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A VASCULAR FLORA OF THE KIAVAH WILDERNESS, SCODIE MOUNTAINS, KERN COUNTY, CALIFORNIA

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ABSTRACT

Congress designated the Kiavah Wilderness in 1994 under the California Desert Protection Act. It is located in the Scodie Mountains in Kern County, ca. 24 km (15 mi) east of Lake Isabella and 24 km (15 mi) west of Ridgecrest, and encompasses a total of 137 mi2 (354 km2) with elevations ranging from 1000 to 2200 m (3500–7294 ft). The Wilderness is ecologically important because it occurs in a transition zone between two floristic provinces, the Sierra Nevada of the California Floristic Province and the Mojave Desert of the Desert Province. It is of cultural significance because it has a rich history of Native Americans harvesting pinyon pine nuts and inhabiting the land. Prior to the study ca. 290 vascular plant taxa had been documented, primarily along roads and the Pacific Crest Trail. Jim Shevock and Barbara Ertter made significant collections and contributions to the floristic inventory during the 1980s and early 1990s, and LeRoy Gross added valuable collections in 2005 and 2006. The purpose of the project was to inventory the vascular plant taxa throughout the Kiavah Wilderness, document special status plants, and assess invasive non-native plants. The project took place in 2013–2015, and 68 days were spent in the field. It coincided with three severe to exceptional drought years, the driest span for the site in recorded history. During the study large stands of Pinus monophylla, found in the Wilderness and much of the Southwest, experienced large die-offs. About 1300 plant specimens were collected for the study, which are deposited at RSA, CAS, and UCR. In total, 70 families, 240 genera, 457 species, and 477 minimum-rank taxa were documented, including those collected previously. A total of 28 non-native taxa (5.9% of the flora) and 26 special status plants (5.4%) were documented. Three special status taxa previously documented in the Wilderness were not relocated: Lewisia disepala (Montiaceae), Cordylanthus rigidus subsp. brevibracteatus (Orobanchaceae), and Delphinium purpusii (Ranunculaceae). A range extension for Eriophyllum mohavense (Asteraceae) was documented.

Key words: California, drought, flora, Kiavah Wilderness, Mojave Desert, Pacific Crest Trail, Scodie Mountains, southern Sierra Nevada, vascular plants.

INTRODUCTION

Herbarium collections provide invaluable data for researchers studying ecology, biogeography, evolution, systematics and climate change to better understand the patterns of biodiversity and the processes that shape those patterns (Prather et al. 2004). Locating, identifying and mapping plant populations are essential first steps towards understanding the flora of a particular area. After a site is thoroughly explored and documented, newly gathered information can be added to preexisting knowledge to gain a greater understanding of plant diversity at different scales, including regional and continental. Floristic studies are particularly important for understanding the relationship between plants and climate, especially in context of climate change. This report is the result of a floristic study conducted over three years that coincided with a severe drought. It is projected that California will continue to experience periods of extended drought throughout the rest of the century (Williams et al. 2015). Knowing this, continued study and monitoring of the California flora are vital to predict where native and invasive plant species will persist, increase or decline, and how these plants may be managed.

The Kiavah Wilderness is located ca. 24 km (15 mi) east of Lake Isabella and 24 km (15 mi) west of Ridgecrest in Kern County, California (Fig. 1). Its ecological importance derives from its occurrence in a transition zone between two floristic provinces, the Sierra Nevada of the California Floristic Province (higher elevations) and the Mojave Desert of the Desert Province (lower elevations) (Baldwin et al. 2002). The Wilderness covers most of the Scodie Mountains, which is a component range of the southern Sierra Nevada. A small portion of the northern end of the Scodie Mountains lies outside the Wilderness boundary. The Kiavah Wilderness encompasses a total of 354 km2 (137 mi2), of which 160 km2 (62 mi2) are managed by the U.S. Department of the Interior, Bureau of Land Management (BLM) and 194 km2 (75 mi2) are managed by the U.S. Department of Agriculture (USDA), Sequoia National Forest (SNF), and Kern River Ranger District (BLM 2017).

Southwest of the Scodie Mountains, separated by Kelso Valley, are the Pute Mountains, another range of the Sierra Nevada (Fig. 1). The South Fork of the Kern River, Chimney Creek and Canebrake Creek border the Scodies on the north. To the northeast is the Owens Peak Wilderness, separated from the Scodie Mountains by Walker Pass and Highway 178. A popular off-highway vehicle (OHV) recreational area located on the Jawbone-Butterbredt Area of Critical Environmental Concern flanks the southern and southeastern boundary of the
Kiavah Wilderness in the Indian Wells-Searles Valley of the Mojave Desert. Private property parcels abut sections along the north, east and west borders of the Wilderness. The Canebrake Ecological Reserve, managed by the California Department of Fish and Wildlife, is located in Scodie and Cap canyons (CDFW 2016). The Canebrake Ecological Reserve is closed to the public and a permit must be obtained to enter the reserve.
Access into the Kiavah Wilderness is via two main routes, Horse Canyon Road/McIver’s 4 × 4 road (36E52) and the Pacific Crest Trail (PCT) (Adkinson 2001; PCTA 2014; Fig. 1, 2). Horse Canyon Road is a rugged and difficult 4 × 4 road that winds its way into the Wilderness and terminates at McIver’s Cabin at 2040 m elevation (6696 ft). A large section of this road (ca. 13 km, 8 mi) is part of the PCT that was constructed during the 1980s and transects the Wilderness for 16 mi (25.7 km), from Bird Spring Pass (1637 m, 5371 ft elevation) to Walker Pass Campground (1542 m, 5060 ft). There is an unmaintained trail on the southwest side of the Wilderness from Cane Canyon (1220 m, 4000 ft elevation) to Yellow Jacket Spring (1790 m, 5873 ft). Maintained dirt roads terminate in Sage Canyon and Cow Haven Canyon; from these, one can hike into the Wilderness. Beyond the PCT, no maintained trails exist but cattle and deer trails are abundant.

**PHYSICAL SETTING**

**Topography**

The Kiavah Wilderness encompasses portions of six USGS 7.5’ topographic quadrangle maps: Cane Canyon, Freeman Junction, Horse Canyon, Onyx, Owens Peak, and Walker Pass. Three valleys and two passes (Fig. 2) surround the Scodie Mountains. Scodie Mountain is the highest point at 2223 m (7294 ft). The next highest peaks in the Wilderness are Skinner Peak at 2170 m (7120 ft), followed by Pinyon and Onyx peaks at 2074 m (6805 ft) and 1598 m (5244 ft), respectively. The higher elevations are part of the crest of the Sierra Nevada and are steep-sided, rugged ridges that trend in an east-west direction. Located in the southeastern section of the Wilderness is a large unnamed plateau that has gentle rolling topography. Baker (1912) described the plateau as “broad-topped summit mountains.” Lower elevations (900–1300 m, 3000–4500 ft) are characterized by gentler slopes that extend into valleys as long narrow shoulders that gradually decrease in elevation (Baker 1912).

Major canyons include Bird Spring, Horse, Sage, Boulder and Cow Haven canyons, all of which drain into Indian Wells-Searles Valley (Fig. 2). This watershed provides drinking water to residents of Inyokern and Ridgecrest (EPA 2016). Major canyons draining into the South Fork Kern River are Short, Cane, Cholla, Scodie, Smith, Cap and Spring canyons.

**Geology**

The history of the Sierra Nevada can be traced back to ca. 542 million years ago (mya) during the Cambrian Period of the Paleozoic Era. At that time, what is now the Sierra Nevada was the floor of an ancient sea where sediments from exposed mountains to the east settled (Hill 2006). At the time of the Triassic Period of the Mesozoic Era, ca. 250–210 mya, magma rose to
the surface and cooled to form the Sierran granite core (Hill 2006). Around the Cretaceous Period, 144–66 mya, the Sierra Nevada began to lift and tilt westward and most of the Sierran plutons were formed to create the foundation of the Sierra Nevada batholith (Hill 2006; Hall 2007). Near the beginning of the Cenozoic Era, 65 mya, the Sierra Nevada began to take shape owing to plate tectonics (Hall 2007). During the Pliocene Epoch, 6–8 mya, the Garlock fault along the southern Sierra Nevada continued to move westward, thus allowing for crestal uplift of the southern Sierra Nevada (Hall 2007). By ca. 2 mya, during the Pleistocene Epoch, the Sierra Nevada reached its present height and extent.

