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FIRE EFFECTS on PLANTS of the JEMEZ MOUNTAINS and the PAJARITO PLATEAU



Compiled by Teralene S. Foxx

FIRE EFFECTS on PLANTS of the JEMEZ MOUNTAINS and the PAJARITO PLATEAU

Compiled by Teralene S. Foxx
Edited by Hector Hinojosa
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April 2013

Report to Bandelier National Monument, National Park Service,
Los Alamos National Laboratory, US Department of Energy, and
U.S. Geological Survey Jemez Mountains Field Station

PREFACE

This document is part of a much wider study. In combination with the document entitled *The La Mesa Fire: Studies and Observations from 1977 through 2012* and a series of documents related to the photographic records of study plots related to the La Mesa Fire, there is a picture of fire in the east Jemez Mountains encompassing the past 37 years.

The way nature heals after fire is a mysterious and amazing event. Over my career as an ecologist, I have observed many plant species in natural and disturbed habitats and after wildfire and I began to see some consistent patterns. These patterns are what I wanted to document.

This publication is about plant species

- that appear early in plant succession after disturbance,
- that appear after wildfire and soon disappear,
- that are rarely seen before wildfire and then become an integral part of the landscape, and
- that do not survive the initial disturbance but may slowly regenerate over time.

This publication is also about the resiliency of nature and how many plant species are adapted to fire through sprouting, seed dispersal, and germination.

Finally, this publication is also about observations. I hope that these observations can be built upon by others as I have built upon previous observations of other researchers through compiled literature in the Fire Effects Information System of the US Forest Service, the US Department of Agriculture Plants Database, and other sources.

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Teralene Foxx
2012

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GLOSSARY

allelopathic: Plants that produce chemicals that can benefit or be adverse to the development of other plants. These chemicals may affect invasion and maintenance of certain species.

arbuscular mycorrhiza (mycorrhizae): A type of fungus that penetrates the cell of the roots of a vascular plant. The fungi help plants capture nutrients such as phosphorus, sulfur, nitrogen, and micronutrients from the soil. These fungi can play a role in colonization of an area.

auxin: A plant hormone that regulates plant growth, particularly through cell elongation.

axillary: In an axil; a term applied to buds, branches, or meristems that occur in the axil of a leaf. The axil is the angle between the stem axis and leaf stem.

apices: Near the tip or point. Plural of apex.

bulb: Short, globelike underground stem, covered with overlapping leaf bases or scales that store food and nutrients.

cambium: The meristematic tissue of woody plants, generally inside the bark. Produces xylem to the inside and phloem to the outside.

caudex: Woody base of the plant of an otherwise herbaceous stem.

corms: A shortened, usually subterranean, stem enclosed by dry, scalelike leaves. Functions to store carbohydrates.

cytokinins: Plant growth substances (plant hormones) that promote division of cells in roots and shoots. The substance also helps break seed dormancy.

duff: Partially decomposed organic matter (leaves, flowers, fruits, etc.) found beneath plants.

fibrous root: A root system composed of many roots similar in length and thickness, such as in grasses.

girdling: The complete removal of a strip of bark (consisting of cork cambium, phloem, and cambium and going into the xylem) from around the entire circumference of either a branch or trunk of a woody plant. Girdling results in the death of wood tissues beyond the damage because food and water are not available.

lignotubers: A starchy swelling of the root crown possessed by some plants as a protection against destruction of the plant stem by fire. The crown contains buds from which new stems may sprout.

ligule: A hairlike or membraneous projection up from the inside of a grass sheath at its junction with the blade.

litter: Layer of un-decomposed or partly decomposed plant debris on the surface of the ground.

meristem: Tissue in which cell division occurs, generally located in various parts such as buds, root tips, etc. (meristematic—pertaining to the meristem)

mycorrhizae: A fungus that grows in association with roots of a plant in a symbiotic or mildly pathogenic relationship.

phenology: The study of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life.

phloem: Food-conducting tissue.

primordia: Cell tissue or organ in its earliest stage of differentiation.

rhizomes: A prostrate, elongated stem growing partly or wholly underground; usually rooting at the nodes.

root crown: Part of a root system from which a stem arises.

ruderal: Weedy; a plant growing in disturbed habitats.

seedbank, soilbank: Seeds that fall from the plant and are stored in the soil until conditions are right for germination.

seedcoat: The outer protective layer of a seed that protects it from drying out.

stolons: A trailing areal stem that grows horizontally, rooting at the nodes.

taproot: A stout, tapering, primary root of a plant that may have small, lateral rootlets.

tillering: Sending shoots from the base of a grass.

tubers: A thickened, fleshy underground stem that functions for food and water storage as well as propagation.

xylem: Water-conducting tissues.

FIRE EFFECTS ON PLANT SPECIES

There are a number of factors that can cause mortality in plants during and after a fire. All these factors will affect the growth tissues and/or seed germination. The response of plants will vary according to the phenology of the plant in question.

Factors for plant mortality include the following:

Temperature of a fire
Tissue susceptibility
Location of the tissue
Reproductive mechanisms
Ability to recover from injury
Chemical compounds of smoke
Duration of a fire

Temperature of a Fire

Survival of a plant after fire is dependent upon the temperature of the fire and the length of time the plant has been exposed to that temperature. Wright and Bailey (1982) found the lowest temperature that a plant cell dies is between 122 to 131 degrees Fahrenheit. Some plants can withstand higher temperatures for a very short time. When a plant is actively growing, it is more sensitive than when it is dormant or quiescent. So, the time period of a fire will also affect survivability.

Tissue Susceptibility and Location of Tissues

The most susceptible tissues are the growth (meristematic) tissues. The meristem, the growing part of the plant, has a higher moisture content than other cells and, therefore, is more susceptible to damage. The size and location of those tissues are also important. Cells that are protected, such as those in roots, are less likely to be damaged than those tissues above ground. Tissues protected by thick bark or long needles (such as ponderosa pine) may be less susceptible than tissues of thin-barked or short-needled species (such as Douglas-fir).

Dormant buds and bud primordia on underground stems and roots, such as stolons, rhizomes, and roots deeper than a few inches, are stimulated to develop after fire. A number of shrub species and species with a woody caudex are able to regenerate quickly by sprouting even after a very hot fire, as in the case of oak. In lightly burned areas, the tops may be singed, but the root crowns or other plant parts with growth tissues may survive and sprouting can occur. Plants that have stolons or other spreading parts can recolonize quickly. Otherwise, the cycle of seed production will slowly increase the number of plants in an area.

Reproductive Mechanisms

Plants can revegetate or recolonize an area in several ways:

Sprouting from undamaged parts
Germination of seeds in the soilbank stimulated by heat or smoke
Recolonizing from unburned areas

Sprouting
In undamaged plants, primordial tissues are inhibited from sprouting by growth inhibitors such as auxin. If plant parts are removed either by fire or other means, these growth inhibitors are eliminated and sprouting begins. Growth substances in the roots called cytokinins flow from the roots to the dormant buds and sprouting begins (Schier et al. 1985). In areas of high-severity fire, plant parts are damaged above the ground and sometimes can seem to be nonexistent, but sprouting can come from below. Generally, even in hydrophobic soils in high-severity burn areas, the heat intensity of the fire goes only two to three inches into the soil surface. The growth tissues located in the root primordia, but below the heat-influence zone, will send out shoots. This is common in many shrub species in fire-sensitive habitats. The ability to sprout from underground, such as bulb, corms, rhizomes, and tubers, is common in some forb and grass species noted in this publication (Anderson 2001; Miller and Findley 2001).

Germination of Seeds and Recolonization
The ability of a plant to recolonize is dependent on the plant's phenology and position in the ecoystem. Some plants are early colonizers because they flourish without competition for resources or prefer sunny, open areas. A burned area with reduction in the overstory canopy will favor these early colonizers, such as fetid goosefoot, lambsquarters, and pigweed.

In some cases, seeds that drop from the plant may lay in the ground for years. Mixed with the litter and the soil, the seeds are protected by a sturdy seedcoat. This reservoir of seeds is called a soil- or seedbank. Researchers have found that some seeds can lay dormant for a few years to hundreds of years (Noste and Bushey 1987). When conditions break the seedcoat, either through heat, scarification, or smoke, the seeds may germinate (Keeley 1987; Rasmussen and Wright 1988).

Other plants may be re-established by off-site colonization. Plants that have seeds that float on the wind or are carried by animals are more likely to recolonize an area. Such is the case with thistles, dandelions, and beggar-ticks.

Fire Severity and Recovery
Fire severity affects the recovery of the plants in that area. Potter and Foxx (1978, 1979) classified and mapped areas burned by the La Mesa Fire based on canopy cover. The Fire Effects Guide (Anderson 2001; Miller and Findley 2001) gives the following classification. This classification is also consistent with the resulting canopy cover.

A light-severity fire occurs where there is little fuel and there is moisture. There is charring and some litter is consumed. Surface area reproductive parts, such as stolons, may be damaged. There is little effect on the roots and subsurface stems, such as bulbs, corms, and rhizomes. In Potter and Foxx (1978, 1979), in a lightly burned area, little damage was done to the crown and most trees were only scorched at the base.

A moderate-severity fire consumes the fine and smaller-diameter fuels, but the large fuels, such as logs, will merely be charred. This type of fire kills stolons, shallow rhizomes, and above-ground structures. Sprouting may be vigorous after a moderate-severity fire. Potter and Foxx (1978, 1979) indicated that the canopy was still fairly intact; however, some trees were singed enough to die.

High-severity fire generally occurs when fuels are dry. This type of fire will consume large and small fuels and crowns of trees. There may be some soil heating in the upper surface of the soil, but sprouting can occur from deeper-buried plant parts. In some cases, hydrophobic soils result from the soil heating. Potter and Foxx (1978, 1979) classified areas in which the canopy was destroyed with no tree foliage left as severely burned.

Table 1 presents possible fire effects related to the life forms of plants.

Table 1. Summary of Possible Fire Effects as Related to Life Form (modified from Brooks and Lust 2008)

Life Form	Locations of regenerative tissues	Potential damage to tissues by fire
Annual plants	Reproduce from seed in soilbank or on dead plants, dispersion via gravity, wind, water, hitchhiking.	Depends on the location of the seeds and exposure to heat. May disappear in a few years when conditions change.
Perennial plants		
Bulbs, corms, tubers	Living tissue is below the soil surface.	Protected from fire because of soil insulation; fire may stimulate sprouting.
Rhizomatous roots	Living tissue is below or just above the soil surface.	Below-ground tissues protected by soil insulation; above ground depends on combustion.
Lignotubers	Living tissue is below soil surface.	Below-ground tissues protected by soil insulation.
Shrubs	Rhizomatous roots, lignotubers, roots below soil surface.	Fire-adapted shrubs will sprout, some non-fire-adapted shrubs will die if top-killed.
Trees	Rhizomatous roots, roots below the soil surface; leaf structure and protection of meristem; thickness of bark	Can be top-killed; some species can sprout, others die; thickness of bark can prevent girdling, if girdled, plant stem will die.

Climate and Weather

The timing of the fire and the post-fire climatic conditions can affect the presence and the growth of plants. Moisture or dryness can affect the ability of a plant to germinate, but also sustain growth. If stored carbohydrate reserves cannot be replenished through growth and photosynthesis, plants will die. Winter snowpack and summer rainfall can influence the survival of plants over the long term. In the Southwest, May and June tend to be dry; July and August are the monsoon months. Figure 1 compares three post-fire weather patterns (La Mesa [Y1977], Cerro Grande [Y2000], and Las Conchas [Y2011] fires). Note the post-fire weather after the Las Conchas Fire more fully parallels that of the La Mesa Fire. Post-fire weather after the Cerro Grande Fire was drier (LANL 1977, 2000, 2011).

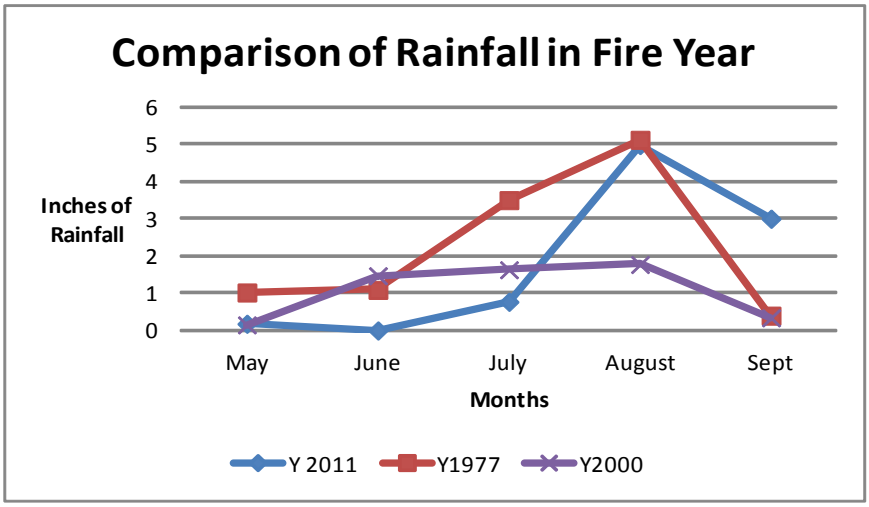


Figure 1. Comparison of rainfall in the first months post-fire for three fire years.

Wildlife and Plants

This publication does not provide information about the effects of fire on wildlife. Fire generally kills or injures a relatively small portion of the animal population (Anderson 2001). For the purposes of this publication, we are more interested in the interaction between plant recovery and some wildlife. For example, elk browsing can reduce the vigor of aspen sprouts. Browsing by both elk and deer have been seen on a number of shrub and forb species. Animals can provide a means of seed dispersal, seed germination, and plant vigor. We have noted the uses that different plant species have to wildlife for that reason.

Rooting Depths

The different type of roots and the depth of roots can provide a mechanism for sprouting and, thus, survival of plant species. Those plants that have underground stems are also potentially able to sprout. Rooting depths have been researched in the Fire Effects Information System (FEIS) database and studies by Tierney and Foxx (1987) and Foxx and Tierney (1987).

About the Document

In this document, a variety of plants are evaluated for the effect of fire and their presence in the La Mesa Fire and prescribed burn on Escobas Mesa. I have also included observations from other fires of the Jemez Mountains that have occurred before and after the La Mesa Fire in 1977, including the Dome (1996), Oso (1998), Cerro Grande (2000), and Las Conchas (2011) fires. Tables 2 through 4 are checklists of graminoids, forbs, and

shrubs indicating the plots where the species were found in the first two years after the La Mesa Fire (Potter and Foxx 1979). Table 5 represents data collected in 2001 after the Cerro Grande Fire in Santa Clara Canyon (Foxx et al. 2001). Information related to the Cerro Grande Fire is based on observations and this data collection. Table 6 quantifies plants found in disturbed areas of the Pajarito Plateau. This table is based on studies done from 1975 through 1999 on old fields, waste sites, and archeological sites (Foxx 1982; Tierney and Foxx 1982; Foxx et al. 1997; Foxx and Tierney 1999).

There are several ways information was gathered. First, selected species were compiled from the author's observations over the past 35 years. Because this is a fire-prone environment, there are many species that respond to fire. There are many additional unlisted plants that have a response to fire—this list is just a beginning.

Second, information about fire effects on individual species has been compiled by the the US Department of Agriculture (USDA), Forest Service, Fire Effects Information System (www.fs.fed.us/database/feis/plants), other literature sources, and personal observations. Nomenclature has been confirmed through the USDA Plants database (www.plants.usda.gov). Phenology, wildlife use, rooting depths, and other information have been gleaned from both of these databases as well as other literature (Foxx and Tierney 1987, Tierney and Foxx 1987, Foxx and Hoard 1995, Foxx et al. 2001, Parker 1972, Stubbendieck et al. 1986, USDA 1971, and Martin and Hutchins 1981). More species will be added as information is compiled.

There are some plants that have an abundance of information and others with very little. I have designated those plants with very little information with an asterisk or with 'ND' [no data available] in the specific information category. Those areas designated with ND need information from others, both amatuer and professional, to improve this body of knowledge. Observations about these plants are important to other researchers.

Information Provided

The plants described within this document are primarily those that have been seen reproducing within the first two years of a fire. The specific data are taken from information gained during the studies on the La Mesa Fire but also observations of several other fires in the last 35 years: Burnt Mesa (1975), Escobas Mesa (1976), Alamo Canyon (1976), La Mesa (1977), Dome (1996), Oso (1998), Cerro Grande (2000), and Las Conchas (2011).

