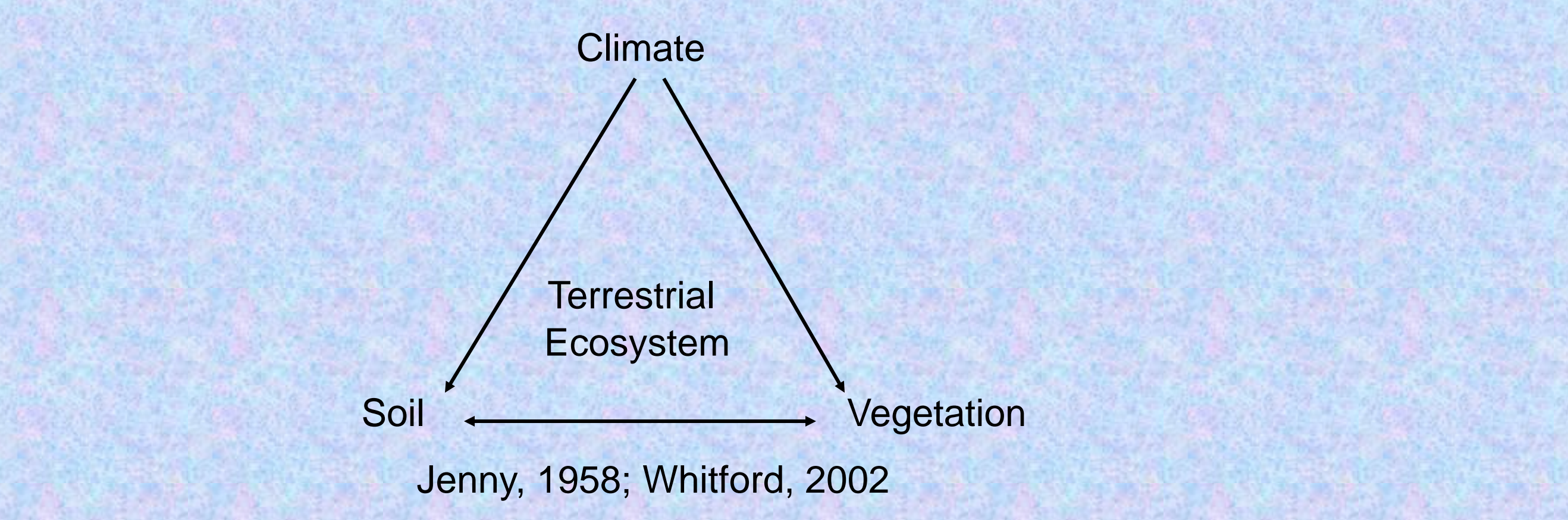


Table 6. Direct gradient analysis matrix integrating climate, soil and vegetation by life zone.

Climate Gradient - Tomo National Forest							Climate Descriptors
Life Zones							
1	2	3	4	5	6		
Lower Sonoran Desert	Upper Sonoran Desert	Grassland	Woodland/Chaparral	Coniferous Forest	Mixed Conifer		
Granite Reef Dam	...	...	Pleasant Valley R.S.	...	...	NDRA
...	Burlett Dam	Gabe R.S.	...	Crow King	Tomo Creek	Weather Station	
1883 - 1979	...	1981 - 2003	1984 - 2004	1914 - 1996	...	Period of Record	
405	...	1133	1539	1804	1948	ME	
22	503	...	53	73	1948	MAP	
37	...	47	53	73	84	...	
14 (6%)	25 (52%)	29 (56%)	43 (89%)	49 (99%)	...	MLSP	
20	...	12	...	12	...	MAAT	
...	21	16	12	10	...	...
...	18.9 - 23.9 (2)	15.0 - 18.3 (2)	11.1 - 13.3 (2)	7.8 - 13.3 (6)	8.9	MAST	
...	20.6 - 22.2 (2)	18.3 - 20.2 (1)	15.6 - 17.9 (3)	12.2 - 12.8 (1)	...	...
...	29.4 - 32.8 (2)	25.6 - 28.9 (2)	...	12.2 - 21.7 (6)	11.7	MSST	
...	30.0 - 34.4 (2)	28.0 - 30.2 (1)	22.2 - 29.4 (3)	16.3 - 20.0 (1)	...	...
...	8.9 - 12.2 (2)	2.8 - 11.1 (2)	...	6 - 7.2 (6)	7.2	MWST	
...	8.3 - 18.9 (2)	8.3 - 12.4 (2)	2.8 - 7.8 (2)	4.4 - 11.7 (5)	5.9 - 10.5 (1)	...	
Arctic	Arctic	Arctic	Arctic	Arctic	Arctic	SMR	
Hyperthermic	Thermic	Thermic	Thermic	Mesic	Mesic	+	
...	Thermic	Thermic	Thermic	Mesic	Mesic	0	
...	Thermic	Thermic	Thermic	Mesic	Mesic	-	
...	Thermic	Thermic	Thermic	Mesic	Mesic	STR	
Type	Udic	Udic	Udic	Udic	Type	Soil Subgroup	
Hypergys	Hypergys	Hypergys	Hypergys	Hypergys	Hypergys	Soil Great Group	
LA/TFT	CA/GP	BO/HA	QU/FL	PI/OS	PI/EG	Veg. Series Name	

