Beaverhead Watershed
Drought Resiliency Plan

2016

Prepared by Chris Carparelli for the Beaverhead Conservation District and the Beaverhead Watershed Committee as part of the National Drought Resilience Partnership.

Acronyms and Abbreviations

ACE	U.S. Army Corps of Engineers
AF	acre feet
BAC	Basin Advisory Council
BAER	Burned Area Emergency Response
BCD	Beaverhead Conservation District
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
BWC	Beaverhead Watershed Committee
CCD	Clark Canyon Dam
CCR	Clark Canyon Reservoir
CCWSC	Clark Canyon Water Supply Company
cfs	cubic feet per second
CIRC	Climate Impacts Research Consortium
CMIP5	Coupled Intercomparison Model Project Phase 5
CoCoRaHS	Community Collaborative Rain, Hail, and Snow Network
CPC	NOAA Climate Prediction Center
CVA	Centennial Valley Association
CWA	Clean Water Act
CWPP	County Wildfire Protection Plan
DAC	Montana Governor's Drought Advisory Committee
DEQ	Montana Department of Environmental Quality
DES	Disaster and Emergency Services
DJF	December-January-February
DNRC	Montana Department of Natural Resources & Conservation
DRP	Drought Resiliency Plan
DTF	Beaverhead County Drought Task Force
EBID	East Bench Irrigation District

ENSO	El Niño Southern Oscillation
EOM	end-of-month
EPA	U.S. Environmental Protection Agency
ET	evapotranspiration
FAA	Federal Aviation Administration
FAO	Food and Agriculture Organization
FOA	funding opportunity announcement
FSA	Farm Service Agency
FWP	Montana Department of Fish, Wildlife & Parks
GHCN	Global Historical Climatology Network
gpm	gallons per minute
GRACE	Gravity Recovery and Climate Experiment
GWAAMON	Groundwater Assessment Act Monitoring Network
GWIC	Groundwater Information Center
GWIP	Groundwater Investigation Program
HCRCD	High Country Resource Conservation and Development Council
HUC	Hydrologic Unit Code
JJA	June-July-August
MAM	March-April-May
MBMG	Montana Bureau of Mines & Geology
MCO	University of Montana Climate Office
MIRG	management intensive rotational grazing
MSU	Montana State University
NASA	National Aeronautics and Space Administration
NDMC	National Drought Mitigation Center
NDRP	National Drought Resilience Partnership
NDVI	Normalized Difference Vegetation Index
NGO	Non-government organization

NIDIS	National Integrated Drought Information System
NIFC	National Interagency Fire Center
NOAA	National Oceanic and Atmospheric Administration
NPRCH	Northern Plains Regional Climate Hub
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
PDM	Pre-Disaster Mitigation Plan
PDO	Pacific Decadal Oscillation
PDSI	Palmer Drought Severity Index
RAWS	Remote Automatic Weather Station
RCP	representative concentration pathway
RISA	Regional Integrated Sciences and Assessment
SCAN	Soil Climate Analysis Network
SNOTEL	Snow Telemetry
SON	September-October-November
SST	sea surface temperature
SWE	snow water equivalent
SWSI	Surface Water Supply Index
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
UMW	University of Montana-Western
USDA	U.S. Department of Agriculture
USDM	U.S. Drought Monitor
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WaterSMART	Sustain and Manage American Resources for Tomorrow
WGA	Western Governors' Association

WMCE	Western Montana College climate station
WRCC	Western Regional Climate Center
WRP	Watershed Restoration Plan
WUIC	Lima Water Users Irrigation Company

Contents

Executive Summary

The National Drought Resilience Partnership (NDRP) is a collaborative effort involving Federal, state, and local government entities; non-government organizations (NGOs); and individual stakeholders. It aims to align and harness technical expertise and financial resources in order to reduce vulnerability to drought at the local level. As part of this effort, the Beaverhead Conservation District (BCD) and the Beaverhead Watershed Committee (BWC) hosted an AmeriCorps-Big Sky Watershed Corps member in 2015 and 2016 in order to increase local drought planning capacity. This plan is a product of BCD's increased capacity to assist with local stakeholder engagement and assess local drought vulnerability as part of the NDRP.

The creation of this plan was motivated by the U.S. Bureau of Reclamation's (BOR) WaterSMART (Sustain and Manage American Resources for Tomorrow) funding opportunity announcements for Drought Contingency Planning and Drought Resiliency Projects; both of which were announced in May of 2015. The purpose of this plan is to articulate the local vulnerabilities to drought within the Beaverhead Watershed and its headwaters, identify strategies for addressing those vulnerabilities, and support access to resources for projects which aim to improve local drought resilience.

This plan provides background information about the Beaverhead Watershed (Section 2), a description of the operational and administrative frameworks relevant to drought management (Section 3), the existing tools for monitoring drought conditions and additional monitoring needs (Section 4), an assessment of the sources of drought vulnerability in the Beaverhead Watershed (Section 5), proposed and existing mitigation actions (Section 6), proposed and existing response actions (Section 7), and a process for updating the plan (Section 8). These elements include descriptions of the roles played by various stakeholders and agencies, and identify potential funding sources.

Section 1: Introduction

What is a Drought Resiliency Plan?

A Drought Resiliency Plan (DRP) is a document which informs and directs a proactive drought planning process. This planning process includes stakeholder engagement, resource inventory, vulnerability assessment, identification of monitoring and resource needs, building public awareness, education programs, and periodic plan revision.

It is important to note the difference between proactive and reactive drought planning. Proactive planning processes are continual and focus on risk assessment and preparedness in order to mitigate impacts when drought occurs, and to improve the rate of economic and environmental recovery. Reactive drought plans emphasize emergency response and crisis management, often through reductions in water use, but may not directly address underlying causes of drought vulnerability.

BOR's Six Required Elements for Drought Plans

BOR's WaterSMART Drought Contingency Planning FOA provides grant funding to entities interested in developing or updating a drought plan. In section I.C.1, it lists six required elements to be included in new or updated drought plans. Page 8 of BOR's WaterSMART Drought Resiliency Projects FOA states that:

> "Under this FOA, Reclamation will prioritize projects supported by an existing drought planning effort. Drought contingency planning efforts frequently identify potential projects or needs to improve resiliency to drought. These can include mitigation actions or tools that will improve water management flexibility; or improve access to critical water supply information that will help water managers build resiliency and avoid a crisis during drought. In support of a proposal submitted under this FOA, applicants must demonstrate that the proposed project meets a need or project identified in an existing drought plan."

With these criteria in mind, this plan adheres to the BOR's six required elements for drought plans:

- Operational and Administrative Framework (Section 3)
- Drought Monitoring (Section 4)
- Vulnerability Assessment (Section 5)
- Mitigation Actions (Section 6)
- Response Actions (Section 7)
- Plan Update Process (Section 8)

This plan also contains recommendations for drought resiliency projects that are not eligible for funding under BOR's WaterSMART Drought FOAs, but is intended to be useful in support of access to funding through other agencies such as USDA, FEMA, and NOAA as well.

Who Develops and Implements the Plan?

This plan has been developed under supervision of the Beaverhead Conservation District (BCD) and the Beaverhead Watershed Committee (BWC), under the auspices of the NDRP, and through consultation with various stakeholders throughout the Beaverhead Watershed and its headwaters. BCD is a local government body comprised of local residents who represent agriculture, fisheries, and local businesses. BWC is a subcommittee of BCD.

The entities responsible for implementation of this plan may vary depending on the nature of project, and the agency jurisdiction and stakeholders involved. Each project proposal in Sections 6 and 7 of this plan references the stakeholders and agencies that figure to be involved in the implementation of that project, as well as potential funding sources.

What is the Goal of the Beaverhead Watershed DRP?

The overarching goal of this DRP is to identify the primary vulnerabilities of the local community to drought, and to propose solutions to mitigate those vulnerabilities. It is intended to be a document in which local concerns regarding drought vulnerability can be formally articulated in order to support efforts to access resources that can be utilized to improve drought resiliency.

How Can I Participate?

BCD and BWC welcome input and participation from landowners, agriculture groups, business owners, anglers and outfitters, conservation groups, government agencies, and local citizens. BCD and BWC seek to understand what makes our community vulnerable to drought, and to evaluate strategies for addressing those vulnerabilities. We encourage citizens to participate in drought monitoring and reporting; attend BCD, BWC, and Beaverhead County Drought Task Force (DTF) meetings; and to share their ideas for improving drought resilience in the Beaverhead Watershed and its headwaters. All of these meetings are open to the public. More information can be found at http://beaverheadcd.org/ and http://www.beaverheadwatershed.org/ .

Section 2: Watershed Background

Geography

The Beaverhead Watershed and its headwaters are located in southwestern Montana, mostly within Beaverhead County with small portions in Madison County. It is predominantly a snowmelt-driven system situated on the eastern boundary of the Continental Divide at the headwaters of the Missouri River. Elevations range from around 4,600 feet along the Beaverhead River to over 11,000 feet in the Pioneer Mountains. The highest source of the Missouri River, the Centennial Valley, is a key source of water supply for the Beaverhead Watershed. The Valley is home to the Red Rock Lakes National Wildlife Refuge which is the largest wetland complex in the Greater Yellowstone Ecosystem. Red Rock Creek is the one of the primary water sources of the Red Rock Lakes. The Red Rock River flows west out of the Lakes and is impounded by Lima Dam before it exits the Centennial Valley. Below Lima Dam, the Red Rock River flows 57 miles northwest past the towns of Lima and Dell and is supplemented by tributaries Little Sheep Creek and Big Sheep Creek from the west, and Sage Creek from the east. Clark Canyon Dam (CCD) impounds flows from the Red Rock River and Horse Prairie Creek. CCD marks the beginning of the Beaverhead River, which meanders 79 miles northeast past the City of Dillon until it's confluence with the Big Hole River near the town of Twin Bridges, at which point it becomes the Jefferson River. The Jefferson River flows northeast for 83 miles until it joins the Gallatin and Madison Rivers near the town of Three Forks to from the Missouri River. Notable tributaries of the Beaverhead River include Grasshopper Creek and Rattlesnake Creek from the west, and Blacktail Deer Creek and the Ruby River from the east.

Land Use

The Beaverhead Watershed and its headwaters has a total area of approximately 2.44 million acres, with approximately 52% being Federal lands (USFS, BLM, BOR, USFWS), 14% State lands (DNRC, FWP), and 34% private land. Of Beaverhead County's 9,341 residents (US Census, 2013), about 20% rely upon agriculture and forestry for their livelihood. According to the Montana Department of Agriculture, Beaverhead County was the top beef producing county in Montana and the third highest sheep producing county in 2013. Approximately 80% of the 97,200 acres harvested in Beaverhead County in 2012 were feed crops such as alfalfa and hay, while the other 20% consisted primarily of spring wheat, barley, and seed potatoes. Most, if not all of these acres are irrigated. There are more than two million acres of range providing excellent summer and fall forage for cattle and sheep. Therefore, many producers cycle their livestock between their private pasture lands in the winter and spring, and public land grazing allotments during the summer and fall. The agricultural economy in Beaverhead County suffers disruptions when drought conditions limit available water supplies for irrigation, and inhibit forage production on the landscape.

The Beaverhead River is a blue ribbon trout fishery that is renowned for the abundance and size of brown trout in its waters. The Beaverhead Watershed and its headwaters also support other fish species such as rainbow trout, brook trout, Westslope Cutthroat Trout, Arctic grayling, mountain whitefish, burbot, common carp, longnose dace, longnose sucker, Rocky Mountain sculpin, and white sucker. Therefore, angling recreation and tourism is another important component of the local economy. The most common impacts to this industry due to drought are low stream flows and high stream temperatures which can stress and kill fish, impair water quality, trigger angling restrictions, and discourage recreation and tourism. This not only affects local outfitting businesses, but also local hotels, restaurants, and other businesses.

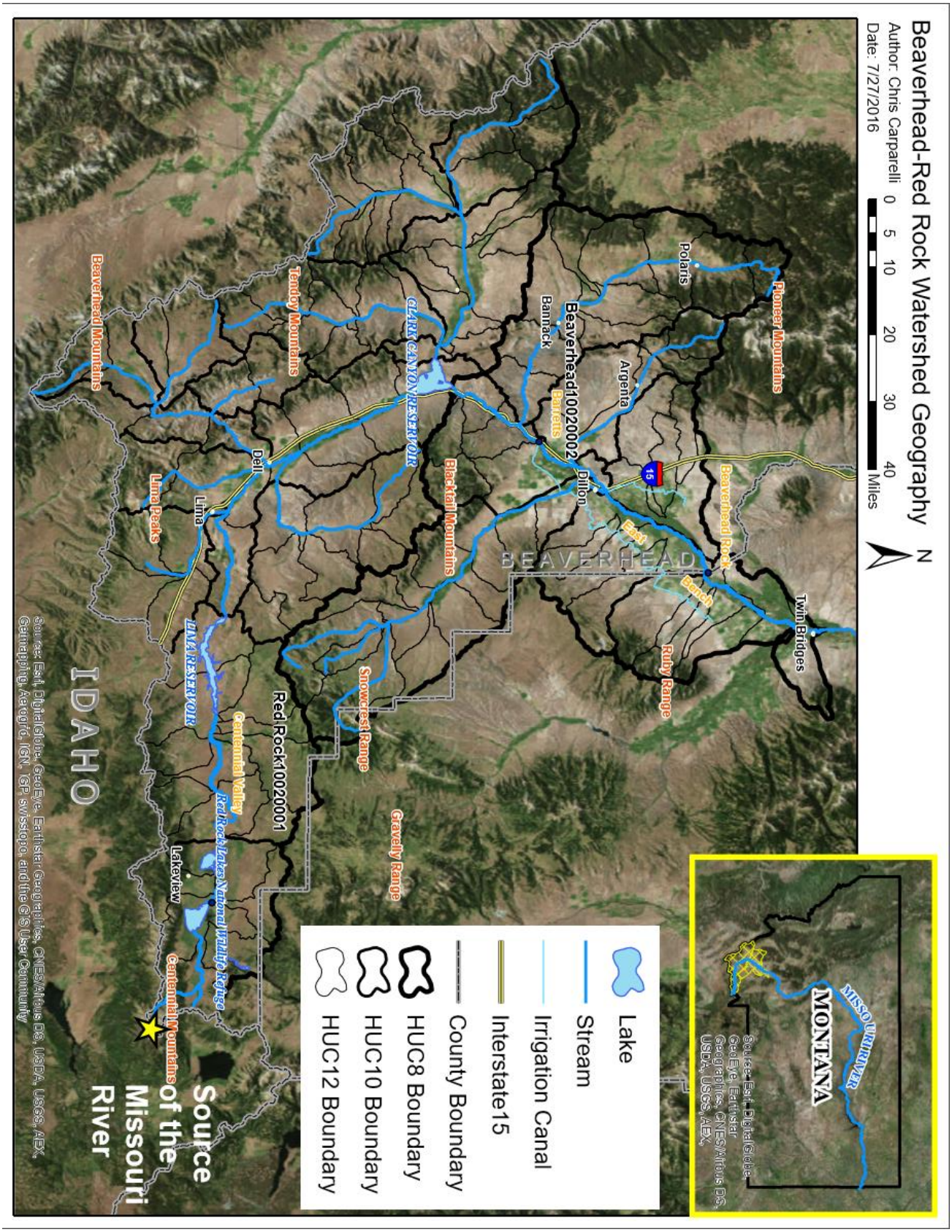


Figure 1. Map of the Beaverhead Watershed and its headwaters.

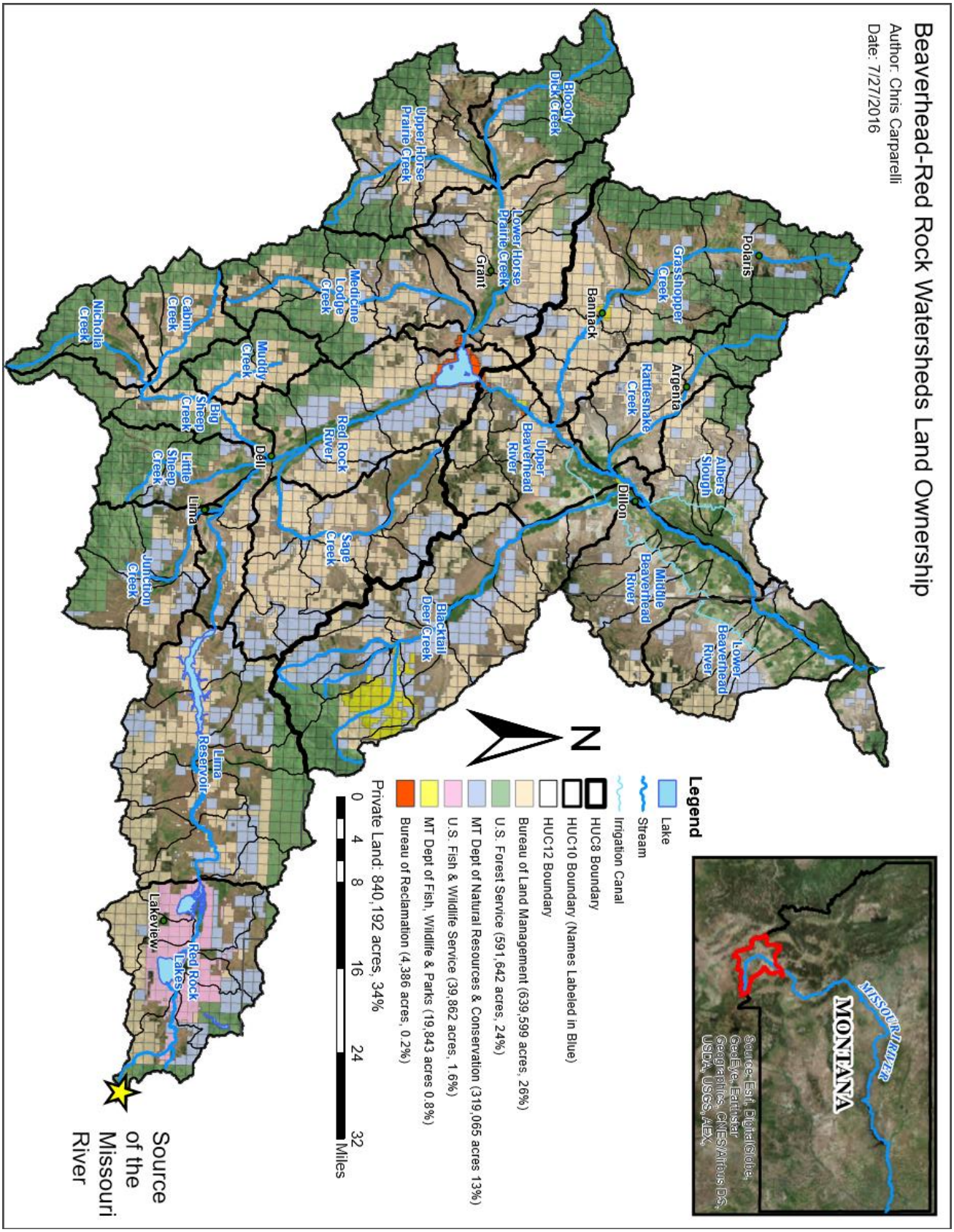


Figure 2. Land ownership map for the Beaverhead Watershed and its headwaters.

Climate

Present

The Beaverhead Watershed and its headwaters are comprised of Midlatitude Steppe and Highland climate zones. Favorable winter atmospheric patterns are ones that provide Pacific moisture from the southwest which is orographically lifted over the Centennial Range and deposited in the form of snow in the Centennial Valley. This snowpack is among the deepest and longest lasting in the Upper Missouri Basin because of the high elevation, cold temperatures, and the protection from wind and sun provided by the northern slope of the Centennial Range. Atmospheric patterns that come out of the northwest are less favorable as they produce less moisture in the Beaverhead Watershed and its headwaters. In general, elevation and precipitation have a positive relationship throughout the watershed. The areas of the Beaverhead Watershed with the highest annual precipitation include the east Pioneer Mountains and the southeast Centennial Valley. The areas with the lowest annual precipitation include the central Horse Prairie watershed around Grant, and the lower portions of the Beaverhead Watershed between Dillon and Twin Bridges. The valley bottoms receive the most significant portions of their annual precipitation in the form of rain during May and June.

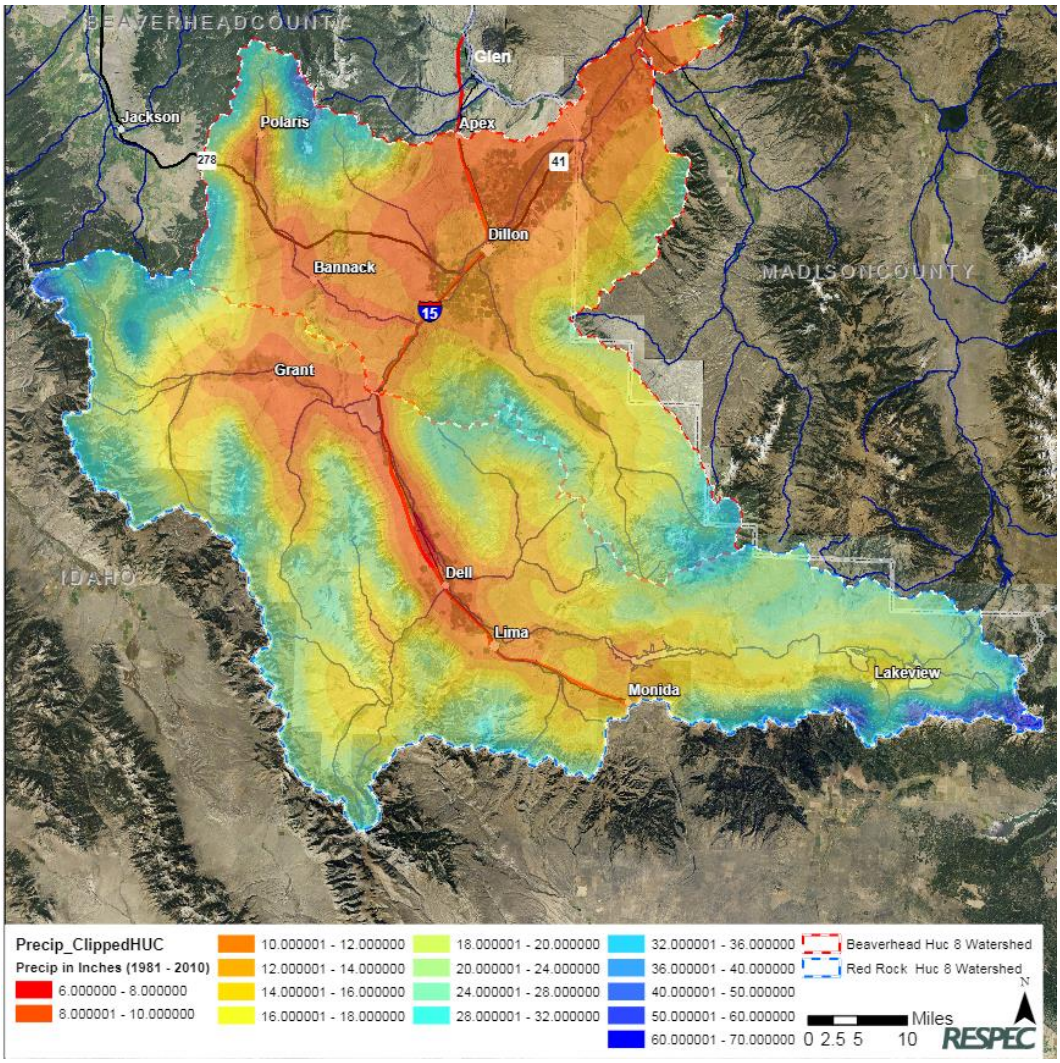


Figure 3. Average annual precipitation in the Beaverhead Watershed and its headwaters. (Courtesy: Zachary Collins, RESPEC)

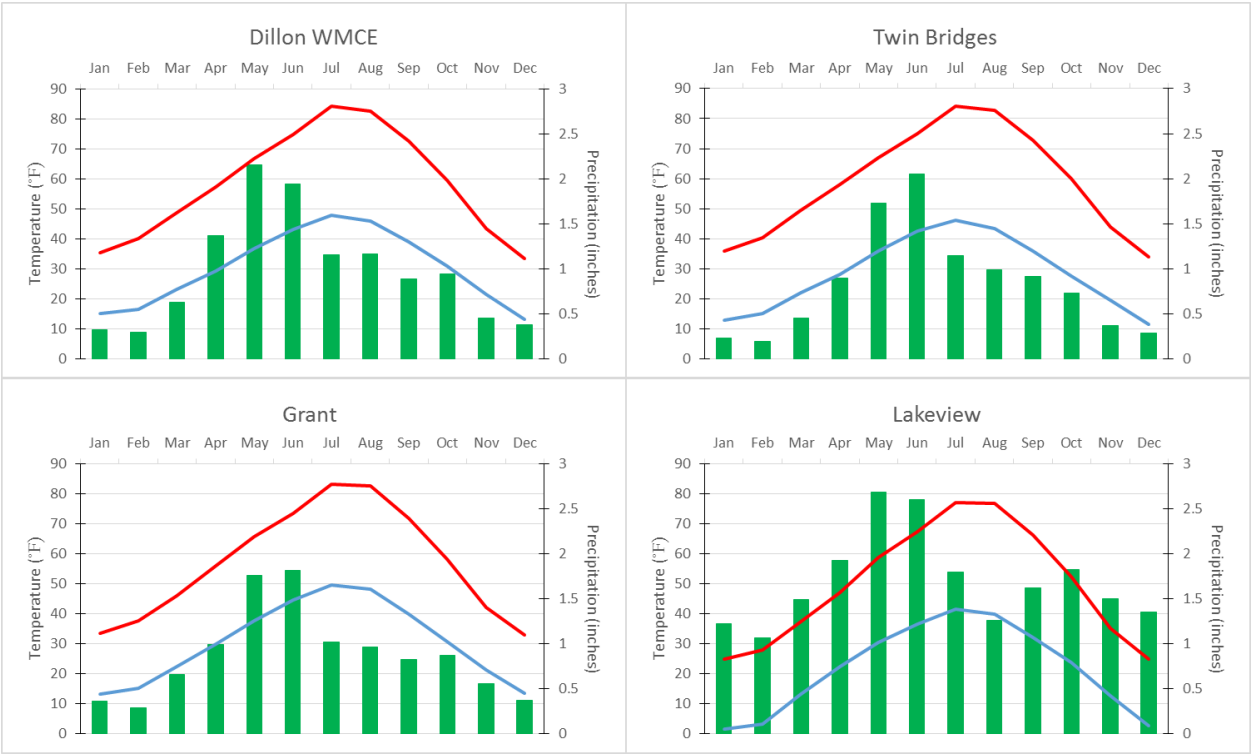


Figure 4. 1981-2010 monthly climate normals for Dillon WMCE, Twin Bridges, Grant, and Lakeview GHCN sites. Red line: average monthly maximum temperature. Blue line: average monthly minimum temperature. Green bars: average monthly precipitation. Website: http://droughtatlas.unl.edu/Data.aspx

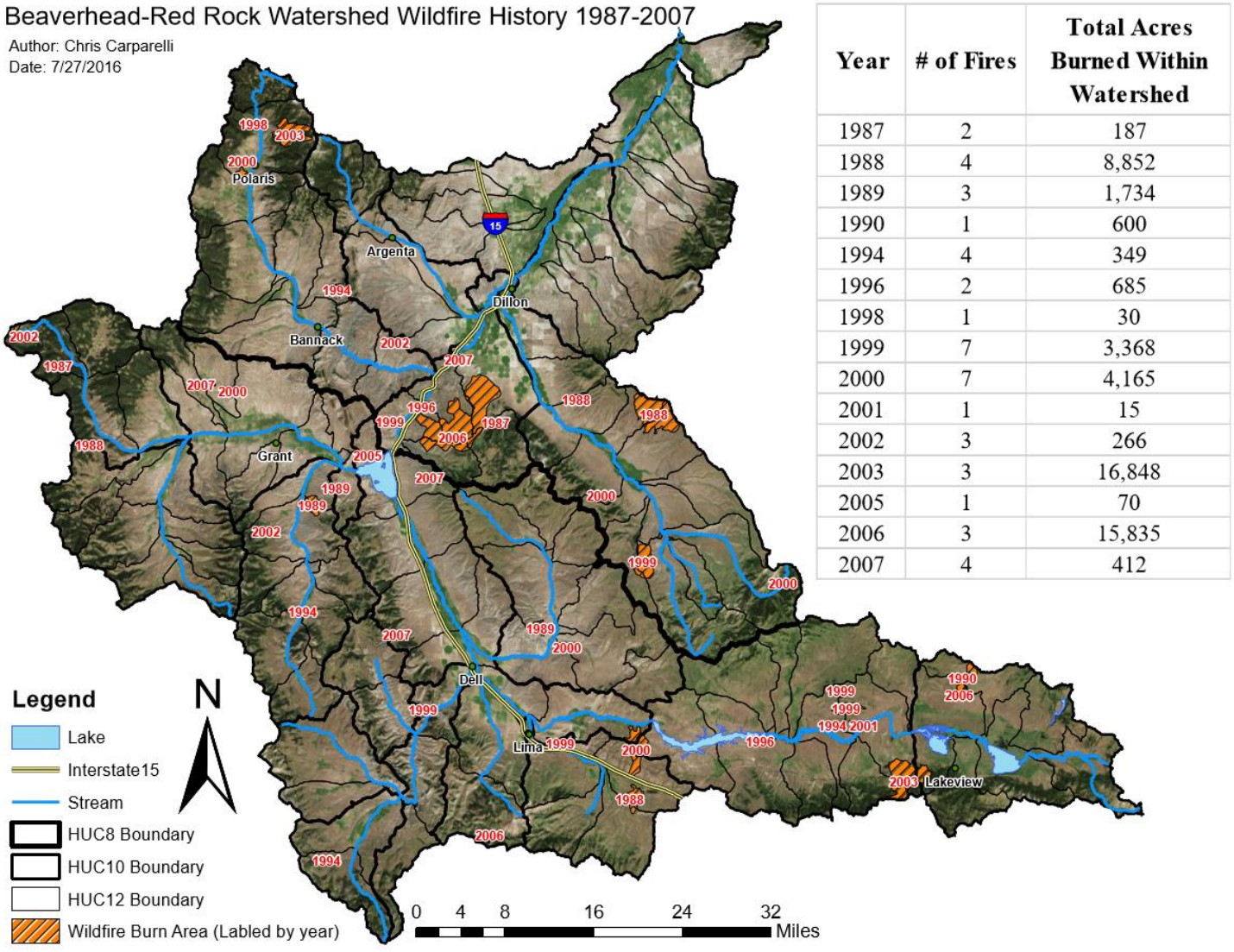
Past

The first quarter of the twentieth century in the Beaverhead Watershed was significantly wetter than the present day climate. This is illustrated by the fact that during that period, dryland wheat was widely grown on the East Bench – which is no longer possible today. During the period from the late 1920s to the 1950s, the Beaverhead Watershed saw a dramatic shift toward a drier climate regime, as did much of the western U.S. during the Dust Bowl era. This climatological shift put dryland farmers in Beaverhead County out of business. One response to this climatological shift was the construction of Clark Canyon Reservoir and the East Bench Canal during the early 1960's to support the viability of agriculture in the Beaverhead Watershed. Since then, the most significant drought events in the Beaverhead Watershed and its headwaters have occurred in 1966, 1974, 1988, 2001-2005, and 2012.