The following information has been compiled:

Family: A common name and scientific name, as well as the plant family the species belongs to, are provided and were checked in the USDA Plants Database and Allred (2011).
Duration: Information about the life cycle of the plant and its origin--native or introduced.
Successional: Information as to where the plant is commonly found.
Regeneration: Information as to the reproductive mechanism of the plant.
Frequency: Where the plant was found within the burned areas of the Jemez Mountains. If there are observations about when the plant was seen, that is also included.
Drought tolerance: The area has experienced drought and the tolerance of the plant will be related to its abundance.
Root depth: Rooting depth will affect the ability of a plant to sprout and recover.
Wildlife: The abundance of the plant after fire will be influenced by wildlife or will influence the presence of wildlife.



Redroot pigweed and fetid goosefoot on Burnt Mesa late September 2011, post Las Conchas Fire.

Table 2. Annotated Checklist of Shrubs Found the First and Second Year after the La Mesa Fire

		Plots																		
		Frijoles Mesa				Burnt Mesa			Escobas Mesa				Apache Spring					Frijoles Canyon	
Species	**Common Name**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**5**	**1**	**2**
Arctostaphylos uva-ursi	Bearberry												x		x				
Berberis fendleri	Colorado barberry																	x	
Brickellia grandiflora	Tassel brickellia																	x	
Ceanothus fendleri	Fendler buckbrush									x									
Cercocarpus montanus	Alderleaf mountain mahagony	x	x	x															
Clematis pseudoalpina	Mountain clematis																		x
Gutierrezia sarothrae	Broom snakeweed	x																	
Opuntia sp.	Prickly pear		x	x															
Populus tremuloides	Quaking aspen												x		x		x		x
Prunus virginiana var. *melano-carpa*	Chokecherry																	x	
Quercus gambelii	Gambel oak					x	x			x	x			x	x		x	x	x
Quercus undulata	Scrub oak	x	x	x	x														
Rhus radicans	Poison ivy																		
Rhus trilobata	Skunkbush sumac																	x	x
Rubus strigosus	Raspberry																	x	
Ribes spp.	Gooseberry, currant												x						
Robinia neomexicana	New Mexico locust									x	x		x		x	x		x	x
Rosa woodsii	Wood's rose																		
Yucca baileya	Soapweed yucca	x			x														

Table 3. Annotated Checklist of Plants Found Within Ponderosa Pine Plots the First and Second Years After the La Mesa Fire									
GRASS		**1977 Moderate**	**1978 Moderate**		**1977 Severe**	**1978 Severe**		**1977 Light**	**1978 Light**
Andropogon gerardii	Big bluestem	1*	0		1	0		0	0
Aristida spp. (*A. divaricata, A. longiseta*)	Poverty three-awn	1	1		0	1		2	2
Agropyron smithii	Western wheatgrass	0	0		0	0		0	0
Blephareoneuron tricholepis	Pine dropseed	1	1		0	2		2	2
Bouteloua gracilis	Blue grama	2	2		0	1		3	1
Bromus spp.		0	0		0	1		0	0
Bromus tectorum	Cheatgrass	0	0		0	0		0	0
Cyperus fendlerianus; C. esculentas	Fendler's flatsedge	3	1		2	2		3	1
Elymus trachycaulus (Andropogon trachycalum)	Slender wheatgrass	0	3		0	3		0	2
Festuca ovina	Sheep fescue	0	3		0	2		0	2
Muhlenbergia montana	Mountain muhly	1	2		1	3		1	2
Muhlenbergia wrightii	Wright's muhly		2			1			0
Schizachyrium scoparium (Andropogon scoparius)	Little bluestem	0	0		1	1		1	2
Sitanion hystrix	Bottlebrush squirreltail	1	2		0	1		0	0
Sporobolus cryptandrus	Sand dropseed	0	0		0	0		0	0
Forbs									
Allium cernuum	Wild onion	2	2		0	1		2	1
Antennaria parvifolia	Littleleaf pussytoes	0	1		0	0		1	0
Bahia dissecta	Ragleaf bahia	1	1		0	1		1	0
Artemisia carruthii	Wormwood	1	1		1	1		2	0
Artemisia dracunculus	False tarragon								
Castilleja integra	Wholeleaf paintbrush	0	0		0	0		2	0
Chenopdium album	Lambsquarters	1	1		0	2		1	1
Chenopodium graveolans	Fetid goosefoot	2	0		2	2		3	1

		1977 Moderate	1978 Moderate		1977 Severe	1978 Severe		1977 Light	1978 Light
Commelina dianthifolia	Dayflower	0	0		0	1		0	0
Heterotheca villosa (Chrysopsis villosa)	Hairy golden aster	0	1		0	1		3	1
Cirsium neomexicanum	New Mexico thistle	1	0		0	1		1	1
Erigeron divergens	Spreading fleabane	1	1		0	0		2	1
Euphorbia serpyllifolia	Thymeleaf sandmat	1	0		0	2		1	0
Gaura coccinea	Scarlet gaura	0	0		0	0		1	0
Geranium caespitosum	James' geranium	0			0			1	
Ipomopsis aggregata									
Tetraneuris acaulus (Hymenoxys acaulis)	Stemless four-nerved daisy	0	1		0	1		1	1
Liatris punctata var. *neomexicana*	Dotted gayfeather	0	0		0	1		0	0
Linum neomexicanum	Stiffstem flax	0	0		0	1		0	0
Lithosperum multiflorum	Puccoon	1	1		0	1		1	1
Lotus wrightii	Wright's trefoil	0	0		0	1		0	1
Lupinus caudatus	Tailcup lupine	1	0		0	1		1	1
Melilotus officinalis		0	0		1	0		0	0
Mirabilis linearis	Four o'clock	0	0		1	0		0	0
Penstemon	Beardstongue	1			1			1	
Dalea candidus var. *candida (Petalostemum candidus)*	White prairie clover	0			1			0	
Physalis subulata var. *neomexicana (Physalis foetens* var. *neomexicana)*	New Mexico groundcherry	1	0		0	1		1	0
Potentilla spp. *(P. hippiana, P. pulcherrima*)	Cinquefoil	1	1		1	1		1	1

		1977 Moderate	1978 Moderate		1977 Severe	1978 Severe		1977 Light	1978 Light
Senecio spp.	Ragwort	0	1		1	1		0	2
Taraxicum officinale	Common dandelion	0	0		0	0		1	0
Tragopogon dubius	Yellow salsify	0	0		0	0		1	0
Thelesperma filifolium var. *intermedium (Thelesperma trifidum)*	Stiff greenthread	0	1		0	0		1	0
Thermopsis rhombifolia var. *montana* (*Thermopsis pinetorum*)	Big golden pea	0	1		0	0		1	0
Verbascum thapsus	Common mullein	0			0			1	
Vicia americana	American vetch	2	2		0	0		1	2

*Number of plots in which plant was found.

Table 4. Annotated Checklist of Plants Found in Piñon-Juniper and Mixed Conifer Plots the First and Second Years after the La Mesa Fire

		Plots										
Grass		**F1**	**F2**	**F3**	**F4**	**A1**	**A2**	**A3**	**A4**	**A5**	**Fj1**	**Fj2**
Bouteloua gracilis	Blue grama	x										
Elymus trachycaulus (Andropogon trachycalum)	Slender wheatgrass	x										
Muhlenbergia montana	Mountain muhly	x										
Schizachyrium scoparium (Andropogon scoparium)	Little bluestem											
Sitanion hystrix	Bottlebrush squirreltail											
Forbs												
Allium cernuum	Nodding onion											
Antennaria parvifolia	Littleleaf pussytoes											
Apocynum androsaemifolium	Spreading dogbane										x	
Bahia dissecta	Ragleaf bahia	x	x	x	x							
Artemisia carruthii	Wormwood	x										
Castilleja integra	Wholeleaf paintbrush	x			x							
Chenopdium album	Lambsquarters			x		x						
Chenopodium graveolans	Fetid goosefoot	x										
Heterotheca canescans (Chrysopsis villosa)	Hairy golden aster	x		x								
Circium neomexicanum	New Mexico thistle											
Corydalis aurea	Golden smoke					x		x	x			x
Eriogonum spp.		x										
Eriogonum jamesii	Jame's false buckwheat	x										
Euphorbia serpyllifolia	Thymeleaf sandmat	x	x	x	x							
Fragaria	Strawberry					x	x	x			x	

		Plots										
		F1	**F2**	**F3**	**F4**	**A1**	**A2**	**A3**	**A4**	**A5**	**Fj1**	**Fj2**
Fragaria americana	Wild strawberry					x	x	x			x	
Galium spp.	Bedstraw						x	x				
Gaura coccinea	Scarlet gaura											
Geranium caespitosum	Purple geranium										x	
Goodyera oblongifolia								x				
Tetraneuris acaulus (Hymenoxys acaulis)	Stemless four-nerved daisy				x	x						
Linum neomexicanum	Stiffstem flax			x								
Lithospernum multiflorum	Many flowered stoneseed					x						
Lotus wrightii	Wright's deervetch	x	x									
Lupinus caudatus	Tailcup lupine			x								
Melilotus officinalis	Sweet clover											
Mirabilis linearis	Four o'clock		x									
Oenothera spp.	Evening primrose	x									x	
Penstemon	Beardtongue											
Dalea candida var. *candida (Petalostemum candidus)*	White prairieclover											
Physalis subulata var. *neomexicana (Physalis foetens* var. *neomexicana)*	Groundcherry	x										
Potentilla	Cinquefoil											
Senecio spp.		x										
Tragopogon dubius	Yellow salsify										x	
Thalictrum fendleri	Fendler's meadow-rue					x	x			x	x	
Thelesperma filifolium (Thelesperma trifidum)	Greenthread											
Thermopsis rhombifolia var. *montana* (*Thermopsis pinetorum*)	Big golden pea											x
Verbascum thapsus	Common mullein											
Vicia americana	American vetch					x			x	x	x	x

Table 5. Plants Found in Whitaker Plots One Year after the Cerro Grande Fire, Santa Clara Canyon				
Scientific Name	**Common Name**	**Ponderosa Pine**	**Ponderosa Pine/ Mixed Conifer**	**Ponderosa Pine/ Mixed Conifer**
		7000 feet elevation	**>7000<8000 feet elevation**	**>8000 feet elevation**
Bouteloua gracilis	Blue grama	x	x	0
Elymus trachycaulus (Andropogon trachycalum)	Slender wheatgrass	x	0	x
Forbs				
Achillea millefolium var. *occidentalis (A. lanulosa)*	Western yarrow	x	0	0
Antennaria parvifolia	Littleleaf pussytoes	0	x	0
Artemisia carruthii	Carruth wormwood	0	0	x
Artemisia dracunculus	False tarragon	x	0	0
Brickellia grandiflora	Brickel bush	0	x	0
Castilleja integra	Wholeleaf paintbrush	0	0	0
Chenopodium album	Lambsquarters	x	x	0
Chenopodium graveolans	Fetid goosefoot	x	x	x
Croton texensis	Dove weed	x	0	0
Circium neomexicanum	New Mexico thistle	0	0	0
Corydalis aureau	Golden smoke	0	0	x
Cryptantha jamesii	James hiddenflower	x	0	0
Euphorbia serpyllifolia	Thymeleaf sandmat	x	0	x
Fragaria americana	Wild strawberry	0	x	0
Geranium caespitosum	Purple geranium	x	x	0
Hymenoxys richardsonii	Pinque, rubberweed	x	0	0
Tetraneuris acaulus (Hymenoxys acaulis)	Stemless four-nerved daisy	x	x	x
Lathyrus arizonicus		0	0	x
Lithospermum multiflorum	Puccoon	0	0	x
Oenothera spp.	Evening primrose	0	x	0

Scientific Name	Common Name	Ponderosa Pine	Ponderosa Pine/ Mixed Conifer	Ponderosa Pine/ Mixed Conifer
		7000 feet elevation	**>7000<8000 feet elevation**	**8000 feet elevation**
Opuntia spp.	Cactus	0	x	0
Mirabilis linearis				
Physalis subulata var. *neomexicana (Physalis foetens* var. *neomexicana)*	New Mexico groundcherry	x	x	0
Senecio bigelovii		0	0	x
Senecio wootonii	Groundsel	0	x	0
Thermopsis rhombifolia var. *montana (Thermopsis pinetorum)*	Big golden pea	0	x	0
Verbascum thapsus	Common mullein	0	x	0
Vicia americana	American vetch	0	x	0
Viola	Wild violet	0	0	x
Shrubs				
Rhus trilobata	Skunkbush sumac	x	0	0
Ribes cernuum	Currant	x	0	0
Yucca baileya	Soapweed yucca	0	x	0

Table 6. Plants Found in Areas of Disturbance on the Pajarito Plateau							
Scientific Name	**Common Name**	**Old Fields***	**Romero Cabin**	**Arch Sites**	**Waste Sites**	**Total**	**Occurrence (%)**
Number of sites		8	5	16	7	36	
Bouteloua gracilis	Blue grama	7	4	16	2	29	81
Elymus elymoides	Bottlebrush squirrel-tail	6	5	8	3	22	61
Artemisia dracunculus	False tarragon	8	4	3	6	21	58
Penstemon spp.	Penstemon	3	1	14	0	18	50
Erigeron spp.	Fleabane daisy	3	1	10	2	16	44
Melilotus spp.	Sweet clover	4	0	6	5	15	42
Opuntia spp.	Prickly pear	1	0	14	0	15	42
Oenothera spp.	Evening primrose	6	3	5	0	14	39
Sporobolus cryptandrus	Sand dropseed	6	4	0	3	13	36
Gaura coccinea	Gaura	3	1	4	4	12	33
Heterotheca villosa (*Chrysopsis villosa*)	Golden aster	7	1	0	4	12	33
Fallugia paradoxa	Apache plume	1	0	10	0	11	31
Artemisia carruthii	Carruth wormwood	7	3	0	2	10	28
Yucca baileya	Soapweed yucca		1	8	1	10	28
Schizachyrium scoparium	Little bluestem	8	0	0	0	8	22
Dalea candidus	White prairie clover	1	0	7	0	8	22
Sphaeralcea coccinea	Globe mallow	3	0	3	2	8	22
Muhlenbergia montana	Mountain muhly	5	2	0	0	7	19
Bahia dissecta	Ragleaf bahia	3	2	2		7	19
Castilleja integra	Wholeleaf paintbrush	1	0	5	0	6	17
Tragopogon dubius	Goatsbeard	4	1	0	1	6	17
Vicia americana	American vetch	6	0	0	0	6	17
Aristida purpurea	Three-awn	3	0	0	2	5	14
Verbascum thapsus	Common mullein	2	0	1	2	5	14
Rhus trilobata	Lemonade berry	0	0	4	1	5	14
Bromus tectorum	Cheatgrass	2	0		2	4	11
Artemisia frigida	Estafiata	2	1		1	4	11

Scientific Name	Common Name	Old Fields	Romero Cabin	Arch Sites	Waste Sites	Total	Occurrence (%)
Chenopodium album/fremontii	Lambsquarters	4	0	0	0	4	11
Lupinus	Lupine	3	1	0	0	3	11
Salsola kali	Russian thistle	3	0	0	1	4	11
Thelesperma filifolium	Greenthread	3	1	0	0	4	11
Lithospermum multiflorum	Puccoon	2	1	0	0	3	8
Amaranthus retroflexus	Redroot pigweed		1	1		2	6
Cryptantha jamesii	Jame's hidden flower	1	1	0	0	2	6
Kochia scoparia	Summer cypress	0	2	0	0	2	6
Corypantha spp.	Pincushion cactus	1	0	0	0	1	3
Tetraneuris acaulus (Hymenoxys acaulis)	Stemless four-nerved daisy	0	1	0	0	1	3
Liatris punctata	Dotted gayfeather	1	0	0	0	1	3
Mirabilis linearis	Narrowleaf four o'clock	1	0	0	0	1	3
Hymenoxys richardsonii	Pinque	5	0	0			
*The number of plots in which the plant was found							



Pigweed



Turning bright red in the fall.



Seedhead

REDROOT PIGWEED

Amaranthus retroflexus

Family: Amaranthaceae
Duration: Introduced annual forb
Successional: Disturbance adapted, widely distributed. Early successional species in bare disturbed sites. Fire reduces competition from other vegetation. Plant extracts more nitrogen from and grows faster on the nitrogen-poor soils of recently abandoned fields than mid- and late-successional species (Tilman 1986). Found in 6% of the disturbed soil plots (see Table 6).
Regeneration: Important in seedbank. Seeds are often found in archeological site float samples (Foxx and Tierney 1999; Foxx 1975). Can be blown by wind from off-site or carried by animals to the site (Kuenzi et al. 2008). In Kansas it was one of the most common seeds found in seedbanks of abandoned fields (Lippert and Hopkins 1950).
Frequency: *La Mesa fire:* Not in the plots until after the prescribed burn in 1998 and drought. *Las Conchas Fire:* In large patches on Burnt Mesa within 90 days post-fire.
Drought tolerance: During the 1934 drought, rough pigweed grew thickly where windblown dust had covered considerable portions of prairies in Kansas and Nebraska. Rough pigweed and other ruderals normally not found in prairies became widely distributed when released from their usual competition with grasses. However, with the end of drought and the return of grasses, rough pigweed nearly disappeared in many prairies (Weaver and Albertson 1944).
Rooting depth: Foxx and Tierney (1987) found the average rooting depth was 39 inches with a range from 39 to 95 inches.
Wildlife: Used by a variety of wildlife, including deer, small mammals, and birds.





