Bluewater Forest Restoration Project – Desired Condition Demonstration, Cibola National Forest

Purpose of Visit: *ERI*

- Discuss the concepts and various aspects of the desired conditions including: the degree of structural openness; the grass/forb/shrub matrix; the size (area, number of trees), shape, and spacing of tree groups; the interlocking crowns of trees within groups; the diversity and interspersion of tree structural (age, size) stages, and the sustainability of the desired conditions.
- Discuss the value of the desired conditions for wildlife habitat and food webs.
- Discuss how key elements of the desired conditions relate to natural disturbances.
- Discuss specific differing existing conditions that are moving towards the desired conditions.
- Discuss the ecological, social, and economic outcomes of achieving the desired conditions.

Project Area Background: *ERI*

- Demonstration site (stand 5A) represents a ponderosa pine forest growing on moderately-productive (average) site. This site has had fire exclusion since the early 1900s; with the exception of slash burning following cutting 25+ years ago.
- Past management: this site was cut 25+ years ago to remove diseased, dying and poorly-formed trees (sanitation/salvage cutting). Pre-treatment (2010) stand condition: uneven-aged structure/high-density, modeled fire behavior - high-intensity crown fire.
- Prescribed cutting treatment (focused on the desired conditions and restoration) were implemented during summer 2010. Prescribed burning treatments are scheduled for fall/winter 2011/12.
- Sandstone/shale soil parent materials.
- Plant association is variable (Ponderosa pine/Arizona fescue, Ponderosa pine/blue grama)

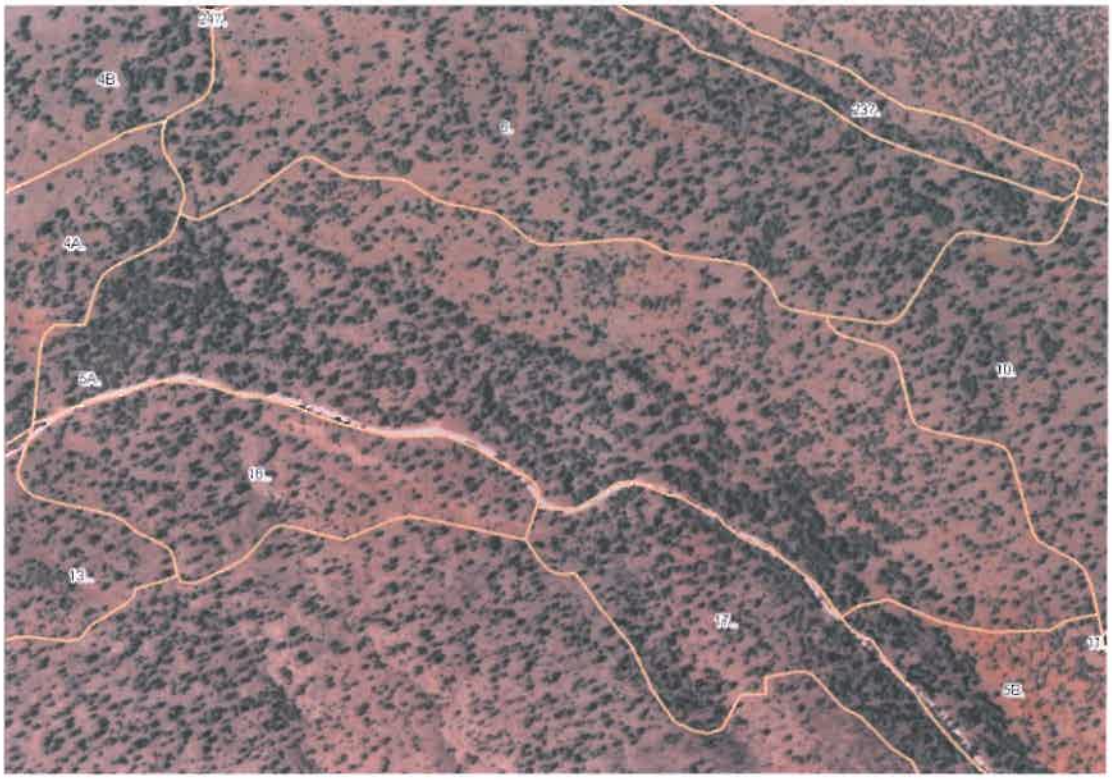
Demonstration Stand (post-treatment): *Jim Youtz (FS-RO)*

- Uneven-aged stand structure (3+ ages): within the stand, there are roughly balanced areas of young, mid, and old age trees with provision of suitable openings between tree groups for development of grass/forb/shrub component and localized recruitment of trees.
- Spatial patterns are <u>similar</u> to natural conditions
    - Mature tree groups with interlocking crowns
    - Fine–scale dispersion of tree groups
    - Grass/forb/shrub openings
- Small diameter woody debris abundance is higher than desired (pre-burning).
- Downed logs and snags are less than desired.
- Tree densities (within group and per unit area) are within desired ranges (overall avg. 40-80 sq. feet basal area).
- Seedlings have not yet established in desired locations.
- Desired grass/forb/shrub cover has not yet established.
- Modeled fire behavior is low-intensity surface fire.

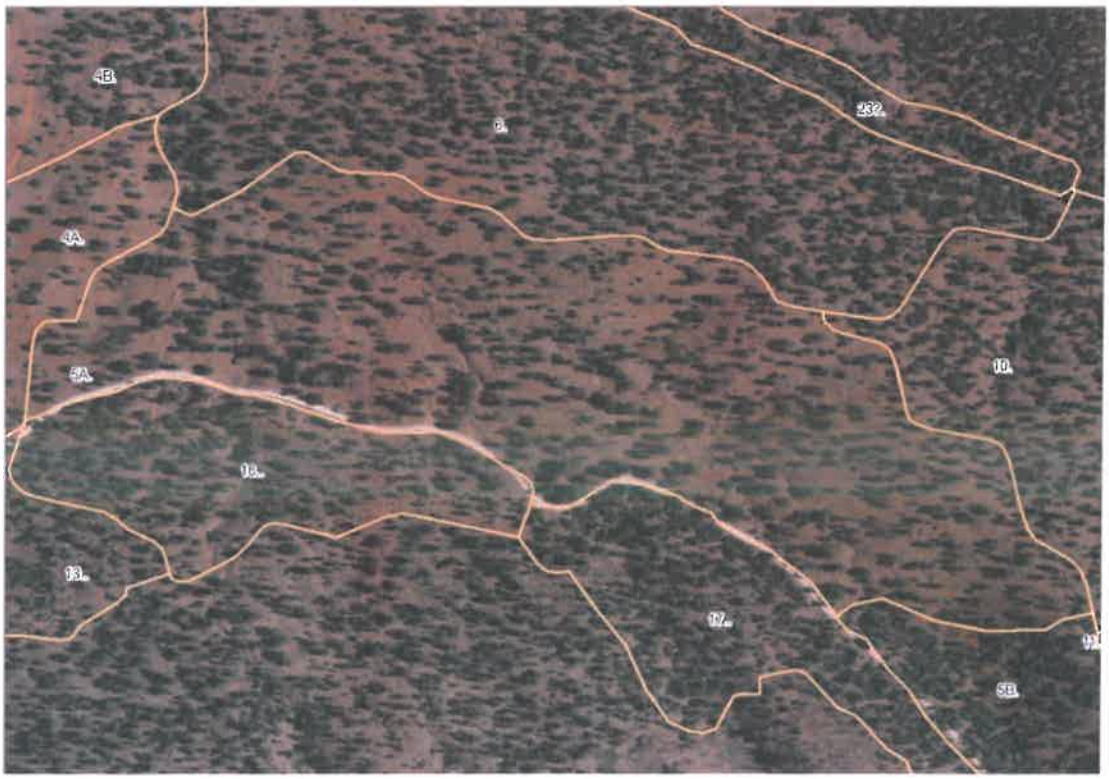
Bluewater Forest Restoration Project – Desired Condition Demonstration Data