Geologic surveys and maps identify the main rock type of the Scodie Mountains as plutonic, Mesozoic in age and characterized by granite, quartz monzonite, granodiorite and quartz diorite (Fig. 3; CDC 2010). Alluvial deposits are described as light brown in color from the feldspar of the Sierra granite (Baker 1912). Alluvial deposits can be found in the older alluvial, lake, playa and terrace deposits on the lower desert floor in Horse, Sage, and Cow Haven canyons; these are generalized as non-marine (continental) sediments, and Pleistocene in age (CDC 2010).

**Climate**

The southern Sierra Nevada experiences a wide range of temperatures, minimal precipitation, and strong winds. Temperature and precipitation are strongly influenced by elevation. According to the Köppen climate classification system, the Kiavah Wilderness experiences a Mediterranean and arid mid-latitude desert climate (Kaufman 2013). Summers are hot and dry, winters are brief and relatively warm, and precipitation is in the form of rain and snow (Twisselmann 1967). In the southern Sierra Nevada, snow typically falls from November through March. At elevations above 2000 m (6561 ft), snow can persist on the ground for several months. The average annual precipitation in the Kiavah Wilderness is about 35 cm (14 in.), although drought conditions have been known to last up to six years in this area (BLM 2017). During the study, from 2013 to 2015, there was no substantial snowfall nor snowpack in the Wilderness.

Weather data were taken from private weather stations located at Bird Spring Pass (MBJ/C1, 1500 m [5000 ft]; RAWS 2013) and Walker Pass (MONYC1, 1600 m [5200 ft]; NOAA 2014). Table 1 shows that average annual temperatures and precipitation in the Kiavah Wilderness for years 2013–2015 (duration

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Walker Pass (MONYC1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Temperature °C (F)</td>
<td>14 (57)</td>
<td>15 (59)</td>
<td>14 (57)</td>
<td>14 (57)</td>
</tr>
<tr>
<td>Maximum Temp °C (F)</td>
<td>40 (104)</td>
<td>39 (103)</td>
<td>38 (101)</td>
<td>39 (102)</td>
</tr>
<tr>
<td>Minimum Temp °C (F)</td>
<td>−10 (14)</td>
<td>−6 (20)</td>
<td>−7 (19)</td>
<td>−8 (18)</td>
</tr>
<tr>
<td>Total Precipitation cm (in.)</td>
<td>12.9 (5.11)</td>
<td>20.4 (7.89)</td>
<td>7.95 (3.13)</td>
<td>13.7 (5.37)</td>
</tr>
<tr>
<td>Bird Spring Pass (MBIJCI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Temperature °C (F)</td>
<td>11 (53)</td>
<td>13 (56)</td>
<td>12 (54)</td>
<td>12 (54)</td>
</tr>
<tr>
<td>Maximum Temp °C (F)</td>
<td>35 (96)</td>
<td>36 (97)</td>
<td>33 (92)</td>
<td>34 (95)</td>
</tr>
<tr>
<td>Minimum Temp °C (F)</td>
<td>−11 (11)</td>
<td>−8 (18)</td>
<td>−8 (18)</td>
<td>−8 (15)</td>
</tr>
<tr>
<td>Total Precipitation cm (in.)</td>
<td>6.78 (2.67)</td>
<td>10.9 (4.30)</td>
<td>7.49 (2.95)</td>
<td>8.39 (3.30)</td>
</tr>
<tr>
<td>Weather stations combined</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Temperature °C (F)</td>
<td>13 (55)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Temp °C (F)</td>
<td></td>
<td>36 (98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Temp °C (F)</td>
<td></td>
<td></td>
<td>7 (16)</td>
<td></td>
</tr>
<tr>
<td>Total Precipitation cm (in.)</td>
<td></td>
<td></td>
<td>11.0 (4.33)</td>
<td></td>
</tr>
</tbody>
</table>

of the study) was a scant 11.0 cm (4.33 in.), although higher and lower elevations likely received greater and lesser amounts, respectively. Long-term precipitation data, taken from the Inyokern weather station for 1940–2012, indicate that average annual rainfall was 10.59 cm (4.17 in.) (Fig. 4). However, this station is at only 760 m (2500 ft) elevation and lies deeper in the rain shadow of the Sierra Nevada.

From 2012 to 2015, California experienced severe to exceptional drought conditions (USDM 2016). Although periodic droughts are not uncommon in California, the 2012–2014 drought is considered a 10,000-year event in the state and the 2012–2015 drought has an incalculable return period (Roberson 2015).

HUMAN HISTORY AND IMPACTS

The native people of the Kiavah Wilderness were the Tübatulabal and Kawaiisu tribes (Kroeber 1925). Others believed to have visited the Scodie Mountain region include tribes from the east (e.g., the Owens Valley Paiute, Panamint Shoshone, etc.).
Table 2. Collectors of plants from the Kiavah Wilderness prior to the present study. Collector, number of specimens, year(s) active, and location are presented in chronological order.

<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Collector</th>
<th>Number of collections</th>
<th>Location(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1911</td>
<td>Museum of Vertebrate Zoology</td>
<td>1</td>
<td>Scodie Canyon</td>
</tr>
<tr>
<td>1911</td>
<td>Unknown</td>
<td>1</td>
<td>Scodie Canyon</td>
</tr>
<tr>
<td>1927</td>
<td>C. S. Robinson</td>
<td>3</td>
<td>Sage Canyon, plateau</td>
</tr>
<tr>
<td>1930</td>
<td>J. Farley</td>
<td>2</td>
<td>Scodie Mtn</td>
</tr>
<tr>
<td>1941</td>
<td>Bell</td>
<td>1</td>
<td>Scodie Canyon</td>
</tr>
<tr>
<td>1964</td>
<td>J. Gillett</td>
<td>1</td>
<td>West of Walker Pass</td>
</tr>
<tr>
<td>1978</td>
<td>B. Orr</td>
<td>1</td>
<td>West of Walker Pass</td>
</tr>
<tr>
<td>1980</td>
<td>S. Lawson</td>
<td>14</td>
<td>Pacific Crest Trail, Horse Canyon, Sage Canyon</td>
</tr>
<tr>
<td>1980</td>
<td>L. Nagata</td>
<td>9</td>
<td>Pacific Crest Trail, Horse Canyon Road, Bird Spring Pass, Sage Canyon</td>
</tr>
<tr>
<td>1980</td>
<td>B. Schwartzman</td>
<td>7</td>
<td>NW of Pinyon Peak, Canyon, Sage Canyon, Sodie Peak</td>
</tr>
<tr>
<td>1980</td>
<td>J. Hiebert</td>
<td>6</td>
<td>NW of Pinyon Peak, Canyon, Sage Canyon, Sodie Peak</td>
</tr>
<tr>
<td>1980</td>
<td>C. Franz</td>
<td>4</td>
<td>Canyon</td>
</tr>
<tr>
<td>1980</td>
<td>J. Janzen</td>
<td>3</td>
<td>Horse Canyon, Sage Canyon</td>
</tr>
<tr>
<td>1980</td>
<td>C. Bauernfeind</td>
<td>2</td>
<td>Pacific Crest Trail, Short Canyon</td>
</tr>
<tr>
<td>1980</td>
<td>Unknown</td>
<td>2</td>
<td>Short Canyon</td>
</tr>
<tr>
<td>1980</td>
<td>Anonymous</td>
<td>1</td>
<td>Bird Spring Pass on Pacific Crest Trail</td>
</tr>
<tr>
<td>1980</td>
<td>USDA</td>
<td>1</td>
<td>Pacific Crest Trail</td>
</tr>
<tr>
<td>1986–1988</td>
<td>B. Ertter</td>
<td>54</td>
<td>Canyon on the N side of Pinyon Peak, Pacific Crest Trail</td>
</tr>
<tr>
<td>1986</td>
<td>M. A. Henry</td>
<td>1</td>
<td>Sage Canyon</td>
</tr>
<tr>
<td>1989</td>
<td>J. Emmel</td>
<td>1</td>
<td>N end Scodie Mts</td>
</tr>
<tr>
<td>1996, 1999</td>
<td>D. York</td>
<td>24</td>
<td>Pacific Crest Trail, slopes of Pinyon Peak</td>
</tr>
<tr>
<td>2002</td>
<td>E. Laeger</td>
<td>1</td>
<td>N ridge of Pinyon Peak</td>
</tr>
<tr>
<td>2004</td>
<td>L. P. Janeway</td>
<td>11</td>
<td>Pinyon Creek</td>
</tr>
<tr>
<td>2005, 2006</td>
<td>L. Gross</td>
<td>88</td>
<td>Head of Horse Canyon, Yellow Jacket Spring, N of Skinner Peak, near radio tower, Pacific Crest Trail</td>
</tr>
<tr>
<td>2010</td>
<td>A. Howald</td>
<td>3</td>
<td>N end of Scodie Mts, Hwy 178</td>
</tr>
<tr>
<td>2011</td>
<td>N. Fraga</td>
<td>19</td>
<td>Base of Pinyon Peak</td>
</tr>
</tbody>
</table>

