presents:

A workshop on:

Natural Resource Needs Related to

Climate Change

In the Great Basin and Mojave Deserts:
Research, Adaptation, Mitigation

April 20 - 22, 2010 | Las Vegas, Nevada

A workshop on:

Natural Resource Needs Related to Climate Change In the Great Basin and Mojave Deserts: Research, Adaptation, Mitigation

April 20-22, 2010
Las Vegas, Nevada

Purpose of Workshop

This workshop focuses on how climate change is affecting natural resources in deserts of the western U.S., as well as the land, water, and species management and research needs that are essential to address in the coming decade. Workshop objectives include:

- Increase understanding of climate change processes and their effects on the physical systems and biota of the Great Basin and Mojave Deserts
- Provide the "best available" scientific information for adapting to change
- Examine research and management needs
- Evaluate management constraints and determine potential solutions
- Develop effective research and management collaborations for addressing climate change into the future

Participants

Stakeholders in the natural resources management and research communities with interest and expertise in the potential effects of climate change on the aridlands of western North America. The intended audience includes federal, state, tribal, and local government land and resource management agencies; federal, state and local government officials; federal, state, university, and non-governmental researchers; and other partners of interest.

Desired Outcomes and Products

Information exchange among participants
Establishing and using interorganizational work groups to explore:
Research and scientific assessments, tools and priorities
Management adaptation and mitigation strategies
Refine information needs related to agency needs and interorganizational collaboratives
Products such as a peer-reviewed publication, internet presence, video archive, or all of the above

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Sponsors

U.S. Geological Survey (USGS)

U.S. Forest Service (USFS)

U.S. Fish and Wildlife Service (USFWS)

Desert Managers Group (DMG)

National Park Service (NPS)

Great Basin Research & Management Partnership (GBRMP)

U.S. Environmental Protection Agency (EPA)

Southern Nevada Agency Partnership (SNAP)

Bureau of Land Management (BLM)

University of Nevada, Las Vegas (UNLV)

Desert Research Institute (DRI)

Organizers

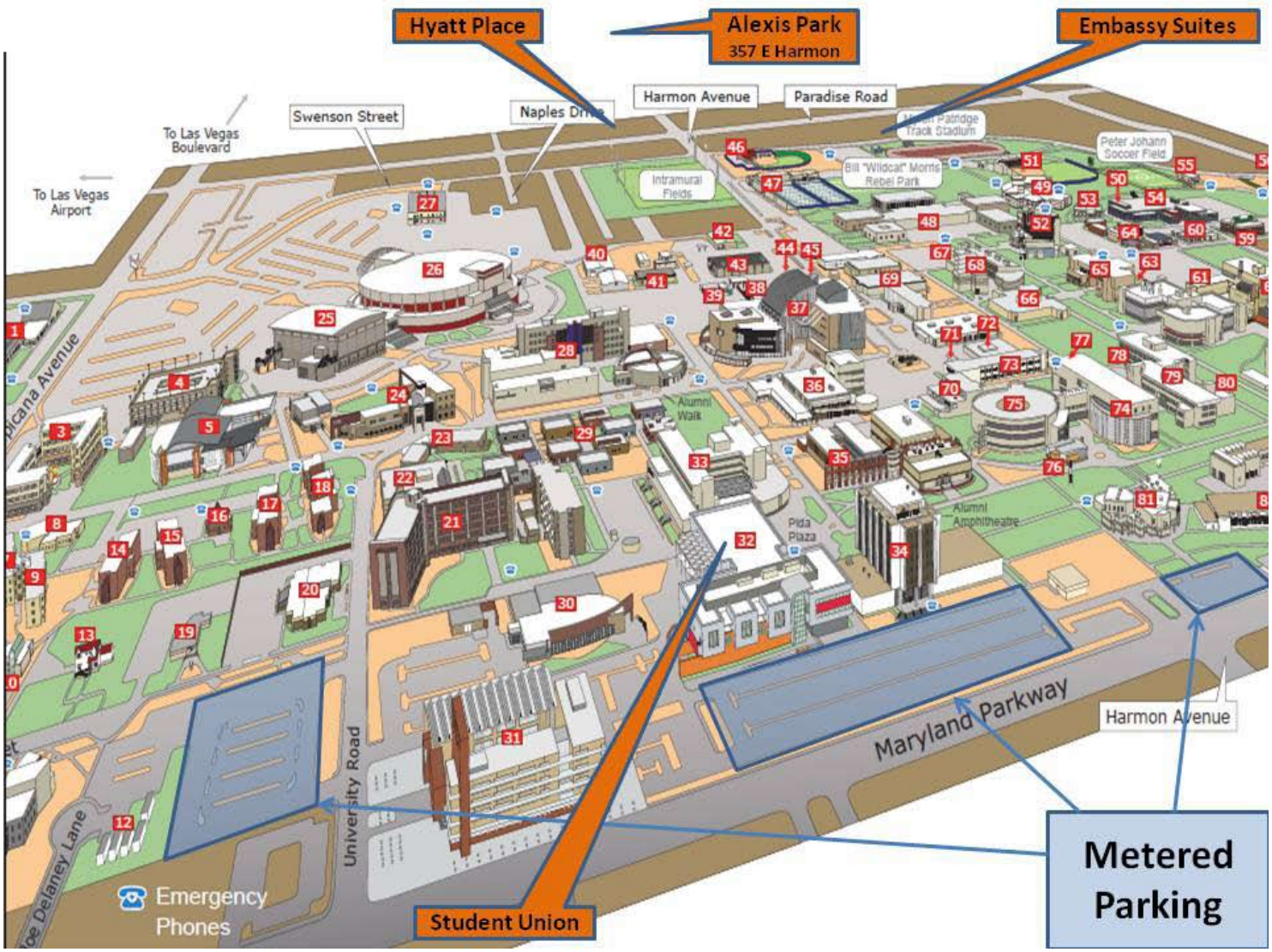
Dave Busch, USGS
Steve Caicco, FWS
Jeanne Chambers, USFS
Scott Davis, BLM
Angie Evenden, NPS
Sean Finn, USGS
Russ Holder, FWS
Sue Husch, AI
Lief Horwitz, USGS
Debra Hughson, NPS
Rick Kearney, FWS
Sue Phillips, USGS
Dennis Schramm, NPS
Nita Tallent-Halsell, EPA
Paul Verburg, DRI

Location and Parking

The workshop sessions will be held at the University of Nevada, Las Vegas (UNLV) on the second floor of the Student Union building.

See workshop floorplan on the following page.

Metered parking is available for participants in the lots highlighted below. All parking at UNLV is paid parking.



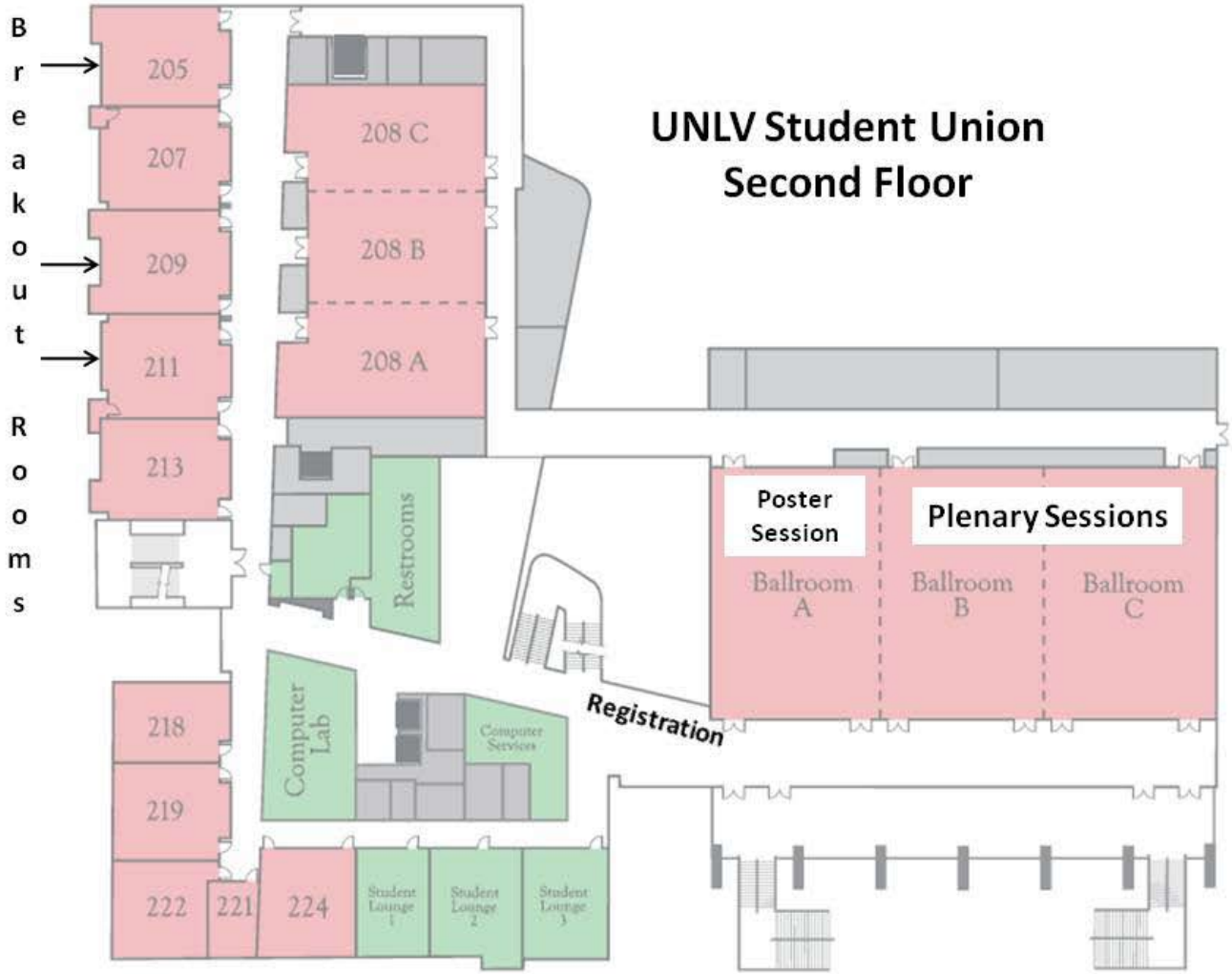
Shuttle Service to Hotels provided on first evening ONLY from 7 - 9 pm. Shuttle pick up is outside east doors of Student Union.

Workshop Floorplan

Plenary Sessions will be held in Ballrooms B and C.

The Poster Session will be held in Ballroom A.

Breakout Sessions (Day 3) will be in rooms 205, 209, and 211.



Food Options

A variety of food and refreshment options are available on the first floor of the Student Union.

 Help the planet and think before you print. All information will be posted and available at workshop.

Agenda

Day 1: April 20, 2010

Registration Open: 10:00 am - 6:00 pm

Time	Topic
Plenary 1: Moderator - Dave Busch (U.S. Geological Survey)	
1:00 - 1:10 pm	***Announcements and Conference Preview.***
1:10 - 1:30 pm	**Ricardo Lopez**, U.S. Environmental Protection Agency, Las Vegas, NV. **Senator Harry Reid** (invited), U.S. Senate Majority Leader, Nevada ***Welcome, expectations, and outcomes***
1:30 - 2:15 pm	**Thomas Armstrong**, Senior Advisor for Climate Change, Office of the Secretary, Department of the Interior, Washington, D.C. ***DOI's climate change science, adaptation, and mitigation strategy***
2:15 - 3:00 pm	**Kelly Redmond**, Desert Research Institute, Reno, NV. ***Observed trends / model predictions – CLIMATE***
3:00 - 3:30 pm	Break - Poster set-up
Plenary 2: Moderator - Nita Tallent-Halsell (Environmental Protection Agency)	
3:30 - 4:15 pm	**Stanley Smith**, University of Nevada, Las Vegas, Las Vegas, NV. ***Observed trends / model predictions – ECOSYSTEMS***
4:15 - 5:00 pm	**Kenneth Bagstad**, University of Vermont. Burlington, VT. ***Land use & water management in the context of ecosystem services***
5:00 - 5:45 pm	**J. Michael Scott**, University of Idaho, Cooperative Fish and Wildlife Research Unit (USGS) ***America's conservation landscape in the face of changing land use and climate change***
5:45 - 6:00 pm	Break - Poster set-up
Poster Session: Moderator - Nita Tallent-Halsell	
6:00 - 8:00 pm	***Poster session / hors d'oeuvres / cash bar***

Shuttle Service to hotels provided from 7 - 9 pm TONIGHT ONLY. Shuttle pick-up is outside east doors of Student Union

Day 2: April 21, 2010

Registration Open: 7:30 am - 5:30 pm

Time	Topic – "Manager-Researcher" Paired Talks
Paired Talks 1: Moderator: Steve Caicco (U.S. Fish and Wildlife Service)	
8:00 - 8:40 am	**Tim Bodeen**, Fish and Wildlife Service, Malheur NWR and **Sue Haig**, Forest and Rangeland Ecosystem Science Center, U. S. Geological Survey, Corvallis, OR. ***Large-scale mitigation and adaptation approaches***

Day 2 continued

Registration Open: 7:30 am - 5:30 pm

Agenda

8:40 - 9:20 am	**Cynthia Martinez**, U.S. Fish and Wildlife Service, Desert National Wildlife Refuge Complex, Las Vegas, NV and **Erica Fleishman**, Bren School of Environmental Science & Management, University of California, Santa Barbara, CA. ***Species conservation in changing environments***
9:20 - 10:00 am	**Scott Florence**, Bureau of Land Management, St. George, UT and **Matthew Brooks**, U. S. Geological Survey, El Portal, CA. ***Adapting to changing fire & fuel regimes***
10:00 - 10:30 am	Break

Paired Talks 2: Moderator: Debra Hughson (National Park Service)

10:30 - 11:10 am	**Scott Abella**, Public Lands Institute, University of Nevada, Las Vegas and **David Pyke**, Forest and Rangeland Ecosystem Science Center, U. S. Geological Survey, Corvallis, OR. ***Restoration objectives in a changing environment.***
11:10 - 11:50 am	**Dennis Schramm**, Mojave National Preserve, National Park Service, Barstow, CA and **Jeanne Chambers**, U. S. Forest Service, Rocky Mountain Research Station, Reno, NV. ***Fixed boundaries / shifting environments***
11:50 am - 12:30 pm	**Rita Beard**, National Park Service, Natural Resource Program Center, Fort Collins, CO and **Bethany Bradley**, Department of Natural Resources Conservation, University of Massachusetts, Amherst, MA. ***Changing gradients - effects on species invasions and migrations***
12:30 - 1:30 pm	Lunch

Paired Talks 3: Moderator: Paul Verburg (Desert Research Institute)

1:30 - 2:10 pm	**Anthony Willardson**, Western States Water Council, Salt Lake City, UT and **Robert Webb**, U. S. Geological Survey National Research Program, Tucson, AZ. ***Water resources in a changing climate***
2:10 - 2:50 pm	**Bruce Bingham**, Inventory and Monitoring Program, Intermountain Region, National Park Service, Lakewood, CO and **Mike Young**, Executive Director, Desert Research Institute Division of Hydrologic Sciences, Reno, NV. ***Monitoring & data collection networks to support adaptive management, analysis and modeling***
2:50 - 3:30 pm	**Scott Flint**, California Department of Fish and Game, Sacramento, CA and **Jeff Lovich**, U.S. Geological Survey Southwest Biological Science Center, Flagstaff, AZ. ***Renewable energy and natural resource conservation***
3:30 - 4:00 pm	Break

