COLORADO RARE PLANT CONSERVATION STRATEGY

By
The Colorado Rare Plant Conservation Initiative

Funded by
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Executive Summary

The Colorado Rare Plant Conservation Initiative (RPCI), a diverse partnership of public agencies, private organizations, and academic institutions, developed this Strategy to set a conservation direction for Colorado's imperiled plants and their habitats. The Strategy represents a collective vision for plant conservation in Colorado, emphasizing a proactive approach to ensure the long-term stewardship and viability of Colorado's rarest plants. The implementation of this Strategy will enable concerned partners to systematically and meaningfully advance urgently needed plant conservation in Colorado, thus avoiding the need for federal listings.

Colorado's rare plants are an important and irreplaceable part of the state and nation's natural heritage. The majority of the state's 155 imperiled species are plants: 119 plants are considered globally imperiled according to the Colorado Natural Heritage Program, meaning they are at significant risk of extinction. Over 68 of these plant species are known to occur only in Colorado and no place else in the world. Approximately 70% of the state's imperiled plants occur on federal lands and 24% occur on private lands; 3% occur on state lands, with the rest occurring on lands managed by non-governmental organizations, local governments, and tribes. The majority of Colorado's rare plants occur in barrens and shrubland habitat types, so concentrated conservation efforts in just these two types of habitats can make a great difference for rare species.

Threats to Colorado's native plants and their habitats are at an all-time high. The human population of Colorado is one of the fastest-growing in the country; demands for housing, energy, recreation, and transportation place unprecedented pressure on plants and natural ecosystems. Climate change also poses serious threats to plants, particularly those that are restricted to specialized habitats (e.g., alpine, barrens). One of the biggest issues is a lack of awareness regarding the presence, distribution, and precarious status of native and rare plants. Nearly half of the state's imperiled plants are poorly or weakly conserved, often due to significant threats or lack of protection. Thirteen plants in Colorado are currently federally listed as threatened or endangered.

Additional concern stems from the fact that, despite rapidly growing threats, Colorado lacks state-level recognition and protection specifically for rare and native plants. Colorado is one of a minority of states with no state plant protection statute. A plant program supported by the state government, with broad stakeholder involvement, is needed to help implement this Strategy and achieve the long-term goal of conserving Colorado's imperiled plant species. Increased coordination, long-term funding, and on-the-ground action are all essential for effective plant conservation in Colorado.

Fortunately, there are still meaningful opportunities to make a difference for plant conservation through strategic actions in Colorado. Compared to animals, rare plants are relatively easy to conserve because they typically occur in small numbers and over relatively small geographic areas. The land area occupied by Colorado's documented imperiled plants is approximately 62,500 acres, encompassing a minute percentage (<

.001%) of the state's total land area. Thus plants can often be protected with a relatively small investment of time and resources through voluntary and cooperative actions. By working together, landowners, land managers, and concerned partners can take proactive steps to improve the conservation status of Colorado's imperiled plants.

The overall goal of the RPCI is to conserve Colorado's most imperiled native plants and their habitats through collaborative partnerships for the preservation of our natural heritage and the benefit of future generations. Conserving imperiled plant species means that their biodiversity status is viable, populations are adequately protected, and threats have been abated. The RPCI has identified the following six conservation objectives, with recommended actions, to guide conservation efforts for imperiled plants over the next decade.

1. Secure on-the-ground, site-specific habitat protection and/or management to achieve specific goals for all of Colorado's imperiled plants.

2. Minimize the impacts of specific land uses that threaten many of Colorado's imperiled plants statewide.

3. Improve scientific understanding of the distribution, natural history, and status of Colorado's most imperiled plants through inventory, research, and monitoring.

4. Develop and implement a state program and policies to enhance the conservation of Colorado's most imperiled plants in cooperation with public land managers, private landowners, and other interested stakeholders.

5. Facilitate the stewardship of Colorado's most imperiled plants through education, outreach, and coordination.

6. Adopt measures for *ex situ* (off site) conservation of Colorado's most imperiled plants in case native populations are extirpated.

This Strategy is a Call to Action, highlighting the conservation steps that federal, state, and local agencies, private groups, academic institutions, and others can take to assist with meeting these six objectives. It will serve as a living document, maintained by the Colorado RPCI partners, to strategically guide future plant conservation efforts in the state. Successful implementation and conserving Colorado's native plant heritage is contingent upon adequate resources and funding to support the recommended conservation actions.

Plants have too long been hidden in plain sight. The prospect of continued threats to the nation's plant life, coupled with the large proportion of the flora already at risk, argues that now is the time to bring plants out from the background, and to put the conservation needs of our nation's flora squarely into view.
Stein and Gravuer, NatureServe, 2008

Mancos milkvetch (*Astragalus humillimus*)
Photograph by Al Schneider

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Introduction

Purpose

The purpose of this Colorado Rare Plant Conservation Strategy is to set a statewide strategic direction for the conservation of Colorado's most imperiled plant species and their habitats, and establish a coordinated statewide approach for partners. The Strategy has been developed by the Colorado Rare Plant Conservation Initiative (RPCI), a diverse partnership of state and federal agencies, private organizations, academic institutions, and individuals, concerned with the stewardship and survival of imperiled plants in Colorado. This Strategy represents a collective vision for plant conservation in Colorado over the next decade, with specific actions for the next five years. It emphasizes a coordinated and proactive approach to identify and carry out the actions needed to address increasing impacts to our imperiled plants and provide for their long-term stewardship. This is an excellent opportunity to systematically and strategically advance plant conservation in Colorado. Proactive conservation actions will help to avoid population declines, habitat loss, and the need for increased federal listings for Colorado's imperiled plants.

The RPCI partners anticipate that implementation of this Strategy will ultimately result in the conservation of all of Colorado's imperiled plant species on public and private lands. One of the first steps will be to prioritize conservation actions and complete a funding and implementation plan for 2009-2010. Plant conservation

projects and partners will be closely coordinated so that resources are maximized. This Strategy is intended to help decision-makers, landowners, land managers, and other Colorado citizens better understand plant status and act in support of conservation efforts. As a result, much needed programs and resources will be directed to support rare plant conservation efforts in the state. This Strategy should serve as a living document, maintained by the Colorado Rare Plant Conservation Initiative partners, to strategically guide future plant conservation actions. And finally, public awareness will be significantly heightened on the status and opportunities to conserve Colorado's imperiled plant species.

Scope

Imperiled plants typically have small numbers of individuals worldwide, narrow geographic ranges, and a few localized populations. They are often threatened because of their inability to recover from random (stochastic) events such as catastrophic fire, drought, or flooding. Some rare species are locally abundant or widely distributed but are subject to major threats, such as habitat alteration, over-collection, or climate change. Rare plants often are at risk due simply to a lack of awareness regarding their precarious status. In general, species with low population density, low reproductive potential, and narrow geographic distributions have a higher likelihood of extinction (Groves 2003).

This Strategy is focused on 119 plant species that are at greatest risk in Colorado (the non-vascular plants, lichens, mosses, and liverworts are not included because they are not as well understood as the vascular plants). These species are ranked as *critically imperiled* (G1) and *imperiled* (G2) at a global level by the Colorado Natural Heritage Program and NatureServe (see Box 1 and Appendix A). They are considered to be at risk throughout their range and vulnerable to extinction. For the purposes of this report, we refer to these plant species interchangeably as *globally imperiled*, *imperiled*, or *rare*. See below for definitions of terms used in this Strategy.

- *Critically imperiled species* are those ranked G1 by the Colorado Natural Heritage Program and NatureServe.

- *Imperiled species* are those ranked G2 by the Colorado Natural Heritage Program and NatureServe.

- *Vulnerable species* are those ranked G3 by the Colorado Natural Heritage Program and NatureServe.

- *Threatened or endangered species* are those that are federally listed under the U.S. Endangered Species Act (ESA) by the U.S. Fish and Wildlife Service.

- *Species at Risk* or *Species of Special Concern* are not necessarily included on the above lists, but may be included on lists of Sensitive Species by U.S. Forest Service (USFS) and/or Bureau of Land Management (BLM) offices.

- *Endemic species* are those whose entire distribution is restricted to a relatively small geographic region. These species occur nowhere else in the world and are often, but not necessarily, vulnerable to extinction (Groves 2003).

- *Rare species* typically have small numbers of individuals worldwide, narrow geographic ranges, and/or few localized populations, making them more vulnerable to extinction than common species.

Box 1. Species Global Conservation Status Definitions of NatureServe and the Colorado Natural Heritage Program. For additional information see Stein *et al*. 2000 and http://www.natureserve.org/explorer/ranking.htm#globalstatus.

G1 **Critically Imperiled:** At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
G2 **Imperiled:** At high risk of extinction due to very restricted range, very few populations (often 20 or fewer populations), steep declines, or other factors.
G3 **Vulnerable:** At moderate risk of extinction or extirpation due to a restricted range, relatively few populations (often 80 or fewer populations), recent and widespread declines, or other factors.
G4 **Apparently Secure**: Uncommon but not rare; some cause for long-term concern due to declines.
G5 **Secure**: Common; widespread and abundant.

Other factors considered in ranking species include: number of individuals, occupied habitat, trends, threats, and level of protection.

The Colorado Natural Heritage Program (CNHP), housed at Colorado State University in Fort Collins, maintains a statewide comprehensive database for rare plants, animals and plant communities, works with public and private partners to inventory and monitor rare species, and provides environmental review on request. CNHP is part of an international network of Natural Heritage Programs coordinated by NatureServe that uses a standard methodology and shares data and information on North American species and habitats.

Audience

The primary audience of this Strategy is all members of the RPCI, including public land managers (federal and state agencies), non-governmental conservation organizations, and decision-makers (e.g., USFS District Rangers, BLM Field Office Managers, conservation organization executive directors and managers). The Strategy will serve as a living document to guide coordinated action and decision making for the primary audience. The secondary audience includes relevant state, federal, and local government officials (e.g., Colorado Governor and General Assembly, USFS Rocky Mountain Regional Forester, USFWS Mountain Prairie Regional Director,

BLM State Director, local elected officials), tribal officials, private landowner groups, and other stakeholders. To this secondary audience, this Strategy serves as an explanation of the challenges and the solutions proposed by the RPCI to conserve and advance stewardship of Colorado's imperiled plant species.

RPCI Partnership

This Strategy has been developed through a collaborative effort with over 20 members of the RPCI, a partnership consisting of state and federal agencies, non-governmental organizations, academic institutions, and interested citizens (see pages ii-iii for a list of RPCI partners and Appendix B for descriptions of their plant conservation efforts).

The RPCI grew out of the Colorado Rare Plant Technical Committee (RPTC), a statewide group of botanists, ecologists, and planners that have been meeting regularly since 1992 to exchange information, assess plant species conservation status, and identify and prioritize management and stewardship actions for plants. In 2007, the group determined that there was a growing need to improve coordination and take proactive steps to address rapidly increasing impacts to rare plants in Colorado. This initiative builds on previous RPTC and partnership efforts, such as the *Colorado Rare Plant Field Guide* (Spackman *et al.* 1997), *Rare Plants of Colorado* (Colorado Native Plant Society 1997), on-the-ground conservation of imperiled plants in the Adobe Hills and Arkansas Valley, Annual Colorado Rare Plant Symposia, Colorado Natural Areas Program (CNAP) special designations, U.S. Forest Service species assessments, and the Denver Botanic Gardens (DBG) monitoring projects. The coalition of partners hopes to build on these efforts to greatly expand conservation efforts for imperiled plants throughout Colorado.

The RPCI is committed to achieving results through a collaborative approach that is based on the best available science, close coordination, data sharing, and taking strategic action.

Why Conserve Native Rare Plants and Their Habitats?

Plants are essential to both wildlife and humans through provision of key services such as food, shelter, fiber, and medicine ... protecting our wild flora goes to the heart of the human condition. Yet without focused conservation attention to the growing plight of the nation's plant species, we are at risk of losing significant portions of our wild heritage, and the ecological resilience that comes with that diversity.
Stein and Gravuer, NatureServe, 2008

Native plants are a vital component of biodiversity, global sustainability, and functional ecosystems. Over the last several decades, hundreds of wild plant species have disappeared worldwide because of habitat loss – some going extinct even before they have been formally described by scientists. Few people are aware or concerned about their fates compared to renowned species such as giant pandas or mountain gorillas. Nonetheless, people do appreciate the loss of the American chestnut and value other iconic plant species. If we consider the important role plants play in the lives of all creatures, perhaps we will better appreciate their importance and the necessity of trying to save all of them (Convention on Biological Diversity 2008; Souza 2003).

Colorado is one of the fastest-growing states in the country. The resulting demands for housing, energy, water, and transportation place tremendous pressure on native plant species and their habitats. A proactive, coordinated approach is needed to conserve Colorado's most imperiled plants, helping to avoid further species loss and the need for federal listing.

CNHP and other partners have been gathering valuable data on rare plants in the state for over 25 years. With the help of numerous botanical experts, the CNHP has mapped some 1,200 occurrences of imperiled plant species in Colorado. While the information is never complete, the CNHP can now inform conservation action with the best available data.

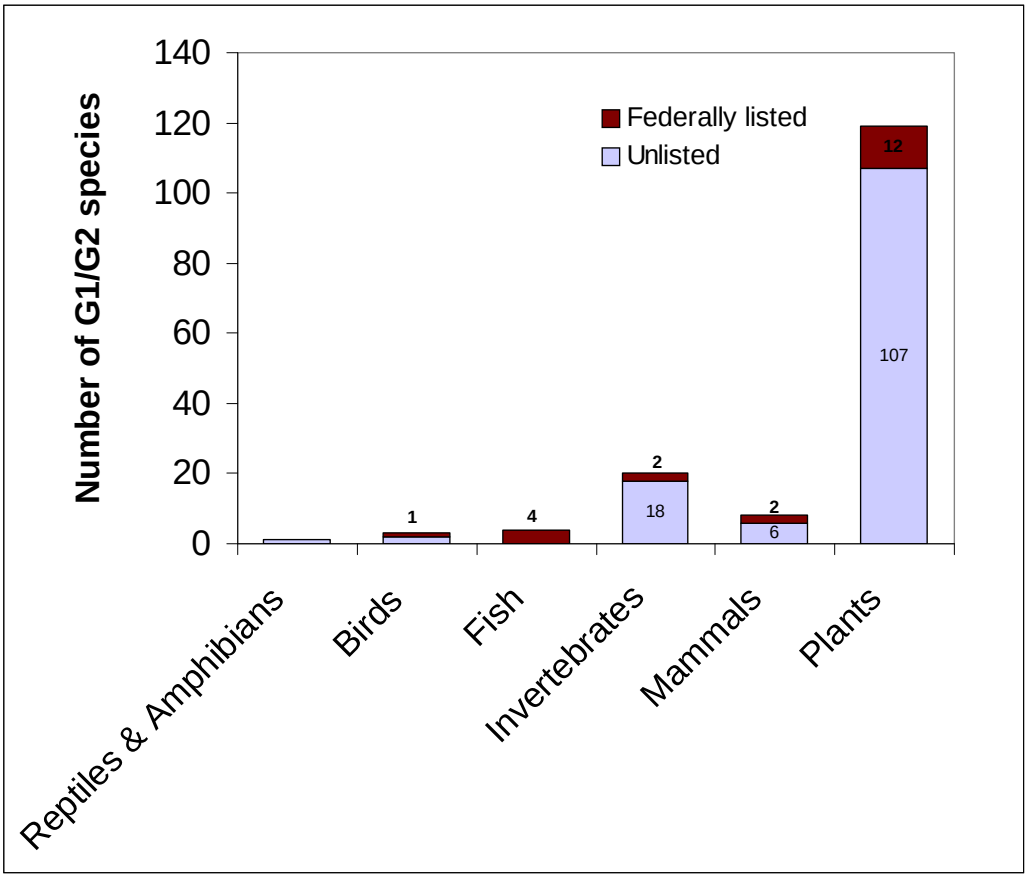
Irreplaceable Natural Heritage

Every native species, however humble in appearance ... has its place in the nation's heritage. It is a masterpiece of evolution, an ancient multifaceted entity that shares the land with us. E.O. Wilson

Rare plants are an important and irreplaceable part of Colorado's natural heritage. The majority (75% or 119 species) of Colorado's imperiled species are plants (36 animal species are imperiled; see Figure 1). Sixty-eight imperiled plants are endemic to Colorado — occurring here and nowhere else in the world. Because rare plants occupy a small portion of Colorado's landscape, they can be viewed as an indicator for how well Colorado is doing at protecting the state's unique biodiversity. When

native plants begin to disappear, the impacts ripple throughout natural systems. Their disappearance means we not only lose species, but also parts of Colorado's precious natural heritage — forever.

Figure 1. Number of imperiled and federally listed plant species compared with animal species in Colorado. Source: Colorado Natural Heritage Program 2008. Note: Colorado has 13 federally listed plant species. However, Colorado hookless cactus (*Sclerocactus glaucus)* is ranked G3; thus, for this chart there are 12 federally listed plant species. Colorado has 17 federally listed animal species; only the nine ranked G1-G2 are included here.



Rooted in Place

Rare plants need active protection because they are rooted in place and cannot move out of the way of impending threats. They often inhabit quite specific habitats and are adapted to particular soils or climates. Their highly localized nature makes rare plants easy to destroy — often without anyone's knowledge or intent. But this localization can also make plants easier to conserve, because they typically occur in small numbers and can often be protected with a relatively small investment of time and resources compared to imperiled animals.

Ecological Services

Who knows, or can say, what potential cures for cancer or other scourges, present or future, may lie locked up in the structures of plants which may yet be undiscovered, much less analyzed? ... Sheer self-interest impels us to be cautious.
U.S. Congressional Deliberations on the Bill Introducing the Endangered Species Act, 1973

Although rare plants occupy relatively few acres, they are embedded within natural communities and larger functioning landscapes consisting of native plants. Native plants provide a range of ecological services to humanity, from production of oxygen and removal of atmospheric carbon dioxide emissions to creation and stabilization of soil, protection of watersheds, and provision of food, fibers, fuel, shelter, and medicines (Convention on Biological Diversity 2008; Roberson 2008). They provide the foundation for ecosystems that support our economic prosperity and our quality of life. They provide habitat and food for wildlife, for mammals, fish, birds, and insect pollinators, and are fundamental to sustaining functional ecosystems. Our ignorance of their ecosystem services becomes increasingly dangerous as the rate of plant extinctions accelerates (Marinelli 2005; Stein *et al*. 2000).

A few of the benefits we receive from native plants are highlighted below.

Clean Air: Plants provide the oxygen that nearly all organisms need to live. The quality of the air we breathe is directly influenced by the presence of plants. Plants humidify the air and are critical in moderating the greenhouse effect from the burning of fossil fuels, removing about 50% of anthropogenic carbon dioxide emissions (Convention on Biological Diversity 2008). Vegetation can also restrict the movement of dust and pollutants.

Carbon Sequestration: Plants absorb carbon dioxide from the atmosphere through photosynthesis and store carbon in the form of living biomass (e.g., tree trunks, branches, foliage, roots). Carbon sequestration, the locking up of carbon in a solid state, particularly in forests and wetlands, is becoming an increasingly important mechanism to consider given increasing carbon dioxide in the atmosphere, a significant issue of global concern (Millennium Ecosystem Assessment 2005).

Clean Water: Plants are very important to the quality of our water. A diverse cover of plants helps to maintain functional watersheds, streams, lakes, and reservoirs by holding soil in place, regulating stream flow, and filtering pollutants from the water. Plants stabilize and protect soils from erosion by wind or water.

Medicine: Valuable medicines come from native plants; e.g., the West's Pacific yew (*Taxus brevifolia*) contains taxol, a powerful treatment for cancer, and Colorado's heartleaf arnica (*Arnica cordifolia*) is used to treat sprains and bruises. Yet only 2%

of the world's plants have been analyzed for plant chemicals that might be effective medicines. Many more drugs remain to be discovered.

