



Science and Research  
Needs Assessment, 2012  
Southern Nevada Agency Partnership

# SNAP Science and Research Needs Assessment 2012

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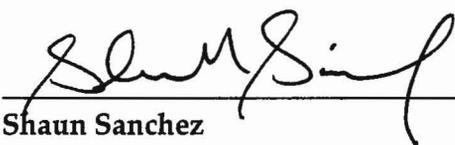
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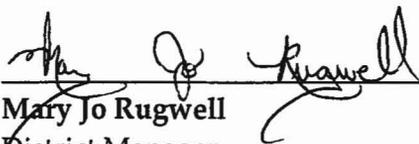
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# 2012 SNAP Science and Research Needs Assessment

## Executive Summary

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National parks, national forests, wildlife refuges, national conservation areas and other public lands are an important part of our national heritage. The managers of these federal lands face many challenges in their efforts to conserve and enhance these resources for current and future generations. Such is the case in Southern Nevada.

The Southern Nevada Agency Partnership (SNAP) was established to address common issues related to federal land management in Clark County, Nevada. An interagency science team with representatives from each of the four SNAP agencies (BLM, NPS, USFWS, USFS)<sup>1</sup> has prepared this report to identify needs for scientific studies or assessments that would improve land management of federal lands in southern Nevada. Our objective is to engage potential science partners such as researchers at universities, federal research agencies, and non-government organizations to help address these science needs.

Priority science questions for the Needs Assessment were obtained from agency managers, resource staff, and scientists through the submission of brief concept papers followed by two outreach workshops and a review by the SNAP Science Panel. The science questions have been organized into six themes based on current management priorities and existing regional influences impacting (or with a high potential to impact) agency natural and cultural resources. These include urban growth and development, renewable energy development, wildland fire, invasive non-native plants and animals, increased recreation uses and needs, and climate change. For each theme, background information is provided regarding known concerns and resource impacts. Key science questions are presented that might be answered by research, monitoring, or assessment activities.

**The Needs Assessment will document priority needs for the immediate future, within the context of current significant ecosystem influences and current management influences and opportunities.**

We encourage the reader to consider partnering with us in finding answers to these important science questions. Please feel free to contact our team members or participate in upcoming focused workshops being planned to identify specific science projects. Additional information is available through our website at <http://snap.gov/projects/science.cfm>.

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<sup>1</sup> BLM (Bureau of Land Management), NPS (National Park Service), USFWS (U.S. Fish and Wildlife Service), USFS (U.S. Forest Service)

## Introduction

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The Southern Nevada Agency Partnership (SNAP) was established as a forum for the four federal land management agencies in Clark County, Nevada (BLM, NPS, USFWS, and USFS) to address common issues to management of public lands in Southern Nevada. Through SNAP, these agencies work with each other, the local community, and partners to conserve and enhance the federal lands of Southern Nevada for current and future generations. The SNAP Board of Director's established an interagency science and research team for the purpose of developing and implementing an interagency science program that creates a consistent scientific approach across agency boundaries to enhance federal lands. That team was charged with the development of a SNAP Science and Research Strategy (<http://snap.gov/upload/SNAP-S-R-Strategy-2009r.pdf>) to guide the development of an interagency science program.

The purposes of the SNAP Science and Research Strategy include: 1) to identify priority science needs related to agency goals; 2) to integrate science activities, projects and results; and 3) to outreach to potential science partners to enhance science capabilities. One of the primary outreach tools outlined within the Strategy is the development of a SNAP Science and Research Needs Assessment. The Needs Assessment will document priority needs for the immediate future, within the context of current significant ecosystem and management influences and opportunities. It will be developed as new emerging needs are identified and previous needs are answered, at a maximum of once per year. Priority science questions for the Needs Assessment were obtained from agency managers, agency resource staff, and agency scientists through a series of outreach meetings and a solicitation of input for science priorities through submission of brief concept. Science questions might be answered by research, monitoring, or assessment activities.