Fetid goosefoot

FETID GOOSEFOOT*
Chenopodium graveolens

Family: Chenopodiaceae
Duration: Native annual forb
Successional: Disturbance-adapted species. Found primarily in the ponderosa pine, rarely in piñon-juniper, and not in mixed conifer plots after fire.
Regeneration: Common where vegetation has been removed, such as under trees. Occurs in patches. In plots in the first two years. Similar patterns were seen in the Rodeo-Chediski fire in Arizona (Kuenzi et al. 2008). Most often in high-severity burn sites. Reproduces by seed.
Frequency: *La Mesa Fire:* Common where vegetation has been removed, such as under trees. Occurs in patches. In plots in the first two years. Similar patterns were seen in the Rodeo-Chediski Fire in Arizona (Kuenzi et al. 2008). Most often in high-severity burn sites. *Cerro Grande Fire*: Seen in low-, mid-, and high-elevation plots (see Table 5). *Las Conchas Fire*: Very common on Burnt Mesa. Bright red in the fall.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



Lambsquarters

LAMBSQUARTERS*
Chenopodium album, C. fremontii

Family: Chenopodiaceae
Duration: Native/introduced annual forb
Successional: Disturbance adapted, found in gardens, waste places, along roadsides. Found in 11% of the 36 disturbed soil plots (see Table 6).
Regeneration: Reproduces by seeds.
Frequency: *La Mesa Fire:* In 33% of the plots in the ponderosa pine and only 25% of the plots in the piñon-juniper and mixed conifer. *Cerro Grande Fire:* In the low- and mid-elevation plots (see Table 5). *Las Conchas Fire:* In patches on Burnt Mesa 90 days post-fire. Large colonies of over-sized individuals in Water, Valle, and Pajarito canyons one year later.
Drought tolerance: ND
Root depth: Tierney and Foxx (1987) measured the taproot at 11.8 inches with a shoot height of 43.3 inches.
Wildlife: Seeds eaten by birds and foliage used by some species of caterpillars.



A. ludoviciana

Wormwoods



A. carruthii

CARRUTH'S SAGEWORT, WORMWOOD

Artemisia frigida, A. ludoviciana, A. carruthii

Family: Asteraceae
Duration: Native forb/subshrub
Successional: *A. carruthii* found both in disturbed (old fields and waste sites) and undisturbed sites (see Table 6).
Regeneration: Can sprout from rhizomes and may increase with frequent fire, *A. ludoviciana* can spread aggressively from rhizomes.
Frequency: *La Mesa Fire*: *A. carruthii* found in 40% of ponderosa pine and 25% of the piñon-juniper plots regardless of fire severity first year post-fire (see Tables 3 and 4). Found in the meadowed areas of Burnt Mesa and Escobas Mesa. *A. carruthii* was most common but others found occassionally. *A. ludoviciana* is generally a higher-elevation species.
Drought tolerance: High
Rooting depths: Tierney and Foxx (1987) found roots were within 3.9 inches of the soil surface.
Wildlife: Good winter browse for deer and elk.





Seedhead (top) and plants (bottom)

RUSSIAN THISTLE

Salsola kali

Family: Chenopodiaceae
Duration: Introduced annual forb; introduced in 1800s. Found in 11% of the 36 disturbed soil plots (see Table 6).
Successional: Shade intolerant, initial colonizer. Thrives in disturbed communities--becomes "tumbleweed." Does not like a crowded canopy.
Regeneration: Aids in fire spread because it burns easily and it rolls. Colonizes a burn site from off-site by the tumbling and spreading of seed. Can dominate one to three years.
Frequency: *La Mesa Fire:* Occasionally in the unseeded area at Technical Area 49 at Los Alamos National Laboratory. Not in the Bandelier plots.
Drought tolerance: Invades ranges during drought. Was important to cattle industry in 1930s when no other feed available (DeLoach et al. 1986; Young 1991).
Rooting depth: Taproot can reach three feet, extensive lateral roots (Allen 1982).
Wildlife: Minor component in mule deer and elk diets. Seeds eaten by small birds. Important food for prairie dogs (Bonham and Lerwick 1976).



False tarragon

FALSE TARRAGON

Artemisia dracunculus

Family: Asteraceae
Duration: Woody native perennial forb
Succession: A weedy species that can displace desirable vegetation. Increases in areas of disturbance and can colonize disturbed sites such as old fields. Found in 58% of the 36 disturbed soil plots; the most common forb (see Table 6).
Regeneration: Fire-adapted species that can re-establish from surviving rhizomes. Seeds do not disperse far from mother plant (Valles and McArthur 2001). Associated with vesicular-arbuscular mycorrhizae (Pendleton and Smith 1983).
Frequency: *La Mesa Fire*: Increased in a number of areas on Burnt Mesa after the prescribed burn and drought (Foxx 1996). *Cerro Grande Fire*: In lower-elevation plots (see Table 5). *Las Conchas Fire*: Sprouting within 14 days of the fire.
Drought tolerance: Drought tolerant
Rooting depth: Tierney and Foxx (1987) found roots were within 3.9 inches of the soil surface.
Wildlife: Forage for elk, mule deer



Dominated some areas on Burnt Mesa in 2010.



Seedhead



Whole plant

SUMMER CYPRESS, BURNING BUSH

Bassia scoparia (Kochia scoparia)

Family: Chenopodiaceae
Duration: Introduced annual forb
Succession: Invasive and noxious weed and may displace desirable vegetation. Found along roadsides, fields, and soils high in salinity. Can be used for soil erosion. Noxious and invasive in some areas.
Regeneration: Reproduces by seed. May colonize burned areas via its tumbleweed effect. Plant is allelopathic, inhibiting early growth of other summer-cypress seedlings as well as growth of other plant species. Seeds have little or no seedbank viability—they either germinate or decay in one year (Iverson and Wali 1981; Boerboom 1993).
Frequency: Occasionally found on the La Mesa Fire area particularly where there was no reseeding.
Drought tolerance: Can be found in areas with as little as six inches of annual rainfall.
Rooting depth: Roots generally penetrate to depths of six to eight feet, but reached depths of 16 feet in a sorghum field in Kansas during a severe drought. Roots can extend laterally up to 22 feet (Durgan et al. 1990; Phillips and Launchbaugh 1958).
Wildlife: Used for food and cover.



Yellow sweet clover



Common mullein

SWEET CLOVER (Yellow and White)

Melilotus officinalis

Family: Fabaceae
Duration: Introduced annual, biennial forb; weedy species.
Succession: Often in disturbed sites such as along roadsides. Produces many seeds—viable for over 81 years (Becquerel 1934). In field may survive over 50 years (Johnson and Nichols 1970). Scarification occurs by fire, freeze/thaw, animals. Good soil stabilizer.
Regeneration: Well adapted to survive fire. Established second-year plants often survive dormant seasonal fires. Seeds are heat tolerant and germination can be stimulated by fire. Contractile roots, which pull the root crown underground in the fall and protect the crown from extreme temperatures (Heitlinger 1975; Kline 1983; Turkington et al. 1978).
Frequency: In one moderately burned plot in the ponderosa pine.
Drought tolerance: High
Root depth: Root nodules when infected with the correct rhizobium bacteria, creating higher levels of soil nitrogen. Semi-woody taproots can reach five feet deep.
Wildlife: Used by birds, bees, and large mammals such as deer and elk.

COMMON MULLEIN, FLANNEL MULLEIN

Verbascum thapsus

Family: Scrophulariaceae
Duration: Introduced biennial forb; weedy species found in 14% of 36 disturbed soil plots.
Succession: Short-lived member of disturbed communities.
Regeneration: Maximum dispersal distances of up to 36 feet are possible, but the median dispersal distance is three feet. Most cases established from long-lived soil-stored seed on burned sites. Seeds found to live 100 years (Odum 1965; Kivilaan and Bandurski 1981). Fire may stimulate germination of common mullein through chemical cues from smoke (Abella et al. 2007).
Frequency: *La Mesa Fire:* Occasionally in ponderosa pine light-burn plots. *Cerro Grande Fire:* Mid-elevation plots.
Drought tolerance: ND
Rooting depth: Tierney and Foxx (1987) found rooting depths varied from 11 to 16.5 inches.
Wildlife: Deer, elk, and small mammals feed on mullein. Deer and elk primarily use it in the winter. Sandoval et al. (2005) found common mullein was a predominant forage for deer in the winter and for elk in the fall and winter. Birds, woodpeckers, and finches eat seeds.



Mullein along the Mitchell Trail 10 years after the Cerro Grande Fire

THYMELEAF SANDMAT, SPURGE*
Euphorbia serpyllifolia

Family: Euphorbiaceae
Duration: Annual forb
Succession: Found in disturbed sites such as gardens and roadsides.
Regeneration: Related species reproduce by seeds.
Frequency: *La Mesa Fire***:** In 40% of the plots, primarily ponderosa pine and piñon-juniper in moderate and light burns, the second year only in severely burned plots where canopy was gone (see Tables 3 and 4). *Cerro Grande Fire:* In low- and high-elevation plots (see Table 5). *Las Conchas Fire:* In large patches on Burnt Mesa 23 days post-fire.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*

COMMON PURSLANE, VERDOLAGA*
Portulaca oleracea

Family: Portulacaceae
Duration: Introduced annual forb
Succession: Found in disturbed sites such as gardens and roadsides.
Regeneration: Repoduces by seeds and stem fragments in soil.
Frequency: *La Mesa Fire:* Not recorded in the plots. *Las Conchas Fire:* Seen in mats associated with thymeleaf sandmat on Burnt Mesa 23 to 90 days post-fire.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



A patch on Burnt Mesa with a combination of verdolaga and thymeleaf sandmat post Las Conchas Fire

YELLOW SALSIFY

Tragopogon dubius



Yellow salsify

Family: Asteraceae
Duration: Introduced biennial forb; weedy species
Succession: Salsify can inhabit most any area from forests to grasslands. It is often found in disturbed area. Generally not a large component of the plant community.
Regeneration: Seeds may survive a low-severity fire. Most commonly an off-site colonizer. It does not produce a long-lived seedbank. Cannot resprout. Fire intolerant.
Frequency: *La Mesa Fire*: Only in one plot in the ponderosa pine and one in the mixed conifer (see Tables 3 and 4). Generally only single plants present.
Drought tolerance: High
Root depth: six inches (minimum)
Wildlife: Browse for deer, elk, small mammals, and birds.

COMMON DANDELION

Taraxicum officinale



Common dandelion

Family: Asteraceae
Duration: Introduced perennial forb
Succession: Found in disturbed sites and lawns.
Regeneration: Does not have the ability to sprout. Generally establishes during the first or second year post-fire. Propagated by seed.
Frequency: In only one plot in the ponderosa pine. After the La Mesa Fire, saw gigantism in the plant due to increased nutrients and lack of competition.
Drought tolerance: Medium
Root depth: six inches (minimum)
Wildlife: Eaten by deer and elk, small mammals, and some bird species.

WHITE FLOWERS



Yarrow

WESTERN YARROW

Achillea millefolium var. *occidentalis (A. lanulosa)*

Family: Asteraceae
Duration: Native perennial forb
Successional: Early successional species establishing on disturbed sites.
Regeneration: Repoduces from rapid rhizome spread and wind disperal of seeds on burned sites from un-burned sites.
Frequency: *La Mesa fire*: Found in 75% of the mixed conifer plots (see Table 4). *Cerro Grande Fire*: Found in low-elevation plots (see Table 5).
Drought tolerance: Medium
Root depth: eight inches (minimum)
Wildlife: Fair to poor graze/browse for deer and elk



Northern bedstraw

NORTHERN BEDSTRAW

Galium boreale and *G. triflorum*

Family: Rubiaceae
Duration: Native perennial forb
Succession: Found at higher elevations and in moist sites such as canyons.
Regeneration: Low-severity fires sprouts from rhizomes. High-severity fires sprouting is from on- and off-site seed sources. Barbed seeds contribute to animal dispersal.
Frequency: *La Mesa Fire:* Found in 50% of the mixed conifer plots. Not found in any lower-elevation plots of the ponderosa pine or piñon-juniper (see Table 3). *Cerro Grande Fire:* Re-growth observed in higher-elevation sites such as near American Springs.
Drought tolerance: Medium
Root depth: six inches (minimum).
Wildlife: Seasonal food for black bears. Also important in elk and deer habitats.



In large patches where soil has been bared of vegetation two months post La Mesa Fire.



Fruits

NEW MEXICO GROUNDCHERRY*

Physalis foetens var. *neomexicana*

Family: Solanaceae
Duration: Native annual forb
Successional: Generally found in disturbed area. Not found in disturbed site plots (see Table 6) but seen after fire, particularly in ponderosa pine.
Regeneration: Fruits look like Chinese lanterns.
Frequency: *La Mesa Fire:* First two years post-fire found in patches. Not common, found in severe and lightly burned areas. In lightly burned areas generally in patches where vegetation has been consumed. *Cerro Grande Fire:* In lower-elevation plots (see Table 5). *Las Conchas Fire:* In patches on Burnt Mesa and Water and Valle canyons where soil was denuded of litter.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*

LITTLELEAF PUSSYTOES
Antennaria parviflora, A. marginata

Family: Asteraceae
Duration: Native perennial forb
Successional: Common in ponderosa and mixed conifer communities. Primarily found at higher elevations.
Regeneration: Colonizes bare mineral soil from light, wind-dispersed seed. Cannot resprout. Growth form stoloniferous and mat forming.
Frequency: *La Mesa Fire:* In only two plots ponderosa pine (see Table 3). *Cerro Grande Fire:* Increasing in canyon areas. In mid-elevation plots (see Table 5).
Drought tolerance: Drought—medium; fire—high
Root depth: 12 inches (minimum)
Wildlife: Little use by wildlife. Some Lepodopterans eat seeds.


Littleleaf pussytoes


Jame's hidden flower

JAME'S CRYPTANTHA;
JAME'S HIDDEN FLOWER*
Cryptantha jamesii

Family: Boraginaceae
Duration: Perennial native forb
Succession: In disturbed sites. In 6% of the 36 disturbed soil plots (see Table 6).
Regeneration: ND
Frequency: *Cerro Grande Fire*: In the low- to mid-elevation plots.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*





Sprouting after fire (top) and flower (bottom)

WILD STRAWBERRY*

Fragaria americana

Family: Rosaceae
Duration: Perennial forb
Succession: Found in canyons and on mountain slopes in ponderosa pine and mixed conifer.
Regeneration: Crowns arise from short rhizomes spreading and forming colonies by stolons that root and produce plantlets at the nodes. Seeds are probably dispersed by birds and mammals. May develop seedbanks (Eriksson 1989).
Frequency: *La Mesa Fire:* Sprouting in 75% of the mixed conifer plots and one canyon plot (see Table 4).
Drought tolerance: ND
Root depth: ND
Wildlife: Fruits eaten by a number of species of birds and mammals.

**There is little or no information in the general literature, the FEIS, or USDA Plants.*





Sprouting after fire (top) and flower (bottom)

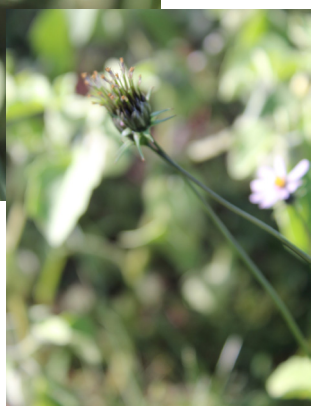
FLEABANE DAISY; SPREADING FLEABANE*

Erigeron divergens and *E. flagellaris*

Family: Asteraceae
Duration: Biennial forb, often in disturbed areas. Found in 44% of the 36 disturbed soil plots (see Table 6).
Succession: *E. flagellaris:* Generally found in disturbed soils of piñon-juniper and ponderosa pine. *E. divergens* found in piñon-juniper to mixed conifer.
Regeneration: ND
Frequency: *La Mesa Fire:* In 30% of plots in the moderate and light burns within the ponderosa pine (see Table 3). Persistent after year one. *Las Conchas Fire:* Runners of *E. flagellaris* on Burnt Mesa.
Drought tolerance: ND
Root depth: ND
Wildlife: High value to pollinators, improves insect diversity and diversity of grassland habitat. Benefits wild turkey, songbirds, small mammals, cottontail, and deer (NRCS 2007).

