PEAK TO PRAIRIE: BOTANICAL LANDSCAPES OF THE PIKES PEAK REGION

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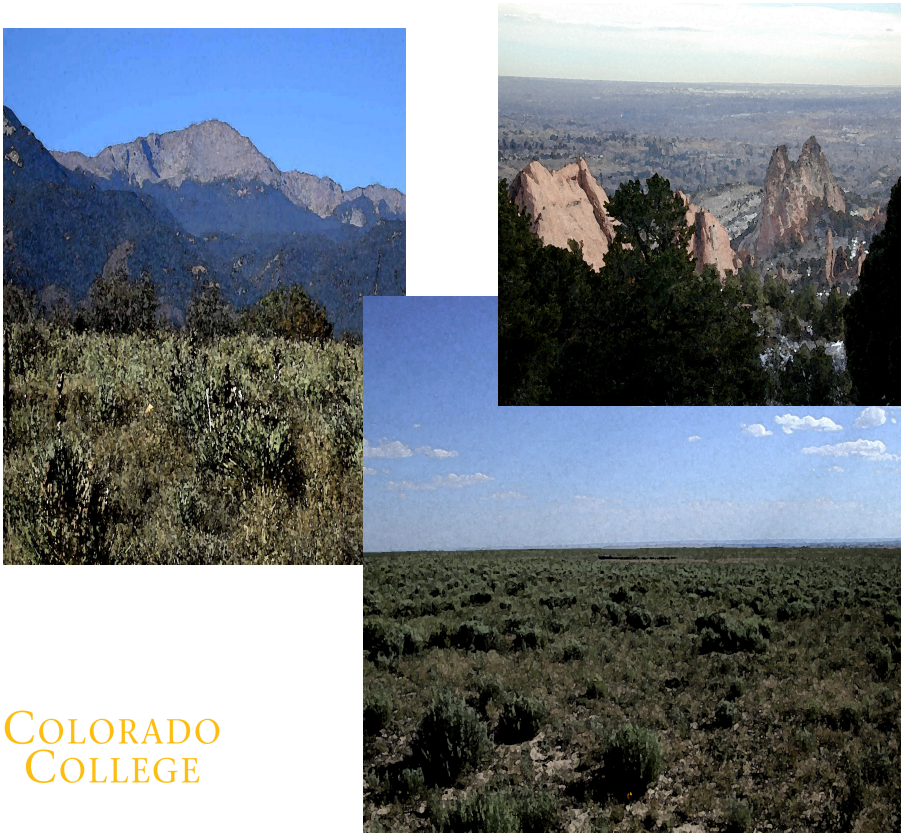
2012



COLORADO COLLEGE

Biodiversity and Place: Landscape's Coat of Many Colors

Mountain peaks often capture our imaginations, spark our instincts to explore and conquer, or heighten our artistic senses. Mt. Olympus, mythological home of the Greek gods, Yosemite's Half Dome, the ever-classic Matterhorn, Alaska's Denali, and Colorado's Pikes Peak all share the quality of compelling attraction that a charismatic alpine profile evokes. At the base of our peak along the confluence of two small, nondescript streams, Native Americans gathered thousands of years ago. Explorers, immigrants, city-visionaries and fortune-seekers arrived successively, all shaping in turn the region and communities that today spread from the flanks of Pikes Peak. From any vantage point along the Interstate 25 corridor, the Colorado plains, or the Arkansas River Valley escarpments, Pikes Peak looms as the dominant feature of a diverse "bioregion", a geographical area with a distinct flora and fauna, that stretches from alpine tundra to desert grasslands.

"Biodiversity" is shorthand for biological diversity: a term covering a broad array of contexts from the genetics of individual organisms to ecosystem interactions. The news tells us daily of ongoing threats from the loss of biodiversity on global and regional levels as humans extend their influence across the face of the earth and into its sustaining processes. On a regional level, biologists look for measures of biodiversity, celebrate when they find sites where those measures are high and mourn when they diminish; conservation organizations and in some cases, legal statutes, try to protect biodiversity, and communities often struggle to balance human needs for social infrastructure with desirable elements of the natural landscape.

What different meanings can biodiversity encompass, and why might we care about them? Some relevant meanings may be purely selfish. For example, biodiversity includes different genetic strains: a particularly drought-tolerant plant, an animal that is resistant to a virus or pathogen that may jump to other species. History is rife with such plagues, and we know with certainty that our future wellbeing, from sustainable agriculture to human health, will depend on a thriving bank of diverse organisms from whose genetic wealth we may need to draw. Similarly, the most common definition of biodiversity: " with many different species", presumes that biodiversity will provide us with the raw materials of future foods or medicines or energy. At its highest level, biodiversity covers ecosystem processes. A functional ecosystem is a one where the interaction of parts, that is, its species and their interactions, make it resilient to crisis and stable across at least human timescales. Destabilized ecosystems create problems for human societies: we depend on their functional abilities to minimize floodwater, fires, or landslides, and to cleanse our groundwater or air. None of these processes are simple ones, so loss of biodiversity elements, from species to communities, may contribute ultimately to profound human and economic costs.

These concepts of biodiversity may seem abstract and relevant only to a distant future. Another more immediate and personal definition of biodiversity may help make sense of its importance for most of us. Biodiversity, even for those who know not a single name of a native organism, is all of those colors, shapes, and patterns that infuse our sense of home landscape. Here in the Pikes Peak region, the landscape is grand and multi-faceted, a richly-resourced home to its original native inhabitants over millennia, a source of inspiration to artists and writers from the early exploring days, and an economic draw to bring new residents here from the 19th century to the 21st. The color, shape and pattern of the natural landscape provided by its species and communities provide underlying connections and reasons why so many of us want to live here. A uniform landscape holds far less appeal than one of rich texture. Our native species shape the unique visual texture of this place: the mahogany of shrublands against a fall sky, silhouettes of grama grass and pronghorns on the plains, contrasting color against a dark forest background from summer wildflowers like columbines, geraniums, locoweeds, and asters. In its simplest essence, devoid of scientific or economic contexts or abstract future values, biodiversity infuses a landscape with unique visual characters that connect people to place. Connected citizens are essential to create communities that thrive. For this relatively simple reason, as well as the multitude of scientific and economic reasons, biodiversity matters on a local and regional scale.

A Wealth of Biology, Centuries of Discovery

Although the Pikes Peak region is historically famous for its short-lived phase as a potential El Dorado of mineral riches, its scientific renown as a biological trove is less widely known, but considerably more lasting than the gold and silver rushes of the 19th century. Edwin James, a member of the pioneering

Long Expedition of 1820 across eastern Colorado and the first botanist to explore the area, found botanical treasures here that have long outlasted his lifetime and first brought scientific renown to the region. His expedition up Pikes Peak, the first biological survey ever of the Colorado alpine, yielded discoveries that included our state-signature species of blue columbine, unique primroses, distinctive saxifrages, and arctic waifs like rock jasmine. Additional discoveries came from the grasslands, foothills canyons, and Arkansas River Valley bluffs. These plants, previously unknown to science, elevated James to eminent heights in the annals of western botany and focused scientific attention on Pikes Peak and its environs. Regional prominence was later enhanced by additional discoveries made by other exploratory botanists intrigued by the region's diversity, and by nationally acclaimed studies on vegetation, moisture, soils, and climate done by ecologists on Pikes Peak, the mesas, the Black Forest, and the plains. A century after the first scientists wandered down Monument Creek, our area had become known as a rich and possibly unique repository of species, and one of dramatic and ecologically instructive vegetation patterns as well. It remains so today, even with a much heavier human imprint on the landscape.

Vegetation, Topography, Climate, and Bedrock Across Time and Space

From south to north, the Pikes Peak bioregion extends from steep east face of the Wet Mts. across the Arkansas River Valley in Pueblo and Fremont Counties to the Palmer Divide at the famously stormy Monument Hill at the junction of El Paso and Douglas counties (Fig. 1).

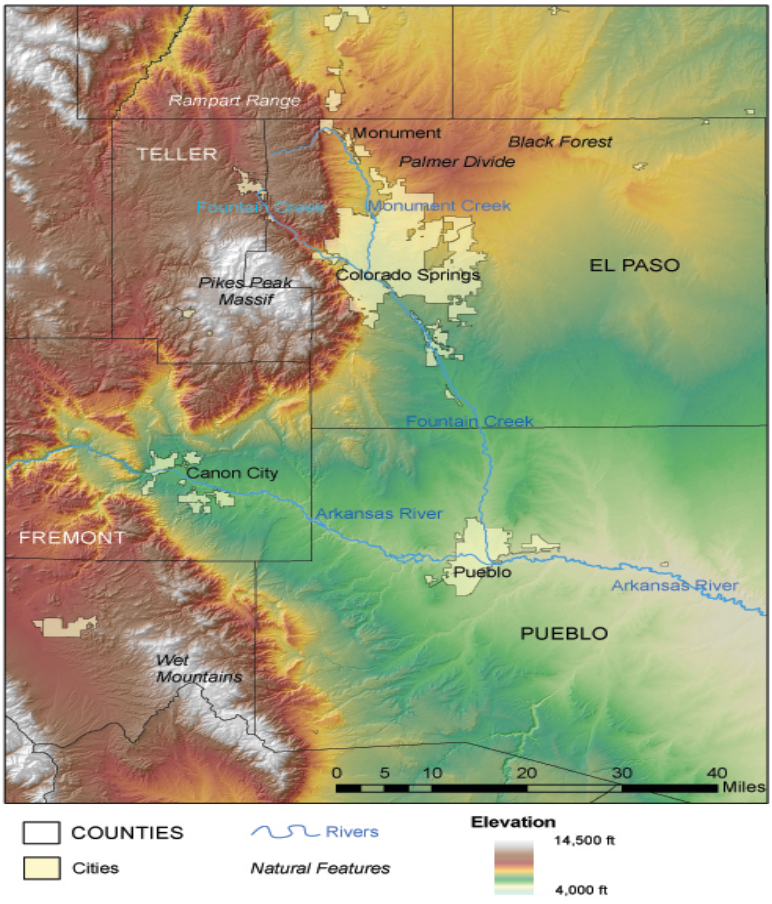


Fig. 1. Topography of the Pikes Peak Region

Along the northern boundary, a grassland-pine ecosystem known as the Black Forest merges into the mixed grass prairie, then shortgrass prairie in the east and south. The shortgrass prairie gradually rises westward across the mesas, through wooded foothill canyons and the montane conifer forests to the high

tundra of the Peak itself. Conifer forests and open high elevation grasslands descend westward into Teller and Fremont Counties. Along the southern edge of the region, dry shale barrens and cholla cactus rich grasslands stand in parched contrast to other plant communities in the area, and transition rapidly across the steep face and abrupt ecological transitions of the east and north faces of the Wet Mts. Throughout this varied topography lies a diverse patchwork of habitats rich in plants and animals, our native "biota".

