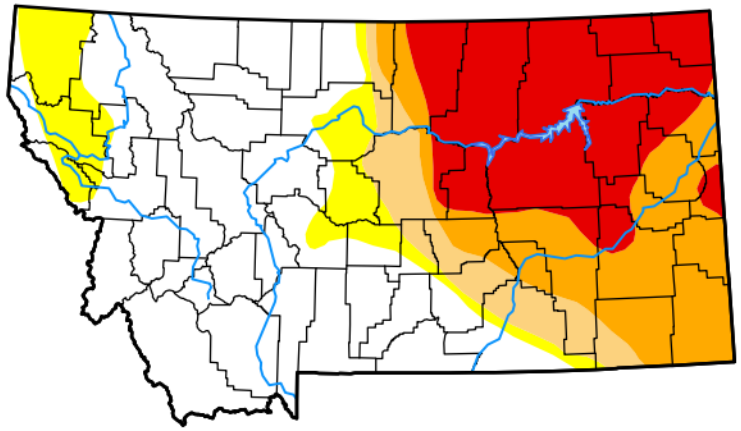
DROUGHT UPDATE

July 2017

US Drought Monitor

U.S. Drought Monitor

Montana



July 11, 2017

(Released Thursday, Jul. 13, 2017)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	45.80	54.20	44.72	37.74	22.00	0.00
Last Week *07-04-2017*	52.28	47.72	42.94	34.93	12.89	0.00
3 Months Ago *04-11-2017*	87.57	12.43	0.00	0.00	0.00	0.00
Start of Calendar Year *01-03-2017*	74.25	25.75	4.87	0.00	0.00	0.00
Start of Water Year *09-27-2016*	55.14	44.86	25.49	5.86	0.33	0.00
One Year Ago *07-12-2016*	70.52	29.48	8.74	0.47	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

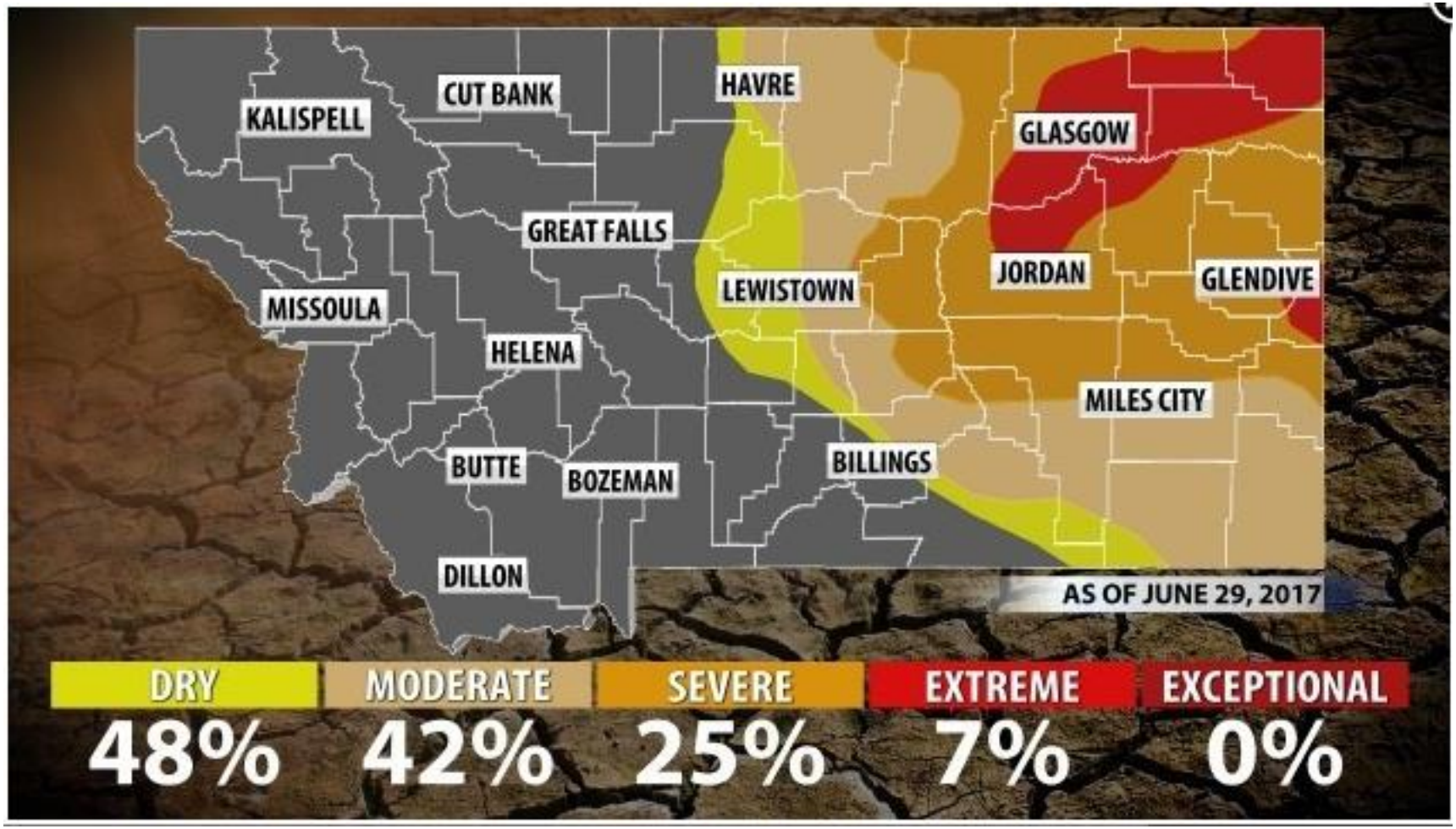
Author:

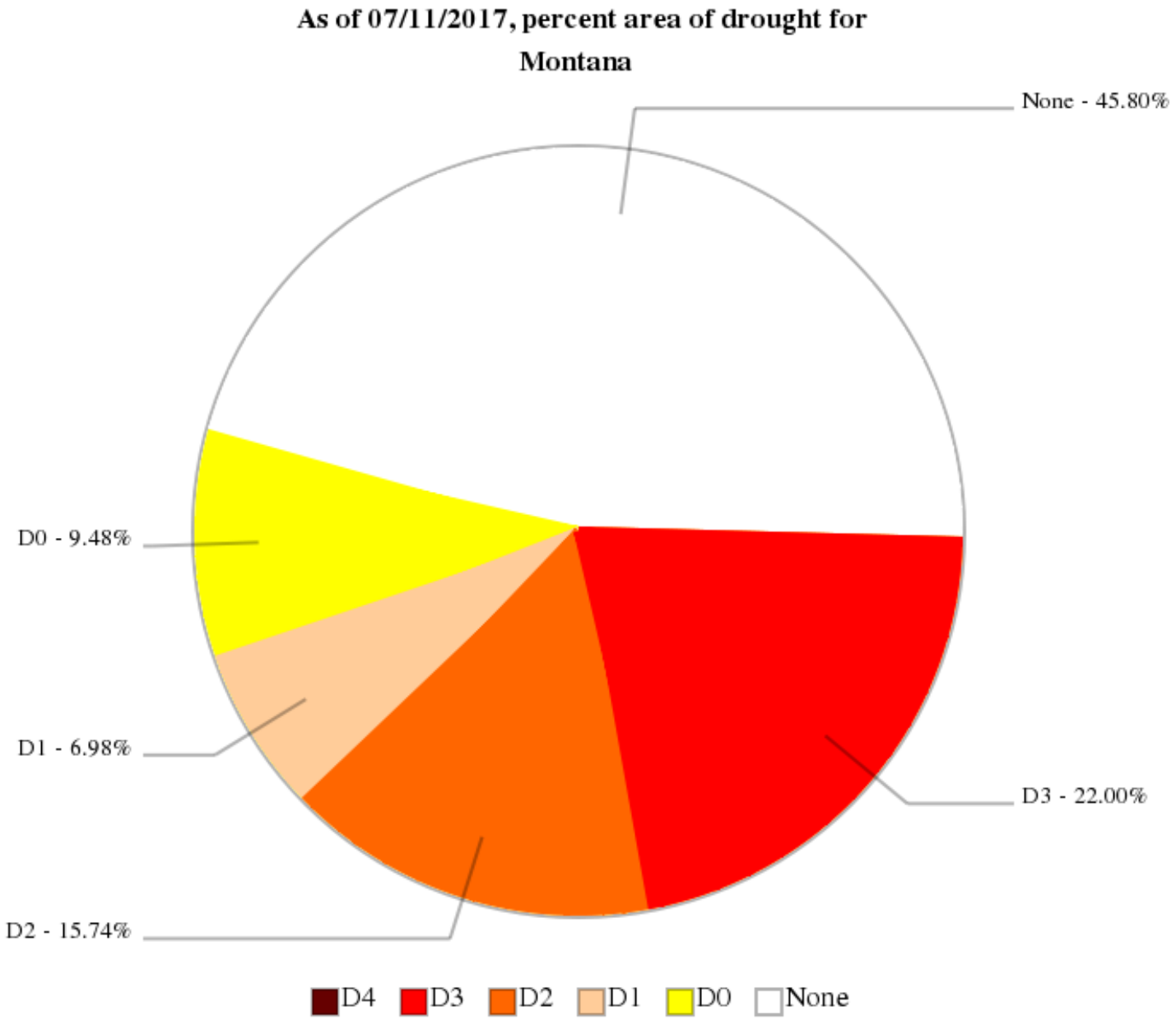
David Simeral

Western Regional Climate Center

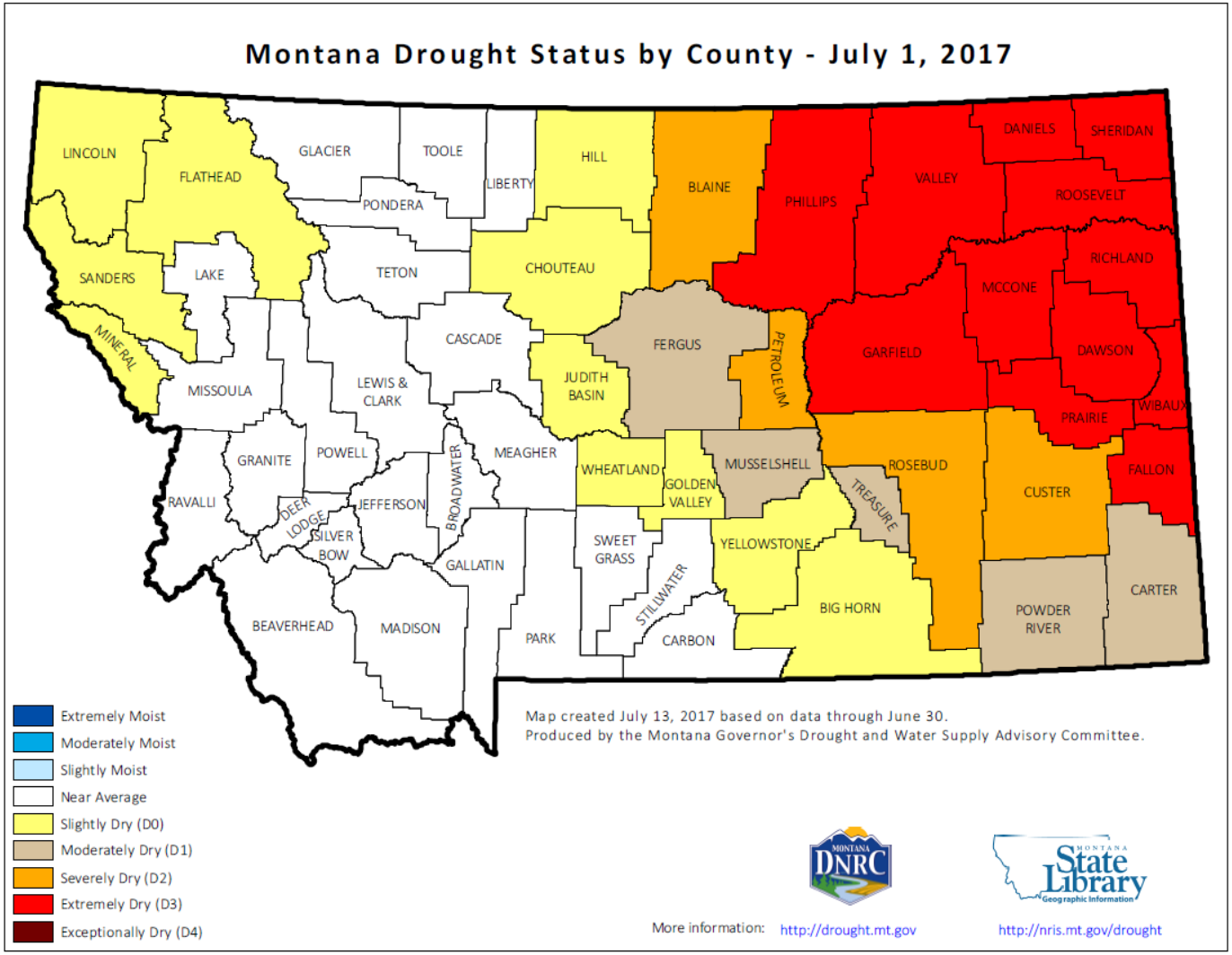
http://droughtmonitor.unl.edu/

As of July 5, 2017



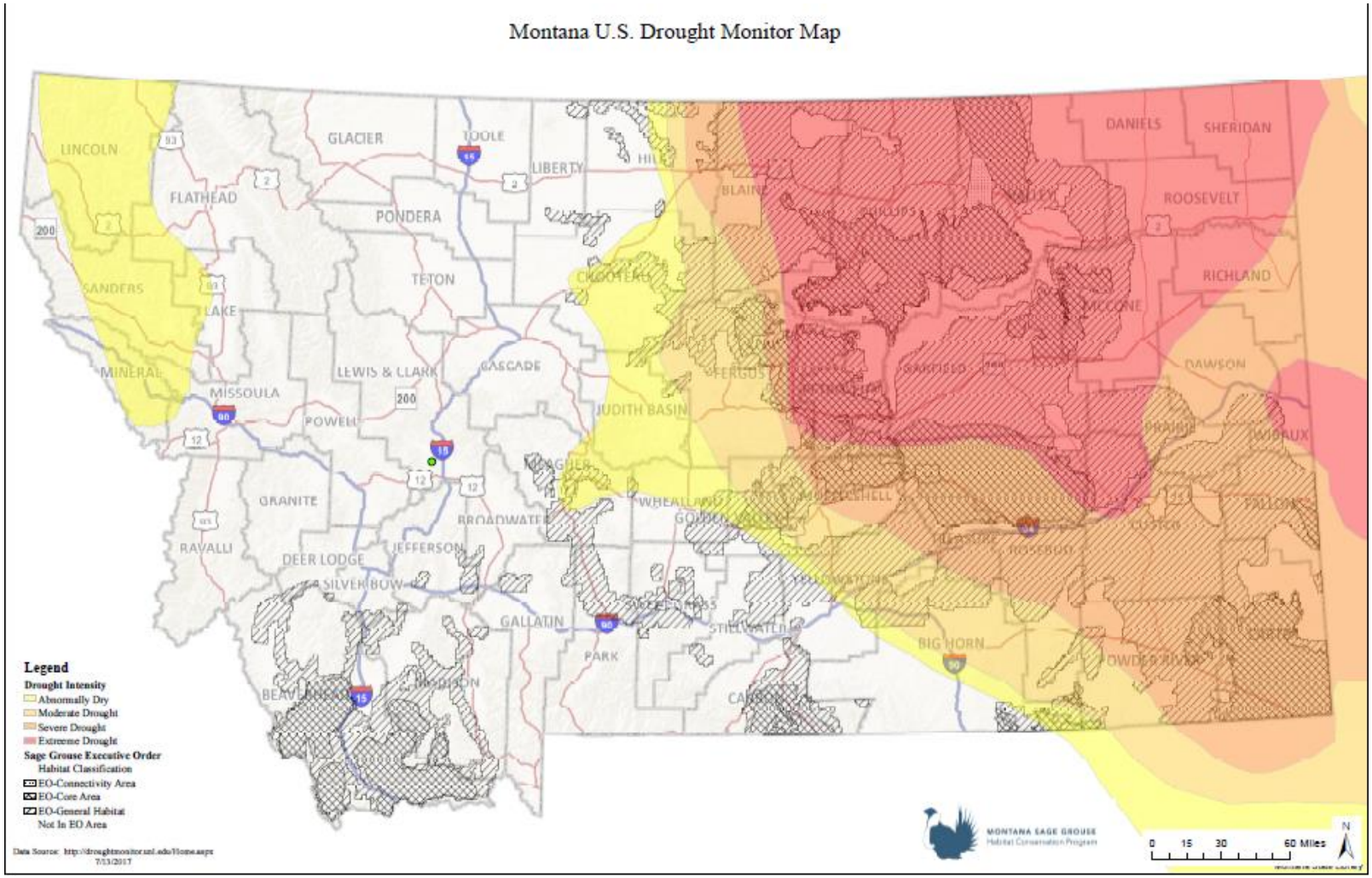

As of 07/11/2017, percent area of drought for Montana
None - 45.80%
D0 - 9.48%
D1 - 6.98%
D3 - 22.00%
D2 - 15.74%
D4
D3
D2
D1
D0
None

Montana County Drought Status Map



Drought Impacts to Agriculture

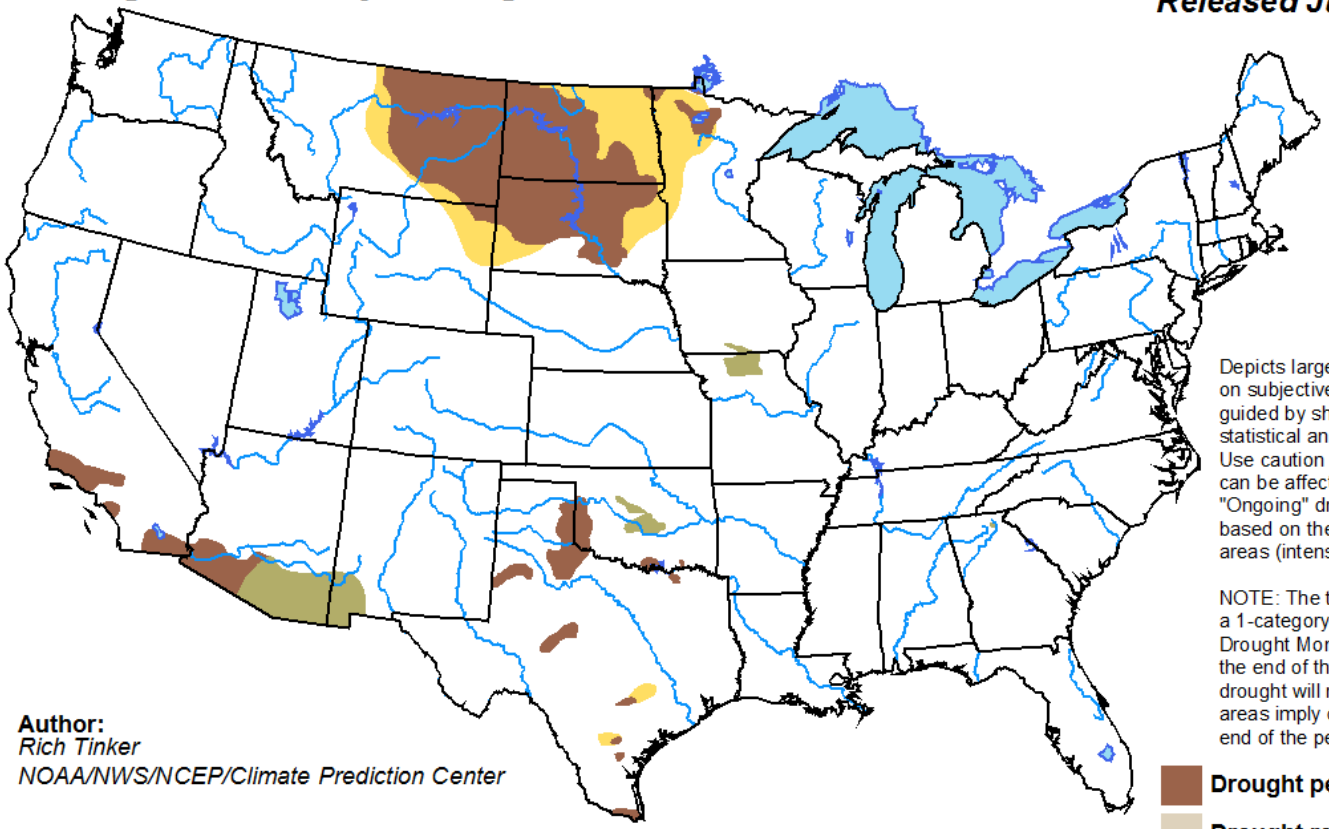
Drought Impacts to Sage Grouse



U.S. Monthly Drought Outlook

Drought Tendency During the Valid Period

Valid for July 2017
Released June 30, 2017



Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Use caution for applications that can be affected by short lived events. "Ongoing" drought areas are based on the U.S. Drought Monitor areas (intensities of D1 to D4).

NOTE: The tan areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period, although drought will remain. The green areas imply drought removal by the end of the period (D0 or none).

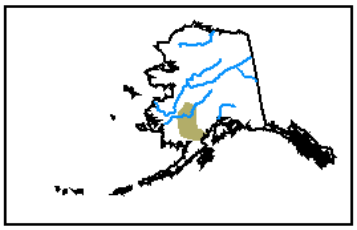
Drought persists

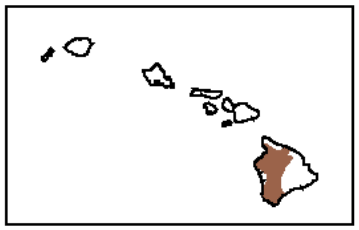
Drought remains but improves

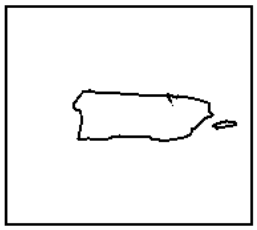
Drought removal likely

Drought development likely

Author:
Rich Tinker
NOAA/NWS/NCEP/Climate Prediction Center







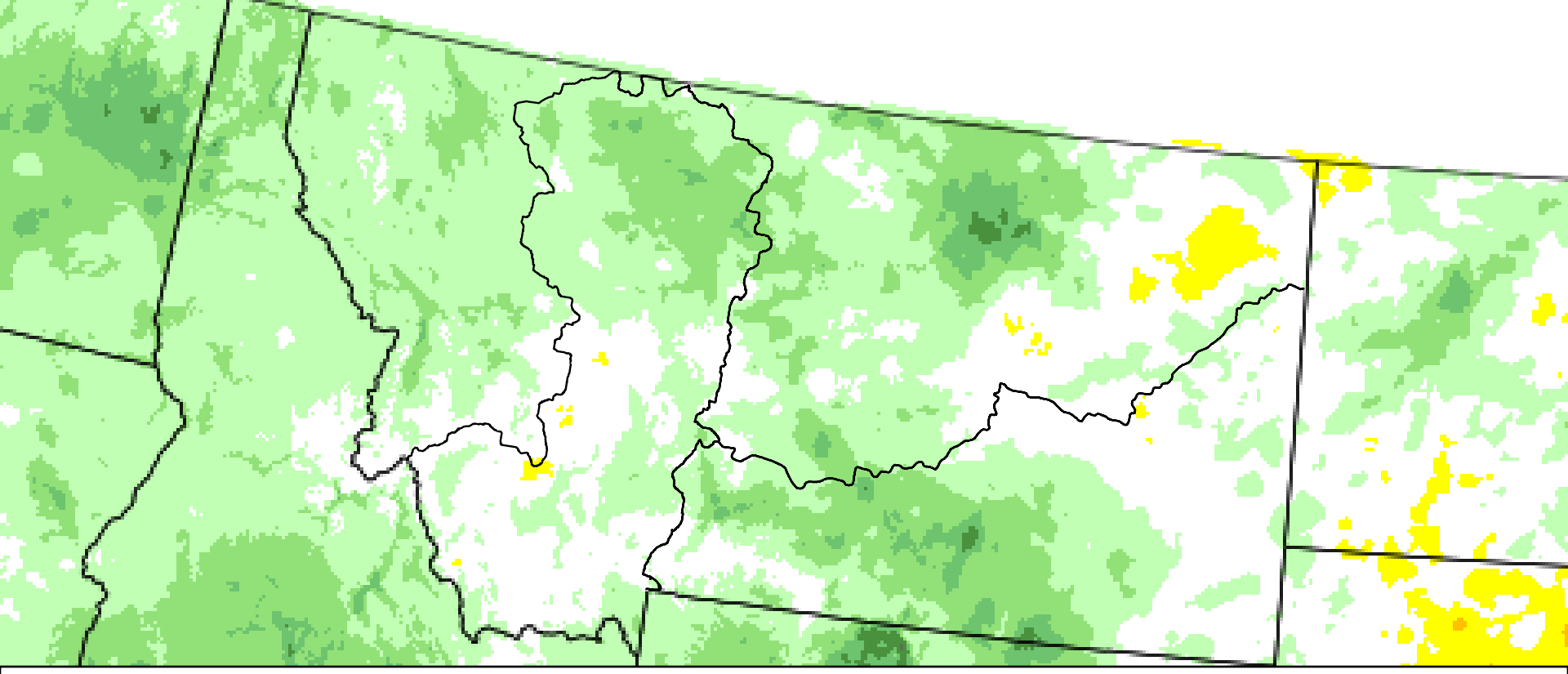
http://go.usa.gov/3eZGd

Montana DWSAC Briefing

July 18, 2017

Weather-Ready Nation

National Oceanic and Atmospheric Administration



Jul 16 – Jun 17 Precip Anomaly

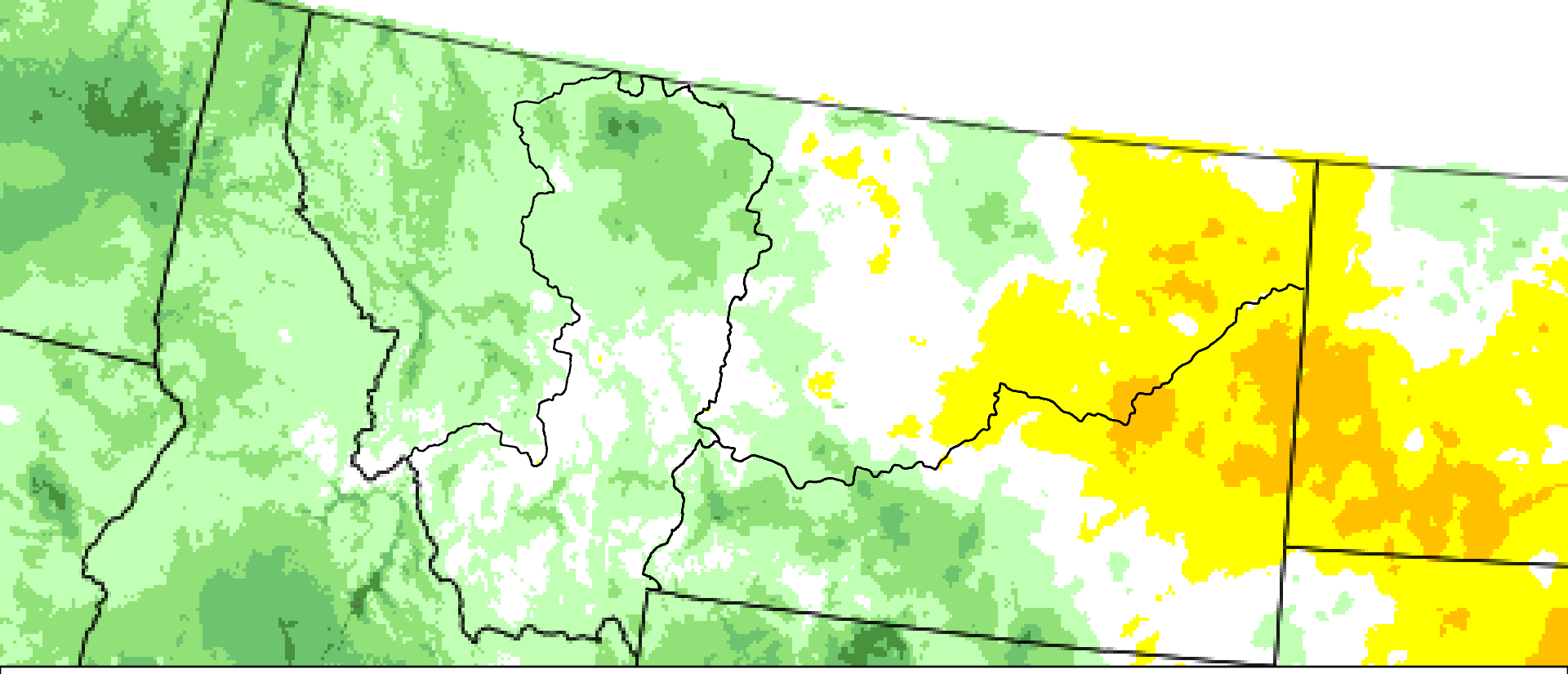
Montana: Jul 2016 – Jun 2017

24th Warmest on Record

Avg Temp	20th Century Average	Departure
42.9°F	41.1°F	1.8°F

20th Wettest on Record

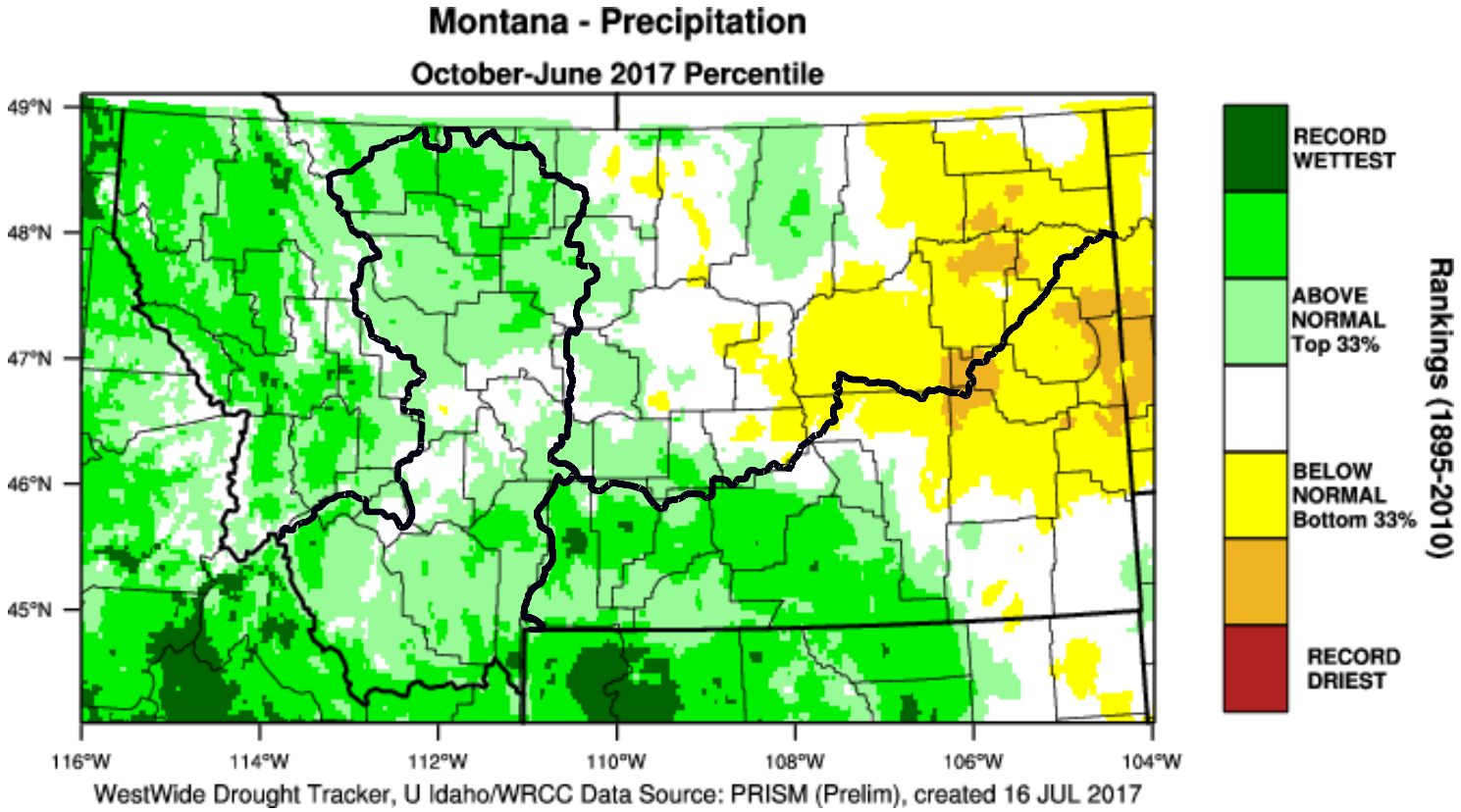
Precip	20th Century Average	Departure
20.99”	18.66”	2.33”



