Aquilegia

Magazine of the Colorado Native Plant Society
Volume 46 No. 1 Winter 2022

2021 Photo Contest Winners

Front Cover (clockwise from top left)**: First place winners. Landscape**: Carol McGowan, Shrine Ridge Trail. **Native Plants**: Robert Lagier, groundnut (*Apios americana*). **Wildlife**: Suzanne Dingwell, western meadowlark on Great Plains yucca (*Yucca glauca*). **Gardens**: Tom Lebsack, Lebsack gardens. **Artistic**: Carol McGowan, aspens (*Populus tremuloides*).

This page (clockwise from top right): **Second place winners. Gardens**: Loraine Yeatts, scarlet penstemon (*Penstemon barbatus*). **Native Plants (tie)**: Bob Clarke, pasqueflower (*Anemone patens*) and Jim Pisarowicz, dusky penstemon (*Penstemon whippleanus*).

Back Cover (clockwise from top left)**: More second place winners. Landscape (tie)**: Tom Lebsack, San Juan Mountains and Anna Wilson, aspen, ferns, and osha. **Wildlife**: Jim Pisarowicz, bee sleeping in a mariposa lily. (*Calochortus gunnisonii*). **Artistic**: Rick Brune, Rocky Mountain bristlecone pine generations (*Pinus aristata*).

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

Inside This Issue

Greetings from Our New Executive Director, Maggie Gaddis! 4

Featured Stories

Report on the 18TH Annual Colorado Rare Plant Symposium: "Globally Imperiled Plants Found in Southeastern Colorado" BY JESSICA SMITH 5

Report on the 45TH Annual CoNPS Conference: "Short Grass Prairie & a Long Look Back"
Conference Presentations 8

Field Trips 17

Colorado Native Plants for Phytoremediation: Improving Air Quality with Plants in Urban and Suburban Landscapes BY ERIC FUSELIER 20

Columns

Botany Basics: General Classification of Plants BY MAGGIE GADDIS 24

Conservation Corner: Fens in Colorado—Their Vulnerabilities and the Threats They Face BY GAY AUSTIN ... 26

Garden Natives: *Melampodium leucanthum,* Blackfoot Daisy BY JIM BORLAND 28

Restoration Roundup: Colorado Ecosystems as Models for Restoring Our Economies BY JOHN H. GIORDANENGO 29

News, Events, and Announcements

Society-Wide Events 33

Webinars 35

The Redesigned CoNPS Website 37

Chapter Events and Updates 39

Cross-Pollination Events 40

Legislative Updates 41

More Photo Contest Results 43

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Greetings from Our New Executive Director, Maggie Gaddis!

As the seasons change, the Colorado Native Plant Society enters a new phase in its 45-year history. The hiring of the first executive director for the society is particularly important during these COVID times. And we owe it to our ingenuity in finding new ways to interact with each other. In moving many of our events and workshops into a virtual format, we are able to truly interact as a statewide nonprofit organization. Our engagement numbers have increased. I am learning so much by interacting with the CoNPS programming beyond the southeast region. I hope your horizons are expanding equally.

To continue our prosperous efforts, the executive director must work to increase perennial funding through membership, fundraising, donor relations, and program support and expansion. I want to move forward in my new position with transparency and openness. The 1,300 members of the Colorado Native Plant Society have immense knowledge collectively. I need your help! I write to you to explain the focal points of the executive director position, as envisioned by the CoNPS Operating Committee and Board. Please contact me with any advice, feedback, ideas, and memories that will help me to operate in the spirit of the organization.

The Colorado Native Plant Society is dedicated to furthering the knowledge, appreciation, and conservation of native plants and habitats of Colorado through education, stewardship, and advocacy. Our chapters radiate throughout the state to meet our mission. One of my primary responsibilities is to support the CoNPS chapters in their efforts to provide programming and member support.

Please reach out to your local chapter leaders. They want to know what programs you'd like to see, and I will help them make that happen. Their contact information is on page 3 of this and every issue, below the table of contents.

In addition to the programming that arises from chapter efforts, our statewide programs generate significant income for CoNPS, and our staff make that happen. Kathy Okon, our workshop coordinator, organizes statewide CoNPS workshops, field seminars, and, now, webinars presented by experts in the field. In the last year, thanks to Kathy's ability to transform these workshops into virtual events, we won the Colorado Alliance for Environmental Education (CAEE) Innovative Environmental Education Award. See page 35 of this issue for more details.

Our marketing and events coordinator, Denise Wilson, manages the garden tours, native-plant sale, annual conference committee, Colorado Gives campaign, and our taxes!

Linda Smith, our retiring office manager, handles emails, sales, our post office box, the e-newsletter, financials, and membership. And she proofreads *Aquilegia*. Amazing. We will certainly miss Linda as our administrative coordinator but look forward to her continued involvement with CoNPS.

These tasks are what keep us moving forward as a functional nonprofit organization. It's not just the wildflower hikes! So much goes on behind the scenes and thus another major focus of my position is to support the staff. We could not do what we do without them. THANK YOU!

In addition to supporting our chapters and staff, I will work to increase our membership. I am already well aware of the 10,000-plus members in Colorado native plant groups on Facebook who are not CoNPS members. As several people have told me, I need to work on that!

I will also work to increase our presence and interactions on Facebook, Twitter, Instagram, and LinkedIn. You will see me sign my name every time with a call for membership. I hope that you, too, are encouraging Colorado Native Plant Society membership among your networks.

Last year, the CoNPS member survey revealed the demographic gaps in our membership. We will work to expand our membership by engaging families and children. The CoNPS member survey results also showed a strong interest in native-plant and pollinator-gardening education, events, and stewardship. Expanding engagement in these areas will also generate new membership. We are already working on several funding strategies to support CoNPS efforts statewide.

Successful nonprofits around us are sustaining their long-term funding with major donors' support. We will work to develop a major-donors program. It is time that we take this step to secure the *next* 45 years of the Colorado Native Plant Society.

I hope you are reading this while sitting in a house jacket, checking the weather outside. As the plants out there sleep under snow patches, we awaken with planning for 2022!

Sincerely,

Maggie Gaddis, Executive Director
ColoradoNativePlantSociety@gmail.com
February 2022

Globally Imperiled Plants Found in Southeastern Colorado

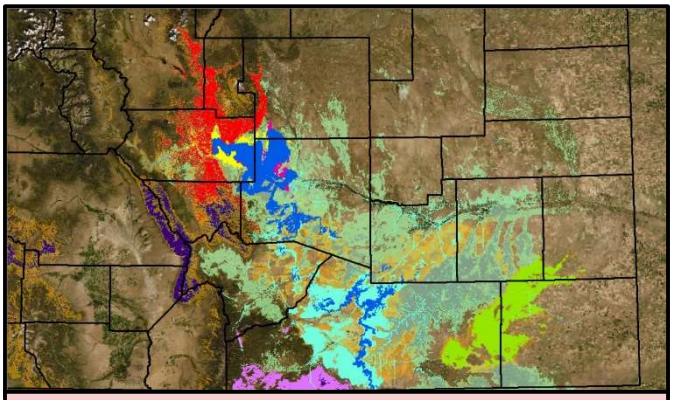
By Jessica Smith and the Botany Vegetation Ecology Team at the Colorado Natural Heritage Program

This year's symposium was kicked off by a photo review of rare plants of southeastern Colorado, including Fishers Peak State Park, by Susan Panjabi, botanist with the Colorado Natural Heritage Program (CNHP). Summary information was presented on each taxon listed in the table below, including a distribution map, photos of the plant and habitat, last observation date, population-size estimates, management concerns, and land-ownership patterns associated with the known distribution. The G rank refers to the global rarity of the species, and S refers to state rarity, with a 1 indicating critically imperiled, 2 indicating imperiled, 3 indicating vulnerable, and 4 indicating "apparently secure." For more information on ranks, see NatureServe's website (https://help.natureserve.org/biotics/content/record_management/Element_Files/Element_Tracking/ETRACK_Definitions_of_Heritage_Conservation_Status_Ranks.htm).

Additional data and photos are needed for all these taxa, and we welcome efforts from the Colorado Native Plant Society and others to help expand our knowledge of these plants through targeted field surveys and observations. See the CNHP website for ways to submit data (https://cnhp.colostate.edu/ourdata/contribute-data/) or contact Susan at susan.panjabi@colostate.edu to contribute information on these species.

Following a short break, CNHP botanist Jessica Smith led the group in a presentation on species distribution modeling for the Plants of Greatest Conservation Need (PGCN; https://cnhp.colostate.edu/download/documents/2021/CODEX-PGCN-Models-Report-Interim-20210831.pdf) and a subsequent group review of nine models for species found in southeastern Colorado, displayed in ArcGIS (arc geographic information system). Her presentation introduced the Colorado State Wildlife Action Plan (https://cpw.state.co.us/aboutus/Pages/StateWildlifeActionPlan.aspx) listed in the modeling project funded by the Colorado Natural Areas Program (CNAP), which is a program within Colorado Parks and Wildlife, and discussed the model's intended uses and constraints. Models were produced to be included in the Colorado's Conservation ►

Scientific Name	**Common Name**	**G Rank**	**S Rank**
Asclepias uncialis	Dwarf milkweed	G2	S2
Cleome (Peritoma) multicaulis	Slender spiderflower	G2G3	S2S3
Delphinium ramosum var. *alpestre (D. alpestre)*	Colorado larkspur	G3	S2
Delphinium robustum	Wahatoya Creek larkspur	G2G3	S2?
Draba exunguiculata	Clawless draba	G2	S2
Draba grayana	Gray's Peak whitlow-grass	G3	S3
Draba smithii	Smith whitlow-grass	G2	S2
Frasera coloradensis	Colorado green gentian	G2G3	S2S3
Herrickia horrida	Canadian River spiny aster	G3	S1
Nuttallia (Mentzelia) chrysantha	Golden blazing star	G2	S2
Nuttallia (Mentzelia) densa	Arkansas Canyon stickleaf	G2	S2
Oenothera harringtonii	Arkansas Valley evening primrose	G3	S3
Oonopsis foliosa var. *monocephala*	Rayless goldenweed	G3G4T2	S2
Oonopsis puebloensis	Pueblo goldenweed	G2	S2
Oxybaphus rotundifolius (Mirabilis rotundifolia)	Round-leaf four-o'clock	G2	S2
Penstemon degeneri	Degener beardtongue	G2	S2
Penstemon versicolor	Variable-color beardtongue	G3?	S3?
Physaria (Lesquerella) calcicola	Rocky Mountain bladderpod	G3	S3
Ptilagrostis porteri	Porter feathergrass	G2	S2
Solidago capulinensis	Capulin goldenrod	G2	S1
Telesonix jamesii	James' telesonix	G3G4	S3



Species distribution models for selected southeastern Colorado Plants of Greatest Conservation Need (https://cnhp.colostate.edu/download/documents/2021/CODEX-PGCN-Models-Report-Interim-20210831.pdf)

◄ Data Explorer (CODEX), a web-based conservation mapping tool launched on November 1, 2021 by CNHP (https://cnhp.colostate.edu/maps/codex/). Forty-five models were completed in Phase I of the project, and CNHP is soliciting expert review on these models. The presentation included a list of available models, a link to the model review form, and a link to the publicly available report on the project (https://cnhp.colostate.edu/download/documents/2021/CODEX-PGCN-Models-Report-Interim-20210831.pdf). If you are interested in reviewing a species distribution model for CNHP, please contact Jessica at jp.smith@colostate.edu.

Following lunch, updates on ongoing conservation work by partner agencies were provided as follows: Gwen Kittel started the session with a presentation of updates on rare willows in Colorado. She discussed *Salix arizonica*, which previously had only one known population in Colorado. However, Kelly Garcia recently found two more populations of this species, which Gwen has confirmed. The species is still limited to Conejos County. The new sites are along La Manga Creek, a healthy population with more than 100 shrubs, and a population of about 35 shrubs near Cumbres. Gwen also discussed an observation of *Salix discolor*, a new county record in Boulder County, with one individual shrub found in Boulder Canyon. She also alerted the group to the need to look for *Salix cascadensis* in Colorado. This is a small plant, with leaves only 3–5 mm in width, which can only be found by literally combing the tundra.

The next presentation was by Dr. Ross McCauley, professor of biology at Fort Lewis College, on the diversification and population genetics of rare *Astragalus* in the Four Corners region. The *Astragalus* genus has the second highest number of species in the state, with six species ranked as globally critically imperiled (G1) by CNHP. The broader Four Corners region has 60 taxa of *Astragalus*, 12 of which are endemic. This presentation focused on *Astragalus schmolliae* and *A. deterior*. *A. schmolliae* is only known from the Mesa Verde National Park and the Ute Mountain Reservation.

Focused monitoring for *A. schmolliae* species began in 2001 by CNHP and the National Park Service. In 2002, 38 percent of the old-growth pinyon-juniper habitat for this species burned in the Long Mesa fire, and the species is showing signs of declining population sizes. To complement the ecological monitoring data, a project to assess genetic diversity in the species was begun in 2018. Ross presented results of this study, which showed good genetic diversity across the national park with no differences across burned and unburned habitat. The pattern of diversity appears to be maintained by the long-lived nature of the species, with recent research indicating plants live up to 50 years.

Ross also introduced a new project initiated this year investigating *A. deterior*. This species is also found only in Mesa Verde National Park, on ledges at the top of sandstone cliffs. Like *A. schmolliae*, its numbers are declining, and Ross is completing a population genetic survey to better understand the species and assist in potential reintroductions. Complicating the biology of *A. deterior* is a close relationship and possible conspecific classification with *A. naturitensis*, a G2 ranked species occurring in parts of western Colorado and New Mexico. While the results are still preliminary, it appears that *A. deterior* does represent a distinct taxon and *A. naturitensis* appears to exhibit regional segregation across its disjunct range.

Three talks by researchers from Denver Botanic Gardens followed. Michelle DePrenger-Levin discussed the soil seed bank dynamics, dispersal, and distribution of *Sclerocactus glaucus*. This study focused on determining the risk of extinction of the species by projecting changes in population size and range, considering exposure and sensitivity to climate change. Michelle tested distance sampling as a method for determining population size and ►

Chapin Mesa milkvetch (*Astragalus schmolliae*). © Bernadette Kuhn, courtesy of CNHP.

◄ discussed using species-distribution models to inform changes in the species range. To improve upon species-distribution models, information on movement of the species is needed. To gather this information, she investigated the soil seed-bank, seed dispersal, and vegetation community, employing several techniques to monitor seed dispersal by ants. Future work will include a seedling-emergence study, seed-bank persistence, quantification of ant dispersal and incorporation of these additional data into a process-based species-distribution model.

Alex Seglias introduced the group to her newly established research project using open top chambers to understand how two rare alpine plants, *Physaria alpina* (Avery Peak twinpod) and *Saussurea weberi* (Weber's saw-wort), will respond to increased warming. Four control plots and four warming plots were established for each target species (16 plots total), with the chambers increasing the temperature by approximately 1.5°F. Data collected include the number of flowers and fruits, plant height and width, and percent cover of associated species. Seeds will also be collected in the plots at the end of the season for follow-up experiments to determine optimal germination conditions.

Jennifer Neale, director of Research and Conservation at Denver Botanic Gardens, presented the North American Botanic Garden Strategy for Alpine Plant Conservation to the group. The strategy, created in partnership with Betty Ford Alpine Gardens (https://bettyfordalpinegardens.org/), is a smaller version of a global strategy and focuses on treeless regions above 11,000 feet in elevation. Within Colorado, alpine environments are effectively conserved, but threats include climate change, with more aridity and higher temperatures. The strategy calls attention to the need for basic research in alpine areas and the need to build capacity, train scientists, and engage with others. They hope to promote awareness for the conservation of these areas. Jennifer showed a slide of a beautiful exhibit at the

Weber's saw-wort (*Saussurea weberi*).
© Kelly Ambler

Colorado hookless cactus (*Sclerocactus glaucus*).
© Gina Glenne, courtesy of CNHP.

Betty Ford Alpine Gardens dedicated to education about alpine areas and encouraged the group to visit the Denver Botanic Gardens Science Pyramid to learn more. The completed strategy is available online at https://www.botanicgardens.org/sites/default/files/file/2021-05/2020AlpineStrategy.pdf, and you can read about other research projects being completed at the gardens on the Denver Botanic Gardens Biodiversity Research page (https://www.botanicgardens.org/science-research/biodiversity-research).

