

# Conservation Priority Setting for Arizona G1 and G2 Plant Species: A Regional Assessment

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## Introduction

The American Southwest supports one of the richest floras in North America, with perhaps as many as 6,000 indigenous species distributed among the deserts and mountains of the region. The area includes six major arid and semi-arid biomes: the Chihuahuan, Colorado Plateau, Great Basin, Mohave, and Sonoran Deserts, and the Madrean region that extends from Mexico into southern New Mexico and Arizona. A recent compilation of rare species in the Greater Southwest (Spence 2006, unpublished) has put the number of NatureServe G1 and G2-ranked (globally imperiled or globally threatened) species<sup>1</sup> at approximately 700. Nearly 200 of these 700 species occur in Arizona. New species are being discovered and described every year in the region.

While NatureServe and state heritage programs provide a clearinghouse and centralized data repository for information on rare plants and animals, the plethora of globally imperiled and threatened species in this region requires an additional level of analysis to assist rare plant conservation. The challenge is especially acute in Arizona. While the Arizona Game and Fish Department's Heritage Data Management System remains an exemplary centralized repository for information on rare plants, the Department's lack of statutory authority concerning native plants precludes the employment of botanical experts to assist in the management of rare plant information. Coupled with scarce funding for plant conservation and the small number of field botanists, there is a need to prioritize among these species to more efficiently allocate resources for conservation purposes. Many of these species are at risk of extinction, and there is an urgent need for regional botanists to share data, discuss information, and organize a coordinated and prioritized response to the conservation of rare plants.

## The Priority Setting/Ranking System

Beginning with the International Union for the Conservation of Nature's Red List in the early 1960s, there have been many systems developed to assess the conservation status of species. All of the systems vary with respect to information required and the components examined<sup>2</sup>. This report focuses on two systems: the NatureServe ranking protocol initially developed by The Nature Conservancy and currently utilized by State Natural Heritage programs and Conservation Data Centers in North America and parts of the Caribbean, and the "Wyoming

Protocol" developed by Walt Fertig and adopted by the Utah Native Plant Society (Fertig 2012).

Traditionally, NatureServe G ranks<sup>3</sup> were based on the number of global occurrences (discrete biological populations), abundance, or risk of extinction as determined by expert opinion (Master *et al.* 2000). Criticism of the system has included that the rankings were weighted towards occurrences in assigning rank numbers. Current NatureServe protocols have become more quantitative and consider additional ranking criteria, including long- and short-term trends, area of occupancy, condition of occurrences, intrinsic rarity, and threat (Regan *et al.* 2004), which suggests that this system alone could provide the finer-grained assessment required to develop a more rigorous priority-setting system. However, the complexity of the protocol limits its utility in Arizona where again the lack of a dedicated rare plant program constrains the effective employment of the NatureServe system. Currently in Arizona, most of the plant taxa ranks have not been updated in well over a decade (Sabra Tonn, Arizona Natural Heritage Program, pers. comm.). Despite these shortcomings, this system provides a good "first cut" of taxa to consider as target species for conservation priority setting.

In the "Wyoming Protocol" developed by Fertig (hereafter referred to as the "Fertig Approach"), taxa are assessed using seven criteria: distribution, number of populations, number of individuals, habitat specificity, intrinsic rarity, magnitude of threats, and population trend. Individual criteria are rated on a binary scale (0 for unthreatened, 1 for at risk) based on expert opinion. Species for which no data are available are scored "unknown." The values for each criterion are summed to derive a rank score and potential rank score for each taxon. The rank score is calculated by summing each individual score and treating any unknown criteria as 0. The potential rank score is derived in the same way, except that unknown criteria are given a value of 1. The two summary scores are averaged to determine a conservation priority rank. Those taxa that are at risk for a large number of criteria have higher conservation priority ranks than those species that are at risk for only a few criteria. Where three or more categories are unknown, significant data gaps exist and these taxa are identified as needing additional research.

Before deciding to employ the Fertig Approach, a second similar system proposed by Spence (2012) was initially proposed as part of this project. Both systems were discussed at the second meeting of the Southwest Rare Plant Task Force in December 2011. The consensus of the group was to employ the

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Fertig Approach given its successful application in Utah and its binary scoring system within categories. Spence's approach is similar but requires more subjective judgment within each category in order to assign a score of 1, 2, or 3. Those who have used these kinds of ranking systems that require users to make multiple decisions based on inadequate information know that decision fatigue is common and in the long run becomes a significant disincentive for their use. Simplifying the decision process (i.e. the value assigned is a 1 or a 0 rather than a graduated scale) may be the most significant utility of the Fertig Approach.

Because this project is a regional assessment, the emphasis is to consider the status of a species throughout its range and not as conscribed by state boundaries. Accordingly, we modified the Fertig Approach to consider global distribution and the total number of populations and individuals throughout the species' range as opposed to the distribution, occurrences and abundance only in the state. The threshold for a score of 1 for the numbers of occurrences was also increased from 25 to 30 (Table 1). It is presumed that conservation actions undertaken in Arizona for these species will provide a significant contribution to species conservation overall.

### Methodology

The initial list of plant species provided by the Arizona Heritage Data Management system in November 2011 included all taxa with a potential rank of G1 or G2, or T1 or T2 (for sub-species or varieties). For purposes of this report only, G1 and G2 taxa were considered but we anticipate that follow-on work will include the entire Arizona list of globally imperiled or globally threatened taxa. This list was compared to a similar list generated at the 2006 Southwestern Rare Plant Taskforce workshop and updated through the end of 2007 to determine if some taxa had inadvertently been overlooked in the 2011 list. A total of 189 G1 and G2 species were on this initial target list<sup>4</sup>.