Water Year 2017 Precip Anomaly

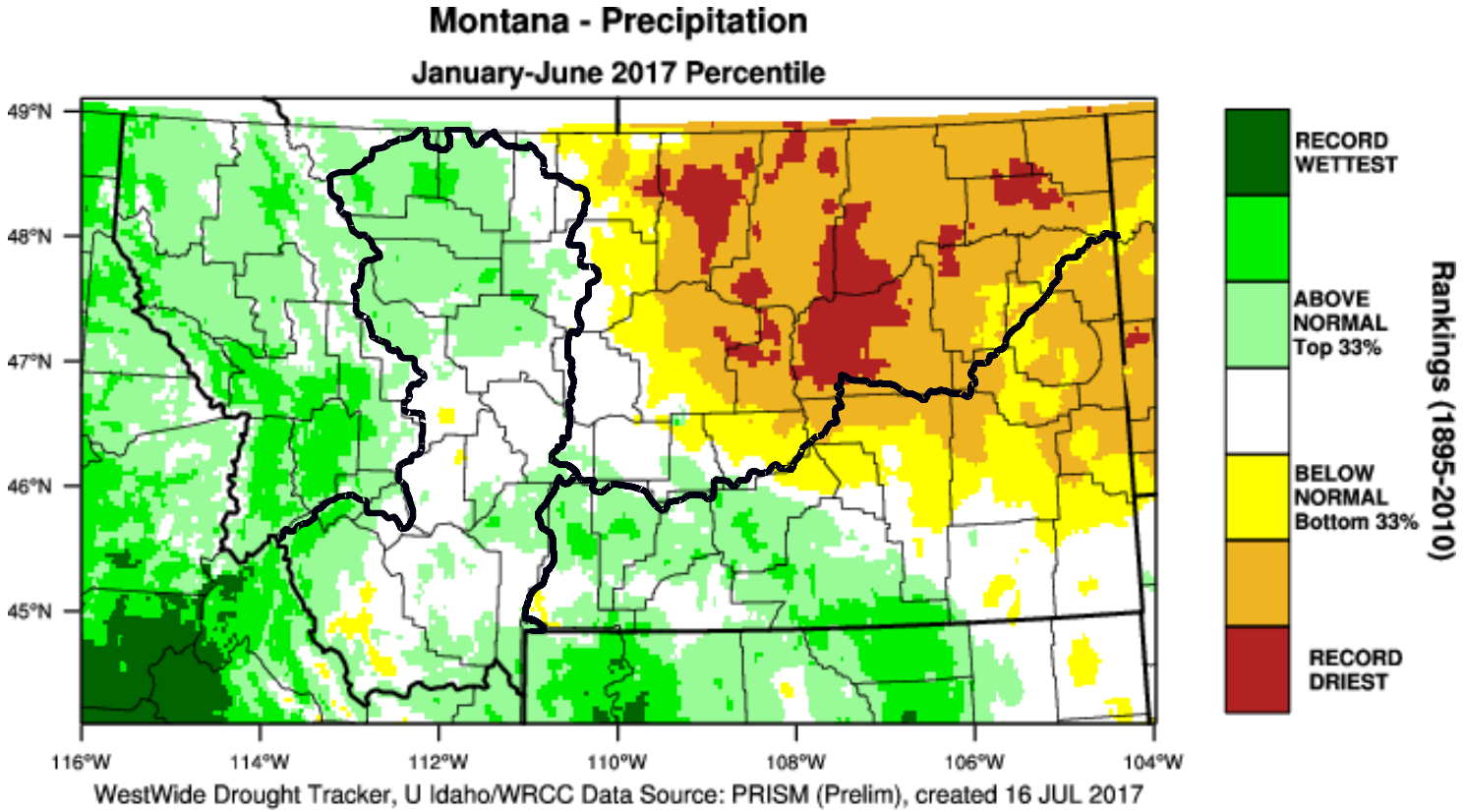
Precipitation Ranking

Water Year 2017



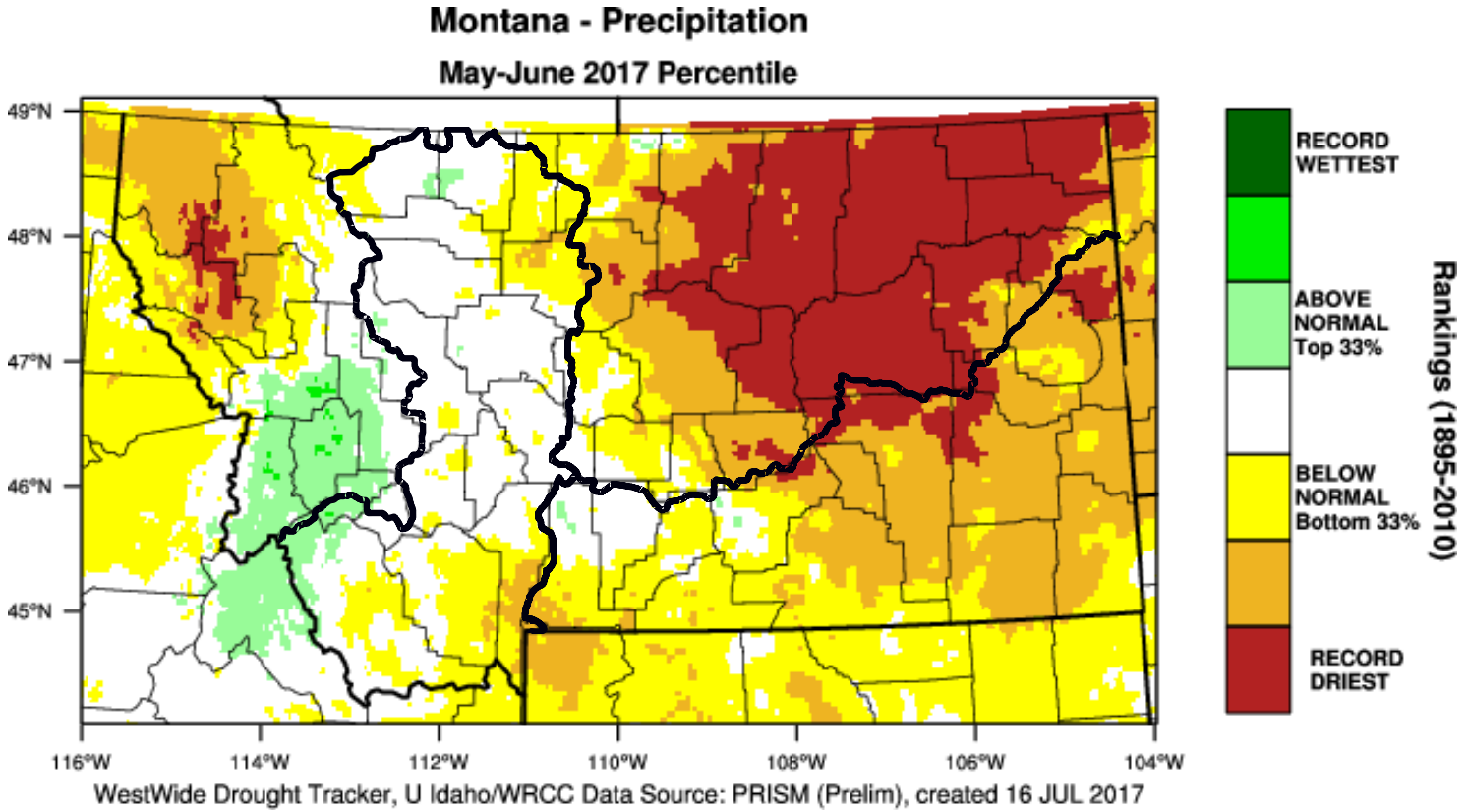
Precipitation Ranking

Calendar Year 2017

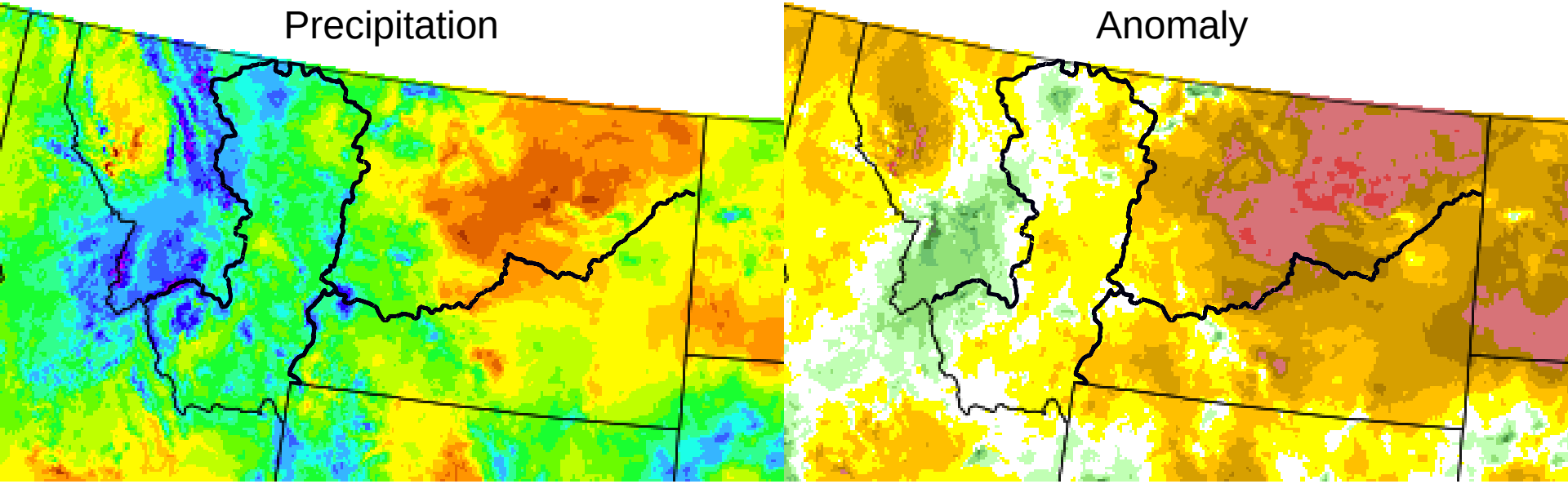


Precipitation Ranking

May-Jun 2017



Jun 2017 Precip vs Anomaly



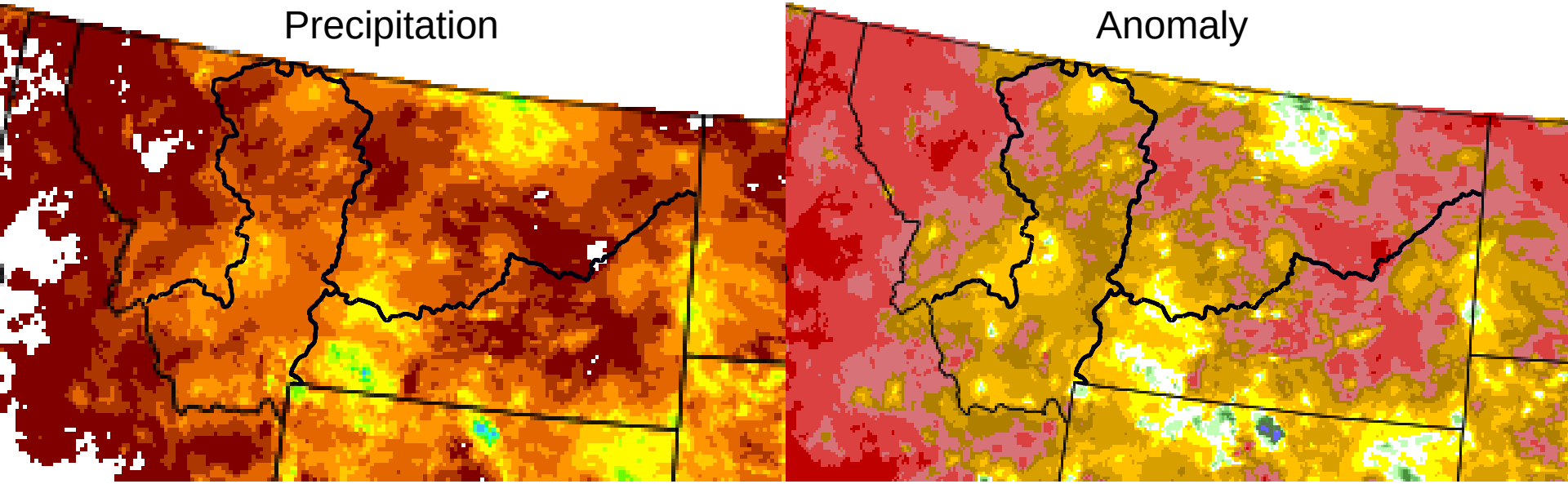
Monthly Precipitation (in.)

< 0.01	0.6 - 0.8	2.4 - 2.8	6 - 8
.01 - 0.1	0.8 - 1.2	2.8 - 3.2	8 - 12
0.1 - 0.2	1.2 - 1.6	3.2 - 4	12 - 16
0.2 - 0.4	1.6 - 2	4 - 5	16 - 20
0.4 - 0.6	2 - 2.4	5 - 6	> 20

% of Average Precipitation

0	50 - 70	150 - 170
1 - 10	70 - 90	170 - 200
11 - 20	90 - 110	200 - 300
20 - 30	110 - 130	300 - 400
30 - 50	130 - 150	> 400

July Precip vs Anomaly – as of 7/17



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< 0.01	0.6 - 0.8	2.4 - 2.8	6 - 8
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0.2 - 0.4	1.6 - 2	4 - 5	16 - 20
0.4 - 0.6	2 - 2.4	5 - 6	> 20

% of Average Precipitation

0	50 - 70	150 - 170
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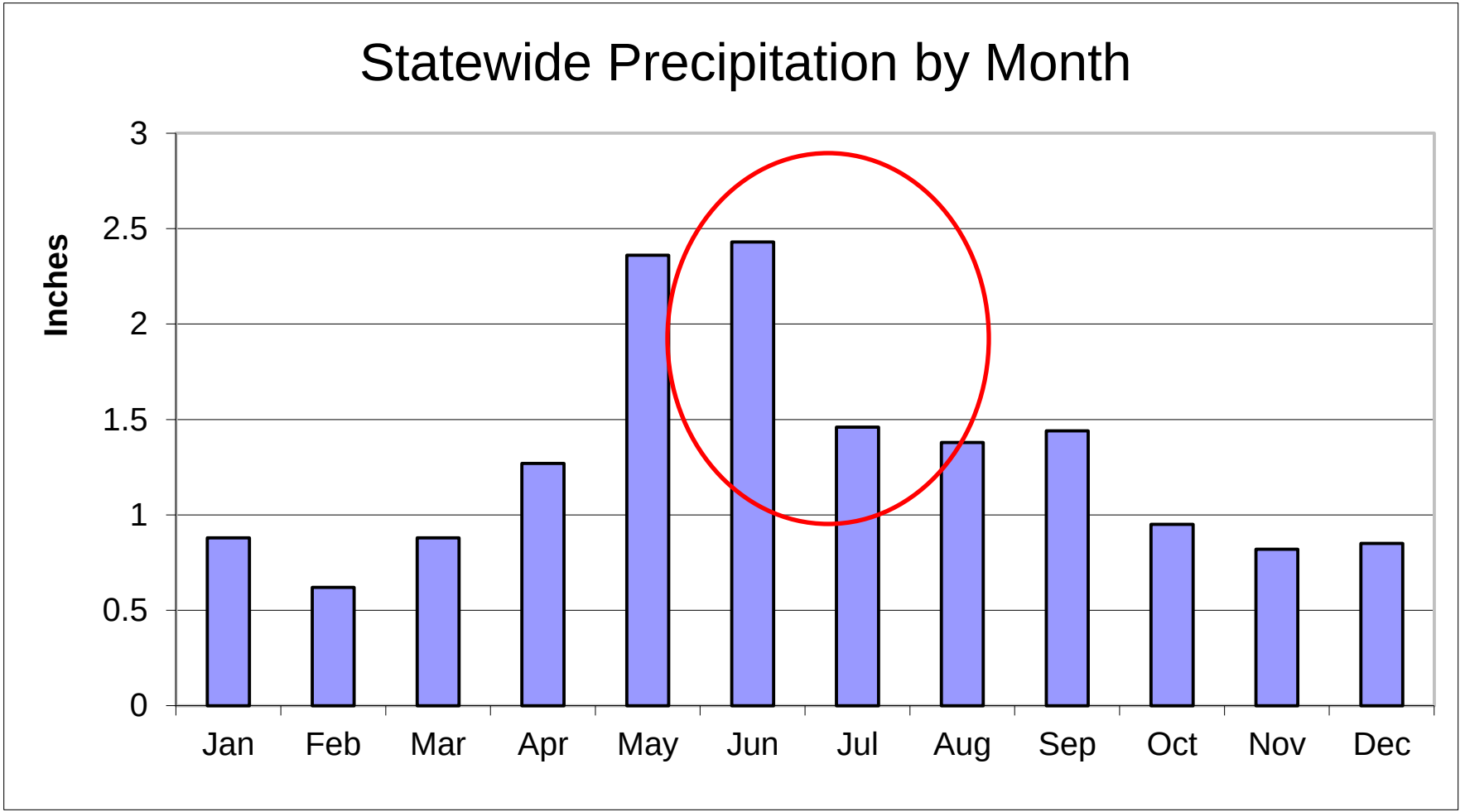
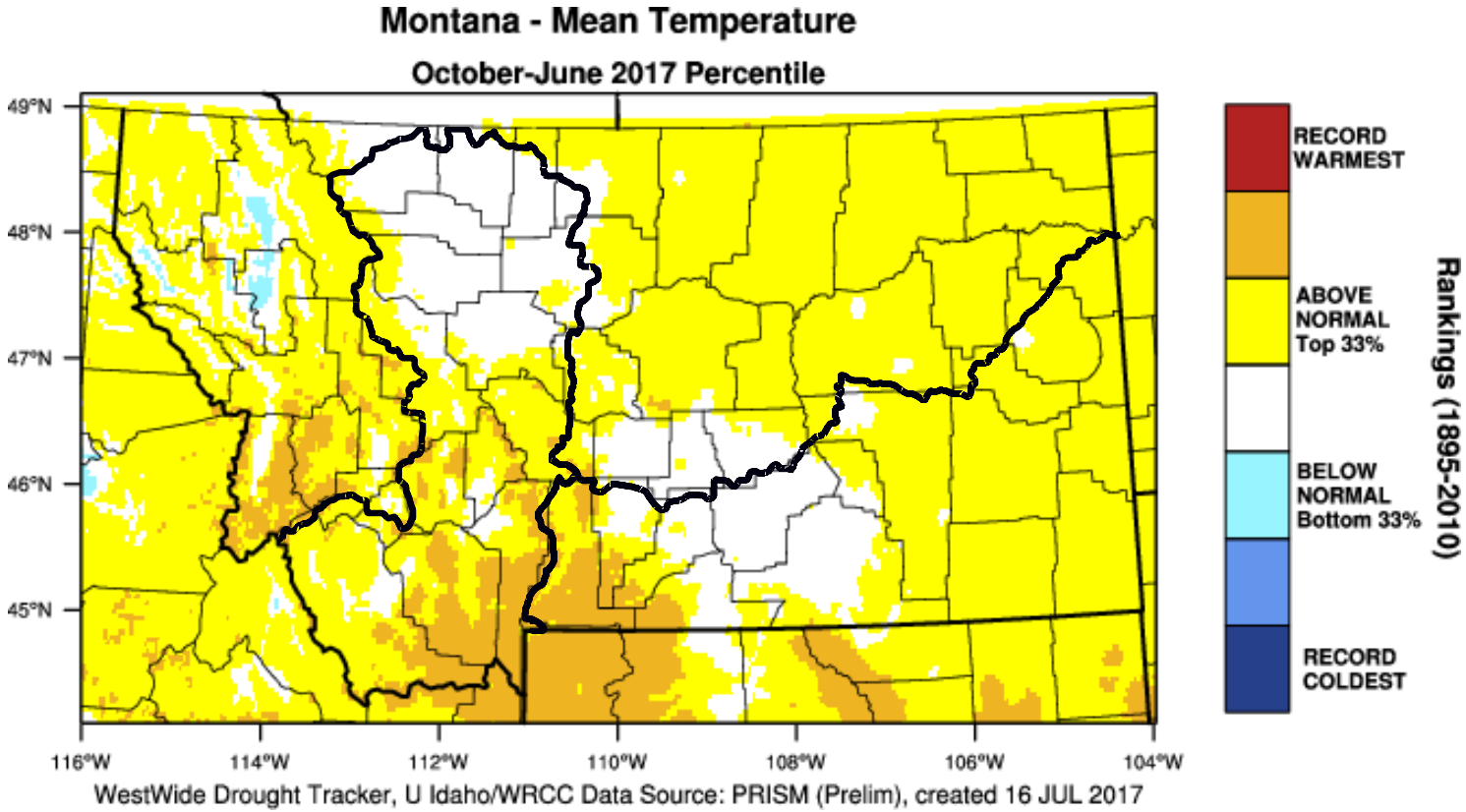

Statewide Precipitation by Month
Inches
3
2.5
2
1.5
1
0.5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

