Managing landscape change in Oregon's Northern Basin & Range: Learning from past, present and future climates

Burns, Oregon, October 18, 2011

Workshop Summary

Introduction

In 2009, the Oregon Department of Fish and Wildlife initiated a process to incorporate information about climate change and its effects on fish, wildlife, and habitats into the Oregon Conservation Strategy. The agency acknowledged that climate change is already affecting Oregon's species and habitats and that future climate change represents one of the most serious long-term challenges to sustaining healthy populations of fish and wildlife.

This workshop brought together representatives of the research, land and resource management, and conservation communities to contribute to the update and implementation of the Oregon Conservation Strategy. Participants were asked to help ODFW identify climate change impacts and adaptation strategies for Oregon's sagebrush and closed-basin habitats. A secondary goal of the meeting was to build and strengthen partnerships in the research and management communities.

The objectives of the workshop were to:

- Learn about past, present, and projected future climates and how they affect vegetation, hydrology, and wildlife in Oregon's basin and range habitats;
- Hear about climate change research relevant to Oregon's basin and range habitats and discuss how to better link research and management efforts; and
- Begin identifying management strategies that are most likely to be successful given future climate conditions and other landscape-scale changes.

Previous workshops addressed adaptation in estuaries and oak woodlands and savannas, two other habitat types identified as conservation priorities in the Oregon Conservation Strategy. Materials from those workshops are available at: http://www.dfw.state.or.us/conservationstrategy/events.asp.

Workshop Structure

The morning session focused on describing the effects of past and future climate change and other kinds of landscape-scale change on sagebrush and closed-basin wetland habitats. Rick Miller (Oregon State University) provided an overview of past shifts in climate and how they affected fire and drought cycles and the distribution and abundance of species in the basin and range region. He also gave us a brief preview of climate-related changes that are projected for the 21st century. The group brainstormed a set of large-scale changes that are currently visible on the landscape.

Tony Svejcar (US Department of Agriculture, Agricultural Research Service) described the recent and projected effects of increasing atmospheric carbon dioxide on basin and range vegetation, with a particular focus on the competitive advantages increased CO_2 gives to non-native invasive species. Ray Angell (US Department of Agriculture, Agricultural Research Service) also briefed the group on work being done to digitize, correct, and summarize historical weather data. This work will help better define current baseline conditions against which future climate changes can be measured. Sean Murphy (US Geological Survey) talked about climate change impacts on Great Basin wetlands and associated wildlife, focusing on shorebirds and their prey.

The afternoon session began with two land managers, Marty St. Louis (Oregon Department of Fish and Wildlife) and Jay Kerby (The Nature Conservancy) describing their efforts to incorporate information on climate and other landscape-scale changes into their land and resource management plans. Participants then split into two discussion groups, one focused on wetlands and the other on sagebrush and other upland habitats, to address questions around the theme of *"What changes will we need to make or what new resources will we need to meet habitat management goals in a changing climate?"*:

- In highly variable environments, how can we tell the difference between "normal" variability and major, potentially irreversible state changes?
- What are the other main factors in landscape change?
- Which systems, functions, or species are most likely to be sensitive to the kinds of landscape changes we've discussed? Which are most likely to be buffered? What kinds of sites might increase or decrease in importance?
- Are there any changes to management practices or priorities that are suggested by current climate information?
- What specific kinds of information are needed to inform management decisions? What critical uncertainties need to be resolved, and which variables should researchers be focusing on?

Workshop Outcomes

The workshop was focused around the following two themes:

1. *What effects might climate change and other landscape-scale changes bring to Oregon sagebrush and closed basin wetland systems now and in the future?* and
2. *What changes will we need to make or what new resources will we need to meet habitat and species management goals in a changing climate?*

1. What effects might climate change and other landscape-scale changes bring to Oregon sagebrush and closed basin wetland systems now and in the future?

