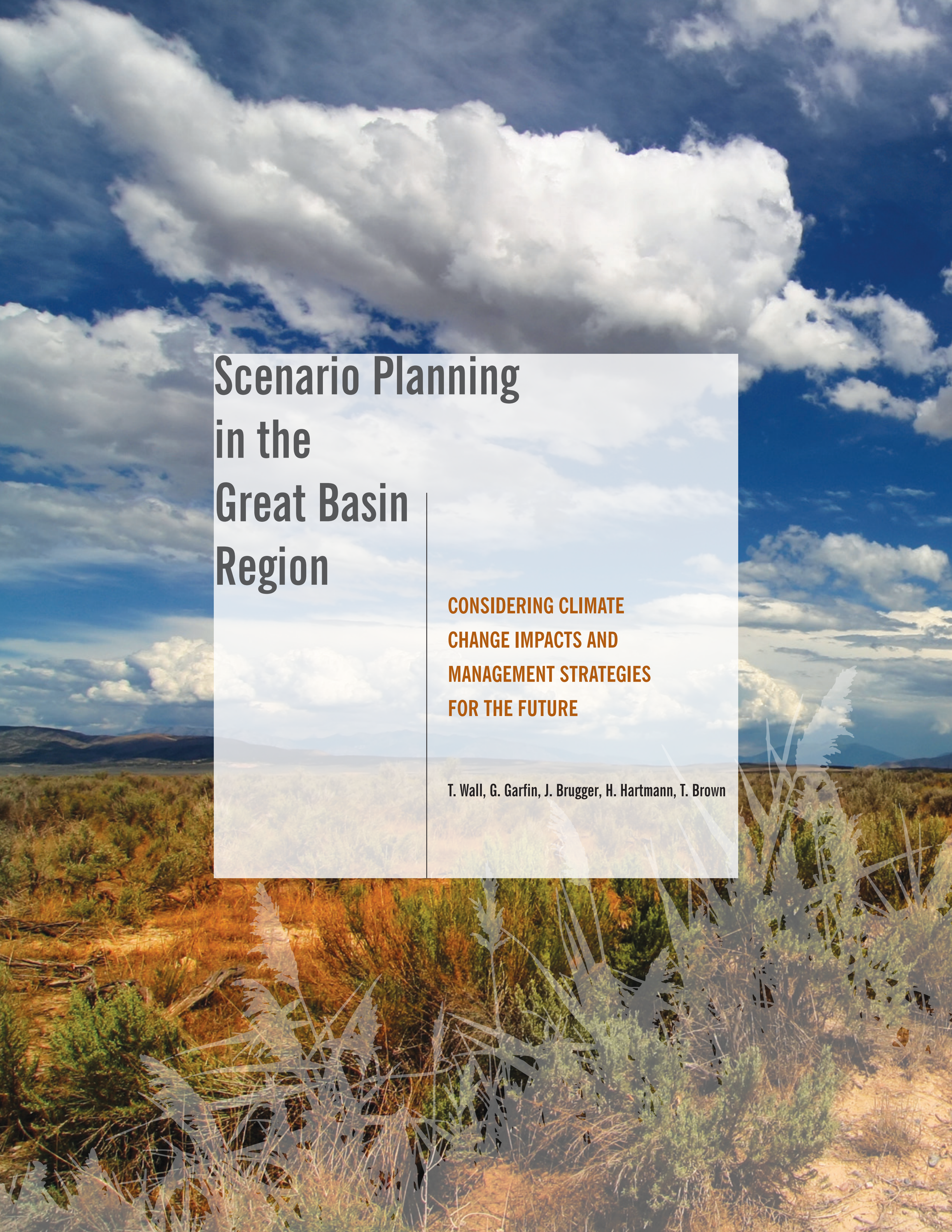


Scenario Planning in the Great Basin Region

CONSIDERING CLIMATE CHANGE IMPACTS AND MANAGEMENT STRATEGIES FOR THE FUTURE

T. Wall, G. Garfin, J. Brugger, H. Hartmann, T. Brown

ACKNOWLEDGEMENTS

We would like to acknowledge the contributions of the members of the advisory committee, webinar and workshop participants—their commitment to the process and willingness to try new approaches were invaluable to assessing the usability and application of these scenario planning processes explored during this project. We are also grateful to the Great Basin Landscape Conservation Cooperative, BLM Nevada and the National Oceanic and Atmospheric Administration Regional Integrated Science Assessment Program for their financial support.

SUGGESTED CITATION:

Wall, T., G. Garfin, J. Brugger, H. Hartmann and T. Brown. 2015. *Scenario Planning in the Great Basin Region: Considering Climate Change Impacts and Management Strategies for the Future*. Reno, NV: Desert Research Institute, 23 p.

EXECUTIVE SUMMARY & RECOMMENDATIONS

For federal, state, tribal and private land managers in Nevada, considering climate change in their resource management plans is both a challenging and pressing concern. It is challenging because of the inherent uncertainty surrounding the effects of climate change on hydrological, ecological, and climatological systems in the Great Basin. The Great Basin Region, which covers much of Nevada, and portions of California, Oregon, Idaho, and Utah, managers are already confronting a changing climate and are beginning to make management decisions despite uncertainty in how climate change effects will manifest in the region. To support decision making, the Great Basin Landscape Conservation Cooperative (LCC) and the National Oceanic and Atmospheric Administration (NOAA) Regional Integrated Science Assessment Program (RISA) funded this project to explore how two scenario planning approaches might be used effectively with existing management planning processes and data sources and how to begin prioritizing adaptation strategies. The two approaches used in this project are Adaptation for Conservation Targets (ACT) and Strategic Scenario Planning (SSP). This report provides an overview of the project webinars and two workshops, our analysis of the strengths and limitations of the scenario planning approaches used, and suggestions for using these methods to prioritize adaptation actions. Some of the key findings:

1. Rapid Ecoregional Assessments (REA) facilitate consideration of climate-related risks in sub-regional hot spots and help to identify areas that have more or less certainty in how climate change will affect resources in those areas. REA projections can also be used as a baseline for examining what might happen in the absence of management actions; thus, REA projections can help inform the effectiveness of management actions.

2. Limitations of the REAs include needs for finer-scale/decision-scale information, improved historical baseline information, filling in missing gaps, and more disaggregated indicator information (i.e., the ability to “look under the hood” at how individual factors influence aggregated indicator indices).

3. REA information flows well with both scenario planning approaches, to provide broad overviews of some current and future conditions, to help identify uncertainties, and to understand Great Basin systems and potential hot spots for examination through scenario planning processes.

4. The ACT method used in this project relies heavily on developing a conceptual model of the elements or factors that affect the focus of the management question. 0While demanding, immersing the workshop participants in developing this model facilitated the development of explicit logic chains—logical connections between cause and effect in thinking about the direction and magnitude of future *impacts*, and to discern management leverage points for action. These features, participants noted, are valuable for bringing the public on board during planning processes, and for integrating knowledge from scientists across multiple disciplines.

5. The greatest merit of the SSP process is the focus on *what is not known* and *what is outside of managers’ control*—which encouraged out-of-the-box thinking about plausible, but low-probability futures with high impacts across the 2020 to 2060 timeline used for the project scenarios. This helped workshop participants engage in developing the scenario futures and think about their impacts, implications, and identify adaptation actions.

6. Scenario planning could be used in tandem with planning for BLM Nevada monitoring, as the consideration of multiple futures helps planners to conceptualize change given high uncertainty. This enables assessment of the robustness of monitoring through time, and helps anticipate needs to change monitoring efforts or protocols.

7. In the second workshop, we asked participants to identify difficult adaptation options, and then systematically disaggregated those actions into more manageable steps across a timeline, including monitoring and identification of indicators for action. This enabled participants to envision how to work within multiple frames of uncertainty—including climatic, economic, and policy—and also identified adaptation actions that could be taken within the next five years to enable further actions down the timeline.

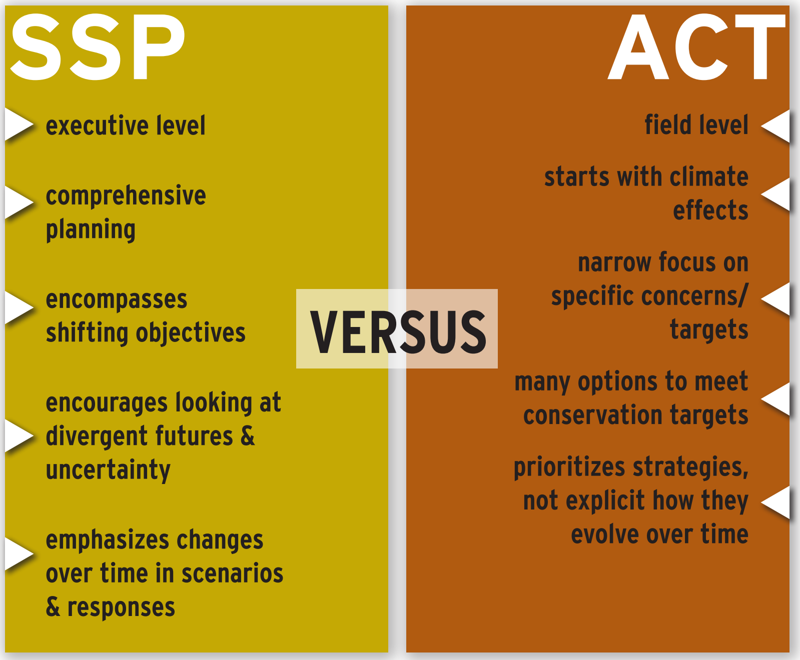
8. This project demonstrated that one team can pick up where another other left off in a scenario planning process, if there is sufficient transparency and credibility built into the process. This is important, given the degree of turnover in many Federal and state resource management positions.

