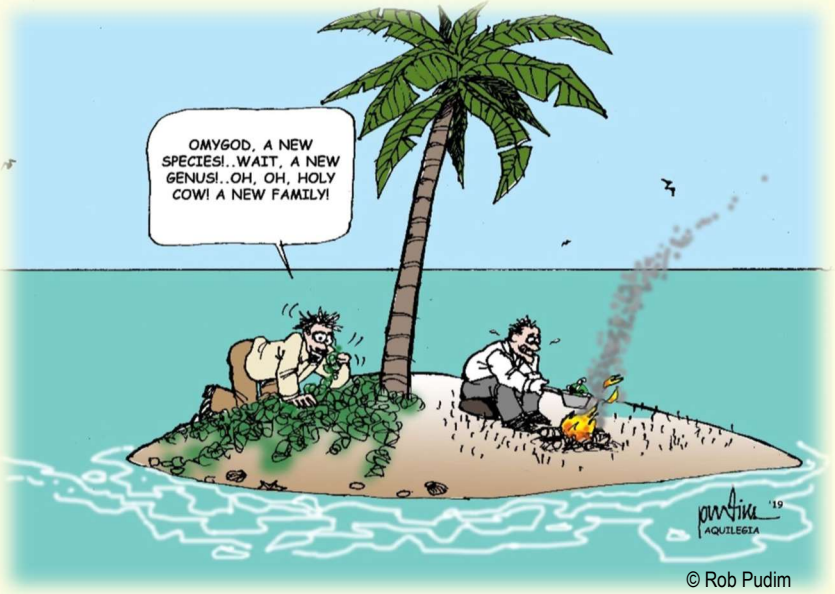
Aquilegia

Newsletter of the Colorado Native Plant Society
Volume 43 No. 4 Fall 2019

Botanicum absurdum by Rob Pudim



2019 Photo Contest

This issue of *Aquilegia* features the winners of the annual photo contest. All 2019 entries were on display at the Annual Conference in September, where attendees voted on their favorites.

Congratulations to all winning photographers in five categories! The photo featured on the cover garnered more votes than any other photograph in the contest. **Wildlife First Place**: Michael Aubrey, black-headed daisy (*Erigeron melanocephalus*) and American pika (*Ochotona princeps*).

Other **First Place** winners are featured on this page and the back cover. On this page are **Plants** (tie): Linda Smith, Gunnison sego lily (*Calochortus gunnisonii*) and Bob Clarke, notch-leafed scorpionweed (*Phacelia crenulate*). On the back cover: **Artistic**: Bill Loessberg, cow parsnip (*Heracleum maximum*); **Landscape**: William Bowman, limber pine (*Pinus flexilis*); **Gardens**: Steve Slocomb, Colorado blue columbine (*Aquilegia coerulea*). First place winners earned a $50 prize.

Second and third place winners are featured on pages 34 and 35 of this issue.

About the American Pika

The American pika (*Ochotona princeps*) is sometimes referred to as a rock rabbit or whistling hare. In fact, it belongs to the same family: Lagomorpha. The American pika is adapted to live in cold temperatures and scientists fear that a rapidly warming climate threatens the species.

Pikas, like the one featured on the cover, are often seen in alpine areas where they spend the summer “haying” or collecting food for winter caches. They cut, stack, and dry a variety of wildflowers and grasses, and then move them deep within their homes beneath talus slides and boulder fields. They do not hibernate and they eat the food stores throughout the winter.

According to *Montana Outdoors* magazine, pikas get their name from the Russian word “pikat,” meaning to squeak. When in their territory, it’s common to hear them communicating with other pikas. MM

Aquilegia: Newsletter of the Colorado Native Plant Society

Dedicated to furthering the knowledge, appreciation, and conservation of native plants and habitats of Colorado through education, stewardship, and advocacy

Inside this Issue

***AQUILEGIA:* Newsletter of the Colorado Native Plant Society**
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Aquilegia is the newsletter of the Colorado Native Plant Society. Members receive at least four regular issues per year (Spring, Summer, Fall, Winter). At times, issues may be combined. All contributions are subject to editing for brevity, grammar, and consistency, with final approval of substantive changes by the author. Articles from *Aquilegia* may be used by other native plant societies or non-profit groups, if fully cited to the author and attributed to *Aquilegia*.
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2019 Colorado Rare Plant Symposium

Botanists Share Tales of Summer Field Work

By Lisa Tasker

What's new in regard to southwest Colorado's globally imperiled plants? If you were one of sixty plus attendees of the Colorado Natural Heritage Program's Annual Rare Plant Symposium in Grand Junction, you know! Professionals to amateur botanists and ardent native plant enthusiasts have coveted this gathering the Friday before the CoNPS annual meeting.

CNHP, under the guidance of botany team leader Jill Handwerk, has always intended for this meeting to allow for data sharing. Botanists look forward to the event as they are usually dispersed across the state. But fresh off a field season in late September, they remarkably assemble in one room for a day with their latest findings fresh on their minds.

Besides providing the opportunity for participants to learn more about Colorado's rare plants, their distribution, levels of protection, and conservation concerns, CNHP puts the information to work. Pertinent information gathered at this meeting goes into maintaining Colorado's most comprehensive dataset of our rare flora. Shared camaraderie and the public education have been the other valuable outcomes.

Reviewed this year at the symposium were 14 G1 species, 23 G2 species, and 25 Threatened and Endangered or Candidate rare plants from southwest Colorado. G1 and G2 species are those considered to be globally at risk throughout their range and vulnerable to extinction.

Based on NatureServe methodology, G1 and G2 ranked species are the starting point for a plant's potential inclusion in the newer United States Forest Service Species of Conservation Concern (SCC) lists. These lists are quickly replacing the older USFS Sensitive Species lists. Of the approximately 520 rare plant species tracked by CNHP, 23% fit this category of imperiled on a global level in Colorado and are eligible for USFS consideration as a species of "substantial concern." This relatively newer approach to rare species by the USFS makes CNHP's communication with them even more essential in recent years.

North Park phacelia, *Phacelia formosula*.
© Susan Spackman Panjabi, CNHP.

Often announced at the annual meeting are the newest strategies to improve our understanding of our rarest plants. This year, Dr. Jennifer Neale with the Denver Botanic Gardens shared the results of an upcoming publication addressing the genetic distinctions between the two populations of North Park phacelia (*Phacelia formosula*) (G1/S1), concluding that both the North Park and Laramie River populations are the same species. Dr. Mit McGlaughlin, with the University of Northern Colorado, reported he is beginning genetic sampling in 2020 to determine the genetic fitness of Rocky Mountain monkeyflower (*Mimulus gemmiparus*) (G1/S1), a factor critical in the species' response to climate change. Dr. McGlaughlin and others voiced concerns that *M. gemmiparus* may not reproduce sexually in the wild, an obvious disadvantage for a rare plant.

Dr. McGlaughlin has also done extensive genetic work on fishhook cactus (*Sclerocactus glaucus*) (G2G3/S2S3) and *S. parviflorus* (G4/S3), revealing information critical to understanding the geographic range of populations and essential to conservation strategies. The important, but frustrating, take-away for both *Sclerocactus* is that neither the curve of the spines nor their absence is a good morphological feature for field identification.

Jill Handwerk announced the start of a pilot study using a drone for parachute penstemon (*Penstemon debilis*) (G1/S1), a plant colonizing steep shale talus-covered slopes. This is a first for Colorado, thanks to the efforts of Raquel Wertsbaugh of the Colorado Natural Areas Program. Researchers who have literally risked life and limb to track plants are undoubtedly thrilled. A drone can obviously cover steep sites that have historically been inaccessible. The potential for new findings and fun photography seems considerable.

"Rare plants …" *continued on page 25* ►

2019 CoNPS Annual Conference

Here's What You Missed

As in years past, we use the Fall issue of *Aquilegia* to provide a recap of sessions at the annual Colorado Rare Plant Symposium and the CoNPS Annual Conference, in addition to the regular features and articles readers have come to expect.

Please enjoy these summaries provided by attendees and mark your calendar now for next year's events scheduled for September 17-18, 2020. Please think about reporting on a session or two. We depend on members to volunteer for these short assignments! *Thank you* to Kelly Ambler, Suzanne Dingwell, Leslie Madsen, Jessica Smith, and Nancy Steinke for their assistance in writing the following summaries. MM

Conference Presentations

Using Genetic Data to Conserve Colorado Hookless Cactus (*Sclerocactus glaucus*)

Dr. Mit McGlaughlin, University of Northern Colorado
Reported by Kelly Ambler

Dr. Mit McGlaughlin opened the 2019 CoNPS Conference with a presentation on the use of molecular genetics as a tool for learning more about plant identification, evolution, and conservation. He initially described why it is important to identify whether morphologically similar organisms are actually separate species rather than phenotypic variations of a single species. Our understanding of species is important for the following reasons:

- Species are the primary units of biologic diversity;
- We organize our thoughts about organisms around speciation;
- Speciation is integral to the process of evolution; and
- Understanding of species impacts our research, our understanding of diversity, our system of classification, our conservation efforts, and our appreciation of nature.

An example of a species that shows huge phenotypic differences between various populations is *Eriogonum umbellatum* (sulphur buckwheat). This plant has over 45 recognized varieties and can be found from sea level to alpine elevations. Yet the genetic differences between the different populations are minimal. Thus, the plants are the same from an evolutionary standpoint.

Of conservation concern is *Sclerocactus glaucus*, Colorado (or Uinta Basin) hookless cactus. This cactus is federally listed under the Endangered Species Act as *threatened* and is also monitored by the Colorado Natural Heritage Program. Most of the known populations are in the Grand Valley east of the Green River. A close relative is *S. parviflorus* (smallflower fishhook cactus), which is not threatened and is mostly found west of Green River and into Utah. The primary morphologic characteristic used to differentiate these two species is the presence or absence of a hook on the central spine. However, there are some populations in which there is a mixture of individual plants with hooked or hookless spines. McGlaughlin posed the question, "Are these cacti phenotypic variations of one another, mixed populations of different species, or hybrids between the two species?"

***Sclerocactus glaucus* (a, b) and *S. parviflorus* (c, d). Schwabe, et.al. 2014 *Conservation Genetics*. 16:443-457.**

Mit's lab used molecular techniques to identify regions of DNA, called microsatellites, that differ between widely spaced populations of the two cacti. They ►

Ode to an Inconspicuous Flower
By Elizabeth Blaker

I followed the bees to you,
Their contented buzzing told me you were near.
You stood taller than I, your pale green stalk
and curving leaf,
Adorned with inconspicuous flowers.

You are a grand old dame of herbaceous plants,
Having lived nearly eighty years in this alpine meadow,
You are only now coming to fruition

Bumblebees are hypnotized by your reward,
Drinking deeply, tongues delving into the fringed
nectar pits of your blossoms.

Leaning close, I feel myself falling into your flowers,
Sliding along pale green petals
decorated with purple spots,
The stamens tower above, their anthers
loaded with pollen.

I swim in your nectar, into your stems, roots,
I dwell with you.

As the weeks pass, I feel your changes,
Your petals desiccate, then fall away,
Your ovules have swollen, developing into seeds.

Your leaves are browning, drooping, and your stalk has
grown brittle.
In the night sky above your mountain,
Songbirds migrate southward by the stars.

Fierce winter winds sweep across the flank of the
mountain, batter you to the ground;
Snowflakes gather upon your dry leaves.

Under drifting snow,
Your leaves have formed a shelter for your fallen seeds
For a slumbering bumblebee queen and the chrysalis of
a butterfly.

You are dead now.
Spring melts the snows,
Revealing only a heap of tangled brown leaves.

As the bumblebee queen wakes and the butterfly
emerges from its chrysalis,
Your great accomplishment, your seedlings,
shelter beneath your leaves;
You have created the perfect conditions for their growth.

For decades your children will be unnoticed, cabbage-y
plants among the bluebells and delphiniums of the
alpine meadow.

Green gentian, charmer of bees, what other
inconspicuous flowers live and die and live again?

Editor's note: This poem is an ode to the Frasera speciosa *(monument plant). Dr. David Inouye suggested the author submit it to* Aquilegia *during this year of monumental bloom. Elizabeth holds a master's degree in biology and an undergraduate degree in microbiology. She is a CEFNS Academic Advisor at Northern Arizona University.*

◄ then analyzed the DNA from over 1500 individual cacti spread throughout the Grand Valley. Interestingly, they determined that the presence or absence of hooks did not always correlate with the genetic markers. In fact, the genetic markers correlated more consistently with whether the sample was obtained east or west of the Green River. Thus, the presence of a hook on the central spine cannot be used as a criterion for exclusion of a sensitive species. His research also showed significant differences in the genetics between these two species.

Dr. McGlaughlin also showed that there appeared to be a minimal amount of gene flow between *S. glaucus* and *S. parviflorus*, thus reducing the concern over hybridization-dilution of the rare species. In addition, there were three genetically (and geographically) distinct populations of *S. glaucus* – a subject for future conservation concern.