**There is little or no information in the general literature, the FEIS, or USDA Plants.*





Flower (top); seed-head

BIGELOW'S BEGGARTICKS*

Bidens bigelovi

Family: Asteraceae
Duration: Native annual forb. Found in disturbed sites of the Pajarito Plateau (see Table 6).
Successional: Found in disturbed areas and around roadsides, piñon-juniper, and ponderosa pine.
Regeneration: Barbed awns attach to clothing and animal fur.
Frequency: *La Mesa Fire*: In 100% of the piñon-juniper plots (see Table 4). *Las Conchas Fire*: In small patches on Burnt Mesa within 90 days post-fire.
Drought tolerance: ND
Root depth: ND
Wildlife: Barbed awns attach to animal fur.

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



Spreading dogbane

SPREADING DOGBANE*

Apocynum androsaemifolium

Family: Apocynaceae
Duration: Native perennial forb
Successional: Found along roadsides, in canyon bottoms
Regeneration: Recolonized from burned areas immediately after fire through rhizomes. Can also colonize through seed germination from off-site seed sources.
Frequency: *La Mesa Fire:* Found in one of two canyon plots (see Table 3). *Cerro Grande Fire:* Found in patches in the canyons 2.5 months post-fire.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



Narrowleaf four o'clock

NARROWLEAF FOUR O'CLOCK*
Mirabilis linearis

Family: Nyctaginaceae
Duration: Native perennial forb
Succession: In ponderosa pine and piñon-juniper plant communities. Found in 3% of the 36 disturbed soil plots (see Table 6).
Regeneration: ND
Frequency: *La Mesa Fire:* In ponderosa pine and piñon-juniper plots.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



Wright's deervetch

WRIGHT'S DEERVETCH
Lotus wrightii

Family: Fabaceae
Duration: Perennial native forb
Succession: In the piñon-juniper woodlands
Regeneration: Has some ability to fix nitrogen. Reproduces by seeds.
Frequency: In ponderosa pine and piñon-juniper plots the second year.
Drought tolerance: High
Root depth: 12 inches (minimum)
Wildlife: Moderate graze for animals





After the La Mesa Fire in the piñon-juniper woodland

DOTTED GAYFEATHER

Liatris punctata var. *neomexicana*

Family: Asteraceae
Duration: Native perennial forb
Succession: Likes open sunny conditions, primarily piñon-juniper; often increases after disturbance (Platt 1975). Minor component of old fields on the Pajarito Plateau (see Table 6).
Regeneration: Good fire tolerance because of reproduction by rhizomes. Produces numerous, small, wind-dispersed seeds. Fire promotes seedling establishment by removing deep litter.
Frequency: *La Mesa Fire:* In one ponderosa pine plot one year post-fire (see Table 3). In the piñon-juniper; burning decreased competition from grass and forb. *Las Conchas Fire*: On Burnt Mesa 90 days post-fire.
Drought tolerance: High
Root depth: A deep taproot that extends up to seven feet in heavy clay soils and to 16 feet in lighter soils. Strong lateral roots branch in the first three feet, but they all penetrate deeply and most absorptive rootlets are at the deeper levels.
Wildlife: Browse for deer. Many species of butterflies, bees, and other native pollinators visit the flowers in full bloom



Large patches on Burnt Mesa after the La Mesa Fire



Sprouting on Burnt Mesa 23 days post-Las Conchas Fire.



TAILCUP LUPINE

Lupinus caudatus var. *argophyllus*

Family: Fabaceae
Duration: Native perennial; cool-season forb
Succession: Primarily piñon-juniper
Regeneration: Fire survivors and present in the initial stages of post-fire plant succession. Germinates from buried seed after fire. Top-killed plants can make a quick recovery and increase in vigor and number, especially during the second season. Sprouts from the caudex but stored seeds are 100% viable (Steele and Geier-Hayes 1993).
Frequency: *La Mesa Fire:* Found on Burnt Mesa and Escobas Mesa (see Table 3) in years one and two. On Burnt Mesa it developed large patches several years post-fire. Over time patches disappeared. Important host plant for blue butterfly species. *Las Conchas Fire:* Found sprouting on Burnt Mesa 23 days post-fire.
Drought tolerance: Medium
Root depth: Stout deep taproot. Tierney and Foxx (1987) found the taproot extended to a depth greater than 6.5 feet.
Wildlife: Toxic to domestic cattle but consumed by deer, birds, and small mammals.



Wild onion

WILD ONION*
Allium cernuum

Family: Alliaceae
Duration: Native perennial forb
Succession: Common component of ponderosa pine and other plant communities.
Regeneration: Although not found to be a common species reported sprouting in FEIS database, we observed it in greater abundance after fire.
Frequency: *La Mesa Fire:* In patches in 40% of the ponderosa pine plots in light, moderate, and severe burns the first and second years post-fire (see Table 3).
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



American vetch

AMERICAN VETCH
Vicia americana

Family: Fabaceae
Duration: Native perennial forb
Succession: Common in forested areas of the Jemez Mountains.
Regeneration: Shade-tolerant, rhizomatous species. Repoduces from seed and creeping rhizomes. Can sprout following light- to moderate-intensity fires. Can revegetate from soil-stored seeds. Fixes nitrogen (Ahlgren 1966; 1979).
Frequency: *La Mesa Fire:* One of the more common species in ponderosa pine and mixed conifer. Found in 70% of the ponderosa pine plots and 50% of the mix conifer plots and both canyon plots (see Tables 3 and 4).
Root depth: Maximum depth of about 40 inches (Woolley 1936).
Drought tolerance: Strong (Wasser 1982a)
Wildlife: Excellent grazing and fodder for game birds, small mammals, black bear, grizzly bear, and mule deer.



Purple prairie clover



White prairie clover

PURPLE PRAIRIE CLOVER

Dalea purpurea (Petalostemum purpureum); D. candidus

Family: Fabaceae
Duration: Native perennial forb
Succession: FEIS information is about purple clover. Both species are in the area. White is more common in our studies. Used along roadsides in some areas for stabilization and wildlife. Considered a mid- to late-successional species. Can fill a pioneer role along roadsides and disturbed locations. Found in 22% of the 36 plots (see Table 6), primarily on old fields and archeological sites.
Regeneration: Establishes from soil-stored seed after fire. Root crowns may survive burning allowing for post-fire sprouting (Towne and Knapp 1996). Fire creates a favorable condition for seedling establishment. Appears to have a soilbank that contributes to post-fire regeneration. Decreased competition allows for re-establishment. The fruit is a one- to two-seeded pod enclosed in bracts (Stubbendieck and Conard 1989; Bare 1979).
Frequency: *La Mesa Fire*: *D. candidus* is most commonly found but *D. purpurea* is also in the area. Found in only one plot in the ponderosa pine zone (see Table 3). *Las Conchas Fire:* White prairie clover seen blooming on Burnt Mesa.
Drought tolerance: ND
Root depth: Has a coarse, nonfibrous root system with a strong woody taproot that is 5.5 to 6.5 feet deep. The taproot gives rise to several minutely branched lateral roots (Menhusen 1973).
Wildlife: Good forage



Forty days post Las Conchas Fire



Blooming on the ski hill road 40 days post Las Conchas Fire

FIREWEED

Chamerion angustifolium (Epilobium angustifolium)

Family: Onagraceae
Duration: Perennial forb
Succession: Found along roadsides, in burned areas.
Regeneration: Surviving rhizomes vigorously sprout after fire and was a residual survivor on Mt. Saint Helens. Rhizomes capable of rapid growth (MacMahon 1983; Means et al. 1982). Sprouts from rhizomes within 20 to 30 days post-fire. Usually an increaser following fire. One plant can produce 80,000 seeds/year (Dale 1989; Archibold 1980). Does not have a long-lived seedbank (Archibold 1979). Seeds can travel 62 to 186 miles (Solbreck and Andersson 1987).
Frequency: *La Mesa Fire:* Most of plots studied were too low elevation. *Las Conchas Fire:* Blooming 40 days post-fire along the ski hill road. Patches blooming vigorously in August. Large colonies in Valle Canyon in 2012.
Drought tolerance: Low
Root depth: Fine roots and rhizomes extend down vertically to 17.7 inches from the plant, with most growing between 0 and 5.9 inches deep. Majority of roots and rhizomes in the top two inches of mineral soil and can survive relatively intense fires (Flinn and Wein 1977; McLean 1968). Four-year-old rhizome found to be 20 feet long (Ingram 1931).
Wildlife: Food source for elk and deer





Blooming 90 days post Las Conchas Fire on Burnt Mesa.

SCARLET GAURA*

Gaura coccinea

Family: Onagraceae
Duration: Perennial forb
Succession: piñon-juniper woodland and ponderosa pine. A disturbed-site species found in 33% of the 36 disturbed soil sites examined—old fields, waste sites, and archeological sites (see Table 6).
Regeneration: ND
Frequency: *La Mesa Fire:* Found in less than 1% of the plots, primarily in ponderosa pine. *Las Conchas Fire*: Blooming on Burnt Mesa 90 days post-fire.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*





James' geranium (above); Richardson's geranium (right)

JAMES' GERANIUM; RICHARDSON'S GERANIUM*

Geranium caespitosum; G. richardsonii

Family: Geraniaceae
Duration: Perennial forb
Succession: Ubiquitous, various plant communities
Regeneration: May sprout from rhizomes.
Frequency: *La Mesa Fire: G. caespitosum* in only one plot in the ponderosa pine and one in mixed conifer (see Tables 3 and 4). Higher-elevation species is *G. richardsonii.*
Drought tolerance: ND
Root depth: Grows from a stout, simple or branched, sometimes rhizomatous caudex. Young plants (one to three years) generally do not have rhizomes; older plants develop rhizomes in the upper 2.8 to 4.0 inches of soil. Rhizomes are 1.2 to 6.8 inches long and arise from a stout woody taproot (Van Cott 1969; Stevens et al. 1985). In addition to rhizomes, Richardson's geranium has a fibrous root system that can grow from 24 to 28 inches deep.
Wildlife: Used by a variety of birds and mammals

**Primarily the information is about* G. richardsonii *in the FEIS database.*



Wavyleaf thistle

WAVYLEAF THISTLE*

Cirsium undulatum

Family: Asteraceae
Duration: Native biennial forb
Succession: ND
Regeneration: Probably most commonly reestablished through off-site seed dispersal.
Frequency: *La Mesa Fire*: Single plants in burned areas. In the ponderosa pine plots both in the first and second year. *Cerro Grande Fire:* Single plants in the ponderosa pine and mixed conifer.
Drought tolerance: ND
Root depth: ND
Wildlife: Appears to be a favorite of butterflies.

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



New Mexico thistle

(some plants have purple flowers)

NEW MEXICO THISTLE*

Cirsium neomexicanum

Family: Asteraceae
Duration: Native biennial forb
Succession: Found in disturbed areas
Regeneration: ND
Frequency: *La Mesa Fire*: Single plants found in 40% of the ponderosa pine plots (see Table 3). Rosettes not identified as to *C. undulatum* or *C. neomexicanum. Cerro Grande Fire*: Seen along the American Springs road, at about 8000 feet.
Drought tolerance: ND
Root depth: ND
Wildlife: Seeds are the favorite food of goldfinches and many other birds. Flowers provide nectar and pollen for bees. Goeden and Ricker (1987) list species that feed on the thistle.

**There is little or no information in the general literature, the FEIS, or USDA Plants.*

INVASIVE/NOXIOUS THISTLES

Noxious weeds are invasive species. They generally like open, disturbed sites, are prolific seed producers, and will overtake the niches of native plant species. They are sometimes stimulated by low-intensity fires. Musk thistle and bull thistle are two species that have been present in previous fires.







Flower head (top, left). First-year rosette of leaves (bottom, left).
Plant before blooming (left).

First-year rosettes 40 days post Las Conchas Fire

MUSK THISTLE
Cardus nutans

Family: Asteraceae
Duration: Introduced biennial forb
Succession: Native of Europe and western Asia. Introduced in ship's ballast in eastern US mid 1800s.
Regeneration: Prolific seed producer and can set up to 20,000 seeds (Klinkhamer and DeJong 1993). Can establish well in environments without competition and with sunlight. It may or may not be killed by fire.
Control: The key to successful management is to prevent seed production. Also, targeting the first-year leaf rosette (USDA 2001).
Frequency: *La Mesa Fire:* Not in any plots. *Cerro Grande Fire*: Near American Springs, well established nine years post-fire.
Drought tolerance: ND
Rooting depth: Rosettes have numerous small roots in the fall and develop a large, fleshy taproot in the spring (Rees et al. 1996) that is hollow near the soil surface. Root crown and upper root tissues contain buds, normally suppressed by apical dominance, which may sprout following damage to plants (Popay and Medd 1990).



In bloom



Noxious thistles can be distinguished from native species by prickles along stem ribs.



BULL THISTLE
Cirsium vulgare

Family: Asteraceae
Duration: Introduced biennial forb
Succession: Noxious weed
Regeneration: Prolific seed producer (100 to 300 seeds/plant), seed windblown. Seeds can remain in the soil-bank for some time. Fire provides an open canopy ideal for establishment. Some evidence of allelopathy (Wardle et al. 1993).
Control: Prevention of seed production and targeting the first-year leaf rosettes (USDA 2001).
Frequency: *La Mesa Fire:* Not found in plots. *Las Conchas Fire*: Rosettes of leaves were seen along ski hill road 40 days post-fire, severely burned area.
Drought tolerance: ND
Rooting depth: Deep taproot
Wildlife: Goldfinches eat the seeds (Mitich 1998). The spines prevent many animals from consuming the plant. Nectar favorite of bees and butterflies (Lackschewitz 1991).



Canada thistle

CANADA THISTLE

Cirsium arvense

Family: Asteraceae

Duration: Introduced perennial forb; introduced to US in 1600 from Europe contaminant in crop seed

Succession: Found in a variety of habitats from moist meadows to dry piñon-juniper woodlands.

Regeneration: Deep and wide-spreading root system with a slender taproot and far-creeping lateral roots. It often forms large patches, and individual clones may reach 115 feet. Reproduces both sexually by seed and vegetatively by creeping roots. Vegetative reproduction contributes to local spread and seeding to long distance dispersal. Seed set is highest when male and female plants are intermixed and decreases when female plants are more than 164 feet from male plants (Lalonde and Roitberg 1994). Seeding with aggressive grasses such as crested wheatgrass, can prevent establishment. Plants are shade intolerant. Adapted to both survive fire on site, and to colonize recently burned sites with exposed bare soil. Canada thistle seedlings established anywhere from two to nine years after fire probably from wind-dispersed seed (Ahlgren 1979, Doyle et al. 1998, Bostock 1978).

Frequency: Observed in the Oso Fire area.

Drought tolerance: ND

Root depth: Most roots are in the top 0.7 to 2 feet of soil, but roots can extend as deep as 6.5 to 22 feet. Adventitious root buds that may form new adventitious shoots can develop along the root at any location, and at any time of the year with favorable growing conditions (Donald 1994). New plants can also form from root fragments as short as 0.2 inch (Nadeau and Vanden Born 1989). Allelopathy not conclusive, this species may produce phytotoxins that inhibit the growth of other plants (Donald 1994).

Wildlife: Insect pollinated, primarily by honeybees (Donald 1994).



Cinquefoil

CINQUEFOIL
Potentilla spp.
Potentilla pulcherrima; P. hippiana

Family: Rosaceae
Duration: Native perennial forb
Succession: Appears to be an increaser on disturbed sites. Found in canyons, moist meadows, and forests.
Regeneration: Recovers quickly from caudex sprouting and germination of numerous seeds. Taproot may facilitate production of new aboveground tissue following fire. Produces abundant seeds and can establish from on- and off-site. Seeds have been found to germinate after soil was heated to over 212 degrees Fahrenheit (Kleinman 2009).
Frequency: *La Mesa Fire:* On Burnt Mesa and other ponderosa pine sites. In 60% of all ponderosa pine plots the first and second year (see Table 3).
Drought tolerance: ND
Root depth: ND
Wildlife: May be eaten by deer and chipmunks.



Golden smoke

GOLDEN SMOKE; SCRAMBLED EGGS
Corydalis aurea

Family: Fumariaceae
Duration: Native annual/biennial forb
Successsion: Early successional in disturbed areas
Regeneration: Generally always top-killed. Quickly invades recently burned areas by seed. Survival in the post-fire community shortlived, generally the first year. Can invade burned areas by wind-dispersed seed (Barth 1970).
Frequency: *La Mesa Fire*: Found exclusively in mixed conifer plots. Seen first two years. *Cerro Grande Fire*: Found at higher elevations (see Table 5). *Las Conchas Fire*: In 2012, dominant early-summer ground cover in Water, Valle, and Pajarito canyons at elevations between 7800 and 8500 feet.
Drought tolerance: ND
Root depth: Slender taproot
Wildlife: ND



Puccoon

PUCCOON*

Lithospermum multiflorum

Family: Boraginaceae
Duration: Perennial native forb
Succession: Found in ponderosa pine and mixed conifer forests. Found in 8% of the 36 disturbed soil plots (see Table 6).
Regeneration: ND
Frequency: *La Mesa Fire:* In 42% of the ponderosa pine plots both the first and second year and piñon-juniper plots (see Table 3). *Cerro Grande Fire:* In the mid-elevation plots.
Drought tolerance: ND
Rooting depth: ND
Wildlife: Visited by butterflies.