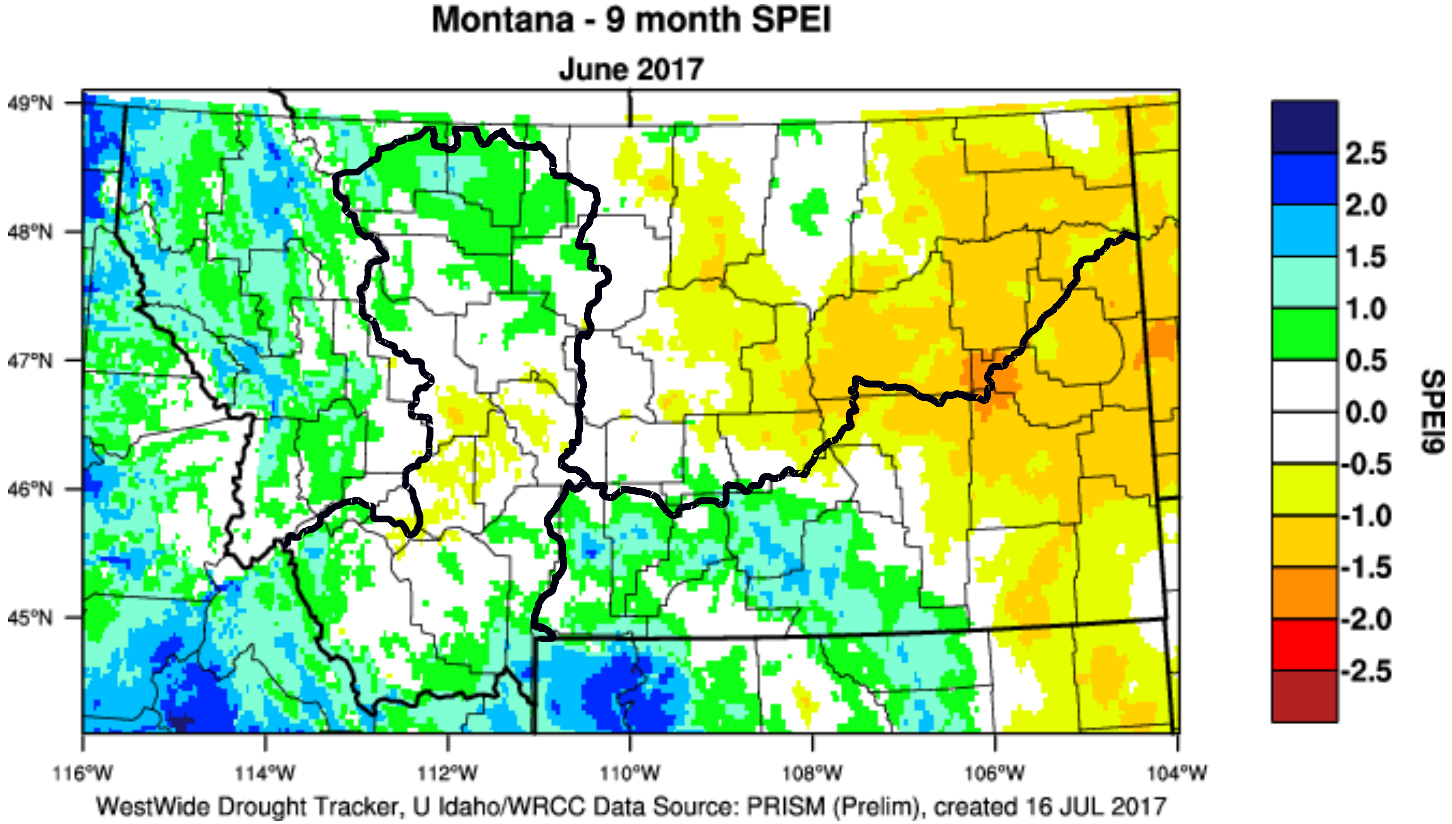
Mean Temperature Ranking

Water Year 2017



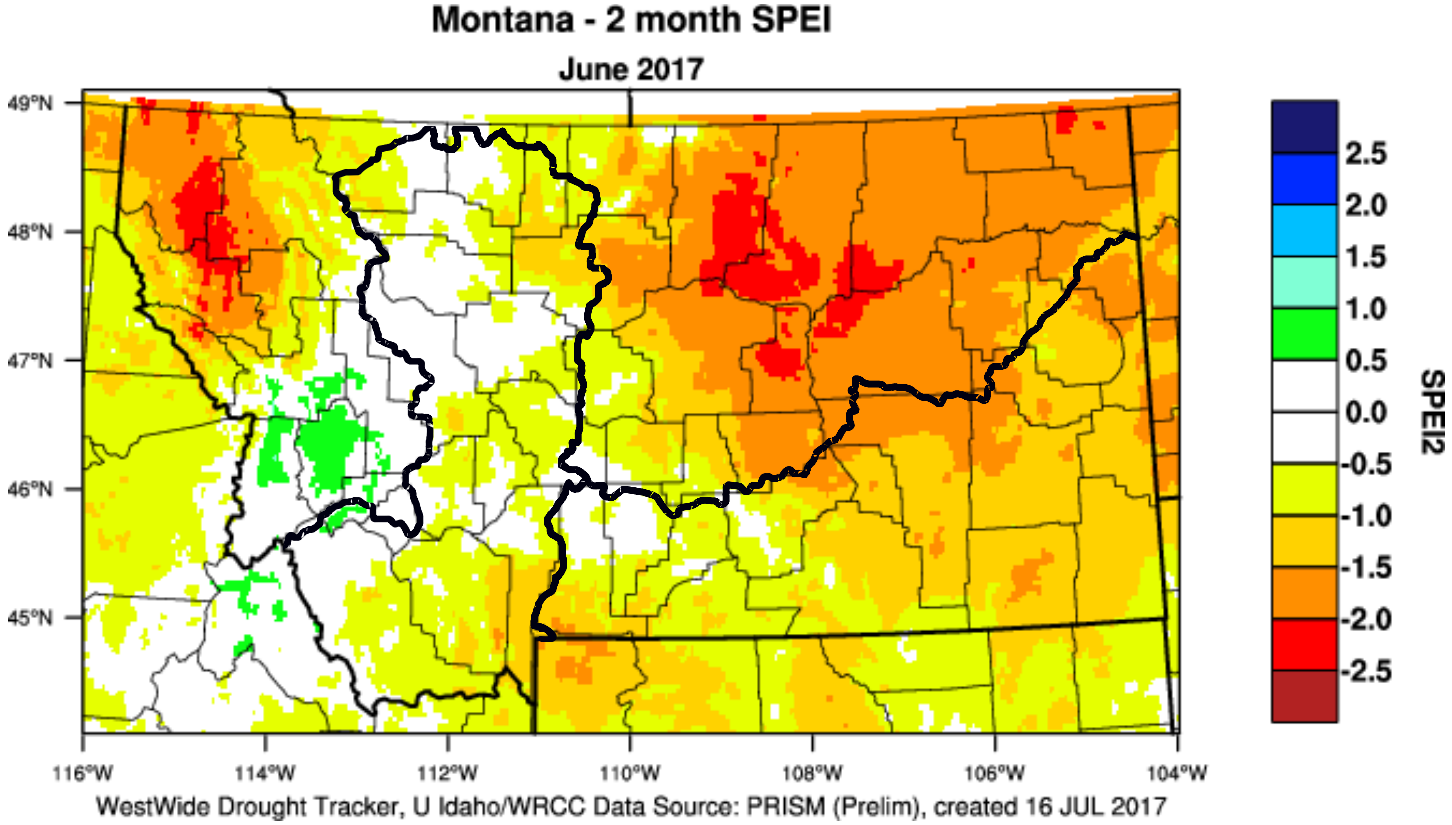
PRISM SPEI

Water Year 2017

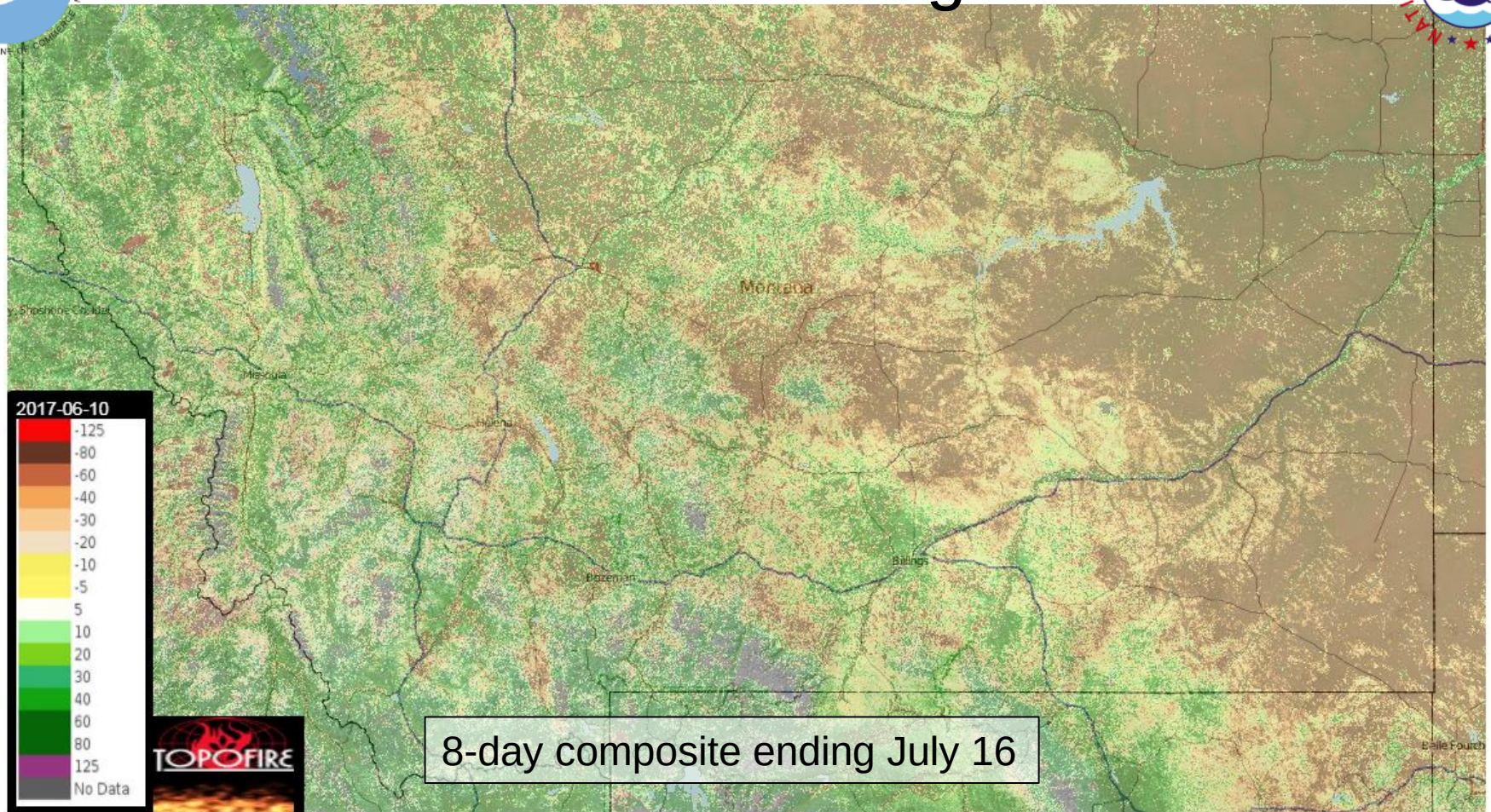


PRISM SPEI

May-Jun 2017

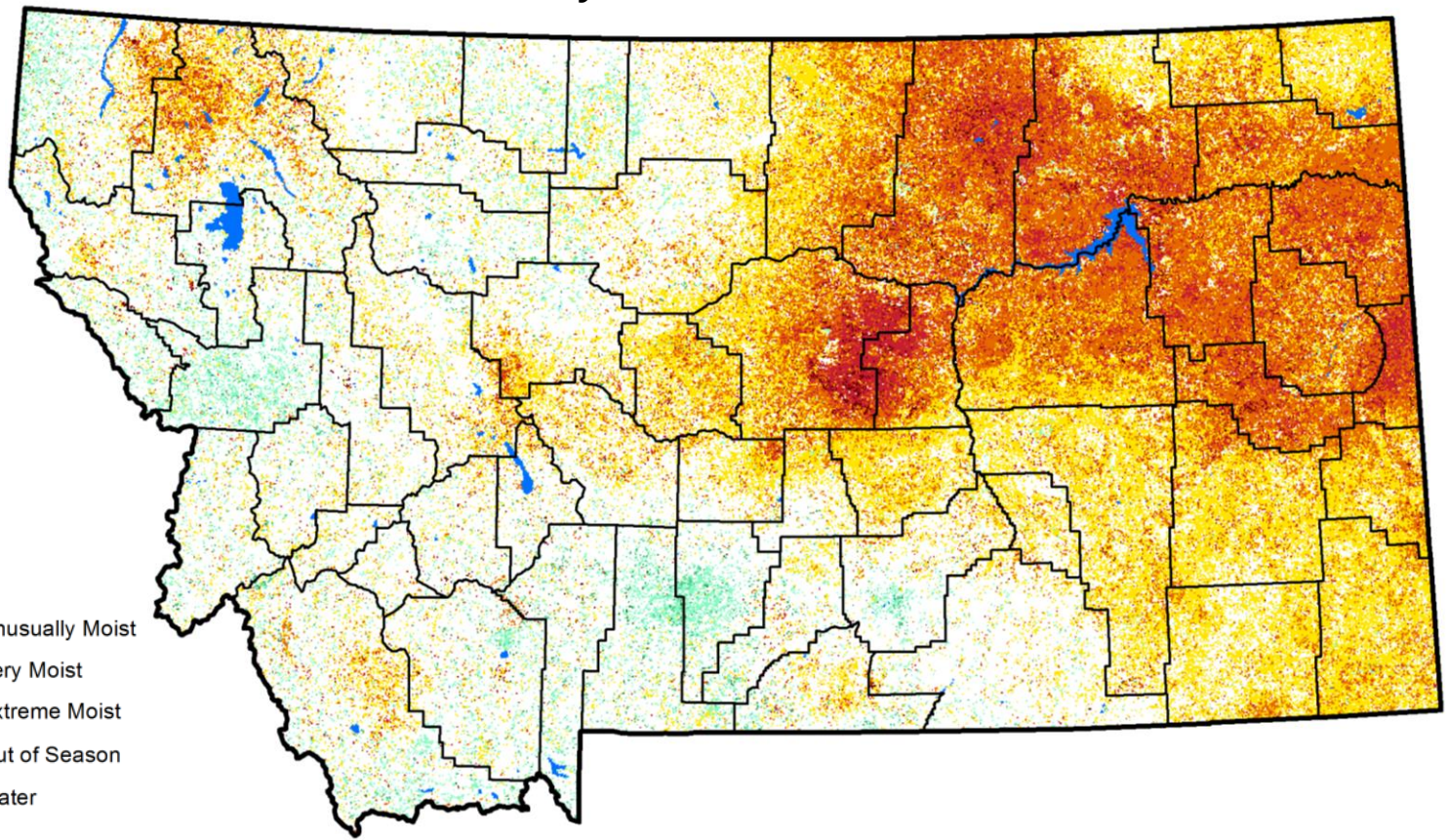


Normalized Difference Vegetation Index



Vegetation Drought Response Index

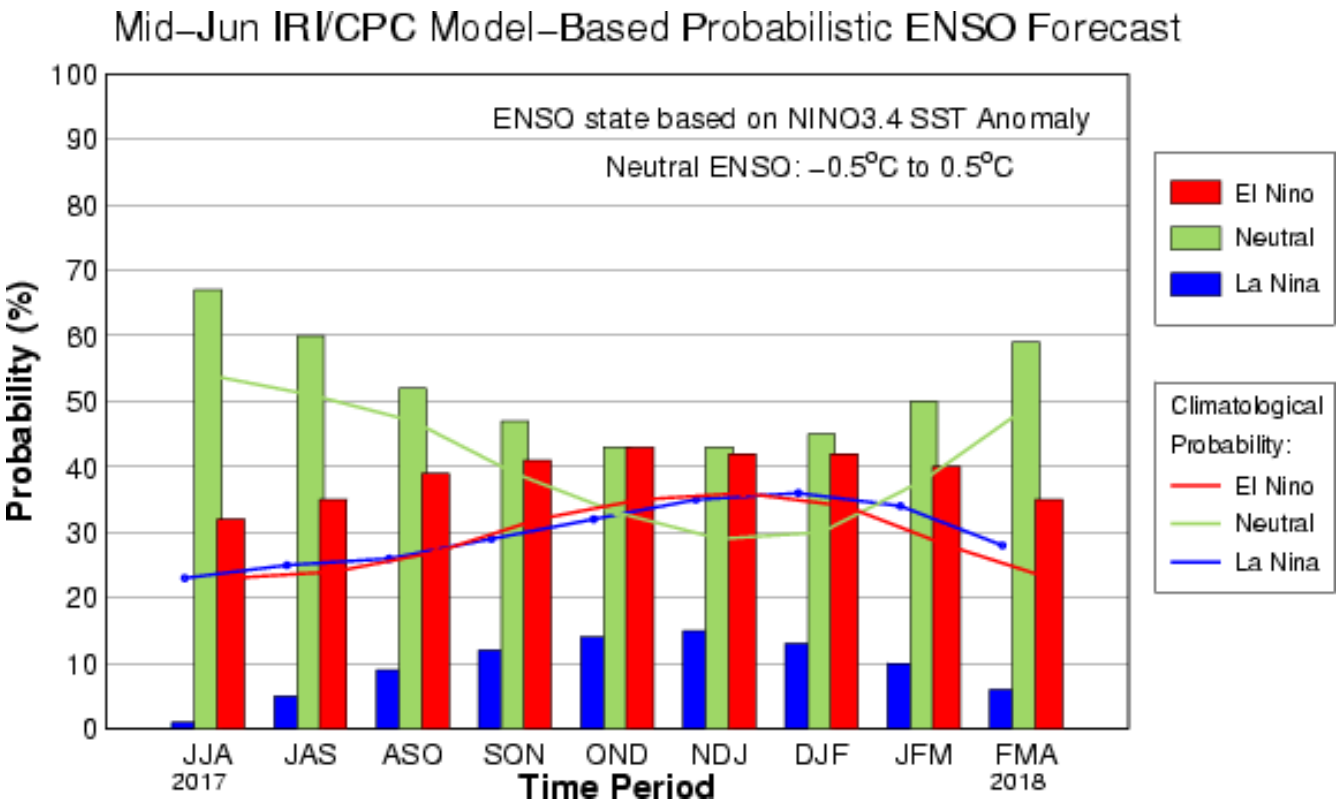
As of July 9

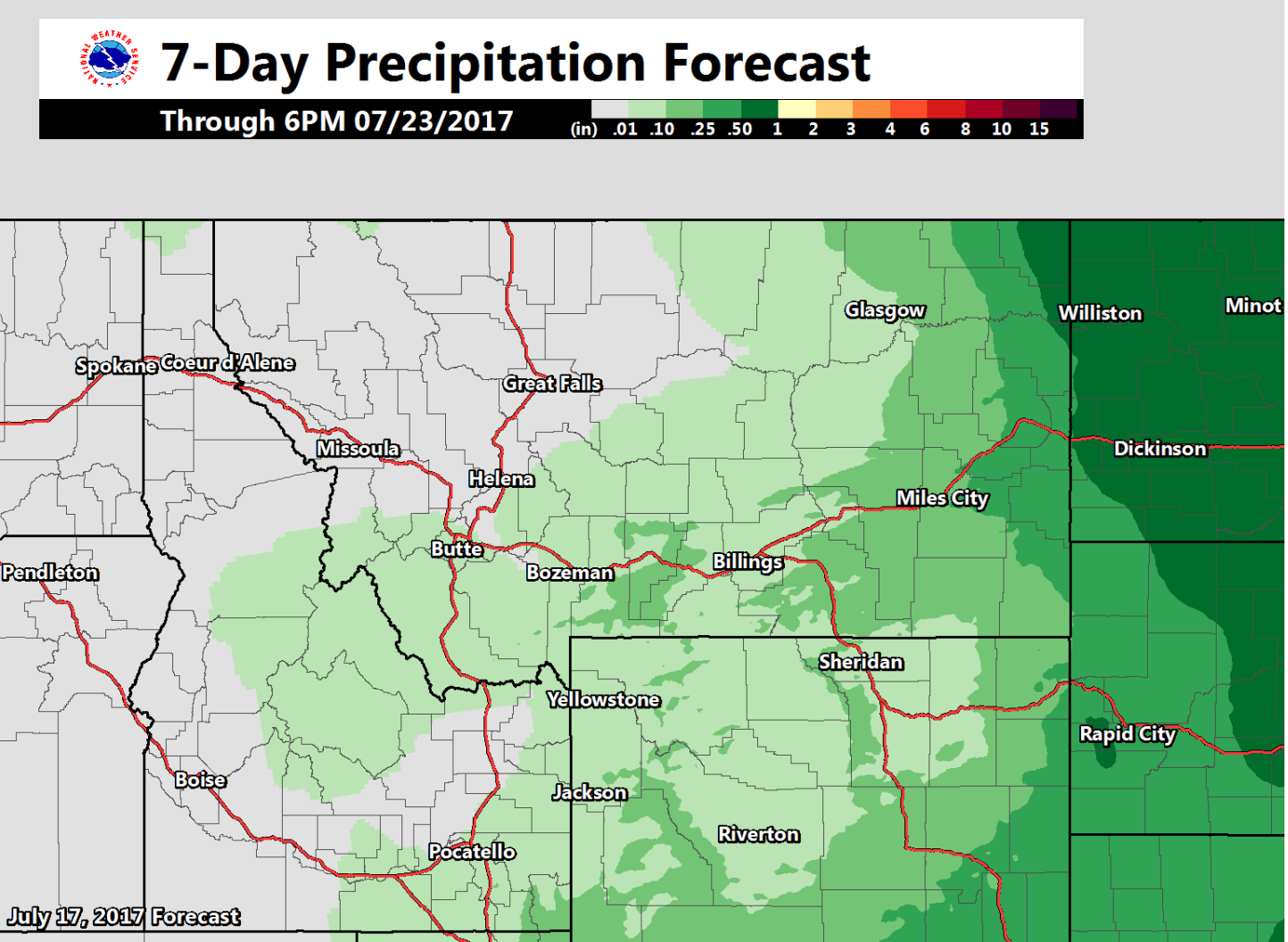


Vegetation Condition

- Extreme Drought
- Severe Drought
- Moderate Drought
- Pre-drought stress
- Near Normal
- Unusually Moist
- Very Moist
- Extreme Moist
- Out of Season
- Water

ENSO
El Niño Neutral



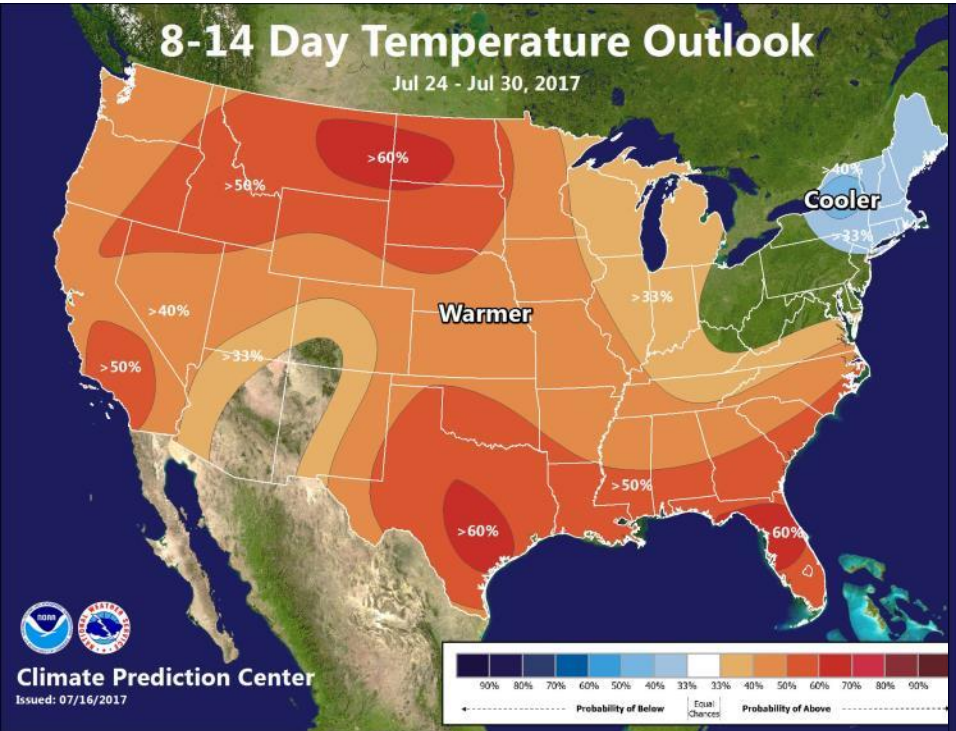


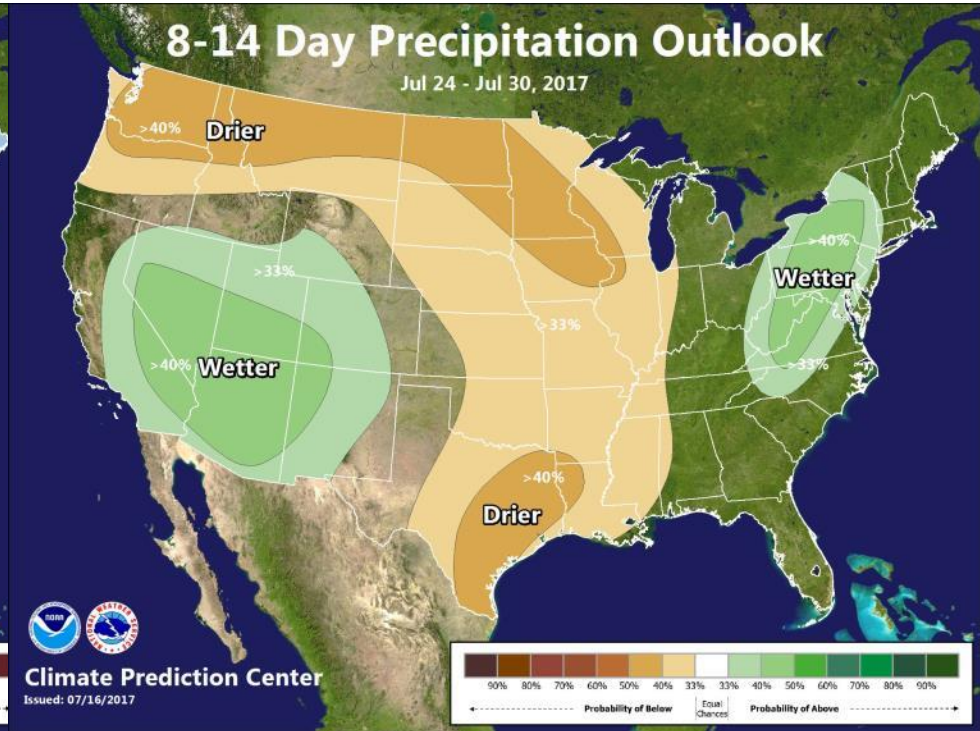
7 Day Precipitation Forecast

Created July 17

8-14 Day Outlook

Created July 16

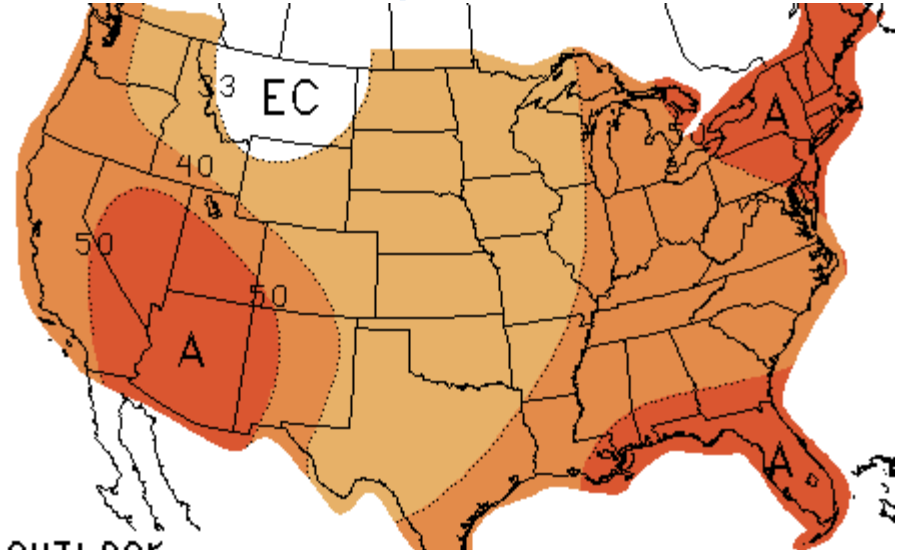




Jul-Sep Outlook

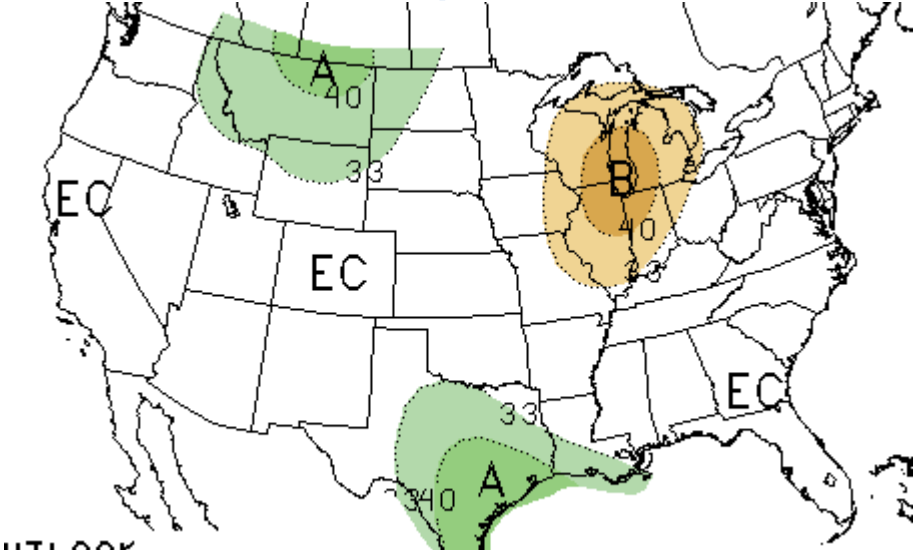
Created June 15

Temperature



Equal chances for above normal or below temperatures over most of Montana

Precipitation

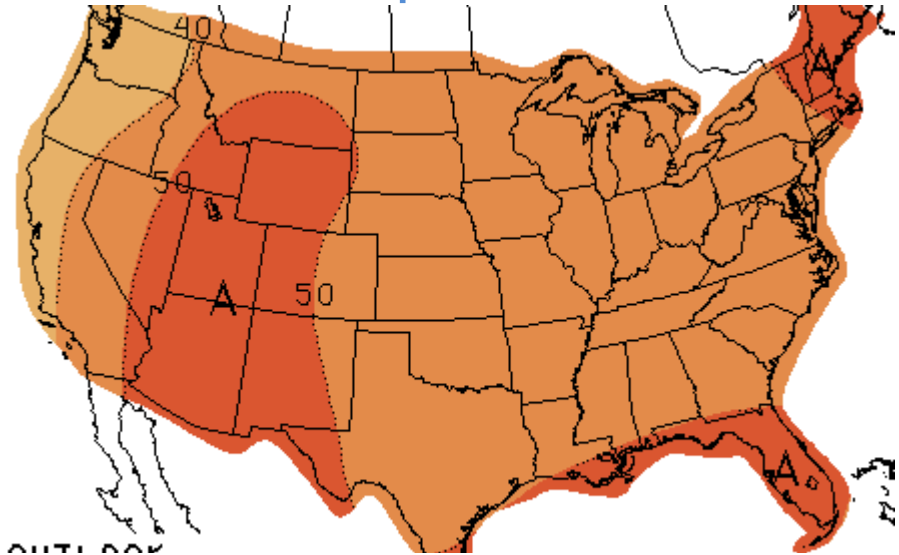


33% chance of above normal precipitation over eastern Montana, but 40% chance of above precipitation northeast Montana

Sep-Nov Outlook

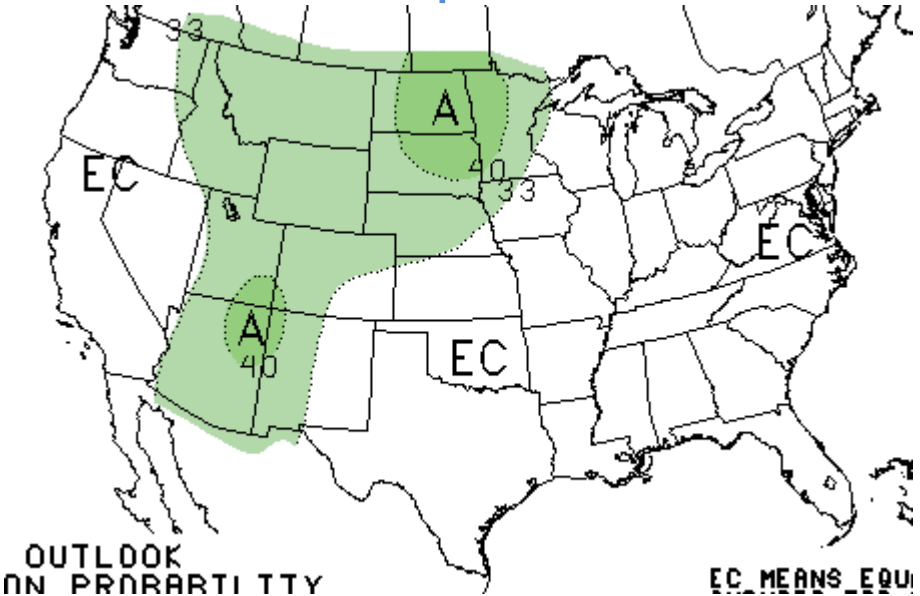
Created June 15

Temperature



40% chance of above normal temperatures north, 50% chance of above normal temperatures south

Precipitation

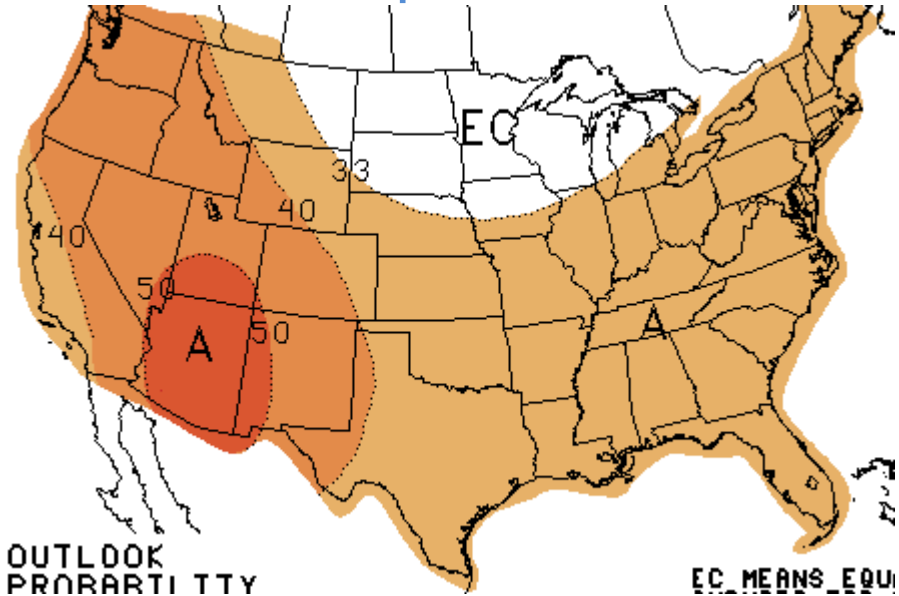


33% or greater chance of above normal precipitation

Dec-Feb Outlook

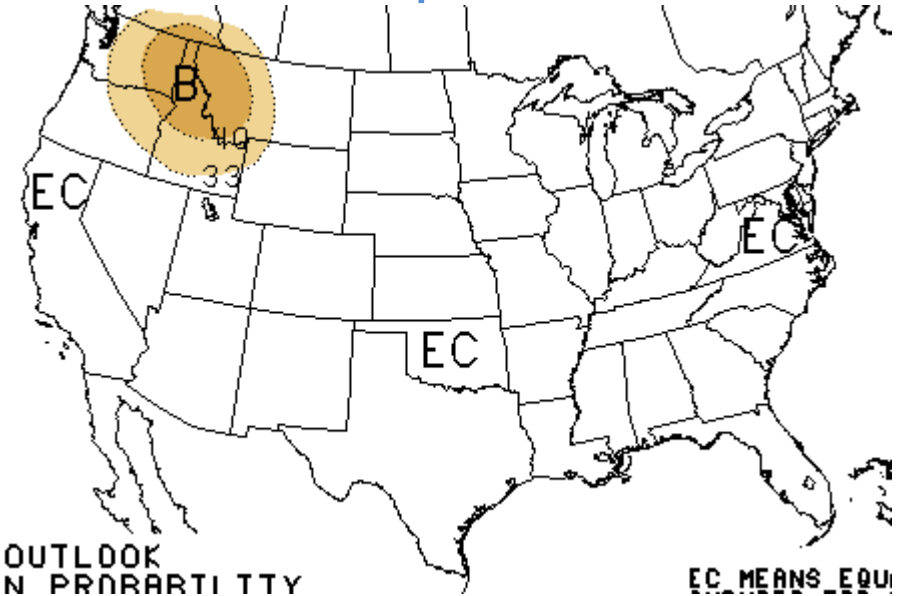
Created June 15

Temperature



33% chance of above normal temperatures, with equal chances northeast Montana

Precipitation

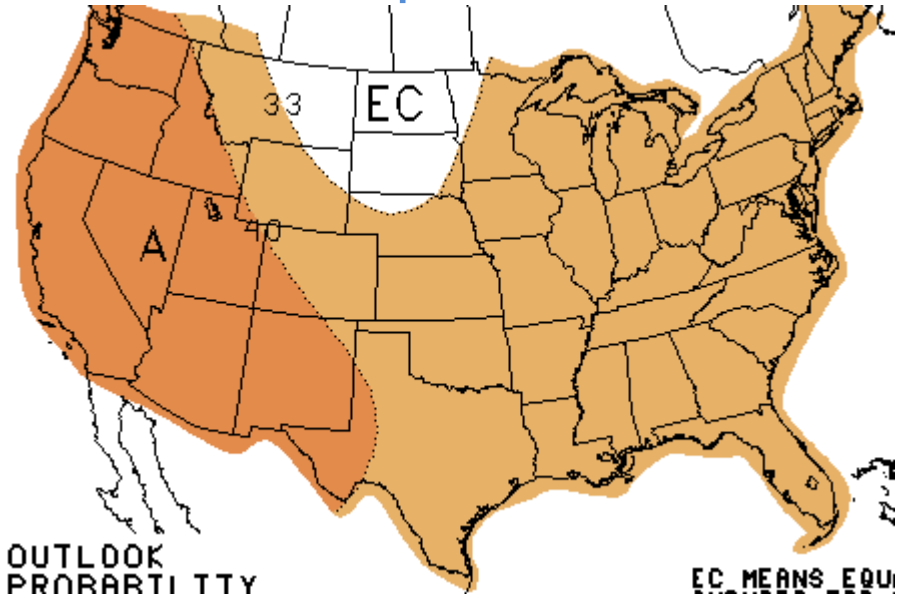


Equal chances of above or below normal precipitation, except 33% chance below normal east slopes westward

Mar-May Outlook

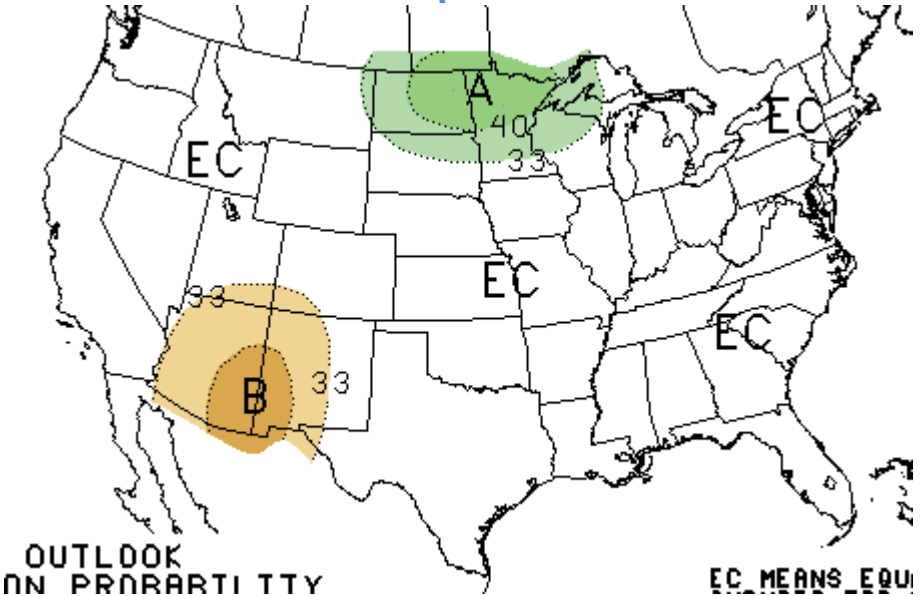
Created June 15

Temperature



Equal chances for above normal or below temperatures northeast Montana, 33% chance or greater over western half of Montana

Precipitation



Equal chances of above or below normal precipitation statewide

weather.gov

weather.gov/billings
weather.gov/glasgow
weather.gov/missoula
weather.gov/greatfalls

Weather-Ready Nation

National Oceanic and Atmospheric Administration

USGS
science for a changing world

Montana – Recent Streamflow Conditions

John Kilpatrick

Wyoming-Montana Water Science Center
U.S. Geological Survey

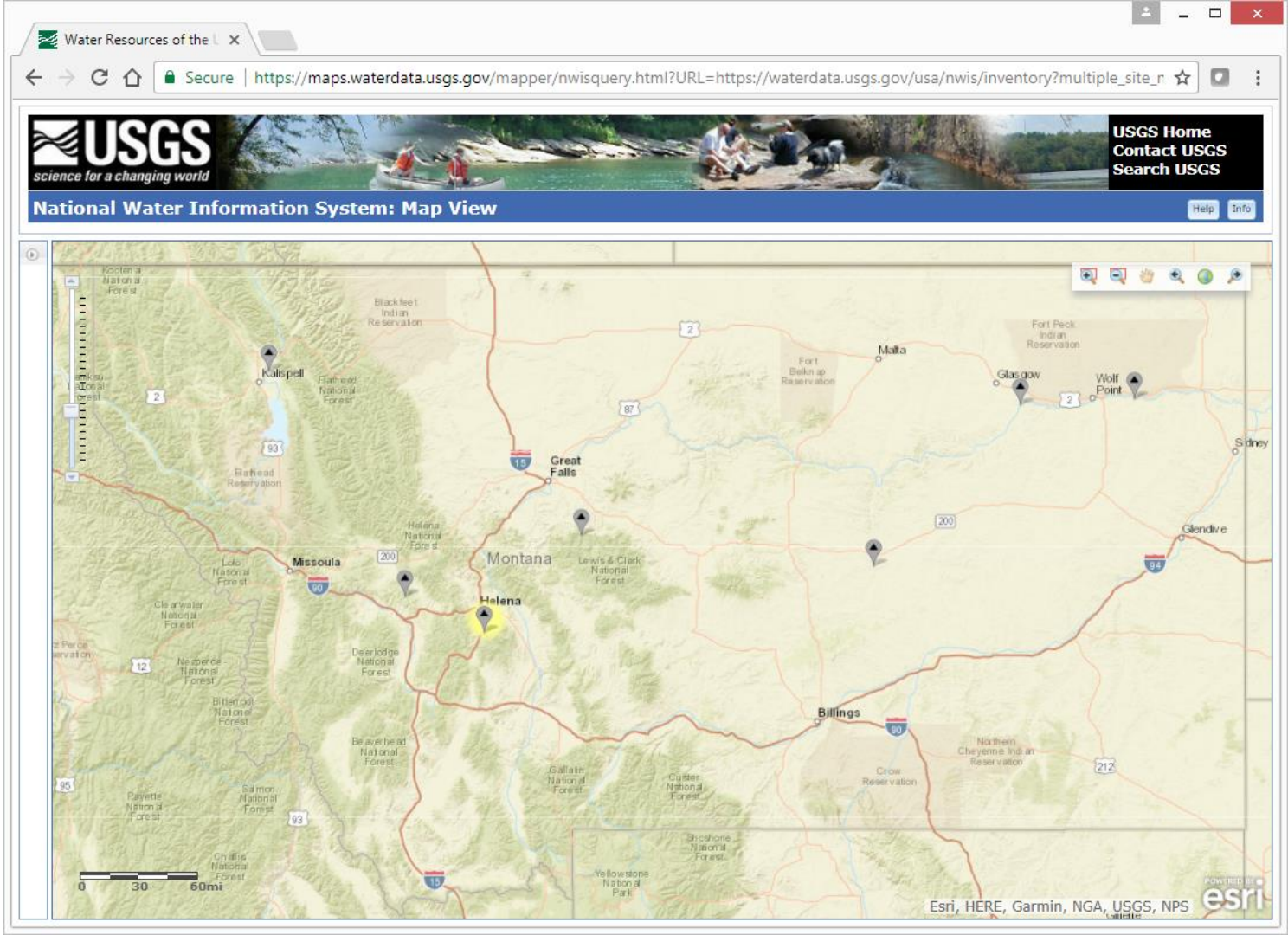
Prepared for the State of Montana
Governor's Drought and Water Supply Advisory Committee

July 18, 2017

U.S. Department of the Interior
U.S. Geological Survey

Recent streamflow conditions

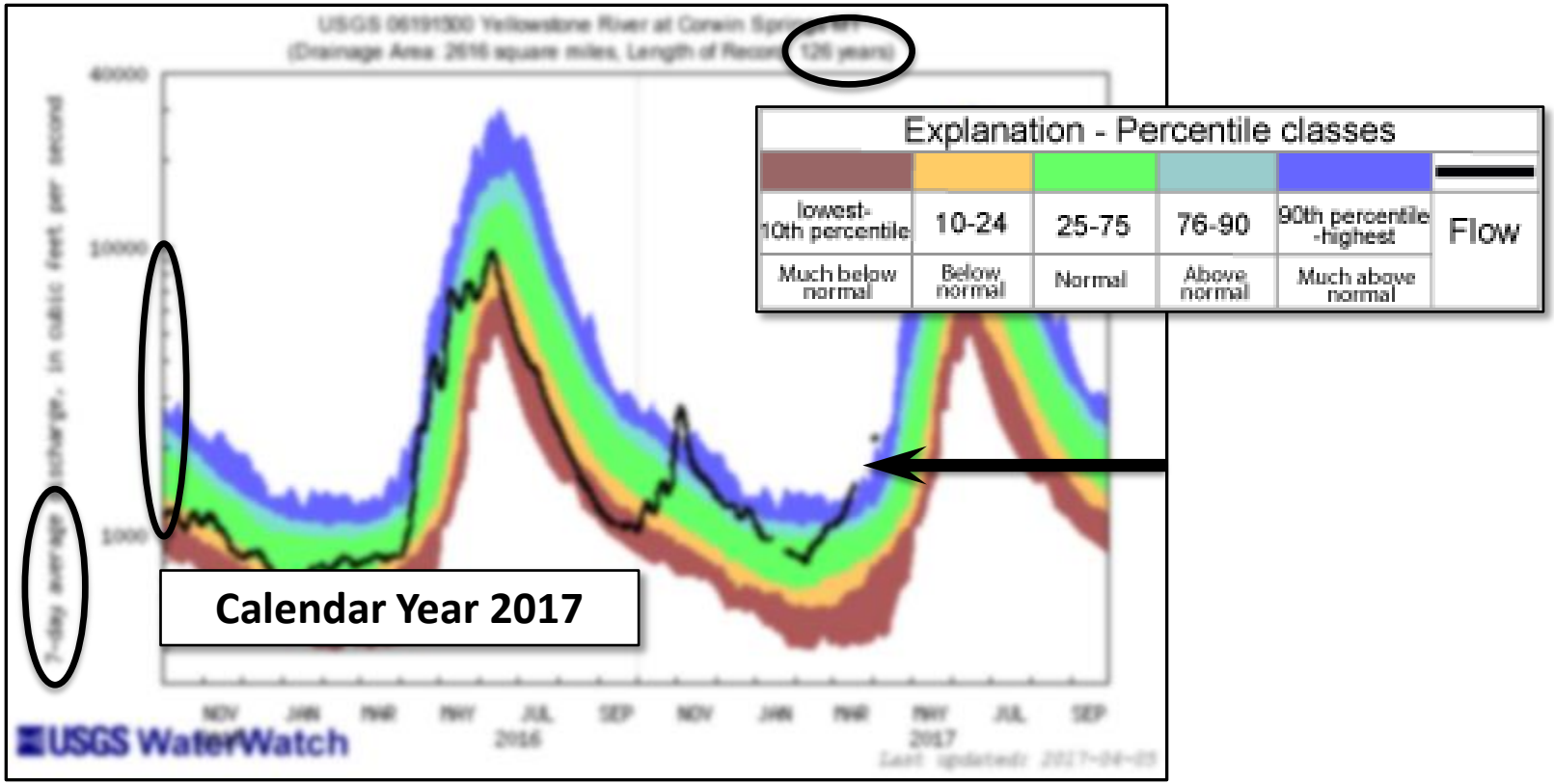
Location map



USGS

Recent streamflow conditions

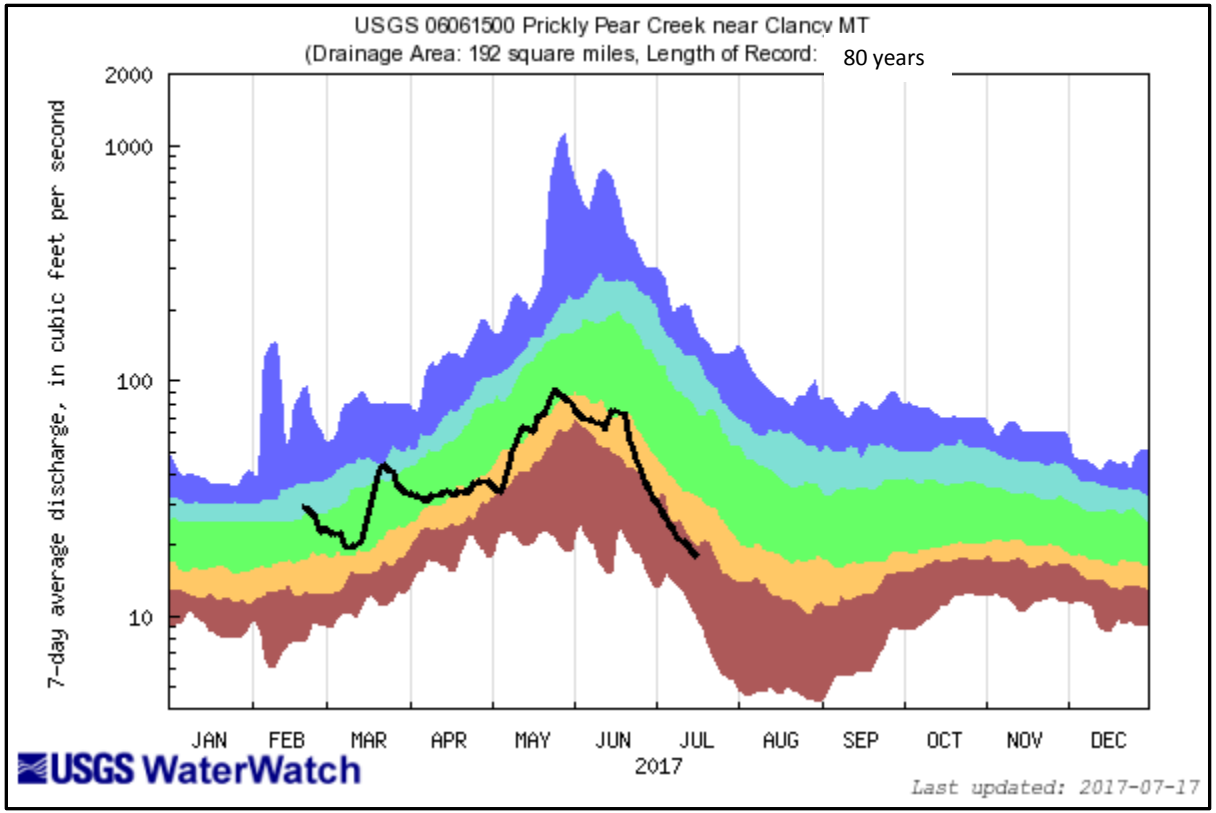
USGS Station Number USGS Station Name (Region)