Finally, Jill Handwerk, Botany Team leader at CNHP, gave an overview of three years of research using unmanned aerial systems (UAS, or drones) to conduct surveys for *Penstemon debilis* on the Roan Plateau. *P. debilis* is a federally listed threatened plant species that is a Colorado endemic with a narrow geographic range. On-the-ground survey and monitoring efforts for *P. debilis* are hindered by the extremely steep and fragile shale habitat, making the capture of imagery using drones an attractive alternative. Multiple cameras and flying altitudes were tested with this research. The captured images were processed into orthomosaics, which were then manually reviewed for the presence of *P. debilis.* Results indicated a flying altitude of 4–7 meters is necessary to capture fine enough resolution images to detect *P. debilis* with a RGB (red-green-blue) camera. The multispectral (5 band color) camera did not provide fine enough resolution at these heights. Utilizing drone filming, CNHP detected 1,604 newly documented *P. debilis* plants within seven areas. Upcoming work will continue to investigate the potential for identifying a unique spectral signature that can be used in machine learning to automate plant identification in the orthomosaic images, as well as continued surveys to find additional populations.

All of the presentations from this meeting, as well as previous symposia, are available online at the CNHP website (https://cnhp.colostate.edu/projects/colorado-rare-plant-symposia/).

2021 Conference Presentations

Short Grass Prairie and a Long Look Back Conference Summary

In this issue of *Aquilegia*, we feature reports on the 2021 annual conference. Many thanks to the members who watched and summarized the conference for *Aquilegia* readers. Conference attendees can also re-watch all the sessions. For anyone who missed the conference, recordings of the sessions are available for purchase at https://conps.org/conps-virtual-annual-conference/#!form/2021VirtualConference KA

Maggie Gaddis

Opening Welcome

Reported by Nan Cole

The Conference began with an opening statement by CoNPS' new Executive Director, Maggie Gaddis. Maggie, who teaches biology, resource management, and conservation and sustainability courses at CU-Colorado Springs, and was president of the Southeast chapter, looks forward to weaving CoNPS' many strengths into a more sustainable organization. She wished happy birthday to the 45th conference, this one dedicated to our presence on the southern front range, from its days as a "new territory" through today as organized land stewards.

Melody Daugherty

Southern Colorado Land Acknowledgement and Opening Prayer

Reported by Nan Cole

Out of the ancient spaces and times of the many Southeast Colorado peoples came a prayer for Trinidad, asking Grandfather Sun, Grandmother Moon, and the Four Winds to send their blessings to CoNPS and its role in stewardship of the land and its life communities. This reverent sequence was recorded by Melody Daugherty in the Garden of the Gods in Colorado Springs, anchored at the edge of the short-grass prairie, a major ecological system of the many landscapes of Southeast Colorado. Melody, an Indigenous woman who has been taught to know and understand the deep interconnectedness of all of life, has worked as a professional gardener in Colorado and the wider Midwest. The prayer instilled a sense of peace in all of us at the conference as we began our day.

Eric Tucker and Steve Wooten

Ranches of Southeastern Colorado

Reported by Sue Keefer

During the section of the conference, "Telling the Story of the Land," attendees heard virtually from two residents of the lower Arkansas Valley, Eric Tucker and Steve Wooten.

Eric, who lives near Ordway, a small town in Crowley County, describes himself as "a cowboy by choice, not by family tradition." He learned that cattle management is really land management, which is the reason he chose to use cattle for land-management projects. He employs electric fencing and portable water to get the cattle "in the right place for the right reasons."

By moving the cattle every day or two, he has discovered that native plants such as Indian paintbrush, spotted gayfeather, and sand dropseed are coming back. In addition, he is also seeing more native grasses: "I want to do the best we can to promote grass; it makes more sense than overgrazing or undergrazing."

Eric emphasized the importance of healthy soil and how proper grazing can improve it: "I get the above-ground herd to stimulate the underground herd" (the soil microbiology).

He said he has also had good success in grazing his cattle on neighboring farmland in the winter. The farmers plant winter wheat or rye, which the cattle then eat. As the cattle graze, they break up the furrows and leave manure, which improves the health of the soil.

Although much of the land is covered with *Kochia* (an invasive species), cattle do like it, and he has learned to allow the cows to graze only the top third of the plants. This has the benefit of providing the greatest nutritional value while preventing seed production.

Steve Wooten, of Beatty Canyon Ranch in Las Animas County, represents the third generation to manage his property. He is joined by the fifth and sixth generations, who together manage the land and cattle. His presentation illustrated how cattle ranching can be achieved without detriment to the land.

Steve celebrates the history of the ranch, not only through his family, but through the Native American and Hispanic populations that lived there before his family purchased the property. He showed photos of an old Hispanic cemetery, old adobe and wooden structures, and petroglyphs with human symbols "indicating an older culture." There is also an old ►

Beatty Ranch. © Zach Mahone (https://riversedgewest.org/sites/default/files/files/SteveWooten.pdf)

◄ Native American agricultural site on his ranch that was selected for an archeological survey and checked to ensure it was not a burial site before any excavation was done. He is pleased that those doing the survey will leave the contents of the site in place. “I want to leave it so future generations can see it,” he said.

Steve described his property as a largely intact ecosystem, noting that in 1980, 17 head of bighorn sheep were reintroduced; there are now 500 head. Also, in 1990, there were no whitetail deer, but now he sees whitetails along with mule deer. The huge canyon structure on the ranch is “the best kept secret.” He noted that biologists from the Colorado Natural Heritage Program did biological surveys on the ranch in 2006 and 2007. After two weeks, he said, one of the biologists commented that “it was like being in a wilderness area.”

Alli Schuch and Julie Knudson

Arkansas River Watershed

Reported by Sue Keefer

The Arkansas River Watershed was the focus in “Telling the Story of the Waters,” presented by Alli Schuch (virtually) and Dr. Julie Knudson (in person).

Alli, a watershed-education consultant for the Fountain Creek Watershed District, started her presentation by explaining that a watershed is an area of land and water flowing to a common valley. “We all live in one,” she noted. The Arkansas River Watershed in Colorado stretches from Leadville to Lamar. A major tributary of the Mississippi River, the Arkansas River is the sixth-longest river in the country.

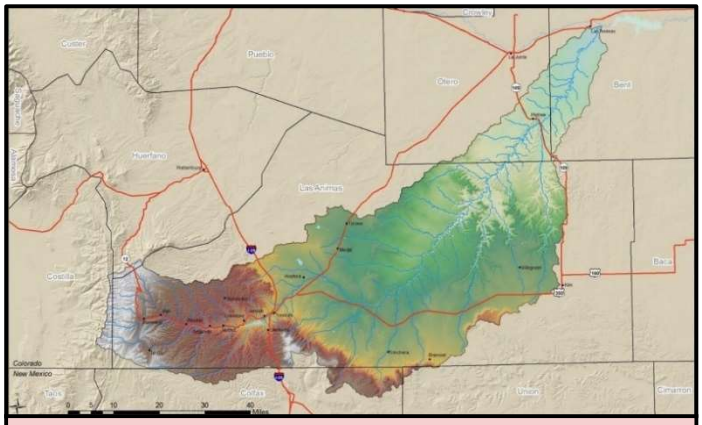
Alli explained that there are nine river-basin roundtables in Colorado, managed by the Colorado Water Conservation Board. Each roundtable has monthly meetings, which are open to the public. She noted that the Arkansas River Basin’s implementation plan is currently being updated. Information can be found at www.arkansasbasin.com. She suggested that attendees might want to watch a film series called “The Ocean Starts in Colorado” in order to learn more about the different watersheds.

The Arkansas River Watershed is comprised of multiple smaller watersheds. One example is the Fountain Creek Watershed, which Alli noted is the second-most-studied watershed in the country, comprising 927 square miles from Palmer Lake to Pueblo, with an elevation change from 14,115 feet to 4,695 feet.

She ended with an explanation of the issues facing watersheds, which include aging infrastructure, historic “flashing” creeks (creeks that flood quickly), water quality and quantity, post-fire impacts, drought, erosion, and sedimentation.

Julie Knudson, the watershed coordinator for the Purgatoire River Watershed and Purgatoire Watershed Partnership, presented an overview of the history of the Purgatoire River, projects within this watershed, recent events revolving around the watershed, and recreational opportunities throughout the watershed. The Purgatoire River Watershed is another example of a smaller watershed nested within a larger one (i.e., the Arkansas River Watershed). ►

Fountain Creek watershed (https://coloradosprings.gov/water-resources-engineering-stormwater/page/our-watershed).



Purgatoire River watershed (https://purgatoirepartners.org/about-us/).

◄ The Purgatoire River is an important tributary of the Arkansas River, which is a major tributary of the Mississippi River. The town of Trinidad is located near the emergence of the Purgatoire River from the mountains before continuing into the eastern plains of Colorado. Trinidad was on the Santa Fe Trail and was an important stopover point for travelers using this route.

Issues facing this watershed include increased demand for recreational opportunities, diversity of water users, catastrophic fire and flood risk, land-management needs, and human-wildlife interactions. She noted that agriculture is the dominant activity in the Purgatoire Watershed, which must be considered in all planning efforts.

Julie outlined the role of the Purgatoire Watershed Partnership, an organization that works with local and regional partners to ensure all users of the watershed have a voice in its management. The partnership has been involved in several projects designed to improve the health of the river.

The last section of her presentation was an overview of our understanding of the flora of the area. One problem is that there is not a local herbarium representing the flora of the Purgatoire Watershed. Another problem is the presence of numerous invasive plant species. Of particular concern is infestation by phragmites, an invasive common reed.

The last slide of the presentation outlined the numerous recreational opportunities throughout the entire watershed area.

Alex Goetz

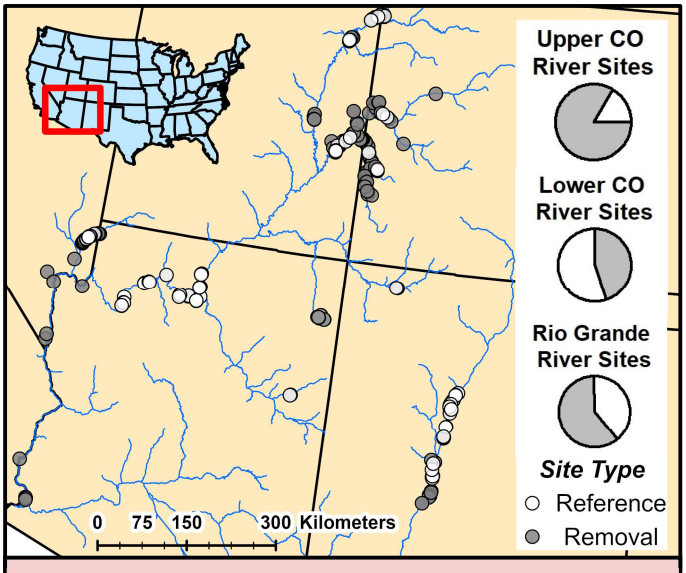
Recovery of *Salix* Following *Tamarix* Removal

Reported by Pat Butler

Alex Goetz, doctoral candidate in the University of Denver Department of Biological Science, reported on his study of *Salix* recovery following removal of invasive tamarisk (*Tamarix* genus). A major concern for tamarisk removal has been the impact on the endangered Southwestern Willow Flycatcher (*Empidonax traillii extimus*, abbr. SWFL), which began building nests in tamarisk after loss of the native willows in the American Southwest. Understanding the characteristics associated with *Salix* recovery can allow for more effective targeting of restoration efforts, considering SWFL conservation. Identifying conditions promoting more native vegetation cover, as well as providing habitat protection for the SWFL, can reduce conflict between conservation goals.

Alex's research used a database of 243 tamarisk treatment sites and 172 reference (control) sites in three watersheds in four states (Arizona, Colorado, New Mexico, and Utah). He developed a statistical model with several independent biotic and abiotic variables: the primary type of removal (biological using beetles in the *Diorhabda* genus, cut-stump, burn, and heavy equipment), climate, soil type, and whether *Salix* was introduced or not. The model's dependent variables were the change in cover by all types of *Salix* and by only *S. exigua* (coyote willow). Alex created five multivariate models to test for the best predictors of change in *Salix* cover. His study asked: (1) Does removal of tamarisk lead to the establishment of *Salix*? (2) Which tamarisk removal methods have the best outcomes in terms of *Salix* cover? (3) What environmental conditions are required to implement a successful *Salix* restoration effort?

His study revealed that both *Salix* spp. and *Salix exigua* increased somewhat when tamarisks were removed by cutting, but the increase in *Salix* did not compensate for the overall losses in canopy cover that flycatchers require. Other than the cut-stump removal method, there was not a statistically significant difference in *Salix* cover among tamarisk-removal methods or relative to negative reference sites, but sites where ►



Map of the study area. © Alex Goetz

◄ herbicide was applied at any point had higher *Salix* cover. The research did reveal positive impacts of a few environmental characteristics: sandy and less salty soils and closer proximity to water were significantly associated with greater subsequent *Salix* cover.

Other study findings were that *Salix* and *Tamarix* occupy distinct environmental niches. The researchers had not anticipated the long lag time between when tamarisks were removed and when newly planted *Salix* became established. Alex concluded that tamarisk removal does not necessarily lead to favorable outcomes for SWFL conservation, but the situation can be improved by focusing on tamarisk removal in sites that favor *Salix* reestablishment: cool and wetter areas with sandy and less saline soils.

Irene Shonle, Susan Carter, and Deryn Davidson

CSU Extension Native Plant Master Program (NPMP)—Preserving Plant Knowledge, Educating the Next Generation

Reported by Elizabeth Kelly

Irene Shonle, CSU extension agent since 2002 and former CoNPS vice-president, opened the three-part program with a brief history of the Native Plant Master Program, which was created in 1997 in the Jefferson County Extension office to increase awareness of native pants, sustainable landscapes, and threats to native plants. Currently, 10 counties in Colorado offer this unique program to help preserve knowledge of native plants, especially as the number of field botanists decreases.

Irene described the single-day classes and three-day courses that are offered through NPMP and taught by volunteers. The three-day course is in one or more locations over three weeks. Participants learn about 40–50 plants. The course is designed so that participants retain the knowledge they gain over the three half-days by taking a deep dive into native plants. Participants learn taxonomy, scientific terms, and the human uses for the native plants.

In addition, there is an option to obtain either a Colorado Flora Certificate, which has no volunteer requirement, or the Native Plant Master Certificate, which does have a volunteer requirement.

The program receives lots of great feedback from attendees. It has proven helpful for new, small-acreage owners to learn how to identify native plants and noxious weeds; for those people working in public outreach; and for individuals working in environmental fields. The program also helps to conserve water resources by increasing the awareness of the value of native plants in the landscape.

Next up was Susan Carter, horticulture agent from the Tri River Cooperative Extension in Grand Junction. Susan also oversees the Ute Learning and Ethnobotany Garden. Her office covers four counties: Mesa, Montrose, Ouray, and Delta. Their program has six volunteer instructors and class sessions that "follow the bloom" in the Colorado National Monument, Black Canyon National Park, and the Grand Mesa, starting in April and ending in July. Like the other counties, they start with a Botany 101 class, and learn some keying and basic terms to get participants ready for fieldwork. Their program also offers "Discovery Walks," walks in the area where only common names for native plants are used rather than scientific names. Trainers also teach about native plants in other venues, such as nursing homes.

Susan concluded by emphasizing that we need more young people to learn and to keep native plant preservation going forward.

The session was completed with a presentation by Deryn Davidson, interim director in Jefferson and Boulder Counties. Deryn emphasized that they couldn't do their program without volunteers! She estimated the time commitment for a volunteer instructor it at between 15–20 hours per year, depending on which class is taught.

Boulder County revived their native-plant program offerings in 2014, starting off with some unique classes such as "Native Plants in Prairie Dog Colonies." Their program has continued to evolve over the years. More recently, they have offered basic botany classes and sketching classes. They, of course, were still offering the three-day Native Plant Master course. Then 2020 happened, and they were not allowed to do in-person programming. Thus, they turned to online classes and were able to offer more and to reach more people, including people from across the country. They also recorded their basic botany class, which is a two-part video now used by other counties as the official Botany 101 class. They also held a virtual hike of Caribou Ranch, which people really enjoyed. They ►

◄ reached audiences that couldn't get outdoors, opening this world to them. Boulder County will continue to offer both virtual and in-person programming.

