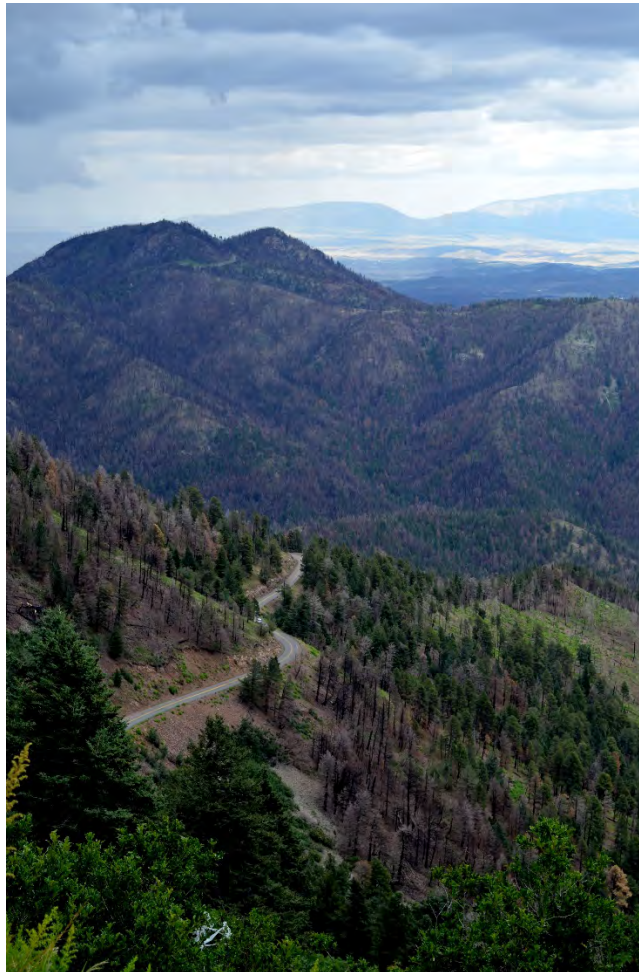


**Wildfire Impacts  
on  
Species of Concern Plants  
in the  
Lincoln National Forest, New Mexico**



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# INTRODUCTION

Although wildfires are a natural driver shaping southwest forest ecosystems, frequent large scale mega fires are a recent phenomenon in the Southwest associated with decades of grazing and fire suppression activities, as well as prolonged droughts caused by climate change. In 2012 and 2013 alone, the Whitewater-Baldy, Little Bear, and Silver wildfires burned nearly half a million (472,750) acres of forested lands in New Mexico. As many as 15 state and federal plant Species of Concern may have had significant portions of their range burned by these fires (Roth 2016). For some of these species, it is estimated that their entire known range might have burned, potentially putting them at risk of extinction and therefore possibly requiring protection under the Endangered Species Act. Although it is generally assumed that native plant species are adapted to natural fire cycles and will therefore experience a natural recovery, the response of these sensitive species to wildfire and potential associated habitat alterations has not been studied.

The Lincoln National Forest is well known for its diverse flora and high degree of plant endemism. Lincoln and Otero counties of New Mexico provide habitat for a total of 51 plant rare and endemic plants, many of which occur in the Lincoln National Forest, including 22 that are listed as Forest Sensitive Species (NMRPTC 1999). All 22 species are also listed as Species of Concern (SOC) with the State of New Mexico and the U.S. Fish & Wildlife Service (USFWS) and include one NM State Listed Endangered plant, Goodding's onion (*Allium gooddingii*). Seven of these had the potential of having a significant portion of their known range impacted by the 2012 Little Bear Fire, which burned 44,330 acres in the Sierra Blanca region of the Lincoln National Forest (Figure 1). The seven species are:

1. Goodding's onion (*Allium gooddingii*)
2. Sierra Blanca cliff daisy (*Ionactis elegans*)
3. New Mexico stonecrop (*Sedum integrifolium ssp. neomexicanum*)
4. Sierra Blanca cinquefoil (*Potentilla sierrae-blancae*)
5. Wooton's alumroot (*Heuchera wootonii*)
6. Wooton's hawthorn (*Crataegus wootoniana*)
7. Sierra Blanca kittentails (*Synthyris oblongifolia*)

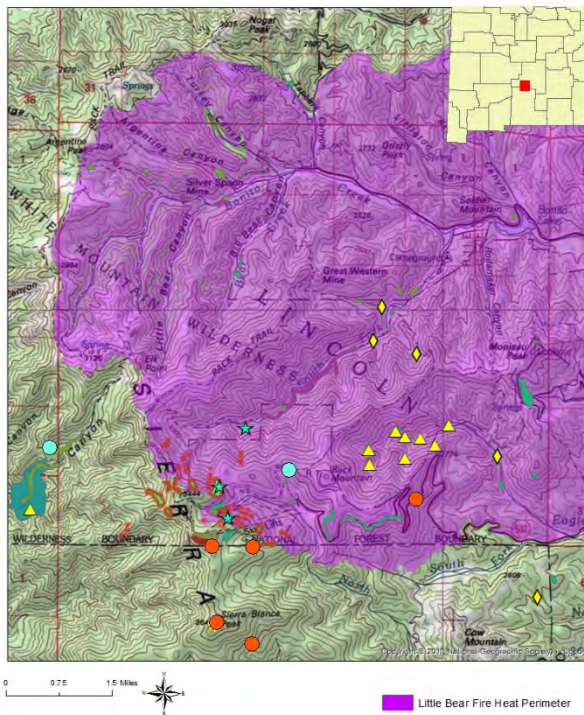
The primary objectives of this study were to collect baseline information on the initial response of rare plant populations to wildfires at varying levels of fire severity, collect baseline information on the impacts of altered fire regimes (increased severity and frequency) to the habitats of rare plants, including the invasion of nonnative plants, and to collect baseline information on how habitats will be altered by vegetation community changes brought on by the synergistic effects of wildfires, continued drought, and the invasion of nonnative species.

## **Expected Results or Benefits:**

- Provide recommendations for Species of Concern (SOC) plant species management before, after, and during wildfires.
- Provide updates on the current, post-fire status of SOC plants to the U.S. Fish and Wildlife Service (USFWS) and land management agencies.
- Provide a framework for addressing SOC plant species management in response to increased wildfire severity and frequency.

# METHODS

Seven plant Species of Concern were selected for study based on their known occurrence within the Little Bear Fire perimeter and overall rarity. Targeted were areas of known occupation within the fire perimeter. Initial location data was obtained from the Southwest Environmental Information Network (SEINet) (<http://swbiodiversity.org/seinet/index.php>). Additional locational information was provided by the Smokey Bear Ranger District of the Lincoln National Forest in the form of field survey assistance and GIS shape files. Status surveys were performed during the optimum survey period for detection and proper identification during flowering and fruiting time. Documented sites within the mapped fire perimeter and its periphery were attempted to be located during the summers of 2013, 2014, and 2015, to the extent possible. Plants were documented using a handheld Garmin Montana GPS and mapped using ArcMap 10.1. Each waypoint represents an occupied location or site where 1 to many plants were documented within approximately 100 ft radius of the waypoint. Large sites were documented by walking a polygon around the perimeter of the population using the Track function of the GPS. Documented were the estimated number of plants, associated species, fire severity, observed disturbances, and the presence of invasive species. Because fires burn in patches and sensitive plant species often occur in small microhabitat sites, burn severity was determined on site where plants were located during the survey or where plants were mapped prior to the fire. An area of occupied habitat was determined severely burned if the tree canopy over the site or in the immediate vicinity of the site was at least 80% dead. A moderate burn was considered if the canopy was 30 - 80% dead, and a light burn contained up to 30% dead trees. Specimens collected for verification of identification and documentation purposes were deposited at the University of New Mexico Herbarium in Albuquerque.