Food: Although some 7,000 plant species have been used as foods by people, 90% of the world's food comes from only 20 species such as rice, corn, and wheat (Convention of Biological Diversity 2008). Increasingly other plant species are being investigated because they may have properties that can enhance our food supply. Insects and birds that rely on native plants pollinate and provide pest control for millions of dollars worth of Colorado's crops (e.g., peaches) each year.

Recreation and Aesthetics: Natural plant communities provide habitat for important recreational activities such as hiking, hunting, photography, and nature observation. Millions of people take time and spend money to enjoy our beautiful Colorado landscapes and the variety of native wildflowers and animals occurring on federal lands, state parks, county open spaces, and similar areas.

We owe it to our children and grandchildren to be good stewards of our natural landscapes, particularly life-sustaining native plants and their habitats. We have an obligation to preserve native and imperiled plants for the benefit of future generations of mankind.

We will determine what the world will be like in the future whether we take direct action or not. Biodiversity gives form and meaning to us because our existence depends on the living world. Our species has developed in direct relationship to our ability to be able to use the plants and animals in which we have come into contact. Obviously, we could use many more types of plants if we knew what they were and understood how they might help us to extend productive agriculture in the world.
Peter Raven, 2008

What is the Current Conservation Status of Rare Plants in Colorado?

Scientists predict that two-thirds of the world's plants are in danger of extinction, a staggering risk of impoverishment for all of us and numerous other species (Convention on Biological Diversity 2008). As many as one-third of all vascular plant species in the United States are currently vulnerable to extinction and some are known to have gone extinct (Stein *et al*. 2000; Stein and Gravuer 2008; Center for Biological Diversity 2008). Colorado ranks eighth in the nation in the percent (11.6%) of plant species at risk of extinction, i.e., those with NatureServe global conservation ranks ranging from Vulnerable (G3) to Extinct (Stein and Gravuer 2008).

In a comprehensive evaluation of the Colorado flora completed over a decade ago (Weber and Wittmann 1992), a total of 3,088 vascular plant species were documented to occur in Colorado; 2,596 of these were native, and 492 non-native but variously naturalized. Some 125 of the native species are endemic to Colorado — not found anywhere else on Earth. The plant families with the greatest number of rare plants in Colorado are the legume, sunflower, mustard, and figwort families.

How Many Plants are At Risk in Colorado?

The Colorado Natural Heritage Program (CNHP) at Colorado State University currently tracks approximately 520 rare plant species in Colorado; of these, 119 species are ranked *critically imperiled* (G1) or *imperiled* (G2) on a global level (see Appendix A). Sixty-eight of these are endemic to Colorado, occurring only here and nowhere else in the world. Another 140 species are vulnerable to extinction (ranked G3) (CNHP 2008). Eighty-two plant species are on the BLM Sensitive Species List, and approximately 70 on the U.S. Forest Service Sensitive Species List.

Currently, 13 Colorado native plant species are federally listed by the U.S. Fish and Wildlife Service as Threatened or Endangered; another five species are candidates for listing (see Boxes 2 and 3). The federal Endangered Species Act (ESA 1973, as amended) is a national law, a legal tool for the protection and recovery of imperiled species. The law protects imperiled animals wherever they live but does not effectively protect plants and their habitats on private lands unless a federal permit is involved (e.g., critical habitat can be designated on private lands and convey substantial protections where there is a federal permit). The ESA goal is to recover listed species — to bring these species to the point where protection by the Act is no longer necessary (Scott *et al*. 2005).

Box 2. U.S. Fish and Wildlife Service Listed Endangered (E) and Threatened (T) Plant Species and Candidates in Colorado (in alphabetical order by scientific name). All of these species are ranked G1 or G2 except for the Colorado hookless cactus, which is the only G3 species included in this Strategy, included because of its federal status. *Although there has been some confusion through the years, the Knowlton cactus has not actually been documented in Colorado.

Federally Listed Plants

1. Mancos milkvetch (*Astragalus humillimus*): E
2. Kremmling milkvetch (*Astragalus osterhoutii*): E
3. Clay-loving wild buckwheat (*Eriogonum pelinophilum*): E
4. Penland alpine fen mustard (*Eutrema penlandii*): T
5. Colorado butterfly plant (*Gaura neomexicana* var. *coloradensis*): T
6. Knowlton cactus* (*Pediocactus knowltonii*): E
7. Penland beardtongue (*Penstemon penlandii*): E
8. North Park phacelia (*Phacelia formosula*): E
9. Dudley Bluffs bladderpod (*Lesquerella congesta*): T
10. Piceance twinpod (*Physaria obcordata*): T
11. Colorado hookless cactus (*Sclerocactus glaucus*): T
12. Mesa Verde cactus (*Sclerocactus mesae-verdae*): T
13. Ute ladies'-tresses orchid (*Spiranthes diluvialis*): T

Candidate Plants

1. DeBeque phacelia (*Phacelia submutica*)
2. Sleeping Ute milkvetch (*Astragalus tortipes*)
3. Pagosa skyrocket (*Ipomopsis polyantha*)
4. Parachute penstemon (*Penstemon debilis*)
5. White River penstemon (*Penstemon scariosus* var. *albifluvis*)

Mancos milkvetch
Endangered
Photography by Al Schneider

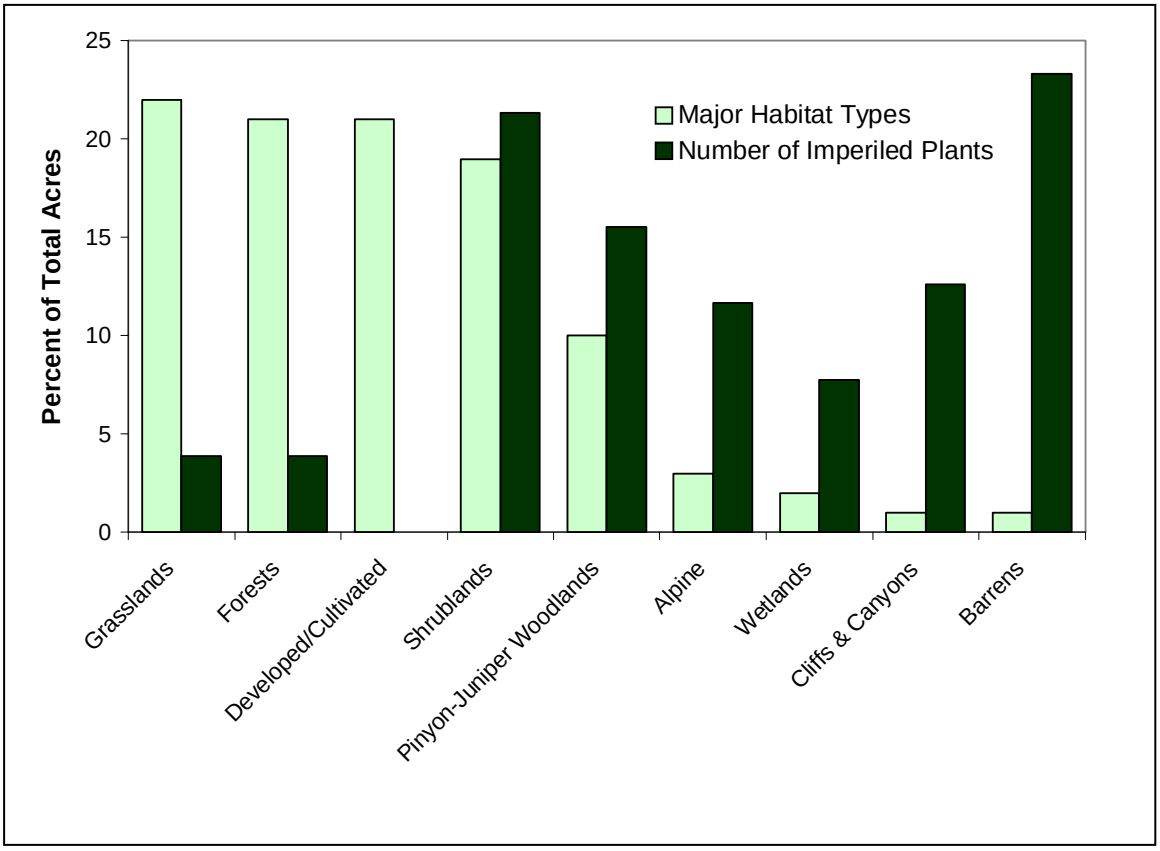
Pagosa skyrocket
Candidate
Photograph by Ellen Mayo

Box 3. Parachute penstemon, a candidate for listing by the U.S. Fish and Wildlife Service, is known only from five locations on upper elevations of shale outcrops of the Parachute Creek Member of the Green River Formation. Photographs by Steve O'Kane and Andrea Wolfe.

Where do Colorado's Rare Plants Occur?

Habitat Types: Colorado's imperiled plants occur within eight major habitat types: alpine, barrens, cliffs and canyons, grasslands, forests, pinyon-juniper woodlands, shrublands, and wetlands (CNHP 2008; CNHP and TNC 2008; Colorado Native Plant Society 1997). Colorado's barrens and shrublands are especially rich habitats for imperiled plant species, followed by pinyon-juniper woodlands, cliffs and canyons, and alpine habitats (CNHP and TNC 2008). Barrens occupy less than 1% of Colorado, but nearly 25 of our rarest plants are primarily associated with barrens (23% of imperiled species). Shrublands are Colorado's second most important habitat for rare plants (supporting 21% of the imperiled species), occupying 19% of the state's acreage. Pinyon-juniper woodlands cover nearly 10% of Colorado, providing habitat for at least 16% of the rare plant species (see Figures 2-3; Box 4).

Figure 2. Major habitat types occupied by Colorado's imperiled plants. Approximate percentage of Colorado's total acres occupied by each habitat type with number of imperiled plants occurring in that habitat. Sources: Southwest ReGAP (Prior-Magee *et al*. 2007) and CNHP and TNC (2008).



Box 4. Major habitat types in Colorado supporting the highest number of imperiled plants.

Pinyon-Juniper Woodland
Photograph by Peggy Lyon

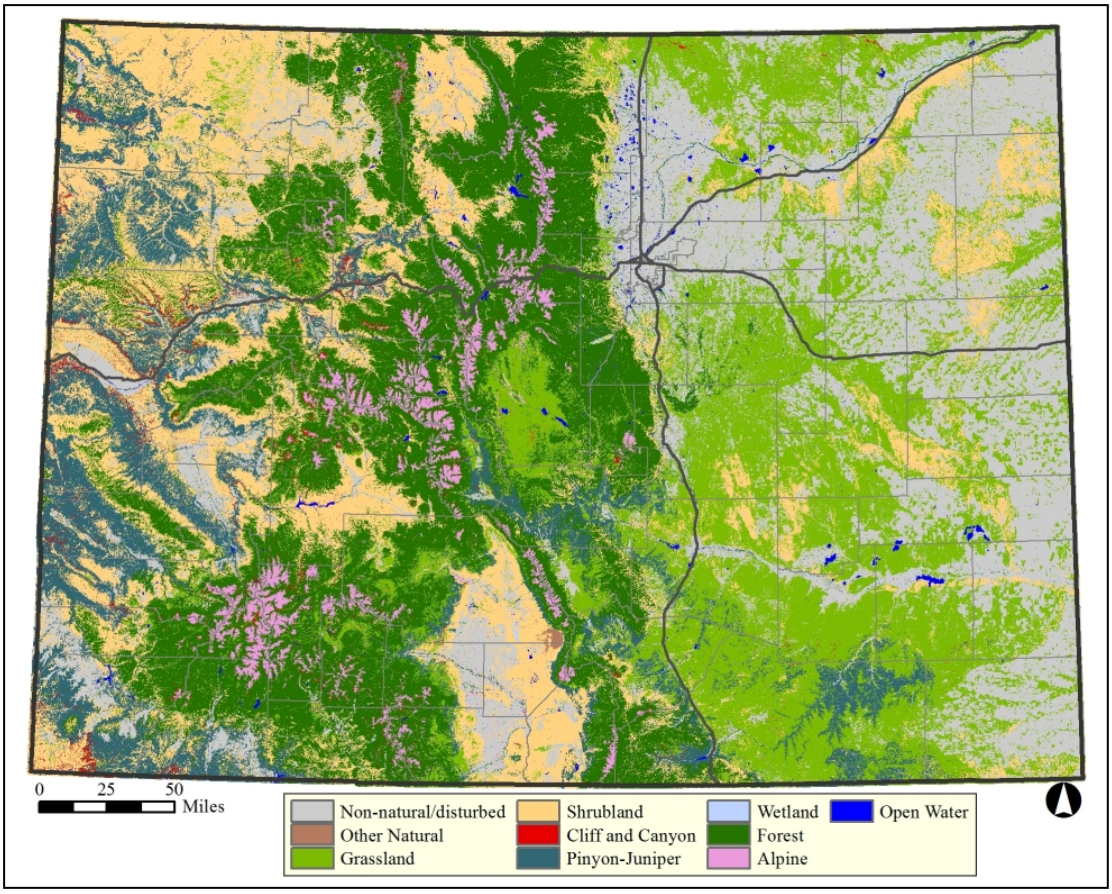
Mancos Shale Formation Barrens
Photograph by Peggy Lyon

Sagebrush Shrublands
Photograph by Renee Rondeau

Cliffs and Canyons
Photograph by J.D. Marston

Green River Formation Shale Barrens
Photograph by Rusty Roberts

Figure 3. Spatial Distribution of Major Habitat Types in Colorado. Source is Southwest ReGAP (Prior-Magee *et al*. 2007). Note: barren and cliff and canyon habitat types cover only <1% of the total land area and are not visible at this scale.



Distribution and Land Ownership: The documented land area occupied by Colorado's imperiled plants is small (approximately 62,500 acres statewide), encompassing a minute percentage (< 0.001%) of Colorado's land area (see Figure 4). Federal lands support nearly two-thirds of the documented acres of Colorado's imperiled plant species (see Figure 5). Bureau of Land Management lands encompass 13% of Colorado's total land area, but approximately 38% of Colorado's imperiled native plant habitat occurs on BLM lands. The U.S. Forest Service manages 22% of the state's land area and supports 23% of the imperiled plant habitat. Privately owned lands, encompassing 56% of Colorado's total land area, are also very important for the conservation of Colorado's imperiled plant habitat, harboring 24% of the acres. The remaining acres are divided among the National Park Service (4%), other federal agencies (4%), the State of Colorado (3%), local governments (1%), non-governmental organizations/land trusts (2%), and tribes (<1%) (CNHP 2008).

Figure 4. Locations of Colorado's most imperiled plants. Source: Colorado Natural Heritage Program. Note: Locations are enlarged for greater visibility.

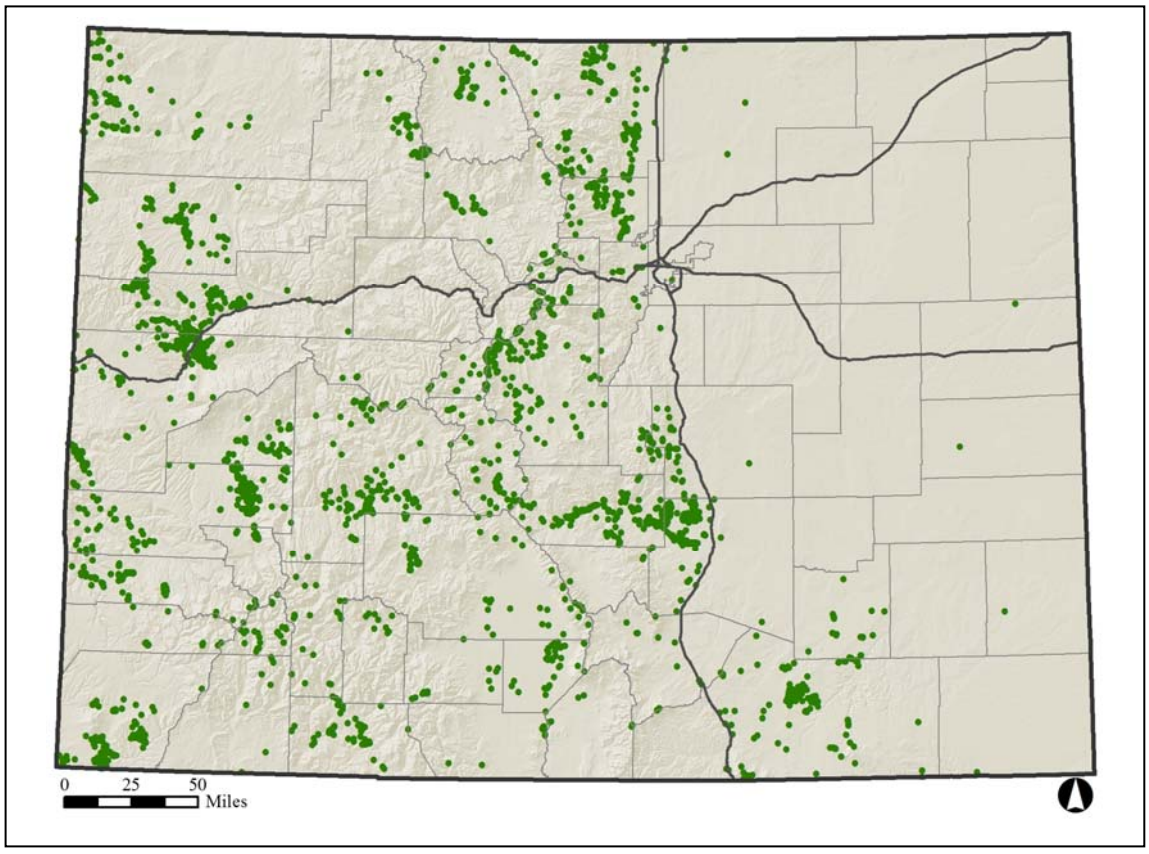
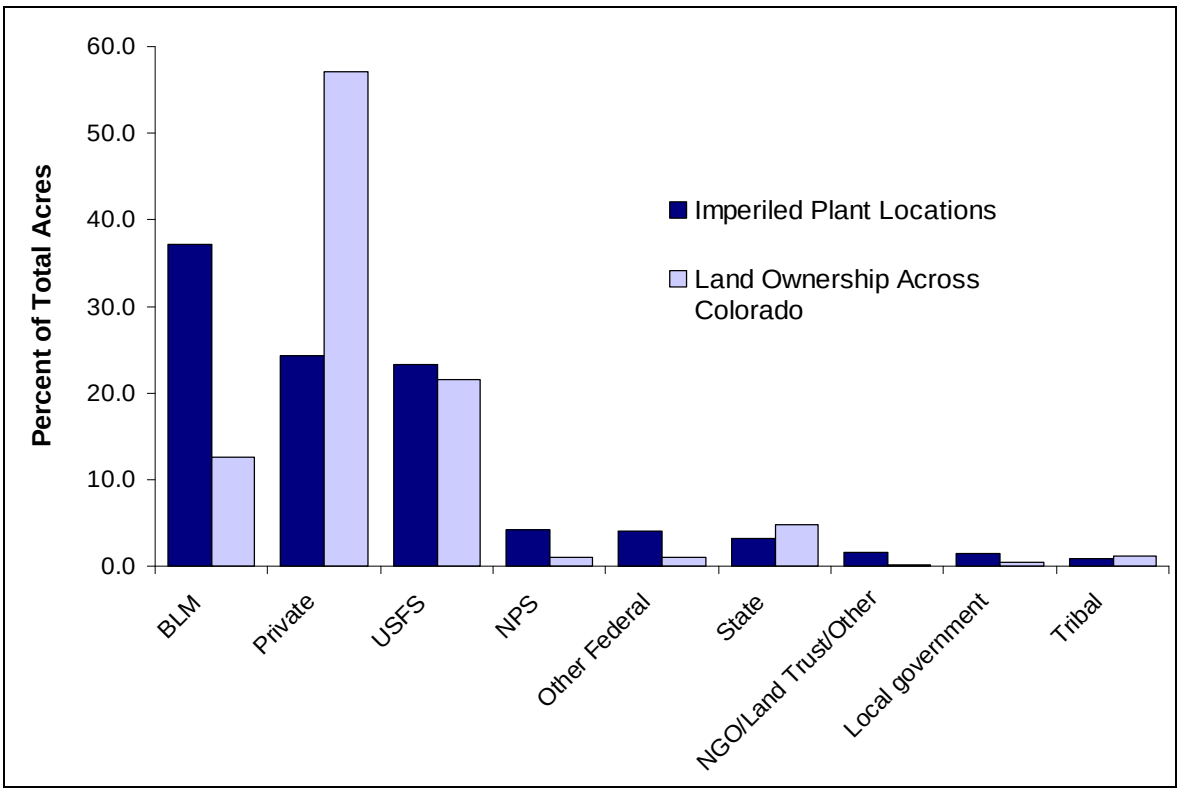


Figure 5. Percentage of acres of known locations of Colorado's imperiled plants by land ownership. Source: Colorado Natural Heritage Program (2008) and CoMap (Theobald *et al* . 2008). BLM= Bureau of Land Management, USFS=U.S. Forest Service, NPS=National Park Service, NGO=non-governmental organizations.



