CREATING USEFUL AND USEABLE CLIMATE TOOLS FOR SAGEBRUSH LAND MANAGEMENT THROUGH SCIENTIST AND MANAGER COLLABORATION

By

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ABSTRACT

The sagebrush ecosystem, home to numerous plant and animal species including big sagebrush (*Artemisia tridentata*) and the endemic greater sage-grouse (*Centrocercus urophasianus),* has endured fragmentation and degradation of both quantity and quality due to the cumulative and synergistic relationships between an abundance of individual disturbances including grazing, invasive annuals and fire. Climate change may now be an additional threat that poses the greatest risk to these imperiled habitats. Natural resource agencies such as the Bureau of Land Management (BLM) seek to conserve sagelands through land management activities that ensure the survival of sage-grouse and continuity of the sagebrush biome. Web-based climate tools can help convey climate information that may be necessary for long-term land management, but these tools may not agree with the needs of land managers, may be too complex, or may be misinterpreted. To overcome barriers of user compatibility, the participation of both climate scientists and land managers is necessary during tool development. With the collaboration of Oregon and Idaho BLM sagebrush land managers and climate scientists, this study sought to assess land manager needs and define the criteria for useful and useable climate tools. Using an initial online survey, individual phone interviews with land managers, and a follow-up online survey, a series of land management activities and related climate variables were identified, and several web-based climate tools were assessed. Most managers perform vegetation management through a variety of means including seeding and herbicide application. Such activities are affected by the magnitude and timing of precipitation and temperature, as well as other variables, on seasonal and annual timeframes. For planning purposes land managers also need information on long-term 10-20 year climate trends. The act of listening to the needs of land managers uncovered communication barriers, and provided feedback on existing climate tools emphasizing accessibility, dependability and consistency, clear explanation of terminology, effective visualizations, and relevant spatial and temporal scales to the scope of management activities. We also identified a need for basic information and education on the location of existing climate tools and climate impacts, and a need for near-term forecasting tools that could bridge the gap between weather (≤ 6 months) and climate (≥ 30 years) projections.

Keywords: sagebrush, sage-grouse, Oregon State University, climate change, BLM, Oregon, Idaho, Great Basin, land management, collaboration, climate tools

1. Introduction

The 'sagebrush ocean' (Shultz 2012) within the Great Basin of the western United States is the largest semi-arid shrub ecosystem in North America (Anderson and Inouye 2001; Miller *et al*. 1994; Miller and Eddleman 2000) and one of the three largest biomes in the U.S., with the Great Plains and the eastern deciduous forests (Barbour and Billings 1988). The sagebrush ecosystem is characterized by a Mediterranean climate. It endures cold wet winters followed by long dry summers with low and variable precipitation rates and limited moisture (Chambers and Pellant 2008; Neilson *et al*. 2005; Shultz 2012). Much of the precipitation received each year falls as snow or during early spring, helping to recharge soil moisture (Paige and Ritter 1999). Within this environment frost tolerant, desert vegetation and spring flowering perennial grasses dominate the landscape (Neilson *et al*. 2005). Of all the plant species present within the sagebrush community, big sagebrush (*Artemisia tridentata*) is the most widespread.

Estimates indicate the sagebrush biome is about 200,000 square miles (~ 450,000 km^2) (Connelly *et al*. 2004; Miller and Eddleman 2000, Neilson *et al*. 2005), far less then it was prior to the settlement of Europeans, which aided in the fragmentation and degradation in both quantity and quality of sagebrush habitat (Connelly *et al*. 2004, Schroeder *et al*. 2004; Xian *et al.* 2012). The reason for sagebrush ecosystem deterioration is the cumulative and synergistic interactions between a variety of threats. Among these, invasive annuals including cheatgrass (*Bromus tectorum*), medusahead (*Taenatherum caput-medusa*) and newly arrived Ventenata (*Ventenata dubia*) constitute a high risk. These annual grasses increase fine fuel loads earlier and later in the growing season and provide a continuity of fuels that never existed before, leading to intensified and altered fire regimes that deteriorate sagebrush land and provide ample conditions for further invasive perpetuation. Other threats to sagebrush include encroaching evergreen shrubs, grazing, severe droughts, agriculture conversion, wild equids, dwindling native grasses, both renewable and non-renewable energy development, recreation, and urbanization (Connelly *et al*. 2004; Knick *et al*. 2003; Miller *et al*. 1994; Shultz 2012; U.S. Fish and Wildlife Service 2013). It has also been suggested that climate change is now an additional threat to be added to this long list, and that it may impose the greatest risk (Bradley 2010; Homer *et al*. 2015; Neilson *et al*. 2005).

Sagebrush is important to a large diversity of species and it is estimated that over 350 plants and animals depend on it (Connelly *et al.* 2004, Davies *et al.* 2011). This habitat is home to endemic sagebrush obligates that cannot survive without the use of sagebrush as food or shelter. Such species include pygmy rabbits (*Brachylagus idahoensis)*, sage thrasher *(Oreoscoptes montanus)*, sage sparrow (*Artemisiospiza nevadensis)*, sagebrush lizard (*Sceloporus graciosus)* and the greater sage-grouse (*Centrocercus urophasianus)*, the icon of sagebrush ecosystem conservation. The greater sage-grouse is one of only two sage-grouse species in the world and is the largest grouse species in North America (U.S. Fish and Wildlife Service 2013). The loss of sagebrush

habitat is closely linked with the decline and extirpation of wildlife, including that of greater sage-grouse populations (Aldridge *et al.* 2008; Connelly *et al*. 2004). Almost 20% of the flora and fauna within the sagebrush ecosystem is imperiled or declining (Chambers and Pellant 2008), and sage-grouse have now declined to occupy only 50% of their historic range (Connelly *et al*. 2004; Schroeder *et al*. 2004). In 2010 the U. S. Fish and Wildlife Service (FWS) concluded that the greater sage-grouse warranted protection through the 1531 *et seq*. amended Endangered Species Act (ESA) of 1973. However, the species fell under "warranted but precluded" behind higher priority listings, and was instead put onto an ESA candidate species list. Following a court-approved agreement to determine listings on more than 200 species nationwide, a decision to list or withdraw the sage-grouse is due September 2015 (U.S. Fish and Wildlife Service 2013).

Currently, natural resource agencies hold conservation and restoration of sagelands as a top priority (Bureau of Land Management 2002; Knick *et al*. 2003). The Bureau of Land Management (BLM) manages close to 62% of both intact and disparate sagebrush lands. Most of this land is comprised of lower elevation shrub lands (Chambers and Pellant 2008; Knick 2011). This study focused on BLM land managers that oversee sagebrush lands located within the states of Oregon and Idaho. Oregon and Idaho sagebrush steppe comprise much of the Northern Great Basin, but the influx of invasive annuals and wildfires has minimized quality sagebrush habitat. In 2007 the Idaho Murphy fire complex damaged close to 600,000 acres of habitat, while in 2012 the Long Draw fire in Oregon damaged nearly 582,000 acres, of which 455,000 acres were considered important sage-grouse habitat (U.S. Fish and Wildlife Service. 2013).

In order to manage sagelands for the survival of the greater sage-grouse and the continuity of the sagebrush biome, managers face tough land management decisions and will need to understand the role of climate (Compagnoni 2013; Dalgleish *et al.* 2011). Interactions between threats to sagebrush, such as grazing, invasive annual grasses and fire, make it hard to tease out which management strategies to use. But examination of these threats alone cannot provide information about the response that sagebrush may have to climatic variables. Only the experience and place-based knowledge of sagebrush land managers can account for associations between past weather events and sagebrush response to these shifts, and help confirm locations where fire, exotic plant expansion and disease have contributed to its demise.

The effects of climate change in sagebrush habitat have not been extensively documented (Neilson *et al.* 2005; Wisdom *et al.* 2005; Xian *et al.* 2012), but some climate change scenarios are projecting increased climate variability and frequency of severe weather events (Chambers and Pellant 2008). Substantial changes in regional and global climate are likely to alter biome properties and effect precipitation and temperature. Such changes will influence vegetation characteristics, species distributions, and water distribution, and will increase sagebrush vulnerability (Bradley 2010; Cook and Irwin 1992; Homer *et al*. 2015). Manager response strategies and future management of sagebrush and sage-grouse will require improved

understanding of habitat changes through spatially explicit information and accurate climate predictions (Chambers and Pellant 2008; Homer *et al*. 2015).

Decision Support Tools (DSTs), such as interactive computer programs, can help target and convey scientific information through quantification and interpretation. Simple DSTs are user friendly but may have limited function. More complex DSTs have increased functionality, but can be difficult to use and therefore limit the audience (Von Winterfeldt 2013). As of 2004, spatial tools and models to assess sagebrush habitat over large areas with local detail were found to be unavailable (Connelly *et al*. 2004). And despite the creation of some recent models to aid in land management, it is unknown if such models are indeed useful or useable (Abatzoglou and Kolden 2011). Existing tools may be unintuitive and incorporate a disciplinary climate language that may be foreign to land managers. Even if managers navigate past these complexities, the tools may incorporate variables or spatial and temporal displays that are incompatible with land manager needs. And should a manager find tools that do match their needs, the climate model projections or climate tool results may be misinterpreted or misunderstood.

To overcome these barriers, tools need to be created through scientist and land manager collaboration. But this collaboration may face existing impediments. There may be communication barriers that include jargon, intellectual turf, team trust, and inefficient facilitators and leadership. And there may be professional barriers that include agency structure, research reputation and identifying with a discipline. Also, funding and time barriers to collaboration may make it difficult for communication to begin in the first place (Institute of Medicine (US) 2000). Studies suggest that the scientist, decision maker and conservation planner relationships are essential for understanding the basis and environment behind challenging decisions and how these decisions influence conservation actions (Alexander *et al*. 2009; Von Winterfeldt 2013).

Given the known obstacles to land manager and scientist partnerships, this study sought to research the feasibility of collaboration using an intermediary research student with unbiased summary knowledge of both climate change and sagebrush management. Questioning the existence of useable and useful land management climate tools, this study sought to assess the needs of Oregon and Idaho sagebrush land managers and to identify the kinds of climate tools most useful and useable by these managers. Through two anonymous surveys and one-on-one land manager phone interviews, land managers were asked to identify the most relevant climate variables, threats and management strategies relevant to their specific sagebrush management areas. They were also asked to use and asses multiple existing web-based climate tools, and give feedback on elements and features of the tools that were either intuitive, interesting and useful, or complicated, unnecessary, and in need of refining. The information provided within this report highlights the responses and information gathered from these surveys and interviews, and proposes elements and variables that should be considered when designing climate tools in the

future. It also suggests areas where technology and climate science may be currently failing in providing useful information. Finally this study provides information about the effectiveness of surveys and interviews in achieving scientist and land manager collaboration.

2. Methods

The project focused on Bureau of Land Management (BLM) sagebrush land managers within Oregon and Idaho (Figure 1). BLM sagebrush habitat districts within Oregon include Vale, Lakeview, Burns and Prineville. Within Idaho BLM sagebrush habitat includes the districts of Boise, Twin Falls, and Idaho Falls.

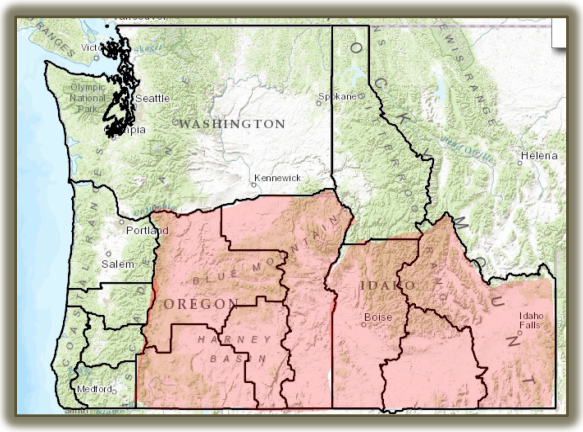


Figure 1. Oregon and Idaho BLM Sagebrush Districts. (source: databasin.org). Areas in red show where sagebrush management currently occurs.

Initial contact information for the land managers was distributed though the BLM Oregon State Office Research Liaison and Climate Change Coordinator. Using a non-random purposive sampling technique (Tongco 2007), survey and interview participants were specifically selected based on job title, job area and sagebrush management association. Additionally, snowball sampling through land manager recommendations helped identify new contacts for consideration. In this document, land manager is defined as a BLM land manager with sagebrush in their district or involved in sagebrush management planning. Due to the nature of participant selection, the opinions in this study may not reflect the opinions of BLM as a whole, and caution should be used before generalizing for all land managers within BLM or from other Federal and State agencies.

We kept the anonymity of all participants during every phase of the project so that participants could speak more freely about their management activities and needs. This meant that only the research student identified and made email or phone contact with each participant. Further, upon acquisition of each participant name, a file was created containing only a participant number that could then be correlated to any statements or documentation provided by that participant.

Land managers were first sent an introductory email to explain project goals, timeline and expectations. Land managers were asked to take part in one or all three anonymous phases of the project, which included an initial online survey, land manager phone interviews, and a follow-up online survey.

The initial survey and follow-up survey sought to compile federal land management insight, activities and planning related to climate change, as other comparable surveys have done (Archie *et al.* 2012; Lemieux *et al.* 2013; Theoharides *et al.* 2009; Trebbia and Moser 2008). Surveys were administered electronically through an online survey generator so that staffing and response time could be minimized, responses could be tracked, and so participants could be straightforward (Sheehan 2001; Sheehan and McMillan 1999). Survey reminders were sent out for each of the surveys, since previous research has found that reminder persistence may increase the rate of responses (Kittleson 1997; Sheehan and McMillan 1999), although this is still being debated (Cook et al. 2000; Kwak and Radler 2002).

Initial Online Survey

The objectives of the initial online survey were,

1) To gather information about climate variables relative to sagebrush land management
2) To identify pros and cons of a series of web-based climate tools
3) To identify baseline information for follow-up phone interviews.

Using purposive sampling, a total of 15 land managers were sent the initial online survey link in an introductory email. The survey was administered from September 18 through January 30, 2015. The survey was deliberately left open during the second phase land manager interviews so that managers who had not yet taken the survey could provide feedback while they were actively involved in thoughtful reflection. A survey reminder was emailed to managers on October 24 prior to the start of the land manager phone interviews to obtain as many land manager responses and as much information as possible before writing interview guidelines.

The initial online survey (Appendix A) was generated using the Qualtrics web-based survey system. The survey included 5 questions.

<u>Questions in the Initial Online Survey</u>

1. "How does your BLM district rank which climate variables affect the successful growth of sagebrush, from most important to least important?"

2. "How does your BLM district rank the threats to sagebrush, from most important to least important?"

3. "How does your BLM district rank which climate variables cause and proliferate the #1 threat (from question 2) to sagebrush in your district, from most important to least important?"

4. "In order to best preserve critical BLM sagebrush areas, what type of information would your agency need from climate scientists?"

5. "We wish to provide both useful and useable climate information to help your agencies sagebrush management decisions. A few climate information packages are provided here. These are provided to help you assess what types of information you prefer and how you would like information displayed. Think about how they could be modified to focus on your domain and your scale of concern. After exploring these packages by clicking on the links provided below, do you see options (information, organization, scale, graphics, color schemes etc.) that you like or do not like, or that may work or may not work for your agency? Do you have other ideas of what kinds of information or graphics could be included in a climate package that may be useful to your agencies management decisions? USGS County Level Climate Projections; Ecoregion Climate Data Explorer; Regional Climate Extremes; and Western Drought Tracker"

The first 3 questions asked managers to rank 1) climate variables most relevant to sagebrush, 2) most important threats, 3) climate variables most relevant to those threats. Managers were then asked to identify the type of information they needed from climate scientists to meet their management goals. Finally, managers were to give feedback on 4 web-based climate tools including *USGS County Level Climate Projections*; *Ecoregion Climate Data Explorer*; *Regional Climate Extremes*; and *Western Drought Tracker* (Table 1.). All questions were optional, participants were able to skip questions, come back to earlier questions, save and continue the survey at their convenience during the entire open period.

Source	**Type of Information**	**URL**
USGS County Level Climate Projections	USGS County Level Climate Projections	http://www.usgs.gov/climate_landuse/clu_rd/apps/nccv_viewer.asp
Ecoregion	Ecoregion	http://adaptwest.databasin.org/app/ecoregion_climate_explorer

Climate Data Explorer	Climate Data Explorer	
Regional Climate Extremes	Regional Climate Extremes	http://www.ncdc.noaa.gov/extremes/cei/graph/nw/5/01-12
Western Drought Tracker	Western Drought Tracker	http://www.wrcc.dri.edu/wwdt/index.php?region=or

Table 1. Initial Online Survey Web-Based Climate Tools (question #5) **for which land managers provided feedback**. (DRI: Desert Research Institute, NOAA: National Oceanic and Atmospheric Administration, USGS: United States Geological Survey).

Land Manager Phone Interviews

The objectives of the one-on-one interviews with land managers were,

1) To enhance knowledge of how climate variables relate to land management activities
2) To get managers feedback on the usefulness and usability of existing web-based climate tools
3) To begin to understand how climate tools could be enhanced to meet land manager needs.

Land managers were first asked to respond to the introduction email with their availability to interview via phone or in person. Managers were then contacted directly by phone to schedule interviews. Due to busy schedules, and the inconvenience and cost of travel, all managers were interviewed by phone. Interviews were conducted in November and December 2015. All 15 land managers who were initially contacted for the survey were again contacted for the interviews. Additionally, these original 15 land managers identified several colleagues as participants, and a CBI scientist also recommended a few managers from the state of Utah. Due to time constraints only 15 of these referred land managers were contacted by both email and phone. Interviews were one-on-one between each land manager and the research student, with the exception of one group interview, that occurred because of time constraints, and consisted of a conference call with three land managers from the same district office, but with different titles. With the verbal consent of the participants at the start of the interview, all interviews were recorded on a Macintosh laptop using QuickTime Player. Following interviews each audio was transcribed and the document was then sent back to each manager for approval and to ensure accuracy of

statements. Upon approval of each document, the audio was erased to maintain the participants anonymity.

The project used a semi-structured interview and a 5-question interview guide (Appendix B) to keep question and information consistency. However, this guide was used loosely allowing for the flexibility of responses from participants. It also allowed for the flexibility of the interviewer to elicit additional information, and provide follow-up questions for interview comparability, and allowed for interview time management. Interviews were estimated to take approximately 1-hour, and consisted of two parts including 1) a preliminary discussion, and 2) the analysis of a *Data Basin* gallery that included Oregon and Idaho maps and datasets, and visits to eight existing web-based climate tools.

The preliminary discussion was an open conversation that allowed managers to briefly familiarize the student to what they do with regard to sagebrush, including management activities and how climate might affect these activities. It also prompted insight about which climate tools are currently being used by land managers, general comments about climate tools and concerns about how a changing climate may affect districts, ecosystems and management decisions now and in the future. It should be noted that this preliminary discussion was only designed to highlight management activities of the specific managers being interviewed and those activities related to sagebrush, and was not meant to exhaustively survey all agency-wide management activities.

During the second part of the interview a gallery in *Data Basin (databasin.org),* a science-based mapping and analysis platform, was set up to explore district maps, sagebrush-relevant datasets, and to provide links to eight existing climate tools hosted outside *Data Basin* including the *National Oceanic and Atmospheric Administration (NOAA) Three-Month Outlooks*; *NOAA Snow Cover Maps*; *NOAA U.S Climate Extremes Index*; *NOAA Climate at a Glance*; *AdaptWest*; *United States Geological Survey (USGS) National Climate Change Viewer*; *Desert Research Institute (DRI) West Wide Drought Tracker*; and *Integrated Climate Scenarios in Data Basin* (Table 2.). Before each interview, participants received an email that included a link to access the *Data Basin* gallery. While using their own computers land managers opened some or all of the eight existing climate tools (depending on their available time) and relayed information about each tool while the student opened the same tools and followed along over the phone. Land managers were first asked to briefly look over and use the tool on their own and then provide initial feedback. The student then asked questions on topics such as tool intuitiveness, graphics quality, temporal and spatial scale relevance, existing variable usefulness, climate models and emission scenario familiarity, colors and color scale appropriateness, and overall impressions of the tool including what might be missing and the usefulness and usability of the tool.

Climate Tool	URL
NOAA Three-Month Outlooks	http://www.cpc.ncep.noaa.gov/products/predictions/90day/
NOAA Snow Cover Maps	http://www.ncdc.noaa.gov/snow-and-ice/snow-cover.php
NOAA U.S Climate Extremes Index	http://www.ncdc.noaa.gov/extremes/cei/graph/nw/5/01-12
NOAA Climate at a Glance	http://gis.ncdc.noaa.gov/map/cag/#app=cdo
AdaptWest	http://adaptwest.databasin.org/app/ecoregion_climate_explorer
(USGS) National Climate Change Viewer	http://www.usgs.gov/climate_landuse/clu_rd/apps/nccv_viewer.asp
(DRI) West Wide Drought Tracker	http://www.wrcc.dri.edu/wwdt/index.php
Integrated Climate Scenarios in Data Basin	http://consbio.webfactional.com/integratedscenarios/

Table 2. Land Manager Interview Climate Tool Web Pages. Each climate tool used in the phone interviews in November and December 2015 could be found using the links in the table. Note that since then, tool addresses may have changed, been updated, or discarded.

Upon transcription of each interview, land manager feedback was compared using manual content analysis to uncover recurring themes between management activities, climate variables, and climate tool evaluations (Archie *et al.* 2012). Each land manager approved interview document was intensively reviewed for comparable remarks as well as differences. Management activities that were mentioned most frequently were included in a table and correlated with the climate variables identified by land managers as being associated with those activities. Feedback about the eight existing web-based climate tools could be split into three categories that included: general information about each climate tool, land manager questions about each climate tool, and specific feedback from individual land managers about each climate tool that did not fall into a general information category. For this report, general information is defined as comments common across most or all participants for individual climate tools, or for all climate tools. Some

remarks were instigated through interviewer questions, such as "How do you feel about this tool?", "Does this tool seem useful?", "Does this tool seem intuitive?", etc. However, some of the remarks were supplied directly by land managers. For each of the eight web-based climate tools a table was created that showed all interview participant remarks color-coded into the three categories. Remarks were tallied to document how many land managers made the same remark. The purpose of comparing remarks is to highlight similar or dissimilar views between land managers, and the importance of specific content. Care should be taken when using the tallied remarks as absolute or when using the remarks as specific land manager statements. For specific and approved land manager statements made during the interviews, it is best to refer to Appendix D*: Land Manager Phone Interviews, Approved Responses.*

Follow-Up Online Survey

The objectives of the follow-up survey with land managers were,

1) To expand upon information received during online surveys and phone interviews
2) To assess the interest of land managers in existing web-based weather and climate tools
3) To propose a new climate tool prototype for managers to explore and provide feedback on

Again using a purposive sampling technique, the follow-up online survey was sent by email to all 22 managers who participated in phone interviews. The survey was administered from April 23 through May 15, 2015. Three reminders were sent out. The first reminder was sent after one week on May 6th, the second was at the beginning of the final week on May 12th, and the last reminder was sent the day before the survey closed on May 14th.

The follow-up online survey (Appendix C) was generated using the Qualtrics web-based survey system. The anonymous survey included 6 questions that built upon the previous survey and interview results.

Questions in the Follow-up Online Survey

1. "The previous sagebrush land manager survey and phone interviews show a need for short range, weather related planning tools that look at seasonal and annual time periods. With this in mind, we have identified a few existing weather tools that already display some of this information. Would you be interested in learning how to find and use these current weather tools, and any relevant climate tools that are already available?" AND "What would be the

best way to provide you information on both identifying and understanding these existing tools? (You may choose more than one)"

2. "The following link leads you to the Climate Console webpage, a brand new climate tool (not weather tool) focusing on the state of Utah and funded by the BLM. The climate variables within this tool were chosen for this particular project, however recommendations gathered during the phone interviews conducted last Fall and Winter were used to improve various tool characteristics. Please follow the link to open and experience the climate tool so that we may gather your first impressions. After navigating within the tool please continue with the following survey questions. (Link: http://eemaps.consbio.webfactional.com/blm)" AND "Please provide your first impressions and feedback about the Climate Console webpage in the box provided below. Please be as specific as possible."

3. "How much time did you spend reading the documentation under the 'about' section on the Climate Console webpage?"

4. "Would a similar tool focused on sagebrush country in the Oregon and Idaho area be useful, and would you be interested in using such a tool?"

5. "Referring still to the Climate Console webpage, if you have not already specified, please give any reporting units or variables (other than the ones provided) that you would like to see in a tool tailored to your area management."

6. "Do you have any suggestions for improvement on the Climate Console webpage, specifically if it were to be tailored to your area?"

The first question was designed to assess whether land managers wanted to learn about existing weather and climate tools, and how this could best be provided. The next question provided a link to an online climate information delivery tool prepared by Conservation Biology Institute (CBI) staff for another project. This tool incorporates some features that were inspired by the manager's remarks from survey and interviews results. It should be noted that during the follow-up online survey this tool was referred to as the 'Climate Console' despite its original un-intuitive name EEMAPS (Environmental Evaluation Mapping and Plotting System). Refinement of this tool was funded by yet another research project and the easier name Climate Console was chosen. The two web pages now correspond to two levels of sophistication of a climate delivery tool created only a few months apart (Figure 2. and Figure 3.). In this report, we refer to the actual web page explored and assessed by managers within the follow-up online survey as the Climate Console. After using and exploring this Climate Console, land managers were asked to answer 5 questions, which included a mixture of multiple choice and open-ended questions. Managers were asked whether a similar tool would be useful if it was dedicated to sagebrush management, and what should be included if such a tool were to be created specifically for them.

The multiple choice questions within this survey used forced response validation, while the open-ended text entry questions did not force a response, but requested a response before allowing the participant to move on. Participants were allowed to move back to questions, and to save and continue the survey at their convenience during the open period. The survey was set up so that if a participant answered 'no' to the first part of question 1, then they would automatically advance to the Climate Console viewing page. And if a participant answered 'no' to question 4, then they would end the survey.

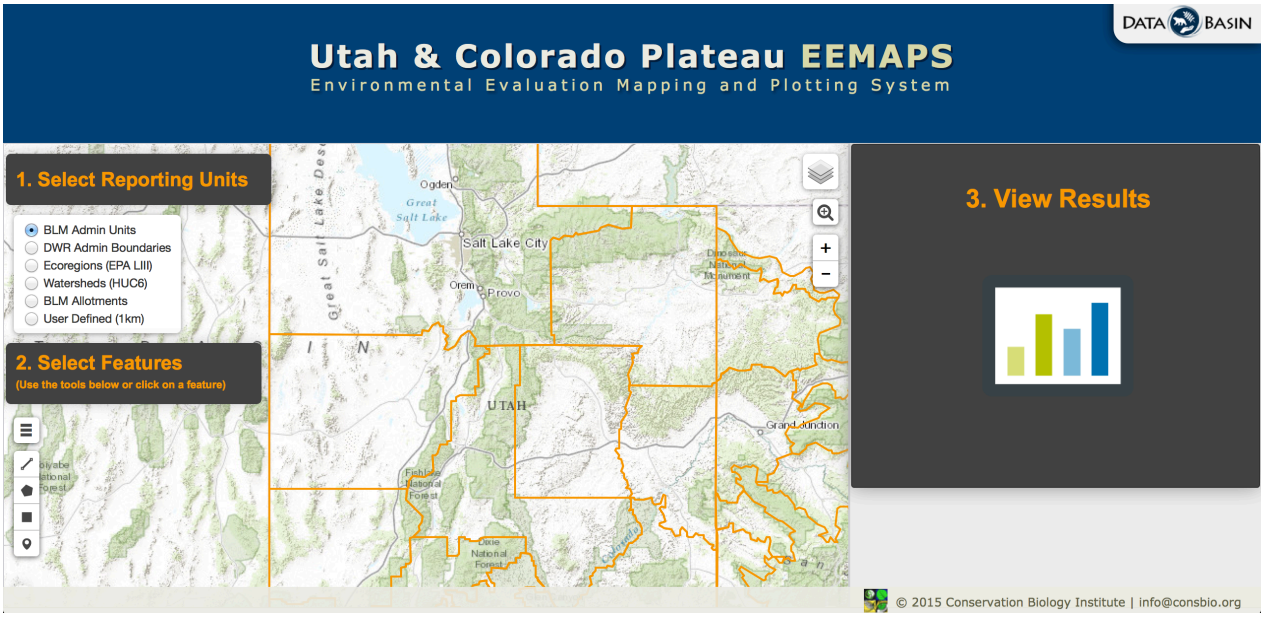


Figure 2. EEMAPS. The Environmental Evaluation Mapping and Plotting System (EEMAPS) is a web mapping application created by the Conservation Biology Institute (CBI), and funded by BLM, as a way to provide land managers with a set of tools for accessing and exploring climate projections and fuzzy logic model results for the state of Utah and the Colorado Plateau. (http://eemaps.consbio.webfactional.com/blm)

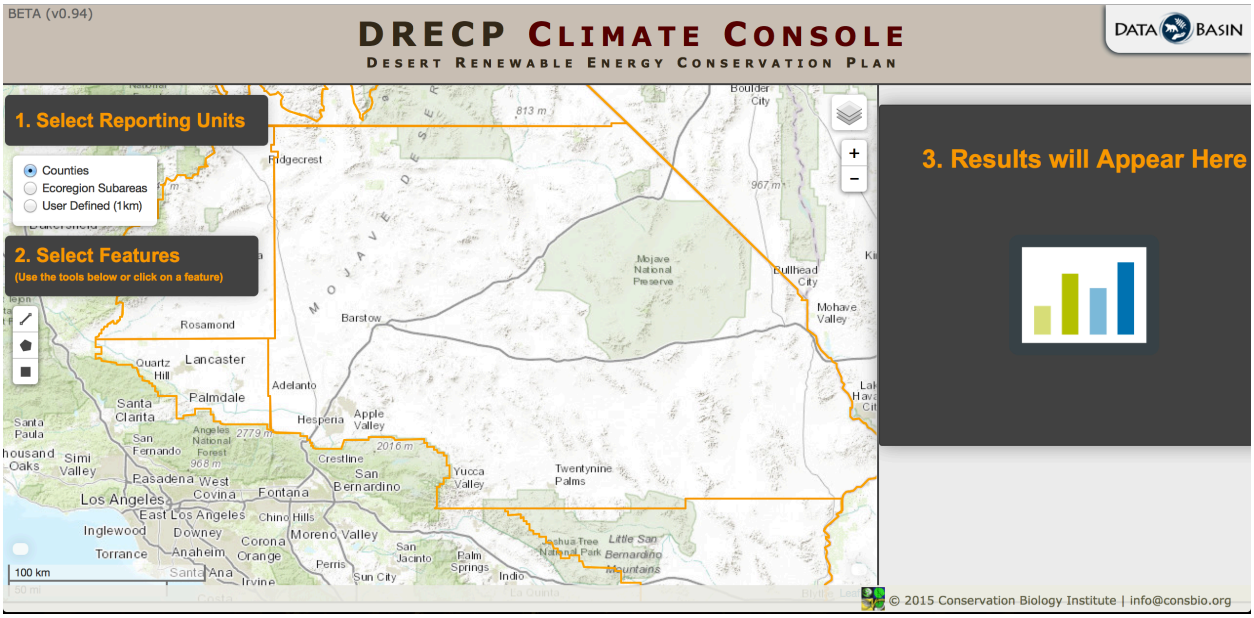


Figure 3. Climate Console Website. The Climate Console is a web mapping application created by CBI, created for the DRECP (Desert Renewable Energy Conservation Plan) in southern California, as a way to provide land managers with a set of tools for accessing and exploring climate projections and fuzzy logic model results. Unlike the EEMAPS tool (Figure 2.) the Climate Console incorporates near-term forecasts. (Near-term forecasts available on line 06/11/15)
(http://drecp.consbio.webfactional.com/climate)

3. Results & Discussion

This study documents the collaboration of climate scientists and Oregon and Idaho BLM sagebrush land managers to determine what climate information, specific climate variables and climate tools can be considered useful and useable for land management decisions now and in the future. It outlines the results of a three-phase project that included an initial online survey, land manager phone interviews, and a follow-up online survey to collect this information.

Initial Online Survey

After the introduction email containing the initial online survey link was sent out to land managers, we counted 8 views and 6 responses. After a reminder email about the survey, we counted 4 additional views but only 1 more response. Out of 15 land managers who were emailed the survey link, 12 opened the survey, an 80% response rate. Of these 12 managers, 3 dropped out, 1 completed 10% of the survey, 1 completed 20%, 2 completed 30%, 3 completed 60%, 1 completed 70% and only 1 completed the entire survey. Qualtrics results indicate a 40%

completion mean and a 60% dropout rate. The question response rate was higher overall for the rank-order questions as opposed the open-ended questions (Appendix A.1).

When asked how they ranked climate variables that might affect the successful growth of sagebrush (Table 3. - 3a.), 4 out of 7 managers ranked rainfall as the leading climate variable, while 3 out of 7 managers ranked snow as the second leading variable for success. The third and fourth important variables for success were drought and high temperature, which are not as easily understood as precipitation, but are assumed to be representative of the arid environment where sagebrush exists. When looking at the expanded responses provided by 3 managers (Table 3a.), two participants confirmed the importance of precipitation, in the form of rain and snow, while another explained that the timing and seasonality of precipitation was just as important as the magnitude. One manager also notes that high and low temperatures are independent variables and that other factors such as solar exposure and aspect should also be accounted for.

#	Answer	1	2	3	4	5	6	7	Total Responses
1	Rain	4	1	0	0	1	0	1	7
2	Snow	1	3	1	0	1	1	0	7
3	Drought	0	1	4	0	0	1	1	7
4	Flood	0	0	1	2	0	1	3	7
5	Wind	0	1	1	0	1	3	1	7
6	Low temperature	1	1	0	0	4	1	0	7
7	High temperature	1	0	0	5	0	0	1	7
	Total	7	7	7	7	7	7	7	-

Table 3. Initial Online Survey: Question #1 Ranked Responses. Table shows the results to question #1, "*How does your BLM district rank which climate variables affect the successful growth of sagebrush, from most important to least important?*"

Text Response
I actually have no idea about our District's ranking of climate variables, save for the personal opinions of specialists such as myself. We are in the High Desert, and so drought and lack of rain/snow are huge issues for all vegetation, not just sagebrush. Combine these environmental factors with disturbances such as grazing and fire, and obviously there's the crux of the issue.
Simply using high and low temperature is not sufficient to really tell anything. It is far more important to understand the solar exposure a average temperature increase will effect the south and west exposures far more than it will other aspects. I also don't understand why the season of the moisture was not considered. These are pretty extreme sites to begin with so the 1 - 4 degree temperature averages or even the higher variability that just normally exists through decades and other climactic patterns isn't very significant. However, the season of moisture and the amounts during those seasons can impact many sagebrush habitat variables.
Most of our Wyoming big sagebrush and mountain big sagebrush communities receive their precipitation in the form of snowfall. Our field office has averaged less than 6" of precipitation over the last decade.

Table 3a. Initial Online Survey: Question #1 Expanded Response. Table shows the detailed responses to question #1, "*How does your BLM district rank which climate variables affect the successful growth of sagebrush, from most important to least important?*" Managers were given space to expand on their ranked answers and provide additional feedback.

When asked how managers ranked threats to sagebrush (Table 4. – 4b.), it was a 3-way tie between fire, invasives and grazing. This was not unexpected, as numerous studies have suggested feedback cycles between those three. One land manager explained (Table 4b.) how fire and grazing are both significant factors, while another participant commented about the broad role of human disturbance, specifically mentioning past chaining of sagelands, but possibly hinting of other human disturbance which may include grazing, fire suppression, all terrain vehicles, and other forms of vegetation manipulation. Two land managers also noted the importance of site differences when associating threats, as differences in sagebrush intactness and physical and biological differences can play a role.

#	Answer	1	2	3	4	Total Responses
1	Fire	2	1	2	2	7
2	Invasive	2	3	1	1	7
3	Juniper encroachment	1	1	4	1	7
4	Other (please insert threat name in text box)	2	2	0	2	6
	Total	7	7	7	6	-

Table 4. Initial Online Survey: Question #2 Ranked Responses. Table shows the rank responses to question #2, "*How does your BLM district rank the threats to sagebrush, from most important to least important?*"

Other (please insert threat name in text box)
Grazing or other human disturbance
grazing
other
Grazing

Table 4a. Question #2 Ranked 'Other' Responses. When asked to rank the leading threats to sagebrush the option to include an additional response of the manager's choice was given by filling in a blank text box next to the choice 'other'. This table reflects the responses filled in.

