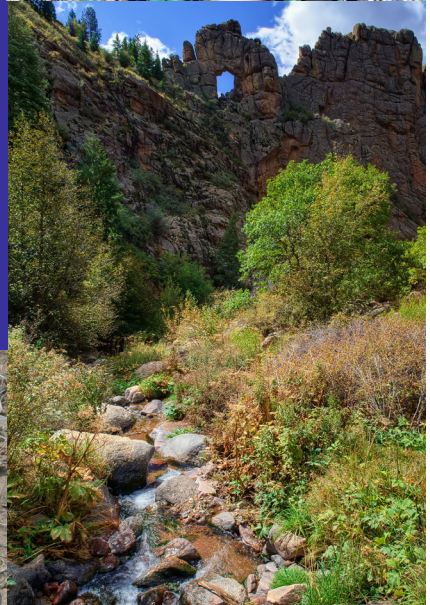




THE STATE OF
COLORADO'S
BIODIVERSITY
2011



Citation: Rondeau, R., K. Decker, J. Handwerk, J. Siemers, L. Grunau, and C. Pague. 2011. The state of Colorado's biodiversity 2011. Prepared for The Nature Conservancy. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Copyright ©2011 Colorado Natural Heritage Program, Colorado State University
All rights reserved.

Cover photos clockwise from top left: west side of Pike's Peak ©Michael Menefee; Arkansas Valley evening primrose (*Oenothera harringtonii*) ©Michael Menefee; boreal toad (*Bufo boreas boreas*) ©CNHP; Window Rock in Teller County ©Michael Menefee; swift foxes (*Vulpes velox*) ©Pat Gaines; Pawnee National Grassland ©Michael Menefee; Swainson's Hawk (*Buteo swainsoni*) ©Michael Menefee; plains ironweed (*Vernonia marginata*) ©CNHP; female lesser earless lizard (*Holbrookia maculata*) ©CNHP.

The State of Colorado's Biodiversity 2011

Colorado Natural Heritage Program
Warner College of Natural Resources
Colorado State University
Campus Delivery 1474
Fort Collins, CO 80523
(970) 491-7331
www.cnhp.colostate.edu

By:
Renée Rondeau
Karin Decker
Jill Handwerk
Jeremy Siemers
Lee Grunau
Chris Pague

December 2011



ACKNOWLEDGEMENTS

This project represents an extensive team effort by staff members of the Colorado Natural Heritage Program (CNHP) and The Nature Conservancy (TNC) working together over a five-year period. Special thanks are due to Chris Pague (TNC) for having the foresight to envision this project, enough patience to review all the details, the faith that it would have meaning, and for finding the funding to complete this first iteration. This project also could not have been completed without the oversight and enthusiasm of Renée Rondeau (CNHP), who directed the collaboration of the many and varied contributors, while also serving as a “scorecard ambassador” to the conservation community at large.

On behalf of the Colorado Natural Heritage Program: Ecological systems were coordinated by Karin Decker, with assistance from Michelle Fink and Renée Rondeau. The rare plant section was coordinated by Jill Handwerk, with

assistance from Dave Anderson, Karin Decker, Georgia Doyle, Michelle Fink, Amy Lavender, Katie Neuhaus, Susan Spackman Panjabi, and Renée Rondeau. Second paragraph. The animal section was coordinated by Jeremy Siemer, Renée Rondeau, and Chris Gaughan, with assistance from Brad Lambert, Rob Schorr, John Sovell, and Chris Pague. Fagan Johnson, Melissa Landon, and Stephanie Neid also provided support for the project. Lee Grunau and Karin Decker compiled and edited this final report.

On behalf of The Nature Conservancy of Colorado: Chris Pague, Terri Schulz, Kei Sochi, Betsy Neely, and Tim Sullivan contributed valuable ideas, hard work, and critical feedback.

Every good vision needs people who can pay attention to details in order to produce a high quality product, and many such have contributed to this project. We are grateful for the input of reviewers

from the Colorado Rare Plant Technical Committee. Special thanks to Veronica Estelle and Dee Malone for reviewing the entire document and providing valuable edits and comments that greatly enhanced the final product.

This project was primarily funded by The Nature Conservancy. Valuable information was also contributed through the work funded by many of CNHP's other sponsors.

Special thanks to the William H. Donner Foundation, Inc., and to Valerie Gates, for providing critical support to TNC for the measures of success project.

Photo credits: all photos are CNHP file photos unless credited otherwise.

EXECUTIVE SUMMARY

Colorado is a “must see” state for many, thanks to its majestic scenery, abundant recreation opportunities, and pleasing climate. We are blessed with a diversity of ecosystems, ranging from the high alpine peaks of the Continental Divide, to the rolling prairies and deep canyonlands of our eastern prairies and western plateaus. We are also faced with many management challenges, including population growth and energy development.

Many groups, including federal, state, and local governments, as well as private conservation organizations, are working together on conserving and managing our state’s biological diversity. Although there are many eyes on biodiversity issues, there is still not enough time, money, and - in some cases - political will, to conserve all of Colorado’s remaining native landscapes. Thus, setting well thought-out priorities for conservation action is essential.

Conservationists and planners need methods to identify priority areas for conservation, information on how to characterize the relative importance, quality, and urgency of these areas (inform conservation strategies), and a means to measure conservation success on a regional or statewide basis over time. In order to assist the Colorado office of The Nature Conservancy with their “Measures of Success” program, and to provide biodiversity status information to other organizations in Colorado, the Colorado Natural Heritage Program has developed a prototype analysis of the status of Colorado’s biodiversity, using a “scorecard” approach.

Following the three-part model of “effective conservation” developed by The Nature Conservancy, our scorecard evaluated the status of ecological systems, at-risk animals, and rare plants under three broad categories: 1) Biodiversity status – including size, quality, and landscape integrity; 2) Threat status – focused on both current and potential future impacts; and

3) Protection status. This scorecard includes 18 ecological systems, 113 of Colorado’s at-risk vertebrate animal species, and 103 of our rarest plant species.

This biodiversity scorecard provides a snapshot of the current conservation status of our rare and imperiled species, and our most widespread ecological systems. We took a systematic and repeatable approach to these assessments, focusing on: quality, quantity, threats, and level of current protection. Resulting scores for these factors were then combined to produce an overall conservation status score. Successful implementation of a comprehensive conservation strategy should result in maintaining or improving these scores over time.

This report is not a strategy for achieving conservation success. Rather, it is a guide to help set conservation priorities, and to develop those strategies that are needed to ensure the long-term

viability of all of our biological resources.

Ecological Systems

Our analysis shows that, while Colorado's dominant ecological systems are still largely intact, many of them are threatened and/or not well protected. Common and widespread ecological systems in Colorado are generally of good to high quality and part of naturally functioning landscapes. For some ecological systems, however, threats and lack of protection may change this situation rapidly. Only two of our systems scored Effectively Conserved; 16 systems are in need of some level of conservation attention if they are to reach Effectively Conserved status (Table ES-1). This situation implies both great risks and great opportunities for conserving functioning landscapes in our state.

Shortgrass prairie is by far the most altered of any of Colorado's major ecological systems, has fair threat status, and is poorly protected as well. Despite the loss of nearly half of Colorado's shortgrass prairie in the past century, there remain some very large, high quality areas that present excellent opportunities for conservation.

Species

It is important to note that the majority of Colorado's plants and animals are not at risk (Figure ES-1). Of the species that are at risk, fish and amphibians – both aquatic dependent species – have the

Table ES-1. Overall conservation status scores for Colorado ecological systems analyzed.

System Name	Conservation Status
Alpine Tundra	Effectively conserved
Aspen	Moderately conserved
Foothill Shrubland	Weakly conserved
Grasslands	Weakly conserved
Greasewood	Under conserved
Juniper	Weakly conserved
Lodgepole Pine	Moderately conserved
Mixed Conifer	Moderately conserved
Oak & Mixed Mtn Shrub	Weakly conserved
Pinyon Juniper - CO PL	Weakly conserved
Pinyon Juniper - SRM	Moderately conserved
Ponderosa Pine	Weakly conserved
Sagebrush	Weakly conserved
Salt Shrub	Weakly conserved
Sand Sage	Under conserved
Shortgrass Prairie	Under conserved
Shrub-Steppe	Moderately conserved
Spruce Fir	Effectively conserved

highest percentage of at-risk taxa. Forty-three percent of all native fish species are at-risk, and of those, almost all are weakly or under-conserved. Amphibians fared only slightly better, with 41% of native species at risk; half are weakly or under-conserved. Mammals, birds, and reptiles are nearly equal with approximately 20% of the species at risk or 80% not at risk. In terms of absolute numbers, plants have the highest number of at-risk species (103). However, 96% of our native plant species are not at risk.

At-risk status does not translate directly into federal legal protection. Of all the at-risk species in our state, a much smaller

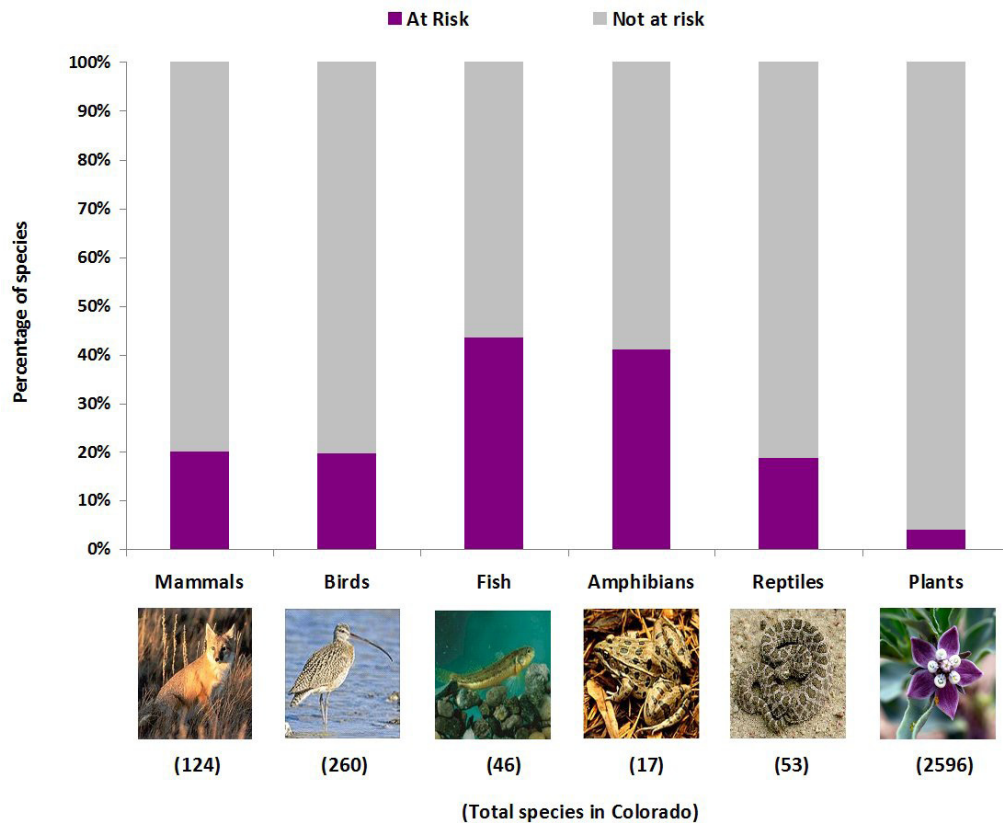
number are listed as threatened or endangered under the Endangered Species Act:

- 🐸 Amphibians = 0
- 🐦 Birds = 6
- 🐟 Fish = 5
- 🐾 Mammals = 4
- 🐍 Reptiles = 0
- 🌱 Plants = 16

Animals

Colorado has approximately 500 vertebrate species, of which approximately 20% are considered at-risk (Figure ES-1). Twelve native vertebrate species have been extirpated from Colorado. We evaluated 113 vertebrate species and found that 68 of these are “under”

Figure ES-1. Comparison of conservation status between taxonomic groups, statewide. Percentage-wise, fish and amphibians are most in need of conservation attention. However, in terms of total numbers of species, the plant group has by far the greatest number of at-risk species.



or “weakly conserved” and would greatly benefit from conservation action. The remaining 45 species are “moderately” to “effectively conserved” and although they would benefit from conservation action, the urgency is not as great. The following describes some of the results from each taxonomic group.

Fish

Prior to European settlement, we had 53 native fishes. Due to direct mortality, introduced species, and water development projects, we lost seven species (mostly from the eastern plains) and we are

struggling to maintain five species, all from the Colorado River Basin and federally listed. Almost half of Colorado’s extant fish are considered at-risk. Primary threats to our fish include introduced species and water development. Colorado now has more non-native (87) than native fish and most waterways have been manipulated.

Amphibians

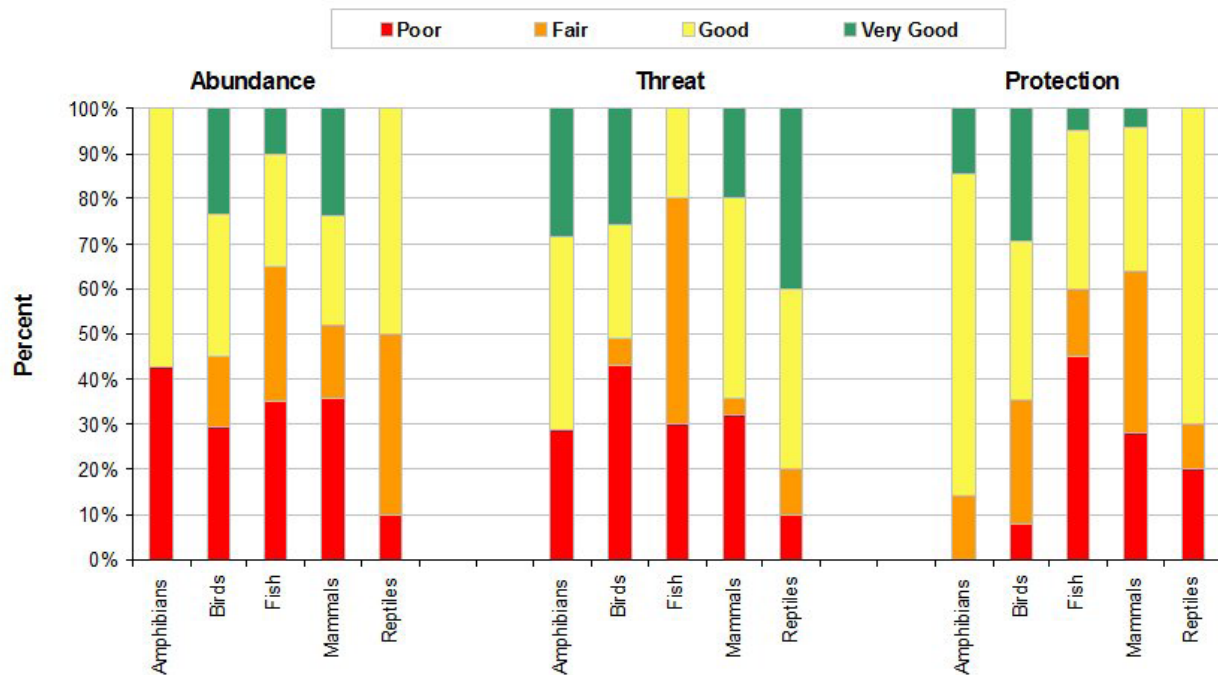
Of Colorado’s 17 native amphibians, almost half (41%) are at-risk, the second highest percentage of any group, following fish. Nearly 30% of these are highly threatened

while protection is good to very good for most species (Figure ES-2). These water-dependent species are threatened by disease and non-native species. The majority of these species are found in the eastern plains although the Rocky Mountains has one of the most imperiled species—the boreal toad, highly threatened from chytrid fungus yet adequately protected.

Mammals

Of the 124 native mammals in Colorado, 99 species (80%) have stable populations, and 25 species (20%) are at risk. Four mammals

Figure ES-2. Conservation status scores for vertebrate animal species by rating factor (abundance, threat, and protection) and taxonomic group.



are federally listed. Fifteen of the at-risk species are weakly or under conserved and are in need of threat abatement and/or protection (Figure ES-2). Nearly half of the at-risk species inhabit grasslands. The primary threats are direct mortality, and urban and energy development.

Birds

There are 240 native breeding bird species in Colorado, by far our largest vertebrate group. Thus it is no surprise that birds have the greatest number of at-risk species (51) among all animal groups. However, in terms of percentages, our native birds are comparable to the mammal and reptile groups, with 20% at risk. Six of Colorado's at-risk bird species are federally listed. The habitats

with the greatest number needing conservation action are grasslands, shrublands, and wetlands. Nearly 50% of the birds have poor threats while nearly 1/3 of them are under protected (Figure ES-2). The most significant threats are habitat loss due to conversion to cropland, forestry, energy development, and wetland/riparian alteration.

Reptiles

Of Colorado's 53 native reptiles, the majority (81%) have stable populations, while 19% are at risk. There are no federally listed reptiles. Eight of the 10 at-risk species are found in the Eastern Plains and grasslands and wetlands are important habitats. Some 20% of the reptiles are highly threatened while 30% are under protected

(Figure ES-2). Invasive species and energy development are the primary threats.

Only 15 of the 113 at-risk vertebrate animal species evaluated received an overall conservation status score of "Effectively Conserved," leaving 98 species (20% of all of Colorado's vertebrates) in need of conservation action (Figure ES-2).

In terms of the ratio of at-risk species to those not at risk, Colorado's aquatic-dependent fish and amphibians are in greatest need of conservation attention, with 44% and 41% of species at risk, respectively (Figure ES-1). Birds, mammals, and reptiles are in somewhat better condition overall, with 20%, 20, and 19% in need of conservation, respectively.

In actual numbers of species, rather than ratio of at-risk to not-at-risk, the bird group has the highest total number of species in need of conservation action, with 28 species receiving an Under Conserved or Weakly Conserved score.

Thirty-one percent of the vertebrate species we scored had very low abundance scores. Once again, fish are doing comparatively worse than other taxonomic groups. Nearly 35% of all of the scored vertebrates were rated highly threatened. The fish group has, by far, the highest proportion of species significantly threatened, with mammals and birds a distant second and third.

Forty-six percent of the scored species received poor scores in the Protection category. Species within the fish and mammal groups have the least protection, while amphibians are the most secure in terms of legal land protection.

Results by Habitat Type

For Colorado's at-risk vertebrates, wetlands (including aquatic habitats) and grassland habitats host the greatest number of our at-risk species. Though wetlands and aquatic areas occupy less than 2% of Colorado, the proportion of at-risk species that rely on them is very high, and the majority of these species are Weakly or Under Conserved. Grasslands occupy 22% of Colorado's landscape (the largest habitat type in Colorado yet it has the greatest loss), and our grassland species continue to decline. Table ES-2 provides a break down by habitat.

Table ES-2. Number of vertebrate species included in this analysis in each habitat.

Habitat	Number of Animal Species
wetlands/aquatics	46
grasslands	28
forests	13
shrublands	10
cliff and canyon	7
pinyon-juniper	7
alpine	1

Plants

There are approximately 2,600 plant species in Colorado. The Colorado Natural Heritage Program tracks over 500 regionally endemic or uncommon (rare) plant species (CNHP 2008). Of these, 253 are critically imperiled (G1), imperiled (G2), or vulnerable to extinction (G3) on a global scale. Sixteen of these G1, G2, and G3 species are federally listed as threatened or endangered. Of Colorado's 113 G1G2 plant species, 100 were included in this analysis, together with three G3 species.

Excluding species with a low percent of their range in Colorado, 51% of the rare species analyzed here are in the moderately or effectively conserved categories (Figure ES-3). Nearly half of Colorado's G1G2 plant species are poorly or weakly conserved, often due to significant threats and lack of protection.

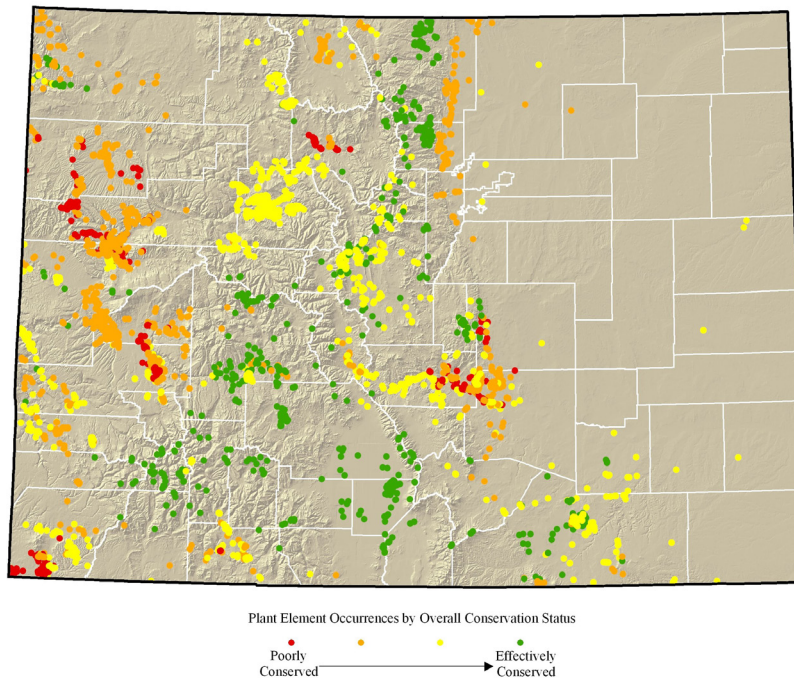
Biodiversity scores were generally low, largely because rare plant species typically have a small number of occurrences and occupy a small area within a limited range. Threat status for 45% of our rare plant species is poor to fair, especially for species occurring in barrens and shrubland habitats. In general, species of higher elevations are less threatened, while those occurring in the Colorado's western plateaus and valleys are most threatened.

Protection status scores for Colorado's rare plants are mixed. Overall, about half of the species, particularly those of higher elevations, have very good protection status scores. Poor protection scores are concentrated in the barrens, shrubland, pinyon-juniper, and wetland habitats.

Results by Habitat Type

Three habitat types accounted for about 60% of the plant species analyzed in our scorecard (Table

Figure ES-3. Distribution of at-risk plant occurrences by overall conservation status.



of Colorado's rare plant species are at risk from resource extraction, motorized recreation, housing and urban development, and roads.

Although the results of our scorecard indicate that many of Colorado's rare plants need more protection, the good news is that because many high quality occurrences are known to exist, there is still time for actions that will ensure effective conservation for these species.

Geographic Regions

Colorado can be divided into three primary geographic regions: Eastern Colorado Plains, Colorado Rocky Mountains, and Western Colorado Valleys and Plateaus.

The Eastern Colorado Plains have the highest number of at-risk animal species – 65, compared to Colorado Rocky Mountains (49) and Western Colorado Valleys (52) (Figure ES-4). The plains also have the highest proportion of its total fauna in some category of

ES-3). Of the 46 species with the poorest threat status scores, the majority (72%) are within the barrens and shrubland habitats. Barrens occupy less than 1% of Colorado acreage, but support more than 20% of the rarest species.

Shrublands are Colorado's second most important habitat for rare plants, and are found on nearly 20% of the state's acreage. The primary threats to Colorado's rare plants are varied, but the greatest impact is likely to come from a few threat types. One third

Table ES3. Number of plant species and threat status scores by primary habitat. The approximate percentage of Colorado's total acreage occupied by each habitat type is shown, together with the number of rare plant species primarily occurring in that habitat, and the number and percentage of those species having a high level of threat).

Habitat	% of Colorado Landscape	Number of Plant Species in Scorecard	Number of species in "most threatened" (red or orange) categories	Percent of plant species in "most threatened" (red or orange) categories
Barrens	< 1%	24	19	79%
Shrubland	19%	22	15	68%
Wetland	2%	8	3	38%
Pinyon-Juniper	10%	16	5	31%
Forest	21%	4	1	25%
Grassland	22%	4	1	25%
Alpine	3%	12	3	25%
Cliff and Canyon	< 1%	13	0	0%

conservation concern. The Eastern Colorado Plains is considered the most species-diverse region in Colorado for amphibians and reptiles, so it isn't surprising that the plains have more amphibians and reptiles of conservation concern than the other regions. Eighty percent of Colorado's native amphibians and reptiles occur in the eastern plains (Hammerson 1999), as do 45 % of our native fish. Fish distribution across geographic regions is relatively consistent, with 35 % in the Colorado Rocky Mountains and 25% in the Western Colorado Valleys and Plateaus. With regard to rare plant species, Colorado's Rocky Mountains and Western Valleys and Plateaus are rich with endemic plant species, many of which are of conservation

concern. While the Eastern Plains have very few rare plants.

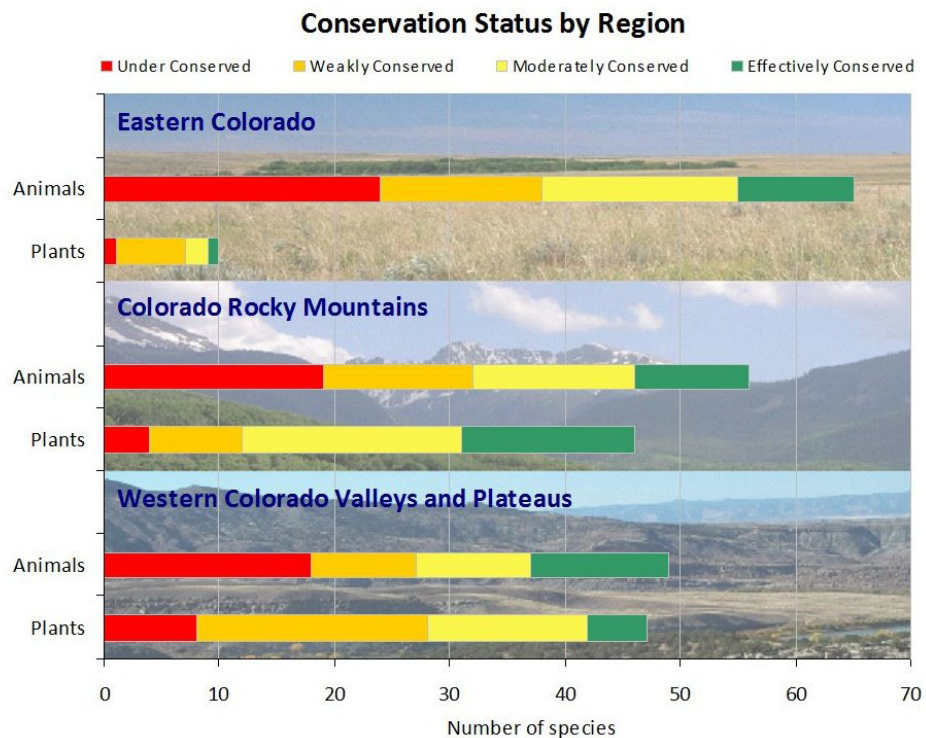
Conclusion

This report presents the current "state of the state" for Colorado's biodiversity, as well as a transparent and repeatable method of evaluating the success of future conservation action. Although the primary purpose of this document is to refocus and set new priorities for conservation efforts, the results also present a picture of work yet to be done that is daunting by any standard. While the numbers, graphs, and pictures demonstrate why we need to continue and improve our efforts, the reader

should also note the tremendous successes already achieved.

Without the contributions of many dedicated individuals, conservation groups and public agencies from the local to national level, Colorado's biodiversity – its species and ecosystems – would not be as rich as it is today. The decades-long efforts of all who are dedicated to conserving our biodiversity are apparent in the results of this scorecard. For example, the push to designate and conserve wilderness areas beginning half a century ago led to the high scores of high elevation ecosystems such as spruce-fir forest and alpine tundra. In species conservation, raptors, including the Bald Eagle and Peregrine Falcon, are a notable success story, thanks

Figure ES-4. Conservation status of at-risk animals and plants by region.



to ongoing efforts to change policies and preserve both individuals and their habitats. Furthermore, a number of our rarest plants have clearly benefited from local and regional conservation efforts, including the Larimer aletes in the Laramie Foothills, the slender spiderflower in the San Luis Valley, and a number of high elevation species that are primarily found in wild areas, such as the Colorado Buckwheat. These successes underscore the importance of holding ourselves, the conservation community, and the citizens of Colorado to a high standard. Our biodiversity is rich and loved by residents and visitors alike – it is the fabric that supports us in both good and bad times. Colorado has developed a strong conservation ethic and this report is an important map to guide our future efforts. The information in this report tells us how well we have done in the past, as well as pointing out where we need to redouble our efforts.

An important note regarding global climate change: this report contains the culmination of several years' worth of data analysis and synthesis. At the time that most of these analyses took place, data for predicting the impact(s) of climate change on biological resources were in the early stages of development, and methods were (and remain) under debate. Therefore, this significant potential threat is not directly addressed in this iteration of the Scorecard analysis for plants and animals, but is a high priority for the next iteration of this report.

The good news is that Colorado is blessed with a relatively intact natural landscape that still supports the majority of our native biological diversity. This means that we still have many options for conserving and protecting our at-risk species and ecological systems. Roughly 80% of our species are doing well, but 20% need help to survive. We hope that with continued conservation action we can improve the conservation status of that 20%. Wetlands and other aquatic habitats, grasslands, shrublands, and barren landscapes are high priority habitats for immediate conservation attention, including protection, restoration, and management. On-going maintenance of our forest and alpine systems is also needed, especially in the face of climate change.

The next step is to develop and implement the management, threat abatement, and protection strategies needed to decrease the number of at-risk species and improve their conservation status. We believe

that with good planning, education, and adequate funding, we can protect and manage Colorado's unique biodiversity features – but this will take a concerted effort on the part of scientists, conservation biologists, policy makers, and funders – not to mention the will of the people.

The information in this report should be valuable to those implementing these strategies. We recommend updating this Scorecard on an on-going basis, including a revised summary report issued every five to 10 years. This will allow the state to monitor trends in the conservation status of its species, habitats, and ecological systems over time. We hope our conservation partners will join with us in this effort. We welcome suggestions on how to improve this document for the next update, and hope that it will be used to help keep Colorado colorful!



CONTENTS

Acknowledgements	4
Executive Summary	5
Introduction	15
Background	15
The Scorecard Approach	16
Natural Heritage Methodology	17
Interpreting this Analysis	17
Treatment of Common Names	18
Overview of Colorado	18
Ecological Systems	25
Vegetation Classification	25
Analysis Methods	25
Results	29
Discussion	35
Ecological System Summary Sheets	37
Species	74
Species: Animals	76
Species included in the analysis	76
Scoring Methods	76
Results	84
Results by Taxa	92
Results by Habitat Type	99
Discussion	100
Species: Plants	110
Species included in the analysis	110
Scoring Methods	113
Results	115
Results by habitat type	122
Discussion	123

Species: Geographic Region	136
Conclusion	139
References	141
Appendices	145
Appendix A: Ecological Systems Scorecard Methodology	145
Appendix B: Ecological Systems Scorecard	159
Appendix C: Animal Scorecard Methodology	162
Appendix D: Animal Scorecard	172
Appendix E: Rare Plant Scorecard Methodology	182
Appendix F: Rare Plant Scorecard	193
Appendix G: Natural Heritage Methodology	204



INTRODUCTION

Colorado is a “must see” state for many, thanks to its majestic scenery, abundant recreation opportunities, and pleasing climate. We are blessed with a diversity of ecosystems, ranging from the high alpine peaks of the Continental Divide, to the rolling prairies and deep canyonlands of our eastern prairies and western plateaus. We are also faced with many management challenges, including population growth, energy development, and climate change.

Many groups, including federal, state, and local governments, as well as private conservation organizations, are working together on conserving and managing our state’s biological diversity. Although there are many eyes on biodiversity issues, there is still not enough time, money, and - in some cases - political will, to conserve all of Colorado’s remaining native landscapes. Thus, setting well thought-out priorities for conservation action is essential.

In developing this Biodiversity Scorecard, the question we set out to answer was “How can we best focus conservation action, and then measure the success of our work?” This Biodiversity Scorecard provides a snapshot of the current conservation status of our rare and imperiled species, and our most widespread ecological systems.

We took a systematic and repeatable approach to these assessments, focusing on four factors: quantity, quality, threats, and level of current protection. Resulting scores for these four factors were then combined to produce an overall conservation status score. Successful implementation of a comprehensive conservation strategy should result in maintaining or improving these scores over time.

This report is not a strategy for achieving conservation success. Rather, it is a guide to help set conservation priorities, and to develop those strategies that are needed to

ensure the long-term viability of all of our biological resources.

Background

The international network of state Natural Heritage Programs and Conservation Data Centers are responsible for compiling and maintaining comprehensive data about at-risk species, natural communities, and ecosystems, that may serve as the focus of conservation efforts. These entities, along with the Colorado Division of Wildlife and expert reviewers, were the primary sources for biodiversity information that was used in the development of this Scorecard.

For many areas of the country, particularly in western states that retain substantial tracts of natural habitat, biological survey information is a work in progress. Even in well-surveyed areas, information is continuously updated, reflecting the dynamic nature of our biodiversity knowledge (Stein and Davis 2000).

At the same time, conservation and planning efforts cannot be put on hold until our knowledge is complete. Conservationists and planners need 1) methods to identify priority areas for conservation, 2) information on how to characterize the relative importance, quality, and protection urgency of these areas, and 3) a means to measure conservation success on a regional or statewide basis over time.

The Scorecard Approach

In order to assist the Colorado office of The Nature Conservancy (TNC) with their “Measures of Success” program, and to provide biodiversity status information to other organizations in Colorado, the Colorado Natural Heritage Program (CNHP) has developed a prototype analysis of the status of Colorado’s biodiversity, using a “scorecard” approach.

Scorecard methods have become widely used in business as a technique for measuring corporate performance indicators (e.g., the “balanced scorecard” of Kaplan and Norton 1992). Other organizations have adopted scorecard techniques to analyze and report on the status of biological and ecological resources at various scales (e.g., Harwell 1999, Heinz Center 2002, Paul 2003, North American Bird Conservation Initiative 2011).

A scorecard provides a comprehensive, repeatable, science-based approach for

identifying constituent components of a subject, exploring relative contributions of these components, identifying which factors are of greatest concern, and producing summary statistics. Scorecards are suitable for use at many levels, from the broad general picture to in-depth, local analysis.

The work reported here includes a representative sample of Colorado’s rarest plant and animal species, as well as Colorado’s most common and widespread ecological systems. Reflecting the three-factor approaches of Parrish et al. (2003) and Ervin (2003), as well as the three-part model of “effective conservation” developed by The Nature Conservancy (Dutton & Salzar 2005), our scorecard evaluates the status of each species and ecological system under three categories:

- 1) Biodiversity status – including abundance and quality,
- 2) Threat status – current and potential future impacts, and
- 3) Protection/Land management status - degree of certainty that management will support continued existence of the species and ecological systems.

Resulting scores for these three factors were then combined to produce an overall conservation status score.

Results of this analysis categorize species and ecological systems according to our level of confidence that the species and systems

will remain extant and viable in Colorado. The four conservation status categories we report on are:

Effectively conserved – Species and systems in this category are relatively unthreatened, have an effective population size (or acreage, in the case of systems), and are well-represented in the state’s network of protected lands. While additional conservation work would benefit these species and systems, we are reasonably confident that conservation to date has improved their status such that viability into the foreseeable future is relatively secure.

Moderately conserved – In general, species and ecological systems in this category received relatively good scores on two of the three analysis metrics (biodiversity status, threats, and protection), but not all three. For example, these species and systems may be characterized by large population size or acreage and relatively low threats, but have little representation on the state’s protected lands. Or, they may be well protected with low threats, but occur in low numbers. Some conservation work remains.

Weakly conserved - In general, species and systems in this category received relatively poor scores on two of the three analysis metrics (biodiversity status, threats, and protection), but not all three. These species and systems may be characterized by large population size or acreage, but have relatively high threats and little representation on the



The majority of our native plant and animal species are still widespread and secure. This is reflective of the vast native landscapes that still persist in Colorado. Golden-mantled ground squirrels (above) inhabit many of Colorado's meadow ecosystems. The collared lizard (top right) thrives in xeric, rocky areas of southern Colorado. The Rocky Mountain Columbine (right) - Colorado's state flower - is found in moist montane and alpine habitats.

state's protected lands. Significant conservation work remains.

Under-conserved – Species and systems in this category are high priorities for conservation attention. These species and systems generally received poor scores on biodiversity status, threats, and level of protection. A sustained and concerted effort to conserve these species and systems in Colorado will be necessary to avoid extirpation or irreparable degradation.

Natural Heritage Methodology

The standardized methods used by all Natural Heritage Programs center around a set of ranking systems that, taken together, direct

conservation resources toward the most imperiled species and natural communities, the highest quality occurrences of those species and natural communities, and places where conservation is most urgently needed. This ranking methodology was a key component of the analysis methods used in production of the conservation status scores presented in this report. Refer to Appendix G for a detailed explanation of Natural Heritage Methodology.

Interpreting this Analysis

Although our objective was to evaluate the quantity, quality, threat, and protection status of all species and ecological systems that we scored, the actual scoring

methods differ somewhat between taxonomic groups. Details on analysis methods for animals, plants, and ecological systems are presented in the corresponding sections of this report. Our analysis is necessarily limited by the available data. Occurrence information is incomplete or unavailable for some species and ecological systems, and statewide georeferenced data are not available for every factor that we wished to consider in our analysis, especially for threats and condition. In particular, it is difficult to address the effects of anthropogenic disturbance in the future, as in the case of global climate change.

It is also difficult to determine the actual level of protection for most species and ecological systems

in Colorado. We have used land ownership and management designation as a surrogate for protection status in portions of this analysis, under the assumption that certain land management types (e.g., wilderness areas, non-split estate conservation easements) are legally protected from being converted to land use that is incompatible with the viability of rare elements.

Treatment of Common Names

The standardized naming convention for birds calls for common names to be capitalized, which we have done. For groups where standardized naming conventions do not exist, only proper names are capitalized.

Overview of Colorado

Colorado's boundaries encompass some 66.6 million acres, or over 104,000 square miles. Within this area, the type and extent of natural vegetation is determined by many factors, including elevation, climate, soils, disturbance patterns, and the ecological history of the landscape.

Colorado spans the Continental Divide amid the highest peaks of the Southern Rocky Mountains. As a result, the state's topology is complex. To the east of the Continental Divide, the eastern plains rise gently at the rate of about 10 feet per mile from elevations of 3,350-3,650 feet at the state's eastern edge. Although they appear

comparatively flat, Colorado's eastern plains boast little-known dramatic river canyons, shale outcrops forming buttes and scarps, sandy stabilized dune fields, and basalt-capped mesas that are local landmarks in our eastern counties.

At elevations of 5,500 to 6,000 feet near the mountain front, the plains transition fairly abruptly to foothills and mesas that, in turn, quickly rise to montane elevations. The central portion of the state is dominated by the peaks and ranges of the Southern Rocky Mountains. Here, a series of mountain ranges trending generally north-south bound a string of high mountain valleys or parks, and include more than fifty peaks reaching elevations of 14,000 feet or more.

To the west, more mountains and extensive plateaus, heavily dissected by ravines and canyons, form the characteristic valley and plateau western slope landscape. Near the western border of the state elevations decrease again, reaching a low of about 4,325 feet where the Colorado River crosses the border with Utah.

Elevation Zones

At a broad scale, it is useful to define elevational zones that reflect changing structural patterns in the vegetation (Figure 1). Our state's lowest elevations (the plains and foothill/lower montane zones) are typically dominated by shortgrass prairie grasslands and shrublands. The plains zone (which also includes some western valleys) extends up to about 6,000

feet. The foothill-lower montane zone lies between 6,000 and 8,000 feet in elevation. Woodlands and forests characterize the mid-to-high elevation montane and sub-alpine zones. Elevations from 8,000 to about 9,500 are characterized as montane, and above 9,500 feet, the subalpine zone extends to the upper limit of tree growth at about 11,400 ft. The highest elevations (alpine zone) are dominated by rock and cold-tolerant, low-growing vegetation.

Transitional elevations between life zones are variable with aspect and latitude. Zone boundaries may occur at lower elevations on north-facing slopes, or at more northern locations, while boundaries may be higher in southern exposures or more southern sites.

Colorado's position at the high point of the continent means that several different weather patterns influence the climate of the state, and hence its vegetation. In general, higher elevations have cooler temperatures and receive more precipitation, although local topography has a significant effect on air movements controlling these factors.

Moisture may reach Colorado from either the Pacific Ocean or the Gulf of Mexico, depending on current air circulation. Storms originating to the west of the state drop much of their moisture as rain or snow on the mountains and west-facing slopes; a rain-shadow effect prevents most of this precipitation from reaching the eastern plains.

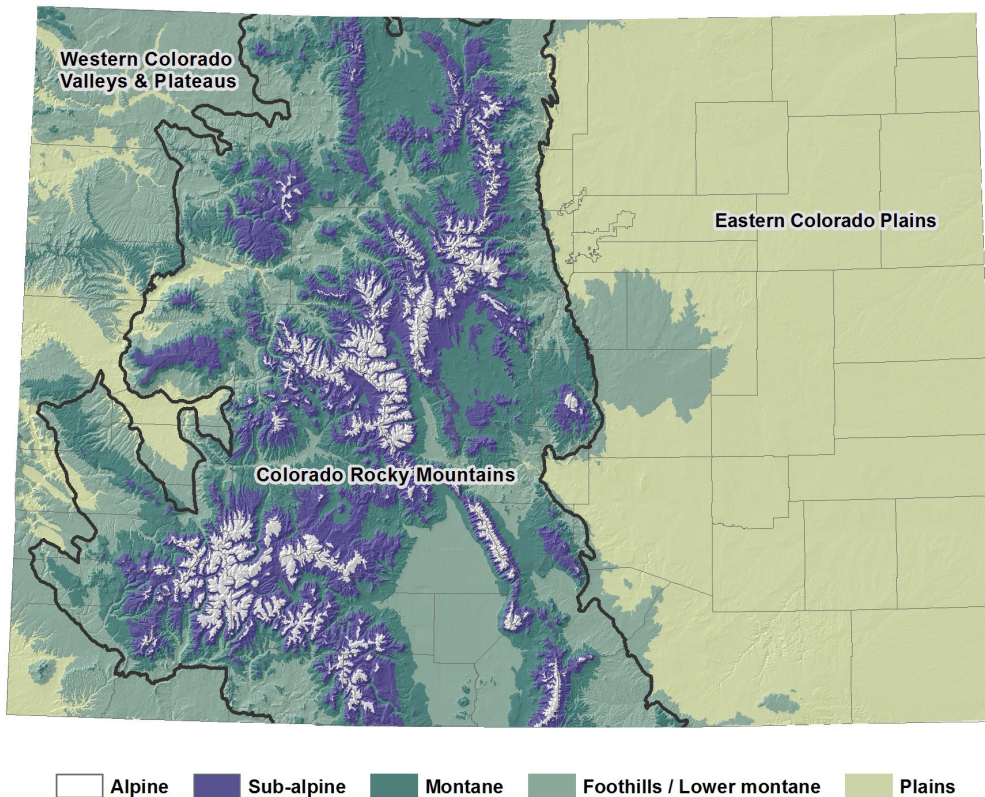
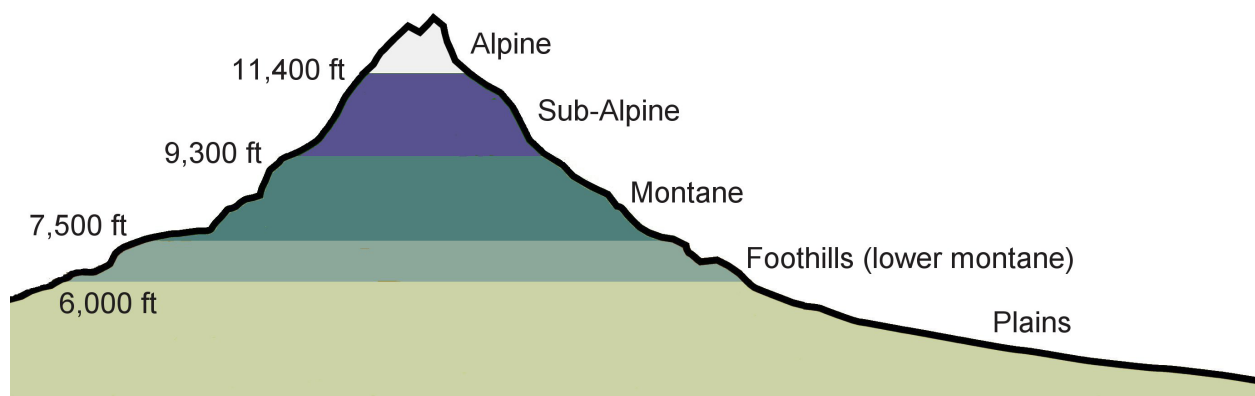


Figure 1. The distribution of elevationally defined life zones in Colorado.



Moisture from the Gulf of Mexico can produce heavy precipitation on the eastern slope of the divide, especially in spring and summer, and the plains receive the majority of their annual precipitation during the growing season. Precipitation on the west slope of Colorado is

more evenly distributed throughout the year, with peak precipitation during the winter months. In the southern mountains, monsoonal moisture often provides significant precipitation during late summer.

Geology and Soils

The landscape we see today is the product of both past and ongoing geologic processes. The effects of continental drift, geologic uplifts, volcanic eruption, and erosion have resulted in a highly complex

Knowles Canyon, Mesa County Colorado. One of many spectacular canyons in Wingate and Entrada sandstone formations in western Colorado.



has resulted in a pattern of land ownership where public lands are a significant part of the landscape.

Settlement history

The first human inhabitants of Colorado had arrived by roughly 13,000 years ago. Early settlements of native peoples in Colorado were scattered. Both hunting/gathering cultures and agricultural settlements are known from times prior to exploration and settlement by Europeans. Spanish explorers and settlers came north into what is now Colorado beginning in the early 1700s.

arrangement of rock and soil types that provide a substrate for Colorado's native vegetation.

Colorado's eastern plains are dominated by soils derived from Tertiary (2-65 million years ago) and Cretaceous (65-140 million years ago) sedimentary formations, shaped by the action of flowing water and wind. In the central portion of the state, the core of the Colorado Rocky Mountains is formed of metamorphic and igneous rocks ranging from Precambrian (up to 1,700 million years ago) to more recent volcanic outflows of primarily Tertiary age. Here soils are generally less well developed, except in low-lying areas, where erosion has deposited substantial soil material. The western plateaus and valleys are also primarily formed in Tertiary and Cretaceous substrates, and many soils have high concentrations of salts and minerals that inhibit plant growth. In combination with climate factors, soils are a good indicator of which

type of vegetation will dominate the landscape in a particular area.

Human Influence

In addition to natural disturbance processes such as fire, wind, and flooding, the effects of human activities have also changed patterns of vegetation in Colorado. The settlement history of Colorado

The eastern portion of Colorado became part of the United States with the Louisiana Purchase in 1803. The remainder of the state was eventually ceded to the U.S. in 1848, at the end of the Mexican-American war. Beginning with the



Mining supports our quality of life by providing many of the goods that support food growth and distribution, transportation, health care, and a myriad of other necessities. Unfortunately, it also causes impacts to natural systems that must be mitigated and planned for appropriately if we are to conserve our biological and physical resources.

Pike expedition of 1806, explorers and trappers began to penetrate the region from the east. The Colorado Territory was delineated in 1861, after the discovery of gold brought a rush of settlers to the Southern Rocky Mountains, and statehood followed in 1876.

Mining

Mining for coal, gold, gypsum, limestone, silver, molybdenum, uranium, soda ash, sodium bicarbonate, sand, gravel, and crushed stone, have had a significant role in shaping Colorado's landscape. Some of these mines still operate today. Land ownership maps, especially in the high country, clearly show a scattered and fragmented pattern of mining claims. Sand and gravel operations are still common across the state, especially in riparian areas.

Energy Development

Energy development is a significant and expanding activity in Colorado, especially in the natural gas and oil-rich areas of the northern Front Range and western slope. Beginning in the 1860s, coal and petroleum were the first energy resources to be developed in Colorado. Together with natural gas and oil shale, these fossil fuels have historically constituted the majority of energy development in the state.

Renewable energy development on a large scale began with the Ponnequin wind facility in Weld county, which came online in 1999. Colorado now has over 1,000 wind turbines in operation, primarily on the eastern plains. Concentrated solar energy facilities are also being developed in several areas

of the state. With the projected future growth of these industries, Colorado can expect to see an increase in transmission line construction as well.

Agriculture

The original shortgrass prairie grasslands of Colorado's eastern plains were home to large numbers of grazing animals including deer, antelope, elk and bison. With European settlement, these native grazers were largely replaced by domestic livestock. Large-scale domestic grazing began in the 1860s, and quickly expanded as railroads provided access to eastern markets.

Both the U.S. Forest Service and the Bureau of Land Management issue grazing permits for public lands in Colorado, and state-owned lands may also be leased for grazing.

Renewable energy development, such as wind farms and solar arrays, offer opportunities to improve our stewardship of natural resources and reduce our dependence on fossil fuels. However, these activities may impact species. Careful planning is needed to minimize potential threats to sensitive species. The complexity of balancing even "green" energy development with conservation of biodiversity requires all our creativity and resourcefulness.





Livestock grazing represents significant economic and cultural aspects of the western landscape. For some ecological systems, ranching maintains habitats and species that evolved under the pressure of herbivory. In the absence of free-ranging bison herds, some at-risk species depend on livestock grazing for their persistence. Conversely, remnants of historic grazing methods, as well as some aspects of modern grazing, may threaten systems and species in areas that were not subjected historically to year-round grazing pressure. We depend on the stewardship of ranching families to strike the right balance and conserve our native landscapes.

Cattle and associated products form the largest portion of Colorado's agricultural cash receipts, followed by field crops.

camping, winter sports, hunting, fishing, and off-road vehicle use. Paradoxically, recreation on Colorado's public lands can

contribute to both its conservation and its degradation.

Around 1900, crop farming began to expand in the state, with wheat and corn as the primary products. Although periodic droughts have repeatedly dealt hard blows to farming and ranching in Colorado, these land uses still make an important contribution to the state's economy, and have had an undeniable effect on the arrangement and condition of Colorado's natural vegetation.

Recreation

In recent decades, recreation has become an increasingly important part of land use in Colorado. From National Parks to local open space lands, an increasing number of visitors are drawn to a variety of outdoor activities such as hiking,



Breckenridge Ski Area, Summit County, Colorado. Recreation is an extremely important component of Colorado's economy and quality of life. Impacts on natural systems and wildlife sometimes result.

In our semi-arid climate, water is among our most precious and limiting resources. Manipulation of hydrological systems can exceed minimum thresholds for timing, quantity, and quality of surface flows, as well as stability of subsurface aquifers. The complexity of western water law greatly complicates management and conservation of hydrological resources. Cooperation on many fronts is necessary to ensure the continued health of our wetland and riparian systems and species.



use patterns within the state. Since Colorado achieved statehood, public officials have allocated water resources in the state according to the Prior Appropriation Doctrine of first-in-time, first-in-right. The first person to appropriate and use water in a particular stream system holds the most senior water right, which must be satisfied before any subsequent water rights can be fulfilled.

Water distribution in Colorado has evolved a complex system of diversions, irrigation wells, and water storage facilities that have altered the original hydrologic regime of many areas.

Water

With the exception of the Green River, which crosses the northwestern corner of the state, all of Colorado's rivers originate within the state and flow away from the Continental Divide. To the east of the divide, streams and rivers drain

toward the Gulf of Mexico. On the western slope, flowing waters are tributaries to the Colorado River, draining toward the Pacific Ocean. Conditions in Colorado watersheds affect many downstream users, both within our borders and beyond. Water is perhaps the primary factor determining settlement and land

Land Ownership

About 57% of the state's surface acres are privately owned, with the remainder in federal, state, local government, or tribal ownership. Federal public lands account for a little over 36% of Colorado acreage, including lands administered by the U.S. Forest Service (22%), Bureau of Land Management (13%), National Park Service (1%), and other federal agencies including the U.S. Fish and Wildlife Service, Bureau of Reclamation, and Department of Defense (<1%). The State of Colorado owns nearly 5% of the land, and also holds about a million acres of sub-surface mineral rights on lands in other ownership. Tribal lands account for about 1% of Colorado's acreage, and the remainder is owned by governments at the county and city level.



Horsetooth Reservoir, Larimer County, CO. The majority of waterways in Colorado have been dammed, diverted, or otherwise altered. This has significant effects on hydrological systems, and the species that depend on wetland and riparian habitats.

Ownership patterns reflect the land use history of the state, and, together with management practices are an important factor in determining the conservation status of Colorado's landscape. Arable lands, especially on the eastern plains and along river drainages, are primarily in private ownership. Colorado's mining history has left a legacy of private inholdings within extensive tracts of public land.

National Grasslands administered by the US Forest Service in eastern Colorado were formed from farmland reclaimed from the ravages of the Dust Bowl days. Higher elevation (mostly forested) parts of the state are largely under the administration of the U.S. Forest Service. Lower elevation lands on the west slope, used primarily for grazing, mining, and oil and gas extraction, are generally administered by the Bureau of Land Management.

The distribution of state-owned land still reflects the school land grant included in the 1875 Enabling Act for the Territory of Colorado, which granted two sections of every township (usually sections 16 and 36) for the support of public schools. These lands typically generate funds for state schools through lease income, and often share the same land use as adjacent privately owned parcels.

In spite of our state's increasing population, more than 75% of Colorado's landscape remains covered by natural vegetation, especially in higher elevation areas.



ECOLOGICAL SYSTEMS

Vegetation Classification

Generally, vegetation classifications group together plant species that are typically found together, and that form repeating and easily identified patterns across the landscape. Because different uses often require different groupings, there is not necessarily one correct classification. In this scorecard we used the ecological system level of vegetation grouping.

Ecological systems are dynamic groupings of plant and/or animal communities that: 1) occur together on the landscape; and 2) are linked by similar ecological processes, underlying abiotic environmental factors, or gradients; and 3) form a readily identifiable unit on the ground (NatureServe 2003). The largest ecological systems form the dominant vegetation over extensive areas, encompassing a range of environmental conditions, and serving as important habitat for

species both common and rare. Other ecological systems may form extensive cover over some areas but are more correlated with a dominant local process such as hydrology, landform, soil type, or fire regime (Anderson et al. 1999). Many ecological systems, especially wetlands and riparian areas, do not occur in patches large enough to be included in this analysis.

Analysis Methods

We analyzed eighteen terrestrial ecological systems that occur in Colorado (Table 1), representing approximately 99% of Colorado's native vegetation. In contrast to the plants and animals scored in this report, these ecological systems are not rare, but do often provide habitat for rare elements. Ecological systems may also serve as a coarse-scale filter in the identification of conservation targets. Unlike other elements of biodiversity, ecological systems have not yet been documented or ranked as occurrences under

Natural Heritage methodology, so our analysis identified contiguous patches of each type and characterized the conservation status of those patches, as well as the conservation status of the larger ecological systems on a statewide basis.

Ecological System Patches

We used the Southwest Regional Gap Analysis Project (SWReGAP) landcover dataset (USGS 2004) and GIS software (ESRI ArcInfo, focal majority routine) to produce a generalized vegetation map from which we could identify discrete ecological system patches. The focal majority technique reduces the number of small inclusions of dissimilar ecological system types within larger patches, resulting in a more homogeneous vegetation map appropriate for larger ecological systems. To the generalized map, we then added current highway data to represent existing fragmentation of the landscape. The resulting discrete

Table 1. Ecological system types included in the analysis.

System Name General Elevation Range Percent of Colorado acres	Includes SWReGAP types:
Alpine Tundra 10,500-11,450 ft. - 3%	North American Alpine Ice Field – note: none in focal majority grid Rocky Mountain Alpine Bedrock and Scree Rocky Mountain Alpine Fell-Field Rocky Mountain Dry Tundra Rocky Mountain Alpine-Montane Wet Meadow
Aspen 7,500-11,000 ft. - 5%	Rocky Mountain Aspen Forest and Woodland Intermountain West Aspen-Mixed Conifer Forest and Woodland Complex
Foothill Shrubland 5,100-8,700 ft. - 1%	Rocky Mountain Lower Montane-Foothill Shrubland
Grasslands (non-shortgrass prairie) 4,600-11,300 ft. - 5%	Southern Rocky Mountain Montane-Subalpine Grassland Western Great Plains Foothill and Piedmont Grassland Inter-Mountain Basins Semi-Desert Grassland
Greasewood 4,400-7,800 ft. - 1%	Inter-Mountain Basins Greasewood Flat
Juniper 4,200-7,800 ft. - 1%	Southern Rocky Mountain Juniper Woodland and Savanna Inter-Mountain Basins Juniper Savanna
Lodgepole Pine 8,000-11,200 ft. - 3%	Rocky Mountain Lodgepole Pine Forest
Mixed Conifer 6,000-11,000 ft. - 1%	Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland
Oak and Mixed Mountain Shrub 5,500-9,300 ft. - 4%	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
Pinyon Juniper - Colorado Plateau 4,650-8,500 ft. - 7%	Colorado Plateau Pinyon-Juniper Shrubland Colorado Plateau Pinyon-Juniper Woodland Colorado Plateau Mixed Bedrock Canyon and Tableland
Pinyon Juniper - Southern Rocky Mtn. 5,000-9,500 ft. - 2%	Southern Rocky Mountain Pinyon-Juniper Woodland
Ponderosa Pine 5,700-9,850 ft. - 5%	Rocky Mountain Ponderosa Pine Woodland
Sagebrush 5,000-10,000 ft. - 8%	Inter-Mountain Basins Big Sagebrush Shrubland Inter-Mountain Basins Montane Sagebrush Steppe
Salt Shrub 4,350-7,100 ft. - 1%	Inter-Mountain Basins Mat Saltbush Shrubland Inter-Mountain Basins Mixed Salt Desert Scrub Inter-Mountain Basins Shale Badland
Sand Sage 3,500-6,000 ft. - 3%	Western Great Plains Sandhill Shrubland Western Great Plains Sandhill Prairie, if any
Shortgrass Prairie 3,450-6,500 ft. - 18%	Western Great Plains Shortgrass Prairie
Shrub-Steppe 4,320-8,900 ft. - 1%	Inter-Mountain Basins Semi-Desert Shrub Steppe
Spruce Fir 8,800-12,400 ft. - 7%	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland

patches of each ecological system type became potential occurrences. Our analysis used only patches larger than a minimum size derived from the C-ranked ecological system occurrence specifications in Rondeau (2001) and CNHP (2005a). The minimum size for each ecological system type is listed in Table 2. Because patch sizes within ecological system types varied by an order of magnitude or more we calculated individual patch scores as area-weighted averages. All patch scores were normalized to fall between 0 – 10, inclusive, with 10 being the best possible score. Results for each ecological system summarize scores by patch instead

of acreages over all patches. Our methods are further detailed in Appendix A.

Biodiversity Status

Biodiversity status scores address the size, condition, and landscape context of each ecological system patch as much as possible. Size scores include proportion of total acreage in at least minimum size patches and proportion in preferred size patches (4x minimum). These two metrics characterize the patch size distribution of an ecological system and can reflect change over time. More acreage in larger patches is preferred

for overall ecological system viability. Condition was scored by using the LANDFIRE Fire Regime Condition Class dataset (USFS 2007) that maps degree of departure from historic fire regime. The fire condition metric is most meaningful for forest ecological systems, but was included for all ecological systems except alpine tundra, greasewood, salt shrub, and shrub-steppe. Landscape context was scored by calculating the percentage of naturally vegetated land within a ½ mile buffer for each patch, and by a landscape integrity score representing the cumulative impacts from oil and gas wells, gas pipelines, surface mines,

Table 2. Ecological system patches in Colorado. Systems are arranged in alphabetical order.

System Name	Total acres	No. patches	Minimum size (ac.)	Number of patches			Acres			
				# Patches min size	# Patches 2x min size	# Patches 4x min size	% ≥ min size	% ≥ 2x min size	% ≥ 4x min size	Largest patch (ac.)
Alpine Tundra	1,681,811	480	10,000	13	9	9	79%	68%	52%	250,971
Aspen	3,580,854	1,564	20,000	10	6	8	72%	55%	48%	513,422
Foothill Shrubland	388,143	562	1,000	19	11	17	82%	75%	67%	43,507
Grasslands	3,020,774	1,551	5,000	33	11	29	75%	75%	69%	281,180
Greasewood	443,159	367	1,000	22	12	17	90%	83%	76%	136,846
Juniper	558,062	231	5,000	5	2	4	85%	79%	75%	261,009
Lodgepole Pine	2,199,719	643	30,000	4	4	6	64%	57%	41%	264,169
Mixed Conifer	881,470	1,562	2,500	38	23	16	62%	46%	28%	39,416
Oak & Mixed Mtn Shrub	2,717,457	1224	5,000	29	20	27	86%	78%	67%	206,256
Pinyon-Juniper, CO PL	4,942,190	668	30,000	11	8	13	91%	83%	69%	512,906
Pinyon-Juniper, SRM	1,253,413	401	30,000	2	5	5	68%	41%	24%	168,167
Ponderosa Pine	3,220,299	1,153	30,000	13	6	6	72%	55%	38%	516,244
Sagebrush	5,564,595	1,995	30,000	15	7	10	69%	58%	47%	924,242
Salt Shrub	763,237	356	1,000	13	10	26	93%	91%	87%	77,768
Sand Sage	1,959,449	672	14,000	10	5	10	79%	68%	58%	179,704
Shortgrass Prairie	11,855,161	1,827	50,000	14	6	14	81%	72%	65%	1,072,828
Shrub-Steppe	776,043	243	5,000	3	1	7	90%	87%	86%	172,992
Spruce Fir	4,880,993	956	20,000	27	9	15	83%	68%	59%	458,277

urban development, agriculture, roads, and transmission lines. The landscape integrity data layer was developed by CNHP as part of this project (See Appendix A for details). Because the ecological system patches vary considerably in size, all scores are area-weighted as appropriate.

Threat Status

In addition to the landscape integrity score included in biodiversity status, we developed several data layers to characterize future threats and historic trends. Future threats include potential energy development, population growth, and highway development.

The likelihood of future energy development was scored as the cumulative potential for development of oil and gas, oil shale, coal mining, uranium mining, and wind energy, using available statewide maps depicting the potential value of these resources (BLM 1998, 2006, TrueWind Solutions 2003). Population growth was based on the 30-year population projections of Theobald (2005), and scored as the projected loss of undeveloped private land for each patch. Highway development was mapped as a variable-width buffer on current highways based on 20-year traffic volume projections from the Colorado Department of Transportation (CDOT 2006), and scored as the proportion of each ecological system falling within the buffer.

Protection/Management Status

The protection and management status of ecological systems in Colorado was evaluated by using the Colorado Ownership, Management and Protection (CoMAP) GIS dataset (Wilcox et al. 2007), in conjunction with Conservation Management Status Measures scores (Supples et al. 2007). Every record in CoMAP was assigned a rank for each of three measures: Conservation Tenure, Management Intent, and Potential Management Effectiveness, as well as an overall protection status score summarizing the three measures. These individual or composite scores are an indication of the degree to which the three conservation factors are formalized and publicly visible. None of the scores address the quality of current management or the dedication of the current managers to conservation. Ranks assigned by The Nature Conservancy's Colorado Field Office were converted to a numeric score, and were used to calculate scores for patches and for entire ecological systems (see Appendix A for details).

Long term trends

Long term vegetation trends were evaluated by comparing the current mapped acreage of each ecological system with a representation of historic vegetation (CNHP 2007). The historic vegetation dataset represents our best estimate of Colorado's natural vegetation as

it appeared in the mid-1800s (e.g. pre-settlement).

Pre-settlement vegetation of Colorado was modeled using a 90m resampled version of the SWReGAP landcover (USGS 2004) as a base layer. Existing non-natural landcover was replaced by:

1. Replacing all agriculture in shortgrass and mixedgrass prairie with the "Historic shortgrass component" dataset (CNHP 2005b),
2. Replacing all other non-natural landcover with the most common native vegetation found on the underlying STATSGO soil type (USDA Soil Conservation Service 1994), following the methods of Duncan et al. (2000),
3. Replacing modeled and existing shortgrass with foothill/piedmont grassland on selected soil types along the mountain front,
4. Manual editing to replace man-made water bodies with the common surrounding landcover types.

Agricultural modifications by native peoples that would have been present (Vale 2002) were not modeled. Changes due to climatic variability are also not reflected in the historic model, but are most likely to have affected the quality instead of the identity of most of the ecological systems considered (Veblen and Donnegan 2005). Short term trends can be evaluated at the next scoring iteration.

Results

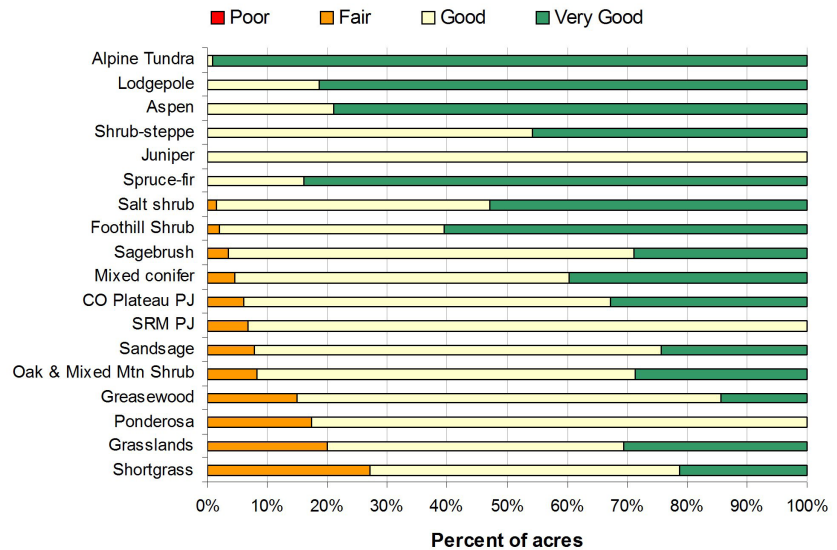
Biodiversity Status

Biodiversity status scores are generally high across the state, especially for the highest elevation ecological systems (Table 3, Figures 2 and 3). Biodiversity status scores varied from “fair” to “very good.” No patches received a “poor” biodiversity score. All ecological systems have at least 70% of their acres in “good” or “very good” biodiversity status patches. Colorado’s high elevation ecological systems (alpine tundra, spruce-fir, and lodgepole) have 80% or more of their acres in patches scored “very good” for biodiversity. Southern Rocky Mountain pinyon-juniper, juniper, and ponderosa pine are the only systems that have no patches in the very good biodiversity category. Only greasewood, ponderosa pine, grasslands, and shortgrass prairie had sizable acreage in the fair category (15-30% of their total acreage). Factors that contributed to lower biodiversity status scores include “poor” landscape integrity and fire condition scores for ponderosa pine, and “fair” landscape integrity scores for the grasslands, shortgrass prairie, sand sage, foothill shrubland, and greasewood.

Threat Status

Threat scores are noticeably worse than biodiversity scores (Table 3). Ten of Colorado’s ecological systems have more than 50% of their acreage in patches considered threatened (scored “poor” or “fair”

Figure 2. Biodiversity status of ecological systems patches. Each bar indicates the percent of acres in that system in poor, fair, good, or very good status. Systems are arranged in descending order of overall status from best to worst.



for threat status, Figures 4 and 5). The least threatened ecological systems (alpine-tundra, spruce-fir, aspen, mixed-conifer, and juniper),

are primarily those of the higher elevation zones. At the other end of the threat scale, greasewood and ponderosa pine have 90% or more

Figure 3. Spatial distribution of biodiversity scores for ecological systems in Colorado. No ecological systems have “poor” (red) biodiversity status.

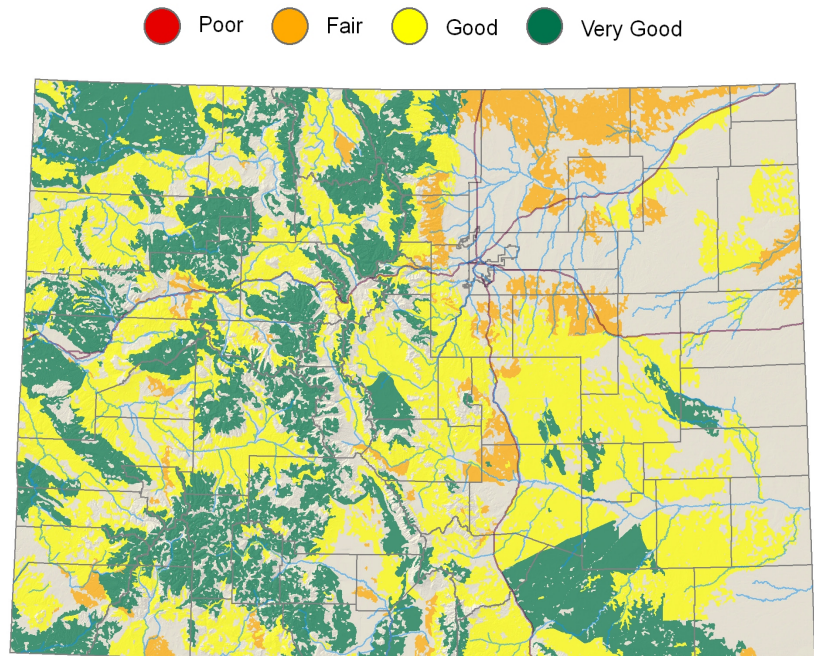


Table 3. Ecological system patch scores for biodiversity status, threat status, and protection status.

Biodiversity Status								
	% acres (number of patches)							
Ecological System	Poor		Fair		Good		Very Good	
Alpine Tundra	0%	(0)	0%	(0)	1%	(1)	99%	(30)
Aspen	0%	(0)	0%	(0)	21%	(10)	79%	(14)
Foothill Shrub	0%	(0)	2%	(4)	38%	(19)	60%	(24)
Grasslands	0%	(0)	20%	(18)	50%	(40)	31%	(15)
Greasewood	0%	(0)	15%	(20)	71%	(21)	14%	(10)
Juniper	0%	(0)	0%	(0)	100%	(11)	0%	(0)
Lodgepole	0%	(0)	0%	(0)	19%	(3)	81%	(11)
Mixed conifer	0%	(0)	5%	(6)	56%	(52)	40%	(19)
Oak & Mixed Mtn Shrub	0%	(0)	8%	(16)	63%	(47)	29%	(13)
Pinyon-juniper - Colo. Plateau	0%	(0)	6%	(6)	61%	(20)	33%	(6)
Pinyon-juniper - So. Rky. Mtn.	0%	(0)	7%	(1)	93%	(11)	0%	(0)
Ponderosa	0%	(0)	17%	(9)	83%	(16)	0%	(0)
Sagebrush	0%	(0)	4%	(3)	68%	(26)	29%	(3)
Salt shrub	0%	(0)	1%	(6)	46%	(22)	53%	(21)
Sandsage	0%	(0)	8%	(6)	68%	(14)	24%	(5)
Shortgrass	0%	(0)	27%	(18)	52%	(13)	21%	(3)
Shrub-steppe	0%	(0)	0%	(0)	54%	(8)	46%	(3)
Spruce-fir	0%	(0)	0%	(0)	16%	(23)	84%	(28)
Threat Status								
	% acres (number of patches)							
Ecological System	Poor (very high threat)		Fair (high threat)		Good (low threat)		Very Good (very low threat)	
Alpine Tundra	7%	(2)	1%	(1)	6%	(2)	86%	(26)
Aspen	15%	(3)	15%	(7)	60%	(8)	9%	(6)
Foothill Shrub	31%	(21)	6%	(7)	34%	(6)	29%	(13)
Grasslands	9%	(13)	30%	(18)	20%	(15)	41%	(27)
Greasewood	4%	(8)	92%	(37)	3%	(5)	2%	(1)
Juniper	2%	(1)	0%	(0)	98%	(10)	0%	(0)
Lodgepole	3%	(1)	43%	(5)	9%	(1)	45%	(7)
Mixed conifer	9%	(10)	15%	(12)	19%	(11)	58%	(44)
Oak & Mixed Mtn Shrub	42%	(36)	32%	(24)	22%	(10)	4%	(6)
Pinyon-juniper - Colo. Plateau	30%	(12)	40%	(9)	22%	(9)	9%	(2)
Pinyon-juniper - So. Rky. Mtn.	15%	(3)	53%	(6)	10%	(1)	22%	(2)
Ponderosa	40%	(12)	50%	(10)	9%	(2)	1%	(1)

Table 3, cont.