Aerial photos

Pre-treatment



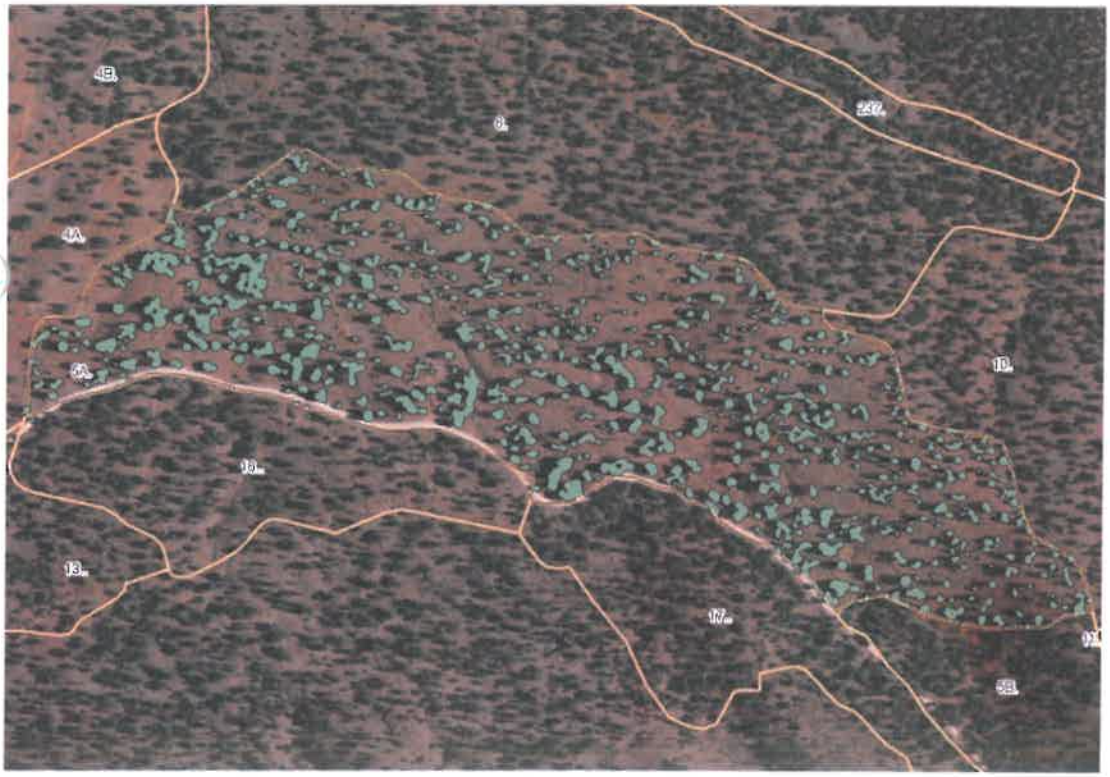
Post-treatment



Stand 5A exam data (post-treatment)

All Species Diameter Class	Trees/ Acre	Basal Area/ Acre
1 - 4.9 in	3.3	0.4
5 - 8.9 in	16.7	4.6
9 - 12.9 in	23.3	16.2
13 - 16.9 in	5.0	6.1
17 - 20.9 in	5.0	10.2
21 - 24.9 in	1.7	4.3
25 + in	1.6	6.1
Total	56.6	47.9

Current conditions (post-treatment) - spatial patterns



Spatial analysis results (Stand 5A)

- 48% of the area to be managed for tree cover
  - 28% of the area is currently represented under mid-old tree crowns (tree drip-line measurement)
  - 20% of the area to be managed for recruitment and/or development of tree seedlings/saplings
- 52% of the area to be managed as open grass/forb/shrub

Modeled future conditions

a. Forest structure (FVS simulation)

FVS SIMULATION: natural growth, no treaments
SIMULATION DONE: 10-11-2011

AVERAGE* SUMMARY STATISTICS BY COMMON CYCLE

year	trees/ acre	basal area	stand density Index	dominant ht	quadratic mean diameter	total cubic ft	merch. cubic ft	merc. board ft	years	cubic ft growth	cubic ft mortality
2011	57	47	72	48	11.6	786	676	3075	10	37	1
2021	198	57	118	53	7.2	1149	1017	4993	10	41	2
2031	195	71	141	58	8.2	1547	1387	7081	10	43	2
2041	264	87	176	63	7.8	1963	1786	9306	10	44	2
2051	259	102	200	67	8.5	2379	2185	11570	10	44	2
2061	269	118	226	70	9	2801	2574	13847	10	41	4
2071	261	131	244	73	9.6	3171	2930	15998	10	38	10
2081	240	139	252	76	10.3	3449	3246	17887	10	36	9
2091	223	147	259	78	11	3717	3547	19354	10	34	8
2101	210	154	266	79	11.6	3968	3815	20799	10	31	8
2111	199	161	273	81	12.2	4196	4057	22137	0	0	0

- This simulation assumes no treatments or fire occurrence for 100 years. Natural regeneration is imputed at intervals, based upon stand density and characteristic ponderosa pine development. Numbers of trees reflect in-growth without the thinning effects of fire or other management. The limited assumptions of this simulation (no fire occurrence or tree-cutting) does not imply management intent, but is presented to show projected growth without disturbances for discussion purposes.

b. Fire Behavior (Flam Map simulation –based on 2011 post-treatment conditions)

- Predicted surface fire on 99% of the area
- Predicted passive crown fire (torching) on 1% of the area

Table1. Historical forest structural characteristics of ponderosa pine (pine-oak shaded) forests of the Southwest, arranged by parent material and average tree density*.

Location	Parent Material	Elev. ft	Size/Age Reported	Ref. date	TPA			BA (ft^2/ac)			Citation
					range	average	stderr	range	average	stderr	
AZ-Coconino, Gus Pearson	Basalt	7398	Age	1875		15.0					White 1985
AZ-Coconino, Coconino (avg)[a]	Basalt	6907	Size	1910		16.0			38.1		Woolsey 1911
AZ-Coconino, GPNR[1]-6a[c]	Basalt	7400	Yes-S	1925		21.8			56.6		Pearson 1950
AZ-Coconino, Gus Pearson	Basalt	7300	No	1876		22.8			46.2		Covington et al. 1997c
AZ-Coconino, Bar M Canyon	Basalt	7000	No	1867	21-24	23.0			65.0		Covington & Moore 1994b
AZ-Coconino, Flagstaff-b	Basalt	7355	No	1880	1-58	23.7	4.0				Abella et al. 2011
AZ-Coconino, Gus Pearson	Basalt	7300	Age	1876		24.0					Mast et al. 1999c
AZ-Coconino, San Francisco Peaks	Basalt	8594	Age	1876		24.8	2.6		33.0	4.9	Cocke et al. 2005
AZ-GCPNM[2]-BLM, Mt. Trumbull	Basalt	7740	Age/Size	1870		25.2	3.5		38.8	6.1	Heinlein et al. 1999
AZ-Coconino, Coconino (max)[a]	Basalt	6907	Size	1910		34.5			81.2		Woolsey 1911
AZ-GCPNM-BLM, Mt. Logan-b	Basalt	7483	Age/Size	1870		38.3	5.8		46.2	7.8	Waltz & Fulé 1998
AZ-GCPNM-BLM, Mt. Trumbull	Basalt	6970	Size	1870	0-220	39.2	3.9	0-143	41.6	4.1	Roccaforte et al. 2010e
AZ-Coconino, Chimney Spring[a]	Basalt	7380	Size	1920		42.8					Biondi et al. 1994
AZ-Coconino, Coulter Ranch[a]	Basalt	7520	Size	1913	30-66	51.5	10.8	67-120	83.0	19.5	Sánchez Meador & Moore 2010
AZ-Dept. of Defense, Camp Navajo	Basalt	7592	Age/Size	1883		59.9	5.8		56.2	6.1	Fulé et al. 1997
AZ-A-S, Fort Apache, Malay Gap[b]	Basalt	7200	Age/Size	1952		124.0			70.1		Cooper 1960
AZ-Coconino, Woolsey[a]	Basalt	7052	Size	1874	18-51	33.1	4.6	40-79	61.5	5.6	Sánchez Meador et al. 2010
AZ-Coconino, Flagstaff-c	Cinders	7355	No	1880	7-74	22.5	6.2				Abella et al. 2011
AZ-GCPNM-BLM, Mt. Logan-c	Cinders	7115	Age/Size	1870	34-38	29.9	6.4	60-64	60.3	9.1	Waltz & Fulé 1998
AZ-Coconinio, Red Cinder	Cinders	7631	Age/Size	1885		74.1			65.3		Abella 2008
AZ-Prescott, Prescott (avg)[a]	Granitic	5320	Size	1910		27.7			25.5		Woolsey 1911