According to the U.S. Drought Monitor (USDM), Beaverhead County experienced 250 consecutive weeks with at least "D1 Moderate Drought" conditions from February 2001 through November 2005. This period included 94 consecutive weeks of "D4 Exceptional Drought" conditions between July 2003 and May 2005. This resulted in the East Bench Irrigation District (EBID) not receiving any water for the 2004 irrigation season. This not only caused significant losses for producers and the local economy, but it also disrupted the water supply of

private domestic wells on the East Bench that derive their drinking water supply from the groundwater aquifer that is replenished by seepage from the East Bench Canal.

Wildfire activity is highly influenced by climate conditions. While wildfire has been somewhat common in the Beaverhead Watershed and its headwaters, it has not been as prone to large, high-intensity wildfires as surrounding areas in Idaho and northwest Montana. Part of the reason for this relatively low wildfire risk is that much of the Beaverhead Watershed and its headwaters are dominated by sagebrush rangeland which has less available fuel, and rangeland fire tends to be easier to control than fire burning on forested lands. Fire risk on sagebrush-dominated landscapes tends to peak in the late summer of years with wet spring months and good vegetative production on rangelands. The largest fires in the Beaverhead Watershed and its headwaters have tended to burn in forested areas during drought years.



Year	# of Fires	Total Acres Burned Within Watershed
1987	2	187
1988	4	8,852
1989	3	1,734
1990	1	600
1994	4	349
1996	2	685
1998	1	30
1999	7	3,368
2000	7	4,165
2001	1	15
2002	3	266
2003	3	16,848
2005	1	70
2006	3	15,835
2007	4	412

Figure 5. History of wildfire in the Beaverhead Watershed and its headwaters 1987-2007.

There is evidence of what the climate in southwest Montana was like prior to Anglo settlement. The USGS has analyzed tree rings samples from the Upper Missouri River Basin to reconstruct over 400 years of hydrology and climate. This analysis, although not specific to the Beaverhead Watershed, can be used to give greater historical context to the recorded drought events that have occurred in southwest Montana.

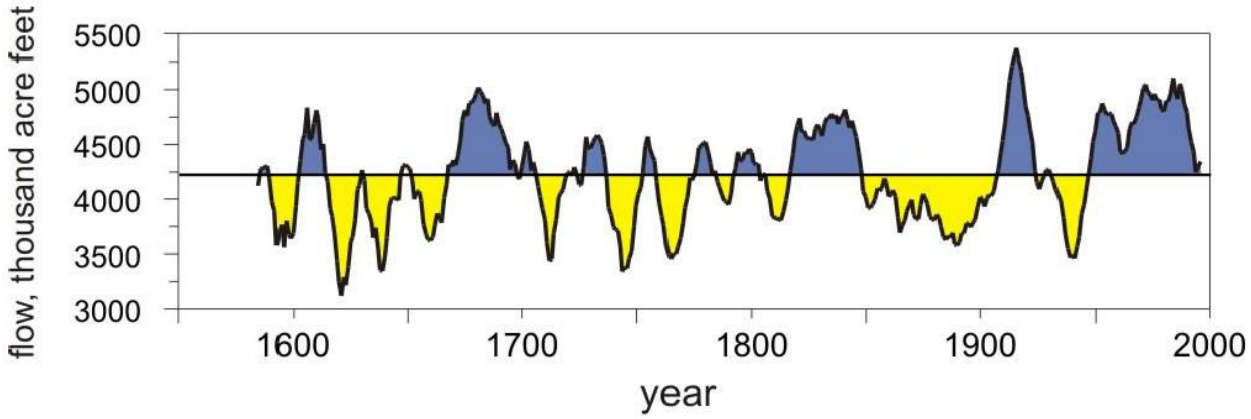


Figure 6. USGS Tree ring climate reconstruction of Missouri River flows at Toston. Smoothed with a 10-year running average (the last year of 10 is plotted). Periods of below average flows are in yellow. Periods of above average flows are in blue. (Courtesy: Gregory Pederson, USGS)

Future

Currently, the most commonly used long-range climate forecasting tool is CMIP5. It is utilized by the USGS, BOR, ACE, NOAA, and several other government agencies and academic institutions. It provides a range of future scenarios produced by 178 different global ocean-atmosphere coupled general circulation climate models. This technology was utilized to simulate potential climate futures for the Beaverhead Watershed and its headwaters. This model output was analyzed using the delta method. Analysis of the output shows average annual temperatures rising 1-3° F by 2025, 1.25-6° F by 2035, and 1.5-8° F by 2050 (Figure 7). The models were mixed as to whether and to what extent annual average precipitation may increase or decrease. A seasonal delta analysis for 2035 suggests the potential for wetter and warmer winters and springs, along with drier and warmer summers (Figure 8).

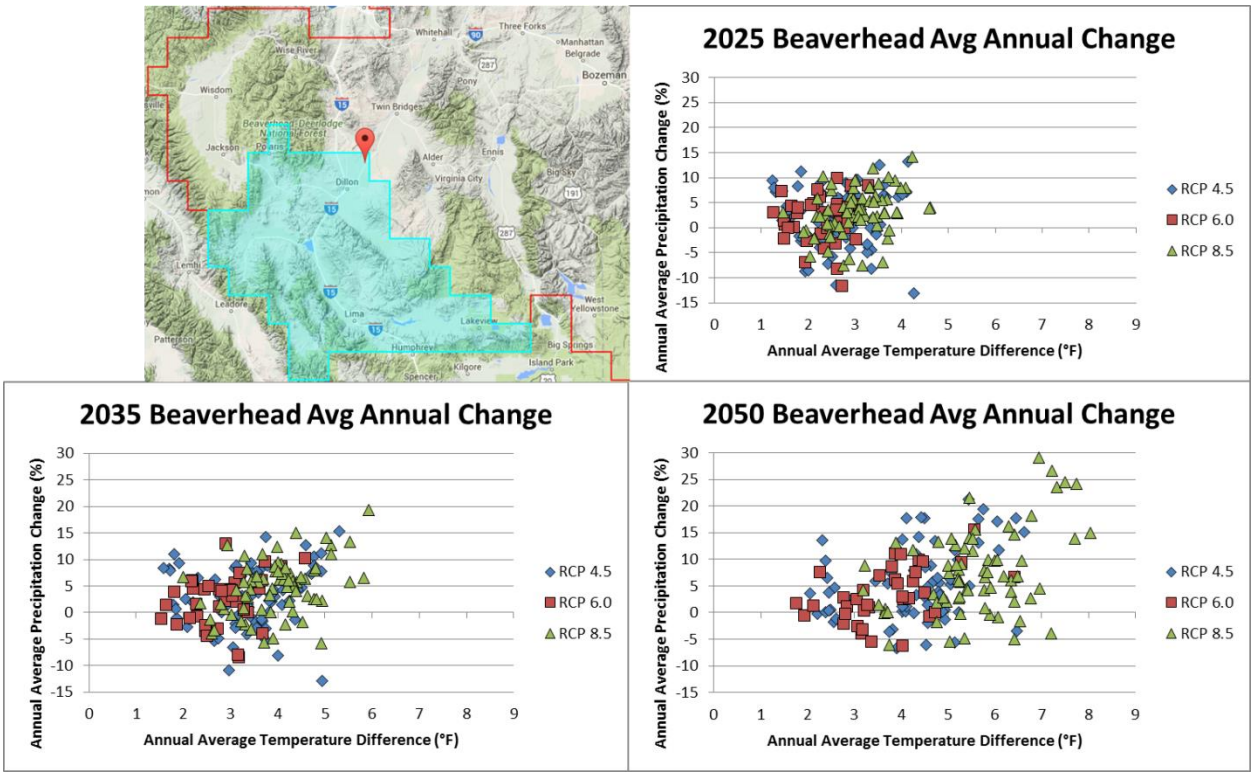


Figure 7. Map: The area for which CMIP5 output was requested is shaded in blue. Scatter plots: Analysis of CMIP5 output for annual changes in average temperature and average precipitation for the Beaverhead Watershed and its headwaters for the periods 2010-2039 (2025, top right), 2020-2049 (2035, lower left), 2035-2064 (2050, lower right) as compared with 1950-1999.
Website: http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/

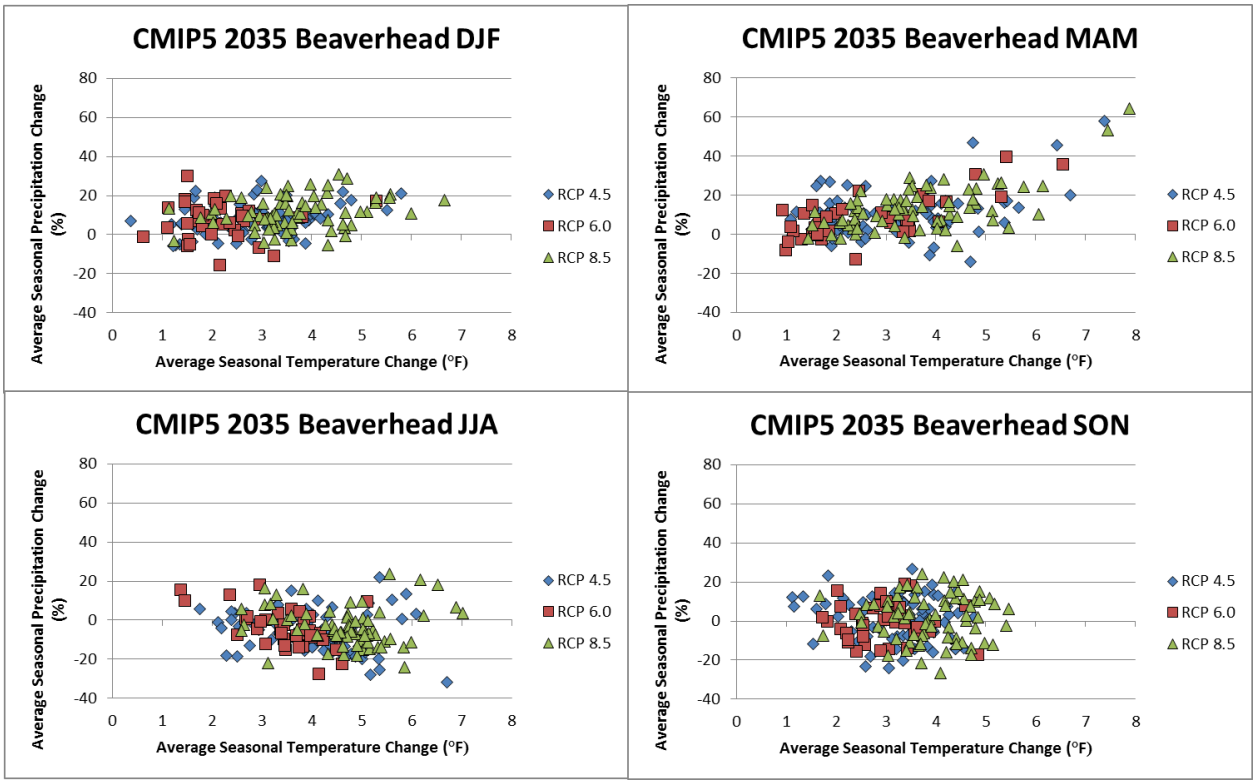


Figure 8. Analysis of CMIP5 output for seasonal changes in average temperature and average precipitation for the Beaverhead Watershed and its headwaters for the period 2020-2049 as compared with 1950-1999. DJF=December-January-February, etc. Website: http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/

USGS analysis of CMIP5 output for the Missouri Headwaters region (Figures 9 and 10) shows projected decreases in April snowpack, which suggests that in the future runoff may occur earlier in the year on average.

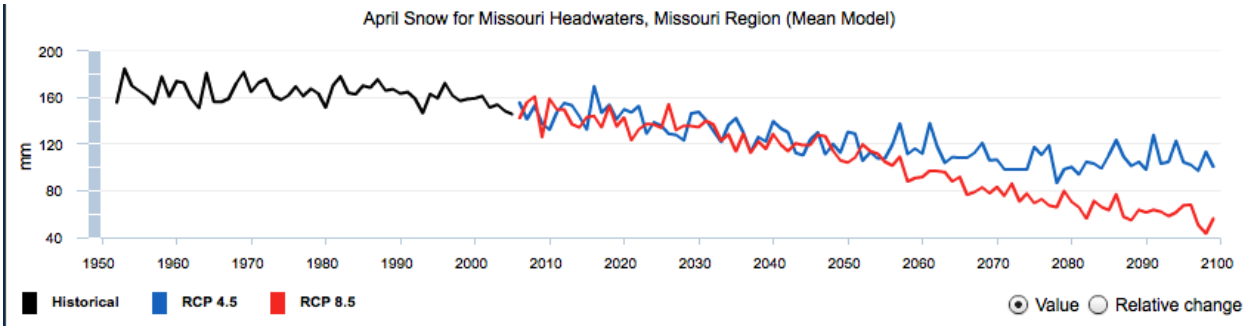


Figure 9. CMIP5 mean model output for April snow for the Missouri Headwaters region. (Courtesy: Gregory Pederson, USGS)

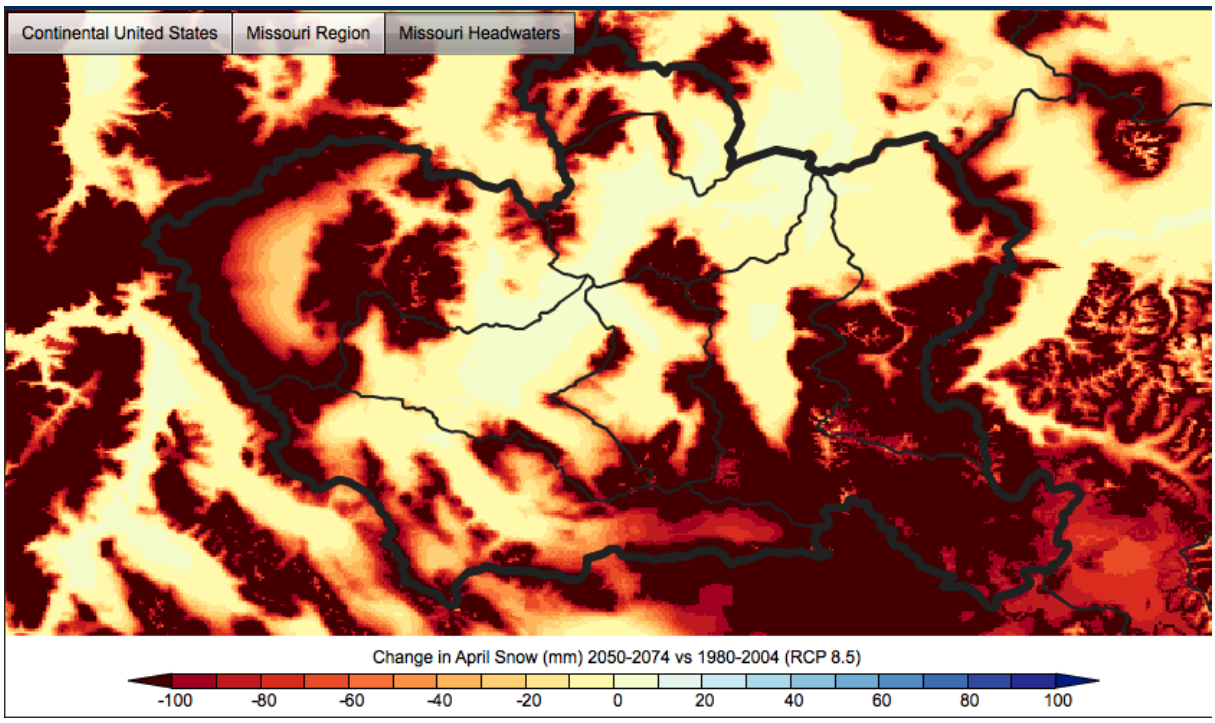


Figure 10. Mapped changes according to CMIP5 mean RCP 8.5 model output for April snow for the Missouri Headwaters region. (Courtesy: Gregory Pederson, USGS)

According to the USDA's 2014 Climate Change Adaptation Plan, American agriculture may experience a variety of interrelated climate stressors in the future whose net effect is difficult to predict. Potential impacts to crops include shifts in crop production areas, increased crop water-demand, longer growing seasons, increased efficiency of plant respiration, increased weed pressure, and more variable water availability. USDA's Plan states that livestock production will likely be affected in four primary ways: (1) feed-grain production, availability and price; (2) pastures and forage crop production and quality; (3) animal health, growth and reproduction; and (4) disease and pest distributions. Wildlife such as deer, elk, antelope, and moose figure to be affected in many of the same ways which may present greater wildlife management challenges agencies and stakeholders.

Forested lands may experience altered disturbance regimes including wildfire, insect infestations, erosion, flooding, and drought-induced tree mortality. These changes are likely to have mixed impacts on the structure, composition, function, and distribution of flora and fauna communities, with habitat areas for many species moving to higher elevations and/or higher latitudes. This may create noticeable changes in ecosystem services.

Hydrologically, USDA, USGS, and NOAA expect that average annual snowpack will decrease, a greater proportion of average annual precipitation will fall as rain, runoff will peak earlier and lower on average, average air and water temperatures will rise, and there will be greater demands on soil moisture on average. Evidence of some of these predicted changes was observed during the 2014-2015 water year when the Centennial Valley experienced record low snowpack, and several major rivers in Montana experienced record low flows.

Influence of the El Niño Southern Oscillation

The El Niño Southern Oscillation (ENSO) is a globally influential climate pattern that is caused by the interaction between sea surface temperature (SST) fluctuations and atmospheric circulation patterns in the equatorial Pacific region. The period of oscillation between the warm phases (El Niño) and cool phases (La Niña) of ENSO is irregular and can vary from two to seven years. El Niño conditions develop when SSTs are warmer than average in the equatorial Pacific for an extended period of time. While each El Niño is different, there are some general patterns that are predictable. For example, the polar jet stream is typically farther north than usual, while the Pacific jet stream tends to persist across the southern U.S.

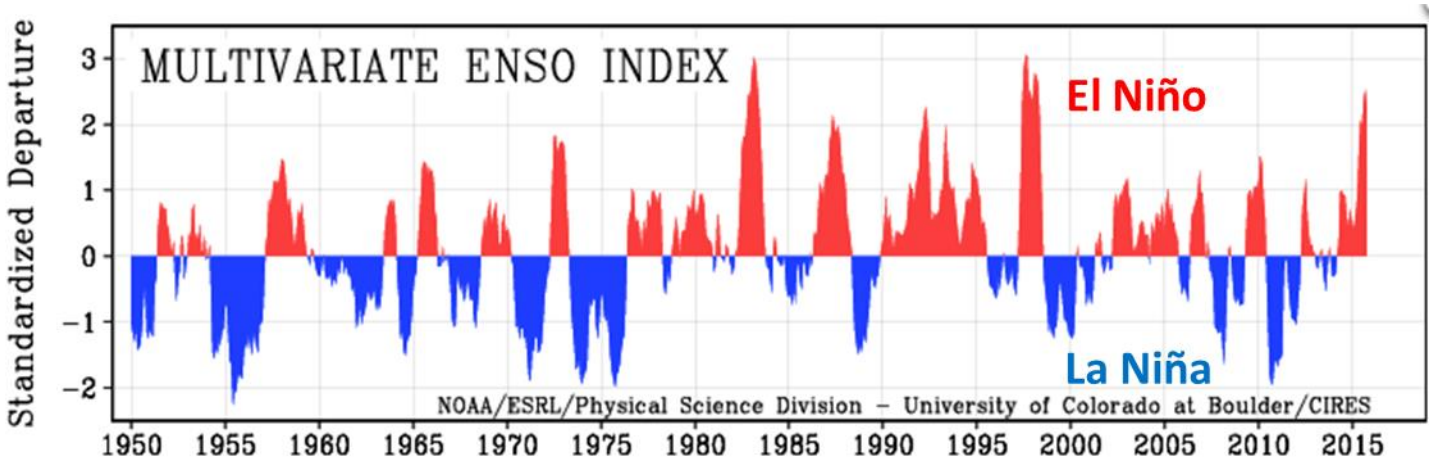


Figure 11. Multivariate ENSO Index since 1950.
Website: http://www.esrl.noaa.gov/psd/enso/mei/

ENSO is an important consideration for seasonal climate forecasting for southwest Montana. El Niño events tend to peak in the winter and increase the likelihood of warmer than normal winter temperatures and below average winter snowpack for the Beaverhead Watershed and its headwaters. Extreme cold weather may be milder and less frequent than normal, and heavy snow events may be less frequent than normal. Typically, these winter temperature and precipitation anomalies are less pronounced in southwest Montana than they are in northwest Montana. El Niño events may also increase the likelihood of above average late spring and early/mid-summer precipitation in the Beaverhead Watershed and its headwaters. Impacts of El Niño in the Beaverhead Watershed may include below average reservoir storage at the beginning of the irrigation season, above average weed pressure, above average range and forage production, and above average summer wildfire risk.

Strongest El Niño Years on Record	1982-83 1997-98 2015-16
El Niño Years Coinciding with Beaverhead Drought	1965-66 1987-88* 2002-03** 2004-05** *Devastating fire year in Western MT, NW Wyoming **Long-term drought peaked with only year ever East Bench Canal got no water (2004)

Figure 12. Notable El Niño years.

La Niña conditions develop when SSTs are cooler than average in the equatorial Pacific for an extended period of time. These conditions may slightly increase the likelihood of below average winter temperatures and above average late winter and early spring precipitation. Impacts of La Niña in the Beaverhead Watershed may include above average reservoir storage and stream flows, and delayed beginning of growing seasons.

Strongest La Niña Years on Record	1973-74 1975-76 1988-89
La Niña Years Coinciding with Significantly Above Average Inflows to CCR	1970-71 1983-84* 2010-11** *Only year water has ever been routed over CCR Spillway **Damaging flood events in Beaverhead Watershed and throughout MT

Figure 13. Notable La Niña years.

The Pacific Decadal Oscillation (PDO) is another globally influential climate pattern which is driven by SST fluctuations in the mid-latitudes of the Pacific Ocean. The PDO's period of oscillation varies irregularly on interannual to interdecadal timescales. Depending on its phase, it can either enhance or suppress the climatic effects of ENSO. A tool for assessing the how ENSO and PDO affect seasonal temperature and precipitation in Montana can be found at http://tools.adaptivehydro.com/.

Infrastructure

Irrigation

Irrigation methods in the Beaverhead Watershed and its headwaters include flood, hand-line, wheel-line, and center pivot. The watershed is in the midst of a decades-long transition process from older methods like flood and hand-line to the less labor intensive systems of wheel-line and center pivot. This transition is changing the timing and amount of return flows throughout the basin due to increased irrigation efficiency. Flood irrigation is a more common method of irrigation in source watersheds like Big Sheep Creek, Sage Creek, Grasshopper Creek, Blacktail Creek, and the Centennial Valley. The Beaverhead and Red Rock Rivers have the most developed irrigation infrastructure and largely consist of sprinkler irrigation, though much flood irrigation still exists in their floodplain areas.

Lima Dam, which impounds the Red Rock River, was originally constructed in the early twentieth century and has a storage capacity of 75,180 acre feet. Below Lima Dam is land irrigated by the Lima Water Users Irrigation Company (WUIC), which privately owns and operates Lima Dam and utilizes the Red Rock River as its principal conveyance feature. The Red Rock River flows into Clark Canyon Reservoir (CCR) from the south.

The East Bench Unit of the Pick-Sloan Missouri Basin Program is along the Beaverhead River. The unit provides supplemental irrigation service to 24,848 acres and 3,156 acres which receive no additional water because early priority water rights provide an adequate supply. Principal features include CCR, Barretts Diversion Dam, East Bench Irrigation District (EBID) and Clark Canyon Water Supply Company (CCWSC). CCR has a total capacity of 257,152 acre-feet which includes an active capacity of 126,117 acre-feet, a joint use capacity of 50,436 acre-feet, and an exclusive flood control capacity of 79,090 acre-feet as well as dead storage and inactive storage capacities. The reservoir surface area is 5,903 acres.

CCD was completed at the head of the Beaverhead River in 1964 to impound surplus flows of Horse Prairie Creek and the Red Rock River, which join to form the Beaverhead River. Water stored at CCR is released into the Beaverhead River for downstream irrigation. Barretts Diversion Dam, 11 miles downstream from CCD, diverts water from the Beaverhead River into the East Bench Canal and the Canyon Canal. The East Bench Canal is 53 miles in length and has a full capacity of about 440 cfs. In 2004 the East Bench Canal and EBID did not receive any water due to drought conditions. As a result, several private domestic wells on the East Bench experienced disruptions, and the East Bench Canal lost the seal that is created by water seepage into the subsurface and subsequent freezing during winter. According to EBID, the seal on the Canal has still not recovered to the pre-2004 level of integrity. CCWSC operates the West Side Canal which is 21 miles in length and diverts water at Dillon to irrigate roughly 6,855 acres on the west side of the Beaverhead River. The West Side Canal has a capacity of about 160 cfs.

There are plans to install hydropower facilities at CCD by 2017. The hydropower facilities will operate under run-of-the-river conditions, as there will be no storage or use rights for hydropower. The principal investor in the facilities is Clark Canyon Hydro, LLC, whose parent company is headquartered in Toronto, Ontario. The electricity generated will be transmitted to Idaho for use by Idaho Power Company's grid system. The hydropower facilities will operate during the irrigation season when CCD releases are highest. Operation of the hydropower facilities will require a minimum of 80 cfs releases from CCD, and therefore they will not have sufficient flows to operate during most winters.

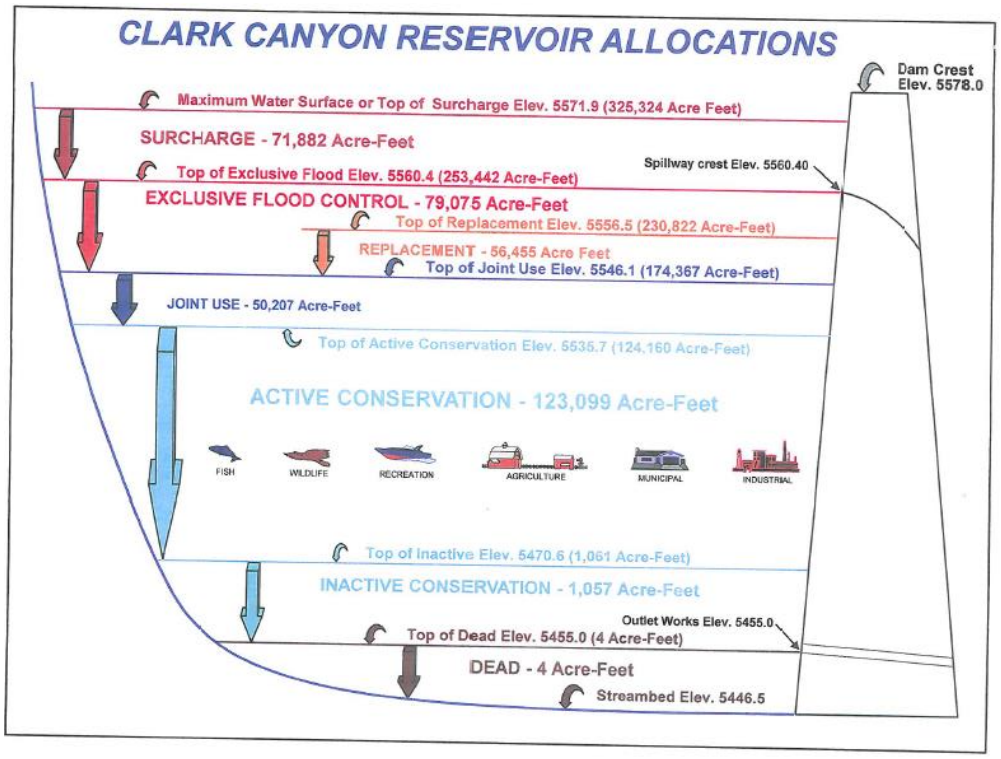


Figure 14. Diagram of Clark Canyon Reservoir storage capacity. (Courtesy: Stephanie Micek, BOR)

Irrigation Infrastructure Needs:

1. EBID has identified a need to install a concrete ramp flume on the lower end of the East Bench Canal. This would benefit irrigation water management through improvements in water measurement and conveyance system efficiency.
2. Several features of WUIC's irrigation conveyance and measurement infrastructure are in need of repair or replacement. In 2015, engineers from the NRCS Dillon Area Office surveyed this infrastructure and recommended replacement or resetting of 29 flumes, and identified 20 diversion points in need of maintenance. This trip report is on file at the NRCS Dillon Area Office. Improvement of these features would enhance WUIC's ability to accurately administer water rights, conserve water, and possibly preserve streamflow in the Red Rock River.

City of Dillon Water System

The City of Dillon's drinking water supply originally was derived from Rattlesnake Creek. Due to problems with water lines freezing during the winter, the City added four groundwater wells to its collection system between 1948 and 1973. These wells produced warmer water that made the city water lines less susceptible to freezing. Three of these wells ranged have a capacity of 500 gpm and one has a capacity of 1,000 gpm.

Beginning in 1993, the Clean Water Act (CWA) mandated that all municipal surface water sources had to be filtered and treated. Due to the high cost associated with the mandated treatment systems, the City opted to discontinue its use of water from Rattlesnake Creek, except in the case of emergencies. Therefore, the City's water supply has been derived exclusively from groundwater since 1993.

In 1996, the City installed a 750,000-gallon reservoir on the southeast side of town off of the East Bench Canal Road. In 2001, the City installed a 1,000,000-gallon reservoir on the southwest side of town off of 10 Mile Road. The wells that fill these reservoirs draw water from aquifers that are recharged by the East Bench Canal and the Beaverhead River. Both reservoirs are perched on hills which allows them to gravity-feed water into the City's distribution system (Bob Cottom, 2006).