Although the area's dramatic relief gives shape to most of the biological patterns, small landscape pieces with their idiosyncratic species may hold the most intriguing stories. Pocket wetlands, remnant patches of tallgrass prairie, and arctic tundra species are probably remnants of much cooler Ice-Ages, 20,000 or more years ago, when conifer forests dotted the Great Plains and the eastern flora spread to the base of Pikes Peak. Plants of the chalky barrens in the Arkansas River Valley suggest a hot, dry period from ca. 8000 years ago when a warmer, drier southwestern climate prevailed. Our few reliable streams in foothill canyons provide cool, humid conditions where remnant enclaves of eastern shrubs cling to moisture pockets rarely found now in the arid mountain front. Thus today the Pikes Peak region is a biological crossroads of species from the north, south, east and west where our biological history lies written in the landscape. Ecological stories intertwine with those of geology: the botanical landscape of the twenty first century is framed by underlying remnants of ancient magma, sand dunes, oceans and glaciers. Plant species diversity is shaped and nurtured by the contributions of soil and bedrock: water and nutrient availability, as well as physical aspects such as temperature, drainage, and slope stability. Consequently, no botanical portrait of the habitats and communities portrayed here can be complete with also including their geological underpinning (Fig. 2, Fig. 3).

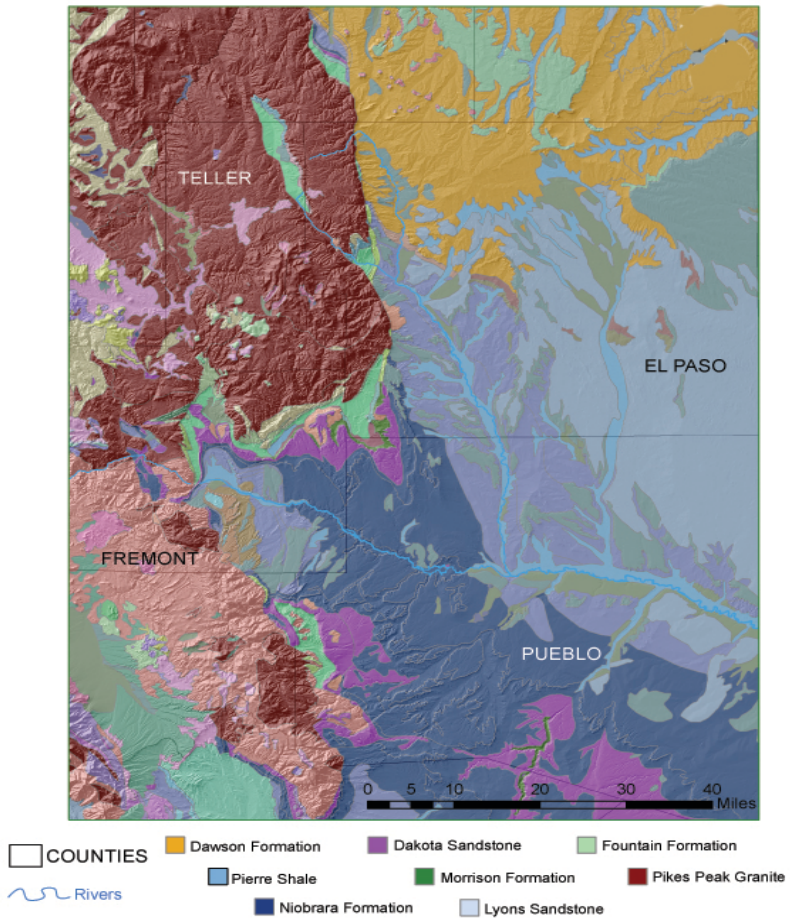


Fig. 2. Geological Formations of the Pikes Peak Region

MYA	ERA	PERIOD	EPOCH	FORMATION
.01	**Cenozoic**	Quaternary	Holocene	Mesa Gravels
2		Tertiary	Pleistocene	
7			Pliocene	
26			Miocene	
37			Oligocene	
53			Eocene	Dawson Formation
65			Paleocene	
136	**Mesozoic**	Cretaceous		Pierre Shale Niobrara Formation Dakota Sandstone
190		Jurassic		Morrison Formation
225		Triassic		
280	**Paleozoic**	Permian		Lyons Sandstone
320		Pennsylvanian		
345		Mississippian		
		Devonian		
		Silurian		
		Ordovician		
		Cambrian		
4600		**Precambrian**		Pike's Peak Granite

Fig. 3. Geological timetable showing major formations in the Pikes Peak region discussed in the text. MYA= Millions of Years Ago.

Of Time and Change: Rare Plants and Weeds

This profile of the Pikes Peak region demonstrates that topographic gradients and geological diversity directly foster the ecological richness that is so notable here. Although biological patterns generally correspond to elevation gradients, factors like slope direction, drainage patterns, and soil composition can dramatically affect plant life on very small scales: distinctive habitats become interwoven into a patchwork assemblage across this remarkable landscape. Like the today's human population, the botanical inhabitants of the region represent influences from the south, east, north and west. However, today's biodiversity stems not only from the current landscape and climate, but also from landscapes and climates of past eras that shape the contemporary biota as a living archive of ecological history where each species has its own unique story. Change has shaped the biodiversity of the Pikes Peak region and continues to shape it today, perhaps affecting it at a rate unprecedented in its history. While the agents of change, human or climatic, can promote diversity, they can also subtract from diversity in quantity or in quality. These subtractions can be seen in rare plants and in their counterpart, weeds. Both are notable components of the overall picture of biodiversity here and deserve some commentary.

The What and Why of Rarity

Any landscape with a complex geological and climatic history will be prime ground for biological complexity that includes species that carry the label "rare". These immediately capture our attention: they might perhaps be regarded as the biological equivalent of Hollywood stars. We give them priority in surveys, fund their habitat protection, pursue an understanding of their lifestyles and promote their presence on a landscape as a hallmark of quality. For all this attention, however, any single definition of rarity becomes problematic. What do we mean by a "rare" plant? Why should we promote them, study them, search them out, document them, protect them?

The answers to these questions differ between species because no comprehensive definition for rarity can be easily crafted. Many biologists have tried to use a set of quantitative attributes: small populations, narrow geographical distributions, and high habitat specificity often, and appropriately, confer some position on a rarity scale. There are other more elusive qualities that may contribute. Some, such as declining seed set or increased pathogen susceptibility, become apparent with detailed ecological assessments; few studies of this kind have been attempted. Even more limited are studies that provide long term perspectives on species dynamics. In North America, our lack of baseline information for previous decades or centuries means we often don't know when declines in geographic range, population numbers or health approach a zone for concern. Some assessments depend on our ability to look ahead rather than backwards. Can we predict climatic or ecological futures to know, for example, what the future of tundra plants will be in a world with increasing temperatures, irregular moisture, and decreased or increased winter snows? Such views are always, at best, murky.

Botanists must combine many perspectives to assess current and future status of any species. The label " rare" or "of conservation concern" can apply to different situations and different scenarios. Sometimes that label emerges from data, sometimes it emerges from our best prognostications. If anything, we've learned that there are no "one size fits all" criteria that confer the dubious honor of sitting in the rarity spotlight: each species inhabits an individual and multidimensional position. Biological capacities to adapt are unique and dependent on a changing matrix of species, climate, and landscape contexts.

A number of descriptors can be applied to assess whether or not a species might warrant special concerns for study, protection, or promotion. Narrow niches (e.g. specialized habitat requirements or dependency on certain insects for reproductive success) or narrow geographic distribution are among these descriptors, as are few populations and small population sizes. These criteria are used by Natural Heritage programs, our national network to track and assess biodiversity, in a system that provides global (G) and state or regional (S) ratings for species of plants and animals. The rating scale runs from 1 to 5 where G1 or S1 represents a narrow distribution (one way to define rarity) and G or S5 represents a broad distribution or relative commonness. Generally a species rated G1-3 or S1-3 falls into a category of conservation concern, of which G1-S1 species merit the most concern or the highest "rarity" rating.

This system, although very helpful, is not perfect. Ratings depend on the number of documented specimens in herbaria and communication among botanists. Sometimes showy or charismatic species are over-collected, that is, a high number of specimens may suggest a species is more common than it actually is. Similarly, under-collecting can lead us to misinterpret true abundance. A species may be locally common, but either it is so common that botanists forget to document it, or it is taxonomically difficult or

challenging to identify so we overlook or ignore it. Lack of documentation can lead to a species appearing to be more rare than it really is. Sometimes G and S ratings differ in the perspective they provide. For example, a species might be regionally abundant (a high S number), but has a relatively narrow geographic distribution resulting in a low G number. Or, a species might be broadly distributed globally (high G number), but regionally very limited (low S number), perhaps because it is at the edge of its range or a lack of appropriate habitat. To what extent do these examples represent rarity? The answers are never unequivocal or uniform.

