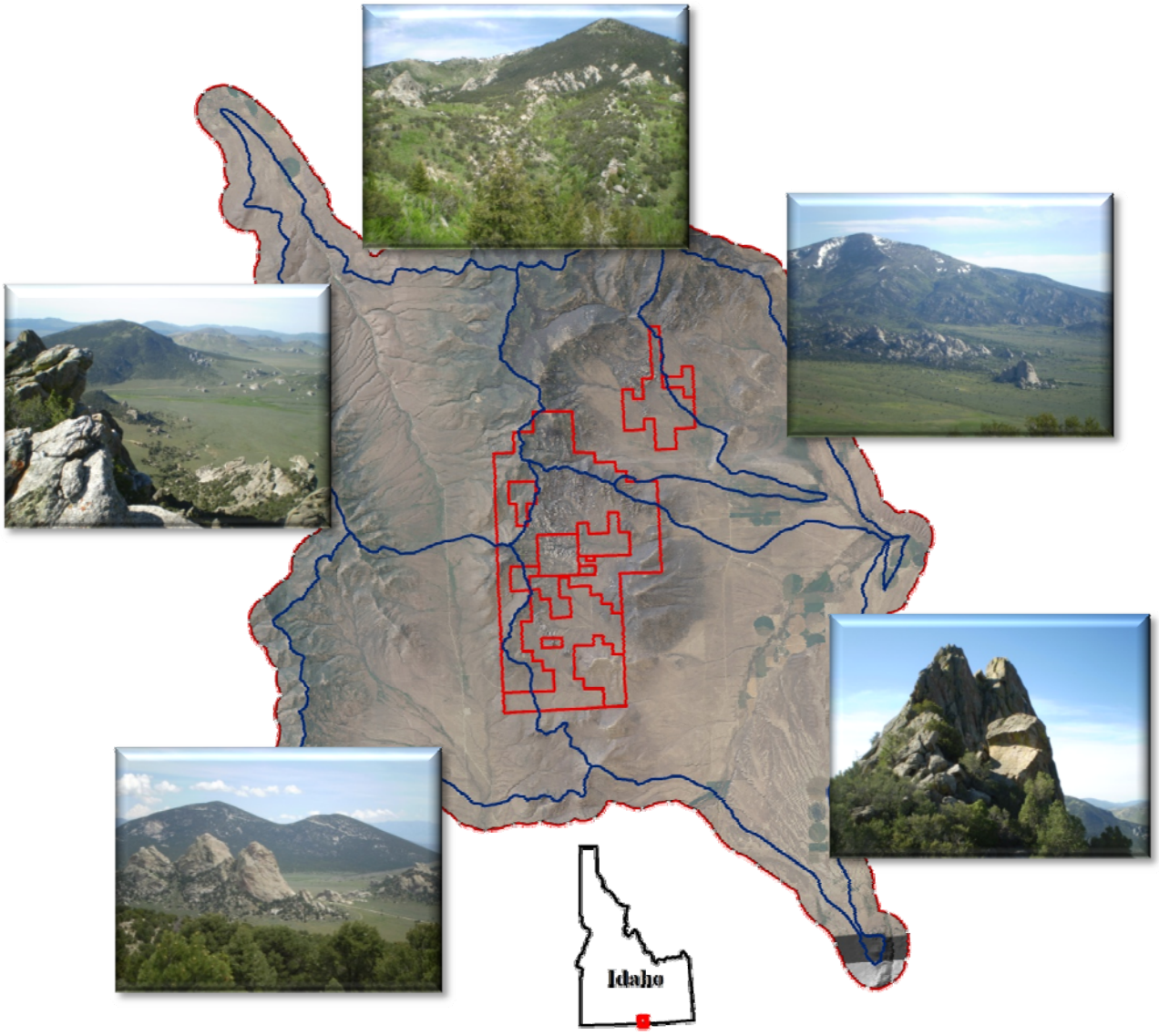
National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Natural Resource Condition Assessment

City of Rocks National Reserve

Natural Resource Report NPS/UCBN/NRR—2012/600



ON THE COVER
Map of City of Rocks National Reserve located in south-central Idaho with insets of pictures from the City of Rocks National Reserve website and Northwest Management, Inc.

Natural Resource Condition Assessment

City of Rocks National Reserve

Natural Resource Report NPS/UCBN/NRR—2012/600

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U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Publisher's Note: Some or all of the work done for this project preceded the revised guidance issued for this project series in 2009/2010. See Prologue (p. viii) for more information.

Executive Summary

City of Rocks National Reserve (CIRO) was created November 18, 1988 through Public Law 100-696, Arizona-Idaho Conservation Act of 1988. The Conservation Act established a 22 mile (35.4 kilometer) boundary around lands owned or managed by the USDA Forest Service (USFS), Bureau of Land Management (BLM), Idaho Department of Parks and Recreation (IDPR), and private holdings. After the approval of the *1994 City of Rocks National Reserve Comprehensive Management Plan,* the National Park Service (NPS) transferred on-site management of CIRO to IDPR on May 2, 1996. The CIRO Natural Resource Condition Assessment (NRCA) report and accompanying geodatabase is designed to give park managers and planners a better understanding of the natural resources present within this unique area. This NRCA was developed through review of existing literature and available data coupled with the collection of new upland and water resource information.

The history of CIRO has been well documented from emigrants travelling the California Trail to ranchers and settlers, and more recently by CIRO's international popularity as a destination for rock climbing enthusiasts. The natural resources comprising CIRO are changing due to influences of humans, climate variations, precipitation fluctuation, and wildfire. Over the last three decades the CIRO area has experienced a marked increase in population which suggests compounded stresses on natural resources. Population growth has occurred from 2000 to 2009 in the counties supporting and nearest CIRO, e.g., Cassia County, Idaho, and Box Elder County, Utah by 7,433 people or 11.6% (U.S. Census Bureau 2010). Increases in population can mean increased habitat conversion outside the CIRO boundary, added recreational use, increased pressure on natural resources, and/or degradation of unique systems supporting common to sensitive species. Unique systems in and around CIRO are defined by interactions between geology, soil, slope steepness and exposure, hydrology, and plant communities supporting a biologically diverse set of wildlife habitats and plant species. The significance of this biological and habitat diversity and the observed anthropogenic impacts is described under the discussion of completed and proposed inventories, existing and proposed monitoring plans, management actions, and the vital signs selected for CIRO.

The increased use of climbing areas, trails, and access roads within CIRO has resulted in soil erosion and vegetation degradation, including non-native plant species invasion in staging areas. Visual impacts to areas of some California Trail Historic viewsheds are also created by the presence of climbers. Climbing route installation has caused degradation of some geologic features (GRI 1999), as well as some disturbance to wildlife. The 1998 Climbing Management Plan expresses concerns associated with impacts resulting from rock climbing and CIRO managers have observed additional impacts to climbing sites including vegetation crushing/removal, soil compaction/erosion, and domestic dogs digging holes for cooler temperature and shade. There is growing interest in public education regarding degradation of staging area vegetation, wildlife habitat, and species, including invertebrates within vernal pools.

Changes in local climate, land use, wildfire, and non-native species invasion of semiarid regions like CIRO alter sagebrush-steppe shrublands and sagebrush-associated endemic species, further altering historical (presettlement) natural systems (Rodhouse 2009). According to the Center for Science, Economics, and Environment (2002), 20% of sagebrush-associated flora and fauna across the intermountain west are considered imperiled due to vegetation changes.

However, there are ecological sites and organisms within CIRO and the adjoining Castle Rocks State Park (CRSP) area that require some soil or slope disturbance to persist. For example, quaking aspen (*Populus tremuloides*) is an important forest/woodland type that contributes to the biological diversity, wildlife habitat structure, and aesthetic significance of the park. Although quaking aspen comprises only a small percentage of the land cover in CIRO (100 acres or 40 hectares total), the community type contributes significantly to plant and wildlife species diversity and richness (Shive and Peterson 2002, Madison et al. 2003). The Upper Columbia Basin Network (UCBN) Inventory and Monitoring (I&M) Program implemented focused monitoring of quaking aspen regeneration and conifer encroachment within CIRO beginning in 2008. The desired condition for quaking aspen within CIRO includes stands with adequate regeneration (>1,200 stems/ha), no or low levels of conifer encroachment and a quaking aspen canopy cover >40%. Preliminary visual examination of the time series aerial photography (1950, 1977, 1990, and 2004) for a central area in CIRO reveals a reduction in quaking aspen density within several clones although the areal extent of the clones over 55 years appear similar. Such results would indicate that older trunks are dying due to age, disease, and/or wind throw leaving the canopy more open.

Grazing has been an influential land use element of the CIRO region since the mid- to late-1800s. Rapid assessments of grazing-affected plant communities conducted as part of this project suggest they are functioning properly. However, vegetation monitoring results provided by the UCBN I&M Program point to some evidence of overgrazing, particularly in the Circle Creek Area (Rodhouse 2011). Tighter grazing management would likely benefit the condition of CIRO and CRSP natural resources, generally, and particularly sensitive riparian and wetland areas would likely receive the most benefit in the short term. Limiting livestock to fenced stream access locations would help prevent streambank degradation and alternating pastures to avoid overgrazing would assist in curtailing the spread of non-native invasive plants and noxious weeds within CIRO. Limiting overgrazing could support fire prevention efforts by CIRO managers by slowing the spread of cheatgrass which invades following burns and increases the occurrence of fire due to production of fine fuels. Clear evidence of the risk of fire to CIRO and CRSP upland vegetation has been demonstrated by UCBN I&M monitoring. Recently burned areas in the southern portion of CIRO are now heavily infested with cheatgrass, whereas most of the other upland portions of the parks have very low levels of cheatgrass infestation (Rodhouse 2011).

Fire has clearly played an important role in facilitating the spread of non-native herbaceous (forb and grass) rangeland species. Through fire suppression, grazing, and recreation, the frequency of fire throughout the intermountain west has historically been reduced, leading to encroachment of woody vegetation like pinyon pine and juniper. Alternatively, the invasion of cheatgrass and other annual exotic grasses has accelerated fire frequencies, particularly in the Snake River Plain of southern Idaho. Together, these two phenomena create an extremely challenging management

environment for the CIRO resource management team. Mountain mahogany tall shrubland and pinyon-juniper woodland stands have encroached into sagebrush communities in the park, increasing the fuel loads across the park, creating the potential for larger, more catastrophhic wildfires (Link et al. 2006). Based on the rapid cheatgrass infestation in the southern portion of the park following fire in pinyon-juniper woodland, it is clear that this poses a serious risk to long-term preservation of biological integrity in the park. Furthermore, the goal of CIRO managers is to restore the historic (pre-settlement) ecosystem while supporting recreation and ranching viability in conjunction with minimizing hazardous wildfire conditions and curtailing the spread of noxious weed species. Therefore, a balanced approach to curtailing woodland encroachment in historic viewshed areas and areas vulnerable to unplanned human-caused fire ignition should be considered. Pinyon-juniper woodlands, particularly those "old-growth" type stands growing in and around rock features provide critical habitat for many wildlife species (Rodhouse et al. 2010), and those should be protected. Removal and thinning of pinyon-juniper woodlands should be approached cautiously, so as not to overly impact soils and spread invasive weeds with heavy equipment. In general, we recommend small well-planned treatments, conducted in conjunction with monitoring so that unintended negative impacts can be evaluated. Over several years, a series of small fuel reduction treatments will result in a net reduction of fire risk, and enable the park managers to minimize unanticipated impacts.

In response to the 2010 EPA-proposed regulations, the NPS has initiated the first air quality monitoring station deployment in CIRO, in part as a means for managers to understand the interactions of ozone and the extant natural resources. One consideration for CIRO managers is to monitor a comparison of ozone/air quality data with climate change and vegetation inventory because some plant species are sensitive to ozone (UCBN 2001) and thereby can be linked to global warming (Hopkin 2007). The vulnerability of habitats and species to climate change can be affected by chosen management pathways because impacts can be reduced or delayed through applied mitigation practices (Parry et al. 2007, Mote et al. 2008). The impact of climate change on natural resources within CIRO and CRSP will be influenced by ecosystem stability and species diversity within each unit.

Ecosystem stability and species diversity depend heavily on management practices when an area receives as much human recreational influence as does CIRO. Balancing management of the flora and fauna species, soils, hydrology, and recreation with growing concerns for climate change and air quality effects present exceptional challenges for managers and require continuous updates of relevant data. The expanding population and changing land use of surrounding areas and the ease of access to climbing areas will further increase pressure for multifaceted management. Additionally, the presence of unique crustaceans and vernal pool habitat, amphibians and reptiles, small mammals, birds, and all 14 bat species known in Idaho, motivates the need for future research and monitoring studies that focus on these organisms and key habitats as indicators of ecosystem health or degradation (Welsh and Olivier 1998, Read 2002, Newson et al. 2009, Jones et al. 2009). Additionally, the potential to use benthic macroinvertebrate data (Starkey 2010) to assist in water quality analyses may benefit wetland and riparian area and water resource conservation efforts focused on preservation of sensitive species such as the Yellowstone cutthroat trout populations which occur outside the CIRO boundary in Almo Creek.

Hydrologic and aquatic resource threats have been identified within CIRO that pose a risk to water resources and require managers to more fully understand the ecological effects of visitor use on streams, wetlands, and riparian stands. Stream bank stabilization, riparian area health, and water quantity and quality in the site watershed(s) should be focal points for management. Routine monitoring of aquatic systems including surface flows, depth to ground water, water quality sampling and analysis, turbidity, and benthic macroinvertebrates should be established to prepare a baseline, track changes, and aid in assessing Proper Functioning Conditions of stream reaches. Future projects providing geographic information will further support more detailed analysis of succession and distribution of CIRO resources to better understand physiographic and biologic attribute relationships.

An overall description of CIRO natural resources, historic overview, condition, threats, and stressors are presented throughout this document followed by a site summary and management recommendations. All management practices structured toward attaining Proper Functioning Conditions within natural ecosystems will aid NPS, UCBN, and CIRO resource managers to accomplish the goal of resource conservation for future generations.

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Prologue

Publisher's Note: This was one of several projects used to demonstrate a variety of study approaches and reporting products for a new series of natural resource condition assessments in national park units. Projects such as this one, undertaken during initial development phases for the new series, contributed to revised project standards and guidelines issued in 2009 and 2010 (applicable to projects started in 2009 or later years). Some or all of the work done for this project preceded those revisions. Consequently, aspects of this project's study approach and some report format and/or content details may not be consistent with the revised guidance, and may differ in comparison to what is found in more recently published reports from this series.

Acronyms and Abbreviations

BLM	U.S. Bureau of Land Management
CAA	Clean Air Act of 1970, as amended
CIRO	City of Rocks National Reserve and Castle Rocks State Park
CRSP	Castle Rocks State Park
DEQ	Department of Environmental Quality (Idaho)
DOI	U.S. Department of the Interior
GIS	Geographic Information System
IDFG	Idaho Department of Fish and Game
ISU	Idaho State University
I&M Program	Inventory and Monitoring Program
IDPR	Idaho Department of Parks and Recreation
IMPROVE	Interagency Monitoring of Protected Visual Environments
ISDA	Idaho State Department of Agriculture
km	Kilometers
km^2	Square kilometers
mi	Miles
mi^2	Square miles
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NASS	National Agricultural Statistics Service
NMI	Northwest Management, Incorporated
NPS	National Park Service
NRCA	Natural Resource Condition Assessment
NRR	Natural Resource Report
NVC	National Vegetation Classification
NVIP	National Vegetation Inventory Program
PSD	Prevent Significant Deterioration
Reserve	City of Rocks National Reserve
UCBN	Upper Columbia Basin Network
U.S.	United States of America
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WCA Program	Watershed Condition Assessment Program
WRCC	Western Region Climate Center

Publisher's Note: Some or all of the work done for this project preceded the revised guidance issued for this project series in 2009/2010. See Prologue (p. viii) for more information.

Introduction

Purpose and Scope

The mission of the National Park Service (NPS) is "*to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of this and future generations*" (NPS 1999). To uphold this goal, the Director of the NPS approved the Natural Resource Challenge to encourage national park managers to focus on the preservation of the U.S. natural heritage through science, natural resource inventories, and expanded resource monitoring (NPS 1999). Through the challenge, 270 units in the national park system were organized into 32 inventory and monitoring networks, including the UCBN.

The UCBN consists of nine widely separated NPS units located in western Montana, Idaho, eastern Washington, and central Oregon; they include: Big Hole National Battlefield, City of Rocks National Reserve, Craters of the Moon National Monument and Preserve, Hagerman Fossil Beds National Monument, John Day Fossil Beds National Monument, Lake Roosevelt National Recreation Area, Minidoka National Historic Site, Nez Perce National Historical Park, and Whitman Mission National Historic Site.

As part of the Natural Resource Challenge, the NPS Water Resources Division received an increase in funding to assess natural resource conditions within selected national park units including City of Rocks National Reserve (CIRO). Management oversight and technical support for this effort is provided by the Water Resources Division, Watershed Condition Assessment (WCA) Program. The WCA Program partnered with the NPS Pacific West Region to fund and oversee an assessment for each park unit in the UCBN. This report documents the results of the Natural Resource Condition Assessment (NRCA) completed for CIRO; it is anticipated that the NRCA will ultimately provide important information for the state of the parks reports that are currently in conceptual planning stages (Garrett, pers. comm. 2011).

Generally, this NRCA seeks to interpret and translate existing scientific information into a form that CIRO managers find useful for supporting natural resource decision-making, action plans, and cultural resource planning. NPS guidelines for creating NRCA's specifies the use of existing data, but field-based rapid assessment techniques can be used if sufficient upland data is lacking for a site (NPS 2009). For the UCBN parks, and CIRO in particular, prior authorization was given to collect new field data via rapid field assessments based on BLM rangeland health methodologies (Pellant et al. 2005).

The assessment of both the existing information and the new rapid assessment data for CIRO is summarized in this NRCA project report. The CIRO NRCA report and set of Geographic Information System (GIS) maps with associated data layers will serve to:

- Describe CIRO resources in a regional context (setting, significance, issues);
- Provide an interdisciplinary (holistic) snapshot of current resource conditions by management area;
- Document high-priority data gaps and resource condition threats and stressors; and

- Identify and describe "high value" and "high vulnerability" (at risk) CIRO resources and management areas.

It is important to note that this preliminary assessment of natural resources at CIRO is of a general level and will focus on providing broad ecological information. Information, data, and recommendations developed under this project will assist CIRO managers to:

- Develop near-term management strategies and priorities for the CIRO resource management program;
- Engage in watershed or landscape scale partnership and education efforts;
- Assist with mid- to longer-term planning (e.g. General Management Plans, Resource Stewardship Strategies, Implementation Plans)
- Meet performance reporting requirements on CIRO resource condition status (Department of Interior "land health" goals, Office of Management and Budget "natural resource condition" scorecard, NPS state of the parks reports, etc.)

NRCA Background

Natural Resource Condition Assessments (NRCAs) are broad-scope ecological assessments intended to develop synthesis "information products" readily usable by park managers for resource stewardship planning. NRCAs are needed for reporting on various performance measures, including the Department of the Interior (DOI) Strategic Plan "*land health*" goals. NRCAs evaluate current conditions for a subset of natural resource indicators in national park units that inform/identify: 1) overall trends (when possible), 2) critical data gaps, and 3) provide general levels of confidence. The resources and indicators emphasized in NRCAs are driven by the park resource setting, status of current resource stewardship planning, and established scientific principles. By evaluating criterion one through three, high-priority indicators are identified and the availability of data and expertise to assess the indicators and resources are addressed. Additional NRCA Program information may be accessed online at: http://www.nature.nps.gov/water/nrca/index.cfm

NRCAs represent a relatively new approach to assessing and reporting on park resource conditions. They are meant to complement, not replace, traditional issue- and threat-based resource assessments. Three key elements make NRCAs valuable for both planning and performance reporting. They include:

1. Building on multi-disciplinary data, information, and knowledge already assembled through efforts of the NPS Inventory and Monitoring (I&M) Program, other NPS science support programs, and from partner collaborators working in and near parks;
2. Emphasizing a strong geospatial component for how the assessment is conducted and in the resulting information products; and
3. Providing narrative and/or semi-quantitative descriptions of science-based reference conditions for resources that will assist park managers to define Desired Future Conditions through park planning processes (reference conditions will become more refined and quantitative over time).

Information gained from this NRCA report will form the basis for developing actions to reduce and prevent impairment of park resources through both park and partnership efforts. The stated goals of the NRCA are to:

Determine the state of knowledge concerning overall natural resource condition,

- Identify information gaps and resource threats,
- Assess overall ecosystem health, and
- Set the stage to establish the context for management actions and collaboration.

The ensuing report is designed to give park staff a moment-in-time or snapshot assessment using a combination of existing data and new rapid assessment point information for various upland sites in CIRO. The goal of this report is to adequately describe the natural resources of CIRO and their current condition while maintaining the consistency set forth under the national NRCA guidelines and standards for study design and reporting products. The overall objective of this project is to determine the state of knowledge of park condition using both existing and new rapid assessment data, identify information gaps, state conclusions or hypotheses on the condition of selected natural resources (unknown, degraded, unimpaired), identify resource threats or potential issues affecting ecosystem health, and recommend further studies.

Study Area

The City of Rocks National Reserve is located in southern Idaho (Cassia County) west of Almo, Idaho and southeast of Oakley, Idaho and two miles (3.2 kilometers) from the northern border of the State of Utah. CIRO encompasses a landscape of granitic spires, domes, and other unique geologic features of the southern Albion Mountains on the northern edge of the Basin and Range physiographic province. This area includes unique geology; granitic formations ranging in height from 5 to 600 feet (1.5 to 183 meters) throughout the approximately 14,407 acres (5,830 hectares) of CIRO (Figure 1). Two of the well known areas of CIRO are the Twin Sisters (granite formation) and preserved sections of the congressionally-designated California National Historic Trail.

CIRO is located in the southern part of the Albion Mountains, part of the Basin and Range. The Raft River Valley lies to the east and the Snake River Valley is to the north (Thornberry-Ehrlich 2010). The Reserve is central to three basins including Circle Creek, Twin Sisters, and Emigrant. These basins consist of erosional substrates (alluvium) underlain by rock layers that are sometimes exposed and have been cut into the predominantly granitic formations that form the mountains and narrow canyons of the area (Miller et al. 2008). Elevation varies from 5,650 feet (1,722 meters) where Circle Creek flows across the CIRO boundary, to 8,867 feet (2,703) at the summit of Granite Peak north of CIRO, and 10,339 feet (3,151 meters) atop Cache Peak (Thornberry-Ehrlich 2010).

Located approximately one mile (1.6 kilometers) north and east of CIRO is Castle Rocks State Park (CRSP) consisting of 1,440 acres (582.7 hectares). This park unit is situated at the base of Cache Peak two miles (3.2 kilometers) northwest of Almo, Idaho (Figure 1). CRSP was a privately owned ranch until 1999 when it was purchased by The Conservation Fund and the Access Fund supported in part by a NPS land trade. An additional 200 acres (80.9 hectares) were added in 2007 in order to fully connect CRSP to the southern base of Cache Peak. For the

purposes of this NRCA, CIRO and CRSP were jointly evaluated and the use of the acronym CIRO includes both units unless otherwise stated.

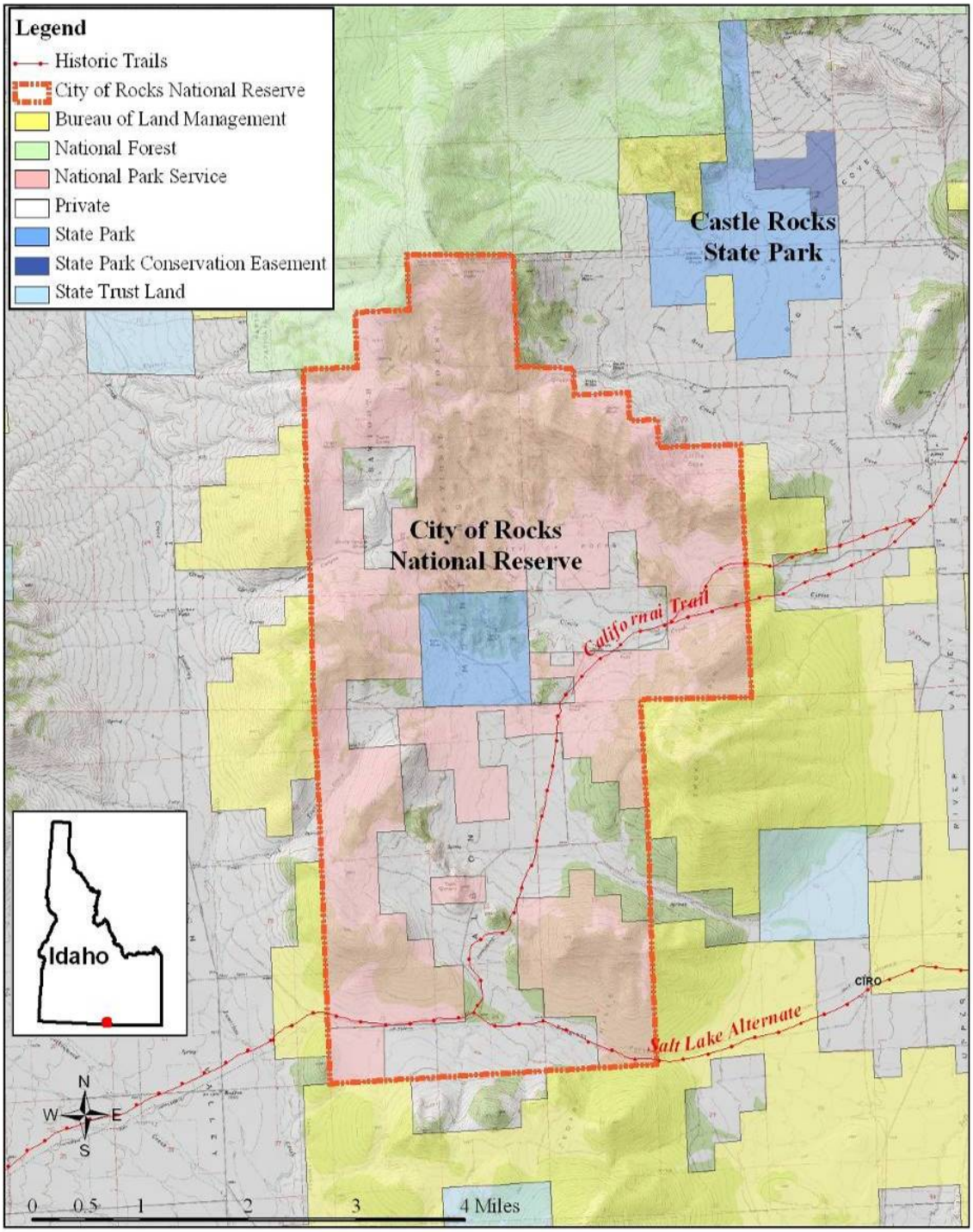


Figure 1. Map of CIRO and CRSP showing location, landownership, and management.

Historical Setting

As an element of the largest overland emigration in American history, the area now managed as CIRO preserves the most intact and authentic setting of the California Trail. The CIRO area served as a passage and place of refuge for Native Americans and emigrants due to the availability of shelter and water, cover, and forage for wild game and livestock. In 1848, Samuel Hensley identified a wagon route from the City of Rocks to the Bonneville Salt Flats and the Great Salt Lake which led to an increase in travelers through the area (Idaho State Historical Society 1995). The California Gold Rush increased the number of travelers passing through CIRO and in 1852 nearly 52,000 people transited the area, traveling mostly westward (Thornberry-Ehrlich 2010). Many travelers using the California Trail (1843-1882) described the CIRO area as "a unique landscape and natural oddity evoking wonder for all who see it". Emigrant artist James F. Wilkins named it the "City of Rocks" in 1849 due to the granitic exposures and spires throughout the area.

By the 1870s, ranchers and farmers began settling in the surrounding area and the communities of Almo and Junction Valley, Idaho were established. On February 27, 1957 the Idaho Legislature declared Section 36 within City of Rocks a state park under the jurisdiction of the Idaho Lands Board, shown in blue (Figure 1). In 1964, Section 36 was re-designated a National Historic Landmark and on March 15, 1973, Section 36 was transferred to the Idaho State Parks and Recreation (IDPR) from the Department of Lands and designated a National Natural Landmark in 1974. On November 18, 1988 the current City of Rocks boundary was created and designated a National Reserve based on its scenic qualities and attributes of historical and geological significance. The term CIRO is an abbreviation used by the NPS to designate the Reserve and does not name the state park called City of Rocks as designated in 1957.

Natural Resources

Wildlife

Wildlife inhabiting the plant communities and geologic exposures of CIRO include a variety of small mammal, bird, and reptile species, as well as larger ungulates and mesocarnivores like skunks and fox. The NPSpecies 2011 database lists 165 birds, 55 mammals, 20 reptiles, one fish, and one amphibian species as probably present to abundant (based on species lists certified for CIRO in 2005). Of the species listed, those considered common or abundant within CIRO include 66 bird, 19 mammal, and six reptile species. Previous wildlife surveys and reports include; a small mammal survey in 2006-2007, general mammal inventory in 2003 (summarized in 2009), herpetological inventory in 2001, a mountain lion (*Puma concolor*) study in 1991, and a fairy shrimp identification study in 2008. Through the combined results documented in these publications, the need for continued inventory and monitoring of the unique fauna of CIRO is well documented.

The University of Idaho Department of Fish and Wildlife Resources (UIDFWR) conducted the 2003 mammal inventory within CIRO under a cooperative agreement with the UCBN (Rodhouse et al. 2009). Inventory fieldwork was conducted from June 9-13 and July 2-September 30, 2003. In 2001, a cost-share project between the BLM, USFWS, IDFG, and ISU to conduct a four-county herpetological inventory centered on Cassia County, Idaho (Shive and Peterson 2002). Very little of the herptile survey occurred within CIRO although the data encompass habitats present in the Reserve. A State Wildlife Grant was provided to CIRO that enabled focused research into the habitat relationships of several unique species of pinyon-juniper woodland

obligate rodents. The results of this study were published and make a compelling case for enhanced protection of pinyon-juniper woodlands in the park, particularly in old-growth areas near rock features (Rodhouse et al. 2010).

CIRO supports communities of single-leaf pinyon pine - Utah juniper woodlands that have established on the northern edge of their range and provide habitat for the northern-most distribution of pinyon-juniper woodland-associated mammals including the pinyon mouse (*Peromyscus truei*) and the cliff chipmunk (*Tamias dorsalis*) described in more detail in this NRCA and by Rodhouse et al. (2010). Studying pinyon-juniper woodland communities at the range periphery can provide important insights into the CIRO management approach to preservation of important to critical transitional habitat during a time of accelerated climate change (Rodhouse et al. 2010).

In 2008, the UCBN staff collected invertebrate fairy shrimp specimens from several vernal pools perched on rock pillars 30-33 feet (9-10 m) above the ground for identification; the resulting identification was *Branchinecta constricta*, a species known in Wyoming and previously undocumented west of the continental divide (NatureServe 2011). Fairy shrimp are small crustaceans that occur within vernal pools, depressions and pot holes on the granite spires and pillars of CIRO fed by rain and snowmelt (UCBN 2011).

Soils

For this NRCA, soil condition was not evaluated but the general soils information presented here is based on the NRCS and NPS (2011) soil survey for CIRO in which soil descriptions were prepared in 2009. Soils are strongly influenced by the characteristics of the parent material (the unconsolidated and more or less chemically weathered mineral or organic matter from which the solum [upper part of a soil profile, above the C horizon, in which the processes of soil formation are active] of a soil is developed by pedogenic [soil formation] processes), particularly the mineralogy and texture (NRCS and NPS 2011). The soils within CIRO formed in residual, alluvial, and colluvial material along with some loess influence.

CIRO is represented by six general soil mapping units and 25 detailed mapping units. The general units are: (1) soils on mountain slopes and hillslopes representing 76% of CIRO [Povey-Pachic Haplocryolls, Howcan-Searla, Ola-Rock outcrop-Earcree, and Birchcreek-Itca-Rock outcrop]; (2) soils on fan remnants representing 24% of CIRO [Arbone-Riceton]: and (3) soils on floodplains and stream remnants representing <1% of CIRO [Cumulic Endoaquolls].

Water

Surface drainages within CIRO represent a portion of the Raft River Watershed (17040210) as determined by the EPA (2004). Area runoff and drainage flows predominantly northwest to southeast from slopes of the Albion Mountains into the Raft River Valley and consists of intermittent and perennial creeks and ground water. Named drainages include: Almo Creek, Stines Creek, Lone Rock Creek, Graham Creek, North Fork of Circle Creek, Center Fork of Circle Creek, South Fork of Circle Creek, Circle Creek, Emery Canyon, Bath Rock Creek, Trail Creek, Heath Canyon, and Emigrant Canyon (NPS 2011).

For this NRCA, on-site evaluation of water resources within CIRO included assessment of six lotic riparian sites which comprise a portion of the upper Raft River Valley and watershed. These

sites were identified and assessed between the Circle Creek and Almo Creek watersheds and completed in 2010 using the Proper Functioning Condition Assessment (PFC) method developed by the BLM for lotic (i.e., flowing water) sites (Prichard et al. 1998). Riparian areas were selected for assessment because they usually determine the quantity/quality of aquatic and wildlife resources dependent on the critical riparian habitats. From the PFC assessments a rating of proper functioning condition, functional-at risk, or nonfunctional was applied to each site to categorize the current conditions.

Geology

For this NRCA, geologic resource conditions were not evaluated but to provide context CIRO is part of the Albion-Raft River-Grouse Creek metamorphic core complex (MCC), one of over two dozen MCCs strung out along the crest of the North American Cordillera from northern Mexico to British Columbia in Canada. MMCs are areas where extension of the earth's crust caused uplift, faulting, and erosion of upper crustal rock layers, thereby exposing deep crustal rocks. Some of the oldest rocks in western North America are exposed from the Albion-Raft River-Grouse Creek MMC in and around CIRO. The dominant exposed rock types at CIRO include two distinct granites, an older one that is metamorphosed and derives from the deep-seated crustal rocks and a much younger one that is derived from several metamophosed sedimentary strata. In addition to the granites a few remnant lava flows from the Snake River volcanics also occur at CIRO.

CIRO is best known for the outcrops created from the two granite formations and although they occur together and appear somewhat similar they are in fact separated by billions of years. The two granites at CIRO are thought to range in age from 2.5-billion years to 28-million years old and can be most readily observed in contact with each other at the Twin Sisters, the west side of Smoky Mountain, and along Granite Ridge formations. The Twin Sisters formation is a prominent landmark at CIRO and the adjacent granitic spires (each made of different granite) are considered to be separated in time by nearly 2.4-billion years (Figure 2).

The exposed outcrops at CIRO contain a vast variety of unique geologic features and processes including joint sets, pinnacles, surface crusts, cavernous forms, and general weathering patterns. Joint sets are cracks, planar zones of preferential weathering, and fractures that display displacement perpendicular to the plane of the fracture and form through myriad processes (Thornberry-Ehrlich 2010). Pinnacles are the most notable geologic feature at CIRO, protruding from the landscape as steep-sided, smooth, and rounded spires, fins, or domes. Exposed pinnacles are derived from a variety of different fracturing and geologic weathering processes that commonly form vertically stable bodies. The name City of Rocks was derived from the many exposed pinnacles occurring on the south, west, and north edges of the Circle Creek Basin. Surface crusts are derived from the dissolution and weathering of granitic material; this is also known as “case hardening”, where iron oxide and other minerals form a hardened crust from the weathering of granitic parent material. Cavernous weathering of the granite on near vertical faces



Figure 2. Twin Sisters Geologic Formation at CIRO.

forms honeycomb features that include windows and arches in rock fins. Another common weathered feature - "panholes" form on more horizontal surfaces; these occur throughout CIRO where bedrock is exposed and range in size proportionate to age. Panholes form where rainwater or snow linger and break down the case hardened surface layer. The large panhole on top of Bath Rock is an example.

Recreationists have long had a deep interest in the geology of CIRO and visitors have been drawn to both viewing the unique formations and to climb the many difficult and challenging routes they present. To better aid with the visitors experience a new geological Interpretive Trail is currently under public review and construction is estimated to begin in September, 2011 (Garrett 2011). Rock climbing has an extensive history at CIRO staring in the 1960s when the first rope-aided climbing was used and documented in the City of Rocks formation by a group of Utah climbers. This group established approximately 200 climbing routes using mostly pitons and infrequent bolts (presently there are approximately 700 routes) and it wasn't long before the granitic spires at CIRO became internationally known by rock climbing enthusiasts. Historically, climbing as a recreational sport was established in the late 1930s with post-World War I expeditions and mountaineering treks. About the 1960s there were approximately 2,000 "active climbers" (experienced climbers who climbed regularly) in the U.S. and the sport was guided under a set of general rules and climbing style etiquette (NPS 1998). Over the ensuing three decades, the climbing industry grew to approximately 50,000 participants nationwide with climbing areas established in most states that support an approximately $20 million per year industry (NPS 1998).

Air Quality

CIRO has been designated a Class II Airshed (areas of the country protected under the federal Clean Air Act of 1970, as amended, but identified for somewhat less stringent protection from air pollution damage than a Class I Airshed, except in specified cases). Air pollutants are known to cause injury to various species of plants, acidify water bodies, and leach nutrients from soils (NPS 2004). The majority of park units have no onsite or nearby acceptable monitoring locations (IDEQ 2009), or geography, meteorology, and topography make it difficult to install representative stations (NPS 2004). During 2010, CIRO staff installed a portable ozone/air quality station for collection of local air quality data. Currently, a weather station at the Visitors Center collects meterological data and conditions are available via a link on the Reserve website.

Vegetation

Floristically, CIRO is diverse, supporting 512 plant species based on 2005 certification efforts. Among these, 67 species are considered to be non-native (NPSpecies Database 2011). The various plant species at CIRO intermix to form vegetation types that comprise important wildlife habitat. Three primary physiognomic types are present at CIRO and include (1) herbaceous vegetation (grasslands), (2) shrub-steppe short shrublands, and (3) woodlands and forests (e.g., transition woodland/forest). In addition to the dominant types, small stands of riparian/wetland and mixed conifer woodland and tall shrubland types also occur within the areas classified as "non-vegetated" geologic exposures.

To further define the three primary vegetation/land cover types mapped in CIRO, the LANDFIRE Dataset was queried, as follows: shrublands (33%), grasslands/herbaceous (14%), herbaceous-shrub steppe (26%), closed and open canopy evergreen (24%), and other (including sparsely vegetated and agriculture) (3%). Additionally, CIRO vegetation was recently classified to the plant association level and mapped to the vegetation alliance or finer level under the NPS-USGS National Vegetation Inventory Program protocols (Erixson and Cogan 2011). The Erixson and Cogan (2011) classification resulted in four forest, eight woodland, three tall shrubland, eleven short shrubland, one dwarf-shrubland, and seven herbaceous vegetation mapping units. In addition, 11 land use units were mapped within CIRO including 757 acres (306 hectares) of unvegetated geologic exposures (Figure 2).

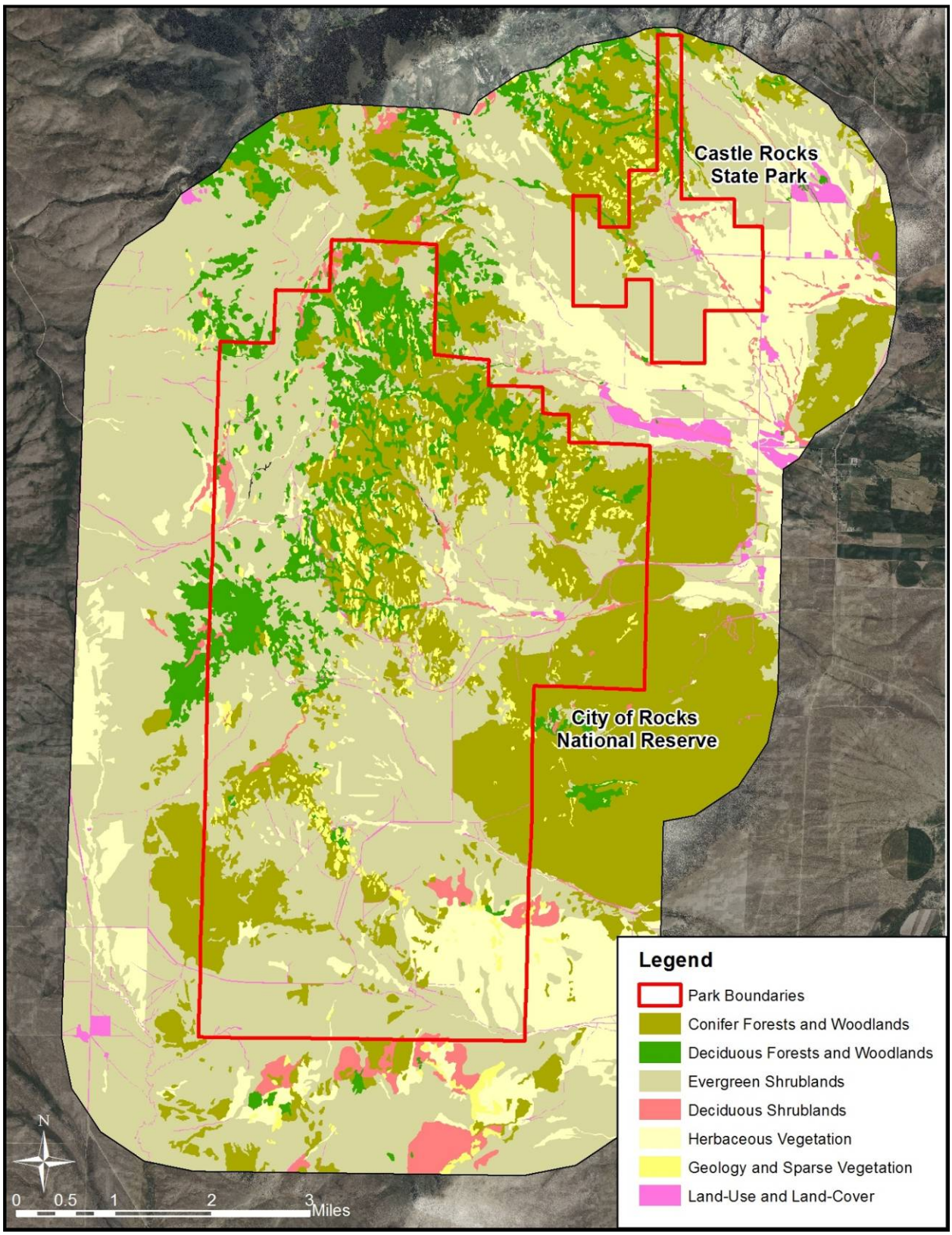


Figure 3. Map of CIRO and CRSP showing vegetation patterns.

Land Use

The land use within CIRO has progressed from a native ecosystem in the mid-1800s (subject to drought, fire, wind and water erosion, and loess deposition), to emigration era travel corridors, livestock grazing, and campsites, to early ranching and livestock grazing (and the influences of livestock and homesteaders including buildings, garden plots, corrals, water development, felling trees for lumber, and firewood gathering), to the current uses of camping, recreational rock climbing, hiking, backpacking, snowshoeing, and horseback riding. Changes in land use have also been realized in the region due to: (1) increased demand for water to irrigate crops and produce livestock; (2) increased soil erosion from trail establishment and use, campsites, and parking areas; (3) livestock grazing, particularly cattle; and (4) the introduction of non-native, invasive, and/or noxious weed species. Human population increases in the area and region of CIRO has resulted in stress on the ecosystem(s) through increased climbing recreation and normal visitor use.

At present, CIRO offers a wide variety of recreation opportunities in a diverse natural setting, both at the Reserve and at the nearby CRSP. Both units encompass about 15,850 acres (6,414 hectares) that includes many of the regions dramatic granite spires, domes, and monolith rock features. The popularity of rock climbing on these features contributes greatly to the average visitation rate of 80,000 visitors per year (NPS 2011). In addition to supporting the many rock climbers, CIRO has a visitor center located in Almo, Idaho, 64 standard campsites, and many wayside exhibits. The number of recreation visitors to CIRO has fluctuated in the last 20 years with highs of nearly 100,000 in 1992 and 2011 to lows of about 60,000 in 1998 (Figure 4).

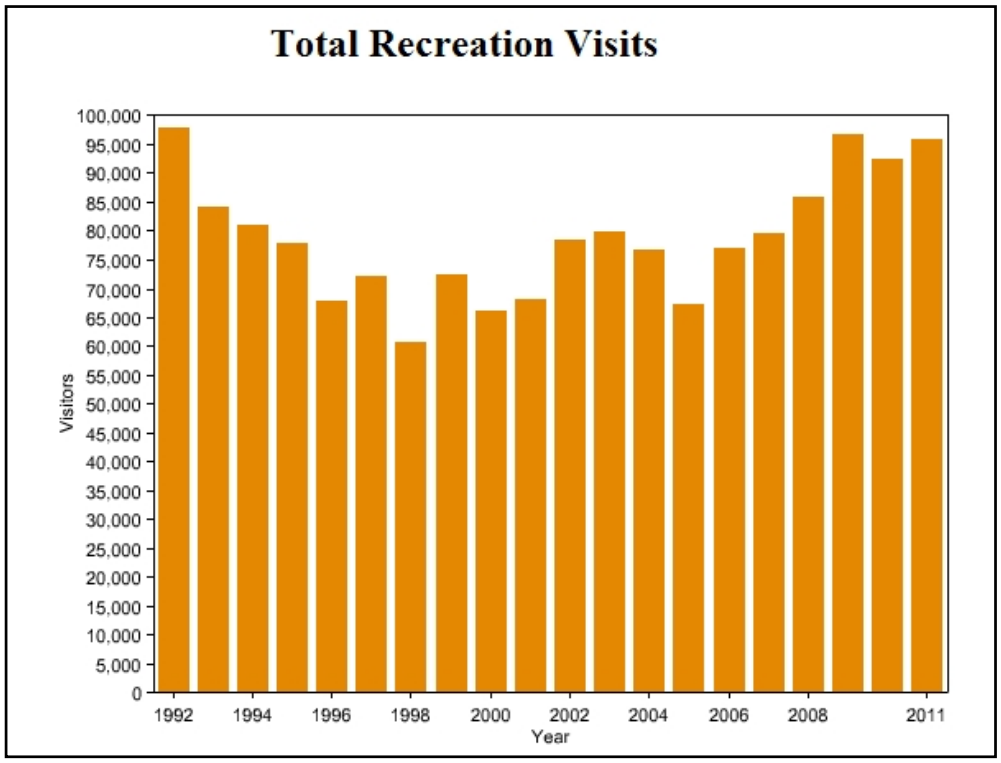


Figure 4. Recreation Use (days/year) from 1992 to 2011.

About 8,000 acres (3,238 hectares) of CIRO is used as rangeland for livestock grazing, wildlife habitat, and recreation sites and as watershed for the Raft River (NRCS and NPS 2011). Livestock grazing at CIRO has a long history coinciding with the establishment of homesteads and ranches in the area. Due to the topographic relief, low temperatures, and the lack of adequate forage in the winter, livestock grazing at CIRO is seasonal with lower elevation rangelands being using in the winter/spring and then switched to higher elevational pastures in the summer and fall. To better understand the impact of grazing and the seasonal movement of livestock on the landscape at CIRO, range management practices that key into the soil types and the potential natural plant communities they support can be implemented (NRCS and NPS 2011). To be effective, it also requires an evaluation of the present range similarity index and rangeland trend. Range similarity index is determined by comparing the present plant community with the potential natural plant community on a particular rangeland ecological site. The more closely the existing community resembles the potential community, the higher the range similarity index. Rangeland trend is defined as the direction of change in an existing plant community relative to the potential natural plant community.

The principle objective under range management is to control grazing so the plant communities and species established on a site are about the same in species and amount as the potential natural plant community for that site. Effective range management generally results in the optimum production of vegetation, control of undesirable shrub and tree species, conservation of water, and control of erosion. Sometimes, however, an area with a range similarity index somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Further information about the range similarity index and rangeland trend is available in the "*National Range and Pasture Handbook*," which is available in local offices of the NRCS or on the Internet.

Climate

The climate of CIRO was evaluated on an area/regional scale for this NRCA based on the coarse-scale data available in reports and from regional meteorological stations. The average precipitation for CIRO was assumed to be analogous to the averages commonly noted in the UCBN region, e.g., transpiring from polar air masses interacting with warm and moist air from the Gulf of Mexico (McWethy et al. 2010) and affected by influential prevailing winds generated over the Pacific Ocean (Kittel et al. 2002). Records of temperature and precipitation near CIRO have been maintained continuously at Oakley, Idaho (Station 106542)(WRCC 2011) from 1893-2010, approximately 20 miles (kilometers) to the northwest of CIRO and at 4,570 feet (1,393 meters) in elevation. CIRO is predominately characterized by a plateau/continental interior climate which is semi-arid with hot and dry summers and cold and dry winters. The Oakley, Idaho data average approximately 11 inches (27.9 cm) of precipitation annually with 40% of the precipitation occurring during the months of April, May, and June and a similar amount of precipitation deposited as autumn through spring snowfall (WRCC 2011).

Wildfire

Historically, fire was the most prevalent natural disturbance process in the CIRO ecosystem and is commonly recognized as the dominant process influencing composition, diversity, energy, and nutrient cycles within the natural environment (Stock and Kauffman 1997). The documented history of fire within CIRO (Morris 2006a) concludes that within the Reserve approximately

25% has burned in the last 75 years, and fire size has been increasing since the 1980s. From 1926 to 2005, 14 fires of adequate size to map have been recorded at CIRO and evidence of the recent 1999 and 2000 fires can be seen in the southern sections of the Reserve (Figure 5).

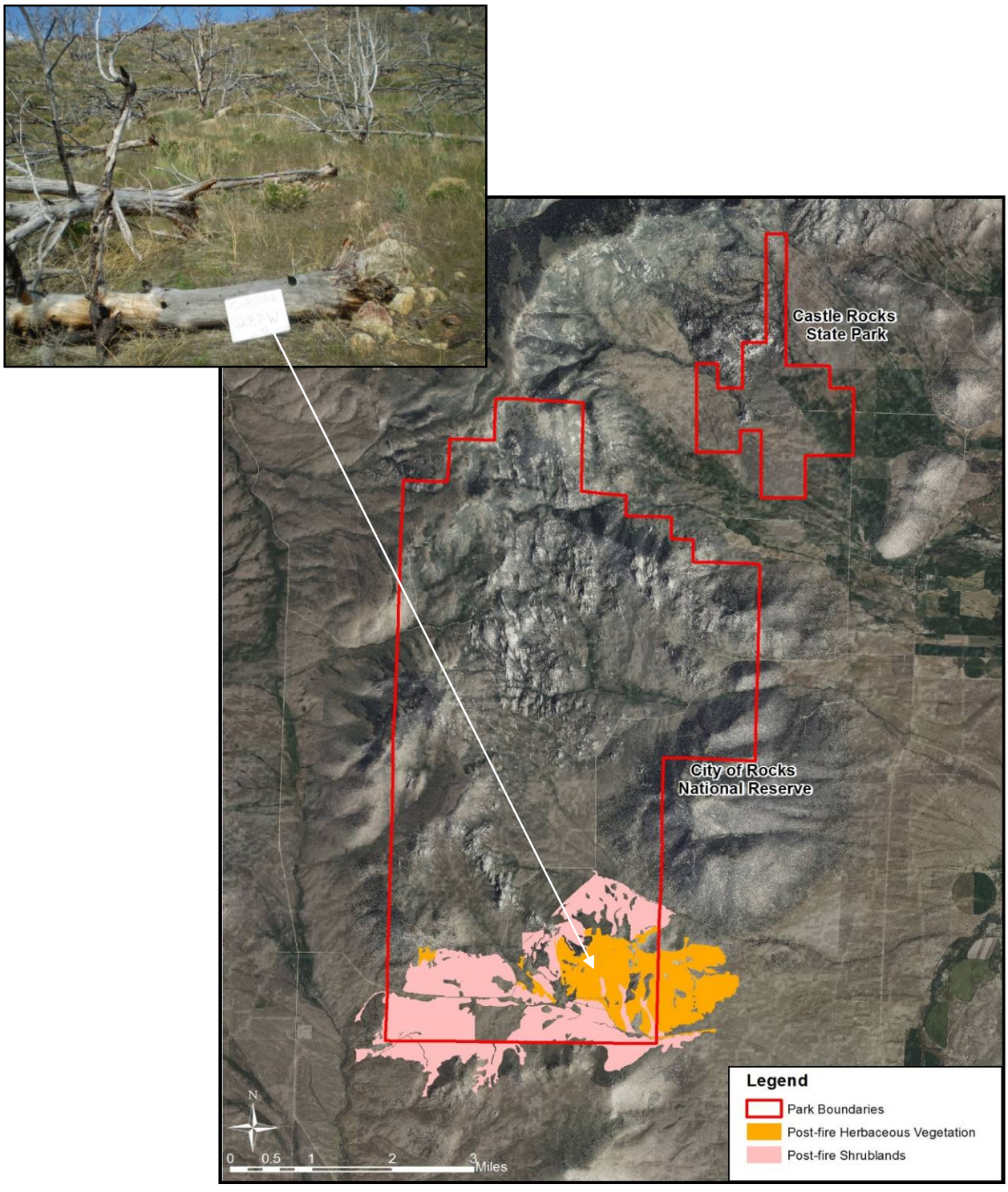


Figure 5. Map and Example Photo of Recent Fire Evidence at CIRO.

Most of the remaining shrub and wooded areas at CIRO are also prone to devastating wildfires and the effects of wildfire suppression on these areas have been well documented. One assessment states that over one-half of the extant vegetation at CIRO is in a high-to-medium risk category for fire (Stock 2005) and Bell and Barton (2010) concluded through aging of selected singleleaf pinyon and Utah juniper trees that fire has been successfully limited or suppressed within much of CIRO. The effects of fire suppression, livestock grazing, drought, and changes in species composition have increased the fire-free interval within CIRO resulting in larger woody species (shrubs and trees) replacing herbaceous species (grasses and forbs) (Miller et al. 2008) (Figure 6). The general exclusion of fire in CIRO has shifted most plant communities to a less biodiverse composition threatening fringe habitats in some areas (Rodhouse 2009).

To help mitigate the fire suppression effects, CIRO managers have realized that a balanced approach is necessary to restore the historic (pre-settlement) ecosystems of the preserve while supporting recreation and ranching viability. Removal and thinning of pinyon-juniper woodlands that encroach into historic viewshed areas and areas vulnerable to unplanned human-caused fire ignition have been considered. Any removal has been approached cautiously however, so as not to overly impact soils and spread invasive weeds with heavy equipment. In addition, pinyon-juniper woodlands, particularly those "old-growth" type stands growing in and around rock features, may be excluded and protected in order to provide critical wildlife habitat (Rodhouse et al. 2010). In general, small well-planned treatments, conducted in conjunction with monitoring so that unintended negative impacts can be evaluated may be the best approach. Over several years, a series of small fuel reduction treatments will result in a net reduction of fire risk, and enable the reserve to minimize unanticipated impacts.



Figure 6. Fire Fuel Evidence at CIRO.

Methods

This NRCA is a collaborative project between the NPS, UCBN, CIRO (the stakeholders for this study), and Northwest Management, Inc (NMI) (the principal investigator). A scoping meeting was held at the onset of the study and a contract established to meet the goals of the NRCA program for CIRO. This section of the assessment summarizes results from scoping meetings and constraints, objectives, and project expectations, and presents the approach to acquisition of new rapid assessment information and the selection of existing data that included electronic datasets, reports and research inventories, and vital signs monitoring data.

NRCA Project Scoping

A series of preliminary meetings and follow-up communications were held in 2009 and included staff representation from UCBN, CIRO and NMI. The purpose of the NRCA was discussed and the goals of this project were to evaluate and report on current conditions, assess critical data and knowledge gaps, and select existing and emerging resource condition influences of concern to CIRO managers. During the planning sessions, the NRCA standards and protocols were reviewed (NPS 2009) and the project scope was outlined with following guidelines: (1) use existing data and information whenever possible; (2) collect new rapid assessment information when no data exists for important resources; (3) identify data needs and gaps within the project framework categories; (4) analyze the natural resource conditions and include a strong geospatial component; and (5) focus and prioritize on resources important to CIRO resource management.

Specific project expectations and outcomes resulting from the initial scoping meeting included: (1) for key natural resource components, consolidate available park data, reports, and spatial information; (2) define an appropriate description of reference condition for each of the key natural resource components and indicators so that statements of current condition can be developed for the NRCA report; (3) develop a reporting format that reflects the spatial delineation of reserve-specific human and ecological focus areas; (4) the resource assessment should clearly identify "management critical" data; (5) where applicable, develop GIS products that provide spatial representation of resource data, ecological processes, resource stressors, trends, or other valuable information that can be better interpreted visually; (6) conduct analysis using existing datasets for geology, vegetation mapping, and invasive plant species to develop descriptive statistics about key natural resource indicators; (7) discuss the issue of key natural resource indicators that are not contained within CIRO or controlled directly by Reserve management activities; (8) describe the relationship between selected human uses and key natural resources; and (9) use "gray literature" and reports from third party research to the extent practical.

