Climate Change Preparation Planning on National Landscape Conservation System Lands

Recommendations for Direction and Approach

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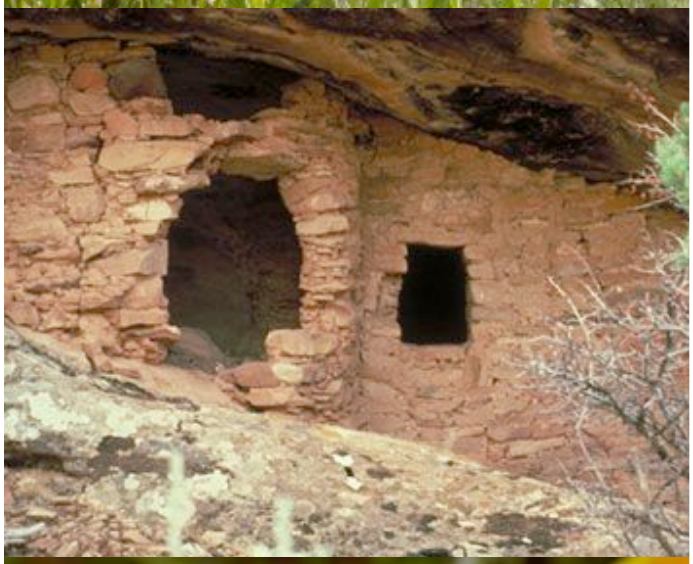

Executive Summary

The National Landscape Conservation System (NLCS or Conservation System) is a collection of the BLM's most rich and unique lands. Through Presidential Proclamation and Congressional legislation, these units are mandated to protect specific resources, including natural, cultural, geologic, scenic, scientific, and recreational resources, found within their boundaries. Climate change presents an emerging threat to these resources, but a review of Resource Management Plans (RMPs) for a sample of 14 Conservation System units revealed little planning for climate change. A recent Secretarial Order (#3289) requires that climate change impacts be considered when multi-year plans are developed and when resource decisions are made. In this report, we provide specific recommendations for Conservation System managers as they move to incorporate climate change impacts into planning documents and management strategies. The guiding principles for preparing for climate change on the Conservation System include the following:

(1) Reduce existing stressors to increase the likelihood that the resources that were identified for protection remain viable into the future;
(2) Plan for changing future conditions, potentially outside the range of historical conditions;
(3) Shift from management for extractive use towards management for conservation of the cultural, natural, scenic, scientific, geologic, and recreational resources of the unit;
(4) Identify climate sensitive species and resources and increase monitoring and management of these resources;
(5) Adopt a scientifically rigorous adaptive management strategy;
(6) Identify triggers for changes in management strategy;
(7) Maintain flexibility while also meeting NEPA requirements and conservation mandate;
(8) Experiment with "hands on" management in a limited and cautious manner to determine the most effective actions;
(9) Maintain/enhance/create connectivity within and across habitat types;
(10) Maintain/enhance/restore riparian areas, wetlands, and floodplains;
(11) Increase communication and collaboration with Native Americans with ties to the area and resources.

We recommend using global climate model projections downscaled to local and regional scales to better understand the potential direction and magnitude of change. Likely future conditions and uncertainty about those conditions will need to be considered when making each and every management decision. The BLM will need to work closely with surrounding land owners, stakeholders, and communities to create integrated climate change preparation plans that protect cultural resources, allow species to move, and continue to support functioning ecosystems. Reducing the myriad of stressors that currently limit the conservation potential of many Conservation System units will be an important first step to meeting their conservation mandate.

Introduction

Climate change has complicated the management of conservation lands. Historical conservation often relied on a "hands off" approach that emphasized letting natural processes take their course and assumed that individual species will continue to persist as long as human-caused disturbance was relatively low. Looking back at historical conditions provided guidance for how species and the landscape should function in the future. Managers strove for a system that functioned within the natural range of variability and set goals for restoring species to their historical ranges. As we look towards the future, however, climate change threatens to have three primary impacts on conservation lands; it will (1) result in patterns and distributions that are different than those of the past, (2) create new stressors for both cultural and natural resources, and (3) exacerbate existing stressors that already impact natural and cultural resources. These impacts make the job of planning for conservation more complex as planners and managers reconsider current management goals and strategies in light of climate change.

The National Landscape Conservation System (NLCS) is the BLM's first collective experience at management specifically aimed at conservation. Each unit in the NLCS was created with a mandate to protect specific resources, including cultural, natural, scientific, scenic, geological, and recreational, that were identified by the President or Congress as warranting special protections. Many of the National Monuments, National Conservation Areas, Forest Reserves, and other units of the NLCS were created within the last ten years, and their final Resource Management Plans (RMPs) were only recently released. Unfortunately, these RMPs are being released at a time of transition from management aimed at maintaining historical conditions to that aimed at climate change preparation (also referred to as "adaptation"), making them already out-of-date.

The BLM will need to move quickly to incorporate climate change into management strategies if they are to meet their mandate for conservation on the NLCS.

A recent Secretarial Order (#3289) from Secretary of the Interior Ken Salazar declares that "Each bureau and office of the Department must consider and analyze potential climate change impacts when undertaking long-range planning exercises, setting priorities for scientific research and investigations, developing multi-year management plans, and making major decisions regarding potential use of resources under the Department's purview." As climate change was not included in most RMPs for units of the NLCS, these long-term planning strategies will need to be revisited.

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on the NLCS. Congress has appropriated $7.5 million in 2010 for climate change adaptation planning and implementation in the NLCS. While other agencies, such as the Forest Service or National Park Service, need only to adapt their current plans to include climate change, the BLM has additional hurdles. The BLM recently issued Instruction Memorandum (IM) 2009-215, which states that the designating language of each unit supersedes the multiple use mandate under the Federal Lands Policy and Management Act (FLPMA). BLM is now tasked with managing the units of the Conservation System for the purposes for which the units were designated, which means a shift towards management for conservation as a primary purpose. On top of that shift in direction, the BLM will need to incorporate climate change planning. This document aims to give the BLM some initial guidance in this effort.

Climate change is expected to have diverse and far-reaching impacts on natural ecosystems and cultural resources. One of the most severe impacts is expected to be the exacerbation of other stressors such as habitat loss, disease, insect infestations, invasive species, wildfire, and erosion. As climate change progresses, many of these stressors will be compounded by the effects of climate change (see Paine et al. 1998). For example, invasive species are already a significant problem on NLCS lands. As climate change progresses, many native species will decline, leaving openings for even more invasions by exotic species, thereby exacerbating impacts. Another example would be the combined stressors of livestock grazing and roads on aquatic systems. Grazing reduces stream shading vegetation and both grazing and roads increase bank erosion and sedimentation. Climate change is expected to exacerbate these problems by increasing water temperatures further and by increasing erosion due to severe storms.

Many of the lands in the NLCS are managed in such a way that stressors are already limiting their conservation potential. Thus, one of the most effective approaches to preparing the NLCS for climate change will be to reduce the many management-related stressors that are currently causing damage to the unique and diverse resources of each unit. By reducing stressors such as grazing, mining, energy development, and roads, natural and cultural resources will become more resilient to climate change.

In addition to exacerbating existing stressors, climate change is expected to bring new stressors. In fact, climate change is already well underway in the West and has begun to cause widespread impacts to the natural resources of the region. In the Grand Canyon-Parashant National Monument , for example, Mohave desert vegetation is in decline due to climate-related increases in fire and long-term drought. On El Malpais National Conservation Area, managers are actively removing juniper from areas that were historically grasslands. In the Santa Rosa and San Jacinto Mountain National Monument, insect infestations in pine and mixed-

conifer forests have led to broad scale vegetation conversions. Finally, on the Snake River Birds-of-Prey National Conservation Area, increases in fire incidence have caused a loss of 50% of shrublands, a vital habitat component for raptor populations.

As climate change progresses, managers will be tasked with overseeing the transition of ecosystems from one type to another. Retaining functioning ecosystems and critical ecosystem services that people rely on will be especially challenging, as certain services are diminished or lost over time. Maintaining viable populations of many important species while allowing them to shift their ranges will also be difficult, but is imperative to conserving native species. Conserving other important resources, such as Native American artifacts and structures, geologic formations, and recreationally important rivers or trails, will become increasingly challenging as climate change progresses. There are many actions that managers can take now that will allow these unique and diverse resources to transition more successfully in the future.

Grand Staircase-Escalante National Monument

Section 1: Guiding Principles for Planning for Climate Change on Conservation System Lands

Climate change preparation strategies will be unique to each NLCS unit based on the natural resources, topography, cultural resources, socioeconomic drivers, and other pertinent issues of each area. As NLCS managers revisit RMPs to incorporate climate change, we present them with a few guiding principles.

1. **Reduce stressors** quickly and thoroughly, using all available tools, including buy-outs of permits and leases, implementation of more stringent lease stipulations (stips), communication with stakeholders about changing needs under climate change, cooperation with conservation organizations that may fund buy-outs or conduct monitoring, revegetation and recontouring of roads, cancellation of plans for new energy and recreational developments, restoration of water quality and flow, control of invasive species, necessary restrictions on some forms of recreation, and proactive prevention of new stressors. As we reviewed the RMPs (Koopman 2009), we noticed a cycle of damage to cultural and natural resources, and restoration activities. Preventing damage to resources rather than reacting to damage would, in fact, save money as well as increase the resilience of natural and cultural resources to climate change.

2. **Plan for the future, not the past.** Because climate change is well underway and is expected to worsen for many decades, regardless of changes in greenhouse gas emissions, management that assumes that historical conditions are a viable goal may be prone to failure (Lawler et al. 2009, Milly et al. 2008). Many plans, including RMPs for Grand-Canyon Parashant and Santa Rosa and San Jacinto Mountain National Monuments, ignored current trends (loss of mature pine forest to insect infestation, loss of Mohave desert ecosystems to drought and fire) and continue to strive towards maintaining historical conditions. Instead, planners will need to develop strategies for allowing changes to dominant species while also maintaining functional ecosystems and species diversity (Mawdsley et al. 2009).

Management that assumes that historical conditions are a viable goal may be prone to failure.

In order to better understand the changes at hand and the full suite of possible conditions for the future, planners will need to consult climate models. Planners can compile climate change

projections using downscaled global climate model output, which is being made more widely available (see appendix A). These projections provide a range of possible conditions for the future. Because the global community is currently on or above the business-as-usual emissions trajectory (A2), we recommend that planners use models based on this trajectory rather than the assumption that worldwide emissions will be quickly reduced (B1). Model output based on assumptions of lower emissions will underestimate mid-century and late-century warming. As new information becomes available, plans will need to be adjusted accordingly.

