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VASCULAR FLORA OF THE LOWER SAN FRANCISCO VOLCANIC FIELD, COCONINO COUNTY, ARIZONA

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ABSTRACT

The San Francisco Volcanic Field lies near the southern edge of the Colorado Plateau in north-central Arizona, and is dominated by an extensive Pinyon-Juniper woodland. During 2004 and 2005, a floristic inventory vouchered 487 taxa from 74 families and 268 genera, including eight species endemic to Arizona. The Asteraceae, Poaceae, Fabaceae, Brassicaceae, and Scrophulariaceae comprised 51% of the total flora. *Eriogonum*, *Muhlenbergia*, *Penstemon*, *Aristida*, *Astragalus*, and *Cryptantha* were the best represented genera. Nonnative taxa accounted for ten percent of the total flora. *Cryptantha minima* and *Suckleya suckleyana* were vouchered as new records for Arizona.

Key Words: Floristics, flora, Pinyon-Juniper woodlands, San Francisco Volcanic Field, volcanic endemism.

Arizona displays the third highest diversity of vascular plants in the United States with over 3,500 known taxa; however, it is also the fifth most "at-risk" state with over 15% of its plant species at risk of extinction due to rarity or habitat loss (Stein 2002). While many floristic inventories document vascular plant diversity around the state, no vascular plant inventory exists for the lower San Francisco Volcanic Field (SFVF), an expansive Pinyon-Juniper woodland in north-central Arizona (Moore and Cole 2004). Inventories in adjacent areas have been primarily restricted to National Park Service units and scenic landscapes such as deep canyons or mountain peaks (e.g., McDougall & Haskell 1960; Joyce 1976; Hazen 1978; Schilling 1980; Kierstead 1981; Gilbert and Licher 2005; Moir 2006). Pinyon-Juniper woodlands have often been overlooked or ignored during the creation of inventories, and thus the relatively vast lower SFVF represents a significant gap in floristic knowledge.

The SFVF lies at the convergence of several biotic communities, in the middle of a large elevational gradient, and at the junction of several known physiographic and floristic zones; and was therefore anticipated to have a high diversity of vascular plants (Brown and Lowe 1980; McLaughlin 1992). Cinder ecosystems resulting from the recent Sunset Crater volcanic eruption are also known to host several edaphically-limited, rare, and endemic plants (AGFD 2005a, b, c).

The distributions of Pinyon-Juniper woodlands, and potentially the understory species associated with this community type, have varied historically with changing climate variables (Betancourt et al. 1990). Shifts in vegetation distributions due to global climate change, especially in semiarid environments and at ecotones, are a definite possibility in upcoming years (Allen and Breshears 1998). The ecophysiographic nature of the lower SFVF (it encompasses a woodland community in a semi-arid climate, and has a widespread ecotonal component) lends greater urgency to a floristic assessment of the area. The findings from this study will provide a benchmark of local floristic diversity and serve as a basis for future comparisons.

Study Area

The SFVF lies near the southern edge of the Colorado Plateau physiographic province in north-central Arizona; south-central Coconino County (Bailey et al. 1994; Bailey 1998). The lower SFVF, and synonymously the study area, was defined as the contiguous *Pinus edulis*/*Juniperus monosperma* dominated portion of the SFVF. It is elevationally bound by montane coniferous forests above and grasslands below (Brown and Lowe 1980). Inclusions of other vegetation on north-facing slopes, drainages, canyons, or unusual microsites were also included as part of the study area.

The study area lies between 35°10′47″ and 35°41′30″ latitude and between −111°21′3″ and −112°10′12″ longitude, and encompasses approximately 1134 km^2 (Fig. 1). Elevations range from 1700 to 2400 m; however, approximately 84% of the study area falls between 1829 and 2134 m. Roughly 73% of the study area lies within the Coconino and Kaibab National Forests, while the remainder occurs on essentially undeveloped private (16%) and State (11%) land. Approximately 70 widely-spaced cinder cones dot the

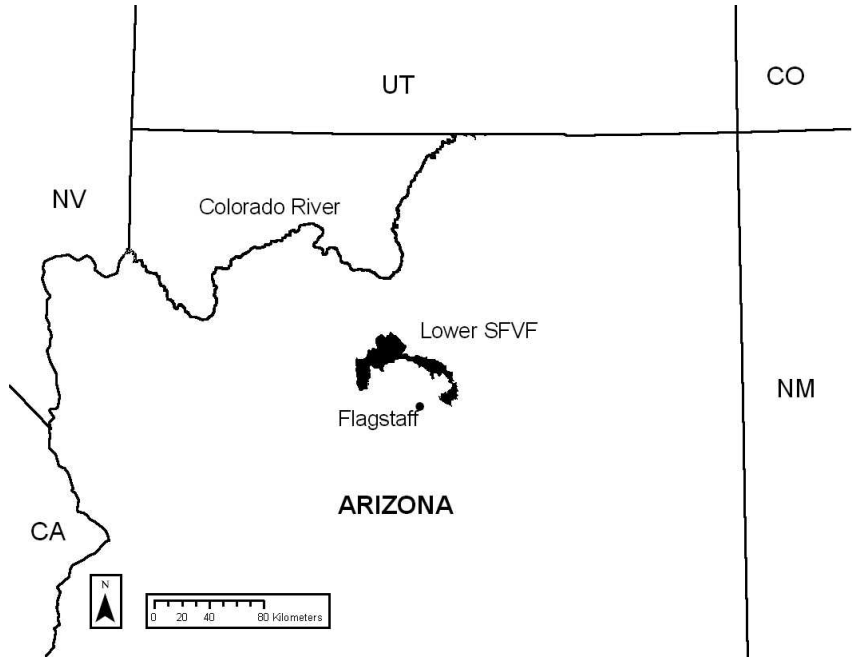

FIG. 1. Location of the lower San Francisco Volcano Field (lower SFVF).

otherwise flat plateau of the lower SFVF. The study area lacks major river systems, bodies of water or streams, and perennial water is essentially absent. Biotic communities are solely restricted to Great Basin Conifer Woodlands with several small inclusions of Petran Montane Conifer Forests and Desert Grasslands at anomalous sites (Brown and Lowe 1980). The SFVF sits near the junction of the Colorado Plateau and Apachian floristic areas (McLaughlin 1989).

The lower SFVF has a semi-arid climate and receives approximately 38 cm of precipitation annually; however, precipitation can vary dramatically, often ranging between 25 and 65 cm from year to year (Bailey et al. 1994; Bailey 1998; WRCC 2005). Precipitation is bi-modal, as very dry late springs and early summers punctuate winter and monsoonal moisture. Approximately 50% of the annual precipitation comes from summer monsoons. The winter of 2004–2005 received 200% of the historical precipitation average, while the spring of 2005 was 140% wetter than normal. Summer rains of 2005 brought 75% of the historical precipitation average (WRCC 2005).

The SFVF was created by at least seven major eruptive events, and is one of the major basaltic volcanic fields of the Colorado Plateau (Cooley 1962; Tanaka et al. 1986). It includes over 600 Pliocene, Pleistocene, and Holocene volcanic vents, volcanoes, and cinder cones, and their associated sheet deposits and lava flows (Tanaka et al. 1986). Local basaltic volcanism began roughly six millions yrs ago and has occurred continuously for the past three million yrs (Moore et al. 1976). Paleomagnetic data, Potassium-Argon dating, and thorough field mapping, suggest that substrates of the SFVF range from less than one-thousand yrs old at the eastern edge of the volcanic field to over six-million yrs old at the southwestern edge of the volcanic field, only 100 km away (Tanaka et al. 1986; Moore and Wolfe 1987; Wolfe et al. 1987)

Due to its volcanic history, igneous rocks and their associated soils are the dominant substrates of the SFVF. Basaltic rocks, cinders, and lava from the Holocene to Middle Pliocene cover about 80% of the of the study area. Quaternary alluviums (3.5%), Holocene to Middle Pliocene rhyolites and andesites (3%), Pleistocene alluviums (2%), and Permian sandstone and limestone (11%) comprise the additional surficial geology (Richard et al. 2000).

METHODS

Vascular plants were collected for 55 d (ca. 400 hr) between March and October of 2004 and 2005. An effort was made to collect every taxon, as well as to collect from the entire geographic and habitat range of the study area. Special effort was made to target areas and habitats that harbored greater diversity or locally unusual taxa. Voucher collections included plant descriptions, habitat descriptions, locality descriptions, and lists of associated species. UTM coordinates and elevations were taken from a Garmin eTrex Legend GPS unit (Garmin International; Olathe,

TABLE 1. TAXONOMIC COMPOSITION OF THE LOWER SAN FRANCISCO VOLCANIC FIELD.

Divisions and Classes	Families	Genera	Species	Infraspecific taxa	Total Taxa
Polypodiophyta	2	3	3	0	3
Pinophyta					6
Pinopsida	2	2	5	0	5
Gnetopsida	1	1	1	0	1
Magnoliophyta					478
Magnoliopsida	57	212	372	6	378
Liliopsida	12	50	98	2	100
Totals	74	268	479	8	487

KS). Voucher specimens were pressed, dried, mounted, and deposited in the Deaver Herbarium (ASC) at Northern Arizona University following typical protocols (Weber 1976). Specimens were identified primarily using the *Intermountain Flora* (Cronquist et al. 1972+), the *Flora of North America* (Flora of North America Editorial Committee 1993+), treatments from the *Manual of Vascular Plants of Arizona* as published in the *Journal of the Arizona-Nevada Academy of Science* (Vascular Plants of Arizona Editorial Committee 1992+), and *Seed Plants of Northern Arizona* (McDougall 1973). All nomenclature follows the USDA PLANTS database (USDA 2005).