Ecological System	% acres (number of patches)							
	Poor (very high threat)		Fair (high threat)		Good (low threat)		Very Good (very low threat)	
Sagebrush	28%	(5)	45%	(15)	17%	(9)	10%	(3)
Salt shrub	16%	(13)	71%	(30)	12%	(4)	0%	(2)
Sandsage	3%	(2)	78%	(18)	19%	(5)	0%	(0)
Shortgrass	24%	(8)	29%	(15)	47%	(11)	0%	(0)
Shrub-steppe	0%	(0)	67%	(7)	33%	(4)	0%	(0)
Spruce-fir	4%	(3)	5%	(6)	14%	(9)	77%	(33)
Protection Status								
Ecological System	% acres (number of patches)							
	Poor		Fair		Good		Very Good	
Alpine Tundra	0%	(0)	2%	(1)	14%	(7)	84%	(23)
Aspen	3%	(1)	5%	(4)	44%	(15)	49%	(4)
Foothill Shrub	39%	(26)	29%	(12)	16%	(6)	16%	(3)
Grasslands	46%	(39)	16%	(14)	31%	(17)	7%	(3)
Greasewood	50%	(34)	14%	(12)	2%	(4)	34%	(1)
Juniper	40%	(7)	58%	(3)	2%	(1)	0%	(0)
Lodgepole	0%	(0)	2%	(1)	70%	(11)	28%	(2)
Mixed conifer	11%	(13)	18%	(12)	38%	(38)	32%	(14)
Oak & Mixed Mtn Shrub	43%	(36)	20%	(25)	27%	(12)	10%	(3)
Pinyon-juniper - Colo. Plateau	5%	(5)	68%	(20)	19%	(6)	8%	(1)
Pinyon-juniper - So. Rky. Mtn.	47%	(8)	53%	(4)	0%	(0)	0%	(0)
Ponderosa	24%	(7)	42%	(12)	12%	(5)	22%	(1)
Sagebrush	33%	(14)	64%	(17)	3%	(1)	0%	(0)
Salt shrub	30%	(18)	37%	(24)	24%	(5)	10%	(2)
Sandsage	92%	(21)	6%	(3)	2%	(1)	0%	(0)
Shortgrass	89%	(32)	11%	(2)	0%	(0)	0%	(0)
Shrub-steppe	24%	(4)	51%	(6)	0%	(0)	25%	(1)
Spruce-fir	0%	(0)	2%	(3)	16%	(19)	82%	(29)

of their acreage in patches scored either “fair” or “poor” for threat status. Ponderosa pine woodlands, foothill shrublands, and oak mixed mountain shrublands have at least 30% of their acreage in “poor” threat status patches. For most ecological systems, energy development is the primary contributor to an unsatisfactory

threat status score. Population growth and transportation are primary threats to patches of ecological systems whose distribution is concentrated in the more heavily populated areas of Colorado, which include the Front Range corridor and the more developed mountain communities.

Protection Status

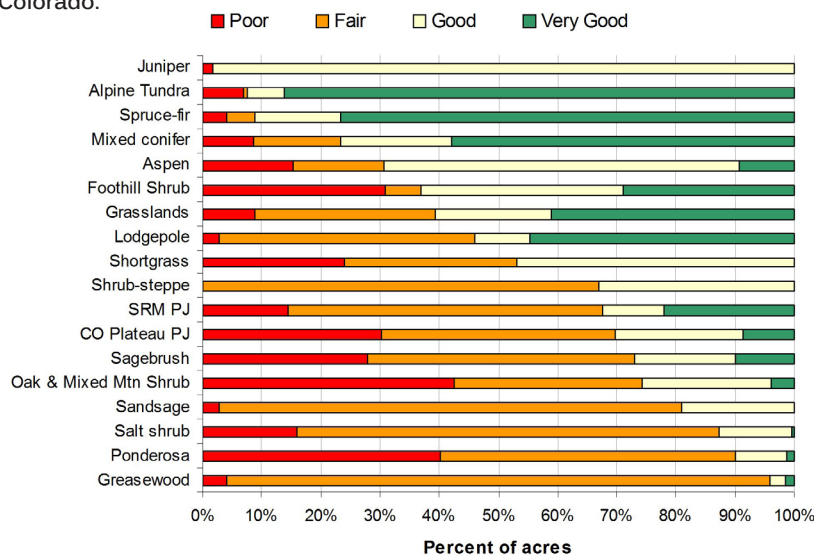
Protection status score patterns are similar to those for threat status (Table 3). Five of Colorado’s ecological systems are very well protected, with at least 70% of their acreage scored as having “good” or “very good” protection (Figure 6). Within this group high elevation

types (spruce-fir, alpine-tundra, and lodgepole) have 98% of their acreage in patches scored “good” or “very good” for protection. Conversely, five of Colorado’s lower elevation ecological systems are not well protected, with over 98% of their acreage in the “fair” or “poor” protection category. This under-protected group includes sagebrush, juniper, sand sage, shortgrass, and Southern Rocky Mountain pinyon-juniper. The other eight systems have at least 35% of their acreage with some form of protection. Overall protection status scores (Figure 7) indicate that public lands with strong management prescriptions (e.g., wilderness areas) score highest in overall protection, while public lands subject to intensive energy development activities score fair to poor. Privately owned lands on which the permanence of conservation tenure is uncertain and for which management intent is largely unknown also score poor to fair in overall protection status.

Conservation tenure scores (Figure 8a) indicate that land protection on the west slope (dominated by public land) is relatively permanent. On the east slope, where privately held lands generally have no known commitment or have only short-term commitments, conservation tenure scores are fair to poor.

Management intent scores (Figure 8b) are generally low across the state, indicating either unknown intent, or that management actions are not explicitly intended for conservation of biodiversity.

Figure 4. Threat status scores by patch for each ecological system in Colorado.



Potential management effectiveness scores (Figure 8c) are high in areas under where a suitable management prescription is being implemented. Scores are poor in areas lacking both conservation management

prescriptions and resources for implementation. This is the case for the majority of private land, and for much of the public land outside wilderness areas.

Figure 5. Spatial distribution of threat status scores for ecological systems in Colorado. Patches with very low threat levels (i.e., “very good” or green) status are generally correlated with higher elevation public lands, especially wilderness areas.

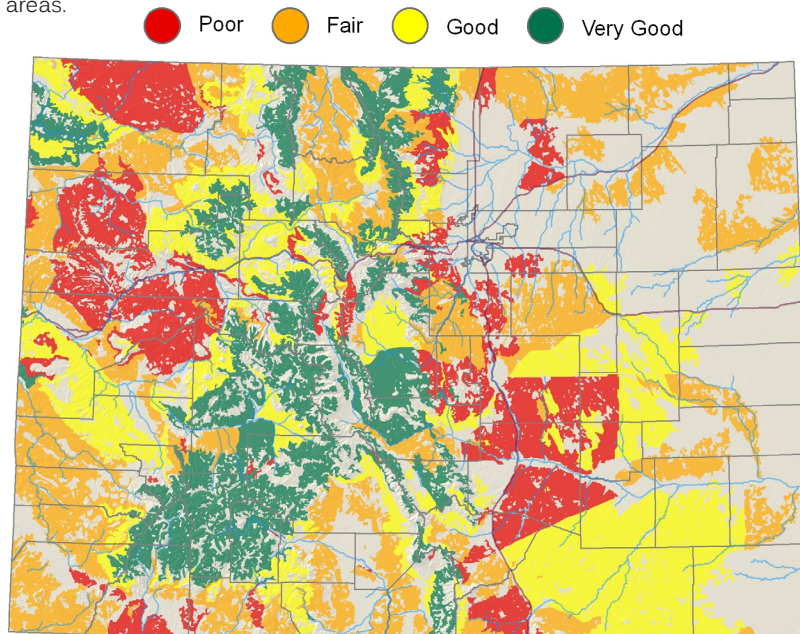
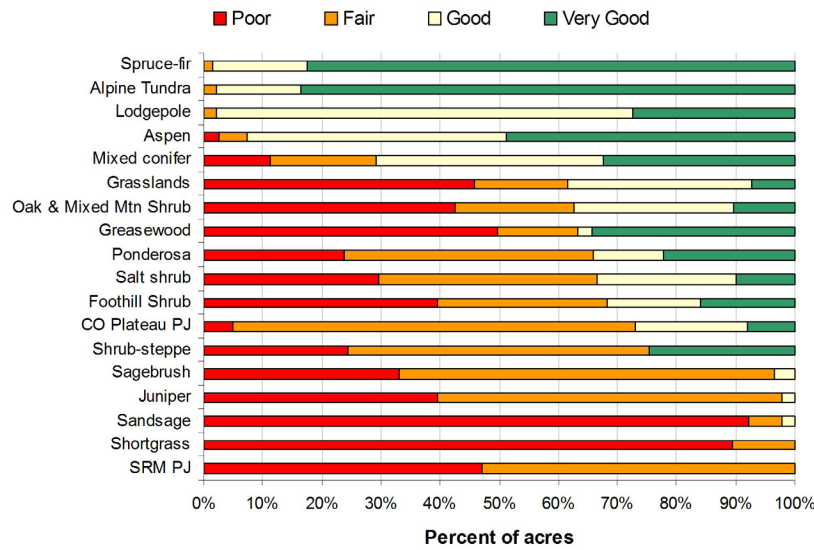


Figure 6. Protection status score by patch for each ecological system.



far the greatest loss has been to the shortgrass prairie, where nearly half of the presettlement acreage has been converted. Significant loss of native vegetation has also occurred in the San Luis Valley, where irrigated agriculture has replaced about a third of the original shrub-steppe and greasewood vegetation. Salt shrub, sand sage, Colorado Plateau pinyon-juniper, grasslands, and sagebrush have lost 12-25% of their historic acreage to agricultural conversion. Other ecological systems have lost an estimated 0.1-8% of their historic acreage. Due to the imprecise nature of the mapping, these types may be regarded as essentially unchanged in extent.

Long-term Trends

Since the 1850s, native vegetation over about one quarter of the state

has been converted to other land uses. Estimated historic trends are shown as a percent loss for each ecological system in Table 4. By

Figure 7. Overall Protection Status. Overall protection status scores represent the combination of conservation tenure, management intent, and potential management effectiveness. The resulting pattern highlights that public lands with strong management prescriptions (such as wilderness areas) score highest in overall protection, while public lands subject to intensive energy development activities score fair to poor. Privately owned lands, on which conservation tenure is uncertain and management intent is largely unknown, also score poor to fair in overall protection status.

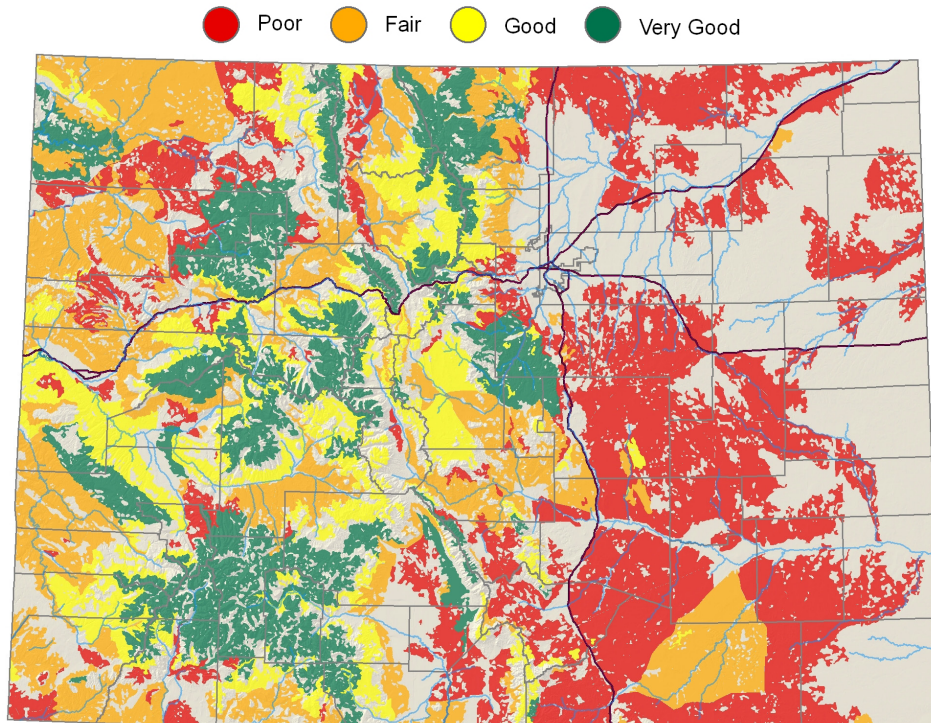
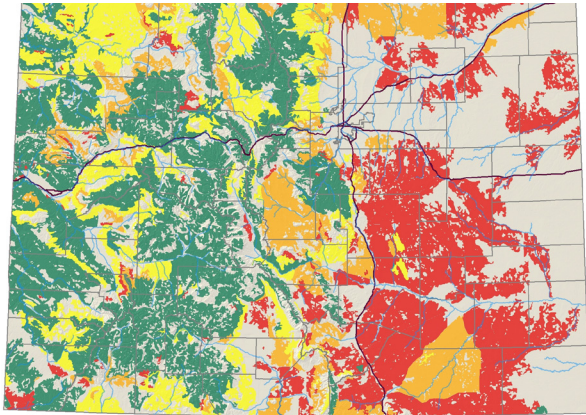


Figure 8. Spatial distribution of patch scores for (a) conservation tenure, (b) management intent, and (c) potential management effectiveness.

(a) Conservation Tenure

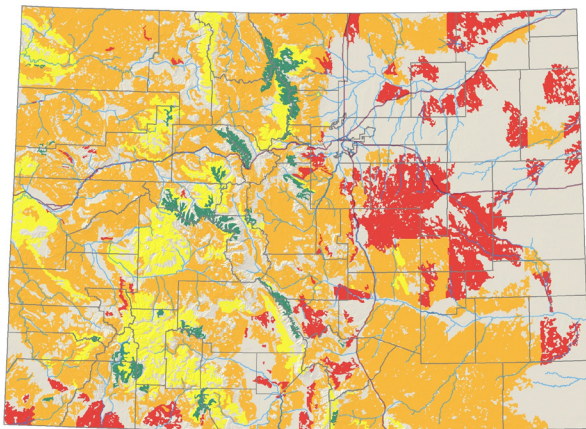


● Poor
 ● Fair
 ● Good
 ● Very Good

Conservation tenure status indicates the degree of permanence of conservation protection. In general, public lands have essentially permanent tenure, while privately owned lands are more susceptible to changes of ownership that may affect conservation protection.

Tenure ranking:
 Permanent = Very good
 Long-term commitment = Good
 Short-term commitment = Fair
 Unknown commitment = Poor

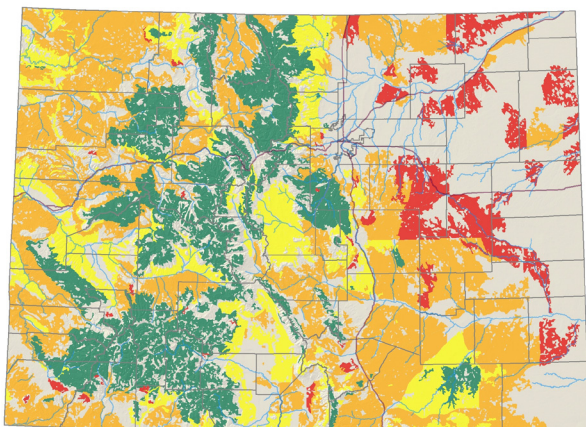
(b) Management Intent



Management intent status indicates the relative degree to which stated objectives of management activities are intended to conserve biodiversity and ecological processes.

Management intent ranking:
 Biodiversity Intent = Very good
 Compatible Intent = Good
 Biodiversity is Incidental = Fair
 Unknown Intent = Unknown
 Incompatible Intent = Poor

(c) Potential Management Effectiveness



Potential Management Effectiveness status indicates the capacity for management actions to be guided and implemented to achieve designated management intent for biodiversity.

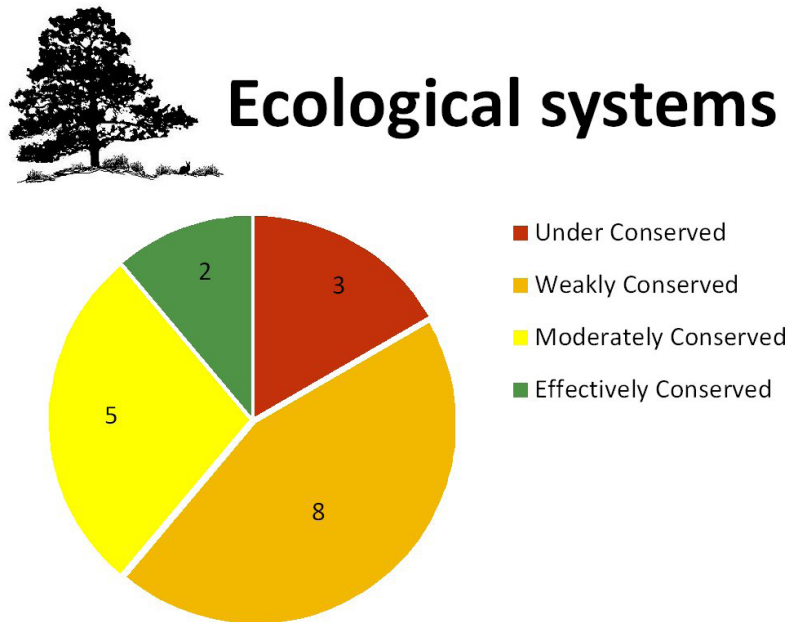
PME ranking:
 High potential for effective management = Very Good
 Intent is primarily supporting ecologically sustainable multiple uses = Good
 Lacks component needed for effective management = Fair
 Unknown potential for management = Unknown
 Not likely to achieve adequate management = Poor

Overall Conservation Status Scores

Seven (~40%) of Colorado’s ecological systems were considered either effectively or moderately conserved, while eleven (~60%) were weakly to under conserved (Table 4, Figure 9). Alpine tundra and spruce-fir ecological systems received the highest overall conservation scores (effectively conserved). Because scoring did not account for the threat of climate change, all of Colorado’s ecological systems, especially alpine tundra, are likely to have a lower conservation status score under changing climatic conditions. Five ecological systems, including many of the montane types were considered “moderately conserved.” Colorado’s “weakly conserved” ecological systems occur primarily in the lower montane-foothill zone: Colorado Plateau pinyon-juniper, sagebrush, ponderosa pine, salt shrub, oak and mixed-mountain shrub, foothill shrubland, grasslands, and juniper. The lowest elevation ecological systems (shortgrass prairie, sand sage, and greasewood) are “under conserved.”

Summary scores under each of three conservation factor categories are shown in Table 4 and color-coded by quartile to assist in a visual interpretation. The statewide distribution of patch scores is shown in Figure 10. Component category scores and statistics within ecological system type are in Appendix B.

Figure 9. Conservation status of Colorado’s major ecological systems.



Discussion

The generalized ecological system patches developed for this analysis

are the first available representation of individual occurrences of large terrestrial ecological system in Colorado. Previous work (e.g.,

Figure 10. Conservation status of Colorado's major ecological systems. All patches within an ecological system are shown according to its overall conservation status.

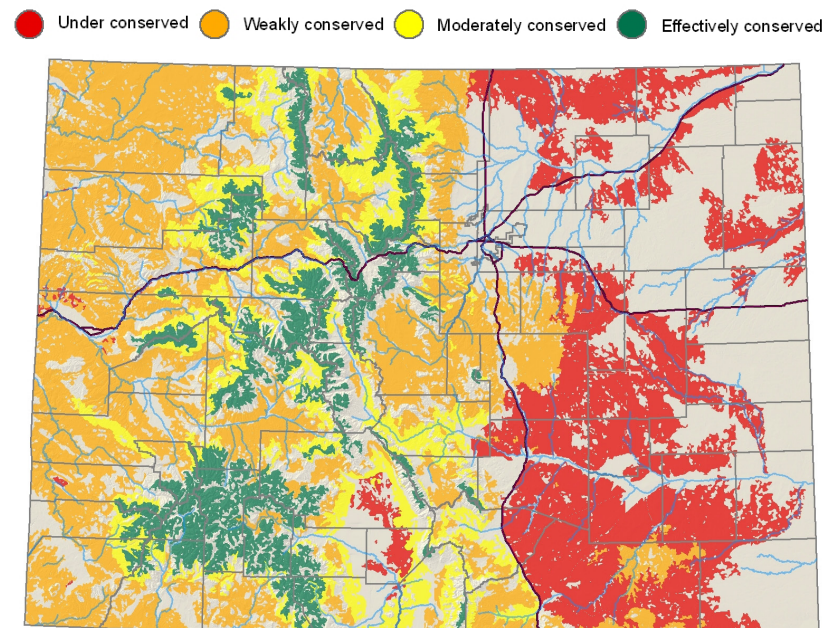


Table 4. Ecological system summary scores for Biodiversity Status, Threat Status, Protection Status, Historic Trend, and overall conservation status. The overall conservation status for each system summarizes the three subcategories according to methods detailed in Appendix A. In general, the ecological systems at high elevations have a better conservation status than those at low elevations. Shortgrass prairie has had the largest loss of total acreage, while most other ecological systems have had minimal to moderate losses.

System Name	Biodiversity Status	Threat Status**	Protection Status	Historic Trend	Conservation Status
Alpine Tundra	8.2	9.2	8.1	-1%	Effectively conserved
Aspen	7.0	5.9	5.6	-3%	Moderately conserved
Foothill Shrubland	7.0	6.3	2.4	-1%	Weakly conserved
Grasslands	6.5	6.6	2.1	-13%	Weakly conserved
Greasewood	6.9	4.4	2.3	-35%	Under conserved
Juniper	7.0	5.8	1.5	-0.1%	Weakly conserved
Lodgepole Pine	6.8	7.4	6.3	-6%	Moderately conserved
Mixed Conifer	6.2	7.5	5.6	-0.3%	Moderately conserved
Oak & Mixed Mtn Shrub	7.3	4.5	2.9	-5%	Weakly conserved
Pinyon Juniper - CO PL	7.0	4.2	4.3	-14%	Weakly conserved
Pinyon Juniper - SRM	5.5	5.9	2.5	-8%	Moderately conserved
Ponderosa Pine	5.6	3.6	3.7	-3%	Weakly conserved
Sagebrush	6.2	4.6	2.7	-12%	Weakly conserved
Salt Shrub	7.3	3.9	3.2	-25%	Weakly conserved
Sand Sage	6.6	4.4	0.8	-19%	Under conserved
Shortgrass Prairie	6.6	4.9	0.9	-48%	Under conserved
Shrub-Steppe	7.8	4.6	2.8	-32%	Moderately conserved
Spruce Fir	7.8	8.4	7.8	-1%	Effectively conserved

**The threat analysis did not directly address climate change. These scores, and consequently the overall conservation status scores, are expected to worsen in the next iteration of the Scorecard, when this significant threat is considered. This is especially true for the alpine ecological system, but will likely affect other systems as well.

Tinker et al. 1998, Theobald 2003) utilized mapped patches of landcover types. These studies, however, focused on landscape fragmentation analysis rather than delineating occurrences that are part of a landscape-scale matrix of functional ecological systems. Previous work in Colorado and other states has analyzed each ecological system type as a single entity within a state (e.g., Merrill et al. 1996, Thompson et al. 1998, Schrupp et al. 2001) or multi-state area (Wright et al. 2001). Although useful for statewide conclusions, such analyses do not directly facilitate prioritization of specific conservation target areas within an ecological system type. Through the use of discrete, spatially explicit patches of generalized ecological system types, our analysis evaluates the conservation status of individual occurrences of an ecological system, and allows conservation groups and land managers to prioritize their actions.

Our analysis shows that, while Colorado's dominant ecological systems are still largely intact, many of them are threatened and/or not well protected. Common and widespread ecological systems in Colorado are generally of good to high quality and part of naturally functioning landscapes. For some ecological systems, however, threats and lack of protection may change this situation rapidly. Only two of our systems scored Effectively Conserved; 16 systems are in need of some level of conservation attention if they are to reach Effectively Conserved status.

This situation implies both great risks and great opportunities for conserving functioning landscapes in our state.

Shortgrass prairie is by far the most altered of any of Colorado's major ecological systems, has fair threat status, and is poorly protected as well. Despite the loss of nearly half of Colorado's shortgrass prairie in the past century, there remain some very large, high quality areas that present excellent opportunities for conservation.

Areas of lower biodiversity status are primarily concentrated in northeastern Colorado, from the urban corridor along the mountain front eastward across the agricultural areas of the plains. Areas with the highest biodiversity scores are predominantly on the west slope (Figure 3).

The spatial pattern of patch threat status scores indicates that the mountain areas of Colorado are generally less threatened than other parts of the state (Figure 5). All ecological systems except shrub-steppe, however, have at least a few of their patches in poor (highly threatened) threat status areas. On the western slope, oil and gas and oil shale development are a primary threat in the Piceance Basin, Roan Plateau and parts of Moffat County. Population growth effects are seen most dramatically in the Pagosa Springs/Durango area. Colorado's eastern plains and foothills show the potential for both energy development and expanding

population from the urban centers of the Front Range.

Protection status scores reflect the distribution of public lands, and the variety of permitted usage on public lands in Colorado. Public lands with strong management prescriptions (such as wilderness areas) score highest in overall protection, while public lands subject to intensive energy development activities score fair to poor. Privately owned lands, where the duration of tenure is uncertain and management intents largely unknown, also score poor to fair in overall protection status.

The scorecard analysis presented herein is almost entirely dependent on the availability of spatial data layers at a statewide level. We would like to incorporate additional information (e.g., climate change models) as it becomes available. Statewide datasets are not always updated frequently, however, and this will limit the frequency at which the scorecard analysis can be revised.

Ecological System Summary Sheets

The following pages provide a brief description of each ecological system (adapted from NatureServe 2008), showing its overall status in Colorado, the spatial distribution of patches larger than minimum size, and the relative importance of the individual scorecard factors, depicted as a "wind rose" graph.

ALPINE TUNDRA

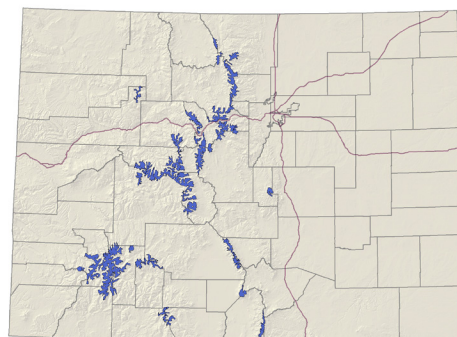


This ecological system includes high-elevation dry tundra, fellfield, wet-meadow, and rock and scree communities. Alpine tundra is found at the highest elevations in our state, usually above 11,000 feet. Here the long winters, abundant snowfall, high winds, and short summers create an environment too harsh for permanent human habitation. Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost, and a short growing season.

Characteristic alpine animals include the pika, marmot, Brown-capped Rosy Finch, and White-

tailed Ptarmigan. Larger mammals such as elk, big horn sheep, and the introduced mountain goat also use these habitats when they are free of snow. One of the world's rarest butterflies, the Uncompahgre

fritillary, lives among the dwarf willows at altitudes above 13,000 feet and is found on just a few of Colorado's high peaks. There are also nine rare and Colorado-



Distribution of patches >10,000 acres (n=31)



American pika (left) and marmot (right): two high elevation species that are currently common, widespread, and secure. The future status of these species is less certain in the face of predicted climate change impacts to alpine areas.

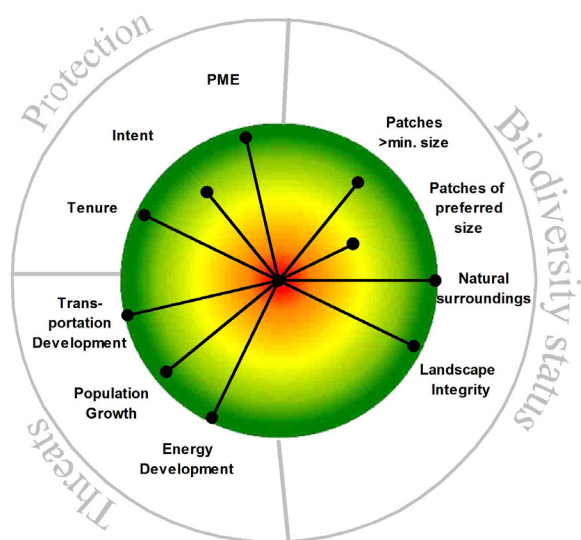
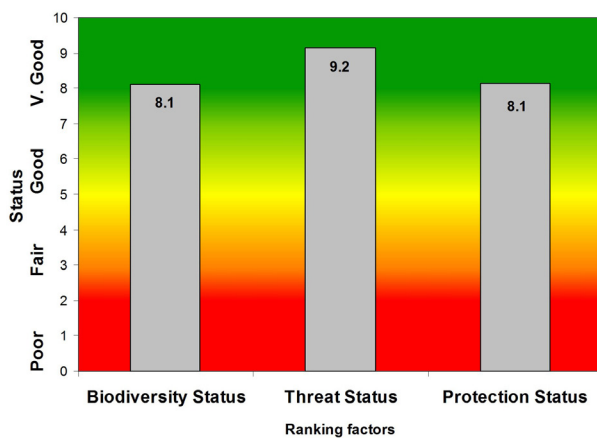
endemic plants found only in the alpine zone.

This ecological system covers over 1.5 million acres in Colorado, or about 3% of the state's landscape. Most of the alpine is federally owned (managed primarily by the U.S. Forest Service) and much of it is in wilderness status. Old privately-owned mining claims are

scattered throughout, but there are very few active mines operating today. In general, alpine tundra in Colorado is in excellent condition and had the highest protection scores of any ecological system we analyzed. The primary threat to this ecological system is global climate change, which could have significant impacts on this ecological system in the future.

Impacts from recreation (primarily ski-area development) are a distant second.

The minimum desired patch size for this ecological system is 10,000 acres. The best occurrences should encompass at least 40,000 acres.



ASPEN



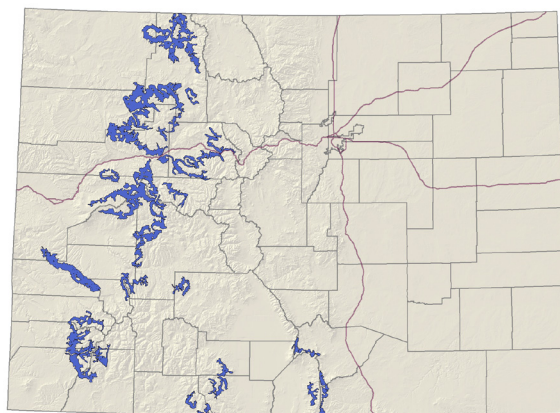
In Colorado, aspen forests are quite common on the west slope, with smaller stands represented on the east slope. These are upland forests and woodlands dominated by quaking aspen, or forests of mixed aspen and conifer, ranging in elevation from about 7,500 to 10,500 feet. Aspen forests and woodlands usually contain a mosaic of many plant associations and may be surrounded by a diverse array of other ecological systems, including grasslands, wetlands, and coniferous forests.

Aspen forests are one of our most species-rich ecological systems. Most of the plant and animal

species that inhabit aspen forests are relatively abundant and not of significant conservation concern. Rarer animals include Purple Martin, Northern Goshawk, Olive-

sided Flycatcher, Flammulated Owl, and dwarf shrew.

Aspen forests cover more than three and a half million acres in



Distribution of patches >20,000 acres (n=24)



Elk in aspen grove. Though the aspen ecological system is comparatively stable, elk browsing of you aspen shoots can have significant local impacts, often resulting in reduced regeneration in some stands.

Colorado, including one patch of more than a half million acres on the edges of the White River Plateau and Flat Tops.

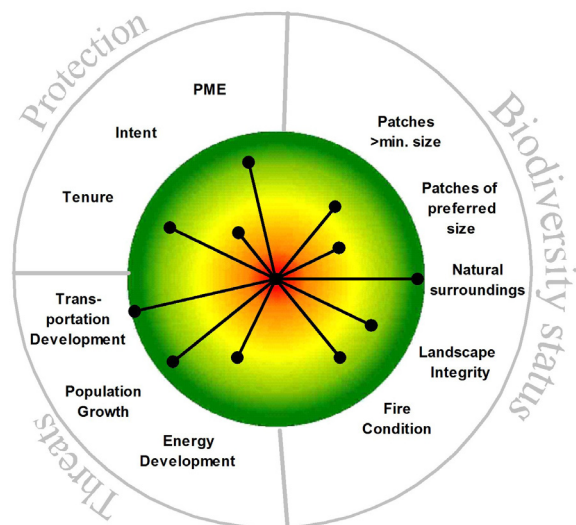
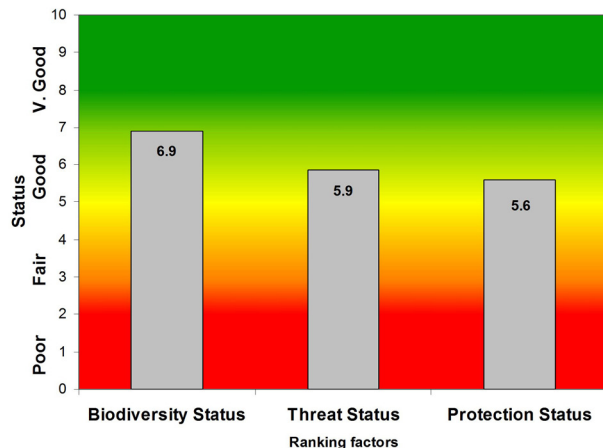
is not as well represented in the nation's Wilderness system as the alpine and spruce-fir ecological systems.

Overall, aspen forests in Colorado are in good condition and not highly threatened. Much of Colorado's aspen forest is on federal lands managed by the U.S. Forest Service. This ecological system

Primary human activities in this ecological system include cattle and sheep grazing, recreation, and hunting. Some aspen stands are cut for timber products.

Threats to the aspen forests and woodlands are comparatively low. However, in some areas, especially in southwestern Colorado, sudden die-offs of aspen stands have been observed. The cause(s) of aspen die-off are unclear and research to identify stressors is on-going. Currently, sudden aspen death is not widely distributed across the state, but there is potential for this condition to pose a more significant threat to our aspen forests in the future if the underlying causes are exacerbated by changing climatic conditions.

The minimum desired patch size for this ecological system is 20,000 acres. The best occurrences should encompass at least 80,000 acres.



FOOTHILL SHRUBLAND



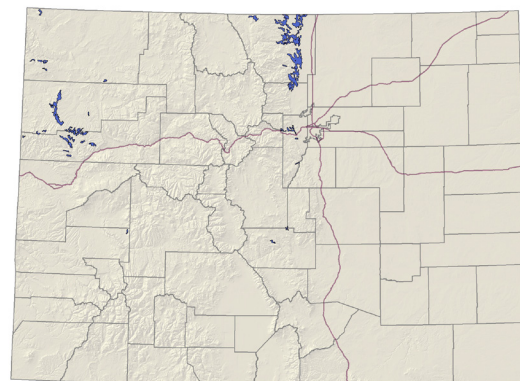
Foothill shrublands in Colorado are found in the Rocky Mountain foothills, ridges, canyons and lower mountain slopes, and on outcrops, mesas, and canyon slopes of the eastern plains. In general, mixed shrublands without oak are most common in the northern Front Range, as well as on drier foothills and prairie hills.

This ecological system occurs at elevations between 4,900-9,500 feet. Scattered trees may be present, but the vegetation is dominated by shrubs such as mountain mahogany, antelope bitterbrush, skunkbush sumac, or currant species. The dominant

shrub species are generally well adapted to poor soils, dry sites, and disturbance by fire. Fire suppression may have allowed an invasion of trees into some of these

shrublands, but in many cases sites are too xeric for tree growth.

These foothill shrublands are used by a number of bird species,



Distribution of patches >1,000 acres (n=47)



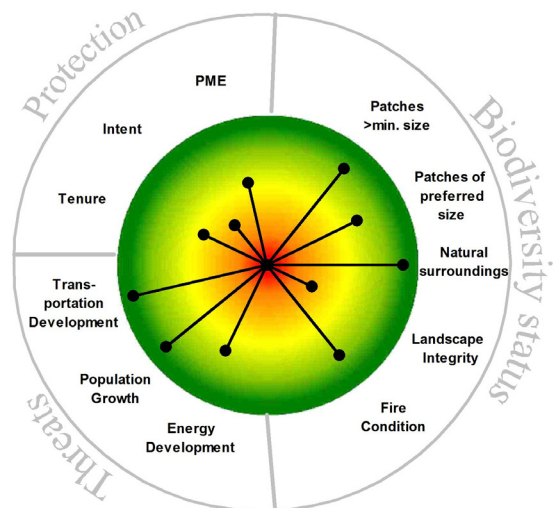
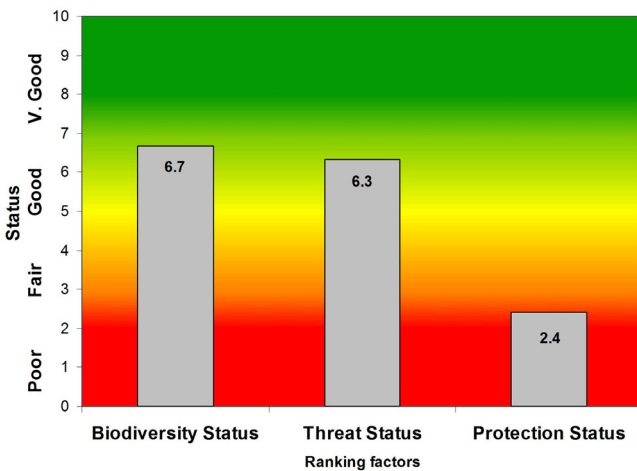
Mule deer (left) and mountain mahogany (right) are characteristic components of the foothill shrubland ecological system.

including Spotted and Green-tailed Towhees, MacGillvray's Warbler, and Broad-tailed Hummingbird. A number of small mammal species are common in this habitat, including the rock squirrel, deer mouse, northern rock mouse, Mexican woodrat, and gray fox.

There are few rare species exclusively associated with foothill shrublands, although they may be important for some insect and bird species. Rare species characteristic of adjacent habitats that may also be found in these shrublands include the Columbian Sharp-tailed Grouse, Larimer aletes, Bell's twinpod, and rare butterflies.

These shrublands cover less than 400,000 acres in Colorado. Most foothill shrublands are on privately owned lands, although some large occurrences have been protected on city and county open space properties. Threats to this ecological system include fragmentation by roads and development. These disturbances provide an unnatural fire break as well as a conduit for weed invasion.

The minimum desired patch size for this ecological system is 1,000 acres. The best occurrences should encompass at least 4,000 acres.



GRASSLANDS

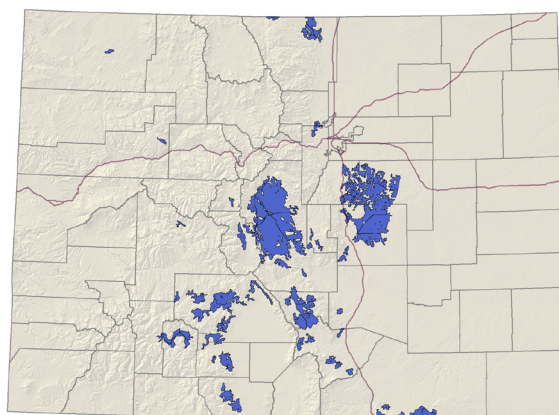


In this analysis we combined three non-shortgrass prairie grassland types: Western Great Plains Foothill and Piedmont Grassland, Southern Rocky Mountain Montane-Subalpine Grassland, and Inter-Mountain Basins Semi-Desert Grassland. Together these grasslands cover about three million acres in Colorado.

Foothill and piedmont grasslands are found at the extreme western edge of the Great Plains, where increasing elevation and precipitation facilitate the development of mixed to tallgrass associations on certain soils. These grasslands typically occur at elevations between 5,250 and 7,200

feet. Typical species include big bluestem, little bluestem, needle-and-thread, and prairie sandreed. Montane-subalpine grasslands in the Colorado Rockies are found

at elevations of 7,200-10,000 feet, intermixed with stands of spruce-fir, lodgepole, ponderosa, and aspen, or as the matrix community in the large intermountain basin



Distribution of patches >5,000 acres (n=73)



Mountain Bluebirds.

Bluebird, Brewer’s Blackbird, and white-tailed jack rabbit. Rarer species include the Gunnison’s prairie dog and a variety of skipper butterflies.

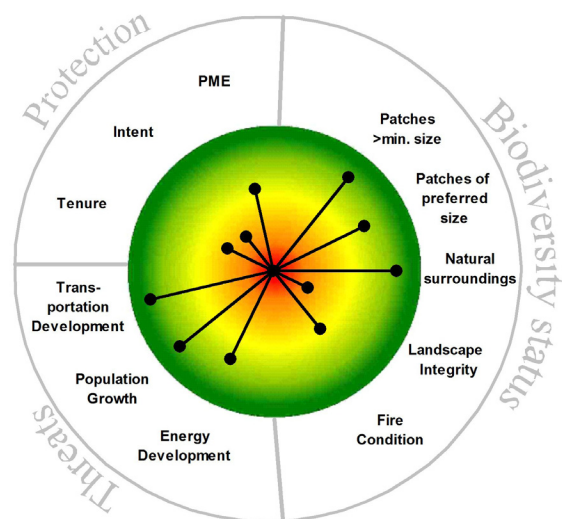
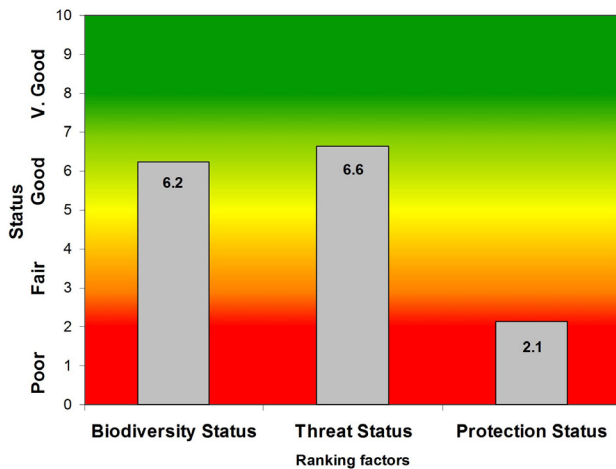
Current impacts from human activity other than domestic livestock grazing are low, especially in the montane grasslands. A significant portion of historic occurrences of lower elevation foothill and piedmont grasslands have been lost through conversion to cropland or other uses. The majority of Colorado’s low elevation grassland acreage is on privately owned lands, while much of the montane grasslands are on federal land managed by the USFS or the BLM. Although much of our remaining grasslands are in good condition, protection for them is generally lacking.

The minimum desired patch size for this ecological system is 5,000 acres. The best occurrences should encompass at least 20,000 acres.

of South Park. Typical dominant grass species include fescue, muhly, oatgrass, and others. Lower elevation montane grasslands are more xeric, while upper montane or subalpine grasslands are more mesic. Grasses of the foothills and piedmont may be included in lower elevation occurrences. Trees and shrubs are generally sparse or absent, but occasional individuals from the surrounding communities may occur.

Colorado’s semi-desert grasslands are found primarily on dry plains and mesas of the west slope at elevations of 4,750-7,600 feet. These grasslands are typically dominated by drought-resistant perennial bunch grasses such as bluebunch wheatgrass, blue grama, galleta grass, and needle-and-thread, and may include scattered shrubs.

Common grassland animals include the Vesper Sparrow, Mountain



GREASEWOOD

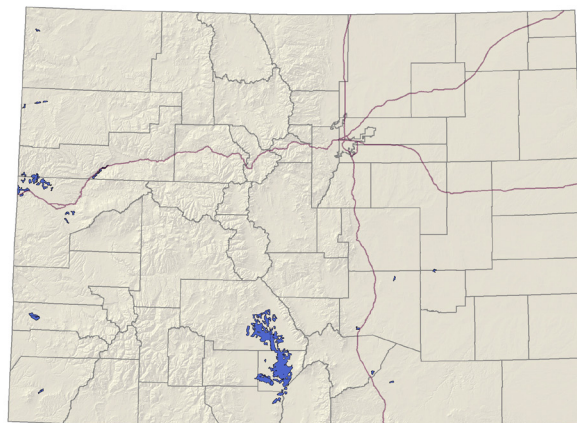


Shrublands dominated by black greasewood accounts for less than 450,000 acres in Colorado, where they are typically found near drainages on stream terraces and flats, on alluvial fans along streams or arroyos, or as rings around playas. In eastern Colorado, greasewood stands are primarily in the southwestern portion of the plains. Large acreages are also found in the lower elevations of Colorado's western valleys and throughout much of the San Luis Valley.

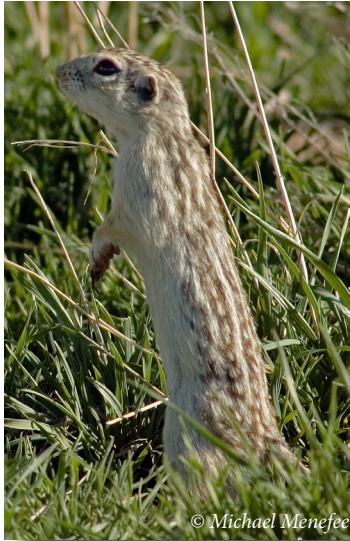
Greasewood flats usually have saline soils, a shallow water table and flood intermittently, but

remain dry for most of the growing season. Because greasewood flats are tightly associated with saline soils and groundwater that is near

the surface, groundwater recharge rather than surface water flow is critical for maintaining these shrublands.



Distribution of patches >1,000 acres (n=51)



Thirteen-lined ground squirrel (left);
Cleome multicaulis (slender
spiderflower) (right).



in greasewood flats in the San Luis Valley.

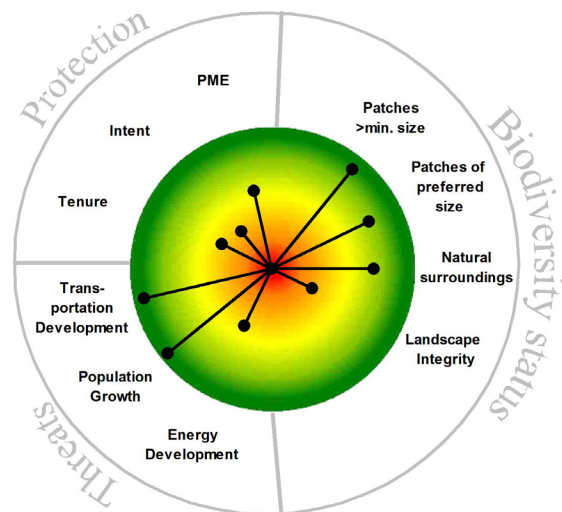
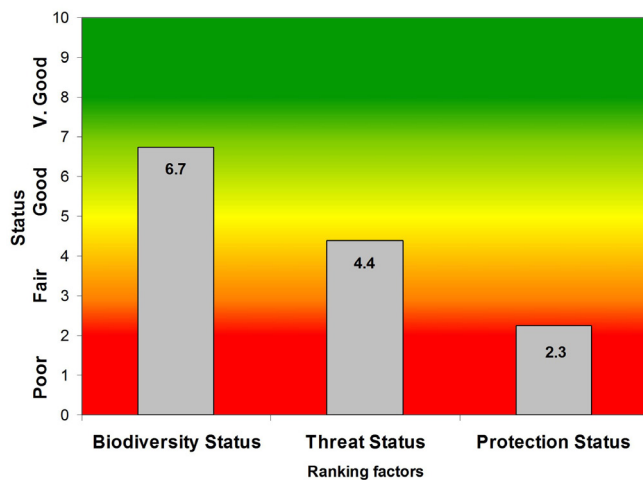
Some large tracts of greasewood shrubland are included within federal lands managed by the National Park Service, the U.S. Fish and Wildlife Service, or the Bureau of Land Management. Generally these tracts are not in protected areas. Primary threats to greasewood are groundwater pumping, conversion to cropland, and energy development.

Elevations range from about 4,000 to 7,700 feet. These open to moderately dense shrublands are dominated by black greasewood, often with rabbitbrush, four-wing saltbush, and alkali sacaton grass.

Sage Thrasher, and small mammals including the white-tailed antelope squirrel. In the San Luis Valley, these shrublands are home to rare local subspecies of the silky pocket mouse and thirteen-lined ground squirrel. The rare slender spiderflower also occurs in alkaline playa wetlands that are imbedded

The minimum desired patch size for this ecological system is 1,000 acres. The best occurrences should encompass at least 4,000 acres.

Greasewood stands are used by some shrubland birds, such as the



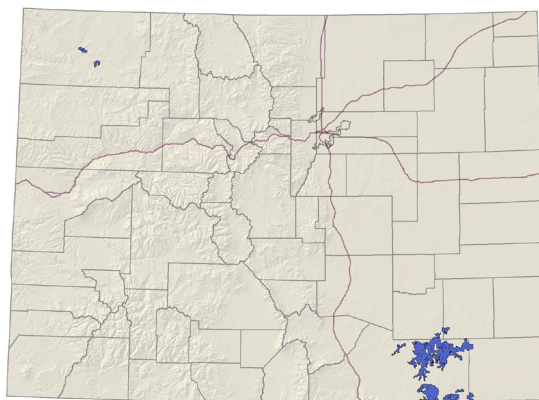
JUNIPER



Our analysis combines the Inter-Mountain Basins Juniper Savanna, found in northwestern Colorado, and the Southern Rocky Mountain Juniper Woodland and Savanna, occurring in the southeastern portion of the state. Together, these two juniper types account for about 558,000 acres in Colorado. Pinyon trees are seldom present in these open juniper woodlands because sites are generally too dry. The juniper savannas of northwestern Colorado are dominated by Utah juniper, while those in southeastern Colorado are characterized by one-seed juniper and Rocky Mountain juniper. Northwestern Colorado stands occur on lower

mountain slopes and plateaus, often on dry, rocky areas, at elevations ranging from 4,900 to 7,550 feet. In the canyons and tablelands of the southern Great Plains, this

ecological system forms extensive cover at some distance from the mountain front, at elevations from 4,100 to 6,200 feet.



Distribution of patches
>5,000 acres
(n=11)

Juniper woodlands are used by a variety of birds, small mammals, and reptiles. The Juniper Titmouse, at the edge of its range in Colorado, nests in tree cavities, while the collared lizard makes use of the rocky terrain under the junipers. The rare long-nosed leopard lizard may occasionally be found in either juniper or pinyon-juniper woodlands in western Colorado. The New Mexico thread snake is occasionally found in these woodlands in southeastern Colorado. One of our state's rarer bird species, the Gray Vireo, is known from these juniper woodlands.



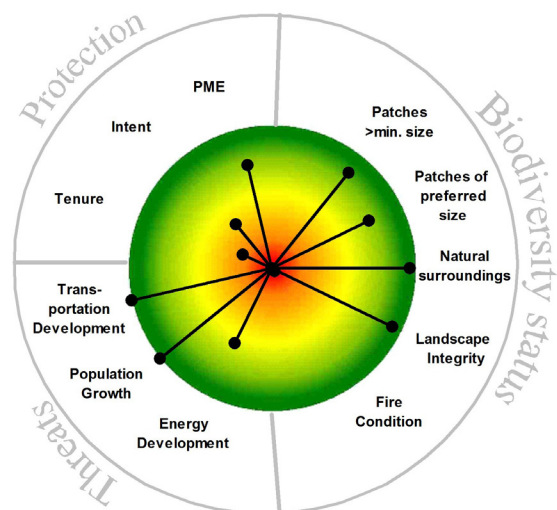
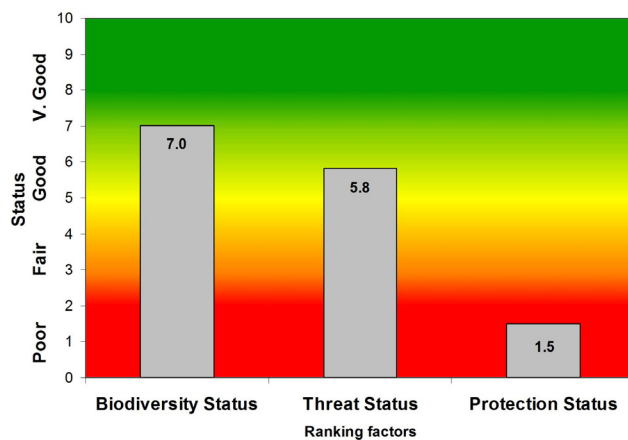
Above: Collared lizard. Right: Utah juniper from northwestern Colorado. This close-up shows the cones, which are often referred to as "berries."

Over 75% of Colorado's juniper woodlands are on privately owned lands, especially in southeastern Colorado. Though the remainder are located primarily on federal lands managed by the Bureau of Land Management and other agencies, or on Colorado State Land Board holdings, this ecological system is under protected in Colorado.

In general, Colorado's juniper woodlands have been little impacted by human activities. However, the extent of juniper woodlands has historically been limited by fire, which kills juniper trees. Fire suppression may have caused an expansion of juniper woodlands in some areas of

southeast Colorado, where most of the junipers not associated with rimrock are young trees (<100 years old).

The minimum desired patch size for this ecological system is 5,000 acres. The best occurrences should encompass at least 20,000 acres.



LOGEPOLE PINE

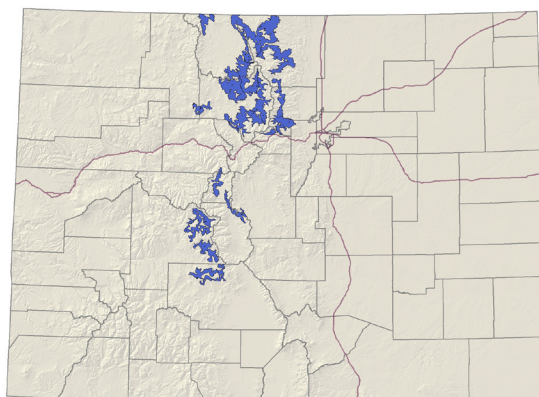


In Colorado, the lodgepole pine ecological system is widespread between 8,000-10,000 feet in elevation, on gentle to steep slopes of the Rocky Mountains in the northern part of the state. Stands may be pure lodgepole pine, or mixed with other conifer species. Following stand-replacing fires, lodgepole pine rapidly colonizes and develops into dense, even-aged stands (sometimes referred to as “dog hair” stands).

Lodgepole pine forests typically have shrub, grass, or barren understories, sometimes intermingled with aspen. Shrub and groundcover layers are often

sparse in lodgepole pine forests. Diversity of plant species is also low, perhaps as a result of the uniform age and dense canopy of many stands.

Lodgepole forests cover more than two million acres in Colorado. Although these forests are common across Colorado, most are experiencing widespread damage



Distribution of patches >30,000 acres (n=14)



from a severe outbreak of mountain pine beetle. The pine beetle is a native species, and periodic outbreaks of this insect are part of the natural cycle that maintains our mountain forests. Climate change, however, may increase the scope and severity of the outbreaks.

Common mammal species in these forests include the pine squirrel (also called chickaree), porcupine, mule deer, and elk. Typical birds are the Mountain Chickadee, Pine Siskin, Ruby-crowned Kinglet, and Yellow-rumped Warbler. Infrequent species include the Three-toed

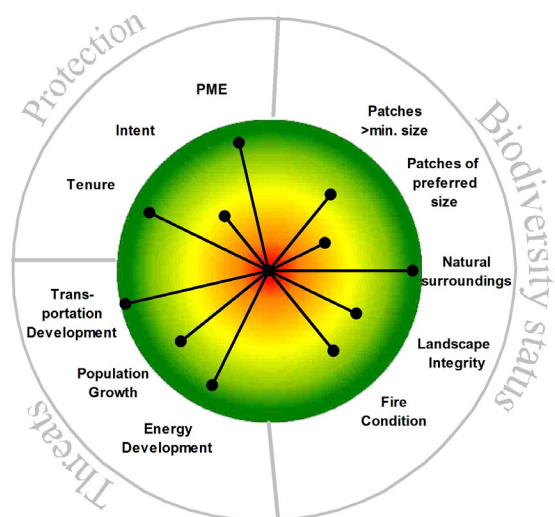
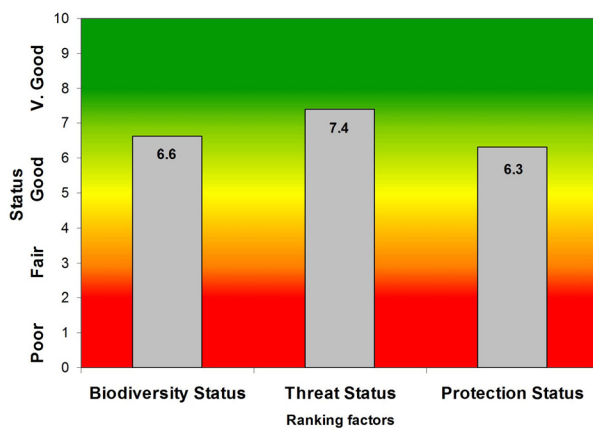
Lodgepole pine forest prior to mountain pine beetle outbreak (left) and after beetle outbreak. The current infestation is extreme by historic standards, but is not expected to result in significant long-term loss of this ecological system in Colorado. Future years may see some lodgepole stands being replaced by aspen or other conifer forest types, depending on local climate conditions.

Woodpecker and Williamson's Sapsucker. These forests are used occasionally by lynx.

Most of our lodgepole forests are on federally owned lands managed by the U.S. Forest Service, Bureau of Land Management, or National Park Service. Most are not completely within wilderness areas, although they may be present along the boundaries of these areas.

Lodgepole pine forests in Colorado generally have good conservation status. Natural processes such as fire and pine beetle infestation are the most obvious impacts to these forests. Fire suppression and logging have affected some areas.

The minimum desired patch size for this ecological system is 30,000 acres. The best occurrences should encompass at least 120,000 acres.



MIXED CONIFER

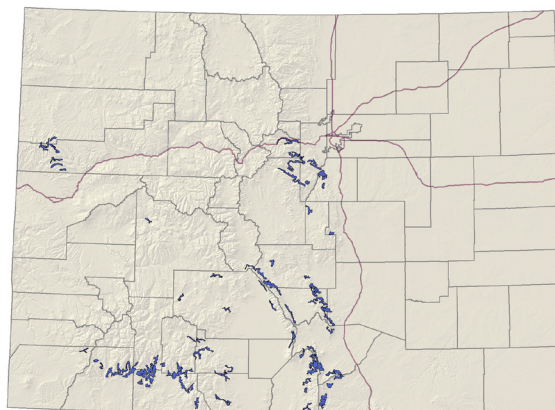


© Michael Menefee

Mixed conifer forests occur at elevations ranging from 4,000 to 10,800 feet. Douglas-fir and white fir are the most common dominant trees, but as many as seven different conifer species may be present. Natural fire processes in this ecological system are highly variable in both return interval and severity. Douglas-fir stands are characteristic of drier sites, often mixed with ponderosa pine. More mesic stands are found in cool ravines and on north-facing slopes, and are likely to be dominated by white fir with blue spruce or quaking aspen stands. Fire in these cool, moist stands is infrequent, and the understory may be quite diverse.

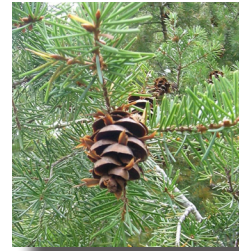
A number of common and rare bird species may be found in mixed conifer forests, including the Western Tanager, Mountain Bluebird, Clark's Nutcracker, Williamson's Sapsucker, and Red-naped Sapsucker.

Mixed conifer forests cover more than 850,000 acres in Colorado. A substantial portion (15%) is on private land, but nearly 70% occurs on federal lands, primarily those managed by the U.S. Forest Service. Though much of the



Distribution of patches >2,500 acres (n=77)

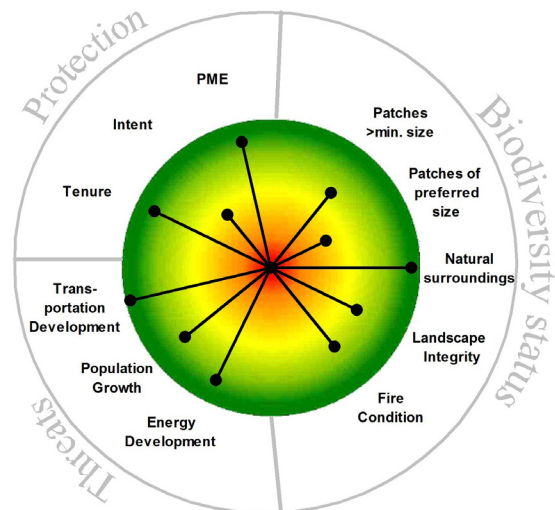
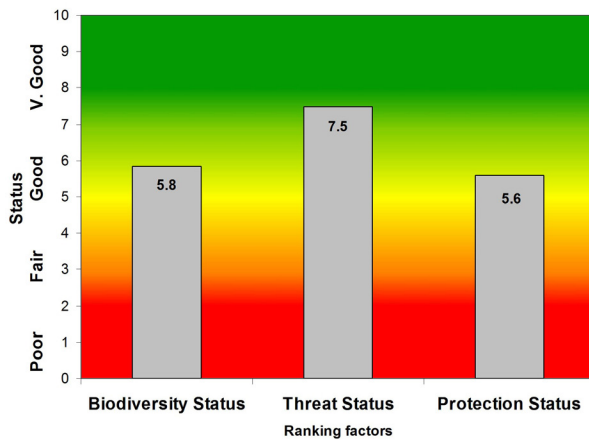
Williamson's Sapsucker (below); Douglas fir cone (upper right); White-crowned Sparrow (lower right).



public land occurrences are lacking wilderness designation or other special protection, many of these habitats are generally in good condition, with minimal threats, and reasonable protection.

Occurrences in the Front Range are vulnerable to the impacts of housing development, while those in western Colorado are often adjacent to active oil and gas development.

The minimum desired patch size for this ecological system is 2,500 acres. The best occurrences should encompass at least 10,000 acres.



OAK AND MIXED MOUNTAIN SHRUB

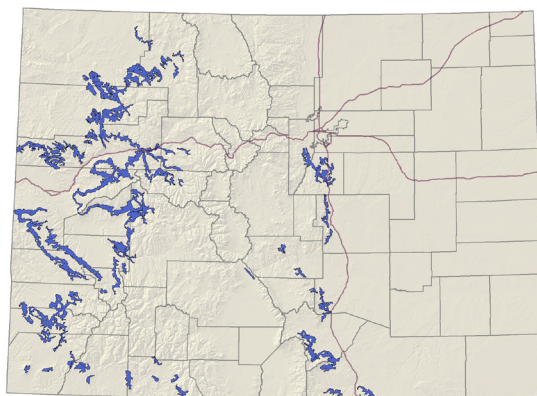


Oak and mixed mountain shrublands generally occur at elevations from approximately 6,500 to 9,500 feet, where they are often adjacent to lower elevation pinyon-juniper woodlands. Gambel oak is typically dominant, but very often mixed with other montane shrubs such as serviceberry, mountain mahogany, antelope bitterbrush, big sagebrush, chokecherry, and snowberry. These shrublands intergrade with foothill shrublands because both types are often found on poor, dry soils.

In Colorado, oak and mixed mountain shrublands are most common on the west slope, where

they form extensive bands on the lower mountain slopes, plateaus, and dry foothills. In eastern Colorado these shrublands are also found at the mountain front

as far north as the Palmer Divide. These shrublands may form dense thickets, or occur as open shrublands with an herbaceous understory. Although this is



Distribution of patches >5,000 acres (n=76)



Black bear (left); Wild Turkey (below).



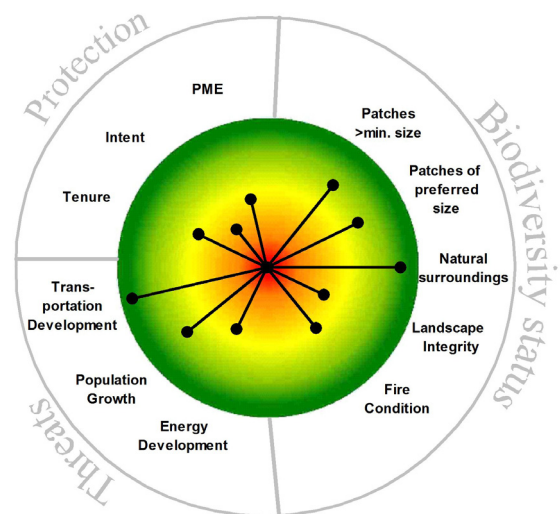
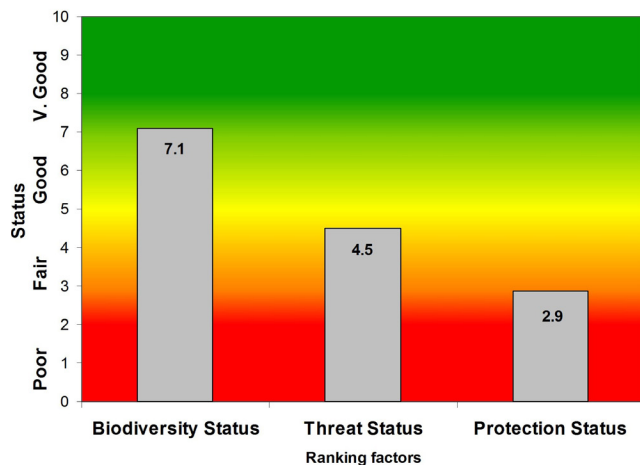
these habitats. Larger mammals such as mule deer, black bear, and mountain lion may take advantage of the cover and food sources offered by thick shrublands.

These shrublands account for about 2.7 million acres in Colorado, more than 50% of it on privately owned land. Other substantial tracts are on state and federally owned lands, especially those managed by the U.S. Forest Service and Bureau of Land Management. Some tracts on federal land are within non-wilderness protected areas. These shrublands are weakly protected in Colorado, but generally have high biodiversity status scores. Impacts include housing development and oil and gas development.

a shrub-dominated ecological system, some trees may be present. Fire typically plays an important role in oak and mixed mountain shrublands, causing shrub die-back in some areas, promoting stump sprouting of shrubs in other areas, and controlling the invasion of trees into the shrublands.

As with foothill shrublands, there are few common or rare species exclusively associated with oak-mixed mountain shrublands. A variety of small mammals, including squirrels and woodrats, and birds such as Spotted Towhee, Green-tailed Towhee, Virginia's Warbler, and Wild Turkey use

The minimum desired patch size for this ecological system is 5,000 acres. The best occurrences should encompass at least 20,000 acres.



PINYON JUNIPER - COLORADO PLATEAU

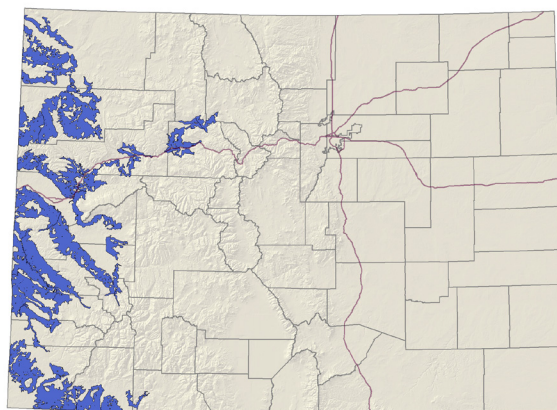


In Colorado, pinyon-juniper may occur as shrublands or woodlands. Sparsely vegetated pinyon-juniper shrublands of the Colorado Plateau Mixed Bedrock Canyon and Tableland ecological system are also included here. This is the characteristic ecological system of Colorado's western mesas and valleys, where it is typically found at lower elevations (ranging from 4,900 - 8,000 ft) on mesas, dry mountains, and foothills of the Colorado Plateau region.

Colorado Plateau Pinyon-Juniper stands may vary considerably in appearance and composition, depending on elevation, geographic

location, and fire history. Pinyon pine and/or Utah juniper form the canopy. Juniper is often more abundant at the lower elevations, while pinyon pine tends to be

more abundant at the higher elevations. Rocky Mountain juniper may replace or co-dominate with Utah juniper at higher elevations. These woodlands often occur in a



Distribution of patches >30,000 acres (n=32)

mosaic with other types, including sagebrush, oak, and semi-desert shrublands. The understory is highly variable, and may be shrubby, grassy, sparsely vegetated, or rocky. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow elevational zones.