Perhaps one of the most difficult aspects to assess is how habitat might be threatened and the extent and timing of habitat loss or degradation. Threats vary: disturbance and land alternation from urbanization, the ever present menace of aggressive alien species that compete with natives for space, water, nutrients or pollinators, and impacts of climate change that affect every aspect of ecology from water availability to ecological interactions all loom large. Species inhabiting restricted habitats defined by one or a combination of attributes such as special soil or bedrock or hydrologic regimes, are particularly vulnerable. Prairie wetlands exemplify this precarious existence. Other habitats may be broad in extent, but determined by an uncertain climate future. Alpine snowfields and cirque communities such as those on dry mountains like Pikes Peak might be included here. Other habitats and their constituents already represent diminished relicts of climatic regimes of the past. For example, tallgrass prairies and the pine forest-savannas of the Black Forest are biological remnants from cooler, moister climates of the past; these contain many increasingly disjunct and rare species as they become restricted to smaller and smaller microhabitats. When development and land practices additionally fragment even broad swaths of habitat, populations become smaller and more disconnected with lessened ability to recover from stress. Some of our habitat loss, and the concomitant loss of species and communities that inhabit them, is dramatic and obvious, but some is subtle as the effects of diminished habitat and population size or reproductive failure become noticeable only after a critical threshold of stress has been breached.

When seeking to determine whether or not a species deserves a label of “rare”, we have some easy references. The Threatened and Endangered Species Act administered by the U.S. Fish and Wildlife Service lists species of extreme concern that merit the most protection we can offer. In the Pikes Peak region, we have only a historical record for a federally listed species, *Spiranthes diluvialis* (Ute ladies tresses) that occurs elsewhere in Colorado but was once known from a location (now much altered)in Colorado Springs. This orchid is almost certainly extinct here now, its wetland habitat long gone. State and federal agency watch lists offer additional species for consideration. Other species occur on no official list, but represent “local characters” of biological interest and potential conservation concern, at least regionally. Perhaps they may be on the edge of their geographic range, are ephemeral in abundance, appearing only under unusual climatic conditions, or they may occur in habitats such as cliff faces that are difficult to reach or assess. These species too, warrant recognition and documentation for their local significance.

Should rare species be protected, whatever their qualities for special notice might be? Yes without question for some: appearance on the federal Endangered Species List mandates or promotes protection for any species and it is illegal to pick or harm them on public land. However, unlike federally listed animal species which receive protected status wherever they occur, Threatened or Endangered plants are <u>not</u> legally protected when they occur on private property. Private landowners are not required by law to provide special treatment for listed plants as they are for listed animals. While ethics might suggest landowners offer such protection and view the occurrence of these plants as a compliment to their stewardship and a statement of landscape quality, federal statutes provide no mandate to do so.

The status of other kinds of rare species may be more legally or ethically ambiguous. Although some states have a list of state statutes to protect regionally rare species, Colorado does not. While picking any wildflower is illegal in national or state parks, the situation is somewhat less clear in other circumstances. The documentation that specimens can provide as herbarium records is enormously helpful; however, casual picking, especially for showy wildflowers, is never encouraged even if it is technically legal. Careless picking combined with changing habitats has diminished beauties such as the tulip gentian (*Eustoma grandiflora*), yellow ladyslipper (*Cypripedium calceolus*) and Philadelphia lily (*Lilium philadelphicum*) almost to the point of disappearance. In general, botanical collection should always be done with discretion and with the intent of scientific documentation. We have an ongoing need for distribution documentation and information about many of these species considered rare or potentially rare. For most of them, there is a need to further assess whether they truly are at risk or might be diminishing at a worrisome rate even if not currently of conservation concern. Not infrequently, additional records and

information about a species thought to be rare, reveals it to be of greater abundance that previously believed.

Rarity does not always signify the same set of qualities. A thesaurus suggests equivalents for "rare" might include "uncommon", "infrequent" or "sparse" -these may indeed be good descriptors, in part because they can be quantified to some extent, but they may not be universal ones. Perhaps other qualifiers for rare status would be adjectives such as "singular" or "tenuous": these underscore aspects of uniqueness and vulnerability that are the philosophical underpinnings we seek to assess in developing lists and criteria for which species most merit our care and attention. Regardless of definition, a "rare" species is always a biological "find" -a landscape component to savor. Rare species can reveal past or present ecology and provide insight on the type and rate of landscape change. Lists of rare species are always works in progress: by their nature they reflect on going natural as well as anthropogenic processes and impacts and they always benefit from our ongoing observation, communication, and exploration.

Weeds: The Botanical Dark Side

For the same reasons that our landscape carries biological rarities, however defined, we also carry their flip side, weeds. Our history of change, our habitat complexity, and our increasing rate and intensity of human use has made us vulnerable to biological invasions of alien, or "adventive" (nonnative) species. No habitat or elevation is immune. Ranchers, landowners, conservation biologists, urban park managers and fire departments are not always natural allies, but in the war against weeds, we share a common enemy. The almost unstoppable influx of aggressive non-natives into our local landscape poses threats on many fronts: diminished quality of forage for grazing, a fire hazard in drought prone landscapes and aggressive competition against our native plants, often displacing them in increasingly impacted habitats.

To gardeners, a "weed" is any plant that grows where it is not wanted. No technical definition for a weed exists, but we all know one when we see it. Garden weeds test our patience, our tools, and our perseverance. To biologists, however, landscape-level weeds pose more insidious problems. A notoriously select few gain the dubious distinction of legal status by appearing on a county "most wanted" list of noxious species since their economic or ecological impacts are so profound. Each county has its own list of particularly problematic species that carry a mandate for landowners to do their best to try to control them, even if eradication is impossible. Dangerous weeds share certain qualities. None are "native" to our landscape. Most originated in Europe or Asia and have escaped the biological controls (pests, diseases, or predators) present in their home territories to run amok in the New World. They prosper where disturbance has occurred in the landscape: roadsides, open lots, and trails offer toeholds for introduction. An ever-expanding transportation grid provides an extensive nursery bed for weed dispersal and establishment.

Invasive species share a biological characteristic of high reproductive capacity. Their copious seed crops spread across the landscape by sticking to tires, socks, or animals, or by riding wind currents across miles of open country. The classic western image of the tumbleweeds roaming the open range next to John Wayne on his horse is symbolic of this almost unstoppable invasion. Tumbleweeds, especially *Kochia* (burning bush, now also known as *Bassia*) and *Salsola* (Russian thistle) far from being native Westerners, are imports from central Asia. As they tumble, they spread their seeds far and wide. Other weedy species not only have heavy seed crops, they also have root systems that defy removal. Simple digging will not eradicate these plants because even a small remaining piece of a rhizome or taproot can regenerate at plant at a remarkable pace. Spurges, thistles, and knapweeds all excel at this belowground resistance.

For the native flora, weeds pose additional threats. A continual seed rain of fast sprouting, fast growing, fast spreading newcomers displace slow growing native species. Many of our native species have ecological stresses on them already from climatic vagaries, loss of water sources and habitat fragmentation. Aggressively competitive invaders can add additional, perhaps lethal, pressure by garnering water, sunlight and nutrients or simply engulfing habitat by their spreading tendency. The native vegetation in arid landscapes does not regenerate easily when disturbed, so our increasing human footprint weakens the land's resistance to weed blitzkriegs. Biologically speaking, weeds are a formidable enemy with no magic bullet to defeat them. Most biologists see weeds as one of the most severe threats to native ecosystems at the current time. Weed impacts are diverse and pervasive, their perseverance astounding. To counter their invasion, knowledge, equal perseverance and creativity must shape our efforts to respond. Alien weeds are biodiversity of a sort, but one that we do not want or need.

Botanical Communities of the Pikes Peak Region: An Overview

The Pikes Peak region is defined here as roughly encompassing four counties: El Paso, Teller, Pueblo and Fremont west to the Royal Gorge. It is framed by the Arkansas River drainages and Wet Mountain front to the south, by the "Palmer" or Platte River-Arkansas River Divide, on the north, by the western drainages of Pikes Peak to the west, and rather diffusely on the east by the high grassland mosaic of eastern El Paso County. It covers about 75 miles east to west and north to south. The altitudinal range is wide: almost 3000 feet north to south, and 8,000 feet from east to west. The area (Fig. 4) can be broadly divided into three principal ecological regions: the plains dominated by diverse types of grasslands, the foothills-montane zone comprising mostly pine forests but also including aspen groves, grasslands, and foothills canyons, and the alpine-subalpine zone of conifer forests and tundra. The plains region is the largest and most diverse; it encompasses the Arkansas River drainage of Pueblo and Fremont Counties, the eastern plains of El Paso County, and on the west side, the low mesas along the mountain front. The Black Forest, from central El Paso County north to about 7500 feet near the Palmer Divide at Monument, has some unique elements, but botanically is most similar to the foothills-montane zone of the Rampart Range and the Pikes Peak massif. Our high elevation subalpine/alpine zone begins where the montane forests change from being dominated by ponderosa pines to a preponderance of spruce, limber pine and bristlecone pine, then transitions to the treeless tundra at about 11,400 feet. Each of these broad regions has significant botanical subdivisions created by the interaction of elevation, climate, water availability, and geology.

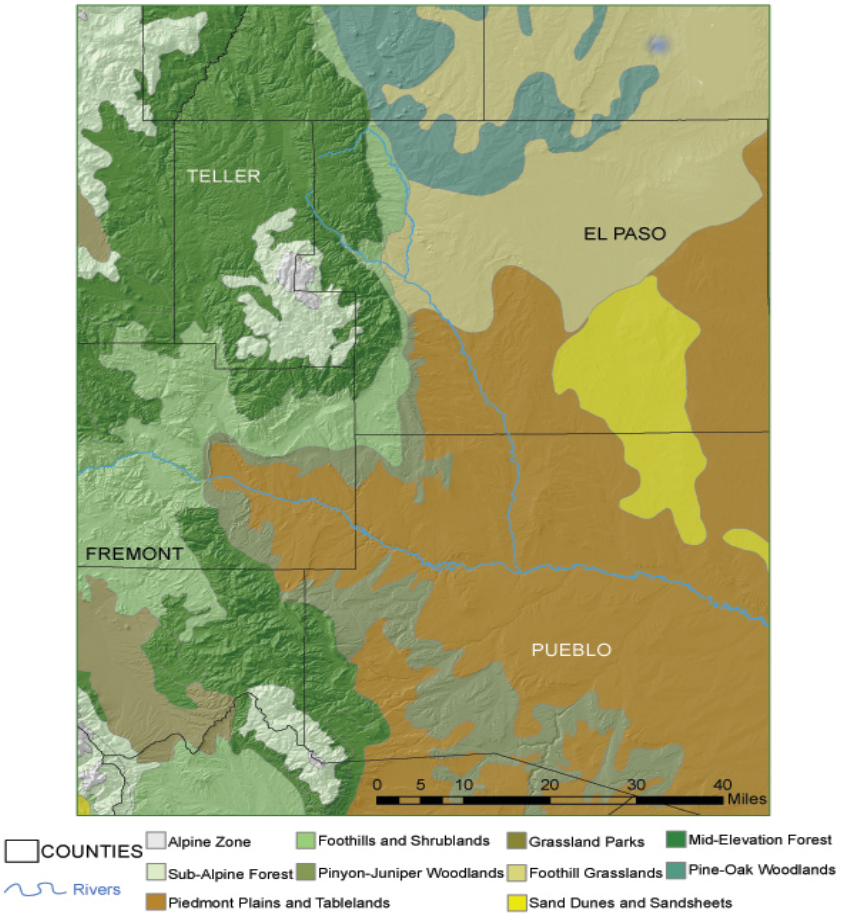


Fig. 4. Ecological Zones of the Pikes Peak Region.

