

Aquilegia

Magazine of the Colorado Native Plant Society

Volume 46 No. 3 Summer 2022





Rocky Mountain monkeyflower, *Mimulus gemmiparus* (Phrymaceae). An annual herb also known as budding monkeyflower that is endemic to Colorado, with only a few known populations occurring between 8,000 and 11,300 feet in elevation. This tiny plant (1–10 cm tall) is typically tucked away on seep-soaked granite outcrops, under overhanging boulders, or on alluvial deposits. The enigmatic monkeyflower exhibits a unique form of asexual reproduction not seen in any other plant in the nontropical parts of the Northern Hemisphere. Instead of producing clones through root or leaf fragments, budding monkeyflower creates unique propagules called “bulbils,” or “gemmae.” Bulbils are formed within deep sacs derived from the leaf petioles and contain all the components necessary to develop into a new, genetically identical plant. The bulbils are shed as the plant matures and are likely carried away by water or wind to take root elsewhere. Even though most reproduction is asexual, plants occasionally produce vibrant yellow flowers that give rise to seeds through sexual reproduction. Multiple populations are protected through the Colorado Natural Areas Program. Ongoing research seeks to answer questions about the species’ genetic diversity, population status, and the mechanisms behind its unique form of reproduction. This species will be discussed at the upcoming Rare Plant Symposium. *By Lucy Haggard, Colorado Natural Areas Program, and Savanna Smith, Colorado Natural Heritage Program. Photos: cover—Loraine Yeatts; this page—Raquel Wertsbaugh, Colorado Natural Areas Program.*

References

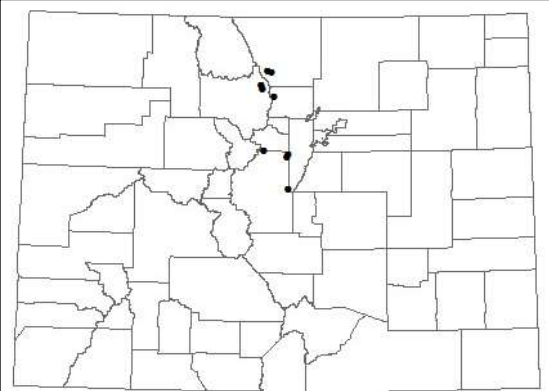
CNAP internal documents;
https://www.fs.fed.us/wildflowers/Rare_Plants/profiles/Critically_Imperiled/mimulus_gemmiparus/index.shtml
<http://www.cnhp.colostate.edu/rareplants/guide.asp?id=18872>
<https://ecos.fws.gov/ecp/species/3325>

Botanicum absurdum by Rob Pudim

SO WE'RE LOOKING FOR NIGHT-BLOOMING FLOWERS, WHAT IF THEY CLAMP SHUT WHEN THEY SEE A FLASHLIGHT?

Rob Pudim
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© Rob Pudim



Range map for Rocky Mountain monkeyflower (*Mimulus gemmiparus*).
 © Colorado Natural Heritage Program Rare Plant Guide
<http://www.cnhp.colostate.edu/rareplants/images.asp?id=18872&pid=2880>.

Aquilegia: Magazine 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

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19TH Annual Colorado Rare Plant Symposium

“Globally Imperiled Plants Found in Northeastern Colorado”

Friday September 16

8:00 AM – 4:00 PM

The Colorado Rare Plant Symposium is held each fall in conjunction with the Colorado Native Plant Society's Annual Conference. Hosted by the Colorado Natural Heritage Program, the symposium is an annual meeting addressing the status and conservation needs of rare plants in Colorado.

Proposed agenda:

8:00 – 9:00 AM: Registration

9:00 – 9:15 AM: Welcome

9:15 – 10:45 AM: Review of NE CO globally imperiled and vulnerable species

10:45 – 11:00 AM: Break

11:00AM – 12:00 PM: Partner presentations

12:00 – 1:30 PM: Lunch

1:30 – 2:30 PM: Updates on CODEX rare plant models, online Rare Plant Guide, and CNHP tracking list

2:30 – 3:30 PM: Partner updates

3:30 – 4:00 PM: Wrap-up

This year's symposium will highlight rare plants of northeast Colorado. CNHP senior botanist Susan Panjabi will present a photo review of species such as *Aletes humilis*, *Mimulus gemmiparus* (shown on the cover), *Physaria bellii*, *Potentilla rupincola*, *Spiranthes diluvialis*, and others.

Updates from partners will be included, along with presentations on rare plant conservation status and research. CNHP botanists will present updates on tools and models that assist with the identification, habitat evaluation, and surveying of rare plants.

CNHP tracks the location and condition of over 500 globally and/or state-imperiled plants, working closely

with botanists and land managers across Colorado to develop the state's most comprehensive and accurate dataset of Colorado's rare flora. Coordination among members of the rare plant conservation community is key to the success of conservation for these species, and information from the symposium will be used to update the location and status information in CNHP's statewide database.

Snacks and coffee and other beverages will be provided during the meeting. Please bring your own beverage cup. Lunch will be on your own; there are several restaurants within a five-minute drive of the symposium.

Please come for an opportunity to network with the rare plant conservation community and contribute to the conservation of Colorado's significant rare plant biodiversity. Registration is \$10 per person. To register, go to <https://conps.org/home-2/events/event-calendar-2/#!event/2022/9/16/19th-annual-colorado-rare-plant-symposium>

Past presentations and species-specific meeting notes from 2004 to 2020 are available on the CNHP website at <https://cnhp.colostate.edu/projects/colorado-rare-plant-symposia/> For more information, contact Jessica Smith at jp.smith@colostate.edu ☞



Spiranthes diluvialis
(Ute lady's tresses).
© Colorado Natural Heritage Program.



From the left: *Aletes humilis* (Colorado parsley), *Physaria bellii* (Bell's twinpod), and *Potentilla rupincola* (rock cinquefoil). © Colorado Natural Heritage Program.

46TH Annual CoNPS Conference

“From Peaks to Prairie: Exploring Diversity and Disturbance in Front Range Ecosystems”

Welcome to the 2022 Annual CoNPS Conference, hosted by the Boulder Chapter. The meeting will be held at the Longmont Museum on September 17, with field trips in the surrounding area on September 18.

On Saturday, we will hear from speakers with a wide breadth of experience in studying the complexities of biological diversity and the influence of disturbance in our wildlands. A variety of ecosystems along the Colorado Front Range and beyond will be showcased by experts who have been working in these landscapes for decades. Boulder County, the conference setting, is an ecologically diverse place with every life zone found in Colorado from 5,000 to 14,000 feet.

Please join your fellow registrants for a field trip on Sunday. Several options are available (see pages 8-10 for field trip descriptions).

In addition to the in-person conference, we plan to live-stream the presentations for virtual attendance. Note that presentations will not be recorded, nor will there be an opportunity to ask questions virtually. We encourage you to attend in person!

To register, go to <https://conps.org/home-2/events/event-calendar-2/#!event/2022/9/16/conps-2022-annual-conference>

Saturday Speakers and Presentations

(arranged alphabetically by last name)



Isabel de Silva

Willow Water Use in Highly Browsed, Nearly Beaver-less Riparian Systems in Rocky Mountain National Park

Willows (*Salix* spp.) are a keystone riparian species facing decline under altered hydrologic regimes (i.e., loss of beaver dams)

and increased herbivore pressure (i.e., ungulate browsing). Consequently, the National Park Service is piloting ways to speed up recovery of tall, willow-dominated montane riparian systems. Two examples of the pilot projects are equipping streams with simulated beaver structures to raise water tables and fencing ungulates out of 160 acres of Rocky Mountain National Park. However, willow recovery has been slow, and extant monitoring of cover and height has not identified mechanisms. De Silva took a novel approach, using ecophysiology to quantify transpiration, photosynthetic rates, and water potential to understand mechanisms of plant response across sites spanning a gradient in hydrological condition (wet, reference to dry, degraded sites) in RMNP. She shows how *in situ* ecophysiological assessments can answer a key management question: Are willows water-limited in RMNP?

Isabel de Silva is a PhD candidate in the Department of Ecology and Evolutionary Biology at CU Boulder. She

studies riparian ecology and restoration from a plant-community and ecophysiological perspective. For her dissertation, de Silva has researched willow water use and long-term plant community trends in Rocky Mountain National Park, in addition to testing novel native planting assemblages and methods to improve resiliency in a stage 0 adaptive riparian restoration setting on the Front Range.



Nancy Emery

Alpine Plant Responses to Changing Climate: Long-Term Trends and Experimental Insights from the Niwot Ridge LTER Program

Perched above the tree line along the most extensive mountain range in North America, the Rocky

Mountain tundra is one the most climatically extreme ecosystems occupied by plants on the planet. Adapted to long, cold winters, shallow soils, and short growing seasons, alpine plants are expected to be particularly vulnerable to climate change. The Niwot Ridge Long-Term Ecological Research program in the Colorado Front Range of the Southern Rockies has been monitoring alpine plant community dynamics for more than 40 years, with the goal of understanding when, where, and how fast alpine vegetation is responding to changing environmental conditions. The long-term data indicate that the responses of tundra plant ►

◀ communities to rising temperatures vary across the landscape, with the most turnover occurring in locations that experience the least amount of snow accumulation. Furthermore, the communities in these particularly dry, windswept locations have shown a trend of “reverse thermophilization,” with an increase in the abundance of cold-tolerant species. This trend may reflect an increasing role of drought tolerance in shaping plant community composition in these locations, which favors traits that often also promote cold tolerance. High rates of shrub expansion have also been documented at Niwot Ridge, consistent with global patterns of the “shrubification” of tundra systems. Shrubs change fine-scale patterns of snow accumulation and microclimate, plant community composition, and the nature of species interactions under their canopy. Collectively, these and other results from the Niwot Ridge LTER highlight the role of fine-scale heterogeneity, due to both abiotic (topography) and biotic (shrub) factors, in driving microclimate variation that drives alpine plant responses to rising temperatures.

Nancy Emery is an associate professor in the Department of Ecology and Evolutionary Biology at the University of Colorado Boulder and a co-investigator of the Niwot Ridge Long-Term Ecological Research Program. Her research program focuses on understanding plant adaptation in spatially and temporally variable environments, and the role of evolutionary processes in shaping plant responses to global change. Meagan Oldfather, postdoctoral researcher in Dr. Emery’s lab, is a collaborator on the described research.



Ava Hamilton
***The Cycles of Life—
 Everything Is Related***

Indigenous knowledge teaches how to understand life through appreciation of natural systems and their interconnections with the Earth. Hamilton’s presentation will center on the sharing of all knowledge, and how the

combining of Indigenous Knowledge Holders and Western sciences is advancing our understanding and approach to climate change as a world community.

Ava Hamilton is a documentary video producer whose primary research is on Indigenous histories. She is on the advisory board of Rising Voices Center for Indigenous and Earth Sciences, which recognizes the “many ways of knowing” through Indigenous knowledges and western Earth sciences. She works across different communities in Boulder County, Colorado, the United States, and her vast network of connections in the Native American community to convey the importance of Indigenous knowledge. Hamilton is Arapaho and has lived in Boulder since 1970. Photograph © Alan Rabold.



Julie Larson
***Mechanisms of
 Change: How
 Disturbance and
 Drought Shape Current
 (and Future) Plant
 Communities in
 Diverse Front Range
 Grasslands***

More frequent or extreme droughts are a major concern in much of the West, but the potential impacts are complex when we consider how disturbance contexts (e.g., grazing or fire management) and the biodiversity of a site may shape outcomes. Colorado’s grassland plant communities can include a diverse range of ecological strategies—both in the vegetation and stored in soil seed banks—that may respond differently to drought and disturbance. In this talk, Larson will discuss a multiyear experiment in Boulder, where research continues to track how plant communities respond to interacting rainfall and grazing conditions; this means looking not only at how plants grow and survive, but also at how the seed bank (and recruitment from it) may shape vegetative turnover and recovery. She will share what researchers have learned so far and discuss the types of questions they’re anticipating as they work to manage and restore biodiversity in an uncertain future.

Julie Larson is a postdoctoral research ecologist with USDA-Agricultural Research Service, working to improve native seed-based restoration in rangelands of the Intermountain West. She recently finished her doctoral degree at CU Boulder, where she continues to explore mechanisms of plant-community response to drought in grazed lands, in partnership with Dr. Katharine Suding and City of Boulder Open Space & Mountain Parks. She loves to discuss seed banks, plant-recruitment strategies, and how to make rangeland science more inclusive.



**Sarah Marshall and
 Laurie Gilligan**
***Wetland Biodiversity,
 from the Peaks to the
 Plains***

This presentation will take participants on a virtual tour of northern Front Range wetland types across the 10,000-foot-elevation gradient from the

Continental Divide to the plains, with discussion of both common and rare-plant communities and conservation needs along the way. Each speaker will share insights from their primary geographic ►

◀ focus, and current efforts to better understand and protect Colorado’s valuable wetlands.

Sarah Marshall is an ecohydrologist at the Colorado Natural Heritage Program who has worked with wetland and riparian ecosystems in the western U.S. for nearly two decades. She has a PhD in water-resources engineering, with expertise in ecological restoration and the effects of land use and management on wetland hydrology, soils, and ecology. Her work focuses on helping partners better understand, manage, and assess the extent and ecological condition of wetlands across Colorado and the West—from watershed planning to prioritizing headwater wetland conservation and restoration efforts to meet habitat, water-quality, and water-supply needs in a changing climate.



Laurie Gilligan has been a wetland ecologist at the Colorado Natural Heritage Program for 10 years and conducting ecology research for nearly 20. Her work at CNHP has focused on wetland inventory and assessment across the state of Colorado, with a recent focus on wetlands of the Colorado Front Range urban areas and eastern plains. She

also worked in urban wetland mapping and assessment for the city of Portland, OR. Prior to her work at the Colorado Natural Heritage Program, she worked a broad variety of ecology field jobs throughout the West, with an applied management focus. She has an MS in botany and plant pathology from Oregon State University, with an ecology focus.



