THE FEDERAL ROLE IN WATERSHED SCALE DROUGHT RESILIENCE

Discussion Paper

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I. Introduction

Drought has always been a concern to water management in the United States, from the dust bowl era of the 1930s to the current long-term droughts affecting major portions of the western United States. But the challenge of planning for drought may be fundamentally changing, particularly in the West, where climate change is expected to increase the likelihood of droughts as well as their intensity (National Climate Assessment 2014). Providing water supply for human needs during times of scarcity while preserving the health of rivers, wetlands, and other ecosystems may require significant changes in planning, management, and infrastructure.

Improving drought resilience is complicated by the multiplicity of entities involved in managing, providing, and regulating water resources. While the critical geographic unit for water management and drought resilience is the watershed, many water suppliers and management agencies are local in nature, and share watersheds with other such agencies. States have primary responsibility and legal jurisdiction over water rights and management, while most watersheds cross state boundaries. Overlaying this basic structure, a web of state and federal agencies, regulations, and programs affects water resources. These include water quality regimes, fish and wildlife programs, state and federal endangered species laws, and agricultural programs. Planning for and weathering droughts in ways that provide for human needs, while preserving environmental quality and ecosystems, requires agencies, water users, and water providers to work across geographic and jurisdictional boundaries to achieve watershed scale solutions.

The goal of this paper is to set the stage for a discussion of the federal role in enhancing watershed scale efforts to increase drought resilience. The paper does not comprehensively catalogue federal programs activities. Rather, our intent is to frame the basic challenge of drought resiliency on a watershed scale, to identify recent efforts of federal agencies to help communities deal with those challenges, and to propose questions for further discussion during the White House drought symposium led by the National Drought Resilience Partnership (NDRP)[1], scheduled for July 15, 2015.

[1] NDRP participating agencies are the Department of the Interior, the Department of Agriculture, the Environmental Protection Agency, the Federal Emergency Management Agency, the Assistant Secretary of the Army (Civil Works),the National Oceanic Atmospheric Administration, and the Department of Energy.

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II. Current and Future Threats of Drought

Drought has become an urgent issue in the United States. The extent of current drought has been widely reported. California is in the fourth year of what has been the worst drought during the period of recorded data. This drought has resulted in a series of milestones, including driest calendar year on record, warmest year on record, and record low (indeed, disappointing) snowpack. The Colorado River basin is in the midst of a drought that has lasted approximately 15 years. Lake Mead is at its lowest level since the reservoir filled after the construction of Hoover Dam, and before a recent wet May, the probability of the first Secretary of Interior shortage declaration by 2017 had increased to above 50 percent. Texas has just officially emerged from a drought that began in 2010 and had widespread impacts on the state. As of June 23, 2015, 40 percent of the U.S. (by area) was experiencing abnormally dry conditions, while 25 percent of the country was in some stage of drought, as measured by the U.S. Drought Monitor. The West is more parched, with 76 percent of the region experiencing abnormally dry conditions, and 58 percent of the region in drought, according to the U.S. Drought Monitor. (2015 Tabular Data Archive, 6/23/15, accessed at http://droughtmonitor.unl.edu/MapsAndData/DataTables.aspx).

There are reasons to believe that parts of the country may experience more intense droughts in the future. Researchers have found evidence of droughts in past centuries in the West that lasted decades. In addition droughts in some parts of the country will be worse due to anthropogenic climate change, as indicated by the National Climate Assessment (2014). One study predicts that the Southwest may experience longer "megadroughts," as the climate warms (Cook, et al. 2015). Another recent study has found that the risk of drought in California will increase, not necessarily because of changes in the amount of precipitation, but because dry conditions will much more likely coincide with warmer conditions (Diffenbaugh, et al. 2015). Warming is predicted to increase the percentage of precipitation in the West that falls as rain, thereby decreasing the amount of water naturally stored in the snowpack creating further water management challenges for water supplies during the summer months (McCabe 2010). Indeed, for the first time in the period of record that dates from the 1940s, California had no official snowpack as of the end of May this year.

The challenge the nation faces is to provide reliable water supplies for growing cities, agriculture, and energy production, while at the same time preserving rivers, streams, and other aquatic ecosystems for future generations. One of the key questions for this drought symposium is whether achieving this goal under the pressure of warmer, more acute, and potentially longer droughts may require fundamental changes to our water management.