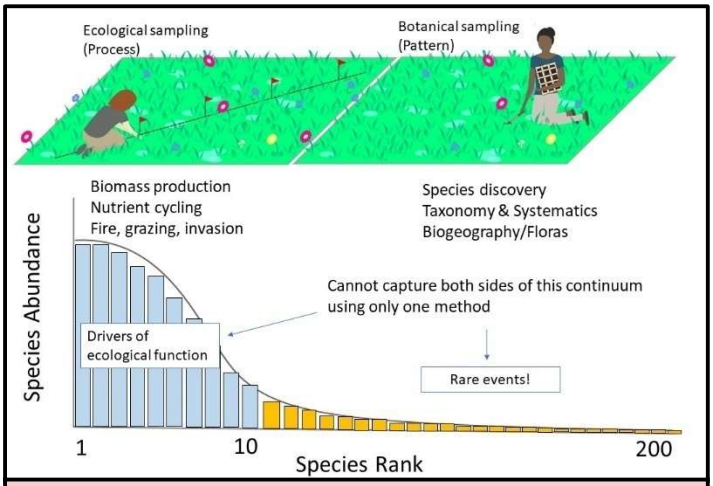
Christina Alba

Natural History Collections at the Nexus of Past and Future: Floristic Inventories Can Spur Successful Ecological Research on the Eastern Plains

Reported by Sue Dingwell

To wander or not to wander? That is the question. Is it better to measure a site's richness by walking through large portions of it, or to measure its evenness by using transects?

These were the questions definitively answered by Dr. Christina Alba, assistant research scientist at the Denver Botanic Gardens, during her presentation in Trinidad. Biodiversity is critically important, she said, but hard to measure. A site's richness, the number of species present, the site's evenness, and the relative abundance or percentage of cover by an individual species are important indicators of a site's health, and her research led to the conclusion that the use of both sampling methods was imperative for an accurate evaluation.



An illustration of a typical "species-area curve" showing how floristic (collections-based) versus ecological (plot- or transect-based) sampling contribute to our understanding of plant biodiversity. Floristics research often captures uncommon species on the long tail of the curve (supporting species discovery and the building of floras), while ecological research captures common species and allows for testing of hypotheses (using statistics) about ecological function.

Wandering over a site is the most fun, Chrissy admitted, and it has the benefit of building a more comprehensive species list than an evaluation using plot sampling or transects. This walk-through process, known as opportunistic or floristic sampling, can capture as many as four times more species than transects do, which can lead to a different characterization of ecosystem health between the two sampling approaches. For example, transects overestimated the proportion of non-native species present along an urban greenway relative to opportunistic sampling. However, though they drastically shrink the area that is sampled, transects do generate the opportunity for researchers to design studies that test hypotheses around specific questions, as they provide replicated and repeatable sampling of a known area that can be returned to over and over again.

Chrissy offered the High Line Canal as a case in point. When a measure of the diversity along the canal was needed, a floristic survey found 452 native and non-native species, representing nearly 20 percent of the state's total plant species. Non-native plants included garden escapees such as ornamental onion, *Allium aflatunense*. (A cautionary tale!) However, it took transects to determine the condition of the canal pathways, which were dominated by three species of non-native grasses.

The next portion of the talk addressed the reasons this dual approach is needed in Colorado's southeastern grasslands. This is an area currently undersampled and also on a different trajectory in ecological function in relation to the northern grasslands. For example, the northern grasslands exhibit increasing perennial grass and forb cover, while the southern grasslands have decreasing cover of these groups. The southern grasslands comprise geographically distinct assemblages of species, many of which do not occur in the northern portion of the state, such as *Bouteloua eriopoda*, or black grama. More information is needed on specific characteristics of these grassland plants: ability to form biomass, root decomposition, nitrogen fixation, phosphorous and carbon retention, forage quality, bird diversity, and pollinator abundance among them.

Rare species have a high importance to ecologic health, Christina noted. They can support vulnerable functions in high-diversity ecosystems. They:

- Contribute disproportionately to the functional structure of species assemblages;
- Increase resistance to invasion by exotics; and
- Influence grassland ecosystem multifunctionality.

Three plants that have functions in the southeastern grasslands are *Frasera coloradensis*, Colorado gentian, which has nectaries that attract insects; *Baccharis wrightii*, Wright's false willow, host to the nymphs of the painted grasshopper (*Dactylotum* ►

Baccharis wrightii, Wright's fall willow is needed to provide food for the nymphs of the painted grasshopper, *Dactylotum bicolor*. © Christina Alba

◄ *bicolor*); and *Dalea jamesii*, James' prairie clover, a strong nitrogen fixer.

Chrissy also noted that private ranchers and landowners were gracious in allowing her onto their lands. Ranchers are interested in the "tail," those rarer species of plants. One of the ranchers, Dallas May, shared this wonderful quote: "Even though it seems disproportionate to compare grasshopper nymphs and the small area they inhabit to miles of wetland and riparian areas and all of the associated species in that large landscape, both contribute significantly to the diversity needed for a healthy and thriving ecosystem."

Researchers will gain improved understanding of biodiversity by using the dualistic approach to site evaluation and measuring both plant richness and relative abundance, adopting sampling practices from botanical floristics and ecology. Floristic inventory will help to define major vegetation types, characterize the full species pool, and build a reference collection. Ecological sampling will help to link relative abundances to environmental variation, and to incorporate both experimental work and work at different scales of organization.

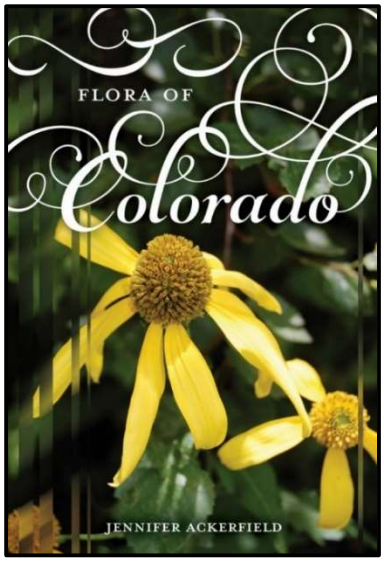
To learn more about the High Line Canal, go to https://highlinecanal.org/about-canal/

Jennifer Ackerfield

Second Edition Updates to *Flora of Colorado*

Reported by Pat Butler

Dr. Jennifer Ackerfield, head curator of natural-history collections, associate director of biodiversity research at the Denver Botanic Gardens, and author of the 2015 *Flora of Colorado*, spoke on "Preserving the Knowledge: Taxonomy Updates." She noted that Harold Harrington's *Manual of Plants of Colorado* (1954) was based on plant lists developed by Per Axel Rydberg, whose lists were in turn based on his own collections



and those of Charles Spencer Crandall and Jacob Cowen (who were associated with the CSU Herbarium).

Jennifer mentioned that while *Flora of Colorado* has undergone some revisions in its third printing, a major update is underway for the second edition. The update will include an introduction with descriptions of the state's ecological zones, more detailed distribution maps (indicating relative abundance in each county where a species is found), and several family and taxonomic revisions. There will be nearly 45 percent more color plates (108 compared to 75 in the current edition). The second *Flora* edition will include 113 additional species, a few of which are introduced, several whose range is now understood to include Colorado; several new taxonomic groups; and a few species entirely new to science.

She expressed gratitude for the remarkable expansion of resource materials since she wrote the first edition of *Flora*. So much information is now available online, including original species descriptions, digitized copies of herbarium specimens from many regional herbaria, botanist correspondence, and the Southwest Environmental Information Network (SEINet), featuring 10 regional botanical portals. Another benefit is the availability of DNA sequencing that can show genetic relationships among plant species.

Jennifer concluded by encouraging us to report more of our own observations to iNaturalist, so that she can add them to her distribution maps, as well as providing to her photos of plants, especially grasses.

A specific publication date is not yet available for the new edition.

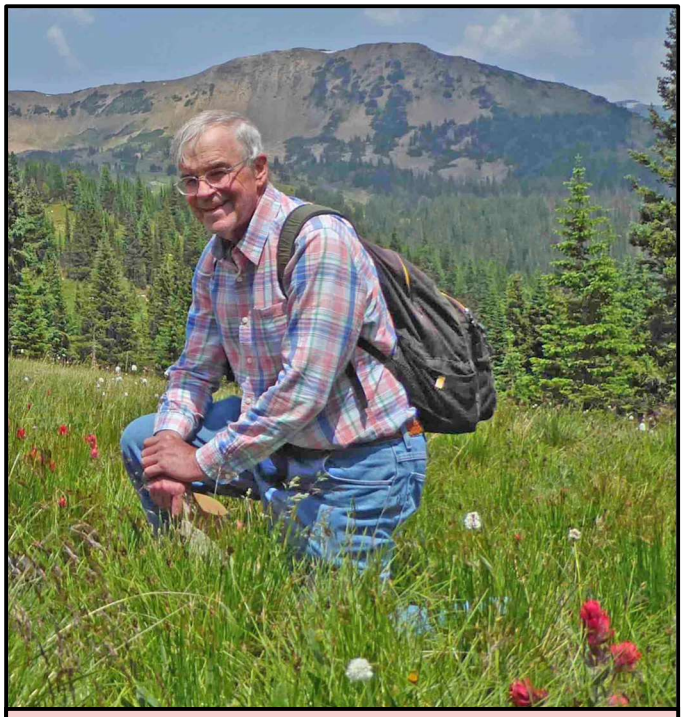
Kathy Okon and Denise Wilson

Volunteer Appreciation

Reported by Nan Cole

Kathy Okon and Denise Wilson gave detailed presentations thanking the many different individuals who keep CoNPS running.

Kathy Okon, CoNPS workshop coordinator, started by thanking the many volunteers for their presentations in botany, plant identification, plant ecology, gardening with native plants, ecosystem revegetation, and citizen science. The presentation formats included webinars, workshops, and field seminars. She was particularly appreciative ►



Mo Ewing, volunteer extraordinaire. Unknown photographer.

◄ of Jennifer Ackerfield and Mo Ewing, who each gave five or more workshops over the last five years.

Next, Denise Wilson, CoNPS marketing and events coordinator, reviewed state-level and chapter-level leaders and volunteers. These include the board of directors, committee chairpersons, and chapter leaders. Wilson also named the people who are active volunteers within their own chapters, showing slides submitted by the volunteers. She finished her presentation by highlighting the various CoNPS committees and the people who lead these committees.

Amy Yarger

Pollinator Districts—Engaging the Community for Our Ecological Future Together

Reported by Jenifer Heath

Dr. Amy Yarger started with a reminder that the more people who are involved with conservation, the more progress will be made.

Habitat loss and disturbance have a significant impact on species' success; more than 40 percent of pollinators globally are at risk of extinction in the coming years. About half of that threat is from habitat loss and factors directly related to habitat loss. Amy emphasized the practical importance of pollinators, including in agriculture, to maintain native plant and ecosystem function, and simply because people like pollinators.

Essential components of pollinator habitat include plant diversity; phenology (seasonal timing of blooms); size, shape, and nutritional qualities; structural complexity; and connected habitats (resources spaced at proper scale). The scale of pollinator habitat is especially important, as illustrated by some sweat bees, which can travel only about 400 feet. Therefore, it is important that "stepping-stones" of habitat be provided as corridors between larger habitat areas. The structural complexity of the habitat is also important, and should provide shelter, nesting opportunities, and protection from predators. Habitat structure must provide for the entire life cycle of the pollinators, including bare ground, shrubs for nesting, and winter leaf litter or, as the speaker put it, "the whole mess."

Pollinator districts, communities that prioritize pollinator conservation in all aspects of their operation, are potential solutions for survival of pollinator species. The hope behind pollinator districts is that, over time, measuring a net gain in habitat can be compared with baseline measurements to understand associated changes in pollinator populations.

Amy's key recommendations were: include pollinators and other invertebrates in wildlife assessment and monitoring; link habitats and maintain refuges for pollinators; identify and incorporate habitat requirements for species of concern, especially specialists; and create habitat plans aimed at a variety of landscapes and ecological interactions.

Amy emphasized that biodiversity should become a central value of future development and quality of life, and that maximizing use of space would provide a range of benefits, including, but not limited to, growing food, creating quality habitat, filtering water, and supporting biodiversity. She discussed a project in Manitou Springs led by Melody Daugherty, who could not be present at the conference. Manitou Springs has a distinct history and culture. A demonstration project has been started that involves many sectors, ►

◄ including schools, nurseries, communities of faith, a watershed alliance, the local CoNPS chapter, a seed library, and more. The project includes a demonstration garden, designated areas as monarch way stations with plenty of host plants, a pollinator garden around the iconic Manitou Springs gnome, use of drainage areas as pollinator corridors, and small way stations with QR codes to educate people about the effort. Perhaps tourists will take that commitment to pollinators home to their own communities!

Ann Grant and Paul Alaback

Budburst and CoNPS Citizen Science

Reported by Sue Dingwell

Dr. Ann Grant, our CoNPS horticulture committee chairperson, presented a talk on Project Budburst. Since Dr. Paul Alaback could not be present, she gave his portion of the presentation as well. Her talk began with this explanation: "Project Budburst is a great way to learn about and better appreciate your backyard and your local flora, and to make important contributions to science, and eventually to conservation!"

She next explained the importance of what is known as citizen science, which allows volunteers with little training to make scientifically valuable contributions that do not require either travel or significant expense. Citizen science is a good way for people to support their local ecosystems.

Ann gave the audience a basic understanding of phenology and its importance. Phenology is the study of the timing of life events, like nature's clock. Breaking the word down, *ology* means "study of," and *pheno* means "to appear." She used the illustration of noting when the first flower appears on a plant, or when the first leaf appears on a shrub. This is how we learn about diversity, she said, and how local microclimates affect plants. Knowing the timing of events like those helps us predict times to plant and harvest. That enables us to better understand climate change and its effects.

An interesting parallel to our present-day efforts is the data kept by the wine growers of Burgundy, France, from 1370 to the present. Centuries of data provide insights to historical change. Current applications of phenological data have shown that we are experiencing earlier emergence of plants in the spring—one-and-a-half to two days earlier each decade. We can gain insights into mismatches in timing that are creating problems for species conservation, such as appearance of first blooms and the arrival of the insects that pollinate them.

To participate in Project Budburst, a program initially developed by the Chicago Botanic Garden, a person would make daily or weekly observations of plants along a trail in a park or in a garden. They would report when each plant reached a certain phenophase. Ann emphasized that simplicity and repeatability were important. Using a mobile app, participants can do many things now. Each photograph of a plant on a smartphone will automatically record the date, time, and the exact location of each observation. Participants can now use the recognition software of iNaturalist to help them correctly identify a plant, too.

River's Edge Natural Area sign designed and painted by Linda Smith. © Linda Smith

The presentation moved on to progress at the CoNPS demonstration garden at River's Edge Natural Area, in Loveland. This garden provides habitat for pollinators and educational activities. Larimer County and several small community groups provided the funding, and several local nurseries helped with plants. For the first two years, water was provided by the city for establishment of the new plants, but no water at all has been applied since then. Linda Smith designed and painted two of the interpretive signs.

Go to https://rena-demo-gardens.tumblr.com/ to visit a comprehensive website with information on native plants, current activities, volunteer opportunities, and weeding schedules.

CoNPS members recently started collecting data at River's Edge Natural Area for Project Budburst. Future plans include involving school groups in making observations. Be on the lookout soon for the rollout of a statewide Project Budburst program with targeted species for Colorado, as detailed on page 34 of this issue. See https://conps.org/citizen-science-projects/ for more information. ►

◄ Maggie Gaddis

Active Revegetation in the Garden of the Gods with Native Species, Citizen Scientists, and No Supplemental Water

Reported by Jenifer Heath

Dr. Maggie Gaddis is the new executive director of CoNPS. Her talk charted her quest to understand how trails at Garden of the Gods change over time, and to investigate the efficacy of revegetation efforts in the area, specifically revegetation of former/closed trails.

She has been implementing co-created citizen science, in which citizens participate in the research design, data collection, analysis, and publication (in contrast to citizens merely gathering data). Citizen engagement has been a key aspect of this research. Some of the questions this research seeks to answer are: Does the trail change over time? Do structures slow the rate of change? What is the effect of slope or aspect on the trails? Is seeding an effective way to accomplish revegetation of closed trails?

Some approaches using citizen scientists include whistleblowing, with citizen scientists as a neutral third party delivering news (sometimes perceived as unwelcome news) to local land managers. This research has involved closure of trails to human uses, decompacting the trail soil, spreading seed mix, mulching, and walking away, followed by monitoring. Absolutely no supplemental water was used.

Maggie said that a commercially available native revegetation seed mix (10 species) worked well in this context. Because the seed mix did not exactly match the plant mix present in undisturbed areas of the site, the species on closed, revegetated trails are slightly different from those nearby, so reclaimed trail is more diverse than adjacent areas. The revegetation yielded a native plant community that is predominantly grasses with some pioneering, native aster species.

This research also monitored human behavior at closed trails and found that people were complying with closure. Unexpectedly, monitoring of human behavior found that some open trails had an order of magnitude more traffic than on others. This information may be useful to land managers for planning and maintenance efforts.