Colorado Plant Scorecard

Plants, animals, and ecological systems can only be considered effectively conserved when their biodiversity status is viable, threats have been abated, and land management/protection is sufficient to ensure the long-term persistence of the element.
Colorado Natural Heritage Program and The Nature Conservancy 2008

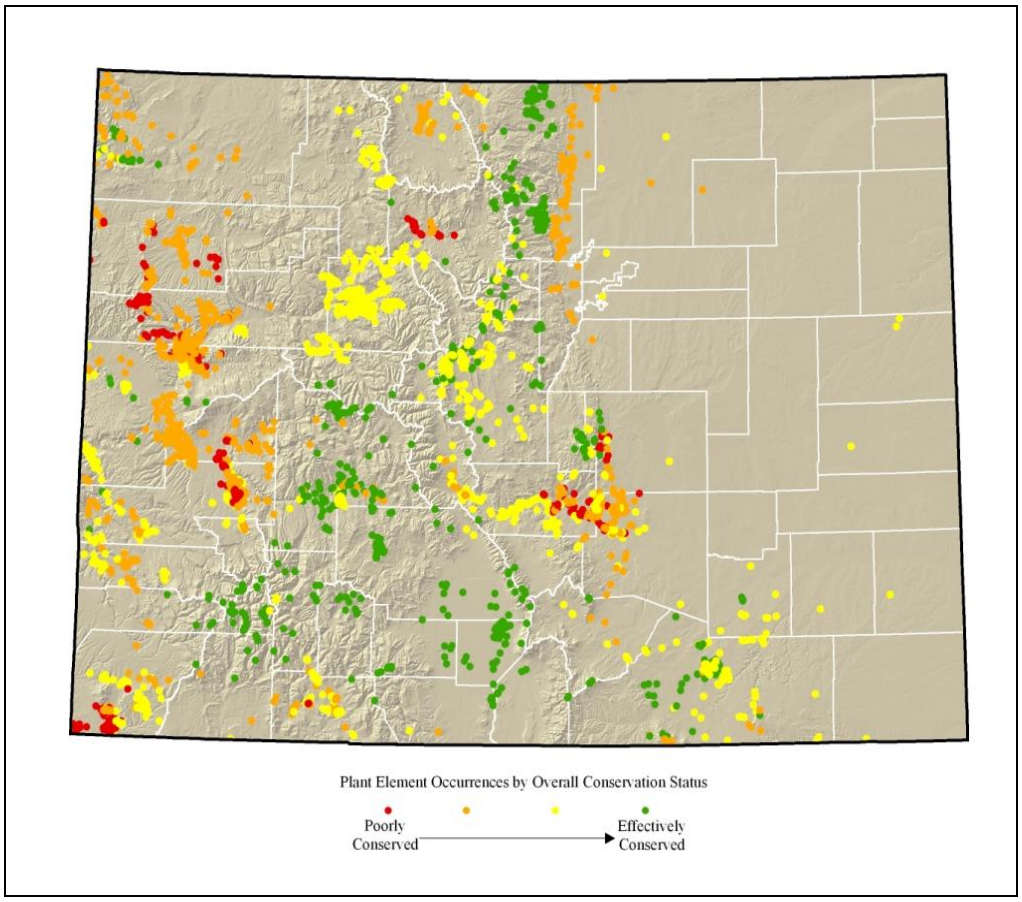
The CNHP, working with The Nature Conservancy (TNC), has developed A Biodiversity Scorecard for Colorado, an analysis of the status of Colorado's species and ecosystems, using a "scorecard" approach (CNHP and TNC 2008). Following the three-part model of effective conservation developed by TNC, the scorecard evaluated the status of a subset of imperiled plants and ecosystems under three broad conservation status categories:

- *Biodiversity status*: including population/occurrence numbers and/or size, quality, and landscape integrity.
- *Threat status*: including both current and potential future impacts.
- *Protection status*: including land management status.

About half of the imperiled plants evaluated received good to very good scores in at least two of the conservation status categories and can be considered reasonably well conserved (see Appendix C for scorecard results). However, nearly half of Colorado's imperiled plant species are poorly or weakly conserved due to significant threats and lack of protection (Figure 6). These species are in need of effective protection and management in order to persist over the long term.

Fortunately, the results of this analysis show that there are still high-quality occurrences of many of these species, providing us the opportunity to improve their scores through prompt conservation action. The foremost strategies that could conserve Colorado's imperiled species are threat abatement and on-the-ground protection for the best occurrences. Colorado's barrens and shrublands are especially rich in rare plants. These habitats are primarily impacted by energy development, residential development, and motorized recreation.

Figure 6. Spatial representation of overall conservation status of Colorado's imperiled plants. Source: *A Biodiversity Scorecard for Colorado* (CNHP and TNC 2008). Note: Locations are enlarged for greater visibility.



How does Colorado Compare with Other States?

Like most states, Colorado has a wildlife statute that provides intent to protect endangered and threatened animal species, gives the Colorado Wildlife Commission authority for compiling a corresponding state list, and provides for the acquisition of habitat for listed species. However, Colorado is one of a minority of states with no state statute recognizing and providing protection for native rare plants, and neither Colorado's Nongame, Endangered, or Threatened Species Conservation Act nor the Colorado Wildlife Action Plan include rare plant protection. The Colorado Natural Areas Program (CNAP) is the only state government program that contains protection of rare plants in its legislative mandate. Colorado's Natural Areas Act provides a means by which lands and waters can be identified, evaluated, and protected. Although designation of Natural Areas calls attention to the significance of the sites, it confers no legal protection. Participation is completely voluntary - the site's status could easily change at any time if the land owner/manager was not interested in maintaining the designation. While CNAP serves a very important conservation purpose, it does not provide the same level of protection to rare plants as most other states' plant protection statutes and programs. Critically, there is currently inadequate funding for inventory, data management, assessment, monitoring, research, education, or plant conservation in Colorado.

State Plant Protection: The majority (32 out of 50, 64%) of U.S. states have enacted endangered/threatened species acts that include or target at-risk plant species; 17 states have specific plant protection statutes, 15 states include plants in their endangered species statutes, and 18 states have no plant statutes (Stein and Gravuer 2008) (see Table 3 and Figure 7). Even though plant species are afforded state-level protection in 32 states, many of these laws specify plant safeguards distinct from, and often weaker than, those afforded to animals (Stein and Gravuer 2008). In addition, 20 states, including Colorado, have natural areas acts but these tend to provide less protection for plants than specific endangered/threatened species statutes.

The key components of the 15 inclusive endangered/threatened species statutes vary by state. For example, 10 statutes include inventory provisions and all 15 include "take" provisions (i.e., prohibition of killing, injuring, or harming), but only seven include state environmental review provisions. Statutory provisions concerning private landowners vary: six states authorize agreements between the state and private land owners, whereas two states specifically say that the statute does not affect private land owners. Similarly, six statutes include provisions authorizing agreements between the state and federal agencies for the management and conservation of plants (Martland 2008).

The listing categories and criteria also vary among the state plant protection statutes. For example, 17 states include an endangered species category in their statutory provisions and 14 also include a threatened category. Other categories include: species of special concern, candidate, proposed, restricted, protected, wild native, endemic, highly safeguarded native, harvest restricted native, salvage restricted native, salvage assessed native, commercially exploited, extirpated, vulnerable, rare,

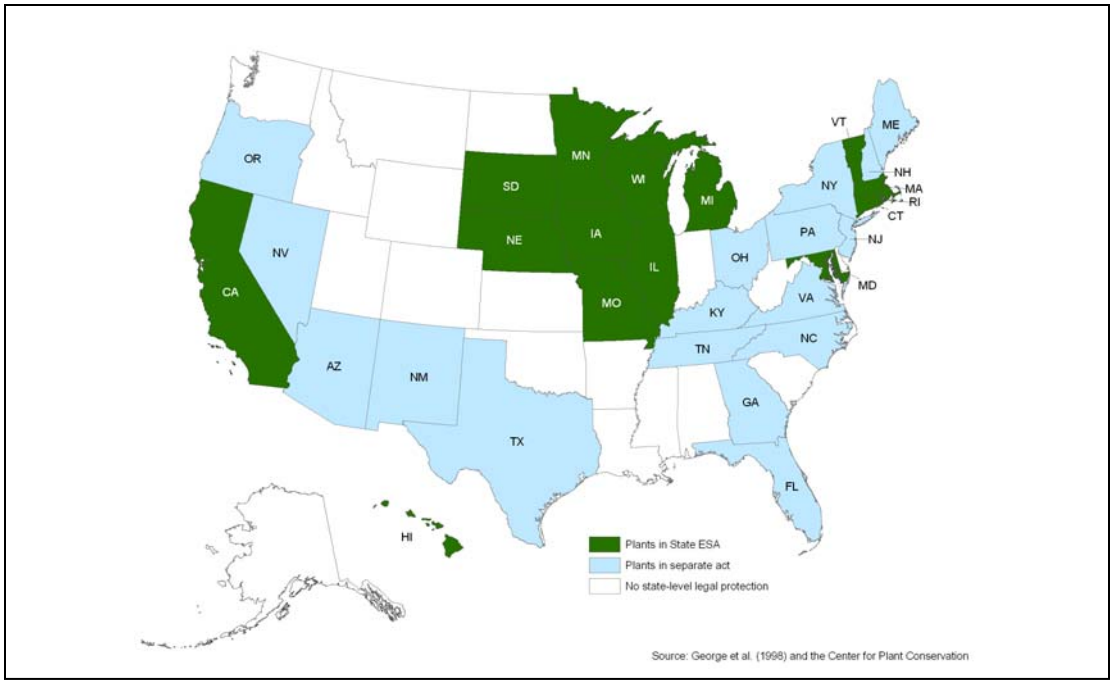
limit of range, and undetermined plants. Most states have supported their plant statutes with rules and regulations (Martland 2008).

Table 1. Summary of State Endangered Species Laws and Key Provisions (Martland 2008).

Category	No. of States	Location of Program in State Government	Provisions	No. of States with Provision
States with Plant Protection Statute (Arizona, Florida, Georgia, Kentucky, Maine, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Tennessee, Texas, Virginia)	17	5 – Agriculture Dept. 11 – Conservation or Natural Resources Dept. 2 – Wildlife Dept.	Inventory	17
			Take (killing, injuring, or harming) on federal lands	16
			Environmental Review	7
			Agreements with federal agencies, private landowners	10
			Endangered species category	17
			Threatened species category	14
States with Endangered Species Act including plants (California, Connecticut, Hawaii, Illinois, Iowa, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, Rhode Island, South Dakota, Vermont, Wisconsin)	15	7 – Conservation or Natural Resources Dept. 4 – Wildlife Dept.	Inventory	10
			Take (killing, injuring, or harming) on federal lands	14
			Environmental Review	7
			Agreements with federal agencies, private landowners	6
			Endangered species category	14
			Threatened species	12

Category	**No. of States**	**Location of Program in State Government**	**Provisions**	**No. of States with Provision**
			category	
States with no Statute (Alabama, Arkansas, Colorado, Delaware, Idaho, Indiana, Kansas, Louisiana, Mississippi, Montana, North Dakota, Oklahoma, South Carolina, Utah, Washington, West Virginia, Wyoming)	18			

Figure 7. States with Endangered Species Acts and Separate Plant Protection Acts (from George *et al*. 1998 and Stein and Gravuer 2008).



Plant Protection Needs in Colorado: A plant protection program supported by state government, with broad involvement of stakeholders at all levels, is needed to ensure the long-term conservation and stewardship needs of Colorado's rare and imperiled plants. Also needed is a legally recognized state plant list with the authority for compiling and maintaining it as information improves. NatureServe/CNHP criteria and methods are widely recognized and suitable for this purpose (Stein *et al*. 2000). Allocation of adequate resources and staffing within a state agency (e.g., Colorado Department of Natural Resources or Colorado Department of Agriculture) are needed to coordinate inventory and monitoring, stewardship, and conservation. Plant program staff is needed to represent the state's interests to federal agencies, facilitate state agency adoption of new practices, and lead outreach to private landowners. Without state recognition of specific species, Colorado's ability to influence the management of rare plants on federal lands, which harbor approximately 70% of known populations, is very limited.

State Wildlife Action Plans: All states and territories recently completed State Wildlife Action Plans as part of a nationwide strategy to prevent wildlife species from becoming endangered. A recent NatureServe study evaluated how each of these plans addressed plants (Stein and Gravuer 2008). While the plans represent a major step forward for coordinated conservation planning, most of the plans, including Colorado's (Colorado Division of Wildlife 2006), did not substantially address the conservation needs of plants. Only eight of the 56 states and territories (14%) took the direct approach of including plants on their lists of species of greatest conservation need, i.e., those species with low or declining populations and/or those indicative

of the diversity and health of the resource. Key recommendations from this NatureServe study are to:

- Promote Wildlife Action Plan strategies that also benefit plants of concern;
- Avoid implementation actions that could be detrimental to sensitive plants;
- Add plant-specific components to existing Wildlife Action Plans;
- Develop state-level plant conservation strategies to complement the Wildlife Action Plans; and
- Ensure that plants are fully represented in major new conservation funding opportunities.

In the first round of Wildlife Action Plans (submitted October 2005), states that effectively integrated plant conservation needs include Oregon, Nebraska, Missouri, and Georgia. Several states are now developing plant action plans parallel to those for wildlife or are integrating plant conservation needs into the next Wildlife Action Plan iteration (these states include Tennessee, Texas, and Idaho).

Threats to Colorado's Rare Plants

Because they are rooted in place, plants can't move out of the way of an oncoming bulldozer, or take shelter until danger passes. And because many rare plants are highly localized, growing only in very specific soils or micro-climates, they are particularly susceptible to being wiped out, often without anyone's knowledge. They are, in effect, hidden in plain sight.
Stein and Gravuer, NatureServe, 2008

Colorado's population is soaring and land uses, such as energy and residential development, are increasing impacts to Colorado's native plants and their habitats. Colorado continues to be one of the fastest growing states in the country. The population is expected to grow from approximately 5 million to over 7.5 million by 2030 and to double to 10 million by 2050. The statewide development footprint increased from 1.3 million acres in 1970 to 2.5 million acres in 2000 and is expected to expand to more than 3.5 million acres by 2030. The state is losing its largest privately owned agricultural and natural lands many times faster than any other state in the nation (Colorado Conservation Trust 2007). Colorado's irreplaceable native plants, plant communities, and ecosystems are thus increasingly being threatened.

Most of Colorado's imperiled plants are naturally rare. They are rare because they are restricted to very specific, narrowly distributed habitats, rather than as a result of human actions, per se. However, because these species occupy such small areas, planning is necessary to avoid placing these species at further risk from human activities. Degradation, fragmentation, and loss of habitat are major reasons plant species and their habitats are imperiled or vulnerable in Colorado. The primary contributors to habitat degradation for imperiled plants are resource extraction (e.g., energy development, mining), motorized recreation, residential development, and road construction and maintenance (CNHP and TNC 2008). Other risk factors include altered hydrologic regime, invasive species, agricultural development, loss of pollinators, incompatible grazing/trampling, and plant collecting (CNHP and TNC 2008). Additionally, there is strong scientific consensus that human-induced climate change is affecting species and ecological systems, and this is likely to exacerbate the effects of other human activities on plants (Enquist and Gori 2008).

One of the biggest issues is a lack of awareness and information regarding the presence, distribution, and precarious status of Colorado's native and imperiled plant species. Many rare plants inhabit small areas, have specialized needs, and have unique habitat requirements that are often missed by other approaches to conservation, e.g., those focused primarily on wildlife.

Human activities that can impact Colorado's imperiled plants and their habitats are described below.

Energy Development: The region's recent energy boom has rapidly transformed areas of Colorado, both economically and environmentally. Applications for oil and gas drilling permits increased by almost 500% from 1999 (1,010) to 2006 (5,904). Over 6,000 drilling permit applications were approved in 2007 — more than two-and-a-half times the 2,378 permits approved during Colorado's last energy development boom in 1981. More than 30,000 oil and gas wells are currently operating statewide and production has grown by almost 60% since 2000 (Colorado Conservation Trust 2007).

The habitat that supports several rare plants is underlain by rich deposits of oil and natural gas. Oil and gas development activities and associated infrastructure can cause population fragmentation, habitat destruction and degradation, introduction of non-native plants, and alteration of surface hydrology. Oil and gas development often creates a high density of roads; these roads can provide easy access to new areas for off-road vehicle use (Center for Native Ecosystems *et al*. 2005).

The habitat for rare plant species restricted to the Green River Formation in the Piceance Basin contains high grade oil shale deposits. The Parachute Creek Member of the Green River Formation is reported to have the best deposits of oil shale known in the world and is considered to be a major potential source of oil in the United States. However, millions of tons of shale must be mined each year to make the process economically feasible. The impacts of oil shale mining and processing can increase erosion due to vegetation removal, increase air pollution, fragment and/or eliminate some plant populations, and degrade remaining habitat, e.g., by spread of introduced invasive plant species (Center for Native Ecosystems *et al*. 2005).

Motorized Recreational Activities: Motorized recreation (including off highway, off road, all terrain, and four-wheel drive vehicles, motorcycles, and snowmobiles) is rapidly increasing in many areas where Colorado's rare plants grow and it is often difficult to enforce regulations or close access to protect plant habitat. Motorized recreation can reduce natural habitat for plants, impacting individual plants and populations. Roads and trails created by off-road vehicles impact plants by altering habitat, killing plants, increasing erosion, and creating dispersal corridors for invasive plant species.

Residential Development: Twenty-four percent of the habitat occupied by imperiled plants in Colorado is found on private land. Accelerating residential and urban development, along with associated infrastructure such as roads and utilities, is consuming and fragmenting important habitat for native plants and plant communities. Exurban development (low-density rural development), the fastest growing land use in the United States, has been found to reduce many native species near homes and increase exotic species, with effects manifested over decades (Hansen *et al.* 2005). In addition to local effects, exurban development may alter ecological processes and biodiversity on adjacent and distant public lands. Underlying mechanisms involve alteration of habitat, ecological processes, biotic interactions, and increased human disturbance (Hansen *et al.* 2005).

Road Construction and Maintenance: Roads can have a serious impact upon the natural integrity and habitat effectiveness of rare plant sites. Along with extirpating populations and destroying habitat, roads contribute to fragmentation that may interfere with natural processes such as pollination and seed dispersal. Roads can act as barriers to insect pollinators for some plants. Other impacts from road construction and maintenance (e.g., mowing and herbicide application) include erosion and sedimentation, as well as introduction of invasive species.

Climate Change: Climate change, one of the greatest threats to the conservation of species and ecosystems, is already having serious impacts across the globe. In the 20th century, global temperatures increased by 0.7 °C (1.3 °F) and Northern Hemisphere snow cover declined by 7% (Intergovernmental Panel on Climate Change 2007). The western United States has experienced an increase in average temperature during the last five years that is 70% greater than the world as a whole (Saunders *et al*. 2008).