Digital searches of the ASC, ASU, ARIZ, DBG, and NAVA herbaria based upon all of the place names within the study area (gleaned from United States Geological Survey 7.5′ Quadrangle maps) were conducted via the Southwestern Environmental Information Network's query tools (SEINet 2005). A geographical extraction based upon georeferenced specimens from the ASU and ARIZ herbaria was also conducted.

Various species richness estimates for the study area were determined in an attempt to access the completeness of the inventory. Nonparametric estimators, functional extrapolation, and predictive regressions were used due to ease of implementation and compatibility with previously gathered data. Species occurrences in twenty randomly selected 0.25 Ha plots were used to input the statistical models. Longino et al. (2002) provide a discussion of the merits of various species richness estimation techniques.

RESULTS

A total of 873 plant collections were made during two field seasons, representing 456 distinct taxa. Herbaria searches revealed an additional 31 taxa, thus the inventory identified 487 taxa from the lower SFVF. This inventory vouchered 313 previously uncollected taxa, representing a 280% increase in the documented flora of the lower SFVF. Seventeen taxa represented by historical collections were not encountered in the field during this survey. (These taxa are indicated by an abundance classification of "0" in Appendix A.) This absence may suggest that these species are locally uncommon; as approximately one-third reach the extent of their ranges near the SFVF, and another one-third lack much suitable habitat in the SFVF. On average it has been 25 yrs since one of these species was collected from the SFVF, perhaps because these species simply no longer occur or have decreased in abundance locally. Fourteen additional common taxa were encountered in the field but were not collected due to documentation by extant herbarium collections. These taxa are indicated with a pound sign (#) in Appendix A. The annotated catalog gives the scientific name, life form, abundance, habitat, and a list of voucher collections for each vascular plant of the lower SFVF (Appendix A).

Seventy-four (74) families, 268 genera, 479 species, and 8 infraspecific taxa were vouchered from within the study area (Table 1). The Asteraceae (97 taxa), Poaceae (76 taxa), Fabaceae (33 taxa), Brassicaceae (22 taxa), Scrophulariaceae (20 taxa), and Polygonaceae (18 taxa) were the best represented families. The five most species-rich families comprised approximately 51% of the flora, while 28 families were represented by a single taxon. *Eriogonum* (12 taxa), *Muhlenbergia* (10 taxa), *Bromus* (8 taxa), *Penstemon* (8 taxa), *Aristida* (7 taxa), and *Astragalus* (7 taxa) were the best represented genera. Perennial and annual herbs accounted for 79% of the total flora; while trees, biennial herbs, and annual graminoids accounted for only 12%.

A total of 49 non-native plant species comprised 10% of the total flora. The Poaceae (12 taxa), Asteraceae (9 taxa), Brassicaceae (5 taxa), Chenopodiaceae (3 taxa), and Fabaceae (3 taxa) represented the most common non-native families. Non-native species were most commonly annual (54%) or perennial herbs (25%). This inventory vouchered 38 new non-native taxa from the lower SFVF. *Populus alba* was the only escaped horticultural species that was discovered. *Salsola tragus*, *Marrubium vulgare*, *Bromus tectorum*, and *Thinopyrum intermedium* seemed to be the most widespread non-natives; while *Carduus nutans*, *Centaurea diffusa*, and *Sisymbrium altissimum* seemed to have the highest potential for displacing native vegetation.

TABLE 2. OVERALL SPECIES RICHNESS ESTIMATIONS. * - functional extrapolation technique.

Technique	Species Estimate	Reference for Technique
1st order Jackknife	258	Smith & van Belle 1984
2nd order Jacknife	288	Palmer 1991
ICE (incidence-based coverage estimator)	250	Chazdon et al. 1998, Chao et al. 2000
Chao I upper 95% C.I.	304	Chao 1987
Chao II upper 95% C.I.	299	Chao 1987
Bootstrap	226	Smith & van Belle 1984
Michaelis-Menten Function* (means)	257	Colwell et al. 2004

Cryptantha minima and *Suckleya suckleyana* represent new records for Arizona (Christie 2006), while collections of *Peteria scoparia* and *Panicum mohavense* represent new records for Coconino County.

This inventory vouchered seven species which are endemic to Coconino and adjacent counties (*Penstemon clutei*, *Mentzelia collomiae*, *Phemeranthus validulus*, *Chrysothamnus molestus*, *Phlox amabilis*, *Lotus mearnsii* var. *mearnsi*, *and Ivesia multifoliolata*); and *Rorippa microtitis* which is endemic to Arizona. *Phacelia serrata*, and *Camissonia gouldii* are nearly endemic to Arizona, but also occur in similar barren cinder habitats in New Mexico and Utah, respectively.

Overall species richness estimates suggest that approximately 250–300 species of vascular plants occur within the lower SFVF (Table 2).

DISCUSSION

The underestimation of actual species richness of the lower SFVF by several techniques (Table 2) probably results from habitat patchiness, and illustrates some of the differences in habitat dynamics between the Southwest and Eastern hardwood forests (where several of the richness estimate techniques originated). While the landscape of the lower SFVF is quite homogeneous as a whole, small landscape anomalies host disproportionate numbers of plant species. For example, a single small spring or wetland encompasses an infinitesimal portion of the study area, but (as with Law's Natural Tank in the case of this inventory) might host 10 species (or 2% of the total flora) found nowhere else within the study area. While 20 sample plots used for the richness estimation analysis were randomly selected, the vast majority occurred on flat, open slopes and represented the most homogeneous portions of the local landscape. Statistically-driven techniques seemed to estimate the overall species richness fairly accurately for the homogeneous portions of the landscape, however as a result of habitat patchiness and random plot selection, they failed to take into account localized habitats of high plant diversity.

Another approach to estimating the completeness of a flora is to apply one's data to a regression based upon similar checklists. In western floras, species diversity is strongly positively-correlated with the elevational range of a study area. Greater ranges of elevation host a wider degree of precipitation and temperature regimes, as well as greater topographic heterogeneity, and thus a greater variety of habitats and microhabitats (Bowers and McLaughlin 1996). Using the findings from 24 floras from Arizona and New Mexico, Bowers and McLaughlin (1996) regressed the number of native species found within an area by its elevational range and created a predictive tool for estimating inventory completeness in the Southwest. The lower SFVF has an elevational range of approximately 700 m (although over 85% of the study area actually occurs within a 350 m range), and based on the predictive tool of Bowers and McLaughlin (1996) is expected to harbor roughly 450 native plant species. This inventory vouchered 440 native plant taxa, which is over 95% of the 450 taxa expected. Areas with a high diversity of community types, canyon environments, permanent water, and a high degree of topographic roughness typically harbor additional plant species than the regression would indicate, while more homogeneous areas typically harbor fewer species (Bowers and McLaughlin 1982; Bennet and Kunzmann 1992; Bowers and McLaughlin 1996). This again suggests the floristic inventory of the lower SFVF is relatively complete as it has a single community type, lacks any major canyon environments or permanent water, and displays a high level of topographic homogeneity.

The most emblematic species of the lower SFVF, *Phacelia serrata*, *Camissonia gouldii*, *Penstemon clutei*, and *Mentzelia collomiae*, are soil endemics that inhabit barren cinder ecosystems mostly associated with the Sunset Crater eruption. The eruption of Sunset Crater roughly 900 yrs ago has left a barren, moon-like landscape devoid of much vegetation or any true soil (Wolfe et al. 1983). Little research has been done on the evolutionary history of these species, but environmental stochasticity followed by subsequent speciation events provides a likely hypothesis for their origin. Restrictive structural components of the cinders and the associated lack of competition, as opposed to nuances of soil

chemistry, seem to influence local endemism in the lower SFVF (see Kelso et al. 2003).

Phacelia serrata and *C. gouldii* are annuals that germinate after summer rains. Precipitation patterns and the presence of somewhat undisturbed, large expanses of fine-textured, barren cinders seem to influence population dynamics. Populations of both species are fairly common within a restricted local range and are seemingly secure. A cursory comparison of Arizona material of *C. gouldii* to Utah material, suggests subspecific variation between the geographically separated populations and warrants further inquiry.

P. clutei, a perennial species, occurs in similar habitats of fine-to-medium textured barren black cinders, and seemingly disturbance and fire regimes influence population dynamics (AGFD 2005b). Unchecked off-road-vehicle traffic poses the greatest threats to populations of these species. The narrowly restricted *M. collomiae* is perhaps the most fascinating of the local endemics. It occurs only within the lower SFVF and populations are uncommon, sporadic, and consist of only several plants. The plant was only recently described, is under-researched, and seems to be untracked by conservation agencies (Christy 1997; see NatureServe 2005). It inhabits medium to coarse-textured, oxidized red cinders, on moderate to steep sloughing slopes, in the vicinity of Red Mountain and Sunset Crater. Although the species was described as an annual, it is seemingly a biennial with a stout taproot, which often diverges at right angles from the stem. This taproot confers a degree of stability to the plant, on the shifting, sloughing slopes which preclude the establishment of other species. This unique plant certainly deserves additional research and monitoring. The presence of appropriate habitat seems to be the primary limitation to the health and distribution of the species, and no human impacts on the populations were observed.