3. **Manage primarily for the purposes for which the units were created.** When we reviewed the RMPs for 14 units, it was clear that most were being managed for activities such as grazing and energy extraction, even when these actions conflicted with the reasons for designation. The recent BLM Instruction Memorandum 2009-215 states that "the land use plan and management direction for such a designation must comply with the purposes and objectives of the proclamation or act of Congress regardless of any conflicts with the FLPMA's multiple-use mandate." In order to prepare for climate change, extractive use should only be allowed to the extent that it doesn't impact the natural, cultural, scenic, geological, scientific, and recreational resources that are to be conserved. Extractive use activities such as oil and gas development, grazing, and commercial timber or firewood harvest would need to be studied extensively to ensure that they are compatible with conservation and that they will not impair the resilience of natural and cultural resources to climate change. The negative impacts of grazing on water quality and riparian condition have been widely documented (DellaSala and Barr 2007, Belsky et al. 1999, Wohl et al. 1996, and many others), and further study is unlikely to show compatibility with conservation.

The negative impacts of grazing on water quality and riparian condition have been widely documented.

4. **Identify climate sensitive resources** for monitoring and additional management effort. Once likely future conditions are delineated, managers, scientists, and other experts will be able to identify the species that are most likely to experience impacts. Species that are already identified as threatened and endangered are likely to be at-risk, but many common species or resources may also be at risk if future conditions are quite different than the conditions that are needed for their persistence. Climate sensitive or focal species might include those at the southern or lower extent of their range (e.g. boreal owls in Southern Colorado), species that are known to be

limited by high temperatures and drought (e.g. Desert bighorn sheep), species reliant on other climate sensitive species (e.g. piñon mouse), dispersal limited species (e.g. many species of amphibians), and species found in areas of climatic homogeneity (e.g. Great Plains species in areas without topographic diversity). Focal species or resources considered "climate sensitive" should be carefully monitored and appropriate action taken to ensure population viability. When species are declining in one area, it will be important to ensure that they are able to persist or expand in another area, even outside the conservation unit.

5. **Adopt a scientifically rigorous adaptive management strategy** that leads to increased monitoring of a variety of resources, especially those thought to be most sensitive to climate change. A rigorous adaptive management approach would (1) identify the data that will increase our understanding of the system or species under climate change, (2) collect and analyze that data in a timely manner, and (3) make well-supported management decisions that are regularly revisited and adjusted based on the latest information.

   While some changes are still uncertain, others are highly certain. For instance, in the Southwestern U.S., planners can be quite certain that average temperatures will increase, that summer temperatures will increase more than winter temperatures, that soil moisture will decrease, that species will shift their ranges, and that vegetation will experience sudden and dramatic change in composition over time. Many other changes are uncertain and effective monitoring will become increasingly important for detecting change. With careful monitoring, areas less susceptible to change could be identified for special management as they may represent refuges for native species. Slightly moister or cooler microclimates may support, for example, piñon pine in an area that otherwise is experiencing loss of this keystone species.

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6. **Identify "triggers"** or conditions that will lead to a change in management strategy for the area. By pre-identifying specific conditions that will lead to management action, managers will be better able to respond quickly and effectively to changing conditions. For example, many native aquatic species are vulnerable to changes in water temperature. Aquatic scientists could identify an average temperature and duration, which, if exceeded, would lead to specific management actions to prevent population collapse and reduce key stressors. Actions that could be prescribed may include

reducing water diversions at specific times, moving fish to cooler stream reaches, reconnecting waterways to allow fish to shift upstream, removing livestock from riparian areas, obliterating failing roads, and creating new cold water inputs to waterways.

Many of the plans and Environmental Impact Statements that we reviewed described situations where state and federal standards were not being met. Most of the units were out of compliance with the Clean Water Act, and many were not meeting state range standards. Rather than allowing degradation of water and range, monitoring to detect a downward trend and identification of specific conditions that "trigger" actions to improve conditions could prevent the BLM from being out of compliance with state and federal regulations. Similarly, identification of trigger points for other conditions, including many that may not be regulated, will be important for quickly responding to climate-related changes.

7. **Maintain flexibility while adhering to the intent of the National Environmental Policy Act (NEPA)**. Many planning documents prescribe conditions and strategies for 15-year time periods, leaving managers with little flexibility in their approach. When conditions change unexpectedly, managers are left struggling to return to Desired Future Conditions (DFCs) or historical conditions that were laid out in planning documents but are unattainable on the ground. Dynamic landscape conservation plans (Hannah and Hansen 2005) lay out interim goals and transition conditions that allow landscapes to change within specified bounds. Management plans that allow for changes in approach as conditions change on the ground will be more successful than plans for static conditions. Rather than aiming for specific species distributions and seasonal patterns, plans may instead aim for functioning ecosystems (Mawdsley et al. 2009) and native species assemblages.

Plans that allow for changes in approach as conditions change on the ground will be more successful.

8. **Experiment with "hands on" management.** Providing water for wildlife during droughts, artificially extending the wet period for ephemeral ponds, creating high-elevation wetlands that lead to late season stream flow, thinning near old growth to reduce the chance of fire, carefully planned and executed translocations, and introducing seeds of neighboring (rather than local) native plants after disturbance, are all acceptable approaches in this new and uncharted territory of climate change. Potential impacts of new management actions will need to be carefully considered and the risks of action versus inaction always weighed. Management actions should be taken in small increments and carefully

monitored while managers should be ready to quickly change course if unintended consequences are detected (Millar et al. 2007). The goals of the management effort should be clearly tied to the intent of the NLCS and authorizing proclamation, and efficacy carefully measured and documented. Many actions may only result in temporary stabilization of resources such as wildlife populations or cultural resources, but even this may give species and managers time to adjust to a changing climate more effectively.

9. **Maintain/enhance/create connectivity** of landcover types and conservation areas across the landscape. BLM will need to meet with stakeholders and other regional landowners and managers to develop a plan that allows species to shift their ranges in response to climate change. Retaining and improving connectivity will be vital, especially across elevational, edaphic, and latitudinal gradients and from currently suitable habitat to habitat likely to be suitable in the future. Such planning efforts are bound to be complicated by many other issues, but are of utmost importance for the long-term viability of many species and unique habitats. Meetings with regional land owners and managers will need to include ecologists who are well-versed in the specific objects of scientific interest of the local unit as well as climate change projections for the area. As local communities or counties plan for climate change, involvement of BLM managers in larger ecoregional issues could result in a more cohesive and effective strategy at a larger scale.

Many actions may only result in temporary stabilization of resources, but this may give species and managers time to adjust to a changing climate more effectively.

10. **Maintain/enhance/restore riparian areas, wetlands, and floodplains**. Floodplains and riparian areas are exceptionally important as harbors of biological diversity, nurseries for terrestrial and aquatic species, and buffers from flood and drought especially in dry regions (Kauffman et al. 2001, Gregory et al. 1991). Functioning wetlands and riparian areas provide climate change resilience far exceeding their proportional extent on the landscape. Yet riparian and floodplain habitats have been degraded and lost at an alarming rate, especially on BLM lands. In the NLCS, riparian and wetland habitats have been impacted by cattle. Cattle graze or trample stream banks and associated vegetation, trample fish spawning and breeding bird habitat, degrade water quality, cause hardening of meadows that would otherwise act as "sponges" and have numerous other negative impacts (DellaSala and Barr 2007, Belsky et al. 1999, Wohl et al. 1996, and many others). Additionally, many springs

Functioning wetlands and riparian areas provide climate change resilience far exceeding their proportional extent on the landscape.

and seeps go dry when they are developed for cattle watering. While fencing cattle from riparian areas is one approach, fencing is expensive and can keep wildlife from much needed water sources. A more effective approach consistent with the intent of the NLCS would be to remove cattle from NLCS units. For instance, based on studies performed by BLM and other researchers, cattle on the Cascade Siskiyou National Monument were found to be incompatible with protection of the monument's outstanding biological objects. Most livestock were removed from the Cascade-Siskiyou National Monument through passage of the Omnibus Public Lands Act and a negotiated buyout of grazing leases by conservation groups and ranchers. Cattle could be removed from other units using a similar approach. Removal of cattle is expected to lead to increased shading, bank stabilization, and lowered water temperatures in areas currently impacted. It would also allow native fish, amphibians, birds, and other taxa to experience greater reproductive and survival rates, making them more resilient to climate change.

11. **Increase communication** with Native Americans to ensure their needs for cultural resources will continue to be met under climate change. Many NLCS units are rich with Native American artifacts and structures that local tribes use for ceremonial reasons and to learn more about their ancestors. The units also support natural resources that are used by the tribes for subsistence, ceremony, and medicine. It is incumbent upon BLM to ensure continued viability of such resources for cultural and ecological purposes. As species that are important to Native Americans shift their ranges, the BLM should work closely with tribes and with adjacent land owners to continue to provide access to these species for tribal members. Culturally important resources should also be given priority for management actions that maintain their viability in the area. Finally, proactive planning to reduce negative impacts to artifacts and structures rather than waiting until damage is detected will greatly enhance the ability of the BLM to continue to fulfill their responsibilities to Native Americans living on or near NLCS units. As climate change progresses, communication between the BLM and Native Americans will be vital so the tribes understand why certain measures are being taken and the BLM understands the most important issues for the tribes.

It is incumbent upon BLM to ensure continued viability of resources for cultural and ecological purposes.

Many of the guiding principles above may sound like common sense approaches to conservation, while others are more specific to climate change. Some units of the Conservation System have been managed without clear direction as to conservation management (Koopman 2009), but the recent IM as well as some common-sense conservation practices will go a long way towards climate change preparation. All management actions and strategies, however, will need to be compatible with both the intent of the individual unit and NLCS' purpose, in addition to constant consideration of the dynamics of a changing climate (Mawdsley et al. 2009). Managing primarily for conservation and compatible uses rather than extractive use will increase the resilience of natural and cultural resources so they may remain viable under the additional stress of climate change.

Increasing the ability of natural, cultural, and scientific resources to withstand and respond to climate change is likely to be effective at maintaining resources over the next few centuries. Even if greenhouse gas emissions are sufficiently reduced in the near future, the climate is not expected to stabilize for 30-50 years. If the U.S. and other key nations fail to reduce emissions, however, runaway climate change is expected to proceed, causing such major changes to the landscape that increased resilience may no longer be sufficient. In this case, more creative and drastic management actions will need to be taken for the NLCS to fulfill its mission over the next century.

Upper Missouri River Breaks National Monument, Montana. Photo courtesy of the Conservation Alliance.

Section 2: Climate change impacts to five units of the NLCS

Below we discuss what climate change may look like in the following five NLCS units (numbers correspond to those in white circles on Figure 1):
(1) Santa Rosa and San Jacinto Mountain National Monument
(2) El Malpais National Monument
(3) Canyons of the Ancients National Monument
(4) Grand Canyon-Parashant National Monument
(5) Snake River Birds of Prey National Conservation Area

These five areas provide a sample of five different BLM Level III Ecoregions (Fig. 1); three are priority ecoregions for BLM climate adaptation strategy development (Colorado Plateau, Mohave Basin and Range, and Sonoran Desert).