This first step was to review taxonomic nomenclature using the Integrated Taxonomic Information System ([www.itis.gov](http://www.itis.gov)), an easily accessible database with reliable information on species names and their hierarchical classification. Eleven species were dropped from further consideration because the taxonomic nomenclature used in the initial target list was no longer accepted and these species were subsumed within more widespread species that are not ranked G1 or G2 by

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**Table 1. Ranking Category and Scoring Criteria**

<b>Distribution</b>	<b>2</b>	<b>Local endemic</b> (global range less than 16,500 km <sup>2</sup> or about 1 degree of latitude x 2 degrees of longitude)
	<b>1</b>	<b>Regional endemic</b> (global range covering 16,501-250,000 km <sup>2</sup> or an area about the size of Wyoming)
	<b>0</b>	<b>Widespread</b> (occurs widely across portions of North America [covering more than 250,000 km <sup>2</sup> ])
<b>Number of Occurrences</b>	<b>1</b>	<b>Low</b> (fewer than 25 extant populations in state)
	<b>0</b>	<b>Medium to High</b> (25 or more extant populations in state)
<b>Abundance</b>	<b>1</b>	<b>Low</b> (depends on life history of species, but typically less than 30,000 individuals for perennials [higher numbers allowable for annuals] or occupying an area of less than 3,000 acres throughout its range)
	<b>0</b>	<b>Medium to High</b> (known from well over 30,000 individuals for perennials or occupying an area greater than 3,000 acres throughout its range)
<b>Habitat Specificity</b>	<b>1</b>	<b>High</b> ("Specialist" restricted to one or a few specialized geologic substrates, topographic environments situations, soil types, or vegetation types)
	<b>0</b>	<b>Medium to Low</b> ("Generalist" found in numerous geologic substrates, topographic environments soil types, or vegetation types)
<b>Intrinsic Rarity</b>	<b>1</b>	<b>High</b> (unusual life history, dependence on rare or specialized pollinators, poor dispersal, low fecundity, poor seedling survival, etc.)
	<b>0</b>	<b>Medium to Low</b> (no unusual life history or biological attributes limiting establishment or persistence)
<b>Threats</b>	<b>1</b>	<b>High</b> (current or foreseeable threats significant or broad in scale or scope)
	<b>0</b>	<b>Medium to Low</b> (threats minimal or limited to small percentage of populations now or in the foreseeable future)
<b>Trends</b>	<b>1</b>	<b>Decreasing</b> (short to long-term decline in number, size, or vigor of populations)
	<b>0</b>	<b>Increasing</b> (stable, or oscillating around a mean)

NatureServe (Appendix A, pages 15–17). Seven species were split into at least two sub-species or varieties and removed from the G1 and G2 list here (*Astragalus mokiacensis*, *Atriplex griffithsii*, *Carex curatorum*, *Choisya mollis*, *Coryphantha sneedi*, *Lesquerella kaibabensis*, *Pediomelum epipsilum*, and *Senecio multidentatus*). Three varieties were elevated to a full species (i.e. *Hexalectris spicata* var. *arizonica* now referred to as *H. arizonica*, *Hexalectrus revoluta* var. *colemanii* now referred to as *H. colemani*, and *Astragalus wootoni* var. *endopterus* now referred to as *A. endopterus*). Previously recognized varieties of four species (*Astragalus pinonis*, *Astragalus eurylobus*, *Lepidium integrifolium*, *Potentilla sanguinea*), are not considered valid, and four species were added that have been recently described (*Agave verdensis*, *Agave yavapaiensis*, *Alliciella cliffordii*, and *Mentzelia canyonensis*). One species, *Agave x arizonica*, a spontaneous hybrid, was not considered here.

The final target list of 176 species was then used to solicit expert opinion to score each species within each of the seven ranking categories based on criteria listed in Table 1. This occurred through personal meetings, telephone conversations, or by experts who filled out the ranking categories themselves. For species in which no expert was identified or consulted, we populated the rank system categories based on information provided by the Arizona Heritage Data Management System, the Southwest Environmental Information Network (SEINet) ([www.swbiodiversity.org](http://www.swbiodiversity.org)), and NatureServe ([www.natureserve.org](http://www.natureserve.org)). In all instances where species occurred outside of Arizona, we consulted and incorporated, as appropriate, information on rare plants available in New Mexico through the New Mexico Rare Plant Council ([nmrareplants.unm.edu/rarelist.php](http://nmrareplants.unm.edu/rarelist.php)), the California Native Plant Society Inventory of Rare and Endangered Plants ([www.cnps.org/cnps/rareplants/inventory/index.php](http://www.cnps.org/cnps/rareplants/inventory/index.php)), the Nevada Rare Plant Atlas ([heritage.nv.gov/atlas](http://heritage.nv.gov/atlas)), and the Utah Native Plant Society Rare Plant List (Fertig 2012).

In the case of the Utah list, rank data that were available were incorporated taking into consideration global distribution, occurrences, and abundance which in some instances revised the score. Arizona reports from 2003 to 2013, prepared through grants authorized in Section 6 of the U.S. Endangered Species Act, were reviewed for relevant information and in most instances Heritage Data Management System Element Abstracts were also consulted.

## Results and Discussion

We classified plants in the same manner as Fertig (2012) based on the average between rank score and potential rank score rounded down. Our results were as follows:

**Very High Priority** — Rank Score of 7 or 8. Localized endemic plants species in need of immediate and focused conservation attention. If not already listed or proposed for listing as threatened or endangered should be given priority consideration for such listing. (10 species). Four of the ten species are currently listed as threatened or endangered by

the U.S. Fish and Wildlife Service (USFWS) or are a candidate for listing.