Panel on Key Initiatives in the Intermountain West

4:00 - 5:30 pm	**Rick Kearney** (moderator), Fish and Wildlife Service / Landscape Conservation Cooperatives; **Jon Sjoberg**, Nevada Department of Wildlife / Desert Fish Habitat Partnership; **Terry Mansfield**, Intermountain West Joint Venture; **Nat Frazer**, Utah State University / Great Basin Research and Management Partnership

Agenda

Day 3: April 22, 2010

Registration Open: 7:30 am - 12:00 pm

Time	Tentative Topics			
8:00 - 8:15 am	**Breakout session:** *Each breakout is about 90 minutes, so your facilitator has been instructed to allot about 30 minutes to each question. Because each question builds on the prior one(s), your facilitator has also been asked to address them in the sequence shown.* • *What do you perceive to be the major challenges that you face over the coming decade in adapting your practices to the changing climate?* • *What research is needed to inform adaptive management for climate change over the coming decade?* • *How can we best integrate existing and new (e.g., Landscape Conservation Cooperatives, ecoregional assessment, Climate Science Centers) approaches to address these needs?*			
8:15 - 10:00 am	Break Out 1 **Facilitator:** **Lief Horwitz (USGS)** ***Management Across Boundaries***	Break Out 2 **Facilitator:** **Steve Caicco (FWS)** ***Species & Habitat Assessment: Mojave Terrestrial***	Break Out 3 **Facilitator:** **Angie Evenden (NPS)** ***Species & Habitat Assessment: Great Basin Aquatic***	Break Out 4 **Facilitator:** **Nita Tallent-Halsell (EPA)** ***Great Basin/Mojave Ecosystem Services in a Changing Climate (Air and Water)***
10:00 - 10:30 am	Break			
10:30 am - 12:00 pm	Break Out 5 **Facilitator:** **David Patte (FWS)** ***Monitoring for Climate Induced Change***	Break Out 6 **Facilitator:** **Debra Hughson (NPS)** ***Species & Habitat Risk Assessment: Mojave Aquatic***	Break Out 7 **Facilitator:** **Jeanne Chambers (USFS)** ***Species & Habitat Risk Assessment: Great Basin Terrestrial***	Break Out 8 **Facilitator:** **Scott Davis (BLM)** ***Great Basin/Mojave Ecosystem Services in a Changing Climate (Soils and Landscapes)***
12:00 - 1:00 pm	Lunch **Special presentation:** ***The Heat is On: Desert Tortoises and Survival*** A film by Steven M. Wessel and Steven E. Schwarzbach in the main ballroom			
1:00 - 2:15 pm	**Workshop synthesis & wrap up: Moderator – Dave Busch** **Synthesis plenary speaker:** **Julio Betancourt**, U. S. Geological Survey, National Research Program, Tucson, AZ Panelists: Session Facilitators			
2:15 - 2:30 pm	***Acknowledgements, adjourn***			

Directory of Poster Presenters

Poster #	Category	Title	Authors (presenter bold)	Affliations
1	Group Initiatives/ Collaboration	The Great Basin Research and Management Partnership	Jeanne Chambers[1], Stuart Hardegree[2], Linda Schueck[3], Thomas Zarriello[3], **Sean Finn[3]**	[1]USDA Forest Service, Rocky Mountain Research Station, Reno, NV [2]USDA Agricultural Research Service, Northwest Watershed Research Center, Boise, ID [3]USDI Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID
2	Group Initiatives/ Collaboration	Renewable energy locations for existing and potential facilities within BLM leased land	**Scott Davis**	Bureau of Land Management, Lakewood, CO
3	Group Initiatives/ Collaboration	Soil climate characterization project: an application for monitoring climate change	**James C. Hurja[1]**, Douglas J. Merkler[2]	[1]Humboldt-Toiyabe NF, Spring Mountains National Recreation Area, Las Vegas, NV [2]USDA, NRCS, Mojave Special Project Office, Las Vegas, NV
4	Group Initiatives/ Collaboration	Southwest Ecosystem Services Project	**Nita G. Tallent-Halsell**	U.S. Environmental Protection Agency, Las Vegas, NV
5	Group Initiatives/ Collaboration	Southern Nevada Agency Partnership Science and Research Strategy	Kent Turner[1], Amy M. LaVoie[2], Carolyn J. Ronning[3], Randall M. Sharp[4], **Craig J. Palmer[5]**, Jennell M. Miller[6]	[1] National Park Service, Lake Mead National Recreation Area, Boulder City, NV [2]U.S. Fish and Wildlife Service, Nevada Fish and Wildlife Office, Las Vegas, NV [3]Bureau of Land Management, Las Vegas Field Office, Las Vegas, NV [4]USDA Forest Service, Humboldt-Toiyabe National Forest, Sparks, NV [5]University of Nevada, Las Vegas, Harry Reid Center for Environmental Studies, Las Vegas, NV [6]University of Nevada, Las Vegas, Public Lands Institute, Las Vegas, NV
6	Group Initiatives/ Collaboration	Development and use of climate, land-use, and hydrology scenarios in EPA/NCEA's global change research program	Christopher P. Weaver, Britta G. Bierwagen, Thomas E. Johnson, Susan H. Julius, Philip Morefield, Jordan H. West	U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Global Change Research Program
7	Hydrology	Water, salt, and plants -- links in climate sensitive niches of the Mojave Desert	**George N. Breit[1]**, Harland L. Goldstein[2], Sharon McKelvey[3], Richard L. Reynolds[2]	[1]U.S. Geological Survey, Crustal Geophysics and Geochemistry Science Center, Denver, CO [2]U.S. Geological Survey, Geology and Environmental Change Science Center, Denver, CO [3]Fish and Wildlife Service, Ash Meadows National Wildlife Refuge, Amargosa Valley, NV

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8	Hydrology	Influence of timing and amount of precipitation on plant prodcution and soil respiration	**Richard A. Gill**[1], Bradley Chandler[2]	Department of Biology, Brigham Young University, Provo, UT[1] Department of Chemical Engineering, Brigham Young University, Provo, UT[2]
9	Hydrology	Long-term trends in extreme precipitation frequency in the Great Basin and Mojave Desert	**Kenneth E. Kunkel**[1], David Easterling[2], Byron Gleason[2], David A.R. Kristovich[3], Rebecca Smith[3], Leslie Ensor[3]	[1]Division of Atmospheric Sciences, Desert Research Institute, Reno, NV [2]National Climatic Data Center, Asheville, NC [3]Illinois State Water Survey, University of Illinois, Champaign, IL
10	Hydrology	Trends in temperature, precipitation, and snowpack in the Klamath Basin region	**Timothy D. Mayer**[1], Seth W. Naman[2]	[1]US Fish and Wildlife Service, Portland, OR [2]NOAA Fisheries, Arcata, CA
11	Hydrology	Potential for water salvage by release of the biocontrol, *Diorhabda elongata*, on Tamarisk dominated rivers	**Pamela Nagler**[1], R. Scott Murray[2], Edward Glenn[1], Charles van Riper[2], Dan Bean[3]	[1]U.S. Geological Survey, Southwest Biological Science Center, Sonoran Desert Research Station, Tucson, AZ [2]Environmental Research Laboratory of the University of Arizona, Tucson, AZ [3]Biological Pest Control, Palisade Insectary, Colorado Department of Agriculture, Conservation
12	Hydrology	Climate and land cover change impacts on stream flow in the southwest U.S.	**Wenming Nie**, Paula E. Allen, Yongping L. Yuan, Maliha S. Nash, William G. Kepner	U.S. Environmental Protection Agency, Environmental Sciences Division, Las Vegas, NV
13	Hydrology	Temporal analysis of Great Basin using spaceborne microwave backscatter and radiometric temperature observations	**Haroon Stephen**, William J. Smith Jr.	University of Nevada, Las Vegas, NV
14	Modelling/ Database	Microbial control of total nitrogen and total organic carbon in soils across two climatic provinces	**Steve W. Blecker**[1], Lisa L. Stillings[1], Nicole Decrappeo[2]	[1]U.S. Geological Survey, Western Mineral and Environmental Resources Science Center, Reno, NV [2]U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis, OR
15	Modelling/ Database	Modeling rangeland performance and climate change effects on Big Sagebrush in the Owyhee Uplands	**Stephen P. Boyte**[1], Bruce K. Wylie[2], Yingxin Gu[3], Donald J. Major[4]	[1]Stinger Ghaffarian Technologies, Inc. Contractor to the U.S. Geological Survey EROS, Sioux Falls, SD [2]U.S. Geological Survey, EROS, Sioux Falls, SD [3]ASRC Research and Technology Solutions, Contractor to the U.S. Geological Survey EROS, Sioux Falls, SD [4]BLM NIFC—Great Basin Restoration Initiative, Boise, ID

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16	Modelling/ Database	Projecting future changes in sagebrush distribution in the Great Basin	Lorraine E. Flint[1], Alan L. Flint[1], Alicia Torregrosa[2], Andrea Woodward[3], Justin Welty[4], **Sean Finn[4]**, Steven L. Garman[5], David S. Pilliod[4], J.R. Matchett[6], Michael L. Casazza[7], Matthew L. Brooks[6] , Lore.A.Baer[8]	[1]U.S. Geological Survey, Water Resources Discipline, Sacramento, CA [2]U.S. Geological Survey, Geography, Menlo Park, CA [3]U.S. Geological Survey, Biological Resources Discipline, Seattle, WA [4]U.S. Geological Survey, Biological Resources Discipline, Boise, ID [5]U.S. Geological Survey, Biological Resources Discipline, Denver, CO [6]U.S. Geological Survey, Biological Resources Discipline, El Portal, CA [7]U.S. Geological Survey, Biological Resources Discipline, Dixon, CA [8]U.S. Geological Survey, Geography, Denver, CO
17	Modelling/ Database	Availability of land treatment data for time-series investigations of vegetation responses to climate	**David S. Pilliod**, Justin L. Welty	U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID
18	Modelling/ Database	Geospatial integration of hazards, infrastructure and resources in an assessment of potential disasters and effects of climate change in Clark County, Nevada	**Swapan K. Sahoo**, S.A. Nowicki, T. Adams[1], C. Adcock, Z. Alemu, C. Carrier, S. Dawadi, P. Flynn, R. Haiduck, L. Kryder, V. Meyers, B. Pakzadeh, C. Palelei, J. Sampson, N. Santos, A. Sloat, J. Swatzell	University of Nevada Las Vegas, Geoscience Department, Las Vegas, NV
19	Modelling/ Database	What can predictive modeling tell us about plant vulnerability to climate change in the Southwest?	**Kathryn A. Thomas[1]**, Patty Guertin[2], Leila Gass[1]	[1]U.S. Geological Survey Southwest Biological Science Center, Tucson, AZ [2]University of Arizona, Tucson, AZ
20	Modelling/ Database	A Scenario-based Urban Growth Study in the Greater Las Vegas Area	**E. James Trammell[1]**, D. Mouat[1], S. Bassett[2], S. Thomas[1], D. Casserly[1], Q. Korbulic[1], J. Lancaster[1], P. Marin[1]	[1]Desert Research Institute, Division of Earth and Ecosystem Sciences, Reno, NV [2]University of Nevada, Reno, Department of Geography, Reno, NV
21	Modelling/ Database	Precipitation marginal response as a tool for merging state-and-transition model concepts with climate uncertainty	**Jeb Williamson[1]**, Brandon Bestelmeyer[2]	[1]New Mexico State University, Jornada Experimental Range, Las Cruces, NM [2]USDA-ARS, Jornada Experimental Range, Las Cruces, NM
22	Plant Ecology	Identifying trends in distribution of noxious weeds for early detection and rapid response in Nevada	**Lisa A. Blecker[1]**, J. Earl Creech[2], Jason Davison[1]	[1]University of Nevada Cooperative Extension, Fallon, NV [2]Extension Agronomist, Utah State University, Logan, UT

Directory of Poster Presenters

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23	Plant Ecology	The past, present, and future distributions of Joshua tree	Kenneth L. Cole[1], **Kirsten Ironside[2]**, Jon Eischeid[3], Gregg Garfin[4], Phil Duffy[5], Chris Toney[6]	[1]USGS Southwest Biological Science Center, Colorado Plateau Research Station, Northern Arizona University, Flagstaff, AZ [2]Merriam-Powell Center for Environmental Research, Northern Arizona University, Flagstaff, AZ [3]NOAA Earth Systems Research Laboratory, Boulder, CO [4]Institute of the Environment, University of Arizona, Tucson, AZ [5]Lawrence Livermore National Laboratory and University of California, Merced CA [6]USDA Forest Service, Rocky Mountain Research Station, Missoula, MT
24	Plant Ecology	Global change effects on Mojave Desert perennial plants: summer monsoons, nitrogen deposition, and soil disturbance	**Beth A. Newingham[1,2]**, Cheryl H. Vanier[2], T.N. Charlet[2], Stanley D. Smith[2]	[1]University of Idaho, College of Natural Resources, Moscow, ID [2]University of Nevada, School of Biological Sciences, Las Vegas, NV
25	Plant Ecology	29 years of vegetation community change across environmental gradients in a Mojave Desert mountain range	**Chris L. Roberts[1]**, Scott R. Abella[2], James S. Holland[1]	[1]National Park Service, Lake Mead National Recreation Area, Las Vegas, NV [2]Department of Environmental Studies, University of Nevada Las Vegas, Department of Environmental Studies, Las Vegas, NV
26	Plant Ecology	Water additions and soil disturbance effects on native and non-native Mojave Desert winter annuals	**Alexis A. Suazo**, Jessica E. Spencer, E. Cayenne Engel, Scott R. Abella	University of Nevada, Las Vegas, School of Environmental and Public Affairs, Las Vegas, NV
27	Plant Ecology	Plant responses to experimental warming and precipitation alteration on the Colorado Plateau	**Tamara J. Zelikova**, Sasha C. Reed, Jayne Belnap	USGS, Southwest Biological Science Center, Canyonlands Research Field Station, Moab, UT
28	Public Policy	Quantifying the effects of climate change within the Navajo Nation	Rian Bogle[1], Debra Block[1], John Vogel[1], Margaret Hiza Redsteer[1], **Miguel Velasco[1]**, Amy Draut[2], Barry Middleton[1]	[1]U.S. Geological Survey, Flagstaff, AZ [2]U.S. Geological Survey, Santa Cruz, CA
29	Public Policy	Climate change policy, public lands, and local government needs	**Derek Kauneckis***, Orion Cuffe[1], Zhongwei Liu[2]	[1]University of Nevada, Reno, Department of Political Science, Reno, NV [2]University of Nevada, Las Vegas, School of Environmental and Public Affairs, Las Vegas, NV
30	Public Policy	Perceptions of ranchers and farmers on climate change impacts and adaptation strategies in Nevada	**Zhongwei Liu**, William J. Smith Jr., Ahmad Safi	School of Environmental and Public Affairs, University of Nevada, Las Vegas, NV