The City of Dillon water system has approximately 1750 service connections and serves approximately 4300 people. More information about the City of Dillon's water system can be found here: http://sdwisdww.mt.gov:8080/DWW/JSP/WaterSystemDetail.jsp?tinwsys_is_number=3003&tinwsys_st_code=MT&wsnumber=MT0000201 .

Water Rights

Overview

The State of Montana adheres to the prior appropriation doctrine system of water rights; the basic philosophy of which is "first in time, first in right". The Beaverhead Watershed, along with the rest of the Upper Missouri River Basin, was closed to all new surface water right appropriations in 1993 because the basin was deemed by DNRC to be over-allocated. This means that surface water right claims in the basin exceeded the available water supply. DNRC's Water Adjudication Bureau is currently assisting the Montana Water Court in the adjudication of all claims to pre July 1, 1973 water rights. As of the writing of this DRP, preliminary decrees had been issued for the Beaverhead and Red Rock river basins. It is unknown exactly when the statewide adjudication process will be complete, but it is anticipated to be sometime between 2017 and 2020.

In Montana, anyone who anticipates using more than 35 gallons per minute (gpm) or 10 AF per year of groundwater is required to obtain a permit to appropriate water before any development begins or water is used. Groundwater wells with capacities below these thresholds are referred to as "exempt" wells. In a controlled groundwater area, a permit may be required to appropriate any amount of water, depending on the terms of the groundwater area.

Stream depletion zones are defined as areas where hydrogeologic modeling has determined a groundwater well will deplete a stream by a certain amount during a certain time period. The stream depletion zone can allow for two possible regulatory actions: either a new exempt groundwater well within an established stream depletion zone may be limited to a volume of 2 AF per year (or 20 gpm); or a stream depletion zone may render exempt groundwater wells subject to calls from senior surface water right holders that are determined to be affected by groundwater pumping. Stream depletion zones may be established in a closed basin by DNRC, a municipality, a county, a conservation district, or the owners of at least 15% of the flow rate of the surface water rights in the area estimated to be affected.

The followings information about water rights on the Beaverhead River and the Red Rock River was provided by the CCWSC Water Conservation Plan and Dick Gosman of Lima, respectively.

Beaverhead River

The water right claims for CCR are for 257,152 acre feet of water for irrigation, flood control, fish and wildlife, recreation, municipal and industrial, and other uses. The water right claims have February 21, 1961 priority dates. There are 70 diversion points along the Beaverhead River water right holders. Historically, there were insufficient flows in the Beaverhead River after snowmelt runoff to satisfy the irrigation demands in the basin prior to construction of CCR. This is evidenced by the fact that there is an existing old decree in the basin. CCR was constructed to store water during periods of excess flow, normally spring snowmelt runoff, then release water to the Beaverhead River to provide water to EBID. EBID water rights are enforced by a district court-appointed water commissioner. BOR also entered into a contract with water users who had decreed water rights prior to construction of CCR. This group of existing water users formed the CCWSC and entered into a contract for supplemental water from the reservoir. CCWSC is generally guaranteed 4 AF of water per acre by contract, which includes the amount of water diverted under their direct flow water rights.

Water can be stored under this right any time that downstream senior rights are satisfied. The blue ribbon tail water trout fishery on the Beaverhead River does not have a water right. However, releases are made to maintain the fishery in the Beaverhead River so long as they do not jeopardize the irrigation water supply. There is a minimum flow requirement of 25 cfs at the low point of the river, regardless of where that low point is.

Red Rock River

The Red Rock decree, case 576, is the result of a suit filed in 1896. It names the owners of every operating ditch on the reach of the river from one mile east of Lima to the plaintiff's ditch about 4 miles below Dell as defendants. The decree was issued August 21, 1899. There were 49 decreed separate rights issued, all still in use today. The total quantification required 7,870 miner inches (196.75 cfs) to fill all this decree. The WUIC water right for storage in Lima Dam is not decreed, it is based on an appropriation for 1,000,000 miner inches. The WUIC right is junior to all of the Red Rock decreed rights.

There is another decree on the Red Rock extending from the lower end of the 576 decree to CCR. This is the remnant of the 828 Beaverhead Decree left after the completion of CCD in 1964. There are 15 ditches involved here requiring a total of 5,184 miner inches (129.6 cfs). In the past the return flow waters have more than supplied their needs.

The decreed rights apply only to the natural flow of the river defined as the flow absent any water from storage. Inflows into Lima Dam are not measured, but can be calculated from outflows and changes in storage. The natural river flow includes inflow to the dam plus accretions from tributaries and returns from irrigation.

The nature of the Red Rock River divides it into two reaches, one from Lima Dam to the Red Butte near Dell, the other from Dell to CCR. The irrigated lands of the upper reach are light and porous and require constant and heavy applications of flood water. Records indicate as much as 6 to 8 acre feet per season. Much of this water percolates down into the underground aquifer and reappears as springs and running streams about four to six weeks later. These return flows have been estimated at as much as 250 cfs. In the mid 1930's state engineers completed a study of stream flow on the Red Rock and concluded that the return flow near Armstead (which was submerged with the construction of CCR) was 50% of the original flow. These waters played a large role in the management of the resource. Since about the year 2000 the increase in the use of sprinkler irrigation has

brought on a marked decrease in return flow volume. This along with the uncertainty in the approaching re-adjudication present challenges that will require WUIC to adapt their water management practices.

A major issue with the management of the water resource by WUIC has been the fair and equitable delivery of the storage water to the members. After the construction of CCR, WUIC amended the by-laws to provide that the delivery point of storage waters is to be at the outlet gates at the dam, and not the point of diversion of the river. The decreed rights were managed by a court appointed water commissioner. WUIC deliveries were managed by a water master, who had no legal authority to regulate a head gate. Attempts to deliver a given quantity downstream past numerous other users has been a challenge.

Stream	Number of Claims	Earliest Private Priority Date	Latest Private Priority Date	Earliest Public Priority Date	Latest Public Priority Date
Beaverhead River	963	1865	1998	1858 (BLM)	1985 (FWP)
Grasshopper Creek	171	1860	1967	1858 (BLM)	1985 (FWP)
Blacktail Deer Creek	338	1864	1973	1858 (BLM)	1985 (BLM)
Rattlesnake Creek	188	1865	1979	1865 (City of Dillon)	1906 (USFS)
Red Rock River	620	1870	1997	1858 (BLM)	2002 (BLM)
Little Sheep Creek	79	1885	1971	1906 (USFS)	1932 (State of MT)
Big Sheep Creek	65	1883	1982	1858 (BLM)	1985 (BLM, FWP)
Sage Creek	89	1883	1973	1858 (BLM)	1973 (State of MT)
Red Rock Creek	26	1900	1930	1888 (USFWS)	1999 (USFWS)
Horse Prairie Creek	295	1865	1973	1858 (BLM)	1985 (FWP)
Medicine Lodge Creek	70	1871	1970	1858 (BLM)	1985 (BLM)
Bloody Dick Creek	68	1865	1929	1906 (USFS)	1985 (FWP)

Figure 15. Water right claims for key streams in the Beaverhead Watershed and its headwaters.
Website: http://dnrc.mt.gov/divisions/water/water-rights/records-unit

Section 3: Operational and Administrative Framework

Overview

There are several government agencies and groups that have responsibilities related to the management of drought impacts to natural resources, and dissemination of drought related information. Each of the Federal agencies identified in this section are official Federal partners in the NDRP. Many state and Federal agencies have their own standardized drought decision making processes which are conducted in consultation with appropriate stakeholders. Interagency coordination groups offer opportunities for various agencies to share drought-related information that is then made available to the public at large. Individual agencies and interagency groups may also have documented procedures and/or work plans which direct their drought management activities. In many cases these procedural and planning documents articulate common resource concerns, goals, and resource management strategies. This DRP does not offer any additional operational or administrative framework other than a means to articulate drought vulnerabilities in the Beaverhead Watershed and its headwaters which the local community would like to address with the help of public and private expertise and resources.

Interagency Coordination Groups

Beaverhead County Drought Task Force

The DTF meets monthly from March through October of each year. The Beaverhead County DES coordinator organizes the meetings and the county commissioners host them at the Beaverhead County Courthouse in Dillon. Meetings are open to the public and are generally held on the second Monday of the month at 11:00 AM. Email invitations are sent out to contacts on the DTF email list the week prior to the meetings. These contacts include representatives of EBID/CCWSC, BWC, BCD, the City of Dillon, DNRC, FWP, MSU Extension, BLM, USFS, NRCS, FSA, fire management personnel, and local media. Each meeting consists of a slide show presentation about local drought conditions and outlooks prepared by the National Weather Service (NWS) Great Falls office; a report on reservoir storage and operations by EBID; an opportunity for any other agency personnel present to provide reports; and a question/discussion session. After the meetings, NWS presentations are posted on the BWC website for public consumption.

Joint Board of Control for Clark Canyon Dam

The Joint Board of Control for CCD is composed of three board members of EBID, three board members of CCWSC, and one representative from the BOR Montana Area Office in Billings. Their meetings are held at the EBID offices in Dillon and are open to the public. Meetings are commonly attended by FWP, and occasionally by BCD, BWC, DNRC, and NRCS. Each year they meet in March to set tentative irrigation allotments, in April to finalize irrigation allotments, in August to set tentative overwinter releases, and in September to finalize overwinter releases. They may also meet at other times during the summer to adjust allotments based on changes in hydrologic conditions. Operational decisions are made based upon guidelines articulated in EBID and CCWSC's 2006 repayment contract with BOR.

Montana Governor's State Drought Advisory Committee

The DAC meets monthly at 9:30 AM on the third Thursday of the month from April to October. These meetings are usually held in Helena, but participants are able to join the meeting online and on the phone. The meetings are organized and hosted by DNRC. The meetings always consist of presentations by personnel from NWS, NRCS Montana Snow Survey, BOR, USGS, and DNRC; and sometimes include presentations by FWP, FSA, MCO, MSU Extension, and ACE. Much of the information from the presentations given at DAC meetings is publicly disseminated via the NWS website http://www.wrh.noaa.gov/tfx/hydro/DGT.php?wfo=tfx and the DNRC drought website http://www.drought.mt.gov .

Southwest Montana Resource Advisory Committee

The Southwest Montana Resource Advisory Committee (RAC) covers Madison, Beaverhead, Jefferson, and Silver Bow counties and includes lands on the Beaverhead-Deerlodge, Helena, and Gallatin National Forests. RACs were established under the Reauthorization of the Secure Rural Schools and Community Self-Determination Act of 2000. Their role is to recommend how to allocate a portion of Federal funds that counties receive under the Act. The Act directs that funds be spend on projects that benefit National Forest lands such as

road, trail and infrastructure maintenance or obliteration; improvements in soil and forest ecosystem health; restoration and improvements of wildlife and fish habitat; control of weeds; and reestablishment of native animals and plants. RACS are comprised of 15 members made up of people from the general public, with representation from industry, environmental groups, elected officials, and other local interests. More information about the Southwest Montana RAC can be found here: http://www.fs.usda.gov/main/bdnf/workingtogether/advisorycommittees .

Western Governors' Association Drought Forum

Through the Western Governors' Drought Forum, WGA has collected best practices, case studies and the insights of western leaders on drought response and management. These resources are collected in the Drought Forum online resource library. Drought Forum participants have shared drought management strategies and other information during the initiative's first year of workshops and webinars. Seven key themes have emerged from the discussion, including: data and analysis; produced reused, and brackish water; forest health and soil stewardship; water conservation and efficiency; infrastructure and investment; working within institutional frameworks to manage drought; and communication and collaboration. More information about the WGA Drought Forum can be found here: http://www.westgov.org/initiatives/drought-forum .

NDRP Federal Partners

National Integrated Drought Information System

The NIDIS Program Office is housed at NOAA's Earth System Research Laboratory in Boulder, Colorado. NIDIS assists with nationwide drought planning, monitoring, analysis, and publication of the USDM. NIDIS has also participated in the NDRP effort in the Upper Missouri Basin by assisting with drought early warning systems workshops and drought planning training webinars for watershed groups in southwest Montana. More information about NIDIS can be found here: https://www.drought.gov/drought/ .

National Oceanic and Atmospheric Administration

NOAA plays a key role in monitoring, forecasting, and researching the behavior of the ocean, weather, and climate. NIDIS and NWS are both part of NOAA. The NWS Office in Great Falls serves Beaverhead County and is a regular contributor to DTF and DAC meetings. NOAA's drought information page can be found here: http://www.cpc.ncep.noaa.gov/products/Drought/ .

NOAA's Western Regional Climate Center (WRCC) delivers climate services at regional and state levels working with NOAA partners in the National Climatic Data Center, NWS, the American Association of State Climatologists, the Regional Sciences and Assessment Program, and other NOAA Research Institutes. It also partners with the Department of Interior Climate Science Centers and Landscape Conservation Cooperatives. WRCC's mission is to act as a repository of historical climate data and information; disseminate high quality climate data and information pertaining to the western U.S.; engage in applied research related to climate issues; and improve the coordination of climate-related activities at state, regional and national scales. This effort has resulted in jointly developed products, services, and capabilities that enhance the delivery of climate

information to the American public. As NOAA and Congress work to help society adapt to climate and its variations, these collaborative efforts form a framework for a comprehensive suite of activities encompassing service, data stewardship, and applied research components. More information about WRCC can be found here: http://www.wrcc.dri.edu/ .

NOAA's Regional Integrated Sciences and Assessments (RISA) program supports research teams that help expand and build the nation's capacity to prepare for and adapt to climate variability and change. RISA teams work with public and private user communities to advance understanding of context and risk; support knowledge to action networks; innovate services, products and tools to enhance the use of science in decision making; and advance science policy. The NOAA RISA which serves the Beaverhead Watershed and its headwaters is called the Climate Impacts Research Consortium (CIRC) and includes researchers from Oregon State University, the University of Oregon, the University of Washington, and the University of Idaho. More information about CIRC can be found here: http://pnwcirc.org/ .

Bureau of Reclamation

BOR's Montana Area Office in Billings manages CCR and is responsible for providing hydrologic and climate data and forecasts to EBID and CCWSC to support water supply decision making processes. That office also regularly contributes to DTF and DAC monthly meetings.

BOR is also currently working on the Upper Missouri Basin Climate Impacts Assessment. This study is being conducted as a baseline assessment to support the Missouri River Headwaters Basin Study in Montana. The focus of the Impacts Assessment is to develop a regional water planning model, which will be used as the basis for analysis of imbalances in water supply and demand, and subsequent evaluation of proposed alternatives to reduce any identified imbalances as part of the Missouri Headwaters Basin Study. This Impacts Assessment will provide a foundation for future collaborative efforts, including the Missouri Headwaters Basin Study and drought resiliency planning efforts. More information can be found at http://www.usbr.gov/watersmart/wcra/impacts.html .

U.S. Geological Survey

USGS is a key provider of surface water data in Montana. USGS surface water data is used for decision making processes by several stakeholders and agencies in the Beaverhead Watershed including BOR, ACE, FWP, EBID/CCWSC, other irrigators, and anglers and outfitters. USGS's Wyoming-Montana Water Science Center has its main Montana office in Helena. http://wy-mt.water.usgs.gov/index.html .

USGS also has the Northern Rocky Mountain Science Center (NOROCK) office, which is co-located with Montana State University in Bozeman. NOROCK is part of the Northwest Region of the USGS. Scientists from the Center work in the northern Rocky Mountains and throughout the western U.S. researching climate change, aquatic ecology, wildlife diseases, bison ecology, and large carnivores. Researchers work with partners from the Department of the Interior including USFS, BLM, BOR, National Park Service, and the U.S. Fish and Wildlife Service. Researchers also work in collaboration with state resource agencies throughout the U.S. More information about NOROCK can be found at http://www.nrmsc.usgs.gov/ .

U.S. Fish & Wildlife Service

USFWS manages Red Rock Lakes National Wildlife Refuge from their offices at Lakeview in the Centennial Valley. The Refuge is a critical area in the headwaters of the Beaverhead Watershed because it is a major source of water supply, provides habitat for highly sensitive species such as Arctic grayling and trumpeter swan, and has some ability to accommodate multiple beneficial uses of resources such as livestock grazing and commercial timber harvest. More information about the Red Rock Lakes National Wildlife Refuge can be found at http://www.fws.gov/refuge/Red_Rock_Lakes/ .

Bureau of Land Management

BLM's Dillon Field Office manages over 900,000 acres of public land in Beaverhead and Madison Counties. The office has a mandate to ensure that the land under its jurisdiction is safely and sustainably managed. To that end, BLM works seasonally with individual permittees that graze livestock on BLM lands to verify that the stocking density and duration of grazing permitted for each grazing allotment is appropriate for the condition of the range. These determinations are based upon range conditions and trends which are influenced by climate, hydrology, and previous land management. The BLM Dillon Field Office also conducts watershed assessments on a rotating ten-year schedule to evaluate longer term trends in the health of riparian and upland areas. These watershed assessments are available on the BLM Dillon Field Office's website. Documents detailing the BLM's official policies for administering public lands grazing and resource management during drought are also available upon request from the Dillon Field Office: http://www.blm.gov/mt/st/en/fo/dillon_field_office.html .

U.S. Forest Service

Portions of the Beaverhead-Deerlodge National Forest that are within the Beaverhead Watershed and its headwaters are managed by the USFS Dillon Ranger District Office. The USFS's Dillon offices also house the Forest Supervisor's Office and the Dillon Interagency Dispatch Center. The Dillon Ranger District is responsible for managing fisheries, wildlife, livestock grazing, wildfire mitigation, and timber harvest on USFS lands. The Dillon Interagency Dispatch Center is responsible for coordinating wildfire detection and fire crew dispatch for several agencies including USFS, BLM, BOR, USFWS, DNRC and Beaverhead and Madison Counties. More information about the Beaverhead-Deerlodge National Forest can be found at http://www.fs.usda.gov/main/bdnf/home .

Natural Resource Conservation Service

The NRCS Montana Snow Survey team operates out of the state office in Bozeman and provides information about snowpack conditions and runoff forecasts to EBID, CCWSC, BOR, DTF, and DAC. One notable product provided by NRCS Montana Snow Survey is the monthly Surface Water Supply Index (SWSI) map of major watersheds in Montana. SWSI is a measure of surface water availability for the upcoming months and accounts for mountain snowpack, mountain precipitation, streamflow, reservoir storage, and soil moisture. The NRCS Montana Snow Survey website can be found at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/mt/snow/ .

The NRCS Dillon Field Office offers services for range management, stock water development, irrigation infrastructure design and repair, irrigation efficiency management, and environmental quality incentives.

Farm Service Agency

FSA's Dillon Field Office offers a range of drought relief assistance programs to producers including emergency farm loans, noninsured crop disaster assistance, Federal crop insurance, the emergency conservation program, emergency haying and grazing, forage disaster assistance, and emergency stock water. Some of these aid programs are triggered by thresholds related to duration and severity of drought conditions according to the USDM. Questions about FSA's drought assistance programs and eligibility should be directed to the FSA's Dillon Field Office: http://www.fsa.usda.gov/FSA/stateoffapp?mystate=mt&area=home&subject=landing&topic=landing .

USDA Northern Plains Regional Climate Hub

The USDA Northern Plains Regional Climate Hub covers the Beaverhead Watershed and its headwaters and is located at the Agricultural Research Service Plains Area Office in Fort Collins, Colorado. The Hub delivers science-based knowledge and practical information to farmers, ranchers, forest landowners to help them to adapt to climate change and weather variability by coordinating with local and regional partners in Federal and state agencies, NGO's, private companies, and Tribes. The Hub provides technical support for land managers to respond to drought, heat stress, floods, pests, and changes in growing season; assessments and regional forecasts for hazard and adaptation planning to provide more time to prepare; and outreach and education for farmers, ranchers, and forest landowners on ways to mitigate risks and thrive despite change.

Environmental Protection Agency

The Beaverhead Watershed and its headwaters fall within EPA's Region 8, which is headquartered in Denver, Colorado. EPA's nexus to drought management is water quality protection. EPA grant funding opportunities, such as CWA Section 319 funding, may be used to mitigate water quality impairments that can be exacerbated during drought conditions. EPA also offers assistance with drinking water quality protection through its Source Water Assessment Program.

Federal Emergency Management Agency

The Beaverhead Watershed and its headwaters fall within FEMA's Region 8, which is headquartered in Denver, Colorado. FEMA has the ability to distribute funding for drought and wildfire response through its Hazard Mitigation Grant Program, as well as funding for drought and wildfire mitigation through its Pre-Disaster Mitigation Grant Program: http://www.fema.gov/pre-disaster-mitigation-grant-program .

U.S. Army Corps of Engineers

ACE's Omaha District Headquarters is responsible for managing flood control in the Missouri River Basin. ACE's regulatory offices in Helena and Billings may become involved with drought management in Beaverhead County through the CWA Section 404 "dredge and fill" permitting process. The Omaha District Headquarters may assume management control over CCR from BOR due to reservoir storage reaching the exclusive flood control pool elevation. More information on how ACE manages drought can be found at http://www.usace.army.mil/Missions/EmergencyOperations/Drought.aspx .

National Drought Mitigation Center

The NDMC is based out of the University of Nebraska-Lincoln. Its mission is to help people and institutions develop and implement measures to reduce societal vulnerability to drought, stressing preparedness and risk management rather than crisis management. It offers several drought monitoring products including the USDM, the Drought Risk Atlas, as well as the Drought Impact Reporter. NDMC has been involved in the development and implementation of the NDRP demonstration project both at the national level, and within the Upper Missouri Basin of Montana. The NDMC homepage can be found at http://drought.unl.edu/Home.aspx .

State Agencies

Montana Department of Natural Resources & Conservation

DNRC's headquarters and its water resources regional office that serves Beaverhead County are both located in Helena. The Helena water resources regional office administers water rights in the Beaverhead Watershed according to the prior appropriation doctrine, and is currently in the process of adjudication for all pre-July 1, 1973 water rights. DNRC Headquarters also gathers and disseminates statewide drought information through the DAC and its drought website. The DNRC Dillon Unit manages forestry, fire, and grazing on DNRC lands in the Beaverhead Watershed and its headwaters. DNRC also administers several grants that can be used to promote drought resiliency.

Montana Department of Fish, Wildlife and Parks

FWP's headquarters are in Helena, the Region 3 offices covering the Beaverhead Watershed and Upper Missouri Basin are in Bozeman, and there is a field office located in Dillon.

FWP's Fisheries Program is tasked with balancing the wellbeing of Montana's aquatic ecosystems with public access to recreational opportunities. Drought impacts to aquatic ecosystems may include reductions in available habitat, increased water temperatures, increased stress on fisheries, and increased predation rates. FWP has established stream flow and temperature thresholds to guide decisions to close and re-open streams to angling.

Drought conditions can create shifts in distribution of wildlife populations, diminished forage production, and restricted access to habitat and migration corridors due to wildfire. Based on these impacts, FWP's Wildlife Division may make adjustments to hunting access and game species harvest quotas, and in extreme cases, may

implement emergency winter-feeding measures for big game species. More information about FWP's policies regarding drought can be found at http://fwp.mt.gov/fishAndWildlife/habitat/fish/waterManagement/drought.html .

Montana Department of Environmental Quality

DEQ's nexus to drought management is water quality protection. DEQ performs water quality sampling throughout the Beaverhead Watershed and analyzes the data to produce Total Maximum Daily Load standards (TMDLs). These TMDLs are incorporated into the BWC's Beaverhead Watershed Restoration Plan which identifies projects and strategies to mitigate water quality impairments which may become exacerbated during drought. These projects and strategies are implemented using CWA 319 funding, which is administered by DEQ in the State of Montana. More information on DEQ's water quality protection policies and efforts can be found at http://deq.mt.gov/Water .

Montana Bureau of Mines & Geology

Montana Bureau of Mines and Geology (MBMG) is a department of Montana Tech of the University of Montana in Butte, and has a mandate to collect and publish information on Montana's geology to promote orderly and responsible development of the energy, groundwater, and mineral resources of Montana. A non-regulatory state agency, the MBMG provides extensive advisory, technical, and informational services on Montana's geologic, mineral, energy, and water resources. The MBMG is increasingly involved in studies of the environmental impacts to land and water caused either by past practices in hard-rock mining or by current activities in agriculture and industry. MBMG has done groundwater studies on the lower Beaverhead River and on Blacktail Deer Creek. More information about MBMG can be found here: http://www.mbmg.mtech.edu/ .

Montana Climate Office

MCO is based out of the University of Montana in Missoula and is an independent state-designated body that provides Montanans with climate information and services. The State of Montana recognizes MCO as the official steward of climate information for Montana. MCO employs the Montana State Climatologist who is a regular participant in DAC meetings, and has also been involved in the NDRP effort in Montana. More information about MCO can be found here: http://www.climate.umt.edu/ .

Montana State University Extension Service

MSU Extension Service provides unbiased research-based education and information that integrates learning, discovery and engagement to strengthen the social, economic and environmental well-being of individuals, families, and communities. MSU Extension agriculture and natural resources programs apply university research and resources to help Montana agricultural producers and land owners increase profits, reduce loss, protect food supply and sustain natural resources. More information about MSU Extension can be found here: http://www.msuextension.org/ .

MSU Extension is a participant in WERA 1020, Western Water Resources, which is a Western Education/Extension and Research Activity (WERA) Project formed in 2012 as a mechanism to continue efforts and programs previously conducted under the USDA-National Institute of Food and Agriculture Regional Integrated Water Program, which has been discontinued. WERA 1020 integrates water resources research, teaching, and outreach in the western U.S. It's goals are to develop new multidisciplinary approaches to address water challenges specific to the West; develop new collaborative research and extension projects and programs that fit the needs of the western region to enhance and protect our water resources; increase awareness and knowledge of water quality issues and tools by Master Gardeners and Master Naturalists, conservation districts, landscapers, watershed managers, NRCS Technical Service Providers, and others; increase adoption and use of best management practices for water quality by farmers, ranchers, institutions and municipalities, range managers, custodians of natural areas, landscape professionals, homeowners, and others; increase adoption of water conservation measures and practices in western watersheds; and improve food and water security in the West. More information about WERA can be found here: http://werawater.org/ .

Local Government

Beaverhead County Disaster & Emergency Services

Beaverhead County DES is based in Dillon and is an integrated effort to prevent or minimize the seriousness of emergencies and disasters and to plan and coordinate the community's response to those emergencies and/or disasters. It requires establishing partnerships among emergency response and management personnel to prevent, respond to, recover from and mitigate emergencies and disasters. Coordination is a key factor of the emergency management program to protect lives, property and resources.

As part of this integrated effort, the Beaverhead DES coordinator helps to plan and organize DTF meetings. DES also plays an important role in coordination and mobilization of wildfire response, which is especially important during drought. More information about disaster mitigation in Montana can be found here: http://letsmitigatemontana.com/ .

Beaverhead Conservation District

BCD is composed of locally elected representatives from Beaverhead County and is responsible for administering the state 310 permitting process. Any private, nongovernmental individual or entity that proposes any activity that physically alters or modifies the bed or banks of a perennially flowing stream on public or private land must first acquire a 310 permit from the local conservation district, according to Montana state law. A person planning a project must contact the conservation district office to obtain a permit application prior to any activity in or near a perennial-flowing stream. Once an application is accepted, a team that consists of a conservation district representative; a Montana Fish, Wildlife & Parks biologist; and the applicant may conduct an on-site inspection. The team makes recommendations to the conservation district board, which has 60 days from the time the application is accepted to approve, modify, or deny the permit. BCD votes on 310 permit approval at its monthly public meetings which are held on the third Thursday of each month at the USFS building in Dillon. During drought, there may be a spike in the number of 310 permit applications submitted to BCD because low stream flows can cause disruptions to irrigation diversions.

In addition to this standard function, BCD is also involved in other soil and water conservation and education efforts. In 2015 and 2016, BCD and its subcommittee, BWC, hosted an AmeriCorps-Big Sky Watershed Corps member with funding support from BOR to work on drought resilience as part of the NDRP. This assistance enabled the development of this DRP.

Beaverhead County Extension

The Beaverhead County Extension Service is linked to MSU Extension and provides the citizens of Beaverhead County with research based knowledge and information. The Beaverhead County Extension office is a resource for: livestock and cropping questions, yard and garden questions, noxious weed identification and recommendations, bug and spider identification, and DNRC conservation seedlings. It also provides services in soil testing, forage nitrate testing, weed free hay certifications, private pesticide applicator licensing and training, and beef quality assurance certifications. It supports the community's youth and their leadership development through 4-H programming. More information about Beaverhead County Extension can be found here: http://www.beaverheadcounty.org/html/extension_agent.html .

Procedural and Planning Documents

Beaverhead County Pre-Disaster Mitigation Plan

The Beaverhead County Pre-Disaster Mitigation Plan (PDM) was previously updated in 2009 under the authority of Beaverhead County, the City of Dillon, and the Town of Lima. It is currently being updated in 2016. The 2009 PDM rates wildfire as a high hazard priority, and drought as a moderate hazard priority. This DRP is recommended for adoption by Beaverhead County and the City of Dillon as an appendix to the 2016 PDM revision. Local governments with adopted PDMs are eligible to receive funding for hazard mitigation projects from FEMA's Pre-Disaster Mitigation Grant Program, which in 2016 has a budget of $100 million. The 2009 Beaverhead County PDM can be found at http://letsmitigatemontana.com/wp-content/uploads/2013/05/BeaverheadCountyPDMPlanSept2009.pdf.

Beaverhead County Public Land's Resource Use Policy and Plan

In the case of Federally managed lands, managers are required, to varying degrees, to ensure that management, planning, and decision making are consistent with local government plans, policies, and ordinances. The 2010 Beaverhead County Public Land's Resource Use Policy and Plan reflects the County's position on the management and use of public lands within the County or that impact the County's interests. The plan clearly and concisely states the County policies, goals and objectives that relate to Federal and state public land management, planning efforts, and decision-making processes. The intent of this plan is to protect the interest of the County, its customs and culture, the health and safety of its residents, and to communicate County interest and concerns regarding management of public lands to the appropriate agency. It is designed to ensure that the spirit and intent of the laws, regulations and policies that govern management and use of public lands are followed and to provide a basis for productive communication, consistency review, and analysis. The plan is intended to be a guide to the County so it may provide consistent input on planning and management

decisions on public lands. This plan can be found here: http://www.beaverheadwatershed.org/wp-content/uploads/2015/08/Beaverhead-County-Public-Land-Resource-Use-Plan-2010.pdf .