In addition to the volcanic endemics, *Phemeranthus validulus* and *Panicum mohavense* were found on a single limestone bench at the northern edge of the SFVF. *Phemeranthus validulus* is intolerant of competition but can inhabit a variety of substrates. While populations are known from Yavapai and Coconino counties, the collection from this inventory represents a new, intermediate locality for the plant (AGFD 2005d). Only several plants were seen, and this species is seemingly very uncommon locally. The critically imperiled (G1/S1) *P. mohavense* was previously known only from Mohave Co., AZ, and from a single small population in Socorro Co., NM that has not been relocated in over 15 yrs (NatureServe 2005; NMRPTC 2005). This species is a diminutive annual, and active grazing within its narrow local habitat could threaten the species. *Chrysothamnus molestus*, *Phlox amabilis*, and *Lotus mearnsii* var. *mearnsii* are also endemic to northern Arizona. These species grow in a variety of soil types and habitats throughout a several-county range, and seem somewhat tolerant of competition. They occur at lower elevations within the SFVF, and perhaps can only persist in somewhat xeric climatic regimes. Potentially this group of endemics represents a relictual component of a past flora. *C. molestus* occurs on the northern edge of the volcanic field in shrub-dominated openings of the surrounding woodlands. Some synergistic qualities of open, low-lying habitats within Pinyon-Juniper woodlands seem to influence its distribution. *P. amabilis* occurs primarily on the western side of the volcanic field in fine-textured clay soils with some interspersed rock. This perennial flowers very early in the season, perhaps as a temporally-based strategy to cope with infraspecific competition. Within the study area, the high levels of early season soil moisture associated with clay-based soils, combined with the structural nuances of shallow rocky soil, seem to influence the distribution of *P. amabilis*. *L. mearnsii* var. *mearnsii* prefers fine-textured to sandy soils on flat, open slopes. It occurs, mostly singly or in small groups, in small patches of open soil at lower elevations. It is unclear what influences the distribution of this species, however the minimal sizes of populations suggest specific recruitment or pollination requirements.

Ivesia multifoliolata and *Rorippa microtitis*, also Arizona endemics, are found in wet habitats within the lower SFVF. These species are typically found in either higher or wetter areas. *I. multifoliolata* grows in rocky drainage bottoms, while *R. microtitis* prefers moist or wet soils near ponds, fields, or meadows. These species seem secure regionally, albeit quite restricted within the lower SFVF.

Conclusion

This inventory has contributed significantly to the floristic knowledge of the San Francisco Volcanic Field by vouchering 313 new records from the study area, and through the contribution of 873 collections to the Deaver Herbarium. These collections provide both a snapshot of the flora at a time of potentially intensified climate change, and also support future botanical and ecological research. This inventory gathered crucial data on the area's rare and endemic plants, which will hopefully to be used in conservation decisions by management agencies. This flora, in conjunction with the flora of the higher elevation San Francisco Peaks (Moir 2006), documents a remarkable hotspot of plant diversity in Arizona. The greater San Francisco Volcanic Field encompasses only about 0.5% of

the state's area, but hosts almost 30% of its vascular plant species.

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APPENDIX A

ANNOTATED CHECKLIST OF THE VASCULAR PLANTS OF THE LOWER SAN FRANCISCO VOLCANIC FIELD

Species are arranged first by division and class, then alphabetically by family, genus, species, and infraspecific rank. Nomenclature, author names, nativity status, and life form descriptions follow the United States Department of Agriculture PLANTS database (USDA 2005). Life form descriptions include: annual (A), biennial (B), perennial (P), shrub (S), and tree (T). Abundance classifications and habitat descriptions are subjective observations and pertain only to the lower SFVF. The abundance classifications: dominant or co-dominant (1), frequent (2), occasional (3), infrequent (4), very infrequent (5), and unseen, but previously vouchered from within the study area (0), follow Palmer et al. (1995). Habitat descriptions include: barren soil (BS), barren black cinders (BBC), canyons (CA), cinders (CI), cliffs (CL), cindery soil (CS), disturbed areas (DA), ditches (DI), drainages (DR), flat open slopes (FOS), fine-textured soil (FTS), high elevations (HE), low elevations (LE), mesic areas (MA), north-facing slopes (NFS), rocky areas (RA) roadsides (RO), sandy areas (SA), steep slopes (SS), sedimentary soils (SSO), tanks (TA), ubiquitous (UB), various habitats (VH), and wet areas (WA). All specimens were collected by the author, and are deposited at the Deaver Herbarium (ASC) unless otherwise noted. Taxon entries include: an asterisk (*) to indicate non-native, a pound sign (#) to indicate documentation from a previous herbarium collection, scientific name with authority, life form code, abundance code, general habitat descriptions, pertinent notes, and a list of voucher collections.

PTERIDOPHYTA

Dryopteridaceae

Woodsia oregana D.C. Eat. ssp. *cathcartiana* (B.L. Robins.) Windham - P; 5; CL, NFS, RA; 1228.

Pteridaceae

Cheilanthes feei T. Moore - P; 4; CL; 357.

Pellaea wrightiana Hook. - P; 5; CL; 725.

PINOPHYTA – PINOPSIDA

Cupressaceae

Juniperus deppeana Steud. - T; 4; CSL; 1259.

Juniperus monosperma (Engelm.) Sarg. - T; 1; UB; 512, 530, 1204, 1308, 1322.

Pinaceae

Pinus edulis Engelm. - T; 1; UB; M. Porter 11.

Pinus ponderosa P.& C. Lawson var. *scopulorum* Engelm. - T; 3; CA, NFS, HE; 987.

Pseudotsuga menziesii (Mirbel) Franco var. *glauca* (Beissn.) Franco - T; 5; NFS, CA; 599.

PINOPHYTA – GNETOPSIDA

Ephedraceae

Ephedra viridis Coville - S; 3; BBC, 614.

MAGNOLIOPHYTA – MAGNOLIOPSIDA

Aceraceae

Acer negundo L. var. *interius* (Britt.) Sarg. - T; 5; CA, MA; 1264B.

Amaranthaceae

Amaranthus albus L. - A; 3; DA, FOS; 1073, 1261.

Amaranthus powellii S. Wats. - A; 2; DA, CLS; 761, 1038, 1233.

* *Amaranthus retroflexus* L. - A; 3; DA, CLS; 888.

Amaranthus torreyi (Gray) Benth. ex S. Wats. - A; 3; VH, CLS; 1146, 1202B, 1210.

Anacardiaceae

\# *Rhus trilobata* Nutt. var. *trilobata* - S; 3; FOS, DR, RA; H.C. Sanchez 36.

Toxicodendron rydbergii (Small ex Rydb.) Greene - P; 4; MA, RA, CA; 977.

Apiaceae

Cymopterus purpurascens (Gray) M.E. Jones - P; 3; FTS, FOS; 513, 597.

Lomatium foeniculaceum (Nutt.) Coult. & Rose ssp. *macdoualii* (Coult. & Rose) Theobald - P; 3; FTS, RA, FOS; 572, 647.

Lomatium nevadense (S. Wats.) Coult. & Rose var. *parishii* (Coult. & Rose) Jepson - P; 3; FTS, RA; 551, 576, 712.

Apocynaceae

Apocynum cannabinum L. - P; 4; DR; 783, 1245.

Asclepiadaceae

Asclepias asperula (Dcne.) Woods. ssp. *asperula* - P; 4; VH, RA, DR; 643.

Asclepias engelmanniana Woods. - P; 4; DR, RA; 777.

Asclepias involucrata Engelm. ex Torr. - P; 5; FOS, FTS, LE; 730.

Asclepias latifolia (Torr.) Raf. - P; 4; VH, BBC, LE; 1293.

Asclepias subverticillata (Gray) Vail - P; 2; VH, RO; 480, 1132.

Asteraceae

Achillea millefolium L. var. *occidentalis* DC. - P; 4; MA, DR; 1114.

Acourtia wrightii (Gray) Reveal & King - P; 5; RA, LE; 1176.

Ageratina herbacea (Gray) King & H.E. Robins. - P; 3; DR, NFS; 934, 1181.

Agoseris glauca (Pursh) Raf. var. *laciniata* (D.C. Eat.) Smiley - P; 3; FTS, FOS; 546, 575.

Ambrosia acanthicarpa Hook. - A; 2; RO, DA; 1039, 1067, 1318.

Ambrosia psilostachya DC. - P; 3; DR, DI; 1142.

Ambrosia tomentosa Nutt. - P; 4; FTS, DI, RO; 1077.

Antennaria rosulata Rydb. - P; 4; HE; 1260.

* *Artemisia biennis* Willd. var. *biennis* - B; 5; WA; 1236.

Artemisia bigelovii Gray - S; 0; FOS, LE; H.C. Sanchez 42.

Artemisia campestris L. ssp. *borealis* (Pallas) Hall & Clements var. *scouleriana* (Hook.) Cronq. - P; 3; FOS, CS; 896, 1206.

Artemisia carruthii Wood ex Carruth. - P; 2; UB; 507, 920, 944, 1000, 1321.

\# *Artemisia dracunculus* L. - P; 2; VH; S.P. McLaughlin 2294 (ASU).

Artemisia frigida Willd. - P; 3; VH; 952.

Artemisia ludoviciana Nutt. ssp. *ludoviciana* - P; 4; DR, CA, NFS; 936.

Artemisia tridentata Nutt. ssp. *tridentata* - S; 4; RO; 1024, 1098.

Baccharis pteronioides DC. - S; 5; RA, CA, DR; 343.

Bahia dissecta (Gray) Britt. -B; 2; CSL; 1314.

Bidens heterosperma Gray - A; 4; CI, RO; 872, 1101.

Brickellia californica (Torr. & Gray) Gray var. *californica* - S; 1; BBC, CA; 1165.

Brickellia eupatorioides (L.) Shinners var. *chlorolepis* (Woot. & Standl.) B.L. Turner - P; 3; VH, RA; 1092.