While these findings do complicate field studies, they clearly show the importance of examining multiple factors when working with rare plant populations.

Phenology and How Wildflowers and Pollinators Respond to Changes in Climate

Dr. David Inouye, Rocky Mountain Biological Laboratory
Reported by Kelly Ambler

Dr. David Inouye gave an overview of 40-plus years of observational and experimental data on plants and insects in the Crested Butte/Gothic area. These data were correlated with seasonal changes in temperature, precipitation, and snowpack. The data show that peak snow melt is occurring earlier in the year, April mean temperatures are higher, and summers are warmer now compared to when the studies first began. These changes are also correlated with earlier flowering times.

Will the pollinators be able to adapt to these changes? According to Inouye, "it depends." Some animals exhibit behavioral changes in tune with the changes in flowering times. Examples of animal adaptation include queen bumblebees that appear to be moving up in elevations as flowers move up. Other species may not have adapted yet. For example, the arrival time of broad-tailed hummingbirds has not changed much, although glacier lilies (*Erythronium grandiflorum*), a major source of early nectar, are blooming earlier.

Another interesting finding from these observations is the determination of the trigger for mast flowering events of the monument plant (*Frasera speciosa*). Monument plants take decades to mature, at which time they flower, then die. Occasionally, an entire field of plants will produce flowering stalks simultaneously. ►

◄ Inouye and his colleagues showed that the mast flowering event correlated with summer rainfall that occurred four years previously. Life cycles in other plants, such as corn husk lily (*Veratrum californicum*) and Nuttall's larkspur (*Delphinium nuttallianum*), also appear to be dependent upon events occurring well in the past.

The sheer amount of time and human hours put into these studies is staggering! Students, research scientists, and volunteers have been gathering extensive amounts of data in this valley since the early 1970s. And some of the climatic data go back to the early 20th century. Clearly, our understanding of such complex relationships requires these types of extensive and rigorous studies.

Colorado's Native Bees

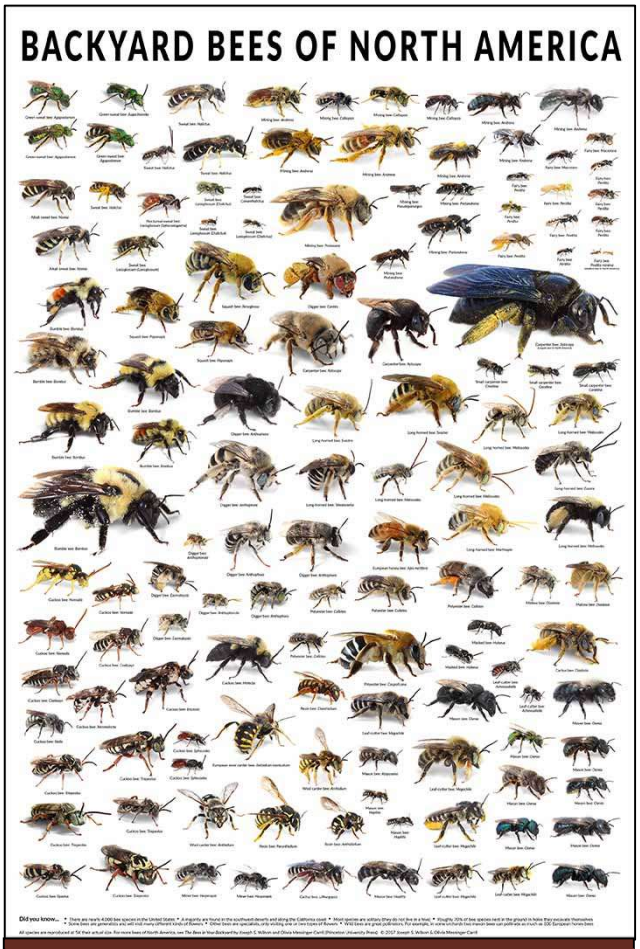
Abi Saeed, CSU Extension Agent, Garfield County
Reported by Kelly Ambler

The morning session wrapped up with an informative and entertaining presentation about pollinators, particularly native bees, by Abi Saeed. Why should we care about pollinators? Three-fourths of the world's flowering plants (and better than 90% in the tropical regions) and about 35% of the world's food depend on animal pollinators to reproduce. Insect pollinators also support native plant communities that provide food for wildlife. Insects and angiosperms have co-evolved over time to support each other. We are only beginning to understand these complex relationships.

All pollinators are important, but bees are particularly effective pollinators. They are covered in branched hairs that efficiently gather pollen. North America is home to more than 4,000 species of native bees, of which 946 species are known to occur in Colorado. Bee diversity is related to ecosystem and geologic diversity. Most bees nest in the ground, while approximately 30% nest in cavities.

Abi followed this introduction with a brief description of the main types of bees in Colorado.

- Bumblebees (Apidae family): There are 16 known *Bombus* species in Colorado and these bees are often visible in alpine meadows. These bees are social, although new colonies are established each year. The bees are quite hairy and large.
- Sweat bees (Halictidae family): Colorado has 40 species of sweat bees. These bees are solitary nesters, but gregarious in their nesting sites, which are subterranean. These bees are attracted to the salt in sweat, which is how they obtained their common name. They are usually easy to recognize by their shiny green carapaces.
- Mining bees (Andrenidae family): There are more than 250 species of mining bees in Colorado. These bees are also solitary and nest in the soil. They are most active in the spring and are often found in orchards.
- Perdita bees (Andrenidae family): More than 80 species are found in Colorado. Solitary bees nest in dry soils, often in the desert. These very tiny insects are often the dominant pollinator of euphorbia plants.
- Cellophane bees (Colletidae family): This is another group of solitary, ground nesting bees. There are around 60 species found in Colorado. These bees line the walls of their nests with a cellophane-like material, hence their common name.
- Leafcutter, mason, and wool carder bees (Megachilidae family): These bees are all cavity nesters. Leafcutter bees line their nests with circular pieces of leaves. Mason bees nest in existing holes in wood, which they plug with mud. And the wool carder bees line their nests with plant fibers.



The Bees in Your Backyard. **http://beesinyourbackyard.blogspot.com/p/poster.html**

Unfortunately, populations of native bees are declining. The biggest threat is habitat loss due to urbanization and agriculture. In addition, management practices (e.g., the use of pesticides and herbicides) ►

◄ are also detrimental. Landscaping uses the largest amount of pesticides and herbicides.

What can we do to help our native bees? Bees need nesting sites (e.g., undisturbed soil, old stems, etc.) and floral resources. These resources should include a variety of plant species, a range of flower types and flowering times, and the absence of toxins. Thoughtful landscaping practices can provide the food and shelter necessary to support healthy bee populations around our homes. Even container gardens can be sufficient. And don't be too quick to clean up the garden in the fall! Many insects over-winter in dead plant stems or fallen leaves. Use the "mullet" approach for landscaping, if necessary—'business-in-the-front, party-in-the-back!' See the CSU Extension Service for guides addressing gardening for pollinators.

Amazing Female Botanists of Colorado

David Anderson, Director and Chief Scientist, Colorado Natural Heritage Program
Reported by Leslie Madsen

David Anderson's presentation highlighted the accomplishments of over a dozen women, all of whom contributed greatly to the documentation and understanding of Colorado's natural history. Common themes emerged from their life histories, such as: determination, scholarship, resilience, and an unwavering passion for preserving the natural environment. What stood out for me were the achievements of Alice Eastwood and Hazel Schmoll.

Alice Eastwood, 1927. From the California Academy of Sciences Library. https://oac.cdlib.org/findaid/ark:/13030/kt28703348/dsc/#ref11

Alice Eastwood was a self-taught botanist and formidable hiker who actually invented a garment that allowed her to ride a horse western style (versus side saddle which was the custom of the day). She was recruited to guide Alfred Russel Wallace (a leading evolutionary thinker of the 19th century) to the summit of 14er Grays Peak. Over the next seven decades, Alice spearheaded numerous collecting expeditions, documenting existing plant specimens and discovering new ones. As the curator of the herbarium at the California Academy of Sciences, Alice oversaw the rescue of a significant portion of the Academy's type plant collection during the 1906 earthquake and fire, a feat in large part due to her previous organizing efforts that had separated the type specimens from the main collection.

Trailblazer Hazel Schmoll (1890-1990) grew up in Ward, Colorado, and graduated from CU Boulder in 1913 with a degree in biology. She earned a master's degree in botany from the University of Chicago in 1919 and a PhD in 1932 using the vegetation of the Chimney Rock area of southwestern Colorado as the subject of her dissertation. She mounted and cataloged Alice Eastwood's botanical collections (several specimens are in the Herbarium COLO on the Boulder Campus). As the Colorado State Botanist, Hazel helped pass the "Columbine Bill" in 1925, a law protecting the Colorado blue columbine (*Aquilegia coerulea*), from the ruthless hordes of wildflower pickers that collected thousands of columbines in a single outing.

Kelly Ambler noted, "David also summarized the lives and achievements of over a dozen other women who have provided important contributions to understanding of Colorado botany, many of whom have not been adequately recognized. He finished his presentation with a call to action for us all to make a concerted effort to mentor women and minorities and support their career efforts."

Habitats and Dominant Plant Species of Western Colorado

Dr. Stephen Stern, Mesa State University
Reported by Kelly Ambler

Dr. Stephen Stern presented a thorough and interesting overview of the ecosystems and plants native to the Grand Junction area. His presentation started with a discussion on the diverse habitats surrounding Grand Junction. The Grand Valley around the Colorado and Green Rivers is just over 4,000' in elevation, whereas Grand Mesa rises to over 11,000' in elevation in less than 50 miles. The other mountains surrounding the valley rise to 6,000-9,000' in elevation. Thus, topography, and the dependent differences in precipitation, create a huge variation in climate zones in a short distance. Almost all of the areas share one characteristic, however—these are stressful environments. The lower elevations deal with high temperatures and alkaline and/or high salinity soils, which can get water-logged during wet periods. The higher elevations are subject to low temperatures ►

◄ and high levels of ultraviolet light. Both extremes are often subjected to low humidity and desiccating winds.

The lower valleys are dominated by basin grasses and shrublands. Dominant shrubs include several members of the Chenopodiaceae family, such as greasewood (*Sarcobatus vermiculatus*), fourwing saltbush (*Atriplex canescens*), and winterfat (*Krascheninnikovia lanata*). Common grasses include saltgrass (*Distichlis stricta*) and foxtail barley (*Hordeum jubatum*). These plants have evolved special mechanisms for removing salt and/or for conserving water during photosynthesis.

As the elevation increases, pinyon-juniper woodlands emerge. The dominant trees of these elevations are pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*). Shrubs include single-leaf ash (*Fraxinus anomala*), cliff fendlerbush (*Fendlera rupicola*), serviceberry (*Amelanchier alnifolia* var. *utahensis*), shortspine horsebrush (*Tetradymia spinosa*), big sagebrush (*Artemisia tridentata*), and Mormon tea (*Ephedra viridis*). The peak bloom period for these plants is mid-May through June. There are also many ephemeral spring-blooming forbs in this area. Flowering in these plants is highly dependent on winter and spring precipitation, which produces a large variability in phenology. A common plant found in this area is the Grand Junction milkvetch (*Astragalus linifolius*). This plant is endemic to the area, so globally rare. Interesting micro-environments include hanging gardens—areas of moist seeps along cliffs. Uncommon plants found here include Mancos columbine (*Aquilegia micrantha*) and arctic rush (*Juncus arcticus*). More commonly found plants include star Solomon's seal (*Maianthemum stellatum*), alkali buttercup (*Ranunculus cymbalaria*), and Nebraska sedge (*Carex nebrascensis*).

As expected, the highest elevations on Grand Mesa are dominated by spruce-fir-aspen forests. These forests, and their associated plants, are more similar to the forests found in the high elevations of the Front Range mountains.

Stephen finished his presentation with a synopsis of his research in McInnes Canyon National Conservation Area. Along with his students, he has been performing a floristic inventory of the NCA. This area is just west of the Colorado National Monument and is similar with respect to habitats and geology. Interestingly, each area has 150-200 plants that are not found in the neighboring area. Dr. Stern felt this fact indicated both areas are under-studied.

One major goal of the floristic inventory project was to hire and train undergraduate students in field botany methods. This project also provides a species list that can be used for comparisons with other nearby areas

***Amsonia jonesii* herbarium sample. swbiodiversity.org/seinet/collections/individual/index.php?occid=8479416**

and for guiding land management decisions. So far, 838 collections have been made, including 310 collected by students.

Notable results include two new county records (*Melilotis albus*, white sweetclover – previously uncollected despite abundance – and Shockley's buckwheat (*Eriogonum shockleyi*), and locating several rare plants, including Preuss' milkvetch (*Astragalus preussii*), bluestar (*Amsonia jonesii*), canyonlands biscuitroot (*Lomatium latilobum*), Osterhout's cryptantha (*Oreocarya osterhoutii*), and Grand Mesa beardtongue (*Penstemon mensarum*). A laudable piece of work!