INTRODUCTION

In support of a transition to a broader landscape management approach, the BLM Nevada began the process of developing the Rapid Ecological Assessments (REAs), which were designed to provide a "snapshot" of current landscape-level conditions and using existing climate models, project those conditions into the future. With the President's Executive Order 13653 (2013), all federal agencies are now required to consider climate change in their management plans. For the land management agencies in the western United States, this is simultaneously a challenging and a pressing task. *Challenging*, because of the uncertainty surrounding the coupled effects of climate change on the hydrological cycle (e.g., the timing of precipitation as snow or rain), wind patterns, fire regimes, and invasive species and how these might effect species of concern. *Pressing*, because like many areas of the southwestern United States, the region is already starting to experience a climate change signal as daily minimum temperatures have increased over the past century (Tang and Arnone 2013). Unlike other regions of the United States that have yet to show a clear climate signal, in the Southwest, natural resource managers will soon need to begin making management decisions despite the uncertainty inherent in other climate-related factors. Currently, there are few well-accepted approaches in existing management frameworks that address this level of uncertainty and nonstationarity in climate regimes.

Figure 1.

STRATEGIC SCENARIO PLANNING (SSP)
ADAPTATION FOR CONSERVATION TARGETS (ACT)



In an effort to begin addressing this need in the Great Basin, BLM Nevada and NOAA's RISA program, with support from the Great Basin Landscape Conservation Cooperative, funded several scenario planning initiatives. These were focused on exploring approaches that incorporate the REA information into existing management planning activities and considering the effects of climate change in the region. The first of these projects began in February 2014 and concluded in December 2015. This project focused on integrating two distinctly different scenario planning processes **(Figure 1)**. *Adaptation for Conservation Targets (ACT)* focuses on well defined field level projects that develops many options to meet conservation targets (Cross et al 2012, 2013).

Figure 2.

STRATEGIC SCENARIO PLANNING (SSP)

PHASE I: SCOPING (WEBINARS)

1. Identify steering committee
2. Overview of the process & project goals
3. Develop a management question
4. Develop a conceptual model of the system
5. Refine the management question

PHASE II: SCENARIO BUILDING (WORKSHOP I)

6. Refine the conceptual diagram
7. Identify key drivers related to the management question
8. Assess and prioritize critical drivers
9. Develop scenario sets
10. Explore implications
11. Select scenarios to build out

PHASE III: SCENARIO DEVELOPMENT (WEBINARS)

12. Develop scenario narratives
13. Develop implications of the scenarios

PHASE IV: USING SCENARIOS (WORKSHOP II)

14. Overview of project and process
15. Identify impacts of the scenarios
16. Explore potential strategies or actions across the timeline
17. Prioritize strategies/actions
18. Disaggregate harder actions across the timeline
19. Identify near term strategies/actions

Strategic Scenario Planning is based on the National Park Service approach to scenario planning, and is oriented toward comprehensive planning at an executive level, emphasizing multiple divergent futures, their evolution at multiple time steps, and climatic, biophysical, and socioeconomic uncertainties (National Park Service 2013). This project integrated these two processes, to explore if the combined approach provided additional insight and depth into identifying climate-related impacts and possible management strategies **(Figure 2)**.

The following report provides an overview of this process and an assessment of the strengths and weakness of the combined ACT/SSP approach. We make a series of recommendations for using REA data in a scenario planning process and integrating scenario planning into current and future BLM Nevada planning frameworks. We also discuss initial criteria for prioritizing climate resiliency and change adaptation strategies in a landscape management approach.

Objectives & Research Questions

The aim of this project was to develop a set of best practices for using scenario planning methods in climate resiliency adaptation planning in the Great Basin that could be integrated into current and future planning processes. The following questions guided this project:

1. ***How can scenario planning approaches best incorporate information from REAs?***
2. ***What are the most appropriate uses for ACT and SSP methods?***
3. ***How do scenario planning outcomes potentially connect with existing management planning processes?***
4. ***What criteria can be used to prioritize effective adaptation strategies for use in resource management plans?***

PROJECT OVERVIEW

PHASE I: SCOPING (WEBINARS)

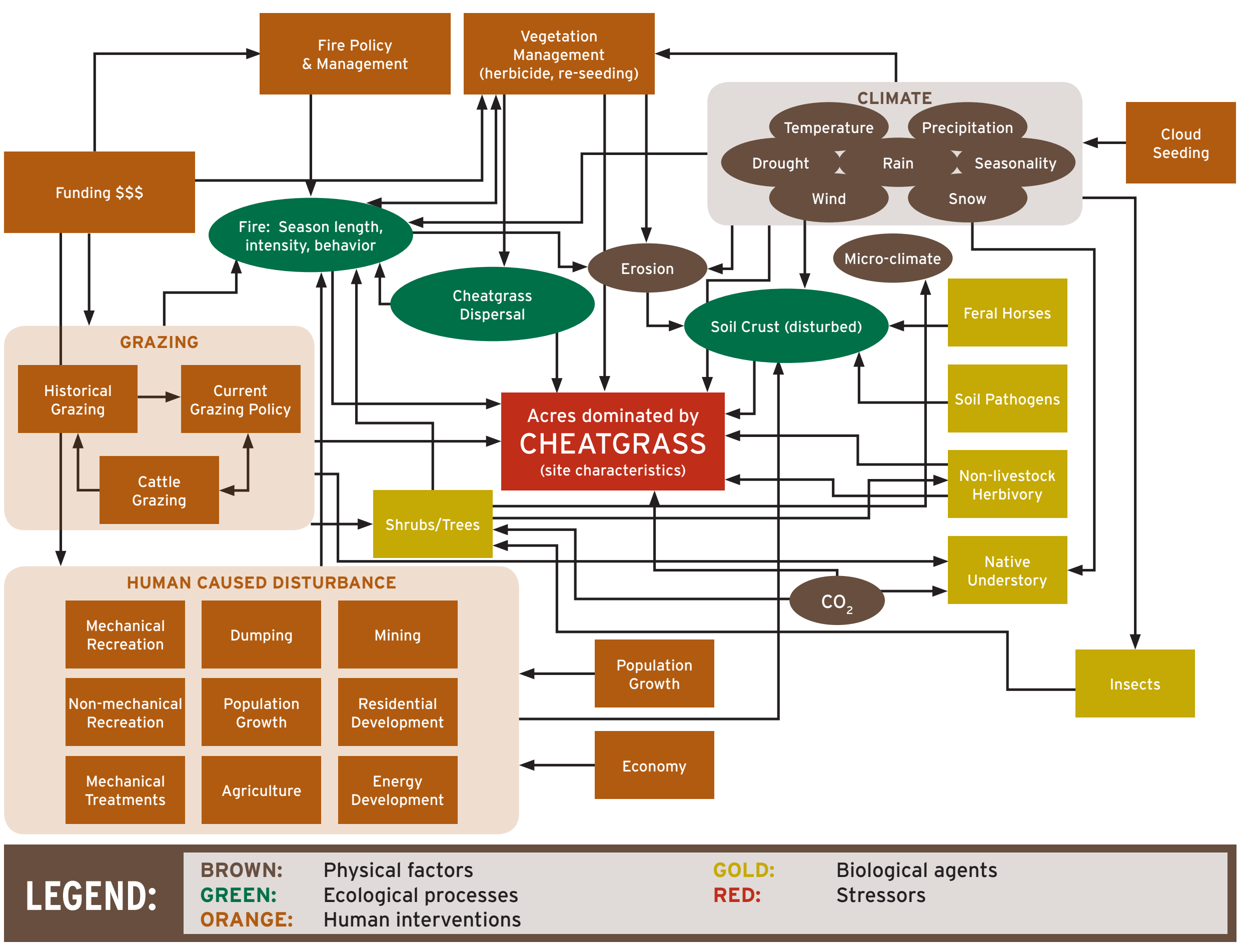
PHASE I: SCOPING (WEBINARS)

1. **Identify steering committee**
2. **Overview of the process & project goals**
3. **Develop a management question**
4. **Develop a conceptual model of the system**
5. **Refine the management question**

The first part of this process was to identify an advisory committee of natural resource experts to help the research team develop a key management question. This question inspired the development of the scenarios and also a conceptual model of the system. With the help of the BLM Nevada, the Great Basin Landscape Conservation Cooperative, and the U.S. Fish & Wildlife Service, we drew together an advisory committee comprised of federal and state resource managers. Over the spring of 2014, we met with the members of the advisory committee and held three webinars to introduce the project and the scenario planning processes, develop a management question, and build a preliminary conceptual model of the system. The advisory committee suggested that we home in on the sagebrush-steppe ecosystem, and focus on the challenge of managing an invasive species, called cheatgrass (*Bromus tectorum*), given projections of future climate for the Great Basin. Cheatgrass (http://www.blm.gov/wy/st/en/programs/weeds _ pests/Cheatgrass/whatis.html) has been an environmental game changer in the Great Basin. It has been described by BLM Nevada researcher Mike Pellant as "the invader that won the West". The management question we developed **"How do we manage cheatgrass dominance in the Central Great Basin?"** helped the advisory committee develop several key questions to help frame both the conceptual model of a sagebrush-steppe ecosystem and the scenario planning process for the workshops **(Figure 3)**.

Figure 3.

CONCEPTUAL MODEL OF A SAGEBRUSH-STEPPE ECOSYSTEM



PHASE II: SCENARIO BUILDING WORKSHOP I

PHASE II: SCENARIO BUILDING (WORKSHOP I)

6. Refine the conceptual diagram
7. Identify key drivers related to the management question
8. Assess and prioritize critical drivers
9. Develop scenario sets
10. Explore implications
11. Select scenarios to build out

Workshop Participants—Demographics & Experiences

The participants for Workshop 1 were from federal, state, university, and private organizations. Similar to many areas of the West, when asked about climate-related impacts to natural resources, water-related concerns topped participants list of concerns, with changes in native vegetation, impacts on wildlife, and fire following. Several participants also noted that they were concerned about understanding changing climate impacts, and how to adapt and manage those impacts. Most had not had any experience with scenario planning exercises. All but two participants commented that they currently use planning processes that require them to consider climate change—and that while the emphasis on considering climate change in management planning is growing, there is little understanding on how to do so.