Beaverhead County Wildfire Protection Plan

The 2005 Beaverhead County Wildfire Protection Plan (CWPP) identifies conditions and characteristics of the environment and human activities within Beaverhead County that affect the potential of severe wildfire. It acknowledges that drought is the primary condition that influences the level of wildfire hazard. It assesses wildfire risk factors related to population density and distribution, travel corridors and destinations, wildfire patterns, structure ignitability, and fire protection infrastructure. Its wildland-urban interface (WUI) risk assessment of the eight planning areas within the county identifies the Red Rock-Beaverhead River Corridor, the Pioneer Mountains, and the southern Centennial Valley as being the areas with greatest overall risk. The Beaverhead CWPP can be viewed here: http://dnrc.mt.gov/divisions/forestry/docs/fire-and-aviation/wui/beaverhead_cwpp.pdf

Dillon Interagency Dispatch Local Mobilization Guide / Dispatch Operating Plan

This 2015 plan articulates how BLM, USFS, and DNRC work together to respond to wildfire and other emergencies in Beaverhead County. It describes organizational frameworks, dispatch operations, daily duties, initial attack/response plan elements, emergency operations, local agreements, communications, and many other aspects of interagency fire management. This plan can be viewed here: http://gacc.nifc.gov/nrcc/dc/mtddc/dispatch/2015MobGuideWholeDocumentAppendixP.pdf .

EBID-CCWSC Drought Management Plan

EBID and CCWSC's 2006 repayment contract with BOR articulates a drought management plan which directs specific incremental reductions to irrigation allotments based upon August end-of-month (EOM) CCR storage forecasts which are provided by BOR, NRCS Montana Snow Survey, and ACE. Decisions regarding reductions to irrigation allotments are made tentatively in March and finally in April. BOR does allow EBID and CCWSC to increase irrigation allotments according to the drought management plan during the summer if favorable hydrologic conditions yield sufficiently improved August EOM CCR storage forecasts. In addition, the drought management plan, the 2006 repayment contract also articulates guidelines for establishing overwinter releases out of CCR. These overwinter release guidelines are also based on BOR seasonal water supply forecasts and are made in consultation with FWP. The 2006 repayment contract can be viewed here: http://www.beaverheadwatershed.org/wp-content/uploads/2015/09/EBID.CCWSC-Repayment-Contract-2004.pdf .

EBID and CCWSC Water Conservation Plans

These plans detail the histories, users, infrastructure, water management protocol, resource concerns, and future needs of these two groups of irrigators. Both plans were last updated in 2004 and have been recommended by BOR for update.

Beaverhead Watershed Restoration Plan

The Beaverhead Watershed Restoration Plan (WRP) was written by the BWC and is designed to systematically protect and restore water quality in the Beaverhead Watershed. Creation of a WRP is one of the requirements for groups receiving grants under Section 319 of the Federal Clean Water Act, which is administered by EPA. In Montana, DEQ manages the EPA grants. The WRP is a comprehensive assessment that identifies nonpoint source pollution, its sources, its effects, and outlines a set of strategies to measure and mitigate each. During drought, water quality impairments can be exacerbated due to increased concentration of contaminants and/or high stream temperatures. The Beaverhead WRP has proven to be an effective tool for mitigating these threats to aquatic ecosystems and water supply by implementing projects such as culvert replacement, bank stabilization, riparian revegetation, channel restoration, and stock water fencing. The Beaverhead WRP can be viewed online at: http://www.beaverheadwatershed.org/wp-content/uploads/2015/09/Beaverhead-Watershed-Restoration-Plan-2013.pdf .

Montana DNRC State Water Plan and Upper Missouri Basin Advisory Council Report

DNRC's 2015 State Water Plan provides a broad overview of Montana's water resources and lays out a path for managing those resources over the next twenty years. It articulates several goals related to expanded monitoring of water availability and improved climate forecasting. The process of assembling the State Water Plan included convening and consulting basin advisory councils (BACs). Each BAC has published recommendation development reports. This basin planning effort was developed by a diverse group of local irrigators; conservation NGOs; and hydrologists, geologists, biologists, and water rights experts from the local, state, and Federal levels. The process for developing recommendations included public comment periods. Like the Montana State Water Plan, this Upper Missouri BAC report prioritizes expanding monitoring of water availability and improved climate forecasting. Both the Montana State Water Plan and the Upper Missouri BAC Recommendations Development Report take climate change into account. These documents are available on DNRC's website: http://dnrc.mt.gov/divisions/water/management/state-water-plan .

Upper Missouri Drought Resilience Work Plan

As part of the NDRP there were several meetings and workshops in 2015 attended by local, state, and Federal government employees, local watershed groups and stakeholders, and NGOs. The discussions at these meetings and workshops were distilled and compiled into the draft Upper Missouri Drought Resilience Work Plan. The overarching goals of the Work Plan are to build and engage communities for drought planning; provide the tools for drought monitoring, assessment, and forecasting; and initiate local projects to build regional drought resiliency. For information about the development of the Upper Missouri Drought Resilience Work Plan visit: http://www.drought.gov/drought/news/upper-missouri-river-basin-building-drought-early-warning-capability .

BLM Dillon Resource Management Plan

The 2006 BLM Dillon Resource Management Plan is the base land use plan for public lands administered by the BLM's Dillon Field Office. It aims to guide that office's efforts to sustain and where necessary restore the health and diversity of forest, rangeland, aquatic and riparian ecosystems; support a sustainable flow of benefits

in consideration of the social and economic systems of southwest Montana; and provide diverse recreational and educational opportunities. All of these goals have implications for drought resilience in the Beaverhead Watershed and its headwaters. The BLM Dillon Resource Management Plan can be found at http://www.blm.gov/mt/st/en/fo/dillon_field_office/rmp/rod.html

BLM Watershed Assessments

The BLM Dillon Field Office's Watershed Assessments comprehensively evaluate the condition and trends of the landscapes under its jurisdiction, and offers management alternatives to improve landscape health and function. Issues addressed in BLM Watershed Assessments include health of riparian, wetland, and aquatic habitat; health of upland and sagebrush steppe habitat; health of forest and woodland habitat; and health of special status species habitat. Resource concerns with implications for drought resiliency that are addressed include fish, wildlife and special status species habitat; noxious and invasive species; wilderness characteristics; wildland-urban interface; recreation and travel management; and socioeconomics. BLM Watershed Assessments can be found at http://www.blm.gov/mt/st/en/fo/dillon_field_office.html.

Watershed	Assessment Year
Beaverhead West	2007
Red Rock/Lima	2007
East Bench	2008
East Grasshopper	2011
Medicine Lodge	2011
Upper Horse Prairie	2012
Centennial Valley	2014
Sage Creek	2015
Big Sheep Creek	2015
Blacktail	2006, 2016

Figure 16. BLM Watershed Assessments for the Beaverhead Watershed and its headwaters. Website: http://www.blm.gov/mt/st/en/fo/dillon_field_office.html

USFS Beaverhead-Deerlodge National Forest Plan

Guidance for all resource management activities of USFS National Forest lands in the Beaverhead Watershed and its headwaters are established in the 2009 Beaverhead-Deerlodge Forest Plan. It articulates goals, objectives, and standards for aquatic resources, economic and social values, fire management, livestock grazing, soils, timber management, vegetation, and wildlife habitat; all of which have implications for drought resiliency in Beaverhead County. The Beaverhead-Deerlodge Forest Plan can be found here: http://www.fs.usda.gov/detail/bdnf/landmanagement/planning/?cid=fsm9_003360 .

Red Rock Lakes National Wildlife Refuge Comprehensive Conservation Plan

The Red Rock Lakes National Wildlife Refuge 2009 Comprehensive Conservation Plan sets the management and use of the Red Rock Lakes National Wildlife Refuge for 15 years. Major actions in the 2009 Comprehensive Conservation Plan include maintain high productivity in wetlands to benefit nesting and migrating trumpeter swans and other waterfowl; restoration of two modified wetlands back to a free-flowing, historical spawning stream Arctic grayling; increase opportunities for environmental education and interpretation to better orient visitors to the values of the refuge and the Centennial Valley; and provide and expand opportunities for quality hunting and fishing experiences while ensuring that trumpeter swans and other priority migratory birds have protected resting areas. The 2009 Comprehensive Conservation Plan can be found here: http://www.fws.gov/mountain-prairie/planning/ccp/mt/rrl/rrl.html .

National Drought Forum Report

In December 2012, high-ranking representatives from several Federal agencies and governors' associations held the National Drought Forum to focus on improving government coordination to support the planning and preparedness needed for enhancing resilience to ongoing or recurring drought. One impetus of the Forum was the drought of 2012 which saw most of the Great Plains and Intermountain West afflicted by severe to exceptional drought conditions, including the Beaverhead Watershed and its headwaters. The NDRP and this DRP are direct outcomes of the National Drought Forum. The report can be viewed here: http://www.drought.gov/media/pgfiles/2012-droughtForumFullReport.pdf .

Section 4: Drought Monitoring

Overview

The primary hydrologic factors that are currently used for drought monitoring in Beaverhead County include snow water equivalent (SWE), streamflow, reservoir storage, and precipitation. Other factors including air temperature, stream temperature, soil moisture, and weather forecasts are also used to assess current and future drought conditions. There are three commonly used drought indices which account for multiple hydrologic and climatological factors to provide broad spatial assessments of drought conditions on a weekly to monthly basis. These include the USDM, the Surface Water Supply Index (SWSI), and the Montana County Water Supply and Moisture Status. All drought monitoring information is disseminated online through agency websites, such as the NWS and DNRC drought webpages. Much of it is also disseminated at the monthly meetings of the DTF and DAC which are open to the public. Contact information for agency personnel responsible for managing climate and hydrology monitoring networks can be found in Appendix A.

Snowpack

The NRCS Montana Snow Survey team in Bozeman maintains an automated network of high-elevation Snow Telemetry (SNOTEL) sites in and around the Beaverhead Watershed and its headwaters. There are also three snow course sites that are checked manually, often by local volunteers. Snow course volunteers typically take

measurements during the last week of each month from February to April. Volunteers have come from the Centennial Valley Association (CVA), The Nature Conservancy (TNC), UMW, BCD, NRCS, USFS and USFWS employees at Red Rock Lakes National Wildlife Refuge. All SNOTEL and snow course sites measure snow depth and SWE.

SNOTEL Sites	Snow Course Sites
Beagle Springs	Dad Creek Lake**
Bloody Dick	Elk Horn Springs
Darkhorse Lake*	Lakeview Canyon
Divide	
Lakeview Ridge	
Lemhi Ridge	
Mule Creek*	
Tepee Creek*	
White Elephant*	

Figure 17. List of SNOTEL and snow course sites with good correlation to water supply in the Beaverhead Watershed and its headwaters. *Denotes sites that are technically outside the watershed boundaries. **NRCS Montana Snow Survey has been working with USFS to convert Dad Creek Lake site from a snow course to an automated SNOTEL station by 2017.
Website: http://www.nrcs.usda.gov/wps/portal/nrcs/main/mt/snow/

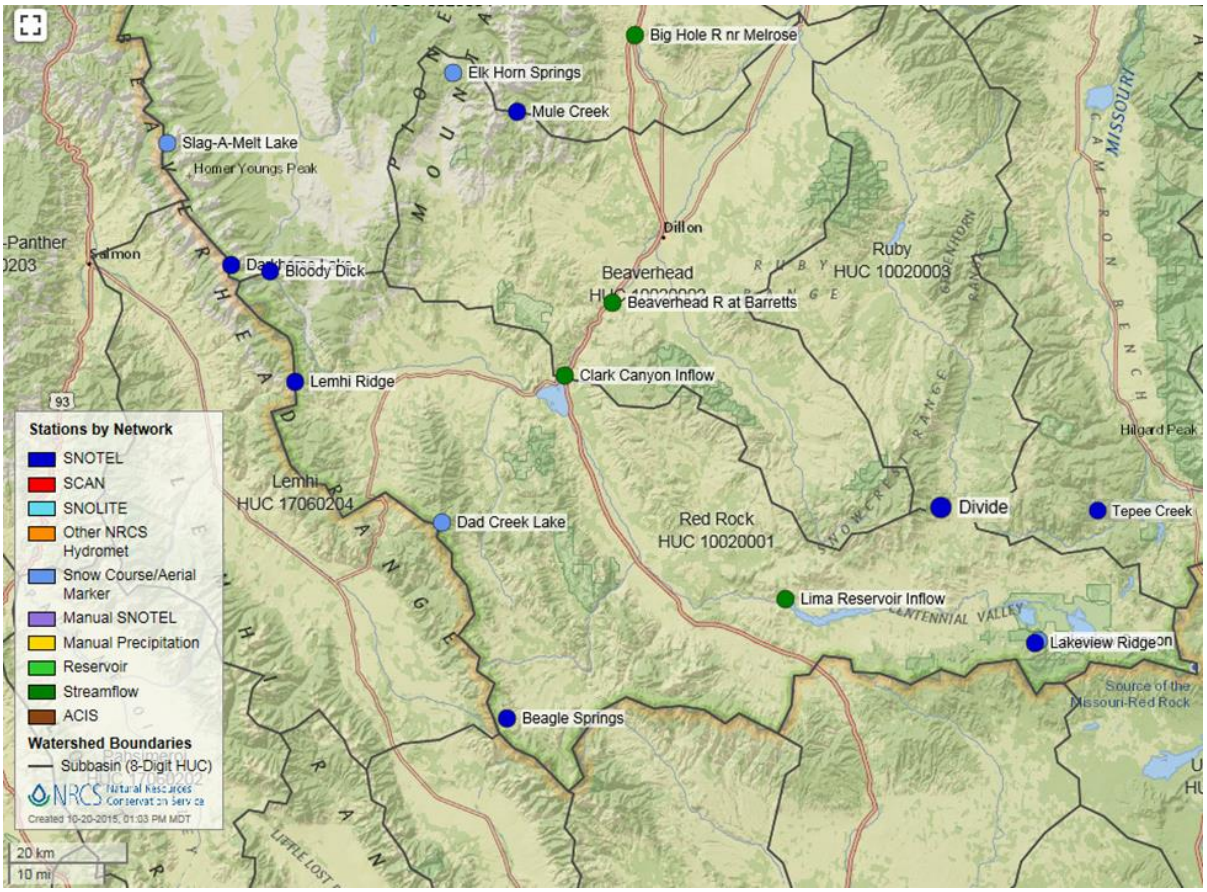


Figure 18. Map of NRCS SNOTEL (dark blue), snow course (light blue), and USGS streamflow (green) monitoring stations. Website: http://www.nrcs.usda.gov/wps/portal/nrcs/main/mt/snow/

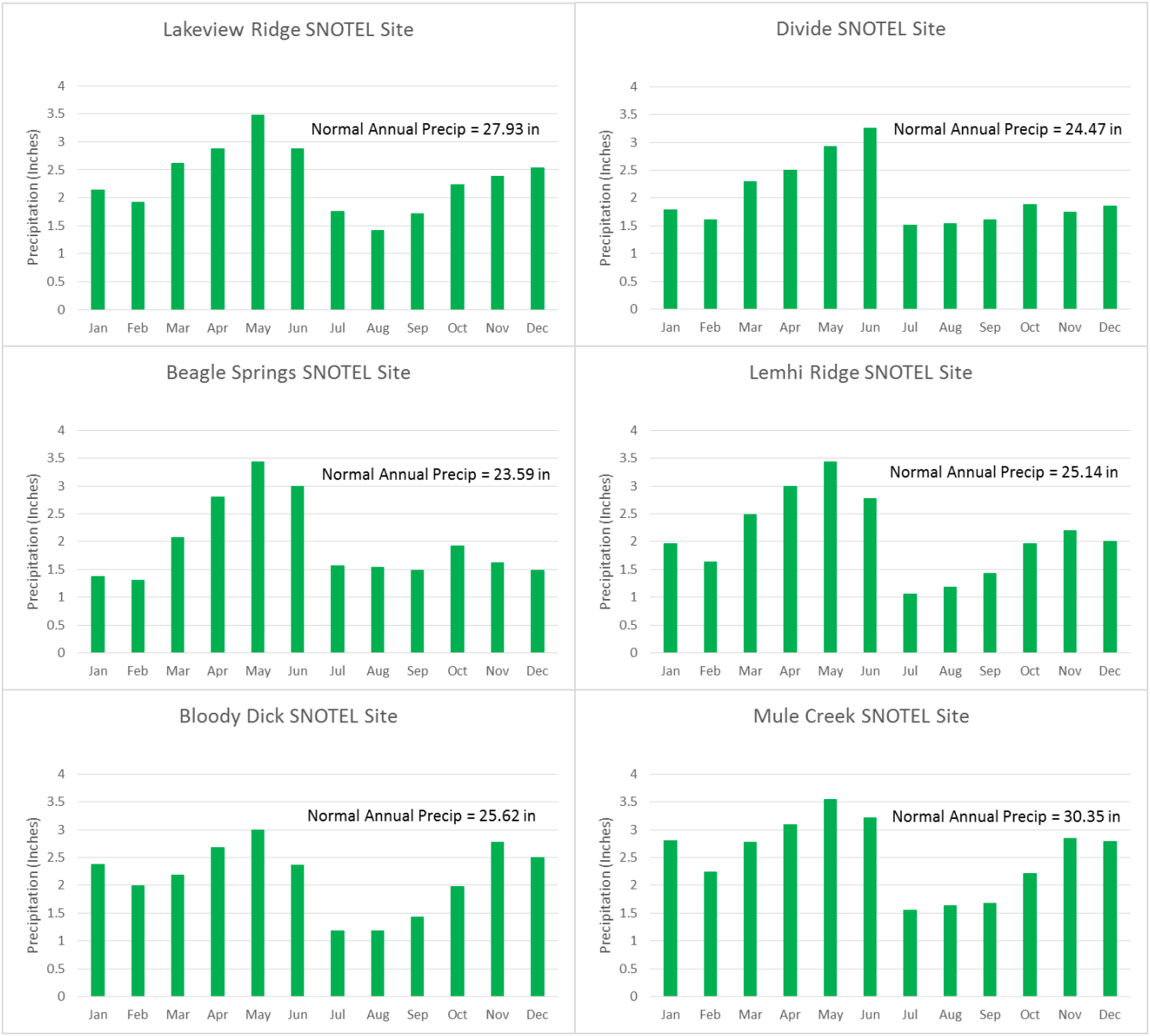


Figure 19. 1981-2010 normal monthly precipitation for high-elevation NRCS SNOTEL sites at Lakeview Ridge, Divide, Beagle Springs, Lemhi Ridge, Bloody Dick, and Mule Creek.

Snowpack Monitoring Needs:

1. Convert snow course sites at Dad Creek Lake, Elk Horn Springs, and Slag-A-Melt Lake to automated SNOTEL sites.
2. Maintain a consistent and reliable volunteer network for snow course monitoring at Lakeview Canyon.
3. Train local citizens with CoCoRaHS rain gauges to measure and report snow accumulation to improve density of data points across valley areas and develop period of record data.

Streamflow

USGS is the primary source for streamflow information in the Beaverhead Watershed. The USGS hydrologic unit code (HUC) for the Beaverhead Watershed is 10020002. The HUC for the Red Rock Watershed is 10020001. There are six USGS stream gaging stations along the Beaverhead and Red Rock Rivers which measure gage height and discharge.

USGS Site Number	USGS Site Name
06006000	Red Rock Creek above Red Rock Lakes near Lakeview
06012500	Red Rock River below Lima Reservoir near Monida
06016000	Beaverhead River at Barretts Diversion
06017000	Beaverhead River at Dillon
06018500	Beaverhead River near Twin Bridges
06023100	Beaverhead River at Twin Bridges*

Figure 20. USGS gaging stations on the Beaverhead and Red Rock Rivers. *Denotes sites that are only active during irrigation season. Website: http://waterdata.usgs.gov/mt/nwis/current/?type=flow&group_key=basin_cd

BOR maintains two Hydromet stream gages in the Beaverhead Watershed. One is located on Grasshopper Creek near Bannack State Park, and the other is located on the Beaverhead River at Giem Bridge, which is just south of Twin Bridges. The Grasshopper Creek gage is important because the Grasshopper Creek drainage includes some of the highest elevations in the Beaverhead Watershed, and its flows join the Beaverhead River between CCD and Barretts Diversion Dam. This means that these flows cannot be stored but they can be diverted into the East Bench Canal for irrigation. Therefore, this gage can be used to inform conservation of reservoir storage. The 2004 EBID Water Conservation Plan specifically notes the importance of maintaining the functionality of this Grasshopper Creek Hydromet gage. The Giem Bridge gage is important because it marks the boundary between two decrees and is used to verify that EBID is delivering adequate flows to downstream users according to Montana state water law. BOR Hydromet data can be found here: http://www.usbr.gov/gp/hydromet/sites_mt.htm .

DNRC plans to expand its state supported network of stream gaging stations in the coming years. Currently there are no DNRC gaging stations in the Beaverhead Watershed. BWC has requested that DNRC add the lower Red Rock River and lower Horse Prairie Creek to the priority list of future stream gaging sites.

Streamflow Monitoring Needs:

1. Install real-time stream gaging stations on Red Rock River and Horse Prairie Creek. These stations will help improve BOR and NRCS modeling and forecasting of snowpack runoff and reservoir storage. More detailed information about this monitoring need can be found in Sections 5 and 6.
2. Build a rating curve for the BOR Hydromet gaging station on Grasshopper Creek at Bannack. This gage is important because it can be used to inform CCR operations and conserve reservoir storage. The gage was knocked out of service by a flood event in 2011. It was serviced in the summer of 2015 and spring of 2016 and now just needs a rating curve built in order to be fully functional.
3. Ensure that the BOR Hydromet gage on the Beaverhead River at Giem Bridge is in proper working condition. Although it appeared to be in functional condition upon last check in summer 2015, it had been heavily impacted by exposure to livestock and weather. This location is important because EBID and CCWSC use the information to ensure that they are fulfilling a downstream decree.
4. Re-establish a gaging station on the Beaverhead River at Anderson Lane. This gaging station was abandoned years ago and CCWSC has expressed interest in its resurrection. The abandoned station may still have some usable components that could reduce the cost of installation. Revival of this gaging station will inform water rights administration and improve system efficiency.
5. Install a stream gaging station on the Beaverhead River near the headgate for Poindexter Slough. A recent Poindexter Slough restoration project included channel reconstruction and the installation of a larger headgate to divert flows from the Beaverhead River. A stream gage in this vicinity would help CCWSC adapt to these changes and better manage irrigation deliveries.
6. Train local stakeholders on basic maintenance and troubleshooting for stream gaging stations. This can reduce delays and expenses associated with stream gage network maintenance. Options for local troubleshooters may include local employees of BOR, FWP, DNRC, EBID/CCWSC, BLM, USFS, and NRCS.

Reservoir Storage

The two largest reservoirs in the Beaverhead Watershed and its headwaters are CCR and Lima Reservoir. CCR is owned and operated by BOR in conjunction with EBID and CCWSC. Lima Reservoir is privately owned and operated by Lima WUIC. BOR monitors outflows, elevation, and storage of both reservoirs. BOR calculates inflows to CCR using an algorithm that accounts for reservoir releases and reservoir elevation. It does not directly measure inflows from the Red Rock River and Horse Prairie Creek into CCR.

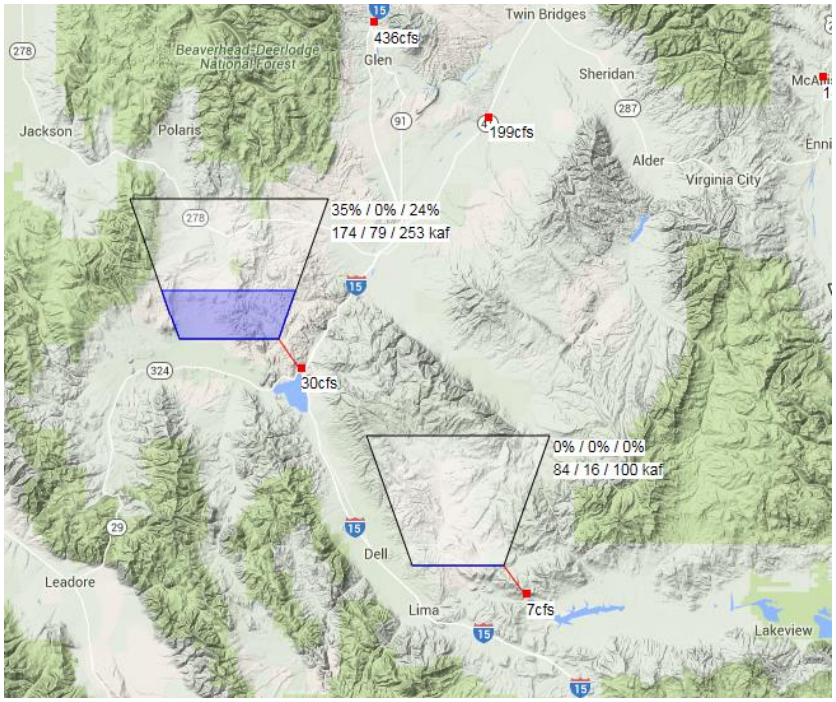


Figure 21. October 2015 BOR "teacup" diagram of reservoir storage in the Upper Missouri Basin.
Website: http://www.usbr.gov/gp/hydromet/teacup_cf.htm

BOR, NRCS, and ACE all provide water supply forecasts to inform annual irrigation allotment decisions for EBID and CCWSC. The forecast models account for historical data, current conditions, and seasonal climate forecasts. BOR's forecasts include a range of scenarios based on "most probable", "maximum probable", and "minimum probable" reservoir inflows, and degree of allotment reductions. For example, one forecast outcome is based on "most probable inflow forecast with 1st reduced allotment", and another is based on "maximum probable inflow forecast with full allotment", etc. The trigger variable for reducing irrigation allotments is the August EOM forecasted reservoir storage. Reductions in irrigation allotments can be used as an indicator of the severity of hydrologic drought.

	August EOM Forecasted Levels	CCWSC Allotments	EBID Allotments
Full Allotment	> 50,000 AF stoarge	4 AF/acre	3.1 AF/acre
1st Reduction	50,000 - 40,000 AF storage	3.5 AF/acre	2.7 AF/acre
2nd Reduction	40,000 - 30,000 AF storage	3.25 AF/acre	2.25 AF/acre
3rd Reduction	30,000 - 10,000 AF storage	3.0 AF/acre	2.0 AF/acre
4th Reduction	10,000 AF minimum storage	3.0 AF/acre	< 2.0 AF/acre or bank*

Figure 22. Reservoir storage thresholds for CCR drought management plan. This drought management plan can be found in EBID and CCWSC's 2006 repayment contract with BOR. *Bank is defined as carrying over irrigation water saved from one irrigation season to the next irrigation season.

Reservoir Storage Monitoring Needs:

1. Currently the inflows to CCR are not directly measured. Instead, they are calculated using an algorithm that accounts for reservoir releases and reservoir elevation. In order to more accurately track and forecast the distinct contributions to CCR storage from the Red Rock River, Horse Prairie Creek, and groundwater accretions, it is recommended that real-time stream gaging stations be installed on the Red Rock River and Horse Prairie Creek near their inlets to CCR. More information about this monitoring need can be found in Sections 5 and 6.
2. Survey bathymetry of CCR and Lima Reservoir to determine any loss of storage capacity due to sedimentation. BOR has stated that they plan to do this for CCR in the summer of 2016. Lima WUIC would likely require financial and technical assistance if they choose to do this for Lima Reservoir.

Precipitation

There are several automated data networks equipped to monitor precipitation on a daily basis. These include NRCS SNOTEL sites listed above; the BOR AgriMet station on the East Bench; the Dillon Airport station operated by NWS and FAA; the NOAA Global Historical Hydrology Network (GHCN) stations at Dillon WMCE, Grant, Lakeview, and Twin Bridges; the NOAA USCRN station at Bannack State Park; and the BLM and USFS Remote Automatic Weather Stations (RAWS) stations at Red Rock in the Centennial Valley, at Antelope near Lima, and at Brenner in the Horse Prairie basin. All of these sites also measure air temperature and their data is publically accessible on the internet.

In 2015, BCD partnered with NIDIS to purchase twelve CoCoRaHS rain gauges to hand out to community volunteers at no cost. This volunteer rain monitoring network has improved the spatial distribution of precipitation data, but requires manual monitoring and reporting and thus has more temporal gaps due to variability of volunteer diligence. As a result of BCD's efforts, Beaverhead County is now one of the top counties in Montana in terms of active CoCoRaHS volunteers despite its relatively small population.

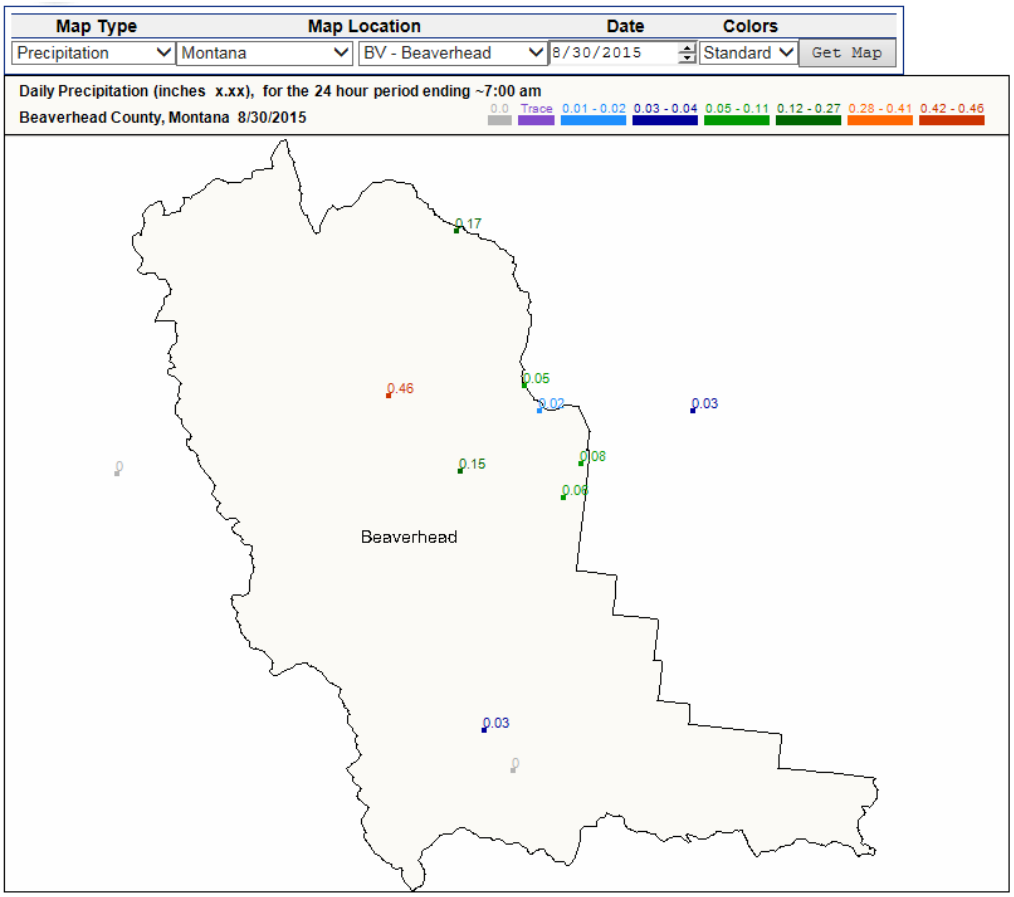


Figure 23. CoCoRaHS map of Beaverhead County for 08/30/2015.
Website: http://www.cocorahs.org/

Precipitation Monitoring Needs:

1. Continue to recruit CoCoRaHS volunteers with emphasis on areas near Horse Prairie Creek, Grasshopper Creek, Lower Red Rock River, Blacktail Deer Creek, the west side of the Beaverhead River, the Lower Beaverhead River, the East Bench, Big Sheep Creek, Sage Creek, and the Big Hole River. This will improve the density of the precipitation data network, as well as promote public awareness of hydrologic conditions.
2. Integrate CoCoRaHS data with other monitoring and decision making processes such as DTF meetings, MBMG groundwater monitoring, soil moisture monitoring, and irrigation water management.

