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Results of Surveys for Potentially Extirpated Plants in High Elevations of the Rincon Mountain District, Saguaro National Park, 2017-2020

**Daniel C. Beckman
Don E. Swann**

Desert Plants

A journal devoted to broadening knowledge of plants indigenous or adapted to arid and sub-arid regions and to encouraging the appreciation of these plants.

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From the editor

The earliest botanical surveys of Arizona took place in the late 19th and early 20th centuries, but in the 1970s and 1980s, plant lists were still being compiled for individual mountain ranges ("Sky Islands") in Arizona. Two botanists, Janice E. Bowers and Steven P. McLaughlin, made 38 journeys on foot into the high-elevation wilderness east of Tucson. They then combined their collections and observations with earlier surveys done by Carole E. Jenkins at lower elevations. The resulting flora was the first for an entire mountain range in southeast Arizona. *Desert Plants* proudly published their work in 1987 as *Flora and Vegetation of the Rincon Mountains, Pima County, Arizona*, Vol. 8 (2).

It has now been 34 years since that special issue. Biologists at Saguaro National Park began asking the question of how high-elevation species had been faring during the serious drought and heat waves of the last two decades. As a point of departure, they considered the list of 41 "missing" plants that Bowers and McLaughlin did not find despite historical records in the Rincon Mountains. Had they died out since those earlier explorations? Park biologists refined the list, and the following pages tell the story of their search, across one of the last roadless mountaintops in Arizona. Their conclusions, as it turns out, are quite encouraging.

We are likewise proud to publish this supplement to Bowers and McLaughlin, by Daniel C. Beckman and Don E. Swann. Daniel C. Beckman has worked as a biological science technician at Saguaro National Park for eight years conducting a wide array of ecological monitoring and resource management activities. He developed a passionate interest in the local flora on the job and taught himself botany, culminating in a lead role on this study's project. He is fascinated by biogeography, springs, and Sky Island plant diversity, and loves hiking and backpacking to under-studied areas. He is now looking to build upon this study and eventually publish an updated flora of the Rincon Mountains.

Don E. Swann has been a biologist with Saguaro National Park for more than 25 years, with an interest in conservation biology and long-term monitoring. He is co-author on several papers about saguaro ecology, desert amphibians, and climate change. Don has an MS in Wildlife Ecology from University of Arizona and a BA in Geology-Biology from Brown University.

Please send comments, future article proposals and manuscripts for submission to me at the above email address. We hope you enjoy the issue!

Jeffrey M. Petrie

Cover Photo: *Graptopetalum bartrami*

Back Cover Photo: North-facing bedrock canyon

Desert Plants journal one-year subscriptions are available: individual \$30 (\$40 outside US), institution \$65 (\$75 outside US). Back issues \$5 each, plus \$3 shipping and handling. Additional copies of Vol. 29(2) are \$20, plus \$5 shipping and handling, Vol. 33(2) are \$35, Vol 34 are \$25. Mailing address: Boyce Thompson Arboretum 37615 E Arboretum Way, Superior, AZ 85173 Email: DesertPlants@btparboretum.org Phone: (520) 689-4546



Severely burned habitat from 2003 Helen's 2 Fire

CONTENTS

Results of Surveys for Potentially Extirpated Plants in High Elevations of the Rincon Mountain District, Saguaro National Park, 2017-2020	5
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View from northeast side of Mica Mountain.

Results of Surveys for Potentially Extirpated Plants in High Elevations of the Rincon Mountain District, Saguaro National Park, 2017-2020

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Abstract In their landmark flora of the Rincon Mountains, a Madrean Sky Island mountain range located just east of Tucson, Arizona, Bowers and McLaughlin (1987) included a list of 41 “excluded species,” including high-elevation species associated with wet soils, that had previously been documented in these mountains but were not encountered during their study. This potentially significant loss of montane plant species in a protected wilderness area, possibly due to climate change, concerned Saguaro National Park biologists and led to a project to revisit the list, determine which species were still unaccounted for, and plan field surveys to search for them. From 2014-2017, we reviewed taxonomic changes as well as recent and historical collections, narrowing the Bowers-McLaughlin list of 41 down to a target list of 14 potentially extirpated native species expected to occur in mid-to-high elevation mountain habitats. From 2017-2020 we searched for these plants and rediscovered 9 of the 14 target species. Along the way, we also found 22 mid-to-high elevation native species not previously reported for the Rincon Mountains and documented other rare montane plants of scientific and conservation interest. Our results suggest that the plant community at high elevations is more stable than previously believed and provide hope that the remaining lost plants may also be rediscovered with continuing effort. Data from this study will form the basis for long-term monitoring of the high-elevation plant community and its potential response to climate change.

Introduction

Species declines and extirpations (local extinctions) in protected natural areas, especially national parks that have the highest level of protection, have long been a major concern in conservation biology (Newmark 1995, Rivard et al. 2000, Langton and Lawler 2015, Wu et al. 2018). Parks and their surrounding ecosystems have seen significant environmental change over the past century (Hansen et al. 2014), including increases in non-native species. Small reserves in particular have seen extirpations of large numbers of native plants (Drayton and Primack 1996, Turner et al. 1996). While past extirpations have been driven by development and loss of habitat outside park boundaries, models suggest that climate change will

dramatically impact ecosystem function and biodiversity (Hansen et al. 2014). Many U.S. national parks are already experiencing warmer annual mean temperatures, and due to their locations, national parks are warming more rapidly than the U.S. as a whole (Gonzalez et al. 2018). Using plant phenology, Monahan et al. (2016) found that most parks are near the extreme warm end of their historical temperature distributions, with spring advancing in 76% of parks, and more than half seeing “early springs” that exceed 95% of historical conditions. These climatic changes have the potential to modify park species assemblages and ecological processes (Langdon and Lawler 2015) and threaten the persistence of species within park boundaries (Monahan et al. 2016).

Montane ecosystems are thought to be particularly vulnerable to the effects of climate change because higher mean temperatures have the potential to reduce or eliminate the cooler, wetter habitats required by some species. In Glacier National Park, Lesica (2014) found a decline in plants restricted to high elevations from 1988–2011 during a period when mean annual temperatures increased 0.6° C. In some montane areas, researchers have found that warmth-demanding plant species are expanding in high-elevation environments, while cold-demanding species are declining in a clear sign of future extirpations due to warming temperatures (Kuhn and Gégout 2018).

The Rincon Mountains, like other Madrean Sky Island mountain ranges in southeastern Arizona, northeastern Sonora, and adjoining areas of New Mexico and Chihuahua, are incredibly rich in plant life; more than 1,100 species have been recorded in the Rincon Mountain District of Saguaro National Park (Powell et al. 2006). Rising from the Sonoran Desert at 914 m (3,000 ft) up to their forested summit at 2,641 m (8,666 ft), the Rincons contain a diverse array of plant communities including riparian woodlands, desert grasslands, oak woodlands, mixed conifer forests, and montane meadows. Their large elevation range partially explains the great plant diversity. Another key factor is their geographical placement at the crossroads of different floristic influences, including two major mountain systems (the Rocky Mountains to the north and the Sierra Madre Occidental to the south), as well as two major deserts (the Sonoran Desert to the west and Chihuahuan Desert to the east).

The Rincons came under the jurisdiction of the US Forest Service in the early 1900s; the majority of the range was then transferred to Saguaro National Monument in 1933, and the Monument was promoted to national park status by Congress in 1994. The Rincons received a fair amount of attention from botanists in the late 19th

and early 20th centuries, with notable figures including G.C. Nealley, Jacob Blumer, and Leslie Goodding making arduous excursions into these roadless mountains to collect and preserve voucher plant specimens.

In 1982, Janice Bowers and Steven McLaughlin set out to complete a vascular plant flora of the Rincons, the first for an entire mountain range in southeast Arizona. They conducted three years of intensive field work (1982–1984) and reported on four years of low-elevation collections (1978–1982) by Carol Jenkins. Jenkins had intended to publish a flora of the park’s Rincon Mountain District below 1,372 m (4,500 ft) as a master’s thesis but was unable to finish due to ill health. Bowers and McLaughlin compiled data from both projects into notes on relative abundance, elevation ranges, and habitats for each confirmed species. They published their results, which included 945 species, in the journal *Desert Plants* (Bowers and McLaughlin 1987). Bowers went on to write eloquently about her experiences in the Rincons in a collection of personal essays titled *The Mountains Next Door* (Bowers 1991).

In their flora publication, Bowers and McLaughlin listed 41 plant species previously recorded in or around the Rincons that they were not able to relocate. Of these 41 species, 22 had been collected during the active late 19th to early 20th century period, but not documented since. Of this group, the authors highlighted 6 species, all described as high-elevation “moisture-loving, cold-tolerant plants,” which they specifically searched for but could not find. They believed that these 6 species might be extirpated and hypothesized two explanations, climate change (drought, particularly winter drought) and habitat disturbance (they highlight the damming of upper Chimenea Creek to create the Manning Camp water source in the 1960s).

Studies of extirpation are complicated because while it is easy to document the presence of a species through a voucher specimen or photograph, it is much more difficult (even theoretically impossible) to definitively document the absence of a species. In addition, historical voucher specimens may have been misidentified or mislabeled, or taxonomic changes may have created a species “loss” when all that really changed was a name. Therefore, while the potential loss of multiple plant species from Saguaro National Park was of great concern, park biologists felt that more information was needed.

The goal of this study was to create an updated and definitive list of “lost” (potentially extirpated) species, including a more thorough examination of results since 1984 (the final year of Bowers’ and McLaughlin’s field work), and then follow up with targeted field searches for

particular species in appropriate habitat. Here we report the results of our first comprehensive field effort with a focus on high elevations in the northern part of the Rincon Mountains near Mica Mountain during the 2017-2020 field seasons.

Study Area

The Rincon Mountains are a major range in the northwest portion of the Madrean Sky Island archipelago, a binational region of scattered mountain “islands” that link the Sierra Madre Occidental with the Colorado Plateau (Figure A). The Rincons are part of the Santa Cruz and San Pedro River watersheds and are situated immediately east of the major metropolitan area of Tucson,