**Figure 1.** Known rare plant distribution prior to the 2012 Little Bear Fire in the Lincoln National Forest, NM.

# RESULTS

## SUMMARY

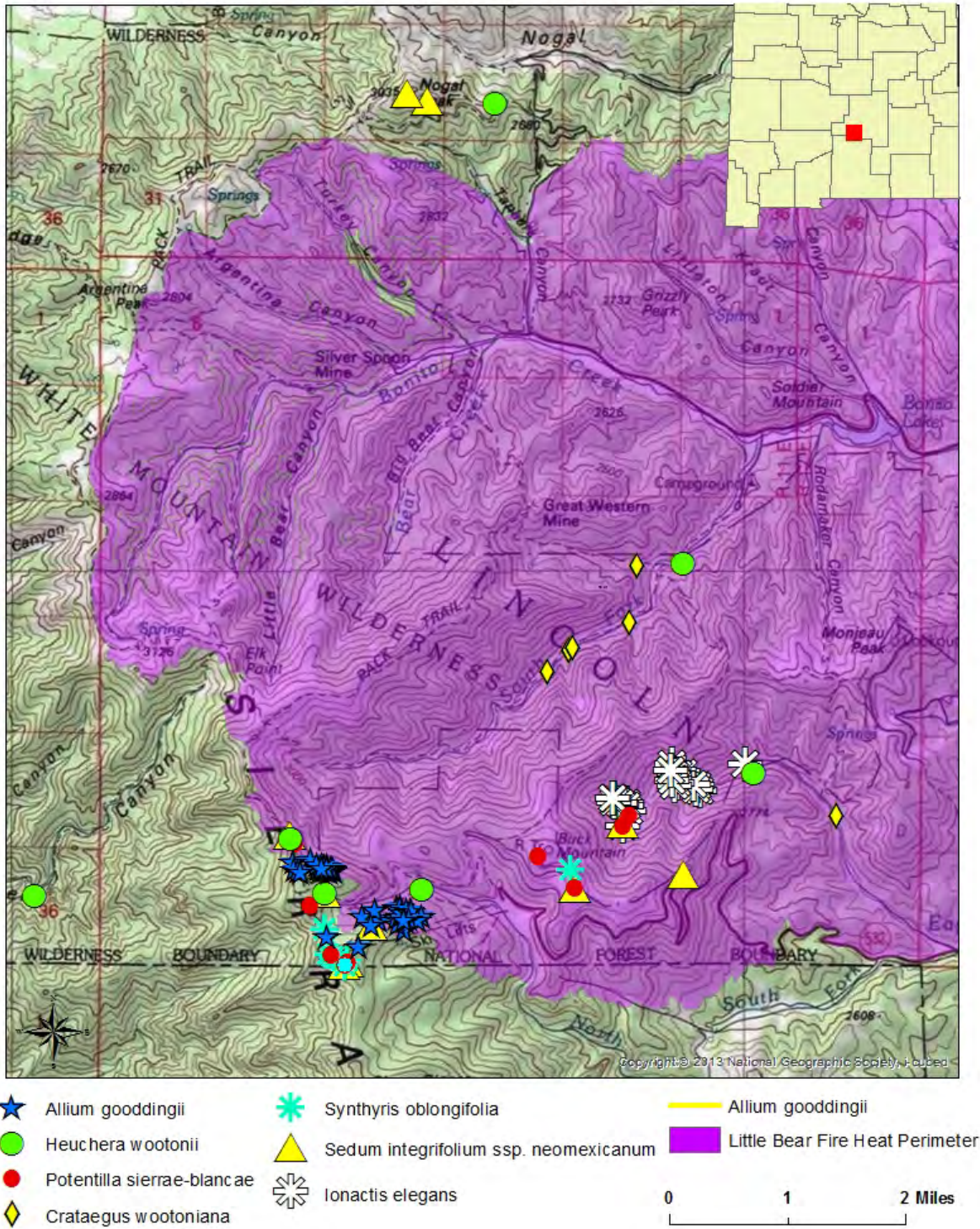
All but one of the sensitive plant sites previously documented and available at the beginning of this study were relocated in 2013 and 2014. Additional locational information was received in 2015 for Goodding's onion and Wooton's hawthorn. Only some of these additional sites could be surveyed in 2015 and not all sites could be relocated. Unfortunately very little information was available on the abundance and distribution prior to the fire for the majority of the 7 target species. The majority of known locations for these rare plants came from the specimen record, providing incidental locational information, but no data on abundance or actual distribution of the species within the Lincoln National Forest. Even for Goodding's onion, the last surveys were performed before 1997 and no data on abundance was available prior to the 2012 fire. In the absence of baseline information it is not possible to determine whether there are fewer or possibly more plants after the fire than there had been prior to the fire. Several sites were not mapped in the correct location or the location given was too general for reasonable resurveys and were therefore omitted from the search.

Based on the findings of this study, it can be assumed that all target species generally survive the direct impacts of fires, irregardless of fire severity. All seven species survived the 2012 Little Bear Fire. However, two species appeared to have fewer populations or fewer plants present than were previously recorded (Goodding's onion, Wooton's hawthorn).

Four of the 7 target species within the Little Bear Fire perimeter are not likely impacted by the fire and are experiencing few, if any, alterations to their habitats from direct impacts of the fire or post-fire impacts. These include Sierra Blanca cinquefoil (*Potentilla sierrae-blancae*), New Mexico stonecrop (*Sedum integrifolium ssp. neomexicanum*), Sierra Blanca kittentails (*Synthyris oblongifolia*), and Sierra Blanca cliff daisy (*Ionactis elegans*). Although much of the habitat for Wooton's alumroot (*Heuchera wootonii*) was altered by the fire, the species is expected to persist because it is frequently found outside the fire perimeter in the Sierra Blanca region, including open areas. In addition, populations of Goodding's onion growing in open areas along ski slopes were not likely impacted by the fire.

Invasive non-native species were a minor issue for this study and were either not present in the vicinity of rare plant sites or only present in very low densities. In general, invasive species were documented in low numbers, typically in patchy stands, primarily in the bottom of the South Fork Rio Bonito area. The most commonly documented invasive species included musk thistle (*Carduus nutans*), mullein (*Verbascum thapsus*), and dandelion (*Taraxacum officinale*).





**Figure 2.** Post-fire rare plant sites documented from 2013 to 2015.



# Goodding's Onion

(*Allium gooddingii*)

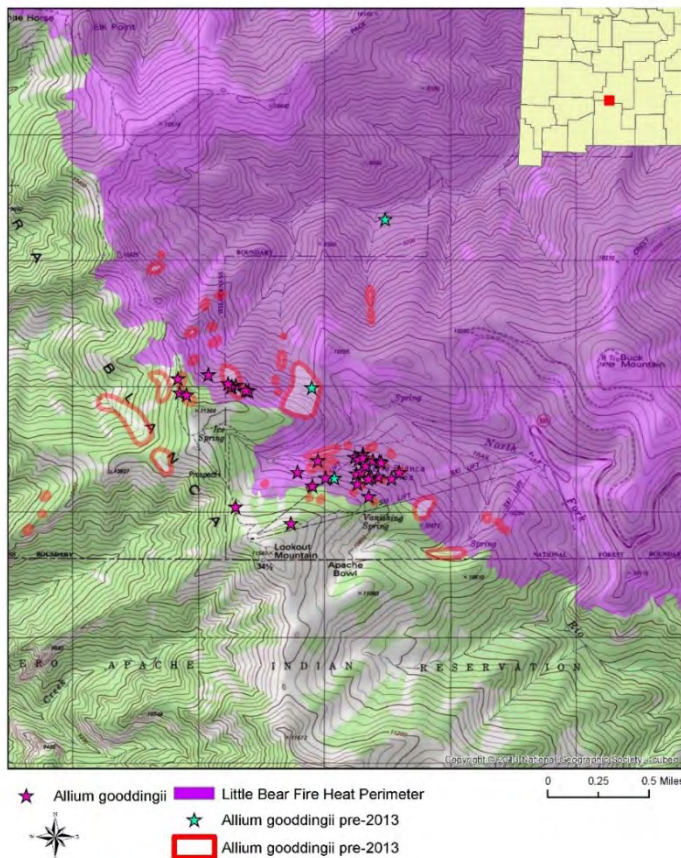


Goodding's onion is perennial herb in the lily family (Liliaceae). It is endemic to New Mexico and Arizona. It generally occurs under the canopy of mature mixed conifer and spruce forests, along north-trending drainage bottoms associated with perennial and intermittent streams at elevations between 7,000 and 11,300 ft (NMRPTC 1999). The White Mountain population in the Sierra Blanca region is unique because plants also occur in open meadows, avalanche chutes and ski slopes surrounded by subalpine forests above 10,200 ft (Figure 3). Associated species include Douglas fir (*Pseudotsuga menziesii*), corkbark fir (*Abies arizonica*), Engelmann spruce (*Picea engelmannii*), Whipple's penstemon (*Penstemon whippleanus*), New Mexico lupine (*Lupinus neomexicanus*), yarrow (*Achillea millefolium*), Parry's thistle (*Cirsium parryi*), fleabane (*Erigeron sp.*), sedges (*Carex sp.*), mountain brome (*Bromus carinatus*), and other grasses.

Goodding's onion was a Candidate for Federal listing under the Endangered Species Act until a Candidate Conservation Agreement (CCA) was signed between the U.S. Forest Service (USFS) and the

USFWS, providing management guidance to ensure the protection of the species in the absence of listing (USFS & USFWS 1997). Except for one site, the majority of sites known prior to this study were last documented well before the 1997 CCA was established. No additional inventories or monitoring took place after the CCA was finalized in 1997 (Laurenzi & Anderson 2011). Goodding's onion continues to be a Forest Sensitive Species and a Species of Concern for the USFWS. It is also listed endangered with the State of New Mexico. NatureServe gives Goodding's onion an updated conservation rank of S2 (imperiled) for New Mexico (2016). It is estimated that 94 % of all documented sites in AZ and NM burned in 3 different fires between 2011 and 2012.