Key questions for discussion for discussion at the Symposium include:

- Are existing water management and infrastructure adequate to ensure water supply during future droughts?
- Are existing laws and programs adequate to preserve and restore ecosystems, ecosystem services, and aquatic species in regions under threat of more extreme droughts in the future?
- What management, infrastructure, and legal changes can best help us prepare for more extreme droughts in the future.

III. The Appropriate Scale of Drought Planning and Resilience

Planning for and responding to droughts present inherent scientific and practical problems. First and foremost, we never know in advance when droughts will start and how long they will last. The one question most people have during a drought – when will it ever rain again – is one that science has difficulty answering with any certainty. By the time a community realizes it faces a drought, it has limited options for mitigating the drought's effects, unless it has taken steps in advance to plan for drought resiliency. Even then, many current drought mitigation measures, such as surface water storage, are not designed to cope with longer-term droughts. Finally, human water use and other activities have already degraded the nation's aquatic ecosystems, resulting in the listing under the Endangered Species Act of numerous aquatic species (see Moyle 2011, for a discussion of declines in California native fishes). Allocating water to protect these already compromised resources and species is extremely difficult to balance against other needs during times of drought, and longer and more severe droughts may pose a serious threat to the viability of some species.

The fractured nature of water governance exacerbates these challenges. Ultimately, drought response needs to happen at the community level, to ensure resilience of local water supplies, and at the watershed level, to ensure that all demands, human and environmental, on a specific watershed are effectively integrated. However, political and jurisdictional boundaries are not established on a watershed basis.

Suppliers of potable water or water for irrigation tend to be local – water utilities, local governments, water management districts, irrigation districts, and others. These agencies may control their own water supply through locally owned and managed reservoirs or local groundwater basins, or they may rely on delivery of water from larger water projects managed by federal or state agencies. Either way, local agencies must have strategies in place to provide water to their customers in times of shortage. Efforts toward local drought planning and response can be further complicated by political boundaries that divide watersheds or groundwater basins, and by competing demands for the same sources of water.

State governments play a lead role in governing water resources – in the West most water is managed by the state, which has the power to appropriate it to specific users. State agencies play a range of other roles related to water supply, including infrastructure projects, coordinating planning among localities, implementing the Clean Water Act and other environmental statutes, and managing fish and wildlife populations.

Federal agencies also play a role in drought planning and response. In states or watersheds with large projects managed by the Bureau of Reclamation or the Army Corps of Engineers, the federal role is direct. However, a number of federal agencies play roles in helping to predict, plan for, and respond to drought more broadly, in ways not directly connected to managing large water projects. Indeed, the need for better coordination simply among federal agencies, and to have a single point of contact for state and local entities, was one of the rationales for creating the NDRP in 2013. One of the purposes of the NDRP White House symposium is to explore how federal agencies can help address these governance issues, collaborate with state and local agencies, and improve watershed scale drought resilience. Below we focus on recent examples of federal agency actions with respect to four issues: watershed scale planning and management; data and research; enhancing natural resources; and improving water efficiency.

Key questions for discussion at the Symposium include:

- Are there best practices to be learned from existing federal drought resiliency efforts that might improve overall coordination with state and local agencies?
- Are there particular shortcomings or gaps in existing federal activities?
- What is the appropriate federal role in watersheds without significant federal projects?

IV. Examples of Effective Federal Engagement in Watershed Scale Drought Planning and Resilience

A. Planning and Management

The Bureau of Reclamation has played a lead role in helping local communities plan for their future water supply and making that supply more sustainable. Recently, Reclamation launched a new program focused on assisting communities with drought planning and drought resiliency projects.

Reclamation's flagship program for watershed scale planning to meet current and future water supply and demand imbalances is the WaterSMART Basin Study Program. The program provides funding through a minimum 50/50 cost share with water or power delivery entities. It addresses four key elements: state-of-the-art projections of future water supply and demand; analysis of how the basin's existing water and power operations will perform in the face of changing water realities; developing options to improve operations and infrastructure to supply adequate water in the future; and recommendations for how to optimize operations and infrastructure in a basin to supply adequate water in the future.