Pinyon-juniper woodlands are influenced by climate, grazing, fires, tree harvest, and insect-pathogen outbreaks. Since the late 1800s, many of these woodlands have been significantly altered by changes in fire frequency, grazing patterns, and climate cycles. Fire acts to open stands, increase diversity and productivity in understory species, and create a mosaic of stands of different sizes and ages across the landscape. Due to fire suppression, the two tree species, especially juniper, have encroached on adjacent shrublands and grasslands in many places, changing the

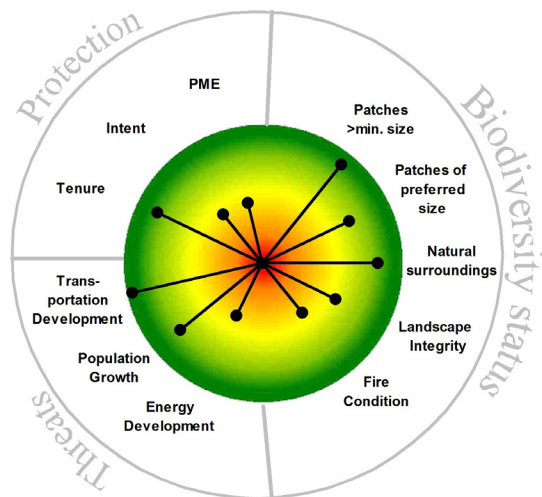
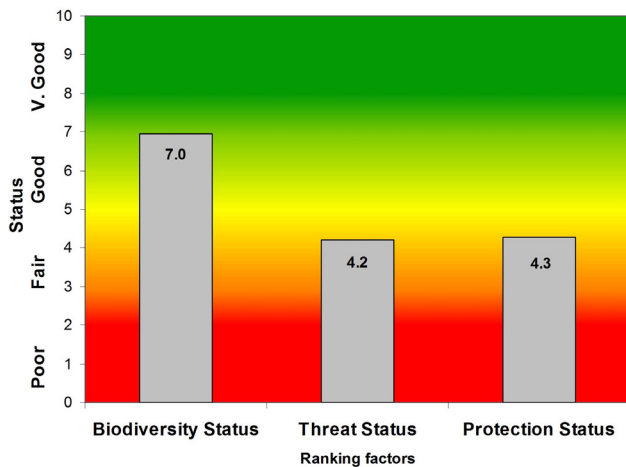
habitats available to wildlife, as well as the forage available to domestic cattle.

These woodlands are used by many common mammal species, including several bat species, desert and Nuttall's cottontails, Mexican woodrats, rock squirrels, pinyon and deer mice, gray foxes, mule deer, and mountain lions. Common bird species include the Pinyon Jay, Western Scrub Jay, Wild Turkey, Chipping Sparrow, and Black-throated Gray Warbler.

These woodlands are also important for some of Colorado's rarest birds, such as the federally listed (threatened) Mexican Spotted Owl, and Gray Vireo. A number of reptiles are characteristic, including the collared lizard, plateau lizard, and tree lizard. Rare reptiles found in pinyon-juniper woodlands include the long-nosed leopard lizard. Pinyon-juniper is the third most important habitat in the state for Colorado's rare plants.

Colorado Plateau pinyon-juniper covers nearly 5 million acres in western Colorado. Ownership is predominantly federal, mostly under the management of the Bureau of Land Management. Pinyon-juniper has declined in both extent and quality compared to historic norms, although a number of very large patches remain. Threats include urban development, recreation (especially motorized recreation), invasive species (most notably an increase in cheatgrass in the understory, which has led to increasing fire ignitions), and energy development.

The minimum desired patch size for this system is 30,000 acres. The best occurrences should encompass at least 120,000 acres.



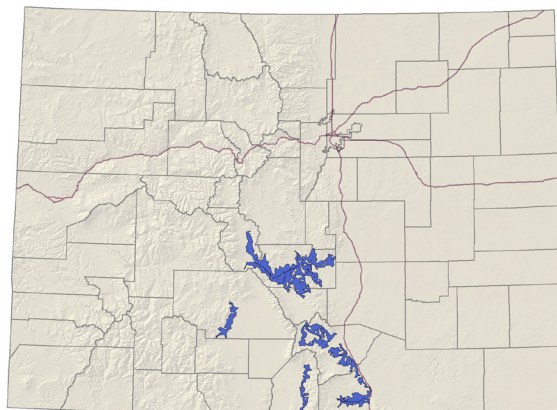
PINYON JUNIPER - SOUTHERN ROCKY MOUNTAIN



The Southern Rocky Mountain Pinyon-Juniper ecological system is similar to the Colorado Plateau Pinyon-Juniper ecological system, but with a more restricted distribution in south central Colorado. In Colorado, these pinyon-juniper woodlands are found in the south central part of the state, around the San Luis Valley, southern mountain front east to Mesa de Maya, and north to the Arkansas River Valley and Palmer Divide. Pinyon-juniper also occurs in a limited distribution on the eastern plains near the Purgatoire River. These are open woodlands of warm, dry sites on mountain slopes, mesas, plateaus, and ridges, found at elevations between 5,000 to 9,000 feet

Pinyon pine and/or one-seed juniper dominate the tree layer, and Rocky Mountain juniper may be present at higher elevations. In the canyons and tablelands to the east, pinyon is absent, and this ecological

system is replaced by Southern Rocky Mountain Juniper Woodland and Savanna. Understory layers are variable and may be dominated by shrubs, grasses, sparse vegetation, or bare ground.



Distribution of patches >30,000 acres (n=12)

Southern Rocky Mountain pinyon-juniper woodlands are influenced by climate, grazing, fires, tree harvest, and insect-pathogen outbreaks. Since the late 1800s, many of these woodlands have been significantly altered by changes in fire frequency, grazing patterns, and climate cycles. Fire acts to open stands, increase diversity and productivity in understory species, and create a mosaic of stands of different sizes and ages across the landscape. Due to fire suppression, the two tree species, especially juniper, have encroached on adjacent shrublands and grasslands in many places, changing the habitats available to wildlife, as well as the forage available to domestic cattle.

These woodlands are used by many common mammal species, including several bat species, desert and Nuttall's cottontails, Mexican woodrats, rock squirrels, pinyon and deer mice, gray foxes, mule deer, and mountain lions. The common hog-nosed skunk reaches



Western Scrub Jay

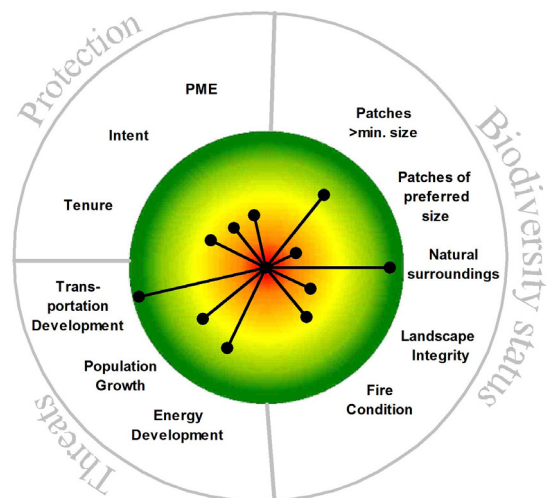
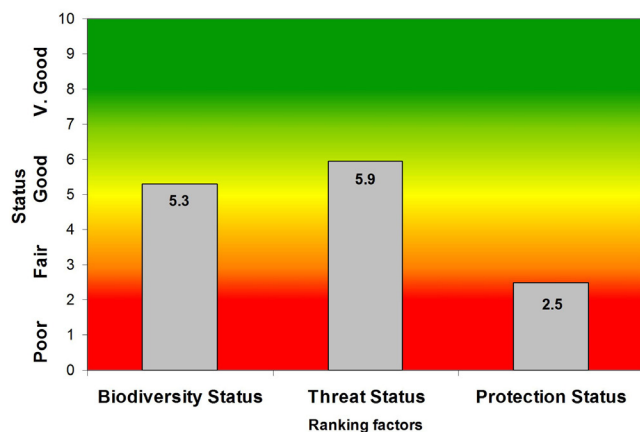
the northern edge of its distribution in this ecological system in southern Colorado.

Bird species include the Pinyon Jay, Western Scrub Jay, and Wild Turkey, as well as the less common Black-throated Gray Warbler. A number of reptiles are characteristic, including the prairie lizard. Pinyon-juniper is the third most important habitat in Colorado for rare plants. However more rare plants are found in Colorado Plateau pinyon-juniper woodlands than in southern Rocky Mountain pinyon-juniper.

Southern Rocky Mountain pinyon-juniper covers some 1.25 million acres in Colorado. Ownership is divided about equally between private and public ownership, with the Bureau of Land Management responsible for the majority of federal holdings.

Pinyon-juniper ecological systems have declined in both extent and quality compared to historic norms, although a number of very large patches remain. Threats include urban development, recreation (especially motorized recreation), invasive species (most notably an increase in cheatgrass in the understory, which has led to increasing fire ignitions), and energy development.

The minimum desired patch size for this ecological system is 30,000 acres. The best occurrences should encompass at least 120,000 acres.



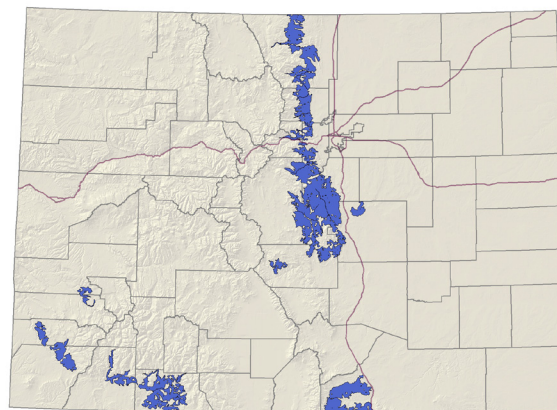
PONDEROSA PINE



In Colorado, ponderosa pine woodlands occur between about 6,000 and 9,000 feet, often at the lower treeline transition between grassland or shrubland and the more mesic coniferous forests above. These woodlands are especially prevalent along the eastern edge of the Rocky Mountains, and on the southern flank of the San Juan Mountains. Fire is the most significant ecological process maintaining this ecological system; frequent, low-intensity ground fires are typical. Healthy ponderosa pine forests often consist of open and park-like stands of mature trees, with an

understory of predominantly fire-tolerant grasses and forbs. Older trees drop their lower branches and develop thick, insulating bark as

they age, which protects them from ground fires. In stands where the natural fire regime occurs, shrubs, understory trees and downed logs



Distribution of patches >30,000 acres (n=25)



Pawnee montane skipper (above); blue grama grass (right).

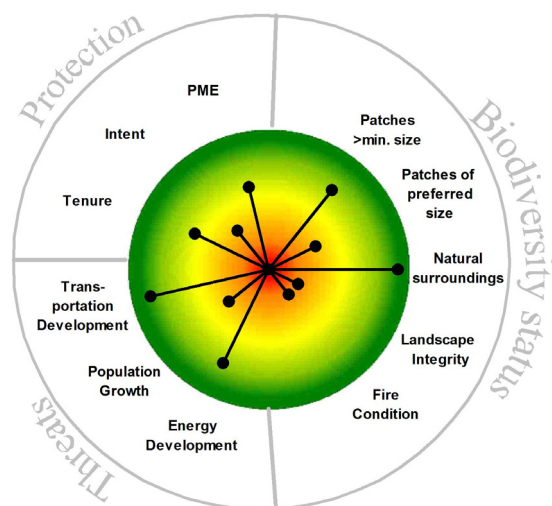
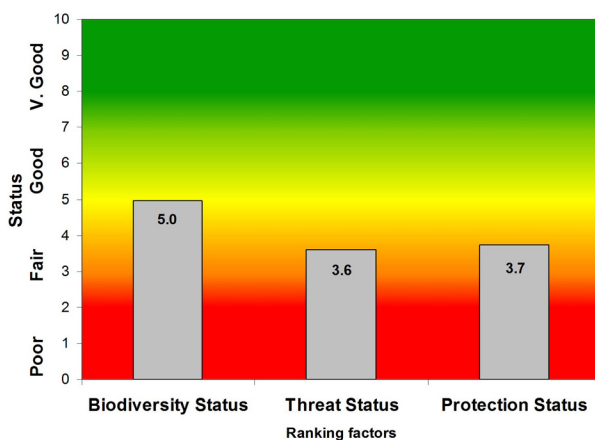
Ponderosa woodlands cover about 3.2 million acres in Colorado. More than half of this acreage is on public lands, and most areas have no special protection. Many stands have been lost to urban development, and many of the remaining stands are in degraded condition. The likelihood of future threats (primarily development and fire suppression) is high, and ponderosa pine is not well represented in our state's system of protected areas.

are uncommon. When fires are not allowed to burn, young trees continue to grow, and places that were once open savannas and woodlands become dense forests. Increased density of trees allows fires to reach the forest canopy, spread rapidly, and burn large areas.

most notable species of concern in Colorado's ponderosa pine woodlands is the federally listed (threatened) Pawnee montane skipper butterfly. This species occurs only in ponderosa pine with an understory of blue grama grass (the skipper's host plant). In Colorado, Grace's Warbler occurs only in old growth ponderosa pine stands in southwestern Colorado. The federally listed (threatened) Mexican Spotted Owl reaches the northern end of its range in ponderosa pine woodlands of south central Colorado.

The minimum desired patch size for this ecological system is 30,000 acres. The best occurrences should encompass at least 120,000 acres.

Ponderosa forests and woodlands provide habitat for a number of mammal species such as mule deer, mountain lion, porcupine, and Abert's squirrel. Characteristic bird species include the Pine Siskin, Mountain Chickadee, Pygmy Nuthatch, Band-tailed Pigeon, and Chipping Sparrow. The



SAGEBRUSH

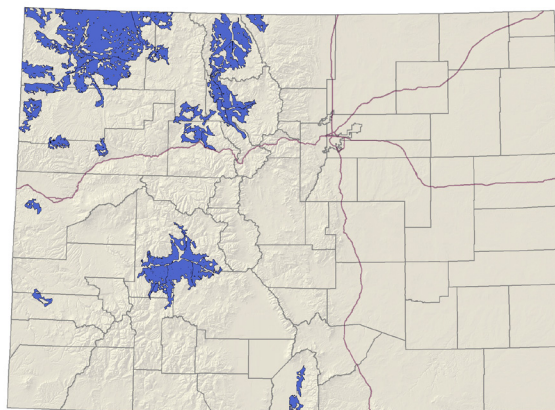


Our analysis combines two major types of sagebrush in Colorado: big sagebrush shrublands and montane sagebrush steppe. These shrublands occur throughout much of the western United States. Although they can be found on Colorado's east slope, the largest occurrences are on the western slope. North Park, Middle Park, and the upper Gunnison Basin have extensive stands of sagebrush shrublands.

Big sagebrush shrublands are characterized by dense stands of taller sagebrush species with a significant herbaceous understory, and are generally found at elevations from 5,000 to 7,500 feet. Big sagebrush shrublands

are typically found in broad basins between mountain ranges, on plains and foothills. Montane sagebrush steppe shrublands are dominated by shorter sagebrush species, and

are usually found at elevations from 7,000 to 10,000 feet. Montane sagebrush steppe primarily occurs on ridges, near flat ridgetops, and mountain slopes.



Distribution of patches >30,000 acres (n=32)

Sagebrush shrublands provide food and shelter for many small mammals and birds. The most significant at-risk animal in Colorado's sagebrush ecological system is the Gunnison Sage Grouse, ranked "critically imperiled" (G1S1) by the Colorado Natural Heritage Program. Other important bird species that are found exclusively (or almost exclusively) in sagebrush habitats are Greater Sage Grouse, Brewer's Sparrow and Sage Sparrow.

In addition, several of Colorado's rarest plants are found primarily in sagebrush shrublands. These include the federally listed (Endangered) Osterhout's milkvetch, as well as several other globally rare members of the milkvetch family (Gunnison milkvetch, violet milkvetch, and skiff milkvetch). Other rare Colorado plants most commonly found in sagebrush shrublands are the globally rare narrow-leaf evening primrose, Bessey locoweed,



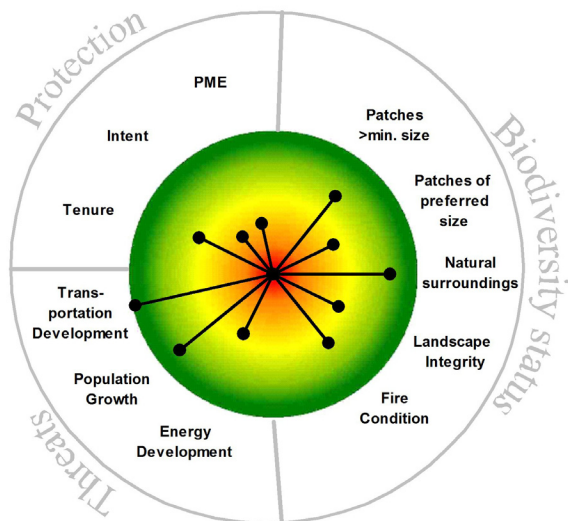
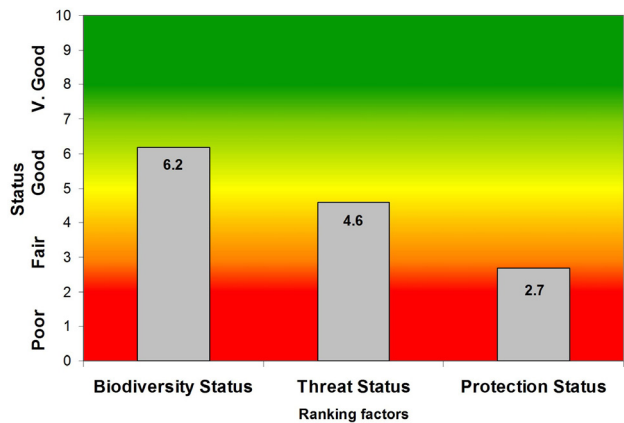
Osterhout's milkvetch (left); Gunnison Sage Grouse (right)

Fremont's beardtongue, and Harrington's beardtongue. Many of Colorado's sagebrush shrublands are vulnerable to changes induced by domestic livestock grazing. Prolonged use can cause a decrease in the abundance of native grasses and forbs in the understory, and an increase in shrubs and non-native grasses such as Kentucky bluegrass. Trampling from livestock grazing significantly decreases the survival of sagebrush and grass seedlings.

Over the past century the condition of much of Colorado's sagebrush shrubland has been degraded due to fire suppression and heavy

livestock grazing. Although many livestock operations are now more sensitive in their treatment of sagebrush shrublands than they once were, recovery in these ecological systems is slow. Furthermore, many remaining sagebrush patches are now being fragmented by fast-paced and widespread energy development.

The minimum desired patch size for this ecological system is 30,000 acres. The best occurrences should encompass at least 120,000 acres.



SALT SHRUB

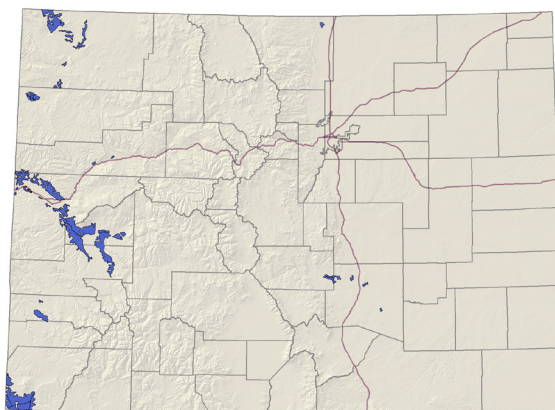


Our analysis of salt shrub combined Inter-Mountain Basins Mixed Salt Desert Scrub, Inter-Mountain Basins Mat Saltbush Shrubland, and Inter-Mountain Basins Shale Badland. All of these ecological system types are typically dominated by saltbush species or other shrubs tolerant of saline or alkaline soils.

These sparse to moderately dense low-growing shrublands are widespread at lower elevations (generally from 4,500 to 7,000 feet) in Colorado's western valleys, and are also found in more limited distribution in the southern part

of the eastern plains. In addition to mid-height and dwarf saltbush species, the shrub layer may include winterfat, wolfberry, horsebrush,

and various sagebrush species. Grasses and forbs are generally sparse, and dominated by species tolerant of the harsh soils. Some



Distribution of patches >1,000 acres (n=49)



Sclerocactus glaucus (Colorado hookless cactus, left); winterfat fruit (center); lesser earless lizard (right).

areas are essentially barren, or very sparsely vegetated.

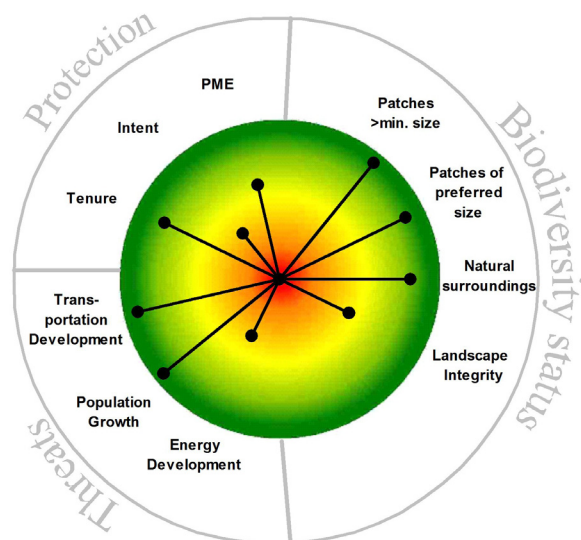
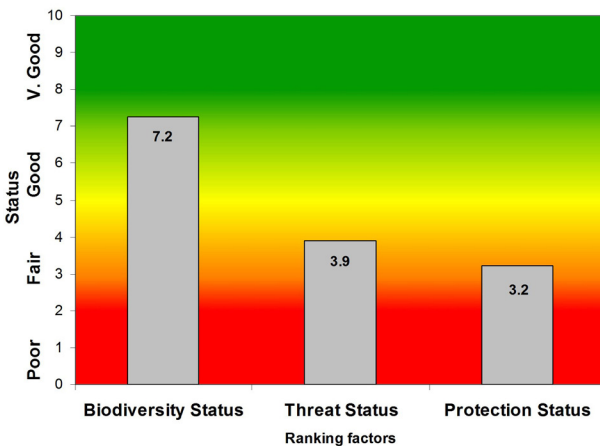
These shrublands and barrens support desert species such as the lesser earless lizard, desert spiny lizard, and the common kingsnake, but provide limited food and cover for mammal and bird species. White-tailed prairie dogs may be found in areas with sufficient vegetation. Salt shrub barren and sparse ecological systems of shaley soils are important for Colorado's rare plants, including the federally listed endangered wild clay-loving

buckwheat, and the threatened Mesa Verde cactus and Colorado hookless cactus.

Salt shrublands cover more than 750,000 acres in Colorado. The majority of occurrences are on federal lands managed by the Bureau of Land Management, and the remainder are on private or tribal lands. Few salt shrublands lie within protected areas with special management directives. Perhaps a quarter of the historic acreage of salt shrublands has been converted to agricultural use, especially in

valley bottoms where irrigation is available. Remaining occurrences are generally not productive agricultural or ranching lands, and appear to be in good condition. Impacts and fragmentation from energy development are the most current threats to this type.

The minimum desired patch size for this ecological system is 1,000 acres. The best occurrences should encompass at least 4,000 acres.



SAND SAGE

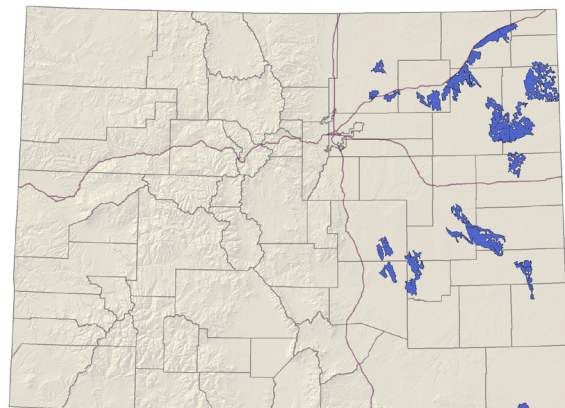


Sand sage shrublands dominate sandy areas on Colorado's eastern plains, where they often intermingle with shortgrass prairie to form a locally patchy sandsage-shortgrass matrix. Occurrences are characterized by sand sagebrush with an understory of tall, mid- or short grasses and scattered forbs. Yucca and snakeweed are common in some areas.

A variety of small mammals and burrowing reptiles live in sand sage shrublands where soils are easy to excavate. Typical species include kangaroo rats, plains pocket mice, grasshopper mice, western rattlesnakes, and western hognose

snakes. Rare species that are typical of this habitat include Greater and Lesser Prairie-chickens, Cassin's Sparrow, and ornate box turtle.

Fire and grazing are the most important dynamic processes for sand sage ecological systems, although drought stress can impact



Distribution of patches >14,000 acres (n=34)



Female box turtle (above left); Greater Prairie-chickens (above); Prairie rattlesnake (above right).

this ecological system significantly in some areas.

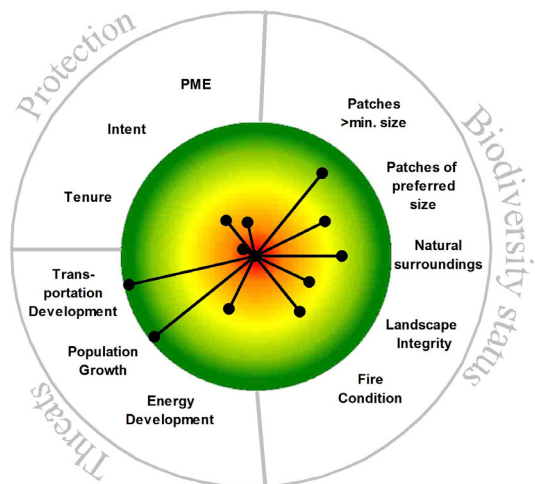
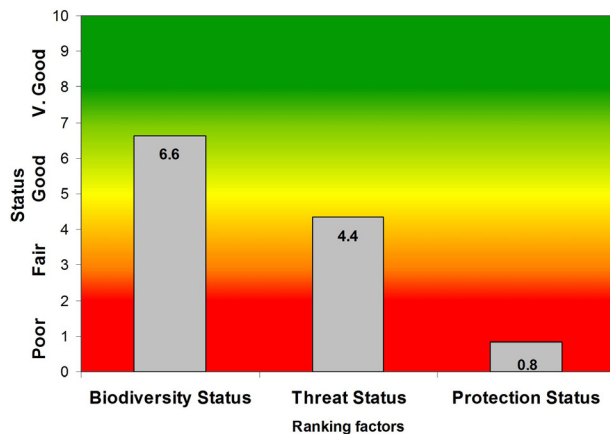
The Lesser Prairie-chicken is the most significant of the at-risk species in sand sage shrublands (in 2010 only 200 individuals remained in Colorado). Populations of the Lesser Prairie-chicken now occupy less than 10% of the range that was occupied in 1900. Their decline is largely due to conversion of native prairie habitats to crop agriculture. The development of wind energy

is a significant threat to Lesser Prairie-chickens.

Sand sage shrublands cover nearly two million acres in Colorado, and more than 80% of this is on private lands. State lands and federal lands managed by the U.S. Forest Service account for most of the remaining area. These sandy-soiled habitats have frequently been passed over while neighboring grasslands are converted to agriculture, however, about 20% of historic acreage has been lost. Remaining tracts

are generally in good condition. Sand sage shrublands had lower protection scores than any other ecological system we analyzed. Few patches are in protected areas. These shrublands in Colorado are vulnerable to adverse impacts from energy development (including wind, oil, and gas).

The minimum desired patch size for this ecological system is 14,000 acres. The best occurrences should encompass at least 56,000 acres.



SHORTGRASS PRAIRIE

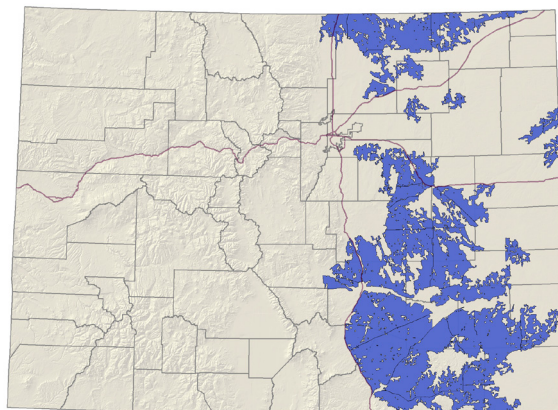


Shortgrass prairie, characterized by blue grama, buffalo grass, and other short to mid-height species, once covered most of Colorado east of the mountain front, at elevations below 6,000 feet. Today, nearly 50% of our historic shortgrass prairie has been converted to tilled agriculture or other uses - the largest loss from any of Colorado's ecological systems.

In the early 1800s the shortgrass prairie was home to massive herds of free-ranging bison and pronghorn, as well as huge prairie dog colonies, deer, elk, and top predators including the gray wolf and grizzly bear. Today, the most conspicuous animal on the prairie

is the domestic cow. Pronghorn and prairie dogs still inhabit Colorado's prairies in reduced numbers, and the former top predators have been replaced by coyotes.

Large-scale ecological processes such as drought, fire, and grazing by large animals exert strong influences in this ecological system. The short grass species that dominate this ecological system are tolerant of drought and grazing.



Distribution of patches >50,000 acres (n=34)



Pronghorn (top); Mountain Plover (above left); Ferruginous Hawk (above right).

Round-leaf four o'clock, Pueblo goldenweed, Golden blazing star, Arkansas Valley Feverfew, and Arkansas Valley Evening Primrose.

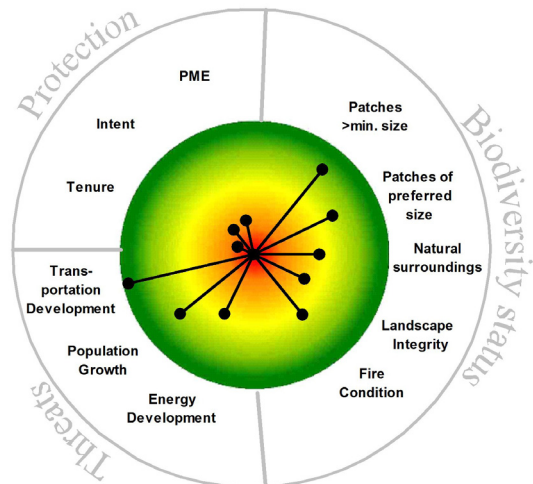
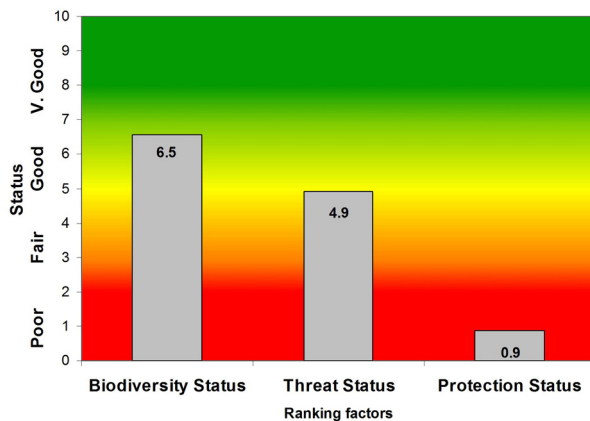
Almost all shortgrass prairie is in private ownership. Some very large expanses of native prairie in good condition still exist, thanks to the stewardship of ranching families. Unfortunately, in the absence of formal, legal protection (such as conservation easements), long-term tenure of private lands is not secure.

Ongoing impacts include renewable and non-renewable energy production (wind, solar, geothermal, oil and gas, and biofuels) and continuing expansion of urban and exurban communities, especially along the Front Range. The continued presence of shortgrass prairie in our state may also be threatened by changing climate.

The minimum desired patch size for this ecological system is 50,000 acres. The best occurrences should encompass at least 200,000 acres.

Many of Colorado's declining animal species are associated with the shortgrass prairie. Grassland bird species constitute one of the fastest declining vertebrate population groups in North America. Birds of conservation concern in the shortgrass prairie include: Burrowing Owl, Ferruginous Hawk, Mountain Plover, McCown's Longspur, Chestnut-collared Longspur, and Long-billed Curlew.

The federally endangered black-footed ferret, previously extirpated from Colorado's shortgrass prairie has been re-introduced. Other declining prairie animals include northern pocket gopher, ornate box turtle, massasagua rattlesnake, and Texas horned lizard. The rarest plants in the shortgrass prairie are associated with isolated shale barren outcrops, and include



SHRUB STEPPE

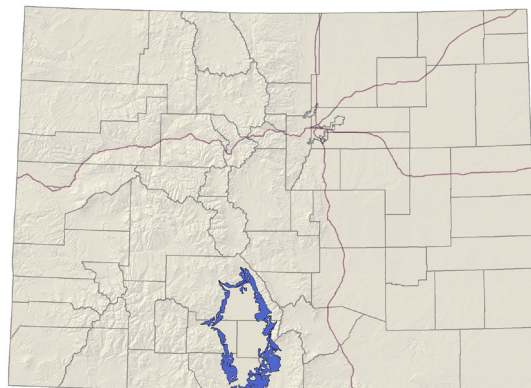


The term steppe generally refers to a treeless, grassy plain. In Colorado, these semi-arid shrubby grasslands are found between 7,500 and 9,500 feet in elevation, on windswept mesas, valley floors, gentle slopes, and on shoulders of ridges. Our shrub-steppes are grass dominated areas with an open shrub layer. Typical grass species include blue grama, needle-and-thread, galleta, saltgrass, Indian rice grass, and alkali sacaton.

Historically, the shrub layer was dominated by winterfat, but this species has decreased under pressure from domestic livestock grazing in many areas. Winterfat

has been replaced by rabbitbrush species and other woody shrubs. In Colorado, this ecological system does not form extensive stands except in the San Luis Valley.

Pinyon-juniper woodlands and sagebrush shrublands commonly occur adjacent to this ecological system at the upper elevations.



Distribution of patches >5,000 acres (n=11)

Shrub steppe provides habitat for many shrubland birds and small mammals. Typical species include Sage Thrasher, Vesper Sparrow, Gunnison's prairie dog, Ord's kangaroo rat, and northern grasshopper mouse. In the San Luis Valley, rare local subspecies of the silky pocket mouse and northern pocket gopher, as well as the rare plant species Weber's cryptantha and James's cryptantha are found in these habitats.



Gunnison's prairie dog.

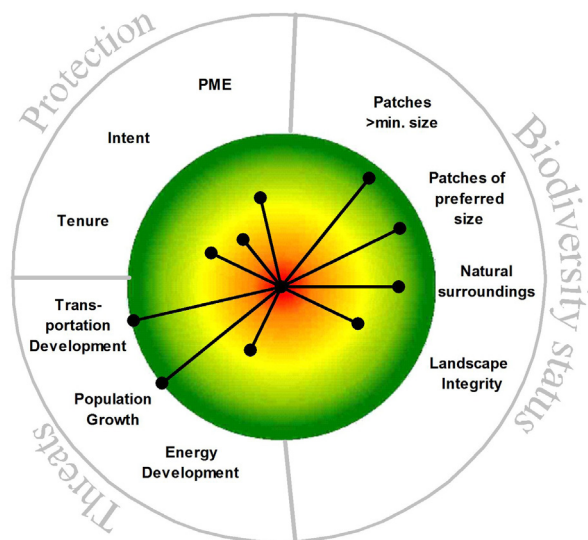
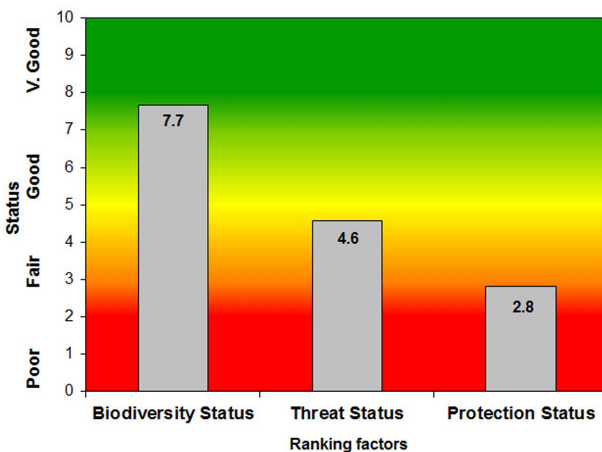
U.S. Fish and Wildlife Service

Shrub steppe covers more than 750,000 acres in Colorado. Historically, it probably accounted for well over a million acres, but many areas were converted to agricultural use. Remaining stands are generally in good condition, except for altered species composition.

About half of shrub steppe acreage is on privately owned lands, and the remainder primarily on federal land managed by the Bureau of

Land Management, National Park Service, or U.S. Fish and Wildlife Service. Limited acreage is within protected areas. Solar energy development in the San Luis Valley, and continued alteration by domestic livestock grazing are the primary threats to this ecological system.

The minimum desired patch size for this ecological system is 5,000 acres. The best occurrences should encompass at least 20,000 acres.



SPRUCE-FIR



© Michael Menejee

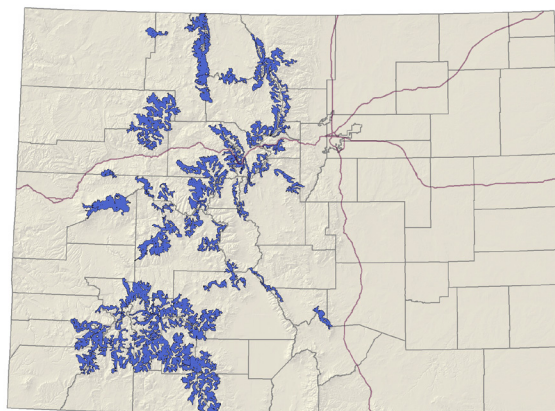
Spruce-fir forests cover about 5% of Colorado's landscape, forming the matrix vegetation of the sub-alpine zone at elevations of 9,500 to 11,500 feet. They are characterized by dense stands of Engelmann spruce and subalpine fir. This is one of the few Colorado forest types that is not fire-adapted - the typical fire return frequency is around 400 years.

Areas with spruce-fir forest typically receive a lot of precipitation in the form of snowfall and frequent summer showers. When periods of drought occur, however, the stressed trees become susceptible to spruce-bud worm and bark beetle outbreaks, which can kill entire hillsides of trees in one summer. In the early

20th century, much of Colorado's old-growth spruce fir was cut for timber.

Species characteristic of these heavily wooded habitats include pine marten, Canada lynx, red

squirrel, snowshoe hare, boreal owls, elk, Gray Jay, and Clark's Nutcracker. Although much of this ecological system is now made up of younger trees, it is still possible to find very old, widely-spaced trees with yellow bark, as well as



Distribution of patches >20,000 acres (n=51)



Canada lynx (left); boreal toad (below); pine marten (right).



snags and downed trees that create perfect habitat for cavity-nesting birds and pine martens.

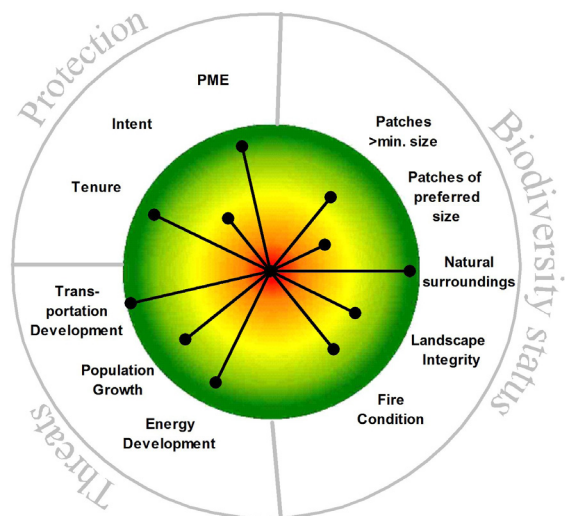
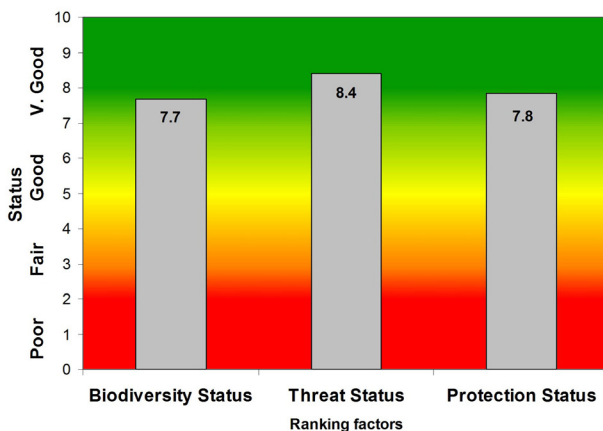
Although forests including spruce-fir occupy over 20% of Colorado's landscape, few rare species are associated with this ecological system. Boreal toads were once a common species in small wetlands within high altitude coniferous forests in the Colorado Rockies. Today few healthy populations

exist; most have apparently succumbed to chytrid fungus infestation. Lynx and boreal owls spend most of their time in or near large stands of spruce-fir forests.

Most spruce-fir forests in Colorado are federally owned and managed by the U.S. Forest Service, with a significant proportion in wilderness status. In general, spruce-fir forests in Colorado are healthy, intact, and well protected. Although this

ecological system is heavily used for recreation and other human activities, its overall threat status is generally low. Global climate change may have significant impacts on this ecological system in the future.

The minimum desired patch size for this ecological system is 20,000 acres. The best occurrences should encompass at least 80,000 acres.





It is important to note that the majority of Colorado's plants and animals are not at risk (Figure 11). Aquatic dependent fish and amphibians have the highest percentage of at-risk species. In Colorado, 43% of all native fish species are at-risk. Mammals, birds, and reptiles are nearly equal, with approximately 20% of their species at risk. In terms of absolute numbers, plants have the highest number of at-risk species (103). However, 96% of our native plant species are not at risk.

We use the term "at risk" to refer generally to species listed as Tier 1 Species of Greatest Conservation Need in Colorado's Wildlife Action Plan, species with NatureServe global imperilment ranks of G1 and G2, and other species of conservation concern identified by The Nature Conservancy. This list is not comprehensive. Rather, it represents the first iteration of this analysis.

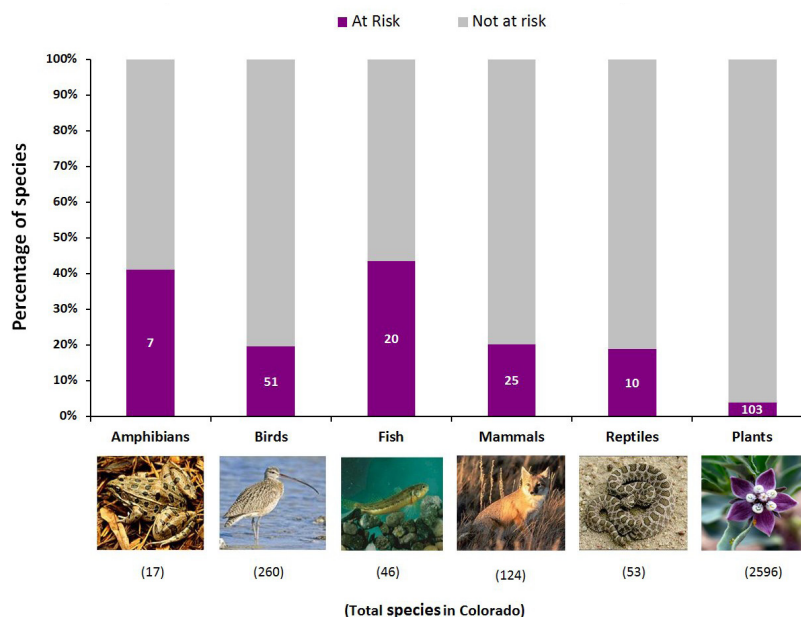
At-risk status does not translate directly into federal legal protection. Of all the at-risk species in our state, a much smaller number are federally listed as threatened or endangered under the Endangered Species Act: amphibians = 0; birds = 6; fish = 5;

mammals = 4; reptiles = 0; plants = 16.

Our Conservation Responsibility

For some of the species discussed in this report, Colorado represents the

Figure 11. Comparison of conservation status between taxonomic groups, statewide.



entirety - or nearly the entirety - of their global range. In these cases, our responsibility toward the species' conservation is clear. If we do not conserve and manage these species, they may go extinct. For other species, such as those that occur at the edge of their range in Colorado, our responsibility is more complex. It may be that conservation actions for these species would be more beneficial in other places. Or, it may be that conservation of fringe populations in our state could protect significant genetic diversity. There is considerable evidence that such populations may be more resilient to change due to their genetic variability, and are able to persist longer than would otherwise be expected (Lomolino

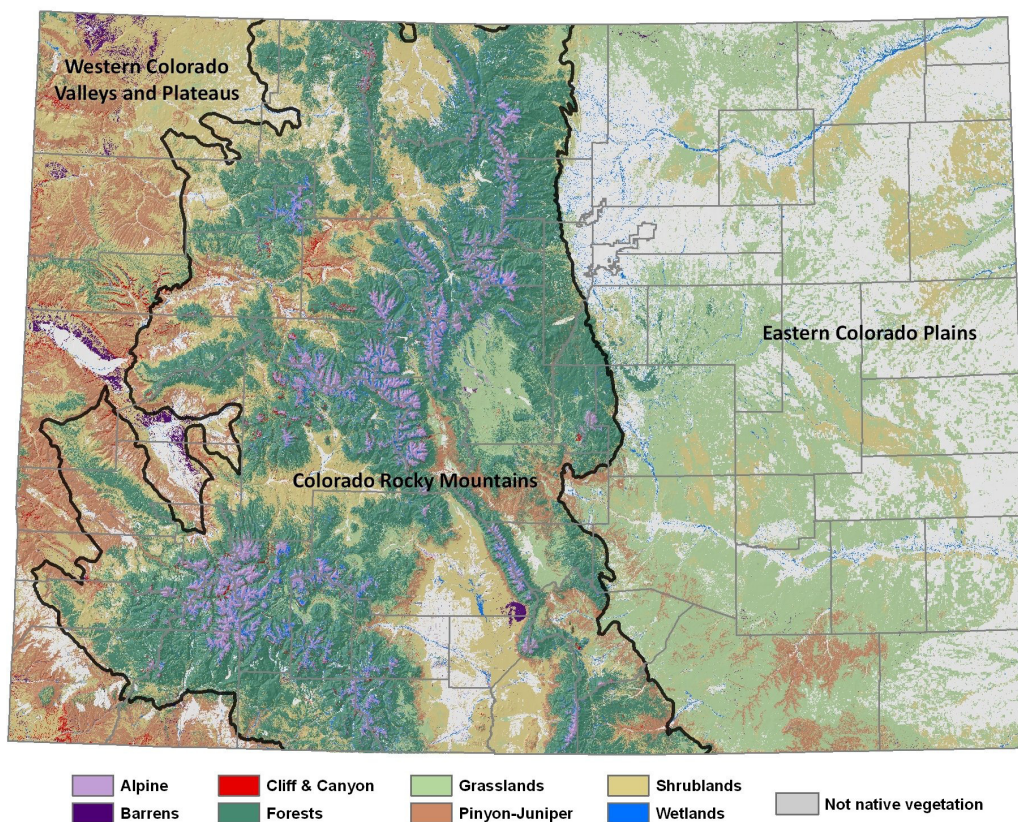
and Channel 1995). When setting conservation priorities and identifying conservation strategies, these questions, and many others, must be taken into account. Therefore, interpretation of the information in this report should consider the full suite of factors at play in the conservation of Colorado's biological diversity.

Species Habitats

The eighteen widespread ecological systems discussed in the previous section of this report, together with several other types not analyzed, form the habitat types for the animal and plant species addressed in the following pages. Because individual plant and animal

species are not always restricted to a single ecological system, we grouped ecological systems into eight categories that more closely resemble appropriate habitat types for the species analyzed (Figure 12). Forests account for about 22% of Colorado's acreage, and pinyon-juniper woodlands add another 10% to the total for tree-dominated habitats. Grassland (22%) and shrubland (19%) habitats also make up a substantial portion of our native vegetation. The other four habitat types - Alpine (3%), Wetland (2%), Cliff and Canyon (<1%), and Barrens (<1%) - each contribute a much smaller amount in terms of acreage, but they provide important habitat for a number of at-risk species.

Figure 12. Distribution of major habitat types for animals and plants as mapped by Southwest ReGAP.





There are about 500 native vertebrate (Fitzgerald et al. 1994, Kingery 1998, Hammerson 1999, Nesler 2003) and innumerable invertebrate species in Colorado. Due to the large number of species in the state and the differences in species tracked by different agencies and conservation organizations in Colorado, a subset of species was selected for the 2011 scorecard analysis. When interpreting the results of this analysis, it is important to remember that the species included do not represent all taxonomic groups equally.

Species Included in the Analysis

This Scorecard evaluated the conservation status of 141 of Colorado's at-risk animals, including 113 vertebrates (23% of native vertebrates) and 28 invertebrates (Table 5). All 107 Tier 1 Species of Greatest Conservation Need identified in the state's Wildlife Action Plan (CDOW 2006)

were included. The Tier 1 species include nine mollusks, five insects, 19 fish, three amphibians, five reptiles, 48 birds, and 18 mammals, and encompass all of Colorado's 17 federally listed animals, as well as 59 of the 74 state listed animals. In addition to the Tier 1 species, we analyzed another 14 invertebrates, as well as six state-rare vertebrates that are high priorities for The Nature Conservancy and the Colorado Natural Heritage Program.

Though 28 of our at-risk invertebrates were scored for this project, and are included in the results table, there are significant data gaps for this group. As a result, our confidence in the scores for invertebrates is comparatively low. For these reasons, invertebrates were not included in further analyses, and are not represented in the majority of maps, figures, and discussions that follow.

Scoring Methods

Conservation scores were generated for each species based on a number of factors that, taken together, provide information on biodiversity status, threat status, and protection status. The primary factors we considered in scoring overall conservation status for animals were abundance, threats, and level of legal protection.

A brief summary of methods is provided in the following sections. Refer to Appendix C for detailed methods and definitions of scores.

Abundance

An estimate of each species' abundance was used as an indicator of its biodiversity status. Because abundance may change quickly and may be difficult to estimate, large ranges of abundance (bins) are used in CNHP's Element State Rank (ESR) database, which was

Table 5. Animal species included in the analysis.

Scientific Name	Common Name	NatureServe Global Rank	NatureServe State Rank	Federal Legal Status	Federal Agency Sensitive Species	State Legal Status	Primary Habitat
AMPHIBIANS							
<i>Anaxyrus boreas pop. 1</i>	Western Toad - Southern Rocky Mountains	G4T1Q	S1		USFS	SE	Wetlands/ aquatic
<i>Anaxyrus debilis</i>	Green Toad	G5	S2				Wetlands/ aquatic
<i>Hyla arenicolor</i>	Canyon Treefrog	G5	S2		BLM		Wetlands/ aquatic
<i>Gastrophryne olivacea</i>	Great Plains Narrowmouth Toad	G5	S1			SC	Wetlands/ aquatic
<i>Scaphiopus couchii</i>	Couch's Spadefoot	G5	S1			SC	Wetlands/ aquatic
<i>Lithobates blairi</i>	Plains Leopard Frog	G5	S3		BLM/ USFS	SC	Wetlands/ aquatic
<i>Lithobates pipiens</i>	Northern Leopard Frog	G5	S3		BLM/ USFS	SC	Wetlands/ aquatic
BIRDS							
<i>Pelecanus erythrorhynchos</i>	American White Pelican	G3	S1B		BLM		Wetlands/ aquatic
<i>Botaurus lentiginosus</i>	American Bittern	G4	S3S4B		USFS		Wetlands/ aquatic
<i>Haliaeetus leucocephalus</i>	Bald Eagle	G5	S1B,S3N		BLM/ USFS	ST	Wetlands/ aquatic
<i>Accipiter gentilis</i>	Northern Goshawk	G5	S3B		BLM/ USFS		Forests
<i>Buteo swainsoni</i>	Swainson's Hawk	G5	S5B				Grassland
<i>Buteo regalis</i>	Ferruginous Hawk	G4	S3B,S4N		BLM/ USFS	SC	Grassland
<i>Aquila chrysaetos</i>	Golden Eagle	G5	S3S4B,S4N				Cliff and Canyon
<i>Falco peregrinus anatum</i>	American Peregrine Falcon	G4T4	S2B		BLM/ USFS	SC	Cliff and Canyon
<i>Falco mexicanus</i>	Prairie Falcon	G5	S4B,S4N				Cliff and Canyon
<i>Centrocercus urophasianus</i>	Greater Sage- Grouse	G4	S4	C	BLM/ USFS	SC	Shrubland

Table 5, cont.

Scientific Name	Common Name	NatureServe Global Rank	NatureServe State Rank	Federal Legal Status	Federal Agency Sensitive Species	State Legal Status	Primary Habitat
<i>Centrocercus minimus</i>	Gunnison Sage-Grouse	G1	S1	C	BLM/ USFS	SC	Shrubland
<i>Tympanuchus cupido pinnatus</i>	Greater Prairie Chicken	G4T4	S3		USFS		Grassland
<i>Tympanuchus pallidicinctus</i>	Lesser Prairie-Chicken	G3	S2	C	BLM/ USFS	ST	Shrubland
<i>Tympanuchus phasianellus columbianus</i>	Columbian Sharp-tailed Grouse	G4T3	S2		BLM/ USFS	SC	Shrubland
<i>Tympanuchus phasianellus jamesi</i>	Plains Sharp-tailed Grouse	G4T4	S1			SE	Grassland
<i>Callipepla squamata</i>	Scaled Quail	G5	S4				Grassland
<i>Grus canadensis tabida</i>	Greater Sandhill Crane	G5T4	S2B,S4N			SC	Wetlands/ aquatic
<i>Grus americana</i>	Whooping Crane	G1	SNA	LE, XN		SE	Wetlands/ aquatic
<i>Charadrius alexandrinus nivosus</i>	Western Snowy Plover	G4T3	S1B	LT	BLM	SC	Wetlands/ aquatic
<i>Charadrius melodus</i>	Piping Plover	G3	S1B	LE, LT		ST	Wetlands/ aquatic
<i>Charadrius montanus</i>	Mountain Plover	G2	S2B		BLM/ USFS	SC	Grassland
<i>Bartramia longicauda</i>	Upland Sandpiper	G5	S3B				Grassland
<i>Numenius americanus</i>	Long-billed Curlew	G5	S2B		BLM/ USFS	SC	Grassland
<i>Sterna antillarum</i>	Least Tern	G4	S1B	LE		SE	Wetlands/ aquatic
<i>Columba fasciata</i>	Band-tailed Pigeon	G4	S4B				Forests
<i>Coccyzus americanus occidentalis</i>	Western Yellow-billed Cuckoo	G5T3Q	S1B	C	BLM/ USFS	SC	Wetlands/ aquatic
<i>Otus flammeolus</i>	Flammulated Owl	G4	S4		USFS		Forests
<i>Athene cunicularia</i>	Burrowing Owl	G4	S4B		BLM/ USFS	ST	Grassland
<i>Strix occidentalis lucida</i>	Mexican Spotted Owl	G3T3	S1B,SUN	LT		ST	Forests
<i>Asio flammeus</i>	Short-eared Owl	G5	S2B		USFS		Grassland
<i>Aegolius funereus</i>	Boreal Owl	G5	S2		USFS		Forests

Table 5, cont.

Scientific Name	Common Name	NatureServe Global Rank	NatureServe State Rank	Federal Legal Status	Federal Agency Sensitive Species	State Legal Status	Primary Habitat
<i>Melanerpes lewis</i>	Lewis's Woodpecker	G4	S4		USFS		Forests
<i>Sphyrapicus thyroideus</i>	Williamson's Sapsucker	G5	S4B				Forests
<i>Sphyrapicus nuchalis</i>	Red-naped Sapsucker	G5	S5				Forests
<i>Contopus cooperi</i>	Olive-sided Flycatcher	G4	S3S4B		USFS		Forests
<i>Empidonax traillii extimus</i>	Southwestern Willow Flycatcher	G5T1T2	SNA	LE		SE	Wetlands/ aquatic
<i>Progne subis</i>	Purple Martin	G5	S3B		USFS		Forests
<i>Gymnorhinus cyanocephalus</i>	Pinyon Jay	G5	S5				Pinyon- Juniper
<i>Baeolophus ridgwayi</i>	Juniper Titmouse	G5	S4				Pinyon- Juniper
<i>Lanius ludovicianus</i>	Loggerhead Shrike	G4	S3S4B		USFS		Grassland
<i>Vireo bellii</i>	Bell's Vireo	G5	S1B				Wetlands/ aquatic
<i>Vireo vicinior</i>	Gray Vireo	G4	S2B				Pinyon- Juniper
<i>Dendroica nigrescens</i>	Black-throated Gray Warbler	G5	S5B				Pinyon- Juniper
<i>Aimophila cassinii</i>	Cassin's Sparrow	G5	S4B		USFS		Grassland
<i>Spizella breweri</i>	Brewer's Sparrow	G5	S4B		BLM/ USFS		Shrubland
<i>Amphispiza belli</i>	Sage Sparrow	G5	S3B		USFS		Shrubland
<i>Calamospiza melanocorys</i>	Lark Bunting	G5	S4				Grassland
<i>Calcarius mccownii</i>	McCown's Longspur	G4	S2B		USFS		Grassland
<i>Calcarius ornatus</i>	Chestnut-collared Longspur	G5	S1B		USFS		Grassland
<i>Dolichonyx oryzivorus</i>	Bobolink	G5	S3B				Wetlands/ aquatic
<i>Leucosticte australis</i>	Brown-capped Rosy-Finch	G4	S3B,S4N				Alpine
FISH							
<i>Oncorhynchus clarkii pleuriticus</i>	Colorado River Cutthroat Trout	G4T3	S3		BLM/ USFS	SC	Wetlands/ aquatic

Table 5, cont.

Scientific Name	Common Name	NatureServe Global Rank	NatureServe State Rank	Federal Legal Status	Federal Agency Sensitive Species	State Legal Status	Primary Habitat
<i>Oncorhynchus clarkii stomias</i>	Greenback Cutthroat Trout	G4T2T3	S2	LT		ST	Wetlands/aquatic
<i>Oncorhynchus clarkii virginalis</i>	Rio Grande Cutthroat Trout	G4T3	S3	C	BLM/USFS	SC	Wetlands/aquatic
<i>Couesius plumbeus</i>	Lake Chub	G5	S1		USFS	SE	Wetlands/aquatic
<i>Gila cypha</i>	Humpback Chub	G1	S1	LE		ST	Wetlands/aquatic
<i>Gila elegans</i>	Bonytail	G1	SX	LE		SE	Wetlands/aquatic
<i>Gila pandora</i>	Rio Grande Chub	G3	S1?		BLM/USFS	SC	Wetlands/aquatic
<i>Gila robusta</i>	Roundtail Chub	G3	S2		BLM/USFS	SC	Wetlands/aquatic
<i>Hybognathus hankinsoni</i>	Brassy Minnow	G5	S3			ST	Wetlands/aquatic
<i>Hybognathus placitus</i>	Plains Minnow	G4	SH		USFS	SE	Wetlands/aquatic
<i>Phenacobius mirabilis</i>	Suckermouth Minnow	G5	S2			SE	Wetlands/aquatic
<i>Phoxinus eos</i>	Northern Redbelly Dace	G5	S1		USFS	SE	Wetlands/aquatic
<i>Phoxinus erythrogaster</i>	Southern Redbelly Dace	G5	S1		USFS	SE	Wetlands/aquatic
<i>Ptychocheilus lucius</i>	Colorado Pikeminnow	G1	S1	LE, XN		ST	Wetlands/aquatic
<i>Notropis cornutus</i>	Common Shiner	G5	S2			ST	Wetlands/aquatic
<i>Catostomus plebeius</i>	Rio Grande Sucker	G3G4	S1		BLM/USFS	SE	Wetlands/aquatic
<i>Xyrauchen texanus</i>	Razorback Sucker	G1	S1	LE		SE	Wetlands/aquatic
<i>Noturus flavus</i>	Stonecat	G5	S1			SC	Wetlands/aquatic
<i>Etheostoma cragini</i>	Arkansas Darter	G3G4	S2	C	BLM	ST	Wetlands/aquatic

Table 5, cont.

Scientific Name	Common Name	NatureServe Global Rank	NatureServe State Rank	Federal Legal Status	Federal Agency Sensitive Species	State Legal Status	Primary Habitat
<i>Etheostoma spectabile</i>	Orangethroat Darter	G5	S3			SC	Wetlands/ aquatic
MAMMALS							
<i>Sorex preblei</i>	Preble's Shrew	G4	S1				Shrubland
<i>Sorex nanus</i>	Dwarf Shrew	G4	S2				Shrubland
<i>Sorex hoyi montanus</i>	Pygmy Shrew	G5T2T3	S2		USFS		Forests
<i>Myotis thysanodes</i>	Fringed Myotis	G4G5	S3		BLM/ USFS		Cliff and Canyon
<i>Euderma maculatum</i>	Spotted Bat	G4	S2		BLM/ USFS		Cliff and Canyon
<i>Corynorhinus townsendii pallescens</i>	Pale Lump-nosed Bat	G4T4	S2		BLM/ USFS	SC	Cliff and Canyon
<i>Lepus townsendii</i>	White-tailed Jackrabbit	G5	S4				Grassland
<i>Cynomys ludovicianus</i>	Black-tailed Prairie Dog	G4	S3		BLM/ USFS	SC	Grassland
<i>Cynomys leucurus</i>	White-tailed Prairie Dog	G4	S4		BLM/ USFS		Grassland
<i>Cynomys gunnisoni</i>	Gunnison's Prairie Dog	G5	S5	PS:C	BLM/ USFS		Grassland
<i>Thomomys bottae rubidus</i>	Botta's Pocket Gopher subsp.	G5T1	S1			SC	Wetlands/ aquatic
<i>Thomomys talpoides macrotis</i>	Northern Pocket Gopher subsp.	G5T1	S1			SC	Grassland
<i>Perognathus fasciatus</i>	Olive-backed Pocket Mouse	G5	S3				Grassland
<i>Perognathus flavescens relictus</i>	Plains Pocket Mouse subsp.	G5T2	S2				Grassland
<i>Zapus hudsonius preblei</i>	Preble's Meadow Jumping Mouse	G5T2	S1	LT		ST	Wetlands/ aquatic
<i>Zapus hudsonius luteus</i>	New Mexican Jumping Mouse	G5T2	S1		BLM/ USFS		Wetlands/ aquatic
<i>Canis lupus</i>	Gray Wolf	G4	SX	LE, LT, XN		SE	all
<i>Vulpes velox</i>	Swift Fox	G3	S3		BLM/ USFS	SC	Grassland

Table 5, cont.

Scientific Name	Common Name	NatureServe Global Rank	NatureServe State Rank	Federal Legal Status	Federal Agency Sensitive Species	State Legal Status	Primary Habitat
<i>Vulpes macrotis</i>	Kit Fox	G4	S1		BLM/ USFS	SE	Shrubland
<i>Mustela nigripes</i>	Black-footed Ferret	G1	S1	LE, XN		SE	Grassland
<i>Gulo gulo</i>	Wolverine	G4	S1		USFS	SE	Forests
<i>Conepatus leuconotus</i>	American Hog-nosed Skunk	G4	S1		USFS		Pinyon-Juniper
<i>Lontra canadensis</i>	Northern River Otter	G5	S3S4		USFS	ST	Wetlands/ aquatic
<i>Lynx canadensis</i>	Canada Lynx	G5	S1	LT		SE	Forests
<i>Bos bison</i>	American Bison	G4	SX				Grassland
REPTILES							
<i>Kinosternon flavescens</i>	Yellow Mud Turtle	G5	S1			SC	Wetlands/ aquatic
<i>Gambelia wislizenii</i>	Long-nosed Leopard Lizard	G5	S1		BLM	SC	Pinyon-Juniper
<i>Phrynosoma cornutum</i>	Texas Horned Lizard	G4G5	S3			SC	Grassland
<i>Phrynosoma modestum</i>	Round-tailed Horned Lizard	G5	S1			SC	Grassland
<i>Aspidoscelis neotesselata</i>	Triploid Colorado Checkered Whiptail	G2G3	S2			SC	Shrubland
<i>Lampropeltis getula</i>	Common Kingsnake	G5	S1		BLM	SC	Wetlands/ aquatic
<i>Tantilla hobartsmithi</i>	Southwestern Black-headed Snake	G5	S2?				Cliff and Canyon
<i>Thamnophis sirtalis</i>	Common Garter Snake	G5	S3			SC	Wetlands/ aquatic
<i>Leptotyphlops dissectus</i>	New Mexico Thread Snake	G4G5	S1			SC	Pinyon-Juniper
<i>Sistrurus catenatus</i>	Massasauga	G3G4	S2	PS:C	BLM/ USFS	SC	Grassland
INVERTEBRATES							
<i>Cicindela formosa gibsoni</i>	Big Sand Tiger Beetle	G5T1	S1				
<i>Cicindela theatina</i>	San Luis Dunes Tiger Beetle	G1	S1				
<i>Cicindela scutellaris yampae</i>	Festive Tiger Beetle	G5T1	S1				

Table 5, cont.

Scientific Name	Common Name	NatureServe Global Rank	NatureServe State Rank	Federal Legal Status	Federal Agency Sensitive Species	State Legal Status	Primary Habitat
<i>Amblyderus weneri</i>	Great Sand Dunes Anthicid Beetle	G1?	S1				
<i>Decodes stevensi</i>	Stevens' Tortricid Moth	GNR	S1				
<i>Hesperia ottoe</i>	Ottoe Skipper	G3G4	S2		USFS		
<i>Hesperia leonardus montana</i>	Pawnee Montane Skipper	G4T1	S1	LT			
<i>Callophrys comstocki</i>	Comstock's Hairstreak	G2G3	S1				
<i>Celastrina humulus</i>	Hops Feeding Azure	G2G3	S2				
<i>Euphilotes rita emmeli</i>	Desert Buckwheat Blue	G3G4T2	S1				
<i>Euphilotes rita coloradensis</i>	Colorado Blue	G3G4T2T3	S2				
<i>Speyeria idalia</i>	Regal Fritillary	G3	S1		USFS		
<i>Speyeria nokomis nokomis</i>	Great Basin Silverspot Fritillary	G3T1	S1		BLM/ USFS		
<i>Boloria selene sabulocollis</i>	Sandhill Fritillary	G5T2	S1S2				
<i>Boloria improba acrocneuma</i>	Uncompahgre Fritillary	G5T1	S1	LE			
<i>Satyroides eurydice fumosa</i>	Smoky-eyed Brown	G5T3T4	S1				
<i>Euproserpinus wiesti</i>	Wiest's Sphinx Moth	G3G4	S2				
<i>Daihinibaenetes giganteus</i>	Giant Sand Treader Cricket	GNR	S1				
<i>Capnia arapahoe</i>	Arapahoe Snowfly	G1	S1				
<i>Anodontoides ferussacianus</i>	Cylindrical Papershell	G5	S2			SC	
<i>Uniomereus tetralasmus</i>	Pondhorn	G5	S1				
<i>Acroloxus coloradensis</i>	Rocky Mountain Capshell	G3	S1		USFS	SC	
<i>Physa cupreonitens</i>	Hot Springs Physa	G5Q	S2				
<i>Physa utahensis</i>	Banded Physa	G5T2	S1				
<i>Promenetus exacuouus</i>	Sharp Sprite	G5	S2				
<i>Promenetus umbilicatellus</i>	Umbilicate Sprite	G4	S3				

Table 5, cont.

Scientific Name	Common Name	NatureServe Global Rank	NatureServe State Rank	Federal Legal Status	Federal Agency Sensitive Species	State Legal Status	Primary Habitat
<i>Ferrissia fragilis</i>	Fragile Ancyloid	G5	S1				
<i>Ferrissia walkeri</i>	Cloche Ancyloid	G4G5	S3				

the primary data source for this analysis. The bins are not always comparable between taxa. For example, when comparing two species for conservation priority, 200-500 lynx are very different from 200-500 Uncompahgre fritillaries. Fourteen different taxonomic groups of animal species were used to assign categories accounting for differences in body size and life history (Appendix C).

Threat Status

Threat status was based on the primary threat as listed in the ESR. Threat status was determined by ranking the scope, severity, and immediacy for the primary threat for each species. Categorical threat scores were then assigned to each species, and reflect the degree to which a species is threatened by the most critical threat.

Protection Status

Protection status for each species was determined by calculating the proportion of populations known to occur on legally protected lands. The number of populations for each species (occurrences) was derived directly from CNHP's

ESR database. For most of the 113 species, the best information on the numbers of populations is contained in CNHP's Element Occurrence Record (EORs) database. For species that CNHP has little EOR data or does not actively track, an estimate was made from literature review.

As noted in the Introduction, we used land ownership as a surrogate for protection, under the assumption that certain land management types (e.g., wilderness areas, non-split estate conservation easements) are protected legally from being converted to a land use that is incompatible with maintaining the species. It is important to note that this measure reflects the long-term security of the existing land use in a legal framework; it is not suggestive of the relative quality of a given occurrence.

Overall Conservation Status Scores

The overall conservation status score was determined using a decision matrix that first considered the threat score, modified by abundance and protection scores

(see Appendix C for details). The overall conservation status score was then adjusted upward if the species' short-term trend was down. Short-term trend was estimated by CNHP biologists through literature review, personal communications with experts on the species, or personal expertise on the species.

Results

Only 15 of the at-risk vertebrates evaluated received an overall conservation status score of "Effectively Conserved," leaving 98 species (20% of all of Colorado's vertebrates) in need of conservation action (Figure 13). In a similar global analysis based on the IUCN Red List, Hoffman et al. (2010) found approximately the same ratio for the world's vertebrates, with one-fifth of species classified as Threatened. Neither this Scorecard nor Hoffman et al. (2010) evaluated all known animal species, so it is unclear how the two analyses would compare if more species were included.

In terms of the ratio of at-risk species to those not at risk, Colorado's aquatic-dependent fish

and amphibians are in greatest need of conservation attention, with 43% and 41% of species at risk, respectively (Figure 11). Birds, mammals, and reptiles are in somewhat better condition overall, with 20%, 20% and 19% in need of conservation, respectively.

There were no fish species that ranked in our Effectively Conserved category; all but one fish species received Under Conserved or Weakly Conserved scores. Additionally, all taxonomic groups have species in the Under Conserved and Weakly Conserved categories, reminding us that conservation action is required in all taxonomic groups.

In actual numbers of species, rather than ratio of at-risk to not-at-risk, the bird group has the highest total number of species in need of conservation action, with 28 species receiving an Under Conserved or Weakly Conserved score.

Approximately 31% of the species analyzed had very low biodiversity status scores; 18% had high scores in this category. Once again, scores for fish are comparatively lower than any other taxonomic group (Figure 15).

Nearly 35% of all of the scored vertebrates were rated highly threatened, while 21% were rated as having slight to no threats. Again, the fish group has, by far, the highest proportion of species experiencing threats, with mammals and birds second and third, respectively (Figure

15). Primary threats include development (urban, water, energy) and invasive species, among others.

Forty-six percent of the scored species received poor scores in the Protection category, while only 6% were considered adequately protected. Species within the fish and mammal groups have the least protection, while amphibians are the most protected (Figure 15).

Although many species have good to very good scores for at least one ranking factor, nearly a third of the species score in the Poor category for all three primary ranking factors. Scores for each factor, and overall conservation status scores for each species are presented in Appendix D. Results for the individual scoring categories are summarized in Table 6.



© Michael Menefee

Table 6. Animal species' scores for threat, abundance, protection, and overall conservation status.