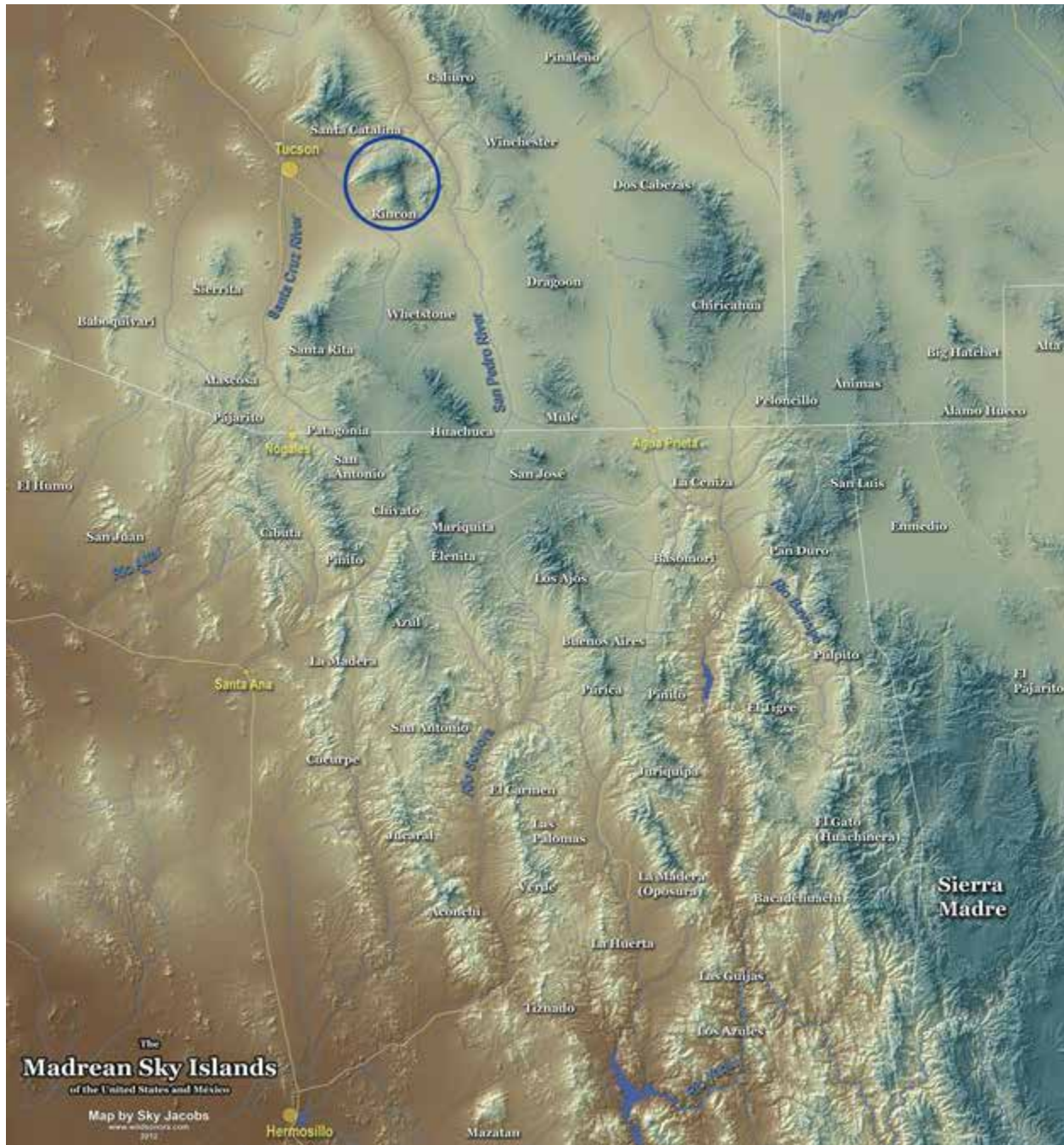


Figure A: The Rincons in Context: The Madrean Sky Islands of the U.S. and Mexico
Map by Sky Jacobs - blue circle added around Rincon Mountains

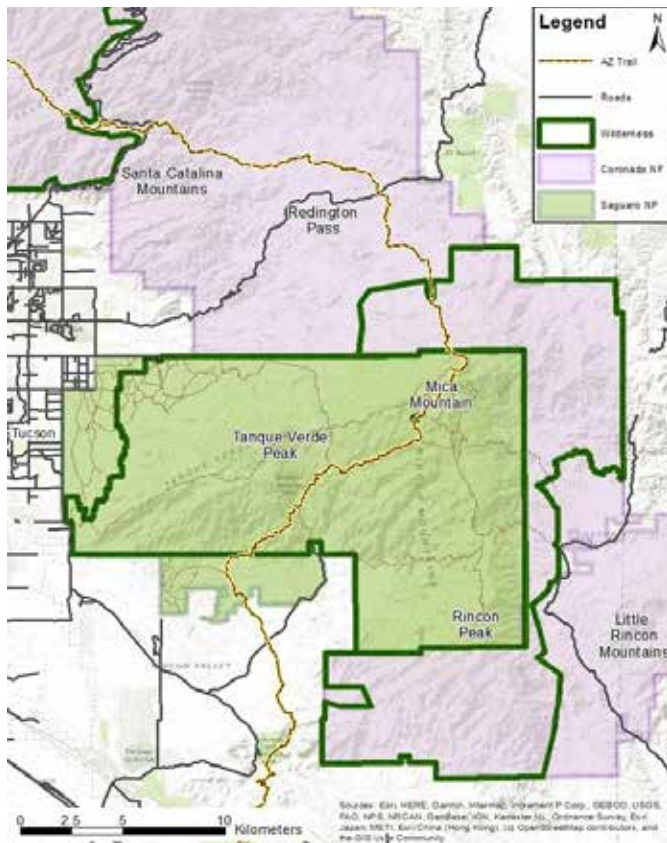


Figure B: Area overview of the Rincon Mountains
Map produced by Saguaro National Park

Arizona. They are bordered closely to the northwest by another major Sky Island range, the Santa Catalina Mountains, separated by Redington Pass. To the east lies a small sister range, the Little Rincon Mountains, separated by Happy Valley and lower Paige Creek. The Rincons are defined by three major peaks: Mica Mountain, Rincon Peak, and Tanque Verde Peak. Mica Mountain, the northernmost peak, is the tallest point in the range at 2,641 m (8,666 ft). The majority of the Rincons is designated federal wilderness, with the Saguaro Wilderness (NPS) and Rincon Mountain Wilderness (USFS) together protecting 96,520 acres of the range (Figure B).

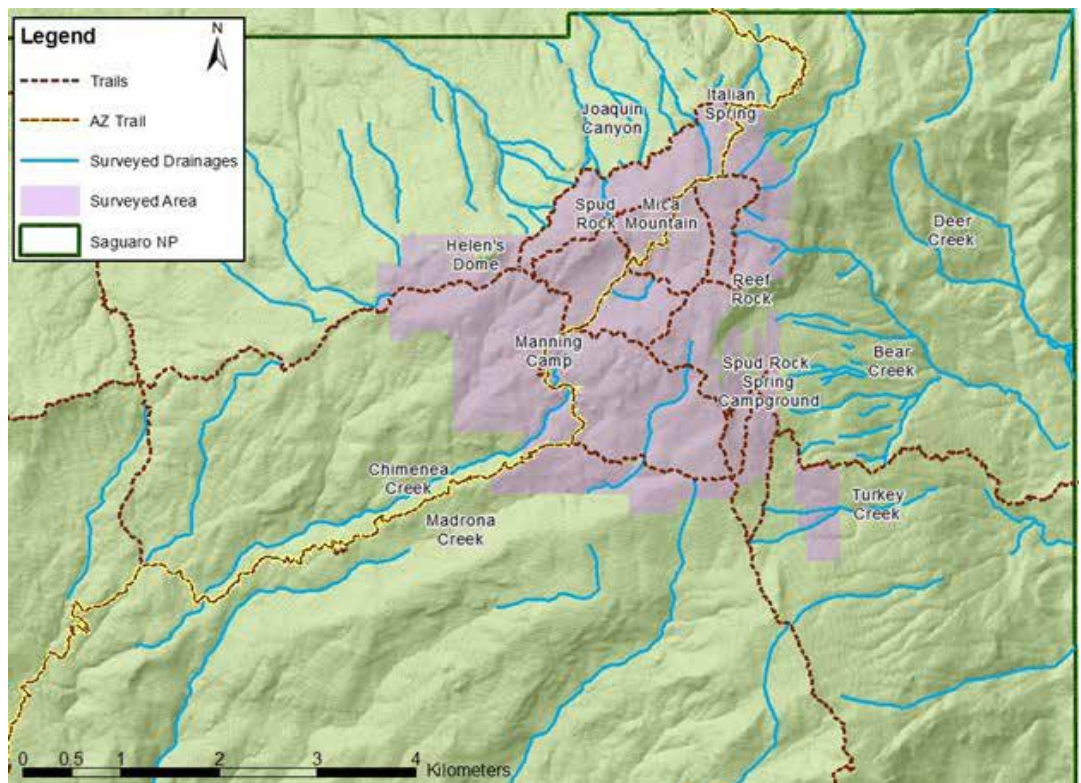
Our study focused on high-elevation areas, mostly 1,829 m (6,000 ft) and above, of Mica Mountain within the boundary of Saguaro National Park (Figure C). This study will also report on findings from limited high-elevation surveys on Tanque Verde Peak and Rincon Peak.

Methods

Review of taxonomy and collection records

Prior to beginning field work in 2017, we initiated a comprehensive records review to determine the current status of the 41 species identified as “excluded species” by Bowers and McLaughlin (1987). We studied taxonomic changes, searched collection records, and reviewed records and notes of botanists who had worked in the range since

Figure C: Survey coverage on Mica Mountain 2017-2020
Map produced by Saguaro National Park



the 1980s. In addition, we removed certain species because they were either non-native (and therefore not relevant for assessing native biodiversity) or were originally collected at or below the base of the Rincons and therefore not montane species.

Addressing taxonomic issues was important due to the many changes in plant taxonomy during the past century, not all of which had been addressed by Bowers and McLaughlin. We used the Integrated Taxonomic Information System (ITIS, a partnership of North American government agencies and other organizations), the Tropicos botanical database (maintained by the Missouri Botanical Garden), as well as taxon-specific research papers in order to evaluate taxonomic changes.

To confirm that a species had not been documented in the Rincons since its original record, we consulted the University of Arizona Herbarium, where Bowers and McLaughlin (1987) had examined historical collections and deposited their own specimens. Additionally, we checked many sources not available to them, especially the SEINet online database which includes collection records from herbaria across the country (<https://swbiodiversity.org/seinet/>). We also reviewed results of more recent surveys, especially a comprehensive USGS inventory that included field surveys in the Rincons in the early 2000s (Powell et al. 2006), internal Saguaro National

Park records, and field surveys from 2009-2016 by Steve Buckley and other botanists with the NPS Sonoran Desert Network inventory and monitoring program.

Field surveys

We conducted field surveys from April-October, 2017-2020. We enlisted park biological technicians and interns working on other projects in the Rincons including Mexican spotted owl surveys, vegetation mapping, and forest health and springs monitoring. For each target species we created laminated species cards that included photos showing key identifying features and detailed botanical descriptions, and encouraged all biologists working on high-elevation projects to keep an eye out for the missing species.

In addition, we conducted targeted surveys for the missing plants based on species-specific habitat descriptions, historical collection notes, and collection records from nearby ranges. At best, historical collection notes provide vague locations such as “Manning Camp, gravelly knoll” or “Spud Ranch, rocky east slope”; often they say nothing more than “Rincon Mountains.” Bowers and McLaughlin (1987) described many excluded species as “moisture-loving, cold-tolerant plants”, so we focused our surveys on canyon habitats with perennial or semi-perennial water and shaded north-facing sites where snow might linger and provide extra soil moisture. Most



Surveying the east side of Rincon Peak

of our surveys were based out of the Saguaro National Park backcountry station at Manning Camp near Mica Mountain at 2,438 m (8,000 ft) in elevation, which was a convenient location for multiple reasons. Saguaro National Park provides mule-packing support for Manning, which is helpful since the Rincons are a roadless wilderness and the easiest access for park personnel requires a 15 km (9 mile) hike and 1,400 m (4,593 ft) elevation gain. The backcountry station is also close to unique high-elevation habitats where many historical specimens were collected, including the north slope of Mica Mountain, with towering rock outcrops and mixed conifer forests, and Spud Rock Spring Campground, a historical farm site with abundant springs, an open meadow, and aspen grove habitat.



Open pine forest habitat on Mica Mountain

We collected and/or photographed target species and other plants of interest, operating with the general ethical principle of not collecting from any population so limited that the collection might have a significant impact on that population's future. When collections were not made, we took a photo voucher and included all the detailed notes that would accompany a physical collection. Identification of collected specimens and voucher photographs were confirmed by University of Arizona Herbarium staff and associated researchers, with collections deposited in the herbarium as permanent records of these species' presence in the park. We posted each record to the SEINet online plant database, complete with photos from the field and/or a scan of the collection, as well as accompanying location and habitat information. Our large collection of dated and georeferenced plant photos was especially important in the later years of the project as botanical knowledge and skill increased.

Our survey methods evolved as the project took shape. We realized quickly how difficult it is to access many parts of the Rincons Mountains due to the size of its roadless area, the distance between trails, and the environmental difficulties of topography, heat, and summer storms. It was challenging even to reach certain areas of the range, let alone move through these areas safely while searching for plants. Most of our initial species findings occurred while descending major drainages, so these areas became our focus from 2018-2020. Through these efforts we discovered a number of previously unmapped springs, many of them with perennial surface water, that also provided important habitat for rare plants.

In addition to day trips from Manning Camp, we conducted backpacking trips to survey areas that were too remote to be realistically covered in a day. We relied heavily on Saguaro National Park biological technicians and interns who were dedicated and proven hikers we could trust to work safely in this rugged and demanding landscape. We also utilized co-workers who supported backpacking trips by dropping off vehicles at remote trailheads on the eastern and northern edges of the range.