Expectations for CIRO staff participation were detailed in the initial scoping meeting. CIRO staff participated in project development and planning, reviewed interim and final products, and participated in ecological/resource assessments. Involvement of CIRO staff in this project ensured that the true needs of CIRO were being met through the efforts of NMI. In addition to CIRO resource staff, UCBN staff was also involved in the development of this NRCA. The NPS Agreement Technical Representative, John Apel, coordinated the efforts of the Principal Investigator, the project work group, CIRO personnel, and the UCBN. The NPS was responsible for informing the NMI Principal Investigator of the specific activities required to comply with

the "NPS Interim Guidance Document Governing Code of Conduct, Peer Review, and Information Quality Correction for NPS Cultural and Natural Resource Disciplines" or any subsequent guidance issued by the NPS Director.

Project findings presented in this report will hopefully aid CIRO resource managers with the following objectives: (1) develop near-term management priorities; (2) engage in watershed or landscape scale partnership and education efforts; (3) conduct park planning (e.g., general management plan, compliance, Resource Stewardship Strategy); and (4) report program performance (e.g., Department of Interior Strategic Plan's "land health" goals).

The CIRO NRCA provides a "snapshot-in-time" summary for all of the CIRO natural resources based on a review and summary of existing data. The summaries were then used to help evaluate the condition of a select set of natural resources that were identified and agreed upon by the project team. If a natural resource was found lacking for existing data, new rapid assessment points were collected at specific sites. In contrast, if the resource had sufficient existing data, the data was synthesized and no new data was collected. Table 1 contains a list the natural resource that were preliminarily summarized, those that were field assessed, and those that were synthesized based on existing data.

Table 1. List of Summarized, Site Specific Field Assessed, and Synthesized Natural Resources for CIRO.

Summarized Resources	Site Specific Field Assessed Resources	Synthesized Assessed Resources
Wildlife	Upland Sites	Wildlife (Mammals and Herpitiles)
Soils	Aquatic / Riparian Areas	Air Quality
Water Resources		Vegetation
Geology		Disease
Air Quality		Invasive Plants
Vegetation		Wildfire
Land Use		
Climate		

GIS and Geodatabases

The majority of data used in this report is Geographical Information System (GIS) data in tabular form tied to spatial features, such as points, lines, polygons, and raster images. GIS software provides spatial analysis capabilities such as overlay, buffer, extraction, and modeling. The ArcMap Version 9.3 GIS software was used to assess, store, edit, and display all available GIS attribute data for CIRO. Feature classes (layers) were organized into categories or Feature Data Sets (directories) based on general theme type. Although data were not available for each Feature Data Set, the empty Feature Data Set is included in the geodatabase for data that may become available in the future. The general Feature Data Sets developed for this project include:

- Air Resources
- Animal
- Climate
- Geography
- Geology
- Land Use
- Plant
- Stressors
- Water Resources

An ArcMap project file (.mxd) was developed for CIRO to manage, control, and store layer annotation using ArcGIS software. Many types of geographic data sets can be accessed and managed within a map project file, including feature classes, attribute tables, and raster datasets. Data layers were stored in an ESRI File Geodatabase providing a compact, easily utilized database structure for storage and distribution. The NPS ArcMap 8.5 x 11 inch layout template was used in the CIRO map project file for map display (Figure 7).

A geographically defined project area was created for CIRO by selecting the 6th level hydrologic unit code watershed basins surrounding the CIRO administrative boundary and adding a two kilometer (1.2 mile) buffer. General base map layers and aerial photography were developed to the full project area extent. All other layers were clipped to the Hydrologic Basins extent for analysis and summarization of attributes.

The map project file was populated with GIS data through an extensive search of NPS sources and a multitude of local, state, and federal web sites. Data determined to be useful and accurate were re-projected into the North American Datum 1983 (NAD83), Universal Transverse Mercator (UTM) zone 12 projection. Metadata for each layer were extracted from the original file, or generated based on known information if available. Some layers were acquired without metadata so an attempt was made to provide general information about the file whenever possible. The metadata for each layer are included within the geodatabase for each file in Federal Geographic Data Committee (FGDC) compliant format. Metadata describe the source, accuracy, data dictionary, projection, datum, and many other details about an individual layer.

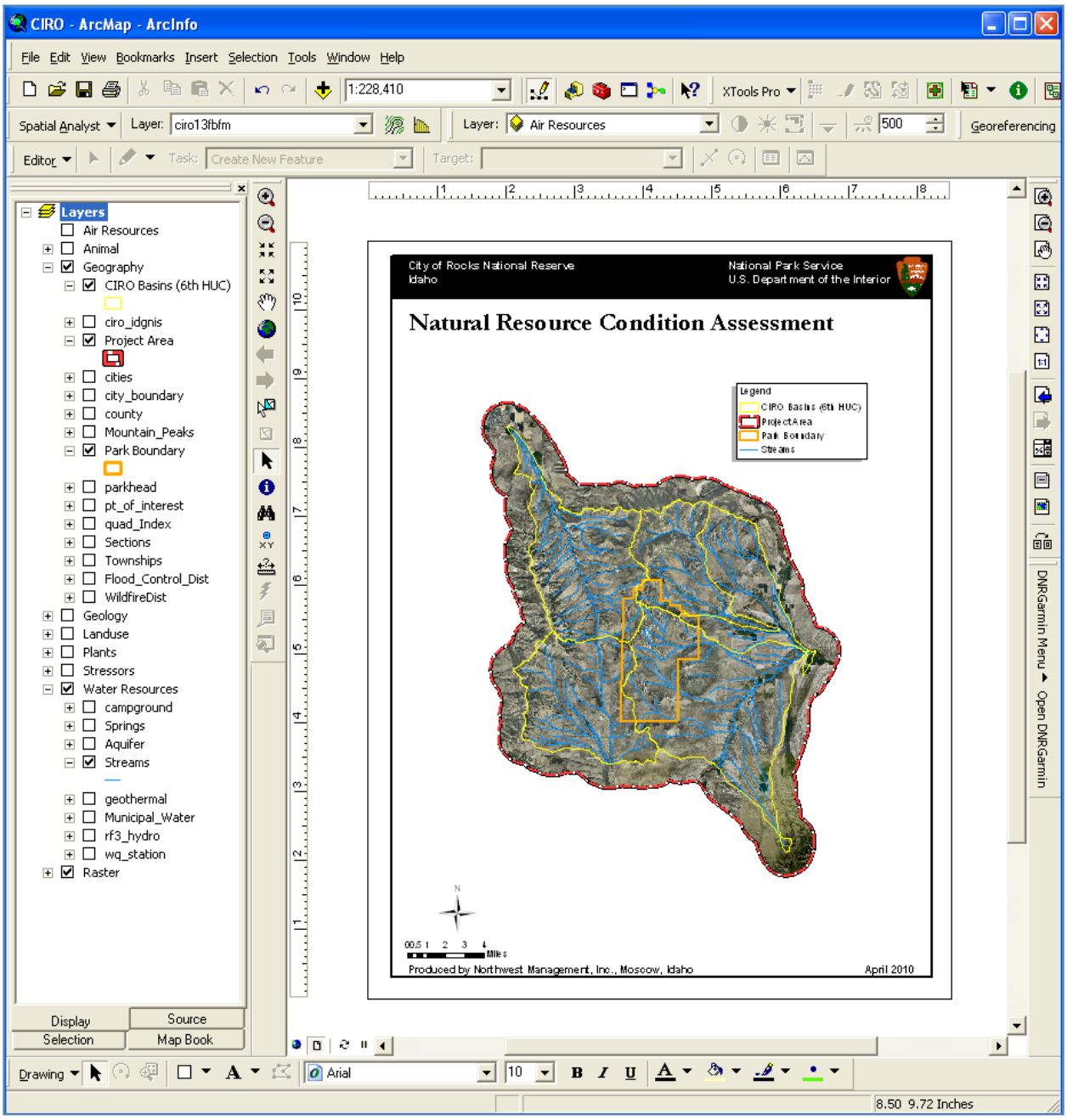


Figure 7. Screen capture of ArcMap Project file for the CIRO project area.

One important source for GIS data was the recently completed CIRO vegetation inventory mapping project prepared under the NPS National Vegetation Inventory Program (NVIP) by NMI staff (Erixson and Cogan 2011). This dataset provided or created the following spatial datasets in the ArcMap project file:

- Aerial and ortho-photography (2009, NAIP true color 1-meter resolution product)
- Vegetation and land-use map classification based on CIRO-specific requirements and documented in a GIS shapefile
- Vegetation map classification description and key incorporated into the final report
- Spatial database of vegetation communities and land-use classes of CIRO incorporated into a GIS layer
- Digital and hardcopy maps of vegetation communities and land-use types
- Metadata for spatial databases
- Complete accuracy assessment of spatial data

Aerial photography and Digital Raster Graphics were processed and clipped to the project area using LizardTech GeoExpress 7 software and converted into a MG3 (MrSid Generation 3) file format. Attribute information for all data layers clipped to the Hydrologic Basins extent were summarized in a Microsoft Excel spreadsheet based on the various attribute parts, lengths, acreage etc. of the various data layers in the map project and associated geodatabase file.

All GIS data layers were imported into an ArcGIS File Geodatabase using ArcCatalog ver. 9.3.1. Feature Data Sets were created based on theme type. A geodatabase is an ArcMap file structure that stores geometry, spatial reference system, attributes data sets, network data sets, topologies, and many other features. Feature Data Sets store the various layers or feature classes in organized categories. This GIS format provides a uniform method for storing and accessing GIS data and provides the flexibility to add new information as it becomes available.

Aerial photography and digital imagery were not included in the geodatabase due to file size and limitation of processing MG3 file formats. Aerial imagery is included in a separate directory outside the geodatabase. All GIS data, project files, and summary tables are included on a digital video disk (DVD) for distribution with this report. As a support product of this search, a Microsoft Access database (included on DVD) was created for websites with documented GIS data that could be downloaded in various formats compatible with ESRI ArcMap software. The database has a custom query form for performing searches on the 3,000+ entries that cover three states; Idaho, Oregon, and Washington.

Literature Review and NPS Data Sources

Additional non-GIS data were acquired from Internet searches, such as NPS NatureBib (https://science1.nature.nps.gov/naturebib) and NPSpecies Database (http://science.nature.nps.gov/im/apps/npspp/) and from direct contact with local and state government agencies. CIRO is in the UCBN established under the NPS I&M Program (NPS 1999) and data were acquired from both entities. Table 2 is the status of inventories of the species taxa groups for CIRO. Available data from completed inventories were used where needed in the report otherwise the data are directly available at the UCBN website: http://science.nature.nps.gov/im/units/ucbn/inventory/index.cfm#table.

Table 2. Status of inventories of species taxa groups for CIRO maintained by UCBN.

Species Taxa	Complete	Year Completed	In Progress	Not Complete
Mammals	√	2007		
Birds	√	2004		
Amphibians	√	2004		
Reptiles	√	2001		
Fish	√	2005		
Invertebrates		Unknown		√
Vascular Plants	√	2005		
Rare Plants		Unknown*		√
Invasive Plants	√	2003		

* Some rare plant studies were completed in 1993 (Moseley 1993).

Additional non-biological data sets have been identified by the UCBN as important for CIRO management (Table 3). Both the biologic and non-biologic inventories were considered and used as baseline information for development of the UCBN vital signs monitoring plan (Garrett et al. 2007). Inventories for invertebrates and rare plants are not complete, the soils inventory was completed in 2011, the vegetation and land use mapping project was completed in 2011, and the inventory for geologic resources was just recently finished.

Table 3. Status of inventories of non-biological data maintained by UCBN.

Non-Biologic Data sets	Complete	In Progress	Not Complete
Air Quality/Emissions	√		
Ozone Risk	√		
Water Quality	√		
Landcover	√		
Paleo Resources	√		
Geology	√		
Soils	√		
Cultural Landscapes	√		

Site Specific Assessments

Site specific assessments were completed at CIRO as a component of this study. These on-the-ground assessments were conducted using standard methodologies allowing for a quick evaluation of the current condition of aquatic and upland environments present at CIRO.

Aquatic Resource Assessment

On-site evaluation of water resources within CIRO included assessment of six lotic riparian sites. An example of the lotic assessment worksheet is displayed in Appendix E. The primary objective

in evaluating these riparian wetland habitats was to provide the NPS with a moment-in-time status point or baseline for managing land use. The three main objectives were to:

1. Identify existing riparian condition.
2. Identify the specific threats and stressors impacting riparian functions and values (e.g., wildlife habitat, water quality improvement, aquatic species protection, etc.).
3. Recommend solutions to minimize or eliminate threats and stressors to riparian and associated aquatic resources.

Riparian areas were selected for assessment since the condition of riparian habitats often control and dictate the quality of aquatic and wildlife resources that depend on these important zones of influence. Riparian habitat serves many functions including erosion control, aquatic shading and cooling, insect production, shoreline bank stabilization, and providing woody debris. Riparian areas are often the most diverse habitats within a watershed, containing the greatest resource diversity and productivity (Barber 2005). Riparian areas provide a buffer between aquatic habitats and upland activities/influences that potentially affect those habitats. In addition, riparian habitat often supports wetlands where water is filtered, retained, and slowly released throughout the year as surface and ground water.

Evaluation of on-site water resources within CIRO included an assessment of the riparian resource condition of Almo and Circle creeks as described below. The assessment of the in-stream condition of Almo and Circle creeks was based on "proper functioning condition" (PFC) assessments (Prichard et al. 1998). Starkey (2010) identified macroinvertebrates and water quality factors within both stream reaches during the 2009 field season.

Detailed PFC Method: The PFC methodology applied at each site to evaluate riparian/stream-bank condition was developed by the BLM for lotic (i.e., flowing water) sites (Prichard et al. 1998) or lentic (i.e., standing water) sites (Prichard et al. 1999). All sites within CIRO were assessed as lotic environments because flowing water and spring-season runoff events are the predominant hydrologic forces affecting Almo Creek and Circle Creek and at no time was standing water observed during field assessments in 2010.

Lotic Riparian PFC Assessment: The lotic PFC method evaluates 17 hydrology, vegetation, and stream geomorphology indicators of riparian condition or "health" and subsequently assigns a functionality rating to each site. The "proper functioning condition" of a lotic riparian area refers to the stability of the physical system, which in turn is dictated by the interaction of geology, soil, water, and vegetation. A properly functioning lotic riparian area is in dynamic equilibrium with its stream flow forces and channel processes. The channel adjusts in slope and form to accommodate flows from larger runoff events with limited perturbation of channel characteristics and associated riparian plant communities. Because of this stability, properly functioning lotic riparian areas can maintain fish and wildlife habitat, water quality enhancement, and other important ecosystem functions even after large precipitation events. In contrast, nonfunctional systems subject to the same precipitation events might exhibit excessive erosion and sediment loading, loss of fish habitat, and loss of associated wetland habitat among other forms of degradation.

During the 2010 field assessment the team assessed lotic-system riparian functional conditions of six sites, two sites in the Almo Creek watershed of CRSP and four sites in the Circle Creek watershed of CIRO. Based on assessments of the hydrologic, vegetation, and geomorphology elements of each lotic riparian area, one of the following three functionality ratings was assigned to each site: (1) Proper Functioning Condition, (2) Functional-At Risk, or (3) Nonfunctional.

Proper Functioning Condition (PFC): Streams and associated riparian areas are functioning properly when adequate vegetation, landform, or large woody debris is present to:

1. Dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality;
2. filter sediment, capture bed-load, and aid floodplain development;
3. improve floodwater retention and groundwater recharge;
4. develop root masses that stabilize stream banks against cutting action;
5. develop diverse ponding and channel characteristics to provide habitat and the water depths, durations, temperature regimes, and substrates necessary for fish production, waterfowl breeding, and other uses; and
6. support greater biodiversity.

Functional-At Risk: Riparian areas are in functional condition, but an existing soil, water, vegetation, or related attribute makes them susceptible to degradation. For example, a stream reach may exhibit attributes of a properly functioning riparian system, but it may be prone to severe erosion during a large storm in the future due to likely migration of a headcut or increased runoff associated with recent urbanization in the watershed. When this rating is assigned to a stream reach, then its "trend" toward or away from PFC is assessed.

Nonfunctional: Riparian areas that clearly are not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows and thus are not reducing erosion, improving water quality, sustaining desirable channel and riparian habitat characteristics, etc., as described in the PFC definition. The absence of certain physical attributes such as a floodplain where one should exist is an indicator of nonfunctioning conditions.

Upland Assessment

On-site evaluation of upland resources at CIRO and CRSP included assessment of 15 ecological sites within eight active grazing allotments. The primary objective in evaluating these resources was to provide the NPS with a moment-in-time status point for managing land use. The eight Allotments are named Emery Canyon, Trail Canyon, Tracy Lane, Heath Canyon, Graham Creek, Bath Rock, Smoky Mountain, and Kempton. The sites were assessed using the BLM rapid assessment for rangeland health methodology. The details of this method are described in "Interpreting Indicators of Rangeland Health" by Pellant et al. (2005).

The rangeland health rapid assessment methodology was designed to provide a preliminary evaluation of three landscape attributes; soil/site stability, hydrologic function, and integrity of the biotic community at the ecological site level. This assessment method assists land managers in identifying areas that are potentially at risk of degradation as well as to support the selection of sites to be designated for monitoring program development. The three landscape attributes are defined as:

Soil Site Stability: The capacity of the site to limit redistribution and loss of soil resources including nutrients and organic matter by wind and water.

Hydrologic Function: The capacity of the site to capture, store, and safely release water from rainfall, run-on (inflow), and snowmelt (where relevant); to resist a reduction in this capacity; and to recover this capacity following degradation.

Integrity of the Biotic Community: The capacity of the site to support characteristic functional and structural communities in the context of normal variability; to resist loss of this function and structure due to disturbance; and to recover following disturbance.

The rapid assessment technique was developed as a tool for conducting a moment-in-time qualitative assessment of rangeland status. It has been accepted as a communication and training tool for land managers, educators, and other interested parties developing an understanding of rangeland ecological processes and their relationship to indicators (Pyke el al. 2002). The assessments use soil survey information, ecological site descriptions, and ecological reference areas to qualitatively assess rangeland health. As part of the assessment process, 17 indicators relating to these attributes are evaluated and the category descriptor or narrative that most closely describes the site is recorded. "Optional Indicators" may also be developed to meet local needs for areas of special concern. The critical link between observed indicators and the degree of departure from the ecological site description and/or ecological reference area is formed within the observer's interpretation process.

This technique provides for multiple ratings of rangeland health based on a "preponderance of evidence" approach. The assessed departure from the ecological site description/ecological reference area(s) for the attributes of soil site stability, hydrologic function, and biologic integrity can be categorized into five levels of departure. These levels of departure which include; "none to slight", "slight to moderate", "moderate", "moderate to extreme", and "extreme", signify the severity of degradation observed.

A slight modification of the methodology was implemented so multiple assessments in each ecological site could be combined for analysis. A rating from one (none to slight) to five (extreme) was assigned to each category. For allotments with more than one sample an average was calculated for each indicator and summed for the applicable landscape attribute. There are ten indicators for soil site stability and hydrologic function and nine for biotic integrity. The score for each landscape attribute was the sum of the indicators minus the reference conditions; determined to be ten for soil site stability and hydrologic function and nine for biotic integrity, based on a score of one for each indicator. Percent departure for each attribute was a proportion calculated by dividing the score by the maximum departure value; 40 for soil stability and hydrologic function and 35 for biotic integrity, and expressed as a percentage. The results are displayed graphically as a percent departure from the reference condition in the range resources grazing section of this report. For the narrative, the percent departure values are converted back into the associated qualitative categories: none to slight (<21%), slight to moderate (21-40%), moderate (41-60%), moderate to extreme (61-79%), and extreme ($\geq$80%).

A Microsoft Access database was developed for digitally storing site data, comments, and the 17 indicator values. A GPS point (using Universal Transverse Mercator coordinates) was collected

at the center of each sample site. Sample sites varied from one to 20 acres (0.4 to 7.9 hectares) in size and maps were generated for each allotment depicting evaluation sites and other land features. The raw point data were included in the geodatabase for reference.

Synthesis of Existing Information

A review and summary of the natural resource issues not assessed by NMI during the field season is presented below. The synthesis includes a literature review that was completed using NPS and UCBN data with the goal of providing an overview of currently available inventories, monitoring, and research projects. Through communication with NPS staff a compilation of CIRO management issues of interest has been developed and is presented in detail under the Results section of this NRCA. The function of this synthesis is to present aspects regarded by CIRO, UCBN, and NPS managers as indicators of natural resource health and functioning condition. For the areas of interest identified, applicable threats and stressors to the specific resource are discussed and data gaps are identified.

Wildlife

Multiple, but dated, wildlife-related reports and GIS data layers were acquired for the CIRO project area. Data layers include the vegetation/wildlife habitat/land use map and database (Erixson and Cogan 2011), rare animal observations and locations, range allotment boundaries, pastures, and the Vincent et al. (2005) Greater Sage-grouse lek survey. The 2003 Mammal Inventory for CIRO and the 2007 Small Mammal Survey Report identified expected species from existing published information and field survey data sampled within CIRO (Vincent et al. 2007, Rodhouse et al. 2009). Prior to the 2003 mammal inventory, no comprehensive mammal inventory had been conducted within CIRO. However, several mammal research projects were conducted and limited information on mammals for CIRO was provided in Larrison (1981). Wildlife observation cards completed by CIRO staff and visitors during the 1980s and 1990s contain most of the historic information. Lyle Lewis used mist netting for bat studies annually in a single location in CIRO from 1995-2000 (Lewis unpublished data). Ryan Monello conducted a limited amount of small mammal trapping in the mid-1990s (Monello and Wright 1998). A long-term mountain lion study was conducted in the CIRO area and several individuals were tracked through CIRO (Laundre et al. 1993). Information on mammal species with federal or state conservation status was made available from the BLM and IDFG.

Limited herptile data were collected within the CIRO boundary for the regional reptile and amphibian survey conducted by Shive and Peterson (2002). A bird brochure and species list was published in 1995 and raptor nesting sites and surveys were conducted from 1999 to 2005 (Vincent and Hirnyck 2006). Monitoring protocol development has occurred for the Greater Sage-grouse and species of bats (UCBN 2007). Fairy shrimp were collected from vernal pools of CIRO in 2008 and identified to species, resulting in a range extension. These sources coupled with additional studies and research at CIRO and within the applicable region were referenced for information completeness.

Mammals: The methods used to complete the 2003 mammal inventory generally follow those described in the UCBN Study Plan (Wright et al. unpublished) and published literature on inventory methodologies (Wilson et al. 1996). Universal Transverse Mercator (UTM) locations were collected using hand-held GPS receivers. Elevation data were acquired from the GPS receivers or from USGS 7.5 minute topographic quadrangles. The horizontal datum for all

locations was collected in North American Datum (NAD) 83. Mammal scientific and common names followed the Integrated Taxonomic Information System (ITIS) which cross-walks closely to the USGS Biological Resource Division's unpublished and expanded update of the 1987 Checklist of Vertebrates of the United States, the U.S. Territories, and Canada (ITIS 2003).

The CIRO boundary was used as the primary boundary of the inventory; however, some species that were observed near but outside the boundary were included. Flexibility in using the boundary was necessary because dispersal abilities of many species enable movement on and off CIRO. Some species documentations resulted from observations obtained near the CIRO Visitor Center (four miles (6.4 kilometers) from the boundary), and also by residents living adjacent to the boundary (Rodhouse et al. 2009).

An expected mammal species list was generated for CIRO by examining published range maps and species accounts and historic observations from the park (Rodhouse et al. 2009). Range, elevation, habitat, and species detection were considered and developed into a criteria set that was used to place species into "expected" or "possible but not expected" categories. Detection was included in the consideration to address species that naturally occur in low abundances or are in some way very difficult to confirm through established mammal survey protocols. Species such as Merriam's shrew (*Sorex merriami*) often require years of consistent trapping to document (Kirkland et al. 1997; Verts and Carraway 1998) and these species were considered "possible but not expected". Species that met all four criteria were included as "expected" species. Published and unpublished sources used to determine the range, habitat, and elevation requirements of mammals included: (1) Mammals of Idaho (Larrison 1981); (2) Land Mammals of Oregon (Verts and Carraway 1998); (3) Mammals of the Rocky Mountains (Fisher and Hartson 2000); (4) National Audubon Society Field Guide to North American Mammals (Whitaker 1998); (5) Digital Atlas of Idaho (2003); (6) Ground Squirrels of the Pacific Northwest (Yensen and Sherman 2003); and (7) Atlas of Idaho Wildlife (Groves et al. 1997). Several historic reports from previous research performed within CIRO were also reviewed, including Monello and Wright (1998), bat mist netting results from 1995-2000 (Lewis, unpublished), and observations from CIRO staff.

A subjective, non-random sampling site selection procedure was adopted for the 2003 inventory (Rodhouse et al. 2009). Specific habitats and locations were identified and targeted for sampling in order to maximize the opportunities to encounter as many previously undocumented species as possible. While a majority of the inventory effort was concentrated near roads and trails due to logistical considerations, effort was made to periodically search more remote portions of CIRO to ensure adequate dispersion of sampling locations. Seasonal changes in species presence or detection were identified and multiple visits to field sites over the course of the year were performed (i.e., summer torpor by ground squirrels required early autumn sampling to occur).

Visual encounter surveys and incidental observations were important tools in the 2003 mammal inventory (Rodhouse et al. 2009). Visual encounter surveys were conducted by methodically searching target habitats during diurnal and nocturnal periods. For example, jackrabbit surveys were conducted in the early morning and late evening timeframes using flashlights and pygmy rabbit surveys were performed during the day to locate burrow systems and look for sign. Incidental mammal observations were made in or near CIRO during travel and other inventory activities as part of the visual encounter category. Information recorded during visual encounter

surveys included time, location, habitat, and notes of interest. Minimal road surveys were conducted in CIRO due to the small number and length of roads; road surveys were used during the day and at night when nocturnal species were likely to be encountered.

A variety of trapping techniques were used to inventory small mammals and bats, generally following procedures outlined in Jones et al. (1996), Cooperrider et al. (1986), Kunz (1988), and the UCBN. Capture and handling procedures were consistent with those outlined by the Ad Hoc Committee on Acceptable Field Methods in Mammalogy (1987) and the University of Idaho Institutional Animal Care and Use Committee.

The primary technique used to capture ground-dwelling small mammals was Sherman live traps in conjunction with museum special snap traps placed along 150-meter (492 feet) transects. Trap stations were established approximately every 15 meters (49 feet) with one live trap and one snap trap placed at each station. Traps were set for four consecutive nights on each transect. Traps were placed within 2 meters (6.5 feet) of the transect center and were placed non-randomly near microhabitat features and mammal sign to maximize capture success. Miscellaneous trapping techniques included the use of larger Havahart wire cage live traps for skunks and weasels and museum special snap traps baited to attract shrews near water. Ancillary data collected with small mammal captures included time, date, location, weather, moon phase, topography, age, sex, and habitat.

To capture bat species, two nights of mist netting were conducted on August 8 and 9, 2003 following methods outlined in Kunz (1988). Mist nets designed specifically for bats (i.e., 38 mm (0.15 inch) mesh size and reduced bag) were erected over water within CIRO on Circle Creek and across one stock pond near the CIRO boundary. A range of net lengths (6, 9, and 18 m) (19.6, 29.4, and 58.8 feet) was used, altering arrays for topographic and strategic considerations. Nets were opened at sunset and remained so for three hours following sunset. Ancillary data collected with bat captures included time of capture, date, location, weather conditions, time of sunset, moon phase, age, sex, reproductive condition, forearm length, and habitat. An *Anabat* echolocation call recording and analysis system (Titley Electronics, Ballina, NSW, Ausralia; Corben Scientific, Rohnert, CA) was used to record and analyze the ultrasonic calls emitted by bats during foraging and commuting.

The *Anabat* system consisted of an *Anabat II* bat detector, type 6-standard Zero-Crossings Analysis Interface Module, an IBM-compatible laptop, *Anabat 6* software, and *Analook* software. A 12-volt 100-watt handheld spotlight was used during recording sessions to illuminate flying bats and provide visual cues to aid in species identification. Species identification of free-flying bats was the primary application of *Anabat* in the inventory, although information on bat activity was also obtained from the use of *Anabat*. Recorded calls of bats were compared with an existing library of *Anabat* call files developed by releasing and recording bats captured and identified in the hand. The library was used to enhance the species identification of calls recorded from free-flying bats. The *Anabat* system was used simultaneously during mist netting sessions. Ancillary information collected with *Anabat* recording included time and location.

Mammal individuals encountered during the inventory were documented using photography, collection of voucher specimens, voucher *Anabat* call files, and field observation records

(Rodhouse et al. 2009). Individuals killed in snap traps and road-killed specimens were prepared into skulls and study skins that were curated by the University of Washington, Burke Museum of Natural History in Seattle, Washington.

Herptiles: The herpetology survey area extended throughout four counties in south central Idaho with the majority of 49 survey sites located within Cassia County (Shive and Peterson 2002). One site occurred within CIRO and was sampled at least once during the survey. Specific sites and data points were recorded in UTM coordinates using a GPS receiver. Environmental conditions such as radiation, cloud cover, precipitation, and air temperature were recorded at each survey site. Radiation and cloud cover were visually estimated, while shaded 1m (3.3 feet) height air temperature measurements were made using a Taylor (Model 9841) digital thermometer. Wetland characteristics recorded included length, width, depth, water temperature, water chemistry (pH and conductivity), and National Wetlands Inventory (NWI) classification (Cowardin et al. 1979). A habitat classification for each survey site was recorded, based on the land cover classification system developed for the Idaho Gap Analysis. Year 2000 sampling was conducted at numerous times throughout the late spring and summer. Voucher photographs were taken of all sensitive species observed within the study area. Visual encounter surveys were the most frequently used field technique; other techniques included road driving (morning and early evening), dipnetting, cover turning, aquatic funnel trapping, and incidental observations. Data were automated and stored into a Microsoft Excel spreadsheet for management and analyses. Maps of species distributions were developed using GIS software and backed up with USGS topographic quadrangles.

CIRO Proposed Wildlife Monitoring Protocols: Properties of faunal assemblages and populations are important indicators of environmental change because fauna serve a great diversity of ecological functions that affect ecosystem productivity, resilience, and sustainability (Marcot 1996). Terrestrial fauna are desirable subjects for long-term ecological monitoring because they have widespread public appeal, and changes in the Reserve fauna are likely to garner a high level of public interest and generate support for corrective or remedial management actions (Rodhouse et al. 2009). At this writing, monitoring plans for bats have been prepared and are summarized under the group discussion. Plans for monitoring the Greater Sage-grouse are being coordinated with the IDFG.

Air Quality

Air quality in National Parks is expected to improve as regulations designed to reduce tailpipe emissions from motor vehicles and pollution from electric-generating facilities become effective over the next few years (NPS 2010). In addition, states and tribes, with assistance from regional planning organizations, are in the process of implementing programs to improve visibility in National Parks and wilderness areas in response to EPA regulations. Information available through the NPS air quality monitoring program has provided a foundation and impetus for pollution control programs that will benefit National Parks. The NPS ability to offer expert and constructive assistance and advice to regulatory and permitting agencies has stimulated collaborative efforts to find creative and cost-effective air quality management approaches (NPS 2010).

Progress toward air quality goals is measured annually through target goals (NPS 2010) using data from visibility, ozone, and precipitation monitoring to assess air quality trends. Six

measures are used in calculating the goal percentages: two are used to measure progress toward the visibility goal, one measure is used for the ozone goal, and three measures are used for the atmospheric deposition goal (not all parks monitor all six of the indicators). A park is considered to have air quality that is improving or not deteriorating if none of the measures used for that goal show a statistically significant degrading trend.

The Air quality of CIRO is thought to be of very good quality; Cassia County, Idaho is in an attainment area (meets or has pollutant levels below the NAAQS) (IDEQ 2011). The nearest NADP monitoring site is located within Craters of the Moon National Monument and Preserve approximately 100 miles (161 kilometers) to the north and east of CIRO. Established in 1980, the monitoring site provides a long term record of precipitation chemistry and mercury deposition data analyzed from the monitoring station samplers; the data are available on the Internet at: http://nadp.sws.uiuc.edu/sites/siteinfo.asp?id =ID03&net=NADP Extensive precipitation chemistry data (National Trends Network wet deposition) and trend plots are available for multiple time periods on the NADP website.

Under the Interagency Monitoring of Protected Visual Environments (IMPROVE) program established in 1992, the NPS monitors ozone, particulates, and examines the clearest days and haziest days to measure visibility conditions; the EPA uses these measures to assess progress toward the national goal of remedying any existing and preventing any future human-caused visibility impairment in protected areas (NPS 2010). Air quality monitoring is now part of the UCBN I&M Program and an ozone and air quality portable sampling station has been established in CIRO as of 2010 (NPS 2010).

Vegetation

Several GIS vegetation data layers were previously created for the CIRO project area. More extensive data layers were clipped to the Hydrologic Unit Code (HUC) watershed basin extent and summarized in the "project summary" MS Excel spreadsheet. The CIRO geodatabase includes vegetation layers developed from: the LANDFIRE Program, National Land Cover Data (NLCD), USGS Sagemap, Idaho GAP Analysis Project, NPS/USGS National Vegetation Mapping (Inventory) Program (NVIP), and The National Agriculture Statistics Service (NASS). The more encompassing raster data files are constructed by individual agencies from visual interpretation classification of satellite imagery, are intended for general geographic display at a scale of 1:100,000 or smaller, and are provided as constructed with many general limitations and overlap to actual ground conditions. The NVIP database was constructed for more detailed use at the 1:12,000 scale.

The NVIP project was a three-year, three-phase program initiated to complete the tasks of sampling, classifying, and mapping the plant associations and vegetation alliances within CIRO. Phase-one, directed by UCBN staff in conjunction with Northwest Management Incorporated (NMI), Idaho State University (ISU), and S.M. Stoller Corporation (Stoller) resulted in the plant association and vegetation alliance classification using the National Vegetation Classification System (NVCS). Vegetation classification was based on the 2009 field sampling of 190 representative classification plots located within the boundary of CIRO and adjoining Castle Rocks State Park. Analysis of the classification plot data by ISU and Stoller ecologists occurred in 2010. Through this process 35 distinct plant associations were identified as were two

vegetation alliances. Vegetation alliance and plant association local descriptions and a field key to determine each association in the field are included in this report (Erixson and Cogen 2011).

Phase-two, directed by NMI and Cogan Technology, Inc. (CTI) resulted in creation of the digital vegetation and land use map and project geodatabase. Mapping was conducted primarily by interpreting vegetation-specific and non-vegetated site signatures from the 2009 National Aerial Imagery Program (NAIP) ortho-photo products. CTI reliably discerned 34 vegetation, 10 land use/land cover, and one geology/sparse vegetation map units. The mapping process relied on manual digitizing of homogenous photo-signatures supported by on-site verification. All interpreted data were converted to Geographic Information System (GIS) databases using ArcGIS© software. The final map layer contains vegetation, land-use, and geologic exposure polygons with corresponding map class, NVC, and modifier attributes (Erixson and Cogen 2011).

Draft maps were printed, field tested, reviewed, and revised based on the field observations. Following verification, edits were applied to create the final vegetation map product for accuracy assessment (AA). In Phase-three the AA was conducted by NMI ecologists during the 2010 field season. Sampling required selecting 597 random point locations throughout the study area based on frequency and abundance for each vegetation map unit. AA locations were accessed by NMI field crews, the vegetation at each target was keyed to the proper association, and representative photographs of each location were acquired. The field data were compared to the electronic vegetation map following the final assessment and three map units with low accuracy were combined with similar map units to increase the accuracy. The AA analysis on the modified vegetation layer revealed an overall thematic accuracy of 88%.

Invasive Plant Species

GIS data representing non-native and invasive plant species and noxious weeds were acquired from existing studies/investigations, including the NVIP existing vegetation map (Erixson and Cogan 2011), and entered into the CIRO geodatabase. These data include lines, points, and polygons (developed from invasive plant surveys, classification plot data, and listing of species encounter in the surveys and plot data). Federal, state, and county databases and websites were searched for invasive/noxious weed locations and local county weed officials were contacted for unpublished data. Metadata are included with each layer describing the data and source; metadata files are imbedded within the files and are viewable using ArcGIS software. The invasive plant species and noxious weed information relevant to CIRO are presented within the "Vegetation" section of the results as stressors to Reserve resources.

Disease

Disease within CIRO was evaluated for vegetation and wildlife through literature review including NPS and non-NPS publications as well as on-line Internet searches and personal communication with UCBN and CIRO managers.

Wildfire

Multiple wildland fire-related data layers are included in the CIRO GeoDatabase under the Stressors heading, and as separate model-derived raster layers. These datasets reside in the public domain from federal agencies. The currently available files provide information relating to fire behavior fuel models, condition, potential and behavior, as well as historic fire locations and fire

extents. The data were clipped to the CIRO project area and summarized within the project summary MS Excel Spreadsheet on the DVD. Fire locations are also expressed as plant association map classes within the NVIP product (Erixson and Cogan 2011).

Fire Regime Condition Class (FRCC) Departure Index data were used to evaluate the condition of vegetation within the CIRO project area. The FRCC Departure Index is not directly related to the risk of wildfire but is one indicator of vegetation departure from presumed historical conditions. The wildfire information relevant to CIRO are presented within the "Vegetation" section of the results as wildfire is considered a stressor to Reserve resources more than a resource in itself.

Results

The following sections focus on the key resource groups and species identified within CIRO through analysis and literature review of known data (inventory and monitoring), proposed monitoring protocols, threats and stressors, and data gaps. Each identified group or species is discussed as a whole, then specific areas of management concern within each group or species are addressed in greater detail.

Wildlife

The wildlife of CIRO is variable and diverse consisting of 242 vertebrate (NPSpecies Database 2011) and many invertebrate species, some endemic, some seasonally transitory, and some as infrequent visitors. The available vegetated, exposed geologic, and aquatic/wetland habitats and diversity of structure within CIRO are the driving factor behind the existing species diversity. From the granitic outcrops and domes to the pinyon-juniper woodlands, and sagebrush shrubland valleys, CIRO harbors some of the most unique and diverse wildlife habitat in south-central Idaho. Historically, within CIRO, there have been a number of wildlife observations, inventory projects/reports, and proposed monitoring protocols for species and species groups. In 2001, sites within CIRO were selected for herpetological inventory by ISU researchers and several of the 20 certified reptile species were documented. In 2003 the first comprehensive mammal inventory within and adjacent to CIRO was competed and a second small mammal survey was completed in 2007. These inventories confirmed 10 species of bats and 45 other mammal species.

CIRO wildlife habitats include several vegetation types (herbaceous, shrubland, and woodland/forest) with a variety of structural niches, resulting from the variation in elevation, geology, soils, and climate (Rodhouse et al. 2009; Erixson and Cogan 2011). Vegetation established on the lower elevation of CIRO is characterized by Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) and includes large areas of rubber rabbitbrush (*Ericameria nauseosus*), green rabbitbrush (*Chrysothamnus viscidiflorus*), Sandberg's bluegrass (*Poa secunda*), and the non-native bunchgrass crested wheatgrass (*Agropyron desertorum*). Woodland vegetation at higher elevations consists of Utah juniper (*Juniperus osteosperma*), single-leaf piñon pine (*Pinus monophylla*), and curlleaf mountain mahogany (*Cercocarpus ledifolius*) with extensive patches of mixed mountain shrubland. Riparian forest/woodland and shrubland habitat consists of quaking aspen, willows (*Salix* spp.), and Woods' rose (*Rosa woodsii*).

Vegetation in and around CIRO has undergone significant changes over time, and likely differs considerably from historic conditions. Grazing, dry-land farming, fire suppression, and land use developments such as roads and campgrounds in addition to wildfires have driven much of this change (NPS 1996). For example, the Emery Canyon area burned in 1992 and again in 1996 and over 2,500 acres (1,008 hectares) burned in Emigrant Canyon during a fire in 2000. These areas experienced significant erosion following the fires and non-native invasive plants including Russian thistle (*Salsola tragus*), cheatgrass (*Bromus tectorum*), and crested wheatgrass have become established. A recent weed mapping project for CIRO confirmed new invasion by several non-native invasive plants, including bull thistle (*Cirsium vulgare*) and spotted knapweed (*Centaurea biebersteinii*) which are likely having a significant impact on small mammal populations, although this impact has not been quantified.

The 2003 project to capture small and medium sized non-volant mammals totaled 2,742 trap nights and a total capture of 873 individuals. Deer mice (*Peromyscus maniculatus*) were the most abundant mammals captured, representing 69% of all captures; the Great Basin pocket mouse (*Perognathus parvus*) was the second most abundant small mammal with 18% of the captures. Two mist net sessions were conducted to sample bats during 2003, but windy conditions negatively affected captures on August 9th. No captures were made along Circle Creek and two species, the little brown myotis (*Myotis lucifugus*) and the western-small footed myotis (*Myotis ciliolabrum*) were captured at the stock pond near Castle Rocks. One spotted bat (*Euderma maculatum*) was heard flying high over the stock pond; they are difficult to capture in mist nets but produce distinctive echolocation calls that are readily distinguished from other Idaho bat species (Fenton et al. 1987). The spotted bat is rare in Idaho and considered a species of special concern by the IDFG.

Anabat recording sessions were conducted simultaneously with mist netting on August 8-9, 2003. On August 8, five species were confirmed through call files and visual cues. Three species, the pallid bat (*Antrozous pallidus*), silver-haired bat (*Lasionycteris noctivagans)*, and the hoary bat (*Lasiurus cinereus*) were previously undocumented within CIRO. The big brown bat (*Eptesicus fuscus*) and the long-eared myotis (*Myotis evotis*) were also observed and recorded during this session. Additionally, several 40 Khz calls produced by unidentified myotis species were recorded. Tentative identification of a portion of these calls focused on the western small-footed myotis (*Myotis ciliolabrum*). Two species, the big brown bat and pallid bat, were confirmed on August 9, but several 40 Khz myotis calls were also recorded.

Identification of the cliff chipmunk (*Tamias dorsalis*) and the pinyon mouse (*Peromyscus truei*) along cliffs and rocky areas of single-leaf pinyon pine woodland habitat within CIRO was important because both species are considered rare within Idaho. Prior to the CIRO collections, the pinyon mouse was known to occur in Idaho in the Owyhee Mountains, approximately 150 miles (242 kilometers) to the west. CIRO is at the northern limit of the range for the pinyon mouse and the capture likely represents a range extension. The cliff chipmunk has been placed on the BLM list for peripheral species in Idaho. In March 2003, a dead ringtail (*Bassariscus astutus*) was identified in the Castle Rocks area, the first record of this unusual mammal in Idaho that represents a significant northward range extension (Rodhouse et al. 2009). Currently, a ringtail study is being assessed by the IDFG (Personnel communication NPS CIRO staff).

In 2006 CIRO staff completed a raptor survey identifying six species active within the available habitats. The 2005-certified species list published by NPSpecies Database (2011) details the most recent tally of known wildlife within CIRO to date and includes 165 birds, 55 mammals, 20 reptiles, one amphibian, the boreal chorus frog (*Pseudacris triseriata maculata*), and one fish, the bluehead sucker (*Catostomus discobolus*).

One amphibian (boreal chorus frog) and one fish (bluehead sucker) have been documented within CIRO (NPSpecies Database 2011). The boreal chorus frog has been observed from Great Bear Lake in the Northwest Territory of Canada, through the southwestern and central U.S. (Stebbins 2003). Management of this species is largely undeveloped and currently relies on general management practices applied to conservation areas and habitats where protection occurs inadvertently. The bluehead sucker is considered native to the Colorado River Basin and the

ancient Lake Bonneville in Idaho, Utah, and Wyoming even though management has been broadly undefined for this species (Ptacek et al. 2005). Currently the bluehead sucker is un-ranked in the State of Idaho (Ptacek et al. 2005) and is considered "unprotected wildlife" (IDFG 2010).

Sixteen herptile species (five snakes, six lizards, and five amphibians) were observed during the 2001 inventory project. Of the 543 amphibian and reptile observations made throughout the regional study area, Pacific treefrogs (*Pseudacris regilla*) exhibited the highest relative abundance representing 42% of the total number of observations (56% of all amphibian observations). Interestingly, northern leopard frogs (*Rana pipiens*), which are considered a sensitive species (BLM) and species of special concern (IDFG 2010), exhibited the second highest relative abundance in the study area representing 24% of the total number of observations (33% of all amphibian observations).

Within CIRO, the western fence lizard (*Sceloporus occidentalis*) had the highest relative abundance of any lizard species representing 55% of all lizard observations, but only contributed 8% to the total number of observations made throughout the regional study area. The sagebrush lizard (*Sceloporus graciosus*) was the second most abundant lizard species within the Reserve. Gopher snakes (*Pituophis catenifer*) had the highest relative abundance of any snake species detected throughout the regional study area representing 38% of all snake observations, and contributed 4% to the total number of observations made throughout the study area. The western terrestrial garter snake (*Thamnophis elegans*) was also commonly observed within CIRO.

Inventory: No comprehensive inventory had been attempted in CIRO prior to the 2003 mammal inventory; in 2001 ISU completed a herpetological inventory with sites in CIRO and a small mammal survey was competed in 2007 (NPS 2011).

Monitoring: The UCBN has identified threatened and endangered species as a priority vital sign for monitoring within CIRO. Within this priority classification, several species of management concern have been identified and are discussed in detail throughout this section. The UCBN monitors selected natural resources to evaluate long-term trends in ecological systems and identify threats or stressors to the resources. This ecological monitoring provides a means of early detection in an attempt to identify and manage undesirable changes to the resource (Garrett et al. 2007). UCBN monitoring plans addressing bat species and the Greater Sage-grouse are summarized herein.

Wildlife Species of Management Concern: The ten bat species observed within CIRO represent the majority of bats that occur within Idaho. Two species, the pallid bat and spotted bat were identified for the first time and represent Idaho species of special concern. Several other unique species occur at CIRO including the cliff chipmunk and pinyon mouse that are obligates using the old-growth pinyon-juniper woodland habitats (Rodhouse et al. 2010). Additional species of interest within CIRO are the Greater Sage-grouse (*Centrocercus urophasianus*), Sage Sparrow (*Amphispiza belli*), Brewer's Sparrow (*Spizella breweri*), and Sage Thrasher (*Oreoscoptes montanus*) because they are sagebrush-obligate birds. The following discussion is a summary of the indicator wildlife species identified within CIRO and has been organized around the subsection points: (1) Background; (2) Data (Inventory and Monitoring); (3) Threats and Stressors; and (4) Data Gaps.

Cliff Chipmunk

Background: There are six subspecies of cliff chipmunk distributed across the western U.S., from southern Idaho, Utah, Nevada, Wyoming, Colorado, Arizona, and New Mexico to Mexico. Within CIRO there are two subspecies of cliff chipmunk thought to be present; subspecies *Tamias dorsalis grinnelli* and *Tamias dorsalis utahensis* (Hall 1981). Cliff chipmunks occur around cliffs, boulders, and rocky outcroppings in pinyon-juniper woodlands and adacent upland habitats and range in elevation from the coast near sea level to high altitude mountain faces in excess of 12,000 feet (3,658 meters) (Broadbrooks 1999, Hall 1981, Hart 1992). The NPS recognizes southern Idaho as the northern limit of the cliff chipmunk distribution and have documented stable populations of *Tamias dorsalis utahensis* within CIRO (Figure 8).

The cliff chipmunk is considered a critical species for monitoring and assessment of the natural resource conditions within CIRO due to the species occurrence at the northern most fringe of its range and the potential impacts of climate change. Rodhouse et al. (2010) considers the cliff chipmunk to be a "peripheral species" in Idaho although the species exists as a relatively large stable population within CIRO and has been noted as a common occurrence (NPSpecies Database 2011). The granitic features and arid mid-altitude range of CIRO presents an optimum ecosystem for continued success of the cliff chipmunk population.

Data: The NPS 2003 mammal survey within CIRO confirmed the cliff chipmunk occurrence; it also established the species as a potential indicator of climate change due to the fringe location of the viable range. The results from the 2003 field survey and trapping effort included capturing two cliff chipmunks (0.1% of total captures); the first confirmed occurrence of the cliff chipmunk within CIRO since a study by Larrison in 1967 (Rodhouse et al. 2009, Rodhouse et al. 2010). The cliff chipmunk has been placed on the BLM list of peripheral species for Idaho, meaning this species presence is rare in this area (Idaho BLM Special Status Animal Species).

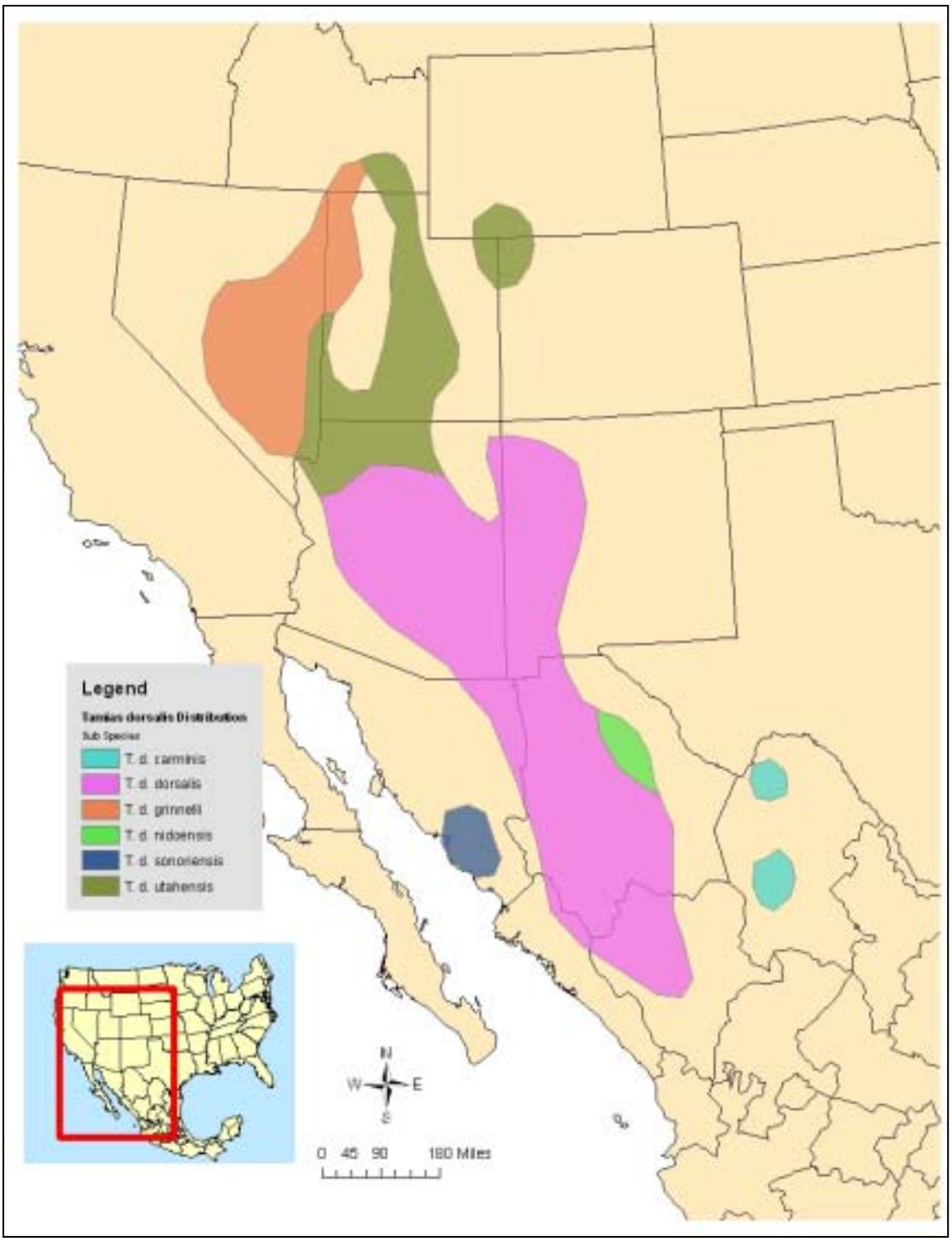


Figure 8. Known geographic distribution of the cliff chipmunk in the United States and Mexico (Linzey and Hammerson 2008) and the distribution of the six Tamias dorsalis subspecies (Hall, 1981).

Threats and Stressors: Climate change poses a potential threat to the cliff chipmunk within Idaho as the species may be sensitive to changes in temperature at the periphery of its range. The cliff chipmunk occurrence within pinyon-juniper woodland habitats within CIRO could tie the species fecundity to the success of these habitat types placing increased attention on the management of pinyon-juniper stands within CIRO. A recent outbreak of pinyon bark beetle (*Ips confusus*) has impacted about 15% of the wooded lands within CIRO posing a potential threat to this species (NPS 2011). Stand-replacing wildfire would affect important cliff chipmunk woodland habitat with unknown consequences.

Pinyon Mouse

Background: The pinyon mouse occurs in the southwestern U.S., from central Oregon and the California coast; east to Colorado and the panhandle of Texas; and south to south-central Mexico (Hoffmeister 1981). In Idaho the species occurs discontinuously in mountainous areas in the southwest part of the state in the Owyhee Mountains (Hammond and Yensen 1982) and the south-central area of Twin Falls and Cassia counties. The pinyon mouse occurs around cliffs, boulders, and rocky outcroppings in pinyon-juniper woodlands and adjacent upland areas especially areas with adequate ground cover.

Individuals of this species occupy elevations from coastal sites near sea level in California to high altitude mountain faces in excess of 8,500 feet (2,591 meters) in Utah (Figure 9) (Honeycutt et al. 1981). The NPS recognizes southern Idaho as potentially the most northern limit of the pinyon mouse distribution and has completed baseline small mammal inventory research in order to further understand this species use of habitats within CIRO. The pinyon-juniper woodland habitats of CIRO including shrub and herbaceous understory cover is known to provide desirable habitat to support the pinyon mouse, therefore the importance of maintaining this habitat amidst climate change elements has become a focus of the NPS.

Data: The NPS conducted a mammal survey within CIRO in 2003; it remains the comprehensive mammal study in CIRO and constitutes the first small mammal inventory and identification of the pinyon mouse in CIRO since an unconfirmed report in 1967 (Rodhouse et al. 2009, Rodhouse et al. 2010). The voucher specimen of the pinyon mouse collected in 2003 may represent a range extension (Rodhouse et al. 2009). The results from the 2003 field surveys and trapping effort included 1% or 12 individual pinyon mice captured (Rodhouse et al. 2009). One specimen was submitted to the University of Washington's Burke Museum of Natural History as a permanent voucher specimen from the 2006-2007 survey (Rodhouse et al. 2010). The distribution of this species within Idaho is poorly documented and the discovery of this species within CIRO provides the NPS a unique opportunity to evaluate the potential impacts of climate change on a fringe species that relies on the pinyon-juniper woodland habitats (Rodhouse et al. 2010).

Threats and Stressors: Threats to the pinyon mouse are in the form of climate change within Idaho as the species may be particularly sensitive to changes in temperature and precipitation patterns which affect singleleaf pinyon pine habitat at the periphery of both its range and the pinyon mouse range. The pinyon mouse occurrence within pinyon-juniper woodland habitats within CIRO could also make this species vulnerable to the loss of habitat and from management effects to these habitats. The NPS has recorded recent outbreaks of pinyon bark beetle (*Ips confusus*) which have impacted nearly 15% of the wooded lands within CIRO which could

present a threat to the pinyon mouse (NPS 2011). Stand-replacing wildfire would affect important cliff chipmunk woodland habitat with unknown consequences. The Red List presented by the International Union for Conservation of Nature and Natural Resources, states that there are currently no conservation actions for the pinyon mouse as the species is considered to have a wide range throughout the southwestern U.S. and includes many protected areas (Linzey and Hammerson 2008).



Figure 9. Geographic distribution of the pinyon mouse throughout the western United States and Mexico (Linzey and Hammerson 2008).

Bats

Background: There are almost 1,000 species of bats throughout the world existing in nearly every ecosystem on the planet. In Idaho there are 14 bat species and 10-12 of them have been identified within the boundaries of CIRO (Table 4). The diversity of bats worldwide means the species exist in a wide variety of ecosystems; the Idaho bat species use habitats ranging from dense evergreen forests to woodlands, shrublands, riparian areas, geologic formations, and arid desert shelters, therefore the occurrence of unique geologic features, pinyon-juniper woodlands, and riparian habitats within CIRO provides important habitat for these unique mammals.

Bats represent a significant portion of diversity among mammals within the UCBN region and many species using habitats in Idaho have been classified as species of concern (Ave et al. 2004). The UCBN monitoring program recognizes bats as important indicators of biodiversity and ecosystem health. Newson et al. (2009) stated that interrupted hibernation cycles of bats due to excessive temperatures and changes in food supplies related to changes in weather patterns could be impacting bat populations. The 1998 IDFG publication *Idaho's Bats* notes that bat populations worldwide are in decline due to a variety of changes in environmental attributes, some of which can be driven by variations in climate at a regional scale.