Minimum tree DBH recorded = 3.5in.[a], 4in.[b], 6in.[c], 10in.[d]

[1]Gus Pearson Natural Area

[2]Grand Canyon-Parashant National Monument

Table 1. Continued.

Location	Parent Material	Elev. ft	Size/Age Reported	Ref. date	TPA			BA (ft^2/ac)			Citation
					range	average	stderr	range	average	stderr	
AZ-S. Kaibab, Tusayan (avg)[a]	Limestone	7075	Size	1910		10.7			22.1		Woolsey 1911
UT-Zion National Park	Limestone	7096	Age	1881	3-25	14.0					Madany & West 1983
AZ-Coconino. Flagstaff-1	Limestone	7355	No	1880	14-34	22.0	2.2				Abella et al. 2011
AZ-Coconino & NPS. Walnut Cyn.[d]	Limestone	6808	Size	1876		29.1			39.2		Menzel & Covington 1997
AZ-N. Kaibab, North Kaibab	Limestone	7300	No	1881		55.9					Covington & Moore 1994a
AZ-N. GCNP, Powell Plateau	Limestone	7533	Age	1879	8-262	63.6	9.4	20-337	78.0	10.9	Fulé et al. 2002
AZ-N. Kaibab, Kaibab Plateau[c]	Limestone	7500	No	1929	40-55						Rasmussen 1941
NM-Cibola, Zuni (max)[a]	Rhyolite	6557	Size	1910		22.6			52.8		Woolsey 1911
NM-Cibola, Cibola[a]	Rhyolite	8382	Age/Size	1890	47-61	54.2	6.9				Moore et al. 2004
NM-Carson, Carson (max)[a]	Shale	6983	Size	1910		38.4			79.9		Woolsey 1911
CO-Uncompahgre Plateau	Shale	7500	Size	1875	30-90	55		20-90	55		Binkley et al. 2008

Minimum tree DBH recorded = 3.5in.[a], 4in.[b], 6in.[c], 10in.[d]

Table 2. Historical forest spatial characteristics of frequent-fire forests of the Southwest, arranged by cover type (PP: Ponderosa pine, PO: Pine-Oak, MC: Mixed-Conifer).*

Reference	Parent Material	Elev. ft	Cover Type	Ref. date	Group Density	Group Size	Trees per Group	BA in Groups	Citation
AZ-A-S, Fort Apache, Malay Gap[b]	Basalt	7200	PP	1952		0.16-0.32			Cooper 1960
AZ-Coconino, Gus Pearson	Basalt	7398	PP	1875		0.05-0.72	3-44		White 1985
AZ-Coconinio, Flagstaff	Varying	7800	PP	1880	1-33		2-25	28%-74%	Abella & Denton 2009
AZ-Coconino, Woolsey[a]	Basalt	7052	PP	1874	25-67	0.003-0.09	3-24	62%-75%	Sánchez Meador et al. 2011
AZ-Coconino, Coulter Ranch[a]	Basalt	7520	PO	1913		0.01-0.1			Sánchez Meador & Moore 2010
CO-Uncompahgre Plateau	Shale	8000	PP/MC	1875		0.1-0.25			Binkley et al. 2008
AZ/NM-Numerous N.F.[a]	Varying	8650	PP/PO/MC	1910	24-80	0.01-0.25	2-72	51%-85%	Sánchez Meador et al. *unpublished data*

Minimum tree DBH recorded = 3.5in.[a], 4in.[b]

Table 3. Historical forest canopy cover spatial characteristics of frequent-fire forests of the Southwest, arranged by cover type (PP: Ponderosa pine, PO: Pine-Oak, MC: Mixed-Conifer).*

Reference	Cover Type	Reference date	Method	Canopy Cover	Citation
AZ-Coconino, Gus Pearson	PP	1875	Standing age class	21.9%	White 1985
AZ-Coconino, Gus Pearson	PP	1876	Dendro-reconstruction	19.0%	Covington et al. 1997
AZ-Coconino, Chimney Springs	PP	1876	Standing size class	17.3%	Covington and Sackett 1986
AZ-N. GCNP, Powell Plateau	PP-oak	1879	Relict Site	15.4-79.2%	Fulé et al. 2002
AZ-Coconino, Woolsey	PP/PP-Oak	1874	Dendro-reconstruction	10.2-18.8%	Sánchez Meador et al. 2011
CO-Colorado Front Range, Cheeseman Lake	PP/MC	1900	FVS-reconstruction	12.9-21.5%	Fornwalt et al. 2002

***From: A management framework for restoring resiliency and sustainability of frequent-fire forests in the Southwest, USDA Forest Service, in draft 2012.**

East Fork Forest Restoration Demo Area, Santa Fe National Forest

Purpose of Visit: *ERI*

- View an area where different forest restoration approaches were implemented for demonstration, and discuss basis for treatment strategies.
- Discuss the concepts and various aspects of the desired conditions including: the degree of structural openness; the grass/forb/shrub matrix; the size (area, number of trees), shape, and spacing of tree groups; the interlocking crowns of trees within groups; the diversity and interspersion of tree structural (age, size) stages; and the sustainability of the desired conditions.
- Discuss forest entomology/pathology (reference and current conditions).

Background: *Bill Armstrong (FS-SFNF)*

- Demonstration sites represent ponderosa pine forests growing on highly-productive sites. Sites have had fire exclusion since the late 1880s, due to livestock grazing followed by active fire suppression.
- Unrecorded selection harvest is likely the only past management.