The iNaturalist app was used in monitoring efforts. One benefit to this app is that data are geolocated in real time. In addition, iNaturalist can be used by a group in real time via Zoom for communal learning and to verify the accuracy of data. A further plus is that participants (citizen scientists) can link socially and interact through iNaturalist, contributing to relationship building that not only supports this research, but also may encourage and support continued relationships, research, and habitat development into the future.

The eastern closed social trail in September 2018 (left) and October 2019 (right). © Maggie Gaddis

2021 Annual Conference Field Trips

Pat Butler and Pat Cooper, co-leaders

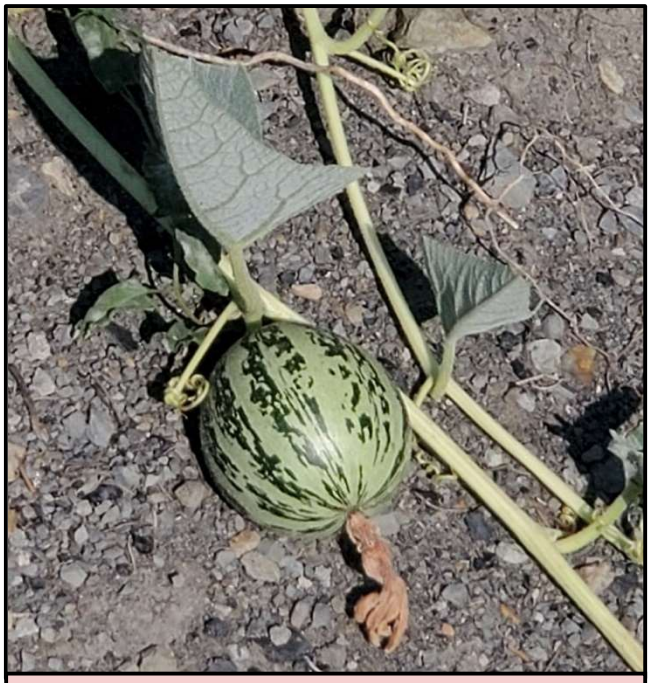
Fishers Peak State Park

Reported by Anna Wilson

More than a dozen of us met at the park on Sunday morning. Leaders Pat Butler and Pat Cooper and park ranger Sydnee Waller greeted us and gave an overview of the park and description of the trails we could explore west of the 9,633-foot-high namesake peak. Only 250 acres of this new park's total of 19,000 acres, and just two miles of trail, are currently open to the public. Naturally, there were many plants visible from the parking lot (6,400 ft), so it took a while to even get to the main trail. A few natives there included *Cucurbita foetidissima* (buffalo/stinking gourd), as well as many asters and senecios.

On the way to First Look Trail, a quarter-mile switchback to a lookout point, we passed *Sambucus cerulea* (blue elderberry), *Euphorbia marginata* (snow-on-the-mountain), *Picradeniopsis oppositifolia* (oppositeleaf bahia), and many others. Both *Quercus grisea* and *Q. gambelii* (gray and Gambel oak) and hybrids stimulated much discussion. These were just a few of the many interesting plants we encountered this day.

We retraced our steps to the Challenge Trail, which is the only route to the highest point (7,200 ft) currently open in the park. Views of Fishers Peak, still two miles east, were had at the end of the trail. Between the 30 percent grade, warm weather, hot sun, visiting with old and new friends, and botanical distractions, each of us had different impressions of the hike.



Buffalo gourd (*Cucurbita foetidissima*). © Anna Wilson

The group on the Fishers Peak State Park field trip. © Pat Cooper

On the descent, some explored a wetland area, some found the Discovery Trail loop at the picnic area, and others revisited spots missed on the Challenge Trail.

Thanks to Pat and Pat for leading this exploration in the new Colorado state park.

Ann Grant, leader

Long's Canyon at Trinidad Lake State Park

Reported by Sue Dingwell

Native plants glowing in fall's colors of yellow, gold, and bronze, and touched by brilliant sunshine were perfectly highlighted against the still-green backdrop along Long's Creek where the trail led to the K-T line. If you're a geologist, you already know that K is the common name for the Cretaceous period. And that T, of course, is short for Tertiary. A chance to see and even to touch that boundary line marking a major extinction event in Earth's history, the end of dinosaurs and the whole Mesozoic Era, was one of the attractions of the Long's Canyon field trip in Trinidad State Park.

We were fortunate to have David Anderson, director and chief scientist of the Colorado Natural Heritage Program, along with our group. He certainly saw and identified many plants we would otherwise have missed! In an area so well-trafficked, we were unsurprised to see many exotic plants having a field day just as we were. Recognizing and seeing so many of those misfits is one of the downsides of learning about native plants, but hopefully it motivates all of us to protect the pristine areas we still have left and to help with invasive control when we can. ►

The K-T boundary layer at Long's Canyon.
© Sue Dingwell

◄ Rabbitbush may be common, but it was in spectacular form in Long's Canyon, just a brilliant yellow. We saw many members of the Asteraceae family still in bloom, and many species of native grasses were waving merry seedheads at us. *Eriogonum jamesii,* James' buckwheat, was the beautiful bronze accent, and we saw a good patch of ripe buffalo gourd melons. Buffalo gourd is another plant that is not uncommon but which I always enjoy seeing. Used in many capacities by Indigenous peoples, its seed is now being stockpiled as an important crop wild relative by the US Department of Agriculture. https://www.fs.fed.us/wildflowers/ethnobotany/documents/cwr/FrameworkNativeCropWildRelativesOct2014.pdf

And just as the heat began to soar, we reached the K-T line. The line was easy to see from the trail, but up a steep slope, which, thankfully, was not too long. Like supplicants at any shrine, up we went. We just had to touch it! The line is abnormally full of iridium, an element more common in asteroids than on Earth. We can't see that, but we can see the tiny glasslike shocked-granite spheres that were formed by extreme heat. This boundary line, visible at many points around the world, is a present reminder of a distant past, one that was changed substantially by the impact of an asteroid, and probably also by volcanic activity. Although there was a massive extinction, life marched ahead on the other side, giving us hope that we, too, can survive the extinctions we see around us today.

Bob Kennemer, leader
Ethnobotany of the Spanish Peaks Region
Reported by Caryl Shields

Bob Kennemer led a diverse group of CoNPS folks on a pleasant walk from the Carpios Ridge area of Trinidad Lake State Park. Bob is an outdoor guide and naturalist with decades of experience in environmental science, education, and in leading outdoor trips. He provided us with an extensive handout on the "Dos and Don'ts" of using wild plants and a reading list of recommended books, especially those by Michael Moore. Bob considers his relationship with wild plants a mix of gardening and grocery shopping. The pinyon juniper country of the Apishapa people that we explored is an area of plentiful edible and medicinal plants, and there is more of this habitat than previously since cattle have eaten the grass.

The following notes were taken on the field trip: PLEASE study further before consuming anything! Different plants are useful at different times of the year. When starting to use wild plants as food, use a small amount, since your system may not be accustomed to wild yeast, molds, and bacteria. Accurate identification is essential. Do not pick plants in state, national, and most public parks, or in some parts of US national forests. Always check first. Use caution harvesting near roads and farms since there may have been pesticides or other pollutants used there.

Artemisia ludoviciana, prairie sage, can be smoked, used as smudge, and used to flavor other foods. *Brickellia californica*, California brickellbush, is an air freshener. Ricegrass (*Oryzopsis asperifolia*) provides rice. *Rhus trilobata* (three-leaf sumac) berries are edible as they turn red from green. Bob makes a salad dressing from these and vinegar. A lemon-like drink ►

Rabbitbrush (*Ericameria nauseosa)*.
© Sue Dingwell

Bob Kennemer and field trip attendee.
© Caryl Shields

◄ can be made from the berries. Juniper berries (*Juniperus scopulorum*) take two years to mature. Wait until they turn purple in the fall if you want to eat them raw; they are a good spice for game meat and sauerkraut. Gambel oak acorns must be soaked or boiled before roasting and then used as nuts or ground to flour. Bob adds the flowers of many nonpoisonous plants to his salads. He uses yucca flowers in stir fry. A pain-relieving tea can be made from willow. For pulling out thorns and for body healing, pinyon sap has been used.

This was a fun and educational trip; I would enjoy going on future trips with Bob.

Steve Olson, leader

Reilly Canyon at Trinidad Lake SP

Reported by Loraine Yeatts

The trail traversed large grassland meadow-like openings bounded by pinyon-juniper open forest and crossed several drainages above Trinidad Lake. We passed coal-bearing strata along the trail which represents the extensive coal mining that occurred in the area. Not much was blooming, but it was fun to be a small group and have Steve Olson as an enthusiastic leader.

Field trip participants get a closer look.
© Loraine Yeatts

Denise Wilson, leader

North Fork of the Purgatoire River

Reported by Denise Wilson

Our driving tour trip started in the Trinidad State College parking lot with a discussion of what the six of us would really like to do. We all agreed that choosing one destination for a nice hike would be preferable to 4 one-half hour short walks away from the cars, and we choose Dikes Trail 1389 in Cuchara, CO.

The drive on Hwy 12 traveling north and west from Trinidad followed the North Fork of the Purgatoire, and

James' buckwheat (*Eriogonum jamesii*).
© Loraine Yeatts

was, as anticipated, beautiful, living up to its name, Highway of Legends. Our caravan was three cars with Denise Wilson, CoNPS, Gib Rokich from La Veta, Nanette Kuich and Emily Griffoul from the Betty Ford Alpine Gardens, and Hallie Flynn and Katie Walsh, of the BLM.

We started at an elevation of 8660 ft, and climbed steadily, viewing and identifying plants along the way in a plant community dominated by white fir, Gambel oak, aspen, and Rocky Mountain maple. New Mexico locust permeated the landscape, too. Some of the forbs we noticed were *Pedicularis procera* (giant lousewort), *Castilleja chromosa* (desert paintbrush), *Streptopus amplexifolius* (twisted stalk), *Apocynum cannabinum* (Indian hemp), *Heliomeris multiflora* (showy goldeneye), *Machaeranthera tanacetifolia* (Tahoka daisy), and *Ligusticum porteri* (osha). This part of the trail was shady and NW facing. We did not quite make it to the top to see the volcanic dikes because burgers at the Dog Bar were calling! Alas, the Dog Bar was closed and we had a Tex-Mex lunch at the Yacht Club (go figure!). We really enjoyed the camaraderie and getting to know one another.

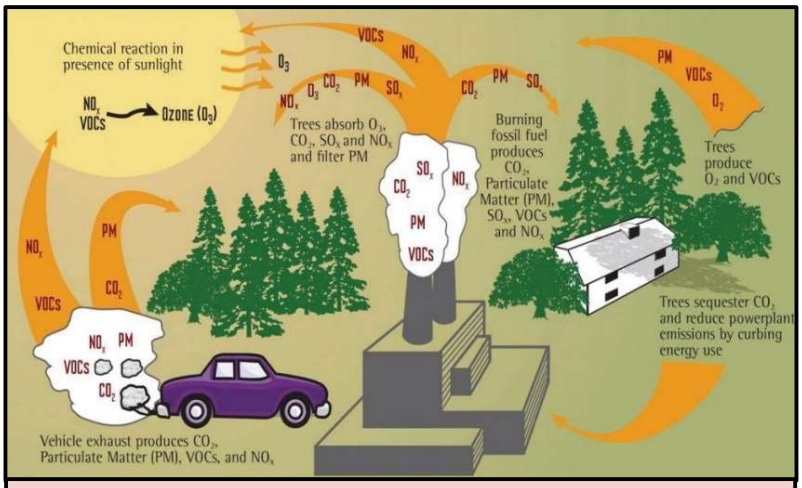
Group on the field trip along the north fork of the Purgatoire River. © Denise C. Wilson

Featured Story

Colorado Native Plants for Phytoremediation: Improving Air Quality with Plants in Urban and Suburban Landscapes

By Eric Fuselier

One of the many ways plants help to sustain life on this planet is by providing the oxygen we need in order to breathe. Molecular oxygen, a by-product of photosynthesis, is essential to the survival of most living organisms on Earth. But oxygen isn't the only molecule found in the atmosphere. Our modern industrial society releases pollutants into the atmosphere on a scale never before seen in human history. Exposure to these airborne pollutants is a risk factor for adverse health effects such as cardiovascular and lung diseases, stroke, and chronic obstructive pulmonary disease (COPD), among others. Suffice it to say that the quality of the air we breathe is just as important as the quality of the water we drink. This article focuses on how we can use native plants to improve air quality by controlling and transforming some of these contaminants.



Urban forests help reduce air pollution in direct and indirect ways. https://www.fs.fed.us/psw/topics/urban_forestry/research/air.shtml

How It Works

There are two main phytotechnological mechanisms that we can use when trying to improve air quality:

- **Phytoaccumulation** refers to a process by which aerosol particles are deposited onto the solid surfaces of leaves, where they then accumulate, thereby decreasing their concentrations in the air. A wide range of other contaminants, such as polycyclic aromatic hydrocarbons, persistent organic pollutants, and heavy metals, may be attached to these airborne particles. Once deposited, some of these particles can be absorbed into the plant, though most are retained on the surface of the leaves. It is important to note that this detention of particles is only temporary, as the particles will later either become re-suspended into the atmosphere or deposited into the soil after being washed off by rain or by leaf abscission (natural detachment of the leaf from the plant). Therefore, additional phytotechnology should be used below these plants to prevent these particles from contaminating stormwater runoff (see part 1 in this series of articles in the summer 2021 issue of *Aquilegia*, volume 45, no. 2, page 22.)
- **Phytometabolism** is a process in which organic contaminants are first broken down by plants through phytodegradation and then incorporated into the plants' biomass (see also the summer 2021 issue of *Aquilegia*). In order for plants to grow, they need nutrients such as nitrogen, phosphorus, and potassium, which they use to carry out photosynthesis and to build biomass. These nutrients are inorganic elements, so plants first have to break down organic molecules (or, in this case, organic contaminants). The metabolites that are left over from this process are then phyto-metabolized and incorporated into the plants' biomass.

Specific air contaminants are discussed below, along with native plant species that can be used to remediate or control these contaminants using these two phytotechnological mechanisms.

Particulate Matter

Particulate matter refers to the mixture of solid particles and liquid droplets found suspended in the air. Common examples include dust, soot, and smoke. These particles can range in size, with some large enough or dark enough to be visible to the naked eye and others only detectable with an electron microscope. Particulate matter (PM) is generally divided into two categories, based on size:

- PM_{10} includes inhalable particles with a diameter of 10 microns or smaller; and
- $PM_{2.5}$ are much finer inhalable particles with a diameter of 2.5 microns or smaller. ►

Table 1: Colorado Native Trees and Shrubs Useful for Removal of Particulate Matter	
Common Name	**Scientific Name**
Wax currant	*Ribes cereum*
Blue spruce	*Picea pungens*
Engelmann spruce	*Picea engelmannii*
Douglas fir	*Pseudotsuga menziesii*
Bristlecone pine	*Pinus aristata*
Limber pine	*Pinus flexilis*
Piñon pine	*Pinus edulis*
Lodgepole pine	*Pinus contorta*
Ponderosa pine	*Pinus ponderosa*
Rocky Mountain juniper	*Juniperus scopulorum*
Oneseed juniper	*Juniperus monosperma*
Common juniper	*Juniperus communis*
Utah juniper	*Juniperus osteosperma*
Rocky Mountain fir	*Abies bifolia*
White fir	*Abies concolor*

◄ Common sources of particulate matter in the air include industrial activities, automobile emissions, construction sites, unpaved roads, smokestacks, and fires. Smaller particles ($PM_{2.5}$) pose a greater danger, due to their ability to become lodged more deeply into lung tissue than larger particles, and their ability to travel greater distances in the air. Once lodged into the lung tissue, the particulates can cause irritation of the respiratory airways and reduce lung function. They can also cross into the blood stream and have been linked to cardiac diseases and some cancers. Particulate matter can carry heavy metals (including lead, a known neurotoxin) and other contaminants that become attached to the particulates.

Phytoaccumulation can offer an effective way to remove these particulates from the air before they enter our lungs or the lungs of other living creatures. Conifers have been shown to be more effective at collecting the ultrafine particles ($PM_{2.5}$) than broad-leaved species. That's not to say that broad-leaved species are completely ineffective in remediating particulates. Research has shown that broad-leaved species with waxy leaf coatings, leaf hairs, and a greater leaf area index can also be effective at removing particulates from the air. See Table 1 for a list of tree and shrub species native to Colorado that meet one or more of these criteria.

