

Historic Ponderosa Pine Stand Structure of Mollisols, and Mollic Integrate Soils on the Coconino National Forest, 7/25/2007

Purpose of Analysis: This analysis attempts to determine historic vegetative stand structure (grassland, open or closed forest stand) of ponderosa pine dominated Mollisols (those soils with a high accumulation of surface organic matter common in grasslands), and Mollic integrate soils (those soils with thinner organic matter accumulations in the soils surface) on the Coconino National Forest.

The central question posed is were current ponderosa pine vegetation types found on Mollisol soils present historically or are they grassland vegetation types that have been invaded by ponderosa pine through disturbances or lack thereof?

Historic ponderosa pine stand structure will be determined through air photo change detection interpretation and on-site investigation by TES ecological unit (integration of soil, vegetation and climate). Historic stand structure is based on analysis and comparison of past and current canopy cover (aerial photo, field sheets), size and age class and presence of old stumps on-site. This information will be useful to determine any current deviation from historic (reference conditions) of Forest stand structure that signifies an ecological need for changes in the 2007 Forest Plan revision process. This information is intended to be used internally (by Forest Plan Revision Interdisciplinary Team members) and has not been edited, peer reviewed or submitted for publication.

Historically, periodic fire disturbance (average fire interval around 5 – 36 years, TNC. 2006) in ponderosa pine is believed to have maintained Ponderosa Pine in more open, less dense stands. Historically, frequent ground fires are believed to have caused seedling and sapling tree mortality resulting in more open stands and larger grassy interspaces compared to current conditions. Contemporary disturbances (fire suppression, grazing, and drought) have produced greater acres of closed canopy forest, altered fire regimes and ecological conditions associated with closed canopies.

In addition, the information collected and reported here could be useful in comparing, supporting and validating information presented in VDDT modeling.

Methodology: For the purpose of this analysis, historic conditions represent those conditions of 100-125 years or older (generally pre-1900). Canopy cover of ponderosa pine vegetation types were interpreted from 1948 and 1949 resource photographs by TES ecological unit and compared to 2003 vintage digital orthophoto quads to determine change in canopy cover over time, by size class of trees. 146 representative (based on average canopy cover appearance on photos) sites (photo stops) were compared and about 60 were visited on-site. These sites selected ponderosa pine vegetation types dominated by either Mollisol soils or Mollic integrate soils. Not all TES map units containing Mollisols or Mollic integrates were sampled. In addition, many other ponderosa pine vegetation types occur on many other non-Mollisol soil types on the Forest but are not specifically studied in this analysis.

The Flagstaff Center including the Peaks, Mormon Lake and Happy Jack Ranger Districts were the only areas of the Forest sampled because they make up the largest areas of Ponderosa Pine PNVT on the Forest. Neither the Blue Ridge Ranger District nor portions of the Red Rock Ranger District were sampled. Results and conclusions found in this analysis may not accurately reflect historic ponderosa pine stand structure in these areas.

On-site field data collection was performed to validate air-photo interpretations made and collect more accurate information of historic stand structure on a large sample (41%) of photo stops. On-site investigations included collection of canopy cover (ocular estimation) by three size classes, small (<11"DBH, medium (11-20" DBH), and Large (>20 " DBH). Stumps were noted and a corresponding projected historic canopy cover estimated. Tree age was determined through the use of a tree auger.

Historic canopy covers by TES unit were then determined by adding tree and projected stump canopy covers older than 100-125 years. A corresponding ponderosa pine stand structure was then determined and classified into one of the following three classes; closed (>30% tree canopy cover (cc), Open (10 – 30% tree cc), or Grassland type (<10% tree cc).

All field stops were photographed with a digital camera. Photos were labeled and inserted into a powerpoint program. The powerpoint program is located on the Forest server under the following area path k:\ppt\sw\fp_revision\ForestPlanRevisionSoils.ppt. Please contact Rory Steinke(Coconino National Forest Watershed Program Manager) for further information at 928-527-3451.