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31	Resource Management	Bureau of Land Management ecoregional assessments and environmental change agents	Scott Archer, Matthew Bobo, **Karl L. Ford**, Craig Goodwin, Travis Haby	Bureau of Land Management National Operations Center, Denver, CO
32	Resource Management	Assessing the benefits of urban forestry in Mojave Desert communities	**Angela M. Hammond**, Nita Tallent-Halsell	U.S. Environmental Protection Agency, Environmental Sciences Division, Las Vegas, NV
33	Resource Management	Changing climates and the role of national wildlife refuges in the conservation of the Great Basin	Paul F. Steblein, **Gail H. Collins**	U.S. Fish and Wildlife Service, Sheldon-Hart Mountain National Wildlife Refuge Complex, Lakeview, OR
34	Resource Management	Synergistic monitoring for adaptive vegetation management in the sagebrush ecosystem of the Great Basin	**Sherman R. Swanson**[1], John C. Swanson[2], Brad W. Schultz[3], J. Kent McAdoo[4], Gary L. McCuin[5]	[1]University of Nevada Cooperative Extension (UNCE), Reno, NV [2]University of Nevada, Reno, Natural Resources and Environmental Sciences Dept, CABNR, Reno, NV [3]University of Nevada, Humboldt County Cooperative Extension, Winnemucca, NV [4]University of Nevada, Elko County Cooperative Extension, Elko, NV [5]University of Nevada, Eureka County Cooperative Extension, Eureka, NV
35	Species Conservation	Implications of climate change for desert tortoises and other reptiles at the Mojave-Sonoran Desert interface	**Cameron W. Barrows**	Center for Conservation Biology, University of California, Riverside, Riverside, CA
36	Species Conservation	Sagebrush Steppe Treatment Evaluation Project (SageSTEP): a long-term monitoring and ecological network	**Jeanne C. Chambers**[1], James D. McIver[2]	[1]USDA Forest Service, Rocky Mt. Research Station, Reno, NV [2]EOARC, Oregon State University, Union, OR
37	Species Conservation	Patterns of small mammal and reptile diversity in Great Basin National Park	**Bryan T. Hamilton**, Margaret Horner	Great Basin National Park, Baker, NV
38	Species Conservation	Climate change, premature seed fall, and the decline of crossbills	**Julie A. Hart**, Craig W. Benkman	University of Wyoming, Program in Ecology, Department of Zoology and Physiology, Laramie, WY
39	Species Conservation	Does climatic change promote niche shifts? A case study of the desert horned lizard *(Phrynosoma platyrhinos)*.	**Tereza Jezkova**[1], Jef R. Jaeger[1,2], Viktoria Olah-Hemmings[1], and Brett R. Riddle[1]	[1]School of Life Sciences, University of Nevada, Las Vegas, NV [2]Public Lands Institute, University of Nevada, Las Vegas, NV

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40	Species Conservation	Impact of recent environmental change on small mammals of the Ruby Mountains: an 80-year resurvey	**Eric A. Rickart**, Rebecca J. Rowe	Utah Museum of Natural History, University of Utah, Salt Lake City, UT
41	Species Conservation	The Grinnell Resurvey Project	Kevin C. Rowe[1], Karen Rowe[1], Michelle Koo[1], Adam B. Smith[1], Toni Lyn Morrelli[1], James Patton[1], Chris Conroy[1], Morgan Tingley[2], Emily Rubidge[1], Carla Cicero[1], Steven Beissinger[2], **Craig Moritz[1]**	[1]Museum of Vertebrate Zoology, University of California, Berkeley, CA [2]Environmental Science Policy and Management, University of California, Berkeley, CA
42	Terrestrial	Assessing the geology and geography of large-footprint energy installations in the Mojave Desert, California and Nevada	David R Bedford, **David M. Miller**	U.S. Geological Survey, Menlo Park, CA
43	Terrestrial	Climate change and land use effects on atmospheric dust in the western United States	**Harland L. Goldstein[1]**, Richard L. Reynolds[1], Mark E. Miller[2], Marith C. Reheis[1], Frank E. Urban[1], George N. Breit[3], John W. Whitney[1], Suzette A. Morman[3], Gary D. Clow[1], Rian C. Bogle[4], Seth M. Munson[5], Jayne Belnap[5]	[1]U.S. Geological Survey, Geology and Environmental Change Science Center, Denver, CO [2]U.S. Geological Survey, Southwest Biological Science Center, Kanab, UT [3]U.S. Geological Survey, Crustal Geophysics and Geochemistry Science Center, Denver, CO [4]U.S. Geological Survey, Western Region Geographic Science Center, Flagstaff, AZ [5]U.S. Geological Survey, Southwest Biological Science Center, Moab, UT
44	Terrestrial	Atmospheric dust transport in the Great Basin	**Maura Hahnenberger[1]**, Kevin D. Perry[1]	[1]University of Utah, Department of Atmospheric Sciences, Salt Lake City, UT
45	Terrestrial	Carbon sequestration in carbonate-rock province of eastern Nevada	**M. Karakouzian[1], Jon W. Wilson[2]**	[1]USGS, Nevada Water Science Center, Henderson, NV [2]University of Nevada, Las Vegas, Department of Civil and Environmental Engineering, Las Vegas, NV
46	Terrestrial	Land Cover Trends: Carbon Storage in the Basin-and-Range Ecoregions	**Christopher E. Soulard**, Benjamin M. Sleeter	USGS, Western Geographic Science Center, Menlo Park, CA
47	Terrestrial	Potential for native plant community recovery following fire in the Mojave desert	**Samuel B. St. Clair**, Joe Wilkinson, Steve White, Kevin J. Horn	Department of Plant and Wildlife Sciences, Brigham Young University, Provo, Utah
48	Terrestrial	Vulnerability of quaking aspen and avian communities to climate change in the northern Great Basin	**Susan Earnst[1]**, Doug Shinneman[1], Peter Weisberg[2], and Jian Yang[2]	[1]USGS Forest and Rangeland Ecosystem Science Center, Snake River Field, Boise, ID [2]University of Nevada-Reno, Reno, NV

Description of Breakout Sessions

Over the first day and a half of the workshop, you will hear from your colleagues and peers about the challenges posed by a changing climate to species, ecosystems, and humans. Now it is your turn to weigh in. Managers, you have the knowledge of what you do every day, your authorities, legal requirements, policies, and standard operating procedures; you also have the collective expertise that is only gained from decades of on-the-ground experience in land management. Researchers, you have the knowledge of both the current status and limitations of our understanding of climate change and the potential threats it poses to the natural world; you also bring the scientific expertise that managers require to guide their adaptive management.

There are many uncertainties about the potential effects of climate change, especially at regional and local scales. Uncertainty, however, is not a new challenge to natural resource managers or researchers. Our success in meeting this challenge will be measured by how well we can develop and implement an adaptation and mitigation strategy that is flexible enough to integrate our emerging understanding of the science of climate change with natural resource management.

Your charge in the breakout sessions is to engage in an open dialogue on the following three basic questions. Each breakout is about 90 minutes, so your facilitator has been instructed to allot about 30 minutes to each question. Because each question builds on the prior one(s), your facilitator has also been asked to address them in the sequence shown.

- What do you perceive to be the major challenges that you face over the coming decade in adapting your practices to the changing climate?

- What research is needed to inform adaptive management for climate change over the coming decade?

- How can we best integrate existing and new (e.g., Landscape Conservation Cooperatives, ecoregional assessment, Climate Science Centers) approaches to address these needs?

- In addition to a facilitator, in each session we will have two note-takers. One will attempt to accurately capture your thoughts on a flip-chart so that there is a “group memory” to help guide the discussion. In addition, a second recorder will be making a written record of your comments with more detail in a word processing file. In case, we need to contact you later for clarification, please preface your comments with your name and organization. The organizers of the workshop will use these notes to provide a synthesis of the outcome of the breakout sessions as one of the products of the workshop.

Speaker Abstracts (in order of presentation)

DOI's climate change science, adaptation and mitigation strategy

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Climate change is of the most important challenges of our time. President Obama's vision for moving the economy from recession to recovery and ultimately to prosperity involves investments in clean energy and combating global warming. DOI is prioritizing coordinating climate change science and adaptive management strategies to better understand how to protect ecosystem health, enable fish and wildlife adaptation, and provide healthy ecosystems to support wildlife and human populations – including Tribal nations and the public at large -- through the provision of ecosystem services, infrastructure, and education opportunities. DOI's extensive land, wildlife and natural resource management responsibilities require DOI leadership in the science of climate change impacts, greenhouse gas mitigation, and the development of management strategies to adapt to a changing climate. The Department harbors a unique collection of scientists, land managers and other professionals who conduct the science, monitoring and management to assess the impacts of climate change -- across multiple scientific disciplines, a wide variety of spatial scales, short- and long-term climate processes (including analysis and study of hundreds of thousands of years of Earth history). DOI's expertise to translate science into decision support and management techniques that facilitate adaptation in the face of a changing climate is an imperative component of the solution. Successful adaptation of our nation's treasured landscapes, ecosystem services, and fish and wildlife requires an integrated DOI-wide climate change and adaptation strategy and an unprecedented collaboration between public and private partners, across the country and internationally.

Climate variability and change in the Great Basin: Observations and projections

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The consensus among climate projections for the next 90 years is that the Great Basin and Mojave Desert will warm, and that annual precipitation will remain near historical values in the north and decrease in the south. Temperature projections show more agreement than those for precipitation. Summer is expected to warm slightly more than winter. Precipitation decreases are expected to be greater in spring and summer, and smaller in winter. Winter is currently the wettest season in much of the region, and winter percentage of annual may rise slightly with time. North American summer monsoon projections presently have minimal confidence. Temperature effects should have initiated around the middle 1970s. Observations show that temperature has risen in this region since about that time. Nighttime temperature has risen more than daytime temperature. The more arid portions have remained warm during the recent cool (west-wide and nationally) years of 2008

and 2009. Precipitation has decreased over the past 15 years, but from the wettest peak in the last 115 years. There has been greater inter-annual precipitation variability in recent decades. Spring shows the greatest seasonal warming, though summer has risen considerably since around 2000. Freezing levels have risen similarly. Temperature increases could lead to reductions in soil moisture recharge. The region has been affected by drought for much of the past 15 years, and the Colorado River drought remains a very significant event. ENSO has strong effects in southern parts of this region, but its response to climate change is not well understood.

Climate change in the Great Basin and Mojave Deserts: Ecosystem responses

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Elevated greenhouse gases (mainly CO_2), climate change (warmer temperatures and changes in precipitation regimes), nitrogen deposition, and land use changes are all factors that are altering the structure and function of ecosystems in the western U.S. Climate change in the western U.S. will probably have its greatest effect on ecosystems via changing precipitation regimes, although increased heat waves could impact wildlife species and relaxed freezing in winter could allow range extensions of plants and animals. Current models predict more pronounced droughts and greater variability of precipitation inputs in the future for this region, and results from large watersheds show recent changes in snowmelt and runoff to earlier in the season, thus exacerbating summer drought conditions. This can effect plant productivity and also strongly influence the structure and function of riparian systems. Elevated CO_2 is well known to stimulate plant production in desert systems, but changes in rainfall amount and patterns impose an important additional driver in this response. Examination of a 10-year record of plant production at the Mojave Desert FACE Facility shows almost all production gains occurred in wet years, with few enhancements in dry years. Drought-wet cycles also had opposite effects on the CO_2 response of native and exotic annuals. Community and ecosystem trajectories are therefore highly dependent on the pattern of future rainfall regimes – warmer/drier conditions will result in more desertification, but an increase in variation (larger events interspersed with longer droughts) will have multiple effects which may cause structural shifts in ecosystems.

Opportunities and challenges for ecosystem services science and policy in arid and semiarid environments

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Ecosystem services provide key contributions to human well-being and local, regional, and national economies. Ecosystem services research and application in arid and semiarid regions has historically lagged behind other regions, though this situation is quickly changing. At least

three key challenges still face the science and policy communities in applying ecosystem services to address resource management in arid and semiarid systems. First, unregulated surface water and the ecosystem services derived from it are truly scarce resources in arid lands, as opposed to scarce but more abundant groundwater and flow-regulated surface water. Understanding how these services stack up against immediate perceived needs to pump or divert ground and surface water is a major challenge. Second, beneficiaries of ecosystem services are more dispersed in the western U.S. than other parts of the country, meaning that spatial flows of benefits cross long distances. While low population density has traditionally been equated to low demand and value for ecosystem services, this may not be the case for services that benefit broad geographic cross-sections of beneficiaries. Finally, for water-based ecosystem services, the location of service provision and use within watersheds matters greatly, and such spatial relationships must be better accounted for in ecosystem services analysis. I will discuss alternative approaches to assessment and economic valuation of ecosystem services that address these challenges. New ecosystem services research approaches, along with better communication with stakeholders and decision makers, may help in reframing traditional resource conflicts while addressing challenges to resource management in the arid and semiarid systems.

Climate change adaptation options for public lands and resources

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Federal conservation land holdings (e.g. National Wildlife Refuges, National Parks, National Forests and other administrative units) provide a significant safety net for vertebrate, invertebrate and plant diversity throughout the United States. Climate change will have heterogeneous and pervasive effects throughout these lands and will add substantial complexity to solving the existing problems of adjacent land conversion and fragmentation, human population growth, and competition for water, among others. We summarize results of a U.S. Climate Change Science Program synthesis and assessment of adaptation options for these lands and focus on the National Wildlife Refuge System (NWRS) as case study. A species, rather than physical area, mandate provides NWRS with substantial legal latitude to respond to climate change. Some species will be winners and some will be losers. The NWRS will need to exploit opportunities as well as prepare for negative effects of climate change. Species with limited dispersal abilities in stranded habitats will be at greatest risk. Rigorous and perceptive projections of the possible futures of species, habitats and management options that result from the synergistic effects of climate and non-climate stressors, at all relevant scales, is required. However, waiting for improved climate effect projections before acting is inappropriate in view of the pervasive and immediate nature of the problem; developing a management culture that rewards risk taking would enhance the speed of adaptation to climate change challenges. Expert opinion will need to be used in the initial response stages, and mistakes will be made while adaptation capabilities are being developed. An expansion of planning and budgeting horizons will be necessary. Refuges and other public lands are not fixed islands of safe haven for species and the previous goal of preserving dynamic

equilibrium must be abandoned. Managers must manage for capacity to adapt to climate change and focus on a system "state" that provides representative, redundant and resilient populations of species that fulfill the key legal mandate of NWRS to maintain the integrity, diversity, and health of conservation targets. This will require an increase in the effective conservation footprint of NWRS. New institutional partnerships; management responses that transcend traditional political, cultural, and ecological boundaries; greater emphasis on trans-refuge and trans-agency management and research; strong political leadership and re-energized collaborations between the NWRS and its research partners at multiple spatial scales will be required to ensure resilience of the NWRS to the challenge of climate change.

Malheur National Wildlife Refuges large scale migration and adaptation in our changing environment

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Malheur National Wildlife Refuge (Refuge) was established on August 18, 1908 by President Theodore Roosevelt using Executive Order No. 929 "as a preserve and breeding ground for native birds, especially colonial nesting water birds." Presently, the Refuge has a land base of over 187,000 acres located in Southeastern Oregon. The Refuge is an integral part of the Pacific flyway and lies within the Intermountain Joint Venture. Climate change may negatively impact the Refuge by decreasing native plant communities, increasing invasive species, varying precipitation patterns impacting water quantity, quality and rights. Climate change prediction models can aid us in gaining insight on the future conditions and management directions for the Refuge. The Refuge is currently in a comprehensive conservation planning process and to ensure biological integrity the best available science is being used to create a viable and adaptable 15-year plan. Given the possibility of changing environmental conditions of the Great Basin and limited Refuge resources, there is need to build partnerships to help solve these very complex landscape issues.

Species conservation in a changing environment: Strategies at National Wildlife Refuges of Southern Nevada

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The National Wildlife Refuge System (System) was established to conserve fish, wildlife, and plants and their habitats by ensuring that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans. In southern Nevada, the Desert National Wildlife Refuge Complex includes 4 wildlife refuges: Ash Meadows NWR, Desert NWR, Moapa Valley NWR, and Pahranagat NWR. Ash Meadows NWR

protects spring-fed wetlands and alkaline desert uplands creating a landscape of desert oases that are now uncommon in the southwestern United States. At least 25 species are endemic to Ash Meadows, 12 of which are listed as endangered or threatened. Most of these species are dependent to some degree on the desert springs or high water table. Desert NWR encompasses over 1.5 million acres of Mojave Desert and mountain ranges, with elevations from 2,500 to nearly 10,000 feet. Desert NWR was established for conservation of wildlife, including the desert bighorn sheep. Shifts in species ranges along elevation and latitudinal gradients within this wildlife refuge may occur with climate change. Moapa Valley NWR secures the headwater habitats of the Upper Muddy River for the endangered Moapa dace. Six thermal springs create the stream channels that support this endemic, thermophilic fish. Pahranagat NWR provides habitat for migratory birds. Most of the water in the wildlife refuge is outflow from 2 regional carbonate springs, Ash and Crystal Springs. Using examples from two of these refuges, management strategies responsive to climate change will be compared for species that are narrow endemics (Ash Meadows NWR) versus wider ranging, across a broader landscape (Desert NWR).