The change in climate is driving plants out of their current geographic ranges and will likely result in regional extirpation and even extinction for some plant species (Schneider *et al*. 2007). Warmer temperatures and changing rainfall have shifted vegetation in several ecosystems up mountain slopes and towards polar regions. Alteration of seasons has changed the timing of life-cycle events of plants and animals, potentially resulting in an asynchrony between plants, environmental cues, and interacting organisms such as pollinators (Joyce 2008).

The United Nations Intergovernmental Panel on Climate Change (IPCC 2007) predicts that all of North America is likely to warm by 2 °C (3.6 °F) during this century. There will likely be more droughts and other extreme weather events. Colorado will likely become hotter and drier with shorter snow seasons, earlier snow melt, and longer fire seasons. These potential impacts will interact with the other stresses to rare plants, e.g., loss or fragmentation of habitat from development, mining, and introduction of invasive species. The full impacts of climate change on imperiled species are likely to significantly reduce habitat, which is particularly problematic for rare plants that demand very specific growing conditions (Loarie *et al*. 2008).

Other Factors: Furthermore, many rare plants are restricted to unusual substrates and comprise very small populations, thereby rendering them subject to random catastrophic events such as landslides or infestation. Other factors that impact Colorado's rare plants include: 1) widespread lack of awareness regarding their existence and precarious status; 2) inadequate funding for conservation and research; 3) inadequate legal protection for plants; and 4) over-collection for horticultural purposes (e.g., penstemons, cacti, orchids) or medicinal uses (e.g., arnica).

Colorado Rare Plant Conservation Goal and Objectives

Without focused conservation attention to the growing plight of the nation's plant species, we are at risk of losing significant portions of our wild heritage, and the ecological resilience that comes with that diversity.
Stein and Gravuer, NatureServe, 2008

The following section outlines the objectives and conservation actions needed to achieve the long-term goal of conserving Colorado's most imperiled plant species. This Strategy is intended to set a statewide strategic conservation direction for Colorado's most imperiled plant species and their habitats. It represents a collective vision for plant conservation in Colorado over the next decade, with specific actions recommended for the next five years. This Strategy emphasizes a coordinated and proactive approach to carry out the actions needed to address increasing impacts to our imperiled plants and provide for their long-term stewardship and survival. Proactive conservation actions will help to avoid the need for increased federal listings for Colorado's imperiled plants.

Conservation Goal

The goal of the Colorado Rare Plant Conservation Initiative (RPCI) is to conserve Colorado's most imperiled native plants and their habitats through collaborative partnerships for the preservation of our natural heritage and the benefit of future generations.

Conservation Objectives and Recommended Actions

The RPCI partnership has identified a set of conservation objectives and recommended actions to pursue that are necessary to meet the conservation needs of Colorado's imperiled plant species (G1-G2). The following six objectives represent the most urgent and critical actions needed to effectively conserve Colorado's imperiled plant species. These objectives will guide conservation activities and catalyze collaborative conservation action over the next decade. Although these objectives are focused on Colorado's imperiled species, the RPCI also recognizes the importance of conservation efforts for other rare and vulnerable species wherever possible, and plans to expand efforts to conserve vulnerable (G3) and non-vascular (lichens, mosses, and liverworts ranked G1-G3) plant species in the future. The six conservation objectives are:

1. Secure on-the-ground, *site-specific* habitat protection and/or management to achieve specific goals for all of Colorado's imperiled plants on public and private lands.

2. Minimize the impacts of specific land uses that threaten many of Colorado's imperiled plants statewide.

3. Improve scientific understanding of the distribution, natural history, and status of Colorado's most imperiled plants through inventory, research, and monitoring.

4. Develop and implement a state program and policies to enhance the conservation of Colorado's most imperiled plants in cooperation with public land managers, private landowners, and other interested stakeholders.

5. Facilitate the stewardship of Colorado's most imperiled plants through education, outreach, and coordination.

6. Adopt measures for the *ex situ* (off site) conservation of Colorado's most imperiled plants in case native populations are extirpated.

See below for the six conservation objectives, along with recommended conservation actions.

Conservation Objective 1. Secure on-the-ground, site specific habitat protection and/or management to achieve specific goals for all of Colorado's imperiled plants on public and private lands.

a. Identify species-specific priorities to focus habitat protection efforts.
   - Maintain a list and updated ranks of globally imperiled plants known in Colorado (Appendix A), including all Colorado G1 and G2 plants based on NatureServe/CNHP methods (Box 1). Presently, there are 119 G1 and G2 plant species known in Colorado.
   - Continually incorporate new information on G1 and G2 plants gathered by researchers statewide or elsewhere.
   - Work with the CNHP to build the central repository of information and assure consistent and thorough rankings.
   - Incorporate findings of the *Biodiversity Scorecard for Colorado* (Appendix C) (CNHP and TNC 2008).
   - Review the species list bi-annually with the RPCI partners, Rare Plant Technical Committee (RPTC), and other experts.

b. Develop a list and maps of Important Plant Areas (IPAs) for Colorado following CNHP methods (Appendix D for methods and Appendices E and F for a list and descriptions of IPAs).
   - Develop Important Plant Areas based on the highest quality occurrences of imperiled species. These are the highest priority areas for plants based on CNHP methods for Areas of Outstanding Biodiversity Significance (ranked B1) that support the best known occurrences of G1 species and Areas of Very High Biodiversity

Significance (ranked B2) that support other occurrences of G1 species and the best known occurrences of G2 species (see Box 5).

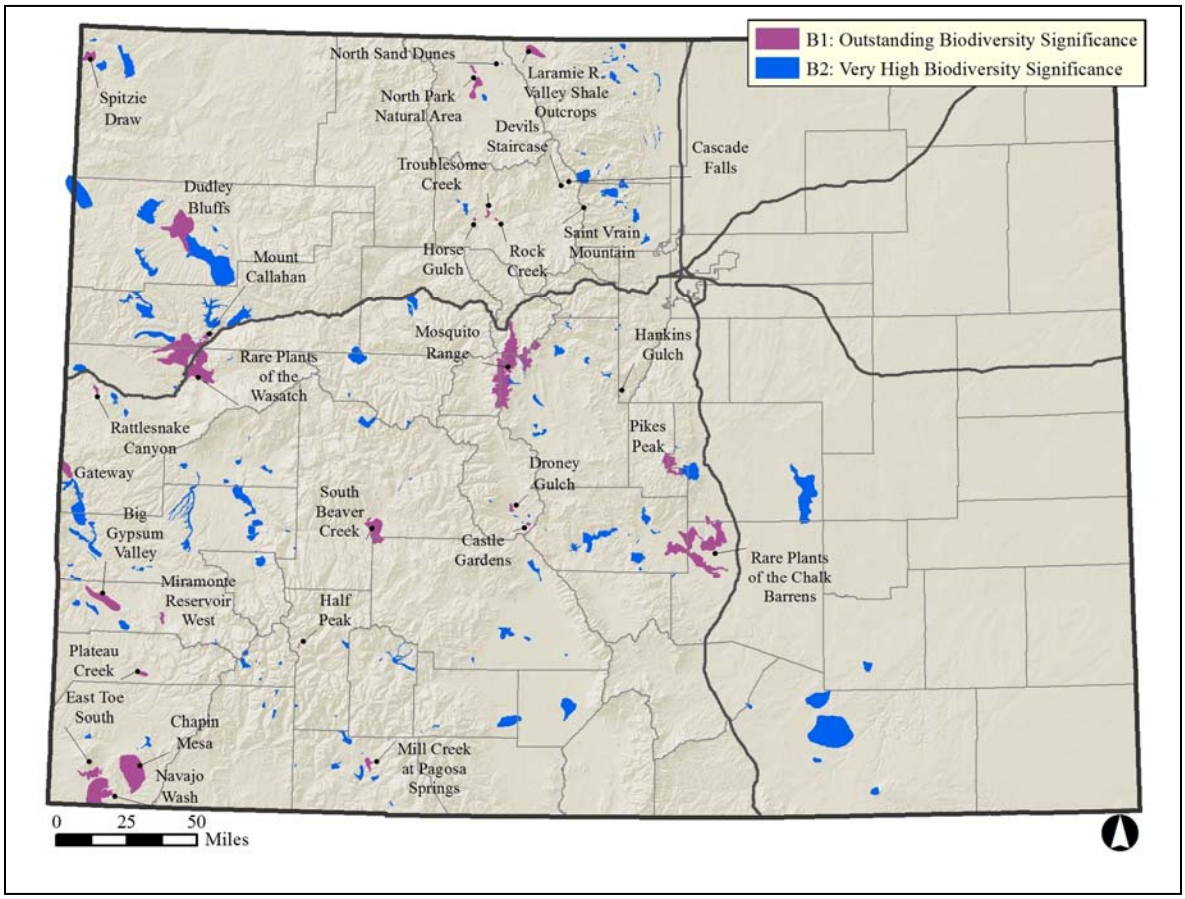
- Delineate Important Plant Areas for imperiled plants based on Potential Conservation Areas (PCAs) which estimate the primary area necessary to support the long-term survival of plant species of concern, while considering other significant co-occurring natural resources at specific locations.
- Review the Important Plant Areas annually with the RPCI partners and other experts.

Box 5. Important Plant Areas in Colorado.

RPCI recognizes over 200 Important Plant Areas (IPAs) based on CNHP Potential Conservation Areas for the most imperiled plants (see Appendix D for methods). These IPAs represent our best estimate of the areas needed to support the continued existence of Colorado's most imperiled plant species. Although IPAs do not carry any regulatory authority, they can provide guidance on opportunities for conservation, and highlight places where public land managers and willing private landowners can help conserve plant species and habitats. These IPAs are ranked by CNHP on a global scale as having either Outstanding Biodiversity Significance (B1 – 32 IPAs) or Very High Significance (B2 – 193 IPAs) (see Figure 8 and Appendices E-F for a list and descriptions of Importance Plant Areas in Colorado).

Gateway: Important Plant Area of
Outstanding Biodiversity Significance
Photograph by Peggy Lyon

Figure 8. Important Plant Areas in Colorado. These areas include all Colorado Natural Heritage Program Potential Conservation Areas developed for high quality or best known occurrences of G1 and G2 plants by the Colorado Natural Heritage Program (ranked B1 & B2). Only the B1 Important Plant Areas are labeled.



c. Identify a subset of the IPAs as Priority Action Areas (PAAs) for approximately a two-year time frame. PAAs for 2008–2010 are shown in Figure 9; see Box 6 for descriptions. Criteria for selecting areas include:
    - Level of imperilment of the rare species.
    - Quality of the plant occurrences.
    - Urgency of the management and protection actions.
    - Other opportunities such as funding and land ownership patterns.

d. Identify potential conservation opportunities within each Priority Action Area.
    - Using county-level data, identify intact landscapes with significant overlap with high-quality or best known rare plant occurrences.
    - Assess the natural quality of the landscape using Terraserver, Digital Orthophoto Quads, Google Earth, and/or similar tools.
    - Conduct field visits to verify current conditions (after obtaining permission from land managers and landowners).
    - Integrate information about other co-occurring species of concern and plant communities..
    - If specific lands are not identified for potential protection of a species, additional inventory work will be needed to identify additional locations and conservation objectives.

e. Develop and implement Conservation Action Plans for each Priority Action Area with working groups consisting of local land trusts, experts, and community representatives (see Box 7 for case study from Middle Park). Develop specific goals, identify threats, and develop strategies for ensuring the long-term viability of all imperiled plants (and other species of concern) within the areas. See Appendix G for methods to develop Conservation Action Plans.

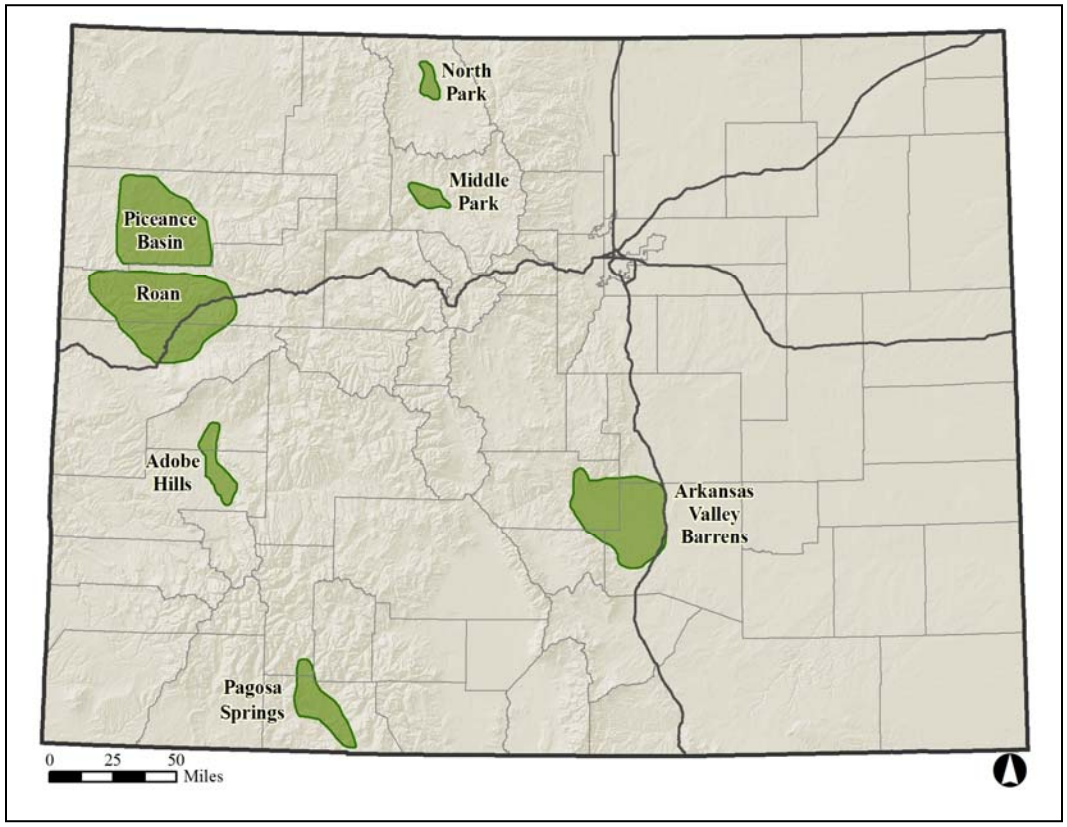
f. Work with land management agencies to secure permanent on-the-ground protection for rare plants and their habitats on public lands (see Box 8).

g. Work with willing private landowners, tribes, and local land trusts to secure permanent on-the-ground protection for rare plants and their habitats on private lands (see Box 9).

h. Integrate imperiled plants into other statewide biodiversity conservation efforts such as the Colorado State Wildlife Action Plan, Colorado Conservation Partnership, State Forest Assessment, and Colorado Conservation Summit.

i. Work with federal agencies to help private landowners receive compensation for their land protection actions through the U.S. Fish and Wildlife Service recovery crediting system (Tollefson 2008) and/or other mechanisms.

Figure 9. Priority Action Areas (PAA) for Colorado's most imperiled plants for 2008-2010. Source: Colorado Natural Heritage Program. Note: boundaries indicate broad planning areas <u>only</u> - plant occurrences are scattered within the PAA.



Box 6. Priority Action Areas for Colorado's most imperiled plants for 2008-2010.

Priority Action Areas (PAAs) are areas needing immediate conservation action to prevent the need for listing, further losses, or extinction of imperiled plants. Selection is based on level of imperilment of rare plants, quality of the occurrences, urgency of the management and protection actions, and other opportunities, such as land ownership patterns. These areas are identified by CNHP with input by the RPCI and the RPTC. The RPCI has sponsored planning workshops in five areas to guide conservation action. One of the key protection strategies is to work with local land trusts to obtain conservation easements on private parcels.

- **Arkansas Valley Barrens:** Includes nearly all of the known occurrences for the globally imperiled: round-leaf four-o'clock (*Oxybaphus rotundifolius*), golden blazing star (*Nuttallia chrysantha*), Pueblo goldenweed (*Oonopsis puebloensis*), Rocky Mountain bladderpod (*Lesquerella calcicola*), Fendler's townsend-daisy (*Townsendia fendleri*), and significant occurrences of the Arkansas Valley evening primrose (*Oenothera harringtonii*) and Brandegee's wild buckwheat (*Eriogonum brandegei*).

- **Middle Park:** Includes all known occurrences of two critically imperiled and federally Endangered Penland penstemon (*Penstemon penlandii*) and Kremmling milkvetch (*Astragalus osterhoutii*).

- **North Park:** Contains all confirmed, current, viable occurrences of the critically imperiled and federally Endangered North Park phacelia (*Phacelia formosula)*.

- **Pagosa Springs**: Includes all known occurrences for the critically imperiled Pagosa skyrocket (*Ipomopsis polyantha*) and the globally imperiled frosty bladderpod (*Lesquerella pruinosa*), and significant occurrences of Gray's Townsend daisy (*Townsendia glabella*).

- **Piceance Basin:** Includes all known occurrences of critically imperiled and federally Threatened Piceance twinpod (*Physaria obcordata*) and Dudley Bluffs bladderpod (*Lesquerella congesta*). The site also contains many other rare plant species, such as sun-loving meadowrue (*Thalictrum heliophilum),* Piceance bladderpod (*Lesquerella parviflora),* Bessey locoweed (*Oxytropis besseyi* var. *obnapiformis*), and Fremont's beardtongue (*Penstemon fremontii* var. *glabrescens*).

- **Roan Cliffs:** Includes all known viable occurrences of the critically imperiled Parachute penstemon (*Penstemon debilis*), DeBeque phacelia (*Phacelia submutica*), and DeBeque milkvetch (*Astragalus debequaeus*). Some of the other globally significant species include the Roan Cliffs blazing star (*Mentzelia rhizomata*), sun-loving meadowrue (*Thalictrum heliophilum*), and the federally Threatened Colorado hookless cactus (*Sclerocactus glaucus*).

- **Adobe Hills**: Includes all known occurrences of clay-loving wild buckwheat (*Eriogonum pelinophilum*), a globally imperiled plant that is also a federally Endangered species.

Box 7. Case Study: Middle Park Rare Plant Conservation Planning Workshop (Kram *et al.* 2008).

Results of a June 2008 workshop sponsored by the RPCI identify conservation strategies for the critically imperiled and federally listed Penland penstemon (*Penstemon penlandii*) and Kremmling milkvetch (*Astragalus osterhoutii*), based on an assessment of the plants' viability and threats.

The Middle Park Priority Action Area, located in Grand County, Colorado, includes all known occurrences of Penland penstemon (known from only two locations in the world) and Kremmling milkvetch (known from only five locations in the world). Although the known occurrences appear to be in good to excellent condition, the habitat of these two imperiled species is threatened by motorized recreation, future residential development, mining, herbivory, and road construction and maintenance.

To abate these and other threats, workshop participants identified a variety of strategies. Some of the highest priority strategies include:

- Inform County master planning efforts.
- Present plant information to Grand County and Town of Kremmling.
- Inform road maintenance planning, e.g., establish placards for no-spray zones.
- Conduct targeted outreach to private landowners to inform them about the rare plants, what they can do to protect them (e.g., conservation easements, surface use agreements for oil and gas development), and pursue conservation easements with willing landowners.
- Investigate possibility of State Land Board or BLM land exchanges.
- Continue to maintain fences.
- Identify and implement best management practices with CDOT.
- Establish an Area of Critical Environmental Concern with restrictions on oil and gas development, mining, water disposal, etc. through the BLM Resource Management Plan (RMP) process.

Penland penstemon
by Scott Dressel-Martin

Kremmling milkvetch
Photograph by Betsy Neely

Box 8. Recommended conservation actions for working with land management agencies (e.g., State of Colorado, BLM, USFS, local public lands) to secure on-the-ground habitat protection for imperiled plants.