Text Response
Depending on the human disturbance caused, it could be #1 for our district. Large tracts of land were chained in the early 60s, which was intended to clear the land of sagebrush and juniper. These areas have experienced high amounts of soil erosion by wind (because of lack of vegetative cover) and are now the most likely to carry invasive annual grasses.
My comments to the previous question were premature! To me, all of these issues are significant factors. Fire is number one, though after that it could vary based upon the site. To me, grazing is a huge issue that degrades the landscape, if not directly in sagebrush habitat then surrounding it.
Our field office experiences very few natural fires in our sagebrush communities. Unlike many other areas in the state, we have large intact tracts of intact Wyoming big sagebrush that have not experienced the altered fire regimes that have been seen in Southern Idaho.

Table 4b. Initial Online Survey: Question #2 Expanded Response. Table shows the detailed open-ended text responses to question #2, "*How does your BLM district rank the threats to sagebrush, from most important to least important?*" Managers were given space to expand on their ranked answers and provide additional feedback.

When asked how they would rank climate variables that might cause or enhance leading threats to sagebrush (Table 5.- 5a.), 3 out of 5 managers chose drought as the lead variable. The second and third most important climate variables enhancing threats include low temperature and rain and snow for 2 out of 5 managers. However, results do not provide enough information about reasons for such ranking. Reviewing results, we found that ranking may not have been the best choice since some participants interpreted the meaning of each ranking variable differently. For example, one participant notes that rain was listed as an important variable, not because rain

itself caused or enhanced the leading threat, but because 'lack of rain' did (Table 5a.). We assumed that "lack of rain" would be associated with 'drought', an example of miscommunication, and why collaboration and communication are so important when discussing climate between scientists and land managers. It was expressed during later land manager interviews that 'drought' is not only the lack of water, but the nexus of high temperatures, low soil water availability and lack of precipitation. Furthermore another participant noted the need for additional choices (Table 5a.) such as the 'other' answer provided for previous questions. But the ranking of climate variables did reveal the overall importance of variables such as drought, temperature and precipitation (both rain and snow). Also, floods are considered by managers as important, while winds are considered less important.

When land managers were asked what type of information would be needed from climate scientists to best preserve critical sagebrush areas (Table 6.), managers provided a variety of responses in an open-ended text entry. Most land managers needed information to plan for the future, in the context of resource management plans, to understand impacts on wildlife habitat, and to derive advice on adaptation strategies and restoration options. There was also a consistent need for information on climate impacts, including drought, fire regime change, ocean warming, adaptation potential and habitat change.

#	Answer	1	2	3	4	5	6	7	Total Responses
1	Rain	0	1	2	0	0	0	2	5
2	Snow	0	1	2	1	1	0	0	5
3	Drought	3	0	0	0	0	2	0	5
4	Flood	2	0	0	1	0	0	2	5
5	Wind	0	0	1	1	1	2	0	5
6	Low temperature	0	2	0	0	2	0	1	5
7	High temperature	0	1	0	2	1	1	0	5
	Total	5	5	5	5	5	5	5	-

Table 5. Initial Online Survey: Question #3 Ranked Responses. Table shows the rank responses to question #3, "*How does your BLM district rank which climate variables cause and proliferate the #1 threat (from question 2) to sagebrush in your district, from most important to least important?*"

Text Response
Rain is included as a lack thereof! Floods and wind are not major issues on our district.
None of these the proliferation of our two highest risks come from over grazing, fire exclusion, and the increased seed source that exponentially has developed due to the fire exclusion.

Table 5a. Initial Online Survey: Question #3 Expanded Response. Table shows the detailed open-ended text responses to question #3, "*How does your BLM district rank which climate variables cause and proliferate the #1 threat (from question 2) to sagebrush in your district, from most important to least important?*" Managers were given space to expand on their ranked answers and provide additional feedback.

Text Response
Realistic models that can be applied to resource management plans.
Potential habitat, LIDAR, etc. to try and determine which areas may be more successful for restoration than others in order to focus efforts.
I deal with more immediate concerns (fire, annual climate, site conditions, natural ARTR seed sources, grazing) regarding maintenance or expansion of sagebrush communities than vague, nebulous, unpredictable "climate change". I haven't a clue how climate scientists might help my day-to-day, year-to-year management of sagebrush communities that are under my supervision.
What are the most likely changes in moisture and timing of that moisture. If the ocean is warming what is that going to do to our specific area relative to El and La Nina event. How will this change the jet stream and thus storm tracking. This would help predict droughts and times of higher moisture when we would be potentially more successful with seeding. Although speculative this would also help us better model potential fire starts in the future thus providing additional rationale for where to develop fire breaks. I have no interest in carbon related information because I don't believe from what I have researched there is enough evidence to allow us to make any factual management decisions based on it.
I am interested in modeling the affects climate change will have related to invasive species adaptation and expansion. Cheatgrass and halogeton are the primary invader of arid landscapes in this region and I am interested in their ability to adapt and thrive in habitats they previously did not have a large impact on (i.e. Chet grass invasion of salt dessert scrub).

Table 6. Initial Online Survey: Question #4 Text Response. Table shows the open-ended text responses to question #4, "*In order to best preserve critical BLM sagebrush areas, what type of information would your agency need from climate scientists?*"

After viewing the eight web-based climate tools including *USGS County Level Climate Projections*; *Ecoregion Climate Data Explorer*; *Regional Climate Extremes*; and *Western*

Drought Tracker, two participants provided feedback (Table 7.) One land manager found the *Western Drought Tracker* to be the simplest and most intuitive. The second land manager did not give specific feedback about the climate tools themselves, but discussed when tools were used, which in this case were only for grazing permitting and decisions. Due to the lack of responses about climate tools, it is hard to determine the specific needs of land managers or understand what they find useable and useful in terms of climate tools. Because of this, and the need for more detailed information, it was decided to include these same four climate tools, plus an additional four climate tools in the second phase phone interviews.

Text Response
They all have their benefits, though I actually like the simpler Western Drought Tracker site as when it loaded, I could immediately discern what it was aiming to display regarding drought. It's very easy to almost instantly have a good feel for what areas are experiencing more drought than others. I know the drier areas of Oregon, but looking at other states is interesting and information comes through very easily and is quickly comprehended.
I only use these sources for making management decisions that affect terms & conditions on my permittees BLM grazing permits - like delaying turn-out later in dry or cool years when the range grasses are not ready for livestock, OR reducing permitted livestock numbers or length of grazing season to reduce livestock impacts to the range resources.

Table 7. Initial Online Survey: Question #5 Text Response. Table shows the open-ended text responses to question #5, "*We wish to provide both useful and useable climate information to help your agencies sagebrush management decisions. A few climate information packages are provided here. These are provided to help you assess what types of information you prefer and how you would like information displayed. Think about how they could be modified to focus on your domain and your scale of concern. After exploring these packages by clicking on the links provided below, do you see options (information, organization, scale, graphics, color schemes etc.) that you like or do not like, or that may work or may not work for your agency? Do you have other ideas of what kinds of information or graphics could be included in a climate package that may be useful to your agencies management decisions? USGS County Level Climate Projections; Ecoregion Climate Data Explorer; Regional Climate Extremes; and Western Drought Tracker*"

Land Manager Phone Interviews

Overview

The 15 original land managers, who were asked to provide the times they were available for interviews, did not respond to email. However, once the same managers were contacted by phone to schedule interviews, many were willing to participate, schedule interviews and some asked for an immediate interview at the time of the call. An email was also sent to the 15 referred managers; intentionally stating they were referred to the student by a colleague (but without

naming that colleague). Those emails generated 5 immediate responses and led to a few additional referrals. Sagebrush land managers constituted a diverse range including (but not limited to) Weed Coordinators, Invasive Species Managers, Fire Ecologists, Wildlife Biologists, Range Management Specialists, Botanists, Natural Resource Specialists, Field Managers, State Management, and BLM Supervisors. In total 22 managers dealing with sagebrush were interviewed, 12 from Oregon, 7 from Idaho and 3 from Utah. Reasons for those not participating ranged from an inability to contact them because 1) they no longer held that position, 2) inadequate contact information, 3) not previously or currently in a position related to sagebrush management.

The 1-hour that was initially set aside for each interview ended up being too short as the amount of material to cover and the eagerness of managers to participate extended the majority of the interviews to about 1.5 hours. As a result of the extra time, the interview format was transformed during the process. Initially the interview consisted of two parts including 1) a preliminary discussion, and 2) the analysis of a *Data Basin* gallery that included Oregon and Idaho spatial datasets, and land manager feedback on eight existing web-based climate tools. During the first few interviews a large amount of time was spent on the preliminary discussion, which was then followed by the review of the Oregon and Idaho district threat maps within the Data Basin gallery. However, the time spent on these two items left little time for the review of the eight web-based climate tools, which the research team felt to be the most important aspect of the interviews. To better balance the interview and to gain more time during the assessment of the climate tools two steps were taken: 1) the preliminary discussion was shortened through direct questions on management activities and related climate variables, and 2) immediately going through the eight web-based climate tools, and either saving the evaluation of the spatial datasets for the end or not considering these maps at all (Appendix D). Land managers were also allowed to choose which climate tools they looked at in order of their preference and interest. As a result, the flexibility of choice for climate tool assessment and the removal of map assessments left some climate tools and maps with 'no information'.

Activities & Climate Variables

As already stated, sagebrush manager titles were diverse and ranged from Weed Coordinators, Invasive Species Managers, Fire Ecologists, Wildlife Biologists, Range Management Specialists, Botanists, Natural Resource Specialists, Field Managers, State Management, and BLM Supervisors. Of these varied job titles, we found similarities in activities included planning, seeding and hand planting, herbicide application, mechanical removal, biological control, prescribed fire, and the implementation of buffer, fuel breaks and green stripping. To meet the projects goal of linking climate variables to sagebrush management activities, land managers were asked what climate variables in their districts were associated with their own management

activities. Table 8. gives an overview of how certain climate variables and other non-climate variables may be needed for or may affect each activity.

Activity	Climate Variable	Other Variable
Planning (e.g. NEPA, ESR, EA's, RMP, FIAT, AUM's, Grazing Permits)	None	Funding, guidance, accuracy, stability, acceptance
Seeding & Hand Planting	Precipitation & temperature (timing: fall & spring important), snow amount & timing, wind, evaporation deficit, drought	Soil available moisture, soil type, vegetation change, funding, seed availability
Herbicide Application (e.g. Aerial, ATV, UTV, backpack sprayers, roadside treatment)	Wind, humidity, rain timing	Runoff
Mechanical Removal (e.g. logging, mastication, chainsaws)	Precipitation, snow, temperature	None
Biological Control	Temperature & precipitation (timing), humidity, drought	None
Controlled Fire	Wind, precipitation, temperature, relative humidity	Manpower
Buffers, Fuel breaks, Green Stripping	Precipitation, temperature,	Funding, manpower, fire severity

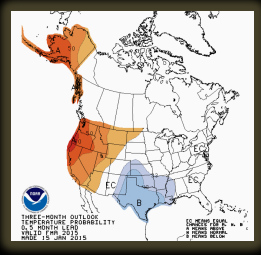
Table 8. Management Activities and Related Climate Variables. The first column within the table lists the commonly mentioned land management activities performed by land managers. The second and third columns mention climate and non-climate variables associated with each land management activity, as mentioned by the land managers during interviews. Where no variables were mentioned for that specific land management activity the word 'none' is used. Note that this table is not an extensive list of the land management activities performed by the land managers that we interviewed and that not all land managers within this survey performed every one of these activities. Note also that climate and non-

climate variables listed here do not represent the complete list of variables associated with each of the land management activities in column 1.

Climate Tools and Manager Needs

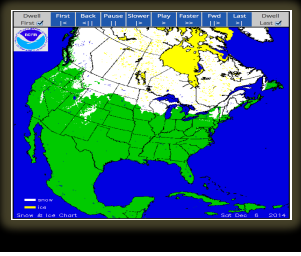
For each of the eight web-based climate tools that were examined, land manager remarks were summarized in a table and classified into three categories: 1) general information, 2) questions about the tool, and 3) specific feedback (Figures 4 - 11). Each category was color-coded, and remarks were tallied to show how many managers mentioned it. If a specific climate tool did not receive specific remarks made for a category, for instance if there were no questions asked for that climate tool, then the category was left out of the figure.

Managers feedback on the 8 climate tools addressed accessibility (both knowledge of and server connectivity), dependability or robustness of the information delivered, spatial and temporal scales of the information, quality of the graphics, colors and color scale, compatibility with ArcGIS, climate variables available, number and display of climate models, definition of terms including variable names, climate models and climate scenarios, intuitiveness of the tool, and overall usefulness and usability of the tool.

NOAA Three-Month Outlooks 		
	Seems useful	**3**
	This tool is not intuitive	**4**
	More useful if it were more intuitive	**2**
	Unsure how this would help	**1**
	I prefer the other map tools rather than this tool	**1**
	There is a lot of information here, I need time to digest it	**3**
	How are they coming up with probabilities?	**1**
	What point in time is this?	**1**
	Are stations close to where data is collected?	**1**
	What do the map numbers mean?	**1**
	Good time scale, period of interest to me	**1**
	This is kind of tool I need but I need 9-month probability as well as the 3 month	**1**

	Spatial scale too big	**1**
	I need a smaller spatial scale	**1**
	Map shading should include specific amounts above or below, or have color bar	**5**
	Should be better definition of terms	**1**
	Graphs need more information	**1**
	Abbreviations i.e. 'mn' need to be more clear	**1**
	Something that talks you through the tools might be helpful (as long as it can be shut off)	**1**
	I like the probability graph	**1**
	NRCS presents predictive stream flow like the probability of exceedence map	**1**
	For precipitation I would rather have numbers, for temperature anomalies are fine	**1**
	Its nice to see precipitation split between rain & snow	**1**
	Color tones work well	**2**
	Axis intervals work well	**1**

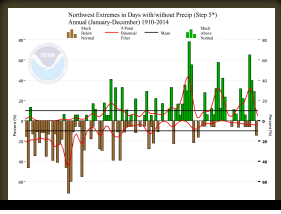
Figure 4. NOAA Three-Month Outlooks.
(http: http://www.cpc.ncep.noaa.gov/products/predictions/90day/)
Remarks made by land managers during the interviews were combined and broken down into three categories: (blue) general information, (brown) land manager specific questions about the web site, and (green) feedback specific to this web site. Remarks were then tallied to show how many land managers made identical or similar remarks.

NOAA Snow Cover Maps 	**Could not open tool**	**1**
	Seems useful	**3**
	Seems interesting	**4**
	Unsure how this would help	**2**
	Not sure I would use this tool	**2**
	Is this from satellite? How do they project this?	**1**

	What is the resolution/pixel size? It would be nice to have some metadata	1
	What data is the map based on? (e.g. Snotel, weather stations)?	1
	White then to green quickly may mean less snow?	1
	Smaller spatial scale would be more useful	3
	Useful if I could hover over area/zoom in to see how much snow received	2
	Useful to see how much snow fall has occurred	1
	It would be useful if it showed snow depth	1
	If its just a light dusting it doesn't matter that much	1
	Useful if showed future projections	6
	Could be useful for planning if future projections	2
	Maybe useful to do seasons instead of months?	1
	Useful to compare this years snowfall to previous years	3
	Date sequencing in right hand corner works	2
	Graphics/colors intuitive	3

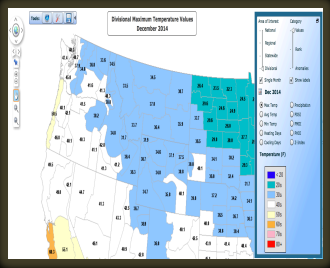
Figure 5. NOAA Snow Cover Maps.
(http://www.ncdc.noaa.gov/snow-and-ice/snow-cover.php)
Remarks made by land managers during the interviews were combined and broken down into three categories: (blue) general information, (brown) land manager specific questions about the web site, and (green) feedback specific to this web site. Remarks were then tallied to show how many land managers made identical or similar remarks.

NOAA U.S Climate Extremes	Data missing once opened	1
	Seems interesting	4
	Useful as hindsight	1
	Unsure how this would help	1
	The spatial scale is too large	1
	Useful if more localized	1



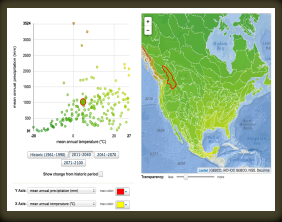
	Useful if future projections	**1**
	Water year might be useful in this tool	**1**
	Graph needs better explanation	**3**
	Maybe useful if extremes turned into probabilities	**1**

Figure 6. NOAA U.S. Climate Extremes.
(http://www.ncdc.noaa.gov/extremes/cei/graph/nw/5/01-12)
Remarks made by land managers during the interviews were combined and broken down into three categories: (blue) general information, (brown) land manager specific questions about the web site, and (green) feedback specific to this web site. Remarks were then tallied to show how many land managers made identical or similar remarks.

NOAA Climate at a Glance		
	**When tried to open received Adobe popup message**	**1**
	Used this tool a bit in the past	**1**
	Seems useful	**1**
	Seems interesting	**1**
	I like this tool	**2**
	Tool easier to read, I like it	**1**
	Pretty basic	**1**
	Not very interested	**1**
	What is the divisional scale?	**3**
	Can you do a seasonal pdsi?	**1**
	The pdsi only tells you about the past	**1**
	Explanation for pdsi numbers &/ colors needed	**4**
	Drought indices should be defines	**1**
	Useful to have info about different drought indices (maybe citation)	**1**
	May show we're in drought but a little spring precipitation may cause big production. Timing important	**1**
	Anomalies in general are good	**2**
	Temperature anomalies are good	**2**

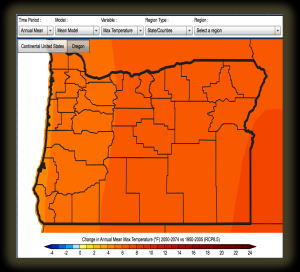
	More information/explanation needed for anomalies	1
	Spatial divisions in this tool work fine	1
	A finer divisional scale would be better	3
	Like that you can change the years	1
	I like that I can change the months	1
	When looking at large scales its pretty informative and tells how long its been bad	1
	100 average will affect outcome, lose information	1
	Better if more variables and shorter timeline	1
	Changing 'period' (warm season, cold season, etc.) useful	3
	Color scheme works well	2

Figure 7. NOAA Climate at a Glance.
(http://gis.ncdc.noaa.gov/map/cag/#app=cdo)
Remarks made by land managers during the interviews were combined and broken down into three categories: (blue) general information, (brown) land manager specific questions about the web site, and (green) feedback specific to this web site. Remarks were then tallied to show how many land managers made identical or similar remarks.

AdaptWest		
	Could not open	1
	Data missing once opened	4
	Seems useful	1
	Seems interesting	1
	I would have to use it more to understand it	2
	My area falls between ecoregions	1
	More useful if could select 1 ecoregion and see different timeframes or model projections on plot graph	5
	I like the variables in this (seasonally based)	2
	Helpful if could switch between Fahrenheit & Celsius	1

	Would be great to hover over a point and have it pop-up coordinates	**1**
	Changing the graph axis is good	**1**
	Interval values too large on x & y-axis	**2**

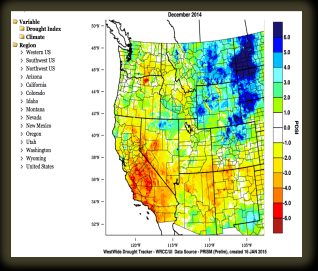
Figure 8. AdaptWest.
(http://adaptwest.databasin.org/app/ecoregion_climate_explorer)
Remarks made by land managers during the interviews were combined and broken down into three categories: (blue) general information, (brown) land manager specific questions about the web site, and (green) feedback specific to this web site. Remarks were then tallied to show how many land managers made identical or similar remarks.

(USGS) National Climate Change Viewer 	**When tried to open received Adobe pop-up message**	**1**
	This tool seems useful	**3**
	This tool seems interesting	**5**
	Very complex for what we do	**1**
	Useful for planning	**7**
	May help justify funding	**1**
	What specific scale is this	**1**
	What's the ecological significance (.1 inch precipitation projection, is less precipitation because we're getting warmer, etc.)	**1**
	Tool good because interactive, move around histogram giving info about bars & points	**1**
	Flags next to model projections is a good visual	**2**
	Hard to determine which climate projection is best to use for our area	**2**
	Need information that isn't conflicting	**3**
	I like comparing the model projections to each other	**7**
	Mean model is useful	**4**
	RCP should be defined	**1**
	Useful if time period closer in the future	**1**

	We need shorter term climate rather than longer	**6**
	Helpful to project short-term (5 years)	**3**
	Timing: we may get moisture but if high temp then not much moisture	**1**
	I like changing the projected time period for each model	**2**
	With historical can compare past failures and why	**1**
	Good that you can select different states	**1**
	Coarse spatial scale	**1**
	Huge difference in precipitation per day for neighboring counties	**1**
	Ecoregions may be nice because similar trends	**2**
	Ecoregion temp and precipitation may work Good tool because can easily select variable & elements and change them	**1**
	Polygon colors and boundaries hard to tell apart	**1**
	Temperature colors very similar to each other	**1**
	With precipitation hard to tell difference between some colors (white and blue)	**1**
	Colors for runoff hard to read, not enough contrast	**1**
	Color continuum intuitive	**4**
	Any color scheme works if you put it into a legend	**1**
	More information is needed about variables (i.e. runoff: what does .1inch per month mean? What does evaporation deficit account for?	**2**
	Define the variables being used (i.e. what does soil storage mean?)	**1**
	I like hovering over specific counties for more data	**1**
	I don't know how useful runoff is	**1**
	Available moisture would be a good variable to add	**1**
	Easy to maneuver through periods, months, variables	**1**

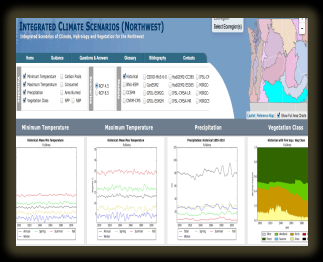
	Download summaries useful	**1**

Figure 9. (USGS) National Climate Change Viewer.
(http://www.usgs.gov/climate_landuse/clu_rd/apps/nccv_viewer.asp)
Remarks made by land managers during the interviews were combined and broken down into three categories: (blue) general information, (brown) land manager specific questions about the web site, and (green) feedback specific to this web site. Remarks were then tallied to show how many land managers made identical or similar remarks.

(DRI) West Wide Drought Tracker 	**Could not open**	**2**
	Data missing once opened	**3**
	Get an adobe pop-up before it opens	**1**
	Took a while to open	**2**
	Seems useful	**7**
	Seems interesting	**2**
	Easy to asses at a glance/intuitive	**1**
	Tool good for documents/planning	**3**
	May help justify funding	**1**
	What scale is the counties, is it a 30 meter? This would be helpful to know to match with other scales	**1**
	If it says decrease, how much decrease?	**1**
	Useful to look back and compare what happened with results	**3**
	Better if looks at future	**2**
	Map colors work well	**2**
	Map colors too similar, especially lower value colors	**1**
	Would be nice to hover over area and receive value (maybe rather then change colors)	**1**
	I like the information and/or hover feature for drought indices	**3**

	PDSI seems helpful	**1**
	I would just use pdsi, not other drought indices	**1**
	Usually look at projected precipitation vs. normal precipitation, not pdsi	**1**
	Timing of precipitation is important	**1**
	I don't know I'd use this tool for temperature	**1**
	Anomaly useful	**2**
	I like the timescale (last full month, last 2 months…)	**2**

Figure 10. (DRI) West Wide Drought Tracker.
(http://www.wrcc.dri.edu/wwdt/index.php)
Remarks made by land managers during the interviews were combined and broken down into three categories: (blue) general information, (brown) land manager specific questions about the web site, and (green) feedback specific to this web site. Remarks were then tallied to show how many land managers made identical or similar remarks.

Integrated Climate Scenarios in Data Basin 	**Could not open**	**2**
	Data missing once opened	**2**
	Took a long time to open	**1**
	Seems useful	**4**
	Seems intuitive	
	Not sure I would use this	**1**
	This is a lot/ Need time to digest this	**3**
	Could be useful for planning documents	**3**
	What is historical vegetation based off of? Helpful to know where vegetation information comes from	**4**
	What does the grass component consist of (annual? Perennial?)	**2**
	I like comparing the model projections to each other	**5**

	Historical information is good, and/or its good to compare past to present	**3**
	Precipitation temporal projection too large	**1**
	Would be useful to choose timeframes such as seasonal or years	**1**
	Timeline doesn't work very well	**1**
	District split between a few ecoregions	**5**
	Ecoregion scale good	**1**
	Ecoregion scale too large	**2**
	Zoom in would help	**1**
	Finding second row of graphs intuitive	**1**
	First row showing graphs for all ecoregions just gets in the way	**1**
	Only shows 3 graphs at time on page, I have to scroll back and forth. Can this be tightened up?	**1**
	Interesting to compare across graphs	**4**
	Colors good	**1**
	Explain the models	**2**
	Graph seems metric? Change?	**1**
	Vegetation class is interesting	**3**
	Climate effect on soil type would be useful	**1**

Figure 11. Integrated Climate Scenarios in Data Basin.
(http://consbio.webfactional.com/integratedscenarios/)
Remarks made by land managers during the interviews were combined and broken down into three categories: (blue) general information, (brown) land manager specific questions about the web site, and (green) feedback specific to this web site. Remarks were then tallied to show how many land managers made identical or similar remarks.

The most frequently cited comments regarding access and dependability include the real need for management tools and for access to useful tools for managers that are intuitive to use. Tools need to be accessible to managers and address browser compatibility. During interviews 7 of the 8 web sites would not open. Managers trying to access them received Adobe update warnings, or opened them but could not access the information. One common problem was that many BLM

managers use Internet Explorer, but many climate tools are designed for used with Firefox or Chrome. Note that Microsoft is now abandoning Internet Explorer and that agencies are slowly migrating towards Chrome.

The need for dependable tools that maintain reliable and consistent information was expressed as a concern among interviewees. When managers are planning and initiating funding, reliable and consistent information will be needed to combat any skepticism and ensure consistency across agencies. All managers use Geographical Information Systems (GIS) to generate maps for planning so having the ability to download Arc Layers from the web site is helpful. Managers may then combine the downloadable map layers with their own spatial datasets and include them in their analysis and planning documents. Managers also explained that a frequently updated and online tool is best. Such a site may need to be updated monthly, seasonally or as soon as significant changes occur so that these changes are quickly announced.

Managers expressed the need for both short-term and long-term temporal scale. Short-term needs include access to weather forecasts including monthly information, seasonal information (e.g. 3-month to 6-month), and on an annual basis for up to 2-3 years. The longer climate change time scales needed by managers include 5 years, 10 years and 10-20 years. Managers also remarked that future time periods should be similar in length to the historical periods that have been documented. For example, a 30-year future precipitation projection should not be compared with a 100-year historical period. Long periods such as a century will hide extreme precipitation periods by simply averaging across so many years.

Managers also need smaller spatial scales, and showed a high interest in areas no larger than a county or ecoregion. The county scale is valuable because some manager districts fall within 3 ecoregions, but ecoregions also work well when looking at general ecosystem trends. Some managers thought that a 30-meter scale would be desirable since some of their own datasets are at that scale. The spatial resolution of the General Circulation Models (GCMs), more commonly known as global climate models, that were designed to simulate the planet's climate conditions, is too coarse to accurately simulate regional climate features and direct impacts on local ecosystem services (Homer *et al*. 2015; Tabor and Williams 2010).

The overarching variables mentioned by all the interviewees include both precipitation and temperature, and most importantly the timing or seasonality of precipitation and temperature. Precipitation includes both rain and snow, and is best expressed in terms of magnitude. Temperature may include magnitude, or change from long term mean. The seasonality should at minimum include both spring and fall, as these seasons are important for sagebrush management and relevant to seeding, plant germination and growth. Summer is also an important season since precipitation and temperature correlate to vegetation (fuels) drying and fire events. Other highly ranked variables mentioned by 10 or more mangers (Appendix D) include wind**,** its speed &

direction; drought, and soil available moisture. Wind affects management activities such as aerial herbicide application and aerial seeding. It also plays a large role in fire spread. Drought and soil available moisture affect water management and plant water stress as well as the timing of fine fuel drying which is an important aspect in fire management. Other important variables mentioned by 4 or more managers (Appendix D) include soil type, which may affect the spread of invasive annuals, the water holding capacity of soil, and the sagebrush species available within the area; evaporation deficit and humidity, which again affects the water equilibrium within the soil and vegetation; fire severity, which affects the amount of vegetation burned, the amount and type of vegetation that grows back, and poses a human danger; and funding, which is not a climate variable but was noted by several managers as a key player of how much of an area can be managed and restored.

Managers looked at the different climate models and the different emission scenarios presented by each website. It was almost unanimously expressed that there was a desire to include not just the mean of all the models, but a robust comparison of all the climate models. It was important for managers to understand what inputs drove the climate models to interpret the differences between projections and choose with some confidence the models that best match their areas of concern. The definition of terms, such as "RCP" (representative concentration pathways) and variable names such as PDSI (Palmer Drought Severity Index) is also very important. Most managers did not know what RCP stood for or how it was defined. Also certain variables, such as ‘evaporation deficit’ do not wholly explain what factors are included or how a manager should interpret the map. Further, colors and color scales should have good separation and scale increments should be consistent for each variable. Some managers mentioned that a hover-over feature giving specific information for each term or variable used would be helpful.

Follow-Up Online Survey

The first email containing the follow-up survey to the 22 land managers received 4 views with 100% completion rate by those participants. The initial reminder email sent on May 6th generated an additional 1 view with a 100% completion rate. The second reminder email sent on May 12th received an additional 2 views, but with only one of the participants completing the survey, and the second participant only answering the first question. The final reminder email sent on May 14th generated no survey response. Of the 22 managers who were emailed the follow-up survey, 7 managers took the survey accounting for a 30% response rate. Of the 7 managers who took the follow-up survey, Qualtrics results show an 80% completion mean and 20% dropout rate.

When land managers were asked if they were interested in learning how to find and use current weather tools and climate tools, the overwhelming majority, 6 of 7 land managers, answered yes (Table 9). When managers were asked the best way to provide this information (Table 9a.), 4 of

6 managers responded that a webpage including links to weather and climate tools that included a short summary of how to use each tool, along with a tech support call number for each tool, would be best. 3 of the 6 participants felt that the webpage with links and summaries without a tech support number would work, and 3 of the 6 participants also felt an online webinar would be helpful. One land manager provided additional feedback in the 'other' text entry box stating that an introductory webinar to introduce people to the webpage with tech support would be beneficial.

#	Answer		Response	%
1	Yes		6	86%
2	No		1	14%
	Total		7	100%

Table 9. Follow-Up Online Survey: Responses to Question #1a. Table shows the multiple choice responses to question #1, "*The previous sagebrush land manager survey and phone interviews show a need for short range, weather related planning tools that look at seasonal and annual time periods. With this in mind, we have identified a few existing weather tools that already display some of this information. Would you be interested in learning how to find and use these current weather tools, and any relevant climate tools that are already available?*"

#	Answer		Response	%
1	Group Workshops that show how to find the tools, how to use the tools, and allow for hands on experience		2	33%
2	Online Webinars that show how to find the tools, how to use the tools, and allow for hands on experience		3	50%
3	One-on-one phone calls that show how to find the tools, how to use the tools, and allow for hands on experience		0	0%
4	A web page that includes links to a variety of tools with a short summary of how to use each tool		3	50%
5	The above web page, but also with a tech support number to call with questions about the tool		4	67%
6	Other (please specify in the box below)		1	17%

Table 9a. Follow-Up Online Survey: Responses to Question #1b. Table shows the multiple choice responses to question #2, "*What would be the best way to provide you information on both identifying and understanding these existing tools? (You may choose more than one)*"

Other (please specify in the box below)
The webpage with links and short summaries would be great, but would benefit from an introductory webinar to introduce people to it

Table 9b. Responses to Question #1b 'Other'. When asked to provide the best way managers could both identify and understand the existing tools, the option to include an additional response of the manager's choice was given by filling in a blank text box next to the choice 'other'. This table reflects the responses filled in.

After reviewing the Climate Console webpage (Figure 3.), 6 managers provided feedback to the newly created web-based climate tool (Tables 10. – 14.). Responses vary and although a couple land managers found it useful and easy to use, others had mixed feelings and received mixed results (Table 10.). As was found with the eight climate tools within the land manager phone interviews, errors occurred when accessing the tool or accessing attributes within the tool. There was also a need for additional explanation and understanding of the tool features and variables. Because this tool was created with some of the land manager feedback from the previous second stage land manager phone interviews, one of the goals was to include well-defined terms and information about the features of the tool. In order to keep tool clutter to a minimum, an 'about' section was created that housed the information. When land managers were asked how much time they actually spent reading the documentation under the 'about' section on the Climate Console webpage (Table 11.) there were mixed results. Out of the 6 participants, 2 didn't even see the about section and 2 read the entire thing, while each of the remaining 2 participants fell somewhere in between and only skimmed it or used it when needed.

Text Response
The base layers loaded alright, but I got an error when trying to select by attribute "Highest Temp 2015-2030" = 90. I found it confusing and awkward
It's nice to have the various reporting units to choose. Could use some explanation of the different climate models to choose from. Didn't really understand the terrestrial intactness bit, because in all the reports I tried it showed as moderate even though there was high climate exposure and site sensitivity.
I could not get the site to fully load using Internet Explorer 9, but could get it to load under Google Chrome. The site seemed to work better when I copied and pasted the web address into Google Chrome opened as stand-alone as opposed to simply clicking on the link and opening it through Bison Connect (BLM's email system). Under the Select Features box, I tried clicking on the icon that looked like a divided box but could not figure out what to put in the box after "contains". Regardless of what I tried, I got a server error message. Once I figured out what I needed to click, it seemed to work fine. Some indication of how to get started would be useful when first entering the tool. I found that the climate variable change layers were hard to understand when zoomed in closely, particularly when zoomed in on the allotment layer, which has a bunch of color in the map already. There appears to be a minimum resolution for that particular layer in order to see what the layer is. I tried drawing a box around a specific allotment that I thought was fairly large to look at the projections there, but the polygon that came back with the results included several allotments, indicating there is a minimum area extent needed to get results. There was also a spurious polygon that showed up when I zoomed out that was nowhere near the one I drew. Managers are used to working in English units, so there may be a need to change the legend units. Otherwise, it was quite interesting to see the results of different variables. The About information was very useful for understanding the various layers.
The choice of reporting units is a very good feature, well designed. The process of selecting an area and getting information works well. The EEMS model outputs and climate variables are not easily interpreted or understood, especially when thinking about how to convey this to the general (non-scientist) public. My use of this data would be to reference it in environmental analysis documents that are intended for the general public. We need to make these easily understandable to an average person.
Seemed easy to use.
Very useful. The BLM Allotment boundaries are very helpful.

Table 10. Follow-up Online Survey: Responses to Question #2. Table shows the open-ended text responses to question #2, "*Please provide your first impressions and feedback about the Climate Console webpage in the box provided below. Please be as specific as possible.*"

#	Answer		Response	%
1	I read the entire thing		2	33%
2	I briefly skimmed it		1	17%
3	I only read the sections where I needed more explanation		1	17%
4	I didn't see an 'about' section		2	33%
5	Other (please specify in the box below)		0	0%
	Total		6	100%

Table 11. Follow-Up Online Survey: Responses to Question #3. Table shows the multiple choice responses to question #3, "*How much time did you spend reading the documentation under the 'about' section on the Climate Console webpage?*"

Because the Climate Console webpage was created for a demographic of land managers in Utah and the Colorado Plateau that were assessing management activities and variables different than those for sagebrush in Oregon and Idaho, this tool was being assessed within the follow-up survey in terms of its general usability and usefulness. When we asked sagebrush land managers if a similar tool that focused on sagebrush country in Oregon and Idaho would be useful, and if they would be interested in using such a tool (Table 12.), the unanimous answer was yes with 6 out of 6 answers. Expanding on this desire for a similar tool, participants were then asked if there are any reporting units or variables (other than the ones provided) that they would like to see in a tool tailored to their area management (Table 13.). One manager felt that the variables were already specified, while another was interested in looking at the individual variables that made up an existing Climate Console variable 'intactness'. Some more specific text entry examples included precipitation zones, ESI data and satellite imagery. The final question in the survey focused on gathering any remaining feedback that the land managers may have through another open-ended text entry box that asked about suggestions for improvement on the Climate Console webpage if it were tailored to the manager's specific area. Of the 4 participants that answered, 2 had no specific comments and one found the Climate Console to be helpful as it is. Another participant however commented that the previous interview climate tool examples were actually easier to follow and asked for the errors within this tool to be fixed.

#	Answer		Response	%
1	YES		6	100%
2	NO		0	0%
	Total		6	100%

Table 12. Follow-Up Online Survey: Respones to Question #4. Table shows the multiple choice responses to question #4, "*Would a similar tool focused on sagebrush country in the Oregon and Idaho area be useful, and would you be interested in using such a tool?*"

Text Response
ESI data, satellite imagery, etc.
Would need to think on it longer. The variables provided are a good start. At some point, I would imagine a desire to look at each variable separately that was used to determine intactness.
Precipitation zone (e.g., 10-12 inches)
They are already specified.