Climate and land use conditions of the present and recent past have not been static. Instead, they represent a period of many transitions, including:

- Warming conditions since the end of the "Little Ice Age" in the late 1800s;
- An acceleration of warming (in the western U.S., about 1° F) and increased precipitation (5-20%) since the beginning of the 20th century, at least in part the result of human-induced climate change;[1]
- Elevated levels of atmospheric carbon dioxide (CO_2) (an observed increase of 14% since the early 1980s and a 34% increase from pre-industrial levels) and air pollutants;
- The decline and near disappearance of Native American land use patterns of fire use, hunting, and food gathering;
- The introduction of large numbers of grazing livestock; and
- The introduction and spread of many new species, some of them highly invasive.

These climate and land-use processes have brought with them significant large-scale patterns of change on the landscape. The introduction and spread of non-native annual grasses has changed vegetation cover and fire cycles at lower elevations. Meanwhile, increasing CO_2 levels are increasing overall plant productivity, a process which tends to favor some vegetation species over others and create shifts in species composition. Increased productivity in cheatgrass, for example, is producing a self-perpetuating cycle of high biomass production (about 50% higher than at 1970s levels), increased fuel continuity and accelerated fire regimes, and further spread of this fire-adapted annual grass. This may help explain an

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[1] High levels of variability in weather data make it difficult to identify trends over short time periods and at specific locations. Reconstruction, correction, and digitization of historical data help provide a glimpse into the recent past (1890-2010). These data suggest a warming trend, but one that varies significantly in magnitude among different locations in the Great Basin. Preliminary data from two southeastern Oregon watersheds suggest these slight increases in temperature have been accompanied by a slight increase in annual average precipitation and a slight decrease in the proportion of precipitation that falls in the winter at those sites over the same timeframe, but more results will be needed to draw any broader conclusions.

observed increase in fire size in the over the past few decades, even as the total number of fires has decreased.

At higher elevations, increased CO_2 levels also appear to be increasing the growth rate of western juniper, allowing saplings to reach a fire-resistant size more quickly and exacerbating the spread of juniper into former shrub- and grassland systems. The expansion of woody vegetation at higher elevations and annual grasses at lower elevations is progressively “squeezing out” the remaining sagebrush habitat in between.

Warming temperatures, along with changes in the seasonality of precipitation and increased variability in precipitation events, are likely already altering the volume, depth, salinity, and relative permanence of Great Basin wetlands. These changes represent significant threats to some freshwater resources and to wildlife species that depend on the availability of a mosaic of freshwater, saline, and hyper-saline wetland systems on the landscape.

Participants reported observing the following trends on the landscape in recent years:

- Expansion of annual grasses;
- Earlier drying of vegetation and wetlands;
- Loss of native perennials;
- Expansion of cactus species;
- Increase in landscape homogeneity and loss of the landscape mosaic;
- Dying back of the top third of juniper in younger stands in some locations;
- Increasing density and variety of invasive species;
- Landscape fragmentation;
- Shifts among invasive species (e.g., from thistle to pepperweed);
- Loss of soil crusts;
- Alteration of wetland hydrology by withdrawals and other management;
- Flashy hydrology resulting from juniper encroachment;
- Incidences of extremely high salinity levels and dieoff of brineflies in closed-basin wetlands;
- Increasing dominance of human land uses: e.g., agriculture, energy, infrastructure, irrigation, development, wetland modification, pollution, grazing, recreation;
- Changes in fire and flood regimes;
- Groundwater depletion and water allocation conflicts;
- Changes in soil properties, including nutrient cycles and abiotic and biotic factors;

Most projections of future climate suggest that temperatures will continue to increase and that warming will continue accelerate in the northern Great Basin over the next 50-100 years. Regional models project, on average, warming of about 3.2°F by the 2040s and 5.3°F by the 2080s, compared to temperatures in the late 20th century.[2] In comparison, 3.3°F of warming is equivalent to about a 1000-