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



Puccoon visited by butterfly



These yellow flowers grace the recovering landscape; ragleaf bahia is in patches, both after fire and prescribed fire (above). An intrepid helper on Burnt Mesa in greenthread, one year after the La Mesa Fire.





Ragleaf bahia

RAGLEAF BAHIA*
Bahia dissecta

Family: Asteraceae
Duration: Native annual/biennial forb
Succession: Found in disturbed soils. Found in 19% of the disturbed soil plots (see Table 6).
Regeneration: Disturbance-adapted species
Frequency: *La Mesa Fire*: In patches. In all the piñon-juniper plots the first year and severely burned plots the second year. Large patches in ponderosa pine (see Tables 3 and 4).
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



Stiff greenthread

STIFF GREENTHREAD*
Thelesperma filifolium var. *intermedium*

Family: Asteraceae
Duration: Native annual forb
Succession: Found in disturbed sites, common prairie species.
Regeneration: No information was found about the influence of fire on this species or mode of reproduction. From observations there appears to be a soil-bank that may be stimulated by fire.
Frequency: *La Mesa Fire:* In plots the first year but the second year plants are abundant, especially in severely burned areas. More common the second year in piñon-juniper and ponderosa pine meadows of Burnt Mesa (see Table 3).
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



Rubberweed, bitterweed

PINQUE RUBBERWEED*

Hymenoxys richardsonii



Family: Asteraceae
Duration: Perennial subshrub
Succession: Found in piñon-juniper and ponderosa pine plant communities.
Regeneration: ND
Frequency: *La Mesa Fire:* In area of plots in 1977. *Cerro Grande Fire:* In lower-elevation plots (see Table 5).
Drought tolerance: ND
Root depth: Tierney and Foxx (1987) found the root length to be 9.8 inches.
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



Wooton's ragwort

WOOTON'S RAGWORT*

Senecio wootonii

Family: Asteraceae
Duration: Native perennial shrub/subshrub
Succession: Found in canyons and on mountain slopes.
Regeneration: ND
Frequency: *La Mesa Fire:* Unidentified species of groundsel were found in the ponderosa pine plots both the first and second year. *Cerro Grande Fire*: Common in the canyons. *Las Conchas Fire*: Not as common as after Cerro Grande Fire.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



Golden aster

GOLDEN ASTER

Heterotheca villosa (Chrysopsis villosa)

Family: Asteraceae
Duration: Native perennial shrub
Succession: Found in dry often disturbed sites, particularly in the piñon-juniper and mixed conifer.
Regeneration: This species is fire tolerant. No information available from other sites.
Frequency: *La Mesa Fire:* Found in plots of the pondersoa pine and piñon-juniper, especially the first year.
Drought tolerance: Medium
Root depth: 14 inches (minimum)
Wildlife: The mission blue butterfly (*Icaricia icarioides missionensis)* feeds on this species in California.



Big golden pea



Sprouting 15 days post Las Conchas Fire.

BIG GOLDEN PEA

Thermopsis rhombifolia var. *montana (Thermopsis pinetorum)*

Family: Fabaceae
Duration: Native perennial shrub
Succession: Used for erosion control and rehabilitation of disturbed sites.
Regeneration: Resists fire by sprouting from rhizomes. Fire can stimulate germination of seeds (Borchert 1989).
Frequency: *La Mesa Fire:* In less than 20% of plots in the ponderosa pine (see Tables 3 and 4) and one canyon plot. Often in patches in mixed conifer although not in plots. *Cerro Grande Fire:* In mid-elevation plots (see Table 5). *Las Conchas Fire:* Sprouting 15 days after fire.
Drought tolerance: Related species drought resistant (*T. mollis*; Allen and Allen 1981).
Root depth: Related species (*T. mollis*) is rhizomatous; deep creeping rhizomes, woody, with roots to 5.6 feet (Copeland and Johnson 1965).
Wildlife: *Thermopsis* spp. contain quinolizidine alkaloids, which discourage browsing by wildlife and livestock (Allen and Allen 1981).



Globe mallow

GLOBE MALLOW
Sphaeralcea coccinea

Family: Malvaceae
Duration: Native biennial, perennial shrub
Succession: Provides ground cover in disturbed sites. It invades disturbed sites. Found in 22% of the disturbed soil plots (see Table 6).
Regeneration: Rhizomes can send up shoots soon after the fire (Wendtland 1993). It can also regenerate from seeds in the soilbank (Wasser 1982b).
Frequency: *La Mesa Fire:* Not found the first year post-fire, found infrequently in subsequent years.
Drought tolerance: High
Root depth: Rhizomes 0.8 to 4 inches below surface, protected from heat. A large proportion of the plant biomass is concentrated below the soil surface in a deep, stout, woody taproot (Grygiel et al. 1984; Kitchen 1994; Stubbendieck et al. 2003). The main root may remain unbranched for three feet before it divides into lateral roots (Albertson 1937). In a Saskatchewan study, maximum root depth was 40 to 72 inches. One or two large lateral roots, 0.04 to 0.12 inch in diameter, occurred in the top 12 inches of soil and extended downward, parallel to the taproot. Smaller lateral roots up to eight inches long were found along the length of the taproot, but secondary branches were scarce (Copeland and Johnson 1965).
Wildlife: Forage for deer, rabbits, prairie dogs, and birds.



Stiffstem flax

STIFFSTEM FLAX, NEW MEXICO FLAX*
Linum neomexicanum



Family: Linaceae
Duration: Annual/perennial native forb
Succession: In ponderosa pine and piñon-juniper plots
Regeneration: Based on information from a related species (*L. lewisii),* probably reproduces by seed after fire. Seedbank possible.
Frequency: *La Mesa Fire:* In severely burned ponderosa pine plots and in piñon-juniper.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*

RED FLOWERS



Indian paintbrush

INDIAN PAINTBRUSH

Castilleja integra

Family: Scrophulariaceae
Duration: Native perennial forb
Succession: Common component of piñon-juniper woodlands and ponderosa pine forests.
Regeneration: May sprout from root crowns or from seeds in the soilbank. Seedlings of an undetermined *Castilleja* species were secondary colonizers following natural fire in Arizona. It was not known if the seeds were on the site before the fire or were imported afterward (Thomas and Anderson 1993).
Frequency: *La Mesa Fire:* Found in 20% of the plots in the ponderosa pine and 50% of the plots in the piñon-juniper (see Tables 3 and 4).
Drought tolerance: ND
Root depth: Foxx and Tierney (1987) average root depth of 11 inches with a range of 10 to 12 inches.
Wildlife: Frequently visited by hummingbirds.



Scarlet bugler

BEARDSTONGUE*

Penstemon spp.
P. barbatus, P. secundiflorus

Family: Scrophulariaceae
Duration: Perennial native forb
Succession: Found primarily in the ponderosa pine, piñon-juniper below 8000 feet.
Regeneration: ND
Frequency: *La Mesa Fire:* Found in 42% of the ponderosa pine plots the first year in light, medium, and severe burn plots.
Drought tolerance: ND
Rooting depth: ND
Wildlife: Visited by bees and hummingbirds.

**There is little or no information in the general literature, the FEIS, or USDA Plants.*

BIRDBILL DAYFLOWER*
Commelina dianthifolia

Family: Commelinaceae
Duration: Native perennial forb
Succession: Found in newly burned otherwise disturbed areas in ponderosa pine and mixed conifer.
Regeneration: Related species sprout from bulb or tuber.
Frequency: *La Mesa Fire:* Species not seen until the La Mesa Fire. Observed in small patches in ponderosa pine the second year. *Las Conchas Fire:* Observed on Burnt Mesa 90 days post-fire.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*





Flower (above); patch of plants (right)



Sprouting after the La Mesa Fire



Flower

PRICKLY PEAR CACTUS

Opuntia spp.

Family: Cactaceae
Duration: Native perennial cactus
Succession: Disturbance-adapted, early serial species. Found in over 40% of the 36 disturbed soil plots (see Table 6).
Regeneration: Vulnerable to fire. Regenerates by sprouting from the root crown, by layering of unburned or partially burned stem pieces that contact soil, and from seedling establishment. Ability of sprout depends on extent of heat to meristems. Cacti with dense spines most susceptible to burning. In some cases seeds stored in the soil can survive fire (Laycock 1983; Thomas 1991; Bunting et al. 1980; Ahlstrand 1982).
Frequency: *La Mesa Fire*: Several cactus species observed sprouting in the La Mesa Fire area as well as other low-elevation fires such as Alamo Canyon. *Cerro Grande Fire:* Found in the mid-elevation plots (see Table 5).
Drought tolerance: High. High water retention allows the plant to survive drought condition.
Root depth: Extensive lateral root system, which can take advantage of rain. Tierney and Foxx (1987) measured the root length varied from 3.1 to 11 inches but found values to 10 feet.
Wildlife: Utilized by small mammals such as prairie dogs, jack and cottontail rabbits, woodrats. When spines are singed by fire, the pads are palatable to cattle (Hanselka 1989; Shoop et al. 1977).



In late June 1977 after the La Mesa Fire



In 1985, eight years after the La Mesa Fire

PINCUSHION CACTUS*

Corypantha vivipara

Family: Cactaceae
Duration: Native perennial/cactus
Succession: Found in rocky, sandy soil of the piñon-juniper woodland. Found infrequently in disturbed places (see Table 6).
Regeneration: Regeneration by sprouting. Little information concerning the species. Described cacti in general as early successional fire "resistors . . . whose adult stages can survive low-severity fire." (Rowe 1983) Thomas (1991) states that cacti rarely burn completely, but their spines may ignite and heat the plant's apex. For small cacti, damage likely depends on the amount of heat that penetrates to the apical meristem; if the apical meristem is not damaged, the cacti usually resume growth after fire. Cacti with dense spines are most susceptible to burning.
Frequency: *La Mesa Fire:* Not found in the plots but observed sprouting in the piñon-juniper.
Drought tolerance: Cactus have extensive lateral root systems that allow them to survive drought.
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants. Three species found in the database that occur in the area are pinkflower hedgehog cactus* (Echinocerus fendleri)*, kingcup hedgehog cactus* (E. triglochidiatus)*, and grama-grass cactus* (Pediocactus papyracanthus)*. Although not observed by this researcher, they may be influenced by the Las Conchas Fire.*

GRASSES



Grass sprouting from the crown 23 days after the Las Conchas Fire around Burnt Mesa

Grasses constitute the largest family in the plant kingdom. Many are of economic importance. Others, often introduced species, are considered some of the worst weeds that can choke out native species (Chase 1964).

These herbaceous plants have round or flattened (never three-angled), usually hollow stems with solid joints at the nodes. They have parallel-veined leaves that have a sheath and a blade. At the junction of the sheath and blade is a small appendage called a ligule. The flowers are small and inconspicuous. The underground structures are generally fibrous roots but can also be underground stems such as rhizomes. Aboveground structures, stolons, exist in some species.

The growing point of grasses is where new leaf tissue is formed. Tillering occurs when the new growth branches from dormant axillary buds in the plant crown or the rhizomes. The survival of the grass is dependent on when the plant is in active growth, the temperature and heating of the meristematic tissues, and the plant structure. Rhizomatous grasses generally respond positively to fire since the meristems are protected by soil. Stoloniferous grasses (such as black grama) are generally more sensitive to heating because the meristematic tissues are aboveground and exposed to heat.

Common to the Pajarito Plateau are a number of bunch grasses. These grasses grow in clumps, tufts, or bunches, rather than forming sod. In bunch grasses, the meristems are near the surface of the bunch and can be exposed to lethal temperatures. A variety of grasses occurred on the plots, many of which sprouted from the root crowns after fire. A number of grasses showed increased vigor after the fire with larger seedheads and plant numbers. In almost every fire since the La Mesa Fire, grasses have been seeded.

Grass species aerial seeded after the La Mesa Fire:

- Sand dropseed (*Sporobolus cryptandrus)*
- Blue grama *(Bouteloua gracilis)*
- Sheep fescue *(Festuca ovina)*
- Spike muhly (*Muhlenbergia wrightii)*
- Western wheatgrass *(Pascopyrum smithii)*
- Slender wheatgrass *(Elymus trachycaulum)*

Grass and forb species used after the Dome Fire (Barclay et al. 2004):

- Ryegrass *(Lolium multiflorum)*
- Mountain brome *(Bromus marginatus/carinatus)*
- Slender wheatgrass *(Elymus trachycaulus)*
- Sideoats grama *(Bouteloua curtipendula)*
- Little bluestem *(Schizachyrium scoparium)*
- Indian ricegrass *(Oryzopsis hymenoides)*
- Purple prairie clover *(Dalea purpurea)*

Seed mix for the Cerro Grande Fire consisted of two cereal grain species and two native species, including one warm-season species and one cool-season species (Foxx et al. 2001).

- Annual ryegrass *(Lolium perenne)*
- Barley *(Hordeum vulgare)*
- Mountain brome *(Bromus marginatus/carinatus)*
- Slender wheatgrass *(Elymus trachycaulum)*



Fendler three-awn

Photo courtesy of Craig Martin

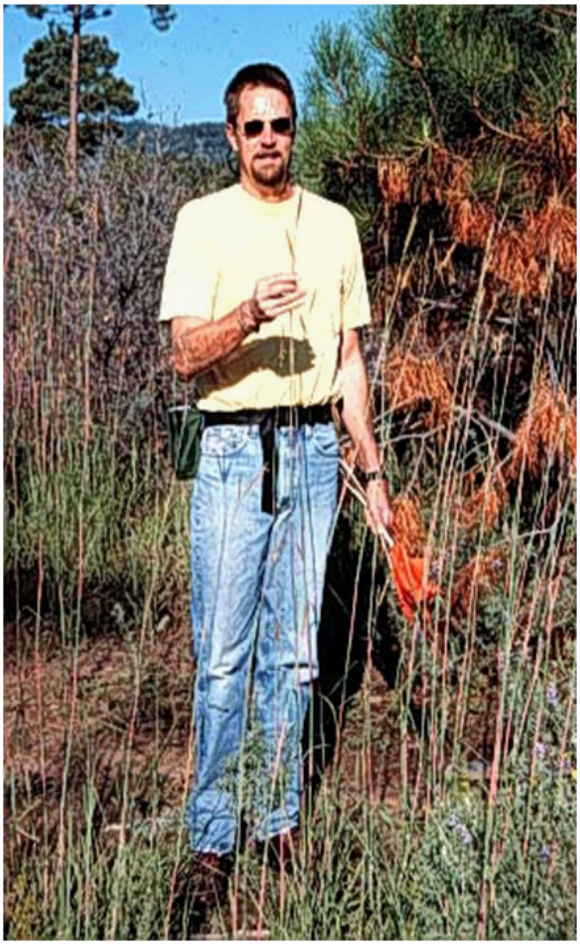
POVERTY THREE-AWN;
FENDLER THREE-AWN
Aristida divaricata, A. purpurea var. *longiseta**

Family: Poaceae
Duration: Warm-season, perennial native bunch grass
Succession: One of the first grasses to establish on abandoned fields and other disturbed sites (Herzman et al. 1959). Found in 14% of disturbed soil plots (see Table 6).
Regeneration: Reproduces by seeds and tillering (Evans 1967) after fire. It is also a seedbank species and can be spread by awns catching in animal fur (Wright et al. 1978). No ability to resprout.
Frequency: *La Mesa fire:* In plots within the ponderosa pine the first two years (see Table 3).
Drought tolerance: High
Root depth: Roots moderately deep. On a few sites, Weaver (1968) found that maximum depth of purple three-awn roots averaged four feet.
Wildlife: Utilized to some extent by small mammals. Awns can irritate skin and mouth of animals.

**A. purpurea* var. *longiseta* in database.



A large patch in an area severely burned in the La Mesa Fire 15 years post-fire.



Height of big bluestem within the burn area. Carey Bare is over six feet tall.