- Provide best available data and expertise on imperiled plants.
- Conduct field surveys in proposed project areas to document existing occurrences, search for new occurrences, and avoid conflicts.
- Develop conservation action plans to guide plant conservation efforts.
- Create or expand special designations (e.g., Areas of Critical Environmental Concern, Special Botanical Areas, Research Natural Areas, National Natural Landmarks, Colorado Natural Areas, etc.).
- Develop best management practices (BMPs) for imperiled plants and work with land managers to implement them.
- Incorporate information regarding protection and management of imperiled plants into Resource Management Plans (RMPs) and other environmental assessments.
- Ensure consideration of imperiled plants in environmental review and assessments.
- Develop and share educational materials about imperiled plants.
- Develop win-win solutions where conflicts arise.
- Work with county planners and identify areas in path of development.

2008 North Park Conservation Action Planning Workshop
Walden, Colorado
Photograph by Betsy Neely

Box 9. Recommended conservation actions for working with private landowners to secure on-the-ground habitat protection for imperiled plants.

- Provide best available data and expertise on imperiled plants.
- Conduct inventories in proposed project areas to better document existing occurrences, search for new occurrences, and avoid conflicts.
- Develop conservation action plans to guide plant conservation efforts.
- Seek on-the-ground protection for imperiled species and their habitats using conservation easements and other protection tools.
- Develop management agreements and other cooperative, voluntary, and incentive-based actions (e.g., technical assistance, cost-share programs to provide funding for management plans, weed management, best management practices, fencing projects).
- Purchase/transfer of development rights.
- Encourage the use of existing funding sources, e.g., Farm Bill programs for private landowners to conserve plants and maintain intact farms/ranches
- Identify new funding sources to support protection of imperiled species on private lands.
- Develop new incentives for private landowners to participate in plant conservation activities.

The Nature Conservancy, with funding from the Department of Defense, secured a conservation easement on ranch lands near Fort Carson to protect habitat for several imperiled plants endemic to the Arkansas River Valley (Photograph of Pueblo goldenweed by Steve Kettler).

Conservation Objective 2. Minimize the impacts of land uses that threaten many of Colorado's imperiled plants statewide.

A proactive coordinated approach is needed to abate negative impacts, prevent further declines, and avoid the need for federal listings. Most impacts to imperiled plants can be avoided or minimized by working collaboratively with affected stakeholders and landowners to share information, provide technical assistance, and conduct early environmental reviews (see Box 10).

The following recommended actions are listed in order of their overall threat status based on scope, severity, and immediacy of the primary threats to imperiled plant species in the *Biodiversity Scorecard of Colorado* (CNHP and TNC 2008). They reflect information gathered from status reports, species assessments, the Annual Colorado Rare Plant Symposia results, and the CNHP plant database. The land uses with the greatest potential impact to imperiled plant species in Colorado are energy development, motorized recreational activities, residential development, and roads, with climate change posing perhaps the most serious long-term impact. Other activities include altered hydrologic regime, mining, agricultural practices, non-motorized recreation, and invasive plants. All of these activities/land uses can have significant impacts to rare plant populations, particularly those species that are narrowly distributed with relatively few individuals.

Box 10. Environmental Review: Evaluating Projects to Minimize Potential Impacts.

The Biodiversity Tracking and Conservation System (BIOTICS, CNHP 2008) is used to evaluate projects for potential impacts to rare plant resources. By working early in the planning phase of a land management or development project, Colorado Natural Heritage Program (CNHP) biologists and conservation planners can help landowners and land managers avoid or minimize impacts while considering alternatives that allow projects to be implemented.

Information from CNHP's statewide data system is available to the public, and can be used for conservation planning and to help facilitate the design and implementation of ecologically sound development projects. CNHP has worked with landowners, local planning departments, government agencies, consulting firms, and conservation organizations. New pipelines, roads, mines, and general conservation planning are examples of projects where CNHP information has been of use.

See www.cnhp.colostate.edu/botany.html

a. **Energy development.** At least 17 imperiled plant species, occurring primarily in barrens, shrublands, and pinyon-juniper woodlands, are threatened by oil and gas development; five species are also known to occur within oil shale development areas (Elliott *et al*. 2008). These species include:

1. DeBeque milkvetch (*Astragalus debequaeus*)
2. Mancos milkvetch (*Astragalus humillimus*)
3. Kremmling milkvetch (*Astragalus osterhoutii*)
4. Gypsum cat's-eye (*Cryptantha gypsophila*)
5. Comb Wash buckwheat (*Eriogonum clavellatum*)
6. Clay-loving wild buckwheat (*Eriogonum pelinophilum*)
7. Dudley Bluffs bladderpod (*Lesquerella congesta*)
8. Piceance bladderpod (*Lesquerella parviflora*)
9. Roan Cliffs blazing star (*Mentzelia rhizomata*)
10. Bessey locoweed (*Oxytropis besseyi* var. *obnabiformis*)
11. Parachute penstemon (*Penstemon debilis*)
12. Fremont penstemon (*Penstemon fremontii* var. *glabrescens*)
13. Graham penstemon (*Penstemon grahamii*)
14. White River penstemon (*Penstemon scariosus* var. *albifluvis*)
15. DeBeque phacelia (*Phacelia submutica*)
16. Piceance twinpod (*Physaria obcordata*)
17. Sun-loving meadowrue (*Thalictrum heliophilum*)

Recommended conservation actions include:

- Conduct field surveys for imperiled plants on private and public lands in energy development areas to help avoid conflicts (after obtaining permission from land managers and landowners).

- Provide best available data and expertise to federal and state agencies, counties, and energy companies to guide decisions regarding applications for drill permits, better site activity, and help avoid surface disturbance to imperiled plant occurrences.

- Develop best management practices (BMPs) to minimize impacts to imperiled plants occurring within oil and gas development areas and work with energy companies and land management agencies to implement them (see Boxes 11-12, and Elliott *et al*. 2008).

- Consider rare plants in environmental reviews with federal and state agencies, counties, and energy companies.

- Incorporate information regarding the protection and management of imperiled plants into Resource Management Plans (RMPs) and

other environmental assessments (e.g., support designation and expansions of Areas of Critical Environmental Concern).

- Monitor imperiled plant occurrences that are potentially threatened by oil and gas development.

- Conduct research to fill key data gaps, inform BMPs, and reduce conflicts between energy development and imperiled plants, e.g., pollination studies to inform buffer distances, recovery potential of imperiled plants, rare plant modeling, or secondary impacts such as dust and evaporation pond over-spray.

- Recognize and reward private landowners, companies, and others for good stewardship with annual Plant Conservation Awards, working with the Colorado Native Plant Society.

- Work collaboratively with energy companies and agencies to avoid and/or minimize negative impacts to imperiled plants through field surveys, comprehensive planning, good siting, best management practices, and no surface occupancy or controlled surface occupancy stipulations.

- Ensure that plants are incorporated into the Colorado Oil and Gas Conservation Commission rules for wildlife, reclamation, and restoration.

- Mitigate the loss or degradation of imperiled plant occurrences due to oil and gas development activities.

- Develop and share educational materials about imperiled plants with energy companies and land managers.

Graham penstemon
Photograph by Leila Shultz

Box 11. Best Management Practices for Plants of Concern: Practices to Reduce the Impacts of Oil and Gas Development Activities (from Elliot *et al.* 2008).

At least 17 globally imperiled plants occur within oil and gas development areas in Colorado, and are in danger of extinction. Collectively, these species occupy approximately 30,000 acres. Avoiding or minimizing impacts to these species during oil and gas development activities will likely reduce the need for listing under the U.S. Endangered Species Act. The RPCI developed Best Management Practices (BMPs), recommendations based on the best available science, to reduce impacts to imperiled plants on federal, state, and/or private lands. BMPs are intended to evolve as additional information becomes available regarding Colorado's imperiled plants, and as resource extraction and conservation technologies develop.

The BMPs are recommendations for voluntary use during the project planning, pre-ground disturbance field work, project implementation, revegetation, and post-project monitoring phases. Examples of specific recommendations include: gather mapped location information from CNHP for plants of concern, conduct field surveys to map plants prior to disturbance, and have an avoidance buffer of 656 feet (200 meters).

DeBeque phacelia
Photograph by Bill Jennings

Oil and Gas Development
Photograph by Josh Pollock

Box 12. Putting Best Management Practices to Work: OXY USA and Colorado Natural Areas Program (CNAP).

Occidental Petroleum Company (OXY USA) owns the land that encompasses the majority of the populations of Parachute penstemon (*Penstemon debilis*), an imperiled species on the Roan Plateau and a federal candidate for listing under the U.S. Endangered Species Act. OXY has played an essential role in the protection of this rare species by voluntarily working with CNAP to implement best management practices that will assure the survival of this plant within an oil and gas development area. By implementing appropriate buffers, dust abatement measures, weed management, and storm water controls, the threats to the plants have been greatly reduced. OXY has demonstrated how limited oil and gas development can be balanced with rare plant conservation.

Parachute penstemon, Roan Plateau
Photograph by Andrea Wolfe

b. **Motorized recreational activities.** At least 14 imperiled plant species, occurring largely in barrens and shrublands, are threatened by motorized recreational activities. Species currently impacted include:

1. Kremmling milkvetch (*Astragalus osterhoutii*)
2. Sleeping Ute milkvetch (*Astragalus tortipes*)
3. Skiff milkvetch (*Astragalus microcymbus*)
4. Eastwood's evening primrose (*Camissonia eastwoodiae*)
5. Boat-shaped bugseed (*Corispermum navicula*)
6. Brandegee buckwheat (*Eriogonum brandegei*)
7. Globe gilia (*Ipomopsis globularis*)
8. Colorado desert parlsey (*Lomatium concinnum*)
9. Degener beardtongue (*Penstemon degeneri*)
10. Gibben's penstemon (*Penstemon gibbensii*)
11. Penland penstemon (*Penstemon penlandii*)
12. North Park phacelia (*Phacelia formosula*)
13. Cushion bladderpod (*Physaria pulvinata*)
14. Weber saussurea (*Saussurea weberi*)

Recommended conservation actions include:

- Conduct field surveys for imperiled plants on private and public lands to help avoid conflicts with motorized recreational activities.

- Provide best available data and expertise about imperiled plant occurrences to federal, state, and local agencies, off-road vehicle (ORV) groups, and others to inform recreation and travel management plans.

- Develop BMPs to minimize impacts of motorized recreation on imperiled plants and work with agencies and ORV groups to implement them.

- Incorporate information regarding the protection and management of imperiled plants into RMPs, recreation plans, and other environmental assessments regarding motorized recreation.

- Monitor imperiled plants that are potentially threatened by motorized recreational activities.

- Develop and share educational materials about imperiled plants with ORV groups/users.

- Assist ORV groups with the protection of threatened plant occurrences, e.g., by establishing interpretive signs to help ORV

users understand the need to avoid certain areas and/or building fences to protect sensitive populations.

- Recognize and reward ORV groups, public land managers, and private landowners for good stewardship of imperiled plants with annual Plant Conservation Awards, working with the Colorado Native Plant Society.

c. **Residential development.** At least 10 imperiled plant species and likely a number of other species, occurring mostly in barrens and shrublands within or near urban areas, are currently threatened by residential development. These include:

1. Kremmling milkvetch (*Astragalus osterhoutii*) near Kremmling.
2. Clay-loving wild buckwheat (*Eriogonum pelinophilum*) near Montrose.
3. Pagosa skyrocket (*Ipomopsis polyantha*) near Pagosa Springs.
4. Pagosa bladderpod (*Lesquerella pruinosa*) near Pagosa Springs.
5. Arkansas Valley evening primrose (*Oenothera harringtonii*) near Pueblo.
6. Round-leaf four o'clock (*Oxybaphus rotundifolius*) near Pueblo.
7. Golden blazing star (*Nuttallia chrysantha*) near Pueblo.
8. Penland penstemon (*Penstemon penlandii*) near Kremmling.
9. Bell's twinpod (*Physaria bellii*) along the northern Front Range.
10. Gray's townsend daisy (*Townsendia glabella*) in southwestern Colorado.

Recommended conservation actions include:

- Conduct field surveys for imperiled plants on private and public lands in residential development areas to help avoid conflicts.

- Provide best available data and expertise on imperiled plants to state/local agencies and integrate imperiled plants into county comprehensive master plans.

- Develop BMPs to minimize impacts of residential development on imperiled plants and work with local governments, developers, landowners, and homeowner associations to implement them.

- Monitor imperiled plants that are potentially threatened by residential development.

- Recognize and reward developers and private landowners for good stewardship of rare plants and habitats with annual Plant

Conservation Awards, working with the Colorado Native Plant Society.

- Develop and share educational materials about imperiled plants with local governments, landowners, homeowner associations, developers, and builders to reduce impacts of development.

- Integrate imperiled plants into other statewide biodiversity conservation and planning efforts, such as the Colorado State Wildlife Action Plan, Colorado Conservation Partnership, State Forest Assessment, and Colorado Conservation Summit.

- Seek on-the-ground protection for imperiled species and their habitats, working with land trusts and willing landowners using conservation easements and other protection tools (see Boxes 9, 13-14).

- Utilize existing funding sources more effectively and identify new sources of funding for habitat protection of imperiled plants at the federal, state, and local levels (e.g., Great Outdoors Colorado, U.S. Fish and Wildlife Service, and Farm Bill [see Box 13]).

- Develop new incentives for private landowners to participate in plant conservation activities (see Box 9).

- Encourage the purchase or transfer of development rights (PDR/TDR) that would prioritize the conservation of imperiled plant habitat, while augmenting city and county open space programs.

Box 13. Farm Bill programs can be used to conserve imperiled plants and help landowners maintain intact lands through conservation easements, fencing, and/or management agreements. Information provided by Terri Skadeland, Natural Resources Conservation Service.

- Environmental Quality Incentives Program (EQIP) offers farmers and ranchers a tool to address natural resource concerns, while achieving environmental benefits. http://www.co.nrcs.usda.gov/programs/eqip/2007eqip.html.
- Conservation Innovation Grants (CIG) promote development and adoption of innovative conservation approaches and technologies in environmental enhancement and protection. http://www.co.nrcs.usda.gov/programs/CIG/cig.htm
- The Wildlife Habitat Incentive Program (WHIP) provides technical and financial assistance to help establish and improve wildlife habitat. http://www.co.nrcs.usda.gov/programs/whip/whip.htm
- The Conservation Security Program (CSP) provides financial and technical assistance to promote the conservation and improvement of soil, water, air, energy, and plant and animal life. http://www.co.nrcs.usda.gov/programs/CSP/CSP2008/CSP2008.html
- Easement programs include Wetlands Reserve Program (WRP), Grassland Reserve Program (GRP), and Farm and Ranchlands Protection Program (FRPP). http://www.co.nrcs.usda.gov/programs/

Box 14. Conservation Partnership Protects Clay-loving Wild Buckwheat.

Colorado State Parks and Natural Areas Program partnered with private ranchers, The Nature Conservancy, and other groups to protect a critical population of the globally imperiled clay-loving wild buckwheat (*Eriogonum pelinophilum*). Through a unique collaboration funded by the State of Colorado Lottery, the U.S. Fish and Wildlife Service, The Nature Conservancy, and a statewide fund-raising effort led by the Center for Native Ecosystems and Colorado Native Plant Society, the state purchased 43 acres from Harold and Kathleen Wacker, a retired couple who were interested in conserving the plants. The ranch is adjacent to a BLM Area of Critical Environmental Concern designated to protect the rare buckwheat. The Program will continue to work with the Wackers, The Nature Conservancy, BLM, and other groups to manage the land as a designated State Natural Area for the preservation of the buckwheat and its unique Adobe Hills habitat.

The buckwheat grows only in Colorado at 16 known locations in Montrose and Delta Counties, and is listed as federally Endangered. The protection of the plants on the Wacker Ranch addresses the goals in the Recovery Plan to "protect populations on private land" and to "remove threats and secure populations and their ecosystems." The Wacker Ranch population of the buckwheat is one of the best in the world, and very important for the survival of the species.

The unique coalition of federal and state government agencies, non-profits and private landowners that banded together to purchase and manage the property showed how quick action by diverse partners can result in the conservation of Colorado's natural heritage. This is a great example of a cooperative, non-controversial way of addressing development issues and conservation. The protection of the Wacker Ranch has shown that conservation can be a "win-win" for all groups involved if government agencies, non-profit groups, and private landowners work cooperatively with common goals in mind.

Clay-loving wild buckwheat
Photograph by Jim Reveal

Harold and Kathleen Wacker
Photograph by CNAP

d. **Roads.** At least eight imperiled plant species, occurring in alpine and shrubland habitats, are threatened by road development and maintenance. These species include:

1. Cronquist milkvetch (*Astragalus cronquistii*)
2. Eastwood's evening primrose (*Camissonia eastwoodiae*)
3. Weber whitlow-grass (*Draba weberi*)
4. Pagosa skyrocket (*Ipomopsis polyantha*)
5. Good neighbor bladderpod (*Lesquerella vicina*)
6. Golden blazing star (*Nuttallia chrysantha*)
7. Pikes Peak spring-parsley (*Oreoxis humilis*)
8. Bell's twinpod (*Physaria bellii*)

Recommended conservation actions include:

- Conduct field surveys for imperiled plants on private and public lands to help avoid conflicts with road development and maintenance.

- Provide best available data and expertise on imperiled plants to the Colorado Department of Transportation (CDOT), Federal Highway Administration departments, counties, and others for environmental review and planning for new and existing roads; to BLM and USFS for travel management plans.

- Develop BMPs to reduce impacts of roads on imperiled plants and work with transportation departments to implement them (see Boxes 10-11).

- Monitor imperiled plants that are potentially threatened by road development and maintenance.

- Conduct research on imperiled plants to help fill key data gaps, inform BMPs, and reduce conflicts between road development/maintenance and plants.

- Develop and share educational materials about imperiled plants with transportation departments and land managers.

- Ensure that federal, state, and local transportation agencies are aware of issues with imperiled plants in road maintenance areas and inform prescriptions that involve mowing and/or herbicide use.

- Develop special ways to mark imperiled plant occurrences to avoid impacts when spraying or cutting vegetation along roads.

e. **Altered hydrologic regimes.** At least nine imperiled plant species, occurring in wetland and riparian habitats and/or seeps across Colorado, are threatened by hydrologic alteration. These include:

1. Slender spiderflower (*Cleome multicaulis*) in the San Luis Valley.
2. Kachina daisy (*Erigeron kachinensis*) in the Dolores River drainage.
3. Penland alpine fen mustard (*Eutrema edwardsii* ssp. *penlandii*) in the Mosquito Range.
4. Colorado butterfly plant (*Gaura neomexicana* ssp. *coloradensis*) east of the northern Front Range at the western edge of the Great Plains.
5. Narrowleaf evening primrose (*Oenothera acutissima*) in northwestern Colorado.
6. Porter feathergrass (*Ptilagrostis porteri*) in South Park and surrounding mountain ranges.
7. Parish's alkali grass (*Puccinellia parishii*) in southwestern Colorado.
8. Ute ladies'-tresses (*Spiranthes diluvialis*) in floodplains of the western Great Plains and on the Western Slope.
9. Pale blue-eyed-grass (*Sisyrinchium pallidum*) in high mountain valleys.

Dam construction may also threaten upland plants, e.g., 10-20% of the global population of Kremmling milkvetch (*Astragalus osterhoutii*) was extirpated by the construction of Wolford Mountain Reservoir (formerly Muddy Creek Reservoir). Currently, Weber's draba (*Draba weberi*) is threatened by dam construction. Recommended conservation actions include:

- Conduct field surveys for imperiled plants on public and private lands to avoid conflicts with water projects.

- Develop and share best available data with federal, state, and local agencies for planning and environmental review of projects.

- Develop BMPs for imperiled plants and work with public officials and planners to implement them (see Boxes 11-12).

- Incorporate protection and management of imperiled plant species into RMPs and other environmental assessments regarding hydrologic regimes.

- Encourage consideration of imperiled plants in local, regional, and statewide water planning efforts such as the Non-consumptive Needs Assessment.

- Monitor imperiled plants that are potentially threatened by hydrologic alterations.