Proactive management of conservation-reliant species as land use and climate change

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Scientific principles for management of species with regulatory protection can be applied to management of species at risk. Ideally, proactive and adaptive management of species at risk will preclude the need to list those species under federal and state endangered species acts or similar statutes. As with listed species, it is useful to build a conceptual model that describes the abiotic, biotic, social, and economic drivers of the status and trend of an at-risk species. If a species is poorly known, it may be possible to draw inference from related species whose ecology is better understood. The management and research communities can collaboratively identify alternative future scenarios of climate and land use, and evaluate how the drivers of distribution, status, and trend of species at risk may be affected directly and indirectly by each scenario. It is also important to specify explicit, measurable objectives for the species that are realistic and based on credible science. We then can identify management interventions that are likely to achieve those objectives under each environmental scenario. At-risk species in the Great Basin and Mojave along a gradient of conservation reliance illustrate how this process can be applied to forestall new listings. The process also is relevant to establishing defensible, feasible guidelines for recovery and for post-recovery management.

Managing fire and fuels in the northeast Mojave Desert: The Mojave Desert Initiative

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The Mojave Desert Initiative (MDI) was established in 2007 as a forum for government agencies and other partners to collaboratively address wildfire and invasive species issues within the NE Mojave Desert in Arizona, Nevada, and Utah. This presentation will review the process used to identify strategic goals and actions for the MDI. The major goals of the MDI are to protect remaining unburned habitats and restore strategically located islands, key habitat areas and corridors. Major actions include the development of regional guidance for fire personnel to minimize further habitat loss to fire and a regional assessment used to identify priority areas of work and project ranking/selection criteria. The presentation will review the types of projects being planned and implemented throughout the region, including strategies to address climate change.

Fuels and fire regimes of the Great Basin and Mojave Desert

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Landscapes of the Great Basin and Mojave Desert are characterized by isolated mountain ranges with steep slopes separated by broad basins. These local elevation gradients, coupled with regional latitudinal gradients, translate into a variety of climatic and vegetation types ranging from arid shrublands to more mesic woodlands and forests. The result is a broad range of fuel types that support a variety of fire regimes. However, there are a few prominent fuel types that dominate most of the area within these two desert regions. In this presentation I will describe these predominant fuel types and their associated fire regimes, report recent fire trends among them, explain where invasive plants have had their greatest effects on fire regimes, hypothesize how potential future climate scenarios may alter these current conditions, and discuss the implications of these dynamics for fire management.

Accommodating climate change in defining objectives for ecological restoration: Practical examples from southwestern arid lands

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Setting objectives for ecological restoration entails determining when and where restoration is desired, what the purposes of restoration are to be (e.g., reestablish evolutionary environments to maintain rare species, reinstate productivity), and what target ecosystem is intended to

be approximated through restoration. The concept of reference conditions underpins these considerations and defining objectives. Reference conditions describe an ecosystem in its generally healthy, intact state, and often represent conditions before an ecosystem was disrupted. Climate change could be viewed as causing problems for reference conditions because past conditions may no longer reflect the environment in which restoration is to be conducted, and when using current (relatively undisturbed) conditions as reference conditions, the references may already have been impacted by climate change. Several practical examples from southwestern arid lands are used to illustrate that (i) reference conditions are as or more useful than ever in a changing climate for establishing baseline descriptors for ecosystems and setting objectives for how to restore them, (ii) how restoration objectives can be modified to enhance chances for success in a changing climate, and (iii) how restoration can be a tool for helping ecosystems adapt and cope with climate change. These examples range from restoring forest structure in the northern Mojave Desert for making ecosystems more robust to climate change to using species-rich seed mixes for restoring native vegetation on desert wildfires.

Restoration quantum mechanics – ecosystem restoration and environmental change

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Atomic science was revolutionized by incorporating quantum mechanics and the uncertainty principle, which quantifies that particle position and momentum cannot both be precisely known. We argue that, like atomic scientists, restoration ecologists and land managers need to embrace uncertainty and begin to frame their objectives in a more probabilistic structure. In strategizing to restore degraded ecosystems, managers assess the initial status of the system and establish restoration objectives. However, both environmental factors and project management constraints may add to or subtract from the project's probability of achieving those objectives. The added uncertainty of climate changes within a region may modify this probability. In some cases, resources needed for achieving restoration goals must be changed, but in other cases it is the objectives themselves that should be modified. Unfortunately, we are only beginning to understand baseline probabilities of achieving restoration goals because we have lacked appropriate effectiveness monitoring over both space and time. Determining baseline probabilities will be essential when objectives must be changed. Such information is better developed for vascular plant restoration, but is still lacking for other important ecosystem components such as biological soil crusts, soil microbes, and nutrient cycling. For vascular plants, we can speculate on the impacts of changes in climate on restoration potential by using expert systems, such as VegSpec, that match plants to soil and weather. For other ecosystem processes, we are in tremendous need for quantifying their status in intact and disturbed systems and for understanding the probability of improving these processes through restoration.

Management across agency boundaries - obstacles and opportunities

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Management across agency boundaries presents both obstacles and opportunities. Most agency personnel view the landscape through lenses that see different laws, regulations, missions and mandates that affect how the lands are managed. Most of the public, and the wildlife for that matter, see the landscape without these filters. To them the land is one big landscape and the morass of federal, state and local regulations and management plans is either completely unknown or at lease not well understood. They simply want to use the land. As land managers we face a future where the management actions around our area of responsibility are as important as those on the lands we manage. It is essential to the future of the desert ecosystem that we eliminate our agency biases and competition with each other and coordinate our efforts to work towards a common goal of public land management for sustainability. The Desert Managers Group in California and the Southern Nevada Agency Partners in Nevada are two existing groups that are good examples of how we can coordinate our efforts. However, more needs to be done to work together on joint management activities (renewable energy development, invasive species, landscape connectivity, habitat and ecosystem management, threatened and endangered species recovery).

Cross-boundary management in a changing environment – a new era of collaboration

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Ecological, social and legal factors interact to cause boundary effects that are often highly visible on the landscape. The Mojave and Great Basin deserts are characterized by a complex mosaic of land ownership where both ecosystems and species transcend these boundaries. Administrative boundaries inevitably lead to ecological boundary zones that influence ecological processes and can hinder movement of plant seeds and animals in a changing environment. In addition, human behaviors can differ across boundaries based upon social norms and mores and may impede adaptive management. Laws determine societies' response to issues like climate change and institutions carry out laws and contribute to public policy. An important recent change in "public" policy making is that watershed and landscape planning efforts based on collaboration among private individuals and multiple state and federal agencies are increasingly shifting policy making outside of governmental processes. Cross-boundary management can be complex and laws and institutions can not be expected to make cross-boundary management mandatory. This indicates that effective management across boundaries requires collaborative approaches that address large scales. Key elements in effective collaboration include obtaining consensus on priority issues, developing common mapping platforms, assessment tools and databases, and using science-based approaches to prioritize management activities. Cross-boundary relationships differ depending on the composition of the collaborative group (private individuals, inter-agency, intra-agency) and the most effective collaborative approach also will differ.

Changing gradients - effects on invasive species and migration

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Climate change and plant invasions in the Great Basin and Mojave Deserts

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Non native invasive plants present a substantial threat to ecosystems in the Great Basin and Mojave Deserts. Invasive plants compete directly with native species, alter habitat, and change ecological processes such as fire frequency. Climate changes, in particular increasing atmospheric CO_2, altered seasonal precipitation regimes, and rising temperatures are likely to have diverse impacts on invasive plants – expanding invasion risk for some species and reducing invasion risk for others. In the western U.S., a range of experiments and models provide some specific projections of changing invasion risk, but further work, including integration of scientific approaches is needed. Combating invasive species in the context of climate change may be facilitated by the following: 1) Using species and landscape specific invasion risk assessments to prioritize treatments. 2) Targeting corridors of invasive species movement and restricting land uses that facilitate invasion. 3) Expanding monitoring activities and information sharing across jurisdictions to identify problems on the horizon. 4) Developing flexible management protocols to respond quickly to newly problematic invasive species. 5) Preparing for possible restoration opportunities in areas where invasive plants are likely to respond poorly to climate change. Treating invasive species increases resistance in native communities and should be a priority for natural resource management in the context of climate change.

Climate change: Water needs & strategies for a sustainable future

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Average temperatures in the West have reportedly risen 2-5ºF during the 20th century—greater than in other regions of the United States. As the West warms, snowfall and snowpack have diminished in major portions of the West, and an increasing fraction of winter precipitation is falling as rain, rather than snow. Additionally, Western snowpacks are melting earlier with peak runoff coming 10 to 30 days earlier in many cases. The region has generally had increases in precipitation, with significant increases in some areas. However, other areas have become drier and experienced more drought. Of the major mountain ranges in the West—the Cascades, the Sierra Nevada, and the Rockies—trends are more pronounced in the Cascades and the Sierra

Nevada and less so in the Central and Northern Rockies. Wildfire losses in the West have also increased, particularly in the last two decades. These changes and the uncertainty surrounding future water supplies make risk reduction an important skill for water managers. State water planning will need to include new and innovative technologies and strategies as we adapt to a changing climate and new hydrologic realities. Water managers need to clearly communicate their need for applied science and real-time information to the climate research and earth observation communities. Climate changes also need to be considered at all levels of water resources planning, particularly the impact on present and future water storage opportunities. Further, states need to examine their existing legal regimes related to water use in light of climate change.

Water resources and ecosystem stability in the changing climates of the North American deserts

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Decadal climate shifts are well documented in the western United States, with known effects on water resources and ecosystem stability. On-going drought in much of the Mojave and Great Basin Deserts is reminiscent of the historical drought that devastated the pastoral economy of this region from 1891 through 1904. The early 20th century pluvial, which occurred from 1905 until about 1942, generated large floods and encouraged dryland farming in the deserts, and the abandoned fields are still recovering today. The mid-century drought was followed by the late 20th century wet period, and then by the current early 21st century drought, continuing the pattern of alternating wet-dry conditions that characterize the climate of the intermountain West. Elements of the hydrologic system respond at differing rates to climate; mountain-front recharge responds to long-term average precipitation, while river systems respond with occasional floods and event-related recharge of alluvial aquifers. Winter precipitation is strongly affected by El Niño conditions, but the effect diminishes northwards into the Great Basin. Terrestrial ecosystems have responded to the boom-bust climate cycles and the generally longer growing season created by warmer temperatures, especially during nighttime. Mojave Desert ecosystems added substantial biomass during the late 20th century wet period but recently have responded with drought pruning. Riparian ecosystems flourished during the late 20th century except where groundwater use was excessive. Although desert ecosystems may undergo substantial changes owing to predicted decreases in winter precipitation, riparian ecosystems may be most threatened by the combination regional climate change and increasing water development.

Monitoring ecological response to climate change in National Parks

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Beginning in fiscal year 2000 as part of the Natural Resource Challenge, Congress greatly increased the funding for the NPS Inventory and Monitoring (I&M) Program to accelerate natural resource inventories, and to design and implement a program for monitoring park "Vital Signs" (measures of resource condition). The I&M program has several key goals but core to them all is to increase our capacity and effectiveness at delivering data and knowledge for the purpose of science-based resource management. The program organized more than 270 park units into 32 I&M networks, linked by geography and shared natural resource characteristics. The networks facilitate collaboration, information sharing, and the integration of science and resource management. A decade later and the momentum behind our efforts to connect our natural resource monitoring, planning, and decision making continues to increase at an ever-growing pace. With new funding from the NPS Climate Change Response Program, our monitoring of ecological indicators of climate change will be expanded within the framework of Landscape Conservation Cooperatives. Our focus is on monitoring ecological response in parks most vulnerable to climate change within four thematic ecological systems: high-elevation, high-latitude, arid-lands, and coastal/marine areas. We are leveraging our NPS Vital Signs Monitoring Networks and other Federal and State agencies, linking NPS monitoring to regional and national scale indicators of climate change. The data and knowledge generated should enhance management efforts to adaptively respond to rapid climate change and help sustain ecosystem resilience.

New research infrastructure in Nevada for climate change science, education, and outreach

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The Nevada System of Higher Education (including DRI, UNLV, UNR and Nevada State College) received a five year research and infrastructure development award in 2008 from the National Science Foundation. A main goal of this project is to create a statewide interdisciplinary program and virtual climate change center that will stimulate research, education, and outreach on the effects of regional climate change on ecosystem resources (especially water) and to support use of this knowledge by policy makers and stakeholders. Six major strategies range from policy coordination to education to scientific pursuits. From the ecological and water resources

perspectives, the goal is to develop data collection, modeling, and visualization infrastructure to determine and analyze effects on ecosystems, disturbance regimes, water balance, and water resources. As part of this project, two observational transects are being established: one in southern Nevada in the Spring Mountains (5 sites), and the second in eastern Nevada in the Snake Range (7 sites). Locations were chosen based on several criteria, which will be presented and discussed. Climate, hydrologic, and ecological data will be collected from different vegetation zones and downloaded into high capacity data storage units and made available to researchers using a new Nevada climate change portal. The research aims to answer two interdisciplinary science questions: 1) How will climate change affect water resources and linked ecosystem resources and human systems; and, 2) How will climate change affect disturbance regimes and linked systems? The status of this new resource will be presented and discussed.

Renewal energy and natural resouce conservation

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Potential effects of energy development and climate change on terrestrial wildlife especially the desert tortoise

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Utility-scale renewable energy development (USRED) and climate change may greatly affect terrestrial wildlife in the desert Southwest where the potential for producing renewable energy, especially from solar resources, is very high. In addition, climate change models predict large increases in temperature in an already warm region. USRED has the possibility to affect large areas of habitat directly and indirectly through intense but short-lived construction activities and long-term operations. A great deal has been published in the scientific literature on the effects of wind energy development on flying (volant) wildlife including birds and bats, but comparatively little has been published on the effects of wind and solar energy development on non-volant wildlife, both terrestrial and aquatic. Documented effects on non-volant wildlife include behavior modification as a result of industrial noise and the possibility of hearing loss. Published research on desert tortoises at a wind energy facility suggests that not all effects of USRED are negative but more research is badly needed, especially controlled before and after studies with replication. Currently, there is insufficient evidence in the scientific literature to conclude that USRED is fully compatible with wildlife conservation in the desert Southwest. Vulnerabilities of desert tortoises to a warming climate in the Mojave Desert include possible poor adaptations to modern desert conditions and environmental sex determination. Adaptive responses of tortoises to warming could include altering their range, shifting distributions to higher elevations, changing the nesting season, and changing the depth or location of their nests to affect sex ratios.

Conservation partnerships in the Great Basin and Mojave: Merging science and management

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Accelerating climate change in the Great Basin and Mojave Desert poses a major challenge to those responsible for natural resource conservation. To deal with this challenge, both innovative strategies and an unprecedented level of collaboration between public and private conservation interests will be needed. In this interactive session, panelists representing conservation partnerships working in the Great Basin will present overviews of the Desert Fish Habitat Partnership (Sjoberg), Intermountain West Joint Venture (Mansfield), and the Great Basin Research and Management Partnership (Frazer) that highlights how each has integrated science and management activities. A representative of the Department of the Interior (Kearney) will introduce concepts involved in the Landscape Conservation Cooperative network being formed across the country. Audience members will have the opportunity to ask questions of the panelists to learn more about the advantages of conservation partnerships.