BIG BLUESTEM, TURKEY FOOT

Andropogon gerardii

Family: Poaceae
Duration: Native perennial grass
Succession: Warm-season tufted grass that has been used for erosion control.
Regeneration: Has rhizomes one to two inches below the surface. There appears to be a mycorrihizae association. Recovers quickly after fire and is adapted to a fire regime.
Frequency: *La Mesa Fire:* In single tufts or large patches in ponderosa pine in both the moderate- and severe-burn plots (see Table 3). Fifteen years after fire, large patches with vigorous growth. *Cerro Grande Fire:* Tufts along Quemazon Trail.
Drought tolerance: ND
Root depth: 20 inches (minimum); rhizomes one to two inches below the surface and to a four-inch depth, excessively branched. Main roots can go to depths of six to ten feet. Most of the biomass found seven to twenty inches (Weaver 1954, 1958; Albertson 1937).
Wildlife: Nesting and cover for birds and mammals; a palatable species.



Dense stands on Burnt Mesa 90 days post Las Conchas Fire

BLUE GRAMA
Bouteloua gracilis

Family: Poaceae
Duration: Tufted native perennial grass
Succession: Warm-season grass found throughout the Pajarito Plateau
Regeneration: Established by seed but also can reproduce by rhizomes and tolerate low-nutrient soils. In the Southwest the best time for planting is between June 15 and July 15. Rhizomes may be stimulated by fire. Response may be dependent on precipitation following the fire; "wet" years tend to increase yield. Seed and seedstalk production may also be stimulated by fire (Rasmussen et al. 1986; Bradley et al. 1992). We noted increased size in the seedheads after the La Mesa Fire.
Frequency: *La Mesa Fire*: Top-killed but surviving rhizomes stimulated by fire. Increased vigor. Found in 90% of the plots first two years post-fire. Ingredient in seed mix (see Table 3). *Cerro Grande Fire:* Found in the lower- and mid-elevation plots (see Table 5). *Las Conchas Fire:* Dense stands on Burnt Mesa 90 days post-fire.
Rooting depth: Roots can reach a depth of 6.5 feet. Roots have considerable lateral development in the first six inches of the soil (Canadell et al. 1996; Costello 1944; Copeland and Johnson 1965; Foxx and Tierney 1987).
Drought tolerance: Drought tolerant and shade intolerant
Wildlife: Forage for mule deer. Seeds are eaten by herbivores, insects, prairie dogs, pocket gophers, and rabbits.



Patches on Burnt Mesa 21 years post-fire

LITTLE BLUESTEM

Schizachyrium scoparium (Andropogon scoparium)

Family: Poaceae
Duration: Native perennial grass
Succession: Common grass found in ponderosa pine and piñon-juniper
Regeneration: Generally non-rhizomatous (Diggs et al. 1999). Increased soil temperature, light penetration, and available nutrients increase growth rates above and below ground. The plant produces large quantities of seed (255,000 seeds/lb).
Frequency: *La Mesa Fire:* In light to severely burned plots in the ponderosa pine. Healthy patches second year post-fire. Dominated areas of Burnt Mesa before drought set in.
Root depth: Root system deep and fibrous (USDA 1997); individual roots are relatively fine with diameters ranging from 0.004 to 0.04 inch. Most roots grow vertically downwards to depths of 4.5 to 5.5 feet, but some extend laterally from the bunches (Weaver 1954, 1968). Hosts arbuscular mycorrhizae, which seem to be most important with water stress (Anderson and Roberts 1993). Mycorrizal colonization increases with declining water availability (Cerligione et al. 1988).
Drought tolerance: High
Wildlife: Eaten by songbirds and cover for small mammals



In the 1945 plot one year post La Mesa Fire



Bunch grass and seedhead

MOUNTAIN MUHLY

Muhlenbergia montana

Family: Poaceae
Duration: Native, perennial, warm-season bunch grass
Succession: Warm-season grass that blooms after summer rains.
Regeneration: Reproduces by seeds or tillering; may sprout after aerial portions are burned. Dense tufts protect basal buds from fire. May take two to three years for recovery to pre-fire biomass (Harris and Covington 1983; Vose and White 1991; Gaines et al. 1958).
Frequency: *La Mesa Fire:* One of the most common native grass species, found in 30% of the plots in the ponderosa pine the first year, increased to 70% the second year (see Table 3).
Drought tolerance: High; prefers full sun.
Rooting depth: Fibrous roots (Berndt and Gibbons 1958). In a variety of soils, 15% of roots were in the first three feet of soil, and 58% were in the first six feet. The deepest roots were nine feet deep (Foxx and Tierney 1987). Potter et al. (1982) found a diffuse root system that extended to 7.8 inches.
Wildlife: ND



Seedhead

BOTTLEBRUSH SQUIRRELTAIL

Elymus elymoides (Sitanion hystrix)

Family: Poaceae
Duration: Perennial bunch grass
Succession: Often in areas of disturbance. Found in over 60% of the 36 disturbed area plots (see Table 6). Single plants common throughout area. Found in areas with 10 inches or more of rain.
Regeneration: Post-fire regeneration occurs from surviving root crowns and from on- and off-site seed sources. Considered one of the most fire-resistant bunch grasses.
Frequency: *La Mesa Fire:* Found in 30% of the ponderosa pine plots first few months post fire; increased to 50% in 1978.
Drought tolerance: High
Root depth: Reynolds and Fraley (1989) found roots to depths of 39.4 inches. A lateral root extension of 16 inches was observed at 9.8-, 20-, 24-, and 39.4-inch depths.
Wildlife: Awns can injure wildlife**.** Forage for ground squirrels, cottontail rabbits, and jackrabbits.



Bunch grass and seedhead

JUNE GRASS

Koeleria macrantha (K. cristata)

Family: Poaceae
Duration: Native perennial grass
Succession: Cool-season grass
Regeneration: Regeneration is accomplished by seed and sprouting from the residual rhizomes.
Frequency: *La Mesa Fire:* Not identified in the plots the first year.
Drought tolerance: ND
Root depth: Has an average maximum rooting depth between 13 to 29.5 inches. Root density decreases after 11.8 inches, with the greatest concentration of fibrous roots found within the upper 1.2 inches. Lateral spread ranges from 5.9 to 7.9 inches near the soil surface (Stevens 1999; Clarke et al. 1943).
Wildlife: Utilization by bighorn sheep, mountain goats, elk, white-tailed deer, and mule deer.



Seedhead

PINE DROPSEED; HAIRY DROPSEED

Blepharoneuron tricholepis

Family: Poaceae
Duration: Native perennial grass
Succession: Warm-season grass
Regeneration: Considered fire resistant
Frequency: *La Mesa Fire:* In 30% of the plots in the ponderosa pine in 1977 and 1978 (see Table 3).
Drought tolerance: Medium
Root depth: 12 inches (minimum)
Wildlife: Food and cover for rodents and birds

INVASIVE/NOXIOUS GRASS

Non-native species can take the niche of native species. One such is cheat grass, or downy chess. This species was a late comer in the plots and was not seen until in the drought years of 1998 through 2010. Research has determined fire must be of certain intensities to kill the seeds (Zohar et al. 2008).



A ripened patch



A cool-season grass

CHEAT GRASS; DOWNY CHESS
Bromus tectorum

Family: Poaceae
Duration: Introduced annual grass
Succession: An aggressive cool-season grass that spreads by awned seeds on clothing and animal fur. It has developed into a severe weed in many areas of the West.
Regeneration: Reproduces by seeds (300/plant). Abundant seed part of the soilbank. Low-intensity fires do not kill the seeds. Stands of cheat grass are highly flammable late in the spring to early fall.
Frequency: *La Mesa Fire:* Although this species has been observed in disturbed areas of the Pajarito Plateau for many years (mostly roadsides and disturbed sites), it was not seen in the plots until after the 1998 prescribed fire. During the past 10 years there has been drought. During drought situations, the presence of cheat grass causes rapid depletion of early-season soil moisture thus out-competes native perennial grass.
Root depth: ND
Drought tolerance: Grows in rainfall areas receiving less than 6 to 22 inches. Survive and expand during drought (Sabo 2006; Crawford et al. 2001).
Wildlife: Awns can cause damage to animals.



Patches on the Mitchell Trail 10 years post Cerro Grande Fire. Left, close-up

SMOOTH BROME

Bromus inermis

Family: Poaceae
Duration: Introduced perennial grass, cool season. Dome Fire seed mix contaminant.
Succession: Invades after disturbance.
Regeneration: Reproduces by rhizomes, seeds, and tillers. Long-lived species. Has been extensively planted to increase forage and/or reduce erosion in burned areas (Clary 1988; Crane and Habeck 1982; Crane et al. 1983). Practice questioned because exotic grasses such as smooth brome may interfere with the growth of native forbs and grasses (Crane and Habeck 1982).
Frequency: *Cerro Grande Fire:* Has increased since the fire. *Dome Fire:* After 14 years has become the dominant grass and is suspected of inhibiting succession of shrubs, ponderosa pine seedlings, and native herbaceous cover (Oertel et al. 2012).
Drought tolerance: Medium
Root depth: In silty loam, roots grew to 18 inches; most root biomass first three inches below ground (Gist and Smith 1948).
Wildlife: Cover for small mammals and birds



Dense stands one year after seeding.

SLENDER WHEATGRASS

Elymus trachycaulus (Agropyron trachycaulum)

Family: Poaceae
Duration: Native perennial tufted bunch grass
Succession: In seed mix for fire and other rehabilitation
Regeneration: Seedlings are vigorous and make good initial plant cover in seed mixes. Short-lived.
Frequency: *La Mesa Fire:* Not present the first year after the fire but created dense stands second year. In second year found in 90% of ponderosa pine plots (see Table 3). Disappeared from the plots after a few years. *Cerro Grande Fire:* Found in lower- and upper-elevation plots (see Table 5).
Drought tolerance: High, less than crested or western wheatgrass.
Rooting depth: The root system is dense, consisting of coarse and fine fibrous roots that extend beyond 12 inches in depth (Potter et al. 1982). One author has reported this species as having short rhizomes (Hardy BBT Limited 1989).
Wildlife: Preferred wheatgrass for elk. Seeds eaten by various birds and mammals.



Apache Springs area in 1985, eight years post La Mesa Fire.
Note the dense mat of sheep fescue in the foreground.

SHEEP FESCUE
Festuca ovina

Family: Poaceae
Duration: In seed mix for fire rehabilitation on the La Mesa Fire. Cool-season grass.
Succession: Was common in higher elevations where it became almost a sod grass.
Regeneration: Was seeded aerially; spreads mostly by vegetative means (Wilson and Newman 1987).
Frequency: Was not in the plots the first year but persisted and increased in subsequent years (see Table 3).
Drought tolerance: ND
Rooting depth: Dense mat of roots; extended 1.0 to 5.9 inches deep. Roots fine and fibrous (Potter et al. 1982).
Wildlife: Browse for elk and deer

SEDGES

Sedges are grasslike plants of the family Cyperaceae, having solid stems, leaves in three vertical rows, and spikelets of inconspicuous flowers, with each flower subtended by a scalelike bract. Most prefer moist habitats but the flatsedge is found throughout dry locations (Racinez and Foxx 1999).



On Burnt Mesa, 90 days post Las Conchas Fire

FENDLER'S FLATSEDGE*

Cyperus fendlerianus; C. esculentus

Family: Cyperaceae
Duration: Perennial graminoid
Succession: Found in the ponderosa pine zone
Regeneration: Rhizomatous
Frequency: *La Mesa Fire:* Found in all areas of burn severity in the ponderosa pine both the first and second year (see Table 3). *Las Conchas Fire:* Seen on Burnt Mesa 90 days post-fire.
Root depth: ND
Drought tolerance: Medium
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*

SPROUTING SHRUBS





Flowers (above); Sprouting 7-11-2011, just over two weeks after the Las Conchas Fire.

SHRUBBY POTENTILLA

Dasiphora fruticosa (Potentilla fruticosa)

Family: Rosaceae
Duration: Native shrub
Succession: Found on overgrazed areas in the Jemez Mountains. Used for erosion control.
Regeneration: Sprouting within two weeks after the Las Conchas Fire in meadowed areas. Can resprout vigorously. Low tolerance for fire.
Frequency: *La Mesa Fire:* Not in the La Mesa Fire plots. *Las Conchas Fire:* Sprouting in the Valle Grande area two weeks post-fire in grazed meadows.
Drought tolerance: low
Root depth: 18 inches (minimum)
Wildlife: Browse for mule deer, fair food value for elk, small mammals. Observed as being held down by elk browsing; present in elk exclosures but not outside.

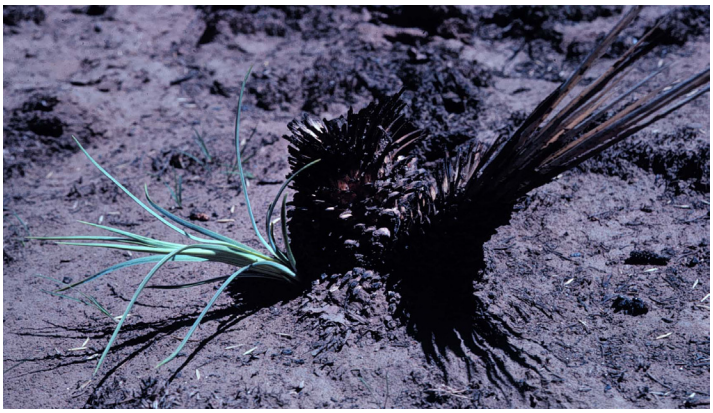


In bloom

SNAKEWEED

Gutierrezia sarothrae

Family: Asteraceae
Duration: Native perennial shrub/subshrub
Succession: Common in piñon-juniper
Regeneration: Killed by fire. Re-establishment occurs by wind-dispersed seeds. Densities will increase after fire in areas were the seedbank is left undamaged by heat.
Frequency: *La Mesa Fire*: Found primarily in piñon-juniper. Not recorded in plots.
Drought tolerance: ND
Root depth: Tierney and Foxx (1987) found root lengths of 9.6 to 12.2 inches.
Wildlife: Utilized by mule deer.



Sprouting one month post La Mesa Fire (top and bottom)





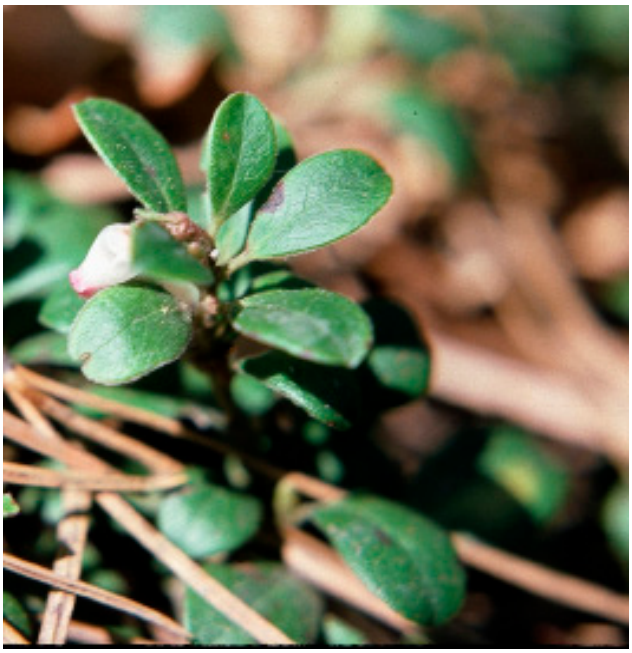
Within piñon-juniper woodland

SOAPWEED YUCCA
Yucca baileya

Family: Agavaceae
Duration: Native perennial shrub/subshrub
Succession: Often found on disturbed soils such as archeological sites and old fields (Foxx and Tierney 1999).
Regeneration: Has extensive rhizomatous mats 4 to 24 inches below the soil surface that are protected from fire damage. Vegetative reproduction (sprouting from the caudex and rhizomes) can be stimulated when top-killed. The seeds susceptible to fire but must be buried in soil to survive heat.
Frequency: *La Mesa Fire:* In ponderosa pine and piñon-juniper. Quickly sprouting within one month. *Las Conchas, Alamo Canyon fires*: Sprouting.
Drought tolerance: ND
Root depth: Has extensive rhizomatous mats 4 to 24 inches below the soil surface that are protected from fire damage (Webber 1953). Tierney and Foxx (1987) found rhizomes to be 7.8 inches long at a minimum.
Wildlife: Consumed by elk in the piñon-juniper woodlands (Allen 1996). Food, shade, and nesting for birds and small mammals. Seeds important food source to small mammals, and leaves are consumed during times of drought and snow. Found in areas that support cotton rat populations in New Mexico (Stubbendieck et al. 1989, 2003).



Berry (left); sprouting two months post Cerro Grande Fire (right, bottom).