For Workshop 2, the participants were more evenly divided between state and federal agencies, non-governmental organizations (NGOs), and academic researchers. Within this group, only two had attended Workshop 1. The remainder had little to no experience with scenario planning, and a similar list of concerns to participants in Workshop 1.

By working with the steering committee, we accomplished a significant amount of progress in preparation for the first workshop. This two-and-a-half day workshop was held June 25–27, 2014 at DRI in Reno, NV. There were 15 attendees, representing the BLM Nevada, State of Nevada, United States Forest Service (USFS), and NGOs. The goals of the first workshop were: 1) give participants exposure to the ACT and SSP Strategic Scenario Planning (SSP) scenario planning processes; 2) introduce participants to the REA data and consider how REA data could be used in these processes; 3) evaluate how these two processes may be helpful to participants. The first day focused on the CBR REA and the ACT process; the second day was devoted to the SSP process; and the third day was a morning session for feedback and evaluation.

DAY 1: INTRODUCTION TO THE CENTRAL GREAT BASIN RAPID ECOLOGICAL ASSESSMENT AND THE ADAPTATION FOR CONSERVATION TARGETS

The day started with a brief introduction to BLM Nevada's REA process by Joe Tague, BLM Nevada and followed with an overview of projected climate changes from the Central Great Basin REA. Participants discussed the value of that information, gaps in it, and potential ways of filling those gaps.

The rest of the day was devoted to exposing participants to the ACT process, with Dr. Gregg Garfin, University of Arizona, acting as facilitator. Dr. Garfin began by giving an overview of the process and then led a discussion aimed at refining the management objective originally formulated by the steering committee. An integral part of the ACT process is the development of a conceptual model of the elements or factors that affect the focus of the management question, in this case, cheatgrass. The workshop group started with a preliminary model, developed by the steering committee, but the discussion took a considerable amount of time. Conceptual models often seem simultaneously complex and overly simplistic to workshop participants **(Figure 3)**. However, they can help participants to come to a shared understanding of the system they are trying to manage and to formulate hypotheses of change (observed and projected climate change impacts). Conceptual models can also help participants develop cause and effect logic chains between components of the system to facilitate identifying intervention points where management actions could be taken. This is important, because people tend to jump directly from problem to solution, without adequately considering how a change agent works, directly and indirectly, to affect the system. Without deliberation on cause-and-effect, participants could develop a solution that is mismatched with the cause, or they could, in knee-jerk fashion, recommend ineffective solutions and solutions that are too narrowly or broadly defined. In conclusion, participants took part in a brief exercise to demonstrate how the ACT process facilitates identification of possible strategic actions for these intervention points.

DAY 2: STRATEGIC SCENARIO PLANNING

On the second day of the workshop, Dr. Holly Hartmann facilitated participation in the SSP process. The SSP process has three phases: process preparation and scoping; scenario building and refining; and using scenarios. A key aspect of SSP is that it focuses on the influential forces that have substantial uncertainties and potentially high impact—those things that cause comments such as "We just don't know enough about that" or "Things could go either way—we just don't know." This makes the initial phases of SSP a more qualitative process than ACT or spatially explicit scenario planning processes that rely on quantitative inputs from geospatial layers (see Vargas-Moreno and Flaxman 2012). However, SSP also allows resource managers an approach to begin disaggregating large, complex management challenges that are ill-defined and full of unknowns.

Process Preparation and Scoping

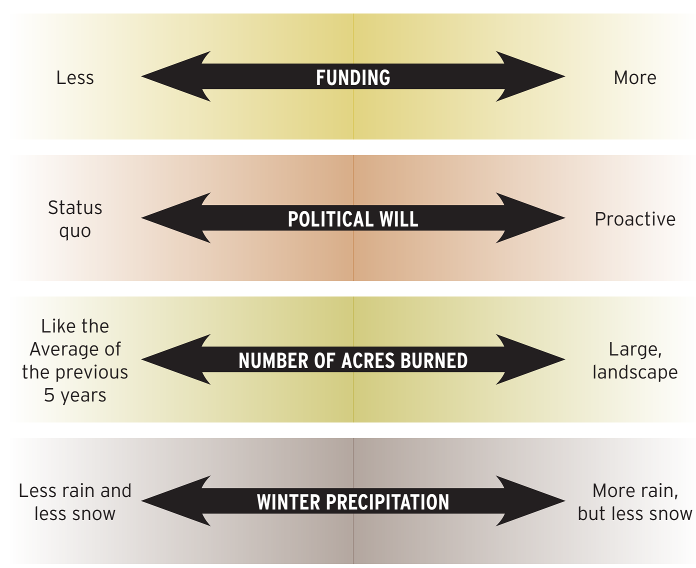
In this workshop, much of the initial steps of SSP were completed pre-workshop by the steering committee. This included identifying the primary issue the scenario planning processes would focus on (cheatgrass dominance) and stating a management question that was both sufficiently broad in scope and with a high level of uncertainty on how influential factors will respond to events and climate shifts in the future. The workshop participants focused on the second phase of SSP, scenario building and refining.

Scenario Building and Refining

The first part of this process was to identify the factors likely to ***drive*** the challenges that managers will be facing in the future. Some critical factors are "pre-determined" or assumed to be unchanging over the future; others are highly likely in their future changes (i.e., the likelihood for a continued trend in increased nighttime temperatures in the Great Basin Region). This process uses factors that are *highly uncertain* and *outside* the control of managers in the region. These are factors or *drivers* that are perceived to have potentially high impact; these form the basis for creating the scenario sets. In this workshop, the participants chose four critical uncertainties as key drivers **(Figure 4)**:

Figure 4.

KEY DRIVERS



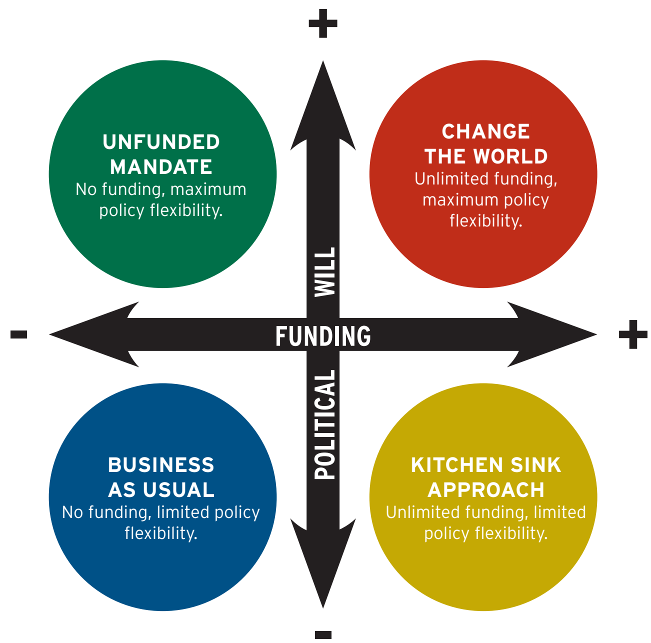
- Funding (more vs. less than the current levels)
- Political will (status quo vs. proactive)
- Number of acres burned (previous 5 year average vs. landscape scale fires)
- Winter precipitation (less precipitation overall vs. increased % precipitation as rain)

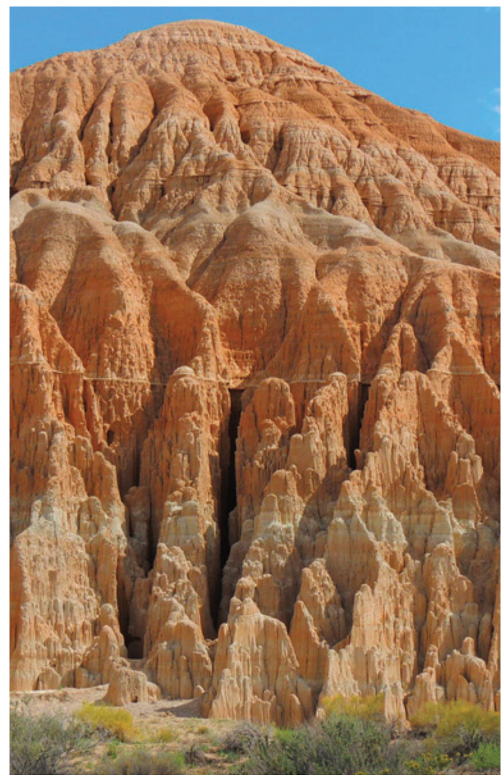
After these were selected, we divided into several smaller groups, and each group used these drivers to develop four possible scenarios and roughly evaluate the implications of each scenario and what that hypothetical future might look like **(Figure 5)**. After reviewing the possible scenarios as a group, we used the following criteria to evaluate each scenario:

Figure 5.