Ute Ethnobotany

Sallie Crum, Archaeologist, US Forest Service
Reported by Mary Menz

Sally Crum arrived early for her presentation and brought freshly-steeped Mormon tea with her to serve to conference attendees at the afternoon break.

"Be careful," warned Sally. "It has a mild stimulant effect. You probably don't want to drink too much of it."

In her presentation, Sally shared common ethnobotanical uses of western slope plants. Her ►

◄ work as an archaeologist and Ute Tribe liaison helped form her knowledge of plant use. “I’m not a botanist,” said Sally, “but I can tell you how the Utes used various plants based on USFS surveys and reports.

Sally demonstrated Ute tools made of pinyon pine such as the atlatl (spear), the use of a metaté (grinding stone), and numerous dried plants with seed heads.

In her presentation, Sally described a cooperative venture leading to the development of the Ute Learning Garden near the Grand Junction Fairgrounds. Ute students from the reservations helped plant indigenous shrubs and trees for the garden, which also boasts two wickiups (shelters), hearths, and a tipi.

Volunteer docents and interpretive signs describe how Utes (and earlier cultures) annually traveled specific routes in the region following game, ripening berries, roots, and nuts. The signs also describe their journey to the upper elevations where summers were spent in the cool forests hunting and gathering until autumn brought them down to the pinyon-juniper.

Sally Crum is author of *People of the Red Earth, American Indians of Colorado* (2009), among other books.

Fire Adapted Landscaping

Susan Carter, Colorado State University Extension, Tri-Rivers Area
Reported by Mary Menz

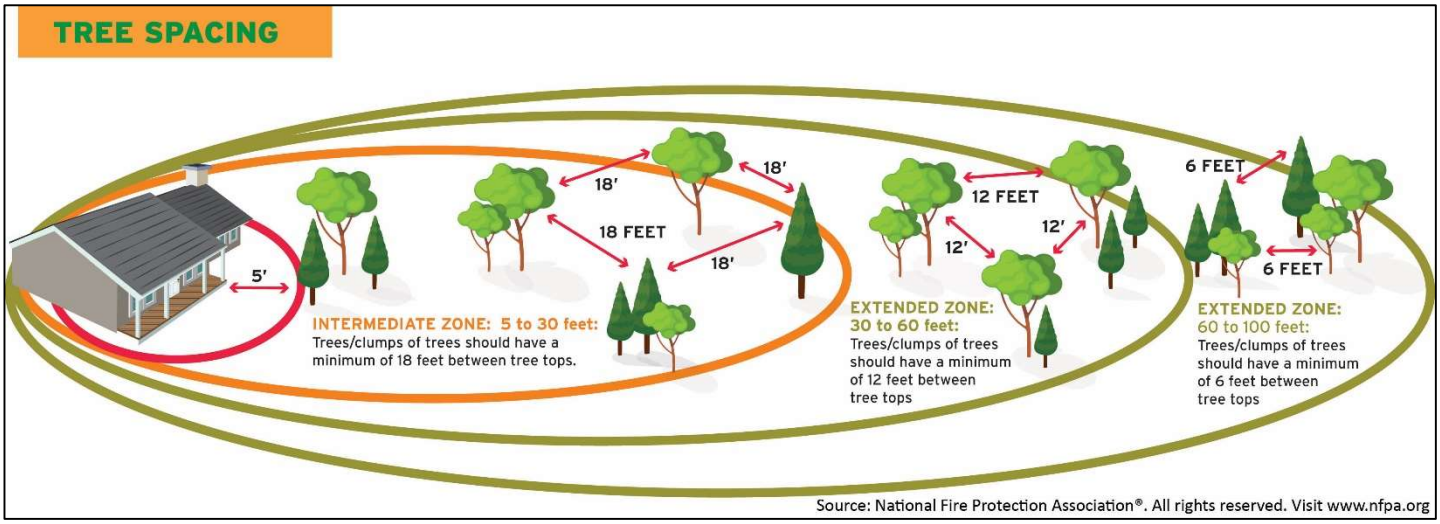
Closing the Annual Conference, Susan Carter presented a brief discussion about defensible space and how vegetation—especially highly flammable vegetation—can create potential fuel for a wildfire.

She emphasized that the location and density of the native plants are more important than the specific plants used to create a fire-adapted landscape. Her specific recommendations echoed those listed in CSU Extension Fact Sheet No. 6305 and include:

- Consider a plant’s moisture content and resin content when placing plants near a home;
- Use deciduous plants that are naturally more fire-resistant; and
- Incorporate into the landscape plants that grow close to the ground.

Susan discussed the difference between drought tolerant plants and fire-resistant plants and provided many examples of native plants suitable for a fire-adapted landscape. She also suggested several vegetation types (shrubs, trees, and wildflowers) used with decorative rock and pathways and described the importance of using nonflammable mulching materials instead of pine park and pine straw that can carry creeping fire under the surface.

CSU Extension has available on its website several free publications about creating defensible spaces, forest home fire safety, and fire-adapted landscaping as well as lists of fire-wise plants suitable for landscaping homes located near urban-wildland interfaces.



Carters Honored with Lifetime Achievement Award

By Jennifer Bousselot

Jack and Martha Carter were honored at the Annual Conference with the CoNPS Lifetime Achievement Award.

As their friend and mentee, it gave me great pleasure to present them with this award. Here's a summary of the couple's many contributions to CoNPS and the field of botany.

Jack's career spanned many decades. He has—

- Taught botany at Colorado College, University of Colorado, and Simpson College;
- Worked for the textbook company, BSCS (Biological Sciences Curriculum Study);
- Edited the prestigious *National Association of Biology Teachers Journal* and provided leadership in the state and national college teachers associations; and
- Traveled extensively with Martha for botanical pursuits

In addition, the Colorado College greenhouses are there thanks to Jack's efforts and the Colorado College herbarium is named in his honor. Jack's herbarium sheets grace many southwestern US herbaria and are as far away as the Missouri Botanic Gardens and the Kew Gardens in England.

Upon retirement, Jack and Martha moved to Silver City, New Mexico where they got to business building a personal herbarium, a publishing company, and a vast array of friends, especially in the New Mexico Native Plant Society. They served the society in many capacities and even started an endowment fund that now exceeds $100,000.

Jack and Martha have published multiple editions of three books: *Trees and Shrubs of Colorado*, *Trees and Shrubs of New Mexico*, and *Common Southwestern Native Plants*.

It is hard to fathom the impact that these books have had on generations of plant enthusiasts in our region.

CoNPS was lucky when Jack and Martha moved back to Colorado in 2015 to be closer to their daughter Diane and her husband John. Right away, both of them dove right back into CoNPS and have supported it in many ways. Jack's many articles and book reviews have been published in *Aquilegia*; they advise the board; and Jack even serves on the mission grants review committee each fall and spring. However, one of the most important things Jack and Martha have done for the society is donating the 3rd edition of the *Common Southwestern Native Plants* book to CoNPS in May 2018. To date, the sales of the book are at nearly $20,000, all of which is income for CoNPS.

Martha and I were extremely pleased to receive the CoNPS Lifetime Achievement Award. At the same time, this honor you have bestowed on us belongs collectively to so many of you. You are among our many friends who make it all happen. Your understanding of why we must all work to protect the flora of this beautiful place is as clear to us as it is to you. Yet there are so many people with little understanding of the concepts of conservation, limits, and change over time.

There are still so many people moving into Colorado and the Rocky Mountains who have so little comprehension and the knowledge, skills and values required to save and protect the biota in this place. They are, in general, takers and users; they have never learned how to protect and save the Earth that surrounds them. Our work is certainly not complete.

Thank you so much for thinking of us. When you teach the ecosystem where we live to a stranger, or you identify a new plant species for the State of Colorado, or you collect and prepare a quality herbarium sheet, or take a group of people on their first plant walk, you are thanking us. We wrote our books to assist you and others in these important tasks.

We deeply appreciate this honor.

Jack and Martha Carter

Field Trips

Plant Photography In Situ

Field trip leader: Jim Pisarowicz
Reporter: Nancy Steinke

Plant Photography in situ promised to be a hands-on experience and proved to be just that. Jim Pisarowicz, noted native plant photographer and co-author of *Common Wildflowers of the San Juan Mountains*, shared his tips and tricks for capturing stunning photos of our native plants.

The excursion started at the visitor center of the Colorado National Monument with an overview of equipment management. One challenge for a hiker who wants to capture the perfect photograph is packing essential hiking gear along with necessary cameras and accessories. Jim unloaded his small pack to show us light diffusers (including a milk carton), ring flashes, tripods, props, lenses, and camera. The only other equipment he carried was a rolled sleeping pad, used when taking shots that require him to stretch out on the ground.

***Symphoricarpos sp.*, snowberry.**
© Nancy Steinke

Attendees then looked for plants and flowers while strolling one half mile on the Alcove Trail and then around the gardens at the Saddlehorn Visitor Center. Jim checked our photos as we went along, offering advice and encouragement as we captured pictures. In addition to learning shooting techniques, conversation included a discussion of Adobe Photoshop versus Adobe Lightroom for perfecting our shots.

Overall, this excursion left this novice photographer excited to practice the new tips and tricks, and to get out with my camera!

Grasses of the Western Slope

Field Trip Leader: Stephen Stern
Reporter: Jessica Smith

The first part of the field trip was held on Bureau of Reclamation land adjacent to the Gunnison River. It was a beautiful day: sunny, windy but with warm temperatures. Cottonwoods were beginning to yellow; a kingfisher was observed flying overhead along with an osprey, which delighted the group.

We observed several grasses along our short, level walk, including the native saltgrass (*Distichlis spicata*) stopping to taste the salt crystals exuded onto the leaves by the plant, and several exotics including barnyard grass (*Echinochloa crus-galli*), annual wheatgrass (*Eremopyrum triticeum*), reed canary grass (*Phalaris arundinacea)*, common reed (*Phragmites australis)*, tall wheatgrass (*Thinopyrum ponticum*), hooked bristlegrass (*Setaria verticillata*), and a new species to me, the less-common green foxtail (*Setaria viridis*). The group discussed the ecology of the reed genus, Phragmites, with Dr. Stern noting there are two genotypes of the species, a native and an introduced, both present in Mesa County. He also discussed the control of tamarisk by a recently released tamarisk beetle. Other graminoid species discussed included soft-stem bulrush (*Scirpus validus = Schoenoplectus tabernaemontani*), a sedge with no edges, and a species of rush (*Juncus sp.*). Dr. Stern helpfully pointed out that grasses have two bracts under the inflorescence; sedges have one bract, and rushes generally have tepals and no bracts.

The second part of the trip was held south of the Colorado National Monument, leaving from Bangs Canyon Trailhead, in the designated Rough Canyon State Natural Area. Over 15 species were discussed, including forbs, grasses, and shrubs. Grasses noted included galleta grass (*Hilaria jamesii*), aka the zigzag grass, needle-and-thread (*Hesperostipa comata*), Indian ricegrass (*Achnatherum hymenoides*), cheatgrass (*Bromus tectorum*), rabbitsfoot grass (*Polypogon monospeliensis*), and crested wheatgrass (*Agropyron cristatum*). Other interesting plants included juniper mistletoe (*Phoradendron juniperinum*), a parasite on the juniper tree, and *Grindelia fastigiata*, a western slope late season blooming gumweed, which is different from *G. squarrosa* in that the inflorescence has no ray flowers. All-in-all, it was an informative trip on a beautiful fall day. ►

◂ Late Bloomers on the Grand Mesa

Field Trip Leaders: Charlie Maurer and Mary Menz
Reporter: Suzanne Dingwell

The words “grand” and “mesa” are used in Colorado so frequently that I hardly suspected the Grand Mesa we would explore on the field trip would far exceed my mild expectations! The day was cool and windy in Grand Junction, and we knew that we were going to be facing cooler temperatures with every thousand feet we traveled upwards. Co-leader and Native Plant Master® Mary Menz assured us that even the drive up the mountain would be spectacular—and she was right. Sunshine graced most of the trip up, lighting vast sweeps of aspen in blazing gold. Dark and stately conifers formed a green background for the aspens, the shining lakes, and the white sandstone monoliths beaming afar from the valley floor.

Aspens dropped away as we neared our destination, a subalpine meadow a bit above the Powderhorn Ski resort. Grand Mesa is actually the highest flat-top mountain in the world. Reaching 11,330 feet, it’s capped by volcanic basalt; but in one of those myriad geological developments that make Colorado so interesting, it was, in ages past, a valley floor. As the softer rock surrounding it submitted to the forces of erosion, Grand Mesa was left soaring in the air, a solitary presence 6,000 feet above the current valley floor where Grand Junction now sits. This explains my next surprise: sinking down to get nearer to the flowers, my knees were met not by unyielding rock, but by gentle, forgiving, soft soil, finely textured and rich in organic material from its previous life as a valley floor. Co-leader and Native Plant Master® Charlie Maurer shared his prodigious knowledge of the scene before us.