During the last several years, the Basin Study Program has been central to long-term water supply planning with respect to several major western rivers. Although these studies are broadly focused on long-term supply and demand, they have played an important role in drought planning. For example, in the Yakima River watershed in Washington, a basin study laid the foundation for a broad,

Yakima Basin

The WaterSMART basin study program was central to the Yakima River Water Enhancement Project (YRBWEP). It produced a comprehensive resources plan (Integrated Plan) for the Yakima River basin that accomplishes a range of goals, including improving the basin's drought resilience. Although the plan is in early stages of implementation, it has been identified as a model in comprehensive, watershed scale water management.

In 2010, Reclamation and the Washington State Department of Ecology conducted the Yakima River Basin Study under Reclamation's WaterSMART Program in cooperation with a work group that included stakeholders such as water users, municipalities, other agencies, and conservation groups. The final version of the plan was adopted in 2013 through a Reclamation record of decision and the Yakima River Basin Water Resource Management Act passed by the Washington state legislature. The Integrated Plan identifies a comprehensive approach to water resources and ecosystem restoration improvements in the Yakima River basin which includes seven elements: 1) reservoir fish passage; 2) structural and operational changes to existing facilities; 3) surface water storage; 4) groundwater storage; 5) habitat/watershed protection and enhancement; 6) enhanced water conservation; and 7) a market-based water bank to reallocate water, including during times of shortage.

The overall cost of implementing the entire plan will be between $3.2 billion and $5 billion dollars. Presumably, most of that funding will come from the federal and state governments, but funding is not certain.

multi-faceted plan to help the river and local communities ensure future adequate water supply for agriculture and cities. At the same time, the plan aims to restore populations of salmon and steelhead and includes provisions for coping with water shortage and drought (see inset).

A Basin Study completed in 2012 for the Colorado River has been a focal point for a new era of interstate cooperation in the basin. The study confirmed the widely held view that the basin would experience continued shortages in the future, and provided the framework for efficiency, planning, and drought resilience projects (Colorado River Basin Stakeholders 2015). It also contributed momentum for high-level cooperation between states and stakeholders to implement significant drought response steps (see inset).

As these examples illustrate, the Basin Study program provides a process and funding for pulling together broad communities of water users, local governments, and state and federal agencies for watershed scale planning. Reclamation has recently announced a new $5 million Drought Response Program more specifically tailored to drought planning, mitigation, and response. The program will fund projects sponsored by water users related to drought planning (predicting droughts and planning response), drought resiliency (improving the reliability of water supply, management, or benefits to the environment during droughts), and emergency drought response. The National Drought Resilience Partnership is also promoting local drought planning through a watershed scale pilot project in the upper Missouri River basin in Montana (see inset). However, a good basin scale plan does not guarantee follow-up action. Implementation of actions contemplated by the plans can be expensive. The Yakima plan described above, for example, has a price tag of between $3.2 billion and $5 billion dollars.

Colorado River

Reclamation has played a key role in improving cooperation among the seven Colorado River basin states in the face of a prolonged drought. This cooperation has led to a series of agreements and programs to help the basin cope with that drought.

Reclamation has facilitated and has implemented two operational agreements in the Colorado River Basin since the start of the 15-year drought that began in 2000: the 2007 Interim Guidelines (in place until 2026), and Minute 319 to the U.S. Mexico Water Treaty (in place from 2013 to 2017). Both of these agreements implement voluntary reductions in water deliveries for users in the U.S. Lower Basin and Mexico, based on elevation triggers at Lake Mead. The agreements would have been impossible without increased cooperation among the basin states. These agreements also put mechanisms into place to allow water users to store conserved water in Lake Mead, thereby increasing lake elevations, and take delivery of that water at a later date.

To further mitigate the impacts of the current drought, in July 2014 Reclamation joined municipal water users from the Upper and Lower Basins to fund a System Conservation Pilot Program. In total, $11 million has been provided for voluntary pilot programs to create system water that will remain in Lake Powell and Lake Mead. The program will be active through at least 2016, and will fund water use reductions primarily among irrigators.

Finally, Reclamation has joined Lower Basin water user states in a Memorandum of Understanding for Pilot Drought Response Actions. The participants' goal is to generate 740,000 acre-feet of water to benefit Lake Mead's elevation from 2014 to 2017, and to generate 1.5 million to 3.0 million acre-feet of water by 2019. Reclamation has committed to making infrastructure improvements to help meet this goal.