**High Priority** — Rank Score of 6. Vulnerable. No concerns in short-term but should be the focus of better data on threats and trends. (39 species). All should be included on agency sensitive species lists. Four are currently listed threatened or endangered by the USFWS or are a candidate for listing.

**Watch** — Rank Score of 5. Plants which are often locally abundant or widespread. If localized, distribution threats are low. (36 species). Two are currently listed threatened or endangered by USFWS or are a candidate for listing.

**Likely Secure** — Rank Score of 4 or less. None of these plants are currently listed threatened or endangered by the USFWS or are a candidate for listing.

**Need Data** — Rank Score in three or more categories are unknown. None of these plants are currently listed threatened or endangered by the USFWS or are a candidate for listing.

**Peripheral** — We determined that there were five species whose range in Arizona constitutes less than 5 percent of the relatively continuous range of the species. There is equivocal evidence that peripheral populations have significant conservation value (Lepig and White 2006), suggesting that the question of whether to include peripheral species should receive further consideration and remain on the list.

The final rank scores for all species listed in Very High Priority, High Priority and Watch rank categories are presented in Appendix B (pages 18–19). The complete list of rank assignment for all taxa can be found at [www.aznps.com](http://www.aznps.com). The list presented here was the first iteration in Arizona using the Fertig Approach. These lists are inherently dynamic and hopefully the ease of using this tool will facilitate at least annual updates. Taxonomic considerations are always a challenge and undoubtedly some of the treatments here may not be acceptable to some researchers.

Geographic range, habitat specificity, number of occurrences, and abundance are well enough known or understood that a score of 1 or 0 was assigned in all but a few cases. Threats were less known and in many instances the assignment of a value for them was very much a subjective determination. In the absence of solid information some experts tended to be conservative and recommended a rank of 1. Exceptions occurred when habitat parameters (e.g. cliffs) or occurrences within large protected areas (e.g. Grand Canyon National Park) were known. Few plants have received the level of study regarding life history attributes (e.g. fecundity, seed viability, dispersal capacity and mechanisms, and pollinators) to allow experts to assign consistently an Intrinsic Rarity score, and many species received an unknown rank score as a result. However, population trend data were far and away the most difficult

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ranking criterion to score. "Unknown" was used in 103 cases. It was very difficult to come by objective trend data or observations that were informed by more than irregular casual visits. The notable exceptions are the long-term monitoring conducted for many years by Lee Hughes of the Bureau of Land Management on the Arizona Strip District and more recently the work of the several Arizona National Forests — most notably the Coconino, Kaibab, and Prescott National Forests — which have been regularly monitoring select forest sensitive species. In some instances, expert opinion differed on threats and trend scores. We usually incorporated the rank that was likely to lead to a higher rank score unless information was available from one expert that clearly provided a rank score based on objective information.

Thirty eight of the 168 ranked species have documented occurrences in Mexico, which is nearly a quarter of the taxa under consideration. For these species, their distribution in Mexico adds another component of uncertainty with respect to their rank score. SEINet does include two Mexican herbaria in its centralized specimen database ([www.swbiodiversity.org](http://www.swbiodiversity.org)) but overall information on species occurrences in Mexico is less well known than occurrences in the United States for the experts who participated and for the information that is readily available.

### Recommendations

1. Complete rank scoring for all T1 and T2 taxa and compile integrated list.
2. Convene Group of Invited Experts at Arizona Botany Meeting in February 2014 to review the current list including decisions to exclude certain species based on distribution and taxonomy.
3. Distribute this report and final G1, G2, T1, and T2 rank list to all agencies for their consideration in identifying species of concern or in the case of USFWS listing as threatened or endangered.
4. Direct volunteer efforts to inventory and monitor all Very High and Priority species. Particular attention should be directed to the establishment of regular monitoring plots to determine trends.

5. Identify major herbaria and systematically research plant specimens in Mexico.



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<sup>1</sup> NatureServe protocol assigns full species a conservation rank on a scale of 1 (critically imperiled) to 5 (demonstrably secure) across their entire global range (G rank).

<sup>2</sup> Fertig (2012) and Spence (2012) provide substantive discussion on some of these systems along with contemporary thinking about the concept of species rarity. The reader is referred to these studies rather than our providing a synopsis here.

<sup>3</sup> Sub-species or varieties are ranked in a similar fashion and assigned ranks of T1 or T2 if they are considered globally imperiled or globally threatened.

<sup>4</sup> Eighteen species that were included in the Arizona Rare Plant Field Guide were not included here based on a ranking of G3. Fourteen species that were considered but not included in the Field Guide were included here.