PNVT Classification and Limitations: Coconino National Forest Potential Natural Vegetation Types (PNVT's) aggregated Terrestrial Ecosystem Survey (TES) map units (Ecological Units) into recognized PNVT's defined by The Nature Conservancy.

The TES Ecological Units (and soils) are derived from the Forest Ecological Unit Inventory, The Terrestrial Ecosystems Survey (TES) of the Coconino National Forest, 1995. The TES is the result of the systematic analysis, mapping, classification and interpretation of terrestrial ecosystems also known as ecological types delineated and numbered in ecological units. It is the only seamless mapping of vegetation and soils available across the Forest that includes field visited, validated and correlated sites with a stringent Regional and National protocol stemming from decades of work. Major field work for the TES was completed during the period of 1987 through 1991. Soil names and descriptions were approved in 1992. Map units are identified by numbers ranging from 11 to 850.

It is important to realize that differences in ecosystem properties including soil and vegetation can occur within short distances. The TES was mapped at a scale of 1:24,000 across the landscape. Generally, small vegetation types smaller than about 10 to 40 acres were not mapped and are included in larger TES map units

Individual map units were based on data collected across the Forest and may or may not represent landscape existing conditions and potential plant community as depicted in the TES. Overall accuracy of mapping and information provided by the TES is considered reliable at the ecological unit or landscape level.

Disturbances: The published TES identifies the potential plant community (PPC) and is based on documented reference sites Forest and Region-wide under contemporary disturbances. The published TES identifies the potential plant community (PPC) and is based on documented reference sites Forest and Region-wide under contemporary disturbance.

Within the Forest, the PPC, and therefore the PNVT indicates site potential and classified according to the late successional vegetation species that would be expected to occupy the site in the absence of major disturbance (Triepke, May 2007) derived from ‘Southwest Forest Assessment Project’ (TNC 2006), Appendix 2-B. Similar to *biophysical settings* conceptualized in the Interagency Fire Regime Condition Class Guidebook (v1.2, 2005), PNVTs combine potential vegetation and historic fire regime to form ecosystem classes useful for landscape assessment:

PNVT = PNV + Historic Fire Regime

The PNVT’s are the result of historic disturbances but more recently developed under the absence of major, chronic disturbances believed to have been present and responsible for vegetative state canopy conditions under historic conditions. For Forest Plan revision analysis, it is necessary to produce information that compares and estimates historic vegetative state conditions to current condition to determine deviations that signify an ecological need for change.

Table 1 summarizes information by TES map unit for the estimated dominant, historic vegetative state. It is recognized that multiple ecological seral stages and vegetative states existed. For purposes of this analysis, the dominant, historic state is estimated based on soil capability and climate under historic disturbances.

Results:

Table 1 displays data collected by photo stop number and infers historic stand structure.

Complete field forms and data collected reside in the Coconino National Forest Supervisors office in hardcopy and some in electronic format (Rory Steinke, Watershed Program Manager).

Table 1. Data by TES Ecological Unit

S = Small (< 11 " DBH), M = Medium (11-20"), L = Large (>20")