Plains

For all the visual dominance of Pikes' Peak, much of this region is not composed of alpine tundra or montane forest, but rather low rolling grasslands that cover about half of El Paso County and most of Pueblo and Fremont Counties. The visual presence of the plains may not be as imposing as an alpine peak, but the plains provide a surprising biological diversity within their wide borders as they contain a complex patchwork of soils and biological communities with distinctive features and species. The plains are subject to dramatic climatic contrasts where the feast of drenching rainstorms and the famine of drought occur on a regular basis. Annually they receive on average 12-14 inches of rain, with lesser amounts to the south and more with higher elevations north and west, but these amounts vary dramatically from year to year, month to month, and even within the region at any one time, precipitation varies locally. Alternating drought and wet cycles have been periodically common. 1999 was one of the wettest years on record for Colorado with widespread flooding across the plains in the spring and late summer, while 2002 and 2003 brought extreme drought, one of the driest periods since dust bowl times of the 1930's. On an annual cycle, 70-80 percent of the precipitation arrives in the growing season of April to early September from thunderstorms, then the plains typically experience dry conditions in the fall and winter, broken by sporadic snows, sometimes deep blizzards with deep drifts, until the spring thunderstorm storm cycle begins again. Wind is common on the plains in all seasons, and this contributes to local aridity. Irregular precipitation means that plants must be both opportunistic and resilient: able to flourish and reproduce in abundance when moisture is plentiful, or resort to dormancy or minimal growth when it is restricted. In extreme years, some species never appear above ground, or if they do, are stunted or lack flowers. The plains can appear lush and colorful in wet times, or drab and almost barren in dry times.

The soils of the plains are a patchwork of contributions from our geological history. Typically they are shallow, somewhat alkaline, and contain little organic matter. Some areas east of Colorado Springs are very sandy, reaching an extreme in the sand sheets of southeastern El Paso and northern Pueblo Counties. These wind, or "aeolian" deposits may date back thousands of years, perhaps even to our last ice age, about 15-20,000 years ago when glacier-front winds deposited fine sands east of the mountain front. These old dune fields have a distinctive flora composed of species that require good drainage and the space to form deep root systems. A few areas of the plains have high water tables from localized alluvial aquifers, and seeps and springs provide unusually wet soil conditions that allow an unusual plains flora to flourish: tall grasses and wildflowers common in the Midwestern prairies but rare here in Colorado. Other areas, which are particularly common in the Arkansas Valley, have silt and clay pockets that retain moisture readily when it is available, but become rock-hard adobe when dry. Outcrops of shale, chalk, and limestone in Pueblo and Fremont Counties provide unusual habitats. These are highly alkaline, rich in calcite or gypsum, and unusually hot and dry; they provide stressful but low competition habitats for species that can tolerate these conditions by extending their roots into thin fissures in the moisture-retentive bedrock. The outcrops, part of the Niobrara Formation, are the remains of an ancient seabed that stretched across the central portion of the U.S. during the Cretaceous. Elsewhere on the plains we see broad surface exposures of Quaternary gravels, geologically recent depositions of eroded granitic material from the mountain front. These occur in flat areas and on mesa and hilltops. The gravels provide shallow cover of a diverse array of other older bedrock types. They are easily seen across the lower elevations of Pueblo and Fremont Counties where no erosion has occurred to cut through the topography and on the north-south ridge of low mesas that extends from just north of Pueblo to the Air Force Academy.

The interaction of soil, climate and topography across the Pikes Peak region shapes a concomitant diverse array of plant communities on the lower elevations. These community types can be broadly delineated as the *Southern Grasslands, Mixed Grass Prairie, Relict Tallgrass Prairie, Sand Sage Prairie, Prairie Wetlands, Mesas, and Barrens*.

Southern Grasslands

The grassland community that begins just south of Colorado Springs near the town of Fountain and extends widely throughout the entire southern portion of the region is dominated by two common bunchgrasses: blue grama (*Bouteloua gracilis*) and galleta grass (*Pleuraphis jamesii*). Frequent co-dominants include sideoats grama (*Bouteloua curtipendula*), sand dropseed (*Sporobolis cryptandrus*) and in the Arkansas River valley, the feathery New Mexico needlegrass (*Hesperostipa neomexicana*). The

grama-galleta grass community is widespread in New Mexico; its northern extent occurs just south of Colorado Springs although all of these species can be found in isolated patches in other mixed communities here. The southern grasslands are an open community with open patches of bare soil, typically a sandy loam with surface gravels. Some areas of the southern grasslands where soils are alkaline and have a high clay content (and thus higher water holding capacity), a mixed grass-shrub community occurs. In these, heat tolerant grasses mix with shrubs such as rabbitbrush (*Ericameria/Chrysothmamnus nauseosa*) and greasewood (*Sarcobatus vermiculatus*). In salty and very alkaline soils, saltbush species, notably *Atriplex confertifolia* and *A. canescens,* are prominent.

Along with the dominant species, other mixed grasses and "forbs" (botanical shorthand for flowering "herbs", or herbaceous wildflowers) occur here. It is common to find ring muhly (*Muhlenbergia torreyi*, growing in a circle with an apparent bare patch in the center) and three awn (*Aristida purpurea*), a short bunchgrass with a purplish cast early in the summer. Three awn, named for the forked appendage on top of its seed, is not a desirable forage grass for livestock; it is particularly common in disturbed or overgrazed areas where purple swaths can be spotted even at highway speeds.

The southern grasslands can be colorful especially in wet years when wildflowers bloom abundantly. The early summer array of prairie flowers is eye catching when diverse members of the pea family like locoweed (*Oxytropis*), vetches (*Astragalus*) and prairie clover (*Dalea*)), species of *Penstemon*, *Phlox*, and globe mallow (*Sphaeralcea*) flourish. Late season color tends towards yellow, orange and purple when multiple members of the Aster Family such as species of sunflower (*Helianthus*), golden aster (*Heterotheca*), gumweed (*Grindelia*), rabbitbrush (*Chrysothamnus*, *Ericameria*) and tansy aster (*Machaeranthera*) dominate the flowering array. Even in dry years and in overgrazed sites, the southern grasslands are noted for the distinctive silhouette of cholla cactus (*Opuntia imbricata*) and the sprawling buffalo gourd (*Cucurbita foetidissima*) These species are tolerant of poor, dry soils and biologically link our region with ecosystems of the Southwest from New Mexico to Texas.

Mixed Grass Prairie and Tallgrass Prairie Remnants

North of the southern grasslands lie prairie communities dominated by grasses needing more moisture and slightly cooler temperatures than those found in the Pueblo-Cañon City area. The wide-ranging blue grama is accompanied here by needle and thread grasss (*Hesperostipa comata*) and by the tall prairie sandreed (*Calamovilfa longifolia*) in sandy areas east of Colorado Springs. Diverse species of sage occur, but fringed or prairie sage (*Artemisia frigida*) is particularly abundant. In drier gravelly areas, side-oats grama and little bluestem (*Schizachyrium scoparium*) are common, and slightly moister or cooler sites include mountain muhly (*Muhlenbergia montana*) and Junegrass (*Koeleria macrantha*). These latter two grasses are very common in the foothills, but spread into the mixed grass prairie in and around the Black Forest. Scattered among the widespread and botanically diverse mixed grass prairie, one can find patches of remnant tallgrass prairie, where the grasses are indeed, taller, and representative of grasslands of the Midwest: big bluestem (*Andropogon gerardii*) is the signature species (although spotty), but other components include indiangrass (*Sorghastrum nutans*), abundant swaths of prairie dropseed (*Sporobolus heterolepis*), and porcupine grass (*Hesperostipa spartea)*.These grasslands, which need moisture to thrive and generally occur in and around the Black Forest and higher elevations of eastern El Paso County where surfaces drainages from the Palmer Divide occur and the water tables are high from underground aquifers, were perhaps once abundant, but are now unusual to find in any extent, for reasons that are probably complex. Ex-urban development and the breakup of once large ranches into small housing tracts, changes in local hydrology and soil moisture availability, climate shifts in temperature and seasonal rainfall, and overgrazing have all taken their collective toll, and tallgrass prairie is increasingly diminished in Colorado. Because of these threats, and visible disappearance of this grassland type since the mid1900's, it is of great conservation interest: our locally rare fragments with their unique botany are special reminders of our biological connections to the great grasslands of the Midwest.

The wildflower component of the mixed and tall grass prairies is diverse and often colorful especially in the spring or late summer when August monsoon rains arrive. Many of these species represent drought tolerant members of the Great Plains flora: Kansas gayfeather (*Liatris punctata*), species of *Packera* and *Senecio* (groundsels), goldenrods (*Solidago*), evening primroses (*Oenothera*), and many types of asters are all examples of prairie elements widespread throughout the prairies east of Colorado and reaching their western extent in here. The tallgrass prairie includes these plants, but also some unique ones. Rarities include Rocky Mountain blazing star (*Liatris ligulistylis*), prairie gentian (*Gentianopsis virgata*), yellow stargrass (*Hypoxis hirsuta*), short-headed rush (*Juncus brachycephalus*), and Philadelphia lily

(*Lilium philadelphicum*), as well as other species that are not rare but occur more commonly in higher elevations in the foothills rather than on the plains; goldenrods, penstemons, asters, and various other grasses and sedges are among these foothills outliers in the moist grasslands.