Brickellia grandiflora (Hook.) Nutt. - P; 4; NFS, DR; 1186.

Brickellia oblongifolia Nutt. var. *linifolia* (D.C. Eat.) B.L. Robins. - S; 4; CI, LE; 394, 623.

* *Carduus nutans* L. - P; 5; DA, WA; 699.

* *Centaurea diffusa* Lam. - P; 3; DA, RO; 958.

Chaetopappa ericoides (Torr.) Nesom - P; 2; VH; 329, 379, 569, 667.

Chrysothamnus depressus Nutt. - S; 3; RA, FOS; 931, 997.

Chrysothamnus molestus (Blake) L.C. Anders. - S; 4; FOS, SSO, N. AZ endemic; 1151, 1310, 1312.

Cirsium arizonicum (Gray) Petrak - P; 4; CA, RA; 780.

Cirsium calcareum (M.E. Jones) Woot. & Standl. - P; 3; RO, CI; 481, 658.

Cirsium neomexicanum Gray var. *neomexicanum* - P; 3; VH; 737, 858.

Cirsium ochrocentrum Gray -P; 3; DI, RO, DR.; 490, 810, 839, 859.

Cirsium undulatum (Nutt.) Spreng. var. *undulatum* - P; 3; CSL, DR, RO; 669, 884, 930, 1297.

* *Cirsium vulgare* (Savi) Ten. - B; 4; DA; 1093, 1307.

Cirsium wheeleri (Gray) Petrak -P; 3; HE, DR; 879, 927, 1078.

Conyza canadensis (L.) Cronq. var. *glabrata* (Gray) Cronq. - A; 4; DA, RO; 922.

Coreopsis tinctoria Nutt. var. *atkinsoniana* (Dougl. ex Lindl.) H.M. Parker ex E.B. Sm. - A; 5; WA; 1196.

Dyssodia papposa (Vent.) A.S. Hitchc. - A; 5; SSO, LE; 1299.

Ericameria nauseosa (Pallas ex Pursh) Nesom & Baird ssp. *consimilis* (Greene) Nesom & Baird - S; 1; UB, FOS; 1040, 1178, 1232.

Ericameria nauseosa (Pallas ex Pursh) Nesom & Baird ssp. *nauseosa* - S; 1; UB, FOS; 1138, 1168.

Erigeron bellidiastrum Nutt. var. *bellidiastrum* - A; 4; CA, RA; 837.

Erigeron canus Gray - P; 5; FOS, HE; 805.

Erigeron colomexicanus Gray - B; 2; RA; 345, 674.

Erigeron concinnus (Hook. & Arn.) Torr. & Gray var. *concinnus* - P; 4; FOS, FTS, SSO, LE; 745, 1303, 1309.

Erigeron divergens Torr. & Gray - B; 2; VH; 331, 571.

Erigeron oreophilus Greenm. - P; 4; RA, CA; 849.

Gaillardia pinnatifida Torr. var. *pinnatifida* - P; 3; FOS, CSL; 397, 509, 866, 943.

Gnaphalium exilifolium A. Nels. - A; 4; WA; 1123, 1191, 1280.

Grindelia nuda Wood var. *aphanactis* (Rydb.) Nesom - P; 3; FOS, RO; 1099.

Grindelia squarrosa (Pursh) Dunal var. *serrulata* (Rydb.) Steyermark - P; 0; RO, LE; S.P. McLaughlin 6475 (ARIZ).

Gutierrezia sarothrae (Pursh) Britt. & Rusby - S; 1; UB, FOS; 1037.

Helianthus annuus L. - A; 3; RO, DS; 873, 1036.

Helianthus ciliaris DC. - P; 3; TA, RA; 648, 1080.

Helianthus petiolaris Nutt. ssp. *fallax* Heiser - A; 3; RO, DA; 863, 1313.

Heliomeris longifolia (Robins. & Greenm.) Cockerell var. *annua* (M.E. Jones) Yates - A; 1; FOS; 1054, 938.

Heterosperma pinnatum Cav. - A; 4; CI, DI; 1109, 1211, 1250.

Heterotheca villosa (Pursh) Shinners - P; 4; DR, HE; 965.

Hieracium fendleri Schultz-Bip. var. *fendleri* - P; 4; CS, HE; 1107.

Hymenopappus filifolius Hook. var. *lugens* (Greene) Jepson - P; 3; CS, DR, FOS; 332, 670.

Hymenothrix loomisii Blake - A; 4; RO; 1129.

Hymenoxys richardsonii (Hook.) Cockerell - P; 2; FOS, FTS; J. Bandoli *s.n.*

* *Lactuca serriola* L. -A; 3; FOS, FTS; 924, 998.

Laennecia schiedeana (Less.) Nesom - A; 3; RA, DA; 932.

Laennecia sophiifolia (Kunth) Nesom - A; 5; RA, CL; 1126.

Layia glandulosa (Hook.) Hook. & Arn. - A; 3; FOS; 579, 660.

Machaeranthera canescens (Pursh) Gray ssp. *canescens* - B; 2; VH; 386, 870, 1130.

Machaeranthera canescens (Pursh) Gray ssp. *glabra* (Gray) B.L. Turner - P; 0; FOS, CS; H.D. Hammond 11804, 11805.

Machaeranthera gracilis (Nutt.) Shinners - A; 3; FOS, LE; 510, 940.

Machaeranthera tanacetifolia (Kunth) Nees - B; 3; VH; 1004, 1147.

Malacothrix torreyi Gray - A; 3; FOS, LE; 407, 587.

* *Onopordum acanthium* L. - B; 4; DA, RO; 939.

Packera multilobata (Torr. & Gray ex Gray) W.A. Weber & A. Löve - P; 3; VH, CS; 685.

Pericome caudata Gray -S; 3; CA, RA, BBC; 950.

Pseudognaphalium canescens (DC.) W.A. Weber ssp. *canescens* - B; 4; RA, CL; 1127.

Psilostrophe cooperi (Gray) Greene - P; 0; FOS, LE; J.M. Rominger *s.n.*

Psilostrophe sparsiflora (Gray) A. Nels. - P; 3; CSL; 386, 620.

Ratibida columnifera (Nutt.) Woot. & Standl. - P; 4; RO; 689.

Sanvitalia abertii Gray - A; 3; FOS, BS; 1059.

Schkuhria multiflora Hook. & Arn. - A; 4; SA, DR; 948, 1266.

Senecio flaccidus Less. var. *flaccidus* - P; 3; FOS, CS; 619.

Senecio spartioides Torr. & Gray var. *multicapitatus* (Greenm. ex Rydb.) Welsh - P; 4; FOS, CS; J. Bandoli *s.n.*

Senecio spartioides Torr. & Gray var. *spartioides* - P; 3; FOS, CS; 941, 1169.

Solidago canadensis L. var. *gilvocanescens* Rydb. - P; 4; SS, DR, HE; 1185.

Solidago velutina DC. - P; 3; RA, DR; 929, 968, 1104.

* *Sonchus asper* (L.) Hill - A; 4; DA, WA; 697.

Stephanomeria pauciflora (Torr.) A. Nels. - P; 2; FOS, CS; 391, 488, 625, 821, 1053.

Stephanomeria spinosa (Nutt.) S. Tomb - P; 3; FOS, CS; 499, 1075.

Stephanomeria thurberi Gray - P; 4; FOS; 823.

*# *Taraxacum officinale* G.H. Weber ex Wiggers - A; 4; DA; J.M. Rominger 2015.

Tetradymia canescens DC. - S; 2; FOS, CSL; 504.

Tetraneuris acaulis (Pursh) Greene var. *arizonica* (Greene) Parker - P; 4; SSO, RA; 338, 634, 833.

Thelesperma subnudum Gray var. *subnudum* - P; 5; SSO, LE; 842.

Townsendia incana Nutt. - A; 3; FOS; 385, 528, 744, 983, 1152.

* *Tragopogon dubius* Scop. - A; 4; DA, RO; 757.

Verbesina encelioides (Cav.) Benth. & Hook. f. ex Gray ssp. *exauriculata* (Robins. & Greenm.) J.R. Coleman - A; 3; DA, RO; 828, 986.

Xanthium strumarium L. var. *canadense* - A; 4; RA, MA, DR, DI; 1128, 1143.

Zinnia grandiflora Nutt. - P; 3; FOS, LE; 383, 830.

Berberidaceae

Mahonia fremontii (Torr.) Fedde - S; 2; VH, FOS; 409.

Mahonia haematocarpa (Woot.) Fedde - S; 0; FOS, RA; R.E. Bodley *s.n.*

Mahonia repens (Lindl.) G. Don - S; 4; DR, MA, NFS; 835.

Boraginaceae

Cryptantha cinerea (Greene) Cronq. var. *cinerea* - P; 3; FOS, CS; 484, 663, 729.

Cryptantha cinerea (Greene) Cronq. var. *jamesii* Cronq. - P; 3; FOS, CS; H.D. Hammond 11100, 12028.

Cryptantha fendleri (Gray) Greene - A; 2; CS; 502, 959, 1026, 1319, 1205.

Cryptantha gracilis Osterhout - A; 4; CSL; 584.

Cryptantha minima Rydb. - A; 5; FOS, FTS; new AZ record; 641.

Cryptantha pterocarya (Torr.) Greene var. *pterocarya* - A; 3; CI, LE; 566, 585, 611.

Cryptantha setosissima (Gray) Payson -P; 4; FOS, HE, DR; 803.

Lappula occidentalis (S. Wats.) Greene var. *cupulata* (Gray) Higgins - A; 3; DA, FOS; 341, 601, 664.