Stand Structure: Grass = < 10% CC, 10-30% CC = Open, >30% CC = Closed

TES Map Unit	Photo Stop #	% Tree Canopy Cover by Size Class, 1949	% Tree Canopy Cover by Size Class, 2003	Inferred Historic (pre-1900) % Tree CC and Structure (7/2007 data in bold green)	Comments
55	116	<5	<5	<5 Grass	static, few Pupos
55	28	2 L	5 SML	<5% Grass	static/few encroach
55	96	<5	<7	<5% Grass	static boundary
55	107	<5	<5	<5% Grass	static, few Pupos
55	133	<5	<5	<5% Grass	static bdy
436	78	30-35 SML	10	25-30% Open	PJ, some treated patchy grasslands
453	143	0-10 SM	0-15 SM	8-10% Grass	
500	75	20 ML	50 ML	< 25% Open	
500	85	20 ML	40 ML	<20% Open	N. golf course
500	86	20 ML	40 ML	<20% Open	
500	77	25 ML	50 ML	<30% Open	
505	81	20 ML	40 ML	<25% Open	some grasslands
515	19	1	1	<10% Grass	few PP stringers
515	73	5-15 ML	<10 SML	<10% Grass	some treated
515	51	<5	<5	<5% Grass	some filled in PP
515	66	3 ML	<10 SML	<5% Grass	LM Area
515	141	<5	<10%	<5% Grass	trt. areas filling in
517	140	20 MLS	45 ML	20% Open	
517	143 (2)			8-10% Grass	some <10% 1949
523	50	10 ML	45 ML	<15% Open	
523	23	15 ML	45 SML	<20% Open	
523	72	25 ML	45 ML	<25% Open	
523	76	20 ML	45 ML	<25% Open	
523	145			<25% Open 25-27%	1/3 Grass
523	67	20 ML	25-35 SML	Open	
523	144			5% Grass	
523	139	15 ML	40 ML	5-10% Grass	33% Forest
523	142	0-25 ML	3-40 SML	5-10% Grass	some Forest
523	18	5 ML	40 ML	5-10% Open	Open/grassland
524	79	15 ML	40 ML	<25% Open	

TES Map Unit	Photo Stop #	% Tree Canopy Cover by Size Class, 1949	% Tree Canopy Cover by Size Class, 2003	Inferred Historic (pre-1900) % Tree CC and Structure (7/2007 data in bold green)	Comments
524	80	5-20 ML	40 ML	18% Open	some grasslands
527	74	35 ML	45 ML	>30% Closed	
532	62	55 North ML	60 North	>45% N Clsd	
536	103	10 ML	15 ML	<10% Grass	20 ac incl. meadow
536	99	8 ML	20 ML	<10% Grass	30 ac incl. meadow
536	84	10-15 ML	45 ML	<25% Open	MLRD office area
536	100	20 ML	40 ML	<25% Open	
536	93	20 ML	35 ML	<30% Open	
536	83	40 ML	50 ML	>30% Closed	
536	92	20 ML	40 ML	15% Open	logged
536	101	35 ML	45 ML	15% Open	
536	105	25 ML	40 ML	17% Open	airport, logging?
536	104	35 ML	45 ML	20% Open	pulliam airport
536	106	40 ML	55 ML	25 Open	Old Munds hwy. 1/3 clsd, 2/3 open
537	102	25 ML	45 ML	<30% Open 25-30% Open	
537	91	25 ML	45 ML	Open	
550	88	40 ML	55 ML	>30% Closed	
551	16	25 ML	55 ML	>30% Closed	
551	59	25 L	55 SML	25% Open	recent WUI trtmnt Meadow Inclusion
557	39	10 ML	25 ML	<10% Grass	
557	38	20 ML	55 ML	<30% Open	
560	64	25 ML	55-60	<25% Open	
560	63	25 ML	2000%	<30% Open >30 Closed	recent burn
562	40	>60 North	>60 North	N. 25% Open S. Closed, N.	
562	127	25 ML	55 ML		static, some Pupos
566	82	<5	<5	<5% Grass	
567	90	25 ML	45 ML	<30% Open	
567	89	35 ML	50 ML	>30% Closed	
567	87	15 ML	50 ML	20% Open	S. CCC
570	35	25 ML		<20% Open	some > cc
570	11	25 ML		<30% Open	
570	37	35 ML	55-60 ML	>35% Closed	
582	36	15 ML	55 ML	< 25% Open	