[2] Mote, P. W, and E. P Salathé. 2010. “Future climate in the Pacific Northwest.” Climatic Change 102 (1-2): 29-50.

foot change in elevation. Atmospheric carbon dioxide is also predicted to continue to increase, and at an accelerating rate. Some researchers project seasonal impacts that are likely to further alter hydrology: decreasing length of snow cover, less snowpack (especially at mid-elevation sites), more warming during the winter months, and less spring inflow to wetlands. There is currently a very high level of certainty about increasing carbon dioxide, a high level of agreement among models that temperatures will continue to increase, and relatively less certainty about the exact magnitude of future warming, changes in precipitation patterns, and the specific effects of these changes on vegetation and wildlife.

Information about past climates can help us inform and interpret assessments of likely future changes. In particular, the scale of previous climate changes and the impacts these changes had on the landscape on the distribution of plant and animal species can help provide perspective on the changes we face now and in the future. In the past, relatively small changes in precipitation and temperature (on the scale of 2-3°F in warming or cooling) created significant effects on vegetation and ecological processes, including fire regimes, soil erosion, and nutrient, water, and energy cycles. An abrupt shift of about 5.5°F at the end of the Pleistocene era (about 10,000 years ago) resulted in mass movement, extinction, and adaptation in species, including northward shifts of 300-400 miles in the ranges of some plant species. The large alluvial fans found at the base of many mountain ranges in the west were primarily deposited during very dry periods, such as the Holocene and Little Ice Age, when there was less vegetation cover and soils were susceptible to large precipitation events. In the past, drought and fire have combined to cause sudden, major shifts in vegetation communities.

Nonetheless, future changes cannot be expected to closely resemble the past, because of the human influences that now predominate. In addition to human-caused climate change, human land uses have fragmented areas of natural habitat, limiting species' capacity to disperse, changing disturbance cycles, and causing direct threats to species survival. The introduction of large numbers of new species presents a particular challenge as species and ecosystems respond to climate change. In general, cooler and wetter communities in the northern Great Basin appear to be more resistant to colonization by non-native species than warmer and drier ones. As a result, climate change will likely cause today's more resistant communities to warm and become less so.

Climate drives the structure and function of ecosystems primarily through energy balance and water availability. It is also closely tied to other disturbance processes, manifesting many of its changes through fire, weedy species, plant and animal diseases, insect infestations, and other kinds of ecological disruptions. In sagebrush ecosystems, changes in atmospheric CO_2, warmer temperatures, and changing fire regimes are expected to continue to favor the expansion of non-native annual grasses, including the potential for cheatgrass – and the accelerated fire regimes associated with it – to expand above the current upper limit of about 5000 ft in elevation. In the past, warming temperatures have also been associated with the movement of Mojave Desert species into the Great Basin, expansion of woody vegetation types, and the decline of grassland and shrubland systems.

The changing climate is also expected to result in changes to water chemistry and the timing of hydrologic flows into wetlands, which in turn may impact the type and distribution of vegetation, invertebrates, and other wildlife in wetland systems. Great Basin wetlands are a critical resource for hundreds of thousands of migrating waterfowl, shorebirds, and other waterbirds; ongoing research is examining the effects of these changes on shorebirds and the distribution and abundance of their prey species. Researchers hypothesize that warming temperatures and changing precipitation patterns may result in an overall reduction in surface water in the Great Basin and an increase in wetland salinity. Some shorebirds depend on a mosaic of freshwater and saline wetlands to meet their needs at specific times of the year, especially during the breeding season. Because of the metabolic costs associated with feeding in higher salinity environments, this trend would be expected to lead to higher mortality in shorebird chicks.

Not all species will be equally vulnerable to climate change. Species can respond to changing climate conditions in three basic ways: migration, extinction, or adaptation. The response of a given species depends on its elasticity (ability to survive under a variety of conditions), relative exposure to changing climate variables, capacity for migration, dispersal, or adaptation, and exposure to other threats, such as habitat loss to development or invasive species.