## Regional Ecological Influences and Management Priority Themes for 2012

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The SNAP Board of Directors and the SNAP Science and Research Team have identified six priority regional ecosystem influences and management priority themes to be addressed within the 2011 SNAP Science Needs Assessment in light of current management priorities and existing regional ecological influences currently impacting or with high potential to impact agency natural and cultural resources. These are:

- Urban growth and development
- Renewable energy development
- Wildland fire
- Invasive non-native plants and animals
- Increased recreation uses and needs
- Climate change

These themes are based upon national priorities within the agencies, such as understanding potential impacts of climate change and the top current regional planning priorities such as site locations and rights-of-way for renewable energy development. Continuing top agency priorities include habitat protection and restoration needs of the agencies such as responses to OHV impacts and non-native

invasive species. Current regional ecosystem influences documented by the scientific community include fire and invasive species relationships and increased fire intensity in the Mojave Desert, current trends in land uses and demands upon public lands resulting from increasing urbanization and related changes in land and water uses, land requirements, and dispersed recreation from these urban centers.

The 2012 SNAP Needs Assessment is intended to implement the 2010 SNAP Science Strategy. For the purposes of long-term implementation of the strategy, actions and information developed will be organized around the nine sub-goals within the Strategy. The table in the appendix provides a link to these sub-goals (see Appendix).

As a check of the validity of the priorities set by the SNAP managers, the SNAP Science and Research Team compared the six SNAP regional influences and system themes to approaches developed by the 2010 BLM Mojave Basin and Range Rapid Ecoregional Assessment, the Mojave Desert Ecoregional Assessment prepared by The Nature Conservancy in 2010, and the Southern Nevada Public Lands Management Act Program for the Mojave Desert and Great Basin Desert of Nevada. The BLM Mojave Basin and Range Rapid Ecoregional Assessment framed their document around change agents, defined as those features or phenomena that have the potential to affect the size, condition and landscape context of conservation elements. Identified as change agents were wildland fire; development; invasive species; and climate change. The Nature Conservancy Mojave Desert Ecoregional Assessment identified threats and conservation challenges. The identified threats included land-use changes, such as urban expansion, energy generation infrastructure and transmission lines, water development, recreation, livestock grazing, mining, military activities, and waste disposal. The Southern Nevada Public Lands Management Act Program pulled information from land management agencies and regional partnerships in the Mojave Desert and Great Basin Desert of Nevada to develop science and research funding themes. These aligned with the needs identified within SNAP. This validity check provides a measure of confirmation for the SNAP process that the SNAP management themes present a valid reflection of the highest priority issues facing managers within the Mojave Desert.

## **Context of SNAP Regional Ecological Influences and Management Themes**

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Each of the SNAP themes reflects a series of either management priorities or significant ecosystem or societal influences. There are also a variety of SNAP agency managed resources of concern relative to potential impacts from each of the themes. The purpose of the SNAP Needs Assessment is to document the priority science questions that will provide the necessary information to guide SNAP agency management decisions and actions for public lands management and resource conservation. To arrive at the priority science questions, it is necessary to outline the context and define the composition of issues and resources reflected within the SNAP management themes. The context for each theme; and their associated science questions, are provided below.

SNAP managers are challenged with maintaining a complex variety of ecosystems and resources in the face of rapidly increasing urbanization within Clark County, Nevada. Additionally, a number of emerging ecosystem influences within the Mojave Desert create even more complexity in working towards the SNAP vision of managing natural and cultural resources on public lands to meet the needs of present generations without compromising the ability of future generations to meet their needs. Urban development and increased land uses bring increased needs for water, with increases in groundwater pumping and surface water diversions. New roads, transmission lines and utility corridors create habitat

fragmentation, and provide new vectors for non-native plants that are altering habitat function. Dispersed recreation from urban centers provides more impacts to cultural and heritage resources and creates a slow degradation of fragile desert soils and habitats. Increases in non-native vegetation increases fine fuel loads and increases the frequency and intensity of fire, threatening large scale vegetation type conversions across broad areas. Exacerbating these challenges are the potential impacts of climate change, which stands to alter rainfall patterns, increase temperatures and alter vegetation communities. Many of these challenges and impacts work synergistically on a number of resources; their influences are woven within the individual themes outlined below.

## 1) Urban Growth and Development ---

Southern Nevada was the fastest growing area within the United States during the 1990s, and the Las Vegas metropolitan was the sixth fastest growing city for the 2010 census. For the past two decades, this growth has been the primary influence upon the public lands of Southern Nevada. Public land uses and societal needs related to recent growth include disposals of public lands for urban development and infrastructure needs, rights of way for roads and utility transmission lines and pipelines, increased need for outdoor recreation areas, increased ground and surface water needs, increased solid waste landfill needs, increases in wastewater discharges and urban water runoff, and gravel pits for construction materials. Some areas within Southern Nevada public lands show impacts from earlier land uses such as grazing, mining, and agricultural land conversions.