Table 13. Follow-up Online Survey: Responses to Question #5. Table shows the open-ended text responses to question #2, "*Referring still to the Climate Console webpage, if you have not already specified, please give any reporting units or variables (other than the ones provided) that you would like to see in a tool tailored to your area management.*"

Text Response
Fix the errors, make it easier to understand! The examples given in the first part of the interview, month ago, were not as tricky to follow. This does not seem like an improvement.
Not at this time. I work at a much higher level in the organization than the intended audience.
No
It is very helpful as is.

Table 14. Follow-up Online Survey: Responses to Question #6. Table shows the open-ended text responses to question #2, "*Do you have any suggestions for improvement on the Climate Console webpage, specifically if it were to be tailored to your area?*"

Significant findings

Throughout the course of the study, key findings have surfaced on land manager needs and remaining obstacles pertaining to climate tools and climate change data, as well as challenges with climate scientist and land manager collaboration. Results indicate that collaboration can uncover and eliminate communication barriers between climate scientists and land managers, while addressing land manager needs through open and continued conversation. This particular collaborative study has confirmed the significant need to find and access climate tools, the need for in-depth understanding of the information presented in climate tools, the need to include

climate change impacts, and the need for providing near-term forecast information that falls somewhere between weather forecast and climate projections.

Collaboration uncovers communication barriers and land manager needs

Challenges to collaboration exist between climate scientists and land managers. Obstacles may include discipline-specific jargon, intellectual turf or 'who knows best', stakeholder motives and trust between team members, as well as poor or ineffective facilitators and/or leadership. Professional barriers may include organizational structure, professional identity within one's discipline, and research reputation (US Institute of Medicine 2000).

In this study we found that jargon played a leading role in the miscommunication and misunderstanding of climate variables and climate tools. The term 'drought' was one such example having multiple meanings. It was presumed by researchers that drought would mean a lack of precipitation, but after speaking with land managers it was found that some associated the term with low precipitation, high temperatures, and low soil water availability. It was also found that the leading climate variables important to sagebrush were precipitation and temperature, but even more importantly their seasonality and timing. Averaging precipitation annually or seasonally did not reflect how much rain was "available" in April or May, which depends on the amount of soil moisture remaining from the winter. Soil available water can determine whether native forbs and perennial grasses can outcompete invasive annual grasses. Furthermore, climate science jargon often expressed in climate tools, such as PDSI (Palmer Drought Severity Index), normal periods (long-term historical periods - 30 years according to the World Meteorological Office), and RCP scenarios (representative concentration pathways) should be well defined. Even interdisciplinary terms such as water deficit, vegetation class and NPP (net primary productivity), for example, should be better described to ensure complete understanding by tool users.

We also found that using an intermediary research student to communicate between climate scientists and land managers worked well to facilitate collaboration, dialogue and trust between parties. We felt that the student may have prevented any disputes over intellectual turf, since it represented a neutral source of information for both climate scientists and land managers. The use of anonymity for all participants and one-on-one phone interviews is believed to have also helped the study in that land managers could speak freely about their needs without threat of reputation, black marks by superiors, or other negative repercussions.

Land managers need to be able to locate and access tools

This study found that the majority of participating land managers want information from weather and climate tools for land management activities and planning. However, of these individuals only a few expressed current use of such tools. The tools that were mentioned, mostly NOAA tools (e.g. drought monitor), USDA tools (e.g. FIREMON, BEHAVE and drought monitor), and NRCS tools (e.g. SNOTEL), comprise only a small range of tools that exist. A few managers mentioned that rather than using interactive web-based tools they use reports from local weather stations because these are relevant to their area, and ecological site descriptions because they guide land suitability for various land management. The stated reasons why some managers do not use existing weather or climate tools included the unfamiliarity of tool availability, the incompatibility of existing tools for management districts, and time constraints for the managers to find, learn and use new tools.

During the land manager interviews, many managers could not open tools due to web browser incompatibility. It was found that most interviewed sagebrush land managers use Internet Explorer, but many climate tools are better suited to more recent web browsers including Firefox and Google Chrome. Upon trying to access the climate tools, many tools were slow to open, and 7 out of 8 tools would not open for some land managers. Some participants received Adobe update warnings, and a few managers who were able to open the tools had trouble viewing the graphics or using the information delivery mechanisms.

Another matter of contention expressed by land managers was the consistency and dependability of the information received from the web sites. One manager expressed concern, based on a prior experience, that upon retrieving information for a report the information needed to still be available in the same site providing the same projections as it did when the report was originally created so that others can verify the information later in time. The importance of reliability and longevity is important to help managers combat skepticism, and confirm reasons why planning documents incorporated a specific climate tool in the first place.

Land managers need to be able to understand climate tools

As repeatedly noted throughout this document, there were multiple obstacles to the understanding of climate tools and their climate information by land managers. These include the aforementioned discipline specific jargon; the use of terms and variables with scarce definition; and tool access issues. Other issues leading to misunderstanding include the use of improper color scales using colors that are too similar and colors that are unidentifiable within maps. Also the use of axis increments that are in metric rather than U.S. units, or that are not properly formatted to the variable of interest. For instance, when looking at precipitation, if increments are too large then the specific amounts of precipitation received may only be a guess.

If multiple climate models are incorporated into the climate tool, then land managers wish to have information about some of the inputs that went into the creation of the model so that they can understand which model may be best suited to their area of interest, and so that they understand how projections are reached. Some common misperceptions about climate models were found, which included the impression that imagery such as country flags beside the models suggested that the climate model and its projections were only relative to that country, rather than simply meaning the country who hosted the modeling team.

Managers need to understand climate tool projections on spatial scales relevant to their own physical and biological context. Large spatial scales may average climate trends over areas with significantly varying microclimates due to topography, water features, elevation, and wind, to name a few. For example, when determining the precipitation magnitude for Oregon, a tool specifying precipitation for the entire Northwest may not account for the influence of the Coast Range or the Cascades on the area. Therefore, the best understanding of climate variables within a tool occurs when land managers can discern features specific to their own districts or ecoregions. Most of the land managers surveyed and interviewed utilized ArcGIS and were interested in retrieving data layers that could be overlaid with their own so that such information could be displayed within planning documents.

Land managers want to know about climate change impacts

In all three phases of this study, managers mentioned the need for information on climate change impacts as compared to outright changes in climate. Climate change impacts can be defined as the effects of climate change on natural resources and society. Land managers are interested in impacts including drought effects, plant migration, changes in vegetation class or wildlife habitat, and changes in fire regimes. Specifically land managers are asking questions about the spread of juniper, the spread of invasive annuals, the survival of seeds, the availability of water, and the spread and intensity of fires. Impact analysis can help formulate future management strategies, but unlike the information available for climate change projections, the information about climate change impacts has not been made widely accessible. GCM climate projections are widely available, but the spatial scale is too coarse for local impact projections. In order to assess impacts, new models driven by GCMs are needed (Tabor and Williams 2010).

Land managers need near-term forecast information

Weather projections provide local short-term atmospheric variables such as temperature, precipitation, atmospheric pressure, cloud cover, humidity, and wind. Weather forecasts extending beyond 3 to 6 months become increasingly unreliable due to the variability of such variables. Climate projections are averaged over the long term, usually 30 years, and take into

account global processes. Any projections less than 30 years have high uncertainty. Surveys and interviews showed that important timescales for land managers were 3 to 6 month seasonal weather outlooks, annual climate projections, and 10-20 year climate projections. As mentioned, the 3-6 month weather projections exist, but unfortunately annual projections and 10-20 year projections fall between weather forecasts and climate projections. This identifies a significant information gap. In order to fill this gap and provide land managers with a useful and useable climate tool, a near-term climate forecast will need to be incorporated into climate tools.

4. Conclusion

Climate change may add an additional threat to the already deteriorating sagebrush biome, and the decline of imperiled and endemic sagebrush species, such as that of the greater sage-grouse. The collaboration of climate scientists and sagebrush land managers has identified key trends in how existing and future climate tools can become more useable and useful for the management of sagebrush habitat in a changing climate. When constructing or refining climate tools, designers should consider all of the aforementioned information about tool access, consistency and dependability; spatial scales, near term temporal scales and relative historical periods; definition and explanation of terms, models and scenarios; inclusion of appropriate climate variables relative to land management activities, as well as climate change impacts; intuitive graphics, color scales; and the ease of incorporating the available information into existing land manager documents.

This study focused on Oregon and Idaho BLM sagebrush land managers and though it is a start to identifying land manager needs, it should not be considered as a finished project. Beyond this assessment of land manager needs, continued communication between climate scientists and land managers needs to take place, and collaboration on tool refinement needs to continue. Both climate scientists and land managers should seek out information and each other. Future surveys and interviews about tools for sage country should extend beyond the boundaries of Oregon and Idaho to incorporate sagebrush land managers throughout the Great Basin. But sagebrush is not the only habitat that will be affected by climate change. Additional surveys and interviews should reach even further to incorporate the needs of land managers of other habitats within a variety of federal, state, public and private entities. For a truly ‘useful’ land manager tool, the scope of collaboration may need to extend beyond land managers and climate scientists, and should include collaboration between separate tool creators and agencies. Climate change does not discriminate between habitats, job titles, disciplines, or agencies, and land managers should not be left alone to piece together future habitat scenarios. With an open ear, climate scientists can assist and support land managers through user-friendly information-rich climate tools that provide some insight into the challenges ahead. As one land manager expressed, “It’s still not

100 percent sure that this will be the scenario that we will see. But it's the best guess. It's the information and best science that you have available to work with at the time."

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APPENDIX A: Initial Online Survey

Default Question Block

How does your BLM district rank which climate variables affect the successful growth of sagebrush, from most important to least important?

	1	2	3	4	5	6	7
rain	○	○	○	○	○	○	○
snow	○	○	○	○	○	○	○
drought	○	○	○	○	○	○	○
flood	○	○	○	○	○	○	○
wind	○	○	○	○	○	○	○
low temperature	○	○	○	○	○	○	○
high temperature	○	○	○	○	○	○	○

If you would like, you may explain your ranking to the above question in more detail here.

How does your BLM district rank the threats to sagebrush, from most important to least important?

	1	2	3	4
fire	○	○	○	○
invasives	○	○	○	○
juniper encroachment	○	○	○	○
other (please insert threat name in text box)	○	○	○	○

If you would like, you may explain your ranking to the above question in more detail here.

How does your BLM district rank which climate variables cause and proliferate the #1 threat (from question 2) to sagebrush in your district, from most important to least important?

	1	2	3	4	5	6	7
rain	○	○	○	○	○	○	○
snow	○	○	○	○	○	○	○
drought	○	○	○	○	○	○	○
flood	○	○	○	○	○	○	○
wind	○	○	○	○	○	○	○
low temperature	○	○	○	○	○	○	○
high temperature	○	○	○	○	○	○	○

If you would like, you may explain your ranking to the above question in more detail here.

In order to best preserve critical BLM sagebrush areas, what type of information would your agency need from climate scientists?

We wish to provide both useful and useable climate information to help your agencies sagebrush management decisions. A few climate information packages are provided here. These are provided to help you assess what types of information you prefer and how you would like information displayed. Think about how they could be modified to focus on your domain and your scale of concern. After exploring these packages by clicking on the links provided below, do you see options (information, organization, scale, graphics, color schemes etc.) that you like or do not like, or that may work or may not work for your agency? Do you have other ideas of what kinds of information or graphics could be included in a climate package that may be useful to your agencies management decisions?

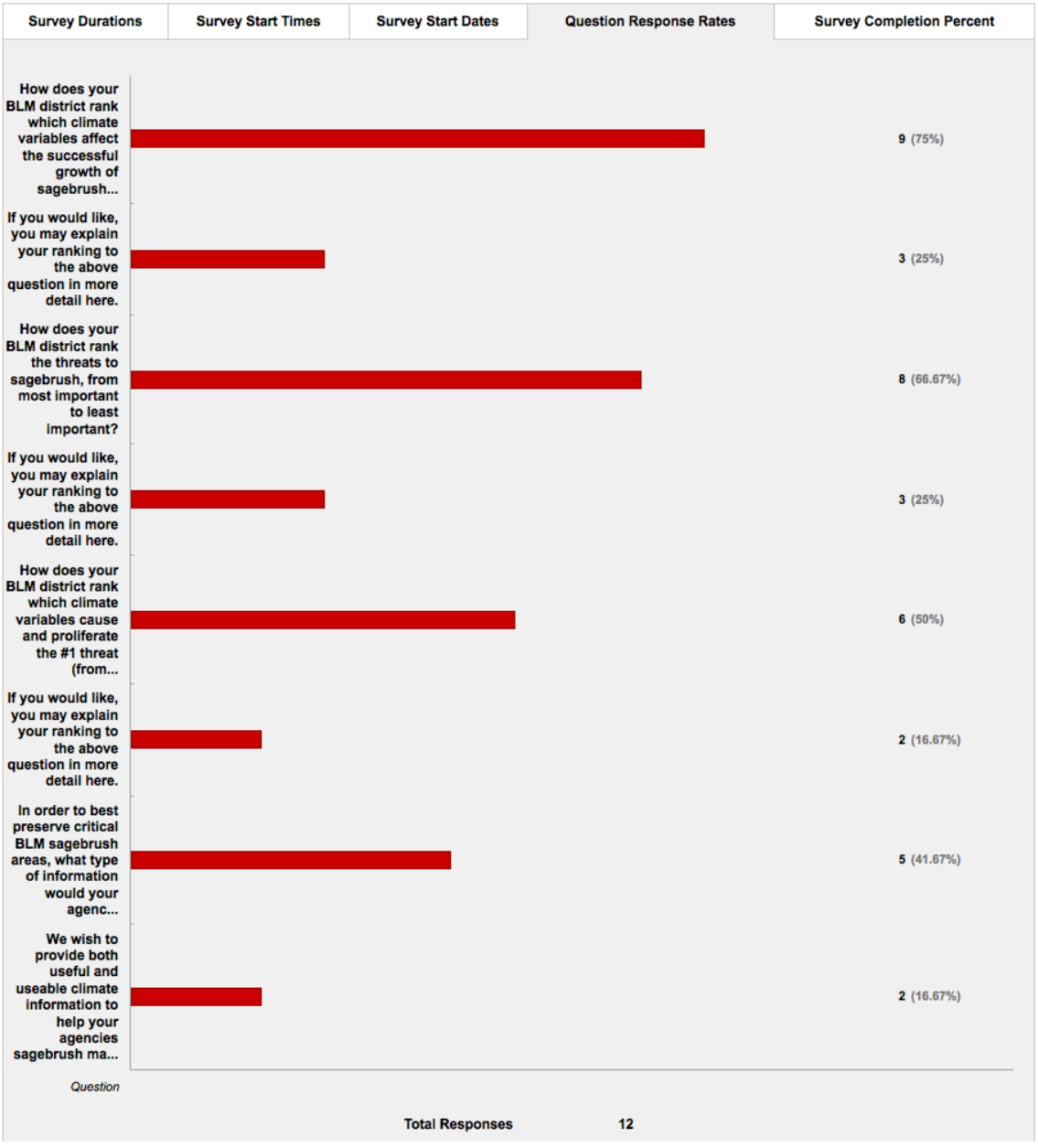
USGS County Level Climate Projections

Ecoregion Climate Data Explorer

Regional Climate Extremes

Western Drought Tracker

APPENDIX A.1: Initial Online Survey: Question Response Rate



APPENDIX B: Land Manager Interview Guide

Land Manager Interview "Guide"

Hello ___(land manager name)___, my name is Melanie Brown and I am contacting you about the sagebrush land manager and climate change research I am conducting.

I previously emailed you about the project and sent out an initial online survey about climate variables and sagebrush management. I would love to ask you some questions and gain some insight into how sagebrush is managed in the ____(district name)___ district.

1. **Response:** I don't have time right now.

- What time would work best for you? **(Response with time)**
- Sounds good. May I email you an outline of the topics I will be asking you about?
- I will give you a call on ___(day requested)__ at ___(time requested)__. Thank you. Have a nice day.

2. Response: I only have time for a brief moment.
- I understand you are busy. Is there a time that would be better for you so we both don't feel rushed through the process? **(Response with time)**
- Sounds good. May I email you an outline of the topics I will be asking you about? I will give you a call on ___(day requested)__ at ___(time requested)__. Thank you. Have a nice day.

3. Response: Sure, what would you like to know?
- Thank you for going over this with me. Do you have access to a computer at the moment? May I email you an outline of the topics I will be asking you about?
- Is it okay with you if I record your responses for this interview? To do this I will put you on speakerphone during this interview and use quick time pro. I will inform you of when recording has begun. Once recording has begun you will not be identified by name but only by participant # __. At the end of our conversation I will create a document of the recorded responses and email them to you for your review at which time you may approve or omit any statements as you see fit. This allows me to give my full attention to our conversation.
    - **a. Response:** No.
        - No problem, I understand. I will still try to capture your main points and email them for your review to be sure they are accurate and that I haven't missed anything.
    - b. **Response:** Yes.
        - Great. I am going to put you on speakerphone and set up the recorder. Please just give me one moment. You are now on speakerphone.
        - Before we begin please be aware that I am asking for your response as a BLM district manager, and that I am not allowed to ask for your personal opinions or views. If at any time during the interview I ask for your opinion, it means your opinion or views as a BLM land manager.

Interview Questions

1. Do you remember a year when the health and growth of sagebrush was in decline?
    - What caused this to happen?
    - What was the leading cause of sagebrush decline?
    - What information would have helped you prepare for this decline?

2. The survey showed fire as the leading cause of sagebrush decline.
    - Do you remember a year when fire in your district was most severe?
    - What caused this bad fire year?
    - What information would have helped you prepare for this fire year?

3. The survey showed grazing was another factor affecting sagebrush.
    - How does grazing affect sagebrush growth?
    - How does grazing affect sagebrush fire?
    - How does light grazing and heavy grazing each affect sagebrush?
    - How do managers decide whether to graze light or heavy?

4. I am now going to ask some questions about the 'Sagebrush Manager and Climate Information Research Group' I have set up for the project in Data Basin. The link to this group can be found at the top of the email I sent you. You will need to 'join group' and then I will authorize your entry.
    - Please take a moment to look at the maps created within the 'content' tab.
    - Is this information fairly accurate?
    - Do you have more accurate invasive, grazing, fire or sagebrush distribution maps you could provide me?

5. Now please take a moment to look through the folder titled 'Climate Tool Examples to Explore' within the 'content' tab. These tools are examples of how past climate information has been presented.
    - Please let me know which tools are most helpful and why. What may or may not work for land management decisions?
    - Can you think of other ways data could be presented to help with land management decisions?
    - Would you prefer receiving climate data through a website or in a news article?

Well that wraps up the interview questions. Do you have any final thoughts you would like to add?
Thank you for your time. I will type up a draft of your responses and email it to you so that you may add, or edit as you see fit. We will be sending out a follow-up online survey in early 2015.

Thanks again, Have a great day!

APPENDIX C: Follow-Up Online Survey

Default Question Block

The previous sagebrush land manager survey and phone interviews show a need for short range, weather related planning tools that look at seasonal and annual time periods. With this in mind, we have identified a few existing weather tools that already display some of this information. Would you be interested in learning how to find and use these current weather tools, and any relevant climate tools that are already available?

- ○ Yes
- ○ No

What would be the best way to provide you information on both identifying and understanding these existing tools? (You may choose more than one)

- ☐ Group Workshops that show how to find the tools, how to use the tools, and allow for hands on experience
- ☐ Online Webinars that show how to find the tools, how to use the tools, and allow for hands on experience
- ☐ One-on-one phone calls that show how to find the tools, how to use the tools, and allow for hands on experience
- ☐ A web page that includes links to a variety of tools with a short summary of how to use each tool
- ☐ The above web page, but also with a tech support number to call with questions about the tool
- ☐ Other (please specify in the box below)

The following link leads you to the Climate Console webpage, a brand new climate tool (not weather tool) focusing on the state of Utah and funded by the BLM. The climate variables within this tool were chosen for this particular project, however recommendations gathered during the phone interviews conducted last Fall and Winter were used to improve various tool characteristics. Please follow the link to open and experience the climate tool so that we may gather your first impressions. After navigating within the tool please continue with the following survey questions.

Link: http://eemaps.consbio.webfactional.com/blm

If you have questions about the tool or would like me to navigate you through the tool, I will be available by phone to do so on Mondays, Wednesdays or Fridays after 9:30 am (PST) from April 24th through May 15th. Please email me at [redacted] to set up a phone call time that works for you.

Please provide your first impressions and feedback about the Climate Console webpage in the box provided below. Please be as specific as possible.

How much time did you spend reading the documentation under the 'about' section on the Climate Console webpage?

- I read the entire thing
- I briefly skimmed it
- I only read the sections where I needed more explanation
- I didn't see an 'about' section
- Other (please specify in the box below)

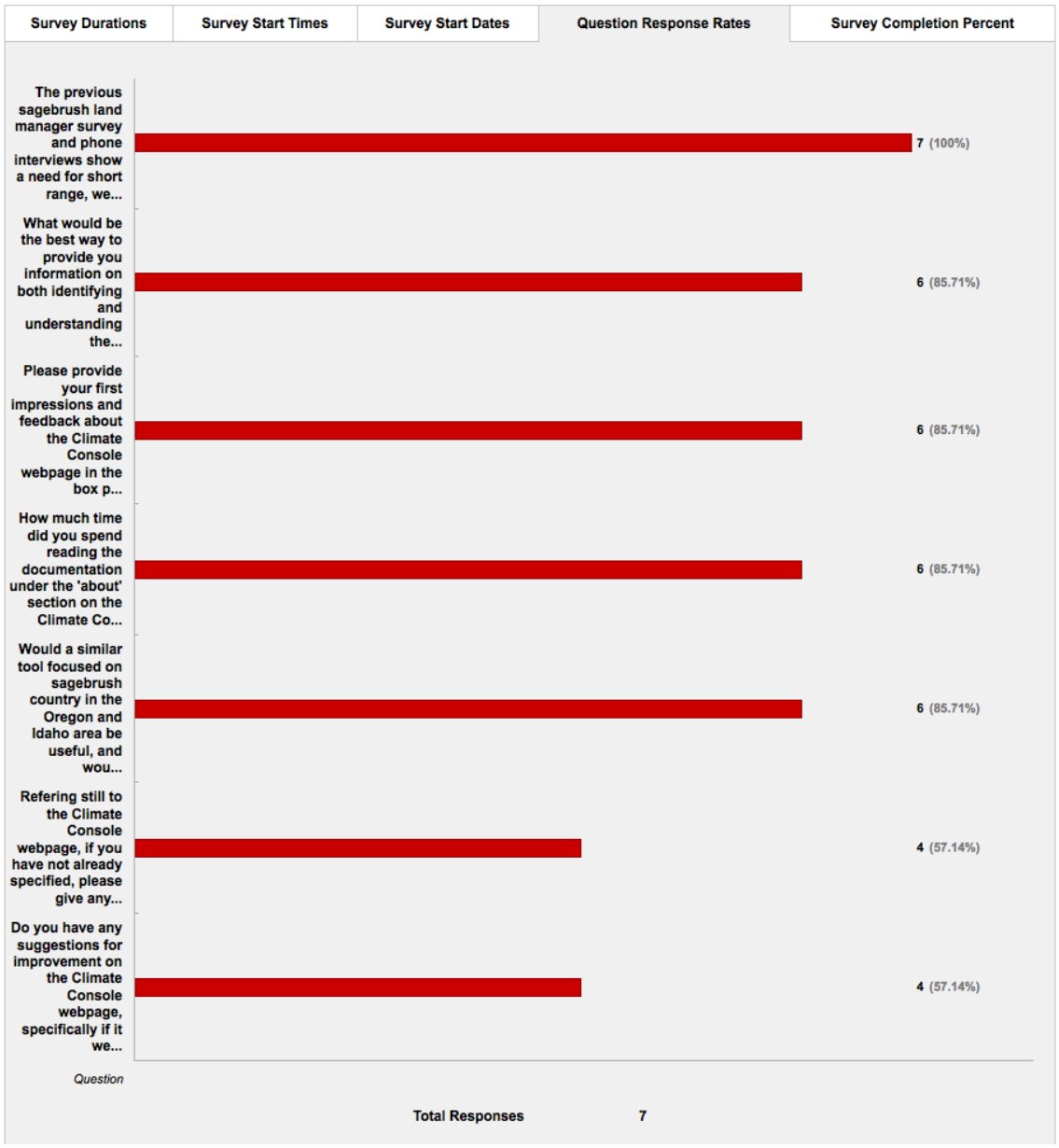
Would a similar tool focused on sagebrush country in the Oregon and Idaho area be useful, and would you be interested in using such a tool?

- YES
- NO

Refering still to the Climate Console webpage, if you have not already specified, please give any reporting units or variables (other than the ones provided) that you would like to see in a tool tailored to your area management.

Do you have any suggestions for improvement on the Climate Console webpage, specifically if it were to be tailored to your area?

APPENDIX C.1: Follow-up Online Survey: Question Response Rate



APPENDIX D: Land Manager Phone Interviews, Approved Responses

(Note: to maintain land manager anonymity, some statements made within the following interviews about location, or other key manager identifier's, have been blacked out.)

Participant #2

i. Preliminary Discussion

- Sagebrush decline is more long term then just over one season. Drought can affect growth, and in Oregon decline is more of a pattern that you see from year to year. The return on a decent sagebrush population is about 30 years. For example, after a fire its pretty bleak looking and I am sent out on projects post fire. Usually we see a slow return that isn't healthy or similar to how it was before the fire, at least with fires that are about 20 years old.
- Most of my experience has been 1-5 years in any between [redacted] and central Oregon, and the return seemed slower (due to dry conditions) than I would have expected.
- Sagebrush drought could be defined as the lack of precipitation or soil moisture (cracked soil). There is also a grazing or browsing pressure.
- Healthy sagebrush could include a diverse ecosystem with a diversity of plants and bunchgrasses that could hold some moisture in the soil, critters working their way through the soil, a duff layer to hold some moisture in, minimized winds or windblown areas where the duff has been blown away, and an area that has been minimally grazed (which impacts grasses as well as sagebrush). The amount of precipitation that is held is more important, rather than what has fallen.
- This district receives rain and snow, depending on elevation. It receives snow or rain in late October and through March or April. There could also be rainstorms in the summer. Both rain and snow have an effect on the healthy growth of sagebrush. If it's a mild winter and there's not enough snow then there won't be enough water in the region.
- Winds within the district are fast but they are intermittent. It isn't windy all the time. But if a front is moving in the winds will pick up.
- Grazing affects sagebrush growth through trampling, browse, and multiple other damaging effects. Sagebrush may be grazed directly but most of the focus is on what grazing is doing to the bunchgrass.
- If grazing occurs and then weed species such as cheatgrass or medusahead move in and create a monoculture (and cattle don't prefer to eat these) then these annuals create a fine fuel layer that will carry a fire through sagebrush.
- Grazing time is usually seasonally but it varies per allotment.
- This past year (2014) was a bad fire year. There were several large fires. Most of these were lightning induced. Some areas had medusahead infestation, some areas had sagebrush and juniper that became crispy from drought, areas with cheatgrass infestation, one area was a former homestead or agriculture field and it had turned to medusahead or cheatgrass. In a bunchgrass area, if that bunchgrass is dry after the rainstorms have stopped and high temperature days have evaporated the soil moisture, usually in August to September, then a lightning strike will ignite.
- Ventenata also occurs within the area.
- There does seem to be a difference in climate variables between areas that contain medusahead verses cheatgrass verses ventenata, but we have not yet quantified this. I have not yet had an opportunity to look at past climate variables and ask questions (Was it a dry spring or wet spring?) and then quantify the results with what was seen in the field, but I have mused on it.
- We do look at weather station data, for example precipitation. But the weather station might not be where the site is so that creates a problem. We have to guess whether the precipitation will be the same five miles away.
- It would be helpful to have annual precipitation information, for instance every May. But not every month within the year.

- Climate trend data is informative. For instance what is the trend for a certain areas over a certain month. Is it only windy? Wind, sunny or cloudy, precipitation, and temperature variables are important.
- If I was trying to understand why we might see medusahead more in one year than in another year we would need to look at historical and current data.
- Soil type is also important, but you would probably know that already because it doesn't change. Important site characteristics include soil type and the sites encroachment potential.
- If juniper goes unchecked it will fill in an area that may have been bunchgrass or sagebrush.
- This district mostly has Wyoming sagebrush (about 90% of the time). There is a little bit of mountain, rigid and low as well. Juniper encroachment and invasive annuals are seen mostly with Wyoming here.

ii. Maps

Current 2014 fires:

- Human started verses lightning started fire is good information to know

Cheatgrass and Medusahead distribution in WA, OR and ID map:

- In this district we don't really map cheatgrass distribution because we just assume that it's almost everywhere. What are we going to do to actively treat that on a daily basis?
- Currently we don't treat cheatgrass on its own; it's always thrown in with the treatment of annual grasses (medusahead, ventenata and cheatgrass). This is different in that if there were a large patch of medusahead we would treat it, but if it were a large patch of cheatgrass we wouldn't necessarily treat it. We assume that if an area is disturbed enough to have cheatgrass that its going to have other invasives within it.
- In the past we have treated annual invasives with imazapic herbicide using either aerial application or atv application on steep areas. There needs to be enough soil moisture for spraying to carry the herbicide into the ground. This herbicide is a pre-emergent and post-emergent, so you don't need to apply it to leaves, it can be applied to the soil. It is best to apply this herbicide after an immediate soil moisture event or rainfall, maybe up to two days after. It is also best to apply it one to two days prior to another rain event. This application usually occurs after a fire. This is more of a reactive behavior because if we had money we would probably treat before the fire.
- Variables that are also important before a spray include paperwork, funding, a contractor, area closures, are there rare plant/animals, is it hunting season, is it a recreation area, is it a cultural site, is there a waterway nearby. But climate conditions would include soil moisture, wind speed (usually about 6-8 but no greater that 10 mph windspeeds or it will drift).
- In some areas annual invasives are hand pulled if they are within a small population, which works pretty well. This is especially true for medusahead because it pulls easy. But hand pulling is not often a preferred method.
- Invasive species can be spread by almost any vector: deer or cattle, humans, vehicles, along the river, atvs, wind. Just because invasives aren't in an area doesn't mean they aren't able to grow there. For example, just because I don't see medusahead in scabland doesn't mean that it won't grow there.
- I do like the medusahead and cheatgrass distribution information but I wish it were polygons so that I could see the extent.

Boundary Land Cover Type:

- If a fire burns over an area we don't just go in and spray that whole area, and it usually comes down to funding, but we look at condition. If half of the area is deemed to be in good condition then we wont spray there. We concentrate on the fair and poor conditioned areas. We assume that healthy areas may re-seed themselves, because fire is a natural process, and we see how it will recover on its own. We may go back and hand pull or spot treat. But aerial application is for the fair and poor areas.

- Invasion of invasive plants is the leading cause in area degradation. The invasives then carry the fire and create conditions for more invasives to move in. It is a cycle.
- Cheatgrass and Medusahead may dry out earlier than native annuals. I don't know about ventenata in this regard yet. Right now medusahead is our main focus.
- An issue that we have on the district is that we haven't mapped medusahead or created medusahead polygons. The medusahead distribution is also changing, it could change every year or after a fire.
- Information about land cover is helpful but I wonder how old it is and where it came from.

Oregon & Idaho cheatgrass/medusahead distribution:

- The polygons show a lot of medusahead within a grassland area in the district. But these maps don't show much. I don't know that I could use it.
- We have internal maps of BLM known infestations of weeds that is better than this one, but our layer is just BLM. This information isn't private, its called NISIMS (National Invasive Species Information Management System) and it should be accessible. It is referred to by managers as a corporate layer, but it isn't comprehensive.
- It's hard to know what is on the ground so it has become common to just spray imazapic. This holds pretty much true for eastern Oregon.

iii. Climate Tools

NOAA Three-Month Outlooks:

- (no information)

NOAA Snow Cover Maps; NOAA U.S Climate Extremes; NOAA Climate at a Glance:

- At first glance I was not too interested in climate extremes or climate at a glance. I am unsure how but the snow cover might be useful.
- Climate Extremes: Once it was explained what the tool was showing it was interesting. Its interesting to see what years have what percent's of extreme weather, but I don't know that I would stick around this map for a long period of time.
- This tool of 'extremes' can be a bit tricky to explain.
- Being able to change the 'period' is interesting (e.g. from annual to warm season, cold season or hurricane season).
- It doesn't look like this is site specific for Oregon
- I look more at seasonal periods, mostly when plants are around (so starting in March) and then plants are curing out by September. The core times we're actually out in the field and trying to identify plants is when they're leafed out or in flower. This usually happened from April – July/August depending on the plant. I don't personally look at precipitation seasonality. I do not use water year.

AdaptWest:

- (no information)

(USGS) National Climate Change Viewer:

- I like the flags next to the different models under the data tab as a quick visual telling you something about the models
- I like comparing the models to each other
- I like being able to change the projected time period for each model
- This tool is interesting and I would play around with this.

(DRI) West Wide Drought Tracker:

- At first glance this tool already looks very useful
- For our area it is good that the source is University of Idaho because its more local, so I trust that its more accurate
- I have never heard of or used the palmer drought severity index (pdsi). The only way I would use it is if I saw a certain trend within a specific plant population I monitor each year. So if I had a question about what might be going on then I could look at the map and see that there was a severe drought. Or I might be looking back 20 years ago when a population was visited and had thousands of plants and try to understand why there are only hundreds of plants now.
- The drought indices kind of look like something I can use.
- The departure from normal temperature (anomaly) seems accurate for my area of interest over the last two months. This is interesting to me. I looked at this map during the original online survey and I found it useful.

Integrated Climate Scenarios in Data Basin:

- The graphs seem too metric. It would be helpful if this could change.
- It might be helpful if you could zoom in per year.
- What are all these models? Are these just models from the climate world? (The land manager seems interested in knowing more information about the models)
- I like the tool. But the ecoregion scale is pretty large. Also in precipitation the projection is very large and I don't know what I could extrapolate from it. Are we in a high rainfall decade or a low rainfall decade? Some of these are on a decade scale but every five years might be more helpful. Or another smaller temporal scale, such as possibly comparing years.

iv. Final Thoughts

- (no information)

Participant #5

i. Preliminary Discussion

- In the last couple of years huge wildfires have impacted sagebrush health. There were .5 million acres burned in 2012 and about 200 thousand acres in 2014. These were both areas with sagebrush and were caused by lightning in contiguous annual grasses under a drought condition.
- Over a couple year periods, maybe 2011 to 2013, there was a huge Aroga Moth infestation that left sagebrush unhealthy, defoliated and led to some sagebrush mortality. Increased moisture led to large annual and perennial grass production, followed by drought. Grazing didn't respond quickly enough so large grass areas remained causing large fire outbreaks when lightning occurred. A fire between this district & Vale district burned about 400 thousand acres
- District precipitation severely below average for a few years now and not much snow pack. District precipitation usually varies from 7-9 inches, 3-5 inches, 8-12 inches, and a tiny bit of 14" in the forested sites. Most precipitation is 7-9 inches, but precipitation has been arriving in spring, which causes grass growth but no recharge in the system, leaving a standing fine fuel that is very dry. Traditionally the majority of yearly precipitation comes from snow pack in winter.
- The elevation of the district ranges from about 3500 - 4000 feet up to 5000-6000 feet, with some at 9000 foot. Sagebrush species include basin and mountain, but Wyoming sage is the most abundant within the district.