Scientific Name	Common Name	Threat Score	Abundance Score	Short-term Trend	Proportion of Populations Protected	Overall Conservation Status
AMPHIBIANS						
<i>Bufo boreas pop. 1</i>	Boreal Toad (Southern Rocky Mountain Population)	0.2	5	down	8	Under Conserved
<i>Bufo debilis</i>	Green Toad	5	2	stable	6	Moderately Conserved
<i>Hyla arenicolor</i>	Canyon Treefrog	8	5	stable	6	Effectively Conserved
<i>Gastrophryne olivacea</i>	Great Plains Narrowmouth Toad	6	1	stable	6	Moderately Conserved
<i>Scaphiopus couchii</i>	Couch's Spadefoot	8	2	stable	4	Weakly Conserved
<i>Rana blairi</i>	Plains Leopard Frog	6	5	stable	6	Moderately Conserved
<i>Rana pipiens</i>	Northern Leopard Frog	2	5	down	6	Under Conserved
BIRDS						
<i>Pelecanus erythrorhynchos</i>	American White Pelican	5	2	up	6	Moderately Conserved
<i>Botaurus lentiginosus</i>	American Bittern	2	1	stable	4	Under Conserved
<i>Haliaeetus leucocephalus</i>	Bald Eagle	8	7	up	8	Effectively Conserved
<i>Accipiter gentilis</i>	Northern Goshawk	8	9	stable	8	Effectively Conserved
<i>Buteo swainsoni</i>	Swainson's Hawk	8	10	stable	6	Effectively Conserved
<i>Buteo regalis</i>	Ferruginous Hawk	6	8	stable	8	Effectively Conserved
<i>Aquila chrysaetos</i>	Golden Eagle	8	8	stable	8	Effectively Conserved
<i>Falco peregrinus anatum</i>	American Peregrine Falcon	8	5	up	8	Effectively Conserved
<i>Falco mexicanus</i>	Prairie Falcon	6	8	up	6	Effectively Conserved
<i>Centrocercus urophasianus</i>	Sage Grouse	2	7	down	6	Under Conserved
<i>Centrocercus minimus</i>	Gunnison Sage Grouse	0.2	3	down	4	Under Conserved
<i>Tympanuchus cupido pinnatus</i>	Greater Prairie Chicken	0.2	7	up	6	Weakly Conserved
<i>Tympanuchus pallidicinctus</i>	Lesser Prairie-chicken	2	2	stable	4	Under Conserved
<i>Tympanuchus phasianellus columbianus</i>	Columbian Sharp-tailed Grouse	2	5	stable	4	Under Conserved
<i>Tympanuchus phasianellus jamesi</i>	Plains Sharp-tailed Grouse	0.2	1	down	6	Under Conserved
<i>Callipepla squamata</i>	Scaled Quail	6	7	stable	8	Moderately Conserved
<i>Grus canadensis tabida</i>	Greater Sandhill Crane	2	1	up	8	Under Conserved

Table 6, cont.

Scientific Name	Common Name	Threat Score	Abundance Score	Short-term Trend	Proportion of Populations Protected	Overall Conservation Status
<i>Grus americana</i>	Whooping Crane	0.2	0.2	down	1	Under Conserved
<i>Charadrius alexandrinus nivosus</i>	Western Snowy Plover	2	1	stable	6	Under Conserved
<i>Charadrius melodus</i>	Piping Plover	2	1	stable	6	Under Conserved
<i>Charadrius montanus</i>	Mountain Plover	6	4	down	4	Weakly Conserved
<i>Bartramia longicauda</i>	Upland Sandpiper	2	3	stable	6	Weakly Conserved
<i>Numenius americanus</i>	Long-billed Curlew	2	2	down	6	Under Conserved
<i>Sterna antillarum</i>	Least Tern	2	1	down	6	Under Conserved
<i>Columba fasciata</i>	Band-tailed Pigeon	8	7	down	6	Effectively Conserved
<i>Coccyzus americanus occidentalis</i>	Western Yellow-billed Cuckoo	0.2	1	down	6	Under Conserved
<i>Otus flammeolus</i>	Flammulated Owl	6	7	unknown	4	Moderately Conserved
<i>Athene cucularia</i>	Burrowing Owl	4	9	down	4	Weakly Conserved
<i>Strix occidentalis lucida</i>	Mexican Spotted Owl	0.2	1	stable	6	Under Conserved
<i>Asio flammeus</i>	Short-eared Owl	0.2	3	up	4	Under Conserved
<i>Aegolius funereus</i>	Boreal Owl	8	2	unknown	8	Moderately Conserved
<i>Melanerpes lewis</i>	Lewis's Woodpecker	4	7	stable	4	Weakly Conserved
<i>Sphyrapicus thyroideus</i>	Williamson's Sapsucker	6	7	down	6	Moderately Conserved
<i>Sphyrapicus nuchalis</i>	Red-naped Sapsucker	8	7	up	8	Effectively Conserved
<i>Contopus cooperi</i>	Olive-sided Flycatcher	8	7	stable	4	Weakly Conserved
<i>Empidonax traillii extimus</i>	Southwestern Willow Flycatcher	0.2	1	down	8	Under Conserved
<i>Progne subis</i>	Purple Martin	6	3	unknown	8	Moderately Conserved
<i>Gymnorhinus cyanocephalus</i>	Pinyon Jay	2	9	down	4	Moderately Conserved
<i>Baeolophus ridgwayi</i>	Juniper Titmouse	5	7	down	8	Moderately Conserved
<i>Lanius ludovicianus</i>	Loggerhead Shrike	8	9	stable	4	Moderately Conserved
<i>Vireo bellii</i>	Bell's Vireo	2	1	down	1	Under Conserved
<i>Vireo vicinior</i>	Gray Vireo	4	3	unknown	6	Under Conserved
<i>Dendroica nigrescens</i>	Black-throated Gray Warbler	8	9	stable	8	Effectively Conserved
<i>Aimophila cassinii</i>	Cassin's Sparrow	8	10	down	1	Moderately Conserved

Table 6, cont.

<i>Scientific Name</i>	Common Name	Threat Score	Abundance Score	Short-term Trend	Proportion of Populations Protected	Overall Conservation Status
<i>Spizella breweri</i>	Brewer's Sparrow	6	9	down	8	Effectively Conserved
<i>Amphispiza belli</i>	Sage Sparrow	6	7	stable	4	Moderately Conserved
<i>Calamospiza melanocorys</i>	Lark Bunting	6	10	down	6	Effectively Conserved
<i>Calcarius mccownii</i>	McCown's Longspur	8	7	stable	1	Weakly Conserved
<i>Calcarius ornatus</i>	Chestnut-collared Longspur	2	3	down	6	Under Conserved
<i>Dolichonyx oryzivorus</i>	Bobolink	5	3	unknown	4	Weakly Conserved
<i>Leucosticte australis</i>	Brown-capped Rosy-finch	2	7	unknown	8	Weakly Conserved
FISH						
<i>Oncorhynchus clarkii pleuriticus</i>	Colorado River Cutthroat Trout	2	9	stable	6	Weakly Conserved
<i>Oncorhynchus clarkii stomias</i>	Greenback Cutthroat Trout	4	5	down	4	Under Conserved
<i>Oncorhynchus clarkii virginalis</i>	Rio Grande Cutthroat Trout	2	10	stable	6	Weakly Conserved
<i>Couesius plumbeus</i>	Lake Chub	6	2	stable	1	Weakly Conserved
<i>Gila cypha</i>	Humpback Chub	4	3	stable	6	Under Conserved
<i>Gila elegans</i>	Bonytail Chub	0.2	0.2	down	1	Under Conserved
<i>Gila pandora</i>	Rio Grande Chub	2	7	down	4	Under Conserved
<i>Gila robusta</i>	Roundtail Chub	4	7	stable	4	Weakly Conserved
<i>Hybognathus hankinsoni</i>	Brassy Minnow	4	3	stable	1	Under Conserved
<i>Hybognathus placitus</i>	Plains Minnow	5	0.2	down	1	Weakly Conserved
<i>Phenacobius mirabilis</i>	Suckermouth Minnow	4	3	stable	1	Under Conserved
<i>Phoxinus eos</i>	Northern Redbelly Dace	6	2	stable	1	Weakly Conserved
<i>Phoxinus erythrogaster</i>	Southern Redbelly Dace	6	3	stable	6	Moderately Conserved
<i>Ptychocheilus lucius</i>	Colorado Pikeminnow	4	2	stable	8	Under Conserved
<i>Notropis cornutus</i>	Common Shiner	4	5	stable	1	Weakly Conserved
<i>Catostomus plebeius</i>	Rio Grande Sucker	0.2	3	down	6	Under Conserved
<i>Xyrauchen texanus</i>	Razorback Sucker	4	2	stable	6	Under Conserved
<i>Noturus flavus</i>	Stonecat	4	3	stable	1	Under Conserved

Table 6, cont.

Scientific Name	Common Name	Threat Score	Abundance Score	Short-term Trend	Proportion of Populations Protected	Overall Conservation Status
<i>Etheostoma cragini</i>	Arkansas Darter	4	2	down	6	Under Conserved
<i>Etheostoma spectabile</i>	Orangethroat Darter	2	5	stable	1	Under Conserved
MAMMALS						
<i>Sorex preblei</i>	Preble's Shrew	5	3	stable	1	Weakly Conserved
<i>Sorex nanus</i>	Dwarf Shrew	5	5	unknown	6	Moderately Conserved
<i>Sorex hoyi montanus</i>	Pygmy Shrew	5	5	unknown	6	Moderately Conserved
<i>Myotis thysanodes</i>	Fringed Myotis	4	5	unknown	4	Weakly Conserved
<i>Euderma maculatum</i>	Spotted Bat	8	1	unknown	4	Weakly Conserved
<i>Plecotus townsendii pallescens</i>	Townsend's Big-eared Bat	6	1	down	1	Weakly Conserved
<i>Lepus townsendii</i>	White-tailed Jackrabbit	8	9	unknown	6	Effectively Conserved
<i>Cynomys ludovicianus</i>	Black-tailed Prairie Dog	8	10	up	4	Moderately Conserved
<i>Cynomys leucurus</i>	White-tailed Prairie Dog	2	8	down	6	Under Conserved
<i>Cynomys gunnisoni</i>	Gunnison's Prairie Dog	2	8	down	8	Under Conserved
<i>Thomomys bottae rubidus</i>	Botta's Pocket Gopher Subsp rubidus	2	1	down	1	Under Conserved
<i>Thomomys talpoides macrotis</i>	Northern Pocket Gopher Subsp macrotis	0.2	3	down	4	Under Conserved
<i>Perognathus fasciatus</i>	Olive-backed Pocket Mouse	2	8	down	4	Under Conserved
<i>Perognathus flavescens relictus</i>	Plains Pocket Mouse Subsp relictus	8	3	unknown	6	Moderately Conserved
<i>Zapus hudsonius preblei</i>	Meadow Jumping Mouse Subsp preblei	2	5	down	4	Under Conserved
<i>Zapus hudsonius luteus</i>	Meadow Jumping Mouse Subsp luteus	5	1	down	6	Moderately Conserved
<i>Canis lupus</i>	Gray Wolf	5	2	up	1	Weakly Conserved
<i>Vulpes velox</i>	Swift Fox	6	9	stable	4	Moderately Conserved
<i>Vulpes macrotis</i>	Kit Fox	0.2	2	down	1	Under Conserved
<i>Mustela nigripes</i>	Black-footed Ferret	0.2	2	stable	6	Under Conserved
<i>Gulo gulo</i>	Wolverine	5	2	stable	1	Weakly Conserved
<i>Conepatus leuconotus</i>	Common Hog-nosed Skunk	8	2	stable	1	Weakly Conserved

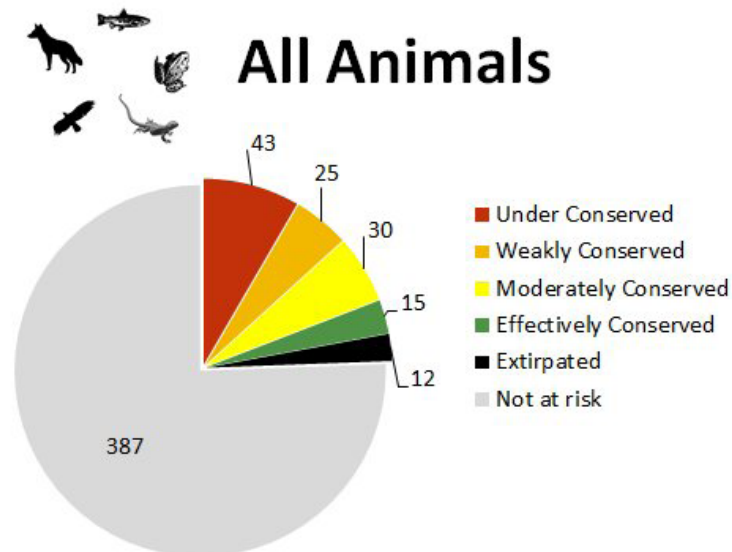
Table 6, cont.

<i>Scientific Name</i>	Common Name	Threat Score	Abundance Score	Short-term Trend	Proportion of Populations Protected	Overall Conservation Status
<i>Lontra canadensis</i>	Northern River Otter	5	7	stable	4	Moderately Conserved
<i>Lynx canadensis</i>	Canada Lynx	6	5	up	4	Moderately Conserved
<i>Bos bison</i>	American Bison	5	3	stable	6	Moderately Conserved
REPTILES						
<i>Kinosternon flavescens</i>	Yellow Mud Turtle	8	3	stable	6	Moderately Conserved
<i>Gambelia wislizenii</i>	Longnose Leopard Lizard	4	3	down	6	Under Conserved
<i>Phrynosoma cornutum</i>	Texas Horned Lizard	8	7	down	6	Effectively Conserved
<i>Phrynosoma modestum</i>	Roundtail Horned Lizard	6	3	stable	1	Weakly Conserved
<i>Aspidoscelis neotesselata</i>	Triploid Colorado Checkered Whiptail	5	7	stable	6	Moderately Conserved
<i>Lampropeltis getula</i>	Common Kingsnake	8	2	stable	6	Moderately Conserved
<i>Tantilla hobartsmithi</i>	Southwestern Blackhead Snake	5	5	stable	4	Moderately Conserved
<i>Thamnophis sirtalis</i>	Common Garter Snake	2	5	down	6	Under Conserved
<i>Leptotyphlops dissectus</i>	New Mexico thread snake	8	3	unknown	6	Moderately Conserved
<i>Sistrurus catenatus</i>	Massasauga	5	5	down	1	Moderately Conserved
INVERTEBRATES						
<i>Cicindela formosa gibsoni</i>	Big Sand Tiger Beetle	6	1	stable	6	Moderately Conserved
<i>Cicindela theatina</i>	San Luis Dunes Tiger Beetle	6	1	stable	8	Moderately Conserved
<i>Cicindela scutellaris yampae</i>	Festive Tiger Beetle	6	1	down	1	Weakly Conserved
<i>Amblyderus weneri</i>	Great Sand Dunes Anthicid Beetle	0.2	1	unknown	6	Under Conserved
<i>Decodes stevensi</i>	Stevens' Tortricid Moth	4	1	stable	6	Under Conserved
<i>Hesperia ottoe</i>	Ottoe Skipper	2	1	down	6	Under Conserved
<i>Hesperia leonardus montana</i>	Pawnee Montane Skipper	0.2	1	down	6	Under Conserved
<i>Callophrys comstocki</i>	Comstock's Hairstreak	4	1	unknown	1	Under Conserved
<i>Celastrina humulus</i>	Hops Feeding Azure	2	1	down	6	Under Conserved
<i>Euphilotes rita emmeli</i>	Desert Buckwheat Blue	5	0.2	down	1	Weakly Conserved
<i>Euphilotes rita coloradensis</i>	Colorado Blue	6	1	down	4	Weakly Conserved
<i>Speyeria idalia</i>	Regal Fritillary	2	1	down	1	Under Conserved

Table 6, cont.

Scientific Name	Common Name	Threat Score	Abundance Score	Short-term Trend	Proportion of Populations Protected	Overall Conservation Status
<i>Speyeria nokomis nokomis</i>	Great Basin Silverspot Butterfly	2	1	down	6	Under Conserved
<i>Boloria selene sabulocollis</i>	Sandhill Fritillary	4	1	down	6	Under Conserved
<i>Boloria improba acrocneuma</i>	Uncompahgre Fritillary	2	2	stable	6	Under Conserved
<i>Satyroides eurydice fumosa</i>	Smoky Eyed Brown Butterfly	2	1	down	6	Under Conserved
<i>Euproserpinus wiesti</i>	Wiest's Sphinx Moth	6	1	stable	4	Weakly Conserved
<i>Daihinibaenetes giganteus</i>	Giant Sand Treader Cricket	4	1	stable	6	Under Conserved
<i>Capnia arapahoe</i>	Arapahoe Snowfly	0.2	1	unknown	1	Under Conserved
<i>Anodontoides ferussacianus</i>	Cylindrical Papershell	0.2	3	unknown	1	Under Conserved
<i>Uniomerus tetralasmus</i>	Pondhorn	2	0.2	down	1	Under Conserved
<i>Acroloxus coloradensis</i>	Rocky Mountain Capshell	0.2	2	down	4	Under Conserved
<i>Physa cupreonitens</i>	Hot Springs Physa	6	5	unknown	1	Moderately Conserved
<i>Physa utahensis</i>	Banded Physa	0.2	2	stable	1	Under Conserved
<i>Promenetus exacuouus</i>	Sharp Sprite	2	1	unknown	4	Under Conserved
<i>Promenetus umbilicatellus</i>	Umbilicate Sprite	2	2	unknown	1	Under Conserved
<i>Ferrissia fragilis</i>	Fragile Ancyloid	2	2	unknown	4	Under Conserved
<i>Ferrissia walkeri</i>	Cloche Ancyloid	2	2	unknown	1	Under Conserved

Figure 13. Distribution of conservation status scores for at-risk vertebrates in Colorado.



Results by Taxa

Most of Colorado's mammal, bird, and reptile species are stable and not declining. Overall, however, more conservation success is needed to raise the status of many of our fish and amphibians (Figure 14).



American Kestrel (left) is one of Colorado's common and widespread bird species. By contrast, the boreal toad (above) is a high priority for conservation efforts.

Figure 14. Number of vertebrate species in each conservation status category.

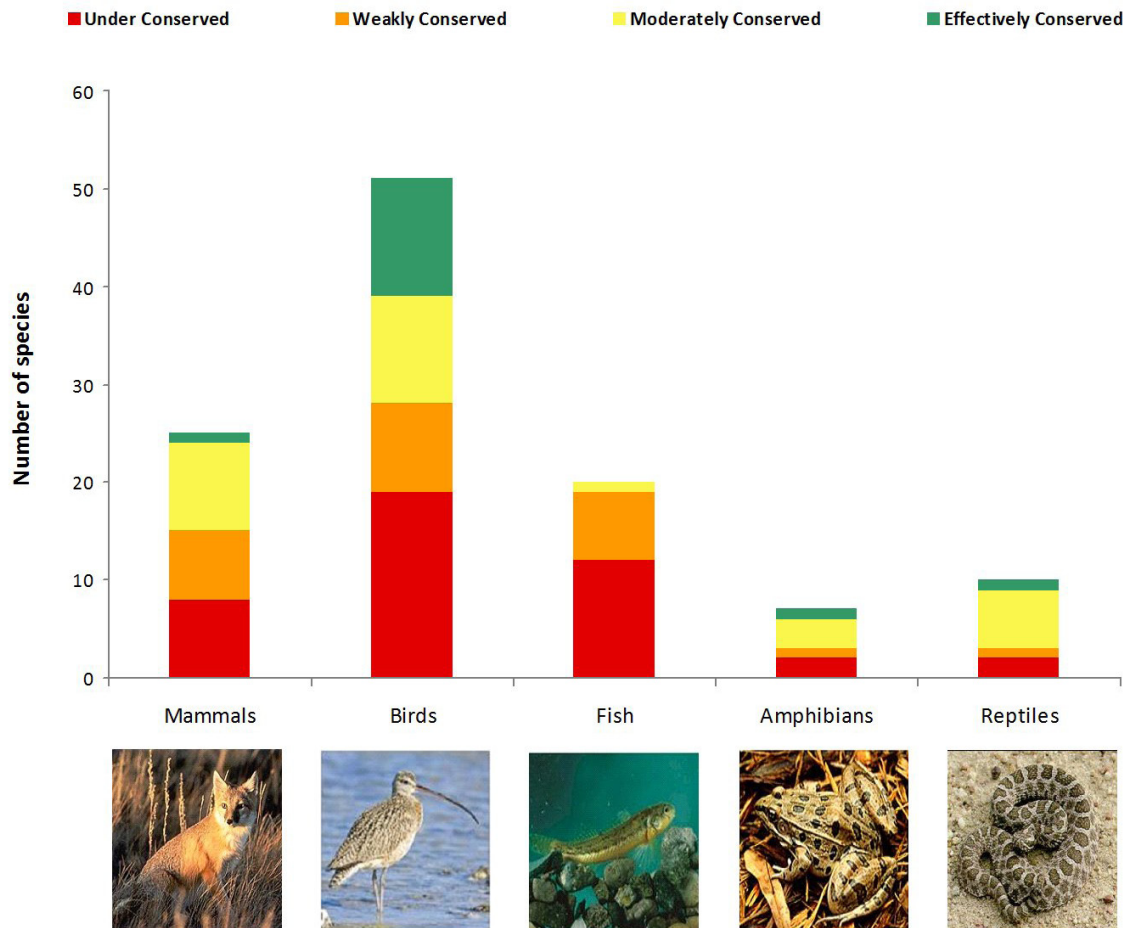
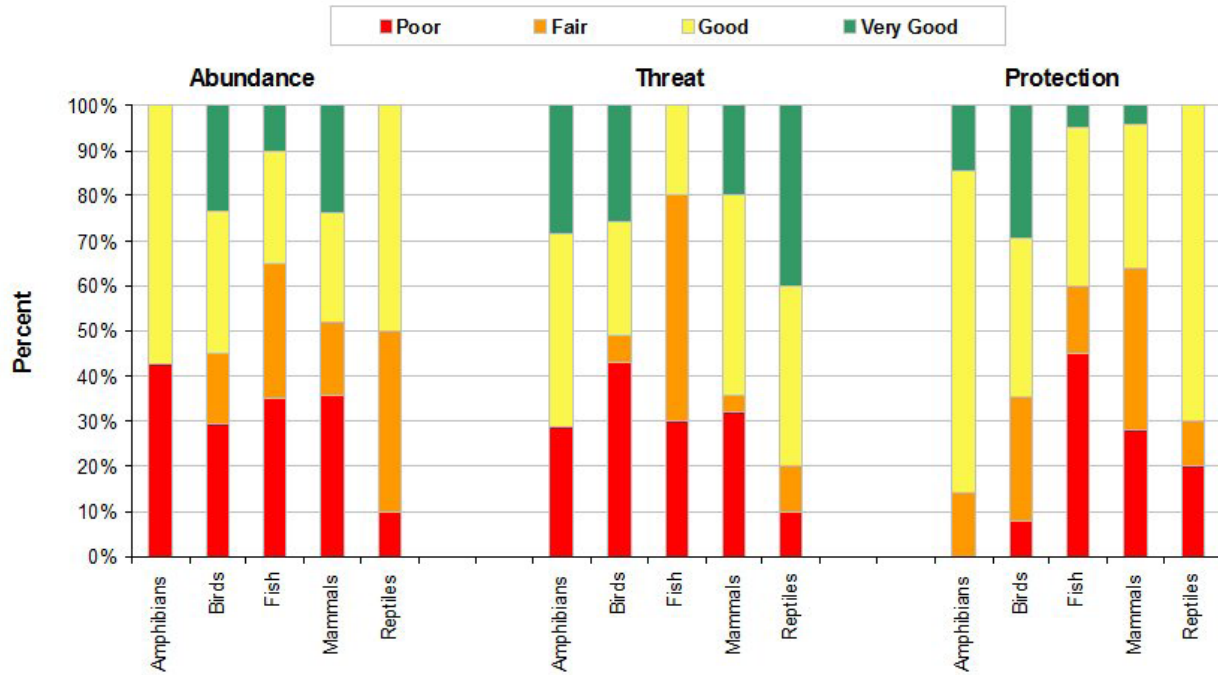


Figure 15. Percentage of Abundance, Threat, and Protection scores by taxonomic group.



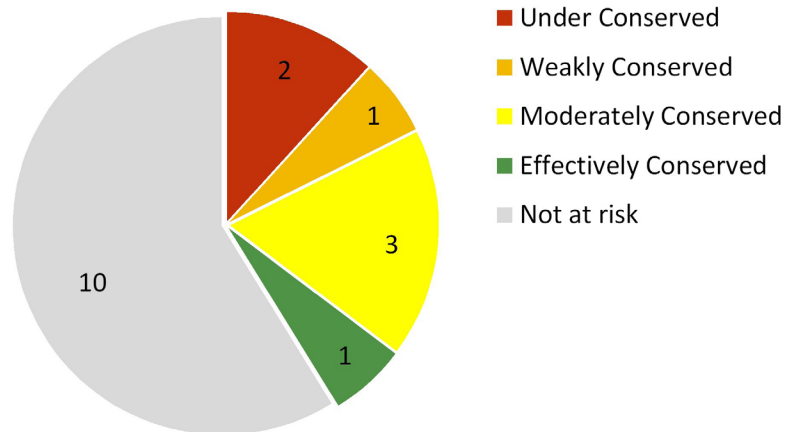
Amphibians

Of Colorado’s 17 native amphibians, almost half (41%) are at risk – the second highest percentage of any group, following fish. Of at-risk amphibians, 43% are Under Conserved or Weakly Conserved (Figure 16). All of Colorado’s at-risk amphibians are associated primarily with wetland habitats. By comparison, Hoffman et al. (2010) state that 41% of the world’s amphibians are threatened. They also state that amphibians have a higher percentage of threatened species than any other taxonomic group and are declining at an unprecedented rate, mostly due to an amphibian chytrid fungus.

Figure 16. Conservation status of Colorado’s native amphibians. Of the seven species that are at risk, only one is currently considered effectively conserved.



Amphibians



Similarly, in Colorado chytrid fungus is the primary concern for our native amphibians – especially the boreal toad and the northern leopard frog. Northern leopard frogs are also threatened by the introduced bullfrog.

Four species (57%) had good abundance scores while 3 species (42%) had poor abundance scores (Figure 15). Colorado's amphibians have generally low threat scores, but two species (boreal toad and northern leopard frog) scored poor. Invasive species are a significant threat to amphibians. Protection for amphibians is generally good in Colorado, with 90% in the moderately to effectively protected category and 10% in the weakly to under protected categories.

Birds

There are 240 native breeding bird species in Colorado (Kingery et al. 1998), by far our largest vertebrate group. Thus it is no surprise that birds have the greatest number of at-risk species (51) among all animal groups. However, in terms of percentages, our native birds are comparable to the mammal and reptile groups, with 20% at risk. Of the at-risk species, over half (55%) are Weakly Conserved or Under Conserved (Figure 17), and (45%) are Moderately Conserved or Effectively Conserved.

Hoffman et al. (2010) found that 13% of the world's bird species are classified as threatened. By comparison, Colorado's bird species in the Moderately Conserved

to Under Conserved categories (roughly equivalent to Threatened in Hoffman et al. 2010) represent 16% of all Colorado breeding birds.

The most critical habitats for at-risk birds are grasslands (nearly 30%, or 15 species) and wetlands (12 species) (Figure 18). Of the at-risk birds inhabiting grasslands, more than half are Weakly Conserved or Under Conserved. More than two-thirds of the at-risk wetland birds and all of the shrubland birds are Weakly Conserved or Under Conserved.

Though none of Colorado's bird species are endemic, the Gunnison Sage Grouse and the Brown-capped Rosy Finch are near endemics, with ranges extending into eastern Utah and northern New Mexico, respectively.

Six of Colorado's at-risk bird species are federally listed: Least Tern, Mexican Spotted Owl, Piping Plover, Southwestern Willow flycatcher, Western Snowy Plover, and Whooping Crane. All of these species received an overall conservation status score of Under Conserved.

Abundance scores for birds were nearly equally split, with 28 species (55%) having good or very good scores and 23 species (45%) having fair or poor scores for this factor.

Twenty- four species (47%) were categorized as having a very high or high level of threat, while 27 species (53%) were categorized as having a low or moderate level of threat. The most significant threat for birds was habitat loss due to conversion to cropland (scored under "farming practices"). Water development,

Figure 17. Conservation status of Colorado's native birds. The majority of our birds are not at risk. Of the 51 species that are at risk, conservation efforts have elevated the status of almost half to Effectively or Moderately Conserved. However, more effort is needed to raise the scores of the remaining 28 species.

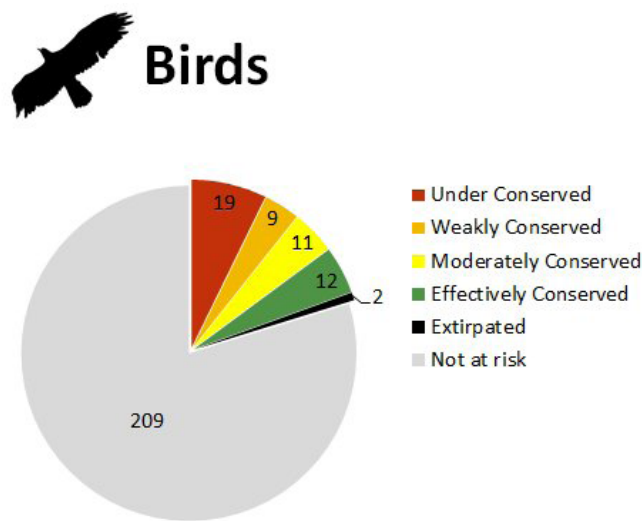
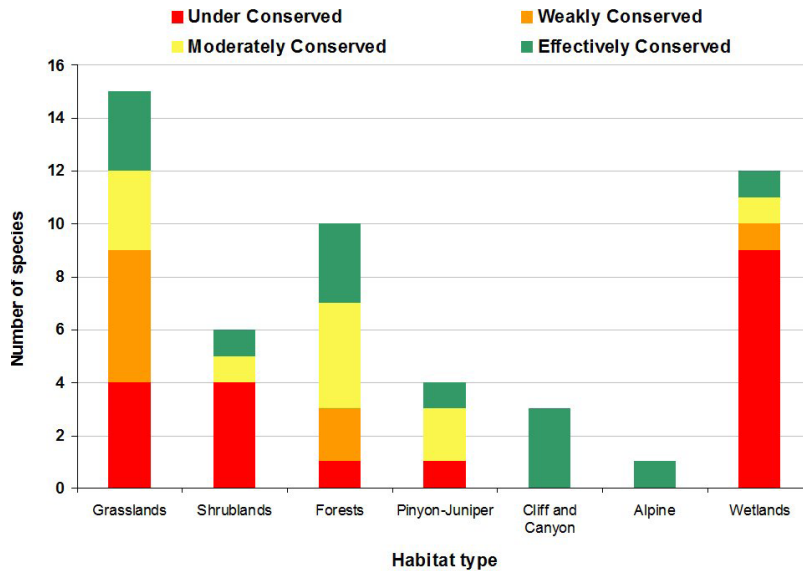


Figure 18. Conservation status of 51 at-risk birds by habitat type.



forestry, energy development, and wetland/riparian alteration were additional reasons for very high or high threat scores.

The protection status scores were split unevenly, with 65% of species scoring moderately or effectively protected and 35% scoring weakly or under protected.

Fish

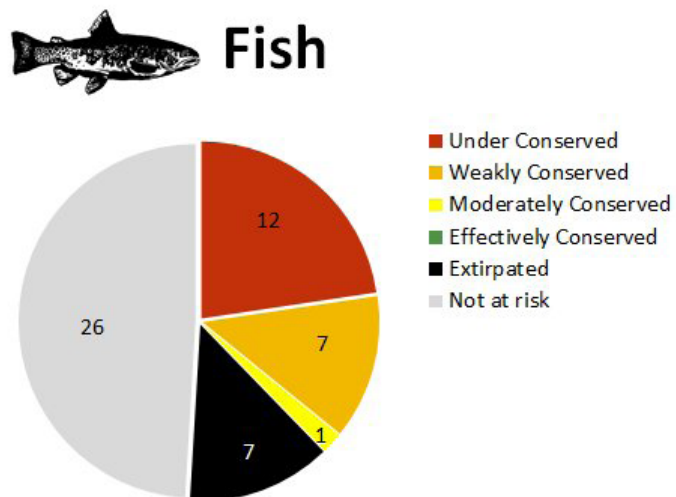
Prior to European settlement, Colorado had 53 native fish species. Seven of these species have been extirpated from our state: American eel, speckled chub, yellowfin cutthroat trout, river shiner, blacknose shiner, horny head chub, and sauger (Nesler 2003). A re-introduced population of the sauger can now be found in the Arkansas drainage (Nesler 2003). Five of the seven extirpated species inhabited rivers and streams on Colorado’s eastern plains. Forty-

six native fish species remain, one of which is endemic (greenback cutthroat trout).

Of the extant native fish, almost half (43%) are at risk – the highest percentage of any animal group. Of these, fully 95% are Weakly Conserved or Under Conserved (Figure 19). None of our at-risk fish are Effectively Conserved (Figure 19).

Five of Colorado’s native fish are federally listed and nearly extinct: bony-tailed chub, Colorado pike minnow, greenback cutthroat trout, humpback chub, and razorback sucker. All but the Greenback cutthroat trout are considered “big-water” fishes, and are found in the Colorado River drainages. The greenback cutthroat trout is a mountain stream fish found on the east side of the Continental Divide. The overall conservation status of all these species is Under Conserved.

Figure 19. Conservation status of Colorado’s native fish. Seven species have been extirpated in Colorado and 43% of the remaining species are at-risk. Of the 20 species that are at risk, none are Effectively Conserved, and only one is Moderately Conserved. Though conservation efforts for native fish have been ongoing for many years, and several species are federally listed, significant conservation challenges remain.



Colorado now has more non-native fish than native (Nesler 2003). We have 57 non-native fish, 21 native but outside their natural range (i.e., stocked or introduced into areas outside their native range), and nine hybrids, totaling 87 non-native fish species inhabiting the waterways of Colorado along with our 46 native species.

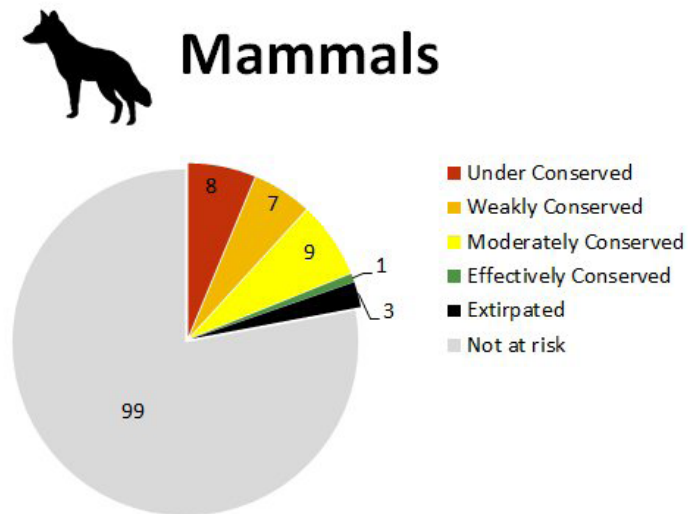
Seven species (35%) had very good or good abundance scores, while 13 species (65%) had fair or poor abundance scores (Figure 15). Generally speaking, Colorado's fish are highly threatened, with 16 species (80%) scoring either poor or fair in threat status; only four species (20%) scored good in threat status and none scored very good. Water developments such as dams and diversions, and invasive species, are primary threats for our native fish. Protection for fish is generally poor, with 60% in the poor or fair categories, and 40% in the good or very good categories.

Mammals

Of the 124 native mammals in Colorado (Fitzgerald et al. 1994), 99 species (80%) have stable populations, and 25 species (20%) are at risk. Of the at-risk species, 10 are Moderately or Effectively Conserved, while 15 are Weakly or Under Conserved (Figure 20).

Nearly half of the at-risk mammal species in Colorado inhabit grasslands; of these, five are Under Conserved (Figure 21). Two of the at-risk mammals are endemic to Colorado: Botta's pocket gopher

Figure 20. Conservation status of Colorado's native mammals. The majority of our native mammals are not at risk. Of the 25 species that are at risk, only one is Effectively Conserved. Mammals most in need of conservation attention include small mammals, bats, and carnivores.



rubidus subspecies and Northern pocket gopher macrotis subspecies.

Four mammals are federally listed: black-footed ferret, gray wolf, lynx, and Preble's meadow jumping mouse. Black-footed ferrets are being re-introduced to select sites in Colorado, and there are breeding facilities for this species in northern Colorado. The overall conservation status score for black-footed ferret is Under Conserved.

There are no known established gray wolf populations remaining in Colorado, but the potential exists for populations from the north to repopulate Colorado. The overall conservation status score for the gray wolf is Weakly Conserved. CDOW began re-introducing Lynx into Colorado in 1999, and they appear to be surviving and extending their range within the

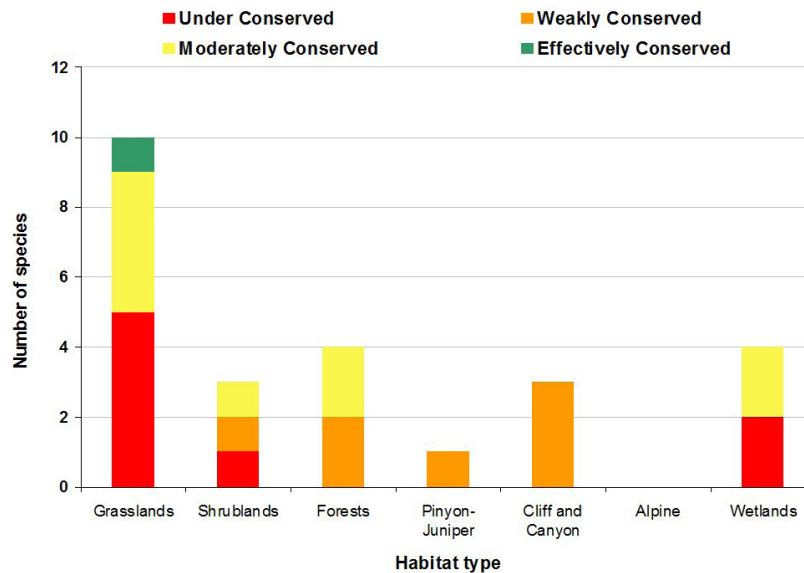
state. The overall conservation status score for lynx is Moderately Conserved.

Preble's meadow jumping mouse is restricted to a narrow distribution along riparian areas of the Front Range, and is threatened by ongoing urban development. Its overall conservation status score is Under Conserved.

Abundance scores for mammals were evenly split, with approximately 50% of the animals scoring good or very good for this factor, and the other 50% scoring fair or poor (Figure 15).

Nine species (36%) were scored as having poor or fair threat scores, while 16 species (64%) scored good or very good for threat (Figure 15). The most important threats to mammals are disease, direct

Figure 21. Conservation status of 25 at-risk mammals by habitat type.



mortality from human causes, urban development, and energy development.

Approximately 32% (8 species) of mammals were scored good in the protection category, with 64% scored fair or poor. Only one (Gunnison's prairie dog) scored very good (Figure 15).

Reptiles

Of Colorado's 53 native reptiles (Hammerson 1999), the majority (81%) have stable populations, while 19% are at risk. Of those reptiles that are at risk, the majority (70%) are Moderately to Effectively Conserved, but about one-third (30%) are Weakly or Under Conserved (Figure 22). At-risk reptiles occur in four habitat types: grasslands, shrublands, pinyon-juniper, and wetlands, with the highest number of species occurring in grasslands and

wetlands, followed by pinyon-juniper (Figure 23). Half of the species in pinyon-juniper, and one-third of the species in grasslands and wetlands, are Weakly Conserved or Under Conserved.

Colorado's only endemic reptile – the triploid Colorado checkered whiptail – is restricted to canyons in the southeastern portion of Colorado. None of Colorado's at-risk reptiles are federally listed.

Five reptiles (50%) scored very good or good for abundance, and five species (50%) had poor abundance scores (Figure 15). Generally speaking, Colorado's reptiles have a low level of threat, with just two species (20%) scoring fair or poor for threats. Invasive species and energy development are the primary threats to reptiles in Colorado.

Protection for reptiles is good for 70% of reptile species. However, almost one-third (30%) of Colorado's at-risk reptiles scored fair or poor in this category.

Figure 22. Conservation Status of Colorado's native reptiles. Most of Colorado's reptiles are doing well, but three species would greatly benefit from conservation action.

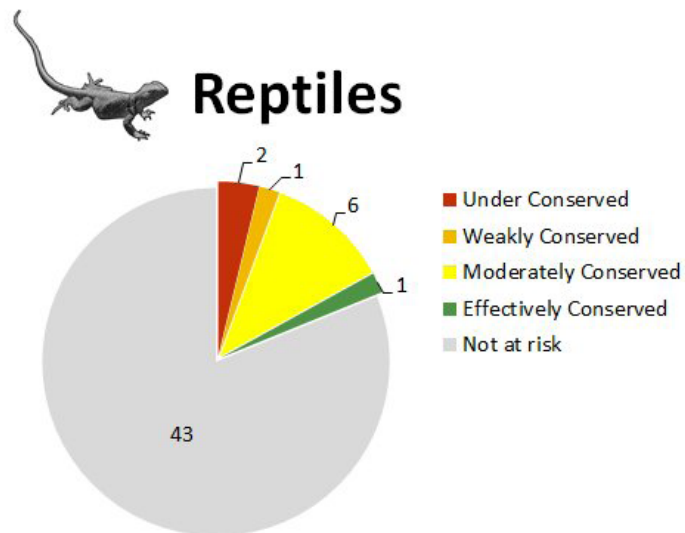
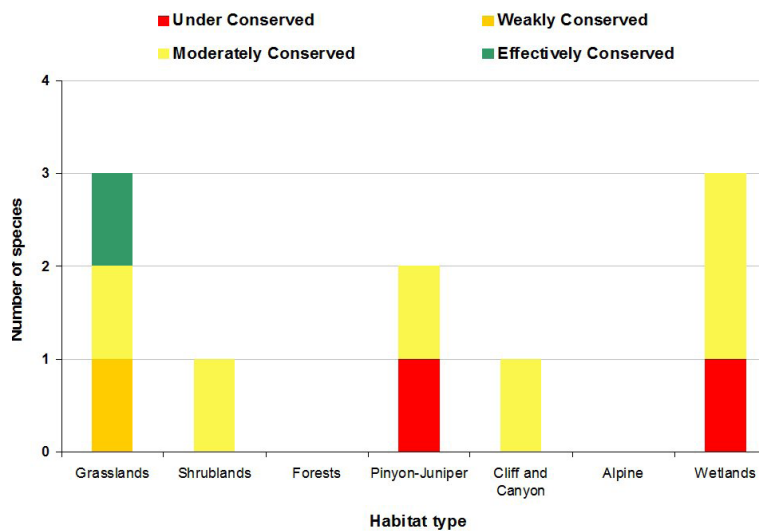


Figure 23. Conservation status of 10 at-risk reptiles by habitat type.



Threats

Water development is an important threat for 15 of our at-risk animals (Figure 24). Activities included under this threat include surface flow alterations such as dams, diversions, and stormwater infrastructure, as well as sub-surface alterations such as wells and groundwater pumping. The hydrological systems on the plains are more severely altered than the mountain systems, but the majority of waterways, regardless of their location in Colorado, have been dammed, diverted, or otherwise effected to some degree. These impacts primarily affect fish, but may also be detrimental to birds and other species who use wetland and riparian habitats.

The Farming Practices category covers conversion of native habitats to cropland, as well as specific farming methods such as pesticide and herbicide application and

tilling (both timing and methods). Roughly half of Colorado's eastern plains have been converted to cropland. Other areas of significant habitat conversion to cropland include the San Luis Valley and the area around Grand Junction. Farming practices are particularly relevant for at-risk bird, amphibian, and reptiles species of the eastern plains.

Activities considered under Energy Development include oil, gas, mining, and renewable energy development (especially wind). Currently, the most widespread energy development in Colorado is in oil and gas, with the most dense development occurring in Weld, Garfield, Rio Blanco, Moffat, and La Plata counties. Energy development is most problematic for species that inhabit sagebrush and other shrublands, as well as grasslands.

The Invasive Species category includes habitat degradation by weeds, as well as invasive animals. Of particular import are introduced sport fish, which may compete with, depredate, and/or hybridize with native fish species. Non-native bullfrogs exert similar pressures on native amphibians. Non-native species that are covered under the disease category include sylvatic plague (a significant source of mortality for prairie dogs) and chytrid fungus (a major threat to amphibians).

Direct mortality covers intentional take as well as indirect effects of intentional take. For example, prairie dog poisoning or shooting causes not only direct mortality of the prairie dog, but also prey reduction for raptors and black-footed ferrets, as well as habitat loss for burrow-dependent species such as Burrowing Owls.

Urban Development, Forestry Practices, and Grazing Practices include both direct habitat loss through conversion and indirect degradation and fragmentation of habitat. Urban development is of particular concern along the Front Range and major transportation corridors, but is also increasingly affecting more remote areas of the state via exurban and second-home development. Forestry practices are problematic mainly in heavily forested mountain areas. Grazing practices are highly variable across the state, and affect primarily grassland, shrubland, pinyon-juniper, and mountain parks. It is important to note that forestry

and grazing practices, depending on timing and method, may have beneficial effects on species and habitats.

Recreation covers direct disturbances such as flushing birds from nests, as well as indirect habitat degradation related to trails and off-road use. The “other” category includes human disturbance that is not reflected in other categories (for example, disturbance of bats in mines and old buildings), and roads.

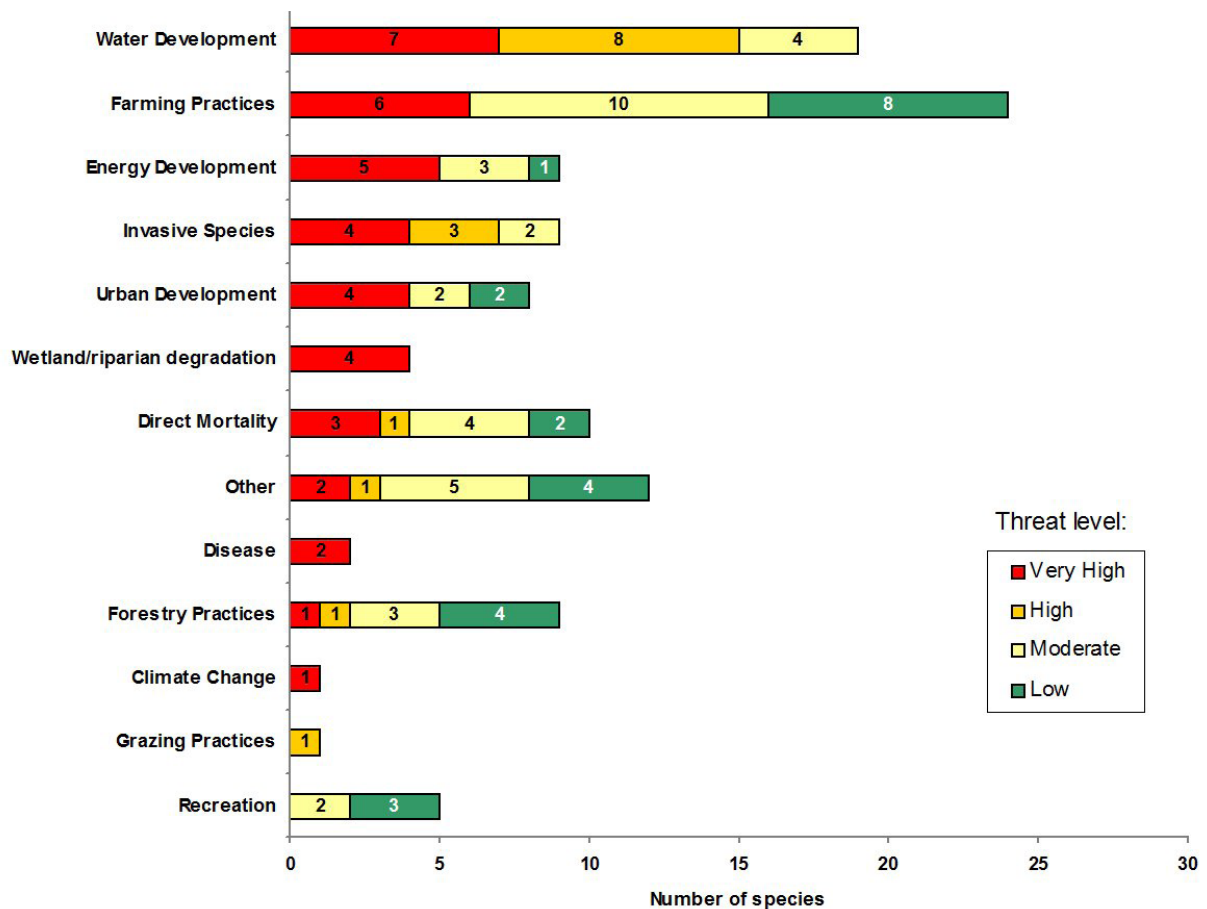
Note that potential threats from climate change were not directly assessed in this Scorecard. This significant issue is a high priority for analysis in subsequent iterations of this report. Meanwhile, climate change is considered the primary threat for one at-risk bird species: the Brown-capped Rosy Finch. This species lives at high elevation and is therefore likely to experience habitat reduction as alpine areas become warmer (and potentially drier).

Results by Habitat Type

As previously noted, we evaluated 141 vertebrate and invertebrate animals for this Scorecard. For the 113 vertebrate species, we included an evaluation of primary habitat as part of this analysis (Figures 26 a-g). Habitats included in this analysis were:

- 🐾 alpine (1 species),
- 🐾 cliff and canyon (7 species)
- 🐾 forests (13 species)
- 🐾 grasslands (28 species)

Figure 24. Primary threats to at-risk animals. The graph is ordered by number of species that scored “Very High” for each threat.



- pinyon-juniper (7 species)
- shrublands (10 species), and
- wetlands/aquatic (46 species).

For Colorado's at-risk vertebrates, wetlands (including aquatic habitats) and grassland habitats host the greatest number of our at-risk species (Figure 25). Though wetlands and aquatic areas occupy less than 2% of Colorado, the proportion of at-risk species that rely on them is very high, and the majority of these species are Weakly or Under Conserved. Grasslands occupy 22% of Colorado's landscape (the largest habitat type in Colorado), and our grassland species continue to decline.

Figures 26 (a) – (g) summarize the average conservation status scores for animal species within each

habitat type. When averaged across species, inhabitants of alpine, cliff and canyon, forest, and pinyon-juniper habitats are moderately well conserved. On average, threats are somewhat higher for grassland and shrubland inhabitants, and most scores for wetland/aquatic inhabitants fall near or below the "poorly conserved" threshold.

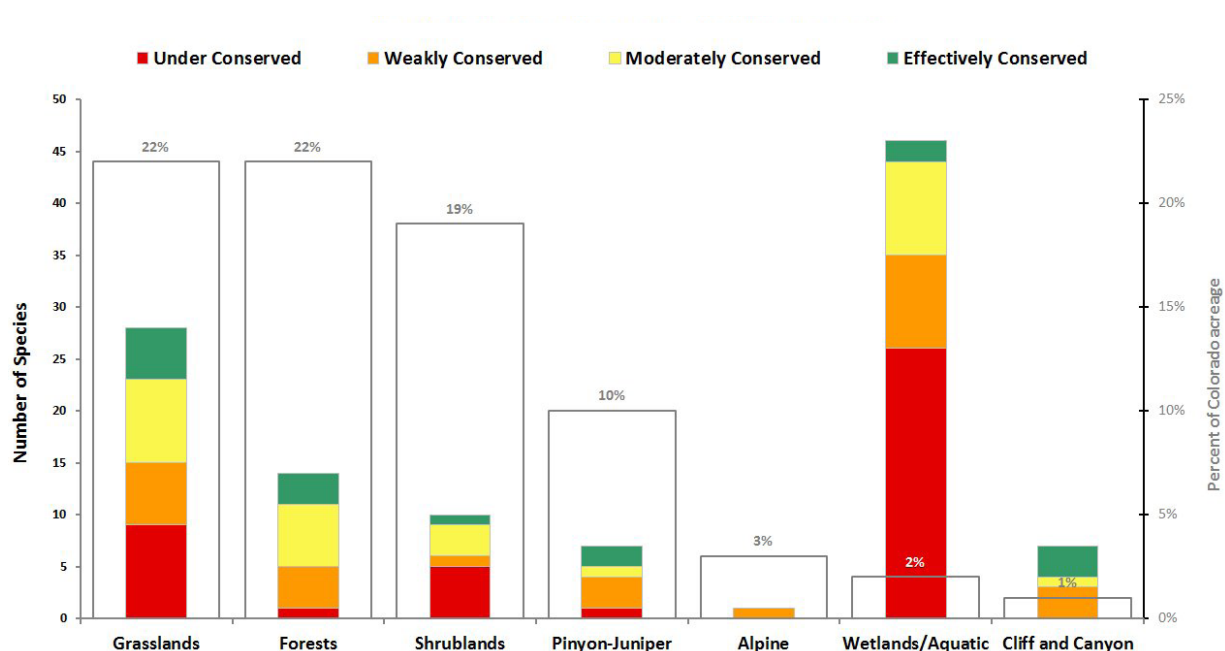
Discussion

The combination of low abundance, few or no high quality populations, and high threats to a species or its habitat equates to a poor outlook for a species' future in Colorado. The Plains Sharp-tailed Grouse, black-footed ferret, and bonytail chub are species at risk of extinction and in need conservation attention regardless of where they occur. However, other species that rise to the top

of our list are those that, while they are very rare in Colorado, may be more abundant in other parts of their range. These "edge of range" species are not necessarily of highest conservation priority in Colorado. Consequently, a species' range should be considered when prioritizing the use of conservation resources.

For example, conservation effort may be better spent on a species that is critically imperiled across its range and is largely dependent on Colorado habitats (GIS1). A species with moderate abundance, high threat, and a downward trend (scorecard rank 7) such as the Gunnison Sage Grouse merits more attention by Colorado conservation groups than one at the top of the list such as the Whooping Crane for which conservation effort would be most effective in another region of

Figure 25. At-risk vertebrate species by habitat type in comparison to percent cover of the habitat in Colorado.



its range. In addition, mechanisms for conservation action will depend on the relative importance of a particular factor for each species. For some species such as the Preble's meadow jumping mouse, abundance may not be the primary concern, and therefore a captive breeding effort would not be as important as habitat protection. On the other hand, abundance is the primary concern for the gray wolf, as there are no viable populations in Colorado.

In the development of potential conservation actions, it is also important to consider the primary threat in relation to the current short term trends for the species. For instance, the canyon treefrog (*Hyla arenicolor*) can be considered to be in relatively good shape in Colorado. Canyon tree frog occurrences in Colorado have good abundance, very good quality, and a low threat. However, if chytrid fungus (*Batrachochytrium dendrobatitis*) continues to spread throughout the state and negatively affect the native amphibians, the current downward trend may be amplified in a relatively short time and the species' conservation priority would need to be re-evaluated.

In contrast, a species such as the bald eagle, also considered to be in relatively good shape, has an upward short-term trend and the current threats will probably not increase in the foreseeable future. Therefore two similarly ranked species may warrant different conservation attention

due to the relationship between population trend and threats. Therefore, we suggest that all of the factors presented here should be considered in prioritization for conservation planning, and not merely the overall scorecard rank.

Wetlands and riparian areas are the most significant habitats in the state for Colorado's at-risk animals.



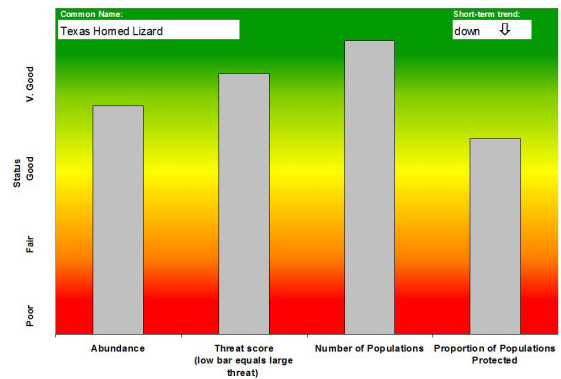
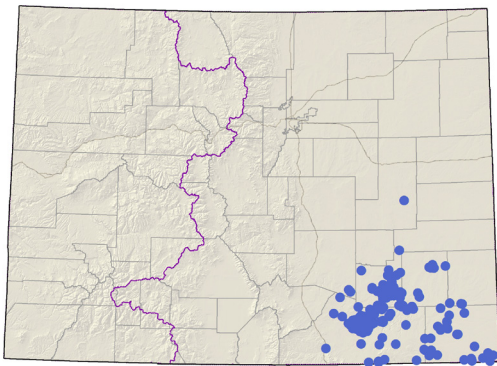
© Michael Menefee

Sample Animal Graphs

EFFECTIVELY CONSERVED Texas horned lizard (G4G5 / S3)



Range

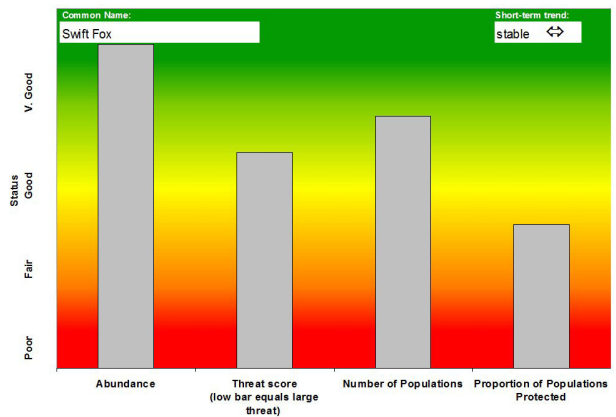
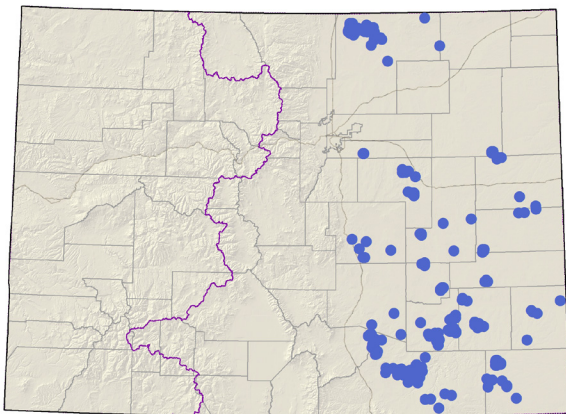


Sample Animal Graphs

MODERATELY CONSERVED
Swift fox (G3 / S3)



Range

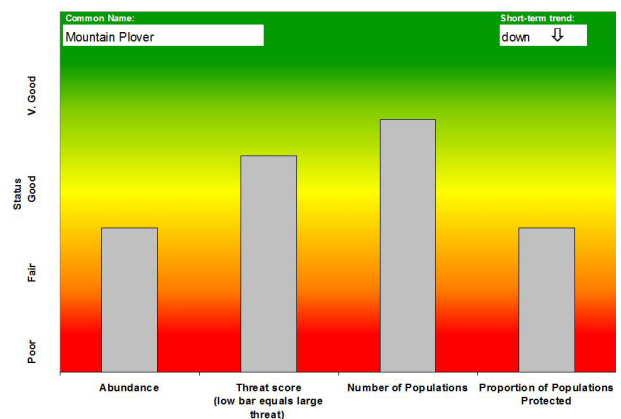
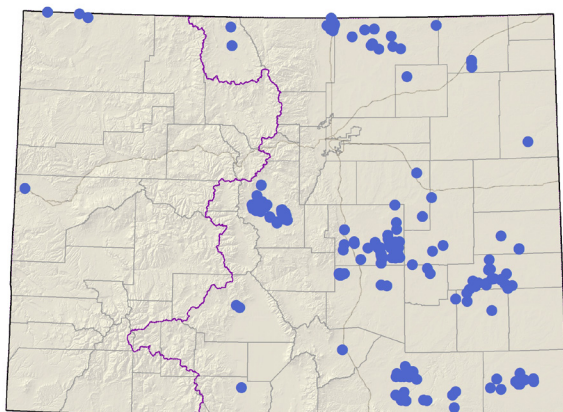


Sample Animal Graphs

WEAKLY CONSERVED Mountain Plover (G2 / S2)



Range



Sample Animal Graphs

UNDER CONSERVED Boreal toad (G1 / S1)



Range

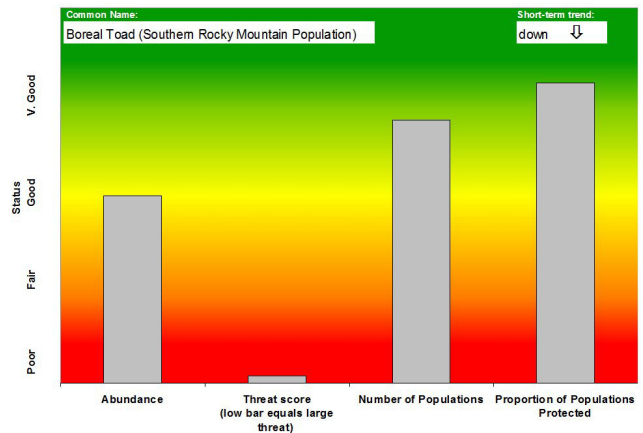
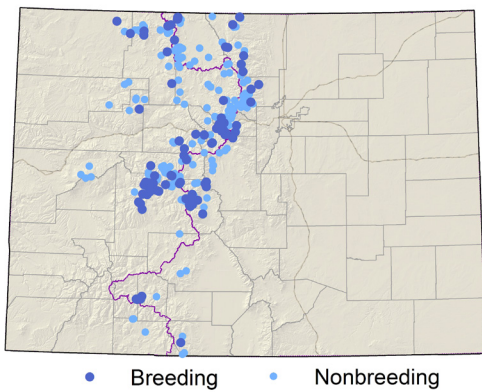
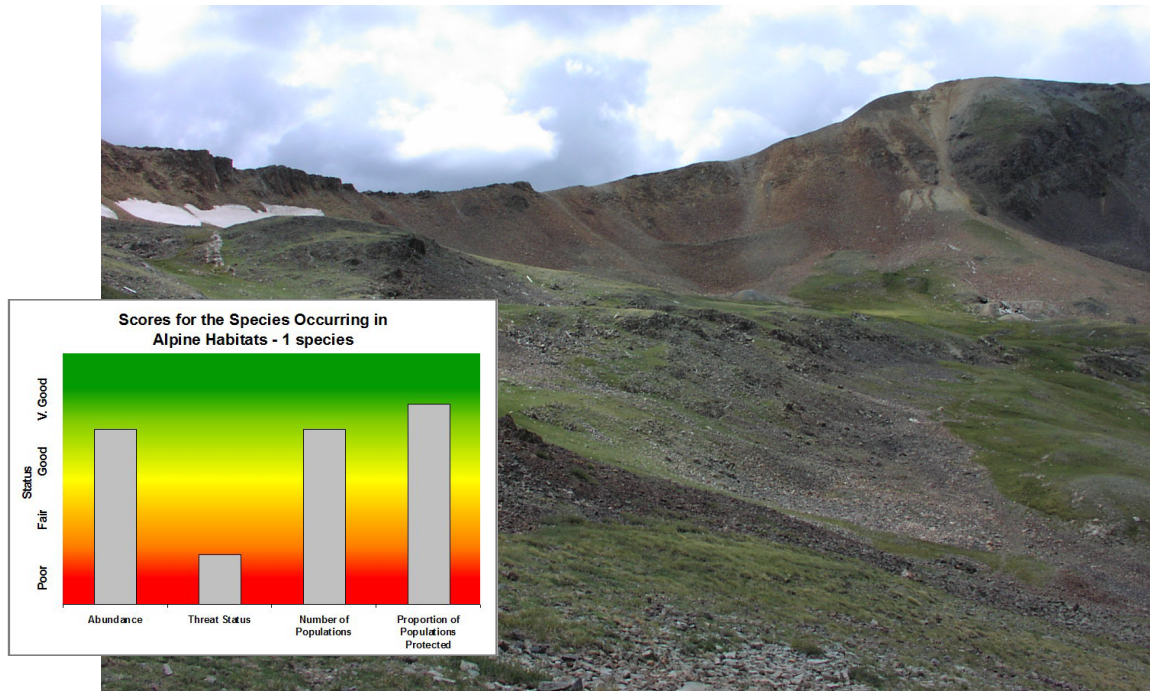
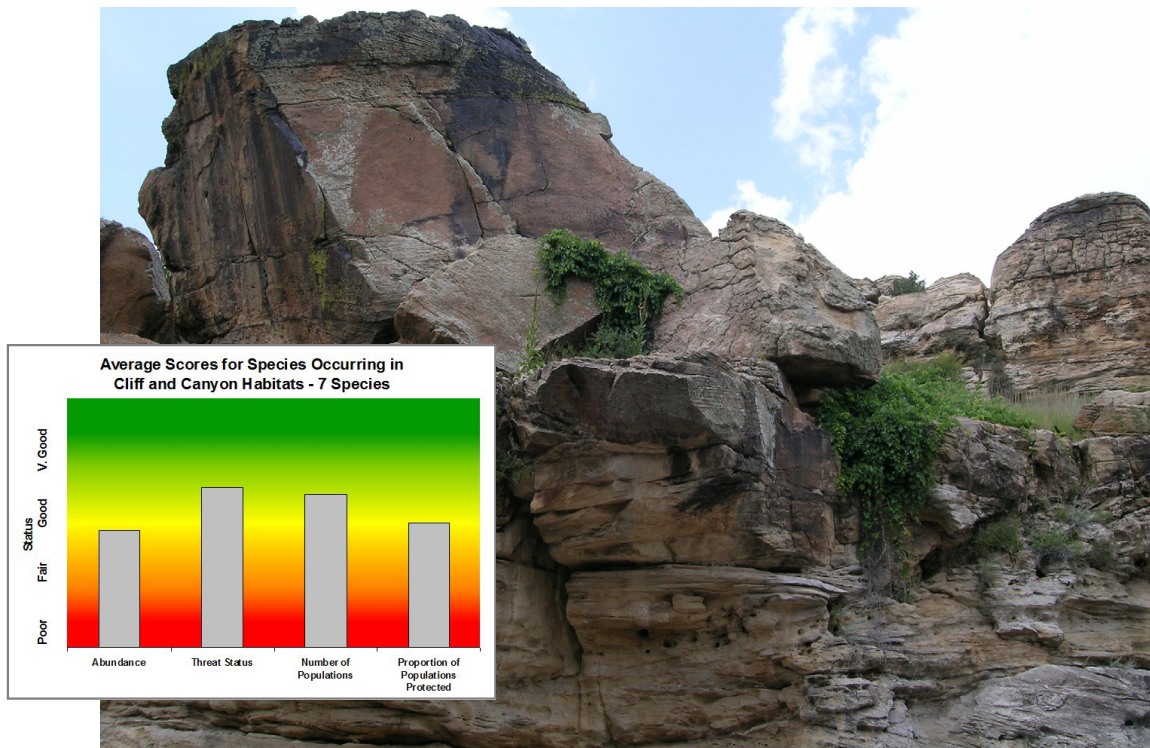


Figure 26. Habitats occupied by at-risk vertebrates and species scores by habitat.

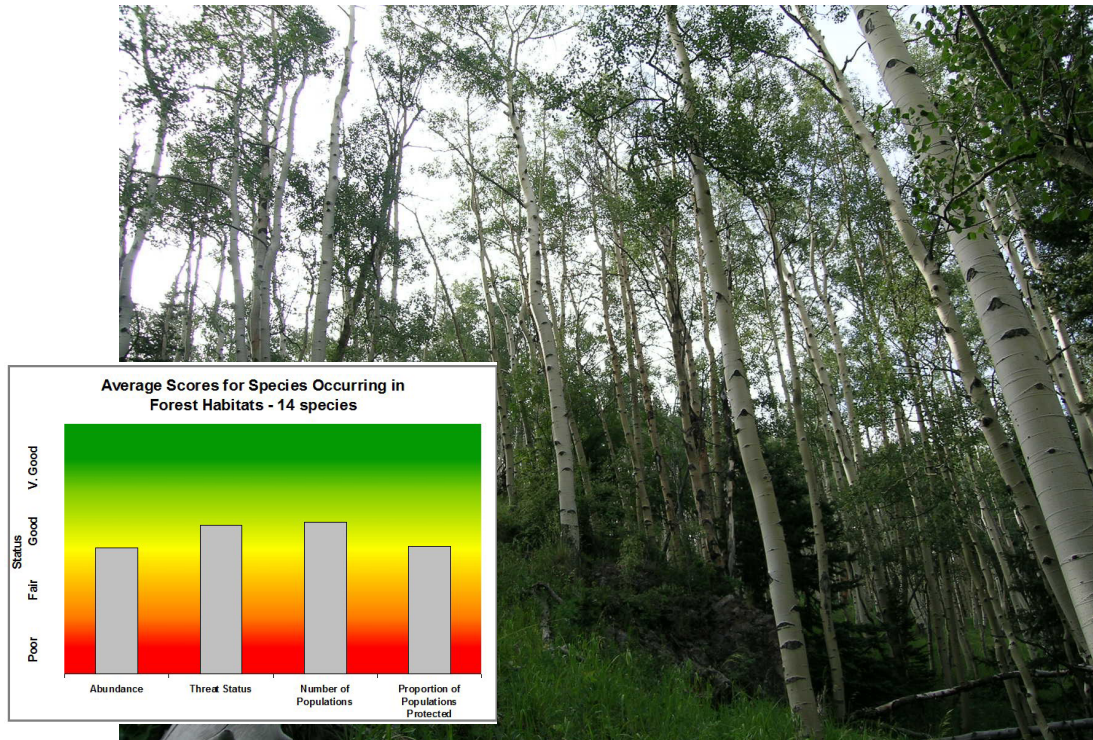
(a) Alpine habitats account for about 3% of Colorado's landscape, and only one at-risk animal (Brown-capped Rosy-finch) depends on this habitat. Alpine habitats are effectively conserved for the time being, but are threatened by climate change.