At the onset of this study a total of 4 locations were documented through the specimen record from the Sierra Blanca region on the Lincoln National Forest (Figure 3). One of these sites was located outside the fire perimeter (Three Rivers Canyon) and turned out to be a misidentification. One site was too general for relocation (upper South Fork of the Rio Bonito drainage). Thus Goodding's onion was reliably only documented from two general areas, both located within the Little Bear Fire perimeter in the vicinity of the Apache Ski area. Three general areas (Goodding's onion Management Units) were described in the 1997 Candidate Conservation Strategy, but associated maps were not available until 2015 (Figure 3). The GIS files obtained in 2015 documented 49 sites in the Ski Apache area and the upper S. Fork of the Rio Bonito drainage. The majority of these sites (75%) were located within the fire perimeter. No data was available on the abundance of the species at these sites prior to the fire.



**Figure 3.** Documented distribution of Goodding's onion on the Lincoln National Forest

A total of 49 extant sites from two general locations (Ski Apache, upper South Fork Rio Bonito) were documented in 2013 and 2015 from the vicinity of previously known locations in the Sierra Blanca region (Figure 3, Table 1). Eight sites were documented in 2013 within the Ski Apache area, along the access road and within ski runs. Forty-one additional sites were documented in 2015, many of which were located in severely burned forest in the upper South Fork Rio Bonito (Table 1).

The majority of plants and densest populations were found in intact unburned mixed conifer forests, but some populations also persisted in moderate to severely burned forests in the upper South Fork of the Rio Bonito drainage (Figure 4, Table 1). Extant sites in the Ski Apache population contained few to a thousand plants and occurred on steep N-facing slopes within developed areas along ski-slopes, including adjacent mixed conifer forests, roadsides, and underneath ski lift towers (Table 1). Within the habitat at the Apache Ski area, Goodding’s onion occurs generally in highly localized small patches within dense stands of other perennial forbs, grasses, and sedges, often associated with seeps. Open areas were not burned or only burned lightly during the fire. Adjacent forested areas burned in patches, some severely, experiencing up to 100% mortality of trees.

Plants were found flowering or just post flowering during the survey periods. In 2013, only between 5 and 10 % of all plants were found reproductive. Flowering was higher in 2015, especially in severely burned areas. However, plants found in unburned intact forest were found largely vegetative in 2015 (Allgoo-9-15, Allgoo-10-15, Allgoo-11-15, Allgoo-26-16). Except for one site, no invasive species were documented in the occupied habitat of Goodding’s onion. Dandelion (*Taraxacum officinale*), an invasive perennial herb, was documented from one site (ALLGOO7-13). Elk were documented throughout the occupied habitat of Goodding’s onion, but only few plants were browsed.

**Table 1.** Documented post-fire population estimates of Goodding’s onion on the Lincoln National Forest.

Waypoint Name	GIS Forest Service FID	Number of Plants	Fire Severity	Comments
Allgoo1-13	None	Hundreds	Light or unburned	Roadside. In localized patches of 5 to 280 plants. NHNM SFID 10684
Allgoo2-13	None	10 plants	Unburned	NHNM SFID 10684
Allgoo3-13	None	Hundreds	Light or unburned	Roadside. Ski slopes. NHNM SFID 10684
Allgoo4-13	None	Hundreds	Light or unburned	Roadside. Ski slopes. No plants in burned patches or edges of burned areas. NHNM SFID 10684
Allgoo5-13	22	Few	Light or unburned	Plants near road and along the edge of burned forest. NHNM SFID 10684
Allgoo6-13	None	35 - 50	Light	Roadside. Underneath ski lift tower. Right below burned patch of forest. No other plants in vicinity. NHNM SFID 10684



Waypoint Name	GIS Forest Service FID	Number of Plants	Fire Severity	Comments
Allgoo7-13	None	50 -100	Light	Roadside. Ski slopes. Underneath live trees, edge of burned area. Lots of dandelions. NHNM SFID 10684
Allgoo8-13	None	Hundreds	Light	Roadside. Right below burned forest. In road cut and in open meadow areas (ski slopes). NHNM SFID 10684
Allgoo-1-15	None	1	Unburned	One plant, may be <i>A. geyeri</i>
Allgoo-2-15	13	2	Severe	
Allgoo-3-15	13	75-100	Severe	
Allgoo-4-15	13	1	Severe	
Allgoo-5-15	13	22	Severe	
Allgoo-6-15	13	8	Severe	
Allgoo-7-15	13	30	Severe	
Allgoo-8-15	None	200	Severe	
Allgoo-9-15	15	500-1000	Unburned	Intact forest. Mixed with ALLGEY
Allgoo-10-15	18	Thousands	Unburned	Intact forest
Agoo-11-15	18	Hundreds	Unburned	Intact forest
Allgoo-073015-1	35	3	Unburned	Forest edge. NHNM SFID 10684
Allgoo-73015-4	37	7	Unburned	Forest edge. NHNM SFID 10684
Allgoo-073015-5	32	500-1000	Moderate to light	Forest edge. NHNM SFID 10684
Allgoo-0730-6	32	1000	Light	Meadow next to moderate burned forest. NHNM SFID 10684
Allgoo-073015-7	32	Hundreds	Moderate	NHNM SFID 10684
Allgoo-073015-8	None	250	Moderate	Forest edge. NHNM SFID 10684
Allgoo-073015-9	25	70	Light	Meadow next to moderate burned forest. NHNM SFID 10684
Allgoo-073015-10	27	25-50	Light	Scattered, meadow next to moderate burned forest. NHNM SFID 10684
Allgoo-073015-11	27	150-200	Moderate	Forest edge. NHNM SFID 10684
Allgoo-073015-12	30	6	Moderate	Forest edge. NHNM SFID 10684
Allgoo-073015-13		6	Light to moderate	Forest edge. NHNM SFID 10684

Waypoint Name	GIS Forest Service FID	Number of Plants	Fire Severity	Comments
Allgoo-073015-14	33	30-50	Moderate to severe	NHNM SFID 10684
Allgoo-073015-15	None	25	Unburned	Open area. NHNM SFID 10684
Allgoo-073015-16	None	10	Unburned	Forest edge. NHNM SFID 10684.
Allgoo-12-15	13	37	Severe	
Allgoo-13-15	13	42	Severe	
Allgoo-14-15	13	24	Severe	
Allgoo-15-15	13	103	Severe	
Allgoo-16-15	13	10	Severe	
Allgoo-17-15	13	>1000	Light to moderate	Inside polygon Track Allgoo2-15
Allgoo-18-15	13	100+	Light to moderate	Inside polygon Track Allgoo2-15
Allgoo-19-15	13	5	Severe	
Allgoo-20-15	13	12	Severe	
Allgoo-21-15	13	7	Severe	
Allgoo-22-15	13	5	Severe	Browsed
Allgoo-23-15	13	50+	Severe	
Allgoo-24-15	13	15	Moderate	Inside polygon Track Allgoo2-15
Allgoo-25-15	13	18	Severe	
Allgoo-26-15	18	40	Unburned	Intact forest
Allgoo-27-15	13	N/A	Severe	

Due to the late discovery of 49 previously mapped polygons for Goodding's onion, not all previously reported sites could be surveyed. Therefore the 2015 survey targeted only 23 of these 49 polygons. No survey dates, identifiers or number of plants were provided with the mapped polygons. 2015 surveys found extant plants in the vicinity of 11 of the 23 previously documented polygons (GIS FID: 13, 15, 18, 22, 25, 27, 30, 32, 33, 35, 37). This included plants found in 2 previously documented polygons outside the fire perimeter in intact forest (GIS FID: 15, 18). These two sites contained the largest number of plants, in fact, Goodding's onion was a dominant understory herb at one site, where thousands of plants were found (Site Allgoo-10-15). No plants were found in the vicinity of 12 previously documented polygons (GIS FID: 8, 10, 11, 12, 16, 17, 20, 21, 36, 38, 41, 42). Half of these sites were located in severely burned forest in the upper South Fork Rio Bonito drainage (Figure 4)(GIS FID: 8, 10, 11, 12, 16, 17), the other half were associated with the ski slopes (GIS FID: 20, 21, 36, 38, 41, 42). Only one site inside the fire perimeter was large enough to map with a polygon (Track Allgoo-2-15, Sites Allgoo-17-15, Allgoo-18-15, Allgoo-24-15). More than a thousand plants were found under light to moderately burned forest canopy.