Sand Sage Prairie

In the southeastern quarter of El Paso County and northern Pueblo County, the grassland community is broken by a different kind of prairie: the sand sage prairie. Here soils are deeper and very sandy, favoring sand sage (*Artemisia filifolia*), a tall shrubby sagebrush with fine linear leaves. Although larger expanses of this ecosystem exist in the Great Plains (notably the Sand Hills region of Nebraska), its occurrence in Colorado is limited. In certain areas the sand sage is very dense, interspersed with only a few native grasses. The sand sheets underlying the sand sage prairie were probably formed during our last glacial episode. Meltwater from the retreating glaciers scoured the mountain front, carrying sediments eroded from adjacent sandstones and depositing them on the plains. Strong off-glacier winds may have transported some sediment from beyond our immediate area and shaped dunes to depths of 20 feet or more. Throughout the last few thousand years, open dunes have occurred at different levels of abundance. Reports of the 19th century explorers suggest dunefields were more extensive then than they are today; poor agricultural practices and drought during the first part of the 20th century also contributed to multiple " dune blowouts" across the plains landscape. Today, the open dunes are few and relatively small in extent, thanks to improved land use practices, extensive revegetation efforts, and more precipitation.

In addition to the dominant sand sage, other species of sage such as fringed sage, wild tarragon (*Artemisia dracunculus*) and Carruth sage (*A. carruthii*) are common here. Grasses include sand bluestem (*Andropogon hallii*), blue grama, hairy grama (*Bouteloua hirsuta*), sand dropseed, and prairie sandreed. In loose open sand, blowout grass (*Redfieldia flexuosa*), sand muhly (*Muhlenbergia pungens*) and purple sandgrass (*Triplasis purpurea*) can be found. Although many common grassland forbs occur in the sand prairie, this community also contains a few species restricted to these open sandy soils: the light purple palafoxia (*Palafoxia sphacelata*), phlox heliotrop (*Heliotropium convolvulaceum*), winged pigweed (*Cycloloma atriplicifolium*), sand penstemon (*Penstemon ambiguous*) and sand milkweed (*Asclepias arenaria*) are few of these specialists that thrive in here. Although not rare in Colorado, they are unusual occurrences in our region.

Prairie Wetlands: Cottonwood Riparian Corridors, Moist Swales and Playas

Although the plains are predominantly covered with plant communities tolerant of arid conditions, a few perennial streams traverse these otherwise dry grasslands, and anomalous wetlands occur in areas where underground water is close to the surface. Drainages that originate on the south side of the Palmer Divide join Monument and Fountain Creeks and ultimately the Arkansas River to the south; Black Squirrel Creek is the largest, but several other unnamed drainages also create at least part-time wetlands. Many grassland streams become intermittent aboveground, but subterranean channels regularly create moist patches in the soil. Some of these former wetlands, or at least seasonally wet areas, have dried out in recent years as water tables have dropped and aquifers are drawn down, perhaps from changing precipitation and less recharge, increased agricultural demands, or from residential wells in the new and expanding developments that support Front Range population growth.

Along creeks with running water, the **Cottonwood Riparian** zone is marked by the tall plains cottonwoods (*Populus deltoides*), often intermixed with narrowleaf cottonwood (*P. angustifolia*), peachleaf willow (*Salix amygdaloides*) and the thicket-forming coyote or sandbar willow (*Salix exigua*). The presence of these species indicates at least subsurface water. As prairie streams flow across sandy soils, they reshape their banks. Sandbars and stream edges provide low competition habitats for plant species able to tolerate mild flooding and instability. Species of rush (*Juncus*) are particularly abundant here.

Perennial and ephemeral streams face many stresses. Housing developments and roads have proliferated on the plains in recent years, often impacting surface and subsurface drainage and water tables. Wells and hard channeling of stream banks diminish groundwater supply. These stream channels also face serious threats from invasive weeds. Canada thistle is particularly adept at spreading in wet soil, and easily displaces native species. In Pueblo and Fremont Counties, the invasive non-native tamarisk or salt cedar (*Tamarix ramossissima*) and Russian olive (*Eleagnus angustifolia*) have colonized banks and overtaken native species. Tamarisk is particularly problematic since its deep roots tap aggressively into subterranean water and makes less water available for other species; it also makes soils more saline and thus additionally challenging for native species.

In seasonally wet drainages across the rolling topography of El Paso County but becoming increasingly infrequent to the south and east, water sources close to the surface and springs provide moisture in low-lying areas. **Moist Swales** are pocket wetlands, often limited in extent, but typically rich in unusual plant species. The dark green color of arctic rush (*Juncus arcticus*) can mark them from a distance. Their flora is unusual and varied, with the showy rarities like great blue lobelia (*Lobelia siphilitica*) or the rare prairie gentian (*Eustoma grandiflora*) found here, or more commonly, cattails (*Typha*), bulrushes (*Scirpus* and *Schoenoplectus*) and mud-loving annuals. The moist swales are an increasingly rare habitat type and botanically unique; like the tallgrass prairie, they have a to Midwestern and eastern floras. These remaining hydrophilic (moisture loving) species are probably relicts of the Pleistocene or early postPleistocene when cooler temperatures prevailed and the Great Plains flora extended much further west than it does today.

Another unusual wetland community can be found in the ephemeral lakes that dot parts of El Paso and Pueblo Counties. These **Playas** are a feature of the arid southwest, occurring in natural depressions. During wet years, especially in the spring when moisture is plentiful, saturated soils and an elevated water table slow the dissipation of surface water, allowing it to collect in playa depressions. Most of the year, however, the playas only distinguish themselves from the surrounding grassland by a circle of greener vegetation. Added water availability at these sites, although temporary, can support an unusual flora. Among the species that are common in playas are the mat-forming grass buffalo grass (*Buchloe dactyloides*), plains ragweed (*Ambrosia linearis*), a local endemic species known only from this region, and short-ray prairie coneflower (*Ratibida tagetes*). When the basins are full of water in late spring, the unusual water-fern pepperwort (*Marsilea mucronata*), which looks like a four-leaf clover but is really a fern, can sometimes be seen.

Mesas

From just north of Pueblo to the Air Force Academy, long intermittent lines of low, flat-topped ridges composed of the Mesa Gravels, mixed layers of clays from the Pierre Shale, and eroded Pikes Peak Granite, run parallel to the mountain front through the surrounding grasslands. The mesas slope gently to the east-southeast, but the west-southwest faces are steeper. Throughout the region, mesas are deeply gullied and fissured. This topography provides a number of microhabitats on slopes of different exposure and steepness. While the mesas provide a signature and often visibly striking landscape component for the mountain front in the Pikes Peak region, on a finer scale, the vegetation that cloaks them is not uniform, and varies considerably from north to south, and according to slope and underlying geological factors. Microclimate effects provide a patchwork of small-scale plant communities. South-facing slopes may have a very different set of species than north-facing ones; slopes may contain different species than valleys. Geologically and botanically, the mesas represent a transitional zone with considerable diversity, where fine-scale patterns of soil, moisture, and temperature are revealed in the plant cover. While few individual species are restricted to the mesas and much of their flora is common throughout the grasslands (for example, species of sage, sunflower and wild buckwheats (*Eriogonum*), as well as snakeweed *(Gutierrezia sarothrae*), rabbitbrush (*Ericameria nauseosus*) and grasses that include grama (*Bouteloua* species) and needlegrasses (*Hesperostipa* species), mesa vegetation patterns are unique enough to justify identifying them as a separate, albeit diverse, community.

On the northern sectors of the mesas, woody species more commonly found at higher elevations in the foothills occur. By the Air Force Academy, shrub thickets of Gambel oak (*Quercus gambelii*), mountain mahogany (*Cercocarpus montanus*), wax current (*Ribes cereum*) and 3-leaf sumac (*Rhus aromatica*) are common, intermixed with grasses like big and little bluestem, mountain muhly, junegrass, and needlegrasses. In central Colorado Springs, Gambel oak and big bluestem are less widespread and the presence of heat and drought-tolerant species like winterfat (*Krascheninnikovia lanata*), four-winged saltbush (*Atriplex canescens*), and rabbitbrush increases. In general, further south the mesas resemble grasslands more closely, and are less like the foothills shrub community. South-facing slopes are typically dominated by grasses, cacti, and forbs; north-facing slopes by shrubs to the north and taller grass species to the south. The southern mesas contain stands of indian ricegrass (*Oryzopsis hymenoides* and cholla cactus. The latter species is rarely found north of Fort Carson, a distribution presumably limited by the cooler temperatures and/or additional moisture found as the elevation increases.

Chalk-Shale Barrens of the Arkansas River Valley

South of Pikes Peak, the Arkansas River has cut through and exposed diverse bedrock formations, ranging from hard metamorphic schists near the Royal Gorge to the sedimentary chalks, shales, and limestones that are remnants of an ancient sea that spread across central North America about 90 million years ago. This is the Niobrara Formation, which underlies much of eastern Colorado and western Kansas; the outcrops are particularly well exposed in the region between Cañon City and Pueblo. However, development, is imposing significant impact here and the barrens habitats are significantly reduced from their former extent, especially between Pueblo and Cañon City. Plant groups of interest include endemics to the barrens as well as scattered representatives of the southwestern and the southern Great Plains floras disjunct from their core range in Oklahoma, Texas, New Mexico, or Arizona. The warm, dry climate of the Arkansas Valley provides conditions that allow these "thermophilic" or heat loving species to persist here. These species may have been more widely distributed once, perhaps during the hotter climate of the early Holocene, almost 8000 years ago.