Key questions for discussion at the Symposium include:

- Does the Basin Study Program consistently trigger effective follow-up action?
- How do we fund the actions set out in basin plans, including infrastructure improvements, management actions, and habitat restoration and protection?
- Would watersheds without significant Reclamation projects benefit from a stronger federal role in water supply and drought resilience planning?
- Could existing planning programs be better focused on improved drought resilience?
- Do these watershed scale planning efforts adequately incorporate protection of ecosystems and ecosystem services?

B. Data and Research

A number of federal agencies play a role in collecting and sharing data, and in conducting research related to drought. Much of this work is publically coordinated through the National Integrated Drought Information System (NIDIS) and its U.S. Drought Portal (www.drought.gov). These programs provide assessments of the progression of drought. They also provide information for decision-makers, about the necessary actions to reduce the impacts of drought.

The Western Governors' Association Drought Forum Report identified data and analysis as one of its key themes. The report identified predictive capacity, understanding of the effects of drought on water availability, data integration, and data analysis regarding soil moisture as key areas for improvement (Western Governors' Association 2015).

Upper Missouri Watershed:

Federal agencies, led by EPA Region 8 and the Bureau of Reclamation working with Montana Department of Natural Resources and Conservation (DNRC) and the Montana Water Resources Division, are conducting efforts to build drought resilience in the Upper Missouri watershed. This will be a demonstration project for the National Drought Resilience Program . Reclamation's Upper Missouri River Basin Climate Impacts Assessment Study and a Reclamation/DNRC co-funded Missouri Headwaters Basin Study, will identify current and future gaps between water supply and demand, and evaluate alternatives to reduce these imbalances. These studies exemplify cooperative water resources planning and will support NDRP activities. Reclamation has identified WaterSMART Water and Energy Efficiency Grants, the Montana Area Office's Water Conservation Field Services Program, the Title XVI Water Reclamation and Reuse Program, and the Cooperative Watershed Management Program as resources that may assist the state as it targets drought resilience. The demonstration emphasizes a comprehensive, watershed scale approach that uses the best available science to identify water supply and demand imbalances. It brings together all available opportunities to decrease those imbalances and improve drought resilience.

The federal government has begun several initiatives to improve agency efforts and coordination on research and information sharing. These include the NDRP, which coordinates agency work to support state, tribal, local, and private sector approaches to managing drought risks and impacts. NOAA's drought task force, established in 2011, convenes researchers across government agencies and academic institutions to improve tools to understand, predict, and monitor droughts. Its work supports the NIDIS, and has included an assessment of the causes and predictability of California's current drought. In 2014, the U.S. Geological Survey (USGS) announced the Open Water Data Initiative. That effort is designed not only to collect water data, but also to integrate that data and make it

more accessible through a variety of tools, including data visualization. In May 2015, NOAA announced the opening of the National Water Center on the University of Alabama campus. The Center's goal is to conduct research on new tools for understanding and predicting hydrologic extremes, including drought.

Federal agencies conduct and fund a range of research not directly coordinated through these central programs. For example, USDA's Agricultural Research Service conducts a range of water-related research as part of its Water Availability and Watershed Management National Research Program. Recent research includes development of a new model (iSnobal) for managing snowmelt in the western United States; operational implementation of a global root-zone soil moisture monitoring system; and development of the Evaporative Stress Index, a drought early warning index that can predict deteriorating crop and soil moisture conditions several weeks in advance of the US Drought Monitor and other drought indicators. The program's action plan and annual reports are located at http://www.ars.usda.gov/research/programs/programs.htm?NP_CODE=211.

These efforts of the Agricultural Research Service complement ongoing activities to monitor drought and watersheds conducted by the USGS. USGS activities include work addressing the potential impact of climate change on water availability (McCabe 2010; Hay and McCabe 2010). Efforts to understand the potential impacts of changing precipitation on land use scenarios, productivity, and drought are part of the research portfolio. (Byrd, et al. 2015).

Federal research programs are also looking at ways to augment future water supplies through advanced water treatment. For example, the Desalination and Water Purification Research Program within Reclamation funds studies to develop more cost-effective, technologically efficient ways to desalinate water. The program offers competitive grants for institutions of higher education, commercial or industrial organizations, private entities, public entities, and Tribes. Also, Reclamation engages with research focused on advanced water treatments through its Science and Technology Program. Reclamation requested funding in the President's Fiscal Year 2016 budget for research within the Title XVI program, described in more detail below.