However, human history in the southern Sierra Nevada can be traced back to ca. 4000 BCE [Before Common Era] during the Lamont Phase (Moratto et al. 1984). Around this time, pinyon-juniper woodlands expanded downslope in response to changing climatic conditions towards a Mediterranean climate, making the area attractive owing to the potential for increased harvesting of pinyon pine nuts (Moratto et al. 1984). From 1200 BCE to 600 CE, during the Canebrake Phase, Native Americans began to settle in pinyon-juniper woodland base camps (Moratto et al. 1984). The Sawtooth Phase (600–1300 CE) is characterized by the presence of obsidian, ‘manos’ and milling stones, bedrock mortars and many other artifacts. The final recorded phase for the history of Native Americans in the Sierra Nevada, the Chimney Phase from 1300 to 1875 CE, saw unchanged settlement patterns and increases in artifact accumulation (Moratto et al. 1984). The Kiavah Wilderness was named after a Paiute chief from Panamint Canyon who took up residence in Sage Canyon (Gudde 1969).

During the late 1700s, Spanish explorers were sent to North America on religious expeditions. In 1776, Father FranciscoGarces was the first European to encounter Native Americans of the lower Kern River Valley (Heard 1987). After this encounter, for the next 50 years, trade between the Native Americans of the southern Sierra Nevada and Europeans ensued (Kern River Valley Specific Plan 2011). In 1834, Tibbatulabal Indians led Joseph Walker and his trappers, the first white men to traverse the southern Sierra Nevada, through what is known today as
In 1994, Congress designated a large portion of the Scodie Mountains as the Kiavah Wilderness under the California Desert Protection Act. There is only one modern structure in the Wilderness, a microwave tower along Horse Canyon Road, that is owned and operated by the Naval Air Weapons Station, China Lake. The PCT, well-traveled by hikers in the springtime, is the only maintained trail in the Wilderness. Horse Canyon Road and the PCT merge near the Microwave tower in the southwest section of the plateau and the road terminates at McIver’s Spring/Cabin (USDA 2014; Fig. 2). Several other dirt roads provide minimal access to the Wilderness but are popular weekend destinations for OHV users and campers. Off-highway vehicle use is one of the greatest threats to the Wilderness. BLM and SNF signs are posted along the Wilderness boundaries to deter OHV users, but OHV trespassing was observed on many occasions during this study. In 2012, to further deter illegal OHV use, the Student Conservation Association began constructing barriers (fences and posts) along the southern BLM boundary. Cattle grazing continues on both BLM and SNF land, even after its designation as a Wilderness. Grazing allotments are located throughout the Wilderness (BLM 2017).

The Kiavah Wilderness is also a destination for target shooting and hunting. According to the Forest Service, visitors do not heavily impact the Wilderness because it does not have any outstanding features to draw many visitors or large crowds. The most harmful human activity, besides OHV use and human-mediated climate change, may be illegal marijuana farming. A remote marijuana farm was discovered by federal authorities in 2014 within the Wilderness. Damage done by these farmers included removal of the native understory vegetation, diversion of water from a nearby unmarked spring, and use of rodenticides. On 11 July 2014, the illegal farmers started a forest fire to destroy evidence of the farming operation, the Nicolls Fire, which burned ca. 1600 acres over 11 days (Incident Information System 2016). The fire cost the state of California an estimated $5.6 million to extinguish (Associated Press 2015).

**BOTANICAL HISTORY**

There has been no previous focused effort to inventory the plants of the Kiavah Wilderness and Scodie Mountains. Inventories of nearby areas include that of Owens Peak eastern watershed (Fraga 2008) and Red Rock Canyon and the El Paso Range (Twisselmann 1970). The earliest known plant specimen from the Wilderness was collected in 1911 by members of the Museum of Vertebrate Zoology club at the University of California, Berkeley. Fewer than 10 specimens had been collected from the Scodie Mountains before the 1960s when Ernest Twisselmann made 61 collections. Upon completion of the PCT, Jim Shevock collected 142 specimens between 1979 and 1992. Others with significant numbers of collections are from LeRoy Gross (88) and Barbara Eritter (54). Table 2 is a list of all individuals and groups who made collections prior to my study.

According to records in the Consortium of California Herbaria (CCH) database (2013), ca. 630 specimens were collected from 1911 to 2011 (Fig. 5–6) documenting ca. 290 native and non-native vascular taxa in the Kiavah Wilderness prior to the study. Most of these specimens were collected in easily accessed areas, along roads and trails such as Horse Canyon Road, Highway 178, Kelso Valley Road, and the PCT.
Study Goals and Methods

The primary goal of the study was to document the vascular flora of the Kiavah Wilderness by surveying as much territory and as many habitats throughout the growing season as possible. This increases our botanical knowledge of the southern Sierra Nevada, adding to Fraga’s (2008) study of the Owens Peak eastern watershed. Field surveys took place between March 2013 and May 2015, for a total of 68 days. All plant species that were encountered and identifiable (i.e., with reproductive parts) were documented via collection of ca. 1300 specimens. Special status taxa (endangered, threatened, sensitive, or watch-list; Table 5) were collected conservatively, taking into account population size and any previous documentation. Standard collection data were recorded, including GPS coordinates and descriptive habitat information. All recorded information was included on the herbarium specimen label. The first set of specimens was deposited at Rancho Santa Ana Botanic Garden (RSA) and duplicate sets were sent to the California Academy of Sciences (CAS) and the University of California, Riverside (UCR). All specimen information is accessible via the CCH database.

The ca. 630 specimens previously collected from the study area were located using the CCH database. These specimens, housed at CAS, UC/JEPS, RSA-POM and UCR, were examined to verify the determinations and update the nomenclature as needed; all were annotated.

Vegetation

Environmental variables such as climate, elevation, slope, and aspect all affect the distributions of plants and plant associations. The vegetation classification in this study is mainly based on A Manual of California Vegetation, second edition (Sawyer et al. 2009), and A California Flora (Munz 1959). Vegetation associations found in the Kiavah Wilderness are singleleaf pinyon woodland, Jeffrey pine forest, cup leaf ceanothus chaparral, ghost pine woodland, sagebrush scrub (Munz 1959), desert needlegrass grassland, Joshua tree woodland, and creosotebush scrub. The elevation range of each vegetation type is shown in Fig. 7. For the purpose of this study the vegetation associations are split into two sections, Sierra Nevada and Mojave.
Fig. 7. Elevational ranges of the eight major vegetation types in the Kiavah Wilderness.