Resource impacts related to land use changes and development include habitat fragmentation, loss of habitat due to land alterations, alteration of surface flows and hydrology, soil erosion, and degradation of air quality, including dust generation. Threats to natural resources from development and increases in dispersed recreation include alterations to desert spring flows and surface water flow, depletion of groundwater resources, degradation of water quality, increased spread of non-native vegetation, and increases in ground and soil disturbances from dispersed recreation from urban areas. Threats to cultural and heritage resources include degradation from soil disturbances, degradation from soil erosion, and vandalism or wear from increases in dispersed recreation.

Key resources and conservation elements of interest to SNAP managers subject to impacts from land use changes and urban growth include groundwater and surface water quality and quantity; biodiversity; cultural and heritage resources; and sustainability of ecosystem and vegetation community functions.

SNAP Managers need information and an understanding of the relationship of the land use changes and urban growth theme to key resources and conservation elements to make land use and permitting decisions, guide regional resource planning, guide agency monitoring and research needs, develop appropriate mitigation programs as requirements in development and land use permits, and to guide agency conservation actions for resource protection and restoration.

### **PRIORITY NEEDS**

- 1.1 What resources are most at risk due to urban growth and development changes in Southern Nevada? (biodiversity, cultural resources, ecosystem elements)
  - 1.1.1 Where is urban growth and development occurring or likely to occur?

- 1.1.2 How are species and habitats potentially affected by land use changes and development in these areas and what are these effects? For example: butterflies, birds (burrowing owl, migratory birds), amphibians (relict leopard frog, Amargosa toad), desert fishes (Devils Hole pupfish), rare plants, habitats (springs, washes).
  - 1.1.3 What cultural resources are most at risk due to land use changes in Southern Nevada?
  - 1.1.4 What effects are past, current, and likely future land use changes having on water quantity and quality, soil quality, and air quality?
- 1.2 Are existing conservation actions sufficient to maintain biodiversity in southern Nevada?
- 1.2.1 Are existing conservation areas for the desert tortoise (i.e., designated critical habitat, Areas of Critical Environmental Concern, National Park Service units, and National Wildlife Refuges) sufficient in size, quality, distribution, connectivity?
  - 1.2.2 Are management actions effective to meet desert tortoise conservation goals within southern Nevada?
  - 1.2.3 Are existing conservation actions sufficient to meet conservation goals of other important species and habitats to maintain biodiversity in southern Nevada? For example: rana onca, Mt. Charleston blue butterfly, spring snails, southwestern willow flycatcher
  - 1.2.4 Are existing conservation actions maintaining the condition of springs in Ash Meadows with an emphasis on protecting discharge, water chemistry, thermal regimes, microbial communities and the lower trophic levels and vegetative structure?
- 1.3 How can we mitigate the adverse effects of land use changes and development?
- 1.3.1 Given current and anticipated future locations of land use changes and development, which habitat areas remain as opportunities for habitat restoration and providing for connectivity?

## 2) Renewable Energy

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Southern Nevada now has a large role to play in national and administration priorities related to alternative energy development. These include the siting of solar and wind energy facilities, and rights of way for energy transmission lines for new energy sources. The Mojave Desert is poised to receive a large number of large-scale renewable energy projects under the BLM's Renewable Energy Program. These projects will take advantage of the region's abundant wind and solar potential. Projects will require not only land for facilities, new roads, and new transmission lines, but also use of groundwater and surface water for facility operations.

Potential impacts include direct habitat loss, habitat fragmentation, groundwater and surface water alterations, direct species mortality, and direct impacts to cultural and heritage resources. Secondary impacts can occur to natural and cultural resources from increases in dispersed recreation from new roads and transmission corridors for projects which are poorly sited. Wind energy turbines have documented impacts upon bird mortalities.

Key resources and conservation elements of interest to SNAP managers subject to impacts from the renewable energy theme include groundwater and surface water quality and quantity; biodiversity; cultural and heritage resources; and sustainability of ecosystem and vegetation community functions.

SNAP Managers need additional information on the impacts of renewable on key resources and conservation elements to make renewable energy facility siting decisions, guide permitting of transmission rights of way, guide required inventory and monitoring as part of the environmental review and compliance process, and develop appropriate mitigation requirements.