- Seek on-the-ground protection for imperiled plants and their wetland and riparian habitats.

f. **Mining.** Several imperiled species are threatened by mining and associated activities. These include:

1. Penland alpine fen mustard (*Eutrema edwardsii* ssp. *penlandii*) in alpine habitats of the Mosquito Range (gold mining).
2. Weber saussurea (*Saussurea weberi*) in alpine habitats of the Mosquito Range (hard rock mining).
3. Piceance twinpod (*Physaria obcordata*) in shale barrens of the Piceance Basin (naucolite mining).
4. Round-leaf four o'clock (*Oxybaphus rotundifolia*) and Pueblo goldenweed (*Oonopsis puebloensis*) in the Arkansas River Valley (limestone mining).

Recommended conservation actions include:

- Conduct field surveys for imperiled plants on private and public lands to help avoid conflicts with mining operations.

- Provide best available data and expertise on imperiled plants to federal, state and local agencies and mining companies.

- Develop BMPs to reduce impacts of mining on imperiled plants and work with mining companies and land management agencies to implement them (see Boxes 10-11).

- Incorporate information regarding the protection and management of imperiled plants into RMPs and other environmental assessments regarding mining.

- Work with mining companies and agencies to ensure that surface disturbance will avoid key imperiled plant occurrences through planning and informed reclamation plans.

- Monitor the impacts of mining activities on imperiled plants and their habitats.

- Seek on-the-ground habitat protection through conservation easements and other protection tools.

- Mitigate the loss or degradation of imperiled plant occurrences due to mining or associated activities.

g. **Agricultural practices.** Only a few species are known to be impacted by agricultural practices, including agricultural development, land conversion, or incompatible livestock grazing. These include:

1. Clay-loving wild buckwheat (*Eriogonum pelinophilum*) on shale barrens in the Montrose area that have been converted for agriculture.
2. Dwarf milkweed (*Asclepias uncialis*) in the shortgrass prairie (conversion to cropland or planted pasture).
3. Payson lupine (*Lupinus crassus*) in pinyon-juniper woodlands in southwestern Colorado (moderately impacted by incompatible grazing).
4. Arizona willow (*Salix arizonica*) in wetland habitats in the San Juan Mountains (moderately impacted by livestock grazing).
5. Stonecrop gilia (*Aliciella sedifolia*) in the western San Juan Mountains (incompatible grazing by domestic sheep).

Recommended conservation actions include:

- Conduct field surveys for imperiled plants on private and public lands to help avoid conflicts with agricultural practices.

- Provide best available data and expertise about imperiled species and their management needs with private landowners, public land management agencies, and other land managers.

- Develop BMPs to minimize impacts of agricultural practices on imperiled plants and work with private landowners, agencies, and other land managers to implement them.

- Monitor imperiled plants that are potentially threatened by agricultural practices.

- Seek on-the-ground habitat protection for imperiled plants, working with local land trusts and willing landowners using conservation easements and/or other protection tools.

- Direct federal funding (e.g., U.S. Fish and Wildlife Service, Farm Bill Programs) to address management needs, e.g., fencing of imperiled species on private lands (see Boxes 13-15).

Box 15. Private Land Success Story for the Colorado Butterfly Plant.
By Erin Robertson, Center for Native Ecosystems

There are only 14 known populations of the Colorado butterfly plant (*Gaura neomexicana* var. *coloradensis*) located mostly in riparian areas on private land within a small area at the junction of Colorado, Wyoming, and Nebraska. Non-selective herbicide spraying, haying and mowing at certain times of year, some water development, land conversion for cultivation, competition from exotic plants, and loss of habitat to urban growth are the main threats to the plant. The low numbers and limited distribution of this herbaceous plant contribute to its vulnerability to natural and human-caused disturbances and environmental stresses. The plant was federally listed as threatened in 2000.

In 2004, biologists from the U.S Fish and Wildlife Service and Center for Native Ecosystems visited a population on private land near Cheyenne, Wyoming. Although it had been healthy when monitored in 1999, during the intervening years it had been overgrazed and was significantly degraded. However, the landowner was interested in protecting the plant but was unaware of the resources and incentive programs under the Endangered Species Act that help landowners be good stewards of the land and endangered species. The landowner enthusiastically took advantage of these resources, and the site is now fenced to keep the cattle from wandering into the riparian area where the butterfly plant lives.

Under Endangered Species Act programs sponsored by the U.S. Fish and Wildlife Service, private landowners have a great deal of management flexibility and access to resources to facilitate conservation efforts.

Colorado Butterfly Plant
Photograph by Bonnie Heidel

h. **Non-motorized recreation.** Several species are known to be impacted by hiking activities but the severity of the impacts is considered to be low. Primary habitats affected are alpine and cliffs and canyons; other habitats include pinyon-juniper woodlands and forests. These species include:

1. Stonecrop gilia (*Aliciella sedifolia*) in the Western San Juans.
2. Weber's skyrocket (*Ipomopsis aggregata* ssp. *weberi*) in the Park Range.
3. Globe gilia (*Ipomopsis globularis*) in the alpine zone of the Mosquito Range.
4. Budding monkeyflower (*Mimulus gemmiparis*) in the Front Range.
5. Arkansas Canyon stickleaf (*Nuttallia densa*) in the Arkansas River Canyon area.
6. Cushion bladderpod (*Physaria pulvinata*) in San Miguel and Dolores Counties.

Recommended conservation actions include:

- Provide best available data and expertise to federal, state and local agencies as well as recreation groups to avoid conflicts.

- Develop BMPs to minimize impacts of recreational activities on imperiled plants and work with land managers and recreation groups to implement them.

- Incorporate information regarding the protection and management of imperiled plants into RMPs, recreation plans, and other environmental assessments.

- Develop and share educational materials about imperiled plants with land managers and recreation groups to help increase public awareness about the precarious nature of imperiled plant species (see outreach/education section).

- Establish interpretive signs to help recreationists avoid specific sensitive areas for imperiled plants.

- Work with land managers to construct fences to protect imperiled plant occurrences.

- Recognize and reward public agencies and private landowners for good stewardship and recreation policies with annual Plant Conservation Awards, working with the Colorado Native Plant Society.

i. **Invasive plant species** (and the associated use of biocontrol and/or herbicides). Several imperiled species are known to be threatened by invasive plant species. These include:

1. Schmoll milkvetch (*Astragalus schmolliae*) is threatened by musk thistle in southwestern Colorado.
2. Narrowleaf grapefern (*Botrichium lineare*) threatened by yellow toadflax on Pikes Peak.
3. Adobe thistle (*Cirsium perplexans)* threatened by application of biocontrols on non-native thistle species invading its habitat.
4. Piceance bladderpod (*Lesquerella parviflora*) threatened by leafy spurge in the Piceance Basin.
5. Ute ladies'-tresses (*Spiranthes diluvialis*) threatened by several noxious weeds along the Front Range and in scattered locations on the West Slope.

Recommended conservation actions include:

- Provide best available data and expertise regarding imperiled plants to state and county weed management programs and staff.

- Take steps to stop the introduction and spread of new invasive species in Important Plant Areas, working with the Colorado Weed Management Association and the Colorado Weed Network.

- Monitor imperiled plants that are threatened by invasive species.

- Control and manage existing noxious weeds to minimize impacts to imperiled plant occurrences and their habitats, working closely with federal, state, and county weed experts.

- Seek increased federal- and state-level funding for invasive species control in Important Plant Areas.

- Monitor the impacts of control efforts, as well as impacts of biocontrol on other related species, working with the Colorado Department of Agriculture.

- Promote the use of native seed in revegetation projects.

- Protect undisturbed native plant communities and ecosystems through on-the-ground habitat protection.

Leafy spurge invasion of Piceance bladderpod habitat
Piceance Basin
Photograph by Betsy Neely

j. **Over-collecting** of selected species for the horticultural/hobby trade and/or herbal trade. Examples include drabas, cacti, orchids, and penstemons.

Recommended conservation actions include:

- Develop BMPs for sustainable collection (wild collection) of species and implement them with public land managers and landowners.

- Monitor imperiled species that are potentially threatened by over-collecting to ensure that these species do not undergo further losses or go extinct from over-collecting.

- Support compliance with all applicable laws and regulations such as state and federal acts, public land-use policies, harvesting prohibitions, and permitting requirements.

- Propagate native and imperiled plants with Denver Botanic Gardens, garden clubs, and academic institutions.

- Develop and share educational materials with landowners, land managers, garden clubs, nurseries, etc. about imperiled plants threatened by over-collecting.

k. **Climate change.** This is a complex issue that has potential to impact all imperiled plants and to unravel the best thought-out plant conservation objectives. Climate change is increasingly having an impact on plant species, particularly those that are restricted to specific geologic substrates and those that occur at higher elevations in the Rocky Mountains. At least 11 of Colorado's imperiled species that occur in the upper elevations of alpine habitats or in narrowly restricted edaphic environments (i.e., specific geologic substrates and/or soils) are particularly vulnerable, including:

1. Stonecrop gilia (*Alicellia sedifolia*)
2. DeBeque milkvetch (*Astragalus debequaeus*)
3. Colorado larkspur (*Delphinium ramosum* var. *alpestre*)
4. San Juan whitlow-grass (*Draba graminea*)
5. Gray's Peak whitlow-grass (*Draba grayana*)
6. Penland alpine fen mustard (*Eutrema edwardsii* ssp. *penlandii*)
7. Pike's Peak spring-parsley (*Oreoxis humilis*)
8. Round-leaf four o'clock (*Oxybaphus rotundifolius*) (see Box 16)
9. Penland penstemon (*Penstemon penlandii*)
10. Piceance twinpod (*Physaria obcordata*)
11. Rothrock townsend daisy (*Townsendia rothrockii*)

Recommended conservation actions include:

- Conduct research to fill data gaps to better understand impacts of climate change on rare plants, identify areas where species will be most affected, how geographic ranges will change, and where future refugia will occur.

- Develop and evaluate the effectiveness of adaptation strategies (or management actions) that can be taken to address climate change impacts on imperiled species.

- Protect sites that may serve as future refugia and conserve landscape connectivity and migration corridors to enable natural dispersal of plant species and pollinators.

- Monitor imperiled plants potentially threatened by climate change.

- Support mitigation strategies (e.g., carbon sequestration) that consider impacts on rare plants.

Box 16. Round-leaf four o'clock, a globally imperiled plant of the Arkansas Valley restricted to shale barrens of the Niobrara Formation.

Round-leaf four o'clock
Photograph by Susan Spackman Panjabi

Conservation Objective 3. Improve scientific understanding of the distribution, natural history, and status of Colorado's most imperiled plant species through field surveys, research, and monitoring to facilitate conservation actions.

a. **Survey:** A number of imperiled species are in particular need of focused field surveys to inform understanding of distribution, level of rarity and imperilment, and status, e.g., Cronquist milkvetch (*Astragalus cronquistii*), Mancos milkvetch (*Astragalus humillimus*), Comb Wash buckwheat (*Erigonum clavellatum*), and Piceance bladderpod (*Lesquerella parviflora*).

Recommended conservation actions include.

- Prioritize survey needs for imperiled plants (see Box 17 regarding newly described species in Colorado).

- Conduct targeted surveys of Colorado's imperiled plant species to fill data gaps and increase knowledge about geographic range, distribution, population size, condition, threats, and status. Document the occurrence and distribution of imperiled plant species with CNHP occurrence records, voucher specimens, and photographs.

- Evaluate recommended conservation actions for priority species and occurrences through targeted site visits and existing database information.

- Develop Important Plant Areas (IPAs, see Box 5 and Figure 8) for all priority species to guide conservation actions. Conduct field visits of existing and potential additional IPAs as identified by the CNHP.

- Secure funding to help update and maintain CNHP database.

- Acquire fine-scale data necessary for high-precision modeling of the rarest plant species and conduct modeling to inform targeted surveys.

Box 17. New Plant Species Discovered in Colorado!
by Steve O'Kane, Biology Professor, University of Northern Iowa

Few are aware that a handful of botanical explorers in Colorado continue to discover plant species that are new to science. Four new species in the mustard family were described in 2006–2007 as a result of field work for the *Flora of North America* and *Four Corners Flora* projects:

- Whitlow-grass (*Draba malpighiacea*) occurs above 9600 feet in Hinsdale, La Plata, and Montezuma Counties.
- Heil's tansy mustard (*Descurainia kenheilii*) occurs in a single population in the alpine tundra of the San Juan Mountains.
- West Silver bladderpod (*Physaria scrotiformis*) is restricted to two small, nearly barren exposures of limestone in alpine habitat of the San Juan Mountains.
- Cushion bladderpod (*Physaria pulvinata*), known from two small areas, occurs on shale outcrops in Dolores and San Miguel Counties.

Other recently described plants include rock-cress (*Boechera glareosa),* rock-cress (*Boechera villosa),* moonwort (*Botrychium furcatum),* Gypsum Valley cateye (*Cryptantha gypsophila),* Lone Mesa snakeweed *(Guterrezia elegans),* blazing star *(Mentzelia multicaulis* var. *uintahensis),* and pincushionplant *(Navarretia saximontana).*

Colorado is still far from being thoroughly explored botanically, particularly in remote areas. Further inventories across the state are certain to yield more species new to science, and improve our knowledge of Colorado's biological richness. It's exciting to know that even in the 21st century there are species still to be discovered in our own backyards!

Lone Mesa snakeweed
New species discovered in 2008 in southwestern Colorado
by Al Schneider and Peggy Lyon
Photograph by Al Schneider

b. **Research**: Very little is known about the life history and reproductive biology of most Colorado's imperiled plants. Additionally, some species need taxonomic work, e.g., golden columbine (*Aquilegia chrysantha* var. *rydbergii)* and boat-shaped bugseed (*Corispermum navicula*). Increased collaboration with academic institutions will help address the key research needs of Colorado's imperiled plants.

   Recommended conservation actions include:

   - Prioritize research needs for Colorado's imperiled species (Annual Colorado Rare Plant Technical Committee Symposia, *Biodiversity Scorecard* updates, etc.) and share priorities with the academic community and other partners.

   - Support and conduct research that seeks to better understand how human activities, such as dust from energy development, ORV use, or herbicide application may impact imperiled plant species, and inform mitigation of the impacts of these activities (e.g. BMPs, reintroduction, etc.).

   - Conduct systematic and genetic research on those imperiled plants for which there are taxonomic questions (see Box 18). Conduct analyses for plant chemicals that could be effective in medicines.

   - Support and conduct species-specific research to answer basic questions about the natural history of imperiled species, including their reproductive biology (e.g., pollination, breeding system, and seed dispersal mechanisms), life history (e.g., germination requirements and survival to reproduction), and ecology (e.g., edaphic or soil requirements and mycorrhizal relationships), as well as other important ecological processes needed for their survival (e.g., fire or other disturbance). See Box 19.

Box 18. Genetic Research Needs for Colorado's Imperiled Plants.

The list below includes examples of Colorado imperiled plant species and subspecies/varieties (taxa) that need additional genetic studies to address taxonomic questions that could alter the prioritization of the taxon in statewide conservation objectives. Please contact the Colorado Natural Heritage Program for more information (species are listed in alphabetical order by scientific name).

1. Golden columbine (*Aquilegia chrysantha* var. *rydbergii*)
2. San Rafael milkvetch (*Astragalus rafaelensis* and *A. linifolius*)
3. Mountain-slope thistle (*Cirsium scapanolepis*)
4. Boat-shaped bugseed (*Corispermum navicula*)
5. Wild buckwheats (*Eriogonum pelinophilum* and *E. clavellatum*)
6. Blazing stars (*Nuttallia chrysantha* and *N. densa*)
7. Heacock's prickly-pear (*Opuntia heacockiae*)
8. Crandall's beardtongue (*Penstemon crandallii* ssp. *procumbens*)
9. Germander beardtongue (*Penstemon teucrioides*)
10. North Park phacelia (*Phacelia formosula*): Larimer County population
11. Colorado hookless cactus (*Sclerocactus glaucus*)*:* DeBeque population

Boat-shaped bugseed
North Sand Dunes, North Park
Photograph by Paula Guenther-Gloss

Golden blazing star
Arkansas Valley
Photograph by Susan Panjabi

Box 19. Cooperative Research by RPCI Partners provides insight into the reproductive biology of Degener beardtongue. By Carol English and Leo P. Bruederle, Department of Biology, University of Colorado Denver

In 2006, the Field Studies Committee of the Colorado Native Plant Society targeted the Degener beardtongue (*Penstemon degeneri*) for fieldwork addressing aspects of the natural history of this species within the context of its globally imperiled status. In response, a partnership formed involving the University of Colorado Denver (UCD), USFS, and the Denver Botanic Gardens. Research was conducted in the field and laboratory between 2006 and 2008. Over this period, data were obtained addressing: distribution; reproductive biology, including effective pollination and breeding system; population trends; and taxonomy. We have already learned a great deal from this research:

- Seven new occurrences were found, bringing the total number of reports to 18.
- Degener beardtongue attracts a diverse guild of visitors, including butterflies, flies, bees, and wasps. Visitation varies dramatically from year to year, most likely due to environmental conditions (e.g., rainfall).
- Of the diverse visitor guild, few species appear to be effective pollinators, including mason bees, bumble bees, and pollen wasps.
- Although the beardtongue is capable of setting seed through self pollination, pollen-ovule ratios suggest that it has a mixed mating system involving insect mediated out-crossing.

Research on the beardtongue is ongoing and students at UCD and the Denver School of Science and Technology are currently using molecular techniques to better understand the taxonomic limits of this species.

There is still much to be learned about the natural history of Colorado's imperiled plants. Partnerships, such as this, demonstrate how collaborations between public agencies and institutions, private organizations, and individuals can increase our knowledge of the Colorado flora.

Mason bee (*Osmia* sp.) approaching Degener penstemon
Phantom Canyon, Colorado
Photograph by Dave Elin

c. **Monitoring:** Relatively few imperiled species are being monitored to help understand long-term trends and/or impacts of various land use activities. Priorities are G1 ranked species and those with suspected downward trends. Several species needing population status monitoring, as determined by the *Biodiversity Scorecard for Colorado* (CNHP and TNC 2008) and CNAP, include:

1. Sleeping Ute milkvetch (*Astragalus tortipes*)
2. Boat-shaped bugseed (*Corispermum navicula*)
3. Gypsum Valley cateye (*Cryptantha gypsophila*)
4. Narrow-lead evening primrose (*Oenothera acutissima*)
5. Pikes Peak spring parsley (*Oreoxis humilis*)
6. Sun-loving meadowrue (*Thalictrum heliophilum*)

Recommended conservation actions include:

- Prioritize monitoring needs for Colorado's imperiled species and share priorities with the scientific and academic communities, e.g., rare plant species in high-density oil and gas development areas.

- Support existing and establish new monitoring projects for priority species (e.g., Rare Plant Monitoring Stewards Program – see Boxes 20 and 21) and provide results to appropriate land managers to facilitate adaptive management for the long-term survival of rare plants.

- Ensure monitoring studies have adequate funding to address key questions, use consistent methodology, and effectively inform adaptive management.

- Devise a monitoring schedule to ensure that all rare plant populations are monitored at appropriate and cost effective intervals in order to quickly detect population declines and ensure occurrence persistence.

- Periodically update the *Biodiversity Scorecard* to record changes in conservation status of imperiled plants.

d. **Assessments/Status Reports:** The U.S. Forest Service has produced species conservation assessments for a number of plants in the Rocky Mountain Region to provide a sound scientific foundation for management. The U.S. Fish and Wildlife Service develops status reports for plants to document conservation status and inform listings. These documents are extremely useful for making conservation decisions as well as informing research.

Recommended conservation actions include:

- Create a clearinghouse for updated information on rare plant species to provide scientists, managers, and decision-makers with a resource to inform actions and priorities.

- Develop species assessments (e.g., U.S. Forest Service species assessments) for all of Colorado's imperiled species.

- Facilitate the timely submission of appropriate information to the U.S. Fish and Wildlife Service to assure up-to-date data is available for listed, candidate, and petitioned species status reports.

