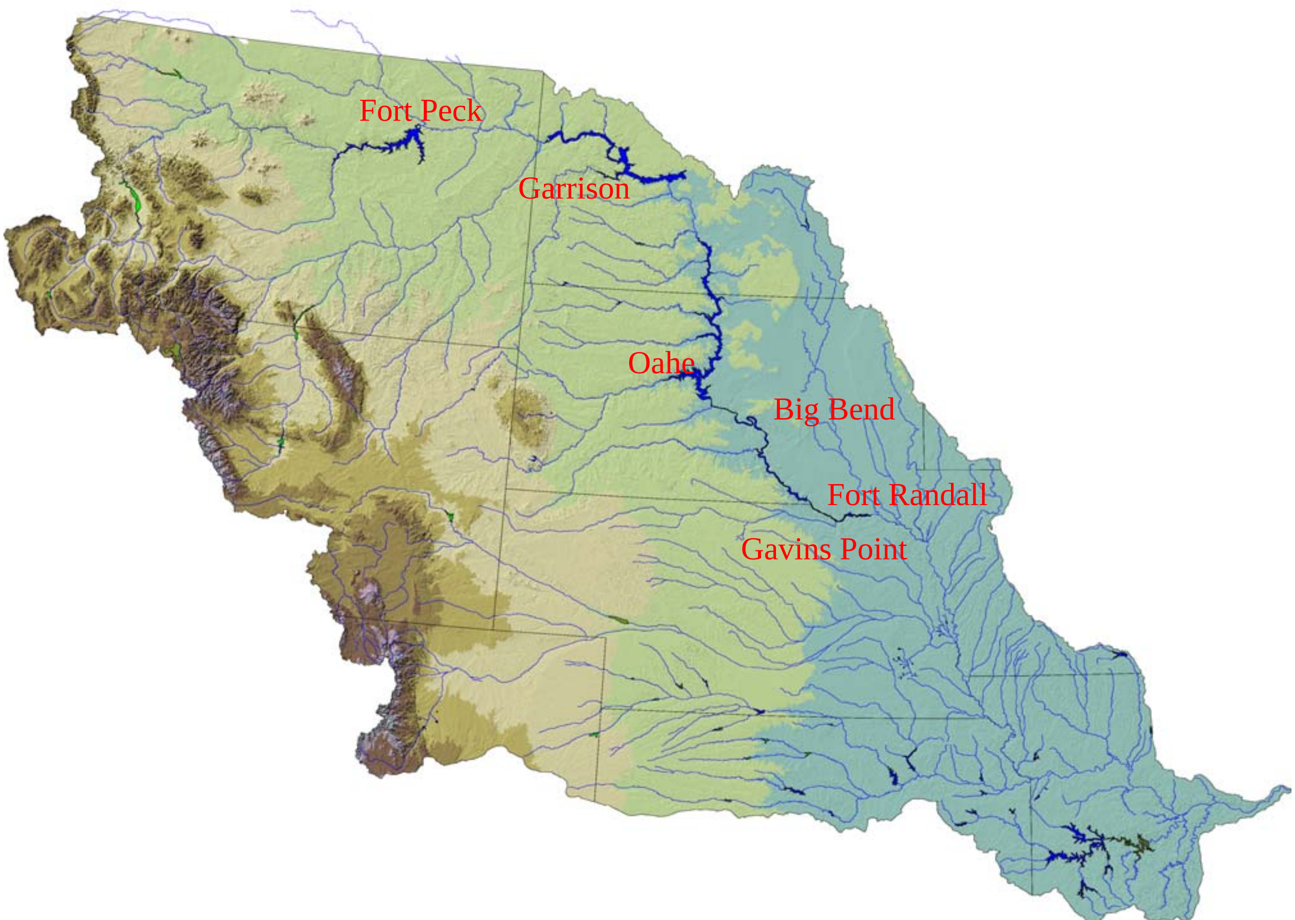
US Army Corps
of Engineers

Northwestern Division

Missouri River Mainstem Reservoir System

Summary of Actual 2015 Regulation

Missouri River Basin



U.S. Army Corps of Engineers
Northwestern Division
Missouri River Basin Water Management Division
Omaha, Nebraska

June 2016

Missouri River Mainstem Reservoir System

Summary of Actual 2015 Regulation

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS AND ACRONYMS

AOP	annual operating plan
AF	acre-feet
cfs	cubic feet per second
BIA	Bureau of Indian Affairs
consultation	government-to-government consultation
CPFLP	coldwater permanent fish life propagation
CY	calendar year (January 1 to December 31)
DMS	Data Management System
deg C	degrees Celsius
deg F	degrees Fahrenheit
EA	Environmental Assessment
ENSO	El Nino Southern Oscillation
EOM	End of Month
Five Year Plan	Cultural Resources Program Five Year Plan
FTT	Flow to Target
ft	feet
ft msl	feet above mean sea level
kAF	thousand acre-feet
kW	kilowatt
kWh	kilowatt hour
M	million
MAF	million acre-feet
Master Manual	Master Water Control Manual
MGD	million gallons per day
μg/l	micrograms per liter
mg/l	milligrams per liter
MRNRC	Missouri River Natural Resources Committee
MRBWM	Missouri River Basin Water Management
msl	mean sea level
MV	motor vessel
MVD	Corps' Mississippi Valley Division
MW	megawatt
MWh	megawatt hour
M&I	municipal and industrial
NDEQ	Nebraska Department of Environmental Quality
NHPA	National Historic Preservation Act
NOAA-CPC	National Oceanic and Atmospheric Administration - Climate Prediction Center
NOAA-NCDC	National Oceanic and Atmospheric Administration - National Climatic Data Center
NOAA-NWS	National Oceanic and Atmospheric Administration - National Weather Service
NOHRSC	National Operational and Hydrologic Remote Sensing Center

LIST OF ABBREVIATIONS AND ACRONYMS (cont'd)

NRCS-SNOTEL	Natural Resources Conservation Service SNOwpack TELemetry
NWD	Corps' Northwestern Division
NWK	Corps' Kansas City District
NWO	Corps' Omaha District
OPPD	Omaha Public Power District
PA	2004 Programmatic Agreement
plover	piping plover
P-S MBP	Pick-Sloan Missouri Basin Program
RM	river mile
SD GFP	South Dakota Game Fish and Parks
SHPO	State Historic Preservation Officer
SR	Steady Release
SWE	snow water equivalent
System	Missouri River Mainstem Reservoir System
tern	interior least tern
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
T&E	Threatened and Endangered
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
VERS	Visitation Estimation Reporting System
WCSC	Waterborne Commerce Statistics Center
Western	Western Area Power Administration
WPFLP	warmwater permanent fish life propagation

DEFINITION OF TERMS

Acre-foot (AF, ac-ft) is the quantity of water required to cover 1 acre to a depth of 1 foot and is equivalent to 43,560 cubic feet or 325,850 gallons.

Cubic foot per second (cfs) is the rate of discharge representing a volume of 1 cubic foot passing a given point during 1 second and is equivalent to approximately 7.48 gallons per second or 448.8 gallons per minute. The volume of water represented by a flow of 1 cubic foot per second for 24 hours is equivalent to 86,400 cubic feet, approximately 1.983 acre-feet, or 646,272 gallons. Conversely, 1.5 cfs for 24 hours is approximately 1 million gallons; therefore, 1.5 cfs is approximately 1 million gallons per day (MGD).

Discharge is the volume of water (or more broadly, volume of fluid plus suspended sediment) that passes a given point within a given period of time.

Drainage area of a stream at a specific location is that area, measured in a horizontal plane, enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into the river above the specified point. Figures of drainage area given herein include all closed basins, or noncontributing areas, within the area unless otherwise noted.

Drainage basin is a part of the surface of the earth that is occupied by drainage system, which consists of a surface stream or body of impounded surface water together with all tributary surface streams and bodies of impounded water.

Drought is three or more consecutive years of below-average calendar year runoff into the Missouri River above Sioux City, IA.

Gaging station is a particular site on a stream, canal, lake, or reservoir where systematic observations of hydrologic data are obtained.

Runoff in inches shows the depth to which the drainage area would be covered if all the runoff for a given time period were uniformly distributed on it.

Streamflow is the discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word "streamflow" uniquely describes the discharge in a surface stream course. The term "streamflow" is more general than "runoff" as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

MISSOURI RIVER MAINSTEM RESERVOIR SYSTEM

Summary of Actual 2015 Regulation

I. FOREWORD

This document contains a summary of the actual regulation of the Missouri River Mainstem Reservoir System (System) for the 2015 Calendar Year (CY). Two other reports related to System regulation are also available, the ***System Description and Regulation*** and ***Final 2014-2015 Annual Operating Plan.*** All three reports can be obtained by contacting the Missouri River Basin Water Management Division (MRBWM), Northwestern Division, U.S. Army Corps of Engineers at 1616 Capitol Avenue, Suite 365, Omaha, Nebraska 68102-4909, phone (402) 996-3841. The reports are also available on the MRBWM website at www.nwd-mr.usace.army.mil/rcc.

A Missouri River Basin (Basin) map is presented on ***Plate 1*** and the pertinent data for the System are shown on ***Plate 2.***

II. REVIEW OF REGULATION – JANUARY-DECEMBER 2015

A. General

This report summarizes the System regulation as it pertains to all eight congressionally-authorized purposes. During 2015 the System was regulated in accordance with the Master Water Control Manual (Master Manual) and the applicable provisions of the Final 2014-15 Annual Operating Plan (AOP), which was made available for review and comment by representatives of State and Federal agencies, Tribes, the general public, and specific interest groups. For the purposes of this report, the upper Missouri River Basin (upper Basin) is the Missouri River Basin above Sioux City, IA and the lower Missouri River Basin (lower Basin) is the Missouri River Basin from Sioux City, IA to the mouth.

B. Precipitation and Water Supply Available in 2015

Plains snowpack, mountain snowpack and general weather conditions in the Basin during the 2015 calendar year are discussed in the following sections. The reference period for average conditions for plains and mountain snowpack, precipitation and temperature is 1981-2010.

1. Plains Snowpack

Cold weather entered the Basin in late November 2014. November soil moisture conditions, as shown on ***Figure 1***, were wetter than normal in much of the Basin, especially in Montana, Wyoming, western Dakotas, northeastern Colorado, eastern Nebraska, western Iowa and northern Missouri. Fall soil moisture is significant in its relation to spring runoff. During the onset of the winter freeze, much of this moisture is locked up in frozen soil moisture and is then released during the spring thaw. Furthermore, soil moisture typically does not change during the winter; therefore, high fall precipitation and high soil moisture typically establishes wet spring soil moisture conditions.

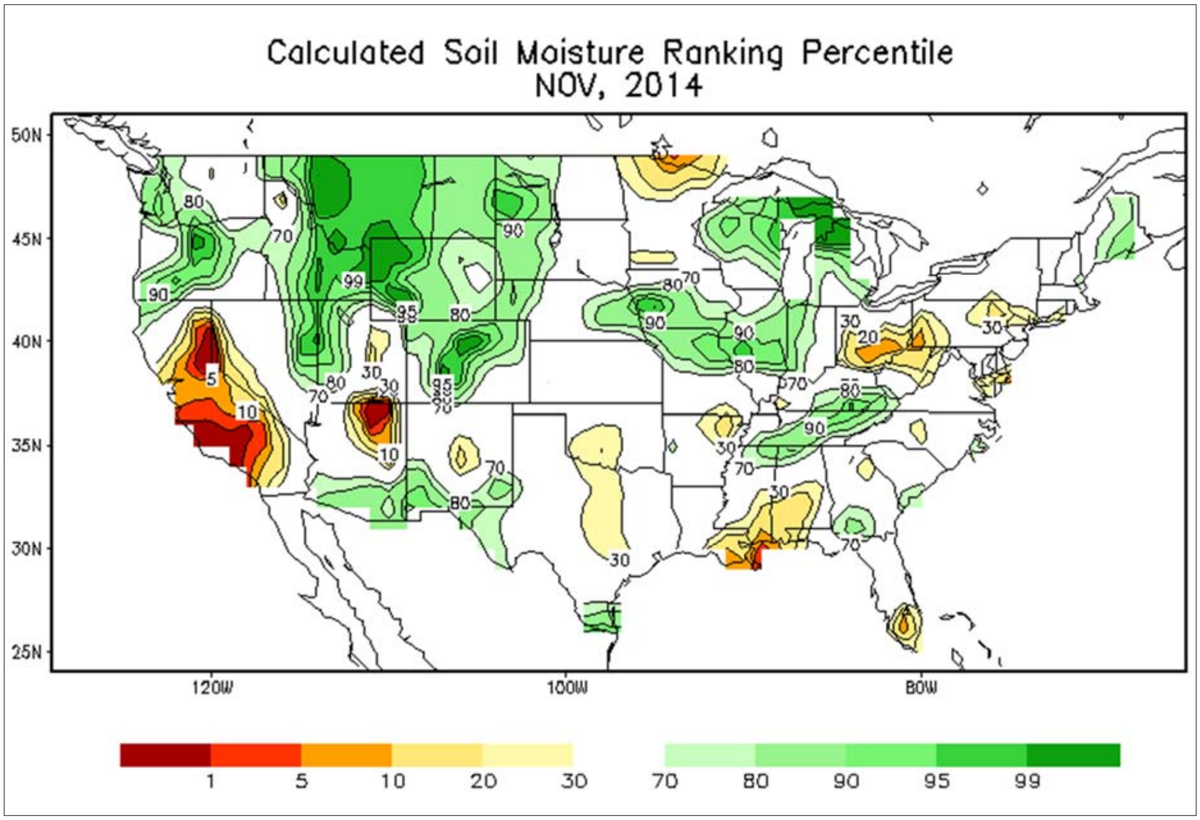


Figure 1. Soil moisture as percent of normal, November 2014. Source: NOAA CPC

The snowpack across the Northern and Central Plains began accumulating in sparse areas during late November and early December 2014. Measurable plains snow was observed in early December in far northeastern Montana, much of North Dakota and northeastern South Dakota. The other areas of the Basin did not have any measureable plains snow during the same time period. ***Figure 2*** displays the snow depth on December 8, 2014.

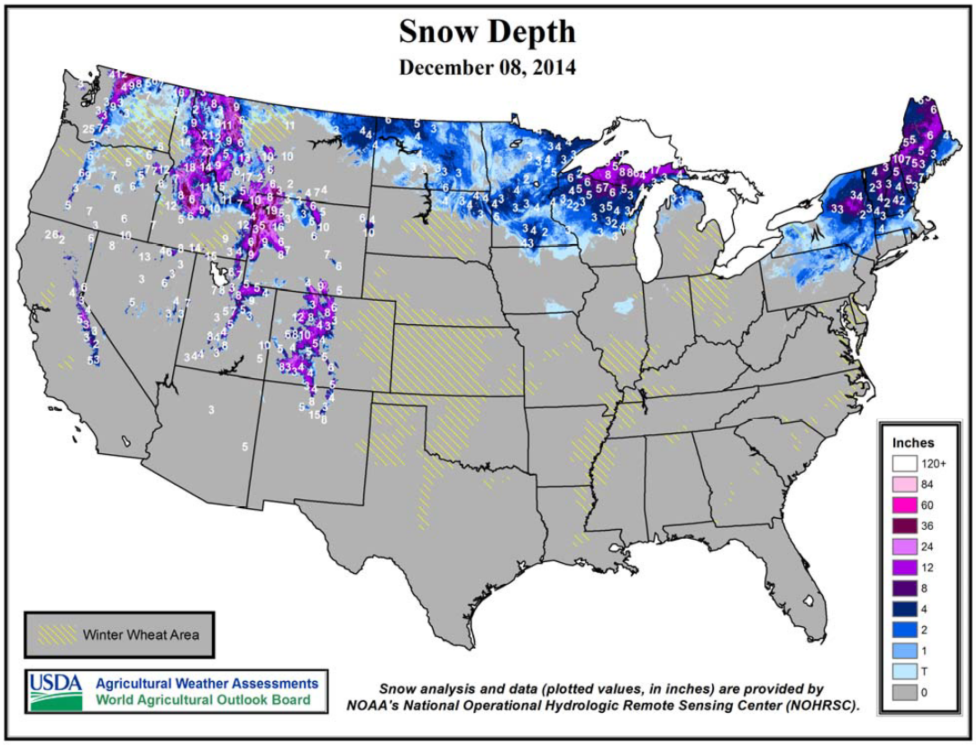


Figure 2. Snow depth in inches on December 8, 2014.

In early December 2014, cold conditions were observed in the Northern Plains and Upper Midwest with some observed temperatures 10 degrees Fahrenheit (deg F) below normal along the Canadian border (see ***Figure 3***). During that period, daily-record low temperatures were exceeded at Bozeman, MT (-23 deg F) and Jamestown, ND (-24 deg F).

During the second week of December 2014 cold conditions in the upper Basin were quickly replaced with very warm and dry conditions which persisted until late in the month. During the month, Rapid City, SD logged multiple days with daily-record highs of 71 deg F, Chadron, NE and Great Falls, MT reached 63 deg F and record high temperatures of 61 deg F and 60 deg F were recorded in Dickinson, ND. The only plains snowpack that remained on the ground during the entire month was in eastern North Dakota and scattered areas in northeastern Montana and northwestern North Dakota. Despite the warmer-than-average temperatures, parts of Wyoming, Nebraska and South Dakota received snowfall, but most of that snowfall melted shortly thereafter. Valentine, NE logged a daily-record snowfall of 3.5 inches on December 15, and Casper, WY received a two-day total of 9.3 inches.