Life Zone Ecoregions - Within each life zone, climate variability (dryness, coolness) influences plant species composition and soils. The central concept (typical of)

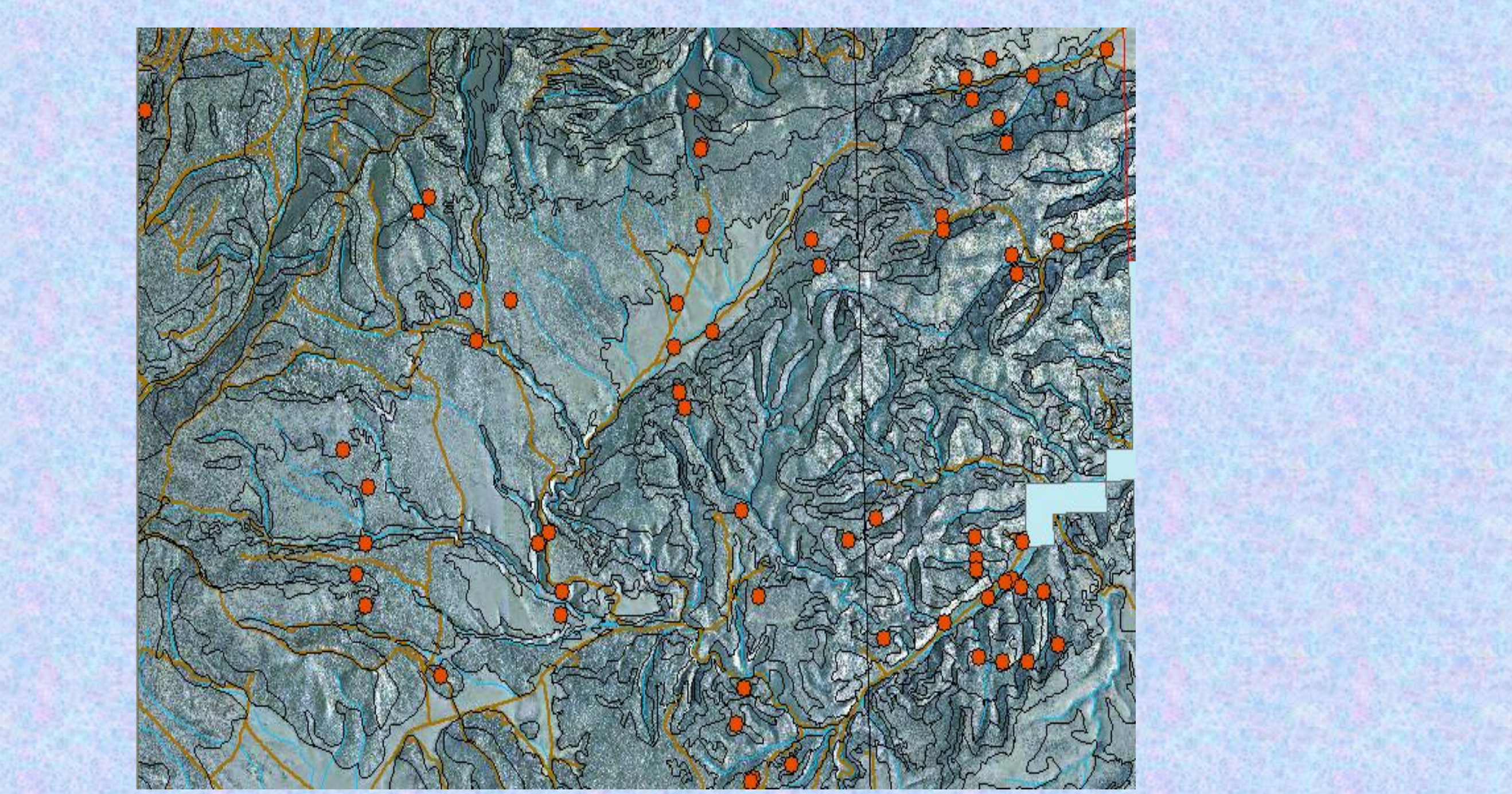


Figure 2. Plots are sampled where climate, soil, vegetation, landform, geology and site characteristics are combined to formulate ecological sites. Initial ecological map unit delineation for locating ecological sites derived from the TEUI Geospatial Toolkit.



ECOLOGICAL SITE DESCRIPTION		VEGETATION	
Map Symbol	Representative Soil Series	Tree %	Shrub %
Map Unit Component	Soil Series	Forb %	Grass %
Map Unit Name	Soil Series	Herb %	Other %
Map Unit Setting	Soil Series
Map Unit Description	Soil Series
Map Unit Location	Soil Series
Map Unit Date	Soil Series
Map Unit Author	Soil Series
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