**SNAP Managers need information and an understanding of the relationship of the renewable energy theme to key resources and conservation elements to make renewable energy facility siting decisions, guide permitting of transmission rights of way, guide required inventory and monitoring as part of the environmental review and compliance process, and develop appropriate mitigation**

### PRIORITY NEEDS

- 2.1 What are the impacts to important natural and cultural resources of renewable energy development (e.g., Amargosa Desert, Big Dune/Lave Dune system, spring-dependent species, desert tortoise, rare plants, Amargosa toad, and dune scarabs)?
- 2.2 Where on the landscape are significant physical, biological, social and cultural resources and resource based values (viewshed, soundscape, and light pollution) potentially affected by renewable energy development?
  - 2.2.1 What is the complete water budget for Amargosa and Pahrump Valley?
  - 2.2.2 What are the reference conditions of springs and seeps in Southern Nevada?
  - 2.2.3 What groundwater conditions and aquatic ecosystems are susceptible to degradation from renewable energy development?

2.3 What are effective design features and mitigation measures to reduce conflict between renewable energy siting and natural resource and cultural resources?

2.3.1 Where are priority areas to translocate sensitive species displaced by additional pressures on existing habitats? (e.g. desert tortoises)

### 3) Wildland Fire

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The effects of wildland fires are a growing concern in Southern Nevada. In recent years, there have been increasing trends in the size of fires. In the summer of 2005, over 1 million acres of the Mojave Desert burned, mostly in Southern Nevada. Land managers are concerned that these trends may be increasing particularly due to the invasion of non-native annual grasses that is creating a grass fire regime that will fundamentally alter the non-fire adapted Mojave Desert ecosystem at lower elevations. At higher elevations such as within the Spring Mountains, historic fire suppression strategies may have altered the role of fire in some fire adapted communities. More research is needed on how fire management has impacted ecosystems and biodiversity and how it can be improved to restore naturally functioning fire regimes in all federal lands in Southern Nevada.

The SNAP Strategy identified several overarching science and research topics: identification of effective pre-fire strategies and post-fire practices to maintain ecosystems; understanding of the effects of current fire management strategies and the changing role of fire; and the historic and current role of fire on the long-term health of Southern Nevada ecosystems.

**The SNAP Strategy identified several overarching science and research topics: identification of effective pre-fire strategies and post-fire practices to maintain ecosystems; understanding of the effects of current fire management strategies and the changing role of fire; and the historic and current role of fire on the long-term health of Southern Nevada ecosystems.**

Resource impacts related to wildland fire and fire management include alteration of vegetation structure and composition. In the lowland desert communities, synergistic actions of invasive plant species, disturbances that enhance exotic plants, and changes in plant communities from fires, are altering the fire regime in an increasing cycle of greater fire frequencies and intensities within habitats that are not fire adapted. These fires also threaten individual species of concern, such as the Joshua tree and the desert tortoise. In the sky island forested areas, such as the Spring Mountains, decreased fire frequency from past fire suppression has resulted in altered vegetation communities.

Key resources and conservation elements of interest to SNAP managers subject to impacts within the wildland fire theme include changes in the vegetation communities resulting in loss of biodiversity and sustainability of ecosystem and vegetation community functions. SNAP Managers need additional information on the role of wildland fire in Southern Nevada ecosystems to guide fire management and suppression activities, to guide regional fire plans and strategies, and to guide land use decisions and mitigation actions that may influence fire ecology and habitat restoration.

## PRIORITY NEEDS

- 3.1 What effect does the changing role of fire have on the health of southern Nevada’s ecosystems and on species biodiversity?
  - 3.1.1 What are the effects of fire suppression activities in forested and woodland communities in southern Nevada?
  - 3.1.2 What are the natural fire regimes for high elevation woodland communities and lowland desert shrub communities?
  - 3.1.3 What frequency and intensity of fire will provide sustainable ecosystem conditions into the future?
  - 3.1.4 What are the effects of fire on non-fire-dependent desert communities in southern Nevada?
- 3.2 What are the effective management activities to disrupt the invasive grass fire cycle in desert plant communities on a landscape scale?
  - 3.2.1 Does intense site selective control of annual exotic brome grasses (e.g. fuel breaks) reduce hazardous fire fuels and potential fire size?
  - 3.2.2 Does herbicide treatment of exotic annual bromus grass reduce flammable biomass/hazardous fuel?
- 3.3 What are the appropriate parameters to be used in a fire risk assessment model for desert communities?
  - 3.3.1 How can same-season fire hazard be predicted to enable fire and resource managers to quickly prepare for an active fire season?
- 3.4 What are effective management activities after fire to restore native communities, reduce long-term impacts to wildlife, and prevent establishment of invasives?