During the latter part of December the majority of the Basin experienced above-average temperatures. Despite the warmer temperatures, many areas recorded precipitation in the form of snow. Scottsbluff, NE received 10.6 inches of snow on December 25-26 and in Great Falls, MT daily-record snowfalls were exceeded on December 24 (5.0 inches) and December 28 (7.5 inches). The year ended with plains snowpack established in much of eastern Montana, the Dakotas and northern Nebraska.

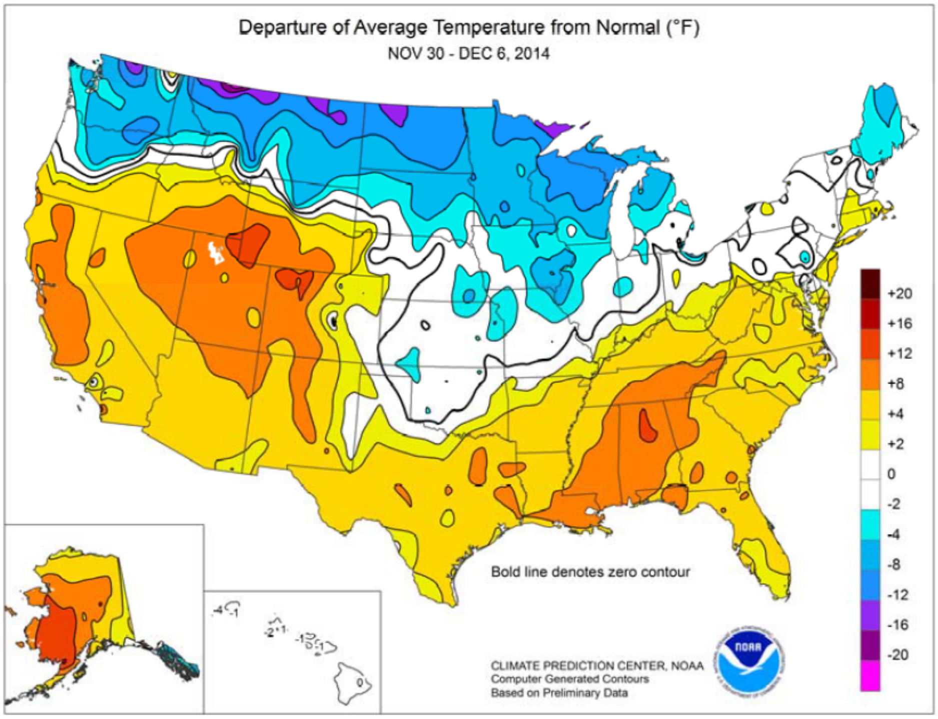


Figure 3. Departure from normal temperature, November 30-December 6, 2014.

During the first half of January snowpack continued to build across the Northern Plains. During the period, temperatures were below average for the entire region, especially in northeastern Montana and western North Dakota where temperatures were around 15 deg F below normal. Daily-record snowfall totals were broken during a storm on January 5 at Glasgow, MT (6.7 inches) and Sioux Falls, SD (5.0 inches). By the end of the second week of the month plains snowpack was observed in all of Montana, Wyoming, the Dakotas and northern Nebraska (see ***Figure 4***).

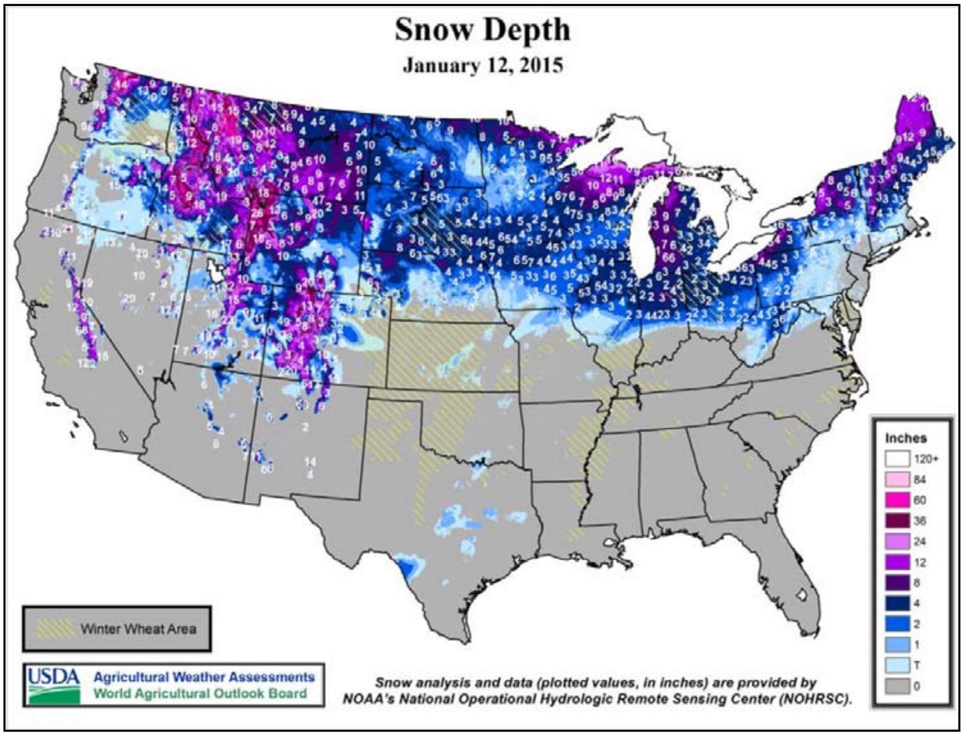


Figure 4. Snow depth in inches on January 12, 2015.

Very warm temperatures were observed during the second half of January resulting in early season snowmelt throughout much of the Northern Plains. Areas near the Canadian border experienced temperatures up to 20 deg F above normal during the period. Great Falls, MT and Choteau, MT broke daily-record highs on January 26 of 67 deg F and 70 deg F, respectively. Other Basin locations that saw record temperatures included Rapid City, SD (73 deg F), North Platte, NE (73 deg F) and Imperial, NE (77 deg F). ***Figure 5*** shows the departure from normal temperature during January.

Figure 6 shows the rapid decrease in snow cover across the Northern Plains due to significantly higher-than-normal temperatures during the period. During this period, areas where snow remained on the ground included eastern Montana, Wyoming, portions of North Dakota and scattered areas in South Dakota, Nebraska and Iowa.

In early February the western half of the Basin experienced above-average temperatures combined with low precipitation. The eastern half of the Basin experienced the opposite with below-normal temperatures and snowfall. ***Figure 7*** shows that the plains snowpack was concentrated on eastern sections of the Basin. Eastern portions of North Dakota, South Dakota, Nebraska, as well as western Iowa, all had snow on the ground. Far northeastern Montana also maintained an area with snow cover.

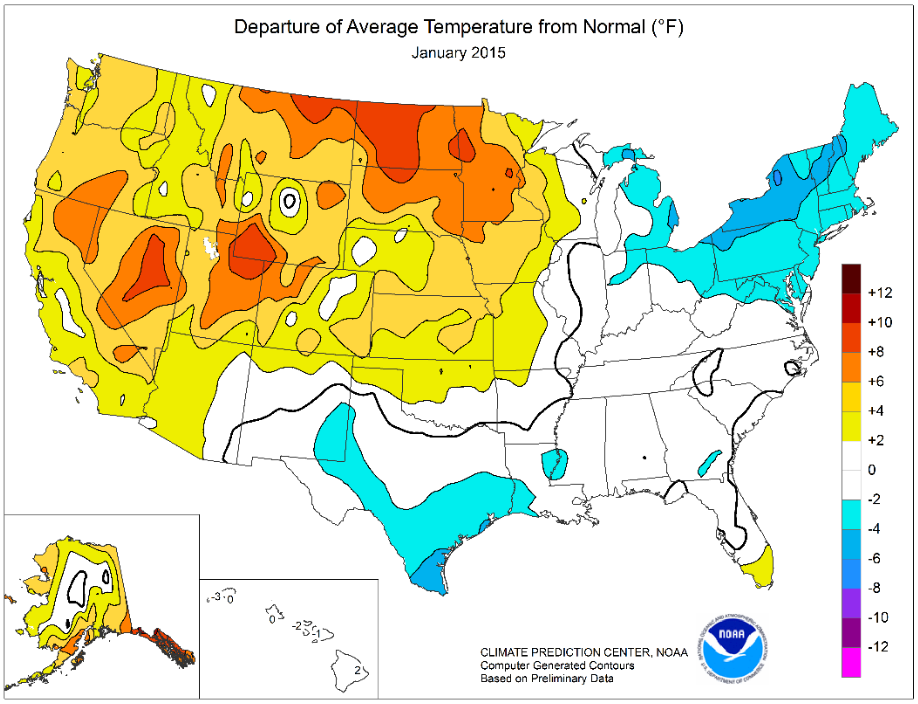


Figure 5. Departure from normal temperature, January 2015.

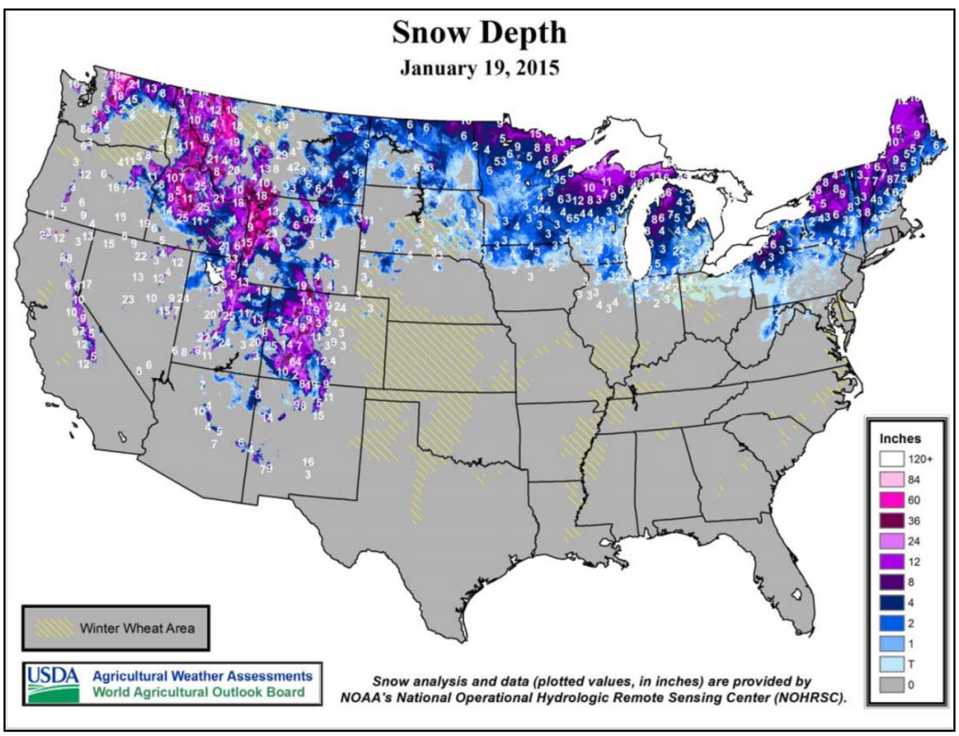


Figure 6. Snow depth in inches on January 19, 2015.

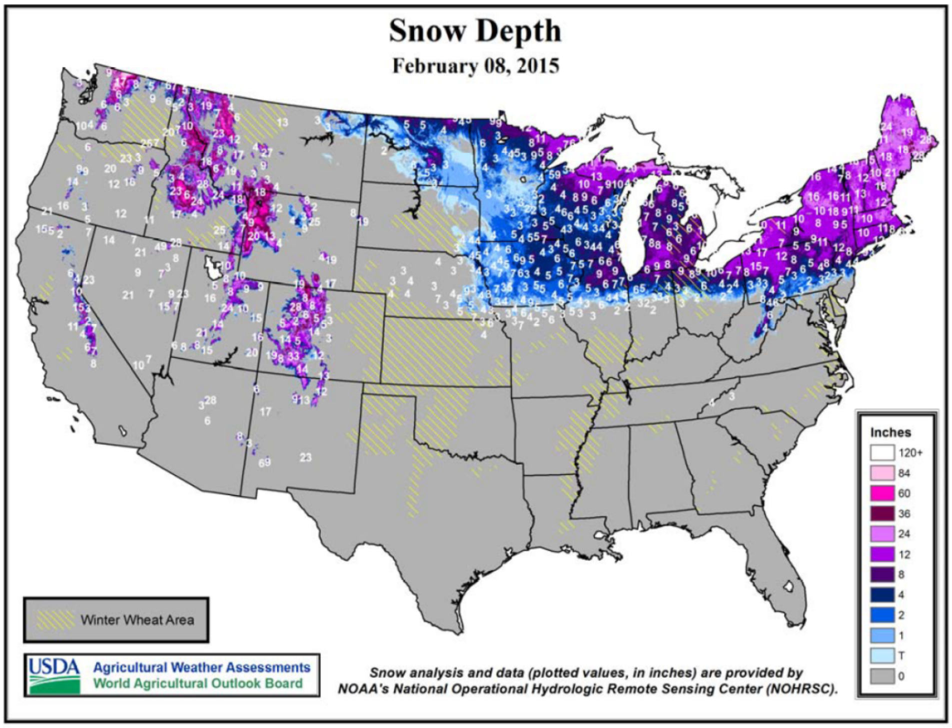


Figure 7. Snow depth in inches on February 8, 2015.

A similar pattern dominated the Basin for the second and third weeks of the month with warm conditions west and cooler conditions east. During the period, the Dakotas and far northeastern Montana maintained consistent snowpack. Snow Water Equivalent (SWE) was estimated to be at its peak in central North Dakota. The area east of Jamestown, ND maintained the highest snowpack in the Basin through the winter months. On February 17, based on modeled SWE data from NOAA (NOHRSC), it was estimated that 2-4 inches of SWE was on the ground in that area (see ***Figure 8***). However, the local snow observer only measured 1.1 inches of SWE on February 13.

Cold temperatures and some snow were prevalent throughout the Basin during the final week of February and the first week of March. Most areas experienced temperatures 15 deg F below normal. By the second week of March, warm and dry conditions entered the Basin, which resulted in a melting of all plains snowpack.

Table 1 shows the plains seasonal snowfall totals during the winters of 2012-2013, 2013-2014 and 2014-2015 in comparison to the 1981-2010 seasonal average snowfall. Seasonal snowfall in this report is defined as the total snowfall from July to June of the following year. With exception to locations in Montana, all other areas shown in the table received significantly less snowfall compared to average.

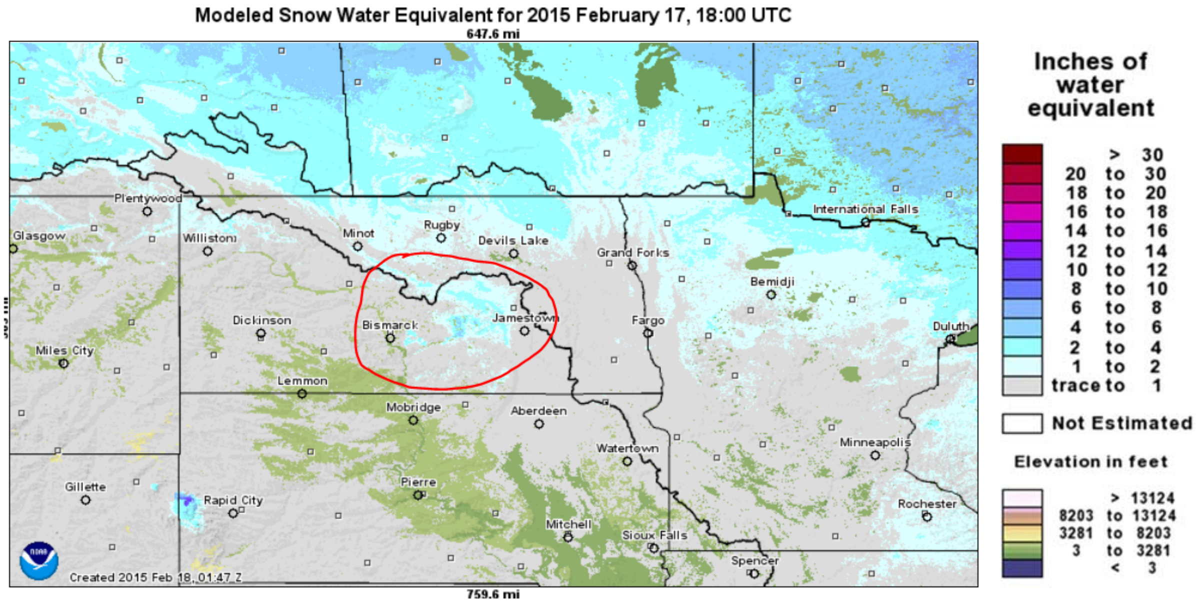


Figure 8. SWE in the upper plains on February 17, 2015. Source: NOAA National Operational Hydrologic Remote Sensing Center (NOHRSC).

