VASCULAR FLORA OF WEST CLEAR CREEK WILDERNESS, COCONINO AND YAVAPAI COUNTIES, ARIZONA

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ABSTRACT

VASCULAR FLORA OF WEST CLEAR CREEK WILDERNESS,

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West Clear Creek Wilderness bisects the Mogollon Rim in Arizona, and is nested between the Colorado Plateau and Basin and Range physiographic provinces. Between 2013 and 2016, a floristic inventory vouchered 542 taxa and reviewed 428 previous collections to produce a total plant inventory of 594 taxa from 93 families and 332 genera. The most species rich families were Asteraceae, Poaceae, Fabaceae, Brassicaceae, Rosaceae, Plantaginaceae, Cyperaceae, and Polygonaceae. *Carex*, *Erigeron*, *Bromus*, *Muhlenbergia*, and *Oenothera* were the most represented genera. Nonnative taxa accounted for seven percent of the total flora. *Stachys albens* was vouchered as a new state record for Arizona. New county records include *Graptopetalum rusbyi* (Coconino), *Pseudognaphalium pringlei* (Coconino), *Phaseolus pedicellatus* var. *grayanus* (Coconino), and *Quercus rugosa* (Coconino and Yavapai).

This study quantified and contrasted native species diversity in canyon versus non-canyon floras across the Southwest. Analyses based on eighteen floras indicate that those centered about a major canyon feature show greater diversity than non-canyon floras. Regression models revealed that presence of a canyon was a better predictor of similarity between floras than was the distance between them. This study documents the remarkable diversity found within canyon systems and the critical, yet varied, habitat they provide in the southwestern U.S.

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INTRODUCTION

Study Area

West Clear Creek Wilderness (WCCW) is located in north-central Arizona and bisects the Mogollon Rim, which divides the southern edge of the Colorado Plateau from the Basin and Range physiographic provinces (McLaughlin 1986). The western terminus of the wilderness is adjacent to the Verde Valley (Ulrich and Bielski 1984) and occurs within Yavapai County. The east portion occurs within Coconino County. WCCW exists near the convergence of the Colorado Plateau and Apachian floristic areas (McLaughlin 1989). West Clear Creek is a perennial tributary of the Verde River. It runs east to west and is bounded by canyon walls throughout the wilderness. Formed by the junction of Willow and Clover creeks near the eastern boundary of WCCW, approximately 40 km of the creek's total 53-km stretch is included within WCCW. The wilderness boundary closely aligns with the canyon rim. The U.S. Congress designated this area as a wilderness in the Arizona Wilderness Act of 1984 (U.S. Cong. House 1984). Its wilderness designation, challenging access, and low mineral resource values have protected WCCW from serious human disturbance and have enabled much of the area to remain in a pristine state.

WCCW lies approximately 65 km south of Flagstaff and 13 km east of Camp Verde. It is bounded between 34°35’8” and 34°30’41” latitude and -111°21’17” and -111°43’1” longitude. It is entirely included within the Red Rock and Mogollon Rim districts of the Coconino National Forest and encompasses approximately 6,260 ha. Elevation gradually decreases from east to west, ranging from a maximum of 2,130 m at the eastern terminus to 1,035 m at the west end.

The origin of the West Clear Creek canyon includes pre-volcanic tectonism, where tectonic plates were pulled apart and the Earth's crust rose and fell along local fault lines. This resulted in a deep down cut and broad channel along the edge of the Colorado Plateau (Ulrich 1984). The channel was further shaped by flows of fluvial and volcanic sediment. Canyon walls expose upper Tertiary volcanic rocks, which overlay Lower Permian sedimentary rocks. The gradual east to west dip of sedimentary layers in addition to faulting has caused structural lowering from east to west. Most local faults trend north to northwest; however the Cash Tank and Toms Creek faults are unique in their northeast trend and length of greater than 5 km. Geologic layers, in ascending order, are the Supai Formation, Coconino Sandstone, and Kaibab Limestone. Evidence of volcanism is prevalent and occurred in the Mogollon Region as recently as five to 16 Ma (Fellows 2000; Ulrich 1984). Volcanic flows were much greater west of Cash Tank fault and overlay the Supai formation and Coconino Sandstone in this area. Prevolcanic erosion removed approximately 400 m of upper Paleozoic strata from the area west of Cash Tank fault. Following this, the valley floor received deposits of coarse conglomerates to a thickness of 90 m (Ulrich 1984). Basalt, limestone, and sandstone rocks and their associated soils are the dominant substrates (NRCS 2015).

Tracking the elevation gradient, the climate varies across WCCW from east to west. There were no weather stations identified within WCCW, so climate data was determined using the nearest active stations (WRCC 2015). The climate of the cooler, eastern end is represented by the Blue Ridge Reservoir weather station (2,097 m elevation), which lies 17 km east of the wilderness boundary. Montezuma Castle NM weather station (970 m elevation) represents a warmer climate of lower elevations and lies 14 km to the west.

Climate records over the past 50 years for both stations were averaged to produce an overall average annual precipitation of 40.5 cm. Approximately 40% of the average annual precipitation occurs during the monsoon season (July-September) and 30% during winter months (December-February). The Blue Ridge Reservoir station typically receives about 14 cm (29%) more precipitation than does Montezuma Castle. The winter of 2013-2014 produced only 33% of the historical precipitation average, while the 2014-2015 winter season received 142% of the average. The monsoon seasons (July-September) in 2014 and 2015 were above average with 162% and 180% of the total historical average precipitation, respectively. The average daily temperature at the west station was 0.6° C warmer than the east station (WRCC 2015). When temperature data from both stations for the past 50 years were averaged, December had the coldest average daily temperature at 2.4° C, while July averaged 24° C as the warmest month.

Plant surveys in West Clear Creek canyon began in 1866 when Dr. Edward Palmer was was stationed at Camp Lincoln in the Verde Valley (McVaugh 1956). Dr. Palmer produced a logbook from his collecting efforts; however, when he left the camp to seek medical attention in Prescott, he was unable to carry his collections with him. Upon his return, he was informed that the entirety of his plant specimens had been discarded in his absence (McVaugh 1956). The earliest existing plant collections from WCCW include three fern specimens collected by Dr. Jack States in 1973 (SEINet 2015) along the Tramway Trail. Following this, various collectors produced only 38 additional collections within the wilderness until 2001 when Richard Bond began collecting specimens within WCCW as part of his M.S. thesis at Arizona State University (Bond 2006). Between 2001 and 2006, Bond vouchered 250 specimens, representing 167 taxa, inside the wilderness, which are

deposited at Arizona State University (ASU), Northern Arizona University (ASC), and the Desert Botanic Garden (DES) herbaria. Additional important collectors include B.G. Phillips, G. Rink, H.D. Hammond, J.C. Baldwin, M. Licher, M.D. Windham, and Z.M. Zdinack. The ASC, ASU, DES, Museum of Northern Arizona (MNA), and Coconino National Forest (COC-AZ) herbaria are the primary repositories for these collections (SEINet 2015).

METHODS

Field Collections

Vascular plants were collected over 56 days between February and October of 2013 through 2015, with one additional collecting day in March 2016. The objectives were to collect every taxon and to collect throughout the entire geographic range of the study area. Once a common taxon was collected, it was not recollected unless the new finding was thought to occur in uncommon habitat. Special effort was made to collect from areas with unique habitat that might harbor greater diversity or locally unusual taxa. Voucher collection information included dates, plant descriptions, habitat descriptions, locality descriptions, and lists of associated species. UTM coordinates and elevations were taken from a Garmin GPSmap 76CSx GPS unit (Garmin International; Olathe, KS). Voucher specimens were pressed, dried, mounted, and deposited at ASC following standard protocols (Weber 1976). Duplicates were provided to COC-AZ in Flagstaff, AZ and triplicates to ASU. Specimens were primarily identified using Arizona Flora (Kearney et al. 1961), the Flora of North America (Flora of North American Editorial Committee 1993+), and treatments from Vascular Plants of Arizona (Vascular Plants of Arizona Editorial Committee 1992+). Nomenclature follows the Integrated Taxonomic Information System database (ITIS 2015). When appropriate, I followed the standards for writing floras as described by Palmer et al. (1995).

Herbarium Searches

Digital searches were undertaken for all collections within the Southwestern Environmental Information Network (SEINet) Regional Herbaria Network based on place

names within the study area in 2015. A search for georeferenced specimens within SEINet was also completed at this time (SEINet 2015).

Statistical Analyses

I applied various species richness estimates to assess completeness of the WCCW flora. A species accumulation curve, bootstrap estimate, and first-order jackknife estimate were generated using the Vegan package in R (Oksanen 2016). The input data for each of these analyses was a matrix of the total collections made during this survey by their associated collection date (total of 56 collection days). The species accumulation curve graphs the cumulative number of novel species as a function of collecting effort, and is represented by total number of collecting days here. Early in the collecting effort, the curve's steep slope reflects the high frequency of encountering new species. As collection effort increases across heterogeneous environments, the curve (and accumulation of new species) approaches an asymptote. The bootstrap and jackknife nonparametric methods were also implemented to estimate species richness within WCCW. The Bootstrap method samples the data with replacement to create a novel estimate of the original sample mean, where each sample set is of identical size as the original sample (n) (Efron 1979; Smith and van Belle 1994). The jackknife method is similar to the bootstrap method, but it samples without replacement to create an overall sample mean estimate (Efron and Stein 1981; Smith and van Belle 1994).

Bowers and McLaughlin (1982) developed a predictive multiple regression based on elevation range and collecting time using 20 Arizona floras. The Bowers and McLaughlin (1982) multiple regression equation is:

$$S_E = 47 + 0.349E + 8.20T$$

Where S_E = estimated species richness, E = elevation range (in meters) and T = collection time, to the nearest 0.5 year. Total collection time in WCCW was summed for all SEINet collection records in WCCW for a total of 11.5 years (SEINet 2015).

In 1996, Bowers and McLaughlin developed another predictive regression based only on elevation using a sample of 24 local floras. This regression exhibited a positive correlation between elevation range and species richness. This regression equation is as follows:

$$S_E = 264 + 0.274E$$

Bowers and McLaughlin (1982) identified three factors associated with relative richness: vegetation community type, aquatic habitats, and canyon environments. WCCW is predominately a canyon environment with perennial water. Consequently, comparing only local floras that include canyons, perennial water, or both might develop a more accurate predictive regression than those developed by Bowers and McLaughlin. Therefore, nine such floristic inventories within Arizona, plus one in New Mexico and Utah were used for this purpose: Aravaipa Canyon (SEINet 2015), Bandelier National Monument (Jacobs 1989), Canyon de Chelly National Monument (Rink 2005), Chiricahua National Monument (SDN 2015), Grand Canyon National Park (NPS 2015), Lower Little Colorado River (Crawford 2015), Sierra Ancha Wilderness (Imdorf 1995), Upper Verde River (Coburn 2015), Walnut Canyon National Monument (SEINet 2015), West Fork of Oak Creek (Gilbert and Licher 2005), and Zion National Park (Fertig and Alexander 2009). All vascular plant checklists, with the exception of the Lower Little Colorado River flora, were retrieved from SEINet (2015) to acquire the most updated lists available. Species names from all checklists

were synonymized using ITIS (2015) and native status was verified using the U.S. Department of Agriculture Plants Database (USDA 2015). Elevation range and area of flora were preferentially recorded from the associated publication or SEINet. This data was verified using USGS topographic maps when it was otherwise unavailable through the previous sources.

Comparison of Canyon and Non-canyon Floras

I employed the Otsuka Index of Similarity to compare the floristic affinity of WCCW with each of the eleven floras above. I added eight more floras to this analysis so similarity could also be compared to non-canyon floras. The eight new floras include one additional canyon flora and seven non-canyon floras: Canelo Hills (SEINet 2015), El Malpais National Monument (SEINet 2015), Lower San Francisco and Volcanic Field (Christie 2008), Petrified Forest National Park (SEINet 2015), Santa Teresa Mountains (Buegge 2001), Upper Basin and Coconino Rim (Olmon 2013), Wupatki National Monument (SEINet 2015), and Zion National Park. The Otsuka Index of Similarity minimizes the effects on similarity caused by disparate sizes of paired floras (McLaughlin 1986). Floras were compared at species and genus levels, and only native taxa were considered. The formula for the Otsuka Index (S) is as follows:

$$S(o) = c/(a \times b)^{1/2}$$

Where c = number of native taxa shared by both floras, a = number of native taxa in flora one, and b = number of native taxa in flora two. The resulting values range from 0 to 1, where 0 = no similarity and 1 = highest degree of similarity (McLaughlin 1986; Hill 2005).

Canyon floras have high species richness relative to floras not centered about major canyon features (Bowers and McLaughlin 1982). To test this concept, eight vascular floras

where a major canyon (or canyons) comprises a substantial portion of their area were compared to eight vascular floras without a major canyon present. All floras occur within the Colorado Plateau or Apachian floristic areas, which lie adjacent to the Mogollon Rim. An equal number of canyon and non-canyon floras were compared within each floristic element. Vascular species checklists for each flora were retrieved from SEINet (2015) and species names were synonymized using ITIS (2015). The five canyon floras from the Colorado Plateau were Canyon de Chelly National Monument, Grand Canyon National Park, Lower Little Colorado River, Walnut Canyon National Monument, and Zion National Park. The five Colorado Plateau noncayon floras included El Malpais National Monument, the Lower San Francisco Volcanic Field, Petrified Forest National Park, Upper Basin and Coconino Rim, and Wupatki National Monument. The three canyon floras from the Apachian floristic element were Aravaipa Canyon, Chiricahua National Monument, and the Sierra Ancha Wilderness Area. The three non-canyon Apachian floras were the Canelo Hills, Santa Teresa Mountains, and the Upper Verde River.

To compare diversity between canyon and non-canyon floras, I contrasted the number of distinct versus shared native species and genera between floras of each category. I also developed simple and multiple regressions using both continuous (elevation range and area) and categorical (canyon or non-canyon) independent variables to determine which best predicted total number of native species in a given flora. Finally, I created a simple linear regression using distance of a given flora from WCCW as the predictive variable and floristic similarity as the response variable. Here, I estimated centroid coordinates in degrees latitude and longitude for all 17 floras to calculate each flora's distance from WCCW. I then calculated Otsuka Similarity values for the combination

of each of the floras with WCCW. The resulting regression analysis was generated using the Vegan package in R (Oksanen 2016).

RESULTS

Floristic Inventory

A total of 1,035 collections were vouchered over 56 days. These collections comprised 543 unique taxa, including 535 species. Of the 542 taxa, 68 were identified to sub-specific rank (29 subspecies and 39 varieties). Herbaria searches uncovered a total of 426 previous collections in WCCW, representing 223 taxa. Fifty-one of these taxa were not collected during this survey. These combined results identified 594 total taxa within WCCW. This inventory vouchered 371 taxa previously undocumented in the area, representing a 166% increase in the known flora. Eleven of the previously collected taxa were not collected during this survey because they were common species. Forty previously collected taxa were not encountered during this survey (these taxa are indicated by an abundance classification of "0" in Appendix A). Six of the previously documented taxa were collected at the edge of their range: *Agave toumeyana* var. *toumeyana*, *Amelanchier alnifolia*, *Betula occidentalis*, *Desmodium arizonicum*, *Phaseolus maculatus*, and *Solanum stoloniferum*. Two taxa have been collected fewer than five times in the state: *Aquilegia formosa* var. *formosa* and *Schizachne purpurascens*. The remaining taxa may not have been observed at a time in their phenology when they were clearly identifiable. Alternatively, individuals or populations may occur sporadically or in specialized habitats within WCCW. The annotated checklist (Appendix A) of all vouchered collections of vascular plants from WCCW includes scientific name, life form, abundance, habitat, and a list of voucher collections. Species of conservation concern, exotic or noxious status, new state records, and taxa vouchered by previous collections are indicated with unique symbols.

A total of 93 families, 332 genera, 594 taxa, and 589 species (including 77

infraspecific taxa) have been vouchered within the study area (Table 1). The majority of life forms were forbs (62%), while shrubs/subshrubs and graminoids comprised 16% and 14% of the total flora, respectively. The most species rich families were Asteraceae (87 taxa), Poaceae (65 taxa), Fabaceae (36 taxa), Brassicaceae (28 taxa), Rosaceae (19 taxa), Plantaginaceae (17 taxa), Cyperaceae (16 taxa), and Polygonaceae (15 taxa). Twenty-five families were represented by a single taxon. The most represented genera were *Carex* (12 taxa), *Erigeron* (9 taxa), *Bromus* (8 taxa), *Muhlenbergia* (8 taxa) and *Oenothera* (8 taxa) (Appendix A).

One new state record was vouchered (*Stachys albens*) during this survey. The nearest existing collections occur in the Beaver Dam Wash National Conservation Area, UT (Washington County) and on the Manse Ranch in Pahrump Valley, NV (Nye County), which lie 360 km northwest and 431 km west-northwest of the WCCW collection site, respectively (SEINet 2015). New county records include *Graptopetalum rusbyi* (Coconino), *Phaseolus pedicellatus* var. *grayanus* (Coconino), and *Quercus rugosa* (Coconino and Yavapai). Vouchers within WCCW representing range extensions and range limits in Arizona include *Agave toumeyana* var. *toumeyana*, *Aquilegia formosa* var. *formosa*, *Betula occidentalis*, *Chylismia cardiophylla*, *Desmodium arizonicum*, *Euphorbia melanadenia*, *Graptopetalum rusbyi*, *Lonicera albiflora*, *Micranthes odontoloma*, *Phaseolus maculatus*, *Quercus rugosa*, *Schizachne purpurascens*, and *Solanum stoloniferum* (SEINet 2015).