USGS

Recent streamflow conditions

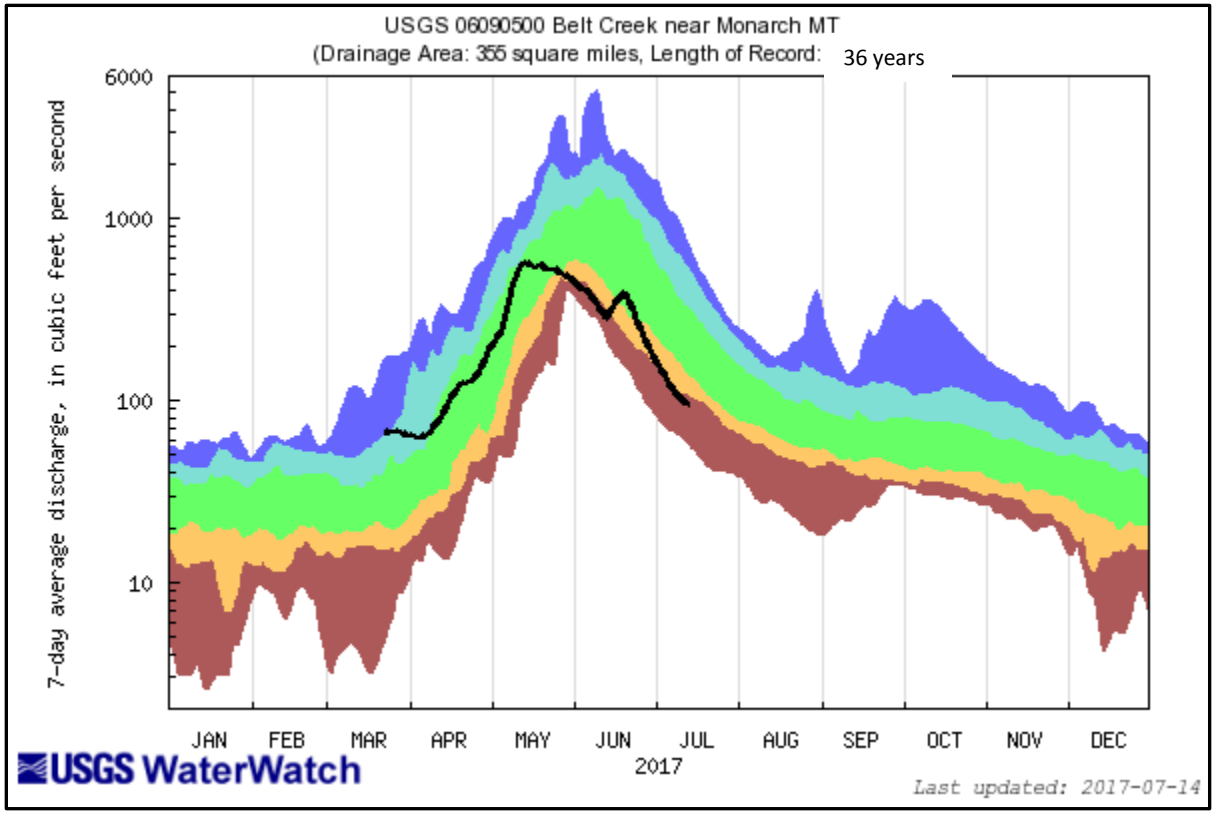
06061500 Prickly Pear Cr nr Clancy (Upper Missouri)



USGS

Recent streamflow conditions

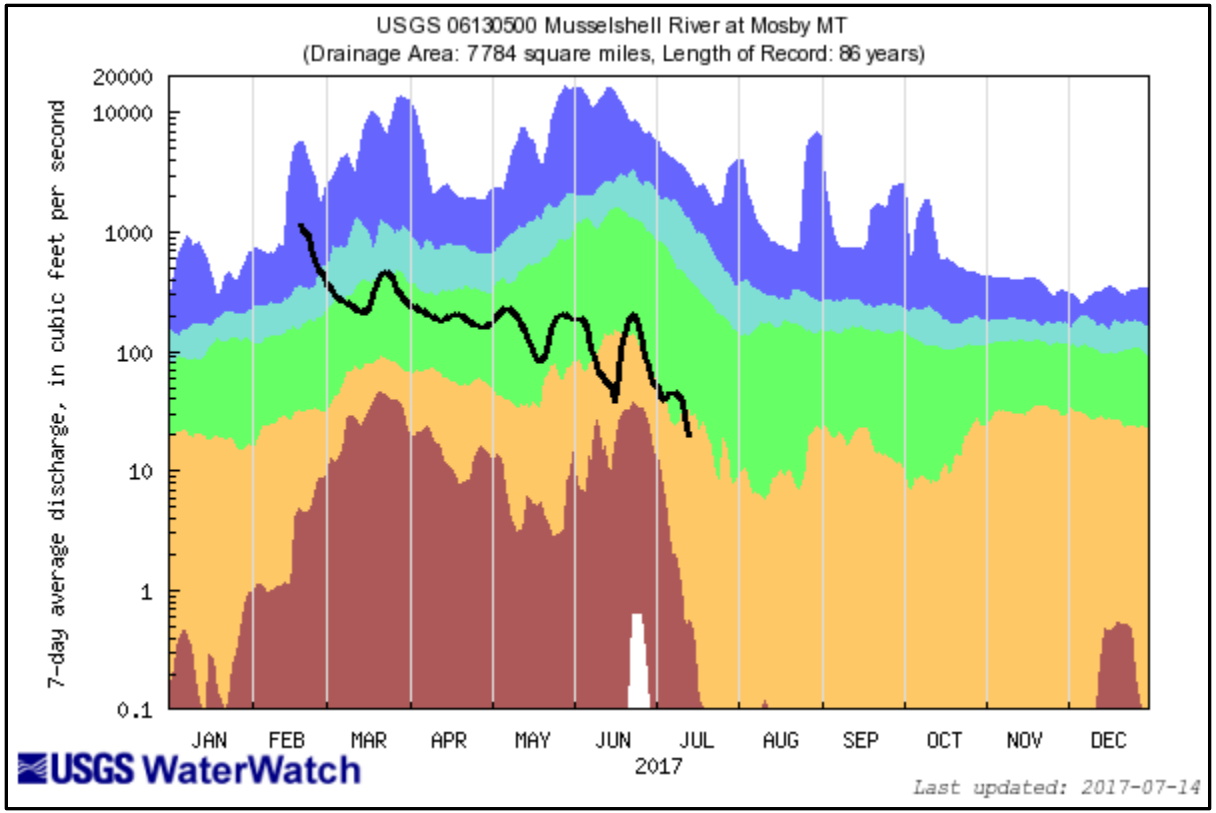
06090500 Belt Cr nr Monarch (Upper Missouri)



USGS

Recent streamflow conditions

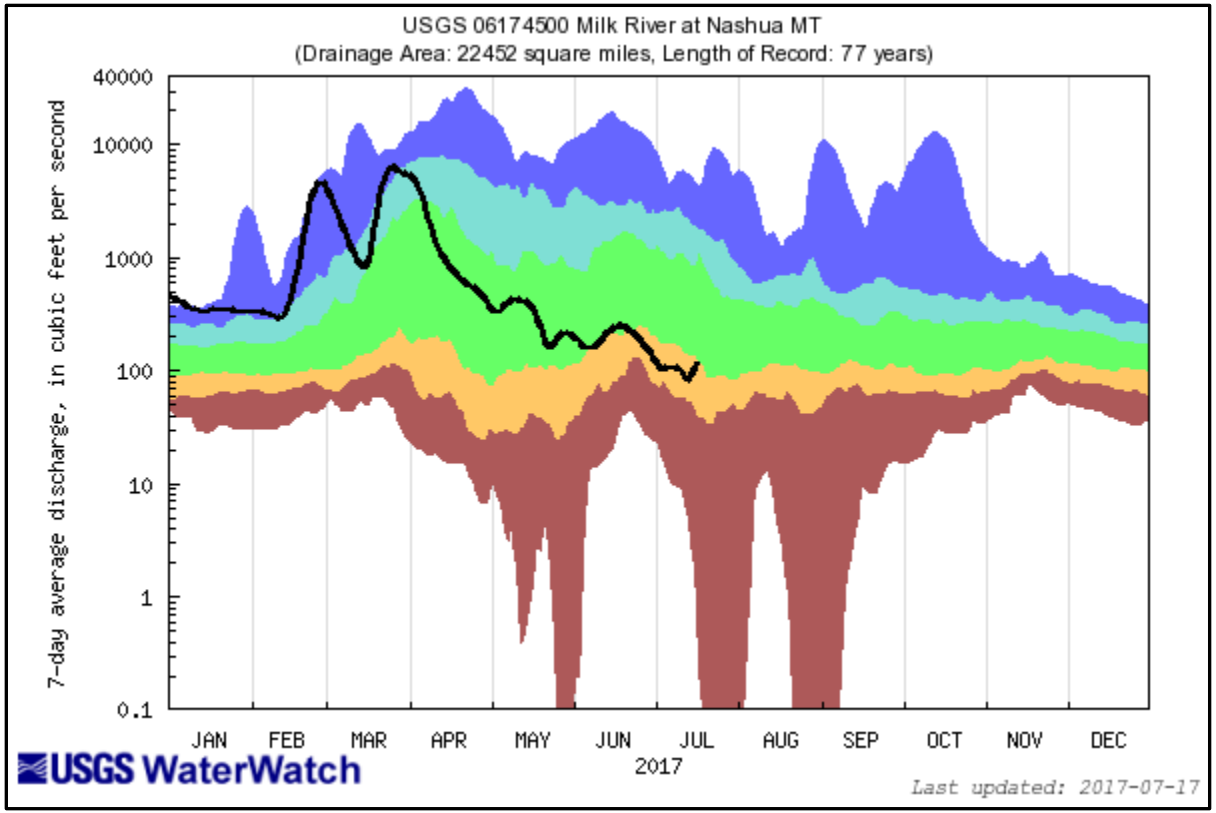
06130500 Musselshell R at Mosby (Musselshell)



USGS

Recent streamflow conditions

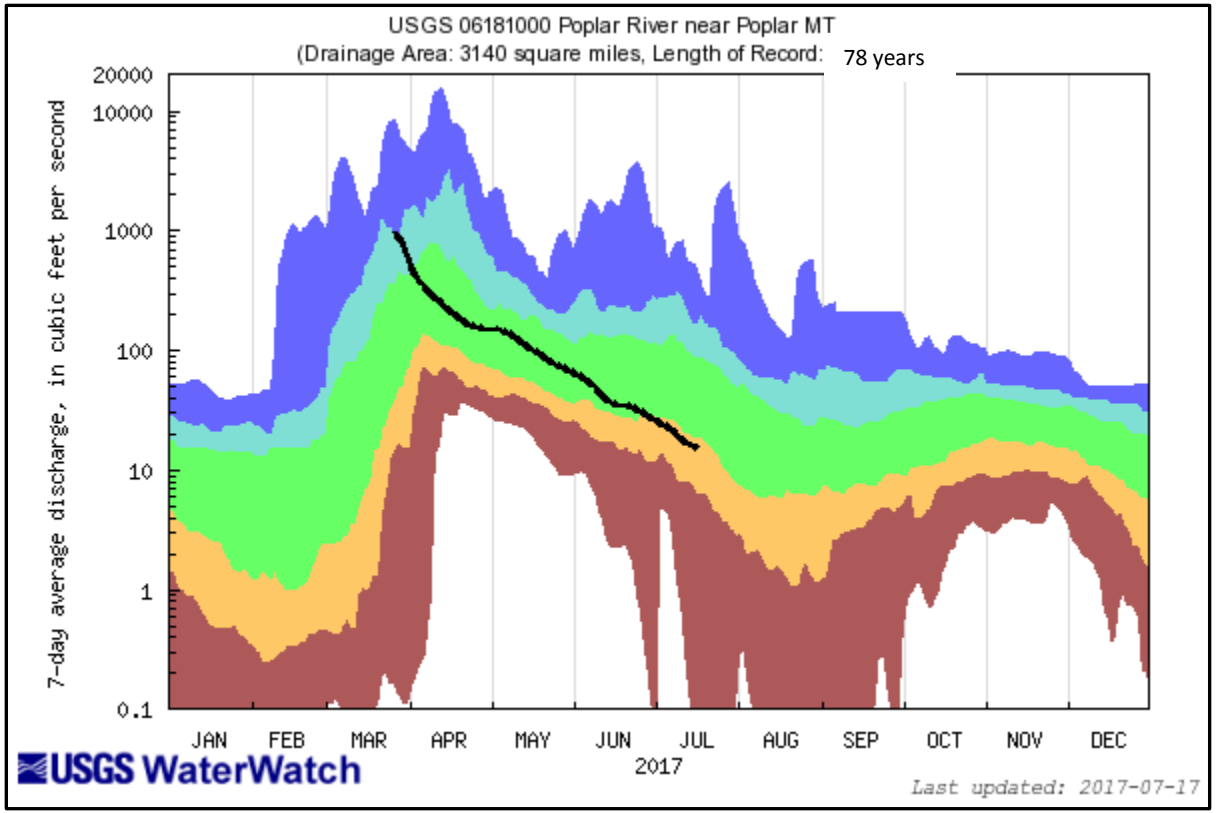
06174500 Milk R at Nashua (Milk)



USGS

Recent streamflow conditions

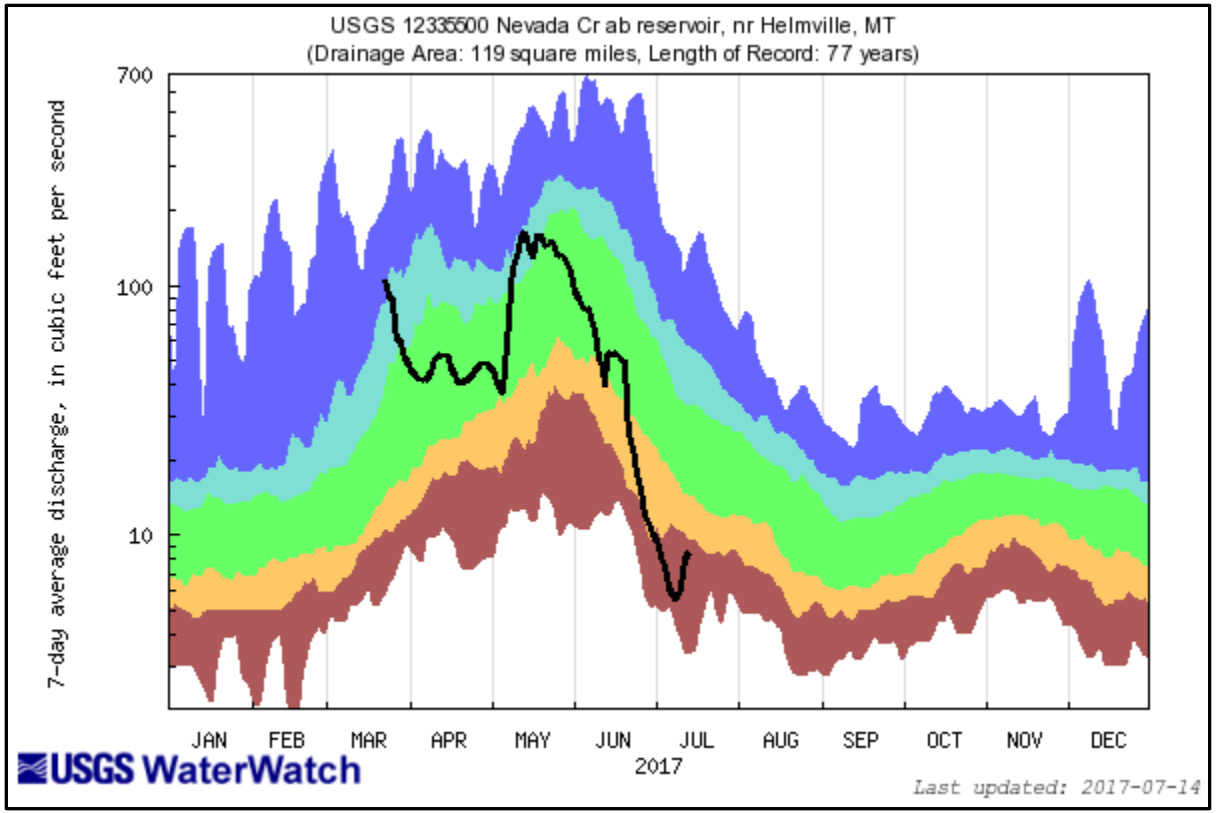
06181000 Poplar R nr Poplar (Missouri-Poplar)



USGS

Recent streamflow conditions

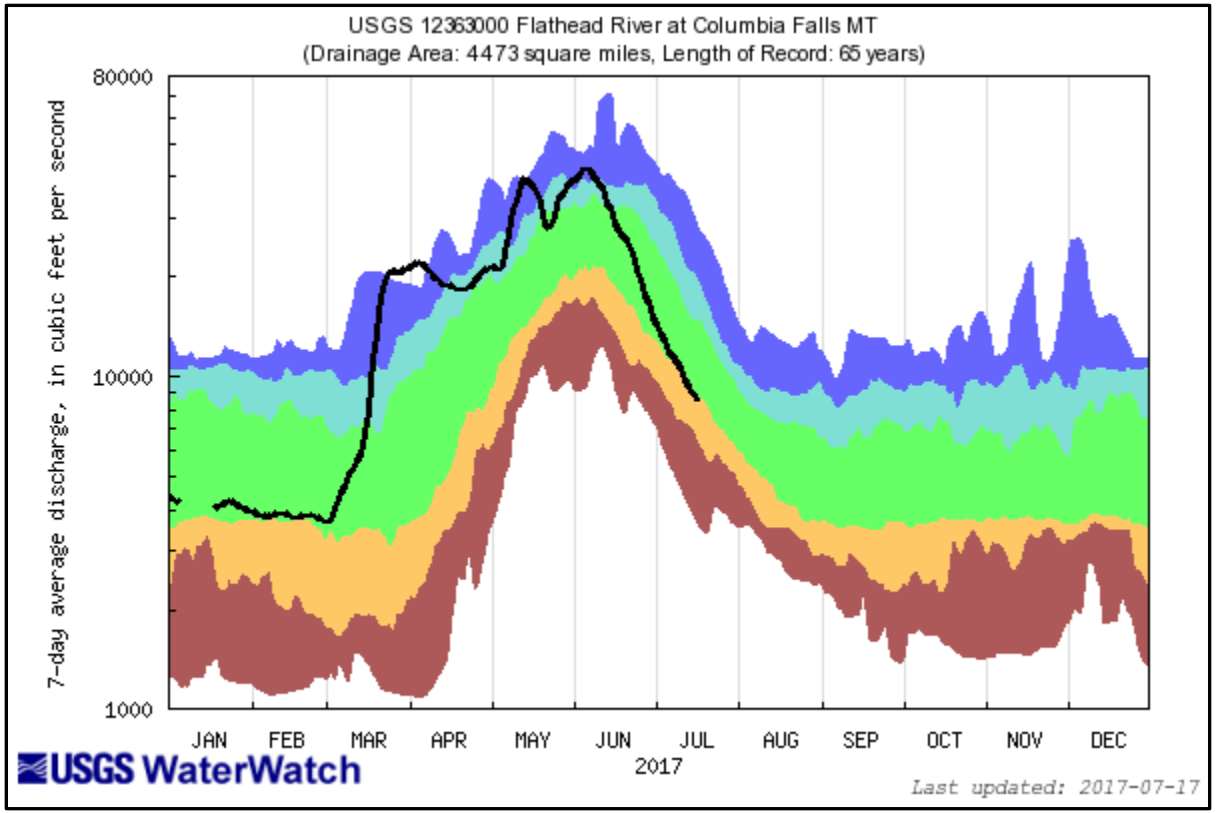
12335500 Nevada Cr ab reservoir nr Helmville (Blackfoot)



USGS

Recent streamflow conditions

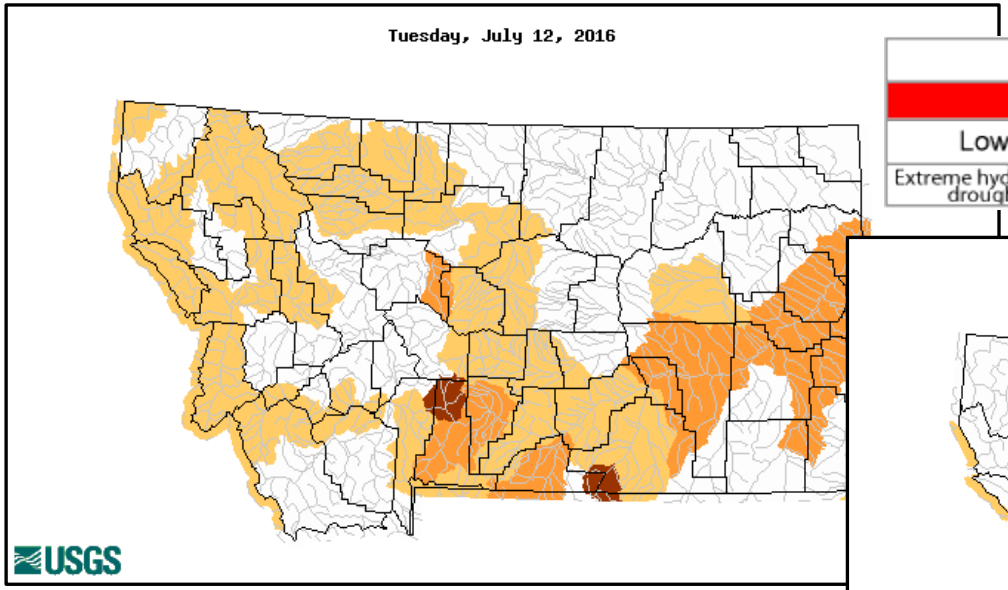
12363000 Flathead R at Columbia Falls (Flathead)



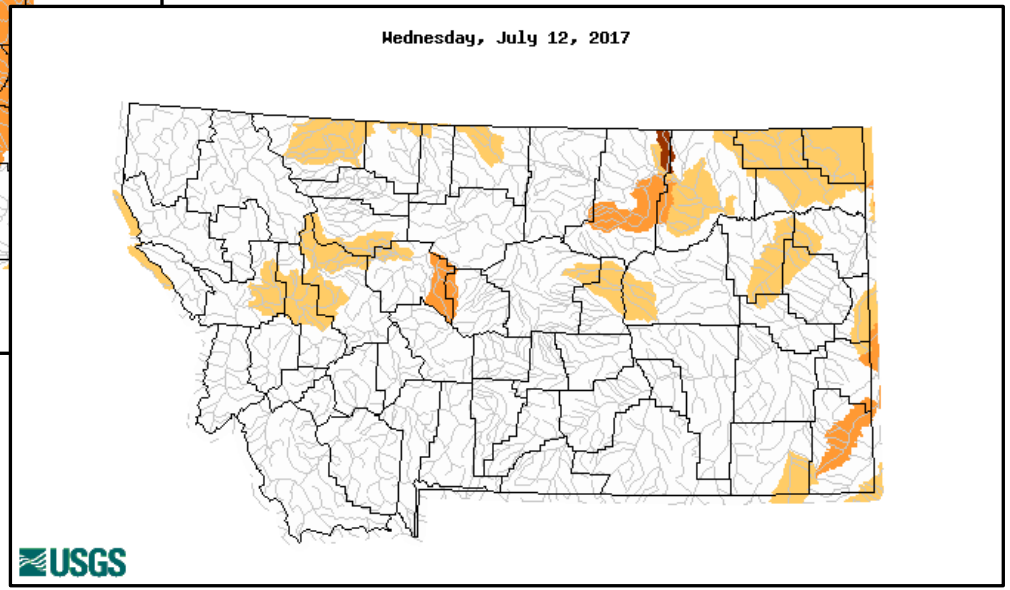
USGS

Statewide below normal streamflow conditions

Comparison with one year ago (July 12)



Explanation - Percentile classes				
Low	<=5	6-9	10-24	Insufficient data for a hydrologic region
Extreme hydrologic drought	Severe hydrologic drought	Moderate hydrologic drought	Below normal	

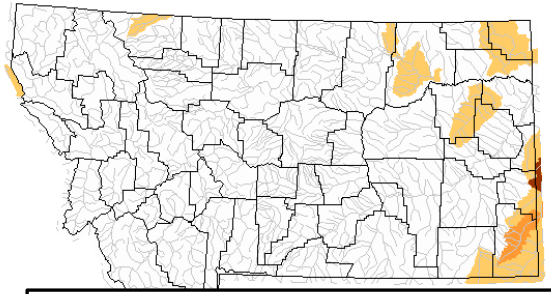


USGS

Statewide streamflow conditions

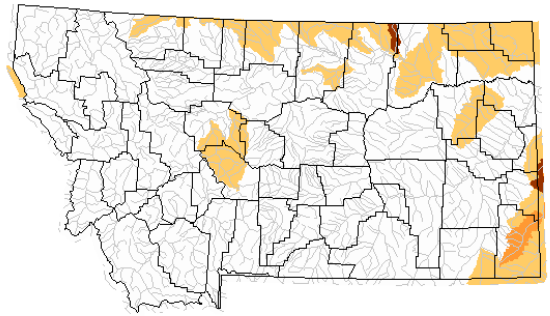
Comparison of last 4 weeks (Wednesday)

Jun 21



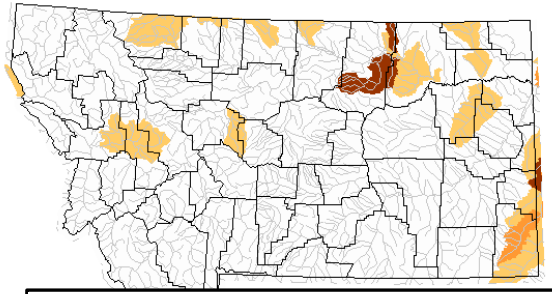
USGS

Jun 28



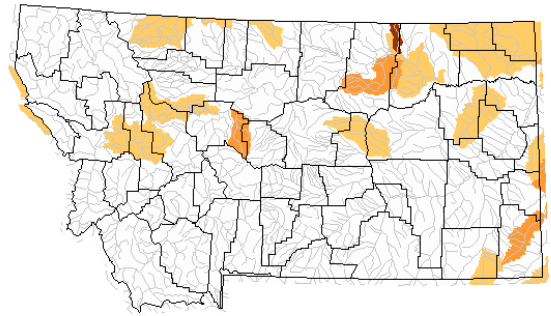
USGS

Jul 5



USGS

Jul 12



USGS

USGS

Recently discontinued USGS streamgages

UPDATES

“Rescued” – Partner commitment to fund

- **06088500 Muddy Cr at Vaughn**
- **12324200 Clark Fork at Deer Lodge**
- **12324680 Clark Fork at Goldcreek**

Discontinued effective July 1

- **06071300 Little Prickly Pear Cr at Wolf**
- **06077500 Smith R at Eden**
- **06130000 Flatwillow Cr nr Mosby ***
- **12338300 N Fk Blackfoot R ab Dry Gulch nr Ovando ****

USGS

U.S. Geological Survey contacts

- **Wyoming-Montana Center Director**
  - **John Kilpatrick (jmkilpat@usgs.gov) (406) 457-5902**
- **Wyoming-Montana Surface-Water Specialist**
  - **Kathy Chase (kchase@usgs.gov) (406) 457-5957**
- **Wyoming-Montana Data Chief**
  - **Kirk Miller (kmiller@usgs.gov) (307) 775-9168**

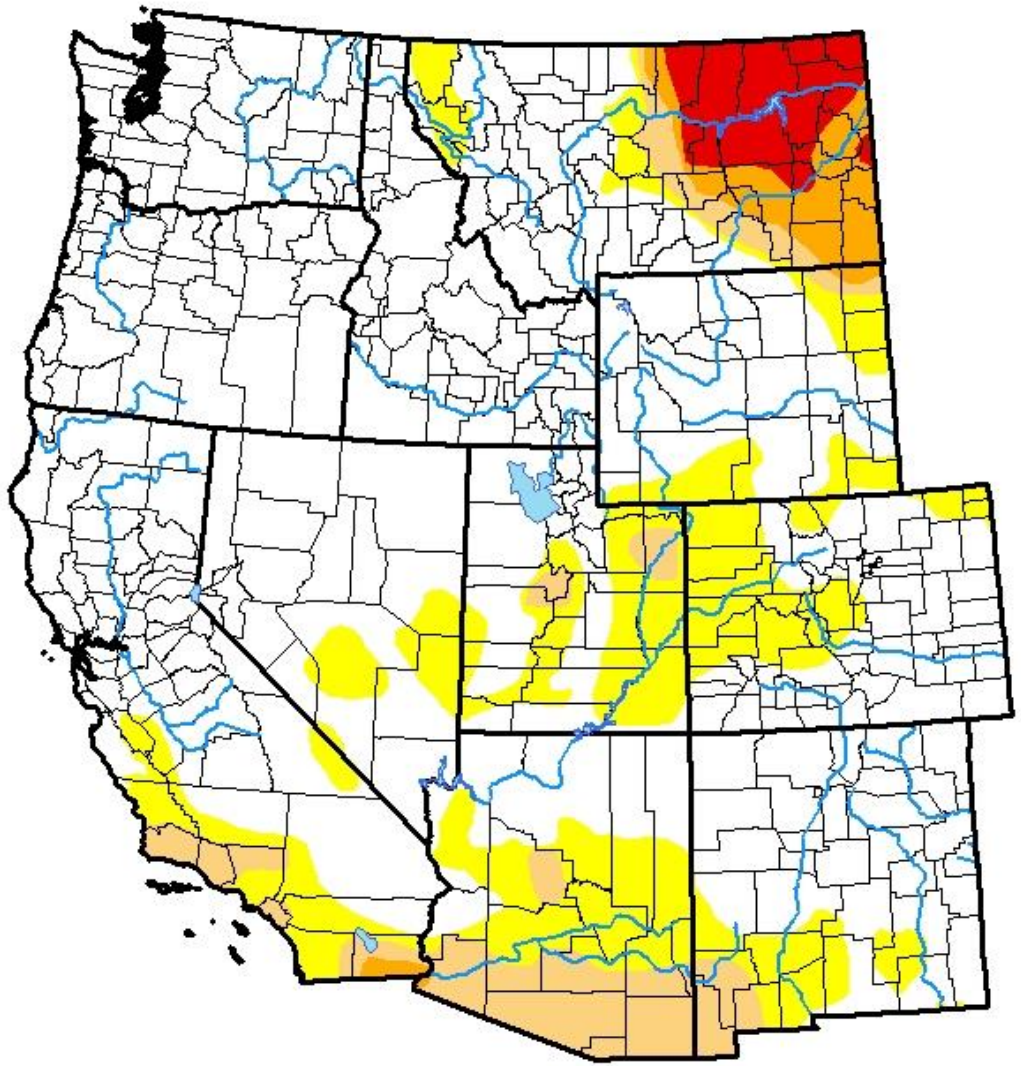
USGS

Governor's Drought and Water Supply Advisory Committee

Wildland Fire Briefing

Bruce Suenram
Deputy Chief

U.S. Drought Monitor
West



July 11, 2017
(Released Thursday, Jul. 13, 2017)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	72.11	27.89	10.86	4.94	2.73	0.00
Last Week *07-04-2017*	75.35	24.65	10.27	4.49	1.60	0.00
3 Months Ago *04-11-2017*	81.58	18.42	5.02	0.16	0.00	0.00
Start of Calendar Year *01-03-2017*	54.19	45.81	21.51	8.53	5.11	2.44
Start of Water Year *09-27-2016*	27.78	72.22	30.95	13.45	5.77	2.81
One Year Ago *07-12-2016*	34.31	65.69	28.08	11.11	5.80	2.81

Intensity:

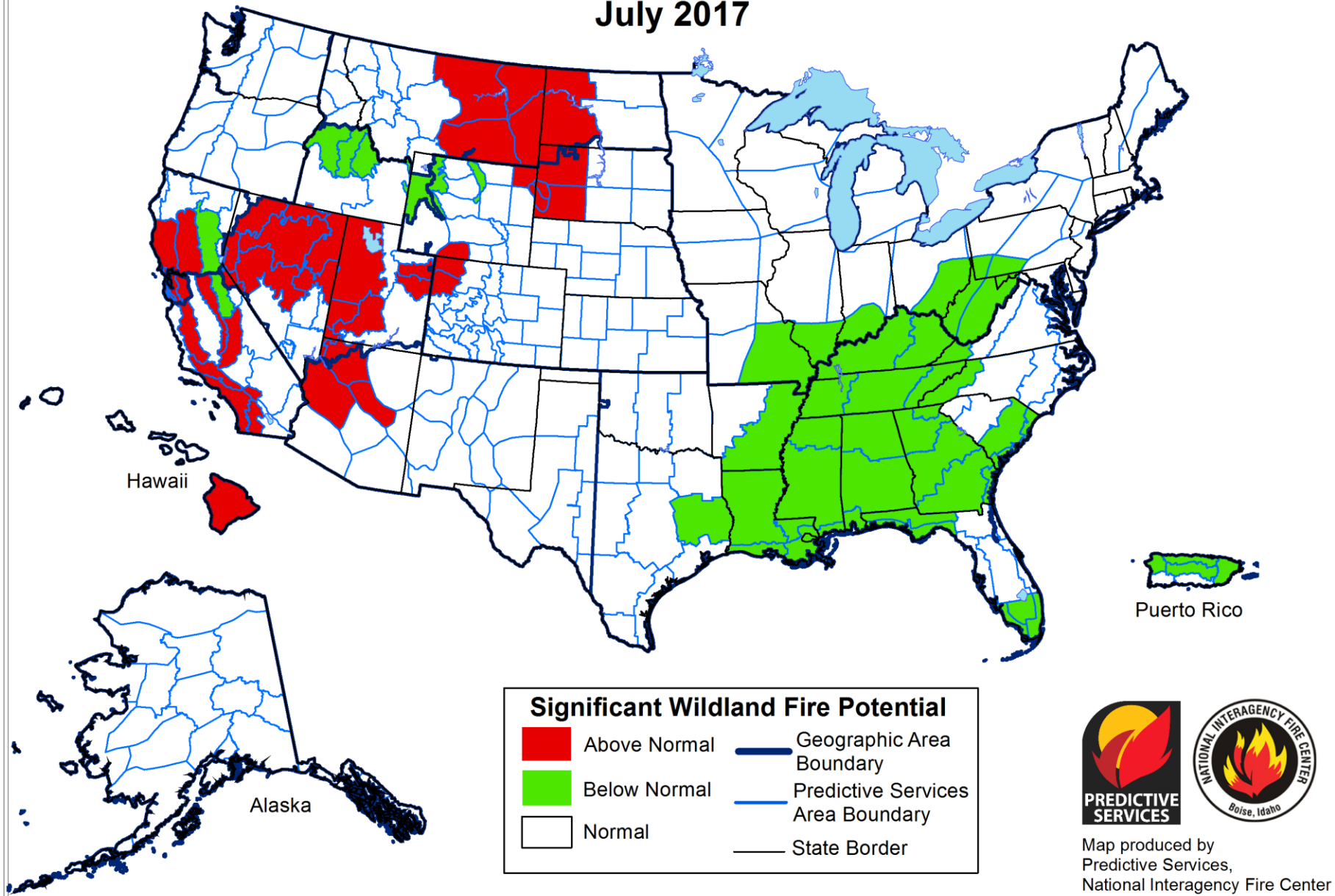
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
David Simeral
Western Regional Climate Center

http://droughtmonitor.unl.edu/

Significant Wildland Fire Potential Outlook
July 2017



Above normal significant wildland fire potential indicates a greater than usual likelihood that significant wildland fires will occur.
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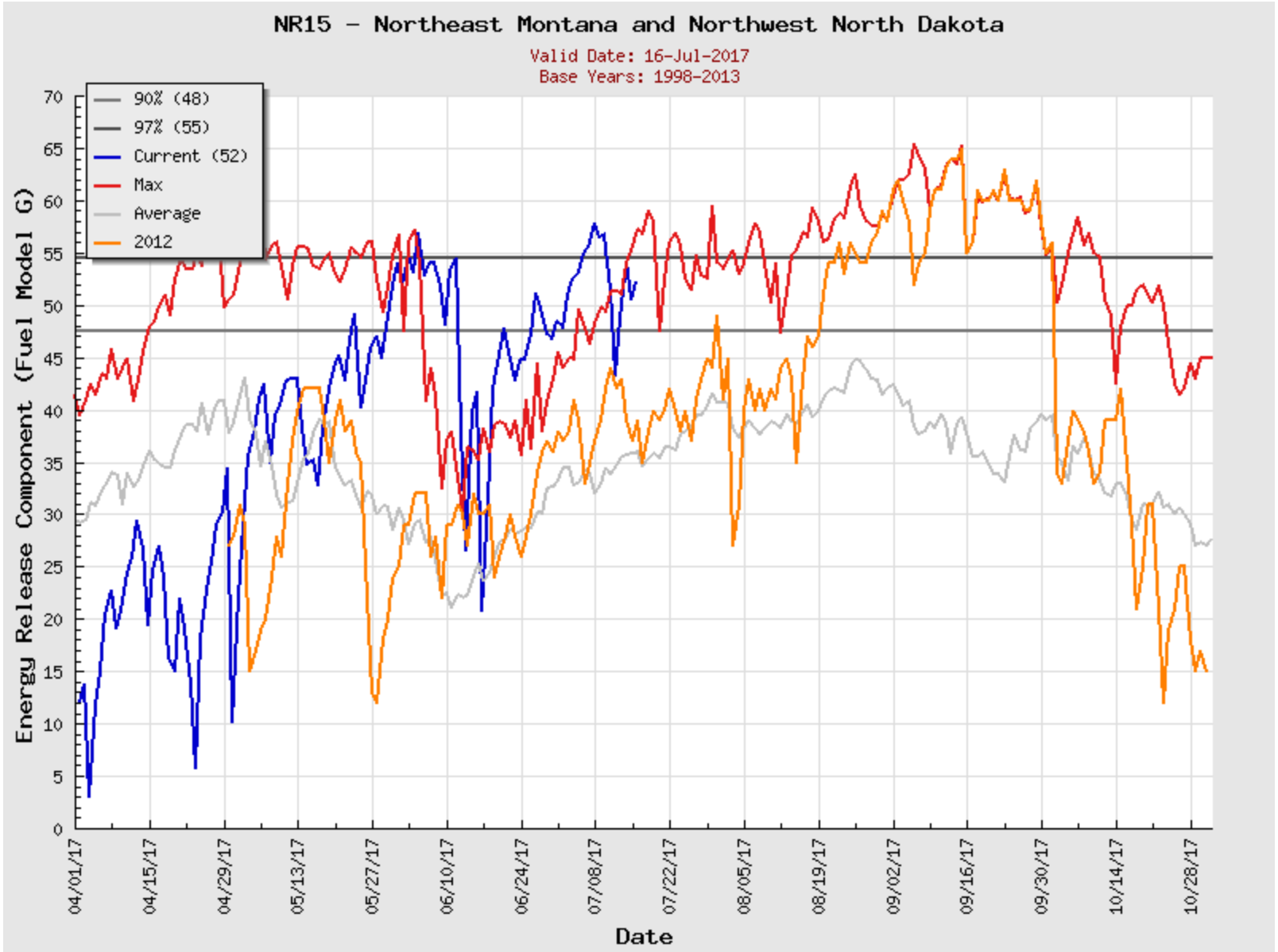
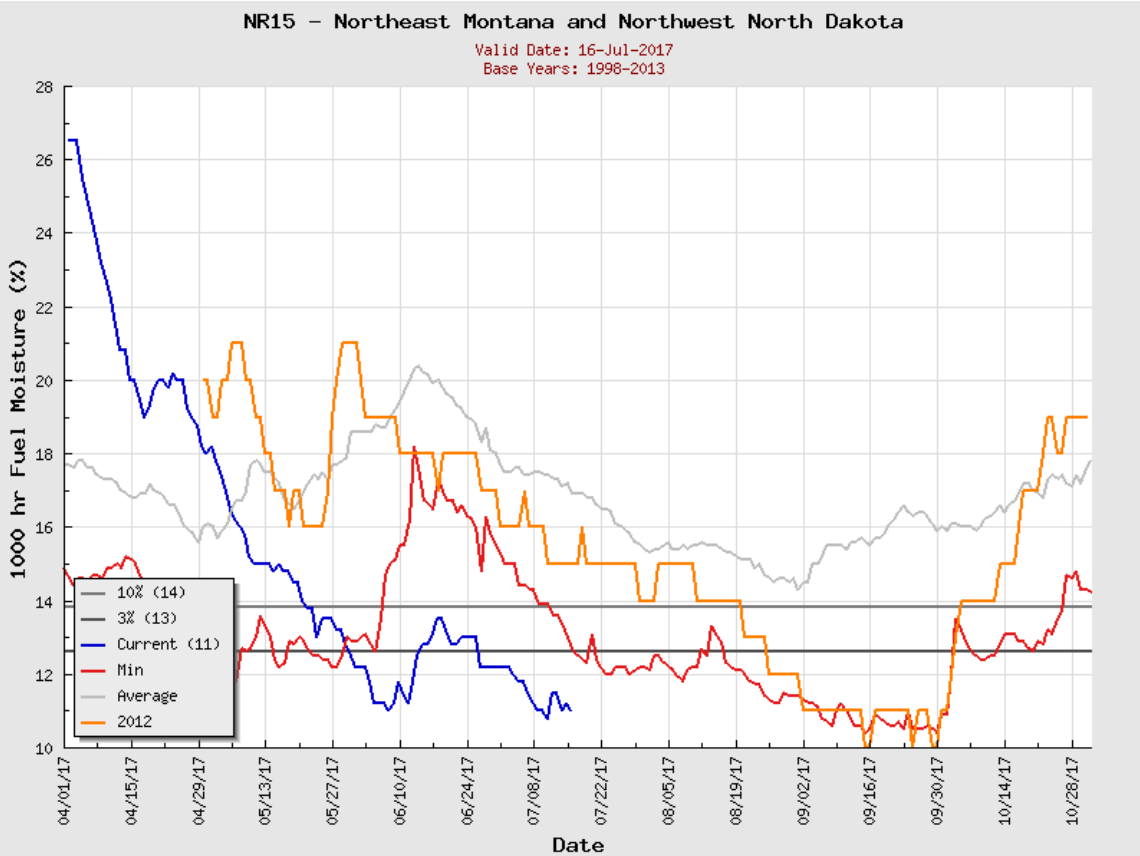
Significant wildland fires are still possible but less likely than usual during forecasted below normal periods.

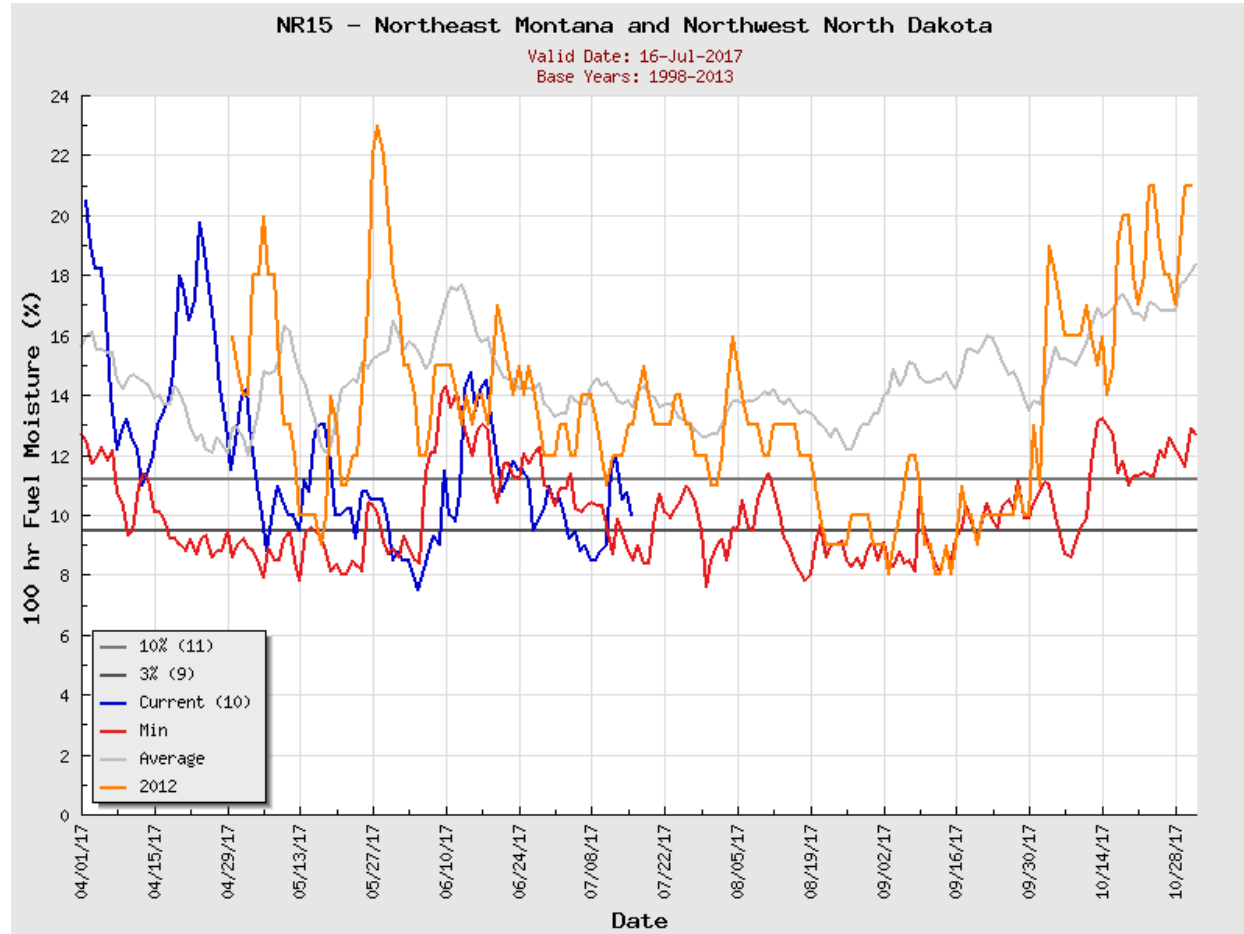
PREDICTIVE SERVICES

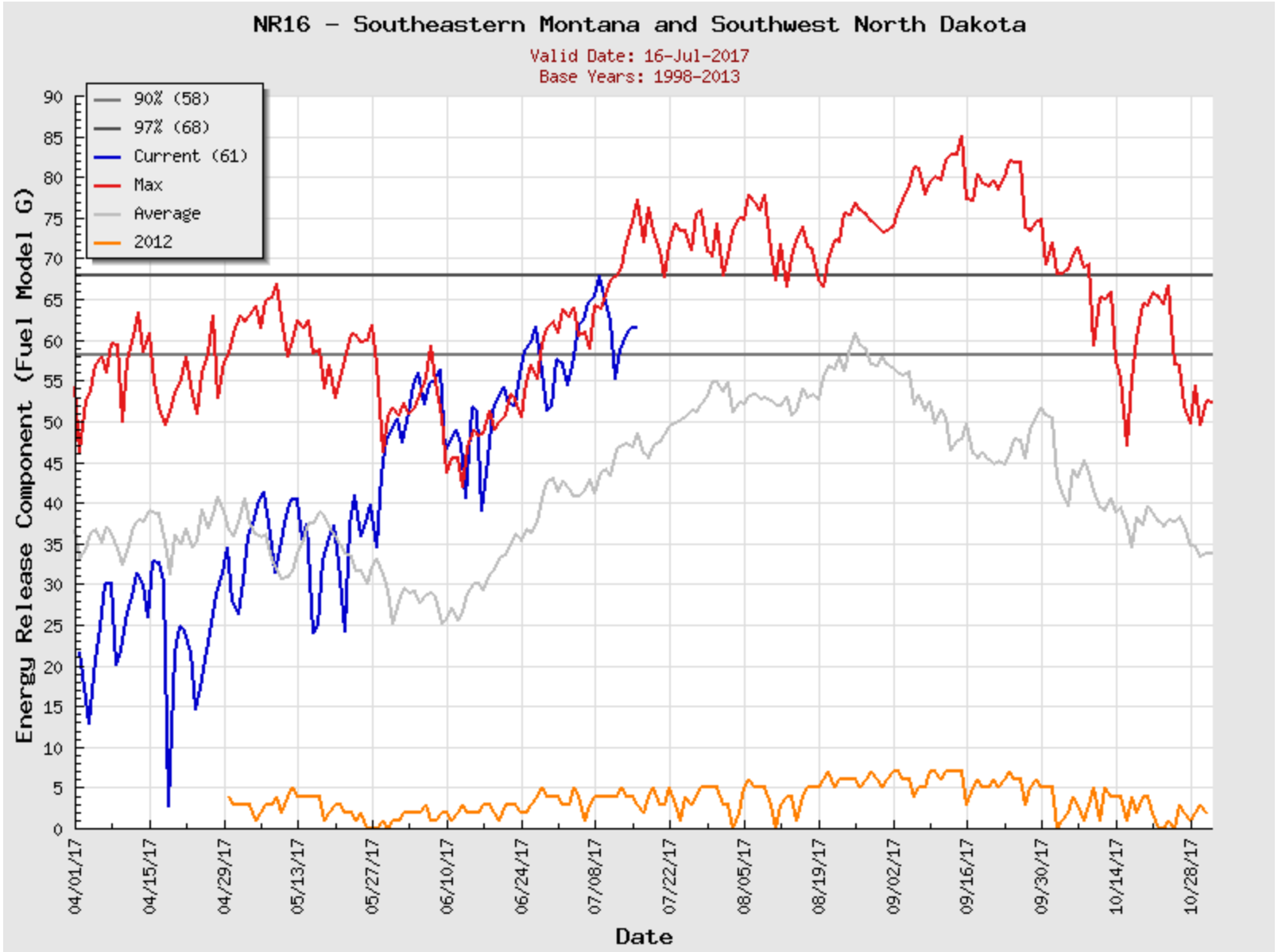
NATIONAL INTERAGENCY FIRE CENTER
Boise, Idaho

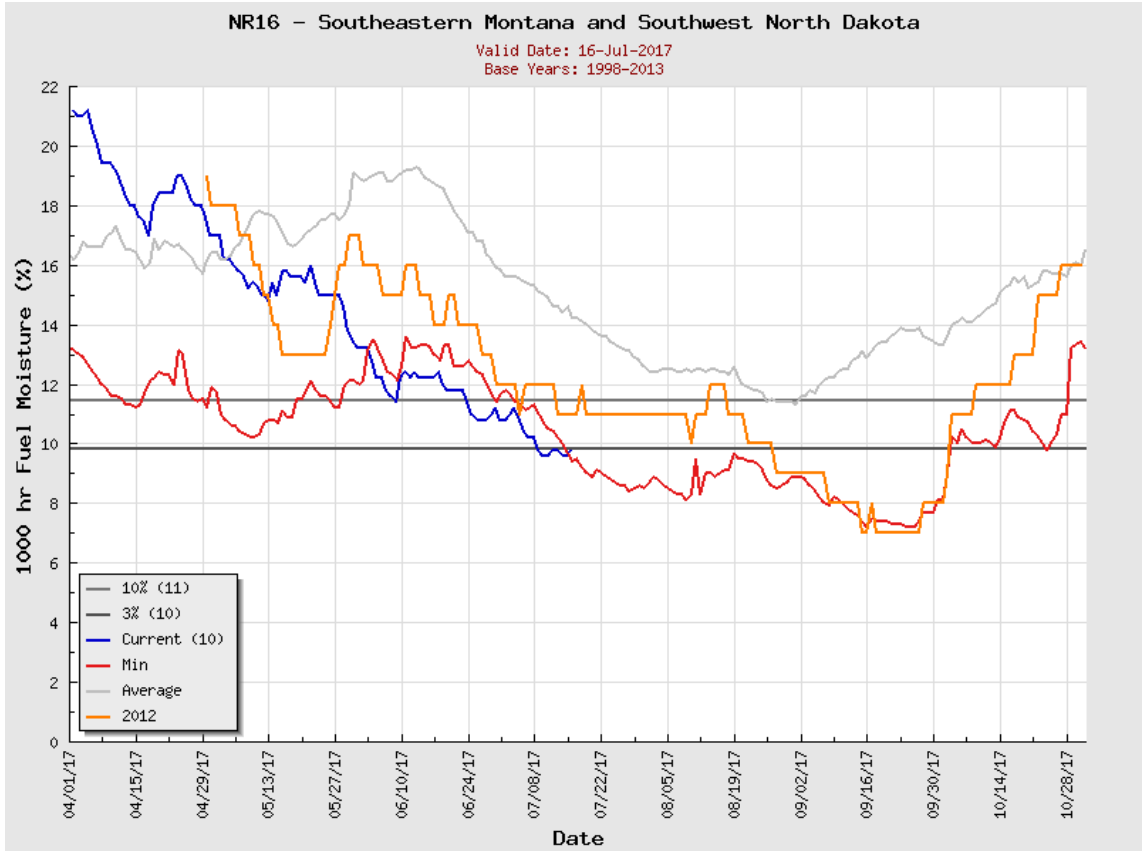
Map produced by
Predictive Services,
National Interagency Fire Center
Boise, Idaho
Issued July 1, 2017
Next issuance August 1, 2017

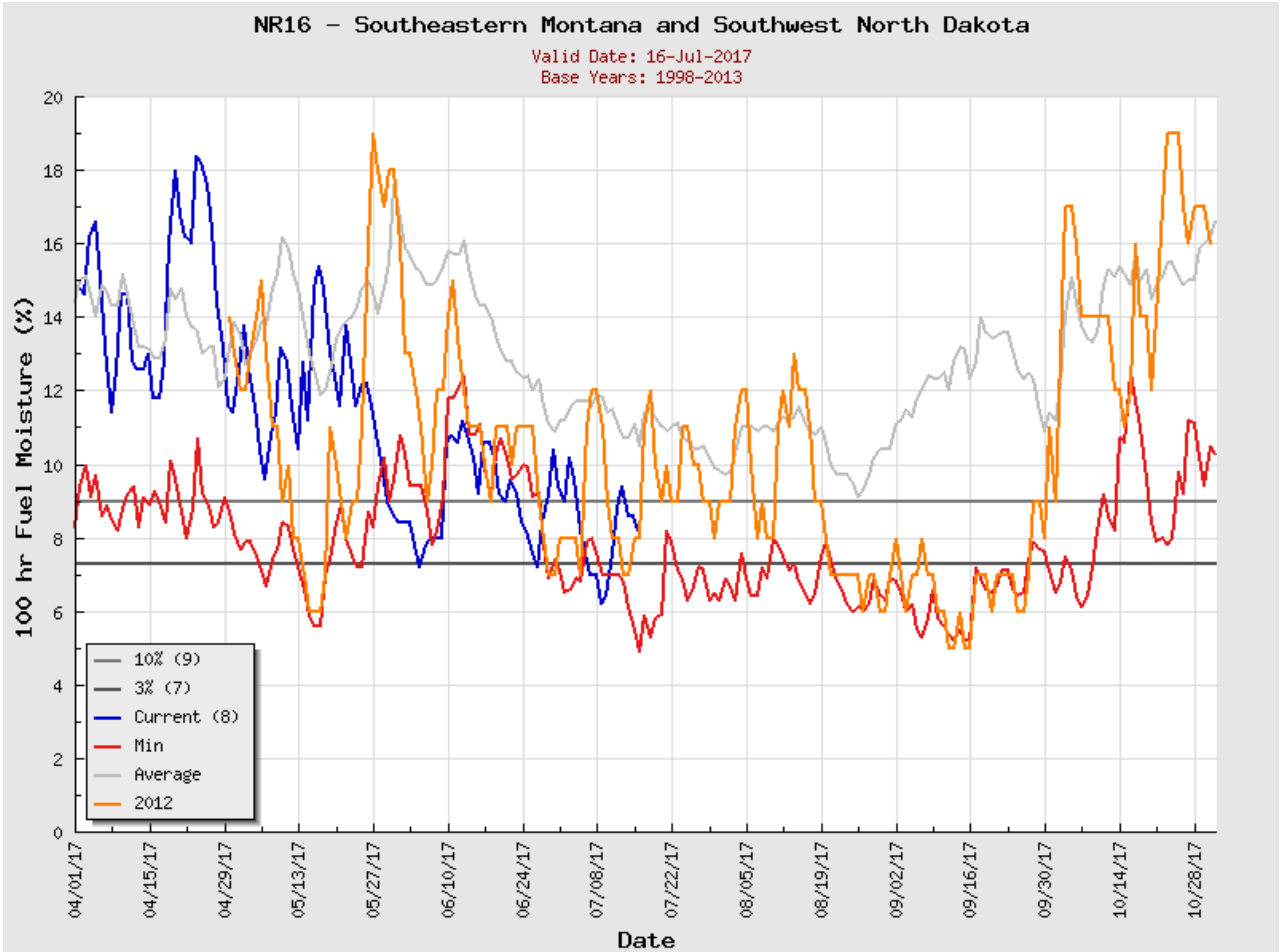

NR15 - Northeast Montana and Northwest North Dakota
Valid Date: 16-Jul-2017
Base Years: 1998-2013
90% (48)
97% (55)
Current (52)
Max
Average
2012
Energy Release Component (Fuel Model G)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
04/01/17
04/15/17
04/29/17
05/13/17
05/27/17
06/10/17
06/24/17
07/08/17
07/22/17
08/05/17
08/19/17
09/02/17
09/16/17
09/30/17
10/14/17
10/28/17
Date


NR15 - Northeast Montana and Northwest North Dakota
Valid Date: 16-Jul-2017
Base Years: 1998-2013
1000 hr Fuel Moisture (%)
28
26
24
22
20
18
16
14
12
10
10% (14)
3% (13)
Current (11)
Min
Average
2012
04/01/17
04/15/17
04/29/17
05/13/17
05/27/17
06/10/17
06/24/17
07/08/17
07/22/17
08/05/17
08/19/17
09/02/17
09/16/17
09/30/17
10/14/17
10/28/17
Date

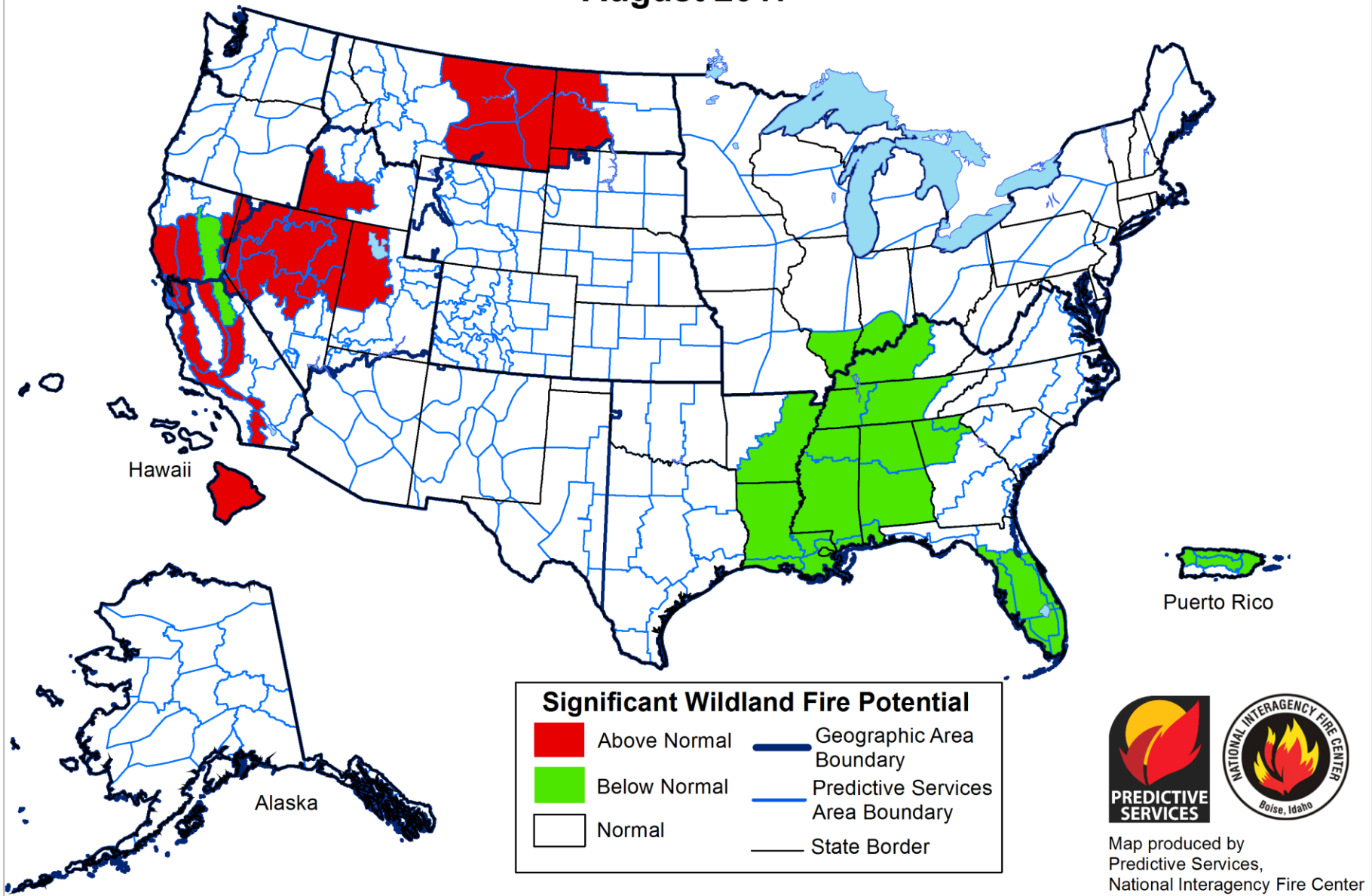

NR15 - Northeast Montana and Northwest North Dakota
Valid Date: 16-Jul-2017
Base Years: 1998-2013
100 hr Fuel Moisture (%)
24
22
20
18
16
14
12
10
8
6
4
2
0
10% (11)
3% (9)
Current (10)
Min
Average
2012
04/01/17
04/15/17
04/29/17
05/13/17
05/27/17
06/10/17
06/24/17
07/08/17
07/22/17
08/05/17
08/19/17
09/02/17
09/16/17
09/30/17
10/14/17
10/28/17
Date


NR16 - Southeastern Montana and Southwest North Dakota
Valid Date: 16-Jul-2017
Base Years: 1998-2013
90% (58)
97% (68)
Current (61)
Max
Average
2012
Energy Release Component (Fuel Model G)
Date
04/01/17
04/15/17
04/29/17
05/13/17
05/27/17
06/10/17
06/24/17
07/08/17
07/22/17
08/05/17
08/19/17
09/02/17
09/16/17
09/30/17
10/14/17
10/28/17


NR16 - Southeastern Montana and Southwest North Dakota
Valid Date: 16-Jul-2017
Base Years: 1998-2013
1000 hr Fuel Moisture (%)
Date
10% (11)
3% (10)
Current (10)
Min
Average
2012


NR16 - Southeastern Montana and Southwest North Dakota
Valid Date: 16-Jul-2017
Base Years: 1998-2013
100 hr Fuel Moisture (%)
Date
10% (9)
3% (7)
Current (8)
Min
Average
2012

Significant Wildland Fire Potential Outlook
August 2017



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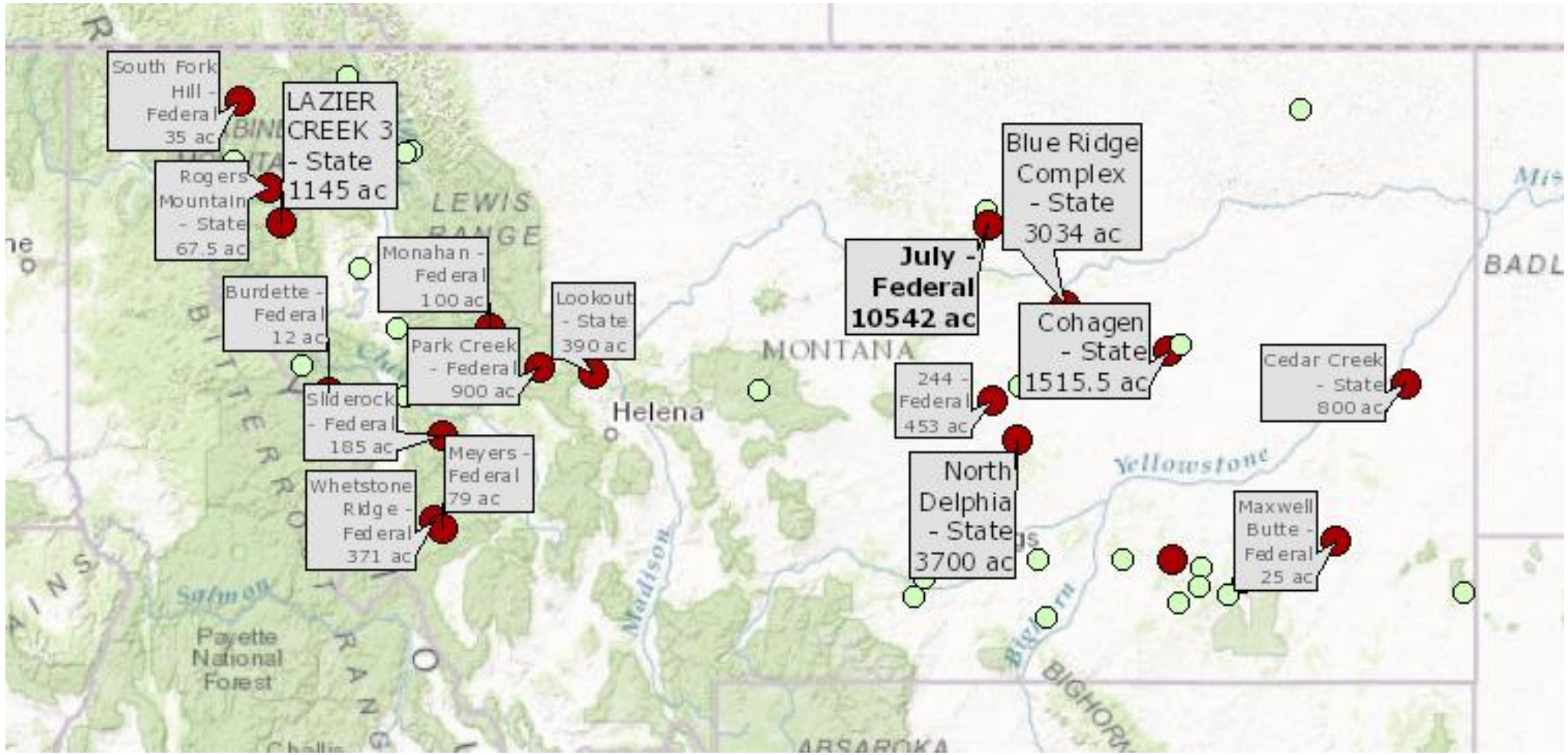
Map produced by
Predictive Services,
National Interagency Fire Center
Boise, Idaho
Issued July 1, 2017
Next issuance August 1, 2017

Fire Restrictions & Burn Bans

Stage 1 Restrictions		Stage 2 Restrictions	Burn Bans
Carter	Richland	Musselshell	Cascade
Chouteau	Rosebud	Yellowstone	Daniels
Custer	Wibaux		Flathead
Fergus			Jefferson
Garfield			Lake
Golden Valley			Lewis & Clark
Hill			Missoula
Judith Basin			Ravalli
Petroleum			Sanders
Phillips			Wheatland
Powder River			


South Fork Hill - Federal 35 ac
LAZIER CREEK 3 - State 1145 ac
Rogers Mountain - State 67.5 ac
Monahan - Federal 100 ac
Burdette - Federal 12 ac
Park Creek - Federal 900 ac
Lookout - State 390 ac
Slide rock - Federal 185 ac
Meyers - Federal 79 ac
Whetstone Ridge - Federal 371 ac
July - Federal 10542 ac
Blue Ridge Complex - State 3034 ac
Cohagen - State 1515.5 ac
244 - Federal 453 ac
North Delphia - State 3700 ac
Cedar Creek - State 800 ac
Maxwell Butte - Federal 25 ac
LEWIS RANGE
MONTANA
Helena
Yellowstone
Madison
Salmon
Payette National Forest
BIGHORN
ABSAROKA