The NPS has identified the importance of bats as species of interest within CIRO and are presently working on presence/absence, distribution, and migration pattern identification throughout Idaho, Montana, Washington, and Oregon (UCBN 2006). In addition to CIRO some of the other park units included under monitoring protocols for bat species are Craters of the Moon National Monument and Preserve in southeastern Idaho, John Day Fossil Beds in Oregon, Big Hole National Battlefield in southwestern Montana, Glacier National Park in northern Montana, and North Cascades National Park in Washington.

Data: During the 2003 mammal inventory two nights of mist netting and echolocation recording information was collected for bats on August 8th and 9th. Four bat species were confirmed for the first time in CIRO; the spotted bat, hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), and the pallid bat. Of these newly identified species the spotted bat is considered a species of special concern by the state of Idaho and is not well understood. Additional work by Rodhouse et al. (2009) illustrates the importance of the pallid bat and Townsend's big-eared bat at NPS units in southern Idaho, therefore the presence of these species within CIRO may indicate important resources for all bat species listed in Table 4.

Table 4. City of Rocks National Reserve bat species (Rodhouse et al. 2009).

Scientific Name	Common Name	Occurrence
Antrozous pallidus	Pallid bat	Present in Park
Eptesicus fuscus	Big brown bat	Present in Park
Euderma maculatum	Spotted bat	Present in Park
Lasionycteris noctivagans	Silver-haired bat	Present in Park
Lasiurus cinereus	Hoary bat	Present in Park
Myotis ciliolabrum	Western small-footed bat	Present in Park
Myotis evotis	Long-eared myotis	Present in Park
Myotis lucifugus	Little brown myotis	Present in Park
Myotis thysanodes	Fringed myotis	Present in Park
Myotis volans	Long-legged myotis	Present in Park
Myotis yumanensis	Yuma myotis	Probably Present
Plecotus townsendii	Townsend's big-eared bat	Probably Present

Monitoring Protocols (Proposed): Bats exhibit high fidelity to foraging and roosting sites and extreme longevity, making them well-suited candidates for long-term monitoring (Fenton 2003). Changes in bat species presence and activity patterns at monitoring sites in the UCBN including CIRO will serve as good indicators of environmental change, especially focus on riparian and aquatic systems because bats concentrate foraging around these habitats (Rodhouse et al. 2009). In the UCBN, maternity roosts of the Townsend's big-eared bat and pallid bat, both sensitive colonial species, are located in cliffs and caves that experience heavy visitation. Monitoring of these sites over time will provide invaluable information to managers about visitor impacts on these resource areas.

In the UCBN bats represent one of the most diverse mammalian groups, second to the rodents; as many as 14 species of bats have been documented in UCBN parks and over half of those are listed as federal and/or state species of concern. Important pup-rearing, hibernation, and foraging resources have been documented including cliff complexes (provide summer roosting for at least six species), lava tubes (maternity colony and winter hibernacula), and aquatic, riparian, and upland foraging sites.

In addition to specific focal points of bat conservation concern in the UCBN, there is an overall condition of vulnerability among the bat fauna. Information on distribution, roosting ecology, and conservation status is so poorly known for most bat species that it is imperative that basic trends begin to be established. Trends from long-term bird monitoring in the region show worrisome declines in many bird species due to habitat loss or alteration, pesticide exposure, and other human-caused stressors (Rich et al. 2004). Rodhouse et al. (2009) state “there is no reason to expect regional bat populations are somehow immune to these same stressors, but we are left only to guess in the absence of reliable trend data”.

Although bats are continually recognized as important components of regional mammalian diversity, are essential providers of important ecosystem services, and have an uncertain

conservation status, few bat monitoring programs exist, due in part to lack of efficient and cost-effective protocols. A recent review of bat monitoring in the U.S. emphasized the need for developing and testing monitoring protocols in the immediate future (O'Shea et al. 2003). Recent technological advances in acoustic tools designed to record and analyze bat echolocation calls have resulted in more efficient and cost-effective long-term monitoring of almost any type of habitat used by bats (aquatic and upland) and areas strategically impossible to conduct bat capture efforts. Rodhouse et al. (2009) based the CIRO monitoring protocol on use of state-of-the-art acoustic tools.

The UCBN will incorporate acoustic monitoring of bat occupancy or use in CIRO riparian zones as part of its integrated riparian and water quality monitoring program. Together, monitoring of riparian vegetation, stream channel morphology, water quality, and bat use will provide for more complete understanding of long-term trends in UCBN aquatic and riparian systems. Monitoring questions addressed by this protocol include: (1) What are the nightly, seasonal, and annual patterns and dynamics of species occupancy (use) among bats in UCBN riparian foraging areas?; (2) Is bat species richness in riparian foraging areas in decline?; (3) Are there declining trends of occupancy and activity by bats in foraging and roosting areas in the UCBN?; and (4) Are trends in bat occupancy, activity, and species composition significantly correlated with trends in weather and climate, water quality, stream/channel morphology, and riparian vegetation? The monitoring objective for CIRO addressed by the bat protocol is to estimate trends in the occupancy dynamics of individual bat species during summer pup-rearing in riparian areas of CIRO: [The justification for the focus on riparian habitats is: *Riparian corridors provide critical foraging and commuting habitat for all 14 bat species in the UCBN. Acoustic monitoring of these areas will provide opportunity for trend detection and possible correlation with other UCBN vital signs. Bat monitoring will provide an important vertebrate component to the UCBN integrated riparian and water quality monitoring efforts*.]

The UCBN will develop an occupancy modeling-based approach to bat monitoring following methods outlined by Mackenzie et al. (2006) in which trends in occupancy, local extinction and colonization rates, and detectability parameters will be estimated over time. Methods will be developed that permit estimation of trends in activity based on the number of calls or minutes of activity per unit time (e.g., minutes, hours, nights). The primary method of detection will be solar-powered ANABAT bat detectors (Titley Electronics, Ballina, NSW, AUS). Bat detectors are extremely cost-effective and efficient relative to the amount of information acquired when compared to manual counting methods. Bat detectors will be rotated through an optimal number of sample sites for a series of nightly "revisits" as determined through power analyses (Mackenzie et al. 2006). Manual roost exit counts and some supplementary capture efforts may be required periodically to calibrate and aid interpretation of acoustic results, to further develop the UCBN acoustic bat call library, and assist with development of filters for acoustic data processing. A sampling design will be developed for locating acoustic monitoring stations in riparian areas in an integrated way with the UCBN riparian vegetation and stream/river channel characteristics vital signs. In particular, bat monitoring will occur at a subset of sampling locations selected through a spatially-balanced sampling procedure known as Generalized Random Tessellation Stratified (GRTS), which will support explicit integration of these three different vital signs monitoring designs along linear stream networks (Stevens and Olsen 2004).

Assigning species identification to call sequences remains the most challenging and time consuming aspect of acoustic monitoring. Several strategies will be evaluated during protocol development, including the use of filters, use of "frequency groups" in lieu of resolution to species for difficult *Myotis* species (i.e., 40 KHz *Myotis*), and a double sampling approach in which only a randomly selected subset of monitoring periods are analyzed in detail for species resolution. This in turn informs an estimation procedure for minutes of activity per species based on overall bat activity patterns. Adaptation of occupancy models to support multi-state occupancy estimation involving multinomial or ordinal logistic regression will be investigated as a strategy to provide finer resolution in the detection of use patterns, thereby increasing the sensitivity to detect biologically meaningful change. Of particular interest in this regard is the ability to discern sites and times of night with high levels of use and patterns of decline that would be obscured with simple presence/absence (i.e. two occupancy states).

The UCBN is monitoring the development of a regional bat monitoring program in the USFS Region 6 and may seek to incorporate the NPS program within this larger regional program. A Microsoft Access database developed by Robert Peppard (Bechtel Nevada Co.) and Mike O'Farrell (O'Farrell Biological Consulting) will be employed during the initial pilot work and modified as needed to support data processing, management, and analysis. Anticipated benefits from collaboration extend beyond protocol development for UCBN purposes and include establishment of a regional acoustic bat monitoring network that will provide status and trend information at a much greater spatial scale. Field data collection will be required for CIRO protocol development. Initial pilot work will focus on assessment of functionality, logistics, and data processing and management strategies of solar-powered Anabat stations along non-randomly selected riparian foraging sites. These sites will be selected based on historic capture records available for the Reserve to maximize recording success and interpretation (Ave et al. 2004). Other acoustic monitoring systems available or under development, including full-spectrum approaches (e.g. Sonobat/Petterson system), will also be considered as they become available.

Threats and Stressors: Human disturbance in the form of recreational climbing, park exploration, vandalism, and destruction/degradation of forage habitat poses the greatest threats to the bats of CIRO as they are known to be sensitive to disruption. Currently the spotted bat and the fringed myotis are listed as species of concern by both IDFG and the USFWS (Ave et al. 2004, Wackenhut and McGraw 1998). The largest known threat to bat species of North America is from the fungus (*Geomyces destructans*) and its respective disease, white-nose syndrome. White-nose syndrome is a fungus that grows in dark cool areas where temperatures remain between 40^{o} and 50^{o} degrees F (4^{o} and 10^{o} C). The fungus is not able to grow at temperatures above 68^{o} F (20^{o} C), therefore it is confined to the cave and mine environments commonly used by hibernating bats. The fungus causes a white mold on hibernating bats and is thought to disrupt winter hibernation patterns and cause individuals to deplete winter fat stores too rapidly. The mortality in affected hibernating populations is very high, between 90% and 100%, and is thought to primarily be related to starvation (USGS 2011).

Greater Sage-grouse

Background: The Greater Sage-grouse is the largest grouse in North America and is a sagebrush-steppe habitat obligate that depends entirely on sagebrush shrublands for cover and forage. Sagebrush-steppe shrublands established throughout the western U.S. are decreasing due to development, insect infestation and disease, and wildfire, and consequently the Greater Sage-grouse population is decreasing in numbers and range (Connelly and Braun 1997, Connelly et al. 2004, Schroeder et al. 2004). This population reduction has been demonstrated in Idaho, where Greater Sage-grouse populations declined at a rate of approximately 1.5% per year from 1965 to 2003 (ISGAC 2006). With as much as 56% of the Greater Sage-grouse historical range lost to alteration including wildfire effects the population numbers have declined to a point where it has been considered for listing as a threatened or endangered species by the USFWS (2011).

The decline in the Greater Sage-grouse population has been documented throughout the western U.S. over the past few decades and recent trends in Idaho have shown total decline in the population as much as 40% (IDFG 2006). Declines in Greater Sage-grouse numbers are attributed to the loss, fragmentation, and alteration of sagebrush-steppe shrublands across the intermountain west, particularly in southern Idaho (West and Young 2000, Reid et al. 2002). Agricultural conversion, historic overgrazing, altered fire regime, and non-native/exotic plant invasion are the primary sources of this habitat loss (West and Young 2000, Bunting et al. 2002, ISGAC 2006). Because the Greater Sage-grouse is a migratory species in southern Idaho, the loss of one or more of the components of the seasonal habitat affects the sub-populations. Greater Sage-grouse nest on the ground under sagebrush shrubs and feed on sagebrush leaves, forbs, and insects, primarily. The degree to which the Greater Sage-grouse sub-populations in the state migrate is variable depending on location and severity of winter.

The Greater Sage-grouse requires large/expansive areas of sagebrush-steppe shrubland habitat including the communities established within much of the vegetated portions of CIRO. This critical habitat is used for breeding and summer range, and in areas of low snow levels (less than 12 inches [30.5 centimeters]) is important winter range. In addition, the Greater Sage-grouse is considered an umbrella species for monitoring the health of the sagebrush-steppe ecosystem (Connelly and Braun 1997, Connelly et al. 2004, Schroeder et al. 2004) as well as other sagebrush-obligate species.

Sagebrush-steppe vegetation comprises over 50% of CIRO land cover much of which is suitable habitat for Greater Sage-grouse (Garrett et al. 2007). Within CRSP, sagebrush-steppe habitat occurs on 716 acres (289 ha) and within CIRO it occurs on 5,723 acres (2,308 ha) (Erixson and Cogan 2011). Greater Sage-grouse occur in CIRO year-round but the status of their occurrence is unknown. There are three active leks (strutting/breeding sites located on herbaceous vegetation stands) on or adjacent to CRSP (Figure 10). An additional 4 leks are located within 2 miles of the western boundary of CIRO. These sites are monitored by the Idaho Fish and Game on an annual basis. Nests, broods, and wintering individuals are occasionally observed in CRSP and CIRO as well as on adjacent rangeland.

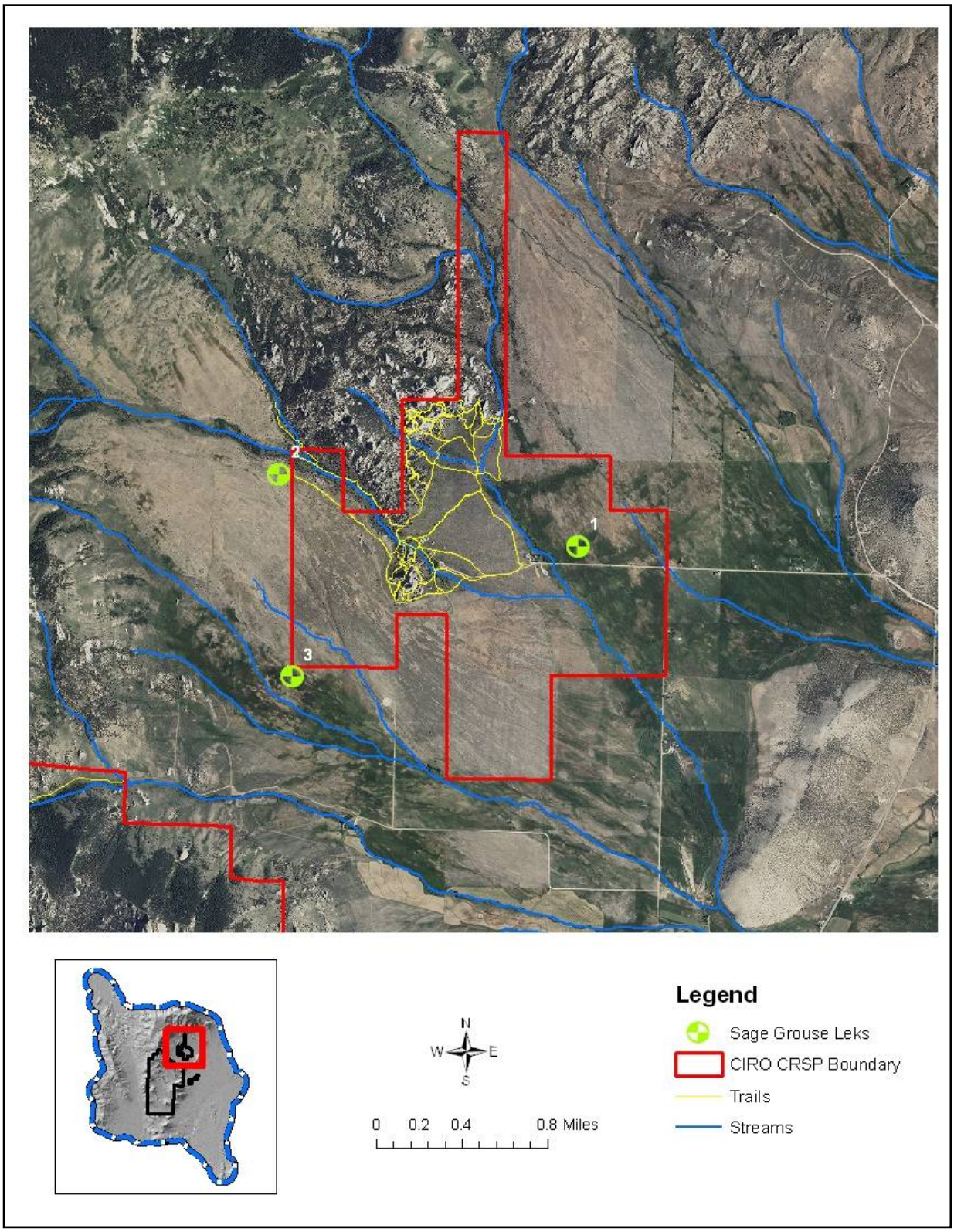


Figure 10. Three Greater Sage-grouse leks have been identified near CIRO in 2005. One is within the boundary of CRSP and two occur near the boundary of CRSP on private land.

Data: Surveys for Greater Sage-grouse within CIRO were conducted from March 20th to April 30th, 2005. The survey methods were outlined in a 2005 NPS-designated protocol for lek identification and consisted of scouting areas from four identified higher elevation vantage points within the park boundary. A total of 24 survey days were completed by six researchers and three new Greater Sage-grouse leks were identified, illustrated on Figure 10 (Vincent et al. 2005). Results of the survey were as follows: (1) Lek 1 had an average of six observed males and two observed females; (2) Lek 2 had an average of two to three males observed with two females observed enroute to this lek; and (3) Lek 3 supported 19 males and zero females on one visit (subsequent visits to this site did not observe any individuals). Sagebrush-steppe habitat within CIRO was surveyed during two visits of the 2005 inventory; however, no leks were observed (Vincent et al. 2005). In 2011, the CIRO Natural Resource staff and the Idaho Fish and Game conducted Greater Sage-grouse surveys. At the time of this report the data and findings were not available. In addition, personal observations by landowners near CRSP reported a viable report of a Greater Sage-grouse hen and offspring in 2011.

Monitoring Protocols (Proposed): It appears that CIRO does not support large numbers of Greater Sage-grouse and Reserve habitat lies on the periphery of more active habitat (Garrett et al. 2007). However, it is important for NPS to monitor Greater Sage-grouse and habitat for several reasons, they include: (1) Greater Sage-grouse require a large area of sagebrush/grassland habitat with a significant amount of canopy cover for nesting and wintering habitat (ISGAC 2006); (2) biologists describe the Greater Sage-grouse as an umbrella species and home range and habitat requirements are large enough that, if protected, will consequently bring other species under protection (ISGAC 2006); (3) Greater Sage-grouse exhibit high fidelity to seasonal ranges, e.g., hens tend to return to the same nesting area each year (Fischer et al. 1993); (4) in the long-term perspective, the importance of CIRO sagebrush-steppe habitat to Greater Sage-grouse may increase as surrounding land cover shifts toward non-suitable habitat (Garrett et al. 2007); and (5) the NPS can make an important contribution to existing state and regional efforts to assess the status and trend of Greater Sage-grouse range-wide. For these reasons, Greater Sage-grouse monitoring will be conducted as a complement to the UCBN sagebrush-steppe vegetation monitoring effort and will add to the overall understanding of sagebrush-steppe ecological condition.

IDFG is currently monitoring Greater Sage-grouse populations of southeastern Idaho on a broader scale to include the expansive habitat used by the species and diverse ownership and agency boundaries. NPS collaboration with IDFG will be essential to the success of this monitoring program (Garrett et al. 2007). Consequently, Greater Sage-grouse information gathered and published in CIRO will benefit IDFG and contribute to efforts and understanding presented in the "Conservation Plan for the Greater Sage-grouse in Idaho," released by the Idaho Sage Grouse Advisory Committee (ISGAC) (2006) and the Idaho Fish and Game Commission.

The UCBN has prepared a monitoring protocol to address the following questions (Garrett et al. 2007): (1) What is the status of Greater Sage-grouse lek activity in CIRO?; (2) What are the long-term trends of lek use in CIRO and are these trends proportional to those statewide?; (3) Where is the potential critical habitat for Greater Sage-grouse in and near CIRO?; and (4) What is the status and trend of Greater Sage-grouse occupancy in these critical park habitat areas? The monitoring objectives addressed by this protocol include: (1) Cooperate with IDFG to estimate

trends in occupancy and abundance of male Greater Sage-grouse through annual lek counts in and adjacent to within 3.2 km [2 mi] of the CIRO boundary. [***Justification:*** *Across the range, lek counts are the most common way to monitor Greater Sage-grouse populations. Leks are relatively easy to identify and survey. Also, state wildlife managers already have a lek monitoring program in place, providing an opportunity to work collaboratively and share information. Long-term lek count data provides insight into Greater Sage-grouse population trends, and consequently, the condition of other sagebrush-steppe obligate species*.] (2) Identify potential critical Greater Sage-grouse habitat areas within CIRO and conduct periodic status surveys in these areas to estimate occupancy and abundance. [***Justification:*** *Greater Sage-grouse have different habitat requirements during each season. Loss or conversion of habitat is reported to be the primary cause of Greater Sage-grouse declines. Each of these important habitats must be identified and protected in order to better manage for the species*.]

The UCBN will develop and implement this protocol in two phases (Garrett et al. 2007). The first phase will address the first objective pertaining to lek counts. The IDFG is currently monitoring leks in and around CIRO. The IDFG monitoring protocol, as described by the ISGAC (2006), will be adopted and modified if necessary to meet the NPS I&M Program standards. NPS personnel will work cooperatively with the regional IDFG office to ensure the protocol is adopted and implemented properly, and information sharing is seamless. Annual ground and aerial lek searches will be coordinated with IDFG.

The second phase of protocol development will address the second objective related to identification and occupancy and abundance of Greater Sage-grouse in critical habitat areas (Garrett et al. 2007). Greater Sage-grouse populations in southern Idaho are migratory, have large annual ranges, and use different habitats at different times of the year (Connelly et al. 2000, 2004). The different requirements for breeding, nesting, summer/brood rearing, fall, and wintering habitats have been described and can be used to describe potential habitat for areas where Greater Sage-grouse use is unknown (Fischer et al. 1993, Connelly et al. 2000, ISGAC 2006). The UCBN will work with the University of Idaho College of Natural Resources and IDFG to develop a GIS-based model of potential Greater Sage-grouse habitat within CIRO. A current vegetation and land use map has been produced for CIRO (Erixson and Cogan 2011) through assistance from the NPS NVIP. Using the vegetation geodatabase, the potential habitat will be stratified into seasonal usage categories and a sampling design relying on flush counts will be developed to support periodic assessment of status and trend in occupancy by habitat type.

Threats and Stressors: Greater Sage-grouse populations have been impacted by the decline in quantity and quality of sagebrush-steppe shrubland habitats resulting from a variety of sources such as: agricultural land conversion and pesticide use, road construction, fire and habitat changes from invasive species, livestock grazing, and climate change. Additionally, the potential impacts to Greater Sage-grouse from the West Nile virus pose a threat to the species. In a study by Naugle et al. (2004) mortality associated with West Nile virus infection was shown to decrease survival of female Greater Sage-grouse by 25% across populations surveyed in Wyoming and Montana and one location in Alberta, Canada, in 2003. At the time of this publication there have not been studies of West Nile virus in populations of Greater Sage-grouse in Idaho.

Livestock grazing, which is permitted in areas of CIRO, may have positive to very negative effects to the Greater Sage-grouse habitat and population. Also much of the land surrounding CIRO is administered by the BLM or private landowners to support grazing livestock; some agricultural production occurs adjacent to CIRO. A change in plant species composition is expected when livestock grazing is conducted in an unsustainable manner.

Wildfire drastically alters the species diversity, structure, and soils of the sagebrush steppe habitat. Wildfires remove sagebrush cover and result in herbaceous vegetation communities, including invasive species stands, for many years. The potential for invasive plants and noxious weeds to become established following wildfire and other disturbance types is high; e.g., the annual invasive cheatgrass alters the plant community by out-competing native bunchgrasses and by increasing fire return intervals. Increase in invasive plant species cover results in increased fire frequency and reduced availability or elimination of desirable plant species supporting Greater Sage-grouse (habitat loss and plant community value decline).

Mormon crickets (*Anabrus simplex*) and grasshoppers (Order Orthoptera: Families Acrididae and Tettigoniidae) are common to abundant and may infest sagebrush-steppe communities. Pesticides used for treating Mormon cricket and grasshopper infestations pose a threat to Greater Sage-grouse chicks which may consume recently killed or treated living insects. Pesticides are typically applied in late May and early June to control insect populations that have reached high densities resulting in vegetation/livestock forage damage.

Climate change poses a threat to the Greater Sage-grouse as precipitation patterns in the sagebrush-steppe community change. Nesting sites are an important component for the Greater Sage-grouse population. Drought cycles decrease the available cover required for nesting and generally decrease the quality and quantity of available forage leading to further declines in the Greater Sage-grouse population.

Sagebrush-obligate Birds (4 Species)

Background: Sagebrush-obligate birds known to occur within CIRO shrubland habitat include the Sage Sparrow (*Amphispiza belli)*, Brewer's Sparrow (*Spizella breweri*), Sage Thrasher (*Oreoscoptes montanus*), and Greater Sage-grouse. Sagebrush-obligate birds rely nearly entirely on the unique habitat provided by the sagebrush-steppe and three of the species discussed herein (e.g., Sage Sparrow, Brewer's Sparrow, and Greater Sage-grouse) are species of conservation concern in Idaho (UCBN 2006). Many of the sagebrush-obligate bird species have shown declines in populations as a result of habitat loss. The sagebrush ecosystem is vitally important as a cover and nesting component for these species and it is estimated that 30% of the historical sagebrush-steppe in the Columbia Basin has been lost to agricultural conversion, invasive species, wildfires, or overgrazing since euro-American settlement.

Studies focused on sagebrush-obligate birds within CIRO have been limited to Greater Sage-grouse monitoring, therefore little information describing other species abundance and use of CIRO habitats was not available at the time of this report. The research presented in the data section has been gathered from several studies outside of CIRO, including monitoring results from CRMO that provide relevant information regarding condition and state-of-conservation.

Data: The Sage Sparrow is ranked S4 in the state of Idaho which represents species that are uncommon but not rare, however they may be rare in parts of their range, usually these species are widespread. These species could be a candidate for long-term monitoring (UCBN 2006). The Sage Sparrow occurs in large contiguous patches of sagebrush and mature sagebrush shrubland ecosystems. This species is strongly associated with sagebrush shrubs for breeding and the presence of Sage Sparrows is positively correlated with big sagebrush (*Artemisia tridentata*), shrub cover, and horizontal patchiness (Martin and Carlson 1998, Paige and Ritter 1998).

The Brewer's Sparrow is ranked S3 in the state of Idaho which represents species that are potentially at risk due to limited and potentially declining numbers, extent and/or habitat even though the species may be observed abundant in some areas of it range (UCBN 2006). This species is a shrub obligate that is threatened by large scale reduction and fragmentation of sagebrush habitats. They are positively correlated with high sagebrush vigor, shrub cover, and above-average vegetation height (Knopf et al. 1990, Rotenberry and Wiens 1980).

The Sage Thrasher is not currently ranked within the state of Idaho; however, it is considered a species of conservation concern in the State of Washington and ranked as a candidate for S3 designation similar to the Brewer's Sparrow (UCBN 2006). Land use changes, fire, livestock grazing, and invasive weeds such as cheatgrass have negatively impacted nesting areas of this species in southern Idaho. Sage Thrashers are not easily displaced from chosen nesting areas and will often return to these sites after habitat alteration that could negatively affect productivity has occurred (Knick and Rotenberry 2002).

Greater Sage-grouse are ranked as an S2 species which represents species at risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to extinction or extirpation within the state (UCBN 2006). Although Greater Sage-grouse are the most commonly studied member of the sage-brush obligate birds, there has not been an identified population of Greater Sage-grouse within CIRO. The NPS has developed a sampling protocol and for CRSP three leks were identified in 2005.

Threats and Stressors: Fragmentation and degradation due to cheatgrass invasion and residential development, agricultural development, and road and powerline right-of-way maintenance negatively impact habitat critical to sagebrush-obligate bird species. The relationship of the sagebrush-obligate birds and the sagebrush-steppe habitat are directly correlated and any loss in habitat or changes in species composition will result in a downward trend in populations (Knopf et al. 1990, Rotenberry and Wiens 1980).

Overgrazing is a contributing factor to the loss of sagebrush-steppe ecosystem diversity and the introduction of undesirable species. The impacts of vegetation changes and land development are not fully understood in relation to sagebrush-obligate birds; however, research has shown changes in habitat can negatively impact sagebrush-obligate bird species. The habitat lost during wildfire affects sagebrush-obligate species immediately due to significant changes in vegetation structure and species composition and could cause permanent shifts in population due to decreased fire reoccurrence intervals and loss of mature sagebrush shrubs. The loss of sagebrush shrubland communities from fire tends to occur as a product of the lack of stump-sprouting and slow maturation of sagebrush and fire return intervals of 20 to 60 years. In some cases the sites

are entirely invaded by non-native species, particularly the annual cheatgrass which outcompetes much of the native vegetation and provides high quantities of fine fuels which commonly decrease the frequency of fire (Whisenant 1990).

Soils

Soil associations with prime agricultural and grazing properties occur in the CIRO area and many acres have been converted to agricultural land use outside the CIRO boundary. Four soil types within CIRO, encompassing 2,134 acres (864 hectares), meet the requirements for prime farmland if irrigated (adequate and dependable quantities of water for irrigation remain available). These soils are: (1) Chayson gravelly silt loam, 2-10% slopes; (2) Cumulic Endoaquolls, 0-4% slopes; (3) Kanlee sandy loam, 4-12% slopes; and (4) Riceton loamy coarse sand, 4-12% slopes (NRCS and NPS 2011). Prime farmland is defined by the USDA as land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. These soils are permeable to water and air, not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.

Classification and Use: Soils within CIRO are largely classified by slope, aspect, parent material, vegetation, and water availability (NRCS and NPS 2011). Currently, approximately 2,134 acres (864 hectares) or about 15% of CIRO soils meet the requirements for prime farmland if irrigated and approximately 8,000 acres (3,238 hectares) or 57% of the Reserve is used as rangeland with about one half of that under private ownership (NRCS and NPS 2011).

Inventory: There are 25 soils described within CIRO (NRCS and NPS 2011). The aerial coverage in acres and percentage of total Reserve area is presented in Table 5. The most defining soils within CIRO are the Ola-Rock outcrop-Earcree complex [mountainous slopes from 35 to 55 percent slope and east to southwest aspects occurring at elevations of approximately 5,770 to 8,460 feet (1,759 to 2,579 meters)] and Itca-Birchcreek-Rock outcrop complex [mountainous slopes from 25 to 35 percent slope and southeast to west aspects occurring at elevations of approximately 5,500 to 7,500 feet (1,676 to 2,286 meters)]. These two soils comprise approximately 5,329 acres (2,157 hectares) or 37% of CIRO (NRCS 2011 and NPS 2011).

Table 5. Acreage and proportion of the identified soils within CIRO (NRCS and NPS 2011).

Symbol	Soil Name	Acres	Percent
6	Arbone loam, 4 to 12 percent slopes	1,515	10.5%
19	Birchcreek extremely stony loam, 20 to 55 percent slopes	55	0.4%
21	Birchcreek-Itca complex, 25 to 55 percent slopes	962	6.7%
26	Chayson gravelly silt loam, 2 to 10 percent slopes	165	1.1%
32	Conneridge very gravelly loam, 20 to 50 percent slopes, extremely stony	15	0.1%
36	Cumulic Endoaquolls, 0 to 4 percent slopes	56	0.4%
78	Hymas-Bezzant association, 10 to 30 percent slopes	30	0.2%
84	Itca-Birchcreek-Rock outcrop complex, 25 to 55 percent slopes	1,908	13.2%
86	Jimsage-Doodlelink complex, 40 to 60 percent slopes	189	1.3%
89	Kanlee sandy loam, 4 to 12 percent slopes	510	3.5%
101	Ola sandy loam, 6 to 20 percent slopes	737	5.1%
102	Pachic Haplocryolls, 15 to 45 percent slopes	346	2.4%
107	Poisonhol loam, 8 to 15 percent slopes, extremely stony	91	0.6%
108	Povey very stony loam, 35 to 55 percent slopes	205	1.4%
109	Povey-Middlehill complex, 20 to 55 percent slopes	9	*
111	Raftriver loam, 2 to 4 percent slopes	180	1.2%
116	Riceton loamy coarse sand, 4 to 12 percent slopes	1,404	9.7%
123	Kanlee-Rock outcrop-Earcree complex, 3 to 30 percent slopes	703	4.9%
124	Ola-Rock outcrop-Earcree complex, 35 to 55 percent slopes	3,421	23.7%
166	Chokecherry very channery sandy loam, 4 to 35 percent slopes	162	1.1%
167	Povey-Nurkey complex 15 to 55 percent slopes	667	4.6%
168	Kanlee sandy loam, 12 to 25 percent slopes	71	0.5%
169	Povey-Ola complex, 35 to 60 percent slopes	228	1.6%
170	Howcan-Searla complex, 4 to 12 percent slopes	64	0.4%
171	Howcan-Searla complex, 12 to 55 percent slopes	714	5.0%
Total	----------	14,407	100.0%

* Less than 0.1 percent.

Ten ecological sites (NRCS reference number) were used to describe the CIRO soils, associated plant species, and range of vegetation production (local climate dependant), as follows:

1) Steep South (R013XY003ID): characterized by mountain big sagebrush (*Artemisia tridentata vaseyana*) / bluebunch wheatgrass (*Pseudoroegneria spicata*) shrubland; production ranges from 1,100-1,600 pounds per acre (499-726 kilograms); also includes antelope bitterbrush (*Purshia tridentata*), mountain snowberry (*Symphoricarpos oreophilus*), Idaho fescue (*Festuca idahoensis*), Nevada bluegrass (*Poa nevadensis*), prairie Junegrass (*Koeleria macrantha*), Sandberg bluegrass, lupine (*Lupinus* sp.), longleaf hawksbeard (*Crepis acuminata*), and arrowleaf balsamroot (*Balsamorhiza sagittata*).
2) Windswept Ridge (R013XY011ID): characterized by black sagebrush (*Artemisia nova*) / bluebunch wheatgrass shrubland; production ranges from 50-1,800 pounds per acre (23-817 kilograms); also includes mountain big sagebrush, low sagebrush (*Artemisia arbuscula*), fringed sagebrush (*Artemisia frigida*), Hood's phlox (*Phlox hoodii*), bluebunch wheatgrass, Sandberg bluegrass, and stemless goldenrod (*Haplopappus acaulis*).
3) Upland Stony Loam (R028AY338UT): characterized by singleleaf pinyon pine – Utah juniper woodland; production ranges from 250-850 pounds per acre (113-386 kilograms); also includes mountain big sagebrush, bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, and arrowleaf balsamroot.
4) Stony Loam (R013XY002ID): characterized by mountain big sagebrush / bluebunch wheatgrass; production ranges from 600-1,800 pounds per acre (272-817 kilograms); also includes antelope bitterbrush, mountain snowberry, Idaho fescue, Sandberg bluegrass, prairie Junegrass, lupine, longleaf hawksbeard, and arrowleaf balsamroot.
5) Shallow Stony (R013XY014ID): characterized by low sagebrush / bluebunch wheatgrass; production ranges from 300-1,000 pounds per acre (136-454 kilograms); also includes Sandberg bluegrass, Nevada bluegrass, and arrowleaf balsamroot.
6) Shallow Gravelly (R013XY004ID): characterized by mountain big sagebrush / bluebunch wheatgrass shrubland; production ranges from 500-1,100 pounds per acre (227-499 kilograms); also includes antelope bitterbrush, Idaho fescue, western wheatgrass, Sandberg bluegrass, and arrowleaf balsamroot.
7) Loamy (R013XY001ID): characterized by mountain (Wyoming) big sagebrush / bluebunch wheatgrass – Idaho fescue; production ranges from 600-1,800 pounds per acre (272-817 kilograms); also includes antelope bitterbrush, green rabbitbrush, Letterman's needlegrass (*Achnatherum lettermanii*), Thurber needlegrass (*Stipa thurberiana*), Nevada bluegrass, prairie Junegrass, Sandberg bluegrass, lupine, longleaf hawksbeard, and arrowleaf balsamroot.
8) Aspen Thicket (R025XY001ID): characterized by quaking aspen (*Populus tremuloides*) forest and woodland stands; production ranges from 500-1,100 pounds per acre (227-499 kilograms); also includes pinegrass (*Calamagrostis rubescens*), Columbia needlegrass (*Achnatherum nelsonii*), mountain brome (*Bromus marginatus*), slender wheatgrass (*Thinopyrum ponticum*), western

needlegrass (*Achnatherum occidentale*), sedge (*Carex* sp.), cinquefoil (*Potentilla* sp.), groundsel (*Senecio* sp.), and geranium (*Geranium* sp.).

9) Mahogany Savanna (R025XY018ID): characterized by curl-leaf mountain mahogany – western snowberry (*Symphoricarpos occidentalis*) / Idaho fescue – needlegrass woodland and tall shrubland; production ranges from 600-1,300 pounds per acre (272-590 kilograms); also includes mountain snowberry, antelope bitterbrush, bluebunch wheatgrass, lupine, and arrowleaf balsamroot.
10) Dry Meadow (R025XY039ID): characterized by Sandberg bluegrass – alpine timothy (*Phleum alpinum*) herbaceous vegetation; production ranges from 1,600-4,000 pounds per acre (726-1,814 kilograms); also includes shrubby cinquefoil (*Pentaphylloides floribunda*), sedges, tufted hairgrass (*Deschampsia caespitosa*), slender wheatgrass, basin wildrye (*Leymus cinereus*), mountain brome, bluegrasses (*Poa* spp.), and rushes (*Juncus* spp.).

Threats and Stressors: Soils generally would receive threats during drought periods or following wildland fires that result in the loss of protective vegetation and biotic crust. Other soil threats occur during patterns of heavy rainfall or local cloudbursts where thinner slope deposits could be washed away and redistributed to drainage banks or depressions. Fire effects to soils are also dependent on texture of the surface layer, content of rock fragments and organic matter in the surface layer, thickness of the surface layer, and slope (NRCS and NPS 2011). Wind can remove fine organic and mineral materials from the soil surface and expose or deposit coarser fragments. Loess may be transported to CIRO via wind currents crossing other erodible areas. Soils developed on mountain and foothill slopes may be subject to erosion by wind and water (inluding sheet and rill erosion) and may be locally affected by landslides. As described under the geology section, pollutants transported by air including chemicals, particulates, and others would likely have a negative effect on soil development, soil microorganisms, biotic crust development, and vegetation cover.

Data Gaps: At the time of this report, no monitoring plan had been established regarding specific areas of impact to geologic features or soils within CIRO. An assessment of the current condition and the affect of potential pollutants, atmospheric deposition, or recreational impacts would provide beneficial baseline of information for Reserve managers. An inventory or monitoring project of this nature would provide critical information regarding the geology and magnitude of any land-based stressors within the Reserve.

Water Resources

The water resources of CIRO include the North Fork, South Fork, and main stem of Circle Creek within the Reserve and Almo Creek within CRSP. Both the Circle Creek and Almo Creek watersheds are part of the Raft River drainage, west and south of Almo, Idaho. During the 2009 field season the first water quality and macroinvertebrate study was initiated, followed in 2010 by the completion of the first riparian condition assessment.

Inventory: On-site evaluation of water resources within CIRO and CRSP included assessment of six lotic riparian sites. The primary objective in evaluating selected riparian habitats was to provide the NPS with a moment-in-time status point for managing land use. The three main objectives were to: 1) identify existing riparian and shoreline condition; 2) identify specific

threats and stressors impacting riparian/shoreline functions and values (e.g., wildlife habitat, water quality improvement, and aquatic species protection; and 3) recommend solutions to minimize or eliminate threats and stressors to riparian/shoreline areas and associated aquatic resources.

A summary of the 2010 Proper Functioning Condition (PFC) assessment and a detailed description of conditions encountered at each site are presented in this report. Table 6 provides a summary of PFC assessment sites sampled during the 2010. Figure 11 identifies locations of riparian/wetland assessment sites within the Circle Creek and Almo Creek watersheds of CIRO and CRSP completed during the 2010 field season. PFC assessments completed during the 2010 field season included Stines Fork of Almo Creek, Almo Creek, Upper North Circle Creek, Lower North Circle Creek, South Circle Creek, and Circle Creek.

Table 6. Summary of the CIRO Proper Functioning Condition assessments completed during the 2010 field season.

Water Resource Area	Functional Rating Assessed
Stines Fork of Almo Creek	√
Almo Creek	√
Upper North Circle Creek	√
Lower North Circle Creek	√
South Circle Creek	√
Circle Creek	√

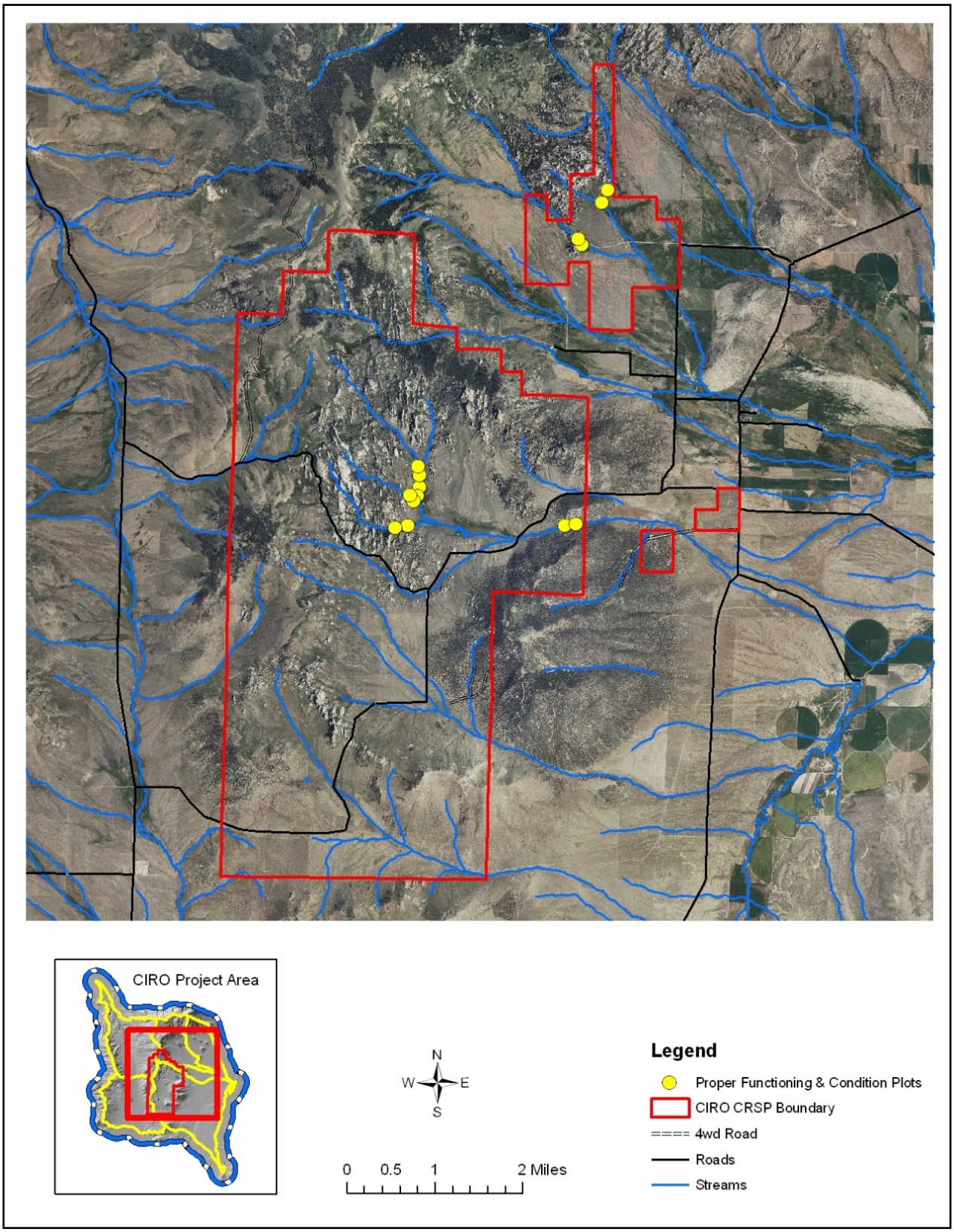


Figure 11. Location of 2010 field surveys for the Proper Functioning Condition Assessment within CIRO.

Monitoring: The NPS goal to preserve water quality within National Park units through inventory and monitoring has lead to the establishment of a three-year monitoring protocol and assessment for CIRO (Starkey 2010, Garrett et al. 2007). During 2009 water quality and macroinvertebrate data were collected from CIRO sites in accordance with the water quality monitoring protocol established during 2009 (Starkey 2010) and macroinvertebrate sampling was conducted per protocol established by the EPA Environmental Monitoring and Assessment Program (EMAP) (Peck et al. 2006). The locations sampled during the 2009 field season for the UCBN Integrated Water Quality Annual Report included North Fork Circle Creek, Main Stem Circle Creek, South Fork Circle Creek, and Almo Creek and the parameters measured at each location were temperature (^{o}F), electrical conductivity, dissolved oxygen, pH, and turbidity (Table 7).

Table 7. Location and sampling parameters collected within CIRO during the 2009 field season for the UCBN - Integrated Water Quality Annual Report.

	Data Collected				
Assessment Location	**Temp °F**	***EC**	****DO**	**pH**	**Turbidity**
North Fork Circle Creek	√	√	√	√	√
Main Stem Circle Creek	√	√	√	√	√
South Fork Circle Creek	√	√	√	√	√
Almo Creek	√	√	√	√	√

*EC – Electrical Conductivity
**DO – Dissolved Oxygen

Threats and Stressors: The potential for soil erosion following wildfire and from grazing pressure and recreational use to contribute to water quality degradation is of concern within CIRO. Erosion and sedimentation also pose a threat to riparian areas through degraded/trampled buffer zones, non-native species invasion, and reduced water quality (Dosskey et al. 2010, Starkey 2010).

Currently, livestock use and grazing impacts are an important focus for planning restoration of streambanks because cattle graze within CIRO allotments and typically congregate in dense vegetation, shade, and watering sites available along streambanks and in wetland areas (Starkey 2010). A reduction in livestock access to the riparian areas and stream channels would substantially reduce erosion, stream turbidity, and undesirable shifting of plant species composition and habitat structure. The cumulative effects of many stressors could be drastic and would likely be seen as a diminished aerial representation of wetland species and riparian zones in the semiarid climate of CIRO (Starkey 2010).

Data Gaps: Given the likelihood of visitor and livestock contact with water in Circle and Almo creeks, each water body should be tested for enteric bacteria, particularly *Escherichia coli* and other fecal coliforms. Enteric bacteria tests are advisable given the extensive use of riparian areas and stream channels by livestock in some grazing allotments.

During the irrigation season, the amount of water diverted from Almo Creek into canals via head gates should be evaluated. Adequate assessment of discharge into the canals would allow CIRO

managers to more accurately determine how much water may legally be diverted based on water right seniority. The installation and use of Parshall flumes and other irrigation water measurement equipment has been highly successful in legal water distribution in semiarid areas similar to CIRO for central Wyoming. Additionally, more precise water measurement and diversion practices may help reduce the impacts of stream water level fluctuations during mid and late summer.

CIRO supports unique aquatic features, vernal pools, which occur in basins and depressions formed atop many of the rock formations. Vernal pools fill with water following snow and rain events and often contain unique macroinvertebrate assemblages of fairy shrimp, copepods, and dipterans. In 2008, several fairy shrimp were submitted for identification and were determined to be *Branchinecta constricta*; representing a range extension west of the Continental Divide from known populations in southern Wyoming (UCBN 2011). A comprehensive inventory of vernal pools and their unique fauna would assist CIRO managers in future planning efforts concerning recreational use adjacent to vernal pool locations and education programs for climbers and other visitors.

Yellowstone cutthroat trout have been observed in the Almo Creek watershed; however, the current fish inventory within CIRO drainages is inadequate to determine their presence or absence. Recent observation suggests Yellowstone cutthroat are not present in the upper reaches of Almo Creek. As Yellowstone cutthroat trout are a species of management concern in Idaho and there is limited information regarding the fish assemblage in Almo and Circle Creeks, it is recommended that a presence/absence fish inventory be conducted in CIRO creeks to establish a baseline of fish species information for the area and to update and certify the NPSpecies Database.

Reserve Specific Information: The North Fork, South Fork, and Main Stem of Circle Creek are a portion of Hydrologic Unit Code (HUC) 170402100207. The Almo Creek watershed comprises HUC 170402100203 and is northwest of Almo, Idaho. Land use in and around the Circle Creek and Almo Creek watersheds is comprised of a combination of grazing lands and recreational use by rock climbers, hikers, sightseers, and campers. The first annual integrated water quality report assessing macroinvertebrates for these streams was performed in 2009 (Starkey 2010) and the first riparian area assessments were completed in 2010.

Inventory: The PFC assessment results are detailed in Table 8 and the site-specific evaluations are presented by watershed starting with Circle Creek. The Lower North Circle Creek reach was determined to be Functional – At Risk with a downward trend. The biological and water quality results are presented following the conclusions of the PFCs for each stream reach within the two watersheds starting with Circle Creek.

Table 8. Summary of Results from CIRO PFC Assessment.

Site	Functional Rating	Trend for Functional - At Risk
Stines Fork of Almo Creek	Proper Functioning Condition	
Almo Creek	Proper Functioning Condition	
Upper North Circle Creek	Proper Functioning Condition	
Lower North Circle Creek	Functional - At Risk	Downward
South Circle Creek	Proper Functioning Condition	
Circle Creek	Proper Functioning Condition	

Circle Creek Watershed

Within the Circle Creek watershed four PFC assessments and three sites for biological and water quality sampling were completed. The assessment findings are presented here organized from North to South and from the upper-most point in the watershed to the mainstem that ultimately confluences with the Raft River east of the CIRO boundary. Additionally, a fifth PFC assessment was performed on the Middle Fork of Circle Creek. However, due to technical difficulties and incomplete data, the site was omitted from this report until future data are gathered and analyzed. Furthermore, at the time of this paper the Circle Creek drainage had not yet been evaluated using the state DEQ 303(d) list criteria (Garrett et al. 2007).

Upper North Fork of Circle Creek (North): The North site was assessed during August 2010 and is located approximately 150 yards (137 meters) northwest of the "Y" in the City of Rocks Backcountry Byway access road on the Twin Sisters Road located on the west half of Section 30, Township 15 South, Range 23 East, Cassia County within the Circle Creek watershed. The North Fork of Circle Creek is subject to high spring-season flows and seasonal fluctuations in water level due to isolated precipitation events, evaporative losses due to low humidity, and transpiration from vegetation in late summer. Evidence of inundation of the floodplain above bank-full width was observed at the time of assessment in the form of minor sediment deposition in areas adjacent to the active channel. The sinuosity, width-depth ratio, and channel gradient are appropriate and in balance with the relatively open upland environment and arid low-gradient basin. The presence of water in the South Fork of Circle Creek during the summer and the late seral stage of some vegetation, indicates this reach has a well established riparian-wetland ecosystem. The upland watershed is comprised of a moderately sloping big sagebrush and juniper/pinyon woodland-dominated basin rising in altitude to slopes with granitic outcrops above 8,500 feet (2,591 meters) in elevation. No degradation was noted for the upland watershed and sediment contribution to the North site from the upland watershed was not observed.

The plant species composition of the North lotic assessment site is predominately riparian shrub and herbaceous species with mixed upland vegetation. The age-class distribution and species diversity of onsite riparian vegetation was moderate to high, dominated by species of willow tall shrubs (obligate wetland) and upland trees and shrubs including Rocky Mountain (*Juniperus scopulorum*) and Utah (*J. osteosperma*) juniper, quaking aspen, singleleaf pinyon pine (*Pinus monophylla*), and big sagebrush. The presence of large woody vegetation provides root masses capable of withstanding high streamflow events, which protect the reach against streambank erosion and discourages bedload transport of sediments. Nonative invasive species established

along the North assessment reach include Canada thistle (*Cirsium arvense*) and cheatgrass. The riparian-wetland plant species observed onsite exhibited moderate to high vigor and did not appear stressed due to a lack of sufficient moisture, which may reduce their ability to withstand high streamflow events. Given the infrequency of high streamflow events at this site the large woody vegetative cover and upland vegetation are presumed adequate to protect streambanks and dissipate energy during high streamflow events.

The North lotic assessment site is subject to high flows in the spring and early summer as a result of snowmelt and precipitation events. Signs of lateral stream movement associated with natural sinuosity, the watershed ability to transport spring-season runoff with minimal degradation, and the present channel characteristics combine to adequately dissipate energy associated with higher streamflow in this reach assessment. The system is primarily vertically stable due to flow regime within the watershed and gentle topographic variations. Erosion and deposition of sediment were observed at this site in the form of livestock tracks and some streamside grazing evidence.

The PFC evaluation of the Upper North Circle Creek (North) lotic site (Figure 12) resulted in a summary determination of "Proper Functioning Condition" Proper Functioning Condition riparian areas are assessed so with respect to existing soil, vegetation, and hydrologic attributes. Sufficient hydrology and hydrophilic soils are present in this stream reach to support a broad array of riparian-wetland vegetation and the present vegetation was observed to adequately support and maintain this hydrologic environment properly functioning state. Any future factors resulting in insufficient riparian hydrology or degradation of the riparian area are within the control of CIRO managers and their ability to maintain the North site lotic environment (Figure 11) at a PFC continuing toward its maximum potential.



Figure 12. Photograph of the North site.

*Lower North Fork of Circle Creek (LNorth):*The LNorth site was assessed in August 2010 and is located approximately 200 yards (183 meters) downstream of the Upper North Fork of Circle Creek (North) reach in the southwest quarter of Section 30, Township 15 South, Range 24 East, Cassia County within CIRO. The North Fork of Circle Creek is subject to high spring-season flows and seasonal fluctuations in water level due to isolated precipitation events, evaporative losses due to low humidity, and transpiration from vegetation in late summer. Inundation of the floodplain above bank-full width was not observed at the time of assessment however a sedimentation "delta" at the end of the assessed reach was present overtopping some riparian vegetation. The sinuosity, width-depth ratio, and channel gradient are not appropriate nor in balance with the upland environment and land features of the basin. There was no water observed in the LNorth channel and no areas of soggy or wet soil were noted. The banks of the LNorth reach are unstable with little to no present vegetation; there are pronounced cut-banks and evidence of livestock use. The upland watershed is comprised of a moderately sloping big sagebrush and juniper/pinyon woodland-dominated basin rising in altitude to slopes with granitic outcrops above 8,500 feet (2,591 meters) in elevation. No degradation was noted for the upland watershed and sediment contribution to the LNorth site from the upland watershed was not observed.

The plant species composition of the LNorth lotic assessment site is predominately upland vegetation with sparsely mixed riparian species. The age-class distribution and species diversity of on-site riparian vegetation was poor, with some established grasses and a big sagebrush border lining the top of the scoured face of the west stream bank. No large woody vegetation or root masses capable of withstanding high streamflow events were observed to curtail streambank erosion and discourage bedload transport. Canada thistle was the single non-native invasive plant species established along the LNorth assessment reach; however cheatgrass is present throughout the area. The vegetation observed at this site exhibited moderate to low vigor and appeared stressed due to a lack of sufficient moisture, which may further reduce the ability to withstand high streamflow events. However, given the infrequency of high streamflow events at this site due to upstream flow dispersal and lack of summer precipitation, the vegetation at this site may be restored with minimal effort if precautions were taken to support streambank soils and restore some natural channel morphology.

The LNorth lotic assessment site is subject to high flows in the spring and early summer as a result of snowmelt and precipitation events. Signs of lateral stream movement associated with natural sinuosity, the watershed ability to transport spring runoff with minimal degradation and the present channel characteristics are all lacking in order to adequately dissipate energy associated with higher streamflow in this reach assessment. The system is primarily vertically stable due to the presence of upstream vegetation and gentle topographic variations. Erosion and deposition of sediment were observed at this site in the form of livestock tracks and stream-side grazing evidence.

The PFC evaluation of the Lower North Circle Creek (LNorth) lotic site (Figure 13) resulted in a summary determination of "Functional – At Risk"– At Risk riparian areas are in functional condition, but an existing soil, water, vegetation, or related attribute makes them susceptible to degradation. When this rating is assigned to a stream reach, then its "trend" toward or away from PFC is assessed. In this case, the trend is "Downward". The streambanks had little to no vegetation and the channel exhibited a strong "V" shape cross-section (Figure). The meadow adjacent to the LNorth reach starting at the east bank has dense establishment of riparian vegetation covering approximately 80% of the soil surface. The factors resulting in "At Risk" status and poor riparian hydrology are beyond the control of CIRO managers as the entire LNorth assessment is on a privately owned ranch (Figure 14).



Figure 13. Photo of the LNorth site (foreground).

The biological and water quality sampling assessment of the North Fork of Circle Creek indicated that all measured parameters were within the water quality standards established by the IDEQ (Starkey 2010, Table 1). The data were collected and analyzed during a period of unusually high precipitation and water chemistry results may vary from those of average precipitation years.

Turbidity, although not a water chemistry parameter, was measured to evaluate sediment transport for quantification of effects in the area. A maximum value of 80.9 Nephelometric Turbidity Units (NTU) was recorded. The regulatory threshold indicates a value of less than 50 NTU (instantaneous) and no more than 25 NTU for ten consecutive days. It was noted that spikes in turbidity were observed in conjunction with increased streamflow due to precipitation events in combination with disturbed streambanks resulting from livestock use.