Soil Moisture

Soil moisture data networks in Beaverhead County are underdeveloped. There are currently no NRCS Soil Climate Analysis Network (SCAN) sites in the Beaverhead Watershed. The nearest SCAN site to the Beaverhead Watershed is Table Mountain site in Gallatin County. SCAN data provides actionable intelligence to producers that can help them make critical decisions such as timing of tillage to minimize moisture loss and compaction, and timing and amount of irrigation. A SCAN site in the Beaverhead Watershed would also help to ground-truth satellite soil moisture data, and improve initial input data for climate and hydrology models. NRCS SNOTEL sites also measure soil moisture on a daily basis. Because SNOTEL sites are located at high elevations in forested areas, they are more useful for forest stress detection and wildfire risk, and less useful for agricultural purposes.

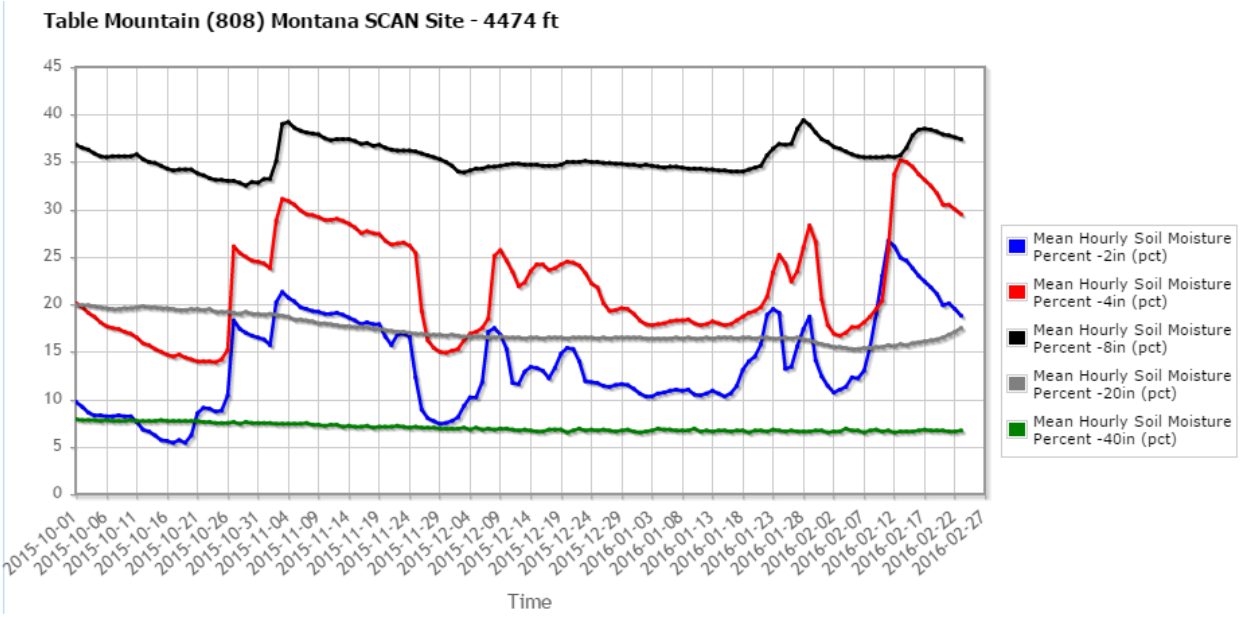


Figure 24. Table Mountain SCAN site data.
Website: http://www.wcc.nrcs.usda.gov/scan/

NASA's Gravity Recovery and Climate Experiment (GRACE) offers satellite derived maps of surface soil moisture, root zone soil moisture, and shallow groundwater. Users of this experimental tool tend to be state and Federal agencies and it is used as a general indicator of drought. This tool is not widely used by local stakeholders for land management decision making purposes.

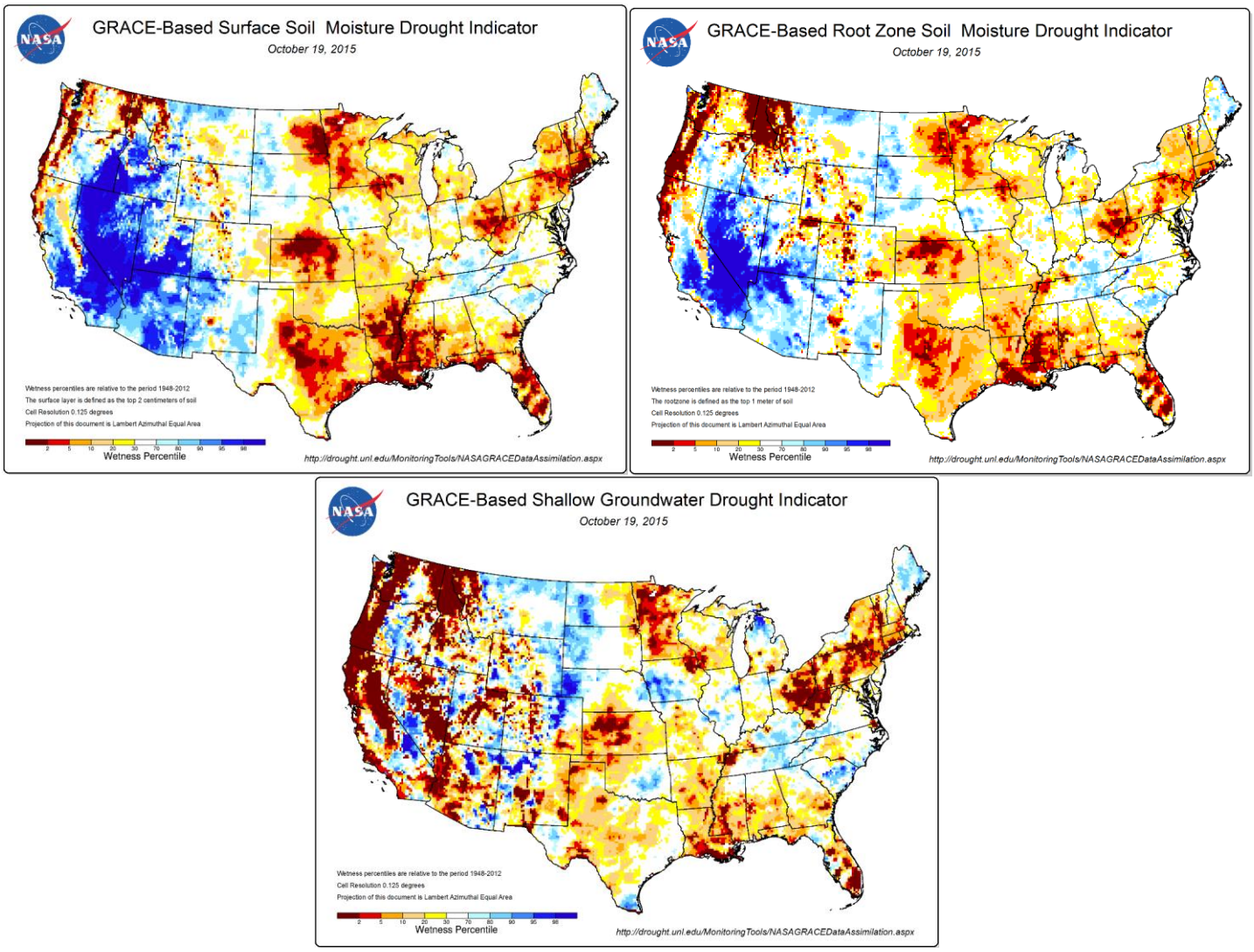


Figure 25. NASA GRACE-based soil moisture data.
Website: http://drought.unl.edu/MonitoringTools/NASAGRACEDataAssimilation.aspx

Soil Moisture Monitoring Needs:

1. Work with local stakeholders and the NRCS Dillon Office to identify and prioritize ideal SCAN network sites, and recommend those sites to the NRCS State Conservationist. Ideal sites are those that capture the prevalent climate and soil types in the basin, are unirrigated, and are on public land to ensure accessibility.
2. Diligent monitoring and reporting of local soil moisture and crop and range conditions by the Beaverhead County Extension Agent via the monthly surveys distributed by the DAC. This will likely require the establishment of standard monitoring sites, and possibly support from volunteer monitors. DTF has also expressed interest in maintaining a record of these surveys.
3. Work with MCO to enhance in situ soil moisture monitoring in the Beaverhead Watershed and its headwaters. Expansion of soil moisture monitoring networks is a goal that has been articulated by the NDRP, MCO, and DNRC. A soil health demonstration project (as described in Section 6) could be an opportunity for collaboration on soil moisture monitoring among BCD, NRCS, MCO, and MSU Extension.
4. Provide educational programming for local producers regarding sources of soil moisture data. This would include both in situ data such as SCAN, as well as satellite derived data from NASA's GRACE and products like Normalized Difference Vegetation Index (NDVI).

Groundwater

MBMG's Groundwater Information Center (GWIC) has several groundwater monitoring resources that are publicly available online at http://mbmggwic.mtech.edu/. They include:

- Statewide maps of groundwater monitoring well locations
- Groundwater well hydrographs
- Drought reports about the relationships between groundwater levels and climate variability
- County-wide groundwater well statistics

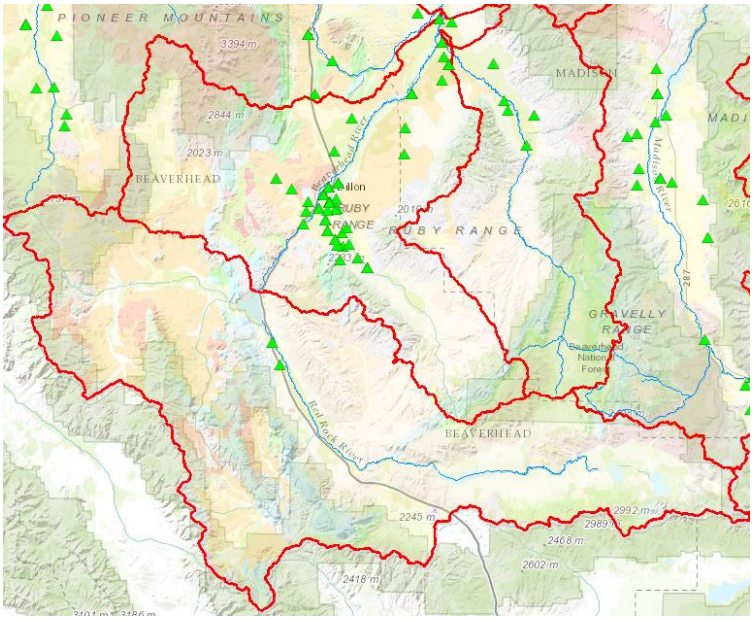


Figure 26. Map of MBMG Groundwater Assessment Act Monitoring Network (GWAAMON) wells in the Beaverhead Watershed and its headwaters. Website: http://data.mbmg.mtech.edu/mapper/mapper.asp?view=Wells&

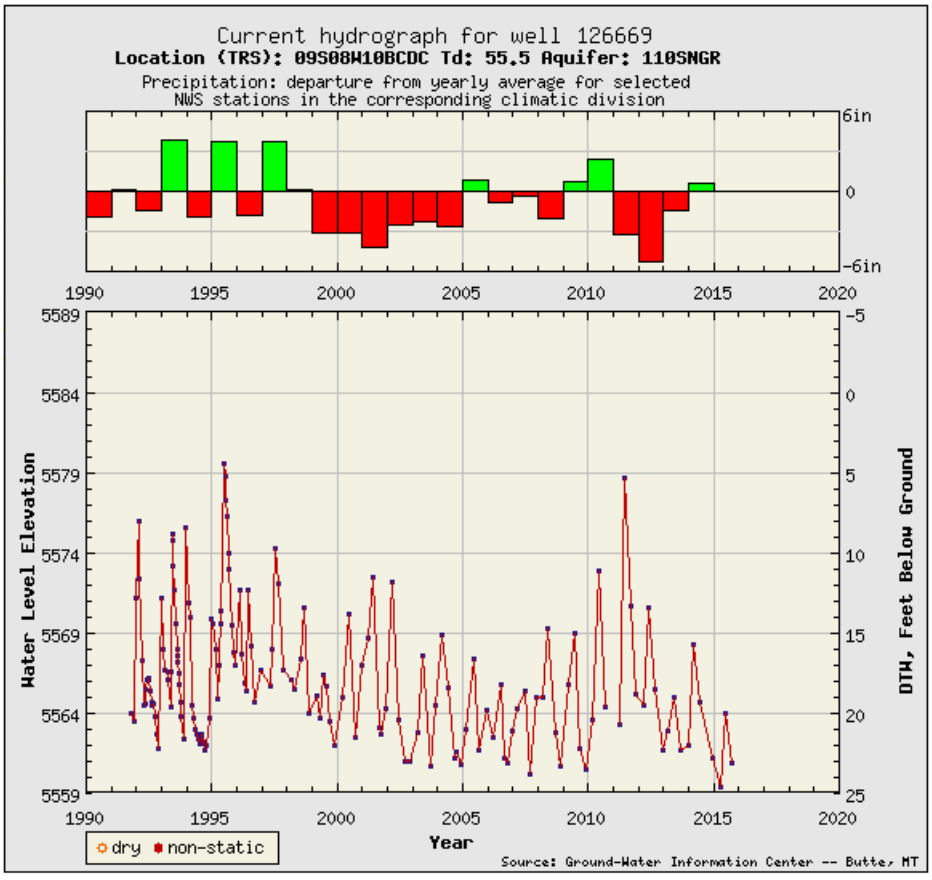


Figure 27. A groundwater well hydrograph from Blacktail Deer Creek. Website: http://mbmggwic.mtech.edu/sqlserver/v11/data/dataProject.asp?MTCounty=BEAVERHEAD&project=GWAAMON&datatype=swl&

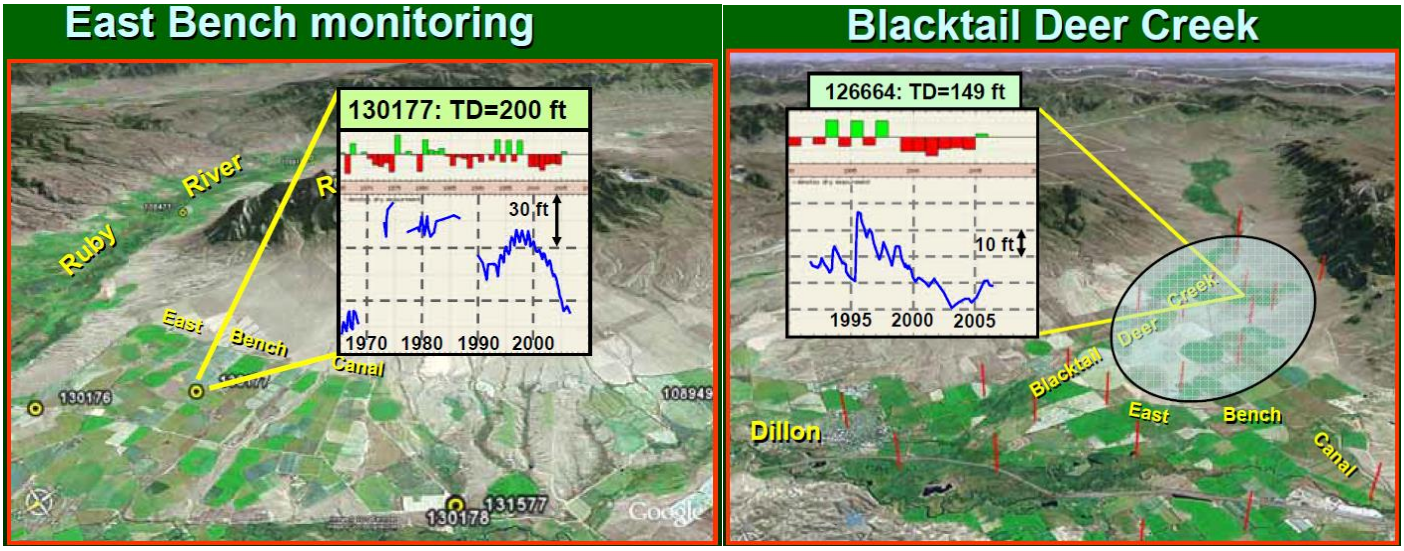


Figure 28. MBMG groundwater monitoring data from the East Bench and Blacktail Deer Creek shows depleted groundwater levels during the early 2000s resulting from a combination of prolonged drought and conversion from flood irrigation to sprinkler irrigation. Website: http://mbmggwic.mtech.edu/sqlserver/v11/reports/pdf/drought2006july.pdf

Wells by Year

The table below shows the breakdown of wells reportedly drilled in the county during the last 20 years. Click the "show all" link to display all data available.

2015	71
2014	64
2013	60
2012	45
2011	52
2010	82
2009	47
2008	98
2007	114
2006	121
2005	117
2004	117
2003	149
2002	101
2001	88
2000	79
1999	86
1998	77
1997	97
1996	103

Wells by Depth

The table below shows the number of wells that fall between the depth ranges in the left hand column. All depths are listed in feet below ground surface.

0 - 99	2735
100 - 199	983
200 - 299	307
300 - 399	140
400 - 499	72
500 - 599	35
600 - 699	13
700 - 799	3
800 - 899	2
900 - 999	0
> 1000	0

Reported Water Use

The table below shows the number of each type of water use that has been reported for wells in this county.

UNKNOWN	79
INDUSTRIAL	13
OTHER	29
PUBLIC WATER SUPPLY	101
TEST WELL	22
UNUSED	27
FIRE PROTECTION	7
MEDICAL	1
MONITORING	430
COMMERCIAL	11
IRRIGATION	242
RESEARCH	2
GEOTECH	74
STOCKWATER	921
DOMESTIC	2761
* Total	4720

* Number may differ from county total since one well may have several reported **water uses**.

Figure 29. MBMG groundwater well statistics for Beaverhead County.
Website: http://mbmggwic.mtech.edu/sqlserver/v11/reports/CountyStatistics.asp?MTCounty=BEAVERHEAD

MBMG has also done several groundwater studies in the Beaverhead Watershed. One of the more recent studies occurred between 2009 and 2012 as part of MBMG's Groundwater Investigation Program (GWIP) to assess how groundwater irrigation wells influence groundwater levels and surface water flows on the Lower

Beaverhead River. This study can be found at http://www.mbmg.mtech.edu/gwip/project_lower-beaverhead.asp. Below is an excerpt from the abstract of that study which summarizes its purpose and its findings:

> "The purpose of this investigation was to determine the magnitude and extent of groundwater drawdown and stream depletion occurring in the Beaverhead River study area due to high-capacity irrigation pumping from aquifers. Possible impacts to sloughs and the Beaverhead River from future groundwater development were also evaluated. The study area extends from Dillon, Montana to Beaverhead Rock, a distance of about 14 miles. It includes the Beaverhead River floodplain and the benches to the east and west of the valley.
>
> Groundwater and surface water are connected and interchange seasonally. The Beaverhead River within the study area generally loses water to groundwater in the fall and winter months and gains water from groundwater during the irrigation season as a result of irrigation return flows. Closer to Beaverhead Rock, the river consistently gains water from the alluvial aquifer. Water primarily exits the study area through surface water where the valley constricts near Beaverhead Rock, forcing groundwater to the surface. The sloughs on the West Bench also gain water from irrigation return flow.
>
> Data during a 3-day aquifer test in the volcanic rock aquifer did indicate a connection between the aquifer and a nearby slough, which recovered as the groundwater level recovered. If any stream depletion has occurred in the Beaverhead River as a result of irrigation wells, it is not apparent in the field measurement data. Numerical modeling indicates that future groundwater development may result in stream depletion in the Beaverhead River and its tributaries. Within the 20-year modeled period, the magnitude of maximum depletion decreased the further the wells were from the river and the timing of depletion was delayed with increasing distance. Modeling also showed that extending the period of canal flow can help offset stream depletion and groundwater drawdown by providing additional groundwater recharge."
>
> - *Hydrogeologic Investigation of the Beaverhead River Study Area, MBMG, 2013*

Groundwater Monitoring Needs:

1. Integrate MBMG GWIC data into DTF meetings.
2. Improve quantification of groundwater accretions for CCR by placing stream gages on the Red Rock River and Horse Prairie Creek near their inlets to CCR.

Air Temperature

There are several automated data networks equipped to monitor and record air temperature. These include NRCS SNOTEL sites listed above; the BOR AgriMet station on the East Bench; the Dillon Airport station

operated by NWS and FAA; the NOAA GHCN stations at Dillon WMCE, Grant, Lakeview, and Twin Bridges; the NOAA USCRN station at Bannack State Park; and the BLM and USFS RAWS network sites at Red Rock in the Centennial Valley, at Antelope near Lima, and at Brenner in the Horse Prairie watershed. Much of this data can be found here: http://www.wrh.noaa.gov/map/?obs=true&wfo=tfx&basemap=OpenStreetMap&boundaries=true,false&obs_popup=true .

Evapotranspiration

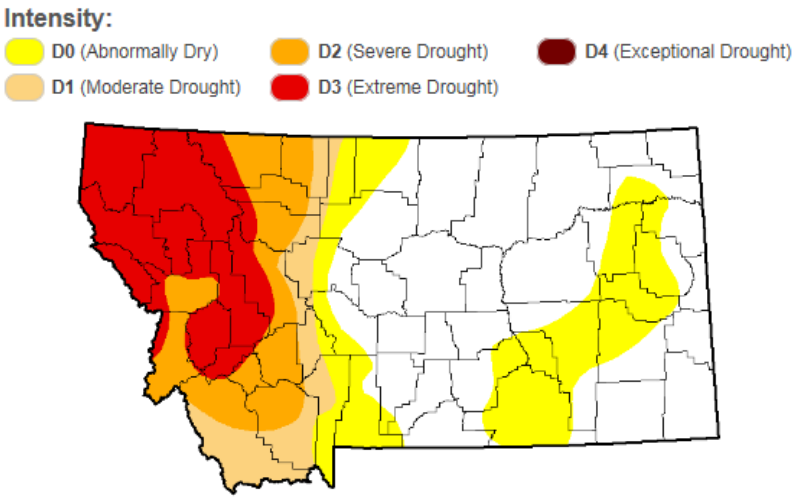
The only source of ET information is the BOR AgriMet station on the East Bench. AgriMet provides generic local crop and weather information accessed via the links on the individual station page. This AgriMet station is equipped to monitor air temperature, solar radiation, relative humidity, precipitation, and wind speed and direction. This information is used to model evapotranspiration and provides producers with estimates of the water demand for certain crops which they can factor into irrigation decision making. Data from the Dillon AgriMet station can be accessed via http://www.usbr.gov/gp/agrimet/station_dlnm_dillon.html .

Evapotranspiration Monitoring Needs:

1. Provide educational programming during the winter for local producers on how to access and interpret Dillon AgriMet station data. This may offer an opportunity for collaboration among BOR, BCD, NRCS, MCO, and MSU Extension.
2. Provide educational programming for local producers on how to access and interpret satellite derived NDVI.

Drought Indices

The most widely utilized drought indices include the USDM, the SWSI, and the Montana County Water Supply and Moisture Status. Other indices include the Palmer Drought Severity Index (PDSI) and NASA's GRACE soil moisture data. All of these indices are utilized by the NWS, DTF, and DAC. Snowpack, streamflow, reservoir storage, precipitation, and air temperature data are also widely used as straightforward drought severity indicators by comparing those current or seasonal conditions with their averages over a given period of time. For example, in 2015 one indicator of drought in southwest Montana was that snowpack in the Jefferson River Basin on April 1st was far below average for that time of year (see Figure 30 on page XX). Reductions to irrigation allotments for EBID and CCWSC can also be used as indicators of hydrologic drought.



Week	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current 2015-10-13	45.80	54.20	35.19	28.11	16.92	0.00
Last Week 2015-10-06	45.80	54.20	35.19	28.11	16.92	0.00
3 Months Ago 2015-07-14	28.58	71.42	42.31	25.92	13.60	0.00
Start of Calendar Year 2014-12-30	98.84	1.16	0.00	0.00	0.00	0.00
Start of Water Year 2015-09-29	30.55	69.45	38.18	28.78	16.92	0.00
One Year Ago 2014-10-14	91.73	8.27	0.89	0.00	0.00	0.00

Figure 30. U.S. Drought Monitor map of Montana produced weekly by the National Drought Mitigation Center. Website: http://droughtmonitor.unl.edu/

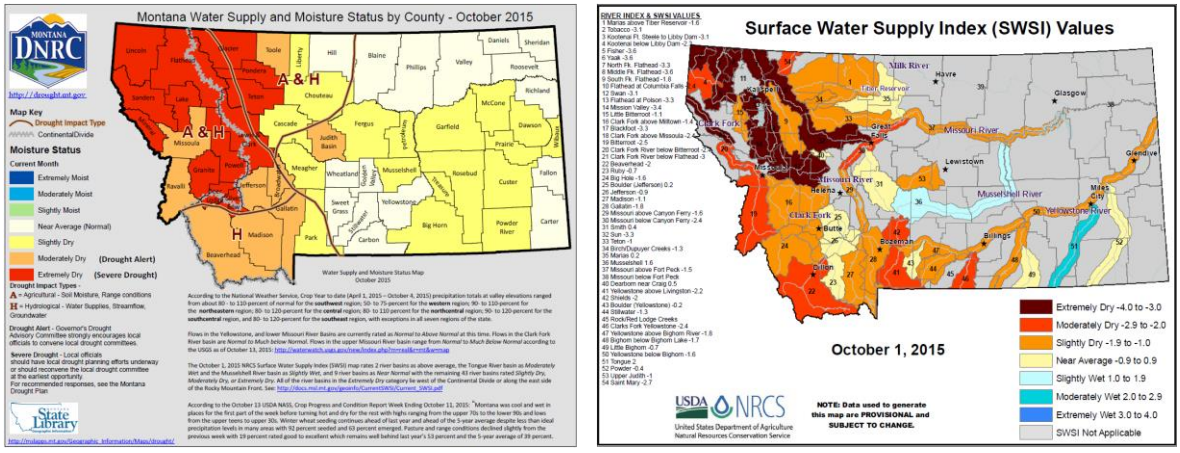


Figure 31. Left: The Montana County Water Supply and Moisture Status map is produced monthly by DNRC. Right: The Montana Surface Water Supply Index map is produced monthly by the NRCS. Website: http://drought.mt.gov/default.aspx

Wildfire Risk

Basin scale wildfire risk indices such as dead fuel moisture, Energy Release Component, and Burning Index are available from the Norther Rockies Coordination Center in Missoula. Monthly and seasonal significant wildland fire potential outlooks are available from the National Interagency Fire Center (NIFC) in Boise, Idaho. NWS includes updates on several regional wildfire risk indices in its monthly presentations to DTF.