Three taxa were included on the U.S. Forest Service Region 3 Sensitive Species list: *Actaea arizonica*, *Desmodium metcalfei*, and *Erigeron saxatilis* (USDA Forest Service 2013). Nine taxa were designated as globally vulnerable (G3) or imperiled (G2) by the

NatureServe database (NatureServe 2016): *Actaea arizonica* (G2), *Agave toumeyana* var. *toumeyana* (G3), *Draba asprella* var. *stelligera* (G3), *Eremogone aberrans* (G2), *Erigeron saxatilis* (G3), *Glandularia chiricahensis* (G2G3), *Hymenoxys jamesii* (G2G3), *Lupinus hillii* (G3), and *Phlox cluteana* (G3). One species was included on the Arizona Department of Agriculture list of highly safeguarded protected native plants (List A): *Actaea arizonica*. Thirty-three taxa are found on the State's list of salvage restricted protected native plants (List B) (Table 2).

Forty-three species (7% of total flora) were nonnative; with only one designated as noxious within AZ (*Tribulus terrestris*). Poaceae (16 species), Brassicaceae (6 species), Polygonaceae (6 species) and Fabaceae (4 species) were the most represented families for nonnative taxa. Annual forbs and perennial grasses were the most common nonnative life forms.

According to Brown's classification system (1994), the major biotic communities of WCCW from lowest to highest elevation include interior chaparral, Madrean evergreen woodland, pinyon-juniper woodland, ponderosa pine forest, and mixed conifer forest. Interior riparian deciduous forest, and montane riparian wetland occur along the riparian corridor and small pockets of semidesert grassland are found near the west end of the wilderness boundary. For 568 out of the total 594 known taxa from WCCW, it was possible to identify the biotic community in which biotic community voucher collections were made based on the associated collection information. Some taxa were collected from more than one biotic community. Of the 568 taxa, 34% were collected in ponderosa pine forest. Collections from mixed conifer forest (29%), montane riparian woodland (25%), Madrean

evergreen woodland (18%), interior chaparral (17%), Interior riparian deciduous woodland (15%), and pinyon-juniper woodland (11%) generally reflect the relative size of the community within WCCW based on general observations. Approximately three percent were collected from springs and seeps, although this community comprises much less than 1% of the total area of WCCW. One point six percent of these collections occurred within semidesert grassland at the southwestern edge of WCCW.

The species accumulation curve (Figure 3) maintains a steep slope in the final collecting days, which suggests that this flora is not complete. Due to the brevity of the project and selective nature of collecting (targeting heterogeneous habitats to maximize collections of novel species), a species accumulation curve may not be the most appropriate richness estimator. The bootstrap and first-order jackknife methods produced estimated species richness values of 666 and 816 species, respectively (Table 3). The Bowers and McLaughlin (1982) multiple regression equation produced a richness estimation of 523 species. The Bowers and McLaughlin (1996) simple regression equation estimated richness to be 559 species.

Previous studies have shown that elevation and area are positively correlated with species richness (Barton and Teeri 1993; Bowers and McLaughlin 1982; Bowers and McLaughlin 1996; Crawford et al. 1999; Harner and Harper 1976; Poulos et al. 2007). Scatterplots with area and elevation range plotted individually against the total number of species for the ten floras expressed positive, linear trends. A linear regression with area as the independent variable and total species as the dependent variable predicted 612 species should occur within WCCW. This regression produced a p-value of 0.0002, suggesting that

area has a significant effect on total number of species. The adjusted R-squared value was 0.77. This value accounts for all independent variables input into any given regression, the sample size, and is adjusted based on the degrees of freedom. It is interpreted as the portion of the variance in the dependent variable that can be explained by the independent variable(s). This R-squared value suggests that 77% of the variance in total species present within a particular flora is attributed to area. Another linear regression using elevation range as the independent variable predicted that WCCW harbors 729 species. The associated p-value was 0.004 and the adjusted R-squared value was 0.58. These values suggest that elevation range significantly affects the total number of species within an area. Regression analyses can be refined when multiple significant variables are used. Therefore, a multiple regression was generated using both area and elevation range as independent variables to predict total species present within WCCW. For this multiple regression, the associated p-values for area and elevation range were 0.005 and 0.075, respectively. The adjusted R-squared value was 0.83. The number of species predicted to occur within WCCW was 643, and the associated regression equation was:

$$S_E = 448.7 + 0.001739A + 0.1678E$$

Where S_E = estimated species richness, A = total area (in hectares), and E = elevation range (in meters).

Comparison of Canyon and Non-canyon Floras

The Otsuka Similarity Index was used to show floristic similarity between WCCW and other canyons in the Southwest, and to contrast similarity between canyons and non-

canyons. At the species level, similarity ranged from 0.58 (West Fork of Oak Creek) to 0.27 (Lower Little Colorado River). The West Fork of Oak Creek was the only flora with a similarity value greater than 0.5 (Table 4). When these areas were compared to WCCW at the genus level, the Otsuka Index showed similarity values ranging from 0.76 (West Fork of Oak Creek) to 0.53 (Lower Little Colorado River).

In general, canyon floras exhibited greater diversity and shared more species than non-canyon floras (Table 5). Canyon and non-canyon floras hosted a combined total of 2,524 species and 774 genera. Canyon floras hosted 2,291 species (91% of total species), while non-canyon floras included 1,434 species (57% of total species). Forty-eight percent of the species found within canyons were exclusive to canyon floras, while only 16% of non-canyon species occurred exclusively in like floras. Canyon floras collectively included 725 genera, 29% of which were exclusive to canyon floras. Non-canyon floras hosted 371 genera, with 13% only occurring in non-canyons. These trends held when floras were contrasted by floristic areas. Colorado Plateau floras collectively included 1,997 species, with 735 species (37%) shared between canyons and non-canyons. Canyons hosted 1,813 of these species (91% of total species), while non-canyons hosted 920 species (46% of the total). Colorado Plateau floras collectively included 633 genera, with 344 (54%) shared between both canyons and non-canyons. Canyons comprised 96% of the total genera (605) and non-canyons hosted 59% (371) of total genera. Apachian floras collectively included 1,410 native species, with 660 (47%) species shared between canyons and non-canyons. Apachian canyons included 1,125 of these species (80% of the total), while non-canyons included 945 of the total species (67%). Apachian floras collectively included 584 genera, with 389 (67%) shared between canyons and non-canyons. Canyon floras included 507

(87%) of the total genera, while non-canyons included 465 genera (80% of the total).

Using the 16 comparative floras, three separate linear regression analyses revealed that each of three independent variables (area, elevation range, and categorical variables of 'canyon' or 'non-canyon') significantly affected total native species within a flora. Area and elevation range produced p-values of 0.0004 and 0.0002, respectively, suggesting strong significance. The categorical variable produced a moderately significant p-value of 0.066. The R-squared values for area, elevation range, and the categorical variables were 0.60, 0.64, and 0.22, respectively. Because elevation range and presence of a major canyon each strongly influences the other, multicollinearity results when both elevation range and categorical identification as 'canyon' or 'non-canyon' are included in a multiple regression analysis. Therefore, two multiple regression analyses were generated. The first included area and elevation range as the independent variables, while the second paired area with the categorical variables. The first multiple regression pairing area with elevation range produced p-values of 0.018 and 0.010, respectively. The adjusted R-squared value was 0.73, suggesting the combination of these two variables explained more of the variance when predicting total native species within a given flora. The second multiple regression pairing area with the categorical variables canyon or non-canyon produced p-values of 0.0002 and 0.028, respectively. The adjusted R-squared value was 0.69, suggesting the combination of these two variables also improved predictions of total native species within a flora than either of the two independent variables did exclusively. While both of the pairings in the multiple regression proved significant, the combination of area and elevation range produced a slightly greater adjusted R-squared value.

Finally, the similarity by distance simple regression with geographic distance from WCCW as the independent variable and Otsuka Similarity as the dependent variable generated a p-value of 0.667 and R-squared value of 0.01. With this data, we can infer that distance from WCCW does not significantly or accurately predict similarity of a flora to WCCW. When these variables are graphed (Figure 4), the observed trend is that canyon floras show greater similarity to WCCW on average as compared to non-canyon floras. Additionally, when the categorical variables of 'canyon' versus 'non-canyon' comprised the independent variable here, the associated p-value was 0.0343 and the R-squared value was 0.28. This data suggests that presence of a major canyon feature has a larger impact on similarity than does geographic distance.

DISCUSSION

Floristic Inventory

Both species richness estimates produced by the Bowers and McLaughlin regression formulas underestimated observed diversity in WCCW. However, the majority of floras used to develop these models did not occur within canyon environments or include perennial water; two of the variables Bowers and McLaughlin (1982) directly cite as positively influencing richness. The first-order jackknife and bootstrap methods rely on identifying the frequency of rare species in a sample to generate estimates of undetected species in an assemblage (Gotelli and Chao 2013). This data is often acquired via plots distributed throughout the study site. Recording a thorough and accurate list of associated species for each specimen collection can also generate frequency data for each species; however, because most species remained unidentified during the first two field seasons, the associated species lists produced in this study were inadequate for this purpose. Therefore, consistent frequency data was not collected during these surveys, and consequently, it is likely that the jackknife and bootstrap results overestimate species richness in WCCW. Probably the most accurate species richness predictions were those produced using the 10 floras selected here based on their similarity with WCCW. The R-squared value of these simple regressions suggests that area and elevation accounted for 83% and 55% of the variability in species richness, respectively. Because both factors significantly influence richness, and the value of one does not strongly drive the other, multicollinearity is minimal. This model predicts a total richness of 643 species, inferring the flora is 92% complete, with 49 species still undiscovered within WCCW.

There are several factors influencing overall plant species diversity within WCCW.

These include elevation range, perennial riparian habitat, presence of several springs, variety of aspects, geologic substrate, and relative lack of human disturbance. Diversity in WCCW is also impacted by its presence along the Mogollon Rim near the convergence of several distinct floristic areas (McLaughlin 2007). Bowers and McLaughlin (1986) explored the distributions of native, terrestrial, vascular plants occurring throughout the Basin and Range and Colorado Plateau physiographic provinces of the southwestern U.S. This study identified seven floristic communities, including one identified as the Mogollon Rim. It was described as being "centered in the mountainous region of central New Mexico, extending into Arizona along the Mogollon Rim, across the Kaibab Plateau, and onto the central Wasatch Plateau of south central Utah." This floristic community was modified by McLaughlin (1989) to be included in the Southern Rocky Mountain – Mogollon element occurring in the mountains of west-central New Mexico and the Mogollon Region of east-central Arizona. However, McLaughlin adds the caveat "there are not enough OGUs (operational geographic units) from the Mogollon Rim area included in this study to firmly establish the affinities of that area." Despite being uncertain whether the Mogollon Region deserves its own classification as a floristic entity, it is clear that this area is uniquely influenced by the convergence of three distinct adjacent communities: the Colorado Plateau, Southern Rocky Mountains and the Apachian region of southeastern Arizona. Canyon environments that bisect Mogollon Rim provide a wide range of habitats and microclimates across a broad elevation range. Consequently, the Mogollon Region may serve as a "melting pot" where species predominately associated with neighboring regions converge to form a completely unique floristic alliance.

Plant species representing new county records and range extensions further

support the diverse influence that neighboring floristic communities have on the Mogollon Region. SEINet (2015) species distribution maps show that most of the county records from WCCW are species that are typically associated with the Apachian floristic community. Of the 13 taxa representing range extensions within WCCW, seven mainly occur within the Apachian floristic range: *Agave toumeyana* var. *toumeyana*, *Desmodium arizonicum*, *Euphorbia melanadenia*, *Lonicera albiflora*, *Phaseolus maculatus*, *Quercus rugosa*, and *Solanum stoloniferum*. *Phaseolus maculatus*, *Solanum stoloniferum* and *Lonicera albiflora* also show overlap into the Southern Rocky Mountain Mogollon (SRMM) range. The range of *Chylismia cardiophylla* shows a strong affinity to the Sonoran floristic community. *Betula occidentalis* and *Micranthes odontoloma* primarily occur within the Colorado Plateau and Southern Rocky Mountain – Mogollon (SRMM) communities. There are only three collections of *Aquilegia formosa* var. *formosa* and *Schizachne purpurascens* in Arizona. The first taxon is more prevalent on the Colorado Plateau and Great Basin, while the range of the second aligns with the SRMM. *Stachys albens*, the new state record, mainly ranges within the California Sierra Nevada and Peninsular floristic communities. These combined records suggest that WCCW provides habitat suitable to taxa from a broad range of floristic areas, creating a unique floristic assemblage. These results might also suggest that the Mogollon Region is the remnant of an ancient floristic region, which previously had a more extensive and continuous reach. In the current climatic regime, this region may serve as an important dispersal corridor between neighboring floristic areas of the present day.

The Otsuka Similarity Index (OSI) results further support the Mogollon Region as a unique floristic community. At a species level comparison, the only flora with an OSI value

greater than 0.5 was the West Fork of Oak Creek (WFOC), which also bisects the Mogollon Rim. When floras were compared at the genus level, WFOC remained the most similar flora to WCCW with a factor of 0.76. The next most similar floras at the genus level were the Sierra Ancha Wilderness (0.69) and Grand Canyon National Park (0.69). Bandelier National Monument followed closely behind with an OSI factor of 0.68. Each of these three floras represents one of the distinct floristic communities lying adjacent to the Mogollon Region. Sierra Ancha Wilderness is located within the Apachian community, Grand Canyon National Park is found within the Colorado Plateau community, and Bandelier National Monument is located within the Southern Rocky Mountain-Mogollon community. In similarity comparisons at both scales, the two least similar floras were Aravaipa Canyon and the Lower Little Colorado River Canyon. While both include canyon environments, there is little overlap in their associated biotic communities with those of WCCW. Aravaipa Canyon receives strong influence from the Sonoran Desert flora and its major biotic communities include Sonoran desertscrub, desert grassland, and semi-desert scrubland (BLM 2015). While these communities are missing from WCCW, some overlap exists with the interior chaparral and deciduous riparian forest biotic communities. The major biotic communities of the Lower Little Colorado River Canyon include: Great Basin woodland, Great Basin desertscrub, warm desertscrub, and warm-temperate desert riparian (Crawford 2015). These communities are not represented in WCCW, and are more representative of climates both drier and colder than that of WCCW.

It is not surprising that the OSI compared at species level resulted in lower similarity values than when floras were compared by genus. In McLaughlin's (1986) analysis of 50 floras throughout the Southwest, the average number of floras that shared

the same species was 4.07, with nearly two-thirds of the species occurring in three or fewer floras. Most of the widespread species were represented by infraspecific taxa, indicating the genetic variability of these species across their range. In the Southwest there is a pattern of having a high ratio of species per genus (McLaughlin 1986). Many of the species within large genera that are characteristic of the Southwest are uncommon, with a high proportion of these species being endemic. These families include Fabaceae, Brassicaceae, Polygonaceae and Cactaceae. Five of the most common genera of the Southwest (*Eriogonum*, *Astragalus*, *Cryptantha*, *Penstemon*, and *Phacelia*) also exhibited a high proportion of endemic species (McLaughlin 1986). Therefore, while it is important to note the similarity of WCCW with WFOC even at the species level, it may be more reasonable to compare floras at the generic level.

It is also no surprise that, of the ten floras, WFOC is the most similar to WCCW. Of the ten floras, WFOC is nearest to WCCW, lying 48 km northwest. Both of these areas bisect the Mogollon Rim and the elevation range of WFOC (1,610-2,130 m) is entirely included within the more expansive range of WCCW. Gilbert and Licher (2005) identify the major biotic communities within WFOC as chaparral, ponderosa pine forest, mixed conifer forest, and riparian deciduous forest, which WCCW also hosts. Dissimilarities between these areas also exist, explaining why the OSI was not larger. The elevation range is over twice as great in WCCW, providing climate suitable for biotic communities largely absent from WFOC: Madrean evergreen woodland and semidesert grassland. The geology of these two areas also differs. The Schnebly Hill Formation is unique to WFOC (Gilbert and Licher 2005), while the Supai Formation is unique to WCCW.

Comparison of Canyon and Non-canyon Floras

On average, canyon floras hosted 160% more species than were found in non-canyon floras; however, it is fair to question whether the difference in area was responsible. The total average area for canyon floras was 175% greater than that of non-canyon floras. Since area has been shown to have a positive impact on species diversity it could be argued that area is what drives the disparity in overall diversity between canyons and non-canyons (Barton 1992; Bowers and McLaughlin 1982; Bowers and McLaughlin 1996; Crawford 1999; Harner and Harper 1976; Poulos 2007). The three largest floras in this analysis were Petrified Forest National Park (non-canyon - 89,686 ha), the Lower San Francisco Volcanic Field (non-canyon - 113,400 ha), and Grand Canyon National Park (canyon - 424,200). Grand Canyon National Park is clearly an outlier with an area nearly four times greater than the next largest flora. Perhaps its massive area adds some amount of bias when considering its equally impressive floristic diversity of 1,400 native species. However, there is strong evidence that this size discrepancy is ultimately insignificant in these comparisons. First, when contrasting floras of the Apachian floristic element, the non-canyon floras are nearly 200% larger on average than corresponding canyon floras. Despite the size difference, the trend of finding greater diversity amongst canyon floras is consistent. Second, there are several examples of individual canyon floras used in this analysis with more species than non-canyon floras of similar or greater size. For example, Zion National Park includes 1,040 native species within an area of 59,900 ha, while Petrified National Forest is only known to host 428 native species within a larger area of 89,686 ha. Aravaipa Canyon has 440 native species recorded within 7,972 ha, while only 392 species are known from the 22,590 ha spanning the Santa Teresa Mountains flora.