Vibrantly alive with the colors of plants entering the senescent stages of their lives, the meadow we explored was brilliant with the reds of fireweed, strawberry, creeping sibbaldia, and whortleberry species. Red and purple stems of yarrow, elephants head, and bistort accented the varying browns of multitudinous grass and sedge species. White fluffy seed heads of prairie smoke were scattered so thickly in the meadow they looked like mini snowdrifts. Stalwart Parry’s gentians (*Gentiana* parryi) were still blooming, also with red stems, but topped with gorgeous purple-blue flowers, closed tightly against the wind and skies that had turned grey. As we reluctantly gave in to the elements ourselves, we all agreed that this lovely meadow was going to the top of our lists for a re-visit next July!

Autumn colors along the top of Grand Mesa. © Sue Dingwell

Parry’s gentian, *Gentiana parryi*. © Sue Dingwell

Participants in the Grand Mesa field trip find plenty to look at. © Kelly Ambler

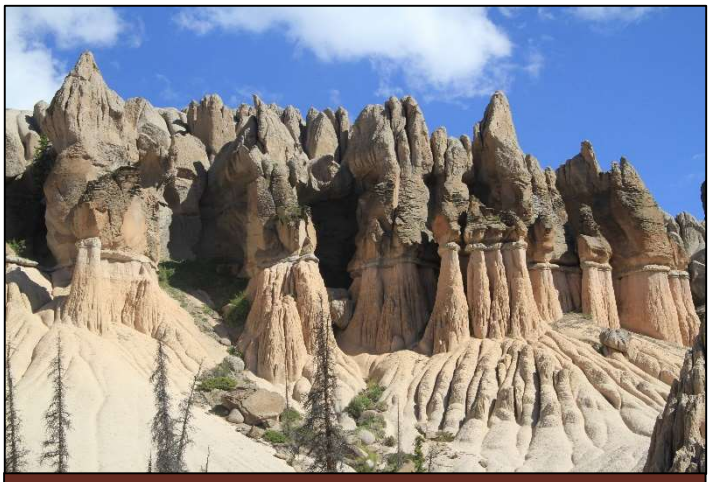
Featured Story

A Taste of Place: Colorado Breweries Celebrating Colorado Native Plants

By Jen Toews

Mt Massive IPA. Whiskey Barrel Quandary. Buffalo Peaks Brown. Elephant Rock IPA. Devils Head Red. Colorado's over 400 established breweries[1] have long celebrated the state's diverse topography by naming beers after its iconic mountains and monoliths. This is hardly surprising as Colorado's unique geology provides the architecture for some of the most dramatic natural landscapes in the world including the bizarre rock gardens of the Pikes Peak batholith, the jagged peaks towering over glacial cirques, crystal-clear alpine lakes, and canyons that carve through time to expose billion-year-old rock. The state's geology is certainly worth celebrating.

Close your eyes and imagine these geologic wonders without plants. The adjectives desolate, monotonous, naked, eerie, and haunting may come to mind. A Colorado without plants is difficult to envision.



Wheeler Geologic Area. © Jen Toews

A floristically diverse state, there are around 2,800 taxa of native plants[2] which hone architecture, create texture, and provide an artist's palette of color. As a result, picture-perfect scenery abounds. Mountain meadows bloom with paintbrush in all warm shades of the color wheel. Brightly colored, oversized alpine flowers including billowy Hall's penstemon (*Penstemon hallii*) and sunny-dispositioned old-man-of-the-mountain (*Hymenoxys grandiflora*) vie for pollinators on a rocky slope. The shortgrass steppe of the eastern plains glimmers with a galaxy of blazingstar (*Mentzelia sp.*) backlit by a setting September sun.

Middle Park Wildflowers. © Jen Toews

Plants are, along with geology, the *sine qua non* to the state's natural beauty.

Given our state's cast of charismatic plants, I began to wonder: How are Colorado breweries celebrating Colorado native plants? I also had a second burning question that is probably on every beer-loving botanist's mind: are native hops (*Humulus neomexicanus*) being used in any of Colorado's beers? I set out to answer these questions.

After evenings spent perusing beer menus on the internet, followed by emails and a few phone conversations, followed by necessary fieldwork in breweries and the occasional trip to a liquor store, the results are in. The following beers are arranged in order of when you might find and drink them.

As the Rocky Mountains become blanketed in snow, look for the first beer featured, **Pine Bough Pale Ale**, at Tommyknocker Brewery (Idaho Springs). According to the crew at Tommyknocker, this ale was initially brewed for Loveland Ski Area's 75th anniversary. Intended to be a one-time small batch, it was so popular that it became a mainstay during ski season. Each year, employees handpick Engelmann or Colorado blue spruce (*Picea engelmannii* var. *engelmannii* or *P. pungens*) tips from trees that grow along a ski run. The tips are chopped until granular form before they are steeped in a pale ale beer. Four days later, the beer is kegged.[3] The result is delightful—an American pale ale with the unmistakable aroma and flavor of the young spruce tips one might nibble as a trail snack.►

***Picea engelmannii*, Brainard Lake Recreation Area. © Jen Toews**

◄This beer is only on tap at the brewery. So, if Idaho Springs is not within your radius, Upslope Brewing Company of Boulder has you covered. During November and December of 2019, Upslope will release a limited-edition **Spruce Tip IPA**, which will also be available in select liquor stores.

When spring sunshine starts to melt the snow and the first wildflowers begin to bloom, look for seasonal and limited releases of raspberry beer such as Elevation Beer Company's **Raspberry Gulch Imperial Saison** (Poncha Springs). Although Elevation leaves the native trailside raspberries for bears and other wildlife, it successfully recreates the flavor of our native red raspberry (*Rubus idaeus* var. *strigosus*) with European cultivars: it "plucks that high altitude tart trailside raspberry and puts it right in your glass."[4] So, how about a hike on the beer's namesake trail, Raspberry Gulch, a section of the Colorado Trail between Salida and Buena Vista known for wildflower displays, stunning views of the Chalk Cliffs and the Arkansas River Valley, and of course, wild raspberries. Then, go drink a raspberry beer. You've earned it!

***Rubus idaeus* var. *strigosus*, Ptarmigan Peak Trail above Silverthorne. © Jen Toews**

If this beer is not offered in 2020, drive across the state to Glenwood Springs. Here, Glenwood Canyon Brewpub offers **Grizzly Creek Raspberry Wheat**, a sour beer that is also named after a hiking trail and wild raspberries.[5] Or, if you live on the Front Range, visit New Terrain Brewing Company in Golden and try their ***Rubus deliciosus***, a tart raspberry wit beer that is, perhaps thankfully, not made with *Rubus*-not-so-*deliciosus*.

As the daytime temperatures grow warmer and the sun lingers into the evening, the green carpet of the short-grass steppe of eastern Colorado lights up with the lemon, lime, orange, and magenta colored flowers of prickly pear cactus (*Opuntia spp*.). This is a glorious time of year to botanize the morning away at Pawnee National Grasslands and then spend the remainder of the day sampling prickly pear cactus beer. 2019 saw its fair share of brews celebrating this iconic southwestern plant: Perilous Prickly Pear Wheat (Boulder Beer Co.), Prickly Pear Gose (Copper Kettle Brewing Company, Denver), Prickly Pear Maceration (New Image Brewing, Arvada), and Guns 'N' Rosé, which is made with hibiscus and prickly pear (Oskar Blues Brewery, Longmont).

***Opuntia sp.*, prickly pear cactus. © Nick Daniel**

A cactus beer that will likely be offered next year is Sanitas Brewing Co.'s **Prickly Pear Sour Ale**. This kettle soured beer uses prickly pear purée which contributes to a beautiful rosy pink pour and a refreshingly tart taste with notes of bubblegum and watermelon.[6] Michael Memsic, co-founder and CEO of Sanitas Brewing Co., reports that this beer has quickly become one of the fastest selling beers for the Boulder-based brewing company.[7] As a side note, this beer pairs very well with Mexican street tacos. ►

***Juniperus monosperma*, one-seeded juniper Comanche National Grasslands. © Jen Toews**

◄ Next up is a juniper-flavored beer that is available year-round at Wild Woods Brewery. This brewery does an all-around good job celebrating nature and has a menu that boasts an array of beers inspired by backpacking trips in the high country, smoky campfires, wildflowers, wild berries, and ponderosa pine. Wild Woods' most produced beer, **Treeline IPA**, is a piney, citrusy beer conditioned with juniper berries (*Juniperus sp*.) sourced sustainably from organic farms[8] under the name "common juniper." This beer pairs well with a stroll in the juniper-dotted foothills above Boulder or a hike to treeline in the Brainard Lakes Recreation Area, where hikers may encounter common juniper (*Juniperus communis*), dwarfed by its harsh environment.

For readers who reside in southwestern Colorado, you can experience juniper beer at Smuggler Union Restaurant and Brewery in Telluride. They offer **Juniper Rye Pale Ale**, which, according to their website, has "a subtle yet intriguing juniper finish."[9]

For a taste of pinyon pine (*Pinus edulis*), try Bristol Brewing Company's (Colorado Springs) **Cheyenne Canyon Piñon Nut Brown Ale**. Available from June through September, this seasonal beer combines pinyon nuts, hops, and malt. The result is a nutty, hearty, roasty brown ale. Part of Bristol's Community Ales series, 100% of the profits from this beer are donated to Friends of Cheyenne Cañon,[10] an organization with a mission to protect the natural resources of North Cheyenne Cañon Park.[11] This park features granite rock formations, several cascades, waterfalls, and native flora. A hike or picnic here would be a great prelude to a pint (or more, since it goes to a good cause) of Piñon Nut Brown Ale.

If you've hiked along rivers, in shady canyons, across rocky slopes, and through alluvial woods in the western United States, you've likely encountered

***Pinus edulis*, pinyon pine. © Mary Menz**

Humulus neomexicanus. This species scrambles rambunctiously over boulders, up shrubs and trees, and even races up signposts as fast as its bines will carry it. The presence of native hops growing in the wild, along with Colorado's long history of beer brewing and the current, experimental trend towards wild and sour flavors, made me hopeful that somewhere in the state there might be a brewery using New Mexican hops.

In fact, as of 2015, there were only a couple of breweries across the country that had used *H. neomexicanus* in their beer.[12] One of these breweries is Crazy Mountain Brewing Company in Denver, formerly of Edwards. The beer, **Neomexicanus Native Pale Ale**, was first brewed in 2015. Although it is made with hops that were grown in Washington state, the hops are indeed *H. neomexicanus* from New Mexican rootstalk. When asked about the flavor, John Allshouse, an employee of Crazy Mountain, responded that there is a hint of tropical fruit—some drinkers have reported tasting pineapple, papaya, guava, mango, and citrus. He added that there are also surprising flavors such as PEZ® candy and biscuits that develop.[13] If your curiosity has been piqued, as mine certainly has, note that Neomexicanus Native Pale Ale can be difficult to come by: Crazy Mountain's 2020 specialty releases will be finalized soon so keep an eye on their social media pages for regular updates or visit their taproom to see what is brewing.

Too excited to wait? Make a beeline to the town of Angel Fire, NM, more specifically to Enchanted Brewing Company, where they serve their own version of neomexicanus beer, **Wet n Wild RyePA**. The hops used in this beer are harvested in the wildlands of New Mexico.[14] Another option closer to home for Front Rangers is Wild Woods Brewery in Boulder. On September 21 it released a **Native Bines IPA** which will be on tap until it sells out. This beer was brewed with 100% *Humulus neomexicanus* hops (the varieties Zappa & Medusa™). When asked if they had plans to brew more Native Bines IPA the answer was an emphatic yes: Likely in the spring, although the recipe will be slightly different. ►

***Humulus neomexicanus*, wild hops. © Mary Menz**

◄ In summary, Colorado native plants including spruce, wild raspberries, prickly pear cactus, juniper, pinyon pine, and native hops are providing both inspiration and ingredients for a handful of beers on the market. While some of these brews are mainstays, others are seasonal, and still others are one-time special releases: they are here today, gone tomorrow. This was the case with several beers I wanted to write about, including Saison Aux Baies Amères, a chokecherry (*Prunus virginiana* var. *melanocarpa*) saison from Left Hand Brewing Co. in Longmont. Part of a series brewed with Colorado native ingredients that also included Saison Au Genièvre (juniper saison), I missed this by a year. It seems that if you are enthusiastic about beer with native ingredients, you must keep your eyes open.