The history of the previously documented polygons is unknown but they were likely digitized from hand drawn maps associated with the Candidate Conservation Agreement and drawn prior to 1997, before the advent of GPS units. Therefore the accuracy of these maps is likely somewhat subjective and plants in these sites may or may not have gone extinct since the maps were originally drawn. Follow-up surveys to all previously documented sites, including sites outside the fire perimeter are essential to determine the current status and distribution of the species. In addition, monitoring of sites persisting under severely

burned forest is needed to document post-fire population trends in response to severe habitat alteration. No Goodding's onions were found in naturally open meadows or avalanche chutes. Plants found associated with ridgetops and rock outcrops in previously documented sites were Geyer's onion (*Allium geyeri*) and may have been misidentified in the past. Goodding's onion sites associated with the developed Apache Ski area are persisting after the forest was cleared for the ski runs, but it is unknown whether these sites are stable or in decline. No plants were found in 6 previously documented sites in the Ski Apache area. Although 7 monitoring plots to document population trends on the ski slopes were established in 1995, monitoring was not continued after 1997 (USFWS & USFS 1997; Laurenzi and Anderson 2011). Goodding's onion sites at Ski Apache may be in decline. Additional surveys and close monitoring of these sites is essential to document population response to habitat alteration. Surveys to document the true abundance and distribution and post-fire persistence on the Lincoln National Forest would greatly assist in the development of conservation measures and management actions needed to protect the species from future catastrophic wildfires as well as management actions associated with wildfires including firefighting activities and post-fire rehabilitation actions. This is especially important at this point, because the Lincoln National Forest has the last remaining significant unburned populations of Goodding's onion in New Mexico. Most populations elsewhere in New Mexico have largely burned within the past decade and they have gone extinct or their future is uncertain (Roth 2016). Burned populations are documented to be in severe decline because their habitat has been significantly altered by stand replacing mega-fires. The unburned populations of Goodding's onion on the Lincoln National Forest may be a last refuge for this rare species and should be managed accordingly. Seed banking should be considered to maintain an ex-situ collection of a population that is adapted to growing in open high elevation areas, in the event that reintroduction will become necessary in the future.

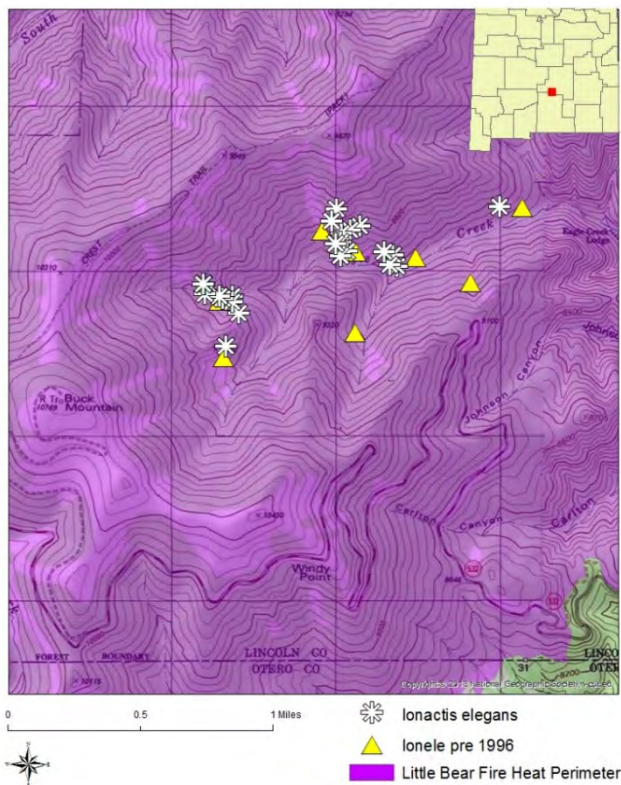


**Figure 4.** Post-fire habitat condition in the upper South Fork Rio Bonito drainage, 2015.



# Sierra Blanca cliff daisy

(*Ionactis elegans*)



The Sierra Blanca cliff daisy is a perennial herb in the daisy family (Asteraceae). It is endemic to Sierra Blanca region of Lincoln County. It is only known to occur within the Eagle Creek and the Three Rivers Canyon drainage areas of the Lincoln National Forest, where it grows on igneous rock faces in montane coniferous forest between 7,600 and 9,500 ft (NMRPTC 1999). The Eagle Creek drainage and all the known Sierra Blanca cliff daisy sites burned in the Little Bear Fire in 2012. The Three Rivers Canyon location did not burn. The Sierra Blanca cliff daisy is a Forest Service Sensitive Species, and a USFWS and NM State Species of Concern. NatureServe gives Sierra Blanca cliff daisy a conservation rank of S2 (imperiled) for New Mexico (2016). Prior to this study the Sierra Blanca cliff daisy was documented from 8 sites within the Eagle Creek drainage. No data was available on the abundance of the species at these sites prior to the fire.

**Figure 5.** Distribution of the Sierra Blanca cliff daisy within the Little Bear Fire perimeter on the Lincoln National Forest.

In 2014, 23 waypoint documented extant sites in the general vicinity from where plants were previously recorded (Figure 5). A total of 630 plants were documented among the 23 sites. Plants were sparsely distributed in small, highly localized groupings of 3 – 150 plants at each recorded waypoint, on east, west, and south facing exposures (Table 2). The majority of sites contained fewer than 20 individuals. Plants were in late flowering stage in late June. Plants occurred in cracks of large rock outcrops, including sheer cliff faces, surrounded primarily by burned Douglas fir (*Pseudotsuga menziesii*) forests mixed with Ponderosa pine (*Pinus ponderosa*), southwestern white pine (*Pinus strobiformis*), Juniper (*Juniperus sp.*), quaking aspen (*Populus tremuloides*), and Gambel oak (*Quercus gambelii*). Other associated species include scarlet penstemon (*Penstemon cardinalis*), Texas tobacco-root (*Valeriana texana*), hairy false goldenaster (*Heterotheca villosa*), brickellbush (*Brickellia sp.*), Geyer’s onion (*Allium geyeri*), cliffbush (*Jamesia americana*), Sierra Blanca cinquefoil (*Potentilla sierra-blancae*), New Mexico locust (*Robinia neomexicana*), gooseberry (*Ribes sp.*), and claretcup cactus (*Echinocereus sp.*). Texas tobacco-root, scarlet penstemon and Sierra Blanca cinquefoil are listed as Species of Concern by the State of New Mexico and the USFWS (NMRPTC 1999).

The majority of the surrounding forest burned severely with the majority of the trees dead or dying. Musk thistle (*Carduus nutans*), an invasive annual herb, was documented to occur in the vicinity of one of the 23 sites (lonele4). Otherwise no invasive species were documented in the habitat of the Sierra Blanca cliff daisy. No other threats were observed.

**Table 2.** 2013 post-fire population estimates of Sierra Blanca cliff daisy in Eagle Canyon on the Lincoln National Forest.

Waypoint Name	Number of Plants	Comments
lonele5-14	15 plants	Rock outcrop in the immediate vicinity of burned Douglas fir.
lonele9-14	150 plants	Large rock outcrop surrounded by burned forest, site not likely impacted by fire due to its distance from trees.
lonele9b-14	9 plants	Large rock outcrop surrounded by burned forest, site not likely impacted by fire due to its distance from trees.
lonele8-14	8 plants	Large rock outcrop surrounded by burned forest, site not likely impacted by fire due to its distance from trees.
lonele8b-14	11 plants	Large rock outcrop surrounded by burned forest, site not likely impacted by fire due to its distance from trees.
lonele8c-14	3 plants	Large rock outcrop surrounded by burned forest, site not likely impacted by fire due to its distance from trees.
lonele8d-14	3 plants	Large rock outcrop surrounded by burned forest, site not likely impacted by fire due to its distance from trees.
lonele8e-14	29 plants	Large rock outcrop surrounded by burned forest, site not likely impacted by fire due to its distance from trees.
lonele8f-14	45 plants	Large rock outcrop surrounded by burned forest, site not likely impacted by fire due to its distance from trees.
lonele8g-14	103 plants	Large rock outcrop surrounded by burned forest, site not likely impacted by fire due to its distance from trees.
lonele4a-14	5 plants	Large rock outcrop surrounded by patchy burned forest. No plants in areas near burned trees. Some musk thistle in vicinity.
lonele4b-14	10 plants	Large rock outcrop surrounded by patchy burned forest. No plants in areas near burned trees. Some musk thistle in vicinity.
lonele4-1		Large rock outcrop surrounded by patchy burned forest. No plants in areas near burned trees. Some musk thistle in vicinity.