KINNIKINNIK, BEARBERRY

Arctostaphylos uva-ursi

Family: Ericaceae
Duration: Subshrub
Succession: Found in ponderosa pine and mixed conifer forests of the area.
Regeneration: Sprouting species that possesses latent buds on the horizontal stems and dormant buds on the stembase or root crown that allow sprouting of surviving plants or rooted stems (Crane 1982; Crane and Fischer 1986; Fischer and Bradley 1987; Mallik and Gimingham 1983)
Frequency: *La Mesa Fire:* In 50% of the plots in the mixed-conifer in first year (see Table 2). *Cerro Grande Fire:* Sprouting and spreading in Rendija Canyon within the first two to three years.
Drought tolerance: ND
Root depth: On one site, 36 inches; on a drier site with the same soil type, 72 inches (Nimlos et al. 1968). In central Alberta, extended from 43 to 53 inches deep (Strong and LaRoi 1986).
Wildlife: The fruits last through the winter. Eaten by songbirds, wild turkey, deer, elk, and small mammals. Black bear eat the fruits in the autumn and spring. Hummingbirds take nectar from the flowers.





Flowers (left); sprouting one year post Cerro Grande Fire (top)



MOUNTAIN LOVER; OREGON BOXWOOD

Paxistima myrisinites

Family: Celastraceae
Duration: Native cool-season shrub, low-growing shrub
Succession: Found in canyons, mixed conifer
Regeneration: Can sprout from buds on the taproot or from the root crown. Some seedling establishment via short-term viability seed stored on-site may also occur.
Frequency: *Cerro Grande Fire:* Sprouting and spreading in Rendija Canyon first two to three years.
Drought tolerance: ND
Root depth: ND
Wildlife: Browse for deer and elk.



Sprouting three months post La Mesa fire (top left), flowers (top right), patch of sprouting plants (bottom)





FENDLER BUCKBRUSH

Ceanothus fendleri (C. greggi syn*)*

Family: Rhamnaceae
Duration: Native shrub
Succession: Found in ponderosa pine, particularly after fire.
Regeneration: Regenerates almost exclusively from long-lived seeds that accumulate in the soil (Pase and Brown 1982; Zedler 1981) and germinate prolifically following fire (Carmichael et al. 1978; Pearson et al. 1972; Vose and White 1987). Fire dependent, with sharp population increases after fire and an intervening period during which there is mortality but little establishment (Zedler 1981).
Frequency: *La Mesa Fire:* Sprouting three months post fire within the ponderosa pine. Developed into patches (see Table 2).
Drought tolerance: ND
Root depth: Roots tend to be shallow and laterally spreading, with lateral growth far exceeding the depth of penetration (9.8 feet) of radial spread in a 2.5-foot-diameter plant. More than 90% of the roots occur within the top 12 to 16 inches of soil (Hellmers et al. 1955).

Wildlife: Browse for deer and elk; often seen clipped



Fruit is relished by wildlife.



In Rendija Canyon three months post Cerro Grande Fire



Rendija Canyon two years post Cerro Grande Fire

CHOKECHERRY

Prunus virginiana var. *melanocarpa*

Family: Rosaceae
Duration: Native, deciduous thicket-forming shrub
Succession: Found within the canyons along streams and on moist slopes.
Regeneration: Although susceptible to top-kill by fire, it resprouts rapidly and prolifically from surviving root crowns and rhizomes; post-fire regeneration also from seed dispersal by birds and mammals (Sampson 1944).
Frequency: *Cerro Grande Fire:* Sprouting in Rendija Canyon.
Drought tolerance: Medium; shade intolerant
Root depth: Minimum of 20 inches; roots a network of rhizomes that can extend 35 feet from base. A network of rhizomes and a deep root system established at intervals along the rhizomes. May extend laterally more than 35 feet and vertically more than six feet. Rhizomes range from 0.4 to 0.8 inch in diameter (Schier 1983; Yeager 1935).

Wildlife: Fruit for birds, rabbits, rodents, bears, coyotes. Cover for birds; browse for deer.

APACHE PLUME

Fallugia paradoxa

Family: Rosaceae
Duration: Perennial shrub
Succession: Common in the piñon-juniper; often in disturbed areas. Most common shrub on disturbed soil sites on Pajarito Plateau (see Table 6).
Regeneration: Has the ability to resprout. It exhibits vigorous sprouting from root suckers after top-kill by fire. Spreads naturally to roadside shoulders and barrow pits. Tolerates fire well in the piñon-juniper habitat type (Ferguson 1983; Aro 1971; Blauer et al. 1975).
Frequency: *La Mesa and Las Conchas fires*: Sprouting after the La Mesa and Las Conchas fires on Burnt Mesa. Not in sample plots.
Drought tolerance: High
Root depth: Tierney and Foxx (1987) found a depth maximum of 10 feet. The taproot descends directly or is laterally directed. Laterals are frequently shoot sprouters.
Wildlife: Cover for small mammals and birds



Sprouting one month post La Mesa fire.





Fruit and flower



Fruit

WILD RASPBERRY

Rubus strigosus var. *arizonica; R. actea*

Family: Rosaceae
Duration: Perennial shrub
Succession: Found in canyons and along slopes. Can regenerate vigorously from this so-called buried seedbank.
Regeneration: Propagated by seeds, sprigs, and tubers. Typically sprouts readily after fire in areas where already present before a fire (Crane 1982).
Frequency: *La Mesa Fire:* In plots in Frijoles Canyon (see Table 2). *Dome, Cerro Grande fires:* In canyon areas.
Drought tolerance: Medium
Root depth: Minimum of 12 inches
Wildlife: High-value food and cover. Berries used by various songbirds, including grosbeaks and bluebirds, and mammals, including squirrels and bears. Leaves and stems eaten by cottontail rabbits and deer. Excellent nesting and escape cover.



Flowers

MOUNTAIN NINEBARK

Physocarpus monogynus

Family: Rosaceae
Duration: Perennial shrub
Succession: Found in drained soils of canyons
Regeneration: Vigorous sprouter after fire. Based on studies, more plants on burned than unburned sites.
Frequency: *Cerro Grande Fire:* In Rendija Canyon one-year post-fire.
Drought tolerance: ND
Root depth: A similar species, mallow ninebark, has a horizontal perennating root system, which is rhizomatous.
Wildlife: Sprouts sometimes browsed but can be used as cover for birds and mammals.



Sprouting one month post La Mesa Fire



Blossoms



Rose hips

WOOD'S ROSE, WILD ROSE

Rosa woodsii

Family: Rosaceae

Duration: Native perennial thicket-forming shrub

Succession: Found in canyons, forests

Regeneration: Regenerates via seeds and vegetatively from the root crown, by root suckering (Evenden 1989), and layering (Welch 2004). Establishes after fire primarily by sprouting from the root crown. While less frequent, may establish after fire by root sprouting (Bradley et al. 1992; Crane and Fischer 1986; Smith and Fischer 1997) or seed establishment (Wright et al. 1979; Neuenschwander 1978). Seeds primarily dispersed by birds and mammals.

Frequency: *La Mesa Fire:* Sprouting in ponderosa and mixed conifer. Much more common in the mixed conifer community.

Drought tolerance: Medium

Root depth: Root crown shallow, root points reach deep into the soil. Roots found to reach a depth of six feet (Nimlos et al. 1968).

Wildlife: Forage for small and large mammals, birds, and ungulates.



Seeds



Sprouting 23 days post-fire

ALDERLEAF MOUNTAIN MAHOGANY

Cercocarpus montanus

Family: Rosaceae
Duration: Perennial shrub
Succession: Native perennial shrub; found in ponderosa pine and piñon-juniper plant communities; canyon edges and drier canyon slopes.
Regeneration: Vegetative regeneration from the root crown and from rhizomes. Roots support nitrogen-fixing bacteria in nodules. Seeds are dispersed by wind and small mammals. Wind-dispersed seed can travel up to 450 feet from the parent plant. Re-establishes mainly by sprouting of the root crown or rhizomes.
Frequency: *La Mesa Fire:* Sprouting in piñon-juniper and ponderosa pine. Found in 75% of the plots in the piñon-juniper. *Las Conchas Fire:* Sprouting within 23 days after fire.
Drought tolerance: High
Root depth: Tierney and Foxx (1987) found the maximum root depth to be 19.5 inches. The roots were rigid with the outer bark hard. Other researchers describe root system as "extensive" (Kitchen 2006). Typically, there are substantial tap and lateral roots (Kitchen 2004). Baker and Korstian (1931) describe one to several taproots extending almost straight down with minimal spread. Rootlets on the taproots persisted to "great" depths. Taproots reached over eight feet deep. Based on data collected in five separate studies, true mountain mahogany roots averaged 44.5 inches and ranged from 15.7 to 59.8 inches deep in northern New Mexico. The large stem base gave rise to "stout lateral roots" (Foxx and Tierney 1987).
Wildlife: Habitat for a number of species. Browse for deer and elk. Between 19 and 32 species of breeding birds occurred in upland forests of east-central Taos County, New Mexico (Stahlecker et al. 1989).







SKUNKBUSH SUMAC

Rhus trilobata

Family: Anacardiaceae
Duration: Native perennial thicket-forming shrub
Succession: Often found in disturbed areas such as old fields, archeological sites, and roadsides (see Table 6). Found in the piñon-juniper plant community.
Regeneration: Propagates by seed and root sprouts. Sprouts readily from the root crown after severe disturbance. Reproduces only rarely from seed. Sprouts vigorously from the root crown following fire (Cable 1957, 1975).
Frequency: *La Mesa Fire:* In one plot of the piñon-juniper and within Frijoles Canyon. *Las Conchas Fire:* Sprouting 23 days post-fire on Burnt Mesa.
Drought tolerance: Moderate; seedlings may be severely affected by drought conditions. Acute drought may shorten twig growth and prevent fruit production.
Root depth: Tierney and Foxx (1987) found the maximum root depth at eight feet. The outer bark medium to dark brown, easily peeled when damaged. All root laterals came from just below the caudex and branched profusely. Has a taproot and a fibrous root system (Horton 1949; Johnson 1977). Roots are deep and extensively branched with somewhat shallow, spreading woody rhizomes (Wasser 1982). Individual shrubs and patches of skunkbush sumac may be connected by underground structures that can exceed 20 feet in length and 30 years in age (Sanford 1970).
Wildlife: Fruit eaten by a number of birds; foliage browsed by mule deer. Fruit an important winter food for birds, including songbirds and gamebirds. Fruit eaten by black bears.



Sprouted three months post Cerro Grande Fire



Blooms (top) and fruit

WAX CURRANT AND GOOSEBERRY

Ribes cernuum; Ribes leptanthum

Family: Grossulariaceae
Duration: Thicket-forming perennial shrub
Succession: Found in canyons or on mountain slopes.
Regeneration: Non-rhizomatous; reproduces mainly from seed, the ability to sprout is weak. Seeds can remain viable for many years; can be dispersed by animals and birds. Regeneration is favored by short-duration, low-severity fire. Soil-stored seed requires scarification to germinate (Steele and Geier-Hayes 1989, 1994).
Frequency: *La Mesa Fire:* In plots in the mixed conifer (see Table 2). *Cerro Grande Fire:* Sprouting in the canyons and lower-elevation plots (see Table 5). *Las Conchas Fire*: Sprouting on Burnt Mesa within 30 days.
Drought tolerance: High; fire resistance high
Root depth: Minimum to 12 inches. Tierney and Foxx (1987) found the caudex of the wax currant was massive. The main roots were laterals emerging radially from the lower parts of the caudex. They estimated the maximum root length to be 10 feet.

Wildlife: Cover for wildlife; chickadees consume the fruit; deer will browse.





A slope dominated after the Dome Fire in 1996 (left). Sprouted approximately one month post La Mesa Fire (above).



Flowers

NEW MEXICO LOCUST

Robinia neomexicana

Family: Fabaceae
Duration: Native rhizomatous, small tree or shrub
Succession: Constituent of piñon-juniper, ponderosa pine, and mixed conifer. Commonly found in disturbed areas such as roadsides.
Regeneration: Vigorous sprouter, becoming the dominant shrub in some areas. Competes with conifer seedlings and saplings for moisture and light (Gottfried 1980).
Frequency: One of the most vigorous sprouters, it is observed within days of a fire. Found in ponderosa pine, mixed conifer, and canyons within the first year. Over the years in areas of the La Mesa, Dome, Cerro Grande, and Las Conchas fires, New Mexico locust was dominant. Potter and Foxx (1979) looked at sprouting on a low-severity burn at post-fire year 2; a moderate-severity burn at post-fire year 17; and a high-severity burn at post-fire year 100. New Mexico locust had the greatest number of sprouts per acre on the moderate-severity burn area at post-fire year 17. Potter and Foxx (1979) found density of 240 plants per acre and had 295 sprouts per acre with an average height of 15 inches.
Drought tolerance: Medium
Root depth: Tierney and Foxx (1987) measured the root length to five feet. Roots near the surface had lateral roots forming new shoots.
Wildlife: Eaten by mule deer, porcupine, chipmunk. Provides cover for birds and small mammals.



Sprouting three months post Cerro Grande Fire.



Sprouting in severely burned area with hydrophobic soils after the La Mesa Fire.



Roots



Leaf of *Q. gambelii*

OAK

Quercus undulata, Q. gambelii

Family: Fagaceae
Duration: Perennial deciduous shrub; species hybridize
Succession: Species from low to high elevations, juniper woodlands to mixed confier. Common component.
Regeneration: Sprouts immediately after the fire. Gambel oak is a fire-adapted species. It responds to fire by vegetative sprouting from the lignotuber and rhizomes. Seen sprouting within 10 days of a fire.
Frequency: *La Mesa Fire:* The most common sprouting shrub (see Table 2). Sprouting after all the fires observed. Generally, sprouting begins within days, even in the severely burned areas with hydrophobic soils.
Drought tolerance: Low
Root depth: Underground system is lignotuber with deep-feeding roots with many scattered adventitious buds. Clones are interconnected with rhizomes that intertwine with lignotubers (Christensen 1949). Root grafting is common; root-endomycorrhizal associations may also occur. Tierney and Foxx (1987) found the roots penetrated greater than 10 feet.
Wildlife: Important cover and food for a variety of wildlife.



Fruit
(Photo by Sally King)

COLORADO BARBERRY
Berberis fendlerii

Family: Berberidaceae
Duration: Perennial thicket forming shrub
Succession: Found in canyons, ponderosa pine, mixed conifer.
Regeneration: ND
Frequency: *La Mesa Fire:* In canyons and on Burnt Mesa.
Drought tolerance: High
Root depth: 16 inches minimum
Wildlife: ND



Flower

VINES



Sprouting 90 days post Cerro Grande fire, Rendija Canyon (top). Blossoms (below)

ROCKY MOUNTAIN CLEMATIS*

Clematis columbiana (Clematis pseudoalpina)

Family: Ranunculaceae
Duration: Perennial vine
Succession: Found in canyons and mountain slopes of ponderosa pine and mixed conifer.
Regeneration: ND
Frequency: *La Mesa Fire:* Within Frijoles Canyon. *Cerro Grande Fire:* Sprouting within 90 days of the fire.
Drought tolerance: ND
Root depth: ND
Wildlife: ND

**There is little or no information in the general literature, the FEIS, or USDA Plants.*



TREES



Sprouting on the Dome, 7-23-99, after the Dome Fire. Also observed 9-20-78, a year after the La Mesa Fire.



Bark



Branchlet showing white dots on the leaves.

ALLIGATOR JUNIPER

Juniperus deppeana

Family: Cupressaceae
Duration: Perennial tree
Succession: In the Jemez Mountains it is found mostly on the southern mesas. A number of trees are near the trailhead going into Capulin Canyon. Single trees have been found at lower elevations. Maximum longevity is reported at 500 years (Loehle 1988).
Regeneration: Burned trees were sprouting from the base both after the La Mesa Fire (one year post-fire) and the Dome Fire (two years post-fire).
Frequency: *La Mesa and Dome fires:* Not in any plot in areas studied by Foxx and Potter during the La Mesa Fire studies. However, it was observed sprouting in areas of the Dome after the La Mesa and the Dome fires.
Drought tolerance: Medium
Root depth: 12 inches (minimum)
Wildlife: Berry-like cones remain on the tree for considerable length of time. When abundant provide available food source for many birds and mammals. During drought years it provides a necessary food source (Arnold et al. 1964; Evans 1988).



Samara (two-winged fruits) of the New Mexico maple



NEW MEXICO MAPLE

Acer glabrum var. *neomexicanum*

Family: Aceraceae
Duration: Small tree or shrub; facultative wet species
Succession: Found at higher elevations in mixed conifer and lower elevations in canyons along streams or on moist slopes.
Regeneration: Large seeds are wind dispersed. Rapid sprouting and wind-blown seeds will re-establish the plants.
Frequency: *Alamo Canyon, Cerro Grande, and Las Conchas fires:* Sprouting within a month of the fires in canyon bottoms or high-elevation forest. Not in La Mesa Fire plots.
Drought tolerance: Weak to moderate
Root depth: ND
Wildlife: Important browse for deer and elk.