Nitrogen Oxide (NO_x) Gases

Nitrogen oxides (NO_x, mainly a mixture of nitric oxide [NO] and nitrogen dioxide [NO_2]) are created by the combustion of fossil fuels. Sources of these gases in the atmosphere include power plants and emissions from automobile engines. Overexposure to nitrogen oxides can cause irritation of the respiratory airways and the mucosa of the eyes and nose. Those already struggling with existing diseases of the airway, such as COPD, are especially susceptible to these adverse effects. Nitrogen oxides are also major contributors to acid rain and smog.

Plants take up nitrogen dioxide from the atmosphere and assimilate it into organic nitrogen-containing compounds, though species vary in their ability to do this. *Robinia pseudoacacia* (black locust) has been shown to have high resistance to damage in its tissue by NO_2, as well as a high capability of assimilating this contaminant into its biomass. Because of this, *Robinia pseudoacacia* is a good candidate for remediating urban air via phytometabolism where NO_X emissions are high.

Volatile Organic Compounds

Volatile organic compounds (VOCs) are compounds that have high vapor pressure and low water solubility. While VOCs are emitted from a variety of sources, including paints, adhesives, cleaning products, fuels, and automobiles, about two thirds of VOC emissions in the atmosphere are generated by the world's vegetation. Once in the atmosphere, VOCs then combine with other elements in the air, such as NO_2, to form ozone (O_3). Exposure to many VOCs has also been linked to an increased risk of cancer. At low levels, they can irritate the tissue in the eyes, nose, and respiratory airways. VOCs also have powerful neurological effects, and can cause headaches, dizziness, and even memory impairment.

Some species of trees release lower amounts of VOCs than others. When we select these species for use in urban and industrial areas where NO_2 emissions are high, harmful reactions with airborne chemicals can be reduced. See Table 2 for a list of ►

Table 2: Colorado Native Tree Species That Emit Fewer VOCs	
Common Name	**Scientific Name**
American dwarf birch	*Betula glandulosa*
Water birch	*Betula occidentalis*
Eastern red cedar	*Juniperus virginiana*

◄ trees native to Colorado that have been shown to release lower levels of VOCs than other species of trees commonly used in urban settings.

Other Air Pollutants

Like nitrogen oxides, carbon dioxide (CO_2) is produced by fossil fuel combustion. At low levels, adverse health effects from exposure to CO_2 are minimal; however, at extremely high levels it can inhibit the ability of the body to take in oxygen. CO_2 is also a major greenhouse gas that contributes to a rise in global temperatures and the resulting changes to climate. All plants sequester carbon from the atmosphere. In the United States, urban trees are estimated to store approximately 700 million tons of carbon in their tissues.

Sulfur oxides (SO_X) from the combustion of fossil fuels are also released into the atmosphere, where they contribute to acid rain and smog. Adverse health effects from exposure to sulfur oxides are similar to those from nitrogen oxides, causing inflammation of the respiratory airways and impaired lung functioning. Sulfur dioxide (SO_2) and NO_2 emitted from automobiles, power plants, and industrial activities create complex chemical reactions that result in most of the forms of particulate matter in the atmosphere.

Ground-level O_3 is created by reactions between VOCs and nitrogen oxides as they are exposed to sunlight. Inhaling O_3 can create a variety of health problems similar to those from nitrogen oxides and sulfur oxides, mostly affecting the respiratory system. It can also exacerbate diseases of the airways, such as asthma and bronchitis, and can impair lung function. Common symptoms of O_3 overexposure include sore throat, coughing, shortness of breath, and pain or burning in the chest. Ozone is also detrimental to other animals and to plants. Studies have revealed that planting trees, especially species that emit lower levels of VOCs, can help reduce urban O_3 levels (see references).

Trees in urban areas also provide additional benefits such as reducing air temperatures (and thus transpiration rates) by providing shade. This helps to reduce energy usage, and consequently, reduces power plant emissions. A reduction in emissions from power plants can also help further reduce urban O_3 levels. A study conducted by Nowak et al. (2006) concluded that in the United States, the positive physical effects provided by urban trees were more beneficial than the negative effects that might be expected from the chemical release of VOCs from those trees in terms of affecting levels of O_3.

Design Techniques

A study conducted by Yang et al. (2008) illustrates the impacts different types of vegetation have on the reduction of the air contaminants discussed above. Larger plants and those with a greater leaf surface are better overall at reducing these contaminants (Table 3).

Since air pollutants are dispersed primarily by wind, the effects of emissions are not necessarily confined to the immediate vicinity of their source. Although the concentration of pollutants does decrease with distance from their source, these pollutants can still cover a large area. One study (Zhua et al. 2002) found that particulates originating from roadways often travel up to 240 feet from their source. Thus, the arrangement in which vegetation is planted can be important.

Vegetated buffers can be planted adjacent to locations where land uses produce emissions high in particulates and nitrogen dioxides, including roadways with high traffic volumes, industrial districts, oil refineries, and coal-burning power plants. When we include species that will maximize the collection of particulate matter, or lower the amount of VOCs emitted where O_3 is a concern, these buffers can be effective for distances up to 600 feet from the sources of these contaminants.

Conclusion

Improving air quality is yet another application of phytoremediation in which native plants can help improve the environment. The greatest improvements in air quality from urban trees and other vegetation have been reported for particulate matter, ozone, sulfur dioxide, and nitrogen dioxide, with a greater percentage of tree coverage found to be correlated with an improvement in air quality. Urban trees ►

Table 3: Annual Removal Rate of Air Pollution per Canopy Cover by Different Vegetation Types in Chicago between August 2006 and July 2007

Vegetation Type	NO_2 ($g/m^2/yr$)	SO_2 ($g/m^2/yr$)	PM_{10} ($g/m^2/yr$)	O_3 ($g/m^2/yr$)	Total ($g/m^2/yr$)
Short grass	2.33	0.65	1.12	4.49	8.59
Tall herbaceous plants	2.94	0.83	1.52	5.81	11.1
Deciduous trees	3.57	1.01	2.16	7.17	13.91

Note: The non-vegetated surfaces were excluded from the calculation. Source: Yang et al. 2008.

◄ contribute to passive temperature cooling and the sequestration of atmospheric carbon. With a simultaneous reduction in our use of fossil fuels, native plants can play an important role in the regenerative efforts to improve and restore air quality.

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The Winter Biology of Plants

By Maggie Gaddis

Many of us retreat to the indoor environment during the winter. Humans are adapted to the tropical climate, and we are great at creating the comfort of a warmer clime with clothing and heating in our homes. Plants do not wear clothes or heat their homes, but they have many adaptations to tolerate the cold and survive the winter.

Native plants reveal how they have evolved to tolerate the cold. The changing day length associated with seasons in mid-latitudes is a signal for many physiological processes in plants. The morphology of plants offers some physical protection from the cold, but what's happening inside of plants reveals the true nature of cold tolerance.

The seeds of native plants protect the offspring of the next generation with a recalcitrant coat that prevents moisture from initiating germination. Seeds also provide an important high-calorie resource for wild mammals bulking up to build a winter coat of fur and a lipid blanket beneath their skin. Seeds persist on the dried stems of grasses (e.g., *Sorghastrum nutans*, Indiangrass; *Schizachyrium scoparium*, little bluestem; *Andropogon gerardii*, big bluestem) until they eventually rest by the weight of snowfall, the pressure of trampling, or the emergence of stems in spring.

Quercus gambelii (Gambel's oak) leaf encrusted in the frost of early winter. © Maggie Gaddis

On the cold, windswept prairie, winters can be snowy and yet paradoxically devoid of plant-available moisture. The snow sublimates (changes directly from a frozen state to vapor) into the winds of high-pressure systems. Given these environmental conditions, native prairie plants require only dry stratification for 30–60 days to break seed dormancy. Dry stratification is a period of cold, not associated with moistening. You can mimic the dry winter season by storing dry native seed in a sealed container in the refrigerator.

Perennial herbaceous plant species persist to some extent via seed propagation, but seeds confer no winter protection for mature plants, so plants bulk up just like wild mammals do. They store water and nutrients in their belowground roots, tubers, and corms while their aboveground parts senesce. The resources collected in the seasons prior to winter make emergence possible in the spring. Likewise, the water stored in the winter snowpack becomes the lifeblood of the growing season when it melts in spring.

The bodies of all living organisms are largely made of water, as the hydrogen atoms in water molecules are the currency of many chemical exchanges that occur within the cellular systems of living organisms. As such, the phase change of water from liquid to solid that occurs at freezing temperatures alters the molecular shape and behavior of water and, in the process, can damage cells.

In the case of conifers (e.g., *Picea*, spruce; *Pinus*, pine; *Abies*, fir) and other trees, translocating chemicals to the belowground parts of the plants can be too calorically expensive simply due to their sheer volume and height. Instead, these species use other adaptations to persist in the winter cold. The recalcitrant lignin of needles (modified leaves) acts as a protective coating to allow the needle to continue to carry out photosynthesis in winter, thereby reducing the pressure for belowground storage of sustenance for the winter. Aspens (*Populus tremuloides)* have a similar tactic for surviving winter, but their winter photosynthesis occurs via the bark because their leaves are deciduous. The persistence of chemical processes such as photosynthesis signals that these species are still physiologically active in winter despite freezing temperatures. ►

◄ So how is it possible for a woody stem to survive temperatures well below freezing? The speed with which the freezing temperatures advance controls the amount of cellular damage that results. As winter sets in, decreasing day length and early cold spells of frost and light freeze prepare the stems to sustain deeper colds later in the winter. Northern and high-elevation species have an amazing ability to supercool the cells within woody stems. The cellular membrane becomes more flexible to ice crystallization while the intermolecular forces of water acting on substances within cells reduce the temperature at which the water phase change occurs, thereby reducing ice crystallization, at least at temperatures near but below freezing.

Winter in Bear Creek, Colorado Springs, where the subalpine forest meets the montane in the city. © Maggie Gaddis

These amazing processes that protect plants from cold injury evolved in response to climate signals. Climate change does not influence day length, which signals many physiological processes in plants. However, erratic weather patterns associated with climate change can send plants into an emergency state. Research shows that woody-stem cold resistance develops through the autumn season. Stems cut from the same tree show variable cold resistance depending on when they are clipped from the plant in the wild (Marchand, 2013).

When erratic weather brings early hard freezes that defy this steady process of acclimating to the cold, cell damage from freezing temperature is greater. We often discuss how winter drought stress affects the health of trees, but damage from unusual winter cold has the same morphological expressions, and thus it is difficult to decipher between cold and drought damage to woody stems.

Here in Colorado, winter is changing. Early- and late-season storms and periods of cold winter drought damage woody plants that are not sleeping like their herbaceous cousins tucked into their belowground beds for winter. While we can confer protection from winter drought in our home landscapes by watering, winter drought and early and late freezes in our ecosystems disturb the complex cellular defenses designed to protect these species from deep cold. Although this is a problem with seemingly no practical solution, we can look to the bigger picture of climate change to find ways to remediate this ecological problem. If we can get our love of carbon back into plants by protecting habitats, reducing fossil-fuel consumption, and embracing a plant-based diet, we might be able to slow the climate changes that threaten our Colorado forests. Cultivating our personal choices to slow our consumption of carbon can help save our Colorado winter and its majestic forests.

Practical advice for protecting your native trees this spring

- Water your woody species in periods of warm drought in winter (above 40°F).
- Since de-icing salts are damaging, consider alternatives near your native plants.
- Prune woody shrubs and trees in late winter before the spring emergence to encourage a natural form and prevent fungus and insect infestations in damaged branches.
- Be slow about augmenting spring water. Try to maintain dormancy for as long as possible. Woody species that begin growing too early are more susceptible to spring storms. If damage ensues, prune back damaged branches.

Inspired by: Marchand, PJ. (2013) *Life in the Cold: An Introduction to Winter Ecology*. 4th ed. University Press of New England.

Conservation Corner

Fens in Colorado—Their Vulnerabilities and the Threats They Face

By Gay Austin

In Colorado, wetlands encompass 1.5% of the total land mass, and fens just 0.3% of mountain wetlands (Chimner and Cooper 2003). Groundwater-dependent fen ecosystems are different from bogs—bog wetlands form above the soil surface in areas of the world with high climate moisture (e.g., Canada, Maine). Fen formation that occurred 8,000 to 12,000 years BCE in Colorado was limited to high-elevation basins, hillsides, toeslopes, and depressions connected to consistent, complex local groundwater flows (Chimner and Cooper 2003, Patterson and Cooper 2007). An example of the complexity of groundwater in fens occurs in the Mt. Emmons Iron Fen in Gunnison County. There, upward flows of groundwater from a lateral moraine through peat have a basic pH, whereas acidic water at the surface originates from water flowing through pyrite in bedrock.

Fens are important ecologically for their high biodiversity and for carbon sequestration. In Colorado, fens support a number of rare plants, such as Chamisso's cottongrass (*Eriophorum chamissonis*) and Rolland's bulrush (*Trichophorum pumilum*), as well as unusual plant communities (e.g., Pacific bog sedge-alpine meadow rue or *Kobresia myosuroides-Thalictrum alpinum*) (Cooper and Sanderson 1997). Researchers also value fens as paleoecological records of ancient climate history and occasionally find fossils in them (Johnson and Miller 2012).

Fully intact fen in the Medicine Bow National Forest © John Proctor

Fens are threatened by recent changes to the Clean Water Act, population growth demanding water, mining, development, ski-area expansion, timber harvest, sedimentation, and increasing motorized and off-road use in National Forests(Marshall and Lemly 2020). On the Grand Mesa in western Colorado, reservoir and ditch companies were formed in the 1800s to construct water storage and irrigation systems for the benefit of orchards in towns below the rim of the mesa. Many of the large reservoirs on Grand Mesa were built in fens and demand continues for additional water storage in fens there (Austin and Cooper 2016). Unnatural or straight lines in fens are often easily recognizable in aerial photographs or Google Earth and are indicators of ditches, dams, or vehicle tracks.

Fens are especially sensitive to loss of groundwater regimes and complex groundwater chemistry from ►

Disturbance Type in Fens	Sites Impacted on Grand Mesa
Flooding and seasonal drainage for reservoir use, peat subsidence	14
Earthen dam and flooding	1
Peat mass modifications	5
Ditches	11
Gas pipeline	1
Road through site	1
Ditch draining into site	1
Rutting from vehicles	7
Spring development for livestock use	1
TOTAL	**42**

Examples of some of the impacts that have occurred and are still occurring on National Forest lands in Region 2. In my research on Grand Mesa, fens occupied less than 1% of the total research area (115,700 acres). Out of the 88 fens that we looked at, 42 had impacts from human activities.

◄ hydrologic alterations (ditches, road construction, flooding from dams, water diversion, groundwater pumping, peat mining, and vehicle ruts). These allow oxygen to enter the system, which initiates aerobic decomposition of the peat. Aerobic decomposition—which is more dominant in most other types of wetlands—occurs 50 times faster than anaerobic decomposition (Clymo 1983). Undisturbed fens accumulate organic material as peat, rather than decompose organic matter.

On Grand Mesa, we compared fens from aerial photographs taken in 1937, 1956 and 1978, and from Google Earth in 2007. We documented changes in peat-forming plant communities, peat mass, and peat subsidence as verified on the ground. We also identified a loss of biodiversity in those damaged fens (Austin and Cooper 2016). Drainage of deep organic soils (called Histosols) causes volume change and soil subsidence or lowering of the soil surface (University of Idaho 2021). Peat may dry and become unable to absorb water. When rewetted, it will not decompress and will continue shrinking from the initial compression depth. In addition, drainage often irreversibly alters the chemical properties of peat (Price et al. 2005). Furthermore, instead of storing carbon, as a fully functioning fen does, a drained fen begins releasing carbon dioxide into the atmosphere.

Colorado fen restoration research is ongoing (Chimner 2011, Schimelpfenig et al. 2014, Cooper et al. 2017, Chimner et al. 2018). Focus is initially on restoring the hydrology of damaged fens and secondly, on encouraging recolonization of peat-forming plants such as sedges (*Carex*) on sites (Sueltenfuss and Cooper 2019).

For more information on the fens of Colorado, see the CoNPS website (https://conps.org/project/high-creek-fen/).

Fen damage continues to this day. Toll Town Fen on the Grand Mesa in August 2021. A ditch is being dug for "reservoir maintenance." © Gay Austin

Gay Austin is a retired botanist and ecologist. She worked 22 years with the Gunnison Ranger District USDA Forest Service and 7-1/2 years with the Gunnison Field Office USDI Bureau of Land Management. She has a master's degree in Botany-Ecology from Prescott College. Her thesis title was "Fens of Grand Mesa, Colorado: Characterization, Impacts from Human Activities, and Restoration."