Megan Matonis ***Shifting Composition: Short-term Impacts of the Calwood Fire on Native and Non-Native Plant Species***

A combination of extreme-fire weather conditions, unplanned ignitions, and dense forest conditions

have resulted in unprecedented wildfire behavior in northern Colorado. Matonis sampled understory vegetation in 12 mosaic-meadows created or expanded by forest thinning on Heil Valley Ranch to assess the response of understory vegetation to the 2020 Calwood Fire. She measured stand density, scorch height, crown scorch/consumption, and fuel loads at 44 plots distributed across the central and eastern portion of Heil Valley Ranch to explore impacts of pre-fire forest structure on burn severity. Understory plant cover and richness increased after the Calwood Fire, with non-native species showing a

strong, positive response to post-fire conditions. Forest structure had a marginal impact on vegetation and soil burn severity due to exceptionally dry and windy conditions during the first day of the Calwood Fire. However, there was evidence that several linked prescribed burns from 2014 to 2016 reduced soil and vegetation burn severity and are an important management strategy for restoring ponderosa pine ecosystems and enhancing their resilience to wildfire.

Megan Matonis is a wildfire behavior analyst with the Ember Alliance, a nonprofit organization dedicated to increasing the pace and scale of prescribed burning, empowering fire-adapted communities, and promoting diversity and inclusion on the fire line. She has a PhD in forest ecology from Colorado State University, and she previously worked for the Colorado State Forest Service and the Rocky Mountain Research Station of the US Forest Service. Dr. Matonis conducts wildfire behavior modeling for community planning efforts and conducts applied research projects on fuel management and wildfire effects. She has been an on-call wildland firefighter with the Larimer County Sheriff’s Office for eight years.

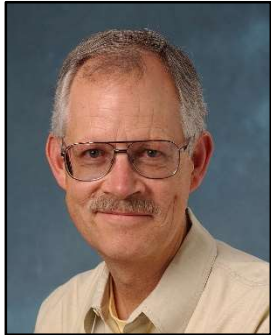


Christian Nunes ***Disturbances, Plants, and the Butterflies That Love Them***

Aristotle famously observed how nature abhors a vacuum. In nature’s race to fill unused space, we find mechanisms for

adaptation, niche partitioning, and ultimately an increase in biodiversity. From this perspective, nature relishes the vacuum created by disturbances. Avalanches, wind, fire, grazing, and all manner of biotic or abiotic processes that alter the energy flow in an ecosystem provide opportunities for uniquely adapted plants. Butterflies in turn capitalize on these early successional plant species and environments. Many of Colorado’s rarest butterflies, such as the hops azure, mottled duskywing, and Pawnee montane skipper, are in some way adapted to disturbance regimes. Land managers and conservationists need to consider these relationships when planning management actions. As the intermediate-disturbance hypothesis demonstrates, having too little or too much disturbance can have negative effects on target populations. Nunes will introduce some butterfly/plant/disturbance relationships and discuss examples of Colorado’s butterfly species that are struggling in the absence of ideal disturbance regimes, or which are being harmed by excessive disturbance. ▶

◀ *Christian Nunes is a wildlife ecologist for the City of Boulder Open Space & Mountain Parks Department. His professional work focuses on monitoring a variety of wildlife species across the city's 50,000-acre open-space system. Nunes works to maintain and improve functioning ecosystems for a variety of conservation targets, such as Colorado Natural Heritage Program–tracked butterfly species, black-tailed prairie dogs, bobolinks, and northern leopard frogs.*



Tom Veblen

The Challenge of Shifting from the Forest Restoration Narrative to an Evidence-Based Climate Adaptation Paradigm in Colorado

Landscape-scale forest restoration in Colorado has been driven largely by the belief that a return to forest structures that existed prior to 20th-century fire exclusion will simultaneously achieve goals of improved forest health, reduced societal exposure to extreme wildfires, and enhanced forest resilience to climate change. Increasingly, the efficacy of forest restoration practices is being questioned in the context of recent and continuing climate change. Competing frameworks focusing more explicitly on climate change adaptation are developing within land management institutions as well as more

broadly in conservation science, including the Resist-Accept-Direct framework. As new climate adaptation frameworks evolve, it is critical that they be based on a sound understanding of how climate variability affects the key broad-scale disturbances of wildfire and tree-killing insect outbreaks. For the forests of the Colorado Front Range, Veblen will synthesize multi-century tree-ring records of fire and insect outbreaks and their relationships to climate variability. In addition, he will summarize recent research from long-term forest monitoring plots, experimental and observational studies of tree establishment following recent wildfires and insect outbreaks, and the implications of these studies for adapting to projected future climate.

Tom Veblen is a University of Colorado Boulder Distinguished Professor Emeritus of Geography. He completed his PhD at UC Berkeley, was a faculty member at the Universidad Austral de Chile, a research scientist with the New Zealand Forest Research Institute, and finished his career in the Department of Geography at CU Boulder. His research centers on how natural and anthropogenic disturbances and climatic variability have shaped the forested landscapes of the Southern Rocky Mountains and the Southern Andean region of Nothofagus forests. In Colorado, he has used tree-ring methods to date past fires and insect outbreaks to reveal the historical range of variability of these disturbances. His current focus is on how to address the effects of climate change on the future of Colorado's forests. ☞

Sunday Field Trips

Please consider joining your fellow members on one of the trips exploring the natural habitats in Boulder County. Our trip leaders have put together a diverse range of possible fieldtrips this year. Details on where to meet will be provided at the conference.

Heil Valley Ranch Post-Fire Recovery and Ecology

Leader: David Hirt

8:30 – 11:30 AM

Explore a variety of habitats on Heil Valley Ranch impacted by the Calwood fire in October 2020. The group will discuss pre-fire forestry treatments and how they impacted fire behavior, and the planning and implementation of post-fire recovery efforts, including limited seeding, hazard tree removal, aerial mulching with wood shreds, the construction of in-stream structures to capture increased sediment, and tree planting and seeding. There will be an opportunity to witness the natural recovery, both good and bad, across the landscape.

One of the most visited parks in Boulder County Parks and Open Space's portfolio, Heil Valley Ranch encompasses over 6,000 acres of ponderosa pine foothills habitat, as well as diverse shrublands and grasslands. Part of the property has been recognized as an area of Outstanding Biodiversity by the Colorado Natural Heritage Program. In October of 2020, the Calwood fire burned nearly 75 percent of the property, including areas previously burned in 2003 by the Overland fire. 20 participants, easy to moderate activity level. Carpooling is strongly recommended.

David Hirt has worked with Boulder County Parks & Open Space since 1997 and is currently the senior plant/restoration ecologist, where he helps manage, monitor, map, and restore over 65,000 acres of public land with a diverse range of vegetation. Much of the restoration work in the recent past has unfortunately been focused on disaster recovery, including the 2013 floods, and multiple wildfires including the Walker, Overland, Fourmile, Calwood, and Marshall fires. ►

◀ Golden Gate Canyon State Park: Raccoon Loop Trail at Panorama Point

Leader: Denise Wilson

9:00 AM – 1:00 PM

Diverse ecosystems are encountered along this foothills trail. The field trip will begin with a 3.3-mile drive from Denise's house and a great view from the parking area. The groomed trail descends through lodgepole pine/spruce forest into an open willow-wetland area, and then along a wooded stream, where three earlier-flowering orchid species occur. Additional communities will include aspen forest with arnicas, asters, and ponderosa pine forest where ptarmigan, rabbits, coyotes, and weasels frequent.

12 participants, moderate activity level (3.5 miles).

Denise Wilson has lived at the north end of Golden Gate Canyon State Park for 34 years and conducted a 280-plot vegetation survey within the park. She completed her master's at the University of Colorado, Denver, and has served on the CoNPS board and as the events director for CoNPS.

Harlequin's Gardens

Leader: Mikl Brawner

9:00 AM – 11:00 AM

Harlequin's Gardens, a sustainable nursery and garden center, has been growing native shrubs for 30 years. There are mature specimens of many varieties, including curly-leaf mountain mahogany, wafer ash, New Mexican privet, New Mexican locust, grape holly, fern bush, Gambel oak, golden currant, big-toothed maple, and more. Native forbs are also featured along with ornamentals that are not native. The nursery focuses on drought-tolerant species. 25 participants, easy activity level.

Mikl Brawner is the founder and current manager of Harlequin's Gardens nursery, a garden writer, and a student and lover of the natural world.

Note that the field trips to Harlequin's Gardens and Rocky Mountain Botanic Gardens can be combined. Participants can register for one or both field trips.

Ron Stewart Preserve at Rabbit Mountain Open Space

Leaders: Stephen Hauptli and John Vickery

9:00 AM – 1:30 PM

Rabbit Mountain Open Space is one of Boulder County's largest contiguous holdings. It extends north to the Larimer County line and is one of only three Plant Conservation Areas in the county with Colorado Natural Heritage Program's highest rating of B1—Outstanding Biodiversity Significance. The field trip leaders participated in a recent floristic survey of Rabbit Mountain sponsored by the Boulder County

Nature Association. There are over two dozen plants at RM that are infrequent-to-rare at the statewide or county level, but these are spread out over a large landscape and many of them are represented by only one or very few occurrences. With this in mind, your trip leaders will choose a location with a good combination of botanical interest, geological interest, and scenery. The plant survey report for Rabbit Mountain can be found at <https://bcna.org/grants-for-research/> and

www.researchgate.net/publication/357646591

15 participants, moderate activity level (largely or entirely off-trail).

Stephen Hauptli has been a plant ecologist for Boulder County Parks & Open Space since 2014 and has been a member of CoNPS since 2007.

John Vickery is an ecologist and land management practitioner. Beginning with his tenure with the Native Plant Master Program a dozen years ago, he has conducted several botanical survey efforts of protected areas, largely in the northern Colorado Front Range.

White Rocks—Sand Prairies and Turtlebacks

Leaders: Dave Sutherland and Lynn Riedel

9:00 AM – 12:00 PM

Millions of years ago, it was a swampy river delta at the edge of a shallow sea. Today we know it as White Rocks, one of the most unique places around Boulder. Join Boulder's Open Space & Mountain Parks plant ecologist Lynn Riedel and naturalist Dave Sutherland for a journey into an area so fragile and precious that it is ordinarily closed to visitors. White Rocks protects unusual plants of exceptional local rarity and showcases local history and geological stories. Bring water and food as well as protection from sun, rain, and mosquitoes. 15 participants, moderate activity level.

Dave Sutherland is an award-winning field naturalist, recently retired from the city of Boulder's OSMP department. Along with working more than 20 years in the Boulder area, he has led outdoor education programs in California, Costa Rica, and the Galapagos Islands. He is a self-professed natural science geek who uses games and activities to inspire others with his love of nature. He has been training for his job since the age of four, when he began collecting rocks and butterflies and drawing his own bird books with crayons.

Lynn Riedel has spent her career in natural areas management in Colorado. She has worked as a plant ecologist with Boulder's OSMP department since the mid-1990s, specializing in grassland ecology. In Dinosaur National Monument and in Boulder, her work has included rare plant monitoring and habitat management, native plant community monitoring and mapping, and comprehensive natural area management planning. ►

◀ Esoterra Culinary Garden

Leader: Mark DeRespinis

9:30 – 10:30 AM

Esoterra Culinary Garden is a small-scale, no-till diversified vegetable farm operating in rural Boulder County. The farm supplies many restaurants in the Denver area with a large variety of produce. Mark DeRespinis, the proprietor, gives captivating tours of this remarkable farm, located on City of Boulder Open Space & Mountain Parks land. The focus of Esoterra Culinary is, "Cultivating a relationship with the soil, harvesting the land, and celebrating beautiful produce." Esoterra Culinary works to fit into the larger natural landscape in the surrounding open space. Join this fascinating and inspiring tour, and then take an optional self-guided walk on the nearby White Rocks Trail. The trail crosses Boulder Creek, where you may see bald eagles and will get a glimpse of the White Rocks cliffs to the west. 20–25 participants, easy activity level.

You are invited to go on an optional self-guided walk on the nearby White Rocks Trail after the farm tour.

Farmer/Owner Mark DeRespinis returned to the Front Range to start Esoterra Culinary Garden after developing a farm at the world-renowned Ojo Caliente Mineral Springs resort in northern New Mexico. He is building long-term relationships with the most innovative and quality-focused food enterprises in the region.

Rocky Mountain Botanic Gardens

Leader: Garima Fairfax

1:00 – 2:00 PM

The Rocky Mountain Botanic Gardens features native plants that grow in the foothills surrounding Lyons as well as plants from the mountains above Lyons, riparian areas along rivers, grasslands to the east of Lyons, and plants from the southwestern part of Colorado. It is the first botanic garden established in Boulder County and is an ideal location, where the mountains meet the prairie. RMBG is a nonprofit organization that is free and open to the public all year, with donations accepted.

Visitors discover labeled native plants that will do well in their yards with little watering or special needs and learn more about Colorado plants that they commonly encounter while enjoying the outdoors. Classes are planned in native plant identification and gardening with native plants to attract bees and butterflies. 25 participants, easy activity level.

Please consider meeting at nearby Bohn Park in Lyons by the St. Vrain River for a bring-your-own picnic lunch before the tour. Participants may stay at the RMBG as long as they wish after the tour.

Garima Fairfax is a Lyons, CO resident who had the idea of developing a botanic garden in Lyons, and she has done that with the help of a dedicated group of volunteers (see <http://www.rmbg.org>).

Note that the field trips to Harlequin's Gardens and Rocky Mountain Botanic Gardens can be combined. Participants can register for one or both field trips.

Tall Oatgrass in Shanahan Ridge/NCAR

Leader: Kelly Uhing

1:30 – 3:30 PM

Learn about the invasive plant tall oatgrass that is currently infesting Open Space & Mountain Parks properties in Shanahan Ridge, south of Boulder. This area is home to xeric tallgrass prairie that is being outcompeted by this aggressive invader. Meet OSMP staff who are working hard to reduce infestations through integrated management, including cattle grazing. Attendees will also look at the recent NCAR burn area and how that has affected tall oatgrass as well as native vegetation. 10 participants; easy to moderate activity level.

Kelly Uhing is the Vegetation Stewardship Program Supervisor for Boulder's Open Space and Mountain Parks. She has worked in the field of natural resources, specializing in noxious-weed management, for 25 years.

Tallgrass Prairie in the Boulder Area

Leaders: Lynne Sullivan and Lynn Riedel

1:30 – 4:30 PM

Tallgrass prairie is one of the most endangered ecosystems on the earth. City of Boulder Open Space & Mountain Parks protects some beautiful examples along the outer Front Range of the Rocky Mountains, disjunct from tallgrass prairie in the Midwest. Explore the ecology and flora of this rare and unique prairie ecosystem with plant ecologist Lynn Riedel and interpretive naturalist Lynne Sullivan. Meet the local species and delve into the evolution of events enabling this rich habitat to survive and thrive. 15 participants, easy to moderate activity level.