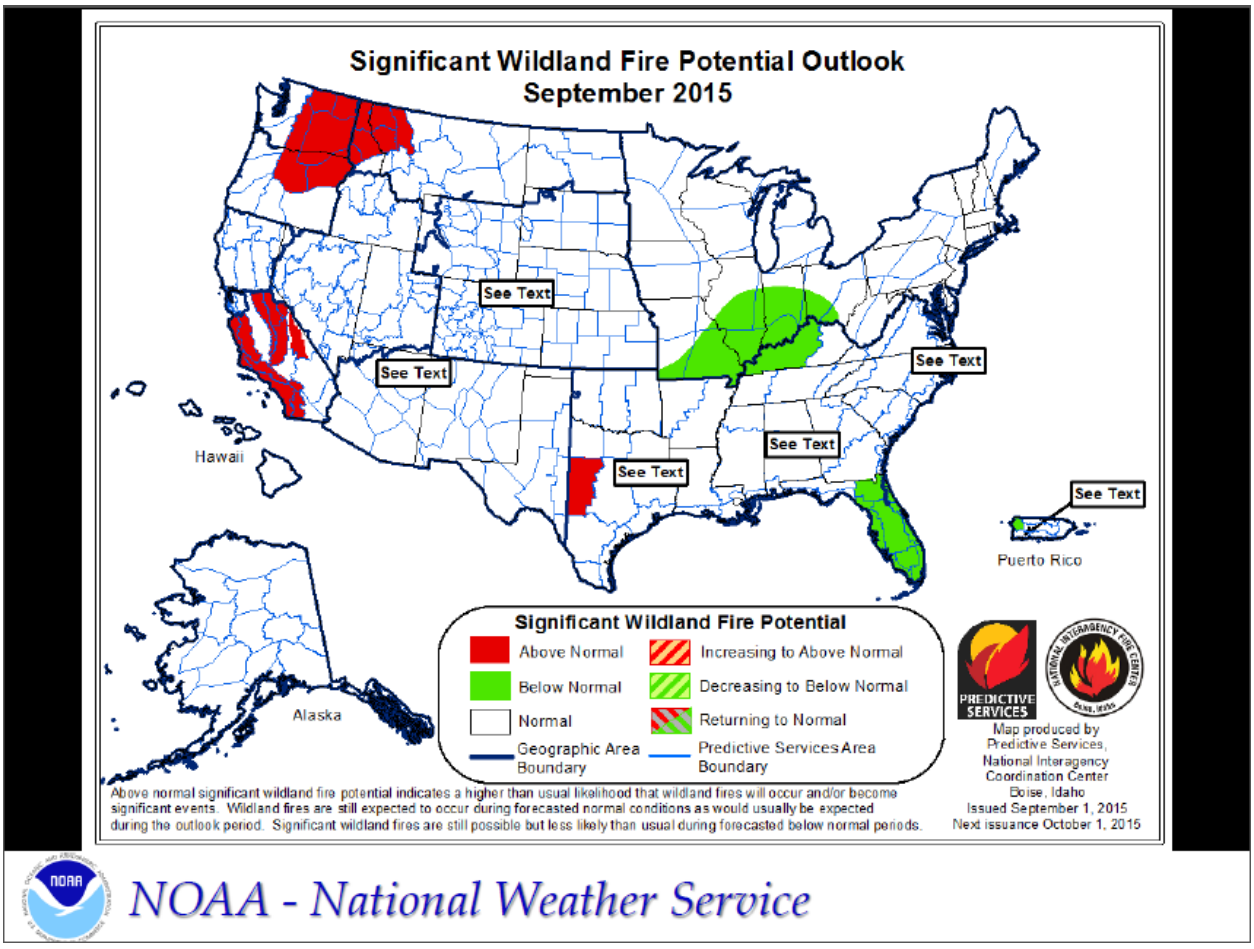


Figure 32. Significant Wildland Fire Potential Outlook Map. Slide from the September 2015 NWS presentation to DTF. (Courtesy: Gina Loss, NWS)

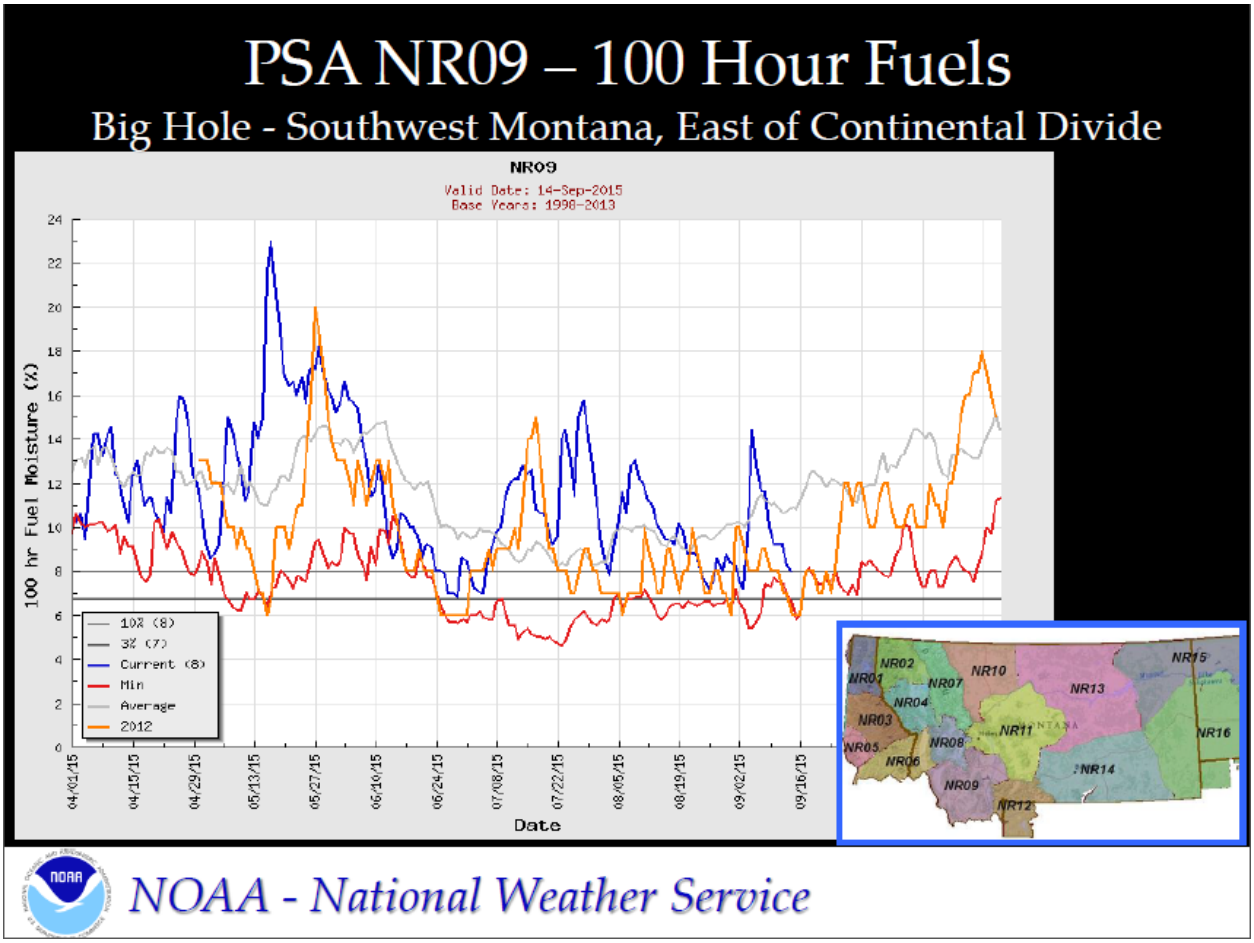


Figure 33. 100 hour fuels in the Upper Missouri Basin. Slide from the September 2015 NWS presentation to DTF. (Courtesy: Gina Loss, NWS)

According to NOAA, the fuel moisture index is a tool that is widely used to understand the fire potential for locations across the country. Fuel moisture is a measure of the amount of water in a fuel (vegetation) available to a fire, and is expressed as a percent of the dry weight of that specific fuel. For example, if a fuel were totally dry, the fuel moisture content would be zero percent. Fuel moisture is dependent upon both environmental conditions (such as weather, local topography, and length of day) and vegetation characteristics. When fuel moisture content is high, fires do not ignite readily, or at all, because heat energy has to be used to evaporate and drive water from the plant before it can burn. When the fuel moisture content is low, fires start easily, will spread rapidly, and all of the heat energy goes directly into the burning flame itself. When the fuel moisture content is less than 30 percent, that fuel is essentially considered to be dead. Dead fuels respond solely to current environmental conditions and are critical in determining fire potential. The dead fuel moisture threshold (10–hour, 100–hour, or 1,000–hour), called a time lag, is based upon how long it would take for 2/3 of the dead fuel to respond to atmospheric moisture. Small fuels (less than 1/4 inch in diameter), such as grass, leaves, and mulch respond more quickly to changes in the atmospheric moisture content, and take 10 hours to adjust to moist/dry conditions. Larger fuels lose or gain moisture less rapidly through time. Fuels that are 3 inches to 8 inches in diameter, such as dead fallen trees and brush piles can take up to 1,000 hours to adjust to moist

conditions, and are represented by the 1,000–hour dead fuel moisture index. 1,000+ hour fuels do not burn easily, but if they do burn, they will generate extreme heat often causing dangerous fire behavior conditions.

The Energy Release Component is based upon the estimated potential available energy released per unit area in the flaming zone of a fire. It is dependent upon the same fuel characteristics as the spread component. The day to day variations of the Energy Release Component are caused by changes in the moisture contents of the various fuel classes, including the 1000-hour time lag class. The Energy Release Component is derived from predictions of the rate of heat release per unit area during flaming combustion and the duration of the burning. It is expressed in BTU's per square foot.

Burning Index is measure of fire intensity. It combines the Spread Component and Energy Release Component to relate to the contribution of fire behavior to the effort of containing a fire. Burning Index has no units, but in general it is 10 times the flame length of a fire. More information about wildfire risk management terms and indices can be found here: http://gacc.nifc.gov/rmcc/predictive/fuels_fire-danger/drgloss.htm .

Drought Impacts

Qualitative socioeconomic and ecological impacts of drought do not necessarily have the established systematic monitoring systems similar to those of climatological and hydrologic impacts. However, monitoring these impacts should be no less of a priority because they are manifestations of how temperature and moisture anomalies are directly and indirectly affecting livelihoods, communities, and ecology. One example of a socioeconomic drought impact in Beaverhead County in 2015 resulted from the vigorous proliferation of noxious weeds. The Beaverhead County Weed District was spread thin in terms of time, money, and manpower to keep noxious weeds in check, as were many individual landowners and citizens. Examples of ecological drought impacts of the anomalously warm and dry winter of 2015 were the fatalities of two moose due to apparent tick infestation. The emaciated moose carcasses were found covered in tens of thousands of ticks, and FWP hypothesized that winter temperatures did not get cold enough for long enough to keep tick populations in check. Each of these impacts likely has implications for local crop and livestock production, and may influence how local stakeholders plan, make decisions, and allocate resources in the future.

The NDMC’s Drought Impact Reporter is an online tool that anyone can use to record and track various types of socioeconomic and environmental drought impacts at the national, state, and county levels. Currently the reports in the Drought Impact Report for Beaverhead County come less from local input, and more from regional media reports.

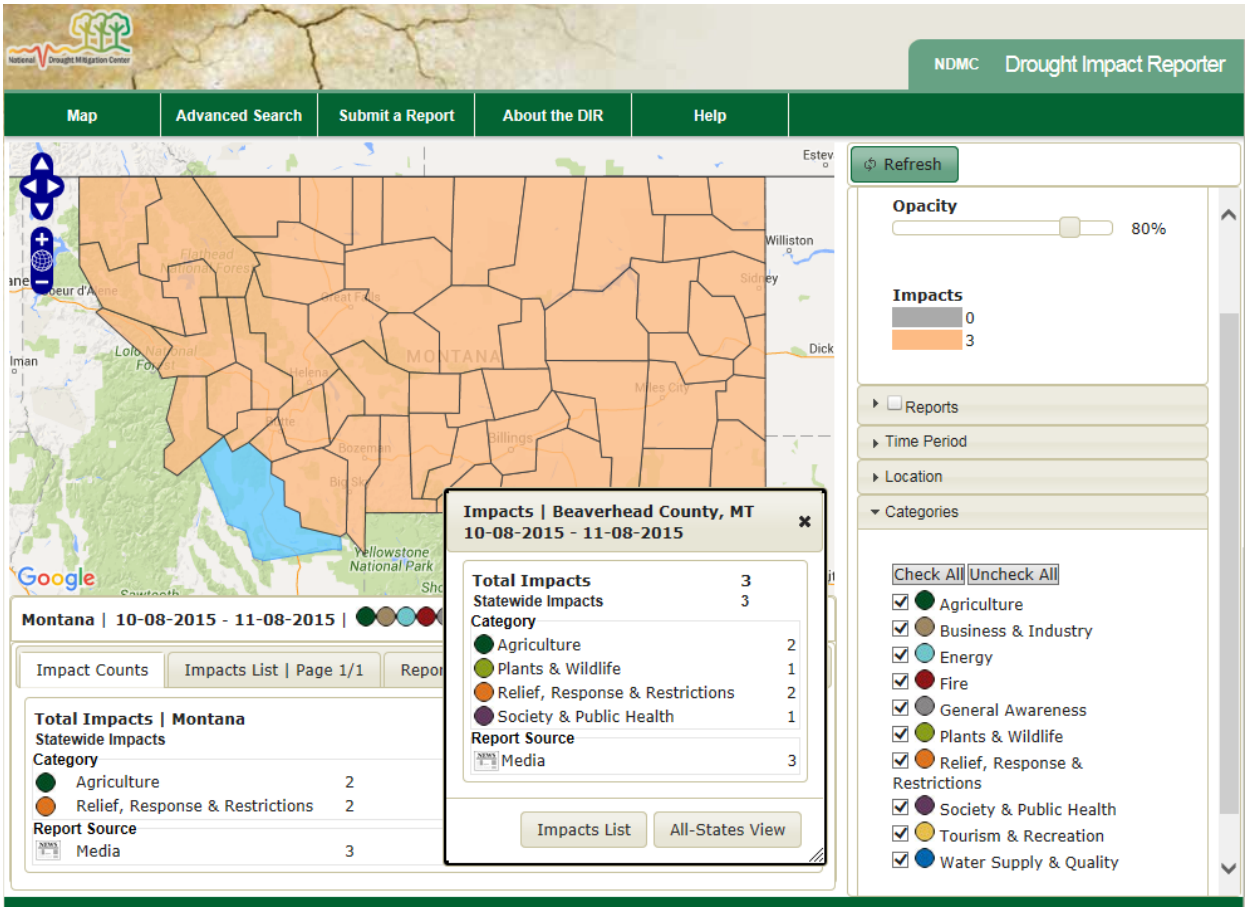


Figure 34. NDMC's Drought Impact Reporter website
Website: http://droughtreporter.unl.edu/

Drought Impact Monitoring Needs:

1. Maintain records of socioeconomic and environmental impacts of drought so that scientists, decision makers, and the community at large can factor these impacts into their understanding of past, present, and potential future drought vulnerability in the Beaverhead Watershed and its headwaters. It is recommended that the DTF solicit monthly drought impact reports from each participating entity, and enter that information into the Drought Impact Reporter website. DAC should review entries in the Drought Impact Reporter and incorporate that information into their monthly Montana County Water Supply and Moisture maps. This will provide a means to improve documentation of anecdotal impacts that are not currently systematically archived in the same way as historical climate data. It will also help state and Federal agencies better understand the qualitative impacts being experienced at the local level.

Forecasting and Planning

EBID, CCWSC, DTF, and DAC all utilize and disseminate several different hydrologic, climate, and weather forecasts of varying timescales. Among these forecasts are NRCS snowpack; BOR, NRCS, and ACE reservoir storage; National Weather Service; Climate Prediction Center (CPC); and ENSO outlooks. These forecasting tools can help anticipate the likelihood and severity of drought development in the short- and medium-range. BOR's Upper Missouri Basin Climate Impacts Assessment will provide an additional tool for long-range drought planning.

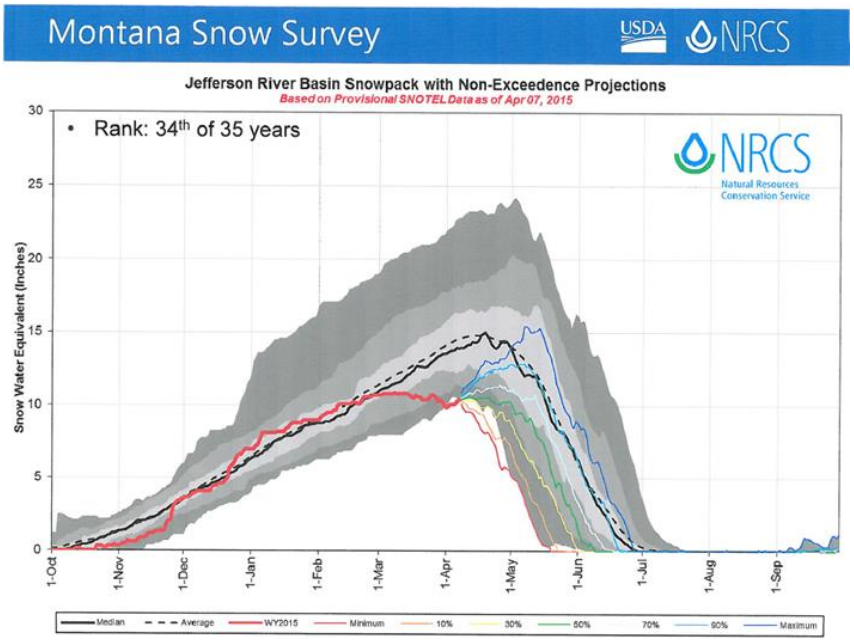


Figure 35. April 2015 NRCS snowpack projections for the Jefferson River Basin. (Courtesy: Lucas Zukiewicz, NRCS)

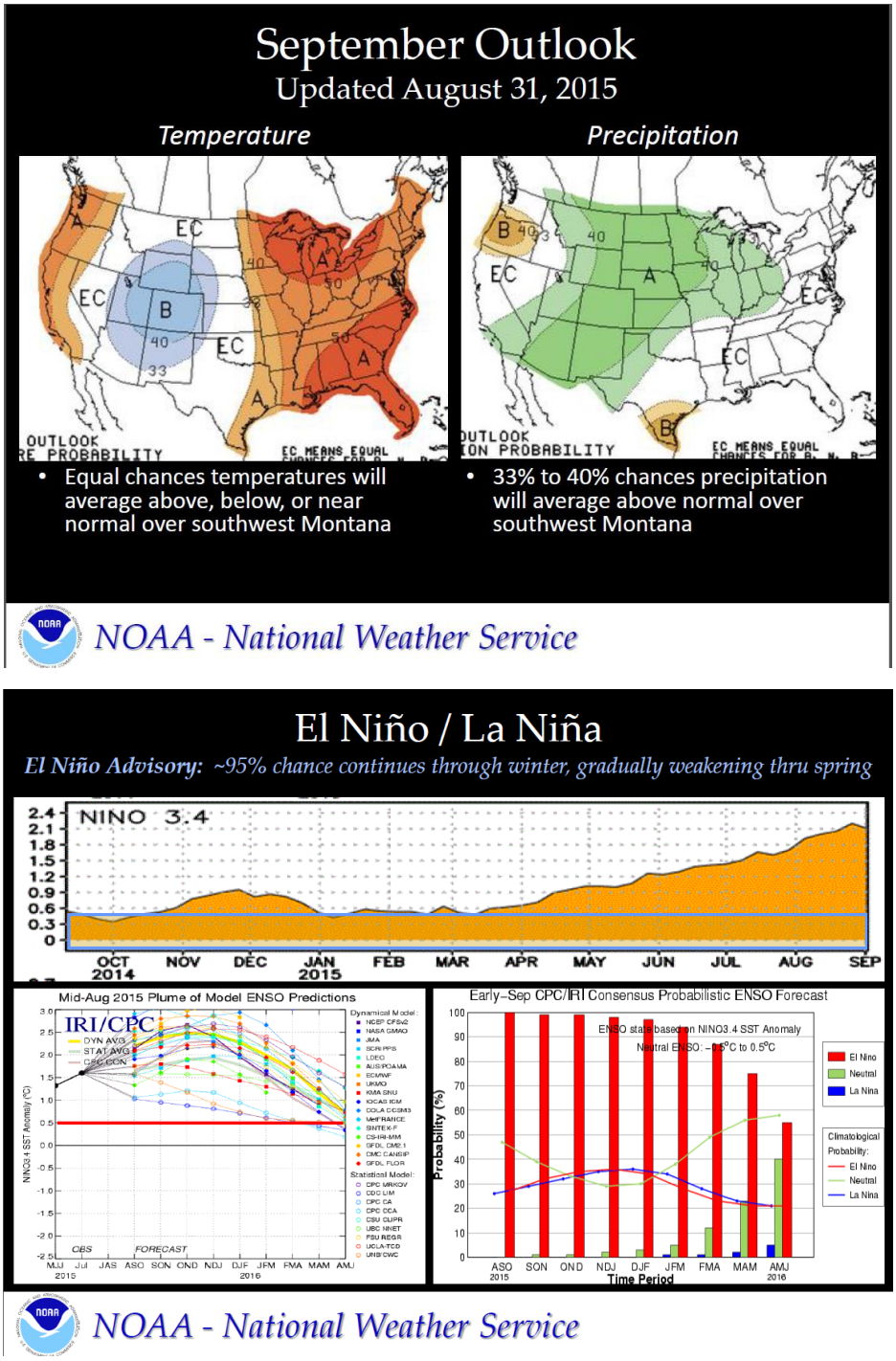


Figure 36. Slides from NWS's September 2015 presentation to DTF. (Courtesy: Gina Loss, NWS Great Falls)
Website: http://www.cpc.ncep.noaa.gov/index.php

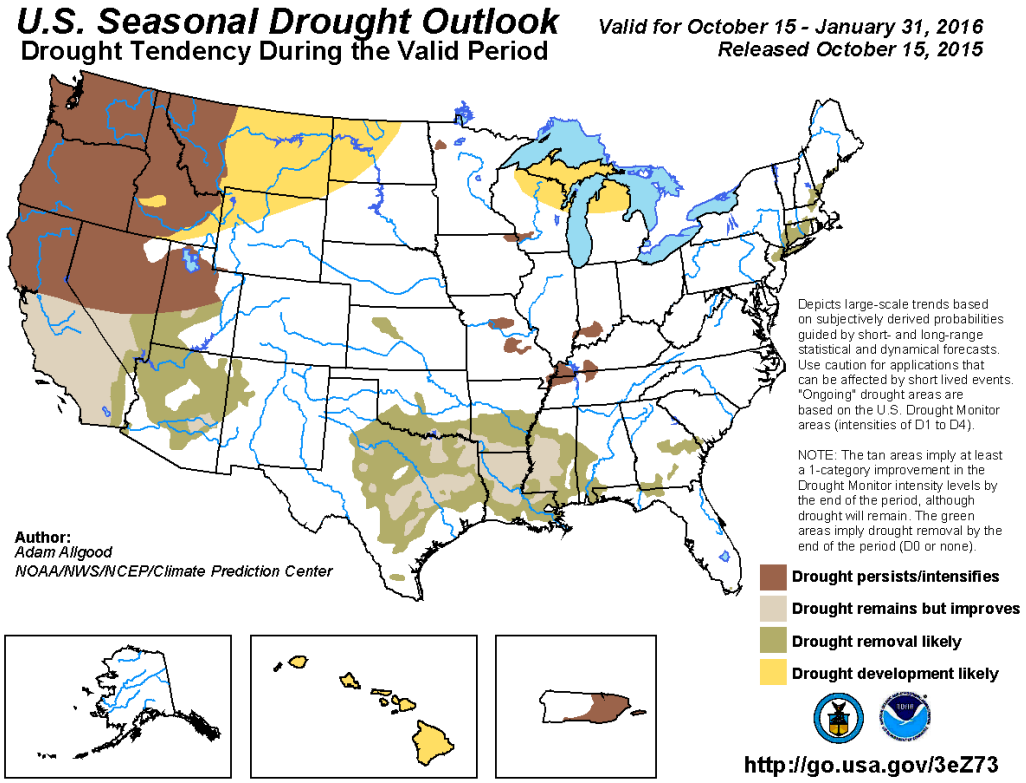


Figure 37. U.S. seasonal drought outlook map produced by CPC.
Website: http://www.cpc.ncep.noaa.gov/index.php

Forecasting and Planning Needs:

1. Improve accuracy and resolution of BOR seasonal water supply forecasting models by installing real-time stream gaging stations on the Red Rock River and Horse Prairie Creek near their inlets to CCR. More detailed information about this forecasting and planning need can be found in Sections 5 and 6.
2. NDRP Federal partners should coordinate to develop a Drought Early Warning System website that merges as many of the climate and hydrology monitoring networks listed in this section as possible. A GIS interface that allows laymen users to click on/off desired data layers would be ideal. The NRCS Montana Snow Survey map would be a good template to follow.
3. Complete a Beaverhead River channel migration zone (CMZ) mapping study. This study may help to anticipate evolution of river geomorphology and disruptions to irrigation diversion infrastructure, and enable proactive efforts to mitigate these disruptions. For example, BCD or local landowners may be able to identify timelines for potential disruptions to certain diversions based on the study, and proactively notify one another in order to facilitate timely execution of the 310 permitting process which is legally required for stream work.

Section 5: Vulnerability Assessment

Overview

This section outlines the most pressing economic and environmental vulnerabilities to drought in the Beaverhead Watershed and its headwaters as expressed by local stakeholders and agencies. Each drought vulnerability assessment in this section includes a synopsis of the issue. Recommendations for strategies to address each issue can be found in Sections 6 and 7. The primary purpose of this DRP is to formally articulate these drought vulnerabilities and to support all local efforts to access the public and private resources and expertise needed to implement projects aimed at improving community drought resilience.

Sources of Drought Vulnerability Identified by Local Stakeholders and Agencies

I. Unmeasured CCR Inflows and Water Supply Forecasting

CCR is arguably the most vital piece of public infrastructure in Beaverhead County. Reservoir contents and water supply forecasts produced by BOR, NRCS Snow Survey, and ACE are critical pieces of information which are used by producers for financial and land use planning in preparation for each growing season. Therefore, it is critical for these agencies to provide the most complete, accurate, and timely forecasts possible in order to give producers an opportunity to make sound management decisions.

Currently, the inflows into CCR are not directly measured. There are three sources of inflow: the Red Rock River, Horse Prairie Creek, and groundwater accretions. Total accretions from these three sources are currently calculated using an algorithm that accounts for reservoir elevation and reservoir releases.

As climate variability becomes more amplified, it will become increasingly important to understand the spatial variability of snowpack between source watersheds and the associated runoff patterns in order to improve water supply model resolution and accuracy. In this case, this can be accomplished by placing stream gauge stations on the Red Rock River and Horse Prairie Creek. Stream gauges on these streams will allow water supply planners to assess the runoff patterns of these two source watersheds separately, as well as provide better quantification of groundwater accretions. It is crucial to separately analyze the runoff patterns of these two watersheds because they differ significantly enough in terms of spatial area, seasonal precipitation and runoff patterns, and irrigation water-use. Furthermore, the usefulness of this data will increase with time, as the expanding period of record will provide more data to inform the model which is expected to lead to increasing accuracy. Therefore, there is incentive to have these stream gauging stations installed as soon as possible.

Trust between irrigators and agencies that provide water supply forecasts is critical to sound cooperative decision making processes. In the past, irrigators have expressed some doubt regarding the accuracy of forecasts. For example, in the winter of 2014-2015 the Centennial Valley experienced record low snowpack which caused water supply models to predict very low reservoir inflows, which triggered significant reductions in irrigation allotments under the EBID-CCWSC Drought Management Plan. Irrigators were concerned that the water supply models may have overreacted to the low snowpack in the Centennial Valley. Furthermore, they speculated that there could be significant moisture storage in groundwater aquifers to supplement stream flows and reservoir storage more than the models predicted. These valid concerns articulated by the irrigators must be addressed in order to improve the accuracy of and preserve the credibility of water supply forecasts.

If irrigation allotments are set improperly, the results can be disastrous and lasting. If allotments are set too high, this increases drought vulnerability in subsequent years. From 2001-2004 there were consecutive years of drought which culminated with EBID not receiving any water in 2004 because reservoir storage was not able to be sufficiently replenished over time. If allotments are set too low, this can affect irrigators' seasonal financial and land use planning processes and potentially limit production and income, which can have a ripple effect throughout the local economy. At this point, the best available strategy to avoid these scenarios is to improve water supply forecasts by adding streamflow data from the Red Rock River and Horse Prairie Creek into the models.

II. Impacts of Minimum Overwinter Releases from CCR on Beaverhead Fishery

Minimum overwinter releases out of CCD have been shown to negatively impact the tail water trout fishery on the Beaverhead River and the local angling tourism economy. FWP has proposed a solution to this issue which involves storing water in the exclusive flood control pool of CCR during wet years in order to bank water that can be used to enhance overwinter flows during subsequent drier years. ACE holds operational authority over the exclusive flood control pool and generally chooses to release water that would occupy the flood control pool if stored. Given this authority, BOR reservoir operations managers generally try to avoid scenarios in which reservoir storage levels reach flood pool elevation.

In September of each year, the Joint Board for the EBID and CCWSC meet to determine overwinter (October through March) releases out of CCD. They make this determination based upon forecasts provided by BOR, and in consultation with FWP's Fisheries Biologist for the Beaverhead River. The Joint Board's 2006 repayment contract with BOR specifies the following guidelines for setting overwinter releases:

September 1 Storage plus July-August Inflow (AF)	**Minimum Release (cfs)**
Less than 80,000	25
80,000 - 130,000	50
130,000 - 160,000	100
160,000 or greater	200

Figure 38. CCD overwinter release guidelines as described in EBID and CCWSC's 2006 repayment contract with BOR.

Between 1988 and 2015, 75% of winters (21 of 28) had below 200 cfs releases from CCD. During that same period, 32% of winters (9 of 28) had below 50 cfs releases. To be clear, irrigators shared in the shortage during many of those years, receiving some level of reduced allotments in 43% of those years (12 of 28), and 2nd or 3rd level reduced allotments in 36% of those years (10 of 28).

Previous FWP studies have utilized the wetted perimeter method of instream flow to determine prime riffle habitat areas and their correlation to standing fish crop, condition factor, and densities of large mature fish. These studies have yielded the recommendation of 200 cfs for minimum instream flow reservations on the

upper Beaverhead River (Oswald, 2009). Overwinter flows below 200 cfs have been shown to diminish the ability of the Beaverhead River to support the large, mature segments of the trout population. This is a concern because the Beaverhead's reputation for having abundant "trophy-sized" fish is one of the primary reasons that anglers worldwide choose to visit and spend money in Beaverhead County. Figure 39 shows the relationship between CCD overwinter releases, abundance of larger fish, angler use, and local economic impact. It is illustrative of how insufficient overwinter releases from CCD create economic and environmental vulnerability to drought in Beaverhead County.

Beaverhead River	**200 CFS Overwinter Flows**	**30 CFS Overwinter Flows**	**Percent Change**
Pounds of fish per mile	2850	2150	25% ↓
Pounds of fish ≥ 18" per mile	650	296	55% ↓
Pounds of fish ≥ 20" per mile	160	41	75% ↓
Angler Use Days	40k to 50k per year	15k to 25k per year	50-60% ↓
Angler Dollars Spent in Beaverhead County	~ $8 million	~ $2.4 million	70% ↓

Figure 39. Relationships between CCD overwinter releases, abundance of larger fish, angler use, and local economic impact. (Courtesy: Matt Jaeger, FWP)

III. Agricultural Soil Health

The Food and Agriculture Organization (FAO) of the United Nations proclaimed 2015 as the "Year of Soils". The reason for this proclamation is that given the current rate of worldwide soil degradation, the FAO anticipates that all of the world's top soil could be gone within 60 years. The primary causes of this rapid soil degradation include overgrazing, tillage, monoculture cropping, and over-application of petrochemicals. These practices contribute to the destruction of microscopic ecosystems that exist in the soil and perform critical biological and chemical functions which growing crops rely upon. Soil fertility is degraded through loss of organic matter and biodiversity, which contribute to other problems such as compaction, reduced infiltration rates, wind and water erosion, and elevated soil surface temperatures. The NRCS Dillon Office has identified soil health degradation as significant source of economic and environmental vulnerability to drought in the Beaverhead Watershed and its headwaters, for both individual producers and the community as a whole.