Table 1
Missouri River Basin - Plains Snowfall Totals (inches)

Location	2012-13 Total	2013-14 Total	2014-15 Total	Annual Average (1981-2010)
Billings, MT	40.4	103.5*	55.4	55.1
Glasgow, MT	62.3	30.4	43.2	34.6
Great Falls, MT	75.3	74.6	57.9	63.2
Bismarck, ND	57.3	40.5	24.1	51.2
Aberdeen, SD	62.8	32.7	20.2	38.1
Sioux Falls, SD	43.3	45.3	31.9	44.5
Watertown, SD	47.1	28.2	25.3	35.9
Sioux City, IA	45.1	23.8	21.5	34.8
Omaha, NE	35.7	17.8	13.8	26.4
Kansas City, MO	31.8	26.1	14.2	18.8

*Maximum of record

Source: NOAA Online Weather Data (NOWData). Totals represent total snowfall from July to June of the following year.

2. Mountain Snowpack

Mountain snowpack is monitored by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service's (NRCS) network of SNOwpack TELemetry (SNOTEL) stations. For purposes of monitoring the mountain snowpack and forecasting spring and summer runoff from the Rocky Mountains, average mountain snowpack expressed as inches of SWE is computed from the SNOTEL stations within the reservoir reaches above Fort Peck and from Fort Peck to Garrison. The 2014-15 mountain snowpack accumulation and melt pattern for each of the two reaches is illustrated in ***Figure 9***. Mountain SWE is discussed in the following paragraphs as a percent of the 1981-2010 average SWE occurring on the first day of each month. SWE accumulation for the two reaches is summarized in ***Table 2***.

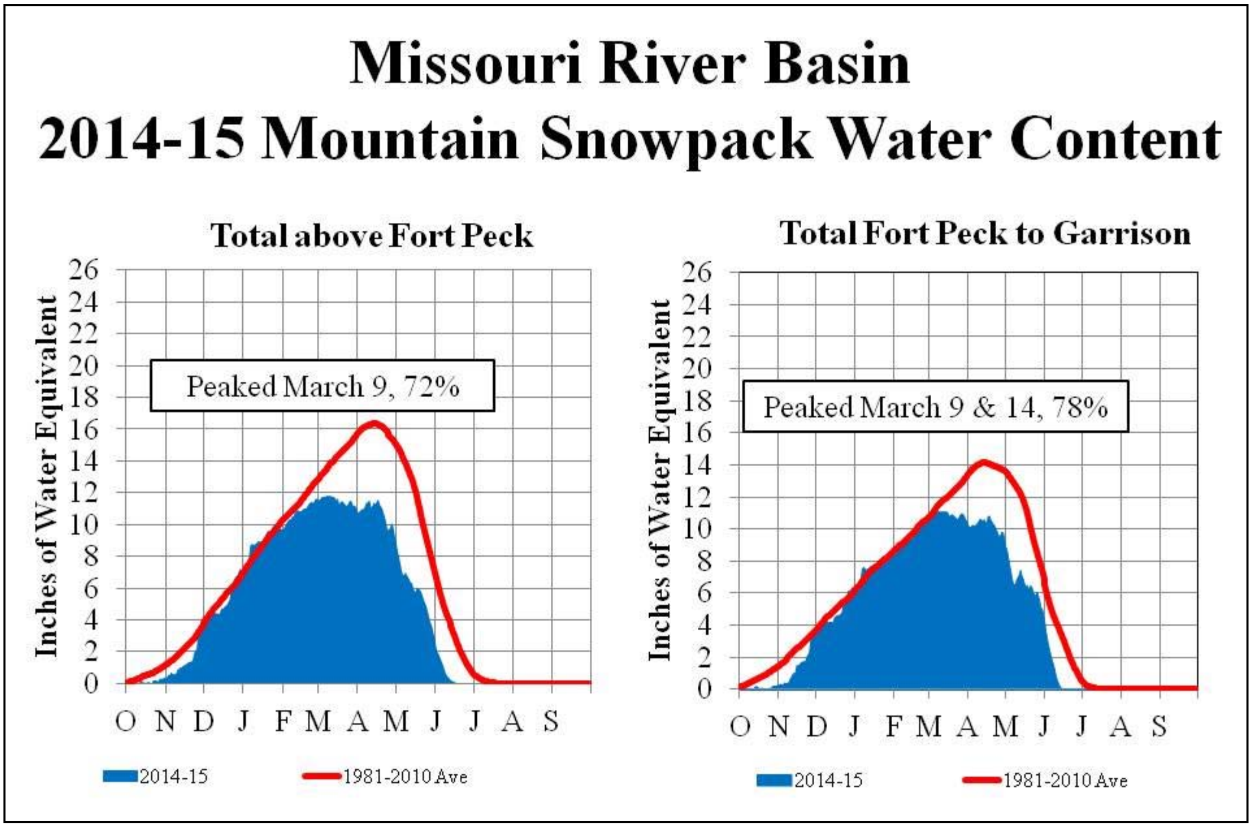


Figure 9. Missouri River Basin 2014-15 mountain SWE. Data Source: USDA-NRCS National Water and Climate Center.

The mountain snowpack accumulated at below-average levels for October and November in both reaches. During the months of December through February, mountain snowpack accumulated at near-average levels in both reaches. However, accumulation ended in early March and both reaches experienced peaks in early to mid-March. After the peak occurred, SWE remained near the peak levels until melting accelerated in late April. Both reaches experienced peaks less than 80 percent of average and the runoff from mountain snowmelt occurred considerably earlier than normal.

Table 2
Mountain SWE Accumulation, 2014-2015

Month	Above Fort Peck % Normal	Fort Peck to Garrison % Normal	Percent of Actual Peak Accumulation
November 1	26	22	9
December 1	102	98	26
January 1	99	101	44
February 1	93	96	64
March 1	88	97	79
Peak	March 9, 72	March 9&14, 78	97
April 1	68	74	100
May 1*	59 / 54	65 / 62	92
June 1*	37 / 14	60 / 26	39
July 1*	2 / 0	4 / 0	3
Melt-out	July 1	July 1	

*Percent of May 1, June 1 or July 1 average SWE / Percent of normal April 15 peak

3. Weather Conditions

Compared to the past 121 years, much of the Basin was wetter and warmer than normal. Montana experienced its record warmest year since 1895. January-December precipitation and temperature statewide and divisional rankings for the past 121 years are shown in ***Figure 10*** and ***Figure 11***, respectively. Percent of normal monthly precipitation maps and departure from normal 3-month maps are shown on ***Figure 12*** and ***Figure 13***, respectively. ***Figure 14*** shows the National Drought Mitigation Center's drought maps in 3-month intervals.

January – March

The year began with warmer- and drier-than-normal weather conditions in much of the Basin from January to March. Large areas in the Dakotas and parts of Nebraska and Kansas experienced Abnormally Dry (D0) conditions. While little precipitation fell, upper Basin runoff in January and February was 178% and 186% of average, respectively. The above-average runoff was primarily due to warmer-than-average temperatures in the northern and western parts of the Basin, which resulted in an early melting of the plains snowpack. By March upper Basin runoff had declined to less than average and most of the plains snowpack melted. With less-than-normal precipitation during March, drought conditions expanded throughout the basin and intensified to Moderate Drought (D1) in parts of the Dakotas, Nebraska, and Kansas.

April – June

Although the western part of the Platte River basin experienced above-normal precipitation in April, most of the Basin received less than 2.0 inches of precipitation and many areas received less that 0.5 inch. This led to drought conditions intensifying across the basin (see ***Figure 14***, April 7, 2015). May precipitation was well above normal in southwestern Montana, Wyoming, Colorado, western Nebraska, much of South Dakota and significant portions of southern and eastern North Dakota (***Figure 12***). Many of these areas received more than two times normal precipitation. May precipitation was also above normal in the lower Basin in eastern Nebraska, western Iowa, and western Missouri. In June, precipitation was also above normal in the Garrison, Oahe, and Fort Randall reaches, northeastern Wyoming, southeastern South Dakota, as well as in southeastern Nebraska, Iowa, and Missouri. Precipitation was near normal and slightly below normal in the rest of the Basin. As a result, drought conditions were nearly eliminated by early July in almost all of the Basin except for eastern Montana and the southeastern portion of South Dakota (see ***Figure 14***, July 7, 2015).

July – September

From July through September, precipitation was above normal in some regions, but not basin-wide. In July, the above Fort Peck, Fort Randall to Gavins Point and Gavins Point to Sioux City reaches, along with parts of the Platte River basin, southern Iowa, eastern Kansas, and Missouri, experienced up to two times normal precipitation. Large portions of Montana, the Dakotas, Wyoming, Nebraska, and Kansas still remained drier than normal. In August, precipitation was well above normal in southeastern Montana, northeastern Wyoming, most of South Dakota, and western Iowa, while remaining below normal in much of Kansas, Nebraska,

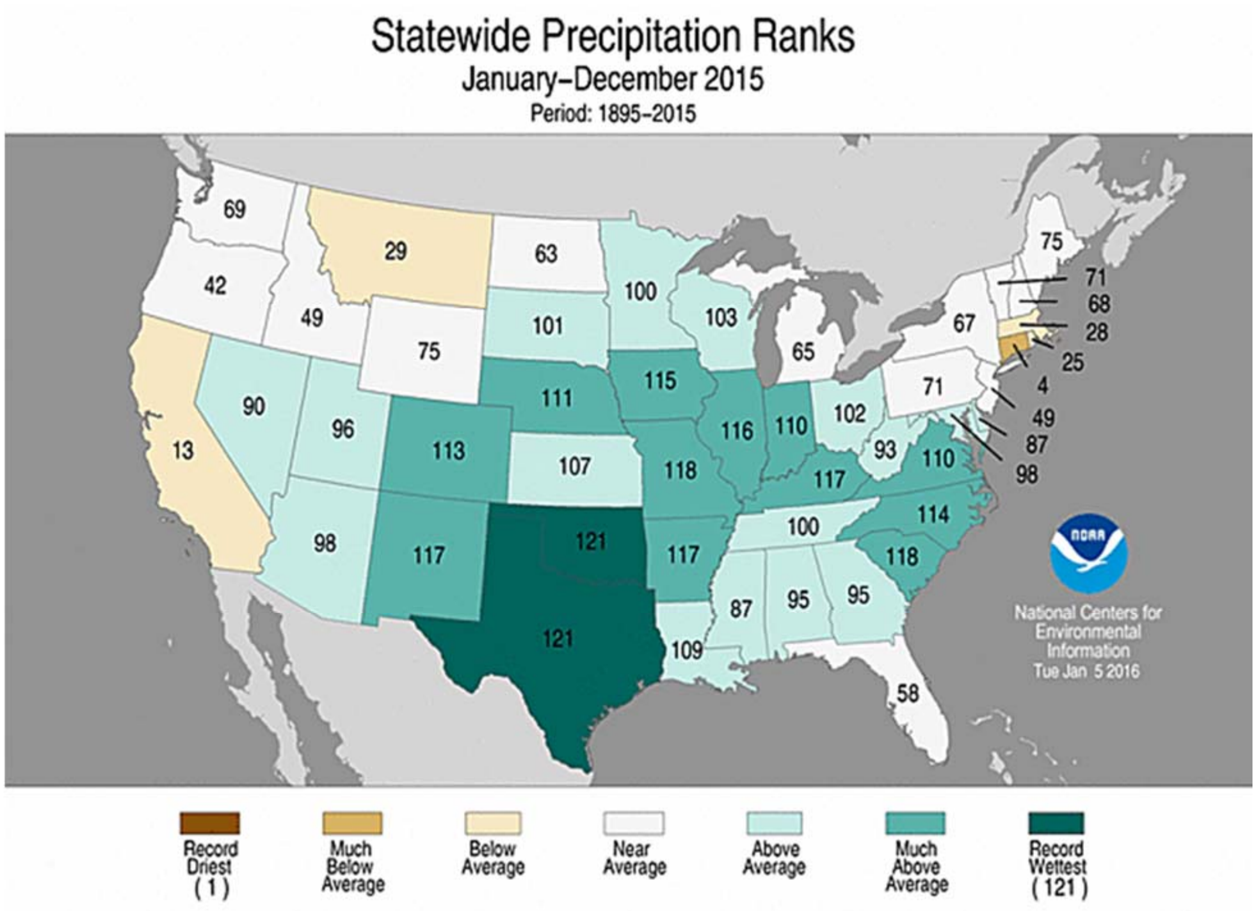


Figure 10a. January-December 2015 Statewide Precipitation Ranks (Source: NOAA/NCDC).

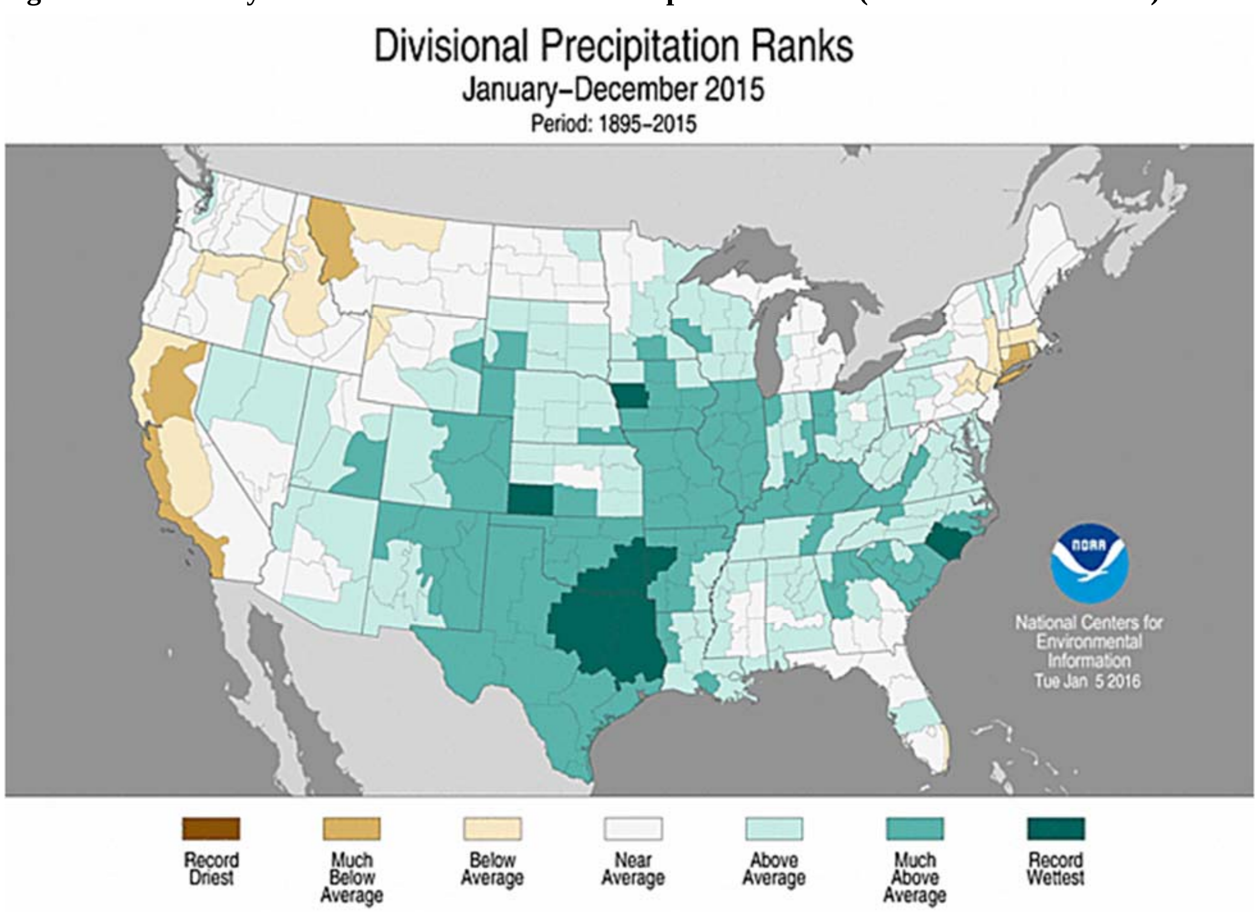


Figure 10b. January-December 2015 Divisional Precipitation Ranks (Source: NOAA/NCDC).