TES Map Unit	Photo Stop #	% Tree Canopy Cover by Size Class, 1949	% Tree Canopy Cover by Size Class, 2003	Inferred Historic (pre-1900) % Tree CC and Structure (7/2007 data in bold green)	Comments
582	25	25 ML	< 25 SML	< 30% Open	Recent Fire Meadow Inclusion
582	41	<10 SML	10-15 SML	<10 Grass	Meadow Inclusion
582	6	5 ML	40	<10% Grass	Meadow Inclusion
582	27	8 ML	20 ML	<10% Grass	Meadow Inclusion
582	52	5 ML	<10	<10% Grass	recent burn
582	120	15 ML	25 SML	<15% Open	Grass inclusion
582	1	20 ML	55 ML	<20% Open	
582	9	15 ML	45 ML	<20% Open	
582	45	15 ML	35 ML	<20% Open	
582	49	20 ML	50 ML	<20% Open	
582	2	25 ML	50 ML	<25% Open	
582	4	20 ML	50	<25% Open	
582	17	15 ML	50 ML	<25% Open	
582	22	20 ML	45 ML	<25% Open	
582	113	20 ML	35 ML	<25% Open	
582	20	20 ML	50 ML	<30% Open	
582	32	25 ML	50 ML	<30% Open	
582	53	20 ML	45 ML	<30% Open	
582	54	25 ML	60 ML	<30% Open	
582	111	25 ML	50 ML	<30% Open	
582	128	25 ML	45 ML	<30% Open	
582	131	20 ML	50 ML	<30% Open	
582	134	25 ML	45 ML	<30% Open	
582	21	3 ML	10 ML	<5% Grass	Meadow Inclusion
582	26	30 ML	55 ML	>30% Closed	
582	30	30 ML	55 ML	>30% Closed	
582	47	35 ML	45 ML	>30% Closed	
582	56	35 ML	55 ML	>30% Closed	
582	58	35 ML	50 SML	>30% Closed	
582	97	35 ML	55 ML	>30% Closed	
582	109	30 ML	50 ML	>30% Closed	
582	135	35 ML	55 ML	>30% Closed	
582	29	20 ML	40 SML	10-15% Open	
582	10	15 ML	45 ML	15-20% Open	
582	137	15 ML	20 ML	20-25% Open	
582	124	25 ML	45 ML	25% Open	

TES Map Unit	Photo Stop #	% Tree Canopy Cover by Size Class, 1949	% Tree Canopy Cover by Size Class, 2003	Inferred Historic (pre-1900) % Tree CC and Structure (7/2007 data in bold green)	Comments
582	136	25 ML	55 ML	25% Open	
582	108	35 ML	50 ML	25-30 Open	
582	115	35 ML	50 ML	25-30 Open	
582	8	20 ML	50 ML	25-30% Open	
582	57	20 ML	50 ML	25-30% Open	
582	129	30 ML	45 ML	25-35% Closed	
582	119	25 ML	45 ML	30-35 Closed	
582	117	45 ML	55 ML	30-35% Closed	
582	122	40 ML	55 ML	35% Closed	
582	130	2-15 ML	2-35 ML	5-10% Grass	65% meadow incl.
584	98	40 ML	60	>30% Closed	35-40% HRV
584	110	40 ML	55 ML	20-30% Open	1/3rd closed
584	126	35 ML	55 ML	25-30% Open	
585	60	15 ML	45 SML	<25% Open	
585	70	25 ML	45 ML	<25% Open	
585	118	20 ML	45 ML	<25% Open	
585	42	20 ML	45 SML	<30% Open	
585	132	20 ML	45 ML	<30% Open	
585	69	5	<10	<5% Grass	Meadow Incl 35 ac
585	94	35 ML	50 ML	>30% Closed	
585	95	35 ML	50 ML	>30% Closed	
585	55	25 ML	50 ML	10-15% Open	
585	146			15% Open	
585	112	25 ML	50 ML	15-20% Open	
585	114	25 ML	40 ML	Open	
585	125	25 ML	55 ML	20% Open	
585	125	25 ML	55 ML	25% Open	
586	48	15 ML	45 SML	<25% Open	
586	65	25 ML	<25	<25% Open	recent burn
586	68	15 ML	35 ML	<25% Open	
586	71	25 ML	45 ML	<25% Open	some meadow
586	33	20 ML	40 ML	<30% Open	100
586	138	20 ML	45 ML	<30% Open	