Natural resources needs related to climate change in the Great Basin and Mojave Desert: Workshop Synthesis

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Two important sources of uncertainty in resource and ecosystem management in the western U.S. are decadal-to-multidecadal (D2M) natural climate variability and anthropogenic climate change. D2M variability is characteristic of the instrumental record of the past century, as well as tree-ring chronologies of last two millennia. D2M variability can synchronize fluctuations in resource availability within and across regions, and regime shifts between prolonged wet and dry conditions play a major role in resetting ecosystems at regional scales. Although the tropical Pacific is paramount, D2M variability in the North Atlantic (the so-called Atlantic Multidecadal Oscillation or AMO) and the North Pacific (Pacific Decadal Oscillation) also may play important roles. Resource managers have barely addressed the challenges posed by D2M variability, which will make it that much harder to reckon the impacts of climate change. Fast advances in climate modeling could lead to robust forecasts on the scale of months to a decade based on decadal variability and anthropogenic forcing.

At present, we don't understand climatic effects on ecosystems well enough to predict the ecological consequences of near-term climate. For example, in the western U.S., over the last few decades average annual temperatures have increased up to 2°C at the highest elevations, and nearly 1°C at the lowest. Abrupt cool season warming beginning in the late 1970's/mid-1980's brought on a marked increase an 8 to 10 day advance in spring onset averaged, a rise in the elevation at which it rains rather than snows, a decrease in snowpack, earlier snowmelt timing, a shift to an earlier pulse of snowmelt-fed discharge, an increase in the frequency of large fires and insect outbreaks. Despite its obvious significance, there has been no systematic effort to gage ecological responses. Were the responses to this abrupt warming large or small, linear or nonlinear, reversible or permanent, or geographically and taxonomically uneven? A clear research directive is for the scientific community to determine how ecosystems have responded to what is being billed in the West as the early stages of anthropogenic climate change.

Video Presentation
The Heat is On: Desert Tortoises & Survival

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A thirty minute movie exploring the world of the Mojave desert tortoise. This is a new USGS/USFWS product officially released on March 8th, 2010. The program is intended to show how science is being used to aid in the recovery of this threatened species. Fire, ravens, invasive plants, disease, roads and climate change are among the threats to tortoises discussed in the movie. It was filmed in high definition and features spectacular scenes of the hatching of a Mojave desert tortoise and male tortoises in territorial battle. Graphics and animation are used to highlight certain aspects of tortoise ecology as well as to demonstrate how technology such as GPS tracking aids the scientists in their work. The film also describes the USGS Desert Tortoise Habitat Suitability Model in the context of identifying ideal tortoise habitat and as a tool for assisting in siting best locations for future green energy projects.

This movie was produced and directed by Stephen M. Wessells (USGS filmmaker) in collaboration with the USGS Western Ecological Research Center (www.werc.usgs.gov) and the US Fish & Wildlife Service.

Poster Abstracts

Category: Group Initiatives/ Collaborations

P-1. The Great Basin Research and Management Partnership

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The Great Basin is considered one of the most endangered ecoregions in the United States. The human population is expanding at the highest rate in the nation and major sociological and ecological changes are occurring across the region. Changes can be attributed to numerous interacting factors including urbanization, changing technology and land use, climate change, limited water resources, altered fire regimes, invasive species, insects, and disease. Managers across the Great Basin are increasingly challenged to maintain or improve the ecological condition of these systems and the services they provide while meeting the needs of a growing number of user groups with diverse and sometimes opposing interests. Sustaining Great Basin ecosystems, resources and human populations will require strong collaborative partnerships among research and management organizations. The Great Basin Research and Management Partnership (GBRMP; http://greatbasin.wr.usgs.gov/gbrmp/) is meeting this challenge by promoting comprehensive and complementary research and management collaborations to sustain these natural and cultural resources. GBRMP's fully vetted Memorandum of Understanding has been signed by 6 federal agencies, 2 state agencies, and 6 academic institutions and is an open invitation to additional members who share our vision. That vision is to foster development of teams representing the full spectrum of organizations and stakeholders that work together to solve the regions ecological and socio-economic issues through the integration of research and management. GBRMP does not replace existing collaborations, but builds upon their strengths by increasing coordination and communication among them. GBRMP provides a mechanism for assembling diverse research and management groups working in the Great Basin to: (1) obtain consensus in identifying and prioritizing regional issues; (2) expand and help focus existing collaborative efforts; (3) facilitate new teams to address emerging issues.

It also provides critical information sharing capacity for both existing collaborations and new teams. GBRMP is developing tools and resources to achieve these objectives. Two of these tools: the Collaborations Database and Experts Database, are fully searchable, interactive web resources designed to bring existing teams and subject matter experts together to tackle common problems and use limited resources efficiently. These databases and other GBRMP tools will be available for demonstration at the Conference.

P-2. Renewable energy locations for existing and potential facilities within BLM leased land

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In 2009, secretarial orders directed the Bureau of Land Management (BLM) to prioritize the development of renewable energy on public lands to reduce the nation's dependence on foreign oil and to reduce greenhouse gas pollution. The Western Governors Association (WGA) collaborated with numerous stakeholders to develop the Western Renewable Energy Zones, identifying areas in 11 western states with vast renewable energy resources. The next steps support commercial transmission projects and their markets along with building interstate cooperation for transmission approvals, cost recoveries, and the evaluation of transmission strategies. A goal will be to facilitate the development of high voltage transmission to areas with high renewable energy and low or easily mitigated environmental impacts. The processing of renewable energy applications (existing and potential) for solar and wind applications and transmission lines were improved by providing complete, accurate, and easily accessible source documents, records, digital data and map products. Environmental analysis included balancing the benefits of renewable energy with the needs to protect other resources such as crucial wildlife habitat. Census records, cities, roads, and wildfire urban interface areas data show areas of increased community growth. The potential energy records are derived from the National Renewable Energy Laboratory models provided by the WGA. The probability classification system relates to electricity that could be produced (1500 MW of solar or wind and 500 MW of geothermal generating capacity), which is needed to support the delivery of energy to major centers. The United States Geological Survey provided estimates for the geothermal energy sites.

The Western Interconnection is the electricity grid that includes the western states and is overseen by the Western Electricity Coordinating Council. Additional information is available at: http://www.westgov.org/wga/initiatives/wrez/zita/index.htm

P-3. Soil climate characterization project: an application for monitoring climate change

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The Spring and Sheep Mountains are two of the most ecologically diverse ecosystems in the Mojave Desert biogeographic region, 24 species are endemic to the Spring Mountains alone. In 2004, the U.S. Forest Service in conjunction with the Bureau of Land Management and the U.S. Fish and Wildlife service partnered with the Natural Resources Conservation Service (NRCS) and the US Geological Service (USGS) to initiate a project to characterize the climate and soils across the ecological life-zones within the Spring and Sheep Mountains in Clark County, Nevada. Understanding the dynamics of such diverse systems requires an understanding of the spatial and temporal interactions among climate, vegetation, and soil. Climate stations were installed along

an elevational transect across vegetative life zones ranging from Mojave Desert (*Larrea tridentata/ Ambrosia* spp.) along the West side of the Spring Mountains to a closed-canopy bristlecone pine (*Pinus longaeva*) assemblage just below 10,000 feet in the Sheep Range of the Desert National Wildlife Refuge. Data collection began in 2007 and continues to present. This study provides linkages useful in understanding desert ecology and pedology and provides a template for understanding soil moisture, evapotranspiration, solar radiation, groundwater recharge modeling and plant dynamics over time. The monitoring stations along the elevational transect currently are being added to a global network and will provide a basis for identifying change in ecological response to our changing climate.

P-4. Southwest Ecosystem Services Project

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The Ecosystem Services Research Program (ESRP) is a multi-year research initiative of the U. S. Environmental Protection Agency's (EPA) Office of Research and Development (ORD) to study ecosystem services and the benefits they provide to human well-being. These benefits include water supply and protection of water quality, flood protection, wildlife habitat support, and food and fiber. The Southwest Ecosystem Services Project (SwESP) is one of five community-based research projects in ESRP. Earth, life, and social scientists are collaborating with other federal agencies, communities, tribes and organizations to develop and implement the methods, models and tools to map, and assess the expected changes in quality and magnitude of ecosystem services under a variety of alternative future scenarios. Research will be conducted through several, integrated, multi-disciplinary, multi-agency partnerships (e.g., USGS, USDA-ARS) in the San Pedro and Santa Cruz watersheds in southeastern Arizona and northern Sonora, Mexico. In addition, a collaborative study will be undertaken in partnership with Native American Tribes to determine how an ecosystem services assessment can be linked with traditional knowledge to improve natural resource management and to identify decision support options. Ultimately, these efforts will be integrated with other community-based ecosystems services projects by EPA to create a transferable suite of methods and tools for evaluating ecosystem services. Using these tools, decision makers can implement proactive policy and management decisions to conserve and enhance ecosystem services vital to human health and well-being and support sustainable planning for current and future generations.

P-5. Southern Nevada Agency Partnership Science and Research Strategy

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The Southern Nevada Agency Partnership (SNAP) consists of four agencies: Bureau of Land Management (BLM), National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), and U.S. Forest Service (USFS). 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 Science and Research Strategy, created by the agencies, is a document designed to integrate and coordinate scientific research programs in Southern Nevada and improve the efficiency and effectiveness of these programs. The Strategy is intended to inform and guide SNAP agencies in identifying and articulating highest priority science research needs, sharing resources and funds from other sources, and eliminating redundancy between research programs within their focus areas. The major focus areas of the Strategy are Fire, Invasive Species, Watersheds and Landscapes, Biodiversity, Cultural Resources, Historic Content, Recreation, Land Use, and Education. The strategy encourages involvement of the scientific community through participation in an annual needs assessment, preparation of research proposals, sharing of research results, and synthesizing information for major focus areas.

P-6. Development and use of climate, land-use, and hydrology scenarios in EPA/NCEA's global change research program

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EPA's Global Change Research Program is devoting a major effort to the development of national-scale, spatially explicit scenarios of future climate, land-use, and hydrologic change in the United States. This work is designed to support assessments of climate change vulnerabilities that start with a focus on existing natural resource management goals. The goals of this effort are: (i) to allow us to make a national-scale assessment of the potential range of sensitivity of hydrologic and water quality endpoints to climate and land-use change; (ii) to provide a large-scale context for more detailed analyses in selected places; (iii) to help guide prioritization of work to the most vulnerable regions

and systems; (iv) to help us synthesize place-based results to draw national-level conclusions; (v) to place a meaningful lower bound on model and methodological uncertainty our assessments. These scenarios are already being applied in a number of research and assessment projects.

Category: Hydrology

P-7. Water, salt, and plants -- links in climate sensitive niches of the Mojave Desert

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Our studies in the Ash Meadows, Franklin Lake playa, and Mesquite Lake playa areas of the Mojave Desert in Nevada and California explore the connection of the composition and depth of shallow ground water to the composition of salts at the ground surface and solutes stored in the vadose zone. Empirical observations suggest that plant communities are complexly limited by water and the abundance and composition of the salts. In addition to the major salt forming ions, these salts are locally enriched in arsenic, boron, molybdenum, selenium, and uranium such that toxicity may also limit plant distribution. Surficial salts are susceptible to removal as dust during wind erosion and infrequent runoff events, but are sustained locally by the evaporation of shallow, and in many areas dilute ground water. Access to shallow ground water also sustains plants including some rare and endemic species. Increased aridity is expected to increase depth to shallow ground water and decrease spring discharge such that salts may accumulate in the shallow subsurface. Lowering both water levels and the zone of salt accumulation are expected to dramatically alter the ability of existing moist environments to host current plant communities. In addition, lower water levels would likely result in lateral spread of saline water beneath basin floors resulting in mortality of established plants. Work is underway within the Ash Meadows NWR to describe the current distribution of water and solutes in the unsaturated zone relative to rare, endemic plants in anticipation of changes to the existing water budget.

P-8. Influence of timing and amount of precipitation on plant production and soil respiration

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Human activities have resulted in well-documented increases in atmospheric carbon dioxide concentration and mean annual temperature, with forecast future increases of between 1.1 and

6.4°C. These increased temperatures will alter patterns of atmospheric circulation and influence hydrologic processes. For ecologists the challenge lies in the ability to understand how critical processes will be affected by two fundamental changes in precipitation – (1) decreases in the amount of summertime rain and (2) the size and frequency of individual rain events. In 2009 we began a rainfall manipulation study at elevations ranging from the valley floor to the crest of the Wasatch Plateau. This work has two specific aims that were addressed at the Great Basin Experimental Range in Ephraim, UT. The first aim was to determine how decreasing monsoon precipitation by 30-70% alters plant physiology, community interactions, and the biophysical environment. After one year we saw substantial changes in soil moinsture associated with our treatments. We also observed moisture-related changes in soil respiration and plant production. In future years we will assess changes in plant communities, with hypothesized changes in the relative importance of early and late-season species.

P-9. Long-term trends in extreme precipitation frequency in the Great Basin and Mojave Desert

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Episodes of extreme precipitation are, by definition, rare but make a greater contribution to precipitation totals in the Great Basin and Mojave Desert than in most other parts of the U.S. Numerous studies have documented increases in U.S. heavy precipitation during the latter part of the 20th Century. The intent of this study is to examine whether the national trends are also present at the regional level of the Great Basin/Mojave Desert. In recent years, newly available digital daily data extending back in time to the late 19th or early 20th Century has become available and opens the door to analyses extending over more than 100 years. Although the number of available stations in the Great Basin and Mojave Desert with such long records is small, the precipitation records of these stations have been analyzed to examine decadal to centennial scale variations in the frequency of extreme precipitation events. Events were defined by duration (1 to 10 days) and recurrence interval (1 to 20 years). A few stations exhibit statistically significant upward trends in the frequency of extreme precipitation episodes while none indicate downward trends. The meteorological reasons behind the observed major decadal-scale variations in heavy precipitation are not understood. In the Great Basin/Mojave Desert, the primary causes of extreme precipitation episodes are cold season storms from the Pacific and the summer monsoon (mostly in southern areas). A preliminary investigation is examining whether there are changes in the occurrence of these major meteorological phenomena.

P-10. Trends in temperature, precipitation, and snowpack in the Klamath Basin region

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Declining spring snowpack as a result of warmer winter temperatures has been documented in much of the western U.S. Reductions in snowpack and warmer temperatures will have important effects on streamflow and aquatic resources. Here we present the results from one of two studies of Klamath Basin hydroclimatology. In this study, we examine historic changes in winter temperature, winter precipitation, and April 1 snow water equivalent (SWE). Our results show that since 1945, winter temperatures have increased an average of 1.1˚C or 0.18˚C/decade. The temperature increase is uniformly distributed and comparable to increases reported in other studies in the Pacific Northwest. It is only partially explained by the changes in the PDO phase after 1977. Winter precipitation trends since 1945 are more variable spatially, with an average decrease of -3% and a range of -26% to +28%. Increasing precipitation trends are observed at several northern California stations; these are associated with El Nino years. Snowpack trends are strongly related to elevation. Snowcourse sites at elevations >1820m have declined as average of -2% while those at elevations <1820m have declined an average of -38%. The larger decline in snowpack at lower elevations is a result of winter warming, with more precipitation falling as rain and earlier spring snowmelt. In northern California, this effect has been slightly compensated for by increasing winter precipitation. Our results suggest that snowpack has declined measurably in much of the Klamath Basin region in recent decades, especially at elevations less than about 1800m.