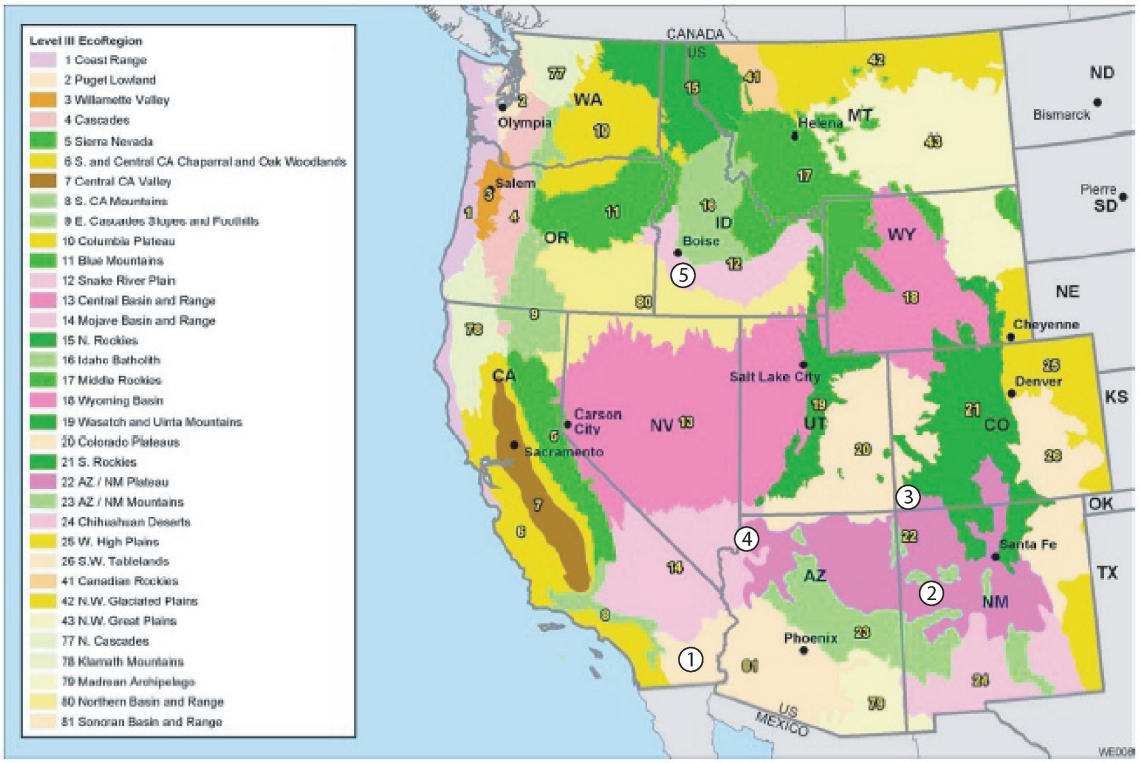


Figure 1.The five NLCS units sampled for this project on a map of the 81 western ecoregions identified by the BLM (from EPA 2002)

Climate change in Santa Rosa and San Jacinto Mountain National Monument, California

The Monument: The Santa Rosa and San Jacinto Mountain National Monument is located in Southern California, approximately 100 miles east of Los Angeles. The Monument extends from near sea level to San Jacinto Peak at 10,834 feet. The BLM portion of the Monument occurs primarily at elevations below 2,700 feet while the Forest Service portion occurs from 2,000 – 10,834 feet. Natural communities within the Monument have been placed in eight classifications: sand dunes and fields, desert scrub, chaparral, desert alkalai scrub, marsh, dry wash woodland and mesquite, riparian, and woodland and forest. The Monument is a recognized "hotspot" of biological diversity with numerous species found only in that region. The Cahuilla Indians occupied the Monument and artifacts are common, especially near the palm oases where the Cahuilla made their residences. Many sites are of ancestral and ceremonial significance to the Cahuilla Tribes. Four Cahuilla Indian reservations have lands within or adjacent to the Monument.

The Climate: The semi-desert system of the Santa Rosa and San Jacinto Mountain National Monument has an arid climate that varies in temperature based on aspect and elevation. The western slopes of the San Jacinto are cooler and receive more moisture than the eastern slopes. West of the Monument are the largely developed areas of Los Angeles and the Pacific Ocean. To the east is the Salton Trough, one of the hottest and most arid areas in the Northern Hemisphere. The San Jacinto Range is effectively isolated, resulting in an amazing assemblage of species unique to this region.

Climate change projections that were specific to the area of Santa Rosa and San Jacinto Mountain National Monument were difficult to find, but regional projections are presented (Fig. 2 and 3). Temperatures for Southern California are expected to increase, on average, by 1.5° F to 4.5° F (0.8° C – 2.5° C) by mid century and 4.5° F – 7.9° F (2.5° C – 4.4° C) by late century (Cayan et al. 2005). Warming will be greater in the summer as compared to the winter (Fig. 2). An ensemble of 18 global climate models projects an increase in summer temperature by 7-8° F and an increase in winter temperature by 5-6° F by the end of the century (data from NOAA, available at www.southwestclimatechange.org/climate/southwest/temperature-changes), based on a moderate emissions scenario. Because we are currently on a higher emissions trajectory, warming is expected to be even greater.

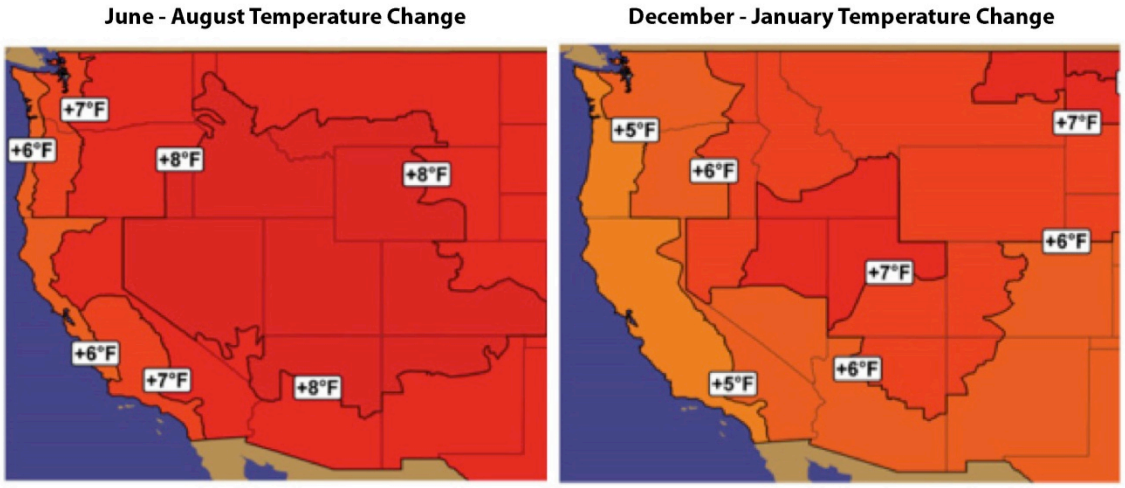


Figure 2. Projected temperature change across the western U. S. by 2091-2100 (from the Southwest Climate Change Network).

Overall precipitation projections range from 35% drier to 17% wetter, on average, but the general pattern of precipitation seasonality and variability remain the same as historical conditions (Messner et al. 2009, Cayan et al. 2005). Continued variability in precipitation over the next century, in addition to higher temperatures, will cause the area to be prone to increasingly severe drought. In addition, increased ENSO activity is expected to lead to more frequent and severe drought (20% drier conditions; Cayan et al. 2005).

Climate Change Impacts:

Climate change impacts are not necessarily gradual but rather, a series of sudden shifts in state. Santa Rosa and San Jacinto is already in the midst of one of these shifts. Pine and mixed-conifer forests in the Monument are experiencing insect infestation and are dying at an alarming rate, with hundreds of acres

Climate scientists expect that many areas will experience more severe storms than in the past due to the greater amount of energy that builds up with higher temperatures. Santa Rosa and San Jacinto Mountain may experience more severe storms, but they may not be more frequent than historical storms.

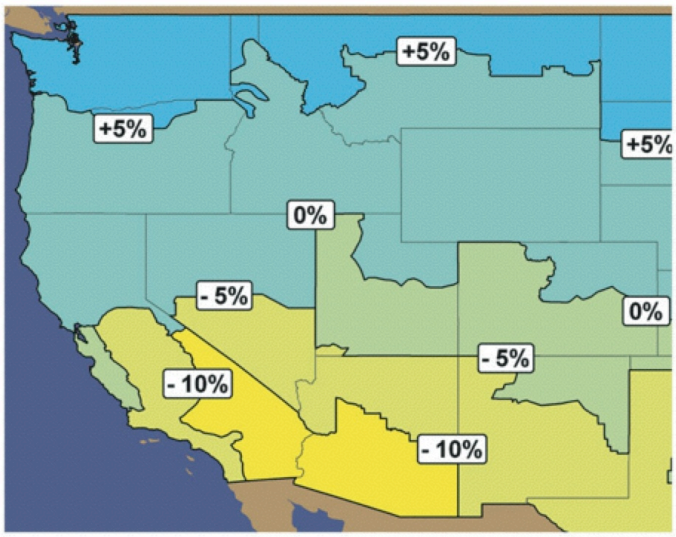


Figure 3. Change in average annual precipitation across the western U.S. by 2091-2100 (from the SW Climate Change Network).

already affected. The current Resource Management Plan for the Monument fails to recognize current climate change impacts or make plans for future conditions that are different from those found historically. As the coniferous component of the Monument dies off in its current distribution, ecologists and natural resource managers will need to determine the best approach to ushering in a new vegetation component that is not primarily composed of non-native species or noxious weeds. They will also need to consider whether coniferous forest will remain viable in some parts of the Monument and surrounding area, and if there are newly suitable locations for this important habitat type.

Santa Rosa and San Jacinto Mountain National Monument will surely experience additional severe impacts from climate change, but the vertical topography of the Monument will likely be beneficial under climate change. As climate change progresses, scientists are concerned about the very short time frame that plants and animals will have for shifting their ranges to find new areas with a suitable climate. Many species are poor dispersers and are unlikely to move to new areas, especially if those areas are distant or disconnected. Other species will be unable to find suitable habitat even if they are able to disperse long distances. Due to its range of elevations, from below sea level to over 10,000 feet, Santa Rosa and San Jacinto National Monument is host to a large variety of life zones. Many species may have to move just a few yards to find a newly suitable climate. Those species already at higher elevations, however, such desert bighorn sheep, mountain yellow-legged frog, southern rubber boa, and Tahquitz ivesia, may be at risk of disappearing from the Monument. Because many of these species are endemic to the area, their declines put them at risk of extinction, and managers will need to carefully consider what measures should be taken to prevent their extinction.