In the northern Great Basin, for example, species that are highly elastic in elevation range are more likely to successfully adapt to future climate conditions than those with a narrow elevation range and specific soil requirements. Those with a lower rate of dissemination by wind or birds, such as sagebrush, are less likely to disperse quickly enough to keep up with rapidly changing climate conditions. In general, warming temperatures result in decreasing habitat for most species, as the area available decreases at progressively higher elevations. Species found at the highest elevations will have nowhere to go unless they can persist in small areas of refugia, where microclimate conditions provide some resistance to climate change. In wetland systems, shorebird species that require specific salinity levels and that have a limited capacity to move among wetlands are more likely to be vulnerable to climate-induced changes in hydrology. In general, habitat specialists are expected to be more at risk than generalists.

2. *What changes will we need to make or what new resources will we need to meet habitat and species management goals in a changing climate?*

At the workshop, both presentations and large and small group discussions addressed the management implications of climate change and other landscape-scale changes in Northern Basin & Range habitats.[3] Several key themes emerged from these conversations:

Focus on conservation and restoration efforts with a high likelihood of success given climate and other threats*.* Given limited knowledge about these ecosystems, limited funding, and limited opportunities for reversing large-scale changes, we should focus our near-term efforts on areas of the landscape where we have a high probability of success. In most cases, this will mean prioritizing sites with relatively intact vegetation communities, such as sagebrush sites at higher elevations where annual invasive grasses have not yet taken over. We currently know very little about how to restore sagebrush

[3] Unedited notes from the large group and break-out group discussions are available at http://www.dfw.state.or.us/conservationstrategy/events.asp

that has been converted to annual grassland, although research is ongoing. In areas where juniper expansion is a concern, a more targeted approach to fire use can help focus efforts on areas where restoration is most likely to be successful (e.g., the SPOTS approach). At its Juniper Hills site, for example, The Nature Conservancy has been focusing on using prescribed fire for management primarily at mid-elevations and on north-facing slopes, where they have found fire controls juniper effectively without causing a transition to invasive annual grasses.

The afternoon discussion groups identified examples of species and systems that were most likely to be affected by or buffered from climate change. Habitats and sites on north slopes and sites near the high end of a species or habitat type's elevation range were expected to be more resilient and would therefore be considered a higher priority for conservation. Participants expected higher vulnerability to climate change among specialist species, species on the edge of their range, species with low mobility, amphibians, fish, and some avian species. They expected spring migrant birds, wintering birds, and generalist species to be less affected. In light of climate change, many also wanted to see a higher priority placed on conserving unique habitats and movement corridors and other lands that facilitate genetic interchange.

Focus on protecting ecological functions and processes. As climate and other drivers of change affect the mix of species at a given site, management becomes more like shooting at a moving target. Maintaining key ecological processes, rather than managing for a particular set of species, is a common recommendation for climate change adaptation. Workshop participants discussed some more specific strategies for addressing this problem:

- Instead of managing a site's vegetation for the historically prevalent species or to maximize the number of native species, consider managing to maintain the full diversity of functional groups that would be expected on the site. For example, maintaining land cover in perennial grasses may prove to be more important than the particular species used in terms of preventing annual grass invasion and a potentially irreversible state change.
- Managing key processes, such as fire, nutrient, energy, and water cycles, can help prevent changes to new, undesirable ecological states. In the near term, it may be possible to protect intact habitats, for example, by maintaining or restoring historical fire cycles. Managers can also work to maintain other key processes through vegetation management (e.g., maintaining an appropriate level of vertical structure through shrub cover will promote nutrient and water exchange lower in the soil profile).
- In the longer term, we should look for better ways to manage these processes as species shift. For example, how can we best maintain mycorrhizae to optimize nutrient and water cycles? How can we manage fire and other processes so that state shifts in response to climate result in the least possible loss of biodiversity and other ecosystem services?