Results

Historical and herbarium records

Based on our reviews of taxonomy, museum collections, recent records, and species descriptions, we reduced the list of 41 "excluded species" from Bowers and McLaughlin (1987) to 14 target species for field surveys. From the original list, we removed six non-native species. We also removed six low-elevation species we were confident had never been recorded in the mountains proper, based on their original collection sites as well as general habitat information.

In addition, we removed five species due to taxonomic changes or misidentifications. One of these involved an old synonym that had been improperly carried over, making a record appear to be a different species. Among the misidentifications, two species had actually been collected, but misidentified, by Bowers and McLaughlin (1987) and were later corrected by experts on those specific plant groups.

We also removed two species from the list that were reported for the Rincons by Kearney and Peebles (1960) but had never actually been documented there.

Finally, we located records or accounts for eight species that had been documented in the Rincons since 1987 and removed those species. Appendix D provides an annotated and updated version of the original Bowers and McLaughlin list.

Rediscovered species

From 2017-2020, we successfully “rediscovered” nine of the fourteen target species. Our rate of rediscovery decreased each year, with six findings in 2017, two in 2018, one in 2019, and none in 2020. The following is a brief discussion of each rediscovery, in chronological order. See Appendix A for a summary of these findings, including more detailed historical and recent collection information.

ANACARDIACEAE - *Rhus glabra* (smooth sumac)

Rhus glabra is a thicket-forming deciduous shrub or small tree with dark green divided leaves. It has a widespread distribution throughout North America, but in southern Arizona is largely confined to riparian zones with rich soil (Anderson 2007). Its historical presence in the Rincons was known from an article by Blumer (1910) discussing the ecological differences he observed between the Rincons’ east and west sides (noting *Rhus glabra* as a species only observed on the east side). However, Blumer did not make a collection and there had been no records of it since.

In March 2017, a Sonoran Desert Network vegetation mapping crew recorded *Rhus glabra* while investigating a dense patch of unusual deciduous vegetation that spans multiple minor branches of upper Bear Creek around 1,829 m (6,000 ft). Our crew revisited the area and found scattered *Rhus glabra* populations in and around this extensive jungle-like thicket dominated by box elder, alder, walnut, dewberry, and poison ivy. We also found two previously unmapped springs. One of these is seemingly perennial, as it was observed flowing in the driest time of year (pre-monsoon in early July). Altogether this appears to be an area of extensive shallow groundwater, an extremely favorable habitat for this species. We have yet to find *Rhus glabra* in any other region of the park, though we did encounter an additional population on U.S. Forest Service land in the eastern foothills of Rincon Peak (just west of Happy Valley Road) in May 2020. This lower-elevation site at 1,341 m (4,400 ft) occurs along a shaded stream course around a series of spring-fed pools, underscoring the importance of rich soil and plentiful water for this species.



Rhus glabra (photo courtesy of Mary Owen)

CORNACEAE - *Cornus sericea* subsp. *sericea* (red osier dogwood)

Cornus sericea subsp. *sericea* is a thicket-forming shrub with broad leaves and dense clusters of small white flowers. It reproduces vegetatively with stolons, allowing it to spread across riparian habitats. *Cornus sericea* was one of the “moisture-loving, cold-tolerant” species that Bowers (1991) had mourned as probably extirpated. It was rediscovered in a damp, deeply shaded portion of upper Chimenea Creek above Manning Camp, by park biologists who were obtaining a water sample from a perennial seep. The localized upper Chimenea population dominates a brief portion of the creek in the species’ typical sprawling fashion.

BETULACEAE - *Alnus incana* subsp. *tenuifolia* (thinleaf alder)

Alnus incana subsp. *tenuifolia* is a shrub or small tree with broad serrated leaves, common in much of western North America but very rare this far south. Though leaf characteristics can be used to distinguish it from the far

more locally common Arizona alder (*A. oblongifolia*), the most striking difference is the sprawling or shrubby growth form in contrast to the tall-growing tree form of *A. oblongifolia*. This was another of the “moisture-loving, cold-tolerant” species highlighted by Bowers and McLaughlin (1987). We found one widely spreading large tree and several small trees in upper Chimenea Creek just upstream of the red osier dogwood population. They were clustered in a narrow mossy bedrock section directly below a seeping overhang.

Both thinleaf alder and red osier dogwood had last been documented by Blumer in 1909, presumably in the same area, as his collections reference proximity to Manning Camp. This short stretch of montane riparian habitat appears to be truly special; we have not located additional populations of either species anywhere else. One of this study's flora additions, *Chimaphila umbellata* (pipsissewa), is also found in this area but is presently unknown elsewhere in the range. The population of *Alnus incana* subsp. *tenuifolia* is particularly notable as it appears to be the southernmost known occurrence of this species globally (SEINet).

POACEAE - *Melica porteri* (Porter's melicgrass)

Melica porteri is a graceful perennial grass with a gently nodding inflorescence and purple-tinged spikelets. We initially found it growing abundantly on the forested north-facing slope below Helen's Dome. This towering rock outcrop is the most visible feature on Mica Mountain from the city of Tucson and casts a long shadow on the mixed-conifer forest below it, creating a uniquely cool and sheltered habitat. In *The Mountains Next Door*, Bowers describes this area where she finally spotted two of her most elusive species, New Mexico maple (*Acer glabrum* var. *neomexicanum*) and male fern (*Dryopteris filix-mas*): “No doubt snow lingers on the deeply shaded slopes below Helen's Dome after it has melted elsewhere. This probably helps to keep the soil moist through the dry, hot months before the summer rains start” (pg. 51).

This selection is what inspired us to thoroughly survey the area and check back on those maple and fern populations (we managed to relocate both). *Melica porteri* had previously been collected by Blumer in 1909 on north-facing rock shelves of Spud Rock, another well-known outcrop to the east of Helen's Dome. In subsequent drainage surveys, we observed scattered populations in other moist, sheltered north-facing sites, including patches in the Rincon Peak vicinity.

ASTERACEAE - *Hymenoxys quinquesquamata* (Rincon rubberweed)

Hymenoxys quinquesquamata is a rare perennial sunflower with leaves divided into extremely narrow, widely spaced lobes. Bierner (2001) describes it as “restricted to Southern Arizona” though plausible in northern Sonora. Reports from New Mexico appear to be based on misidentified specimens. Because of this limited range, the conservation science non-profit NatureServe categorizes it as G3 (globally vulnerable), while the state of Arizona ranks it S2 (imperiled in the state). The only place it has been repeatedly and widely documented is the Huachuca Mountains. It has been collected a few times in the Santa Catalina Mountains (the Rincons' closest neighboring range to the northwest), and only once historically in the Santa Ritas. The one and only historical collection from the Rincons dates to 1891 (Nealley).

While hiking back from a drainage survey in late August 2017, we found an extensive population blooming along the Italian Spring Trail (Arizona Trail) on the north slope of Mica Mountain. *Hymenoxys quinquesquamata* is known to grow in open areas and at the edges of pine-oak forests from 1,524-2,438 m (5,000-8,000 ft) (Bierner 2001). Our rediscovery location was within an area that had been opened up by high-intensity fires in 1994 and 2003 (Parker 2006). While hiking cross-country east of that trail, we found abundant populations on other burned slopes, often scattered amidst dense manzanita stands. We have not yet located it anywhere outside of that general vicinity on the northeast face of Mica Mountain.



Melica porteri (photo courtesy of Tony Palmer)

POACEAE - *Muhlenbergia ramulosa* (green muhly)

Muhlenbergia ramulosa is a tiny annual grass growing only 5-25 cm tall. It flowers late in the summer with small white spikelets clinging closely to the branches of the widely spaced inflorescence. Sometimes these spikelets are mottled with green and black patches that are particularly visible under magnification. We noticed it first right around our home base of Manning Camp, and then in gravelly creek bed habitats just upstream of the camp reservoir. This species was last collected in the Rincons by Blumer in 1909. Though separated by over one hundred years, our collections and Blumer's took place at the same time of year (mid-September), in the same general location (Manning Camp), and in similar habitat (gravelly substrate).

ORCHIDACEAE - *Platanthera limosa* (Thurber's bog orchid)

Platanthera limosa is a summer-blooming perennial orchid with thick bright green leaves and a slender spike of tightly packed yellow-green flowers. This flowering spike can grow tall under favorable conditions, reportedly up to 165 cm (Sheviak 2002). Its typical habitat is a high-elevation site with permanently wet soil, often around springs or seeps. This was another of the "moisture-loving, cold-tolerant" species highlighted in Bowers and McLaughlin (1987). It is widely distributed in Mexico but rare in the United States. Southeast Arizona is the U.S. hotspot, with strongholds in the Huachuca, Chiricahua, and Santa Catalina Mountains. Its status in New Mexico

is uncertain; local orchid expert Ron Coleman stated that it may be extirpated there, lacking any confirmed records since 1903 (Coleman 2002).

Its presence in the Rincons was known only from an 1891 collection (Nealley). We were unable to find location information for this collection beyond "Rincon Mountains," though Bowers and McLaughlin (1987) include a passing reference to its historical location being Deer Head Spring, a well-studied habitat on the east side of Mica Mountain. Our initial survey attempts failed to locate it at any of the historical or otherwise-known high-elevation spring habitats on Mica Mountain.

In July 2018, we surveyed an upper branch of a northeast-facing drainage and encountered a classic spring habitat that took us completely by surprise. We immediately found *Platanthera limosa* scattered along the muddy banks of the narrow spring course, many in full bloom. We later found a smaller second population a little downstream in a wet area fed by a bedrock seep. We have yet to find it in another drainage.

ROSACEAE - *Cercocarpus breviflorus* (hairy mountain mahogany)

Cercocarpus breviflorus is a large shrub or small tree with small evergreen leaves. Its tubular flowers have persistent styles that curl and look like feathery tails. This was a puzzling target species because it is so common in most of the neighboring Sky Island ranges, having a major presence in many mid-to-high elevation plant communities. The lone historical record from the Rincons was a 1908 Goodding collection that offered no further location details.

We rediscovered it in October 2018 on a two-night backpacking survey exploring the remote northeast side of Mica Mountain, specifically upper branches of Deer Creek. This area is not particularly close to any trails, and slopes are covered in dense manzanita thickets (a result of the 1994 Rincon Fire), making travel extremely challenging. After finally dropping into one of these drainage branches, we quickly found *Cercocarpus breviflorus* scattered in the drainage as well as the slopes above. In September 2019 we made a similar trip again targeting the northeast side of the mountain, this time focusing on upper branches of Tres Pipas Canyon. There we found it growing abundantly over a larger area, often a dominant member of the local plant community as we had seen in other ranges. While there is still much to learn about the distribution of this species in



Cercocarpus breviflorus

the Rincons, it appears to be fairly common but perhaps localized in a manner that coincides with some of the more difficult-to-access portions of the range.

POACEAE - *Festuca sororia* (ravine fescue)

Festuca sororia is a perennial grass with flat leaf blades and a drooping inflorescence, typically blooming in late summer or fall. In southern Arizona, it is restricted to upper elevations of the tallest ranges (Santa Catalinas, Pinalenos, Huachucas, and Chiricahuas). It has never been recorded in Mexico, with the Huachucas currently representing its southern range limit. It had two historical records from the Rincons: an 1891 Nealley collection (“in ravines”) and a 1909 Blumer collection with more helpful location notes (“Spud Rock, north side of cliff, follows late-lying snow”).

Though we had an obvious place to look first, we struggled to develop a good search image, and were often confused by common brome (*Bromus*) species with similar growth forms but larger spikelets. The eventual rediscovery in October 2019 resulted from a focused revisit to Blumer’s historical location with improved grass identification skills and confidence. We found it scattered along the northern base of the outcrop, clearly distinct from the more common brome that grew alongside it. After all this time, it had remained in the exact area that Blumer described, still taking advantage of the extra shade and lingering snow melt that this towering outcrop provides. It is notable that this whole area burned severely in 2003, taking out all the large trees, so the species has persisted in spite of a dramatic habitat shift.