Vascular Flora of the Kiavah Wilderness

Desert, although the associations are not confined to one or the other (see overlap in Fig. 7).

Sierra Nevada Section

Single-Leaf Pinyon Woodland (Fig. 8).—The most common vegetation type in the Kiavah Wilderness is singleleaf pinyon woodland. It ranges in elevation from 1300 to 2200 m (4300–7200 ft) and occupies ridges, drainages, alluvial fans, level ground to steep slopes, and all aspects. It usually occurs on soils that are well drained. *Pinus monophylla* (singleleaf pinyon pine) is the dominant or co-dominant tree and the most common tree in the study area overall. The canopy is open or intermittent. Other trees that occur in this woodland include scattered *P. jeffreyi* (Jeffrey pine) and *Quercus chrysolepis* (canyon live-oak). Shrub species include *Artemisia tridentata* (bigsagebrush) and *Ephedra viridis* (Mormon tea). The herbaceous layer consists of *Claytonia* spp. (miner’s lettuce), *Microsteris gracilis* (slender phlox), *Phacelia humilis* var. *dudleyi* (Dudley’s phacelia) and *Stipa* spp. (needlegrass), among others.

The four consecutive years of exceptional drought led to widespread pine mortality, especially of *Pinus monophylla*, which was most severe from Mt. Pinos in the Emigdio Mountains through the Tehachapi Range into the southern Sierra Nevada (USDA 2015). I observed *P. monophylla* die-off in the Scodie Mountains over the course of the study. Figures 12–13 show two images of a slope in Horse Canyon taken exactly one year apart. Some individuals of *P. monophylla* appear brown and dead or dying in 2014, whereas their number had increased substantially one year later. This locality lies at the transition zone between the Desert Province and the Sierra Nevada of the California Floristic Province. At higher elevations, mortality appeared to be lower.

Cup leaf ceanothus chaparral (Fig. 9).—*Ceanothus vestitus* (cup leaf ceanothus) is dominant to co-dominant with *Fremontodendron californicum* (flannel bush). This is the second most extensive vegetation type at higher elevations (1800–2000 m, 6000–6700 ft). Cup leaf ceanothus chaparral carpets the plateau atop the Kiavah Wilderness. *Ceanothus vestitus* produces seedlings in abundance following fire (Sawyer et al. 2009). As discussed below, the plateau is undergoing post-fire succession following a fire in 1997. Understory vegetation is sparse.

Jeffrey pine forest (Fig. 10).—Dense pockets of *Pinus jeffreyi* are found in the Kiavah Wilderness at the highest elevations (1889–2000 m, 6200–6600 ft) on the plateau, ridges, along dry stream benches, and slopes of all aspects. Trees are relatively large, many over 40 ft tall, and the canopy is often continuous. These trees have withstood the assault of wildfires. Scorched trunks of some dead individuals remain upright (Fig. 10), but many more lie scattered on the plateau. Additional evidence that the plateau was once a woodland or forest is the presence of *P. jeffreyi* seedlings and re-sprouting *Quercus chrysolepis*. The understory of Jeffrey pine forest is sparse; however, grasses can be prominent, including *Bromus* spp. (brome grass), *Poa secunda* (pine bluegrass) and *Stipa* spp. (needle grass), among others.

Ghost pine woodland.—*Pinus sabiniana* (ghost pine, gray pine) stands occur on xeric sites at lower elevations (900–1500 m, 3000–5000 ft) in the Sierra Nevada (Sawyer et al. 2009). In the Kiavah Wilderness, prominent stands occur at the upper end of Sage Canyon and along the northwestern and northern boundaries of the Wilderness, but the vegetation type is less widespread than Jeffrey pine forest and single-leaf pinyon woodland. Associated trees include the desert species *P. monophylla* and *Yucca brevifolia* (Joshua tree). Understory vegetation is sparse and includes *Ephedra viridis*, *Eriogonum nudum* var. *westonii* (Winston’s buckwheat) and *Opuntia basilaris* (beavertail cactus).

Sagebrush scrub.—This vegetation type is generally found in flatter, sandy areas at higher elevations atop the plateau (1900 m, 6300 ft) and at lower elevations in flat drainages such as Jack’s Creek (1400 m, 4800 ft) near Walker Pass. *Artemisia tridentata* (big sagebrush) is often co-dominant with *Ephedra*
Fig. 8–11. Vegetation types in the Kiavah Wilderness.—8. Singleleaf pinyon pine woodland is the most common vegetation type.—9. Dense cup leaf ceanothus chaparral dominates the post-burn vegetation on the plateau. A fire-killed *Pinus jeffreyi* stand at left.—10. Jeffrey pine forest: A small stand of unburned *Pinus jeffreyi* on the plateau.—11. Joshua tree woodland forms dense stands at the lower desert elevations.
Vascular Flora of the Kiavah Wilderness

**Fig. 12–13.** Drought-stressed pinyon pine (*Pinus monophylla*): slope in Horse Canyon facing west (35.577000°, −118.114992°; 1600 m [5300 ft]).—12. Photo taken 16 Apr 2014; note the browning (dead or dying) trees.—13. Photo taken exactly one year later, 16 Apr 2015: most of the trees in the stand are dead or dying. These trees experienced extreme drought during 2012–2015. Pinyon pines throughout the Kiavah Wilderness showed signs of drought stress.

Viridis and *Eriogonum fasciculatum* var. *polifolium* (California buckwheat). Herbaceous vegetation is sparse to lacking.

**Mojave Desert Section**

Desert needlegrass grassland.—Generally found on steep, exposed, south-facing slopes at elevations ranging from 1400 to 1600 m (4800–5200 ft), desert needlegrass grassland occurs throughout the Kiavah Wilderness. The dominant cover is *Stipa speciosa* (desert needlegrass), with some shrubs intermixed including *Artemisia tridentata*, *Eriogonum linearifolia* (narrowleaf goldenbush), *Grayia spinosa* (hop sage) and *Krascheninnikovia lanata* (winter fat). Various annual *Eriogonum* (buckwheat) species can form dense patches within the grassland.

Joshua tree woodland (Fig. 11).—At lower elevations (1100–1600 m, 3700–5200 ft) on slopes and the desert floor, dense stands of *Yucca brevifolia* dominate. Species that often co-occur and can co-dominate are *Artemisia tridentata*, *Ephedra viridis* and *Eriogonum fasciculatum* var. *polifolium*. The herbaceous understory includes grasses such as *Bromus tectorum* (cheat grass), an invasive non-native, and a native, *Poa secunda*. Annual herbs include *Camissonia kernensis* subsp. *kernensis* (Kern County evening primrose) and *Phacelia fremontii* (Fremont’s phacelia). Despite the drought, spring 2013 was a record bloom year for *Y. brevifolia* (James 2013) and almost all mature individuals were in full bloom (Fig. 11).

Cresote bush scrub.—In the Mojave Desert-influenced areas at lower elevations (1000–1300 m, 3500–4500 ft), *Larrea tridentata* (creosote bush) is the dominant to co-dominant shrub. The soil is typical of a desert bajada, sandy and loose. Co-dominant shrubs include *Ambrosia dumosa* (burro weed), *A. salsola* (burro bush), *Encelia actoni* (Acton encelia) and *Lycium andersonii* (Anderson thornbush). The many desert annuals include *Camissonia campestris* subsp. *campestris* (Mojave suncup), *Festuca octoflora* (sixweeks grass), *Larthenia gracilis* (needle goldfields), *Linanthus dichotomus* (evening snow), *Linanthus parryae* (sand blossoms) and *Phacelia distans* (common phacelia).

**Habitat Types**

Intermittent Streams (Fig. 14)

Most of the watercourses in the study area are seasonally wet, usually in the winter months. Small stands of *Quercus chrysolepis*, *Salix lasiolepis* (arroyo willow), *Populus fremontii* (Fremont’s cottonwood) and *Pinus sabina* (gray pine) are infrequent along these seasonally wet streams. Diversity here is much greater than on adjacent exposed arid slopes.