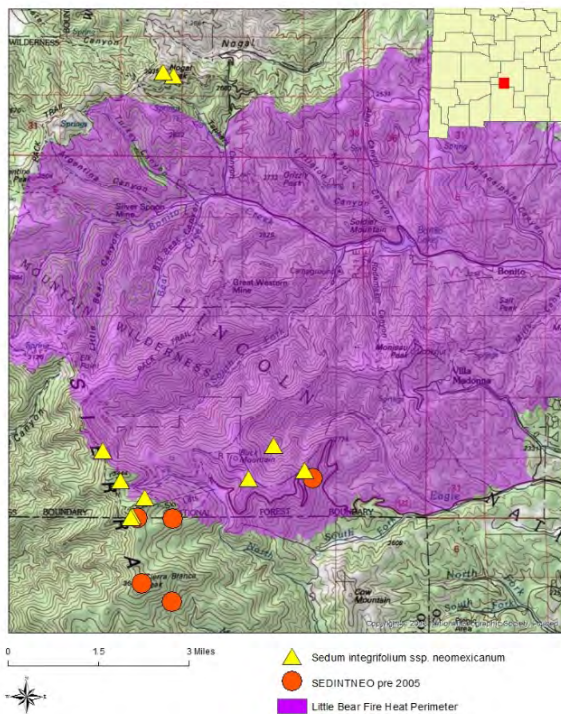
Waypoint Name	Number of Plants	Comments
lonele4-2	134 plants	Large rock outcrop surrounded by patchy burned forest. No plants in areas near burned trees. Some musk thistle in vicinity.
lonele6a-14	5 plants	Large rock outcrop surrounded by patchy burned forest. No plants in areas near burned trees. Waypoints 6 & 7 blend into each other.
lonele6b	3 plants	Large rock outcrop surrounded by patchy burned forest.
lonele6c-14	3 plants	Large rock outcrop surrounded by patchy burned forest.
lonele6d-14	5 plants	Large rock outcrop surrounded by patchy burned forest.
lonele6f-14	4 plants	Large rock outcrop surrounded by patchy burned forest.
lonele6g-14	7 plants	Large rock outcrop surrounded by patchy burned forest.
lonele6e-14	16 plants	Large rock outcrop surrounded by patchy burned forest.
lonele7-1		Large rock outcrop surrounded by patchy burned forest. No plants in areas near burned trees.
lonele7-2	62 plants	Large rock outcrop surrounded by patchy burned forest.

Within the Eagle Creek drainage the fire burned in patches, including some stand replacing severely burned patches. Although no previous population estimates were available, by nature of the habitat of the Sierra Blanca cliff daisy, it is unlikely that the Eagle Creek Canyon population was significantly impacted by the fire. Some plants may have died during the fire from radiant heat transferred from burning trees adjacent to rock outcrops where plants occur. However, the species is largely protected from fire impacts by nature of its habitat preference, which is composed of sheer rock faces and rock outcrops. The habitat of the Sierra Blanca cliff daisy was not significantly altered by the fire and therefore the Eagle Creek Canyon population is expected to persist, even if the surrounding forest composition has dramatically changed. Not all rock outcrops in the Eagle Creek drainage were surveyed and there are likely more plants on unsurveyed rock outcrops and on inaccessible areas of the surveyed rock outcrops. Because of their their highly limited distribution and sparse population numbers, full inventory and monitoring is recommended throughout the habitat of the Sierra Blanca cliff daisy in both the Eagle Creek and the Three Rivers drainages to understand actual abundance and distribution of this species on the Lincoln National Forest and to evaluate population trends through time.



# New Mexico stonecrop

(*Sedum integrifolium* ssp. *neomexicanum*)



The New Mexico stonecrop is a perennial herb in the stonecrop family (Crassulaceae). It is endemic to Lincoln and Otero counties of New Mexico, where it occurs in the Sierra Blanca region of the Lincoln National Forest and adjacent tribal lands. It grows in alpine tundra, in igneous soils, scree-slopes and rocky openings surrounded by subalpine forests at elevations between 9,500 and 11,800 ft (NMRPTC 1999). Prior to this study the species was documented from 3 general areas in the Sierra Blanca region through the specimen record, one of which occurred inside the fire perimeter. No data was available on the abundance of the species at these sites prior to the fire. The New Mexico stonecrop is a Forest Service Sensitive Species, and a USFWS and NM State Species of Concern. NatureServe gives New Mexico stonecrop an updated conservation rank of S2 (imperiled) for New Mexico (2016).

**Figure 6.** Previous and current known distribution of New Mexico stonecrop on the Lincoln National Forest.

Between 2013 and 2015 the New Mexico stonecrop was documented from 10 sites, four of which were inside the fire perimeter (Figure 6, Table 3). The number of plants ranged from one to several hundred per site (Table 3). Plants were found primarily along rocky scree slopes and rock outcrops, on all exposures. The majority of plants were either sterile or post flowering. Sites were surrounded by subalpine or mixed conifer forests including corkbark fir (*Abies arizonica*), Engelmann spruce (*Picea engelmannii*), Douglas fir (*Pseudotsuga menziesii*), Ponderosa pine (*Pinus ponderosa*), southwestern white pine (*Pinus strobiformis*), quaking aspen (*Populus tremuloides*), and Gambel oak (*Quercus gambelii*). Other associated species include pink alumroot (*Heuchera rubescens*), yarrow (*Achillea millefolium*), Geyer's onion (*Allium geyeri*), cliffbush (*Jamesia americana*), wild geranium (*Geranium sp.*), Whipple penstemon (*Penstemon whippleanus*), Wooton's alumroot (*Heuchera wootonii*), and Sierra Blanca cinquefoil (*Potentilla sierra-blancae*). Several populations were in the immediate vicinity of human activity, including trails, roads, lookouts, and ski runs (Table 3). No invasive species were documented in the vicinity of any of the New Mexico stonecrop sites.

**Table 3.** Documented post-fire population estimates of New Mexico stonecrop on the Lincoln National Forest.

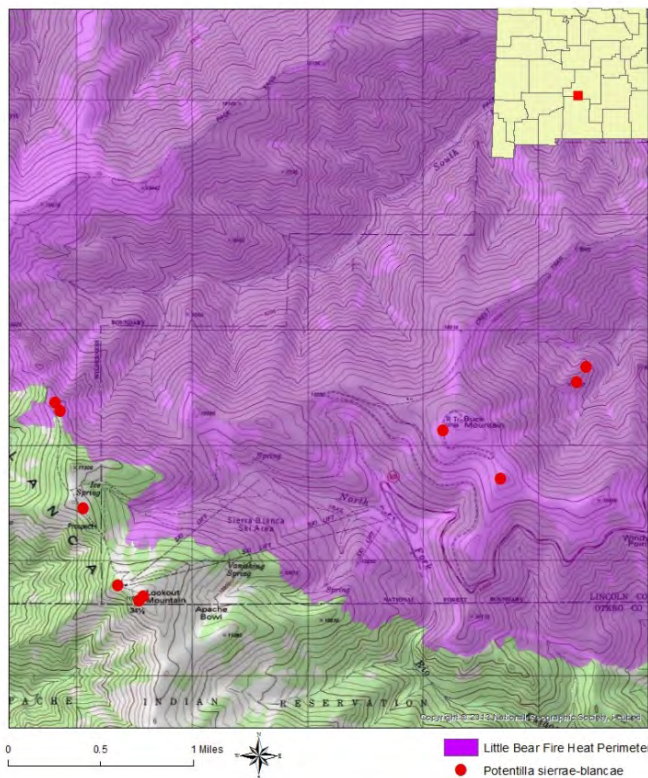
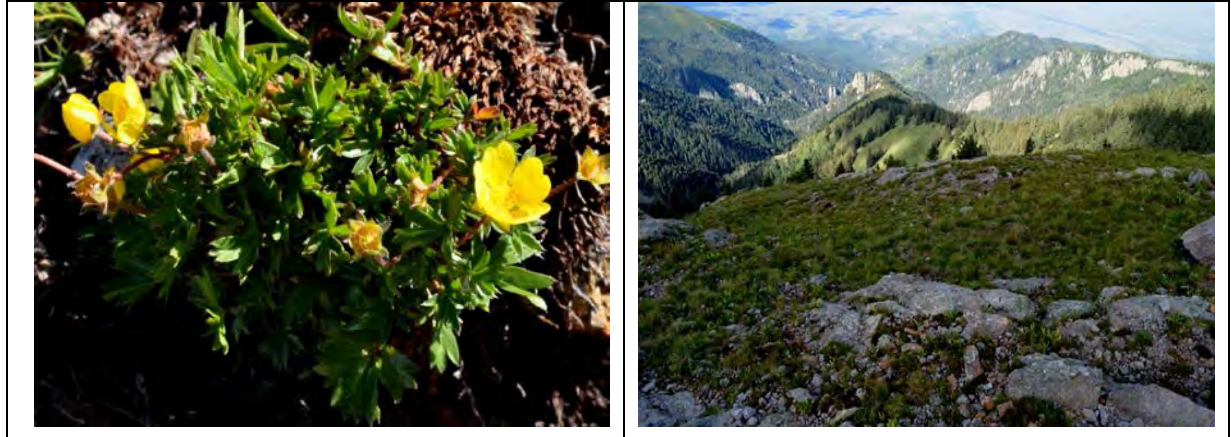
Waypoint Name	Number of Plants	Comments
Seinne-2-13	100 – 200 plants	Unburned. Open slopes, some human trailing through site. Near lookout
Seinne-3-13	Few plants	Unburned area. Along trail
Seinne-4-13	Hundreds of plants	Light burn. Open scree slope
Sedintneo-5-13	75-100 plants	Unburned. Top of Nogal Peak, lookout area
Seinne-6-13	50 plants	Unburned. Nogal Peak
Seinne1-13	Hundreds of plants	Severely burned, both sides of the road. Highly localized. Fire line through the west side of population.
Sedintneo-06-25-14	1 plant	Large rock outcrop surrounded by severely burned forest.
Seinne-1-15	50 plants	Light burn. Rock outcrop near trail
Seinne-2-15	Few plants	Unburned. Near lookout and trails
Seinne-3-15	1 plant	Unburned. Along ski run