Two macroinvertebrate study reaches were established on the North Fork of Circle Creek and data were used to calculate a Hilsenhoff Biotic Index (HBI) as an indicator of water quality. Reach 01 and 02 of the macroinvertebrate sampling had HBI values of 3.49 and 3.68 respectively (Starkey 2010).Water quality is considered “very good” to “excellent” for streams having an HBI between 0.00 and 4.50 (Hilsenhoff 1987).

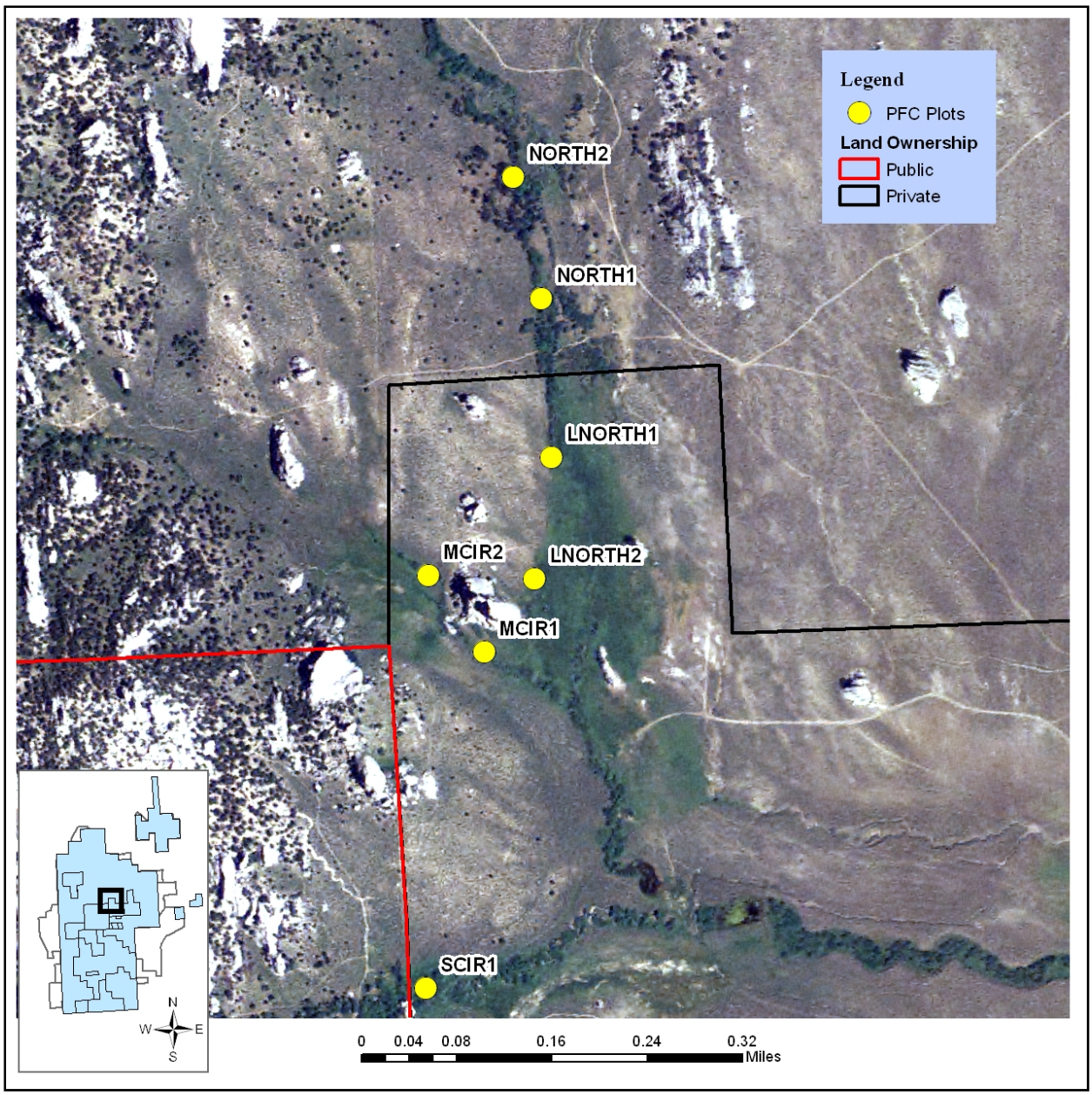


Figure 14. Shows the property boundaries for the public and private ownership within the Upper Circle Creek watershed relative to plot LNorth.

South Fork of Circle Creek (SCir): The SCir site was assessed during August 2010 and is located approximately one and one half miles (2.4 kilometers) upstream from where Circle Creek crosses the City of Rocks Backcountry Byway access road in the northwest one quarter of Section 32, Township 15 South, Range 23 East, Cassia County (Figure 15). The South Fork of Circle Creek is subject to high spring flows and seasonal fluctuations in water level due to isolated precipitation events, evaporative losses due to low humidity, and transpiration from vegetation in late summer. Evidence of inundation of the floodplain above bank-full width was observed at the time of assessment in the form of minor sediment deposition in areas adjacent to the active channel and bedload accumulation at the upstream end of some mid-channel bars. The sinuosity, width-depth ratio, and channel gradient are appropriate and in balance with the relatively open upland environment and arid low-gradient basin. The presence of water in the South Fork of Circle Creek during the summer and the late seral stage of some vegetation, indicates this reach has a well-established riparian/wetland ecosystem. The upland watershed is comprised of a moderately sloping big sagebrush and juniper/pinyon woodland-dominated basin rising in altitude to slopes with granitic outcrops above 8,500 feet (2,591 meters) in elevation. No degradation was noted for the upland watershed and sediment contribution to the SCir site from the upland watershed was not observed.



Figure 15. Photo of the SCir Site.

The plant species composition of the SCir lotic assessment site is predominately riparian species with mixed upland vegetation. The age-class distribution and species diversity of onsite riparian vegetation was moderate to high, dominated by willow species (obligate wetland) and upland trees and shrubs including Rocky Mountain and Utah juniper, quaking aspen, singleleaf pinyon pine, and big sagebrush. The presence of large woody vegetation provides root masses capable of withstanding high streamflow events, which protect the reach against streambank erosion and discourages bedload transport. Some head-cutting and bank erosion was noted in areas of this reach and could have been the result of excessive streamflows observed in 2009 by Starkey (2010) during data collection. Non-native invasive species established along the SCir assessment reach include Canada thistle and cheatgrass. Some patches of Canada thistle measured ten yards (9.1 meters) in diameter and were sufficiently dense to inhibit the growth of other plant species. The riparian-wetland plant species observed onsite exhibit moderate to high vigor. The large woody tree and shrub cover and upland vegetation are adequate to protect streambanks and dissipate energy during high streamflow events.

The SCir lotic assessment site is subject to high flows in the spring and early summer as a result of snowmelt and precipitation events. Signs of lateral stream movement associated with natural sinuosity, the watershed capacity to drain spring runoff with minimal degradation and the present channel characteristics all combine to adequately dissipate energy associated with higher streamflow in this reach. The system is primarily vertically stable due to flow regime within the watershed and gentle topographic variations. Erosion and deposition of sediment were observed at this site in the form of livestock tracks, stream-side grazing evidence, and foot-path crossings such as the Boxtop Trail ford.

The PFC evaluation of the South Circle Creek (SCir) lotic site resulted in a summary determination of "Proper Functioning Condition". Proper Functioning Condition rated riparian areas include existing soil, vegetation, and hydrologic attributes. Sufficient hydrology and hydrophilic soils are present in this stream reach to support a broad array of riparian-wetland vegetation and the present vegetation was observed to adequately support and maintain the hydrologic environment properly functioning state. Any future factors resulting in insufficient riparian hydrology or degradation of the riparian area are within the control of CIRO managers and their ability to maintain the SCir site lotic environment at a PFC continuing toward its maximum potential.

The biological and water quality sampling assessment of the South Fork of Circle Creek were within the water quality standards established by the IDEQ (Starkey 2010, Table 3). The data were collected during a period of unusually high precipitation and water chemistry results may vary from the results based on years with average precipitation.

Turbidity, although not a water chemistry parameter, was measured to evaluate sediment transport for quantification of effects in the area and had a maximum value of 176.1 NTU. The regulatory threshold indicates a value of less than 50 NTU (instantaneous) and no more than 25 NTU for ten consecutive days. It was noted that spikes in turbidity were observed in conjunction with increased streamflow due to precipitation events in combination with disturbed streambanks resulting from livestock use prior to 2009. As of June 2009 livestock have been removed from this area of CIRO and will be absent for several years (Starkey 2010).

Two macroinvertebrate study reaches were established on the South Fork of Circle Creek and the data were used to calculate a Hilsenhoff Biotic Index (HBI) as an indicator of water quality. Reach 001 and 002 of the macroinvertebrate sampling had HBI values of 3.57 and 2.81 respectively (Starkey 2010). Water quality is considered "very good" to "excellent" for streams having an HBI between 0.00 and 4.50 (Hilsenhoff 1987).

Circle Creek Main East of City of Rocks Backcountry Byway (Cir): The Cir site (Figure 16) was assessed during August 2010 and is located approximately one quarter mile (402 meters) downstream from where Circle Creek crosses the City of Rocks Backcountry Byway access road in northwest one quarter of Section 32, Township 15 South, Range 23 East, Cassia County within CIRO. The mainstem of Circle Creek is subject to high spring-season flows and seasonal fluctuations in water level due to isolated precipitation events, snowmelt, evaporative loss due to dry climate, and transpiration from vegetation in late summer. Evidence of inundation of the floodplain above bank-full width was observed at the time of assessment in the form of extensive riparian-wetland vegetation establishment on both sides of the stream channel as far as ten yards (9.1 meters). The sinuosity, width-depth ratio, and channel gradient are appropriate and in balance with the relatively open upland environment. The presence of water in the mainstem of Circle Creek during the summer is partly the result of a retired irrigation diversion dam. The presence of late seral stage riparian trees and shrubs contribute to the well-established riparian-wetland ecosystem established on this creek reach. The upland watershed is comprised of a moderately sloping juniper/pinyon woodland-dominated basin rising in altitude up slopes with granitic outcrops above 8,500 feet (2,591 meters) in elevation and encompassing multiple tributaries some of which are ephemeral. Degradation in the upland watershed and sediment contribution to the Cir site from upland degradation was observed.

The associated degradation began a short distance upstream from the dam when a failed irrigation ditch (no longer in use) blew out and eroded a gully that diverted subsequet irrigation water back into Circle Creek. Updith from the blow out the irrigation ditch has substantially down cut and there is now a large plug of sediment in Circle Creek that has effectively dammed the creek and created a small pond. Sediment has effectively choked Circle Creek downstream of the blow-out dam and has formed a delta that fills about half of the reservoir downstream. All these features can be see on the figure 11.

The plant species composition of the Cir lotic assessment site is predominately riparian with mixed upland vegetation. The age-class distribution and species diversity of onsite riparian vegetation was moderate to high, dominated by species of willow tall shrubs (obligate wetland) and upland tree and shrub species including Rocky Mountain and Utah juniper, quaking aspen, and big sagebrush. The presence of large woody vegetation provides root masses capable of withstanding high streamflow events, which protect the reach against streambank erosion and discourages bedload transport. The single non-native invasive species observed along the Cir assessment reach was Canada thistle and although not observed in the reach, cheatgrass is common in the area. The riparian-wetland plant species observed onsite exhibit moderate-to-high vigor. The large woody cover and upland vegetation are adequate to protect streambanks and dissipate energy during high streamflow events.

The Cir lotic assessment site is occasionally subject to high flows in the spring and early summer as a result of snowmelt and precipitation events, although this site was downstream of a retired irrigation diversion dam. Signs of lateral stream movement associated with natural sinuosity, the watershed capacity to drain spring runoff with minimal degradation, and the present channel characteristics all combine to adequately dissipate energy associated with higher streamflow in this reach. The system is vertically stable due to flow regime within the watershed and gentle topographic variations. Erosion and deposition of sediment were not observed at this site.

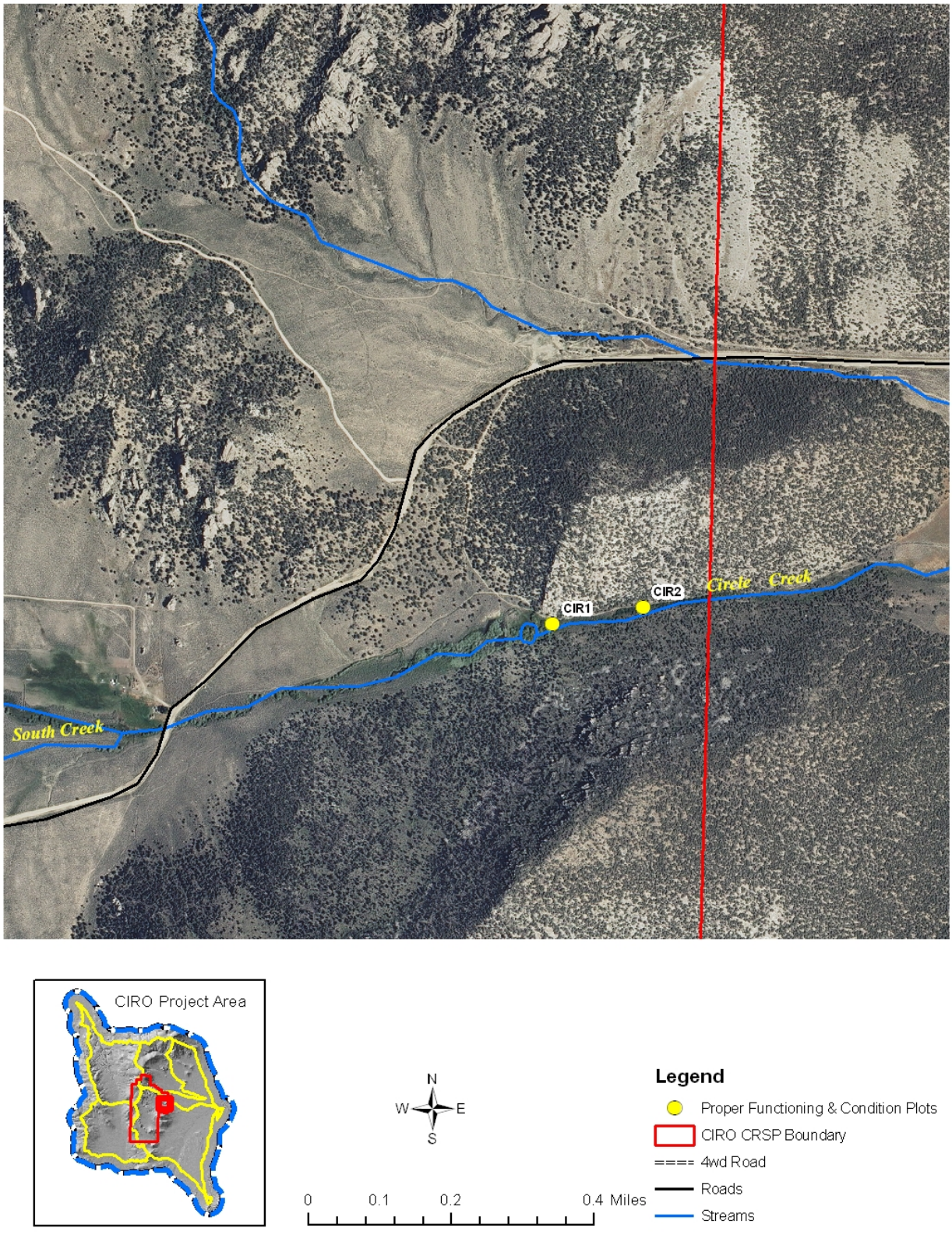


Figure 16. Map of Circle Creek UTM coordinates bounding the transects for the PFC assessment reaches.

The PFC evaluation of Circle Creek (Cir) lotic site (Figure 17) resulted in a summary determination of "Proper Functioning Condition". Proper Functioning Condition with respect to existing soil, riparian vegetation, and hydrologic attributes was assessed. Sufficient hydrology and hydrophilic soils are present in this stream reach to support diverse riparian-wetland communities which adequately supports and maintains this hydrologic environment properly functioning state. Any future factors resulting in insufficient riparian hydrology or degradation of the riparian area are within the control of CIRO managers and their ability to maintain the Cir site's lotic environment at a PFC continuing toward its maximum potential.



Figure 17. Photo of the Cir Site.

The biological and water quality sampling assessment of the Main Stem of Circle Creek were within the water quality standards established by the IDEQ except dissolved oxygen (DO) (Starkey 2010, Table 5). The minimum level of DO exceeded the IDEQ threshold of 6.0 mg/L for one hourly measurement during a 24/hr water quality lab deployment. Even though data were collected during a period of unusually high precipitation and a departure in water chemistry data from the presented results of this analysis is expected on an average precipitation year, a measured DO below the threshold suggests that during years of average precipitation levels of DO on the Main Stem of Circle Creek dip below 6.0 mg/L on a regular basis (Starkey 2010). Turbidity was measured to evaluate sediment transport for quantification of effects in the area. The maximum turbidity of the Main Stem of Circle Creek was measured at 252 NTU which far exceeded the tributary forks of Circle Creek. The regulatory threshold indicates a value of less

than 50 NTU (instantaneous) and no more than 25 NTU for ten consecutive days. Starkey (2010) noted the creek is entrenched one to two meters (three to six feet) exposing both banks and leaving large areas of unstable streambank subject to erosion and degradation.

Two macroinvertebrate study reaches were established on the North Fork of Circle Creek and data were used to calculate a Hilsenhoff Biotic Index (HBI) as an indicator of water quality. Reach 01 and 02 of the macroinvertebrate sampling had HBI values of 5.26 and 5.11 respectively (Starkey 2010).Water quality is considered "good" for streams having an HBI between 4.51 and 5.50 (Hilsenhoff 1987).

Almo Creek Watershed

Within the Almo Creek watershed two PFC assessments and one site for biological and water quality sampling were completed and sampled. The assessment findings are presented here and organized from north to south starting with the mainstem of Almo Creek. The Almo Creek basin is similar to Circle Creek basin encompassing five primary land cover types; shrubland (71%), grassland/herbaceous (23%), evergreen forest (4%), agriculture (3%), and an undefined percentage of ranching acreage (Starkey 2010). Ranching along Almo Creek occurs on both CRSP land in the upstream portoin and on private lands in the downstream areas. In 2008 two sections (518 hectares) of Almo Creek were fenced to exclude livestock use (grazing, watering, and resting) and create wetland mitigation areas. Almo Creek drainage has not yet been evaluated using the IDEQ 303(d) list criteria (Garrett et al. 2007).

Almo Creek North (Almo): The Almo site (Figure 18) was assessed in August 2010 and is located one-half mile (805 meters) North of the ST-BR site and at nearly the same elevation. The The edge of the Almo site was located 24 yards (22 meters) downstream of a riparian area reclamation site (fenced-off area) and assessed in an upstream direction. Due to no discernable differences in habitat type, stem density, and cover the Almo Creek assessment was continued through nearly three quarters of the distance of the riparian reclamation fenced area. The Almo Creek channel is subject to frequent high spring flows and seasonal fluctuations in water level due to isolated precipitation events as well as dry channel conditions in late summer. Evidence of inundation of the floodplain above bank-full width was not observed. The sinuosity, width-depth ratio, and channel gradient are appropriate and in balance with the relatively open upland environment and arid low-gradient basin. Due to the semiarid nature of this watershed and presence of upland vegetation established as a result of seasonal flow, this system has very little potential for a significant riparian-wetland ecosystem establishment and it is assumed the existing riparian-wetland area has achieved near maximum potential. The upland watershed is comprised of a moderately sloping big sagebrush shrubland-dominated basin rising in altitude on slopes with granitic outcrops above 8,500 feet (2,591 meters) in elevation. No degradation was noted for the upland watershed and sediment contribution to the Almo site from the upland watershed was not observed.

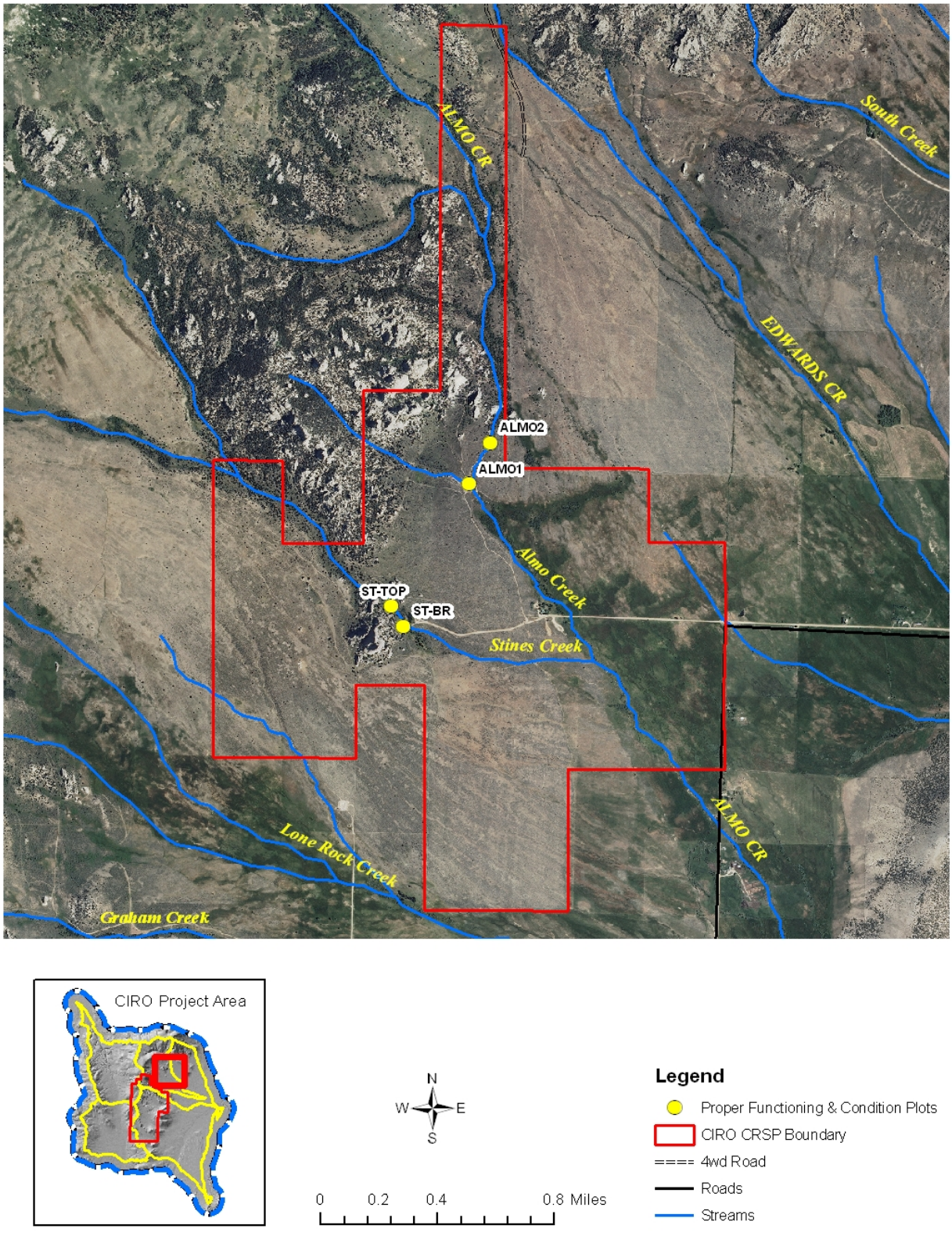


Figure 18. Map of Almo lotic sites.

The plant species composition of the Almo lotic assessment site is predominately upland woodland with mixed riparian species. The age-class distribution and species diversity of riparian vegetation was moderate to low and was dominated by four species of willow (obligate wetland), Rocky Mountain and Utah juniper, and singleleaf pinyon pine, which are semiarid upland trees. The minimal presence of hydrophilic riparian species is indicative of the seasonal availability of water. Onsite silty clay soils have a granitic component derived from erosion of the Almo pluton parent material which results in well drained soils lacking riparian-wetland soil moisture characteristics. The presence of willow, juniper, and singleleaf pinyon pine provides root masses capable of withstanding high streamflow events, which protect against erosion of the stream banks and discourages bedload transport. Non-native invasive plant species established within the Almo assessment reach include Canada thistle and cheatgrass. The riparian-wetland plants observed onsite exhibit low vigor and appeared stressed due to a lack of sufficient moisture, which may reduce their ability to withstand high streamflow events. However, given the infrequency of high streamflow events at this site due to the semiarid region and lack of summer precipitation, the larger woody vegetation cover and adjacent upland vegetation are presumed adequate to protect stream banks and dissipate energy during high streamflow events.

The Almo lotic assessment site is subject to infrequent high flows in the spring and early summer as a result of snowmelt and precipitation events. Signs of lateral stream movement associated with natural sinuosity and the present channel characteristics all combine to adequately dissipate the minimal energy associated with hydrologic functions in this stream. The system is primarily vertically stable due to the watershed flow regime and gentle topographic gradient. No excessive erosion or deposition of sediment was observed at the site.

The PFC evaluation of the Almo Creek (Almo) lotic site (Figure 19) resulted in a summary determination of “Proper Functioning Condition”. Proper Functioning Condition riparian assessments were gathered with respect to existing soil, vegetation, and hydrologic attributes. No “trend’ with respect to the condition of this site was noted. The lack of sufficient hydrology and hydrophilic soils in the stream reach to support diverse riparian-wetland vegetation is not a concern for this stream as the present vegetation adequately supports and maintains the hydrologic environment properly functioning state. Any factors resulting in insufficient riparian hydrology are within the control of CRSP managers and their ability to maintain the Almo site lotic environment at a PFC continuing toward its maximum potential.



Figure 19. Photo of the Almo site.

Stines Creek Tributary of Almo Creek (ST-BR): The ST-BR site was the most upstream location assessed in the Almo Creek watershed during August 2010. It is approximately one mile (1.6 kilometers) upstream of the confluence with Almo Creek, and is seven and three quarters miles (12.5 kilometers) upstream of the confluence of Almo Creek and the Raft River. The site is located north of a foot-bridge leading to a rock climbing area at the end of a NPS parking area and extends northwest upstream. At this location, the channel is subject to frequent high spring flows and seasonal fluctuations in water level due to isolated precipitation events as well as dry channel conditions in late summer. Evidence of inundation of the floodplain above bank-full width was not observed. The sinuosity, width-depth ratio, and channel gradient are appropriate and in balance with the relatively open upland environment and semiarid low-gradient basin. Due to the semiarid nature of this watershed and presence of upland vegetation established as a result of seasonal flow, this system has very little potential for a significant riparian-wetland area and therefore the riparian-wetland area has achieved its potential extent. The upland watershed is comprised of moderately sloping big sagebrush shrubland-dominated basins rising in altitude on slopes with granitic outcrops above 8,500 feet (2,591 meters) in elevation. No degradation was noted for the upland watershed and sediment contribution to the ST-BR site from the upland watershed was not observed.

The plant community of the ST-BR lotic assessment site is characterized by upland trees and shrubs with some riparian species present (Figure 20). Age-class distribution and species diversity of on-site riparian vegetation was moderate to low and the site supported yellow willow (*Salix lutea*), tall shrubs (obligate wetland), and Rocky Mountain juniper and quaking aspen trees which are examples of semiarid mesic, upland, high elevation species. The minimal presence of hydrophilic riparian plant species is indicative of the seasonal availability of water. The silty clay soils have a granitic component derived from the Almo pluton parent material which provides well drained soils lacking riparian-wetland soil moisture characteristics. The presence of willow, Rocky Mountain juniper and quaking aspen trees provides root masses capable of withstanding high streamflow events, which protect against erosion of the stream banks and discourages bedload transport. Non-native invasive species established onsite includes Canada thistle and cheatgrass. The riparian-wetland plant species observed onsite exhibited low vigor and appeared stressed due to a lack of sufficient moisture, which may reduce the ability to withstand high streamflow events. However, given the infrequency of high streamflow events at this site due to the semiarid region and lack of summer precipitation, the larger woody vegetation cover and upland forbs are adequate to protect stream banks and dissipate energy during high streamflow events.

The ST-BR lotic assessment site is subject to infrequent high flows in the spring and early summer as a result of snowmelt and precipitation events. There is lack of lateral stream movement associated with natural sinuosity; however, the floodplain and channel characteristics are adequate to dissipate the minimal energy associated with water fluctuations. The system is primarily vertically stable due to the watershed flow regime and gentle topographic gradient. No excessive erosion or deposition of sediment appeared to be occurring at the site.

The PFC evaluation of the ST-BR lotic site resulted in a summary determination of “Proper Functioning Condition”. Proper Functioning Condition was assessed with respect to existing soil, vegetation, and hydrologic attributes. When this rating is assigned to a stream or river reach, it is not required to assess whether a “trend” toward maximum potential PFC or away from PFC is occurring and the ecosystem is currently in a properly functioning condition. The lack of sufficient hydrology and hydrophilic soils in this stream reach to support a broad array of riparian-wetland vegetation is not a concern because the established vegetation adequately supports and maintains the hydrologic environment properly functioning state. Any factors resulting in insufficient riparian hydrology are within the control of CRSP managers and their ability to maintain the ST-BR site lotic environment at a PFC continuing toward its maximum potential.



Figure 20. Photo of ST-BR site.

The biological and water quality sampling assessment within the Almo Creek watershed listed all parameters measured on Almo Creek to be within the water quality standards established by the IDEQ (Table 9). (Starkey 2010). The data were collected during a period of unusually high precipitation therefore water chemistry results may vary from those recorded during average years of precipitation.

Turbidity was measured on all sites within CIRO and CRSP to evaluate sediment transport for quantification of effects in the area. The regulatory threshold indicates an average value of less than 50 NTU (instantaneous) and no more than 25 NTU for ten consecutive days. At the Almo Creek study site high flows impaired the gauge with suspended sand and gravel resulting in unusable turbidity data. Similar to the Circle Creek watershed, spikes in turbidity are often observed in conjunction with increased streamflow due to precipitation events in combination with disturbed streambanks. The Almo Creek watershed has fewer cutbanks exposed and less livestock use compared to the Circle Creek watershed; however, erosion and stream bank instability caused by frequent changes in water level from irrigation diversions should be considered in future assessments (Dallon 2001).

Three macroinvertebrate study reaches were established on Almo Creek and data were used to calculate a Hilsenhoff Biotic Index (HBI) as an indicator of water quality. Reach 01 and 02 of the macroinvertebrate samples had HBI values of 3.46 and 3.67, respectively, while reach 03 had an HBI value of 5.39. Water quality is considered "very good" to "excellent" for streams having an HBI between 0.00 and 4.50 as observed in reaches 01 and 02 and water quality is considered "good" for streams having an HBI between 4.51 and 5.50 (Hilsenhoff 1987). Macroinvertebrate sample reach 02 was located within a fenced livestock exclusion management area and Starkey et al. (2010) noted the data suggest the fenced management areas are having a positive influence on stream biota; however, additional data are needed to be conclusive.

Geology

CIRO is located on the southern end of the Albion Mountains near the south-central border of Idaho and Utah. The area is part of the Albion-Raft River-Grouse Creek metamorphic core complex. Elevation varies throughout the area from a low of approximately 5,600 feet (1,707 meters) in the Circle Creek drainage to 10,339 feet (3,151 meters) atop Cache Peak. In the vicinity of CIRO three primary geologic provinces intersect; the western North American fold and thrust belt, the Basin and Range, and the Snake River Plain (Thornberry-Ehrlich 2010). CIRO is located on the northern edge of the Basin and Range province and elevations and fault lines generally trend north-south as they parallel other formations. Through faulting and many years of erosion the sedimentary rock that once covered areas of CIRO has been eroded away exposing much older igneous and metamorphic rocks that comprise the regional geologic features (Thornberry-Ehrlich 2010).

The geologic resources of CIRO include domes, spires, and other granitic features that have been ascribed the name "City of Rocks". Throughout the Reserve the geologic features provide a variety of wildlife habitat and recreational opportunities. Two geologic formations comprise the majority of the features within CIRO, the Green Creek Complex and the Almo pluton. The Green Creek Complex is considered to be nearly 2.5 billion years old and the Almo pluton approximately 28 million years old (Thornberry-Ehrlich 2010). The Green Creek Complex represents some of the oldest rock exposed in western North America and comprises the darker-colored, more coarsely grained metamorphosed granite found in the Reserve, while the lighter colored, fine grained granite and coarse-grained pegamites are derived from the Almo pluton.

Inventory: The first geologic resources inventory for CIRO was completed in 2010 and provides an overview of the existing attributes and history within the Reserve. The inventory addresses eight geologic issues within CIRO and their effect on the resource, they are: (1) Erosion and Slope Processes; (2) Joints and Fragile Features; (3) Recreational Demands; (4) Mine-Related Issues and Disturbed Lands; (5) Water Issues; (6) Wind Erosion; (7) Seismicity; and (8) Volcanism (10) (Table 9).

Table 9. The geologic issues identified within CIRO by the 2010 geologic resource inventory (Thornberry-Ehrlich 2010).

Geologic Issue	Inventoried
Erosion and Slope Processes	√
Joints and Fragile Features	√
Recreational Demands	√
Mine-Related Issues and Disturbed Lands	√
Water Issues	√
Wind Erosion	√
Seismicity	√
Volcanism	√

Within CIRO, erosion and slope processes include slope failure and alluvial transport of sediments via isolated rain showers, snowmelt, and a lack of stabilizing vegetation in areas where slope failure regularly occurs or stream channels have developed in granitic parent material. The joints and fragile features discussion focused on the geologic formation of features, their age, and ability to withstand the effects of weathering at locations where joints, cracks, or other formation attributes may have weakened the rocks. Recreational climbing pursuits have resulted in some wear of rock formations within CIRO. Similarly, areas of localized use from rock climbers as staging areas has removed vegetation from the bases of these popular routes exposing soils and lower rock faces to additional weathering. The mine-related issues and disturbed land concerns center on areas of mineral prospecting, four-wheel drive trails, grazing areas, and development adjacent to the CIRO boundary (Miller et al. 2008).

Water and wind issues align with many of the concerns related to erosion and the protection of soils, geologic formations and sensitive areas from degradation. The Snake River Plain and areas extending south into Utah are known to be seismically active and small earthquakes are reported on a daily basis, however they are only detectable using seismographic equipment. Additionally, the presence of CRMO to the northeast of CIRO and Pliocene and younger shield volcanoes along the southern flank of the Snake River Plain show volcanic activity once occurred in the region and suggests that further classification and aging of these volcanic features be inventoried to provide an estimate of the age of the last eruptions (Thornberry-Ehrlich 2010).

The distribution of unvegetated geologic exposures is included as a land use type under the vegetation classification mapping project completed by Erixson and Cogan (2011). Up to 757 acres (306 hectares) within CIRO comprise geologic exposures and unvegetated erosion remnants.

Threats and Stressors: The primary threats to the geologic resources within CIRO are from natural erosion due to weathering and the effects of recreational climbing. CIRO is a world class bouldering, sport, and traditional climbing area with the unique resource of large granite boulders, pinnacles, and summits dispersed across a rolling pinyon/juniper woodland and sagebrush-steppe landscape. CIRO is one of the finest granite climbing sites in North America and is internationally revered as a beautiful climbing destination. In 1998 the NPS published a

management plan stating a "finding of no significant impact" to the geology of CIRO, however, communication with Reserve rangers and the climbing manager of CIRO in 2010 has provided some insight into current concerns for management of climbing resources and conditions. The increased use of climbing areas and trails has produced notable degradation to soils and vegetation cover in "staging areas" (areas at the base of rock climbing routes). The degradation of these areas was said to be attributed to a combination of foot traffic, equipment placement, and domestic dog shade-bed digging. For example; the Bath Rock area was noted as exhibiting many areas where dogs had dug shade-holes and heavy foot-traffic had trampled much of the vegetation between the big sagebrush shrubs leading to sagebrush mortality and loss of biotic crust in some locations. CIRO managers have also constructed fencing in areas near some popular climbing routes to curtail area degradation; however, pet dogs are commonly tied to the fencing intensifying the impacts of shade-holes both inside and outside of the enclosures.

Through recent observations, CIRO staff noted areas that are being threatened by activities associated with rock climbing. As of August 2010 the BLM closed a large portion of federal land near CIRO to recreational climbing as one form of conservation. This action prompted CIRO staff to develop new practices for the protection and restoration of climbing resources within the Reserve. The closure of recreational climbing areas is not preferred by CIRO management and new approaches to management and restoration of affected sites is currently being discussed in an updated climbing management plan. Planning for a new General Management Plan began in 2010, however at the time of this document was not available to the public to summarize herein. With population growth surrounding CIRO increasing at a rate of 11.6% from 2002 to 2007 (U.S. Census Bureau 2010), threats to the natural resources of the Reserve from recreational use including hiking, horseback riding, rock climbing, and camping have the potential to degrade site-specific locations.

Data Gaps: Both bedrock and surficial geology of the Reserve (Almo Quadrangle) were mapped by the USGS in the 1990s, meeting the primary baseline data component of the NPS inventory for geologic resources (Miller, et al. 1999) At the time of this report, no monitoring plan had been established regarding specific impacted geologic features within CIRO. An assessment of the current condition of popular climbing and hiking areas as well as areas within the Reserve that may be more easily eroded by natural processes would provide beneficial baseline information to CIRO managers.

Air Quality

CIRO is located within airshed 25 (MIA 2010) and air quality control region 63 as classified by the IDEQ as part of the EPA state implementation plan of air quality prevention of significant deterioration (IDEQ 2011). Federally, CIRO has been designated a Class II airshed under the Clean Air Act of 1970, as amended and is considered to have generally very good air quality (NPS 2004). Within the state of Idaho the airshed of CIRO is considered unclassifiable by the IDEQ and EPA meaning there is not sufficient monitoring data to allow attainment classification for the six criteria pollutants: ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide, particulates, and lead. Threats to the air quality of CIRO are due in part to proximity to Utah and counties in Utah that are currently classified in nonattainment under the NAAQS. Light scattering pollutants (haze) from air pollution sources such as commercial facilities and

roadways could impact visibility within CIRO potentially affecting sensitive resources including scenery, water quality, soils, vegetation, and wildlife (CIRO 2007).

One major area of concern for CIRO is haze associated with fires and roads throughout the surrounding area. Wildfires, agricultural field burning, and prescribed burns contribute to the fine particulate matter ($PM_{2.5}$) in smoke. Vehicles on Interstate-80, other paved highways, unpaved roads and trails, fires, commercial mining, and dust are the major source contributors to air pollution within CIRO. In addition to contributing to haze, $PM_{2.5}$ can be harmful to humans as small particulates can enter the lungs and cause health problems. Two particulate testing methods are currently being monitored by the IDEQ, $PM_{2.5}$ and PM_{10}, within the Treasure Valley. These testing methods were promulgated in 1997 and as of the date of this paper have not experienced a violation (IDEQ 2011).

Inventory: Since the 1970s the NPS has operated on a system of "vital sign" monitoring for a portion of the comprehensive air quality monitoring program (NPS 2004). This program was established to collect air quality data, ozone data, atmospheric wet and dry deposition data, and assess visibility. In 2001 an assessment of ozone within CIRO was performed using kriging (a statistical interpolation process that uses data from remotely sensed locations) from data collected between 1995 and 1999 (UCBN 2001). The location of data collection and the equipment used for this study was not available for summary herein. The UCBN (2001) assessment identified three species sensitive to ozone; Saskatoon serviceberry (*Amelanchier alnifolia*), quaking aspen, and Scouler's willow (*Salix scouleriana*) and listed the potential for degradation of vegetation at CIRO as "moderate" due to the existence of threshold levels of ozone within a 90-day period. Quaking aspen and Scouler's willow were the two recommended species to be used as bioindicators for future CIRO studies (UCBN 2001).

Monitoring: The UCBN has identified threatened and endangered species as a priority vital sign for monitoring within CIRO. Ecological monitoring is conducted to better interpret the long-term effects on critical resources and provide for an early warning system in an attempt to identify undesirable changes to CIRO resources (Garrett et al. 2007). As of April 2010 a portable ozone monitor has been established in CIRO. It is equipped with an ozone sensor, weather instrumentation, data logger, a solar power system, and a communication package capable of uploading data to the main office for storage and validation checking. This is the first climate station deployed in CIRO and was installed in response to the EPA proposed regulations and need of CIRO managers to understand the interactions of ozone with the natural resources as well as to test the validity of the past kriging or interpolation from air quality maps.

Threats and Stressors: Several counties in northern Utah with the potential to impact CIRO air quality have been designated as nonattainment for fine particulates under NAAQS as of 2006. Additionally, Salt Lake and Tooele counties were in nonattainment for both primary and secondary standards for sulfur dioxide and part of Utah County was in nonattainment for carbon monoxide (CIRO 2007). According to one statistic from the 2004 Government Performance and Results Act (GPRA) the 10-year air quality trend in ammonium is deteriorating within CRMO. The Idaho National Engineering and Environmental Laboratory emits sulfur dioxide and nitrogen oxides, large mineral and chemical plants with significant emissions exist near Pocatello, and two sugar beet processing plants exist in adjacent Twin Falls and Minidoka counties (CIRO 2007). In addition, coal-fired power plants, large gold mines in northeast

Nevada, industrial facilities, and agricultural and wildland fires also have the potential to impact air quality within CIRO (CIRO 2007).

Data Gaps: A cumulative report of the ozone and atmospheric measurement data collected within CIRO will be beneficial to the resource managers. These data will help identify the presence of trends in air quality if compared to NPS 2004 GPRA report findings (sufficient air quality data within CIRO had not been collected as of the date of this report).

Air quality within CIRO has only recently been sampled (Ray and Garrett 2010). A mobile ozone station was installed during 2010 and has been collecting data for two years as of October 2011. The nearest air quality depositional monitoring site is northeast of CIRO within CRMO. At this location the National Atmospheric Deposition Program (NADP) has been monitoring ten air quality constituents that could be indicators of a trend in air quality, they are: field Hydrogen ($H+$), Sulfate (SO_4^{-2}), Nitrate (NO_3^-), Ammonium (NH_4^+), Calcium (Ca), Magnesium (Mg), Potassium (K), Sodium (Na), Chloride (Cl), and Total Inorganic Nitrogen (N). The depositional concentrations measured within CRMO from 1994 to 2009 are presented in Table 10. There was no data shown for 1996, 2003, and 2008 for any of the constituents and the deviation from average of the 2009 values suggests there may have been a change in equipment or condition at the sampling site.

Table 10. These values represent the depositional data for ten analyses collected within CRMO from 1994 to 2009 (the only data available in close proximity to CIRO during preparation of this NRCA).

Deposition Levels at Craters of the Moon National Monument and Preserve from 1994 to 2009 (NADP 2011) http://nadp.sws.uiuc.edu.										
Year	**Field H+**	**SO4**	**NO3**	**NH4**	**Ca**	**Mg**	**K**	**Na**	**Cl**	**Total Inorganic N**
1994	0.02	1	2	0.6	0.3	0.04	0.05	0.1	0.2	0.9
1995	0.03	2	3	0.9	1.1	0.12	0.09	0.3	0.5	1.4
1996	-	-	-	-	-	-	-	-	-	-
1997	0.04	1	2	0.7	0.3	0.04	0.04	0.2	0.3	1
1998	0.04	2	3	0.8	0.5	0.06	0.07	0.2	0.4	1.5
1999	0.01	1	1	0.5	0.3	0.03	0.07	0.1	0.2	0.8
2000	0.02	1	2	0.7	0.3	0.04	0.06	0.1	0.2	1
2001	0.03	1	2	0.5	0.2	0.02	0.02	0.1	0.1	0.7
2002	0.01	1	2	0.7	0.8	0.08	0.07	0.3	0.2	0.9
2003	-	-	-	-	-	-	-	-	-	-
2004	0.01	1	2	0.9	0.4	0.04	0.06	0.1	0.2	1.2
2005	-	2	2	0.9	0.8	0.07	0.07	0.4	0.3	1.2
2006	-	1	1	0.8	0.3	0.03	0.05	0.1	0.1	1
2007	-	1	1	0.6	0.3	0.03	0.03	0.1	0.1	0.7
2008	-	-	-	-	-	-	-	-	-	-
2009	-	3	2	1.1	1.8	0.14	0.18	2.8	2.3	1.3

**** All units are in kg/ha for each of the analytes listed in this table.**

"-" Represents years with no data presented by the NADP.

One consideration for CIRO managers is a comparison of ozone/air quality data from the Reserve to data at nearby locations as well as vegetation survey data because some plant species have known sensitivities to ozone (UCBN 2001). Hopkin (2007) details the potential effects of ozone on vegetation and how the uptake of ozone by plants could affect global warming, thereby emphasizing the need for site specific data.

Vegetation

The vegetation types within CIRO contribute to the viewshed, natural landscape, wildlife habitat, and biodiversity. The unique geology when viewed among forest, woodland, shrubland, herbaceous, and sparse communities in a semiarid landscape provides a unique experience for visitors. Forest stands are characterized by Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), and quaking aspen trees. Woodlands are characterized by the tree species subalpine fir (*Abies lasiocarpa*), limber pine (*Pinus flexilis*), curl-leaf mountain mahogany (*Cercocarpus ledifolius*), singleleaf pinyon pine, and Rocky Mountain and Utah juniper. Riparian tall shrublands support gray alder (*Alnus incana*), chokecherry (*Prunus virginiana*), and Booth willow (*Salix boothii*) stands, primarily, while short shrublands are characterized by subspecies of big sagebrush, low and black sagebrush, snowbrush ceanothus (*Ceanothus velutinus*), green and rubber rabbitbrush, and antelope bitterbrush. Native grasslands support bluebunch and thickspike wheatgrass, Idaho fescue, and the graminoids Nebraska sedge (*Carex nebrascensis*) and Baltic rush (*Juncus balticus*). Non-native grasslands are characterized by cheatgrass, crested wheatgrass, and Kentucky and bulbous bluegrass (*Poa pratensis* and *P. bulbosa*).

Unique plant and wildlife species occur within CIRO that are dependent on the existing habitat types and historic vegetation conditions. CIRO represents the northernmost distribution for singleleaf pinyon pine which has established on middle and upper elevation slopes (Vincent et al. 2007). Plant community boundaries are not always sharp and broad ecotones may occur resulting in physiognomic descriptions such as shrub herbaceous vegetation and wooded shrublands. Sagebrush-steppe shrublands occur on the middle and lower elevations of CIRO where recent fires have not removed shrub cover. They have been the focus of research and development of desired future conditions and as indicator species of biological diversity (Rodhouse 2009). Quaking aspen stands and/or clones are relatively uncommon; however, they have high biological diversity and are considered vital as a cornerstone species (Wilson 1992, Bartos 2001, Strand and Bunting 2010). Rare plant species and species of special concern are established within some CIRO plant communities and are monitored and protected. Disturbed sites often support individuals, patches, and stands of non-native, invasive, and/or noxious plant species that are of management concern.

Prior to creation of CIRO in 1988, the City of Rocks Research Natural Area (RNA) was established by the BLM through amendment to the 1985 *Cassia Resource Management Plan* and by the 1987 USFS *Sawtooth National Forest Land and Resource Management Pla*n. The 312 acre (126 hectare) RNA is composed of 240 acres (97 hectares) from the BLM and 72 acres (29 hectares) from the USFS (Bell and Barton 2010). The major justification for establishing the CIRO RNA was to preserve the exceptional geological features. The vegetation in the RNA is dominated by stands of singleleaf pinyon pine - Utah juniper Woodland and is representative of the northern limit for the range of singleleaf pinyon pine. At the time of designation, there were no established RNAs for this unique woodland community. Rust (1996-1997) inventoried and classified 12 RNAs in southeast Idaho that were dominated by pinyon-juniper and juniper woodlands and four of these supported singleleaf pinyon pine in the overstory cover with the CIRO RNA containing the highest frequency of singleleaf pinyon pine in sample plots (Rust 1996-1997).

Current Condition:
Floristically, CIRO is diverse supporting 512 plant species based on 2005 certification; 67 species that have become established are non-native (NPSpecies 2011). The vegetation within CIRO occurs as patches, stands, and communities of forest, woodland, wooded shrubland, tall shrubland, short shrubland, dwarf-shrubland, shrub herbaceous vegetation, herbaceous vegetation, and sparse vegetation (Erixson and Cogan 2011). Most of the vegetation is upland (approximately 94%) with the remainder being riparian woodland, shrub-scrub wetland, and emergent wetland.

Through analysis of other land-cover types using existing GIS datasets, the vegetation of CIRO has been separated into five primary categories (percent of area covered); shrublands (33%), herbaceous-shrub steppe (26%), open and closed canopy evergreen (24%), grassland/herbaceous (14%), and other (including sparsely vegetated areas and agriculture) (3%). Using on-the-ground observation by experienced field staff, these percentages have been generally accepted as an accurate reflection of CIRO vegetation.

Support GIS database vegetation information for this report was available from the LANDFIRE Program, USFS and USGS 2008, and the 2000 Landsat Thematic Mapper satellite imagery. The CIRO geodatabase includes two vegetation raster datasets covering the CIRO project area. These are public domain layers developed by different agencies based on classification of satellite imagery. The following tables, Table 11 and Table 12, list the general vegetation cover types depicted in each feature class as well as total acres and percent of total area covered by each vegetation type identified in the attribute table of the file. Maps were not produced for the vegetation layers due to the extensive list of vegetation types in the attribute tables.

Table 11. This table displays the vegetation classification attributes identified by the National Land Cover Dataset vegetation raster layer within the CIRO geodatabase.

Attribute (Class_Name) ciro_nlcd	**GIS Acres**	**% Total Area**
Barren Land (Rock/Sand/Clay)	4.5	0.00%
Cultivated Crops	9,877.3	8.64%
Deciduous Forest	1,362.6	1.19%
Developed, Low Intensity	25.8	0.02%
Developed, Open Space	1,483.9	1.30%
Emergent Herbaceous Wetlands	27.6	0.02%
Evergreen Forest	11,319.5	9.90%
Grassland/Herbaceous	7,612.2	6.66%
Pasture/Hay	1,496.6	1.31%
Shrub/Scrub	81,029.8	70.88%
Woody Wetlands	76.2	0.07%

-note: barren outcrops in CIRO were too small for Land Cover project to detect.

Table 12. Summary data sheet for CIRO.

Attribute (nvcsclass) ciro_evt	GIS Acres	% Total Area
Closed tree canopy	1,238.6	1.085%
Herbaceous - grassland	15,965.2	13.984%
Herbaceous - shrub-steppe	30,455.4	26.676%
No Dominant Lifeform	595.6	0.522%
Non-vegetated	10.2	0.009%
Open tree canopy	27,829.6	24.376%
Shrubland	37,679.1	33.003%
Sparse tree canopy	173.5	0.152%
Sparsely vegetated	220.7	0.193%

Inventory: To better understand the distribution of the plant assemblages established within CIRO, the NPS-USGS National Vegetation Inventory Program funded an effort, to map the vegetation within and adjacent to CIRO. The UCBN coordinated the vegetation inventory effort with the goal of classifying and mapping the vegetation, geologic exposures, and land use of the CIRO area. The initial phase of the project was directed by CIRO and UCBN staff in conjunction with NMI and the Idaho Conservation Data Center to develop a vegetation classification using the National Vegetation Classification System (NVCS). The report detailing the four-step approach for the development of the vegetation mapping methods was completed in April 2010 and is available on the UCBN website (Aho and Forman 2010). Currently the draft vegetation classification and mapping final report and geodatabase is available for review (Erixson and Cogan 2011).

The NVIP funded an effort to map the vegetation and land use within CIRO, CRSP, and an adjacent environs area. The entire UCBN I&M project encompassed upland assessments on nine grazing allotments (eight active, one closed) within CIRO (discussed later) as part of the coordination of the vegetation inventory effort with the goal of mapping and classifying the plant communities to the vegetation alliance and plant association level. The initial phase of the project was directed by CIRO and UCBN staff in conjunction with NMI and the Idaho Conservation Data Center to develop a vegetation classification using the NVCS (Aho and Forman 2010).

The draft vegetation and land use map and geodatabase for CIRO has been completed and selected data are presented herein (Erixson and Cogan 2011). Forest stands occur on 631 acres (256 hectares) within CIRO and are characterized by subalpine fir, Douglas-fir, and quaking aspen in the overstory. The understory ranged from dry to mesic with Rocky Mountain maple (*Acer glabrum*) a tall shrub common under Douglas-fir. Woodlands occupied dry to mesic sites on 4,888 acres (1,980 hectares) within CIRO and the stands are characterized by lodgepole pine, limber pine, singleleaf pinyon pine, Utah juniper, Rocky Mountain juniper, and curl-leaf mountain mahogany. One riparian woodland stand occupying 3.2 acres (1.3 hectares) in CRSP is characterized by non-native white poplar (*Populus alba*) and Rocky Mountain juniper overstory trees and non-native Kentucky bluegrass (*Poa pratensis*) in the understory.

Three riparian tall shrublands characterized by gray alder, chokecherry, Booth willow, and Rocky Mountain juniper occur on mesic sites and creek banks and cover 422 acres (171 hectares) within CIRO. Short and dwarf-shublands provide cover for nearly half of CIRO, e.g., 7,763 acres (3,144 hectares), and are characterized by low sagebrush, black sagebrush, basin big sagebrush (*Artemisia tridentata tridentata*), mountain big sagebrush, snowbrush ceanothus, yellow (viscid, green) rabbitbrush (*Chrysothamnus viscidiflorus*), rubber rabbitbrush (*C. nauseosus*), antelope bitterbrush, and mountain snowberry.

Two wetland herbaceous vegetation communities were mapped within CIRO, are characterized by Nebraska sedge, Baltic rush, and non-native Kentucky bluegrass, and provide cover for 482 acres (195 hectares). Native grassland mapping units are characterized by thickspike wheatgrass (*Elymus lanceolatus*) and bluebunch wheatgrass and provide cover on 547 acres (222 hectares) within CIRO. Four non-native invasive herbaceous vegetation types mapped for CIRO covered 403 acres (163 hectares) and were dominated by crested wheatgrass, cheatgrass, bulbous bluegrass, and Kentucky bluegrass. Cheatgrass and crested wheatgrass also provided the dominant understory cover for one big sagebrush-dominated mapping unit covering 708 acres (287 hectares).

Upland Assessment - Grazing Allotments

The upland assessment areas surveyed during the vegetation inventory are presented herein. The soil, hydrologic, and biotic systems were evaluated to provide an overall trend or condition for each upland area. The vegetation mapping final report was important to prepare this section of the NRCA. Additionally, the identified condition on each of the nine grazing allotments is discussed here based on observed soil, hydrologic, and biotic attributes. The Circle Creek Allotment was closed in 2006 and the Smoky Mountain Allotment was not grazed in 2010 or 2011, however they are included in this discussion.

Graham Creek Allotment: The 3,523 acre allotment is divided into seven pastures that consist of land administered by CIRO, BLM, USFS, and private owners. Ninety percent of the allotment occurs within CIRO. Two sites within the Graham Creek Allotment were evaluated using the rangeland health rapid assessment methodology as part of the Upland Assessment for CIRO. Both sites were located in the northern portion of the Allotment, one site in a creek bottom and the other site on an upland backslope. The creek bottom site, an Aspen Thicket 16-22 POTR5 Ecological Site, has a gentle slope (3%), a southerly aspect, and is at an elevation of 7,582 feet (2,311 meters). The vegetation is dominated by quaking aspen in the overstory and by the introduced Kentucky bluegrass in the understory. Low cover by mountain snowberry and wax currant (*Ribes cereum*) short shrubs also occurs. The backslope site, Steep South 16-22 ARTRV/PSSPS Ecological Site, lies on a relatively steep south-facing slope (51%) at an elevation of 7,375 feet (2,248 meters). Mountain big sagebrush is the site dominant short shrub in terms of canopy cover with moderate cover from the tall forb arrowleaf balsamroot and the invasive grass species cheatgrass and bulbous bluegrass in the herbaceous layer.

Both sites were evaluated in terms of their percent departure from the theoretical reference condition of three landscape attributes; soil/site stability, hydrologic function, and integrity of the biotic community. The Aspen Thicket site rated very well on all soil stability (7.5%) and hydrologic function (7.5%) attributes as there was little or no evidence of recent erosion or soil movement and the site has dense cover of vegetation protecting the soil. Evidence of livestock

usage included some plugging and trampling of vegetation both of which contributed to slight departure of these attributes. The site also rates well for biotic integrity with a departure of 2.9% as the vegetation appears to be healthy, vigorous, and reproducing with some invasive plant species observed onsite.

The soil stability and hydrologic function attributes of the backslope site were rated at a slight to moderate departure, 37.5% and 25% respectively. The site has evidence of soil movement and loss (rills and pedestals) and has a higher percentage of bare ground (15%) both of which contribute to the higher departure rate. The biotic integrity attribute rates at slight to moderate departure (20%) with the sparse presence of native bunchgrasses and forbs contributing to this rating.