Lynne Sullivan is a longtime interpretive naturalist who enjoys exploring and sharing the lives and landscapes of our wild kin here in the Front Range of the Colorado Rocky Mountains.

Lynn Riedel has spent her career in natural areas management in Colorado. She has worked as a plant ecologist with the City of Boulder Open Space & Mountain Parks Department since the mid-1990s, specializing in grassland ecology. In Dinosaur National Monument and in Boulder, her work has included rare plant monitoring and habitat management, native plant community monitoring and mapping, and comprehensive natural area management planning. ♻️

Conference Agenda

To register online, go to <https://conps.org/home-2/events/event-calendar-2/#!event/2022/9/16/conps-2022-annual-conference> Or mail in your paper registration (page 14).

Friday, September 16

8:00 AM – 4:00 PM: Rare Plant Symposium at the Longmont Museum, 400 Quail Rd.

Saturday, September 17

8:00 AM – 5:00 PM: CoNPS Annual Conference at the Longmont Museum, 400 Quail Rd.

Time	Description	Speaker
8:00 AM	Attendee check-in/registration; on-site Bookstore; Photo Contest and Silent Auction viewing	
9:00 AM	Welcome and Introductions	Pat Butler, Boulder Chapter Maggie Gaddis, CoNPS ED
9:15 AM	<i>Disturbances, Plants, and the Butterflies That Love Them</i>	Christian Nunes
9:55 AM	<i>Alpine Plant Responses to Changing Climate: Long-Term Trends and Experimental Insights from the Niwot Ridge Long-Term Ecological Research Program</i>	Nancy Emery
10:35 AM	Break	
10:55 AM	<i>The Challenge of Shifting from the Forest Restoration Narrative to an Evidence-Based Climate Adaptation Paradigm in Colorado</i>	Tom Veblen
11:35 AM	<i>Willow Water Use in Highly Browsed, Nearly Beaver-less Riparian Systems in Rocky Mountain National Park</i>	Isabel de Silva
12:15 PM	<i>Lifetime Achievement Award to Linda Smith</i>	Maggie Gaddis
12:30 PM	Lunch	
2:00 PM	<i>Mechanisms of Change: How Disturbance and Drought Shape Current (and Future) Plant Communities in Diverse Front Range Grasslands</i>	Julie Larson
2:40 PM	<i>Wetland Biodiversity, from the Peaks to the Plains</i>	Sarah Marshall and Laurie Gilligan
3:20 PM	Break	
3:40 PM	<i>Shifting Composition: Short-Term Impacts of the Calwood Fire on Native and Non-Native Plant Species</i>	Megan Matonis
4:20 PM	<i>The Cycles of Life: Everything Is Related</i>	Ava Hamilton
5:00 PM	Final Announcements	

Sunday, September 18

Field trips

Meetup locations will be provided at the conference on Saturday.

8:30 AM – 11:30 AM Heil Valley Ranch Post-Fire Recovery and Ecology

9:00 AM – 11:00 AM Harlequin's Gardens

9:00 AM – 12:00 PM White Rocks—Sand Prairies and Turtlebacks

9:00 AM – 1:00 PM Golden Gate Canyon State Park: Raccoon Loop Trail at Panorama Point

9:00 AM – 1:30 PM Ron Stewart Preserve at Rabbit Mountain Open Space

9:30 AM – 10:30 AM Esoterra Culinary Garden

1:00 PM – 2:00 PM Rocky Mountain Botanic Gardens

1:30 PM – 3:30 PM Tall Oatgrass in Shanahan Ridge/NCAR

1:30 PM – 4:30 PM Tallgrass Prairie in the Boulder Area

Annual Silent Auction Benefits CoNPS Activities

We will be holding the silent auction in person at the conference this year and can use your donations now. Plant-related items of all kinds are needed: clothing, art works, books, hiking equipment, gift certificates, equipment, plants, and planting tools are only some suggestions! Landscape planning consultations are especially popular. For preview, see <https://conps.org/silent-auction-preview-2022/>

The auction is a lot of fun, and a beneficial fund raiser for CoNPS. Let's do it again! Items can be brought to the Conference on Friday or by 8AM on Saturday, or dropped off at one of our volunteer member locations. Donors should send photos, descriptions, original cost, and fair market value of items to Sue Dingwell at sageblue892@gmail.com or to Denise Wilson at deniseclairewilson@gmail.com.

Annual Photo Contest Call for Entries

Share your spectacular photos of native plants and scenery in our Annual Photo Contest! We know you have some! Your favorite photos from any year are eligible. You may submit one photo in each of five categories, listed below.

1. Colorado Native **Plants**
2. Colorado Native Plant **Landscapes**
3. Native Plant **Gardens**
4. Colorado Native Plants and **Wildlife**
5. **Artistic** interpretation of Colorado Native Plants. Artists are welcome! Photo of a fine art painting or an altered photograph or collage are acceptable. The artwork must contain at least one recognizable Colorado native plant.

Email entries to Anna Theodorakos, annatheo712@gmail.com, with "CoNPS Photo Contest" written in the subject line.

Entries must be a single work of original material submitted by the contest entrant. Entries MUST include the scientific name of the primary plant species in the photo, at least to genus level, and preferably to species level. Also include your last name and photo category in the file name. Please submit photos by September 2. If you are struggling with identifying the plant in your photo, email Anna and she can provide resources to aid in identifying. For full details, see <https://conps.org/home-2/conps-photo-contests/>

Voting will take place in-person at the CoNPS Annual Conference on September 17.

Contest is open to all CoNPS members. All entries will be on display during the 2022 Conference.

Volunteers Needed for the Annual Conference

We will need volunteers for a variety of jobs at the conference. Please contact the Boulder chapter conference committee at boulderconps@gmail.com

In addition, are you willing to write a summary of one or two of the presentations from the Annual Conference? If so, please contact Kelly Ambler (alpineflowerchild@gmail.com).

Let's Minimize Waste at the Conference!

The Conference Planning Committee is committed to minimizing waste from the food and beverages served at the conference. The Longmont Museum requires food service items (cups, plates, utensils, napkins) be recyclable or compostable. The lunch caterer (Community Table Kitchen) will deliver sandwiches and sides in compostable boxes. We hope that all participants will bring their own cups for coffee and other drinks, though we will have some compostable cups. Food served at breaks will require no plates or utensils, so if you want a plate and utensils, please bring your own. The museum has receptacles to dispose of compostable, recyclable and landfill items and we'll have signs about what goes where. Thank you, everyone!

Opportunity to Sponsor the Colorado Native Plant Society 46th Annual Conference

Daisy Level - \$50 gets your name and logo in the Conference Agenda, in the *Aquilegia* issue summarizing the Conference, and in the eNews, our bi-monthly electronic newsletter.

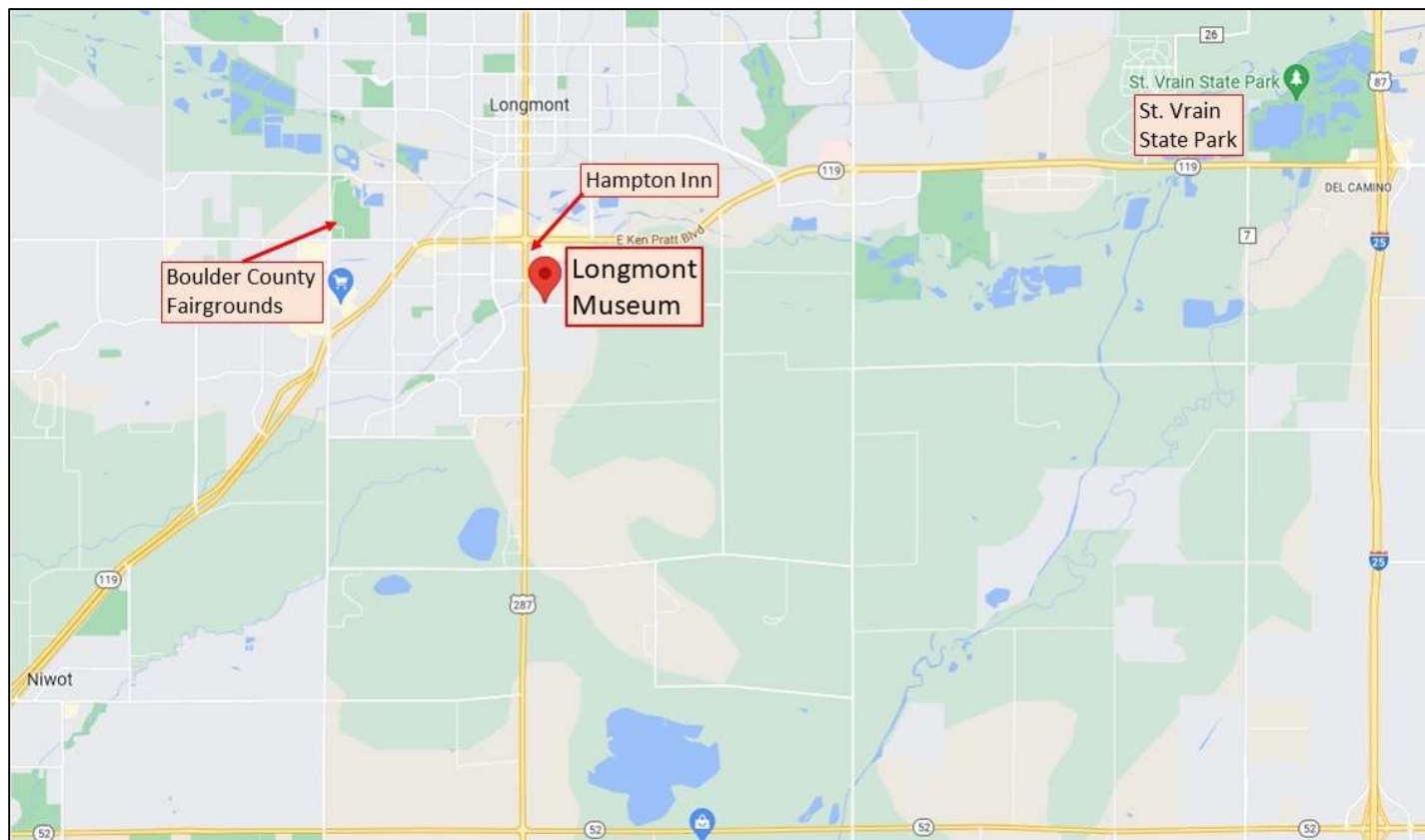
Golden Banner Level - \$100 gets ALL the above acknowledgements plus acknowledgement in the *Aquilegia* magazine for one year.

Columbine Level - \$250 or more gets ALL the above, plus your logo and name on the home page of the CoNPS.org website for one year.

Wood Lily Level - \$500 or more gets ALL of the above, plus a booth/table at the Rare Plant Symposium on Friday, September 16 and at the conference on Saturday, September 17.

<https://conps.org/home-2/events/event-listing/#!event/2022/8/1/business-sponsor>

Longmont Maps and Information



Housing

Discounted hotel rates are available at the Longmont Hampton Inn (850 S Main St, Longmont, CO 80501) until August 16. For reservations, call (303)772-2554 or reserve online using code **CPS**.

<https://www.hilton.com/en/book/reservation/deeplink/?ctyhocn=DENLMHX&groupCode=CHHCPS&arrivaldate=2022-09-15&departuredate=2022-09-19&cid=OM,WW,HILTONLINK,EN,DirectLink&fromId=HILTONLINKDIRECT>

Camping

There are several camping options available in the Longmont area. Here are a few options.

Boulder County Fairgrounds Campground
9595 Nelson Rd, Longmont, CO 80501
<https://www.bouldercounty.org/open-space/fairgrounds/campground/>

St. Vrain State Park
3785 Weld County Rd 24 1/2, Longmont, CO 80504
<https://cpw.state.co.us/placestogo/parks/StVrain/Pages/default.aspx>

Countrywood Inn & RV Park
1550 N Main St, Longmont, CO 80501
<https://www.countrywoodinn.com/>

Flatiron Campground

10528-10932 W County Rd 18E, Loveland, CO 80537
<https://www.larimercamping.com/camping/flatiron-reservoir/r/campgroundDetails.do?contractCode=LARC&parkId=710103>

Carter Lake Shore Campground

4011 S County Rd 31, Loveland, CO 80537
<https://www.larimercamping.com/campgroundDetails.do?contractCode=LARC&parkId=710102>

Riverview RV Park & Campground

2444 River Rim Road, Loveland, CO 80537
<https://www.riverviewrv.com/>

Fireside Cabins & RV

6850 US-34, Loveland, CO 80537
<https://www.firesidervparkandcabins.com>

Loveland RV Resort

https://www.lovelandreresort.com/?utm_source=GoodSam

Pepperpod Campground

450 5th Ave, Hudson, CO 80642
<http://hudsonrvpark.com>

See the CoNPS website for full housing and camping information (<https://conps.org/2022-conps-annual-conference/>).

Registration

Registration is available online through September 8 at 5:00PM. Please log in if you are a CoNPS member, then proceed to the Calendar of Events to register. <https://conps.org/home-2/events/event-calendar-2/#!event/register/2022/9/16/conps-2022-annual-conference>

If registering by mail, please complete the following registration form for each person attending. Mail registration form and payment to:

CoNPS, c/o P.O. Box 200, Fort Collins, CO 80522-0200

Name (first, last) _____

Phone _____ **Email** _____

Mailing address _____

Registration fees include attendance to the Annual Conference on Saturday, September 17, a box lunch and snacks on Saturday, and the Sunday field trip of your choice. There is no price reduction when opting out of the box lunch. Separate fees are charged for attending the Rare Plant Symposium.

Member registration*

The 19 TH Annual Rare Plant Symposium @ \$10	\$ _____
The 46 TH Annual Conference	\$ _____
Regular registration @ \$65 (\$75 after September 9)	\$ _____
Student registration @ \$30	\$ _____
Virtual option only @ \$25	\$ _____
Total enclosed	\$ _____

Non-member registration* Consider becoming a member! See page 42

The 19 TH Annual Rare Plant Symposium @ \$10	\$ _____
The 46 TH Annual Conference	\$ _____
Regular registration @ \$75 (\$85 after September 9)	\$ _____
Student registration @ \$40	\$ _____
Virtual option only @ \$35	\$ _____
Total enclosed	\$ _____

* A limited number of scholarships are available. See [CoNPS.org](https://conps.org) for details.