With increasing recognition of the importance of soil health to the sustainability of agricultural systems, there has been growing nationwide attention given to practices such as cover cropping, no-till, and management intensive rotational grazing (MIRG). These methods are gaining acceptance across all climates and landscapes because of their potential to more rapidly build soil structure, reduce input costs, and improve crop water-use efficiency. Early adopters of these methods are proving that these practices can improve their operations' resilience to drought, flood, and market fluctuation.

In Beaverhead County, ranchers rely heavily upon irrigation and public lands grazing in order to raise livestock and make a living. During severe drought, access to both of these resources can be curtailed. Furthermore, wind erosion has been a cause of topsoil loss from fallow cropland in the winter and spring in the Beaverhead

Watershed. Therefore, it is highly recommended that producers evaluate their exposure to these risks, and investigate how they can build resilience into their operations through cover cropping, no-till, and MIRG. The demonstrated economic benefits of these practices include reduced input costs, forage stand longevity, reduction or elimination of the need to put up hay, improved crop and forage production per acre, improvements in livestock performance, and improved crop water-use efficiency. Therefore, producers can reduce their input expenditures and potentially increase their income, thereby increasing net profits and improving the economic resilience of their operations to drought.

Notable examples of how improvement of soil health can improve drought resilience include farmer/rancher Gabe Brown of North Dakota, potato farmer Brendon Rockey of Colorado, cattle rancher Neil Dennis of Saskatchewan, and ranch manager Race King of LaCense Beef located south of Dillon. Reducing agricultural vulnerability to drought will reduce overall community vulnerability to drought in Beaverhead County. However, it is up to each individual producer to evaluate whether and to what extent practices like cover cropping, no-till, and MIRG are applicable to their operation. Currently, barriers exist that inhibit implementation of these practices by local producers. These barriers include financial risks associated with fundamental adjustments in management, and lack of awareness and understanding of conservation practices and their potential benefits.

IV. Cloud Seeding in Idaho

Since the early 2000's there has been a winter orographic cloud seeding program operated by Idaho Power Company and High Country Resource Conservation and Development, Inc. (HCRCD) in the Upper Snake River Basin. The cloud seeding has been done using ground-based generator towers on the windward slopes of mountain ranges in the eastern Idaho counties of Clark and Fremont between the dates of November 1 and April 15 each year. The goal of this program is to increase mountain snowpack and spring runoff in the Upper Snake River Basin to benefit hydropower generation, irrigation, recreation, and fish and wildlife. According to Idaho Power, the program has been effective in accomplishing this goal.

There is concern among the community in Beaverhead County – particularly among DTF and irrigator groups like WUIC, EBID, and CCWSC – that this cloud seeding program causes precipitable water that would normally be available to the headwaters of the Beaverhead Watershed to instead be preemptively induced to fall in the Upper Snake River Basin on the west side of the Continental Divide. Documentation of this concern can be found in meeting minutes of the Beaverhead County Commissioners and DTF as far back as April 2002 – prior to the commencement of these particular cloud seeding operations. These concerns are amplified during years of below average snowpack in the Centennial Valley, especially when these conditions coincide with drought in the Beaverhead Watershed and its headwaters. Currently, there is no scientific evidence that validates these concerns because the hydrologic effects of upwind cloud seeding on the Beaverhead Watershed have not been scientifically investigated.

Atmospheric modeling of cloud seeding program operations in the intermountain west indicates that cloud seeding may actually increase precipitation as far as 100 miles downwind from generator towers. Other estimates say that precipitation enhancement tends to occur only between 5 and 15 miles downwind of generators. However, there is insufficient in situ data to definitively corroborate any of these estimate effects for Idaho Power's cloud seeding operation on the Beaverhead Watershed.

The cloud seeding program in Idaho has grown steadily since its inception and Idaho Power has indicated that it plans to install between ten and twenty additional cloud seeding generators on the west side of the Continental Divide in the coming years. The combination of unchecked expansion of Idaho Power cloud seeding operations, the significance of the Centennial Valley as a major water source for the Red Rock and Beaverhead Rivers, the presence of the largest wetland complex in the Greater Yellowstone Ecosystem (Red Rock Lakes National Wildlife Refuge), and the limited information and understanding about the hydrologic effects of these operations on the Beaverhead Watershed and its headwaters makes Idaho Power cloud seeding a potentially significant source of drought vulnerability for stakeholders in the Upper Missouri River Basin.

In May 2016, BWC and the Big Hole Watershed Committee co-sponsored an informational meeting on cloud seeding in Dillon. A hydrometeorologist and an engineer from Idaho Power gave presentations at the meeting which was attended by local farmers and ranchers, DNRC, MCO, Montana Farm Bureau, and candidates running for the Montana legislature. Some attendees articulated their interest in developing cloud seeding programs in Montana, while others remained concerned about the potential for Idaho Power's program to diminish water supplies in Montana.

V. Vulnerabilities Described in Other Plans

Several of the planning documents listed in Section 3 describe drought-related vulnerabilities and water supply disruption threats. This DRP recognizes these vulnerabilities and supports the proposed remedies described in those plans.

Wildfire – Several plans describe wildfire vulnerability factors which are closely related to drought. These plans include the BLM Dillon Resource Management Plan, the BLM Watershed Assessments, the Beaverhead-Deerlodge Forest Plan, the Beaverhead CWPP, and the Beaverhead County PDM. Among the resource concerns described in these plans that contribute to wildfire vulnerability in the Beaverhead Watershed and its headwaters are: forest stand density; spruce budworm and whitebark pine beetle infestation; conifer encroachment on rangeland and wetlands; decrepit willow bottoms; and noxious weeds. These resource concerns pose threats to public infrastructure and private property at the wildland-urban interface; forest runoff yield; water quality; forage production and livestock grazing; and wildlife and fisheries.

City of Dillon Water System – The 2009 Beaverhead County PDM describes the vulnerability of critical infrastructure, including the City of Dillon's municipal water infrastructure, to earthquakes. There are several fault lines in the Beaverhead Watershed and its headwaters, and the area has a history of earthquakes. FEMA's HAZUS-MH loss estimation software program estimated potable water infrastructure could incur up to $5.2 million in damages from an earthquake. The PDM rates the expected impact from an earthquake to critical infrastructure such as the municipal water system as moderate-high.

According to the PDM, other sources of vulnerability for the potable water supply infrastructure include drought (low-moderate), and energy and utility failure (moderate).

Blacktail Deer Creek - Blacktail Deer Creek has been identified by the Beaverhead County Commissioners, Beaverhead County DES, and the 2009 Beaverhead County PDM as posing a flood risk to multiple subdivisions southwest of Dillon. Several undersized culverts and low bridge crossings on Blacktail Road contribute to frequent ice jamming in the winter, causing water to be rerouted out of the channel over roads and bridges, and through roadside ditches and borrow pits. This can lead to damage of private property including homes, irrigation systems, and livestock, and public infrastructure including roads, bridges, and powerlines. Many of the subdivisions at risk are not currently built out. Of the homes currently present, many are built within the floodplain which contributes to their higher risk. There is the potential for more homes to be built in the floodplain as the subdivisions are built out.

Figure 40. Left: Beaverhead County DES Coordinator, Tom Wagenknecht points out flooding around a powerline off of Blacktail Road southwest of Dillon. Right: Blacktail Deer Creek water flowing through a ditch along Blacktail Road. (Photos courtesy: Ann Schwend, DNRC, February 2016)

While the primary concern that has been formally identified by Beaverhead County relates to flood, efforts to mitigate this vulnerability through improving channel and floodplain function can also improve drought resilience in the Beaverhead Watershed. These drought resilience benefits would come in the form of improved habitat and connectivity for fisheries, mitigation of erosion and sediment-related water quality impairments, and natural water storage and retention. Protecting and improving fish habitat and connectivity throughout the Beaverhead Watershed has been identified as a priority by BWC and FWP. Furthermore, TNC has identified the Blacktail watershed as especially important for fisheries because it contains well-shaded north-facing mountain peaks which can retain snowpack and moisture longer, contribute cooler flows later into summer, and offer short and long term thermal refugia. Sediment impairment has been identified by DEQ and BWC in the Beaverhead WRP as being the primary water quality concern in the Beaverhead Watershed. And natural water storage and retention in floodplains, riparian areas, and wetlands has been identified by DNRC in the State Water Plan as an important strategy for improving drought resilience. Therefore, it can be said that multiple agencies and stakeholders have an interest in improving the functionality of the channel and floodplain of Blacktail Deer Creek to reduce both flood and drought vulnerability.

Section 6: Mitigation Actions

Overview

This section identifies, evaluates, and prioritizes mitigation actions and activities that will build long-term resiliency to drought and mitigate the risks posed by drought. Mitigation measures are actions, programs, and strategies implemented before drought to address potential risks and impacts. These actions are outside of regular water management activities and are intended to decrease sector vulnerabilities and reduce the need for response actions. The proposed mitigation actions in this section are based on the drought vulnerabilities described in Section 5. Planning and implementation of these proposed mitigation actions will require additional expertise and resources from both public and private sources. This section also describes existing mitigation actions that are ongoing in the Beaverhead Watershed and its headwaters.

Proposed Mitigation Actions

I. Measure Red Rock River and Horse Prairie Creek stream flows to Improve Water Supply Forecasting

Placing real-time stream gaging stations on the Red Rock River and Horse Prairie Creek is a top priority for BOR, NRCS Snow Survey, EBID, CCWSC, DNRC, and FWP. These gaging stations will allow BOR, NRCS Montana Snow Survey, and ACE to incorporate valuable datasets into water supply forecast models which simulate snowmelt, runoff, and reservoir storage. Forecasters regard CCR water supply as one of the most challenging hydrologic forecasts to make in Montana. Irrigators rely on these forecasts to set annual irrigation allotments, and for seasonal financial and land-use planning. There are three sources of water for CCR including the Red Rock River, Horse Prairie, and groundwater accretions. However, none of these sources are currently measured directly. Instead the model calculates and simulates reservoir inflow sources cumulatively. Differences between the Red Rock and Horse Prairie watersheds in terms of spatial area, seasonal precipitation patterns, and irrigation patterns make it important to model the two watersheds separately in order to more accurately assess their snowmelt and runoff patterns. Installation of these gauges will improve economic and environmental resilience to drought by improving water supply forecast resolution and accuracy and by helping irrigators make better-informed water management decisions.

Component	**Cost**
SUTRON 8310 DCP	$3,675
SUTRON Constant Flow Bubbler	$3,215
36" x 24" x 12" NEMA enclosure	$750
SUTRON crossed YAGI Antenna w/15-foot cable	$500
10-W Solar Panel w/mounting bracket	$300
12 V Battery	$75
Miscellaneous wires/cables/lumber	$500
Labor to install site (2 people for 3 days)	$5400
Total	**$14,415**

Figure 41. Cost breakdown of one BOR Hydromet stream gauge. (Courtesy: Stephanie Micek, BOR)

BOR, NRCS Snow Survey, FWP, DNRC, and BWC have agreed that the ideal site for the stream gage on Horse Prairie Creek is located at approximately Latitude: 44.977834°, Longitude: -112.944160°. This site is ideal because it is downstream of the confluence of Horse Prairie Creek and Medicine Lodge Creek; flows are confined to a single channel; and there is a bridge crossing which provides good access for maintenance and measuring high flows. However, the site is located on private land and would require a memorandum of understanding with the landowner which would ensure long term accessibility to the gage for maintenance. If such an agreement cannot be secured, the second option would be to place a stream gage on Horse Prairie Creek at approximately Latitude: 45.014137°, Longitude -113.226110°, which is downstream from the confluence of with Bloody Dick Creek and is also at a point of flow confinement into a single channel. However, this site is also on private land and would also require a memorandum of understanding with the landowner.

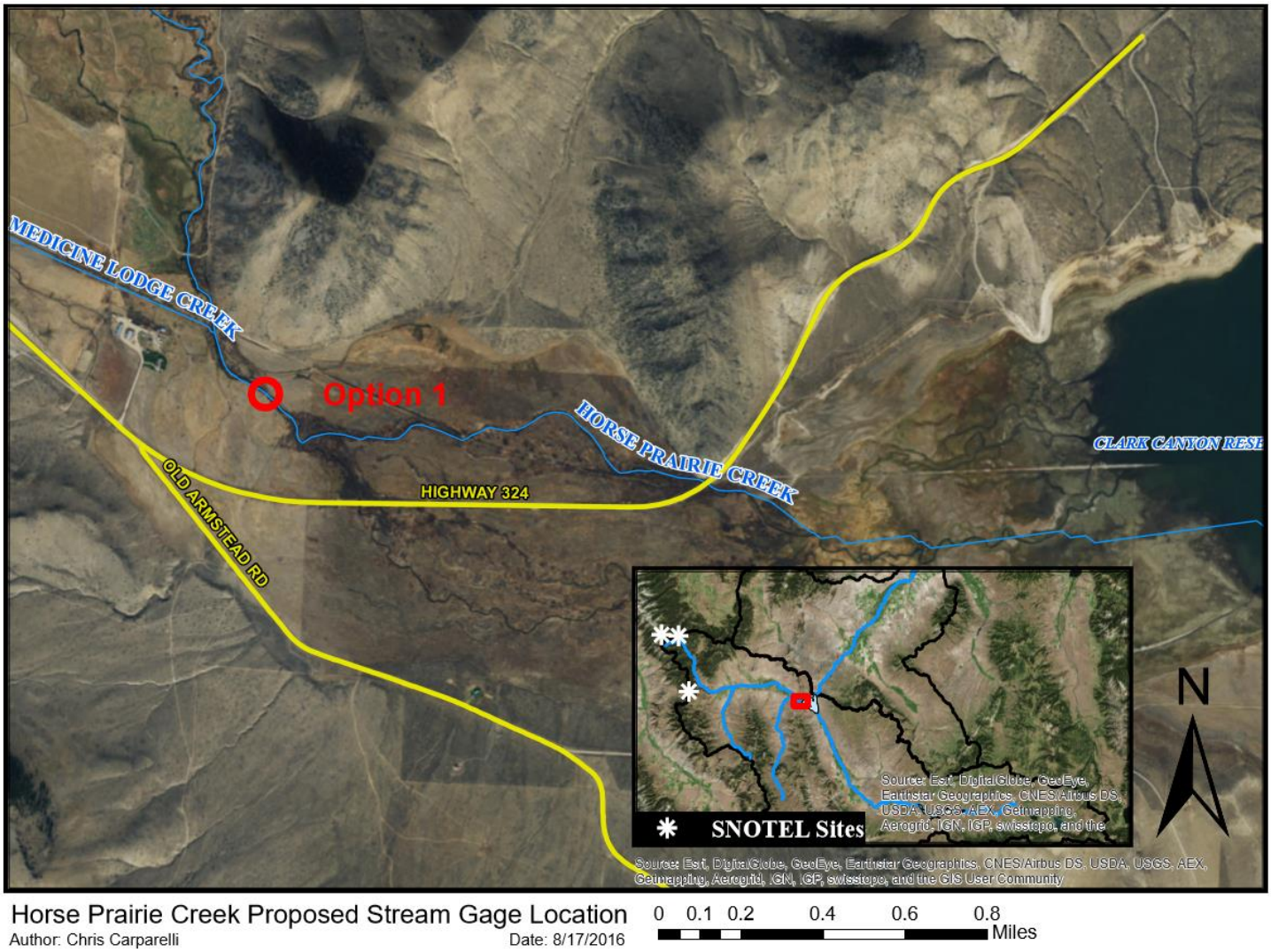


Figure 42. Potential stream gage site on Horse Prairie Creek.

BOR, NRCS Snow Survey, FWP, DNRC, and BWC have agreed that the ideal site for the stream gage on the Red Rock River is located at the Roe Lane bridge (Figure 43) at approximately Latitude: 44.915013°, Longitude: -112.827020°. This site is ideal because all Red Rock flows are confined to a single channel; there is a bridge crossing which provides good access for maintenance and measuring high flows; and the site is far

enough upstream of the reservoir to avoid any backwatering affect. However, the site is also located on private land and this site would require a memorandum of understanding with the landowner which would ensure long term accessibility to the gage for maintenance. If such an agreement could not be secured, the second option would be to place the gage on BOR land at Latitude: 44.918774°, Longitude: -112.834590°.

Figure 43. Potential stream gage sites on the Red Rock River.

Grant funding may be an option to cover equipment and installation costs. However long-term sustainability of funding for annual operations and maintenance is highly dependent upon agency budgets and stakeholder support. In the event that stream gages cannot be deployed within the next two years (by 2018), it would be worthwhile to begin collecting data using temporary instrumentation such as TruTrack data loggers. Several agencies and conservation NGOs such as DNRC, USFS, and TNC have this equipment on hand and have expressed some willingness to assist with measuring stream flows on the Red Rock River and Horse Prairie Creek. While this temporary solution would not provide real-time data, it would provide logged data that would be useful for initializing a period of record and integrating into BOR water supply forecasting models.

Stream Gage Cost Comparison	Estimated Equipment + Installation Cost	Annual O&M Cost	Network Contact
USGS	$2k - $3k	$17,250 (3% annual increase)	Wayne Berkas
BOR	$14k -$15k	$3k -$5k /gage/yr	Stephanie Micek
DNRC	$12k - $13k	$5k/gage/yr	Matt Norberg

II. Evaluate Management Alternatives to Improve CCD Overwinter Releases for Beaverhead Fishery

FWP has worked with BOR and ACE to explore opportunities to create greater operational flexibility for CCR to allow for the possibility of storage in the exclusive flood control pool. While FWP has recommended a minimum of 200 cfs for instream flow reservations, it has stated a willingness to concede that target in favor of achieving greater annual consistency of overwinter releases. The current "boom and bust" pattern of overwinter releases is depicted below in Figure 42. FWP's goal would be to release less water over the winter during wet years like 2010, 2011, and 2012 and store more of that water in the flood control pool, in hopes that this stored water would then be available to enhance CCR overwinter releases during subsequent dry years like 2013, 2014, and 2015.

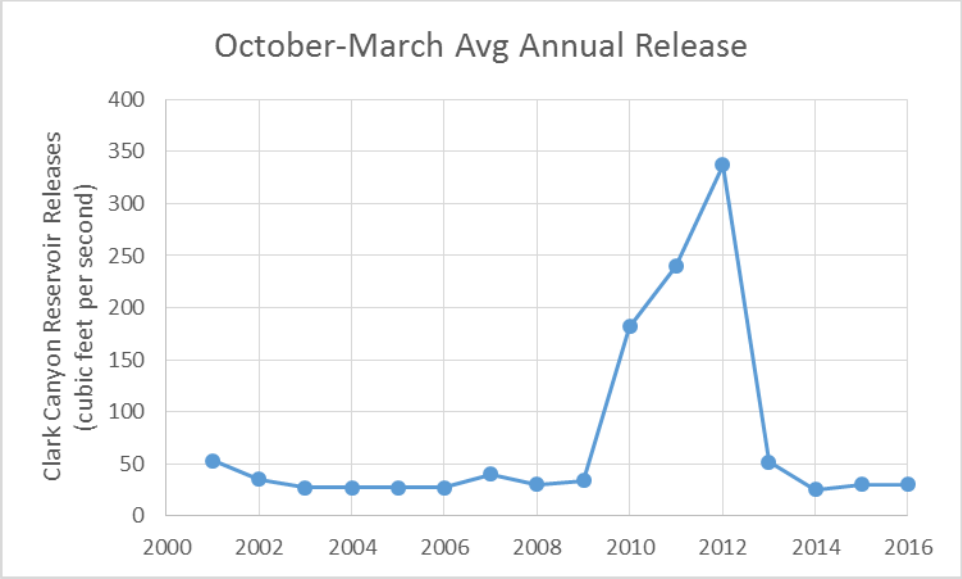


Figure 44. Clark Canyon Reservoir overwinter releases 2001-2016.

In 2015, at FWP's request, BOR completed some preliminary reservoir modeling exercises to evaluate the benefit of raising the flood control pool elevation by 4 feet (to 5550.1 feet) and limiting overwinter releases to 100 cfs during some wet years. The results show that these operational adjustments do have some potential to improve the annual consistency of CCR overwinter releases (Figure 37).

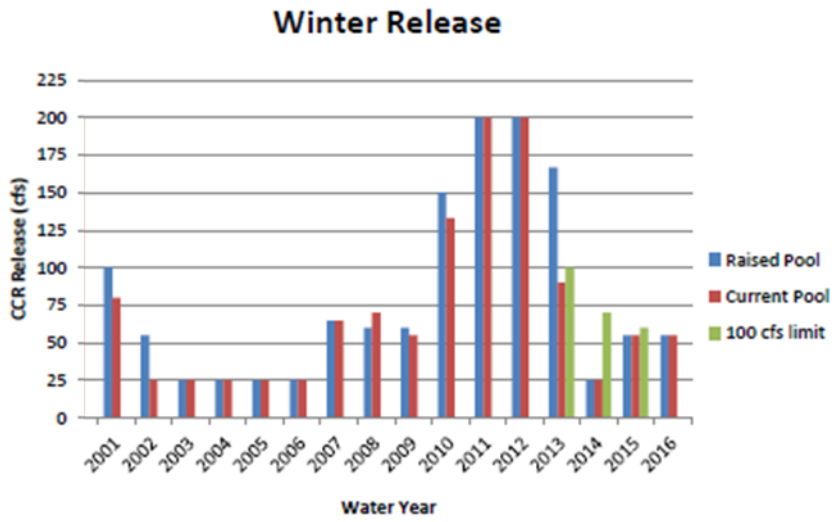


Figure 45. Modeled CCR releases with 4-foot increase in flood control pool elevation and 100 cfs overwinter release limits for some years. (Courtesy: Stephanie Micek, BOR)

Any adjustment in reservoir operations must balance the risks of flood and drought. Records of CCR's annual inflows show that drought has been a more consistent threat than flood (Figure 38). It should be noted that 1984 was the only year in CCR's history that water was routed through the spillway. Meanwhile, reservoir inflow records indicate that the climate has shifted toward a drier regime on average over the last 30 years.

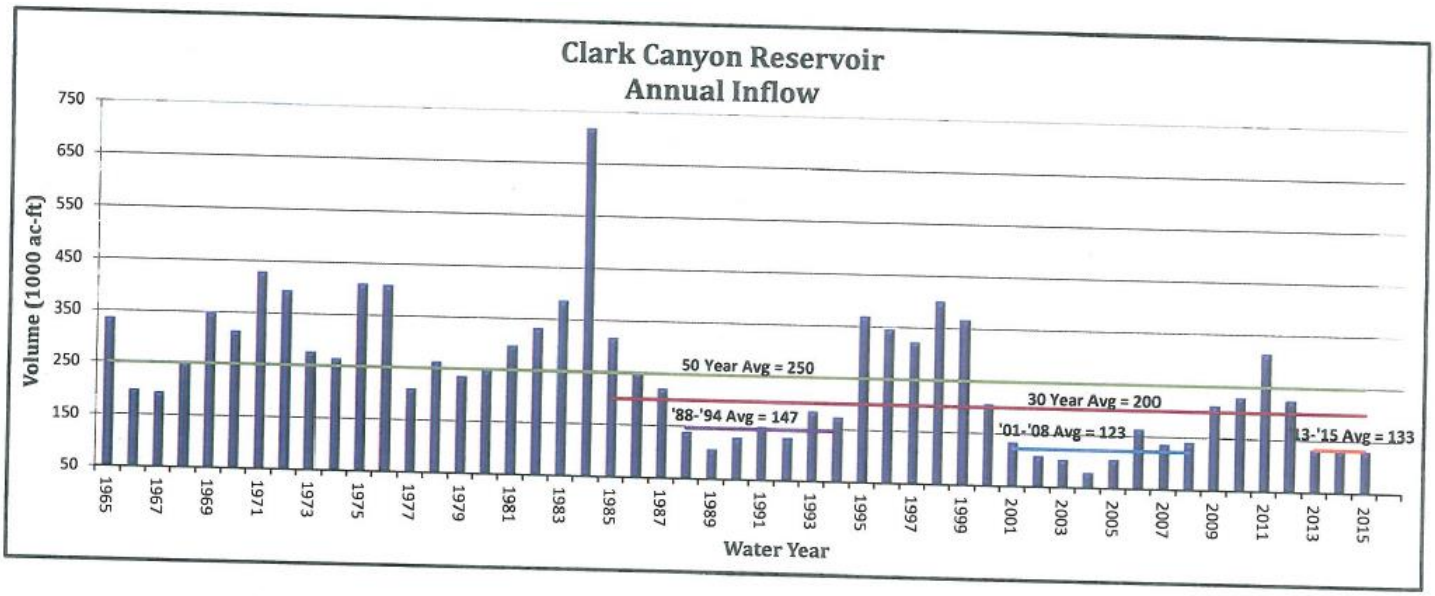


Figure 46. Clark Canyon Reservoir Annual Inflows (Courtesy: Stephanie Micek, BOR)

There is recent precedent for allowing water to be stored in the exclusive flood control pool. In 2015, ACE approved the storage of 5,825 AF in the flood control pool of Lake Mendocino in California in order to protect public water supplies and aquatic ecosystems against drought conditions. California legislators are also hoping to get ACE to revise its operations manual for Lake Mendocino in order to prevent "untimely and wasteful release of water" by incorporating more NOAA weather and climate forecast information into decision making processes.

In early 2016, FWP, BOR, ACE, and BWC engaged in a discussion of this proposed mitigation action. This discussion identified several challenges regarding storage of water in the flood control pool of CCR. These challenges included the high cost of a feasibility study, questionable frequency of years with sufficient inflows to provide flood pool storage opportunities, questionable cost-benefit ratio, potential flood risk and dam safety issues, potential need for renegotiation of the EBID and CCWSC repayment contract with BOR, and reluctance on the part of stakeholders and agencies to invest time and money in contract renegotiation. Given these challenges, it is recommended that agencies and stakeholders evaluate alternative strategies for improving overwinter releases from CCD for the benefit of the Beaverhead River fishery.

III. Agricultural Soil Health Demonstration Project

Soil health demonstration projects are taking place in several areas throughout Montana and provide many examples for project design and implementation. One strategy has been to demonstrate soil health management practices with participation from multiple local producers. In recent years, several Montana conservation districts have utilized DNRC's HB223 grants to offer local producers cost-share for cover crops seed, allowing those producers to experiment with cover crops on small parcels of their own land (20-25 acres) for three to five years. This multi-producer approach can help soil health demonstration projects to incorporate variability and diversity of weather and climate patterns, soil types, resource concerns, and management practices. It can also engender producer-to-producer dialogue regarding management challenges and successes.

Another soil health demonstration approach is to establish a single local demonstration plot. This was the approach taken by the Ruby Habitat Foundation which partnered with the NRCS Sheridan Field Office on a series of agricultural soil health trials on the Woodson Ranch in Madison County between 2011 and 2015. They tested different practices related to tillage, fertilization, companion cropping, and crop rotation to compare how they affected yields, input costs, net profit, soil composition, and soil nutrient levels.

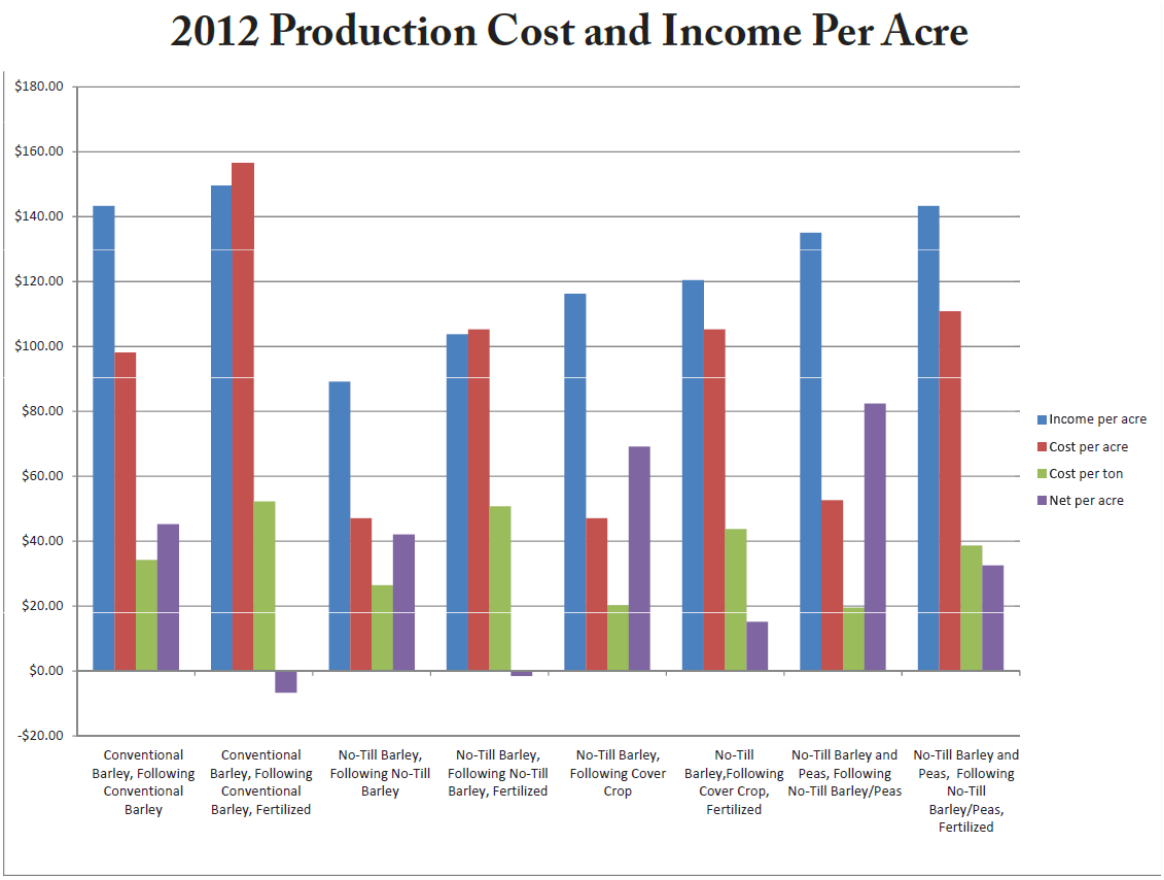


Figure 47. A figure from the 2013 update of the Ruby Habitat Foundation and NRCS soil health project in Madison County. (Courtesy: Ruby Habitat Foundation and NRCS)
Website: http://198.199.118.142/home/projects/current-projects/soil-health-project/

BCD and the NRCS Dillon Field Office are interested in doing some type of soil health demonstration project in the Beaverhead Watershed. This would afford the opportunity to learn about and demonstrate the potential economic and environmental benefits of practices like input reduction, cover cropping, no-till, and MIRG in the specific agricultural context of the Beaverhead Watershed. The drought resilience benefits that have been demonstrated elsewhere from improvement in soil health include:

- Improvements in agricultural water use efficiency:
    - Improved soil infiltration rate due to increased soil porosity.
    - Improved soil water holding capacity due to increased soil porosity.
    - Reduced runoff due to reduced soil compaction and improved canopy cover.
    - Reduced soil moisture evaporation due to reduced soil surface temperature and improved canopy cover.
    - Reduced soil erosion caused by wind and water due to increased amount and duration of soil surface cover by residual organic matter.
- Opportunities to improve annual net profit margins for producers:
    - Reduced fertilizer application due to improved nutrient availability and cycling facilitated by cover crop cocktails.