- The district contains a sagebrush steppe area with mostly bunchgrass. Native species include Idaho fescue, blue bunch wheatgrass, Stipas, and needlegrass. Some sandier sites include species such as Indian rice grass, needle and thread, Sandbergs bluegrass, squirreltail. There is also some meadow habitat, but the district mostly contains upland vegetation. Interspersed through that is annual grasses, that has considerable amounts of medusahead (about a million acres) and a lot of areas with cheatgrass to varying degrees. Cheatgrass is everywhere but it is not problematic everywhere, its just present.
- The district has invasive annuals, such as cheatgrass, but very annual natives. There are some places where the cheatgrass is dense and problematic. It can become very tall and receives good growth because of a jump in fall followed by spring moisture and warm temperatures.
- Medusahead seems to have an advantage on heavy clay soils, and clay soils (27% or more clay) are common in the district. Places in the district with these soils are in fact places where medusahead is more common. Cheatgrass seems to grow better on loamy or sandy soils.
- A speculative possibility of why cheatgrass isn't a problem within the area is because of the districts very cold winters with no snow cover. A lot of frost heaving may then impact plants that receive fall growth. The district seems to show a difference from other areas in the uniqueness of these winters.
- Where medusahead occurs on heavy clay soils there tends to be big interspaces between sagebrush more so than on sites without heavy clay. This is because heavy clay can only support so much plant material and though plants may have a below ground root network there isn't much vegetation cover above ground. There are some forbs but mostly a lot of bare ground. Another possibility is that medusahead is successful because no matter how much drought occurs, there will always be spring moisture, and medusahead can germinate at very low temperatures and produces a seed in a short amount of time if moisture becomes limited.
- In a year with a lot of resources Medusahead will produce tons of seed, but in normal years it will still produce seed, although not as many. Either way there ends being a lot of plant material over the years.
- Natives need conditions just right to produce seed (which occurs maybe once every five years or so), and to have viable seeds and seedlings. So natives do not fill in as fast as medusahead.
- Areas where sagebrush is doing well, both mountain sage and basin sage communities, is usually associated with deeper, riparian soil and occur more often on private more fertile farmlands. Most areas like this include Wyoming sage, about a 3.2 million acre district. Fires are able to take sagebrush communities back to seral.
- Fire is the leading cause of sagebrush decline
- Not sure that grazing impacts sagebrush, except that grazing may have an effect on western juniper invasion in the sagebrush steppe community. Historic grazing (80-100 years ago) was intensive and juniper that historically was on mountaintops was able to move down eventually crowding sagebrush out. Cows don't generally eat or trample sagebrush. This is much more of a problem where inappropriate grazing levels can impact the understory.
- If there is a decrease in the perennial grasses then there could potentially be an increase in invasive annual grasses causing an area to be more prone to fire.
- There are many allotment management plans that for the last 50 years have made amazing improvements in understory species. The biggest issue right now is whether target grazing can be used to regulate invasive annual and decadent perennial grasses without damage and removal of annual seed, thus allowing for more vigorous bunchgrass. This seems to work in some places, but livestock grazers and cows cannot be sustained on this alone and need to be supplemented with other food sources.
- Bunchgrass gets going later in the year as temperatures warm, so if there is only spring moisture then the invasive annuals get the benefit and the perennial grasses have a harder time maintaining with this type of precipitation regime and they are more susceptible to drought impacts.
- There is a current discussion about how to manage sagebrush area (i.e. if there is a drought and then an early spring rain and an influx of invasive annuals then we might want to think about putting grazing pressure on so to prevent a larger area from burning)
- Light grazing over an allotment depends on vegetation condition. If the vegetation is in good condition then aim for light to moderate grazing treatment on it, but every plant wont be grazed on every level so aim for average and end up with places with some grazing and places with heavy grazing. But average will be whatever level of grazing you're shooting for.

- Grazing is meant to target a grazing level that maintains plant communities in a condition that you want them to be in. If these communities are in a poor condition you would chose a grazing regime that is going to help the native grasses improve. If vegetation is in fantastic shape then it can take heavier grazing. Typically grazing rotates through pastures. If you graze in one area one year you wont graze there the next year. Design grazing systems to maintain the health and viability of understory species that you're targeting.
- Currently using weather forecasts to know what is predicted, but then decisions are made out on the ground. Able to tell if its going to be a short precipitation year if by the time you get to mid-summer you have a lot of dry grass standing. You then know you're going to have bad fire year. Probably aren't a lot of models that are going to be able to make these decisions on a piece of ground.
- When we think it's a year that we're going to have a lot of fires all we can kind of do is cringe and go "oh my god here it comes again!"
- Weed program tries to come up with a district strategy and treat certain areas (e.g. buffers to prevent fires from happening, brush beating, green stripping) because we know our areas are susceptible to fire and we live in an area that's fire prone. We're looking to moderate fires to slightly more defendable spaces but that can be tricky.
- On a daily basis there isn't enough time to analyze where things are coming from or what is being done. If there was time then climate tools may be interesting but unsure of what would be most valuable. Specifically, if one looks at models and projections and then looks at what's actually happening on the ground, it may take decades to see if there's a correlation.
- Personally, climate tools would be most useful if delivered via the internet and looked more at annual trends. Some may find a need for a daily, weekly or monthly basis.
- Job duties include planning treatments; tracking weed infestations; cooperate with partners on addressing issues across ownerships; prevention program to keep spread of weeds via people; outreach and education awareness to multiple audiences (e.g. BLM staff, check permitees, road builders and lot builders); significant bio-controls; reasonable treatments; herbicide application program.

ii. Maps

Cheatgrass Boundaries Map:

- The problem with invasive annual grass mapping is that there hasn't been good tools to deal with it for last 30 years because the state was under court injunction that only allowed a handful of herbicides to be used and these weren't very effective for annual grasses. No one wanted to spend any time mapping it because no one knew when anything was going to be done with it. Generally we map as we go to deal with it. Currently the district is developing a district evaluation for treating noxious weeds and is putting together a strategy on how to display areas where invasive annual grasses are present. The district is putting together medusahead management blocks (i.e. polygons where known issues with medusahead have been inventoried). The same is also being done with cheatgrass but now there is an assessment of areas where cheatgrass has been an issue (particularly with wildfires) but has not been mapped. This may soon be available information on the Oregon BLM website.

iii. Climate Tools

NOAA Three-Month Outlooks:

- (no information)

NOAA Snow Cover Maps:

- I'm not sure that snow cover would help

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- Pretty basic

AdaptWest:

- (no information)

(USGS) National Climate Change Viewer:

- (no information)

(DRI) West Wide Drought Tracker:

- Palmer Drought Severity Index (PDSI) is not used in my specific management. The environment is pretty dry getting 7-9 inches if lucky.

Integrated Climate Scenarios in Data Basin:

- This tool did not work for me

iv. Final Thoughts

- (no information)

Participant #6

i. Preliminary Discussion

- I am the district invasive plant species coordinator. The majority of our weed populations tend to be in areas where the range is depleted. [redacted] we pretty much work exclusively in sagebrush steppe. Then we also have a lot of wildfires that happen, which takes out all the sagebrush and it is likely in those areas that weeds will move in. It takes awhile for the sagebrush to grow back.
- We primarily have Wyoming and mountain big sage, but there is scattered stiff sage and low sage. The invasives we're most concerned with in my district is rush skeleton weed, white-top (hoary crest), medusahead, cheatgrass, yellow-star thistle, ventenata, jointed goat grass, and vulvus blue grass. As well as a variety of thistles and other knapweeds. These are a mix of annual and perennial invasives.
- Our main focus is towards skeleton weed. It encroaches on the sagebrush areas and grows in conjunction with sagebrush very well. It's a rhizomatous perennial so it takes resources away from the desirable plants, with sagebrush being one. It likes to come into places that have burned. It is a wind born seed so it spreads fast over large areas. We get a lot of it [redacted]. We are trying to maintain our skeleton weed infestation to keep it from marching west.
- Primarily we use herbicide and some biological control agents that are in the experimental phases. We use both aerial and ground application for herbicides. We currently don't manage for cheatgrass infestation in the district but we will start here in the next couple years and we have plans in the process for this. [redacted] have previously been under herbicide injunction. Both BLM and Forest Service land under that injunction have only been able to treat state, county or federally listed noxious weeds. And the

cheatgrass has not been listed as one of these noxious weed types. But that's changing now and we're writing new NEPA and by this time next year we should be able to do treatments. This includes the annual invasive complex as it pertains to sage-grouse habitat mostly, so medusahead and ventenata as well.

- For skeleton weed, the chemical treatments are driven by temperature and soil moisture. So the soil can't be frozen, it can't be over 85 degrees and we need some moisture in the soil in order for the chemical to be active. In this district we get all sorts of moisture in spring and fall, but then it dries out so fast and it gets so dry that we can't spray at all until the fall again. So we're pretty much shut down in the summertime. The chemical we currently use is a pre-emergent. It doesn't matter whether the soil moisture comes from rain or snow.
- Rush skeleton weed is a plant that can pretty much grow all year long as long as it has the right amount of precipitation and the right temperatures. Its very drought tolerant and can grow in widely varying conditions. It's very tenacious. It's easy to find. We usually look for it in the summer time when it's really hot and when everything else is crispy. Skeleton weed will still be green and growing because it has deep roots in the soil and it can still draw whatever moisture it needs.
- As the climate seems to be warming we suspect that this will favor the increase of cheatgrass. I expect it to expand. We have a 5 million acre district and we've estimated probably that half of that already has cheatgrass on it. Usually where there's cheatgrass there is also venteneta and medusahead, depending on your soil type.
- There seems to be a difference between where cheatgrass or medusahead establish based on soil type. Medusahead seems to be tied to soils that are a little higher in clay.
- Cheatgrass and medusahead are winter annuals that tend to germinate in the fall and they like it cool. For instance if you get a cool, moist fall or winter. We're used to hard cold winters with lots of snow, but the past few years we've been seeing the winters getting warmer and wetter. More rain and less freezing. So the cheatgrass is germinating all winter long.
- Variables I would like to see in a tool besides temperature and precipitation (snow and rain) would be elevation and soil type.
- Temperature, wind and humidity are also factors that play a role when we do aerial applications. But these things are determined in the field on the day you're going to spray. You may have a contractor lined up but you don't actually know if you'll be able to spray that day until you get there. We look at these factors before we go out anyways but the information isn't as refined or site specific.
- If there were a way to know that when you were out there on a spray job to be able to pull something up through internet or satellite and do a localized forecast for that particular area and what's predicted to happen over the next 12-48 hours, this would be helpful.
- We really need it to be site specific. We do a lot of guessing. We consider topography and prevailing winds, but it's more about being able to pinpoint current conditions and predict how that's going to change over the next several hours. As opposed to an average forecast that just tells you its windy or 90% chance of rain. But it needs to instead be tied to your GPS location somehow.
- I agree that fire is the leading cause of sagebrush decline. Our summers seem to be warmer and drier for longer. We've always had times where it might approach 100 degrees for a few days, but what we've seen in the past three years is that we'll have about three weeks where its in the high 90's. If you talk with older folks they say that this is really unusual. I think that it's probably having an effect on our fires. I was looking at some fire history yesterday, and our fires in the last 5 years tend to be a whole lot bigger and we're getting more of them.
- We're doing more fuel break projects such as green stripping with fire resistant plants, and mowing along roads to create fuel breaks. Especially in areas where we have important sage-grouse areas, which is most of our district. We're also looking to do a lot more of this.
- Part of the process will be doing some more rehabilitation projects in areas that have already converted to invasive annual grasses because they're so flammable. And that's why our fires are getting more frequent and larger because we're getting an increase of annuals that like to burn. They are not resilient to fire like our native communities are.
- The ideal situation is that we remove the invasives and then re-vegetate with something desirable. We've talked about going as far as actually planting sagebrush plants but this may be prohibitably expensive. It's a multi-varied perspective from spraying or burning and then walking away, to actually going out and

planting sagebrush. With the importance of sage-grouse habitat this planting may not be an un-realistic thing to plan.
- The best tool for me would be looking at a 10 year progressive time period. Looking at at annual increments such as 1 year, 2 year, 3 year etc. Seasonal, in 3-month intervals would also be useful information to have.
- A tool would be most useful if it were online; because everyone's doing things online now and our offices are too small to store publications. And this tool would be most useful if it were updated once a year.

ii. Maps

- (no information)

iii. Climate Tools

NOAA Three-Month Outlooks:

- (no information)

NOAA Snow Cover Maps:

- (no information)

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- Its cool that I can look at the temperature anomalies, or anomalies in general.
- I don't personally every use the Palmer Drought Severity Index (PDSI).
- I like this tool. I like that you can look at different years.
- I would like it better if it were finer scale, finer than divisional. Maybe into counties instead.

AdaptWest:

- My area falls between a few ecoregions on this map.
- When I hovered on the map ecoregion there was no graph on the left highlighting a point for me. This tool did not work for me.

(USGS) National Climate Change Viewer:

- I like that you can select different states in this tool.
- We would be interested in some of the climate inputs that go into the different climate models that make the different projections. Or we should at least able to find that information easily if we wanted to.

(DRI) West Wide Drought Tracker:

- This tool took a while to open.
- I like the question marks next to the different drought indices that explain what each drought index abbreviation stands for.
- This tool, when looking at the temperature anomaly for the last full month (November 2014) makes sense and seems to be accurate. It portrays a higher temperature, which correlates to the warmer, longer

temperatures and higher fires that we've been seeing. The amount of precipitation seems to correlate as well.
- This tool is easy to assess and the map colors work well.
- I don't do any kind of modeling stuff and I'm not usually the person looking at this type of data, I delegate that to other people. But I like that this tool is really useful for someone like me to look at this data at a glance.
- I think for what we do the drought indices are really important. I like having the variety of the drought indices.
- We have a GIS specialist and I do a little bit of GIS myself.

Integrated Climate Scenarios in Data Basin:

- This tool took a while to open up for me.
- I hadn't heard of RCP (Representative Concentration Pathway) scenarios, such as RCP 4.5 or RCP 8.5, before this.
- None of the graphs appeared for me in this tool. None of the variable words above where the graphs were supposed to be were there either. This tool didn't work for me.

iv. Final Thoughts

- (no information)

Participant #7

(*Note this specific interview is a group interview with 3 land managers. Comments necessarily specific to each land manager are labeled 7a, 7b, or 7c to indicate each land manager separately.)

i. Preliminary Discussion

- We currently have an ongoing loss of sagebrush due to wildfire. In 2012 we had the Long Draw fire and approximately 800,000 acres burned [redacted] Since then we average greater than 100,000 acres burned a year. Prior to that we averaged about 100,000 acres burned.
- The change in this climate regime is probably from climate and fuels. We have a lot of annual invasive grasses and we have had a drought going on the last few years, which has been conducive with fire starts.
- We define drought from the SNOTEL site. I can't remember how much below average we were this year (2014), maybe 30-40% below. It was substantial enough that the agriculture farm services was giving out money to ranchers because of the persistent drought conditions that have been going on for the past few years.
- Precipitation usually comes in the form of snow, usually about 11 inches. Down south last year we may have gotten 7-8 inches (snow?). This year it came at a time where it promoted grass growth but there wasn't water anywhere else. It created a paradigm because there was all this fuel but we didn't have any water in the springs, creeks or for the livestock. This may have been part of the reason we had such a bad fire year too.
- The district is a little greater that 5 million acres [redacted] Elevations range from about 800 feet to a little over 8000 feet [redacted]. We have mountain, basin and Wyoming big sagebrush in the district.
- In the district we have native grasses as well as medusahead, cheatgrass and ventenata. The crested wheat grass and intermediate wheatgrass are also seeded grasses in the district.

- Sagebrush is deeper rooted and it is well adapted for the winter precipitation we have here in the northern great basin and Blue Mountains. Cheatgrass and medusahead are winter annuals and they're well adapted to precipitation as well. The warming temperatures we're having are wonderful for them to sprout and start growing early. This year (2014) we didn't get much of a snow pack but in mid-late spring the rains came and they came hard. Many of the non-native grasses and native grasses put on a lot of growth. Last year was the first year I really noticed that the precipitation came at an abnormal time of year.
- We definitely received more rain in the spring than we've seen prior. Snowpack was pretty average in the mountains over the winter, but we did not have the snowpack down lower in elevations. Sagebrush is well adapted for disbursing seed across snow.
- We have juniper encroachment in the area.
- Our soil types are variable from clay to silt to sandy soils.
- We've been seeing that most of the Wyoming big sagebrush is more susceptible to cheatgrass invasion. That's also what it says in the research. Up in our mountain big sagebrush where it is a little cooler and there is more precipitation we have good stands of native grass underneath the shrubs. But in our lower elevation sagebrush is where we're seeing problems.
- I would agree that the leading cause of sagebrush decline is fire.
- In the northern part of the district we've been developing our grazing system based on research we've received out of Montana, and its been working well. Our trend plots show we're improving and we're meeting rangeland health standards when we change over to this system. I don't think that livestock grazing here is really having that much of an impact because we've got good deferment during the critical growing season of the native grasses. We've got fairly low utilization standards. The areas where land use was converted back in the 30' s-40 are still bad but the grazing we have now I don't see as a problem.
- Basically we're trying to figure out how we can maintain rangeland health using grazing. We don't really use grazing as a tool to improve the area but we do practice early spring and fall grazing to see if we can knock cheatgrass down and promote some native vegetation to come back in. We mainly just try to maintain grazing and rangeland health instead of using it as a tool.
- Right now there isn't much we can do to control annual invasives because we're under a herbicide injunction. But that's going to be lifted shortly. We can only use a handful of chemicals and none of these at our disposal are appropriate for cheatgrass. One thing we do is livestock grazing of the cheatgrass to reduce the fuel loads and fire severity, so that we don't kill off the natives in adjoining areas.. The science says that if you have a high severity fire in these areas then you're running the risk of converting it over to cheatgrass. This is one of the things we put in our environmental documents. We tried in the past to burn some of the medusahead sites and then go back in and re-seed them and they were failures so we gave that up a number of years back. We're optimistic that in the coming years we'll be able to use the application of herbicides to be able to knock these grasses out. The Soil and Water Conservation District (SWCD) here has been having really good results on private land treating medusahead in sage-grouse areas. We're optimistic that once we can use these chemicals we can improve some of these areas.
- On a small scale the range folks will manually pull weeds, shovel weeds, whack weeds. This can be significant at some sites over the years for scotch thistle, but not medusahead. We mostly pull during the spring rosette stage for the thistle. The rosette stage for scotch thistle usually occurs in early spring when the snowpack has left and there is moist ground, maybe around February-March.
- (7a) As a manager in the range department fire isn't on our mind. We focus on vegetation growth in conjunction with how the rangeland is looking in all the areas. How much the cattle have eaten or not eaten. Where are the cattle? Are they on the allotment right now or not? We'll try to cover a bunch of land we're, not just in specific areas. We have a lot of thistle encroachment that grows very tall and can take over some key areas (sometimes riparian, sometime not). For me it is whack em' when I see them over a large area. I look for what the grass is doing, the shrubbery that's in riparian areas, the cattle disbursement, and how much cattle have eaten in certain areas.
- (7b) For me as a land manager fire does take precedence. I deal with fire suppression during the summer and making sure the fires out. Once the fires out then we have 21 days to complete the rehab plan. It's a tight timeline that needs to get done in a timely manner. The proactive restoration of sagebrush is a second priority but there's not that much time spent on it.

- (7c) As a BLM supervisor there is day to day work: going out to the range, making sure we're in compliance with our permits, doing fire suppression, etc. Then we also deal with project work. We look for cooperators, so that the project has a better chance of being pushed through. For example our juniper reduction project. Many times these projects work in cohorts with projects that are occurring on private lands so we're getting the biggest bang for our buck. We've treated alongside private land and state, and try to get a complete approach and treat the entire landscape. We're trying to reach 40, 80 and 120 acres here trying to take out big chunks of juniper in order to promote the sagebrush and the sage-grouse habitat. We get multiple potential projects that may make it a year but not all of them are able to make it through the first or second cut. We sit down and try to weigh the pros and cons of each project. We need to figure out which projects we're going to devote staff and staff time to. Its pretty much looking at a landscape approach.
- We've had a pest infestation of aroga moth in the past but currently they're not that abundant. Prior to about 10 years ago or so you could find dead stands of sagebrush on the district and I believe aroga moth was the cause.
- We've had a sagebrush seed collection contract going for the last three seasons and it hasn't been really successful. We haven't seen great sagebrush seed production because it seems to be reliant on late season summer precipitation for the plants to actually develop good seed. So the ongoing drought has probably limited the seed production. In addition we've been targeting Wyoming sagebrush for seed collection and it is typically mature in late November. The last two years we've had sub-zero temperatures in November and December and we've observed that the seed has dropped very quickly from the plants after these types of temperatures.
- When planning fire suppression and fire rehab we look at more immediate weather and how is it going to affect fire. We look out a couple of months to see what the drought forecast and the temperature forecast are. This helps us plan resource allocations for fire suppression. I'm not involved in that but I believe that's what they do.
- We do look at national drought indices for our management currently.
- We pretty much rely on the monthly weather forecast, the SNOTEL sites, and the drought indices from NOAH. If it looks like it'll be a really dry winter and we wont be getting too much spring growth then we start calling our ranchers and letting them know that they likely wont be able to go out or stay as long as they have in the past. We will cut their numbers or their AUM's. If the drought index shows we'll be going into a severe drought then we start writing letters to permitees to inform them. We usually look about once a month to see the percent of normal snowpack.
- In range management we look at short scale, usually to see if we have enough moisture during the beginning part of spring, or to see later on in the year. Usually the monthly drought indices or monthly precipitation maps is what we go on. We'll use these but we also use the fieldwork that we've done. I have four permanent employees that go out regularly to look at the range and see if things are okay. These folks plus some seasonal staff seem to work well for us and it is how we've been doing it for a long time. I don't really foresee improving it much. When the staff go out into the field they're looking to see if there is enough grass for the livestock to eat, so they'll go out before the rancher turns out, especially if we're going into drought conditions, and they'll report back to there supervisor or sometimes they'll even just go talk to the ranchers themselves.
- We're looking at the critical growth stage of bluebunch wheatgrass or Idaho fescue (our two most native grasses here) to make sure that we're not grazing them during a detrimental time. In the riparian areas they're looking at the stubble height of the herbaceous plants making sure there's enough material to handle the high flows of the following year. They're also looking at upland forage utilization making sure that there's enough residual plant material there to handle the winter rains, so that we reduce the probability of massive erosion occurring.
- Overall they are looking at the type of vegetation on the ground, the amount of vegetation on the ground and the health of the vegetation.
- We look at past weather and upcoming weather. We don't really do any water table monitoring.
- We have a variation in wind across the resource area. I've been working in a new area just east of Baker and I've noticed that the wind factor does play a role in that area, compared to other areas in the district. A few of the more seasoned staff say that if we get a decent rain but then the wind picks up that the soils are going to be dry fast. Sometimes we don't get the production that we thought we would with the

spring rains just because that wind blew so much and dried out the soil. This is what long-term staff say they've been noticing for the 15+ years that they've been here.

- We have such a variation in elevation, and this comes into play in the production of forage. In higher elevations the ground keeps the soil moisture and so our forage production is more robust and will hang in there for a greater length of time. The lower elevations are a bit drier. The soil type plays an important role too.
- We do see some juniper encroachment in some of our drier sites and in Wyoming sagebrush country.

ii. Maps

- (no information)

iii. Climate Tools

NOAA Three-Month Outlooks:

- (no information)

NOAA Snow Cover Maps:

- (no information)

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- (no information)

AdaptWest:

- We would have to play with tis tool for a bit to understand more of what it does.

(USGS) National Climate Change Viewer:

- This tool could be useful but it could be hard to determine which climate model information to use.
- As a manager, we may have to go to court on something and we need information that isn't conflicting. For example, if there is one-model projections that says it will rain a lot and another model projection that says it's going to be dry. And we write our document on the worst-case scenario dry model and cut livestock grazing in half based on these future projections. Then we get taken to court. The other side is going to say why didn't you use this other model that was more favorable for us. In a lot of these things we need to be able to justify which model we used or the science that we're choosing. Is it the model projection that is best fro our area? We can't be arbitrary in choosing a model projection.
- I would like to see all of the models compared. I don't prefer just an average because I feel that you loose something with an average. It would be best to see which model fits us best here [redacted]. If you gave me this tool now I would be throwing darts at it trying to figure out which model is best for this area.
- Knowing some of the inputs to the models would be helpful and useful. Having the average along with the different models would also be good.
- In our management we're looking at the resource area or the district. Using the ecoregion temperature and precipitation may work, but it is hard because our resource area extends all the way up into

[redacted] and variables can be completely different. We're always cautious about this when we write our documents.
- This tool is good because you can easily select for the variables and different tool elements and can easily change them.

(DRI) West Wide Drought Tracker:

- I believe the Palmer Drought Severity Index (PDSI) is what we do use.
- I am not sure if we use the other indices provided in this tool, we just use whatever drought index is on the NOAH site.
- November (2014) seemed colder than usual, and now December (2014) has been very warm, which is a weird temperature anomaly that I've seen.
- When we go to open the various things within this tool we're getting an adobe pop-up first.
- This tool seems interesting. I can see some use in this, especially if we have something that we cant explain. If rangeland health was managed to the best of our ability and then all of a sudden we're seeing changes in vegetation then we can look here at the drought maps or the past temperature maps and see climate variables occurring on the site verses grazing or other non-climatic factors.
- I can see a utility in this tool for our documents.

Integrated Climate Scenarios in Data Basin:

- I haven't heard of RCP (representative concentration pathways) prior to this interview.
- Looking at these maps side by side for our ecoregion, and looking at the vegetation, I am not sure that the historical decline in grass in necessarily climate driven. What is the historical vegetation in this tool based off of?
- The BLM back in the 60's-70's-80's were aggressively treating sagebrush stands with herbicides so that we could improve the livestock forage. Now we hardly do any of that, any big sagebrush removal or prescribed burns, or brush beating. I also don't know about the woodlands, but back in the 80's we logged quite a bit. The production we've done now for both the forest service and the BLM is significantly lower. I don't know if the vegetation graph in this tool is showing climate variables or if it's showing the changes in how we've been managing our lands. What is this historical vegetation class based off of? It would be helpful to know where this information comes from, whether it's from historical projections based on climate variables or if its from on the ground information.
- We have seen an increase in forest as the historical vegetation graph for our ecoregion is showing, but the dramatic loss of shrubs doesn't seem conducive to what we really see on the ground.
- What we've used in the past is soil surveys that are linked with potential vegetation as a baseline of what historic vegetation was. We also have records of what we've done and personal experience from being out here so many years. We've started mapping the areas that were converted over to non-native annual grasses, and putting in areas we've been seeding with crested wheatgrass since the 1950's. This gave us a rough idea of how many acres have been disturbed on the [redacted] resource area and we have used this in our planning documents. It is pretty substantial. About 30-40% or more of Wyoming big sagebrush has been converted or seeded. These maps went out in our AMF.
- This tool is useful, but if it doesn't make sense to us then we're not going to use it, especially compared to what we see on the ground.

iv. Final Thoughts

- (no information)

Participant #9

i. Preliminary Discussion

- I have been with BLM 2.5 years now. I was previously with the forest service [redacted]. Over the past two years the natural cycle and health of sagebrush has come in ebbs & flows. [redacted] (2012) it was dry and there was a bit of a drought. Growth was not so good that year, but in 2014 the growth was impressive and a lot of it was driven by more moisture.
- In 2014 there was a lot of late spring moisture and sagebrush looked fantastic. There was then a lot of moisture again in August into September, and it looked as though the sagebrush was putting on a second phase of growth. In August 2014, there was 4-6 inches of rain and this was late rain that doesn't commonly occur in these amounts.
- As a manager, it seems that most of the decline in sagebrush health comes from decadent foliage.
- In several areas where there is juniper encroachment the juniper is very hardy (the 'weed' of trees). Juniper essentially sucks a good portion of the nutrients away from other vegetation types in the area. Over time as the juniper gets older and become prolific in reproduction they move in and suffocate other species. There are different phases of juniper encroachment: stage 1 = fairly healthy sagebrush/steppe with a couple of junipers intermixed; phase 2 = 50% juniper and 50% sagebrush holding on; phase 3 = start to see only skeletons of sagebrush and a large recruitment of cheatgrass on the drip-line ring of juniper. This may not happen in all areas but it's typical in a lot of this area. As juniper grows old you breach a new site. According to the ecological site descriptions, when it's a true phase 3 you have gone over the ecological threshold of expressed vegetation type and you have come into an unknown new site. This can happen over a hundred years or more (approximately) if it occurs on a site where nothing has been done. Looking at historical photos, there seems to be quite a bit of juniper encroachment from historical sites to now.
- In the middle of 20th century there was a moisture period that may have allowed for a many junipers to proliferate and move down further into lower elevations, but there's a lot of different players that go into why juniper can encroach.
- A lot of climate variables are my personal opinion from working in different areas and looking at progression since I began at BLM.
- The mid-20th century moisture that may have produced larger cone crops and seed crops, thereby producing larger availability for those seeds to spread. Its about trying to figure out what is happening, what's going to happen, and how to deal with it.
- Fire has become a problem since the late 20th century into the 21st century. We are seeing more sporadic fire behavior and the sagebrush itself seems a lot more susceptible to fire because of the drought and the dryness. In some fires the relative humidity may have been lower.
- Sagebrush typically grows very dense, so fire behavior in sagebrush can be larger and erratic. In 2006-2007 large acres of fires burned sagebrush country because the erratic fire behavior didn't allow the placement of people in front of it.
- Sagebrush crowns spread far and the wind behind them allows the fire to jump the gaps between sagebrush. In healthy sagebrush you have a forb and grass component that creates a ground fuel to carry the fire.
- In addition to fire, juniper encroachment into sagebrush increases fire behavior. In a phase 2 juniper encroachment into sagebrush steppe, the crown level of sagebrush increases to a crown level of juniper (20-50 feet tall). The increase in crown height makes fire more available to wind and also increases the spotting distance.
- In Phase 1 fire somewhat more isolated and more manageable. In a phase 2 or 3 firemay transition vertically.. Much of this depends on a variant of weather conditions such as wind, temperature, relative humidity, fuel moisture and topography as well.
- 2006 was a bad fire year. I was [redacted] in the great basin and it was very dry, very hot and very windy. There was fire after fire. There was also a lot of lightning that year. Essentially we were always behind the curve. I remember dry lightning and little precipitation that came out of those storms. South in Utah I recall almost 115 degree days that were very warm. Some of these same warm and dry conditions translated into 2007. Both of these years produced large fire years. A lot of the areas [redacted] in that year also had really low relative humidity.

- I am interested in information about what climatically caused the juniper encroachment in the first place. I could then look to see if we're going to see more of that or maybe that it moves based on the soil type or where is the water table underneath (juniper have longer roots than sagebrush).
- Understanding what climate conditions promotes the invasion or spreading of juniper would be really helpful. At what elevation would this spreading be worse? Is it elevation, is it aspect, is it general climate trend?
- My elevation runs from 3500 to 10,000 feet and includes mountain, Wyoming and big basin sagebrush. There may be Bonneville sagebrush in the lower lake areas. The juniper seems to encroach into a lot of them.
- From talking to some long time BLM managers and looking at historic photos of when the area was being established in late 1800s, it seem that the juniper wasn't as low in elevation as it is now. It has been a hundred years since these photos and the juniper is now down much lower. What happened in this time frame that allowed junipers to establish and proliferate? Maybe they have always been moving this way but it was just one static photo in time? It can be hard to date as we were just coming into this area. Either way there is more juniper on the hillsides now than there were in those photos.
- Juniper treatment is generally mechanical. We have used several different methods of including logging equipment, mastication equipment, and guys with chainsaws. How climate would help that I do not know. These are usually done year round. Mastication depends on the soil type or the erosion level of the soil. I have done some winter mastication verses summer mastication. Snow might help because it holds the soil in place. For the rest of it we pretty much cut in the summer and burn in the winter.
- Sagebrush on the landscape helps capture snow and as wind blows it creates snow pockets. Rain comes in early spring and then stops, and we don't see moisture again until the monsoons in late July or early August. This year (2014) monsoons were a bit greater and for longer. From looking at NRCS outputs for this area the 30 year trend is a lot lower now than it used to be, and the 30 year trend previously was a bit higher in precipitation. This last winter our SNOTEL sites said we were at 120% normal, but that's the new normal. The previous historical year normal may have been average. There is a difference from last 30 year trend and the new 30 year trend, which we just switched over to. I recommend looking at 'NRCS 30 year trend' precipitation amounts because the amount has decreased. This tool gets distributed once a month around the office.
- I look at fire tools put out by NIFC (National Interagency Fire Center). I realize it isn't an end all but it helps to project what might happen for the year. But these models from such a large area that are put into a small area are not always conducive.
- Most of the work I do is around urban interface. There isn't much grazing within this area.
- We use ecological site descriptions put out by the NRCS. These show what vegetation would grow or should exist using the soil type.
- I used the palmer drought index and other drought indices more in southeast areas of the US, but now so much in my current position and location.
- I do almost all GIS work myself. There is also a GIS specialist that helps out when I get stuck.
- I generally need to forecast out about 10 days. That is as far in advance that can be planned for burn piles or broadcast burning, to see if there will be a dry window with precipitation on the backside so that the burn can be carried out successfully but then have mother nature helping with the process. We look as far out as the weather service will allow us. The restriction is from both the tools and how far out they allow me to see and the resources that are available. Burn piles usually happen when work force has been depleted during the winter months. In fall & spring there is a greater workforce when fire crew captains and assistants are back and then later in the spring when the hotshot crew is back on. These added people allow for a larger burn such as a 60-100 acre burn, instead of a 40 acre burn. We can burn the whole unit instead of having to split it into two smaller burns. It is usually safer to burn during a spring window because it will take out the more decadent (old) growth and the younger sagebrush has a greater survival because has a higher moisture component to it. There is more of a mosaic effect during a spring burn verses in fall where it all may burn.

ii. Maps

Cheatgrass distribution:

A good portion of the Snake River Plain and south of Boise has a lot of cheatgrass. Over in our area we do have some cheatgrass but not like near Boise or the Snake River Plain. Cheatgrass is a problem because it converts the vegetation type and it increases the fire return interval from a 75 year interval to a 3-5 year return interval in this area. The Idaho state office would have better information about cheatgrass distribution.

BLM district boundaries:

BLM boundaries include a tiered system in Idaho. From state offices, then district offices, and then field offices.

Weed Presence:

State of Idaho Dept. of Agriculture have a good weed distribution maps. But the BLM state office has good state wide seed map.

Juniper Encroachment:

Conifer encroachment maps would be best found at the BLM Idaho state office. I was just looking at the maps the other day and they are fairly detailed.

Fire Map:

It is hard to tell if it is accurate at such a coarse scale.

Other maps used as a land manager:
I use 'ecological site descriptions' put out by NRCS. These are essentially descriptions that use soil type and what type of vegetation typically should exist on that soil type specific to the area of interest.

iii. Climate Tools

NOAA Three-Month Outlooks:

NOAA Snow Cover Maps:

- Is it an inch rating that this tool provides? Is it just where snowfall occurs? I can watch the two air masses collide which is fairly interesting, but I am unsure how it would help me.
- This model is interesting but I am not sure if it is useful. If there was some sort of future prediction it might be more useful then what has happened in the past. It would help show a snow layer that could be useful for fire fuel operation and burn regime.

NOAA U.S Climate Extremes:

- The crests and valleys are interesting and its an inverse from what was happening in the early 20th century. It flopped.
- This is a very interesting model.
- What defines the Northwest area? This would be something good to define and good to know. This makes a big difference. For instance Oregon gets ocean influences, but then in Idaho there are multiple rain shadows that affect the average.
- I don't use water year. Seasonal trends are very useful. This tool is on a greater scale than I can use. It might be good to use it for historical. If this model were to be more localized then it would be more useful to me.

- I do enjoy the timeline periods because it defines a lot of what we would do and see. When you go into remote automated weather stations (RAWS) sites you can collect local data and the Wind Rose Data are similar to this but we worry about smoke production and where that smoke is going to go during different times of the year. We have a general trend of winds out of the SW quadrant but where does this wind come from? We're going to have a different timeframe for burn piles verses broadcast burning. It shows the strongest gradient of wind direction, which is helpful because it is focused towards a smaller aspect.
- Where is the smoke going to go and how is it going to affect different populations in the mountain valley?
- It is more helpful to have localized models for the area. For instance an isolated rainstorm may hit one area but not another.
- Something that included wind and elevation, wind eddies, or precipitation events would be helpful. The tool 'wind ninja' does a lot of this. It helps project and is a useful model. It'll show the funneling effect and eddies based on local topography instead of just looking at 20 foot level winds. It'll show stronger wind gradients' coming out of a narrow drainage verses a wider drainage.

NOAA Climate at a Glance:

AdaptWest:

(USGS) National Climate Change Viewer:

- It is an interesting tool.
- The mean model precipitation shows a northeastern area deficit of zero but above that shows above zero.
- There are several different models here. Is there a place to figure out what each of these different models provides? To me its just a bunch of letters and numbers. Having a list I can understand and the ability to compare other models would be helpful. Maybe a key to the models. As a manager I don't know what all the models represent. It would be like me providing fire models to a climate scientist. The acronyms wouldn't be understood.
- Comparing the models under the 'data' tab is very interesting and a good feature to have. Its needs more model information, not just what the acronyms stand for.