Box 20. Rare Plant Monitoring Stewards Program.

The Rare Plant Monitoring (RPM) Stewards program is a collaborative effort between the Colorado Natural Areas Program (CNAP), Denver Botanic Gardens, and several land management agencies to 'rev-up' the quality and quantity of data for the rarest plants of Colorado. This cooperative program trains 'citizen scientists' to provide up-to-date, quantitative information on the status of Colorado's most imperiled plant species. More abundant data on rare plants can be used to inform adaptive land management decisions and to assess the trends of rare plant populations. Photograph by Brian Kurzel, CNAP.

Box 21. Selected imperiled plant species currently being monitored in Colorado (with lead organization/agency responsible for monitoring). Species are listed in alphabetical order by scientific name.

1. Larimer aletes (*Aletes humilis*): The Nature Conservancy
2. DeBeque milkvetch (*Astragalus debequeus*): Bureau of Land Management
3. Skiff milkvetch (*Astragalus microcymbus*): Bureau of Land Management, Denver Botanic Gardens
4. Kremmling milkvetch (*Astragalus osterhoutii*): Bureau of Land Management
5. Brandegee's buckwheat (*Eriogonum brandegei*): Bureau of Land Management, Denver Botanic Gardens
6. Clay-loving wild buckwheat (*Eriogonum pelinophilum*): Bureau of Land Management, Colorado Natural Heritage Program, Colorado Natural Areas Program
7. Colorado butterfly plant (*Gaura neomexicana* ssp. *coloradensis*): City of Fort Collins
8. Pagosa skyrocket (*Ipomopsis polyantha*): Colorado Natural Heritage Program
9. Dudley Bluffs bladderpod (*Lesquerella congesta)*: Colorado Natural Areas Program
10. Frosty bladderpod (*Lesquerella pruinosa*): Colorado Natural Heritage Program, The Nature Conservancy
11. Narrow-leaf evening primrose (*Oenothera acutissima*): Bureau of Land Management
12. Parachute penstemon (*Penstemon debilis)*: Bureau of Land Management, Colorado Natural Areas Program
13. Graham's penstemon (*Penstemon grahamii*): Bureau of Land Management
14. Penland's penstemon (*Penstemon penlandii*): Denver Botanic Gardens
15. North Park phacelia (*Phacelia formosula*): Bureau of Land Management
16. Bell's twinpod (*Physaria bellii*): City of Boulder, Colorado Natural Areas Program, Denver Botanic Gardens, City of Fort Collins, The Nature Conservancy
17. Piceance twinpod (*Physaria obcordata*): Colorado Natural Areas Program
18. Colorado hookless cactus (*Sclerocactus glaucus*): Bureau of Land Management, Denver Botanic Gardens
19. Ute ladies'-tresses (*Spiranthes diluvialis*): City of Boulder, City of Fort Collins

North Park phacelia
Photograph by Frank Weston

Piceance twinpod
Photograph by Steve O'Kane

Conservation Objective 4. Develop and implement a state program and policies to enhance the conservation of Colorado's most imperiled plants in cooperation with public land managers, private landowners, and other interested stakeholders.

Work with elected officials and partners to develop and pass a state statute that: 1) establishes a legally recognized list of rare and imperiled native plants in Colorado; 2) acknowledges the state's interest in protecting these plant species as part of Colorado's natural heritage; and 3) provides a variety of mechanisms and resources, including long-term funding, for their conservation. This statute should:

a. Establish criteria and a process by which a state agency will identify and designate a state list of rare and imperiled species to be conserved. The act language will emphasize utilizing the best available science, such as the nationally tested and accepted criteria and methodology of the CNHP/NatureServe, to designate G1-G2 species and federally listed species, as those of State concern. It will specify a periodic review requirement to ensure that the list remains contemporary and reflects current scientific understanding.

   Presently, such a list would incorporate 119 imperiled Colorado species. In order to make progress in safeguarding the listed species and utilize resources cost-effectively, the Program established by the act will need to prioritize species for conservation based on criteria such as the level of threat, the conservation status, and the confidence level in related information.

b. Provide a programmatic framework that facilitates due diligence from all relevant parties, emphasizes collaboration, and guides the agency's efforts to conserve designated species through: 1) targeted strategies for specific rare plant occurrences; 2) multi-jurisdictional strategies for abatement of landscape-scale threats; and 3) landowner specific strategies that recognize unique circumstances and opportunities of federal, state, tribal, local, and private landowners.

   - Federal Land Management Entities: The Program will encourage and facilitate federal agency involvement in rare plant conservation and influence federal government actions that may negatively impact designated plant species. These goals will be accomplished by ensuring that the state list meets existing federal thresholds for recognition of state interests. The state list will result in enhanced federal analysis of actions that may jeopardize the viability of all state-listed species (not solely federally listed species) and will trigger consideration of alternatives that could avoid damaging populations of state-designated plants. The Program will monitor relevant federal actions and maintain effective, cooperative

relationships with key federal entities, especially the BLM and USFS.

- State Land Management Entities: The Program will encourage and facilitate state agency (SLB, CDOW, State Parks, and CDOT) involvement in rare plant conservation and influence state land management actions that may negatively impact designated plant species. This will be accomplished by requiring an analysis of rare plant populations and their habitat (through an established environmental review process) when operations on state lands may jeopardize species viability, and consideration of alternatives that will avoid damaging sensitive species populations. Emphasis will be placed on avoiding negative impacts whenever possible, but will not be assumed to prohibit operations. This process is intended to ensure that state agencies conduct their operations and carry out their responsibilities with the full knowledge and consideration of any designated rare plant population that may be affected.

- State Regulatory Entities: The program will facilitate and encourage state agencies that have regulatory responsibility over oil and gas, minerals, water, and other natural resources or agricultural operations to consider the impacts of regulated activities on designated species via an established but streamlined environmental review process using existing data. This process is intended to ensure that state regulatory agencies carry out their responsibilities with the knowledge and consideration of any designated rare plant population that may be affected. Language will require due diligence but refrain from requiring costly or lengthy environmental assessments and will not prohibit regulated activities.

- Tribes, Local Governments, and Private Landowners: The Program will engage these partners through a non-regulatory and service-oriented program that encourages stewardship of rare plants. The program will offer technical and financial resources including assistance with the identification of rare plants, management recommendations (e.g., BMPs), and small grants on a cost-share and/or direct assistance basis as incentives for good stewardship. Tax breaks for conservation should also be considered.

- Multi-jurisdictional Threats: The program will work collaboratively with industry, academic, land management, conservation, and other non-governmental partners to evaluate landscape-scale threats to designated rare plant populations and identify measures and practices that could be implemented in a cost-effective and practical manner to mitigate negative impacts.

c. Establish additional program functions pertaining to inventory, monitoring, and research efforts that contribute to a better understanding of Colorado's rare plants and improve their conservation.

- Inventory: Conduct regular inventories to check existing locations and search for new occurrences of rare plant species to reduce uncertainty about their rarity and/or conservation status.

- Monitoring: Continue existing monitoring for globally imperiled plants undertaken by BLM, USFS, USFWS, NPS, CNAP, CNHP, DBG, and other groups as appropriate and initiate targeted new monitoring projects. Limited resources will require coordination and partnership with other entities as well as a threat-based approach.

- Research: Address taxonomic uncertainty and reveal facets of natural history that bear upon plant species survival. Such research may allow for removal of plants from the list. Limited resources require partnership with other entities, such as colleges and universities, to prioritize and coordinate research efforts. This could be facilitated by a small fund to support partner participation as well as collaborative efforts to secure other sources of funding for this research.

d. Create and maintain long-term funding mechanisms that support Program staff, enable education and outreach, create private landowner incentives and direct assistance, and facilitate research and genetic conservation efforts such as seed bank storage.

e. Establish an advisory board comprised of scientific advisors, stakeholders representing environmental and landowner public interest groups, and representatives from each of the affected landowners, user groups, and industries to inform the Program.

Conservation Objective 5. Facilitate the stewardship of Colorado's most imperiled plants through education, outreach, and coordination.

One of the biggest challenges to plant conservation is the lack of awareness of the precarious status of Colorado's rare native plants. The implementation of objectives and recommended actions outlined in this Strategy can be enhanced and accelerated through education and outreach efforts with partners, stakeholders, decision-makers, land trusts, landowners, county and city governments, and the public. The RPCI can serve as a clearinghouse for sharing rare plant information, coordinating conservation activities, matching researchers with research needs and data gaps, and sharing priorities to facilitate stewardship and direct resources for Colorado's imperiled plants.

a. Expand the RPCI partnership to facilitate stewardship and conservation:

   - Develop new partnerships and improve existing partnerships to promote, support, and increase coordination on rare plant stewardship and conservation throughout Colorado (e.g., Crested Butte Wildflower Festival, Celebrating Wildflowers, and University of Colorado Museum of Natural History's BioHall).

   - Promote communication and collaboration among state and regional botanists at the Rare Plant Technical Committee's (RPTC) Annual Colorado Rare Plant Symposia.

   - Coordinate research and conservation efforts, and share information on status, research needs, and data gaps regarding Colorado's rare plant species.

b. Develop outreach materials and a website to increase awareness and conservation action:

   - Develop materials such as press releases, brochures, displays, slide programs, newsletter articles, and a website to increase public awareness about Colorado's imperiled plant species.

   - Develop fact sheets for a variety of audiences emphasizing conservation action and with specific information on how they can help, e.g., a hotline for landowners to call if they would like to have a botanist conduct a site visit prior to a change in land use; how interested parties can contribute funding; volunteer opportunities; and how teachers, landowners, and land managers can get involved.

- Use these materials to educate, garner support, and call to action decision-makers, local community members, landowners, and the public.

c. Conduct education and outreach activities emphasizing conservation needs:

- Collaborate with the Rocky Mountain Society of Botanical Artists on RARE Imperiled Plants of Colorado, the traveling art exhibit to begin in 2009 (see Box 22).

- Enhance public understanding of imperiled plants, the challenges they face, and the need to conserve them (e.g., develop K-12 school programs for teachers and students, colleges, and universities; organize Rare Plant Day activities with Denver Botanic Gardens, Colorado Rare Plant Awareness Week, and others).

- Use natural areas or preserves for field excursions and research with students.

- Establish interpretive signs to help recreationists and others understand why they should avoid certain areas needed for imperiled plant species.

- Promote ecotourism focused on botanical field trips and explore partnerships to incorporate plants into other efforts such as the Colorado Birding Trail by the Colorado Division of Wildlife.

d. Support volunteer projects to increase understanding and conservation:

- Support and expand existing volunteer projects, e.g., DBG and CNAP Rare Plant Monitoring Stewards Project and CNHP's Adopt a Rare Plant Program, with emphasis on better understanding and conserving Colorado's most imperiled species.

e. Develop native plant gardens and promote local pride:

- Support and expand the rare plant garden exhibit at DBG and identify additional locations to display cultivated specimens of selected rare plant species (e.g., based on location and habitat).

- Increase awareness and appreciation of rare plants by partnering with local communities and various other entities (e.g., Colorado Historical Society, Cheyenne Mountain Zoo, University of Colorado System) to create native and rare plant gardens at zoos,

history museums, community centers, and college campuses near where Colorado's most imperiled species occur.

- Change the "common" (non-Latin) names of rare plants where necessary to encourage interest and pride. For example, some species with common names suggesting alien weeds, such as goldenweed, or species with common names that are less informative (such as Osterhout's milkvetch), could benefit from a name that better reflects the plant's narrow geographic range, uniqueness, and/or interest or beauty (e.g., goldenflower or Kremmling milkvetch).

Pueblo goldenweed
Photograph by Susan Spackman Panjabi

f. Develop and support incentives for private landowners:

- Support and promote programs, such as the Farm Bill, that assist private landowners in protecting and managing imperiled plants on their lands.

g. Present conservation awards annually:

- Recognize and reward landowners, land managers, and others for good stewardship of imperiled plants and their habitats with annual Plant Conservation Awards, working with the Colorado Native Plant Society (see Box 23).

Box 22. RARE, The Imperiled Plants of Colorado Traveling Art Exhibit.
by Carol Till, Rocky Mountain Society of Botanical Artists Exhibit Manager

The Rocky Mountain Society of Botanical Artists (RMSBA) has organized a juried exhibit of 40 rare plants of Colorado. The exhibit titled *RARE, Imperiled Plants of Colorado* will travel to four locations around Colorado during 2009 and 2010. The exhibit is designed to introduce the public to the most imperiled plants in Colorado and educate them to the importance of protecting these plants. We also seek to demonstrate the usefulness that contemporary botanical art plays in ecological education and preservation. The illustrated plants were selected from the Colorado Rare Plant Master List. RMSBA will be working with the Colorado Rare Plant Conservation Initiative to promote rare plant education at each showing.

The exhibit will debut at Denver Botanic Gardens in March 2009, and later travel to Steamboat Art Museum in Steamboat Springs, the Center of Southwest Studies at Fort Lewis College in Durango, and the Business of Art Center in Manitou Springs.

Colorado hookless cactus (*Sclerocactus glaucus*)
By Susan Olson

Box 23. 2008 Colorado Rare Plant Conservation Initiative Conservation Award Recipients with RPCI member Brian Kurzel, CNAP (2nd from left): Steve Adam, OXY USA, Ken Holsinger, BLM, Peggy Lyon, CNHP, and Daniel Padilla, OXY USA. Colorado Native Plant Society Annual Meeting, Montrose, Colorado. Photograph by Betsy Neely.

Conservation Objective 6. Adopt measures for the *ex situ* (off site) conservation of Colorado's most imperiled plants in case native populations are extirpated.

In addition to serving as a source for the restoration of extirpated populations, collections of seeds and other reproductive propagules are a scientific resource that can be used in research on imperiled plant species (e.g., germination requirements). Furthermore, genetic diversity in *ex situ* (off-site) collections can serve as a baseline to measure shifts in populations as the climate changes and as a metric to evaluate effectiveness of various *in situ* (in-habitat) conservation objectives.

Ex situ conservation is an important backup and complementary strategy but should not be considered a substitute for *in situ* conservation in the natural environment. Imperiled plants should be effectively conserved through *in situ* conservation efforts. Whereas the top priority is to conserve imperiled plant species and their habitats through on-the-ground protection and management, *ex situ* conservation may be necessary for assisted migration, research, and restoration (see the 1992 California Native Plant Society policy on appropriate application of *ex situ* conservation techniques). It is also a proactive tool that can be used a last resort when *in situ* populations are extirpated.

a. Collect seeds and other propagules for *ex situ* conservation:

- Identify plant species to be collected for *ex situ* conservation.
    - Identify collections of imperiled plant species already represented in the USDA's National Center for Genetic Resources Preservation (NCGRP) collections.
    - Collect samples of all globally imperiled plant species within Colorado (see Box 24). Set yearly priorities based on species most 'at risk' in a given year. Develop a long-term strategic plan outlining milestones and establishing an annual assessment process that will review the previous year's progress and pitfalls as well as determining next year's goals.
    - Identify species to be collected each year through discussion among partners of the RPCI and projected seed yields for a given year.
- Develop protocols for seed collections within the populations of the plant species and within locations (occurrences). Ensure that collections will be sufficient for long-term viability, i.e., approximately 10,000 seeds collected per species to keep a collection viable in long-term storage for 200 years (Menges *et al*. 2004).

- Establish procedures for sampling within a species to ensure strategic coverage of genetic diversity.

- Follow and adapt procedures in the *Genetic Sampling Guidelines for Conservation Collections of Endangered Plants* (Center for Plant Conservation 1991) for sampling within a location such that representative genetic diversity is captured and associated data are recorded without harming imperiled plant populations.

- Establish procedures for updating or replenishing collections. Determine a timeline for initial and subsequent collections. It is important to note that small collections over many years will have less of an impact on population survival than larger collections in fewer years (Menges *et al*. 2004).

- Establish the procedures for collecting from more widely distributed congeners when appropriate. Thus, comparisons of demographic, genetic, or adaptive changes with time or *in situ* management strategies can be placed in perspective.

- Collect voucher specimens for species for which seeds are collected and deposit vouchers in regional herbaria.

b. <u>*Ex situ* conservation through seed banking</u>:

- Develop a Memorandum of Understanding with the NCGRP to establish Researchable Collections at their facility in Fort Collins. Identify funding sources for long-term maintenance of Researchable Collections.

- Establish additional locations for seed banking. Typically collections are housed in two locations: a 'primary' (or 'active') location from which distribution of stored seed occurs, and a 'back up' (or long-term) storage location that provides facilities to maximize shelf life but is not logistically supported for distribution, evaluation, or regeneration.

- Develop protocols to evaluate initial seed quality, predict storage behavior, and monitor viability during storage. Scheduling seed replenishment and instituting a viability monitoring schedule every 5-10 years is also recommended.

- Develop germination protocols for all species collected. Protocols will be produced in a standardized manner and then be readily

available when seeds need to be germinated for conservation or cultivation purposes.

- Restore extirpated populations with appropriate stored seed.

c. Cultivate and grow-out *ex situ* collections in display and reference collections. Living collections can be linked with the seed collections by using them as sites for evaluation of growth requirements and reproductive biology. Botanic gardens and seed banks will work together to evaluate the extent to which genetic diversity has been captured and devise the most efficient strategy to preserve genetic integrity.

    - Identify botanic gardens and additional locations to display cultivated specimens of select species as an educational outreach tool. Gardens or locations will be selected based on species location and habitat.

    - Develop procedures to monitor and reduce genetic erosion in cultivated collections.

    - Collect voucher specimens of cultivated collections for comparison with wild populations of initial collections. The specimens can be housed at regional herbaria.

Box 24. Center for Plant Conservation Seed Collecting by Denver Botanic Gardens.

Conservation of rare species can take many forms, from on-the-ground habitat protection, to collection of seed and germplasm for *ex situ* (off site) conservation. Denver Botanic Gardens (DBG) helps protect several imperiled species in Colorado through the collection of seed. Collected seed provides a backup resource for reintroducing or augmenting natural populations, and serves as a scientific resource to understand species growth requirements, reproductive biology, and population structure. These data, when combined with data collected through *in situ* (on site) conservation efforts, provide land managers with detailed information for making management decisions regarding rare species.

DBG, as a participating institution in the Center for Plant Conservation (CPC), is charged with the collection and storage of seeds of over 50 native rare plants occurring in the Rocky Mountain Region. The species collected are part of the CPC's National Collection of over 600 of the country's most imperiled plants. The CPC is a network of over 30 botanical institutions whose mission is to recover America's vanishing flora through a combination of field work and off-site collections. Examples of the species stewarded by the DBG are skiff milkvetch (*Astragalus microcymbus*), clay-loving wild buckwheat (*Eriogonum pelinophilum*), Dudley Bluffs bladderpod (*Lesquerella congesta*), and Penland penstemon (*Penstemon penlandii*).

In optimal years, DBG collects a small amount of seed for storage from several of these species. The seeds are sent to the USDA's National Center for Genetic Resources Preservation in Fort Collins for long-term cold storage. The seeds are stored for future restoration or reintroduction should the species decline to the point that it needs this help to survive in the wild. By collecting seed of rare plants, DBG provides another avenue for conservation of plants at risk of extinction from such threats as habitat destruction or degradation, invasive species, or over-collecting.

Dudley Bluffs bladderpod, Piceance Basin
Photograph by Rusty Roberts

Measuring Success and Progress towards Conservation Objectives

Conserving Colorado's most imperiled plant species means that they are adequately protected, with low threats and high viability. Four fundamental questions facing the RPCI over the long term are:

- *How are Colorado's imperiled plant species doing?*
- *Do we understand the challenges to the status of these plants and how to address them?*
- *Are the conservation actions we are taking having the intended effects?*
- *Is there adequate capacity to achieve our goals?*

To answer these four questions, the RPCI will evaluate a number of indicators that gauge the status of the imperiled plant species and their primary threats. Tracking progress towards goals and evaluating the effectiveness of conservation actions will provide the feedback needed to adjust priorities and objectives. Measuring results provides the basis for adaptive management in this conservation approach.