Lunch options, choose one:

- Chipotle chicken wrap with spiced black bean spread, avocado, and queso fresco
- Gluten-free chipotle chicken wrap with spiced black bean spread, avocado, and queso fresco
- Hummus sandwich with avocado, sprouts, spinach, and cucumber
- Gluten-free hummus sandwich with avocado, sprouts, spinach, and cucumber
- Grilled vegetables on herb focaccia with goat cheese and basil pesto
- Gluten-free grilled vegetables on herb focaccia with goat cheese and basil pesto

The box lunches include the sandwich, chips, and a dessert. Coffee, tea, water in carafes, and canned beverages will be available at lunch and at snack breaks.

Field Trip Options

Please indicate first and second choices for Sunday field trips (included in registration), assigned on first come, first served basis.

_____ Esoterra Culinary Farm	_____ Heil Valley Ranch	_____ Rocky Mountain Botanical Garden
_____ Golden Gate Canyon SP	_____ Invasive tall oatgrass	_____ Tall grass prairie
_____ Harlequin's Gardens	_____ Rabbit Mountain	_____ White Rocks Preserve

Please check if you would like to be contacted about carpooling. If checked, your phone/email information will be provided to others interested in carpooling.

Colorado Native Plants for Phytoremediation: Improving Heavy Metal Contaminated Soil with Native Plants

By Eric Fuselier

Without soil, life on land would be impossible. Soil is a medium for plant growth and a habitat for living organisms. Our society depends on soil to grow our food, and soil is the foundation upon which the web of life depends. History has shown that civilizations that do not take care of their soil eventually suffer the consequences of their poor choices and collapse. Even today, we could easily suffer the same fate if we are not wise in our approach toward soil management.

Soils can become degraded through the accumulation of toxic levels of heavy metals by a variety of means, from mine tailings to smelting operations, leaded gasolines and paints, wastewater irrigation, and land application of fertilizers, pesticides, animal manures, and sewage sludge.

Soil is a major sink for heavy metals, which can pose hazards to both humans and ecosystems through physical contact with or direct ingestion of contaminated soil, drinking contaminated groundwater, or through the food chain (soil-plant-human and soil-plant-animal-human). Exposure to toxic levels of heavy metals can have adverse effects on human health, such as decreasing our immunological defenses, impairing our mental faculties, and increasing our risk of certain cancers.

Mining and smelting industries have impacted soil quality at several locations within Colorado. For example, smelting operations left soil contaminated with cadmium and zinc at the Smelertown Superfund site near the city of Salida in Chaffee County. Mining operations have contaminated soil with zinc, cadmium, and copper, and other heavy metals at the Nelson Tunnel/Commodore Waste Rock Superfund site near Creede in Mineral County, the Eagle Mine Superfund site near Minturn in Eagle County, the Summitville Mine Superfund site in Rio Grande

County, and the Standard Mine Superfund site in the Gunnison National Forest in Gunnison County.

Native plants offer one potential solution for remediating soil contaminated with these heavy metals, through a process called phytoremediation. Without implying that phytoremediation is the perfect solution in every case of heavy-metal contamination (or for any of the above-listed Superfund sites), this article will examine how phytoremediation of heavy metals

works, leaving it to the engineers and environmental professionals to determine when this technique would be a feasible remediation option for their projects.

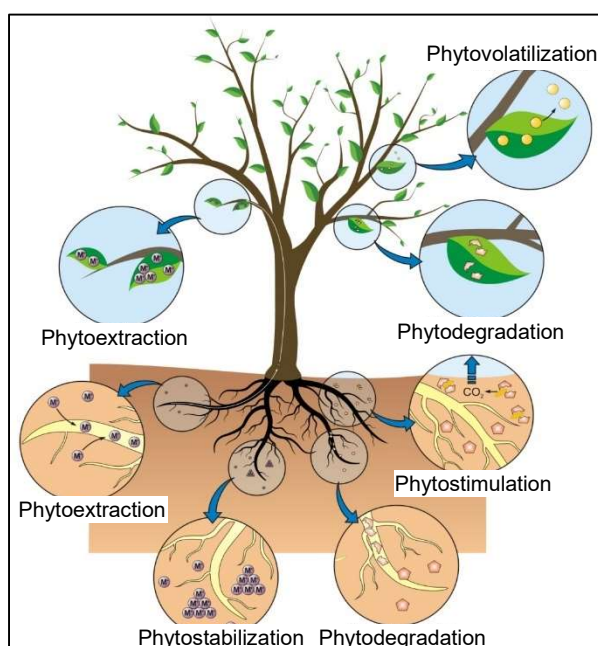
How It Works

Unlike organic contaminants, heavy metals cannot be broken down to be made less toxic. Because of this, other methods than those we have discussed in previous *Aquilegia* articles will need to be used to remove these elements from contaminated soil.

The first step is to identify native species that can colonize metalliferous soils. Heavy metals generally produce toxic effects on most plant species, making it difficult or impossible for them to survive in these soils.

Adverse effects that heavy metals have on plants include low biomass accumulation, chlorosis of leaf tissue, inhibition of photosynthesis, altered water balance, and altered nutrient assimilation, all of which can ultimately cause the plant to die. However, some plant species have evolved physiological mechanisms that enable them to tolerate metal toxicity and allow them to grow in soil contaminated with heavy metals.

“Accumulator” species are those plant species that can absorb metals from the soil into their tissues. In order to do this, the metal must first be dissolved into a solution that the plant roots can absorb. Once this has happened, the plant roots can then absorb ►



From Favas P, Pratas J, Varun M, D'Souza R, and Paul MS. 2014. *Phytoremediation of Soils Contaminated with Metals and Metalloids at Mining Areas: Potential of Native Flora* <https://www.intechopen.com/chapters/46355> DOI: 10.5772/57469

◀ the solution, along with the heavy metal. Once absorbed, the plant must then surround the heavy metal and bond it chemically to an organic compound (a process known as chelation) to both protect itself and make the metal more mobile. Once the metal has been chelated, the plant can then transport the metal to a location where it can be stored safely. The transportation stage is the most critical, since the heavy metal is most likely to damage the plant during this process, and the plant must adapt to any damage the heavy metal causes. Once the heavy metal has been transported, though, it is then stored in a location where it cannot damage the plant, typically within the vacuoles of the plant cells.

“Hyperaccumulator” species are similar to accumulator species, but they can absorb extremely high levels of heavy metals into their tissues due to having overdeveloped metal transport systems. In hyperaccumulators, heavy metals are most often stored in the vacuoles of the cells within the leaves of the plant.

Other adaptations that have allowed some plant species to colonize metalliferous soils are those used by “excluder” species. Excluder species have adaptations that enable them to take up only low levels of heavy metals, regardless of what the concentration levels are in the soil.

With these adaptations in mind, there are three main phytotechnological mechanisms that we can make use of when trying to improve the quality of soil contaminated with heavy metals:

- **Phytoextraction** refers to the absorption and uptake by plants of large amounts of inorganic contaminants such as heavy metals, and to the translocation of these contaminants into the aboveground parts of these plants. With this technique, consider using hyperaccumulator species, or accumulator species with a high growth rate and that produce a high quantity of biomass. In order for these species to effectively remediate soils contaminated with heavy metals, the plants must be harvested after an adequate period of growth that allows them to accumulate the metal contaminants in sufficient quantities, and then removed and disposed of in a manner that is in accordance with local, state, and/or federal environmental laws and regulations. For herbaceous species, this means harvesting the plant at the most optimal time during the growing season to maximize the uptake of soil contaminants before the aboveground portion of these species begin to decompose and return the elements to the soil.
- **Phytometabolism** refers to the uptake of heavy metals by plants followed by the incorporation of these heavy metals into their tissue as nutrients. At

low levels, some heavy metals such as copper, nickel, and zinc serve as nutrients that are essential for plants to carry out their physiological processes. Depending on the heavy metal(s) contaminating a soil, phytometabolism may be an effective technique for soil remediation. However, not all metals are equal in their ability to be extracted from soil. Some metals such as nickel can be extracted quite easily, while phytoextraction of other heavy metals, such as cadmium, can take decades or even centuries. For heavy metals that are difficult or impossible to extract, other techniques must be considered.

- **Phytostabilization** of heavy metals is the use of certain plant species to immobilize contaminants found in soil by sequestering them around the roots of the plant or in the plant’s biomass. A ground cover consisting of a heavy metal “excluder” species (known as a stabilization mat) can be an effective means to phytostabilizing soil contaminated with heavy metals. Depending on the situation or the heavy metal that is being targeted, large woody accumulator species often used for biomass production, such as willows (*Salix* spp.), poplars (*Populus* spp.), can sometimes be used to effectively sequester a heavy metal in their biomass. It should be noted that this technique does not remove the heavy metals from the site, but effectively immobilizes or stabilizes them, making them unavailable for entry into the food chain or preventing them from coming into contact with humans or wildlife. The goal with this technique is for long-term stabilization and containment of the pollutant by sequestering it in soil around the roots (and not in plant tissues).

Phytoremediation of Heavy Metals

See the table on page 18 for species recommendations.

Cadmium (Cd)

Sources of cadmium contamination in soil can include fertilizers, sewage sludge, NiCd batteries, mining activities, and smelting operations. Phytoextraction can be effective for low levels of cadmium contamination. If cadmium concentrations are too high, plant growth is inhibited, making phytoextraction difficult. As mentioned above, phytoextraction of cadmium is a very slow process that can take decades or centuries. However, due to the high bioavailability of cadmium, phytoextraction can still be employed when the presence of cadmium is presenting a danger to food chains, such as when contamination occurs in ecologically sensitive areas.

Phytostabilization of cadmium can be employed by using large woody accumulator species often used for biomass production, such as willows (*Salix* spp.) ▶

◀ and poplars (*Populus* spp.), that will effectively sequester the cadmium in their biomass. Another species, tufted hair grass (*Deschampsia caespitosa*), is a cadmium excluder species and can also be used for phytostabilization.

Chromium (Cr)

Sources of chromium in soil can include pressure-treated lumber, paints, leather tanning, and the automotive industry. However, phytoextraction of chromium is very difficult and not a feasible option for soil contamination. Phytostabilization of chromium-contaminated soil using tufted hair grass (*Deschampsia caespitosa*) is a more feasible option.

Copper (Cu)

Sources of copper contamination in soil can include pesticide residues, mining activities, and smelting operations. Phytoextraction of copper is moderately difficult and not a feasible option for field scale remediation projects. Like zinc, copper is a plant micronutrient, and phytometabolism can be feasible in situations where the concentration of copper in the soil is not so high that it inhibits the ability of the plants to grow.

Phytostabilization of soil contaminated with copper can be accomplished with excluder species such as tufted hair grass (*Deschampsia caespitosa*) and red fescue (*Festuca rubra*).

Nickel (Ni)

Sources of nickel in the soil include battery production, stainless-steel production, mining activities, burning of fossil fuels, and wind-blown dusts from industrial areas.

Phytoextraction is an effective means of removing nickel and an efficient technique for field scale remediation projects. Because nickel has high bioavailability, phytoextraction should be considered when it presents a danger to nearby food chains.

Zinc (Zn)

Sources of zinc contamination in soil can include mining activities, smelting operations, steel production and galvanization, and tire dust and debris. Like cadmium, phytoextraction can be effective for low levels of zinc contamination that don't inhibit the growth of the plants, but is a very slow process that can take decades or centuries. But due to zinc's high bioavailability, phytoextraction can still be employed when it presents a danger to food chains.

However, zinc is also a plant micronutrient, and phytometabolism can be feasible in situations where the concentration of zinc in the soil doesn't inhibit the plant's growth. Since it is a micronutrient, large woody accumulator species used for biomass production can be used to sequester zinc as a form of phytostabilization.

Red fescue (*Festuca rubra*) is an excluder of zinc and can be used for phytostabilization of soil contaminated with this heavy metal. Phytostabilization of zinc can also be accomplished using willows (*Salix* spp.) to sequester zinc in the woody biomass.

Phytomining

Phytomining is a technique that uses high-biomass plants that accumulate metals to be reclaimed for reuse. Once the accumulator species have had sufficient time to extract heavy metals from the soil, the plants are then harvested and burned into ash. This ash is then smelted to produce a metal. This exciting new field of research offers a potential alternative to existing, environmentally destructive, open-pit mining practices, and holds potential for the extraction of ore bodies that are currently uneconomical to mine by conventional methods. With existing technology, research indicates that phytomining nickel shows the most promise for being an economical technique for reclaiming this metal because of the ease with which nickel can be extracted from soil. Perhaps with more research, other metals will become more economical to phytomine as well.

Conclusion

Improving soil quality, especially with regard to heavy-metal contamination, is yet another application of phytoremediation in which native plants can help improve environment quality. By employing extraction plots, many types of heavy metals can be removed from the soil to reduce ecological harm and prevent adverse health effects to humans and wildlife. And using stabilization mats consisting of heavy metal excluder species can be an ideal technique for field-scale remediation projects for those hard-to-extract heavy metals, such as chromium.

It should be noted that lead and molybdenum are both ongoing environmental issues in Colorado. A future brief article will explore potential roles, if any, of native plants in addressing excess lead or molybdenum in our environment.

The emerging science of phytomining provides hope that perhaps we'll soon see a day when remediating soil contaminated with heavy metals has become an economically viable industry. And perhaps soon we'll see a day where certain Superfund sites are seen as a lucrative opportunity to improve the environment.