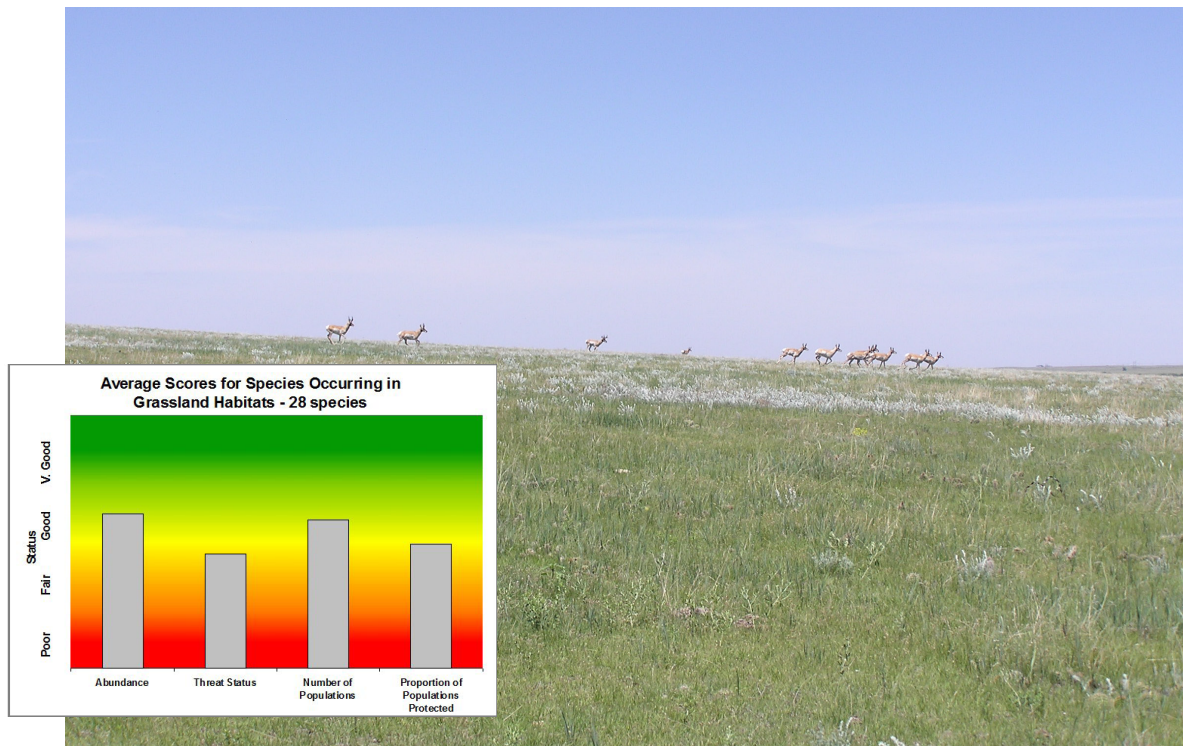
(b) Cliff and canyon habitats are little threatened, and most occurrences are well protected. This habitat type occupies <1% of Colorado's landscape. These habitats are critical for some bird, mammal (especially bats), and reptile species.



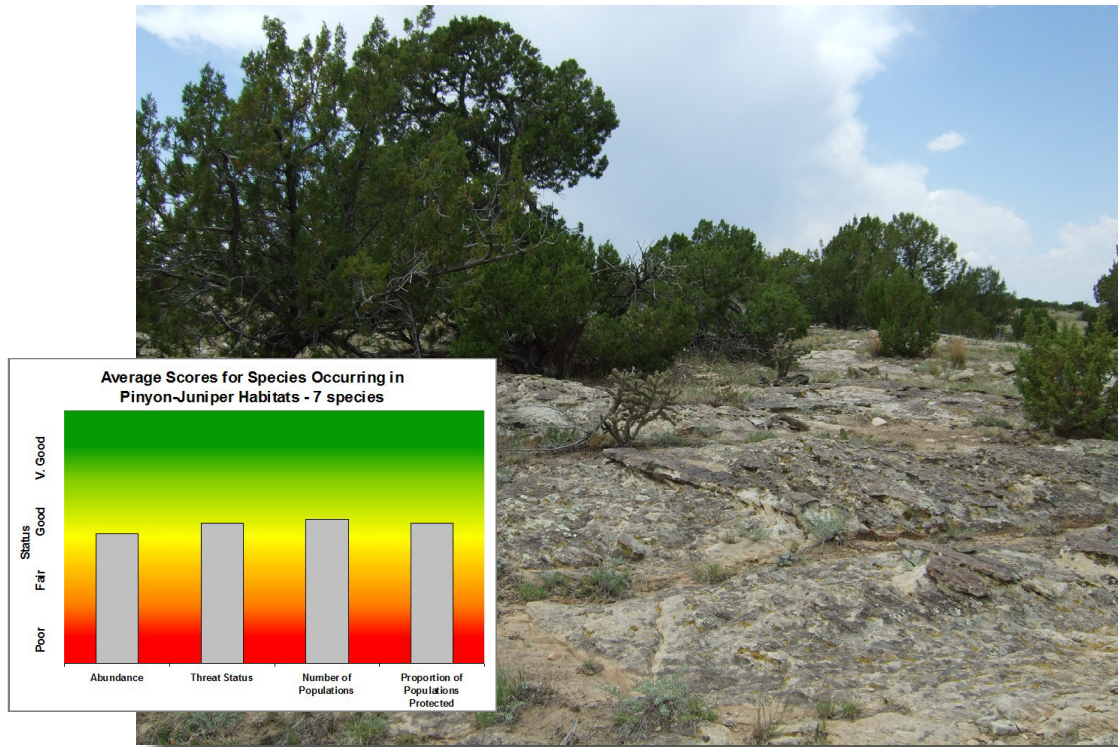
(c) Forest habitats are widespread in Colorado (covering over 20% of the state's acreage), and are especially important for bird and mammal species. Threats are generally low.



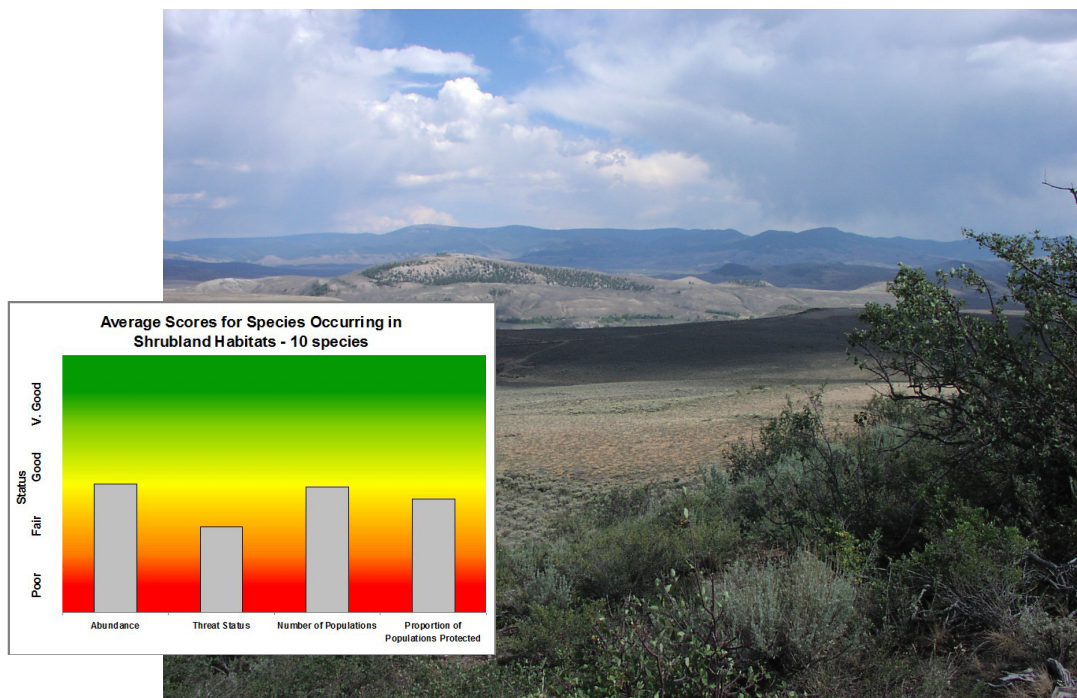
(d) Grassland habitats are an important part of Colorado's landscape (about 22%), and are generally poorly protected. These habitats are particularly important for bird and mammal species.



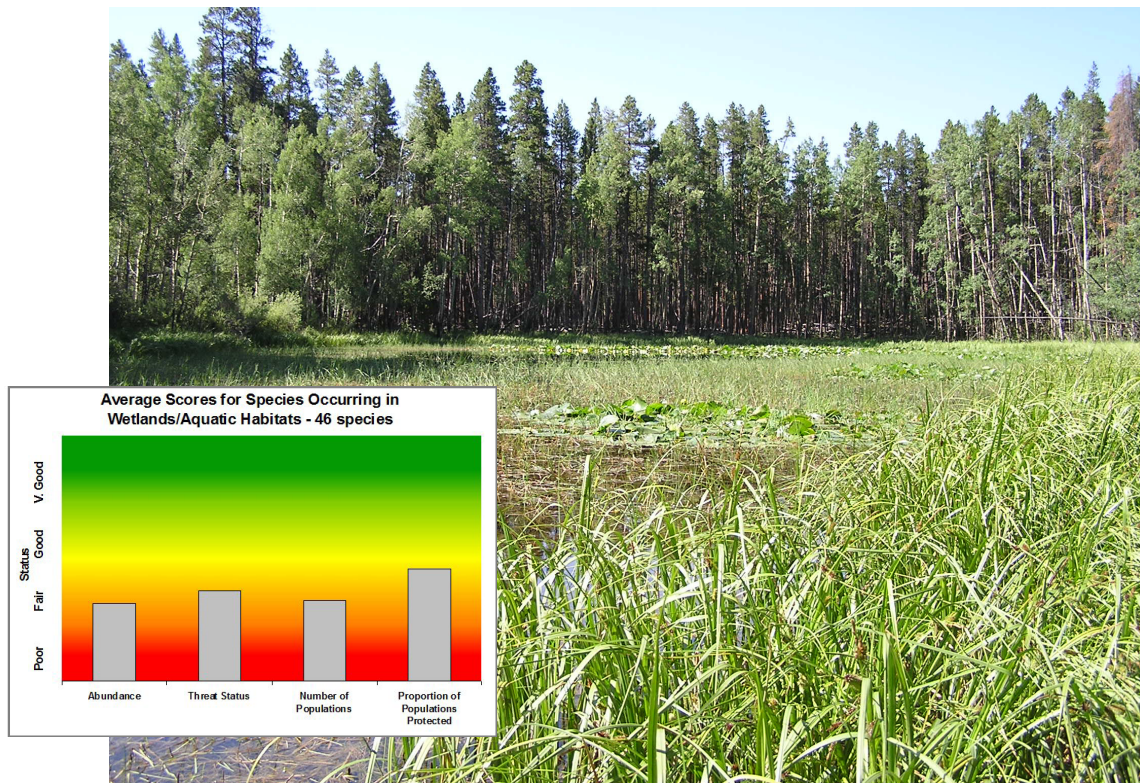
(e) Most of Colorado's pinyon-juniper habitats are on public lands, and this habitat type covers nearly 10% of Colorado's landscape. Although threats to at-risk species in pinyon-juniper are currently low, the great potential for energy development in this habitat will require careful planning to avoid impacts.



(f) Shrublands are found on nearly 20% of the Colorado's acreage. This habitat is also highly threatened, and the bird, mammal, and reptile species they host are vulnerable to both current impacts and future energy development.



(g) There are 46 species that occupy wetland habitats, yet wetlands cover only 2% of Colorado's landscape. Unfortunately, these habitats are often the most altered. Threats to wetland species are high and protection is generally poor. Primary threats are dams, diversions, and invasive species.





Colorado's growth rate is soaring and imminent threats, such as energy development and residential development, are increasing impacts to Colorado's rare plants. The recent onset of rapid development of oil and gas reserves, as well as urban growth, development, and recreation, have prompted the need for botanists, land managers and conservationists to have the ability to rapidly assess species conservation status.

Species Included in the Analysis

There are approximately 2,600 plant species in Colorado. The Colorado Natural Heritage Program tracks over 500 regionally endemic or uncommon (rare) plant species (CNHP 2008). Of these, 253 are critically imperiled (G1), imperiled (G2), or vulnerable to extinction (G3) on a global scale. Sixteen of these G1, G2, and G3 species are

federally listed as threatened or endangered.

Due to the large number of tracked plant species in Colorado, a subset of 103 species was selected for this analysis (Table 7). Species selected for analysis were prioritized by degree of imperilment based on NatureServe's G rank (Appendix E), endemism, and completeness of data. Selected species are either endemic to Colorado (occurring no place else in the world) and/or globally imperiled. All of the 16 federally listed species were included.

We included 100 G1 and G2 (or T1, T2) plants tracked by CNHP in this analysis (Table 7), and three G3 plants, which were included for comparison and validation of scorecard methodology. The three G3 species included are *Penstemon breviculus* (not endemic), *P. harringtonii* (endemic), and *Sclerocactus glaucus* (endemic,

and federally listed as Threatened under the Endangered Species Act). Thirteen G1 and G2 (or T1, T2) plant species were excluded from the analysis either because of data limitations associated with their records, or because taxonomic uncertainty precluded their inclusion (see Appendix E).

The analysis presented here is limited by the available data because not every occurrence is well documented. The scorecard will be updated periodically to record changes in the conservation status of targeted rare plant species, and to add additional species as resources become available. In addition, as we continue to improve our knowledge about the size, quality and distribution of rare plant populations, future scores will better reflect the true status of a species.

Table 7. Plant species included in the analysis. Species are listed alphabetically by the scientific name used in Colorado (Weber and Wittmann 2001). Agency status indicates federal listing under the Endangered Species Act (LE = listed endangered; LT = listed threatened; C = candidate for listing), and/or inclusion on the Sensitive Species lists of the Bureau of Land Management Colorado Office or US Forest Service Region 2 (blanks indicate no sensitive status). The percent of a species range in Colorado is defined as: Endemic = 100% of range (EOs) within Colorado, Very High = 75-99% within Colorado, High = 50-75% within Colorado, Medium = 25-50% within Colorado, Low = <25% within Colorado.

Scientific Name (State)	G/S Rank	Agency Status	% Range in Colorado	Primary Habitat
<i>Aletes humilis</i>	G2G3 / S2S3		Endemic	Cliff & Canyon
<i>Aletes latilobus</i>	G1 / S1	BLM	Medium	Cliff & Canyon
<i>Aletes macdougalii</i> ssp. <i>breviradiatus</i>	G3T2T3 / S1		Medium	Pinyon-juniper
<i>Aliciella sedifolia</i>	G1 / S1	USFS	Endemic	Alpine
<i>Anticlea vaginatus</i>	G2 / S2		Low	Cliff & Canyon
<i>Aquilegia chrysantha</i> var. <i>rydbergii</i>	G4T1Q / S1	BLM/USFS	Endemic	Forest
<i>Asclepias uncialis</i> ssp. <i>uncialis</i>	G3G4T2T3 / S2	BLM/USFS	Very High	Grassland
<i>Astragalus anisus</i>	G2G3 / S2S3	BLM	Endemic	Shrubland
<i>Astragalus cronquistii</i>	G2 / S2	BLM	High	Shrubland
<i>Astragalus debequaeus</i>	G2 / S2	BLM	Endemic	Pinyon-juniper
<i>Astragalus deterior</i>	G1G2 / S1S2		Endemic	Cliff & Canyon
<i>Astragalus equisolensis</i>	G5T1 / S1		Low	Pinyon-juniper
<i>Astragalus humillimus</i>	G1 / S1	LE	Low	Cliff & Canyon
<i>Astragalus iodopetalus</i>	G2 / S1		Medium	Shrubland
<i>Astragalus lonchocarpus</i> var. <i>hamiltonii</i>	G1 / S1		Low	Pinyon-juniper
<i>Astragalus microcymbus</i>	G1 / S1	BLM	Endemic	Shrubland
<i>Astragalus missouriensis</i> var. <i>humistratus</i>	G5T1 / S1	USFS	Endemic	Shrubland
<i>Astragalus naturitensis</i>	G2G3 / S2S3	BLM	High	Cliff & Canyon
<i>Astragalus osterhoutii</i>	G1 / S1	LE	Endemic	Shrubland
<i>Astragalus piscator</i>	G2G3 / S1	BLM	Low	Shrubland
<i>Astragalus rafaelsenis</i>	G2G3 / S1	BLM	High	Pinyon-juniper
<i>Astragalus schmolliae</i>	G1 / S1		Endemic	Pinyon-juniper
<i>Astragalus tortipes</i>	G1 / S1	C	Endemic	Shrubland
<i>Botrychium lineare</i>	G1 / S1	C, USFS	Medium	Forest
<i>Camissonia eastwoodiae</i>	G2 / S1		Medium	Shrubland
<i>Carex stenoptila</i>	G2 / S2		Medium	Forest
<i>Castilleja puberula</i>	G2G3 / S2S3		Endemic	Alpine
<i>Cirsium perplexans</i>	G2G3 / S2S3	BLM/USFS	Endemic	Shrubland
<i>Cleome multicaulis</i>	G2G3 / S2S3	BLM	High	Wetland
<i>Corispermum navicula</i>	G1? / S1		Endemic	Barrens
<i>Cryptantha gypsophila</i>	G1G2 / S1S2		Endemic	Pinyon-juniper
<i>Delphinium ramosum</i> var. <i>alpestre</i>	G2 / S2		High	Alpine
<i>Draba exunguiculata</i>	G2 / S2	USFS	Endemic	Alpine
<i>Draba graminea</i>	G2 / S2		Endemic	Alpine
<i>Draba smithii</i>	G2 / S2	USFS	Endemic	Cliff & Canyon
<i>Draba weberi</i>	G1 / S1		Endemic	Alpine
<i>Erigeron kachinensis</i>	G2 / S1	BLM	Low	Cliff & Canyon
<i>Erigeron wilkenii</i>	G1 / S1		Endemic	Cliff & Canyon
<i>Eriogonum brandegeei</i>	G1G2 / S1S2	BLM/USFS	Endemic	Barrens
<i>Eriogonum clavellatum</i>	G2 / S1	BLM	Medium	Shrubland
<i>Eriogonum coloradense</i>	G2 / S2	BLM	Endemic	Alpine
<i>Eriogonum pelinophilum</i>	G2 / S2	LE	Endemic	Shrubland
<i>Eutrema edwardsii</i> ssp. <i>penlandii</i>	G1G2 / S1S2	LT	Endemic	Wetland
<i>Gaura neomexicana</i> ssp. <i>coloradensis</i>	G3T2 / S1	LT	Medium	Wetland
<i>Hackelia gracilentia</i>	G1 / S1		Endemic	Pinyon-juniper
<i>Herrickia horrida</i>	G2? / S1		Medium	Pinyon-juniper
<i>Ipomopsis aggregata</i> ssp. <i>weberi</i>	G5T2 / S2	USFS	Very High	Forest
<i>Ipomopsis globularis</i>	G2 / S2	USFS	Endemic	Alpine
<i>Ipomopsis polyantha</i>	G1 / S1	LE, BLM/ USFS	Endemic	Barrens

Table 7, cont.

Scientific Name (State)	G/S Rank	Agency Status	% Range in Colorado	Primary Habitat
<i>Lepidium crenatum</i>	G2 / S2		Medium	Shrublands
<i>Lesquerella calcicola</i>	G2 / S2		High	Barrens
<i>Lesquerella congesta</i>	G1 / S1	LT	Endemic	Barrens
<i>Lesquerella parviflora</i>	G2 / S2	BLM	Endemic	Barrens
<i>Lesquerella pruinosa</i>	G2 / S2	BLM/USFS	Endemic	Barrens
<i>Lesquerella vicina</i>	G2 / S2	BLM	Endemic	Pinyon-juniper
<i>Limnorchis zothecina</i>	G2 / S1		Low	Cliff & Canyon
<i>Lomatium concinnum</i>	G2G3 / S2S3	BLM	Endemic	Shrubland
<i>Lupinus crassus</i>	G2 / S2	BLM	Endemic	Pinyon-juniper
<i>Lygodesmia doloresensis</i>	G1G2 / S1	BLM	High	Pinyon-juniper
<i>Machaeranthera coloradoensis</i>	G2 / S2	USFS	High	Alpine
<i>Mentzelia rhizomata</i>	G2 / S2		Endemic	Barrens
<i>Mertensia humilis</i>	G2 / S1		Medium	Shrubland
<i>Mimulus gemmiparus</i>	G1 / S1	USFS	Endemic	Cliff & Canyon
<i>Nuttallia chrysantha</i>	G2 / S2	BLM	Endemic	Barrens
<i>Nuttallia densa</i>	G2 / S2	BLM	Endemic	Pinyon-juniper
<i>Oenothera acutissima</i>	G2 / S2	BLM	Medium	Shrubland
<i>Oenothera harringtonii</i>	G2G3 / S2S3	USFS	Endemic	Grassland
<i>Oonopsis foliosa</i> var. <i>monocephala</i>	G3G4T2 / S2		Endemic	Grassland
<i>Oonopsis puebloensis</i>	G2 / S2		Endemic	Grassland
<i>Oreocarya osterhoutii</i>	G2G3 / S2	BLM	Low	Barrens
<i>Oreoxis humilis</i>	G1 / S1	USFS	Endemic	Alpine
<i>Oxybaphus rotundifolius</i>	G2 / S2		Endemic	Barrens
<i>Oxytropis besseyi</i> var. <i>obnapiformis</i>	G5T2 / S2		Very High	Shrubland
<i>Penstemon breviculus</i>	G3 / S2		High	Pinyon-juniper
<i>Penstemon debilis</i>	G1 / S1	LT	Endemic	Barrens
<i>Penstemon degeneri</i>	G2 / S2	BLM/USFS	Endemic	Pinyon-juniper
<i>Penstemon fremontii</i> var. <i>glabrescens</i>	G3G4T2 / S2		Endemic	Shrubland
<i>Penstemon gibbensii</i>	G1 / S1	BLM	High	Barrens
<i>Penstemon grahamii</i>	G2 / S1		Low	Barrens
<i>Penstemon harringtonii</i>	G3 / S3	BLM/USFS	Endemic	Shrubland
<i>Penstemon penlandii</i>	G1 / S1	LE	Endemic	Shrubland
<i>Penstemon scariosus</i> var. <i>albifluvis</i>	G4T1 / S1	C	Low	Barrens
<i>Penstemon scariosus</i> var. <i>cyanomontanus</i>	G4T2 / S2		High	Pinyon-juniper
<i>Phacelia formosula</i>	G1 / S1	LE	Endemic	Barrens
<i>Phacelia submutica</i>	G4T2 / S2	LT, USFS	Endemic	Barrens
<i>Physaria bellii</i>	G2G3 / S2S3		Endemic	Barrens
<i>Physaria obcordata</i>	G1G2 / S1S2	LT	Endemic	Barrens
<i>Physaria pulvinata</i>	G1 / S1		Endemic	Shrubland
<i>Physaria rollinsii</i>	G2 / S2		Endemic	Barrens
<i>Potentilla rupincola</i>	G2 / S2	USFS	Endemic	Cliff & Canyon
<i>Ptilagrostis porteri</i>	G2 / S2	BLM/USFS	Endemic	Wetland
<i>Puccinellia parishii</i>	G2 / S1		Low	Wetland
<i>Salix arizonica</i>	G2G3 / S1	USFS	Low	Wetland
<i>Saussurea weberi</i>	G2G3 / S2	BLM	High	Alpine
<i>Sclerocactus glaucus</i>	G3 / S3	LT	High	Shrubland
<i>Sclerocactus mesae-verdae</i>	G2 / S2	LT	Low	Barrens
<i>Sisyrinchium pallidum</i>	G2G3 / S2	BLM	High	Wetland
<i>Spiranthes diluvialis</i>	G2 / S2	LT	Medium	Wetland
<i>Telesonix jamesii</i>	G2 / S2		Very High	Cliff & Canyon
<i>Thalictrum heliophilum</i>	G2 / S2	USFS	Endemic	Barrens
<i>Townsendia fendleri</i>	G2 / S1		High	Barrens
<i>Townsendia glabella</i>	G2 / S2		Endemic	Barrens
<i>Townsendia rothrockii</i>	G2G3 / S2S3		Endemic	Alpine

Scoring methods

The selected plant species were scored in three categories: biodiversity status, threat status, and protection status (see Appendix E for details). The overall conservation status of each species was determined by combining scores for biodiversity, threat, and protection status.

Possible scores for each category range from 0 to 10, where 0 represents most at risk and 10 least at risk. Scores are color-coded to indicate a relative level of concern, ranging from red (highest level of concern) through orange and yellow, to green (lowest level of concern) (Table 8). The scale is designed to include all the plant species of Colorado, both rare and common.

Biodiversity status

Biodiversity status includes scores for size, quality, and landscape integrity. The size score incorporates the number of documented occurrences, known occupied area, and estimated range in Colorado for each plant species. Quality was evaluated as the percentage of occurrences with good viability (A or B rank, NatureServe 2002). For species in which many occurrences are lacking rank information, this metric is shown as “unknown.” Landscape integrity was scored for the area within a ¼ mile buffer around each occurrence, using the GIS dataset developed for ecological system scoring (see

Table 8. Color-coded summary categories reflecting the level of concern for each species used to assign the scores. The color gradient ranges from red (highest level of concern) to green (lowest level of concern).

Color code	Threats Score and Landscape Integrity Score	Size, Quality, Protection Status, and Energy Development Potential Scores
Red (most at risk)	0	0-1.9
Orange	2-4	2.0-2.9
Yellow	5-6	3.0-4.9
Green (least at risk)	8-10	5.0-10

Appendix A). The three scores were summarized as a biodiversity status score. Because the landscape integrity dataset was created at a coarse scale, it was de-emphasized in the summary to reflect its relative lack of precision.

Threat status

Threat status was evaluated for the primary threat listed in the element ranking record in CNHP's BIOTICS database (CNHP 2008). Threat status was evaluated by ranking the scope, severity, and immediacy for the primary threat for each species (see Appendix E for details). Categorical threat scores were calculated from this information, and reflect the degree to which a species is threatened by the most critical known threat.

Protection status

The protection status score was determined from current land management status for each occurrence. Land management status was evaluated using the

Colorado Ownership, Management and Protection (CoMAP) GIS dataset (Wilcox et al. 2007), in conjunction with the Conservation Management Status Measures developed by The Nature Conservancy (Supples et al. 2007). See Appendix E for a detailed description of scoring methodology. The protection status score represents an overall protection level for the species, and does not indicate which occurrences are best protected.

Other scores and categories

Energy development potential was scored for the area within a ¼ mile buffer around each occurrence, using the GIS dataset developed for ecological system scoring. Plant species included in our analysis were assigned to one of eight primary habitat types (alpine, barrens, cliff and canyon, forest, grassland, pinyon-juniper, shrubland, or wetland). We also characterized plant species by the degree to which their global range

occurs in Colorado. Additionally, for each plant species, we recommend a conservation action. Recommendations include on-the-ground protection, field inventory, taxonomic work, or monitoring (see Appendix F for details).

Finally, a confidence score for each species is included that reflects the completeness of the data used in the scoring process. All database-derived values were current as of May 2008.

Overall conservation status and prioritization

One desired outcome for this scorecard was to identify which rare plants are most in need of conservation attention. Our first priority is to evaluate conservation needs for plant species having low scores (in the red or orange color code) in two or more categories (Table 9). Such plant species have imminent threats and may have a limited distribution with little

protection. The lowest priority for evaluation of conservation needs is plants with “green” or “yellow” color coded scores in all categories. Methods shown in Table 9 represent a decision tree beginning with the scores for threat status, together with the color combinations of the biodiversity and protection status scores. For example, any species with a red coded score for threat status and red or orange coded score for biodiversity and protection is

Table 9. Prioritization methods for plants. The color category of threat status scores, in combination with the color categories of biodiversity and protection scores, are used to assign each species to an overall conservation status category. Not all possible color combinations are represented by the species chosen for this analysis. R=Red, O=Orange, Y=Yellow, G=Green, RO=Red or Orange, YG=Yellow or Green. An asterisk indicates species that may be naturally low in abundance even under adequate threat abatement and protection. Such species are considered inherently vulnerable, and may never achieve effectively conserved status.

IF Threat Status	AND		AND		THEN Overall Conservation Status	Number of species	
	Biodiversity		Protection			Endemic or high-med % in Colo.	Low % range in Colo.
R	R	O	R	O	Under Conserved	2	
R	Y	G	R	O		4	
R	R	G	Y	G		0	
O	R	R	R	O		2	1
O	R	Y	G			2	1
O	O	R	O			1	
O	O	Y	G		Weakly Conserved	6	1
R	O	Y	G			3	
R	Y	G	Y	G		5	
O	Y	G	R	O		3	
Y	R	O	R	O		3	
G	R	O	R	O		6	
G	Y		R	O		1	
O	Y		Y			6	
O	G		Y		Moderately Conserved	0	
O	Y		G			8	1
O	G		G			1	
Y	R	O	Y	G		6*	2
Y	Y	G	R	O		1	2
G	R	O	Y	G		10*	2
G	G		R	O		0	
Y	Y		Y			2	
Y	G		Y		Effectively Conserved	0	
Y	Y		G			4	1
Y	G		G			0	1
G	Y	G	Y	G		14	1

regarded as under conserved. A species with an orange threat status score and at least one green score for biodiversity or protection is considered moderately conserved.

There may be species that are low in abundance even though they are little impacted by anthropogenic activities. If such species are otherwise well protected and little threatened, we consider them moderately or effectively conserved, but inherently vulnerable. The final determination of vulnerability will depend on more detailed information about the species in question. For instance, a species with only one known population may score as effectively conserved, but it is still more vulnerable to extinction than other species in that category. See Appendix F for the complete listing of species, their scores, and their overall conservation status.

Results

Excluding species with a low percent of their range in Colorado, half of the rare species analyzed here are in the moderately or effectively conserved categories (Figure 27). Nearly half of Colorado's G1G2 plant species are poorly or weakly conserved, often due to significant threats and lack of protection. A few species are extremely rare (one or two known occurrences), but are relatively unthreatened and well protected. In general, these extremely rare species should be considered inherently vulnerable, and monitored carefully.

Status scores

Biodiversity scores were generally low (Table 10), largely because rare plant species typically have a small number of occurrences and occupy a small area within a limited range (Figure 29a). However, scores for the components of biodiversity status (size, quality, and landscape integrity) indicate that high quality and landscape integrity may compensate for low size scores in some situations. As expected for the rarest plants, size scores were distributed on the low end of the scale, ranging from 0 to 5.8. The score considers only Colorado occurrences and not all occurrences rangewide. Therefore, a G5 (globally common) S1 (state critically imperiled) species could receive the same score as a G1 (globally critically imperiled) S1 species, although no globally common species were included in the analysis. Two of the three G3 species included in the analysis and one G2G3 species scored in the green category for size. Size scores are poor to fair for more than 60% of the rare plant species analyzed (Figure 29b).

In contrast, for many documented occurrences, quality and landscape integrity is high enough to ensure that efforts to abate threats and provide on-the-ground protection have a good chance of succeeding. Of the 80 species receiving a quality score, 58 (72.5%) scored good to very good (Figure 29c). The average score for the 80 species receiving a quality score was 4.8.

Landscape integrity scores were fairly evenly distributed, but with generally more scores in the upper ranges of the scale (the most frequent score was 8). The spatial distribution of landscape integrity scores primarily reflects the distribution of urban development, agriculture, and transportation development (Figure 29d).

Threat status scores ranged from 0 to 10, but the most frequent score was 2, indicating a moderate to severe, imminent threat to 20-60% of the population for those species. Threat status for 45% of our rare plant species is poor to fair, especially for species occurring in barrens and shrubland habitats. In general, species of higher elevations are less threatened, while those occurring in the Colorado's western plateaus and valleys are most threatened (Figure 29e).

Protection status scores for Colorado's rare plants are mixed, with an average of 4.9. Overall, about half of the species, particularly those of higher elevations, have very good protection status scores. The spatial distribution of protection scores reflects the underlying public and private land ownership patterns in Colorado (Figure 29f). Poor protection scores are concentrated in the barrens, shrubland, pinyon-juniper, and wetland habitats.

Overall conservation status scores (Figure 28) reflect patterns shown by the component subscores. Moderately to effectively conserved plant species are concentrated

Table 10. Biodiversity, threat, and protection status scores, and overall conservation status, for at-risk plant.

Scientific Name (State)	Overall Conservation Status	Biodiversity Score	Threats Status Score	Protection Status Score	% Range in CO
<i>Aletes humilis</i>	Effectively Conserved	5.4	9	7.0	Endemic
<i>Aletes latilobus</i>	Effectively Conserved	3.3	6	9.4	Medium
<i>Aletes macdougalii</i> ssp. <i>breviradiatus</i>	Weakly Conserved	1.7	9	0.9	Medium
<i>Aliciella sedifolia</i>	Moderately Conserved	2.1	5	7.0	Endemic
<i>Anticlea vaginatus</i>	Effectively Conserved	3.9	5	10.0	Low
<i>Aquilegia chrysantha</i> var. <i>rydbergii</i>	Under Conserved	1.7	2	5.1	Endemic
<i>Asclepias uncialis</i> ssp. <i>uncialis</i>	Moderately Conserved	3.9	5	4.6	Very High
<i>Astragalus anisus</i>	Effectively Conserved	3.3	8	5.7	Endemic
<i>Astragalus cronquistii</i>	Under Conserved	1.8	2	1.7	High
<i>Astragalus debequaueus</i>	Weakly Conserved	3.4	0	3.6	Endemic
<i>Astragalus deterior</i>	Moderately Conserved	1.4	9	9.8	Endemic
<i>Astragalus equisolensis</i>	Moderately Conserved	0.7	8	5.2	Low
<i>Astragalus humillimus</i>	Moderately Conserved	3.3	6	2.0	Low
<i>Astragalus iodopetalus</i>	Moderately Conserved	1.5	8	5.2	Medium
<i>Astragalus lonchocarpus</i> var. <i>hamiltonii</i>	Effectively Conserved	4.7	8	4.6	Low
<i>Astragalus microcymbus</i>	Moderately Conserved	3.1	2	5.7	Endemic
<i>Astragalus missouriensis</i> var. <i>humistratus</i>	Weakly Conserved	2.1	8	0.7	Endemic
<i>Astragalus naturitensis</i>	Moderately Conserved	2.8	6	4.5	High
<i>Astragalus osterhoutii</i>	Under Conserved	3.4	0	2.1	Endemic
<i>Astragalus piscator</i>	Moderately Conserved	3.4	2	5.9	Low
<i>Astragalus rafaelsenis</i>	Moderately Conserved	2.1	9	3.6	High
<i>Astragalus schmolliae</i>	Moderately Conserved	3.2	2	10.0	Endemic
<i>Astragalus tortipes</i>	Weakly Conserved	3.2	2	2.0	Endemic
<i>Botrychium lineare</i>	Moderately Conserved	1.9	9	6.6	Medium
<i>Camissonia eastwoodiae</i>	Weakly Conserved	2.0	2	4.1	Medium
<i>Carex stenoptila</i>	Effectively Conserved	4.3	10	9.3	Medium
<i>Castilleja puberula</i>	Effectively Conserved	3.1	8	5.8	Endemic
<i>Cirsium perplexans</i>	Weakly Conserved	2.9	5	2.7	Endemic
<i>Cleome multicaulis</i>	Effectively Conserved	3.0	5	5.9	High
<i>Corispermum navicula</i>	Moderately Conserved	4.6	2	6.2	Endemic
<i>Cryptantha gypsophila</i>	Weakly Conserved	4.2	0	3.9	Endemic
<i>Delphinium ramosum</i> var. <i>alpestre</i>	Effectively Conserved	4.1	9	8.2	High
<i>Draba exunguiculata</i>	Moderately Conserved	2.6	8	6.9	Endemic
<i>Draba graminea</i>	Effectively Conserved	3.9	9	7.5	Endemic
<i>Draba smithii</i>	Effectively Conserved	4.2	9	7.8	Endemic
<i>Draba weberi</i>	Under Conserved	0.2	0	0.0	Endemic
<i>Erigeron kachinensis</i>	Effectively Conserved	5.1	5	10.0	Low
<i>Erigeron wilkenii</i>	Moderately Conserved	2.2	9	9.2	Endemic
<i>Eriogonum brandegeei</i>	Weakly Conserved	2.7	2	4.9	Endemic
<i>Eriogonum clavellatum</i>	Under Conserved	1.6	2	2.1	Medium
<i>Eriogonum coloradense</i>	Effectively Conserved	3.2	8	9.7	Endemic
<i>Eriogonum pelinophilum</i>	Under Conserved	2.2	0	1.9	Endemic
<i>Eutrema edwardsii</i> ssp. <i>penlandii</i>	Moderately Conserved	3.4	2	8.2	Endemic
<i>Gaura neomexicana</i> ssp. <i>coloradensis</i>	Weakly Conserved	1.6	5	1.7	Medium
<i>Hackelia gracilentia</i>	Moderately Conserved	2.2	9	6.5	Endemic
<i>Herrickia horrida</i>	Weakly Conserved	2.3	9	0.0	Medium
<i>Ipomopsis aggregata</i> ssp. <i>weberi</i>	Moderately Conserved	2.5	6	6.4	Very High
<i>Ipomopsis globularis</i>	Moderately Conserved	3.7	2	7.7	Endemic
<i>Ipomopsis polyantha</i>	Under Conserved	2.7	0	0.0	Endemic
<i>Lepidium crenatum</i>	Weakly Conserved	3.4	10	1.9	Medium
<i>Lesquerella calcicola</i>	Weakly Conserved	2.4	8	0.9	High
<i>Lesquerella congesta</i>	Weakly Conserved	4.9	0	5.9	Endemic

Table 10, cont.

Scientific Name (State)	Overall Conservation Status	Biodiversity Score	Threats Status Score	Protection Status Score	% Range in CO
<i>Lesquerella parviflora</i>	Under Conserved	4.2	0	2.3	Endemic
<i>Lesquerella pruinosa</i>	Moderately Conserved	3.1	2	5.7	Endemic
<i>Lesquerella vicina</i>	Moderately Conserved	2.5	5	5.2	Endemic
<i>Limnorchis zothecina</i>	Moderately Conserved	2.5	5	10.0	Low
<i>Lomatium concinnum</i>	Weakly Conserved	3.7	2	3.0	Endemic
<i>Lupinus crassus</i>	Weakly Conserved	2.4	2	7.9	Endemic
<i>Lygodesmia doloresensis</i>	Moderately Conserved	2.1	8	4.1	High
<i>Machaeranthera coloradoensis</i>	Effectively Conserved	4.6	9	7.0	High
<i>Mentzelia rhizomata</i>	Weakly Conserved	3.3	2	3.8	Endemic
<i>Mertensia humilis</i>	Weakly Conserved	0.7	10	2.1	Medium
<i>Mimulus gemmiparus</i>	Effectively Conserved	4.2	5	9.9	Endemic
<i>Nuttallia chrysantha</i>	Under Conserved	2.4	2	2.9	Endemic
<i>Nuttallia densa</i>	Moderately Conserved	2.2	6	4.6	Endemic
<i>Oenothera acutissima</i>	Weakly Conserved	2.8	2	3.1	Medium
<i>Oenothera harringtonii</i>	Moderately Conserved	3.0	6	2.3	Endemic
<i>Oonopsis foliosa</i> var. <i>monocephala</i>	Effectively Conserved	4.2	9	6.2	Endemic
<i>Oonopsis puebloensis</i>	Weakly Conserved	3.0	2	1.2	Endemic
<i>Oreocarya osterhoutii</i>	Moderately Conserved	2.8	9	6.0	Low
<i>Oreoxis humilis</i>	Moderately Conserved	5.1	2	6.8	Endemic
<i>Oxybaphus rotundifolius</i>	Weakly Conserved	3.9	2	4.5	Endemic
<i>Oxytropis besseyi</i> var. <i>obnapiformis</i>	Weakly Conserved	2.6	0	4.4	Very High
<i>Penstemon breviculus</i>	Moderately Conserved	2.7	9	6.1	High
<i>Penstemon debilis</i>	Under Conserved	3.4	0	1.3	Endemic
<i>Penstemon degeneri</i>	Moderately Conserved	3.1	2	5.9	Endemic
<i>Penstemon fremontii</i> var. <i>glabrescens</i>	Weakly Conserved	2.7	0	4.6	Endemic
<i>Penstemon gibbensii</i>	Weakly Conserved	4.5	2	4.0	High
<i>Penstemon grahamii</i>	Weakly Conserved	2.2	2	6.3	Low
<i>Penstemon harringtonii</i>	Moderately Conserved	3.6	6	3.2	Endemic
<i>Penstemon penlandii</i>	Weakly Conserved	3.7	2	2.1	Endemic
<i>Penstemon scariosus</i> var. <i>albifluvis</i>	Under Conserved	1.5	2	5.7	Low
<i>Penstemon scariosus</i> var. <i>cyanomontanus</i>	Effectively Conserved	4.1	9	10.0	High
<i>Phacelia formosula</i>	Weakly Conserved	4.3	2	3.1	Endemic
<i>Phacelia submutica</i>	Under Conserved	1.7	2	4.7	Endemic
<i>Physaria bellii</i>	Weakly Conserved	3.0	2	3.3	Endemic
<i>Physaria obcordata</i>	Weakly Conserved	3.8	0	4.8	Endemic
<i>Physaria pulvinata</i>	Weakly Conserved	3.9	0	5.0	Endemic
<i>Physaria rollinsii</i>	Weakly Conserved	1.3	10	2.2	Endemic
<i>Potentilla rupincola</i>	Effectively Conserved	3.9	9	7.2	Endemic
<i>Ptilagrostis porteri</i>	Moderately Conserved	4.0	2	5.9	Endemic
<i>Puccinellia parishii</i>	Moderately Conserved	4.2	5	1.0	Low
<i>Salix arizonica</i>	Moderately Conserved	1.4	6	7.3	Low
<i>Saussurea weberi</i>	Effectively Conserved	3.2	5	6.6	High
<i>Sclerocactus glaucus</i>	Weakly Conserved	2.7	0	3.6	Endemic
<i>Sclerocactus mesae-verdae</i>	Under Conserved	1.9	2	2.0	Low
<i>Sisyrinchium pallidum</i>	Moderately Conserved	2.7	6	3.6	High
<i>Spiranthes diluvialis</i>	Weakly Conserved	2.1	2	4.4	Medium
<i>Telesonix jamesii</i>	Effectively Conserved	3.5	9	6.7	Very High
<i>Thalictrum heliophilum</i>	Weakly Conserved	3.9	2	4.3	Endemic
<i>Townsendia fendleri</i>	Moderately Conserved	2.4	8	4.4	High
<i>Townsendia glabella</i>	Weakly Conserved	2.1	6	1.3	Endemic
<i>Townsendia rothrockii</i>	Effectively Conserved	4.3	8	7.2	Endemic

Figure 27. Number of species in each conservation status category.

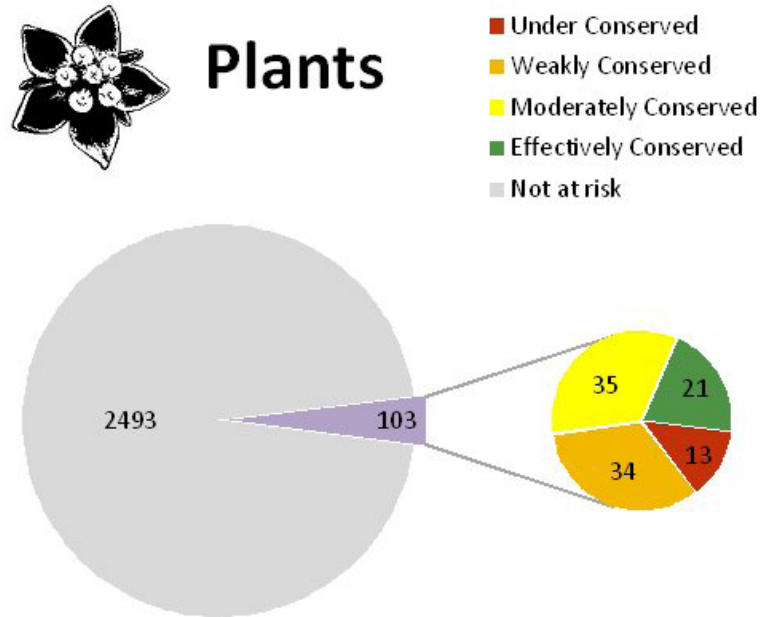


Figure 28. Spatial representation of plant species overall conservation status using point locations for each species. Because the analysis is at the species level, all points for a species are the same color on the map.

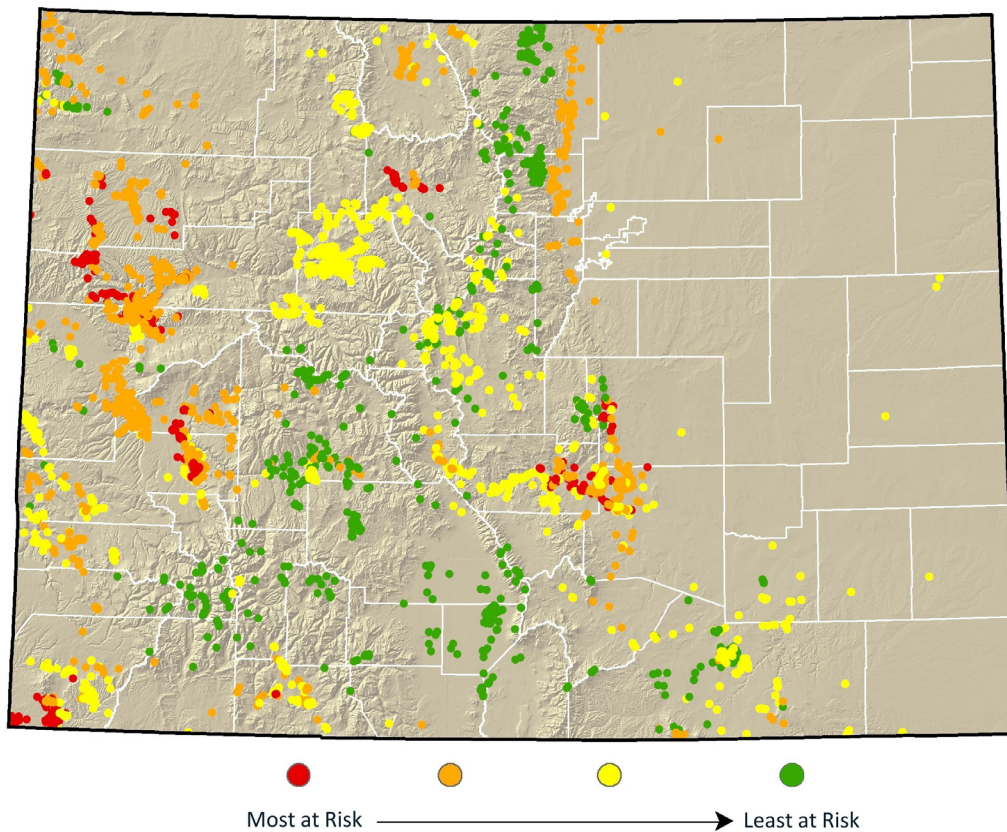
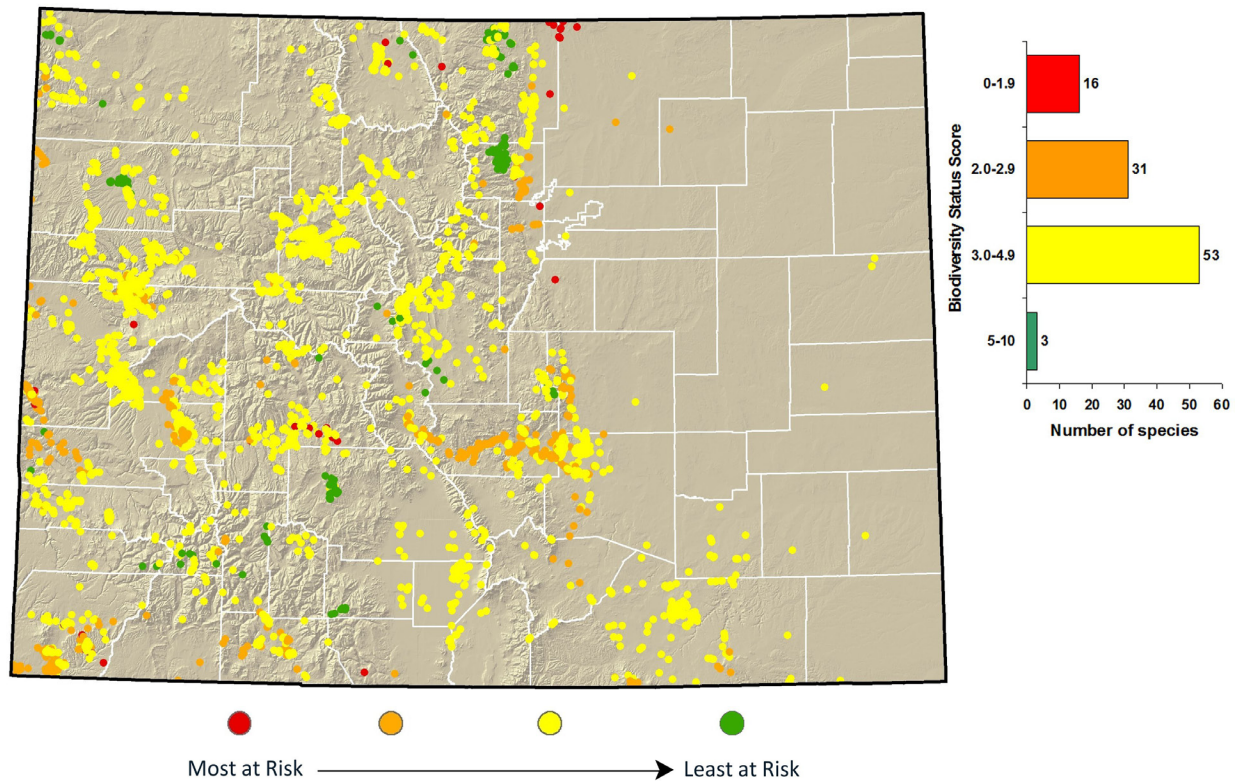
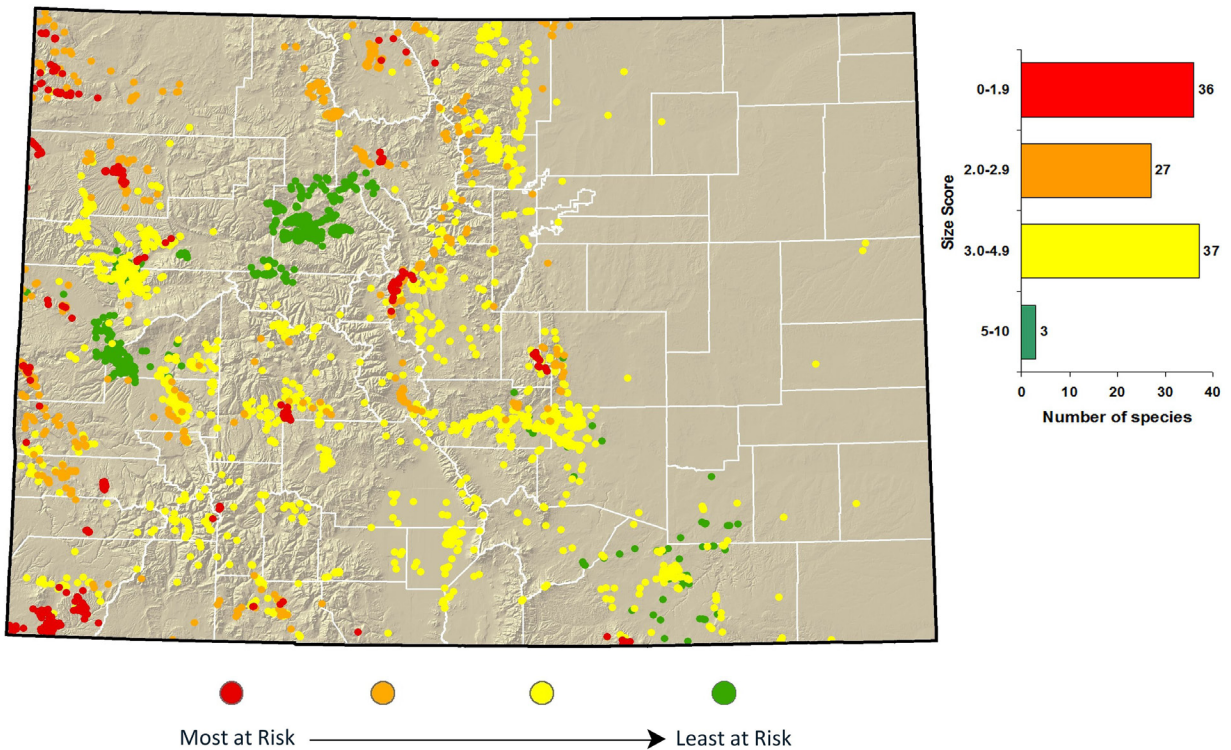


Figure 29. Spatial distribution of plant species occurrences color coded by score. Red = poor; orange = fair; yellow = good; green = very good.

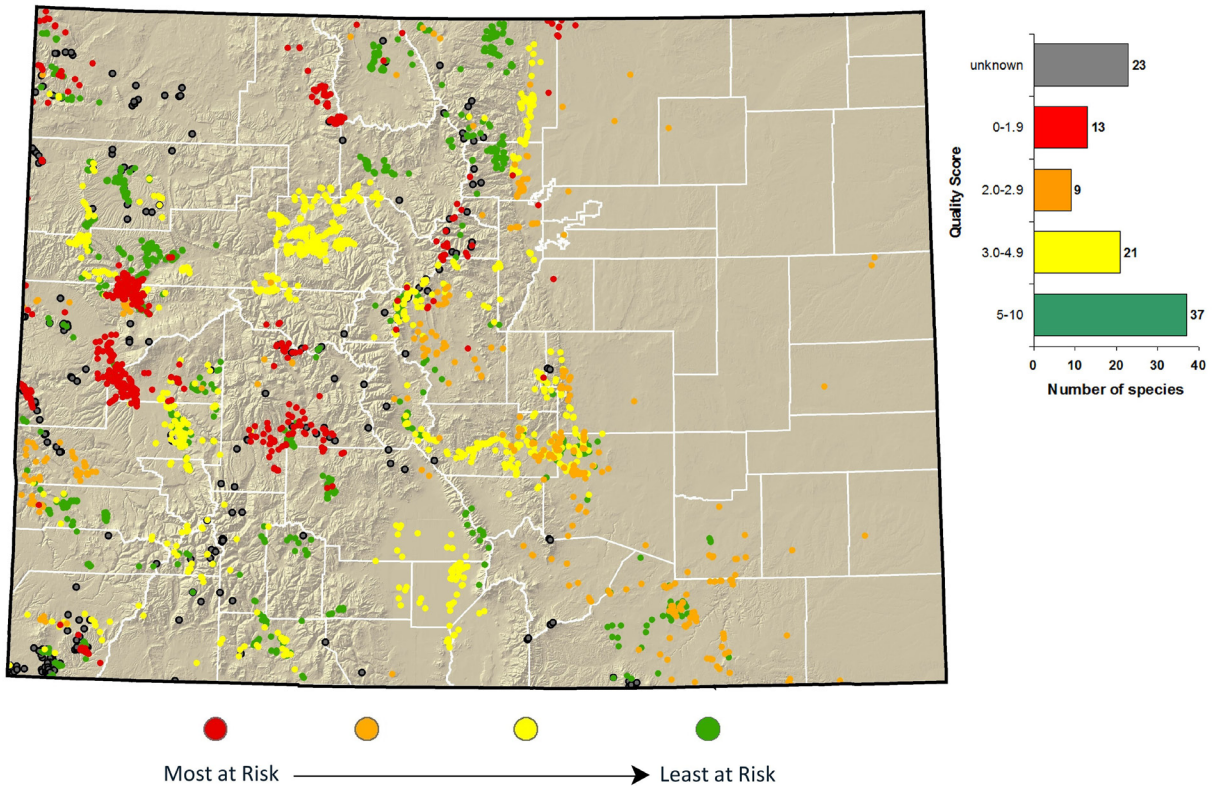
(a) Plant species biodiversity status scores.



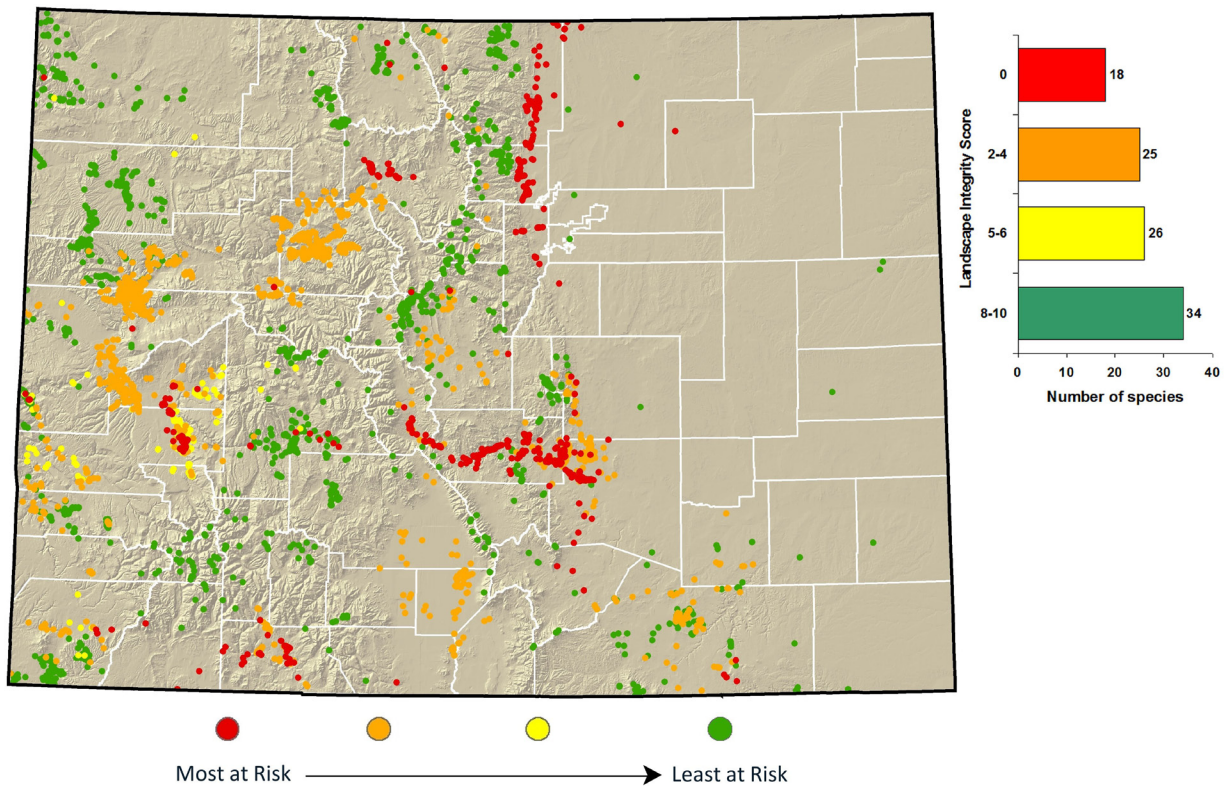
(b) Plant species size scores.



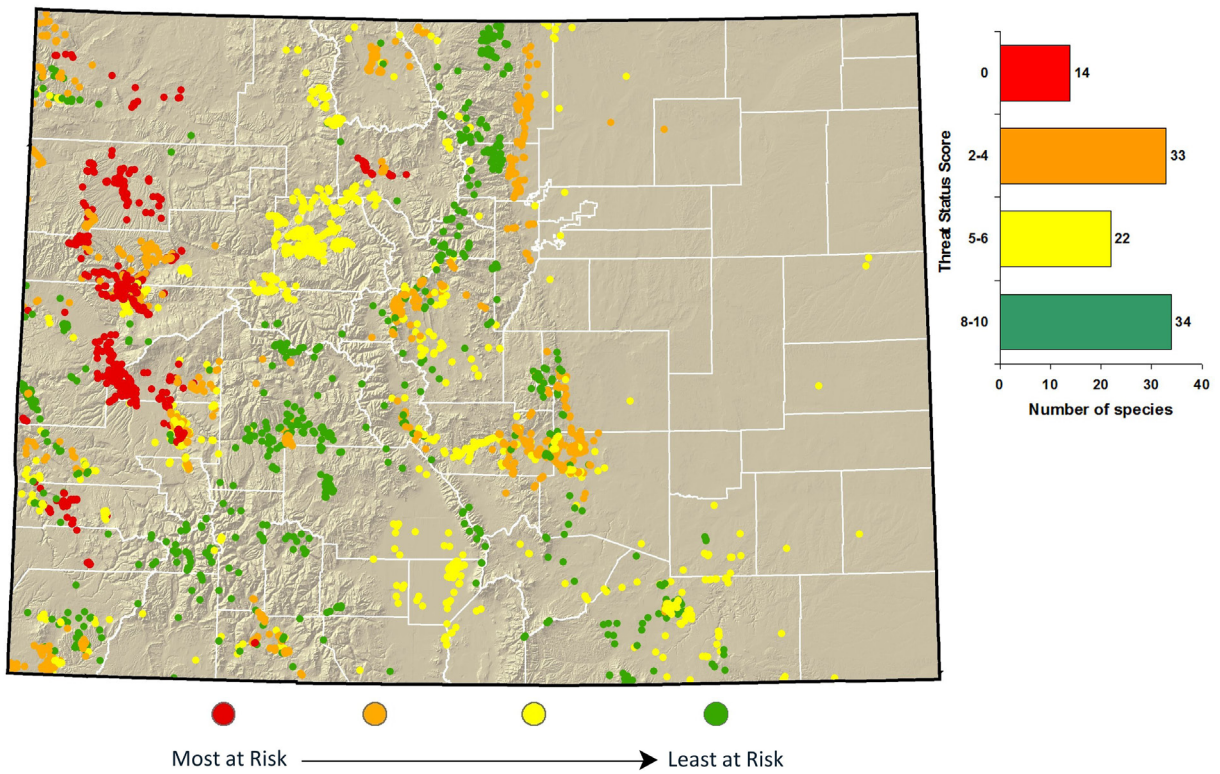
(c) Plant species quality scores.



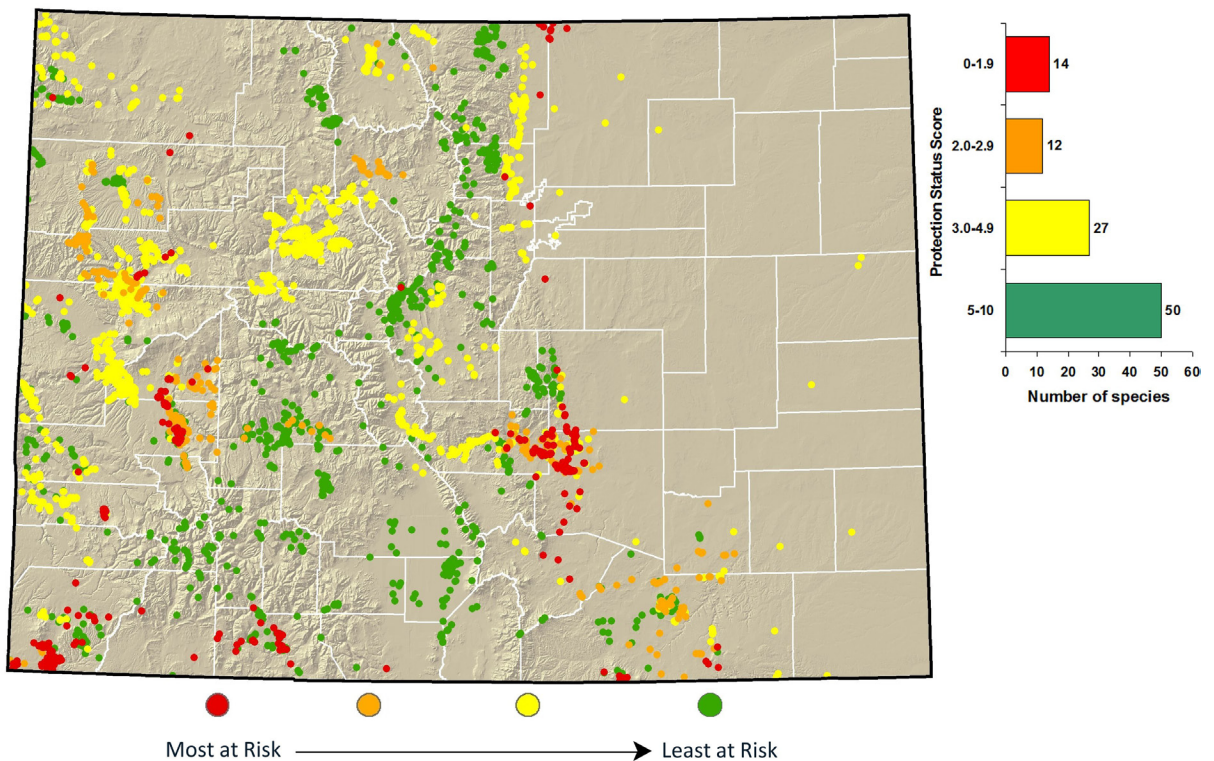
(d) Plant species landscape integrity scores.



(e) Plant species threat status scores.



(f) Plant species protection status scores. Although all points for a species show the same color of the average protection level, the spatial patterns reflect the underlying public and private land ownership in the state.



in higher elevation, public lands with fewer threats, while under to weakly conserved species are found in areas with higher anthropogenic impact.

Results by Habitat Type

Three habitat types accounted for about 60% of the plant species analyzed in our scorecard (Table 11). Of the 46 species with the lowest threat status scores (red or orange, indicating a high level of threat), the majority (72%) are within the barrens and shrubland habitats (Figures 30 and 31).

Alpine habitats account for about 3% of Colorado's landscape and are effectively conserved; the primary threat to Colorado's alpine plants is probably global climate change. Plant species of alpine habitats had poor to fair size scores (Figure 30a), mixed quality scores (Figure 30b), and very good landscape integrity scores (Figure 30d). Biodiversity, threat, and protection status for rare

plants of alpine habitats is generally good to very good (Figure 30d-f).

Barrens occupy less than 1% of Colorado acreage, but support more than 20% of the rarest species. These habitats are typically sparsely vegetated lands often associated with specific geologic substrates such as shale. Barrens plant species were fairly evenly divided between poor, fair, and good scores for size (Figure 30a), had generally good or very good quality scores (Figure 30b), and were about evenly divided between good to very good and poor to fair landscape integrity scores (Figure 30c). Barrens plants had generally poor to fair threat status (Figure 30d). The primary concern for barrens plants are energy development, exurban growth, and motorized recreation, all of which can have direct impacts on the plant species. More than half of these species, however, are in areas with acceptable protection status (Figure 30f).

Cliff and canyon habitats are little threatened, and most occurrences are well protected. This habitat type occupies <1% of Colorado's landscape. Plant species of cliff and canyon habitats generally scored low for size criteria (Figure 30a), but had acceptable quality and landscape integrity scores (Figure 30b and c). In general, biodiversity, threat, and protection status scores for these species are good to very good (Figure 30d-f).

Forest habitats are widespread in Colorado (covering over 20% of the state's acreage), however, few rare plants are found in these habitats. Most rare plants of forest habitats scored low for size and quality of occurrence (Figure 30a and b), and fair to very good landscape integrity (Figure 30c). Biodiversity status is poor, but threats are generally low, and protection very good (Figure 30d-f).

Grassland habitats are a significant part of Colorado's landscape (about 22%), and are generally

Table 11. Number of plant species and threat status scores by primary habitat. The approximate percentage of Colorado's total acreage occupied by each habitat type is shown, together with the number of rare plant species primarily occurring in that habitat, and the number and percentage of those species having a high level of threat).

Habitat	% of Colorado Landscape	Number of Plant Species in Scorecard	Number of species in "most threatened" (red or orange) categories	Percent of species in "most threatened" (red or orange) categories
Barrens	< 1%	24	19	79%
Shrubland	19%	22	15	68%
Wetland	2%	8	3	38%
Pinyon-Juniper	10%	16	5	31%
Forest	21%	4	1	25%
Grassland	22%	4	1	25%
Alpine	3%	12	3	25%
Cliff and Canyon	< 1%	13	0	0%

poorly protected. These habitats, however, also support only a small proportion of Colorado's rare species. Rare plant species of grassland habitats scored good to very good for size (Figure 30a), but were about evenly divided between acceptable (good or very good) and fair quality and landscape integrity scores (Figure 30b and c), resulting in generally good biodiversity status scores (Figure 30d). Threat and protection status for rare grassland plant species are mixed, with about half of species having fair threat status (Figure 30e), and poor to fair protection status (Figure 30f).

Most of Colorado's pinyon-juniper habitats are on public lands, and this habitat type covers nearly 10% of Colorado's landscape. Size scores (Figure 30a) were dominated by poor to fair, but quality scores were generally high (Figure 30b). Landscape integrity scores are about evenly divided between acceptable (good or very good) and poor to fair quality (Figure 30c). A majority of rare plants in pinyon-juniper habitats scored fair to poor for biodiversity status (Figure 30d), but threat and protection status scores were generally good to very good (Figure 30e and f). Although threats to rare species are currently low, the great potential for energy development in the future will require careful planning to avoid impacts to rare plants.

Shrublands are Colorado's second most important habitat for rare plants, and are found on nearly 20% of the state's acreage. Shrubland habitats that support

rare plant species are primarily those dominated by various types of sagebrush. The majority of shrubland rare plant species had low size scores (Figure 30a), although quality scores were generally in the good or very good range (Figure 30b). Landscape integrity scores are dominated by low values (Figure 30c). Consequently, biodiversity status scores are fair to poor for more than half of these species (Figure 30d). These habitats are also highly threatened, and species are vulnerable to both current impacts and future energy development (Figure 30e). Protection status is good to very good for more than half of the species analyzed (Figure 30f).

Wetland habitats account for about 2% of Colorado's landscape. Although relatively few rare plants are associated with wetlands, these habitats are often the most altered. About half of rare wetland plant species scored poor to fair for size, quality, or landscape integrity (Figure 30a-c), with a similar result for biodiversity status (Figure 30d). Threats to wetland species are high and protection is generally poor (Figure 30e and f).