    - Reduced herbicide application due to reduced weed pressure resulting from increased residual organic matter armoring soil surface, more competitive agricultural plant communities, and less selective grazing by livestock in MIRG systems.
    - Reduced pesticide application due to biodiverse cropping systems which support more predator species and keep pest species in check.
    - Reduced fuel costs due to fuel-efficiency of no-till seeding, reduced need for field conditioning, reductions in petrochemical application, and potential reduction or elimination of the need to put up hay.
    - Increased livestock daily weight gains through MIRG systems.
    - Reductions in veterinary costs due to improvements in livestock health.
    - Reductions in pest control costs for livestock due to frequent movement and less grazing of plants down to soil surface level where most pests live.
    - Increases in dry matter forage production and crop yield.
- Other potential drought resilience benefits to the watershed include:
    - Improved surface water and groundwater quality due to reductions in soil erosion and petrochemical inputs.
    - More water available for junior water right holders and instream flows due to improved agricultural water-use efficiency.
    - Reduction of producers' risk exposure to curtailments of irrigation allotments and public land grazing allotments.

In April 2016, BCD and NRCS met with local producers and representatives from local agribusinesses to discuss their perspectives on what a soil health demonstration project in Beaverhead County should seek to demonstrate. General feedback included:

- Economic viability of soil health practices.
- Relationship between soil organic matter and water holding capacity.
- Relationship between soil health practices and crop/forage production.
- Increase biodiversity by testing viability of new crop types, mixes, and rotations.
- Extended fall livestock grazing to reduce hay feeding.
- Improve local producers' access to and understanding of effective equipment such as heavy no-till drills and vertical tillers that can help improve soil health.

A soil health demonstration project would provide BCD, NRCS, and other potential partners with a venue for ongoing soil health research and education programming for producers, youth, and other members of the community. It would also improve the ability of these organizations to provide credible and context-specific expertise and advice to producers that need assistance with implementation of conservation management practices.

Soil Health Demonstration Project Funding Options	Funding Source	Amount	Match Requirement	Deadline
HB223 Conservation District Grant	DNRC	Max $20k	None	Quarterly. 2016: January, April, July, October
Grants and Education to Advance Innovations in Sustainable Agriculture	Western SARE	Varies	Varies	Variable. 2016: November/December
Advancing Soil Health, Conservation, and Outreach on Grazing Lands	National Grazing Lands Coalition	$5k to $10k	50% non-Fed	Varies. Likely early 2017
Conservation Innovation Grant	NRCS	Up to $2m	50% non-Fed	2016: May
319 Nonpoint Source Management Program	DEQ	Varies. 2016: $50k -$300k	40% non-Fed	2016: July

IV. Research Effects of Cloud Seeding on Downwind Hydrology

Stakeholders in the Beaverhead Watershed and its headwaters are concerned about the effects of Idaho's orographic cloud seeding operations in the Upper Snake River Basin on water supply in the Upper Missouri Basin. Other orographic cloud seeding operations throughout the intermountain west in places like Wyoming, Utah, and Colorado have also raised water supply concerns among downwind stakeholders. The majority of scholarly research on orographic cloud seeding has focused either on its efficacy for providing benefits to the target watersheds and stakeholders, or on the localized downwind impacts from cloud seeding on shorter timescales. Therefore, this DRP recommends that research institutions independently investigate the effects of cloud seeding on downwind landscapes and hydrology. One recommended approach is to expand the spatial and temporal domains of atmospheric circulation model runs comparing precipitation with cloud seeding versus precipitation with no cloud seeding. This approach would be useful for exploring the total effect of all cloud seeding generators in Idaho on western portions of Montana over the course of seasons, years, and decades. This research should be repeated on a periodic basis to reexamine whether the increases in number of generators, changes in frequency of generator operation, or the increasing period of time that generators are operable may change conclusions drawn by previous studies. Statistical significance and uncertainty measures should be included in these studies because they have very often been omitted from previous studies. Institutions that may be able to conduct with this research include CIRC, NOROCK, WERA, MCO, NDMC, and NPRCH.

V. Support Proposed Mitigation Actions from Other Plans

Wildfire – This DRP supports wildfire mitigation recommendations described in the BLM Dillon Resource Management Plan, the BLM Watershed Assessments, the Beaverhead-Deerlodge Forest Plan, the Beaverhead CWPP, and the Beaverhead County PDM. Among the recommended wildfire mitigation actions are prescribed fire, mechanical treatment, livestock grazing, noxious weed management, and commercial timber harvest. Please refer to the afore-mentioned plans for specific recommended applications of these mitigation actions.

City of Dillon Water System – This DRP supports the City of Dillon's efforts to mitigate the risk of disruptions to its municipal water system due to earthquake, drought, groundwater contamination, and utility and energy failure. Projects to mitigate these risks may include water main replacement, installation of shutoff valves, and additional city water system wells.

Furthermore, this DRP recommends the City of Dillon engage in community source water assessment and protection. The City of Dillon's groundwater wells on the west side of town are in close proximity to a concentrated animal feeding operation, as well as the city's old decommissioned landfill. It is unclear to what extent these sites pose a threat to the public drinking water supply. The Beaverhead Trails Coalition has agreements to purchase the land occupied by the animal feeding operation and the old landfill within the next ten years, pending funding. The City of Dillon may be able to assist with securing funding for this land acquisition and source water protection through EPA: https://www.epa.gov/sourcewaterprotection/funding-source-water-protection .

Blacktail Deer Creek – This DRP supports the Beaverhead County PDM plan's recommendation to mitigate flood hazard on Blacktail Deer Creek by improving culverts and bridge crossings on Blacktail Road. Restoring the channel and floodplain of Blacktail Deer Creek to proper functioning condition will mitigate vulnerability to both flood and drought. Drought vulnerabilities that figure to be mitigated through implementation of this recommendation include water quality protection through reductions in sediment loading, and improved fisheries habitat quality and connectivity.

Existing Mitigation Actions

Floodplain Restoration

DNRC's Montana State Water Plan identifies the need to explore the use of natural water storage and retention to benefit water supplies and ecosystems. Currently, there are many headwaters streams in southwest Montana that have experienced significant losses of riparian vegetation and channel down-cutting over the last century. As a result, many of these streams are cutoff from their historical floodplains.

To address these issues, TNC is spearheading experimentation with various floodplain restoration techniques in the Centennial Valley, including beaver mimicry and construction of gravel-core structures. These techniques place brush or gravel-core structures in incised streambeds with the intent of slowing stream flows, especially during spring runoff. Slowing stream flows enables more sediment to be deposited in the streambed over time, thereby aggrading the streambed. By raising the elevation of the streambed, the stream will eventually be able to re-access its historical floodplain. The potential benefits of this strategy include raising the water table;

improvement of riparian vegetation and wildlife habitat; reductions in sediment loading; reductions in surface water evaporation; reductions in stream temperatures through improved riparian shading and groundwater exchange; and improvements in late season flows downstream. Given that future climate scenario projections favor earlier spring runoff, these floodplain restoration strategies hold promise for mitigation and adaptation to these changing conditions.

TNC is also looking at the annual solar insolation of headwaters streams to evaluate which streams have the greatest potential to contribute cold water to the overall system. This is one of TNC's evaluation criteria for selecting sites for floodplain restoration. More information about TNC's conservation efforts in southwest Montana can be found by visiting:
http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/montana/placesweprotect/southwest-montana.xml .

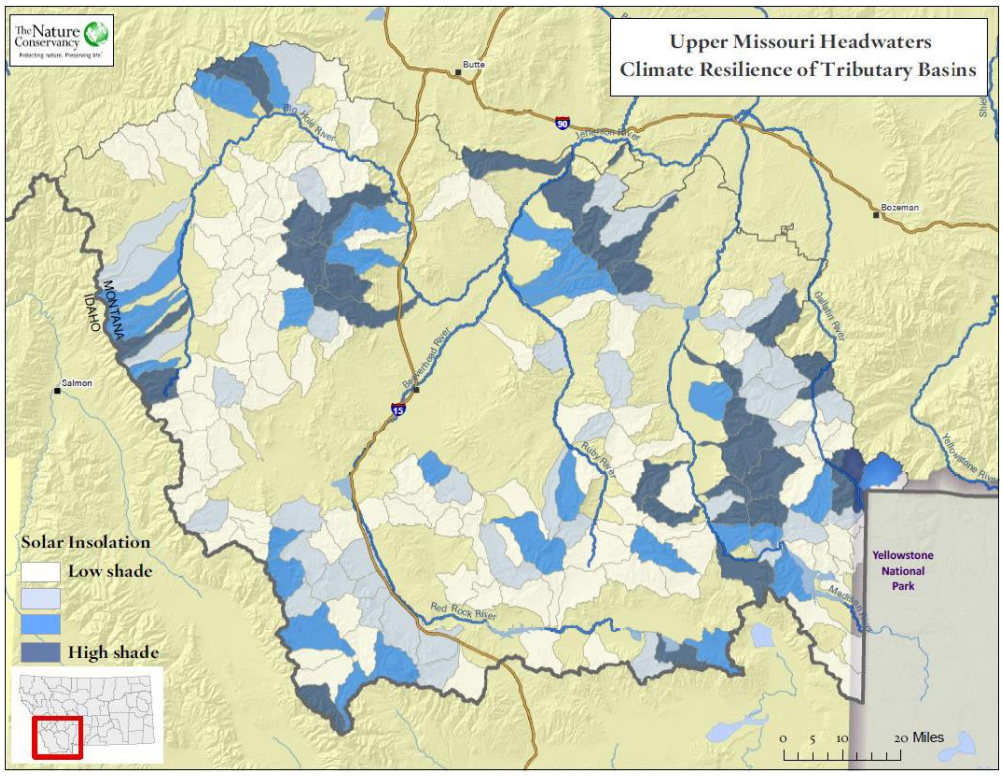


Figure 48. Relative solar insolation of headwaters streams in southwest Montana. (Courtesy: Nathan Korb, TNC)

Wildfire Mitigation

Several agencies including Beaverhead County, BLM, USFS, NRCS and DNRC are active in wildfire risk mitigation in the Beaverhead Watershed and its headwaters. Their primary wildfire mitigation objectives are to protect lives and property, and to avoid large, high intensity crown fires. Risk areas to be mitigated include high forest stand density, beetle-induced tree mortality, conifer encroachment on rangelands and riparian areas, decrepit willow bottoms, and noxious weeds. Common strategies for mitigating these risk areas include

prescribed fire, mechanical treatment, livestock grazing, and commercial timber harvest. More information about wildfire mitigation activities in the Beaverhead Watershed and its headwaters can be found in the Beaverhead CWPP, the Beaverhead County PDM, the Beaverhead-Deerlodge Forest Plan, the BLM Watershed Assessments, and the BLM Dillon Resource Management Plan.

Red Rock Arctic Grayling Candidate Conservation Agreement with Assurances

Arctic grayling were once abundant in the entire Upper Missouri Basin upstream of Great Falls, and could also be found in Michigan. The only remaining native populations of Arctic grayling in the U.S. reside in the Big Hole River and the Upper Red Rock watershed above Lima Dam. Arctic grayling are particularly vulnerable to drought because they become stressed when stream temperatures reach 63°F, and they cannot survive when stream temperatures exceed 73°F. For comparison, 77°F is considered by FWP to be the potentially lethal stream temperature threshold for rainbow and brown trout. In order to avoid listing under the Endangered Species Act (ESA), stakeholders in the Big Hole watershed entered into a Candidate Conservation Agreement with Assurances (CCAA) with USFWS, NRCS, FWP, and DNRC. Participants in the CCAA agreed to make voluntary changes in water management to preserve the native grayling population and habitat and were successful in avoiding ESA listing. In the event that their voluntary efforts were unsuccessful in preventing listing, they were assured that they would be protected from potential future legal obligations to make certain further adjustments in water management under the ESA.

FWP, USFWS, and local landowners in the Centennial Valley are currently working to establish a CCAA to protect the grayling population in the Upper Red Rock watershed.

Sage Grouse Initiative

The Sage Grouse Initiative is aimed at protecting Greater Sage Grouse habitat in the western U.S. through sustainable range management and livestock grazing systems. These management efforts dovetail with maintaining and improving drought resilience of rangelands. More information on the Sage Grouse Initiative can be found at: http://www.sagegrouseinitiative.com/ .

Beaverhead Watershed Restoration Plan

The Beaverhead WRP is important for drought mitigation because it is designed to systematically address and reduce water quality impairments throughout the watershed. These water quality impairments become exacerbated if drought-induced low stream flows increase concentrations of stream contaminants and stream temperatures. Examples of mitigation actions implemented by BWC through the Beaverhead WRP include riparian revegetation, culvert replacement, off-stream stock water, stock water fencing, and sediment flushing flows.

Section 7: Response Actions

Overview

This section identifies, evaluates, and prioritizes response actions and activities that can be implemented during a drought to mitigate impacts. Response actions are different than mitigation measures in that they are triggered during specific stages of drought to manage the limited supply and decrease the severity of immediate impacts. Response actions can be quickly implemented and provide expeditious benefits. The proposed response actions in this section are based on the drought vulnerabilities described in Section 5. Planning and implementation of these proposed response actions may require additional expertise and resources from state and Federal government. This section also describes existing response actions that are commonly utilized in the watershed.

Proposed Response Actions

IV. Triggers for Idaho Cloud Seeding Reduction or Cessation

A scientific study of the hydrologic effects of Idaho Power cloud seeding on the Beaverhead Watershed and its headwaters may be more expensive and time consuming than stakeholders in Beaverhead County can afford. Asking legislatures and/or judiciaries to make decisions based on such highly complex scientific studies would likely be incredibly difficult and would certainly multiply the expenses of time and money. Furthermore, it would prove to be a tremendous waste of these resources if these processes yielded no change in the status quo. Therefore, it may be most prudent for Beaverhead County stakeholders to avoid expensive and litigious strategies for addressing this matter in favor of other resolution approaches.

This plan recommends that Beaverhead County stakeholder groups such as DTF, CVA, WUIC, EBID, CCWSC, BWC, and BCD, engage Idaho Power and HCRCD in discussions about local concerns and negotiate a resolution that is workable for both parties. Two potential resolutions that could be sought are:

- Idaho Power and HCRCD voluntarily reduce or cease cloud seeding operations when areas within the Red Rock Watershed are designated as “D3 Extreme Drought” and/or “D4 Exceptional Drought” by USDM. Such a gesture of good will on the part of Idaho Power and HCRCD would potentially help avoid the exacerbation of drought conditions or inhibition of drought recovery in the Beaverhead Watershed and its headwaters.
- Idaho Power and HCRCD provide information about timing, location, and magnitude of cloud seeding operations to DTF on either a monthly or seasonal basis. This would create transparency and would foster greater stakeholder understanding of the Idaho cloud seeding operations and effects.

V. Develop a City of Dillon Water Conservation Plan

Many municipal water providers have developed plans to conserve water in the face of reduced supply. While drought has not posed a significant threat to the quantity of the City of Dillon’s water supply in the past, this DRP recommends that the City of Dillon consider developing a water conservation plan in case such a scenario does arise in the future. Elements of the plan may include:

- Lawn watering restrictions or guidelines
    - "Odd-even" days which ask residents to water only on a certain day of the week depending on the last digit of their street address.
    - Guidance on when to water (early mornings or evenings).
    - Conservation that escalates from voluntary to mandatory depending on drought severity.
- Public education and outreach
    - Raise awareness about drought conditions through newspaper, radio, and electronic signage around town.
    - Raise awareness about how household water conservation improves overall community drought resilience.
    - Provide literature/brochures with water saving tips.
    - Raise awareness about per capita and householder water use statistics.

Existing Response Actions

EBID-CCWSC Drought Management Plan

The EBID-CCWSC Drought Management Plan provides a framework for incremental reductions in irrigation allotments based upon water supply forecasts provided by BOR, NRCS, and ACE. This framework is given by the table below:

	August EOM Forecasted Levels	CCWSC Allotments	EBID Allotments
Full Allotment	> 50,000 AF stoarge	4 AF/acre	3.1 AF/acre
1st Reduction	50,000 - 40,000 AF storage	3.5 AF/acre	2.7 AF/acre
2nd Reduction	40,000 - 30,000 AF storage	3.25 AF/acre	2.25 AF/acre
3rd Reduction	30,000 - 10,000 AF storage	3.0 AF/acre	2.0 AF/acre
4th Reduction	10,000 AF minimum storage	3.0 AF/acre	< 2.0 AF/acre or bank*

Figure 49. Reservoir storage thresholds for CCR drought management plan. *Bank is defined as carrying over irrigation water saved from one irrigation season to the next irrigation season.

Angling Restrictions

FWP has a specific set of stream flow and temperature thresholds for salmonids to guide decisions regarding stream closures. FWP's Fisheries Biologist may choose to close streams to angling if:

- Flows are at the 95% daily exceedance level (1-in-20-year low flows)
- Daily maximum water temperature reaches or exceeds 73° F (23° C) for at least some period of time during three consecutive days.

Closures on some streams may create overcrowding and excessive angling pressure on other nearby streams that remain open. In these instances, FWP may choose to implement restrictions on streams that have not exceeded flow or temperatures thresholds to alleviate angling pressure. Stream closures may be "hoot owl" closures, which prohibit fishing between the hours of 2:00 pm and 12:00 am, or full closures which prohibit

angling at any time of day on designated streams. A stream may be re-opened to fishing by FWP if the water temperature does not exceed 70.0° F for three consecutive days.

The upper portion of the Beaverhead River is a tailwater fishery which receives regulated releases of relatively cool water from CCD, and therefore it tends to be less susceptible to summer closures due to stream flow and temperature threshold exceedances. However, the Beaverhead River becomes increasingly susceptible to stream flow and temperature threshold exceedances the further downstream from CCD one goes.

Wildfire Response

Local wildfire response in the Beaverhead Watershed and its headwaters is coordinated from USFS's Dillon Interagency Dispatch Center. The 2015 Dillon Interagency Local Mobilization Guide and Dispatch Operating Plan describe how USFS, BLM, and DNRC work together to respond to wildfires and other emergencies. This plan can be found here: http://gacc.nifc.gov/nrcc/dc/mtddc/dispatch/ddc_dispatch.htm .

The Northern Rockies Coordination Center in Missoula is responsible for regional coordination of wildfire response activities in Montana, northern Idaho, Yellowstone National Park, North Dakota, and a portion of South Dakota: http://gacc.nifc.gov/nrcc/index.htm .

The National Interagency Fire Center is located in Boise, Idaho and coordinates the national mobilization of resources for wildland fire and other incidents throughout the U.S. Its member agencies include USFS, BLM, NWS, USFWS, the Bureau of Indian Affairs, the National Park Service, and FEMA. Its four primary operational elements include equipment and supply dispatching; overhead and crew dispatching; aircraft dispatching; and intelligence and predictive services. NIFC also coordinates the Burned Area Emergency Response (BAER) program. The BAER objectives are to determine if an emergency condition exists after a fire; alleviate emergency conditions to help stabilize soil; control water, sediment, and debris movement; prevent impairment of ecosystems; mitigate significant threats to health, safety, life, property, and downstream values at risk; and monitor the implementation and effectiveness of emergency treatments. More information about NIFC, its member agencies' fire management directives, and BAER can be found at: http://www.nifc.gov/BAER/Page/NIFC_BAER.html.

Clark Canyon Flushing Flows

Clark Canyon Creek is the first major tributary that joins the Beaverhead River below CCD. The Clark Canyon Creek watershed experienced wildfire in 2006, and is prone to dumping heavy sediment loads into the Beaverhead River, especially following rain on snow events. These sediment events pose a threat to the tail water fishery in the Beaverhead River. When flows in the Beaverhead are low, the sediment load cannot be transported and instead settles in the streambed damaging fish spawning habitat and smothering eggs.

To address this issue, FWP, BWC, EBID, CCWSC, and BOR forged an agreement in 2013 to store 2,000 AF of water in CCR each winter that can be used as a flushing flow to dilute sediment pulses out of Clark Canyon Creek and keep them mobilized downstream. This flushing flow storage account accrues over each winter by reducing the annually established overwinter releases from CCD by an additional 5 cfs. More information about CCR flushing flows can be found at: http://www.beaverheadwatershed.org/resource-library/

Farm Service Agency Programs

The 2014 Farm Bill made the Livestock Forage Disaster Program (LFP) a permanent program and provides retroactive authority to cover eligible losses back to Oct. 1, 2011. LFP provides compensation to eligible livestock producers that have suffered grazing losses for covered livestock on land that is native or improved pastureland with permanent vegetative cover or is planted specifically for grazing. The grazing losses must be due to a qualifying drought condition during the normal grazing period for the county. LFP also provides compensation to eligible livestock producers that have suffered grazing losses on rangeland managed by a Federal agency if the eligible livestock producer is prohibited by the Federal agency from grazing the normal permitted livestock on the managed rangeland due to a qualifying fire.

Livestock producers are eligible for LFP coverage if they own or lease grazing land or pastureland physically located in a county that has met certain USDM thresholds. These USDM thresholds are:

- D2 (severe drought) intensity in any area of the county for at least eight consecutive weeks during the normal grazing period is eligible to receive assistance in an amount equal to one monthly payment;
- D3 (extreme drought) intensity in any area of the county at any time during the normal grazing period is eligible to receive assistance in an amount equal to three monthly payments;
- D3 (extreme drought) intensity in any area of the county for at least four weeks during the normal grazing period or is rated a D4 (exceptional drought) intensity at any time during the normal grazing period is eligible to receive assistance in an amount equal to four monthly payments;
- D4 (exceptional drought) in a county for four weeks (not necessarily four consecutive weeks) during the normal grazing period is eligible to receive assistance in an amount equal to five monthly payments.

FSA's Dillon Field Office offers a range of other drought relief assistance programs to producers including emergency farm loans, noninsured crop disaster assistance, Federal crop insurance, the emergency conservation program, emergency haying and grazing, and emergency stock water. Questions about FSA's drought assistance programs and eligibility should be directed to the FSA's Dillon Field Office: http://www.fsa.usda.gov/FSA/stateoffapp?mystate=mt&area=home&subject=landing&topic=landing .

Adaptive Management of Public Lands Grazing

Livestock are permitted to graze on public lands managed by BLM, USFS, DNRC, and USFWS. Each agency adapts its grazing management when drought conditions are present. Management adaptation measures may include adjustments in stocking density based on forage production of the landscape; adjustments to duration of grazing based upon observation of forage utilization; and adjustments to grazing permit conditions based on long term trends in range health. Specific questions regarding grazing management during drought should be referred to the appropriate agency.

Section 8: DRP Update Process

Overview

Often the distinguishing characteristic between a response-based drought plan and a mitigation-based drought planning process is the articulation and execution of a periodic plan update procedure. Changes in land- and water-use, population, infrastructure, monitoring and forecasting capabilities, and organizational and administrative frameworks happen continuously and at varying rates. Therefore, in order to ensure that this DRP remains relevant and applicable to drought management in the Beaverhead Watershed and its headwaters, it is recommended that this DRP is updated as part of the Beaverhead County PDM plan update process. The following guidelines include target dates for implementation of proposed mitigation and response action items (detailed in Sections 6 and 7), timelines for evaluation of effectiveness of implemented action items, and basic guidance for how to update each of the sections of this DRP.

Frequency and Timing

It is recommended that this plan be updated every five years as part of the Beaverhead County PDM plan update. This update schedule also allows the plan to promptly incorporate updated 30-year climate normal data. The current 30-year climate normal period is 1981-2010. The next plan update should occur in 2021 in order to incorporate the new 30-year climate normal data from the period 1991-2020.

Ideally, the proposed action items described in Sections 6 and 7 will be in some stage of implementation by the next plan update year. For example, the target year for having deployed stream gaging stations on the Red Rock River and Horse Prairie Creek is 2021. If implementation of action items is on schedule, then the effectiveness of these action items should be evaluated during the plan update year that comes ten years after the plan year in which they were articulated. For example, the stream gaging stations on the Red Rock and Horse Prairie were articulated in the 2016 DRP, and assuming they are installed by 2021, an evaluation of their effectiveness should appear in the 2026 update of the DRP. The update schedule for this DRP is given in the table below:

Update Year	30-year Climate Normal Period	Complete Implementation of Action Items from Plan Year:	Complete Evaluation of Action Items from Plan Year:
2021	1991-2020	2016	xxxx
2026	1991-2020	2021	2016
2031	2001-2030	2026	2021
2036	2001-2030	2031	2026
2041	2011-2040	2036	2031
2046	2011-2041	2041	2036
2051	2021-2050	2046	2041

Figure 50. DRP update schedule.

The plan update process should be undertaken during the winter months (November – March) in order to get the greatest participation from stakeholders and agencies that are often busy with fieldwork during the rest of the year. Their participation is critical during the update process because they may offer technical expertise and local knowledge regarding emerging drought vulnerabilities.

Procedural Guidelines

In 2016, the Beaverhead County PDM plan is being updated by a contractor. It is recommended that future contractors or agency personnel tasked with update this DRP follow the basic guidelines listed below.

- **Section 2 Watershed Background**
  - MCO advise on of update *Climate* section.
- **Section 3 Operational and Administrative Frameworks**
  - Determine if any of the listed Procedural and Planning Documents have been updated.
- **Section 4 Drought Monitoring**
  - Survey agencies in charge of monitoring networks to see if new sites have been added.
- **Section 5 Vulnerability Assessment**
  - DTF, BCD, and BWC advise if vulnerabilities need to be added or eliminated from this section.
- **Section 6 Mitigation Actions**
  - Have *Proposed Mitigation Actions* been implemented?
    - If NO: Appropriate agencies/stakeholders should advise whether to leave in next iteration.
    - If YES: provide brief evaluation assessment of implemented mitigation action, if possible.
  - DTF, BCD, and BWC recommend additional mitigation actions.
  - Additions to *Existing Mitigation Actions?*
- **Section 7 Response Actions**
  - Have *Proposed Response Actions* been implemented?
    - If NO: Appropriate agencies/stakeholders should advise whether to leave in next iteration.
    - If YES: provide brief evaluation assessment of implemented response action, if possible.
  - DTF, BCD, and BWC recommend additional response actions.
  - Additions to *Existing Response Actions*?

Appendix A: Contacts

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Appendix B: Online Resources

Beaverhead Conservation District	http://beaverheadcd.org/
Beaverhead County	http://www.beaverheadcounty.org/
Beaverhead Watershed Committee	http://www.beaverheadwatershed.org/
BLM Dillon Field Office	http://www.blm.gov/mt/st/en/fo/dillon_field_office.html
BOR Montana Area Office	http://www.usbr.gov/gp/mtao/
Centennial Valley Association	http://centennialvalleyassociation.org/
City of Dillon	http://www.dillonmt.org/
Clark Canyon Reservoir	http://www.usbr.gov/gp/mtao/clarkcanyon/
Community Collaborative Rain, Hail and Snow Network (CoCoRaHS)	http://www.cocorahs.org/
Dillon AgriMet Station	http://www.usbr.gov/gp/agrimet/station_dlnm_dillon.html
Dillon Interagency Dispatch Center	http://www.fs.fed.us/fire/dispatch/dillon/
FSA Dillon Service Center	http://offices.sc.egov.usda.gov/locator/app?state=mt&agency=fsa
Montana Bureau of Mines & Geology Groundwater Information Center	http://mbmggwic.mtech.edu/
Montana DNRC Drought Website	http://drought.mt.gov/default.aspx
Montana FWP Drought Page	http://fwp.mt.gov/fishAndWildlife/habitat/fish/waterManagement/drought.html
Montana State University Extension	http://www.msuextension.org/
Montana Trout Unlimited - Lewis & Clark Chapter	http://www.lctu.org/lctu-chapter-waters.htm
National Drought Mitigation Center (NDMC)	http://drought.unl.edu/
National Drought Resilience Partnership	http://www.drought.gov/drought/content/ndrp
National Integrated Drought Information System (NIDIS)	http://www.drought.gov/drought/
National Interagency Fire Center Burned Area Emergency Response	http://www.nifc.gov/BAER/Page/NIFC_BAER.html

National Weather Service Montana Drought Website	http://www.wrh.noaa.gov/tfx/hydro/DGT.php?wfo=tfx
NDMC Drought Impact Reporter	http://droughtreporter.unl.edu/
NDMC Drought Risk Atlas	http://droughtatlas.unl.edu/
NOAA Climate Prediction Center	http://www.cpc.ncep.noaa.gov/
NOAA RISA Pacific Northwest Climate Impacts Research Consortium	http://cpo.noaa.gov/ClimatePrograms/ClimateandSocietalInteractions/RISAProgram/RISATeams/CIRC.aspx
NRCS Montana Snow Survey	http://www.nrcs.usda.gov/wps/portal/nrcs/main/mt/snow/
Red Rock Lakes National Wildlife Refuge	http://www.fws.gov/refuge/red_rock_lakes/
Ruby Habitat Foundation Soil Health Project	http://198.199.118.142/home/projects/current-projects/soil-health-project/
The Nature Conservancy Southwest Montana	http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/montana/placesweprotect/southwest-montana.xml
U. S. Department of Interior Northwest Climate Science Center	https://edit.doi.gov/csc/northwest/
U.S. Drought Monitor	http://droughtmonitor.unl.edu/
University of Montana Climate Office	http://www.climate.umt.edu/
USDA Northern Plains Climate Hub	http://climatehubs.oce.usda.gov/northernplains
USFS Beaverhead-Deerlodge National Forest	http://www.fs.usda.gov/bdnf/
USFS Service Northern Rockies Fire Detection Map	http://activefiremaps.fs.fed.us/activefiremaps.php?sensor=modis&op=maps&rCode=nrw
USGS Montana Water Data	http://waterdata.usgs.gov/mt/nwis/rt
USGS Northern Rocky Mountain Science Center	http://www.nrmsc.usgs.gov/
Western Regional Climate Center Drought Monitoring	http://www.wrcc.dri.edu/drought-monitoring/
Western Governors' Drought Forum	http://www.westgov.org/initiatives/drought-forum
Western Education/Extension Research Activity Western Water Resources	http://werawater.org/

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