Many species in the Santa Rosa and San Jacinto Mountain National Monument are desert-adapted species that have withstood severe drought conditions in the past, and may be able to persist under hotter, drier conditions. These include the Coachella Valley round-tailed ground squirrel, Palm Springs pocket mouse, flat-tailed horned lizard, desert tortoise, desert slender salamander, LeConte's thrasher, burrowing owl, Coachella Valley milk vetch, and Orocopia sage, among others. Climate change threatens to intensify severe drought due to higher temperatures. Whether or not desert-adapted species in the Monument will be able to persist under such conditions needs to be carefully assessed on a species-by-species basis by the appropriate experts. Peninsular ranges desert bighorn sheep, for example, are limited by water and may be especially at risk from severe drought, but may be able to persist with water provisioning. Other species may need assistance in moving to slightly cooler microclimates. By removing additional stressors, such as grazing, OHV travel, recreational impacts, and non-native plants and animals, some species may be able to become established in suitable areas on their own, especially

if connectivity is enhanced and maintained.

Santa Rosa and San Jacinto Mountain National Monument is dotted with palm oases that are able to persist in small seeps and washes. Species distribution and palm reproduction in these oases are determined by water availability (Vogl and McHarhue 1966). With increased temperatures and evaporation, many of these oases are expected to disappear. Due to the importance of these areas to a variety of endemic species, careful monitoring of oases should be undertaken and those at risk identified. Some species may need to be established in new localities to ensure their persistence. Any remaining stressors may need to be removed from the oases. The oases should also be given priority invasive species control.

Santa Rosa and San Jacinto Mountain National Monument is important to the Cahuilla Indian Tribe. Artifacts from early residents abound throughout the Monument. Increases in severe storms and fire could have negative impacts on these artifacts, as erosion could increase. Loss of vegetation cover due to extended drought may also result in increased erosion. Impacts of climate change that affect the ability of the BLM and Forest Service in meeting their responsibilities to the Cahuilla Indian Tribe will need to be carefully assessed and management alternatives considered.

Santa Rosa and San Jacinto Mountain National Monument

Reducing Stressors: Current stressors, such as grazing, energy development, invasive species, roads, and others, are currently acting to reduce the resilience of natural and cultural resources to climate change. As climate change imposes a series of additional stressors to natural and cultural resources, existing stressors could be reduced to maintain resilience (Mawdsley et al. 2009, Julius and West 2007, Lovejoy 2005). Because climate change is expected to exacerbate existing stressors, reducing those stressors can have an even greater benefit as climate change progresses.

Santa Rosa and San Jacinto Mountain National Monument has fewer stressors than many other NLCS units. Grazing is already greatly reduced, and only two miles of road are open to the public. Mineral and energy development are not allowed. While the stressors are comparatively low, they can still be reduced further to prepare for climate change. Because cattle are so damaging to sensitive ecosystems, even in small numbers, retiring all grazing permits on the Monument may have some benefit. Additionally, as climate change poses the threat of increased storm severity, revegetation and recontouring of Dunn Road are recommended. This road was created illegally, is costly to maintain, is closed to the public, and causes erosion. The road also crosses through sensitive bighorn sheep areas. Restoration to natural contours and vegetation would increase the resilience of endemic species and ecosystems to climate change.

Other factors: The BLM, as managers of the Santa Rosa and San Jacinto Mountain National Monument has a significant responsibility to the Cahuilla Indians to preserve cultural resources, including artifacts and culturally important species. As climate change results in changes to precipitation patterns, storm severity, and species ranges, communication with the Cahuilla Indians about their needs would allow the BLM to make suitable management decisions. Information on locations for culturally important species and artifacts is often sensitive information and the BLM will need to maintain a certain level of trust with the tribes in order to develop strategies without compromising traditional knowledge.

Quick guide:

- Reduce stressors (grazing, Dunn road, invasive species, recreation impacts)
- Monitor palm oases for endemic species declines.
- Identify and monitor climate sensitive species such as bighorn sheep.
- Identify refuges (oases expected to remain moist, pockets of wetter or cooler microclimate, middle to higher portions of a species' range).
- Aggressively control invasive species and other stressors in oases, potential refugee, and other sensitive areas.
- Consider water or forage provisioning for imperiled wildlife.
- Assist the migration of rare plants and wildlife, as needed.
- Monitor and maintain resources important to Cahuilla tribe.

Climate change in El Malpais National Conservation Area, New Mexico

The Conservation Area: El Malpais National Conservation Area encompasses 263,000 acres and is adjacent to El Malpais National Monument (administered by the National Park Service). The Conservation Area encompasses striking geological formations, semi-desert ecosystems, and archaeological artifacts from over 10,000 years of habitation by numerous Native American tribes. Dominant ecosystem types on the Conservation Area include grassland-shrublands, Ponderosa pine woodlands, piñon-juniper woodlands, and special-feature habitats (including volcanic plains, cinder cones, caves, and riparian wetlands). Only 80 miles from Albuquerque, the Conservation Area is an important destination for local recreationists. Multiple use in El Malpais Conservation Area includes development of facilities for recreation, grazing, mining, and oil and gas development.

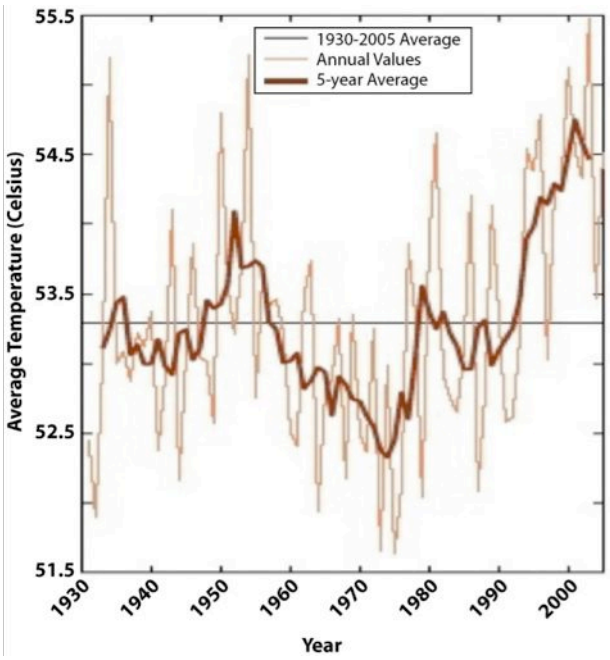


Figure 4. Change in average temperature in New Mexico since 1930.

The Climate: The semi-desert climate of El Malpais National Conservation Area receives about 10 inches of rain, on average, per year, mostly in the monsoon season (July-Sept.). Daytime temperatures range from 80-100° F during the summer and 30-50° F during the winter. Nighttime temperatures can often dip below 0° F during the winter. The Conservation

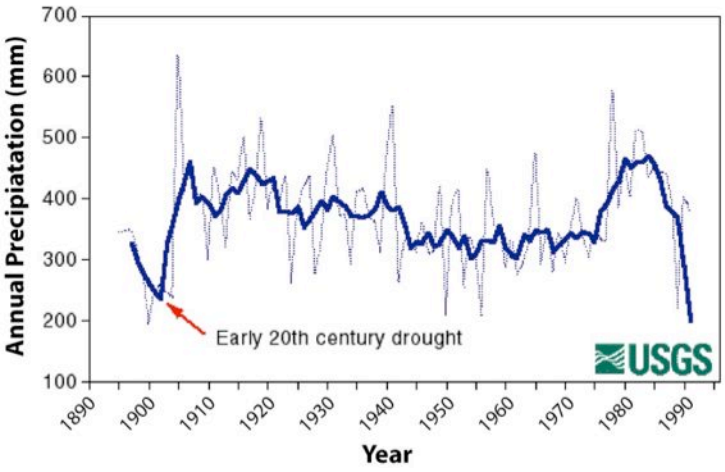


Figure 5. Average annual precipitation in the Southwest since 1890.

Area ranges from 6,500-8,000 feet in elevation.

Climate change in the Southwestern U.S. is well underway and expected to be especially severe and transformative. New Mexico has warmed by 1.8° F over the last 30-40 years (Fig. 4) and has experienced drought since 1985 (Fig. 5). Experts warn of an "imminent transition" to a more arid climate (Seager et al. 2007) because small declines in precipitation lead to much larger declines in water traveling through the landscape, especially when temperature rises. Based on an ensemble of 19 global climate models, future conditions are likely to resemble "dust bowl" conditions from the 1930s across the Southwest. Future projections for the climate of the area include:

- 4-10°F higher temperatures by the end of the century (Fig. 6)
- Greater warming in the summer than in the winter
- 5-10% decline in annual precipitation (Fig. 3)
- 35-40% decline in spring precipitation
- Earlier spring snow melt
- Substantial declines in snowpack
- Larger, more destructive flood events

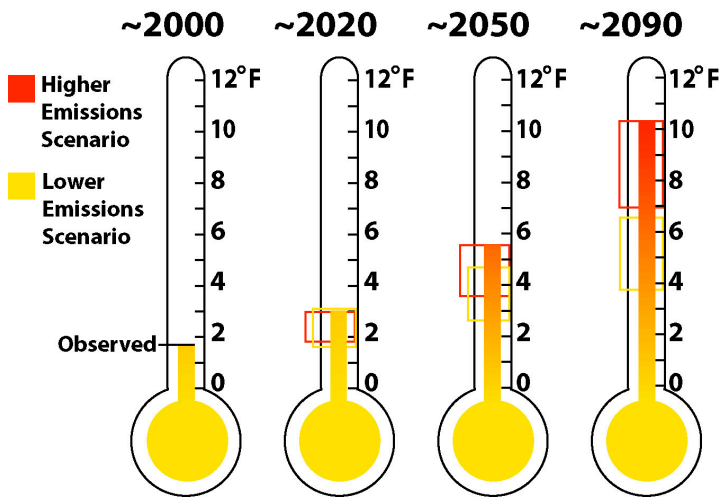


Figure 6. The average temperature in the Southwest has already increased roughly 1.5°F compared to a 1960-1979 baseline period. By the end of the century, average annual temperature is projected to rise approximately 4°F to 10°F above the historical baseline, averaged over the Southwest region. The brackets on the thermometers represent the likely range of model projections, though lower or higher outcomes are possible.