Lappula occidentalis (S. Wats.) Greene var. *occidentalis* - A; 3; DA, FOS; 561.

Lithospermum incisum Lehm. - P; 2; FOS, CS; 359, 570, 590.

Lithospermum multiflorum Torr. ex Gray - P; 4; FOS, DR, RA; M.L. Carson 19.

Tiquilia nuttallii (Hook.) A. Richards. - A; 3; BBC, LE; 605, 919, 982.

Brassicaceae

* *Alyssum minus* (L.) Rothm. var. *micranthum* (C.A. Mey.) Dudley - A; 4; DA, RO; 754, 854.

Arabis fendleri (S. Wats.) Greene var. *fendleri* - P; 3; RA, CA; 550, 893.

Arabis gracilipes Greene - P; 4; RA, FTS; 577.

Arabis perennans S. Wats. - P; 3; CSL, SS, CS; 537, 563, 596, 753.

* *Camelina microcarpa* DC. - A; 5; DA, RO; 853.

Descurainia obtusa (Greene) O.E. Schulz ssp. *adenophora* (Woot. & Standl.) Detling - A; 3; VH, CS; 857.

Descurainia pinnata (Walt.) Britt. - A; 2; VH, CS; 526, 559, 739, 747, 759.

* *Descurainia sophia* (L.) Webb ex Prantl - A; 4; FOS; 406, 552.

Draba cuneifolia Nutt. ex Torr. & Gray var. *cuneifolia* - A; 3; FOS, LE; 515, 535, 553.

Erysimum capitatum (Dougl. ex Hook.) Greene var. *purshii* (Dur.) Rollins - P; 5; FOS; 1012.

* *Erysimum repandum* L. - A; 5; TA, FTS; 401.

Lepidium densiflorum Schrad. var. *densiflorum* - A; 5; DA; 755.

Lepidium montanum Nutt. var. *montanum* - P; 3; FOS, FTS; 479, 841, 1047, 1058.

Lesquerella intermedia (S. Wats.) Heller - P; 3; SSO; 339, 633.

Lesquerella rectipes Woot. & Standl. - P; 5; FOS, FTS; 1061.

Physaria newberryi Gray - P; 4; BBC; 533, 568.

Rorippa microtitis (B.L. Robins.) Rollins - A; 4; WA, TA; AZ endemic; 1121, 1156.

Rorippa sphaerocarpa (Gray) Britt. - A; 4; WA, TA; 1243, 1281.

Schoenocrambe linearifolia (Gray) Rollins - P; 3; CS, CI; 482, 487, 506.

* *Sisymbrium altissimum* L. - B; 3; FOS, CS, DA; 586, 602.

Thelypodium wrightii Gray ssp. *wrightii* - B; 4; CA, RA, CL, NFS; 937, 1298.

\# *Thlaspi montanum* L. var. *montanum* - P; 5; HE; M. Porter 13.

Cactaceae

Echinocereus fendleri (Engelm.) F. Seitz - P; 3; FOS; 688, 746.

Escobaria vivipara (Nutt.) Buxbaum var. *arizonica* (Engelm.) D.R. Hunt - P; 4; RA, FOS; 806.

Opuntia fragilis (Nutt.) Haw. - P; 5; FOS, FTS; 1050.

Opuntia macrorhiza Engelm. - S; 3; FOS,GA, SA, FTS; 692, 740, 832.

Opuntia phaeacantha Engelm. - S; 0; FOS, LE; J. Bandoli *s.n.*

Opuntia whipplei Engelm. & Bigelow - S; 2; UB; 609, 827.

Callitrichaceae

Callitriche heterophylla Pursh ssp. *heterophylla* - P; 5; TA, WA; 715.

Capparaceae

Cleome lutea Hook var. *lutea* - A; 0; RO, LE; R.J. Barr 216 (ARIZ).

Cleome serrulata Pursh - A; 2; RO, DA; 489.

Polanisia dodecandra (L.) DC. ssp. *trachysperma* (Torr. & Gray) Iltis - A; 3; BBC; 372, 1216.

Wislizenia refracta Engelm. ssp. *refracta* - A; 5; FOS, LE; 984.

Caprifoliaceae

Symphoricarpos rotundifolius Gray var. *parishii* (Rydb.) Dempster - S; 5; NFS, RA, CA; 344, 836.

Caryophyllaceae

Arenaria eastwoodiae Rydb. var. *adenophora* Kearney & Peebles - P; 4; RA, CA; 348, 574.

Arenaria lanuginosa (Michx.) Rohrb. ssp. *saxosa* (Gray) Maguire - P; 4; DR, HE; 724, 874, 1230.

Drymaria glandulosa K. Presl - A; 3; VH, CS; 1096, 1108.

Drymaria leptophylla (Cham. & Schlecht.) Fenzl ex Rohrb. - A; 0; BS, BBC, C.M. Christy 1868 (ASU).

Drymaria molluginea (Lag.) Didr. - A; 3; BS, BBC; 501B, 1184, 1211.

Chenopodiaceae

Atriplex canescens (Pursh) Nutt. var. *canescens* - S; 4; LE, RA, FOS; 378.

* *Atriplex rosea* L. - A; 3; DA, RO; 1068, 1069, 1070, 1194.

Chenopodium atrovirens Rydb. - A; 4; VH; 1029.

Chenopodium fremontii S. Wats. var. *fremontii* - A; 2; UB, CS, DA; 1046, 1085, 1093, 1161, 1183, 1269.

Chenopodium graveolens Willd. - A; 2; CI, BS, CS; 1034.

Chenopodium leptophyllum (Moq.) Nutt. ex S. Wats. - A; 3; DA, FOS; 942.

Chenopodium neomexicanum Standl. var. *neomexicanum* - A; 4; FOS, CS; 1203.

Chenopodium salinum Standl. - A; 4; TA, RA, FTS; 403, 1264.

Chenopodium watsonii A. Nels. - A; 3; FOS, FTS; 1045, 1072, 1134.

* *Kochia scoparia* (L.) Schrad. - A; 3; DA, RO; 1234.

Krascheninnikovia lanata (Pursh) A.D.J. Meeuse & Smit - S; 3; FOS, FTS, LE; 978.

* *Salsola tragus* L. - A; 3; DA, FOS; 608.

Suckleya suckleyana (Torr.) Rydb. -A; 5; MA, WA, TA; new AZ record; 1193.

Convolvulaceae

* *Convolvulus arvensis* L. - P; 4; DA, RO; 656.

Ipomoea costellata Torr. - A; 5; DR, RO; 1160, 1180.

Cucurbitaceae

Cucurbita foetidissima Kunth - P; 4; DR, RO; 767.

Cuscutaceae

Cuscuta pentagona Engelm. var. *pentagona* - A; 5; parasite on various hosts, LE; 1190.

Elaeagnaceae

* *Elaeagnus angustifolia* L. - T; 5; RO, DI; 1249.

Elatinaceae

Elatine brachysperma Gray - A; 5; WA, TA; 1197.

Euphorbiaceae

Acalypha neomexicana Muell.-Arg. - A; 5; BS, CS; 1255.

Chamaesyce albomarginata (Torr. & Gray) Small - P; 3; FOS, CS, RO; 651, 1179.

Chamaesyce chaetocalyx (Boiss.) Woot. & Standl. var. *chaetocalyx* - P; 5; FOS, FTS, LE; 1149.

Chamaesyce fendleri (Torr. & Gray) Small - P; 2; VH, CS; 371, 589, 683, 1090.

Chamaesyce glyptosperma (Engelm.) Small - A; 5; CSL, RO; 921.

Chamaesyce revoluta (Engelm.) Small - A; 3; BBC; 1008, 1097, 1163, 1208.

Chamaesyce serpyllifolia (Pers.) Small ssp. *serypllifolia* - A; 2; UB, BS, DA; 483, 495, 902, 1084, 1122, 1164, 1189, 1231, 1262.

Euphorbia bilobata Engelm. - A, 5, SS, BBC; 1217.

Euphorbia brachycera Engelm. - P; 4; VH, CS, HE; 503.

Tragia ramosa Torr. - P; 3; CSL, CI, RA; 389, 624.

Fabaceae

Astragalus allochrous Gray var. *playanus* Isely - A; 2; UB, CS; 337, 392, 560, 610, 666, 1060.

Astragalus brandegeei Porter - P; 4; FTS, RO, DI; 749, 819.

Astragalus calycosus Torr. ex S. Wats. var. *scaposus* (Gray) M.E. Jones - P; 4; SSO, LE; 843.

Astragalus humistratus Gray var. *humistratus* - P; 4; RA, DR; 826.

Astragalus lentiginosus Dougl. ex Hook. - B; 3; FOS, LE; 521, 640, 742, 868.

Astragalus mollissimus Torr. var. *mogollonicus* (Greene) Barneby - P; 4; FOS, FTS; 736.

Astragalus sabulonum Gray -A; 5; RO, DI, BBC; 630.

Caesalpinia drepanocarpa (Gray) Fisher - P; 5; CS, FOS, LE; 384.

Dalea albiflora Gray - P; 4; DR, RA; 1103.

Dalea candida Michx. ex Willd. var. *oligophylla* (Torr.) Shinners - P; 4; DR, RA; 491.

Dalea leporina (Ait.) Bullock - A; 4; RO, BBC; 760, 995, 1248.

Dalea polygonoides Gray -A; 5; BBC, BS; 1158, 1212, 1254.

Dalea urceolata Greene - A; 5; BBC, BS; 1159, 1213.

Desmanthus cooleyi (Eat.) Trel. - P; 4; FOS, FTS, SA; 831, 999.