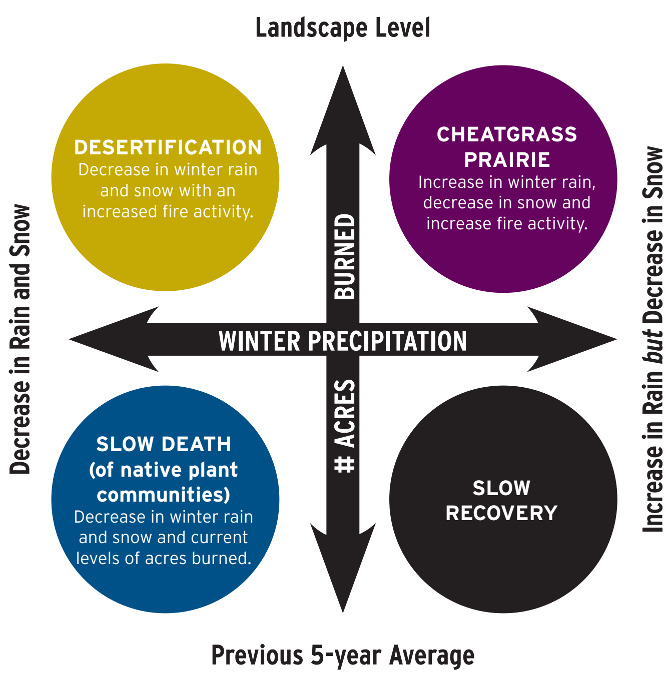
HYPOTHETICAL SCENARIOS

Social Factors





Biophysical Factors

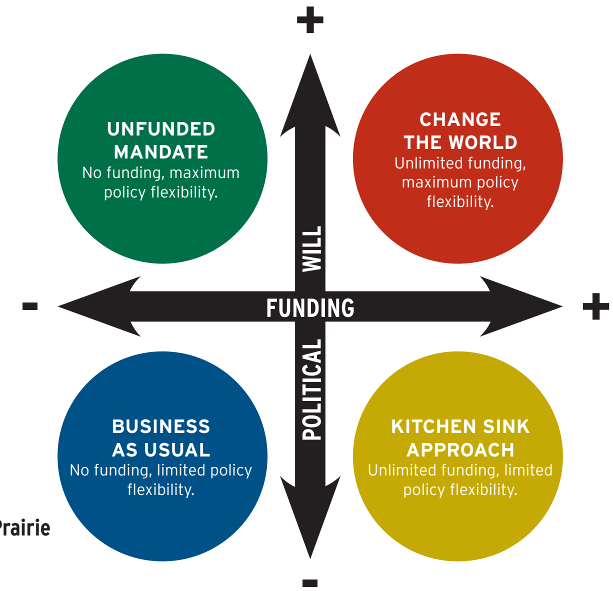


1. Are the scenarios plausible?
2. Is each scenario sufficiently divergent from the others to generate different management implications?
3. Are they of management interest?

After this discussion, we chose four scenarios to build out from the combination of the two matrices, using one combined scenario from each of the quadrants of the Funding/Political will matrix **(Figure 6)**:

Figure 6.

SELECTED SCENARIOS

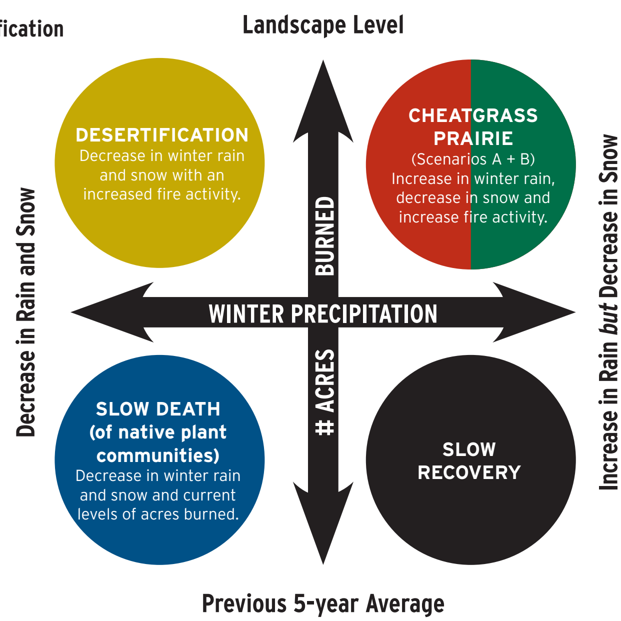


● **SCENARIO A:**
Change the World + Cheatgrass Prairie

● **SCENARIO B:**
Unfunded Mandate + Cheatgrass Prairie

● **SCENARIO C:**
Kitchen Sink Approach + Desertification

● **SCENARIO D:**
Business As Usual + Slow Death



The remaining portion of Day 2 was spent exploring the indirect and interacting effects of the driving forces and impacts of each specific scenario. Looking at three different timeframes, 2020, 2040, and 2060, we began to identify possible management challenges and opportunities *without making any choices about specific management responses*. Key elements we considered included vulnerabilities, emergent needs, and opportunities created by the scenario conditions. In the workshop, we focused on building out two of the scenarios, and in follow-up webinars later that summer, completed building out the remaining scenarios.

DAY 3: SUMMARY

The final half-day of the workshop focused on participant feedback about the two scenario planning processes and discuss how they might fit into existing agency planning processes. In both this feedback session and in post-workshop evaluation forms, participants described many of the hardest parts of these processes—developing the conceptual diagram and the scenario matrices—as the most frustrating, but also the most interesting. A noted value was the opportunity to challenge conventional modes of thinking by focusing on uncertainty, elements outside of management control, and contemplating outcomes and futures that were plausible, low probability, and high impact. The workshop participants felt that this process would be most useful to planners, land managers and resource specialists.

PHASE III: SCENARIO DEVELOPMENT (WEBINARS)

12. Develop scenario narratives

13. Develop implications of the scenarios

PHASE III: SCENARIO DEVELOPMENT

After the June workshop, we held two additional webinars to develop impacts of each of the scenarios. These webinars focused on each scenario, identifying possible impacts for 2020, 2040, and 2060, as well as which agencies, organizations, sectors of society would be most likely affected by these impacts. Once the scenario impacts were identified, each scenario was summarized into a short narrative **(Figure 7)**.

Figure 7.

CRITICAL DRIVERS

SCENARIO A:
CHANGE THE WORLD & CHEATGRASS PRAIRIE

Unlimited funding, maximum policy flexibility with increase in winter rain, decrease in snow and increased fire activity. By 2020, there is an increased probability of fire starts. We see increased erosion with winter rain on burned areas, improving cheatgrass competitiveness. Funding is increased, but targeted towards specic programs, for example, sage grouse habitat improvement. By 2050, fire events are getting bigger, connecting to each other, with continued loss of soil and native vegetation, but higher elevations are not burned. Funding remains consistent with biophysical challenges. By 2060, burning is expanding into high elevations and less desirable species are more competitive (other than cheatgrass) and sagebrush systems (leks and brooding areas) have burned at least once.

SCENARIO B:
UNFUNDED MANDATE & CHEATGRASS PRAIRIE

No funding, maximum policy flexibility with increase in winter rain, decrease in snow and increased fire activity. By 2020, when previously burned areas burn, there is cheatgrass expansion. Soil moisture is decreased earlier in the growing season, leading to increased cheatgrass dominance in the understory. By 2040, interagency coordination increases, and regulatory barriers diminish. Dust storms become common. By 2060, fire seasons are occurring much earlier and policies allow prescriptive grazing to control cheatgrass. The Central Great Basin has made the conversion to annual grassland, and there is increased collaboration between agencies.

SCENARIO C:
KITCHEN SINK & DESERTIFICATION

Unlimited funding, limited policy flexibility with decrease in winter rain and snow with an increased fire activity. By 2020, fires are patchy, with increased funding for fire suppression. There is less coordination between agencies but increased funding and a focus on continuing current management practices. By 2040, fires start to connect at the landscape level with increasing erosion and desert pavement emerges. Big opportunity for drought tolerant weeds emerge, as cheatgrass is out-competed. By 2060, fires have become patchy again and are more easily contained, but with a decreased return interval. Noxious invasives such as bursage moves in with increased impacts from disease/insects.

SCENARIO D:
BUSINESS AS USUAL & SLOW DEATH

No funding, limited policy flexibility with decrease in winter rain and snow and current levels of acres burned. By 2020, Pinyon-Juniper will dry out and burn more readily, but will be contained more easily due to the lack of fine fuels and there will still be patchiness in the fires. Staffing levels are reduced, and resources allow for only one opportunity to “get it right.” By 2040, there are fewer wet days, but more variability. Policies allow grazing and allotment reductions. Reduced capacity to manage overall, and fire policy focuses on high elevations. By 2060, there are more fires, but smaller in size, wind events have more impact (soil loss and increased airborne dust) and fires are allowed to burn. Increased loss of seasonal staff and more “regional” specialists. Loss of annuals and desertification in some areas, with lower diversity overall.

PHASE IV: USING SCENARIOS (WORKSHOP II)

The second two-and-a-half day workshop was held November 19-21, 2014 at DRI in Reno. There were 10 attendees, representing BLM Nevada, State of Nevada, USFS, and NGOs. Most of the participants had not attended the first workshop, and this was their first involvement with the project and the scenario planning process. The first day of the workshop started with an overview of the project and the process, and then we moved into identifying the impacts of the scenarios.

DAY 1

Due to time constraints participants worked with three of the four previously developed scenarios. Participants identified *possible management actions* using modified tables from the ACT process (hypotheses of change, intervention point, action) across the timeline, using the 5R framework **(Figure 8)**. The tables were aggregated by the research team that evening, and used the following day to begin applying impacts across the project timeline of 2020, 2040, and 2060 into adaptation options **(Appendix A)**.

DAY 2 AND 3

On the second day, a series of exercises helped participants consider several different ways to assess the management options they had generated, including: a) sorting actions; b) evaluating actions; and c) operationalizing actions. Participants started with the adaptation options aggregated by themes (e.g., cheatgrass control, erosion, fire, planning), assessed the degree of difficulty in implementing options, developed sequences of steps needed to implement actions, and identified triggers for implementing actions. One exercise focused on disaggregating the actions perceived as most difficult to implement into achievable, sequenced steps. The group then discussed how to combine actions into a portfolio of time-evolving options, using a decision tree. This allows for discrete action paths associated with specific decision points and time frames. In each of the Day 2 exercises, practice in establishing cause-and-effect logic chains laid the foundation for thinking through the chains of events that would establish a solid basis for implementing adaptation strategies. While these strategies may not be inherently complicated, their execution is often complex, occurring in an environment that requires public support, has legal and political constraints, and gaps in ecological knowledge.