Demonstration Areas: *Bill Armstrong/Dave Huffman (NAU-ERI)*

- Uneven-aged structure (3+ ages). This site is in a designated goshawk post fledging family area (PFA) adjacent to historic nesting areas. Therefore, the objective was to favor older taller trees in groups to provide nesting/roosting sites. The original stand conditions, with smaller trees in dense suppressed groups, required thinning this younger age group to permit regeneration of the understory. Mature/old age trees were below desired proportional representation before treatment, therefore none were cut (yellow-bark trees range 95-160 years old).
- Post-treatment spatial patterns are similar to natural conditions
    - Tree groups with interlocking crowns
    - Fine–scale dispersion of tree groups
    - Grass/forb/shrub openings
- Many trees on this site have evidence of mistletoe infection. Since the primary management direction on this site is to provide habitat for goshawk, management of mistletoe during this treatment was not a primary concern.
- Slash was masticated, not yet burned. Large woody debris abundance is lower than desired.
- Tree densities (within group) are within desired ranges (overall averages 45-150 sq. feet basal area). Overall density remains higher than desired at 90-95 sq. feet basal area.
- Seedlings have not yet established in desired locations.
- Desired grass/forb/shrub cover has not yet fully established, will likely respond to prescribed burn of masticated material.
- Modeled fire behavior is low-intensity surface fire (some questions remain about ground fire intensity due to slash mastication?).
- How demonstrations differ:
    - Demo #1 represents a managed framework for restoration: roughly balanced area of grouped young, mid, and mature/old aged trees with provision of suitable openings for development of grass/forb/shrub component and localized recruitment of trees. Old age trees were below desired proportional representation before treatment, therefore none were cut. This treatment represents an approach to

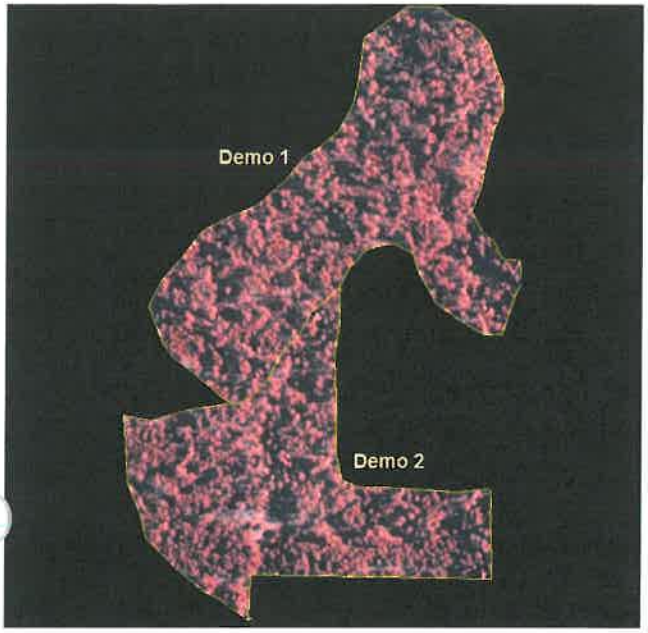
create and maintain structure to provide for habitat and to allow fire to be safely reinitiated, while providing opportunities for multiple-use strategies for maintenance of the restored forest landscape.

- Demo #2 represents a natural processes framework for restoration based on a reconstruction of historic stand structure based on observed site evidence. This results in an uneven-aged forest, but age structure is not balanced (more mid and old trees than young). This represents an approach to initiate a fire maintained restored forest landscape.

East Fork Forest Restoration Demo Area – Data *Bill Armstrong/Dave Huffman*

Aerial photos

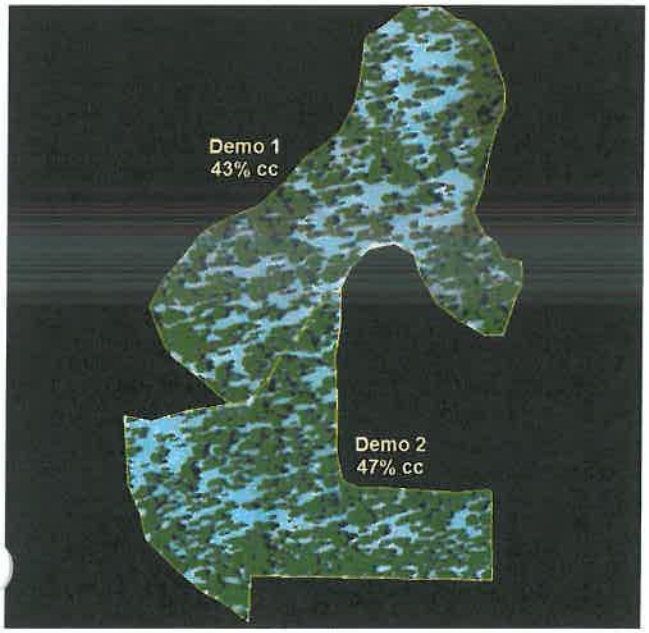
Pre-treatment:



Current conditions (post-treatment)

a. Spatial analysis from aerial photos

Post-treatment



Demo site #1

- 43% of the area represented under mid-old tree crowns (tree drip-line measurement)
- 57% of the area represented as open grass/forb/shrub

Demo site #2

- 47% of the area is currently represented under mid-old tree crowns (tree drip-line measurement)
- 53% of the area to be managed as open grass/forb/shrub (not including meadow areas)

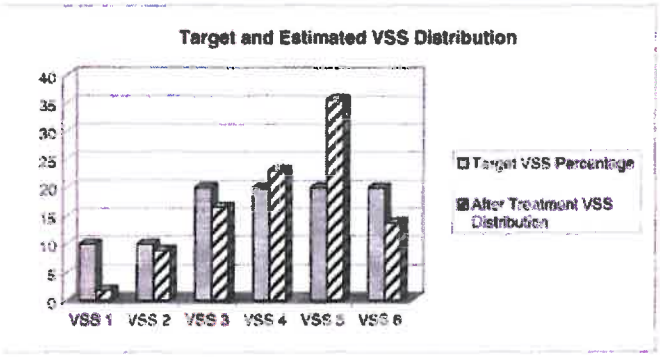
b. Stand exam data (2012)

Demo site #1, post-treatment

All Species Diameter Class	Trees/ Acre	Basal Area/ Acre (ft^2)
1 - 4.9 in	0	0
5 - 8.9 in	13.3	3.5
9 - 12.9 in	36.7	23.5
13 - 16.9 in	23.3	27.1
17 - 20.9 in	8.3	16.7
21 - 24.9 in	5	13.8
25 + in	1.7	6
Total	88.3	90.6

Demo site #2, post-treatment

All Species Diameter Class	Trees/ Acre	Basal Area/ Acre (ft^2)
1 - 4.9 in	0	0
5 - 8.9 in	3.3	.9
9 - 12.9 in	18.3	13.7
13 - 16.9 in	15	17.2
17 - 20.9 in	8.3	15.8
21 - 24.9 in	8.3	25.3
25 + in	3.3	17
Total	56.5	89.9



Tree group size distribution for demo #1

Forest entomology/pathology discussion (reference and current conditions) *Andrew Graves (FS-RO)*

- Understand how biological forest disturbance agents function in reference condition and contemporary forest landscapes.
- Discuss implications for forest resilience and sustainability

East Fork Even-aged Forest Discussion Area, Santa Fe National Forest

Purpose of Visit: *ERI*

- View two areas where past conditions and treatments have resulted in two different current conditions
- Discuss desired conditions and relationship to current sites

Background: *Bill Armstrong (FS-SFNF)*

- **Mature Forest Stand** (management history)
  - High-site ponderosa pine with fire exclusion since the late 1880s.
  - The site has had some undocumented selection harvest
  - The site was thinned from below, removing firewood and precommercial-sized trees in 2002. Some slash was piled and burned in 2003. Slash remains scattered in the drainages.

- **Current conditions**
  a. stand exam data, 04/2012)

Current averages per acre

All Species Diameter Class	Trees/ Acre	Basal Area/ Acre
1 - 4.9 in	4.8	0.7
5 - 8.9 in	17.2	6
9 - 12.9 in	14.8	11.4
13 - 16.9 in	21.9	27.9
17 - 20.9 in	2.9	5.5
21 - 24.9 in	1.9	5.4
25 + in	4.5	20.9
Total	68	77.1

Range of plot data:

current trees per acre = 38 to 105
current basal area = 46 to 125 square feet/acre

b. spatial patterns

- 41% of the area is under tree canopy (even-distribution)
- 59% of the area is open grass/forb/shrub (small interspaces)

Discussion: where does this stand fit in the context of DCs, resilience and sustainability? *ERI-All*

- **Young Forest Stand**
  - The stand was a multi-storied ponderosa pine-dominated stand with some Douglas-fir on north aspect of drainages.
  - Due to extensive dwarf mistletoe infection, the stand received an overstory removal harvest in 1998 to release advanced regeneration.