As I am enthusiastic about the potential for more beers brewed with native plants, I'll keep looking for a golden currant (*Ribes aureum*) beer. Note that I do not advocate for the foraging of wild plants that are already under a tremendous amount of pressure from development and its associated habitat loss, invasive species, recreation, and climate change. There is another solution. What if native plants were planted in beer gardens and in pocket gardens in parking lots? (Props to breweries who are already landscaping with native plants!) Not only would this provide native and local ingredients for a taste of place, but it would also create a stronger sense of place and contribute to an unmistakable Colorado brand. Furthermore, it would benefit our diverse native pollinators, who buzz around looking to sip nectar while we sip our brews. Local nurseries growing the native plants would also benefit. Finally, what if these breweries, in consultation with native plant societies, also included interpretation in their gardens to introduce a potentially new audience to some of Colorado's 2,800 species of native plants? These are ideas to ponder while enjoying your favorite Colorado brew.

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Jen Toews works in the plant records department at the Denver Botanic Gardens and is a Colorado Native Plant Master® who advocates for native plants at every opportunity. In her free time, she enjoys expanding her native plants garden, hiking to see native flora, photographing native flora, writing, country-western dancing, and of course, visiting craft breweries.

Native Bines IPA, Wild Wood Brewing Company. © Jen Toews

Conservation Corner

Colorado Takes the Lead in Protecting Alpine Plants in North America

By Jennifer Neale

Characterized by high mountains and heavy snow, Colorado's striking landscapes impress many as barren and low in biodiversity. Contrary to appearances, our alpine environments support unique and diverse communities of plants, animals, and fungi. Many of these species are restricted to alpine environments, with some found only in specific mountain ranges or on singular mountains. Globally, around 4% of all known plant species are native to alpine environments, which is surprising given that alpine habitats occupy only 3% of the earth's land surface (Korner 2003).

The Betty Ford Alpine Gardens located in Vail, Colorado, and Denver Botanic Gardens are partnering to conserve Colorado's alpine habitats and plant diversity. Beyond just Colorado, however, these organizations are aiming to protect alpine habitats throughout North America.

Horticulturists and scientists from both gardens partner to collect seed, tissue, and herbarium vouchers of alpine plants. They use these to understand these fragile species and to ensure they do not go extinct in the wild. Additionally, these two gardens hold unique and nationally recognized alpine collections. Betty Ford Alpine Gardens is accredited with the National Collection of Colorado's alpine flora by the American Public Gardens Association (APGA). With over 200 species represented, this is the only North American botanical garden with a collection devoted to Colorado alpine plants, mainly with wild origins.

Denver Botanic Garden's Alpines of the World collection houses over 500 alpine plant species and is recognized by APGA as the only one of its kind in North America. Alpine plants are exhibited at all Denver Botanic Gardens locations providing a unique opportunity to showcase living examples of both native and non-native alpine flora. Understanding how to grow alpine plants will prove essential to their conservation as restoration becomes more important with the continuation of climate change. We know Colorado's alpine plants are experiencing impacts from climate change. In a recent study, scientists at Denver Botanic Gardens used herbarium specimen data to examine the relationship between temperature and precipitation and bloom time of alpine plant species across 60 years. Results show that, on average, some species are blooming up to 39 days earlier than in previous years, thus indicating the sensitivity of these species to climate change (Hufft et al. 2018).

These two botanic gardens with strong alpine collections are currently working together on a formalized protection plan for fragile alpine ecosystems. Team members from all three organizations have drafted the North American Botanic Garden Strategy for Alpine Plant Conservation ("the strategy") as a first step towards enhancing our collaborative work. The strategy is a blueprint for protecting alpine plants and ecosystems in the US and Canada, focusing on the role of botanic gardens in this effort, including research, conservation, and education programs. The strategy uses two existing templates—the Global Strategy for Plant Conservation, first approved at the Conference of the Parties to the Convention on Biological Diversity (2002), and the North American Botanic Garden Strategy for Plant Conservation (2016-2020), which focuses on conservation efforts where botanic gardens can have the largest impact.

The alpine strategy provides a framework for North American botanic gardens to address environmental and climate change challenges facing alpine ecosystems. It highlights the critical role that botanic gardens in North America play in research, conservation, and education and is intended to encourage more plant conservation organizations to contribute to the collective goal. Additionally, the Strategy fosters collaborative relationships among nations in North America, as plant conservation is often not as effective when separated by national boundaries (BGCI, 2016).

This strategy is intended for use by not only botanic gardens, but natural history museums, universities, governments, native plant societies, and other stakeholders interested in preserving the natural heritage and ecological integrity of alpine zones in North America.

As we roll out the strategy, work related to each objective is well underway. Betty Ford Alpine Gardens is developing educational programming with an alpine-themed traveling exhibit funded in part with a grant from the National Informal Science Education Network. It will be part of its "Alpines in 2020" exhibit, running from June to October 2020. Afterward, it will be packed in a trunk and made available to botanic gardens and classrooms on request. Additionally, staff and docents will have the opportunity to participate in an alpine ecosystem training program that will be included in the traveling trunk. ►

The North American Botanic Garden Strategy for Alpine Plant Conservation has four objectives and 12 target activities:

Objective 1. Understand and document alpine plant diversity.

- **Target 1.** Develop a working map of all North American alpine areas by 2020.
- **Target 2.** Create a list of all known alpine plants of North America that highlights alpine plants with a Heritage Program global rank of G1/T1-G3/T3 by 2021.
- **Target 3.** Assess land management designations for all North American alpine habitats by 2023.
- **Target 4.** Provide comprehensive online access to floristic inventories and research on North American alpine plants to minimize gaps in knowledge by 2030.

Objective 2. Conserve alpine plants and their habitats.

- **Target 5**. Protect 50 percent of the most Important Plant Areas (IPA's) for alpine plant conservation in North America by 2030.
- **Target 6**. Conserve at least 25 percent of North American alpine flora *in situ* by 2025.
- **Target 7.** Conserve 60 percent of threatened alpine plant species in North America *in situ* by 2030.
- **Target 8**. Ensure that 60 percent of all identified alpine plant species in North America are placed in *ex situ* collections by 2035.
- **Target 9**. Ensure that at least 75 percent of threatened North American alpine plant species are held in *ex situ* collections, and 10 percent are in recovery and/or restoration programs by 2030.

Objective 3. Promote awareness of the alpine ecosystem and plant diversity through education and outreach.

- **Target 10**. Incorporate the irreplaceable value of the North American alpine ecosystem and plant diversity into educational and public awareness programs at botanic gardens by 2021.

Objective 4. Build capacity for the conservation of alpine plant species and associated habitats.

- **Target 11**. Increase the number of trained professionals working on North American alpine plant conservation to address local, regional and national needs by 2030.
- **Target 12**. Establish and strengthen networks, partnerships, associations and stakeholders for alpine conservation activities at regional, national and international levels by 2030.

◄ We've also made exciting headway by drafting a map that designates alpine zones throughout North America. Using this map, along with many floras, guidebooks, and research papers, we've started compiling a list of all North American alpine plants. This list, which will ultimately be publicly available, will help us to measure progress by calculating the percentage of alpine plants that are protected. We've also begun an assessment of important alpine plant areas in Colorado, noting species diversity and known threats within each area. The work we are doing in Colorado will help serve as a template for partners to use when assessing alpine areas in their own regions.

Additionally, we are working towards Targets 8 and 9 of the strategy through seed collection of rare and common alpine species in Colorado. So far, we have collected seed from several alpine tundra species. In addition to seed collection, research being conducted at Denver Botanic Gardens aims at understanding the seed storage behavior of alpine species in *ex situ* seed banks. Understanding how viability may change over time during storage is essential to effectively conserving alpine plant species and working towards Objective 2 of the strategy.

The alpine strategy team includes several team members from the Denver Botanic Gardens including Rebecca Hufft, Mike Kintgen, Jennifer Neale, Amy Schneider, and Alexandra Seglias. Team members from the Betty Ford Alpine Gardens include Nanette Kuich, Brittney Marshall, and Nicola Ripley. Antioch University PhD student Dawn Barton is also on the team.

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As the Director of Research & Conservation at the Denver Botanic Gardens, Jennifer serves as the public face of its work. She participates in regional, national, and international collaborative projects focused on biodiversity conservation. Her research is focused on using molecular methods to address questions of conservation concern related to rare plants in Colorado.

The Obscure and Ignoble Two-Grooved Milkvetch

By Jim Borland

Hundreds of thousands of dollars have been spent learning how to eradicate western native plants poisonous to livestock. Not a penny has been expended on their horticultural domestication. A case in point is two-grooved milkvetch (*Astragalus bisulcatus*), one of about 25 species of *Astragalus* that are naturally restricted to growing in soils with high levels of selenium. In these soils, *A. bisulcatus* is a hyper-accumulator of selenium, a fact immediately apparent to anyone who has collected its seed or stems and carried them for any distance in the car. Like riding a bike, one will never forget the smell of selenium after the initial experience.

Cattle, horses, and sheep ingesting large volumes of this plant can suffer blind staggers, loss of hair and hooves, and death. However, several insect species can ingest it without accumulating toxic levels of selenium and thus are not harmed.

Two-grooved milkvetch (*Astragalus bisulcatus*). © Matt Lavin https://www.flickr.com/photos/plant_diversity/albums/72157704251076655

None of these symptoms, however, are of any consequence to gardeners since we do not regularly graze our ornamental landscapes. Besides, in a classic case of tolerance versus need, plants, including two-grooved milkvetch, that are obligated to growing in selenium-bearing soils in nature do not need high levels of selenium in the garden. In nature, these plants tolerate selenium better than other plants and use it much like other plants use sulfur.

Obscurely known and ignobly named, two-grooved milkvetch is naturally found from Alberta to Saskatchewan and Manitoba south to Montana, New Mexico, Colorado, Nebraska, and western Kansas at elevations from 3,500 to 8,000 feet. This area corresponds to cold hardiness zones 6a (-5 to -10°F) to 3b (-30 to -35°F), mean annual precipitation of 12 to 20 inches, and pan evaporation of 55 to 90 inches. Its common name is derived from the Latin name *bisulcatus*, which refers to the two grooves found in the legume or bean pod.

On the plains, grasslands, mesas, bottomlands, and badlands, this perennial grows into a large, 16-to 36-inch tall by 20- to 24-inch wide clump of many pinnately leafy stems. Showy pink, lavender, deep purple to red spike-like racemes festoon the plant May through June. Pure white flowers occasionally occur as they do in my landscape. In fall, it dies back to a caudex, supported over winter by a deep stout taproot and nitrogen-fixing roots.

Propagation is most conveniently accomplished via commonly available seeds (119,000 to 136,200/lb.), which first must be extracted from a tough, but flexible, one-inch long pod. While some germination may result with the simple sowing of the 3-mm seed, scarification increases that probability to 88-98% of sound seeds. With no more than a little extra attention to soil aeration, seedlings and plants are easily grown and transplanted. Bloom can be expected in two to three years when grown in full sun and given limited irrigation.

Gravelly to clayey soils are accommodated by this plant equally well, and moisture in excess of that received in its native habitat should not prove too deleterious.

Aside from needing a better common name, two-grooved milkvetch requires little more than full sun to perform well in a naturalistic setting or in a no-water perennial bed.

Jim has been fooling around with native plants for more than 40 years in private, commercial and public venues. His home garden contains thousands of native plants, most grown from seed at home and now not supplementally watered for 20 years. Jim has written hundreds of articles, given talks too numerous to count, and continues to grow and plant the two or three native plants not yet in his garden.

Northern Chapter Completes Fall Planting at River's Edge Natural Area in Loveland

On a warm, sunny September morning at a popular Loveland Natural Area, CoNPS members, area volunteers, and city Open Lands staff gathered to install 119 plants representing 18 species native to the Big Thompson River corridor in west-central Loveland. Operating on a Larimer County Small Grant, volunteers interspersed the new plants among those established in two previous plantings completed in the Spring and tended by volunteers over the summer. Most of those 224 forbs, grasses, and shrubs had survived the heat, stress, and wildlife browsing, as had many young sprouts from directly seeded beeplant and globemallow seeds. Volunteers wrapped up the fall planting by sowing Loveland-harvested prickly poppy seed that should germinate next spring.

The project started as an inquiry from Loveland Open Lands staff to CoNPS members Nan Daniels and Curt Cole after a spring 2018 meeting of the city's Open Land Advisory Commission, whose monthly sessions they attend as observers for CoNPS. Nan and Curt were asked if CoNPS could provide guidance in planting natives in a small plot near the picnic tables at River's Edge. They took their photos of the picnic plot—and also of a larger weedy triangle at converging trails which was begging for attention—

On May 11, northern chapter president Hugh Mackay and Loveland Open Lands resource specialist Debbie Eley discuss the CoNPS mission, while community volunteer Hiroko Ishimaru plants prairie coneflower (*Ratibida columnifera*) in the background. Hugh initiated the chapter's monitoring of local boards to listen for opportunities to advocate for and protect rare plants or unusual ecosystems, such as when a new bike trail is being

CoNPS member Bob Trout gives Rhydge Asturi direction on how deep to plant a milkweed. Bob also heads up a separate project with local students to establish more milkweed (*Asclepias sp.*) around the ponds at River's Edge.
© Nan Daniels

and presented them at the next northern chapter meeting, where members started to think cautiously about what role CoNPS could play and how such a project could be funded.