Maintain a mosaic of wetland types across the landscape. As salinity and water quality in wetlands are likely to change in response to climate change, it is increasingly important to plan for the needs of migratory waterfowl at the landscape level. Maintaining a mosaic of wetland types across the area is the only way to ensure that the unique needs of different species are met and maintain the values of continental significance that the region provides today, and management decisions for a given wetland site should be made in that context. Today, private and public lands fill different seasonal roles, with private lands often providing habitat in the spring through flood irrigation and public lands providing fall water and breeding habitat. Ensuring these values continue to be protected in a rapidly changing environment will require a more formal analysis of what sites provide which values, how these values are likely to change over the next 50-100 years, and what management changes will be needed to ensure the needs of migratory shorebirds and other native species continue to be met.

Identify and take advantage of opportunities for flexibility in water management. Water management practices at Summer Lake provide an example of how intensive management can create opportunities for flexibility in response to climate and other changes. As water supplies at the lake have diminished in recent years, the Oregon Department of Fish and Wildlife has responded by changing vegetation management practices, holding some areas dry for several seasons to interrupt succession into a closed system, and upgrading water control structures to allow for more flexibility in management of water levels. Although intensive management of this type will be impractical in most wetland systems, upgrades to existing infrastructure where it is already in place would expand options to adapt management strategies to changing conditions.

If climate change results in increased drying of natural wetlands, the seasonal waterfowl habitat values provided by flood irrigation may become even more important. Land managers should also look for opportunities to improve natural water storage on the landscape through restoration of montaine wet meadows and riparian and floodplain systems and the reintroduction of landscape-shaping species such as beavers and wolves.

Research needs:

Participants discussed what kinds of information are needed to improve management decisions with regards to climate change and other landscape changes. Several key points emerged:

- We need more information on restoration in sagebrush systems, especially at lower elevations. A better understanding of plant competition and fire resistance is needed to cope with annual invasives, which are expected to increase in dominance and expand their range upslope with climate change. USDA ARS is doing research that should lead to improved restoration options in the next 4-5 years. Knowing more about how to work in warmer, drier systems will be particularly important as the region in general becomes warmer and perhaps drier.
- We need a better understanding of how to tell the difference between normal variability in these highly variable ecosystems and the kind of state change that has profound, long-term ecological impacts and may be difficult or impossible to reverse. For example, cheatgrass sometimes appears in rangelands as a temporary response to high nitrogen availability, and we need to be able to distinguish these cases from situations where a landscape is shifting into a long-term cheatgrass-dominated system. State and transition models have been a useful tool for identifying potential state changes in range communities, and some early efforts are now being

made to adapt this tool for use in wetland ecosystems and wildlife management. Participants identified a number of potential indicators of state changes, including the loss of functional groups or addition of new functional groups, changes in soils or hydrograph outside the historical range of variability, the presence of highly invasive species, and long-term or large-scale human-caused disturbances on the landscape (e.g., energy development).

- Climate researchers should focus more on variables that are relevant to biological systems and meaningful to land and resource managers. For example, instead of looking at changes in total annual or seasonal precipitation, wetland managers would be more interested in looking at hydroperiod and the timing of precipitation at finer temporal scales (e.g., by what date does half of the total annual water flow pass by a given point?). Similarly, we need to know more about how species will respond to projected changes. For example:
  - How do native and invasive species respond to salinity gradients?
  - How will vegetation species respond to changing temperatures, humidity, precipitation patterns, and other variables, and especially to the interaction of these different changes?
- More information on historical and current conditions is needed to define the baseline against which change is measured. Monitoring of special status species will be particularly important in gauging the response to changing conditions.
- Social science research is needed to help determine what people want and expect from managed ecosystems and how they prioritize different values that may be difficult or impossible to maintain in a changing environment.

Final Agenda

October 18th, 2011, 9 am – 5 pm
Harney County Community Center
Burns, Oregon

Goal: Contribute to update and implementation of the Oregon Conservation Strategy by identifying climate change impacts and adaptation strategies for sagebrush and closed-basin wetland habitats and strengthening partnerships in the research and management communities.