RECLAMATION

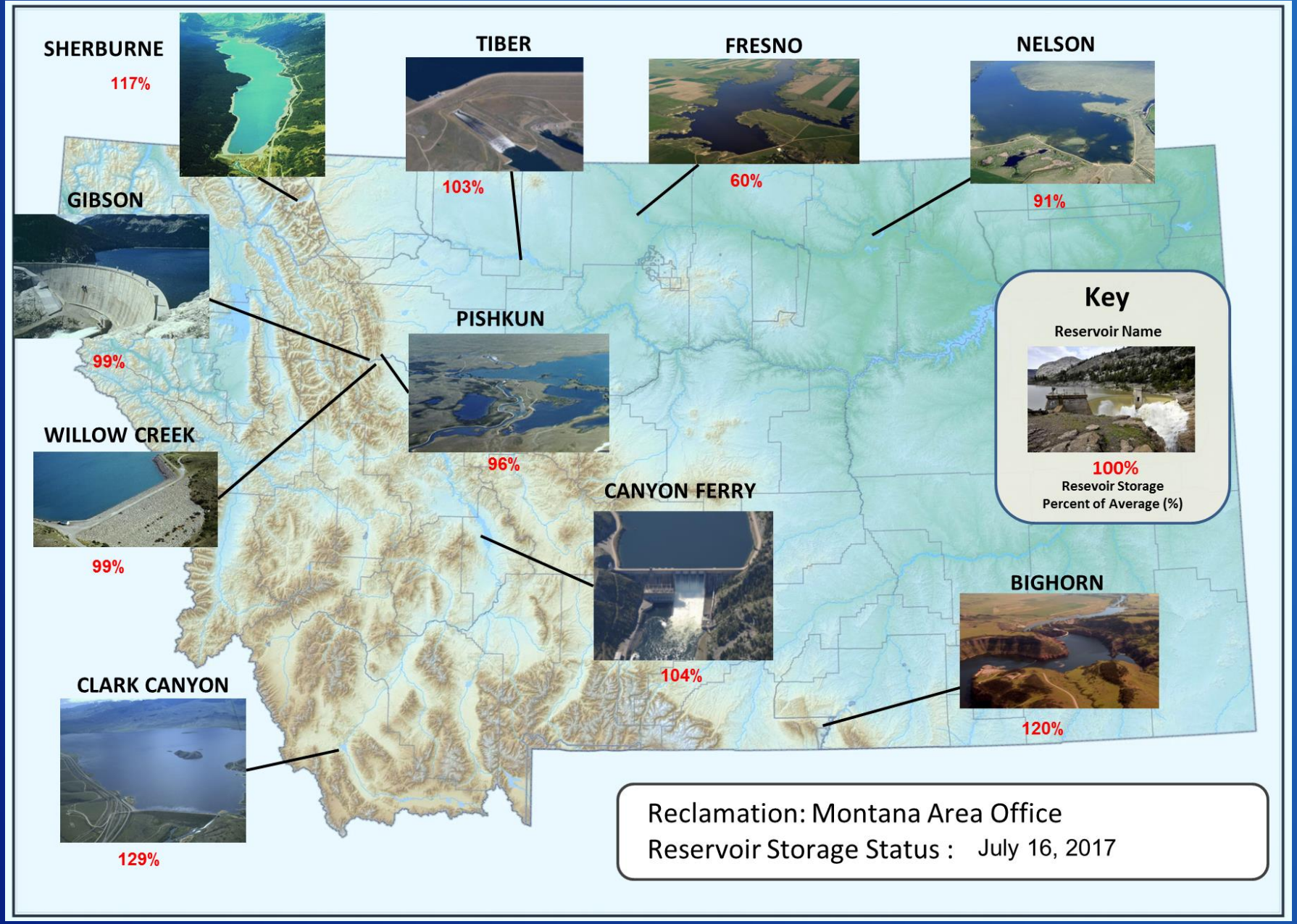
Managing Water in the West

River and Reservoir Status Briefing

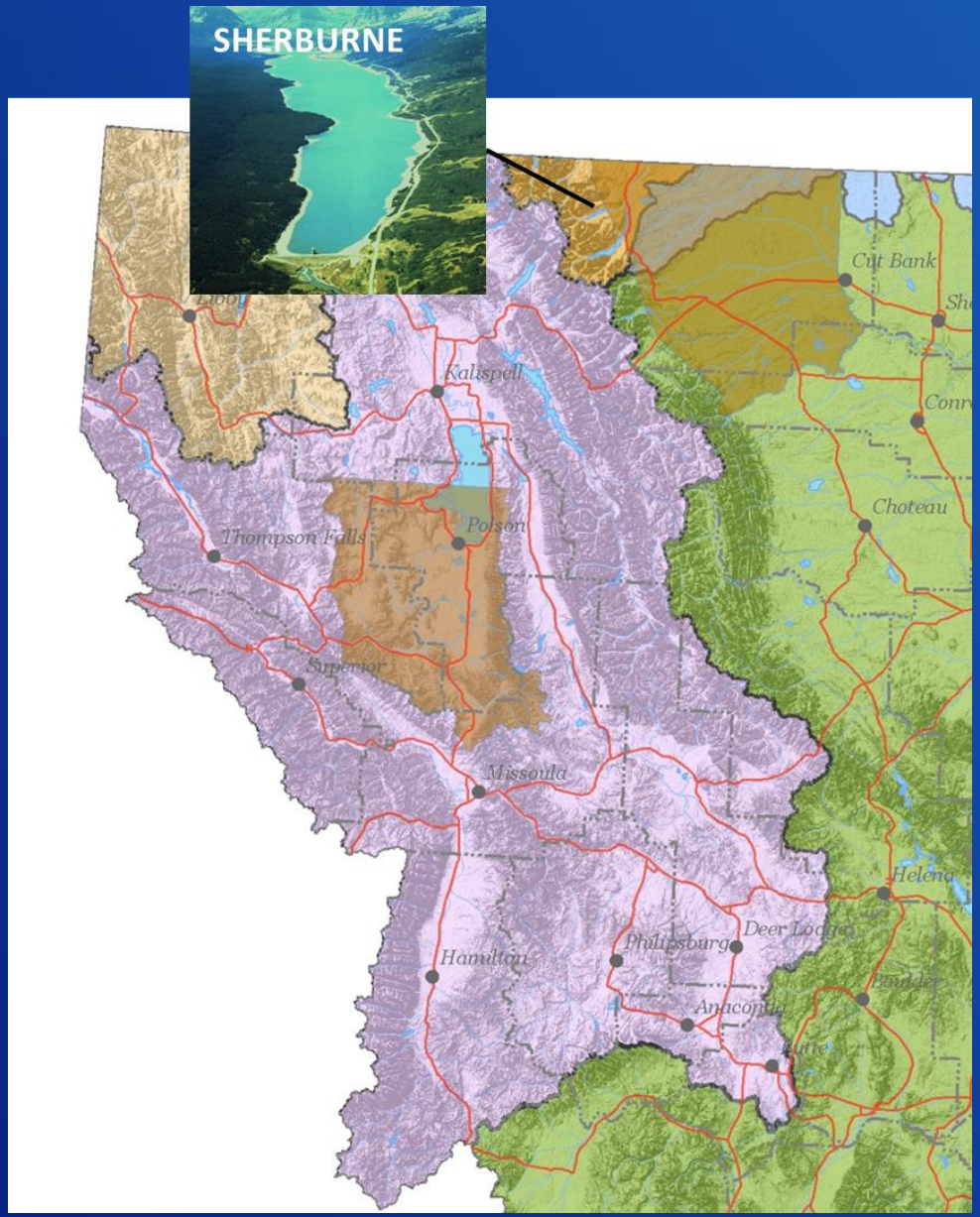
RESERVOIR AND RIVER OPERATIONS

Montana Area Office
Billings
July 18, 2017

U.S. Department of the Interior
Bureau of Reclamation



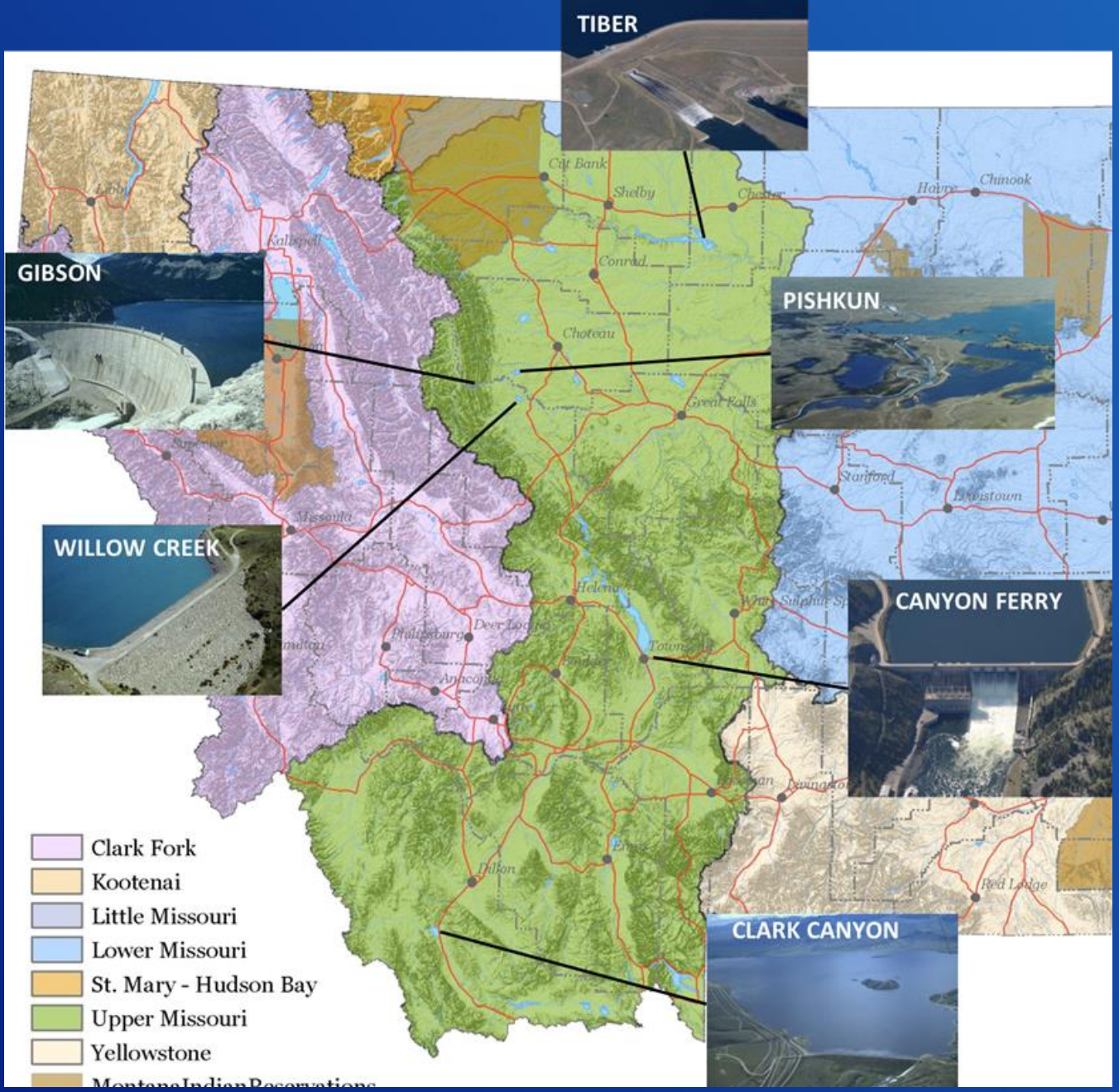
RECLAMATION



Summary of Conditions

- Reservoir Elevation – 1 ft below full pool
- Reservoir Release – 400 cfs

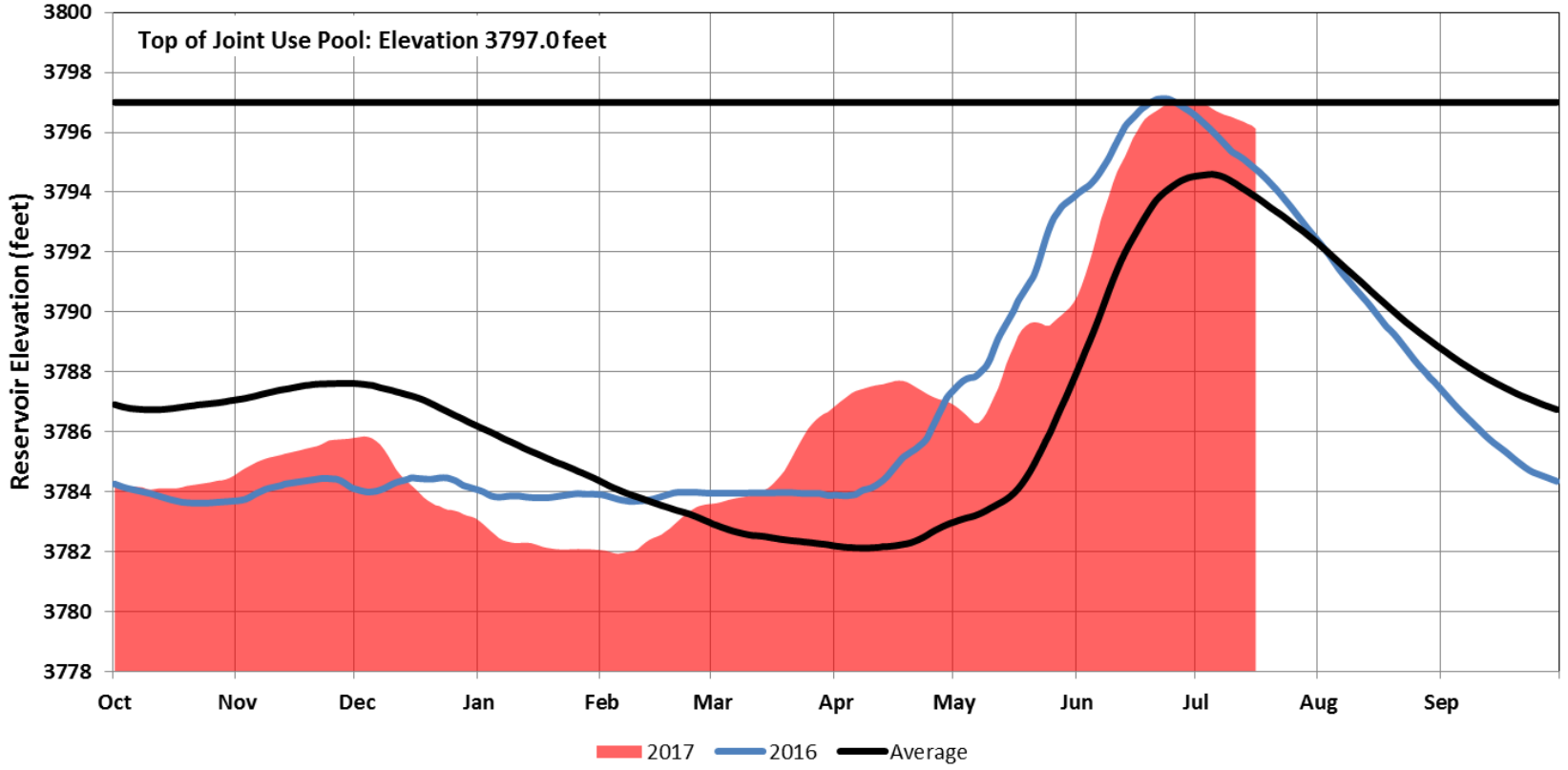
RECLAMATION

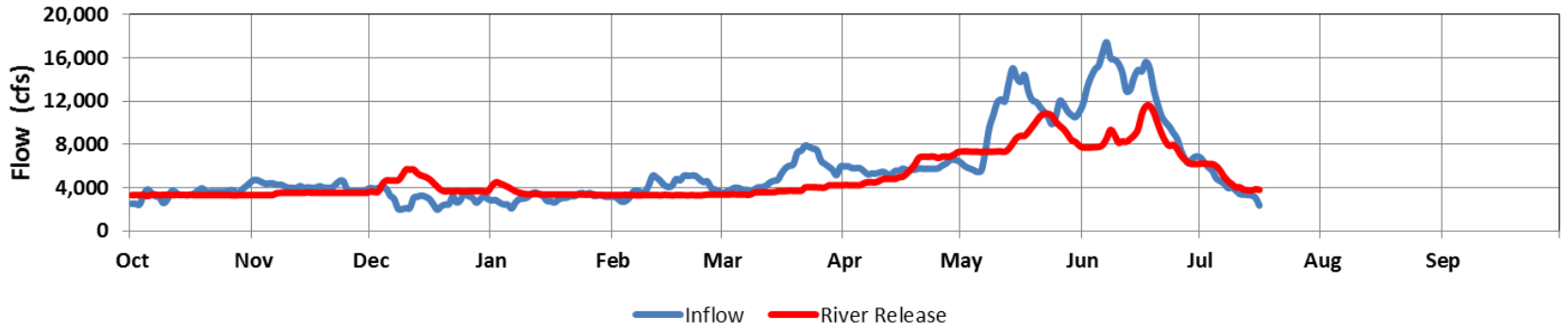


Upper Missouri Basin

RECLAMATION

Canyon Ferry Reservoir Operations





Summary of Conditions

- **Full Irrigation Allotments**

  East Bench & Clark Canyon Company

  Greenfield Irrigation District

- **River Flows**

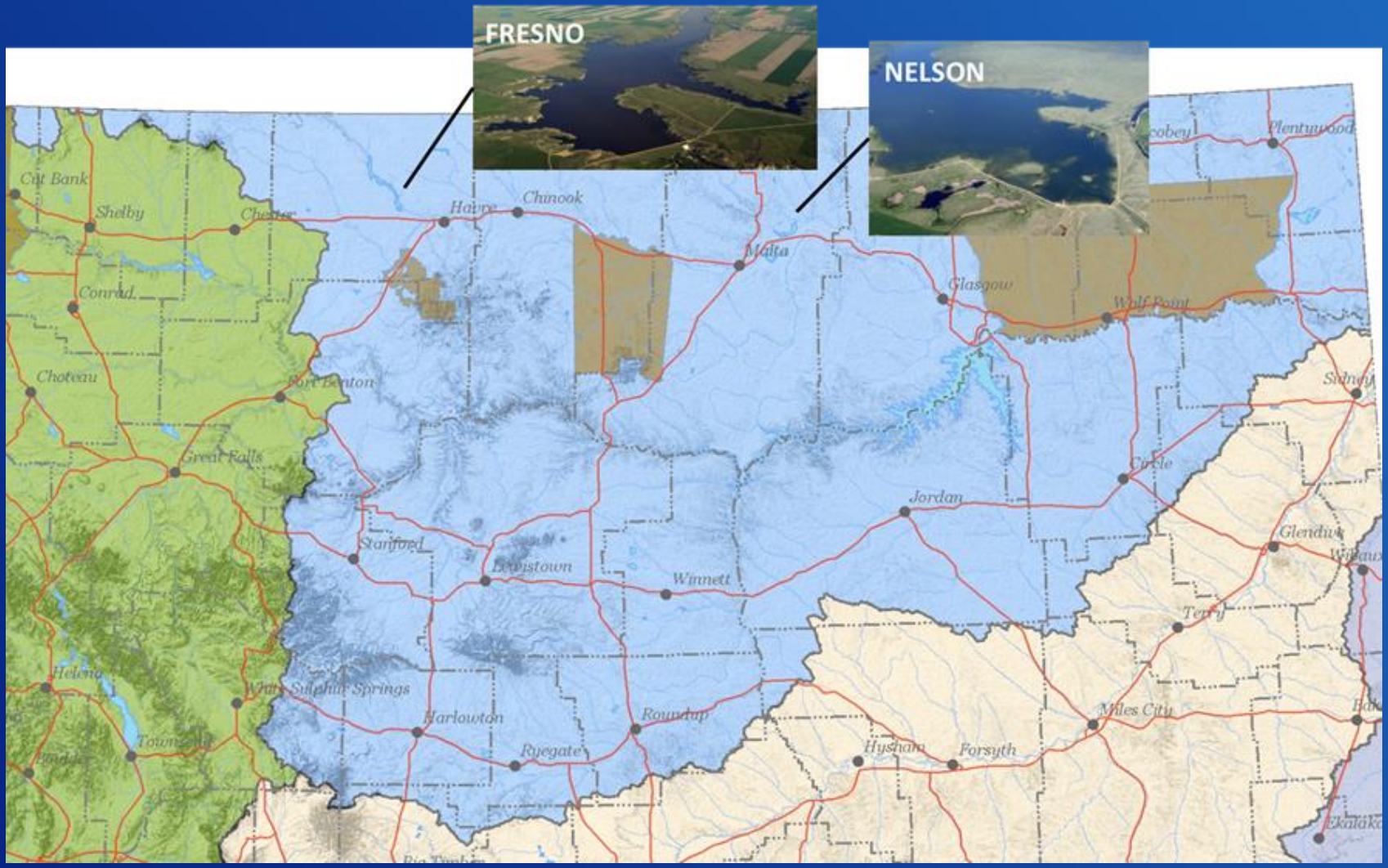
  Sun River below Diversion Dam – 130 cfs

  Missouri River below Holter Dam – 4,200 cfs

  Marias River below Tiber – 750 cfs

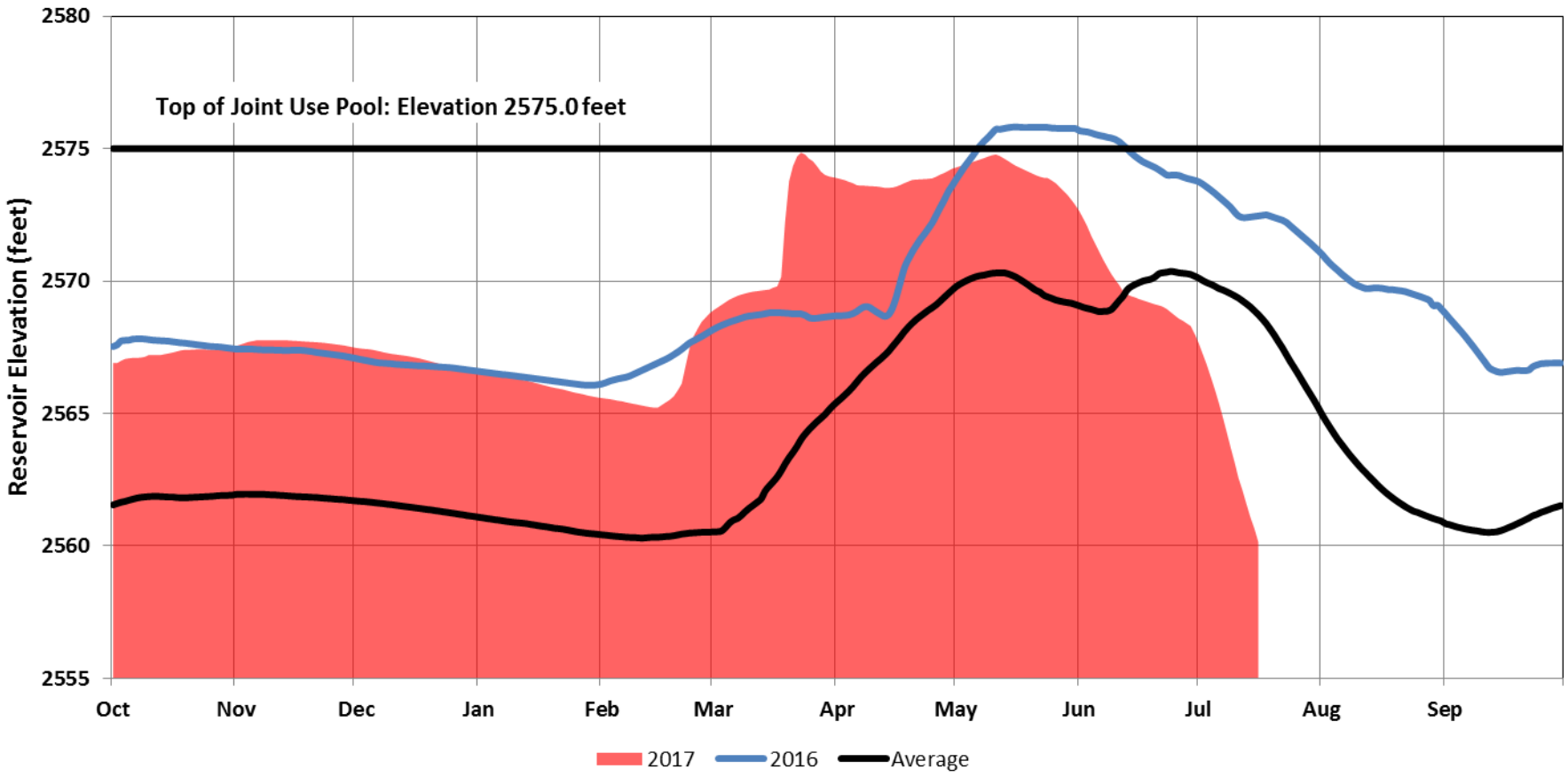
  Beaverhead below Clark Canyon – 790 cfs

Lower Missouri Basin



RECLAMATION

Fresno Reservoir Operations



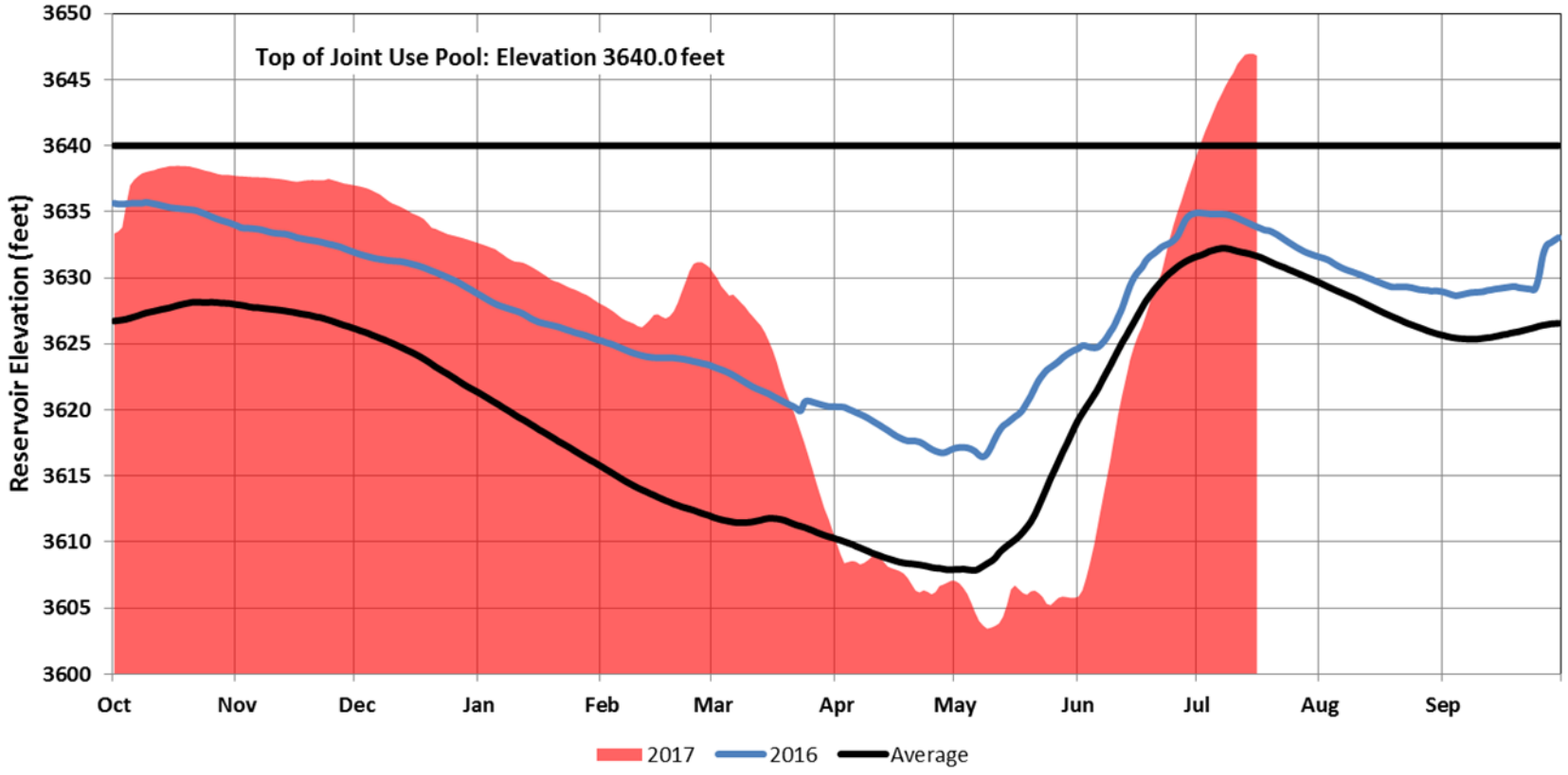
- Irrigation on Milk River shut down August 3rd
- Fresno Release – 1,080 cfs
- Nelson Release – 600 cfs

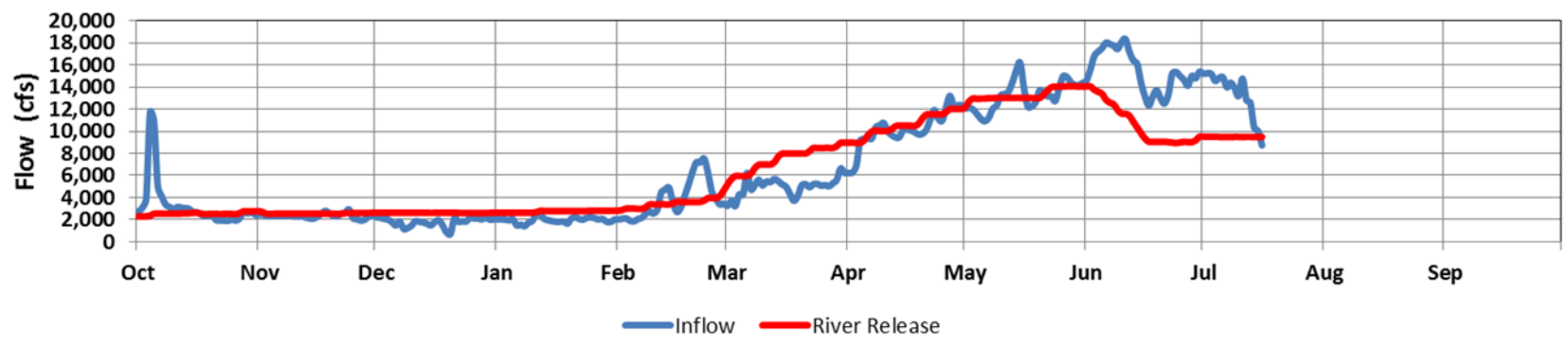
RECLAMATION

Yellowstone Basin

RECLAMATION

Bighorn Lake (Yellowtail Dam) Operations





Summary of Conditions

Yellowtail Dam

Bighorn River Release – 9,500 cfs

Boysen River Release – 6,500 cfs

Buffalo Bill River Release – 2,000 cfs

Reclamation's Internet Website

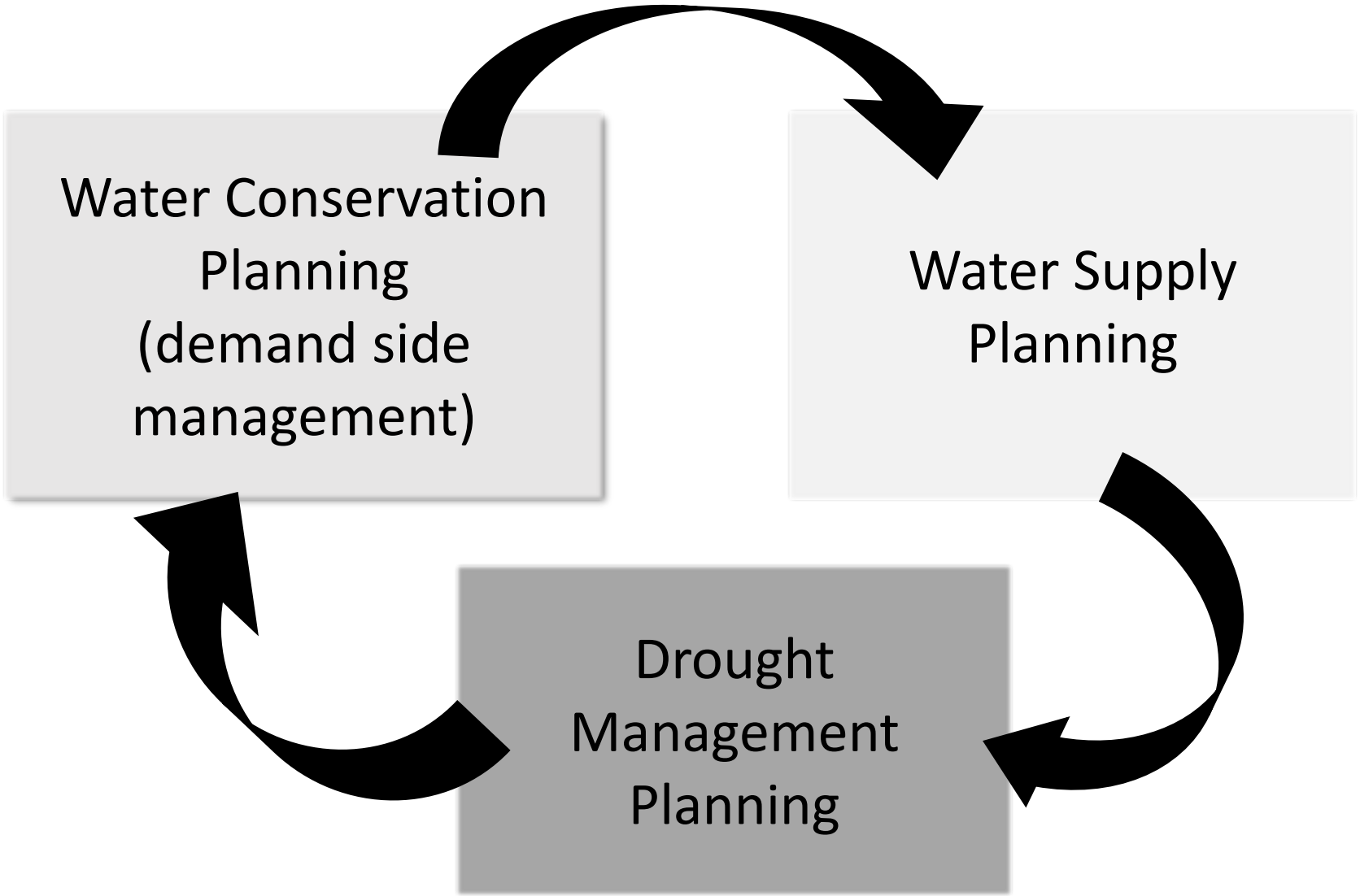
http://www.usbr.gov/gp/hydromet/

- near real-time data available through the HYDROMET data system
- summaries and plots of historical data
- annual reservoir operating plan publication
- monthly water supply reports
- project data
- snow plots
- links to related internet sites

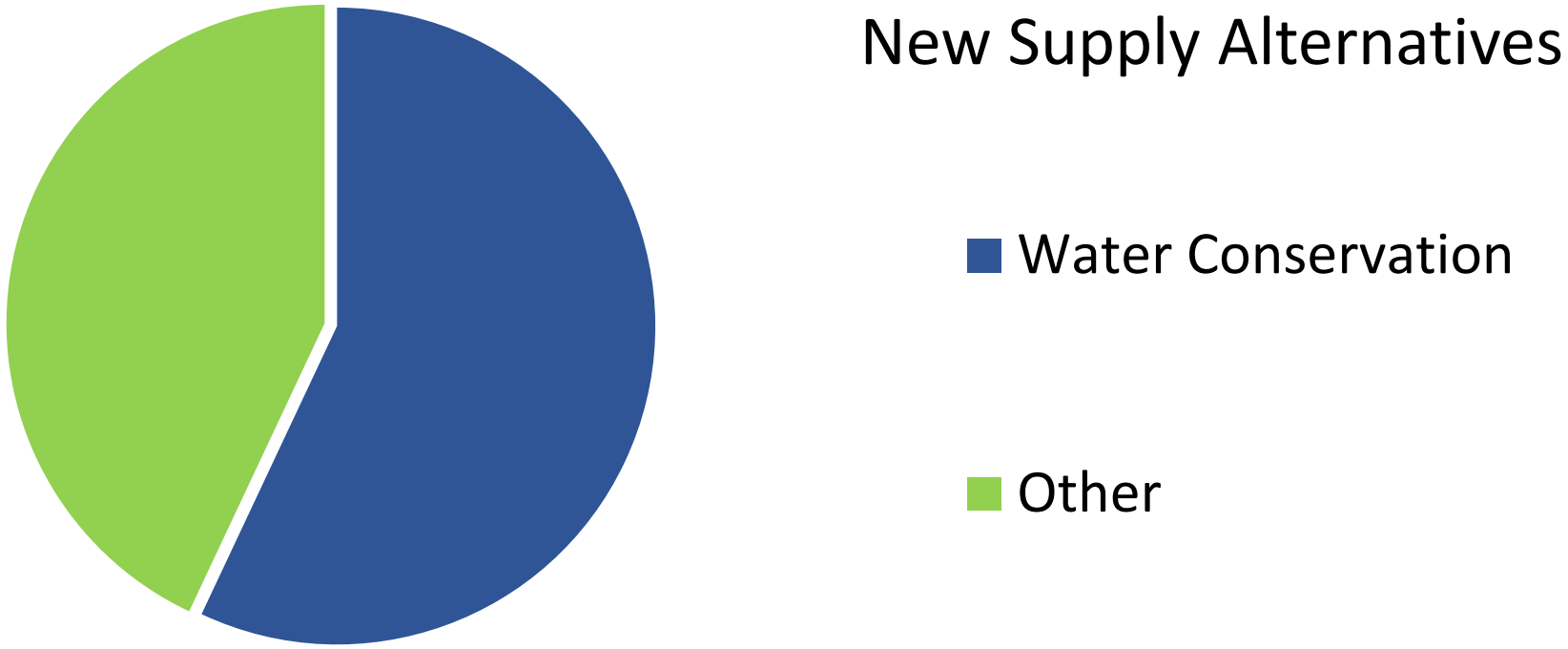
City of Bozeman 2017
Drought Management Plan