Climate Change Impacts:

Climate change impacts are already well underway on El Malpais National Conservation Area. Hundreds of thousands of acres of juniper have encroached into areas that were historically grasslands. Juniper encroachment is at least in part due to livestock grazing and fire suppression, as well as long-term post-glacial warming. Human-caused climate change has likely sped up the rate at which juniper was encroaching into grasslands. Long-term juniper control is costly, time consuming, and may be futile. By defining a set of Potential Natural Conditions (PNCs), and striving to convert vegetation from one type to another to meet those PNCs, the BLM may be attempting to create vegetation communities in areas where they are no longer supported by the local climatic conditions.

As natural vegetation becomes increasingly drought stressed in the Southwest, insect outbreaks and fire will become increasingly common, as they already have throughout much of the region. Insect outbreaks and fire are expected to be the major mechanisms that lead to vegetation change. If native species that are more tolerant of increased drought stress are unable to quickly colonize new areas, non-native invasive species will dominate the landscape. This could have catastrophic impacts to native wildlife that are dependent on specific types of habitat.

El Malpais National Conservation Area is host to ephemeral playa lakes that fill during the rainy season and go dry during the rest of the year. These lakes are important habitat for migratory birds, invertebrates, and amphibians. With increased aridity throughout the region, the playa lakes are expected to be dry for longer periods and shallower lakes may disappear. Species dependent on these lakes are especially vulnerable. The management at El Malpais already provides water for livestock and may also want to consider artificial filling of playa lakes at strategic times during drought years if they wish to maintain certain species.

Another important component of the ecosystem that may be threatened by climate change is the piñon pine. Piñon pine is less drought tolerant than its counterpoint – juniper. As juniper expands throughout the west, piñon pine is dying at alarming rates. Piñon pine is often the backbone of diverse ecosystems, with many species reliant on its heavy crops of pine nuts. Managers will need to identify which areas of piñon pine are most at risk from drought and the species associated with them. Maintaining areas of piñon pine that are in slightly moister or cooler microclimates, and encouraging them to expand, should be a priority.

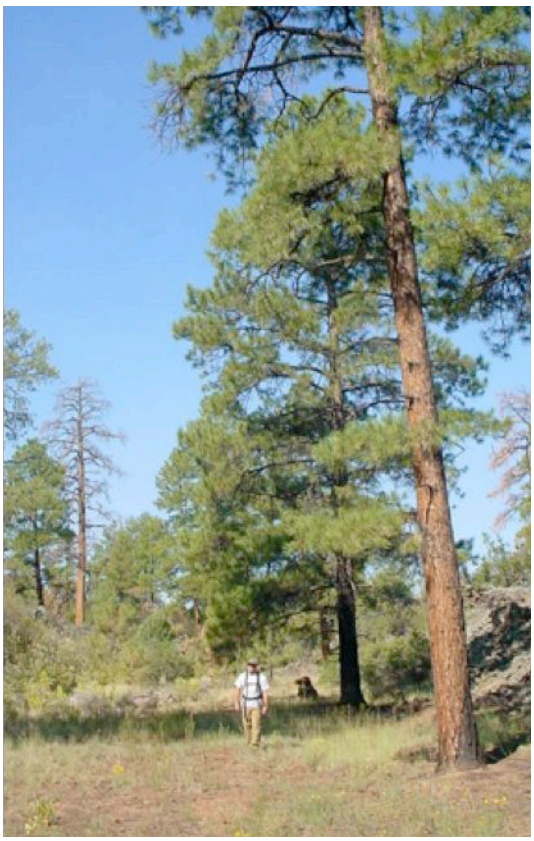
The mountain plover is one of many species on El Malpais National Conservation Area that may be at risk from climate change. As juniper expands into grasslands, Mountain plover may lose suitable habitat. A thorough analysis of vegetation types and trajectories under climate change would need to be conducted to

determine future habitat availability for mountain plover. Areas expected to support this species will need to be identified to ensure that sufficient habitat continues to be available.

The El Malpais EIS reports that no surveys have been conducted for special status species, but that some have been randomly observed. As climate change progresses, monitoring of species will become increasingly vital to document and respond to changes in ecosystems. As species shift to new areas, managers will need to keep tabs on the biological resources of the Conservation Area in order to fulfill the mandate to protect resources on the unit.

The Resource Management Plan for El Malpais relies heavily on PNCs, which are determined based on soils, other physical features, and climate. The conditions that have been identified as "ideal" for the Conservation Area are currently out-of-date because they do not take climate change into consideration. Thus, many management actions are likely to fail because they are striving towards conditions that are no longer viable in a more arid and variable climate.

Reducing Stressors: Over-grazing on El Malpais National Conservation Area has been implicated in the deterioration of much of the natural vegetation of the area. Removing the stress of grazing from the Conservation Area would advance the area towards preparing for climate change. When NPS excluded grazing from its adjacent National Monument, improvements in vegetation were soon apparent, although subsequent drought has slowed the recovery. If vegetation is allowed to recover sufficiently prior to the more severe impacts of climate change, current species of native vegetation would have a greater chance of long-term viability on the landscape.



El Malpais National Monument (NPS)

El Malpais has many other stressors in addition to grazing. Road densities appear to be quite high and can cause stress to both natural and cultural resources. Roads provide a movement corridor for invasive species, which can quickly outcompete native species as vegetation types change. By reducing the influx of invasive species, managers can improve the likelihood

that native species will become established in new areas. Roads also provide travel corridors for people, increasing the risk of fire ignition and damage to cultural resources. As aridity increases and cultural artifacts become more exposed, visitors to the area are more likely to remove artifacts that are important to Native Americans. Roads also create barriers to dispersal for many species, thereby preventing them from shifting to new areas as the climate changes. Finally, roads cause sedimentation in sensitive aquatic areas, thereby negatively impacting aquatic species. Many roads on El Malpais National Conservation Area are slated to be closed, but not necessarily recontoured and revegetated. Simply closing a road is often insufficient in reducing stress, especially to aquatic ecosystems.

In addition to the current stressors of grazing and roads on El Malpais, the Conservation Area has plans for increasing the footprint of recreation on the unit. The Resource Management Plan reveals extensive planning for new campgrounds, roads, pull-outs, trails, signs, developed cultural resource areas, etc. Some other NLCS units, however, take another approach and try to locate developments off site; this option should be considered for the El Malpais Conservation Area. We would encourage the managers of El Malpais to reconsider extensive on-site developments so that the natural and cultural resources of the unit have increased chances at remaining resilient to climate change.

Other factors: El Malpais National Conservation Area is part of a larger landscape that includes El Malpais National Monument (NPS) and numerous private inholdings as well as private land surrounding the area. The BLM will need to work across these jurisdictions to create long-term regional plans that are effective at allowing species movements and increasing resilience. NPS is well underway with its scenario-based planning efforts for climate change and the two agencies will need to communicate as well as collaborate with private landowners for collective action.

Quick guide:

- Reduce stressors (road density, new developments, grazing, prairie dog shooting, invasive species).
- Buy out mineral leases.
- Monitor playa lakes and consider measures to support their viability.
- Identify climate refuges for keystone species (e.g. piñon pine or prairie dogs).
- To preclude invasive species, identify and encourage more drought tolerant native species to expand where suitable/beneficial.
- Increase monitoring of special status and climate-sensitive species.
- Develop PNCs that are more flexible to changing conditions and develop goals for maintaining ecological function when species composition changes.

Climate change in Canyons of the Ancients National Monument, Colorado

The Monument: Canyons of the Ancients National Monument, covering 164,000 acres, has the greatest concentration of archaeological resources in the nation. This extraordinary Monument was created in 2000 by Presidential proclamation. The Monument is host to cliff dwellings, villages, shrines, and other artifacts from the Ancestral Pueblo people and other Native American tribes. It also is host to a wealth of ecosystems and species, including unique reptiles such as the Mesa Verde nightsnake, long-nosed leopard lizard, and twin-spotted spiny lizard. The Monument is located in the four corners region of Colorado.

The Climate: Canyons of the Ancients has a semi-desert climate, with dry sunny days, clear nights, and extreme daily temperature fluctuations. Average summer high temperatures are 90-95° F and lows are 55° F. Winter high temperatures average 40° F with lows around 15° F. The area has low precipitation, with the driest months in May and June. Snowfall is possible throughout the fall and winter.

The final RMP for Canyons of the Ancients was just released in July of 2009, yet already needs to be updated to include climate change. Climate change is well underway on the Colorado Plateau, and the impacts of climate change are expected to be especially severe in the region.

The Colorado Plateau is already experiencing severe impacts from climate change in the form of an extended drought that has lead to broad scale vegetation die-off. Since 1999, the Monument has experienced precipitation at levels of 49-89% of normal. Four of the 10 driest years on record occurred during this period.

The southwest region has warmed by 1.8° F over the last 30-40 years and has experienced drought since 1985 (Fig. 5). Experts warn of an "imminent transition" to a more arid climate (Seager et al. 2007) because small declines in precipitation lead to much larger declines in water traveling through the landscape, especially when temperature rises. Future projections for the climate of the area include:

- 4-10°F higher temperatures by the end of the century (Fig. 6)
- Greater warming in the summer than in the winter
- 0-5% decline in annual precipitation (Fig. 3)
- 25-30% decline in spring precipitation
- Earlier spring snow melt
- Substantial declines in snowpack
- Larger, more destructive flood events

These changes will have significant impacts on vegetation, wildfire, stream flow, water temperature, and wildlife. They will also have impacts on the natural and cultural resources

that were identified for protection when the Monument was created.

Climate Change Impacts: Under climate change, many resources in Canyons of the Ancients are at risk. The number of sites of archaeological significance on the Monument is estimated at 20,000-30,000 – most of which are undocumented. These sites are threatened primarily by current activities such as oil and gas development, tourism, vandalism, and off-road travel. Climate change will have two primary impacts on archaeological sites; it will exacerbate many of the current stressors and it will cause increased damage from erosion through loss of vegetation and increase in severe storms.

Climate change is expected to exacerbate the current stressors in many ways. Climate change is likely to increase the incidence of wildfire, which in turn would damage cultural resources, and also cause decreases in vegetative cover. If climate change leads to less vegetative cover on the Monument, more archaeological resources may be exposed, leading to increases in vandalism and looting. Similarly, loss of vegetative cover, in addition to increased visitation, could lead to increases in illegal off-road travel and subsequent damage to resources. The potential increase in severe storms is expected to negatively impact cultural resources as well. This could be especially damaging for the many structures with standing walls that are already experiencing erosion.