Walnut Canyon includes 435 native species within 1,452 ha; while nearby Wupatki National Monument has only 332 native species across an area nearly 10 times larger (14,334 ha). This evidence is supportive that, despite the greater average size of canyon floras as a whole, the trend showing greater overall diversity in canyon floras is warranted.

Canyons are capable of hosting an incredibly broad array of species, providing unique habitat in areas where these species might otherwise be unable to persist. Nearly 50% of the species found across canyon floras were absent from non-canyon floras. This dwarfs the 16% of species found exclusively in non-canyon floras. Canyon floras also included 91% and 94% of the total species and genera identified by both canyon and non-canyon floras, respectively. Non-canyon floras included only 57% and 48% of the total species and genera, respectively. According to Stein (2002), with over 3,500 plant species, Arizona ranks as the third most diverse state in the nation. The eight Arizona canyon floras used in this study (Aravaipa canyon, Canyon de Chelly National Monument, Grand Canyon National Park, Chiricahua National Monument, Lower Little Colorado River, Sierra Ancha Wilderness, West Fork of Oak Creek, and West Clear Creek Wilderness) collectively host 2,417 native species within a combined area of 573,318 ha, or 70% of the total diversity found within just 2% of the total area of the entire state (29,526,000 ha). Canyons are capable of including myriad microhabitats suitable for plants with such diverse needs because of their great topographic variation, broad elevation ranges, wide variety of geologic formations and associated substrates, climatic buffering and influence from surrounding biogeographic provinces (Stebbins and Major 1965; Richerson and Lum 1980; Harrison and Inouye 2002; Christie et al. 2011).

Canyons may also act as important refugia, providing suitable habitat for plant species with shifting ranges. Topographic complexity provides climatic buffering and abundant niches, features that enable species to persist, and perhaps, avoid local extirpation (Lancaster and Kay 2012; Irl et al. 2015). For example, Brown (1994) describes Interior Riparian Deciduous Forests and Woodlands as relictual communities, adapted to Early Tertiary climates that have since "retreated to pockets where the warm temperate (ancient) climate persists". In Arizona, these pockets include canyons that serve as cold-air drainages and often include north facing slopes. According to SEINet (2015), several individual taxa occur at the lower limits of their elevation range in WCCW and other canyons throughout the state. Species such as *Acer glabrum, Anticlea elegans*, *Aralia racemosa, Actaea rubra, Asplenium septentrionale, Dryopteris filix-mas, Maianthemum stellatum, Ribes pinetorum, Sambucus racemosa, Sedum cockerellii,* and *Valeriana edulis* are typically encountered at high elevations in montane environments. These species have apparently avoided local extirpation at lower elevation localities by inhabiting cold-air drainages (e.g. canyons) as their once more-extensive ranges slowly receded to higher elevations when the climate warmed.

Natural disturbance regimes drive diversity in canyon environments (Zimmerman et al. 1999). Regular disturbance events contribute to environmental heterogeneity and, in some cases, reduce the effects of competitive dominance (Miller 2011; Banks 2013). It is thought that biodiversity may be most pronounced at intermediate disturbance levels, with more extreme levels of disturbance more often resulting in species loss or invasion (Miller 2011). Zimmerman et al. (1999) found that light and flood disturbance were central drivers of the abundance and distribution of understory plant species in a canyon system along the

Mogollon Rim. Fire is another natural disturbance capable of influencing diversity; however, these events tend to occur with less frequency in canyons. While more research is needed to untangle the complex relationship between frequency and intensity of disturbance events and their effects on canyon diversity, there is no question that they are significant in shaping plant communities in these systems.

Krause et al. (2015) indicated precipitation, soil type, and dispersal ability as the three limiting factors to plant distribution and diversity. Canyons are ideal environments for facilitating dispersal and diversity because they often include favorable conditions for all three of these factors. Broad elevation ranges and varied topography allow plant species to move up and down in elevation with relative ease as they escape temperatures or moisture regimes beyond their tolerance. Canyons also typically cut through multiple geologic layers, exposing an assortment of substrates. The summer monsoon season across the southwestern U.S. provides moisture and cooler temperatures during the hottest and driest part of the year. Canyons such as WCCW, which occurs along a plateau that rises from lower terrain, further benefits from the increased moisture that results from the altitudinal gradient.

Finally, according to Lancaster and Kay (2012), high plant diversity in a concentrated area may be fostered by any combination of high speciation rates, high immigration rates, and low extinction rates. While it is difficult to speculate here on speciation rates within canyon systems, the results in this paper bring to light the potential of high immigration rates and low extinction rates as co-conspiring to manifest and maintain such high diversity in these canyon systems. Understanding more about the role

canyons play in maintaining local biodiversity, and facilitating dispersal could benefit conservation efforts in these species-rich areas (Lancaster and Kay 2012).

Conclusions

This inventory has contributed significantly to the floristic records of West Clear Creek Wilderness by vouchering 542 additional records for the area, and reviewing (with occasional annotations) an additional 428 previous collections. Additionally, 1,035 new collections were contributed to local herbaria, which will be publically available into perpetuity for future research and public use. This inventory also gathered information useful for local land managers, including data on rare and endemic plants, invasive species, and secondary field observations which will hopefully be useful for future decision making and conservation planning. Further, this study presents evidence that the Mogollon Region might represent an entirely unique floristic element. The completion of more local floras and their corresponding data are necessary for clearer resolution. This study contributes to this effort and further provides greater knowledge of the overall flora of Arizona.

This study quantifies the remarkable biodiversity found within canyon systems in the Southwest and provides direct floristic comparisons with adjacent, less topographically complex areas. These results document that canyon communities provide critical and varied habitat in the Desert Southwest. These canyons have likely played an instrumental role in plant dispersal during the previous millennia. They have certainly served as centers of accumulation of plants originating from varied habitats and distant floristic provinces. In an age of potentially intensified climate change, they will continue to serve as places of refuge for an increasing number of displaced species. Protection and mindful stewarding of these canyons may provide much needed habitat for millennia to come.

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Table 1. Summary of vascular plant taxa of West Clear Creek Wilderness.

Category	**Number of Taxa**	**% of Flora**
Taxonomic diversity		
Families	93	
Genera	332	
Species (excluding varieties and subspecies)	589	
Total (including varieties and subspecies)	594	
Life form diversity		
Trees	27	5%
Shrubs & subshrubs	95	16%
Vines	5	1%
Perennial forbs	237	40%
Annual/biennial forbs	129	22%
Perennial graminods	74	12%
Annual graminoids	13	2%
Ferns	13	2%
Spikemosses	1	0.2%
Conservation Concern		
U.S. Forest Service Region 3 sensitive spec	3	0.5%
NatureServe status (G2 or G3)	9	4%
Imperiled (G2)	2	
Vulnerable to imperiled (G2G3)	2	
Vulnerable (G3)	5	
State protected	34	6%
List A: highly safeguarded native plants		
List B: salvage restriected native plants		
Other categories		
Natives	550	93%
Introduced	43	7%
Noxious weeds	1	0.2%

Table 2. Species of conservation concern in West Clear Creek Wilderness.

U.S. Forest Service Region 3 Sensitive Taxa
Actaea arizonica
Desmodium metcalfei
Erigeron saxatilis

NatureServe Globally Vulnerable (G2) or Imperiled (G3) Taxa	
Actaea arizonica	G2
Agave toumeyana var. *toumeyana*	G3
Draba asprella var. *stelligera*	G3
Eremogone aberrans	G2
Erigeron saxatilis	G3
Glandularia chiricahensis	G2G3
Hymenoxys jamesii	G2G3
Lupinus hillii	G3
Phlox cluteana	G3

AZ Dept. of Agriculture List of Highly Safeguarded (List A) and Salvage Restricted (List B) Taxa	
Actaea arizonica	A
Agave parryi	B
Agave toumeyana var. *toumeyana*	B
Allium acuminatum	B
Allium bisceptrum	B
Anticlea elegans	B
Aquilegia chrysantha	B
Aquilegia desertorum	B
Calochortus ambiguus	B
Calochortus flexuosus	B
Calochortus kennedyi	B
Corallorhiza maculata	B
Cylindropuntia acanthocarpa var. *thornberi*	B
Dichelostemma capitatum ssp. *pauciflorum*	B
Echinocereus coccineus	B
Echinocereus engelmannii	B
Epipactis gigantea	B
Eriogonum capillare	B
Escobaria vivipara	B
Fouquieria splendens	B
Graptopetalum rusbyi	B
Lobelia cardinalis	B
Maianthemum racemosum ssp. *amplexicaule*	B
Maianthemum stellatum	B
Malaxis macrostachya	B
Malina micracarpa	B
Opuntia chlorotica	B
Opuntia engelmannii var. *flavispina*	B
Opuntia macrorhiza	B
Opuntia phaeacantha	B
Platanthera sparsiflora	B
Sedum cockerellii	B
Yucca baccata	B
Yucca elata	B

Table 3. Observed species richness and five estimates of species richness for WCCW using two non-parametric models and three regression models to predict actual species richness. The First-order Jackknife and Bootstrap models were generated using the Vegan package in R (Oksanen 2016). The Bowers & McLaughlin 1982 multiple regression used elevation range and collection time from 20 local floras as predictive variables while the 1996 simple linear regression used only elevation to predict species richness. Finally, a multiple regression was developed in this study using area and elevation range as predictive variables for the total species richness estimate.

Species Richness Estimator Method	Species Richness Estimate	Comparison to Observed	Estimate of Completeness
Bootstrap[1]	666	+77	88%
First-order Jackknife[2]	816	+227	72%
Bowers & McLaughlin (1982) Multiple Regression[3]	523	-66	113%
Bowers & McLaughlin (1996) Simple Regression[4]	559	-30	105%
Multiple Regression (area, elevation range)	643	+54	92%
WCCW Observed Species	**589**		

[1] Efron 1979; Smith & van Belle 1994

[2] Smith and van Belle 1984

[3] Bowers & McLaughlin 1982

[4] Bowers & McLaughlin 1996

Table 4. Otsuka Similarity Index values comparing similarity between WCCW with both canyon and non-canyon floras from the adjacent floristic elements: Apachian, Colorado Plateau, and Southern Rocky Mountain-Mogollon.

		Similarity to WCCW	
Flora	**Floristic Area**	**Genus-level Comparison**	**Species-level Comparison**
West Fork of Oak Creek*	Southern Rocky Mountain-Mogollon	0.76	0.58
Sierra Ancha Wilderness*	Apachian	0.69	0.46
Grand Canyon National Park*	Colorado Plateau	0.69	0.45
Bandelier National Monument*	Southern Rocky Mountain	0.68	0.42
Upper Verde River	Apachian	0.67	0.46
Walnut Canyon National Monument*	Colorado Plateau	0.67	0.47
Chiricahua National Monument*	Apachian	0.67	0.42
Canyon de Chelly National Monument*	Colorado Plateau	0.66	0.39
Zion National Park*	Colorado Plateau	0.63	0.39
Upper Basin	Colorado Plateau	0.62	0.38
Lower San Francisco Volcanic Field	Colorado Plateau	0.61	0.38
Aravaipa Canyon*	Apachian	0.60	0.34
Santa Teresa Mountains	Apachian	0.60	0.34
El Malpais National Monument	Colorado Plateau	0.59	0.37
Lower Little Colorado River*	Colorado Plateau	0.53	0.27
Petrified Forest	Colorado Plateau	0.46	0.21
Wupatki National Monument	Colorado Plateau	0.45	0.23
Canelo Hills	Apachian	0.45	0.20

* Denotes a flora with major canyon(s) included

Table 5a. Comparison of native plant diversity between Apachian canyon and non-canyon floras.

	Apachian Floristic Area			
Category	**Canyon Floras**	**Non-canyon Floras**	**Shared**	**Combined**
n =	**3**	**3**		**6**
Area descriptors				
Average area (ha)	7221	14000		
Average elevation range (m)	1294	660		
Species diversity				
Species	1125	945	660	1410
% Species shared by all floras	*9.3%*	*4.7%*		
% Exclusive species	*41.3%*	*30.2%*		
Genus diversity				
Genera	507	465	389	583
% Exclusive genera	*23.3%*	*16.3%*		
% Genera shared by all floras	*29.8%*	*18.9%*		
% Species rich genera*	*3.7%*	*5.8%*		

* Genera represented by ≥ 1% of species of at least one flora

Table 5b. Comparison of native plant diversity between Colorado Plateau canyon and non-canyon floras.

	Colorado Plateau Floristic Area			
Category	**Canyon Floras**	**Non-canyon Floras**	**Shared**	**Combined**
n =	**5**	**5**		**10**
Area descriptors				
Average area (ha)	108890	56233		
Average elevation range (m)	1112	471		
Species diversity				
Species	1813	920	735	1997
% Species shared by all floras	*3.9%*	*6.6%*		
% Exclusive species	*59.5%*	*20.0%*		
Genus diversity				
Genera	605	371	344	633
% Exclusive genera	*43.0%*	*7.3%*		
% Genera shared by all floras	*17.1%*	*20.5%*		
% Species rich genera*	*7.9%*	*13.5%*		

* Genera represented by ≥ 1% of species of at least one flora

Table 5c. Comparison of native plant diversity between all canyon and non-canyon floras.

	Combined Floristic Areas			
Category	**Canyon Floras**	**Non-canyon Floras**	**Shared**	**Combined**
n =	**8**	**8**		**16**
Area descriptors				
Average area (ha)	70764	40395		
Average elevation range (m)	1181	542		
Species diversity				
Species	2291	1434	1201	2524
% Species shared by all floras	*0.6%*	*0.3%*		
% Exclusive species	*47.6%*	*16.2%*		
Genus diversity				
Genera	725	371	19	774
% Exclusive genera	*29.4%*	*13.2%*		
% Genera shared by all floras				
% Species rich genera*				

* Genera represented by ≥ 1% of species of at least one flora

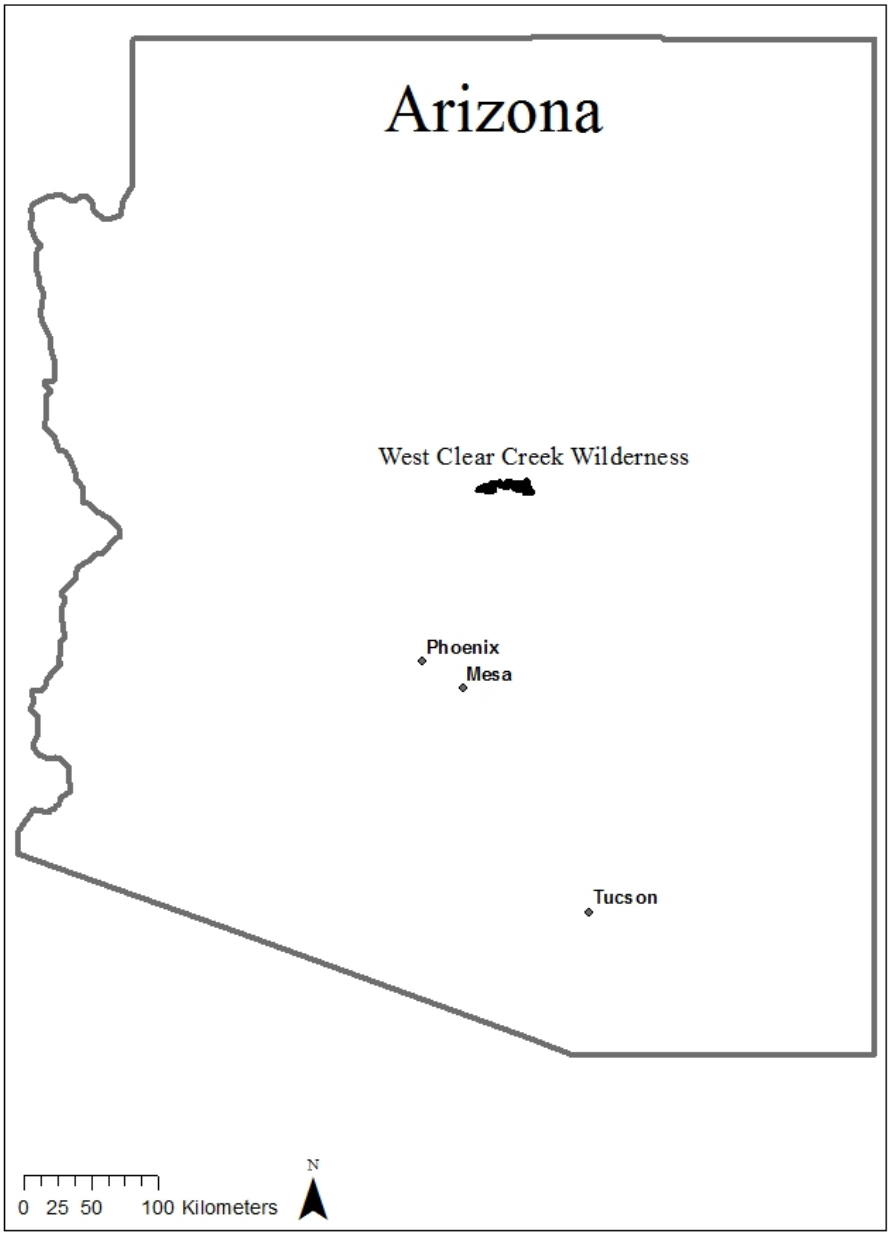

Figure 1. West Clear Creek Wilderness study area.