Eric Fuselier is an environmental scientist at Olsson where he works with civil engineers and landscape architects to minimize the environmental impact from the infrastructure projects they design. Fuselier also serves as a national director for Wild Ones – Native Plants, Natural Landscapes, and is involved with the Arkansas Native Plant Society. ►

Native Plants for Mineral Phytoextraction

Common Name	Scientific Name	Vegetation Type	Sunlight requirements	Soil moisture requirements	Minerals Affected	Accumulation Quantity
Common yarrow	<i>Achillea millefolium</i>	Forb	Full sun	Dry to medium	Cd	Accumulator
False indigo bush	<i>Amorpha fruticosa</i>	Shrub	Full sun	Medium to wet	Cu	Accumulator
Big bluestem	<i>Andropogon gerardii</i>	Forb	Full sun	Dry to medium	Cu	Accumulator
Sideoats grama	<i>Bouteloua curtipendula</i>	Grass	Full sun	Dry to medium	Zn, Cu	Accumulator
Fox sedge	<i>Carex vulpinoidea</i>	Sedge	Full sun to part shade	Wet	Cd, Cu	Accumulator
Canadian horseweed	<i>Conyza canadensis</i>	Forb	Full sun	Dry to medium	Cd, Zn, Ni	Accumulator
Common sunflower	<i>Helianthus annuus</i>	Forb	Full sun	Dry to medium	Cd, Zn, Cu, Ni	Accumulator
Balsam groundsel	<i>Packera paupercula</i>	Forb	Full sun to part shade	Medium	Ni	Hyperaccumulator
Switchgrass	<i>Panicum virgatum</i>	Grass	Full sun to part shade	Medium to wet	Cd	Hyperaccumulator
Pale smartweed	<i>Persicaria lapathifolia</i>	Forb	Full sun to part shade	Medium	Cu	Hyperaccumulator
Balsam poplar	<i>Populus balsamifera</i>	Tree	Full sun	Medium	Cd	Accumulator
Quaking aspen	<i>Populus tremuloides</i>	Tree	Full sun	Dry to Medium	Cd	Accumulator
Black locust	<i>Robinia pseudoacacia</i>	Tree	Full sun	Dry to medium	Ni	Hyperaccumulator
Peachleaf willow	<i>Salix amygdaloides</i>	Tree	Full sun to part shade	Medium to wet	Cd, Zn, Ni	Accumulator
Narrowleaf willow	<i>Salix exigua</i>	Tree	Full sun to part shade	Medium to wet	Cd, Zn, Ni	Accumulator
Sand willow	<i>Salix interior</i>	Tree	Full sun to part shade	Medium to wet	Cd, Zn, Ni	Accumulator
Scouler's willow	<i>Salix scouleriana</i>	Tree	Full sun to part shade	Medium	Cd, Zn, Ni	Accumulator
Little bluestem	<i>Schizachyrium scoparium</i>	Grass	Full sun	Dry to medium	Cu	Accumulator

◀ References

Adesodun JK, Atayese MO, Agbaje TA, Osadiaye BA, Mafe OF, and Soretire AA. 2010. Phytoremediation potentials of sunflowers (*Tithonia diversifolia* and *Helianthus annuus*) for metals in soils contaminated with zinc and lead nitrates. *Water, Air, and Soil Pollution* 207:195–201.

Algreen M, Trapp S, and Rein A. 2013. Phytoscreening and phytoextraction of heavy metals at Danish polluted sites using willow and poplar trees. *Environmental Science and*

Pollution Research, epub. Ahead of print, DOI, 10.1007/s11356-013-2085-z.

Baker AJM and Brooks RR. 1989. Terrestrial higher plants which hyperaccumulate metal elements: A review of their distribution, ecology and phytochemistry. *Biorecovery* 1:81-126.

Blaylock MJ and Huang JW. 2000. Phytoextraction of metals. In Raskin I and Ensley BD (eds.). *Phytoremediation of Toxic Metals: Using Plants to Clean Up the Environment*. New York: John Wiley and Sons, Inc., p. 53–70. ▶

- ◀ Brooks RR, Lee J, Reeves RD, and Jeffre T. 1977. Detection of nickeliferous rocks by analysis of herbarium specimens of indicator plants, *Journal of Geochemical Exploration* 7:49–57.
- Brooks RR, ed. 1998. *Plants That Hyperaccumulate Heavy Metals*, CAB International.
- Chaney RL. 1983. Plant uptake of inorganic waste constituents. In Parr JF, Marah PB, and Kla JM (eds.). *Land Treatment of Hazardous Wastes*, Noyes Data Corp. p. 50–76.
- Chaney RL, Angle JS, and Li YM. 1998. Method for phytomining of nickel, cobalt and other metals from soil, *US Patent 5711784*.
- Cutright T, Gunda N, and Kurt F. 2010. Simultaneous hyperaccumulation of multiple heavy metals by *Helianthus annuus* grown in a contaminated sandy-loam soil. *International Journal of Phytoremediation* 12:562–73.
- Dickinson NM, Baker AJM, Doronila A, Laidlaw S, and Reeves RD. 2009. Phytoremediation of inorganics: realism and synergies. *International Journal of Phytoremediation* 11:97–114.
- Evangelou MWH, Robinson BH, Günthardt-Goerg MS, and Schulin R. 2013. Metal uptake and allocation in trees grown on contaminated land: implications for biomass production. *International Journal of Phytoremediation*. 15:77–90.
- Gawronski S, Greger M, and Gawronska H. 2011. Plant taxonomy and metal phytoremediation. In Sherameti, I, and Varma, A (eds.). *Detoxification of Heavy Metals*, DOI, 10.1007/978-3-642-21408-0_5, Berlin, Heidelberg: Springer-Verlag.
- Hinchman R, Negri C, and Gatliff EG. 1997. Phytoremediation: using green plants to clean up contaminated soil, groundwater, and wastewater. Submitted to the US Department of Energy, Assistant Secretary for Energy Efficient and Renewable Energy, Contract W-31-109-Eng-38.
- Iyaka YA. 2011. Nickel in soils: a review of its distribution and impacts. *Scientific Research and Essays*. 6: 6774–77.
- Kennen K and Kirkwood N. 2015. *Phyto: principles and resources for site remediation and landscape design*. Hoboken: Taylor and Francis.
- Kumar PBA, Dushenkov V, Motto H, and Raskin I. 1995. Phytoextraction: the use of plants to remove heavy metals from soils. *Environmental Science and Technology* 29:1232–38.
- Kumari P, Kumar P, and Kumar T. 2019. An overview of phytomining: a metal extraction process from plant species. *Journal of Emerging Technologies and Innovative Research* 6:1367–76.
- Martin HW, Young TR, Kaplan DI, Simon L, and Adriano DC. 1996. Evaluation of three herbaceous index plant species for bioavailability of soil cadmium, chromium, nickel, and vanadium. *Plant and Soil* 182:199–207.
- McGrath SP, Sidoli CMD, Baker AJM, and Reeves RD. 1993. The potential for the use of metal-accumulating plants for the *in situ* decontamination of metal-polluted soils. In Eijsackers, HJP, and Hamers, T (eds.). *Integrated Soil and Sediment Research: A Basis for Proper Protection*, Kluwer, p. 673–76.
- Nicks LJ, and Chambers MF. 1995. Farming for metals, *Mining Environmental Management* 15–18 September.
- Nicks LJ and Chambers MF. 1994. Nickel farming, *Discover Magazine*. 19 September.
- Nicks LJ and Chambers MF. 1998. A pioneering study of the potential of phytomining for nickel. In Brooks, RR, *Plants That Hyperaccumulate Heavy Metals*, CAB International, p. 313–26.
- Padmavathamma PK and Li LY. 2009. Phytoremediation of metal-contaminated soil in temperate humid regions of British Columbia, Canada. *International Journal of Phytoremediation* 6:119–37.
- Reeves RD and Brooks RR. 1983. Hyperaccumulation of lead and zinc by two metallophytes from mining areas of Central Europe, *Environmental Pollution. Series A: Ecological and Biological* 31:277–87.
- Reeves RD, Baker AJM, and Brooks RR. 1995. Abnormal accumulation of trace metals by plants, *Mining Environmental Management* 4–8 September.
- Reeves RD and Baker AJM. 2000. Metal-accumulating plants. In Raskin I and Ensley BD (eds.). *Phytoremediation of Toxic Metals: Using Plants to Clean Up the Environment*. New York: John Wiley and Sons, Inc., p. 193–229.
- Ruttens A, Boulet J, Weyens N, Smeets K, Adriaensen K, Meers E, Van Slycken S, Tack F, Meiresonne L, Thewys T, Witters N, Carleer, Dupae J, and Vangronsveld J. 2011. Short rotation coppice culture of willows and poplars as energy crops on metal contaminated agricultural soils. *International Journal of Phytoremediation* 13:194–207.
- Salt DE, Blaylock M, Kumar NP, Dushenkov V, Ensley BD, Chet I, and Raskin I. 1995. Phytoremediation: a novel strategy for the removal of toxic metals from the environment using plants. *Biotechnology* 13:468–74.
- Singh S, Parihar P, Singh R, Singh VP and Prasad SM 2016. Heavy metal tolerance in plants: role of transcriptomics, proteomics, metabolomics, and ionomics. *Frontiers in Plant Science* 6:1143.
- Stritsis C, Steingrobe B, and Claassen N. 2013. Cadmium dynamics in the rhizosphere and Cd uptake of different plant species evaluated by a mechanistic model. *International Journal of Phytoremediation* 16:1104–18.
- Van Slycken S, Witters N, Meiresonne L, Meers E, Ruttens A, Van Peteghem P, Weyens N, Tack FMG, and Vangronsveld J. 2013. Field evaluation of willow under short rotation coppice for phytomanagement of metal-polluted agricultural soils. *International Journal of Phytoremediation* 15:677–89.
- Wei SE, Zhou QX, Wang X, Cao W, Ren LP, and Song YF. 2004. Potential of weed species applied to remediation of soils contaminated with heavy metals. *Journal of Environmental Sciences* 16:868–73.
- Wuana RA and Okieimen FE. 2011. Heavy metals in contaminated soils: a review of sources, chemistry, risks and best available strategies for remediation. *International Scholarly Research Notices* 2011, 20 pages. ☺

Trends in Alpine Ecology: The Role of Microclimates in Determining Alpine Plant Response to Climate Change

By Miles A. Moore and Laurel M. Brigham

Mountainous regions comprise 10 percent of the Earth's total land, nearly one-third of which is alpine-tundra (3 percent of the Earth's landmass; Immerzeel et al.; Körner). The tundra biome is warming more quickly than any other biome on the planet, yet it contains some of the oldest plants in the biosphere (Morris and Doak). However, at the landscape level, there are conflicting ideas as to whether the ecosystem is robust or vulnerable to a changing climate (Seastedt and Oldfather). This variation among predictions is likely driven by the environmental complexity that exists in the tundra.

This landscape "complexity" can be generated either abiotically (e.g., topography) or biogenetically, such as around krummholz trees or within the encroaching shrubs discussed through an article in a previous issue of *Aquilegia* (Brigham, 2021; see also Brigham et al., 2018; Bueno de Mesquita et al.; Formica et al.; Myers-Smith et al.). In either case, a sort of texture is brought upon an area by some organism, object, or formation that is comparatively more prominent than the short vegetation around it.

It is this texturing effect that is creating variation in the environment of alpine vegetation. For example, there

are rolling hills, steep slopes, rugged cliffs, more-forgiving wet alpine meadows, exposed and dry rocky hilltops, as well as shrub and krummholz regions in the lower reaches of the alpine among many other features. Each of these features exists at slightly different elevations and possesses varying degrees of connectivity to its local water catchments. Wind and solar exposure, temperature, moisture, soil type, and nutrient availability are all impacted by the existence of landscape complexity, termed the microclimate.

According to Gentili et al. and Grabherr et al., more than one-third of alpine flora live in extremely heterogeneous habitats, which arose from geophysical disturbances or perturbations (e.g., talus slopes, snow beds, or debris fields) and may experience microclimates that are consistently different from regional climate averages.

Importantly, research from the Institute of Arctic and Alpine Research and the Niwot-Ridge Long-Term Ecological Research Program has shown that microclimates can control vegetation distribution. The authors found that trees and shrubs were increasing in abundance in the tundra, and tundra vegetation was moving uphill into what was previously barren soil (Bueno de Mesquita et al.). The authors found that this change in community distribution was strongly predicted by the amount of solar radiation exposure present in an area, indicating the importance of fine-scale variations in this environmental characteristic. While the distributions of trees and shrubs responded positively to increased solar radiation, tundra distribution responded negatively. The authors propose that soil moisture is the limiting factor for tundra colonization and thus an increase in solar input equates to a decrease in soil moisture for a given patch. Together, these findings highlight the role of environmental heterogeneity and suggest the importance of microclimates in future shifts in vegetation distribution.

A growing body of research is investigating the propensity of alpine plants to respond most strongly to these finer-scale variations around them (microclimate) rather than the larger-scale climate (macroclimate) trends in their region. The response of alpine plants to climate change can be altered by microclimates in two important ways. One, ►



A krummholz tree in late spring in the Indian Peaks Wilderness demonstrates how organisms can contribute complexity to their environment. Snow has accumulated on the leeward side of the tree and is persisting longer into the season than other areas. © Micaela Seaver

◀ microclimates offer sites of favorable establishment that could enhance population persistence (microrefugia) and even increase the speed of uphill movement through “stepping stones” (Hannah et al.). Two, landscape complexity creates the opportunity for a lag in biotic response to climate by generating surprising variation in environmental conditions (Armbruster et al.; Bueno de Mesquita et al.; Erickson et al.; Scherrer and Körner). These pathways through which microclimates could alter alpine plant response to climate change are important areas of research that should enhance our ability to predict shifts in plant population and community dynamics.

It is clear that environmental heterogeneity is altering alpine and arctic plant response to directional macroclimate change, but more research should be done to understand this interaction. How regional, local, and climate variations interplay, with the resultant lag in biotic response to climate, can have important implications on conservation and management efforts. The amount of time conservation biologists have to protect threatened alpine flora is

strongly influenced by the timescales with which these organisms are experiencing and responding to stress.

Miles Alan Moore is an undergraduate student studying ecology and evolution at the University of Colorado at Boulder, with research interests in plant population and community ecology in alpine ecosystems. He is also a research technician at CU’s Institute of Arctic and Alpine Research. Outside of school and work, Moore is a husband to an amazing wife, and both enjoy rock climbing, backpacking, and botanizing with friends in Colorado and beyond. He can be contacted via email at miles.moore-1@colorado.edu

Laurel M. Brigham is a postdoctoral researcher at the University of California, Irvine, who recently received her PhD in Ecology and Evolutionary Biology from the University of Colorado, Boulder. She loves to botanize both at work and for fun, and to hike and read. She can be contacted at brighaml@uci.edu.