Circle Creek Allotment: consisted of 910 acres (367 hectares) administered by CIRO, BLM, and a small area of private land. Ninety-three percent of the allotment was located within CIRO. Because California Trail restoration is underway, this allotment has been closed since 2006 and the permittee moved to another allotment within CIRO.

One site (Shallow gravelly 12-16 ARTV/PSSPS Ecological Site), provided the sample for the former Circle Creek Allotment. The site is located in the western portion of the former allotment at an elevation of 6,103 feet (1,860 meters) on a gentle southwest-facing slope. The extant vegetation is dominated by mountain big sagebrush in the shrub layer with a mixture of native bunchgrasses and rhizomatous grasses and with non-native grasses (cheatgrass, desert wheatgrass, and bulbous bluegrass) interspersed.

The site rated as slight to moderate departure for the soil stability and hydrologic function attributes, 30% and 32.5% respectively, due to quantity of bare soil and evidence of slight overland water movement. The biotic integrity attribute was also rated at slight to moderate departure (37%) due primarily to the low cover of the native perennial bunchgrasses and forbs, poor annual production of the plants, and the presence of non-native invasive plant species.

Kempton Allotment: is 336 acres (136 hectares) located near the center of CIRO. The allotment is divided into three pastures and is comprised solely of CIRO administered lands. One Ecological Site (Loamy 16+ ARTRV/FEID) was sampled for the assessment of this allotment. The site is located within the northern portion of the allotment on a gently sloping toeslope at an elevation of 6,344 feet (1,934 meters). Both the soil stability and hydrologic function attributes were rated in the slight to moderate departure rate, 15% and 15% respectively. Contributing to this rating were the amount of bare ground (19%) and the evidence of compaction from livestock usage onsite.

The vegetation type is characterized by basin big sagebrush, antelope bitterbrush, yellow rabbitbrush, and mountain big sagebrush with an understory and small patches of native bunchgrasses (thickspike wheatgrass and Sandberg bluegrass). The non-native and invasive cheatgrass and Kentucky bluegrass provide sparse cover in the herbaceous layer. The biotic integrity rate for this site is rated as slight to moderate, 20%, primarily resulting from the lower than expected annual production and the presence of shrub mortality.

Emery Canyon Allotment: This allotment is 1,065 acres which includes land administered by CIRO, a small parcel of BLM land, and private land. This allotment is divided into two pastures, the Bath Rock unit and Emery Creek unit. Ninety-seven percent of the allotment occurs within CIRO. Two sites were evaluated for the three landscape attributes, the Stony Loam 16-22 ARTRV/PSSPS Ecological Site and the Mahogany Savanna Ecological Site (Figure 21).

The Mahogany Savanna site is located on a valley bottom with a gentle slope and a southern aspect at an elevation of 6,851 feet (2,088 meters). This area receives relatively high recreational use, e.g., hiking, camping, and rock climbing that has resulted in heavy trampling and large areas devoid of vegetation. The soil stability attribute was rated as slight to moderate departure, 35.2% and the hydrologic function landscape attribute was rated at slight to moderate departure, 35.0%, both ratings attributable to the amount of bare ground, soil compaction, and evidence of soil erosion.

The extant vegetation includes mountain big sagebrush, singleleaf pinyon pine, and Utah juniper with an herbaceous layer dominated by non-native grass species [Kentucky bluegrass and smooth brome (*Bromus inermis*)] and the native perennial rhizomatous grass species Douglas' sedge (*Carex douglasii*) and mountain rush (*Juncus arcticus* ssp. *littoralis*). The biotic integrity attribute was rated as slight to moderate departure, 22.9%. The departure rating was due to the presence of invasive plant species and the soil disturbance onsite.

The Stony Loam site is located near the middle of the allotment on an east-facing moderately sloping toeslope at an elevation of 6,740 feet (2,054 meters). This area experiences very light use from both recreationists and grazing livestock. All three landscape attributes rated in the none to slight rating. The average soil stability and hydrologic function attributes were rated 0% and 0%, respectively. The average biotic integrity attribute rated as 5.7% due to the presence of a healthy native stand of plants on site. The current vegetation is dominated by mountain big sagebrush, bluebunch wheatgrass, bulbous bluegrass, and arrowleaf balsamroot.

Trail Canyon Allotment :The allotment includes 2,245 acres which includes land administered by CIRO, BLM, and private land. This allotment is managed as a single pasture. Thirty percent of the allotment occurs within CIRO. Two sites within this allotment were sampled, the Loamy 16+ ARTRV/FEID Ecological Site and the Shallow Stony 12-20 ARAR8/PSSPS Ecological Site. Both sites are located on moderately sloping toeslopes and have generally west-facing aspects. The elevation of the Loamy 16+ is 6,592 feet (2,009 meters) and the Shallow Stony 12-20 site is at 6,471 feet (1972 meters).

Within the Shallow Stony 12-20 site, all three landscape attributes were rated as none to slight departure; soil stability 7.5%, hydrologic function 10%, and biotic integrity 8.6%. The extant vegetation is dominated by low sagebrush and mountain big sagebrush. Native bunchgrasses include Idaho fescue, bluebunch wheatgrass, and Sandberg bluegrass. The native bunchgrasses as a group provide low cover of 12%. Low to sparse cover by the non-native desert wheatgrass (3%) has established on site.

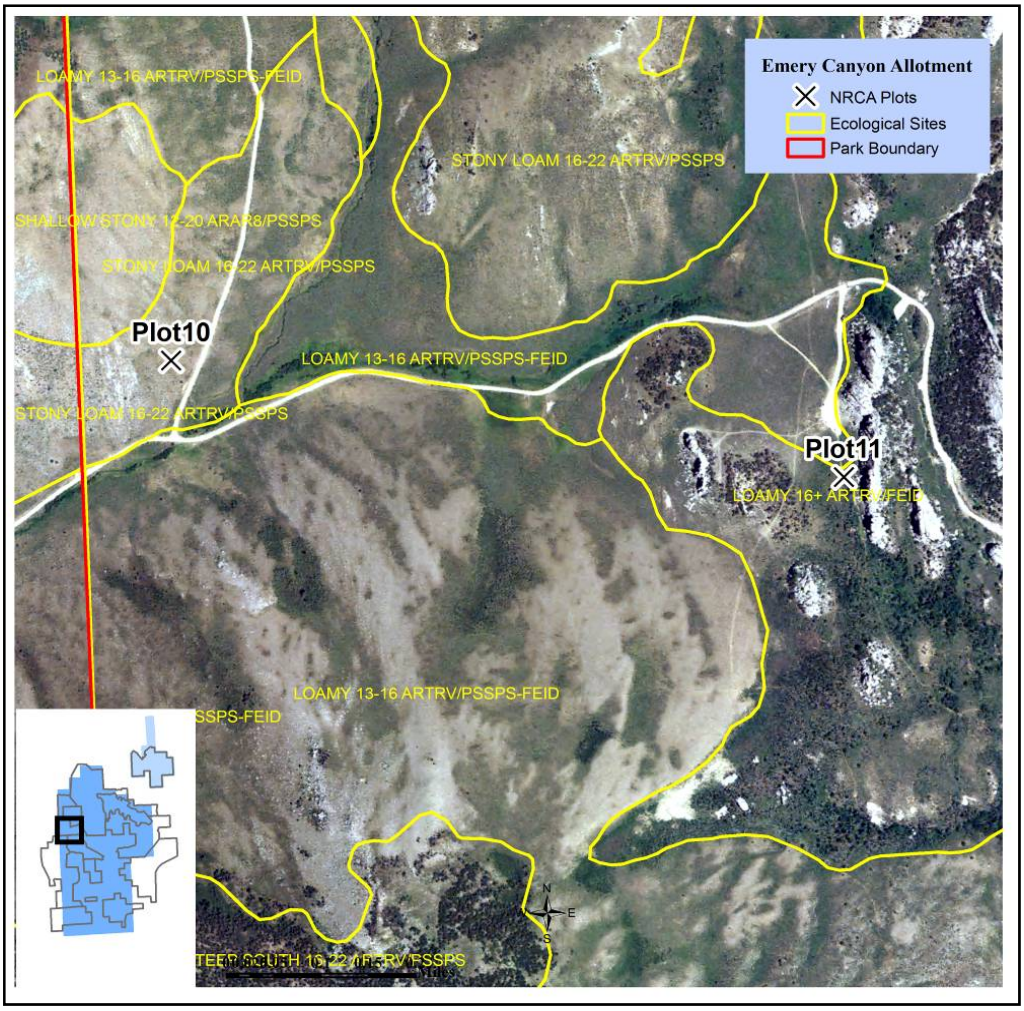


Figure 21. Map of ecological site sample plots 10 and 11 in the Emery Canyon Grazing Allotment.

Within the Loamy 16+ site livestock grazing evidence was noticeable and the results of past grazing contributed to the slightly higher departure rating. The soil stability attribute is rated as None to slight at 17.5%, but the hydrologic function is rated slight to moderate at 20%. The amount of bare ground and compaction from cattle trampling contribute to these ratings. The extant vegetation established onsite includes mountain big sagebrush with low to sparse cover of basin big sagebrush, antelope bitterbrush, and mountain snowberry. Non-native grasses have invaded the site and include cheatgrass, bulbous bluegrass, and crested wheatgrass. Due to the presence of non-native species and the low percentage of native bunchgrasses the biotic integrity of the site is rated as slight to moderate departure (37.5%).

Tracy Lane Allotment : This allotment is 880 acres which includes land administered by CIRO and BLM. Currently, this allotment is not divided into separate pastures although dividing it into two pastures is being considered (Sanders 2008) as the new fence would coincide with the CIRO boundary so each agency (e.g., NPS and BLM) could manage lands under approved plans. Sixty-nine percent of the allotment occurs within CIRO. The Loamy 12-16 ARTRW8/PSSPS Ecological site was sampled as part of the assessment within CIRO.

The site is located in the south-central portion and occupies a gentle south-facing toeslope at an elevation of 6,128 feet (1,868 meters) and is within the City of Rocks wildfire perimeter (burned August 2000). The plot had a slight to moderate departure rating (31.4%) in the biotic integrity attribute which reflects a site that is beginning to respond to the effects of the wildfire. The diminishment and lack of vigorous response of the native bunchgrasses contributes to this rating as does the high cover contributed by non-native grasses; cheatgrass, desert wheatgrass, and bulbous bluegrass. The soil stability, hydrologic function, and biotic integrity landscape attributes were rated as slight to moderate departure, 22.5%, 25.0 and 31.4%, respectively and can be attributed to the amount of bare ground (25%) and indicators of soil movement from water and wind action.

Heath Canyon Allotment: This allotment is 2,740 acres which includes land administered by CIRO, BLM, and private land. Currently, this allotment is divided into six pastures. Thirty-nine percent of the allotment occurs within CIRO. The sample site is located near the southern allotment boundary and occurs within the City of Rocks wildfire perimeter (burned August 2000). The site is located on a gently sloping southwest-facing footslope at 5,837 feet (1,779 meters) in elevation.

The plot had a slight to moderate departure in the biotic integrity attribute (34.3%) as a result of non-native grasses being the major component of the herbaceous layer (cheatgrass and Kentucky bluegrass). The native bunchgrasses, Indian ricegrass (*Achnatherum hymenoides*), squirreltail (*Elymus elymoides*), Sandberg bluegrass, and Idaho fescue are beginning to recover and Utah juniper and singleleaf pinyon pine seedlings have become established onsite. Minimal evidence of livestock grazing was noted within the site. The soil stability and hydrologic function landscape attributes were rated as slight to moderate departure, 20% and 27.5%, respectively. The percentage of bare ground (15%) and the indicators of past soil erosion contribute to this rating.

Smoky Mountain Allotment: is located on the eastern CIRO boundary and is administered by the BLM; it was not grazed in 2010 or 2011 due to an agreement with the permittee. Approximately 11% of the allotment (224 acres) occurs within CIRO. The Loamy 13-16 ARTRV/PSSPS-FEID Ecological Site within this allotment was sampled at one location near the western boundary. This site is located on a gentle west-facing valley bottom at an elevation of 6,212 feet (1,893 meters).

The average soil stability attribute and the hydrologic function were rated as slight to moderate departure, 20.0% and 22.5% respectively. Approximately 30% of the area is comprised of exposed bare ground and there is evidence of water moving soil on the site, both of which contribute to this rating. The vegetation on the plot is primarily native shrubs; mountain big sagebrush with low cover by green rabbitbrush and mountain snowberry. The herbaceous layer includes Sandberg bluegrass and the non-native crested wheatgrass, primarily. Past grazing has likely contributed to the reduction in cover of native bunchgrasses and shifted the plant species composition on this site. The average biotic integrity attribute was rated as none to slight departure at 17.1% due to the afore-mentioned conditions.

Bath Rock Allotment: includes 551 acres (222 hectares) located near the west-center portion of CIRO. The allotment is administrated by IDPR and CIRO. Two sites were evaluated for the three landscape attributes, the Loamy 16+ ARTRV/FEID Ecological Site and the Mahogany Savanna 16-22 Cele3-Syor2/Feid-Achna Ecological Site.

The Loamy 16+ ARTRV/FEID Ecological Site was sampled at one location in a valley bottom in the southeast quadrant of the allotment. The site occurs on a nearly flat east-facing valley bottom at the elevation of 6,342 feet (1,933 meters). There is good diversity of plant cover composed primarily of native species including mountain big sagebrush and arrowleaf balsamroot. Sparse cover by non-native species including crested wheatgrass occurred. The biotic integrity attribute was rated as none to slight departure (17.1%) due to the slight presence of invasive plant species, the presence of dead shrubs, and the slightly diminished reproductive capability of the native perennial grasses.

The site has indicators of recent and past livestock grazing. The soil stability and hydrologic function attributes were rated as none to slight departure, 20% and 17.5%, respectively. Contributing to the rating are the amount of bare ground exposed and the indicators of litter and soil movement from wind and water action.

The Mahogany Savanna site is located in an area laced with hiking trails and is near a staging area for recreational rock climbers. The site occupies a gentle southeast-facing toeslope near the northeastern boundary of the allotment. The elevation of the site is 6,538 feet (1,993 meters). Given the amount of exposed bare ground and indicators of soil movement, the soil stability and hydrologic function attributes were rated as slight to moderate departure, 40% and 35%, respectively.

The site is in relatively good condition for biotic integrity even with the heavy foot traffic resulting in a rating of none to slight departure (20%). The extant vegetation cover includes curlleaf mountain mahogany and singleleaf pinyon pine trees in the canopy layer with mountain big sagebrush, mountain snowberry, and antelope bitterbrush in the short shrub layer. Native bunchgrasses onsite included needle-and-thread, Sandberg bluegrass, and thickspike wheatgrass.

Threats and Stressors: Sudden Aspen Decline (SAD) or aspen die-off threatens the quaking aspen resources of the western U.S. (Strand and Bunting 2010) and CIRO could possibly be affected in the future resulting in the potential loss of established clones. In cases of SAD, mature quaking aspen stems are dying with no apparent regeneration in the form of suckering (http://www.fs.fed.us/rmrs/docs/congressional-briefing/issues/aspen-die-off.pdf). Scientists and managers are currently researching the causes and trying to find solutions to SAD, currently affecting as much as 10% of western quaking aspen stands (http://spectre.nmsu.edu/dept/docs/forest/AspenDieOff.pdf).

The loss of quaking aspen clones within CIRO would result in removal of approximately 423 acres (171 hectares) of one of the most biodiverse plant communities. Loss of structured softwood habitat, and deleterious effects to wildlife and species of concern would likely occur. Loss of wildlife diversity, species abundance, species of concern, and shifts in precipitation and runoff patterns would occur and provide threats due to regional climate change. Climate change

has the potential to cause large shifts in species composition both in flora and fauna, including a decline of woodland and shrubland habitats and revegetation by non-native invasive plant species. A shift from approximately 3,777 acres (1,523 hectares) of pinyon-juniper woodland and/or 6,634 acres (2,675 hectares) of sagebrush-steppe short shrubland habitat could mean the loss of or permanent migration of many wildlife species within CIRO.

Overgrazing by livestock, wildfire, and changes in land use inside and outside of park boundaries on private lands has the potential to impact native vegetation types and species composition. Dominance by undesirable invasive and weed species due to loss of native vegetation vital to the survival of species of concern and habitat-obligate species within CIRO could result. Grazing, browsing, and wildfire cause additional threats to CIRO vegetation through loss of historic vegetation cover protecting the soil surface from raindrop splash, sheet and wind erosion, and binding soils together with root structure, resulting in increased soil erosion including rill and gully erosion and the establishment of aggressive undesirable weed species. The resultant plant communities would consist of semi-natural annual and perennial herbaceous vegetation types with little wildlife habitat value. Currently, CIRO has non-native and invasive plant species establishment on approximately 1,114 acres (449 hectares) which includes cheatgrass understory to big sagebrush and Kentucky bluegrass establishment along wetland margins. The boundaries of established grazing allotments are marked by fences and the CIRO staff is familiar with allotment boundaries which aid in monitoring natural resources. Boundary maintenance of existing fencelines and cattle guards is highly recommended to minimize affects of annual cattle grazing to CIRO resources, where cattle have access outside grazing allotment boundaries.

Recreational uses, particularly climbing access trails and staging areas, are a threat to the vegetation established near and between granite exposures within CIRO. Additionally, the population growth adjacent to the CIRO boundary increased at a rate of 11.6% from 2002 to 2007 (U.S. Census Bureau 2010). Threats to CIRO resources resulting from recreation pursuits also include hiking, horseback riding, and camping. As recreation use increases the primary concern of high importance to CIRO staff is rock climbing. The equipment and gear associated with rock climbing can be extensive and during staging for a climb, gear is usually placed or staged in an orderly fashion on the ground around the immediate area for inventory and setup thereby impacting site vegetation. Additionally, many recreationists prefer to visit natural recreation sites which allow entry to pets; therefore, with increasing numbers of visitors to CIRO come an increase in domestic animals, primarily dogs. Dogs are usually tied to nearby brush, fences, or a ground-stake and are occasionally left to roam free. Daytime temperatures in CIRO often exceed 85° F (29.4 °C) and climbers and dogs alike seek shade. CIRO managers have expressed the concern that dogs dig holes in and under vegetation of staging areas to provide shade/shelter from direct sunlight. This domestic animal behavior and other activities associated with rock climbing have been expressed by managers as a significant source of degradation to vegetation of some CIRO climbing areas.

Data Gaps: Mapping and inventorying invasive plants, patches, and stands within CIRO has occurred using NVIP methods (e.g., interpretation of 1:12,000-scale 2007-acquired aerial imagery), but has not been completed by field staff on foot therefore the locations, densities, and spread of undesirable plant species are poorly known. A database comparing descriptions of status and maps that show the locations, sizes of invasive plant occurrences, the invasive plant

species present and their abundance, as well as treatment information would be an invaluable tool for CIRO managers and neighboring land owners and managers. This database would include existing GIS data layers of non-native species locations from the EPMT and field treatment work that have been compiled to date.

Livestock grazing is currently an integral part of CIRO management occurring both within and outside the park boundary and on adjacent federal, state, and private land. The full potential impact of grazing in CIRO allotments or portions of other allotments that include CIRO land is difficult to assess due to the lack of monitoring data and information for the timing and level of forage utilization within allotments or portions of allotments. As of 2011, the Circle Creek Allotment located southeast of CIRO has been decommissioned and grazing is no longer planned (Personal Communication NPS Seattle 2011).

Plant Species of Management Concern: Information regarding the three plant species of special concern within CIRO (Table 13) is generally absent and specific inventory, research, and monitoring of special concern species to determine locations, densities, life histories/phenology, and trends are needed.

Table 13. CIRO Sensitive Plants.

Scientific Name	Common Name	Abundance
Pediocactus simpsonii var. *robustior*	Simpson's hedgehog cactus	Unknown
Castilleja angustifolia var. *flavescens*	Northwestern Indian paintbrush	Unknown
Polystichum kruckebergii	Kruckeberg's swordfern	Common

Within CIRO there are three species of special concern: Simpson's hedgehog cactus, narrow-leaved Indian paintbrush, and Krukeberg's swordfern. Habitat for these three species in addition to important sagebrush-steppe shrubland and quaking aspen forest habitats are vitally important to CIRO management. The occurrence of these species and habitats within CIRO adds to the importance of proactive resource management for the continued preservation and enjoyment for future generations. Included in this section are specific information and data for each of the critical vegetation resources identified within CIRO.

Simpson's Hedgehog Cactus

The Simpson's hedgehog cactus (*Pediocactus simpsonii*) is commonly observed on powdery soils within sagebrush shrublands and pinyon-juniper woodland communities. This rounded cactus typically grows to a height of two to three inches (5.1 to 7.6 centimeters) with a spherical diameter of about one to 1.5 inches (2.5 to 3.8 centimeters). Simpson's hedgehog cactus usually occurs in clusters of five to 11 individuals spreading out in concentric circles (NRCS 2011). Simpson's hedgehog cactus is widely distributed throughout the western U.S., from eastern Washington, south to New Mexico, east to Colorado, and north to Montana (Kartesz 1994).

There are three varieties of Simpson's hedgehog cactus throughout its range; *P. s.* var. *minor*, *P. s.* var. *robustior*, and *P. s.* var. *simpsonii*. In Idaho the species has been placed on the state monitor list. Currently, the global status ranking for *P. s.* var. *minor* is G4, which is defined as: "the species is apparently secure, though it may be quite rare in parts of its range, and/or

suspected to be declining" (NatureServe 2011). *P. s.* var. *robustior* and *P. s.* var. *simpsonii* are protected as a cactus species in Nevada and *P. s.* var. *simpsonii* is listed as a salvage-restricted protected native plant in Arizona (NRCS 2011). At the time of this report there has not been an assessment of Simpson's hedgehog cactus within CIRO; however, the species is listed as present in the park (NPSpecies Database 2011) and viable habitat for this species may occur due to the CIRO location within the assumed species distribution area (NRCS 2011).

Northwestern Indian Paintbrush

The northwestern Indian paintbrush (*Castilleja angustifolia* var. *flavescens*) occurs at moderate elevations within sagebrush shrublands established on slopes primarily in Nevada, western Utah, and the edge of southern Idaho (NRCS 2011, Kartesz 1999). Northwestern Indian paintbrush commonly grows to a mature height of 2.5 feet (76 centimeters or 0.76 meters); however, it can be shorter at higher elevations near the edge of its range. This species requires a minimum of 12 and a maximum of 45 inches (30.5 and 114.3 centimeters, respectively) of precipitation a year and can tolerate temperatures as low as -33^{o}F (-36.1^{o}C) (NRCS 2011). The color of *C. a.* var. *flavescens* bracts is commonly yellow, white, pink, or light violet or a combination of these colors.

There are three varieties of northwestern Indian paintbrush within the established range of the species; *C. a.* var. *angustifolia*, *C. a.* var. *dubia* (listed as present in CIRO), and *C. a.* var. *flavescens* (listed as present in CIRO). *C. a.* var. *flavescens* is currently ranked as an S1 species of special concern within Idaho (NatureServe 2011). The rank of S1 is defined as; "taxa in danger of becoming extinct or extirpated from Idaho in the foreseeable future if identifiable factors contributing to their decline continue to operate. These are taxa whose populations are present only at critically low levels or whose habitats have been degraded or depleted to a significant degree" (BLM 2003). The presence of northwestern Indian paintbrush in Cassia County, Idaho is reported and illustrated on the NRCS (2011) website. However, confirmation from the NPS has not been completed as of the date of this paper and this variety is largely undocumented within Idaho.

Kruckeberg's Swordfern

Kruckeberg's swordfern (*Polystichum kruckebergii*) occurs at moderately high elevations between 6,700 and 9,500 feet (2,042 and 2,896 meters) on alpine and subalpine cliffs and talus slopes. Individuals exhibit evergreen fronds that are 3.5 to 14 inches (8.9 to 35.6 centimeters) long in clusters on a short rhizome with narrow lance-shaped blades (Lellinger 1985). Kruckeberg's swordfern is reported for CIRO as common in the Reserve (NPSpecies Database 2011) and also occurs in California, Nevada, Utah, Idaho, Montana, Oregon, and Washington (Sagebud 2011). It is currently listed in Montana and California as an S1 species of concern. No inventory reports were located for CIRO or southern Idaho.

Threats and Stressors: The threats and stressors to the plant species of special concern within CIRO are primarily through climate change and altered precipitation and temperature patterns within the region and wildfire that results in non-native invasive species establishment or soil erosion due to loss of cover. Alterations in precipitation and temperature can influence species composition and habitat development, leading to the potential exclusion of key species, the habitat structure and shelter they provide, and introduction of successional species or undesirable invasive species. Wildfire and drought are threats to the plant species of concern within CIRO.

The possible impact of wildfire and drought to these species could be amplified with a warmer climate and less precipitation.

Additional threats to the species of special concern within CIRO are the localized recreational use such as rock climbing and livestock grazing. Both activities expose vegetation to breakage, soil compaction, drying, and trampling near grazed habitats or climbing sites located along trails and staging areas at the base of popular climbing formations. The potential impacts of rock climbing on area vegetation and geologic features are discussed in further detail within the Geology Resources section of this document.

Reserve Specific Information: in addition to the three sensestive plant species at CIRO, UCBN has also identified of special concern within CIRO (Table 13) is generally absent and specific inventory, research, and monitoring of special concern species to determine locations, densities, life histories/phenology, and trends are needed

Quaking Aspen

Quaking aspen forest establishment within CIRO is predominately in damp draws, riparian areas, and on sparse upland areas with sufficient seasonal moisture (Strand and Bunting 2010). Approximately 423 acres (170 hectares) of quaking aspen forest stands were mapped within CIRO, the understory ranged from dry herbaceous vegetation to mesic shrublands (Erixson and Cogan 2011). Regional die-off of quaking aspen trees and clones referred to as Sudden Aspen Decline (SAD) has been occurring across the western U.S. for more than a century (Knight 2001, Worrall et al. 2008) resulting in a natural resource and ecological focus on the species. The potential effects of SAD on large mammals such as elk, deer, and black bear, changes in biodiversity, and water availability from forested basins containing quaking aspen are important considerations (Perala 1990, Wilson 1992, Bartos 2001, Rogers 2002, Strand and Bunting 2010). This has raised concerns from natural resource managers regarding the management and restoration of historic quaking aspen clones and stands.

Quaking aspen commonly occurs in conjunction with conifer species, providing shade and protection for conifer seedlings and saplings which may overtop the host and reduce its importance in the stand (Perala 1990). When quaking aspen establishes under favorable conditions it can develop uneven-aged self-regenerating stands or clones from root sucker shoots. A stable multi-age quaking aspen stand usually occurs as a result of unsuitable conifer habitat or a lack of conifer regeneration in the area (Mueggler 1989, Strand and Bunting 2010). Quaking aspen is considered a cornerstone species by many researchers (Perala 1990, Wilson 1992, Bartos 2001, Rogers 2002, Strand and Bunting 2010) and the disturbance driven growth cycles of quaking aspen make proliferation in ecosystems with little to no disturbance (Bartos 2001, Shepperd 2004) a challenge for natural resource managers. In the absence of disturbance, quaking aspen is typically overtaken by slower growing species of conifers and sagebrush can become established in the understory (Mueggler 1985, Shepperd et al. 2006); both of these associations occur within CIRO.

Condition: The baseline survey of quaking aspen within CIRO was completed by the OMSI botany research team in 2005 (Batten et al. 2005) and was followed by the UCBN quaking aspen field monitoring and report published in 2009 (Strand and Bunting 2010). Quaking aspen stands occur primarily in the western and northern areas of CIRO on the north- and east-facing slopes of

terrain features that catch winter snow and shelter them from early melt. Small quaking aspen stands/clones also occur along the bases of some of the larger geologic features that provide runoff and increased water availability and by shading areas of snow accumulation. Quaking aspen were chosen as a vital sign indicator for CIRO due to present and historic decline in the western U.S. in addition to the importance of this species in terms of biological diversity within CIRO.

Inventory: During the 2009 field season 30 quaking aspen stands within CIRO were visited and 45 plots were established and sampled (Strand and Bunting 2010). The total trunk/stem density by size class was calculated and the statistics for trunk/stem density per hectare were reported in order to classify suckers, regeneration, mature trees, and dead trees. In CIRO, levels of regeneration of quaking aspen were noted in combination with counts of dead stems per hectare as high as 895 on plot number 73 (Strand and Bunting 2010). This high dead stem count on plot number 73 occurred within 448 mature trunks per hectare (greater than 2.5 cm (1 inch) in dbh and taller than 75% of the stand height), 3,332 regeneration stems per hectare (greater than 152 cm (5 ft); up to or greater than 2.5 cm (1 inch) in dbh; and shorter than 75% of the stand height), and 2,288 sucker shoots (suckers or seedlings < 46 cm to 152 cm [1.5 ft to 5 ft] tall) per hectare. Throughout the quaking aspen stands within CIRO approximately 63% are experiencing encroachment from conifer species. These data are supported by Bartos (2001) who concluded that due to conifer encroachment, quaking aspen across the entire western U.S. has declined by 50% to 96%. Similarly, Rogers (2002) reported that more than 50% of quaking aspen plot data collected confirms the presence of conifer species.

The Plant Feature dataset stored in the CIRO geodatabase contains feature classes pertaining specifically to plant GIS data other than the general vegetation raster layers (Figure 22). Two files provided by the UCBN are included that focus on quaking aspen stands and permanent plot locations. The data are specific to a few small sites in the northern and central portions of CIRO.

Threats and Stressors: Quaking aspen is considered a cornerstone species by many researchers (Perala 1990, Wilson 1992, Bartos 2001, Rogers 2002, Strand and Bunting 2010) and the disturbance driven growth cycles of quaking aspen make proliferation in ecosystems with little to no disturbance or inadequate soil moisture a challenge (Bartos 2001, Shepperd 2004). In the absence of disturbance, quaking aspen is typically overtaken by slower growing species of conifers or sagebrush short shrubs may become established in the understory (Mueggler 1985, Shepperd et al. 2006). Regional die-off of quaking aspen stands and clones by SAD has been occurring across the western U.S. for more than a century (Knight 2001, Worrall et al. 2008) raising concerns for natural resource managers regarding the management and restoration of current and historic stands/clones.

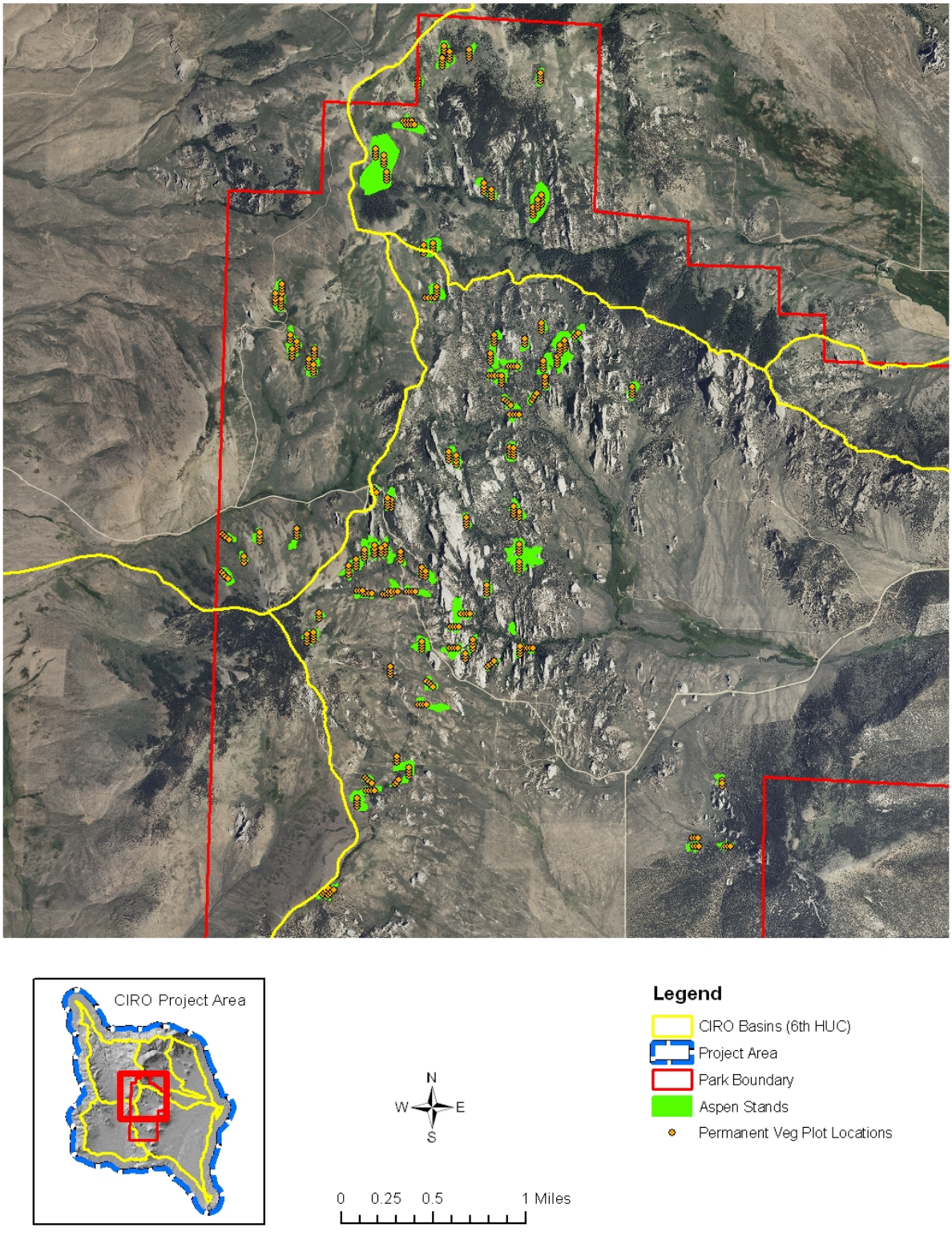


Figure 22. Vegetation datasets for CIRO project area.

Pinyon-Juniper Woodlands

Rust (1997) stated that the most developed singleleaf pinyon pine community and perhaps the best representative stands of this plant community in Idaho occur within CIRO. Nearly monotypic stands of singleleaf pinyon pine within CIRO were classified, mapped, and described by Erixson and Cogan (2011) and occupied 1,400 acres (565 hectares). Also classified, mapped, and described were two woodland units of singleleaf pinyon pine in association with Utah juniper and/or curlleaf mountain mahogany that occupied 2,377 acres (958 hectares). In total, 470 separate map polygons represented the pinyon-juniper woodland communities of CIRO (Erixson and Cogan 2011).

Condition: The pinyon-juniper woodland stands within CIRO are distributed primarily on the slopes, ridges, and hills of the north-central portion (Erixson and Cogan 2011, Vincent et al. 2007). The singleleaf pinyon pine community within the current RNA meets the definition for being classified as an old growth stand (Miller et al. 1999). Old growth stands of pinyon-juniper woodland are rare and structurally complex with higher levels of biological diversity (Miller et al. 1999). The proposed RNA expansion areas contain additional specimens of this age class of singleleaf pinyon and limber pine thereby affording the possibility to expand the protection of the RNA to a larger extent of this unique ecosystem.

Three associations of singleleaf pinyon pine were classified, mapped, and described during the NVIP for CIRO (Erixson and Cogan 2011). In general, singleleaf pinyon pine and Utah juniper trees are highly susceptible to fire due to both highly flammable foliage and no to little self-pruning of dead branches on the lower trunk. When burned these trees are usually killed or severely damaged and do not resprout. However, because these woodlands often have an open canopy, sparse understory, and lack fine fuels, fire frequency is relatively low. The local descriptions of each woodland association are summarized as follows (Erixson and Cogan 2011):

Singleleaf Pinyon Pine Woodland: This monotypic woodland association is characterized by an open to moderately dense tree canopy dominated by singleleaf pinyon pine; Utah juniper trees may be present but provide sparse cover. Mountain big sagebrush, yellow rabbitbrush, mountain snowberry, and curl-leaf mountain mahogany often occur in the short- and tall-shrub layer, but total shrub cover is generally low. The herbaceous layer is typically sparse in terms of cover and characterized by Sandberg bluegrass and occasionally other grass species which can be locally abundant. Forbs are generally sparse in the herbaceous layer, arrowleaf balsamroot occurs regularly; however, forb composition can be quite variable from one stand to the next. Stands occur on flat to moderately-sloping sites on all aspects. The soils are variable, but are typically shallow and rocky. Litter from trees (needles, cones, and branches) often covers much of the ground surface. Rock, pavement, or bare ground surface may be significantly exposed depending on the site.

Singleleaf Pinyon Pine / Curl-leaf Mountain-mahogany Woodland: This woodland association is characterized by an open tree canopy dominated by singleleaf pinyon pine with a significant tall-shrub layer of curl-leaf mountain mahogany. Stands may support several short shrub species, including mountain snowberry, antelope bitterbrush, mountain big sagebrush, and slender buckwheat (*Eriogonum microthecum*). The associated shrub species occur frequently; however, the canopy cover is usually low. Herbaceous cover is generally sparse and typically includes

Sandberg bluegrass and arrowleaf balsamroot. Forb composition can be diverse and is variable from one stand to another. Stands occur on flat to moderately-sloping sites on all aspects. The soils are variable, but are typically shallow and rocky. Litter from trees (needles, cones, and branches) often covers about half the ground surface. Exposure of rock, pavement, or bare ground may also be significant depending on the site.

Singleleaf Pinyon Pine – Utah Juniper / Sparse Understory Woodland: This woodland association is characterized by an open to moderately dense tree canopy co-dominated by singleleaf pinyon pine and Utah juniper. The short shrub layer is typically sparse in terms of canopy cover and species composition can be variable with mountain big sagebrush as the most constant shrub species. Sandberg bluegrass occurs regularly in the herbaceous layer providing sparse cover; forbs provide sparse cover in the herbaceous layer and may be diverse. Stands occur on flat to moderately-sloping sites on all aspects. The soils are variable, but are typically shallow and rocky. Litter from trees (needles, cones, and branches) often covers much of the ground surface. Rock, pavement or bare ground surface may also be significantly exposed depending on the site.

Inventory: The 2009 field season vegetation assessments within CIRO, including pinyon-juniper woodland habitats, documented 211 plant species from a total of 533 taxa currently listed on the NPSpecies Database list (NPS 2011). This group of species includes the abundant, common, and uncommon native and non-native plant species that drive vegetation classification within the NVCS. The relatively short time period for field data collection (one window in time) and the selection of classification plot sites focused on vegetation mapping support provides the baseline and opportunity for more in-depth future plant community studies within CIRO (Erixson and Cogan 2011). The vegetation map prepared from 2009 classification data resulted in eleven woodland and forest units (plant associations/vegetation alliances) representing the dominant tree species subalpine fir, Douglas-fir, lodgepole pine, limber pine, singleleaf pinyon pine, Rocky Mountain juniper, Utah juniper, curl-leaf mountain mahogany, and quaking aspen. The vegetation map and report was finalized during production of this NRCA. Past field inventories have revealed that both singleleaf pinyon and limber pine are in mature status (> 200 years old) within CIRO and show no signs of decadence or disease.

Figure 23 is presented as an example of the vegetation condition within CIRO in areas of recreational exposure. The plot is located on a valley bottom with gentle slopes and a southern aspect. This area receives relatively high recreational use (hiking, camping, and rock climbing) that has resulted in heavy trampling and large areas devoid of vegetation. The impacts from recreational activities are concentrated and do not extend into the surrounding habitat. The current vegetation established on the plot is dominated by the short shrub mountain big sagebrush, the trees singleleaf pinyon pine and Utah juniper, and the herbaceous vegetation layer is represented by the non-native grasses Kentucky bluegrass and smooth brome and native perennial rhizomatous graminoids Douglas' sedge, and mountain rush.

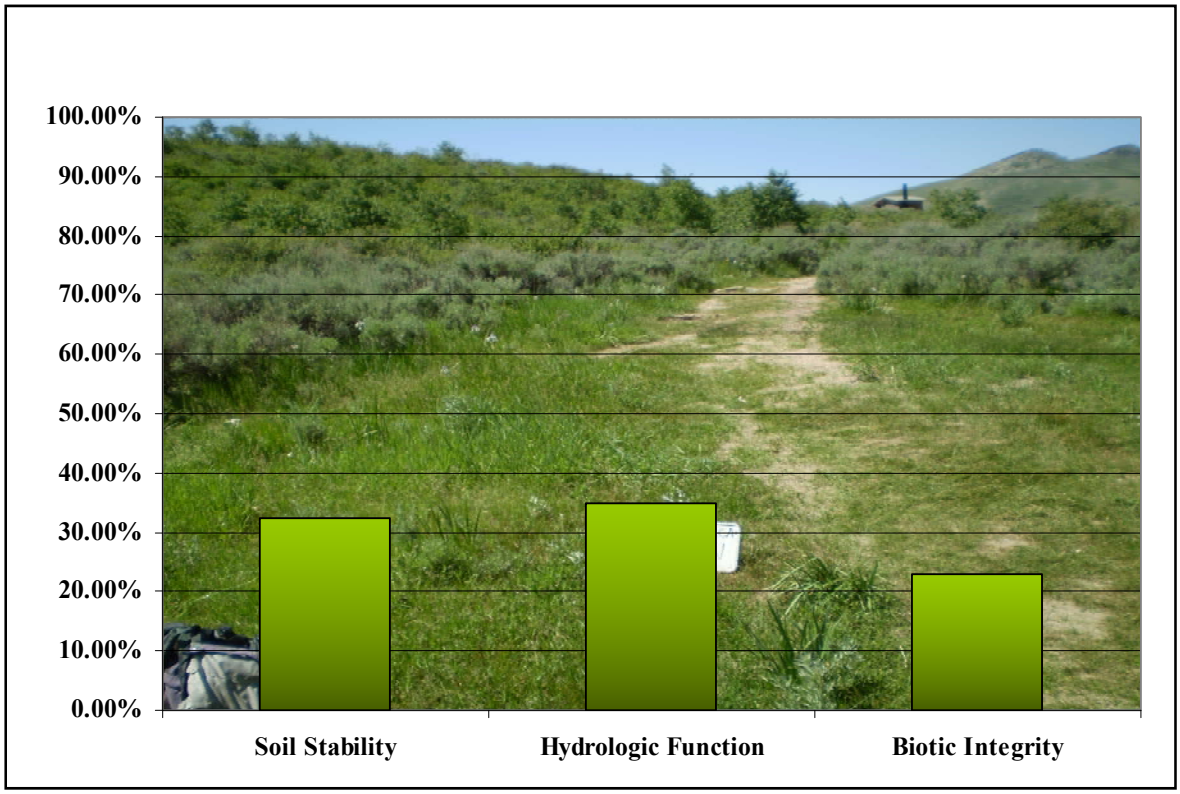


Figure 23. This graph shows an example of the departure from reference condition for three landscape attributes in the Mahogany Savanna 16-22, Emery Canyon Grazing Allotment (Plot 11 is in the background).

Threats and Stressors: Wildfire represents a threat to the extant plant communities established within CIRO. Woodland and shrubland communities dominated by species of sagebrush or Utah juniper and singleleaf pinyon pine have an average fire-free interval of 20-70 years relative to topography, fuel load, and occurrence of natural ignitions. Similarly, areas supporting stands of pinyon-juniper woodlands are also threatened by fire and often tend to have a more frequent fire-free interval (NPS 2005). With changes in regional climatic conditions and wildfire management affecting the historic fire regime of CIRO, pinyon-juniper stands have encroached into sagebrush communities increasing the biomass and habitat structure across the landscape and the potential for larger more intense wildfires (Link et al. 2006).

Climate change, wildfire, invasive plant species, and localized recreational use are threats to species of special concern within the pinyon-juniper woodlands of CIRO. Some of these species are unique and not found elsewhere in Idaho and are known to be obligates of old-growth pinyon-juniper woodlands (Rodhouse et al. 2009). Two small mammal species with the greatest management concern for CIRO staff are the cliff chipmunk and pinyon mouse. These species and other wildlife species of concern within CIRO are discussed in further detail within the *wildlife* section of this report.

Sagebrush-steppe Shrubland

The historic land cover encompassing much of southern Idaho and the Intermountain West prior to European colonization was most likely the sagebrush-steppe shrubland ecosystem (West and Young 2000). Sagebrush-steppe shrubland is currently the predominant vegetation type covering much of the Snake River Plain. It is adapted to high desert regions with hot dry summers and cold relatively wet winters. The sagebrush-steppe shrubland plant associations established within this ecosystem generally consist of a short shrub canopy with an understory of and/or open patches of perennial grasses and forbs. The common shrubs include several species of sagebrush, antelope bitterbrush, and rabbitbrush. The Snake River Plain is a dry region largely due to the rain shadow effect of mountain ranges to the west. When winter storm systems enter the mountain ranges that surround the plain, air rises and the temperature cools causing water vapor to condense and fall mostly on the windward side of the mountains leaving the leeward side semiarid in terms of precipitation regime. The sagebrush-steppe shrubland ecosystem has adapted to this condition.

The structure and composition of most sagebrush-steppe shrubland vegetation has undergone major changes since European settlers arrived. With the reduction of sagebrush-steppe distribution in southern Idaho resulting from cultivation, fire, and non-native plant species/noxious weed invasion, some sagebrush communities within CIRO are rated among the best remaining examples regionally.

Condition: Yeo et al. (2009) developed a sagebrush-steppe monitoring protocol for five UCBN park units including CIRO and stated that more than 50% of CIRO is dominated by sagebrush-steppe shrublands, and substantial portions have been degraded by altered fire regimes, invasive plants, and grazing. Erixson and Cogan (2011) classified and mapped 5,926 acres (2,390 hectares) of six sagebrush-dominated types with native grass and forb understories. Additionally 708 acres (286 hectares) of big sagebrush with an invasive grass (cheatgrass, crested wheatgrass) understory occurred. Through the analysis of nearly a half century of monitoring data collected on the Idaho National Laboratory near CRMO, sagebrush-steppe long-term plant community response to drought is expected to impact management (Yeo et al. 2009). Similarly, Rodhouse (2009) found that bare ground exposure percentage was higher in the northern portions of CIRO, particularly in the Circle Creek grazing allotment area. These findings suggest impacts from drought and/or livestock grazing could increase the susceptibility of soils to degradation including loss of biotic crust and invasion by species such as cheatgrass, thereby affecting sagebrush-steppe shrubland associations. CIRO has been somewhat resistant to cheatgrass invasion [92 acres or 37 hectares were mapped by Erixson and Cogan (2011)], yet the abundance of cheatgrass in areas that have burned within the last ten years (Trace Lane and Heath Allotments) suggests disturbance of soils particularly by wildfire should be avoided in order to minimize further degradation (Rodhouse 2009).

The soil stability attribute ratings indicate much of the CIRO area within the grazing allotments is in good to fair condition. Eight plots had a departure rating of none to slight (<21%), and seven plots had a rating of slight to moderate (21%-40%). One plot had a rating of 40% (the top end of the slight to moderate departure rating). Visual observations indicated areas lower in the valleys with gentle slopes and areas close to and at popular rock climbing routes and access trails had a generally poor vegetation condition due to livestock grazing and recreational use patterns.

Steeper slopes surrounding the valleys and areas without rock outcrops were generally in better condition in terms of soil stability.

Monitoring: A sagebrush-steppe shrubland vegetation monitoring protocol was developed by the NPS and UCBN implemented initially within CIRO during 2008 (Rodhouse 2009, Yeo et al. 2009). The sagebrush-steppe ecosystem within CIRO is critical to area biodiversity and is considered one of 12 vital sign indicators of ecosystem health for NPS managers. Vital signs are defined by the UCBN monitoring program as: "a subset of physical, chemical, and biological elements and processes of park ecosystems that are selected to represent the overall health or condition of park resources, known or hypothesized effects of stressors, or elements that have important human values" (http://science.nature.nps.gov/im/monitor/).

Through practices encompassing the vital signs for CIRO, land management operations are assessed and monitored to determine trends and resource health. One of the land uses within CIRO is livestock grazing, Grazing allotments commonly share boundaries with multiple landowners and overlap of cattle use has occurred between different land owners and in the Reserve. The sagebrush-steppe shrubland monitoring by Rodhouse (2009) focused on the species composition, density, and aerial coverage of extant plant species within grazing allotments. The overall assessment of sagebrush-steppe ecosystem composition within CIRO is presented in a regional context separated into northern CIRO, southern CIRO, and CRSP. Tables 14 – 16 display the results of field assessments during the 2008 field season.

Table 14. Summary information for the sagebrush-steppe vital sign in the northern portion of City of Rocks National Reserve (CIRO North), 2008 (Rodhouse 2009).

UCBN Vital Sign Sagebrush-steppe	**Measure**	**Current Condition**
Percent cover (median, mid-point cover class)		
	Bare ground (%)	15
	Annual grass (%)	0
	Bunchgrass (%)	15
	Forbs (%)	15
	Shrubs (%)	37.5
Frequency (% 1 m^2 plots present, n = 78)		
	Big sagebrush (%)	81
	Bluegrass (%)	68
	Western wheatgrass (%)	29
	Bluebunch wheatgrass (%)	16
	Basin wildrye (%)	14
	Crested wheatgrass (%)	26
	Cheatgrass (%)	31
Soil/site stability (% plots ≥ rank 3; moderate to severe)		
	Flow patterns	24
	Litter movement	19
	Soil pedestals	16
	Rills	1
	Gullies	0

Table 15. Summary information for the sagebrush-steppe vital sign in the southern portion of City of Rocks National Reserve (CIRO South), 2008 (Rodhouse 2009).

UCBN Vital Sign Sagebrush-steppe	Measure	Current Condition
Percent cover (median, mid-point cover class)		
	Bare ground (%)	2.5
	Annual grass (%)	0
	Bunchgrass (%)	37.5
	Forbs (%)	15
	Shrubs (%)	37.5
Frequency (% 1 m^2 plots present, n = 100)		
	Big sagebrush (%)	60
	Bluegrass (%)	67
	Western wheatgrass (%)	4
	Bluebunch wheatgrass (%)	44
	Basin wildrye (%)	7
	Crested wheatgrass (%)	24
	Cheatgrass (%)	47
Soil/site stability (% plots $\geq$ rank 3; moderate to severe)		
	Flow patterns	22
	Litter movement	11
	Soil pedestals	27
	Rills	0
	Gullies	0

Table 16. Summary information for the sagebrush-steppe vital sign in Castle Rocks State Park (CRSP), 2008 (Rodhouse 2009).

UCBN Vital Sign Sagebrush-steppe	Measure	Current Condition
Percent cover (median, mid-point cover class)		
	Bare ground (%)	2.5
	Annual grass (%)	2.5
	Bunchgrass (%)	15
	Forbs (%)	15
	Shrubs (%)	37.5
Frequency (% 1 m^2 plots present, n =80)		
	Big sagebrush (%)	70
	Bluegrass (%)	59
	Western wheatgrass (%)	44
	Bluebunch wheatgrass (%)	31
	Basin wildrye (%)	29
	Crested wheatgrass (%)	4
	Cheatgrass (%)	1
Soil/site stability (% plots $\geq$ rank 3; moderate to severe)		
	Flow patterns	4
	Litter movement	4
	Soil pedestals	11
	Rills	0
	Gullies	0

Threats and Stressors: The sagebrush-steppe ecosystem is one of the most threatened ecosystems in the Intermountain West due to land use conversion and wildfire. Determining trends in sagebrush-steppe communities is essential for understanding them and creating management strategies to better preserve this vulnerable ecosystem.

The threats to the sagebrush-steppe ecosystem within CIRO are primarily from habitat degradation and species impacts due to non-native, invasive, and noxious weeds, wildfire, and to a lesser degree livestock grazing and localized recreational use. These threats result from exposure, compaction, and erosion of critical soils, destruction of existing vegetation and biotic crust, and the introduction and spread of invasive/undesirable weedy species. An evaluation of noxious weed and wildfire monitoring within CIRO is presented herein.

Noxious Weeds

Over time human influences have resulted in substantial change to the sagebrush-steppe ecosystem which has allowed the introduction of many non-native, noxious, and/or invasive weedy species (Rodhouse 2009). Noxious weeds are a threat to the sagebrush-steppe shrubland and pinyon-juniper woodland resources/habitats within CIRO. Idaho currently lists 64 species of weeds designated as noxious by state law; this list is updated annually and can be accessed on a number of websites and public information releases. Identified noxious weed species within Idaho are separated into three categories of concern based on control requirements: Early Detection Rapid Response, Control, and Contain (State of Idaho Agriculture 2010). The successful management of noxious weeds requires the development of evolving strategic plans that incorporate prevention, education, and control options that are also financially and economically sustainable to effectively manage the changing status of current species of concern (DiTomaso 2000). NPSpecies Database (2011) lists 62 species of non-native plants present within CIRO as of the 2005 certification.

Monitoring: During the 2003 field season a survey of 14 noxious weeds was conducted within CIRO and ten species were identified as present within the park (Prather 2003). A later study and publication by Vincent (2006) which is also the current weed management plan for CIRO, determined three additional noxious weed species were present. Data from field assessments had been used to create maps in a GIS describing the location and extent of each species to aid in the development of future weed management plans. As of this publication there are nine confirmed Idaho-designated noxious weeds, two common species of concern, and five exotic species of concern present within CIRO (Vincent 2006, Rodhouse 2009, Prather 2003). **Table 17** displays the known weeds of concern within CIRO and confirmed locations. Location maps for identified weed species are presented in Vincent (2006).

Table 17. Idaho Designated weeds found in CIRO. (Prather 2003, Vincent 2006, Rodhouse 2009).

Common Name	Scientific Name	Primary Locations
Black henbane	*Hyoscyamus niger*	Roadside
Bull thistle	*Cirsium vulgare*	Disturbed areas, Water sources
Canada thistle	*Cirsium arvense*	Water sources
Cheatgrass	*Bromus tectorum*	Distributed Throughout
Chicory	*Cichorium intybus*	East of CRSP
Common burdock	*Arctium minus*	Homesteads
Common mullein	*Verbascum thapsus*	Dispersed throughout
Field bindweed	*Convolvulus arvensis*	Homesteads, parking lots
Houndstongue	*Cynoglossum officinale*	Emery Canyon well site
Musk thistle	*Carduus nutans*	Bath Rock
Saltcedar	*Tamarix* spp.	Possibly within CIRO Area
Scotch thistle	*Onopordum acanthium*	CRSP, Circle Creek, Twin sisters
Spotted knapweed	*Centaurea maculosa*	CRSP Ranch house, laneway, Bread Loaves, Bath Rock and trail, Camp Rock
Sulphur cinquefoil	*Potentilla recta*	Emery Canyon road
Wavyleaf thistle	*Cirsium undulatum*	Un-documented
Whitetop	*Cardaria draba*	Visitors Center

A general description of the abundance and distribution information is presented in the City of Rocks Invasive Plant Inventory (Prather 2003), the 2006-2010 Weed Management Plan for the City of Rocks Reserve (Vincent 2006), and Monitoring Sagebrush-steppe Vegetation in the UCBN (Rodhouse 2009).

Table **18** below identifies the invasive species tallied, acres and level of concern for each, established during the Prather (2003) City of Rocks Invasive Plant Inventory assessment.

Table 18. List of invasive species and acres for CIRO. (Prather 2003).

Species	Area (acres)	Level of Concern
Black henbane	0.09	Low
Bull thistle	6.66	Low
Canada thistle	14.52	Medium
Chicory	0.03	Medium
Field bindweed	8.38	Medium
Houndstongue	0	High
Musk thistle	0.09	High
Saltcedar	3.14	Very High
Scotch thistle	0.001	High

Species	Area (acres)	Level of Concern
Spotted knapweed	0.12	High
Sulfur cinquefoil	4.72	High
Wavyleaf thistle	0.01	High

Numerous options are available for the control and management of noxious weeds including mechanical and chemical controls. Multiple herbicides are registered as safe for use around livestock and wildlife and most biological control programs focus on noxious weed control for rangelands affording further protection for foragers (DiTomaso 2000). The successful management of noxious weeds requires the development of strategic plans that incorporate prevention, education, and control options that are financially and economically sustainable (Whitson 1998, DiTomaso 2000). On average the U.S. loses $33 billion in crop production to weeds each year and an additional $7 billion is spent on herbicide control alone (USDA 2010).

Wildfire

Stressors are disturbance events that result in significant ecological effects within a system to cause change. The documented history of fire within CIRO by Morris (2006) shows that approximately 25% of the 14,407 acres (5,809 hectares) comprising CIRO have burned in the last 75 years and fire size has been increasing since the 1980s (approximately 1% Reserve area), 1990s (approximately 4% Reserve area), to the single fire of 2000 that burned 14% (2,090 acres or 843 hectares) of CIRO. Additionally, an unpublished report by Stock (2005) stated that over half of the vegetation within CIRO was in a high to medium risk category for fire.