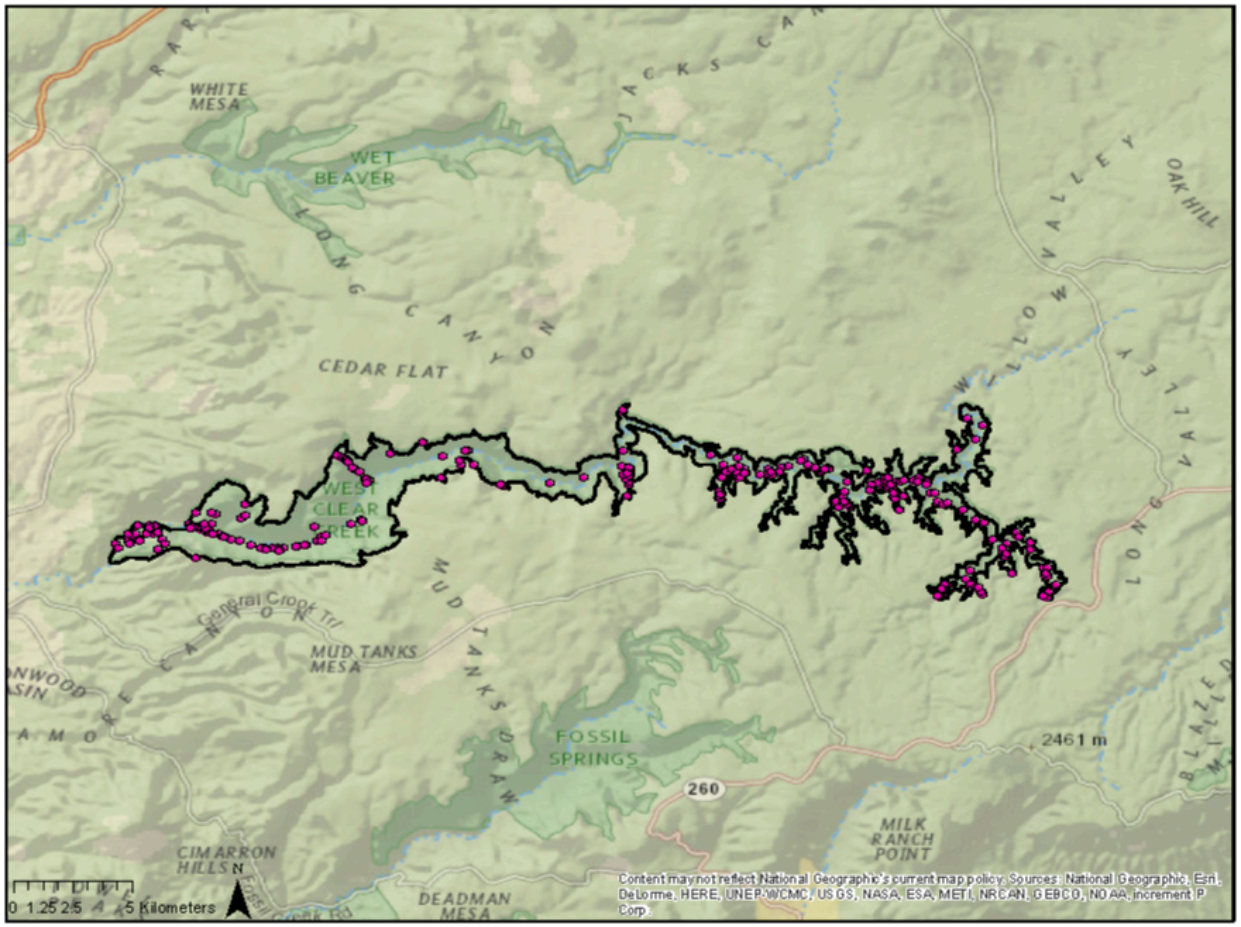

Figure 2. Collection locations for West Clear Creek Wilderness.

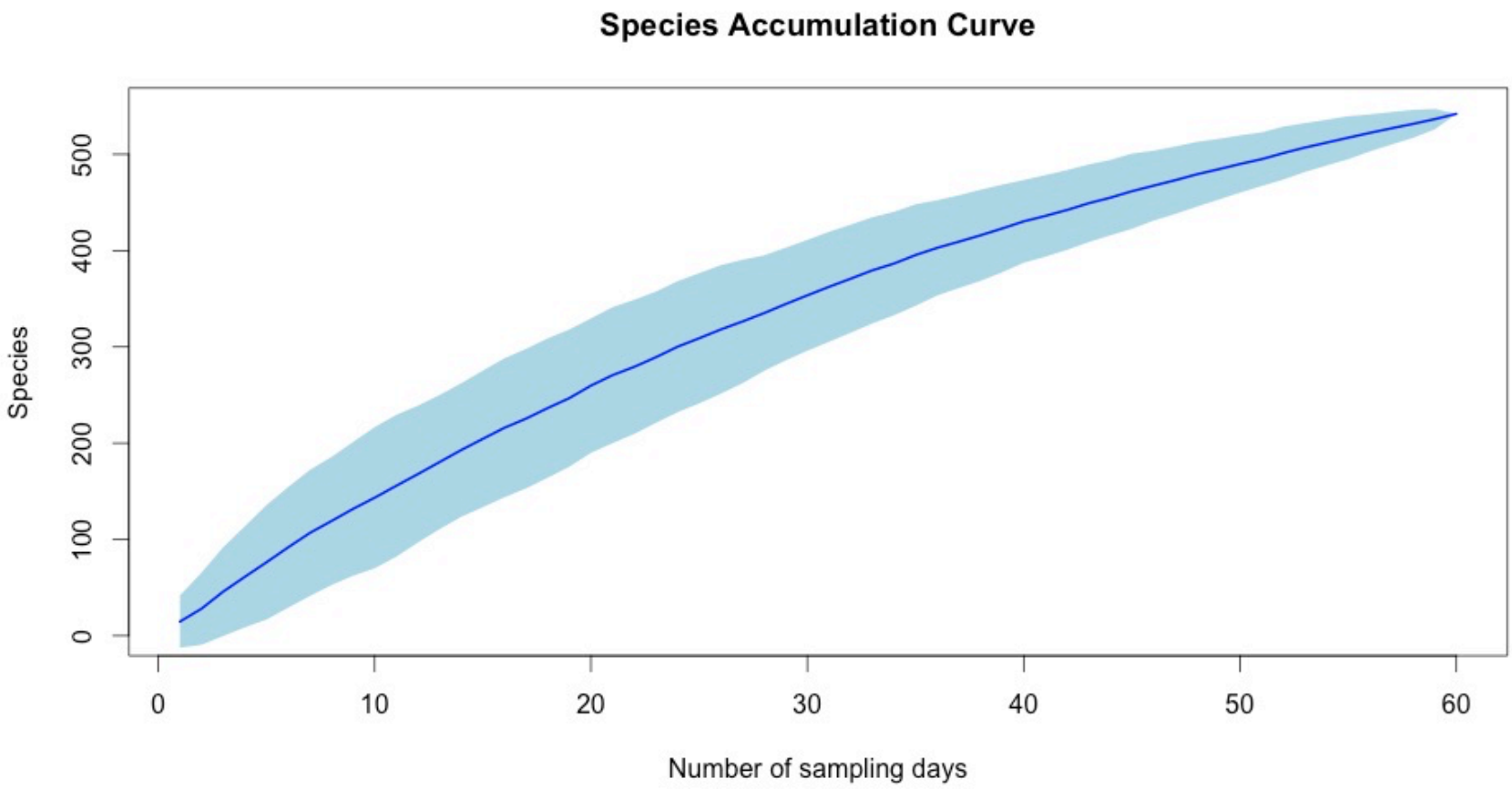

Figure 3. Species accumulation curve of 542 taxa collected over 56 days in West Clear Creek Wilderness.

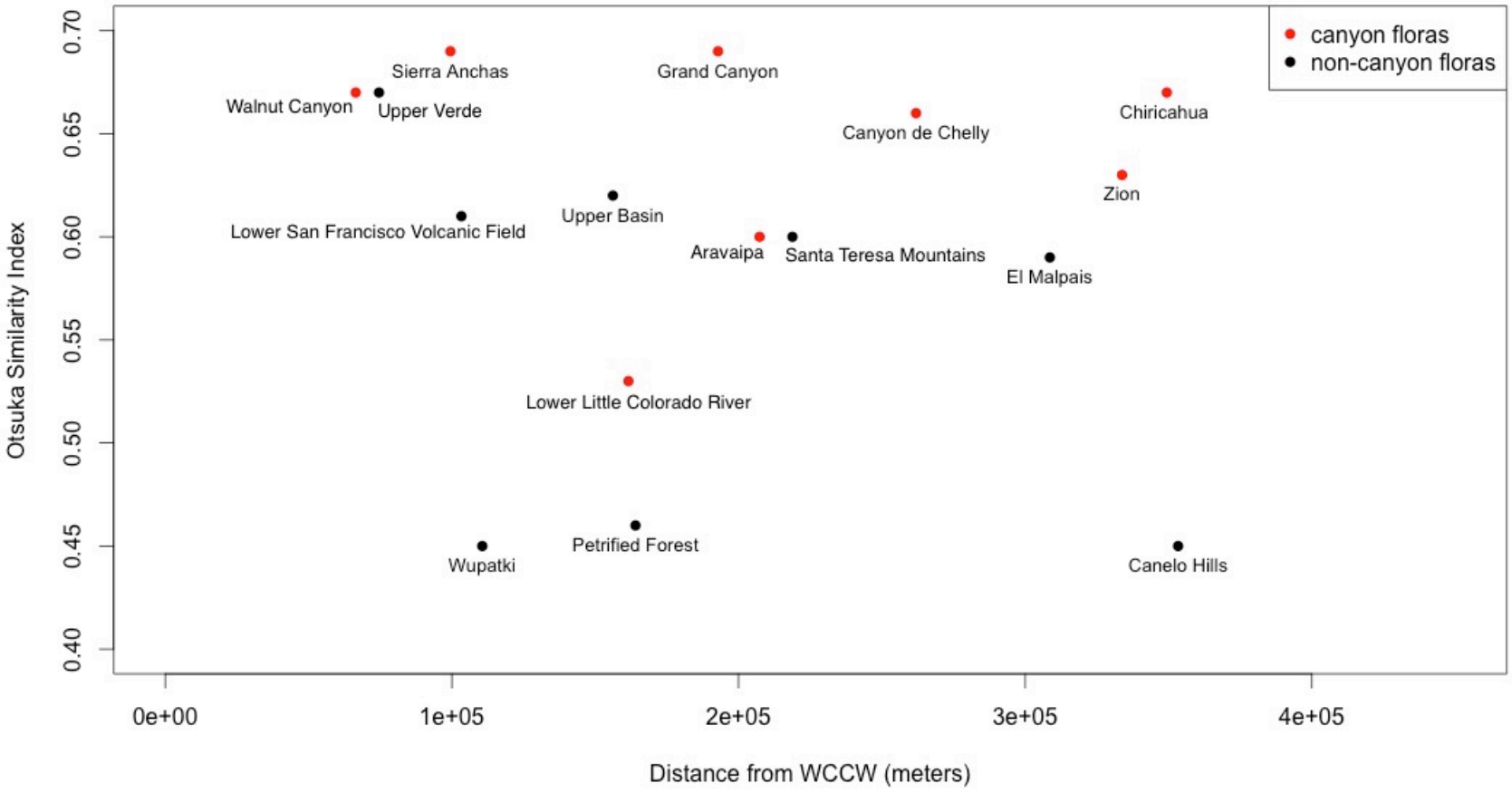

Figure 4. Scatterplot of the relationship between geographic distance of canyon and non-canyon floras from West Clear Creek Wilderness (x-axis) and the associated Otsuka Similarity Index when paired with West Clear Creek Wilderness (y-axis).

APPENDIX A:

ANNOTATED CHECKLIST OF THE VASCULAR PLANTS OF WEST CLEAR CREEK WILDERNESS

Species are arranged first by division and class according to the United States Department of Agriculture PLANTS database (USDA 2016), then alphabetically by family, genus, species and infraspecific rank according to the Integrated Taxonomic Information System (ITIS 2015). Native status, duration and life form descriptions follow the USDA PLANTS database (USDA 2016). Duration classifications include annual, biennial, and perennial. Life form descriptions include spikemoss, fern, graminoid, forb, sub-shrub, shrub, tree, and vine. Abundance classifications are subjective observations and pertain only to WCCW. The abundance classifications follow Palmer et al. (1995) and include: 0 – Unseen, but previously vouchered within the study area, 1 – Dominant or co-dominant in one or more common habitats, 2 – Frequent in one or more common habitats, 3 – Occasional, but not difficult to find, 4 – Infrequent, with few individuals or colonies, but found in several locations, 5 – Very infrequent, limited to uncommon habitats or few locations. Biotic community assignments follow Brown (1994) and include: IC – Interior chaparral, MC – Mixed conifer forest, MR – Montane riparian woodland, MW – Madrean evergreen woodland, PJ – Pinyon-juniper woodland, PP – Ponderosa pine forest, RW – Interior riparian deciduous woodland, SD – Semidesert grassland, and SP – Spring or seep. All specimens collected by the author include only collection numbers, while collections made by previous collectors include the collector's last name followed by their collection number(s). Taxon entries include scientific name with authority, native status, duration,

life form, abundance, biotic community, relevant notes (if any) and a list of voucher collections.

LYCOPODIOPHYTA

Selaginellaceae

Selaginella underwoodii Hieron.; Native; Perennial; Spikemoss; 3; MC, PP, RW; 504, 916, 1037.

EQUISETOPHYTA

Equisetaceae

Equisetum arvense L.; Native; Perennial; Forb; 2; MC, MR; 527, 950.

Equisetum hyemale L.; Native; Perennial; Forb; 2; MR; 522.

PTERIDOPHYTA

Aspleniaceae

Asplenium septentrionale (L.) Hoffm.; Native; Perennial; Forb; 0; Bond 580.

Asplenium trichomanes ssp. *trichomanes* L.; Native; Perennial; Forb; 3; MC, MR; 731, 1099, 499, 518.

Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn; Native; Perennial; Forb; 1; MR; 437.

Dryopteridaceae

Dryopteris filix-mas (L.) Schott; Native; Perennial; Forb; 3; MC, MR; 337, 501.

Polypodiaceae

Polypodium hesperium Maxon; Native; Perennial; Fern; 3; MC, MR; 375, 458, 500, 583.

Pteridaceae

Adiantum capillus-veneris L.; Native; Perennial; Fern; 2; RW; 1124.

Astrolepis cochisensis ssp. *cochisensis* (Goodd.) D.M. Benham & Windham; Native; Perennial; Fern; 3; MW; 838, 908.

Cheilanthes eatonii Baker; Native; Perennial; Fern; 3; PP; 673.

Cheilanthes feei T. Moore; Native; Perennial; Fern; 3; PP; 421.

Cheilanthes fendleri Hook.; Native; Perennial; Fern; 3; MW, PP; 168, 230, 940.

Cheilanthes yavapensis T. Reeves ex Windham; Native; Perennial; Fern; 3; MW, IC; 82, 824.

Pellaea atropurpurea (L.) Link; Native; Perennial; Fern; 3; PJ, PP; 423, 894.

Pellaea truncata Goodd.; Native; Perennial; Fern; 3; IC, MW; 78, 173, 249, 272.

Woodsiaceae

Cystopteris reevesiana Lellinger; Native; Perennial; Fern; 3; MC; 503.

Cystopteris tenuis (Michx.) Desv.; Native; Perennial; Fern; 0; Rink 10768.

Cystopteris utahensis Windham & Haufler; Native; Perennial; Fern; 4; MR, PP; 360.

Woodsia neomexicana Windham; Native; Perennial; Fern; 4; PP; 757.

GNETOPHYTA

Ephedraceae

Ephedra cutleri Peebles; Native; Perennial; Shrub; 3; PP; 156.

Ephedra viridis Coville; Native; Perennial; Shrub; 2; MW; 171.

CONIFEROPHYTA

Cupressaceae

Juniperus coahuilensis (Martínez) Gaussen ex R.P. Adams; Native; Perennial; Tree; 1; IC, PJ; 81, 807.

Juniperus deppeana Steud.; Native; Perennial; Tree; 1; Bond 218, 351.

Juniperus scopulorum Sarg.; Native; Perennial; Tree; 1; MC, PP; Bond 219.

Pinaceae

Abies concolor (Gordon & Glend.) Lindl. ex Hildebr.; Native; Perennial; Tree; 1; MC; 1038.

Pinus edulis Engelm.; Native; Perennial; Tree; 1; PJ; 1123.

Pinus monophylla Torr. & Frém.; Native; Perennial; Tree; 1; PJ; 1114.

Pinus ponderosa Douglas ex P. Lawson & C. Lawson; Native; Perennial; Tree; 1; PP; 1125.