In July 2020, we found a second population at an unmapped north-facing spring in shaded mixed conifer forest. We named it “Manna Grass Spring” for its dominant population of *Glyceria elata* (tall manna grass); *Festuca sororia* was growing sparsely within and around the dense *Glyceria*.

Remaining Target Species

We did not relocate 5 of the 14 target species identified for field surveys: *Melampodium strigosum* (shaggy blackfoot), *Muhlenbergia arenicola* (sand muhly), *Sicyos laciniatus* (cut-leaf bur cucumber), *Symphyotrichum lanceolatum* var. *hesperium* (white panicle aster), and *Vicia leucophaea* (Mogollon Mountain vetch). We suspect that three of them (*Melampodium*, *Muhlenbergia*, and *Sicyos*) may have been originally recorded outside park boundaries, because they



"Manna Grass Spring"

have vague collection labels as well as known affinities for low to mid-elevation habitats. *Symphyotrichum* was collected by Blumer in 1909 at Spud Rock Spring but remains unaccounted for. *Vicia* was also collected by Blumer in 1909, but the precise location is hard to decipher from his collection label (See Appendix D).

Flora additions

While surveying for the “potentially extirpated” target species list, we soon began to encounter species that had never previously been recorded in the Rincon Mountains, so searching for additions to the flora became another element of our project. From 2017-2020, we documented 27 species that are new to the Rincon Mountains flora. At least 22 of these species are native (one, *Rhus ovata*, is of questionable nativity; four others are certainly non-native). Among these native species, seven of the new records represented global range extensions. Our rate of finding new species records decreased slightly over time, with nine in 2017, seven in 2018, five in 2019, and six in 2020.

One addition, *Potentilla albiflora* (Pinaleno cinquefoil) is a species of conservation concern due to its extremely limited known range (also recorded in the Pinalenos, Santa Catalinas, and one spot on the Mogollon Rim). Its trifoliate (three-part) leaves resemble the genus *Fragaria* (strawberries). In bloom, it is easily distinguishable with striking yellow flowers. The misleading species epithet *albiflora* (white flower) was likely based on a pressed

specimen with faded petals (Ertter 2014). In our surveys we observed it primarily on the north side of Mica Mountain, scattered widely in drainages and shaded spots.

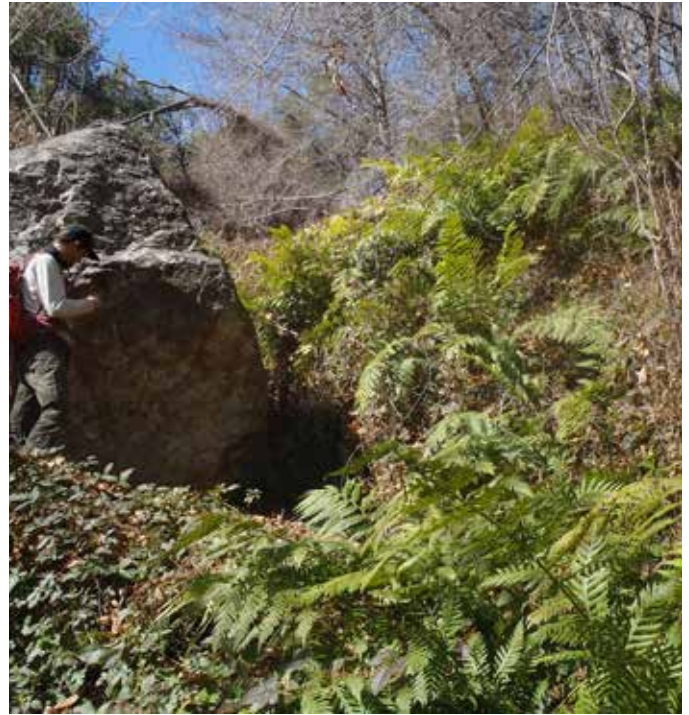
Two other flora additions are particularly notable for being rare in the Madrean Sky Island region. A population of *Woodwardia fimbriata* (giant chain fern) was found at Turkey Creek Spring on the east side of Mica Mountain around 1,524 m (5,000 ft). This spring appears on maps, but not in the correct location. *Woodwardia fimbriata* follows the wet spring course in a lush woodland of oaks and deciduous trees (sycamore, cottonwood, willow, alder). This species, the largest native fern in North America, is widely known along the Pacific coast but has a disjunct and highly localized distribution in Arizona and Sonora.

Even more rare regionally is *Chimaphila umbellata* (pipsissewa), a low-growing rhizomatous perennial with shiny evergreen leaves and clusters of nodding pink flowers. Though widespread in temperate zones all around the Northern Hemisphere, in the Madrean Sky Island region it had only previously been recorded in the Pinalenos and Chiricahuas. We found a very small population on a north-facing bank in upper Chimenea Creek, the same hotspot of montane plant diversity where red osier dogwood (*Cornus sericea* subsp. *sericea*) and thin-leaf alder (*Alnus incana* subsp. *tenuifolia*) were rediscovered. For more detailed information on all the flora additions, refer to Appendix B.

Other plants of interest

We also tracked some additional plants of interest, rare either locally or globally. Two of these species, *Rosa woodsii* (Woods' rose) and *Agrimonia striata* (roadside agrimony), were highlighted by Bowers and McLaughlin (1987) as "moisture-loving, cold-tolerant" on their excluded species list, but we removed them based on reports from a Sonoran Desert Network botanist. We found *Rosa woodsii*, a sprawling shrub with pink flowers, in a few canyons around 1,829 m (6,000 ft), often associated with a spring. We also confirmed its continued presence in the Spud Rock Spring aspen grove, where Blumer collected it in 1909. We only found a single small population of *Agrimonia striata*, a yellow-flowered perennial herb, around the Manning Camp Reservoir, making us somewhat concerned for this species' long-term viability in the Rincons.

Another species appearing in Bowers and McLaughlin's "excluded species" list was *Pennellia tricornuta* (Rincon rockcress), a high-elevation mustard of conservation concern due to its extremely limited global range (just four southeast Arizona ranges). This slender perennial has



Woodwardia fimbriata at Turkey Creek Spring

bell-shaped, cream-colored flowers followed by flattened siliques (elongate seed pods). Bowers and McLaughlin had in fact collected it in 1982 but misidentified it as the similar, typically lower-elevation *Pennellia micrantha*. We found *Pennellia tricornuta* in many scattered high-elevation locations including drainages, trails, and pine forest slopes.

We also found additional populations of *Acer glabrum* var. *neomexicanum* (New Mexico maple), which in the Rincons is apparently restricted to north-facing sites. Bowers and McLaughlin (1987) observed it at one location, the north side of Helen's Dome, and reported it as no longer occurring at Spud Rock, where Blumer collected it in 1909. Our surveys confirmed a continued presence around Helen's Dome and a continued absence around Spud Rock. This classic-looking maple tree has three-part leaves, sometimes fully divided, and can grow very tall under favorable conditions. We found extensive populations in two north-facing canyons on Mica Mountain, one deeply forested and the other fairly exposed from recent fire, and we confirmed a small population on the north side of Rincon Peak that had been photo-documented by Douglas Koppinger in 2017.

Another noteworthy and locally rare species was added to the Rincon flora in 2013 by the Sonoran Desert Network vegetation mapping crew, initially reported as *Erythranthe cardinalis* (scarlet monkeyflower, formerly of the genus *Mimulus*) but reported here as belonging

to a newly described taxon, *Erythranthe cinnabarina* (Arizona big red monkeyflower) (Nesom 2014). *E. cinnabarina* occurs at high elevations of a small number of southeast Arizona Sky Island ranges, closely related but significantly disjunct from *E. cardinalis*, which occurs in California, Oregon, Baja California, and Nevada. Nesom (2014) reports the species in only three ranges, the Santa Catalinas, Pinalenos, and Chiricahuas. The single known Rincon population, occurring abundantly around and downstream of a north-facing spring site, adds a fourth range to the distribution of this stunningly beautiful species that appears to be endemic to the region.

During long canyon surveys that extended into middle elevations, we documented numerous populations of a rare succulent currently proposed for federal listing as a threatened species, *Graptopetalum bartramii* (Patagonia Mountain leatherpetal or Bartram's stonecrop). This species grows in rocky mid-elevation canyon habitats and features a rosette of thick blue-green leaves and star-shaped multicolor blooms in the fall and winter. It appears to reach its northern range limit in the Rincons; it is well-reported in ranges to the south but has never been found in the Santa Catalinas to the northwest. Our surveys suggest that this species is widely scattered around rocky canyons of the Rincons (particularly on the south and east sides of the range) at mid-elevation, not typically abundant but not particularly uncommon.

We also documented a number of rare orchid species. *Tamayorkis porphyrea* (Cochise adder's mouth orchid, formerly genus *Malaxis*) first appears as a very short stem and single oval leaf before sending up a stalk with rows of tiny purple flowers. These flowers, the smallest of any Arizona or New Mexico orchid (Coleman 2002), are stunning in form and color, especially when viewed under magnification. It was not recorded by Bowers and McLaughlin (1987) but was collected in the Rincons shortly thereafter by an NPS fire effects monitoring crew in 1990. Also known in New Mexico and northern Mexico, this species is considered rare in Arizona given its limited distribution and few official records. We found it occasionally in pine forest habitats near the summit of Mica Mountain, typically around drainages or trails.

Hexalectris arizonica (Arizona crested coralroot) is a fully mycoheterotrophic orchid, a parasite that obtains all its nutrients from a fungal host. This oak woodland species produces a leafless pinkish-brown stem topped with tan, purple-veined flowers. Though striking when



North-facing spring site with *Erythranthe cinnabarina*



Platanthera limosa (photo courtesy of Nic Perkins)



Hexalectris arizonica

open, these flowers are often found closed or only partially open due to the species' apparent autogamous (self-pollinating) reproduction strategy. This species is considered vulnerable throughout its range (Arizona, New Mexico, Texas, northern Mexico) because of its tendency to occur as widely scattered individuals, rarely forming even locally abundant populations (Coleman 2002). Bowers and McLaughlin were first to report it in the Rincons, documenting a single locality. Through extensive drainage surveys, we found four widely scattered additional populations, all in shaded oak woodland habitats.

Finally, we followed up on the Bowers and McLaughlin (1987) collection of *Corallorhiza striata* var. *vreelandii* (striped coral root), another fully mycoheterotrophic orchid known regionally in high-elevation mixed conifer forests. As with *Hexalectris arizonica*, they were the first to report it in the Rincons, documenting a single population



Corallorhiza striata var. *vreelandii* (photo courtesy of Nic Perkins)

on the north side of Mica Mountain. This orchid has a thickened leafless stem and flowers appearing in early summer with distinct purple veins, giving them a “striped” appearance. Verrier (2017) studied the habitat preferences of *Corallorhiza* species in the neighboring Santa Catalina Mountains and reported *C. striata* to have a frequent association with *Abies concolor* (white fir), potentially linked by a common mycorrhizal fungal partner. This clue led us to a particularly rich pocket of mixed conifer forest with a heavy white fir presence that was surrounded by areas severely burned by the 2003 Helen's 2 Fire. There we found multiple small populations of the orchid, just past flowering but with distinctive banana yellow fruits, an encouraging rediscovery of a record from the more recent past.

For more detailed information on these additional species of interest, refer to Appendix C.

Discussion

Implications for Rincon Mountains flora

Plant surveys of specific areas like the Rincon Mountains have value far beyond the mere cataloging of species. Floristic surveys provide data for evaluating how the environment is changing and create opportunities for research on species and communities (Funk 2006), while contributing to regional, national, and continental understanding of plant diversity (Knapp et al. 2021). In national parks and other protected areas, floristic surveys provide a baseline for understanding the changing ecological health of areas that are set aside specifically to protect biological diversity (Drayton and Primack 1996, MacKenzie et al. 2019).