References

Armbruster WS, Rae DA, and Edwards ME. 2007. Topographic complexity and terrestrial biotic response to high-latitude climate change: Variance is as important as the mean. In Ørbæk JB, Kallenborn R, Tombre I, Hegseth EN, Falk-Petersen S, and Hoel AH (Rds.), *Arctic* ▶



Winter (top) and Spring (bottom) photos from the same vantage point further demonstrate the influence of macrotopography’s influence on snow deposition and persistence and its resultant impacts on alpine vegetation. © Laurel M. Brigham



A watershed in Colorado demonstrates how topography can influence snow deposition, accumulation, and persistence on a large scale. Note the variation in snow cover, solar exposure, and topography. Look closely in the bottom of the frame and you will notice *Primula angustifolia* flowering despite snowy conditions in much of the area! © Miles A. Moore

◀ *Alpine Ecosystems and People in a Changing Environment*, Springer, pp. 105–21.

Brigham L. 2021. Can shrubs act as stepping-stones for subalpine vegetation to move uphill? *Aquilegia*. 45.3:27-29.

Brigham LM, Esch EH, Kopp CW, and Cleland EE. 2018. Warming and shrub encroachment decrease decomposition in arid alpine and subalpine ecosystems. *Arctic, Antarctic, and Alpine Research*, 50:e1494941.

Bueno de Mesquita CP, Tillmann LS, Bernard CD, Rosemond KC, Molotch NP, and Suding KN. 2018. Topographic heterogeneity explains patterns of vegetation response to climate change (1972–2008) across a mountain landscape, Niwot Ridge, Colorado. *Arctic, Antarctic, and Alpine Research*, 50:e1504492.

Erickson TA, Williams MW, and Winstral A. 2005. Persistence of topographic controls on the spatial distribution of snow in rugged mountain terrain, Colorado, United States. *Water Resources Research*, 41:1-17.

Formica A, Farrer EC, Ashton IW, and Suding KN. 2014. Shrub expansion over the past 62 years in Rocky Mountain alpine tundra: Possible causes and consequences. *Arctic, Antarctic, and Alpine Research*, 46:616–31.

Gentili R, Baroni C, Caccianiga M, Armiraglio S, Ghiani A, and Citterio S. 2015. Potential warm-stage microrefugia for alpine plants: Feedback between geomorphological and biological processes. *Ecological Complexity*, 21:87–99.

Graae BJ, Vandvik V, Armbruster WS, Eiserhardt WL, Svenning JC, Hylander K, Ehrlén J, Speed JDM, Klanderud K, Bråthen KA, Milbau A, Opedal ØH, Alsos IG, Ejrnæs R, Bruun HH, Birks HJB, Westergaard KB, Birks HH, and Lenoir J. 2018. Stay or go—how topographic complexity influences alpine plant population and community responses to climate change. *Perspectives in Plant Ecology, Evolution and Systematics*, 30:41–50.

Grabherr G, Gottfried M, Gruber A, and Pauli H. 1995. Patterns and current changes in alpine plant diversity. In Chapin FS and Körner C (eds.), *Arctic and Alpine Biodiversity: Patterns, Causes and Ecosystem Consequences*, Springer, pp. 167–81.

Hannah L, Flint L, Syphard AD, Moritz MA, Buckley LB and McCullough IM. 2014. Fine-grain modeling of species' response to climate change: Holdouts, stepping-stones, and microrefugia. *Trends in Ecology and Evolution* 29:390–97.

Immerzeel WW, Lutz AF, Andrade M, Bahl A, Biemans H, Bolch T, Hyde S, Brumby S, Davies BJ, Elmore AC, Emmer A, Feng M, Fernández A, Haritashya U, Kargel JS, Koppes M, Kraaijenbrink PDA, Kulkarni AV, Mayewski PA, Nepal S, Pacheco P, Painter TH, Pellicciotti F, Rajaram H, Rupper S, Sinisalo A, Shrestha AB, Viviroli D, Wada Y, Xiao C, Yao T, and Baillie JEM. 2020. Importance and vulnerability of the world's water towers. *Nature*, 577(7790), 364-369.

Körner C. 2002. Mountain biodiversity, its causes and function: An overview. In *Mountain Biodiversity*. Routledge.

Löffler J and Pape R. 2020. Thermal niche predictors of alpine plant species. *Ecology*, 101:e02891.

Morris WF and Doak DF. 1998. Life history of the long-lived gynodioecious cushion plant *Silene acaulis* (Caryophyllaceae), inferred from size-based population projection matrices. *American Journal of Botany*, 85:784–93.

Myers-Smith IH, Forbes BC, Wilmking M, Hallinger M, Lantz T, Blok D, Tape KD, Macias-Fauria M, Sass-Klaassen U, Lévesque E, Boudreau S, Ropars P, Hermanutz L, Trant A, Collier LS, Weijers S, Rozema J, Rayback SA, Schmidt NM, Schaeppman-Strub G, Wipf S, Rixen C, Ménard CB, Venn S, Goetz S, Andreu-Hayles L, Elmendorf S, Ravolainen V, Welker J, Grogan P, Epstein HE, and Hik, DS. 2011. Shrub expansion in tundra ecosystems: Dynamics, impacts and research priorities. *Environmental Research Letters*, 6:045509.

Scherrer D and Körner C. 2010. Infra-red thermometry of alpine landscapes challenges climatic warming projections. *Global Change Biology*, 16:2602–13.

Seastedt TR and Oldfather MF. 2021. Climate change, ecosystem processes and biological diversity responses in high elevation communities. *Climate*, 9:87-103.

Zellweger F, De Frenne P, Lenoir J, Vangansbeke P, Verheyen K, Bernhardt-Römermann M, Baeten L, Hedl R, Berki I, Brunet J, Van Calster H, Chudomelovaa M, Decocq G, Dirnbock T, Durak T, Heinken T, Jaroszewicz B, Kopecky M, Máliš F, Macek M, Malicki M, Naaf T, Nagel TA, Ortmann-Ajkai A, Petřík P, PielechR, Reczyńska K, Schmidt W, Standovár T, Świerkosz K, Teleki B, Vild O, Wulf M, and Coomes D. 2020. Forest microclimate dynamics drive plant responses to warming. *Science*, 368:772-775. ☞

Blast from the Past

Aquilegia, 1981, 5.2:8

A Note on the Bush Morning-Glory by Paul Moran

The bush morning-glory, *Ipomoea leptophylla*, grows on the sandhills of eastern Colorado. Hot pink flowers, 2" to 3" long, grace its branches, and like most colorful flowers, the trumpet-shaped blossoms produce nectar to attract pollinating insects. But the bush morning-glory is unusual in that other parts of the plant also produce nectar. The unfolding leaves bear nectaries at the junction of blade and petiole, and other nectar-producing glands are found on the outer surfaces of sepals.

These extra nectaries attract insects. If an ant colony is near a bush, steady streams of workers collecting nectar move along the branches. The ants either scare off or kill beetles, caterpillars, grasshoppers, and other insects that feed on green tissue. The plant gains protection from herbivorous insects by supplying nectar to the ants, and the most vulnerable tissues receive the most attention. Ants concentrate around the sepals, which cup developing ovaries, and on the young, tender leaves. Not every bush has a complement of ants, but those that do produce more seed. This is a mutualistic relationship which benefits both the shrubs and their insect guardians.

The Unseen Garden: Night-Blooming Natives

By Jim Borland

Who cares what your garden looks like during the day? You're not there anyway. What you need are flowers that will greet you in the morning, in the evening, and during the night so that you can visit them between television commercials. Once again, Mother Nature is way ahead of us. Anticipating our needs during the frenzied life that too many of us lead, nature gives us flowers that waste not their beauty during daylight hours, but instead hold their freshness for when their owners are at home.

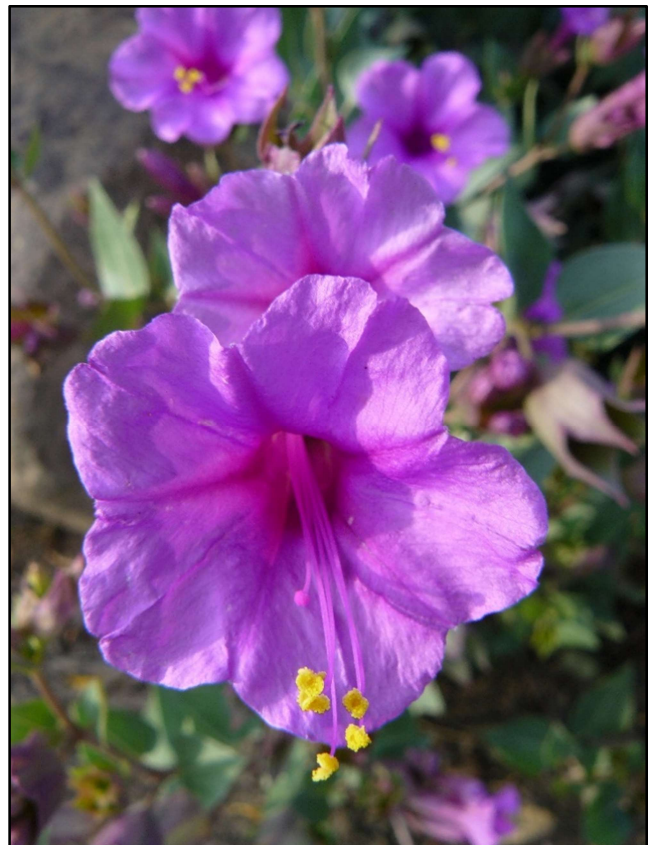
Topping the list of sun-shunners is bush morning-glory (*Ipomoea leptophylla*). Now, hear me out: don't be repelled by the "morning-glory" tag. This one does not spread by land or by sea. Roots do not sprout from Hades, and seeds do not haunt the garden year after year. Instead, the bush morning-glory is a stay-in-place perennial that arises each spring from a human-size tuber (indeed, the plant has been known as man-root or man-of-the-earth), attaining a height of three feet or more and spreading up to six feet across. Be sure to consider its location carefully—*I. leptophylla* does not easily transplant.

Long, gracefully arching stems and six-inch-long, thick, narrow leaves form the backdrop for scattered clusters of two- to four-inch-wide, deep-pink blooms. These blossoms festoon the plant from June to August and are open only during early-morning hours or during cool, cloudy days. Normally found in sandy soils along railroad tracks in Denver and all over the sandier portions of the eastern plains, it has yet to find its way into a garden-center container to any measurable extent. A clean perennial, bush morning-glory readily abscises from its tuber in late fall and blows into the neighbor's yard.

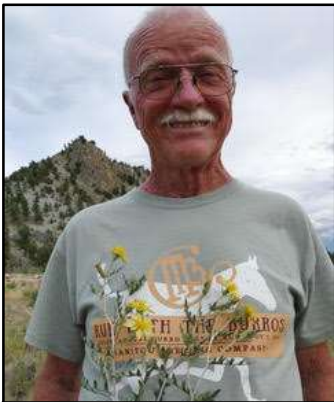
Celebrating the sun's demise at the other end of the day is another tuberous perennial that older generations would readily recognize, at least as far as the flower is concerned: the plains four-o'clock (*Mirabilis multiflora*) is a sprawler, up to 40 inches long in some cases, and in others resembling a small bush of thick, waxy bluish-green leaves. Emerging in late spring after all danger of frost has passed, the stiff, but vinelike stems angle their way across the ground and over small obstructions or down short precipices, where they appear as globs or mats of green until the sun begins its descent ►



Bush morning-glory (*Ipomoea leptophylla*).
© Loraine Yeatts



Plains four-o'clock (*Mirabilis multiflora*).
© Loraine Yeatts



Frank Morey demonstrating the Velcro-like qualities of Royal Gorge blazingstar (*Mentzelia densa*). © Loraine Yeatts

◀ into the horizon. Then, the plant comes alive as its involucre of flower buds open with tubular displays of all-too-familiar four-o'clock, magenta flowers. Soon, the air is abuzz with the flights of hummingbird look-alikes as the hawk moths search the bases of these evening trumpets for nectar with their probing, coiled tongues. Expect the flowers to remain open all night and into the early sunlit hours of the next morning.

Even more afraid of the sun is a group of plants known collectively as blazingstars (*Mentzelia* spp.). The giant among the eight species native to the East Slope is the 10-petal *M. decapetala* (ten-petal blazingstar), with its seven-inch-wide, cream-colored flowers borne on three- to four-foot-tall plants. The name “10-petal” refers to what appear on the plant to be 10 petals, but five of these are actually modified sterile stamens. The effect of an entire blooming roadside caught in the headlights is nothing less than stunning—especially when earlier in the day the same plants looked like nothing more than tall weeds. An interesting feature of the leaves, stems, flower petioles, and sepals is the rough, pagoda-shaped hairs that act like Velcro. Individual flowers may be plucked and placed on clothing without the aid of pins or clips.

Should your blazingstar fancy lean more toward shiny golden-yellow blooms, try beautiful smoothstem blazingstar (*M. laevicaulis*), similar to *M. decapetala* in overall size but with slightly larger flowers. This plant is a native of the Great Basin and more recently has

been found in Moffat County. Where excessive size might be eschewed, there are a multitude of other species that might fill the bill. The creamy blooms of bractless blazingstar (*M. nuda*) and others are only two to four inches across. Botanical texts list blazingstars as biennial or possibly perennial—a dead giveaway that plants will not be persistent residents of the garden without periodic replanting.

Sand verbena (*Abronia fragrans*), with its deep and elongate woody taproot, and up to three-foot-long sprawling stems, is just the ticket for the perennial prairie garden. When the sprawling winecup (*Callirhoe involucrata*) closes up shop for the day, sand verbena puts out its “Open” sign, heralding its trade with three-inch-wide spheres of pure white to off-pink clusters of 30 to 40 funnel-like flowers, each with deeply cleft lobes and looking like a fuzzy baseball. Throughout the dark hours of the night, these glowing globes guide winged denizens of the dark to their reward with a rich, sweet, parlor-room perfume.

Each of these remarkable, bloom-only-when-you-are-at-home flowers is native to Colorado and Utah, and each will carry out its assigned blooming duties with no more than 12 to 15 inches of precipitation per year. That’s right. No supplemental irrigation is necessary, and none is warranted. Those of you who can’t keep your hands off the hose should not attempt to grow these plants (and we know you’re out there). The penalty for doing so is death—of the flower, that is.