## 4) Invasive Non-native Plants and Animals ---

Biotic invaders are species that establish a new range in which they proliferate, spread, and persist to the detriment of the environment. Invasive species are a critical threat to Southern Nevada ecosystems. Invasive plants can spread rapidly across the landscape transcending administrative boundaries. Invasive plants can out-compete native plants and alter trophic structure and wildlife communities through aggressive negative growth, extensive root structures and allelopathy. Increasing densities of non-native annual plants are increasing fine fuel loads and altering the fire ecology of the entire Mojave Desert. In addition, aquatic invasive species can negatively impact native aquatic habitats and species. Delays in preventing the spread of invasive species escalates negative ecosystem effects, boosts the costs of control measures and undermines efforts to restore habitats.

The SNAP Science and Research Strategy identified three overarching science and research topics: known or potential invasive species of concern and their basic biological attributes related to invasiveness; the effects of invasive species on natural biotic communities; and effective management methods to prevent, control, and eradicate invasive species.

Many aquatic and terrestrial invasive species are of concern in Southern Nevada. Crayfish are often abundant and destructive to native species and impact conservation efforts for rare and endemic aquatic species. This is particularly prevalent in pools and streams within the Ash Meadows National

Wildlife Refuge and Warm Springs National Wildlife Refuge, where crayfish threaten listed species and hamper habitat restoration efforts. An understanding of their dispersal ability is needed to prevent movement into currently unoccupied areas and to achieve eradication from spring systems in Southern Nevada. Invasive quagga mussels have spread rapidly throughout the lower Colorado River system impacting water delivery infrastructure and changing food web dynamics. Sahara mustard is an invasive plant that has spread quickly across the Mojave Desert. It has increased fire potential and may out-compete rare endemic plants. Research is needed to understand the basic biological attributes related to the invasiveness of these species.

The tamarisk beetle, released for bio-control of salt cedar in riparian ecosystems, has been documented on the Virgin River near Mesquite, Nevada. Federal agencies want to reduce the dominance of tamarisk and increase native plants in riparian systems along rivers and lakes in southern Nevada. In light of the arrival of tamarisk beetles, the agencies are interested in understanding the most effective restoration techniques to enhance the natural regeneration of native plants in these riparian systems.

Resource impacts related to the invasive species theme include loss of habitat from habitat alterations or direct species competition, alteration of fire regimes, type conversions and alteration of vegetation communities. In addition, other resource impacts include alterations to population dynamics and threats to species, and negative impacts to visitors recreating on public lands.

Key resources and conservation elements of interest to SNAP managers subject to impacts from the invasive non-native species theme include loss of biodiversity due to threats to desert tortoise habitat from increased fire occurrence and intensity in the lowland desert; loss of key species such as the Joshua tree due to changes in fire regime due to invasive species; impacts to aquatic biota and systems; and sustainability of ecosystem and vegetation community functions.

SNAP Managers need information and an understanding of the relationship of the invasive non-native species theme to key resources and conservation elements to guide agency conservation actions and restoration, develop appropriate mitigation programs as requirements in development and land use permits, and to develop best management practices for invasive species prevention.

## **PRIORITY NEEDS**

- 4.1 What are the known or potential invasive species and what are their basic biological attributes related to invasiveness?
  - 4.1.1 What is the current distribution of invasive species and what is the potential risk of expansion?
- 4.2 What are the effects of invasive species on natural biotic communities?
  - 4.2.1 What are the effects of Quagga mussels on Lakes Mead and Mojave?
  - 4.2.2 What habitats are prone to invasion and how do we make them more resilient?
- 4.3 How can we use our understanding of the effects of invasive species on natural communities to prioritize management methods of invasive species?
- 4.4 What are effective management methods for investigation, prevention, control, eradication, and restoration with invasive species to meet management objectives for terrestrial habitats?