New Mexico stonecrop appears to be widely distributed in the appropriate habitats of the Sierra Blanca region in burned and unburned areas above 9,500 ft elevation. Although we have no information on the abundance of plants prior to the Little Bear Fire, the species is largely protected from fire impacts by nature of its habitat preference, which is primarily composed of open areas on scree slopes and rock outcrops. The habitat of the New Mexico stonecrop was not significantly altered by the fire and therefore the populations are expected to persist, even if the surrounding forest composition has dramatically changed. The only disturbance associated with the fire was a fire line cut through a known occupied site adjacent to the Hwy 532. Although the fire burned over this site, plants were locally abundant except for the trail cut through by firefighters between the road and the forest. The impacts of human caused disturbances from roads and trailing are unknown but may be impacting several populations.



# Sierra Blanca cinquefoil

(*Potentilla sierrae-blancae*)



The Sierra Blanca cinquefoil is a perennial herb in the rose family (Rosaceae). It is endemic to New Mexico where it occurs at high elevations in the Sierra Blanca region of Lincoln and Otero counties. It grows along open, windswept ridges and mountain tops on igneous soils and rock outcrops at elevations between 9,200 and 12,000 ft (NMRPTC 1999). Prior to this study it was known from three general areas (Eagle Creek Canyon, Sierra Blanca, and Lookout Mountain), one of which burned in the 2012 Little Bear Fire (Eagle Creek Canyon). No data was available on the abundance of the species at these sites prior to the fire. Due to its very limited distribution the Sierra Blanca cinquefoil is a Forest Service Sensitive Species, and a USFWS and NM State Species of Concern. NatureServe gives Sierra Blanca cinquefoil a conservation rank of S2? (imperiled) for New Mexico.

**Figure 7.** Documented 2015 distribution of Sierra Blanca cinquefoil within the Little Bear Fire perimeter on the Lincoln National Forest.



Between 2013 and 2015, Sierra Blanca cinquefoil was found in 10 sites in 4 general locations (Eagle Canyon, Buck Mountain, Lookout Mountain, Crest Trail)(Figure 7). Plants occurred in highly localized population sites ranging from 100 to thousands of plants per site (Table 4). For the most part, plants were well past flowering. At the highest elevations plants were found in open, exposed meadow areas on slopes, along ridgelines, on rock outcrops, or flat areas adjacent to spruce-fir forests including corkbark fir (*Abies arizonica*), Engelman spruce (*Picea engelmannii*), Douglas fir (*Pseudotsuga menziesii*), and southwestern white pine (*Pinus strobiformis*). Associated species above 10,000 ft include Sierra Blanca kittentails (*Syntheris oblongifolia*), Parry’s primrose (*Primula parryi*), New Mexico stonecrop (*Sedum integrifolium var. neomexicanum*), Geyer’s onion (*Allium geyeri*), lupine (*Lupinus sp.*), and various grasses. At the lower elevations, in Eagle Creek Canyon, plants grew in the cracks of large rock outcrops in burned mixed conifer forests, including Douglas fir (*Pseudotsuga menziesii*), Gambel oak (*Quercus gambelii*), Ponderosa pine (*Pinus ponderosa*), Juniper (*Juniperus sp.*), and southwestern white pine (*Pinus strobiformis*). Other associates include Sierra Blanca cliff daisy (*Ionactis elegans*), hairy false goldenaster (*Heterotheca villosa*), clarecup cactus (*Echinocereus sp.*), cliffbush (*Jamesia americana*), scarlet penstemon (*Penstemon cardinalis*), and Geyer’s onion (*Allium geyeri*). Five sites were in the immediate vicinity of human activity, including trails or roads (Potsiebla-1-13, Potsiebla-2-13, Potsiebla-2-15, Potsiebla-5-15, Potsiebla-6-15). Dandelions (*Taraxacum officinale*) were found in the vicinity of one population of Sierra Blanca cinquefoil (Potsiebla-4-13). No invasive species were documented in the vicinity of the other sites. Elk were observed throughout the higher elevation sites, but plants did not appear to be browsed.

**Table 4.** Documented post-fire population estimates of Sierra Blanca cinquefoil on the Lincoln National Forest.

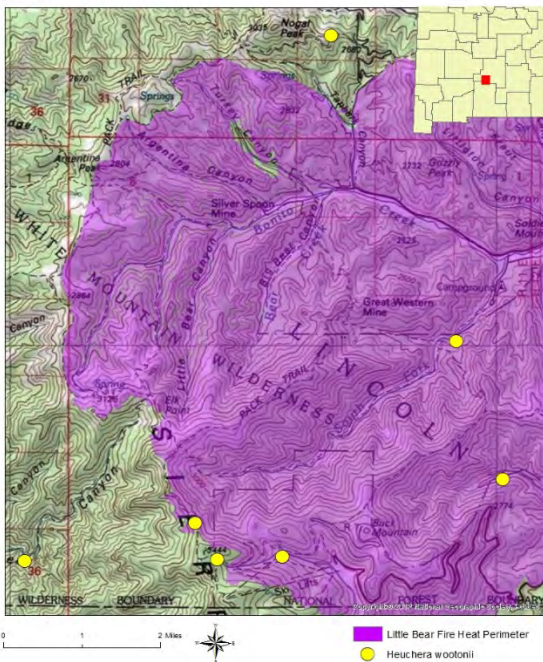
Waypoint Name	Number of Plants	Comments
Potsiebla-1-13	100	Lightly to moderately burned, along roadcut
Potsiebla-2-13	100-200	Not burned. Some human trailing in vicinity
Potsiebla-4-13	Hundreds	Light burn. Dandelions in vicinity
Potsiebla-2420	100-200	Surrounded by severely burned forest. On large rock outcrop
Potsiebla-2419	100-200	Surrounded by severely burned forest. On large rock outcrop
Potsiebla start	Hundreds of plants	Light burn. Along ridge; partially burned
Potsiebla end	Thousands	Light burn
Potsiebla-2-15	Thousands	Unburned. Rocky ridge, along trail
Potsiebla-5-15	Hundreds of plants	Unburned. Rocky outcrops only. Below lookout point
Potsiebla-6-15	Hundreds of plants	Unburned. Heavy development, ski area

By nature of its habitat, it is unlikely that Sierra Blanca cinquefoil populations were significantly impacted by the fire. Although we have no information on the abundance of plants prior to the Little Bear Fire, the species is largely protected from fire impacts by nature of its habitat preference, which is composed of open exposed areas and rock outcrops. The habitat of the Sierra Blanca cinquefoil was not significantly altered by the fire and therefore the populations are expected to persist, even if the

surrounding forest composition has dramatically changed. It is likely that more populations of Sierra Blanca cinquefoil exist along the rocky outcrops along the Crest Trail and elsewhere where appropriate habitat can be found in the Sierra Blanca region. The impacts of human caused disturbances from roads and trailing are unknown but may be impacting several populations.

# Wooton's alumroot

(*Heuchera wootonii*)



Wooton's alumroot is a perennial herb in the saxifrage family (Saxifragaceae). It is endemic to New Mexico, where it is primarily documented from the White and Capitan mountains of Lincoln and Otero counties (SEINet 2015). It is also known from a few sites in Taos and Catron counties. It occurs along mountain slopes and protected, usually shaded, north-facing rock outcrops, or under Gambel oak thickets in piñon-juniper woodlands and lower and upper montane coniferous forest at elevations between 7,000 and 12,000 ft (NMRPTC 1999). Other associate species include Rocky Mountain iris (*Iris missouriensis*), yarrow (*Achillea millefolium*), Whipple's penstemon (*Penstemon whippleanus*), gooseberry (*Ribes sp.*), wild geranium (*Geranium sp.*), cliffbush (*Jamesia americana*), New Mexico locust (*Robinia neomexicana*), Rocky Mountain maple (*Acer glabrum*), and elderberry (*Sambuccus cerulea*).

**Figure 8.** Documented distribution of Wooton's alumroot in the White Mountain area on the Lincoln National Forest, 2013-2015.