Pseudotsuga menziesii (Mirb.) Franco; Native; Perennial; Tree; 1; MC; Bond 366.

MAGNOLIOPHYTA – LILIOPSIDA

Amaryllidaceae

Allium acuminatum Hook.; Native; Perennial; Forb; 3; MW; AZ Dept. of Agriculture List B protected species; 958, 986.

Allium bisceptrum S. Watson; Native; Perennial; Forb; 3; MC, PP; AZ Dept. of Agriculture List B protected species; 313, 540.

Asparagaceae

Agave parryi Engelm.; Native; Perennial; Shrub; 2; PJ; AZ Dept. of Agriculture List B protected species; 1018.

Agave toumeyana var. *toumeyana* Trel.; Native; Perennial; Shrub; 0; MW; NatureServe G3 rank and AZ Dept. of Agriculture List B protected species; extends distribution 56 km north of Barnhardt canyon in Mazatzal Mountains; Hodgson 17367.

Dichelostemma capitatum ssp. *pauciflorum* (Torr.) Keator; Native; Perennial; Forb; 2; PJ, PP, RW; AZ Dept. of Agriculture List B protected species; 87, 145, 215, 945.

Maianthemum racemosum ssp. *amplexicaule* (Nutt.) LaFrankie; Native; Perennial; Forb; 2; MR, RW; AZ Dept. of Agriculture List B protected species; 236, 366.

Maianthemum stellatum (L.) Link; Native; Perennial; Forb; 2; PP; AZ Dept. of Agriculture List B protected species; 316.

Nolina microcarpa S. Watson; Native; Perennial; Shrub; 2; PP; AZ Dept. of Agriculture List B protected species; 663.

Yucca baccata Torr.; Native; Perennial; Shrub; 2; IC, MW, PP; AZ Dept. of Agriculture List B protected species; Bond 383.

Yucca elata Engelm.; Native; Perennial; Shrub; 2; IC, MW, SD; AZ Dept. of Agriculture List B protected species; Bond 143.

Commelinaceae

Commelina dianthifolia Delile; Native; Perennial; Forb; 3; MC, PP; 39, 64, 750.

Tradescantia pinetorum Greene; Native; Perennial; Forb; 3; MC, PP; 61, 679, 727.

Cyperaceae

Carex brevior (Dewey) Mack.; Native; Perennial; Graminoid; 4; PP; 656.

Carex geophila Mack.; Native; Perennial; Graminoid; 3; PP; 917.

Carex occidentalis L.H. Bailey; Native; Perennial; Graminoid; 3; MC, MR, PP; 318, 361, 439, 543, 1010.

Carex pellita Muhl. ex Willd.; Native; Perennial; Graminoid; 4; MC, MR; 562, 1014.

Carex praegracilis W. Boott; Native; Perennial; Graminoid; 0; Bond 87, 601.

Carex rossii Boott; Native; Perennial; Graminoid; 3; MC; 330, 492, 1013.

Carex scoparia Schkuhr ex Willd.; Native; Perennial; Graminoid; 0; MR; Rink 10777.

Carex senta Boott; Native; Perennial; Graminoid; 1; IC, MC, RW; 184, 188, 240, 341.

Carex sp. nov. aff. *klamathensis* [; Native; Perennial; Graminoid; 5; MR; Species description ongoing with scientific name as *Carex arizonica* Reznicek, Licher & Rink; 343, 555.

Carex subfusca W. Boott; Native; Perennial; Graminoid; 3; MC, MR, PP; 350, 393, 430, 516.

Carex thurberi Dewey; Native; Perennial; Graminoid; 4; MR, SP; 636, 1060.

Carex vallicola Dewey; Native; Perennial; Graminoid; 3; MC; 354, 497, 544.

Cyperus fendlerianus Boeckeler; Native; Perennial; Graminoid; 2; MC, MR, PP; 33, 68, 706, 714, 748.

Eleocharis parishii Britton; Native; Perennial; Graminoid; 4; PP; 720.

Schoenoplectus tabernaemontani (C.C. Gmel.) Palla; Native; Perennial; Graminoid; 4; RW; 480.

Scirpus microcarpus J. Presl & C. Presl; Native; Perennial; Graminoid; 3; MR, SP; 344.

Iridaceae

Iris missouriensis Nutt.; Native; Perennial; Forb; 3; MC, MR; 331, 359.

Juncaceae

Juncus balticus ssp. *ater* (Rydb.) Snogerup; Native; Perennial; Graminoid; 0; ; Bond 557.

Juncus dudleyi Wiegand; Native; Perennial; Graminoid; 4; RW; 22.

Juncus interior Wiegand; Native; Perennial; Graminoid; 4; MR, RW; 447, 514.

Juncus saximontanus A. Nelson; Native; Perennial; Graminoid; 3; MC, MR; 515, 730.

Juncus xiphioides E. Mey.; Native; Perennial; Graminoid; 4; MR, RW; 471, 634.

Liliaceae

Calochortus ambiguus (M.E. Jones) Ownbey; Native; Perennial; Forb; 4; MW; AZ Dept. of Agriculture List B protected species; 985.

Calochortus flexuosus S. Watson; Native; Perennial; Forb; 3; IC, MW; AZ Dept. of Agriculture List B protected species; 160, 192.

Calochortus kennedyi Porter; Native; Perennial; Forb; 5; MW, SD; AZ Dept. of Agriculture List B protected species; 955, 971.

Melanthiaceae

Anticlea elegans (Pursh) Rydb.; Native; Perennial; Forb; 4; MR, PP, RW, SP; AZ Dept. of Agriculture List B protected species; 559, 647, 724, 615.

Orchidaceae

Corallorhiza maculata (Raf.) Raf.; Native; Perennial; Forb; 4; PP; AZ Dept. of Agriculture List B protected species; 1003.

Epipactis gigantea Douglas ex Hook.; Native; Perennial; Forb; 3; RW, SP; AZ Dept. of Agriculture List B protected species; 470, 557.

Malaxis macrostachya (Lex.) Kuntze; Native; Perennial; Forb; 5; PP; AZ Dept. of Agriculture List B protected species; 728.

Platanthera sparsiflora (S. Watson) Schltr.; Native; Perennial; Forb; 4; MR; AZ Dept. of Agriculture List B protected species; 511, 1084.

Poaceae

Agrostis exarata Trin.; Native; Perennial; Graminoid; 3; RW; 479.

Agrostis gigantea Roth; Introduced; Perennial; Graminoid; 2; MR, RW; 5, 21.

Agrostis stolonifera L.; Introduced; Perennial; Graminoid; 0; Bond 220, 403.

Aristida adscensionis L.; Native; Annual; Graminoid; 3; MW; 829.

Aristida arizonica Vasey; Native; Perennial; Graminoid; 3; IC; 297.

Aristida purpurea var. *purpurea* Nutt.; Native; Perennial; Graminoid; 3; PP; 400.

Bouteloua curtipendula (Michx.) Torr.; Native; Perennial; Graminoid; 1; MW, PP; 56, 769.

Bouteloua eriopoda (Torr.) Torr.; Native; Perennial; Graminoid; 2; MW; 860.

Bouteloua gracilis (Kunth) Lag. ex Griffiths; Native; Perennial; Graminoid; 1; PP; 770.

Bromus carinatus Hook. & Arn.; Native; Annual; Graminoid; 3; MC, RW; 241, 599.

Bromus frondosus (Shear) Wooton & Standl.; Native; Perennial; Graminoid; 3; PP; 305.

Bromus inermis Leyss.; Introduced; Perennial; Graminoid; 1; MR; 550.

Bromus japonicus Thunb. ex Murray; Introduced; Annual; Graminoid; 2; PJ, PP; 466, 1049.

Bromus lanatipes (Shear) Rydb.; Native; Perennial; Graminoid; 4; PP; 752.

Bromus richardsonii Link; Native; Perennial; Graminoid; 3; MC; 48.

Bromus rubens L.; Introduced; Annual; Graminoid; 2; RW; 75, 139.

Bromus tectorum L.; Introduced; Annual; Graminoid; 2; MC, PP; 329, 389.

Dactylis glomerata L.; Introduced; Perennial; Graminoid; 3; MR; 349.

Dasyochloa pulchella (Kunth) Willd. ex Rydb.; Native; Perennial; Graminoid; 3; MW; 858.

Dichanthelium acuminatum var. *acuminatum* (Sw.) Gould & C.A. Clark; Native; Perennial; Graminoid; 5; MR; 635.

Dichanthelium oligosanthes (Schult.) Gould; Native; Perennial; Graminoid; 4; MR, PP; 449, 566.

Digitaria californica (Benth.) Henrard; Native; Perennial; Graminoid; 4; IC; 819.

Elymus canadensis L.; Native; Perennial; Graminoid; 3; MR; 686.

Elymus elymoides (Raf.) Swezey; Native; Perennial; Graminoid; 3; MW, PP, RW; 147, 181, 303, 751.

Elymus glaucus Buckley; Native; Perennial; Graminoid; 3; MC, RW; 239, 547.

Elymus repens (L.) Gould; Introduced; Perennial; Graminoid; 0; MR; Rink 12612.

Elymus trachycaulus ssp. *trachycaulus* (Link) Gould ex Shinners; Native; Perennial; Graminoid; 0; Zdinak 71039.

Eragrostis intermedia Hitchc.; Native; Perennial; Graminoid; 4; RW; 796, 996.

Eragrostis pectinacea (Michx.) Nees; Native; Annual; Graminoid; 4; PP; 32.
Festuca arizonica Vasey; Native; Perennial; Graminoid; 1; PP; 725.

Glyceria striata (Lam.) Hitchc.; Native; Perennial; Graminoid; 4; MC, MR; 509, 1098.
Hilaria belangeri (Steud.) Nash; Native; Perennial; Graminoid; 1; IC, MW, PJ; 94, 276, 806.

Hordeum pusillum Nutt.; Native; Annual; Graminoid; 4; IC; 191.

Koeleria macrantha (Ledeb.) Schult.; Native; Perennial; Graminoid; 0; Bond 375.

Leptochloa dubia (Kunth) Nees; Native; Perennial; Graminoid; 4; RW; 794.

Leptochloa panicea ssp. *brachiata* (Steud.) N.W. Snow; Native; Annual; Graminoid; 4; PJ; 802.

Melica porteri Scribn.; Native; Perennial; Graminoid; 4; MC; 1101.

Muhlenbergia longiligula Hitchc.; Native; Perennial; Graminoid; 3; MC, PP; 67, 1090, 1095.

Muhlenbergia minutissima (Steud.) Swallen; Native; Annual; Graminoid; 4; PP; 31.

Muhlenbergia pauciflora Buckley; Native; Perennial; Graminoid; 4; PP, RW; 58, 619.

Muhlenbergia phleoides (Kunth) Columbus; Native; Perennial; Graminoid; 4; IC, PP; 66, 787.

Muhlenbergia racemosa (Michx.) Britton, Sterns & Poggenb.; Native; Perennial; Graminoid; 3; RW; 23.

Muhlenbergia straminea Hitchc.; Native; Perennial; Graminoid; 3; PP; 918.

Muhlenbergia virescens (Kunth) Trin.; Native; Perennial; Graminoid; 3; MC; 125, 130.

Muhlenbergia wrightii Vasey ex J.M. Coult.; Native; Perennial; Graminoid; 3; MC; 40.

Panicum virgatum L.; Native; Perennial; Graminoid; 4; MR; 687.

Pappostipa speciosa (Trin. & Rupr.) Romasch.; Native; Perennial; Graminoid; 3; IC; 295.

Piptochaetium pringlei (Beal) Parodi; Native; Perennial; Graminoid; 4; PP; 753.

Poa bigelovii Vasey & Scribn.; Native; Annual; Graminoid; 3; IC, PJ; 199, 266.

Poa compressa L.; Introduced; Perennial; Graminoid; 3; MR, PP; 379, 415.

Poa fendleriana (Steud.) Vasey; Native; Perennial; Graminoid; 1; PJ; 105, 164, 167.

Poa fendleriana ssp. *longiligula* (Scribn. & T.A. Williams) Soreng; Native; Perennial; Graminoid; 1; MC, RW; 73, 124, 137, 325, 339.

Poa pratensis L.; Introduced; Perennial; Graminoid; 2; MC, MR, MW, PP; 238, 347, 392, 429.

Schedonorus arundinaceus (Schreb.) Dumort.; Introduced; Perennial; Graminoid; 4; MC, MR, PP, RW; 204, 299, 396, 593.

Schedonorus pratensis (Huds.) P. Beauv.; Introduced; Perennial; Graminoid; 3; RW; 24.

Schismus barbatus (L.) Thell.; Introduced; Annual; Graminoid; 3; MW; 909.

Schizachne purpurascens (Torr.) Swallen; Native; Perennial; Graminoid; 0; MC; Occurring along southwestern range limit; Rink 8619.

Schizachyrium scoparium (Michx.) Nash; Native; Perennial; Graminoid; 3; MC; 47.

Setaria macrostachya Kunth; Native; Perennial; Graminoid; 4; RW; 795.

Sorghastrum nutans (L.) Nash; Native; Perennial; Graminoid; 3; MR; 694.

Sorghum halepense (L.) Pers.; Introduced; Perennial; Graminoid; 4; RW; 793.

Thinopyrum intermedium ssp. *barbulatum* (Schur) Barkworth & D.R. Dewey; Introduced; Perennial; Graminoid; 0; Generic identification verified, material insufficient for positive species identification. Bond 402, 588.

Thinopyrum ponticum (Podp.) Barkworth & D.R. Dewey; Introduced; Perennial; Graminoid; 4; RW; 25.

Vulpia microstachys var. *pauciflora* (Scribn. ex Beal) Lonard & Gould; Native; Annual; Graminoid; 4; MW; 180.

Vulpia octoflora (Walter) Rydb.; Native; Annual; Graminoid; 3; MW; 97.

Zuloagaea bulbosa (Kunth) Bess; Native; Perennial; Graminoid; 0; Bond 202.

Typhaceae

Typha domingensis Pers.; Native; Perennial; Forb; 3; MR; 631.

Typha latifolia L.; Native; Perennial; Forb; 3; RW; 477.

MAGNOLIOPHYTA – MAGNOLIOPSIDA

Adoxaceae

Sambucus nigra ssp. *cerulea* (Raf.) R. Bolli; Native; Perennial; Shrub; 3; PP; 658.

Sambucus racemosa var. *melanocarpa* (A. Gray) McMinn; Native; Perennial; Shrub; 3; RW; 507.

Amaranthaceae

Amaranthus powellii S. Watson; Native; Annual; Forb; 3; MC; 34.

Amaranthus torreyi (A. Gray) Benth. ex S. Watson; Native; Annual; Forb; 3; IC, MW; 784, 881.

Atriplex canescens (Pursh) Nutt.; Native; Perennial; Shrub; 1; IC, RW; 487, 855.

Chenopodium fremontii S. Watson; Native; Annual; Forb; 3; MC, MW, PP; 733, 775, 867.

Dysphania graveolens (Willd.) Mosyakin & Clemants; Introduced; Annual; Forb; 3; PP; 758.

Anacardiaceae

Toxicodendron rydbergii (Small ex Rydb.) Greene; Native; Perennial; Forb; 2; MC; 488.

Rhus aromatica Aiton; Native; Perennial; Shrub; 2; PJ, RW; 74, 108.

Apiaceae

Cicuta douglasii (DC.) J.M. Coult. & Rose; Native; Perennial; Forb; 2; RW; 475.

Cicuta maculata L.; Native; Perennial; Forb; 2; MR; 650.

Daucus pusillus Michx.; Native; Annual; Forb; 3; MW; 953, 978.

Ligusticum porteri J.M. Coult. & Rose; Native; Perennial; Forb; 2; MC; 221.

Lomatium foeniculaceum ssp. *macdougalii* (J.M. Coult. & Rose) W.L. Theob.; Native; Perennial; Forb; 3; IC, MC, PJ; 214, 255, 948.

Lomatium nevadense (S. Watson) J.M. Coult. & Rose; Native; Perennial; Forb; 3; IC, MC; 254, 286, 946.

Pseudocymopterus montanus (A. Gray) J.M. Coult. & Rose; Native; Perennial; Forb; 3; PP; 761.

Yabea microcarpa (Hook. & Arn.) Koso-Pol.; Native; Annual; Forb; 3; RW; 135.

Apocynaceae

Apocynum androsaemifolium L.; Native; Perennial; Shrub; 2; MC; 1035.

Apocynum cannabinum L.; Native; Perennial; Forb; 2; MR, PP; 351, 563.

Asclepias asperula ssp. *asperula* (Decne.) Woodson; Native; Perennial; Forb; 4; IC; 821.

Asclepias tuberosa L.; Native; Perennial; Forb; 4; MC; 597.

Araliaceae

Aralia racemosa L.; Native; Perennial; Forb; 2; MC; 539, 743.

Asteraceae

Achillea millefolium L.; Native; Perennial; Forb; 2; MR, SP; 561, 651.

Acourtia wrightii (A. Gray) Reveal & King; Native; Perennial; Forb; 3; IC, MW; 282, 863.

Adenophyllum porophylloides (A. Gray) Strother; Native; Perennial; Subshrub; 4; MW; 857.

Ageratina herbacea (A. Gray) King & H. Rob.; Native; Perennial; Forb; 3; IC, MC; 882, 1085.

Amauriopsis dissecta (A. Gray) Rydb.; Native; Biennial; Forb; 3; IC; 813.