TES Map Unit	Photo Stop #	% Tree Canopy Cover by Size Class, 1949	% Tree Canopy Cover by Size Class, 2003	Inferred Historic (pre-1900) % Tree CC and Structure (7/2007 data in bold green)	Comments
586	24	25 ML	55 ML	>30% Closed	
586	31	35 ML	55 ML	>30% Closed	
586	43	45 ML	60 ML	>40% Closed	
586	121	25 ML	40 ML	20% Open	
586	44	35 ML	55 ML	25-30 Open	
				25-35%	
586	123	30-35 ML	55 ML	Closed	
595	3	1	2	<2% Grass	
595	5	1	1	<2% Grass	
595	7	1 S	5 ML	<2% Grass	
595	46	<5 ML	<5 ML	<5% Grass	static, few Pupos
				static, few PP	
595	34	<5 ML	<5 ML		
612	15	40 ML	40 ML	>50% Closed	
613	13	40 ML	40 ML	>50% Closed	Mix Conifer
634	14	55 SML	55 SML	>50% Closed	Mix Conifer
640	61	5 SL	15 SML	<5% Grass	
KNF	12	5 ML	50 ML	<10% Grass	Meadow

Table 2 displays soil classification, % Mollisols and Mollic Integrades, Climate Class, PNVT on current map and Inferred Dominant Historic PNVT based on change detection of resource photos and on-site filed validation. It is recognized that historic vegetative state/type was variable due to different levels of disturbance but the overall dominant historic state is inferred.

Key:

- <10% Tree Canopy Cover = Grass Vegetative State or Stand Structure
- 10-30% Tree Canopy Cover = Open Vegetative State or Stand Structure
- >30% Tree Canopy Cover = Closed Vegetative State or Stand Structure

Table 2

TES Map Unit	Soil Classification	% Mollisols or Mollic Integrate	PNVT on Current Map 2/2007	Climate Class	Inferred Dominant Historic Vegetative State/Type
55	Mollisols	100%	Montane/Subalpine Grassland	LSC, 5,0	Grass/ Montane/Subalpine Grassland
505	Mollic Eutroboralfs, deep, cnv-l	>90	Ponderosa Pine (Pipos/Pied?Jude2 Quga)	HSC, 5,-1	Open Canopy/ Ponderosa Pine
515	Vertic Argiborolls, deep, cb-l	>90	Great Basin Grasslands	HSC, 5,-1	Grass/Great Basin Grasslands, few pine stringers
523	Mollic Eutroboralfs, deep, cbv-cl	90	Ponderosa Pine	HSC, 5,-1	Open Canopy/ Ponderosa Pine Pine mixed with large, grassy interpaces
524	Mollisols/Mollic integrades, mod. deep, cbv-l	50/30	Ponderosa Pine	HSC, 5,-1	Open Canopy and Grass/ Ponderosa Pine mixed with large, grassy interpaces
527	Mollisols, shallow and mod. deep, cbx-fsl	80	Ponderosa Pine	HSC, 5,-1	Open Canopy and Grass/ Ponderosa Pine mixed with large, grassy interpaces
536	Mollic Eutroboralfs, mod. deep, fsl	55	Ponderosa Pine Pipos/Fear2	LSC, 5,0	Open Canopy/ Ponderosa Pine
537	Mollisols, shallow and mod. deep, stv-sl	50	Ponderosa Pine Pipos/Fear2	LSC, 5,0	Open / Ponderosa Pine
550	Mollic Eutroboralfs, deep, cb-fsl	45	Ponderosa Pine	LSC, 5,0	Open and Closed /Ponderosa Pine
551	Mollic Eutroboralfs, deep, stv-sl	>85	Ponderosa Pine Pipos/Fear2	LSC, 5,0	Open to Closed/Ponderosa Pine