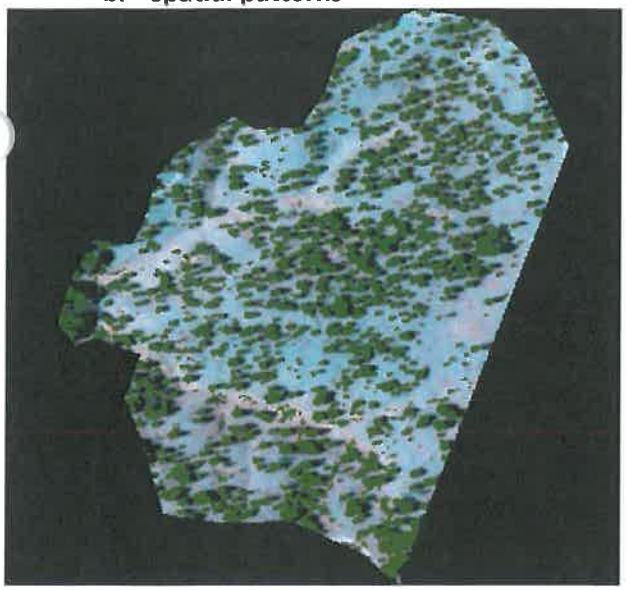
Current conditions

a. stand exam data, 04/2012)

Current averages per acre

All Species Diameter Class	Trees/ Acre	Basal Area/ Acre
1 - 4.9 in	0	0
5 - 8.9 in	22.5	6.3
9 - 12.9 in	32.5	20
13 - 16.9 in	10	10.3
17 + in	0	0
Total	67.5	38.9

b. **spatial patterns**



- 27% of the area is under tree canopy (9.6 acres)
- 73% of the area is open grass/forb/shrub (14.8 acres)

Discussion: where does this stand fit in the context of DCs, resilience and sustainability? ***ERI-All***

Monument Canyon Forest Research Natural Area, Santa Fe National Forest

Purpose of Visit: *ERI*

- View the oldest and longest-protected Research Natural Area in New Mexico (1930s).
- Discuss reference conditions at an intact old-growth ponderosa pine site with ongoing annual monitoring.
- Discuss restoration treatment and current conditions.
- Discuss maintenance of forest restoration treatments.

Background: *Kent Reid (NMHU)*

- **Reference conditions**
  - Among the best preserved old-growth ponderosa pine/dry mixed conifer sites in NM
  - Living trees to 1500s, tree-ring evidence to 1200s
  - Frequent fire ecosystem (MFI = 3.4 years/fire entire RNA)
  - Scaled fire history study 1598-2000, 200 cross-dated trees

- **Management history**
  - RNA status since 1930s, never logged
  - Fire exclusion since early 1900s
  - Adjacent to 8000-ac San Juan Fire Management Area (SFNF)
- **Pre-treatment conditions (see Table below)**
  - Density of the larger trees was normal for the Jemez
  - 35% of larger trees were dead in some areas where 20th century ingrowth was highest
  - Small tree density was among highest documented in the Southwestern Region
- **Research history (University of Arizona)**
  - Permanent plot network established 1998
  - Detailed fire history 2004
  - Ongoing annual tree-scale monitoring since 2002

Demonstration Restoration Treatment: *Kent Reid*

- **Treatment prescription and implementation (2006)**
  - Collaboration of SFNF and UA
  - Funded by CFRP, RMRS, JFSP
  - Design to facilitate restoration of surface fire regime
  - Mastication of trees $\leq$ 9 in dbh; utilized existing stand structure

Aerial photos

Pre-treatment:

Current conditions (post-treatment)

a. **Spatial analysis from aerial photos**

- 34% of the area represented under mid-old tree crowns (tree drip-line measurement)
- 76% of the area represented as open grass/forb/shrub (not including established tree regeneration)

b. Stand exam data

Pre-treatment (2002)

Diameter Class	Status	Trees/Acre
<1 in	Live	300
<1 in	Dead	10
<1 in	Both	310
>1in and <10in	Live	604
>1in and <10in	Dead	151
>1in and <10in	Both	754
>10 in	Live	46
>10 in	Dead	25
>10 in	Both	71
Total		1135

Post-treatment (2011)

All Species Diameter Class (dbh)	Trees/ Acre	Basal Area/ Acre (ft^2)
0 – 1 in	5	0.0
1 - 4.9 in	18	1.2
5 - 8.9 in	26	7.8
9 - 12.9 in	31	18.8
13 - 16.9 in	12	14.5
17 - 20.9 in	9	17.9
21 - 24.9 in	5	13.2
25 + in	2	11.4
Total	108	84.8

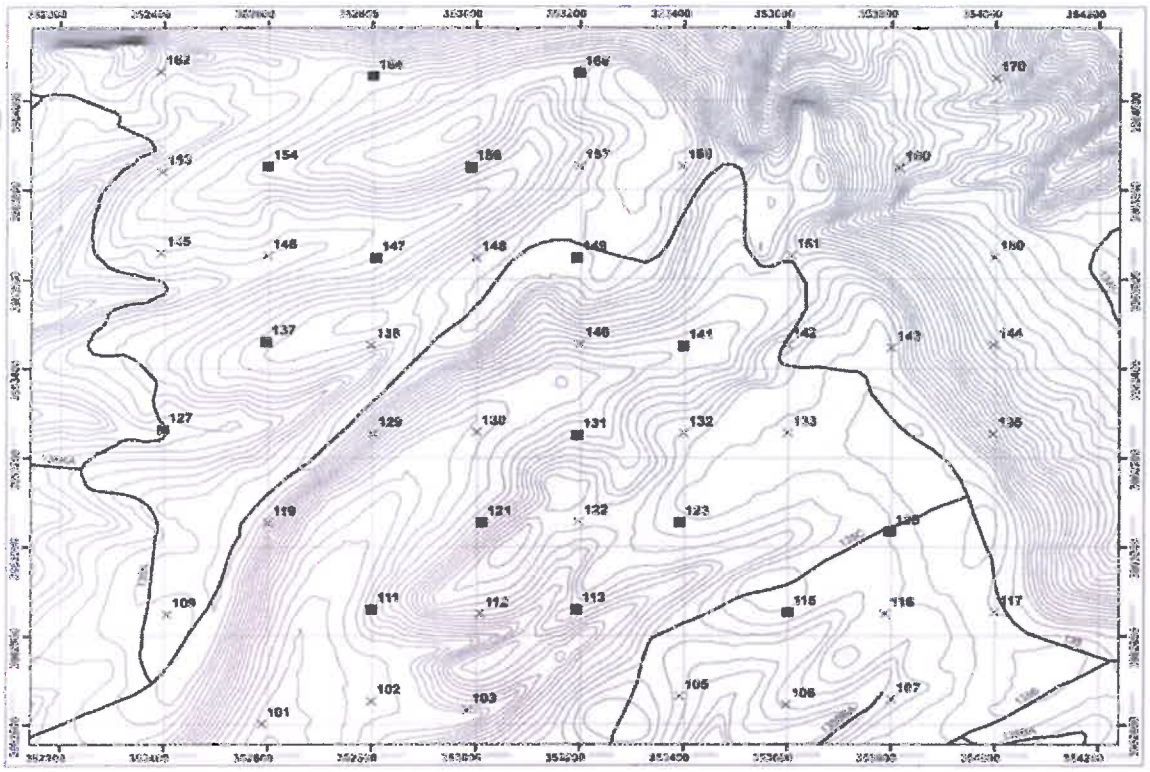
Post treatment (2011) observations

- Ponderosa pine comprised 81% of the basal area.
- Other species were white fir, Douglas-fir, limber pine, and aspen.
- Down woody debris ranged from 26 to 50 tons per acre, excluding masticate.
- Ponderosa pine regeneration was very patchy, and ranged to 63,000 stems per acre.