Ambrosia confertiflora DC.; Native; Perennial; Forb; 0; Bond 188.

Ambrosia psilostachya DC.; Native; Perennial; Forb; 3; MW; 836, 837.

Antennaria marginata Greene; Native; Perennial; Forb; 2; PP; 386, 405.

Antennaria parvifolia Nutt. ; Native; Perennial; Forb; 2; PP; 404.

Artemisia campestris ssp. *pacifica* (Nutt.) H.M. Hall & Clem.; Native; Biennial; Forb; 3; PP; 1033.

Artemisia carruthii Alph. Wood ex Carruth.; Native; Perennial; Forb; 3; MW; 887.

Artemisia dracunculus L.; Native; Perennial; Forb; 3; IC; 783.

Artemisia ludoviciana Nutt.; Native; Perennial; Forb; 3; IC; 785.

Baccharis brachyphylla A. Gray; Native; Perennial; Shrub; 3; MW; 843.

Baccharis pteronioides DC.; Native; Perennial; Shrub; 3; IC; 294.

Baccharis salicifolia (Ruiz & Pav.) Pers.; Native; Perennial; Shrub; 3; MR; 110.

Baccharis sarothroides A. Gray; Native; Perennial; Shrub; 4; MW; 848, 875.

Bahiopsis parishii (Greene) E.E. Schill. & Panero; Native; Perennial; Subshrub; 3; MW; 956.

Baileya multiradiata Harv. & A. Gray ex A. Gray; Native; Perennial; Forb; 3; IC; 205.

Bebbia juncea (Benth.) Greene; Native; Perennial; Subshrub; 3; MW; 869.

Brickellia atractyloides A. Gray; Native; Perennial; Subshrub; 3; PJ; 260.

Brickellia californica (Torr. & A. Gray) A. Gray; Native; Perennial; Subshrub; 3; MW; 874.

Brickellia grandiflora (Hook.) Nutt.; Native; Perennial; Forb; 3; MC, PP; 69, 760.

Chaetopappa ericoides (Torr.) G.L. Nesom; Native; Perennial; Subshrub; 2; IC; 194.

Cirsium arizonicum (A. Gray) Petr.; Native; Biennial; Forb; 3; MC, PP; 332, 665.

Cirsium neomexicanum A. Gray; Native; Biennial; Forb; 3; IC, MW, PP; 284, 300, 469, 988.

Cirsium vulgare (Savi) Ten.; Introduced; Biennial; Forb; 4; PP; 1028.

Conyza canadensis (L.) Cronquist; Native; Biennial; Forb; 0; Bond 157.

Coreopsis tinctoria Nutt.; Native; Biennial; Forb; 3; MR; 641, 704.

Dieteria asteroides var. *glandulosa* (B.L. Turner) D.R. Morgan & R.L. Hartm.; Native; Perennial; Forb; 3; MW; 53.

Dieteria canescens var. *aristata* (Eastw.) D.R. Morgan & R.L. Hartm.; Native; Biennial; Forb; 3; IC, PJ, PP, RW; 662, 779, 853, 892.

Encelia virginensis A. Nelson; Native; Perennial; Shrub; 3; IC, MW; Bond 328.

Ericameria laricifolia (A. Gray) Shinners; Native; Perennial; Subshrub; 4; PJ; 872.

Erigeron divergens Torr. & A. Gray; Native; Biennial; Forb; 2; MC, MW, PJ, PP; 36, 114, 213, 306, 401.

Erigeron flagellaris A. Gray; Native; Biennial; Forb; 2; IC, MR, RW; 149, 298, 382.

Erigeron formosissimus Greene; Native; Perennial; Forb; 3; MW, PP; 114, 746.

Erigeron neomexicanus A. Gray; Native; Perennial; Forb; 3; MC, MR, PP; 43, 565, 768.

Erigeron oreophilus Greenm.; Native; Perennial; Forb; 3; PJ; 893, 1043.

Erigeron saxatilis G.L. Nesom; Native; Perennial; Forb; 4; MC, MR; USFS Region 3 sensitive species and NatureServe G3 rank; 517, 1104.

Erigeron speciosus (Lindl.) DC.; Native; Perennial; Forb; 3; MC, MR; 14, 1094.

Erigeron tracyi Greene; Native; Biennial; Forb; 4; PJ; 162.

Erigeron vreelandii Greene; Native; Perennial; Forb; 3; MC, MR; 652, 677, 1117.
Gutierrezia microcephala (DC.) A. Gray; Native; Perennial; Subshrub; 2; MR; 1118.

Gutierrezia sarothrae (Pursh) Britton & Rusby; Native; Perennial; Subshrub; 1; MW; 55.

Helianthella quinquenervis (Hook.) A. Gray; Native; Perennial; Forb; 4; MR, PP; 549, 737.

Heliomeris longifolia var. *annua* (M.E. Jones) Yates; Native; Annual; Forb; 3; PJ, MW; 862, 868.

Heliomeris multiflora var. *nevadensis* (A. Nelson) Yates; Native; Perennial; Forb; 3; PP; 759.

Heterotheca fulcrata (Greene) Shinners [*Heterotheca fulciens* Nesom]; Native; Perennial; Subshrub; 0; Bond 374a, 398.

Heterotheca villosa (Pursh) Shinners; Native; Perennial; Subshrub; 3; MC, PP; 46, 60.

Hieracium fendleri Sch. Bip.; Native; Perennial; Forb; 3; MC, PP; 334, 397, 1004.

Hymenopappus filifolius var. *lugens* (Greene) Jeps.; Native; Perennial; Forb; 3; MW; 984.

Hymenothrix wrightii A. Gray; Native; Perennial; Forb; 3; PJ, PP; 63, 895.

Hymenoxys bigelovii (A. Gray) K.F. Parker; Native; Perennial; Forb; 3; PP; 425, 951, 1005.

Hymenoxys cooperi (A. Gray) Cockerell; Native; Biennial; Forb; 0; Bond 79.

Hymenoxys jamesii Bierner; Native; Biennial; Forb; 3; PP; NatureServe G2G3 rank; 736, 763.

Lactuca graminifolia Michx.; Native; Biennial; Forb; 4; MC; 1096.

Lactuca ludoviciana (Nutt.) Riddell; Native; Biennial; Forb; 4; SP; 1066.

Lactuca serriola L.; Introduced; Biennial; Forb; 3; MC; 1103.

Leucanthemum vulgare Lam.; Introduced; Perennial; Forb; 4; MC; 1102.

Melampodium leucanthum Torr. & A. Gray; Native; Perennial; Subshrub; 1; IC, MW, PJ; 175, 201, 805.

Mulgedium oblongifolium (Nutt.) Reveal; Native; Biennial; Forb; 4; MC, PP; 595.
Packera hartiana (A. Heller) W.A. Weber & A. Löve; Native; Perennial; Forb; 3; MR, PP, SP; 312, 373, 556.

Packera neomexicana var. *mutabilis* (Greene) W.A. Weber & A. Löve; Native; Perennial; Forb; 3; PP; 385, 406.

Packera neomexicana var. *neomexicana* (A. Gray) W.A. Weber & A. Löve; Native; Perennial; Forb; 3; PP; 398.

Packera quercetorum (Greene) C. Jeffrey; Native; Perennial; Forb; 2; MC, MW, PP, RW; 132, 179, 232, 609.

Parthenium incanum Kunth; Native; Perennial; Shrub; 3; MW; 828.

Pectis rusbyi Greene ex A. Gray; Native; Annual; Forb; 2; MW; 827, 865.

Pericome caudata A. Gray; Native; Perennial; Forb; 3; MR; 1105.

Perityle ciliata (L.H. Dewey) Rydb.; Native; Perennial; Subshrub; 2; MC, MR; 582, 688, 774.

Pseudognaphalium macounii (Greene) Kartesz; Native; Annual; Forb; 3; PP; 719, 749.

Rudbeckia laciniata var. *ampla* (A. Nelson) Cronquist; Native; Perennial; Forb; 2; MC, MR, SP; 685, 1065, 1069.

Sanvitalia abertii A. Gray; Native; Annual; Forb; 4; MW; 54.

Senecio actinella Greene; Native; Perennial; Forb; 4; MR, PP; 399, 1011.

Senecio eremophilus var. *macdougalii* (A. Heller) Cronquist; Native; Perennial; Forb; 4; PP; 1041.

Senecio flaccidus var. *monoensis* (Greene) B.L. Turner & T.M. Barkley; Native; Perennial; Forb; 2; IC, MR, PJ; 208, 257, 482.

Senecio wootonii Greene; Native; Perennial; Forb; 3; PP; 413.

Solidago altissima L.; Native; Perennial; Forb; 3; PP; 747.

Solidago canadensis L.; Native; Perennial; Forb; 0; Bond 213.

Solidago missouriensis Nutt.; Native; Perennial; Forb; 3; MC; 666.

Solidago wrightii A. Gray; Native; Perennial; Forb; 3; MC, MW, RW; 44, 851, 876.

Stephanomeria pauciflora (Torr.) A. Nelson; Native; Perennial; Forb; 3; PJ; 803.

Stephanomeria thurberi A. Gray; Native; Perennial; Forb; 4; PP; 462.

Symphyotrichum lanceolatum var. *hesperium* (A. Gray) G.L. Nesom; Native; Perennial; Forb; 3; MR; 629.

Taraxacum erythrospermum Andrz. ex Besser; Native; Perennial; Forb; 3; PP; 317.

Taraxacum officinale F.H. Wigg.; Native; Perennial; Forb; 2; MC; 120.

Uropappus lindleyi (DC.) Nutt.; Native; Annual; Forb; 4; MW; 957.

Xanthisma gracile (Nutt.) D.R. Morgan & R.L. Hartm.; Native; Annual; Forb; 2; IC; 486, 972.

Berberidaceae

Berberis haematocarpa Wooton; Native; Perennial; Shrub; 2; MW, PJ; 103.

Berberis repens Lindl.; Native; Perennial; Subshrub; 2; PP; 302.

Betulaceae

Alnus incana ssp. *tenuifolia* (Nutt.) Breitung; Native; Perennial; Tree; 0; MR; Zdinak 73071, 73072.

Alnus oblongifolia Torr.; Native; Perennial; Tree; 3; RW; 84.

Betula occidentalis Hook.; Native; Perennial; Tree; 0; Collected along southern range limit; Zdinak 74104.

Boraginaceae

Amsinckia intermedia Fisch. & C.A. Mey.; Native; Annual; Forb; 3; PP; 151.

Cryptantha nevadensis A. Nelson & Kennedy; Native; Annual; Forb; 3; IC, RW; 143, 268.

Cryptantha pterocarya (Torr.) Greene; Native; Annual; Forb; 3; IC, SD; 267, 962.

Lappula occidentalis var. *occidentalis* (S. Watson) Greene; Native; Annual; Forb; 3; PP; 301, 463, 932.

Lithospermum macromeria J. Cohen; Native; Perennial; Forb; 3; MC, MR; 573, 653.

Lithospermum multiflorum Torr. ex A. Gray; Native; Perennial; Forb; 3; MC, PP; 2, 357, 442, 1032.

Mertensia franciscana A. Heller ; Native; Perennial; Forb; 3; MC; 1074, 1083.

Pectocarya setosa A. Gray; Native; Annual; Forb; 3; IC; 190.

Brassicaceae

Arabis pycnocarpa M. Hopkins; Native; Biennial; Forb; 3; MR; 526.

Barbarea vulgaris W.T. Aiton; Introduced; Biennial; Forb; 3; MC, MR, PP; 427, 532, 538, 1012, 1031.

Boechera gracilipes (Greene) Dorn; Native; Perennial; Forb; 3; MC, MR; 224, 371, 454, 525.

Boechera perennans (S. Watson) W.A. Weber; Native; Perennial; Forb; 3; IC, MW, PJ; 80, 104, 902.

Capsella bursa-pastoris (L.) Medik.; Native; Annual; Forb; 3; MC; 131.

Descurainia californica (A. Gray) O.E. Schulz; Native; Annual; Forb; 4; MR; 701.

Descurainia obtusa (Greene) O.E. Schulz; Native; Annual; Forb; 3; IC, MC; 781, 1036.

Descurainia pinnata ssp. *glabra* (Wooton & Standl.) Detling; Native; Annual; Forb; 2; PP; 773.

Descurainia pinnata ssp. *ochroleuca* (Wooton) Detling; Native; Annual; Forb; 2; IC, PP, RW; 146, 153, 198.

Draba asprella var. *stelligera* O.E. Schulz; Native; Perennial; Forb; 2; MC, MR, PP; NatureServe G3 rank; 117, 128, 227, 311, 326, 374, 402, 531.

Draba cuneifolia var. *cuneifolia* Nutt. ex Torr. & A. Gray; Native; Annual; Forb; 2; PP, RW; 90, 926.

Erysimum capitatum (Douglas ex Hook.) Greene; Native; Biennial; Forb; 3; MC, MW, PJ, RW; 136, 170, 211, 588.

Erysimum inconspicuum (S. Watson) MacMill.; Native; Biennial; Forb; 3; MC; 941.

Halimolobos diffusa (A. Gray) O.E. Schulz; Native; Perennial; Forb; 3; MC, MR; 490, 682, 703, 1092.

Hesperidanthus linearifolius (A. Gray) Rydb.; Native; Perennial; Forb; 3; MC, PP; 333, 664, 681, 776.

Lepidium campestre (L.) W.T. Aiton; Introduced; Annual; Forb; 3; MR, PP, RW; 355, 416, 510, 519, 698, 1120.

Lepidium densiflorum Schrad.; Introduced; Annual; Forb; 2; MR, PP; 450, 455.

Lepidium thurberi Wooton; Native; Annual; Forb; 3; SD; 964.

Lepidium virginicum ssp. *virginicum* L.; Native; Annual; Forb; 3; MR, PP; 699, 711, 735.

Nasturtium officinale W.T. Aiton; Introduced; Perennial; Forb; 2; RW; 186.

Noccaea fendleri ssp. *fendleri* (A. Gray) Holub; Native; Perennial; Forb; 2; MC, PP; 118, 403, 920.

Pennellia longifolia (Benth.) Rollins; Native; Biennial; Forb; 3; MR, PP; 567, 745.

Physaria fendleri (A. Gray) O'Kane & Al-Shehbaz; Native; Perennial; Forb; 3; MW; 983.

Physaria rectipes (Wooton & Standl.) O'Kane & Al-Shehbaz; Native; Perennial; Forb; 3; MW; 102.

Sisymbrium altissimum L.; Introduced; Annual; Forb; 3; PP; 1034.

Sisymbrium irio L.; Introduced; Annual; Forb; 3; RW; 76.

Thelypodium wrightii A. Gray; Native; Biennial; Forb; 2; CO, IC, MW, PJ; 576, 606, 823, 879, 1021, 1046.

Thysanocarpus curvipes Hook.; Native; Annual; Forb; 2; PP; 931.

Cactaceae

Cylindropuntia acanthocarpa var. *thornberi* (Thornber & Bonker) Backeb.; Native; Perennial; Shrub; 2; IC, MW; AZ Dept. of Agriculture List B protected species; 485, 976.

Echinocereus coccineus Engelm.; Native; Perennial; Shrub; 3; PP; AZ Dept. of Agriculture List B protected species; 426, 942, 991.

Echinocereus engelmannii (Parry ex Engelm.) Lem.; Native; Perennial; Shrub; 3; MW; AZ Dept. of Agriculture List B protected species; 975.

Escobaria vivipara (Nutt.) Buxb.; Native; Perennial; Shrub; 4; PP; AZ Dept. of Agriculture List B protected species; 467.

Opuntia chlorotica Engelm. & J.M. Bigelow; Native; Perennial; Shrub; 4; PJ; AZ Dept. of Agriculture List B protected species; 1050.

Opuntia engelmannii var. *flavispina* (L.D. Benson) B.D. Parfitt & Pinkava; Native; Perennial; Shrub; 2; MW; AZ Dept. of Agriculture List B protected species; 977.

Opuntia macrorhiza Engelm.; Native; Perennial; Shrub; 1; MC, MW; AZ Dept. of Agriculture List B protected species; 600.

Opuntia phaeacantha Engelm.; Native; Perennial; Shrub; 1; MR; AZ Dept. of Agriculture List B protected species; 1121.

Campanulaceae

Lobelia cardinalis L.; Native; Perennial; Forb; 4; RW; AZ Dept. of Agriculture List B protected species; 1051.

Cannabaceae

Celtis reticulata Torr.; Native; Perennial; Tree; 4; RW; 1053.

Humulus lupulus var. *lupuloides* E. Small; Native; Perennial; Vine; 2; MR; 3.

Caprifoliaceae

Lonicera albiflora Torr. & A. Gray; Native; Perennial; Shrub; 3; PP, RW; extends distribution 12 km north from Fossil Springs Wilderness, Yavapai County; 248.

Lonicera arizonica Rehder; Native; Perennial; Shrub; 2; MR; 457.

Symphoricarpos oreophilus A. Gray; Native; Perennial; Shrub; 0; Bond 381, 404.

Symphoricarpos rotundifolius A. Gray; Native; Perennial; Shrub; 3; MC; 502, 533.
Valeriana acutiloba Rydb.; Native; Perennial; Forb; 3; MC; 127.

Valeriana arizonica A. Gray; Native; Perennial; Forb; 2; MC; 323, 923.

Valeriana edulis Nutt. ex Torr. & A. Gray; Native; Perennial; Forb; 3; MC, PP; 721, 1073.