Key questions for discussion at the Symposium include:

- What research and predictive tools are most needed for drought response and planning at the local, state, and watershed level?
- Are current federal data collection, analysis, and sharing programs adequately integrated and accessible to state and local water managers?
- Should researchers focus on improving predictive capacity in particular time frames (meteorological and climatic)?
- What is the federal role in financing and fostering research on new treatment technologies, including desalination and wastewater recycling?
- Are there major data gathering, data sharing, or research needs that lack funding?

C. Improving Drought Resilience through Enhancing Natural Resources

The overall health of natural resources such as aquatic ecosystems, wetlands, watershed functioning, and soils is a key aspect of drought resilience. If these resources are healthier, they and the ecosystems and human activities that depend on them will better weather droughts and other dry periods. Federal agencies play myriad roles in protecting and restoring these resources, and the full

range of these activities is beyond the scope of this paper. We will briefly look at two examples, each of which involves federal efforts to improve resources on private lands: soil health, and fish and wildlife habitat.

1. Improving soil health

Soil health is defined as the capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans. Improving soil health can improve drought resilience, because one of the components of soil health is enhanced water-holding capacity. More available soil water will delay the onset of agricultural drought. Improving soil health offers other benefits, including improved water quality, improved resilience to extreme weather (heavy rain as well as drought), enhanced nutrient cycling, carbon sequestration, better wildlife habitat (including for pollinators), and increased food productivity. Consequently, USDA's Natural Resources Conservation Service (NRCS) has launched an integrated campaign to increase the adoption of Soil Health Management Systems among America's farmers, ranchers, and forest landowners. Specific focus areas include: ensuring the scientific basis for recommendations to enhance soil health; training and preparing the NRCS workforce; developing tools for assessing soil health status and enhancing soil water-holding capacity; aligning Conservation Innovation Grant priorities to address demonstration and evaluation needs; leveraging the national network of NRCS Plant Materials Centers for cover crop evaluation and training opportunities; and providing partner resources and other materials through a soil health communications campaign. The NRCS has also built partnerships with universities, local agencies, other USDA programs, conservation groups, and trade associations to create, share, and implement tools to promote soil health. Since 2012, the NRCS has invested approximately $481 million for implementing soil health-promoting practices by farmers and ranchers.

2. Fish and wildlife habitat on private lands

Human uses of water, along with other human activities, have degraded rivers, streams, and wetlands, and diminished fish and wildlife populations on a wide scale. Although many species have evolved to survive drought, their ability to do so is undercut by long-term habitat degradation, by the extent to which human diversions of water exacerbate the effects of drought, and potentially by climate change. Many fish and other species have been listed under the Endangered Species Act (ESA) due to human water use and other loss of habitat. Extreme drought makes these species even more vulnerable, and making water management decisions that meet human needs while protecting ecosystems and complying with the ESA is exceptionally difficult. During droughts, water managers are typically faced with range of choices, all of which are bad for both fish and people.

Federal conservation programs to improve the quality of aquatic habitat over the long term can improve the drought resilience of ecosystems.[2] Improved habitat can increase baseline populations, creating more buffer during times of drought; provide better conditions for species to weather drought; and enhance the chance of population rebound after drought. These programs include Farm Bill cost share programs, such as the Conservation Reserve Program and the Environmental Quality Incentives Program, and the U.S. Fish and Wildlife Service's Partners for Wildlife Program. One of the strengths of these programs is that they directly engage landowners, and so can break down some of the conflicts between species protection and water use that have flared up over the last twenty years.

[2] This section briefly addresses only efforts to fund voluntary habitat improvements on private land. We recognize that there are extensive efforts related to federal lands, as well as regulatory measures under the ESA and other statutes. Many of the questions raised here could apply to those efforts as well.

There have been success stories of integrating long-term water management and drought planning with efforts to restore habitat and set aside water for aquatic species. One example is the Yakima basin, discussed above. Another is the Blackfoot River in Montana, where a large community of individual water rights holders came together around a drought plan that involved a mix of sharing of the burden of shortages, long-term habitat restoration, and environmental water transfers to protect fish habitat and create greater certainty for irrigators (see inset).