Desmodium rosei Schub. - A; 5; SS, BBC; 1218.

Glycyrrhiza lepidota Pursh - P; 5; DR, SA; 775.

Hedysarum boreale Nutt. ssp. *boreale* - P; 0; FOS; G.A. Goodwin 1227.

Lathyrus eucosmus Butters & St. John - P; 4; DR, RA; 970, 1089, 1141.

Lotus mearnsii (Britt.) Greene var. *mearnsii* - P; 4; FOS, LE, FTS, N. AZ endemic; 637, 732.

Lotus wrightii (Gray) Greene - P; 3; VH, FOS, DR; 334.

Lupinus brevicaulis S. Wats. - A; 3; BS, LE; 330, 582, 638, 668.

Lupinus hillii Greene - P; 0; FOS, DR, HE; E. Van Winkle 110, 143.

Lupinus kingii S. Wats. var. *kingii* - A; 3; BS; 645, 662, 875.

* *Medicago minima* (L.) L. - A; 5; RO; 657.

* *Medicago sativa* L. ssp. *sativa* - P; 5; DA; 1201.

* *Melilotus officinalis* (L.) Lam. - B; 3; RO, DA; 686, 1315.

Oxytropis lambertii Pursh var. *bigelovii* Gray - P; 3; FOS, CS; 615.

Peteria scoparia Gray - P; 5; CS; new Coconino County record; 801.

Phaseolus angustissimus Gray - P; 3; BBC; 616.

\# *Psoralidium lanceolatum* (Pursh) Rydb. - P; 4; BBC, SA, DR; C.F. Deaver 473 (UA).

Psoralidium tenuiflorum (Pursh) Rydb. - P; 3; RA, DR, FOS, CS; 782, 877.

Robinia neomexicana Gray var. *neomexicana* -S; 5; CA, RA; 346.

Sophora nuttalliana B.L. Turner - P; 0; FOS; G.A. Goodwin 1224.

Fumariaceae

Corydalis aurea Willd. - A; 4; DA, RO; 400, 543, 603.

Geraniaceae

* *Erodium cicutarium* (L.) L'Hér. ex Ait. ssp. *cicutarium* - A; 4; DA, CSL; 527, 554.

Geranium caespitosum James var. *caespitosum* - P; 4; FOS, HE, CS; 802.

Grossulariaceae

Ribes cereum Dougl. - S; 2; VH, CS; 410, 524, 531, 536, 598.

Hydrophyllaceae

Nama dichotomum (Ruiz & Pavón) Choisy - A; 4; CSL; 501A.

Phacelia alba Rydb. - A; 3; FTS, DI, TA; 336, 646, 713, 1062.

Phacelia crenulata Torr. ex S. Wats. var. *crenulata* - A; 4; CSL, LE; 388, 617, 867.

Phacelia serrata J. Voss -A; 3; BBC; endemic to N. AZ and N. NM; 971, 988, 1015, 1032, 1215.

Juglandaceae

Juglans major (Torr.) Heller - T; 5; MA, DR; 774.

Lamiaceae

Dracocephalum parviflorum Nutt. - A; 3; BS, DA; 710.

Hedeoma drummondii Benth. - A; 3; RA; 492, 613, 844, 918.

Hedeoma oblongifolia (Gray) Heller - P; 5; MA, RA, DR; 1157.

* *Marrubium vulgare* L. - P; 3; DA, DR, TA; 335, 679.

Monarda fistulosa L. ssp. *fistulosa* var. *menthifolia* (Graham) Fern. - P; 5; MA, RA, DR; 773, 778.

Monardella odoratissima Benth. - P; 5; SS, NFS, BBC, HE; 889.

Salvia reflexa Hornem. - A; 3; RO, DI; 818, 871, 993.

Salvia subincisa Benth. - A; 4; RO, MA, RA; 991, 1145.

Stachys rothrockii Gray - P; 3; FTS, DI, TA; 846, 1079.

Linaceae

Linum australe Heller var. *glandulosum* Rogers - A; 3; FOS; 382, 876, 1041, 1071, 1086, 1110.

Linum lewisii Pursh var. *lewisii* - P; 4; FOS, RO; 766, 1044.

Linum puberulum (Engelm.) Heller - P; 5; FOS, FTS; 703.

Loasaceae

Mentzelia albicaulis (Dougl. ex Hook.) Dougl. ex Torr. & Gray - A; 3; FOS, BBC, CI; 326, 583.

Mentzelia collomiae C.M. Christy - B/P; 4; BBC, SS; narrowly endemic to the SFVF; 626, 891, 895, 1017, 1219.

Mentzelia montana (A. Davids.) A. Davids. - A; 3; FOS, BBC, CI; 591, 701.

Mentzelia multiflora (Nutt.) Gray - P; 1; CSL, RO; 390, 485, 768, 807, 865, 946, 989, 1131, 1209, 1292.

Mentzelia rusbyi Woot. - B; 4; RO; 856, 883.

Malvaceae

* *Malva neglecta* Wallr. - A; 4; DA; 1076.

Sphaeralcea fendleri Gray - P; 3; VH; 678, 711, 809, 816, 1202.

Sphaeralcea hastulata Gray - P; 3; LE, FOS, DR; 333, 735, 829.

Sphaeralcea parvifolia A. Nels. - P; 3; LE, FOS, CS; 627, 981, 1296, 1306.

Molluginaceae

* *Mollugo cerviana* (L.) Ser. - A; 4; BBC; 1031, 1162, 1320, 1291.

Nyctaginaceae

Mirabilis albida (Walt.) Heimerl - P; 0; FOS; C.F. Deaver 3355 (ASU).

Mirabilis coccinea (Torr.) Benth. & Hook. f. - P; 4; FOS, RA; 847.

Mirabilis decipiens (Standl.) Standl. - P; 5; HE, CS; 1227.

Mirabilis linearis (Pursh) Heimerl - P; 3; VH, RO, RA; 741, 899, 990, 1035.

Mirabilis multiflora (Torr.) Gray - P; 3; FOS, CS; 370.

Mirabilis oxybaphoides (Gray) Gray - P; 3; RA; 1005.

Oleaceae

Forestiera pubescens (Gray) Gray var. *pubescens* - S; 3; DR, CA, BBC; 342, 374, 974.

Menodora scabra Gray - P; 3; FOS, FTS, CS; 700, 731, 1011.

Onagraceae

Camissonia gouldii Raven - A; 3; BBC; endemic to N. AZ and S. UT; 607, 915, 985, 1014, 1166.

Epilobium brachycarpum K. Presl - A; 4; FOS; 886, 1100.

Epilobium ciliatum Raf. ssp. *ciliatum* - P; 5; WA, DA; 1237.

Gaura coccinea Nutt. ex Pursh - P; 3; FOS, FTS; 644, 728, 881.

Gaura hexandra OrteA ssp. *gracilis* (Woot. & Standl.) Raven & Gregory - P; 3; FOS, DR, CS; 960, 992.

Gaura mollis James - A; 4; RO; 758.

Gayophytum ramosissimum Torr. & Gray - A; 5; FOS, FTS; 639, 734.

Oenothera caespitosa Nutt. ssp. *marginata* (Nutt. ex Hook. & Arn.) Munz - P; 4; BBC; 539, 594, 892.

Oenothera coronopifolia Torr. & Gray - P; 5; CS, RO; 659.

Oenothera flava (A. Nels.) Arrett ssp. *flava* - P; 5; HE, FTS; 1049.

Oenothera pallida Lindl. ssp. *runcinata* (Engelm.) Munz & W. Klein - P; 3; RO, CS; 1002.

Orobanchaceae

Orobanche fasciculata Nutt. - A; 5; SS, CI; 622.

Orobanche ludoviciana Nutt. ssp. *ludoviciana* - A; 4; DI, FTS; 733, 815.

Oxalidaceae

Oxalis sp. L. - A; 5; MA, RA, DR; 1117.

Papaveraceae

Argemone pleiacantha Greene ssp. *ambigua* G.B. Ownbey - P; 4; LE, RO, FOS; 704.

Plantaginaceae

Plantago argyraea Morris - A; 3; FOS, RA; 500, 727, 845, 1048, 1251.

Plantago patagonica Jacq. - A; 4; fFOS, LE; 738.

Polemoniaceae

Gilia leptomeria Gray - A; 4; BBC, LE; 581.

Gilia ophthalmoides Brand - A; 3; FOS, CS; 399, 523, 525, 542, 593, 702.

Ipomopsis aggregata (Pursh) V. Grant ssp. *formosissima* (Greene) Wherry - B; 3; CSL; 1317.

Ipomopsis arizonica (Greene) Wherry - B; 3; CSL;562, 808.

Ipomopsis longiflora (Torr.) V. Grant - B; 3; FOS, CS; 612.

Ipomopsis multiflora (Nutt.) V. Grant - P; 3; CSL; 498, 994.

Ipomopsis polycladon (Torr.) V. Grant - A; 5; LE, CSL; 629.

Phlox amabilis Brand - P; 3; RA, FTS; endemic to N. and C. AZ; 545, 547, 573, 1253.

Phlox gracilis (Hook.) Greene ssp. gracilis - A; 3; FOS, BA; 541, 578, 604.

Phlox longifolia Nutt. - P; 4; FTS, RA; 529.

Polygonaceae

Eriogonum alatum Torr. var. *alatum* - P; 4; FOS, HE, FTS; 763.

Eriogonum cernuum Nutt. var. *cernuum* - A; 3; FOS, CS; 869, 945, 1016, 1135.

Eriogonum corymbosum Benth. var. *corymbosum* - S; 4; BBC; 1174.