Caryophyllaceae

Arenaria lanuginosa var. *saxosa* (A. Gray) Zarucchi, R.L. Hartm. & Rabeler; Native; Perennial; Forb; 3; MR, PP; 552, 674, 689.

Cerastium brachypodum (Engelm. ex A. Gray) B.L. Rob.; Native; Perennial; Forb; 3; MC; 732.

Cerastium texanum Britton; Native; Annual; Forb; 3; MC, MR, PP; 169, 234, 568, 936, 1119.

Dianthus armeria L.; Introduced; Annual; Forb; 2; MR; 614, 649, 696.

Eremogone aberrans (M.E. Jones) Ikonn.; Native; Perennial; Forb; 4; MC, MW, PJ; NatureServe G2 rank; 157, 216, 987.

Pseudostellaria jamesiana (Torr.) W.A. Weber & R.L. Hartm.; Native; Perennial; Forb; 2; MC; 321, 1015.

Silene antirrhina L.; Native; Annual; Forb; 3; PJ, PP; 259, 452.

Silene laciniata ssp. *greggii* (A. Gray) S. Watson; Native; Perennial; Forb; 4; MC, PP; 70, 716, 1042.

Silene verecunda S. Watson; Native; Perennial; Forb; 4; MR; 530, 551.

Celastraceae

Canotia holacantha Torr.; Native; Perennial; Shrub; 1; IC; 637.

Parnassia parviflora DC.; Native; Perennial; Forb; 3; SP; 1108.

Cleomaceae

Polanisia dodecandra (L.) DC.; Native; Annual; Forb; 2; MW; 354.

Polanisia dodecandra ssp*. trachysperma* (Torr. & A. Gray) Iltis; Native; Annual; Forb; 2; PJ; 291.

Convolvulaceae

Evolvulus nuttallianus Schult.; Native; Perennial; Forb; 3; IC; 206.

Ipomoea costellata Torr.; Native; Annual; Vine; 4; MW; 51.

Ipomoea cristulata Hallier f.; Native; Annual; Vine; 4; MC; 778.

Cornaceae

Cornus sericea L.; Native; Perennial; Shrub; 1; MC, MR; 327, 378.

Crassulaceae

Graptopetalum rusbyi (Greene) Rose; Native; Perennial; Forb; 5; PP; AZ Dept. of Agriculture List B protected species; New record for Coconino County; extends distribution 70 km from Seven Springs on 51 Ranch in Yavapai County; 1002.

Sedum cockerellii Britton; Native; Perennial; Forb; 2; MC; AZ Dept. of Agriculture List B protected species; 1100.

Euphorbiaceae

Euphorbia albomarginata Torr. & A. Gray; Native; Perennial; Forb; 3; IC; 189.

Euphorbia brachycera Engelm.; Native; Perennial; Forb; 3; MC; 596.

Euphorbia melanadenia Torr.; Native; Perennial; Forb; 3; IC, MW; Collected along northeastern range limit; 100, 293, 839, 840, 910.

Euphorbia revoluta Engelm.; Native; Annual; Forb; 3; PJ; 798.

Euphorbia schizoloba Engelm.; Native; Perennial; Forb; 3; IC; 291.

Euphorbia serpyllifolia Pers.; Native; Annual; Forb; 3; PP; 756.

Euphorbia setiloba Engelm. ex Torr.; Native; Annual; Forb; 3; IC; 812.

Tragia ramosa Torr.; Native; Perennial; Forb; 3; IC; 292.

Fabaceae

Acmispon humistratus (Benth.) D.D. Sokoloff; Native; Annual; Forb; 2; IC, MW; 98.

Acmispon oroboides (Kunth) Brouillet; Native; Perennial; Forb; 2; IC; 280.

Acmispon rigidus (Benth.) Brouillet; Native; Perennial; Forb; 2; MW, RW; 101, 115, 141.

Acmispon wrightii (A. Gray) Brouillet; Native; Perennial; Forb; 2; MC, PJ, PP; 1, 212, 601.

Amorpha fruticosa L.; Native; Perennial; Shrub; 4; MR; 586.

Astragalus didymocarpus Hook. & Arn. ; Native; Annual; Forb; 3; MW; 952.

Astragalus hallii A. Gray; Native; Perennial; Forb; 3; MR; 591.

Astragalus lentiginosus Douglas ex Hook.; Native; Biennial; Forb; 3; MW, PP, SD; 172, 310, 970.

Astragalus recurvus Greene; Native; Perennial; Forb; 4; MC; 220.

Astragalus tephrodes A. Gray; Native; Perennial; Forb; 3; PP; 425, 934, 1006.

Calliandra humilis var. *reticulata* (A. Gray) L.D. Benson; Native; Perennial; Forb; 4; PP; 764.

Dalea albiflora A. Gray; Native; Perennial; Forb; 3; IC, MC, MR, PJ, PP; 622, 709, 790, 890, 900.

Dalea formosa Torr.; Native; Perennial; Subshrub; 2; MR, RW; 140, 633.

Desmodium arizonicum S. Watson; Native; Perennial; Forb; 0; PP; Collected along northern range limit; Licher 84027, 84048.

Desmodium grahamii A. Gray; Native; Perennial; Forb; 4; MC, PP; 62, 1079, 1089.

Desmodium metcalfei (Rose & J.H. Painter) Kearney & Peebles; Native; Perennial; Forb; 5; MR, RW; USFS Region 3 sensitive species; 476.

Desmodium rosei B.G. Schub.; Native; Annual; Forb; 4; MC; 1110.

Lathyrus graminifolius (S. Watson) T.G. White; Native; Perennial; Forb; 4; PP; 1016.

Lathyrus laetivirens Greene ex Rydb.; Native; Perennial; Forb; 3; MC, PP; 219, 387, 424.

Lupinus concinnus J. Agardh; Native; Annual; Forb; 3; RW; 144.

Lupinus hillii Greene; Native; Perennial; Forb; 3; PP; NatureServe G3 rank; 384, 740.

Lupinus kingii S. Watson; Native; Annual; Forb; 4; IC; 285.

Medicago lupulina L.; Introduced; Annual; Forb; 2; MC, MR, PP; 320, 381, 395.

Melilotus albus Medik.; Introduced; Biennial; Forb; 2; RW; 472.

Melilotus officinalis (L.) Lam.; Introduced; Biennial; Forb; 2; RW; 473.
Mimosa aculeaticarpa var. *biuncifera* (Benth.) Barneby; Native; Perennial; Shrub; 3; IC; 788.

Phaseolus angustissimus A. Gray; Native; Perennial; Forb; 3; IC, RW; 209, 474.

Phaseolus maculatus Scheele; Native; Perennial; Forb; 0; Occurring along northern range limit; Hodgson 3954.

Phaseolus pedicellatus var. *grayanus* (Wooton & Standl.) A. Delgado ex Isely; Native; Perennial; Forb; 4; MC, PP; New record for Coconino County; 739, 1078.

Prosopis juliflora (Sw.) DC.; Native; Perennial; Tree; 1; MW; 954.

Robinia neomexicana A. Gray; Native; Perennial; Shrub; 1; PP; Bond 382.

Senegalia greggii (A. Gray) Britton & Rose; Native; Perennial; Shrub; 0; IC; Bond 136, 154.

Thermopsis montana Nutt.; Native; Perennial; Forb; 3; MC; [Bond 69 as *Thermopsis divaricarpa* A. Nels. included here]; 342.

Trifolium repens L.; Introduced; Perennial; Forb; 2; MR; 345, 513.

Vicia americana Muhl. ex Willd.; Native; Perennial; Forb; 3; MC, MR; 512, 1071.

Vicia ludoviciana Nutt. ex Torr. & A. Gray; Native; Annual; Forb; 3; IC; 279.

Fagaceae

Quercus chrysolepis Liebm.; Native; Perennial; Tree; 1; IC, MR, PJ, PP, RW; 247, 459, 578, 616, 627, 786, 871, 884.

Quercus gambelii Nutt.; Native; Perennial; Tree; 1; PP; Bond 210.

Quercus palmeri Engelm.; Native; Perennial; Tree; 1; IC, PJ; 883, 1112.

Quercus rugosa Née; Native; Perennial; Tree; 1; PP, SP; New record for Coconino and Yavapai Counties; Extends distribution 25 km North of Bear Canyon in Gila County. 992, 1063, 1115, 1116.

Quercus turbinella Greene; Native; Perennial; Shrub; 2; IC, MW; Bond 147, 391, 395.

Fouquieriaceae

Fouquieria splendens Engelm.; Native; Perennial; Shrub; 5; SD; AZ Dept. of Agriculture List B protected species; 968.

Garryaceae

Garrya wrightii Torr.; Native; Perennial; Shrub; 2; IC, PJ; 580, 800.
Erodium cicutarium (L.) L'Hér. ex Aiton; Introduced; Annual; Forb; 2; IC, MC; 83, 122.

Gentianaceae

Frasera speciosa Douglas ex Griseb.; Native; Perennial; Forb; 4; PP; 723.

Geraniaceae

Geranium caespitosum E. James; Native; Perennial; Forb; 2; MR, PP; 380, 451.

Geranium richardsonii Fisch. & Trautv.; Native; Perennial; Forb; 2; MR; 435.

Grossulariaceae

Ribes cereum Douglas; Native; Perennial; Shrub; 3; MC, MR, PP; 228, 581.

Ribes pinetorum Greene; Native; Perennial; Shrub; 3; MC; 441, 542.

Hydrangeaceae

Fendlera rupicola Engelm. & A. Gray; Native; Perennial; Shrub; 3; MC, PJ; 163, 218.

Philadelphus microphyllus A. Gray; Native; Perennial; Shrub; 2; MC, RW; 608, 620.

Hydrophyllaceae

Hydrophyllum occidentale (S. Watson) A. Gray; Native; Perennial; Forb; 3; MC, MR; 336, 376, 494, 541.

Nama dichotoma (Ruiz & Pav.) Choisy; Native; Annual; Forb; 0; PP; Licher 1589.

Phacelia coerulea Greene; Native; Annual; Forb; 3; PP; 1001.

Phacelia crenulata Torr. ex S. Watson; Native; Annual; Forb; 3; IC; 269.

Phacelia cryptantha Greene; Native; Annual; Forb; 2; MW; 176, 959.

Phacelia distans Benth.; Native; Annual; Forb; 3; IC, PJ; 262, 289.

Phacelia egena (Greene ex Brand) Greene ex J.T. Howell; Native; Biennial; Forb; 0; Bond 372, 377.

Phacelia heterophylla Pursh; Native; Biennial; Forb; 3; MC; 598, 610, 667.

Phacelia ramosissima Douglas ex Lehm.; Native; Perennial; Forb; 4; MR; 592.

Hypericaceae

Hypericum scouleri Hook.]; Native; Perennial; Forb; 2; MR; 571 [Bond 214, 367 as *Hypericum formosum* H.B.K. included here].

Juglandaceae

Juglans major (Torr.) A. Heller; Native; Perennial; Tree; 2; RW; 621.

Krameriaceae

Krameria erecta Willd. ex Schult. & Schult. f.; Native; Perennial; Shrub; 3; RW; 854.

Lamiaceae

Clinopodium vulgare L.; Native; Perennial; Forb; 0; MR; Rink 12617.

Agastache pallidiflora (A. Heller) Rydb.; Native; Perennial; Forb; 4; MC; 1072.

Agastache wrightii (Greenm.) Wooton & Standl.; Native; Perennial; Forb; 3; MW, PP, SP; 825, 1057, 1093.

Dracocephalum parviflorum Nutt.; Native; Biennial; Forb; 3; RW; 356.

Hedeoma hyssopifolia A. Gray; Native; Perennial; Forb; 3; MC, PP; 45, 672, 1025.

Hedeoma oblongifolia (A. Gray) A. Heller; Native; Perennial; Forb; 3; MW, PJ, PP, RW; 468, 766, 826, 850, 891, 1113.

Leonurus cardiaca L.; Introduced; Perennial; Forb; 4; MC, MR; 537, 1107.

Marrubium vulgare L.; Introduced; Perennial; Forb; 3; SP; 1064.

Mentha arvensis L.; Native; Perennial; Forb; 2; MC, MR; 628, 690.

Monarda fistulosa var. *menthifolia* (Graham) Fernald; Native; Perennial; Forb; 2; MC, MR; 7, 587, 680, 697.

Prunella vulgaris L.; Native; Perennial; Forb; 2; MC, MR; 9, 545, 680, 697.

Salvia reflexa Hornem.; Native; Annual; Forb; 4; MW; 52.

Stachys albens A. Gray; Native; Perennial; Forb; 5; RW; State record; 1052.

Linaceae

Linum lewisii Pursh; Native; Perennial; Forb; 2; MC, PJ, PP; 165, 223, 659.

Loasaceae

Mentzelia albicaulis (Douglas ex Hook.) Douglas ex Torr. & A. Gray; Native; Annual; Forb; 3; IC; 273, 980.

Mentzelia multiflora (Nutt.) A. Gray; Native; Biennial; Forb; 3; IC, MW, PJ; 270, 810, 868, 1022.

Lythraceae

Lythrum californicum Torr. & A. Gray; Native; Perennial; Forb; 4; MR, SP; 639, 1061.

Malpighiaceae

Cottsia gracilis (A. Gray) W.R. Anderson & C. Davis; Native; Perennial; Forb; 3; MW; 841.

Malvaceae

Abutilon parvulum A. Gray; Native; Perennial; Forb; 5; PJ; 1047.

Sida abutifolia Mill.; Native; Annual; Forb; 4; MW; 183, 859.

Sidalcea neomexicana A. Gray; Native; Perennial; Forb; 2; MR; 700.

Sphaeralcea ambigua A. Gray; Native; Perennial; Forb; 3; RW; 92.

Sphaeralcea emoryi Torr. ex A. Gray; Native; Perennial; Forb; 3; PJ; 264.

Sphaeralcea rusbyi A. Gray; Native; Perennial; Forb; 3; IC, MC, PP; 465, 780.

Montiaceae

Claytonia parviflora Douglas ex Hook.; Native; Annual; Forb; 3; IC; 197.

Claytonia perfoliata Donn ex Willd.; Native; Annual; Forb; 3; MC, PP, RW; 72, 229, 947.

Claytonia rosea Rydb.; Native; Perennial; Forb; 4; MC, PP; 119, 913, 924.

Moraceae

Morus microphylla Buckley ; Native; Perennial; Tree; 4; IC, PP; 210, 250, 999.

Nyctaginaceae

Allionia incarnata L.; Native; Annual; Forb; 2; MW; 159, 834.

Boerhavia coccinea Mill.; Native; Perennial; Forb; 3; MW; 864, 877.

Boerhavia erecta L.; Native; Annual; Forb; 3; MW; 846.

Boerhavia purpurascens A. Gray; Native; Annual; Forb; 3; PJ; 797.

Mirabilis albida (Walter) Heimerl ; Native; Perennial; Forb; 4; IC, MW, PP; 898.

Mirabilis coccinea (Torr.) Benth. & Hook. f.; Native; Perennial; Forb; 4; IC, PJ, PP; 258, 453, 577.

Mirabilis linearis var. *decipiens* (Standl.) S.L. Welsh; Native; Perennial; Forb; 3; PP; 713.

Mirabilis multiflora (Torr.) A. Gray; Native; Perennial; Forb; 4; IC; 814.

Mirabilis oxybaphoides (A. Gray) A. Gray; Native; Perennial; Forb; 0; Phillips 84-247.

Oleaceae

Forestiera pubescens Nutt.; Native; Perennial; Shrub; 3; PJ; 1044.

Fraxinus anomala var. *lowellii* (Sarg.) Little; Native; Perennial; Shrub; 3; MR, MW; 638, 1055.

Fraxinus velutina Torr.; Native; Perennial; Tree; 3; MC, MR, PP; 225, 456, 655.

Menodora scabra A. Gray; Native; Perennial; Subshrub; 2; IC, PJ; 274, 804.

Onagraceae

Chylismia cardiophylla (Torr.) Small; Native; Annual; Forb; 5; SD; extends distribution 80 km northeast from Tangle Creek, Yavapai County; 965.

Circaea alpina ssp. *pacifica* (Asch. & Magnus) P.H. Raven; Native; Perennial; Forb; 4; MC; 498.

Epilobium ciliatum ssp. *ciliatum* Raf.; Native; Perennial; Forb; 3; MC, MR; 648, 683.

Eremothera chamaenerioides (A. Gray) W.L. Wagner & Hoch; Native; Annual; Forb; 4; IC, MW; 281.

Oenothera cespitosa ssp. *marginata* (Nutt. ex Hook. & Arn.) Munz; Native; Perennial; Forb; 3; PP; 738.

Oenothera elata Kunth; Native; Biennial; Forb; 3; MC; 1070.

Oenothera flava (A. Nelson) Garrett; Native; Perennial; Forb; 3; PP; 390, 444.

Oenothera hexandra ssp. *gracilis* (Wooton & Standl.) W.L. Wagner & Hoch; Native; Annual; Forb; 3; MR, PP; 705, 710.

Oenothera neomexicana (Small) Munz; Native; Biennial; Forb; 4; MC; 678.

Oenothera pubescens Willd. ex Spreng.; Native; Annual; Forb; 4; MC, PP; 35, 718, 1024.

Oenothera suffrutescens (Ser.) W.L. Wagner & Hoch; Native; Perennial; Forb; 3; PJ; 261.