Springs (Fig. 15)

Usually occurring in depressions on the plateau, springs are formed where water from below ground rises to the surface. Springs marked on topographic maps include Boulder Spring, McIver’s Spring, Scodie Spring and Yellow Jacket Spring (Fig. 2). During the study, many of the springs were completely dry due to drought conditions. The graminoids *Carex* spp. (sedges), *Juncus* spp. (rushes), and grasses dominate these habitats. Non-native taxa are abundant at all these sites, especially invasive grasses such as *Festuca arundinacea* (tall fescue) and *Poa pratensis* subsp. *pratensis* (Kentucky bluegrass). Wildlife as well as cattle and PCT hikers frequently visit these springs; the latter especially heavily impact McIver’s and Yellow Jacket springs.

Granite Rock Outcrops (Fig. 16)

Eroding granitic outcrops often harbor unique plant diversity compared to surrounding habitats. Shrubs common on granite outcrops include *Ericameria cuneata* (desert rock goldenbush), *Ivesia* spp. (mousetail), *Penstemon newberryi* (mountain pride), *Holodiscus microphyllus* (oceanspray), and *Eriogonum* spp. These plants grow in rock cracks and at the base of large boulders. Very large outcrops are often devoid of canopy cover and have little vegetation. Annuals can be found in abundance...
Fig. 14–17. Habitat types in the Kaibab Wilderness—14. Intermittent stream in upper, narrow Sage Canyon.—15. Spring with dense cover of graminoids.—16. Rock outcrops provide habitat for a number of species including annuals.—17. Site of the 1997 burn on the plateau.
around the base of outcrops in sandy decomposed granite. High rock walls provide protection, shade, and moisture for annuals.

**POST-FIRE SUCCESSION**

The earliest recorded fire in the Wilderness occurred in August 1997. Started by lightning, it burned ca. 5700 acres mostly on the plateau (Schifrin et al. 2003). It consumed Jeffrey pine forest and single-leaf pinyon woodland. The only published observations of post-fire succession are in *Southern California, Pacific Crest Trail*, a hiking guide by Schifrin et al. (2003) that mentions that hikers should watch out for dermatitis-causing *Eriodictyon parryi* (poodle-dog bush) in the burn area. I encountered only two old plants of *Eriodictyon parryi*. Since the fire, *Ceanothus vestitus* and *Fremontodendron californicum* have grown into dense stands that are almost impassable except via deer trails that weave among the shrubs (Fig. 9). Understory plants are sparse except for *Bromus tectorum*, which invaded the post-burn site successfully. Around an unnamed spring at the headwaters of Scodie Canyon, hundreds if not thousands of *Pinus jeffreyi* saplings were observed in June 2014 (Fig. 17), indicating that the site has the seed bank and potential for Jeffrey pine forest to regrow. It has taken up to 17 years for these *P. jeffreyi* plants to reach the sapling stage. *Pinus monophylla* recruitment was not observed in the post-burn site; however, *Quercus chrysolepis* was observed re-sprouting from trunk bases.

A more recent fire occurred during the study on 11 July 2014 in the northwestern part of the Wilderness in Smith Canyon when marijuana farmers set a fire to destroy evidence of their growing operation. The Nicolls Fire burned ca. 1600 acres on slopes that were predominantly single-leaf pinyon woodland (Incident Information System 2016). In 2015, when I visited the burn site, drought conditions prevailed and plants were sparse but I documented *Claytonia rubra* (red stemmed spring beauty), *Galium aparine* (common bedstraw), *Microsteris gracilis* (slender phlox) and *Dickelostemma capitatum* subsp. capitatum (blue dicks). A few individuals of *Quercus chrysolepis* and *Fremontodendron californicum* were starting to re-sprout from their bases. Future surveys to document post-fire succession, including fire followers from the seed bank, would be informative.

**FLORA**

A total of 477 minimum-rank vascular plant taxa (including 457 species, 73 subspecies and 84 varieties) occur in the Kiavah Wilderness based on specimens collected prior to and during the study (Appendix A). Seventy families and 240 genera are represented. The largest families are Asteraceae (73 minimum-rank taxa), Poaceae (36), Polemoniaceae (35), Polygonaceae (25) and Fabaceae (24). Family rankings are comparable to those of the Kern County floristic surveys (Twisselmann 1967; Moe 2016), with Asteraceae and Poaceae also having the greatest number of minimum-rank taxa, but in the county floras Fabaceae, Polygonaceae and Polemoniaceae ranked fourth, fifth and sixth, respectively.

The largest genera in the Kiavah Wilderness are *Gilia* (18), *Eriogonum* (17), *Phacelia* (13), *Cryptantha* (12) and *Lupinus* (8), whereas in the Kern County flora by Twisselmann (1967) the top five genera were, in descending order, *Eriogonum*, *Gilia*, *Carex*, *Mimulus*, and *Lupinus*. Annual plants account for 45.6% of the total flora, followed by perennial herbs (28.1%) and large shrubs (12.3%). Life forms are based on species descriptions in Baldwin et al. (2012). Table 3 provides a summary of the flora.

**Non-Native Taxa**

A total of 28 non-native minimum-rank taxa were documented from 20 genera (Table 4), representing 5.9% of the total flora. Most non-native taxa are in Poaceae (13), Asteraceae (4) and Brassicaceae (3). Introduced grasses were observed in every vegetation type in the Kiavah Wilderness. These grasses can be ecological generalists and can outcompete native species (Brooks 2000). Moreover, dense stands of dead *Bromus tectorum* and *B. madritensis* subsp. *rubens* can carry wildfires that negatively impact native species (Brooks and Pyke 2000). Both grass species occur in abundance in the Kiavah Wilderness and, according to the California Invasive Plant Council (Cal-IPC

Table 3. Summary of the documented flora of the Kiavah Wilderness, including numbers of taxa characterized as native or non-native, and life forms.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Genera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native</td>
<td>429 (89.9%)</td>
</tr>
<tr>
<td>Non-native</td>
<td>28 (5.9%)</td>
</tr>
<tr>
<td>Largest Families</td>
<td></td>
</tr>
<tr>
<td>Asteraceae</td>
<td>73</td>
</tr>
<tr>
<td>Poaceae</td>
<td>36</td>
</tr>
<tr>
<td>Polemoniaceae</td>
<td>35</td>
</tr>
<tr>
<td>Polygonaceae</td>
<td>25</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>24</td>
</tr>
<tr>
<td>Boraginaceae</td>
<td>22</td>
</tr>
<tr>
<td>Hydrophyllaceae</td>
<td>21</td>
</tr>
<tr>
<td>Brassicaceae</td>
<td>21</td>
</tr>
<tr>
<td>Largest Genera</td>
<td></td>
</tr>
<tr>
<td><em>Gilia</em></td>
<td>18</td>
</tr>
<tr>
<td><em>Eriogonum</em></td>
<td>17</td>
</tr>
<tr>
<td><em>Phacelia</em></td>
<td>13</td>
</tr>
<tr>
<td><em>Cryptantha</em></td>
<td>12</td>
</tr>
<tr>
<td><em>Lupinus</em></td>
<td>8</td>
</tr>
<tr>
<td><strong>Life Forms</strong></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>219 (45.6%)</td>
</tr>
<tr>
<td>Perennial herb</td>
<td>135 (28.1%)</td>
</tr>
<tr>
<td>Large shrub</td>
<td>60 (12.3%)</td>
</tr>
<tr>
<td>Geophyte</td>
<td>27 (6.3%)</td>
</tr>
<tr>
<td>Tree</td>
<td>13 (3.1%)</td>
</tr>
<tr>
<td>Parasitic perennial herb</td>
<td>10 (2.3%)</td>
</tr>
<tr>
<td>Small shrub</td>
<td>5 (1.0%)</td>
</tr>
<tr>
<td>Succulent perennial herb</td>
<td>2 (0.4%)</td>
</tr>
<tr>
<td>Succulent shrub</td>
<td>2 (0.4%)</td>
</tr>
<tr>
<td>Parasitic annual</td>
<td>1 (0.2%)</td>
</tr>
<tr>
<td>Succulent annual</td>
<td>1</td>
</tr>
<tr>
<td>Parasitic annual vine</td>
<td>1</td>
</tr>
<tr>
<td>Liana</td>
<td>1</td>
</tr>
<tr>
<td>Perennial vine</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 4. Non-native taxa documented in the Kiavah Wilderness. California Invasive Plant Council (2016) impact rank is given for those taxa that are ranked.