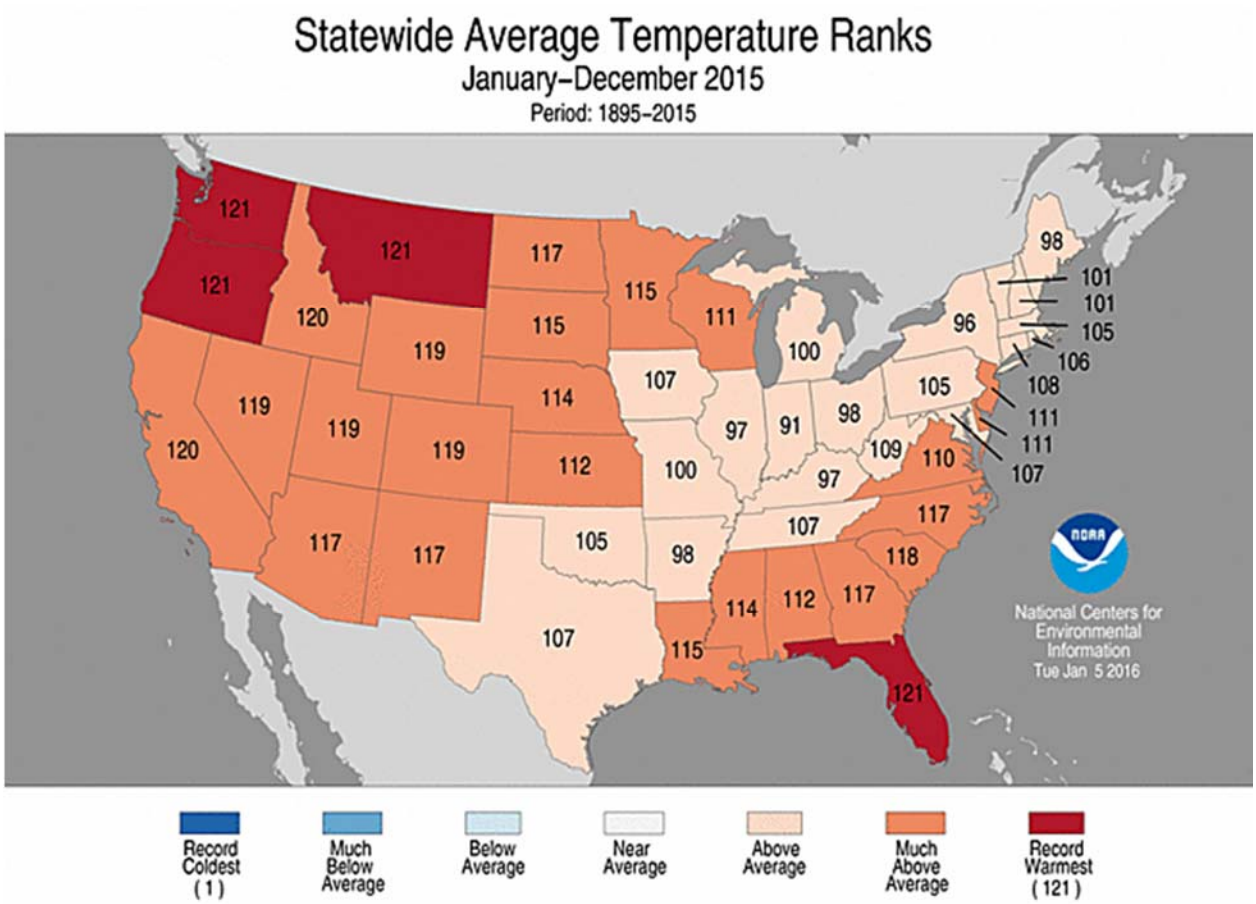


Figure 11a. January-December 2015 Statewide Temperature Ranks (Source: NOAA/NCDC).

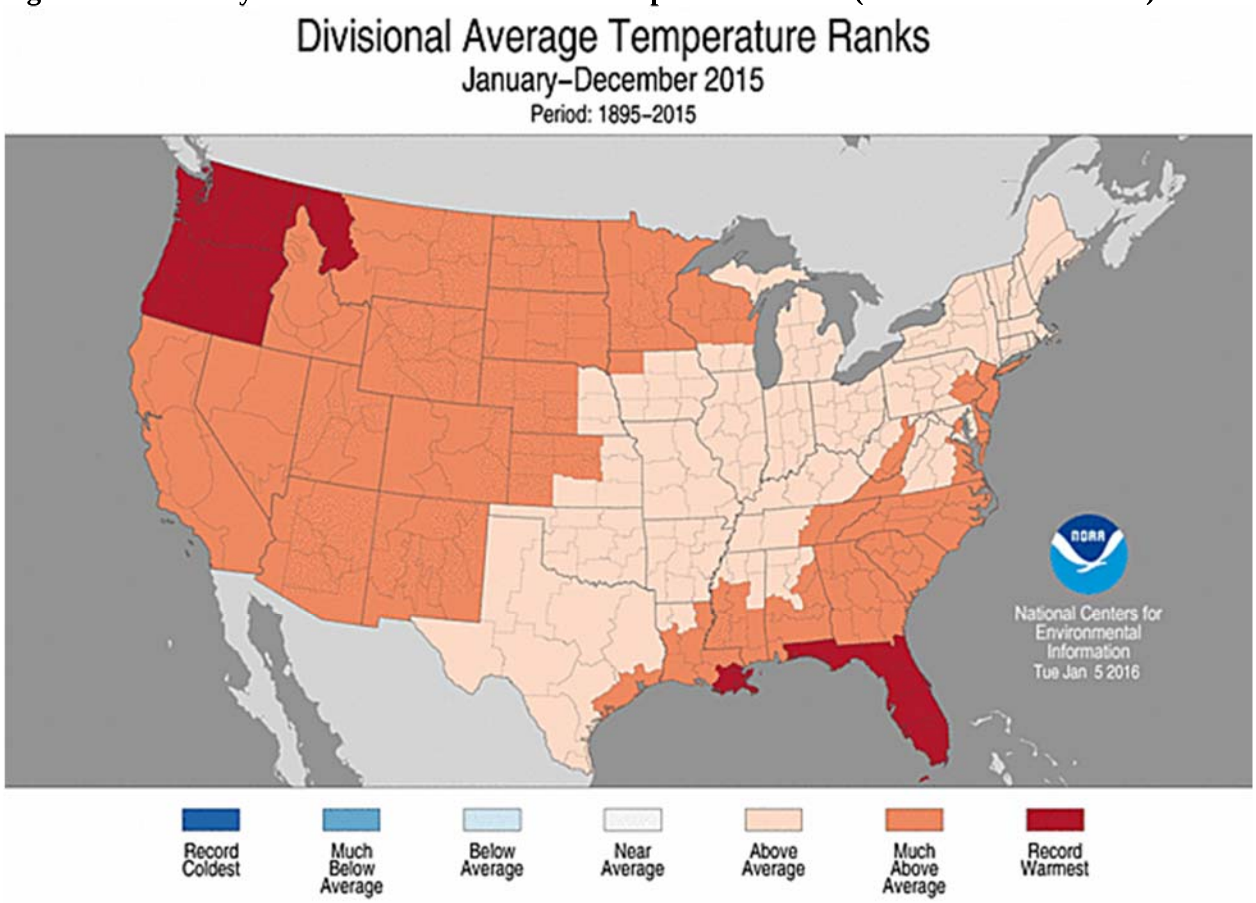


Figure 11b. January-December 2015 Divisional Temperature Ranks (Source: NOAA/NCDC).

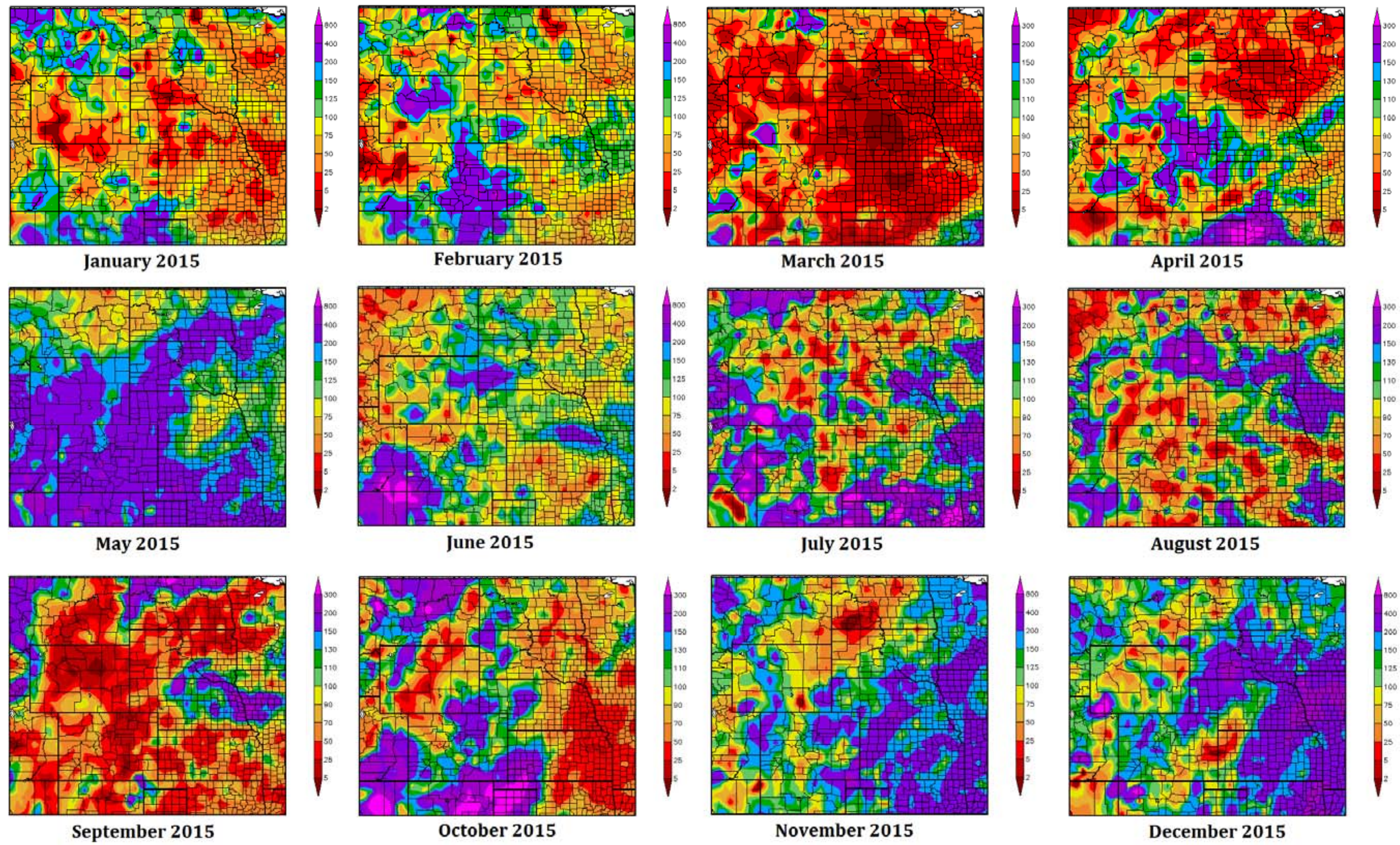


Figure 12. Percent of normal precipitation maps for 2015, by month. Reformatted from the High Plains Regional Climate Center Climate Summary Maps.

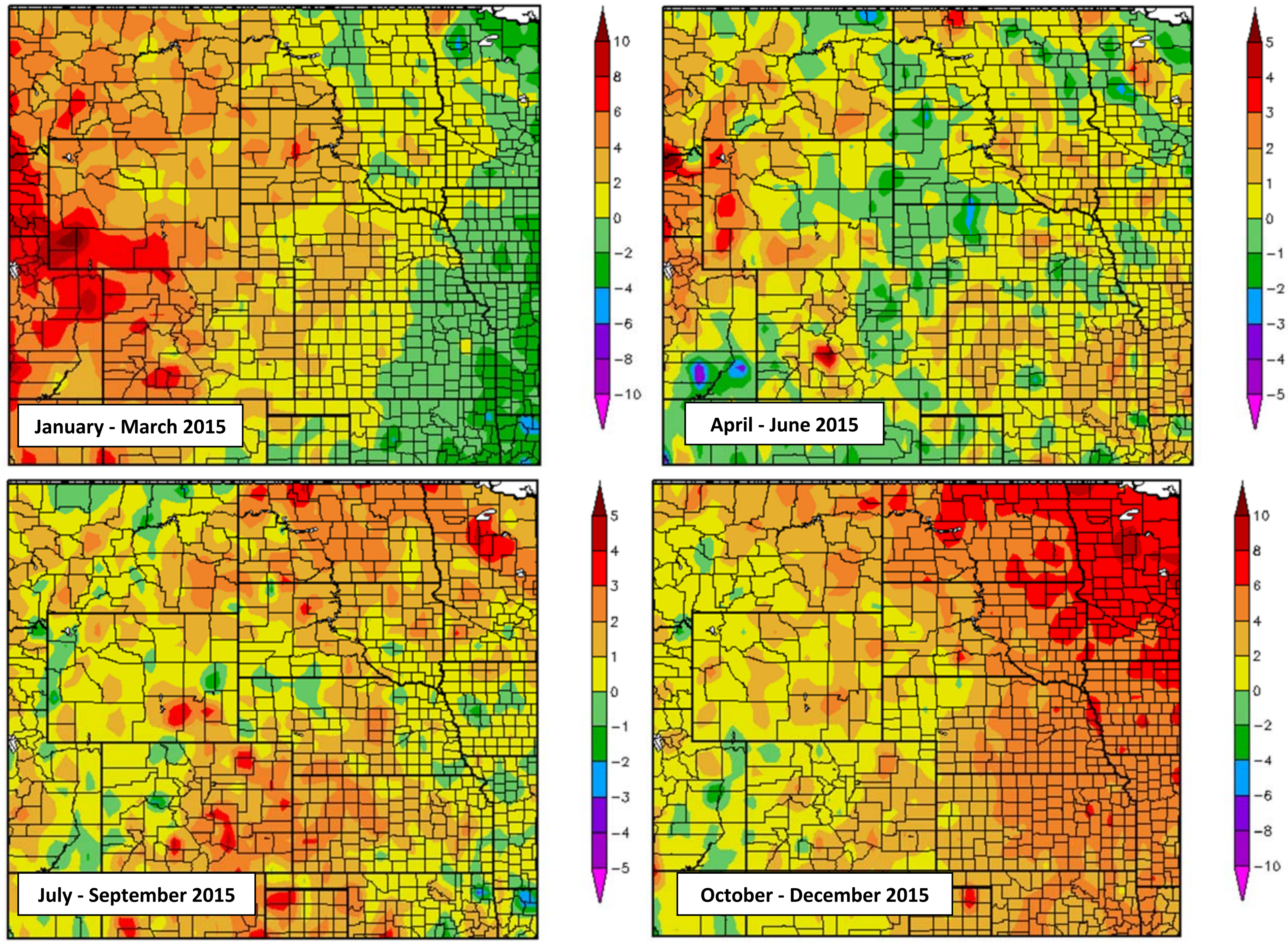


Figure 13. Departure from normal temperature (degrees F) for the 2015 three-month periods: January-March, April-June, July-September and October-December. Reformatted from the High Plains Regional Climate Center Climate Summary Maps.

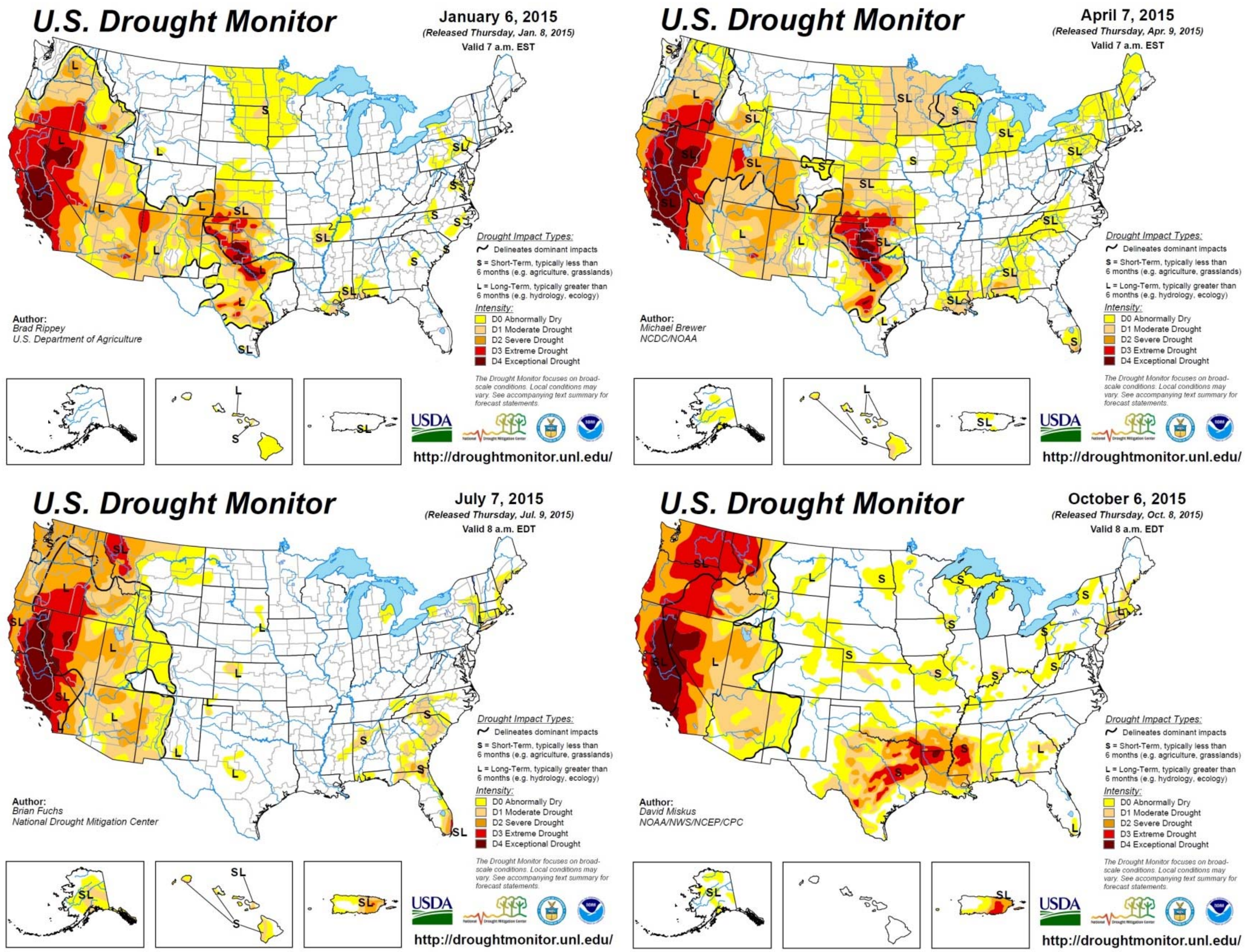


Figure 14. The National Drought Mitigation Center's drought maps for early January, April, July and October 2015.