Our revisit of Bowers and McLaughlin's Rincon Mountains flora builds upon their work, including their concerns about loss of montane species. Through research, we were able to update and shed additional light on each of the 41 excluded species listed in Bowers and McLaughlin (1987). For the purposes of this study on native montane plant diversity, we removed 27 of the 41 species from consideration, either because they were already accounted for (recent records, taxonomic updates, previous misidentifications) or irrelevant to our study (non-native status, low-elevation habitat). In our field searches, we rediscovered nine montane species that had not been documented in the Rincons for more than a century. In addition, we documented 22 native species not previously known for the range and mapped distribution of sensitive species that will be useful for long-term monitoring. In further work, we hope to publish an updated flora for the Rincons, a regionally important Sky Island range that is experiencing significant changes in both desert (Winkler et al. 2019) and forest ecosystems (Baisan and Swetnam 1990, Iniguez et al. 2016).

The challenge of extirpated species

Our study was inspired by the work of Janice Emily Bowers, an accomplished botanist whose interests have ranged from searching for plants in remote mountain ranges to the interplay between botany and history. In addition to many scientific papers, Bowers has written non-fiction

books about Sonoran Desert plants, desert gardens, and the influential early 20th-century botanist Forrest Shreve. We initiated our research after reading Bowers' personal account of creating a flora for the Rincon Mountains, *The Mountain Next Door* (Bowers 1991). In this book, Bowers discusses her search for plants, such as *Rosa woodsii* (wild rose), that had been collected in 1909 by botanist Jacob Blumer. Bowers was unable to find this and several other species that Blumer and other early botanists had documented for the range:

"Search as I might, though, I never did find the wild rose or red osier dogwood, and I finally decided that both must have died out, along with four other moisture-loving species Blumer collected that I couldn't relocate. All six doubtless depended on the winter snowpack to tide them over for the arid foresummer. Several decades-long droughts since Blumer's day (including a series of exceptionally dry winters) were probably their demise."

"So floras change before our eyes and behind our backs..." Bowers concluded, likening the Sky Island mountain ranges to floristic experiments in the making (Bowers 1991).

Because of the profound effects that climate change is expected to have on montane plants (Kim et al. 2018, Sudden et al. 2018), we felt that Bowers' unsuccessful efforts to find these species was important for interpretation and management at Saguaro National Park. The park was established in 1933 (originally as a national monument) specifically to preserve, study, and interpret Sonoran Desert plants (U.S. Presidential Proclamation No. 2032, March 1, 1933). Like other parks, it has a mandate to protect its natural resources for future generations (National Park Service Organic Act, Aug. 25, 1916). Losing species in parks, while perhaps inevitable under climate change scenarios, nevertheless has profound meaning in the sense that extirpation represents a failure of humans to protect the natural world even when we have given it the highest possible priority.

At the same time, we were aware that not finding a rare plant species, even after targeted searches, does not necessarily mean that it is locally extinct. The conservation biology literature includes many cases where species believed to be lost were rediscovered with further searching. For example, Berger (2008a) announced that the white-tailed jackrabbit was locally extinct in Yellowstone National Park, then followed up with a letter acknowledging that park staff had

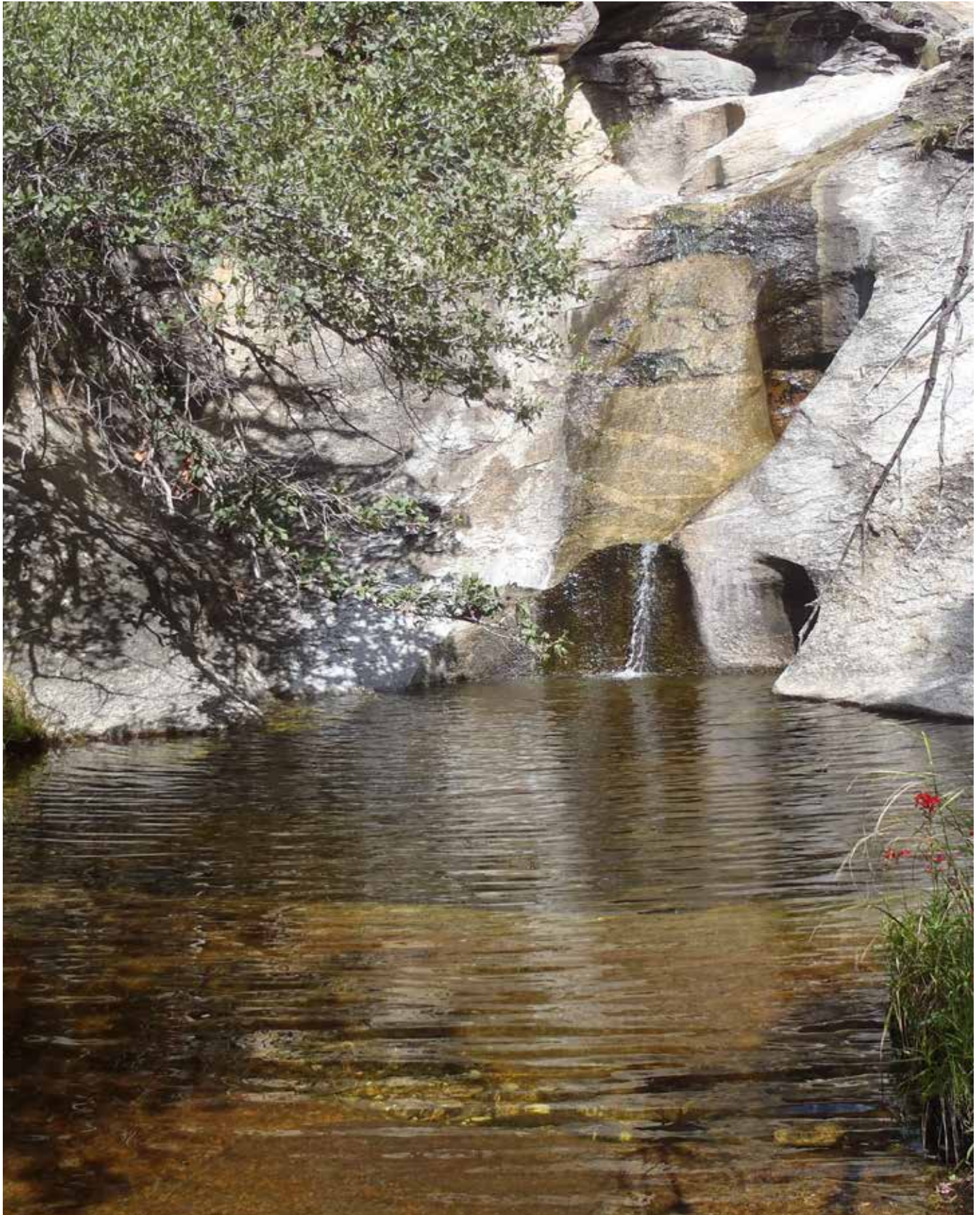
recently photographed it (Berger 2008b). In a classic paper in the journal *Conservation Biology*, Drayton and Primack (1996) repeated a botanical survey of the Middlesex Fells Reservation in Massachusetts from the 1890s, and in the century since reported both a large increase in invasive plants and a dramatic loss of 155 native plant species. Yet more recent botanical surveys in the Fells, while confirming the increase in non-natives, have relocated most of the plant species that Drayton and Primack believed were extirpated (Hamlin 2012, Hamlin and Kittredge 2014, 2016).

Similarly, our results are a good reminder that absence of evidence of species presence is not the same as absence of the species. We suspect that Bowers and McLaughlin were simply not lucky enough to find their way up the same section of upper Chimenea Creek that Blumer had wandered up on the day he found red osier dogwood and thinleaf alder. In common with the recent studies in the Middlesex Fells, we had far greater human resources than Bowers and a longer period of time in which to explore. From our point of view, Bowers (1991, and pers. comm. 2021) presented a challenge for future botanists, one that we were grateful had been offered.

Importance of partnerships in conservation biology

Our study provides further evidence that conservation biology is well served by partnerships between dedicated individual naturalists and established organizations. Using data to study ecological change requires separating what we are interested in (change in status) from system noise due to human error and changes in taxonomy. We were able to resolve complex collection records and taxonomic questions with the support of the University of Arizona Herbarium botanical staff and volunteers. Museum collections are essential for studies of environmental change (Pyke and Ehrlich 2010), and our study, like so many others, would not have been possible without this help.

Similarly, our fieldwork was supported by the Friends of Saguaro National Park, other internship programs, and the National Park Service. Community member donations to the Friends supported the interns who collected much of the field data, and the park provided logistical and safety support, mule packing, and assistance from enthusiastic backcountry rangers. This support was essential in maximizing the geographic breadth and efficiency of our field surveys. In turn, we reported our findings through both organizations' social media platforms, newsletters, and websites.



Chimenea Canyon bedrock pool

Monitoring and protecting plants in wilderness areas

Conducting floristic surveys in designated wilderness areas, even relatively small areas that are near urban areas, is challenging. Wilderness is remote by definition, which makes conducting plant surveys difficult, and legal and philosophical issues can make gathering information on native plants challenging. Saguaro National Park is 78% designated federal wilderness, and the Rincons are the only roadless Sky Island in the southwestern United States. Indeed, the higher-elevation areas of the range have never been accessible to motor vehicles, do not have private in-holdings, have not been grazed by cattle in more than a half-century, and have a history of limited fire suppression.

While wilderness designation makes for much longer hikes and more challenging field work than in nearby mountain ranges, these challenges are offset by the benefits to ecological communities. A pleasant surprise of our survey efforts was the relative paucity of non-native plants at high elevations, especially since invasive grasses such as buffelgrass are so abundant at low elevations (Elkind et al. 2019). Two of the more problematic invasive species threats, *Bromus tectorum* (cheatgrass) and *Marrubium vulgare* (horehound), appear to be quite limited in distribution and declining due to NPS control efforts. In contrast to the nearby Santa Catalina Mountains, where non-natives are abundant along high-elevation roadsides,

the reduced number of non-natives in the Rincon high country is likely related to the lack of roads and much lower visitation.

Our study was supported by an expansive view of wilderness that places focus on preserving not only the untrammelled and undeveloped character of wilderness but also the natural character identified as of importance in the 1964 Wilderness Act (Public Law 88-577, September 3, 1964). Protecting nature and native species in wilderness can only be accomplished through promoting scientific exploration and monitoring, and our work benefited from Saguaro National Park's holistic approach to wilderness management. Too often, wilderness has been used as a reason not to conduct science in wilderness areas (Parsons 2000), yet science is essential for the basic understanding required to protect the natural character of areas like the Saguaro Wilderness. Sensitivity to wilderness concerns led us to be thoughtful and minimal in our collection of specimens, using photo vouchers as an alternative in the case of small or otherwise vulnerable populations.

Biodiversity hotspots and the importance of ecological refugia

Where are the hotspots of biodiversity? Our paper demonstrates that in the Rincons, as elsewhere in arid regions, high-elevation biodiversity is concentrated in more



Bouldery landscape east of Italian Spring Trail

mesic areas, often associated with north-facing slopes and/or springs. Current research (McLaughlin et al. 2017, Cartwright et al. 2020) highlights the regional importance of these microhabitats as climate refugia, places where species intolerant of changing climatic conditions can persist locally despite range-wide or regional population declines. Some of these springs and mesic sites have likely already served as refugia historically, as indicated by the presence of rare relict species with localized populations. Examples in the Rincons include the portion of upper Chimenea Creek where three rare montane species were documented despite a lack of recent or historical records anywhere else in the range. This mesic area possesses a special combination of high elevation, shaded forest canopy, abundant leaf litter, and extra moisture both from a perennial bedrock seep as well as runoff from the summit of Mica Mountain. Another example is a newly recorded spring on the north side of Mica Mountain. Two species have been documented around the spring that are not currently known anywhere else in the range, *Erythranthe cinnabarina* (Arizona big red monkeyflower) and *Epilobium ciliatum* (fringed willowherb). The special combination of high elevation, northern aspect, and plentiful year-round water allows these wetland species to thrive, as well as other locally rare plants like *Actaea rubra* (red baneberry) and *Rubus idaeus* subsp. *strigosus* (grayleaf red raspberry).