These programs, as well as many other federal and state efforts related to restoring habitat, are broadly applied across the landscape. They do not explicitly focus on drought resilience and habitat that serves as refuge during drought. Similarly, habitat restoration programs, the ESA, and other regulatory statutes do not comprehensively factor in climate change or target areas that species are more likely to use in a warmer future. Whether, and how, to modify fish and wildlife restoration efforts to factor in drought risk and climate change is a central question for the near-term future.

Key questions for discussion at the Symposium include:

- Do the federal conservation programs need to be better tailored to help landowners and species cope with increased drought risk and climate change?
- Should habitat restoration efforts be focused on enhancing the drought resilience of certain species, including by identifying and then protecting and restoring areas that are likely to serve as drought refuge habitats?
- What water management solutions are available that serve multiple objectives by improving water supply for both wildlife habitat and human uses? Are these solutions location specific, or can they be adopted more broadly?

D. Water Use Efficiency

Federal agencies fund and implement a number of programs focused on water use efficiency. Through the Environmental Quality Incentive Program, USDA-NRCS provides financial and technical assistance to agricultural producers for addressing natural resource concerns and delivering environmental benefits, including groundwater and surface water conservation. Cost-share contracts are developed with eligible landowners who agree to follow conservation practices that research has shown meet the purpose of the practice, such as improved water use efficiency. A related program, the Conservation Stewardship Program (CSP), provides financial incentives for agricultural producers to further enhance natural resources conservation on their land. Since 2012, NRCS has invested $638 million to increase irrigation efficiency through such practices as sprinkler systems, irrigation pipeline, and water control structures. Such water savings at the farm can offset rising water costs, as well as reduce expenditures for energy, chemicals, and labor, while enhancing revenues through higher crop yield and quality.

These programs also help ranchers adapt to dry conditions, through financial assistance for establishing more drought-tolerant forage species, prescribed grazing, installing livestock watering facilities, and other practices. Since 2012, NRCS has invested $410 million to help ranchers implement such practices. All of these practices hold the potential to enhance drought resilience and contribute to efforts to protect aquatic ecosystems. This is particularly true if they are implemented as part of watershed scale management and restoration effort, as in the Blackfoot River example.

In watersheds where irrigators receive water from Reclamation projects, the central federal program for irrigation efficiency is WaterSMART, established in February 2010. Previously, we discussed the Basin Studies Program of WaterSMART. Through WaterSMART, Reclamation also provides leadership and financial assistance with respect to water efficiency and coordinating the water conservation activities of the various Interior offices. Reclamation administers grants, conducts scientific studies, and provides technical assistance as part of its implementation of the program. Through WaterSMART grants, Reclamation provides 50/50 cost share funding to irrigation and water districts, Tribes, States and other entities with water or power delivery authority. The grants fund projects that seek to conserve and use water more efficiently, increase the use of renewable energy, protect endangered species, or facilitate water markets.

Also part of the WaterSMART program, Reclamation implements Title XVI of P.L. 102-575, to identify and investigate opportunities to reclaim and reuse wastewaters and naturally impaired ground and surface water in the 17 Western States and Hawaii. Since 1992, over $625 million in Federal cost-share has been leveraged with more than $1.8 billion in non-federal funding to design and construct water recycling projects. Projects selected from 2010 to 2014 through these programs and Reclamation's other water conservation activities, are expected to bring about annual water savings of 860,299 acre-feet once completed.

Blackfoot River Drought Response Plan

The Blackfoot River in Montana provides an excellent example of a watershed scale effort to both improve drought resilience and protect aquatic species. The Blackfoot does not have a major Reclamation project or large irrigation districts. Its agricultural community is made up of numerous individual irrigators (the watershed includes nearly 3,500 water rights of record). Both irrigators and stream flows have suffered during past droughts. In addition, the river's population of bull trout are listed as threatened under the ESA. Beginning in 2000, the watershed community came together around the Blackfoot River Drought Response Plan, which was designed to improve the health of the river during normal periods, and improve both streamflows and certainty for irrigators during droughts. The plan's overarching principle is that of shared sacrifice during drought, and its elements include projects to improve physical habitat, leasing of some water rights to enhance streamflow, a series of drought levels that trigger greater sharing of shortfalls by irrigators, and a series of minimum flow targets based on hydrologic conditions. The plan provides more certainty for junior water rights holders in particular by allocating them some water during droughts, improves the ability of bull trout and other fish to survive droughts by enhancing habitat, and provides the river some guarantee of flow during all but the most extreme drought conditions. The NRCS played a central role by funding stream flow leases and other projects through its EQIP program, while the U.S. Fish and Wildlife Service both coordinated bull trout restoration and funded habitat projects through its Partners for Wildlife program.