## APPENDIX A. Full List of Species Considered and Taxonomic Nomenclature (www.Itis.gov)

TAXON	CURRENT TAXONOMIC TREATMENT	TAXON	CURRENT TAXONOMIC TREATMENT
<i>Arabis tricornuta</i>	<i>Pennellia tricornuta</i> (Rollins) R.A. Price, C.D. Bailey & Al-Shehbaz. Consider under this name.	<i>Brickellia baccharidea</i>	
<i>Arceuthobium microcarpum</i>	<i>Arceuthobium campylopodum</i> Engelm. Widespread drop from consideration.	<i>Browallia eludens</i>	
<i>Arenaria aberrans</i>	<i>Eremogone aberrans</i> (M.E. Jones) Ikonn.	<i>Camissonia confertifolia</i>	<i>Chylismia confertiflora</i> (P.H. Raven) W.L. Wagner & Hoch.
<i>Argemone arizonica</i>		<i>Carex curatorum</i>	Formerly considered <i>Curatorium scirpoidea</i> var. <i>curatorum</i> . Consider as full species.
<i>Asclepias welshii</i>		<i>Carex specuicola</i>	
<i>Asplenium exiguum</i>		<i>Castilleja kaibabensis</i>	
<i>Astragalus ampullarius</i>		<i>Castilleja mogollonica</i>	<i>Castilleja sulphurea</i> Rydb. Widespread drop from further consideration.
<i>Astragalus beathii</i>		<i>Choisya mollis</i>	<i>Choisya dumosa</i> var. <i>mollis</i> (Standl.) L.D. Benson. Drop from full species list.
<i>Astragalus endopterus</i>	Formerly considered <i>Astragalus wootonii</i> var. <i>endopterus</i> . Consider as full species.	<i>Cirsium mohavense</i>	
<i>Astragalus eurylobus</i>	Formerly considered <i>Astragalus tephrodes</i> var. <i>eurylobus</i> Barneby. Consider as full species.	<i>Cirsium rusbyi</i>	<i>Cirsium mohavense</i> (Greene). Consider under this name.
<i>Astragalus holmgreniorum</i>		<i>Cirsium virginense</i>	<i>Cirsium mohavense</i> (Greene). Consider under this name.
<i>Astragalus hypoxylus</i>		<i>Cirsium wrightii</i>	
<i>Astragalus mokiaticensis</i>	<i>Astragalus lentiginosus</i> var. <i>mokiaticensis</i> (A. Gray) M.E. Jones. Remove from full species list.	<i>Clematis palmeri</i>	<i>Clematis bigelovii</i> Torr. Widespread drop from further consideration.
<i>Astragalus pinonis</i>	Previous two varieties not taxonomically accepted. Consider as full species.	<i>Cleome multicaulis</i>	<i>Peritoma multicaulis</i> (DC.) Iltis. Not found in Arizona.
<i>Astragalus septentriorema</i>		<i>Conioselinum mexicanum</i>	
<i>Astragalus sophoroides</i>		<i>Cordylanthus nevinii</i>	
<i>Arabis tricornuta</i>	<i>Pennellia tricornuta</i> (Rollins) R.A. Price, C.D. Bailey & Al-Shehbaz. Consider under this name.	<i>Coryphantha sneedii</i>	<i>Escobaria sneedii</i> var. <i>sneedii</i> Britt. & Rose. Highly variable complex. Drop from full species list.
<i>Arceuthobium microcarpum</i>	<i>Arceuthobium campylopodum</i> Engelm. Widespread drop from consideration.	<i>Crassula viridis</i>	
<i>Arenaria aberrans</i>	<i>Eremogone aberrans</i> (M.E. Jones) Ikonn.	<i>Croton wigginsii</i>	
<i>Argemone arizonica</i>		<i>Cryptantha atwoodii</i>	
<i>Asclepias welshii</i>		<i>Cryptantha ganderi</i>	
<i>Asplenium exiguum</i>		<i>Cryptantha osterhoutii</i>	
<i>Astragalus ampullarius</i>		<i>Cryptantha semiglabra</i>	
<i>Astragalus beathii</i>		<i>Cuscuta dentatasquamata</i>	
<i>Astragalus endopterus</i>	Formerly considered <i>Astragalus wootonii</i> var. <i>endopterus</i> . Consider as full species.	<i>Cuscuta mitriformis</i>	
<i>Astragalus eurylobus</i>	Formerly considered <i>Astragalus tephrodes</i> var. <i>eurylobus</i> Barneby. Consider as full species.	<i>Cuscuta odontolepis</i>	
<i>Astragalus holmgreniorum</i>		<i>Cylindropuntia abyssii</i>	
<i>Astragalus hypoxylus</i>		<i>Cymopterus beckii</i>	
<i>Astragalus mokiaticensis</i>	<i>Astragalus lentiginosus</i> var. <i>mokiaticensis</i> (A. Gray) M.E. Jones. Remove from full species list.	<i>Cymopterus davidsonii</i>	<i>Pteryxia davidsonii</i> (J.M. Coult. & Rose) Mathias & Constance. Consider under this name.
<i>Astragalus pinonis</i>	Previous two varieties not taxonomically accepted. Consider as full species.	<i>Dalea tentaculoides</i>	
<i>Astragalus septentriorema</i>		<i>Draba standleyi</i>	
<i>Astragalus sophoroides</i>		<i>Dryopteris rossii</i>	
<i>Astragalus straturensis</i>		<i>Enceliopsis argophylla</i>	
<i>Astragalus troglodytus</i>		<i>Ephedra funerea</i>	
<i>Atriplex griffithsii</i>	<i>Atriplex torreyi</i> var. <i>griffithsii</i> (Standl.) G.D. Br. Remove from this full species list.	<i>Ermeothera gouldii</i>	
<i>Berberis harrisoniana</i>		<i>Ericameria arizonica</i>	
		<i>Erigeron anchana</i>	
		<i>Erigeron arisolius</i>	
		<i>Erigeron compactus</i>	
		<i>Erigeron heliographis</i>	
		<i>Erigeron kuschei</i>	

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**APPENDIX A. Full List of Species Considered and Taxonomic Nomenclature (www. Itis.gov) continued**