Objectives:

- Learn about past, present, and projected future climates and how they affect vegetation, hydrology, and wildlife in Oregon's basin and range habitats.
- Hear about climate change research relevant to Oregon's basin and range habitats and discuss how to better link research with management efforts.
- Begin identifying management strategies that are most likely to be successful given future climate conditions and other landscape-scale changes.

Outcomes:

Based on results of the working groups, the organizers will develop and distribute a summary document describing:

- An overview of projected climate impacts on sagebrush and SE Oregon wetland systems.
- Major workshop outcomes, including proposed climate change adaptation strategies for northern great basin priority habitats.

Agenda:

9 am – noon

Welcome and introductions
Goals, objectives, and outcomes
Art Martin, Oregon Department of Fish and Wildlife

Overview of past and future climates in Northern Basin & Range habitats
Rick Miller, Oregon State University

Discussion: What kinds of changes are you seeing on the landscape today?

Break

Climate change in rangelands: What are the management implications?
Tony Svejcar, USDA Agricultural Research Service
Ray Angell, USDA Agricultural Research Service

Predicting and managing climate change: Impacts on Great Basin Wetlands
Sean Murphy, US Geological Survey

Working lunch provided

12:30 – 5 pm

Management perspectives on planning for landscape change

Discussion in upland and wetland working groups:
What changes will we need to make or what new resources will we need to meet habitat management goals to cope with changing climate?:

- *In highly variable environments, how can we tell the difference between "normal" variability and major, potentially irreversible, state changes?*
- *What are the other main factors in landscape change?*
- *Which systems, functions, or species are most likely to be sensitive to the kinds of landscape changes we've discussed? Which are most likely to be buffered? What kinds of sites might increase or decrease in importance?*
- *Are there any changes to management practices or priorities that are suggested by current climate information?*
- *What specific kinds of information are needed to inform management decisions? What critical uncertainties need to be resolved, and which variables should researchers be focusing on?*

Report back and closing
Outcomes

5:30 pm: Happy hour at the Pine Room

List of participants

Glen Ardt, Oregon Department of Fish and Wildlife
John Bauer, The Wetlands Conservancy
Rachel Beaubien, Bureau of Land Management
Chris Carey, Oregon Department of Fish and Wildlife
John Christy, Institute for Natural Resources
Devon Comstock, Oregon Natural Desert Association
Max Corning, Natural Resources Conservation Service
Bill Dragt, Bureau of Land Management
Lisa Gaines, Institute for Natural Resources
Andrea Hanson, Oregon Department of Fish and Wildlife
MaryJo Hedrick, Oregon Department of Fish and Wildlife
Mark Howell, Natural Resources Conservation Service
Dustin Johnson, Oregon State University Extension Service
Jimmy Kagan, Institute for Natural Resources
Rhonda Karges, Bureau of Land Management
Jay Kerby, The Nature Conservancy
Jason Kesling, Burns Paiute Tribe
Autumn Larkins, Oregon Department of Fish and Wildlife
Esther Lev, The Wetlands Conservancy
Holly Michael, Oregon Department of Fish and Wildlife
Rick Miller, Oregon State University
Travis Miller, Bureau of Land Management
Sean Murphy, US Geological Survey
Sara O'Brien, Defenders of Wildlife
Rick Roy, Bureau of Land Management
Zola Ryan, Natural Resources Conservation Service
Julie Schneider, Oregon Department of Fish and Wildlife
Marty St. Louis, Oregon Department of Fish and Wildlife
Amy Stuart, Oregon Department of Fish and Wildlife
Tony Svejcar, US Department of Agriculture, Agricultural Research Service
Bruce Taylor, Oregon Habitat Joint Venture/Defenders of Wildlife
Jess Wenick, US Fish and Wildlife Service
Simon Wray, Oregon Department of Fish and Wildlife