Presentation to the Governor's Drought and Water Supply Advisory Committee – July 18, 2017

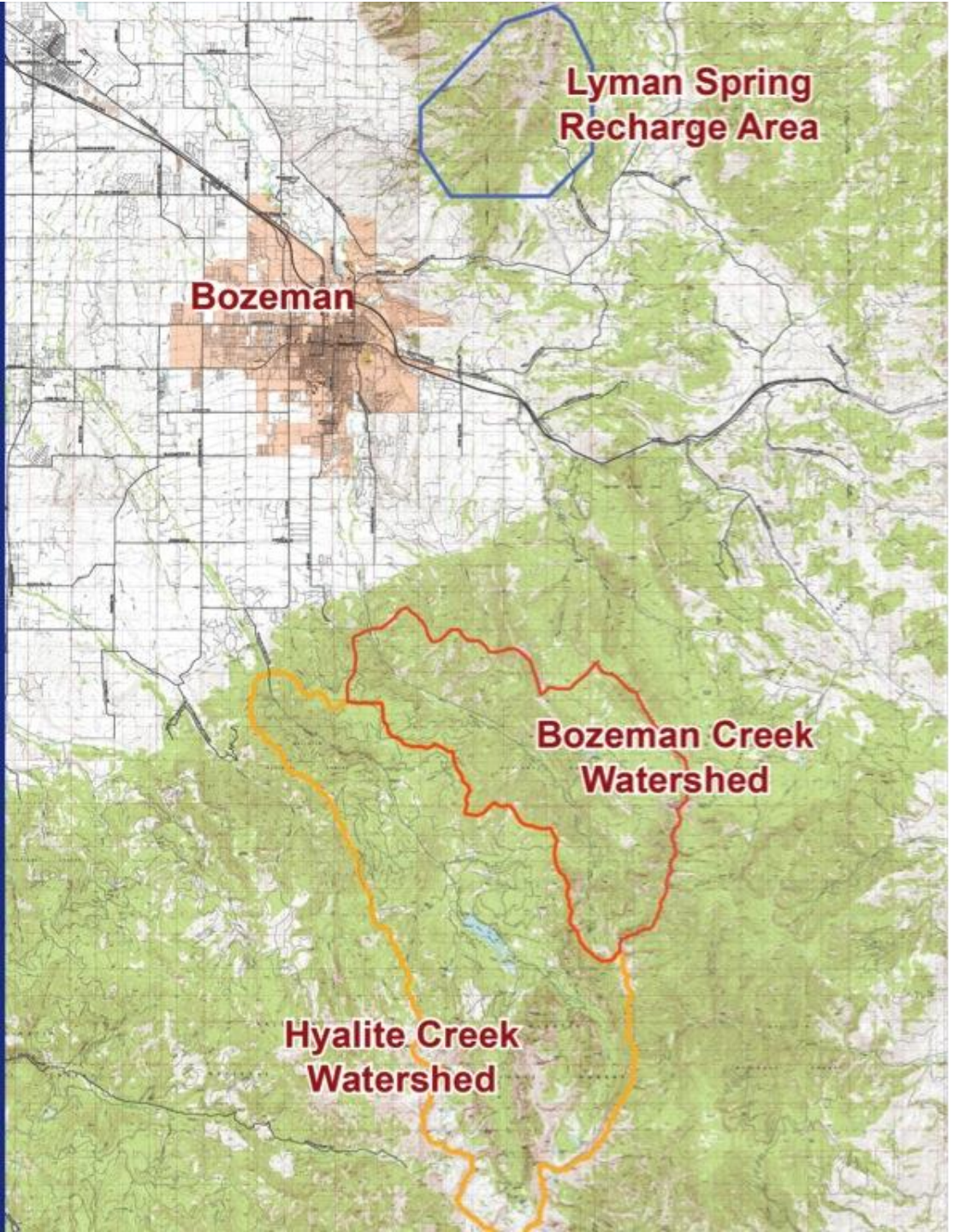
Integrated Water Resources Planning



City of Bozeman Integrated Water Resources Plan



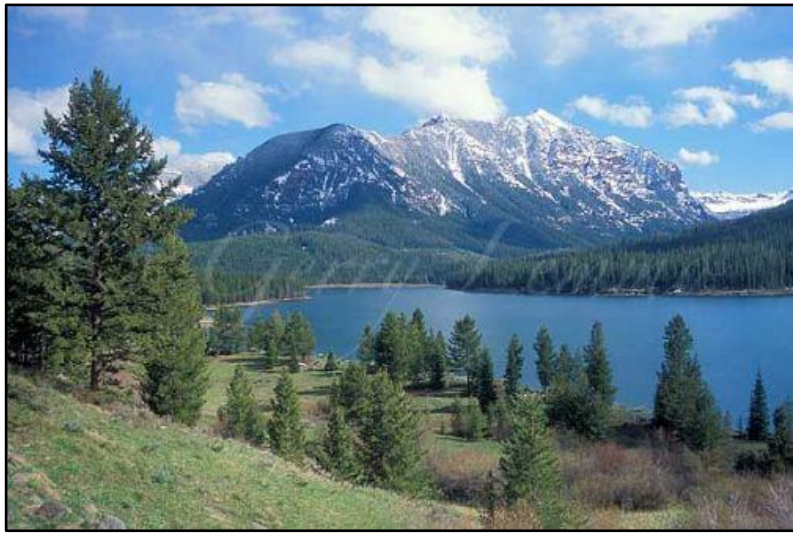
"Water conservation and water-use efficiency should be the bedrock of the city's water resource management" - IWRP



Bozeman's Water Supply

17 acre-feet/day

- Hyalite Creek (40%)
- Bozeman Creek (40%)
- Lyman Creek (20%)

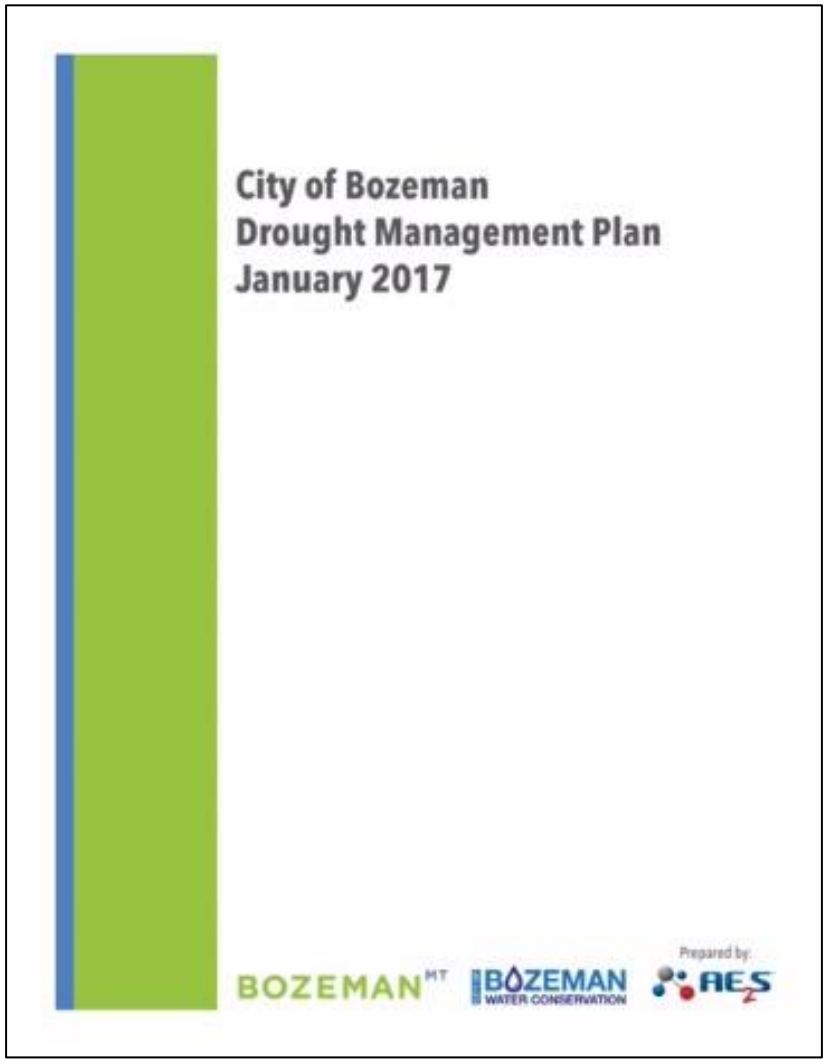


BOZEMAN MT
Public Works Department

Drought Management Plan Objectives

"…Maximize available water supplies and reduce use during times of shortage..."

- Preserve essential public services.
- Reduce adverse impacts (health, safety, economy, environment).
- Provide a complete but flexible roadmap for implementation.
- Develop an effective public communications strategy.
- Coordinate drought management (city, county, state).



CITY OF BOZEMAN WATER CONSERVATION

BOZEMAN MT Public Works

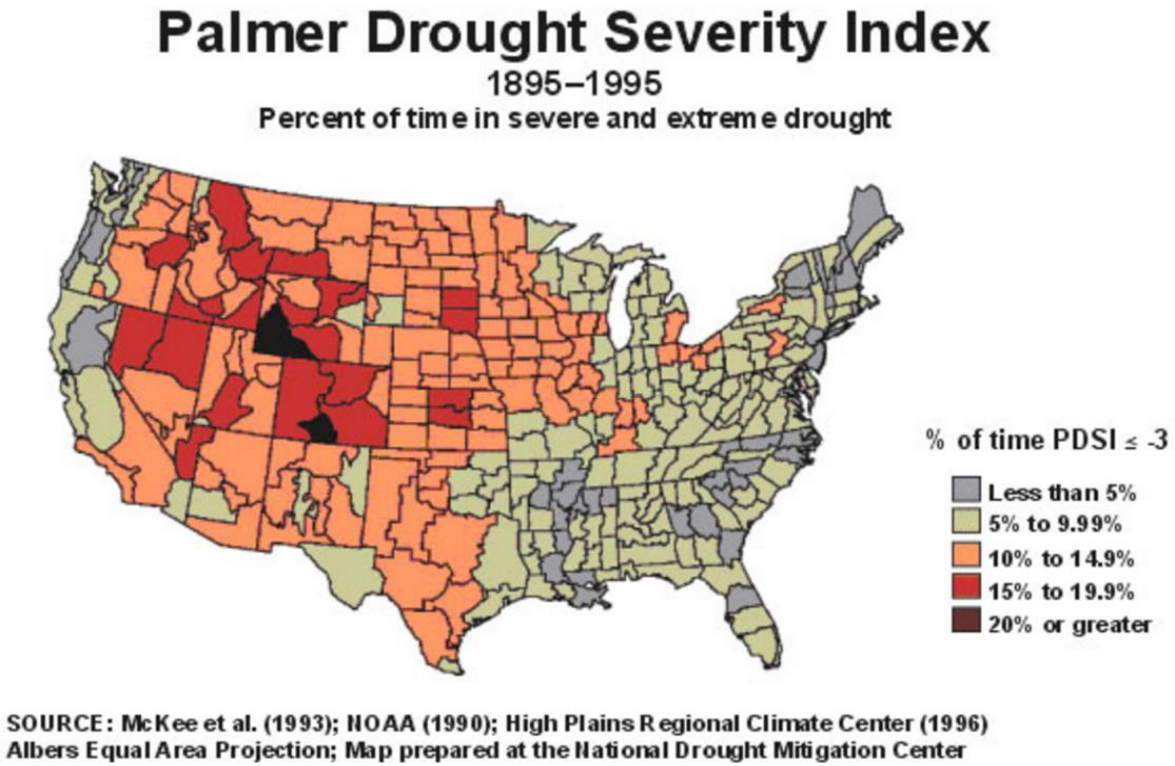
City of Bozeman Drought Management Plan

- Vulnerability Assessment
- Drought Monitoring
- Drought Response Actions and Program Enforcement
- Drought Response Program Measures
- Ongoing Drought Communications Campaign

CITY OF BOZEMAN WATER CONSERVATION

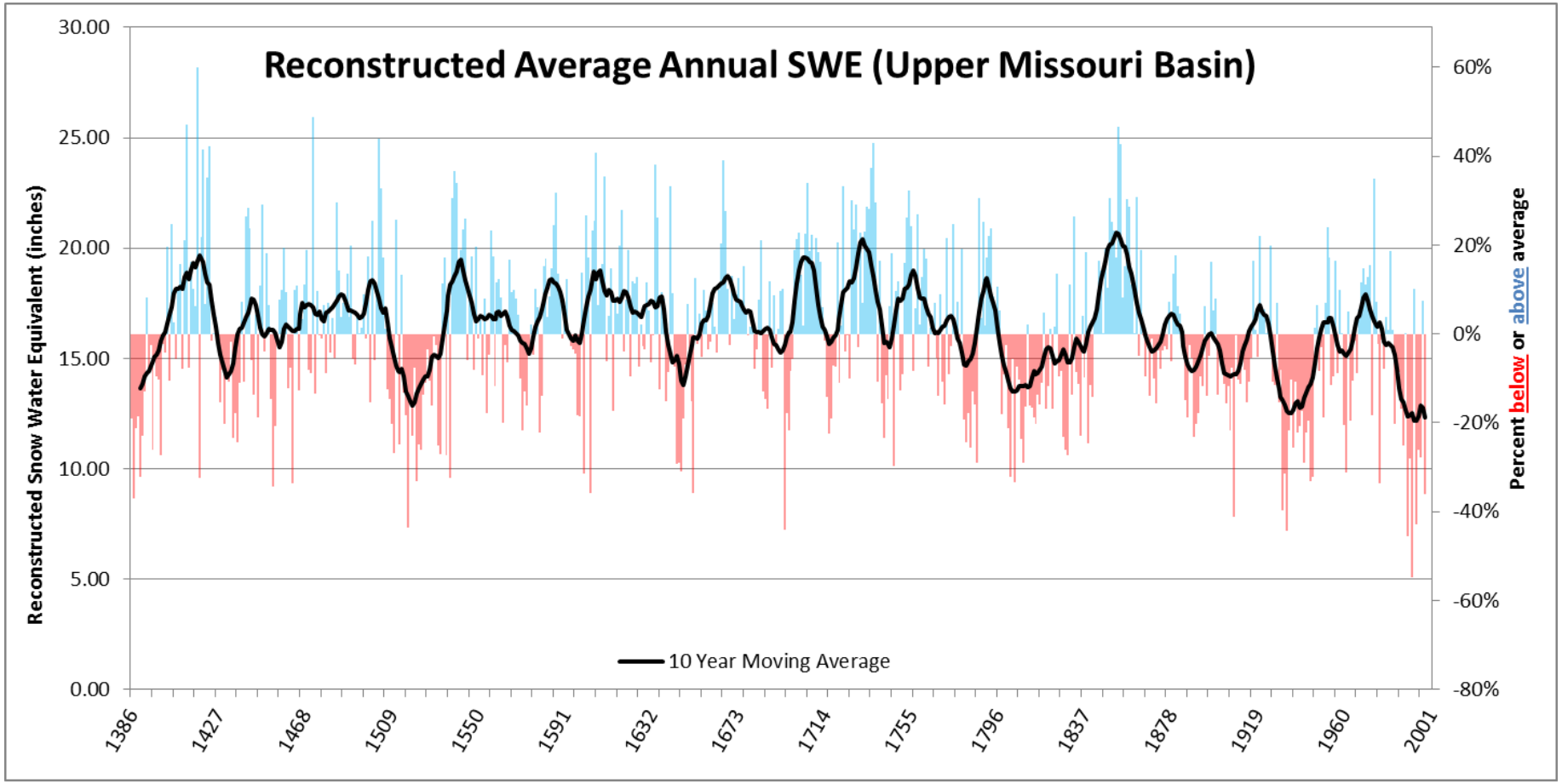
BOZEMAN MT Public Works

Vulnerability Assessment



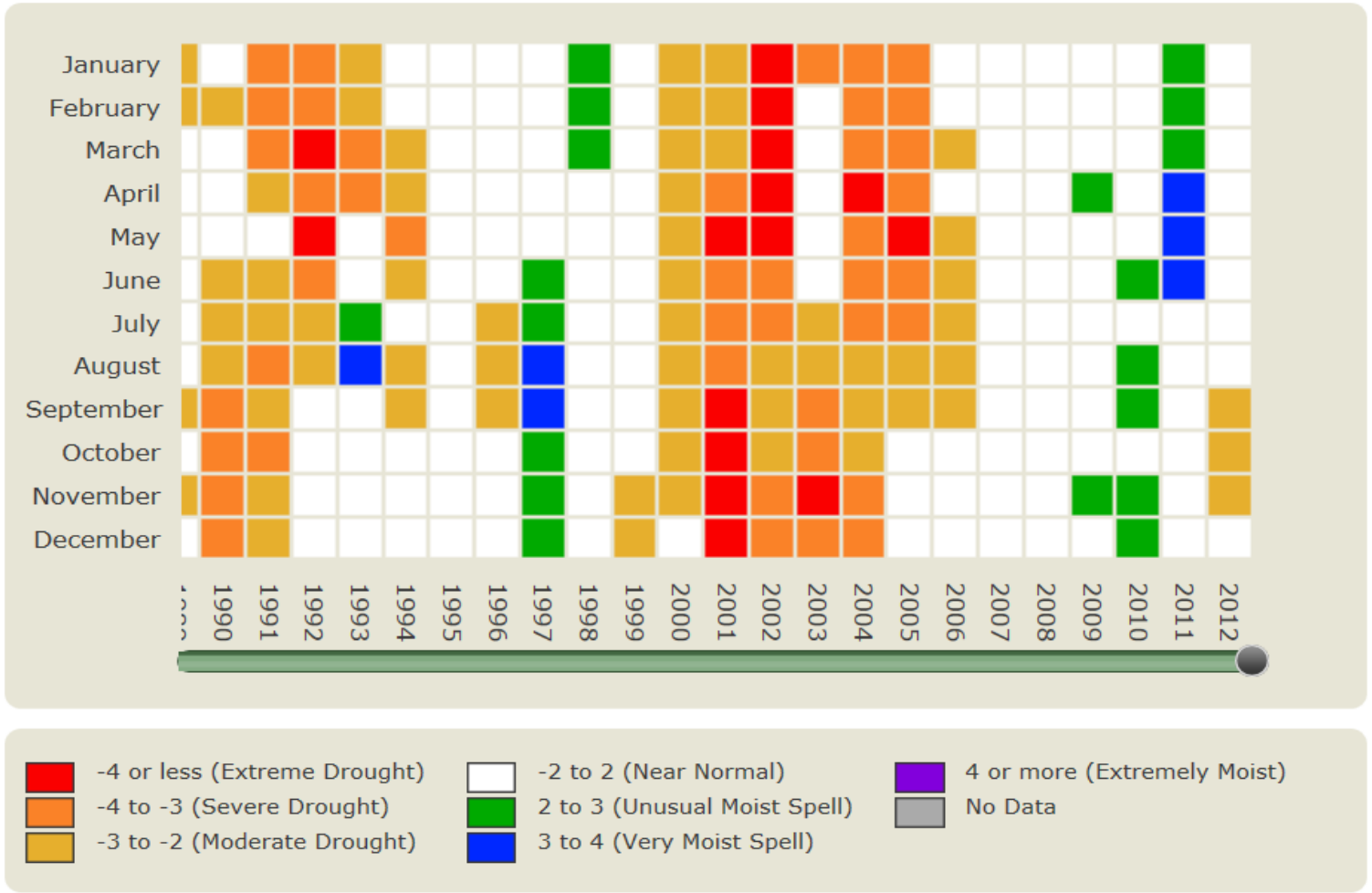
Drought History

- Southwestern Montana was in severe or extreme drought 15% to 19.9% of time between 1895 and 1995
- Only southwest Wyoming and south central Colorado are more susceptible to drought conditions.



Historical Streamflow and Snow Water Equivalent Trends from Tree-Ring Data for the Upper Missouri Basin (1386-2001).

- Dust Bowl was the fifth driest 5-year period from 1676-1966
- Prolonged and severe drought in the area is chronic



Monthly PDSI for Bozeman Region (1990 – 2012).

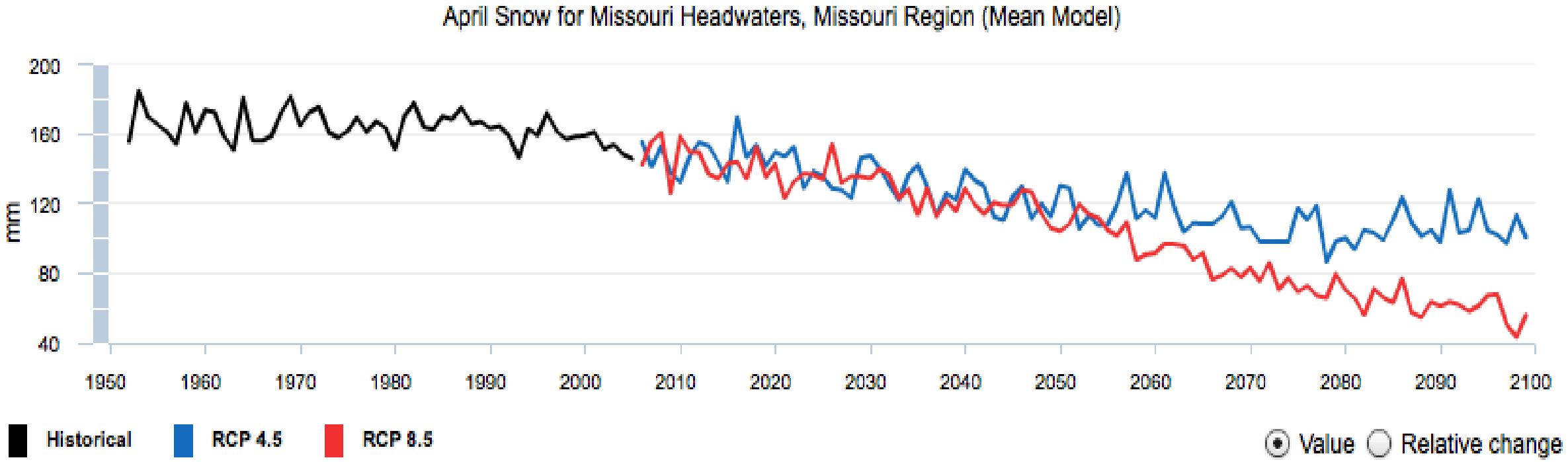
- Moderate to extreme drought in several months between 2000 and 2006.
- Late spring/early summer precipitation and evapotranspiration rates correlate to Bozeman water demand.

Vulnerability Assessment

Potential Climate Change Impacts

- Regional warming
- Longer dry spells
- Earlier melting of snowpack and peak runoff
- Increased evapotranspiration
- Reduced stream flows in late spring and summer
- Increased climate variability

Bozeman's reliance on snowpack and limited storage will result in significant impacts from even a short-term drought.

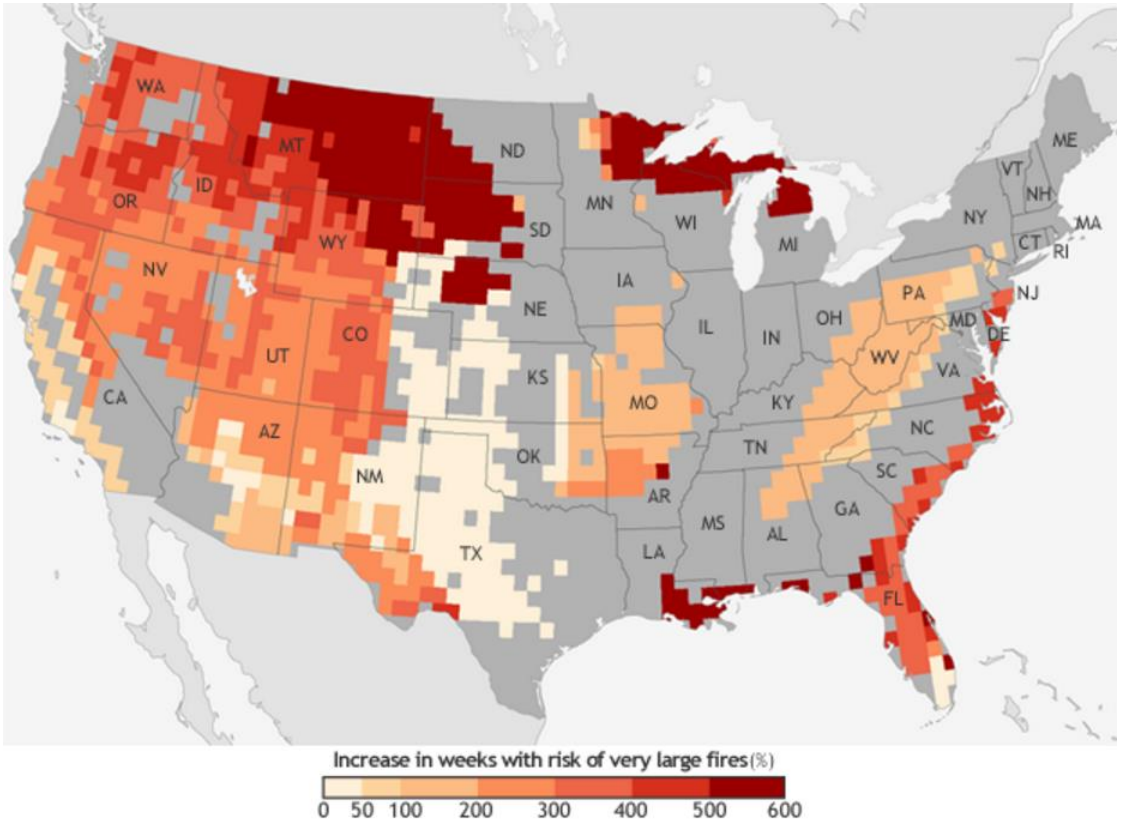


Historical and Projected April Snow for Missouri River Headwaters Region (1950 – 2100).

Vulnerability Assessment

Wildfire Risks and Impacts

- Increased wildfire frequency and duration, as well as longer fire seasons are predicted.
- Bozeman's watersheds are forested and susceptible to wildfire. A fire in Hyalite watershed could increase sediment deposition and reduce the capacity of Hyalite Reservoir.

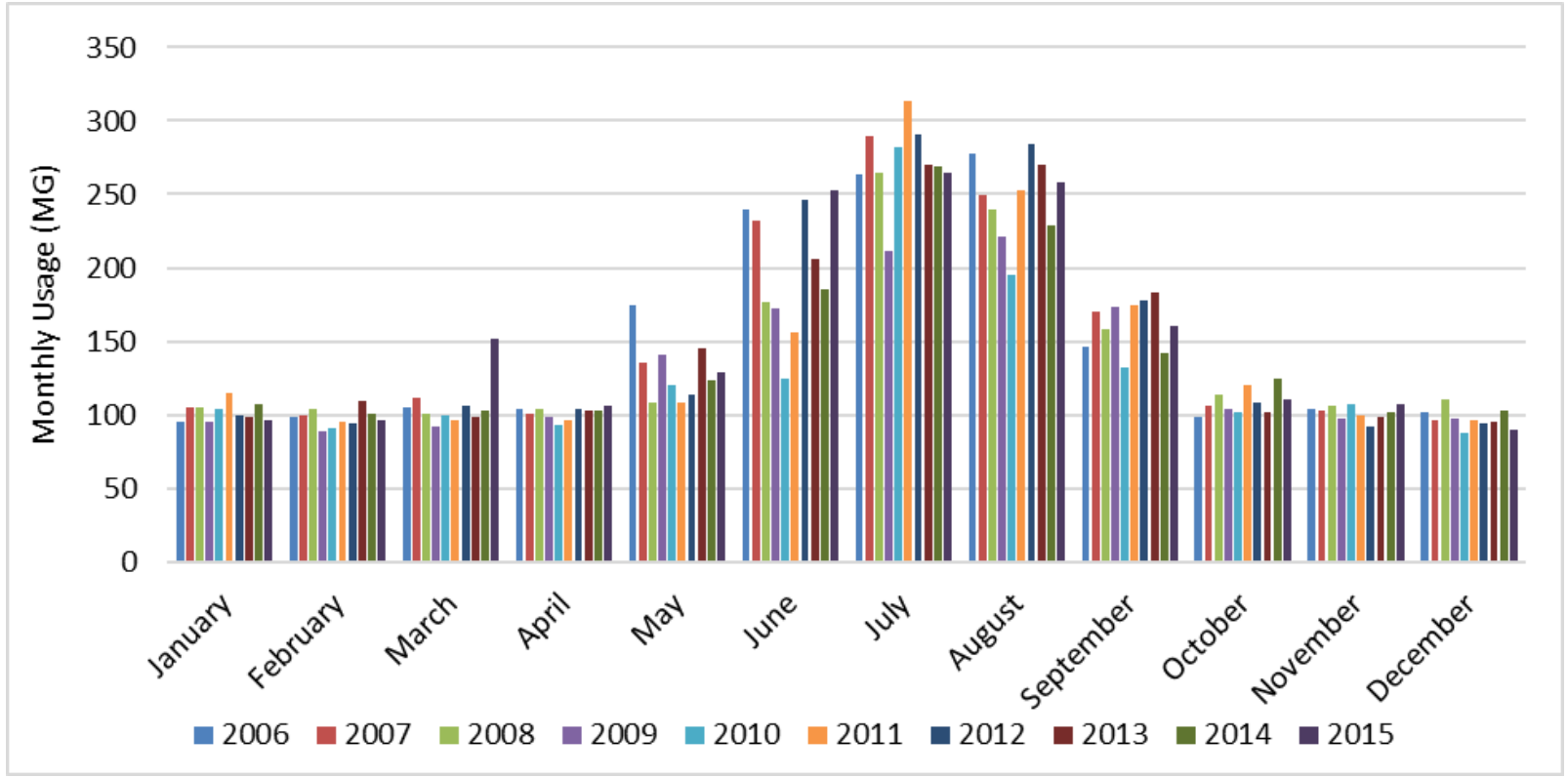


Relative Increased Risk of Very Large Wildfires in Contiguous U.S.

Vulnerability Assessment

Increased Summer Consumption and Population Growth

- Peak summer demands for lawn watering are nearly 240% of the average winter demand.
- Correlation between water demand and evapotranspiration.
- The hotter and drier it is, the more residents irrigate.

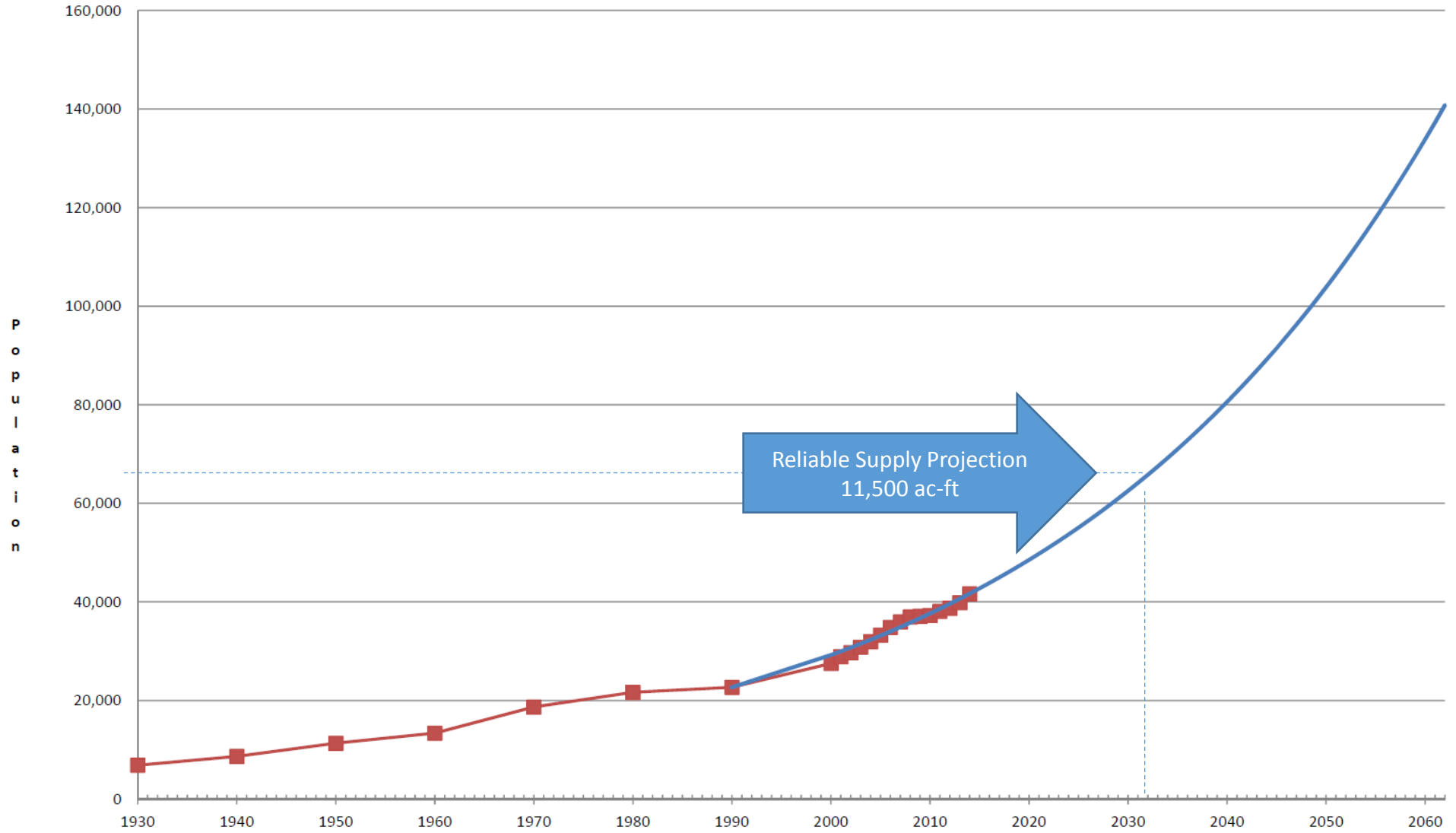


City of Bozeman Total Monthly Water Usage (2006 – 2015).