Canyons of the Ancients National Monument

Canyons of the Ancients National Monument is also home to a diverse array of native and endemic species. The Monument is characterized by a semi-desert ecosystem with piñon-juniper, sagebrush, grassland, and riparian habitats. Piñon-juniper is important to a variety of piñon-juniper obligates in the area. Climate change projections indicate that the piñon component of this habitat may decline due to increased drought and aridity, while juniper will likely remain common. Many obligates, however, rely on the seeds from piñon pine, including Clark's nutcracker, piñon jay and piñon mouse. These species are at risk under climate change. A widespread loss of piñon pine due to extended drought and increased fire is already occurring across the Southwest. Many other species, including many species of bats (most are special status), the gray flycatcher, the juniper titmouse, and the gray vireo, will likely be able to

persist as long as the area maintains its wooded structure. If fire were to increase enough to wipe out the juniper component, many of these species could become less common. A variety of reptiles are especially numerous in the piñon-juniper woodlands and could also be impacted, including the western whiptail, plateau striped whiptail, tree lizard, and striped whipsnake.

Vegetation models for other areas show widespread replacement of sagebrush by grassland. Across the western U.S., 80% of sagebrush is projected to disappear if temperatures warm by 6° F, on average. In order to determine the likely persistence of sagebrush in Canyons of the Ancients National Monument, model output specific to this area would need to be produced. If sagebrush habitat were to decline in the Monument, a variety of species could be impacted, including sagebrush lizard, sage thrasher, sage sparrow, Brewer's sparrow, Gunnison sage grouse, Gunnison's prairie dog, Ord's kangaroo rat, Hopi pocket mouse, and others.

Riparian habitat represents only a small percentage of the Monument, yet is host to a large percentage of the area's wildlife species. Increased aridity in the area is expected to cause the riparian zone to contract, while increased storm severity is expected to increase erosion and stream sedimentation. These changes could have negative effects on both aquatic and riparian species, including many native fishes, breeding birds, and amphibians. Maintaining, restoring, and increasing riparian zones and restoring floodplains would allow for greater resilience in this disproportionately important habitat type.

As piñon or sagebrush decline, the most likely invader in the area is cheatgrass, a noxious weed. By increasing the resilience of the native vegetation of the area to climate change, the spread of cheatgrass in the Monument could be reduced. Two BLM-listed plant species reside in the Monument and should be closely monitored as climate change progresses.

Reducing Stressors: The most effective approach to preparing for climate change is to reduce current stressors sufficiently such that climate change related stress to natural and cultural resources has less damaging impacts. Canyons of the Ancients National Monument is greatly impacted by a variety of stressors, including grazing, CO_2 drilling, mountain biking, OHV travel, other recreation, and more. Grazing and drilling appear to be the two greatest stressors on the Monument. Livestock grazing affects 98% of the Monument and energy and mineral leasing affect 81%.

The EIS completed in 2009 extensively documents the degradation of natural resources caused by cattle grazing on the Monument. They detail the loss of mixed-age cottonwood gallery forest due to grazing, as well as the disturbance to biological soil crusts. The EIS also reveals that only 3 of 11 springs in the Monument meet the standards of Proper Functioning

Condition (PFC) due to grazing impacts. Livestock grazing was responsible for increasing sedimentation in streams, compacting streambanks, and development of springs for water troughs (resulting in dewatering of the spring). Removal of cattle from the Monument would release natural ecosystems from a number of current stressors, resulting in greater resilience and resistance to climate change as recovery proceeds. Due to the unexpectedly fast nature with which climate change is advancing in the Southwest, cattle would need to be removed relatively soon to allow systems to recover to some extent prior to the more extreme impacts of climate change that are to come.

Cattle grazing is not only a threat to natural ecosystems; it also threatens cultural resources. Most of the 20,000-30,000 artifacts on the Monument remain undocumented. Cattle are likely to increase erosion near riparian zones and can trample artifacts that have not been excavated. Removing cattle would benefit long-term stability of ancient Native American artifacts that otherwise may be lost or damaged. When these artifacts are lost, so is the history of the people and the region.

Energy development on the Monument is for oil, natural gas, and CO_2, with CO_2 being the most significant mineral resource. There are 125 active wells on the Monument. More than 80% of the Monument is already leased for energy development. The newly released Resource Management Plan calls for at least 880 acres of new drilling sites.

CO_2 wells on Canyon of the Ancients National Monument

CO_2 is pumped from under the ground and transported to Texas to inject into oil wells, thus increasing their yield. There is some irony to the drilling of CO_2 as a contributor to the stress of climate change on the natural and cultural resources on a National Monument, considering the role of CO_2 as a leading cause of climate change.

Energy development increases stress to natural and cultural resources in numerous ways. Well development involves new road creation, which leads to erosion and stream sedimentation. Direct impacts to cultural resources during the development period are supposed to be avoided, but are likely to occur anyway. Many wildlife species, such as sage grouse, are sensitive to development and do not continue to use the area, even if their habitat remains largely intact (Doherty 2008). The development of new roads (Canyons of the Ancients is one of the only Monuments in the NLCS in which road density is expected to increase) and influx of maintenance vehicles help to spread invasive species. Energy development also can lead to

poor air quality, spread of wildlife disease, such as West Nile virus (from mosquitoes in open water tanks), fragmentation of habitat and loss of movement corridors. All of these impacts greatly reduce the resilience of local wildlife populations to climate change and other stressors.

As climate change progresses, habitat connectivity will become increasingly important for persistence of species across the landscape, especially connectivity across elevational and vegetational gradients. Species will need to be able to move to new localities in response to the changing climate. Oil and gas development is a leading form of habitat fragmentation in the area due to the patchy footprint of wells over the landscape and the abundance of roads needed to support the industry. In order to plan for climate change, additional drilling should be halted, preferably by trading for leases on already impacted BLM lands or buying out active leases. Many currently active wells in Canyons of the Ancients are nearing the end of their production. As wells go dry and are capped, oil and gas will eventually have fewer impacts on the resources that are unique to this area and that are currently being damaged. Many roads will need to be decommissioned, recontoured, and revegetated.

Canyons of the Ancients is one of the most unique and spectacular units of the NLCS, yet it also has some of the highest levels of impact from a variety of uses. Because the impacts from grazing and oil and gas development are so widespread, reducing these two activities would have long-lasting positive effects on the resources of the Monument.

Quick guide:

- Reduce stressors (CO_2 wells, energy development, road density, grazing, invasive species, recreation impacts, West Nile Virus).
- Buy out mineral leases.
- Improve water quality.
- Protect and restore riparian areas.
- Identify refuges for sensitive habitats such as sagebrush and piñon pine.
- Protect important cultural resources from fire, erosion, and vandalism.
- Increase communication and collaborative planning with Native American tribes.
- Identify and monitor climate-sensitive species such as bighorn sheep.
- Increase dispersal opportunities for species by maintaining and enhancing connectivity within and outside the Monument.
- Work with regional landowners to develop long-term plans that allow for shifts in species yet retain ecosystem function.

Climate change in Grand Canyon-Parashant National Monument, Arizona

The Monument: The Grand Canyon-Parashant National Monument is administered by both the BLM and NPS. Encompassing over 1 million acres, the Monument was created in 2000 by Presidential proclamation to protect an array of scientific, biological, geological, hydrological, cultural, and historical objects. Directly north of the Grand Canyon, the Monument is characterized by scenic vistas, rough canyons, ponderosa pine stands, expansive piñon/juniper woodlands, and Mojave desert. Significant cultural resources are found in the Monument from Native American habitation and from early European settlers. Important wildlife habitat is also found, supporting numerous special status species, including California Condor, desert tortoise, yellow-billed cuckoo, and other species.

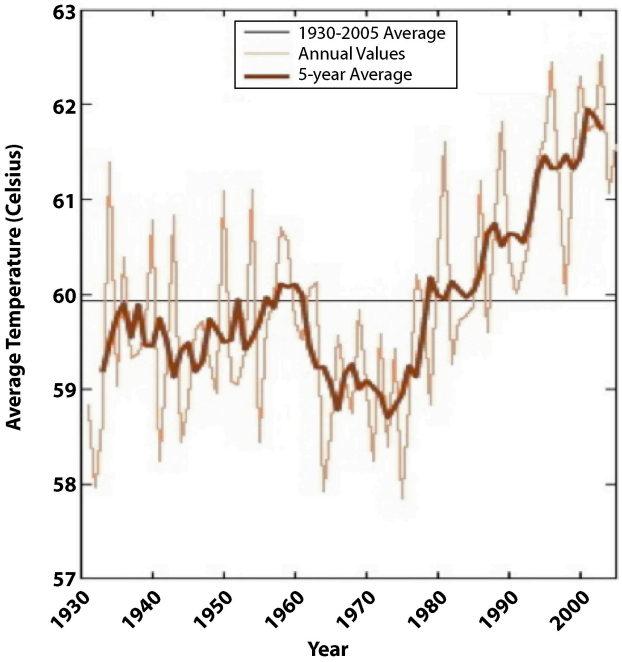


Figure 7. Change in average temperature since 1930 in Arizona.

The Climate: The climate of Grand Canyon-Parashant National Monument is expected to change similarly to that of El Malpais and Canyons of the Ancients. Temperatures across Arizona have already warmed 2.5° F since 1976 (Fig. 7). Land managers are already battling climate change on the Monument as Mohave desert vegetation is dying from fire and drought. Future projections for the climate of the area include:

- 4-10°F higher temperatures by the end of the century (Fig. 6)
- Greater warming in the summer than in the winter
- 10-15% decline in annual precipitation (Fig. 4)
- 30-35% decline in spring precipitation
- Earlier spring snow melt
- Substantial declines in snowpack
- Larger, more destructive flood events

Climate Change Impacts:

Climate change will have similar impacts on Grand Canyon-Parashant National Monument as it will have on other Monuments in the region (El Malpais, Canyons of the Ancients, and Santa Rosa and San Jacinto Mountain). Increased aridity will cause changes to dominant vegetation, with declines of piñon pine and sagebrush likely. As some species of plants decline, influx of cheatgrass and other invasive species is likely, exacerbating the already severe problem of invasive species spread. Monitoring and quick response to new invasions will be vital to preventing loss of native species habitat.

Ponderosa pine habitats are only found at the highest elevations of the Monument, putting them at risk under climate change. Gambel oak, found closely associated with ponderosa in the area, may also disappear from the Monument. Intensive efforts to restore the historical structure and fire frequency to these stands are currently underway. Multiple species of wildlife, including Kaibab squirrels, goshawks, and Merriam's turkey, are dependent on ponderosa in this area.

The most common ecological zone in the Monument is the Great Basin ecological zone, which includes sagebrush and piñon-juniper communities. Sagebrush and piñon pine are largely expected to decline with climate change, although vegetation projections specific to the area would need to be carried out to get more information. Juniper may increase or remain constant, while grasslands are expected to expand but become less productive. Fire frequency is likely to increase throughout the area.