TES Map Unit	Soil Classification	% Mollisols or Mollic Integrate	PNVT on Current Map 2/2007	Climate Class	Inferred Dominant Historic Vegetative State/Type
557	Mollic Eutroboralfs, deep, gr-l	>80	Ponderosa Pine	LSC, 5,0	Open Canopy/Ponderosa Pine
560	Ustochrepts, deep, ashy-skeletal	<15%	Ponderosa Pine (S. Aspect) and Mixed Conifer (N. Aspect)	LSC, 5,0	Open Canopy on South Aspect/Closed on North Aspect/ Ponderosa Pine
562	Ustochrepts/Eutrochrepts, deep, ashy-skeletal	<10	Ponderosa Pine	LSC, 5,0	Closed Canopy/Ponderosa Pine
566	Haploborolls, deep, cnv-sl	>95	Montane/Subalpine Grassland	LSC, 5,0	Grass/ Montane/Subalpine Grassland
567	Mollic Eutroboralfs, deep, fsl and mod. deep Typic Eutroboralfs	<35	Ponderosa Pine Pupos/Jude2/Quga	LSC, 5,0	Open Canopy/ Ponderosa Pine
570	Mollic Eutroboralfs, mod. deep and Typic Eutroboralfs, mod. deep	<15	Ponderosa Pine	LSC, 5,0	Open to Closed Canopy/Ponderosa Pine
582	Typic Argiborolls, deep, gr-l and Mollic Eutroboralfs, mod. deep, cb-l	70 and 30	Ponderosa Pine	LSC, 5,0	S. of I-40 is Generally Open. Some Closed Canopy in central and southern portion of Forest where it is open to closed Ponderosa Pine /. N. of I-40 is Open Canopy and Grass in large interspaces (mostly inclusions)/Ponderosa Pine and Montane Subalpine Grassland in some large interspaces Ponderosa Pine /.
584	Mollic Eutroboralfs, mod. deep, cb-l and Typic Argiborolls, deep, cbv-l	55 and 45	Ponderosa Pine	LSC, 5,0	S. of I-40 is generally Open. Some Closed Canopy (especially in central and

TES Map Unit	Soil Classification	% Mollisols or Mollic Integrate	PNVT on Current Map 2/2007	Climate Class	Inferred Dominant Historic Vegetative State/Type
					southern portions of Forest) Ponderosa Pine./ N. of I-40 is Open Canopy/ Ponderosa Pine
585	Lithic Eutroboralfs, shallow, stx-1 and Mollic Eutroboralfs, mod. deep, cbv-1 and Mollisol inclusion	55	Ponderosa Pine	LSC, 5,0	Generally Open. Some Closed Canopy (especially in central and southern portions of Forest) /Ponderosa Pine
586	Mollic Eutroboralfs, mod. deep, stv-1	85	Ponderosa Pine	LSC, 5,0	Generally Open. Some Closed Canopy (especially in central and southern portions of Forest) /Ponderosa Pine
595	Mollisols	>90	Montane/Subalpine Grassland (Fear2/Mumo)	LSC, 5,0	Grass Montane/Subalpine Grassland
596	Haploborolls, shallow, grx-sl, steep, association with Psmeg and Rock Outcrop	20	Ponderosa Pine	LSC, 5,0	Open Canopy/Ponderosa Pine

Discussion:

Forest-wide photo interpretation (before field validations):

Current Stand Structure: Analysis of Table 1 shows that most (108 sites out of 123 sites or **88%**) of the Ponderosa Pine PNVNT currently has “**Closed**” stand structure. The remainder or about **9%** is “**Open**” or **3%** “**Grasslands**”.

Historic Stand Structure: This stage of the analysis estimated that most sites (about 83 out of 123 or **68%** of the photo points) in Ponderosa Pine PNVNTs were inferred to have **open** stands historically. 30 out of 123 or **24%** were inferred to be **closed** stands and about 10 out of 123 or **8%** were **grassland** states historically.

Mollisol presence indicates that historically, the soil was probably dominated by a competitive, herbaceous understory layer or grassland that broke down and formed a thick (7 – 10 inches or more), organic layer over time, especially on deep soils (> 40 inches to bedrock).

Mollisols on deep or moderately deep soils have a higher capability (greater water holding capacity) to support more biomass including herbaceous understories than on rocky or shallow Mollic integrate soils. Historically, Mollisols probably included large interspaces dominated by grassy, herbaceous understories capable of outcompeting trees for soil moisture and nutrients and carrying ground fires that resulted in seedling and sapling mortality, open canopies, grassy interspaces and fewer trees.