<table>
<thead>
<tr>
<th>Family</th>
<th>Taxon</th>
<th>Cal-IPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranthaceae</td>
<td>Amaranthus albus</td>
<td></td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Cirsium vulgare</td>
<td>Moderate</td>
</tr>
<tr>
<td>Lactuca serriola</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sonchus asper subsp. asper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taraxacum officinale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horneanthus procumbens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saxymbrium altissimum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saxymbrium orientale</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chenopodiaceae</td>
<td>Salso1a tragus</td>
<td>Limited</td>
</tr>
<tr>
<td>Euphorbiae</td>
<td>Euphorbia peplus</td>
<td></td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Lotus corniculatus</td>
<td></td>
</tr>
<tr>
<td>Geraniaceae</td>
<td>Erodium cicutarium</td>
<td>Limited</td>
</tr>
<tr>
<td>Iris pseudacorus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marrubium vulgare</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avena fatua</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bromus madritensis subsp. rubens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bromus tectorum</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Festucar arundinacea</td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td>Festucay myrurus</td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td>Hordeum murinum subsp. glaucum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hordeum murinum subsp. marinum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poa annua</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polygo1on interruptus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polygo1on monspelensis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polygo1on viridis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Schismus arabicus</td>
<td></td>
<td>Limited</td>
</tr>
<tr>
<td>Schismus barbatus</td>
<td></td>
<td>Limited</td>
</tr>
<tr>
<td>Polygonaceae</td>
<td>Polygonum aviculare subsp. aviculare</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Taxa documented in the Kiavah Wilderness that are listed in the California Native Plant Society (CNPS) Inventory of Rare and Endangered Plants (CNPS 2013) or as rare, threatened or endangered in California by the CNDDB (2013).

<table>
<thead>
<tr>
<th>Taxon</th>
<th>CNPS Rare California State Rank 1</th>
<th>California State Rank 2</th>
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<tbody>
<tr>
<td>Androsace elongata subsp. acuta</td>
<td>4.2</td>
<td>S3S4</td>
</tr>
<tr>
<td>Astragalus erterterae</td>
<td>1B.3</td>
<td>S2</td>
</tr>
<tr>
<td>Camissonia integrifolia</td>
<td>1B.3</td>
<td>S2</td>
</tr>
<tr>
<td>Camissonia kernensis subsp. kurnensis</td>
<td>4.3</td>
<td>S3</td>
</tr>
<tr>
<td>Erodium parviflora</td>
<td>4.3</td>
<td>S4</td>
</tr>
<tr>
<td>Cordylanthus rigidus subsp. brevicateae</td>
<td>4.3</td>
<td>S4</td>
</tr>
<tr>
<td>Delphinium purpusi</td>
<td>1B.3</td>
<td>S3</td>
</tr>
<tr>
<td>Dudleya abramsii subsp. calicina</td>
<td>4.3</td>
<td>S4</td>
</tr>
<tr>
<td>Eriogonum brewdlei var. shevockii</td>
<td>4.3</td>
<td>S3</td>
</tr>
<tr>
<td>Eriophyllum mohavense</td>
<td>1B.2</td>
<td>S2</td>
</tr>
<tr>
<td>Fritillaria pinetorum</td>
<td>4.3</td>
<td>S4</td>
</tr>
<tr>
<td>Galium angustifolium subsp. onycense</td>
<td>1B.3</td>
<td>S3</td>
</tr>
<tr>
<td>Gilia interior</td>
<td>4.3</td>
<td>S4</td>
</tr>
<tr>
<td>Gilia latiflora subsp. cuyamensis</td>
<td>4.3</td>
<td>S4</td>
</tr>
<tr>
<td>Gilia lepantha subsp. pinetorum</td>
<td>4.3</td>
<td>S4</td>
</tr>
<tr>
<td>Lewisia disepala</td>
<td>1B.2</td>
<td>S2</td>
</tr>
<tr>
<td>Monardella lindes subsp. oblonga</td>
<td>1B.3</td>
<td>S2</td>
</tr>
<tr>
<td>Muilla coronata</td>
<td>4.2</td>
<td>S3</td>
</tr>
<tr>
<td>Nemacladus calcaratus</td>
<td>1B.2</td>
<td>S1</td>
</tr>
<tr>
<td>Oreonona vestita</td>
<td>1B.3</td>
<td>S3</td>
</tr>
<tr>
<td>Perideridia pringi1e</td>
<td>4.3</td>
<td>S4</td>
</tr>
<tr>
<td>Phacelia exilis</td>
<td>4.3</td>
<td>S4</td>
</tr>
<tr>
<td>Phacelia nashiana</td>
<td>1B.2</td>
<td>S3</td>
</tr>
<tr>
<td>Phacelia noyenmillensis</td>
<td>1B.2</td>
<td>S2S3</td>
</tr>
</tbody>
</table>

1 CNPS Rare Plant Rank: 1B.2: rare, threatened, or endangered in California or elsewhere; moderately threatened.—1B.3: rare, threatened, or endangered in California or elsewhere; not very threatened.—4.2: limited distribution watch list; moderately threatened.—4.3: limited distribution watch list; not very threatened.
2 California State Rank: S1: critically imperiled because of extreme rarity.—S2: imperiled due to restricted range.—S2S3: rank is between S2 and S3.—S3: vulnerable due to restricted range.—S3S4: rank is between S3 and S4.—S4: apparently secure; uncommon but not rare.

2016), each is ranked as high impact, which means a species has “severe ecological impacts on physical processes, plant and animal communities and vegetation structure.” Another generalist species that was found in almost every habitat is Erodium cicutarium, which is ranked by Cal-IPC (2016) as having limited impact. Most of the non-native taxa were found around water sources, such as springs and cattle troughs, especially Cirsium vulgare, Festuca arundinacea and Taraxacum officinale. Riparian areas are frequented by wildlife, cattle and hikers and are thus dispersal sources and sinks for non-native plants that are adapted to these disturbed habitats.

Special Status Taxa

Collections made prior to the study documented 19 minimum-impact taxa in the Kiavah Wilderness that are listed in the California Native Plant Society (CNPS) Inventory of Rare and Endangered Plants (2013). My study added seven taxa for a total of 26 (5.4% of the total flora) (Table 5). Of the seven additions, Camissonia integrifolia (Onagraceae) was last documented in 1964 just west of the Wilderness in Kelso Valley. Three occurrences of Eriophyllum mohavenense (Asteraceae) discovered near the southern boundary of the Wilderness are disjunct by ca. 90 km (55 mi) northwest of the closest known populations near Pilot Knob (24 Apr 1965, Henry s.n., CAS). Three of the 26 special status taxa were not relocated during the study. Numerous attempts were made to find Lewisia disepala (Montiaceae), which was documented in 1984 (Shevock 9488, CAS). Shevock (1988) noted that L. disepala can be found in wet years and tends to flower soon after the snowpack melts. A late-flowering taxon (Sep 1979, Shevock 6550, CAS), Cordylanthus rigidus subsp. brevicateae (Orobanchaceae) was not re-
located either. Another species not encountered was Delphinium purpureum (Ranunculaceae), which had been collected exclusively along Highway 178 near the town of Onyx (May 2010, Howald s.n., UCR). Drought conditions concurrent with the study may explain the failure to find these species, and they should be targets of future surveys.

Another special status species, Oreonana vestita (Apiaceae), was first documented in 2002 (Laeger & Bogan 1403, CAS). This species is only known from two small occurrences in the Kiawah Wilderness that are disjoint from the only other known populations in the San Gabriel and San Bernardino mountains.