In the Mohave desert ecological zone of the Monument, Joshua trees are common. A 2005 study on Joshua tree range projections under climate change demonstrated that Joshua trees will be greatly limited by poor seed dispersal (Cole et al. 2009), and may no longer persist in Arizona as climate change advances. If Joshua tree seeds are able to move to suitable locations, they will be able to persist in new areas, but humans would need to move the seeds to prevent extinction of this striking species. The Mohave desert ecological zone is already declining in the Monument due to increased fire and invasive cheatgrass. The RMP plans for continued historical coverage of the Mohave desert ecological zone rather than planning for transition as Mohave desert species decline.

On a positive note, the Grand Canyon-Parashant National Monument encompasses a transition area between Mohave desert ecosystems and Great Basin ecosystems. This transition area allows for greater biological diversity across a range of elevations and soil types that should allow for many species to shift and expand their ranges. While many species will undoubtedly decline and disappear, and some already are doing so, it is likely that some will find new areas of suitable climate and expand their ranges. Monitoring will be vital to detect ecosystem-wide changes and determine when management can

enhance declining populations or allow them to move to new areas. Preventing invasive species from precluding native species expansions will be especially challenging.

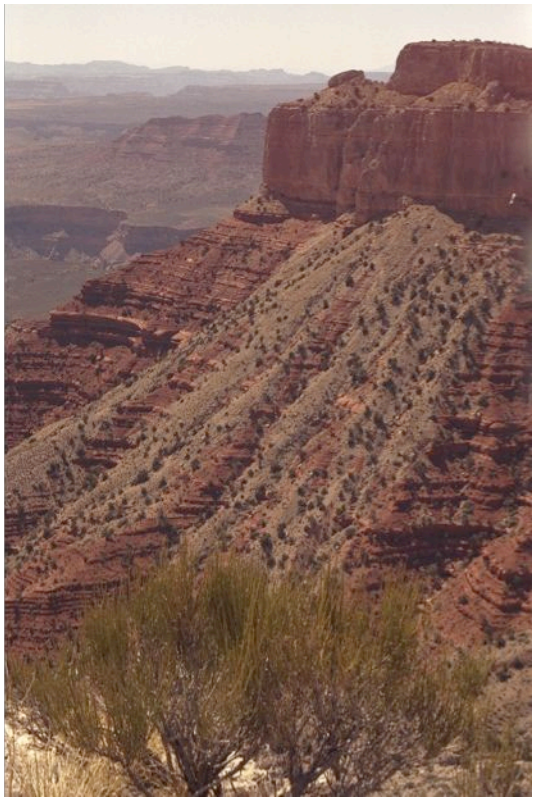
Climate change will greatly impact the success of the current RMP. The current plan calls for reintroductions of many species to their historic ranges, and identifies specific amounts of each desired future condition (DFC). Mechanical and chemical vegetation treatments are prescribed to try to convert one type of vegetation to another to meet DFCs. Many actions in this plan are futile under climate change and a new approach will need to be considered that allows for and encourages transition of one native vegetation component to another.

Reducing Stressors: Grand Canyon-Parashant's EIS opens with the following quote – "Something's gotta happen to keep it the same" Kelly Heaton, 2002.

While "keeping it the same" is no longer a viable option, we agree that "Something's gotta happen". For instance, Grand Canyon-Parashant National Monument supports over 1,700 miles of roads open to the public, with only 188 miles scheduled to be closed. As mentioned before, roads increase the stress to cultural and biological resources. They provide greater numbers of people with access to sensitive resources, increase the chance of fire ignition, increase looting or vandalism, increase poaching of species like desert tortoise, and increase the spread of invasive species. They also lead to siltation and degradation of aquatic habitat, and reduce habitat connectivity. Roads will need to be greatly reduced on Grand Canyon-Parashant to prepare for climate change. Road reductions would have immediate positive effects on a variety of sensitive species, including desert tortoise and Brady pincushion cactus.

OHV travel presents an additional stress to natural and cultural resources. OHV travel is common in neighboring areas and may need to be largely eliminated from the Monument. If OHVs are to continue to use open roads, law enforcement should be increased to prevent illegal off-road use of OHVs and the resulting damage to resources.

Eighty percent of the Monument is



Grand Canyon-Parashant National Monument

open to grazing. Many riparian areas do not meet Proper Functioning Conditions (PFCs) due to impacts from cattle, including stream bank trampling, erosion, soil compaction, water quality decline, and overgrazing of sensitive vegetation. The negative impacts of grazing are well-documented in the Environmental Impact Statement (EIS) for the unit, as well as on other units and in the Cascade-Siskiyou study (DellaSala and Barr 2007). Cattle grazing has also been found to reduce forage enough to cause reduced reproduction in desert tortoise, a special status species on the Monument, especially in dry years. Removal of cattle would greatly enhance the resilience of natural and cultural resources on the Monument.

Desert bighorn sheep are already declining in the Southwest due to climate change (Epps et al. 2004), and are known to be susceptible to disease carried by domestic sheep, yet domestic sheep grazing still continues in the area. In order to allow desert bighorn sheep greater opportunity to disperse to new areas as the climate changes, a larger buffer between domestic sheep and bighorn sheep may need to be instituted and adhered to.

Other factors: Land ownership and management is complex in the area of the Grand-Canyon Parashant National Monument, which neighbors an NPS Monument, a National Park, non-NLCS BLM lands, USFS lands, and others. A regional plan will need to be developed that is more cohesive and allows for long term persistence and movement of species and habitats. Increased communication and collaboration with region-wide policies and approaches to conservation would greatly increase the chances that many of the important resources of the region are able to persist in the future.

Quick guide:

- Reduce stressors (grazing, road density, invasive species, OHVs).
- Manage NPS and BLM land cohesively for conservation, connectivity, ecological function, and species range shifts.
- Improve water quality.
- Protect and restore riparian areas.
- Identify refuges for sensitive habitats such as Mohave desert ecosystems.
- Design DFCs that encompass climate change and help to usher in new and desirable vegetation types when other decline.
- Reconsider species reintroductions based on latest climate change projections specific to the area.
- Meet state water quality standards and rangeland health standards.
- Increase dispersal opportunities for species by maintaining and enhancing connectivity within and outside the Monument.
- Work with regional landowners and NPS to develop long-term plans that allow for shifts in species yet retains ecosystem function.

Grand Canyon-Parashant National Monument

Climate change in Snake River Birds-of-Prey National Conservation Area, Idaho

The Conservation Area: Snake River Birds-of-Prey National Conservation Area was established in 1993 to protect a unique environment that supports one of the world's densest concentrations of nesting birds of prey. The Conservation Area encompasses 483,700 acres of grasslands and shrublands extending 81 miles along the Snake River. The canyons, shrublands, and riparian areas support, on average, 700 breeding pairs of 16 species of breeding raptors each year. This Conservation Area is unique in the NLCS in that multiple use was considered secondary to protection of raptors early on in the planning process.

The Climate: Boise, which is 20 miles away from the Conservation Area, averages just over 12 inches of rain per year, on average, and has an average high of 36.7° F in January and 89.2° F in July.

The 2009 report by the U.S. Global Change Research Program (USGCRP 2009) is a valuable resource for regionally specific climate change information. According to this report, the climate of the Pacific NW, which includes Oregon, Washington, Idaho, and western Montana, has warmed by 1.5° F over the past century. In addition, snowpack on April 1st has declined by 15-30% in the area near Snake River Birds-of-Prey Conservation Area, since 1950. The Pacific NW is expected to warm by another 3-10° F by the end of the century, on average. Many climate models also project increases in winter precipitation and decreases in summer precipitation for the area.

As temperatures warm, snowpack is expected to continue to decline and the timing of snowmelt and runoff will continue to shift earlier in the spring. Snowmelt timing is crucial to many aquatic species. Runoff could shift to 20-40 days earlier. Increasing winter rainfall (rather than snowfall) could also lead to more winter flooding while longer warmer summers are expected to lead to greater drought stress. This increase in both extremes could have significant impacts on plants and animals of the Conservation Area.

Climate Change Impacts: As are many other NLCS units, this Conservation Area appears to already be battling climate change, although it is difficult to separate the individual contributions of land management, invasive species, and climate change to specific patterns of change across the landscape. The Conservation Area has experienced increases in fire leading to broad scale loss of shrub habitat, which is being replaced by exotic forbs and grasses, including cheatgrass. From 1979 to 1999, more than half the shrublands were lost on the Conservation Area.

Shrublands on the Conservation Area support Piute ground squirrels in unusually high abundance, which, in turn, support the unusually high

abundance of breeding raptors for which this area was protected in the NLCS. Unfortunately, with the loss of half the shrublands on the Conservation Area, breeding prairie falcons have declined by 50%. As temperatures rise and summers become drier, fire incidence is likely to continue to increase. Cheatgrass, an invasive annual exotic, has been implicated in the increase in fire as it is highly flammable when senescent (Knick and Rotenberry 2000). Native shrub species are not fire adapted and are poor colonizers (Antolin et al. 2001).

Reducing Stressors:

Unfortunately, Snake River Birds-of-Prey Conservation Area is already caught in a vicious cycle of increasing fire and invasive species that is self-perpetuating and exacerbated by climate change. On top of this stress to native species, grazing, roads, and military maneuvers all impact the Conservation Area. Grazing can increase the spread of invasive species like cheatgrass, in addition to causing degradation to vital riparian habitat. The RMP for Snake River Birds-of-Prey Conservation Area details extensive impacts by cattle to riparian areas, shrublands, and grasslands throughout the Conservation Area. Cattle have also been implicated in extensive negative impacts to vegetation and water quality on other NLCS units and other lands. Cattle should be removed from the unit.

One of the goals of the Conservation Area, as reported in the RMP, is to have most of the Conservation Area accessible by motorized vehicle. This goal is problematic for many reasons, but especially when climate change is considered. Road networks cause habitat fragmentation, provide conduits for invasive species influx, and impact water quality. By increasing motor vehicle access to interior portions of the Conservation Area, the incidence of human-caused fire may also increase. Because fire has had such serious consequences to the raptors in the Conservation Area, all management actions that reduce fire, including closing of roads, should be considered. Decreasing road density in the Conservation Area will have multiple benefits to raptors and their prey, thereby increasing their resilience to climate change.

In order to prepare for climate change, the Snake River Birds-of-Prey Conservation Area will need to extract itself from the cycle of cheatgrass and fire. Because cattle and roads both exacerbate this cycle, in addition to lowering the resilience of raptor populations and their prey to climate change, these stressors will need to be reduced on the Conservation Area. In addition, identifying fire ignition sources could aid in preventing human-caused fire. Fire control efforts are already well-developed and help to reduce the risk to shrublands in the Conservation Area. Preventing the spread of cheatgrass and invasion by other exotic species will also be important.