P-11. Potential for water salvage by release of the biocontrol, *Diorhabda elongata*, on Tamarisk dominated rivers

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The biocontrol beetle, *Diorhabda elongata*, has been widely released in the upper basin of the Colorado River to control Tamarisk in the western U.S. A primary motivation for beetle release is to salvage water that would otherwise be lost to transpiration by Tamarisk. We summarize preliminary findings of our assessment of water usage. We used the Enhanced Vegetation Index (EVI) from the MODIS sensors on the Terra satellite to evaluate the prospects for water salvage at 15 riparian release sites in Utah, Colorado, Nevada and Wyoming. EVI was combined with meteorological data to estimate evapotranspiration (ET) at the release sites and in adjacent sites to which the beetle might have spread. ET was estimated at 16-day intervals from 2000 to 2008, encompassing

pre-release and post-release periods at each site. Baseline ET rates tended to be low, from 2-6 mm d-1 in summer (less than half of potential ET). At four of the sites, ET rates estimated by MODIS EVI decreased markedly one to two years after release. At other sites, however, no decrease in ET was detected, and ET tended to recover to pre-release levels at affected sites. At each location, the results support our past 3 years of findings for the ET seasonally and annually time-series curves as the beetle came into the area and defoliated saltcedar. This study supports phenological observations showing that beetle damage is spotty and localized at most sites, and reduction in ET is confined mainly to July when beetles are actively feeding.

P-12. Climate and land cover change impacts on stream flow in the southwest U.S.

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Vegetation change in arid and semi-arid climatic regions of the American West are a primary concern in sustaining key ecosystem services such as clean, reliable water sources for multiple uses. Land cover and climate change impacts on stream flow were investigated in a southeast Arizona and northeast Sonora, Mexico watershed. Using AGWA/SWAT hydrological models in combination with land cover change measurements derived from satellite remote sensing, we investigated the relationships among climate, land use, and stream flow. To gain an historic perspective on climate change and its impact on stream flow in this watershed over time, we used the site specific Bryson Macrophysical climate model to model climate, calibrated to 1961-1990 climate normals; and stream flow calibrated to USGS gauge data, for the Holocene at a 100-yr resolution. Measured stream-flow values collected from the Redington stream gauge (1985-1995) were used to calibrate the Bryson Macroclimate Model stream flow for the site. Landscape composition and pattern metrics were generated from the digital land cover maps derived from the Landsat earth observing satellites and compared over ~25-years (1973-1997).
The relation of stream flow with urban, mesquite cover, and rainfall was analyzed identifying stages of changes in land cover to be linked to either anthropogenic or climate causes. The process demonstrates a simple procedure to document changes and determine ecosystem vulnerabilities through the use of change detection and hydrological process modeling, especially in regard to human-induced degradation processes and natural phenomena that have occurred throughout the western rangelands.

P-13. Temporal analysis of Great Basin using spaceborne microwave backscatter and radiometric temperature observations

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Great Basin has undergone a region-wide increase in temperature and reduction in snowpack over last 50 years. In the Great Basin, most of precipitation occurs in the form of snow and this limited resource is fully or over allocated. Due to over exploitation of water resources and periodic droughts, this basin is an endangered ecosystem with decreased biodiversity. Due to the ecological and social significance of this basin, it is important to understand its temporal behavior in relation to large-scale artificially and naturally induced forcing. In this research, we use multiple spaceborne microwave instruments to analyze the regional scale temporal change in the Great Basin. Backscatter measurements from Ku-band Seasat A Satellite scatterometer (1978), NASA scatterometer (1996-1997), and Seawinds scatterometer (1999-2009); and C-band European Remote Sensing scatterometer (1992–2001) are used for change detection. Ku-band is used to identify key changes over last three decades. C- and Ku-band backscatter temporal variations are linked to landcover (vegetation and snow cover) and water content (canopy and soil moisture) change. Temporal changes in the thermal characteristics over the last decade are observed using multi-frequency Advanced Microwave Scanning Radiometer (2002–2009) brightness temperature measurements. The expansion of population has resulted in changes linked to the large scale vegetation type conversion and degradation of riparian ecosystems. This research provides preliminary analysis of multisensor microwave observations of the Great Basin.

Category: Modelling/Database

P-14. Microbial control of total nitrogen and total organic carbon in soils across two climatic provinces

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We are developing an index for mineralized ecosystems to assess ecosystem function in areas associated with mining. An index is produced by distilling quantitative measurements into one descriptive number. These quantitative measurements may include soil physical and chemical data, vegetation biomass and diversity, and microbial biomass, diversity, and activity. Results of our work include empirical models for Total Organic Carbon (TOC) and Total Nitrogen (TN) in soil, as a function of measurements that describe the activity level of the microbial community. These measurements include Fluorescein Diacetate Analysis (FDA; a general indicator of enzyme

activity), arylsulfatase (a measure of use of S compounds), Phospholipid Fatty Acids (PLFA; analysis of microbial community structure and biomass), C Mineralization potential (general measure of microbial activity), and Community Level Physiological Profiling (CLPP, measure of activity and functional diversity). Regression models based upon these measurements fit a disparate dataset of soil ecosystems developed on 3 unique styles of mineralogically/chemically-altered bedrock (acid sulfate, Mo/Cu porphyry, and serpentinization) with varying degrees of disturbance from mining (undisturbed, waste rock, tails piles), with an r^2 of 0.67-0.92, depending upon the variables used. When datasets from 2 climatic provinces are combined, then the r^2 is 0.72. The provinces are: the Bailey Intermountain Semidesert and Desert Province (MAT = 4-13°C; MAP = 130-490mm), and the Bailey Sierra Steppe Province (MAT = 2-11°C; MAP = 250-380mm). We wish to test whether the microbial parameters employed by our model will explain variations in TN and TOC among other climate regimes, as well.

P-15. Modeling rangeland performance and climate change effects on Big Sagebrush in the Owyhee Uplands

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Big Sagebrush (Artemisia tridentata) provides critical habitat for many species in the Great Basin of the United States, and this habitat is likely to be affected by climate change. In this study, we used a technique that models ecosystem change based upon projected climate change. We developed regression tree models that predicted ecosystem performance (growing season Normalized Difference Vegetation Index) from weather data for five rangeland types in an area of the Great Basin called the Owyhee Uplands. We used the models and projected 2040 weather scenarios to estimate the expected weather-based ecosystem performance for Big Sagebrush. We analyzed differences between the 2040 estimates and historical estimates to identify areas vulnerable to climate change. The regression tree models also were used to create annual maps of expected ecosystem performance based on annual weather conditions and performance anomalies (areas more or less productive than expected from weather) from 2000 to 2008. Performance anomalies were validated with percent bare ground and stocking rate information. We located persistent anomalies from these annual maps and also created a trend map of anomalies to identify areas that are trending toward degraded states. In the Greater Platte River Basin area, this method is being used to analyze ecological consequences of a potential change from marginal cultivated cropland to grass for biofuels.

P-16. Projecting future changes in sagebrush distribution in the Great Basin

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Changes to the Great Basin landscape are due to the singular or interactive effects of numerous drivers including climate change. These changes may be significantly reducing or altering the quality of wildlife habitat, rates and pathways of nutrient, water, and energy flows, and the quality and quantity of ecosystem goods and services the landscape produces. A pilot study was initiated to evaluate approaches to assess the causative factors for changes in landcover for a 250-sq kilometer area surrounding Great Basin National Park. Landsat derived landcover change at ~5 year intervals from 1985-2007 were analyzed to detect transitions in sagebrush communities either to or from cold desert scrub or pinyon-juniper communities. These transitions were then evaluated with regard to the climatic and hydrologic conditions that corresponded to changes in these communities to define “bioclimatic envelopes” for each community type that could be used to anticipate future changes in vegetation distribution. Downscaled future climate scenarios were then used with a regional hydrologic model to project future bioclimatic envelopes across the study region to provide an estimate of the direction and trend of actual landcover change in the study area, and to quantify the relative influence of each ecohydrologic driver or interaction among drivers. Refinement of this approach and extension to the entire Great Basin region will provide tools and information for regional land and resource management in the face of a changing climate.

P-17. Availability of land treatment data for time-series investigations of vegetation responses to climate

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Models that predict changes in vegetation communities under projected climate change scenarios can benefit from long-term vegetation data sets. Scientists also can use data on land treatments, such as post-fire seedings, to investigate how individual plant processes (germination, growth), community processes (competition, succession), and vegetation structure and composition are influenced by climate. However, land treatment data have not been readily available for climate

change or other research because of the lack of a centralized data system. The goal of this presentation is to introduce the Land Treatment Digital Library (LTDL), a data system created by the U.S. Geological Survey (USGS) to catalog information about land treatments in the western United States. The LTDL currently houses >6000 land treatments across 15 Bureau of Land Management (BLM) field offices, including >1000 aerial seeding treatments and >700 drill seeding treatments. Land treatment data from all 106 western BLM field offices will be entered and verified over the next 5 years. The LTDL can be used to respond to information requests, conduct analyses and other forms of information syntheses, produce maps, and generate reports for DOI managers, scientists and other authorized users.

P-18. Geospatial integration of hazards, infrastructure and resources in an assessment of potential disasters and effects of climate change in Clark County, Nevada

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During the spring term of 2010, graduate and undergraduate students enrolled in the GIS course offered in the UNLV Geoscience department are collaboratively developing a database of known potential environmental, anthropogenic, and natural factors that could influence the population of the Las Vegas metropolitan area. The spatial distribution of hazard effects are in some cases well known, and other cases are highly variable. The hazards that this mapping project covers are potential disasters and major disruptions to residential and businesses within the urban areas of Clark County. There are three major types of emergencies: predictable events, geologic anomalies, and environmental change. In many cases the effects to the residents of the region are very similar, despite drastically different events, such as an earthquake or drought which may compromise the water supply system. This effort to consolidate hazard and climate change-related disasters is designed to establish the highest potential failures of resources or infrastructure, and provide an event-independent assessment of the likelihood of disasters. These maps and data may help to educate residents, develop action plans for emergency services, and even provide information for policy-makers in the future.

P-19. What can predictive modeling tell us about plant vulnerability to climate change in the Southwest?

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Habitat suitability models can provide insight into the distribution of biota, both current and potential future. These models map areas expected to be suitable to a species of interest by establishing the relationship of known locations of the species with environmental variables. In order to assess which plants might be vulnerable to climate change in the Southwest, we are predicting the suitable habitat for dominant and indicator plants in Southwest ecoregions by modeling the location of their current 'climate envelope' and comparing their current and predicted future geographic locations. Potential vulnerability of individual plant species is indicated where their current habitat, defined by average temperate and precipitation, becomes less favorable under future climate-change scenarios. Such an assessment, while coarse, is one measure of the impact different scenarios of climate change may have upon each plant species. The poster presents preliminary results for representative species in the Mojave and Great Basin for six different climate change scenarios: high, medium, and low change scenarios for 2050 and 2100. The habitat suitability models for Joshua tree (*Yucca brevifolia*), creosote (*Larrea tridentata*), and sagebrush (*Artemisia tridentata*) were developed using a maximum entropy algorithm implemented in Maxent. The continuous habitat suitability score was converted to binary (presence-absence) using two threshold values.

P-20. A scenario-based urban growth study in the greater Las Vegas area

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The ability to project urban growth scenarios that represent a suite of potential land-use policies is crucial to understanding future landscape change, especially in the context of climate change. Many of the resources that facilitate urban growth are likely to be modified through global climate change. The combined impact of increasing urbanization and climate change on critical resources like fresh water, energy and ecosystem health varies with different future scenarios. Multiple scenarios representing potential urban growth for the greater Las Vegas region are presented here. The alternative futures represent policies that encourage growth, enforce strict environmental regulation, adapt to extreme drought and encourage renewable energy production. Comparison of the potential impacts associated with each land use pattern provides a tool for land use managers to understand the future impacts of current policies. Impacts on water resource availability and biodiversity resources are presented as examples of the types of impacts that can be modeled using the alternative futures framework.

P-21. Precipitation marginal response as a tool for merging state-and-transition model concepts with climate uncertainty

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Two related concepts, ecological site classifications and state-and-transition models, have emerged as powerful tools for rangeland assessment, monitoring, and management. A general weakness of state-and-transition models is the assumption of static climate regimes with known variability. Evaluating the geographic distribution of ecological states along regional climate gradients may be one method of inferring the susceptibility of different climate and soil combinations to undesirable transformations. A first step in this exercise is to map ecological states or drivers of interest. Here, we demonstrate a remote sensing approach likely to have utility in a host of arid and semiarid regions. This approach employs readily available satellite imagery to assess spatial variability in precipitation marginal response, or the response of plant production to inter-annual changes in precipitation. In southern New Mexico's Chihuahuan Desert, shrub encroachment into perennial grasslands is a prominent ecological transition often leading to persistent changes in vegetation and soils. We examined an eight year time series of rainfall and MODIS NDVI and found the slope of the precipitation marginal response to be negatively correlated with shrub canopy cover and positively correlated with herbaceous foliar cover. The general approach demonstrated here should be useful for a variety of other ecosystems at risk to undesirable changes in plant functional groups or modifications to net primary productivity. Incorporating indices of non-photosynthetic vegetation may increase the performance of this method in areas characterized by highly fluctuating fine fuel biomass and provide a more refined tool for evaluating the regional distribution of ecological states.

Category: Plant Ecology

P-22. Identifying trends in distribution of noxious weeds for early detection and rapid response in Nevada

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Changes in climate across the Mojave Desert and Great Basin regions are likely to have variable effects on noxious weed dynamics by enhancing, inhibiting or shifting their habitat and ability to spread. Early detection of new weed species in an area involves diligent monitoring for new invasions. Once a new, high-impact weed has been detected in an area, eradication is essential. Traditionally, new weed invasions are not detected or addressed until they are so dense and

widespread that eradication is not feasible. To address this issue, we completed county-based weed surveys in Nevada and bordering counties of surrounding states. Data were synthesized using ArcMap to illustrate the current distribution and abundance of each weed surveyed, and utilized to create a list of priority "Weeds to Watch" in each Nevada county based on their potential to spread. We will present examples of our work including the southern expansion of medusahead (*Taeniatherum caput-medusae*) from California and Oregon into northern Nevada and the potential movement of species such as African mustard (*Brassica tournefortii*) northward from the Mojave Desert into the Great Basin. These baseline data documenting the current trends in noxious weed abundance will allow us to tailor weed identification and eradication education efforts to each county, to monitor future trends in the spread of these weeds, and to determine areas of focus for more detailed, quantitative research.

P-23. The past, present, and future distributions of Joshua Tree

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The future distribution of Joshua Tree is projected by combining a geostatistical analysis of Twentieth Century climates over its current range, future modeled climates, and paleoecological data showing its response to a past similar climate change. As climate rapidly warmed about 11,700 years ago, the range of Joshua tree contracted, leaving only the populations near what had been its northernmost limit. Its ability to spread northward into new suitable habitats after 11,700 years ago may have been inhibited by the somewhat earlier extinction of megafaunal dispersers, especially the Shasta Ground Sloth. We applied a model of climate suitability for Joshua Tree, developed from its Twentieth Century range and climates, to future climates modeled through a set of six individual GCM models and one suite of 22 models for the late Twenty-first Century. All distribution data, observed climate data, and future GCM results were scaled to spatial grids of ~1 and ~4 km in order to facilitate application within this topographically complex region. All of the models project the future elimination of Joshua tree throughout most of the southern portions of its current range. Although estimates of future monthly precipitation differ between the models, these changes are outweighed by large increases in temperature common to all the models. Only a few populations within the current range are predicted to be sustainable. Several models project significant potential future expansion into new areas beyond the current range, but the species' historical and current rates of dispersal would seem to prevent natural expansion into these new areas. Several areas are predicted to be potential sites for relocation/assisted migration.