- 4.4.1 What are effective management methods for prevention and eradication of Sahara mustard?
- 4.5 What are effective management methods for investigation, prevention, control, eradication, and restoration with invasive species to meet management objectives of riparian and aquatic habitats?
  - 4.5.1 What are the effective management methods for riparian restoration in light of the tamarisk beetle bio-control project?
  - 4.5.2 What are effective management methods for prevention and eradication of invasive aquatics such as red-swamp crayfish and Quagga mussels?

## **5) Increased Recreation Uses and Needs** \_\_\_\_\_

The rapid urbanization of Southern Nevada has increased the use of nearby public lands for recreation. Research is needed to identify trends for recreation on public lands, how to meet these recreation needs without compromising resources, how to gain an understanding of current visitor-use patterns and characteristics, and market demands for recreation on public lands.

A key concern is increasing off-highway vehicle (OHV) recreation. Increased urbanization and development adjacent to public lands bring significant new populations able to recreate on public lands literally in minutes from their door. This greatly increases the impacts of dispersed recreation on public lands. There is fair amount of literature on the impacts of fragmentation as a result of road and trail proliferation in various landscapes, ecosystems and species habitats throughout the United States, including the Mojave Desert. The federal land managing agencies need to understand how this information applies to the Mojave Desert and utilize the best available information to guide agency management related to OHVs and road densities. Understanding the thresholds for density of roads and trails can assist the federal land management agencies in southern Nevada to employ appropriate management strategies to maintain viability of species habitats and populations in light of meeting recreation needs.

Land managers are interested in learning if the federal lands are providing adequate recreation opportunities of the increasingly diverse population in Southern Nevada. This topic should address not only be quantity issue but also a quality issue. Information is needed on the specific interests of special components of the population such as youth or minorities and their specific interests where opportunities may not yet be available, or where there are current deficiencies in opportunities.

Recreational climbing continues to increase in popularity, and demand for use at existing and new locations continues to grow, particularly in wilderness areas. Research is needed to identify the potential impacts to sensitive, cliff-dwelling species from recreational climbing. In addition, information is needed on visitor-use demands and trends for wilderness areas on public lands in southern Nevada to determine characteristics of use, impacts and future needs. The overall goal is to develop strategies for wilderness preservation and maintain solitude and primitive recreation.

Resource impacts related to recreation theme include habitat fragmentation, loss of habitat due to soil and vegetation alterations and degradation, alteration of surface flows and hydrology, soil erosion, increased spread of non-native vegetation. and degradation of air quality, including dust generation. Threats to cultural and heritage resources may occur directly and indirectly from dispersed recreation.

Key resources and conservation elements of interest to SNAP managers subject to impacts from the recreation theme include fragmentation of habitats; biodiversity; heritage resources; sustainability of watershed and ecosystem function, and provision to the public of a variety of high quality, appropriate recreation experiences.

**Research is needed to identify trends for recreation on public lands, how to meet these recreation needs without compromising resources, how to gain an understanding of current visitor-use patterns and characteristics, and market demands for recreation on public lands.**

SNAP Managers need information and an understanding of the relationship of the recreation theme to key resources and conservation elements to develop land use and recreation management plans, guide agency conservation actions for resource protection and restoration, and develop appropriate conservation education and public information programs.

## **PRIORITY NEEDS**

- 5.1 What are the current and projected future patterns of recreational use (spatial and temporal) and the relationship to urban development?
- 5.2 What are the effects of increased recreation uses on natural biotic communities and cultural resources?
  - 5.2.1 What are the impacts of rock-climbing and what are effective actions to minimize impacts?
  - 5.2.2 What are the impacts of dispersed recreation on cultural resources?
  - 5.2.3 How is current recreation use affecting wilderness characteristics in designated Wilderness areas?
- 5.3 What are the effects of OHV activities to the health of resources and users?
  - 5.3.1 What are the thresholds of road and trail density and use that meet recreational needs without compromising habit and species viability (with a focus on fragmentation of Mojave Desert scrub and salt desert scrub)?
  - 5.3.2 What are air quality effects including related human health impacts associated with OHV activities?
- 5.4 What are the effective tools for changing human behavior to reduce the public's impacts to the ecosystem as a result of recreation use on federal lands?