Other factors: Management of Snake River Birds-of-Prey National Conservation Area is complicated by mixed ownership and land use designation throughout the area. Part

of the Conservation Area is used as a military training ground, which, unfortunately, adds to the impacts of erosion, invasive species, and fire. Private landowners are also interspersed with the conservation lands, making a cohesive strategy, especially for fire and invasive species control, difficult to implement. The BLM will need to increase its outreach and communication with its stakeholders, Idaho National Guard and private landowners in order to disseminate information on climate change and develop a regional plan that allows for species movements across borders and more effective invasive species control.

Quick guide:

- Reduce stressors (grazing, road density, invasive species).
- Meet state water quality standards and rangeland health standards.
- Improve water quality.
- Protect and restore riparian areas and shrublands (this is being done).
- Identify climate refuges for sensitive species such as Piute ground squirrel.
- Adapt current management based on "trigger" conditions to include climate change variables in the identification of triggers.
- Develop a plan to extract the Monument from the cheatgrass-fire cycle that is exacerbating the loss of shrublands.
- Increase dispersal opportunities for species by maintaining and enhancing connectivity within and outside the Monument.
- Work with regional landowners to develop long-term plans that allow for shifts in species yet retains ecosystem function.
- Manage for changes in the types of prey species if Piute ground squirrel populations cannot be maintained on the Monument.

Snake River Birds-of-Prey National Conservation Area

Section 3: Reviews of 14 Resource Management Plans for Climate Change Preparation

We reviewed 14 Resource Management Plans (RMPs) for individual NLCS units. Only one of the 14 plans mentioned climate change. While the others did not specifically mention climate change, some prescribed actions that are compatible with sound climate change adaptation strategies, but many other prescriptions were not compatible and will need to be revisited (Table 1). Actions were considered to be compatible with climate change adaptation strategies if they are expected to result in maintenance of or an increase in the resilience of natural and cultural resources as climate change progresses. Actions were considered to be incompatible with climate change adaptation strategies if they are expected to reduce the resilience of natural and cultural resources to climate change or if they are expected to be ineffective as climate change progresses (such as reintroductions of species to their historical ranges). When Congress or the President created each NLCS unit, specific resources were identified for protection and conservation. We focus our discussion on these resources because their protection takes precedence over other uses, and their long-term viability is the core purpose for protecting these lands.

In the following section we list, by NLCS unit, the actions that we found to be potentially compatible with climate change adaptation and those that we found to be potentially incompatible.

The 14 units that we reviewed RMPs for include: Aqua Fria National Monument, Canyons of the Ancients National Monument, Carrizo Plain National Monument, Cascade-Siskiyou National Monument, El Malpais National Conservation Area, Grand Canyon-Parashant National Monument, Grand Staircase-Escalante National Monument, Gunnison Gorge National Conservation Area, Headwaters Forest Reserve, Las Cienegas National Conservation Area, Santa Rosa and San Jacinto Mountain National Monument, Snake River Birds-of-Prey National Conservation Area, Steens Mountain Cooperative Management and Protection Area, and Upper Missouri River Breaks National Monument.

Table 1. Overview of the types of actions and strategies proposed in NLCS RMPs. Actions that may be unsuccessful under climate change or cause declines in resilience are listed as "potentially inappropriate" while those that are likely to contribute to resilience are listed as "potentially appropriate."

NLCS unit	Potentially inappropriate	Potentially appropriate
Agua Fria National Monument	Extensive grazing, even in riparian areas, allowing 30% of stream banks to become eroded near protected fish habitat. New roads and campgrounds. Species reintroductions to historical ranges. Maintain vegetation in its historical range.	Retain wild and scenic river characteristics. Close roads that impact WSR stream reaches. Preserve and restore connectivity. Pursue water rights.
Canyons of the Ancients National Monument	At least 880 acres of new leases for oil and/or gas. Extensive grazing by cattle and sheep. Species reintroductions into their historical ranges. Manage for historical patterns of fire.	Close and reclaim illegal roads. Use only native seed in reclamation. (This could be problematic if they won't allow neighboring seed) Control and prevent noxious weeds with an effective approach. Pursue water rights.
Carrizo Plain National Monument	Species reintroductions to historical ranges. Grazing in the Wilderness Study Area. Very specific conservation targets that will be difficult to meet under climate change and require an amendment to the RMP to change.	Maintain ecological processes rather than just species. Adaptive management. Expanding and reconsidering species' core areas. Connectivity. Acquire mineral rights. Monitor target species.
Cascade-Siskiyou National Monument	Allow continued grazing (this was later changed). Maintain presence of climate-sensitive species without plans for shifts.	Close numerous roads. Long-term plans for broad-scale trends. Increase connectivity. Restore native grasslands. Adaptive management and monitoring. Buffer mature forest from fire.
El Malpais National Conservation Area	Development of extensive new facilities, roads and campgrounds. Juniper control over extensive areas. Unrealistic juniper goals. Allow prairie dog (an important keystone species) shooting in some areas.	Increase wilderness area. Reduce road density. Acquire mineral interests and inholdings. Long-term vegetation goals. Remove cattle from sensitive areas.

Grand Canyon-Parashant National Monument	Desired future conditions based on historical range. Planning for continued historical fire patterns and extent. Numerous species reintroductions to historical ranges. Grazing in riparian areas. Predator control to support grazing. New campgrounds and other developments.	Study the impacts of grazing on riparian areas, specifically SW Willow Flycatcher nesting areas (need to also study impacts on water quality). Maintain nesting habitat for raptors and other birds.
Grand Staircase-Escalante National Monument	Reestablish fish and wildlife species to "historic ranges" Continued cycle of grazing and restoration activities.	Protect corridors Reassess grazing in riparian areas. Control noxious weeds. Use only native seed for reseeding. (This could be problematic if they won't allow neighboring seed) Restrict development to off site.
Gunnison Gorge National Conservation Area	Reseeding with "genetically appropriate" native seeds will need to be relaxed in the future, as "climatically appropriate" becomes more important. Continue the cycle of grazing and restoration. Allow off road OHV travel. Allow domestic sheep close to bighorn range. Allow cattle in globally imperiled forest type. Allow oil and gas development near Gunnison sage grouse area.	Consider replacing one subspecies of bighorn sheep with another. Restore degraded riparian areas.
Headwaters Forest Reserve	Long term forest structure goals that may be unattainable under climate change. Invasive species control limited to hand pulling.	Reduce risk of fire to mature forest stands. Reduce sediment inputs to streams. Increase stream complexity. Remove fish passage barriers. Acquire mineral rights. Adaptive management to develop effective forest prescriptions. Update goals and actions every 4 years rather than 15.
Las Cienegas National Conservation Area	Vegetation goals and reintroductions based on historical conditions. Continued grazing, even in riparian areas.	Investigate the impacts of grazing. Improve connectivity for pronghorn.

Santa Rosa and San Jacinto Mountain National Monument	Lack of planning for vegetation change. Strive for historical conditions and species.	Technical team assigned to incorporate new data into management. Extensive cooperation with Cahuilla tribe. Monitoring to track changes. Emergency water for wildlife. Invasive species control. Broad scale planning across the region with numerous partners.
Snake River Birds-of-Prey National Monument	Five new recreation sites could increase stress. Plans to increase vehicle access, which could lead to more fires. Continued grazing, even in areas that are out of compliance with state rangeland and water quality standards.	Adaptive management strategy that includes the identification of "trigger" conditions that lead to changes in management.
Steens Mountain Cooperative Management and Protection Area	Continued energy and mineral development, even in bighorn sheep areas. Goals of restoring presettlement vegetation communities. Non-native seeds used.	Identify refuges (cold water areas in streams) for fish. Monitor vegetation to measure the effects of grazing and other activities. Reintroduce beavers to create wetlands. Restore wetlands
Upper Missouri River Breaks National Monument	Continued grazing at current levels. Water developments for cattle allowed near grouse leks.	Manage for bighorn sheep range shifts. Control invasive species. Assess hydrological data to determine water needs. Road closures.

Conclusions

The National Landscape Conservation System is concentrated in the Southwestern U.S., but also extends to the Pacific Coast, Northwest, and Great Plains. Climate change will impact all regions, but some of the impacts to the Southwest are especially advanced and well documented (Seager et al. 2007). We were surprised to find that 4 of 5 of the units we assessed for climate change were already battling broad scale vegetation change resulting from, among other factors, climate change. Thus, planning for climate change is relevant in both the near and long term. By failing to include climate change in the decision-making process, the BLM risks failing to meet its mandate to protect and conserve the biological, cultural, scenic, geological, scientific, and recreational resources of the Conservation System.

Current RMPs reveal on-going efforts to retain historical distributions of species and vegetation associations. Such efforts include removal of one vegetation type and revegetation with another type. Reintroductions of species to their historical ranges were included in most plans. Some plans attributed broad scale changes to temporary drought conditions, thereby continuing with out-of-date vegetation prescriptions. Such efforts are risky due to the changing climatic conditions that may make historical ranges unsuitable for future populations. They are also costly. Because the BLM manages the Conservation System with less funding than comparable NPS and USFWS lands, as well as less funding than its non-NLCS lands, identifying which strategies are likely to succeed under climate change will help to direct these especially precious management funds.

Updating RMPs to incorporate climate change represents a monumental challenge for the BLM. But without considering climate change, the plans will, at best, cause monetary resources to be wasted on ineffective strategies and, at worst, cause harm to the resources that they are intended to protect. As the 10-year anniversary of the Conservation System nears, and the system is re-directed in its mission to prioritize conservation over extractive use, revisiting the plans to incorporate this new direction and climate change science will prove a worthwhile endeavor.

As the BLM moves forward in this effort, we would like to emphasize the importance of collaboration across boundaries and jurisdictions. Climate change impacts will be felt throughout the region. Regional plans that incorporate climate change planning for people and local communities as well as public private lands will be more effective than piecemeal plans that fail to connect actions in one area with impacts in another. As species react to climate change, they will need to adjust, regardless of land ownership. The BLM has the opportunity to act as a beacon of climate change information and ideas that can be shared and adopted across boundaries.

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Appendix A. Climate change adaptation resources

California is in the process of producing numerous reports about the impacts of climate change across the state. These reports, primarily released by the California Energy Commission (CEC), provide detailed climate change projections that are useful for managers of private and public lands in determining the best approach to planning for the future. http://www.energy.ca.gov

Free, online resources for climate change projections include the Climate Wizard (www.climatewizard.org) and the Southwest Climate Change Network (www.southwestclimatechange.org). Output is limited to temperature and precipitation projections. The National Center for Conservation Science and Policy (nccsp.org) can provide model projections at the 8km scale, including temperature, precipitation, vegetation, wildfire, stream flow and other variables.

The Southwest Climate Change Network (www.southwestclimatechange.org) and CLIMAS (Climate Assessment for the Southwest; www.climas.arizona.edu) are some of the best sources of information and model projections for the Southwestern U.S. One report (Lenart et al. 2007) provides an especially good overview of climate change throughout the southwest.

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