A project leader emerged to take on coordination with Loveland Open Lands: Kathy Maher, aided by Linda Smith and Ann Grant, developed a plant list based on SEINet-listed natives common within a five-mile radius. Kathy designed the two garden plots and applied for Small Grant funds. After a site visit by Larimer County Small Grants for Community Partnering program staff and a few tweaks to proposal details, a $3,000 grant was approved in time to put plants on order for spring 2019 planting and for Loveland Parks Open Lands to schedule site prep. The chapter procured plant stock from local vendors and supervised volunteers drawn from schools, nearby communities, and CoNPS. The City recruited volunteers and provided water, gravel, tools, and staff to support planting events and ongoing maintenance.

The plantings are already serving as demonstration gardens. Many summer and fall visitors to River's Edge have stopped by to thank the volunteers as they planted, watered, or weeded the plots. A few of those passersby even volunteered themselves, in a demonstration of community stewardship. ►

◄ Interpretative signage featuring native plant illustrations by CoNPS member Linda Smith will be installed in early 2020; and an accompanying website developed by Kathy Maher that identifies and describes the plant species will be launched at the same time so that visitors can look up information on individual native species and learn how they might use local natives in their home gardens.

Northern chapter secretary and past CoNPS board member Nan Daniels helped set out natives, as well as photograph the activities, at Loveland's River's Edge Natural Area on the three planting days of this project.

Volunteers Terri Morton and Cheryl Lafond create a water-retention ring for winterfat (*Krascheninnikovia lanata*), while James Hartman and Allen Goodness prepare holes for *Yucca* and rabbitbrush (*Chrysothamnus sp.*) on April 20. © Nan Daniels

Later on April 20, CoNPS member Maddie Maher weeds while community volunteer Vin Mahida digs a hole for a rabbitbrush (*Chrysothamnus sp.*) plant. In the background, organizers Linda Smith and Kathy Maher confer while Terri Morton, James Hartman, Cheryl Lafond, and Hugh Mackay keep the pace going. © Nan Daniels

Berthoud High School students Haley Hanks, Kendra Maitland, and Cole Hanks plant dotted blazing star (*Liatris punctata*) and Indian ricegrass (*Achnatherum hymenoides*) during the morning's work, fulfilling part of their STEM program requirements. © Kathy Maher

Volunteers, students, and Open Lands staff survey the plants over the summer. © Nan Daniels

Research and Reports

Shoot Production in the Rare Alpine Calciphile *Saussurea weberi* Hultén: Insights into Its Population Dynamics

By Ron Abbott

CoNPS annually funds grants to support field and laboratory research as part of its John W. Marr and Myrna P. Steinkamp grant programs. Reporting on projects is a requirement of all grant recipients. In this issue, we are pleased to feature both Ron Abbott and Dr. Megan Peterson, who references Ron's work in her research. MM

One of my favorite quotes is by Jacob Bronowski, the late host of a wonderful television series called *The Ascent of Man*:

> ***"That is the essence of science: ask an impertinent question and you are on the way to the pertinent answer."***

In 1994, as part of fieldwork for a study of the pollination biology of the rare alpine calciphile, Weber's saw-wort (*Saussurea weberi* Hultén), I used rebar to permanently mark a series of inflorescences of the plant in Horseshoe Cirque on the east side of Horseshoe Mountain in the Mosquito Range of Colorado, west of the town of Fairplay (Abbott, 1998). Here is a confession which I feel perhaps only members of CoNPS would understand: having come to know them as individuals, by the end of that fieldwork, I had grown so fond of my *Saussurea* plants (and also of the bumblebees that I believe to be its principal effective pollinator). I wanted some way to continue to follow their lives. And so I formulated two impertinent questions:

Does shoot production in *Saussurea weberi* exhibit patterns?

If so, might those patterns provide insights into the population dynamics of *S. weberi* in particular, and perhaps reveal something fundamental about the biology of alpine plants in general?

Thus, beginning in 1996—for no other reason than simply to do it—I initiated a long-term monitoring project of shoot production in the population of *S. weberi* at my study site. I defined fifty of those rebar markers as foci of circular 1 m² plots. At the end of July and start of August that year and every summer since, I have counted the number, size, and reproductive status of *S. weberi* shoots growing within those plots. In particular, I count vegetative and floral shoots, classifying them within three size categories based upon number of leaves (Abbott, Doak, and Peterson, 2017).

Over the ensuing years the answer to the first question has been a resounding "yes." Patterns, some distinct, some subtle or suspected, have emerged for both the population as a whole and for individual plots. For this report, I present a few of the most evident patterns which 22 years of continued monitoring has revealed.

Fieldwork 2018

First, let me share the raw data and some anecdotal observations from the census in 2018. A total of 1290 shoots were found in all study plots: 797 in leaf class 1-5, 299 in class 6-10, and 194 in class 11 or more (a typical ratio among the size classes over the years of this study). Within the latter, 163 shoots bore inflorescences (shoots bearing inflorescences overwhelmingly occurred in this size class, the handful of exceptions falling in the next-smaller 6-10 class). This was a year of higher inflorescence production (see explanation below). The total number of shoots per plot ranged from 0 to 79 (suggesting high variation in local density throughout the population), and the number of inflorescences per plot from 0 to 18.

In past years, maggots of the anthomyiid fly *Botanophila furcula* (Huckett) (Abbott, 2007) have destroyed as much as 70% of fruit and florets within inflorescences of *S. weberi* in Horseshoe Cirque (Abbott, 1998). This year, for the first time since my shoot counts began, virtually no maggot damage was evident. Nearly all inflorescences seen were perfect in anthesis. Also, for the first time in many years, bumblebees were observed extensively in the Cirque, many visiting *S. weberi*.

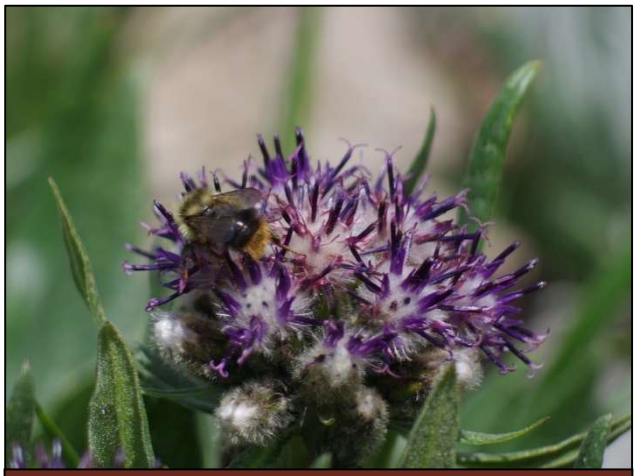
Population Persistence

Answers to the second question have only begun, but the first of those addresses continuity of the Horseshoe Cirque population of *Saussurea weberi*. Total shoot count had fallen steadily from a high of 1601 in 1999, but has stabilized and been holding steady since, with numbers ranging from 1275 to 1340 in each of the last five years. In the same way investing in multiple stocks provide a stable return on investment, "portfolio effects" have been determined to contribute to population *Saussurea* stability (Abbott, Doak and Peterson, 2017). (See the accompanying ►

◄ article by Dr. Megan Peterson.) Greater biodiversity tends to result in more stable plant populations.

Mortality and Local Extinction

Certainly, the extensive vegetative growth habit of *S. weberi* has contributed significantly to continuance of the population in Horseshoe Cirque (see Dr. Peterson's article). But the plant nonetheless has been extirpated altogether in one plot, and is very close to being so in two others.



Weber's saw-wort (*Saussurea weberi*, Hultén) with *Bombus sp.* © Kelly Ambler

In one study plot located on mine rubble, the number of *S. weberi* shoots fell drastically from 19 in 1997 to 8 the following year and finally 0 in 1999, and none have been found there since. In a second plot nearby, the number of *S. weberi* shoots has dwindled steadily from 80 shoots in 1996 to only 1 remaining in 2018. I believe interspecific competition is implicated in these disappearances, especially in the second plot where a tight mat of mountain avens (*Dryas octopetala*) now covers 75% of the plot.

Pocket gophers have impacted shoot production in a few study plots over the years. In most, *S. weberi* has bounced back from the effects of burial and predation of underground parts. In one plot, however, the number of *S. weberi* shoots was driven to 0 in 2015 by pocket gophers and only 1 shoot has been found each year since. Pocket gopher activity thus has a stochastic effect upon shoot production by *S. weberi*: some plants simply have the bad luck of finding themselves in a gopher's sights.

Floral Shoot Production

I have observed the strongest patterns in floral reproduction. The number and consistency of floral shoots from year to year has varied considerably among plots. The several plots located on mine rubble and those found near the north end of Leavick Tarn have consistently produced the greatest number of floral shoots as a proportion of the population total in any given year (although this may be an artifact of those plots also producing some of the largest total number of shoots per plot). One of those plots has produced at least one floral shoot every year since the beginning of the study, and a few more have missed floral reproduction in only one to a few years. Conversely, one plot not among these has shown a gap of 19 years between floral reproduction events, producing but a single floral shoot each time. Other plots have shown patterns varying between these extremes.

Perhaps the most interesting pattern—and the one which was first evident to me—is the alternation every other year from high to low inflorescence production for the population as a whole. Dr. Peterson has statistically confirmed this pattern to be real (Peterson, personal communication, 2017). Low floral reproduction has ranged from 35 inflorescences in 2013 to 84 in 1999; conversely high production has ranged from 94 in 2016 to 292 in 2005.

More interesting still are the two "hiccups" which have occurred in this alternating pattern. Sequential years showed high floral reproduction rather than alternating from high to low. From 2003 to 2005 the number of inflorescences increased each year to the greatest number (292) seen so far in the study, while in 2009 and 2010 nearly the same higher number (95 and 94, respectively) were produced. Afterward in each case, the alternating pattern was resumed.

For the time being these floral reproduction patterns remain unexplained. Certainly, part of the explanation will be found to involve the metabolic expense of producing a floral shoot. It likely takes a *Saussurea* plant more than a single growing season (and possibly multiple seasons) to accrue the excess photosynthate needed to produce such a robust structure.

While a tenuous proposition, it is nonetheless fun to speculate upon the broader possible adaptive value of a pattern of higher versus lower shoot production for *S. weberi*. Improved competitive ability for pollinators during higher production years might be one possibility. Another might involve "swamping" the *Botanophila* fly plant predator. Years of low inflorescence production would result in fewer adult *Botanophila* flies to lay fewer eggs on *Saussurea* inflorescences the following year. A higher number of inflorescences produced would be too many for the limited number of fly predators to damage, thus potentially resulting in a greater number of propagules for that year than would otherwise result.

Given the unprecedented low damage to inflorescences by *B. furcula* and the abundance of bumblebee pollinators in 2018, perhaps 2019 will be a banner year for sexual reproduction in the *S. weberi* ►

◄ population in Horseshoe Cirque. What will shoot counts be for the next year? Stay tuned for a future update.

Conclusion

These 20+ years of shoot production data on *Saussurea weberi* offer much grist for future investigation. I have done this work with the hope that researchers might find the information I have obtained useful for their own particular lines of inquiry. I would invite anyone who is interested in this information or knows someone who might be interested to contact me. I will happily forward data to them.

I am enormously grateful to the Colorado Native Plant Society for its support of not one (as I had originally applied for), but two years of fieldwork to conduct shoot counts of *Saussurea weberi* in Horseshoe Cirque. I hope that Myrna Steinkamp would be pleased with my efforts.

Ron has been a member of the Colorado Native Plant Society since 1984. With the assistance of his Bernese mountain dogs, Ron's goal is to personally accrue 40 years of shoot count data on Saussurea weberi *in Horseshoe Cirque, and to eventually hand the project on to others to continue into the future. Contact Ron at phippsia@aol.com.*

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Editor's note: Read more about the Horseshoe Cirque and its geology at

https://cmsgeologypost.blogspot.com/2013/10/horshoe-cirque-colorado=treasure.html

◄ "Rare plants …" *continued from page 4*

Pam Smith, a botanist with CNHP, orchestrated the afternoon session. Everyone gained insights into the importance of the Floristic Quality Assessment project. Through CNHP, Pam is leading the charge to cover the remaining 800 or so plants that were not given what is called a coefficient of conservatism, or C-value, during the first efforts in the 2000s to complete an FQA database for Colorado.

The FQA index reflects a plant's fidelity to a natural area or how obligated it is to a high-quality habitat versus its tolerance to landscapes with anthropogenic disturbances. On a scale of one to ten, a plant with a value of one resides almost exclusively in highly disturbed sites, such as annual sunflower (*Helianthus annuus*). A value of ten would reflect a plant wholly found in undisturbed, intact habitats, such as Kachina daisy (*Erigeron kachinensis*).