TAXON	CURRENT TAXONOMIC TREATMENT	TAXON	CURRENT TAXONOMIC TREATMENT
<i>Erigeron lemmonii</i>		<i>Nissolia wislizeni</i>	
<i>Erigeron piscaticus</i>		<i>Oenothera cavernae</i>	
<i>Erigeron pringlei</i>		<i>Opuntia martiniana</i>	
<i>Erigeron rhizomatus</i>		<i>Packera franciscana</i>	
<i>Erigeron sivistrii</i>		<i>Packera quaerens</i>	<i>Packera hartiana</i> (A. Heller) W.A. Weber & A. Löve. Ranked G3G4. Drop from further consideration.
<i>Eriogonum darrovii</i>		<i>Panicum mohavense</i>	
<i>Eriogonum jonesii</i>		<i>Pediocactus bradyi</i>	
<i>Eriogonum mortonianum</i>		<i>Pediocactus paradinei</i>	
<i>Eriogonum ripleyi</i>		<i>Pediocactus sileri</i>	
<i>Eriogonum terrenatum</i>		<i>Pediomelum epipsilum</i>	<i>Pediomelum megalanthum</i> var. <i>epipsilum</i> (Barneby) J.W. Grimes. Remove from full species list.
<i>Eriogonum viscidulum</i>			
<i>Errazurizia rotundata</i>			
<i>Eryngium phyteumae</i>		<i>Pediomelum pauperitense</i>	
<i>Eryngium sparganophyllum</i>		<i>Pediomelum pentaphyllum</i>	
<i>Escobaria robbinsiorum</i>		<i>Pediomelum verdiensis</i>	
<i>Eupatorium bigelovii</i>	<i>Chromolaena bigelovii</i> (A. Gray) R.M. King & H. Rob. Consider under this name.	<i>Pellaea lyngholmii</i>	
<i>Euphorbia aaron-rossii</i>		<i>Penstemon albomarginatus</i>	
<i>Flaveria mcdougallii</i>		<i>Penstemon clutei</i>	
<i>Fraxinus papillosa</i>		<i>Penstemon discolor</i>	
<i>Gentianella wislizeni</i>		<i>Penstemon distans</i>	
<i>Glandularia chiricahensis</i>		<i>Penstemon nudiflorus</i>	
<i>Grindelia laciniata</i>	<i>Grindelia arizonica</i> A. Gray. Widespread drop from consideration.	<i>Penstemon petiolatus</i>	
<i>Hackelia besseyi</i>		<i>Perityle ajoensis</i>	
<i>Hermannia pauciflora</i>		<i>Perityle ambrosiifolia</i>	
<i>Heterotheca rutteri</i>		<i>Perityle cochisensis</i>	
<i>Heterotheca zionensis</i>		<i>Perityle congesta</i>	
<i>Hexalectris colemanii</i>	Formerly considered <i>Hexalectris revoluta</i> var. <i>colemanii</i> . Consider as full species.	<i>Perityle gracilis</i>	
<i>Hexalectris arizonica</i>	Formerly considered <i>Hexalectris spicata</i> var. <i>arizonica</i> . Consider as full species.	<i>Perityle saxicola</i>	
<i>Hexalectris warnockii</i>		<i>Perityle tenella</i>	
<i>Hieracium pringlei</i>		<i>Petalonyx parryi</i>	
<i>Hieracium rusbyi</i>	<i>Hieracium abscissum</i> Less. Consider under this name.	<i>Phacelia buell-vivariensis</i>	
<i>Hymenoxys jamesii</i>		<i>Phacelia cronquistiana</i>	
<i>Imperata brevifolia</i>		<i>Phacelia howelliana</i>	
<i>Lepidium integrifolium</i>	Formerly considered <i>L.i.</i> var. <i>integrifolium</i> Nutt. Consider as full species.	<i>Phacelia laxiflora</i>	
<i>Lesquerella kaibabensis</i>	<i>Physaria kingii</i> ssp. <i>kaibabensis</i> (Rollins) O'Kane. Remove from full species list.	<i>Phacelia parishii</i>	
<i>Lesquerella navajoensis</i>	<i>Physaria navajoensis</i> (O'Kane). Consider under this name.	<i>Phacelia welshii</i>	
<i>Lupinus huachucanus</i>		<i>Phaseolus supinus</i>	<i>Macroptilium supinum</i> (Wiggins & Rollins) A. Delgado & L. Torres. Consider under this name.
<i>Lupinus lemmonii</i>		<i>Philadelphus crinitus</i>	<i>Philadelphus microphyllus</i> var. <i>microphyllus</i> A. Gray. Widespread drop from further consideration.
<i>Mabrya acerifolia</i>			
<i>Mentzelia memorabalis</i>		<i>Phlox amabilis</i>	
<i>Mimulus dentilobus</i>		<i>Pholisma sonora</i>	
<i>Muhlenbergia curtifolia</i>		<i>Physalis latiphysa</i>	
<i>Muhlenbergia dumosa</i>		<i>Platanthera zothecina</i>	
<i>Muhlenbergia dubiodes</i>	<i>Muhlenbergia palmeri</i> Vasey. Consider under this name.	<i>Potentilla albiflora</i>	
<i>Myosurus nitidus</i>		<i>Potentilla sanguinea</i>	Formerly considered <i>Potentilla thurberi</i> var. <i>sanguinea</i> (Rydb.) Kearney & Peebles. Consider under this name.
		<i>Puccinellia parishii</i>	