(DRI) West Wide Drought Tracker:

Integrated Climate Scenarios in Data Basin:

- [redacted]We are a hodgepodge of several areas so planning can be complicated. Looking at this we incorporate at least three different ecoregions [redacted]
- The historical is great because it compares past to present so that a shift can be seen.
- (The manager) was able to intuitively scroll to see graphs for the specific ecoregion selected below the graphs for all ecoregions.
- The vegetation class is quiet interesting. It's hard to tell how accurate it is but the trend itself is interesting. It's interesting to look at the past dates and then see where the shrubs have dropped off. It is interesting to compare across all the graphs (temperature max and min, and precipitation). Makes me feel better about what I'm seeing in the field and then correlate it back to the graphs.
- It will take more time to go through the models and take a look at them. But the NW one was very interesting.

iv. Final Thoughts

- I really like how you can see the trend in the NW Scenarios tool. I don't know how you could do this but some sort of climate effect on soil type would be useful because it essentially is what hosts the vegetation. I don't know how the soil types are being affected or if they are, but that is essentially the driver of the

vegetation type that would occur on the site. Typically we look above ground but the soil type has a lot to do with what can exist in the area. That would be helpful and interesting. And if there is a fraction of specific soil types that sagebrush or juniper occurs in to forecast encroachment.

- I appreciate being involved and I think some of these climate tools are interesting and I can see good use in some of them. Thanks for pointing me to them.

Participant #10

i. Preliminary Discussion

- The health and decline of sagebrush has probably come and gone through the years. In the old days they did a lot of herbicide treatment, some with large scale 24-D. We don't do that anymore. I don't know that I can say sagebrush is in decline now compared to what it used to be.
- The south end of our field office has more intact sagebrush and occurs at a higher elevation than here in the lower end. Our field office ranges from 4500-8000 feet. The upper end has the most variety of species of sagebrush, its less impacted, and its larger. There are areas of unbroken sagebrush habitat. The valley is more developed, there's a lot ranches in the bottom, and there's more impacts in the foothills from grazing and other heavy uses (roads, invasive species).
- Sagebrush species that occur in the district include Wyoming, mountain big, fringe sage, black sage, three-tip in the higher elevations, and a few more.
- The effects of grazing don't particularly affect the sagebrush but instead effect what's around it in the vegetative community. Grazing in this vegetative community makes it more vulnerable to invasives through over use and minimal rest. This impacts the soil crust and other factors that impact the health of the sagebrush itself.
- Invasive annuals in the area are mainly cheatgrass, which increases the fire regime. Cheatgrass interspersed between the sagebrush allows fire to take out large swaths of sagebrush. Cheatgrass isn't too bad in our area yet, but down below us in the lower Snake country it's a huge problem.
- I'm the weed coordinator and invasive species manager for the field office here. I mainly deal with the invasives. We don't have medusahead or ventenata but we have cheatgrass, spotted knapweed, and we're starting to get a lot of rush skeleton weed in some areas. We're pretty lucky in this area [redacted] that we don't have Medusahead and Ventenata, just an expanding cheatgrass situation.
- What we're doing now is going to areas where we don't have a lot of cheatgrass and trying to treat it from there and work our way back. Climate wise we're starting to see more moisture in the spring, hotter and drier conditions, and not as much moisture in the fall. But its really variable. I think climate change is going to actually help cheatgrass. If we get no precipitation and then some precipitation, a drought situation, I think it will push cheatgrass right along. This year we got a lot of moisture in August and September and the cheatgrass exploded and was able to re-boot. So next spring it'll be ready to go and competitive. Then if we get hot and dry conditions we could get a lot more fire activity.
- On average we get about 12 inches of precipitation. At this point fire isn't a leading cause of sagebrush decline in this area and we don't have a large fire problem. But the possibility is there down the road. Any rangeland fire that starts we get out right out there and because we don't want to lose anymore range than we have now. That's all based on sage-grouse habitat intactness.
- We are focused both on treating the cheatgrass we have and on managing the healthy sagebrush we have. My cheatgrass program is focused towards treating cheatgrass and getting it under control in the intact good. We're looking at doing aerial application for our weed program so that once we identify places in need and once when we get funding we can apply treatment significantly. I am currently writing a proposed action for aerial application for our weed EA. We do not have that right now.
- In the past we have done application by ATV's, UTV's, backpack sprayers, and roadside treatments. I work closely with the county here. They help with what treatments need to be done. In house we'll spray maybe 50-100 acres but the county usually does the majority of it for us.

- Some variables that affect treatments include wind speed, incoming weather, atmospheric humidity, and temperature. We want to do most treatment in the fall. We'll probably be using the herbicide 'plateau' which is most effective in the fall as a pre-emergent or right after we get a little moisture and the cheatgrass starts to come up. Getting precipitation after an application is a good thing because it helps get the treatment in the ground, as long as it's not a downpour. If there is a higher humidity then the chances of getting the treatment on the ground may be better because there may be less drift.
- If grazing is properly done than light grazing or heavy grazing is fine. But if you reduce the strength of the vegetative community to where the invasives can get in, get a niche and get going then you're essentially going to weaken the whole sagebrush community. This can affect moisture retention, lack of species biodiversity, lack of plant health or vigor, a loss of soil crust, and eventually the health of the sagebrush. The goal is to do grazing right, give it a rest, and keep track of indicators, which is not always easy to do.
- We have used grazing as an early season strategy to limit cheatgrass. But for perennial grass or forb health we don't usually use a grazing strategy. We look at grazing to assist an area affected by invasives more than anything. I've used goat grazing a lot on leafy spurge and some knapweed in sagebrush communities and it was very effective on the weeds.
- In treating an area infested with cheatgrass I hope for sufficient moisture to get cheatgrass to where grazing can affect it. If invasives are grazed then the natives are going to get grazed also. People have talked about using cattle for cheatgrass and that's fine if it's a monoculture because in the early spring when the cheatgrass has bolted out (before it goes to seed) it's a good food source for livestock and or wildlife. If your not careful then cattle will also eat the natives that may be in the bolt stage. It's a delicate balancing act.
- This year we had moisture in August and September that allowed the already dormant cheatgrass to bolt up again from 1-3 inches. It'll sit there like that all winter long and come spring the remaining soil moisture from the late precipitation and the winter melt off will allow cheatgrass to quickly do its thing. But the late precipitation also benefits the natives too. Anytime you go into winter with good moisture in the soil you're going to have a good re-boot in spring for everything.
- Cheatgrass always has a jump on the natives. Cheatgrass roots will grow very slowly all winter long and once April gets here it'll take off. Bluebunch wheatgrass and all the other natives don't get going until late May and June. That's why these weeds outcompete, suck up moisture and nutrients, and go to seed before the natives. Cheatgrass growing and bolting time is September and October and then March and April.
- We plan for the optimal time to treat invasives based on the climate. We look at how to treat invasives in the future and how they might spread in the future. We've done modeling with wind currents and susceptible areas below infestations. We'll go out and inventory likely areas we think airborne seeds will go, especially rush skeleton weed, which is highly moveable. We've been fairly successful at tracking and finding new infestations based on predominate wind currents and habitat susceptibility. All the different weeds also have different phenology's. The best treatment for each species may be at different times of the year. For example spotted knapweed will rosette in the fall but it doesn't bolt until May or early June. To be effective you don't want to wait until August, you want to hit it when its small and knock it way back.
- We have done spray applications in the spring as well but with varied success. I anticipate doing more spring application because of time crunches, budgets, and resource availability, whatever. But even the label on the herbicide says fall application to be most effective. I'd like to talk with some people who have been doing spring application and see what they come up with.
- I utilize GIS myself and use this as a tool. We did a solar radiation map of the entire resource area to determine where the most susceptible habitat would be for things like rush skeleton weed, and for using bio-controls on knapweed. We looked at where the infestations where to try and determine the best place to get the best bang for the buck with the limited insects that we have. Our GIS specialist was really good with that. I work with them a lot.
- We have had aroga moth outbreaks. About 10 years ago we had a pretty substantial one in the upper valley elevations. No one really ascertained the impacts at that time or how much sagebrush it took out. Aroga moth has occurred spotty here and there. In the future we should pay more attention to climate factors that line up with these infestation, but we haven't really made any past correlations.
- We receive about 12 inches of precipitation in the form of snow and rain. It varies from year to year. Some years we get a 100% normal snowpack for the area, and some years we'll get 60-70-80%. Some

years we get moisture, like last year in August, and then some years we don't. One out of four may be a good wet year. Whether that's changing I'm not sure. I suspect it is. I think we're getting a longer winter maybe into May or early June, and then it stays hotter and drier well into October and November. That's a pattern I see. Snow can leave pretty quickly but then it goes cold again. It really varies. I just feel that winter and summer stay generally a bit longer, in terms of temperature and maybe a bit of precipitation. This year (2014) almost the entire month of October it was sunny and bluebird. I wish I could track it on a graph to prove this.

- If we get rain its more important. But the more snow you have and the more gradual it melts off is important. If we actually get 2-3 inches of rain in August or September then it is way more important than getting a better snowpack to linger a little longer into June or July in the high elevation, I think overall. It made a huge difference this year. Wildlife and cattle stayed up in the higher elevations longer and they weren't down in the riparian areas when they had adequate regrowth on the hillside grasses in late summer and fall.
- We receive 6-8 inches of snow in the valley bottom in late fall early winter this year (2014). Some years we get very little. A couple years ago we had about 10-12 inches in the valley bottom and then it just increases as elevation increases. We're at 4,000 feet here. We've already had some snow this winter and it's melting off. I was at about 7,000 feet yesterday and there was about 2 feet of snow on the ground. It's a good start this early in winter (Nov/Dec).

ii. Maps

Weed presence:

- Not everyone in Idaho is up on NISMS yet.
- I use some county data and some forest service data, CWMA data, and I don't really look at everyone else very much, I just concentrate on this area. Although I have looked at areas south of here to try to predict what's coming our way.
- There's been a lot of inventory here (forest service, BLM, county) and its all been put into GIS. This map looks pretty accurate for our area.
- The amount of cheatgrass inventory, at least on the BLM here, is fairly limited. We're gearing up to find out what we really have for cheatgrass to figure out what we can do. The county and myself have inventoried no more than 500 acres. But in [redacted] corridor cheatgrass is everywhere. It's not a monoculture but it's in the understory [redacted]. You couldn't walk out on a hillside below 8000 feet and not find some cheatgrass. But this isn't true of the upper Levy Valley or over on the continental divide. That's why we want to go where we don't have it, throw the sage-grouse priority habitat map over the top of that, and figure out what we can do for the future.

iii. Climate Tools

NOAA Three-Month Outlooks:

- (no information)

NOAA Snow Cover Maps:

- Seems useful

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- (no information)

AdaptWest:

- This tool is pretty cool (the manager seemed pretty excited about this one).
- Being able to change the graph axis is interesting.
- This tool would probably be more useful for fire or restoration people, but for what I do this may be somewhat useful.

(USGS) National Climate Change Viewer:

- Comparing all of the different models could be useful.
- Being able to change the time period to a period closer in the future is good.
- This tool seems helpful to me maybe in the short term if I wanted to predict the next five years and what we could expect in cheatgrass control.
- Precipitation, temperature, snow, and wind would all be good variables to have. If I think of others I will add them to this document.

(DRI) West Wide Drought Tracker:

- Seems useful

Integrated Climate Scenarios in Data Basin:

- If I were trying to predict what we could expect in the next 5-10 years for a restoration project or other trends than yes this tool would be useful.
- I prefer a regional spatial scale, depending on what you're defining is the region. The ecoregion scale in this tool is also good.
- Monthly data or quarterly data would be a good time scale.
- I use more of a general calendar year, instead of a water year.
- I don't use drought indices such as the palmer drought severity index (PDSI) but I bet the fire severity people do.

iv. Final Thoughts

- Overall climate and moisture predictability would be useful to get an idea of trends in the future. Not just weeds, but overall vegetative health, predictability for tracking, restoration efforts, trends to apply to all kinds of management and all the different things that come at us being multiple use. Grazing is a big one here because everything is allotted and permitted.
- It would be nice to be able to predict the climate and the trends down the road. An average over the different models would be nice if you can assume that the average is going to be what you can apply to the future. With that said, maybe the comparison between the two extremes could be valuable.
- A tool would best be presented through a website that was accessible at anytime. It would be best if this online tool were updated monthly.
- These tools are all very cool and are good new tools to work with.

Participant #11

i. Preliminary Discussion

- I have been working in this office for about 14 years now. We're one of the driest spots in the state (5-7 inches precipitation on a good year). We don't have a lot annual invasive grasses. We have a lot of intact and somewhat healthy sagebrush ecosystems. Probably the largest impact to our sagebrush area over the past 100 years is large scale grazing to the point where it affected sagebrush growth (Most of this heavy use happened from the 1880's to the 1930's. The Taylor Grazing Act was passed in 1934 establishing guidelines for management of grazing on public lands). Talking with some of the older individuals within the district and looking at historic photos there seems to be evidence that there was a big flush of sagebrush regrowth after this grazing, and with this we saw an increase in sagebrush obligates such as mule deer, antelope and sage-grouse especially. Around the 30's, 40's and 50's there was a big increase in brush growth before it was managed specifically for grass. We were still doing treatments as an agency to promote grass growth up until the 70's and 80's, but the large scale shift really happened probably 100 years ago.
- From a climate standpoint, the late 90's into 2000 was probably the start of a drying trend and our current drought. There were quite a few years where we received about 5 inches of precipitation. Throughout our field office precipitation is usually hit or miss, right down to adjacent drainage areas. One area could get good plant growth while another just drops off. What we noticed on the ground was a big decrease in grass and forb production, but from a sagebrush standpoint I cant say how the sagebrush responded during that time. We have a lot of Wyoming sage and really healthy mountain big sage areas adjacent to our forested areas.
- We saw a decline not necessarily in grass species but a decline in growth and vigor. Mostly bluebunch wheatgrass needle and thread grass, and sandberg bluegrass. Years 2006 and 2009 were some of the best grass years I've seen but they were anomalies within that drought period.
- We didn't see any conversion of habitat due to that drought. Certain species like sandberg bluegrass will have a competitive advantage on some sites where it shares with bluebunch wheatgrass because the bluebunch might already be at its tolerant limits and the sandberg is more drought tolerant allowing it to replace bluebunch on some sites.
- 100 years ago the unregulated grazing was very large scale. Thousand heads of cattle were driven through the area and the sheer number of individuals on the range probably led to trampling sagebrush. Current grazing practices have very little effect on sagebrush growth. If anything there are some areas where the sagebrush has an advantage because livestock select the grass and the sagebrush take advantage of the now freed up resources that the grass once held.
- In southern Idaho they've lost huge expansions of sagebrush from fire and cheatgrass invasion, changing the fire regime to 2-5 years. My district has had maybe 3-5 acres of sagebrush total burned in 14 years. Where we have seen invasives come in they haven't been related to fire disturbance but related to general disturbance such as pipelines, roads, and in some instances concentrated grazing. From a climate stand point in a drier year where our grass species are having trouble establishing and where early June growth might not be so vigorous, the annual invasive grass seems to take advantage of limited resources better than the natives.
- Most of our precipitation comes in the form of snow. We get a little rain in May and June and then the rest of the year its just episodic events that happen maybe within a half and hour and the vegetation cant take advantage of this rain as it would if it fell over a longer period. In certain years a lot of our low lying areas might not receive any snowpack. Traditionally these areas received 3-4 inches. This snow is what gives the initial jumpstart for the perennial species to get going, but if that is lacking then cheatgrass takes advantage. All cheatgrass needs is the one small rain in May to get established and then by mid-June they've produced seed and cured out by early July. They have already taken advantage of the little resources and taken those resources away from the native perennials.

- The timing of precipitation is important for how the species take advantage of it. For instance this last August gave a lot of good rain and some species that would have cured out by then started to get more growth. If you get good fall moisture then forb species do very well because they may be biennial or short lived perennials that germinate and establish in the fall, and set a basal rosette. The following spring we then see a very good forb and grass crop. It's not just the current years precipitation that's important, but also the residual moisture. When we get good fall rains it really helps everything going into the next year.
- We get a lot of fires adjacent to us [redacted]. The last several years we've had slow fire seasons and we hardly had any temperatures that reached above 100 degrees. When we do get large fire seasons on the adjacent forest, those prolonged 95 degrees or more really seems to increase the length and severity of the fire season. In our district that translates to the health and vigor of our vegetation when we get those prolonged drying periods (hot and dry). Since we're so dry to begin with, even our noxious weeds start to suffer at that point. When you see a spotted knapweed wilting you know its getting dry.
- One vegetation indicator for dryness is the timing of curing for the bluebunch wheatgrass. Looking at historical photos from the 80's shows bluebunch wheatgrass green well into August. Now it may cure out by late June. There are some years that are anomalies and receive decent growth. But around 2000 is when the earlier drying season started and this is also when the fires in the forest started getting larger too.
- We don't see large prolonged wind events and wind doesn't have much affect in this area. On our drier years wind seems to desiccate plants a lot faster. This year with the August rains the sagebrush showed overall better growth and appearance.
- Basin big sagebrush can take advantage of water pretty far down in the soil profile. Low sagebrush grows on a windswept site and is adapted to shallow soils and harsh environments. Wyoming sage falls between these two but it also has a very deep root system. We also found that the extent of sagebrush root systems is outcompetes perennial weed species such as leafy spurge.
- In a dry environment where there is perennial bunchgrasses, sagebrush and forbs you can also be susceptible to leafy spurge. Leafy spurge is an Idaho listed noxious weed. It has a 25 foot deep root system and the only thing that competes with it in the dry environments is sagebrush. It's critical to maintain sagebrush in these areas maintain these weed species.
- We don't have juniper in the mountain sage eco-tone. But Douglas fir is encroaching on mountain sage and mountain mahogany. There we have more wildlife-centered treatments where we're trying to maintain mountain sage and forb species for big game and sage-grouse. We're trying to maintain those edge areas.
- Both mountain sage and mountain mahogany are pretty shade intolerant species. Once conifers overtop them they cannot compete for sunlight. Young Douglas fir also takes a great amount of moisture from the environment. The lack of fires and increased fire suppression of small scale low intensity fires in the last 100 years has resulted in no check for young Doug fir. Historically mountain sage had fire return intervals between 30-70 years. But when fire is withheld mountain sage becomes decadent and doesn't provide good forage, and then the conifers move into the area.
- Mountain sage is one of the more fire adapted sagebrush. Three-tip sage (one of the few sagebrush species that actually re-sprout from the crown) is also fire adapted. Other sagebrush species rely on seed.
- Part of the problem is that when there's huge 600 thousand acre fires there's no seed bank left on site or nearby to re-seed the area.
- Sagebrush is a very small seed, about 500,000 seeds per pound. General rule of thumb: smaller softer seeds like this have a short viability.
- Sagebrush receives increased browsing pressure of new growth, decreased precipitation from a poor snow year, and competition from Doug firs moving in and utilizing space, sunlight and moisture. It is in these mountain sage habitats that we usually focus treatment. The browsing pressure can contribute to the decadence of the sagebrush. If you have two sagebrush of the same age and one is getting more browsing than the other, then the less browsed shrub will appear to have more decadent growth (more woody, and scraggly growth appearance) than the one constantly having new vegetation removed.
- Wintering big game feeds mostly on mountain & three-tip sage. You get some browse on the Wyoming sage but not very much. There are also all kinds of different sagebrush obligate species that can have an impact on sagebrush. Some areas have agora moth, which will completely desiccate a sagebrush area. We

don't have that here. No grasshopper infestation either. But get normal and natural native pathogens such as gall mites. Nothing that hits epidemic levels. Everything is pretty much kept in check.

- Some of the 'quote' desert sites get more precipitation than we do.
- I am interested in some of the snow pack models because we have such variable snowpack around here. Some areas might be dry or have minimal snow cover throughout winter due to solar radiation, aspect, or wind events. It would be good to model the snowpack and residual snowpack in certain areas. That would be interesting.
- As a manager, the ability of non-native invasive species to adapt where they previously couldn't find a niche (cheatgrass in salt desert shrub; cheatgrass in shadscale salt brush environments) is important to know. About 10-15 years ago it was widely believed that cheatgrass wouldn't be able to invade these sights, but it has gradually adapted. Knowing the adaptability of the invasives would be a useful tool.
- I have read that most of our invasive species will increase with the projected climate change and will spread into environments where before they couldn't. We have an elevation where cheatgrass usually cannot get a foothold, but that elevation could possibly be pushed higher and higher.
- Our elevation is about 5200, and the highest point in our field office area is about 10,000 feet. Right now the 7500-8000 foot mark is the highest extent where we see cheatgrass, depending on the site and the resiliency of that site. Previously, a higher elevation site would have a lot more resilience but as it gets drier they will have less resilience in dealing with invasive species
- One thing I see is cheatgrass moving into some of the forested environments post fire with a change in climate. Modeling tools along these lines would be helpful to project that.
- Solar radiation refers mostly to aspect, not so much intensity.
- If I can find the articles about how climate change might affect the spread of cheatgrass or invasives I will send email these.

ii. Maps

Cheatgrass & Medusahead distribution:

- In Idaho cheatgrass has to be mapped on a large scale because there's are hundred thousand acre stands of it. I believe some large-scale cheatgrass mapping is being accomplished with satellite imagery. In our field office we're fortunate to have very little cheatgrass and we're mapping it by hand with GPS units in the field (polygon or point data). We usually try to prioritize it on areas that have very little for inventory purposes. So on a large scale map like this it wouldn't even show up unless you zoomed in quite a bit.
- This information was just provided to USGS for the land treatment data. But we can provide this data to you for this research project. I could provide a shape file.
- The Idaho state office should have a pretty up-to-date cheatgrass map.
- We do not have medusahead in this district, I haven't seen even one. Ventenata also has not been seen in this area yet.

Wildfire perimeter history:

- You can see from this map that [redacted] our district is void of fires. It doesn't show the forest service fires [redacted].
- One of the biggest effects I've seen, as far as climate variables, is the increase in fire severity. But this big shift in fire severity has just started to happen in the past few years.

Wildfires current 2014:

- This past year (2014) was one of the slowest fire seasons in the salmon-challis forest. A bad fire year could burn 100-200 thousand acres, and some years its been up to 500 thousand acres. I don't even think they hit 1000 acres this year. Those August rains made all the difference.

BLM Grazing Allotments:

- Differences in high grazing verses low grazing is usually on a very small scale, and has really localized disturbances of less than an acre.
- This district has used targeted cheatgrass grazing earlier in the year as a tool, when it's the only green forage before it gets the awn. They have utilized cattle in reducing that biomass earlier in the year.
- Karen Launchbaugh from University of Idaho wrote a paper on prescriptive grazing for cheatgrass recently.
- We monitor drought conditions and let the permitees know if there might be a grazing reduction several months before hand. Sometimes letters are even sent at this time of year to try and give a long term outlook for potential reductions. I think notice is usually given 4-6 months in advance for drought restrictions. But its not on any long term outlook because it could look pretty dire and then some big rains may come right before we turn out. We do a range readiness check before turnout and see if the grass is even up and ready to graze depending on the moisture and timing that year.
- This map looks accurate.

Land Cover Types

- We haven't used NISMS (national invasive species management system), which is just for invasives, but we are about to start using this. Mostly we use ARC and SURGO soil cover layer that dictates vegetation cover.
- This map seems pretty accurate down to a fairly small scale and is very interesting.

iii. Climate Tools

NOAA Three-Month Outlooks:

- This could be helpful depending on the accuracy
- Another thing I do is restoration of sagebrush environments and mostly re-seeding grass species. Some are small seeding's but we are about to start some larger scale seeding. Some of the readings I've seen show that there will be large species shift in some areas. Some of the drier grasses might have more utility on those re-seeding than the native perennial or what the ecological site description states for that site. You may have to do a drier species just to buffer yourself for the drier years. If you seed bluebunch wheatgrass into an area that's already marginal then you have to be banking on a 7 inch precipitation year establishment.
- The planning process starts with the NEPA process and depending on whether its site specific or programmatic across the entire office it can be a year to two years before that project gets implemented from the start of the NEPA phase. We're trying to streamline so that we can be able to implement once we see an need for it. Depending on the sites and the circumstances sometimes that process only takes a month from identifying a need for re-seeding to actually putting seed in the ground. And then subsequent monitoring after that is essential to see if the seeds can establish and thrive.
- It all depends on the precipitation you receive following a treatment. But to call a treatment a success you really have to wait or project at least 5-7 years out.
- If you have a large site that you need treatment on first, the planning stage takes only a couple of months, then you must obtain ecological and wildlife clearances, which makes the project last a while. With some other sites that I've re-seeded we just reconverted the site back to native.
- If information can be accurate 10 years out, verses a guess from a computer model, then that would be good. But if its not going to give us much guidance or show our next step in the management of that site, then more than 10 wouldn't be useful.
- The finest scale that would be useful would be seasonally within the current year. Thinking back to the necessary fall moisture, an 18 month projection would be helpful too.
- We usually look at water year.
- I've never heard of the palmer drought severity index (pdsi) and I don't use it in my daily work.

NOAA Snow Cover Maps:

- I do like the snow cover map, that tool is pretty interesting.
- Is this from a satellite image? How do they project this?
- It would be more useful if it could be taken down to a smaller scale. This tool could then be very useful for determining the timing of snowmelt at certain sites. We cant visit all of our sites throughout the year to see what they're doing so this tool would be handy to show that wind or aspect might be affecting the melt rate.
- A regional, a state scale, a 1:5 million or 1:3 million scale would be good. A scale that you could actually discern something from your field office

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- (no information)

AdaptWest:

- All the variables within this one are very useful. Even if not for planning but just to browse through.
- We have climate change sections that go into our planning document and we have one person in the office that usually addresses those, our geologist. I don't know what are used. Personally I use quite a few of the NOAH products, the RAW weather stations and the fire-weather planning forecast are used quite a bit but these are very short term outlook products. Other than that we don't use anything similar to these tools at all.
- An online tool would be the best to use for management.
- I use arc myself, and any of these tools as a geo-referenced arc product would be very useful because that's still what we use in all of our planning documents. It has all of our current vegetation layers, soil layers, wildlife layers. And to be able to incorporate some of this stuff with those would be useful.
- I'll show the other folks these tools as well.

(USGS) National Climate Change Viewer:

- Didn't know what RCP (representative concentration pathways) meant until explained
- This tool is pretty neat
- From a planning stand point we have an RMP (resource management plan) large-scale land use planning document. It's our larger document that we base all of our other documents off of. That would be where some of these tools could be useful because it's a long term plan. Some of the projects were looking at go 10-20 years and recently we have needed to analyze climate. These longer projections would be helpful for the longer term projects.
- Every field office within Idaho has an RMP and each field office comes up with their RMP for their area. These all usually have a 10-20 year plan. A new one for my district will occur in the next 2-3 years.
- All the variables in this model are good areas to look at. I can't think of any other variables that would be very important.

(DRI) West Wide Drought Tracker:

- (no information)

Integrated Climate Scenarios in Data Basin:

- These graphs and comparing them side by side is pretty interesting.

iv. Final Thoughts

- (no information)

Participant #14

i. Preliminary Discussion

- Sagebrush has changed in spread compared with historical distribution mainly due to fire and invasive species but no notice a specific year of change, as it has occurred over many years
- During the 1970's was a drought and there have been grasshopper outbreaks affecting the district over time. Back in 1986/so in Shoshone a species of migratory grasshoppers (Melanopus spp.) defoliated large areas of sagebrush.
- Currently involved in the integrated weed program looking at the health of land and causal factors, and the spread of noxious weeds or invasive species that can impact the historical plant communities.
- Work with perennial grass species, many of which occur in concert with sagebrush, and how invasive annual grasses affect ecosystem nutrient cycling, native plant recruitment, and in the longer term perennial weeds.
- Perennial weeds have a different affect on the native plant communities and how they can recover after disturbance or how they react to a disturbance.
- Within the district occur annual bromes (e.g. rattlesnake brome, downy brome (cheatgrass), Medusahead, and ventenata. Also native bunchgrasses that are widespread and historical components of bunchgrass communities would be Idaho fescue, bluebunch wheatgrass, sand dropseed, needlegrasses (e.g. needle and thread, Thurber's needlegrass), great basin wild rye, and sandburg bluegrass.
- The effects of climate change aren't well known; it's just known that things are going to change. In areas that do have a lot of annual brome how do managers rehabilitate or re-vegetate for a more historical community consisting of perennial bunchgrass & perennial forbs (and the southern shrub component as well). How do you get it back to a form that's more resilient and a plant community that can maintain itself over time with disturbance? What would that plant community look like? How do you achieve those goals with perhaps a different suit of species that can tolerate different moisture conditions or timing of precipitation?
- Some tools already available and used by managers include looking at ecological site descriptions to see what the soils are indicating and what plant communities can maintain at that point. Another thing I pay attention to is historical precipitation, especially monitoring within an area that may have had seedling failure and look at historical data and timing of precipitation and temperatures to compare possibilities for this failure. This tool I look at is mostly Western Regional Climate Center, which gives records for local weather stations. Mainly look at monthly precipitation and temperature highs and averages.
- Early fall rain gets winter annuals going, and enough early spring moisture helps maintain growth. But if an early drought arrives before perennial grasses get a start then it seems annual grasses can take hold by photosynthesizing at a lower temperature as long as adequate moisture is available. The annuals then remove moisture out of ground before the perennials get started with their yearly growth. Probably the worst case scenario for perennial grass vigor.
- Manage for invasive annual species through re-vegetation efforts that are costly and variable. So the focus is on the establishment of perennial species and not so much on the eradication of annual invasives., although control of the annuals during re-vegetation efforts is key.
- If perennial species do establish in this district they can normally hold their own. The annuals are still present in the understory but they aren't as severe as before the perennial establishment.

- In my opinion, multiple fires over an area are causing decline and sagebrush loss. Particularly where fires are close enough in interval there is a removal of mature sagebrush plants that could potentially reproduce. The cheatgrass is more adapted to fire than the native species; especially once you get multiple fires burning over time (year after year).
- The problem with getting perennial plants established is that once you have a large component of invasive annual grasses they are so competitive in the seedling stage that they outcompete the perennial seedlings leading to a perennial recruitment issue.
- Depending upon the year, human influence can affect the start of many fires (e.g. a lot occur along roadways), and lightning storms that come through also have a large impact. Annual grasses dry out and cure much earlier than perennials creating a long fire season with readily available fuels to burn. It is self-perpetuating.
- In a perennial plant community (e.g. a historical community of deep rooted perennial grasses) plants typically stay green and non-flammable into June or even July. Cheatgrass completes its life cycle earlier than that and is typically already dried out and flammable by the last part of May or early June.
- Historically, summers don't receive much rain anyway. Typically annuals have produced their seed and are already beginning to cure (completed life cycle). Even if rain comes they will continue to cure. So at lower elevations annuals are usually done by first of May. Cure out means to complete its life cycle.
- It appears that here, the impact/success of invasive annuals is driven by precipitation more than by temperature. At higher elevation, generally above 3,500 feet, where there is more precipitation (>18 inches) perennial native grasses appear to compete better with cheatgrass and are holding their own. Seasonality of precipitation is probably the leading factor in perennial grass promotion below 3,500 feet. Most important is adequate moisture available to perennial plants from the soil profile in early stages of plant growth. In my area this is usually provided by additional late spring/early summer rains to replace the soil moisture removed by invasive annuals in the early spring
- As long as invasive annuals are in an earlier stage before they produce seed then they will take any shot of moisture they can and utilize it for additional seed production/growth whenever it happens.
- Historically some grazing actually promoted sagebrush because of the competitive effects of the non-shrub vegetation.
- A main concern or question I have is about the final impacts. What are they going to be? What will be the seasonality and the amounts of moisture? What's going to happen and how are climate variables going to impact the communities that existed historically? Where is the climate headed and what is the plant community response to it going to be?
- Invasive species (e.g. rush skeleton weed) that have a very light and wind-driven seed are being studied. Something like a wind model or that shows wind intensity patterns could be a useful tool.
- Ventenata is of concern because it is an annual that can persist and compete in areas that cheatgrass cannot (higher precipitation/higher elevation). In areas where cheatgrass is currently not competing with perennial grasses, ventenata may tip the balance and change the perennial plant communities. These communities may have been maintained because native grasses were able to compete with cheatgrass possibly due to precipitation. But ventenata is showing up where there is increased precipitation and it seems to persist in Idaho fescue communities that also may be related to the amount of precipitation received.
- I have used NOAA drought tracker and it seemed pretty accurate.
- I have related precipitation to what has been seen on the ground
- When I am developing a plan to deal with invasive plant species, I look at the different species and the range of precipitation zones that they can persist in. I look at specifics about the various plant species and where they will grow. NRCS has a lot of tools for soil type, plant type, etc. Seems similar to plant zones. This may be something managers can gather information for if the amount of precipitation is known.
- BLM and USGS have been doing research about vegetation and precipitation. Cannot remember the name of it but its about trees species presence due to climate. I get emails about available webinars from the Great Basin Fire Science Exchange. Numerous research on fire, climate change, seed zones, rehab, etc. I try to catch ones of interest to my specific job.

ii. Maps

- Landfire is probably what's utilized for invasives distribution, land cover type
- In Idaho its goes state, district and then field office, [redacted]
- I no longer have an in house GIS, but most people in the office have rudimentary GIS experience. I don't know how to do analysis so we are currently missing that.

iii. Climate Tools

NOAA Three-Month Outlooks:

- (no information)

NOAA Snow Cover Maps:

- (no information)

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- (no information)

AdaptWest:

- (no information)

(USGS) National Climate Change Viewer:

- I find this this helpful and I will bookmark it to explore it more in depth later.

(DRI) West Wide Drought Tracker:

- I do not use PDSI. I cannot say that any specific indices have been used. I usually only look at projected precipitation verses normal precipitation.
- This tool seems accurate
- This could be a useful tool

Integrated Climate Scenarios in Data Basin:

- It would take time to digest information in these tools, but I may add information into the recorded document. I will bookmark the site and come back to it.
- I do not use water year much, but I mostly use seasonal and annual precipitation.

iv. Final Thoughts

- (no information)

Participant #16

i. Preliminary Discussion

- There was a documented incident of widespread sagebrush decline during a period in the 1980s across the northern Great Basin. Scientists looked into it, but no-one was sure as to why. The leading theory for the decline said it was due to soil saturation because it was a relatively wet period and big sagebrush doesn't like to be in very wet soil.
- Only other declines have been insect related. Widespread sagebrush mortality in mid-1960s due to Aroga moth (*Aroga websteri*) outbreak across both the northern and central Great Basin. Also major Aroga moth outbreak in 2012, but there is unknown sagebrush mortality for this event.
- Fire is leading 'chronic' annual cause of sagebrush decline. Fires are strongly dependent on antecedent conditions that create continuous fuel loads in grasses and build up enough energy to help the fire perpetuate. In healthy sagebrush, it usually takes 1-3 wet years followed by dry year before you have a big fire season. Where annual grasses dominate big fires occur more years than not because of a continuous fuel bed.
- In Oregon, cattle are currently the dominant grazer, but in the past there was much sheep grazing as well. Previous grazing reduced the amount of herbaceous layer and opened up the area for sagebrush, which allowed sagebrush density increases and expansion. Fine fuel reduction also limited fire occurrence in higher elevations and promoted expansion of juniper. However, now juniper expansion is self-perpetuating and doesn't need anything to facilitate it. Sagebrush is continuing to be lost to juniper expansion.
- Light grazing has little impact to sagebrush, especially since cattle prefer to eat vegetation other than sagebrush. Horses are more apt to eat sagebrush. Heavy grazing helps increase density of sagebrush, which happened at the turn of the last century and helped promote sagebrush densification. Grazing can also promote invasion of grass species, although so can drought and possibly aroga moth outbreaks.
- Managers have allotment management plans (http://www.blm.gov/ras/) that specify allowable utilization levels for grazing. There are also standards for rangeland health, which says managers need to meet certain criteria in terms of the plant community, erosion, etc. Managers use these tools to determine appropriate level of grazing. But when drought happens it can be hard to recognize the beginning or end of the drought. This may lead to higher utilization because too many animals may be put out to graze before we recognize we are in a drought or when we fail to recognize that a drought has not actually ended. There can be wet years and periods within a generally dry, or drought, period. Often managers do not know when the drought starts until it's too late or when it is really over.
- Currently climate tools for assessing drought, whether a drought is coming or whether it is about to end aren't very good because there is more than one kind of drought and most tools don't recognize the different types. Most tools base drought on precipitation, but temperature is just as important, or more so, to determine if drought is occurring or not. Temperature drives evapotranspiration demand. The higher the temperature the greater the evapotranspiration demand and the more the soil water is used up sooner. For example, in the southwest during the 1950s and early 2000s there was a massive die off of pinyon pine due to drought. The die off in the 2000s occurred under wetter conditions than in the 1950s, but 2000s die off also occurred under much warmer conditions.
- The Northern Great Basin is heavily dependent on fall and winter precipitation that stores water deep into the soil. Sagebrush draws on that deep water well into the growing season. But if precipitation in low or declines in fall and winter then there is not much soil water storage, and soil moisture occurs only in the upper soil layers.
- One of the biggest issues manager's face is what to do after a fire, particularly with seeding. In lower elevations annual precipitation is less than about 12" and is highly variable from year to year. Mangers need to know fall and winter precipitation. They also need to know late spring precipitation, which favors native species. Managers don't always know how much precipitation they will get or when once they plant and they need to make decisions about what to plant and when to plant soon after a fire. Most fires come early in the fire season with most rangeland fires occurring in July and the first half of August. Decisions need to be made by mid-August in hopes to catch rain. A few studies suggest that if there is a dry fall, one may be better of planting in the late winter or early spring for spring precipitation. What would help managers is forecast with that level of detail, currently the 30-90 day forecasts that aren't

long term enough to help with those decisions and often don't provide enough information to support this kind of decision-making.