Field Validation Findings:

Approximately 60 sites were field visited. 56 sites were mapped as Ponderosa Pine PNVNT, 4 mapped as Montane/Subalpine Grassland PNVNT and 2 mapped as Pinyon-Juniper PNVNT.

The vast majority of the Ponderosa Pine PNVNT field validated sites (about 44 out of 56 or about 79%) were determined to be “Open” Ponderosa Pine PNVNTs historically while 6 or 11% were “Closed” historically. The remainder was “Open” sites found to be historic grasslands (further described below in portions of TES units 523 and 517).

Seven photo-interpreted “closed” sites were found to be open Ponderosa Pine PNVNT stands. Three field validated “closed” sites were found to be “closed”. Other visited sites included 4 Montane Meadows/Subalpine Grasslands PNVNT sites currently and historically and 2 Pinyon-Juniper PNVNTs.

Field validation suggests that change detection air-photo interpretation estimates were fairly similar (e.g 68% “Open” vs 79% “Open”) to field validated information collected except estimates of some “Closed” canopies may have been over estimated (24% vs. 11%) before field validation. **Therefore, there is a fairly high degree of confidence in the information presented in Table 1.**

Summary of Data Findings:

Current Ponderosa Pine Stand Structure (from Photo Interpretation and Field Validation and analysis of Table 1).	Inferred <u>Historic</u> Ponderosa Pine Stand Structure Range (from analysis of Table 1)
88% “Closed”	11% - 24% “Closed”
9% “Open”	68% - 79% “Open”
3% “Grassland”	8% “Grasslands”

Conclusions:

The central question posed was, were ponderosa pine vegetation types found on Mollisol soils present historically or are they grassland vegetation types that have been invaded by ponderosa pine through disturbances or lack thereof? **This analysis concludes that the Ponderosa Pine PNVT was dominated (possibly 68% – 79%, see Table 3) by an open stand structure (10 – 30% canopy cover) on Mollisols and Mollic integrate soils.** In addition, the Ponderosa Pine PNVT occurs on other non-Mollisol soils throughout the Coconino National Forest. Therefore, historically, Ponderosa Pine vegetation types were found on Mollisol soils historically and the great majority of sites were not grassland sites invaded by ponderosa pine. However, it is clear that over time, the majority of the Ponderosa Pine PNVT in the central and northern portions of the Forest has increased in density and canopy cover with the lack of fire disturbance in the ecosystem.

Most sites visited in Ponderosa Pine PNVT’s appear to have been historically dominated by open forest stands (10-30% tree canopy cover) especially in the central and northwest part of the Forest where Ponderosa Pine and Arizona Fescue plant associations prevail. Some scattered Ponderosa Pine and Gambel Oak plant associations located in the central or southern portions of the Forest (Happy Jack Ranger District) appear to have been closed Forest stands (>30% canopy cover) possibly due to slightly more annual precipitation received and lack of greater fire disturbance.

Current canopy covers on Mollisols and Mollic integrate soils are variable but commonly exceed 30 – 50% or more (representative of a closed canopy state). Historically these soils probably supported clumps of trees and grassy interspaces. It is speculated that Mollisol and Mollic integrate soils supported more herbaceous biomass in interspaces than soils with thinner organic surface horizons. However, this analysis cannot conclude that thinner organic soils (generally perceived to be forest soils) have smaller, less herbaceous interspaces and greater tree canopy covers than Mollisol and Mollic integrate soils because it was not analyzed.

Historic canopy covers were probably variable but dominated by “Open” stand structure. Natural fire disturbance probably maintained these stands in “Open” states. It should be hypothesized that the entire Forest was not historically “Open” because multiple seral stages probably existed forest-wide following fire disturbance or lack thereof creating areas of “Open”, “Closed” and early seral “Grassland” states.

For comparison purposes, the Midscale Ponderosa Pine PNVT vegetation modeling shows 84% of PNVT is currently in “Closed” states, 12% is “Open” and 4% in “Grass” state. This analysis shows similar numbers as followed, “current “Closed” state is about 88%, 9% “Open”, and 3% “Grass” states.