Discussion

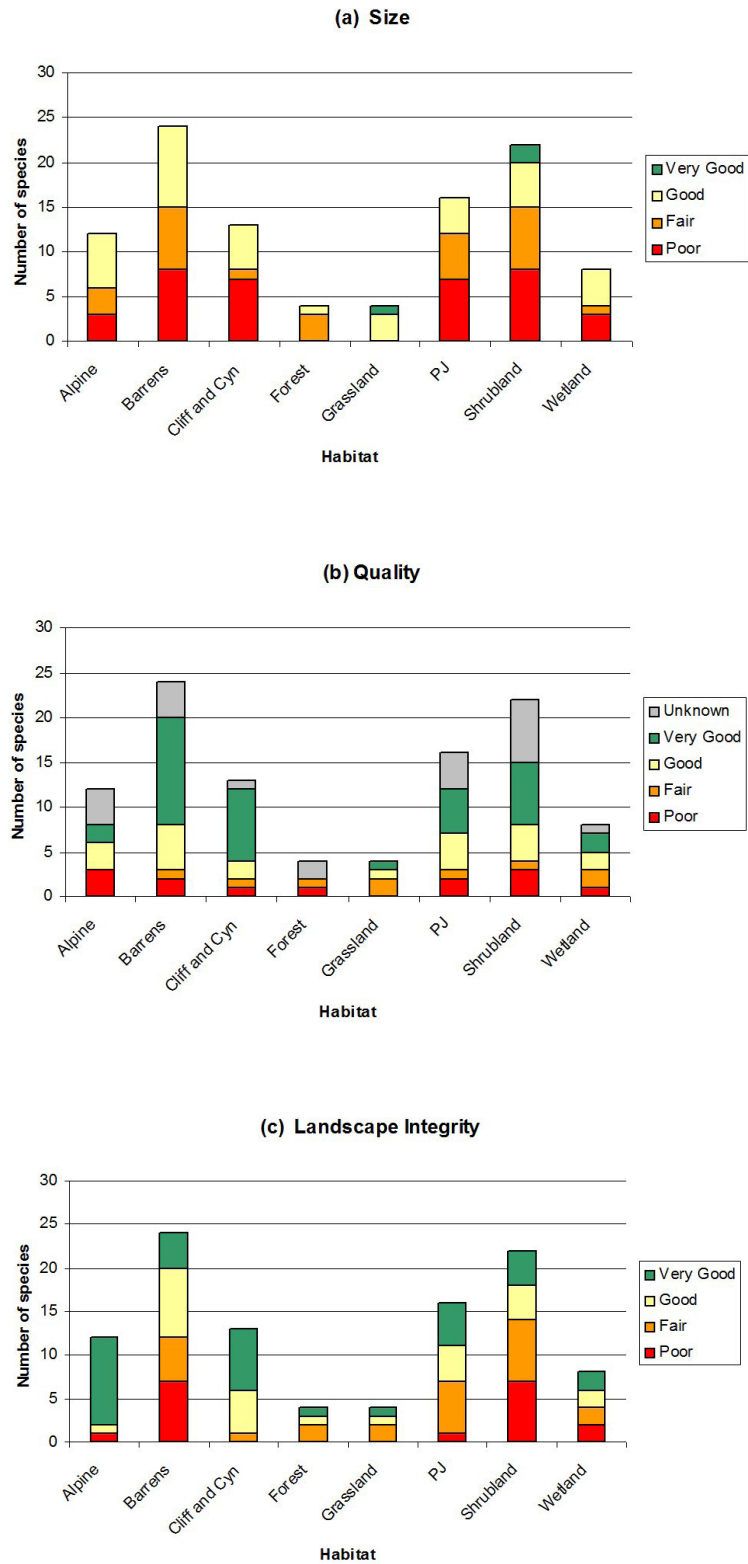
Although our results indicate that many of Colorado's rare plants need more protection, the good news is that because many high quality occurrences are known to exist, there is still time for actions that will ensure effective conservation for these species.

Our analysis also revealed that occurrence quality information for many species needs to be augmented by ongoing survey efforts. Scoring confidence could also be improved with more detailed information on the distribution of rare species whose range overlaps states adjacent to Colorado. Moreover, although many of the rare plants occur within areas that appear to have relatively good landscape integrity, the scale of our analysis was small enough that this may not reflect true landscape-scale effects for a particular occurrence or species. Consequently, field inventory is a priority for many species, both to improve occurrence quality data, and to validate the results of the spatial analysis for landscape integrity and energy development potential.

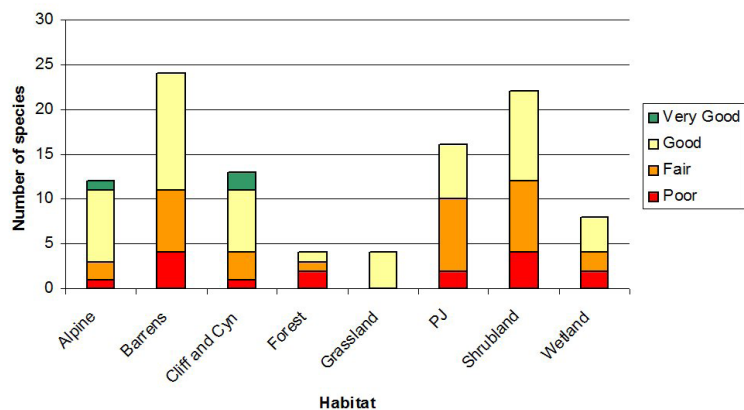
The primary threats to Colorado's rare plants are varied, but the greatest impact is likely to come from a few threat types. One third of Colorado's rare plant species are at risk from resource extraction, motorized recreation, housing and urban development, and roads (Figures 32 and 33).

Non-motorized recreation is the primary threat for the highest number of species (22). The majority of these species scored moderate or low for threats (i.e., have yellow or green scores) for such impacts, usually because the scope of the threat is limited in area.

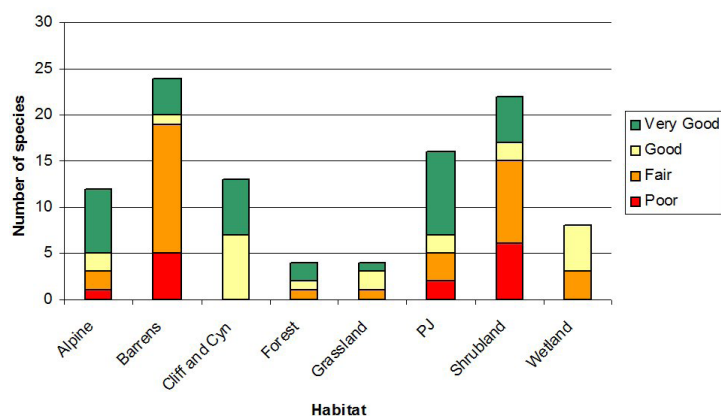
Figure 30. Rare plant scores within habitat type.



(d) Biodiversity Status



(e) Threat status



(f) Protection status

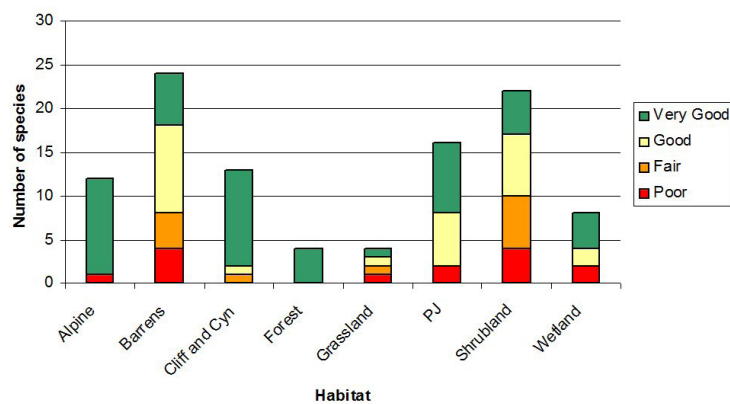
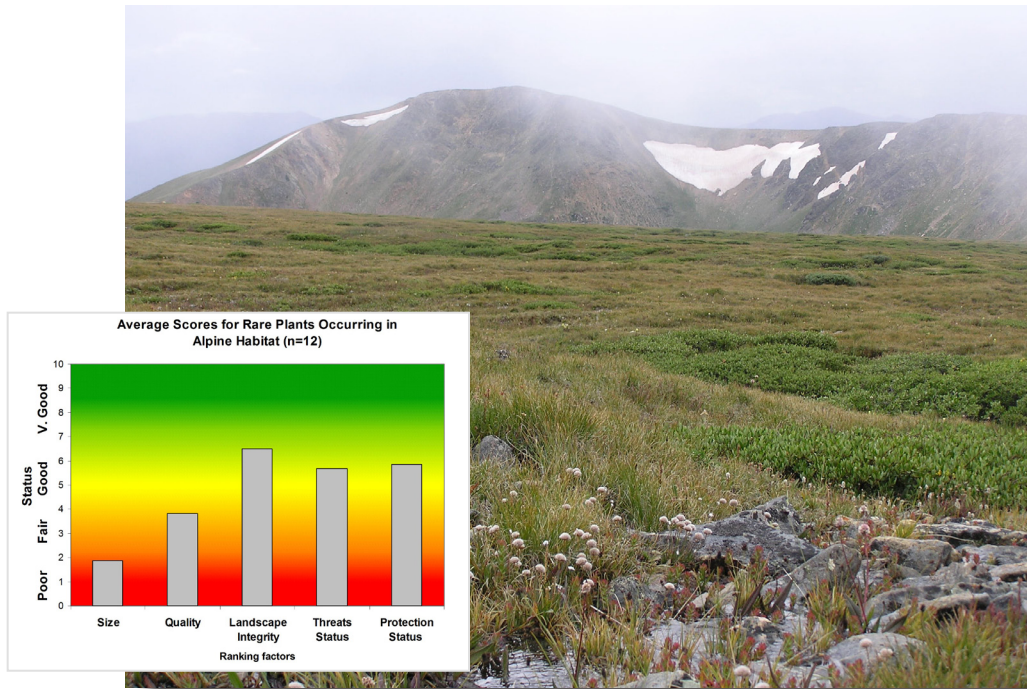
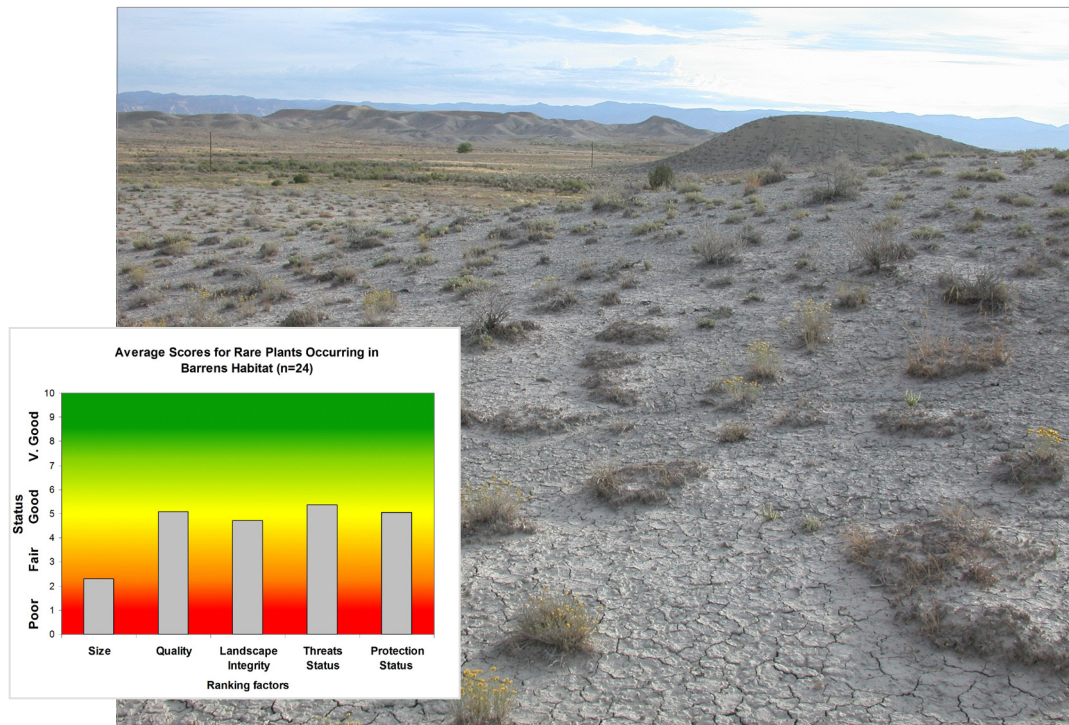


Figure 31. Rare plant habitat types.

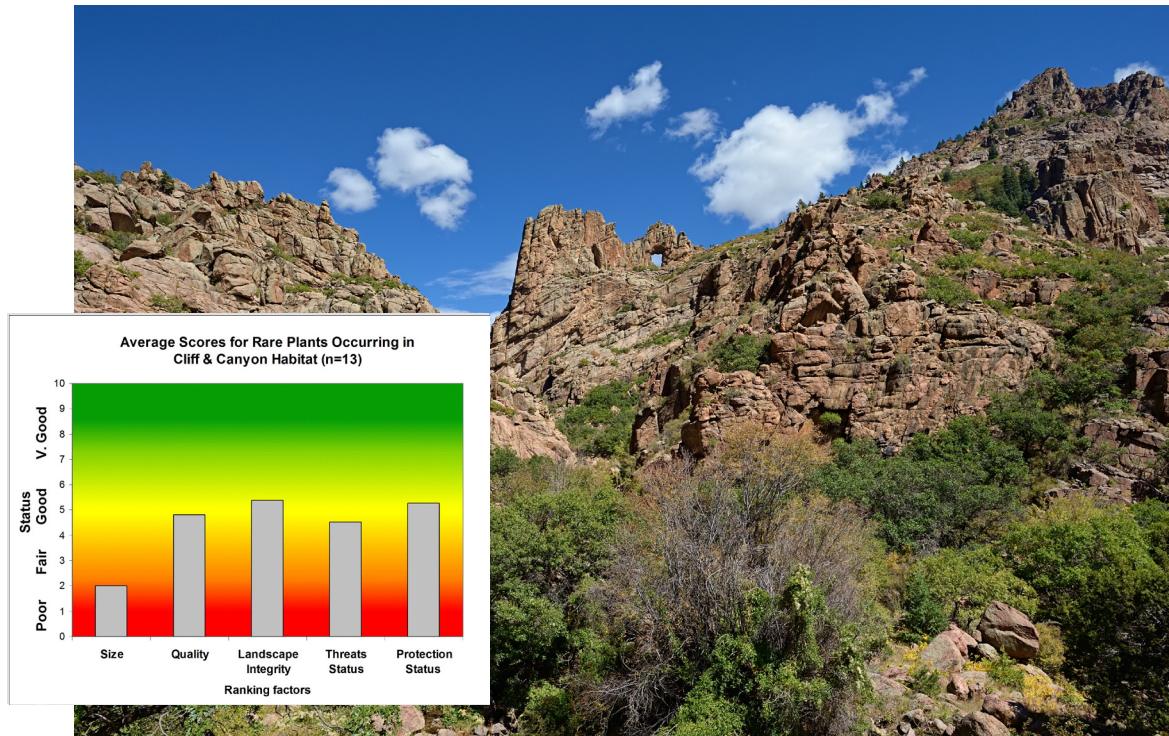
(a) Alpine. Alpine habitats account for about 3% of Colorado's landscape. Alpine habitats are effectively conserved; the primary threat to Colorado's alpine plants is probably global climate change.



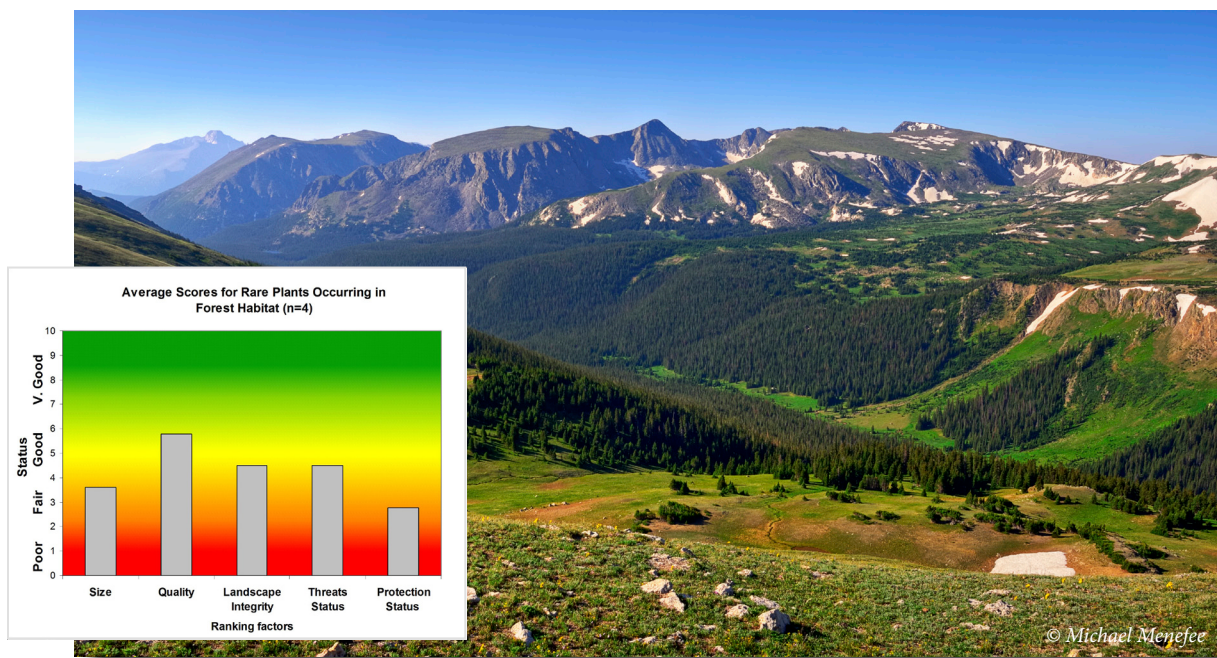
(b) Barrens. Barrens occupy <1% of Colorado, but nearly one in four of our rarest plant species are primarily associated with this habitat type. The primary concern for barrens plants are energy development, exurban expansion, and motorized recreation, all of which can have direct impacts on the species.



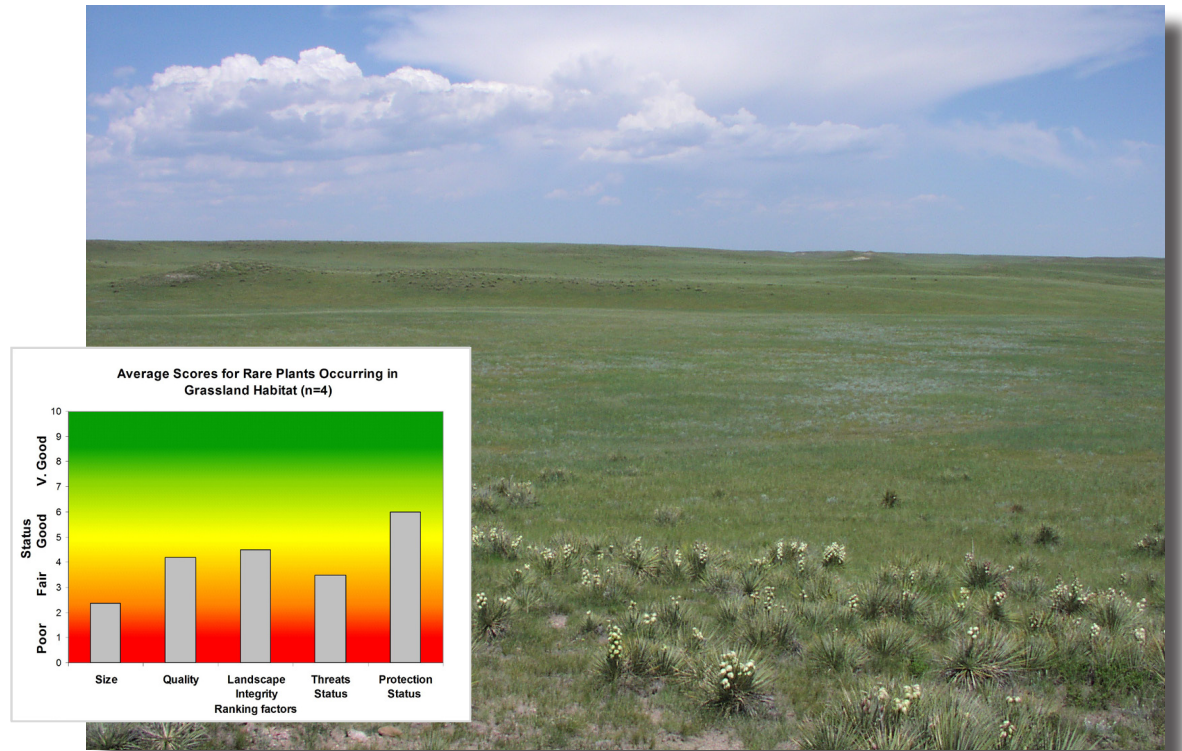
(c) Cliff and Canyon. Cliff and canyon habitats are little threatened, and most occurrences are well protected. This habitat type occupies <1% of Colorado's landscape.



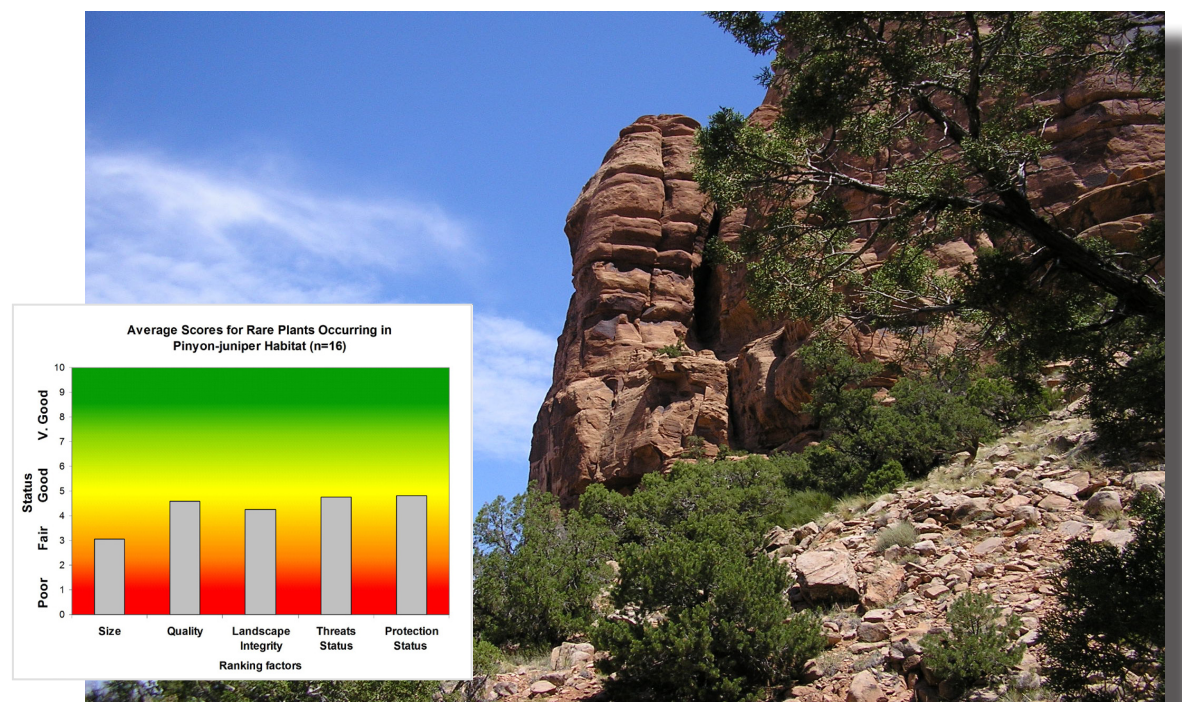
(d) Forests. Although forest habitats are widespread in Colorado (covering over 20% of the state's acreage), few rare plants are found in these habitats. Threats are generally low, but occurrences often have low quality.



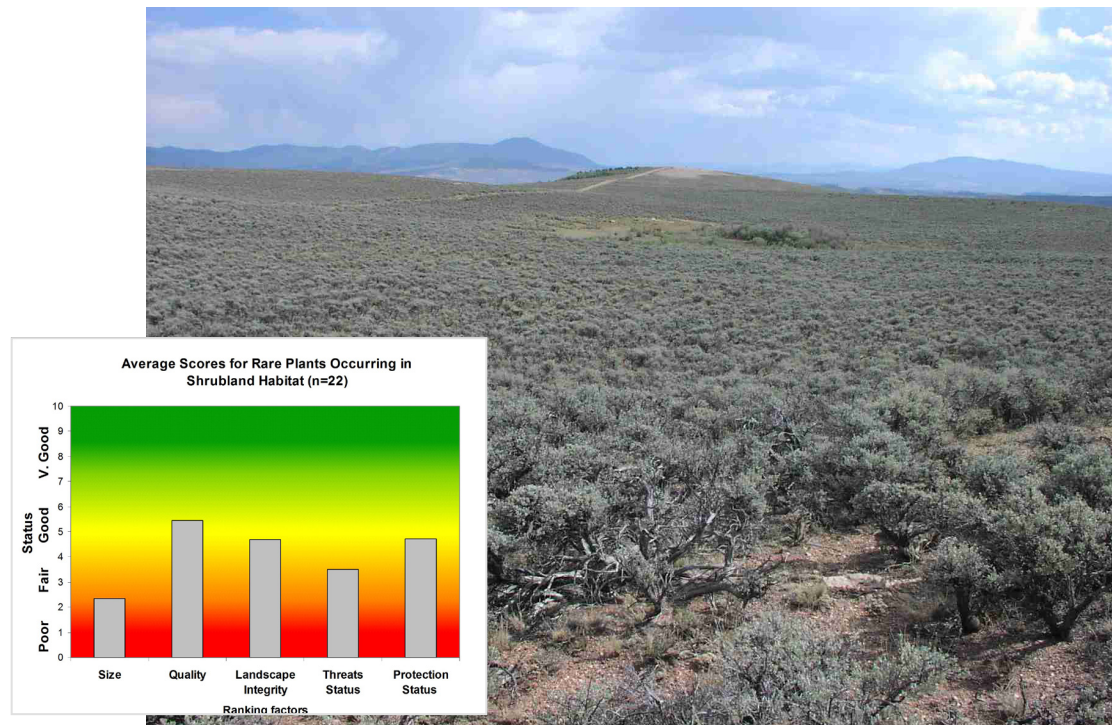
(e) Grassland. Grassland habitats are a significant part of Colorado's landscape (about 22%), and are generally poorly protected. These habitats, however, also support only a small proportion of Colorado's rare species.



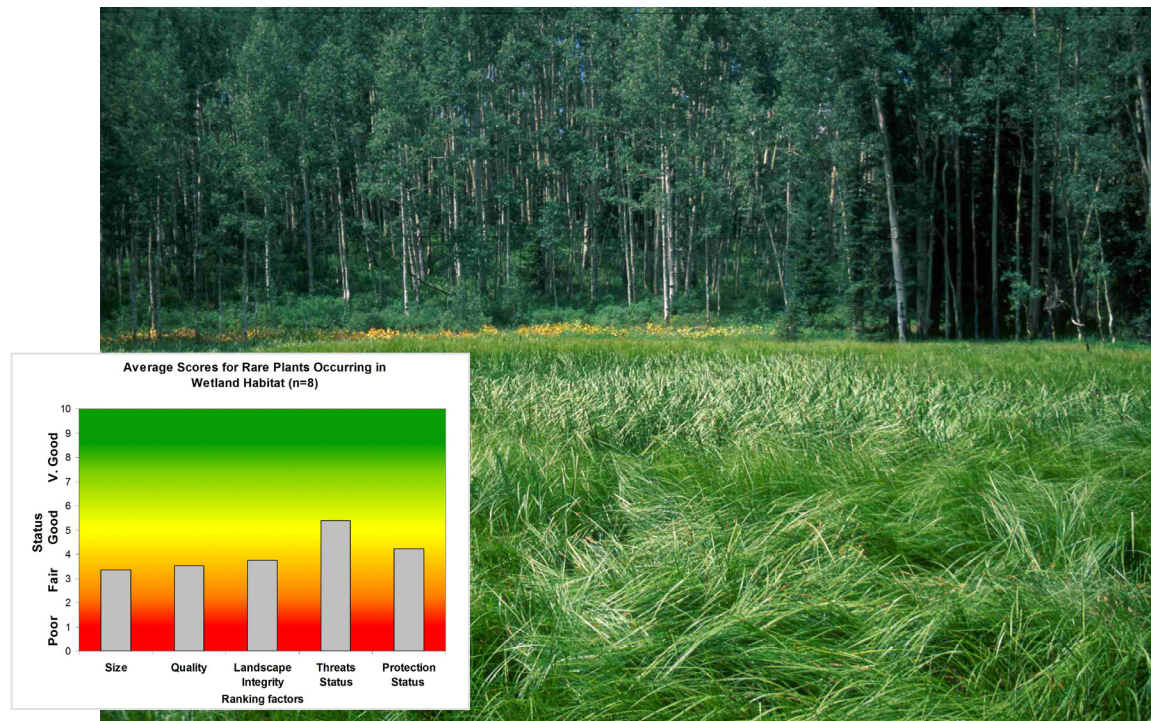
(f) Pinyon-juniper. Most of Colorado's pinyon-juniper habitats are on public lands, and this habitat type covers nearly 10% of Colorado's landscape. Although threats to rare species are currently low, the great potential for energy development in the future will require careful planning to avoid impacts to rare plants.



(g) Shrublands. Shrublands are Colorado's second most important habitat for rare plants, and are found on nearly 20% of the state's acreage. These habitats are also highly threatened, and species are vulnerable to both current impacts and future energy development.



(h) Wetlands. Wetland habitats account for about 2% of Colorado's landscape. Although relatively few rare plants are associated with wetlands, these habitats are often the most altered. Threats to wetland species are high and protection is generally poor.



In contrast, motorized recreation is the primary threat for 13 species, 11 of which have red or orange threat status scores. The overall threat from motorized recreation is therefore greater, typically because it affects a greater proportion of the habitat. Rare plants occurring in the barrens or shrublands habitat types are the most likely to have threat status scores in the red or orange zone (Figure 32), indicating that conservation efforts focused on these habitat types can make the greatest difference for rare species.

Nearly 60% of Colorado's rare plants have received some attention from federal agencies. In addition to the 16 species listed as threatened or endangered under the Endangered Species Act, 32 of the species in this analysis are on the BLM Colorado Office Sensitive Species List, and 23 are on the US Forest Service Region 2 Sensitive Species List. Land ownership patterns in Colorado reflect this situation; federal lands support nearly two-thirds of the well-documented acreage of G1 and G2 (or T1 and T2) species included in this analysis.

Privately-owned lands are also important to the conservation of Colorado's rare plant species, because they encompass over a quarter of the acreage of G1, G2, T1, or T2 species. The protection analysis presented here could be improved by collecting better data for individual occurrences. We currently lack accurate protection information for many occurrences; a more detailed analysis of protection patterns would enable us to correlate protection level and quality for each occurrence, and to focus on identifying the highest quality occurrences needing protection.

Figure 32. Primary threat types for at-risk plant species. Summary of primary threat types, and the number of species most affected by each type. Resource extraction includes oil and gas development, oil shale mining, and other types of mining. Motorized recreation is distinct from other types of recreation, such as hiking, camping, hunting, etc. Roads include both construction of new roads and maintenance of existing rights of way. Agriculture includes development of new tilled areas, and incompatible grazing practices. The Other category includes effects of exotic species or their control, collecting, and herbivory at a level that threatens the entire species.

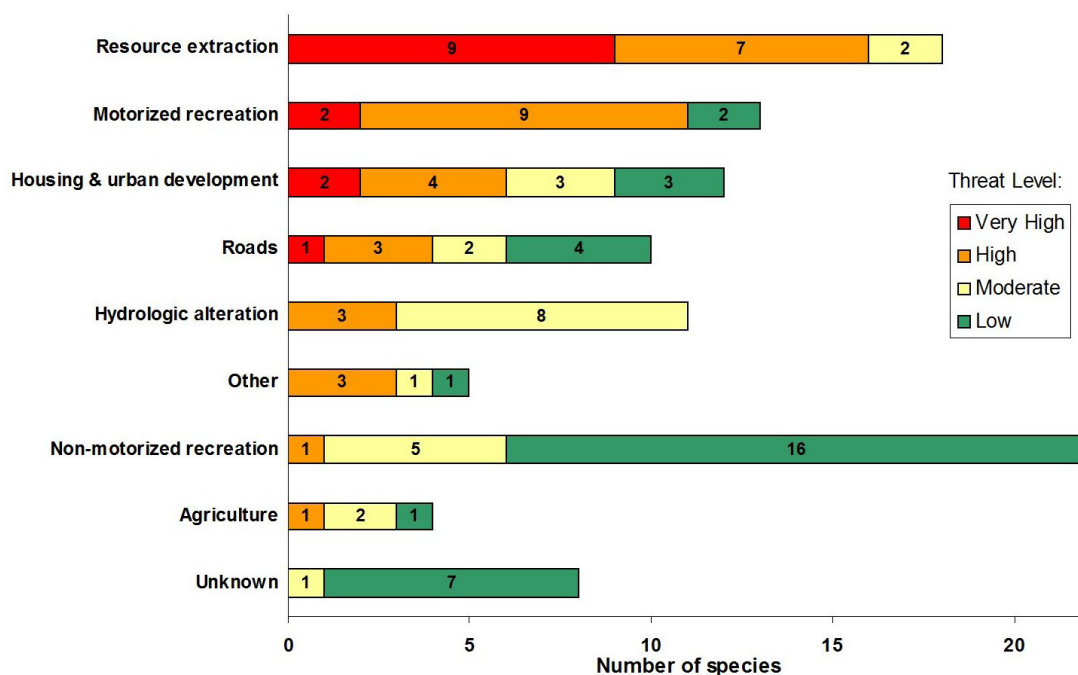
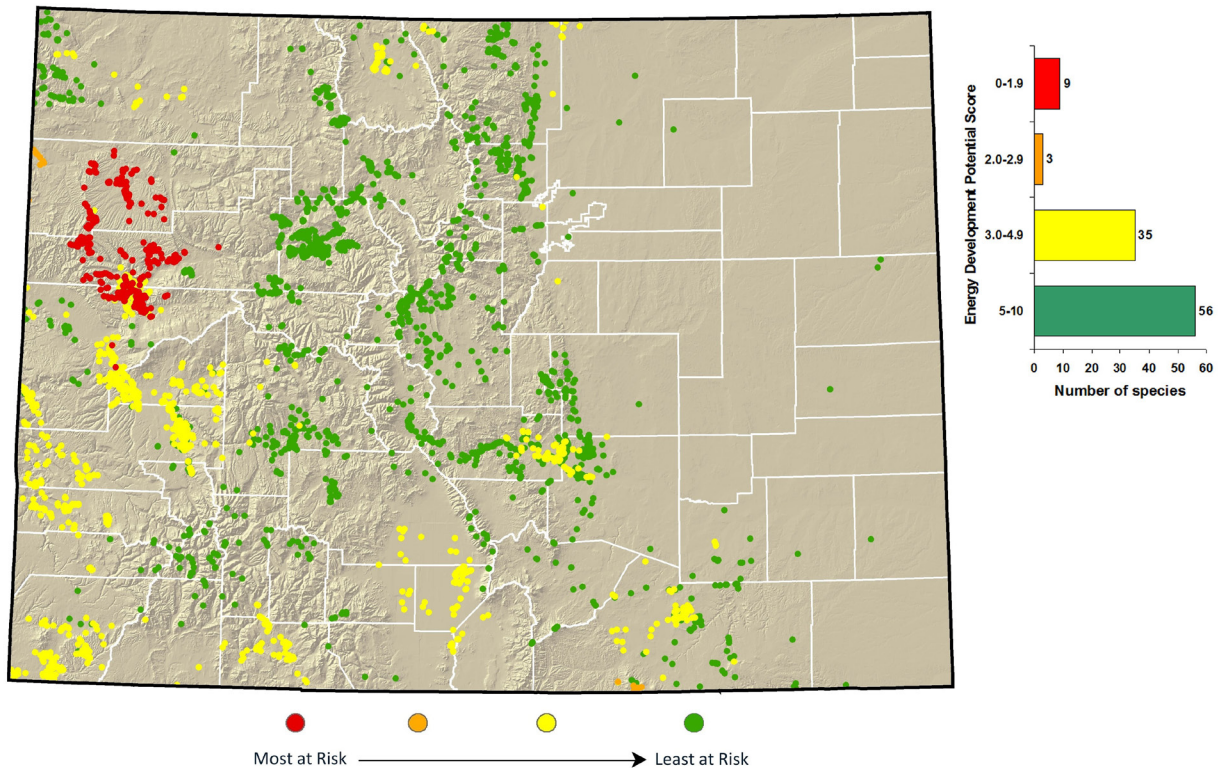


Figure 33. Plant species energy development potential. A high potential threat from energy development is a factor for about 10% of the species analyzed. Note: this map was created for illustrative purposes to highlight the significant issue of energy development in rare plant habitats. These scores were not included in the overall conservation status scores.



On a statewide basis, roughly half of the rare plant species evaluated (all of which are considered imperiled on a global scale) are reasonably well conserved. This also means that approximately half of the rare plant species in our scorecard are inadequately conserved. The future effects of global climate change were not addressed in this evaluation, and are likely to add to the impacts even on species that are currently well conserved. The persistence of high quality occurrences of many these species means that there is still time to act to improve the conservation of rare plant species in Colorado.

Pensetmon penlandii, a plant known from fewer than five occurrences in the world, is primarily threatened by motorized recreation.

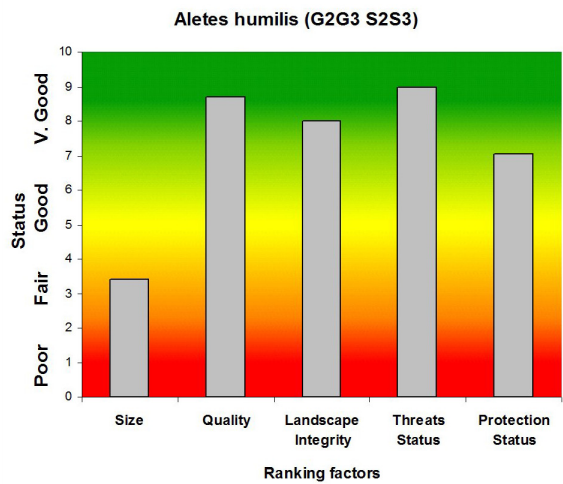
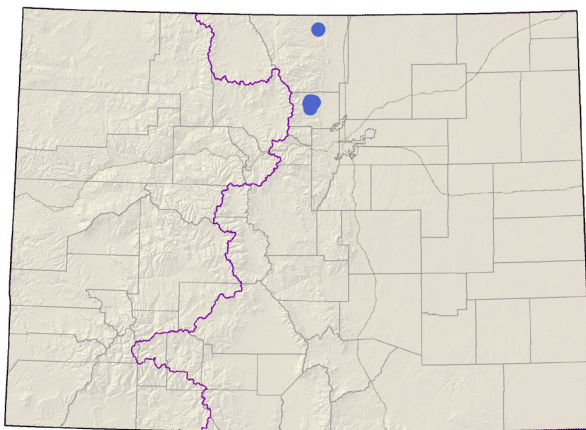


Sample Rare Plant Graphs

EFFECTIVELY CONSERVED
Aletes humilis (G2G3 / S2S3)



Range

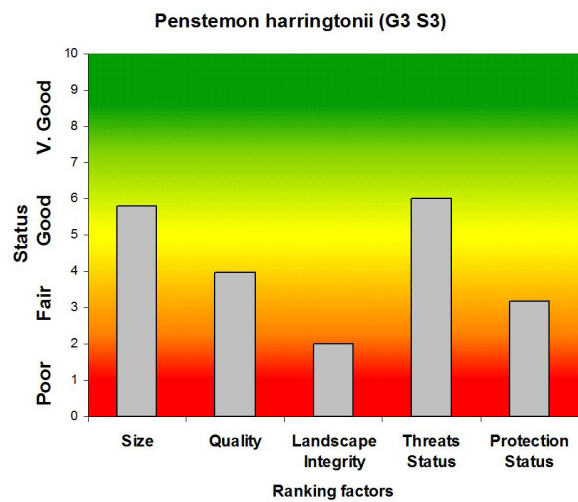
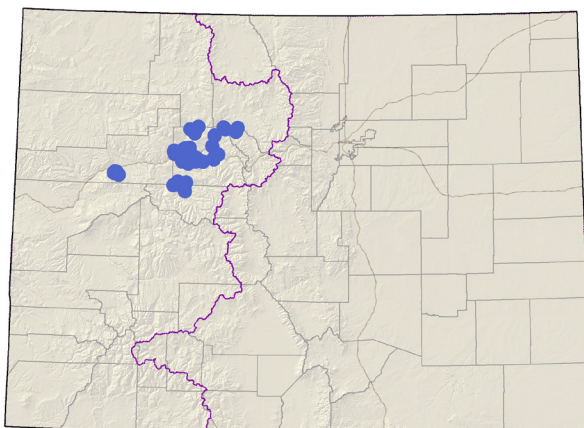


Sample Rare Plant Graphs

MODERATELY CONSERVED
Penstemon harringtonii (G3 / S3)



Range

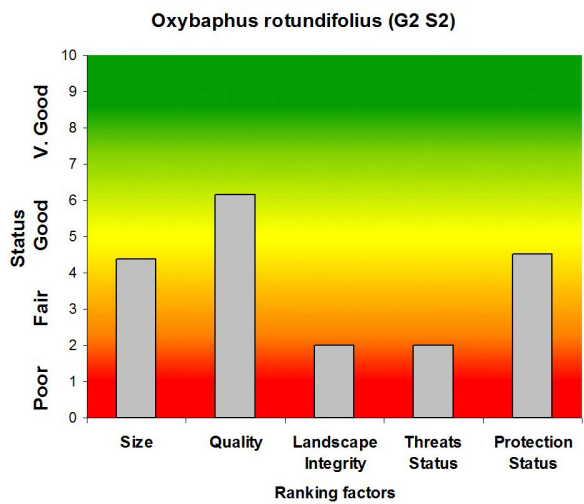
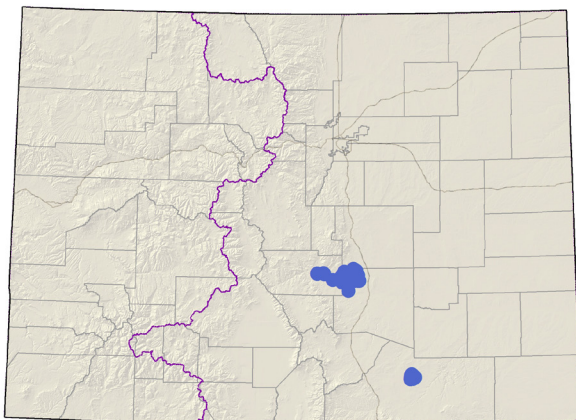


Sample Rare Plant Graphs

WEAKLY CONSERVED
Oxybaphus rotundifolius (G2 / S2)



Range

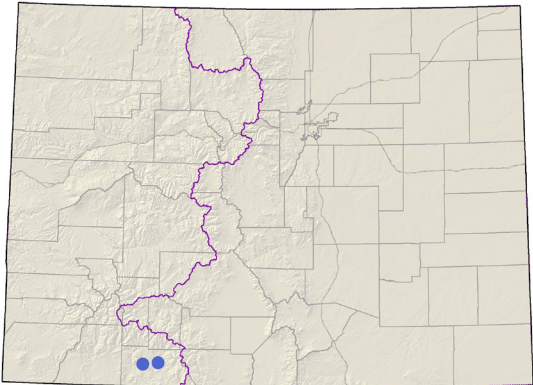


Sample Rare Plant Graphs

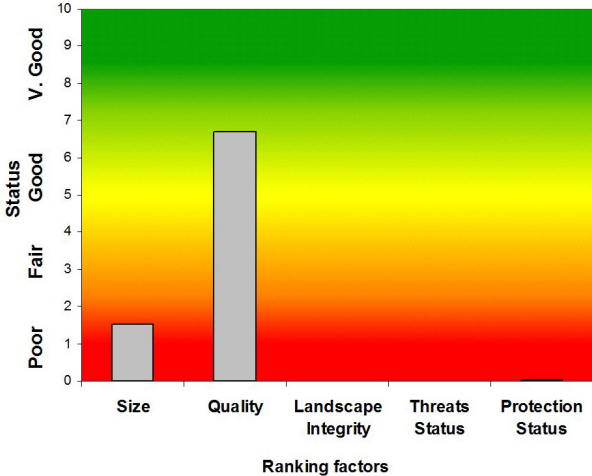
UNDER CONSERVED
Ipomopsis polyantha (G1 / S1)



Range



Ipomopsis polyantha (G1 S1)





GEOGRAPHIC REGION

Colorado can be divided into three primary geographic regions: Eastern Colorado Plains, Colorado Rocky Mountains, and Western Colorado Valleys and Plateaus. Of these three regions, the Eastern Colorado Plains has the least topographic and geologic diversity, which translates into the fewest number of native species of the three regions. By comparison, the Colorado Rocky Mountains and Western Colorado Valleys and Plateaus are rich in topographic relief and geologic substrates, and have a much higher diversity of plant and animal species.

The Eastern Colorado Plains have the highest number of at-risk animal species – 65; compared to Colorado Rocky Mountains (49) and Western Colorado Valleys (52) (Figure 34). The plains also have the highest proportion of its total fauna in some category of conservation concern. The Eastern Colorado Plains is considered

the most species-diverse region in Colorado for amphibians and reptiles, so it isn't surprising that the plains have more amphibians and reptiles of conservation concern than the other regions. Nearly 80% of Colorado's native amphibians and reptiles occur in the eastern plains (Hammerson 1999), as do 45 % of our native fish. Fish distribution across geographic regions is relatively consistent, with 35 % in the Colorado Rocky Mountains and 25% in the Western Colorado Valleys and Plateaus.

With regard to rare plant species, Colorado's Rocky Mountains and Western Valleys and Plateaus are rich with endemic plant species, many of which are of conservation concern. The Colorado Rocky Mountains and Western Colorado Valleys and Plateaus support many species that are highly restricted to small geographic areas. Endemic species are numerous in these regions. By contrast, most of our

grassland plants are widespread and common, with few endemic species known from the eastern plains. Most of the plants of conservation concern on the plains are edaphic species associated with shale and limestone geologic substrates. Most of Colorado's effectively and moderately conserved animal species are in the Colorado Rocky Mountain region (Figure 36). Most of the poorly and weakly conserved plants are in the Western Colorado Valleys and Plateaus and in Eastern Colorado Plains (Figures 35, 37).

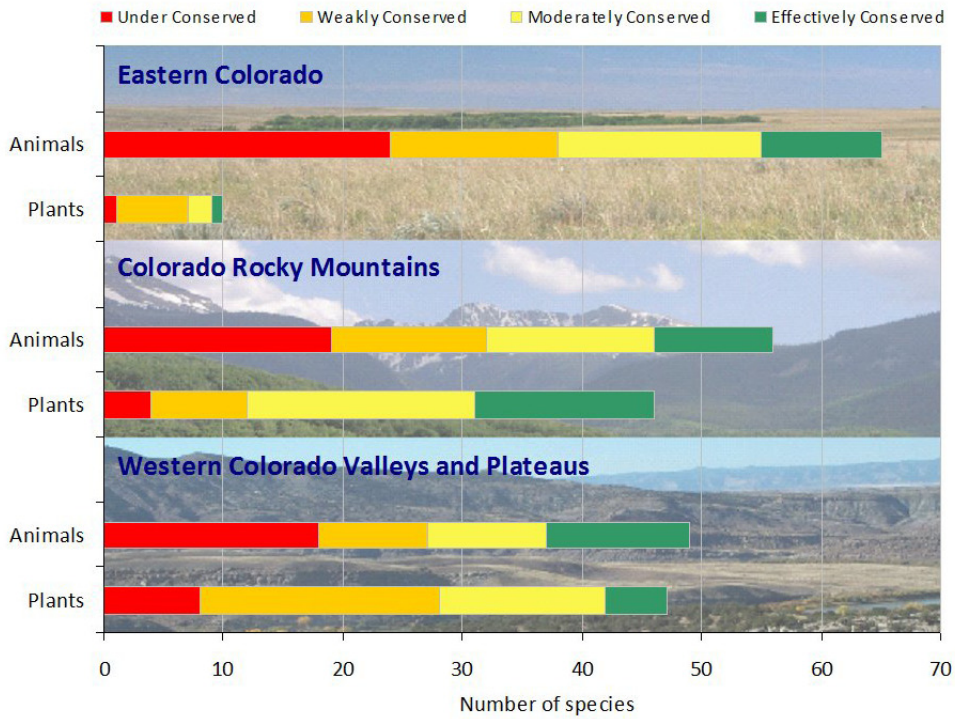
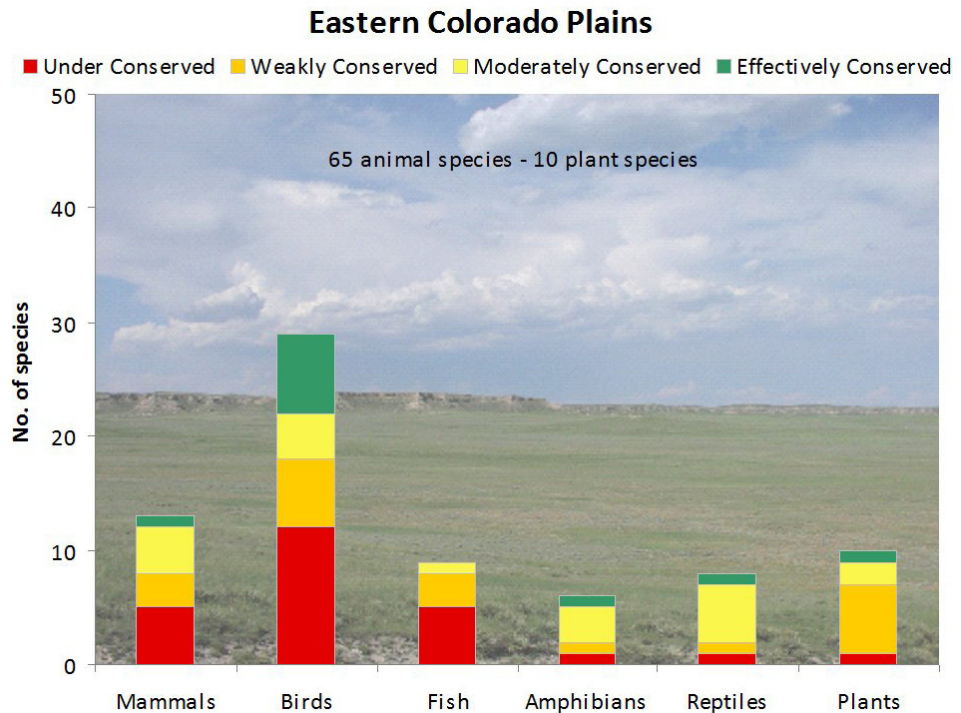


Figure 34. Conservation status for at-risk plants and animals by geographic region.

Figure 35. Conservation status for at-risk plants and animals, by taxonomic group, for Colorado's eastern plains.



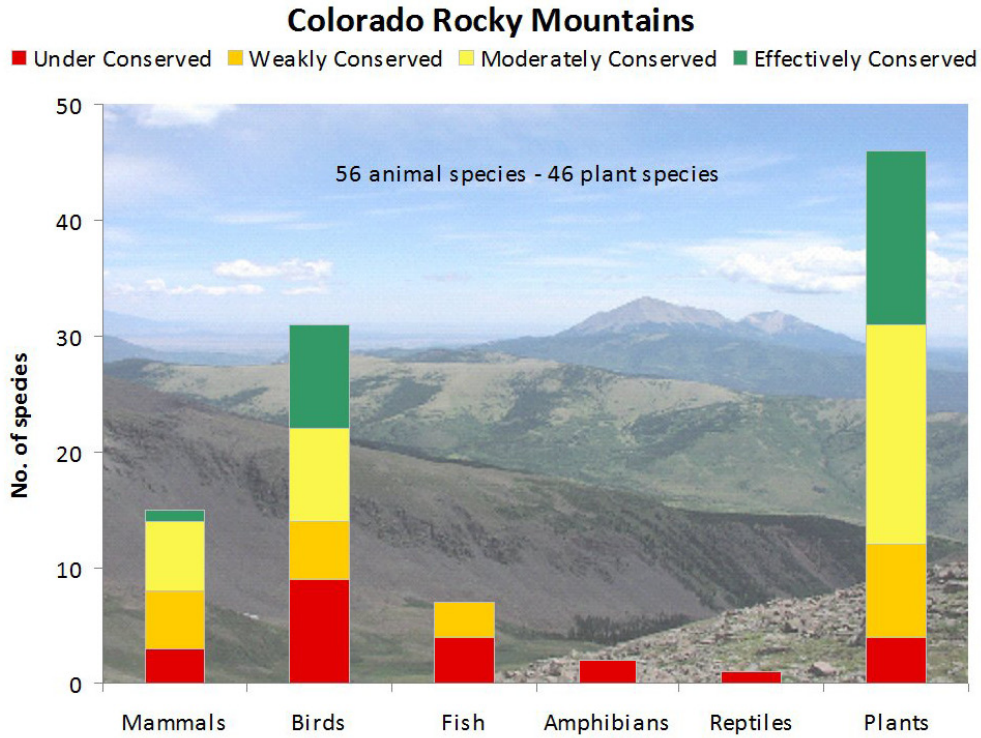
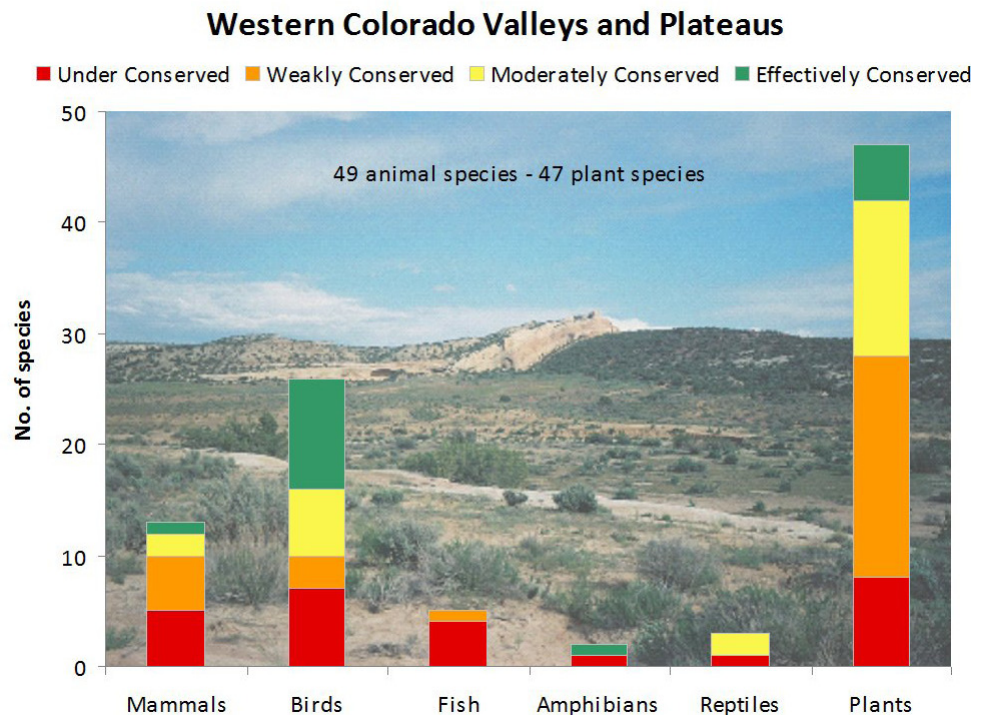


Figure 36. Conservation status for at-risk plants and animals, by taxonomic group, for Colorado's Rocky Mountains.

Figure 37. Conservation status for at-risk plants and animals, by taxonomic group, for Colorado's western valleys and plateaus.





CONCLUSION

The primary purpose of this Scorecard was to present the “state of the state” for Colorado’s biodiversity. We now have a clear picture of which species and ecological systems are most in need of conservation. We have also summarized and understand the primary threats to the systems and species of Colorado, as well as their current level of legal protection.

The development of strategies and actions that the conservation community needs to take to decrease the number of at-risk species and improve their conservation status now need to be discussed and formalized by stakeholders. The information in this report should be valuable to agencies, conservation organizations, private landowners, and others for developing these much-needed conservation strategies.

Common sense is still necessary when interpreting the species scores presented in this document, but we are confident that the information we used was as accurate and as up-to-date as possible. New information is constantly being generated, and this means that the data within this Scorecard need to be continually updated. Nonetheless, we believe that our results can help guide biodiversity conservation efforts in Colorado for the next five to ten years.

Although the goal of this document is to refocus and set new priorities for conservation efforts, the results also present a picture of work yet to be done that is daunting by any standard. While the numbers, graphs, and pictures demonstrate why we need to continue and improve our efforts, the reader should also note the tremendous successes already achieved.

Without the contributions of many dedicated individuals, conservation groups and public agencies from the local to national level, Colorado’s biodiversity – its species and ecosystems – would not be as rich as it is today. The decades-long efforts of all who are dedicated to conserving our biodiversity are apparent in the results of this scorecard. For example, the push to designate and conserve wilderness areas beginning half a century ago led to the high scores of high elevation ecosystems such as spruce-fir forest and alpine tundra. In species conservation, raptors, including the Bald Eagle and Peregrine Falcon, are a notable success story, thanks to ongoing efforts to change policies and preserve both individuals and their habitats. Furthermore, a number of our rarest plants have clearly benefited from local and regional conservation efforts, including the Larimer aletes in the Laramie Foothills,

the slender spiderflower in the San Luis Valley, and a number of high elevation species that are primarily found in wild areas, such as the Colorado Buckwheat. These successes underscore the importance of holding ourselves, the conservation community, and the citizens of Colorado to a high standard. Our biodiversity is rich and loved by residents and visitors alike – it is the fabric that supports us in both good and bad times. Colorado has developed a strong conservation ethic and this report is an important map to guide our future efforts. The information in this report tells us how well we have done in the past, as well as pointing out where we need to redouble our efforts.

We recommend updating this Scorecard every five years, including a revised summary report issued every five to ten years. This will allow the State to monitor trends in the conservation status of its species, habitats, and ecological systems over time. We hope that government agencies, non-governmental organizations, and researchers who have new information on Colorado's imperiled species and systems will share their data with CNHP so that we can maintain the database and improve the efficiency of generating future Scorecards.

Colorado is blessed in that it still retains a relatively intact natural landscape, and the beauty of this landscape entices many people to visit and live in the state. Population estimates for future

years are significantly higher than we currently have; with this increasing human population will undoubtedly come an increase in our human footprint. The unfortunate fact of an increasing population is that it will increase threats to some species' survival. We believe that with good planning, education, and adequate funding, it will be possible to protect and manage Colorado's unique biodiversity features. This work will take a concerted effort on the part of scientists, conservation biologists, policy makers, and funders – not to mention the will of the people.

Today we know that roughly 80% of our species are doing well, with the exception of fish and amphibians, and we hope that with continued conservation action we can improve these scores. Wetlands and other aquatic habitats, grasslands, shrublands, and barren landscapes are high priority habitats for immediate conservation attention,

including protection, restoration, and management. On-going maintenance of our forest and alpine systems is also needed, especially in the face of climate change.

Climate change is one of the big unknowns in this status report, but we know that it will change our ecological systems. We would like to conduct climate change vulnerability assessments and other climate-related analyses for many of our at-risk species and ecological systems. These analyses will be crucial to revising the picture of Colorado's biodiversity health and stability into future years. We hope our conservation partners will join with us in this effort for the next iteration of this Scorecard.

We welcome suggestions on how to improve this document for the next update, and hope that it will be used to drive the conservation strategies that keep Colorado colorful.



© Michael Menefee

Colorful Colorado!

REFERENCES

Anderson, M., P. Comer, D. Grossman, C. Groves, K. Poiani, M. Reid, R. Schneider, B. Vickery, and A. Weakley. 1999. Guidelines for Representing Ecological Communities in Ecoregional Plans. The Nature Conservancy. 71 pp.

BLM. 2006. Map of Oil Shale and Tar Sands Deposits in the Three-State Area. Oil Shale and Tar Sands Leasing Programmatic EIS Information Center. <http://ostseis.anl.gov/guide/maps/index.cfm>.

BLM. 1998. State of Colorado maps for Oil and Gas Potential Map, Coal Mineral Potential, and Areas Favorable for Uranium and Vanadium in Colorado.

CDOT. 2006. GIS dataset of public highways that are maintained by and under the jurisdiction of the Colorado Department of Transportation. Colorado Department of Transportation, Denver, Colorado.

CDOW. 2006. Colorado's Comprehensive Wildlife Conservation Strategy. http://wildlife.state.co.us/NR/rdonlyres/D26A4806-8776-4460-831E-AA654EC7DDED/0/CWCS_FinalReport2006.pdf

Colorado Natural Heritage Program. 2005a. Ecological System Descriptions and Viability Guidelines for Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program. 2005b. Historic shortgrass component for the Central Shortgrass Prairie. GIS dataset. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Colorado Natural Heritage Program. 2007. Generalized pre-settlement distribution of ecological systems in Colorado. GIS dataset. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO. Colorado Natural Heritage Program. 2008. Biodiversity Tracking and Conservation System (BIOTICS). Colorado State University, Fort Collins, Colorado.

- Duncan, B.W., V.L. Larson, and P.A. Schmalzer. 2000. Modeling historic landcover: an evaluation of two methodologies for producing baseline reference data. *Natural Areas Journal* 20:308-316.
- Dutton, I. and D. Salzer. 2005. Our Conservation Measures Framework. Briefing for The Nature Conservancy Science Council Meeting September 21, 2005.
- Ervin, J. 2003. Protected area assessments in perspective. *BioScience* 53:819-822.
- Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. *Mammals of Colorado*. Denver Museum of Natural History and University Press of Colorado, Niwot, Colorado. 467pp.
- H. John Heinz III Center for Science, Economics, and the Environment. 2002. *The state of the nation's ecosystems : measuring the lands, waters, and living resources of the United States*. Cambridge University Press, Cambridge, UK and New York, New York.
- Hammerson, Geoff. 1999. *Amphibians and Reptiles in Colorado: a Colorado field guide (Second Edition)*. University Press of Colorado and Colorado Division of Wildlife, Denver, Colorado. 484pp.
- Harwell, M.A., V. Myers, T. Yound, A. Bartuska, N. Gassman, J.H. Gentile, C.C. Harwell, S. Appelbaum, J. Barko, B. Causey, C. Johnson, A. McLean, R. Smola, P. Templet, and S. Tosini. 1999. A framework for an ecosystem integrity report card. *BioScience* 49:543-556.
- M. Hoffmann, C. Hilton-Taylor, A. Angulo, M. Böhm, T.M. Brooks, S.H.M. Butchart, et al. 2010. The impact of conservation on the status of the world's vertebrates. *Science* 10: Vol. 330 no. 6010 pp. 1503-1509.
- Kaplan, R.S. and D.P. Norton. 1992. The balanced scorecard – measures that drive performance. *Harvard Business Review* Jan-Feb, pp.71-79.
- Kingery, H.E. 1998. *Colorado Breeding Bird Atlas*. Colorado Bird Atlas Partnership and Colorado Division of Wildlife, Denver, Colorado. 636 pp.
- Lomolino, M.V. and R. Channell. 1995. Splendid isolation: patterns of geographic range collapse in endangered mammals. *J. of Mammalogy* 76: 335-347.
- Merrill, E.V., Kohley, T.H., Herdendorf, M.E., Reiners, W.A., Driese, K., Marrs, R., Anderson, S., 1996. *The Wyoming Gap Analysis project final report*. Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie, Wyoming.
- NatureServe. 2002. *Element Occurrence Data Standard*. NatureServe, in cooperation with the network of Natural Heritage Programs and Conservation Data Centers. <http://www.natureserve.org/prodServices/eodata.jsp>
- NatureServe. 2003. *Working Classification of Terrestrial Ecological Systems in the Coterminous United States*. International Terrestrial Ecological Systems Classification. NatureServe, Arlington, VA. 61 pp. + appendices. <http://www.natureserve.org/library/usEcologicalsystems.pdf>

- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. <http://www.natureserve.org/explorer>
- Nesler, T. 2003. Native and introduced fish species by major river basins in Colorado. Colorado Division of Wildlife, Denver, Colorado.
- North American Bird Conservation Initiative, U.S. Committee, 2011. The State of the Birds. 2011 Report on Public Lands and Waters. U.S. Department of Interior: Washington, D.C. 48 pp.
- Parrish, J.D., D.P. Braun, and R.S. Unnasch. 2003. Are we conserving what we say we are? Measuring ecological integrity within protected areas. *BioScience* 53:851-860.
- Paul, J.F. 2003. Developing and applying an index of environmental integrity for the US Mid-Atlantic region. *Journal of Environmental Management* 67:175-185.
- Rondeau, R. 2001. Ecological Systems Viability Specifications for Southern Rocky Mountains Ecoregion. Colorado Natural Heritage Program, Fort Collins, Colorado.
- Schrupp, D.L., W.A. Reiners, T.G. Thompson, L.E. O'Brien, J.A. Kindler, M.B. Wunder, J.F. Lowsky, J.C. Buoy, L. Satcowitz, A.L. Cade, J.D. Stark, K.L. Driese, T.W. Owens, S.J. Russo, and F. D'Erchia. 2001. Colorado Gap Analysis Program: A geographic approach to planning for biological diversity. USGS/BRD Gap Analysis Program and Colorado Division of Wildlife, Denver, Colorado.
- Stein B.A and F.W. Davis. 2000. Discovering life in America: Tools and techniques of biodiversity inventory. Pages 19–53 in Stein BA, Kutner LS, Adams JS, eds. *Precious Heritage: The Status of Biodiversity in the United States*. Oxford University Press, Oxford, U.K.
- Stein, B.A., L.S. Kutner, J.S. Adams. 2000. *Precious Heritage. The Status of Biodiversity in the United States*. Oxford University Press, New York, New York.
- Supples, C., J. Higgins, C. Conboy, S. Farone, J. Fisher, and T. Guthrie. 2007. United States Conservation Management Status Project: Framework and Methods. Version 1. The Nature Conservancy, Boulder, Colorado. 23 pp.
- Theobald, D.M. 2003. Targeting Conservation Action through Assessment of Protection and Exurban Threats. *Conservation Biology* 17:1624-1637.
- Theobald, D. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. *Ecology and Society* 10:32.
- Thompson, B.C., P.J. Crist, J.S. Prior-Magee, D. Garber, and M. Hughes. 1998. Gap Analysis of Biological Diversity Conservation in New Mexico Using Geographic Information Systems. New Mexico Cooperative Fish and Wildlife Research Unit, Las Cruces, New Mexico.
- Tinker, D.B., C.A.C. Resor, G.P. Beauvais, K.F. Kipfmüller, C.I. Fernandes, and W.L. Baker. 1998. Watershed analysis of forest fragmentation by clearcuts and roads in a Wyoming forest. *Landscape Ecology* 13:149-165.
- TrueWind Solutions/National Renewable Energy Laboratory. 2003. Colorado wind resources at 50m above ground level dataset. National Renewable Energy Laboratory, Golden, Colorado.

USDA Forest Service. 2007. LANDFIRE Fire Regime Condition Classes (FRCC) dataset. USDA Forest Service Fire Science Laboratory, Rocky Mountain Research Station, Missoula, Montana. <http://gisdata.usgs.net/website/landfire/>
USDA Soil Conservation Service. 1994. State Soil Geographic (STATSGO) data base for Colorado. U.S. Department of Agriculture, Soil Conservation Service, Fort Worth, Texas.

USGS National Gap Analysis Program. 2004. Provisional Digital Land Cover Map for the Southwestern United States. Version 1.0. RS/GIS Laboratory, College of Natural Resources, Utah State University.

Vale, T.R. 2002. The pre-European landscape of the United States: pristine or humanized. Pages 1-39 in *Fire, Native Peoples, and the Natural Landscape*, T.R. Vale ed. Island Press, Washington, D.C.

Veblen, T.T. and J.A. Donnegan. 2005. Historical range of variability for forest vegetation of the national forests of the Colorado Front Range. Report prepared for the USDA Forest Service. University of Colorado, Boulder, Colorado.

Weber, W.A., and R.C. Wittmann. 2001. *Colorado Flora*. University Press of Colorado, Niwot, Colorado.

Wilcox, G., D.M. Theobald, and J. Whisman. 2007. Colorado Ownership, Management, and Protection V6. <http://www.nrel.colostate.edu/projects/comap/contact.html>

Wright, G.R., J.M. Scott, S. Mann, and M. Murray. 2001. Identifying unprotected and potentially at risk plant communities in the western USA. *Biological Conservation* 98:97-106.

APPENDIX A: ECOLOGICAL SYSTEMS SCORECARD METHODOLOGY

This appendix presents definitions and interpretation guidelines for each of the scoring categories (shown on the ecological systems scorecard in Appendix B) used to evaluate the status of Colorado’s ecological systems. Additional technical details and computations are included in the metadata attached to GIS datasets developed for this analysis.

Because occurrences for ecological systems have not been delineated or incorporated into BIOTICS, we were not able to use existing ranking information for these conservation targets. Scoring methods were intended to address the three factors (size, condition, and landscape context) that would contribute to an overall element occurrence ranking under natural heritage methodology. These three factors reflect the present status, or quality of an occurrence and are used as the basis for estimating its long-term viability. For ecological systems, the term “viability” is used loosely, since systems are comprised of many separate communities and species, each with their own viability. The viability of an ecological system is considered to be the sum of the viability or persistence of the component communities and their ecological processes. More directly, the ranks usually reflect the degree of negative anthropogenic impact to a community (i.e., the degree to which people have directly or indirectly adversely impacted community composition, structure, and/or function, including alteration of natural disturbance processes).

Our first task was to develop a surrogate for ecological system occurrences. We based our analysis on the Land Cover Map for the Southwestern United States - SWReGAP landcover (USGS 2004). This dataset provides a statewide vegetation map for Colorado that uses the same U.S. National Vegetation Classification ecological system names as our conservation targets. Most of our calculations were based on a smoothed version of SWReGAP landcover using a focal majority window of ½ mile radius (CNHP 2006a). The focal majority analysis reduces the number of small inclusions of disparate ecological systems within larger patches, to create a more generalized landcover appropriate for statewide analysis of ecological systems. Highways (CDOT 2006) were then added to represent anthropogenic fragmentation of ecological systems. Resolution of the grid is 30m cells (900 m² or 0.2 acre), however, all measurements are rounded to the nearest thousand acres because they are based on an abstraction of data with only a modest level of accuracy to begin with.

Scores for ecological systems were normalized to fall between 0 – 10, inclusive, with 10 being the best possible score. Ecological system names used in this document are crossreferenced to the SWReGAP landcover types as outlined in Table A1.

Biodiversity Status (Abundance/Quality)

Total acreage of the ecological system in Colorado

Definition: This is the total area, in acres, for an ecological system (also calculated for each patch). This value is used to calculate the proportion of total acres in patches larger than minimum size, and the proportion of total acres in patches of preferred size (4x minimum). Percent area calculations for all additional categories are based on the acreage in patches of at least minimum size, and not on the total acreage.

Interpretation: This is the total amount of an ecological system within Colorado. For individual patches, this is the total size of the patch.

Minimum size patches

Definition: This score represents the proportion of total acreage in patches equal to or larger than the minimum size. Minimum size is derived from the C-ranked ecological system occurrence specifications in Rondeau (2001) and CNHP (2005a), but does not imply that patches are occurrences. This figure is used in all percent area calculations below. This score does not apply to individual patches.

Interpretation: This score, in combination with the acreage in preferred size patches (see below), gives an indication of the patch size distribution of the ecological system and how this may change over time. The minimum and preferred patch size scores are the only instance in which acreage in patches below minimum size is part of the calculations. More acreage in larger patches is preferred for overall ecological system viability.

Preferred size patches

Definition: This score represents the proportion of total acreage in large patches (patches of at least 4x minimum size). For individual patches scores range from 5 to 10, since no patches below minimum size were included.