Now, if we can just find flowers that open only on weekends!

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. ☺



Bractless blazingstar (*M. nuda*). © Loraine Yeatts



Sand verbena (*Abronia fragrans*). © Loraine Yeatts

Plant Profile

The Amazing Yucca and Its Amazing Pollinators

By Carol English

Outside, under a darkening sky in summer, the nocturnal pollinators, or the “night crew” as I refer to them, are waking up and beginning their important pollination work. Tiny white silky-looking moths are mating within the blossoms of 40–50 native *Yucca* species that have evolved all over the Americas and the Caribbean. Six different *Yucca* species occur in Colorado, and each has its own species of moth to pollinate it. This is a mutualistic relationship that includes a bit of give-and-take and is nature’s way of keeping the yucca plants from becoming overpopulated.

Turns out no other insect can pollinate yucca blossoms. Scientists figured this out long ago when yucca plants were taken to Europe and never formed fruit. Soon scientists realized there must be a particular pollinator needed for the yucca plant. The yucca moth is the only efficient and effective yucca pollinator. After the moths mate, the female gathers as much pollen as she can handle from the six anthers that occur in the center of the flower, and forms the pollen into a sticky ball about the size of her head. She tucks the pollen ball under her chin and flies off into the dark sky. As she flies, pheromones (fragrances of other blooms) guide her path.

The female moth flies far away to a distant yucca plant and flower, barely escaping the jaws of a little brown bat! For most native perennial plants, pollen transfer to distant plants is essential for maintaining healthy genetic diversity among the plant population. The moth arrives at a distant yucca plant and determines which flower has not been visited by other female

moths and is at the perfect stage to accept her pollen. Using her amazing sense of smell, she knows if other flowers have been visited and eggs already laid within them; she avoids these flowers. Too many eggs in one flower ovary will cause the flower to abort and all her larvae would starve. She lays eggs into the base of the pistil and then carefully deposits pollen into the stigma. Each tiny grain of pollen grows a microscopic tube which grows from the stigma down the pistil and

finally reaches an ovule within the area where the moth eggs will hatch.

Her pollen delivery allows the flower to develop a fruit with plenty of seeds for the young larvae to dine on, and enough other seeds to ensure future yucca reproduction. A week after the moth lays her eggs, the larvae hatch and begin to munch on a few of the newly developing yucca seeds. Within a few weeks of feeding on the young developing yucca seeds, the larvae are fully grown. They drill their way through the yucca fruit, lower themselves to the ground with threads of silk, and nest within the soil and make a cocoon. If there has been enough winter precipitation, the moths emerge from the cocoons the following spring; if not, they wait to emerge during a healthy

wet year. Next time you walk by a yucca plant, check for tiny holes in the fruit where the yucca moth larvae made their escape, displaying evidence of this amazing pollination story!

Indigenous people take advantage of the entire yucca plant, including ceremonial use, medicine, food, tools, and clothing. Young Apache, Pueblo, and Navajo ►



Soapweed yucca (*Yucca glauca*). © Carol English

◀ girls take part in a transitional ceremony celebrating childhood to adulthood. Their hair is washed with the soapy yucca roots.

“Juice from the thicker leaves of banana yucca provides Navajo midwives with a lubricant they frequently employ to ease childbirth. The roots and leaves are pulverized and made into a poultice to treat sprains and arthritis in the joints. The young white-green flowers can be eaten raw, steamed, or boiled. The ripened fruit pod can be roasted and eaten. Later, the seeds from the ripened and dried fruits are roasted and pounded into edible cakes. The long fresh leaves of yucca are easily bent and folded into footwear” (from *Iwigara: The Kinship of Plants and People: American Indian Ethnobotanical Traditions and Science*, by Enrique Salmón, 2020, Timber Press).

Yuccas make a lovely addition in a native landscape, and with care can sometimes be transplanted around your own property; however, many transplants do not survive. Garden centers sell native yucca species from around Colorado. They require little water and, of



Yucca moth with a pollen ball in a yucca blossom.
© Carol English

course, support native yucca moths. I suggest using local yucca species because we only have the local pollinating moths. Plant *Yucca angustissima*, *Yucca glauca*, or *Yucca baccata*, depending on your location.

Carol English grew up in the mountains of northern California, loving nature at a very young age. She obtained an undergraduate degree in earth science from University California, Santa Cruz, and, later, a secondary science teaching degree. She also holds a second BS in biology and botany, writing an undergraduate thesis on the pollination biology of a rare Colorado penstemon (Penstemon degeneri). She is a Native Plant Master and has taught Native Plant Master classes for CSU and the Audubon Society. English's professional

career includes teaching high-school science, working as an interpretive specialist for Jefferson County Open Space, and working as a botanist for the Colorado Natural Areas Program, the Colorado State Land Board, and Yosemite National Park. In 2012, she started her own business called CoVeg, named in honor of Colorado vegetation. She also does fieldwork with Elliot Environmental Consulting, and On Pointe Consulting, working with rare plants and doing wetland delineation. 🌀

Recovering America's Wildlife Act

A bill moving through Congress to fund conservation efforts has both fauna and flora in mind. Recovering America's Wildlife Act (also known as RAWA) has bipartisan support in both the US House ([HR 2773](https://www.congress.gov/bill/117th-congress/house-bill/2773), <https://www.congress.gov/bill/117th-congress/house-bill/2773>) and US Senate ([S 2372](https://www.congress.gov/bill/117th-congress/senate-bill/2372), <https://www.congress.gov/bill/117th-congress/senate-bill/2372>).

The legislation seeks to provide annual funding to assist states, territories, and tribes in pursuing their respective State Wildlife Action Plan goals. Where plants are included in these plans, there would be additional funding available specifically for plant species of greatest conservation need (PGCN). As of mid-2022, the bill would disburse an estimated \$1.4 billion annually.

Colorado's most recent [State Wildlife Action Plan](https://cpw.state.co.us/aboutus/Pages/StateWildlifeActionPlan.aspx) (<https://cpw.state.co.us/aboutus/Pages/StateWildlifeActionPlan.aspx>), published in 2015, includes a Rare Plant Addendum that prioritizes imperiled plant species and habitats from around the state. This means that if RAWA is passed, it would provide up to \$26 million annually to Colorado for species of greatest conservation need and an additional \$2 million annually specifically for PGCN flora.

RAWA has been introduced in Congress before the 2022 legislative sessions, but it gained more traction this year. As of April, the bill had passed out of necessary committees in both chambers of Congress. It passed the US House in June. Depending on if and when the bill becomes law, states, territories and tribes may start seeing funds before the end of 2023.

Member Profile

The Sunia Memorial Botanical Illustration Fund Brings People and Plants Together through Art

By Donna Baker-Breningstall

This is a story about my daughter, Sunia, who loved art and all of nature, and has been an inspiration to me and all who knew her. Sunia passed away in February 2020, at the age of 28. Despite her significant physical and mental health challenges, she continued to draw and paint in the last two years of her life. The act of creating beautiful, charming images on paper or canvas gave her a bit of relief. She is very deeply missed by our family and by the many, many people who loved her!

Sunia was intensely kind, giving, and creative. She loved making art and sharing it with others. She often gave her art away to folks she knew, but even sometimes to strangers. She was a member of the Access Gallery on Santa Fe Drive in Denver, an art gallery for folks with disabilities, for five years. When Sunia was exhibiting at a show, she would engage with patrons to talk about her work. If a patron couldn't afford her work, Sunia would try to give it to them for free. Sunia had a big heart and always loved to share.

As a Colorado Master Gardener in Denver for 10 years and a member of CoNPS for many years, I passed my love of plants, and more recently native plants, on to Sunia. She would spend stretches of time in the garden carefully studying plants and insects. She was instrumental in putting in a pollinator garden at Denver Academy, where she attended high school. When she and her sister were younger, I used to take them on what we called nature walks, usually along a canal or wild area. She picked up many items along the way that interested her: pinecones, insects, plants, feathers, rocks... She

would then arrange some of them in a still life and paint or draw them.

For several years, I threw an art-in-the-garden party on our property. I invited 30 to 40 artists to come and paint en plein air in our gardens. I hired a model whom many of the artists painted, but other artists painted or sketched flowers, trees, or other plant material in and around the property. Beginning, mid-career, and seasoned and advanced artists all attended the art-in-the-garden parties.



Sunia in her element. © Donna Baker-Breningstall

I then invited art lovers to stroll the gardens, chat with the artists, and buy some art. Sunia always had a table set up at these festive affairs with drawings and paintings she made. She usually sold out!

I recently approached CoNPS with the idea of starting a fund in memory of Sunia because I feel the work of conserving native plants and educating more folks about the importance of native plants is critical. I felt that dovetailing that with Sunia's passion for art was a natural fit to honor her.

The new Sunia Memorial Botanical Illustration Fund will support courses in botanical illustration throughout Colorado. I

would like to encourage the same type of participation as that of my art-in-the-garden parties, and I hope this fund facilitates inclusive art programming in which people with a wide range of abilities can participate and expand their knowledge of native plants.

My hope is that this botanical-illustration fund will not only teach participants more about the intricacies of this art form, but also give them great joy in ►



Sunia's artwork. © Donna Baker-Breningstall



◀ expressing themselves as they closely examine the plants around them.

I also hope to continue a partnership with CoNPS as it seeks to expand its reach in a variety of other areas.

Thank you for your interest in Sunia and keeping her memory alive. ☺

The Value of Connecting

By Maggie Gaddis

Many connections blossomed at the 2021 CoNPS Annual Conference in Trinidad, CO. One such connection led to a particularly beautiful outcome: The Sunia Memorial Botanical Illustration Fund. Established from a generous gift from Donna Baker-Breningstall in memory of her daughter, Sunia, this fund will allow CoNPS to partner with groups in areas throughout the state to provide courses in botanical illustration as a way of *bringing people and plants together through art*.

This fund and initiative would not have come to life if the annual conference had been held elsewhere. That this partnership did form illustrates the good that can happen when CoNPS reaches out to areas of the state where it has not had a strong presence before; seeks partnerships with individuals and groups to heighten its success in promoting native plants; and nurtures and expands volunteer involvement.

These foci are central to my approach as executive director, and I am humbled and gratified to see them bear fruit through this very special initiative. I invite the CoNPS membership and supporters to join me in acknowledging the many individuals and groups who make this new fund and initiative possible, including:

- Donna Baker-Breningstall and her late daughter, Sunia, in whose memory the fund and initiative were established.
- Julie Knudson, executive director of the Purgatoire Watershed Partnership, and Kelsey Backiewicz, plant ecologist, Boulder County Parks & Open Space, and longtime southeast Colorado resident and rancher. These women involved CoNPS in the community conversations in and around Trinidad that led to the development of a botanical illustration course that will be offered through the Trinidad History Museum's Baca-Bloom Heritage Gardens programming in fall 2022.
- Roberta Lutgens, Denver Botanic Gardens–certified botanical Illustrator, and the CoNPS team who successfully recruited her to teach the course.

News, Events, and Announcements

Please check the **Calendar of Events** online at <https://conps.org/event-calendar-2/#!calendar> for up-to-date information on webinars, chapter meetings, garden tours, field trips, and other events. With the evolving COVID-19 situation, the status of in-person CoNPS events might change.

CoNPS may offer some chapter meetings, workshops, and lectures as webinars or other online meetings. Others might be postponed or canceled. Information will be posted online and will be promoted via the CoNPS E-News.

CoNPS Society-Wide Events and News

The 2022 CoNPS Plant Sale was a Huge Success!

Despite adverse conditions across the Front Range, the CoNPS plant sale was a huge success this year. Nearly 300 native plants were distributed, generating funds for CoNPS-sponsored activities. Thank you, Denise Wilson, for planning this event. And thank you one and all for participating!



Volunteers sort and distribute native plants at the Chatfield Farms. © Kelly Ambler

Herman Gulch Trail Field Trip Led by Maggie Gaddis

August 23, 8:00 AM – 12:00 PM

Hike to Herman Lake. Wind up to Herman Lake through a wooded landscape. Species along the route include blue columbine (*Aquilegia coerulea*), Parry's gentian (*Gentiana parryi*), alpine buttercup (*Ranunculus adoneus*), and many more. There are mosquitoes at the lake! And the trail is a steady uphill, which we will take at a botanist's pace.

Flowers of the 2022 CoNPS Garden Tours, Virtual Presentation Presented by Maggie Gaddis

August 11, 6:00 – 8:00 PM

Come one, come all! See the flowering natives of the 2022 CoNPS Garden Tours. Over 30 native plants were flowering throughout our gardens. Thank you for participating in the Garden Tours. Now it's time to reconvene and celebrate the beautiful blooms in review.

Participants will be free to engage in the discussion so we can enjoy each other's company and share our knowledge of growing native plants.

CoNPS Bookstore Open House Volunteer Event

First and third Thursdays, 9:00 – 11:00 AM

CoNPS has a new office at the Sustainacenter in Colorado Springs. The CoNPS bookstore is now a place, not just an online retail space! Come browse our book selection and help us process book orders. We will provide refreshments. We can't wait to see you.

Native Plant Summit, Colorado Springs, Field Event Led by CoNPS and the City of Colorado Springs Horticulture Department

August 20, 9:00 AM – 5:00 PM

Keynote speaker Alex Crochet, Colorado Springs City Horticulturist, will describe the vision for native demonstration gardens and open-space restoration. We will tour the city greenhouses where groundbreaking native plant propagation is taking place.

Lunch will be served at the new CoNPS office in the Sustainacenter in Colorado Springs (704 E. Boulder St. Colorado Springs, CO 80903). CoNPS Executive Director Maggie Gaddis will speak at the lunch about all the exciting progress we've made in facilitating native plant propagation in 2022. Following lunch, the CoNPS bookstore will be open, and several local gardens will be open for touring.

8:45 – 9:15 AM morning refreshments

9:15 – 9:45 AM keynote speaker, Alex Crochet

9:45 – 10:45 AM tour of the city greenhouses

10:45 – 11:45 AM hands-on native plant seeding

12:15 – 1:15 AM lunch at the Sustainacenter;

Dr. Maggie Gaddis will speak during lunch

1:30 – 4:00 PM CoNPS bookstore open, native

landscapes and garden tour, travel at your own pace

3:00–5:00 PM happy hour ►

◀ Committee Meetings

In an effort to boost participation and work to align our chapter activities with our committee work, we are having monthly committee meetings. Every committee has at least dozens of CoNPS members affiliated with it, but, since COVID, some committees have been very quiet. Please attend these virtual meetings to express your continued interest in committee work. We will plan our projects for 2023 and facilitate the cooperation of chapters and committees in meeting the mission of CoNPS.