Eriogonum corymbosum Benth. var. *glutinosum* (M.E. Jones) M.E. Jones - S; 4; BBC; 972, 1175.

Eriogonum deflexum Torr. var. *deflexum* - A; 4; CI; 1295.

Eriogonum hookeri S. Wats. - A; 4; CI; 917, 1033.

Eriogonum jamesii Benth. var. *flavescens* S. Wats. - P; 5; FOS, FTS, CS; 1018.

Eriogonum palmerianum Reveal - A; 5; SS, CI, CS; 1182.

Eriogonum pharnaceoides Torr. var. *pharnaceoides* - A; 3; CI; 486.

Eriogonum polycladon Benth. - A; 3; FOS, CS; 961, 1027, 1173.

Eriogonum racemosum Nutt. - P; 4; FOS, FTS, HE; 1001.

Eriogonum wrightii Torr. ex Benth. var. *wrightii* - P; 4; FOS, FTS, RA; 1136, 1140, 1177.

Polygonum amphibium L. - P; 5; WA; 1198.

* *Polygonum aviculare* L. - P; 3; DA, MA, TA; 1238.

Polygonum douglasii Greene ssp. *johnstonii* (Munz) Hickman - A; 4; FOS, FTS; 709.

Polygonum lapathifolium L. - A; 5; WA; 1235.

* *Rumex crispus* L. - P, 5; WA; 862, 1242.

Rumex salicifolius Weinm. var. *mexicanus* (Meisn.) C.L. Hitchc. - P; 4; WA; 402, 825, 1082.

Portulacaceae

Phemeranthus validulus (Greene) Kiger - P; 5; SSO; N. AZ endemic; 1302.

Portulaca halimoides L. - A; 4; DR, BS, CI; 1167, 1267B, 1273.

Portulaca oleracea L. - A; 4; DR, CSL; 979, 1267.

Primulaceae

Androsace septentrionalis L. ssp. *puberulenta* (Rydb.) G.T. Robbins - A; 5; CS, HE, DR, CA; 1229.

Ranunculaceae

* *Ceratocephala testiculata* (Crantz) Bess. - A; 4; BS, DA; 514, 544.

Clematis ligusticifolia Nutt. var. *ligustisifolia* -P; 5; DR, RA; 955.

Delphinium scaposum Greene - P; 3; FOS; 395, 654, 684, 751.

Myosurus apetalus C. Ay var. *montanus* (Campbell) Whitemore - A; 5; WA; 714.

Thalictrum fendleri Engelm. ex Gray - P; 4; DR, CA, NFS; 680.

Rosaceae

Amelanchier utahensis Koehne var. *utahensis* - S; 4; DR, SA; 897.

Chamaebatiaria millefolium (Torr.) Maxim. - S; 4; RA, CL, SSO; 412.

\# *Fallugia paradoxa* (D. Don) Endl. ex Torr. - S; 2; VH, BBC; H.C. Sanchez 31

Holodiscus dumosus (Nutt. ex Hook.) Heller - S; 5; NFS, CL, HE; 1257.

\# *Ivesia multifoliolata* (Torr.) Keck - P; 5; MA, RA, DR, endemic to N. and C. AZ, not collected due to lack of flowering material; S.J. Pinkerton *s.n.*

Potentilla biennis Greene - A; 5; DR, RA; 676.

Potentilla norvegica L. ssp. *monspeliensis* (L.) Aschers. & Graebn. - P; 5; WA, MA; 861, 1241.

Potentilla penslyvanica L. var. *pensylvanica* - P; 5; RA, CL, HE; 1256.

* *Potentilla recta* L. - P; 5; FOS, MA, DR; 1087.

Purshia stansburiana (Torr.) Henrickson - S; 3; CS, DR, RA; 898.

Rosa woodsii Lindl. var. *woodsii* - S; 5; MA, RA, DR; 973.

Rubiaceae

Galium wrightii Gray - P; 3; SS, CSL, CA, RA; 890, 1010, 1207, 1226.

Rutaceae

Ptelea trifoliata L. ssp. *angustifolia* (Benth.) V. Bailey - S; 5; RA, DR; 772.

Salicaceae

* *Populus alba* L. - T; 5; RO, DA; 852.

Populus angustifolia James - T; 5; MA, RA, CA, DR; 771.

Populus tremuloides Michx. - T; 5; NFS, RA, CA; 838.

Salix exigua Nutt. - S; 4; DR, CA, WA; 588, 1244, 1272, 1288.

Salix gooddingii Ball - T; 5; WA, DI, RO; 1043, 1286.

Saxifragaceae

Heuchera rubescens Torr. var. *rubescens* - P; 4; NFS, CL; 779, 894, 1222.

Scrophulariaceae

Castilleja austromontana Standl. & Blumer - P; 5; CSL; 687.

Castilleja integra Gray var. *integra* - P; 3; CSL; 549, 595, 764.

Castilleja linariifolia Benth. - P; 3; FOS, BBC; 497, 964.

Cordylanthus parviflorus (Ferris) Wiggins - A; 4; FOS, LE; 851, 1088.

Cordylanthus wrightii Gray ssp. *tenuifolius* (Pennell) Chuang & Heckard - A; 3; FOS; 923.

Limosella acaulis Sessé & Moc. - A; 5; WA; 1195.

* *Linaria dalmatica* (L.) P. Mill. ssp. *dalmatica* - P; 4; DA, CSL; 621.

Mimulus rubellus Gray -A; 3; CSL; 516, 522, 532, 564, 565.

Orthocarpus purpureoalbus Gray ex S. Wats. - A; 3; FOS, FTS; 850, 1003.

Penstemon barbatus (Cav.) Roth ssp. *torreyi* (Benth.) Keck - P; 3; CSL; 822, 962, 963.

Penstemon caespitosus Nutt. ex Gray var. *desertipicti* (A. Nels.) N. Holmgren - P; 4; FOS, SSO, LE; 635, 743.

Penstemon clutei A. Nels. - P; 4; BBC; endemic to N. AZ; 618.

Penstemon linarioides Gray ssp. *linarioides* - P; 4; VH, CSL; 665.

Penstemon ophianthus Pennell - P; 3; RA, FOS, CS; 358, 632, 671.

Penstemon palmeri Gray var. palmeri - P; 4; RO; 408.

Penstemon rostriflorus Kellogg - P; 3; RA, CA, CL; 848.

Penstemon strictus Benth. - P; 5; RO, HE; 878.

* *Verbascum thapsus* L. - B; 3; DA; 804.

Veronica anagallis-aquatica L. - P; 5; WA; 698.

Veronica peregrina L. ssp. *xalapensis* (Kunth) Pennell - A; 5; WA; 723.

Solanaceae

Chamaesaracha coronopus (Dunal) Gray - P; 4; DA, FTS, RA; 653.

Datura wrightii Regel - P; 4; RA, LE; 631.

Lycium pallidum Miers var. *pallidum* - S; 3; FOS; 377, 600.

Nicotiana attenuata Torr. ex S. Wats. - A; 4; FOS, FTS, DI; 493.

Nicotiana obtusifolia Mertens & Aleotti var. *obtusifolia* - P; 4; CI, DI; 398, 567.

Physalis hederifolia Gray var. *fendleri* (Gray) Cronq. - P; 3; FOS, RA; 880, 933, 1028.

Solanum jamesii Torr. - P; 4; FOS, FTS; 511, 1133.

Solanum triflorum Nutt. - A; 4; CSL; 887.

Tamaricaceae

* *Tamarix ramosissima* Ledeb. -S; 5; DR, RO; 769, 1294.

Ulmaceae

* *Ulmus pumila* L. - T; 5; RO, DI; 380.

Verbenaceae

Glandularia bipinnatifida (Nutt.) Nutt. - P; 3; FOS, TA, RO; 381, 705, 1111.

Phyla cuneifolia (Torr.) Greene - P; 4; TA, FTS, RA; 649, 1083.

Verbena bracteata Lag. & Rodr. - P; 3; TA, FTS; 494, 1192.

Viscaceae

Arceuthobium divaricatum Engelm. - P; 4; parasitizing *Pinus edulis*; 901.

Phoradendron juniperinum Engelm. ex Gray - P; 4; parasitizing *Juniperus monosperma*; 900.

Vitaceae

Parthenocissus vitacea (Knerr) A.S. Hitchc. - P; 5; DR, RA; 776.

Vitis arizonica Engelm. - P; 5; DR, RA; 774B.

Zygophyllaceae

* *Tribulus terrestris* L. - A; 4; RO, DA; 817.

MAGNOLIOPHYTA - LILIOPSIDA

Agavaceae

Yucca angustissima Engelm. ex Trel. var. *angustissima* - S; 2; VH, CSL; 655, 677.

Yucca baccata Torr. var. *baccata* - S; 4; RA; 834.

Yucca baileyi Woot. & Standl. - S; 0; FOS, CS; H.J. Fulton 8220 (ARIZ).

Alismataceae

Alisma triviale Pursh - P; 5; WA, TA; 1285.

Commelinaceae

Commelina dianthifolia Delile var. *longispatha* (Torr.) Brashier - P; 3; SS, CI; 1188, 1214.

Tradescantia occidentalis (Britt.) Smyth var. *occidentalis* - P; 4; BBC; 1013.

Cyperaceae

Carex athrostachya Olney - P; 0; WA; H.D. Hammond 12019.

Carex brevior (Dewey) Mackenzie - P; 5; WA; 1153, 1283.

Carex duriuscula C.A. Mey. - P; 5; RA, CA; 935.

Carex geophila Mackenzie - P; 4; RA, CA, NFS; 925.