## 6) Climate Change

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Changes in climate can affect the integrity of different ecological life zones. Change in temperatures, precipitation, and climate variability can put stress on plant communities and potentially cause movement to more favorable habitat conditions. Research is needed to understand the potential effects of climate change on Southern Nevada ecosystems such as effects on plants communities (phenology, flowering lives, and recruitment of native plants), aquatic systems (water temperature, chemistry, discharge, biota), and animal distributions. This information is needed to help plan appropriate landscape-level management actions in response to climate change.

The US Climate Change Science Program published a report entitled Global Climate Change Impacts in the United States in June 2009. That report summarized a number of potential impacts to resources in the southwestern US resulting from climate change and current weather models. These include higher temperatures, increased drought, and more intense summer thunderstorms. These patterns are likely to increase erosion and promote invasion of exotic grass species in arid lands. Increases in exotic grasses are already seen to provide fuel increasing fire frequencies in Mojave Desert ecosystems. These changes result in loss of habitats for species such as the desert tortoise, and potential loss of iconic species such as the Joshua tree.

**Resource impacts related to the climate change theme include habitat fragmentation, loss of habitat, alterations to desert spring flows and surface water flow, alteration in watershed and community functions, and direct threats to species.**

River and riparian ecosystems in arid lands will very likely be negatively impacted by decreased stream flows, and decreases in spring discharges. Increases in temperatures and decreases in water availability, or changes in water seasonality, will alter plant and animal distributions and communities.

Resource impacts related to the climate change theme include habitat fragmentation, loss of habitat, alterations to desert spring flows and surface water flow, alteration in watershed and community functions, and direct threats to species.

Key resources and conservation elements of interest to SNAP managers subject to impacts from the climate change theme include biodiversity; sustainability of watershed and ecosystem function; and plant and animal communities.

SNAP Managers need information and an understanding of the relationship of the climate change theme to key resources and conservation elements to develop land use and management plans, guide agency conservation actions for resource protection and restoration, assess climate change adaptation strategies including wildlife and plant dispersal corridors, and develop appropriate conservation education and public information programs.

## PRIORITY NEEDS

- 6.1 What monitoring protocol will detect climate changes affecting southern Nevada natural resources?
- 6.2 What are the predicted climate change impacts on water resources in southern Nevada?
- 6.3 What are the predicted effects resulting from climate change on southern Nevada resources (natural and cultural), ecosystem processes, and resource uses?
  - 6.3.1 Changes in plant and animals (phenologies, distributions or densities)?
  - 6.3.2 Are we experiencing earlier flowering times?
  - 6.3.3 Decreased/increased recruitment of native plants?
  - 6.3.4 How would climate change alter discharge, water chemistry, thermal regimes, microbial and micro- / macro-algal communities, lower trophic levels and vegetative structure of springs at Ash Meadows?
- 6.4 What are potential management adaptations (short-term and long-term) to respond to predicted climate change effects?

# Appendices

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## RELATIONSHIP OF SCIENCE THEMES TO STRATEGY SUBGOALS

The 2011 SNAP Needs Assessment is intended to implement the 2009 SNAP Science Strategy. For the purposes of long-term implementation of the strategy, actions and information developed will be organized around the nine sub-goals within the Strategy. The following table provides a link to these sub-goals.

Science and Research Strategy Sub-Goals	Land Use Changes & Development	Renewable Energy	Wildland Fire	Invasive non-native plants and animals	Increased Recreation Uses and Needs	Climate Change
1.1 Manage wildland fire to sustain Southern Nevada’s ecosystems			X			
1.2 Protect Southern Nevada’s ecosystems from the adverse impacts of invasive species			X	X		
1.3 Restore and sustain proper function of Southern Nevada’s watershed and landscapes	X	X	X	X	X	X
1.4 Sustain and enhance Southern Nevada’s biotic communities to preserve biodiversity and maintain viable populations	X	X	X	X	X	X

<b>2.1 Develop an understanding of human interactions with the environment through time</b>						
<b>2.2 Provide heritage resources through responsible use of Southern Nevada’s lands</b>	X	X			X	
<b>2.3 Manage current and future authorized Southern Nevada land uses in a manner that balances public need and ecosystem sustainability</b>	X	X				
<b>2.4 Provide for appropriate (type and location), quality, and diverse recreational experiences, resulting in responsible visitor use on federal lands in Southern Nevada</b>					X	
<b>2.5 Promote an effective conservation education and interpretation program to improve the quality of resources and enhance public use and enjoyment of Southern Nevada public lands.</b>					X	