Wyoming, North Dakota, and Missouri. Most of the Basin noted as little as 25 percent of normal precipitation, although above-normal precipitation was seen in the Fort Peck to Garrison reach, northern North Dakota, the Fort Randall to Gavins Point and the Gavins Point to Sioux City reaches, as well as western Iowa. Temperatures throughout the Basin were from 1 to 4 deg F above normal during this period, with only small patches of normal temperatures. By early October, some areas of Abnormally Dry (D0) conditions had developed in the Dakotas, Wyoming, Nebraska, Kansas, and Missouri, while drought conditions were somewhat alleviated in the Fort Peck reach.

October – December

In October, precipitation was above average in the western Platte River basin, parts of western North and South Dakota, and the reach upstream of Fort Peck, while the eastern and southeastern parts of the Basin experienced below-average precipitation. November and December, however, brought much above-normal rainfall to a large area of the Basin including much of South Dakota, Nebraska, Iowa, Kansas, and Missouri. The period from October to December was much warmer than average throughout the Basin, with large parts of the Dakotas experiencing up to 8 deg F above normal.

Significant Rainfall Events

Three events of particularly heavy precipitation occurred in 2015. The first event occurred in May and the second and third events occurred from December 12-14 and 25-28. May precipitation totals and departures for selected locations in the Basin are shown in ***Table 3***. The total May rainfall was 6.5 inches at Big Horn, WY, 4.0 inches above normal; 9.4 inches at Mobridge, SD, 6.7 inches above normal; and 10.9 inches at Lincoln, NE, 6.6 inches above normal.

Runoff generated by May and June rainfall in the upper Basin was attenuated by the six mainstem dams on the Missouri River. Plots of the natural or unregulated flow versus the actual or regulated flow are shown in ***Figure 15A, 15B*** and ***15C***. As shown ***Figure 15A***, regulation of tributary and mainstem projects resulted in a reduction of Missouri River flows at Wolf Point, MT from a 30,000 cfs natural or unregulated peak to an actual or regulated peak of about 9,000 cfs. At Bismarck, ND, an unregulated peak of over 100,000 cfs was reduced to about 25,000 cfs. At Sioux City, IA, an unregulated peak of about 130,000 cfs was reduced to about 35,000 cfs. During the dry period from July through September, actual Missouri River flows were fairly steady above Gavins Point. In the lower Basin, however, mainstem regulation had less effect on flood peaks, such as those shown on ***Figure 15B***, Missouri River at St. Joseph, MO. Above-average rainfall in the Nishnabotna, Nemaha, Tarkio, and Nodaway river basins, all of which are unregulated, resulted in high Missouri River flows downstream of Nebraska City, NE.

The majority of the December 12-14 precipitation occurred in unregulated basins downstream of Gavins Point Dam, specifically in the lower Big Sioux River basin and more generally throughout much of Nebraska, Iowa, Kansas, and Missouri. The December 25-28 event was primarily over the Osage and Gasconade River basins in the lower Basin. The Osage River basin is regulated by several Corps tributary projects and Bagnell Dam-Lake of the

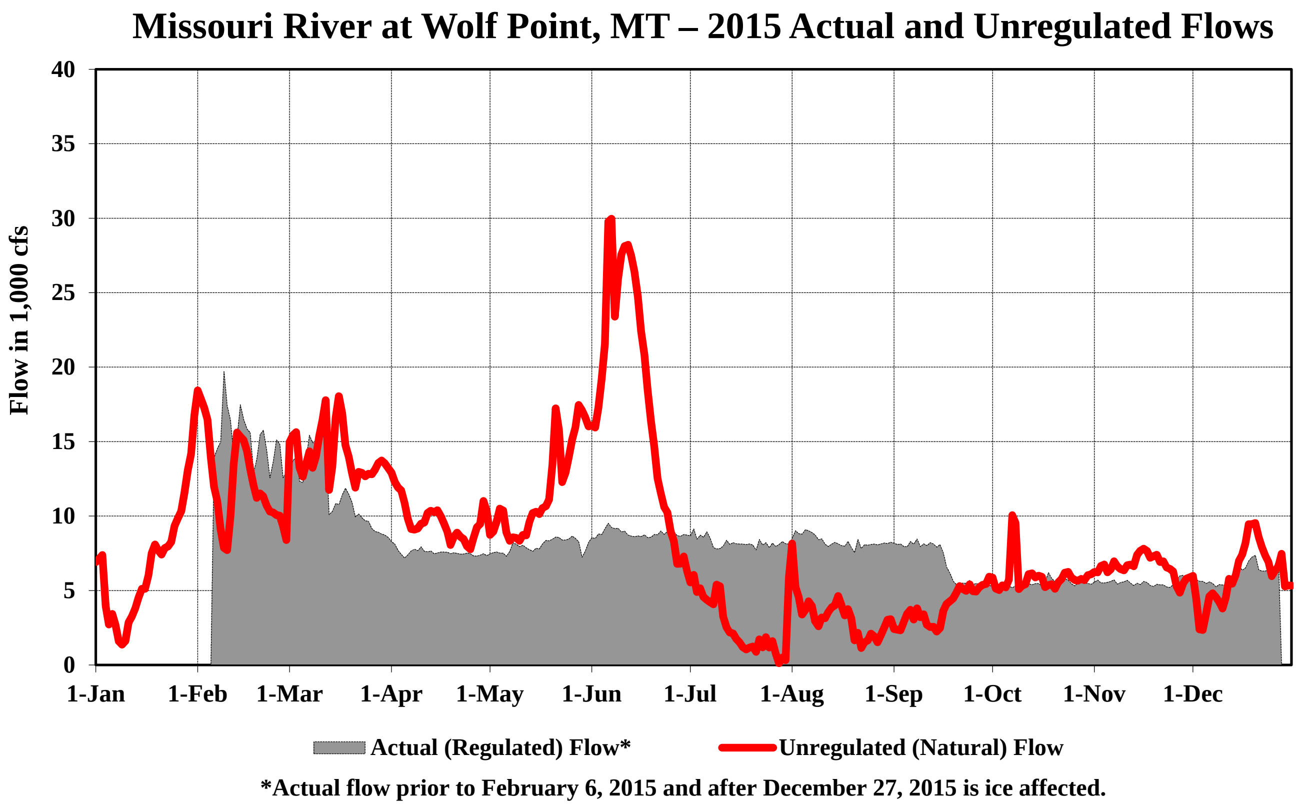
Ozarks, a privately-owned project. The Gasconade River is unregulated. As shown in ***Figure 15C***, regulation of the NWK Osage River basin projects reduced the Missouri River flow at Hermann on December 31 from 675,000 cfs (unregulated) to 435,000 cfs (actual). ***Table 4*** shows November-December precipitation totals and departures. The total November-December precipitation was 7.5 inches at Sioux City, IA, 5.3 inches above normal; 17.0 inches at Jefferson City, MO, 10.6 inches above normal; and 20.4 inches at Rolla, MO, 13.9 inches above normal.

Table 3. May 2015 precipitation totals and departures in inches.

Location	Total inches	Departure inches
Buffalo Bill Dam, WY	4.1	2.4
Cody, WY	5.1	3.3
Big Horn, WY	6.5	4.0
Sheridan AP, WY	5.4	3.1
Gillette, WY	6.4	3.2
Cheyenne, WY	6.0	3.7
Lander AP, WY	6.1	3.9
Mobridge, SD	9.4	6.7
Aberdeen RGNL AP, SD	6.4	3.3
Pactola Dam, SD	9.5	5.5
Rapid City RGNL AP, SD	6.9	3.6
Pierre RGNL AP, SD	6.2	3.0
Watertown RGNL AP	4.6	2.0
Scottsbluff AP, NE	8.0	5.5
Valentine AP, NE	7.1	4.0
Lincoln AP, NE	10.9	6.6
Nebraska City, NE	7.5	2.3

Table 4. November-December 2015 precipitation totals and departures in inches.

Location	November		December		November-December	
	Total inches	Departure inches	Total inches	Departure Inches	Total inches	Departure inches
Sioux Falls, SD	3.9	2.5	1.3	0.6	5.2	3.1
Sioux City, IA	4.6	3.2	2.9	2.1	7.5	5.3
Lincoln AP, NE	2.0	1.8	4.4	3.5	6.4	5.3
Omaha Eppley AP, NE	2.5	0.8	5.3	4.2	7.8	5.0
Tuttle Creek Lake, KS	5.4	3.9	3.7	2.7	9.1	6.6
Manhattan, KS	5.3	3.4	3.1	2.1	8.4	5.5
Topeka, KS	5.1	3.3	2.7	1.4	7.8	4.7
Lawrence, KS	4.4	2.2	3.2	1.7	7.6	3.9
Smithville Lake, MO	4.8	2.5	3.3	1.7	8.1	4.2
Kansas City, MO	4.4	2.3	3.2	1.7	7.6	4.0
Sedalia, MO	7.7	4.4	5.2	2.9	12.9	7.3
Kirksville, MO	4.7	2.1	4.4	2.6	9.1	4.7
Jefferson City, MO	9.6	5.9	7.4	4.7	17.0	10.6
Columbia, MO	8.4	5.2	7.0	4.6	15.4	9.8
Truman Dam, MO	8.3	4.8	5.2	n/a	13.5	n/a
Rolla, MO	10.1	6.2	10.3	7.7	20.4	13.9
St. Louis, MO	6.5	2.6	11.7	8.9	18.2	11.5



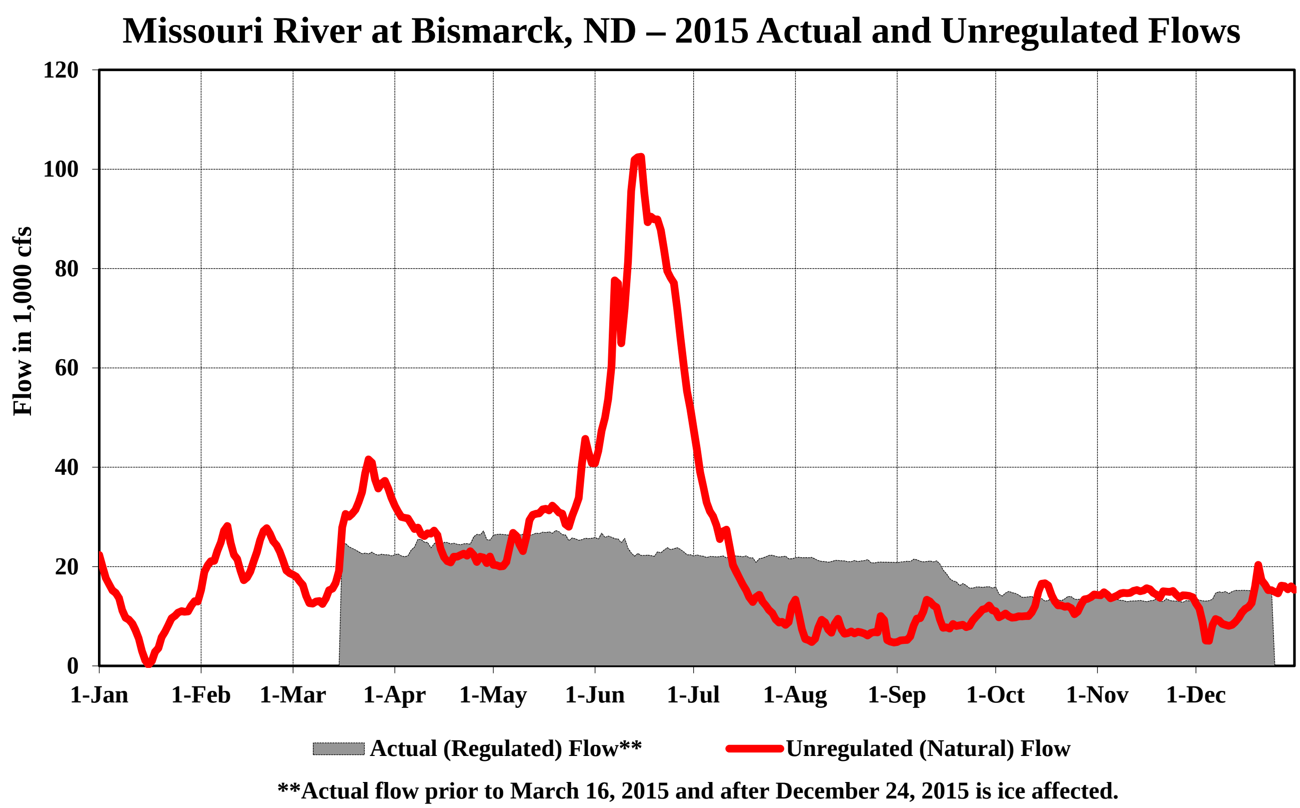
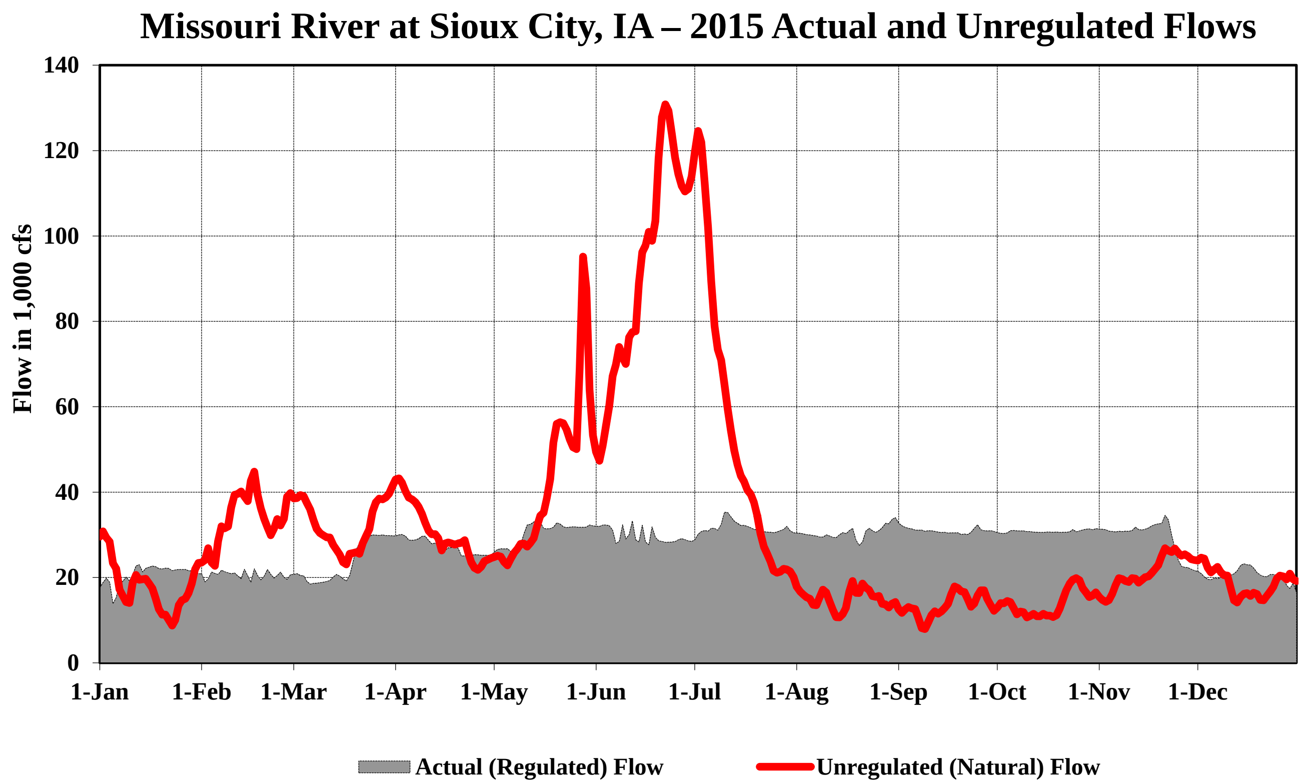


Figure 15A. 2015 actual and unregulated flows – Wolf Point, MT and Bismarck, ND.