Prior to the Little Bear Fire, Wooton’s alumroot was documented in the specimen record from 5 general sites on the Lincoln National Forest, one of which burned in 2012. No data was available on the abundance of the species at these sites prior to the fire. Wooton’s alumroot is a USFWS and NM State Species of Concern. NatureServe gives Wooton’s alumroot a conservation rank of S3 (vulnerable).

Between 2013 and 2015 Wooton’s alumroot was documented from 7 sites within the Lincoln National Forest, 4 of which were within the Little Bear Fire perimeter (Figure 8). Where found, Wooton’s alumroot occurs in small localized patches of few up to 50 (or more) plants (Table 5). Plants were either flowering or senescent. Most sites were in the immediate vicinity of human trails (HEUWOO\_2305, HEUWOO\_2291, HEUWOO\_2315, HEUWOO\_2299, HEUWOO\_2576). Dandelions (*Taraxacum officinale*) were found in the vicinity of one population of Wooton’s alumroot (HEUWOO\_2299). No invasive species were documented in the vicinity of the other 6 sites. Elk were observed throughout the higher elevation sites, but plants did not appear to be browsed.

**Table 5.** Documented post-fire population estimates of Wooton’s alumroot on the Lincoln National Forest.

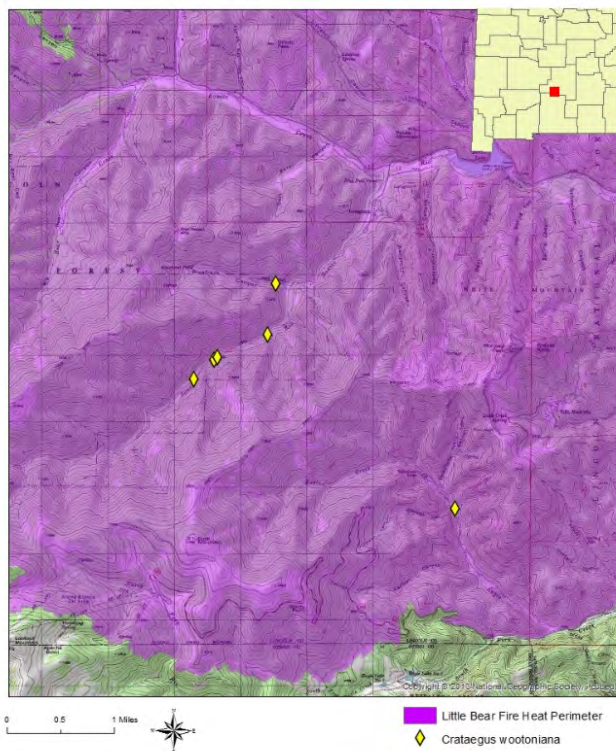
Waypoint Name	Number of Plants	Comments
HEUWOO_2205	Few	Cut bank of small stream in the immediate vicinity of severely burned forest.
HEUWOO_2305	25	Unburned area. Trailside
HEUWOO_2291	Few	Unburned area. Trailside
HEUWOO_2299	25-50	Severely burned forest. Trailside. <i>Taraxacum officinale</i> in vicinity
HEUWOO_2315	25	Unburned area. Trailside
HEUWOO_2190	25	Light to moderate burn
HEUWOO_2576	Few	Light to moderate burn. Rock outcrop, trailside.

Although generally preferring protected shady habitats, Wooton’s alumroot was also found growing in open areas along rock outcrops of the Crest Trail. In addition, plants were found under dead trees in severely burned forest. Whether these populations persist over time is questionable. However, the species is relatively widespread and was documented from several sites outside the burned areas.



# Wooton's hawthorn

(*Crataegus wootoniana*)



Wooton's hawthorn is a small tree or shrub in the rose family (Rosaceae). It is endemic to Catron, Grant, Lincoln & Otero counties in New Mexico, where it occurs along canyon bottoms and in the forest understory of lower montane coniferous forest at elevations between 6,500 and 8,000 ft (NMRPTC 1999). Prior to the 2012 Little Bear Fire, it was documented in specimen record from 3 locations in the South Fork Rio Bonito and Eagle Creek drainages in the Sierra Blanca region, all of which were inside the fire perimeter (SEINet 2015). No data was available on the abundance of the species at these sites prior to the fire. Wooton's hawthorn is a Forest Service Sensitive Species, and a USFWS and NM State Species of Concern. NatureServe gives Wooton's hawthorn a state conservation rank of S2 (imperiled).

**Figure 9.** Documented distribution of Wooton's hawthorn within the Little Bear Fire perimeter on the Lincoln National Forest, 2013 - 2015.

All three previously known sites at Eagle Creek and the South Fork Rio Bonito drainages were located in 2013 (Figure 9). Additional locational information was provided in 2015, documenting the species from the other sites in the South Fork of Rio Bonito Creek, Little Bonito Creek, and the Bear Creek areas. Only the additional sites in the South Fork of the Rio Bonito Creek drainage could be surveyed in 2015.

The Eagle Creek site had not burned or only lightly burned during the fire and plants were generally not harmed and were thriving along the creek banks. All other sites were located in the drainage bottom of the South Fork Rio Bonito in light to severely burned mixed conifer forest. Associated species include Douglas fir (*Pseudotsuga mentzesii*), Gambel oak (*Quercus gambelii*), Rocky Mountain maple (*Acer glabrum*), elderberry (*Sambucus sp.*), fetid goosefoot (*Dysphania graveolens*), nodding onion (*Allium cernuum*), fleabane (*Erigeron sp.*), mullein (*Verbascum thapsus*), scarlet cinquefoil (*Potentilla thurberi*), yarrow (*Achillea millefolium*), wild geranium (*Geranium sp.*), cutleaf coneflower (*Rubeckia laciniata*), heal all (*Prunella vulgaris*), lambsquarters (*Chenopodium album*), pigweed (*Amaranthus sp.*), musk thistle (*Carduus nutans*), stinging nettle (*Urtica dioica*) and seeded grasses.

The number of plants found in 2013 and 2015 ranged from 3 to 150 per site (Table 6). Two sites were only lightly burned and plants were found alive in small patches of unburned forest along the stream bottom or just above the flood channel (Crawoo-1-13, Crawoo-3-15). The other sites were severely burned and individual plants sprouted from the base of burned and dead stems. In 2013, only one site was documented with a few mullein plants (*Verbascum thapsus*) growing in the immediate vicinity (Crawoo-2-13). In 2015, mullein and musk thistle (*Carduus nutans*) were found in scattered patches throughout the South Fork of the Rio Bonito drainage, including the vicinity of burned Wooton’s hawthorn sites. Sprouting plants at Site Crawoo-2-13 were heavily browsed by elk in 2013. Although elk were present throughout the South Fork drainage in 2015, no browsing was observed on resprouting Wooton’s hawthorn plants.

**Table 6.** Post-fire population estimates of Wooton’s hawthorn on the Lincoln National Forest.

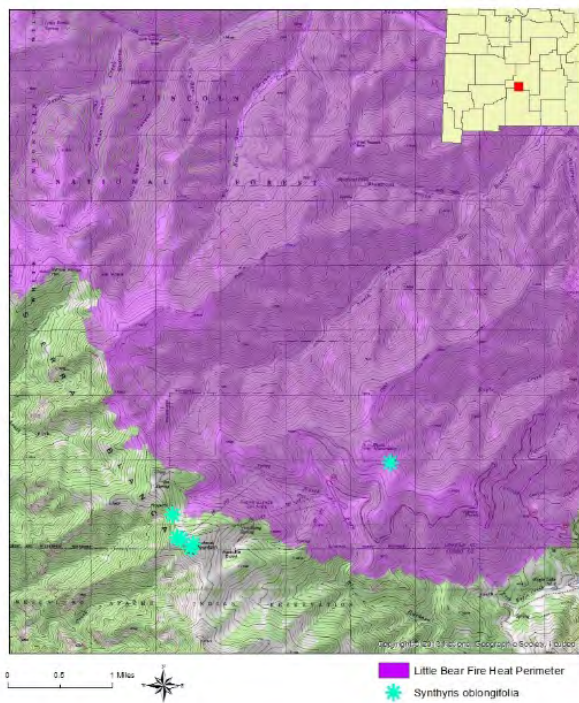
Waypoint Name	Number of Plants	Comments
Crawoo-1-13	20	Lightly burned
Crawoo-2-13	150	Severely burned. Some mullein in the vicinity. Browsed by elk.
CRAWOO	N/A	Not burned.
Crawoo-3-15	6 plants	Unburned patch surrounded by burned forest
Crawoo-4-15	3 plants	Severely burned
Crawoo-5-15	12 plants	Severely burned

Wooton’s hawthorn generally prefers protected shady habitats in the understory of coniferous forest along creeks and stream bottoms. This habitat was severely altered in three of the six documented sites. In addition, some the surviving resprouting plants were browsed by elk. Whether populations persists over time in severely altered habitats is questionable. Other sites within the Little Bear fire perimeter should be surveyed to determine survival and population status after the fire (Little Bonito Creek, Bear Creek). Extant populations in severely burned areas should be monitored over time to determine long term population trends.