BOXELDER

Acer negundo

Family: Aceraceae
Duration: Tree
Succession: Generally found along streams and the Rio Grande.
Regeneration: Seeds dispersed by wind or animals. Sprouts from the roots, the root collar, or stump if girdled or top-killed by fire.
Frequency: *Alamo Canyon Fire:* Sprouting within 30 days of fire.
Drought tolerance: High
Root depth: 40 inches minimum
Wildlife: Valuable cover for wildlife



Shreddy bark



Berries

ONE-SEED JUNIPER

Juniperus monosperma

Family: Cupressaceae
Duration: Long-lived evergreen
Succession: A dominant tree in the piñon-juniper woodland of the Pajarito Plateau.
Regeneration: Seed dispersal by water, gravity, birds, and mammals. Produces large seed crops at two- to five-year intervals (Johnsen 1962). Post-fire recovery from seeds brought from off-site. Regeneration slow. Rarely resprouting.
Frequency: *La Mesa Fire*: Top-killed. Common throughout the piñon-juniper region.
Drought tolerance: High, drought resistant.
Root depth: Mature plants have both tap and lateral root systems. Taproots ranged from 18 inches to more than 12 feet in length. Of 500 trees examined, 347 had well-developed taproots. Lateral roots were widespread, commonly being 2.5 to 3 times as long as the tree was tall. Most lateral roots were in the surface three feet of the soil, most of those concentrated below the surface six inches (Johnsen 1962). Deep root system of mature one-seed junipers adapted for growth on dry sites (Johnsen 1962; Rundel and Yoder 1998; Hall and Carr 1968). Foxx and Tierney (1987) reported rooting depths ranging from 16 to 197 feet (found along roof of a mine).
Wildlife: Succulent, berrylike cones abundant and food source for wildlife species. Cones provide food year-round. Birds that use the berries include Steller's jay, Cassin's finch, robin, western bluebird, evening grosbeak, and mountain chickadee. Mammals include coyote, chipmunk, rock squirrel, and deer mouse.



Sprouts three months post La Mesa Fire



Leaves in summer



Grove nine years post Cerro Grande Fire

QUAKING ASPEN

Populus tremuloides

Family: Salicaceae
Duration: Native deciduous tree; forms clones.
Succession: Most widely distributed tree in North America. A dominant species above 8000 feet, particularly where there has been fire or other disturbance.
Regeneration: Highly competitive on burned sites, even where barely a detectable component in pre-fire vegetation. Root systems of top-killed stems send up a profusion of sprouts for several years after fire. Sprouts grow rapidly by extracting water, nutrients, and photosynthate from an extant root system. Will develop pure stands.
Frequency: *La Mesa, Dome, Oso, Cerro Grande, and Las Conchas fires:* Sprouting immediately after fire in the higher elevations.
Drought tolerance: Low
Root depth: Root system relatively shallow, wide-spreading lateral roots and vertical sinker roots descending from the laterals. Laterals may extend over 100 feet into open areas. In Utah, vertical roots extended more than nine feet down, branching into fine, dense roots at their extremities (Jones and DeByle 1985; Gifford 1966).
Wildlife: Important breeding, foraging, and resting habitat for a wide variety of birds and mammals. Elk feed on bark, branch apices, and sprouts year-round.



Male and female cones

PINON PINE; COLORADO PINON

Pinus edulis

Family: Pinaceae
Duration: Native short-needled (two to bundle) long-lived tree.
Succession: Dominant species in the piñon-juniper woodlands of the Jemez Mountains about 6000 to 7000 feet.
Regeneration: Very sensitive to fire and may be killed by even low-severity surface burns. Regenerates solely from wingless seeds. Dispersed by birds and small mammals, primarily squirrels and chipmunks (Arnold et al. 1964, Chambers et al. 1999). Seeds short-lived only a temporary seedbank, most seeds germinating the spring following dispersal. Needs partial shade until 12 inches in height. Begin producing cones at 25 years, more seed at 75 to 100 years.
Frequency: *La Mesa Fire:* Found in the lower-elevational plots generally dead after fire.
Drought tolerance: High
Rooting depth: Colorado piñon's root system consists of a taproot and shallow lateral roots occurring more than one inch below the soil surface. Taproots extend to soil depths of at least 20 feet. Laterals are generally found at depths of 6 to 16 inches and can extend from the tree up to twice the crown radius (Foxx and Tierney 1987, Harrington 1987a, Ronco 1990, Tueller and Clark 1975).
Wildlife: Habitat for mule deer, elk, rabbit, wild turkey. Clark's nutcracker, Steller's jay, scrub jay, and pinyon jay help in seed dispersal.







Thick bark of the ponderosa makes it fire resistant.

PONDEROSA PINE
Interior Pinus Ponderosa,
Rocky Mountain Ponderosa Pine
Pinus ponderosa

Family: Pinaceae
Duration: Native with long needles in bundles of three. Tree can grow 180 feet and reach over 300 years of age.
Succession: Dominant tree within the 7000- to 8000-foot elevation range of the Jemez. Also a component to the mixed conifer forest.
Regeneration: Bark of mature trees is about three inches thick making it very fire resistent and often producing fire scars (Lanner 1983). Adaptations to survive surface fires include open crowns; self-pruning branches; thick, insulative, relatively unflammable bark; thick bud scales; tight needle bunches that enclose and protect meristems, then open into a loose arrangement that does not favor combustion or propagation of flames; high foliar moisture; and rooting habit (Bradley et al. 1992, Lanner 1983). Trees in widely spaced stands better equipped to survive surface fire than trees in denser stands. Cannot survive crown fire (Davis et al. 1968, Lanner 1983), but mature trees can survive a considerable amount of scorching (Dieterich 1979, Harrington 1987b, Potter et al. 1982, Potter and Foxx 1979).
Frequency: Data in plots on Burnt and Escobas mesas (Foxx et al., in prep).
Drought tolerance: Interior ponderosa pine is valued as a drought-resistant ornamental. It is light, drought, and shade tolerant.
Root depth: Root system is deep and spreading. An 85-year-old tree in Colorado that was 19 feet in height and 4.5 inches at chest height had a maximum root depth of five feet and a maximum lateral spread of 10 feet, with the majority of roots growing down slope. Fine roots were absent (Berndt and Gibbons 1958). Foxx and Tierney (1987) found ponderosa pine may root 30 feet. Specimens measured had maximum root depths of 59 and 63 inches.
Wildlife: An important wildlife habitat. Critical habitat for owls, wild turkey, and cavity nesters, Western tanagers, American robins, chipping sparrows, hermit thrush, Cassin's finches, bluebirds, pygmy nuthatches, white-breasted nuthatches, violet-green swallows, and mountain chickadees can be found in these forest types. Abert's squirrels and tree squirrels use seeds and trees for nesting.



These two species are found infrequently within the Jemez Mountains. Where found, the taxonomic differences are difficult to determine. Both are long-lived trees that are fire susceptible when young and can produce scars when mature.

Southwestern white pine with cone (left), young tree bark (middle), older tree bark (bottom)





SOUTHWESTERN WHITE PINE

Pinus strobiformis

Family: Pinaceae
Duration: Native long-lived trees, long needles in bundles of five.
Succession: A component of the mixed conifer forest above 8000 feet in the Jemez Mountains. Scattered and infrequent.
Regeneration: Produces cones when pole sized, or about 15 years. Seeds require two weeks to four months stratification before germinating. Not fire adapted; it does not have fire-induced sprouting, seed germination, or biomass increases (Jones 1967, Krugman and Jenkinson 1974). Southwestern white pine is fire sensitive in young age classes. Older trees with somewhat thicker bark are relatively more fire resistant (Dietrich 1983). The thin bark and horizontal or drooping branches increase its susceptibility to fire. Fire-damaged stems of young (less than 15 years) Southwestern white pine usually die; older trees (more than 50 years) are susceptible to scarring (Ahlstrand 1980).
Frequency: Infrequent
Rooting depth: ND
Wildlife: The wingless seeds are dispersed by birds, primarily by the Steller's jay and Clark's nutcracker (Benkman et al.1984, Tomback and Linehart 1990).

LIMBER PINE

Pinus flexilis

Family: Pinaceae
Duration: Native long-lived tree, long needles in bundles of five, mature trees can be 1000 years old.
Succession: A component of mixed conifer forest above 8000 feet. Scattered and infrequent.
Regeneration: Thin bark of young trees does not protect from low-severity fires. Older trees can withstand scorching from low-severity fires. Terminal buds are somewhat protected from the heat associated with crown scorch by the tight clusters of needles around them (Fischer and Clayton 1983, Keeley and Zedler 1998, Potter and Greene 1964). Limber pine reproduces entirely from seed; seeds are not effectively dispersed by wind (Lanner 1985, 1996, Lanner and Vander Wall 1980). The minimum seed-bearing age of limber pine ranges from 20 to 40 years.
Frequency: Infrequent
Rooting depth: ND
Wildlife: Small mammals and birds, especially Clark's nutcrackers and pinyon jays, disperse seeds.



Cones





Bark

ROCKY MOUNTAIN DOUGLAS-FIR

Pseudotsuga menziesii var. *glauca*

Family: Pinaceae
Duration: Native tall single-needled tree
Succession: A component of the mixed conifer forest above 8000 feet in the Jemez Mountains. Sometimes scattered along the north-facing cliffs.
Regeneration: Bark on saplings is photosynthetically active, smooth, and covered with resin blisters; mature individuals have thick, deeply furrowed, corky bark. At about age 40, bark becomes thick and corky (Bradley et al. 1992, Harrington 1991) and more resistant to fire. Monserud (1979) found that bark thickness (both layers) is equal to 13% of diameter. Douglas-fir has winged seeds that are dispersed primarily by wind and gravity. Seeds are disseminated about twice as far as seeds of ponderosa pine. Caching of cones by red squirrels and consumption by chipmunks, mice, voles, and birds reduce seed quantity considerably (Shearer 1984, Hemstrom et al. 1987). Between seedfall and germination, much seed is consumed by rodents and birds (Burns and Hankala 1990).
Frequency: In plots at higher elevations. The effects of fire on Rocky Mountain Douglas-fir vary with fire severity and tree size. Seedlings are most susceptible to fire damage. Chance of survival generally increases with tree size. Because larger trees have thicker bark and larger crowns, they can withstand proportionally greater bole and crown damage than small trees.
Drought tolerance: Low
Root depth: Eighty-year-old trees found with root systems that extended 2.7 to 5 feet vertically and 10 to 21 feet laterally (Berndt and Gibbons 1958). Richardson (2000) reported root growth rates averaging 2.9 inches, ranging from 1.1 to 6 inches. Rocky Mountain Douglas-fir is ectomycorrhizal and sometimes ectendomycorrhizal; 2000 fungal associates have been reported (Harvey et al. 1987). Colonization is not inoculum-limited except in nursery conditions (Burns and Honkala 1990).
Wildlife: Numerous species of song birds nest in Douglas-fir foliage. Steller's jays, pine siskins, western tanagers, red-breasted nuthatches, and Cooper's hawks.



Cones and branches





Bark (above), needles (left)

ENGELMANN SPRUCE

Picea engelmannii

Family: Pinaceae

Duration: Native long-lived, coniferous, evergreen tree. Typically will reach 65 feet in height but have been found as tall as 130 feet. Becomes stunted as elevation increases. Needles four sided, sharp.

Succession: Found at high altitudes greater than 8000 feet. At 9000 feet to higher, can be a dominant species.

Regeneration: Bark is loose, scaly, and reddish-brown to grey. Seed shed by the end of October, but some may continue to fall throughout the winter. The winged seeds are wind dispersed. Seeds travel primarily with the prevailing winds, but upslope drafts can influence dispersal at low and middle elevations. Seed is generally dispersed within 300 feet of a windward source (Alexander and Shepperd 1984, Noble and Ronco 1978). Seed dispersed during winter can travel great distances skidding over glazed snow (McCaughey et al. 1986). Postfire reestablishment is via wind-dispersed seeds off site, which readily germinate on fire-prepared seedbeds. Seeds do not establish well in the open.

Frequency: Very fire sensitive. Generally killed even by low-intensity fires. The occasional mature tree survives fire. Las Conchas and Cerro Grande fires were at higher elevations.

Drought tolerance; Low

Rooting depth: 20 inches (minimum)

Wildlife: Hiding and thermal cover for deer, elk, and bear. Summertime shade for big game. Year-round hiding cover for small animals. Snags are used by cavity-nesting birds.



White fir with the cones on the upper third of the tree.





Bark (top), needles (bottom)

WHITE FIR

Abies concolor

Family: Pinaceae

Duration: Native large coniferous tree single needle growing to 180 feet tall.

Succession: A component of the mixed conifer range of the Jemez Mountains above 8000 feet.

Regeneration: Bark smooth, whitish gray, irregularly furrowed with age. Reproduces by seed. Begins to produce cones at about 40 years; cones on upper third of tree. Seedlings grow best in full sun. Mycorrhizal associations are important to growth (Laacke 1990, Alvarez et al. 1979). Easily killed by fire. Low branches provide a ladder to crown. Seeds that germinate in the snowpack rarely survive therefore seeds must fall before ground covered with snow cover (Gordon 1970). After fire wind-spread seeds from trees in non-burned areas important. Low-intesity fires can thin areas so shade-intolerant white fir can be established.

Frequency: *La Mesa Fire:* In plots within the upper elevations. *Cerro Grande and Las Conchas fires:* Mixed conifer zone was burned.

Drought tolerance; Shade intolerant; medium drought tolerance.

Rooting depth: Fairly shallow, adaptable to local conditions. Susceptible to wind throw following partial cutting. Mycorrhizal associations important. Minimum root depth 40 inches.

Wildlife: Habitat includes summer and winter ranges of deer, elk, and bear. Many bird species including brown creeper, red-breasted nutatches, and Clark's nutcracter consume seeds.

MOSSES, SOIL CRUSTS, AND LICHENS

Most information about fire effects is about vascular plants with little information in the literature about non-vascular plants and the effects of fire. However, we observed after the La Mesa fire that the most severely burned areas, devoid of trees, had the highest cover of soil crust (2.3% to 3.5%) 16 years post-fire. Those areas with needle litter had the lower cover of soil crust (0.14% to 1.6%) (Foxx 1996). We observed moss and lichens very quickly after the La Mesa fire, both in the ponderosa pine and mixed conifer. No species identifications were made. Further studies shoud be done to determine the relationship of these species and the presence of early successional vascular plants.

Mosses: Reports indicate that most moss and lichen species are killed by fire but can colonize from off-site areas through wind-dispersed spores. Studies in Canada have found that fire moss (*Celdon purpureus*) colonizes burned areas and is often the dominant vegetation for several years following high-severity fire (Richardson 1981). *Marchantia polymorpha* invades burned areas by windborne spores. Exposed mineral provides favorable conditions for gametophyte (Bliss and Wein 1972).

Cryptogamic Soil Crusts: Cryptogamic soil crusts are an important component of many arid rangeland ecosystems in the western US. They are important in the reduction of soil erosion and facilitate vascular plant seedling establishment by improving water penetration and reducing runoff. Little information has been found on the effect of fire on these soil crusts (Johansen and St. Clair 1986; Johansen et al. 1984).

Lichens: Lichens have also been sparsely studied. Most are found to be very flammable in a fire. One species, *Collema tenax*, found in shadscale-black greasewood habitats of Camp Floyd State Park, Utah, was the first to invade the burned area. Application of soil crust slurries to burned areas in central Utah resulted in rapid stabilization of the soil due to crust re-establishment (St. Clair and Johansen 1985).



Moss in the Apache Springs area one year after the La Mesa fire



Moss and lichens on the edge of a root burn on Escobas Mesa two months post fire.



Moss and lichens on the edge of a root burn.

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Note: References have been grouped according to plant life form in case readers want to know which life form is discussed by specific authors. Consequently, some reference entries are presented in more than one section.

Also, the two main sources of information were the USDA Plants Database and the Fire Effects Information System:

US Department of Agriculture. Plants Database (www.plants.usda.gov)

US Department of Agriculture Forest Service. Fire Effects Information System (www.fs.fed.us/database/feis/plants)

The Plants Database provided information about phenology, wildlife use, rooting depths, and succession; and the FEIS database compiles information about fire effects on plants.

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Spreading Fleabane 29
Western Yarrow 26
Wild Strawberry 29
Wild Onion 34
Wild Raspberry 74
Wild Rose 75
Wild Strawberry 29
Wood's Rose 75
Wooten's Ragwort 47
Wormwood 19
Wright's Deervetch 31

Y

Yellow Flowers
Big Golden Pea 48
Cinquefoil 42
Golden Aster 47
Golden Smoke 42
Pinque Rubberweed 46
Ragleaf Bahia 45
Scrambled Eggs 42
Stiff Greenthread 45
Wooten's Ragwort 47
Yellow Salsify 25
Yucca
baileya 68