Given the sheer number of committees that we have and the lack of engagement therein, these committee meetings are set to convene two to three committees at the same time. Let's see what we can generate. If necessary, we will split out the committee meetings and/or meld committees to concentrate our efforts. See the CoNPS calendar for registration details.

Horticulture / Education Committee Meetings

Third Monday of each month: August 15, October 17, November 21, December 19
8:00 – 9:00 AM on Zoom

Media Committee Meetings

Third Tuesday of each month: August 16, October 18, November 15, December 20
8:00 – 9:00 AM on Zoom

Field Studies / Restoration / Conservation Committee Meetings

Third Wednesday of each month: August 17, October 19, November 16, December 21
8:00 – 9:00 AM on Zoom

Membership / Scholarships / Grants Committee Meetings

Third Thursday of each month: August 18, October 20, November 17, December 15
8:00 – 9:00 AM on Zoom

Annual Conference Committee Meetings

Third Friday of each month: August 19, October 21, November 18, December 16
8:00 – 9:00 AM on Zoom

All committees will meet socially during mealtimes at the Annual Conference, September 16–18.



Yellow Lady Slipper Orchid Imperiled by Poaching

By Ann Grant

On a recent weekend in June, a few Northern Chapter members visited a local spot in search of yellow lady slipper orchids. We found a few, along with coralroot and the well-camouflaged frog orchid (*Coeloglossum viride*). We also found many large holes, recently dug. Unfortunately, the yellow lady slipper (*Cypripedium parviflorum*, aka *C. calceolus* ssp. *parviflorum*) is not classified as federally endangered in Colorado, and so receives no special protection here.

Everyone should be aware that it is illegal to dig orchids or any native plant on USFS, state, county,

local government, or privately owned land—in other words, anywhere—without express permission of the landowner. It is unlikely that sensitive plants like orchids will survive transplanting, as they require specific soil microorganisms and mycorrhizal fungi to survive since they are hemiparasitic.

If you see anyone digging up plants, call the local authorities. Do not purchase plants online or anywhere from persons or sites that are not well established, reputable businesses. You could be contributing to the poaching of rare or uncommon plants from the wild. ☹



One of the few yellow lady slipper plants (*Cypripedium parviflorum*) remaining in the area. © Ann Grant



One of several recently dug holes. © Ann Grant

CoNPS Webinars

CoNPS Webinar: *Wildscaping 101 – Native Plants for Birds*

Presented by Kate Hogan

September 25, 9:30 – 11:00 AM

Are you passionate about native plants and want to learn more about the ecological connections between our natives and our Colorado bird life? Join us for an engaging and exciting webinar on ways to diversify the birds found within your neighborhood or your own backyard using a variety of food groups provided by our native plants. We will cover some of the science behind the essential need for native plants within our landscape, as well as review the Native Plants for Birds handout that was created in partnership between Denver Audubon, CoNPS, Audubon Rockies, and CSU Extension. This webinar is designed for all skill levels of native plant enthusiasts.

Kate Hogan has worked in the field of ecology for over 20 years. She holds a BS in Natural Science and Biology from the University of Puget Sound and an MS in Nonprofit Management from Regis University. For the last seven years, Kate has worked at Denver Audubon as the Community Outreach Coordinator, where she creates strategic partnerships that help fulfill the organization's mission to "inspire actions to protect birds, other wildlife, and their habitats through education, conservation, and

research." She presents outreach programs throughout the Denver metro area and manages the Audubon Center at Chatfield, providing public programs and events for visitors who desire a deeper connection to nature.

CoNPS Field Seminar: *Colorado Native Grasses*

Presented by Maggie Gaddis

October 8, 10:00 AM – 1:00 PM

Join Maggie Gaddis for a tour around the Garden of the Gods, focusing on grass identification and the interesting land history of the Garden. We will see examples of post-agricultural grassland and native grassland. We will also visit Maggie's research sites to collect cover data, part of a multi-year investigation of active revegetation in closed social trails.

Dr. Maggie Gaddis is the Executive Director of the Colorado Native Plant Society. She is also a member of the Geography and Environmental Studies faculty at the University of Colorado - Colorado Springs. Maggie studies native plant revegetation in the wildland context, and increasingly in the horticultural setting. This research began in the Garden of the Gods where we will travel for this field seminar. Maggie lives in Colorado Springs with her family, including three children, her husband, nine chickens, Bodhi the German shepherd, and Olive the garden cat.

CoNPS Chapter Updates and Events

Boulder Chapter

We are busy planning the 2022 annual CoNPS conference, to be held in Longmont in September. Please contact us at BoulderCoNPS@gmail.com if you would like to be involved in the planning process or would like to volunteer during the conference.

Metro-Denver Chapter

August 19, 5:30 PM

Metro-Denver Social Hour

Raices Brewing Company (2060 W. Colfax Ave.)

Come meet with other members of the Metro Denver Chapter for eats and drinks, and to talk about all things native plants!

August 22, 8:00 AM – 2:00 PM

Field Trip

Rocky Mountain Arsenal Wildlife Refuge

Led by Kelly Ambler

A field trip to look for late season prairie plants. We might see Rocky Mountain bee plant (*Peritoma*

serrulata), blazingstars (*Mentzelia* spp.), and joeyeweed (*Eutrochium maculatum*), among others.

September 5, 6:30 – 8:30 PM

Chapter Meeting

Sturm Family Auditorium in the new Freyer-

Newman Center

Topic TBD

Northern Chapter

August 20, 12:00 – 6:00 PM

Poudre River Fest Volunteer Opportunity

We will be promoting CoNPS and the role that native plants play in making our everyday spaces more sustainable and inviting to pollinators, birds and other wildlife.

August 30, 8:00 AM – 12:00 PM, Field Trip

Location TBA

Led by Maggie Gaddis

Got a favorite trail? Tell me about it. I am trying to lead a hike in every chapter, but I need suggestions for trails in the northern region. Email me your ideas:

ColoradoNativePlantSociety@gmail.com ►



Southeast Chapter field trips. Top: Paint Mines Interpretive Park, June 3. Bottom: Elk Park at Pikes Peak, June 15. © Curt Nimz

◀ Southeast Chapter

The Southeast Chapter volunteers led several field trips this past spring and summer. Participants thoroughly enjoyed each trip. Additional events are planned as follows.

August 10, 9:00 AM – 12:00 PM, Field Trip The Craggs Led by David Elwonger

The Craggs are a group of rock pinnacle formations on the west side of Pikes Peak. The hike will be two to four miles out and back along a mostly moderate trail with some difficult places. Wildflowers that should be present are Parry's gentian (*Gentiana parryi*), rose gentian/ autumn dwarf gentian (*Gentianella acuta*), Gunnison's mariposa lily (*Calochortus gunnisonii*) and nodding onion (*Allium cernuum*).

Anyone is welcome to participate. Bring typical day-hike gear, including, water, snacks, sunscreen, rainwear, favorite flora reference, and hand lens.

August 11, 9:00 AM – 12:00 PM, Plant Inventory Black Canyon Open Space, Manitou Springs Led by Curt Nimz

We will be working to inventory the flora—trees, shrubs, grasses, and flowering plants—that are found in Manitou Springs Black Canyon Open Space. The CoNPS SE Chapter is doing the plant inventory to support the certification of the Manitou Springs Pollinator District. We will be documenting all observations with photographs and recording them on iNaturalist. The hike will be moderate to difficult because there is no trail. We will be going over rocks and climbing for about 1 mile with an elevation gain of about 300 feet.

Anyone is welcome to participate. To complete the inventory tasks, participants are needed who have an iNaturalist ID and have experience with recording observations on iNaturalist.

August 13, 8:30 AM – 1:00 PM, Plant Inventory Corral Bluffs View property Led by Maggie Gaddis

We will be working to inventory the flora—trees, shrubs, grasses, and flowering plants—that are found on the Corral Bluffs View property owned by Jax Hilaire. We will be documenting all observations with photographs, and recording them on iNaturalist. The Corral Bluffs View property has a prairie section, which will be easy hiking, and a bluff/canyon section, which will be more difficult. Because of the presence of rattlesnakes, participants should wear long pants and hiking boots. Snake gaiters and rose gloves are also recommended.

Anyone is welcome to participate. To complete the inventory tasks, people are needed who have an iNaturalist ID and experience in recording observations on iNaturalist.

August 19 and September 16, 2:00 – 4:00 PM, Volunteer Event TGIF! Thank Goodness It's Flowering at Phelan Gardens Greenhouse

Have fun at these third Friday volunteer events at Phelan Gardens. We will work in the greenhouse to plant native seeds in native soil. This is part of our efforts to expand native plant propagation in Colorado nurseries. CoNPS members can affect change by aiding nurseries in their learning and development of native plant propagation.

Southwest Chapter

August 25, 8:15 AM – 2:00 PM Ute Mountain Ute lands Seed Collection Led by Amanda Kuenzi

Please join the Mountain Studies Institute, the Southwest Chapter of the Colorado Native Plant ▶

◀ Society, and the Ute Mountain Ute Tribe Environmental Programs for a day of seed collection on Ute Mountain Ute tribal lands. Registration is hosted by the Mountain Studies Institute.

We will be gathering seeds from specific species to aid Ute Mountain Ute biologists in future reseeding efforts to promote biodiversity and restoration on tribal lands.

**September 11, 8:00 AM – 2:00 PM, Field Trip
Lichens of Coal Bank Pass
Led by Bob Powell**

Bob will show us many different forms of lichens, from crustose to foliose and others. Very little walking as we examine lichens on rocks and trees on the pass. Bring lunch, water, sunscreen, hat, and rainwear.

Cross-Pollination Events

Other Neighboring Events

August 14
Rocky Mountain Botanic Gardens Tour
<http://events.r20.constantcontact.com/register/event?oidk=a07ej92s9ps939b7b7c&llr=rt4dogcbb>

August 14-19
Ecological Society of America Annual Meeting
<https://www.esa.org/montreal2022/>

August 23 - October 29
Native Seed Collections along the Front Range with
Wildlands Restoration Volunteers
<http://seeds.wlrv.volunteerhub.com/>

August 30-September 2
International Oak Society Conference
<https://www.internationaloaksociety.org/content/10th-international-oak-society-conference-2022>

September 19-21
Western Collaborative Conservation Network
<https://conferencereg.colostate.edu/Registration/Welcom.e.aspx?e=FEAD6A98F1F44D316CE517BA3669171A>

September 24
National Public Lands Day

October 5-7
Colorado Parks and Recreation Association
<https://www.cpra-web.org/events/EventDetails.aspx?id=1581491&group=>

October 6-7
Symposium on Conservation Impact
<https://salazarcenter.colostate.edu/events/2022-symposium/>

October 8
Urban Wildlife Conservation Day

Colorado Alliance for Environmental Education Advancing Environmental Education Conference "Power of Connection: Growing the EEcosystem"

**September 6-10
Granby, CO**

The Colorado Alliance for Environmental Education is the professional organization for environmental educators in Colorado.

CoNPS Executive Direction, Dr. Maggie Gaddis will be speaking at this conference.

<http://www.caeec.org/conference>

Colorado Open Space Alliance Annual Conference "Renew, Recharge, Reconnect"

**September 19-22
Crested Butte, CO**

The Colorado Open Space Alliance is a regional organization that works cooperatively to share information, create public awareness, and foster partnerships needed to protect and preserve the special places of Colorado.

CoNPS Executive Direction, Dr. Maggie Gaddis will be speaking at this conference on "*Applied Approaches for Native Plant Conservation*"

<https://coloradoopenspace.org/conference>

October 9-15
National Wildlife Refuge week
<https://www.fws.gov/story/national-wildlife-refuge-week>

October 11-13
Sustaining Colorado Watersheds Conference
<https://www.watereducationcolorado.org/programs-events/conferences/>

October 19-20
Colorado Section Society for Range Management Annual Meeting
https://www.cssrm.org/uploads/1/1/9/9/119955786/2022_spring_range_rider.pdf

November 9
Colorado Pollinator Summit
<https://butterflies.org/copollinatornetwork/> ☞

Become a CoNPS Member

Name _____
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 Chapter (if known) _____

- New Renewal
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Printed Color Copy of the magazine, *Aquilegia*, \$20

CHAPTERS: Boulder, Metro-Denver, Northern (Ft. Collins-Greeley), Plateau (Grand Junction and West Slope), San Luis Chapter (Crestone, Alamosa, Salida), Southeast (Colorado Springs-Pueblo), Southwest (Durango) or Unaffiliated

If this is a change in address, please write your old address here.

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Check box to receive information on volunteer opportunities

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

The full color electronic publication arrives by PDF in member email boxes in February, 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.

You may also join online at <https://conps.org/join-donate/>

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 \$ _____

Alice Eastwood Scholarship fund to help support undergraduates pursuing bachelor's degrees that ultimately advance the mission of the Society \$ _____

Mission Grant to support the mission of the Society \$ _____

Total included: \$ _____

Please make check payable to:
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Send completed form and full remittance to:
 CoNPS Office
 PO Box 200
 Fort Collins. CO 80522



Thank you for sponsoring the 2021 CoNPS Annual Conference!



Can You Identify These Alpine Plants?



Answers (clockwise from upper left): alpine ivesia (*Ivesia gordonii*), Hall's penstemon (*Penstemon hallii*), sweetflower rockjasmine (*Androsace chamaejasme*), fournerve daisy (*Tetaneuris acaulis* var. *caespitosa*), American false candytuft (*Smelowskia americana*), and alpilly (*Lloydia serotina*). © Marlene Borneman

Colorado Native Plant Society



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

Are You an Artist?

Please submit your Artwork on
Native Plants to the
2022 CoNPS Photo Contest!

<https://conps.org/home-2/conps-photo-contests/>

19TH Rare Plant Symposium, September 16
Globally Imperiled Plants
Found in Northeastern Colorado

and

46TH Annual CoNPS Conference, September 17–18
From Peaks to Prairie:
Exploring Diversity and Disturbance in
Front Range Ecosystems