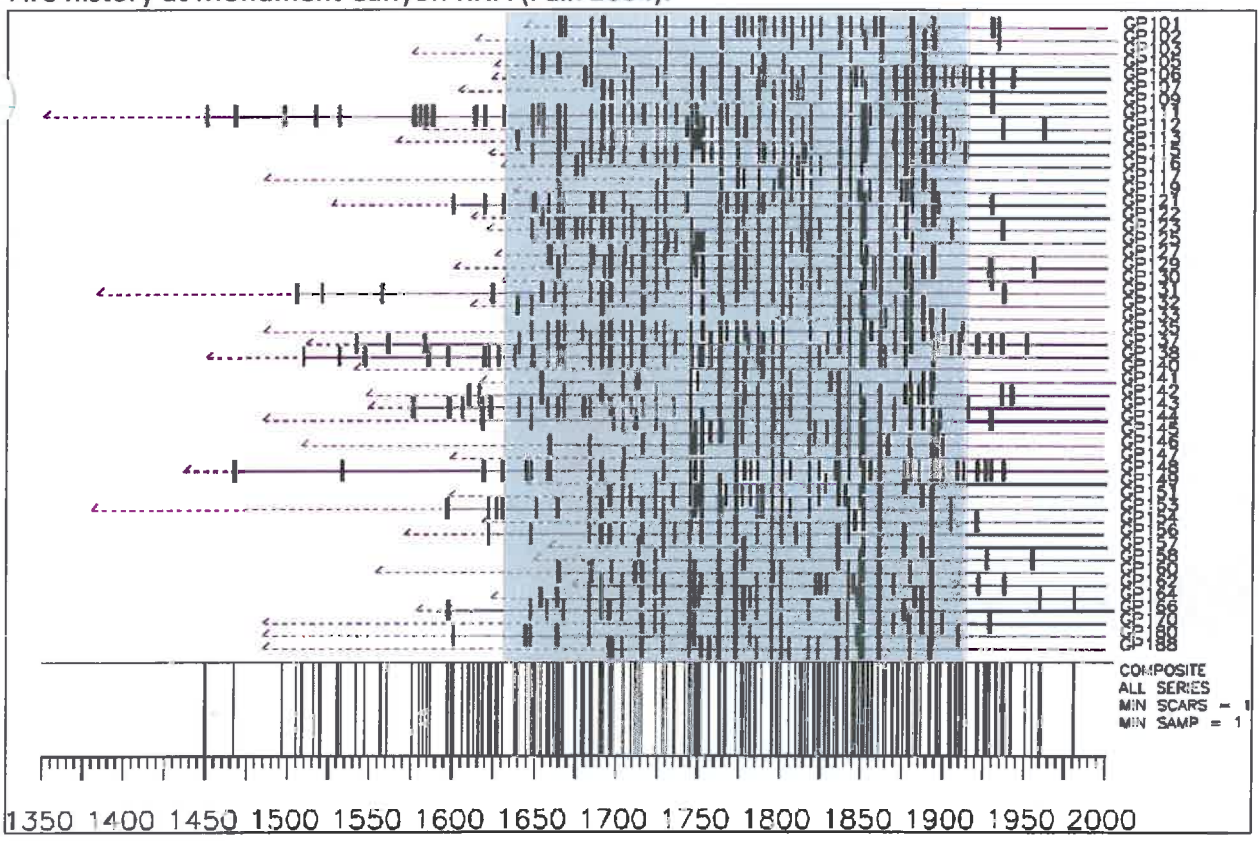
Post-treatment regeneration per acre (averages from 36 0.01-acre plots, 2011): Trees < 4.5' height

Species/ Class	Regeneration height <8"	8" – 2.5'	2.5' – 4.5'	Total
Ponderosa pine	6375	4308	1528	12,211
Dead ponderosa	19	64	14	97
Limber pine	0	<1	0	<1

Permanent plot network at MCN (Falk 2004):



Fire history at Monument Canyon RNA (Falk 2004):



1929 University of Chicago Botany Field Trip:

Dry Mixed Conifer Forest Ecology, San Antonio Creek, Santa Fe National Forest

Purpose of Visit: *ERI*

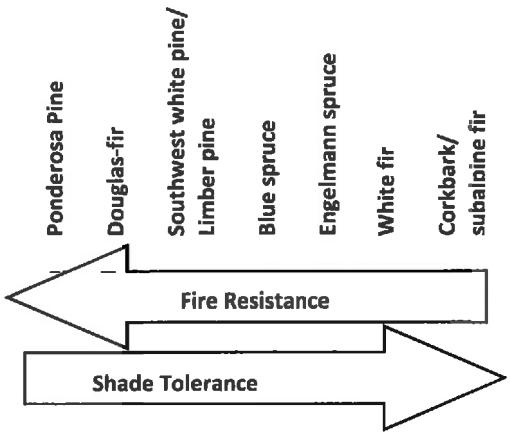
- Discuss classification and ecological differences between ponderosa pine, dry mixed conifer & wet mixed conifer forest types.
- View a dry mixed conifer forest site where the tree species composition and function has changed over time as a result of fire suppression and past vegetation management.
- Discuss desired forest species composition for dry mixed conifer forests, and relationships to ecological function.

Natural fire regimes of Southwestern forest types. Fire frequency refers to the mean number of years between fires, and fire severity relates to the effect of the fire on dominant overstory vegetation. Infrequent-fire forests (wet mixed-conifer and spruce-fir) are included for comparison to frequent-fire forests. *Jim Youtz (FS-RO)*

Forest Type (sub-type)	Fire Regime[1]		Fire Type[2]	Forest Structure	Seral Species	Climax Species
	Fire Frequency	Fire Severity				
Ponderosa pine (all sub-types)	Regime I 0-35 years	Low	Surface	Uneven-aged, grouped, open	**Dominant:** ponderosa pine	**Dominant:** ponderosa pine
Dry mixed-conifer	Regime I (common) 0-35 years	Low	Surface	Uneven-aged, grouped, open	**Dominant:** ponderosa pine **Subdominant:** aspen and/or oak (in sub-stand scale patches)	Shade-intolerant species under fire dis-climax historic conditions. **Dominant**: ponderosa pine **Subdominant**: Douglas-fir and Southwestern white pine or limber pine
(warmer/drier)	Regime III (rare) 35-100+ years	Mixed	Mixed	Uneven-aged, patched, open		
Wet mixed-conifer	Regime III (common) 35-100+ years	Mixed	Mixed	Uneven-aged, patched, closed	**Dominant** (depending on habitat type): aspen or Douglas-fir	Shade tolerant species. **Dominant** (depending on habitat type): white fir and/or blue spruce
(cooler/wetter)	Regime IV (rare) 35-100+ years	High	Stand-replacing	Even-aged, closed		
Spruce-fir (mixed, lower sub-alpine)	Regime III and/or IV 35-100+ years	Mixed / High	Mixed/ stand-replacing	Even-aged, closed	**Dominant** (depending on habitat type): aspen or Douglas-fir	Shade tolerant species. **Dominant** (depending on habitat type): Engelmann spruce and/or white fir Shade tolerant species.
Spruce-fir (upper sub-alpine)	Regime V 200+ years	High	Stand-replacing	Even-aged, closed	**Dominant** (depending on habitat type): aspen, Douglas-fir, or Engelmann spruce	**Dominant:** Engelmann spruce and corkbark fir or sub-alpine fir

[1] Schmidt et al. (2002)
[2] The Nature Conservancy (2006)

Relative shade and fire tolerance of common conifer tree species in mixed conifer and spruce-fir forests



Forest Ecology/Reference Conditions for Dry Mixed Conifer Forests in the Southwestern US:

Table 1. Historical forest structural characteristics of dry mixed-conifer forests of the Southwest, arranged parent material and average tree density*.