# Sierra Blanca kittentails

(*Synthyris oblongifolia*)



Sierra Blanca kittentails is a perennial herb in the plantain family (Plantaginaceae). It is endemic to New Mexico where it is only known to occur in open, alpine meadow areas above 10,500 ft in the Sierra Blanca region of Lincoln and Otero counties. It was reliably documented in the specimen record from 2 general areas, in the Lookout Mountain/Sierra Blanca area and from Buck Mountain. Other records vouchered from elsewhere in New Mexico proved to be misidentifications. No data was available on the abundance of the species at these sites prior to the fire. Due to its very limited distribution, Sierra Blanca kittentails is a Forest Service Sensitive Species, and a USFWS and NM State Species of Concern. NatureServe gives Sierra Blanca kittentails a state conservation rank of S2 (imperiled).

**Figure 10.** Known distribution of Sierra Blanca kittentails within the Little Bear Fire perimeter in the Lincoln County, 2015.



In 2013, Sierra Blanca kittentails was found at both previously documented sites (Figure 10). The Buck Mountain record was inside the fire perimeter and the other one just outside the fire perimeter on Lookout Mountain. The Buck Mountain site was only lightly burned. Plants occur in highly localized small patches containing up to 200 plants (Synobl-2-13) (Table 7). Plants were well past flowering. The Buck Mountain site was adjacent to a dirt road leading to the Buck Mountain radio towers. Three additional sites were documented in 2015, in unburned areas at Lookout Mountain and along the Crest Trail. The Lookout Mountain sites were impacted by trampling along trails associated with the lookout and a ski hut. Some dandelion (*Taraxacum officinale*) was present at the Buck Mountain site. Otherwise no invasive species were found growing in the vicinity of the Sierra Blanca kittentails sites.

**Table 7.** Post-fire population estimates of Sierra Blanca kittentails on the Lincoln National Forest.

Waypoint Name	Number of Plants	Comments
Synobl-1-13	100-200	Just outside the fire perimeter. Some human trailing in immediate vicinity.
Synobl-2-13	150-200	Lightly burned. Next to Buck Mountain road. Dandelions in vicinity.
Synobl-1-15	1 plant	Along Crest Trail
Synobl-2-15	25 - 45 plants	Unburned. Under spruce
Synobl-3-15	few plants	Unburned
Synobl-4-15	few plants	Unburned. Heavily impacted by ski area development & trampling

By nature of its habitat, it is unlikely that Sierra Blanca kittentails populations were significantly impacted by the fire. Although we have no information on the abundance of plants prior to the Little Bear Fire, the species is largely protected from fire impacts by nature of its habitat preference, which is composed of open exposed meadow areas. The habitat of the Sierra Blanca kittentails was not significantly altered by the fire and therefore the populations are expected to persist, even if the surrounding forest composition has dramatically changed. Due to the highly limited known distribution of Sierra Blanca kittentails, low population numbers, and ongoing human impacts to the Lookout Mountain population, full inventory and monitoring are recommended throughout the habitat to understand actual abundance and distribution of this species on the Lincoln National Forest and to evaluate population trends through time.

## DISCUSSION AND RECOMMENDATIONS

This and a similar study in the Gila National Forest of New Mexico have documented that, in general, rare plants will survive the direct impacts of fire, regardless of fire severity (Roth 2016). Rare plants are more vulnerable to firefighting and post fire restoration activities and changes in their habitats associated with fires, including floods, erosion, and competition with associated plant species, than to the fire itself (Roth 2016). In general, all seven species targeted for this study survived the 2012 Little Bear Fire. Four of the seven target species of this study grow in habitats where they were naturally protected from the consequences of the Little Bear Fire (Sierra Blanca cliff daisy, Sierra Blanca cinquefoil, New Mexico stonecrop, Sierra Blanca kittentails). Although this study documented the continued existence of known sites of Species of Concern within the Little Bear Fire perimeter, baseline information on the actual pre-fire abundance and distribution of sensitive species was largely lacking. Therefore analyzing whether these plants are in decline in direct response to the fire is not possible. Collecting and maintaining baseline information on current abundance and distribution of these vulnerable species is essential for land management planning, evaluating endangerment, and establishing best management practices and conservation measures for resource management planning and the environmental review process, especially for ground disturbing projects such as recreational area maintenance and development projects, thinning and prescribed burning. Identifying and avoiding sensitive species locations during firefighting activities and post fire restoration and clean-up activities should be an integral part of fire management. Once baseline information has been established it becomes a primary tool for assessing vulnerability and land use planning. Large scale high severity fires are expected to have significant long term impacts on the persistence of some rare plants, because of the complete alteration of the majority of their habitat and expected long periods of time until the habitat is recovered. Plants requiring cool, shaded N-facing slopes and drainage bottoms for survival and persistence are expected to have a slow or even no recovery. Long term impacts of radical habitat alteration caused by severe fires may ultimately cause the decline or even disappearance of several species from their current occupied habitats. In the Sierra Blanca region these include Goodding's onion (*Allium gooddingii*) and Wooton's hawthorn (*Crataegus wootonii*). It is assumed that these species may disappear over time, as indicated by survey results for Goodding's onion sites in the Gila National Forest, which severely burned in the 2006 Bear Fire (Roth 2016). Surveys in areas severely burned in the 2006 Bear Fire documented the complete absence of this species, likely due to habitat and plant community changes over time, causing by the complete removal of the forest canopy overstory. However, in the Lincoln National Forest, Goodding's onion does persist in open areas along ski slopes above 10,000ft. It is possible that Goodding's onion sites in burned forests may persist and adapt to habitat alteration caused by complete canopy removal. Some of the extremely rare and vulnerable plant populations and those that remain in severely burned forests, but are naturally adapted to growing in the understory of forests, should be closely monitored to document their persistence and population trends over time (Goodding's onion, Wooton's hawthorn). For these species it may be necessary to increase resilience with prescribed fires and thinning and adding them to the priority treatment list. In addition, it is recommended that seeds of sensitive species are collected for ex-situ storage and conservation purposes, in the event that reintroduction or population augmentation may be necessary in the future. Invasive species are not expected to be a threat to the recovery of the 7 Species of Concern within the Little Bear Fire perimeter.

# MANAGEMENT RECOMMENDATIONS

Although little can be done about the occurrence of wildfires and more frequent and catastrophic large fires are expected in the future, a variety of management actions can be implemented to minimize the potential devastating impacts on vulnerable Species of Concern.

➤ **Collect baseline information**

Obtaining baseline information on the actual distribution, abundance and potential threats to a sensitive species is essential in determining the status of a species and determining what, if any, management actions need to be taken to ensure persistence of a species on the Forest. In addition, baseline information is fundamental to analyzing the potential impacts of management activities, including wildfire suppression and management, thinning & logging projects, road maintenance, habitat improvement & restoration projects, and recreational activities such as ski area development and management, trail & campground development and maintenance.

➤ **Assess vulnerability**

Once baseline data has been collected, the vulnerability of species can be assessed and proper management actions can be implemented, if needed, to protect a species from stochastic events caused by wildfires, floods, and forest management activities

➤ **Increase resilience with prescribed fires and thinning**

Habitat improvement projects focusing on plant species determined to be vulnerable to extinction caused by potential catastrophic wildfires can significantly improve a species' ability to survive wildfires and persist following the fire if the habitat experiences little post-fire alteration.

➤ **Add vulnerable sensitive species habitats to the priority treatment list**

Occupied habitats of species determined to be vulnerable to habitat alteration associated with wildfires need to be prioritized for restoration treatments, including thinning and prescribed burns.

➤ **Avoid sensitive species populations during firefighting and post-fire clean-up & restoration activities**

Knowing the location of sensitive species (baseline information) and sharing this information with firefighters and post-fire management activities can significantly increase the survival of sensitive plant species during and after the fire. Firefighting and post-fire activities may include the construction of fire breaks, application of fire suppressants, mulching & seeding, post-fire erosion control, and various restoration projects.

➤ **Stock up seed banks**

Ex-situ conservation of these vulnerable species in the form of seed banking may be the last resort for plants that are extremely limited in their distribution and whose post-fire long term persistence is questionable. This is especially urgent for species whose entire range has already burned and whose habitat has been severely altered. In addition, all sensitive plant species determined to be



vulnerable to extinction from catastrophic wildfires should be collected for storage and potential post-fire restoration projects.

➤ **Monitor vulnerable populations and adjust management based on monitoring results**

Monitoring population trends of plant species determined to be vulnerable to wildfires and species whose habitat has already been altered by wildfires is essential to determine endangerment and provide appropriate management direction.

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