Further, the Rincons sit at a rich biogeographic crossroads where different floristic elements come together. Such crossroads areas have been identified as strategic priorities for biodiversity conservation given their high rates of species richness within relatively small areas (Spector 2002). This makes the entire range somewhat of a biodiversity hotspot, with species from many floristic regions persisting at the extremes of their global distributions. Janice Bowers and Steven McLaughlin studied these floristic regions extensively throughout their careers, and they included a detailed analysis of the Rincons' chief floristic affinities in their 1987 flora. High-elevation springs and north-facing microhabitats allow for species mostly known from more northern floristic regions like the Rocky Mountains and Mogollon Rim. Among our findings, *Alnus incana* subsp. *tenuifolia* (thinleaf alder) and *Asplenium septentrionale* (forked spleenwort, a fern of high-elevation rock outcrops) are examples of species at an apparent southern range limit in the Rincons. The Rincons are also at an interesting east-west nexus with the west side foothills at the very eastern edge of the Sonoran Desert ecoregion (Griffith et al. 2014). The east side foothills are quite different, marked by rolling grasslands rather than desert, as well as a floristic transition towards more

Chihuahuan Desert influence. Blumer (1910) even noted a sharp contrast in the respective high-elevation plant communities, both in terms of composition and structure, though his causal speculation focused on topography and climate rather than biogeography. On the ground, the east side of the Rincons certainly feels different than other parts of the range: denser vegetation, a higher concentration of springs, more mesic soils, and certain characteristic plant species not found elsewhere.

Bowers and McLaughlin (1987) suggest that floristic regions to the south have the strongest affinities with the Rincon flora. These include the Sonoran and Chihuahuan Deserts, the Sierra Madre Occidental, as well as the neotropical flora of Mexico. Though present range-wide, these influences seem to be most emphasized in the "rincón" (inside corner) portion where the Rincons' three major ridges surround the southwest-facing Rincon Valley. Bowers (1984) discusses this local trend, highlighting low-to-mid elevation species like *Lysiloma watsonii* (feather tree) and *Mariosousa millefolia* (Santa Rita acacia) that appear to reach their northern distribution limits in this area. She posits that this insulated "rincón" may be just warm and well-watered enough to provide refuge for certain frost-sensitive subtropical species. Our study provides additional evidence that many species reach their apparent northern limits in the Rincon Mountains, including flora additions *Crusea diversifolia* (mountain saucerflower) and *Valeriana sorbifolia* (pineland valerian). The importance of the Rincons as a biogeographical nexus has likely been underestimated due to its remoteness, which has resulted in spotty collection histories. Many of these southerly species have long been assumed to reach no farther north than the Santa Rita Mountains, but are now known to occur in the Rincons, a trend predicted to continue with further survey efforts into more remote portions of the range.



Crusea diversifolia

Long-term monitoring of climate change effects on plant communities

High-elevation moisture-loving plants may be particularly vulnerable to environmental change related to warming temperatures (Lesica 2014). A continuation or worsening of the warming and drying trends already observed in recent decades could spell danger for plants that rely on the coolest and/or wettest extremes of available mountain habitat. In the Madrean Sky Islands, decreases in total montane habitat as well as increased isolation of these habitats are predicted outcomes of climate change, though refugia can help mitigate extirpation risk (Yanahan and Moore 2019). Our study provides a degree of hope in that, since most of the target plant species have not yet been lost in the Rincons, it also provides a basis for long-term monitoring. We have already established monitoring protocols for the park's localized populations of *Platanthera limosa* (Thurber's bog orchid) and *Chimaphila umbellata* (pipsissewa) and intend to set up more for other seemingly vulnerable high-elevation populations such as *Agrimonia striata* (roadside agrimony) and *Alnus incana* subsp. *tenuifolia* (thinleaf alder). With long-term monitoring, land managers can learn of population declines before a species is lost entirely from the range. This crucial data will allow the park to report on local climate change effects to the public, as well as inform potential interventions such as the use of prescribed fire to protect keystone habitats.



Chimaphila umbellata (photo courtesy of Nicole Gonzalez)

Suggestions for further research

Our study reveals that even though the Rincons are largely within a national park, have a rich history of plant research, and lie on the edge of an urban area of over 1 million people, they are still relatively unstudied. This was clearly borne out by the many unreported plant species and unmapped springs we encountered during off-trail explorations of park lands. This phenomenon of under-reported biodiversity is not unique to the Rincons either, as recent vegetation fieldwork in Grand Canyon National Park resulted in 21 new species for the park's flora (Christie et al. 2011). In the Rincons, there are still huge areas we

have not surveyed extensively that also show minimal, if any, collection history. Most of these areas are outside the park and managed by Coronado National Forest.

Rincon Peak in particular is deserving of much more attention from botanists. As the southernmost of the Rincons' three major peaks, it would figure to be particularly promising for documenting range extensions of species known to the south. The entire north side of Mica Mountain, particularly outside park boundaries, is another vast and promising landscape that includes an extensive boulder field reminiscent of the Dragoon Mountains. The northeast face of Mica Mountain, extremely far from major roads and trails, may be the most remote and under-studied area of all.

There are of course obvious challenges to conducting botanical field work in these areas. Though roadlessness is a given throughout the Rincons, these areas are also mostly free of established trails. Significant off-trail backpacking is often required to do any kind of thorough plant surveying. Terrain throughout the range tends to be rugged, but Rincon Peak merits even greater caution as its east and west faces are particularly steep.

Recent exploratory ventures into these areas by one of our study authors (Beckman) and other local researchers have already yielded a number of additional new species records for the Rincons (to be reported in a future checklist or flora). More frequent survey efforts into these extremely under-studied areas would likely expand our knowledge of the Rincon flora at a significant rate. There is enormous potential for publishing a significantly updated Rincon Mountains flora that would incorporate the results of this study, future findings, and other follow-up work.

Conclusion

Through four years of extensive survey effort, we confirmed the continued presence of 9 species that had not been recorded in the Rincon Mountains in over 100 years. Some of these species, moisture-loving high-elevation specialists, had been considered likely extirpated (locally extinct) due to previous unsuccessful searches.

Potential extirpations are incredibly important to track, particularly in protected wilderness areas that are meant to protect biodiversity and natural history. However, definitive conclusions based on negative evidence can be problematic,

so extensive and targeted follow-up is important for painting the clearest possible picture of habitat change and species loss. In the present and future context of rapid anthropogenic climate change, these efforts are increasingly critical. Collaboration between land management agencies, conservation organizations, research institutions, individual scientists, and volunteers represents the best hope to complete such ambitious undertakings. Projects such as ours can also produce unexpected yet similarly crucial results, such as the documentation of locally rare species that had never previously been recorded in the area.

Though our study offers many encouraging findings, we were not successful in locating all target species. In addition, others seem to only be persisting in refugia habitats as small, localized populations. Rare montane species, as well as high-elevation plant communities in general, are at obvious risk from climate change. In the Madrean Sky Island region, there is much at stake, as this global biodiversity hotspot provides a biological linkage between two of the continent's major mountain systems and contains an array of local endemic species.

Continued surveying for rare habitats and species informs long-term monitoring and conservation priorities that are essential for conservation biologists and wilderness managers looking to ensure that these habitats and species persist into the future. Small, near-urban wilderness areas like the Rincon Mountains can hold surprising biodiversity and, despite a rich history of plant research, continue to provide opportunities for botanical discovery.

Acknowledgements

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Finally, the authors would like to acknowledge that the Rincon Mountains are ancestral lands of many native people, including the O'odham, Apache, and individual present-day tribes. Although the National Park Service and U.S. Forest Service today manage most of the range as wilderness, the Rincons have been a working landscape for thousands of years. The O'odham name for the range is Cew Do'ag (Zepeda 2008).

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APPENDIX A

REDISCOVERED SPECIES, 2017-2020

* = SEINet photo voucher only

Finding years refer to distinct populations, not revisits of a single population

All collections from this study housed at University of Arizona Herbarium (ARIZ)

Herbarium codes referenced:

ARIZ = University of Arizona

F = Field Museum of Natural History

GH = Harvard University

MO = Missouri Botanical Garden

NY = New York Botanical Garden

US = Smithsonian Institution

ANACARDIACEAE - Sumac Family

Rhus glabra L.

Smooth sumac

Reported for east side of Rincons in Blumer (1910). East side creek branches, springs, and areas of shallow groundwater (2017-2018, 2020) (*Beckman s.n.*).

ASTERACEAE - Sunflower Family

Hymenoxys quinquesquamata Rydb.

Rincon rubberweed

1891 collection (*Nealley 208*, US), “Rincon Mountains”. North-facing trail in burned area (2017-2018) and burned slopes among manzanita (2019-2020) (*Beckman 29*).

BETULACEAE - Birch Family

Alnus incana subsp. *tenuifolia* [Nutt.] Breitung

Thinleaf alder, mountain alder

1909 collections, “Manning Trail” (*Blumer 3420*, ARIZ) and “Manning Camp (falls)” (*Blumer 3420*, ARIZ, F, GH). Bedrock creek bottom in pine forest (2017) (*Beckman s.n.*).

CORNACEAE - Dogwood Family

Cornus sericea L. subsp. *sericea*

Red osier dogwood

1909 collection (*Blumer 3466*, ARIZ), “brook, Manning Camp”. Shaded creek bottom in pine forest (2017) (*Hetherington s.n.*).

ORCHIDACEAE - Orchid Family

Platanthera limosa Lindl.*

Thurber’s bog orchid

1891 collection (*Nealley 78*, NY), “Rincon Mountains”. Northeast-facing spring and seep in burned area with patchy mixed conifer forest (2018) (*Beckman 2018-07-26*, 2018-08-07; SEINet).

POACEAE - Grass Family

Festuca sororia Piper

Ravine fescue

1891 collection (*Nealley 177*, GH, MO, NY), “in ravines”; 1909 collection (*Blumer 3443*, ARIZ), “Spud Rock, north side of cliff”. North-facing base of large rock outcrop (2019); north-facing spring site in mixed conifer forest (2020) (*Beckman 73*, 100).

Melica porteri Scribn.

Porter’s melicgrass

1909 collections, “Spud Rock, north side of cliff” (*Blumer 3444*, MO) and “Spud Rock, north rock shelves” (*Blumer 3444*, ARIZ). Shaded north-facing slopes and north-facing drainages (2017-2020) (*Beckman s.n.*).



Cornus sericea subsp. *sericea* (photo courtesy of Drew Jackson)

Muhlenbergia ramulosa (Kunth) Swallen

Green muhly, Ponderosa muhly

1909 collections, “Manning Camp, gravelly knoll” (*Blumer 3365*, ARIZ) and “Manning Camp, bare soil” (*Blumer 3365*, MO). Gravelly soils, high elevation disturbed areas and creek banks (2017) (*Beckman s.n.*, *s.n.*).

ROSACEAE - Rose Family

Cercocarpus breviflorus A. Gray

Hairy mountain mahogany

1908 collection (*Goodding 30*, ARIZ), “Rincon Mountains”. Widespread on northeast side of Mica Mountain, mid-to-high elevations (2018-2020) (*Beckman 35*).



Hymenoxys quinquesquamata
(photo courtesy of Drew Jackson)



Festuca sororia



Muhlenbergia ramulosa

APPENDIX B

Additions To The Rincon Mountains Flora, 2017-2020

* = SEINet photo voucher only

= Not formally documented in this study (iNaturalist or other photo observations)

Finding years refer to distinct populations, not revisits of a single population

All collections from this study housed at University of Arizona Herbarium (ARIZ)

ANACARDIACEAE - Sumac Family

Rhus ovata S. Watson - *Likely introduced*

Sugar sumac

Exposed hillside, mid-elevation (2019) (*Beckman 54*).
Native to central Arizona, cultivated locally.

ARALIACEAE - Ginseng Family

Aralia racemosa subsp. *bicrenata*

(Wootton & Standl.) S.L. Welsh & N.D. Atwood

American spikenard

Mesic areas in north-facing drainages (2017-2018, 2020) (*Beckman s.n.*).

ASPLENIACEAE - Spleenwort Family

Asplenium resiliens Kunze*

Black-stem spleenwort

Bedrock crevices in east-facing drainage (2018, 2020) (*Beckman 2020-06-29*, SEINet).