The integral role of fire in the progression of a landscape through disturbance and nutrient cycling is a process managers are continually monitoring. The CIRO basins are mid-elevation landforms that historically were driven by wildfire (Morris 2006) to maintain a sagebrush shrubland with grassland understory and openings intermixed with pockets of curlleaf mountain mahogany and pinyon-juniper woodland stands. With fire exclusion from these plant communities and adequate precipitation, larger woody plant species become more densely established within shrublands and increase the availability of large woody fuels for wildfires; evapotranspiration and snow ablation are also increased and potentially lead to a decrease in spring runoff from snowpacks and available soil water moisture.

Condition: The effects of fire suppression, grazing, and changes in species composition have increased the fire-free interval within CIRO as larger woody species have replaced herbaceous species (Miller et al. 2008). The encroachment/expansion of Utah juniper into the sagebrush/grassland communities is common within CIRO because the historical role of fire in maintaining the species and community diversity has diminished. The general exclusion of fire within CIRO has shifted most plant communities to more homogenous compositions (Rodhouse 2009).

Inventory: Fire suppression, livestock grazing, and past land management activities have affected the species composition and fire occurrence rate within CIRO (Morris 2006). Over time these land uses and alterations to fire regimes can facilitate progressive conversion of herbaceous and shrubland habitats to a higher density of late seral species. Additionally, as invasive grass species establish more homogenous stands, fire regimes become further altered and often support the

propagation of the invasive species. Wildfire data from the BLM, NPS, and USFS collectively document fire occurrence for the period 1953 through 2008. According to the BLM_Fire_Pts_72-08 dataset, approximately 36,544 acres (14,736 hectares) burned as a result of wildfire ignitions during the period 1981- 2008.

Table **19** lists the BLM recorded fires from 1981-2008, within the project area and Table 20 lists the number of fires by source from the BLM records. NPS records documented that 14 fires occurred within the CIRO boundary during the period 1949-2000, encompassing approximately 3,562 acres (1,436 hectares) (**Table 21**).

Table 19. BLM recorded burned acres by year and cause for CIRO, 1981-2008.

BLM Fire Pts 72-08 FIRE YEAR/ Cause>	Human (Ac)	Natural (Ac)	Unknown (Ac)	Grand Total (Ac)
1981		40		40
1985	70	2		72
1988	0.5	1900		1900.5
1989	1	1		2
1990		0		0
1992	50			50
1996	80	13012		13092
1999			3399.2	3399.2
2000	155.4	11787.5		11942.9
2001	0.1	2759	79	2838.1
2004		0.1		0.1
2006	120			120
2007		3086		3086
2008	1.5			1.5
Grand Total (Ac)	478.5	32587.6	3478.2	36544.3

Table 20. Number of ignitions recorded by BLM Count for recorded fires by year in the CIRO project area, 1981-2008.

BLM Fire Pts 72-08 FIRE YEAR/ Cause>	**Human (Ac)**	**Natural (Ac)**	**Unknown (Ac)**	**Grand Total**
1981		1		1
1985	1	2		3
1988	1	2		3
1989	1	1		2
1990		1		1
1992	1			1
1996	1	4		5
1999			1	1
2000	1	3		4
2001	1	1	1	3
2004		1		1
2006	1			1

BLM Fire Pts 72-08 FIRE YEAR/ Cause>	Human (Ac)	Natural (Ac)	Unknown (Ac)	Grand Total
2007		1		1
2008	1			1
Grand Total	9	17	2	28

Table 21. Mapped fires within the City of Rocks National Reserve (Source Morris 2006).

Fire Name	Date of Fire	Reported Acres	Mapped Acres	CIRO Acres	Cause
Burn	1949	none	12	12	unknown
Trail Creek	Sept. 7, 1951	390	164	164	smokers
Sisters	Oct. 9, 1953	90	57	90	smokers
Ward	Sept. 16, 1957	300	325	300	debris burning
Graham Canyon	Oct. 17, 1964	120	52	52	refuse burning
City of Rocks #60	Sept. 9, 1964	30	27	30	campfire
Pinion (sic)	Oct. 8, 1977	45	43	45	cooking fire
Big Rock	May 16, 1985	60	60	61	human
Graham	July 22, 1986	0.1	0	0.1	lightning
Emmigrant (sic)	Aug. 5, 1988	346	51	51	natural
Emery Canyon	July 31, 1992	50	75	50	unknown
Emery Canyon	Oct. 17, 1996	80	78	52	human
City of Rocks #3	Sept. 29, 1999	565	565	565	unknown
City of Rocks	Aug. 18, 2000	17,605	2,089	2,090	natural
Total Acres Burned				**3,562.1**	

The extant vegetation within CIRO suggests fire has been limited; the areas with the species composition dominated by sagebrush species or Utah juniper and single-leaf pinyon pine have an average fire-free interval of 20-70 years relevant to topography, fuel load, and occurrence of natural ignitions. Typically, areas with stands of pinyon-juniper woodlands tend to have a more frequent fire-free interval, as low as ten years (Burkhardt and Tisdale 1969, Gruell 1983). Additionally, fire-adapted grasses, such as cheatgrass which increase fine fuels, increase the rate of fire spread, and thrive in fire dominated ecosystems, can decrease the return interval of fire (Link et al. 2006) in ecosystems that historically supported fire regimes of 60 to 110 years to as little as three to five years (Whisenant 1990). The return interval decrease is expected to challenge resource managers in the future as evolving species composition and recreation use can play an integral role in the frequency of wildfires.

Land Use

Vegetation cover provides a visual representation of land uses and can be an indicator of developing changes in land use over time. Landscape characteristics, vegetation, and land use can also be indicative of the extent of change, current condition, structure, and influence on an area from processes at local and regional scales (NPS 2011). Monitoring different scales at multi-spatial bases provides natural resource managers with the opportunity to evaluate changes in and around CIRO and the surrounding areas and attribute representation at a regional scale. The EPA uses land cover which is a reflection of land use to identify various nonpoint sources of

pollution, including chemical and air pollution, for permitting through the National Pollution Discharge Elimination System (NPDES).

Variations in land cover and ultimately land use is a vital aspect for evaluation of the measurable changes in land uses and how they affect the integrity of CIRO ecosystems. For example, the historic sagebrush-steppe land cover occupied over 25-million acres (10.1-million hectares) in Idaho. Today more than 33% of the sagebrush-steppe shrubland has been converted to agricultural uses or otherwise developed, resulting in fragmentation of this important plant community. Activities that can affect the ecological integrity of CIRO include farming, grazing, development, and recreation activities both within the Reserve and on adjacent areas.

Erixson and Cogan (2011) classified and mapped 11 land cover/land use types within CIRO and areas adjacent to the boundary. The principle types mapped included unvegetated geology and soil, water bodies, transitional land, agricultural fields and farm/ranch sites, quarries and gravel pits, transportation corridors, and facilities and residential sites. This dataset provides CIRO managers with both relational information and a snapshot of conditions at the time of the aerial imagery (2009).

A critical aspect of CIRO management is the continuation of public access to natural resources, primarily for recreation. Access to the resources of CIRO is the foundation of this NPS unit. It is internationally recognized as providing scientific pursuits and recreational enjoyment for geologists and climbers alike. CIRO also provides a livelihood for local families and small businesses through livestock grazing in and adjacent to the Reserve and tourism.

Condition: The vegetation within CIRO is primarily characterized by woodland and forest stands, short shrublands, grasslands, and riparian tall shrublands. Additional ground cover types include herbaceous wetlands and non-vegetated rock outcrops. The current general land cover types defined for CIRO physiognomic types consists of approximately 33% shrublands, 26% shrub-herbaceous steppe, 24% open canopy evergreen (woodland and forest), 14% grasslands/herbaceous, and 3% other including sparsely vegetated and agricultural land. Livestock grazing occurs on both public and private lands in the Circle Creek and Almo Creek basins outside of CIRO to the southeast and northwest, respectively.

A draft vegetation and land use map prepared by Erixson and Cogan (2011) was available at the time of this report. This database includes 34 vegetation map units (vegetation alliance and plant association level) and 11 land use map units. The land use types mapped into the NVIP database include: (1) Stream / River; (2) Canal / Ditch; (3) Lake / Pond; (4) Residential – single family housing; (5) Agricultural Business; (6) Transportation; (7) Transitional; (8) Quarries / Strip Mines / Gravel Pits; (9) Bare Rock / Sand / Other Bare Ground; (10) Planted / Cultivated; and (11) Park/Reserve Facilities.

Vegetation data evaluated through the LANDFIRE Program, USFS and USGS 2008, was compiled from the 2000 Landsat Thematic Mapper satellite imagery and classified into the National Vegetation Classification System (NVCS) Physiognomic Subclasses (Comer, et al. 2003); categorized vegetation is presented by land cover classification in Table 22.

Table 22. NVCS physiognomic subclasses within the CIRO project area.

NVCS Physiognomic Subclass	Acres	Percentage
Closed tree canopy	1,238.60	1.09%
Herbaceous - grassland	15,965.20	13.98%
Herbaceous - shrub-steppe	30,455.40	26.68%
No Dominant Lifeform	595.6	0.52%
Non-vegetated	10.2	0.01%
Open tree canopy	27,829.60	24.38%
Shrubland	37,679.10	33.00%
Sparse tree canopy	173.5	0.15%
Sparsely vegetated	220.7	0.19%

Monitoring: The Land Use Feature Data Set in the CIRO geodatabase contains feature classes pertaining to human development, ownership, land classification, and infrastructure. Several layers in the dataset are specifically associated with infrastructure in and around the Reserve boundary. Major road and utility features were gathered from public and private organizations with some overlap in coverage. The various feature classes within the CIRO Land Use Feature Data Set are presented in Table 2.

Table 2. Land Use Feature Data Set for CIRO.

Themes	Geodatabase File Name	Number Parts	Length Miles
Land Use			
Campgrounds	campground	64]	
Ownership	CIRO_Ownership	7	
Dirt Roads	dirt_roads	252	114.7
Highways	highways	1	3.5
Fenceline	CIRO_CRSP_Fenceline_UCBN_NAD83_Z12_2009	390	
Mine Locations	mines	30	
Oil & Gas Wells	Oil_Gas_Wells	2	
Roads	Roads	70	65
General Land Use	strata_a_id	4	
Trails	Trails	6	21.6
Four Wheel Drive Roads	wd_roads	18	18.4

The General Land Use feature class (strata_a_id) listed above provides an overview classification of the homogeneous land use areas of the region. This classification, produced by the USDA National Agricultural Statistics Service (NASS), is developed from visual interpretation of satellite imagery. An example of the need for accurate land use and vegetation mapping as provided by Erixson and Cogan (2011) is displayed in Table 24 where the NASS classification of the majority of area within CIRO is “lightly cultivated” when in reality it is clearly identifiable on aerial photography as rangeland or woodland cover.

Table 24. General land use by acres for CIRO.

General Land Use USDA-NASS (strata_a_id)	Acres	% Total
Dryland Grain, > 33% Cultivated	5,403.1	4.91%
Dryland Grain, Extensive Cultivated	3,819.5	3.47%
Snake River, Extensive Cultivated	7,123.3	6.47%
Lightly Cultivated (SPEC 40: South)	93,797.7	85.16%

Additionally, the Land Use Feature data set includes land ownership information showing Federal, State, and private land in Idaho. The Federal ownership depicted in this information is presented by the land management agency. For example, in Table 25 the land ownership/management pattern within the CIRO project area, the acres owned and percent of total area are defined. The map presented as Figure 24 displays the Land Ownership feature classes shown by the Land Use Feature data set.

Table 25. Ownership acres within CIRO project area.

Owner	Acres	% Total
Bureau of Land Management (BLM)	25,965.5	22.74%
National Park Service (NPS)	13,889.6	12.17%
Private	50,310.4	44.07%
State	8,560.8	7.50%
US Forest Service (USFS)	15,441.9	13.53%

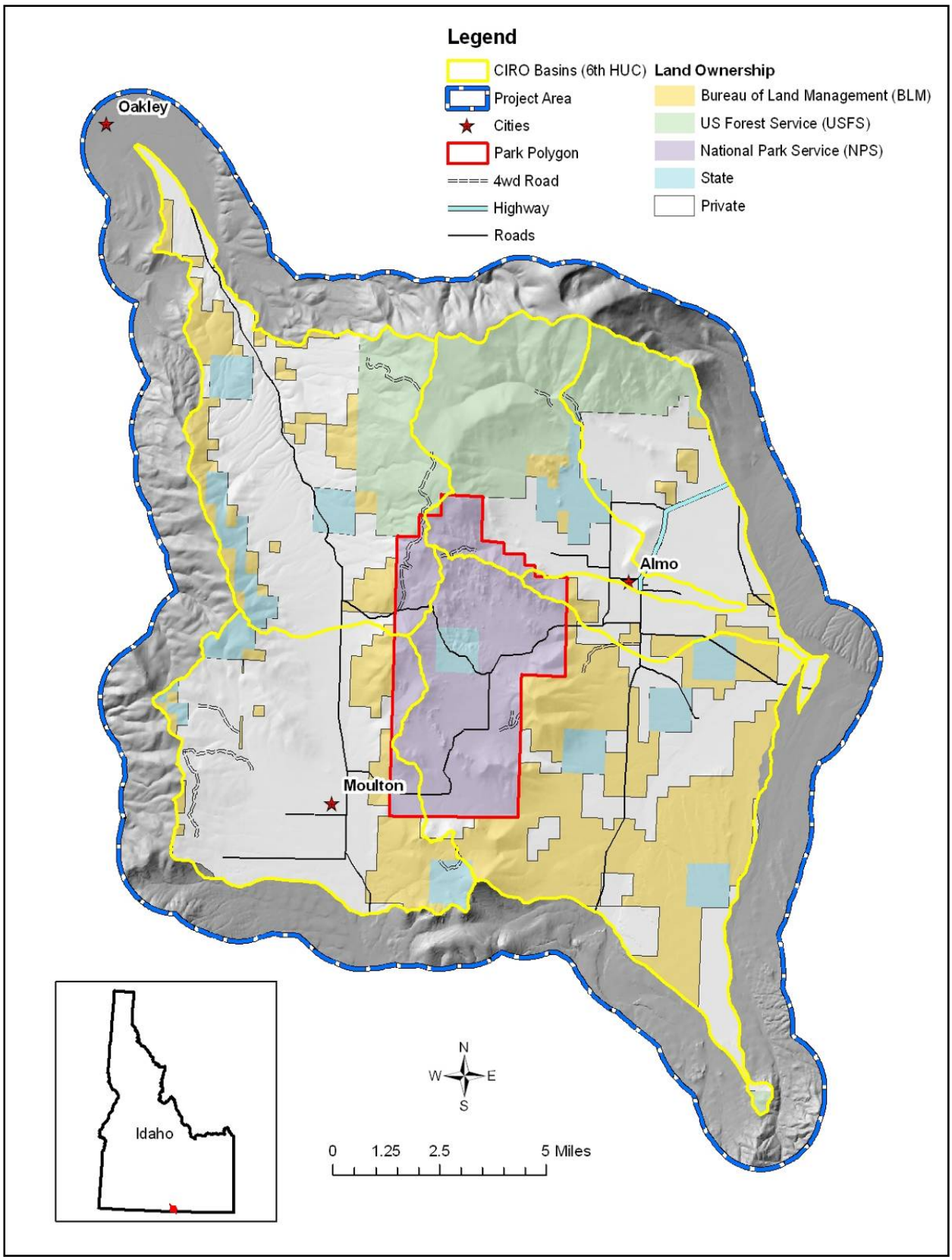


Figure 24. Land ownership within CIRO project area.

Threats and Stressors: Using CIRO field assessments, land use changes on adjacent private lands were identified as a threat to the natural resource values of the Reserve. CIRO abuts private land and grazing allotments and some grazing allotments are permitted within the CIRO boundary. Some areas where private land abuts CIRO the fences are in disrepair or do not exist; thus, no barriers are present to exclude grazing. Additionally, NPS-owned lands will not be developed, which makes lands adjacent to CIRO attractive for private ownership. Homes and other developments, such as roads and recreation facilities, will increase susceptibility of CIRO to non-native and invasive plant species that would negatively impact plant communities and wildlife habitat including habitat supporting sensitive wildlife species. The potential for wildfire ignitions would increase along this interface. Development whether for ranching, agriculture, or rural homesites around or neaby CIRO may further disrupt the migration patterns of wildlife and fragment CIRO habitats.

Evaluating CIRO in a broader regional context suggests variations in natural conditions such as climate change are outside of the control of CIRO managers and could lead to encroaching pinyon-juniper woodland stands threating sagebrush-steppe ecosystems or other management goals within the Reserve (CIRO 2007). Threats to the current combination of land cover dynamics and land use characterizations also occurs because of the lack of natural fire, caused in part by fire suppression policies, overgrazing, and invasive plant species.

Data Gaps: An initial inventory of the local land use and the associated vegetation cover types would provide CIRO managers with key information related to the status and extent of ecological systems. Dissemination of the Erixson and Cogan (2011) vegetation and land use classification and mapping geodatabase will provide this baseline information. Analyzing and monitoring the changes in land use can indicate changes in critical systems detrimental to the local ecosystem and sensitive wildlife or plant communities. A long term monitoring program to assess the changes of land use and affects within CIRO should be initiated to provide resource managers with vital information.

Climate

Climate change will fundamentally alter the ecosystem within CIRO. Currently, summers are moderately long and dry with daytime temperatures averaging 86.6°F (30.3°C), nights averaging 54.4°F (12.4°C) during July, and annual precipitation near 11 inches (28 centimeters) most of which falls during winter months as snow (Idaho State Climate Service 2003, WRCC 2011). The coldest average winter temperatures occur in January with average lows of 19°F (-7.2°C) and highs of 38°F (3.3°C) (WRCC 2011). With climate change, temperatures are expected to increase globally by 2–4 ˚F with some localized variation (Ashton 2010). Additionally, summers are expected to be drier and winters are expected to be wetter resulting in higher evaporation rates of rainwater and rapid snowmelt which leads to less available water for the common and unique plant communities and wildlife habitat within CIRO (NPS 2011).

Accelerated global climate change may be the most far-reaching and consequential challenge facing NPS natural resource managers (UCBN 2011). The Intergovernmental Panel on Climate Change (IPCC), a scientific intergovernmental body formed from the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP), focuses on climate change impacts, adaptation, and vulnerability (Parry et al. 2007). The IPCC has generally observed and noted climate in the region becoming warmer and drier and has also identified affects between climate change and terrestrial ecosystems in North America (Field et al. 2007,

Parry et al. 2007). Reported changes included variations in seasonal precipitation and temperature, timing of life-cycle events, plant growth or primary production, and biogeographic distribution. Increased temperatures and variations in precipitation also support wildfires through extended summer seasons that cause a reduction in fuel moisture levels (Running 2006).Wildfire frequency was nearly four times the average of 1970 to 1986, and the total area burned by these fires was more than six and a half times its previous level. Interannual variability in wildfire frequency is strongly associated with regional spring and summer temperature (Westerling et al. 2006)

The threats to CIRO resources from climate change include altered precipitation patterns, seasonal weather patterns, and temperatures that could lead to degradation of habitats, loss of or shifts in biodiversity, and species composition. Climate change could modify available water regimes through alteration of precipitation patterns; these variations could result in larger spring season snowmelt driven streamflow, increased flood stages, and hotter, drier summers. The effects of climate change would pose a threat to the Greater Sage-grouse, pinyon mouse, cliff chipmunk, vernal pool crustaceans, and other species of management concern within CIRO. Local or regional changes on a large scale would impact the natural resources of CIRO, including water availability, local and regional migration patterns of animals (some species may lose seasonal benefits from the area and be exposed to competition from species capable of using the altered environment), encroachment of invasive, non-native, noxious, and otherwise undesirable plant species, and overall diversity of local species. Under this scenario, native species diversity would likely decrease, however an influx of non-native species could result in higher diversity overall with climate change affects.

Current Condition: The IPCC Working Group II focuses on climate change impacts, adaptation, and vulnerability. Parry et al. (2007) published a technical summary of the working group most recent findings; listed below are a few of the notable findings from the report:

- Observational evidence from all continents and most oceans show that many natural systems are being affected by regional climate changes, particularly temperature increases.
- A global assessment of data since 1970 has shown it is likely that anthropogenic warming has had a discernible influence on many physical and biological systems.
- Other effects of regional climate changes on natural and human environments are emerging, although many are difficult to discern due to adaptation and non-climatic drivers.
- Some large-scale climate events have the potential to cause very large impacts, especially after the 21st century.
- Impacts of climate change will vary regionally but aggregated happen slowly over time, they are very likely to impose net annual costs, which will increase over time as global temperatures increase.
- Vulnerability to climate change can be exacerbated by the presence of other stresses.

- Future vulnerability depends not only on climate change but also on development pathway.
- Many impacts can be avoided, reduced, or delayed by mitigation.

The IPCC Working Group II published reports on many areas of the world. North America was addressed by Field et al. (2007) which documented three observable connections between climate change and terrestrial ecosystems. Field et al. (2007) reported changes in seasonal timing of life-cycle events and phenology, plant growth or primary production, and biogeographic distribution. Also noted was direct impacts on organisms that have indirect effects on ecological mechanisms (competition, herbivory, disease) and disturbance (wildfire, hurricanes, human activities).

Plants emerge (green-up) and flower earlier in the spring and leaf fall occurs later in the autumn. Primary production has increased in North American forests over the past 10 years (Running 2006). Nesting and breeding occurs earlier for birds, migration is earlier for migratory species, and some species are shifting home ranges to higher elevations or to more northern latitudes. Warming climates result in more wildfire potential because of a longer summer period that further reduces fuel moisture providing easier ignition and faster spread (Running 2006).

The Joint Institute for the Study of Atmosphere and Oceans (JISAO) is a cooperative institute between the National Oceanic and Atmospheric Administration (NOAA) and the University of Washington. JISAO has published a report titled "Impacts of climate variability and change in the Pacific Northwest" (Mote et al. 2005). Climate models developed by JISAO predict warmer, wetter winters, an increase of 3.1° F (1.7^{o}C) by 2030 and a 5% increase in precipitation. Precipitation would be expressed by more rainfall with smaller snowpack development.

The predicted seasonal stream flows will shift markedly toward larger winter and spring flows and smaller summer and autumn flows. The change in flows induced by climate change will likely coincide with increased water demand locally and from new regional growth.

Climate features included in the CIRO Geodatabase are data layers showing the average precipitation and temperature within the project area. Precipitation averages range from 11-31 inches (27.9-78.7 centimeters) annually, with temperature averages ranging from 31-47^{o}F (17.2-26.1^{o}C) annually. The data layers also provide the average temperature and precipitation gradient across the project area. Figure 25 illustrates the information in the precipitation and temperature layers of the CIRO Geodatabase while Figures 26-27 the average monthly precipitation and temperature data from the Malta Aviation, Idaho gauge No. 105567 (WRCC 2011). The Malta station is the closest location to CIRO with continual climate data collection.

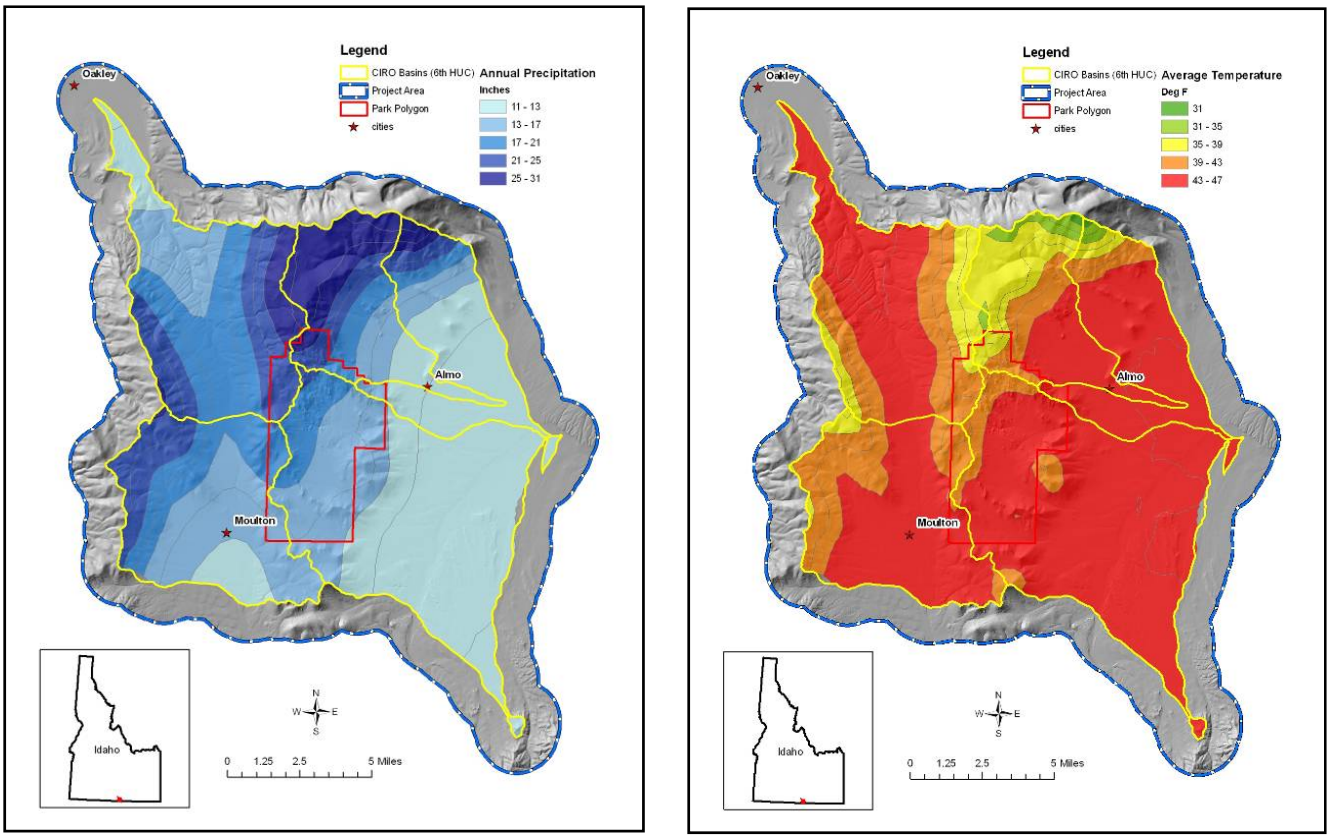


Figure 25. Precipitation and temperature zones within the CIRO project area developed using the CIRO Geodatabase.

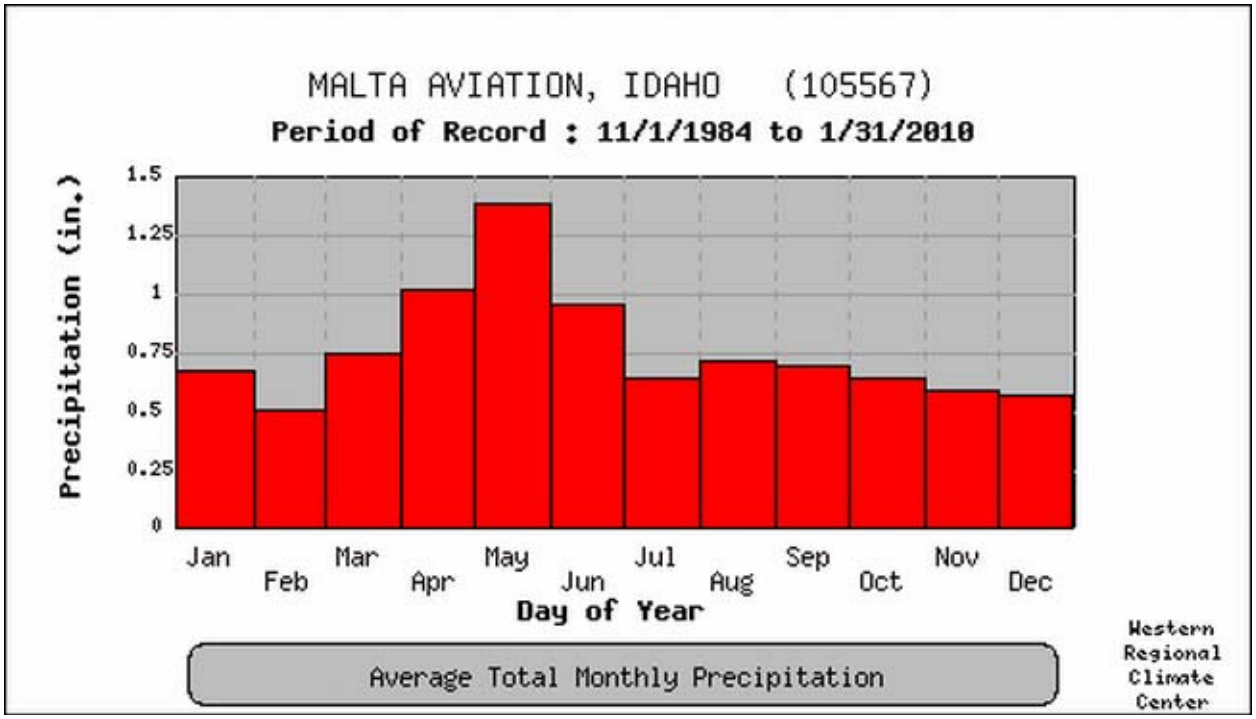


Figure 26. Total average monthly precipitation data from the Malta Aviation, Idaho weather station No. 105567 located approximately 27 miles north and east of CIRO (WRCC 2011).

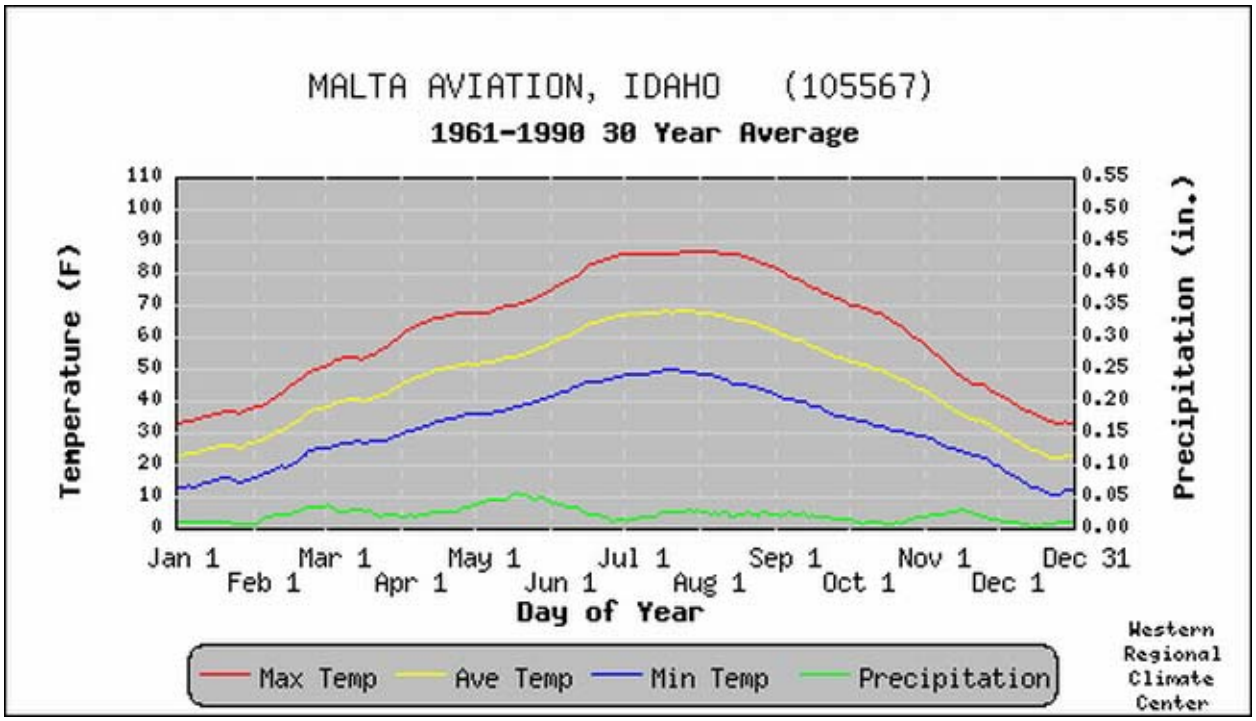


Figure 27. Total minimum, maximum, and average monthly temperature as compared to average total monthly precipitation data from the Malta Aviation, Idaho weather station No. 105567 located approximately 27 miles north and east of CIRO (WRCC 2011).

Monitoring: The UCBN is committed to tracking changes in CIRO natural resources that may be influenced or caused by accelerated climate change; monitoring activities would contribute to fulfilling this commitment. The direct and indirect impact of predicted climate changes on natural resources within CIRO is complex and difficult to manage. Climate is an additional factor which contributes to the diversity of park units and also presents a potential stress to many ecosystem components. Climate changes could be positive or negative depending on the ecosystem processes, communities, and/or species under consideration. Plant and animal species dependent upon existing conditions, including amphibians, aquatic reptiles, crustaceans, and fish, could experience possible habitat disruption. Warming temperatures may also alter the composition of plant communities and allow non-native and invasive plant species to invade from warmer regions. Specific affects on species and ecosystems attributed to global climate change (Mawdsley et al. 2009) include:

(1) Shifts in species distributions, often along elevation gradients.

(2) Changes in the timing of life-history events or phenology for particular species.

(3) Decoupling of coevolved interactions, such as plant-pollinator relationships.

(4) Effects on demographic rates, such as survival and fecundity.

(5) Reductions in population size.

(6) Extinction or extirpation of range-restricted or isolated species and populations.

(7) Direct loss of inland habitat due to increased fire frequency, bark beetle outbreaks, altered weather patterns, and direct warming of habitats.

(8) Increased spread of wildlife diseases, parasites, and zoonoses (a disease primarily of animals which can be transmitted to humans as a result of direct or indirect contact with infected animals).

(9) Increased populations of species that are direct competitors of focal species for conservation efforts.

(10) Increased spread of invasive or non-native species, including plants, animals, and pathogens.

Mawdsley et al. (2009) identified 16 adaptation strategies in the four major adaptive strategy categories to conserve species and ecosystems from the effects of global climate change. Many of the strategies are focused at the national and regional level and would not be applicable to individual park units. The major category is titled "Strategies Related to Monitoring and Planning" identifies four adaptation strategies that could be implemented at the park level: (1) evaluate and enhance monitoring programs for wildlife and ecosystems; (2) incorporate predicted climate-change impacts into species and land management plans, programs, and activities; (3) develop dynamic landscape conservation plans; and (4) ensure wildlife and biodiversity needs are considered as part of the broader societal adaptation process.

The Climate Friendly Parks Program was funded through July 2009 via an interagency agreement between the NPS and the EPA. NPS assumed full funding for the program in August 2009. The program encourages and enables National Park unit managers to develop strategies to reduce greenhouse gas emissions. The program also entails a commitment on the part of participating parks to educate the public about the actions the Park management is taking to mitigate emissions.

The Pacific West Region is on schedule to have member parks including CIRO to be Climate Friendly Parks by FY 2011. NPS interpreters have been working in partnership with NASA and other scientists to develop climate change training materials and interpretive products such as brochures and exhibits. NPS, in cooperation with EPA, BLM, USFWS, USFS, NASA, and NOAA developed a product entitled "Climate Change: Wildlife & Wildlands, a Toolkit for Formal and Informal Educators." The kit will aid educators in teaching how climate change is affecting wildlife, habitat, and public lands and how people can become "climate stewards." The toolkit is available online at http://www.globalchange.gov/resources/educators/toolkit.

Threats and Stressors: A change in climate will have broad ecological affects on much of the habitat extant within CIRO. Species dependent on critical habitat like that of the sagebrush-steppe or quaking aspen forest will likely migrate upslope or to the north (Ashton 2010, NPS 2011). The rate of change is expected to be variable depending on regional stressors which may include the occurrence of invasive species or changes in land use (Ashton 2010). The threat of changing climate is real and research supports the likelihood of broad ecological changes as a result. An important and immediate trend to monitor is warmer and drier summer weather patterns (NPS 2011).

Temperature in the northern Rocky Mountains has increased by 2 to 4 ˚F over the past three decades. The resulting change in existing plant communities is not well understood at this time; however, changes are anticipated to occur due to affects in soil water-holding capacity and plant available water. Research suggests that with increasing temperatures and the likelihood of changes in plant communities, an increase in non-native and invasive plant species establishment is likely (Ashton 2010). When plant communities change within a relatively short period of time species linked to specific microhabitats are particularly susceptible to the effects of climate-induced variation. Ashton (2010) suggests that biodiversity is a likely casualty of changing global temperatures, therefore threatened, endangered, and sensitive species like the cliff chipmunk, pinyon mouse, and Greater Sage-grouse are more likely to be extirpated from CIRO.

An increase in temperature and reduction in precipitation is expected to increase the frequency and severity of regional wildland fires. Increases in wildfire have the potential to accelerate species composition changes further threatening the current resources and species of special concern within CIRO. A consistent increase in total acres burned is likely one of the first indicators of a regional change in climate (Ashton 2010).

Data Gaps: The direct and indirect impact of predicted changes in climate on natural resources within CIRO is a complex and difficult issue to address. Changes could be positive or negative depending on the ecosystem processes, communities, and/or species under consideration. CIRO managers should focus on plant and animal communities and/or species of special interest and address the possible impacts a change in climate would have for each species or habitat. Where possible, plans could be developed to mitigate the potential negative impacts on communities and/or species.

Using vegetation classification and mapping products produced by Erixson and Cogan (2011) makes it possible for the Reserve to maintain a basic phenological information dataset. A dataset of this nature can assist in the quantification of changes in plant phenology and associations over a relatively short period of time which would allow CIRO managers to identify specific events or changes which could be used to recognize early transformations in the ecological system.

Summary Discussion and Recommendations

This NRCA used GIS databases for primary analyses of upland and aquatic plant communities. All GIS data layers were imported into an ArcGIS File Geodatabase using ArcCatalog version 9.3. In addition, all currently available and relevant reports and publications were identified and reviewed to form the introduction, results, natural resource analyses and preceding summary and recommendation statements. The vegetation inventory information was available for CIRO however the information was not sufficient to determine the current condition or established a reference condition. Therefore, selection and application of several on-the-ground, rapid assessment tools were used to assess the condition of upland and aquatic/riparian vegetation resources that have become established within CIRO using 17 indicator values.

Site specific assessments were completed for the Reserve during the 2009 and 2010 field season. The goal of each assessment was to gather information regarding the current status of specific Park unit resources to identify trends in resource health or degradation. The details of each upland and aquatic assessment are presented herein.

Upland Assessments

Ecological assessments were completed throughout CIRO during the 2009 field season. Nine sample areas, distinguished by grazing allotment boundaries, within and adjacent to the Reserve were assessed across all distinguishable upland environs. Evaluated under the rangeland health rapid assessment methodology were the three landscape attributes of soil/site stability, hydrologic function, and integrity of the biotic community at the ecological site level. The nine areas sampled at CIRO represented a wide range of all available upland habitat types.

Within the Reserve, the attributes of soil stability, hydrologic function, and biotic integrity were a mixed rating of none to slight departure (<21%) and slight to moderate departure (21 – 40%) from reference conditions. The findings for each site are reported in the results section of this NRCA. Grazing and recreation impacts are present throughout the Reserve resulting in soil erosion and water quality degradation in areas rated as slight to moderate departure. With relatively localized grazing in some areas and the cessation of livestock use in other areas as of 2011, the overall assessment of CIRO suggests the land is in good to excellent condition and functioning properly. Soil erosion is occurring in select areas, primarily along cattle trails and recreational trails used by hikers, climbers, and horseback recreationalists. Over all, based on this assessment of current soil conditions and hydrologic function, ratings are expected to remain stable or improve in the future due to changes in ranching and livestock use within the area.

Future research projects, including vegetation classification and mapping and vital signs monitoring, would provide geographically-based information allowing for detailed analyses of vegetation succession and distribution. More detailed vegetation information would allow managers to compare physiographic and other landscape attribute relationships to vegetation patterns resulting in the preparation of vegetation management plans. Implementation of these plans would begin the process of reducing non-native and noxious plant individuals, patches/stands, and populations thus increasing native plant distribution, diversity, and cover as well as related ecosystem processes.

Aquatic/Riparian Assessment

During the 2009 field season, aquatic/riparian resource assessments using the Proper Functioning Condition Assessment (PFC) method developed by the BLM were used to evaluate the water resources of CIRO. These assessments provide baseline information regarding the current condition of streams within the Reserve as well as a rating of possible trends associated with the observed condition. Six ecological sites were identified and assessed within the Circle Creek and Almo Creek watersheds of CIRO and CRSP. The aquatic resource assessments specifically examined and rated lotic riparian/riverine characteristics of the North Fork of Circle Creek, Middle Fork of Circle Creek, South Fork of Circle Creek and Almo Creek (Figure 28).

Each PFC reach was selected based on the consistency of vegetation and start and end points were established where vegetation or notable changes in ecosystem compositions existed. Assessments included evaluation of flow, bank stability and vegetation. No fish were observed during the assessments and only the area assessed within the most downstream reach of Circle Creek had sufficient water to potentially harbor fish during early developmental stages. A summary of the PFC assessment results and a detailed description of conditions encountered at each site are presented in the results portion of this report. Table 26 provides a summary of these results with one of the six sites exhibiting a rating of "Functional-At Risk," with either a "downward" (i.e., moving away from functional) or "not apparent" trend and five sites exhibiting a "Proper Functioning Condition" rating.

Five of the six assessments appeared to have stable stream channels and were functioning at ecologically efficient levels. No restoration is recommended for any of the assessment sites as the potential for natural revegetation is high if cattle can be excluded from degraded areas and stream bank access. Existing impacts were noted at one assessment site (Lower North Circle Creek), although potential stressors exist for other areas in the form of nearby grazing, wildlife browsing, human recreation, nearby roads, and excessive irrigation withdrawals. The noxious weed Canada thistle occurred as scattered patches throughout the Circle Creek watershed, however control efforts were noted and dieback of herbicide-sprayed thistle was observed in some areas.

Currently, livestock use is an important focus for CIRO in regards to restoration of streambanks as grazing allotments are part of the Reserve and overgrazing has caused detrimental effects to some stream banks and wetland areas (Starkey 2010). A reduction in livestock access to the riparian areas and stream channels would substantially reduce erosion, stream turbidity and degradation of the plant communities. If degradation is not curtailed localized vegetation composition shifts, influencing the biogeochemical cycles of CIRO have the potential of changing it from a carbon sink to a carbon source (Millennium Ecosystem Assessment 2005). The cumulative effects on a region could be drastic and would likely be seen as an overall drying-trend and a diminished aerial representation of water resources, wetland diversity, and riparian zones.

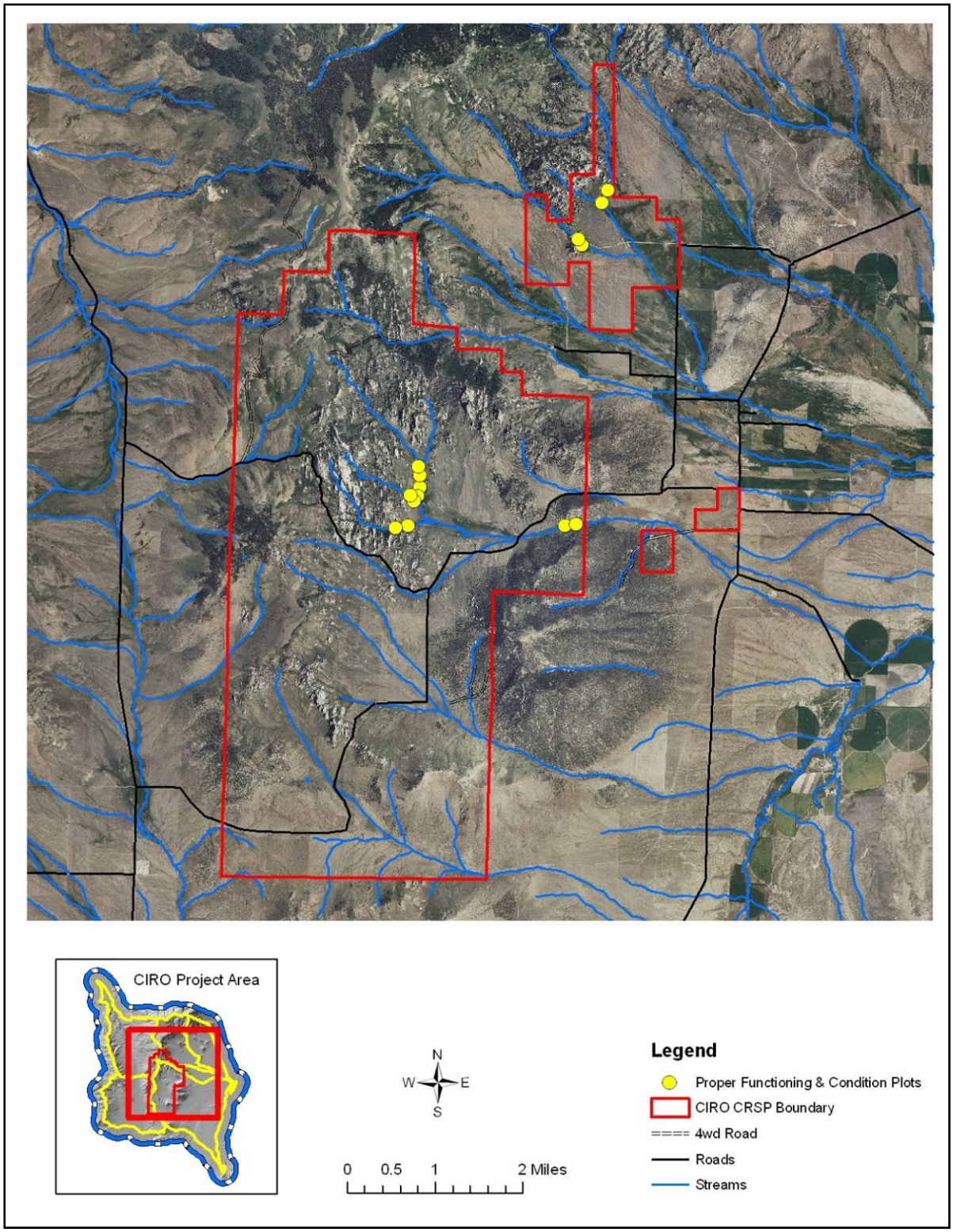


Figure 28. The six locations of the Proper Functioning Condition Assessments reaches within City of Rocks National Reserve are displayed within the Circle Creek and Almo Creek watersheds.

Table 26. Summary of Results from CIRO and CRSP PFC Assessment.

Site	Functional Rating	Trend for Functional - At Risk
Stines Fork of Almo Creek	Proper Functioning Condition	
Almo Creek	Proper Functioning Condition	
Upper North Circle Creek	Proper Functioning Condition	
Lower North Circle Creek	Functional - At Risk	Downward
South Circle Creek	Proper Functioning Condition	
Circle Creek	Proper Functioning Condition	

Threats and Stressors

Threats and stressors thought to be crucial to management of the CIRO natural resources were examined using available information and data collected from on-the-ground assessments. Conclusions and recommendations are provided in the following subsections.

Wildfire

Fire is a major event with the potential to alter woodland and shrubland vegetation cover of CIRO and to somewhat alter the herbaceous types within grazing areas. The presence or absence of natural fires within a given ecosystem is recognized as an important factor promoting, slowing, or eliminating various components of the ecosystem. Most natural fires in southern Idaho are lightning caused and are recognized as natural events which must be permitted to continue to influence the ecosystem if truly natural systems are to be perpetuated (fire may contribute to or hinder the achievement of Reserve objectives). CIRO fire management programs are designed around resource management objectives and the established management zones (historic, development, and/or special use).

Historically and prehistorically, fire was the most prevalent natural and human-ignited disturbance process in the ecosystems of CIRO and CRSP. Fire is the dominant process influencing composition, diversity, energy, and nutrient cycles (Kauffman et al. 1997). Since 1926 there have been 14 documented mappable fires within CIRO, burning a total of approximately 3,562 acres (1,441 hectares) and occurring through a variety of human and natural causes (Morris 2006). Wildfire originating within or adjacent to Reserve lands may pose a threat to the upland resources, particularly forest and woodland stands, grasslands, and meadows of predominantly graminoids. Depending on fire intensity and extent, effects could range from forest, woodland, or shrubland stand removal and replacement to combustion of fine fuels or thinning of understory shrubs and saplings. The total removal of woodland or shrubland habitat types would reduce the overall wildlife habitat structure for many species, although there may be increased use by grazing species. Ground surface cover would be removed (increasing soil erosion and the potential for non-native plant species invasion/establishment).

Recent comprehensive fire history in the CIRO region was first documented by Morris (2006) through the cooperation of various federal agencies. Wildfire data on file were compiled and included an almost 80-year period from 1926 through 2005. The data represents documented fires that have occurred in the area of the Reserve and are representative of the type of fires common to southern Idaho. In order to avoid an increase in invasive species, current Reserve

management should not promote the use of prescribed fires in degraded habitats and suppress wildfires in these degraded areas until the sites have recovered.

Fire Regime Group (FRG) or historical fire regime can be employed as a coarse-scale indicator of ecosystem sustainability to explain processes in terrestrial systems that constrain vegetation patterns, habitats, and ultimately, species composition. Land managers need to understand historical fire regimes, the fire return interval (frequency), and fire severity prior to settlement by Euro-Americans, to be able to define ecologically appropriate goals and objectives for the managed area. FRGs are critical components for characterizing the historical range of variability in fire-adapted ecosystems. Furthermore, understanding ecosystem/community departures provides the necessary context for managing sustainable ecosystems/communities. This information could be incorporated into an updated fire management plan that is aimed at curtailing the spread of noxious and invasive species for CIRO. For example, in the event of a wildfire where an invasive species not presently abundant within the Reserve such as cheatgrass may become more widely established, managers may want to focus their efforts on introducing fire tolerant native species that can adapt to a changed ecosystem/community and out-compete cheatgrass thus reducing its cover or eliminating its establishment.

Water

The sampling and assessment locations within the Circle Creek and Almo Creek watersheds for CIRO were conducted through the use of the BLM PFC method. Six locations were assessed throughout these watersheds in order to identify the current state of the resource as well as any potential trend in condition that may be occurring. As mentioned in the preceding sections five of the six water resource assessments exhibited no identifiable trend and were observed to be maintaining a properly functioning riparian/aquatic level. The "Lower North Circle Creek" assessment reach received a "Functional At-Risk" condition and was observed to exhibit a downward trend in ecosystem function. The classification was based on the observations that this reach was located within an actively grazed pasture, there was little to no large woody debris present in the channel, nearly no woody plant species remained along the channel that had not been damaged or browsed by cattle, the remaining vegetation was nearly a monoculture and the stream banks were actively eroding sediments into the channel over much of the assessment reach. The "Functional At-Risk" composition of the assemblage included all expected components, and the proportional representation of each was appropriate, therefore based on the current knowledge that cattle actively use the area a downward trend would be observed until cattle access to this stream reach was discontinued.

The water resources of CIRO are affected by cattle grazing, recreational use from rock climbers, hikers, equestrian enthusiasts and general tourism use of the trail network, as well as natural stream processes of channel shifting and spring season high water events. Currently, livestock use is an important focus for Reserve managers when planning wetland and steambank restoration projects. Cattle grazing is an active management tool in the Reserve, however, grazing activities are known to negetatively impact stream banks and wetland areas in the Reserve (Starkey 2010). A reduction in livestock access to the riparian areas and stream channels would substantially reduce erosion, stream turbidity, and undesirable shifting of vegetative species compositions. The cumulative effects of many of these stressors in an ecoregion could be drastic and would likely be seen as a diminished aerial representation of wetland species and riparian zones in a semiarid setting like CIRO (Starkey 2010). Additionally, the potential for soil

erosion to contribute to water quality degradation from grazing pressure and recreational use is of increasing concern within CIRO. Erosion and sedimentation pose a threat to riparian areas through degraded/trampled buffer zones, non-native species invasion, and reduced water quality for all aquatic organisms (Starkey 2010).

Riparian and aquatic invasive species may become a greater concern for Reserve managers if not controlled through constant noxious weed, invasive algae, and non-native fish management. Prevention that includes education of visitors is an important and cost effective management tool. Additionally, prevention of new and spreading colonies of Canada thistle on riparian and emergent wetland habitats is the most efficient and cost effective method of management and control. Prevention can be approached by maintaining complex native overstory canopies. A healthy overstory component will reduce the chances of establishment and spread of non-native and noxious plant species. Additional means of control can include jute matting with an additional three to four inches of mulch that will prevent sunlight from accessing invasive plants and allow overstory vegetation to mature. Managers must be persistent in control efforts over time because established invasive species will likely never be fully eradicated from CIRO streams and aquatic environments.

Wildlife and Animal Use

The numerous species supported by the ecosystems and variable habitats that exist within CIRO is a testament to the importance of this Reserve. According to NPSpecies (2011) there are 165 birds, 56 mammals, 20 reptiles, one amphibian, the boreal chorus frog and one fish, the bluehead sucker. Currently some of the species of greatest management concern within CIRO are the cliff chipmunk, pinyon mouse, Greater sage-grouse, sage sparrow, sage thrasher, spotted bat, fringed myotis, pallid bat, and Townsend's big-eared bat. Fragmentation and degradation of vegetative communities and residential development, agricultural development, livestock grazing, and road and powerline right-of-ways negatively impact habitat critical to these species. In particular the relationship of sagebrush obligate birds and the sagebrush-steppe habitat are directly correlated and any loss in habitat or changes in species composition has been shown to result in a downward trend in these species populations (USGS 2002, Knopf et al. 1990, Rotenberry and Wiens 1980). Grazing by livestock and elk is also a contributing factor to the loss of sagebrush-steppe ecosystem diversity and the introduction of undesirable plant species.

The impacts of vegetative changes and land development are not fully understood in relation to sagebrush obligate birds and bat species; however, research has shown changes in habitat can negatively impact these species. Habitat lost during wildfire is similarly detrimental to sagebrush obligate species due to significant rapid changes in vegetation and could cause permanent shifts in population due to decreased fire reoccurrence intervals and loss of mature sagebrush and associated shrub species. The loss of sagebrush communities from fire tends to occur as a product of the slow maturation of sagebrush and common fire return intervals of 20 to 60 years. In some cases the sites are entirely overtaken by invasive species such as cheatgrass which out compete much of the native vegetation and commonly decrease the frequency of fire (Link et al. 2006, Whisenant 1990).

Greater Sage-grouse populations are of particular interest as they have been impacted by the decline in quantity and quality of habitats caused by a variety of sources including: agricultural land conversion, road construction, residential construction, fire and habitat changes from

invasive species, insecticide application, and grazing. Additionally, the potential impacts to Greater Sage-grouse from West Nile virus pose a threat to the species. In a study by Naugle et al. (2005) mortality associated with West Nile virus infection was shown to decrease survival of female Greater Sage-grouse by 25% across populations surveyed in Wyoming and Montana as well as one location in Alberta, Canada during 2003. An assessment of the threat of West Nile virus on Greater sage-grouse within CIRO is recommended for future population management and conservation of existing lek areas.

Human disturbance in the form of recreational cave exploration, vandalism, and destruction/degradation of forage and forest/woodland roosting habitat poses the greatest threat to the 10-12 species of bats known to exist within CIRO. Currently the spotted bat and the fringed myotis are listed as species of concern by both the State of Idaho and the U.S. Fish and Wildlife Service (Rodhouse et al. 2009, Ave et al. 2004, Wackenhut and McGraw 1998). The largest known threat to bat species of North America is from the fungus (*Geomyces destructans*) which causes what is known as white-nose syndrome. The mortality in hibernating bat populations from white-nose syndrome is between 90 to 100% and is thought to primarily be related to starvation (USGS 2011). Additional monitoring of the bat species existing within CIRO is warranted to aid in determining critical habitat and any trends in species population numbers.

Vegetation

CIRO supports a variety of plant communities serving as wildlife habitats varying from sagebrush-steppe and coniferous forest ecotones to areas of wetland and riparian streambank vegetation (NPS 1997). CIRO is characterized predominately by pinyon-juniper woodlands on slopes, sagebrush-steppe shrublands on benches, and riparian and wetland grassland, willow and quaking aspen stands. A complete and updated list of plant species present within CIRO is available in the NPSpecies Database (2011).

Quaking aspen are currently in regional decline due to sudden aspen die-off (SAD) and a lack of environmental disturbance to initiate maximum suckering within the species range. Suppression of wildfire and limited use of prescribed fire negatively affect quaking aspen due to pinyon-juniper and sagebrush-steppe encroachment. Quaking aspen populations are also in decline possibly due to a response to drought and fire suppression and are negatively affected by invasive plant species, and heavy livestock grazing. The majority of the quaking aspen stands sampled in CIRO in 2008-2009 are regenerating and contain a distribution of age classes (Strand and Bunting 2010). There are some stands, however, with relatively low quaking aspen stem densities, low regeneration, and/or high dead aspen stem and conifer densities.

To further understand the distribution of plant assemblages within CIRO, the NPS Vegetation Mapping (Inventory) Program funded the classification and mapping of vegetation alliances, plant associations, and land uses within the Reserve commencing in 2009 under UCBN Inventory and Monitoring program oversight. The initial phase of the project was directed by CIRO and UCBN staff in conjunction with Northwest Management, Inc. and the Idaho Conservation Data Center to develop a vegetation classification using the National Vegetation Classification System (NVCS). The report detailing the four-step approach for the development of the vegetation mapping methods is complete (Erixson and Cogan 2011) and is available online (https://irma.nps.gov/App/Reference/Profile/2176266).