P-24. Global change effects on Mojave Desert perennial plants: Summer monsoons, nitrogen deposition, and soil disturbance

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Many global changes are predicted to affect the Mojave Desert, including changes in precipitation, nitrogen, and disturbance. We investigated the effects of summer monsoons, nitrogen deposition, and soil disturbance on the C_3 drought-deciduous shrub, *Lycium pallidum*, the C_4 grass, *Pleuraphis rigida*, and the C_3 evergreen shrub, *Larrea tridentata*. Experiments occurred at the Mojave Desert Research Facility in southern Nevada by irrigating to simulate summer monsoons, adding $Ca(NO_3)_2$ in 10 or 40 kg N ha^{-1} yr^{-1} for nitrogen deposition, and creating soil disturbance by trampling the surface. We measured various growth attributes throughout 2004, 2005, and 2006, which were average, above-average, and average years of precipitation, respectively. *Lycium pallidum's* responses were similar among years; monsoons and disturbance did not affect growth but nitrogen increased growth. *Pleuraphis rigida* had variable responses among years; monsoons and nitrogen increased growth in 2004, had a negative effect in 2005, and had no effect in 2006. *Larrea tridentata's* responses varied among years; monsoons had a positive effect on growth in 2004, while monsoons decreased growth in 2005. Nitrogen increased some *L. tridentata* growth parameters while not affecting others. When monsoons and nitrogen were applied simultaneously, *L. tridentata* growth increased in 2005 and 2006. Disturbance generally decreased *L. tridentata* growth in 2005. Variable responses to treatments among years suggest difficulty in predicting perennial responses to global change in an unpredictable desert system. Additionally, our data suggests that plant functional types may respond differently to global change. These various growth responses will likely affect Mojave Desert community composition.

P-25. Twenty-nine years of vegetation community change across environmental gradients in a Mojave Desert mountain range

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Utilizing extant vegetation data sets with repeatable methodology can provide opportunities for insight into previous vegetation change and provide base line data for long term monitoring projects useful for modeling vegetation community trajectories. We have relocated and resurveyed 106 sites from a vegetation community study completed in 1979. The original methodology was repeated and used to establish permanent long term monitoring plots. All perennial plant species were measured for density, frequency and cover within each plot. Plots are located throughout the

Newberry mountain range of extreme Southern Nevada. In comparing 1979 and 2008 data sets we wanted to know if changes have occurred in the vegetation community and if the degree of change differs between environmental gradients and individual species. Using MRPP to compare species composition within data sets, we found no significant difference p= .28. Changes in species diversity were only detected at high elevation sites. Plots at high elevation sites in 2008 had significantly greater mean Shannon-Wiener diversity index (H) than high elevation sites in 1979 (p=0.0211). Significant changes in individual species have occurred such as increasing or decreasing density of long-lived shrubs in the absence of acute disturbance. For example, *Coleogyne ramosissima* (blackbrush) decreased from an average of 308 plants/ha in 1979 to 176 plants/ha in 2008 ($p<0.05$). In contrast, *Ferocactus cylandraceus* (barrel cactus) increased from an average of 39 plants/ha in 1979 to 90 plants/ha in 2008.

P-26. Water additions and soil disturbance effects on native and non-native Mojave Desert winter annuals

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Global climate change models predict an increase in precipitation patterns in desert ecosystems of the American Southwest, which might enhance the susceptibility of arid ecosystems to invasions by non-native exotic plants. Resource availability and habitat modification (i.e, disturbance) have been identified as possible underlying mechanisms for invasibility of plant communities. In the eastern Mojave Desert, habitat disturbance has increased due to increased human activities, and water availability is considered to be the main limiting resource for plant production. To elucidate the effects of soil disturbance and water on plant invasions, we created experimental patches that varied in levels of soil disturbance and resource availability (i.e., water) in a fully crossed factorial field experiment, and documented responses of native and non-native winter annuals over two field seasons. Our treatments had no effects on the density (seedlings m^{-2}) of the non-native herb, *Brassica tournefortii*. However, water and soil disturbance positively influenced plant height and consequently silique production. Density (seedlings m^{-2}) of the non-native Mediterranean grass (*Schismus* spp.) increased in watered and disturbed plots, and seedling density was associated with time in disturbed plots. In contrast, experimental manipulations influenced density (seedlings m^{-2}) of winter native annuals differently. Seedling density increased in watered plots and decreased in disturbed plots in 2009 but not in 2008. These results suggest that habitat invasibility may be species specific; the establishment of native and non-native winter annual plants in arid systems can be influenced by the state of the habitat and by the level of resource availability.

P-27. Plant responses to experimental warming and precipitation alteration on the Colorado Plateau

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The global climate is rapidly changing and the ecological implications of these changes remain uncertain for much of the world. This is especially true for dryland ecosystems, which represent some of the most extensive and least understood ecosystems on Earth. To assess how changes in climate affect plants and soils on the Colorado Plateau, we established a large field experiment to simultaneously manipulate both temperature and precipitation. We imposed two temperature treatments, +2 and +4 C, and two watering regimes: shallow water, which adds smaller, more frequent precipitation events of 1.2mm of rain, and deep water, which adds enough water to bring the total precipitation up to the biweekly long term average. We focused our investigation of climate effects on the responses of 4 common plant species: *Stipa hymenoides* (rice grass), *Hilaria jamesii* (galleta grass), *Bromus tectorum* (cheatgrass), and *Atriplex confertifolia* (shadscale saltbrush). We are starting to see effects of warming on plant phenology. Earlier in the growing season, plants in warmed plots are reaching phenophases faster than plants in control plots. For S. hymenoides, this effect appears to depend on the size of the plant early in the growing season. In addition to phenology responses, we are also starting to see responses in plant biomass, reproductive output, and plant physiology. Taken together, our results suggest that plants on the Colorado Plateau are responding to experimental changes in climate and these results have important implications for predicting how these ecosystems will function in the context of future climate.

P-28. Quantifying the effects of climate change within the Navajo Nation

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Native Americans of the southwest live on ecologically sensitive semiarid to arid lands with limited resources. On the 65,000 km^2 Navajo Nation, southern Colorado Plateau, traditional people often live a subsistence lifestyle. Increased temperature and changing precipitation are transforming the landscape and thereby negatively impacting the residents. For people to continue to inhabit these lands successfully, we must both understand the processes that are rapidly altering these drylands and develop mitigation strategies. To this end, our team is: 1) using a network of meteorological stations to calculate, and map, ratios of precipitation to potential evapotranspiration; 2) establishing in-situ automated cameras to record changes in dune morphology and capture dust transport; 3) performing repeat high-precision GPS and terrestrial LiDAR surveys to assess dune migration rates; 4) using high-resolution remote sensing to record changes in vegetative cover, speciation, and phenology, as well as landscape vulnerability to eolian processes; and 5) documenting

planform changes in the Little Colorado River. With this data we are creating a record of climate variables and coincident landscape change. Initial assessments indicate that the areal extent of sand susceptible to mobilization has increased significantly; recorded sand dune migration rates are in excess of 35 m/yr and regionally significant dust storms emanating from the study area are becoming common. Additionally, remobilized surfaces are rapidly changing in vegetative cover and composition. Furthermore, channel change, although influenced by changing riparian vegetation, appears to be driven by flow variation that is in turn related to precipitation variability.

Category: Public Policy

P-29. Climate change policy, public lands, and local government needs

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Research in the field of public policy suggests that an effective response to climate change will require action at multiple levels of government, including local and state agencies. Those organizations that deal with public lands and resource management will need to adapt to the effects upon their activities brought about by changes in climate. This poster integrates information from a recent state-wide survey of Nevada's public agencies and GIS-based research on Nevada's public lands, in order to better understand the needs of governments in developing local climate change policy. Data on the types, scales, and sources of climate change information that Nevada's public agencies use and/or need is presented. The poster also addresses what kinds of organizations are associated with different issues and problems related to climate change on public lands.

P-30. Perceptions of ranchers and farmers on climate change impacts and adaptation strategies in Nevada

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Climate change poses potentially adverse consequences to natural resources, including the management of water and land, ecosystems, and human health. Farming and ranching communities are especially sensitive and vulnerable to adverse effects of climate change due to their strong dependence on agricultural production for their livelihood. To gather information on the perspectives of ranchers and farmers regarding climate change science, risk, and policy in Nevada, 1,892 surveys were mailed out in December, 2009. At the time this abstract was written, 324 surveys have been received (17%). Preliminary survey results have been analyzed using

descriptive statistics and correlation techniques. Locations of survey respondents have been geo-coded and mapped to detect spatial patterns with geographic information system (GIS) software ArcGIS 9.3. The knowledge gained from this research will help researchers and natural resource managers understand how to best communicate climate change science and effectively perform outreach with vulnerable Nevada ranching and farming communities. Invaluable information from local rural communities, acquired through generations of experience of working on the land, will also support policy makers and stakeholders in identifying adaptation and mitigation options.

Category: Resource Management

P-31. Bureau of Land Management ecoregional assessments and environmental change agents

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Historically, BLM conducted land use planning at the field office level and will continue to do so. However, development and environmental change is becoming regional or even multi-state in scale and landscape level assessments of ecological condition and management strategies are increasingly necessary to plan for conservation of biological natural resources. Recently, ecoregional assessments have been piloted by BLM and partners for the Northern Great Basin, Chihuahuan Desert, and Wyoming Basins. Question: Where are focal areas of conservation, restoration and development potential on BLM-administered lands in the West? In 2010, BLM's Ecoregional Assessment Initiative will begin ecoregional assessments in the Sonoran Desert, Mohave Desert, Central Great Basin and Range, Colorado Plateau, Northern Glaciated Plains/ Northern Great Plains, Middle Rockies and Seward Peninsula EPA Level III ecoregions. The goal of the new assessments is to evaluate three categories of conservation targets or values: species of conservation concern, terrestrial ecosystems and aquatic ecosystems; and the effect of four change agents: climate change, fire, invasive species, and development (including fossil and renewable energy) on the values. Climate change assessment tools will be presented. This information will lead to the identification of focal areas for conservation, restoration and development potential. This presentation will explore typical management questions associated with the conservation values and environmental change agents, methodology, data sources and partnerships that are planned.

P-32. Assessing the benefits of urban forestry in Mojave Desert communities

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As the climate and environment change due to human activity, an understanding of the existing natural resources becomes paramount. Urban forests of Mojave Desert communities have the potential to reduce air pollution, heat island effects, and energy consumption. Regions throughout the globe have utilized models to quantify such benefits, but studies seem to be primarily conducted temperate areas. Arid regions have drastically different climate, vegetation, and water availability, and questions arise as to the transferability of cost/benefit analysis models to areas with drier climates. i-Tree is a free, peer-reviewed software suite developed by the USDA forest service that can provide information on species distribution and the monetary benefits of an urban forest in the categories of energy, storm water, air quality, carbon dioxide, carbon stored, and aesthetic value. The objective of the USEPA's Southwest Ecosystem Services Program, SwESP, is to develop and implement methods, models, and tools to map and assess the condition of Southwestern ecosystems. To demonstrate the functionality of i-Tree in desert landscapes, sample data was obtained from the City of Las Vegas Planning and Development department and analyzed using i-Tree Streets. Results indicate i-Tree analysis is applicable in arid regions if irrigation costs and benefit prices are accurately estimated. Future studies will focus on the utilization of additional i-Tree modules to understand the relationship between southwest urban forestry, air quality, and climate.

P-33. Changing climates and the role of national wildlife refuges in the conservation of the Great Basin

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The Great Bain extends across large portions of the Intermountain West, however very little of the sagebrush biome remains undisturbed or unaltered. Both natural and anthropogenic processes have and are resulting in rapid and extensive changes to vegetation and other habitat components. The sagebrush-steppe ecosystem now constitutes one of North America's most imperiled and neglected ecosystems. This is due to profound influences of converging ecosystem stressors including livestock grazing, wild horse and burro management, agriculture, mineral extraction, invasive species, roads, utility corridors, and energy development. In addition, the relationship of these stressors to the influence of climate change is unknown. The conservation and resilience of the Great Basin will be dependant upon the ability to reduce ecosystem stressors across the landscape in the face of climate change. National wildlife refuges, working in partnership, have the potential to provide critical areas for such conservation, including opportunities for research, monitoring, and adaptive management. The Sheldon-Hart Mountain National Wildlife Refuge

Complex, located in Oregon and Nevada, will be used as one example of potential ecosystem conservation occurring on a landscape-scale. The strategy for management at this refuge complex is to reduce the impact of ecosystem stressors (e.g., horses/burros, mining, invasive species, and catastrophic wildfire), restore habitats and ecosystem processes, and build partnerships with public/private stakeholders to advance conservation on the landscape. A scientific underpinning to these actions is necessary, and includes conducting research, inventory, and monitoring of ecosystem components and system responses. Results are then incorporated using adaptive management concepts.

P-34. Synergistic monitoring for adaptive vegetation management in the sagebrush ecosystem of the Great Basin

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As scientists and land managers realize the magnitude of Great Basin sagebrush ecosystem change, many proactive projects to improve resource sustainability, value, and productivity have been implemented. These include seedings, vegetation manipulation, noxious weed control, and post-wildfire rehabilitation across a variety of ecological sites. Faculty within UNCE and the Nevada Agricultural Experiment Station in collaboration with the Nevada Department of Wildlife, USDI Bureau of Land Management, USGS's Great Basin Integrated Landscape Monitoring Pilot Project, and the USDA Agricultural Research Service seek new learning from these endeavors. Through monitoring vegetation and soil responses within these treatments, we can understand the consequences of management action and inaction; continue to refine project implementation tools; adapt management; and disseminate important and valuable information. By using data from existing State-wide events, we can study more treatments than any scientist or team of scientists could afford to implement as individual experimental treatments. Our current, collaborative harvesting and pooling of data sets will provide abundant replicates for statistical analyses. Once analyzed, these data will improve our understanding of landscape-level ecological processes and our ability to manage and predict rangeland health and resiliency under a variety of natural disturbance and restoration regimes.

Category: Species Conservation

P-35. Implications of climate change for desert tortoises and other reptiles at the Mojave-Sonoran Desert interface

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The interface between ecoregions, often defined by shifts in climatic regimes, provides opportunities to evaluate climate-change sensitivity for species whose distributions span those ecoregions. I employed the Mahalanobis D^2 statistic to model spatially explicit niche spaces for reptiles occurring at the Mojave-Sonoran Desert ecoregion interface. Niche spaces incorporated climate variables as well as those that define soils and terrain that constrain a species' distribution. To assess climate-change sensitivity I shifted climate variables along a gradient of increasingly severe levels of predicted climate change and then calculated spatial changes in the species' modeled niche. Each of the reptiles' niches responded uniquely to simulations of climate change. The model for the yellow-backed spiny lizard, *Sceloporus uniformis*, which is at the southern margin of its range, indicated the greatest reduction (85%). Similarly climate-shifting the niche model for the desert tortoise, *Gopherus agassizii*, which was near its western range margin, revealed a 49% loss of suitable niche space. Models for species with broad ranges spanning both ecoregions, such as chuckwallas, *Sauromalus ater*, and desert horned lizards, *Phrynosoma platyrhinos*, had more modest responses to climate change. For the spiny lizard and tortoise the prognosis may be more severe than indicated by a totaling of suitable hectares; both niche models indicated large degrees of habitat fragmentation. The models identify potential climate change refugia and linkages to more contiguous suitable niche areas. These are areas where land managers could focus protection efforts, including land acquisition, habitat improvements and monitoring, to help insure the species' persistence.