The Niobrara barrens are visible around Pueblo Reservoir and along Highway 50 to Cañon City. Typically they occur on moderately steep slopes that provide shallow soils from erosion of the chalky layers in the Niobrara Formation. Bunchgrasses like New Mexico needlegrass and Indian ricegrass are common, as is the odd small shrub frankenia (*Frankenia jamesii*), another southwestern species with narrow leaves and shortlived white flowers. Miscellaneous species of wild buckwheat, bladderpod (*Lesquerella*), and prairie clover also occur frequently. The overall vegetative cover is low here, thus allowing the less competitive but drought tolerant species to thrive in these water-limited environments. Some, like round-leaf four o'clock (*Mirabilis rotundifolius*), Arkansas River feverfew (*Bolophyta tetraneuris*) and golden blazing star (*Mentzelia chrysantha*) are rare and limited to the barrens habitat. The Southwestern flora is well represented by a number of species. Those like cholla cactus or blackfoot daisy (*Melampodium leucanthum*) are botanically significant for their biogeographic connections but so locally abundant they are not considered rare.

Foothills-Montane Zone

At about 6500 feet in elevation in El Paso and Teller Counties, and 5500 feet in Fremont County, the landscape of the Pikes Peak region begins to reflect the effects of cooler temperatures and increased precipitation. East of Colorado Springs, in and southeast of the Black Forest area where the high plains elevations also reach this height, similar effects occur, and at least some elements of the foothills-montane zone occur in the grasslands here. With rainfall reaching 20-25 inches per year in the lower foothills and more in the upper forests, the grasslands transition to the higher elevation conifer forests, with an intermediate mountain shrub zone at the base of the foothills to the west of Colorado Springs and on the outcrops of the Palmer Divide. North of Cañon City, this shrub zone is more complex, with the addition of a southwestern community type, the piñon pine-juniper woodland that is similar to vegetation that occurs in New Mexico and parts of Arizona The woodland transition from the Arkansas Valley into the aptly named Wet Mountains is even more complex, with desert grasslands and piñon pine-juniper woodlands becoming rapidly intermixed with shrubs that include oak, sumac and mountain mahogany, and a significant component of more southern species like buckbrush (*Ceanothus*), hoptree (*Ptelea*), and mockorange (*Philadelphus*). These more southern elements are rare or lacking elsewhere in our region. The steep rugged faces of the Wet Mountains and the considerable amount of precipitation received from winter snows and summer storms, means that the shrub transition to conifer forests occurs very rapidly, and vegetation patterns are more mixed than on the foothills of Pikes Peak.

Geologically, foothills soils are mostly derived from the ancient Precambrian Pikes Peak Granite, with its characteristic pinkish-orange tint from the presence of potassium feldspar. The soils typically have a shallow profile, with lots of gravel and little water-holding capacity. These soils erode easily and the steep slopes are particularly unstable habitats for plants. Early explorers grumbled about the difficulty in climbing many of these lower slopes, and modern hikers today share their frustration about the ball bearing pebbles underfoot. In the Arkansas Valley, the geological picture is more complex, with additional layers of Cretaceous sedimentary units of sandstones and shales appearing as a skirt to the lower edge of the Pikes Peak massif northwest of Penrose and Cañon City. These units include the Cretaceous formations of Carlile Shale, Greenhorn Limestone, and Graneros Shale, as well as Dakota Sandstone. Soils derived from these formations are more alkaline and finer grained than those derived from Pikes Peak Granite. The Wet Mountain slopes in western Pueblo and southern Fremont counties are diverse and complex, where metamorphic rocks, very different in composition than anything in Pikes Peak massif, dominate.

Although glaciers shaped some upper contours of Pikes Peak, numerous canyons result from surface runoff that splits the foothill apron. The shape of these canyons varies from narrow chasms with extensive bare-cliff outcrops to gentle, heavily vegetated slopes. A few canyons have permanent water fed by alpine snows or reservoirs, but many are quite dry, holding ephemeral moisture only when storms occur. Between the canyons, there are particularly obvious differences between north and south-facing slopes where direction determines whether the dominant vegetation is the grassland, shrubland, or pine forest typically seen on south facing slopes, or conifers like Douglas fir and blue spruce that prefer the cooler conditions on north facing slopes. On the more gentle western flanks of Pikes Peak, conifer forests of ponderosa pine (*Pinus ponderosa*) are widespread through western El Paso Co. and most of Teller Co. These pine forests inter-finger with aspen forests, the communities of spruce and bristlecone pine at higher elevations, with the foothills shrub communities at lower elevations and on south-facing slopes, and with montane meadows on rolling hills and gentle ridges. The Foothills-Montane zone, then, comprises a number of plant communities determined by the interaction of elevation, topography, and geology. These transitions don't occur in tidy bands across an elevational gradient, since small scale environmental effects create pockets of vegetation communities and species more typical of higher or lower elevation through the middle and upper elevations. These main plant communities of the Foothills-Montane Zone include ***Ponderosa Pine Forests, Aspen Groves, Piñon Pine-Juniper Woodlands, Mountain Shrub Community, Riparian Canyons,*** **and** ***Black Forest Ponderosa Pine-Savannah.***

Ponderosa Pine Forests and Aspen Groves

The widespread ponderosa pine ecosystem can be found across the Southwest with slight regional differences. In our area it covers the foothills and higher elevations between about 8000 feet and 10,500 feet, including much of the Pike National Forest of Teller Co. and the Rampart Range. These are warm, dry forests with a relatively open canopy in mature stands; in second or third growth areas where fires have not occurred for some years, individuals can be thin, stunted, and close-growing: a "dog-hair" forest. Most of

the foothills forests here are unfortunately in this condition, and as recent years have shown, fires can be devastating and spread rapidly here. In the few remaining healthy stands of ponderosa pine, however, trees stand relatively far apart, with little understory. Shrubby components of these forests are numerous and diverse: species of current (*Ribes cereum, R. montigenum* and *R.inerme* are particularly common), wild rose (*Rosa acicularis* and *R. woodsii*), common juniper (*Juniperus communis*), and mountain spray (*Holodiscus dumosus*) are frequent , along with kinnickninnick (*Arctostaphylos uva-ursi*) and a diverse array of forbs tolerant of dry gravelly soils. Yarrow (*Achillea lanulosa*), sandwort (*Arenaria fendleri*), harebell (*Campanula rotundifolia*), and greenleaf penstemon (*Penstemon virens*) are abundant wildflowers here, and grasses such as Junegrass *(Koeleria macrantha*) and mountain muhly (*Muhlenbergia montana*) are frequent. Some patches of mountain grassland communities, now diminished due to land use alteration from their historical abundance, also occur intermixed in the pine forests, especially in Teller County. These grasslands are described under ***Montane Meadows.***

While many ponderosa pine forests in Colorado contain expansive groves of Colorado's popular fall tourist attraction, quaking aspen (*Populus tremuloides*), the Pikes Peak region has relatively few of these compared to regions west and north of us. Most aspen groves occur where disturbance such as fire or avalanche has broken the pine forest cover. Aspens may individually occur where soil moisture is higher, often where a spring comes out of a hillside. Few groves appear on the east face of Pikes Peak, but on the west side in Teller Co., more extensive ones can be seen, especially visible in their brilliant autumn gold. The understory in aspen groves is more diverse and colorful than that of ponderosa forests. Look for the state flower blue columbine (*Aquilegia coerulea*) here, as well as golden banner (*Thermopsis montana*), green gentian or monument plant (*Frasera speciosa*), heart leaf arnica (*Arnica cordifolia*), wild geranium (*Geranium*), paintbrush (in particular, red flowered *Castilleja miniata* and *C. linariaefolia*) as well as many representatives of the Apiaceae.

Montane Meadows

The gentle rolling hills of Teller County support open grasslands once dominated by unique mix of the robust bunchgrasses *Danthonia parryi* (Parry oatgrass) and *Festuca arizonica* (Arizona fescue). Over a century of grazing and agriculture has diminished the extent of oatgrass meadows and this is now considered a relatively rare community type. However, open grasslands are still abundant in the middle elevations; they may include native species like *Muhlenbergia montana* (mountain muhly), *Koeleria macrantha* (Junegrass), *Festuca thurberi* (Thurber fescue), *Festuca arizonica*)Arizona fescue, and *Poa fendleriana* (muttongrass), or introduced grasses such as *Bromus inermis* (smooth brome). Originally used as a revegetation grass or for forage, smooth brome's aggressive spread via rhizomes and its tendency to form a thatchlike cover can eliminate native species. Meadows provide habitat for numerous summer wildflowers such as lupines (*Lupinus*), asters, harebells (*Campanula rotundifolius*), and *Oxytropis* (locoweed). Locoweed species hybridize and provide a colorful palate along Highway 24 and the backroads of Teller County in summer.

Mountain Shrub Community

In the foothills west of Colorado Springs and north to Monument, a distinctive zone of shrubs lines the lower mountain front. Additional stands can be found on rocky outcrops like the flanks of Palmer Park or Austin Bluffs to the east. This community type is dominated by three shrub species: Gambel oak (*Quercus gambelii*), mountain mahogany (*Cercocarpus montana*), and skunkbrush or 3-leaf sumac (*Rhus aromatica* ssp. *trilobata*). Oak thickets require the most water of these three, and when it is available such as in gulleys, the oaks can reach almost tree size in height or provide hikers with a substantial navigational challenge due to the density of their thicket. Some sectors of the shrub community are dominated by oak, while in drier areas, mountain mahogany and skunkbrush are intermixed or prevail over the oaks. On south-facing exposures, shrub thickets may be interspersed with open grasslands where species of needlegrass (*Hesperostipa*), mountain muhly (*Muhlenbergia montana*) and Canada wildrye (*Elymus canadensis*) are common components with a number of wildflowers. Pasqueflower (*Pulsatilla patens*) is one of the earliest spring wildflowers; later, *Penstemon, Castilleja integra* (paintbrush), *Anemone cylindrica* (thimbleweed), and many species in the Asteraceae create a palate of colors. While most of the mountain shrub community is composed of fairly common species, some locally rare plants occur here as well. These include *Commelina dianthifolia*, (dayflower), *Penstemon gracilis* (lilac penstemon), and the buckbrush *Ceanothus herbaceus*. The latter two species are eastern prairie relicts, perhaps once common

here but increasing rare, as development and the spread of invasive species like butter and eggs (*Linaria vulgaris* and *L. dalmatica*) and smooth brome (*Bromus inermis*) are diminishing or degrading habitat.