Midscale historic modeling (Coconino National Forest Ponderosa Pine Risk Assessment, 2007) shows reference conditions to be solely dominated (100%) by “Open” stand states while this analysis infers about 68% – 79% “Open” with the remainder including “Closed” and “Grassland” states. It is doubtful that 100% of the Forest was dominated by “Open” vegetative states as VDDT modeling suggests. A better understanding and analysis of VDDT modeling figures is needed to accurately compare results with this analysis.

Most currently mapped Ponderosa Pine PNVTS interpreted to be historic grasslands are actually inclusions of grassland soils (Montane/Subalpine PNVT) within Ponderosa Pine PNVT where the scale of TES mapping limited delineations finer than about 40 acres in size. These polygons would better fit into grassland PNVT’s if finer detailed mapping is desirable. There are however, a couple of areas (TES unit 523, and 517) in the NW portion of the Forest that appeared to have been historic grasslands where they are presently mapped as Ponderosa Pine PNVT.

Not all TES map units containing Mollisols or Mollic integrate soils were sampled in this analysis. However, it can be hypothesized that their current and historic stand structure closely resembles stand structure found in similar soils throughout the Ponderosa Pine PNVT.

It is beyond the scope of this analysis to accurately compare Ponderosa Pine states between non-Mollisol soils to Mollisol soils in the Ponderosa Pine PNVT. However, personal observations estimate that most non-Mollisol or Mollic integrate soils occurring in the Ponderosa Pine PNVT currently have “Closed” stands and historically may have had a higher percentage of “Open” stands somewhat similar to Mollisol soils in the Ponderosa Pine PNVT.

Grassland vegetation types and PNVTS: (Great Basin and Montane/Subalpine Grassland PNVTS) occur on Mollisol soils also but have been maintained historically and currently by recurring fire disturbance. Montane/Subalpine grasslands are identified by TES units 55, 515, 566, 595 and 640

These soils are Mollisols and currently classify as Grasslands where tree canopy cover is much less than 10%. Only narrow polygons (generally less than about 250 meters) have

young ponderosa pine seedlings, saplings and poles regenerating throughout but still less than about 10% canopy cover. Larger meadow patches have static boundaries and few pine trees invading the site except some encroachment along the meadow edge. One large transitional area north of Kendrick Park currently identified as a Ponderosa Pine/Pinyon –Juniper ecotone (TES unit 523 and some of TES unit 517) was probably historic grassland (Great Basin Grassland).

Most currently mapped Ponderosa Pine PNVTs interpreted to be historic grasslands are actually inclusions of grassland soils (Montane/Subalpine PNVT) within Ponderosa Pine PNVT where the scale of TES mapping limited delineations finer than about 40 acres in size. These polygons would better fit into grassland PNVT's if finer detailed mapping is desirable. There are however, a couple of areas (TES unit 523, and 517) in the NW portion of the Forest that appeared to have been historic grasslands where they are presently mapped as Ponderosa Pine PNVT.

Mixed Conifer PNVT's: were all observed to have “Closed” stand structure with canopy covers well over 30 – 50%.

Pinyon-Juniper PNVTs:

Although the conclusions above are based on Ponderosa Pine vegetation types, many of the same conditions, disturbances and processes occur in the Pinyon-Juniper Woodlands including non-Woodland soils (thinner, organic layer). PJ Woodland map units listed in the above table are the classified Mollisols on the Coconino National Forest.

Currently many PJ stands are closed (>30 - 50% canopy cover) with little or no herbaceous interspaces as a result of fire suppression, grazing disturbance and drought. PJ Woodlands in less disturbed sites provide herbaceous interspaces under a more open canopy (10 – 30 %). Personal observations indicate where PJ Woodland canopy cover exceeds about 40%, there is little to no herbaceous understory (with and without grazing) and soil condition declines.

Follow-up analysis of Pinyon-Juniper Woodland PNVTs historic vegetative conditions is recommended.

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