PHASE IV: USING SCENARIOS (WORKSHOP II)

14. Overview of project and process
15. Identify impacts of the scenarios
16. Explore potential strategies or actions across the timeline
17. Prioritize strategies/actions
18. Disaggregate harder actions across the timeline
19. Identify near term strategies/actions

Figure 8.

The 5 Rs*

1. RESISTANCE: defend against change
2. RESILIENCE: 'bounce back' after disturbance.
3. RESPONSE: facilitate change.
4. REALIGNMENT: accept different systems, focus on function.
5. RETREAT/TRIAGE: let go.

*(ADAPTED FROM C. MILLAR ET AL., 2007)

SORTING ADAPTATION ACTIONS

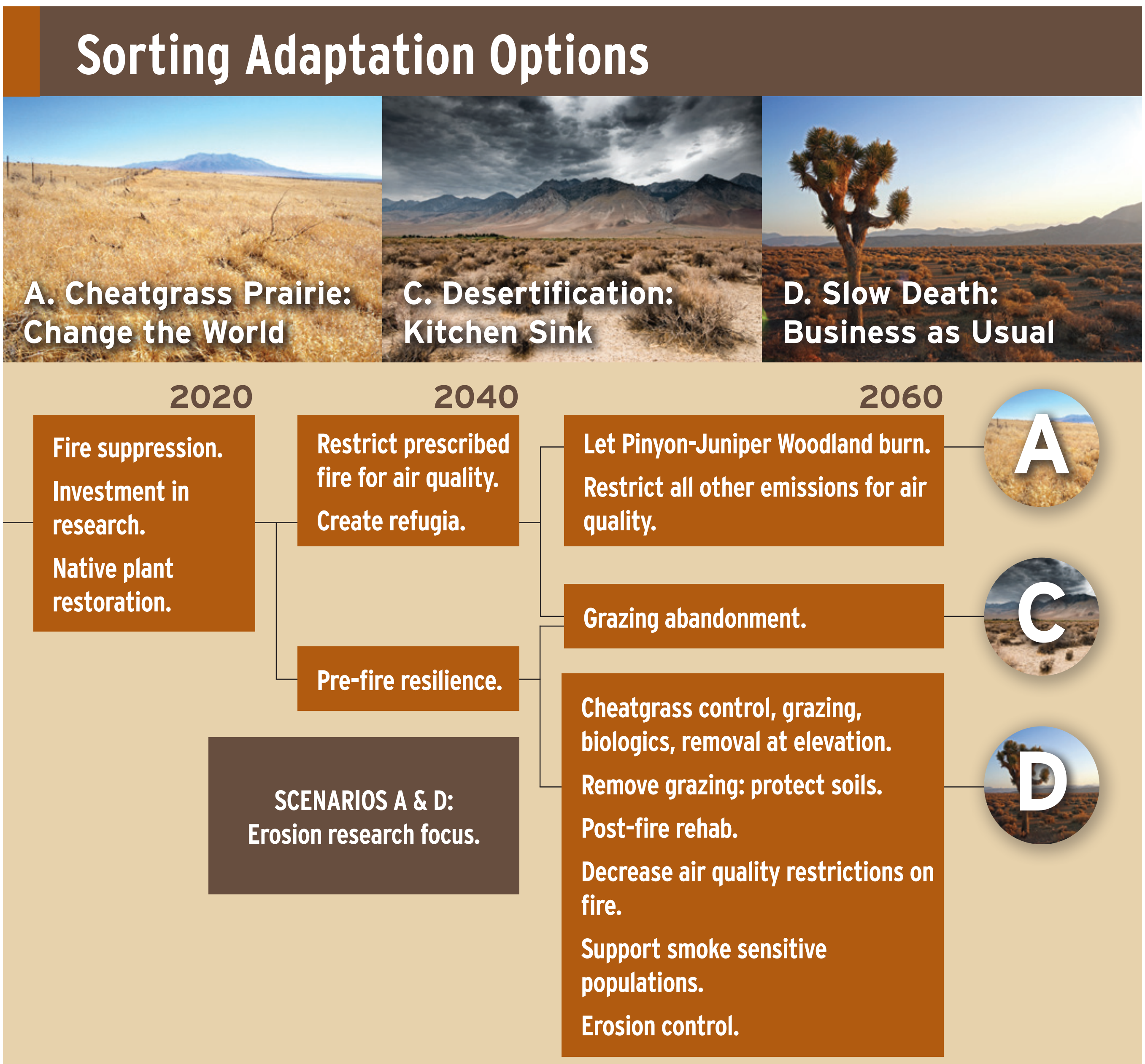
Some management activities are applicable to all scenarios, while others are suitable only for a single scenario. We sorted adaptation options into those that work for all possible futures, those that work for only some futures, and those that work for only unique futures. This exercise formed the basis for developing a "decision tree" that will help managers choose appropriate adaptation activities over time, as it becomes more evident which scenario is in fact becoming more likely **(Figure 9)**. Once the decision tree is constructed, managers can begin to determine how they will decide that it's time to implement new adaptation strategies. Questions we considered during this exercise included:

Arrangement:
- Can the order of adaptation options increase the ability to accommodate the different scenarios?

Decision Points:
- How will a manager know they are at the decision node?
- What indicators are required?
- Would the indicators be different for an option requiring a long lead-time to implement vs. one with a short time of implementation?
- What information would be required to make the choice between one option or another, when you are at the point of making the choice about which path to satisfy?

Policy:
- Do any any policies need to change to accommodate any of the adaptation options, their ordering, or choosing a pathway in the future?

Figure 9.



EVALUATE ACTIONS

Some adaptation options can be relatively easy to implement, while others can be very difficult, for a variety of reasons, including policy barriers, expense, risk of failure, potential impacts (known and unknown), or design challenges. Some options may reflect future management objectives and criteria, rather than those in use today. We classified options using the aggregated adaptation charts **(Appendix B)**, by using a simple dot exercise to evaluate the options generated the day before. The criteria for this exercise was:

1. **GREEN** dots to indicate options that would be 'no regrets' or 'low regrets' options.
2. **YELLOW** dots to indicate options that pose significant change from current practice, i.e., all the options that reflect realignment or retreat.
3. **RED** dots to indicate options that would be 'hard' choices for decision makers.

OPERATIONALIZE ACTIONS

This part of the workshop began to move into thinking about the actual implementation of selected adaptation options, by looking at the sequence of actions required to plan, assess, implement, and sustain each option. In addition, the workshop participants identified the conditions, or indicators, that would trigger an action(s) across the timeline of the scenarios (2020, 2040, and 2060). **Figure 10** below outlines the leading indicators identified by the participants from Scenario D for fire response in Pinyon-Juniper systems.

Figure 10.

Leading Indicators

Limit fire responses in Pinyon-Juniper Woodland (PJ) systems

LOSS IN SAGEBRUSH

- **Decrease in lek areas, decrease in habitat quality, reduction in post-fire recovery**
- **Decrease in water availability and moisture for shrubs**
- **Trigger: ecological dominance of Pinyon-Juniper**

INCREASE IN PINYON-JUNIPER EXPANSION INTO SAGEBRUSH SYSTEM

- **In proximity to leks. Spatial Trigger: abandonment of leks**

CONTINUED FUNDING SHORTFALLS

- **Suppression resources (engines, aircraft) insufficient. Response is limited by initial attack success resources.**
- **Proactive fuels management, pre-suppression "hazardous fuels program" resources insufficient**
- **Funding available only for Priority 1 response areas**
- **Chain: initial attack success: if succeeds, then resources in other program not needed. This increases Pinyon-Juniper expansion/infilling, increasing long-term risk of catastrophic fire.**

NAAQS STANDARD TIGHTENING: LEADING TO REGIONAL TIGHTENING OF BURNING – "FIRE-MANAGEMENT" BY EXCEPTION EVENTS

- **Trigger: 3-year average non-attainment occur**
- **Exceptional events packages continue to be accepted by EPA (or at least 'non-action')**
- **NVAQ continues to let prescribed/treatment burns convert to wildfire as exceptional events**

The final step in this exercise was to select several difficult adaptation options, disaggregate those actions into achievable steps, and then construct a timeline to identify when actions should or could be taken. We used several criteria to prioritize a range of hard actions to disaggregate:

- Actions suggested for more than one scenario
- Actions suggested for 2060, for one scenario only, and requiring a long lead-time
- Actions that stop being effective in either the 2040 or 2060 periods
- Actions that have a short lifespan of effectiveness
- An action that bridges a near-term action that loses effectiveness and a far-term action

Building on the leading indicators identified in **Figure 10** and rated adaptation options **(Appendix B)**, the example below in **Figure 11** looks at how the adaptation option to limit fire response in Pinyon-Juniper systems could possibly be put into place by 2040, through a succession of management actions starting in 2020. While these actions are guesswork, they are plausible given Scenario D's combination of critical drivers: low funding and support, decreased precipitation in all forms, but relatively the same level of wildfire on the landscape as experienced under current conditions.

Figure 11.

Disaggregated Steps

2020

Map the encroachment areas, leks and other key features

+ ongoing track leading indicators – track over time and evaluate whether still beneficial
- Requires cost-benefit analysis
- Requires impact analysis

Public information campaign about why decisions are being made, why changes are being made: public, key agencies (Air quality)

Develop emergency/public health response effort: hospitals, sensitive groups, emergency episode response

Monitoring: soil moisture, climate variables

Management objectives/criteria shift
- Fire benefits higher priority than risk
- Importance of fire acknowledged
- Post-fire benefits worth the cost and risk to different systems
- Value of different systems

Working relationships between land managers and air quality agencies

Research on cost-benefit of non-suppression vs. suppression/ pro-active management (e.g., Pinyon-Juniper removal)

2040

Develop criteria/ triggers/ thresholds for limiting response

Map and ID where fire response would be limited

2060

Update fire management plans
- Resource management plans (20 years)
  2040 Resource Management Plan (RMP)—have the criteria in, then tier down to specific fire management plans. Carson City: draft out now for use in 2016–2036. Process started 3–5 years prior. Need criteria, research, etc. for 2036 RMP (by 2030) feeds into fire management plans
- Fire management plans (monitor annually; rewrite every 10 years)
- Suppression plan (annual)

Air quality state implementation plans
- If non-attainment, then within 1-year
- If in attainment, then 10-year maintenance plan (crematoria, restaurants, etc.)