Plants from the Wilderness differ from those in San Gabriel Mountains populations and may be described as a new sub-species (Jane Tirrell, pers. comm. 2015).

ACKNOWLEDGEMENTS

I am forever grateful to my parents, Ian and Erma Gardner, and to my fabulous mentors Naomi Fraga and Sula Vanderplank. Special thanks to Kitty Blassey, Nick Jensen and Grant Godden. This project would not have been possible without the tireless efforts of all my amazing field assistants. I would like to thank the staff and volunteers at RSA and at the following herbaria: CAS, UC and UCR. I am grateful for the support received from Rancho Santa Ana Botanic Garden, the United States Forest Service, Sequoia National Forest and the Bureau of Land Management, Southern California Botanists, and California Native Plant Society—Bristlecone and Orange County chapters. I would especially like to thank Kathy LaShure for her hospitality and the amazing volunteers at the Maturango Museum and my committee members Lucinda McDade and Mark Porter for their dedication to the program. Finally, yet importantly, to my advisor Travis Columbus—thank you for your advice, humor, patience, and trail mix!

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APPENDIX 1

ANNOTATED CATALOG OF THE VASCULAR FLORA

The following list includes all taxa collected during this study; vouchers are deposited at RSA, CAS, UC/JEPS and UCR. Existing specimens at these institutions from the study area were annotated and included in this checklist. Family classification adheres to FNA (2016), whereas genera and species follow Baldwin et al. (2012), except for the following genera: Eriastrum (De Groot 2016), Erythranthe (Fraga 2012) and Cryptantha (Simpson and Hasenstab 2009). Non-native taxa are designated by (*) and special status taxa are designated by (#). Life forms are included with each taxon, following descriptions in Baldwin et al. (2012). Habitat information is based on field observations in the Kiavah Wilderness.

LYCOPHYTES

SELAGINELLACEAE


FERNS

EQUISETACEAE


PTERIDACEAE


PENTAGRAMMA TRIANGULARIS (Kauf.) Yatsk., Windham, & E. Wollenw. subsp. TRIANGULARIS. Perennial herb. Common on rock outcrops on desert slopes and in pinyon woodlands, 900–1600 m (3000–5300 ft). Gardner & Stoughton 543.

GYMNOSPERMS

CUPRESSACEAE


EPHEDRACEAE


PINACEAE


PINUS SABINIANA D. Don. Tree. Occasional in canyons and on rocky desert slopes, 1500 m (4900 ft). Gardner & Paik 93.

ANGIOSPERMAE—MAGNOLIIDS

SAURURACEAE


ANGIOSPERMAE—EUDICOTS

ADoxaceae

AMARANTHACEAE

* Amaranthus albus L. Annual. Disturbed areas, roadside in mud-flat, 1500 m (4900 ft). Gardner & Pilapil 489.

APIACEAE


APOCYNACEAE


ASTERACEAE

Acamptonopus spheerocephalus (Harv. & A. Gray) A. Gray. Small shrub. Occasional on desert bajadas in compact exposed soil, 1300 m (4300 ft). Gardner 1385.


Artemisia dracunculus L. Perennial herb. Occasional along banks of washes and in rocky washes, 1300 m (4300 ft). Gardner & Nazaire 1044.


Chrysothamnus viscidiflorus (Hook.) Nutt. subsp. viscidiflorus. Shrub. Uncommon on the plateau and along the Pacific Crest Trail, 1900 m (6300 ft). Twisselmann 13713 (CAS).


Boraginaceae


Cryptantha maritima (Greene) Greene. Annual. Uncommon along bank of drainage and in wash, 1500 m (4900 ft). Gardner & Poutasse 821.


EUPHROCYNIA CHRYSTANTHEMFOLIA (Benth.) Greene var. BIPINNATIFIDA (Torr.) Constance. Annual. Occasional on bajadas and Joshua tree woodland, 1400 m (4600 ft). Gardner & Sutton 1268.


PECTOCARYA TWINSUM (Hook.) Greene var. COULTERIS WATSON. Annual. Occasional in pinyon woodlands and drainages, 1800 m (5900 ft). Gardner & Stoughton 345.


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CHENOPODIACEAE


**Dudleya saxosa** (M.E. Jones) Britton & Rose subsp. aloides (Rose) Moran. Perennial herb (Succulent). Uncommon in rock outcrops on exposed desert slopes, 1500 m (4900 ft). Gardner & Gardner 156.

**Crassula connata** (Ruiz & Pav.) A. Berger. Annual (Succulent). Rare on steep sandy soils and exposed flat level ground in the desert, 1000–1600 m (3300–5300 ft). Gardner & De Groot 649.

**Crassula cornuta** (Ruiz & Pav.) A. Berger. Annual (Succulent). Rare on steep sandy soils and exposed flat level ground in the desert, 1000–1600 m (3300–5300 ft). Gardner & De Groot 649.


**Cynomorium procumbens** (Greene) Brouillet var. jepsonii (Otley) Brouillet. Perennial herb. Uncommon in disturbed sandy soil around pinyon pines, 2000 m (6600 ft). Shevock 9819 (CAS).


**Crambe calcitrapa** (Conradson) K. Schum. Perennial herb. Uncommon on exposed sandy soils and exposed flat level ground in the desert, 1000–1600 m (3300–5300 ft). Gardner & De Groot 649.


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**FAGACEAE**


*Quercus wislizeni* DC. Tree. Uncommon on N rocky mountain slopes, 1700 m (5600 ft). Gardner & Terrell 1401.

**GERANIACEAE**


**GENTIANACEAE**

*Fraseria tubulosa* Coville. Perennial herb. Rare along the Pacific Crest Trail in shade of pinyon and oaks, 2100 m (6900 ft). Gardner & Nazaire 1041.

**GERANIIACEAE**


**GROSSULARIACEAE**


*Ribes boezelii* Regel. Shrub. Uncommon in canyons and on mountain ridges, 1700 m (5600 ft). Shevock 11418 (CAS).

**HYDROPHYLLEACEAE**


**LAMIACEAE**


*Monardella oodoratisima* Benth. Perennial herb. Uncommon on rocky exposed desert slopes, 1900 m (6300 ft). Gross 2535.


LENNOACEAE


LOASACEAE


LYTHRACEAE


MALVACEAE


MONTIACEAE


LEWISIA DISPALESD Rydby. Geophyte. Rare in exposed rolling compacted conglomerate soil. Was not found during this study, 1900–2100 m (6300–6900 ft). Shevock 9488 (CAS).

LEWISIA REDIVIVA Pursh var. REDIVIVA. Geophyte. Common on rocky exposed soils surrounded by pinyon pines and in quartz outcrops, 1900–2100 m (6300–6900 ft). Gardner & Fraga 162.

NYCTAGINACEAE


OLEACEAE


ONAGRACEAE


CAMISSONIA KERNENSIS (Muns) P.H. Raven. Annual. Rare on bajadas on flat exposed sandy soil, 1400 m (4600 ft). Gardner & England 721.


OROBANCHACEAE


# CORYDANThUS RIGIDUS (Benth.) Jeps. subsp. BREVIbrACTEATUS (A. Gray) Munz. Annual (parasitic). Rare in pinyon woodlands, 1900 m (6300 ft). Shevock 6550 (CAS).

KOPSIOPIS STROBLACEA (A. Gray) Beck. Perennial herb (parasitic). Rare in pinyon woodlands on ridges, 1900 m (6300 ft). Shevock 10804 (CAS).


OROBANCHE UNIFLORA L. Perennial herb (parasitic). Rare in unburned Jeffrey pine forest in pine duff, 2100 m (6900 ft). Gardner & Columbus 993.

PAPAVERACEAE


ESCHSCHOLZIA CAESPItOSA Benth. Annual. Uncommon in pinyon woodlands and along the Pacific Crest Trail, 1700 m (5600 ft). Shevock 12164 (CAS).


PAPAVER HETEROPHYLLUM (Benth.) Greene. Annual. Uncommon on bank of wash in canyon, 1000 m (3300 ft). Gardner & Fraga 1355.