Riparian Canyons

Many canyons in the Pikes Peak region lack permanent water. Outside of the Wet Mountain front, only a few contain major drainages fed by reservoirs or by natural runoff from the Rampart Range or the peak itself. The drainages with permanent water in our region include West Monument Creek in the northern sector of El Paso Co., Douglas Creek, Queen's Canyon, Cheyenne Canyon, Bear Creek Canyon, Rock Creek Canyon, and Little Fountain Creek Canyon, in the central and northern parts of El Paso Co, and Phantom Canyon in Fremont Co. The presence of water increases the humidity in these otherwise dry foothills, the fissured topography shades north-facing slopes, and dense cold air can drain down the topographic channels here. As a result, the canyons are considerably cooler and moister than foothills slopes, and encompass different plant communities than the rest of the foothills.

North-facing slopes, since they lack direct sun exposure, are always cooler than south-facing ones, and snow lingers here in the spring. Less sun exposure means less evaporation, so more moisture lingers in the soils all year. This enables a thick vegetation cover, dominated by *Pseudotsuga menziesii* (Douglas fir) and scattered patches of ponderosa pine. In the lower canyons, especially near streams, we have the elegant long-needled white fir (*Abies concolor*), a southwestern species reaching its northern limits in our region, and our state tree, *Picea pungens* (Colorado blue spruce), as well as Rocky Mountain juniper (*Juniperus scopulorum*). The shrub *Jamesia americana* (waxflower) is common and striking with its hairy opposite leaves and white flowers. It thrives on rocky areas and almost vertical rock faces, accompanied by mats of *Saxifraga bronchialis* (spotted saxifrage, also known as *Cilaria austromontana*), alumroot (*Heuchera hallii*), mosses and clubmosses (several species of *Selaginella*). In a few areas here (and in the alpine as well) a visual treat is the deep pink flowers of *Telesonix,* a striking species of early summer that clings to moist rocky ledges and cracks.

The most densely vegetated canyon habitats occur along drainage bottoms where water exists in relative abundance. Few trees grow here, with the exception of occasional cottonwoods in the lower canyons: *Populus deltoides* (plains cottonwood), *P. angustifolia* (narrowleaf cottonwood) and their hybrid, *P. acuminata*. However, deciduous shrubs such as ninebark (*Physocarpus monogynus* and *P. opulifolius*), mountain maple (*Acer glabrum*), river birch (*Betula fontinalis*), alder (*Alnus incana*), and dogwood (*Cornus*) flourish on the streambanks and on moist slopes. Some locally unusual species found here include hazelnut (*Corylus cornuta*), highbush cranberry (*Viburnum edule*), and the vine *Smilax lasioneuron* (carrionflower*)*. Some of these species are common in moister regions, but in our area are restricted to a few sites in these cool, relatively wet canyons. Moist canyons also contain colorful wildflowers, many of which might be familiar components of forests of the northern and eastern U.S. Cool forest species include sweet cicely (*Osmorhiza*), baneberry (*Actaea*), diverse orchids, and tall ferns such as *Athyrium* (ladyfern). More geographically widespread hydrophilic ("moisture-loving") components include *Dodecatheon* (shooting star), avens (*Geum*), waterleaf (*Hydrophyllum*), *Viola* (violet) and *Rudbeckia* (black-eyed Susan).

Fewer species can tolerate the dry, arid condition on south-facing canyon sides, or their frequently shifting gravelly soils, so plant diversity is relatively low here. Throughout the foothills, ponderosa pine occurs commonly on gentle south-facing slopes with many of the shrub species growing in patches with open soils between. *Arctostaphylos uva-ursi* (kinnikinnick) is a very common understory component, forming large evergreen mats under the pines and in open gravelly areas. Its bright red berries are tasteless and mealy for humans, but used by wildlife as a winter food. A few unusual species to look for on open gravelly slopes include smooth sumac (*Rhus glabra*), butterflyweed (*Asclepias tuberosa*), a milkweed with brilliant red-orange flowers, bladderpod (*Physaria vitulifera*), smooth penstemon (*Penstemon glaber*) with large -purple flowers, *Mentzelia speciosa* with sprawling habit, Velcro-like leaves and bright yellow flowers, and stemless evening primrose (*Oenothera caespitosa*) with large white, 4-petalled flowers loved by hawkmoths.

Piñon Pine-Juniper Woodlands

In the southern portion of the Pikes Peak region, grasslands give way to an open woodland community type widespread across New Mexico and reaching its northern extent here. The "P-J" as many nickname it, is a woodland only in the sense that it contains two diagnostic woody species: *Pinus edulis* (piñon pine) and *Juniperus monosperma* (singleseed juniper). In most areas these are well-spaced and

intermixed with grasses like New Mexico needlegrass (*Hesperostipa neomexicana*), little bluestem (*Schizachyrium scoparium)* or galleta grass (*Hilaria/Pleuraphis jamesii*), but with some increase in moisture, these short trees can grow more closely together and the community appears more of a woodland than a grassland.

The Piñon-Juniper community occurs on rocky soils or bedrock outcrops; in the lower foothills it becomes more extensive especially on the sedimentary layers exposed northwest of Cañon City and south of the Arkansas River near the Custer County border. While the herbaceous component of this community is slim and generally not very showy, a few species are able to thrive in the thin soils and limited water here. They can include the sprawling pink-purple many-flowered four o'clock (*Mirabilis multiflora*), fineleaf hymenopappus (*Hymenopappus filifolia*), and large-flowered townsendia (*Townsendia grandiflora*). In rocky areas with rugged bedrock exposures, claret cup cactus (*Echinocereus triglochidiatus*) can provide an eye-catching blast of red-orange on the landscape in early summer. It is especially common in Fremont County and southern El Paso County.

Subalpine and Alpine Zones

In the upper portions of the montane zone beginning at about 10,000 feet in elevation, the first scattered representatives of the characteristic species of the subalpine and alpine zones begin to appear. These zones are often difficulty to delineate, as plant communities and individual species of the montane, subalpine and alpine interfinger and entwine in the upper elevations. The subalpine theoretically extends from the upper montane forests at about 10,500 feet and ends around 11,400 feet in elevation where the treeless alpine tundra begins. "Treeline" is often irregular here, particularly on the east face of Pikes Peak, as slope steepness, direction, and stability affect local occurrence of woody species. The subalpine forest is dominated by conifers: Engelmann spruce (*Picea engelmannii*) and limber pine *(Pinus flexilis*), then bristlecone pine *(Pinus aristata*), increasingly stunted, to treeline. Above this, the tundra extends to the summit of Pikes Peak and surrounding high ridges such as Almagre Mountain. Here, too, exposure, soil depth, slope stability, and moisture profoundly affect the vegetation patterns of the landscape; vastly different communities can be found at similar elevations but different topography or exposure.

At higher elevations on Pikes Peak, the bedrock is entirely composed of Pikes Peak Granite, in some places with large bedrock boulders or outcrops exposed, in others, with coarse gravelly soils of bedrock fragments. These inhospitable soils are typically acidic from the mineral components of the granite and from the needles dropped by the conifer species themselves. These acidic nutrient-poor soils with little water holding capacity selects for a relatively sparse group of species able to tolerate the conditions. A comparison of our high elevation forests with those to the west and north shows here two striking omissions from the typical conifer species list: *Abies lasiocarpa* (subalpine fir) and *Pinus contorta* (lodgepole pine). Although a patch of subalpine fir was historically reported from a site (now highly modified) on a slope below Almagre Mountain, this species, the usual companion to Engelmann spruce elsewhere, is not otherwise known from here. Lodgepole pine occurs to the west in Park County, and picks up in occurrence on the Rampart Range to our north around the Douglas County line. Otherwise, the presence of lodgepole pine, except in a few small groves on the north side of Teller County, is virtually unknown. The poor water-holding capacity of our granitic foothills soils may explain the lack of these two otherwise common species for western forests.

Moisture stress in the higher elevations can occur from regional climatic patterns as well as from porous soils. Most of the rainfall carried by prevailing weather fronts falls on neighboring ranges as storm systems move over the Mosquito Range to the west, the Palmer Divide to the north, or the Wet and Sangre de Cristo Mountains to the south. Other than manmade reservoirs where water flow is controlled, we have few natural water catchment basins or large snowfields on Pikes Peak to supply reliable summer moisture. Strong winds add to the desiccating effect that is an almost constant factor on our tundra. Because of this aridity, our alpine flora is comparatively less diverse than that of other parts of Colorado, but it does have distinctive elements that probably resulted from the isolation of the Pikes Peak massif. Most of the tall peaks in Colorado cap significant mountain ranges with interconnected chains of peaks and ridges. Pikes Peak, however, stands alone as a broad island, separated from the Sangre de Cristo and Front Ranges by the broad channel of the Arkansas River Valley and the low-shoulders of the Rampart Range. To the west, South Park grasslands distance the Mosquito Range and Continental Divide. This ecological separation dates back to the ancient orogenies that created the Rocky Mountains in Colorado, and as a result, the Pikes Peak biota developed in relative isolation from other linked mountain systems.

The high elevation zone in our region can be roughly delineated into three broad community types: **subalpine *Engelmann Spruce-Limber Pine Forest*, *Engelmann Spruce-Bristlecone Pine Forest, Subalpine/alpine Wetlands*, and *Alpine Tundra*.**

Engelmann Spruce-Limber Pine Forest

The upper forests of the slopes of Pikes Peak, collectively known as the "subalpine", receive the most precipitation in our region, over 30 inches in most years. This comes both from rain and from snow that not only falls directly in winter storms, but also blows over and across the summit to accumulate on the leeward sides. Cooler temperatures prevail and lessen evaporation of soil moisture. Thus, this zone has more available moisture than either the tundra above or the montane forests below.