Carex occidentalis Bailey - P; 3; RA, DR, CA, MA; 340, 719, 840.

Cyperus esculentus L. var. *leptostachyus* Boeckl. - P; 5; DR, SA; 770, 1271.

Cyperus fendlerianus Boeckl. - P; 4; RA; 505, 1091.

Cyperus squarrosus L. - A; 5; DR, SA; 947.

Eleocharis palustris (L.) Roemer & J.A. Schultes - P; 5; WA; 720, 1199.

Schoenoplectus acutus (Muhl. ex Bigelow) A.& D. Löve var. *occidentalis* (S. Wats.) S.G. Sm. - P; 5; WA; 1287.

Hydrocharitaceae

Elodea bifoliata St. John - P; 5; WA; 1200.

Iridaceae

Iris missouriensis Nutt. - P; 5; MA, DR; 1115.

Juncaceae

Juncus tenuis Willd. - P; 4; WA, DR; 721, 1120, 1278.

Liliaceae

Calochortus ambiguus (M.E. Jones) Ownbey - P; 3; FOS, FTS, RA; 650, 707.

Echeandia flavescens (J.A. & J.H. Schultes) Cruden - P; 5; HE, FTS, RA; 1106.

Poaceae

Achnatherum hymenoides (Roemer & J.A. Schultes) Barkworth - P; 4; FOS, LE, BBC; 373.

Achnatherum speciosum (Trin. & Rupr.) Barkworth - P; 5; RA; 1006.

* *Aegilops cylindrica* Host - A; 4; DA, RO; 693.

Agropyron cristatum (L.) Aertn. ssp. *pectinatum* (Bieb.) Tzvelev - P; 4; FOS, FTS; 691, 1102.

Alopecurus carolinianus Walt. - A; 5; WA; 718.

Andropogon gerardii Vitman - P; 3; BBC, DR; 375, 969.

Aristida adscensionis L. - A; 5; RA; 1268.

\# *Aristida arizonica* Vasey - P; 4; BBC, CI; R.A. Darrow *s.n.* (UA).

Aristida divaricata Humb. & Bonpl. ex Willd. - P; 3; BBC; 1025, 1170, 1247.

Aristida havardii Vasey - P; 4; BBC; 916.

Aristida purpurea Nutt. var. *fendleriana* (Steud.) Vasey - P; 3; VH, CSL; 606, 1171.

Aristida purpurea Nutt. var. *longiseta* (Steud.) Vasey - P; 3; FOS; CSL; 661, 706.

Aristida purpurea Nutt. var. *purpurea* - P; 3; FOS; CSL; 606, 1172.

Bouteloua aristidoides (Kunth) Griseb. - A; 4; CSL, LE, RA; 1290.

Bouteloua curtipendula (Michx.) Torr. - P; 3, RA; C. Jass *s.n.*

Bouteloua eriopoda (Torr.) Torr. - P; 3; FOS, LE; 328, 387.

Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths - P; 1; UB; 996, 1304.

Bouteloua simplex Lag. - A; 5; BS; 1064.

Bromus carinatus Hook. & Arn. - P; 0; TA; L.C. Moore *s.n.*

Bromus ciliatus L. - P; 5; RA; 1223.

* *Bromus commutatus* Schrad. - A; 3; DA, RO; 708, 762, 855.

* *Bromus inermis* Leyss. ssp. *inermis* - P; 4; DA, RO; 690, 1042.

* *Bromus japonicus* Thunb. ex Murr. - A; 4; DA, MA; 717.

Bromus lanatipes (Shear) Rydb. - P; 4; CA, DR, NFS, HE; 975, 1125.

* *Bromus rubens* L. - A; 5; DA, LE; 628.

* *Bromus tectorum* L. - A; 3; DA, CSL; 534, 540, 592.

Dasyochloa pulchella (Kunth) Willd. ex Rydb. - P; 5; LE, FOS, BS; 980.

* *Echinochloa crus-galli* (L.) Beauv. - A; 4; WA; 1240.

Echinochloa muricata (Beauv.) Fern. var. *microstachya* Wieg. - A; 4; WA; 1118, 1154, 1239.

Elymus canadensis L. - P; 5; MA, DR, RA; 976, 1274.

Elymus elymoides (Raf.) Swezey ssp. *brevifolius* (J.G. Sm.) Barkworth, comb. nov. ined. - P; 3; FOS; 405.

Elymus trachycaulus (Link) Gould ex Shinners ssp. *trachycaulus* - P; 3; DI, RO, FTS; 722, 748, 820.

Eragrostis lutescens Scribn. - A; 4; MA, DR, SA; 1265, 1282.

Eragrostis mexicana (Hornem.) Link ssp. *mexicana* - A; 4; VH, BS, MA; 1124, 1305.

Eragrostis pectinacea (Michx.) Nees ex Steud. var. *pectinacea* - A; 3; BS, RA, DR, RO, DA; 957, 1052, 1139.

Festuca arizonica Vasey - P; 5; HE, RO; 1019.

Hesperostipa comata (Trin. & Rupr.) Barkworth ssp. *comata* - P; 3; FOS, CS, RA; 393, 682.

Hesperostipa neomexicana (Thurb. ex Coult.) Barkworth - P; 5; RA, LE; 1030.

Hordeum jubatum L. ssp. *jubatum* - P; 3; MA, TA, DA, RO; 681, 695, 716, 1119.

* *Hordeum murinum* L. ssp. *murinum* - A; 5; DA, WA; 694.

Koeleria macrantha (Ledeb.) J.A. Schultes - P; 3; RA, CA; 642, 672, 673.

Lolium pratense (Huds.) S.J. Darbyshire - P; 5; RO; 1023.

Lycurus setosus (Nutt.) C.G. Reeder - P; 5; RA; 1007.

Monroa squarrosa (Nutt.) Torr. - A; 4; FOS, BS, DA; 1148.

Muhlenbergia depauperata Scribn. - A; 5; LE, RA, BS; 1270, 1301.

Muhlenbergia minutissima (Steud.) Swallen - A; 3; VH, BS, CS; 1095, 1252.

Muhlenbergia montana (Nutt.) A.S. Hitchc. - P; 3; RA, DR, HE; 356, 1105, 1187.

Muhlenbergia pauciflora Buckl. - P; 0; RA, CS; B. Chaney *s.n.*

Muhlenbergia porteri Scribn. ex Beal - P; 0; RA, LE; B. Chaney *s.n.*

Muhlenbergia racemosa (Michx.) B.S.P. - P; 4; RA, DR, SS, NFS; 951, 1224, 1275.

Muhlenbergia ramulosa (Kunth) Swallen - A; 5; SS, CSL, HE; 1217.

Muhlenbergia repens (J. Presl) A.S. Hitchc. - P; 5; LE, FTS, DI; 1066.

Muhlenbergia rigens (Benth.) A.S. Hitchc. - P; 3; DR; 953, 1113, 1144.

Muhlenbergia torreyi (Kunth) A.S. Hitchc. ex Bush - P; 4; FOS; 1057, 1074, 1112.

Muhlenbergia wrightii Vasey ex Coult. - P; 3; RA, DR; 726, 752, 926, 1022, 1051.

Panicum bulbosum Kunth - P; 5; MA, DR, RA; 1116.

Panicum capillare L. - A; 4; MA, DR, WA; 956, 1155.

Panicum hirticaule J. Presl var. *hirticaule* - A; 5; SS, CI; 1220.

Panicum mohavense J. Reeder - A; 5; LE, RA, SSO, endemic to N. AZ and C. NM; new record for Coconino Co.; 1300.

Panicum virgatum L. var. *virgatum* - P; 3; RA, DR; 781, 966, 1021, 1276.

Pascopyrum smithii (Rydb.) A. Löve - P; 4; RO, DI, DA; 1055.

Piptatherum micranthum (Trin. & Rupr.) Barkworth - P; 3; RA; 347, 411, 675.

Pleuraphis jamesii Torr. - P; 3; FOS, LE; 327.

Poa fendleriana (Steud.) Vasey - P; 3; VH, RA, DR, HE; 538, 548, 555.

Poa pratensis L. ssp. *pratensis* - P; 4; MA, DA, TA; 696.

* *Psathyrostachys juncea* (Fisch.) Nevski - P; 5; FOS, DA; 750, 1150.

Schedonnardus paniculatus (Nutt.) Trel. - P; 3; FOS, FTS; 404, 652, 1065, 1081, 1137, 1263.

Schizachyrium scoparium (Michx.) Nash var. *scoparium* - P; 4; DR, CA, RA; 954,.

* *Secale cereale* L. - A; 4; DA, RO; 756.

* *Setaria viridis* (L.) Beauv. var. viridis - A; 4; RA, DR, RO, DI; 1277, 1311.

Sorghastrum nutans (L.) Nash - P; 4; RA, DR; 967, 1289.

Sporobolus airoides (Torr.) Torr. - P; 5; RO, LE; 1020.

Sporobolus contractus A.S. Hitchc. - P; 4; VA, LE, RO; 949, 1246, 1316.

Sporobolus cryptandrus (Torr.) Gray - P; 3; VH, DR; 508, 864, 928, 1009.

* *Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey - P; 3; RO, DI, DA; 824, 1056.

Vulpia octoflora (Walt.) Rydb. var. *hirtella* (Piper) Henr. - A; 5; LE, FOS, FTS; 636.

Potamogetonaceae

Potamogeton pusillus L. ssp. *tenuissimus* (Mert. & Koch) Haynes & C.B. Hellquist - P; 5; WA; 1279.

Typhaceae

Typha latifolia L. - P; 5; WA; 860.