CNHP is now planning the next Rare Plant Symposium to ensure it stays lively and well attended as it has for sixteen years. So look for an even more alluring gathering for 2020.

For more information

- All of the information from this meeting, as well as previous symposia (2004-2019), is available online at the Colorado State University, CNHP website: https://cnhp.colostate.edu/projects/colorado-rare-plant-symposia/.
- For more information on the FQA efforts, contact pamela.smith@colostate.edu.
- View the Colorado Rare Plant Guide here: https://cnhp.colostate.edu/library/field-guides/.
- The Rare Plant Symposium is open to anyone with an interest in the rare plants of Colorado. For more information contact Jill Handwerk at jill.handwerk@colostate.edu and check the CoNPS website (www.conps.org) for details as they become available for the 2020 symposium.

Lisa Tasker is a botanist for CNHP and works primarily on Western Slope projects.

The Importance of Local Variation for the Conservation of Rare Plants

By Megan Peterson, Ph.D.

Among the abandoned mining claims of Horseshoe Cirque, in the Mosquito Range west of Fairplay, CO, one can find several rare alpine plant species. These include Hoosier Pass ipomopsis (*Ipomopsis globularis* (Brand) W.A. Weber), Gray's draba (*Draba grayana* (Rydb.) C. L. Hitchcock), and Weber's saw-wort (*Saussurea weberi* Hultén) (Schorr 2013). This last species, a perennial member of the Asteraceae family, is limited to limestone or dolomite-derived soils such as those at Horseshoe Cirque (Figure 1). In fact, Weber's saw-wort is only known from a few patchy and isolated populations in Colorado, Wyoming, and Montana. The existence of Weber's saw-wort and the many species with similar distributions reflects an important question in ecology—how can such rare species continue to persist in isolated and small populations?

Figure 1: Weber's saw-wort (*Saussurea weberi*, Hultén) in bloom at Horseshoe Cirque, CO. © Ron Abbott

The persistence of small populations over long periods of time has long been a mystery to ecologists. It is obvious why such populations should *not* exist: only a few bad years should, it seems, be enough to drive these populations to local extinction. One thing that is certain is that environmental conditions vary dramatically from year to year, and bad conditions (like droughts, heat waves, or outbreaks of herbivores or pathogens) are bound to occur. Yet, rare species persist in spite of these events. So, how do rare species avoid severe population crashes that could lead to extinction?

One explanation for population persistence is that not all plants within even a small population will have the same environmental responses. In other words, a bad year for some plants could be a neutral or even good year for others in the same population. This idea has its roots in economic. Portfolio theory argues that a more diverse portfolio of stocks—each of which will increase or decrease in value at different times—will maximize long-term profits. The ideas underlying portfolio theory were later developed in ecosystem and community ecology, where it has been argued that greater biodiversity of species can lead to a variety of ecological responses to changing environmental conditions from year to year (Thibaut & Connolly 2013). This so-called response diversity could explain why more diverse communities tend to be more stable over time. But, could we see the same benefits of diverse responses among individuals of a single species?

Response Diversity Within Small Populations

The central idea of response diversity is that different plants will have different responses to shared environmental conditions, like drought or warmer temperatures. Because the performance of the entire population depends on the performance of all of its individuals, these different responses can cancel each other out and prevent the population from either increasing or decreasing too much in response to a good or bad year (Figure 2). Stabilizing the size of the population from year to year can decrease the risk of a small population going extinct from a few bad years (Inchausti & Halley 2003).

One of the best examples of this general effect has been found in Weber's saw-wort, using data that Ron Abbott has collected on the abundance of this species in 49 study plots (1 m^2 in area) at Horseshoe Cirque every year since 1995 (see his article in this issue). Thanks to his long-term, consistent, and careful monitoring of this rare species, Ron, Dr. Dan Doak at the University of Colorado, Boulder, and I have been able to test for response diversity and whether it matters for the stability of this population.

Our analyses show that over the last 20 years, Weber's saw-wort plants growing in different plots did show variable responses to June temperature, one of the environmental variables with the biggest effect on this species (Abbott, Doak & Peterson 2017). Some parts of the population increased in numbers during warmer years while other parts of the population declined.

Importantly, the diversity of temperature responses across plots has stabilized the entire population size by almost three times what we would expect if all plants in the population had the same response to ►

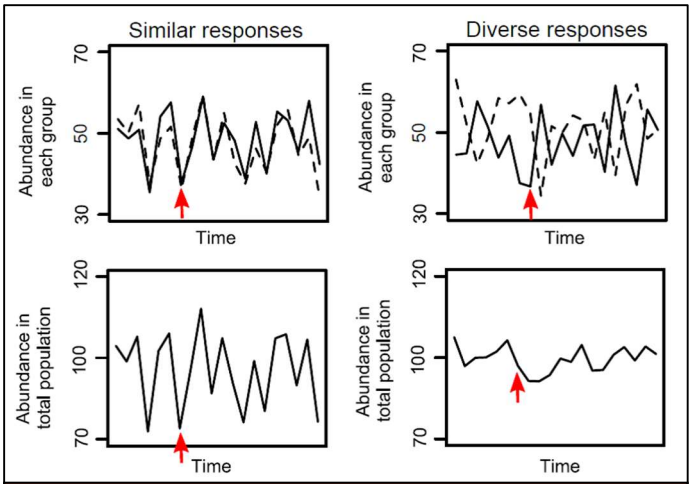

Figure 2: If different groups of plants respond similarly to environmental change from year to year (top left), then the entire population can decrease dramatically in bad years (bottom left), but if different groups have diverse environmental responses (top right), then the entire population can be much more stable over time (bottom right). Red arrow shows an example of a year with 'bad' environmental conditions.

◄ temperature. Equally important, these differences occur across exceptionally small distances and are not the result of any sharp habitat, slope, aspect, or elevational differences.

What could cause this response diversity? At this point, we cannot say definitively but there are a few intriguing possibilities. One is that there could be fine-scale environmental differences, like variation in shade, soil moisture, or nutrient availability, that could cause plants in those areas to be affected differently by warmer temperatures. For example, plants in a wetter, shadier location might benefit from warmer years while plants in a drier, sunnier location might experience heat stress. A second possibility is that local groups of plants could be more closely related to each other, and therefore, there could be genetic differences between groups of plants in different areas in the population. If these genetic differences affected the plants' temperature tolerances, it could explain why we might see different responses to temperature in different portions of the population. The biology of Weber's saw-wort makes this last possibility particularly intriguing. This species can spread vegetatively through rhizomes, which could mean that local groups of shoots could actually come from the same genetic individual.

Implications for conservation

Although there are still many unanswered questions regarding the causes of response diversity, its existence within Weber's saw-wort suggests interesting implications for the conservation of rare species and small, isolated populations. Local variation within populations, either environmental or genetic variation, could be really important to maintain response diversity and help to prevent population declines. Said differently, even for tiny populations of rare species, it may be generally important to save a range of habitats, rather than trying to target a single "optimal" habitat for conservation actions.

Although response diversity has played an important role in stabilizing Weber's saw-wort in the past, we also know that June temperature is and will continue to increase in alpine environments with forecasted global climate change (IPCC 2014).

What will happen to this rare species if June temperatures continue to increase? We have seen some hints of this in Ron's 20+ year data set, as Weber's saw-wort plants throughout the population have begun to respond more similarly, and the population as a whole declines, during really warm years (Abbott, Doak & Peterson 2017). Decreasing response diversity, coupled with population declines, could spell trouble for this rare species if June temperatures continue to increase. Luckily, Ron Abbott is continuing his valuable long-term study—with support from the Colorado Native Plant Society—to test the effects of climate change on response diversity and continue to monitor the health of Weber's saw-wort at Horseshoe Cirque. This work is not only important for understanding and conserving this rare species, but for understanding the mechanisms that allow many rare species to persist in a variable, and now changing, world.

Megan Peterson is a postdoctoral researcher at the University of Colorado Boulder. She studies the ecology and evolution of wild plant populations, with an emphasis on alpine and montane species.

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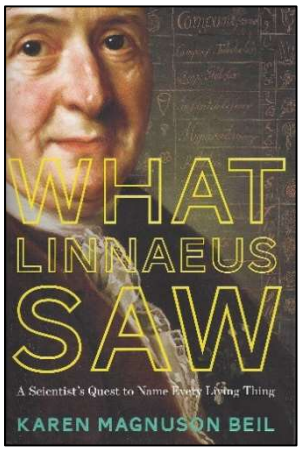
Book Review

What Linnaeus Saw: A Scientist's Quest to Name Every Living Thing by Karen Magnuson Beil

Reviewed by Mary Menz



Have you ever wondered how plants and animals got their scientific names? Author Karen Magnuson Beil answers the question in *What Linnaeus Saw: A Scientist's Quest to Name Every Living Thing*.

Beil shares with readers the story of a young Carl Linnaeus and his dream to organize every plant, mineral, and living being of the earth using a consistent methodology. As the author chronicles the life of Linnaeus, she renders such relatable facts as how he struggled with Latin and theology classes much to the dismay of his minister father, studied abroad and published texts on flora, and ultimately became a professor of medicine and botany at Uppsala University in Sweden.

This book is characterized as a Young Adult title, but the easy-to-read text and fascinating images—including Linnaeus's design for a tall cupboard to hold 6,000 sheets of pressed plants—are interesting to all levels of readers. According to *Atlantic Magazine* in a 2017 article, 55% of all YA readers are adults, "because a good story is just a good story, regardless of the intended audience."

Perhaps pick up a copy of this book for yourself, and then pass it along to a young friend. He or she might someday be inspired to study science just as Linnaeus, the father of modern taxonomy, was inspired by doctor and botanist Johan Rothman.

News and Announcements

(Please check the Events Calendar at https://CoNPS.org for updated information and registration.)

Chapter Events

Boulder Chapter Meetings: 2nd Tuesday of the month (usually), 6:30–8:30 PM

December 10: Tim Seastedt, "*The causes and consequences of changes in plant species composition found at low- and high-elevation communities along the Front Range.*" Tim Seastedt is professor emeritus of Ecology and Evolutionary Biology and senior fellow, Institute of Arctic and Alpine Research, University of Colorado. Presentation at 7:00 PM.
Venue: Open Space Mountain Parks Hub, 2520 55th St., Boulder CO.

January 14: Catherine Kleier, professor of Biology at Regis University in Denver, "Facilitation in Colorado Alpine Cushion Plants." Her current research interests include long-term restoration ecology of Colorado alpine trails, ecological impacts of skiing, and urban restoration ecology. Presentation at 7:00 PM.
Venue: Boulder Rural Fire Protection 6230 Lookout Rd, Boulder, CO.

Denver Chapter Meetings: 2nd Tuesday of the month (usually), Denver Botanic Gardens, plant society building 6:30–9:00 PM

December 14 (Saturday, 1:00–3:00 PM): Holiday Party, snacks and door prizes! Also, revelations about this year's fantastic floral blooms - bring your stories and photos! This will be a celebration especially for all the wonderful volunteers who've helped with chapter events, as well as a planning session for our participation in the 50th year celebration of EARTH DAY - April 22, 2020!! More info on Earth Day to come. Check out: www.earthday.org

January 14: Mike Bone, "Steppe flora of Colorado and worldwide." Mike Bone is the curator of Steppe Collections at DBG and co-author of book: "Steppes - the Plants and Ecology of the World's Semi-arid Regions."

February 11: Tyler Johnson, US Forest Service, "Which trees grow where and why; differences between deciduous and coniferous trees; Front Range trees and shrubs."

Workshop and Field Seminars a Success

By Kathleen Okon

Now that the field season has wound down to a close, CoNPS would like to recognize and thank all who were involved in making this a most successful year. Thanks to all the workshop and field seminar instructors who generously gave of their time and expertise to share with others. Because of your efforts, more than 275 participants attended 20 CoNPS-sponsored workshops and field seminars.

These instructors helped educate participants on the diversity, identification, unique characteristics or adaptations, and importance of native plants for all levels of plant lovers. Other topics included vegetative mapping, weed management, and seed collection programs for professionals in the field; a three-part native plant garden series for novice to experienced gardeners; wildflower identification workshops for budding plant enthusiasts; and botanic garden tours and ecology/ecosystems, butterfly, and photography field seminars—all were rated highly by attendees.