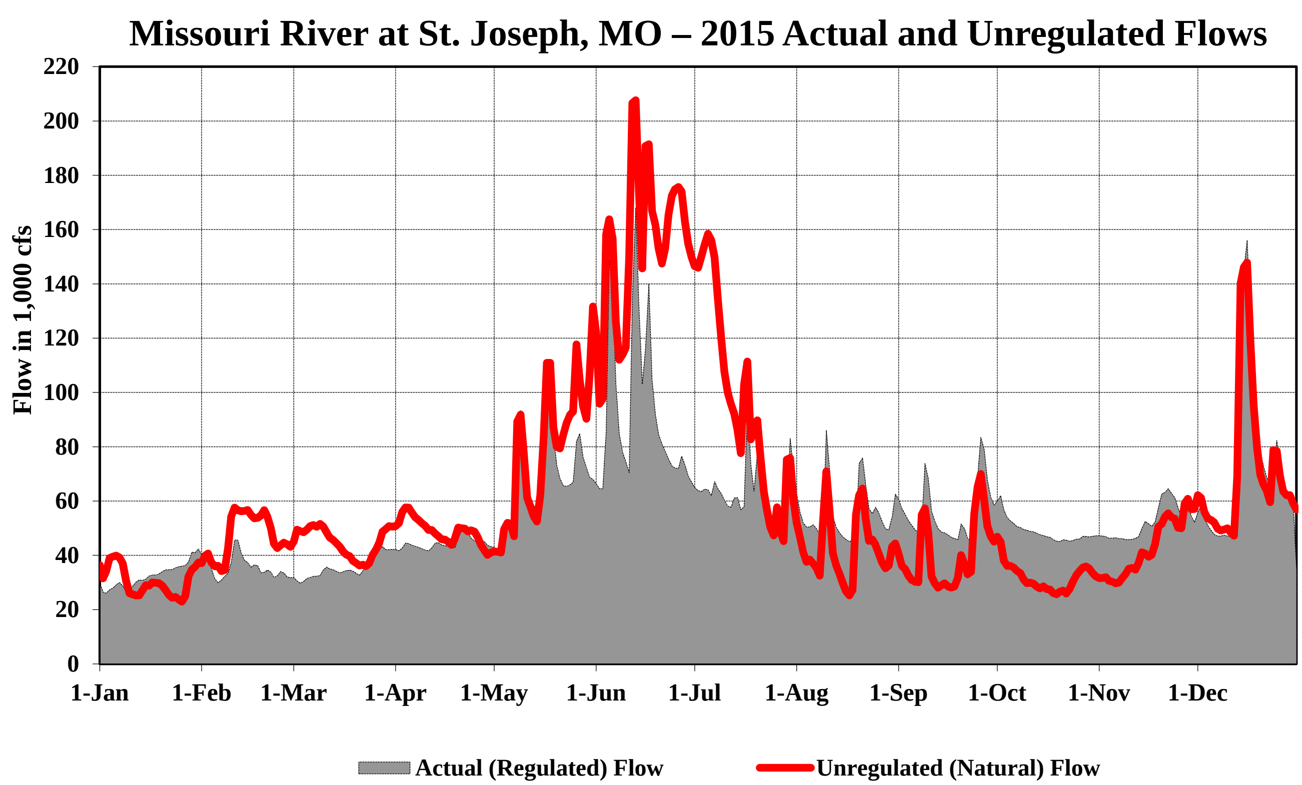
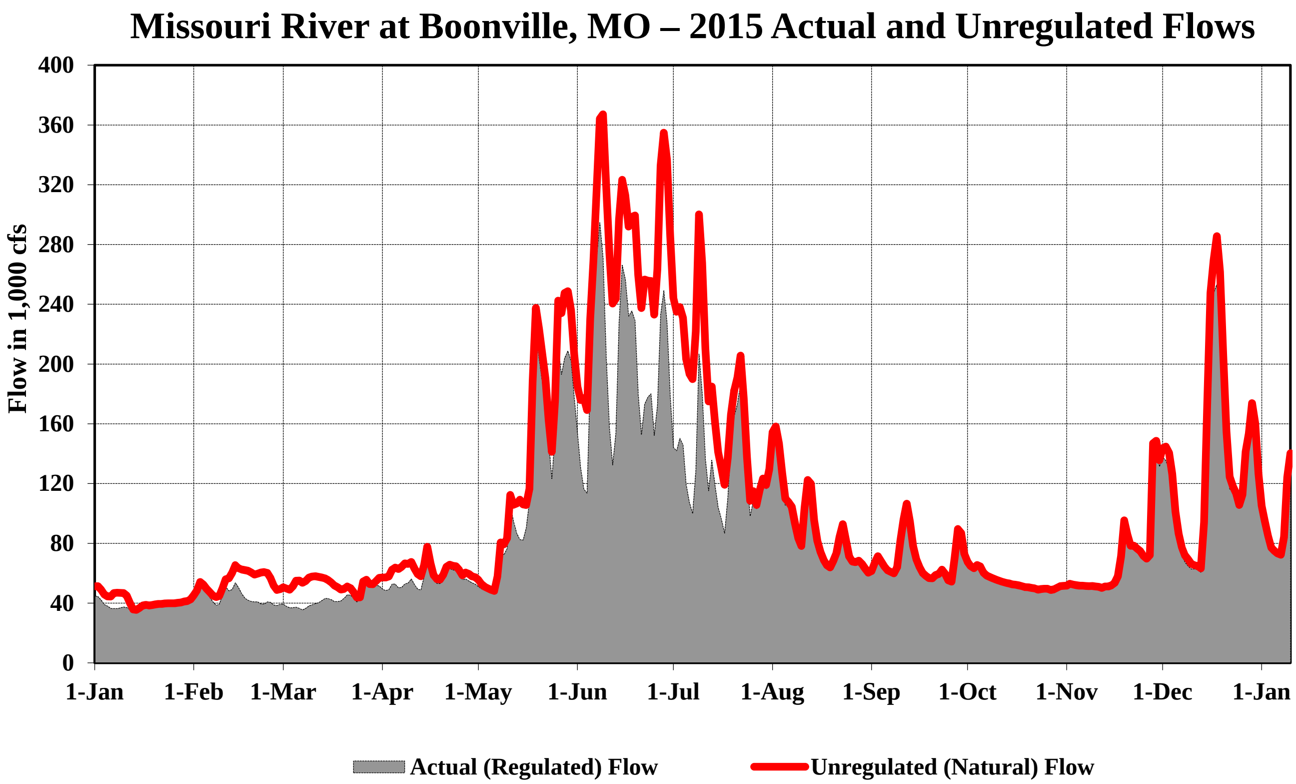


Figure 15B. 2015 actual and unregulated flows – Sioux City, IA and St. Joseph, MO.



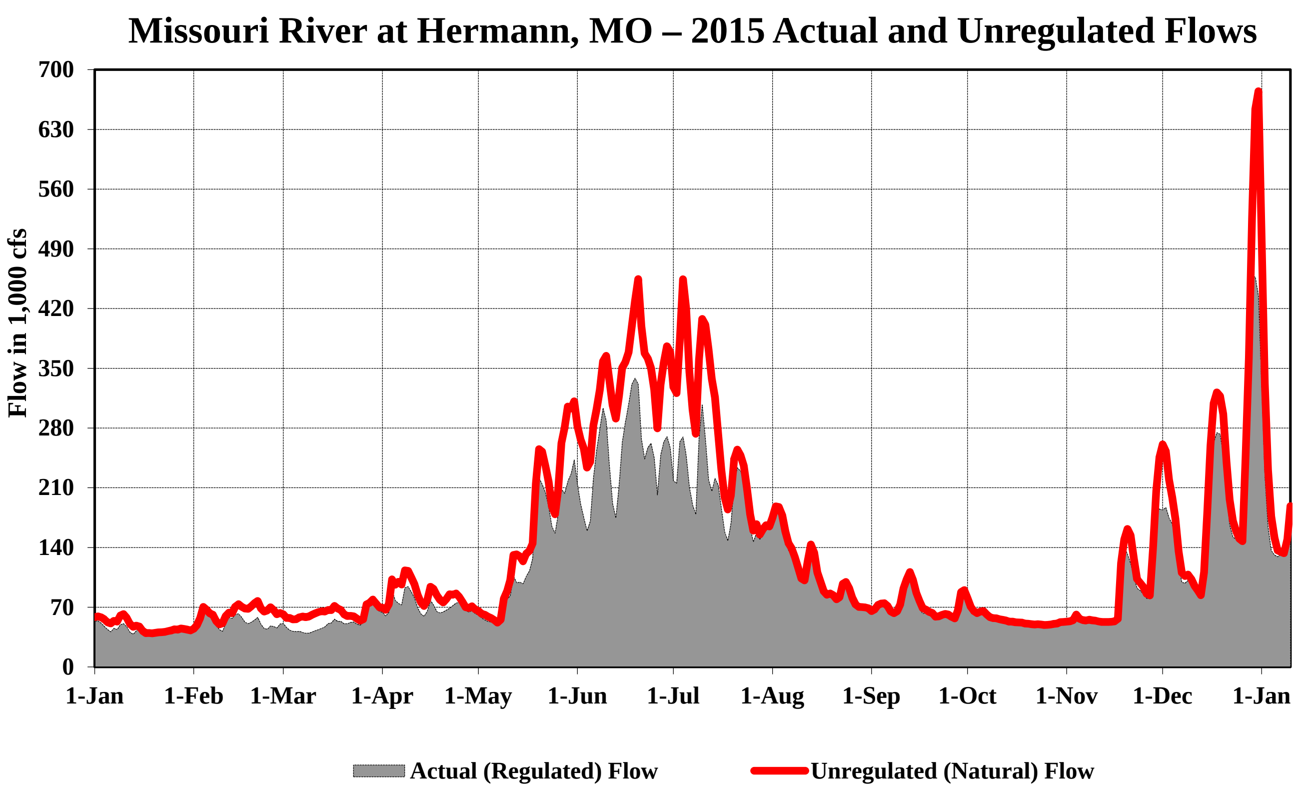


Figure 15C. 2015 actual and unregulated flows – Boonville, MO and Hermann, MO.

4. 2015 Calendar Year Runoff

The 2015 unregulated runoff volume for the upper Basin above Sioux City, IA totaled 25.8 million acre-feet (MAF), 102 percent of average, based on the historical period of 1898-2014, as shown in ***Table 6*** and ***Figure 16***. ***Table 6*** lists the runoff for the upper Basin by month and reach and is the adjusted compilation of the runoff into the System. As the year progresses, this table is filled in with observed monthly runoff data for those months that have occurred and with forecasted runoff data for the remaining months in the year. This forecast forms a basis for intra-system balancing of storage accumulated in the System and is updated by MRBWM on the first of each month to forecast the runoff for the remainder of the year. The monthly accumulation of actual runoff is shown under the "Accumulated Summation above Sioux City" column. As the season progresses, more of the actual runoff is accumulated, and the estimate of annual runoff volume becomes more reliable. The majority of the annual runoff has usually occurred by the end of July, and the remainder of the year can be estimated with a greater degree of accuracy.

Total runoff in the lower Basin, from Sioux City, IA to Hermann, MO totaled 59.9 MAF, 140 percent of average (see ***Table 5***). Of the six reaches in the upper Basin, runoff was above average in three and below average in the other three. Of the three reaches in the lower Basin, all three experienced above-average runoff.

Figure 17 illustrates the monthly variation of the runoff summation above Sioux City, IA compared to the long-term average variation of runoff based on the 1898-2014 historical period.

Table 5
2015 CY Runoff Volumes for Selected Reaches (1,000 acre-feet)

Reach	**1898-2014 Average Runoff**	**2015 CY Runoff**	**% of Average Runoff**
Above Fort Peck	7,242	5,922	82
Fort Peck to Garrison	10,745	10,462	97
Garrison to Oahe	2,491	3,745	150
Oahe to Fort Randall	907	1,351	149
Fort Randall to Gavins Point	1,693	1,586	94
Gavins Point to Sioux City	2,240	2,741	122
TOTAL ABOVE SIOUX CITY	**25,317**	**25,807**	**102**
	1967-2014 Average Runoff	**2015 CY Runoff**	**% of Annual Runoff**
Sioux City, IA to Nebraska City, NE*	7,590	12,130	160
Nebraska City, NE to Kansas City, MO*	11,590	16,950	146
Kansas City, MO to Hermann, MO*	23,680	30,847	130
TOTAL BELOW SIOUX CITY*	**42,860**	**59,927**	**140**

** Runoff in the reaches from Sioux City, IA to Hermann, MO is not adjusted to 1949 depletion levels. Annual averages are taken from the USGS Water Data Reports for the period 1967-2014.*

Table 6
Missouri River Basin
2015 Runoff above Sioux City, IA

Reach Above	Fort Peck	Garrison	Oahe	Fort Randall	Gavins Point	Sioux City	Summation above Gavins Point	Summation above Sioux City	Accumulated Summation above Sioux City
				Values in 1000 Acre Feet					
	(Actual)								
JAN 2015	399	369	44	107	111	146	1,030	1,176	1,176
AVERAGE*	312	263	13	28	100	51	716	767	767
DEPARTURE	87	106	31	79	11	95	314	409	409
% OF AVE	128%	140%	338%	381%	111%	287%	144%	153%	153%
FEB 2015	646	820	245	50	138	135	1,899	2,034	3,210
AVERAGE	360	355	96	55	132	101	998	1,099	1,866
DEPARTURE	286	465	149	-5	6	34	901	935	1,344
% OF AVE	179%	231%	255%	91%	105%	134%	190%	185%	172%
MAR 2015	547	973	276	42	146	163	1,984	2,147	5,357
AVERAGE	597	1,002	587	214	210	325	2,610	2,935	4,801
DEPARTURE	-50	-29	-311	-172	-64	-162	-626	-788	556
% OF AVE	92%	97%	47%	20%	70%	50%	76%	73%	112%
APR 2015	496	637	72	37	110	161	1,352	1,513	6,870
AVERAGE	643	1,080	508	144	180	384	2,555	2,939	7,740
DEPARTURE	-147	-443	-436	-107	-70	-223	-1,203	-1,426	-870
% OF AVE	77%	59%	14%	26%	61%	42%	53%	51%	89%
MAY 2015	707	1,041	846	311	183	245	3,088	3,333	10,203
AVERAGE	1,082	1,265	321	147	185	322	3,000	3,322	11,061
DEPARTURE	-375	-224	525	164	-2	-77	88	11	-858
% OF AVE	65%	82%	264%	211%	99%	76%	103%	100%	92%
JUN 2015	1,220	3,369	1,163	456	196	368	6,404	6,772	16,975
AVERAGE	1,640	2,720	445	160	185	325	5,149	5,474	16,536
DEPARTURE	-420	649	718	296	11	43	1,255	1,298	439
% OF AVE	74%	124%	262%	285%	106%	113%	124%	124%	103%
JUL 2015	508	1,385	482	162	156	353	2,693	3,046	20,021
AVERAGE	831	1,822	189	58	138	246	3,038	3,284	19,819
DEPARTURE	-323	-437	293	104	18	107	-345	-238	202
% OF AVE	61%	76%	255%	279%	113%	143%	89%	93%	101%
AUG 2015	336	509	268	86	99	313	1,298	1,611	21,632
AVERAGE	361	614	77	42	116	149	1,210	1,359	21,178
DEPARTURE	-25	-105	191	44	-17	164	88	252	454
% OF AVE	93%	83%	348%	205%	85%	210%	107%	119%	102%
SEP 2015	215	311	152	54	117	205	849	1,054	22,686
AVERAGE	330	453	112	37	110	109	1,042	1,151	22,329
DEPARTURE	-115	-142	40	17	7	96	-193	-97	358
% OF AVE	65%	69%	136%	146%	106%	188%	82%	92%	102%
OCT 2015	255	449	1	-27	80	160	758	918	23,604
AVERAGE	380	529	73	5	119	89	1,106	1,195	23,524
DEPARTURE	-125	-80	-72	-32	-39	71	-348	-277	81
% OF AVE	67%	85%	1%	--	67%	180%	69%	77%	100%
NOV 2015	300	248	102	35	119	250	804	1,054	24,658
AVERAGE	380	391	68	4	118	81	961	1,042	24,566
DEPARTURE	-80	-143	34	31	1	169	-157	12	93
% OF AVE	79%	63%	150%	--	101%	309%	84%	101%	100%
DEC 2015	293	351	94	38	131	242	907	1,149	25,807
AVERAGE	328	251	3	12	100	58	694	752	25,317
DEPARTURE	-35	100	91	26	31	184	213	397	490
% OF AVE	89%	140%	--	317%	131%	417%	131%	153%	102%
				Calendar Year Totals					
	5,922	10,462	3,745	1,351	1,586	2,741	23,066	25,807	
AVERAGE	7,242	10,745	2,491	907	1,693	2,240	23,078	25,317	
DEPARTURE	-1,320	-283	1,254	444	-107	501	-12	490	
% OF AVE	82%	97%	150%	149%	94%	122%	100%	102%	