continued

**APPENDIX A. Full List of Species Considered and Taxonomic Nomenclature (www. Itis.gov) continued**

TAXON	CURRENT TAXONOMIC TREATMENT	TAXON	CURRENT TAXONOMIC TREATMENT
<i>Purshia subintegra</i>	<i>Purshia x subintegra</i>	<i>Stephanomeria schottii</i>	<i>Stephanomeria exigua</i> ssp. <i>exigua</i> Nutt. Widespread drop from further consideration.
<i>Salix arizonica</i>		<i>Streptanthus lemmonii</i>	<i>Caulanthus lemmonii</i> S. Watson.
<i>Salvia amissa</i>		<i>Symphotrichum potosinum</i>	
<i>Salvia davidsonii</i>	<i>Salvia henryi</i> A. Gray. Widespread drop from consideration.	<i>Symphotrichum welshii</i>	
<i>Samolus vagans</i>		<i>Talinum gooddingii</i>	<i>Pheimeranthus parviflorus</i> (Nutt.) Kiger. Widespread drop from further consideration.
<i>Sclerocactus sileri</i>	<i>Sclerocactus spinosior</i> (Engelm.) Woodruff & L. Benson. Consider under this name.	<i>Talinum humile</i>	<i>Pheimeranthus humilis</i> (Greene) Kiger. Consider under this name.
<i>Sclerocactus terrae-canyonae</i>		<i>Talinum marginatum</i>	<i>Pheimeranthus marginatus</i> (Greene) Kiger. Consider under this name.
<i>Sclerocactus whipplei</i>		<i>Tetraneris verdiensis</i>	
<i>Senecio multidentatus</i>	Two varieties recognized <i>S. m.</i> var. <i>huachucanus</i> and <i>multidentatus</i> . Drop from full species list.	<i>Thelypodopsis ambigua</i>	Previously recognized varieties no longer accepted. Consider as full species.
<i>Senecio quaerens</i>	<i>Packera hartiana</i> (A. Heller) W.A. Weber & A. Löve. Widespread drop from consideration.	<i>Townsendia smithii</i>	
<i>Silene rectiramea</i>		<i>Trifolium neurophyllum</i>	
<i>Sphaeralcea gierschii</i>		<i>Verbena pinetorum</i>	
<i>Spiranthes delitescens</i>		<i>Zigadenus virginatus</i>	<i>Anticlea vaginata</i> Rydb. Consider under this name.
<i>Stellaria porsildii</i>			

BOOK REVIEW *Douglas Ripley, President, Cochise Chapter, Arizona Native Plant Society*

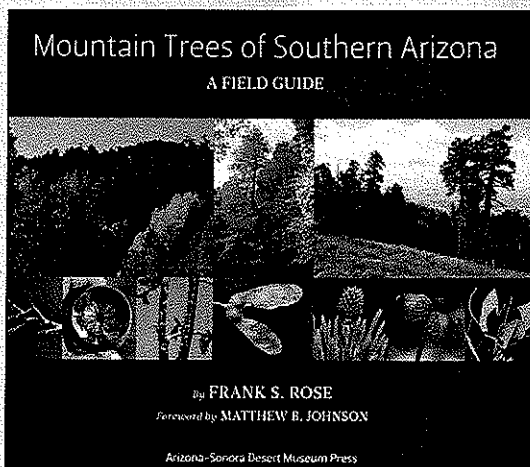
## Mountain Trees of Southern Arizona — A Field Guide

by **Frank Rose**. 2012. 104 pp. \$19.95. Arizona-Sonora Desert Museum Press.

This beautiful and useful field guide to the mountain trees of Southern Arizona is a sequel to long-time Arizona Native Plant Society member Frank Rose's highly acclaimed *Mountain Wildflowers of Southern Arizona — A Field Guide to the Santa Catalina Mountains and Other Nearby Ranges*, published in 2011.

The geographical area of the guide includes the mountain areas of Southern Arizona south of the Mogollon Rim. Forty one of the most common native tree species to be encountered in those regions are represented. For each species an interesting description is provided, including information on the tree's physical characteristics, habitat, and distribution. But it is the author's superb photographs that make this field guide exceptional. A series of nine photographs accompany the discussion of each species

which illustrate beautifully the overall habit of the tree and its individual characteristics such as its bark, leaves, reproductive structures, etc.



Also included is a distribution table of trees in selected ranges of Southern Arizona, a very informative etymology and miscellany of botanical names which I found most interesting, and a comprehensive glossary of botanical terms. The complete index of botanical and common names makes finding an individual tree in the text easy.

It would be hard to imagine a more useful or attractive field guide to the mountain trees of Southern Arizona for anyone

interested in our native flora, regardless of their professional training, than this impressive book.