Thank you to these instructors who presented top notch workshops and field seminars:

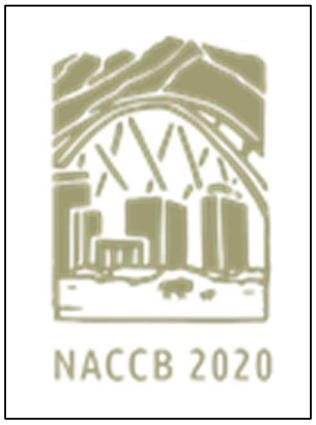
Jennifer Ackerfield
David Buckner, PhD
Casey Cisneros
Denise Culver
John Emerick, PhD
Mo Ewing
Debra Foster
Maggie Gaddis, PhD
Beth Hanson
Jim Ippolito, PhD
Panayoti Kelaidis
Tanner Marshall
Anthony Massaro
Lenore Mitchell
Evi Opler
Paul Opler, PhD
Lynn Reidel
James R. Self, PhD
Irene Shonle, PhD
Scotty Smith
Irene Weber
Andrew Wilson, PhD
Denise C. Wilson

Denise Culver, senior ecologist for the Colorado Natural Heritage Program, exhibits dame's rocket (*Hesperis matronalis*), a noxious weed, during her Wetlands Ecology Field Seminar.

Internationally known butterfly expert, Dr. Paul Opler, and his wife, Evi, presented a Butterfly Field Seminar at Golden Gate Canyon State Park.

Cross-Pollination Events

NACCB Conference: "Crossing Boundaries: Innovative Approaches to Conservation"
July 26th – 31st, 2020
Sheraton Downtown Hotel, Denver, Colorado
Closing reception at Denver Botanic Gardens.



This event brings together conservation professionals and students working across a wide variety of disciplines and institutions for discussion, innovation, and opportunities in science.

The goal of the North American Congress for Conservation Biology is to provide a forum for presenting and discussing new research, developments, and strategies that will inform policy changes and conservation practices to address today's conservation challenges. Most importantly, these conferences connect a regional community of conservation professionals and serve as the major networking outlet for anyone interested in conservation in North America.

The 2020 congress theme is *Crossing Boundaries: Innovative Approaches to Conservation*. There are various ways to participate in the 2020 congress:

- Call for Proposals is an invitation to submit proposals for symposia, interactive sessions, short courses, and workshops;
- Call for Abstracts is an invitation to submit abstracts for contributed talks, speed talks, and posters;
- Call for sponsors, exhibitors, and advertisements. See conference prospectus for details

Students may submit an extended abstract for consideration in the Student Presentation Awards, and also apply for a travel grant provided by SCB North America. For more information about the conference, visit www.scbnacongress.org

Whitebark Pine Ecosystem Foundation's International Conference: "Research and Management of High Elevation Five Needle Pines in Western North American"

Call for Presenters at WPEF

September 15-17, 2020
Missoula, MT

Forest managers, researchers, advocates, and the public are invited to attend this important event. Visit the conference website at www.highfivepines.org for details on presenting a paper or poster, becoming a sponsor, volunteering, or attending. Registration and presentation submissions will begin in February 2020.

Many high-elevation, five-needle pine forests are rapidly declining throughout North America. In particular, the following six species are the focus of the conference:

- Whitebark pine (*Pinus albicaulis* Engelm.);
- Limber pine (*P. flexilis* James);
- Southwestern white pine (*P. strobiformis* Engelm.);
- Great Basin bristlecone pine (*P. longaeva* D.K. Bailey); and
- Rocky Mountain bristlecone pine (*P. aristata* Engelm.).

At this conference the WPEF intends to bring together scientists, managers, and concerned citizens to exchange information on the ecology, threats, and management of these important pines; learn about the threats and current status of pine populations; describe efforts to mitigate threats through restoration techniques and action plans; and build a foundation for the synthesis of research efforts and management approaches.

Volunteers are needed to help at the 5th Annual Landscaping with Colorado Natives Conference February 29 in Denver.

Volunteers at Landscaping with Natives Conference receive 50% off Registration

See page 32 for more information about the conference. Volunteers will be assigned specific tasks from setting up signage, checking in registrants, distributing landscaping guides, monitoring in lecture rooms, monitoring in hallways, helping setup and take down the CoNPS Book Store, and taking down signage at the close of the conference. The registration fee for Volunteers is one-half that of regular attendees.

Contact Ronda Koski at ronda.koski@colostate.edu for more information.

Other Events

January 10
Boulder County Open Space Grant deadline
http://bouldercolorado.gov/osmp/funded-research-program

January 11
Audubon Rockies Bird-Friendly, Climate-Friendly Conference
Fort Collins, CO
https://rockies.audubon.org/events/bird-friendly-climate-friendly-conference

February 25-27
Colorado Plateau Native Plant Program (CPNPP) Annual Meeting
https://chapter.ser.org/rockymountains/event/colorado-plateau-native-plant-program-2020-annual-meeting/

February 5-7
Riparian Restoration Conference
Phoenix, AZ
https://riversedgewest.org/events/2019-riparian-restoration-conference

February 25-27
Native Prairie Restoration/Reclamation and Transboundary Grasslands Workshop
"The Big Picture: Planning and Partnership"
Regina, SK.

https://www.pcap-sk.org/upcoming-events/native-prairie-restorationreclamation-workshop-2020

February 16-20
SRM Annual Meeting
"A New Look: Transformation & Translation"
Denver, CO
http://rangelands.org/events-abstracts/

February 29
Landscaping with Colorado Native Plants Conference
Denver, CO
https://landscapingwithcoloradonativeplants.wordpress.com/

February 20-23
Colorado Environmental Film Festival
https://ceff.net/

February 22-March 1
Colorado Home and Garden Show
Denver, CO
http://coloradogardenfoundation.org/colorado-garden-home-show

March 3
Utah Rare Plant Meeting
https://www.unps.org/index.html?PAGES/calendar.html

April 22
Earth Day

Wildflower Coloring Books Available from the US Forest Service

Looking for something to brighten the drab winter days? Download free coloring books—or individual pages—for all ages from the US Forest Services website at https://www.fs.fed.us/wildflowers/kids/coloring/coloringbooks.shtml

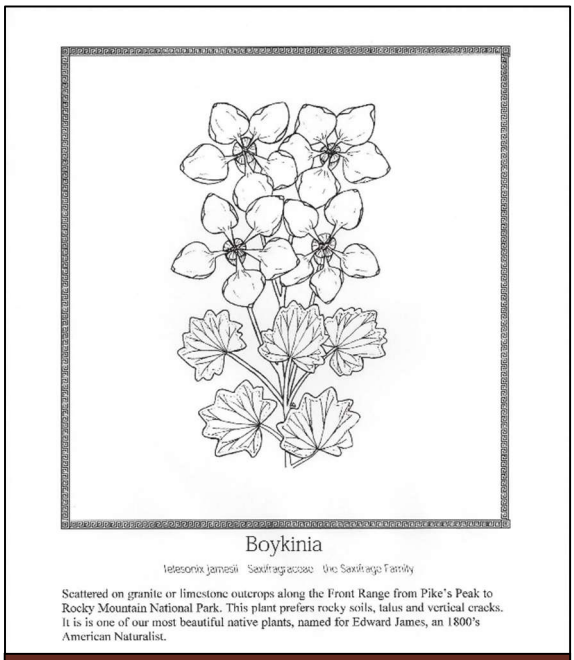
Each page features black and white illustrations with relevant information about the plants depicted. There are four coloring books relevant to the habitats in Colorado:

Wildflowers of the Western US (50 pages)
Drawings by Julie Kierstead Nelson

Wildflowers of the Ponderosa Pine Forests (29 pages)
Drawings by Karl Urban

Plants to Color from the Aspen Forest (10 pages)
No attribution

Wildflowers of the Colorado Mountain Tops (34 pages)
Drawings by Karl Urban and Janet Wingate



A sample page from the US Forest Service's *Wildflowers of the Colorado Mountain Tops* featuring *Telexonix jamesii*.

Support CoNPS on Colorado Gives Day!

Please help us reach our goal of $5,000. Thanks to the $1.5 Million Incentive Fund from Community First Foundation and FirstBank, your donation goes further on Colorado Gives Day. For example, if we receive one percent of the total donations made on Colorado Gives Day, we will also receive one percent of the $1.5 Million Incentive Fund – which would be $15,000! **To qualify, the donation must be made on Colorado Gives Day.**

Colorado's largest day of giving, Colorado Gives Day, is taking place on Tuesday, December 10, 2019. On this day, thousands of people come together to support Colorado nonprofits like ours. When you donate to CoNPS, you're helping our 3,000+ species of Colorado native plants. CoNPS is the only nonprofit organization in Colorado dedicated to furthering the knowledge, appreciation and conservation of native plants and habitats of Colorado through education, stewardship and advocacy.

Take your time and schedule donations at your leisure! Your donations will process on Colorado Gives Day, December 10, and still count towards the $1.5 Million Incentive Fund.

How to Schedule Your Donation in Advance:

1. Go to https://www.coloradogives.org/ColoradoNativePlantSociety/overview

2. Click the green Donate button. Enter or choose your donation amount. Under Donation Frequency, choose the option "CO GIVES DAY" to schedule the donation to process on December 10. Complete the other fields and click "ADD TO CART."

3. When your scheduled donation is in the cart, finish checking out by clicking on "PROCEED TO CHECKOUT", logging into or creating a donor account, entering or selecting your payment information, and then click on the green Submit button.

About Colorado Gives Day - Colorado Gives Day, presented by Community First Foundation and FirstBank, is powered by ColoradoGives.org, a year-round website featuring more than 2,000 nonprofits. ColoradoGives.org encourages charitable giving by providing comprehensive, objective and up-to-date information about Colorado nonprofits and an easy way to support them online.

Apply Now for Marr and Steinkamp Research Grants

Thanks to the generous contributions of many CoNPS members and supporters, approximately $10,000 each year is available for research grants. These two separate funds honor the late Dr. John Marr, professor at the University of Colorado and first president of the society, and Myrna Steinkamp, a founding member of the society who worked on behalf of CoNPS for many years in a variety of capacities.

The Marr fund supports research on the biology of Colorado native plants and plant communities. The Steinkamp Fund supports research on the biology of rare Colorado native plants.

Applications are due February 15. Visit the CoNPS website for more information.

CoNPS Membership

Name_____
Address _____
City _____ State_____ Zip_____
Phone _____
E-mail_____
Chapter (if known) _____

CHAPTERS: Boulder, Metro-Denver, Northern (Ft. Collins-Greeley), Plateau (Grand Junction & West Slope), Southeast (Colorado Springs-Pueblo), Southwest (Durango) or Unaffiliated

If this is a change in address, please write your old address here.
Address _____
City _____ State_____ Zip_____

☐ **Check box to receive information on volunteer opportunities**

DUES include the electronic version of the *Aquilegia* newsletter, published quarterly.

The 36-page, full color electronic publication arrives by PDF in member email boxes in March, May, August, and December. For those members without email addresses, please apply for a scholarship to receive print copies.

Membership dues cover a 12-month period.

□ New □ Renewal

□ Student $17 □ Senior (65+) $17 □ Individual $25
□ Family $35 □ Plant Lover $50 □ Supporting $100
□ Patron $250 □ Benefactor $500 □ Life Member $800

☐ **Printed Color Copy** of the newsletter, *Aquilegia*, $20

CONTRIBUTIONS to CoNPS are tax deductible:

John Marr fund for research on the biology and natural history of Colorado native plants $ _____

Myrna P. Steinkamp Memorial fund for research and other activities to benefit the rare plants of Colorado $ _____

Total included: $ _____

Please make check payable to:
Colorado Native Plant Society

Send completed form and full remittance to:
CoNPS Office
PO Box 200
Fort Collins, CO 80522

You may also join online at https://conps.org/mfm-join-page/

Thank you to our Conference Sponsors!

2019 Photography Contest

Second place winners on this page include (clockwise from top left): **Artistic**: Steve Olson, one-seed juniper (*Juniperus monosperma*). **Garden**: Linda Smith, nodding onion (*Allium cernuum*). **Plants** (tie; see next page): Bill Loessberg, roundleaf four-o'clock (*Mirabilis rotundifolia*). **Landscape** (tie): Carol McGowan, prairie smoke (*Geum triflorum*), and Ed Ogle, high-elevation meadow wildflowers. **Wildlife**: Kelly Ambler, alpine dusty maiden (*Chaenactis douglasii* var. *alpina*) and *Bombus sp.*

2019 Photography Contest

Second place winners on this page: **Plants** (tie; see previous page): Kelly Ambler, old-man-of-the mountain (*Hymenoxys grandiflora*, photo to the right).

Third place winners (starting below, counterclockwise): **Artistic**: Connie Vadheim Roth, quaking aspen (*Populus tremuloides*). **Landscape:** Bruce Tohill, mountain lupine (*Lupinus alpestris,* possibly an intergrade variety). **Plants**: Suzanne Dingwell, narrowleaf four-o'clock (*Mirabilis linearis*). **Wildlife** (tie): Linda Smith, three-leaf sumac (*Rhus trilobata*) with bee, and Steve Slocomb, Colorado blue columbine (*Aquilegia coerulea*) and *Bombus sp.*

Colorado Native Plant Society

P.O. Box 200
Fort Collins, Colorado 80522
http://www.conps.org

See page 32 for details