Interpretation: This score, in combination with acreage in patches of at least minimum size (above), gives an indication of the patch size distribution of the ecological system and how this may change over time. More acreage in larger patches is preferred for overall ecological system viability. For individual patches, this score indicates how close the patch size is to the preferred size.

Table A1. Crossreference of ecological system names to SWReGAP vegetation types.

System Name	Includes SWReGAP types:
Alpine Tundra	North American Alpine Ice Field – note: none in focal majority grid Rocky Mountain Alpine Bedrock and Scree Rocky Mountain Alpine Fell-Field Rocky Mountain Dry Tundra Rocky Mountain Alpine-Montane Wet Meadow
Aspen	Rocky Mountain Aspen Forest and Woodland Intermountain West Aspen-Mixed Conifer Forest and Woodland Complex
Lodgepole Pine	Rocky Mountain Lodgepole Pine Forest
Pinyon Juniper - Colorado Plateau	Colorado Plateau Pinyon-Juniper Shrubland Colorado Plateau Pinyon-Juniper Woodland Colorado Plateau Mixed Bedrock Canyon and Tableland
Pinyon Juniper - Southern Rocky Mtn.	Southern Rocky Mountain Pinyon-Juniper Woodland
Ponderosa Pine	Rocky Mountain Ponderosa Pine Woodland
Sagebrush	Inter-Mountain Basins Big Sagebrush Shrubland Inter-Mountain Basins Montane Sagebrush Steppe
Sand Sage	Western Great Plains Sandhill Shrubland Western Great Plains Sandhill Prairie, if any
Shortgrass Prairie	Western Great Plains Shortgrass Prairie
Spruce Fir	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
Foothill Shrubland	Rocky Mountain Lower Montane-Foothill Shrubland
Grasslands	Southern Rocky Mountain Montane-Subalpine Grassland Western Great Plains Foothill and Piedmont Grassland Inter-Mountain Basins Semi-Desert Grassland
Greasewood	Inter-Mountain Basins Greasewood Flat
Juniper	Southern Rocky Mountain Juniper Woodland and Savanna Inter-Mountain Basins Juniper Savanna
Mixed Conifer	Rocky Mountain Montane Dry-Mesic Mixed Conifer Forest and Woodland Rocky Mountain Montane Mesic Mixed Conifer Forest and Woodland
Oak and Mixed Mountain Shrub	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
Salt Shrub	Inter-Mountain Basins Mat Saltbush Shrubland Inter-Mountain Basins Mixed Salt Desert Scrub Inter-Mountain Basins Shale Badland
Shrub-Steppe	Inter-Mountain Basins Semi-Desert Shrub Steppe

Table A2. Minimum patch sizes for ecological systems.

System	Minimum Size (ac)	System	Minimum Size (ac)
Alpine Tundra	10,000	Pinyon-Juniper, CO Plateau	30,000
Aspen	20,000	Pinyon-Juniper, Southern Rocky Mtn	30,000
Foothill Shrubland	1,000	Ponderosa	30,000
Grasslands	5,000	Sagebrush	30,000
Greasewood	1,000	Salt Shrub	1,000
Juniper	5,000	Sandsage	14,000
Lodgepole	30,000	Shortgrass	50,000
Mixed Conifer	2,500	Shrub-Steppe	5,000
Oak & Mixed Mountain Shrub	5,000	Spruce-fir	20,000

Landscape context

Definition: This score represents the proportion of the landscape within ½ mile of a patch that is covered with natural vegetation. Natural landscape was based on original SWReGAP landcover (not the smoothed version), and includes all map classes having codes beginning with “S.” Classes representing open water, developed areas, agriculture, and disturbed areas were considered not natural.

Interpretation: This score gives an indication of the landscape context of the ecological system or the individual patch. Decreasing percent natural landscape indicates that viable patches of the ecological system are becoming functionally isolated from each other.

Landscape Integrity score

Definition: This score was calculated using a “landscape integrity” GIS raster dataset that represents cumulative impacts from oil and gas wells, surface mining, urban development, agriculture, and roads (CNHP and TNC 2008). The concept is adapted from distance decay methods of Tuffly and Comer (2005a & b). We used modifications of an s-curve for the decay functions:

$$y = \frac{1}{1 + \exp\left(\frac{bx}{c} - a\right)} \times w$$

where

y - the impact of the threat

a - shifts curve to right or left

b - determines spread of curve, or slope of the rapidly decreasing part of curve.

c - scalar to adjust total distance of interest (=distance in meters divided by 20)

x - distance in meters from threat

w - weight of threat (maximum value)

By adjusting the shift and spread of the curve, it can be tailored to specific threats. The inflection point marks the distance where the effect of the threat is reduced by half. This curve is asymptotic at both ends, therefore the

results of the equation must be manually adjusted to equal the maximum weight at zero distance and zero weight at a distance at which the weight becomes essentially zero (“cutoff distance”).

As an example, for a threat whose effect is estimated to be zero at a distance of 2,000 m from its mapped location, different values of a and b produce the curve types shown in Table A3.

The cumulative integrity layer ranges in value from 0 to 2,235 (Figure A2). High impact was considered to be ≥ 500 , medium impact ≥ 250 and <500 , low impact <250 . The score for landscape integrity is calculated using the percent of total acreage in high or medium impact. These are actual percentages, not normalized scores, and represent the proportion of each ecological system (patch sizes equal to or greater than the minimum) or individual patch that falls within severely impacted areas. The overall score is the weighted sum of the two impact categories (high and medium), converted to a scale of 0-10. High impact is weighted twice that of medium impact. Scores are truncated at zero if negative, or at 10 if greater than 10.

Interpretation: This score represents the overall level of impact to the ecological system from land uses. Note that such a method of scoring does not take into account how much of an ecological system may have been entirely replaced by a particular land use (such as agriculture or urban development), only the proximity of these land uses to remaining ecological system patches.

Table A3. Distance decay curve types.

Curve Type	a	b	Inflection Pt	Cutoff
abrupt	1	5	100m	250m
moderately abrupt	2.5	2	300m	600m
moderate	5	1	500m	1,250m
gradual	10	0.5	1,000m	2,000m

Figure A1. Distance decay curves for threat layers used in the landscape integrity analysis.

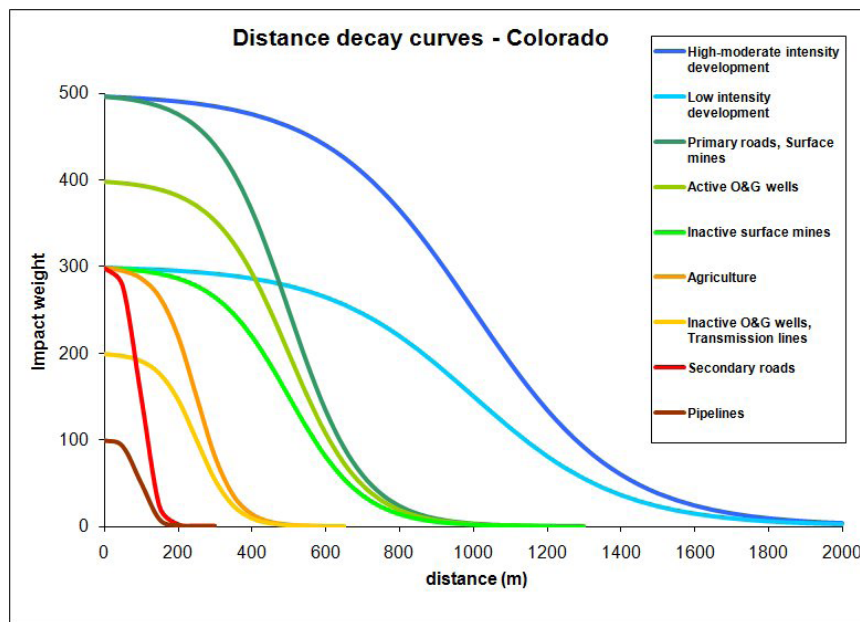
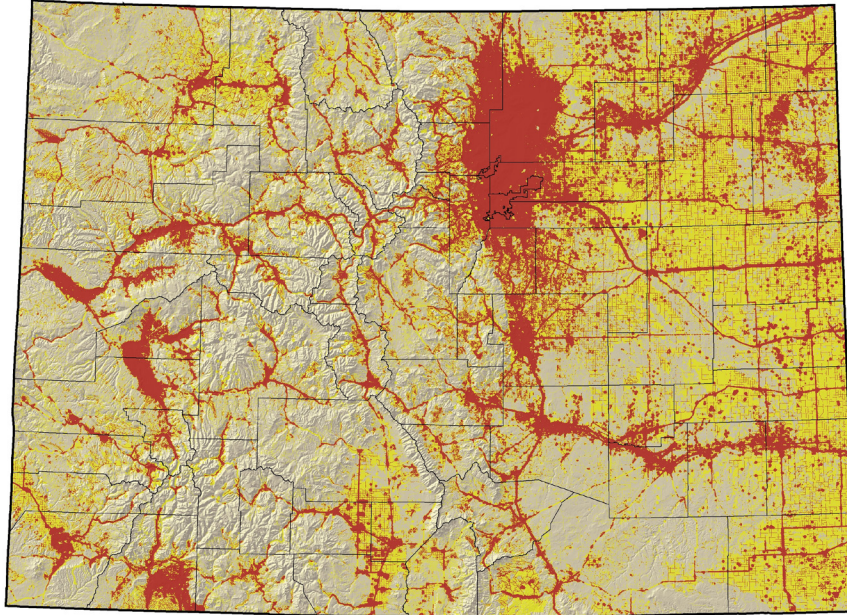


Figure A2. Landscape Integrity, showing high (red) and medium (yellow) impact areas (CNHP and TNC 2008).



Individual threat layers

Each individual threat dataset (GIS layer) has its own relevant weight and decay function type (Figure A1). The individual threat layers are then additively combined to produce an overall landscape integrity layer. These layers are not mutually exclusive in the threats they represent and are in fact chosen to complement one another to compensate for incomplete and inaccurate source data (Table A4).

Fire Regime Condition score

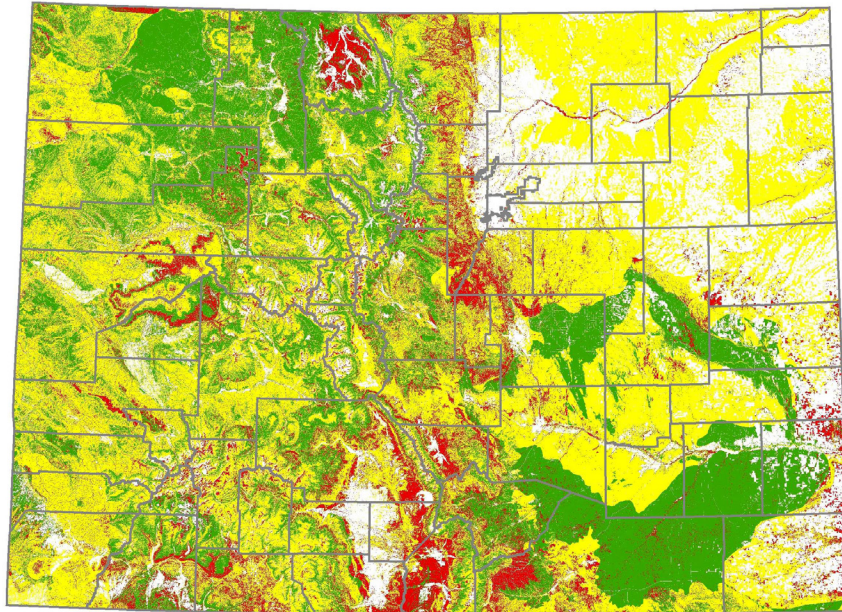
Definition: We used the LANDFIRE Fire Regime Condition Class (Figure A3), a relative measure describing the degree of departure from the reference fire regime (USFS 2007). Scores were calculated as area-weighted proportions of high (full weight) and moderate (2/3 weight) departure from reference conditions. Scored as inverse of percent acreage in Moderate+High.

Interpretation: Most meaningful for forest types, this indicates the relative departure of an ecological system or individual patch from its natural fire disturbance regime.

Table A4. Threat layers.

Threat type	Weight	Distance Decay Function Type	Data source
High/med intensity development	500	gradual	SWReGAP high/medium development types
Low intensity development	300	gradual	SWReGAP low intensity development types
Agriculture	300	mod-abr	SWReGAP agriculture
Roads - primary & secondary	500	moderate	2006 TIGER/Line roads (A1-A3)
Roads - local & rural, 4WD etc.	300	abrupt	2006 TIGER/Line roads (all other roads)
Oil & gas wells - active	400	moderate	Colorado Oil & Gas Commission (2008)
Oil & gas wells - inactive	200	mod-abr	Colorado Oil & Gas Commission (2008)
Gas pipelines	100	abrupt	2006 TIGER\Line utilities
Transmission lines	200	mod-abr	Digital Chart of the World Utilities layer
Surface Mines - active	500	moderate	Colo. Division of Reclamation, Mining, & Safety
Surface Mines - inactive	300	moderate	Colo. Division of Reclamation, Mining, & Safety

Figure A3. Fire Regime Condition Class (USFS 2007).



Biodiversity status score

Definition: Average of scores for the minimum size patch, preferred size patch, landscape context, landscape integrity, and (where appropriate) fire regime condition class.

Interpretation: The biodiversity status score represents an estimate of the current condition of an ecological system in Colorado.

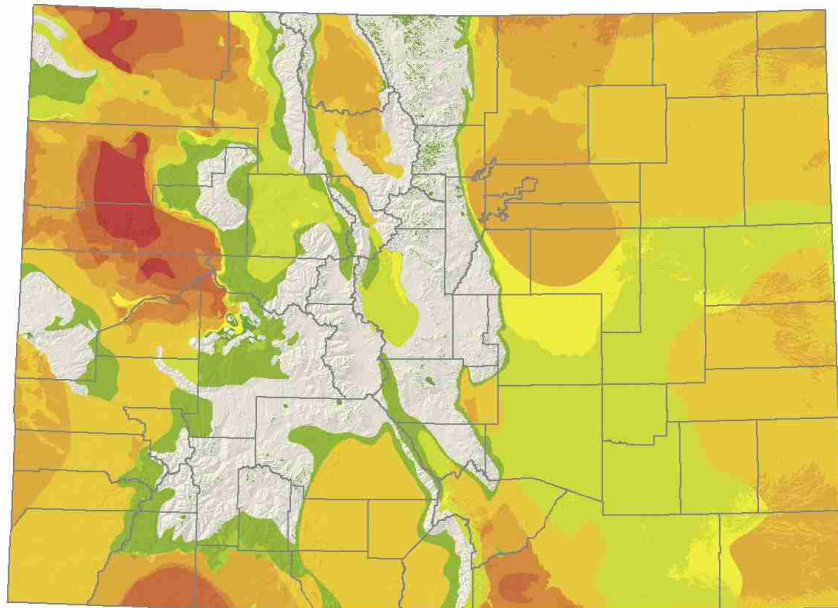
Threat status

Energy Development

Definition: This score is based on a combination of statewide layers showing oil & gas potential, coal potential, and uranium/vanadium potential (BLM 1998), oil shale potential (digitized from BLM 2006), and wind energy potential (TrueWind Solutions 2003). Potential levels in the original data were converted to ranks of High = 3, Medium = 2, Low = 1, No potential = 0, or to potential = 1, no potential = 0 if levels were not specified. Original shapefiles were converted to 30m grids and added; the oil and gas potential layer was double-weighted in order to emphasize the widespread and immediate nature of this threat in Colorado (CNHP 2006b). Possible scores for any cell range from 0 to 10 (Figure A4). An area-weighted average score for each patch and for the entire ecological system was calculated.

Interpretation: This score represents the combined potential for impact from a variety of energy development activities.

Figure A4. Energy development potential (CNHP 2006b).

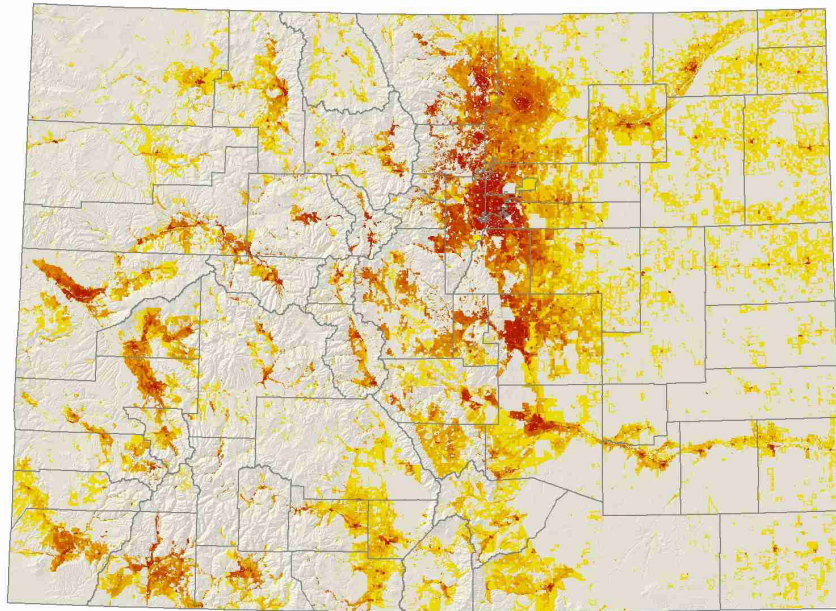


Population growth and development

Definition: This score is based on population growth projections (Figure A5) modeled by Theobald (2005). The score is calculated as the area-weighted increase in developed private lands (urban, suburban, exurban, and rural), scaled to the proportion of private lands in the patch. Scores are scaled to approximate a minimum “acceptable” level of development (e.g. a patch with 25% private lands experiencing a 5% loss of undeveloped private land receives a score of 5). Scores are truncated to zero if negative. The summary score for each ecological system is calculated as the area-weighted sum of the individual patch scores.

Interpretation: This score reflects the net loss of undeveloped private and rural acreage as lands shift to exurban, suburban, and urban classes.

Figure A5. Population growth, projection for 2030 (Theobald 2005).

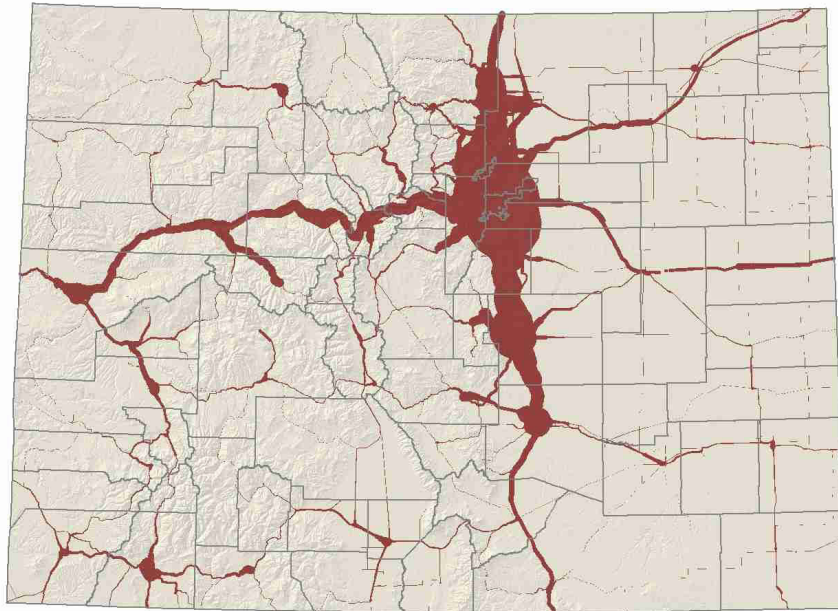


Transportation development

Definition: The Colorado Department of Transportation highways dataset (CDOT 2006) includes a field that predicts the Annual Average Daily Traffic (AADT = Total of all vehicles counted in a year for each segment, divided by 365 days) for 20 years in the future. In order to estimate the relative potential for impacts from increased traffic across an entire patch, this number was used to produce a variable-width buffer on the current linear highway coverage (CNHP 2006c). An arbitrary buffer width measuring AADT/10 meters on each side of the highway was used to convert traffic volumes to spatial impact. Range of buffer width is from about 60 km (37 mi) at the highly congested I-25/I-70 interchange in Denver to about 0.02 km (0.01mi) in rural Bent County (Figure A6).

Interpretation: The degree to which the buffered highway layer overlaps an ecological system patch is roughly reflects the relative impacts from future local roadway expansion and development associated with increasing traffic.

Figure A6. Transportation development – 20 year traffic projection (CNHP 2006c).



Threat status score

Definition: The minimum score of the three threat category scores.

Interpretation: This score represents the level of the most critical threat for this ecological system or patch in the future.

Protection Status

Calculations are based on three conservation management status measures developed by The Nature Conservancy (Supples et al. 2007). Every record in the Colorado Ownership, Management, and Protection (COMap) GIS dataset (Wilcox et al. 2007) was assigned a rank for each of three categories: conservation tenure, management intent, and potential management effectiveness, as well as a summary rank for conservation management status. These ranks represent the current state of knowledge about the status of the three conservation indicators on each parcel in COMaP. In southeastern Colorado, ranks assigned by TNC to private ranches were modified to reflect information collected during CNHP's 2007 survey of the area. Ranks assigned by TNC and CNHP were converted to a numerical score, and used to calculate area-weighted scores for patches and entire ecological systems.

Conservation Tenure

Definition: This score indicates the degree of permanence of conservation protection for an ecological system or an individual patch. Rank scoring and definitions:

Very good	10	There is permanent protection or management for the conservation of biodiversity (100 yrs or greater). Tenure is unlikely to be revoked (e.g. protection is recognized under a system of law).
Good	7	There is mid-term protection or management for the conservation of biodiversity (25 -99 years). Tenure is unlikely to be revoked during the stipulated time.
Fair	4	There is temporary, voluntary, and / or renewable protection or management for the conservation of biodiversity, which includes certification (< 25 years).
Poor	0	There is no conservation tenure.

Interpretation: This score provides information on the likelihood that protection and management activities will persist.

Management Intent

Definition: This score indicates the relative degree to which stated objectives of management activities are intended to conserve biodiversity and ecological processes. Rank scoring and definitions:

Very good	10	The management intent is primarily to support the conservation of biodiversity and ecological processes.
Good	7	Management intent is primarily directed at supporting ecologically sustainable multiple uses. An intent to be compatible with biodiversity conservation is explicit.
Fair	4	The management intent is primarily to support non sustainable multiple uses. An intent to be compatible with biodiversity conservation is not explicit but may be incidental
Unknown	2	There is insufficient information to determine the compatibility of management intent with biodiversity conservation.
Poor	0	The management intent is not compatible with biodiversity conservation.

Interpretation: The levels of management intent provide information about the stated objectives for the protection and management activities of a particular parcel that are intended to conserve biodiversity and ecological processes.

Potential Management Effectiveness (PME)

Definition: The capacity for management actions to be guided and implemented to achieve the designated management intent for biodiversity. Rank scoring and definitions:

Very good	10	There is a management prescription. Capacity to implement it is sufficient to achieve the biodiversity component of the intent.
Good	7	There is a management prescription. Capacity to implement it is mostly sufficient to achieve the biodiversity objectives in the intent. Few components are lacking.
Fair	4	There is a management prescription but it is inadequately resourced or unsuitably applied to achieve the stated biodiversity objectives. Many critical components are lacking to fully achieve the intent.
Unknown	2	There is insufficient information to determine the management intent.
Poor	0	There is NO management prescription or the capacity to implement one is virtually non-existent.

Interpretation: The levels of PME evaluate the potential for objectives ranked under management intent to be effectively implemented.

Protection status score

Definition: The individual Tenure, Intent, and PME ranks were combined to provide a final protection status rank according to a formula adapted from the method provided by The Nature Conservancy. For each COMaP parcel, scoring was majority rule, with the following exceptions and “averaging” rules: if any one category is Poor, then protection status is Poor; if two indicators are Very Good and one Fair, then protection status is Good; if one indicator is Very Good, one is Good, and one is Fair, then protection status is Good; if one indicator is Very Good, one is Fair, and one is Unknown, then protection status is Fair. The scored COMaP parcels were then converted to a 30m resolution grid, so that each grid cell had a numeric value or 0, 2, 4, 7, or 10, representing Poor, Unknown, Fair, Good, and Very Good protection status, respectively. The protection status score was then calculated by area-weighted average for each ecological system and patch. Large patches (of at least 4x minimum size) were weighted by the proportion of Good and Very Good conservation status acreage present in the patch, to compensate for the difficulty of achieving a higher score across a very large area.

Interpretation: This score represents the overall level of protection for the patch or ecological system.

Trends

Description: Long term trend reported as the loss of acreage in comparison with pre-settlement vegetation (circa 1850) as modeled by CNHP (2007). The pre-settlement model was produced using the SWReGAP GIS data (USGS 2004). Existing non-natural landcover was replaced by

- 1) replacing all agriculture in shortgrass and mixedgrass prairie with “Historic shortgrass component” dataset (CNHP 2005),
- 2) replacing all other non-natural landcover with the most common native vegetation found on the underlying STATSGO soil type,

- 3) replacing existing modeled and existing shortgrass with foothills/piedmont grassland on selected soil types along the mountain front,
 - 4) manual editing to replace man-made water bodies with the common surrounding landcover types.
- Agricultural modifications by native peoples that would have been present were not modeled.

Interpretation: The long term trends analysis gives a very rough estimate of the relative degree to which historic acreage in Colorado of an ecological system has been lost. Short-term trends will be evaluated at the next scoring iteration. This score is calculated only for ecological systems at a statewide level.

References

- Bureau of Land Management. 1998. State of Colorado maps for Oil and Gas Potential Map, Coal Mineral Potential, and Areas Favorable for Uranium and Vanadium in Colorado.
- Bureau of Land Management. 2006. Map of Oil Shale and Tar Sands Deposits in the Three-State Area. Oil Shale and Tar Sands Leasing Programmatic EIS Information Center. <http://ostseis.anl.gov/guide/maps/index.cfm>
- Colorado Natural Heritage Program. 2005. Historic shortgrass component. GIS dataset. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.
- Colorado Natural Heritage Program. 2005a. Ecological System Descriptions and Viability Guidelines for Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.
- Colorado Natural Heritage Program. 2007. Generalized pre-settlement distribution of ecological systems in Colorado. GIS dataset. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.
- Colorado Natural Heritage Program. 2006a. Generalized map of Colorado ecological systems. GIS dataset. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.
- Colorado Natural Heritage Program. 2006b. Energy development potential in Colorado. GIS dataset. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.
- Colorado Natural Heritage Program. 2006c. Transportation development potential in Colorado. GIS dataset. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.
- Colorado Natural Heritage Program and The Nature Conservancy. 2008. Landscape integrity in Colorado. GIS dataset. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.
- Colorado Department of Transportation. 2006. GIS dataset of public highways that are maintained by and under the jurisdiction of the Colorado Department of Transportation. Colorado Department of Transportation, Denver, Colorado.
- Rondeau, R. 2001. Ecological Systems Viability Specifications for Southern Rocky Mountains Ecoregion. Colorado Natural Heritage Program, Fort Collins, Colorado.

Supples, C., J. Higgins, C. Conboy, S. Farone, J. Fisher, and T. Guthrie. 2007. United States Conservation Management Status Project: Framework and Methods. Version 1. The Nature Conservancy, Boulder, Colorado. 23 pp.

Theobald, D. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. *Ecology and Society* 10:32.

TrueWind Solutions / National Renewable Energy Laboratory. 2003. Colorado wind resources at 50m above ground level dataset. National Renewable Energy Laboratory, Golden, Colorado.

Tuffly, M., and P. Comer. 2005a. Calculating Landscape Integrity: A Working Model. Draft of 4/19/2005. NatureServe, Boulder, Colorado. http://conserveonline.org/workspaces/human.activity.index/li_data_4_19_2005.doc

Tuffly, M., and P. Comer. 2005b. Example of landscape integrity from Puerto Rico. NatureServe, Boulder, Colorado. http://conserveonline.org/workspaces/human.activity.index/PR%20example_Landscape%20Integrity.doc

USFS. 2007. LANDFIRE Fire Regime Condition Classes (FRCC) dataset. USDA Forest Service Fire Science Laboratory, Rocky Mountain Research Station, Missoula, Montana. <http://gisdata.usgs.net/website/landfire/>

USGS National Gap Analysis Program. 2004. Provisional Digital Land Cover Map for the Southwestern United States. Version 1.0. RS/GIS Laboratory, College of Natural Resources, Utah State University. [Available online at: http://earth.gis.usu.edu/swgap/](http://earth.gis.usu.edu/swgap/)

Wilcox, G., D. M. Theobald, J. Whisman, and N. Peterson. 2007. Colorado Ownership, Management, and Protection (COMaP) v6. <http://www.nrel.colostate.edu/projects/comap/contact.html>

APPENDIX B: ECOLOGICAL SYSTEMS SCORECARD

Ecological System	Total CO acreage (fm model with maj hwy's)	Proportion of total acreage in patches of preferred size	Percent natural within 1/2 mile of patches	Land-scape Integrity Score	Condition Index Score	Biodiversity Status	Energy Dev.	Population Growth & Dev.	Trans. Dev.	Threat Status	Tenure	Intent	PME	Protection Status
Alpine Tundra	1,681,811	5.2	9.9	9.8	N/A	8.2	9.6	9.2	9.8	9.2	9.4	7.2	9.2	8.1
Acres	1,330,518													
Aspen	3,580,854	4.8	9.5	7.7	6.8	7.0	5.9	8.9	9.7	5.9	7.9	4.0	8.0	5.6
Acres	2,255,988													
Foothill Shrubland	388,143	6.7	9.1	4.5	7.7	7.0	6.3	8.6	9.1	6.3	4.6	3.4	5.6	2.4
Acres	317,069													
Grasslands	3,020,774	6.9	8.4	3.7	5.1	6.5	6.6	8.2	8.6	6.6	3.5	3.0	5.7	2.1
Acres	2,481,642													
Greasewood	443,159	7.6	7.1	3.7	N/A	6.9	4.4	9.4	9.2	4.4	3.9	3.4	5.6	2.3
Acres	398,612													
Juniper	558,062	7.5	9.6	9.3	0.3	7.0	5.8	10.0	10.0	5.8	2.2	3.9	7.4	1.5
Acres	473,271													
Lodgepole	2,199,719	4.1	9.4	7.5	6.8	6.8	8.3	7.4	9.6	7.4	8.7	4.6	8.6	6.3
Acres	1,413,574													
Mixed Conifer	881,470	2.8	9.7	8.1	4.3	6.2	7.5	9.7	9.5	7.5	7.6	4.8	8.4	5.6
Acres	543,111													
Oak & Mixed Mountain Shrub	2,717,461	6.7	8.9	4.9	5.1	7.3	4.5	6.8	9.2	4.5	5.1	3.2	4.7	2.9
Acres	1,908,735													
Pinyon-juniper CO Plateau	4,942,190	6.9	8.3	6.3	4.6	7.0	4.2	7.6	9.6	4.2	8.4	4.5	4.5	4.3
Acres	4,484,531													
Pinyon-juniper Southern Rocky Mtn.	1,253,413	2.4	9.1	4.4	4.6	5.5	6.4	5.9	9.5	5.9	4.5	3.7	3.8	2.5
Acres	848,576													
Ponderosa	3,220,000	3.8	9.2	5.4	2.4	5.6	7.4	3.6	8.5	3.6	5.8	3.5	6.0	3.7
Acres	2,312,645													
Sagebrush	5,565,000	4.7	8.1	5.3	6.1	6.2	4.6	8.3	9.8	4.6	5.7	3.4	3.6	2.7
Acres	3,866,641													
Salt shrublands	763,237	8.7	8.2	5.1	N/A	7.3	3.9	9.3	9.1	3.9	8.0	3.7	6.0	3.2
Acres	713,577													

Ecological System	Total CO acreage (fm model with maj hwy's)	Proportion of total acreage in patches of preferred size	Percent natural within 1/2 mile of patches	Land-scape Integrity Score	Condition Index Score	Biodiversity Status	Energy Dev.	Population Growth & Dev.	Trans. Dev.	Threat Status	Tenure	Intent	PME	Protection Status
Sandsage		5.8	6.4	4.4	5.3	6.6	4.4	9.6	9.6	4.4	1.1	3.4	2.6	0.8
Acres	1,959,451	1,543,059												
Shortgrass		6.5	4.9	4.3	5.7	6.6	4.9	7.0	9.5	4.9	1.3	2.4	2.6	0.9
Acres	11,855,000	9,609,816												
Shrub-steppe		8.6	7.6	6.2	N/A	7.8	4.6	9.8	9.8	4.6	5.0	3.9	5.9	2.8
Acres	776,043	700,193												
Spruce-fir		5.9	8.9	8.9	5.8	7.8	8.4	9.7	9.8	8.4	9.6	6.2	9.6	7.8
Acres	4,881,000	4,070,538												

APPENDIX C: ANIMAL SCORECARD METHODOLOGY

Introduction

The goal of the scorecard procedure is to produce a baseline analysis that incorporates aspects of each element's abundance, degree and types of threats, trends in population size, and degree of protection. These analyses are summarized in a variety of formats (spreadsheets and graphs). This scorecard will be updated periodically to record changes in the conservation status of elements at risk in Colorado.

This is essentially a qualitative analysis based on the best information currently available. With the exception of our abundance variable, scores are based on letter grades that represent Very Good, Good, Fair, and Poor categories as defined in the following tables. These categories were assigned a range of numerical scores to enable us to graph results. Color categories are used to assist with visual display of scores and relationships between scores.

Information from the Element State Ranking record (ESR) in the Colorado Natural Heritage Program database (BIOTICS) is the basis for scoring the animal species. There are 113 species, subspecies, and distinct populations included in this version of the zoology scorecard. All but six of these are the Tier 1 species of the Colorado Comprehensive Wildlife Conservation Plan (CDOW 2006). The set of six species are state-rare species that are high priorities for The Nature Conservancy and the Colorado Natural Heritage Program. The six state-rare species are included to provide insight on a larger range of taxa that may be scored in future scorecard versions.

Abundance Score

The abundance variable is based on the number of individuals estimated to exist in Colorado. Because this is a dynamic metric and in many cases a very difficult number to estimate with adequate precision, large bins (ranges) are used in the ESR. Furthermore the bins are not always comparable between taxa. For example, when comparing the two species for conservation priority, 500 lynx are very different from 500 Uncompahgre fritillary butterflies. Fourteen taxonomic groups were used to assign weights accounting for differences in body size and life history, as defined below (Tables C1 and C2). The color coding in Table C1 identifies taxonomic groups that have the same bins.

Table C1. Bins used to assign animal scores for the abundance variable.

Abundance Bin	Turtles	Lizards and Snakes	Frogs and Toads	Small mammals	Artiodactyls	Carnivores	Raptors	Owls	Galliformes	Other birds	Mollusks	Insects	Small fish	Large fish
Zero	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0
1 to 50	1	1	1	1	1	2	2	1	1	1	1	1	1	1
50-250	2	2	1	1	1	5	5	2	1	1	1	1	1	1
250-1,000	3	3	2	1	2	7	7	3	2	1	2	1	2	2
1,000-2,500	5	5	3	3	3	8	8	5	3	2	3	1	3	5
2,500-10,000	7	7	5	5	3	9	9	7	5	3	5	1	5	7
10,000-100,000	9	8	7	8	6	10	10	9	7	7	7	2	7	9
100,000-1,000,000	10	10	9	9	8	10	10	10	9	9	9	6	9	10
> 1,000,000	10	10	10	10	10	10	10	10	10	10	10	10	10	10

Table C2. Categorization of species into taxonomic groups used in abundance bins.

Taxonomic Group	Species	Taxonomic Group	Species
Turtles	Yellow mud turtle	Carnivores, cont.	Kit fox
Lizards and Snakes	Texas horned lizard		Black-footed ferret
	Triploid Colorado checkered whiptail		Northern river otter
	Common garter snake		Canada Lynx
	Massasauga		Wolverine
	Common kingsnake		Common hog-nosed skunk
	Longnose leopard lizard	Raptors	Bald Eagle
	New Mexico thread snake		American Peregrine Falcon
	Roundtail horned lizard		Northern Goshawk
	Southwestern blackhead snake		Ferruginous Hawk
Frogs and Toads	Boreal toad		Golden Eagle
	Plains leopard frog		Prairie Falcon
	Northern leopard frog		Swainson's Hawk
	Canyon treefrog	Owls	Mexican Spotted Owl
	Great Plains narrowmouth toad		Boreal Owl
	Green toad		Short-eared Owl
	Couch's spadefoot		Flammulated Owl
Small Mammals	Dwarf shrew		Burrowing Owl
	Fringed myotis	Galliformes	Gunnison Sage Grouse
	Spotted bat		Plains Sharp-tailed Grouse
	Townsend's big-eared bat		Lesser Prairie-chicken
	White-tailed jackrabbit		Columbian Sharp-tailed Grouse
	Black-tailed prairie dog		Greater Prairie-chicken
	White-tailed prairie dog		Sage Grouse
	Gunnison's prairie dog	Other Birds	Piping Plover
	Botta's pocket gopher subsp.		Least Tern
	Northern pocket gopher subsp.		Western Snowy Plover
	Olive-backed pocket mouse		Mountain Plover
	Meadow jumping mouse subsp.		McCown's Longspur
	Preble's shrew		Gray Vireo
	Plains pocket mouse subsp.		Long-billed Curlew
	Pygmy shrew		Greater Sandhill Crane
Artiodactyls	Bison		Upland Sandpiper
Carnivores	Gray wolf		Purple Martin
	Swift fox		Sage Sparrow

Table C2 (cont.)

Taxonomic Group	Species	Taxonomic Group	Species	
Other Birds, cont.	Bobolink	Small Fish, cont.	Plains minnow	
	Brown-capped Rosy Finch		Suckermouth minnow	
	American Bittern		Rio Grande sucker	
	Olive-sided Flycatcher		Common shiner	
	Loggerhead Shrike		Arkansas darter	
	Lewis's Woodpecker		Orangethroat darter	
	Juniper Titmouse		Colorado pikeminnow	
	Lark Bunting		Northern redbelly dace	
	Scaled Quail		Large Fish	Southern redbelly dace
	Band-tailed Pigeon			Stonecat
	Williamson's Sapsucker			Colorado River cutthroat trout
	Brewer's Sparrow			Greenback cutthroat trout
	Cassin's Sparrow			Rio Grande cutthroat trout
	Pinyon Jay			Razorback sucker
	Red-naped Sapsucker			
	Black-throated Gray Warbler			
	Whooping Crane			
	Southwestern Willow Flycatcher			
	Western Yellow-billed Cuckoo			
	American White Pelican			
Bell's Vireo				
Chestnut-collared Longspur				
Mollusks	Banded physa			
	Rocky Mountain capshell			
	Fragile ancyliid			
	Pondhorn			
	Hot Springs physa			
	Cylindrical papershell			
	Sharp sprite			
	Umbilicate sprite			
Insects	Cloche ancyliid			
	Comstock's hairstreak			
	Pawnee montane skipper			
	Uncompahgre fritillary			
	Hops feeding azure			
	Ottoo skipper			
	A stonefly			
	A tiger beetle			
	Colorado blue			
	Desert buckwheat blue			
	Giant sand treader cricket			
	Great Basin silverspot butterfly			
	Great Sand Dunes anthicid beetle			
	Regal fritillary			
	San Luis Dunes tiger beetle			
	Sandhill fritillary			
	Smoky eyed brown butterfly			
	Stevens' tortricid moth			
Wiest's sphinx moth				
Small Fish	Lake chub			
	Humpback chub			
	Bonytail chub			
	Rio Grande chub			
	Roundtail chub			
	Brassy minnow			

Threats

The primary threat(s) are those that are considered to have the greatest overall impact on a species, subspecies, or population (referred to hereafter as “species”). In the case of multiple threats, the scope, severity, and immediacy are calculated by combining variables of all threats listed.

Threat Scope

Definition: For the threat(s) with the greatest overall impacts on the species, the proportion of the species that is observed, inferred, or suspected to be directly or indirectly affected by the threat or compounding threats.

Interpretation: High: >60% of total population, occurrences, or area is affected; Moderate: 20-60% of total population, occurrences, or area is affected; Low: 5-20% of total population, occurrences, or area is affected; Insignificant: <5% of total population, occurrences, or area is affected.

Threat Severity

Definition: For the threat(s) with the greatest overall impact on the species, how badly and irreversibly the species is observed, inferred, or suspected to be directly or indirectly affected by the threat or compounding threats.

Interpretation: High: loss of species population or habitat with effects essentially irreversible or requiring long-term recovery (>100 years); Moderate: major reduction of population or long-term degradation or reduction of habitat, with recovery expected in 10-50 years; Low: low but nontrivial reduction of population or reversible degradation or reduction of habitat, with recovery expected in 10-50 years; Insignificant: essentially no reduction of population or degradation of habitat, with ability to recover (within 10 years).

Threat Immediacy

Definition: For the threat(s) with the greatest overall impact on the species, how likely the threat(s) to the species is and how soon it is expected to be realized.

Interpretation: High: threat is operational (happening now) or imminent (within a year); Moderate: threat is likely to be operational within 2-5 years; Low: threat is likely to be operational within 5-20 years; Insignificant: threat not likely to be operational within 20 years.

Threat Status Score

Definition: Overall measure by which a species is observed, inferred, or suspected to be directly or indirectly threatened. BIOTICS calculates the overall degree of threat based on values entered for Scope, Severity, and Immediacy (Table C3).

Table C3. Calculation of Threat Status Scores based on values for threat status, severity, scope, and immediacy.

Scope	Severity	Immediacy	Value	Description	Score		
High	High	High	A	Moderate to high, imminent threat to >60% of population	0		
High	High	Moderate					
High	Moderate	High					
High	Moderate	Moderate					
Moderate	High	High	B	Moderate to high, imminent threat to 20-60% of population	2		
Moderate	High	Moderate					
Moderate	Moderate	High					
Moderate	Moderate	Moderate					
High	High	Low	C	Moderate to high, non-imminent threat for >60% of population	4		
High	Moderate	Low					
Moderate	High	Low	D				
Moderate	Moderate	Low					
Low	High	High	E			Moderate to high, non-imminent threat to 20-60% of population	5
Low	High	Moderate					
Low	High	Low					
Low	Moderate	High					
Low	Moderate	Moderate					
Low	Moderate	Low					
High	Low	High	F	Moderate to high threat for small proportion of population	6		
High	Low	Moderate					
High	Low	Low					
Moderate	Low	High					
Moderate	Low	Moderate					
Moderate	Low	Low					
Low	Low	High	G	Low severity threat for most or significant proportion of population	8		
Low	Low	Moderate					
Low	Low	Low	G	Low severity threat for small proportion of population	9		
	Unthreatened (value resulting if Scope, Severity, or Immediacy are considered "Insignificant")				10		

Estimated Number of Populations

The estimated number of populations score is taken directly from the ESR. For most of the 107 species, the best data available came from counting the number of extant and ranked element occurrence records (EOR). For some species where CNHP has little EOR data or does not actively track, an estimate was made via literature review. The method for categorizing estimated number of populations in Colorado is shown in Table C4.

Table C4. Categories for assigning the estimated number of populations scores.

Estimated Number of Populations	Score
Z = 0 (zero)	0
A = 1 - 5	1
B = 6 - 20	3
C = 21 - 80	7
D = 81 - 300	9
E = >300	10

Protected Populations

The protected populations variable is derived from the “number of protected occurrences” field in the ESR. This field is estimated by CNHP biologists by either querying the spatial data available for the species with a land management layer such as CoMap (Wilcox et al. 2007), or a literature review of the areas in Colorado where the species is known to exist. Due to the lack of precision of this type of analysis, the data are sorted into ranges (Table C5).

Table C5. Ranges used to determine Number of Protected Populations score.

Number of Protected Populations	Score
A = No occurrences appropriately protected and managed	0
B = Few (1-3) occurrences appropriately protected and managed	3
C = Several (4-12) occurrences appropriately protected and managed	5
D = Many (13-40) occurrences appropriately protected and managed	7
E = Very many (>40) occurrences appropriately protected and managed	10
U = Unknown whether any occurrences are appropriately protected and managed	--





Proportion of Protected Populations

The proportion of protected populations was calculated by dividing the number of protected populations by the number of known populations, and then categorizing overall protection status, as shown in Table C6a and C6b. The “Z” value for Estimate Number of Populations does not appear in the table, but would be equivalent to red (“poor”).

Table C6a. Method for calculating proportion of protected populations.

A/A	A/B	A/C	A/D	A/E
B/A	B/B	B/C	B/D	B/E
C/A	C/B	C/C	C/D	C/E
	D/B	D/C	D/D	D/E
		E/C	E/D	E/E
U/A	U/B	U/C	U/D	U/E

Table C6b. Method for categorizing overall protection status.

	POOR	1
	FAIR	4
	GOOD	6
	VERY GOOD	8

Short-term Trend

The direction of a species short-term trend was estimated by CNHP biologists through literature review, personal communications with experts on the species, or personal expertise on the species. Population trend data are stored in each species' Element State Rank record in BIOTICS. Score categories are shown in Table C7.

Table C7. Categories for assigning Short-term Trend scores.

Short-term Trend	Score
A = Severely declining (decline of >70% in population size, range, area occupied, and/or number or condition of occurrences)	Down
B = Very rapidly declining (decline of 50-70%)	Down
C = Rapidly declining (decline of 30-50%)	Down
D = Declining (decline of 10-30%)	Down
E = Stable (unchanged or remaining within $\pm 10\%$ fluctuation)	Stable
F = Increasing (increase of >10%)	Up
U = Unknown (short-term trend unknown)	Unknown

Conservation Status

The conservation status is a summary score determined from a combination of threat, abundance, short-term trend, and proportion of protected populations (Table C8).

Global and State Rank

G-Ranks and S-Ranks characterize the relative rarity or endangerment of a native taxon at the level of global or rangewide (G), state (S), or subspecies (T). Methodology follows NatureServe Conservation Status Ranks (NatureServe 2008). Native species are assigned a numeric rank of relative imperilment based on standard rank factors applied at the geographic or taxonomic levels as appropriate (shown below). A subnational rank cannot imply the species is more abundant at the subnational level than it is nationally or globally (e.g., a G1/S2 rank should not occur). All scores aside from G-Ranks are based only on Colorado data and do not include occurrences outside Colorado. Definitions for global and state ranks are presented in Table C9.

Table C8. Overall conservation status. Color codes apply to numerical scores as follows: Red (most risk) = 0-2; Orange = 3-4; Yellow = 5-7; Green (least risk) = 8-10; White = not applicable unless trend is downward.

THREAT	ABUNDANCE	TREND	PROTECTION	OVERALL CONSERVATION STATUS
	Green	White	Green	Effectively Conserved
	Green	White	Yellow	Effectively Conserved
	Green	White	Orange	Moderately Conserved
	Green	White	Red	Moderately Conserved
	Yellow	White	Green	Effectively Conserved
	Yellow	White	Yellow	Effectively Conserved
	Yellow	White	Orange	Weakly Conserved
	Yellow	White	Red	Weakly Conserved
	Orange	White	Green	Moderately Conserved
	Orange	White	Yellow	Moderately Conserved
	Orange	White	Orange	Weakly Conserved
	Orange	White	Red	Weakly Conserved
	Red	White	Green	Moderately Conserved
	Red	White	Yellow	Moderately Conserved
	Red	White	Orange	Weakly Conserved
	Red	White	Red	Weakly Conserved
	Green	White	Green	Effectively Conserved
	Green	White	Yellow	Effectively Conserved
	Green	White	Orange	Moderately Conserved
	Green	White	Red	Moderately Conserved
	Yellow	White	Green	Moderately Conserved
	Yellow	White	Yellow	Moderately Conserved
	Yellow	White	Orange	Moderately Conserved
	Yellow	White	Red	Moderately Conserved
	Orange	White	Green	Moderately Conserved
	Orange	White	Yellow	Moderately Conserved
	Orange	White	Orange	Weakly Conserved
	Orange	White	Red	Weakly Conserved
	Red	White	Green	Moderately Conserved
	Red	White	Yellow	Moderately Conserved
	Red	White	Orange	Weakly Conserved
	Red	White	Red	Weakly Conserved
Orange	Green	Red ↓	Green	Weakly Conserved
Orange	Green	White	Green	Moderately Conserved
Orange	Green	Red ↓	Yellow	Weakly Conserved
Orange	Green	White	Yellow	Moderately Conserved
Orange	Green	Red ↓	Orange	Weakly Conserved
Orange	Green	White	Orange	Moderately Conserved
Orange	Green	Red ↓	Red	Under Conserved
Orange	Green	White	Red	Weakly Conserved
Orange	Yellow	Red ↓	Green	Weakly Conserved

Table C9. Definitions of NatureServe global and state ranks.

Rank	Definition
X	Presumed Extinct (species)— Not located despite intensive searches and virtually no likelihood of rediscovery. Eliminated (ecological communities)—Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.
H	Possibly Extinct (species)— Missing; known from only historical occurrences but still some hope of rediscovery. Presumed Eliminated— (Historic, ecological communities)-Presumed eliminated throughout its range, with no or virtually no likelihood that it will be rediscovered, but with the potential for restoration, for example, American Chestnut Forest.
1	Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
2	Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
3	Vulnerable—At moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
4	Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
5	Secure—Common; widespread and abundant.

References:

Colorado Division of Wildlife. 2006. Colorado's Comprehensive Wildlife Conservation Strategy. Prepared for the citizens of Colorado and its visitors by the Colorado Division of Wildlife, Denver, Colorado.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. <http://www.natureserve.org/explorer>

Wilcox, G., D. M. Theobald, and J. Whisman. 2007. Colorado Ownership, Management, and Protection (COMaP) v6. <http://www.nrel.colostate.edu/projects/comap/contact.html>

APPENDIX D: ANIMAL SCORECARD

Refer to Animal Scorecard Methodology (Appendix C) for explanation of codes presented in the following table.

Scientific Name	Common name	Global Rank	State Rank	Abundance	Threat: Scope	Threat: Severity	Threat: Immediacy	Threat: Summary	Threat Score	Primary Threat	Short-term Trend	Estimated Number of Populations	Estimated Number of Populations Score	Estimated Number of Populations on Protected Land	Estimated Number of Populations on Protected Land Score	Proportion of Populations Protected	Conservation Status
Amphibians																	
Bufo boreas pop. 1	Boreal Toad (Southern Rocky Mountain Population)	G4T1Q	S1	5	High	High	High	A	0.2	Disease	down	C	7	D	7	8	Under Conserved
Bufo debilis	Green Toad	G5	S2	2	Insignificant	Insignificant	Insignificant	H	5	Farming Practices	stable	B	3	C	5	6	Moderately Conserved
Hyla arenicolor	Canyon Treefrog	G5	S2	5	Low	Low	Low	G	8	Recreation	stable	C	7	C	5	6	Effectively Conserved
Gastrophryne olivacea	Great Plains Narrowmouth Toad	G5	S1	1	Moderate	Low	High	F	6	Farming Practices	stable	A	1	B	3	6	Moderately Conserved
Scaphiopus couchii	Couch's Spadefoot	G5	S1	2	Low	Low	Moderate	G	8	Farming Practices	stable	B	3	B	3	4	Weakly Conserved
Rana blairi	Plains Leopard Frog	G5	S3	5	Moderate	Low	Low	F	6	Invasive Species	stable	D	9	D	7	6	Moderately Conserved
Rana pipiens	Northern Leopard Frog	G5	S3	5	Moderate	Moderate	Moderate	B	2	Invasive Species	down	D	9	D	7	6	Under Conserved
Birds																	
Pelecanus erythrorhynchos	American White Pelican	G3	S1B	2	Low	Moderate	Moderate	E	5	Recreation	up	A	1	B	3	6	Moderately Conserved
Botaurus lentiginosus	American Bittern	G4	S3S4B	1	Moderate	Moderate	High	B	2	Wetland/riparian degradation	stable	B	3	B	3	4	Under Conserved
Haliaeetus leucocephalus	Bald Eagle	G5	S1B,S3N	7	Low	Low	Low	G	8	Farming Practices	up	C	7	D	7	8	Effectively Conserved
Accipiter gentilis	Northern Goshawk	G5	S3B	9	Low	Low	Low	G	8	Forestry Practices	stable	C	7	D	7	8	Effectively Conserved
Buteo swainsoni	Swainson's Hawk	G5	S5B	10	Low	Low	Low	G	8	Farming Practices	stable	E	10	D	7	6	Effectively Conserved
Buteo regalis	Ferruginous Hawk	G4	S3B,S4N	8	Moderate	Low	Low	F	6	Farming Practices	stable	D	9	E	10	8	Effectively Conserved
Aquila chrysaetos	Golden Eagle	G5	S3S4B, S4N	8	Low	Low	Low	G	8	Direct Mortality	stable	E	10	E	10	8	Effectively Conserved

Scientific Name	Common name	Global Rank	State Rank	Abundance	Threat: Scope	Threat: Severity	Threat: Immediacy	Threat: Summary	Threat Score	Primary Threat	Short-term Trend	Estimated Number of Populations	Estimated Number of Populations Score	Estimated Number of Populations on Protected Land	Estimated Number of Populations on Protected Land Score	Proportion of Populations Protected	Conservation Status
<i>Falco peregrinus anatum</i>	American Peregrine Falcon	G4T4	S2B	5	Low	Low	Low	G	8	Recreation	up	C	7	D	7	8	Effectively Conserved
<i>Falco mexicanus</i>	Prairie Falcon	G5	S4B,S4N	8	Moderate	Low	Low	F	6	Recreation	up	E	10	D	7	6	Effectively Conserved
<i>Centrocercus urophasianus</i>	Sage Grouse	G4	S4	7	Moderate	Moderate	Moderate	B	2	Energy Development	down	D	9	D	7	6	Under Conserved
<i>Centrocercus minimus</i>	Gunnison Sage Grouse	G1	S1	3	High	Moderate	High	A	0.2	Farming Practices	down	B	3	B	3	4	Under Conserved
<i>Tympanuchus cupido pinnatus</i>	Greater Prairie Chicken	G4T4	S3	7	High	Moderate	High	A	0.2	Farming Practices	up	C	7	C	5	6	Weakly Conserved
<i>Tympanuchus pallidicinctus</i>	Lesser Prairie-chicken	G3	S2	2	Moderate	High	High	B	2	Energy Development	stable	B	3	B	3	4	Under Conserved
<i>Tympanuchus phasianellus columbianus</i>	Columbian Sharp-tailed Grouse	G4T3	S2	5	Moderate	Moderate	Moderate	B	2	Urban Development	stable	B	3	B	3	4	Under Conserved
<i>Tympanuchus phasianellus jamesi</i>	Plains Sharp-tailed Grouse	G4T4	S1	1	High	High	High	A	0.2	Energy Development	down	A	1	B	3	6	Under Conserved
<i>Callipepla squamata</i>	Scaled Quail	G5	S4	7	Moderate	Low	Low	F	6	Farming Practices	stable	C	7	D	7	8	Moderately Conserved
<i>Grus canadensis tabida</i>	Greater Sandhill Crane	G5T4	S2B,S4N	1	Moderate	Moderate	High	B	2	Wetland/riparian degradation	up	C	7	D	7	8	Under Conserved
<i>Grus americana</i>	Whooping Crane	G1	SNA	0.2	High	High	High	A	0.2	Direct Mortality	down	Z	0.2	A	0.2	1	Under Conserved
<i>Charadrius alexandrinus nivosus</i>	Western Snowy Plover	G4T3	S1B	1	Moderate	Moderate	Moderate	B	2	Water Development	stable	B	3	C	5	6	Under Conserved
<i>Charadrius melodus</i>	Piping Plover	G3	S1B	1	Moderate	Moderate	Moderate	B	2	Water Development	stable	A	1	B	3	6	Under Conserved
<i>Charadrius montanus</i>	Mountain Plover	G2	S2B	4	Moderate	Low	Moderate	F	6	Direct Mortality	down	C	7	C	5	4	Weakly Conserved
<i>Bartramia longicauda</i>	Upland Sandpiper	G5	S3B	3	Moderate	Moderate	High	B	2	Farming Practices	stable	A	1	B	3	6	Weakly Conserved
<i>Numenius americanus</i>	Long-billed Curlew	G5	S2B	2	Moderate	Moderate	Moderate	B	2	Farming Practices	down	C	7	C	5	6	Under Conserved

Scientific Name	Common name	Global Rank	State Rank	Abundance	Threat: Scope	Threat: Severity	Threat: Immediacy	Threat: Summary	Threat Score	Primary Threat	Short-term Trend	Estimated Number of Populations	Estimated Number of Populations Score	Estimated Number of Populations on Protected Land	Estimated Number of Populations on Protected Land Score	Proportion of Populations Protected	Conservation Status
<i>Sterna antillarum</i>	Least Tern	G4	S1B	1	Moderate	Moderate	Moderate	B	2	Water Development	down	A	1	B	3	6	Under Conserved
<i>Columba fasciata</i>	Band-tailed Pigeon	G4	S4B	7	Low	Low	Low	G	8	Urban Development	down	E	10	D	7	6	Effectively Conserved
<i>Coccyzus americanus occidentalis</i>	Western Yellow-billed Cuckoo	G5T3Q	SNA	1	High	Moderate	High	A	0.2	Wetland/riparian degradation	down	A	1	B	3	6	Under Conserved
<i>Otus flammeolus</i>	Flammulated Owl	G4	S4	7	Moderate	Low	Low	F	6	Forestry Practices	unknown	D	9	C	5	4	Moderately Conserved
<i>Athene cucularia</i>	Burrowing Owl	G4	S4B	9	Moderate	Moderate	Low	D	4	Direct Mortality	down	D	9	D	7	4	Weakly Conserved
<i>Strix occidentalis lucida</i>	Mexican Spotted Owl	G3T3	S1B,SUN	1	High	Moderate	High	A	0.2	Forestry Practices	stable	B	3	C	5	6	Under Conserved
<i>Asio flammeus</i>	Short-eared Owl	G5	S2B	3	High	Moderate	Moderate	A	0.2	Farming Practices	up	B	3	B	3	4	Under Conserved
<i>Aegolius funereus</i>	Boreal Owl	G5	S2	2	Low	Low	Low	G	8	Forestry Practices	unknown	C	7	D	7	8	Moderately Conserved
<i>Melanerpes lewis</i>	Lewis's Woodpecker	G4	S4	7	Moderate	Moderate	Low	D	4	Forestry Practices	stable	D	9	C	5	4	Weakly Conserved
<i>Sphyrapicus thyroideus</i>	Williamson's Sapsucker	G5	S4B	7	Moderate	Low	Moderate	F	6	Forestry Practices	down	D	9	D	7	6	Moderately Conserved
<i>Sphyrapicus nuchalis</i>	Red-naped Sapsucker	G5	S5	7	Low	Low	Moderate	G	8	Forestry Practices	up	E	10	E	10	8	Effectively Conserved
<i>Contopus cooperi</i>	Olive-sided Flycatcher	G4	S3S4B	7	Low	Low	Low	G	8	Forestry Practices	stable	D	9	C	5	4	Weakly Conserved
<i>Empidonax traillii eximius</i>	Southwestern Willow Flycatcher	G5T1T2	SNA	1	High	Moderate	High	A	0.2	Water Development	down	A	1	C	5	8	Under Conserved
<i>Progne subis</i>	Purple Martin	G5	S3B	3	Moderate	Low	Low	F	6	Forestry Practices	unknown	C	7	D	7	8	Moderately Conserved
<i>Gymnorhinus cyanocephalus</i>	Pinyon Jay	G5	S5	9	Moderate	Moderate	Moderate	B	2	Energy Development	down	D	9	C	5	4	Moderately Conserved
<i>Baeolophus inornatus</i>	Juniper Titmouse	G5	S4	7	Low	Moderate	High	E	5	Energy Development	down	D	9	E	10	8	Moderately Conserved
<i>Lanius ludovicianus excubitorides</i>	Loggerhead Shrike	G4	S3S4B	9	Low	Low	Moderate	G	8	Farming Practices	stable	E	10	C	5	4	Moderately Conserved

Scientific Name	Common name	Global Rank	State Rank	Abundance	Threat: Scope	Threat: Severity	Threat: Immediacy	Threat: Summary	Threat Score	Primary Threat	Short-term Trend	Estimated Number of Populations	Estimated Number of Populations Score	Estimated Number of Populations on Protected Land	Estimated Number of Populations on Protected Land Score	Proportion of Populations Protected	Conservation Status
<i>Vireo bellii</i>	Bell's Vireo	G5	S1B	1	Moderate	Moderate	High	B	2	other	down	A	1	A	0.2	1	Under Conserved
<i>Vireo vicinior</i>	Gray Vireo	G4	S2B	3	Moderate	Moderate	Low	D	4	Grazing Practices	unknown	C	7	C	5	6	Under Conserved
<i>Dendroica nigrescens</i>	Black-throated Gray Warbler	G5	S5B	9	Low	Low	High	G	8	Energy Development	stable	E	10	E	10	8	Effectively Conserved
<i>Almophila cassinii</i>	Cassin's Sparrow	G5	S4B	10	Low	Low	Moderate	G	8	Farming Practices	down	D	9	B	3	1	Moderately Conserved
<i>Spizella breweri</i>	Brewer's Sparrow	G5	S4B	9	Moderate	Low	Moderate	F	6	Energy Development	down	E	10	E	10	8	Effectively Conserved
<i>Amphispiza belli</i>	Sage Sparrow	G5	S3B	7	Moderate	Low	High	F	6	Energy Development	stable	D	9	C	5	4	Moderately Conserved
<i>Calamospiza melanocorys</i>	Lark Bunting	G5	S4	10	Moderate	Low	High	F	6	Farming Practices	down	E	10	D	7	6	Effectively Conserved
<i>Calcaricus mccownii</i>	McCown's Longspur	G4	S2B	7	Low	Low	Moderate	G	8	Farming Practices	stable	C	7	B	3	1	Weakly Conserved
<i>Calcaricus ornatus</i>	Chestnut-collared Longspur	G5	S1B	3	Moderate	Moderate	High	B	2	Farming Practices	down	A	1	B	3	6	Under Conserved
<i>Dolichonyx oryzivorus</i>	Bobolink	G5	S3B	3	Insignificant	Insignificant	High	H	5	Farming Practices	unknown	B	3	B	3	4	Weakly Conserved
<i>Leucosticte australis</i>	Brown-capped Rosy-finch	G4	S3B,S4N	7	Moderate	Moderate	Moderate	B	2	Climate Change	unknown	C	7	D	7	8	Weakly Conserved
Fish																	
<i>Oncorhynchus clarkii pleuriticus</i>	Colorado River Cutthroat Trout	G4T3	S3	9	Moderate	Moderate	Moderate	B	2	Invasive Species	stable	D	9	D	7	6	Weakly Conserved
<i>Oncorhynchus clarkii stomias</i>	Greenback Cutthroat Trout	G4T2T3	S2	5	High	High	Low	C	4	Invasive Species	down	B	3	B	3	4	Under Conserved
<i>Oncorhynchus clarkii virginalis</i>	Rio Grande Cutthroat Trout	G4T3	S3	10	Moderate	Moderate	Moderate	B	2	Invasive Species	stable	D	9	D	7	6	Weakly Conserved
<i>Couesius plumbeus</i>	Lake Chub	G5	S1	2	Moderate	Low	Low	F	6	Invasive Species	stable	A	1	A	0.2	1	Weakly Conserved
<i>Gila cypha</i>	Humpback Chub	G1	S1	3	Moderate	High	Low	D	4	Water Development	stable	A	1	B	3	6	Under Conserved

Scientific Name	Common name	Global Rank	State Rank	Abundance	Threat: Scope	Threat: Severity	Threat: Immediacy	Threat: Summary	Threat Score	Primary Threat	Short-term Trend	Estimated Number of Populations	Estimated Number of Populations Score	Estimated Number of Populations on Protected Land	Estimated Number of Populations on Protected Land Score	Proportion of Populations Protected	Conservation Status
<i>Gila elegans</i>	Bonytail Chub	G1	SX	0.2	High	High	High	A	0.2	Water Development	down	Z	0.2	A	0.2	1	Under Conserved
<i>Gila pandora</i>	Rio Grande Chub	G3	S1?	7	Moderate	Moderate	Moderate	B	2	Water Development	down	B	3	B	3	4	Under Conserved
<i>Gila robusta</i>	Roundtail Chub	G3	S2	7	Moderate	Moderate	Low	D	4	Water Development	stable	B	3	B	3	4	Weakly Conserved
<i>Hybognathus hankinsoni</i>	Brassy Minnow	G5	S3	3	Moderate	Moderate	Low	D	4	Water Development	stable	C	7	A	0.2	1	Under Conserved
<i>Hybognathus placitus</i>	Plains Minnow	G4	SH	0.2	Unknown	Unknown	Unknown	U	5	Water Development	down	Z	0.2	A	0.2	1	Weakly Conserved
<i>Phenacobius mirabilis</i>	Suckermouth Minnow	G5	S2	3	Moderate	Moderate	Low	D	4	Water Development	stable	B	3	A	0.2	1	Under Conserved
<i>Proximus eos</i>	Northern Redbelly Dace	G5	S1	2	Moderate	Low	Low	F	6	Water Development	stable	A	1	A	0.2	1	Weakly Conserved
<i>Phoxinus erythrogaster</i>	Southern Redbelly Dace	G5	S1	3	Moderate	Low	Low	F	6	Water Development	stable	A	1	B	3	6	Moderately Conserved
<i>Ptychocheilus lucius</i>	Colorado pikeminnow	G1	S1	2	Moderate	High	Low	D	4	Water Development	stable	A	1	C	5	8	Under Conserved
<i>Notropis cornutus</i>	Common Shiner	G5	S2	5	Moderate	Moderate	Low	D	4	Water Development	stable	B	3	A	0.2	1	Weakly Conserved
<i>Catostomus plebeius</i>	Rio Grande Sucker	G3G4	S1	3	High	High	High	A	0.2	Invasive Species	down	A	1	B	3	6	Under Conserved
<i>Xyrauchen texanus</i>	Razorback Sucker	G1	S1	2	Moderate	High	Low	D	4	Water Development	stable	A	1	B	3	6	Under Conserved
<i>Noturus flavus</i>	Stonecat	G5	S1	3	Moderate	Moderate	Low	D	4	Water Development	stable	A	1	A	0.2	1	Under Conserved
<i>Etheostoma cragini</i>	Arkansas Darter	G3G4	S2	2	Moderate	Moderate	Low	D	4	Invasive Species	down	C	7	C	5	6	Under Conserved
<i>Etheostoma spectabile</i>	Orangethroat Darter	G5	S3	5	Moderate	Moderate	High	B	2	Water Development	stable	C	7	A	0.2	1	Under Conserved
Mammals																	
<i>Sorex preblei</i>	Preble's Shrew	G4	S1	3	Unknown	Unknown	Unknown	U	5	Other	stable	A	1	A	0.2	1	Weakly Conserved
<i>Sorex nanus</i>	Dwarf Shrew	G4	S2	5	Unknown	Unknown	Unknown	U	5	Other	unknown	B	3	C	5	6	Moderately Conserved

Scientific Name	Common name	Global Rank	State Rank	Abundance	Threat: Scope	Threat: Severity	Threat: Immediacy	Threat: Summary	Threat Score	Primary Threat	Short-term Trend	Estimated Number of Populations	Estimated Number of Populations Score	Estimated Number of Populations on Protected Land	Estimated Number of Populations on Protected Land Score	Proportion of Populations Protected	Conservation Status
<i>Sorex hoyi montanus</i>	Pygmy Shrew	G5T2T3	S2	5	Unknown	Unknown	Unknown	U	5	Other	unknown	A	1	B	3	6	Moderately Conserved
<i>Myotis thysanodes</i>	Fringed Myotis	G4G5	S3	5	Moderate	Moderate	Low	D	4	Other	unknown	B	3	B	3	4	Weakly Conserved
<i>Euderma maculatum</i>	Spotted Bat	G4	S2	1	Low	Low	Moderate	G	8	Recreation	unknown	B	3	B	3	4	Weakly Conserved
<i>Plecotus townsendii</i>	Townsend's Big-eared Bat	G4T4	S2	1	High	Low	High	F	6	Other	down	C	7	B	3	1	Weakly Conserved
<i>Lepus townsendii</i>	White-tailed Jackrabbit	G5	S4	9	Low	Low	Low	G	8	Farming Practices	unknown	E	10	D	7	6	Effectively Conserved
<i>Cynomys ludovicianus</i>	Black-tailed Prairie Dog	G4	S3	10	Low	Low	Low	G	8	Direct Mortality	up	E	10	C	5	4	Moderately Conserved
<i>Cynomys leucurus</i>	White-tailed Prairie Dog	G4	S4	8	Moderate	Moderate	High	B	2	Disease	down	C	7	C	5	6	Under Conserved
<i>Cynomys gunnisoni</i>	Gunnison's Prairie Dog	G5	S5	8	Moderate	Moderate	High	B	2	Direct Mortality	down	C	7	D	7	8	Under Conserved
<i>Thomomys bottae rubridus</i>	Botta's Pocket Gopher Subsp	G5T1	S1	1	Moderate	Moderate	Moderate	B	2	Urban Development	down	A	1	A	0.2	1	Under Conserved
<i>Thomomys talpoides macrotis</i>	Northern Pocket Gopher Subsp macrotis	G5T1	S1	3	High	High	High	A	0.2	Energy Development	down	B	3	B	3	4	Under Conserved
<i>Perognathus fasciatus</i>	Olive-backed Pocket Mouse	G5	S3	8	Moderate	High	Moderate	B	2	Urban Development	down	B	3	B	3	4	Under Conserved
<i>Perognathus flavescens relictus</i>	Plains Pocket Mouse Subsp relictus	G5T2	S2	3	Low	Low	Low	G	8	Other	unknown	A	1	B	3	6	Moderately Conserved
<i>Zapus hudsonius preblei</i>	Meadow Jumping Mouse Subsp preblei	G5T2	S1	5	Moderate	High	High	B	2	Urban Development	down	B	3	B	3	4	Under Conserved
<i>Zapus hudsonius luteus</i>	Meadow Jumping Mouse Subsp luteus	G5T2	S1	1	High	Insignificant	Low	H	5	Urban Development	down	A	1	B	3	6	Moderately Conserved
<i>Canis lupus</i>	Gray Wolf	G4	SX	2	Insignificant	Insignificant	Insignificant	H	5	Direct Mortality	up	A	1	A	0.2	1	Weakly Conserved
<i>Vulpes velox</i>	Swift Fox	G3	S3	9	Moderate	Low	Low	F	6	Farming Practices	stable	C	7	C	5	4	Moderately Conserved
<i>Vulpes macrotis</i>	Kit Fox	G4	S1	2	High	Moderate	Moderate	A	0.2	Other	down	A	1	A	0.2	1	Under Conserved
<i>Mustela nigripes</i>	Black-footed Ferret	G1	S1	2	High	High	High	A	0.2	Direct Mortality	stable	A	1	B	3	6	Under Conserved

Scientific Name	Common name	Global Rank	State Rank	Abundance	Threat: Scope	Threat: Severity	Threat: Immediacy	Threat: Summary	Threat Score	Primary Threat	Short-term Trend	Estimated Number of Populations	Estimated Number of Populations Score	Estimated Number of Populations on Protected Land	Estimated Number of Populations on Protected Land Score	Proportion of Populations Protected	Conservation Status
<i>Gulo gulo</i>	Wolverine	G4	S1	2	Low	Moderate	Moderate	E	5	Direct Mortality	stable	Z	0.2	A	0.2	1	Weakly Conserved
<i>Conepatus leuconotus</i>	Common Hog-nosed Skunk	G4	S1	2	Low	Low	Low	G	8	Urban Development	stable	A	1	A	0.2	1	Weakly Conserved
<i>Lontra canadensis</i>	Northern River Otter	G5	S3S4	7	Low	Moderate	Low	E	5	Water Development	stable	B	3	B	3	4	Moderately Conserved
<i>Lynx canadensis</i>	Canada Lynx	G5	S1	5	Moderate	Low	High	F	6	Direct Mortality	up	B	3	B	3	4	Moderately Conserved
<i>Bos bison</i>	American Bison	G4	SX	3	Insignificant	Insignificant	Insignificant	H	5	Other	stable	A	1	B	3	6	Moderately Conserved
Reptiles																	
<i>Kinosternon flavescens</i>	Yellow Mud Turtle	G5	S1	3	Low	Low	Low	G	8	Other	stable	B	3	C	5	6	Moderately Conserved
<i>Gambelia wislizenii</i>	Longnose Leopard Lizard	G5	S1	3	Moderate	Moderate	Low	D	4	Invasive Species	down	B	3	C	5	6	Under Conserved
<i>Phrynosoma cornutum</i>	Texas Horned Lizard	G4G5	S3	7	Low	Low	Low	G	8	Farming Practices	down	D	9	D	7	6	Effectively Conserved
<i>Phrynosoma modestum</i>	Roundtail Horned Lizard	G5	S1	3	Moderate	Low	Low	F	6	Farming Practices	stable	A	1	A	0.2	1	Weakly Conserved
<i>Aspidoscelis neotesselata</i>	Triploid Colorado Checkered Whiptail	G2G3	S2	7	Low	High	High	E	5	Farming Practices	stable	C	7	C	5	6	Moderately Conserved
<i>Lampropeltis getulia</i>	Common Kingsnake	G5	S1	2	Low	Low	Low	G	8	Other	stable	A	1	B	3	6	Moderately Conserved
<i>Tantilla hobartsmithi</i>	Southwestern Blackhead Snake	G5	S2?	5	Insignificant	Low	Low	H	5	Urban Development	stable	B	3	B	3	4	Moderately Conserved
<i>Thamnophis sirtalis</i>	Common Garter Snake	G5	S3	5	Moderate	Moderate	Moderate	B	2	Wetland/riparian degradation	down	D	9	D	7	6	Under Conserved
<i>Leptotyphlops dissectus</i>	New Mexico thread snake	G4G5	S1	3	Low	Low	Low	G	8	Other	unknown	A	1	B	3	6	Moderately Conserved
<i>Sistrurus catenatus</i>	Massasauga	G3G4	S2	5	Low	Moderate	Moderate	E	5	Farming Practices	down	C	7	B	3	1	Moderately Conserved
Invertebrates																	
<i>Cicindela formosa gibsoni</i>	Big Sand Tiger Beetle	G5T1	S1	1	Moderate	Low	Low	F	6		stable	A	1	B	3	6	Moderately Conserved

Scientific Name	Common name	Global Rank	State Rank	Abundance	Threat: Scope	Threat: Severity	Threat: Immediacy	Threat: Summary	Threat Score	Primary Threat	Short-term Trend	Estimated Number of Populations	Estimated Number of Populations Score	Estimated Number of Populations on Protected Land	Estimated Number of Populations on Protected Land Score	Proportion of Populations Protected	Conservation Status
<i>Cicindela theatina</i>	San Luis Dunes Tiger Beetle	G1	S1	1	High	Low	Low	F	6		stable	A	1	B	3	8	Moderately Conserved
<i>Cicindela scutellaris yampae</i>	Festive Tiger Beetle	G5T1	S1	1	Moderate	Low	Low	F	6		down	A	1	A	0.2	1	Weakly Conserved
<i>Amblyderus wernerii</i>	Great Sand Dunes Anthicid Beetle	G1?	S1	1	High	Moderate	Moderate	A	0.2		unknown	A	1	B	3	6	Under Conserved
<i>Decodes stevensi</i>	Stevens' Tortricid Moth	GNR	S1	1	High	Moderate	Low	C	4		stable	A	1	B	3	6	Under Conserved
<i>Hesperia ottoe</i>	Ottoe Skipper	G3G4	S2	1	Moderate	Moderate	Moderate	B	2		down	B	3	C	5	6	Under Conserved
<i>Hesperia leonardus montana</i>	Pawnee Montane Skipper	G4T1	S1	1	High	Moderate	Moderate	A	0.2		down	A	1	B	3	6	Under Conserved
<i>Callophrys comstocki</i>	Comstock's Hairstreak	G2G3	S1	1	Moderate	Moderate	Low	D	4		unknown	A	1	A	0.2	1	Under Conserved
<i>Celastrina humulus</i>	Hops Feeding Azure	G2G3	S2	1	Moderate	High	High	B	2		down	C	7	C	5	6	Under Conserved
<i>Euphilotes rita emmelli</i>	Desert Buckwheat Blue	G3G4T2	S1	0.2	Unknown	Unknown	Unknown	U	5		down	Z	0.2	A	0.2	1	Weakly Conserved
<i>Euphilotes rita coloradensis</i>	Colorado Blue	G3G4 T2T3	S2	1	Moderate	Low	Moderate	F	6		down	B	3	B	3	4	Weakly Conserved
<i>Speyeria idalia</i>	Regal Fritillary	G3	S1	1	Moderate	High	High	B	2		down	A	1	A	0.2	1	Under Conserved
<i>Speyeria nokomis nokomis</i>	Great Basin Giverspot Butterfly	G3T1	S1	1	Moderate	Moderate	Moderate	B	2		down	A	1	B	3	6	Under Conserved
<i>Boloria selene sabulocollis</i>	Sandhill Fritillary	G5T2	S1S2	1	Moderate	High	Low	D	4		down	A	1	B	3	6	Under Conserved
<i>Boloria improba acrocne</i>	Uncompahgre Fritillary	G5T1	S1	2	Moderate	Moderate	High	B	2		stable	B	3	C	5	6	Under Conserved
<i>Satyrodes eurydice fumosa</i>	Smoky Eyed Brown Butterfly	G5T3T4	S1	1	Moderate	Moderate	High	B	2		down	A	1	B	3	6	Under Conserved
<i>Euproserpinus wiesti</i>	Wiest's Sphinx Moth	G3G4	S2	1	High	Low	Moderate	F	6		stable	B	3	B	3	4	Weakly Conserved
<i>Dalmanibaeetes giganteus</i>	Giant Sand Treacher Cricket	GNR	S1	1	Moderate	Moderate	Low	D	4		stable	A	1	B	3	6	Under Conserved
<i>Capnia arapahoe</i>	Arapahoe Snowfly	G1	S1	1	High	Moderate	High	A	0.2		unknown	A	1	A	0.2	1	Under Conserved
<i>Anodontoides ferussacianus</i>	Cylindrical Papershell	G5	S2	3	High	Moderate	Moderate	A	0.2		unknown	B	3	A	0.2	1	Under Conserved

Scientific Name	Common name	Global Rank	State Rank	Abundance	Threat: Scope	Threat: Severity	Threat: Immediacy	Threat: Summary	Threat Score	Primary Threat	Short-term Trend	Estimated Number of Populations	Estimated Number of Populations Score	Estimated Number of Populations on Protected Land	Estimated Number of Populations on Protected Land Score	Proportion of Populations Protected	Conservation Status
Uniomerus tetralasmus	Pondhorn	G5	S1	0.2	Moderate	Moderate	High	B	2		down	Z	0.2	A	0.2	1	Under Conserved
Acroloxus coloradensis	Rocky Mountain Capsnell	G3	S1	2	High	High	High	A	0.2		down	B	3	B	3	4	Under Conserved
Physa cupreonitens	Hot Springs Physa	G5Q	S2	5	High	Low	High	F	6		unknown	A	1	A	0.2	1	Moderately Conserved
Physa utahensis	Banded Physa	G5T2	S1	2	High	Moderate	Moderate	A	0.2		stable	A	1	A	0.2	1	Under Conserved
Promenetus exacacous	Sharp Sprite	G5	S2	1	Moderate	Moderate	Moderate	B	2		unknown	B	3	B	3	4	Under Conserved
Promenetus umbilicatus	Umbilicate Sprite	G4	S3	2	Moderate	Moderate	High	B	2		unknown	B	3	A	0.2	1	Under Conserved
Ferrissia fragilis	Fragile Ancyloid	G5	S1	2	Moderate	Moderate	Moderate	B	2		unknown	B	3	B	3	4	Under Conserved
Ferrissia walkeri	Cloche Ancyloid	G4G5	S3	2	Moderate	Moderate	High	B	2		unknown	A	1	A	0.2	1	Under Conserved

APPENDIX E: RARE PLANT SCORECARD METHODOLOGY

The goal of the Scorecard procedure is to produce a baseline analysis that incorporates aspects of occurrence size and quality, degree and types of threats, and degree of protection for each species. These analyses are summarized in a variety of formats. This scorecard will be updated periodically to record changes in conservation status of species.