A proposed framework for measuring success of the implementation of this Strategy is proposed below. These indicators should be measured or assessed every five years unless greater urgency is identified.

a. Viability Status:

- Proportion of all imperiled plant species with good to excellent viability scores (measured with the proportion of A or B ranked occurrences of each species).
- Proportion of all imperiled plant species with viable seeds in seed bank.

b. Threat Status:

- Number of imperiled plants with average to low threat ranks in the *Biodiversity Scorecard for Colorado* (CNHP and TNC 2008). Presently, there are at least 43 species with high threat ranks. This number should decrease overtime.

c. Protection/Conservation Status:

- Proportion of all Important Plant Areas with conservation action plans completed with local stakeholder involvement. There are currently five areas with conservation action plans.
- Proportion of Important Plant Areas with land trusts or agencies working on habitat conservation.

- Proportion of occurrences of imperiled plant species with on-the-ground habitat protection (e.g., conservation easements, special designations, management agreements, etc.).
- Success in obtaining state legislation to conserve rare plants.
- Success in obtaining a long-term program and funding mechanism to support a rare plant conservation program in Colorado.

Conclusions and Recommendations

This Strategy outlines what needs to be accomplished in the next ten years to ensure the long-term conservation of all of Colorado's imperiled plant species and their habitats. This is a pivotal time for plant conservation. At least 119 plant species in Colorado are thought to be at risk of extinction, primarily due to unprecedented and accelerating threats, small population sizes, lack of awareness about their precarious status, and lack of coordination and resources.

The Rare Plant Conservation Initiative (RPCI) is a diverse partnership of over 20 public agencies, academic institutions, and private groups committed to working together to conserve all of Colorado's imperiled plants. Specifically, conservation means that these plant species are adequately protected, with low threats and high viability. By accomplishing the conservation objectives and actions presented in this Strategy, the RPCI will ensure the long-term survival of these rare species and their habitats.

Even though the RPCI has made significant accomplishments since October 2007 (see Box 25) with support from the National Fish and Wildlife Foundation and others, a state plant program is critically needed to achieve the goal of conserving all of Colorado's imperiled plant species and their habitats. Increased capacity, resources, and long-term funding mechanisms are essential for effective implementation of this Strategy.

Box 25. Accomplishments of the Colorado Rare Plant Conservation Initiative: October 2007–January 2009.

- Established RPCI Coalition of over 20 public and private partners.
- Drafted a collaborative, statewide Colorado Plant Conservation Strategy.
- Completed Conservation Action Plans for five Priority Action Areas.
- Completed Best Management Practices to reduce negative impacts from oil and gas development.
- Completed research on the plant protection programs in all 50 states.
- Drafted a legislative concept paper.
- Drafted a state plant policy for Colorado Department of Natural Resources.
- Presented 2008 Conservation Awards to three individuals/organizations for outstanding conservation work on imperiled plant species.
- Completed an educational brochure to raise awareness for the need to conserve Colorado's imperiled species. http://www.conps.org/conservation.html
- Ensured that plants are integrated into the first Colorado Conservation Summit and the Colorado Forest Assessment.
- Established a framework to measure success and progress towards goals.

Priority Conservation Actions and Recommendations

To expedite the implementation of this Strategy, the RPCI partners identified eight short-term and four long-term conservation actions (see below). The partners need to develop funding strategies and mechanisms to support these actions and to accomplish the conservation objectives, e.g., habitat protection, minimize impacts, improve scientific understanding, develop a state program, and ex situ conservation. The RPCI will develop annual implementation plans and convene every six months to monitor progress, review priorities, and adapt the plans as needed.

Summary of Recommended Conservation Actions for Short-term (1-5 years)

1. Prioritize the 119 imperiled plant species for site-specific conservation action in 2009 (e.g., selecting poorly conserved species from the Plant Scorecard).

2. Prioritize the 32 Important Plant Areas ranked (B1) for action in 2009-2013. Develop and implement conservation action plans with working groups consisting of local experts, land trusts, and land managers. Identify appropriate actions for each area.

    a. Work with land trusts and willing landowners to place conservation easements on private lands within the 32 B1 Important Plant Areas (and selected B2s).
    b. Develop multi-species proposals to fund habitat protection of imperiled plant species across Colorado.

3. Work with public agencies to collect/share best available data, develop and implement best management practices, and pursue special designations for imperiled plants.

4. Develop a plant policy for the Colorado Department of Natural Resources, General Assembly joint resolution, and Governor's executive order during 2009.

5. Develop a bill for a state plant statute that establishes a legally-recognized list of imperiled plants, acknowledges Colorado's interest in protecting them, and provides a variety of resources for their conservation.

6. Integrate plants into other statewide conservation planning and protection efforts, e.g., the State Wildlife Action Plan, State Forest Assessment, Colorado Conservation Partnership, Colorado Conservation Summit, federal management plan revisions, and local planning efforts.

7. Improve scientific understanding of the distribution, natural history, and status of rare plants through inventory, research and monitoring.

8. Adopt measures for *ex situ* (off site) conservation in case native populations are extirpated.

Long-term Recommendations (5-10 years)

1. Update the *Biodiversity Scorecard* every five years and address climate change and other emerging impacts in future iterations.

2. Update this *Colorado Rare Plant Conservation Strategy* every five years, starting in 2014, and include consideration of other plant species groups such as vulnerable vascular plant species (ranked G3 by CNHP and NatureServe) and non-vascular plants (lichens, mosses, and liverworts).

3. Develop conservation action plans for all high priority B2 Important Plant Areas, working with local experts, land trusts, and land managers.

4. Assess status of threats, protection/conservation, and viability of Colorado's imperiled plant species every five years.

A Call to Action

Conservation of Colorado's imperiled plants will require significantly increasing coordination and resources, data sharing, and actions based on the best available science. This strategy outlines a number of ways to help conserve Colorado's imperiled plants. Below is a brief summary of conservation actions that federal, state, and local agencies, private groups, academic institutions, and others can take to help ensure long-term viability of Colorado's imperiled plant species and their habitats.

- Federal agencies: Conduct field surveys of imperiled plants to help avoid conflicts; use best available data on plants in Resource Management Plans; develop conservation action plans for imperiled plants; designate/expand special management areas for imperiled plants and their habitats; incorporate rare plants into environmental reviews for proposed projects; develop and implement best management practices; monitor trends of imperiled plants; and work with academic institutions to conduct research to fill key data gaps and inform adaptive management.

- State agencies: Conduct field surveys of imperiled plants to help avoid conflicts; use best available data on rare plants in management plans; develop conservation action plans for imperiled plants; designate/expand special management areas for imperiled plants and their habitats; incorporate rare plants into environmental reviews for proposed projects; develop and implement best management practices; monitor trends of imperiled plants; and work with academic institutions to conduct research to fill key data gaps and inform adaptive management.

- Local governments: Contact CNHP, CNAP, TNC, CoNPS, academic institutions, or other RPCI members to learn about imperiled plants in the local area; conduct field surveys; use best available data in planning; develop conservation action plants for plants; designate special management areas for imperiled plants; develop and implement best management practices; monitor imperiled plants and conduct research; and work with RPCI members on proposals to conserve imperiled plant habitat.

- State and local land trusts: Contact CNHP, CNAP, or other RPCI members to learn about imperiled plants in areas of interest; develop conservation action plans to identify strategies for plants within Priority Action Areas; seek protection of imperiled plant species with willing landowners using conservation easements and/or other protection tools; and work with RPCI members on proposals and management plans to conserve imperiled plants and their habitats.

- Private landowners: Contact the CNHP, CNAP, or TNC if you are interested in learning if your land provides habitat for one or more imperiled plants. If you are interested in learning more about management agreements or state natural area designation, contact CNAP. Contact your local land trust, COL, or TNC for information about conservation easements. Contact CDA or NRCS regarding potential stewardship programs for plants.

- Private organizations (e.g., CoNPS, garden clubs): Educate members and the public regarding the unique values and threats to imperiled plants and their habitats; encourage state legislators to develop and pass a state statute that establishes a state plant list, acknowledges the state's interest in protecting plants, and provides resources for their conservation; and organize volunteer days to monitor or inventory for imperiled plants, working with CNAP, CNHP, and/or DBG (see private citizens below).

- Private citizens: Volunteer with one of the organizations or agencies actively protecting rare plant species (monitor a plant with the CNAP or DBG, become a local steward of a natural area with the CNAP, or join the Adopt a Rare Plant Program with CNHP); donate money to one of the RPCI private partner organizations to support their on-the-ground conservation work (e.g. TNC, COL, CNE); and contact and encourage your state legislators to support a state-level plant program, a state list of imperiled species, and long-term funding for plant conservation.

- Educational institutions: Incorporate native flora and the importance of plant conservation into lesson plans at every level (K-12, colleges, and universities); use natural areas or preserves for field excursions and research with students; and conduct research to fill data gaps on imperiled plants, e.g., in areas of

taxonomy, genetics, reproductive biology, affects of climate change, and adaptation strategies.

Acronyms

ACEC: Area of Critical Environmental Concern

BFAG: Betty Ford Alpine Gardens

B1: Area of Outstanding Biodiversity Significance

B2: Area of Very High Biodiversity Significance

BLM: Bureau of Land Management

BMP: Best Management Practices

CDA: Colorado Department of Agriculture

CFGC: Colorado Federation of Garden Clubs

CNAP: Colorado Natural Areas Program

CNE: Center for Native Ecosystems

CNHP: Colorado Natural Heritage Program

CDOT: Colorado Department of Transportation

CDOW: Colorado Division of Wildlife

COL: Colorado Open Lands

COLO: University of Colorado Herbarium

CO NPS: Colorado Native Plant Society

CPC: Center for Plant Conservation

CU: University of Colorado

DBG: Denver Botanic Gardens

G1: Critically Imperiled

G2: Globally Imperiled

IPA: Important Plant Area

IPCC: United Nations Intergovernmental Panel on Climate Change

NCGRP: National Center for Genetic Resources Preservation

NPS: National Park Service

NRCS: Natural Resources Conservation Service

PAA: Priority Action Area

PCA: Potential Conservation Area

RMP: Resource Management Plan

RMSBA: Rocky Mountain Society of Botanical Artists (RMSBA)

RPCI: Rare Plant Conservation Initiative

SLB: State Land Board

TNC: The Nature Conservancy

UNC: University of Northern Colorado

USFS: U.S. Forest Service

USFWS: U.S. Fish and Wildlife Service

Glossary

Biocontrol: The use of one species of organism to control another through a biological mechanism such as predation.

Endemic: A species or taxon native to a particular place and found only there.

Environmental Review: The evaluation of land use projects for potential impacts to rare plant species and/or other natural resources.

***Ex situ* conservation**: The practice of protecting rare plants outside of their native habitat, typically through the collection and storage of germplasm in a seedbank (off site).

Extirpation: The process by which an individual, species, or population disappears from a given habitat or area.

Extinction: The process by which an individual, species, or population is totally extirpated.

Exurban: A residential area beyond suburbs or a city, beyond the suburbs.

Imperiled: Species classified as globally imperiled or critically imperiled with global ranks of G1 or G2 by NatureServe.

Important Plant Areas: The Colorado Natural Heritage Program's best estimate of the geographic areas needed to support the continued existence of the most imperiled plant species.

***In situ* conservation**: The practice of protecting rare plants by conserving their native habitat (on site).

Invasive species: A species that does not naturally occur in a specific area and whose introduction, often accidental, causes economic or environmental harm or harm to human health.

Occurrence: An occurrence is an area of land and/or water in which a species or natural community is, or was, present (defined by NatureServe).

Potential Conservation Areas: The areas identified by the Colorado Natural Heritage Program representing the area needed to support the continued existence of the most imperiled plant or animal species or plant community.

Priority Action Areas: A subset of Important Plant Areas needing conservation attention in the near future to prevent extinction or loss of plant species.

Rare species: Species that were formerly more abundant but have recently been reduced to small population size due to habitat destruction, invasive species, and/or change in disturbance regimes; or species with small population size that were historically rare.

Refugia: Places where species at risk from climate change will persist under anticipated climate conditions.

Stochastic: Random events, such as catastrophic fire or flooding.

Take provisions: Provisions in the federal Endangered Species Act that relate to killing, injuring, or harming of species. The prohibition against "take" covers fish and wildlife but not plants. It is, however, illegal to remove an endangered plant from federal land and reduce it to possession, and federal law also federalizes state law prohibitions on the taking of plants.

Taxon (Taxa): A taxonomic group of any rank, such as species or subspecies.

References

California Native Plant Society, 1992. Policy on Appropriate Application of *Ex Situ* Conservation Techniques. http://www.cnps.org/archives/ex_situ.htm.

Center for Native Ecosystems, Colorado Native Plant Society, and S.L. O'Kane, Jr. 2005. Petition to list DeBeque phacelia (*Phacelia submutica*) as Threatened or Endangered and designate Critical Habitat under the Endangered Species Act. Submitted to the Secretary of the United States Department of the Interior and the Director of the USDI Fish and Wildlife Service.

Center for Plant Conservation. 1991. Genetic Sampling Guidelines for Conservation Collections of Endangered Plants. Pages 225-238 in D.A. Falk and K.E. Holsinger, editors, Genetics and Conservation of Rare Plants. Oxford University Press, New York.

Colorado Conservation Trust. 2007. Colorado Conservation at a Crossroads. 2007 Land Conservation Report. Colorado Conservation Trust, Boulder. 24 pp.

Colorado Division of Wildlife. 2006. Colorado's Comprehensive Wildlife Conservation Strategy and Wildlife Action Plans. Colorado Division of Wildlife, Denver. 328 pp.
http://wildlife.state.co.us/WildlifeSpecies/ColoradoWildlifeActionPlan/

Colorado Native Plant Society. 1997. Rare Plants of Colorado, 2nd edition. Falcon Press, Helena, Montana and the Rocky Mountain Nature Association, Estes Park, Colorado in cooperation with the Colorado Native Plant Society. 108 pp.

Colorado Natural Heritage Program. 2008. Biodiversity Tracking and Conservation System (BIOTICS). Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Colorado Natural Heritage Program and The Nature Conservancy. 2008 (August). *A Biodiversity Scorecard for Colorado*. Colorado Natural Heritage Program, Colorado State University, Fort Collins and The Nature Conservancy, Boulder. Unpublished report to The Nature Conservancy. 133 pp.

Convention on Biological Diversity. 2008. Plant Conservation Report: A Review of Progress in Implementing the Global Strategy for Plant Conservation. UNEP/CBD/COP/9/INF/25. 50 pp.

Elliott, B., S. Panjabi, B. Neely, R. Rondeau, B. Kurzel, and M. Ewing. 2008. Best Management Practices: Practices Developed to Reduce the Impacts of Oil and Gas Development Activities to Plants of Concern. Unpublished report on file at The Nature Conservancy, Boulder, Colorado. 10 pp.

Enquist, C. and D. Gori. 2008. A Climate Change Vulnerability Assessment for Biodiversity in New Mexico, Part I: Implications of Recent Climate Change on Conservation Priorities in New Mexico. 68 pp.

Groves, C.R. 2003. Drafting a Conservation Blueprint: A Practitioner's Guide to Planning for Biodiversity. The Nature Conservancy, Island Press, Washington, DC. 457 pp.

Hansen, A. R. Knight, S. Powell, K. Brown, P. Gude, and K. Jones. 2005. Effects of Exurban Development on Biodiversity: Patterns, Mechanisms and Research Needs. Ecological Applications (15:6): 1893-1905.

Joyce, L.A. 2008. Personal communication. Rocky Mountain Research Station, U.S. Forest Service, Fort Collins, Colorado.

Kram, M., B. Neely and S. Panjabi. 2008. Rare Plant Conservation Planning Workshop: Middle Park Priority Action Area. Prepared by The Nature Conservancy and the Colorado Natural Heritage Program. Unpublished report prepared for the National Fish and Wildlife Foundation. 14 pp.

Loarie, S.R., B.E. Carter, K. Hayhoe, S. McMahon, R. Moe, C.A. Knight, and D.D. Ackerly. 2008. Climate change and the future of California's endemic flora. *PLoS One* 3(6): e2502. doi:10.1371/journal.pone.0002502.

Marinelli, J., editor. 2005. Plant: The Ultimate Visual Reference to Plants and Flowers of the World. DK Publishing, New York. 512 pp.

Martland, L. 2008. Legislative Research Regarding Plant Protection across the United States. Unpublished report on file at the Colorado Department of Agriculture and The Nature Conservancy, Denver.

Menges, E. S., E.O. Guerrant Jr., and S. Hamzé. 2004. Effects of Seed Collection on the Extinction Risk of Perennial Plants. In Guerrant Jr. E.O., Kayri Havens, and Mike Maunder eds., Ex situ plant conservation. Pp. 305-324. Island Press, Washington.

Millennium Ecosystem Assessment. 2005.Ecosystems and Human Well-Being: Current State and Trends: Findings of the Condition and Trends Working Group (Series Volume I). Island Press. 948 pp.

Prior-Magee, J.S., K.G. Boykin, D.F. Bradford, W.G. Kepner, J.H. Lowry, D.L. Schrupp, K.A. Thomas, and B.C. Thompson, Editors. 2007. Southwest Regional Gap Analysis Project Final Report. U.S. Geological Survey, Gap Analysis Program, Moscow, ID.

Roberson, E. 2008. Medicinal Plants at Risk. Center for Biological Diversity, Tucson, Arizona. 16 pp.

Saunders, S., C. Montgomery, T. Easley, and T. Spencer. 2008. Hotter and Drier: The West's Changed Climate. Rocky Mountain Climate Organization and Natural Resources Defense Council. 54 pp.

Schneider, S.H., S. Semenov, A. Patwardhan, I. Burton, C.H.D. Magadza, M. Oppenheimer, A.B. Pittock, A. Rahman, J.B. Smith, A. Suarez, and F. Yamin. 2008. Assessing key vulnerabilities and the risk from climate change. Pages 779-810 in Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson, editors). Cambridge University Press, Cambridge, UK.

Scott, M., D.D. Goble, J.A. Weins, D.S. Wilcove, M. Bean, and T. Male. 2005. Recovery of imperiled species under the Endangered Species Act: The need for a new approach. *Frontiers in Ecology and the Environ*ment 2(7): 383-389.

Souza, D.M. 2003. Endangered Plants. Franklin Watts, A Division of Scholastic, New York. 63 pp.

Spackman, S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land Management, U.S. Fish and Wildlife Service and U.S. Forest Service by the Colorado Natural Heritage Program, Fort Collins.

Stein, B.A., and K. Gravuer. 2008. Hidden in Plain Sight: The Role of Plants in State Wildlife Action Plans. NatureServe, Arlington, Virginia. 28 pp.

Stein, B.A., L.S. Kutner, and J.S. Adams, editors. 2000. Precious Heritage: The Status of Biodiversity in the United States. The Nature Conservancy & Association for Biodiversity Information. Oxford University Press, New York. 399 pp.

Theobald, D.M., G. Wilcox, S.E. Linn, N. Peterson, and M. Lineal. 2008. Colorado Ownership, Management, and Protection v7 database. Human Dimensions of Natural Resources and Natural Resource Ecology Lab, Colorado State University, Fort Collins, CO. 15 September. www.nrel.colostate.edu/projects/comap

Tollefson, C. 2008. Secretary Kempthorne Announces New Conservation Mechanism for Threatened and Endangered Species. Press release. U.S. Fish and Wildlife Service, Washington, DC.

United Nations Intergovernmental Panel on Climate Change. 2007. Fourth Assessment Report on Climate Change. http://www.ipcc.ch/ipccreports/assessments-reports.htm

Weber, W. A. and R. C. Wittmann. 1992. Catalog of the Colorado Flora: A Biodiversity Baseline. University of Colorado Museum. University Press of Colorado, Boulder, Colorado. Electronic version, revised March 11, 2000. http://cumuseum.colorado.edu/Research/Botany/Databases/catalog.html