Asplenium septentrionale (L.) Hoffm.

Forked spleenwort

Crevices of high elevation rock outcrops (2020) (*Beckman 99*). Southern range extension.

ASTERACEAE - Sunflower Family

Brickellia floribunda A. Gray#

Chihuahuan brickellbush

Exposed north-facing drainage (2020) (*Beckman 2020-09-15*, iNaturalist). Vegetative specimen, needs confirmation.

Brickellia parvula A. Gray

Mt. Davis brickellbush

Rocky areas of east-facing drainage (2020) (*Beckman 116*, 117).

Lactuca graminifolia Michx.*

Grass-leaf lettuce

Exposed north-facing drainage (2018) (*Beckman 2018-06-24*, SEINet).

Tragopogon dubius Scop.* - *Introduced*

Yellow salsify, western goat's beard

High elevation north-facing slope in burned area (2017) (*Beckman 2018-10-28*, SEINet).

BLECHNACEAE - Chain Fern Family

Woodwardia fimbriata Sm.

Giant chain fern

Mid-elevation spring site in riparian woodland (2018) (*Beckman s.n.*). Rare in southern Arizona.

CAPRIFOLIACEAE - Honeysuckle Family***Valeriana sorbifolia* Kunth**

Pineland valerian

Wet bedrock areas in canyons (2018, 2020) (*Beckman 34*).

Northern range extension.

DRYOPTERIDACEAE - Wood Fern Family***Phanerophlebia auriculata* Underw.**

Eared vein fern

Shaded crevices in bedrock canyons (2017-2018) (*Beckman 41*).

EUPHORBIACEAE - Spurge Family***Jatropha macrorhiza* Benth.**

Ragged nettle-spurge

Dry mid-elevation hillside (2019) (*Beckman 69*). Northern range extension.

ERICACEAE - Heath Family***Chimaphila umbellata* (L.) W. P. C. Barton**

Pipsissewa, western prince's pine

North-facing mesic creek bank at high elevation (2019)

(*Beckman 63*). Rare in southern Arizona.

FABACEAE - Bean Family***Astragalus cobrensis* var. *cobrensis* A. Gray**

Copper mine milkvetch

North-facing drainage in pine-oak woodland (2019)

(*Beckman 52*). Southwestern range extension.

LAMIACEAE - Mint Family***Mentha spicata* L. - Introduced**

Spearmint

East-facing opening in pine-oak forest at historical cabin site (2020) (*Beckman 109*).

ONAGRACEAE - Evening Primrose Family***Epilobium ciliatum* Raf.**

Fringed willowherb

North-facing spring-fed stream course at high elevation

(2017) (*Beckman s.n.*).

ORCHIDACEAE - Orchid Family***Dichromanthus michuacanus* (La Llave & Lex.) Salazar & Soto Arenas***

Michoacán lady orchid

Various habitats at mid-to-high elevation (2017-2020)

(*Beckman 2017-10-12, 2018-09-26*; SEINet).

OROBANCHACEAE - Broomrape Family***Castilleja attenuata* (A. Gray) Chuang & Heckard**

Valley tassels, attenuate paintbrush

Saturated soil mat in mid-elevation bedrock canyon (2019);

marshy areas near cattle tanks on U.S. Forest Service land

(2020) (*Beckman 53*). Southern range extension.

POACEAE - Grass Family***Vulpia myuros* (L.) C. C. Gmel. - Introduced**

Rat-tail fescue

Mossy soil mat in north-facing bedrock canyon (2019)

(*Beckman 60*).

PTERIDACEAE - Maidenhair Fern Family***Myriopteris tomentosa* (Link) Fée**

Woolly lipfern

East-facing drainages at mid-to-high elevation (2018, 2020)

(*Beckman 113*).

RANUNCULACEAE - Buttercup Family***Actaea rubra* (Aiton) Willd.**

Red baneberry

North-facing spring site and sheltered spot in mesic creek bed,

both high elevation (2017) (*Beckman s.n.*).

ROSACEAE - Rose Family

Fragaria virginiana subsp. *glauca* (S. Watson) Staudt
Virginia strawberry
1983 collection (*Bowers R-1213*, ARIZ), “occasional in deep shade in mixed conifer forest”, but misidentified as *F. vesca* subsp. *bracteata* (now not known to occur in the Rincons). Banks and floodplain of mesic high elevation creek in pine forest (2018) (*Beckman 61*).

Potentilla albiflora L.O. Williams
Pinaleno cinquefoil
2001 collection by Saguaro NP Fire Effects Monitoring but misidentified as *P. glandulosa*. High elevation drainages, mostly north-facing (2017-2020) (*Beckman s.n.*). Globally rare species, southern range extension.

Prunus emarginata (Douglas) Eaton
Bitter cherry
North-facing drainages (2018-2019) (*Beckman 28, 58*).

Rubus idaeus subsp. *strigosus* (Michx.) Focke
Grayleaf red raspberry
Spring site and sheltered drainage, both high elevation and north-facing (2017, 2020) (*Beckman s.n.*).

RUBIACEAE - Madder Family

Crusea diversifolia (Kunth) W.A. Anderson
Mountain saucerflower
Soil mats in south-facing bedrock canyon (2020) (*Beckman 108*). Northern range extension.

ULMACEAE - Elm Family

Ulmus pumila L. - Introduced
Siberian elm
Mesic area in north-facing drainage (2017) (*Beckman s.n.*).



Actaea rubra



Asplenium resiliens



Asplenium septentrionale



Astragalus cobrensis var. *cobrensis*



Brickellia parvula



Epilobium ciliatum



Dichromanthus michuacanus
(photo courtesy of Tony Palmer)



Rhus ovata

APPENDIX C

Other Rare Plants of Interest, 2017-2020

* = SEINet photo voucher only

= Not formally documented in this study (iNaturalist or other photo observations)

Finding years refer to distinct populations, not revisits of a single population

All collections made for this study housed at University of Arizona Herbarium (ARIZ)

BRASSICACEAE - Mustard Family

Pennellia tricornuta (Rollins) R.A. Price, C.D. Bailey & Al-Shehbaz
Rincon Mountain rockcress
1982 collection (*Bowers R-266*, ARIZ), “North Slope Trail”. Scattered at high elevation: trails, drainages, rocky slopes (2017-2020) (*Beckman s.n.*). Regional endemic: also known in Santa Ritas, Huachucas, and Chiricahuas.

CRASSULACEAE - Stonecrop Family***Graptopetalum bartramii* Rose#**

Patagonia Mountain leatherpetal

1982 collection (*Bowers R-870*, ARIZ), “shallow soil on bedrock outcrops”; 2001 collection (*West 1502*, ARIZ). Scattered in bedrock drainages, mostly mid-elevation (2018-2020). Photo-vouchered findings reported to U.S. Fish and Wildlife Service and Arizona Game and Fish Department.

ORCHIDACEAE - Orchid Family***Corallorhiza striata* var. *vreelandii* (Rydb.) L.O. Williams***

Striped coralroot

1983 collection (*Bowers R-1212*, ARIZ), “mixed conifer forest”. High elevation north-facing mixed conifer forest (2020) (*Beckman 2020-07-11*, SEINet, *Perkins 2021-05-28*, SEINet).

Hexalectris arizonica* (S. Watson) A.H. Kennedy & L.E. Watson

Arizona crested coralroot

1982 collection (*Bowers 435-R*, ARIZ), “pine-oak woodland”. Mid-elevation oak woodlands, usually near a drainage (2018-2020) (*Beckman 2018-06-21*, *2020-07-13*, SEINet).

Tamayorkis porphyrea* (Ridl.) Salazar & Soto Arenas - formerly genus *Malaxis

Cochise adder’s mouth orchid

1990 collection by Saguaro NP Fire Effects Monitoring (as *Malaxis ehrenbergii*). High elevation trails and drainages in pine forest (2017-2019) (*Palmer s.n.*).



Tamayorkis porphyrea (photo courtesy of Tony Palmer)

PHRYMACEAE - Lopseed Family***Erythranthe cinnabarina* G.L. Nesom#**

Arizona big red monkeyflower

2013 collection (*Galvin 2013-06-22*, ARIZ) as *Mimulus cardinalis*, “riparian woodland in a north-facing drainage”. Same vicinity, north-facing spring site and downstream area (2017) (*Beckman 2017-07-09*, iNaturalist). Recently described regional endemic: also known in Santa Catalinas, Pinalenos, and Chiricahuas.

ROSACEAE - Rose Family***Agrimonia striata* Michx.#**

Roadside agrimony

1909 collection (*Blumer 3384*, ARIZ), “Manning Camp, willow copse”. High elevation wet meadow (2017), same vicinity as Blumer (*Beckman 2017-08-04*, iNaturalist).

***Rosa woodsii* Lindl.**

Woods’ rose

1909 collections, “Spud Ranch [Spud Rock Spring area], aspen grove” (*Blumer 3425*, ARIZ) and “Spud Ranch” (*Blumer s.n.*, ARIZ). Mid elevation canyons, often around springs (2018-2020), Spud Rock Spring aspen grove (2021-confirmed just before publication) (*Beckman 74, 114, Gonzalez 1*). All collections (historical and recent) appear to be subsp. *arizonica*, though more follow-up is needed.

SAPINDACEAE - Soapberry Family***Acer glabrum* var. *neomexicanum* (Greene) Kearney & Peebles**

New Mexico maple

1909 collection (*Blumer 3441*, ARIZ), “Spud Rock, north side of cliffs”; 1983 collection (*Bowers R-1217*, ARIZ), “Helen’s Dome, north base of cliff”. High elevation north-facing drainages and sheltered sites (2017-2018, 2020) (*Beckman s.n.*).



Rosa woodsii (photo courtesy of Mary Owen)



Jatropha macrorrhiza (photo courtesy of Nicole Gonzalez)

Appendix D: Bowers and McLaughlin (1987) Excluded Species List – Annotated and Updated (B&M = Bowers & McLaughlin)

Family	Scientific Name [As appearing in B&M and now]	Common Name	Field Target?	Historical Record	Update and Comments [Codes indicating primary reason a species was left off our field target list: NN (non-native), LE (low elevation record), TM (taxonomic change or misidentification), KP (unsubstantiated report in Kearney & Peebles), RR (recent records since 1987)]
Acanthaceae	<i>Elytraria imbricata</i> (Vahl) Pers.	Purple scalystem	No	Collected 1913 by Thornber, “foresters cabin near Vail”	Collected in 2002 (Quinn) and 2019 (Beckman). Low elevation species but does extend into mountains. Rincons appear to be northern range limit. (RR)
Anacardiaceae	<i>Rhus glabra</i> L.	Smooth sumac	Yes	Cited in Blumer (1910), east side	FOUND in 2017. Collected in 2017 (Beckman & O’Brien).
Apiaceae	<i>Cymopterus multinervatus</i> (Coult. & Rose) Tidestrom	Purplenerve springparsley	No	Collected 1960 by Goodding, “east side...flats and mesas.”	Collected in 1998 (Schmidt) and 2001 (McLaughlin) along Mescal/Happy Valley Rd on east side. Low elevation species. (RR)
Asteraceae	<i>Aster coerulescens</i> DC. – redetermined as <i>Symphyotrichum lanceolatum</i> var. <i>hesperium</i> (A. Gray) G.L. Nesom	White panicle aster	Yes	Collected 1909 as <i>Aster hesperius</i> Gray by Blumer, “Spud Ranch” (Spud Rock Spring area)	Still not found. This species has undergone many taxonomic changes. A similar but clearly distinct species, <i>S. falcatum</i> var. <i>commutatum</i> (Torr. & A. Gray) G.L. Nesom (white prairie aster), has been continually documented at Spud Rock Spring from 1909 to the present.
	<i>Chaenactis carphoclinia</i> A. Gray	Pebble pincushion	No	Collected 1905 by Thornber, “foothills, Rincon Mountains”	Low desert species, historical record presumably not from study area. Collected in 2016 (Fonseca) in Cienega Creek Natural Preserve. (LE)
	<i>Conyza sophiifolia</i> H.B.K. – now <i>Laennecia sophiifolia</i> (Kunth) G.L. Nesom	Leafy marshtail	No	Collected 1909 by Blumer, “Spud Ranch” (Spud Rock Spring area)	Collected in 2000 and 2003 (Saguaro NP Fire Effects). Collected in 2018 (Beckman & Goraj); observed in other mid to high elevation drainages. (RR)
	<i>Hieracium lemmonii</i> A. Gray – now <i>H. crepidispermum</i> Fries	Lemmon’s hawkweed	No	Collected 1909 by Blumer, “Anvil Rock” (Man Head)	Collected in 1998 (Saguaro NP Fire Effects) and 2017 (Palmer). Observed extensively in summer 2017 (trails and slopes all over Mica Mountain). (RR)
	<i>Hymenoxys quinquesquamata</i> Rydb.	Rincon rubberweed	Yes	Collected 1891 by Nealley, “Rincon Mountains”	FOUND in 2017. Collected in 2018 (Beckman & Cardenas).
	<i>Melampodium strigosum</i> Stuessy	Shaggy blackfoot	Yes	Collected 1907 by Goodding, “Rincon Mountains”	Still not found. Mid-elevation species well-documented to the south and east, so Rincon populations could likely be outside park boundaries.