Location	Parent Material	Elev. ft	Size/Age Reported	Ref. date	TPA			BA (ft^2/ac)			Citation
					range	average	stderr	range	average	stderr	
AZ-Coconino, S. Francisco Peaks-E	Basalt	8318	Age	1892		20.9	3.4		39.6	3.9	Heinlein et al. 2005
AZ-Coconino, S. Francisco Peaks-W	Basalt	8318	Age	1876		21.0	1.7		54.0	6.1	Heinlein et al. 2005
AZ-A-S, Sitgreaves (max) [a]	Basalt	6300	Size	1910		31.0			66.9		Woolsey 1911
AZ-Coconino, S. Francisco Peaks	Basalt	9200	Age	1876		65.1	6.8		77.9	12.8	Cocke et al. 2005
AZ-A-S, Apache, Blue & White Mts.[b]	Basalt	8950	Size	1912		68.7			84.4		Greenamyre 1913
CO-San Juan, Middle Mtn.	Granitic	8520	Size	1870	51-59	57.3	4.0	43-60	47.9	4.6	Fulé et al. 2009
NM-Santa Fe, Jemez (max)[a]	Limestone	7013	Size	1910		35.6			91.2		Woolsey 1911
AZ-N. Kaibab, Kaibab Plateau[c]	Limestone	7500	Size	1909		45.3			60.7		Lang and Stewart 1910
NM-Lincoln, Alamo (max)[a]	Limestone	8650	Size	1910		46.5			97.9		Woolsey 1911
NM-Gila, Gila [a]	Limestone	9055	Age/Size	1890		65.6					Moore et al. 2004
NM-Santa Fe, Jemez [a]	Limestone	7825	Age/Size	1890	66-112	88.8	23.2				Moore et al. 2004
AZ-N. GCNP[1], Little Park	Limestone	8640	Age	1880		98.3	5.8		76.7	9.1	Fulé et al. 2003
AZ-N. GCNP, Swamp Ridge	Limestone	8143	Age	1879	36-151	99.4	5.2	65-235	124.1	7.8	Fulé et al. 2002
CO-Uncompahgre, Uncompahgre Plateau	Shale	8000	Size	1875	30-110	60		25-130	70		Binkley et al. 2008

Minimum tree DBH recorded = 3.5in.[a], 4in.[b], 6in.[c]
[1]Grand Canyon National Park

***From: A management framework for restoring resiliency and sustainability of frequent-fire forests in the Southwest, USDA Forest Service, in draft 2012.**

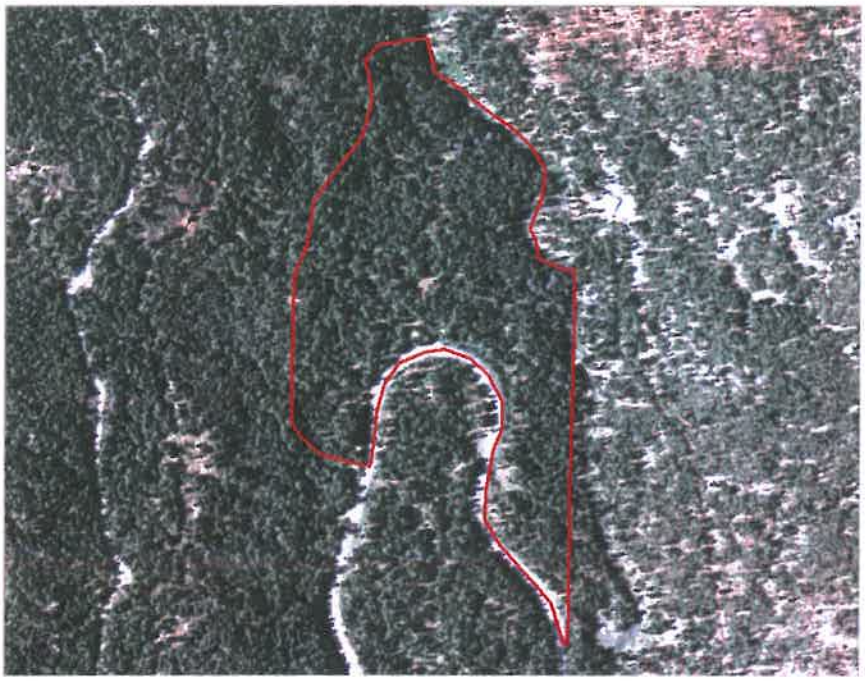
Table 2. Jemez Mountains fire scar dates. Period of reliability is the period when the number of samples was deemed sufficient to reliably estimate presuppression fire regime characteristics. Generally this was the period during which at least three or four samples recorded fire events. Sites are listed by forest types (PIPO = ponderosa pine, PIPO/MC = ponderosa pine/mixed conifer, and MC = mixed conifer).

Site name	Site code	Veg. type	Tree-ring date		Earliest fire-scar date	Latest fire-scar date	No. of fire-events (years)	Period of reliability	
			Earliest	Latest				Beginning date	Ending date
Monument Canyon Natural	MCN	PIPO	1408	1972	1493	1909	57	1648	1892
Ban-Group 3 (Apache Mesa)	BAN-GR3	PIPO	1459	1988	1480	1939	66	1614	1890
Pajarito Mountain Ridge	PMR	PIPO	1626	1993	1632	1912	39	1685	1875
Cerro Pedernal	CPE	PIPO	1380	1993	1522	1959	30	1598	1873
Continental Divide	CON	PIPO	1387	1979	1601	1899	54	1654	1870
Clear Creek Campground	CCC	PIPO	1538	1978	1548	1881	45	1664	1860
Capulin Canyon	CCP	PIPO/MC	1554	1990	1624	1955	44	1664	1893
Gallina Mesa	GAM	PIPO/MC	1531	1979	1558	1921	66	1663	1870
Cañada Bonito South	CAS	PIPO/MC	1378	1993	1480	1966	33	1672	1893
Camp May East	CME	PIPO/MC	1660	1993	1709	1880	11	1709	1879
Pajarito Mountain North-East	PME	MC	1702	1993	1773	1949	13	1801	1879
Pajarito Mountain North-West	PMW	MC	1617	1993	1669	1925	10	1841	1879
Camp May North	CMN	MC	1683	1993	1729	1880	7	1847	1879
Cañada Bonito North	CAN	MC	1655	1993	1685	1914	12	1801	1893

Fire return Interval Range = 3-16 yrs.