These vegetation products (classification, map, local description of plant associations, field key, photo-interpretive key) and GIS databases are integral in conducting threat and stressor analyses for both plant and animal species and habitats. Particularly important is the use of accurate vegetation mapping to inform fire fuels potential and various monitoring plans that can be applied to species and habitats of concern like sagebrush-steppe and quaking aspen targeted by CIRO managers.

Threatened, Endangered, Sensitive, and Species of Special Concern (TESS): Rare species within natural to urbanized habitats often become classified by federal agencies as sensitive, threatened, or endangered or are given a status rank by state agencies, typically heritage programs. TESS species within CIRO were determined using the CIRO species list (NPSpecies Database 2011) and other literature references of rare animal and plant species. Invertebrates, bryophytes, and lichens were not included due to lack of survey information within the Reserve. Three TESS plant and four bird taxa within CIRO have been identified by the NPS as of the date of this publication, but a complete species list was not available.

The seven TESS taxa identified as present in CIRO included one federal T&E candidate. Under the Idaho ranking status, there were two S1, one S2, one S2B, one S3 and two S3B TESS taxa in CIRO. Climate change or increased land use within the Circle Creek or Almo Creek drainage basins resulting in drought, vegetation cover conversion to other land uses, additional water diversion to irrigate crops, or more rapid runoff would negatively affect aquatic, riparian, and wetland TESS taxa. Stressors would include changes in flow periodicity, reduced flows, decreased water quality, reduction of favorable habitat, and increased water temperatures, among other effects. Additionally, the threat to the species of special concern within CIRO is largely from localized recreational use such as rock. The potential impacts of rock climbing on area vegetation and geologic features were discussed in detail within the *geology resources* section of this NRCA.

TESS plant species of CIRO include the Simpson's hedgehog cactus, Northwestern Indian paintbrush, and Kruckeberg's swordfern (Table 27) (Figures 29-31).

Table 27. The plant species of concern existing within CIRO.

Scientific Name	Common Name	State/Global Rank
Pediocactus simpsonii var. *robustior*	Simpson's hedgehog cactus	S3/G4
Castilleja angustifolia var. *flavescens*	Northwestern Indian paintbrush	S1/G5
Polystichum kruckebergii	Kruckeberg's swordfern	S1/G4



Figure 29. The Simpson's Hedgehog Cactus commonly occurs in powdery soils with some gravel among sagebrush and pinyon and juniper cover types. This cactus commonly grows to a height of 2 to 3 inches (5 to 8 cm) with a spherical diameter of about 1 to 1.5 inches (2.5 to 3.8 cm).



Figure 30. The Northwestern Indian Paintbrush occurs at moderate elevations on sagebrush covered slopes primarily in Nevada and western Utah with some populations occurring along the fringe of southern Idaho (Kartesz 1999).



Figure 31. The Kruckeberg's Swordfern occurs at higher elevations between 6,700 feet and 9,500 feet (2,042 m and 2,896 m) on alpine and subalpine cliffs and talus slopes. Individual fern plants exhibit evergreen fronds that are 3.5 to 14 inches (8 to 36 cm) long in clusters on a short rhizome with narrow lance-shaped blades (Lellinger 1985).

TESS sagebrush obligate bird species known to be using habitats within CIRO include the Sage Sparrow, Brewer's Sparrow, Sage Thrasher and Greater Sage-grouse (Table 28). Little is known about these avian species within Reserve habitats, the most well studied is the Greater Sage-grouse. Wildfire and use of prescribed fire can impact/affect sagebush-steppe and pinyon-juniper habitat types due to grass and noxious weed encroachment and the loss of sagebrush due to vegetative competition. Sagebrush obligate birds are likely also affected by invasion by non-native plant species, heavy livestock grazing, grassland and shrubland conversion to agriculture, insecticide application, and fragmentation of habitats.

Table 28. The City of Rocks National Reserve sagebrush obligate bird species are presented here, not all of these species have been assigned a TESS State status within Idaho.

Scientific Name	Common Name	State/Global Rank
Anthus spraguei	Sprague's pipit	S3B/G4
Ammodramus bairdii	Baird's sparrow	S3B/G4
Charadrius montanus	Mountain plover	S2B/G3
Centrocercus urophasianus	Greater sage-grouse	S2/G4

Non-native Plant Species, Invasive Plant Species, and/or Noxious Weeds: The management and control of invasive non-native plant species has been identified as a high priority issue within the NPS and is a primary (accountable) goal under the Government Performance Results Act of 1993 (USDA 2011). Prevention and early detection of invasive plants and noxious weeds within CIRO is critical to effective management. Monitoring status and trend detection of a prioritized list of target invasive species would be accomplished in a cost-effective approach that would rely on integration with other terrestrial vegetation monitoring efforts. Reserve staff is making a concerted effort to locate, identify, and treat nonnative plant species with proven Integrated Pest Management procedures to guarantee that federally and state listed noxious weeds and other non-native plant species do not become established and replace native plant communities (NPS 1997). An invasive plant management plan including CIRO has been drafted and is currently being evaluated in an environmental assessment.

Of the plant taxa known in CIRO, 14 are considered non-native noxious weed species by the State of Idaho (NPSpecies Database 2011, USDA Plants Database 2011). These species are: black henbane, bull thistle, Canada thistle, cheatgrass, chicory, common burdock, common mullein, field bindweed, houndstongue, musk thistle, saltcedar, scotch thistle, spotted knapweed, sulfur cinquefoil, wavyleaf thistle, and whitetop. The approximate acres of coverage for these species within CIRO are presented in Table 18 (p. 104) in the Vegetation Section of this document.

Management of all species of non-native and/or noxious invasive plant species is important for good stewardship of natural resources; however, some species pose greater threats to the natural resources of CIRO but are not currently the most abundant. Invasive plant species including cheatgrass and knapweeds are low in terms of abundance, but pose a threat to ecosystems and plant communities. The NPS (2002) vegetation management plan identified threats due to the spread of invasive plant species into native plant communities or establishment on newly disturbed soils. Protection of the old growth pinyon-juniper stands and sagebrush-steppe ecosystems within CIRO is extremely important relative to invasive plant species management.

The Pacific Northwest Weed Management Handbook (Peachey 2008) describes five major options for land managers, summarized as follows:

- Prevention is the most cost effective method for management of noxious species.
- Biological management is the use of other organisms against noxious or invasive weeds.
- Cultural management techniques integrate numerous components to minimize the impact of noxious weeds.
- Mechanical management physically manipulates the noxious weed directly or the ground to kill or prevent sprouting.
- Herbicides are chemicals used in many forms (liquid or solids) to directly kill or prevent germination of noxious weeds.

Mapping and inventorying invasive plants within and adjacent to CIRO should be a top priority for managers. Maintaining updated maps of occurrences and status of invasive plant species is a key element to an efficient strategic management program and will help ensure that Reserve resources are used as effectively and efficiently as possible. A database comparing descriptions

of status and maps that show the locations, sizes of invasive plant species occurrences, the invasive plant species present and their abundance, as well as treatment information would be invaluable. The data collected from inventorying and mapping would provide fundamental information used for assessing and prioritizing invasive plant management efforts. Typically, invasive species management plans consider the following attributes:

- Decrease invasive plant species cover and increase native plant species cover.
- Document and standardize best management practices to more effectively meet goals and objectives relative to invasive plant species management.
- Provide options or tools to managers in reducing the threat to natural and cultural resources.
- Use monitoring to more effectively implement and adapt management practices.
- Determine the minimum tool/treatment or combinations of treatments needed to restore functioning native plant communities.
- Develop a document that will meet required federal and state environmental compliance.
- Develop a document that will provide future direction for invasive plant species management projects that fall under its scope.
- Assist in restoring native plant communities and wildlife habitat to reduce resources dedicated to invasive plant species control and removal.

Cooperation with adjacent landowners, private and public, is the most effective method to prevent and control noxious weeds. Cooperators include private landowners, county government, state agencies, federal land management agencies, other interested agencies, and individuals.

Climate Change: A change in climate will have broad ecological affects on much of the habitat established within CIRO. Wildlife species dependent on critical habitat like the sagebrush-steppe, limber pine, or quaking aspen will likely migrate upslope or to the north (Ashton 2010, NPS 2011). The rate of change is expected to be variable depending on regional stressors which may include the occurrence of invasive species or changes in land use (Ashton 2010). The threat of changing climate is real, and research points to the likelihood of broad ecological changes as a result. An important and immediate trend to monitor is the warmer and drier summer weather (NPS 2011).

Accelerated global climate change may be the most far-reaching and consequential challenge facing NPS natural resource managers (UCBN 2011). The Intergovernmental Panel on Climate Change (IPCC), a scientific intergovernmental body formed from the World Meteorological Organization and the United Nations Environment Program, focuses on climate change impacts, adaptation, and vulnerability (Parry et al. 2007). The IPCC has generally noted climates in the CIRO region becoming warmer and drier and has also identified affects between climate change and terrestrial ecosystems in North America (Field et al. 2007, Parry et al. 2007). Reported changes included variations in seasonal precipitation and temperature, timing of life-cycle events, plant growth or primary production, and biogeographic distribution. Increased temperatures and variations in precipitation also support wildfires through extended summer seasons that cause a reduction in fuel moisture levels (Running 2006). In the last three decades burn duration of large wildfires has increased and the wildfire seasons in the western U.S. are

estimated to have lengthened by approximately 78 days in response to spring/summer warming of 1.6 °F (0.87 °C) over average temperatures (Westerling et al. 2006).

The UCBN is committed to tracking changes in Reserve natural resources that may be influenced or caused by accelerated climate change and monitoring activities would contribute to fulfill this commitment. The direct and indirect impact of predicted changes in climate on natural resources within CIRO is complex and difficult to manage. Climate is an additional factor which contributes to the diversity of park units and also presents a potential stress to many ecosystem components. Climate changes could be positive or negative depending on the ecosystem processes, communities, and/or species under consideration. Plant and animal species dependent upon existing conditions, including amphibians, aquatic reptiles, and fish, could experience possible habitat disruption. Warming temperatures may also alter the composition of plant communities and allow exotic plant species to invade from warmer regions.

Listed below are specific effects on species and ecosystems attributed to global climate change (Mawdsley et al. 2009).

- Shifts in species distributions, often along elevation gradients.
- Changes in the timing of life-history events or phenology for particular species.
- Decoupling of coevolved interactions, such as plant-pollinator relationships.
- Effects on demographic rates, such as survival and fecundity.
- Reductions in population size.
- Extinction or extirpation of range-restricted or isolated species and populations.
- Direct loss of inland habitat due to increased fire frequency, bark beetle outbreaks, altered weather patterns, and direct warming of habitats.
- Increased spread of wildlife diseases, parasites, and zoonoses.
- Increased populations of species that are direct competitors of focal species for conservation efforts.
- Increased spread of invasive or non-native species, including plants, animals, and pathogens.

Mawdsley et al. (2009) identified 16 adaptation strategies in the four major adaptive strategy categories to conserve species and ecosystems from the effects of global climate change. Many of the strategies are focused at the national and regional level and would not be applicable to individual park units. The major category titled “Strategies Related to Monitoring and Planning” identifies four adaptation strategies that could be implemented at the park-level: (1) evaluate and enhance monitoring programs for wildlife and ecosystems; (2) incorporate predicted climate-change impacts into species and land management plans, programs, and activities; (3) develop dynamic landscape conservation plans; and (4) ensure wildlife and biodiversity needs are considered as part of the broader societal adaptation process.

The threats to CIRO resources from climate change include altered precipitation patterns, seasonal weather patterns, and temperature that could lead to degradation of habitats, loss of or shifts in biodiversity, and species composition changes. Climate change could alter stream flow regimes through changes in precipitation patterns; alteration could result in larger spring-season flows, increased flood stage, and induce hotter, drier summers. These climate change effects

would pose a threat to the Simpson's hedgehog cactus, northwestern Indian paintbrush, Kruckeberg's swordfern and stream flows within CIRO. Local or regional changes on a large scale would impact natural resources of the Reserve, including water availability, possible migration patterns of animals such as bats (may lose seasonal benefits the area previously provided and competition from species capable of using the altered environment), encroachment of invasive, non-native, noxious, and otherwise undesirable plant species, and overall diversity of local species composition.

General Threats and Stressors

Due to the lack of consistent quantitative information on many threats and stressors, impacts were also evaluated in a qualitative manner. Table 29 is an overall estimate of the potential impact to the major landscape attributes from the threats and stressors reported previously, including upland and aquatic habitats as well as from a regional aspect based on climate change. It should be understood that the actual impact from these threats and stressors to any specific site will vary depending on the existing natural resource and landscape setting.

Table 29. Matrix of potential impact from threats/stressors examined in this report to the major resources/processes at CIRO.

Threats/Stressors		Major Resource/Process		
		Soils	**Hydrologic**	**Biotic**
Upland Habitats	Wildlife			
	Noxious Weeds			
	Land Use Change			
	Grazing			
	Invasive Riparian Species			
Aquatic Habitats	Fine Sediments/Flooding			
	Land Use Practices			
All Habitats	Climate Change			
Key to Rating for Threats and Stressors				
Potential Impact to Resource		High	Moderate	Low

Data Gaps

Several types of information were not available or were too outdated to inform this NRCA. Summarized herein are the important data which would improve natural resource management by CIRO staff. We did not estimate cost or indicate agency responsibility due to the extensive nature of the data. This summary should provide guidance to Reserve staff for future research/data collection efforts within and outside CIRO:

- CIRO also has unique aquatic features in the form of vernal pools topping many of the rock formations. These pools often contain unique macroinvertebrate assemblages dominated by fairy shrimp, copepods, and dipterans. In 2008, several fairy shrimp were submitted for identification. The results indicated the species was *Branchinecta constricta* and represented the first time this species has been documented west of the continental divide. A comprehensive inventory of vernal pools and their unique fauna would assist Reserve managers in future planning efforts concerning recreational use adjacent to vernal pool locations.
- Accurate and standardized land cover/use mapping for the project area that meets National Map Accuracy Standards (± 40 ft) and is repeatable over time. This information is very important for watershed modeling of water quality attributes, wildfire risk assessment, wildlife habitat structure, soils, and other resource values.
- Invasive plant species and noxious weed and land use maps in digital format focused on adjacent private lands and ranches within the HUC or other established buffer zone. Information collected by Exotic Plant Management Teams (EPMT) and the County Weed Management Associations (CWMAs) may provide foundation work for the development of this type of project. Currently, there are multiple sources of information regarding invasive plant species in CIRO, however there are inconsistencies including differing lists of invasive, native, and non-native plant species. Managers would be more aware of possible new invasive plant species and could develop better management strategies for existing non-native and noxious plant species using more consistant information. The newly prepared invasive plant species management plan, when adopted, will further inform this data gap.
- The published vegetation survey and the newly completed *Vegetation Inventory Report* will aid in updating the 2005 comprehensive Fire Management Plan based on present conditions of vegetation and ecosystem composition. Mapping of invasive, noxious, and undesirable plant species would also provide needed information on the influences of fire and management of species of concern.
- Yellowstone cutthroat trout have been observed in the Almo Creek watershed; however, the current fish inventory in CIRO/CRSP is inadequate to determine their presence or absence within the Reserve as Yellowstone cutthroat trout are a species of management concern in Idaho. In addition, there is limited information regarding the fish assemblage or presence in Circle Creek. It is recommended that a presence/absence fish inventory be conducted at CIRO and CRSP to establish a baseline on fish species information for the area.

- There is a need for CIRO managers to design and conduct field assessments of existing resource conditions for water resources, animal resources, air quality monitoring, species of concern, and wildfire in addition to the current vegetation inventory work because these data are important to inform Reserve management. Much of the available research and information in this area is outdated or only presently available at a county or regional scale.
- Studies focused on bat species were lacking for CIRO beyond the OMSI paper (Ave et al. 2004); many bat species within Idaho are species of concern and further research on population distribution and occurrence would aid efforts to provide species conservation and possibly provide insight into climate variations based on bat behavioral patterns.
- During the irrigation season, the amount of water diverted from Almo Creek into canals via head gates should be evaluated. Adequate assessment of discharge into the canals would allow the Reserve managers to more accurately determine how much water must legally be diverted. The installation and use of Parshall flumes and other irrigation water measurement equipment has been highly successful in legal water distribution in semiarid areas similar to CIRO for central Wyoming (WYSEO, 2010). Additionally, more precise water measurement and diversion practices may help reduce the impacts of stream water level fluctuations during mid and late summer.
- Given the likelihood of visitor contact with water in Circle and Almo Creeks, each should be tested for *Escherichia coli* and other fecal coliforms and parasites (Starkey 2010). These tests are advisable given the extensive use of riparian areas and stream channels by livestock in some grazing allotments, wildlife species, and visitor pets.

Management Action Recommendations

This NRCA examined the literature, GIS databases, and field observations of six riparian ecosystems and ten upland area grazing allotments within CIRO using rapid resource assessment methodology. Management practices structured toward attaining proper functioning condition of ecosystems through suggested recommendations and the use of additional resources is expected to accomplish the NPS goals and objectives for conservation for future generations.

Recommended management actions include but are not limited to: (1) acquire some or all of the non-NPS water rights in areas of irrigation impact and convert them to instream water rights; (2) monitor private irrigation facilities and associated access roads within CIRO; (3) fence additional acreage surrounding the Reserve along the east and north boundary, inventory the resources, and assess condition for future management; (4) account for visitor access by updating trails to meet Americans with Disability Act standards; (5) monitor for social trailing and enact deterrents; (6) assess the climbing resources of CIRO and future management and update the climbing management plan; (7) evaluate and determine control methods for invasive and noxious plant species in accordance with neighboring land managers; (8) monitor plant communities and wildlife species to determine climate change effects within CIRO; and (9) the exclusion of cattle from riparian areas showing signs of degraded conditions.

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Appendix A – List of Macroinvertebrate Species

Circle Creek	Almo Creek
Acari	*Acari*
Aeshna sp.	*Ameletus sp.*
Agabus sp.	*Atrichopogon sp.*
Alotanypus sp.	*Baetis bicaudatus*
Amphiagrion sp.	*Baetis sp.*
Amphicosmoecus canax	*Baetis tricaudatus*
Apedilum sp.	*Chloroperlidae*
Aquarius sp.	*Cinygmula sp.*
Argia sp.	*Dicosmoecus atripes*
Atractides sp.	*Dicranota sp.*
Baetis sp.	*Diphetor hageni*
Brillia sp.	*Diptera*
Centroptilum sp.	*Dolichopodidae*
Ceratopogonidae	*Drunella coloradensis/flavilinea*
Ceratopogoninae	*Drunella doddsi*
Chaetocladius sp.	*Ecdyonurus sp.*
Chelifera/Metachela sp.	*Epeorus longimanus*
Chironomus sp.	*Epeorus sp.*
Chloroperlidae	*Ephemerella inermis/infrequens*
Constempellina sp.	*Ephemerella sp.*
Corynoneura sp.	*Erioptera sp.*
Crustacea	*Eukiefferiella sp.*
Cryptolabis sp.	*Hesperoperla pacifica*
Diamesa sp.	*Hesperophylax sp.*
Dicranota sp.	*Hexatoma sp.*
Diphetor hageni	*Hydropsyche sp.*
Dixa sp.	*Larsia sp.*
Ecdyonurus sp.	*Lebertia sp.*
Empididae	*Lepidostoma sp.*
Epeorus longimanus	*Leptophlebiidae*
Ephemerella inermis/infrequens	*Limnephilidae*
Ephemerella sp.	*Malenka sp.*
Ephemerellidae	*Micropsectra sp.*
Eukiefferiella sp.	*Nemouridae*
Helochares sp.	*Neophylax splendens*
Helophorus sp.	*Onocosmoecus sp.*
Hesperoperla pacifica	*Optioservus sp.*
Hesperophylax sp.	*Oreodytes sp.*
Heterlimnius sp.	*Ostracoda*

Circle Creek	Almo Creek
Heterotrissocladius marcidus gr.	*Paraleptophlebia sp.*
Hexatoma sp.	*Parametriocnemus sp.*
Hydraena sp.	*Phaenopsectra sp.*
Hydrophilidae	*Pisidium sp.*
Hydropsyche sp.	*Polycelis sp.*
Hydropsychidae	*Polypedilum sp.*
Kogotus sp.	*Pseudosmittia sp.*
Krenopelopia sp.	*Psilometriocnemus sp.*
Krenosmittia sp.	*Ptychoptera sp.*
Laccobius sp.	*Rhabdomastix fascigera gr.*
Larsia sp.	*Rheocricotopus sp.*
Lebertia sp.	*Rhithrogena sp.*
Lepidostoma sp.	*Rhyacophila angelita gr.*
Leptophlebiidae	*Rhyacophila sp.*
Limnophyes sp.	*Simulium sp.*
Lymnaeidae	*Sperchon sp.*
Macropelopiini	*Sphaeriidae*
Malenka sp.	*Stempellinella sp.*
Micrasema sp.	*Stictotarsus sp.*
Micropsectra sp.	*Sweltsa sp.*
Narpus sp.	*Tipula sp.*
Nematoda	*Tipulidae*
Oligochaeta	*Torrenticola sp.*
Optioservus sp.	*Tvetenia bavarica gr.*
Ormosia sp.	*Uenoidae*
Orthocladiinae	*Vorticifex effusa*
Orthocladius Complex	
Ostracoda	
Pagastia sp.	
Paraleptophlebia sp.	
Paramerina/Zavrelimyia sp.	
Parametriocnemus sp.	
Paraphaenocladius sp.	
Physa sp.	
Pisidium sp.	
Polycelis sp.	
Polypedilum sp.	
Prosimulium sp.	
Pseudodiamesa sp.	
Psychodidae	
Psychoglypha sp.	
Pteronarcella sp.	

Circle Creek	Almo Creek
Pteronarcyidae	
Ptychopteridae	
Rheocricotopus sp.	
Rhyacophila brunnea gr.	
Sialis sp.	
Simulium sp.	
Siphlonurus sp.	
Sperchon sp.	
Sphaeriidae	
Stratiomyidae	
Sweltsa sp.	
Thienemanniella sp.	
Thienemannimyia gr. sp.	
Tipula sp.	
Tipulidae	
Trichoptera	
Tvetenia bavarica gr.	

Appendix B – List of Species of Concern in CIRO

Group	Species Name
Mammals	
	Western small-footed myotis (*Myotis ciliolabrum*)
	Long-eared myotis (*Myotis evotis)*
	Fringed myotis (*Myotis thysanodes)*
	Long-legged myotis (*Myotis volans)*
	Pygmy rabbit (*Brachylagus idahoensis)*
	Piute ground squirrel (*Spermophillis mollis*)
	Cliff chipmunk (*Tamias dorsalis*)
	Townsend's big–eared bat (*Plecotus townsendii* var *townsendii*)
Birds	
	Bald eagles (*Haliaeetus leucocephalus*)
	Northern goshawk (*Accipiter gentilis*)
	Ferruginous hawk (*Buteo ragalis*)
	Swainson's hawk (*Buteo swainsoni*)
	Prairie falcon (*Falco mexicanus*)
	Greater sage-grouse (*Centrocercus urophasianus*)
	Long-billed curlew (*Numenius americanus*)
	Short-eared owl (*Asio flammeus*)
	Western burrowing owl (*Athene cunicularia*)
	Calliope hummingbird (*Stellula calliope*)
	Lewis' woodpecker (*Melanerpes lewis*)
	Red-naped sapsucker (*Sphyrapicus nuchalis*)
	Williamson's sapsucker (*Sphyrapicus thryoideus*)
	Loggerhead shrike (*Lanias ludovicianus*)
	Cordilleran flycatcher (*Empidonax occidentalis*)
	Hammond's flycatcher (*Empidonax hammondii*)
	Willow flycatcher (*Empidonax traillii*)
	Pinyon jay (*Gymnorhinus cyanocephalus*)
	Sage thrasher (*Oreoscoptes montanus*)
	Green-tailed toehee (*Pipilo chlorurus*)
	Brewer's sparrow (*Spizella breweri*)
	Sage sparrow (*Amphispiza belli*)
	Cassin's finch (*Carposdacus cassinii*)
Reptiles and Amphibians	
	Western night snake (*Hypsiglena torquata*)
	Short-horned lizard (*Phrynosoma douglassi*)

Appendix C – List of Noxious Weeds of Idaho

State of Idaho Noxius Weeds List		
Statewide Noxious Weed EDRR List	Common Name	Latin Name
	Brazilian Elodea	*Egeria densa P.*
	Giant Hogweed	*Heracleum mantegazzianum*
	Hydrilla	*Hydrilla verticillata*
	Policeman's Helmet	*Impatiens glandulifera*
	Squarrose Knapweed	*Centaurea squarrosa*
	Syrian Beancaper	*Zygophyllum fabago*
	Tall Hawkweed	*Hieracium piloselloides*
	Water Hyacinth	*Eichhornia crassipes M.*
	Yellow Devil Hawkweed	*Hieracium glomeratum*
Statewide Noxious Weed Control List		
	Black Henbane	*Hyoscyamus niger*
	Bohemian Knotweed	*Polygonum bohemicum*
	Buffalobur	*Solanum rostratum*
	Common Crupina	*Crupina vulgaris*
	Dyer's Woad	*Isatis tinctoria*
	Eurasian Watermilfoil	*Myriophyllum spicatum*
	Giant Knotweed	*Polygonum sachalinesnse*
	Japanese Knotweed	*Polygonum cuspidatum*
	Johnsongrass	*Sorghum halpense*
	Matgrass	*Nardus stricta*
	Meadow Knapweed	*Centaurea pratensis*
	Mediterranean Sage	*Salvia aethiopis*
	Musk Thistle	*Carduus nutans*
	Orange Hawkweed	*Hieracium aurantiacum*
	Parrotfeather Milfoil	*Myriophyllum aquaticum*
	Perennial Sowthistle	*Sonchus arvensis*
	Russian Knapweed	*Acroptilon repens*
	Scotch Broom	*Cytisus scoparius*
	Silverleaf Nightshade	*Solanum elaegnifolium*
	Skeletonleaf Bursage	*Ambrosia tomentosa*
	Small Bugloss	*Anchusa arvensis*
	Toothed Spurge	*Euphorbia dentata*
	Vipers Bugloss	*Echium vulgare*
	Yellow Hawkweed	*Hieracium caespitosum*
Statewide Noxious Weed Containment List		
	Canada Thistle	*Cirsium arvense*

State of Idaho Noxius Weeds List	
Dalmatian Toadflax	*Linaria genistifolia* ssp. *dalmatica*
Diffuse Knapweed	*Centaurea diffusa*
Field Bindweed	*Convolvulus arvensis*
Hoary Alyssum	*Berteroa incana*
Houndstongue	*Cynoglossum officinale*
Jointed Goatgrass	*Aegilops cylindrica*
Leafy Spurge	*Euphorbia esula*
Milium	*Milium vernale*
Oxeye Daisy	*Chrysanthemum leucanthemum*
Perennial Pepperweed	*Lepidium latifolium*
Plumeless Thistle	*Carduus acanthoides*
Poison Hemlock	*Conium maculatum*
Puncturevine	*Tribulus terrestris*
Purple Loosestrife	*Lythrum salicaria*
Rush Skeletonweed	*Chondrilla juncea*
Saltcedar	*Tamarix*
Scotch Thistle	*Onopordum acanthium*
Spotted Knapweed	*Centaurea maculosa*
Tansy Ragwort	*Senecio jacobaea*
White Bryony	*Bryonia alba*
Whitetop	*Cardaria draba*
Yellow Starthistle	*Centaurea solstitialis*
Yellow Toadflax	*Linaria vulgaris*

A complete list of Idaho's noxious weeds with picture, description and maps of known occurrences can be found at http://www.idahoag.us/Categories/PlantsInsects/NoxiousWeeds/watchlist.php.This data has been summarized on maps and recommendations made by species at this web site.

Appendix D – List of NRCA Geodatabase Feature Data Sets

Data Type	File Name	Source	Graphic Example
Air Resources	**N/A**	**N/A**	
Animal			
Grazing Allotment	CIRO_Allotment_id_blm	Department of Interior, BLM	Yes
CIRO Grazing Allotment	CIRO_Grazing_Allotments UCBN_NAD83_Z12N_2009	UCBN-NPS	Yes
Climate			
Precipitation	Precipitation	US Dept of Agriculture NRCS PRISM	Yes
Temperature	Temperature_ave	US Dept of Agriculture NRCS PRISM	Yes
Geography			
Watershed Basins	ciro_basins	US Dept of Agriculture NRCS	Yes
CIRO CRSP Boundary	CIRO_CRSP_bndy_NAD83_Z12_	UCBN-NPS	Yes
Geographic Feature Names	ciro_idgnis	US Geological Survey	Yes
Project Area	ciro_project_area	US Dept of Agriculture NRCS	Yes
Cities	cities	National Park Service Water Resources Division	Yes
City Municipal Boundary	city_boundary	National Park Service Water Resources Division	Yes
Counties	county	National Park Service Water Resources Division	
Flood Control Districts	Flood_Control_Dist	IdahoState Tax Commission	
MountainPeaks	Mountain_Peaks	National Park Service Water Resources Division	Yes
Park Boundary	park_polygon	National Park Service Water Resources Division	Yes
Park Headquarters	parkhead	National Park Service Water Resources Division	
Points of Interest	pt_of_interest	National Park Service Water Resources Division	
USGS Quadrangle Index	quad_index	US Geological Survey	
PLSS Sections	sections	Department of Interior, BLM	
PLSS Townships	Townships	Department of Interior, BLM	Yes
Wild Fire Districts	WildfireDist	Idaho Department of Lands	Yes
Geology			
Detailed Soils	CIRO_Soils_SSURGO	US Dept of Agriculture NRCS	
Fault Lines	fault_lines	US Geological Survey	Yes
Geology	geology _polygon	US Geological Survey	Yes
Groundwater	groundwater_lithology	Idaho Department of Water	

Data Type	File Name	Source	Graphic Example
Lithology		Resources	
General Soils ID	Id_statsgo	US Dept of Agriculture NRCS	
Seismic Hazard Rating	seismic_hazard	US Geological Survey	
Land Use			
Campgrounds	campground	National Park Service Water Resources Division	
Fenceline	CIRO_CRSP_Fenceline UCBN_NAD83_Z12_2009	UCBN-NPS	
Ownership	CIRO_Ownership	Department of Interior, BLM	Yes
Dirt Roads	dirt_roads	National Park Service Water Resources Division	
Highways	highways	National Park Service Water Resources Division	Yes
Mine Locations	mines	National Park Service Water Resources Division	
Oil & Gas Wells	Oil_Gas_Wells	Idaho Bureau of Mines, Utah Division of Oil, Gas	
Roads	Roads	National Park Service Water Resources Division	Yes
General Land Use	strata_a_id	US Dept of Agriculture	
Trails	Trails	National Park Service Water Resources Division	Yes
Four Wheel Drive Roads	wd_roads	National Park Service Water Resources Division	Yes
Plant			
Aspen Stands	CIRO_Aspen2007 available-for-sampling	UCBN-NPS	Yes
Permanent Veg Plot Locations	PermanentPlotLocationsCIRO	UCBN-NPS	Yes
Stressors			
Fire Locations BLM	BLM_Fire_Pts_72_08	FAMWEB National Interagency FireCenter	Yes
Weeds CIRO From BLM	City_of_Rocks_Weeds_BLM	Department of Interior, BLM, Burley	Yes
Fire Locations NPS	NPS_Fire_Pts_72_08	FAMWEB National Interagency FireCenter	Yes
Sawtooth NF Fire Areas	Sawtooth_NF_Fire_Areas	United States Fores Service, Sawtooth NF	Yes
Sawtooth NF Fire Points	SNF_Fire_Points	United States Fores Service, Sawtooth NF	Yes
Sawtooth NF Invasive Inventory	SNF_Invasive_Inventory_CIRO	United States Fores Service, Sawtooth NF	Yes
USFS historic fire locations	USFS_famweb_Fire_Points	FAMWEB National Interagency FireCenter	Yes
Weed locations Idaho dept ag	Weed_Points_IDAG	Idaho Department of Agriculture	Yes
Wildfire Polygons BLM	wildfire_polygons_blm	Department of Interior, BLM,	Yes

Data Type	File Name	Source	Graphic Example
Water Resources			
Aquifer	Aquifer	US Geological Survey	
Streams	ciro_streams	Idaho Department of Water Resources	Yes
Geothermal Locations	geothermal	Idaho Department of Water Resources	Yes
Municipal Water Locations	Municipal_Water	Idaho Department of Water Resources	Yes
River Reaches	rf3_hydro	National Park Service Water Resources Division	
Springs	Springs	National Park Service Water Resources Division	Yes
Water Quality Monitoring Site	wq_station	National Park Service Water Resources Division	Yes
Raster Data			
Andersons 13 Fire Behavior Model	ciro13fbfm	United StatesForest Service	Yes
Elevation	ciro_dem	USDANationalCartography & GeospatialCenter	Yes
Digital Raster Graphic (DRG) USGS Topo	ciro_drg	US Dept of Agriculture NRCS	Yes
Existing Vegetation Type	ciro_evt	United StatesForest Service	Yes
Fire Regime Condition Class	ciro_frcc	United StatesForest Service	Yes
Fire Regime Group (HFR)	ciro_frg	United StatesForest Service	Yes
Hillshade	ciro_hlsd	Derived Product from DEM	Yes
Mean Fire Return Interval	ciro_mfri	United StatesForest Service	Yes
Agricultural Land Use	ciro_nass	United States Dept of Agriculture	Yes
NationalLand Cover Vegetation	ciro_nlcd	US Dept of Agriculture NRCS	Yes
Aerial Mosaic 2006	ciro_naip_2006.sid	USDA-FSA-Aerial Photo Field Office (APFO)	Yes
Aerial Mosaic 2009	ciro_naip_mosaic_09.sid	USDA-FSA-Aerial Photo Field Office (APFO)	

Appendix E – Lotic stream PFC data sheet

START SOUTH OF RIPARIAN AREA → 24 yard TO FENCE → NORTH TO PICTURE GPS POINT.

Standard Checklist

Name of Riparian-Wetland Area: ALMO – NORTH

Date: 8/24/2010 Segment/Reach ID: ALMO1

Miles: _____ Acres: _____ (ALMO1 - ALMO2) (GPS POINTS)

ID Team Observers: MARK CORRAO / KRISTEN BASTIS

Yes	No	N/A	HYDROLOGY	
	X	X	1) Floodplain above bankfull is inundated in "relatively frequent" events	NOT PART OF THIS ECOSYSTEM EXCEPT DURING SPRING FLOWS [HIGH]
		X	2) Where beaver dams are present they are active and stable	
X			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)	
X			4) Riparian-wetland area is widening or has achieved potential extent	② POTENTIAL.
X			5) Upland watershed is not contributing to riparian-wetland degradation	

Yes	No	N/A	VEGETATION	
		X	6) There is diverse age-class distribution of riparian-wetland vegetation (recruitment for maintenance/recovery)	MOSTLY UPLAND VEGETATION MIXED WITH SOME WILLOW
		X	7) There is diverse composition of riparian-wetland vegetation (for maintenance/recovery)	
		X	8) Species present indicate maintenance of riparian-wetland soil moisture characteristics	
X			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high-streamflow events	JUNIPER WELL ESTABLISHED
		X	10) Riparian-wetland plants exhibit high vigor	VEG DOES, BUT RIPARIAN VEG IS LESS PRONOUNCED.
X			11) Adequate riparian-wetland vegetative cover is present to protect banks and dissipate energy during high flows	
X			12) Plant communities are an adequate source of coarse and/or large woody material (for maintenance/recovery)	

Yes	No	N/A	EROSION/DEPOSITION
X			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody material) are adequate to dissipate energy
X			14) Point bars are revegetating with riparian-wetland vegetation
X			15) Lateral stream movement is associated with natural sinuosity
X			16) System is vertically stable
X			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

(Revised 1998)

Remarks

HIGH-FLOW SPRING EVENTS = BRAIDED CHANNEL ATTRIBUTES [CANAL MIGRATION]
SAGEBRUSH DOMINATED - GRASS - POCKETS OF WILLOWS
PLACES OF OVER-GROWN BANKS - STABLE
COBBLE ? ROCK - BOAR
TWO MAJOR BRANCHES W/ ALMO CREEK HIGH-FLOW EVIDENCE (SEASONAL)

THERE ARE SIGNS OF HIGH FLOW EVIDENT IN BEDLOAD TRANSPORT, SOME HEADCUTS [MINIMAL] AND MULTIPLE CHANNEL PATHS. STREAM BANKS ARE DOMINATED BY UPLAND VEGETATION AND THE PRESENCE OF WETLAND VEG - REEDS, SEDGE, RUSH WEEDS NOT NOTED.

LARGE JUNIPER ARE ESTABLISHED AT OR ON STREAM CHANNEL BANKS PROVIDING SUPPORT DURING HIGH FLOW EVENTS. FROM STACKEY ET. AL, 2009 HIGHER THAN AVERAGE STREAM FLOWS WERE OBSERVED DURING YOUR ASSESSMENTS IN THE RESERVE AND THESE ARE ASSUMED TO HAVE CAUSED SOME OF THE FEATURES DOCUMENTED DURING THE PFC ASSESSMENT OF ALMO CREEK BY OUR TEAM.

THE UPPER 3/4's OF THIS ASSESSMENT ARE WITHIN A RIPARIAN MGT. ZONE. FENCES TO MGT ZONES NEED TO BE MAINTAINED, HOWEVER ECOSYSTEM STABILITY APPEARS TO BE STABLE IN & OUTSIDE OF THE EXCLOSURE.

Summary Determination

Functional Rating:

Proper Functioning Condition	X
Functional—At Risk	
Nonfunctional	
Unknown	

Trend for Functional—At Risk:

Upward	
Downward	
Not Apparent	X

Are factors contributing to unacceptable conditions outside the control of the manager?

Yes	
No	X

If yes, what are those factors?

___ Flow regulations	___ Mining activities	___ Upstream channel conditions
___ Channelization	___ Road encroachment	___ Oil field water discharge
___ Augmented flows	___ Other (specify)_____	

Appendix F – Upland Assessment of Grazing Allotments

Bath Rock Grazing Allotment

Loamy 16+ ARTRV/FEID Ecological Site:

This ecological site is dominated by soils developed from alluvium and/or colluvium over residual weathered igneous rock. The soils are sandy loams over sandy loam dominated subsurface. Rooting depth is restricted to 20 to 40 inches by bedrock and the soil is well drained. The sample in Plot 5 is in the Loamy 16+ ecological site (R025XY022ID) in the Bath Rock Grazing Allotment. Plot 5 is located in a valley bottom in the southeast quadrant of the Allotment (Figure 4). The soil stability and hydrologic function attributes were rated as none to slight departure, 20% and 17.5%, respectively. The biotic integrity attribute was rated as none to slight departure (17.1%) due to the presence of invasive plants, which hampered reproductive capability of the native perennial grasses (Figure 2). Plot 5 is in Ola sand loam formed in alluvium and colluvium. The historic climax plant community is big sagebrush (*Artemisia tridentata* ssp. *tridentata*)/Idaho fescue (*Festuca idahoensis*).

The current vegetation is dominated by mountain big sagebrush (*Artemisia tridentata* ssp. v*aseyana*), desert wheatgrass (*Agropyron desertorum*) and arrowleaf balsamroot (*Balsamorhiza sagittata*). There is only a small amount of big sagebrush and no Idaho fescue on the plot. The departure rating to this site could be due to the low level of grazing by livestock. The plot is in good condition for soil stability and hydrologic function.

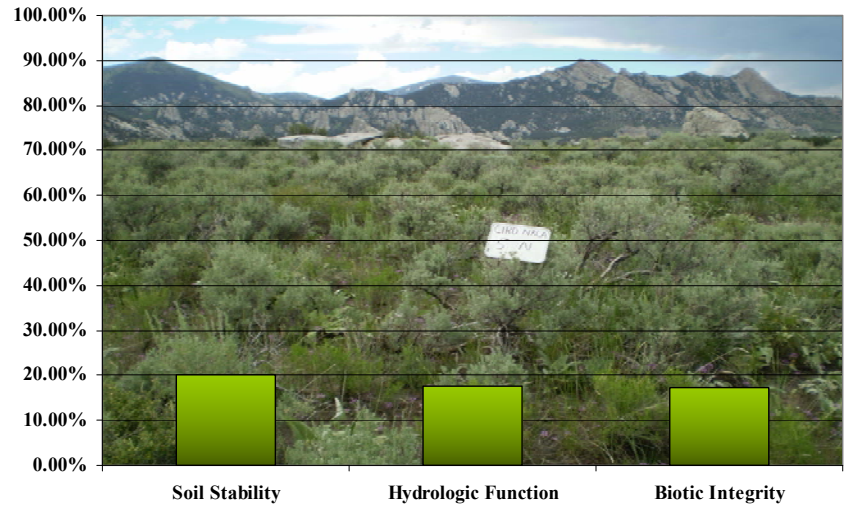


Figure 2. Departure from reference condition of the three landscape attributes in the Loamy 16+ ecological site, Bath Rock Allotment (plot 5 in background).

Mahogany Savanna 16-22 Cele3-Syor2/Feid-Achna Ecological Site:

This ecological site is dominated by soils with parent materials consisting of alluvium and/or colluvium derived from andesite, quartz-diorite, gradodiorite or granite. The soils are gravelly coarse sandy loams over very gravelly loamy coarse sand subsurface. The depth to a root restrictive layer is greater than 60 inches and the soil is well drained. Plot 12 was sampled in the Mahogany Savanna 16-22 Cele3-Syor2/Feid-Achna in the Bath Rock Grazing Allotment. Plot 12

is located near the northeastern boundary of the Allotment on a toeslope (Figure 4) soil stability and hydrologic function attributes were rated as slight to moderate departure, 40% and 35%, respectively due to numerous trails to climbing routes near the plot. The biotic integrity attribute was rated at none to slight departure 20%; (Figure 3). Plot 12 is in Ola-rock outcrop-Earcree complex of soils formed from colluvium derived from andesite, quartz-diorite, grandodiorite or granite. The potential climax plant community is dominated by the tree curl-leaf mountain mahogany (*Cercocarpus ledifolius*) with mountain snowberry (*Symphoricarpos oreophilus*) and mountain big sagebrush (*Artemisia tridentata* ssp. v*aseyana*) in the shrub component and Idaho fescue (*Festuca idahoensis*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) the dominant grasses.

The current vegetation is dominated by the trees curl-leaf mountain mahogany and pinyon pine (*Pinus monophylla*). The predominant shrubs include mountain big sagebrush, mountain snowberry and antelope bitterbrush (*Purshia tridentata*). The bunchgrasses on the site include needle and thread (*Hesperostipa comata*), Sandberg bluegrass (*Poa secunda*) and thickspike wheatgrass (*Elymus lanceolatus*). The slight to moderate rating for hydrologic function and soil stability on this site could be due to the heavy foot traffic in the area as people access the nearby climbing areas. The plot is in good condition for biotic function.

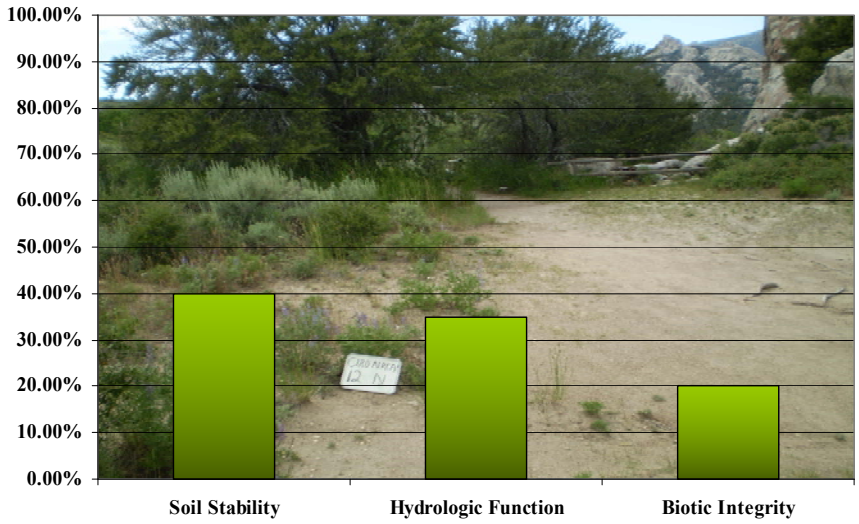


Figure 3. Departure from reference condition of the three landscape attributes in the Mahogany Savanna 16-22 ecological site, Bath Rock Allotment, plot 12 in background.

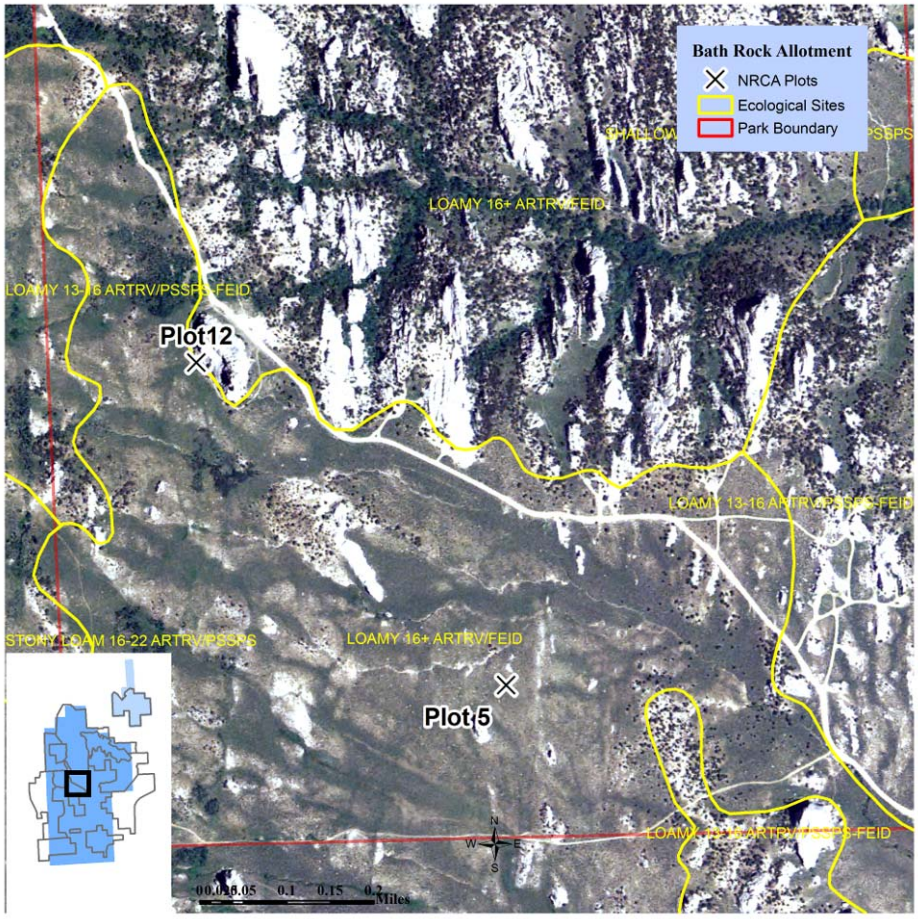


Figure 4. Map of the ecological site sample plots 5 and 12 in Bath Creek Allotment.

Circle Creek Grazing Allotment

Shallow gravelly 12-16 ARTRV/PSSPS Ecological Site:

This ecological site is dominated by soils with parent materials consisting of alluvium derived from igneous rock or granodiorite. The soils are loamy coarse sand over very gravelly loamy coarse sand. The depth to a root restrictive layer is greater than 60 inches and the soil is well drained. Plot 14 was sampled in the Shallow gravelly 12-16 Artrv/pssps in the Circle Creek Grazing Allotment. The soil stability and hydrologic function attributes were rated as slight to moderate departure, 25% and 32.5%, respectively due to quantity of bare soil and evidence of slight overland water movement. The biotic integrity attribute was rated at slight to moderate departure (37%) due to the grazing by livestock, deer and rodents (Figure 5). Plot 14 is within the western portion of the Allotment in a valley bottom (Figure 6). Plot 14 is in Riceton loamy coarse sand soil from alluvium of igneous rock or granodiorite. The potential climax plant community is dominated by the bluebunch wheatgrass and mountain big sagebrush.

The current vegetation is dominated by mountain big sagebrush in the shrub layer. There are numerous native bunchgrasses and rhizomatous grasses present as well as non-native grasses that include cheatgrass (*Bromus tectorum*), desert wheatgrass and bulbous bluegrass (*Poa bulbosa*). The slight to moderate rating for hydrologic function and soil stability on this site could be due

to the amount of bare soil. The slight to moderate rating for biotic integrity is due to use by the various herbivores and due to presence of invasive or non-native grass species.

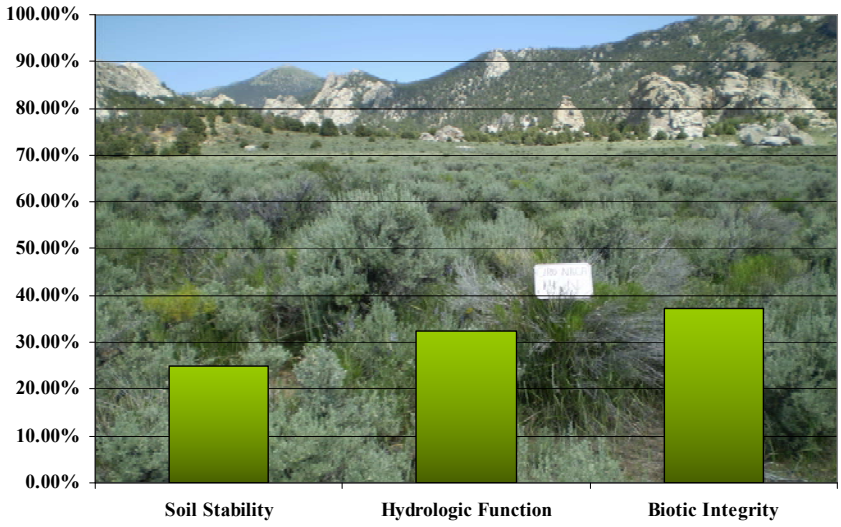


Figure 5. Departure from reference condition of the three landscape attributes in the Shallow gravelly 12-16 ecological site. Circle Creek Allotment, Plot 14 is in the background.

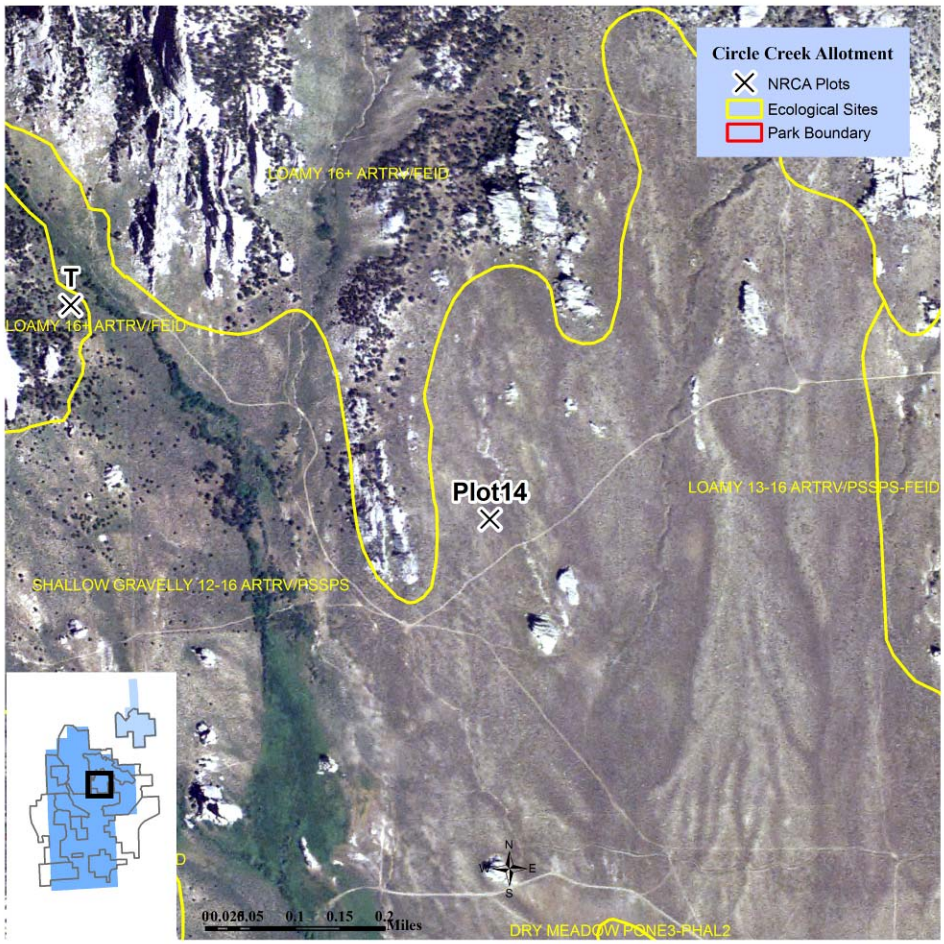


Figure 6. Map of the ecological site sample plot 14 in the Circle Creek Allotment.

Castle Rocks State Park (CRSP) Area

Loamy 16-22 ARTRV/FEID-PSSPS Ecological Site:

This ecological site is dominated by soils consisting of volcanic ash, loess or mixed alluvium. The soils are gravelly loams over gravelly silty clay loam dominated subsurface. Rooting depth is greater than 60 inches and the soil is well drained. Plot 13 was sampled in the Loamy 16-22 Artrv/feid-Pssps ecological site (R013XY005ID) in the CRSP area. The soil stability and hydrologic function attributes were rated as slight to moderate departure, 27.5% and 27.5%, respectively. The biotic integrity attribute was rated as none to slight departure (20%) due to the presence of invasive plants, and hampered reproductive capability of the native perennial grasses (Figure 7). Plot 13 is located near the center of this Park unit in a valley bottom and upslope from the wetland enclosure (Figure 9). Plot 13 is in Hades gravelly loam soil formed of volcanic ash, loess or mixed alluvium. The potential climax plant community is dominated by bluebunch wheatgrass and mountain big sagebrush.

The current vegetation is dominated by mountain big sagebrush, with a minor component of both native perennial grasses and forbs. Two tree species are also present on the site Utah juniper (*Juniperus osteosperma*) and pinyon pine, but only in minor amounts. The plot has a "none to slight" departure in the biotic integrity attributes, but is near the upper limit due to the presence of the invasive grasses, cheatgrass and bulbous bluegrass. There is only a small amount of big sagebrush and no Idaho fescue on the plot. The plot is in fair condition for soil stability and hydrologic function as there is evidence of some soil loss through water sheeting and rills.

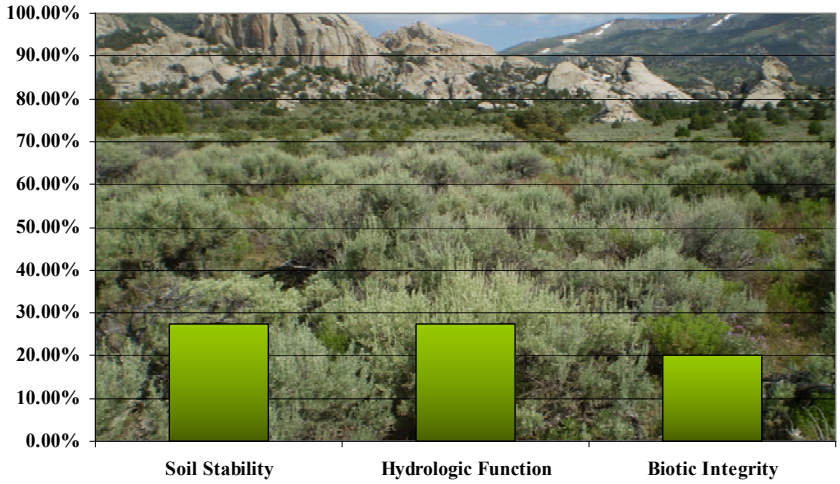


Figure 7. Departure from reference condition of the three landscape attributes in the Loamy 16-22 ecological site, Plot 13 is in the background.

Mahogany Savanna 16-22 CELE3-SYOR2/FEID-ACHNA Ecological Site:

This ecological site is located on mountainous slopes and is dominated by soils consisting of colluvium over residuum over bedrock derived from quartz-monzonite or granodiorite. The soils are gravelly coarse sandy loam over very gravelly loamy coarse sand dominated subsurface and are well drained. Rooting depth is restricted to 20 to 40 inches by paralithic bedrock. One plot was sampled in the Mahogany Savanna 16-22CELE3-SYOR2/FEID-ACHNA ecological site (R025XY018ID) in the CRSP area. Plot 15 is located near the southern portion of this Park unit

on a toeslope beneath a rock outcrop (see Figure 9). The soil stability and hydrologic function attributes were rated as slight to moderate departure, 22.5% and 22.5%, respectively. The biotic integrity attribute was rated as slight to moderate departure (25.7%) due to the presence of invasive plants (see Figure 8). Plot 15 is in Kanlee-rock outcrop-Earcree complex of soils formed of quartz-monzonite granodiorite colluvium over bedrock. The potential climax plant community is dominated by curl-leaf mountain mahogany, bluebunch wheatgrass, mountain snowberry and mountain big sagebrush.