PRHYMACEAE


PLANTAGINACEAE


KECKIella BREVIFlORa (Lindley) Straw var. BREVIFlORa. Shrub. Occasional in rock outcrops and exposed sandy soil, 1800 m (5900 ft). Gardner & Columbus 279.

PENSTEMON grENELLEI Eastw. var. GRINELLEI. Perennial herb. Uncommon only one found in Scodie Canyon, bank of wash, 1100 m (3600 ft). Gardner & Poutasse 857.


POLEMONIACEAE

ALLOPHYLLUM GILIOIDES (Benth.) A.D. Grant & V.E. Grant subsp. GILIOIDES. Annual. Occasional in post-burn site in soft well drained soil in disturbed soil along the Pacific Crest Trail, 2000 m (6600 ft). Gardner & Columbus 936.


ERIAstrUM DENSIFOLium (Benth.) H. Mason subsp. ELONGATUS (Benth.) H. Mason. Perennial herb. Occasional on exposed steep slopes, 1600 m (5300 ft). Gardner 36.

ERIASTRAUM EREMICUM (Jeps.) H. Mason subsp. EREMICUM. Annual. Occasional on bajadas and compact soil, 1100 m (3600 ft). Gardner & Paik 1445.


GILIA BRECCiARUM M.E. Jones subsp. BRECCiARUM. Annual. Common in washes and exposed rocky slopes in and pinyon woodlands, 1900 m (6300 ft). Gardner & Fraga 169.


GILIA CAPITATA Sims subsp. ABROTANIFOLIA (Greene) V.E. Grant. Annual. Occasional on steep exposed rocky slopes and in seeps, 1300–2000 m (4300–6600 ft). Gardner & Columbus 372.


GILIA lATIFLORA (A. Gray) A. Gray subsp. CUXAMENiS A.D. Grant & V.E. Grant. Annual. Rare on desert slopes and in rock outcrops only found in Cholla Canyon, 1300 m (4300 ft). Gardner & De Groot 610.


GILIA lATIFLORA (A. Gray) A. Gray subsp. lATIFLORA. Annual. Common on bajadas and steep sandy slopes, 1100–1900 m (3600–6200 ft). Gardner & Columbus 924.

GILIA leptANTHA Parish subsp. PINETOBUi A.D. Grant & V.E. Grant. Annual. Rare on rocky flat ground on the plateau, 2000 m (6600 ft). Gardner & Nazaire 1024.


GILIA MALIORA G. DAY & V. E. GRANT. Annual. Rare on exposed steep mountain slopes, 2000 m (6600 ft). Gardner & Pilipal 470.


SHEVOCKII J. T. HOWELL. Perennial herb. Rare around rock outcrops on ridges. Determination confirmed by Dr. J. Mark Porter, 2000 m (6600 ft). Gardner & Columbus 314.


ERIOGONUM HIRTIFLORUM S. WATSON. Annual. Uncommon on mountain ridges in well drained soil, 1500 m (4900 ft). Eetzer 6000 (UC).


ERIOGONUM WRIGHTI T. TORR. var. SUBCAPITUM S. WATSON. SHRUB. Common on the plateau and along the Pacific Crest Trail, 2000 m (6600 ft). Shevock 11023 (CAS).

POLYGONACEAE


CHORIZANTHE RIGIDA (T. TORR.) & A. GRAY. Annual. Rare on bajadas and rolling compacted conglomerate clay soil, 1200 m (4000 ft). Gardner, Poutasse, & Chumcinn 1184.


RANUNCULACEAE

AQUILEGIA FORMOSA DC. Perennial herb. Rare in seeps in protected shaded canyon. Only found in Sage Canyon, 1600 m (5300 ft). Gardner & Columbus 317.


DELPHINIUM HANSENII (GREENE) GREENE. Annual. Rare on gentle sloping exposed sandy soil, 1000 m (3300 ft). Gardner & Fraga 1561.


GALIUM APARINE L. Annual. Rare along Highway 178 near Onyx, 900 m (3000 ft). Howald 2496 (UCR).

MYOSOTIS MINUS L. Annual. Uncommon in moist soil in open pinyon woodland, 1400 m (4600 ft). Ertter 6007 (UC).


RHAMNACEAE


ROSACEAE


CERCOCARPUS LEDIFOLIUS Nutt. Shrub. Rare on exposed mountain slopes, 1900 m (6300 ft). Shevock 10800 (CAS).


DRYOMOCALLIS GLANDULOSA (Lindl.) Rydb. var. REFLEXA (Greene) Erter. Perennial herb. Occasional in drainages and rocky soil, 1900 m (6300 ft). Gardner & Columbus 286.


RUBIACEAE

# GALLIUM AUGUSTIFOLIUM A. Gray subsp. ONYCENSE (Dempster) Dempster & Stebbins. Perennial herb. Rare in rocky drainages on plateau, 2000 m (6600 ft). Gardner & Columbus 932.


SALICACEAE


SALIX LUTEA Nutt. Shrub. Occasional in drainages along the Pacific Crest Trail, 1600 m (5300 ft). York 744 (CAS).

SAXIFRAGACEAE


SCROPHULARIACEAE


SOLANACEAE


URTICACEAE


VALERIANACEAE


VIOLACEAE

VIOLA PURPUREA Kellogg subsp. QUEBECIUM (M.S. Baker & J.C. Clausen) R.J. Little. Perennial herb. Rare in unburned Jeffrey pine forest in pine duff, 2100 m (6900 ft). Gardner & Columbus 990.

VISCACEAE


ZYGOPHYLLACEAE

**ALLIACEAE**


**ALLIUM LACUNOSUM** S. Watson var. ALBUM. Geophyte. Occasional on compacted, exposed conglomerate clay desert bajada soils, 1000–1300 m (3500–4300 ft). *Gardner 1384.*

**ALLIUM PENINSULARE** Greene var. PENINSULARE. Tree. Occasional on rocky steep slopes and outcrops, 1200–1700 m (4000–5600 ft). *Gardner & Paik 98.*

**ALISOGARDNER**

**JUNCUS BUFONIUS** L. var. BUFONIUS. Perennial herb. Occasional in springs and washes, 1200–2000 m (6600 ft). *Shevock 9572 (CAS).*

**JUNCUS XIPHIÓIDES** E. Mey. Common in washes, intermittent streams and compacted soils, 2000 m (6600 ft). *Gross 2477.*


**CYPERACEAE**


**JUNCACEAE**


**JUNCUS RUGOLUS** Engelm. Perennial herb. Occasional in desert wash in shade of oaks in wet soil, 1500 m (4900 ft). *Gardner & Pongrave 417.*


**LILIACEAE**

* IRIS PSEUDORORIS L. Geophyte. Rare in moist wet soils along Highway 178, found at only one site, 1200 m (4000 ft). *Gardner & Park 1446.*


**LILIACEAE**


* FITRIALLARIA PINTORIUM** Davidson. Geophyte. Rare on coarse, fine, gravelly, steep, sandy N-facing slope, 1700 m (5600 ft). *Shevock 11432 (CAS).*

**ORCHIDACEAE**

**EUPHAXIS GRAEIAE** Hook. Perennial herb. Rare in shaded moist canyons. Only one known occurrence in Cap Canyon, 1200 m (4000 ft). *Shrock 12152 (CAS).*

**POACEAE**

* AVENA PATULA L. Annual. Uncommon only one patch found in Scodie Canyon along bank of wash, 1200 m (4000 ft). *Gardner & Poutasse 837.*


* SCHISMUS ARABICUS Nees. Annual. Common on bajadas and roadsides, 1100 m (3600 ft). *Shevock 10369 (CAS).*

* SCHISMUS BARBATUS (L.) Thell. Annual. Common on bajadas and in pinyon woodlands, 900–1300 m (3000–4300 ft). *Shevock 9208 (CAS).*


STIPA PARISHII Vasey var. PARISHII Perennial. Uncommon in pinyon woodlands and drainages, 1900 m (6300 ft). *Gardner & Fraga 290.*


THEMIDACEAE


TYPHACEAE