From: Ramzi Touchan, Craig D. Allen, and Thomas W. Swetnam, *Fire History and Climatic patterns in Ponderosa pine and Mixed Conifer Forests of the Jemez Mountains, NM*. Fire Effects in Southwestern Forests: Proceedings of the Second La Mesa Fire Symposium, Los Alamos, NM, March 29-31, 1994. USDA Forest Service, Rocky Mountain Research Station

Local Site Conditions: *Jerry Simon (FS-RO), Kent Reid (NMHU)*



Plant Habitat Type Association Classification: Blue Spruce/Dryspike Sedge[1]

Dominant seral[2] tree species:

- Ponderosa pine
- Southwestern white or limber pine
- Aspen on some sites

Dominant climax[3] tree species:

- Douglas-fir
- Blue spruce
- White fir

Common grass/forb shrub species:

- Dryspike sedge
- Screwleaf muhly
- Arizona fescue
- Gambel oak
- Common juniper
- Currants (*Ribes* species)

Species Composition

Tree Species (conifer)	Current age range of the most mature individuals on site	Estimated historic (1880) % of composition	Current composition (% of basal area)
Ponderosa pine	110 - 220 yrs. Avg. = 170	80%	45%
Douglas-fir	100-190 yrs. Avg. = 132	<20%	35%
Blue spruce	80-90 yrs. Avg. = 86	<1%	17%
White fir	75-120 yrs. Avg. = 98	<1%	3%

1997, USDA Forest Service, Plant Associations of Arizona and New Mexico, edition 3, volume 1: Forests

[2] Seral species will remain dominant under frequent disturbance conditions, such as characteristic frequent fire

[3] Climax species will develop and dominate over time when frequent disturbances do not occur (no frequent fire or cutting)

Treatment Demonstration

Jerry Simon, USFS-RO/ Kent Reid, NMHU
Monday, May 07, 2012

Marking Assumptions San Antonio Creek Dry Mixed ConiferArea

Leave trees are marked with orange flagging
Approximately 9.4 acres were flagged

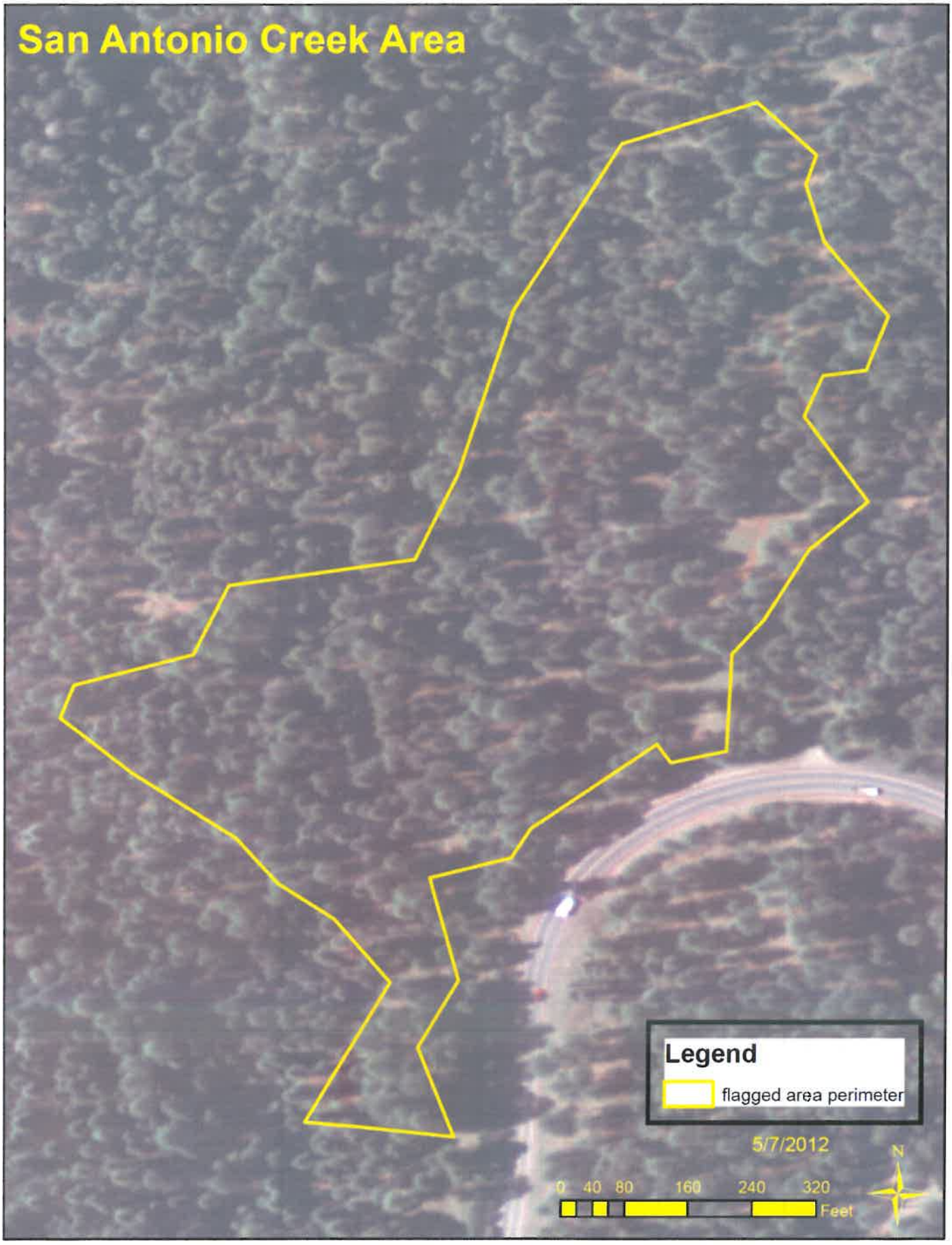
1. Retain most old ponderosa pine and Douglas-fir trees.
2. Move species composition toward historic conditions while retaining some species diversity.
3. Manage for deficit age classes of ponderosa pine and Douglas-fir
4. Look for opportunities to regenerate ponderosa pine and Douglas-fir by removing groups of spruce and white fir.

Most mature/old ponderosa pine and Douglas-fir were marked as leave trees, the exceptions being suppressed trees and severely mistletoe infested trees. Because there are so many large mature/old trees, within this sample flagged area, the resulting stand will be primarily made up of these large trees. A regeneration opening was created by removing a mistletoe pocket of overstory ponderosa pine trees. The objective being to create ponderosa pine seedlings free of mistletoe. In order to facilitate a more sustainable overall mix of age classes, additional trees would need to be removed to initiate tree regeneration if desired.

In the northwestern portion of the flagged area there were fewer mature/old ponderosa pine trees and more blue spruce and Douglas-fir. This area was marked as a larger leave tree group by spacing spruce and Douglas-fir leave trees to provide for forest cover and diversity. Alternately, ponderosa pine and Douglas-fir regeneration opportunities in the larger stand can be created by removal of young blue spruce/white fir groups. Where primary species were Douglas-fir, white fir, and blue spruce, the best formed Douglas-fir trees were retained with occasional blue spruce for species diversity. White fir trees were not intentionally marked for retention. Two Southwestern white pines were marked for retention one was marked to be cut because of severe form defects.

Tally for San Antonio Creek Dry Mixed Conifer demo area for
May 1012 Public Desired conditions tour
Leave trees (note DBH specifications are modified to conform to VSS classes)

	DBH	PIPO	PSME	ABCO	PIFL	PIPU	Total Trees Marked	Number Trees in VSS Class	Percent of Trees by VSS Class
	4				1		1	1	<1%
	5		6				6		
	6		6		1	1	8		
	7		11				11		
VSS 3	8		14				14		
	9	1	7				8		
	10	5	7			2	14		
	11	4	6				10	71	23%
	12	4	7				11		
	13	6	6				12		
VSS 4	14	5	3			3	11		
	15	7	3			2	12		
	16	14	3			1	18		
	17	13	3				16	80	26%
	18	9	6			1	16		
	19	7	2				9		
VSS 5	20	7	1				8		
	21	12					12		
	22	8					8		
	23	13	1				14	67	22%
	24	13					13		
	25	10	2				12		
	26	8					8		
	27	8	1				9		
	28	10	3				13		
	29	4	1				5		
VSS 6	30	5					5		
	31	4	2			1	7		
	32	3					3		
	33	3					3		
	34	1					1		
	35	2					2		
	36		1				1		
	37	1					1		
	38	1					1	84	28%
Total Trees		188	102	0	2	11	303		


San Antonio Creek Area
Legend
flagged area perimeter
5/7/2012
N
0 40 80 160 240 320
Feet