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Melampodium leucanthum, Blackfoot Daisy

By Jim Borland

Someday, horticulture at large will be so sophisticated that each sector of the country will have its own lengthy and very specific list of easily available native plants—from annuals to trees—suited to the specific growing-conditions ecoregion of that sector and not necessarily any other. Colorado gardeners will find six regionally distinct native plant lists on the CoNPS website (similar lists can be found elsewhere), but generally it is up to individual gardeners to gather, propagate, and grow a palette of plants suited for their own gardens and the ecosystems in which they live.

One plant that has caught the fancy of a few Rocky Mountain growers is blackfoot daisy, a native herbaceous perennial of the Great Plains' southern quarter. Hailing from the very center of the American dust bowl, it occupies some of the driest sites (those receiving less than 15 inches of annual precipitation) on high plains, uplands, shortgrass prairies, and limestone shale outcrops. The blackfoot daisy is included in the CoNPS list of low-water natives for southeastern Colorado.

Blackfoot daisy (*Melampodium leucanthum*) on the Comanche National Grasslands. © Ernie Marx

Its bouquet-like mounding habit (8 to 12 inches tall and wide) presents, depending upon your outlook, either a nightmare or a dream to breeders, who may find little long-term security in working with an already nearly perfectly formed and flowered plant. This mound is covered ground to top with 1- to 2-inch-wide flowers composed of creamy-white, toothed rays, with dark veins beneath and yellow centers. Leaves are opposite, sessile, linear-oblong, dark olive-green, and covered with abundant short hairs.

In the wild, its long bloom period, from June to frost, is often punctuated with dry periods when blooming may stop. However, existing blooms dry in near perfect shape and color, giving the casual observer the impression that bloom continues unabated. The seed is curious in shape and borne on a thickened and hooded inner bract of the involucre. Only ray flowers are fertile; disk flowers are sterile.

Propagation is easy from seed, with no special treatment needed. However, seed is not commonly available, primarily because it does not remain viable for more than a year in open storage. Cuttings are easy to work with if young shoots are utilized. Drainage is not a major concern; instead, extra aeration in the container and in the landscape results in a strong, long, and well-branched taproot.

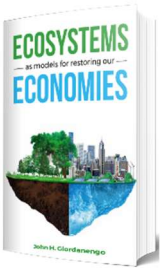
In the landscape, blackfoot daisy works well in dry, sunny borders with its companion in the field, the golden-yellow Rocky Mountain zinnia (*Zinnia grandiflora*). It should perform well, without any known pests, in at least cold-hardiness zone 5 or warmer. Interested gardeners south of the New Mexico–Kansas state lines may be more familiar with *Melampodium cinereum* (hoary blackfoot), a very similar, if not identical species, separated botanically by some from *Melampodium leucanthum* by small morphological details.

If you are wondering about the derivation of either the botanical or common name, don't go too far afield. It seems Linnaeus merely picked a name already in use for another plant, possibly from what is now known as Lenten rose (*Helleborus orientalis*), a species whose short roots are indeed black.

Since our own US flower breeders have not historically expressed much interest in perennial flowers, and European and Japanese breeders do not focus on drought-tolerant species, blackfoot daisy and others like it will probably never be taken seriously in the horticultural world. And that is a shame, since little improvement is needed to make *Melampodium leucanthum* a fine and sought-after bedding plant for dry areas. Lucky for Colorado native plant fans, the blackfoot daisy is already very appealing and is starting to become available commercially.

Colorado Ecosystems as Models for Restoring Our Economies

By John H. Giordanengo



Editor's note: This article summarizes ideas presented in the author's book, *Ecosystems as Models for Restoring Our Economies* (2021).

If there is one factor that both economies and ecosystems can depend on over time, it is change. A case in point is Colorado, with its alpine peaks and temperate forests giving way to the plains flowing out to the east. Today, there is a tremendous reservoir of fossil fuel lying below our shortgrass prairie, where a vast inland sea once teemed with ancient tropical life. Ecologically and geologically speaking, Colorado has received a recent makeover.

Some 300 million years ago, when fossil fuels around the globe were just forming, Colorado was situated closer to the Yucatan Peninsula of Mexico. Ever since, life-exterminating events have carved and molded Colorado's natural history, while tectonic movements nudged it ever northward. The Himalayas rose, causing a shift in the global airstream and Earth's climate. A monstrous asteroid struck near present-day Yucatan, extinguishing the reign of dinosaurs and driving three out of four plants to extinction. Oxygen levels dwindled and the age of mammals was ushered in.

Later, primates climbed down from the safety of trees as dense tropical forests dissolved into open savanna. Over time, humans ventured into North America, where they used fire to shape the prairie, and were followed by current-era humans, who converted significant tracts of diverse prairie into monocultures, suppressed forest fires, and began extracting fossil fuels to power the extraction of other resources.

Yet, in the face of these cataclysmic events, Colorado's ecosystems did not permanently collapse. They stayed their course, maintaining optimal performance, given the environmental context of the day. As new species came and went, the diversity and complexity of the systems allowed them to efficiently sequester ample energy and other resources. In turn, the productive capacity and resilience of the ecosystem remained secure.

Dozens of theories, principles, and case studies from ecology and economics are drawn upon in my recent book, *Ecosystems as Models for Restoring Economies*. If you believe our knowledge of ecosystems cannot inform the sustainable structure and function of our economies, it is my hope that this article (as a glimpse into the book) will make you think again.

Diversity Confers Resilience

When we think of biological diversity, we often consider the number of species in a given area, which is referred to as "species richness." We might also consider the various tree canopies, low shrubs, and forbs that can exist in the same space, which is "structural diversity." However, diversity expresses itself in several other forms, including functional diversity, functional redundancy, and landscape diversity (the patchwork of various habitats in a region).

The actual measure of "diversity" is a function of richness, and the distribution of species in an ecosystem. Economies exhibit the same forms of diversity, though the basic unit of measure is the business rather than the species, upon which evolution acts to ensure the fittest individuals survive in a world of continual threats.

Besides the resilience that diversity confers to economies and ecosystems, many other benefits arise. Across entire economies, business diversity has been tied to greater stability, wage growth, increased productivity, lower unemployment rates, higher profitability, etc. (Felix 2012; LaCanne & Lundgren 2018; Templet 1999; Tran 2011). Similar benefits are conferred to ecosystems, whose productivity and diversity rise and fall as the system travels through time.

Succession, Diversity, and Net Primary Productivity in Ecosystems and Economies

It is not intuitive, but most ecosystems reach their peak in diversity and productivity not in the early or very late successional phases following a severe disturbance, but in the middle phases (Odum 1969, Tang et al. 2014, Gough et al. 2016). For example, a forest recovering from a wildfire is dominated by a relatively low diversity of quick-growing species, each capable of high rates of productivity. As the years go by, diversity increases, biomass accumulates, and energy is increasingly directed toward system maintenance. This process of plant community change over time is referred to as "succession." Absent another disturbance, a forest can become dominated by towering trees, which demand that more energy be allocated to maintenance than to growth. As a result, late-successional ecosystems, those that have not been disturbed in quite some time, can exhibit lower productivity, with productivity often reported as the rate of biomass generated in a given span of time, such as a year. Eventually, an ►

◄ equilibrium is reached between community-wide production and maintenance. This late successional stage is often referred to as a "climax community."

In addition to exhibiting low levels of production, late successional communities also tend to be low in diversity. In a recent study in America's temperate deciduous forests, Gough et al. (2016) showed that the middle stages exhibit the highest levels of productivity (Figure 1). In the middle stages, the actual structure of the forest is being shaped by a higher frequency of small-scale disturbances, such as blowdowns of individual trees. The result is a more complex and diverse forest which can more efficiently sequester energy and nutrients (Cadotte 2013, Cardinale et al. 2007, Odum 1973).

In contrast to ecosystems, the global market economy tends to achieve its highest levels of productivity (as measured by GDP) immediately prior to significant disturbances, such as depressions and recessions. Recall the roaring 1920s that preceded the Great Depression, the booming U.S. economy prior to the Great Recession (2007–2009), and the record-breaking GDP and market performance prior to the COVID-19 crash. Long before, the 1850s through the 1870s were booming, right up until the 1890s recession. Though the concept of system-wide succession has not crept into mainstream economics, it is a core component of *Ecosystems as Models for Restoring Our Economies*.

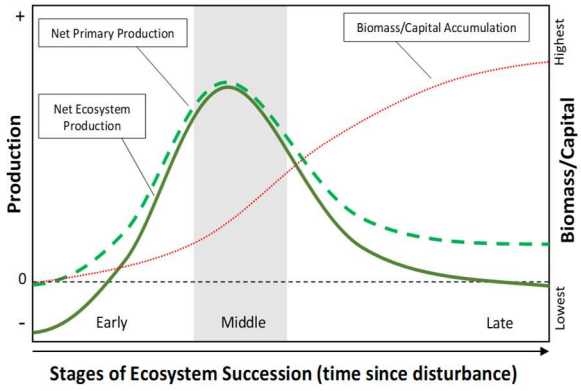


Figure. 1. Predictions of aboveground net primary production (NPP), net ecosystem production (NEP), and biomass (i.e., capital in an economy) over the course of ecological succession (modified from Gough et al., 2016; and Odum, 1969). NEP is the difference between gross primary production and *total* ecosystem production.

The Global Market Economy: Failing to Deliver after 700 Years of Evolution

During his tenure at John Hopkins University, Giovanni Arrighi (2007) detailed the evolution of capitalism through four major epochs spanning nearly 700 years. Arrighi believed the roots of capitalism could be traced back to a budding system of trade among European merchants. It was amid the rivalry among Italy's medieval city-states—Florence, Lucca, Genoa, Venice—that a shrewd body of entrepreneurs realized a truism often taken for granted today: profit could be made simply by shipping goods from areas where production was cheap to communities where consumers would pay a premium.

As capitalism has evolved into a global system, monumental efforts have been waged by dozens of nations and countless activists over the past century to resolve our most important social, environmental, and economic challenges. Painful as it may seem, we must question if those important efforts can succeed, let alone be sustained, without first resolving the economic flaws responsible for their creation.

During the Great Recession, Professor Simon Johnson of MIT revealed a powerful metaphor at an annual meeting of the American Economic Association. Johnson noted that sustained progress in health and sanitation came only after society had discovered how diseases worked (e.g., the germ theory of disease). Economics, Johnson professed, has failed to make meaningful progress, for it has yet to discover its own "germ theory of disease."

Based on our knowledge of ecosystems, the model of global market capitalism, while growing unprecedented levels of wealth for some, appears to be built upon a faulty structure. Akin to a disease, that faulty economic structure places every human at risk of supply-chain disruptions, turbulent energy markets, political uncertainties among trading partners, and a whole litany of social and environmental impacts. Hanging in the balance are the security, health, and prosperity of people across the world, the wholeness of our communities, and the ecosystems upon which we rely.

The structure of our economy further governs the richness of our relationships. This includes the amount of time we spend with robots and computers rather than with those we love; how motivated we are to work, or to feed and clothe our neighbors; or whether we will ever know the people who feed and clothe us. The structure of our economy further determines not only how well today's needs are met, but how well our needs will be met in the age of economic turmoil lying ahead.

Ecosystems as Models for Restoring Our Economies reflects several decades of work and research in ecology, business, and economics, and is an attempt to peel back those layers of our economy that are the focus of mere policy, basic economic theory, social ►

◄ science, and environmental context (Figure 2), to reveal the structure around which the system is built.

A Gross Error in Quantifying Economic Productivity

Gross domestic product is a standard measure of an economy's performance and is tied to boundless historical data. However, the use of GDP to reflect economic performance represents a critical error in accounting. To gain a better understanding of an economy's ability to sustain its productivity, distribute resources, and maintain other values in the face of continual internal and external threats, *net domestic product* is a far better measure.

But even our basic measure of NDP, which accounts for some depreciation costs, ignores many other costs associated with production. To begin with, the degradation of natural resources caused by various industrial activities is rarely accounted for in the same year that production occurred. As a result, neither NDP nor GDP fully account for the degradation of the system resulting from economic activities. The tens of billions of dollars spent to clean up the Chesapeake Bay (e.g., degraded water quality, habitat loss, impacts to fisheries, etc.) from past production activities, for example, was not accounted for in the years in which the industrial activities contributed to the productivity of the US economy. GDP and NDP were therefore artificially inflated in those years.

Similarly, the soil-fertility losses caused by modern agriculture are not accounted for in NDP. Nor are the mental- and physical-health costs associated with hyperproductive economic activity. (If only we could drive our cars like our economies, without worrying about replacing the tires, changing the oil, or giving the driver a break!)

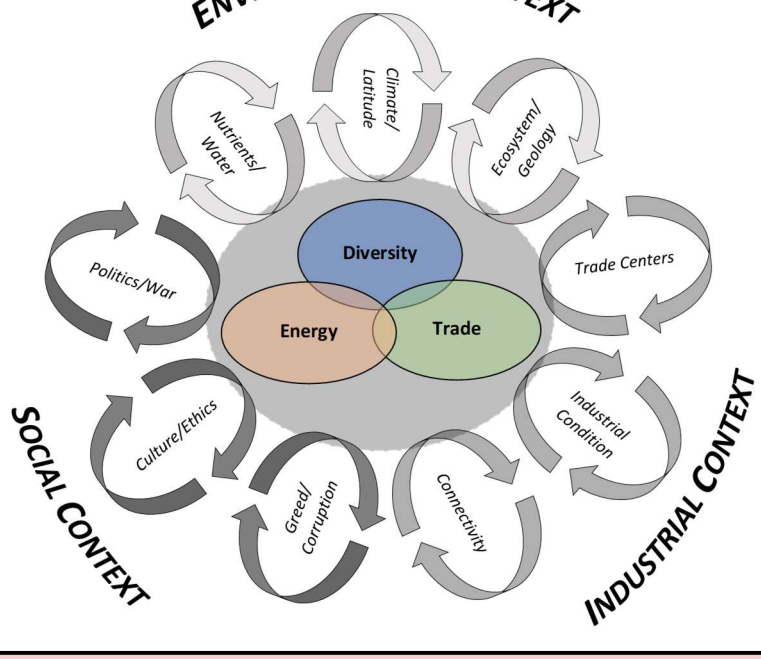


Figure 2. The structure of a complex self-regulating system consists of its foundational components: diversity, energy, and trade. The forces within the chasing arrows, such as war, politics, nutrients, recession, revolts, etc., are external to the system, yet form feedback loops with foundational components.

To be in alignment with complex ecosystems, I propose a fuller definition of *net domestic product*: an economy's productivity after accounting for depression of capital assets, social assets, and ecological assets. The scale at which NDP, GDP, or other units of productivity should be measured is important.

The Basic Operational Unit of a Self-Regulating (Sustainable) Economy

Ecosystems exhibit a condition that is radically different from any lower-order systems, such as the organs within a human body, or the individuals interacting within a population of humans. Informative to a sustainable economy, the persistence of a given ecosystem does not rely heavily on interactions with adjacent ecosystems. There is a nuance here that may be clarified with an example.

Deserts by and large exist around 30 degrees north and south latitude, where the biosphere is extremely dry. Tropical rainforests exist primarily between the Tropics of Cancer and Capricorn—within 23.5 degrees of the equator—where the biosphere is extremely wet. If one attempted to erect a large enough wall around an entire desert or tropical forest, without interrupting its connection with the atmosphere, the walled ecosystem would persist for quite some time. That is, ecosystems and similarly complex systems follow a complexity-persistence principle: the more complex the system, the longer it can persist in isolation of similar basic operational units (e.g., other systems of similar complexity).

The degree of persistence experienced by ecosystems or economies is not found in far simpler systems. If a doctor were to separate a patient's heart from their lungs, each component would fail, and the patient would perish almost immediately. Further up the complexity ladder, if all human beings were kept in isolation from one another, or from all other species, humans would soon go extinct. ►

◄ In economics, the complexity-persistence principle also explains why the performance of one region's economy—a reflection of its unique social-environmental-industrial (SEI) context—does not have a noticeable influence on the economy of adjacent regions (Tran 2011). That is, the "economic identity" of a given region is more influenced by its unique SEI context than by that of an adjacent economy. Businesses and industries come and go over time, but the economy persists. Unlike ecosystems, however, the resilience of our economies appears to be decreasing over time, while the duration of each epoch of capitalism has grown shorter, from 220 years to about 100 years (Arrighi 2007). Global market capitalism has existed for 50 years, with its future as a homogeneous, top-down system unknown.