The current vegetation is dominated by curl-leaf mountain mahogany, western juniper (*Juniperus scopulorum*), mountain big sagebrush and cheatgrass. The plot has a slight to moderate departure in the biotic integrity attributes, due to the presence and quantity of the invasive cheatgrass and the relative absence of native bunchgrasses. The plot is in fair condition for soil stability and hydrologic function as there is evidence of some soil loss through water sheeting and rills. There are a series of hiking trails and climbing staging areas within this area resulting in areas of trampled and damaged vegetation and bare, compacted soil.

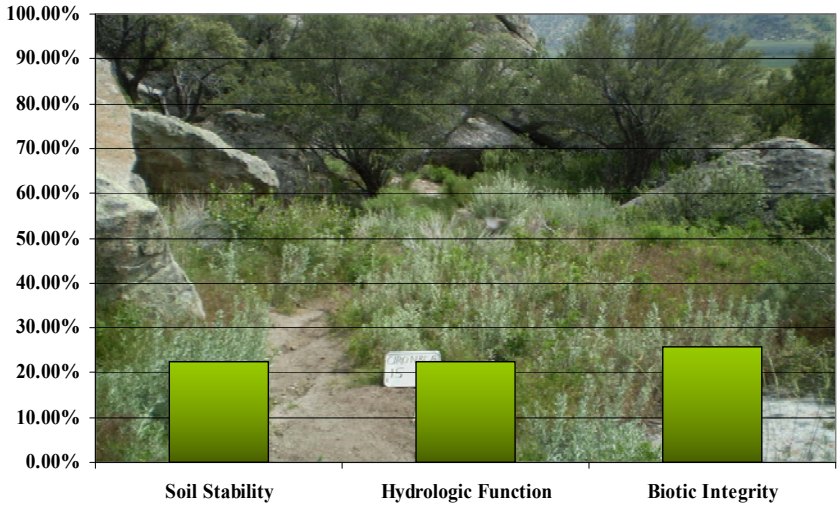


Figure 8. Departure from reference condition of the three attributes in the Mahogany Savanna, Castle Rocks State Park area, Plot 15 in the background.

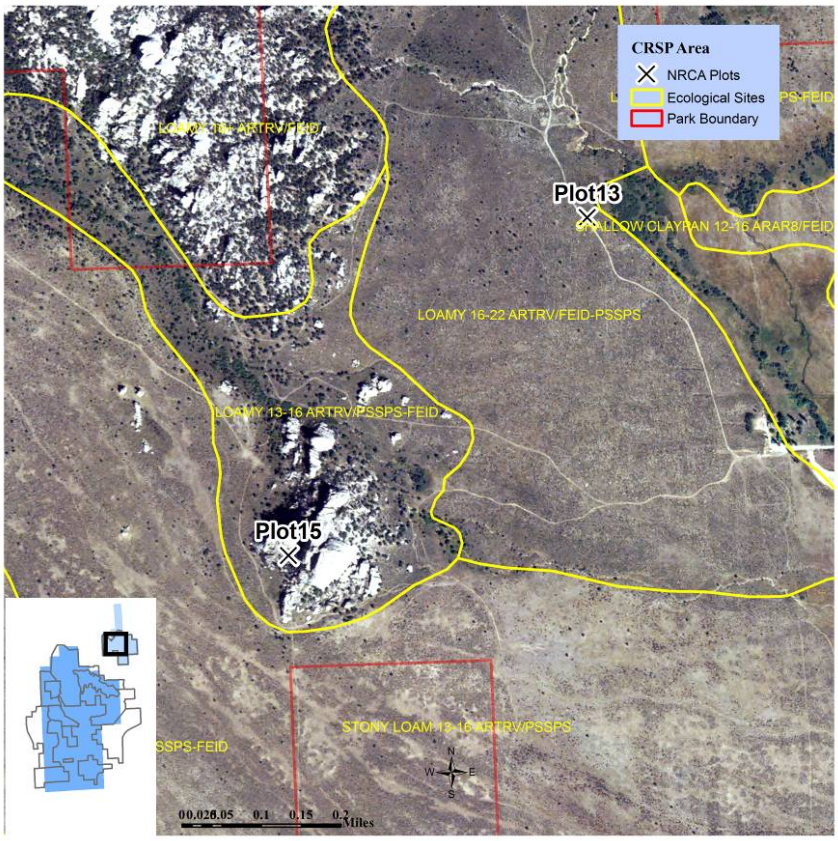


Figure 9. Map of ecological site sample plots 13 and 15 in the Castle Rocks State Park.

Emery Canyon Grazing Allotment

Stony Loam 16-22ARTRV/PSSPS Ecological Site:

This portion of the Emery Canyon Grazing Allotment is composed mainly of a Stony Loam 16-22 ecological site (R013XY019ID). The site is dominated by soils developed from alluvium and slope alluvium derived from weathered igneous rock parent material. Plot 10, located near the middle of the Allotment was sampled (Figure 12). The average soil stability and hydrologic function attributes were rated as none to slight departure, 0% and 0%, respectively. The average biotic integrity attribute was also rated as none to slight departure (5.7%) due to the presence of healthy native plants on the plot (Figure 10). This plot is in Howcan-Searla complex of soils that is a very gravelly loam to very cobbly loam over a very stony loam. Depth to a root restrictive layer is greater than 60 inches and the natural drainage class is well drained. The potential climax plant community is mountain big sagebrush//bluebunch wheatgrass.

The current vegetation on this plot is dominated by mountain big sagebrush, bluebunch wheatgrass, bulbous bluegrass and arrowleaf balsamroot. The good ratings for biotic integrity, soil stability and hydrologic function are likely due to the relatively light domestic livestock use and its location away from rock climbing areas.

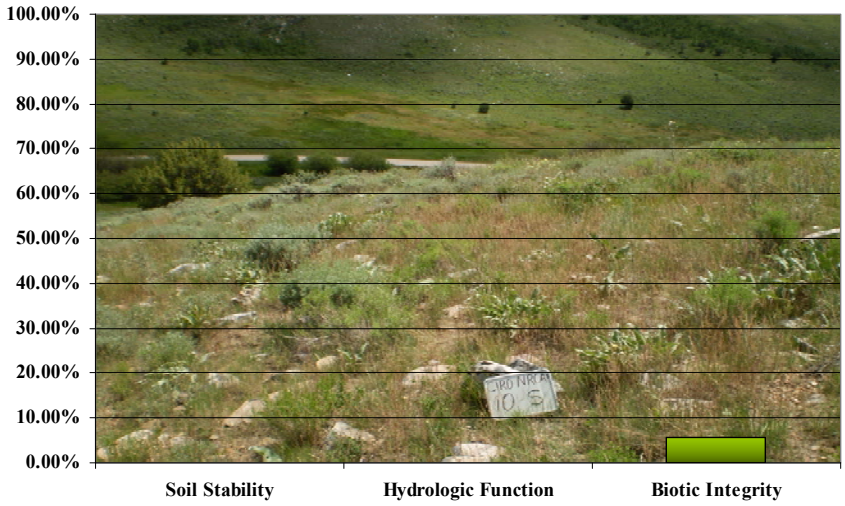


Figure 10. Departure from reference condition of the three landscape attributes in the Stony Loam 16-22, Emery Canyon Allotment, Plot 10 is in the background.

Mahogany Savanna 16-22 CELE3-SYOR2/FEID-ACHNA Ecological Site:
The Mahogany Savanna 16-22 is dominated by gravelly coarse sandy loam soils developed from alluvium and colluvium andesite or granodiorite parent material. Plot 11 was sampled in this grazing Allotment in the eastern and southern portion (Figure 12). The soil stability attribute was rated as slight to moderate departure, 32.5%. The hydrologic function landscape attribute was rated at slight to moderate departure, 35.0%. The biotic integrity attribute was rated as slight to moderate departure, 22.9% (Figure 11). The departure ratings were due to the presence of invasive plant species and high use by recreational climbers. The soil is primarily an Ola-rock outcrop-Earcree complex, a gravelly coarse sandy loam soil with depths of up to 37 inches. The soil is considered well drained. The historic climax plant community is a curl-leaf mountain mahogany-mountain snowberry/Idaho fescue-needlegrass (*Achnatherum P. Beauv.*) with a well-developed perennial forb composition.

The plot is located within a valley bottom on gentle slopes with a southern aspect. This area receives relatively high recreational use, hiking, camping and rock climbing that has resulted in heavy trampling and large areas devoid of vegetation. The impacts from these activities are concentrated and do not extend into the surrounding area. The current vegetation on the plot is dominated by mountain big sagebrush, pinyon pine and Utah juniper. The grass layer is dominated by non-native species, Kentucky bluegrass and smooth brome (*Bromus inermis*), and native perennial rhizomatous species Douglas' sedge (*Carex douglassii*) and mountain rush (*Juncus balticus*).

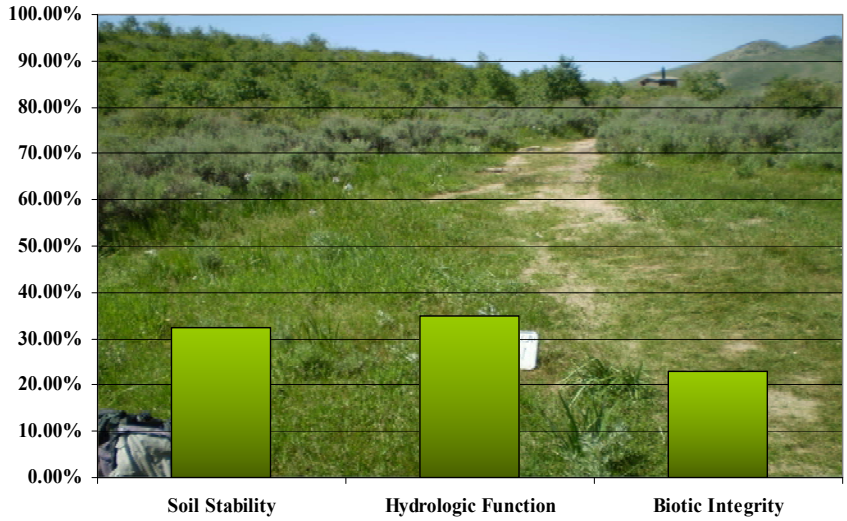


Figure 11. Departure from reference condition of the three landscape attributes in the Mahogany Savanna 16-22, Emery Canyon Allotment, Plot 11 is in the background.

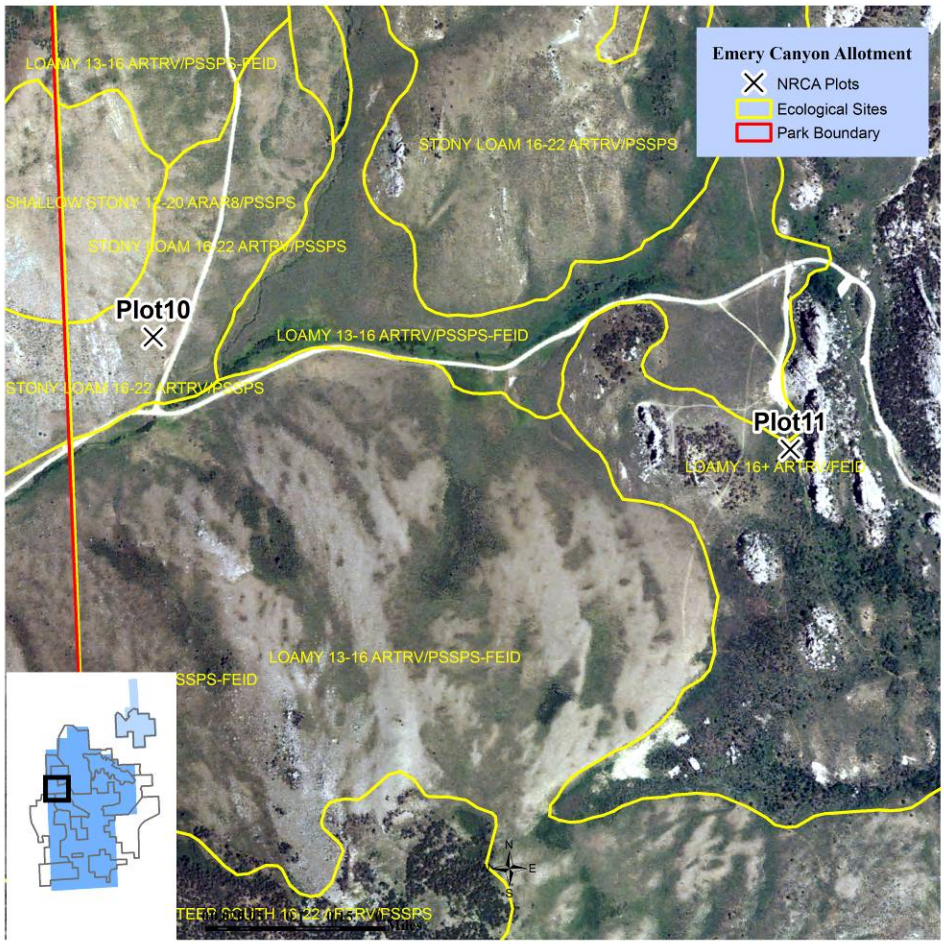


Figure 12. Map of ecological site sample plots 10 and 11 in the Emery Canyon Allotment.

Graham Creek Grazing Allotment

Steep South 16-22 ARTRV/PSSPS Ecological Site:

The Steep South 16-22 ecological site is dominated by very stony loam soils developed from mixed alluvium and alluvium derived from igneous rock parent material. Plot 8 was sampled on this ecological site and is located near the center of the Allotment (Figure 15). The soil stability and hydrologic function attributes were rated as slight to moderate departure, 27.5% and 25.0%, respectively (Figure 13). The biotic integrity attribute was rated as none to slight departure at 20% due to the presence of non-native plants. The soil is primarily a Povey-Nurkey complex stony loam soil with a restrictive rooting layer at 40 to 50 inches. The soil is considered well drained. The potential climax plant community is mountain big sagebrush/bluebunch wheatgrass with a well-developed perennial forb cover from arrowleaf balsamroot.

Plot 8 is a 51% south-facing slope. The vegetation is dominated by shrubs, primarily mountain big sagebrush and invasive grasses, cheat grass and bulbous bluegrass. A slight occurrence (1%) of pinyon pine and curl-leaf mountain mahogany is present. The area receives use from livestock grazing but is not over-grazed.

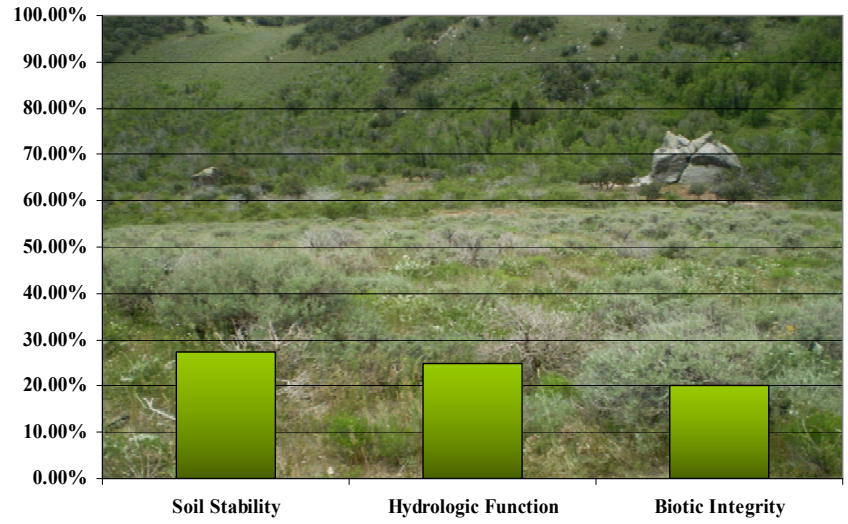


Figure 13. Departure from reference condition of the three landscape attributes in the Steep South 16-22, Graham Creek Allotment, Plot 8 is in the background.

Aspen Thicket 16-22 POTR5 Ecological Site:
This portion of the Graham Creek Grazing Allotment is composed mainly of an Aspen Thicket 16-22 PTRT5 ecological site (R025XY001ID). The site is dominated by soils developed from mixed alluvium and colluvium. Plot 9 is located in the northwest portion of the Allotment (Figure 15). The average soil stability and hydrologic function attributes were rated as none to slight departure, 7.5% and 7.5%, respectively. The average biotic integrity attribute was rated as none to slight departure (2.9%) due to the relatively healthy native vegetation on the site (Figure 14). This plot is in a Pachic Haplocryolls soil that is a stony loam to gravelly loam over an extremely cobbly loam dominated subsurface. Soil depths vary from 13 to 24 inches and are considered well drained. The historic climax plant community is quaking aspen (*Populus tremuloides*). The understory is composed of a rich diverse layer of forb and grass cover.

Plot 9 is located in a creek bottom with gentle slopes. The tree stratum is dominated by quaking aspen with a presence of limber pine (*Pinus flexilis*), sub-alpine fir (*Abies lasiocarpa*) and lodgepole pine (*Pinus contorta*). The grass vegetation is dominated by Kentucky bluegrass and native rhizomatous grasses. Mountain snowberry and wax currant (*Ribes cereum*) are the only shrubs present on the plot. The relatively good biotic integrity rating is due to the light grazing that this portion of the Allotment receives.

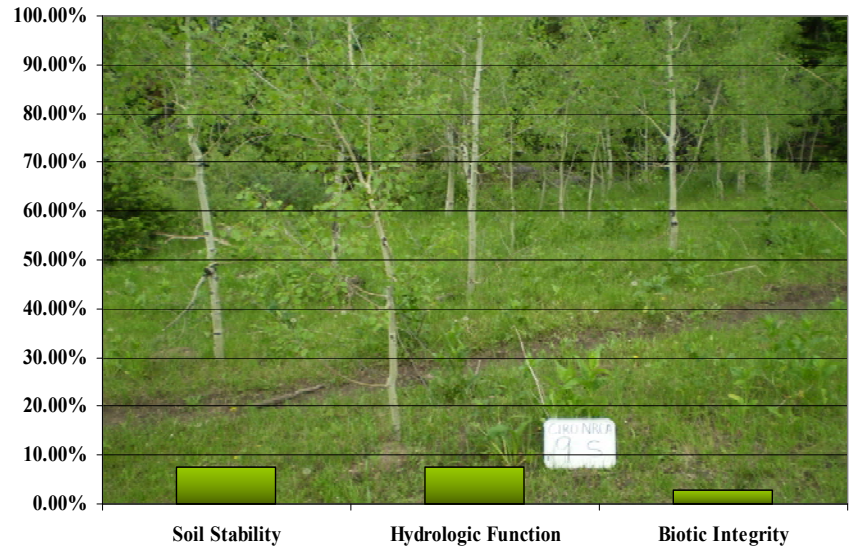


Figure 14. Departure from reference condition of the three landscape attributes in the Aspen Thicket 16-22, Graham Creek Allotment, Plot 9 in the background.

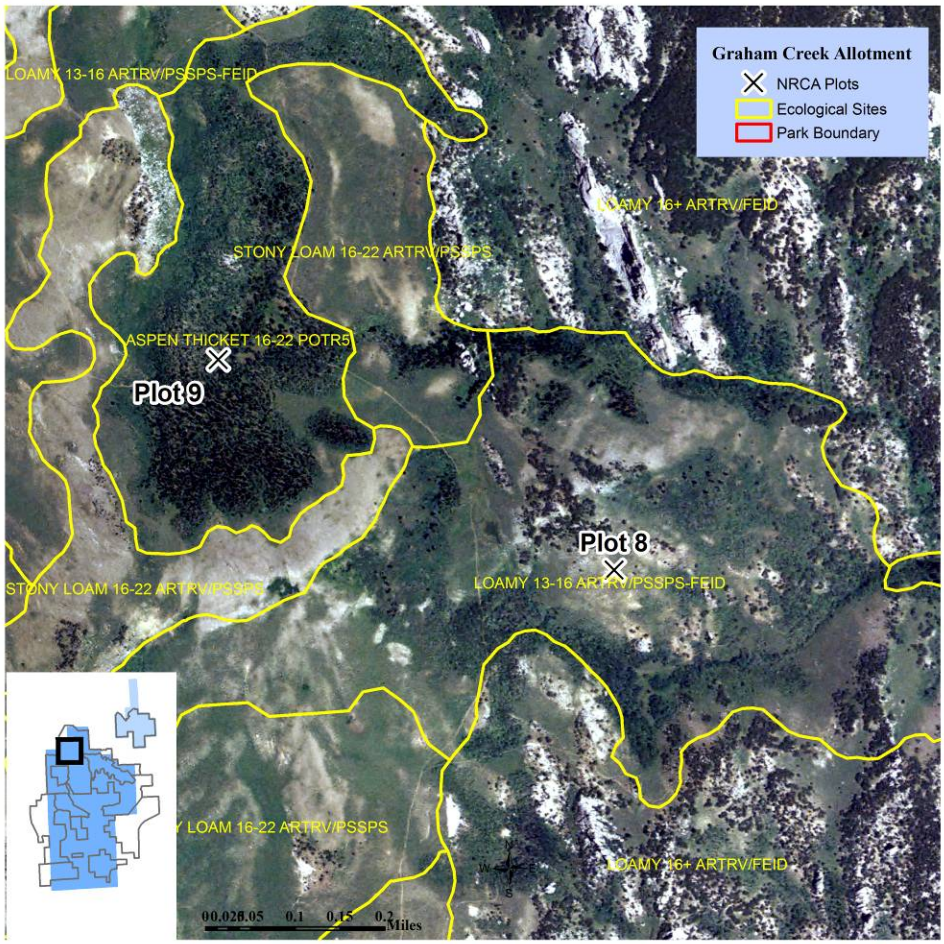


Figure 15. Map of ecological site sample plots 8 and 9 in the Graham Creek Allotment.

Heath Canyon Grazing Allotment

Upland Stony Loam Singleleaf Pinyon-Utah Juniper Ecological Site:

This ecological site is dominated by soils developed from alluvium or colluvium over bedrock derived from quartzite and/or mica schist. The soils are very stony loams over extremely cobbly clay loam and weathered bedrock. Soil depth varies from 3 to 17 inches and is considered well-drained. Plot 1 was sampled in the Upland Stony Loam Singleleaf Pinyon-Utah Juniper ecological site (R028AY338UT) in the Heath Canyon Grazing Allotment. This plot is located in the extreme southern end of the Allotment within the burned area from the 2000 wildfire (Figure 17). The soil stability attributes were rated as none to slight departure, 20% and hydrologic function landscape slight to moderate 27.5%. The biotic integrity attribute was rated as slight to moderate departure (34.3%) (Figure 16). The plot is in Itca-Birchcreek-Rock outcrop soil complex formed on alluvium or colluvium. The potential climax plant community based on ecological site is singleleaf pinyon-Utah Juniper. The predominant shrub in this community is mountain big sagebrush and the major grass species are Idaho fescue and bluebunch wheatgrass.

Plot 1 is in the City of Rocks wildfire area (8/18/2000). The plot had a slight to moderate departure in the biotic integrity attribute and reflects a site that responded relatively well to the effects of the wildfire. Non-native grasses are still a major component of the grass strata, cheatgrass at 17% and Kentucky bluegrass at 2% as well as a weedy forb component. Native bunchgrasses, Indian ricegrass (*Achnatherum hymenoides*), squirreltail (*Elymus elymoides*), Sandberg bluegrass (*Poa secunda*) and Idaho fescue appear to be recovering and comprise 10% of the plant cover. Both Utah juniper and singleleaf pinyon pine seedlings have been established on the plot. The site was on a gently sloping southwest-facing footslope. The site has been grazed by livestock historically but appears to be lightly used now and was not in climax condition prior to management by the Reserve. The fire would have reduced the potential biotic integrity from pre-burn conditions by improving conditions for annual grasses over perennial grasses and sagebrush. The soil stability and hydrologic function were in good condition and have recovered from the burn.

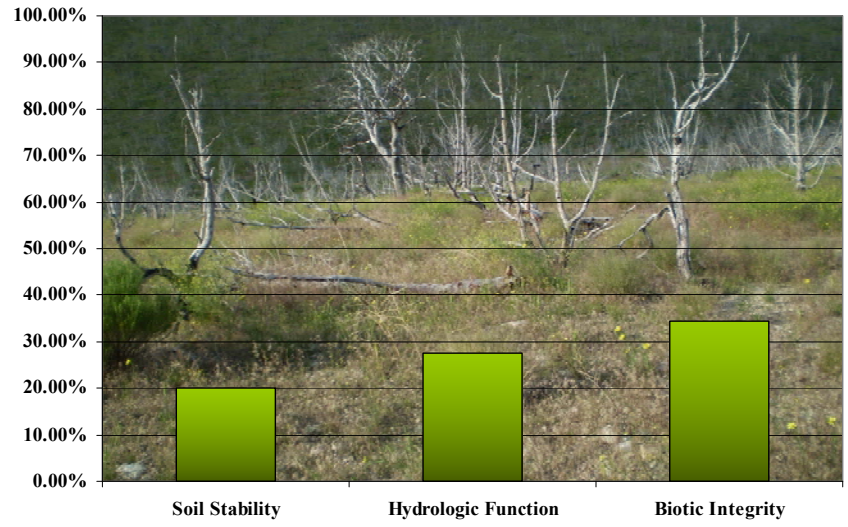


Figure 16. Departure from reference condition of the three landscape attributes in the Upland Stony Loam Singleaf Pinyon- Utah Juniper ecological site, Heath Canyon Allotment, Plot 1 is in the background.

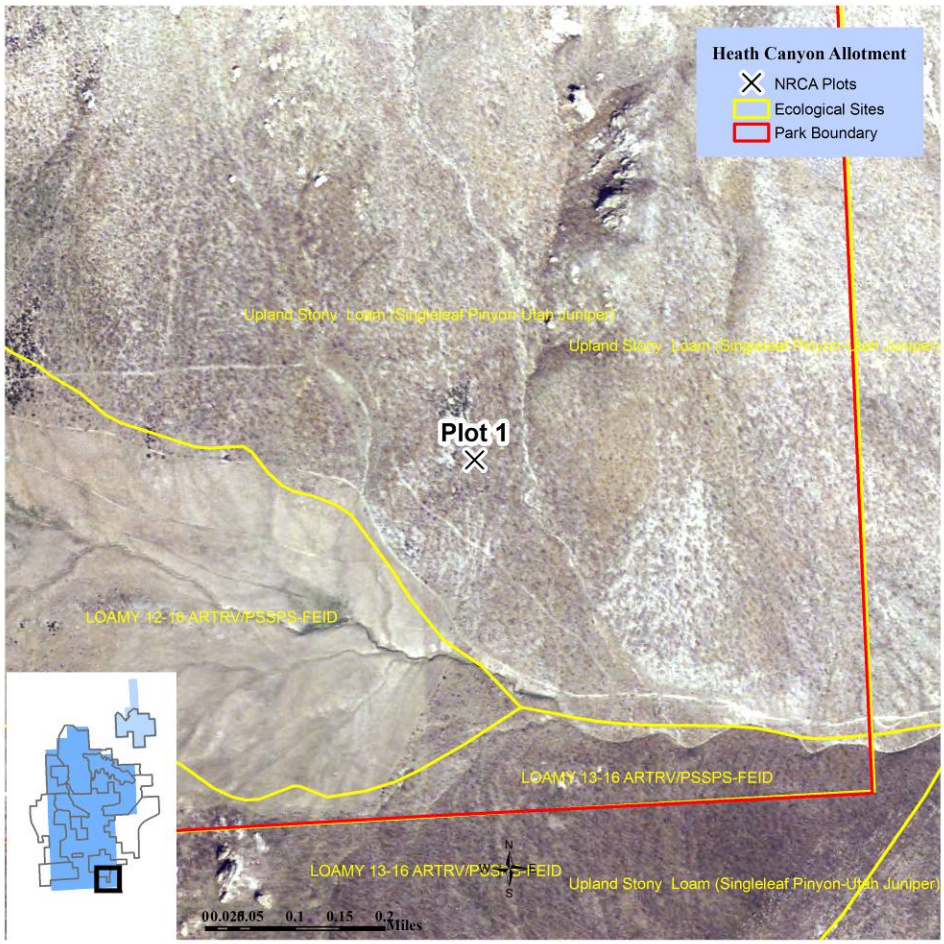


Figure 17. Map of ecological site sample plot 1 in Heath Canyon Allotment.

Kempton Grazing Allotment

Loamy 16+ ARTRV/FEID

This ecological site is dominated by soils developed from weathered igneous rock or granodiorite rock. The soils are sandy loams over a weathered bedrock subsurface. Soil depth varies from 16 to 22 inches with a root restricting layer at 20 to 40 inches. This soil is considered well drained. Plot 4 was sampled in the Loamy 16+ ARTRV/FEID ecological site (R025XY022ID) in the Kempton Grazing Allotment. This plot is located within the northern portion of the Allotment (Figure 19). Soil stability and the hydrologic function were rated as none to slight departure; 15.0%, 15.0%, and biotic integrity rated as none to slight, at 20.0% (Figure 18). The plot is on Ola sandy loam soils generally found on fan remnants or hillslopes. The potential climax plant community based on ecological site is predicted to be mountain big sagebrush/Idaho fescue with other components including bluebunch wheatgrass and other perennial grasses.

Plot 4 is located in a gently sloping toeslope. The shrub stratum is dominated by basin big sage (*Artemisia tridentata var. tridentata*), antelope bitterbrush, yellow rabbitbrush and mountain big sagebrush. Native bunchgrasses comprise 19% of the cover and include thickspike wheatgrass

and Sandberg bluegrass. Both cheatgrass and Kentucky bluegrass are minor components of the grass layer.

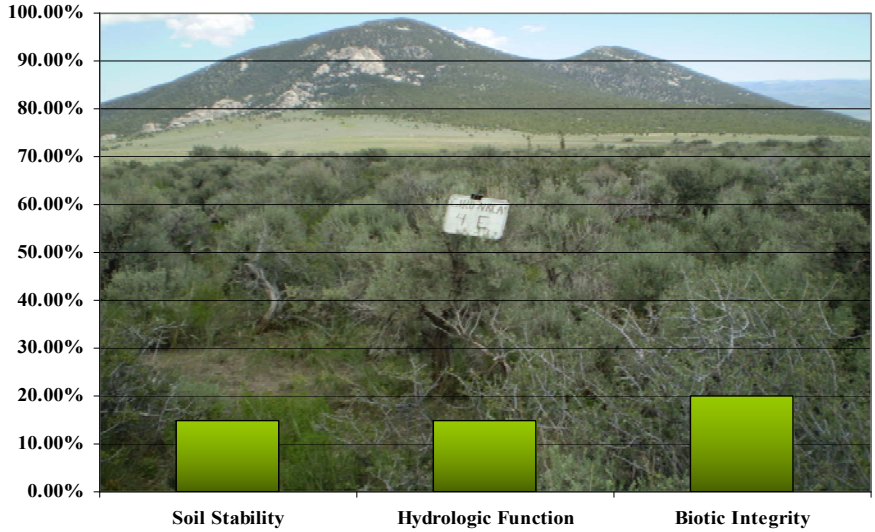


Figure 18. Departure from reference condition of the three landscape attributes in the Loamy 16+, Kempton Allotment, Plot 4 is in the background.

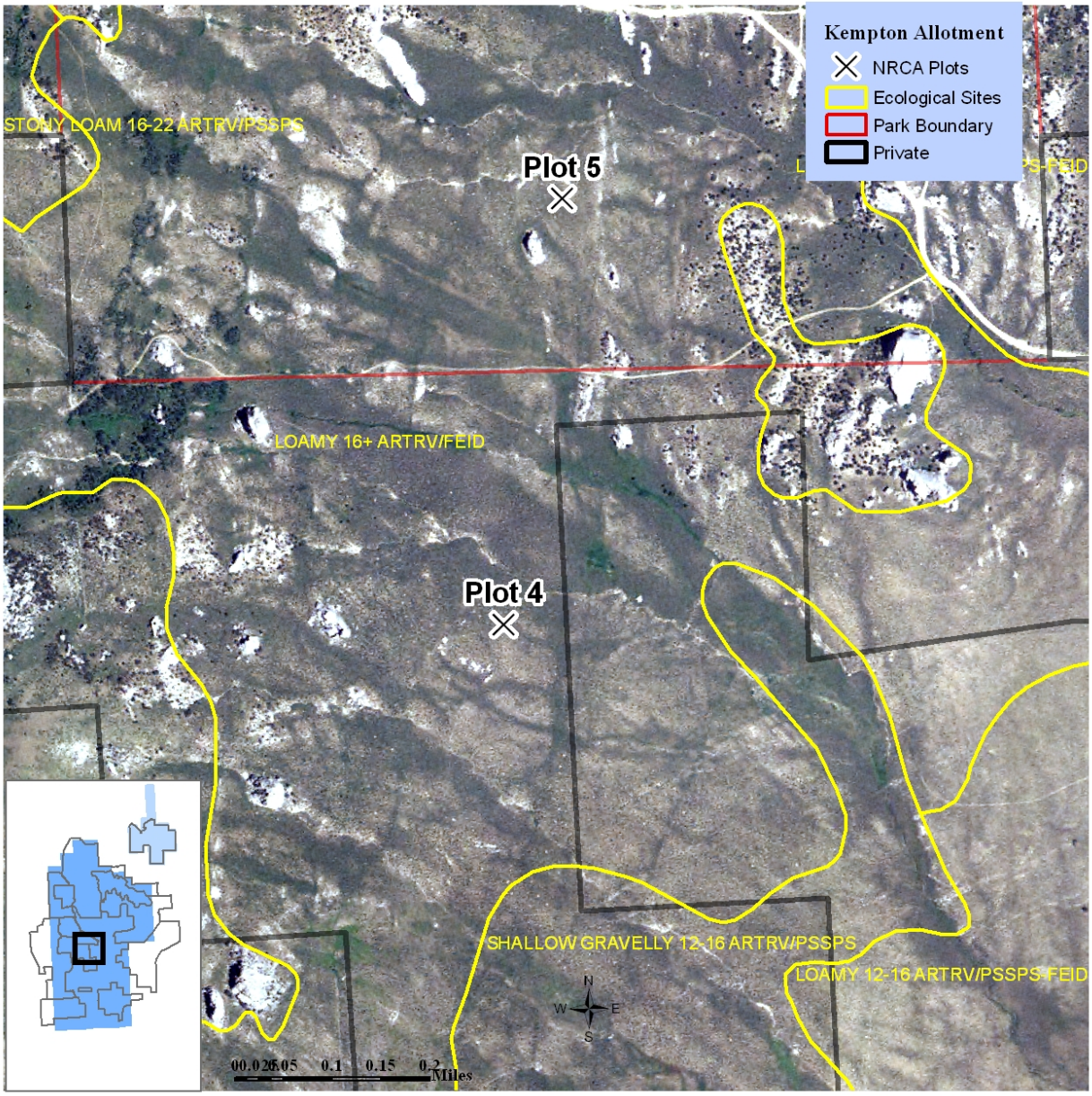


Figure 19. Map of ecological site sample plot 4 in Kempton Allotment.

Smoky Mountain Grazing Allotment
Loamy 13-16 ARTRV/PSSPS-FEID Ecological Site:

The Loamy 13-16 ARTRV/PSSPS-FEID ecological site is dominated by sandy loams developed from alluvium and colluvium derived from weathered igneous or granodiorite parent material. Plot 3 was sampled in the area in the extreme west of the grazing Allotment (Figure 21). The average soil stability attribute none to sight departure (20.0%) and the hydrologic function were rated as slight to moderate departure 22.5% (Figure 20). The average biotic integrity attribute was rated as none to slight departure at 17.1%, the higher end of this class and is due to the presence of non-native plants and the low cover percentage of native bunchgrasses. The soil is primarily an Ola sandy loam soil with depths of up to 22 inches on 6-20% slopes. The soil is considered well drained. The historic climax plant community is a mountain big sagebrush/bluebunch wheatgrass with a well-developed perennial forb composition.

Plot 3 is a 4% west-facing slope. The vegetation on the plot is dominated by native shrubs; primarily with mountain big sagebrush and minor amounts of green rabbitbrush and mountain snowberry. The grasses are composed mainly of Sandberg bluegrass and the non-native desert wheatgrass. Grazing has contributed to the reduction of the native bunchgrasses and has contributed to compositional change on this site.

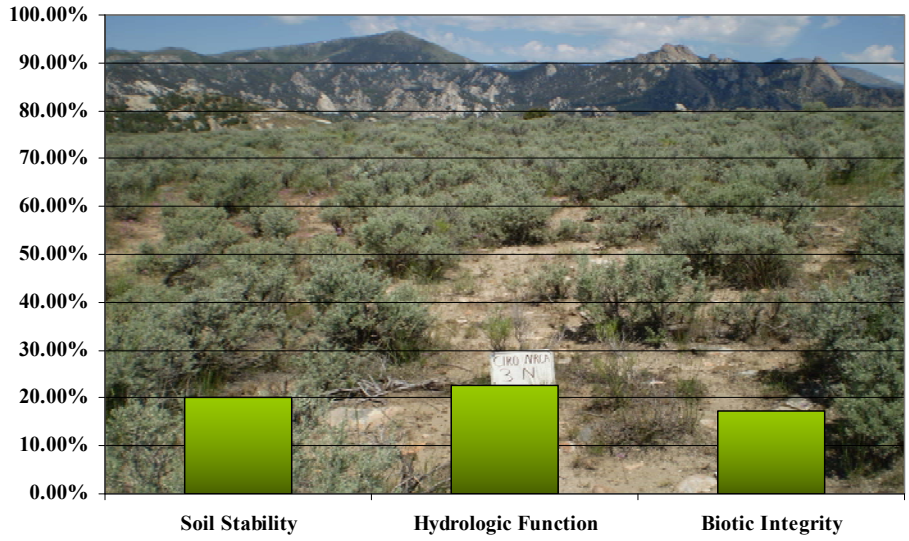


Figure 20. Departure from reference condition of the three landscape attributes in the Loamy 13-16 Smoky Mountain Allotment, Plot 3 is in the background.

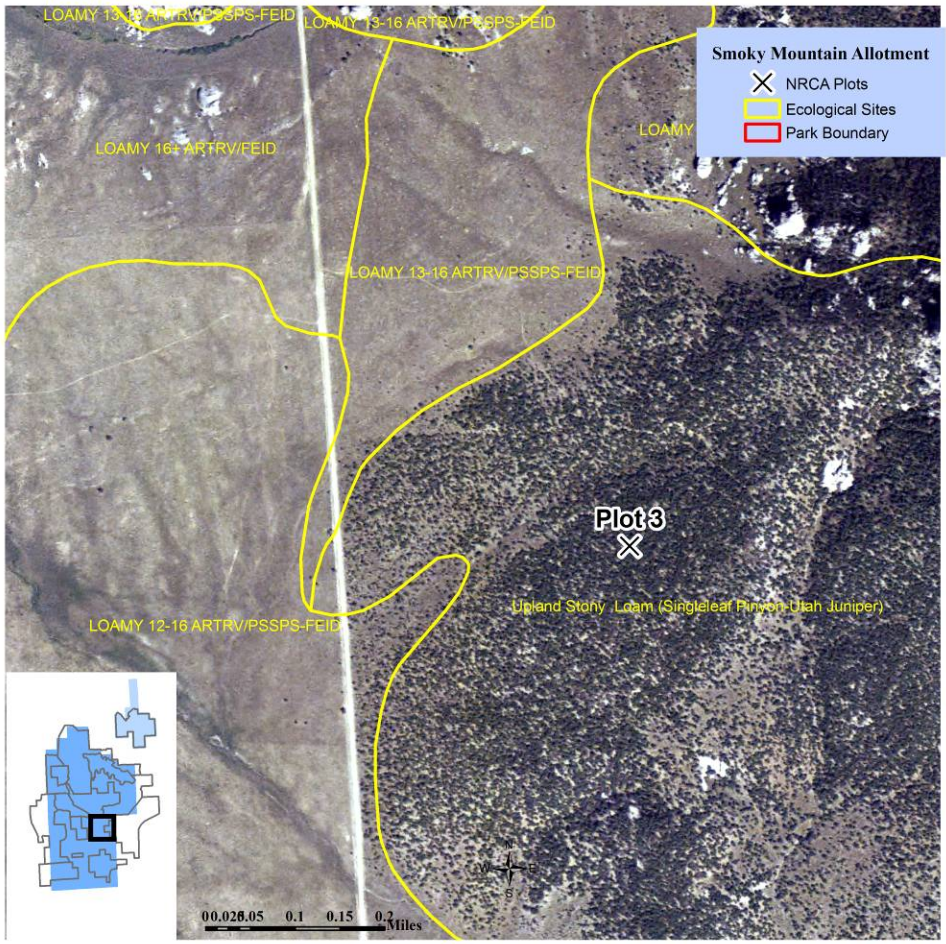


Figure 21. Map of ecological site sample plot 3 in the Smoky Mountain Allotment.

Tracy Lane Grazing Allotment

Loamy 12-16 ARTRW8/PSSPS Ecological Site:

This ecological site is dominated by soils developed from alluvium and/or colluvium over weathered igneous or grandodiorite bedrock material. The soils are sandy loams over weathered bedrock. Soil depth varies from 16 to 22 inches and is considered well-drained. Plot 2 was sampled in the Loamy 12–16 ARTRW8/PSSPS ecological site (R025XY022ID) in the Tracy Lane Allotment. Plot 2 was located in the center of the southern portion of this unit (Figure 23). The soil stability, hydrologic function and biotic integrity landscape attributes were rated as slight to moderate departure, 22.5%, 25.0 and 31.4%, respectively (Figure 22). The plot is in Raft river loamy soil formed on remnant alluvial fans from alluvium or colluvium. The historic climax plant community based on ecological site is big sagebrush/Idaho fescue.

Plot 2 is within the City of Rocks wildfire (8/18/2000). The plot had a slight to moderate departure in the biotic integrity attribute and reflects a site that is beginning to recover from the effects of the wildfire. The diminishment and lack of vigorous response of the native bunchgrasses contributes to this rating. Cheatgrass, desert wheatgrass and bulbous bluegrass, all non-natives, are the major component of the grass layer (24%). Mountain big sagebrush, yellow rabbit brush and antelope bitterbrush seedlings are beginning to establish on the plot indicating a recovery from the wildfire. The site was on a gently sloping south-facing toeslope. The site is grazed by livestock and had a component of juniper prior to the wildfire. The soil stability and hydrologic function were in good condition and are recovering from the fire.

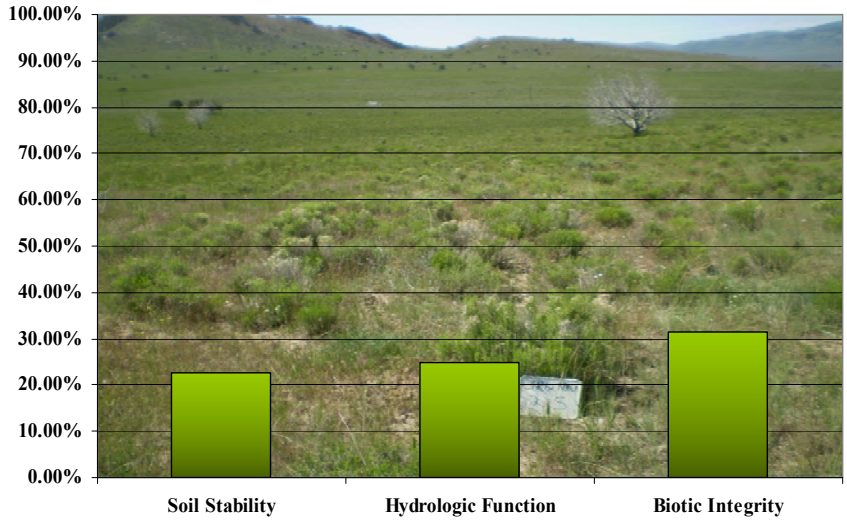


Figure 22. Departure from reference condition of the three landscape attributes in the Loamy 12-16 Tracy Lane Allotment, Plot 2 is in the background.

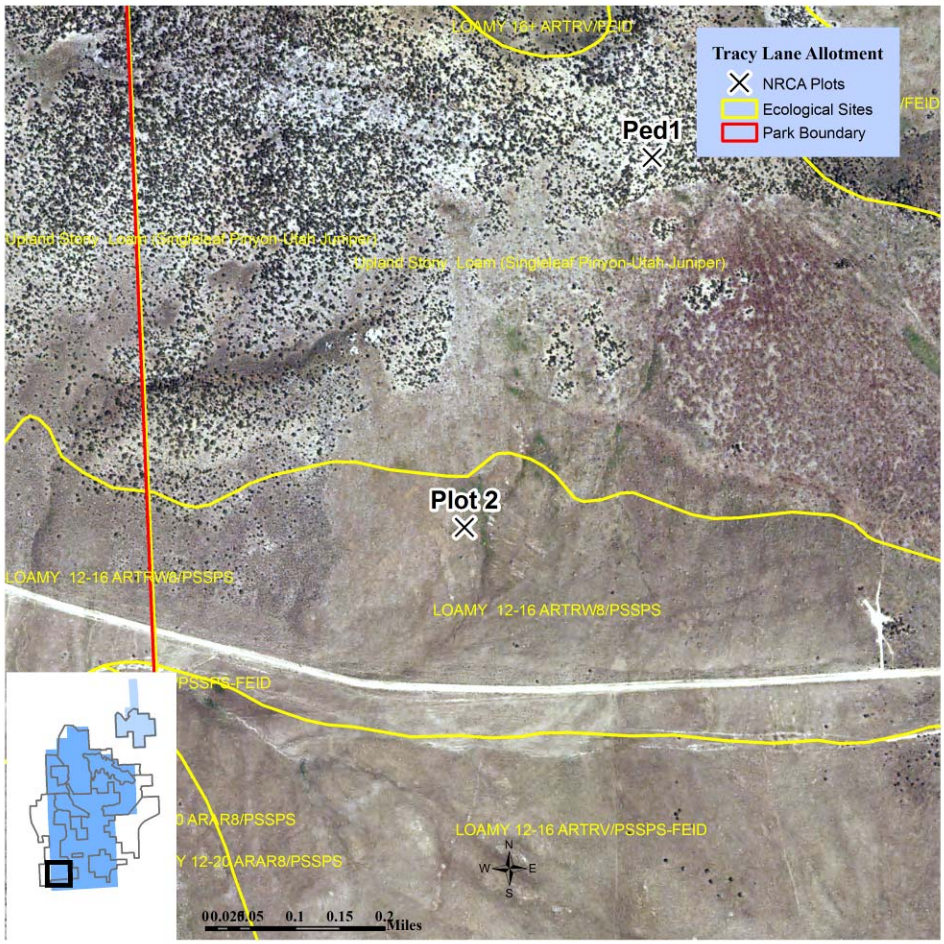


Figure 23. Map of ecological site sample plot 2 in the Tracy Lane Allotment.

Trail Canyon Grazing Allotment

Shallow Stony 12-20 ARAR8/PSSPS Ecological Site:

This ecological site is dominated by soils developed from alluvium and/or colluvium over weathered igneous or grandodiorite bedrock. The soils are sandy loams over weathered bedrock. Soil depth varies from 16 to 22 inches and is considered well-drained. One plot was sampled in the Loamy 12–20 ARTRW8/PSSPS ecological site (R013XY014ID) in the Trail Canyon Allotment. Plot 6 was located in the center of this unit (Figure 26). The soil stability, hydrologic function and biotic integrity landscape attributes were rated as none to slight departure, 7.5%, 10.0 and 8.6%, respectively (Figure 24). The plot is in Jimsage sandy loam soil formed on remnant alluvial fans from alluvium or colluvium. The historic climax plant community based on ecological site is Wyoming big sagebrush/bluebunch wheatgrass.

The plot is located on a moderately sloping toeslope with a west-facing aspect. This area receives usage from cattle grazing that has reduced the relative abundance of native bunchgrasses on the site. The current vegetation on the plot is dominated by little sagebrush (*Artemisia arbuscula*) and mountain big sagebrush. Native bunchgrasses include Idaho fescue, bluebunch wheatgrass and Sandberg bluegrass. The native bunchgrasses as a group comprise 12% of the cover. A small amount of desert wheatgrass (3%) has established itself on the site.

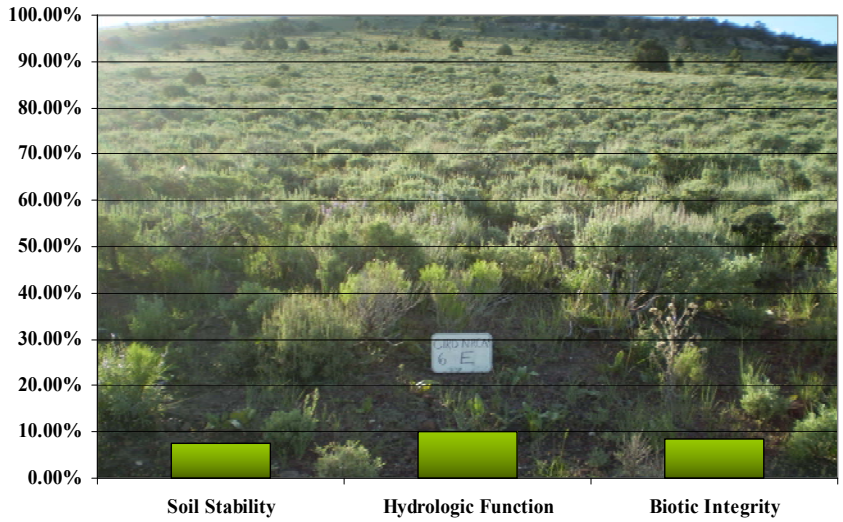


Figure 24. Departure from reference condition of the three landscape attributes in the Shallow Stony 12-20, Trail Canyon Allotment, Plot 6 is in the background.

Loamy 16+ ARTRV/FEID Ecological Site:

This ecological site is dominated by soils developed from alluvium and/or colluvium over weathered igneous or grandodiorite bedrock. The soils are coarse sandy loams over weathered bedrock. Soil depth varies from 16 to 22 inches and is considered well-drained. One plot was sampled in the Loamy 16+ ARTRV/FEID ecological site (R025XY022ID) in the Trail Canyon Allotment. Plot 7 was located in the southern third of this unit (Figure 26). The soil stability landscape attributes were rated as none to slight departure, 17.5%. The hydrologic function and biotic integrity attributes were rated as none to slight departure, 20.0% and slight to moderate

31.5% (Figure 25). The plot is in Ola-Rock outcrop-Earcree complex coarse sandy loam soil formed on mountain slopes from alluvium or colluvium derived from weathered igneous or granodiorite bedrock. The potential climax plant community based on ecological site is Wyoming big sagebrush/Idaho fescue.

The plot is located on a moderately sloping toeslope with a west-facing aspect. Grazing has been prevalent in the area and has likely changed the plant composition on the site. The current vegetation on the plot is dominated by the shrub layer (40%) composed predominantly of mountain big sagebrush with minor amounts of basin big sagebrush, antelope bitterbrush and mountain snowberry. Non-native grasses have invaded the site and are represented by cheatgrass, bulbous bluegrass and desert wheatgrass.

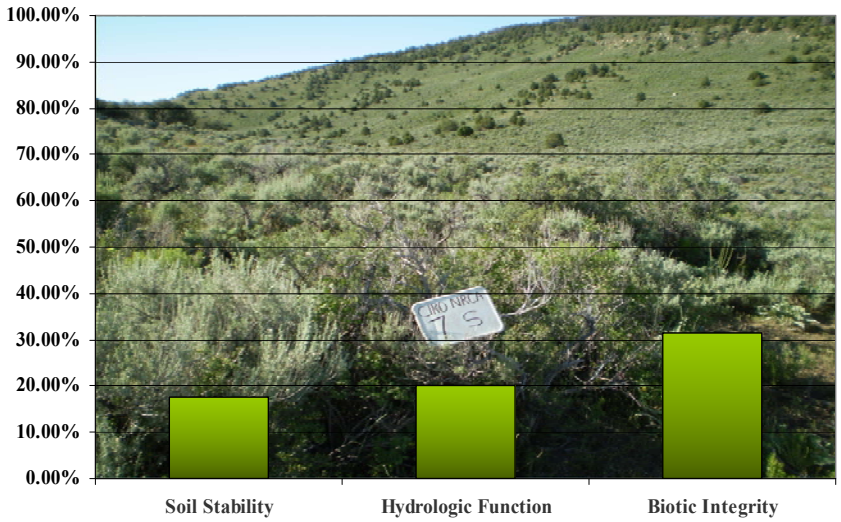


Figure 25. Departure from reference condition of the three landscape attributes in the Loamy 16+, Trail Canyon Allotment, Plot 7 is in the background.

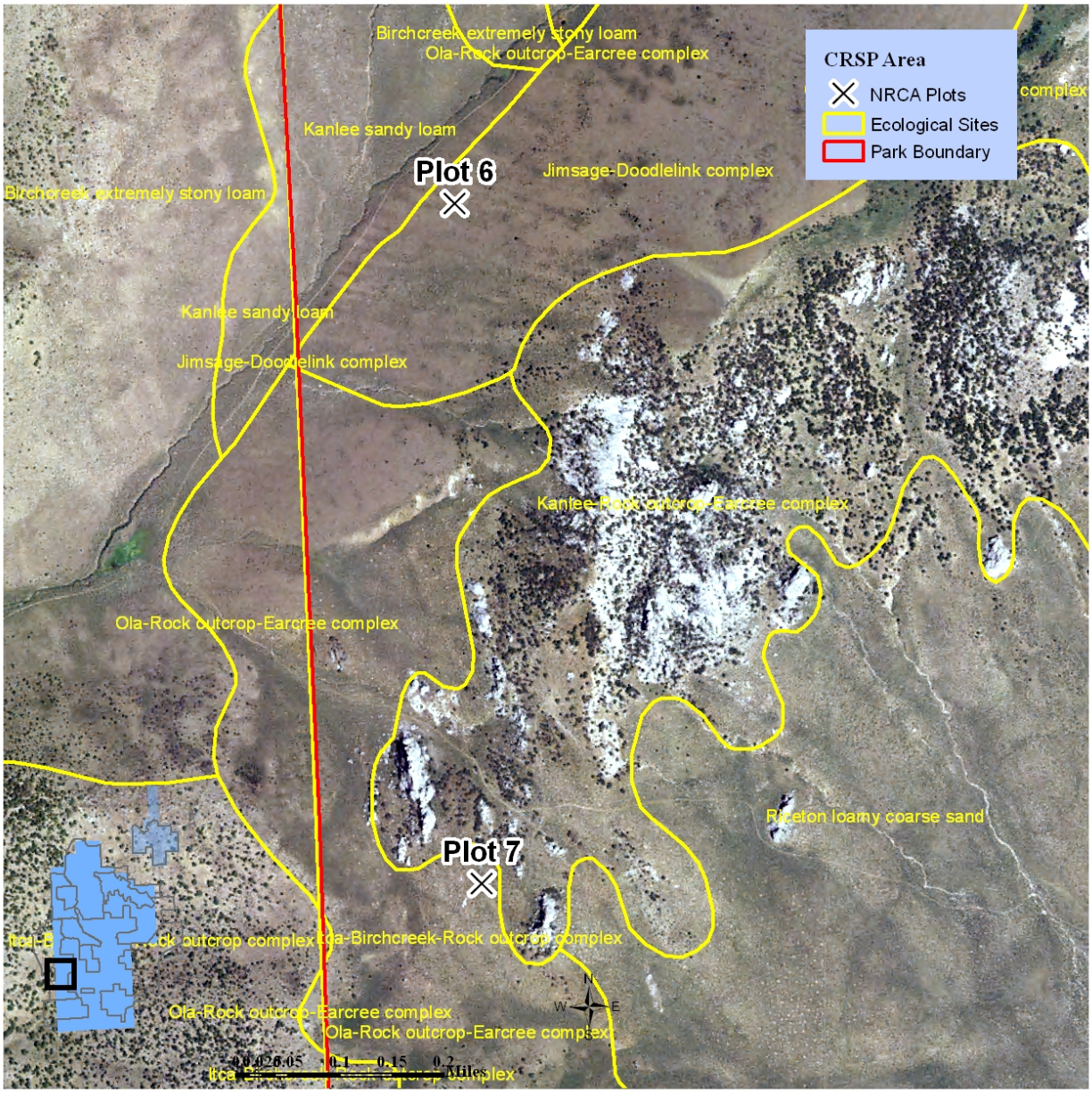


Figure 26. Map of ecological site sample plot 6 and plot 7 in the Trail Canyon Allotment.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 003/117868, December 2012

National Park Service
U.S. Department of the Interior

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