*1898-2014

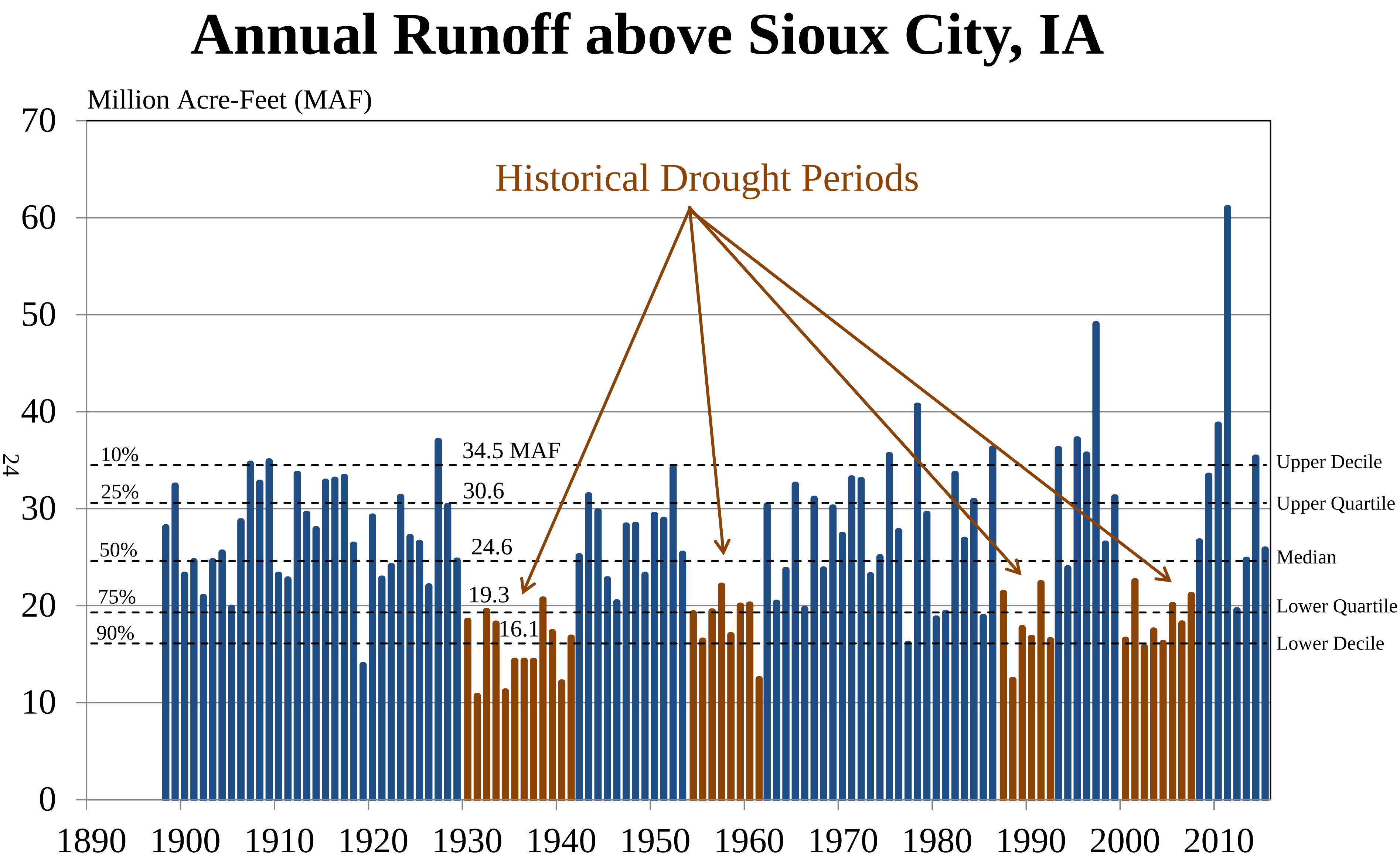


Figure 16. Missouri River Basin annual runoff above Sioux City, IA.

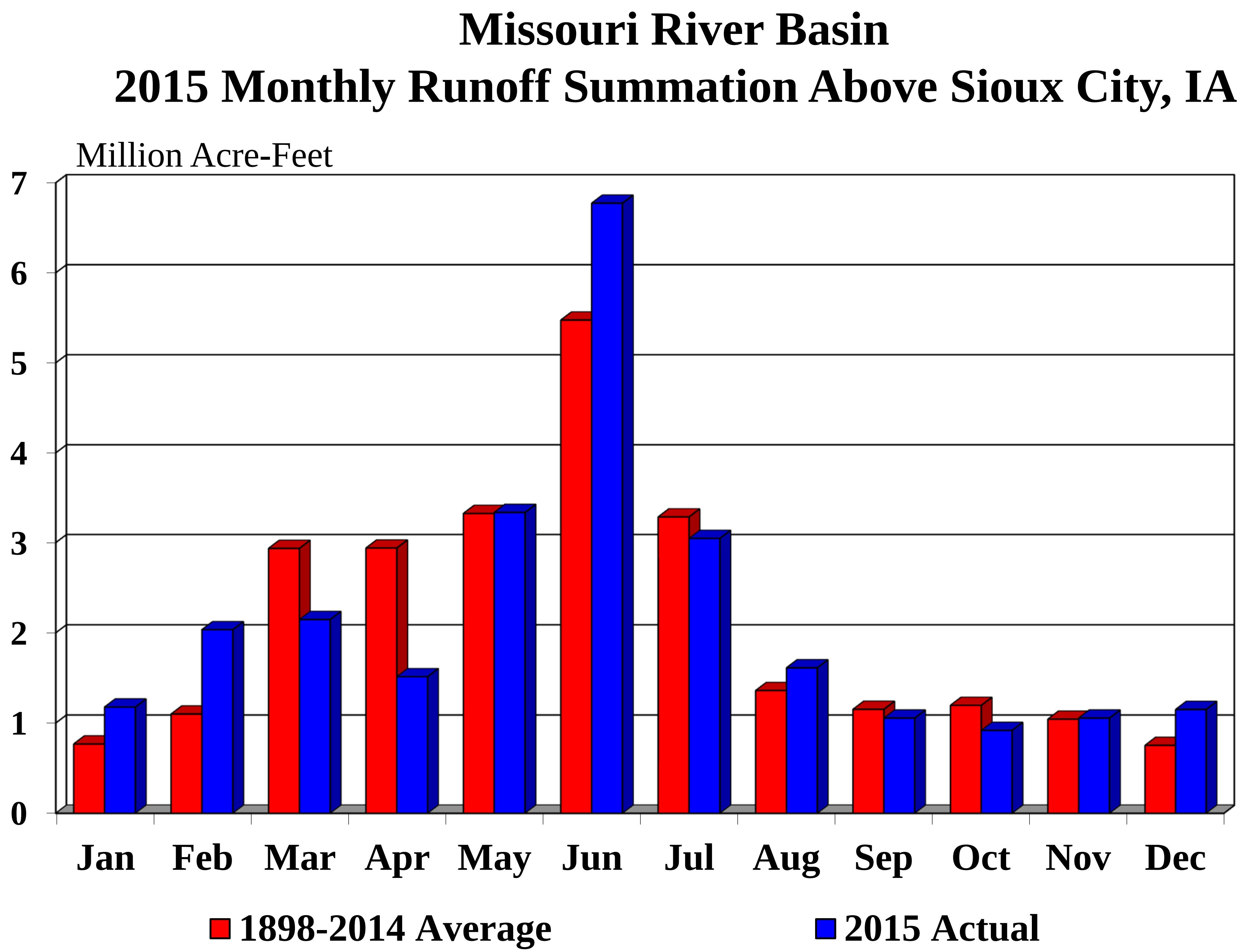


Figure 17. Missouri River Basin 2015 monthly runoff summation above Sioux City, IA.

C. System Regulation – January to December 2015

1. Basin Conditions and System Regulation

Runoff above Sioux City, IA in 2015 was 25.8 MAF, 102 percent of average (***Table 5***). Runoff in 2014 was 35.3 MAF of runoff, 140 percent of average. The near-average runoff in 2015 allowed System storage to remain within the Annual Flood Control and Multiple Use Zone almost the entire year and provide good service to all authorized purposes.

a. Conditions on March 1

System storage reached 56.1 MAF, the base of the Annual Flood Control and Multiple Use Zone on January 6, which means that all 2014 stored flood waters had been evacuated. Due to above-average January and February runoff, the March 1 System storage was 57.1 MAF, 1.0 MAF above the base of the Annual Flood Control and Multiple Use Zone and 6.4 MAF more than the previous year.

The plains snow coverage on March 1 was light with very little change since February 17. End-of-February soil moisture conditions were very wet in Montana, Wyoming and the western portions of the Dakotas (***Figure 18***). Soil moisture conditions in the eastern Dakotas and the lower Basin plains were dry. Since accumulated runoff through February was 172 percent of average (***Table 5***) and very limited plains snowpack existed on March 1, March-April runoff was expected to be below average in the upper Basin.

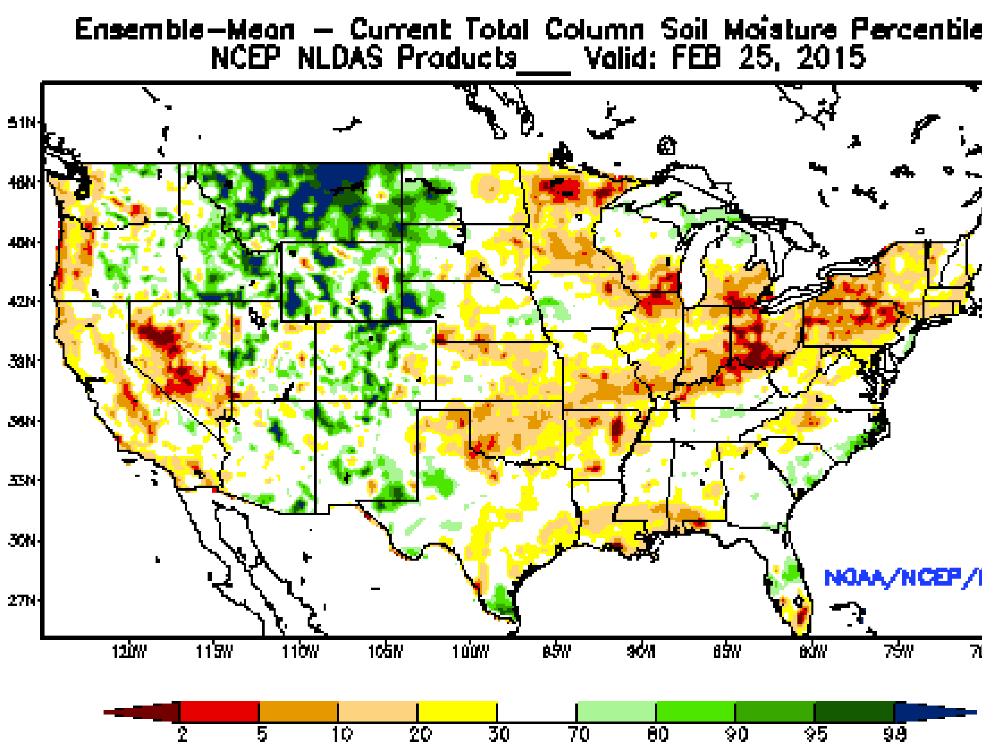


Figure 18. Soil moisture ranking percentile, February 25, 2015. Source: NOAA NCEP NLDAS.

Mountain SWE was near average in both the Fort Peck and Garrison reaches on February 1 (see ***Table 2***); however, during February the SWE accumulation began to slow in the Fort Peck reach. By March 1, mountain SWE was 88 percent of average and 97 percent of average in the above Fort Peck and Fort Peck to Garrison reaches, respectively. The March 1 annual runoff forecast was 24.6 MAF, 97 percent of average. Per the Master Manual, the March 15 System storage check of 57.4 MAF set navigation flow support to the full service level for the first half of the navigation season. System releases were increased beginning on March 17 to begin full service flow support on the Missouri River in river reaches where commercial navigation was present and anticipated.

b. Conditions on April 1

System storage on April 1 was 57.6 MAF, 1.5 MAF above the base of the Annual Flood Control and Multiple Use Zone. Precipitation during the January-March period was well below normal in the Basin (***Figure 12***) while temperatures were well above normal (***Figure 13***). The March runoff summation above Sioux City was 2.1 MAF (73 percent of average) and the accumulated 2015 runoff through March was 5.4 MAF (112 percent of average). Drought conditions as of April 7, 2015 (***Figure 14)*** were present in southwestern Montana and Wyoming, the Dakotas, and Nebraska. Moderate Drought (D1) conditions had developed in Nebraska, South Dakota, and eastern North Dakota. The mountain SWE peaked on March 9 at 72 percent of average above Fort Peck and on March 9 and 14 at 78 percent of average from Fort Peck to Garrison (***Table 2***). On April 1, the mountain SWE was 68 percent of average above Fort Peck and 74 percent of average from Fort Peck to Garrison reach. The April 1 annual runoff forecast was reduced to 20.3 MAF, 80 percent of average.

c. Conditions on May 1

April precipitation in the upper Basin was well below normal in North Dakota, South Dakota and Montana (***Figure 12***). Soil moisture conditions at the end of April were similar to conditions at the end of February (***Figure 18***). Below-normal precipitation led to below-average April runoff (51 percent of average). On May 1, the mountain SWE above Fort Peck was 59 percent of average and it was 65 percent of average from Fort Peck to Garrison. The May 1 annual runoff forecast was reduced to 19.3 MAF, 76 percent of average. System storage on May 1 was 57.2 MAF, 1.1 MAF above the base of the Annual Flood Control and Multiple Use Zone.

In contrast to April, accumulated precipitation in May was well above normal in southwestern Montana, Wyoming, western Nebraska, South Dakota, and southern North Dakota (***Figure 12***). In the lower Basin, May precipitation was above normal in southeastern Nebraska, Kansas, western Iowa and Missouri. Although May runoff in the Fort Peck and Garrison reaches was below average, above-average runoff in the Oahe and Fort Randall reaches resulted in average upper Basin runoff during May.

d. Conditions in June and July

System storage continued to increase to a June 1 level of 58.4 MAF, 2.3 MAF above the base of the Annual Flood Control and Multiple Use Zone. The June 1 annual inflow forecast was 22.5 MAF, 89 percent of average. June precipitation accumulations were generally normal in the upper Basin, but precipitation was below normal in northern and western Montana. Precipitation was more than two times normal in northeastern Wyoming and southwestern South Dakota.

Due to the above-normal rainfall in May and June in Wyoming and South Dakota, the June runoff summation was 6.8 MAF, 124 percent of average. With the exception of runoff above Fort Peck, which was 74 percent of average, runoff in all other reaches was above average. Runoff was 124 percent of average runoff for Garrison, 262 percent of average runoff for Oahe, and 285 percent of average runoff for Fort Randall.

On July 1 System storage was 61.7 MAF, 5.6 MAF above the base of the Annual Flood Control and Multiple Use Zone. The July 1 System storage check resulted in the continuation of full service navigation flow support for the second half of the navigation season as well as a normal 8-month navigation season length. The July 1 annual runoff forecast was increased to 26.6 MAF, 105 percent of average due to abundant rainfall that increased June runoff in the upper Basin in all reaches except Fort Peck. Accumulated July precipitation was generally below normal, resulting in a 93 percent of average July runoff summation (***Table 4***). However, runoff continued to be above average in the Oahe, Fort Randall, Gavins Point and Sioux City reaches. The System storage peaked at 61.9 MAF on July 9.

e. Conditions from August through December

August 1 System storage was 61.4 MAF, 5.3 MAF above the base of the Annual Flood Control and Multiple Use Zone. The August 1 annual runoff forecast was 25.0 MAF, 99 percent of average. August precipitation was generally below normal except for over 150 percent of normal precipitation in large portions of South Dakota, southeastern Montana, northeastern Wyoming, and western Iowa (***Figure 12***). As a result, Oahe and Fort Randall runoff in August continued to be above average (***Table 4***). On August 18, System releases were reduced to 23,000 cfs to assist in the recovery of drowning victim below the dam. The System release was increased to 28,000 cfs by August 28 and held at that level through the remainder of the T&E nesting season.

September 1 System storage was 60.3 MAF, 4.2 MAF above the base of the Annual Flood Control and Multiple Use Zone. Based on the September 1 System storage check, the Gavins Point winter release would be at least 17,000 cfs. The September 1 and October 1 annual inflow forecasts were 25.0 MAF, 99 percent of average, and 24.9 MAF, 98 percent of average, respectively. Predominantly below-normal precipitation during September and October (***Figure 12***) resulted in 92 percent of average runoff in September and 77 percent of average runoff in October (***Table 5***). The System release of 28,000 cfs was maintained until September 21, then increased to 28,500 cfs from September 22 through November 20 to meet downstream navigation targets.

November 1 System storage was 58.0 MAF, 1.9 MAF above the base of the Annual Flood Control and Multiple Use Zone. November precipitation in the upper Basin was generally below normal. Precipitation in the lower Basin was nearly two times normal (***Figure 12***). The System release was gradually reduced by 3,000 cfs per day to the 17,000 cfs winter release rate beginning on November 21 to end the navigation flow support at the mouth of the Missouri River on December 1.

While November runoff above Sioux City was 101 percent of average, December runoff was 153 percent of average due to above-normal precipitation (***Figure 12***) and much warmer-than-normal temperatures (***Figure 13***) across the upper Basin. December 31 System storage was 56.9 MAF, 0.8 MAF above the base of the Annual Flood Control and Multiple Use Zone. The 2015 calendar year runoff summation was 25.8 MAF, 102 percent of average (***Table 5***).