Oenothera villosa ssp. *strigosa* (Rydb.) W. Dietr. & P.H. Raven; Native; Biennial; Forb; 0; MR; Rink 10778.

Orobanchaceae

Castilleja angustifolia (Nutt.) G. Don; Native; Perennial; Forb; 3; MW; 873.

Castilleja applegatei ssp. *martinii* (Abrams) T.I. Chuang & Heckard; Native; Perennial; Forb; 3; PJ, RW; 148, 263.

Castilleja integra A. Gray; Native; Perennial; Forb; 3; PP; 304, 464, 939, 943.

Castilleja linariifolia Benth.; Native; Perennial; Forb; 3; MW; 886.

Cordylanthus laxiflorus A. Gray; Native; Annual; Forb; 3; MW; 1111.

Cordylanthus wrightii A. Gray; Native; Annual; Forb; 0; Bond 122.

Orobanche fasciculata Nutt.; Native; Annual; Forb; 4; MW, PP; 177, 938.

Pedicularis centranthera A. Gray; Native; Perennial; Forb; 3; MC, PJ; 129, 256.

Oxalidaceae

Oxalis albicans Kunth; Native; Perennial; Forb; 0; Specimen on loan and not yet verified; Bond 191b.

Oxalis alpina (Rose) Rose ex R. Knuth; Native; Perennial; Forb; 3; MC; 670.

Oxalis caerulea (Small) R. Knuth; Native; Perennial; Forb; 0; PP; Licher 1591.

Oxalis stricta L.; Native; Perennial; Forb; 3; PP; 417.

Papaveraceae

Corydalis aurea ssp. *aurea* Willd.; Native; Perennial; Forb; 3; MC, PJ, RW; 85, 107, 123.

Corydalis aurea ssp. *occidentalis* (Engelm. ex A. Gray) G.B. Ownbey; Native; Annual; Forb; 3; MR; 372.

Eschscholzia californica Cham.; Native; Perennial; Forb; 5; MW; 1127.

Phrymaceae

Mimulus guttatus DC.; Native; Annual; Forb; 1; MR, RW; 4, 185, 246, 346.

Mimulus rubellus A. Gray; Native; Annual; Forb; 5; PP; 937.

Plantaginaceae

Collinsia parviflora Lindl.; Native; Annual; Forb; 3; PP, RW; 91, 134, 927.

Maurandella antirrhiniflora (Humb. & Bonpl. ex Willd.) Rothm.; Native; Perennial; Forb; 4; IC, RW; 290, 809, 849.

Penstemon barbatus (Cav.) Roth; Native; Perennial; Forb; 3; PP; 661.

Penstemon eatonii A. Gray; Native; Perennial; Forb; 4; PJ, RW; 138, 1020.

Penstemon linarioides A. Gray; Native; Perennial; Forb; 3; IC, MR, PJ, PP; 623, 791, 817, 1017.

Penstemon palmeri A. Gray; Native; Perennial; Forb; 4; IC; 207.

Penstemon pseudospectabilis M.E. Jones; Native; Perennial; Forb; 3; IC, RW; 150, 251.

Penstemon rostriflorus Kellogg; Native; Perennial; Forb; 3; MR, MW, PJ; 630, 880, 1019.

Penstemon virgatus A. Gray; Native; Perennial; Forb; 4; PP; 722.

Plantago argyrea E. Morris; Native; Annual; Forb; 3; MC; 41.

Plantago lanceolata L.; Introduced; Biennial; Forb; 4; PP; 448, 755.

Plantago major L. ; Introduced; Perennial; Forb; 3; MC, PP; 419, 546.

Plantago patagonica Jacq.; Native; Annual; Forb; 3; MW; 95.

Synthyris plantaginea (E. James) Benth.; Native; Perennial; Forb; 4; PP; 407.

Veronica americana Schwein. ex Benth.; Native; Perennial; Forb; 3; MC; 38.

Veronica anagallis-aquatica L.; Native; Perennial; Forb; 3; MR, RW; 478, 524, 528.

Veronica peregrina L.; Native; Annual; Forb; 4; PP; 445.

Platanaceae

Platanus wrightii S. Watson; Native; Perennial; Tree; 2; RW; 585.

Polemoniaceae

Eriastrum eremicum (Jeps.) H. Mason; Native; Annual; Forb; 4; IC, MW; 193, 275, 973.

Gilia flavocincta A. Nelson; Native; Annual; Forb; 0; Bond 323.

Gilia mexicana A.D. Grant & V.E. Grant; Native; Annual; Forb; 3; PP; 944.

Gilia transmontana (H. Mason & A.D. Grant) A.D. Grant & V.E. Grant; Native; Annual; Forb; 3; PP; 1000.

Ipomopsis aggregata ssp. *formosissima* (Greene) Wherry; Native; Biennial; Forb; 3; MR; 708.

Leptosiphon nuttallii (A. Gray) J.M. Porter & L.A. Johnson; Native; Perennial; Forb; 2; CO, MR, PP; 13, 607, 717, 1088.

Phlox cluteana A. Nelson; Native; Perennial; Forb; 5; MC, PP; NatureServe G3 rank; 217, 388, 443.

Polemonium foliosissimum var. *flavum* (Greene) Anway; Native; Perennial; Forb; 2; MC, PP; 493, 646, 671.

Polygonaceae

Eriogonum abertianum Torr.; Native; Annual; Forb; 3; IC, MR, MW; 835, 866, 899, 981, 1109.

Eriogonum alatum Torr.; Native; Perennial; Forb; 0; Bond 378, 379.

Eriogonum arcuatum Greene; Native; Perennial; Forb; 4; MW; 885.

Eriogonum capillare Small; Native; Annual; Forb; 3; IC; AZ Dept. of Agriculture List B protected species; 811.

Eriogonum jamesii Benth.; Native; Perennial; Forb; 0; Bond 124.

Eriogonum racemosum Nutt.; Native; Perennial; Forb; 3; PP; 767.

Eriogonum wrightii var. *wrightii* Torr. ex Benth.; Native; Perennial; Subshrub; 3; MW, PJ; 50, 870.

Fallopia convolvulus (L.) Á. Löve; Introduced; Annual; Forb; 4; MC; 1086.

Persicaria lapathifolia (L.) Gray; Native; Annual; Forb; 5; PJ; 1045.

Persicaria maculosa Gray; Introduced; Annual; Forb; 5; MC; 741.

Polygonum aviculare L.; Introduced; Annual; Forb; 3; PJ; 889.

Polygonum sawatchense ssp. *sawatchense* Small; Native; Annual; Forb; 3; PP; 762, 1026.

Rumex acetosella L.; Introduced; Perennial; Forb; 3; MC, PP; 391, 438, 553, 712.

Rumex crispus L.; Introduced; Perennial; Forb; 3; MR; 684.

Rumex mexicanus Meisn.; Native; Perennial; Forb; 3; PP; 754.

Primulaceae

Androsace septentrionalis L.; Native; Annual; Forb; 2; MR, PP; 370, 394, 919, 1122.

Ranunculaceae

Aconitum columbianum Nutt.; Native; Perennial; Forb; 4; MR; 521.

Actaea arizonica (S. Watson) J. Compton; Native; Perennial; Forb; 5; MC; USFS Region 3 sensitive species, NatureServe G2 rank, and AZ Dept. of Agriculture List A protected species; 570, 669, 744, 1075, 1077, 1080, 1081, 1087.

Actaea rubra (Aiton) Willd.; Native; Perennial; Forb; 3; MC; 335, 431, 668.

Anemone tuberosa Rydb.; Native; Perennial; Forb; 3; IC, RW; 77, 906.

Aquilegia chrysantha A. Gray; Native; Perennial; Forb; 3; MC, RW; AZ Dept. of Agriculture List B protected species; 200, 245, 535.

Aquilegia desertorum (M.E. Jones) Cockerell ex A. Heller; Native; Perennial; Forb; 4; MC, MR, PP; AZ Dept. of Agriculture List B protected species; 377, 420, 534, 536.

Aquilegia formosa var. *formosa* Fisch. ex DC.; Native; Perennial; Forb; 0; PP; Extends distribution 185 km south from Upper Ribbon Falls, Grand Canyon; Rink 11997.

Clematis ligusticifolia Nutt.; Native; Perennial; Vine; 3; MC; 691.

Delphinium scaposum Greene; Native; Perennial; Forb; 3; IC, PP; 195, 252, 946, 1117.

Myosurus apetalus var. *montanus* (G.R. Campb.) Whittem.; Native; Annual; Forb; 5; IC; 79.

Ranunculus hydrocharoides A. Gray; Native; Perennial; Forb; 3; MC, MR; 548, 742.

Ranunculus macounii Britton; Native; Perennial; Forb; 0; Bond 385.
Thalictrum fendleri Engelm. ex A. Gray; Native; Perennial; Forb; 2; PP; 645.

Rhamnaceae

Ceanothus fendleri A. Gray; Native; Perennial; Shrub; 3; PP, RW; 584, 675, 1007.

Ceanothus greggii A. Gray; Native; Perennial; Shrub; 3; IC, MW, PJ, PP; 154, 161, 960.

Rhamnus californica ssp. *ursina* (Greene) C.B. Wolf; Native; Perennial; Shrub; 3; MC, PP; 496, 657.

Rhamnus ilicifolia Kellogg; Native; Perennial; Shrub; 3; IC, MC; 579, 995.

Ziziphus obtusifolia var. *canescens* (Hook. Ex Torr. & A. Gray) A. Gray; Native; Perennial; Shrub; 3; IC; 1126.

Rosaceae

Amelanchier alnifolia (Nutt.) Nutt. Ex M. Roem.; Native; Perennial; Shrub; 0; MC; Rink 12615.

Agrimonia gryposepala Wallr.; Native; Perennial; Forb; 0; MC; Rink 10764.

Agrimonia striata Michx.; Native; Perennial; Forb; 2; MC, PP; 643, 692.

Amelanchier utahensis Koehne; Native; Perennial; Shrub; 3; MC, MR; 365, 433, 1009.

Cercocarpus montanus Raf.; Native; Perennial; Shrub; 2; IC; 288.

Chamaebatiaria millefolium (Torr.) Maxim.; Native; Perennial; Shrub; 3; MC, PP; 604, 930.

Drymocallis arizonica Rydb.; Native; Perennial; Forb; 3; MC, MR; 436, 612.

Fallugia paradoxa (D. Don) Endl. ex Torr.; Native; Perennial; Shrub; 2; IC; 271.

Fragaria virginiana ssp. *glauca* (S. Watson) Staudt; Native; Perennial; Forb; 3; PP; 411.

Geum triflorum Pursh; Native; Perennial; Forb; 3; PP; 409.

Holodiscus discolor var. *dumosus* (S. Watson) Maxim. ex J.M. Coult.; Native; Perennial; Shrub; 2; MC; 491.

Petrophytum caespitosum (Nutt.) Rydb.; Native; Perennial; Subshrub; 3; PP; 57.

Potentilla crinita A. Gray; Native; Perennial; Forb; 3; PP; 1029.

Potentilla subviscosa var. *ramulosa* (Rydb.) Kearney & Peebles; Native; Perennial; Forb; 3; PP; 410, 921.

Potentilla thurberi A. Gray; Native; Perennial; Forb; 3; MC, MR; 42, 642.

Purshia mexicana var. *stansburyana* (Torr.) S.L. Welsh; Native; Perennial; Shrub; 3; IC, MW; Bond 151.

Rosa woodsii ssp. *arizonica* (Rydb.) W.H. Lewis & Ertter; Native; Perennial; Subshrub; 2; PP; 352.

Rubus neomexicanus A. Gray; Native; Perennial; Subshrub; 2; MC, MR, RW; 242, 319, 368, 1008.

Rubus sachalinensis var. *sachalinensis* H. Lév.; Native; Perennial; Subshrub; 3; RW; 506.

Rubiaceae

Galium aparine L.; Native; Annual; Forb; 3; MC, PP, RW; 133, 187, 233, 613.

Galium collomiae J.T. Howell; Native; Perennial; Forb; 3; IC; 815.

Galium microphyllum A. Gray; Native; Perennial; Forb; 4; MR, MW; 182, 626.

Galium triflorum Michx.; Native; Perennial; Forb; 3; RW; 508.

Galium wrightii A. Gray; Native; Perennial; Shrub; 3; MC, PJ, PP; 575, 605, 765, 799.

Houstonia wrightii A. Gray; Native; Perennial; Forb; 3; MR, PP; 707, 715.

Rutaceae

Ptelea trifoliata var. *angustifolia* (Benth.) M.E. Jones; Native; Perennial; Shrub; 3; MC, PP; 18, 353, 495, 654.

Salicaceae

Populus angustifolia E. James; Native; Perennial; Tree; 1; MR; 572.

Populus fremontii S. Watson; Native; Perennial; Tree; 1; RW; 618.

Populus tremuloides Michx.; Native; Perennial; Tree; 4; MC; 432.

Salix amygdaloides Andersson; Native; Perennial; Shrub; 2; MR; 112.

Salix gooddingii C.R. Ball; Native; Perennial; Tree; 2; MR; 202.

Salix laevigata Bebb; Native; Perennial; Shrub; 3; MR; 113, 203.
Salix lasiandra var. *lasiandra* Benth.; Native; Perennial; Shrub; ; MR; Zdinak 74123.

Salix ligulifolia (C.R. Ball) C.R. Ball ex C.K. Schneid.; Native; Perennial; Shrub; 3; MC, MR; 111, 340, 358, 569, 949.

Salix lutea Nutt.; Native; Perennial; Shrub; 0; MR; Generic identification verified, material insufficient for positive species identification. Zdinak 73370.

Santalaceae

Comandra umbellata ssp. *pallida* (A. DC.) Piehl; Native; Perennial; Forb; 3; MC, PP; 155, 222.

Phoradendron capitellatum Torr. ex Trel.; Native; Perennial; Subshrub; 3; IC; 822.

Phoradendron villosum (Nutt.) Nutt. ex Engelm.; Native; Perennial; Subshrub; 3; PJ, RW; 86, 109.

Sapindaceae

Acer glabrum Torr.; Native; Perennial; Shrub; 3; MR; 1106.

Acer grandidentatum Nutt.; Native; Perennial; Tree; 2; MR; 434.

Acer negundo L.; Native; Perennial; Tree; 2; RW; 244.

Sapindus saponaria L.; Native; Perennial; Shrub; 4; MR; 632.

Saxifragaceae

Heuchera parvifolia Nutt. ex Torr. & A. Gray; Native; Perennial; Forb; 2; PP; 408.

Heuchera rubescens Torr.; Native; Perennial; Forb; 2; MC, MR; 348, 362, 489.

Lithophragma tenellum Nutt.; Native; Perennial; Forb; 4; PP; 928.

Micranthes odontoloma (Piper) A. Heller; Native; Perennial; Forb; 4; MR, RW; Occurring along southern range limit; 520, 617.

Scrophulariaceae

Scrophularia parviflora Wooton & Standl.; Native; Perennial; Forb; 4; MR; 1091.

Verbascum thapsus L.; Introduced; Biennial; Forb; 2; PP; 644.

Simmondsiaceae

Simmondsia chinensis (Link) C.K. Schneid.; Native; Perennial; Shrub; 1; MW; 847.

Solanaceae

Datura wrightii Regel; Native; Annual; Forb; 4; RW, SP; 792, 1056.

Lycium fremontii A. Gray; Native; Perennial; Shrub; 3; IC, MW; 296, 901.

Lycium pallidum Miers; Native; Perennial; Shrub; 3; IC; 196.

Nicotiana obtusifolia var. *obtusifolia* M. Martens & Galeotti; Native; Biennial; Forb; 4; IC, SD; 287, 816, 966.

Physalis hederifolia A. Gray; Native; Perennial; Forb; 3; IC, MR, MW; 484, 820, 961.
Solanum americanum Mill.; Native; Annual; Forb; 2; MW, PJ; 897, 1048.

Solanum douglasii Dunal; Native; Perennial; Forb; 3; IC; 789.

Solanum stoloniferum Schltdl.; Native; Perennial; Forb; 0; PP; Extends distribution 60 km Northwest of Woods Canyon, Sitgreaves Recreation Area in Coconino County; Licher 1588.

Urticaceae

Parietaria pensylvanica Muhl. ex Willd.; Native; Annual; Forb; 4; IC, SD; 277.

Urtica dioica ssp. *gracilis* (Aiton) Selander; Native; Perennial; Forb; 2; MR; 523.

Verbenaceae

Aloysia wrightii (A. Gray) A. Heller; Native; Perennial; Shrub; 2; MW, PJ; 808, 842.

Glandularia chiricahensis Umber; Native; Perennial; Forb; 2; MR, PP; NatureServe G2G3 rank; 460, 590, 660.

Glandularia gooddingii (Briq.) Solbrig; Native; Perennial; Forb; 2; IC, MR, MW, PP; 174, 283, 307, 483.

Violaceae

Viola canadensis L.; Native; Perennial; Forb; 2; MC, MR, PP; 49, 231, 315, 364, 412.

Viola sororia var. *affinis* (Leconte) L.E. McKinney; Native; Annual; Forb; 2; MC, MR, RW; 237, 322, 363, 529.

Vitaceae

Vitis arizonica Engelm.; Native; Perennial; Vine; 1; MC, MR, RW; 328, 367, 481, 505.

Zygophyllaceae

Tribulus terrestris L.; Introduced; Annual; Forb; 4; MW; Noxious weed; 856.