## Appendix B. Rank Scores for Very High Priority, High Priority, and Watch Rank Categories

NAME   COMMON NAME	Range	No. of Populations	Abundance	Habitat Specificity	Intrinsic Rarity	Threats	Population Trend	Rank Score	Potential Rank Score	Average Rank Score	Mexico Rank Score	AZ Rare Plant Field Guide <sup>1</sup>
<b>VERY HIGH PRIORITY</b> <i>Agave delamateri</i> W.C. Hodgson & L. Slauson   Tonto Basin Agave	2	0	1	1	1	1	1	7	7	7		c
<i>Agave phillipsiana</i> W.C. Hodgson   Grand Canyon Century Plant	2	0	1	1	1	1	1	7	7	7		nc
<i>Anticlea vaginata</i> Rydb.   Sheathed deathcamus	2	1	1	1	1	1	unk	7	8	7.5		nc
<i>Astragalus holmgreniorum</i> Barneby   Holmgren (Paradox) Milk-vetch	2	1	1	1	1	1	0	7	7	7		c
<i>Chylismia exilis</i> (P.H. Raven) W.L. Wagner & Hoch   Cottonwood Springs suncup	2	1	1	1	1	1	unk	7	8	7.5		c
<i>Eryngium sparganophyllum</i> Hemsl.   Ribbonleaf Button Snakeroot	2	1	1	1	unk	unk	1	6	8	7	y?	nc
<i>Mentzelia memorabilis</i> N.H. Holmgren & P.K. Holmgren   September 11 Stickleaf	2	1	1	1	1	1	0	7	8	7.5		nc
<i>Pediocactus bradyi</i> L. Benson   Brady Pincushion Cactus	2	1	1	1	1	1	1	8	8	8		c
<i>Phacelia cronquistiana</i> S.L. Welsh   Cronquist's Phacelia	2	1	1	1	1	1	unk	7	8	7.5		nc
<i>Salvia amissa</i> Epling   Aravaipa Sage	2	1	1	1	1	unk	1	7	8	7.5		c
<i>Sphaeralcea gierischii</i> N.D. Atwood & S.L. Welsh   Gierisch mallow	2	1	1	1	unk	1	1	7	8	7.5		nc
<b>HIGH PRIORITY</b> <i>Actaea arizonica</i> (S. Watson) J. Compton   Arizona Bugbane	2	1	1	1	1	0	0	6	6	6		c
<i>Agave murpheyi</i> F. Gibson   Hohokam Agave	1	0	1	1	1	1	1	6	6	6		c
<i>Agave yavapaiensis</i> Hodgson & Saliwan   Yavapai Agave	2	1	1	1	1	0	unk	6	7	6		nc
<i>Aliciella cliffordii</i> J.M. Porter	2	1	1	1	unk	0	unk	5	7	6		nc
<i>Amsonia kearneyana</i> Woodson   Kearney's Blue-star	2	1	1	0	1	0	1	6	6	6		c
<i>Asclepias welshii</i> N.H. Holmgren & P.K. Holmgren   Welsh's Milkweed	2	1	1	1	1	0	unk	6	7	6.5		c
<i>Astragalus ampullarius</i> S. Watson   Gumbo Milk-vetch	1	1	1	1	1	1	unk	6	7	6.5		
<i>Astragalus beathii</i> C.L. Porter   Beath Milk-vetch	2	1	1	1	unk	0	unk	5	7	6		c
<i>Astragalus sophoroides</i> M.E. Jones   Tuba City Milk-vetch	2	1	1	1	unk	0	unk	5	7	6		c
<i>Carex specuicola</i> J.T. Howell   Navajo Sedge	1	0	1	1	1	1	1	6	6	6		c
<i>Castilleja kaibabensis</i> N.H. Holmgren   Kaibab Paintbrush	2	1	1	1	1	0	0	6	6	6		c
<i>Cirsium mohavense</i> (Greene) Petr.	1	1	1	1	0	1	1	6	6	6		
<i>Cryptantha semiglabra</i> Barneby   Smooth Catseye	2	1	1	1	1	0	0	6	6	6		nc
<i>Erigeron kuschei</i> Eastw.   Chiricahua Fleabane	2	1	1	1	unk	0	unk	5	7	6		c
<i>Eriogonum mortonianum</i> Reveal   Morton Wild-buckwheat	2	1	1	1	0	unk	unk	5	7	6		c
<i>Eriogonum ripleyi</i> J.T. Howell   Ripley Wild-buckwheat	2	1	1	1	0	1	unk	6	7	6.5		c
<i>Eriogonum terrenatum</i> Reveal   San Pedro Wild Buckwheat	2	1	1	1	1	0	0	6	6	6		nc
<i>Errazurizia rotundata</i> (Wooton) Barneby   Roundleaf Errazurizia	2	1	1	1	unk	0	unk	5	7	6		c
<i>Escobaria robbinsiorum</i> (W.H. Earle) D.R. Hunt   Cochise Pincushion Cactus	2	1	1	1	unk	0	unk	5	7	6		c
<i>Flaveria mcdougallii</i> Theroux, Pinkava & Keil   Grand Canyon Flaveria	2	1	1	1	unk	0	1	6	7	6.5		c
<i>Muhlenbergia curtifolia</i> Scribn.	2	0	1	1	unk	1	unk	5	7	6		nc
<i>Pediocactus paradinei</i> B.W. Benson	2	1	1	1	unk	0	1	6	6	6		c
<i>Perityle ambrosiifolia</i> Greene ex A. Powell & S.C. Yarborough   Ajo Rock Daisy	2	1	1	1	unk	0	Unk	5	7	6		nc
<i>Phacelia welshii</i> N.D. Atwood   Welsh Phacelia	2	1	1	1	unk	0	unk	5	7	6		c
<i>Puccinellia parishii</i> Hitchc.   Parish Alkali Grass	1	1	1	1	unk	1	unk	5	7	6		c
<i>Sclerocactus terrae-canyonae</i> Heil   Longspine Fishhook Cactus	2	1	1	0	unk	1	unk	5	7	6		c
<i>Spiranthes delitescens</i> Sheviak   Madrean Ladies'-tresses	2	1	1	1	0	unk	1	6	7	6.5	y	c