- Bi-monthly to 3 month, and more 'robust' predictions that go from the fall thru to the spring and that have a fair amount of confidence would be helpful. This helps managers answer the questions about when they should plant to allow for plant establishment.
- Currently the leading factor in seed establishment is precipitation, how much, and what kind (mostly rain, mostly snow, or mix). In the lower elevations it will most likely be rain, but as you move up in elevation more snow instead of rain can be very important.
- Snowfall amount may be even more important than rain because snowmelt rates deliver moisture for longer period of time than rain. Deep snow is good, because if plantings are early and then get a snowpack on top of them, there is a lot of moisture on the site. The snow also helps minimize competition from other species. For example, many of our native species are evolved to sprout in the fall, put out a basal rosette of leaves and then go to sleep for the winter. Snow accumulation on top of these species minimizes establishment of competing species until the snow melts.
- Seasonal variables that affect grazing depend on the individual allotment plan because managers try to vary grazing pastures so that grazing doesn't occur over and over at the same time of year within the same pasture. Pastures need to rest sometimes during growing season in order to remain healthy. Figuring out when to turn animals out, when to bring them in, and how many animals managers can permitted within a given year is dependent on how much grass production there is. Native grass species are adapted to fall and winter deep soil moisture. For example, in eastern Oregon there is a decline in precipitation rates in late winter and early spring, and then bump up in late spring. Oregon ecotypes and native grasses adapted to this precipitation increase in late spring.
- Moisture occurring in early spring instead of late spring favors cheatgrass. A dry early spring with late spring precipitation favors native grasses. If there is an overall wet spring then competition will occur between the natives and invasive cheatgrass, but it is not known to what degree.

ii. Maps

- Invasive distribution may be found using the existing vegetation layer in LANDFIRE, which shows the dominant species but not what species occur in the understory. The best source for Oregon invasive annual grasses is the Integrated Landscape Assessment Project (ILAP) vegetation database, which has the highest resolution. This site is better for cheatgrass than for medusahead. Oregon used the ILAP data for annual grass distribution in the sage-grouse amendments. The ILAP data shows both the dominant overstory and what is dominant in the understory, unlike LANDFIRE. For Idaho it would probably just be LANDFIRE.
- The BLM Oregon district boundaries look accurate in Data Basin.
- Another source of invasive distribution might be found through the National Invasive Species Information Management System (NISIMS)
- In the lower elevations, sagebrush recovery takes a long time so it is important to have fire history dating back past 10 years. Do not use GAP for vegetation.
- The Data Basin Land Cover type map uses broad categories. The 'barren' land designation located near Steens Mountain and Cantwell Valley isn't actually barren but has a lot of salt desert scrub. The other side of Steens Mountain in the Alvord Desert is barren but also includes desert scrub areas as well. The areas designated 'barren' seem to occur in old lakebeds.
- Mapping of Ventenata (*Ventenata dubia*) may not be currently available

iii. Climate Tools

NOAA Three-Month Outlooks:

- (no information)

NOAA Snow Cover Maps:

- (no information)

NOAA U.S Climate Extremes:

- It might be useful if another category could be added to look at 'water year', which runs from October 1st through September 30th. September is when plants go dormant and water starts accumulating in the soil. The line graphs for extremes are interesting because managers may be able to see the probability and frequency of extremes.
- Graphs should have a better explanation of what bars, lines and graphs mean. It would be good if there was a way to turn extremes information into probabilities. For example a way to give an estimated temperature likelihoods, such as a hot spring.
- A good person to talk with would be Kathi Dello (OCCRI) who is working on a project about drought for the BLM. She mentioned there are four "flavors" of drought we should think about in making decisions. She said most drought indicators focus on precipitation either exclusively or primarily, when temperature in fact plays a pretty dominant role.
- It seems like the information within 90 day forecasts could be utilized.
- Climate data would be better received through an up to date website. Web based applications are a wave of the future. The frequency of updating would depend on the parameter. For example, 90 day forecasts would need to be update every month, but climate extremes that seem to be annual might only be updated every year.

NOAA Climate at a Glance:

- (no information)

AdaptWest:

- (no information)

(USGS) National Climate Change Viewer:

- Tool looks coarse and may not be very valuable. The polygon colors are hard to tell apart and the boundaries cannot be seen very well. It may be useful to look at this climate information for land use planning instead of project planning. The all model mean is useful. The tool is interactive and lets you move around the histogram giving information about different bars and points. Download summaries may be useful. There needs to be shorter time frames that look at models for 2015, etc.

(DRI) West Wide Drought Tracker:

- (no information)

Integrated Climate Scenarios in Data Basin:

- There looks like there is a lot more land for juniper to occupy

iv. Final Thoughts

- (no information)

Participant #17

i. Preliminary Discussion

- The health and decline of sagebrush in my area, in my opinion, is the result of the shift in vegetation due to invasive annual grass and juniper, which has a lot to do with fire, and which is probably climatically driven by shifts in such factors as CO2. But in the late 1800's there were shifts in land management practices such as high stocking rates of livestock and fire suppression activities.
- Other players such as invasive annuals have started to dictate where our plant communities are heading. [redacted] Looking at the literature the turn of the century has bought a drastic change, especially with invasive annuals in the lower elevations and their increase into our higher elevations and precipitation zones over 12 inches, which affects fine fuel loads and fuel connectivity that increases fire spread.
- There is also a drastic decline in sagebrush production as woodland areas encroach and begin to enclose. There is direct competition that causes shrub mortality and a decline in production of herbaceous plant species.
- Woody fuels are becoming so great that when they do burn the fires have greater intensity, which results in more understory mortality. This results in more opportunities for invasive annuals to move into the system.
- Our trend data for sage-grouse show a downward trend in the last 30 years. A lot of the management practices such as fire suppression, heavy livestock grazing, and the introduction of invasive plants that occurred from the late 1800s to the early 1900s are starting to catch up.
- Our elevation ranges form 4000 - 8000 feet. Our high elevation (mountain big sage) ranges between 12-16 inches precipitation (average 14 inches). We have basin sage too but its range is based more on soil depth instead of elevation. Currently the majority of our projects to maintain or restore wildlife habitat are around 5500-6500 feet/12-16 inches precipitation. Low elevation (Wyoming big sage ecological types) range between 8-12 inches of precipitation (average 10 inches) and elevation ranges between 4000 to 5500 feet.
- We have invasive annual grasses, and the invasive we are most concerned with and that has been spreading rapidly is medusahead rye. We do have some ventenata but right now it's not prominent enough across the landscape to be a concern. I wouldn't call ventenata a driving part of the system yet as far as function, structure and processes of plant communities as compared to cheatgrass and medusahead invaded sites.
- Where cheatgrass and medusahead are located verses where they're not located or dominate comes down to where you have native and desirable non-native bunchgrasses. Plant communities dominated by deep, long-lived perennial bunch grasses such as bluebunch wheatgrass, Idaho fescue, Thurber's needle grass, and crested wheatgrass (desirable nonnative) intermixed with Sandburg's bluegrass (which is shallow rooted)are more resilient to disturbance and resistant to invasive annual grasses. Areas where we have depleted or reduction in the density of these species is where invasives begin to come in. The shrub or woody component doesn't keep the invasives out and when these woody systems burn the invasive annuals then become the dominant plants driving the system's structure function and processes.
- It's the bunchgrasses that maintain a healthy system and maintain a healthy nutrient cycle. Once you reduce or lose the bunchgrasses you lose the glue that holds the system together, which results in a different plant community such as invasive monoculture or woodland component.
- Lower elevation invasive annuals are a large problem because at these sites there is less water/precipitation, and less water means less resilience and resistance to disturbance.
- Wyoming and lower elevation types are more susceptible to these invasives. But we're seeing invasives, especially medusahead moving into soil types that they weren't supposed to be able to spread into. We're

seeing these invasives move up in elevation and become more prominent at mid to high elevations. It's still not as prominent in these upper elevations but its more present that we would like to see.

- It seems like medusahead may replace cheatgrass. The longer it is in an area it creates a litter mat that basically suffocates everything else except itself. From what I see in the trend sites and what I see on the ground I'd say medusahead would probably eventually crowd out cheatgrass in some areas.
- For now cheatgrass and medusahead seem pretty well distributed in the 8 inch to 12-inch precipitation zone, and I don't see a difference between the two in soil type. Once you get to about 14 inches these invasives have not yet become prominent, but they are present.
- Last year we had a bumper of invasive grasses and we had a drought year. We had a warm spring with enough precipitation in April that gave everything a boost, including all of our bunchgrasses, natives & nonnatives.
- Climatic variation has a lot to do with how these plants respond on an annual basis. One year is not equal to another. This makes it difficult for land managers because it is difficult to predict what the fire year will be, how much forage production you'll have, or when should we seed to restore a disturbed site. It's also not just about how much precipitation, but about the timing of the precipitation, the soil and the air temperature as well.
- Historically, when you talk with older folks, we had colder winters and springs, and the majority of precipitation came in the form of snow. Lower temperatures would most likely prolong the dormancy of the invasive annuals reducing their competitive advantage. The invasive annuals typically germinate in the fall giving them a competitive advantage in the spring when temperatures warm up, and when we have warm winters and springs the production of annual grasses increases.
- Now things vary year to year. Sometimes things start growing very early (April) and sometimes there is a delay and things start growing in mid-May or June. This past year (2014) favored early spring herbaceous production. We didn't have much precipitation and it looked like it was going to be another bad year like the year before when we had low invasive annual and perennial grass production with a colder spring and very dry conditions. This year was another dry year again, low snow pack, and warm winter. But then we had enough precipitation and the temperature warmed up enough in April that it went from a no grass year to a bumper crop of grass. It looked like we had above average precipitation when we really only received maybe half the average.
- It seems like the growth of the invasives and the natives are very similar in this timing. Our grasses are cool season (C3) grasses so they start growing pretty early. Our summers are typically dry and warm so growth and water is limited. Most of the grasses are trying to take advantage of the early precipitation when it's still cool, so they start to photosynthesize and set up their seed stock fairy early. If it's really cold neither natives or invaisves will grow, But if soil temperatures are warm enough then both invasives and natives seem to be coming up at the same time. I would say the natives and the crested wheatgrass tend to produce more available leaf tissue earlier during cooler temperatures. I have noticed on several grazing trials where we tried to target invasive annual grasses in the early spring, but instead we saw the cattle taking preference to the perennial natives and crested wheatgrass. From my observations the invasive annual grasses had germinated and had leafed out but were at such a short stature that cattle were not utilizing those plants, and when those annual finally put on growth the window of opportunity and palatability was very short and target grazing of those plants did not meet our objectives.
- We've been trying to do a few grazing studies on the medusahead and the cheatgrass where we also have a lot of natives and crested mixed in. It always seems like the cows utilize the natives and the crested much earlier while often avoiding the annual grasses. It seems like maybe the annuals were a little bit delayed and then all of a sudden they bolted. And you're trying to get grazing in before the seed heads come up because then the grazing ability drops off rapidly, especially for medusahead due to a decrease in palatability.
- The perennials are more predictable because they are here year round and they'll grow no matter how favorable the year. The annuals are there and depending on the year they'll produce more then others, but the window for their growth is very narrow.
- The greatest threat to sagebrush is fire from fine fuels accumulation.
- When you have a productive wet year (2009, 2010, 2011) followed by a severe drought year in 2012 with massive wildfires (about a million acres burning) then this is the set up for a perfect desert fire. When

you get these really productive years followed by drought were the vegetation dries out late spring or early summer you have fuels for the perfect fire season.

- We're going to get fires out here, we have lots of lightning and the evidence shows that we've always had fires in these systems. So if you want to protect sagebrush you have to do something with those fine fuels, especially in those years where you have above average production because it has a high likelihood of burning. As a land manager you need to ask what tools do I have? I can't go out there and mow it, but I have livestock.
- In those really productive years we have to balance our animal unit months (AUM's) to meet the average, because in years when we don't have as much production we have to cut back on AUM's. Animal Unit Months are calculated by number of livestock and the duration of those animals in an area. In a productive year you may want to have a higher amount of animals in a shorter period of time, or maybe have fewer animals for a longer period of time. But when you have fewer animals in a shorter period of time you may have behavior issues and they tend to congregate in certain areas while not utilizing other areas effectively.
- Another problem with drought years is water availability, which reduces livestock distribution across the landscape meaning a lot of areas aren't going to be grazed. If you follow that with a couple years of heavy production where you weren't meeting the targeted utilization and reducing those fine fuels down enough then we cant just tell the permitted to go out and buy a couple thousand cows to throw out on the allotment this year and then next year you've got to cut back 1500 cows. It doesn't work that way. It really handicaps our ability to truly manage these fine fuels. Then the invasive annual grasses create connectivity, which increases the rate and spread of fire on top of this.
- For a lot of the areas we burned in 2012, rangeland condition/vegetative condition some were in poor shape, some were in moderate shape and most were in great shape. They all burned equally. That's where climate concern comes in. Are we starting to get more years where the opportunity window for fire to burn is increasing? Are we getting longer fire seasons?
- It's more then just what climate change is going to do, but its what I'm going to do about it on the ground when we're dealing with it on the landscape. On the ground we're starting to talk about what we would do to try to control the size of these fires across the landscape. I don't think grazing by itself is the solution. You have to start thinking about how you look at the landscape. Do you start parceling it up? You have 100,000 acres of continuous sagebrush fuel. Do you try to break it up into smaller acre units with some kind of buffer such as a green-strip? Then maybe firefighters have an opportunity to keep the fire within that smaller area verses the whole area.
- Just telling me that it's going to be warmer or drier doesn't help. I also need some support as a land manager to say these are the tools we need to implement and use. If we don't have that kind of backing then there are a lot of interest groups that will say how we should manage, but they may lack the background and experience in rangeland ecology to dictate land management actions.
- Sometimes I see all these climate change publications or models and think, so what? What do you want me to do about it? Thanks for another publication that's tells me I'm in trouble. I need to know how to prepare for it. What tools do I have to try to reduce the risk to these systems from continual decline? We're not there yet and we're already dealing with climate changes or variability that is causing land management to reconsider how to reduce the impacts to sagebrush steppe ecotypes.
- Water, temperature , and timing of the two would be the best predictive tools for restoration actions. This really dictates success verses failure of restoration projects on an annual basis. We're trying to establish plants or seed plants.
- Other abiotic components in particular soils . But if you have enough moisture in a year there's going to be opportunities when the temperatures are adequate for germination, plant establishment and survival. The more precipitation you get in the spring when temperatures are adequate is when you're successful. If you get cold or dry then your success starts to go down. We just don't know what the next year is going to bring.
- The other challenge we're faced with is funding and the timing of our funding as a government agency.
- It's easier to implement planned projects, but wildfires are a bit more challenging because we don't know what we're going to get for money. If I have a landscape project and I'm trying to restore a sagebrush steppe and restore the sagebrush understory, I'm hoping that I get my money, which I have to spend that year. It would be nice to know if I have the flexibility on how I spent that money based on the

predictability of favorable vs. unfavorable conditions for plant establishment during the next spring and summer.

- If I knew that my next growing season in spring (after seeding in the fall) will have precipitation and temperature that are desirable for successful plant emergence and establishment then I would be successful as a land manager in meeting my objectives, which would be amazing.
- Right now it is wintertime and I'm going to buy all of my seed. I'll do seeding now and hope for success this spring and summer. But if I could retain my money before I buy the seed because I know this year has a height probability of poor success then maybe I would wait until next year when success might be higher. But I don't know my probability and I have to use my money this fiscal year anyways so I'll have to roll the dice and go with it. I'll have to spend all of that money and just hope that I'm successful.
- A 3 to 6 month projection would be best. But it's complicated because some years we have to wait to find out if we're even getting any money. Sometimes we don't know if we'll have the money until almost the spring.
- To my knowledge we don't have a mechanical means of dealing with annual grasses and most mechanical treatments might favor annuals due to ground disturbance.
- Right now we use the pre-emergent herbicide imazipic for annuals including cheatgrass, medusahead, and ventenata. This herbicide has a very narrow window. We apply it early in the fall from September through parts of October. We have about a month or two to apply. We need moderately warm soil temperatures before things freeze. Its best to apply it when the ground is dry and the application is followed by a rain, which pushes the herbicide through the soil and inhibits the emergence and germination of those annual grasses.
- Depending on the rates of application, it may carry over to the spring and will hit the spring emergence as well. It's fairly effective but its short term. It only gives us a couple years to get something else established. If you don't then the invasives will move back in. Knowing what kind of fall you're going to have dictates how many acres you can treat. If it's too windy you cant apply the herbicides. We'll treat thousands of acres with aerial application and it doesn't take a lot of wind to shut the treatment down. If it reaches 10 mph or above wind gusts then we'll probably have to shut down. That's why spraying is usually done early morning when things are calm and its quiet.
- From what I know relative humidity effects fire behavior. The lower the relative humidity, the drier the fuels are, and this mean a faster and hotter burn. We'll have days that are 90-100 °F where the relative humidity drops significantly, and then night time temperatures dropdown to 50-60 °F. But on some of the warmer nights we only cool down into the 70's and we don't have an RH recovery to help us get ahead of the fire. This last year [redacted] the Buzzard Complex fire and [redacted] at least 2 am before RH recovery was high enough to quiet the fire down.
- I've read that sometimes juniper and some plants benefit from CO2 increases, increasing their season of growth and production. Juniper is effective at using water throughout the soil profile and can transpire more than 20 gallons a day, but they are also very efficient at shutting down when water becomes deficient.
- A lot of data shows that juniper has taken favor, and I don't know if its climate related or related to how we manage our lands. Research shows that juniper has benefited from the reduction of fire in mid to upper elevations.
- In the research of Dr. Richard Miller, it shows that in some areas about 10% of the juniper out there is pre-settlement verses 90% are post-settlement. And most of the prior 10% is be found in fire safe sites such as ridgeline rocky outcrops. And in places with reduced fuel loads that decrease the risk of fire spread and killing the trees.
- A lot of the encroachment can be directly tied to European settlement and the grazing that was being done on the landscape at that time. Dendrology work that compares fire scars, especially in ponderosa pine, has showed fire frequencies of 10-20 years. Then at the turn of the century with high stocking rates of livestock wildland fire frequency or maybe I should say fire size decreased significantly.
- Juniper trees are a mid-elevation plant. I see it going up in elevation and down in elevation. We have areas where I see juniper encroachment and cheatgrass invasion overlapping.
- CO2 information would be useful. How does CO2 effect plant physiology meaning how does it affect plant growth and production? Am I going to continue to see junipers or annuals expand as a result of increased

CO2? From my experience I need to know what tools I'm going to use to identify and address the threats to what we deem as desirable for plant communities across the Great Basin.

- A reoccurring problem that land managers face for restoration projects is what tools are considered acceptable or unacceptable by different interest groups and differences in professional opinion. There is controversy over the use of non-natives but they are often more adaptable to different ecological sites and to a range of different precipitation zones, which gives us a chance to be more successful in meeting our objectives for structure, function and process. Furthermore, many of my colleagues would not like to hear me say this, but these plants may be more adaptive to some of the predictive climate change models that show an increase in temperatures and potential changes in precipitation amount and form (i.e. snow vs. rain).
- I don't currently use any climate tools. The biggest thing we use are ecological site descriptions that tell us what our soil types are, precipitation zone, and site potential. But a precipitation zone can change from year to year. The problem is the annual variability. The type and timing of precipitation is just as important because if we get predominately snowpack and no spring precipitation then I could have the same outcome as I would in a drought year. My first year, [redacted] as a Range Management Specialist for the BLM the precipitation year was looking to be a terrible drought year. There was little to no precipitation and I thought what a terrible way to start as a range con and working with permittees. And then in the spring of that year we received the majority of our annual precipitation in one shot and it was a phenomenal grass and forb year. We received about 6 inches in 2 months.
- A three month tool would be good because it would help plan as money becomes available, but then three months now and three months later could tell me a whole different scenario.
- A year is probably not enough because depending on the timing of when the information is available to me, I may find that its going to be a good year and I already should have planted but now its too late. Fall of this year would have been the perfect opportunity to tell me what kind of spring and what kind of year I'm going to have. But most importantly what kind of spring I'm going to have.
- If I find that it's going to be a bad year, the problem that I face with choosing to not seed is that I have a short time line of about 2 to 3 years before invasive annual grass establishment, and inhibit restoration efforts. Once the invasives move in you have competition and now I may need to spray before seeding can occur.
- Maybe 3 months, 6 months, annual and then a two and three year projection would be good.

ii. Maps

- (no information)

iii. Climate Tools

NOAA Three-Month Outlooks:

- (no information)

NOAA Snow Cover Maps:

- (no information)

NOAA U.S Climate Extremes:

- This tool looks accurate for spring precipitation
- This tool is useful as hindsight, but how would I use this for the current or coming year, which is more important to me. I can look back and see that I'm glad I didn't plant this year because it was a bad year, but that wont change what I plan to do this year or even further out years.

- I had some trouble 'back-paging' to the prior page in Data Basin.

NOAA Climate at a Glance:

- (no information)

AdaptWest:

- (no information)

(USGS) National Climate Change Viewer:

- I hadn't heard of RCP (representative concentration pathway) scenarios, such as RCP 4.5 or RCP 8.5, prior to this.
- When we looked at snowpack [redacted] for the 2025-2049 projected period, it showed only -.4 inches under the mean model and -.5 inches under the MIROC5 model. For me as a land manager I'm not sure that the loss of half of an inch makes that much of a difference.
- When looking at the models side by side I found it interesting all of the different countries that have developed these different models. It's interesting that there are a number of model projections for April showing just over half and inch (.6 inches) and then the lowest being .1 inches. I'm trying to figure out the significance of that. Is it ecologically significant or not. But this was only for one month in April.
- This tool was easy to navigate to change the time periods, months and variables.
- The most important variables would be temperature and precipitation. The foundation such as the geology or soils isn't really going to change. We wont see a shift in these for 10 to 20 years unless there's a major erosion event. It's about what maintains the plants that are here through time, which comes down to temperature and precipitation.
- For this tool my biggest question is if there is ecological significance. This tool may say less snow, but will that actually be less snow or less precipitation because we're getting warmer. And how will this change affect both the existing plants on the ground and the plants that I hope to establish. Also if this is showing less snow is that because of temperature? If so this might mean I have more warming and that may increase the duration of the fire season.
- A lot of our success comes from trial and error, but this may be good to see that if you fail why you failed. What factors led to me to failure and then maybe next year I will be successful because a climate shift might occur that allows me to be successful. But even if I know that it didn't work for these reasons last time, how do I know it's going to work for these other reasons next time.
- Comparing the different model outputs could be useful. But it depends on the context you're trying to use these in, past verses future. But each of these projections is showing a projected average. You're going to have years that don't look like this at all. Within a 10-year period you're going to see all these different extremes, different temperatures and timing.
- The average may be the same as it was last year, but the reality is that it's about the timing of precipitation and temperature in the spring. This projection might show that we're going to get cloudier or warmer, but what does that mean for me when I'm trying to do a restoration project this year or next year. I'm not sure that this tool is useful in helping me answer this question.
- Something with a finer temporal scale would be much more useful to me, and preferably predicting annual and seasonal variability.
- Being able to look at the state and county is a good spatial scale. But nothing to complicated because then it isn't easy to use.
- Projections like this can be useful to cite when we are proposing projects and management actions. If I were to use these projections to write my NEPA, these models could give the BLM justification to try to implement some projects and the methods selected. So this tool would be useful to help understand the annual variability especially when you have the projects in hand and when you're implementing them at the time.

- Right now we use ecological sites more because they tell us the potential of the site on the ground. I don't think you're going to be able to effectively use predictive models when you could incorporate an ecological site description (ESD). Site potential, precipitation and temperature, and how they coincide with each other, makes the difference in success or not. With ESDs I can have a fairly accurate idea how the site will respond to treatments such as seeding or prescribed burning, but again climatic annual variability is still an issue. Just because I have a Loamy 12-16 precipitation zone does not mean that the area will receive that amount of moisture or that favorable temperatures will occur that year.
- It would also be nice to project what type of fire year it will be, or how much of a drought will occur. Will it be a low risk fire season or a high-risk fire season? I'm not sure how you would ever be able to accurately model that.

(DRI) West Wide Drought Tracker:

- We don't use the palmer drought severity index (PDSI) in everyday management. We do use it when we are looking at yield index, which is related to your precipitation and what the carrying capacity is. If we look at grass production in relation to livestock we want to know if we have the proper number of AUM's out there or do we need to reduce the stocking level. I have a link to the tool that I could send. It has some of our RAW stations and the collection of precipitation and temperature, but we mostly just look at precipitation.
- The problem with this tool is that in some cases it shows we had lower than average precipitation for the year, which is true but yet we still may have had higher than average grass production.
- This tool allows me to look at why we had a certain amount of production for the year, or why we had a drought year. However, can this be developed into something that can help me for the upcoming year?

Integrated Climate Scenarios in Data Basin:

- This tool initially didn't respond and took a long time to open.
- Our district is split between a few ecoregions on the map. We have quite a range of ecological sites across our district.
- Looking at the projections for the changes in the vegetative model is interesting. I wonder why some of these changes are occurring?
- I am curious what input variables went into the MIROC5 model that dictates an increase in shrubs in the future in the vegetative output graph. My guess would be that we would be seeing a continued increase in grass especially invasive annual grasses. If climate projections predict a warming trend then wildland fire return intervals and duration will increase, which would reduce shrubs and other woody plant species. I am curious as to what inputs for this model are leading to this increasing shrubs projection for example increased CO2, more draughty conditions, etc.
- When we looked at the historical vegetation it shows that with fire suppression the woody component increases as conifers encroach into the sagebrush steppe ecosystems, which leads to decline in shrub. This makes sense and is seen in the literature.
- I am curious what the grass component consists of. Is it perennial or annual? Invasive annual grasses have been and still are increasing in their distribution across the west.
- This tool could definitely be of use to me. There is temperature and precipitation, and its based annually. But because it's based annually there is still some information lacking, such as seasonality or the timing of precipitation. This kind of gives you the hindsight. The stuff you try to project out would be more useful for me to develop a NEPA plan for a specific project so I could try to justify that project.
- If there were something more finely tuned to an annual projection then it would be more applicable to the projects we do on the ground because each month can be so different. (*Note, the manager says 'annual', but the manager seems to be very interested in the seasonality such as a monthly, 3-month or 6-month timing of climate events.)

iv. Final Thoughts

- Sometimes I get frustrated with the publications about climate change because I am not sure how to use the information as a land manager. They don't provide me with anything other than that things will change, and historically things have always changed climatically. Just think about the changes going into the last ice age and then coming out of the ice age to today's current conditions. But if things are changing what do we do on the ground and on the landscape.
- To me the problem is that some of this stuff is still a guess, its still not 100% that this will be the scenario that we will see. But it's the best guess. It's the information and best science that you have available to work with at the time. We get a lot of political pressure to do or not to do. There are political opinions that make it challenging and our NEPA has become messy and stagnant because of this. So instead of having a short concise document we end up with long and messy, multiple alternative scenario documents. We try to use these kinds of tools to show that what we're trying to do on the ground is supported by the best information we have available.
- A tool would best be presented through an Internet web page because we're so Internet oriented now. There could be an email saying if an update was available. It could be updated quarterly or monthly. Weekly would be too much as we receive multiple junk mail.
- We usually use a water year. But our budgeting doesn't fall under this same timetable making it difficult to implement restoration projects that occur in the fall.
- I use GIS myself, but we have a GIS lab that does most of the work so I usually bring stuff to them which saves me a lot of time. They can do it very fast. I used to think I could do it myself but then I realized I don't have that kind of time available anymore.

Participant #18

(Note: Power outage during interview disconnected phone lines after the general information but just before the climate tool assessment part of the interview. Participant contacted saying they would look over the climate tools and email any comments. Those comments are attached to the 'Climate Tools' section of this interview response sheet.)

i. Preliminary Discussion

- There is a concern with sagebrush in our area, especially at lower elevations where the sagebrush understory is depleted. There are a lot of areas threatened by fire and cheatgrass and so they don't have an opportunity for the sagebrush to re-generate following fire. This happens across the whole state.
- I deal with the management [redacted] We do have some medusahead issues, and in some areas there are broadleaved weeds as well. It's the cheatgrass and medusahead that are producing a positive feedback loop that perpetuate an accelerated fire cycle in sagebrush.
- Most of the threat occurs in Wyoming sagebrush, and the drier, lower elevation sagebrush that are vulnerable to cheatgrass and fire. The mountain big sage usually occurs in a mesic site with that has less of a cheatgrass invasion threat. We also have basin sage. We have been noticing that the basin sage has been expanding in some areas where it will replace some of the Wyoming big sage. Basin sagebrush is usually more constrained so cheatgrass invasion isn't a large concern in basin sage exclusive sites. We manage the basin big sage within the context of the other sagebrush it is intermixed with.
- Cheatgrass is able to germinate in the winter (especially with warmer winter conditions) allowing it to get a head start allowing in early spring when it uses up the soil moisture to grow before the native grasses, such as bunchgrass. Cheatgrass doesn't compete directly with sagebrush, but it prevents sagebrush establishment sites because cheatgrass forms a dense mat. It all has to do with the how cheatgrass effects the fire cycle.
- In some areas we treat cheatgrass with herbicide so we can establish herbaceous vegetation to compete with it. For example, we're looking at using green strips of prostrate kochia (or forage kochia) because

we've found that it competes well with cheatgrass. Kochia is a broad-leaved plant that stays green later into the year. It is effective at helping contain fire-spread.

- If we're going to establish a green-strip of kochia we might do a ground application to knock the cheatgrass back enough so that we can seed. I don't work in the weeds department enough to know if they're specifically doing any aerial application. I am not very familiar with the climate variables that may play into the establishment of kochia.
- Our best defense is to maintain the perennial grasses that we already have and to keep them in good enough condition that they're able to resist invasion in the first place. This is the most economical solution when we're managing 12 million acres of the state. In Idaho we also have a lot of seeded grasses, mainly crested wheatgrass. We maintain those seeding's to keep cheatgrass at a manageable level.
- We are at the mercy of luck during the year when we seed. We have decent success in early winter in areas that we have snow because getting snow on top of a seeding allows the seed to be watered into the soil. But it's really luck to get precipitation at the right time to germinate and establish seeds. This is where climate tools could come into play. If we had the tools to understand our success then that would be very beneficial.
- We don't want to seed early enough that the seedlings would try to germinate in the fall. Generally it's more about logistics. We have a pretty large post-fire rehab program. Operationally it's a matter of timing to get out and get the seeding done. There is no temperature window but its about getting the machinery on the ground at a time when the ground is firm enough so that we're not tearing everything up. If we're drill seeding then the ground needs to be firm enough to get big machines out, but if the grounds frozen then you wont be able to get the seeds in either. It needs to be when the ground isn't saturated or frozen solid.
- In the last couple years we haven't had steady moisture from winter into spring and I can see that as a contribution to seeding failures. We may get a pulse that causes seedlings to germinate and emerge but then there will be a dry period until late April or the end of May. This might be a critical time when the seedlings are experiencing drought and may not survive. We may then get some moisture later in May, but this may be too late for plants to pull through and make it through summer.
- I am the monitoring and ecology lead in the range program. I work with the grazing management program and specifically the vegetation monitoring program. I've also been working on the REA's and the healthy lands initiative, where I evaluate proposals from the field for restoration and habitat enhancement projects and determine how to fund those projects.
- I am working on a climate supplement for an ecoregional assessment. We're supposed to be looking at climate change when we do our NEPA analysis for any projects. We never know what climate models to use because there are so many of them. Even if we know which ones to use we don't have the data in-house and then we don't have a consolidated place that tells us how the climate variables are going to affect our resources of concern. What we're working on developing is getting an evaluation of the downscaled climate data that is available and pulling it all together. That way we'll have a paper trail of why these were the appropriate models to use and we'll have the data prepared in-house so its easily accessible to the field.
- We're also working on getting the vulnerability assessment or write-ups for our main vegetation types and how we expect them to be affected by the climate variables in the future. These are the tools I've been working on putting together. We're still in the phase trying to figure out what the climate change will be and set up the documentation for that. Our actions in the field aren't being influence by climate projections yet.
- We are using the MOCA datasets from University of Illinois for the climate data. We're getting some hydrology datasets from University of Washington. We also may get some of Dr. Bachelet's vegetation models. We will then be pulling all of this information together to figure out what going to happen to the sagebrush or aspen.
- We're hoping to decide what climate variables we need from the models. We're working with a contractor and putting this climate information as a supplement to the ecoregional assessment. The contractor looks at what data available to help us assess which climate models are most appropriate for our ecoregion and then will build us an ensemble model from those. The contractor also is completing a literature review on the vegetation and teasing out the most important variables (e.g. temperature,

precipitation) for each vegetation type (e.g. sagebrush) so that we can track climate variables and the effect they will have over time on the vegetation. This is all a current process.

- In the state of Idaho we dot really have one person acting as a climate expert or looking at climate modeling. We can only get so technical with our use of it. We basically need a toolbox that somebody (i.e. wildlife biologist or a botanist) can utilize and have confidence that they are using the appropriate model. They need to know that the GIS shop has that data layer that can be pulled in and have guidelines on how to use that layer. They need to know how much confidence there is in these model predictions and have some information about these predictions are going to effect the vegetation or wildlife species their trying to analyze the effects for. They need the ability to analyze affects and maybe inform the management action that they're trying to do.
- I don't think that 99% of our staff are going to have the time or the ability to go backwards the model projections look at all of the nuts and bolts of how the climate model outputs came to be.
- It seems that we should be using at least two emission scenarios and at least two time-slices. I think this is enough for the average field office staff to deal with. It makes sense to have one average ensemble model to look at. I don't think they want to look at RCP 8.5 2050 and then try to digest 10 different climate models for that. That might be overload for them.
- RCP 4.5 and 8.5 seem to be the two that we're currently standardizing around.
- In an ecoregional assessment that we initially did we looked at 2025 and 2060 each individually. With the climate supplement I'm doing more of the mid-century and late-century time-slice.
- We're wrestling with how the selected time slices can be applicable to everyday management. Its going to depend on the area you're working in because some of the drier vegetation operates on a multi-decade timescale so its valuable to look at the projections 50 years out. But some projects we'd be interested in just the short term so it wouldn't be useful to look at a late century time-slice. Right now we're dealing in general trends for the nearer timeframe, with a general conclusion about the changes we might expect to see. For example, summer precipitation or less snowpack that may have effects on changes in hydro-graphs.
- When I'm looking at a project proposals its about whether they do the project in a certain year. That's how the government functions, that we treat so many acres in a year, say 2015. Project proposals need to analyze effects for their area through a NEPA analysis. They would need to design there treatment and decide what the changes in climate would be 20 years out for a NEPA, because if we're going to put a lot of money into trying to re-establish native plants in an area we want the treatment to be durable and last rather than die after 10 years. For instance, we would need to know if we're in an area where plants may not exist because the climates getting hotter and drier. This is where a tool could be useful to predict what the climate change would be for a specific area. This would help us identify areas where we might have more durable treatments on the ground or help us make selections for different types of plant cultivars that would be adapted to drought so that they can survive in those areas.
- The shorter time scales are driven mostly by funding cycles because we don't have a lot of flexibility. Its not like I can get money to do a seeding and think I'll just do it next year because this year doesn't look good. Sometimes we're able to get projects planned and implemented and in the best-case scenario the short-term window would be two years. Other times it takes a long time for everything from getting the planning in place, to completing the NEPA and getting that decision out through the litigation gauntlet, and then receiving enough funding that we can put it in place. This can sometimes take a decade.
- Many times the plantings happen after wildfires. If a fire burns in the summer then we're going to go in that same year and seed or do whatever treatments are needed. This happens on a much faster cycle and there's not a large time window to plan and design treatments. From when the fire gets put out we need to have our ESR plan approved within about two weeks. After that we have a little more time. If a fire burns in August, then in December then would go in and seed or do treatment. There is some time in between to do some fine-tuning of our seed mix; approach or whatever, but ore or less the plan is already going to be laid out.
- FIAT (fire invasive assessment tool) is being done for the sage-grouse planning effort to look at what areas in sage-grouse habitat we may want to treat. Its also developing a strategy before fires for post fire actions. This gives us some guidelines because we have such a short time frame for planning post fire. This is already in place for specific areas so we have an idea of how we want to treat those areas after a fire.