P-36. Sagebrush Steppe Treatment Evaluation Project (SageSTEP): A long-term monitoring and ecological network

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SageSTEP is a regional research and management project that is monitoring the long-term effects of treatments designed to reduce fuels and restore sagebrush ecosystems in the Great Basin. The project is evaluating the effects of standard fuel management treatments (fire, mechanical thinning, and herbicide) on the recovery of sagebrush ecosystems threatened by cheatgrass invasion and pinyon and juniper tree encroachment. Treatments implemented between 2006 and 2009 are being monitored over gradients of cheatgrass invasion or woodland encroachment at 21 different sites.

An inter-disciplinary approach is being used in which nearly 100 variables describing treatment effects on vegetation, soils, wildlife, and fuels will be analyzed to provide information on treatment effectiveness. Project results are being used to develop recommendations and guidelines for fuels management and for maintaining and restoring sagebrush ecosystems. These results also will be useful landscape-level strategic planning and for understanding the implications of climate change.

P-37. Patterns of small mammal and reptile diversity in Great Basin National Park

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Historical impacts of climate change in the Great Basin are well documented through tree rings, lake levels, and Neotoma middens. Recent examination of temperature data in Great Basin National Park (GRBA) shows a strong trend toward a warmer and earlier onset of spring. As an isolated montane high elevation national park, climate change is expected to have dramatic effects on biodiversity in GRBA. Several species have suffered local extinctions under past warming climates and published models have suggested that three montane mammal species will not survive a 3°C increase in mean annual temperature. We used two datasets, small mammals and reptiles, to address the relationship between biodiversity, elevation, and riparian areas. We predicted the highest measures of alpha diversity at mid elevation riparian areas and the highest beta diversity between low, mid, and high elevation sites. We developed four a priori hypotheses and used Akaike information criteria to determine relative support for these hypotheses. Great Basin National Park is mandated to protect its biological resources unimpaired for future generations and understanding patterns of biodiversity is critical to understanding and predicting the effects of climate change and other anthropogenic impacts on that biodiversity.

P-38. Climate change, premature seed fall, and the decline of crossbills

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The recently described South Hills Crossbill (*Loxia sinesciurus*) is restricted to 100 km^2 in southern Idaho on the northern edge of the Great Basin. The population has declined by over 60% in the last five years. The most plausible hypothesis of the observed decline is that warmer temperatures have increased the opening of serotinous lodgepole pine cones, which reduces seed availability for crossbills over the winter and thereby decreases their carrying capacity. I propose to determine the effect of increasing temperature on seed abundance in closed cones; correlate landscape variation in microclimates with cone opening, seed abundance, and crossbill abundance; and use a spatially-explicit model to predict landscape-scale changes in crossbill abundance under different climate change scenarios. I will deploy temperature data loggers across the South Hills to create a temperature surface that will be used to test whether cone opening varies across the

landscape depending on local temperature. I will then be able to project the effect of a warming climate on cone opening to create a map of future food resources (seed availability). Given that crossbill abundance is related to seed availability, I can project how changes in temperature at the landscape scale (e.g., using downscaled PRISM data) will impact abundance of the South Hills Crossbill. These results will enable me to develop a conservation plan for the South Hills Crossbill. Without a clear conservation strategy this crossbill and the pine population on which it is dependent are likely to go extinct by the end of the century.

P-39. Does climatic change promote niche shifts? A case study of the desert horned lizard *(Phrynosoma platyrhinos)*

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During climate change, species are believed to shift ranges by tracking environmental conditions to which they are adapted, with the assumption that species niches remain conserved. To test this assumption, we used mitochondrial DNA and climatic niche assessments to evaluate response to climate change at the end of the last glacial maximum (LGM) in the desert horned lizard (*Phrynosoma platyrhinos*). The phylogeographic analysis revealed high genetic diversity and pronounced phylogeographic structure within the Mojave and Sonoran deserts. Conversely, within the Great Basin, we documented low genetic diversity and a northward thinning of haplotypes. These genetic signals are consistent with recent expansion of *P. platyrhinos* from the warm southern deserts into the Great Basin, likely following warming climate after the LGM. Assessment of climatic niche similarity revealed that populations within the Great Basin occupy a different climatic niche (colder and wetter) with respect to the southern, stable populations. Additionally, our assessment revealed that the current climatic niche within the Great Basin did not have an equivalent during the LGM in the southern regions, where temperature and precipitations averages never reached the climate extremes that *P. platyrhinos* experiences within the Great Basin today. We hypothesize that climatic changes at the end of the LGM opened novel niche space within the Great Basin that promoted a niche shift in these lizards, although biological relevance of this niche shift remains unclear. We also suggest that interspecific competition with congeneric species might have influenced the extent and direction of a niche shift in *P. platyrhinos*.

P-40. Impact of recent environmental change on small mammals of the Ruby Mountains: an 80-year resurvey

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Biotic communities in the Great Basin are changing dramatically due to land use, invasive plant species, and climate change. Using data from comprehensive historical (1927-1929) and modern (2006-2008) field surveys conducted at identical and nearby locations in the Ruby Mountains, we assess changes in small mammal community structure and function and shifts in the elevational distributions of species over an 80-yr interval. The Ruby Mountains are located in northeastern Nevada and constitute one of the largest mountain systems (1821 km^2) within the Great Basin. Comparison of climate data for the two sampling intervals indicate increases in both precipitation and summer maximum temperature across all elevations, and increased winter minimum temperature at mid to high elevations. At individual localities there have been significant changes in relative abundance or occurrence of small mammal species, some in conjunction with major floristic changes, and others apparently in direct response to climate warming. Overall, total small mammal abundance, biomass, and energy use have declined at both local sites and landscape scales suggesting a major drop in resource availability. Along the elevation gradient, we observe upslope range shifts of two mesic-adapted species consistent with predicted responses to climate warming. However, we did not observe upslope range shifts or expansions for any xeric-adapted species. This is inconsistent with a climate-based hypothesis and may reflect the unexpected predominance of habitat changes driven by land use at lower elevations.

P-41. The Grinnell Resurvey Project

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Recent model-based predictions of how fauna will respond to future climate change are essential to developing adaptive management plans. However, these predictions are largely untested and the widely disparate projections resulting from different models suggest contradictory management decisions. The Grinnell Resurvey Project aims to test model-based predictions of future climate scenarios by documenting changes over the last 100 years in the diversity and distribution of mammals and birds along altitudinal transects in the western United States. Historic transects were first surveyed by Joseph Grinnell and colleagues at the Museum Vertebrate Zoology in the early part of the 20th century. We are currently resurveying these sites to document the changes in species' spatial and elevational ranges in relation to documented changes in climate across the state. Detailed locality and survey effort data allow us to simultaneously estimate detectability and occupancy of species across these elevational gradients. To date, we have surveyed over 200 sites

along 5 elevational transects in the Lassen, Tahoe, Yosemite, Sequoia and White Mts. regions of California. We are currently developing models based on known historical species' distributions, applying those models to predict species' responses to observed climate change over the last 100 years, and testing the models using independent survey data from the present. Future surveys will revisit historic surveys in the Mojave Desert and Great Basin. Here we present a summary of the project objectives, findings and future directions.

Category: Terrestrial

P-42. Assessing the geology and geography of large-footprint energy installations in the Mojave Desert, California and Nevada

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Large-footprint energy installations such as solar and wind farms are proposed for wide areas of drylands that are publicly owned. These installations impact areas of 400 to 2000 hectares each, requiring land-use assessments that are novel compared to past decisions for relatively small installations such as mine sites and roadways. Solar installations require low-gradient smooth topography, areas for which we have several data sets that can help with evaluations. We use topography (30m DEMs) and surficial geology (1:100,000 scale) for an area of 40,400 km^2 stretching from Lancaster and Mojave on the west to Jean, NV, and Goffs, CA, on the east to evaluate potential lands for solar energy installations. The geology was mapped using uniform methods across the northern Mojave Desert so that a consistent database is available for analytical purposes. We use slope categories, surficial geology attributes, and land ownership to describe this area in a series of maps. About 48% of the entire area is less than 5% slope, and 8.3% is less than 1% slope, the favored slope category. For this lowest-slope category, deposits underlying about 98% of the area are either mixed eolian-alluvial origin or are fine-grained alluvial deposits, and thus are susceptible to eolian dust and sand transport, especially after disturbance. In addition, in this low-slope category, 89% of the area is susceptible to flooding, based on the age and geomorphology of alluvial deposits. These maps are examples of several we present for decision-making with respect to hazards and ecological attributes in the face of climate change.

P-43. Climate change and land use effects on atmospheric dust in the western United States

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Dust emission within western United States has far-reaching effects on human health and safety, ecosystem health, land management, desertification, and runoff. Interacting factors that promote or suppress dust emission in the western United States include geologic processes, settings, and materials; vegetation dynamics; hydrology; climate; and human activities. These interactions are illustrated from dust-emission monitoring of shrublands, grasslands, rehabilitated burned areas, and dry lakes throughout the Great Basin-Mojave desert region. Dust from these areas moves into heavily populated areas, protected airsheds, and undeveloped natural landscapes, raising concerns about air quality, human and ecosystem health, and landscape change. The influence of changing climate and land use on dust emission can be partly addressed through understanding past responses and monitoring present-day responses of dust generation along with modeling future climate, soil moisture, vegetation, and land use. Vegetation monitoring shows that plant cover, important for protecting soils from wind erosion, decreases during hot, dry years, and modeling reveals increased dust production as a result. A warmer western United States, coupled with human and natural disturbance of desert landscapes, will result in more dust emission relative to recent decades. Potential consequences of interactions among increasing aridity, disturbances such as wildfire, and land-management practices in Great Basin landscapes are illustrated by the 2007 Milford Flat Fire and subsequent post-fire rehabilitation treatments. The wildfire and conventional post-fire management prescriptions in some soil-geomorphic settings resulted in extreme levels of dust emission with potential long-distance effects on human health and safety, ecosystems, and runoff as dust influences snowpack-melt rates.

P-44. Atmospheric dust transport in the Great Basin

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The suspension of dust and soil particles by wind is a natural process that results in wind erosion, dust transport, and dust deposition. The distance of dust transport can be local, regional, or long range. These processes perform critical geologic and biological services such as erosion and redistribution of nutrients. However, human activities such as grazing, human-caused wildfires, and development on arid lands have resulted in an increase in dust transport in some regions.

This increased rate of dust transport has implications for air quality problems in populated regions, higher snowmelt rates in alpine areas that provide water resources, and removal of soil nutrients from source regions, among others. This project proposes to answer the questions: What are the main dust sources for the population centers in the Great Basin region? What factors (geologic or meteorological) make these sites prone to dust production? How much dust is deposited into valley and alpine ecosystems? How does dust production, transport, and deposition vary annually currently? How will dust production, transport, and deposition change in the future? These questions will be answered by deploying an 8-stage rotating drum impactor which collects size and time resolved aerosol elemental composition using Synchrotron X-Ray Fluorescence (SXRF). Combining this data with soil sampling and analysis from likely source regions we can determine the temporal variability of source, amount, size, and type of dust that is impacting the deposition sites.

P-45. Carbon sequestration in carbonate-rock province of eastern Nevada

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Weathering exposes carbon ions in sedimentary rock to the atmosphere, allowing it to be oxidized. Carbon exchange in carbonate-rock terrain may come from atmospheric sources, from soils or from discharging springs. The sensitivity of the carbonate-rock outcrops and soils near spring discharge points alludes to the ability of the rock or soil to release CO_2 into the atmosphere. Modeled from work done by Liu and Zhao (1999) in carbonate-rock areas of mainland China, this study will provide additional understanding of the potential for soils and rock in the carbonate-rock province of eastern Nevada to exchange atmospheric carbon. The study will use field data to examine the sensitivity, frequency, and volume of carbonate-rock dissolution and CO_2 emissions and sequestration from springs emanating from carbonate-rock outcrops located in the Carbonate-Rock-Provence of eastern Nevada.

P-46. Land-cover trends: carbon storage in the basin-and-range ecoregions

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Land-use and land-cover change directly affect the ability of terrestrial ecosystems to store and remove atmospheric CO_2. Efforts are underway to assess terrestrial carbon capacity across the United States and to assess management actions to increase the terrestrial sink of carbon (e.g. USGS LandCarbon project). Accurate historical measurements of land-use and land-cover change at local and regional scales are critical inputs to these efforts. Land-use histories are also a valuable component for projecting land use into the future as a way to model the response of alternative land-use management actions. Few multi-temporal landscape-change data currently

exist for the basin-and-range provinces of the United States. As part of the U.S. Geological Survey Land Cover Trends project, we present land-use/land-cover change estimates for each of the basin-and-range ecoregions (Northern, Central, Mojave, and Sonoran) between 1973 and 2000. Estimates for four ecoregions were calculated by utilizing a sampling strategy coupled with manual interpretation of Landsat imagery for five dates (1973, 1980, 1986, 1992, and 2000). Although harsh climate, infertile soils, and lack of viable natural resources have historically impeded anthropogenic land-use change across the region, varying influences from agriculture, mining, development, and fire have altered the landscape, resulting in the loss of grasslands and shrublands across all of these ecoregions. Between 1973 and 2000, the footprint of change across the entire basin-and-range was 3 percent (21,160 km²). Roughly 8,900 km² of the change was the direct loss of grasslands and shrublands. This loss of rangeland may have implications for future management of livestock and national carbon resources.

P-47. Potential for native plant community recovery following fire in the Mojave Desert

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Variation in the timing and magnitude of precipitation patterns at varying temporal scales along with plant invasions are hypothesized to be driving a plant invasion/fire cycle that is increasing the extent and intensity of fires in the Mojave Desert. Pockets of native plants within the burned areas that survived the fire may be important seed sources for regenerating the native vegetation. The objectives of this study were to assess the physiology and reproductive potential of surviving vegetation in burned areas. Seven paired transects along burn boundaries from the 2005 fire were set up in the Beaver Dam Wash (southwestern Utah) in March of 2008. Surviving creosote in the burned transects demonstrated better water relations and higher leaf carbohydrate concentrations than creosote in the unburned transects. Joshua tree showed no differences in water relations or leaf carbohydrate status. Flower production in Joshua trees did not differ along burned and unburned transect but fruit production was considerably lower in burned transects. The data suggest that reductions in competition and nutrients pulses stemming from the fire stimulated physiology in surviving creosote in the burn zone. However, pollination failure may reduce viable seed production.

P-48 Vulnerability of quaking aspen and avian communities to climate change in the northern Great Basin

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Quaking aspen populations are declining in much of the Intermountain West due to altered fire regimes, competition with conifers, herbivory, drought, disease, and insect outbreaks. Aspen stands typically support higher bird biodiversity and abundance than surrounding habitat types, and maintaining current distribution and abundance of several bird species in the northern Great Basin is likely tied to the persistence of aspen in the landscape. This project will examine the effects of climate change on aspen and associated bird communities by coupling empirical models of avian-habitat relationships with landscape simulations of vegetation community and disturbance dynamics under various climate change scenarios. Field data on avian abundance, stand age structure, and other vegetation characteristics will be combined with existing spatial data sets. Key questions to be addressed include: (1) what is the current successional, structural, and spatial distribution of aspen on the landscape, and how do these factors affect abundance of bird species; (2) how have aspen stand condition and distribution, and avian abundance and distribution, been shaped by disturbance, e.g., grazing and fire; (3) how is global climate change likely to affect aspen condition and distribution, and what are the implications for avian species; and (4) how are today's management strategies, or adaptive adjustments to those strategies, likely to affect long-term risks and persistence of aspen and associated avian communities. Our first field season has yet to occur; thus, we will discuss the study area ecology, sampling strategies, and methods for integrating empirical data and climate change data into our models.

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