Key questions for discussion at the Symposium include:

- Are there unmet funding needs for irrigation and urban efficiency projects?
- Is government assistance the best way to incentivize water efficiency or are there alternative ways of doing so?
- How do we incorporate efficiency projects into overall water management efforts to improve drought resilience?
- What are the best opportunities for integrating improved water efficiency into efforts to restore aquatic species and ecosystems?

References

Allen, P.M., R.D. Hamel, J.A. Dunbar, and J.G. Arnold. 2011. Upland contribution of sediment and runoff during extreme drought: a study of the1947-1956 drought in the Blackland Prairie, Texas. J. Hydrology 407:1-11.

Byrd, K.B., L.E. Flint, P. Alvarez, C.F. Casey, B.M. Sleeter, C.E. Soulard, A.L. Flint, and T.L. Sohl. 2015. Integrated climate and land use change scenarios for California rangeland ecosystem services: wildlife habitat, soil carbon, and water supply. Landscape Ecology. 30:729-750.

Blackfoot Challenge. Angling for the Future of the Blackfoot River. Available at http://blackfootchallenge.org/Articles/wp-content/uploads/2012/06/BFC_Drought-Brochure.pdf.

Blackfoot River Drought Response Plan (Revised May 2014). Available at http://blackfootchallenge.org/Articles/wp-content/uploads/2015/06/Blackfoot-Drought-Response-Plan_May2014FinalUpdate.pdf.

Colorado River Basin Stakeholders *Moving Forward* to Address Challenges Identified in the Colorado River Basin Water Demand and Supply Study. 2015.

Cook, B.I., T.R. Ault, and J.E. Smerdon. 2015. Unprecedented 21st century drought risk in the American Southwest and Central Plains. Scientific Advances.

Diffenbaugh, N.S., D.L. Swain, and D. Touma. 2015. Anthropogenic warming has increased drought risk in California. Proceedings of the National Academy of Sciences. 112:3931-3936.
Gordon, E., and D. Ojima. 2015. Colorado Climate Change Vulnerability Study. University of Colorado-Boulder and Colorado State University. 190 pp.

Gray, S.T., and G.J. McCabe. 2010. A combined water balance and tree-ring approach to understanding the potential hydrologic effects of climate change in the Central Rocky Mountain Region. Water Resources Research 46:W05513, doi:10.1029/2008WR007650.

Hay, L.E., and G.J. McCabe. 2010. Hydrologic effects of climate change on the Yukon River Basin. Climatic Change. 100:509-523.

McCabe, G.J., and D.M. Wolock. 2010. Long term variability in Northern Hemisphere snow cover and associations with warmer winters. Climatic Change. 99:141–153

Moyle, P.B., J.V.E. Katz, R.M. Quinones. 2011. Rapid decline of California's native inland fishes: A status assessment. Biological Conservation. 144:2414-2423.

Tigkas, D., H. Vangelis, and G. Tsakiris. 2012. Drought and climatic change impact on streamflow in small watersheds. Science of the Total Environment. 440:33-41.

Tomer, M.D., and K.E. Schilling. 2009. A simple approach to distinguish land-use and climate-change effects on watershed hydrology. Journal of Hydrology. 376:24-33.

United States Drought Monitor. Tabular Data Archive., Accessed on 5/26/15 at http://droughtmonitor.unl.edu/MapsAndData/DataTables.aspx.

USDA-Agricultural Research Service. 2001. Protecting our watersheds through research and management: Challenges and Opportunities. Program Aid 1681. Washington, DC. 16 pp.

U.S. National Climate Assessment. 2014. Climate Change Impacts in the United States. 725 pp.

Western Governors' Association. Western Governors' Drought Forum Special Report. June 2015.

Wu, Y., S. Liu, and O.I. Abdul-Aziz. 2012. Hydrological effects of the increased CO_2 and climate change in the Upper Mississippi River Basin using a modified SWAT. Climatic Change. 110:977-1003.