	<i>Solidago canadensis</i> var. <i>scabra</i> Torr. & A. Gray – now <i>S. altissima</i> subsp. <i>altissima</i> L.	Late goldenrod; Canada goldenrod	No	“Collected” 1909 (as <i>Solidago californica</i> Nutt.) by Blumer, “Spud Ranch” (Spud Rock Spring area)	Never collected in Rincons. Blumer’s collection was misapplied to <i>S. altissima</i> by Kearney in 1947, leading to its inclusion on the B&M list. <i>S. californica</i> is now recognized as a variety of <i>S. velutina</i> , a common species in the Rincons. This variety is not known to AZ, however, so the collection merits a closer look. (TM)
Betulaceae	<i>Alnus incana</i> subsp. <i>tenuifolia</i> [Nutt.] Breitung	thinleaf alder; mountain alder	Yes	Collected 1909 by Blumer, “falls, Manning Camp” and “Manning Trail”	FOUND in 2017. Collected in 2017 (Beckman & Swann).
Brassicaceae	<i>Arabis tricornuta</i> Rollins - now <i>Pennellia tricornuta</i> (Rollins) R.A. Price, C.D. Bailey & Al-Shehbaz	Rincon Mountain rockcress	No	Collected 1909 by Blumer, “eastview”	Never really lost. B&M made a collection that was later determined in 2004 (Soriano) to be this species. Collected in 2017 (Beckman). See Appendix C. (TM)
	<i>Brassica nigra</i> (L.) W. D. J. Koch	Black mustard	No	Collected 1913 by Thornber, “Tanque Verde”	Non-native. Low elevation species. (NN)
	<i>Nasturtium officinale</i> R. Br.	Watercress	No	Collected 1913 by Thornber, “Tanque Verde”	Non-native. Low elevation collection, not from study area. (NN)
Cannabaceae (Moraceae in B&M)	<i>Humulus americanus</i> Nutt. – now <i>H. lupulus</i> var. <i>lupuloides</i> E. Small	Common hop	No	Cited as <i>H. lupulus</i> in Blumer (1910), Spud Rock Spring aspen grove	Informally documented since 1987. <i>H. lupulus</i> var. <i>lupuloides</i> is not known regionally, but var. <i>neomexicanus</i> A. Nels. & Cockerell grows abundantly in the same location as Blumer’s citation. Collected in 2019 (Beckman). Not encountered elsewhere in the range. (RR)
Cornaceae	<i>Cornus sericea</i> L. subsp. <i>sericea</i>	Red osier dogwood	Yes	Collected 1909 by Blumer, “brook, Manning Camp”	FOUND in 2017. Collected in 2017 (Hetherington).
Cucurbitaceae	<i>Sicyos ampelophyllus</i> Woot. & Standl. – now <i>S. laciniatus</i> L.	Cut-leaf bur cucumber	Yes	Collected 1907 by Goodding, “Rincon Mountains”	Still not found. Mid-elevation riparian species.
Cyperaceae	<i>Eleocharis parishii</i> Britt.	Parish’s spikerush	No	Collected 1910 by Thornber, “summit of Rincon Mountains”	Never really lost. B&M made three collections that were later determined to be this species in 2000 (Smith). Multiple recent collections. (TM)

	<i>Scirpus acutus</i> Muhl. ex Bigelow – now <i>Schoenoplectus acutus</i> (Muhl. ex Bigelow) Á. Löve & D. Löve	Hardstem bulrush	No	Collected 1913 by Thornber, “Tanque Verde, near base of Rincon Mountains”	Low elevation historical collection, not from study area. (LE)
Fabaceae	<i>Vicia leucophaea</i> Greene	Mogollon Mountain vetch	Yes	Collected 1909 by Blumer, “Divide, lower trail”, 7200 ft elevation.	Still not found. Deciphering the meaning of Blumer’s stated collection location has been a challenge.
Hydrophyllaceae	<i>Phacelia arizonica</i> A. Gray	Arizona scorpionweed	No	Collected 1959 by Goodding, “flat, valleys, mesas, east side”	Collected in 1998 (Schmidt) and 2001 (McLaughlin) along Mescal/Happy Valley Rd on east side. Low elevation species. (RR)
Juncaceae	<i>Juncus balticus</i> Willd.	Baltic rush	No	Collected 1913 by Thornber, “Tanque Verde”	Low elevation historical collection, not from study area. Collected at La Cebadilla Cienega in 2013 (Wolkis). (LE)
	<i>Juncus tenuis</i> Willd.	Poverty rush	No	Cited in Kearney and Peebles (1960)	The original citation was likely based on a misidentified 1909 Blumer collection from Manning Camp, later redetermined to be <i>J. interior</i> Wiegand. <i>J. tenuis</i> is often confused with the widespread <i>J. interior</i> and not currently known in Pima County (Licher and Rink 2019). (TM)
Orchidaceae	<i>Habenaria limosa</i> (Lindl.) Hemsl. – now <i>Platanthera limosa</i> Lindl.	Thurber’s bog orchid	Yes	Collected 1891 by Nealley, “Rincon Mountains”	FOUND in 2018. Photo-vouchered in 2018 (Beckman).
Poaceae	<i>Calamagrostis canadensis</i> (Michx.) P. Beauv.	Bluejoint	No	Cited in Kearney and Peebles (1960)	Never collected in the Rincons. One Tucson-area collection (Goodding) is thought to be from an experimental garden. (KP)
	<i>Critesion murinum</i> subsp. <i>glaucum</i> (Steud.) W.A. Weber – now <i>Hordeum murinum</i> subsp. <i>glaucum</i> (Steud.) Tzvelev	Smooth barley	No	Collected 1909 by Blumer, “Spud Ranch” (Spud Rock Spring area)	Non-native. Collected in 2001 (West) in Rincon Creek. (NN)
	<i>Festuca sororia</i> Piper	Ravine fescue	Yes	Collected 1909 by Blumer, “Spud Rock, north side of cliffs”	FOUND in 2019. Collected in 2019 and 2020 (Beckman).
	<i>Gastridium ventricosum</i> (Gouan) Schinz & Thellung - redetermined as	Nit grass	No	Collected 1905 by Thornber, “foothills, Rincon Mountains”	Non-native. Low elevation historical collection. (NN)

	<i>G. phleoides</i> (Nees & Meyen) C.E. Hubbard			(not able to locate on SEINet)	
	<i>Hordeum vulgare</i> L.	Common barley	No	Collected 1909 by Blumer, "Spud Ranch" (Spud Rock Spring area)	Non-native. Still not documented since Blumer. (NN)
	<i>Melica porteri</i> Scribn.	Porter's melicgrass	Yes	Collected in 1909 by Blumer, "Spud Rock, north rock shelves"	FOUND in 2017. Collected in 2017 (Beckman & Duncan).
	<i>Muhlenbergia arenicola</i> Buckley	Sand muhly	Yes	Collected 1900 by Griffiths, "Rincon Mountains"	Still not found. Low to mid-elevation species well-documented to the south and east, so Rincon populations could likely fall outside park boundaries.
	<i>Muhlenbergia wolfii</i> (Vasey) Rydb. – now <i>M. ramulosa</i> (Kunth) Swallen	Green muhly	Yes	Collected 1909 by Blumer, "Manning Camp, gravelly knoll"	FOUND in 2017. Collected in 2017 (Beckman).
	<i>Polypogon interruptus</i> H.B.K - now <i>P. interruptus</i> Kunth	Ditch rabbitsfoot grass	No	Collected 1913 by Thornber, "Tanque Verde Ranch"	Low elevation historical record, not from study area. (LE)
	<i>Setaria viridis</i> (L.) P. Beauv.	Green bristlegrass	No	Collected 1913 by Thornber, "Tanque Verde, foothills of Rincon Mountains"	Non-native. Low elevation historical record, not from study area. (NN)
Polygonaceae	<i>Rumex altissimus</i> Alph. Wood	Pale dock	No	Collected 1913 by Thornber, "Tanque Verde, near base of Rincon Mountains"	Low elevation historical record, not from study area. (LE)
Ranunculaceae	<i>Delphinium virescens</i> subsp. <i>wootonii</i> (Rydb.) Ewan – now <i>D. wootonii</i> Rydb.	Organ Mountain larkspur	No	Collected 1906 by Thornber, "Mescal, railroad right way"	Low elevation historical record, not from study area. (LE)
	<i>Myosurus minimus</i> L.	Tiny mousetail	No	Collected 1960 by Goodding, "east side of Rincons, very rocky slope"	Needs further investigation. Goodding's collection is now listed under <i>M. aristatus</i> Benth. ex Hook.f. (<i>M. apetalus</i> var. <i>borealis</i> Whittm.). However, <i>M. cupulatus</i> S. Watson (well documented in Rincons) and <i>M. minimus</i> appear to be the only members of the genus reliably and repeatedly documented in southern Arizona. Goodding's habitat description would seem to favor the common <i>M.</i>

					<i>cupulatus</i> , as <i>M. minimus</i> is associated with wet soils. (TM)
Rosaceae	<i>Agrimonia striata</i> Michx.	Roadside agrimony	No	Collected 1909 by Blumer, “Manning Camp, willow copse”	Reported by NPS botanist Steve Buckley. We only observed a single small population around the Manning Camp Reservoir. See Appendix C. (RR)
	<i>Cercocarpus montanus</i> Raf. - redetermined as <i>C. montanus</i> var. <i>paucidentatus</i> (S. Wats.) F.L. Martin (now <i>C. breviflorus</i> A. Gray)	Hairy mountain mahogany	Yes	Collected 1908 by Goodding, “Rincon Mountains”	FOUND in 2018. Collected in 2018 (Beckman).
	<i>Rosa woodsii</i> Lindl. var. <i>woodsii</i> – redetermined as <i>R. woodsii</i> subsp. <i>arizonica</i> (Rydb.) W.H. Lewis & Ertter	Woods’ rose	No	Collected 1909 by Blumer, “Spud Ranch [Spud Rock Spring area], aspen grove”	Reported by NPS botanist Steve Buckley. Collected in 2019 and 2020 (Beckman) and 2021 (Gonzalez); all collections appear to also be subsp. <i>arizonica</i> . See Appendix C. (RR)
Salicaceae	<i>Salix amygdaloides</i> Andersson	Peachleaf willow	No	Cited in Kearney and Peebles (1960)	Kearney and Peebles (1960) cite it for the Rincons, but a footnote adds “Arizona specimens that had been identified as [<i>S. amygdaloides</i>] were referred by C. R. Ball to <i>S. gooddingii</i> .” In any case, our research found no collections from the Rincons. (KP)



Castilleja attenuata



Phanerophlebia auriculata (photo
courtesy of Tony Palmer)



Potentilla albiflora



Prunus emarginata



Fragaria virginiana subsp. *glauca*



Rubus idaeus subsp. *strigosus*



Acer glabrum var. *neomexicanum*
(photo courtesy of Nicole Gonzalez)



Valeriana sorbifolia