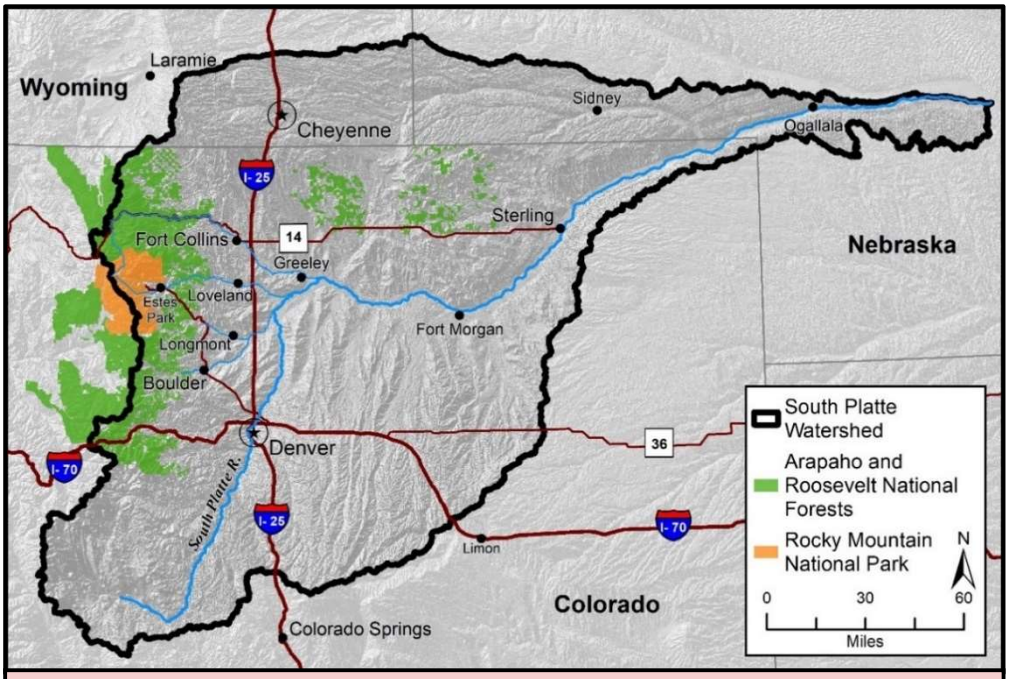


Figure 3. Potential South Platte Free Economic Zone, based on a 6th level Hydrologic Unit (USGS, 2020).

The book summarized in this article details several other essential means by which ecosystems serve as the archetype for our economies and draws heavily upon systems thinking to inform our understanding of economics. Every ecosystem on Earth, such as the coastal redwood forest, is nested within a larger system, such as the coast range. The coast range is nested within the northwestern forested mountains, which is nested in higher-order systems all the way up to the biosphere. Though higher-order ecosystems can persist more or less independently from one another, the health of each ecosystem depends on the health of its lower-order systems, just as the health of the human body depends on the health of its organs. Does the health and function of the US economy depend on the health of the economies comprising it? Part I of the book attempts to answer this and other questions related to the structure and function of our global market economy.

Part II of the book describes three foundational components of both economies and ecosystems that contribute to their resilience, resistance, and productive capacity. Analogous to the architecture of earth's ecosystems, the basic units of operation of the global market economy are our regional economies. It is these units that must be fully functional and "healthy," such that the global system may persist. From the evidence provided in parts I and II of the book, the current model of global market capitalism has maximized resource transfers and energy transfers across economic borders (the basic units of operation). However, the productivity of the global economy has occurred at the expense of the diversity, resilience, resistance, and productive capacity of our regional and even our national economies. This disconnect between global and regional scales must be addressed in order to provide the greatest benefits to the greatest number of people, without jeopardizing the ecosystems and human systems upon which global economy depends.

The restoration of an example of a basic economic unit, the South Platte Economic Zone (Figure 3), is detailed in part III of the book.

Economic Restoration

As informed by ecosystems, the economy should not be managed as one colossal and homogenous system at the national or global scale. Not only are the health and resilience of our communities at stake from such a system, but of course the health and resilience of the ecosystems upon which we depend. With this in mind, the final chapters of the book outline one path for economic restoration, which begins at the local and regional level, and is informed by our knowledge of ecological restoration, succession, evolution, and other principles and theories.

John Giordanengo's drive to synthesize the principles of ecology and economics grew out of a passion for conserving natural resources. While studying business

"Ecosystems…" *continued on page 38* ►

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

2022 Spring Plant Sale

Ordering online will start on April 1, with the pickup date on Saturday, May 21. We will offer 50-plus species of native wildflowers, grasses, and shrubs.

This year, we will have three pickup locations:

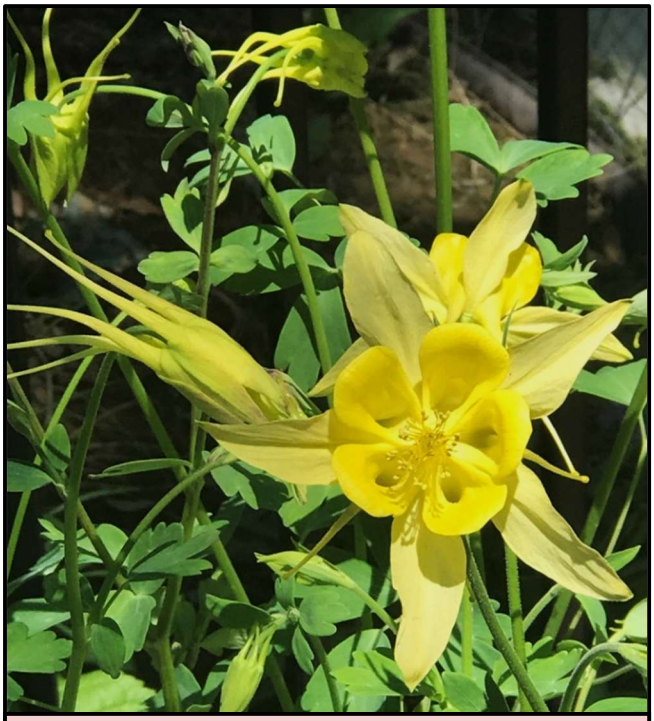
- Chatfield Farms
- Lafayette
- Colorado Springs

New this year! We will have a good stock of substitution plants from which the CUSTOMER gets to pick up in case their first choices are not available.

Plant growth depends upon the weather, and growers do their utmost to deliver exactly what we order; however, nature cannot be ordered, so if your order is missing a plant, you will now be able to choose from among the overage of many other species! We are going for a no-refund, every-plant-desirable, every-customer-happy sale.

Many volunteers needed for this sale! This year, we hope to pull orders on the Thursday afternoon and Friday before the pickup day (Wednesday for the Boulder-area orders). Free pizza/lunch for volunteers! Contact deniseclairewilson@gmail.com. ►

Monarda fistulosa, bee balm/wild bergamot, a perennial offered in the sale, blooms on 2- to 5- foot open-branched stems. It has a minty aroma; the oil being used to treat respiratory ailments. It is named for the Spanish physician and botanist, Nicolas Bautista Monardes (1493–1588), who studied medicinal plants brought back from the New World. These pink to lavender tubular (fistulosa) flowers attract birds, hummingbirds, and butterflies. © Denise Wilson



Another perennial in our sale is *Aquilegia chrysantha,* golden columbine, a drought-tolerant upright, perfect for rock, woodland, or cottage gardens. It requires good drainage and can't take excessive sun, but it's reasonably adaptable to any soil. It is pollinated by moths, butterflies, and bees. It tolerates rabbit and deer herbivory. An adaptable and vigorous grower. *Photo from Marcia Tatroe's garden, 2021.* © Denise Wilson

◂ Announcing the 2022 CoNPS Garden Tours!

We will be holding three in-person garden tour events on different dates in June 2022. Please see the calendar of events for ticket pricing.

- Longmont/Boulder/Lafayette—Saturday, June 4. An educational tour of Jack's Solar Garden to view the solar arrays and the Habitat Hero's Garden of 3,000 native perennials will also be available.
- Denver—Saturday, June 11. Denver ticket will include admission to DBG's Chatfield Farms
- Fort Collins/Loveland—Saturday, June 25.

For our Denver tour, we have a special viewing of three Denver Botanic Gardens horticultural curators' home gardens: those of Mike Bone, Mike Kintgen, and Dan Johnson. Also on the tour will be the gardens of Jim Borland, which contain many years of mature native plantings, and Kelly Grummons, whose landscape includes many of the cacti he sells.

Please contact Denise Wilson at deniseclairewilson@gmail.com if you are interested in either hosting or volunteering.

As we did last year, volunteers will work a half-day helping a host, and will receive a FREE ticket to view the gardens in the tour for the other half of the day.

A garden on the Longmont tour. © AJ Parmidge

Save the Date!

CoNPS Annual Conference

September 16–18, 2022

Longmont Museum

"From Peaks to Prairie: Exploring Biodiversity and Disturbance in Front Range Ecosystems"

The conference will showcase the work of ecologists in each of our local ecozones.

Colorado Native Plant Society Launching a New Statewide Budburst Program

The Budburst Colorado team is launching a new Statewide Budburst Group through the popular Budburst Phenology program hosted by Chicago Botanic Garden. The new program will look at the phenology of specific plants throughout the entire state of Colorado.

For the past year, we have been making observations at River's Edge Natural Area in Loveland, where native plant gardens offer a convenient assemblage of plants to monitor. These gardens, funded by a Larimer County small grant, were designed and installed by members of our Society in partnership with the Loveland Parks & Recreation Department and community volunteers. In 2021 alone, over 500 phenology observations were made in the native plant gardens and the surrounding natural area.

The new project will concentrate on 12 iconic and easy to identify species from around the state of Colorado. They include trees like Ponderosa pine (*Pinus ponderosa*), shrubs like golden currant (*Ribes aureum*), and favorite wildflowers and grasses. Tutorials are being developed so that even those new to plant ID and phenology will know what to look for and how to make observations.

To see the full list with color photographs, go to https://budburst.org/about-us/our-partners/colorado-native-plant-society. To join in this important statewide Citizen science Project, write to budburstcolorado@gmail.com

Prairie coneflower (*Ratibida columnifera*). © Ann Grant

CoNPS Receives CAEE Award

By Kathleen Okon

The Colorado Native Plant Society received a 2021 Outstanding Environmental Education Program Award for Covid-19 Response from the Colorado Alliance for Environmental Education, the state professional organization for environmental educators, for webinars initiated/implemented in 2020 in lieu of workshops and field seminars, due to the COVID-19 pandemic. These webinars, according to CAEE, "*(1) allowed CoNPS to continue to fulfill its educational mission while ensuring a safe environment for participants; (2) provided cost savings for participants, (due to shorter program times) and increased revenues for CoNPS (due to increased numbers of registrants); (3) saved program costs; (4) promoted a sense of normalcy for participants amid the pandemic; and (5) allowed for the creation of a Special Speaker Series, composed of nationally/internationally known speakers.*

The results were astonishing: (1) Program registration increased by 250%, and CoNPS' reach expanded to 17 states throughout the country, allowing [CoNPS] to spread the word about the importance of native plants, native pollinators, and native ecosystems throughout the nation; (2) program evaluations were extremely positive; and (3) net program revenues increased by 311% (due to increased registrations and decreased program costs). In conclusion, what could have been a devastating year for this nonprofit organization turned out to be one of the highest-reaching for participants and highest program revenue-producing years in CoNPS history." (https://caee.org/programs/act/be-recognized/colorado-native-plant-society-webinars)

Kathleen Okon, CoNPS Workshop Coordinator (center), receives a CAEE Outstanding Environmental Education Program Award from Chris Aaby, CAEE Board President (left); and Katie Navin, CAEE Executive Director (right). © Erin Kendall

Thanks to the CoNPS Operating Committee and Board of Directors for approving my webinar proposal and for their continued support throughout the year. A HUGE thanks to the incredible webinar presenters for sharing their time and expertise so that others could learn about the importance of native plants for native pollinators and other native wildlife, native ecosystems, and, ultimately, the health of the planet. Special thanks to all of you who attend these webinars. We hope you have gained valuable information you can use to promote native plants and native ecosystems, in whatever capacity that might be.

Our Thanks to Webinar Presenters and Participants!

This has been another successful year for CoNPS webinars! These webinars have provided equal opportunities for members throughout the state to attend 16 webinars on a variety of topics throughout the year and have also expanded CoNPS's reach nationwide. At the time of this publication, over 700 participants throughout Colorado and 19 other states have registered for and/or attended these programs, Other states with webinar registrants include Arizona, California, Florida, Georgia, Illinois, Iowa, Maryland, Minnesota, Missouri, Montana, New Jersey, New Mexico, New York, North Carolina, Oklahoma, Tennessee, Utah, Washington, and Wyoming!

Thanks to all the webinar presenters who generously gave of their time and expertise to share with others. You helped educate participants on a wide variety of topics, including four native plant family webinars, two ecosystem webinars, five native plant gardening webinars, two restoration/professional development webinars, a free citizen science webinar, and two Special Speaker Series webinars.

Specifically, thanks to these presenters:
Jennifer Ackerfield, Paul Alaback, Christina Alba, Jennifer Bousselot, Whitney Cranshaw, Carol English, Mo Ewing, John Giordanengo, Ann Grant, Kate Hogan, Stephanie Mayer, Irene Shonle, and Scott Smith. A BIG thanks to our Special Speakers: David Inouye and John Fielder!

Thanks, also, to over 700 participants for attending these webinars. We hope these educational opportunities have increased your knowledge and appreciation of native plants and have inspired you to protect/plant native plants for native pollinators and native ecosystems.

Please see the calendar of events for specific events (https://conps.org/event-calendar-2/#!calendar). ►

◂ Colorado's Wonderful Alpine

Presenter: Mike Kintgen

March 12; 9:30 AM – 12:00 NOON

We will cover the various alpine areas in Colorado. We'll start with a general definition of alpine and then look at specific alpine areas around the state, exploring geology, climate, and ecological differences between these areas. Then, we'll dive into some of the common alpine plants that call Colorado home. Lastly, if time allows, we'll touch on the *North American Botanic Gardens Strategy for Alpine Conservation*.

James' alumroot (*Telesonix jamesii*). © Mike Kintgen

Mike Kintgen has worked at Denver Botanic Gardens for over 17 years and is currently the Curator of Alpine Collections. He holds a BS in Landscape Horticulture from Colorado State University and a MS in Environmental Science (Alpine Ecology) from Regis University. Mike has worked with a wide variety of alpines in DBG's various gardens and has travelled to observe alpines in Europe, South America, North Africa, and throughout North America. He has helped with numerous DBG publications, including Steppes and Wildflowers of the Rocky Mountain Region *and writes for various journals on alpine and western natives. He also assisted with the* North American Botanic Strategy for Alpine Plant Conservation *with Betty Ford Alpine Gardens and DBG's Research Department, which was published in early 2021.*

Sustainable High Altitude Gardening Education (SAGE)

Presenter: Maggie Gaddis

March 24, 6:00 – 8:00 PM

A high-elevation garden. © Maggie Gaddis

In this self-paced, online learning community, students will learn the basics of sustainable high-altitude gardening. We will discover the ecological parameters of our gardens, select seeds and design planting schedules, implement water conservation practices, and consider plant care, harvest and seed collection. Class meetings 3/24, 4/21, 5/19, 6/16, but participants can start accessing the course materials any time after they register.

How to Design a Native Plant Garden

Presenter: Deryn Davidson

March 26; 9:00 – 11:30 AM

In this webinar, we will cover the basics of the landscape design process and how you can apply them to a native plant garden. The elements and principles of design, site analysis, and plant & material selection will all be covered. We will also touch on how to incorporate green infrastructure elements into your landscape to help with water conservation. Whether you're going to hire a pro or DIY, this webinar will give you the language and tools to create a beautiful native plant landscape for your home yard.

This webinar is designed for people new to landscape design with beginner to intermediate native plant knowledge.

Deryn Davidson holds a Bachelor of Science Degree in Horticulture from Colorado State University and a Master of Landscape Architecture Degree from the University of Arizona. Her passion for native plants and pollinators grew during her time as a Horticulturist at the Ladybird Johnson Wildflower Center in Austin, Texas. Currently, Deryn is the CSU Horticulture Extension Agent for Boulder County, a position in which she enjoys combining her training in design and horticulture with ecological function, and helping people discover new ways to incorporate native plants into their home landscapes through good design and responsible horticultural practices.