<sup>1</sup>Arizona Rare Plant Field Guide Codes: (c=considered, nc=not considered, cr=considered rejected)

continued



**Appendix B. Rank Scores for Very High Priority, High Priority, and Watch Rank Categories** *continued*

NAME   COMMON NAME	Range	No. of Populations	Abundance	Habitat Specificity	Intrinsic Rarity	Threats	Population Trend	Rank Score	Potential Rank Score	Average Rank Score	Mexico Distribution	AZ Rare Plant Field Guide!
HIGH PRIORITY	<i>Townsendia smithii</i> L.M. Shultz & A.H. Holmgren   Blackrock Ground Daisy	2	1	1	1	unk	0	unk	5	7	6	c
	<i>Trifolium neurophyllum</i> Greene   White Mountains Clover	2	1	1	1	unk	0	unk	5	7	6	c
WATCH	<i>Agave verdensis</i> Hodgson & Saliwan	2	0	1	1	1	0	unk	5	6	5.5	nc
	<i>Berberis harrisoniana</i> Kearney & Peebles   Kofa Mt Barberry	2	1	1	0	unk	0	unk	4	6	5	c
	<i>Chylismia confertiflora</i> (P.H. Raven) W.L. Wagner & Hoch   Grand Canyon Suncup	2	1	1	0	unk	0	unk	4	6	5	nc
	<i>Cryptantha atwoodii</i> Higgins   Atwood Catseye	2	1	0	1	unk	0	unk	4	6	5	nc
	<i>Cylindropuntia abyssii</i> (Hester) Beckeberg	2	1	1	1	0	0	0	5	5	5	nc
	<i>Dalea tentaculoides</i> Gentry   Gentry Indigo Bush	1	1	1	0	unk	1	unk	4	6	5	y c
	<i>Enceliopsis argophylla</i> (D.C. Eaton) A. Nelson	2	1	1	1	unk	0	0	5	6	5.5	
	<i>Eremothera gouldii</i> (P.H. Raven) W.L. Wagner & Hoch   Gould Evening-primrose	1	1	1	1	0	1	unk	5	6	5.5	
	<i>Erigeron heliographis</i> G.L. Nesom   Pinalenos Fleabane	2	1	1	1	0	0	unk	5	6	5.5	c
	<i>Erigeron lemmonii</i> A. Gray   Lemmon Fleabane	2	1	1	1	0	0	unk	5	6	5.5	c
	<i>Erigeron rhizomatus</i> Cronquist   Zuni (Rhizome) Fleabane	2	0	1	1	unk	0	unk	4	6	5	c
	<i>Erigeron sivinskii</i> G.L. Nesom   Sivinski's Fleabane	2	1	1	1	0	0	unk	5	6	5.5	c
	<i>Gentianella wislizeni</i> (Engelm.) J.M. Gillett   Wislizeni Gentian	1	1	1	1	0	1	unk	5	6	5.5	y nc
	<i>Heterotheca rutteri</i> (Rothr.) Shinnery   Huachuca Golden Aster	2	1	1	0	unk	unk	0	4	6	5	y nc
	<i>Hexalectris colemanii</i> (Catling) A.H. Kennedy   Chisos Coral-root	2	1	1	0	1	0	unk	5	6	5.5	nc
	<i>Hieracium pringlei</i> A. Gray   Pringle Hawkweed	2	1	1	0	0	unk	unk	4	6	5	y c
	<i>Lesquerella navajoensis</i> O'Kane   Navajo bladderpod	1	1	1	1	unk	0	unk	4	6	5	c
	<i>Mabrya acerifolia</i> (Pennell) Elisens   Mapleleaf False Snapdragon	2	0	1	1	unk	0	unk	4	6	5	nc
	<i>Macroptilium supinum</i> (Wiggins & Rollins) A. Delgado & L. Torres	2	1	1	0	1	0	unk	5	6	5.5	nc
	<i>Packera franciscana</i> (Greene) W.A. Weber & A. Löve   San Francisco Peaks ragwort	2	1	1	1	unk	0	0	5	5	5	c
	<i>Panicum mohavense</i> Reeder   Mojave panicgrass	2	1	1	1		0	unk	5	6	5.5	c
	<i>Pediomelum pauperintense</i> S.L. Welsh, M. Licher & N.D. Atwood   Kane Breadroot	2	1	1	1	unk	0	0	5	6	5.5	nc
	<i>Pediomelum pentaphyllum</i> (L.) Rydb.   Poverty Mountain Breadroot	2	1	1	0	unk	1	unk	5	6	5.5	nc
	<i>Penstemon distans</i> N.H. Holmgren   Catalina Beardtongue	1	1	1	1	1	0	0	5	6	5.5	cr
	<i>Perityle ajoensis</i> T.K. Todsen   Sheep Range Beardtongue	2	1	1	0	0	unk	unk	4	6	5	c
	<i>Phacelia buell-vivariensis</i> N.D. Atwood   Buell Park phacelia	1	1	1	1	unk	0	unk	4	6	5	nc
	<i>Phemeranthus marginatus</i> (Greene) Kiger   Tepic Flame Flower	1	1	1	0	unk	unk	1	4	6	5	y c
	<i>Platanthera zothecina</i> (L.C. Higgins & S.L. Welsh) Kartesz & Gandhi   Alcove Bog-orchid	1	0	1	1	1	1	unk	5	6	5.5	y c
	<i>Potentilla sanguinea</i> Rydb.   Flagstaff Cinquefoil	2	1	1	0	unk	0	unk	4	6	5	nc
	<i>Purshia x subintegra</i> (Kearney) Henrickson (pro sp.)   Arizona cliffrose	2	1	1	1	0	0	0	5	5	5	c
	<i>Salix arizonica</i> Dorn   Arizona willow	1	1	1	1	0	1	unk	5	6	5.5	c
	<i>Sclerocactus spinosior</i> (Engelm.) Woodruff & L. Benson   Siler Fishhook Cactus	2	1	1	1	0	0	0	5	5	5	c
<i>Silene rectiramea</i> B.L. Rob.   Grand Canyon Catchfly	1	1	1	1	unk	0	unk	4	6	5	nc	
<i>Symphotrichum welshii</i> (Cronquist) G.L. Nesom   Welsh's American-aster	1	1	1	1	unk	0	unk	4	6	5	nc	