CITY OF BOZEMAN WATER CONSERVATION

BOZEMAN MT Public Works

Figure-2: Historical Population and Future Projections



Vulnerability Assessment

Requirements of Neighboring Water Users

- Agriculture interests
- Adjacent cities, towns, and residential communities
- Recreational interests
- Environmental interests

Photo: Bozeman Daily Chronicle

Drought Monitoring

Local Indicators

- Reservoir storage (40%)
  - percent exceedance
- Area streamflow (15%)
  - percent exceedance
  - Gallatin River at Logan (100%)
  - Hyalite Creek
- SNOTEL (20%)
  - percent exceedance
  - Shower Falls (75%)
  - Sacajawea (25%)
- City well (0%)
  - depth to water table

National Indicators

- Palmer Drought Severity Index (5%)
  - -1.0 to -4.0
- Standard Precipitation Index (5%)
  - -0.5 to -2.0
  - 6-month SPI (80%)
  - 12-month SPI (20%)
- U.S. Drought Monitor (15%)
  - D1 – D4

City of Bozeman

Drought Monitoring

2016 Tracking

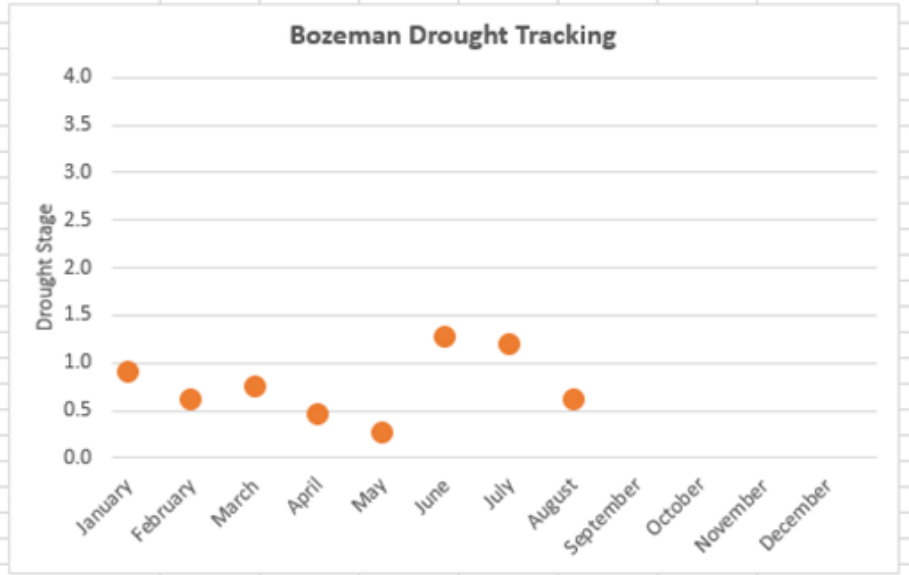
8/17/2016

Month		SNOTEL Data		Streamflow Data		Reservoir Data	Well Data	Regional Drought Indicators - Southwest Montana								Composite Drought Stage
		Shower Falls Snow-Water (in)	Sacajawea Snow-Water (in)	Gallatin River Flowrate (cfs)	Hyalite Creek Flowrate (cfs)	Middle Creek Storage (ac-ft)	Bozeman Well Depth (ft)	Palmer Drought Severity Index	Standard Precipitation Index		US Drought Monitor - Percent Area					
									6-Month	12-Month	None	D0	D1	D2	D3	D4	
January	Value	8.3	6.4	624	20	5545	24.24	-1.33	0.34	-0.28	9.74	56.03	31.08	3.16	0	0	0.90
	Date	1/15/2016	1/15/2016	1/15/2016	1/15/2016	1/15/2016	1/5/2016	1/15/2016	1/15/2016	1/15/2016						1/19/2016	
February	Value	12.2	10.7	705	18	5551	24.24	-1.39	0.25	-0.28	9.74	57.93	32.18	0.15	0	0	0.60
	Date	2/15/2016	2/15/2016	2/15/2016	2/15/2016	2/15/2016	1/5/2016	2/15/2016	2/15/2016	2/15/2016						2/23/2016	
March	Value	15.2	12.5	740	22	5557	24.24	-1.01	0.04	0.11	9.74	90.26	0	0	0	0	0.75
	Date	3/15/2016	3/15/2016	3/15/2016	3/15/2016	3/15/2016	1/5/2016	3/15/2016	3/15/2016	3/15/2016						3/15/2016	
April	Value	20.7	10.6	1370	30	9164	23.6	-1.4	0.09	0.07	100	0	0	0	0	0	0.45
	Date	4/15/2016	4/15/2016	4/15/2016	4/15/2016	4/15/2016	4/5/2016	4/15/2016	4/15/2016	4/15/2016						4/26/2016	
May	Value	18.8	0	2320	47	9164	23.6	-1.4	0.09	0.07	100	0	0	0	0	0	0.25
	Date	5/17/2016	5/17/2016	5/17/2016	5/17/2016	4/15/2016	4/5/2016	4/15/2016	4/15/2016	4/15/2016						5/17/2016	
June	Value	0	0	1800	144	9908	24.42	-2.02	-1.02	-0.11	98.78	1.22	0	0	0	0	1.26
	Date	6/12/2016	6/5/2016	6/15/2016	6/15/2016	6/15/2016	7/6/2016	6/15/2016	6/15/2016	6/15/2016						6/28/2016	
July	Value	0	0	351	78	7806	24.42	-2.14	-0.83	-0.46	98.77	1.23	0	0	0	0	1.18
	Date	7/5/2016	7/5/2016	7/15/2016	7/15/2016	7/15/2016	7/6/2016	7/15/2016	7/15/2016	7/15/2016						7/12/2016	
August	Value	0	0	237	55	7157	24.42	-2.14	-0.83	-0.46	0	87.67	12.33	0	0	0	0.60
	Date	8/5/2016	8/5/2016	8/16/2016	8/16/2016	8/17/2016	7/6/2016	7/15/2016	7/15/2016	7/15/2016						8/9/2016	
September	Value																-
	Date																
October	Value																-
	Date																
November	Value																-
	Date																
December	Value																-
	Date																

CITY OF BOZEMAN WATER CONSERVATION

BOZEMAN MT Public Works

Weighting Factors		Criteria		Stage Triggers			
				Stage 1	*Stage 2*	*Stage 3*	*Stage 4*
15%		Stream Flow					
	10%	Hyalite	Annual PCT Exceedance	90.0%	95.0%	97.0%	99.0%
	90%	Gallatin	Monthly PCT Exceedance	85.0%	92.0%	96.0%	98.0%
30%		Reservoir - Middle Creek	Monthly PCT Exceedance	70.0%	80.0%	90.0%	95.0%
20%		SNOTEL					
	75%	Shower Falls	Monthly PCT Exceedance	70.0%	80.0%	90.0%	95.0%
	25%	Sacajawea	Monthly PCT Exceedance	75.0%	85.0%	90.0%	95.0%
10%		Palmer Drought Severity Index (PDSI)		-1.00	-2.00	-3.00	-4.00
10%		Standard Precipitation Index (SPI)					
	80%	6-Month		-0.5	-1.0	-1.5	-2.0
	20%	12-Month		-0.5	-1.0	-1.5	-2.0
10%		City Well off South 3rd	Depth to Water (Feet)	25.0	25.5	26.0	26.5
5%		US Drought Monitor Index	Stage				
		None	0.0				
		D0	1.0				
		D1	1.5				
		D2	2.0				
		D3	3.0				
		D4	4.0				

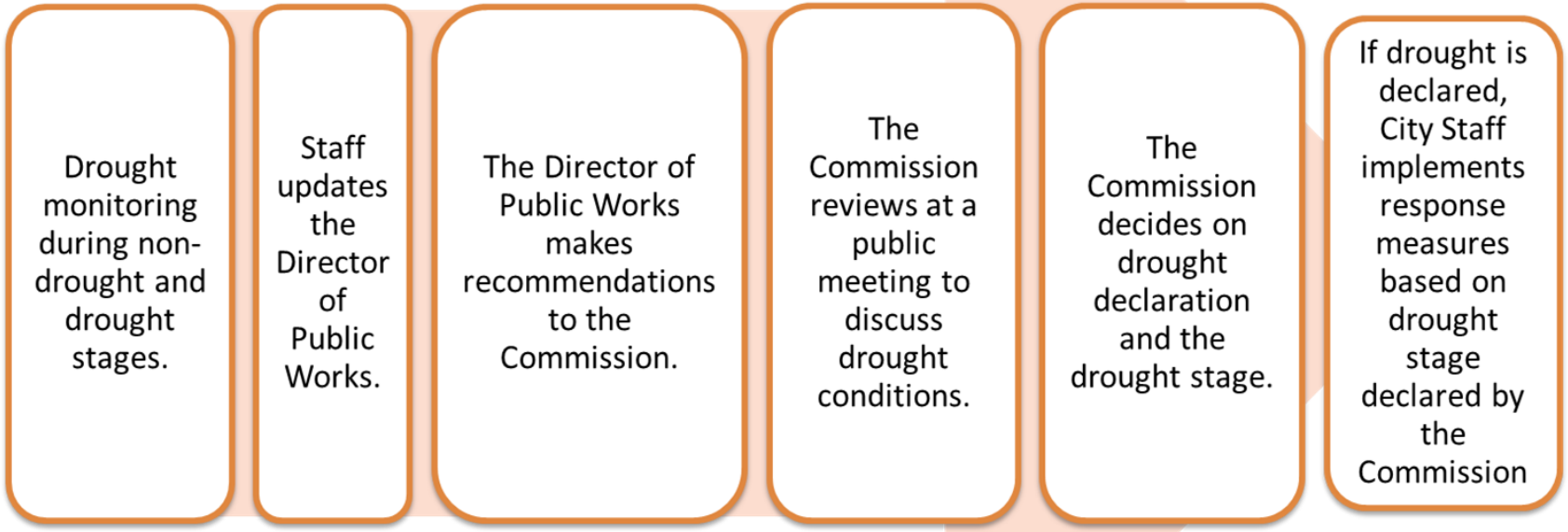


CITY OF BOZEMAN WATER CONSERVATION

BOZEMAN MT Public Works

Drought Response Actions and Program Enforcement

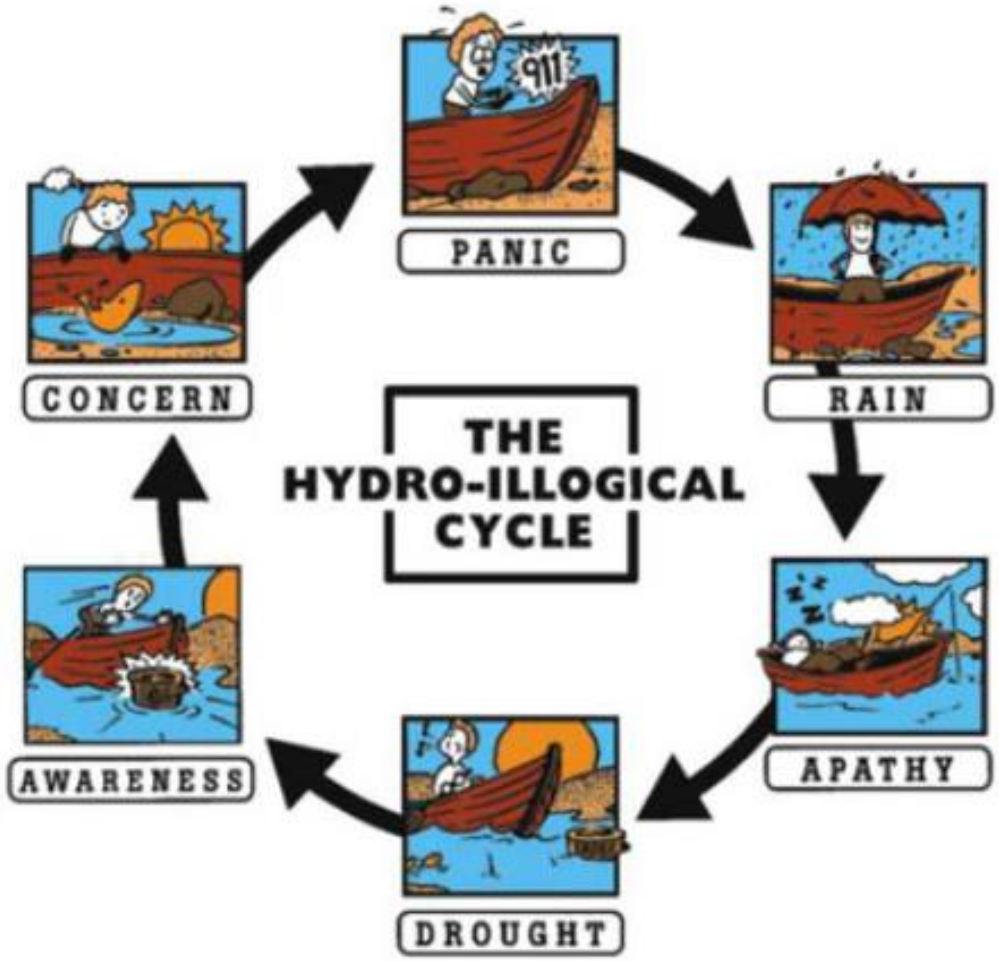
Monitoring and Evaluation



Enforcement

- Authority resides in Bozeman Municipal Code
- Violator can be fined $100 - $500

Drought Communications Campaign

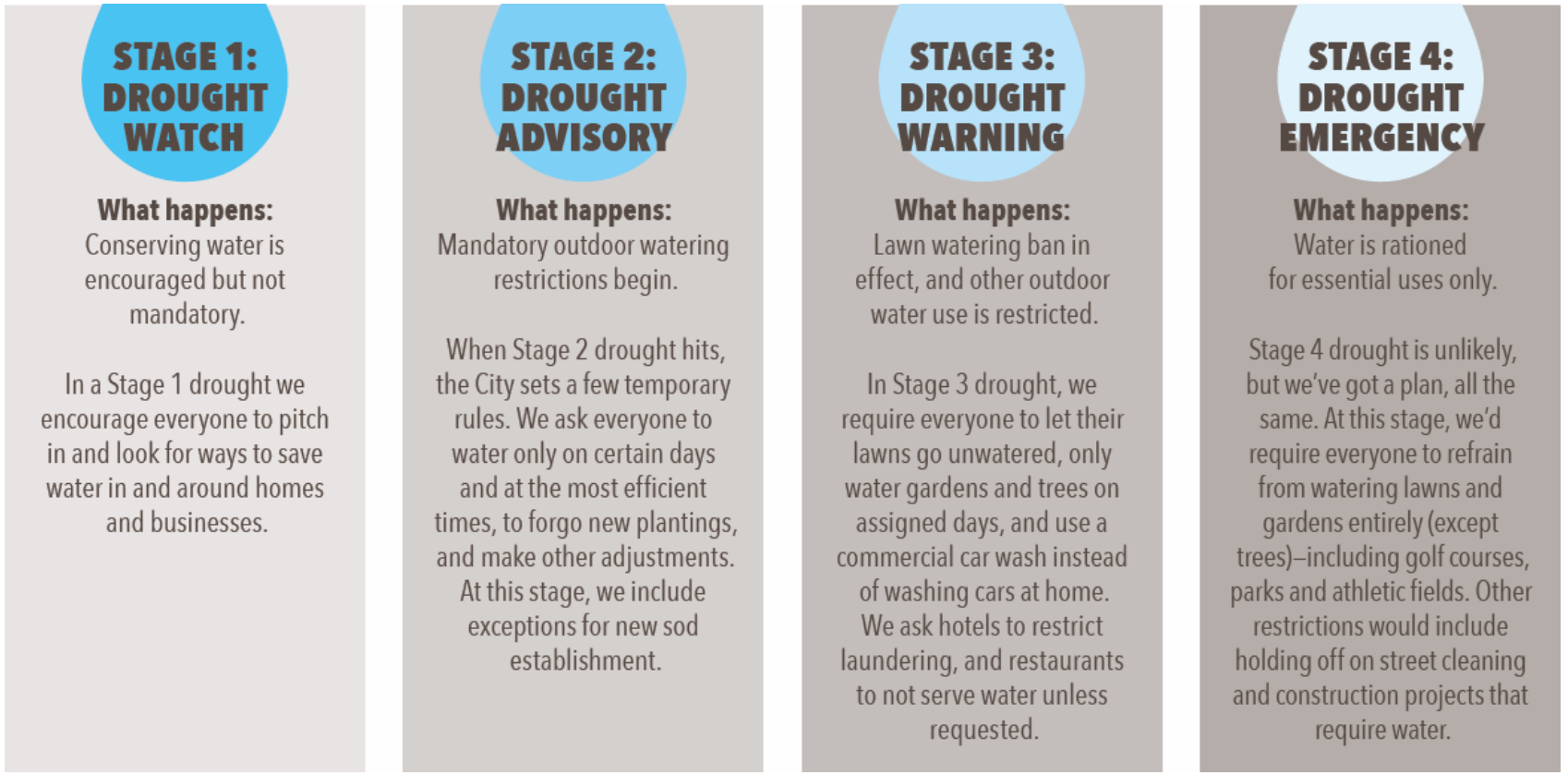


Drought Response Program Measures

System-Wide Water Reduction Target	Watch	Advisory	Warning	Emergency
	10%	20%	30%	40%

Specific response measures outlined for:

- Outdoor Watering
- Water Features
- Washing/Events
- Commercial and Institutional Processes

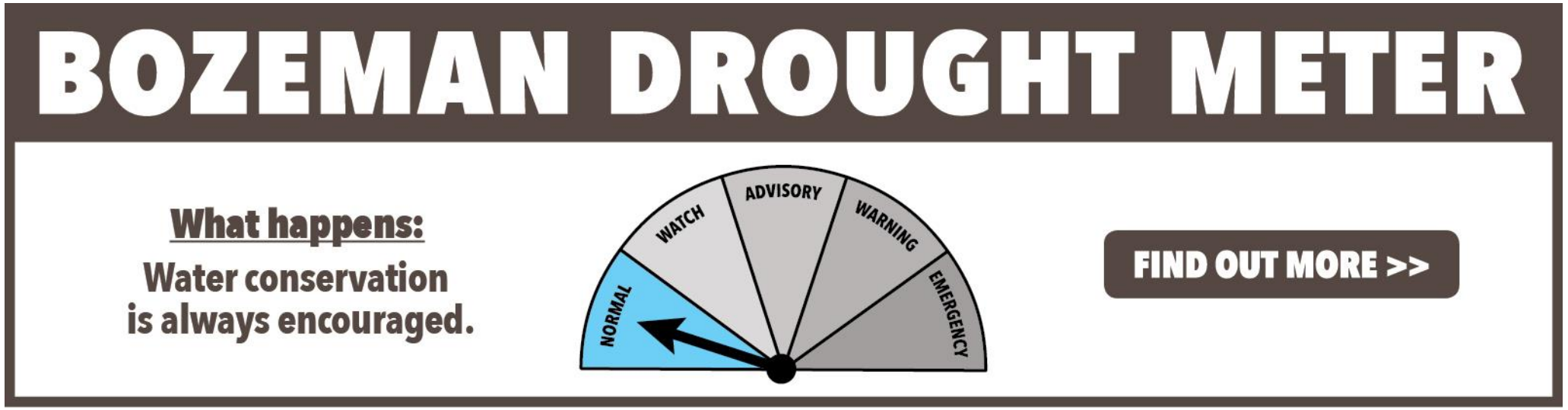


CITY OF BOZEMAN WATER CONSERVATION

BOZEMAN MT Public Works

City of Bozeman Next Steps / Drought Mitigation Efforts

- Ongoing Water Conservation Division Efforts (public outreach)
- Drought Tool
  - Ongoing refinement
  - Improving data pull frequency
  - Incorporating new data (Lyman, Eagle Rock Ranch well, Sourdough SNOTEL, Sourdough streamflow data)
- Sunset Hills Cemetery and Lindley Park Irrigation Project
  - Improve efficiency of Story Ditch (1,082 AF saved)
  - Use non-potable water to irrigate cemetery and park (201 AF saved)
- Strategic Water Reserve (drought reserve) Study
  - Year over year storage not currently reservoir management practice
- Sourdough Creek Natural Storage Study
- Rate Study (water conservation and drought rates)



Thank you!

Jessica Ahlstrom

City of Bozeman Water Conservation Division

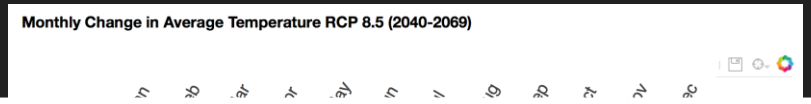
jahlstrom@bozeman.net

406-582-2265

Montana Mesonet: Beginnings of a Drought and Water Supply Early Warning System

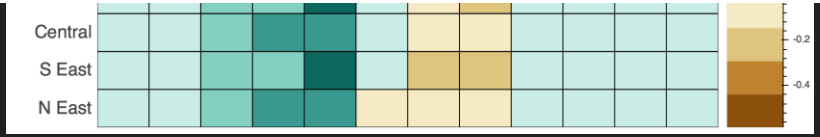
Kelsey Jencso
Montana Climate Office

Monthly Downscaled Projections



Temperature

Outstanding Need in Montana: Soil Moisture!



- Decreases in Summer

MT Mesonet

- A densely spaced network that serves landowners and agencies with local soil moisture and weather information required for daily to seasonal decisions
- Conduct research and education for application of data
- Co-develop user-guided applications and web-interfaces to share data and products
- Use Mesonet data to verify and improve gridded data sets across MT (e.g. Drought and Evapotranspiration)

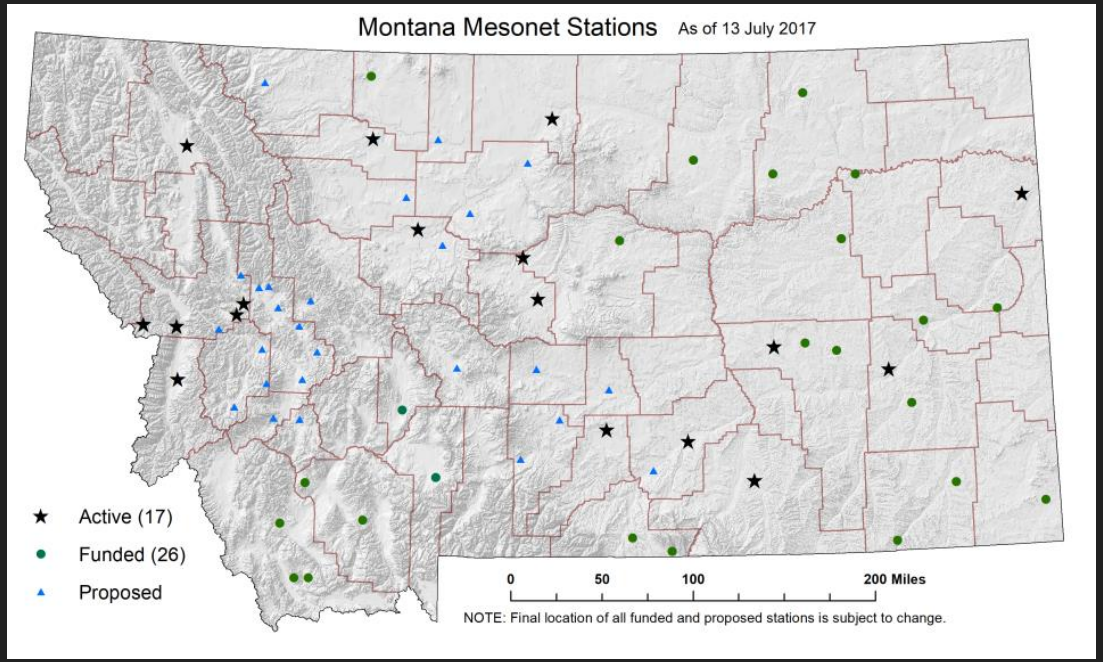
Mesonet Benefits

- Precision Agriculture
  - irrigation scheduling, spraying recommendations, frost protection, planting and harvesting and prescribed burning
- Natural Resources
  - Local drought and water supply assessments
  - Fuel moisture and fire danger
- Calibrate and ground-truth satellite and soil moisture models
- *Oklahoma mesonet = $2,000,000 to $5,000,000 in savings annually*


Lolo Watershed

http://climate.umt.edu/mesonet/

A Collaborative Framework

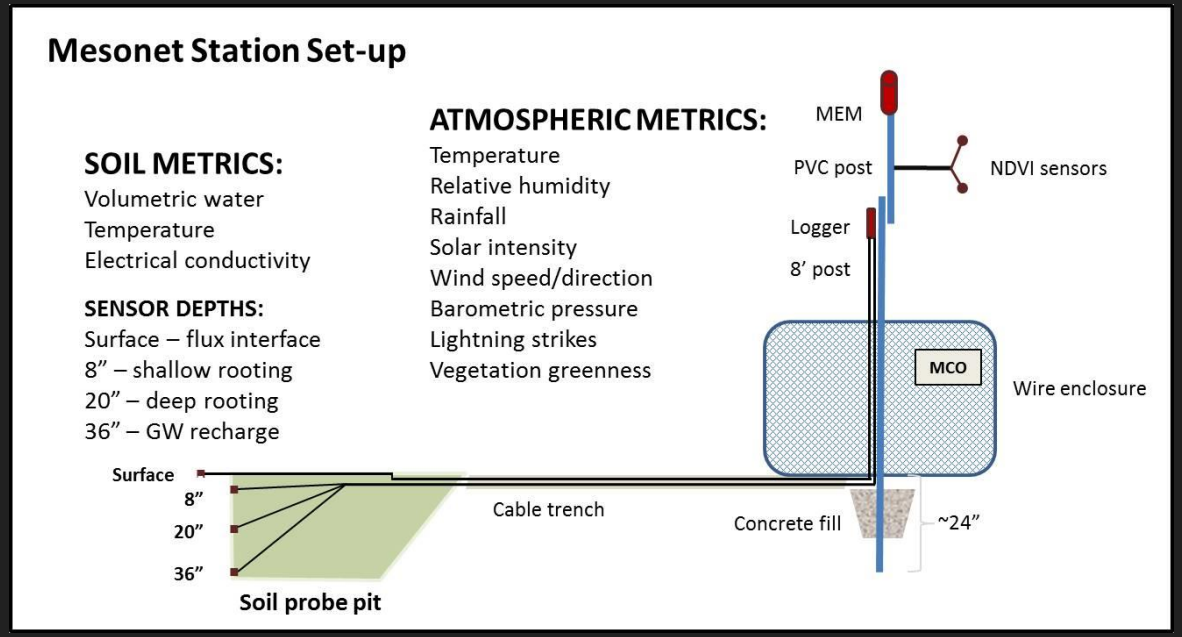


- Initial $45,000 from the MT MREDI
- $360,000 invested from 2016 to present

Federal, State, and Private Partnerships

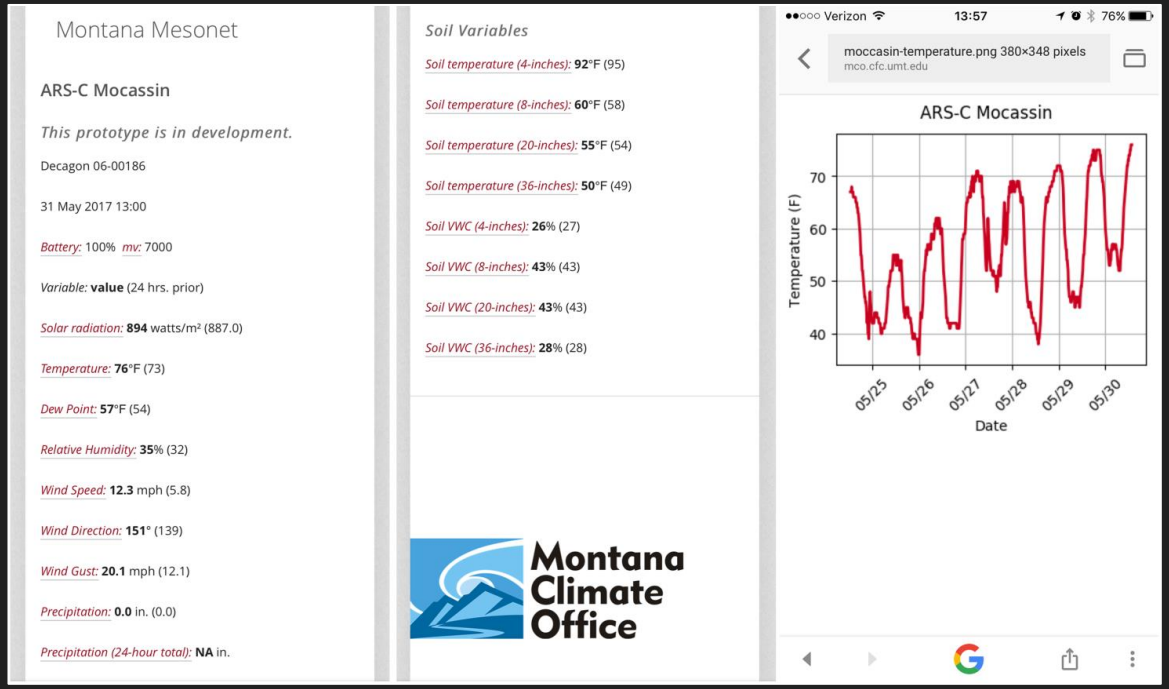
- National Oceanographic and Atmospheric Administration (NOAA MADIS)
- DOI Bureau of Land Management
- USDA Forest Service
- USDA Agricultural Research Service
- MSU Extension
- MSU Agricultural Research Centers
- Bureau of Indian Affairs: Little Big Horn College, Crow Agency
- Lolo Watershed Group
- Blackfoot Challenge
- Trout Unlimited
- National Drought Resiliency Partnership
- Community Collaborative Rain, Hail and Snow Network (CoCoRahs)
- Montana Department of Natural Resources and Conservation
- Montana Bureau of Mines and Geology
- Roberts L7 Ranch
- Tureck Ranch
- E Bar L Ranch
- Merja Farms

Station Measurements



- $6,200 science grade station custom built by METER Devices with a 20% discount
- Same design being used to complete the TAHMO a network of 20,000 stations across Africa

Data Availability

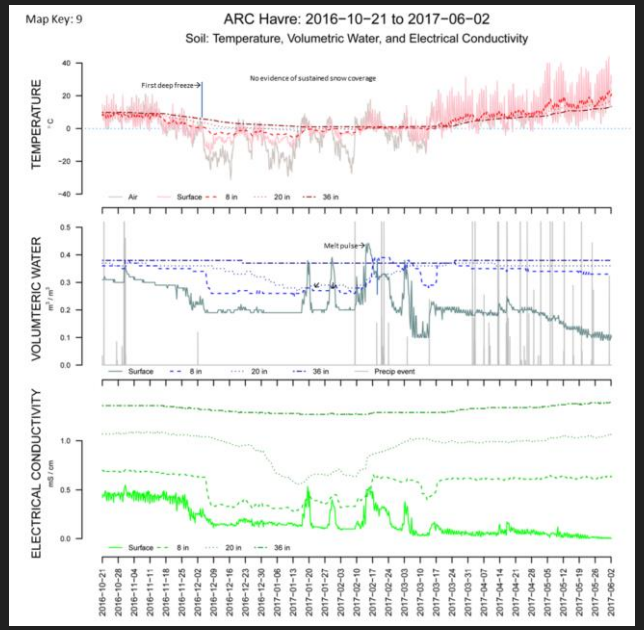


- Publicly available
- Graphical summary
- Updated every 30 minutes
- Smartphone accessible
- Web accessible
- Stewards can access historical data

climate.umt.edu/mesonet

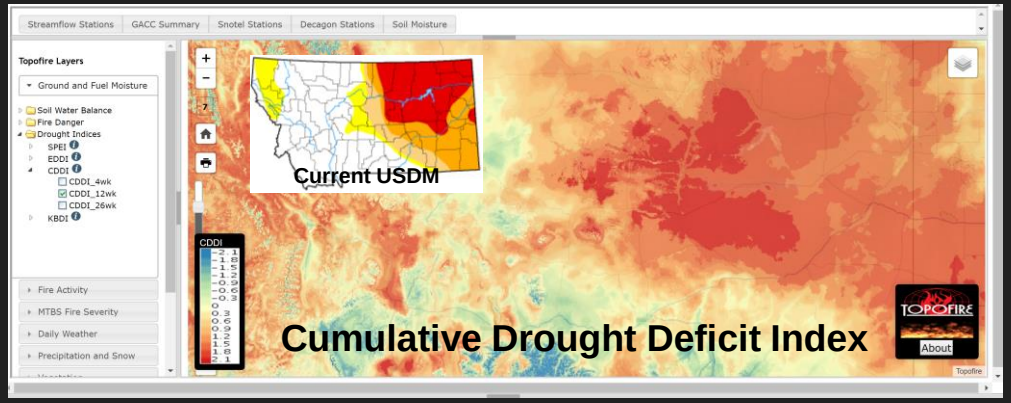
Next Steps: User Oriented Tools

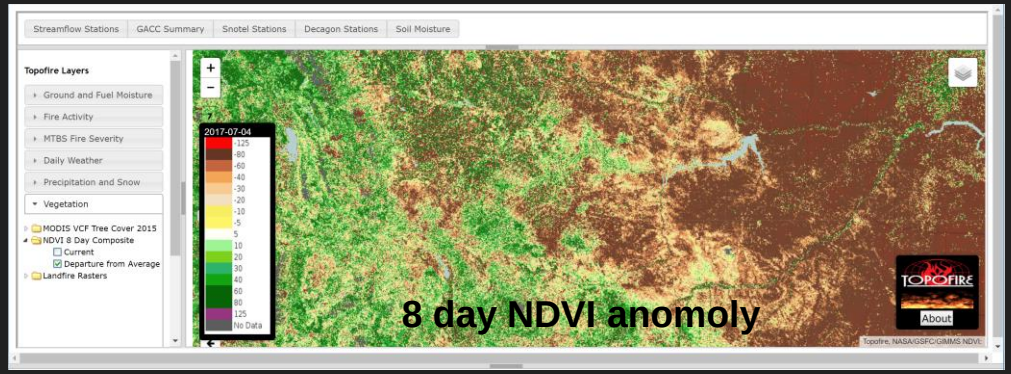
Continuous 30 minute Data → User Community Needs → Automated User Specific Tools



www.mesonet.org

Next Steps: Spatially continuous drought and ET characterizations



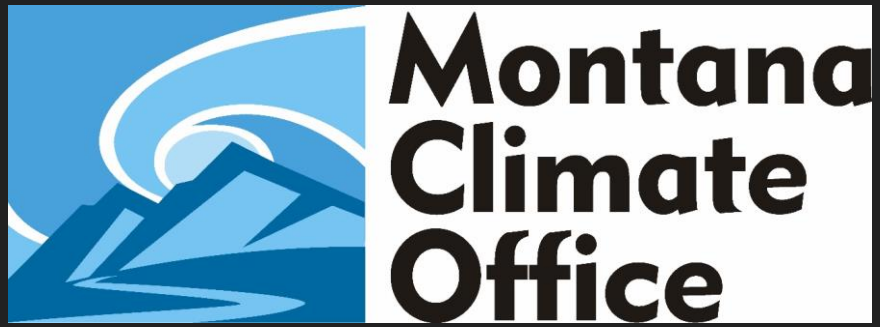


TopoFire – $1.2 million NASA sponsored project at USFS/UM

Operational Products?

- Interactive
- Daily to weekly
- 30m - 1km resolution
- Require local calibration (mesonet)

Questions?



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http://www.cfc.umt.edu/mco/