+ ongoing air quality responding to public health, businesses, EPA/ federal level

SUMMARY

The conclusion of Workshop II focused on next steps for the project, as well as overall feedback and comments about the process. Since most of the Workshop II participants were not involved with the previous workshop or webinars, the research team was interested in how participants viewed the credibility and legitimacy of the work they had to build upon from Workshop I. Overall, while there was some initial confusion about the process at the beginning of the workshop, the participants felt that they could adequately build upon this previous work and push it into the final phase of the process. Since most other workshops using the SSP method stop before considering the implementation of adaptation options, there was a heightened interest in seeing “where they could take this.” In addition, there was a general sense of empowerment in the participants from going through the process of disaggregating the actions necessary to implement hard adaptation options. This also seemed to encourage awareness that there are actions that can be taken in the near-term to leverage future adaptation options.

SYNTHESIS: USING SCENARIO PLANNING TO INFORM RESOURCE MANAGEMENT PLANNING ACTIVITIES

The following section is a synthesis of the information gathered during the webinars and workshops that aims to address the research questions that guided this project. Objectives of this project included developing a set of best practices for utilizing scenario planning methods in natural source management activities and identify how scenario planning could function as decision support for developing adaptation options through 2060.

How can scenario planning approaches best incorporate information from the rapid ecological assessments?

Based on conversations during the workshops and in a September 2014 webinar, we garnered input on the value of the REA to inform planning for future climate changes. First, the information in the REA is valuable for discerning the certainty or lack of certainty in projections of future climate and environmental changes. REA assessments facilitate consideration of sub-regional hot spots, with respect to current and future fire risk, ecosystem type change (expansion or contraction of certain ecosystem types and some individual species), energy development, and other factors (BLM Nevada, 2015). This type of information is valuable to inform the development of conceptual models of system interactions, relationships between parts of a system, and management leverage points for potential actions. Thus, REA information can help managers refine their questions about future change, and interactions between parts of Great Basin ecosystems. REA *projections* can also be used as a baseline for examining what might happen in the absence of management actions; thus, REA projections can help inform the effectiveness of management actions. We learned, too, about limitations of REA projections and assessment information. These include needs for finer-scale/decision-scale information, improved historical baseline information, filling in missing gaps, and more disaggregated indicator information (i.e., the ability to “look under the hood” at how individual factors influence aggregated indicator indices). In summary, REA information flows well with both scenario planning approaches, to provide broad overviews of some current and future conditions, to help identify uncertainties, and to understand Great Basin systems and potential hot spots for examination through scenario planning processes.

What are the most appropriate uses for Adaptation for Conservation Targets and Strategic Scenario Planning methods?

ACT. Overall, the research team and participants found the ACT conceptual diagram (aka, influence diagram) approach to be an effective way to help scenario planning process participants establish common understanding of a system and its elements, and to develop common language for discussing aspects of the system. We determined that it was feasible to develop a conceptual diagram, through an online webinar process, which could streamline the use of ACT. We learned, from participants’ remarks that conceptual diagrams may need to be more flexible, in order to take into account either details (e.g., specific species) or generalities (e.g., broadening the diagram to account for multiple interconnected concerns), which could be facilitated through a systems modeling approach. In systems modeling, a team of people uses analytical software to construct a model of a system and its component parts, in order to evaluate and test ideas about the way system components interact with each other, and how parts of the system are affected by these interactions. One advantage of modeling is that it allows quantitative analysis of the system. The ACT process facilitated the development of explicit logic chains—logical connections between cause and effect in thinking about the direction and magnitude of future *impacts*, and to discern management leverage points for action. These features, participants noted, are valuable for bringing the public on board during planning processes, and for integrating knowledge from scientists across multiple disciplines; they also noted that the process was straightforward enough to be useful to a range of groups, from field-level staff to management teams. The research team noted that ACT is particularly useful in helping describe how an action might be effective—through logic chains—which would make it valuable for assessing the feasibility of implementing certain actions.

On the other hand, implementing the ACT process revealed some barriers to effectively using the process. For example, the research team noted that during the *possible management action* identification part of ACT (Day 1; see page 10 of this report), the process constrained innovation. Participants were occasionally confused by the aspect of identifying intervention points; also, the somewhat novel inclusion, in our implementation of ACT, of a requirement to identify the associated “5R” (Millar et al. 2007), may have further slowed down creative thinking. Participants in the first workshop noted that achieving consensus on a management objective, which is a focal point of the ACT process, might be difficult, especially in a charged, politically contentious, public process. Whereas participants in the June 2014 workshop noted that ACT might be valuable for scoping climate change planning, the research team noted that the ACT process did not encourage thinking about increasing the capacity to act, which relates to the aforementioned remark about constrained innovation. In our assessment, ACT is valuable for considering single, and relatively narrow, management focus issues, for establishing cause-and-effect logic chains, and in a post-SSP action feasibility assessment.

SSP. Overall, the research team and participants found great value in the way the SSP process fosters thinking that integrates multiple issues across multiple programs, and in its explicit consideration of the time-evolution of environmental changes and associated actions to prepare for or respond to change. The SSP approach of embracing multiple uncertainties was appealing to participants, for various reasons, including: (a) it takes the emphasis off of dependence on [contentious] climate model projections; (b) the method's use of story lines and multiple futures allows for social and cultural flexibility—participants need not agree upon common values, and the process does not lock agencies into a single plan for the future; (c) the emphasis on uncertainty and driving forces that are out of the control of managers, allows managers to consider factors and multiple climate change-motivated alternatives and how they might fit with plan revisions, or NEPA processes. Participants universally praised the SSP process of sorting adaptation options by degree of difficulty (e.g., low hanging/win-win, highly difficult, and so on) and then disaggregating the steps needed to implement difficult strategies and actions. Participants valued the no-modeling, conceptual level at which the research team implemented the SSP process in our engagements, because conceptual thinking—informed by scientific evidence, such as REA, and manager experience—would allow a small group to proceed in an efficient manner, identify decision points, not get bogged down in details, and get people involved in the process, in a way that acknowledges the value of their ideas, their agency perspectives, and their logic. Some participants also noted that SSP embodies a strong trust-building component, which would allow for conflict resolution—again, because the emphasis is on drivers outside the control of managers.

Barriers to SSP include the need, in most applications, for a relatively long time commitment to go through the planning process, its first-glance complexity—which may deter some groups; difficulties in getting participants to embrace thinking multiple decades into the future (an issue for both methods); and the possibility that non-participants would not buy into the futures identified by a small group.

Combining ACT & SSP. Participants valued SSP for the ability of the process to work in a from-the-ground-up manner. The SSP emphasis on uncertainty and lack of control fosters a free-wheeling style for generating ideas, and improves the odds of generating creative solutions. Moreover, SSP's consideration of time-evolving issues and strategies allows for disaggregation of actions over realistic time frames. In our assessment, SSP is ideal for scoping and defining multiple paths forward for addressing complex, multi-sector, multi-factor problems. In our assessment, ACT is valuable for considering single, and relatively narrow, management focus issues, for establishing cause-and-effect logic chains, and in a post-SSP action feasibility assessment. A potential barrier to both processes is the need to include all perspectives in the mutual airing of concerns, agreement on the components and inter-relations in a system, and the formulation of future scenarios. Participants were concerned that "if people are not part of the scenario development process, then they are less likely to buy in." Yet, the fact that participants in our second workshop were able to accept and build on scenarios developed by a mostly different set of participants from our first workshop, demonstrates that it may not be as difficult as expected to gain buy in.

How do scenario planning outcomes connect with existing and future management planning processes?

This project demonstrates that using scenario planning is a strong path for involving stakeholders and partners into the planning process, and gaining a wider community of support for addressing climate change. The conceptual model and logic chain exercises would benefit current management planning processes, either as a "starter" exercise to look at a system or as a detailed analysis for a specific location. Both ACT and SSP offer different opportunities to engage a wider community. Because both are non-regulatory and non-binding processes, it allows participants to think through a more diverse array of futures and actions, without committing to any single future or action. This may be especially useful when looking at what might be exceptionally difficult changes, such as significant changes to resource management plans. This hard-to-stomach prospect could be made easier through the prioritization exercises that we used, especially the difficult disaggregation steps.

In terms of long-term planning, scenario planning could be used in tandem with planning for BLM Nevada monitoring, as the consideration of multiple futures helps planners to conceptualize change given high uncertainty. This enables assessment of the robustness of monitoring through time, and helps anticipate needs to change monitoring efforts or protocols.

What criteria can be used to prioritize effective adaptation strategies for use in resource management plans?

Throughout our scenario exercises we used a variety of criteria for prioritizing strategies and substeps of complex actions. These criteria are part of examining the effectiveness and robustness of options under changing conditions, and to associate options with future time frames. These criteria could be used in tandem with more typical decision-making criteria, such as the urgency of the issue, cost of implementation, technical feasibility and others that are needed in a comprehensive discussion of moving from planning to implementation (see Rowland et al., 2014, Table 2.11).