- For climate tools, all managers will need to have access to all temporal scales, because the post fire plans are approved at the Washington level and they have plans pouring in from all over the country. They're the ones evaluating the plans and deciding which ones get funded.
- Wind is an important variable, especially in the Snake River plain with wind erosion. Minimums and maximums are also always important.
- One thing that is a challenge for me observing the weather over the last few years is the day-to-day variability. We've been seeing very strange day-to day temperature swings. For instance, in November (2014) we had a cold snap with record-breaking lows for almost a week right after we received a record-breaking snowfall. And then it got warm up to about 60 degrees maybe two weeks later. It would be helpful if there is anyway for us to understand when we'll be seeing these wild temperature swings in the future. I don't know how we'd prepare for it but it would certainly be useful information.
- We mostly have temporary employees that do a lot of fieldwork or some technicians. Most of our field office specialists spend the majority of their time in the office and they're likely the ones who will be downloading information and doing analysis and project design. We do have some windows based tablets that we collect data on in the field but they're not 3G or anything like that, and a lot of our areas are too remote to have Internet access anyways. We're mostly gathering data in the field and then going to the office and plugging in any data that we have.
- An online tool that is updated quarterly or twice a year depending on the level of information would be useful. This could happen by email.
- The joint fire science project did a lot of this type of research when they were getting their science delivery project up and running in about 2009-2010. [redacted] was the coordinator at the time. They went through a lot of work on how to deliver information to resource managers.
- The calendars that we use vary. We use fiscal year, grazing year, and our hydrologist uses water year.
- Grazing doesn't directly affect sagebrush but it affects more of the herbaceous component. The BLM has standards and guidelines that we're supposed to manage grazing according too. If we're meeting those standards and guidelines then the sagebrush habitat is maintained pretty well. We've been backlogged where we haven't been able to address all of our grazing permits, especially in this area where we deal with a lot of litigation. Areas of overgrazing or improper grazing have an effect on the native bunchgrasses, which at the lower levels creates a niche for the cheatgrass to come in.
- Grazing can also take out larger stature bunchgrasses that are more susceptible to grazing pressure. We end up with a lot of smaller bunchgrasses that don't have the deep root system to stabilize soils, don't have as much value for wildlife, and don't provide as much cover. We also have sheep grazing that can reduce some of our native broad-leaved and flowering plants, which can be an issue too. In the upper elevations you can have an opposite effect where overgrazing on the grasses allows increases in woody plants including juniper in areas where its not supposed to be. Grazing can also affect riparian areas too which are important for habitat.
- In limited cases, grazing may be used to control cheatgrass where herbicides are limited. For vegetation treatment they graze the cheatgrass very heavily which opens up areas for successful seeding. In other limited situations livestock have been used to graze down cheatgrass as a firebreak on an annual basis. This requires precision and high intensity grazing so it's not really feasible to do over broad areas.
- Grazing effects juniper encroachment by removing herbaceous plants to the extent that they're no longer outcompeting juniper seedlings that sprout up, and also reducing the herbaceous component could reduce fine fuels so that you don't have a fire regime that removes junipers, which allows them to get big enough so that they outcompete the sagebrush. Fire in upper elevations is needed to maintain the sagebrush system. The mountain big sage is killed by fire but because its such a mesic system there are more opportunities for re-establishment of the seedlings and they are able to grow a lot faster.
- We don't have the cheatgrass problem at these mountain sage sites. The cheatgrass is less competitive in higher elevations; it won't take over a site and persist. Cheatgrass is a lot more flammable than the native bunchgrasses. Fire in native vegetation won't behave the same way. If a mountain big sage site burns you may get a little cheatgrass but it doesn't just come in and form a monoculture. It will just come in for a couple years after the fire and generally the native vegetation will come back pretty well and recover the site.

- We have a fair amount of medusahead around the Oregon/Idaho state line, around [redacted] and in the foothills. Ventenata comes in to these same areas but it occurs more in dry drainages. It has moved out into the foothills over the past few years but it hasn't been as dominant as the cheatgrass.
- Over the last few years there has been enough forage for livestock, but the water sources for livestock have been drying up. The water sources that are still available are utilized more and the vegetation around those sources get hit harder than in the past. It is an issue for us to be able to predict where water is gong to be available and how much. We've set up a management system where the livestock utilize an area rather uniformly and there may be a few different water sources in that area. If half of the water locations dry up then you still have the same amount of livestock going to half as many waterways and grazing along the way. This means some areas see higher grazing than others, as cattle aren't going to disburse the same way as they used to.

ii. Maps

- (no information)

iii. Climate Tools

- I had a chance to look at the web tools, and talk to our NEPA coordinator, and we had basically the same over-arching comment, which is that any tool that we rely on as an agency has to be documentable for maintaining our administrative record. Also, we need to be able to work with the data either by downloading an output shape file to work with in the ArcGIS environment or potentially through Google Earth, though that may have limitations. Version control is very important for us. An example is a time that we used climate data from an EPA website, but the data on the website was changed after our analysis was complete, causing a problem with our administrative record not accurately reflecting our NEPA analysis. Metadata are also very important to us, so that we can ascertain data quality, source, etc.

iv. Final Thoughts

- (no information)

Participant #19

i. Preliminary Discussion

- I am a field manager. A field manager oversees a defined land area ranging anywhere from 250,000 to over 3 million acres. My experience in the past is those field offices with the extensive 2-3 million plus acreage that are often in the high desert or high plains and that do have a lot of sagebrush.
- My particular experience was in [redacted]. It was primarily a timbered office but it did have a sagebrush component. The grassland and shrub land as it transitioned to the Cascade Range to the west of Klamath Falls over to the high desert around Lakeview Oregon and further to the east.
- In my current position as [redacted] we have about 1.8 million acres of which approximately 75% is pinyon juniper woodland transitioning to sagebrush flat grasslands as it drops down in elevation. Then the lower elevations drop out of that and into a blackbrush community. Around 15-20% of this area is considered good sagebrush habitat.

- My daily duties are to oversee the program resource specialists and persons who manage particular programs. We have two primary individuals who deal with vegetation management. A wildlife biologist who is often involved with projects to manage the sagebrush for purposes of wildlife habitat (big game), winter range for mule deer and some elk or sage obligate species such as sage-grouse [redacted] The other individual is our rangeland management specialist who oversees our livestock-grazing program and permitting process. Their role is the affect landscape management has on sagebrush, with the primary purposes of livestock grazing where we need more grass than browse species.
- For the [redacted] office we have a relatively recent resource management plan. In that plan, as in most BLM management plans, it provides guidance for managing specific land areas and gives direction on management of habitat in vegetative communities as well. That's our overriding guidance for the management of lands.
- We have specific management direction or decisions for managing vegetation. We have goals and objectives. We have management actions, and under those actions we have 18 different specific actions that we could or should implement for managing vegetation.
- Some of these actions are very focused for sagebrush. One particular is Veg3: 'Implement guidance for addressing sagebrush conservation as described in the BLM's national sage-grouse conservation strategy.' Even though it is for vegetation its focus is 'Why are you managing vegetation?'
- Another gives some specific guidance on treatments, VEG15: 'Implement 30,000 to 50,000 acres of vegetation treatment in fire regime condition class 3 areas over a 15 year period.' Then VEG16: 'The following sagebrush communities are prioritized for treatment…Hardstraw, Beef Basin,…' and then it specifically names places that we would focus our management on. Then VEG18: 'Maintain an estimated 1500 acres per year of existing land treatments and implement new vegetation treatments to restore ecosystem health, function, condition, etc. in the following ecosystem vegetation types…' where sagebrush is 1500 acres per year. So this does provide a fair amount of direction and this is what the resource specialists and I refer to. Part of what they do is going out and restoring the health to the communities as we see it.
- In our process we have an overriding resource management plan and it says either do this or don't do this. So even though it gives that direction it doesn't authorize the on the ground activity.
- We go through an analysis with the EPA and that analysis is site specific. We've had a variety of treatments in sagebrush. Primarily treatment of in over story woodland community. Historically chaining of pinyon and juniper. Today we more commonly cut it and use if for firewood, and piling it and burning it. Rarely do we do prescribed unit fires where we just let the fires go across the landscape. Mostly because the fire wont be carried very well through the juniper woodland because the juniper came in and pushed out all of the grasses and brush.
- We also used mastication and a variety of mechanical means for knocking down and tearing up the juniper and pinyon in order to open up and remove the canopy thus allowing the sagebrush and the grass seed to come in with less competition.
- In both resource management plans, back in 2008, there was a recognition of the role that climate plays. Before I came to the [redacted] office, in other areas we didn't see how we could take climate into our management based on the literature we had at the time.
- The Resource Management Plan now, though it takes climate into effect I don't know how much climate set the direction for the examples I gave except when it talks about restoring the ecosystem health and function.
- [redacted]. There are a lot of scientists that come from all over the area and the new research is based on climate or climate change and the effects that it might have on the vegetation out here. I think their focus is really sagebrush more than anything.
- In the [redacted] office, there have been questions raised about the direction of our resource management plan to do ecosystem restoration projects on the sagebrush. There are differences of opinions between the scientists about the permanence of the sagebrush in some of these communities.
- I don't think that anyone can come up with why the sagebrush has turned into a decadent and almost non-producing stand after it has been there for decades. There's no research that's says a climate change has caused that.

- For a site-specific analysis, including sagebrush and a few hundred to a couple thousand acres, we try to utilize current climate research to determine the types of treatment we should use. Do we just remove the juniper, cross our fingers and hope the sagebrush comes back in? Or do you have to worry about weeds? Do we have to worry about establishing a good seed source for the sagebrush? Is it that far gone?
- We vary treatments on land areas based on how we assess the soils and the current climate conditions, including precipitation and what we've seen over the last decade. We do take climate into account but not to a high degree because of a lack of localized data.
- If we have a certain location and the particular soils are susceptible to compaction and rutting by equipment then we have two options: we can do a treatment without ground equipment or we can schedule the treatment at a time of year when the surface soils are dry enough so compaction wont happen. The time of year may also depend on the amount of invasive species that are in the area. Do we have to treat cheatgrass because it will outcompete sagebrush? Is there a time of year we can do the treatment and minimize the influence that these invasive species have on the sagebrush?
- Most of the mastication projects were woodland projects in pinyon and juniper.
- As land managers we look at historic photos of what used to be a few juniper up on the hillside. Now it's a dense carpet of juniper coming down the hillside into what used to be a forested alluvial plain.
- We are just now becoming familiar with actual treatments for sagebrush, particularly because of the Greater sage-grouse and the Gunnison sage-grouse.
- Sometimes we use aerial application depending on the site. If we decide to treat is in the fall or spring then we can't access it with ground equipment. A timing problem is that many of the areas here are not accessible by road in winter and you have to wait for things to dry out far into spring.
- We may use an aerial application on fire, an aerial application of seeding, and an aerial application of the chemicals for invasive species.
- We have an ongoing project that is a treatment to restore the sagebrush. In one area they hand-planted the sagebrush and in another area they aerial seeded the sagebrush seed for a trial. It is an area that has substantial concern for cheatgrass. We aerial treated the cheatgrass this fall and we may use an aerial application again of a pre-emergent this fall.
- Temperature and humidity come into play when we do burning projects. We go out on the ground and check moisture and temperatures of three different size fuels (fuel moisture measurements). Depending on the range of relative humidity, the range of temperature, the range of wind and the range of fuel moisture, we will create a whole fire plan. In fire treatments wind can be used as a tool to move the fire across the landscape.
- For aerial seeding the main variable is wind because you can get drift or equipment issues with flying. But drift can be especially bad when doing chemical application.
- Depending on the chemical treatment rain may be needed. The chemical compound needs to come in contact with the soil or with the vegetation. Some treatments are pre-emergent and need to get into the soil, which may benefit from moisture. But other chemical compounds are directly applied to the leaves and you would not want moisture on the vegetation prior to application because you want the chemical to absorb into the plant.
- Depending on which application you're using will decide whether rain or snow is more important. For example, with Juniper we hand cut it and then pile it, and then we come back when there is snow on the ground and burn the piles.
- For seeding, sagebrush seedling planting and rangeland re-vegetation when you're trying to get seed on the ground its beneficial to wait until after the first snow. When you have a couple inches of snow on the ground you spread the seed on the snow and typically you will still have warm enough temperatures where the seed will warm up and melt down into the snow and onto the ground where it will be covered and protected from wind or birds. Then if more snowfalls the seed will be even more covered. This provides the best seeding opportunity.
- We currently work with the national weather service, and depending on the area, whenever we burn we get a spot forecast for that day. We need to know whether we'll have gusty winds, strong steady winds, what wind direction will be and when its going to change, when the temperature is going to change, and when the humidity is going to change. Then we put all of that data together to make sure we are meeting the controls and the objectives. A tool related to climate would all depend on what that tool does and what it's going to give us.

ii. Maps

- (no information)

iii. Climate Tools

NOAA Three-Month Outlooks:

- (no information)

NOAA Snow Cover Maps:

- (no information)

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- (no information)

AdaptWest:

- We're not going to have time to individually go through every one of these tools in Data Basin. People are going to have to spend time individually searching through them.
- Rather then click on historic and then click on the map and then all it does is give me one of many dots that are highlighted, instead let me select the [redacted] and let me select all of the time periods that I want to look at. To have it graphically show that would be fine.
- It would also be helpful would be display the dots on the graph for just one area. And then when I'm looking at the [redacted], I can start visually changing my x-axis and y-axis to visually mean something as I go through it.

(USGS) National Climate Change Viewer:

- In short term weather forecasting they'll talk about a Canadian model or European model. Is this similar in that the flags next to the models show the countries that created the models or the people who made the models? If it's a Canadian model or a Korean model then is it a model from that country?
- There are two models under datasets, one that shows a change in 1.3 degree F and another that shows a change of 8.5 degrees F. If you're talking about the application of a tool at my level, then someone needs to go through all these different models and help the land managers understand the differences between them.
- All the land managers work independently but we happen to have in our state office someone who deals with climate, climate change and air quality. We seldom have those skills at the district level and almost never have those skills at the field office level.
- If I'm going to use this tool, someone is going to have to say 'always use this model' or 'that model'.
- I predict that all the scientists cant even agree, so if I use one model I'm going to be told by all the people who oppose everything we do that I used the wrong model. So guidance would have to be provided before I find this tool useful at my level.
- I am not sure that I've heard of the IPCC (Intergovernmental Panel on Climate Change) before.

- At this level I don't think knowing the inputs to the models that create the different climate projections would be useful to me. If I were just given this link and I had to write up a climate change section for a particular analysis, I would go and use a NOAA model or a NASA model, because I'm sure that the people who critique what we do would not be supportive of this tool. They'll critique that we used a South Korean model for climate that occurred in southeast Utah.
- But I guess you could explain what the model input information was. If there was a mini-abstract that talked about how that model works differently than the other models.
- And the two levels of RCP (which would also need to be explained), would be useful if I was doing a relatively scientific technical analysis, but that is rarely ever done at this level. These types of analyses are going to come by a specialist at the state office, just one person in the entire state.
- Any color scheme can be easy to understand if you put it in a legend.

(DRI) West Wide Drought Tracker:

- I don't personally use the PDSI (Palmer Drought Severity Index). We do use fire indices for fire planning but I cannot recall which one. Palmer does sound like one of the ones we have used in fire management at the district and state level. We used this or one similar to track the drought in a given year so we can give a prediction to the local ground fire crews and land mangers of the drought severity and if it will continue. It helped us preposition fire crews where there may be severe drought conditions.
- Drought trackers gives us an indication in the coming season that could help us plan what we might expect so that we can plan projects or what type of resources we may need in terms of fire severity.
- I would both want a climate tool to give me projections that are seasonally over three months, and over one year. The most useful time frame would be shorter term, like its explained here in the anomalies and percentiles (last full month, last two months, etc.). But not too far back because that's history.
- 12 months is probably reasonable because we often compare the prior year to what we're experiencing now. Also a year or two out would be sufficient at this level because our project planning and budget are both done on an annual basis So
- If we're doing a long-term analysis and we're trying to predict something over a long term then a 10-20 year period may be needed. But most of the needs at this level are shorter-term projections.
- We use both water year and calendar year. Most of our work from a resource standpoint is calendar year. So our precipitation in the last calendar year.
- When I tried to change this tool to temperature it wouldn't work for me.
- This tool might be good for seeing that the urgency in doing a treatment is increasingly beneficial instead of just waiting to see what happens. In that way I can see some usefulness to it.

Integrated Climate Scenarios in Data Basin:

- I was not familiar with the RCP (representative concentration pathways) scenarios such as RCP 4.5 or RCP 8.5 before now.
- As we continue to increase our understanding of climate and climate change and as we continue to improve assessments of climate change I see a lot of value in this tool for when an office is initiating a resource management plan.
- Based on historical trends, this allows me to see what is going on in a certain area.
- I presume under these different models there will be a difference. There are acronyms that land managers may not know. These model comparisons wouldn't be useable now without a lot of explanation.
- Also the appropriateness of the use of a model is dependent on the parameters on which the model is built. If there was a way to understand these different models it may be beneficial on a very broad scale for each area.
- The historical I can understand.
- Ideally if this information was utilized in something like the AdaptWest tool, but where I can click on a specific portion of [redacted] and have it show what has been historically happening, and I could select an RCP scenario and have it show what is going to happen under that scenario. It could also show

what is going to happen under another scenario and maybe model so I could come up with a variety of alternative solutions.

- We can prescribe certain land management actions based on certain scenario outcomes or model outcomes. Show the different models but also show the different scenarios so that we can make management plans based off of these.

iv. Final Thoughts

- There is a lot of data in all of these tools. We just had the National Weather Service give a presentation to us last week. For what they showed the group in general we all had similar comments to, which are similar to what I've made here. Basically, 'That's nice…but most people aren't going to use that unless they can predict the rains that are going to come in the next couple of days because I have crews coming in from out of town or something.' That would be beneficial. But this is shirt term. And we will use short term fire forecasting. We don't do much long term planning at this level, and if we do long term planning at this level its once every ten years that we do a resource management plan or project analysis in our area.
- Depending on where we are or whom we're working with we have other tools available to us. A lot of the tools here in data basin I have seen except for maybe the AdaptWest.

Participant #20

i. Preliminary Discussion

- I supervise wildlife and range management in [redacted] I supervise the range management on about 2 million acres and then some of these wildlife projects. We have two upcoming wildlife projects that will benefit sagebrush. We also have the just recently listed [redacted] sage-grouse. We did our most current resource plan in 2008 and planned for sage-grouse habitat at that point.
- Our 2008 resource management plan had very little on climate. We do have some drought management in our range program but very little on climate.
- We've had some sagebrush vegetation treatments to improve some sagebrush areas in our field office. We have a project where we are burning an area, mechanically treating and then also spraying the area and then re-planting sagebrush. How we move forward with this is very dependent on climate factors such as precipitation and temperature.
- In our planning process we identified parameters on how we'd move forward with the process and the precipitation and temperature really guide what we do or don't do each year on a project. For example, last fall we planted 11,000 sagebrush seedlings. When we're planning a project the most important variable is precipitation. Here is southeast Utah we get snow and we get monsoonal rains. It's fairly dependent on those monsoonal rains that come from about June to August. Sometimes they come and sometimes they're very sparse.
- Humidity, wind and temperature play a role for prescribed fire.
- We look at all of these different climate variables on the long term, so maybe next year or the next couple of years. The projects are usually about a five-year project. The shortest time interval would maybe be 3 months.
- I am not currently using any climate tools.

ii. Maps

- (no information)

iii. Climate Tools

NOAA Three-Month Outlooks:

- The terms slightly above average, above average, below average, etc. don't give us any specific numbers of how above or how below. These terms could be better defined.
- I don't know that this tool seems intuitive but it's useful. I would have to spend some time with it to understand it. It doesn't seem to flow. But it does seem to have good information once you learn where everything is.
- I would need more time with the region number probability graph. At first glance it's not very useful but maybe if I had time to study and understand it. It would be more useful to have something a bit more intuitive at first glance.

NOAA Snow Cover Maps:

- For our office I don't see us using this. We're pretty rugged country. Our elevation is between 5000 feet to 8000 or 9000 feet, and snow cover varies a lot.
- If this tool were to look into the future then it may be used as a tool in out planning.
- Just precipitation in general would be important.

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- (no information)

AdaptWest:

- Couldn't you select only one ecoregion and only see that, instead of all the other ecoregions?
- I would prefer to see the time periods for one ecoregion on the graph. This seems like it would be easier to understand to me.
- Overall I would have to spend more time with this tool to be able to give better feedback on it.

(USGS) National Climate Change Viewer:

- Variables we would be most interested in are temperature, precipitation, soil storage, and evaporation. Those all seem pretty useful.
- When it says .1 inch per month in runoff, what does that mean? What scale or area size is this for? Knowing that would make this number more understandable. I really don't understand what one-inch per month, especially in terms of runoff, really means.
- This tool might be good for planning. In the Department of Interior we're suppose to be planning for climate change but we have no direction. For planning we could potentially reference some of these models. I think it's useful to have the average mean model, but to also compare the models because it seems to give it more credibility.
- I did think that the color continuum for the runoff variable was a little hard to read because there didn't seem to be enough contrast between the colors.
- Another variable I would like to see is wind, because we're in a really windy area and that really influences things.

(DRI) West Wide Drought Tracker:

- I don't use PDSI (Palmer Drought Severity Index) in my position but the fuels folks would and potentially our wildlife crew.
- I really enjoy weather, so personally I love this tool. I also think for planning its pretty useful. If we could pull up the last year and be able to put it into our analysis for a planning document then that would be good.
- I like that it's separated into counties because in the BLM we separate our offices almost exclusively by county. Our district includes about 1.8 million acres with all of that in one county except a small portion of it. So I think dividing it by counties is useful for the BLM.
- When I tried to use the PDSI drought index in Utah it took a really long time to come up.
- This PDSI drought severity index seems helpful. I don't know that I would use this specifically but our hydrologist uses it.

Integrated Climate Scenarios in Data Basin:

- Previous to this interview I had no idea what RCP (Representative Concentration Pathway) scenarios meant or were, for example RCP 4.5 or RCP 8.5.
- Where does the information for the historic vegetation class come from? Is this from vegetation inventories or transects? Or is this a projection of the historic vegetation?
- One of the projects we're working on uses information like this, and there is actually some good fieldwork information gathered, at least from the 50's.
- I would want to know the inputs that are used in the climate models to create the different projections. I think that would be helpful.
- This tool seems pretty intuitive and useful. This includes the colors.
- I like that I can track the historic precipitation alongside the vegetation, and then try to project that into the future.

iv. Final Thoughts

- A climate tool could be best presented via the Internet. This tool would best be updated monthly or as frequent as possible.
- There is so much information within all of these tools that I can't think of anything else. I think really short basic information of what's in the tool itself would be really helpful. Almost like an easy, quick access guide.
- Yes I think something that talks you through the tools, as long as it can be shut off, would be useful.

Participant #21

i. Preliminary Discussion

- I am a Natural Resource Specialist. My primary responsibilities include the management of weeds and invasive annuals (e.g. cheatgrass, medusahead, and ventenata) within the district.
- Precipitation is probably the most important variable for management. Specifically snow more than rain because otherwise seed becomes bird food. Snow is important for seeding and sagebrush seedling establishment.
- Uses an integrative approach to weed management including mechanical removal, aerial and ground herbicide application, and seeding of perennial grasses, sagebrush and other sage grouse forbs.

- New herbicides becoming available for use will hopefully work more effective so that less active ingredient herbicide will need to be used to manage invasive plants and a focus can go towards seeding, or groups of sagebrush seedling plantings.
- Herbicide application can be dependent on drought conditions (i.e. Herbicides don't need to be applied if drought already killed back the annuals. In a drought some of the herbicides may actually be less effective due to the plant performing less translocation.
- Seeding takes place soon after a fire. Must get seeding and herbicide applications in before windstorms arrive in October or before annual grasses emerge and out compete the new seeding's.
- Managers look more at current or daily conditions from day to day , weekly and monthly for drought.
- The best timeframe for a tool would be monthly, seasonally (every couple/few months) and up to a 10 year timeframe. Monthly and seasonally is needed for fire and management, while long term plans require looking out 10 years.
- Not sure these tools will be useful because there is much information already available to BLM employees in-house about past site conditions. Looking at this past information seems to work well for projections.
- Current tools utilized include a NOAA tool (manager will find out the name) and local weather station data.

ii. Maps

- (no information)

iii. Climate Tools

NOAA Three-Month Outlooks:

- (no information)

NOAA Snow Cover Maps:

- This tool would be useful if it showed future projections.
- This tool is pretty intuitive.
- The date in right bottom corner of the map works well in correlation to the moving snow and ice on the map.
- This tool would be useful to compare this year's snowfall to previous years snow fall.
- I am not sure that I would use this tool.

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- (no information)

AdaptWest:

- This tool would be more helpful I could switch between degrees Celsius and Fahrenheit on the axis.
- It would be useful if there was less space between number on x and y axis (more focused).
- This tool would be more helpful if I could look at one ecoregion and then have timeframe points on the left graph that were relative to that ecoregion, rather than point for all ecoregions.
- Ecoregions can be helpful, but counties would be better because can see where you location is on the map.

- It would be useful if these maps could be utilized as layers to use in Arc. Everyone in this office uses Arc and is currently using it for upcoming management plans.

(USGS) National Climate Change Viewer:

- The precipitation and temperature variables within this tool are good. Not sure that I would use the others.
- The color continuum intuitive.
- Comparing the different models within this tool may be helpful.
- Knowing a bit more about the models, such as inputs, and explanation of what model names or scenarios mean, would be useful.
- Being able to compare models side by side could be helpful.
- It would be helpful to look at other timeframes more current than 25 year projections.

(DRI) West Wide Drought Tracker:

- I don't use PDSI in my work
- I couldn't open the tool
- I use internet explorer

Integrated Climate Scenarios in Data Basin:

- I didn't know what RCP scenarios meant
- This tool is more confusing and I would need time to look through it
- It would be helpful to be able to choose timeframes such as specific years or seasonal
- Ecoregions is a good spatial scale
- Knowing a bit more about the models, such as inputs, and explanation of what model names or scenarios mean, would be useful
- Not sure that I would use this and I would really only use something like this if I'm looking for it

iv. Final Thoughts

- (no information)

Participant #22

i. Preliminary Discussion

- I'm a botanist for the district and I deal with special management plants and any monitoring or re-vegetation efforts we have post fire on the district. Special management plants are based on the BLM sensitive plants list that may derive from state or federal threatened or endangered, or any other species that BLM feels warrants special concern due to rarity or potential loss of habitat. Sagebrush is not defined as one of these plants. Invasive annuals are tracked as noxious weeds so they are separate from this.
- Precipitation is probably the largest climate variable that plays a role in what I do. We use ecological site descriptions, which are based on how much precipitation an area receives. And that defines what our seed mix is going to be when we go into those areas.
- Predominantly we do seeding. Seeding is usually drilled. We have planted seedlings of bitterbrush. I don't think at any time we've planted sagebrush seedlings. The timing of precipitation plays a role. Typically

we try to do a fall seeding, but another option is to go in spring. That would depend on whether we got precipitation as snow.

- We are starting to treat for invasive annual grasses (cheatgrass, medusahead) post fire with an herbicide treatment. We apply both a ground and aerial herbicide application. The wind would come into play if we were doing an herbicide treatment. Day by day it's important to know if it's too windy to spray and if we're going to get to much drift.
- Our projects typically come under emergency stabilization and rehabilitation projects (ESR). We have 30 days after the fire to develop a plan and then the plan runs for 3 years. We typically get the seed in the ground year one or at least in year two. That's so we hopefully have enough time within that three-year window to monitor and see if we were successful and still have time to make any changes in the third year. So essentially its three years from the fire.
- We usually seed in the first fall post fire.

ii. Maps

iii. Climate Tools

NOAA Three-Month Outlooks:

- On the map for each outlook there are numbers, what do these numbers mean?
- The anomaly map is a little hard to understand.
- I don't know how I feel about this tool. It's a lot of information. The three-month outlook is something that I am looking for. But this has been a little difficult to figure out. I think there's good stuff here its just not as intuitive.
- The precipitation probability graph has a lot of information. If I took some time I may be able to figure it out but it can seem very overwhelming the amount of information on the graph at first. There is too much going on in this.

NOAA Snow Cover Maps:

- There is no depth to the snow in this tool. It just shows snow on the ground. Having some sort of depth would be important. We get a lot of half-inch snow that soon disappears, but its important to know depth because we would need to know if this is going to be a persistent snow pack for us. A deeper snow pack is more important to plan if we'll have moisture in the spring.
- This tool seems to work well for what it's showing.
- It would be more useful if it forecasted into the future. But I think forecasting snow depths would be pretty tough. It would be interesting to see how reliable that could get.
- It is interesting that you can change the historical date and see how the snowpack from different years has affected things.

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- (no information)

AdaptWest:

- It's interesting that the variables you can choose are seasonally based (e.g. summer precipitation or winter precipitation, coldest month or warmest month). I could use seasonally based variables.

- The timescales in this tool are far beyond the management that I do. I would like to see a yearly time scale.
- It would be more useful to have different years for the same ecoregion. All of the points for the other ecoregions are useless to me. We work in the one ecoregion so all the other ecoregions aren't going to make any management decisions for us.
- The axis increments are pretty rough (i.e. 300 to 400 mm). But this is probably because there is such a big range with the ecoregion. But if you're going year by year for the same ecoregion you should be able to tell with much finer precision.
- The other thing that would be nice is that when you hover over a point in the graph to have it pop-up with the coordinates. This way I'm not sitting here wondering is it 10 or 20? The program knows where it's graphing it so this should be do-able.
- I like the ecoregion scale. It's often something I use.

(USGS) National Climate Change Viewer:

- This shows a 20-year average but I'm more interested in a forecast for next year. Are we going to get a good snow year this year or is 2016 going to be the good snow year and I should wait a year to plant seed. The fact that the entire next two decades are going to be a little less than current isn't going to be applicable from my position.
- It's interesting to compare the different model projections side by side but I don't know where the value would come in.
- The colors are good.
- The counties work well for us because it matches with our districts, not exactly but it works very well. So counties do help. For this level of specifics or getting specific data, the counties work better than the ecoregions. I do like that the resolution is better with counties.
- It would be helpful to define whatever variables are being used. For instance what does 'soil storage' mean? Is it soil moisture?
- Otherwise the variables in this tool are good. I don't know that wind would be particularly helpful.

(DRI) West Wide Drought Tracker:

- I do not use the PDSI (Palmer Drought Severity Index). I do check the US Drought Monitor (USDA). I also currently use the PRISM model for precipitation.
- I don't know that I would use this tool for temperature.
- The color schemes seem to make sense.
- I like to see a monthly precipitation and then be able to track that back for a year or two. That is more important than if we're getting precipitation for this month on a 30 year average. So I would want to see all 12 months, January through December and when did we get that precipitation. A time series of data over a couple years is more useful for me.
- This tool ended up not working properly half way through using it.

Integrated Climate Scenarios in Data Basin:

- I have not heard of RCP (Representative Concentration Pathway) scenarios prior to this interview (i.e. RCP 4.5, RCP 8.5)
- This tool is overwhelming.
- The first row showing the graphs for the whole area just seems to be in the way. It took me a while to figure out that I had to scroll below it to see the graphs for my ecoregion of interest. There is already enough information just having the four graphs for one ecoregion side by side.
- It only shows three graphs at a time and I have to scroll back and forth to see the results between all four graphs. Tightening that up would help.
- The timeline also doesn't work very well.
- It might be good for landscape level, but I'm not involved with projects at that scale.

- I like having the historical projection there. I don't know enough between the different models to know. It would take a lot of research for me to say I like this MIROC5 projection because its using the right soil class and vegetation classes or whatever, verses another model projection.
- I definitely think that there's too much here for someone who doesn't know without and explanation, of the RCP even. It would be beneficial to have some sort of explanation about the models or inputs for the model projections.
- I don't think a voice-animated direction would be good. But I do like where you hover over and it gives you a one sentence blurb and a link to more.

iv. Final Thoughts

- The biggest thing for me is the timeline.
- Another thing is that when I work with the PRISM data it doesn't always match up very well with our actual weather stations. So for projects, if there are stations close enough to the project area I will use that more then the PRISM model. That's just a general critique of models in general, and how applicable are they to real world conditions.
- Precipitation is the biggest variable. It would be nice to see the variable split between rain and snow.

Participant #23

i. Preliminary Discussion

- I deal with emergency fire rehab and burned area rehabilitation, and I'm the noxious weed program manager. I'm involved with treating sagebrush after wildfire events and the noxious weed invaders into rangeland. This includes cheatgrass, medusahead, ventenata, all of it.
- We mostly use spot treatment on noxious weeds including some mechanical, some chemical and we also incorporate as much bio-control as we can. The regional bio-control specialist works for me so we're really pro bio-control. This is something that I think needs to be up and coming; it's a tool we're not utilizing to its fullest extent.
- After wildfire we can do a host of things for ESR. The mechanical removal of cheatgrass is usually limited. We've done some chaining in the past trying to bury it and then seeding over it. We have used chemical removal in the past and direct seeding trying to get something in that's more competitive in the long run trying to outcompete invasives over time. We use drill seeding, aerial seeding, and hand planting of seedlings.
- The climate variables would be more of the weather that year. Are we putting it treatments during with the right treatment windows? Are we going to have a cold period? Will we seed on snow or under snow? But that's more weather.
- Climate to me in something that I think about a lot and that comes into mind when choosing your seed selection. There's a big push for native seed and localized seed, but we need to be thinking about species that are more tolerant and elastic and could persist into the future. None of us really know where this is going to go so we need to have our seed and plant selection as things that could persist with the shifts in climate. And I think we need to think more about the future then the past.
- Right now there aren't any specific climate tools that I use, its mostly my gut feel. I've been here doing this for 20 years. Our seed selection now is based on competitiveness because cheatgrass is so competitive here is southern Idaho. That's mostly what we're using.
- I'm selecting species that are very hardy, very drought tolerant, and maybe can handle a different spring. One of the things that alarming me most is that we'll get a really warm February and then a cold March. That is killing our seedlings. We'll get germination and then the frost will kill them off.

- We've got local weather stations here and we're starting to work with USGS on some local climate models. We're reaching out.
- When a fire happens we have ten days to write a plan. I need to know what the average precipitation is in the spring and in the long term. Is it a 6 inches, 8 inches or up to 12 inches because that influences our seed selection. Or are they still going to be 8 inches but all that moisture comes at the wrong time.
- The saying is '3 rains in March make or break me'. I can have an excellent seeding in March but it's that key rain in the spring with the right temperature that makes or breaks a seeding. When everyone says it's a failure its usually because that March or into April wasn't favorable. The soil temperature and moisture didn't occur at the same time.
- If we knew it was going to be a favorable year for temperature and precipitation then we could do a lot of seeding's because we would know they're going to be successful.
- In this district we have a lot of winter soil moisture, as sagebrush holds the snow. But we're getting less snow in the valley and so we're getting less soil moisture. For a fire area where we've drilled we can't keep snow on the ground because we don't have the aboveground stand of shrubs to catch and hold the snow. So we rely more now on the spring rains.
- But that winter moisture is gone. We may even do a seeding but all we see is cheatgrass and maybe some acacia koa?
- I need to know if my precipitation in the next year or ten years going to be reduced. Will there be more droughts here? That would influence my seed selection. In July I need to know what the next March is going to look like and the whole next year. I'm looking about 9 months out. Sometime 3 months doesn't do me any good. I have to have the plan approved, get funding, buy seed and have everything in the ground before thanksgiving.
- I use mostly annual precipitation based on water year.
- I do not use any drought indices such as the PDSI (palmer Drought severity Index). The range guys do a little.
- We like to do winter seeding because that's when seed is available. Sometimes its your supply and not your treatment window. Sees harvesting is in late November to December so we may not get seed until Christmas. The ideal would be by December 1st.
- To seed you need bare soil, frozen or not, and then you want to get snow on top of it. You want to get it down and put it to rest so it will germinate come spring. Sometimes we don't seed until January and we may seed on top of snow and I think we get a lot of loss when we do this maybe from wind.
- Temperature and wind play a role in aerial seeding. You're actually going out there when you get a still day. Wind plays a role in how much seed you get on the ground. We have a 10 mph maximum.
- Herbicides have wind limitations too; I think it has to be above 3 mph and below 10 mph. The label for each chemical has its own wind limitations. That has to do with getting the chemical on the ground and reducing causing drift. With herbicides you cant have the ground frozen because you need to incorporate it into the soil. And depending on if it's a pre-emergent you want it in the soil to get things germinating. If its a contact herbicide you want it applied directly to the plant. In the fall we put herbicide down and we want a rain to follow and water it into the soil. The opposite for the contact herbicide, you don't want rain for at least 48 hours or longer. For this we need to local storm system and weather information.
- For biological control we use fungus, pathogens, and predators. You have to mimic the climates that the bio-control agents like and are adapted to. We've seen that as we increased generations of bio-control, that they're adapting and moving possibly into a wetter community. [redacted] may have some modeling going on watching some old releases and how they're migrating. If they've drifted or migrated into a wetter area and if that's where they gather then maybe we can move them to the same area type elsewhere. So climate for [redacted] would also be about timing because bio-control hatch may be different each June in two consecutive years. Timing also affects the plants, and if the plant matures too quickly then the bio-control doesn't have anything to feed on. So precipitation and temperature play a role.

ii. Maps

- (no information)

iii. Climate Tools

NOAA Three-Month Outlooks:

- This is the kind of tool I need, but I need a 9-month probability. The 3-month is good but all the treatments are in the ground. I need to know what the spring is going to be and if it's going to be a successful seeding.
- The tools need to be long enough so that when we're starting to plan a project we know what to expect. I'm on the fast track with stabilization after a fire. We get plans done in 10 days and then we're going. But some of the EA's take 2-3 years and they may have more of a luxury to wait for that perfect year. But not really because if we got funded for it this year then we have to do it this year. It would be nice to get funding and these climate projection models to coincide.
- This tool would currently be extremely useful for our monitoring program. It will give us a small predictor of what we're going to see out there. Say we're in a second year after a seeding, or the third year when its not just the germination but it's a growth phase, we better not graze it this year if the model says we're not going to have a lot of precipitation. It could maybe lean a manager into a decision a little easier.
- I feel this tool is pretty intuitive, but I would say the outlooks abbreviations such as 'MN' made me think for a minute about what I was looking at in terms of timescale.
- The colors are good but I would say that instead of having an 'A' or 'B' it would be nice to know what the colors mean. I would have a color bar beside 'A' or something, or a legend with variations in color.
- Looking at the probability graph for each 'region' (i.e. I'm 78) shows normal observed data, final forecast and then an error envelope, but how long is this for? So at what point in time is this? For the whole 3-month period?
- I'm having a hard time with this probability graph. So it goes from 100% to zero over a 3-month period but there are inches at the bottom? To tell you the truth I have no idea what this graph is telling me. So the graph in the tool isn't as intuitive.
- I had to talk my way through this trying to figure out what this graph was showing. I sort of get the graph but the curve could be for any month. But its just showing probability?
- I guess just because I don't get it at first doesn't mean that its not a good graph. But looking at it again it is helpful to know that there is an 80% probability that we're going to get this much rainfall according to this graph. This is how we could justify the money.