The rare plant species included in this Scorecard are 100 G1 and G2 (and T1 T2) plants and three G3 plants. There are 63 plants with a rank of G1 or G2 (and T1 or T2) that are endemic to Colorado and 50 G1 or G2 (and T1 or T2) plants that are not endemic to Colorado that are tracked by CNHP. Of these, 57 of the Colorado endemics and 43 of the non-endemics are included in this Scorecard. The others are currently excluded, either because more data processing is necessary, or because taxonomic uncertainty or a lack of information preclude their inclusion. The three G3 species included are *Penstemon breviculus* (not endemic), *P. harringtonii* (endemic), and *Sclerocactus glaucus* (recently recognized as endemic).

For each plant species, we provide a recommendation of what conservation action is needed. These recommendations may include on-the-ground protection, field inventory, taxonomic work, and monitoring.

Explanation of Scores for Plants

Element occurrence records in the Colorado Natural Heritage Program database as of May, 2008, provide the basis for scoring plant species for most of the scoring factors. Scoring for the threat factor was based on our qualitative understanding of the primary threat to each species. For each factor, we used a numeric scale of 0-10 for calculating scores.

Data for three of the factors derived from the element occurrence records (# of element occurrences, occupied area, and range) were converted to a scale of 0-10 using best fit non-linear transformations. The graphs and equations used for the transformations are described in the following sections of this appendix (Figures E1-6). Two graphs are included for each: the first shows the beginning of each curve in detail; the second includes the entire range (0-

10). We used a continuous transformation to calculate scores. The number ranges used in standard Nature Heritage methodology (NatureServe 2008) were used to calibrate the curves in a trial-and-error fashion.

Three of the factors (landscape integrity, potential for energy development, and protection status) were derived by overlaying the element occurrences on the appropriate GIS layers and developing scores. All scores are based only on Colorado element occurrences (EOs), and do not include occurrences outside Colorado.

Independent of the scoring, two additional columns in the Scorecard were developed to help put the scores in context. “Percent Range in Colorado” indicates what portion of the species range is within Colorado, and hence how important conservation within Colorado is to continued existence of the species. “Confidence in Score” indicates the degree to which CNHP feels the data provide an adequate basis for scoring, with high confidence reflecting a thorough understanding of distribution, abundance, occupancy, quality, and threats, and low confidence indicating a lack of information in many of those categories. The global and state rank, agency status (i.e., USFWS listing, BLM Colorado Office and USFS Region 2 Sensitive), and primary ecological system for each species are also provided.

Overall Conservation Status

Definition: The overall conservation status was determined using scores for three primary scoring factors: biodiversity status, threat status, and protection status. Color categories for each of these three factors were used to assign each species to an overall conservation status category according to the methods shown in Table 9 (in main body of report). This decision tree is ordered first by the color categories for threat status, followed by the possible color combinations of the other two factors. Any species with a red score for threat status and red or orange for biodiversity and protection is regarded as under conserved. A species with an orange threat status score and at least one green score for biodiversity or protection is considered moderately conserved. R=Red, O=Orange, Y=Yellow, G=Green, RO=Red or Orange, YG=Yellow or Green. Not all possible color combinations are represented by species in this analysis. Categories marked by * indicate species that may be naturally low in abundance even under adequate threat abatement and protection. Such species are considered inherently vulnerable, and may never achieve Effectively Conserved status.

Biodiversity Status Score

Definition: The biodiversity status score is an average of the scores for three factors: size, quality, and landscape integrity. Landscape integrity was down-weighted by half. When a score for quality was unknown, the same value as size was substituted.

Interpretation: One of the three primary categories used to determine effective conservation.

Size Score

Definition: Average of scores for number of occurrences, occupied area, and range.

Number of Occurrences

Definition: The number of occurrences of a species. Element occurrence records were filtered to eliminate sub-occurrences and extirpated occurrences; all other occurrences are included in the analysis (all of the subsequent scoring factors calculated or mapped from element occurrences follow this protocol). Species with excessive unprocessed data (over 25% of the total number of EOs) were excluded from the Scorecard analysis until processing of the data is complete; these species are included in the list of species and marked as awaiting data processing.

Figure E-1. Lower end of scoring range for number of occurrences.

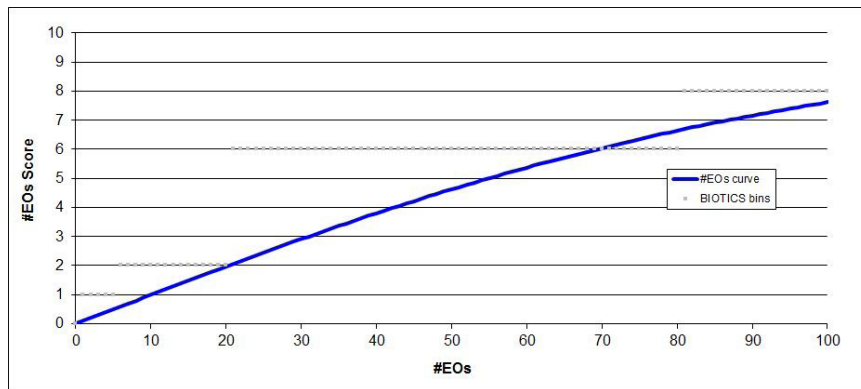
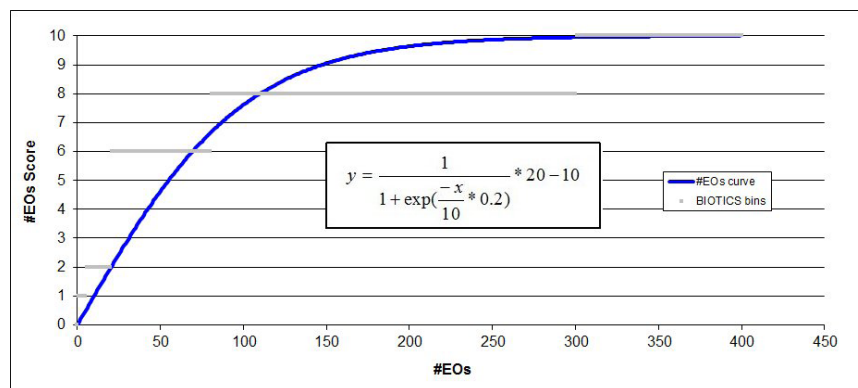


Figure E-2. Full scoring range for number of occurrences.



Occupied Area

Definition: For plants, occupied area represents the sum of the area of EO polygons mapped in BIOTICS. All occurrences except those that are extirpated are included. Seconds records represented by a dot rather than a mapped polygon, minutes records, and general records were assigned an area of 0.5 acre for each occurrence (dots were assigned a buffer of 25 meters, resulting in an area of approximately 0.5 acre).

Figure E-3. Lower end of scoring range for occupied area.

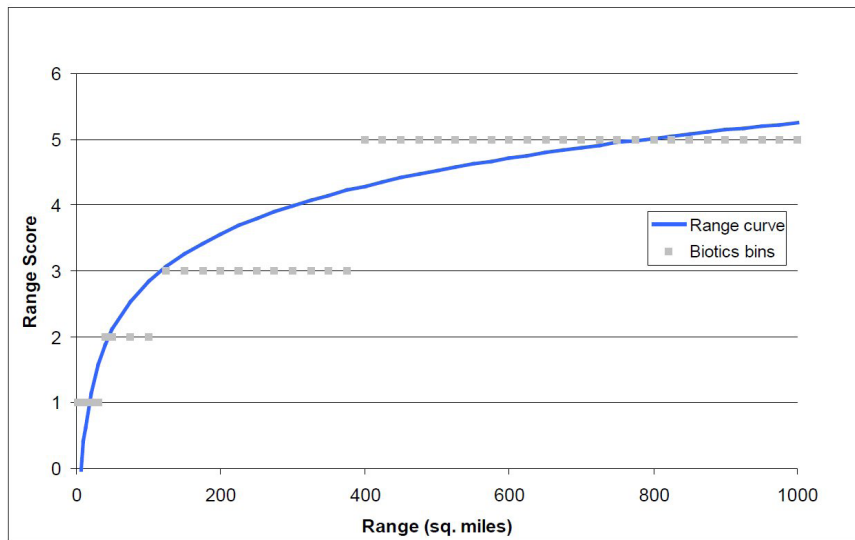
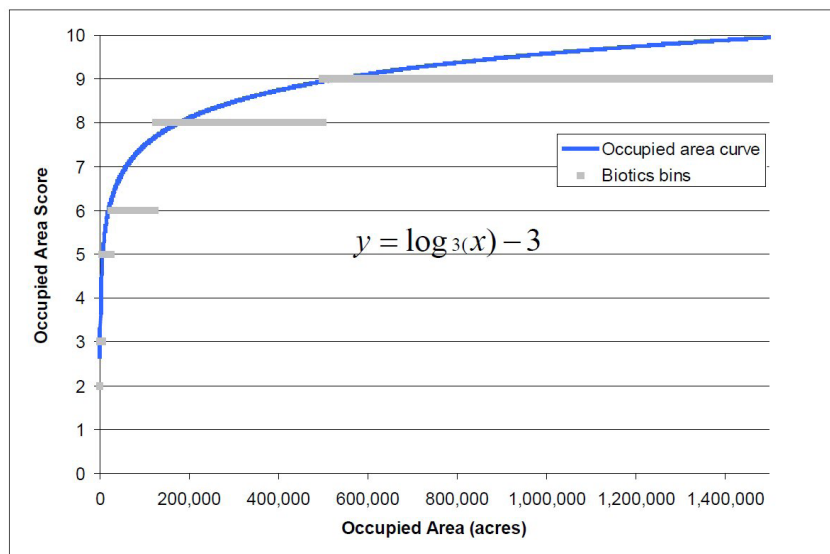


Figure E-4. Full scoring range for occupied area.



Range

Definition: The best estimate of the current range of the species in square miles. For plants, range was estimated by calculating the area of a minimum convex polygon drawn around all mapped occurrences of the species. Element occurrences flagged as identity questionable were not included in the minimum convex polygon.

Figure E-5. Lower end of scoring range for range.

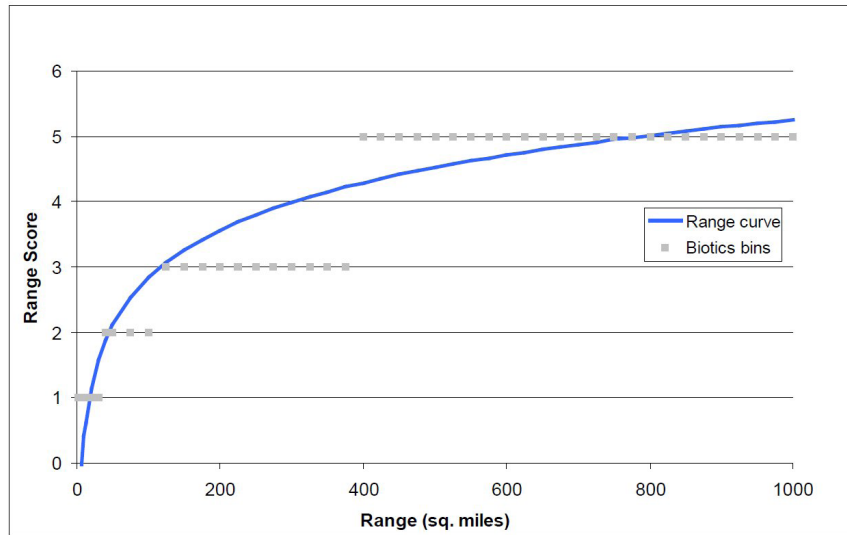
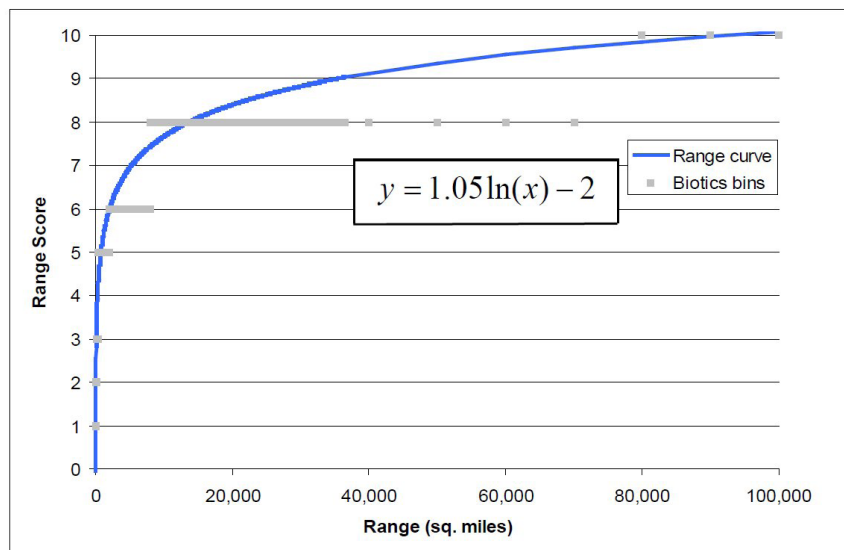


Figure E-6. Full scoring range for range.



Quality Score - % of EOs with Good Viability

Description: Number of A- and B-ranked element occurrences divided by the total number of element occurrences and converted to percent. If greater than 80% of the element occurrences were ranked E (extant), H (historic), or unranked, the quality score was considered “unknown” and marked as such.

Interpretation: The proportion of all element occurrences that have good viability, considered one measure of the overall condition of the species.

Landscape Integrity Score

Description: The landscape integrity score was derived from the area of the buffered element occurrences (1/4 mile) that fall within high and medium impact areas, converted to a scale of 0-10 (Table E-1 and Figure E-7). The landscape integrity GIS layer used in this analysis includes cumulative impacts from oil and gas wells, surface mining, urban development, agriculture, and roads (CNHP and TNC 2008). The layer’s values range from 0 – 2,235. High landscape integrity was defined as ≥ 500 . Medium integrity was defined as ≥ 250 and < 500 .

Interpretation: This score is an estimate of the overall level of impact to a plant species (based on buffered element occurrences) from land uses. It may be used as a measure of the overall landscape context for the species.

Table E-1. Landscape Integrity Scores.

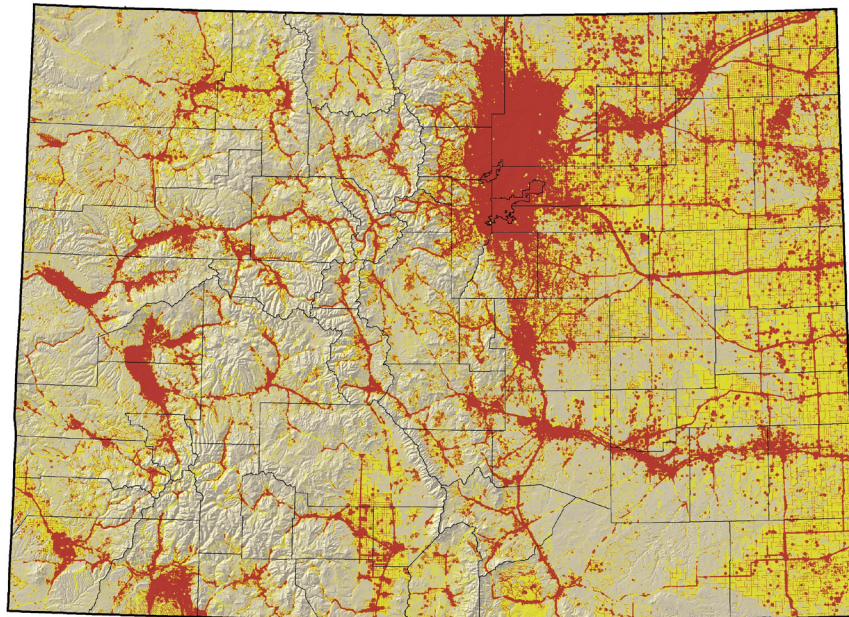
% acreage in High Impact	% acreage in Medium Impact	Interpretation	Score
50-100%	any	Poor integrity	0
25-50	50-100		1
25-50	25-50	Fair integrity	2
25-50	0-25		4
1-25	50-100	Good integrity	5
1-25	25-50		6
1-25	0-25	Very good integrity	8
<1	<5		10

Threat Status Score

Definition: Overall measure by which a species is observed, inferred, or suspected to be directly or indirectly threatened. BIOTICS calculates the overall degree of threat to the species based on values entered for the scope, severity, and immediacy of the threat (Table E-2). We converted the BIOTICS nominal scores to numeric scores so that the values could be incorporated into Scorecard calculations. A low score indicates a species is highly threatened by the primary threat and a high score indicates a low level of threat.

Interpretation: The descriptions of each threat score category are shown in Table E-2.

Figure E-7. Landscape Integrity, showing high (red) and medium (yellow) impact areas (CNHP and TNC 2008).



Primary Threat

Definition: Scoring for threat is based on the scope, severity, and immediacy of what is considered to be the threat with the greatest overall impact on the species within Colorado. Primary threats listed include energy (e.g., oil and gas) development, housing/urbanization, hydrologic alteration, recreation (motorized/non-motorized), agricultural development, collecting, exotic species, and transportation (e.g., roads).

Scope

Definition: For the threat with the greatest overall impact on the species, the proportion of the species that is observed, inferred, or suspected to be directly or indirectly affected by this threat.

Interpretation: High threat is calculated as $\geq 60\%$ of total population, occurrences, or area affected. Moderate threat is 20-60% of total population, occurrences, or area affected, and Low is 5-20% of total population, occurrences, or area affected. Insignificant = $< 5\%$ of total population, occurrences, or area affected.

Severity

Definition: For the threat with the greatest overall impact on the species, how badly and irreversibly the species is observed, inferred, or suspected to be directly or indirectly affected by this threat.

Interpretation: High = Loss of species population or destruction of species habitat in area affected with effects essentially irreversible or requiring long-term recovery (> 100 years); Moderate = Major reduction of species population or long-term degradation or reduction of species habitat in area affected, with recovery expected in 10-50 years; Low = Low but nontrivial reduction of species population or reversible degradation or reduction of species

habitat in area affected, with recovery expected in 10-50 years; Insignificant = Essentially no reduction of species population or degradation of species habitat, with ability to recover quickly (within 10 years) from minor temporary loss.

Immediacy

Definition: For the threat with the greatest overall impact on the species, how likely the threat to the species is and how soon it is expected to be realized.

Interpretation: High = Threat is operational (happening now) or imminent (within a year), Moderate = Threat is likely to be operational within 2-5 years, Low = Threat is likely to be operational within 5-20 years, Insignificant = Threat not likely to be operational within 20 years.

Protection Status Score

Definition: Calculations are based on three conservation management status measures developed by The Nature Conservancy (Supples et al. 2007). Every record in COMaP (Wilcox et al. 2007) was assigned a rank for each of three categories: tenure, intent, and potential management effectiveness (PME), as well as a summary score for conservation management status (CMS). These scores represent the current state of knowledge about the status of the three conservation indicators on each parcel in COMaP. In southeastern Colorado, ranks assigned by TNC to private ranches were modified to reflect information collected during CNHP's 2007 survey of the area. The individual tenure, intent, and PME ranks were combined into an overall protection status score according to a formula adapted from the method provided by The Nature Conservancy. For each COMaP parcel, scoring was majority rule, with the following exceptions and "averaging" rules: if any one category is Poor, then protection status is Poor; if two indicators are Very Good and one Fair, then protection status is Good; if one indicator is Very Good, one is Good, and one is Fair, then protection status is Good; if one indicator is Very Good, one is Fair, and one is Unknown, then protection status is Fair. Ranks assigned by TNC and CNHP were converted to an interval category. The scored COMaP parcels were then converted to a 30m resolution grid, so that each grid cell had a numeric value of 0, 2, 4, 7, or 10, representing Poor, Unknown, Fair, Good, and Very Good protection status, respectively. The protection status score was then calculated by area-weighted average for each species.

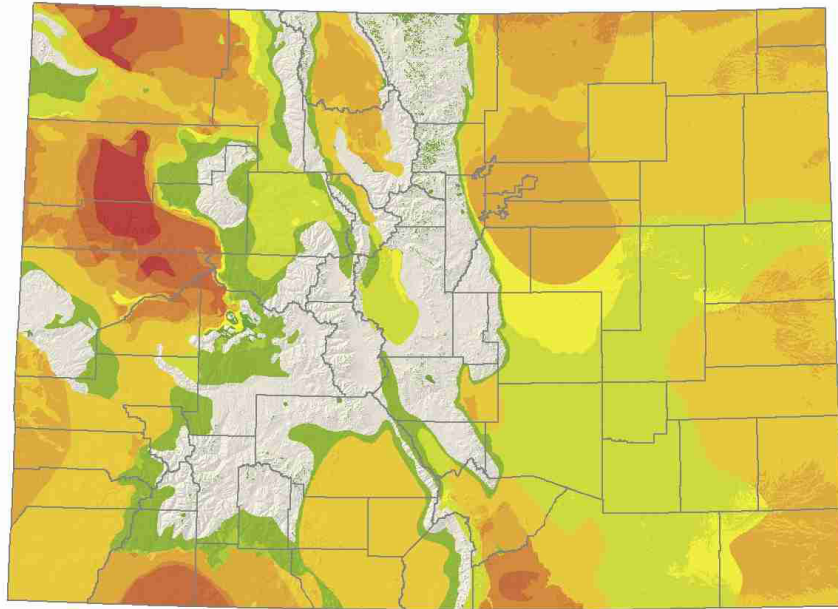
Interpretation: This score represents a summary of the land ownership, intent to manage for biodiversity, and potential effectiveness of such management for a particular species. Because an occurrence may span several land management categories, this score is a generalization of land management trends across all occurrences of a species.

Energy Development Potential Score

Definition: An energy development GIS layer was created from a combination of statewide layers showing oil & gas potential, coal potential, and uranium/vanadium potential (BLM 1998), oil shale potential (digitized from BLM 2006), and wind energy potential (TrueWind Solutions 2003) (Figure E8). Original shapefiles were converted to 30m grids, and added; Oil and Gas potential was double-weighted. Possible scores for any cell range from 0 to 10. An area-weighted average score for each buffered (1/4 mile) plant occurrence and for the entire species was calculated. This method was developed for scoring of ecological systems, and was applied here to plant species (see Appendix A - Ecological Systems methodology - for details).

Interpretation: This score represents the combined potential for impact from a variety of energy development activities. This score was only used to create a map (Figure 33 in the main body of this report). It was not included in the Overall Conservation Status scores.

Figure E-8. Energy development potential. The color gradient ranges from yellow (low) to red (high). Gray areas do not have significant potential for energy development.



Habitat

Description: Generalized setting of the plant in the context of the following habitats: alpine, barrens, cliff and canyon, grassland, forest, pinyon/juniper, shrubland, and wetland.

Percent Range in Colorado

Definition: This field provides a context for the overall conservation status as it describes the importance of Colorado to the conservation of the plant species rangewide. Range maps were not available for non-endemic species. Therefore, values for percent range in Colorado are based only on the percentage of the element occurrences that are within Colorado. We used NatureServe's online rangewide data set as the source of element occurrences outside of Colorado.

Interpretation: Endemic = 100% of a species' range within Colorado; Very High = 75-99% of range within Colorado; High = 50-75% of range within Colorado; Medium = 25-50% of range within Colorado; Low = <25% of range within Colorado.

Table E-2. Threat summary table from BIOTICS.

Scope	Severity	Immediacy	Score	Description
High	High	High	0	Moderate to high, imminent threat for most (>60%) of population, occurrences, or area
High	High	Moderate		
High	Moderate	High		
High	Moderate	Moderate		
Moderate	High	High	2	Moderate to high, imminent threat for a significant proportion (20-60%) of population, occurrences, or area
Moderate	High	Moderate		
Moderate	Moderate	High		
Moderate	Moderate	Moderate		
High	High	Low	4	Moderate to high, non-imminent threat for most (>60%) of population, occurrences, or area
High	Moderate	Low		
Moderate	High	Low	5	Moderate to high, non-imminent threat for a significant proportion (20-60%) of population, occurrences, or area
Moderate	Moderate	Low		
Low	High	High	6	Moderate to high threat for small proportion (<20%) of population, occurrences, or area
Low	High	Moderate		
Low	High	Low		
Low	Moderate	High		
Low	Moderate	Moderate		
Low	Moderate	Low		
High	Low	High	8	Low threat for most or significant proportion of population, occurrences, or area
High	Low	Moderate		
High	Low	Low		
Moderate	Low	High		
Moderate	Low	Moderate		
Moderate	Low	Low		
Low	Low	High	9	Low threat for a small proportion of population, occurrences, or area
Low	Low	Moderate		
Low	Low	Low		
Unthreatened (value resulting if scope, severity, or immediacy are considered "Insignificant") (Score = 10)				

Confidence in Score

Definition: This field categorizes CNHP's confidence in the scoring process for the individual species based on the completeness of the data, as follows:

A = % EOs with imprecise locational information (General and Minute EOs)

B = % EOs with no recent information (EO Rank of Historical (>20 years since last observed) or Failed to Find (searched for and not found))

C = % EOs with incomplete information (EO Rank of Extant (E) – i.e., not enough information available to determine an EO Rank of A, B, C, or D)

D = % EOs mapped using CNHP old methodology versus new methodology. New methodology maps polygons showing observed extent of the occurrence when that information is available. Old methodology maps all occurrences as dots.

Interpretation: Very High: A, B, and C <10% and D < 30%, High = A, B, and C ≤10-30% and D ≤ 50%, Moderate = A, B, or C ≤30-50% or D ≤50-80%, Low = A, B, or C >50% or D >80%. In some cases, CNHP has greater confidence in the data and score than this rating process indicates; ratings adjusted by hand are marked with an asterisk (*).

Conservation Recommendation

Definition: These fields summarize recommended conservation actions for each species or subspecies. For taxa where the distribution is well documented and high quality occurrences are known, the recommended action is on-the-ground conservation action such as special designation of a species, land purchase, or conservation easement. Monitoring is recommended for most G1, T1, and federally listed species. Field inventory is recommended for those species with a low confidence in score so as to enhance our knowledge of those species. Taxonomic work is recommended for several species that are not well understood. Species with moderate confidence in scores may be recommended for a combination of actions based on institutional knowledge of the individual species.

References

- BLM. 1998. State of Colorado maps for Oil and Gas Potential Map, Coal Mineral Potential, and Areas Favorable for Uranium and Vanadium in Colorado.
- BLM. 2006. Map of Oil Shale and Tar Sands Deposits in the Three-State Area. Oil Shale and Tar Sands Leasing Programmatic EIS Information Center. <http://ostseis.anl.gov/guide/maps/index.cfm>
- Colorado Natural Heritage Program and The Nature Conservancy. 2008. Landscape integrity in Colorado. GIS dataset. Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.
- NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. <http://www.natureserve.org/explorer>.
- Supples, C., J. Higgins, C. Conboy, S. Farone, J. Fisher, and T. Guthrie. 2007. United States Conservation Management Status Project: Framework and Methods. Version 1. The Nature Conservancy, Boulder, Colorado. 23 pp.
- TrueWind Solutions / National Renewable Energy Laboratory. 2003. Colorado wind resources at 50m above ground level dataset. National Renewable Energy Laboratory, Golden, Colorado.
- Wilcox, G., D. M. Theobald, and J. Whisman. 2007. Colorado Ownership, Management, and Protection V6. <http://www.nrel.colostate.edu/projects/comap/contact.html>

APPENDIX F: RARE PLANT SCORECARD

Scientific Name (State)	Overall Conservation Status	# Occurrences Score	Occupied Area Score	Range Score	Size Score	Quality Score	Land-scape Integrity Score	Bio-diversity Score
<i>Aletes humilis</i>	Effectively Conserved	3.0	2.6	4.6	3.4	8.7	8	5.4
<i>Aletes latilobus</i>	Effectively Conserved	0.5	1.1	1.4	1.0	6.0	6	3.3
<i>Aletes macdougallii</i> ssp. <i>breviradiatus</i>	Weakly Conserved	0.1	0.0	0.0	0.0	unknown	10	1.7
<i>Aliciella sedifolia</i>	Moderately Conserved	0.2	1.7	0.0	0.6	unknown	10	2.1
<i>Anticlea vaginatus</i>	Effectively Conserved	0.4	0.0	0.0	0.1	7.5	8	3.9
<i>Aquilegia chrysantha</i> var. <i>rydbergii</i>	Under Conserved	1.0	2.0	3.5	2.2	2.0	2	1.7
<i>Asclepias uncialis</i> ssp. <i>uncialis</i>	Moderately Conserved	3.5	2.4	8.7	4.9	2.7	8	3.9
<i>Astragalus anisus</i>	Effectively Conserved	3.7	4.0	5.0	4.2	1.5	8	3.3
<i>Astragalus cronquistii</i>	Under Conserved	1.3	0.0	2.4	1.2	unknown	6	1.8
<i>Astragalus debequaeus</i>	Weakly Conserved	1.7	3.6	4.8	3.4	5.9	2	3.4
<i>Astragalus deterior</i>	Moderately Conserved	1.5	0.0	2.0	1.2	0.0	6	1.4
<i>Astragalus equisolensis</i>	Moderately Conserved	0.4	0.0	0.2	0.2	0.0	4	0.7
<i>Astragalus humillimus</i>	Moderately Conserved	0.4	1.2	0.7	0.8	5.0	8	3.3
<i>Astragalus iodopetalus</i>	Moderately Conserved	0.4	0.0	6.3	2.2	unknown	0	1.5
<i>Astragalus lonchocarpus</i> var. <i>hamiltonii</i>	Effectively Conserved	0.1	0.0	0.0	0.0	10.0	8	4.7
<i>Astragalus microcymbus</i>	Moderately Conserved	0.4	0.0	0.8	0.4	5.0	8	3.1
<i>Astragalus missouriensis</i> var. <i>humistratus</i>	Weakly Conserved	1.0	2.1	4.1	2.4	4.0	0	2.1
<i>Astragalus naturitensis</i>	Moderately Conserved	3.3	3.1	6.6	4.3	2.9	2	2.8
<i>Astragalus osterhoutii</i>	Under Conserved	0.6	3.1	2.4	2.0	8.3	0	3.4
<i>Astragalus piscator</i>	Moderately Conserved	0.2	0.0	0.0	0.1	10.0	0	3.4
<i>Astragalus rafaensis</i>	Moderately Conserved	0.8	2.4	4.6	2.6	unknown	2	2.1
<i>Astragalus schmolliae</i>	Moderately Conserved	0.6	3.9	0.4	1.6	5.0	6	3.2
<i>Astragalus tortipes</i>	Weakly Conserved	0.2	1.7	0.0	0.6	5.0	8	3.2
<i>Botrychium lineare</i>	Moderately Conserved	0.5	0.0	6.5	2.3	unknown	2	1.9

Primary Threat	Threat - Scope	Threat - Severity	Threat - Immediacy	Threats Status Score	Protection Status Score	Confidence in Score	On-the-Ground Action	Field Inventory	Monitoring	Taxonomic Work
recreational uses	Low	Low	Low	9	7.0	Very High			X	
recreation/ hiking	Low	Moderate	Low	6	9.4	Moderate*	X	X	X	
recreation/ hiking	Low	Low	Low	9	0.9	Low		X		
recreation/ hiking	Moderate	Moderate	Low	5	7.0	Moderate	X	X	X	
hydrologic alteration	Moderate	Moderate	Low	5	10.0	Low		X		
recreational uses	Moderate	Moderate	Moderate	2	5.1	Low		X	X	X
agricultural development	Moderate	Moderate	Low	5	4.6	Moderate	X	X		
roads	Moderate	Low	Moderate	8	5.7	Moderate	X			
roads	Moderate	Moderate	Moderate	2	1.7	Low		X		
oil & gas	High	Moderate	High	0	3.6	Very High	X		X	
recreation/ hiking	Low	Low	Low	9	9.8	Low		X	X	
recreation	Moderate	Low	Unknown	8	5.2	Low		X		
none documented	Low	Moderate	Low	6	2.0	Low		X	X	
recreation/ hiking	Moderate	Low	High	8	5.2	Low		X		
recreation/ hiking	Moderate	Low	Low	8	4.6	Low		X		
herbivory/ motorized rec.	High	Moderate	High	2	5.7	High*	X		X	
housing/ urban dev.	Moderate	Low	Moderate	8	0.7	Moderate	X		X	
oil & gas	Low	Moderate	High	6	4.5	Moderate	X			
recreation/ motorized	High	High	Moderate	0	2.1	High	X		X	
roads/urban dev.	Moderate	Moderate	High	2	5.9	High	X			
none documented	Low	Low	Low	9	3.6	Low		X		
exotic species	Moderate	Moderate	High	2	10.0	Moderate	X		X	
Recreation / motorized	Moderate	Moderate	High	2	2.0	Very High	X		X	
roads	Low	Low	Low	9	6.6	Low		X	X	

Scientific Name (State)	Overall Conservation Status	# Occurrences Score	Occupied Area Score	Range Score	Size Score	Quality Score	Land-scape Integrity Score	Bio-diversity Score
<i>Camissonia eastwoodiae</i>	Weakly Conserved	0.4	3.0	4.4	2.6	2.5	2	2.0
<i>Carex stenoptila</i>	Effectively Conserved	1.1	4.0	8.1	4.4	unknown	8	4.3
<i>Castilleja puberula</i>	Effectively Conserved	1.9	0.0	6.2	2.7	unknown	8	3.1
<i>Cirsium perplexans</i>	Weakly Conserved	2.9	3.2	5.9	4.0	3.7	2	2.9
<i>Cleome multicaulis</i>	Effectively Conserved	3.6	4.7	5.6	4.6	3.4	2	3.0
<i>Corispermum navicula</i>	Moderately Conserved	0.2	2.5	0.0	0.9	10.0	6	4.6
<i>Cryptantha gypsophila</i>	Weakly Conserved	1.6	2.7	4.3	2.9	6.9	6	4.2
<i>Delphinium ramosum var. alpestre</i>	Effectively Conserved	0.9	2.9	7.3	3.7	unknown	10	4.1
<i>Draba exunguiculata</i>	Moderately Conserved	1.7	1.6	6.2	3.2	0.6	8	2.6
<i>Draba graminea</i>	Effectively Conserved	2.4	2.2	5.4	3.4	4.4	8	3.9
<i>Draba smithii</i>	Effectively Conserved	2.2	1.2	7.0	3.5	5.0	8	4.2
<i>Draba weberi</i>	Under Conserved	0.1	0.0	0.0	0.0	0.0	1	0.2
<i>Erigeron kachinensis</i>	Effectively Conserved	0.2	2.8	1.1	1.4	10.0	8	5.1
<i>Erigeron wilkenii</i>	Moderately Conserved	0.4	0.0	1.9	0.8	unknown	10	2.2
<i>Eriogonum brandegeei</i>	Weakly Conserved	0.9	2.9	4.3	2.7	5.6	0	2.7
<i>Eriogonum clavellatum</i>	Under Conserved	0.8	0.0	2.0	0.9	unknown	6	1.6
<i>Eriogonum coloradense</i>	Effectively Conserved	2.1	2.5	6.6	3.7	1.9	8	3.2
<i>Eriogonum pelinophilum</i>	Under Conserved	1.9	3.4	3.8	3.0	3.7	0	2.2
<i>Eutrema edwardsii ssp. penlandii</i>	Moderately Conserved	1.0	0.4	2.5	1.3	6.0	6	3.4
<i>Gaura neomexicana ssp. coloradensis</i>	Weakly Conserved	1.0	2.0	5.7	2.9	2.0	0	1.6
<i>Hackelia gracilentia</i>	Moderately Conserved	1.0	0.0	1.4	0.8	unknown	10	2.2
<i>Herrickia horrida</i>	Weakly Conserved	0.5	2.8	1.1	1.4	unknown	8	2.3
<i>Ipomopsis aggregata ssp. weberi</i>	Moderately Conserved	1.8	1.2	5.3	2.8	1.7	6	2.5
<i>Ipomopsis globularis</i>	Moderately Conserved	0.9	4.4	2.9	2.7	4.4	8	3.7

Primary Threat	Threat - Scope	Threat - Severity	Threat - Immediacy	Threats Status Score	Protection Status Score	Confidence in Score	On-the-Ground Action	Field Inventory	Monitoring	Taxonomic Work
roads/ORV	Moderate	Moderate	Moderate	2	4.1	Moderate	X	X		
unknown - recreation?	Insig.	Insig.	Insig.	10	9.3	Low		X		
recreational uses	Moderate	Low	Low	8	5.8	Low		X		
Cirsium bio control	Moderate	Moderate	Low	5	2.7	High	X			
hydrologic alteration	Moderate	Moderate	Low	5	5.9	High*	X			
recreation/ motorized	Moderate	Moderate	High	2	6.2	Very High		X		X
oil & gas	High	Moderate	Moderate	0	3.9	Very High	X	X	X	
recreation/ hiking	Low	Low	Low	9	8.2	Moderate		X		
recreation/ hiking	Moderate	Low	Moderate	8	6.9	Moderate		X		
recreation/ hiking	Low	Low	Low	9	7.5	Moderate		X		
recreation/ hiking	Low	Low	Low	9	7.8	Moderate		X		
road/dam construction	High	High	Moderate	0	0.0	Very High	X	X	X	
hydrologic alteration	Moderate	Moderate	Low	5	10.0	High			X	
none documented	Low	Low	Low	9	9.2	Low		X	X	
Recreation / motorized	Moderate	Moderate	Moderate	2	4.9	Moderate	X		X	
oil and gas	Moderate	Moderate	Moderate	2	2.1	Low		X		
recreation/ hiking/ ORV	Moderate	Low	High	8	9.7	Low		X		
housing/ urban dev., agriculture	High	High	High	0	1.9	Moderate	X		X	
hydrologic alteration/ mining	Moderate	Moderate	Moderate	2	8.2	High*	X		X	
hydrologic alteration	Moderate	Moderate	Low	5	1.7	Low	X	X		
recreational uses	Low	Low	Low	9	6.5	Low		X	X	
none documented	Low	Low	Low	9	0.0	Low		X		
recreation/ hiking	Low	Moderate	Low	6	6.4	Moderate*	X			
recreation / motorized	Moderate	Moderate	High	2	7.7	Moderate*	X	X		

Scientific Name (State)	Overall Conservation Status	# Occurrences Score	Occupied Area Score	Range Score	Size Score	Quality Score	Land-scape Integrity Score	Bio-diversity Score
<i>Ipomopsis polyantha</i>	Under Conserved	0.3	2.9	1.4	1.5	6.7	0	2.7
<i>Lepidium crenatum</i>	Weakly Conserved	1.4	3.0	7.7	4.0	unknown	4	3.4
<i>Lesquerella calcicola</i>	Weakly Conserved	3.0	3.5	7.6	4.7	2.6	0	2.4
<i>Lesquerella congesta</i>	Weakly Conserved	0.7	3.0	1.7	1.8	10.0	6	4.9
<i>Lesquerella parviflora</i>	Under Conserved	2.4	3.4	5.8	3.9	4.8	8	4.2
<i>Lesquerella pruinosa</i>	Moderately Conserved	1.7	3.9	3.7	3.1	5.3	2	3.1
<i>Lesquerella vicina</i>	Moderately Conserved	1.9	0.4	4.5	2.2	3.2	4	2.5
<i>Limnorchis zotheцина</i>	Moderately Conserved	0.3	0.0	0.0	0.1	3.3	8	2.5
<i>Lomatium concinnum</i>	Weakly Conserved	3.6	2.9	5.5	4.0	5.0	4	3.7
<i>Lupinus crassus</i>	Weakly Conserved	2.1	1.1	5.7	2.9	2.4	4	2.4
<i>Lygodesmia doloresensis</i>	Moderately Conserved	0.9	1.5	4.1	2.2	1.1	6	2.1
<i>Machaeranthera coloradoensis</i>	Effectively Conserved	3.0	3.3	7.5	4.6	5.2	8	4.6
<i>Mentzelia rhizomata</i>	Weakly Conserved	2.4	2.4	4.6	3.1	5.8	2	3.3
<i>Mertensia humilis</i>	Weakly Conserved	0.3	0.0	2.8	1.0	unknown	0	0.7
<i>Mimulus gemmiparus</i>	Effectively Conserved	0.8	0.0	5.2	2.0	7.5	6	4.2
<i>Nuttallia chrysantha</i>	Under Conserved	2.6	3.5	4.6	3.6	3.7	0	2.4
<i>Nuttallia densa</i>	Moderately Conserved	2.1	2.8	5.4	3.4	3.3	0	2.2
<i>Oenothera acutissima</i>	Weakly Conserved	1.5	2.7	4.7	2.9	1.3	8	2.8
<i>Oenothera harringtonii</i>	Moderately Conserved	5.1	4.3	7.2	5.5	2.5	2	3.0
<i>Oonopsis foliosa var. monocephala</i>	Effectively Conserved	1.3	2.7	6.1	3.4	6.2	6	4.2
<i>Oonopsis puebloensis</i>	Weakly Conserved	2.4	4.1	4.4	3.6	4.4	2	3.0
<i>Oreocarya osterhoutii</i>	Moderately Conserved	0.8	0.0	5.8	2.2	unknown	8	2.8
<i>Oreoxis humilis</i>	Moderately Conserved	0.3	2.8	1.1	1.4	10.0	8	5.1
<i>Oxybaphus rotundifolius</i>	Weakly Conserved	3.3	4.2	5.7	4.4	6.2	2	3.9

Primary Threat	Threat - Scope	Threat - Severity	Threat - Immediacy	Threats Status Score	Protection Status Score	Confidence in Score	On-the-Ground Action	Field Inventory	Monitoring	Taxonomic Work
housing/ urban dev.	High	High	Moderate	0	0.0	Very High	X		X	
unknown	Insig.	Insig.	Insig.	10	1.9	Low		X		
housing/ urban dev.	Moderate	Unknown	Moderate	8	0.9	Moderate		X		
oil & gas/oil shale mining	High	High	High	0	5.9	Very High	X		X	
oil & gas/oil shale mining	High	High	High	0	2.3	Low		X	X	
housing/ urban dev.	Moderate	Moderate	Moderate	2	5.7	Moderate	X			
roads/ recreation	Moderate	Moderate	Low	5	5.2	Moderate	X			
hydrologic alteration	Moderate	Moderate	Low	5	10.0	Low		X		
recreation/ motorized	Moderate	Moderate	High	2	3.0	High	X			
incompatible grazing	Moderate	Moderate	Moderate	2	7.9	Low		X		
roads	Moderate	Unknown	High	8	4.1	Moderate	X	X		
recreation/ hiking	Low	Low	Low	9	7.0	High			X	
oil & gas/oil shale mining	Moderate	Moderate	High	2	3.8	Moderate	X			
unknown	Insig.	Insig.	Insig.	10	2.1	Low		X		
recreation/ hiking	Moderate	Moderate	Low	5	9.9	High	X		X	
housing/ urban dev.	Moderate	Moderate	High	2	2.9	High	X			
recreational uses	Low	Moderate	High	6	4.6	Moderate	X			
hydrologic alteration	Moderate	Moderate	Moderate	2	3.1	Low		X		
housing/ urban dev.	Low	Moderate	High	6	2.3	High	X			
roads	Low	Low	Low	9	6.2	High			X	
mining/ urbanization	Moderate	Moderate	High	2	1.2	Very High	X			
recreation/ hiking	Low	Low	Low	9	6.0	Low		X		
roads	Moderate	Moderate	Moderate	2	6.8	Very High			X	
housing/ urban dev.	Moderate	Moderate	High	2	4.5	Very High	X			

Scientific Name (State)	Overall Conservation Status	# Occurrences Score	Occupied Area Score	Range Score	Size Score	Quality Score	Land-scape Integrity Score	Bio-diversity Score
<i>Oxytropis besseyi</i> var. <i>obnapiformis</i>	Weakly Conserved	1.6	0.0	5.8	2.5	unknown	6	2.6
<i>Penstemon breviculus</i>	Moderately Conserved	2.2	3.3	6.1	3.8	3.2	2	2.7
<i>Penstemon debilis</i>	Under Conserved	0.6	0.7	0.4	0.6	6.7	6	3.4
<i>Penstemon degeneri</i>	Moderately Conserved	1.3	2.8	5.2	3.1	3.1	6	3.1
<i>Penstemon fremontii</i> var. <i>glabrescens</i>	Weakly Conserved	1.2	2.3	4.3	2.6	unknown	6	2.7
<i>Penstemon gibbensii</i>	Weakly Conserved	0.2	1.1	0.0	0.4	10.0	6	4.5
<i>Penstemon grahamii</i>	Weakly Conserved	0.5	2.9	0.3	1.2	unknown	8	2.2
<i>Penstemon harringtonii</i>	Moderately Conserved	6.2	5.2	6.0	5.8	4.0	2	3.6
<i>Penstemon penlandii</i>	Weakly Conserved	0.2	3.1	0.0	1.1	10.0	0	3.7
<i>Penstemon scariosus</i> var. <i>albifluvis</i>	Under Conserved	0.2	1.4	0.2	0.6	0.0	8	1.5
<i>Penstemon scariosus</i> var. <i>cyanomontanus</i>	Effectively Conserved	1.1	0.0	2.3	1.1	7.3	8	4.1
<i>Phacelia formosula</i>	Weakly Conserved	1.1	2.8	3.9	2.6	7.3	6	4.3
<i>Phacelia submutica</i>	Under Conserved	3.4	2.8	3.9	3.4	0.9	2	1.7
<i>Physaria bellii</i>	Weakly Conserved	2.8	3.8	5.6	4.0	5.0	0	3.0
<i>Physaria obcordata</i>	Weakly Conserved	1.0	2.6	3.7	2.4	6.0	6	3.8
<i>Physaria pulvinata</i>	Weakly Conserved	0.2	0.8	1.5	0.8	10.0	2	3.9
<i>Physaria rollinsii</i>	Weakly Conserved	0.8	0.0	5.2	2.0	unknown	0	1.3
<i>Potentilla rupincola</i>	Effectively Conserved	2.4	3.0	6.0	3.8	5.0	6	3.9
<i>Ptilagrostis porteri</i>	Moderately Conserved	2.4	3.0	5.6	3.7	4.4	8	4.0
<i>Puccinellia parishii</i>	Moderately Conserved	0.1	0.0	0.0	0.0	10.0	5	4.2
<i>Salix arizonica</i>	Moderately Conserved	0.1	0.0	0.0	0.0	unknown	8	1.4
<i>Saussurea weberi</i>	Effectively Conserved	1.2	3.0	3.3	2.5	4.2	6	3.2
<i>Sclerocactus glaucus</i>	Weakly Conserved	7.5	3.6	6.1	5.7	1.4	2	2.7
<i>Sclerocactus mesae-verdae</i>	Under Conserved	2.3	0.0	1.7	1.3	unknown	6	1.9

Primary Threat	Threat - Scope	Threat - Severity	Threat - Immediacy	Threats Status Score	Protection Status Score	Confidence in Score	On-the-Ground Action	Field Inventory	Monitoring	Taxonomic Work
oil & gas	High	High	High	0	4.4	Low		X		
recreation/ motorized	Low	Low	Low	9	6.1	Moderate				
oil & gas	High	High	High	0	1.3	Very High	X		X	
recreation/ motorized	Moderate	Moderate	Moderate	2	5.9	Moderate	X	X	X	
oil & gas	High	High	High	0	4.6	Low		X		
recreation/ motorized	Moderate	Moderate	Moderate	2	4.0	High	X		X	
oil and gas	Moderate	Moderate	High	2	6.3	Low	X	X	X	
housing/ urban dev./ recreation	Low	Moderate	Moderate	6	3.2	Very High			X	
recreation/ motorized	Moderate	Moderate	High	2	2.1	Very High	X		X	
oil & gas	Moderate	Moderate	High	2	5.7	Very High	X		X	
incompatible grazing	Low	Low	Low	9	10.0	Low		X		
recreation/ motorized	Moderate	Moderate	Moderate	2	3.1	High	X		X	
oil & gas	Moderate	Moderate	High	2	4.7	Moderate	X	X	X	
housing/ urban dev.	Moderate	Moderate	High	2	3.3	High	X			
oil shale, nahcolite mining	High	High	High	0	4.8	Very High	X		X	
recreation/ motorized and non	High	Moderate	High	0	5.0	Very High	X	X		
unknown	Insig.	Insig.	Insig.	10	2.2	Low		X		
exotic species	Low	Low	Low	9	7.2	High			X	
hydrologic alteration	Moderate	High	Moderate	2	5.9	High	X			
hydro. alteration/ recreation	Moderate	Moderate	Low	5	1.0	High*	X	X		
incompatible grazing	Low	Moderate	Moderate	6	7.3	Moderate*	X	X		
mining	Moderate	Moderate	Low	5	6.6	Moderate	X	X		
oil & gas	High	Moderate	High	0	3.6	Moderate	X	X	X	
collecting/ insect herbivory	Moderate	Moderate	High	2	2.0	Low		X		

<i>Scientific Name (State)</i>	Overall Conservation Status	# Occurrences Score	Occupied Area Score	Range Score	Size Score	Quality Score	Land-scape Integrity Score	Bio-diversity Score
<i>Sisyrinchium pallidum</i>	Moderately Conserved	3.9	3.1	7.3	4.8	2.4	2	2.7
<i>Spiranthes diluvialis</i>	Weakly Conserved	1.8	2.4	8.4	4.2	2.2	0	2.1
<i>Telesonix jamesii</i>	Effectively Conserved	2.2	2.4	5.9	3.5	4.1	6	3.5
<i>Thalictrum heliophilum</i>	Weakly Conserved	3.3	2.1	5.3	3.6	5.0	6	3.9
<i>Townsendia fendleri</i>	Moderately Conserved	0.8	1.1	5.4	2.4	3.8	2	2.4
<i>Townsendia glabella</i>	Weakly Conserved	1.9	1.1	5.2	2.7	3.7	0	2.1
<i>Townsendia rothrockii</i>	Effectively Conserved	2.7	2.9	7.8	4.5	unknown	8	4.3

Primary Threat	Threat - Scope	Threat - Severity	Threat - Immediacy	Threats Status Score	Protection Status Score	Confidence in Score	On-the-Ground Action	Field Inventory	Monitoring	Taxonomic Work
hydrologic alteration	Low	High	Moderate	6	3.6	Moderate	X			
hydrologic alteration	Moderate	Moderate	Moderate	2	4.4	High	X		X	
recreation/ hiking	Low	Low	Low	9	6.7	Moderate		X		
oil & gas	Moderate	Moderate	Moderate	2	4.3	Low	X	X		
housing/ urban dev.	Moderate	Unknown	Moderate	8	4.4	Moderate		X		
housing/ urban dev.	Low	Moderate	High	6	1.3	Moderate	X			
motorized recreation	Moderate	Low	Unknown	8	7.2	Low		X		

APPENDIX G: NATURAL HERITAGE METHODOLOGY

Our scorecard uses standardized natural heritage methodology that incorporates a rigorous set of procedures for identifying, inventorying, and mapping species and ecosystems of conservation concern (Master 1991, Master et al. 2000, NatureServe 2008). In the standardized usage of natural heritage methodology, species, natural communities, and ecological systems are “elements of biodiversity,” and as such are often identified as conservation targets in planning and management efforts. The central concept in tracking imperiled elements is the “element occurrence,” a spatial representation of a species or ecological community at a specific location (Stein et al. 2000, NatureServe 2002). An element occurrence delineates a species population or contiguous tract of ecological community or system, and is intended to represent the biological feature that is the target of conservation and management efforts. Element occurrence records contain information about the extent, population size, condition, and management status of each occurrence. Elements are tracked by state natural heritage programs or conservation data centers according to their degree of imperilment and taxonomic status.

The standard natural heritage methodology is a consistent method for evaluating the relative imperilment of species, and designating a conservation status rank (Master 1991, Stein et al. 2000). In addition to the information contained in element occurrence records, NatureServe and the individual natural heritage programs compile and maintain qualitative and descriptive information about each element. Together with the element occurrence records, this data serves as the basis for an element’s global and state conservation ranking. For plant and animal species these ranks provide an estimate of extinction risk.

To determine the status of species within Colorado, CNHP gathers information on plants, animals and plant communities. Each of these elements of natural diversity is assigned a rank that indicates its relative degree of imperilment on a five-point scale (for example, 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences (in other words, the number of known distinct localities or populations). This factor is weighted more heavily than other factors because an element found in one place is more imperiled than something found in twenty-one places. Also of importance are the size of the geographic range, the number of individuals, the trends in both population and distribution, identifiable threats and the number of protected occurrences. The Colorado Natural Heritage Program uses the Biodiversity Tracking and Conservation System (BIOTICS) database to track species and plant community elements. As of May 2008 the database contained

information on 13,067 element occurrences (CNHP 2008), and served as the primary data source for analysis of rare species presented in this report.

Status is assessed and documented at both the global (G), and state/provincial (S) geographic scales. Intraspecific taxon ranks (T-ranks) refer to subspecies, varieties and other designations below the level of the species, and have a similar interpretation. Conservation status ranks are on a scale from one to five, ranging from critically imperiled (G1, S1 or T1) to demonstrably secure (G5, S5 or T5). These ranks are based on the best available information, and incorporate a variety of factors such as abundance, viability, distribution, population trends, and threats. CNHP actively collects maps and electronically processes specific occurrence information for animal and plant species considered extremely imperiled to vulnerable in the state (S1 - S3). Several factors, such as rarity, evolutionary distinctiveness and endemism (specificity of habitat requirements), contribute to the conservation priority of each species. Certain species are “watchlisted,” meaning that specific occurrence data are collected and periodically analyzed to determine whether more active tracking is warranted. A complete description of each of the Natural Heritage ranks is provided in Table G-1.

This single rank system works readily for all species except those that are migratory. Those animals that migrate may spend only a portion of their life cycles within the state. In these cases, it is necessary to distinguish between breeding, non-breeding and resident species. As noted in Table G-1, ranks followed by a “B,” for example S1B, indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an “N,” for example S4N, refer to non-breeding status, typically during migration and winter. Elements without this notation are believed to be year-round residents within the state.

Table G-1. Definition of Natural Heritage Imperilment Ranks.

G/S1	Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or 1,000 or fewer individuals), or because some factor of its biology makes it especially vulnerable to extinction.
G/S2	Imperiled globally/state because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or because other factors demonstrably make it very vulnerable to extinction throughout its range.
G/S3	Vulnerable through its range or found locally in a restricted range (21 to 100 occurrences, or 3,000 to 10,000 individuals).
G/S4	Apparently secure globally/state, though it may be quite rare in parts of its range, especially at the periphery. Usually more than 100 occurrences and 10,000 individuals.
G/S5	Demonstrably secure globally/state, though it may be quite rare in parts of its range, especially at the periphery.
G/SX	Presumed extinct globally, or extirpated within the state.
G#?	Indicates uncertainty about an assigned global rank.
G/SU	Unable to assign rank due to lack of available information.
GQ	Indicates uncertainty about taxonomic status.
G/SH	Historically known, but not verified for an extended period of time.
G#T#	Trinomial rank (T) is used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.
S#B	Refers to the breeding season imperilment of elements that are not residents.
S#N	Refers to the non-breeding season imperilment of elements that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used.
SZ	Migrant whose occurrences are too irregular, transitory and/or dispersed to be reliably identified, mapped and protected.
SA	Accidental in the state.
SR	Reported to occur in the state but unverified.
S?	Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking.
Note: Where two numbers appear in a state or global rank (for example, S2S3), the actual rank of the element is uncertain, but falls within the stated range.	

Legal Designations for Rare Species

Natural Heritage imperilment ranks should not be interpreted as legal designations. Although most species protected under state or federal endangered species laws are extremely rare, not all rare species receive legal protection. Legal status is designated by both the U.S. Fish and Wildlife Service under the Endangered Species Act or by the Colorado Division of Wildlife under Colorado Statutes 33-2-105 Article 2. In addition, the U.S. Forest Service recognizes some species as "Sensitive," as does the Bureau of Land Management. Table G-2 defines the special status assigned by these agencies and provides a key to abbreviations used by CNHP.

Table G-2. Federal and State Agency Special Designations for Rare Species.

Federal Status:	
1. U.S. Fish and Wildlife Service (58 Federal Register 51147, 1993) and (61 Federal Register 7598, 1996)	
LE	Listed Endangered: defined as a species, subspecies, or variety in danger of extinction throughout all or a significant portion of its range.
LT	Listed Threatened: defined as a species, subspecies, or variety likely to become endangered in the foreseeable future throughout all or a significant portion of its range.
P	Proposed: taxa formally proposed for listing as Endangered or Threatened (a proposal has been published in the Federal Register, but not a final rule).
C	Candidate: taxa for which substantial biological information exists on file to support proposals to list them as endangered or threatened, but no proposal has been published yet in the Federal Register.
PDL	Proposed for delisting.
XN	Nonessential experimental population.
2. U.S. Forest Service (Forest Service Manual 2670.5) (noted by the Forest Service as "S")	
FS	Sensitive: those plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by:
	Significant current or predicted downward trends in population numbers or density.
	Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.
3. Bureau of Land Management (BLM Manual 6840.06D) (noted by BLM as "S")	
BLM	Sensitive: those species found on public lands designated by a State Director that could easily become endangered or extinct in a state. The protection provided for sensitive species is the same as that provided for C (candidate) species.
4. State Status:	
The Colorado Division of Wildlife has developed categories of imperilment for non-game species (refer to the Colorado Division of Wildlife's Chapter 10 – Nongame Wildlife of the Wildlife Commission's regulations). The categories being used and the associated CNHP codes are provided below.	
E	Endangered: those species or subspecies of native wildlife whose prospects for survival or recruitment within this state are in jeopardy, as determined by the Commission.
T	Threatened: those species or subspecies of native wildlife which, as determined by the Commission, are not in immediate jeopardy of extinction but are vulnerable because they exist in such small numbers, are so extremely restricted in their range, or are experiencing such low recruitment or survival that they may become extinct.
SC	Special Concern: those species or subspecies of native wildlife that have been removed from the state threatened or endangered list within the last five years; are proposed for federal listing (or are a federal listing "candidate species") and are not already state listed; have experienced, based on the best available data, a downward trend in numbers or distribution lasting at least five years that may lead to an endangered or threatened status; or are otherwise determined to be vulnerable in Colorado.

Element Occurrences and their Ranking

Actual locations of elements, whether they are single organisms, populations, or plant communities, are referred to as element occurrences. The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of the Natural Heritage Methodology. As part of the application of standard natural heritage program methodology to element occurrence data, CNHP develops and uses ranking specifications for individual element occurrences. To prioritize element occurrences for a given species, an element occurrence rank (EO-Rank) is assigned according to the ecological quality of the occurrences whenever sufficient information is available. Element occurrence ranks are intended to reflect the likelihood that a particular occurrence will remain extant if current conditions remain essentially unchanged for the foreseeable future, and to provide a measure of the relative quality of an occurrence (NatureServe 2002). Ranks are a summary estimate of the viability of an occurrence. The EO-Rank is based on three factors:

Size – a measure of the area or abundance of the element's occurrence. Takes into account factors such as area of occupancy, population abundance, population density, population fluctuation and minimum dynamic area (which is the area needed to ensure survival or re-establishment of an element after natural disturbance). This factor for an occurrence is evaluated relative to other known and/or presumed viable, examples.

Condition/Quality – an integrated measure of the composition, structure and biotic interactions that characterize the occurrence. This includes measures such as reproduction, age structure, biological composition (such as the presence of exotic versus native species), structure (for example, canopy, understory and ground cover in a forest community) and biotic interactions (such as levels of competition, predation and disease).

Landscape Context – an integrated measure of two factors: the dominant environmental regimes and processes that establish and maintain the element and connectivity. Dominant environmental regimes and processes include herbivory, hydrologic and water chemistry regimes (surface and groundwater), geomorphic processes, climatic regimes (temperature and precipitation), fire regimes and many kinds of natural disturbances. Connectivity includes such factors as a species having access to habitats and resources needed for life cycle completion, fragmentation of ecological communities and systems and the ability of the species to respond to environmental change through dispersal, migration, or re-colonization.

Each of these factors is rated on a scale of A through D, with A representing an excellent rank or D representing a poor rank. These ranks for each factor are then averaged to determine an appropriate EO-Rank for the occurrence. If not enough information is available to rank an element occurrence, an EO-Rank of E is assigned. EO-Ranks and their definitions are summarized in Table G-3.

Table G-3. Element Occurrence Ranks and their Definitions.

A	Excellent viability.
B	Good viability
C	Fair viability.
D	Poor viability.
H	Historic: known from historical record, but not verified for an extended period of time.
X	Extirpated (extinct within the state).
E	Extant: the occurrence does exist but not enough information is available to rank.
F	Failed to find: the occurrence could not be relocated.

Literature Cited

Master, L.L. 1991. Assessing Threats and Setting Priorities for Conservation. *Conservation Biology* 5:559-563.

Master, L.L., Stein, B.A., Kutner, L.S., Hammerson, G. 2000. Vanishing Assets: Conservation Status of US Species. In Bruce, A., Stein, Kutner, L.S., Adams, J.S., eds. *Precious Heritage: Status of Biodiversity in the United States*. Oxford University Press, pp. 93–118.

NatureServe. 2002. Element Occurrence Data Standard. NatureServe, in cooperation with the network of Natural Heritage Programs and Conservation Data Centers. <http://www.natureserve.org/prodServices/eodata.jsp>

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. <http://www.natureserve.org/explorer>

Stein, B.A., L.S. Kutner, J.S. Adams. 2000. *Precious Heritage. The Status of Biodiversity in the United States*. Oxford University Press, New York, New York.



© Michael Menefee

Colorado Natural Heritage Program, Warner College of Natural Resources
Colorado State University
Fort Collins, Colorado, www.cnhp.colostate.edu