First, we used the 5Rs (Millar et al. 2007) as criteria for classifying and understanding the characteristics of the strategies and actions proposed by scenario planning participants **(Figure 8)**. The utility of associating strategies with the 5R framework is that the 5Rs make clear the intention of the strategy (e.g., to resist change within a system, as opposed to facilitating realignment of a system), and can help in determining the time frame associated with the proposed strategy (e.g., resistance actions typically require shorter lead times to implement, and are likely more familiar to an array of stakeholders). We learned that it was somewhat difficult for participants to make these associations, but they can help infuse a kind of "logic tag" in BLM Nevada plans, because the 5Rs can help planners discern broad strategic categories—they take the planning process a step further from labeling an action as "strategic" to labeling an action as part of a specific family of strategies that are aimed at achieving a major goal. Thus, this kind of prioritization can help in explicitly aligning actions and strategies with overarching agency policies and mandates.

Second, participants evaluated the degree to which strategies were unique to a particular scenario of the future, or whether the strategies were common to multiple scenarios. This enabled participants to construct decision trees for identifying common strategy pathways. In most cases, strategies common to multiple futures would be considered robust; examples from our workshops include enhanced monitoring, investment in research, or in our fire management example, native plant restoration **(Figure 9)**. Other strategies might be contingent on the conditions of a particular future, and would only be implemented if an indicator crossed a threshold. This prioritization exercise also helped participants identify actions to bridge between near-term situations and anticipated futures; in our workshop, implementing demonstration projects was suggested as a bridge in anticipation of a future where a new operational policy was needed. This sorting of priorities could be used by the BLM Nevada to assist planners in assessing how well a currently used strategy fits with changing conditions, and to foster explicit acknowledgement of uncertainty and risk tolerance. Thus, for example, strategies that are explicitly acknowledged as bridges to one or more futures could help BLM Nevada gain agency buy-in and public acceptance.

Third, in our criteria for prioritizing strategies, we assessed the degree of difficulty in implementing a strategy. Disaggregating difficult strategies into smaller, more specific and more contained, time-evolving steps, and explicitly acknowledging the sequence of steps needed to move from current conditions to a challenging future helped participants establish clear priorities. Because the sequence of steps is critical to achieving strategy implementation, this prioritization exercise adds detail and a greater sense of the evolving real-world situation as strategies are implemented. For example, in our workshop, achieving the update of a resource management plan **(Figure 11)**—a seemingly insurmountable task, given uncertainties in climate and public support—required very clear prioritization of bridging tasks, such as mapping, research, tracking indicators, conducting public information campaigns, enhanced coordination among agencies, and so on. Also, identifying which strategies require a change in direction (e.g., category of strategy, or agency policy) aids in clarifying priorities, because some proposed strategies might be a mismatch for the current management environment, and thus the strategies might not be seen as a high priority. Using difficulty-disaggregation techniques that effectively encourage prioritization could help BLM Nevada planners overcome risk aversion. These approaches may be especially effective when used in tandem with the more common considerations such as cost or alignment with laws. Using these types of approaches demonstrates a strong possibility of helping people turn what often seems to be an unthinkably complex and overwhelming task into a set of plausible actions that can inform an overall strategy in addressing adaptation to climate change effects.

OVERALL SUMMARY

In conclusion, the central message to take away from this project is that scenario planning has a multitude of uses within existing management planning processes. It can be used as a relatively short-term exploratory process and involve a wider group of participants to consider multiple perspectives on resource management or it can be used by a small team to assess conditions at fine scales. The strength of the ACT process is that it encourages participants to envision a system holistically, the links between different parts of the system and their impacts. SSP encourages thinking about *what isn't known* and *what is out of the managers' immediate control*, allowing resource managers to think through implications and possible actions for a diverse array of possible futures and outcomes in a more neutral process than current regulatory processes. These processes take time and time is a precious commodity for natural resource managers. However, we suggest that scenario planning processes are worth the time investment by offering a framework to explicitly address the uncertainty in climate conditions and their effects planning efforts must work within, across multiple decades.

REFERENCES

Bureau of Land Management (BLM), 2015: Central Basin and Range Rapid Ecoregional Assessment: Examining the Findings to Identify Potential Challenges and Opportunities for the Ecoregion. Technical Report. 15 pp.

Cross, M. S., P. D. McCarthy, G. Garfin, D. Gori, and C. A. F. Enquist, 2013: Accelerating Adaptation of Natural Resource Management to Address Climate Change. *Conservation Biology*, 27, 4-13.

Cross, M. S., and Coauthors, 2012: The Adaptation for Conservation Targets (ACT) framework: a tool for incorporating climate change into natural resource management. *Environmental Management*, 50, 341-351.

Millar, C. I., N. L. Stephenson, and S. L. Stephens, 2007: climate change and forests of the future: managing in the face of uncertainty. *Ecological Applications*, 17, 2145-2151.

National Park Service, 2013: Using Scenarios to Explore Climate Change: A Handbook for Practitioners. National Park Service Climate Change Response Program.

President of the United States, 2013: Preparing the United States for the Impacts of Climate Change. Executive Order 13653. Federal Register 78 no. 215 (6 November 2013): 66819. http://www.gpo.gov/fdsys/pkg/FR-2013-11-06/pdf/2013-26785.pdf.

Rowland, E. L., M. S. Cross, and H. C. Hartmann, 2014: Considering Multiple Futures: Scenario Planning to Address Uncertainty in Natural Resource Conservation., U.S. Fish & Wildlife Service.

Tang, G., and J. A. Arnone, 2013: Trends in surface air temperature and temperature extremes in the Great Basin during the 20th century from ground-based observations. *Journal of Geophysical Research: Atmospheres*, 118, 3579-3589.

Vargas-Moreno, J., and M. Flaxman, 2012: Using Participatory Scenario Simulation to Plan for Conservation Under Climate Change in the Greater Everglades Landscape. Restoring Lands - Coordinating Science, Politics and Action, H. A. Karl, L. Scarlett, J. C. Vargas-Moreno, and M. Flaxman, Eds., Springer Netherlands, 27-56.

Adaptation Options

Fire

FIRE SUPPRESSION

- Maintain initial attack rate at 98% **(D) 2020**
- Limit fire response in Pinyon-Juniper **(D) 2040**
- Limit fire response in salt desert shrub **(D) 2040, 2060**
- Buy more tankers, hire more staff, spend more money **(C) 2040, 2060**
- Develop water reserves for fire suppression **(A) 2020, 2040, 2060**
- Maximize fire suppression through green strips, brown strips, controlled burns, and extensive grazing **(A) 2060**

FIRE TRIAGE

- Let Pinyon-Juniper burn **(D) 2060**

PRE-FIRE RESILIENCE

- Increased prescribed burning **(C) 2020**
- Strategic fuel breaks **(A) 2020, 2040, 2060**

FIRE REHABILITATION

- Delayed post-fire grazing on rehab projects **(A) 2020, 2040, 2060**
- Change BAER/ESR policy to retain funding for multi-year starts (e.g., delayed re-seeding during drought) **(A) 2020**
- Fall re-seeding **(A) 2040, 2060**

Wildlife

- Introduction or re-introduction of species (e.g., sharp-tailed grouse, chukar) **(A) 2040**
- In the ESA consultation, allow for abandonment of parts of the species range (due to climate change considerations) **(A) 2040**
- Actively manage for northward/upward migration of wildlife habitat **(C) 2040**

Refugia

- Negotiate conservation easements in sage grouse areas (with willing sellers) **(D) 2040**
- As ecosystems collapse and private lands sell out, purchase land to protect habitat islands **(C) 2040**
- Purchase high priority sites with water, as reserves for native vegetation **(C) 2020, 2040, 2060**
- Prioritize most resilient areas for resource management and retreat from the rest **(D) 2040**
- Exclusionary actions due to ESA enforcement **(D) 2040**

Erosion

- Research on biological crusts and their rehabilitation **(D) 2020, 2040**
- Research on soil stabilization – "fake crusts" **(A) 2020**
- Use native vegetation or cheatgrass for soil stabilization **(A) 2020, 2040, 2060**

LEGEND A) Change the World + Cheatgrass Prairie | (C) Kitchen Sink Approach + Desertification | (D) Business As Usual + Slow Death

Adaptation Options

- Implement policy for a land reclamation requirement to reduce soil erosion **(A) 2040**
- Implement strong flood control measures (storage, capture) to reduce erosion **(A) 2060**
- Use grazing permitting and feral horse management policy to reduce livestock and feral horse populations on sensitive soils **(A) 2020, 2040, 2060**
- Seasonal closures **(D) 2020, 2040, 2060**
- To minimize further disturbance, create wilderness **(D) 2020, 2040, 2060**
- Define desertification area and prepare for expansion **(D) 2060**

Air Quality

REGULATION OF OTHERS

- Business as usual in regulation of prescribed burning by NV Air Quality **(C) 2020**
- Restrictions on prescribed fire (none/less) to address air quality **(D) 2020**
- Further restrictions on all emissions including prescribed burning **(D) 2020, 2060**
- Decrease air quality restrictions at state and federal levels **(A) 2020, 2040, 2060**

MITIGATION

- Develop clean air centers and increased communication targeted to smoke sensitive groups (public health) and to encourage indoor activities during increased fire **(A) 2040**
- Dust suppression using vegetation or water **(D) 2060**
- Suspend 2060 Regional Haze SIP goals **(A) 2060**

Planning and Administrative

- Use expedient environmental review to develop the best land management plan that money can buy **(A) 2020, 2040, 2060**

LAND USE

- Expand solar development **(D) 2060; (C) 2060**
- Revise recreation plans, allow for more ATV areas and outdoor festivals (e.g., Burning Man) **(D) 2060**
- Increase buyouts of grazing allotments and conservation easements **(C) 2020, 2040, 2060**
- Increased subdivision of private lands and easements **(C) 2020, 2040, 2060**

MONITORING

- Develop community monitoring programs **(D) 2020**
- Remote sensing and drone surveys **(D) 2040**

PARTNERSHIPS

- Test adaptation or resistance and resilience on private and/or tribal lands **(D) 2020, 2040, 2060**
- Partner with NGOs on volunteer restoration projects **(D) 2040, 2060**