Habitat Gardening and Native Plants for Year-Round Interest

Presenter: Irene Shonle

Horticulture Associate, CSU Extension El Paso County

April 5, **6:00 – 8:30 PM**

Title TBA

Presenter: Jennifer Ackerfield

Head Curator, Denver Botanic Gardens,

April 12, 6:00 – 8:00 PM

Plant Propagation

Presenter: Mike Bone

Curator, Denver Botanic Gardens

April 23, 9:30 AM – 12:00 NOON

Introduction to Colorado Native Plant Families

Presenter: Lenore Mitchell

May 14, 9:30 AM – 12:00 NOON

The Redesigned CoNPS Website

Last January, CoNPS webmasters Sue Dingwell and Mo Ewing decided that it was time to upgrade the CoNPS website. Mo had rebuilt the original website nearly 10 years ago, which was designed by Al Schneider several years before then primarily to facilitate communication among CoNPS members. In addition, a then-new platform called WordPress allowed volunteers to add content to the website without having to understand how to code. The most important feature of that website was a new program called MembershipWorks, which allowed us to better manage our membership and to give members the ability to create profiles, renew memberships, sign up for events, and purchase products, such as plants and books, online. Previously, membership had been managed by Linda Smith using an Excel spreadsheet.

In January 2021, we found from Google Analytics that our website was used primarily for membership and event activities, as we expected, but also that one of the main attractions was the wonderful collection of native plant and landscape photos contributed by our members over the years. These photos had hundreds of individual "hits" by both members and nonmembers. In addition, the single page, aside from membership, that received the most hits was our garden page. Large numbers of people were going to that page for information about native plant gardening.

The CoNPS mission states that we are "dedicated to furthering the knowledge, appreciation and conservation of native plants and habitats of Colorado through education," but our previous website didn't do that. We were missing out on a huge opportunity to educate people about native plants!

Our new website opened for business on October 1, 2021, with a new focus to "further the knowledge…of native plants and habitats of Colorado through education." The site still includes all the membership, events, and product activities, plus all the descriptions of chapters, committees, history, board activities, grants, and CoNPS. But now there is a new focus on native plants and habitats. This new, enlarged section comprises articles written by a dozen or so dedicated CoNPS volunteers and is featured on the home page.

The new Plants & Habitats section starts with a discussion of Colorado's six ecological zones: alpine, subalpine, montane, desert shrublands, foothills, and plains, and describes a few interesting and/or important plant communities in each, along with the characteristic native plants found there (https://conps.org/plants-habitats/).

We will be adding more information in the future, inviting all CoNPS members to contribute to this effort. Additionally, all the native plants are shown in new "lightbox" galleries, which display the photos in full-screen size with a black background. Information about each species is included with each photo. ►

◄ New sections will include information on a wider range of Colorado native species, even some organisms that are not scientifically classified as plants. Examples of more in-depth information include

- Introduced (non-native) species
- Bryophytes (mosses, liverworts, hornworts)
- Lichens, ferns, and fungi
- Photo galleries with information on specific groups of plants, such as orchids and *Physaria*.

We are excited about another new page on the website, called "The Aquilegia Project" (https://conps.org/aquilegia-project/). On this page, we revive articles from old black-and-white *Aquilegia* magazine issues that are still of interest today and publish them with new full-color photographs.

Then we have a section that describes all our local herbaria, herbaria consortiums, CoNPS plant lists, CoNPS plant keys, and descriptions of native plant websites.

Another fun feature is the ability to search our whole database of native plant photos by plant name, genus, or a variety of other plant characteristics, such as tree, shrub, fern, native, introduced, etc.

The new Colorado Landscapes page contains a gallery of landscape photographs that we have collected from our CoNPS photographers (https://conps.org/colorado-landscapes/). Each photo contains information about the location of the photo taken (click on **i** when viewing the photograph). This is a celebration of our wonderful Colorado spaces. Another new feature allows visitors to search our database of landscape photos by name, county, and other location information using photo-tags to sort exactly what they want to see.

Another new addition to our website is the CoNPS blog (https://conps.org/conps-blog/), which we started last spring. A new format will make it easy to scroll through and see the collection of articles already there. We are inviting everyone to contribute to our blog; any timely items can be featured there. Shoot us an email and we will help you every step of the way!

Finally, since many of our website visitors access the site by cellphone, the new website will be formatted to work with cellphones, tablets, and desktop computers.

We thank the many volunteers who contributed to this project and are really excited about using it as a vehicle to further the education about Colorado's wonderful plants and habitats. We also encourage our members to make suggestions about new subjects we should discuss, as well as how we can make the website more interesting and easier to use.

◄ "Ecosystems…" *continued from page 32*

and ecology at San Diego State University in the early 1990s, he began to see the relationship between ecosystems and economies. Over the next three decades, John has continued to explore the relationships between ecosystems and economies as he pursued a career in ecological restoration. He has come to believe that to address our most important ecological and social challenges, we must first address the economic flaws responsible for their creation. Not only do these two global systems share the same structure, but they have grown intertwined, such that the fate of one depends on the health of the other. And the restoration of one provides enduring benefits to the other.

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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

We are seeking additional Leadership Team members! If you are interested in joining the team, please email us at MetroDenverCoNPS@gmail.com Everyone from all backgrounds is welcome, and no experience is necessary, just enthusiasm!

Seeking volunteer field trip leaders for the 2022 season! Please fill out the form if you are interested in leading a field trip for the 2022 season. We encourage new volunteers to apply at https://docs.google.com/forms/d/1gx710x6g4xrxaGoSt8_gKxoQdVw2shajF8Rh7g12Src/edit

Northern Chapter

April 5, 6:45 – 8:30 PM, Virtual Meeting
Grasslands and Carbon Sequestration: A Nature-Based Climate Mitigation Solution?
Presented by Tim Seastedt
Tim Seastedt, Professor Emeritus and Fellow, Institute of Arctic and Alpine Research at CU-Boulder, will discuss the relationship between biotic diversity and carbon draw-down on the prairie, and whether or not grasslands make meaningful contributions to greenhouse gas reduction.

April 7–9
Volunteer judges needed for the annual Colorado Science and Engineering Fair, held at CSU. This important statewide event encourages middle and high school students to submit research projects in STEM fields. CoNPS gives an award in Plant Science. Actual judging of student projects takes place on Thursday afternoon, April 7, with other optional activities volunteers are welcome to join. To volunteer and for more information, contact Jim Gano at jgano1144@gmail.com For an expanded description of the Fair, go to https://www.cns-eoc.colostate.edu/science-fair/

Quote from a former CoNPS judge: “This was a lot of fun. I enjoyed talking to the student reseachers about their projects and results. I was amazed by their knowledge and the quality of the work.”

Plateau Chapter

April 23, 8:00 AM Potholes Campground
April 24, 8:00 AM Bridgeport Trailhead
Back by Popular Demand!
Join in the fun and find flowers with fellow CoNPS members at these two Plateau chapter events.

The sites are located in Dominguez-Escalante National Conservation Area (elevation 4800’ to 8000’) where we’ll find the oft-overlooked and colorful pallid milkweed, Aztec milkvetch, Fender’s cliffrose, and Indian breadfruit, to name a few species. These species bloom for short periods of time and are habitat specific. Each year brings a different perspective to the landscape depending on winter precipitation, spring temperatures, and more. Bring cameras and nature journals to satisfy your creative outlets.

Last year, we had a group camp Saturday night at the Potholes and Jim shared a night-time presentation of Spring-Fall blooms.

Questions?
Contact either of us BEFORE Thursday, April 21. We have another event in the area on Friday and there is little to no cell service in the canyon.

Mary Menz, (719) 684-4009, mary.t.menz@gmail.com

Jim Pisarowicz, (970) 275-2516, pisarowicz@alumni.hamline.edu

Southeast Chapter

March 22, 6:00 – 8:00 PM, Virtual Meeting
Love our Land
Presented by Jax Hilaire
Jax Hilaire will relate her history of land preservation. The largest land preservation effort she had the pleasure of being involved with is Corral Bluffs Open Space. But she has been blessed to have 45 acres and has been working to preserve and carefully enhance the property with native or near-native plants in a limited area: a wildlife berm, a cactus garden, a no-water courtyard garden, and limited raised garden beds, always planting with wildlife in mind. Zoom details will be sent with the registration acknowledgement. More information about Corral Bluffs Open Space is at: https://www.corralbluffs.org/

April 28, 9:00 AM – 12:00 NOON
Field Trip—Tunnel Drive in Canon City

April 29-May2
City Nature Challenge, iNaturalist Activity.

June 3, 8:30 AM – 12:00 NOON
Field Trip—Paint Mines Interpretive Park

June 11, 10:00 AM – 1:00 PM
SE Chapter Field Trip - Florissant Fossil Beds National Monument ►

◄ Southwest Chapter

Here are some of the field trips already scheduled. New trips will be added, so please continue to check the calendar of events.

May 15, depart Durango at 8:00 AM
David Temple will lead us on his Trees of Trail Canyon property in McElmo Canyon west of Cortez.

May 21, meet at the property entrance at 7:30 AM
John Bregar will lead a walk on the Durango Nature Center property south of Durango.

July 2, depart Durango at 7:00 AM
Sue Parks will lead us on a hike up West Lime Creek, searching for subalpine species.

July 19, depart Durango at 8:00 AM
Travis Ward will lead us up the Pass Creek Trail from Coal Bank Pass.

September 11, departure time from Durango TBD
Bob Powell will take us on a tour of lichens at Coal Bank Pass.

Cross-Pollination Events

March 1, 8, and 15
Rocky Mountain National Park "Science Behind the Scenery" Webinar Series
https://www.nps.gov/rlc/continentaldivide/research-conference.htm

March 5
High Plains Landscape Workshop virtual event
Inspiring Hope: Planning for Tomorrow's Garden
https://www.fcgov.com/gardens/high-plains-workshop

March 21
International Day of Forests

April
National Native Plant Month

April 6-7
Society of Wetland Scientists Rocky Mountain Chapter Annual Meeting
https://members.sws.org/event-calendar/Details/rocky-mountain-chapter-annual-meeting-550766?sourceTypeId=Website

April 6-7
NAFWS Regional Conference
https://www.nafws.org/product/2022-great-plains-regional-conference/

April 12-14
HAR SER-RM 2022 Conference
https://sites.warnercnr.colostate.edu/restoration-conference/

April 13, 20, 27, and May 4, 12pm
Webinars Series
Grasslands: Culture, Conservation, and Resiliency
https://institute.dmns.org/perspectives/posts/grasslands-culture-conservation-and-resiliency/

April 18-20
Colorado Partners in the Outdoors Conference
https://cpw.state.co.us/partnersconference

April 22
Earth Day

May
Garden for Wildlife month

May 11
Plant Conservation Alliance Meeting
Sky Islands of the Desert Southwest
https://www.plantconservationalliance.org/meetings

May 15-22
Colorado Noxious Weed Awareness Week

May 16-22
Colorado Endangered Species Week

May 16-20
Society of Wetland Scientists Annual Meeting
https://members.sws.org/event-calendar/Details/sws-annual-meeting-2022-joint-aquatic-sciences-meeting-298764?sourceTypeId=Website

May 20
Endangered Species Day
https://www.endangered.org/campaigns/endangered-species-day/

Are you involved in a volunteer-based rare plant monitoring project or know of one? We (Plant Conservation Volunteer Program, Native Plant Trust & Plants of Concern, Chicago Botanic Garden) are conducting a survey to assess the role of rare plant monitoring projects in plant conservation nationally and internationally. We're interested in contacting you to find out about what you do, how you do it, your successes, etc. Please send an email to Jessa Finch (jfinch@NativePlantTrust.org) to express your interest. We look forward to finding out about you and ultimately creating a network for sharing ideas about rare plant monitoring.

https://saveplants.org/forums/topic/community-science-rare-plant-monitoring-survey/

Legislative Updates

SB22-131: Protect Health of Pollinators and People

A new bill designed to protect pollinators and their habitats was recently introduced to the Colorado Senate. This proposed piece of legislation would make great strides to address specific gaps in both resources and pollinator protection. Provisions in the bill include a comprehensive study on pollinator health in order to document recommendations on how best to address any existing and potential threats to Colorado's pollinators; the limitation on the use of neonics and offer an incentive for farmers to try uncoated seed; limitations on the use of pesticides on school grounds; and return of control to local communities so that they can determine how best to protect their natural resources and community members.

While Colorado is home to more than 900 species of bees, 250 species of butterflies, and hundreds of birds and small animals which provide critical pollinator services, Colorado does not have a comprehensive plan to ensure we protect these species. Colorado lacks resources to work across our agencies to ensure adequate planning, protection, and coordination for pollinators and there's insufficient capacity to protect human health as we consider pesticide use. This proposed piece of legislation will make strides to address pesticide risks and protection of people, pollinators, and soils. Please see the following link for more information.
https://www.peopleandpollinators.org/pollinator-human-health-bill

HB22-1151: Turf-Replacement Program

The bill requires the Colorado Water Conservation Board to develop a statewide program to provide financial incentives for the voluntary replacement of irrigated turf with water-wise landscaping. The bill defines water-wise landscaping as a water- and plant-management practice that emphasizes using plants with lower water needs.

The bipartisan bill would create a $2-4 million annual pool from general fund money to pay homeowners, businesses or any other landlords willing to replace thirsty bluegrass on lawns, road medians, highway ditches, and other places the decorative greens are draining state reservoirs. Local governments, certain districts, Native American tribes, and nonprofit organizations with their own turf replacement programs may apply to the board for money to help finance their turf replacement programs.

House Bill 1151 (https://leg.colorado.gov/sites/default/files/documents/2022A/bills/2022a_1151_01.pdf) is sponsored by Sen. Jeff Bridges, D-Greenwood Village, Sen. Cleave Simpson, R-Alamosa; Rep. Marc Catlin, R-Montrose; and Rep. Dylan Roberts, D-Avon.

CoNPS Endorses April as National Native Plant Month

Our executive director, Maggie Gaddis, made a statement that will be quoted in the promotion of this Ohio resolution and may show up in their press release. The CoNPS's statement is as follows: "The Colorado Native Plant Society supports the resolution in the US Senate designating the month of April as National Native Plant Month. The Colorado Native Plant Society is a statewide non-profit organization dedicated to furthering the knowledge, appreciation and conservation of native plants and habitats of Colorado through education, stewardship, and advocacy.

Native Plant Month, especially in April, brings focus to our native ecosystems at a time when people are already participating in civic engagements related to Earth Day. It is not enough to focus on the "Earth" in general. We need to focus on the native ecosystems we are destroying with our human expansion. Let's re-wild our human landscape to bring native plants into our backyards to sustain our human health and survival."

https://www.portman.senate.gov/newsroom/press-releases/portman-hirono-praise-unanimous-senate-passage-bipartisan-resolution

https://www.portman.senate.gov/newsroom/portman-difference/conservation-advocates-praise-passage-portmans-resolution-designating

To find your legislator:

https://leg.colorado.gov/find-my-legislator (enter your street address)

To find out more about specific bills:

https://leg.colorado.gov/bills (enter bill # in search bar, use appropriate formatting – ex. SB22-063)

You can also watch/listen to the debates around these bills live:

https://leg.colorado.gov/ (scroll about halfway down to the day's schedule in House and Senate)

CoNPS Membership

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

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.
Address _____
City _____ State_____ Zip_____

☐ **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/

□ New □ Renewal

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

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

CONTRIBUTIONS to CoNPS are tax deductible:

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

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

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

Total included: $ _____

Please make check payable to:
Colorado Native Plant Society

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

Third Place Photo Contest Winners













Photo contest third place winners: (left-to-right, top-to-bottom). **Native Plants (tie)**: Dina Baker, hedgehog cactus (*Pediocactus simpsonii*), Michael Aubrey, fairy slipper (*Calypso bulbosa*), and Rick Brune, big bluestem (*Andropogon geradii*). **Landscape (tie)**: Margaret Foderaro, aspens (*Populus tremuloides*) and Maroon Bells; Michael Remke, alpine blooms of southwest Colorado; and Loraine Yeatts, stonecrop (*Sedum lanceolatum*) and orange lichens. **Gardens**: Anna Wilson, thimbleberry (*Rubus parviflorus*). **Wildlife**: Loraine Yeatts, mariposa lily (*Calochortus nuttallii*) and red-blue checkered beetle (*Trichodes nuttalli*). **Artistic (tie)**: Marlene Borneman, pinedrops (*Pterospora andromedea*); Mere Nimz, Edwards' fritillary (*Speyeria edwardsii*) on western wallflower (*Erysimum capitatum*); Dina Baker, mariposa lily; Betty McLain; blister beetle (*Lytta vesicatoria*) on wild iris (*Iris missouriensis*); Jim Pisarowicz, alpine avens (*Geum rossii*); and Anna Wilson, fringed gentian (*Gentianopsis detonsa*).

Colorado Native Plant Society

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

Save the Dates!
Spring Plant Sale

Online ordering starts April 1, plant pickup on May 21.

Volunteers Needed!