The dominant species is *Picea engelmannii* (Engelmann spruce), with frequent occurrences of *Pinus flexilis* (limber pine). Limber pine tolerates exposed rocky conditions, so the more extreme habitats on north-facing slopes or around windy outcrops from the higher elevations through the foothills typically contain the most individuals of this resilient pine with easily bendable limbs. Other tree species that occur

sporadically include *Populus tremuloides* (aspen) and *Pseudotsuga menziesii* (Douglas fir); both are common from the foothills on upwards. The herbaceous species reflect incursions from the tundra species above and from the montane species below. Subalpine forests are typically somewhat dense, with little light reaching the forest floor; consequently, understory growth is limited. Species with northern forest affinities include *Vaccinium* (huckleberry), extremely common elsewhere in Colorado in most forests, but limited in occurrence here, several wintergreen species in the genus *Pyrola*, tiny pink-flowered twinflower (*Linnaea borealis*), fireweed (*Chamerion angustifolium*), and the wide ranging shrubby cinquefoil (*Pentaphylloides floribunda*). This latter shrub has a wide ecological tolerance, and while most abundant in the upper montane to subalpine zones, it can occur as low as the edge of the foothills north of Colorado Springs along Monument Creek and its drainages. The most open moist areas in these forests contain an array of summer wildflowers, with some tundra species reaching down into the forests in small patches where sufficient light and moisture are available. Species of paintbrush (*Castilleja*), aster, daisy, (*Erigeron*), and vetch (*Astragalus*) are abundant, as are monkshood (*Aconitum*), *Potentilla* (cinquefoil), and *Polemonium* (Jacob's ladder).

Engelmann Spruce-Bristlecone Pine Forest

The forest component begins to become increasingly dwarfed somewhat below 11,400 feet in elevation and a few individuals of tree species can be found growing even higher in protected areas. The treeline community is composed primarily of *Picea engelmanni* (Engelmann spruce) and *Pinus aristata* (bristlecone or foxtail pine), although limber pine, willows, and common juniper can also be found. In the harsh conditions at high elevation, the "trees" assume the stunted "krummholz" morphology common at timberline around the world. The term krummholtz comes from the German meaning elfin timber or crooked wood, very descriptive of the gnarly, flagged, and stunted growth seen at high elevation. For all their small size, many of the high elevation "trees" are ancient, perhaps even as old as a thousand years or more for some of the bristlecones. Slow growth and ability to regenerate viable limbs off damaged wood allows them to persist under extreme conditions with astounding longevity on a human scale. Bristlecones thrive at higher elevation, but on the west side of Pikes Peak, can range below 10,000 feet in cool, moist drainages.

As the dwarf conifers transition into the treeless zone above, they become more and more separated into clumps or low-growing tree "islands. Interspersed between these clumps are meadow communities with a diverse herbaceous component containing species from the tundra and the subalpine forests. Because of the additional moisture and wind protection here, the meadow communities at treeline are typically more species-rich than those found above on the tundra itself. Look here for the sunflower-like *Rydbergia grandiflora* (old man of the mountains), many species of gentian, daisy, and aster, as well as bluebells (*Mertensia*) and saxifrages.

Subalpine/Alpine Wetlands

The arid nature of Pikes Peak means that snow accumulation is more limited here than it is in other mountains of Colorado, and the steep faces enhance rapid runoff. While high elevation wetlands are a common component elsewhere in the state, they are not abundant on Pikes Peak. Some do occur, however, especially on the south and southwest face of the peak where moister areas once containing "the Seven Lakes" have now been modified into a reservoir system. Around this water system, and in a few flatter areas of the east face, wetlands with both common and unusual vegetation occur: many willows, of course, the hydrophilic shrubby cinquefoil (*Pentaphylloides floribunda*), and graminoids of great diversity: many sedges, wetland grasses like tufted hairgrass (*Deschampsia caespitosa*), and alpine rushes (*Juncus* spp.). We know of one rare sedge, *Carex leptalea*, that occurs here in a high drainage. While most of the wetlands are fairly standard willow bogs, a few fens occur: groundwater fed peatlands characterized by sedge species and sometimes, cottongrass *(Eriophorum)*.

Alpine Tundra

The true alpine zone, an expanse of meadows and boulderfields, extends from treeline around 11,400 feet to the summit of Pikes Peak at 14,109 feet. The lower tundra contains relatively few boulderfields and extends to about 13,000 feet. Alpine meadows dominate the vegetation here, in the dry areas typically with sedges like *Kobresia myosuroides* (kobresia) and *Carex rupestris* (curly sedge) accompanied by alpine sage (*Artemisia scopulorum*). Other common species include the mat-forming *Dryas octopetala* (mountain dryad) and *Acomastylis rossii* (mountain avens). Mountain avens often forms

broad expanse of alpine "turf". The alpine wildflowers can be striking: look for the pink *Primula angustifolia* (fairy primrose), blue alpine forget me not (*Eritrichum aretioides*), white *Androsace chamaejasme* (rock jasmine), pink mats of *Silene acaulis* (moss campion), and species of *Draba* (whitlow-wort) are all early bloomers, and the yellow *Potentilla* (cinquefoil) with its many representative species occurs all summer. Two common species are considered by some to be endemic to Pikes Peak: *Mertensia alpina* (alpine bluebell), and Pikes Peak spring parsley (*Oreoxis humilis*), a mat forming species common above 12,000 feet. While their genetic distinctiveness is under investigation, they do exhibit a few morphological differences from their relatives elsewhere in the Colorado mountains and their isolation is suggestive of some degree of genetic uniqueness.

Telesonix jamesii, with its eye-catching pink-magenta flowers, is common on upper elevation rocky areas on the peak, especially in the ancient glacial cirque on the east face known as "the Bottomless Pit". Many of these now famous alpine plants were first discovered by botanist Edwin James on his climb to the summit in 1820, the first white man to survey the terrain. Some of the more interesting areas on Pikes Peak have not been fully assessed floristically, but historical collections and recent surveys indicate that alpine species with arctic affinities that are more easily found in moister alpine zones of Colorado do occur in out of the way habitats such as the Bottomless Pit, its east-face companion "the Crater", and in high boulder-ridden valleys on the southslope watershed. These areas hold a more diverse herbaceous flora in microhabitats where moisture lingers; such unusual finds include alpine columbine *Aquilegia saximontana*, species of *Saxifraga*, and mustards like *Draba*.

The tundra becomes progressively drier, rockier and less hospitable to plants with elevation; near the summit, the landscape consists almost entirely of boulder fields and permafrost patches lurking below. Vegetation is restricted to patches between the boulders, with scattered individuals hiding beneath rock edges out of the wind. Species of *Carex* (sedge) and arctic-alpine grasses such as *Poa alpina* (alpine bluegrass), *Trisetum spicatum* (spike tristetum) and *Festuca brachyphylla* (alpine fescue) are abundant. Only the hardiest of the wildflowers can tolerate these habitats, but among them are *Lewisia pygmaea* (pygmy bitteroot), *Claytonia megarhiza* (largeroot spring beauty), *Oxyria digyna* (alpine sorrel) and *Senecio fremontii* (Fremont's groundsel).

While the Pikes Peak alpine flora may not have the showy color of other alpine floras in Colorado, its diversity is significant and unusual, and perhaps not yet fully known. The alpine and subalpine plants, bits and pieces from high and low elevations in a vegetation patchwork that defies easy characterization, contributions from mountains elsewhere, and geographic affinities from afar, unique sometimes, connectives to other times and place at others, exemplifies much of the botany of the Pikes Peak region. Not least of the example it provides is a landscape of ongoing discovery. The hidden crevices and remote corners of this isolated peak and its companion ridges stand high, dry, isolated, and ancient, still providing surprises and rewards to explorers who botanize or hike its challenging topography. Edwin James called it "a landscape of surprising beauty", as true now as in 1820. Today Pikes Peak is our signature feature, a draw to tourists and locals for exercise, escape from the city, and views in all directions. It is a storm magnet, a severe weather-generator, and provider of a complex water system that struggles to support our growing urban population. The ancient faces of Pikes Peak remind us of our past: geologically recent glaciers, periods of upheaval and uplift, and even more ancient, almost to the point of the unimaginable, internal vulcanism that formed its crumbly granites and rugged rock faces. At its feet lie equally aged reminders of sand dunes, floods, mineral-melting heat: the changes that time wreaks on a landscape, but also, the contributions of time to biodiversity in all of its complexity.

Our Place: The Meaning of Small Pieces

We cannot change the longterm global course of planetary shifts in climate, geological uplift, or erosion, nor is it possible to permanently freeze any landscape in time. Landscapes are everchanging, temporary on a geological scale, and in the long view, fluid in their species and community compositions. However, we can and should know and appreciate what the geology, the biota and the communities of our place and our time mean. These provide a fundamental text for how we define a unique place in Colorado: a text that extends far to the past beyond Colorado Springs' visionary founder General Palmer, the Goodnight-Loving cattle trails, the Native Americans who first felt the spiritual power of the Garden of the Gods and Pikes Peak, beyond the glaciers and beyond the sand dunes of the ancient seas. The stories may be quiet ones writ small, but nonetheless, relevant and rich.

Perhaps the most important message left for us today in our landscape quilt of communities and ecosystems is of the remaining importance of even small places. Our small niches of dunes, wetlands, canyons and crevices are today some of our richest habitats in terms of biological stories. If, in the face of perhaps unstoppable change from human or nonhuman forces, we are to keep our biological archives, then we need to remember that even small landscape patches may be important for species to persist. While large reserves play an unarguably critical role in landscape preservation, sometimes a mesa, a sand dune, a canyon, a playa, or a meadow can also play a critical role in maintaining species and communities. These small places provide at least a temporary resting point in time and space for species, and they contribute color, pattern, texture, and dimension to the compelling "viewscape" that comprises the Pikes Peak region from the Arkansas River Valley to the Palmer Divide and prairie to summit.

"Conservation" is often a confrontational term and one surely defined differently by different human constituencies who hold different values. A less antagonistic and more comprehensive term might be "appreciation"- one that most residents and visitors here would embrace here for this diverse regional landscape, and one that allows for different scales of reference. Appreciation lies as much, or more, in the hands of the average citizen as in the hands of the politicians and biologists. It can be as simple as learning some names and basic ecology, pulling weeds so that native species can prosper, or learning to observe details of the backyard or the roadside. The Pikes Peak region has been an exciting place to explore for many centuries for its original inhabitants and those who now call it home, for the adventurers and scientists who made it famous, and for the few who made their fortunes here. It remains a place where unexpected rewards and surprises still lie in the plains, the canyons, and the crevices of the peak for those who learn to see its patterns and read its stories.