LEGEND A) Change the World + Cheatgrass Prairie (C) Kitchen Sink Approach + Desertification (D) Business As Usual + Slow Death

Adaptation Options

- Public/private partnerships for leveraged funding **(D) 2020, 2040, 2060**
- Increase funding to Landscape Conservation Cooperatives **(C) 2020, 2040, 2060**
- Create public awareness/public buy-in **(D) 2040**

STAFFING

- Prioritize or retrain in the face of reduced staffing **(D) 2020**
- Increase regulation and law enforcement for recreation, basin-wide (e.g., Basin Burning Man) **(C) 2040, 2060**
- Shift funding to science and research **(C) 2020, 2040**

Cheatgrass Control vs. Native Vegetation Enhancement

DIRECT CHEATGRASS CONTROL

- Use active cheategrass pathogen application (pre/post) in moderately resilient sagebrush (partially cheatgrass infested) **(A) 2020, 2040, 2060**
- Introduce Pseudomonas **(A) 2020, 2040, 2060**
- In higher elevations that have not burned, control cheatgrass invasions immediately **(A) 2040, 2060**

NATIVE PLANT ENHANCEMENT

- Native plant nurseries **(A) 2020, 2040, 2060**
- Fall re-seeding **(A) 2040, 2060**
- Sequester native seeds and plant material and conduct research on restoration **(A) 2020, 2040, 2060**
- Stop cutting down Pinyon-Juniper and reallocate funds to restoration of native vegetation and reduced grazing levels **(D) 2020, 2040, 2060**
- Low-cost methods (e.g., permaculture) for vegetation restoration **(D) 2020, 2040, 2060**
- Restoration and research on drought- and fire-tolerant natives **(C) 2040, 2060**

MIXED METHODS

- Strategic grazing through expansion of temporary non-renewable permits **(A) 2020, 2040, 2060**
- Remove less desirable vegetation species from selected areas, in order to promote native vegetation **(A) 2060**

USE OF VEGETATION

- Increase cattle stocking rates when cheatgrass in palatable **(A) 2060**
- Increased grazing, more forbs **(C) 2020**

LEGEND A) Change the World + Cheatgrass Prairie | (C) Kitchen Sink Approach + Desertification | (D) Business As Usual + Slow Death

Rated Adaptation Options

Fire

FIRE SUPPRESSION

- Maintain initial attack rate at 98% **(D) 2020** 🟢
- Limit fire response in Pinyon-Juniper **(D) 2040** 🟣 🟣 🔴
- Limit fire response in salt desert shrub **(D) 2040, 2060** 🟣 🔴 🔴
- Buy more tankers, hire more staff, spend more money **(C) 2040, 2060** 🔴
- Develop water reserves for fire suppression **(A) 2020, 2040, 2060** 🟣 🟣 🔴
- Maximize fire suppression through green strips, brown strips, controlled burns, and extensive grazing **(A) 2060** 🟣 🔴

FIRE TRIAGE

- Let Pinyon-Juniper burn **(D) 2060** 🔴

PRE-FIRE RESILIENCE

- Increased prescribed burning **(C) 2020** 🟢 🟢 🔴 🔴
- Strategic fuel breaks **(A) 2020, 2040, 2060** 🔴

FIRE REHABILITATION

- Delayed post-fire grazing on rehab projects **(A) 2020, 2040, 2060** 🟢
- Change BAER/ESR policy to retain funding for multi-year starts (e.g., delayed re-seeding during drought) **(A) 2020** 🟢 🟢 🟣 🟣 🔴
- Fall re-seeding **(A) 2040, 2060**

Wildlife

- Introduction or re-introduction of species (e.g., sharp-tailed grouse, chukar) **(A) 2040** 🟣 🔴
- In the ESA consultation, allow for abandonment of parts of the species range (due to climate change considerations) **(A) 2040** 🟣 🟣 🟣 🔴 🔴
- Actively manage for northward/upward migration of wildlife habitat **(C) 2040** 🟢

Refugia

- Negotiate conservation easements in sage grouse areas (with willing sellers) **(D) 2040** 🟢 🟢 🟢
- As ecosystems collapse and private lands sell out, purchase land to protect habitat islands **(C) 2040**
- Purchase high priority sites with water, as reserves for native vegetation **(C) 2020, 2040, 2060** 🟣 🟣
- Prioritize most resilient areas for resource management and retreat from the rest **(D) 2040** 🟣 🔴 🔴
- Exclusionary actions due to ESA enforcement **(D) 2040** 🟣 🔴

Erosion

- Research on biological crusts and their rehabilitation **(D) 2020, 2040**
- Research on soil stabilization – "fake crusts" **(A) 2020** 🟣
- Use native vegetation or cheatgrass for soil stabilization **(A) 2020, 2040, 2060** 🔴

LEGEND

(A) Change the World + Cheatgrass Prairie
(C) Kitchen Sink Approach + Desertification
(D) Business As Usual + Slow Death

🟢 "No regrets" or "low regrets."
🟣 Poses significant change from current practice, i.e., all the options that reflect relaignment or retreat.
🔴 "Hard" choices for decision makers to make.

Rated Adaptation Options

- Implement policy for a land reclamation requirement to reduce soil erosion **(A) 2040**
- Implement strong flood control measures (storage, capture) to reduce erosion **(A) 2060**
- Use grazing permitting and feral horse management policy to reduce livestock and feral horse populations on sensitive soils **(A) 2020, 2040, 2060**
- Seasonal closures **(D) 2020, 2040, 2060**
- To minimize further disturbance, create wilderness **(D) 2020, 2040, 2060**
- Define desertification area and prepare for expansion **(D) 2060**

Air Quality

REGULATION OF OTHERS

- Business as usual in regulation of prescribed burning by NV Air Quality **(C) 2020**
- Restrictions on prescribed fire (none/less) to address air quality **(D) 2020**
- Further restrictions on all emissions including prescribed burning **(D) 2020, 2060**
- Decrease air quality restrictions at state and federal levels **(A) 2020, 2040, 2060**

MITIGATION

- Develop clean air centers and increased communication targeted to smoke sensitive groups (public health) and to encourage indoor activities during increased fire **(A) 2040**
- Dust suppression using vegetation or water **(D) 2060**
- Suspend 2060 Regional Haze SIP goals **(A) 2060**

Planning and Administrative

- Use expedient environmental review to develop the best land management plan that money can buy **(A) 2020, 2040, 2060**

LAND USE

- Expand solar development **(D) 2060; (C) 2060**
- Revise recreation plans, allow for more ATV areas and outdoor festivals (e.g., Burning Man) **(D) 2060**
- Increase buyouts of grazing allotments and conservation easements **(C) 2020, 2040, 2060**
- Increased subdivision of private lands and easements **(C) 2020, 2040, 2060**

MONITORING

- Develop community monitoring programs **(D) 2020**
- Remote sensing and drone surveys **(D) 2040**

PARTNERSHIPS

- Test adaptation or resistance and resilience on private and/or tribal lands **(D) 2020, 2040, 2060**
- Partner with NGOs on volunteer restoration projects **(D) 2040, 2060**
- Public/private partnerships for leveraged funding **(D) 2020, 2040, 2060**

LEGEND

(A) Change the World + Cheatgrass Prairie
(C) Kitchen Sink Approach + Desertification
(D) Business As Usual + Slow Death

- "No regrets" or "low regrets."
- Poses significant change from current practice, i.e., all the options that reflect relaignment or retreat.
- "Hard" choices for decision makers to make.

Rated Adaptation Options

- Increase funding to Landscape Conservation Cooperatives (C) 2020, 2040, 2060 ● ●
- Create public awareness/public buy-in (D) 2040 ● ●

STAFFING

- Prioritize or retrain in the face of reduced staffing (D) 2020 ●
- Increase regulation and law enforcement for recreation, basin-wide (e.g., Basin Burning Man) (C) 2040, 2060 ●
- Shift funding to science and research (C) 2020, 2040 ● ● ● ● ●

Cheatgrass Control vs. Native Vegetation Enhancement

DIRECT CHEATGRASS CONTROL

- Use active cheategrass pathogen application (pre/post) in moderately resilient sagebrush (partially cheatgrass infested) (A) 2020, 2040, 2060 ● ● ● ●
- Introduce Pseudomonas (A) 2020, 2040, 2060 ● ● ● ● ● ●
- In higher elevations that have not burned, control cheatgrass invasions immediately (A) 2040, 2060 ●

NATIVE PLANT ENHANCEMENT

- Native plant nurseries (A) 2020, 2040, 2060 ● ● ●
- Fall re-seeding (A) 2040, 2060
- Sequester native seeds and plant material and conduct research on restoration (A) 2020, 2040, 2060 ● ● ● ●
- Stop cutting down Pinyon-Juniper and reallocate funds to restoration of native vegetation and reduced grazing levels (D) 2020, 2040, 2060 ● ● ● ● ●
- Low-cost methods (e.g., permaculture) for vegetation restoration (D) 2020, 2040, 2060 ● ● ●
- Restoration and research on drought- and fire-tolerant natives (C) 2040, 2060 ● ● ● ●

MIXED METHODS

- Strategic grazing through expansion of temporary non-renewable permits (A) 2020, 2040, 2060 ● ● ●
- Remove less desirable vegetation species from selected areas, in order to promote native vegetation (A) 2060 ●

USE OF VEGETATION

- Increase cattle stocking rates when cheatgrass in palatable (A) 2060 ● ● ●
- Increased grazing, more forbs (C) 2020 ● ●

LEGEND

(A) Change the World + Cheatgrass Prairie
(C) Kitchen Sink Approach + Desertification
(D) Business As Usual + Slow Death

● "No regrets" or "low regrets."
● Poses significant change from current practice, i.e., all the options that reflect realignment or retreat.
● "Hard" choices for decision makers to make.