NOAA Snow Cover Maps:

- A tool like this may be useful if it had a future projection, but snow is so fickle.
- This tool is at such a large scale (not zoomed in enough) that this is more interesting than I think it is useful. It's impossible to tell from this scale if the [redacted] is going to have enough snowfall this year. For an actual treatment map this is not zoomed in enough.
- Things like el Niño are a big deal for us this year. What's that going to do for this district? What are the changes in temperature in other parts of the globe doing to us this year?
- For seeding snow isn't as important as I think the precipitation is in the spring. And even though it might show snow in December if it's just a light dusting on the ground it wont matter much. This probably has a lot to do with the health of your ecosystem but for treatment not so much.

NOAA U.S Climate Extremes:

- This tool is interesting but I'm not sure how useful it is.
- The graph would need to be clearer or give an example. For example it could say that on an average day you get a half-inch of rain. What are the extremes?
- This graph is not really predictive unless its showing trend. But as far as planning a one or two year event I'm not sure that this would be useful.

NOAA Climate at a Glance:

- Is the temperature anomaly for one day or an average for the month? It may be helpful to have more explanation here.
- I'm not sure that I use heating days or cooling days but I think it would be a good tool to have.
- This tool is interesting. I like this one.
- I like that I can go around to different months.
- But this tool shows 1901-2000. When I went on the temperature it's showing a negative but we've had the warmest temperatures ever. If you're taking a historical average over 100 years it's going to affect the outcome. And 2000 was pretty far back too. So in this tool they're comparing this month to the last century?
- I like the makeup of this tool more, but it would be better if they could extend it to more variables and with a different timeframe.
- This tool seems easier to read.
- I cannot tell what the divisional scale is? Its not ecoregions or counties. But it looks more ecologically driven then a county would be. A county would be too messy because it would be too small.
- This tool just seems to be a little easier to navigate around in.
- When looking at the PDSI (palmer drought severity index) on this tool it would be good to have an explanation of what the numbers mean. Are they a deviation from the normal precipitation? Also to have an explanation of what the colors in the table mean. Or if you could do a seasonal (3-month) PDSI..
- Other variables that might be useful include wind. Wind would be interesting because it affects the available moisture so much. Also maybe the change in wind.
- The color schemes in this tool are good. They have a good separation.
- I think these spatial divisions work fine.

AdaptWest:

- The graph on the tool did not load for me properly. There was a map to the right but no graph to the left. This tool did not work for me.

(USGS) National Climate Change Viewer:

- This tool seems to give a long term trend.
- Looking at the precipitation, and the minimum and maximum temperature variables (because essentially these are the three that are effective) what is this region going to do long term. We may get more moisture but if it's hotter than there is actually less available moisture. That's a case for what we're planting? What are we doing? Is it going to persist through this time period? This is what is needed long term when trying to select a seed mix that's going to have that adaptability.
- If available moisture could be a variable that is included then that would be great. If you just look at precipitation or moisture then that's important but its not the precipitation as much as it's the available precipitation. If we get a rain here we can still have dry soil in a couple of hours with a little wind or sun on it. We'll put out our wind gauges and we'll do a moisture probe 1-2" and then one at 8". The one directly under the surface of the soil will record every rain event and if it doesn't get down to that 8" then we know we didn't retain any of it.
- Evaporation deficit might be helpful but looking at evaporation deficit with this tool shows a decrease over the whole US. It would be helpful to define what this variable is actually looking at, what evaporation deficit is taking into account.
- Its sort of useful to see the different model projections next to each other. I'm trying to apply this to writing an EA or trying to justify funding. Once we've established that the model says we're going to have certain conditions, then I can say these were the conditions that led me to my decision. These conditions are never going to change when I come back to this model. So I'll used it possibly once to look at future trends, and that would probably be it.

- It would be helpful to know what some of the different inputs are that go into some of these different projections. But these models are never going to change, whatever is in there now, the worst case scenario or best case scenario, but think about what we have to do on a day to day and yearly basis, its all about trying to justify a smaller and smaller pot of funding to do something. Basically we're competing for funds with all agencies and this would show that we have a higher probability of success and sustaining that success into the future. Knowing some of the inputs to the projections would be helpful because it would help assure the reasoning behind why we picked certain models to use over others for our planning.
- I think it's the shorter-term climate that we need rather than the longer.
- The colors are readable, but with precipitation it is hard to tell the difference between some of the colors. I can barely tell the white from the blue.
- Both counties and ecoregions are useful for spatial scale. The counties allow you to know where you are. But with the ecoregions you could too, and the ecoregions may be nice because they have similar trends. For example it may be more interesting to know the trends in the Snake River then in a county.
- If you could change the timescale then that would be good. For example if this took 70 years in the past and then projected 70. But for the shorter term it would be nice to see the last 5-years, 10-years and 20-years, or the shorter-term historical change. There may be some noise if we're using all the way back to 1950.
- This is what I'm looking for as far as a long-term future projection, but we need the short term for our writing so we can get funding.
- Actually 25 years would be good. Looking at a historical 25 years to project 25 years into the future.
- This tool is pretty amusing.

(DRI) West Wide Drought Tracker:

- If an area burns you cant sit back and wait for the right climate because something's going to happen to that land whether you treat it or not. Its hard to do the no-go situation, because if you leave it cheatgrass comes up, or if you spray it but then leave it for a year then you may not get funding that next year. That's why we go in and hope for the right weather.
- The cattleman wont stay off for two years. So if the tools are available you can justify your funding because they want us to have 100% success rate. But it doesn't help anything after that. Are we going to have precipitation for two years? Are we going to be able to keep the animals off? One of the best reasons for climate models is to justify the funding.
- If there is a drought then sometimes you can get the numbers reduced or the time reduced for grazing. But it's really rough because there's nowhere for them to go if they cant buy hay. So we need to figure out how to manage. Having climate tools might help with allocating areas with resources for grazing verses those areas that may be more sensitive to climate variables that year.
- This tool was not working properly when I tried using it. This tool did not work for me.

Integrated Climate Scenarios in Data Basin:

- This tool took a long time to open and when it did one the graphs and other graphics were not visible. This tool did not work for me.

iv. Final Thoughts

- We need to know what climate is going to do for the long term. There are several tools that are looking out at 25-year increments. Are we getting drier into the future? Thinking about seed selection, what should we be doing? What should we be planting what will adapt into the future?
- And then we also need short-term projections. The 3-month tool is cool. What is the precipitation going to do next spring?
- The rest of the tools are amusing but they're not as helpful.

- The main variable should be precipitation. Short-term trends for precipitation are harder to model on a smaller scale.
- I'll show these tools off to others.

Participant #24

i. Preliminary Discussion

- I am a supervisor for a [redacted]. All of whom are intimately involved in monitoring and management of sagebrush ecosystems.
- Among other things, we spend a lot of time on livestock grazing management, emergency stabilization and rehabilitation (ESR) and riparian area management. Upland grazing and ESR, and especially seeding are all very dependent on the weather to get the effects you were hoping for from your management.
- What I do can be rather variable. Currently we are doing a complex allotment management plan, which has a lot to do with managing invasive annual grasses.
- Throughout this winter we are also focusing on writing sage-grouse Candidate Conservation Agreements (CCA's). CCAs are used to identify threats to and conservation measures to protect candidate species and their habitat. Candidate species is a classification with less protections than "threatened" or "endangered" under the Endangered Species Act. US Fish and Wildlife Service approves CCAs. We are also writing ESA, through the fish & Wildlife service. This is a pretty formalized process. We identify the threats and you select conservation measures to address them. We work with a permitee on an allotment or permitees on groups of allotments and implement it over time or decades.
- Seeding is probably the activity that is most impacted by weather. We need favorable moisture & temperature conditions in the spring after we have seeded to allow germination and establishment. We try to seed in the winter after the potential for fall germination has past. Then we are really dependent on the weather the next spring to get that seed established.
- For weeds there are standard operating procedures that have to do with wind and especially precipitation. If you're ready to spray and the wind is blowing at 15 mph then you can't. But this is more about the normal variation of weather as opposed to climate.
- Both rain and snow precipitation are important but for different reasons. Native plants in the Great Basin are adapted to cold, snowy winters and hot dry summers. And spring is maybe more variable. For example, when we're working with bluebunch wheatgrass it is pre-adapted to the temperature and precipitation regime. But if we're using something like crested wheatgrass or forage kochia, then these are a lot more broadly adapted to different weather conditions, but they are still dependent on spring or summer moisture to establish. The thing about forage kochia is that it can grow if we get precipitation in the summer. So rain and snow have different impacts on different species.
- Herbicide application can be affected by wind. The aerial herbicide applications on our district are targeted at medusahead and cheatgrass. We try to do applications in August and September when the humidity is low and it is very dry here. The factor that impacts whether we do the treatment is the wind. We have been using Plateau (imazipik), which is a pre-emergent. Both cheatgrass and medusahead are facultative winter annuals. If you apply pre-emergent in August or September and then you get moisture, some of the seeds in the soil seedbed will germinate which is what we hope for because then the herbicide kills these. So the moisture and humidity do impact the success of the herbicide treatments.
- We would like hourly temperature and precipitation, 100% accurate for the next 30 years (ideal!)
- Dave Pike works at USGS and has done studies of rehab seeding's for BLM in southeast Idaho and Northern Nevada. Some of his conclusions include that after about 20 years, on maybe about 500 sites, none were really rehabbed. And the [redacted] division of wildlife resources has a permanent vegetation plot that may be approaching 50 years old. Among their conclusions for the Utah part of the Great Basin is that once cheatgrass is present, not even dominant, it is inevitably that it will perpetuate regardless of management or fire. It establishes a huge seed bank in the soil so even if there is a drought every two

years, with just a little bit of spring precipitation the cheatgrass will grow and set seed. In some of those years the native's perennials will be dormant the whole year. We have to win basically every year in order to keep the invasive annuals out, especially in the lower and drier sagebrush. Climate tools are a big part of whether we win or not.

- If there was any way to predict favorable establishment or germination for 3 or 4 years then that would be very useful.
- Once we get a seeding or a perennial species established then management becomes more and more important. We can generally manage around weather. The germination and establishment of mature plants is what would be very beneficial.
- We would need information quarterly for maybe five years. (Note from interviewer: What do you mean by quarterly?)
- A lot of our drought stuff is based on water year because that's what is available, but water year or calendar year doesn't matter for us.
- We use a NOAA drought report and I think a USDA report. PDSI (palmer drought severity index) is part of one of them. We use drought indices in just a general manner.
- Spring for us would be March through June.
- Our most often-used climate tool is the day that money arrives. That is a big part of when we decide to do stuff because most of our money has time limits within one fiscal year. Sometimes if we have the money we will do the project regardless of what the outcome is. Or to do the contracts so that they can apply the seed or apply the herbicides or whatever.

ii. Maps

- The two cheatgrass and medusahead maps, don't show hardly any data and in one Oregon has a bunch of medusahead and below the state line Nevada has all cheatgrass. Oregon BLM might be a good source for more accurate invasive distribution.

iii. Climate Tools

NOAA Three-Month Outlooks:

- The normal period seems accurate for my area.
- I think this tool is useful. The scale is always going to be an issue because we do stuff at a pretty site-specific scale and this is bigger.
- If money arrives according to these projections then that would improve it. It helps us plan stuff.
- I guess for precipitation I would rather see actual numbers, but for temperature it can be more general, such as anomalies from a normals period.
- I don't think it matters if we have more current historical periods. I think the predictive period should be approximately the same time frame as the period you're using to project. Because if you have a 100 historic years and you're projecting the next 10 years then statistically this doesn't seem right because you have just averaged out all the variability in those 100 years. So depending on how you present it, the historic period and the projection period should be similar.
- Do I have to click on the area number map or on the table below the map?
- In the exceedance graph, on the zero percent line, there is a red star near 5 inches and then there's a 90% with a blue line, does that mean that there's a 90% chance that there will be approximately 5.25 inches?
- What do some of the notations in the graph mean? Can these be explained better?
- I don't know that this graph is intuitive but I think I could figure this out. This is sort of the way that the NRCS presents predictive stream flows too. So this might be something that BLM managers would be used to. But I don't know what the observed data line (the yellow stair step) means? Is this the actual observed data?

- Because this is projecting into the future it makes it hard to interpret observed data. Maybe this is the normal data? This is where it would be good to explain that this is observed data based on a certain time frame (i.e. 1900's – 2000).
- I kind of like this graph because I am semi-used to seeing runoff graphed like this, but also because it kind of gives me a range for a relatively confined period that might be of interest to me. If this were way off then that would be a warning that maybe we should try and stockpile our money and do this project some other time if we had that level of flexibility.

NOAA Snow Cover Maps:

- This tool is pretty cool.
- What data is the map based on? Is it Snotel? Is it airport weather stations? It might be good to identify on the map within this tool where the information is coming from. We get questioned about who made this.
- Since the snow moves from white and then to green quickly in some areas you might guess that it isn't a lot of snow. But it's not quantitative in any manner.
- BLM doesn't really do research, however if in 2012 we had a big fire and we did a lot of seeding and it fizzed, then we could use this sort of tool to look at snow cover late in the winter and into the spring. This would be a useful piece of information in deciding why it succeeded or not.
- It would be useful if this could project snowfall into the future, but this would depend on how confident the projections are or how accurate they turn out to be.
- The color scheme is easy to view. Can you zoom in?
- I like the date sequencing in the bottom corner.
- The other thing that might be useful is that instead of by months do seasons.

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- I have used this tool in the past quite a bit when I worked in [redacted]. There are two issues. One is that the scale is pretty general. The other is that it shows we're at -2.1 for January. We're still below and still in some level of drought. But last year by the time spring came we were at about 1/3 of normal snowpack or precipitation. However we had a fabulous growing season because we got a little bit of precipitation in May, and then a little in June and them maybe even again in July. So the timing was perfect to grow grass, however we were still in a drought. A lot of our management is pretty site specific. And a lot of these tools are both temporally and spatially fairly gross. A 30-meter scale would be great!
- Soil moisture is in a way predicting the short term future from past precipitation, and if used in this manner it is useful (for soil active herbicides and seed germination). But it lasts until you have warm windy weather. So it is interesting and it can be useful, but it is pretty short term.
- I like PDSI, however it just tells you what has already happened.
- I like this map, including the color scheme and I have used it quite a bit in the past. When you're working with large scales its pretty informative and it tells you how long it has been this bad.
- It would be useful to have some information about the different drought indices and what they are. I did not know what the abbreviations are but when you choose one it does spell out what they are. If there was a citation underneath the name then if I needed to know more about it I could look it up.

AdaptWest:

- The graph associated with this tool wasn't working with the ecoregion map. This did not work for me.

(USGS) National Climate Change Viewer:

- There seems to be a huge difference in precipitation per day for neighboring counties.

- I like this model but if I'm planning a project it still doesn't tell me what the weather is going to be like in three years in the spring. That's seems to be the weakness of these types of tools for our uses. But it's interesting.
- I don't know if this is still true, but the Great Basin had the least stable outputs for these climate change tools. It ranged from warmer and wetter winters, to warmer and drier winters, and then summer would still be hot & dry or maybe a little hotter. So the big deal is going to be what happens to precipitation in the spring? The most useful for BLM management is accurately projecting the late winter and early spring period.
- It would be very useful to have projections that are 3 months to a year. And then the longer term that would allow us to predict the survival of our management actions.
- I like to see the average mean for all of the projections, but I also like to look at the different models. This lets me know the degree of uncertainty, and helps summarize the data.
- I think inputs for the different model projections are very important. Both what data is used and what is the geographic scale of data collection. Is there one point in [redacted] County or are there 5 points in [redacted] County? Or is the great Basin based off of the airport in Salt Lake?
- For my office the scale of counties is great because most of our office is in [redacted]. I think that would generally be the case with BLM Oregon. But when branching out into some areas, say Nevada, ecoregions might be more important.
- The color scheme in this tool works well. I have no trouble picking out what is what. I like being able to hover over the counties and see specific data for each variable.
- The variables I would like to see are precipitation, maximum and minimum temperature, soil moisture, and evaporation deficit. These are probably more useful. I don't know how useful runoff is. Snow is useful in whether it's present late in the winter or not.
- I was not familiar with RCP (Representative concentration Pathway) scenarios before they were explained to me during this interview. If there was a citation that let you see what RCP meant then that would be helpful. I do think its helpful to see the different RCP scenarios, but I'm not sure why.

(DRI) West Wide Drought Tracker:

- The axis for the PDSI within the tool didn't seem to be working.
- This tool did not work for me.

Integrated Climate Scenarios in Data Basin:

- When trying to use this tool no graphs were shown for me, and parts of the variables were not there. This tool did not work for me

iv. Final Thoughts

- The smaller the spatial and temporal scale, the more useful its going to be.
- I cannot cite this, but something like 80% of the variability of annual production can be predicted by April precipitation. So that's a rule of thumb in the Northeastern Great Basin. Some parts of the year are going to be more important too, like late winter and into spring. And especially precipitation at this time. The more that these tools focus on accurate predictions of that time frame, the more useful they're going to be.
- I use GIS myself, but we also have some GIS specialists in the office. It would be useful if we could export the information in the tool as a polygon or map layer, but again it would depend on the scale. It could be informative for planning.

Participant #25

i. Preliminary Discussion

- I am a wildlife biologist, but I am more of an ecologist for our field office. I'm responsible for habitat management as well as restoration and reclamation type projects for the field office. Specifically for our area because sagebrush is such a huge component and its one of the components that is declining. It is one of my focus areas.
- Yes, I deal with invasive species. The only thing we don't do here is green stripping because fire isn't really a component that we deal with. We do manage using seeding, herbicide application (ground and aerial application), planting actual seedlings, and with grazing.
- This field office and I are taking more of a holistic approach. We try to incorporate all of the aforementioned management goals and techniques and look at what's going to work best for each specific area. We cover almost 2 million acres so we have a lot of variability in what we work with as far as climate and vegetation. We try to do things outside the box and try as many things as we can.
- We have used some biological controls. Mostly it's been for tamarix removal. We haven't done anything with it yet for weed management. We do have a couple of projects where goats have been proposed for specific weed management. We haven't used any fungus or parasite.
- Ideally what's important for us is to be able to predict drought and moisture. That plays into everything that we do. We're a dry climate anyways but it impacts us greatly. Knowing or choosing the right year to do a seeding is important and we try to look at as many models as we can to see variables such as precipitation. But we just don't know what's going to happen a year from now. Being able to focus on precipitation and moisture is really a key factor.
- Moisture includes precipitation (both snow and rain), soil water availability, evaporation deficit, and moisture availability. Both rain and snow are important. We need a good snow pack, it helps to feed all of our creeks and springs, which contribute to livestock grazing distribution.
- We do use some drought indices, such as the PDSI (Palmer Drought Severity Index).
- We use a lot of NOAA tools. There are also some BLM models, more in the fire realm that I specifically use. Some of these are FIREMON (USDA), BEHAVE (USDA). I can't think of any of the specific NOAA tools but I can get back to you.
- Realistically the shortest term that we could actually get a project on the ground is usually a year, and that's pushing it. We try to write our projects so that they cover 5 to 10 years, and that's what our NEPA is good for. We try to do phase projects across the landscape, so we do look into the future for our management planning.
- We generally do fall seeding and we depend on both fall moisture and spring precipitation. We try to seed as late into September and into October. We think about when we will be putting the seed on the ground at least a year in advance.
- It would be helpful to know what the precipitation is going to be in the next month or in the next 6 months. The tools we use and the historical data that we have give us some insight about this. But if we need a better way to pinpoint moisture. For example, If I knew we're going to get so much moisture in a certain week then I would need to seed the week before. That would be helpful.
- Wind and temperature play a big role in herbicide and seeding application because of drift and success rates. We'd like to have the best control we can.

ii. Maps

- (no information)

iii. Climate Tools

NOAA Three-Month Outlooks:

- I think this tool is good but I would need more of an explanation on exactly what they're using and how they're coming up with the probability. If there is a probability that we're going to get this much precipitation and someone is basing whether or not to do a project on that, I don't think I would trust it because I don't know where the information is coming from.
- I like the probability graph. I would be scared to use this tool because the graph is for the whole division and looking at where the division goes it looks like its covering an area that gets a lot more moisture than we do. If they're basing some of the stuff on that area then there would be no way I would use it
- I think the shading for the outlook maps is good, but it would probably be good to have the specific amounts of how much above or how much below.

NOAA Snow Cover Maps:

- When I tried opening the tool I got a box with an 'x' showing that the map would not open. This tool did not work for me.

NOAA U.S Climate Extremes:

- (no information)

NOAA Climate at a Glance:

- Its cool that you can see the temperature change based on the historic in this tool.
- Our region is huge and I could probably say that the information in this tool isn't true for our field office because of how far up it goes to the interstate and how the weather moves through this area. It would be useful to have a smaller spatial scale then what is in this tool.
- The variables that are used in this tool are great. I would need to play with this tool a little more to see if there are any other variables that I need.
- For folks who don't often use the drought indices then it would benefit them to have these indices defined.
- The anomalies are great and helpful. The color scheme also works well.

AdaptWest:

- This tool wouldn't open for me

(USGS) National Climate Change Viewer:

- Prior to this interview I didn't know what RCP (Representative Concentration Pathway) scenarios were, such as RCP 4.5 or RCP 8.5.
- A concern I have with this tool it is really complex for when we do our impact analyses. It is more of what I would consider the science community to use. As a manager I would not even want to delve into this tool because its too much. Anything I use in my prescribed actions I have to also be able to describe to the general public and this would get very difficult. It's a neat tool and I may use it in my planning, but it would not be the primary thing that I would go to.
- It is helpful to see the projections of the different models side by side, but I would like to know what variables are going into the models that make the projections because as a manager I would have to explain the changes and I can't do that if I don't know what is going on.
- It would be very helpful if it told me what some of the major inputs were that went into these models. If I had this information I could then utilize this tool for my planning.
- The colors seem okay, but the temperature colors seem to be very similar to each other.

- I think it's important to see the difference between the RCP scenarios, but RCP should be defined so someone can easily see what it is. But I do like it.
- Shorter duration time intervals would be great (maybe seasonal), but then 1 year increments would also be great
- I think its good to take a larger historical average and then make a shorter term projection
- I think that the variables within this tool are good. I am interested in evaporation deficit and runoff, but I would like to keep precipitation and temperature too. A fire severity index would also be good.
- Counties work perfectly for a spatial scale.

(DRI) West Wide Drought Tracker:

- (no information)

Integrated Climate Scenarios in Data Basin:

- This tool would not open for me

iv. Final Thoughts

- For any of these models some fire information would also be a helpful variable.
- I use ARC myself.
- It would be extremely helpful for a tool that could allow the transfer of the information as a layer to be used in ARC. We use GIS a lot for our planning and when we present information to the public they really tend to go to graphics more than reading, so if we can display it as images that's fantastic. ARC would be preferable because we have our own layers too and I have specific data that I've collected. To be able to overlay those would be great.

Participant #26

(Note: Many climate tools would not open for this land manager during the interview. In order to still get feedback about elements within the tools, the land manager was asked questions about the tool elements by the interviewer)

i. Preliminary Discussion

- I am the Fire Ecologist and ESR lead for the [redacted] which manages 1.8 million acres of public land within [redacted] Idaho. Sagebrush restoration within our Field Office (FO) consists largely of looking at ways to improve degraded sagebrush habitat, mostly by increasing sagebrush densities lost due to wildland fire. Conversely, our FO also has sagebrush stands that are in a declining or decadent state where treatments are implemented (e.g. roto-mowing, aeration, etc.) to improve both the overstory shrub component and the understory that may be lacking the herbaceous components of native grasses and forbs.
- In those areas void of sagebrush, whether it is from fire or other disturbances, it has been found that the most practical and successful methods for reestablishment include hand planting sagebrush seedlings, primarily bare-root using augers, and drilling sagebrush seed using the Truax® rangeland drill. If the treatment area has a dense cheatgrass understory that is causing or may lead to a reoccurring wildfire problem, a combination of chemical and native grass seeding treatments may be implemented to lower the density of cheatgrass and increase the native herbaceous component prior to seedling planting. In areas containing poor herbaceous vegetation and a decadent sagebrush overstory the use of either a

roto-mower or a Lawson® aerator may be employed to break up the decadent stand allowing more sunlight and nutrients into the understory. This may be followed by either a native grass drill seeding, sagebrush seedling planting treatment or both if there is insufficient native vegetation to naturally recover the site.

- The FO primarily has cheatgrass, we haven't experienced the influx of medusahead as of yet. However, with that being said, we're right on the northern cusp of its expansion so it's probably only a matter of time until it moves into the FO.
- Our biggest problem in years past has been not receiving a sufficient winter snowpack or spring precipitation for establishing seeding's. It has fluctuated more in the past decade. Looking back you see where seeding's planted in the 80s'-90's (even as far back as the 1950's) were very successful but when you compare our more recent seeding's (2000's) to our past seeding's we haven't had the same kind of success. It is believed that this is primarily due to the lack of consistent moisture that we historically relied upon to establish those seeding's. For fall seeding's to establish they are highly dependent upon spring moisture and it seems like that is the leading factor for the success or failure of the seeding.
- For chemical applications you need to worry about humidity, wind, and moisture (precipitation and RH). I'm not the weed guy and don't have a strong chemical background, but those are just a few of the things that I know they look into prior to application.
- Conducting a prescribed burn requires you to closely look at multiple variables including humidity, temperature, wind speed and direction, and precipitation within the last week and hours leading up to the burn that may have increased fuel moistures and various other factors that can effect how your burn will behave. If you want high consumption rates you tend to focus your burning efforts around days with high temperatures and low humidity. Conversely, if you're trying to achieve 50% consumption you tend to focus your burning efforts around days with low to moderate temperatures and moderate humidity. Bottom line is that you're always looking at the different climate elements that may affect the burn. From a wildlands perspective you always hope for a nice mosaic burn that is low intensity and severity and does not result in long-term negative effects to the soil and vegetation but achieves the goals and objectives of the treatment.
- Implementing drill seeding or hand plantings in the fall requires that the soil is not too moist so as to result in widespread disturbance due to equipment use, but yet the soil cannot be frozen either. We've had problems in the past with the drills not being able to penetrate the soil due to a hard freeze. If we cannot drill into the soil then we're basically broadcasting seed on the surface and not allowing for the proper seed to soil contact that is needed for a successful seeding. For example, this year we had below zero temperatures for a week or so before the fall planting and it froze the ground solid, resulting in what felt like a hardpan layer that the augers could not penetrate so we had to delay the planting until spring 2015. There have been people who have had success with spring seedling plantings; however it seems that we've always had the most success planting our seedlings in the fall. Nevertheless we'll go ahead and give it another shot this spring, since we missed our planting window last fall, and hope for the best. Its all going to depend on how much moisture we're going to get this spring and if we can get out to the project area during a dry window and plant, and then have a few weeks of moisture with a gradual warm up. Then maybe we'll have success.
- We get drought reports about 3-4 times per year. The reports (drought map) are distributed by the Fuels state lead at the Idaho State Office, and show the progression of the drought severity (decreasing or increasing) throughout our region and the rest of the nation and what the precipitation and temperature potential is for the next few months (above average, below average or average).
- Models or predictive services maps/reports can be used to determine whether or not a seeding or hand planting should be implemented, and I wish we were a little more flexible with implementation dates within the ESR program. However, with ESR funding, the first year is usually devoted to seeding and you don't have a second shot at it. If the climate modelers are saying its going to be an El Niño year with poor precipitation then we may want to postpone the seeding, but at this point we do not have that flexibility. I wish they would give us a little more flexibility in identifying when the best time (year) to seed an area would be, maybe within a five-year period.
- I don't really use any other drought forecast. I try to look at the long-term trend data that is distributed by the NRCS, NOAA and other agencies on weather and precipitation modeling, but it seems that it is never that accurate. My wife works in [redacted] and they use several programs to base their upcoming year's

merchandise orders on. I think one is called 'weather trends'. I was wondering how applicable that service would be because it's an agricultural based model. I was looking to experiment with that a bit to see if it would be beneficial. I think it goes 11-months out.

- With a post fire rehab plan (ESR) we try to plan out 3 years. The first year is devoted to site stabilization (drill seeding, hand planting, and ground covers such as straw or mulch). Then it's monitoring for three years, with any additional seedling plantings done on out years. And then re-treatments, and so on.
- A lot of our fuels projects, or EA's, have a lifespan of about 10 years. We try to go out that far for planning treatments and monitoring.
- The shortest term would be a 2-month window. A good portion of our wildfires occur within the months of August through September. Following a fire we have anywhere between 1 to 3 months to implement our seeding projects so we look to see what the temperature and precipitation predictions are for the months of October, November and maybe even December.
- 6 months precipitation is also important because it dictates whether a seeding will be successful from the time we plant in fall until the spring rains. If we can have good solid winter precipitation events, preferably snow (a good snow pack) and then have good normal spring rain events then there is a high likelihood that the seeding will be successful.
- Ideally, a 1-3 month, 6 month, and then annually (maybe 1 year, 3 year, 5 year and 10 year) timescale for a tool would work the best.

ii. Maps

- (no information)

iii. Climate Tools

NOAA Three-Month Outlooks:

- I've looked at the 3-month outlook used within this tool before. This is something we also receive from the state office. These get sent out on a regular basis or anytime there is a change.
- The color tones work well.
- It would help to have some more information about what 'how much above' or 'how much below' actually means.
- It would be best if I could see the three-month average and a one-month average, so that I can differentiate between what months are going to be the most productive. If you could show a progression, maybe a 3 month total or average, then this would be good.
- I have not used the probability of exceedance area number graph. This is an interesting graph. There is definitely a lot of information on it. Its not very intuitive, I would need more time to digest it and understand it more.
- I prefer the maps used in the other tools rather than this graph.
- I prefer the most refined scale. So maybe this division scale would be the best instead of county or ecoregion because our seeding's are on a finer scale sometimes between two counties. If we can figure out temperature or precipitation within that smaller area then that would be good
- I think the intervals along the axis are good; you don't want to go any smaller or you'll lose the information. You want small but not too small.

NOAA Snow Cover Maps:

- It doesn't show the future, but having snow cover movement would help to validate your monitoring. It could give a reason why something failed. For example, we did have snow cover but its duration was short and did not help with moisture retention.

- There are precipitation maps that show estimated inches or accumulation, which would be good with this tool. If you could hover over an area or zoom in on an area and see how much has been received. That would be very useful.
- The graphics and colors in this are pretty self-explanatory.
- Again I am just wondering what the pixel size is and the resolution. It would be nice to have a little metadata.
- A lot of us here use GIS ourselves, make our own maps and do our own GIS work. Depending on the person it may be basic or in depth GIS. Some are pretty savvy and others know enough to get by, there's a wide skill level.

NOAA U.S Climate Extremes:

- This tool opened up but I didn't get a graph that I could see. I could not use this tool.

NOAA Climate at a Glance:

- When I tried to open this tool I was told that I needed a newer version of Adobe Flash Player. I couldn't use this tool.

AdaptWest:

- I am using Internet explorer. It took awhile for this map to open.
- When it did open there was no scatter plot available to look at. This tool did not work for me.

(USGS) National Climate Change Viewer:

- When I tried to open this tool I was told that I needed a newer version of Adobe Flash Player (again). I couldn't use this tool.
- I would have hoped that we would have been able to access a sister agency like USGS

(DRI) West Wide Drought Tracker:

- The colors seem to be very similar to one another especially the lower value colors. Sometimes you can't tell if it's plus one or minus one. For example, the lime green, yellow and turquoise are similar. The extremes are easy to tell apart but the middle variations can be difficult.
- I think this tool is pretty effective. Although it looks at the past. What we need is the next year and whether it'll be conducive to a successful drill seeding or successful sagebrush hand planting. It is useful to look back and see why a seeding failed based on precipitation and temperatures.
- I like the timescale (last full month, last two months, last twelve months, etc.). It seems fine.
- I've always looked at just the pdsi (palmer drought severity index) and not really at the other two drought indices in this tool. I like that there is a hover feature with more information about the other two indices. Anything that gives a description is good.
- The county scale is good. Is this a 30 meter? It may be helpful to know the actual scale, especially if you are comparing different variables at different scales and your seeding area is right in the middle of these. It might be nice to have a finer scale and resolution if at all possible.
- It would be nice to hover over a certain area and have it tell you what the value of that area is, besides just giving you a range for that area. Rather than having it change colors it could just allow the hover option to read a 70-90 percent of normal? If it says decrease, well how much decrease?

Integrated Climate Scenarios in Data Basin:

- This tool eventually opened but there was nothing to look at in it. This tool did not work for me.

Thoughts About Tools I Couldn't Open (after interviewer gave questions about elements in the tools)

- I think having different climate model projections to compare to each other would be good.
- I think it is important to know some of the inputs that are used in each model to create the different projections.
- If I could click on one county or ecoregion and see the different model projections for one variable on a scatter plot I think this would be useful. (Such as with AdaptWest tool)
- I think a smaller timeframe is better. I would like to know what the temperature and precipitation are over a ten-year period.
- If they could have a historical normal period in a progression that looked at the last 20 year period, 10 year period, 5 year period, etc. But getting out a 100 years in the past you lose some information. 30 years or 40 years may be good or may be pushing it. Maybe a 10 years normal historical period compared with a 10-year projection and then a 20-year future projection.
- I think maximum and minimum temperature, precipitation, runoff, evaporation deficit, snow, soil storage; and drought indices (pdsi) are good variables. I can't think of any others. Soil storage is definitely important. Depending on what your soils are is going to affect this. So knowing what kind of soils you have is good.
- I have not heard of RCP scenarios before this interview (Representative Climate Pathway Scenarios, for example RCP 4.5, RCP 8.5, etc.). But I think it is important to see the differences between the different scenarios.
- I think it would be good to see graphs side by side, such as temperature, precipitation and vegetation class graphs (such as in the NW Scenarios in Data Basin tool).

iv. Final Thoughts

- Temperature and precipitation change over time is the most relevant to me.
- When you start talking about climate change I start thinking about how climate change is going to impact the current vegetation that we have on site. What's the climate pattern going to be? Is it going to be hotter and drier? Cooler and wetter? Are we going to see shifts when we start getting our precipitation? Will is shift from a springtime event to a monsoonal summer event? And how is that going to impact our current vegetation state? Will we start seeing our vegetation moving in a northern pattern? Will we start getting changes in vegetation from what we've historically seen, such as invasives?
- I would like to have a tool on an Internet site that has up to the date information that can be navigated through and used as needed. Maybe interactive.
- The site should be updated anytime there's a substantial change. Three-months should be efficient but if your getting major changes in the weather then it should be posted immediately if at all possible.