2. Fort Peck Regulation – January to December 2015

a. General

Fort Peck, the third largest Corps storage reservoir, serves all authorized purposes. Fort Peck's primary functions are: (1) to capture the snowmelt runoff and localized rainfall runoff from the large drainage area above Fort Peck Dam, which are metered out at controlled release rates to meet the authorized purposes while reducing flood damages in the Fort Peck to Garrison reach; (2) to serve as a secondary storage location for water accumulated in the System reservoirs from reduced System releases due to major downstream flood control regulation, thus helping to alleviate large pool increases in Garrison, Oahe and Fort Randall; and (3) to provide the water needed to meet all authorized purposes that draft storage during low-water years.

Table 7 lists the average monthly inflows and releases and the end-of-month (EOM) pool elevation for Fort Peck for 2014 and 2015 as well as the averages since the System first filled in 1967.

Table 7
Fort Peck – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2015	2014	1967-2014	2015	2014	1967-2014	2015	2014	1967-2014
January	8,800	6,100	7,200	6,200	6,900	10,600	2234.2	2222.8	2227.3
February	10,900	6,200	8,600	6,900	6,900	10,900	2235.2	2222.5	2226.6
March	9,000	13,700	11,800	6,900	7,000	7,800	2235.7	2224.6	2227.7
April	7,300	11,700	10,300	6,800	7,600	7,300	2235.8	2225.8	2228.5
May	9,200	17,000	15,600	7,700	8,700	9,100	2236.0	2228.3	2230.2
June	13,000	15,100	19,600	8,800	8,900	10,500	2236.9	2230.0	2232.7
July	6,800	8,800	12,200	8,100	7,500	10,500	2236.2	2230.1	2232.7
August	6,100	15,900	8,000	7,900	7,300	10,100	2235.3	2232.2	2231.6
September	6,400	8,500	7,800	6,200	5,400	9,000	2234.8	2232.7	2230.8
October	6,300	7,800	7,400	4,700	5,100	7,900	2234.8	2233.0	2230.3
November	5,300	7,200	7,100	4,800	5,000	8,200	2234.6	2233.2	2229.6
December	5,500	7,800	6,600	5,400	5,700	9,400	2234.3	2233.5	2228.5

* monthly minimum of record ** monthly maximum of record

b. Winter Season

The Fort Peck Reservoir level was at elevation 2233.5 feet msl on January 1, 0.5 foot below the base of the Annual Flood Control and Multiple Use Zone and 10.4 feet above the previous year.

c. Winter River and Ice Conditions below Fort Peck

No special release reductions were required due to ice-jam flooding downstream of Fort Peck. The average monthly discharges for December 2014 and January and February were below average at 5,700, 6,200 and 6,900 cfs, respectively. Ice-cover formation on the Missouri

River downstream from Fort Peck occurred in early and late December 2014. This resulted in the Missouri River stage rising about 4 feet in the Wolf Point reach on November 30-December 4, 2014. The stage leveled off at about 14 feet and remained at that level until December 14 before dropping to just under 11 feet on December 15. Sub-zero (deg F) temperatures were experienced at the end of December and early January, which resulted in the stage at Wolf Point rising about 4 feet. The peak winter stage at Wolf Point was 15.8 feet on January 9, 7.2 feet below the 23-foot flood stage. No reports of ice-affected flooding on the Missouri River below Fort Peck were recorded during the 2015 winter season. The Fort Peck Reservoir froze over on January 7 and was free of ice on March 24.

d. Spring Open Water Season

Both inflows and releases from Fort Peck were below average from April through June. Average monthly inflows to the reservoir were 7,300 cfs (71 percent of average) in April, 9,200 cfs (59 percent of average) in May and 13,000 cfs (66 percent of average) in June. Fort Peck releases averaged 6,800 cfs (93 percent of average) in April, 7,700 cfs (85 percent of average) in May, and 8,800 cfs (84 percent of average) in June. Fort Peck reservoir rose 1.2 feet from its April 1 elevation of 2235.7 feet msl to 2236.9 feet msl near the end of June, 2.9 feet above the base of the Annual Flood Control and Multiple Use Zone.

e. Summer Open Water Season

Average monthly release rates from Fort Peck continued to be below average (75 percent of the July-September average) during the summer with 8,100, 7,900, and 6,200 cfs in July, August, and September, respectively. Inflows for that same 3-month period were also below average (69 percent) with 6,800 cfs, 6,100 cfs, and 6,400 cfs, respectively. Over the 3-month period the reservoir level steadily decreased 2.1 feet from 2236.9 feet msl (June 30) to 2234.8 feet msl (September 30).

f. Fall Open Water Season

Releases during the fall continued to be well below average with 4,700 cfs in October (59 percent of average), 4,800 cfs in November (59 percent of average) and 5,400 cfs in December (57 percent of average). The lower releases were made to help balance storage in the upper three reservoirs. Inflows for October, November and December were also below average, ranging from 75 percent to 86 percent of average. The pool elevation fell 0.5 foot over the 3-month period from 2234.8 feet msl (September 30) to 2234.3 feet msl (December 31), 0.3 foot above the base of the Annual Flood Control and Multiple Use Zone.

g. Summary

The highest 2015 Fort Peck Reservoir pool elevation occurred on June 19 at 2237.2 feet msl, 3.2 feet above the base of the Annual Flood Control and Multiple Use Zone. The lowest 2015 reservoir level was 2233.3 feet msl on January 14. The 2015 average daily inflow of 7,900 cfs was 78 percent of average. The 2015 average daily release of 6,700 cfs was 73 percent of average.

3. Garrison Regulation – January to December 2015

a. General

Garrison, the largest Corps storage reservoir, is another key component in the regulation of the System. Its primary functions are (1) to capture the snowmelt runoff and localized rainfall runoff from the large drainage area between the Fort Peck and Garrison dams, which are metered out at controlled release rates to meet the authorized purposes while reducing flood damages in the Garrison to Oahe reach, particularly the urban Bismarck area; (2) to serve as a secondary storage location for water accumulated in the System from reduced System releases due to major downstream flood control regulation, thus helping to alleviate large pool increases in Oahe and Fort Randall; and (3) to provide water needed to meet all authorized purposes that draft storage during low-water years.

Table 8 lists the average monthly inflows and releases and the EOM pool elevation for Garrison for 2014 and 2015 as well as the averages since the System first filled in 1967.

Table 8
Garrison – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation(ft msl)		
	2015	2014	1967-2014	2015	2014	1967-2014	2015	2014	1967-2014
January	14,100	14,900	15,200	19,600	17,800	22,400	1839.4	1832.4	1831.9
February	20,400	14,600	18,400	23,100	17,900	23,500	1838.8	1831.7	1830.9
March	23,200	37,000	26,600	19,400	16,500	19,100	1839.4	1835.9	1832.3
April	16,800	29,800	23,000	21,100	22,100	18,800	1838.6	1837.3	1833.0
May	23,600	41,700	29,800	22,800	28,300	21,600	1838.5	1839.8	1834.5
June	53,700	60,500	48,000	21,000	29,700	25,100	1844.3	1845.3	1838.7
July	21,600	35,100	33,500	20,800	28,500	26,000	1844.2	1846.1	1839.8
August	13,500	23,500	18,700	20,200	28,000	25,100	1842.6	1844.9	1838.1
September	14,400	23,300	17,000	16,400	24,800	21,000	1841.6	1844.3	1836.9
October	13,300	17,800	17,300	13,400	21,500	19,000	1841.1	1842.7	1836.2
November	12,400	11,900	15,900	12,900	20,300	19,900	1840.7	1841.1	1835.1
December	12,500	14,700	13,800	14,600	16,100	19,900	1840.0	1840.5	1833.6

* monthly minimum of record ** monthly maximum of record

b. Winter Season

The Garrison Reservoir level was at elevation 1840.4 feet msl on January 1, 7.4 feet above the previous year's elevation of 1833.0 feet msl. This elevation was 2.9 feet above the base of the Annual Flood Control and Multiple Use Zone. Releases from the Garrison were below average for December 2014 and January, and February. The reservoir level declined throughout the winter season and ended February at 1838.8 feet msl, 7.1 feet above the previous year's elevation and 1.3 feet above the base of the Annual Flood Control and Multiple Use Zone. Garrison Reservoir froze over on January 5 and was free of ice on April 12.

c. Winter River and Ice Conditions Below Garrison

The Missouri River in the Bismarck, ND area rose about 5 feet, from a stage of about 4 feet to a stage of about 9 feet, from December 29, 2014 through January 3 during river ice-cover formation. This type of rise in stage during river ice formation is normal. The river ice-cover conditions were generally continuous from December 29, 2014 through March 16 at which time the river was free of all ice due to warmer temperatures. The peak winter ice-affected Missouri River "freeze in" stage at Bismarck was 9.7 feet on January 28. This was 4.8 feet below the Bismarck flood stage of 14.5 feet and 3.3 feet below the Corps' winter freeze-in maximum stage target of 13 feet. From January 24 through March 13, there was an open channel along the right bank of the Missouri River while the left bank remained ice-covered. No reports of ice-affected flooding on the Missouri River below Garrison were recorded during the 2015 winter season.

d. Spring Open Water Season

Below-average mountain and plains snowpack resulted in below-average March-May inflows. However, above-normal precipitation in May and June in the Dakotas and Wyoming resulted in above-average inflows in June. Releases from Garrison were slightly above average from March through May and then were reduced to below-average levels in June. The below-average inflows and above-average releases resulted in Garrison pool levels decreasing 0.9 foot, from 1839.4 feet msl (April 1) to 1838.5 feet msl at the end of May. In June, above-average runoff and below-average releases caused the pool to rise 5.8 feet to 1844.3 feet msl by the end of the month, 6.8 feet above the base of the Annual Flood Control and Multiple Use Zone. Inflows were 16,800 cfs (73 percent of average) in April, 23,600 cfs (79 percent of average) in May and 53,700 cfs (112 percent of average) in June. Releases were 21,100 cfs in April (112 percent of average), 22,800 cfs in May (106 percent of average), and 21,000 cfs in June (84 percent of average).

e. Summer Open Water Season

Inflows into Garrison Reservoir fell below average during July (21,600 cfs; 64 percent of average), August (13,500 cfs; 72 percent of average), and September (14,400 cfs; 85 percent of average). Releases during the 3-month period continued to track below average with an overall average of 80 percent. During the 3-month period, the pool crested at 1845.2 feet msl on July 28, 7.7 feet into the 12.5-foot Annual Flood Control and Multiple Use Zone. Following the crest, the Garrison pool slowly declined 3.6 feet to 1841.6 feet msl at the end of September. A daily peaking pattern was established at Garrison from May 14 through September 3 to protect endangered birds nesting on sandbars below the project.

f. Fall Open Water Season

Below-average inflows and releases continued in October through December. Inflows were 81 percent of average while releases were 70 percent of average during the 3-month period. Releases averaged 13,200 cfs from October through November and were increased to 15,000 cfs in early December to serve winter power loads and to continue to draw the reservoir down to the base of the Annual Flood Control and Multiple Use Zone. A release of 15,000 cfs was maintained through the anticipated freeze-in of the Missouri River between Washburn and Bismarck, ND, which occurred from December 28-30, 2015. The December 31 Garrison Reservoir elevation was 1840.0 feet msl, 2.5 feet above the base of the Annual Flood Control and Multiple Use Zone.

g. Lake Audubon / Snake Creek Embankment

During the 2000-2007 drought, a restriction was put in place to limit the water level difference between Lake Audubon and Lake Sakakawea to 43 feet. This restriction required a pool restriction for Lake Audubon as a result of an under seepage evaluation of the Lake Audubon embankment by the Corps' Omaha District. Since that time relief wells have been installed and under seepage issues should not be a factor in future operations of Lake Audubon. The Omaha District's current position is that the 43-foot restriction will remain in place until low Lake Sakakawea pool conditions occur again. Once this occurs, the Omaha District's Geotechnical Branch will obtain relief well performance data to determine if there are any controlling pressure and/or stability concerns for the Lake Audubon embankment. Since the Garrison Reservoir has returned to more average elevations following the 8-year drought, this water level difference restriction has not been an issue. Lake Audubon was drawn down to a winter level of 1843.5 feet msl in the fall.

h. Summary

The Garrison pool elevation peaked at 1845.2 feet msl on July 28, 7.7 feet above the base of the Annual Flood Control and Multiple Use Zone. The lowest Garrison Reservoir level during 2015 occurred on May 12 at 1838.2 feet msl, 0.7 foot above the base of the Annual Flood Control and Multiple Use Zone. The average annual inflow of 20,000 cfs was 87 percent of average. The average annual release of 18,800 cfs was 87 percent of average.

4. Oahe and Big Bend Regulation – January to December 2015

a. General

Oahe, the second largest Corps storage reservoir, serves all authorized purposes. Oahe's primary functions are (1) to capture snowmelt and localized rainfall runoff from the large drainage area between the Garrison and Oahe dams, which are metered out at controlled release rates to meet the authorized purposes, while reducing flood damages in the Oahe to Big Bend reach, especially in the urban Pierre and Fort Pierre areas; (2) to serve as a primary storage location for water accumulated in the System from reduced System releases due to major downstream flood control regulation, thus helping to alleviate large reservoir level increases in Big Bend, Fort Randall and Gavins Point; and (3) to provide water needed to meet all authorized purposes that draft storage during low-water years, particularly downstream water supply and navigation. In addition, hourly and daily releases from Big Bend and Oahe fluctuate widely to meet varying power loads. Over the long term, their release rates are geared to back up navigation releases from Fort Randall and Gavins Point in addition to providing storage space to permit a smooth transition in the scheduled annual fall drawdown of Fort Randall. Big Bend, with less than 2 MAF of total storage, is primarily used for hydropower production, so releases from Oahe are generally passed directly through Big Bend.

Table 9 lists the average monthly inflows and releases and the EOM pool elevation for Oahe for 2014 and 2015 as well as the averages since the System first filled in 1967.

Table 9
Oahe – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2015	2014	1967-2014	2015	2014	1967-2014	2015	2014	1967-2014
January	20,800	20,100	22,900	21,500	17,200	20,700	1607.3	1601.9	1598.8
February	26,300	20,800	26,900	20,100	16,300	18,200	1608.2	1602.8	1600.5
March	23,600	31,100	31,100	23,500	18,600	18,100	1608.1	1605.2	1603.0
April	21,400	31,200	27,200	26,800	27,800	20,900	1607.3	1605.9	1604.1
May	37,100	35,800	28,200	21,500	25,000	22,200	1609.9	1607.8	1605.0
June	37,500	44,900	31,000	20,700	19,300	26,900	1612.7	1612.5	1605.4
July	24,500	33,000	28,600	20,800	24,800	31,300	1613.3	1613.6	1604.5
August	22,500	39,000	26,700	24,100	28,000	33,800	1612.5	1615.3	1602.5
September	19,100	28,800	22,600	23,800	38,200	30,000	1611.1	1612.8	1600.6
October	13,900	23,800	20,800	17,200	39,000	24,200	1610.0	1609.3	1599.5
November	15,100	23,100	21,300	16,900	31,300	22,800	1609.6	1607.9	1598.9
December	15,500	18,200	20,200	14,600	18,600	20,700	1609.2	1607.4	1598.6

* monthly minimum of record ** monthly maximum of record

A settlement agreement was approved in an order of dismissal by the United States District Court, District of South Dakota on August 8, 2003, in the case of Lower Brule Sioux Tribe et al. v. Rumsfeld, et al. (Civil No. 02-3014 (D.S.D.)). The agreement provides that the Corps will consult with the Lower Brule Tribe and the Crow Creek Sioux Tribe during any review and revision of the Master Manual. This agreement also provides that the Corps will coordinate the regulation of Big Bend and the water level of the Big Bend reservoir with the two Tribes to include the following: the Corps will normally strive to maintain a Big Bend reservoir level between elevation 1419.0 feet msl and 1421.5 feet msl and, when the level of Big Bend reservoir drops below elevation 1419.0 feet msl or exceeds elevation 1421.5 feet msl, the Chief of MRBWM will provide notice to such persons as the Tribes shall designate in writing. When it is anticipated that the water level will drop below 1418.0 feet msl or rise above 1422.0 feet msl or, in the event the water level falls below 1418.0 feet msl or rises above 1422.0 feet msl, the Commander, NWD, or his designee, shall immediately contact the Chairpersons of the Tribes or their designees to notify them of the situation and discuss proposed actions to remedy the situation. During 2015 the Big Bend reservoir level varied in the narrow range between elevations 1419.0 feet msl to 1421.5 feet msl. As per the settlement agreement, no additional coordination was necessary.

Table 10 lists the average monthly inflows and releases and the EOM pool elevation for Big Bend for 2014 and 2015 as well as the averages since the System first filled in 1967.

Table 10
Big Bend – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2015	2014	1967-2014	2015	2014	1967-2014	2015	2014	1967-2014
January	19,900	16,300	20,400	19,600	16,600	20,300	1420.8	1420.2	1420.5
February	18,500	15,400	18,200	18,800	15,100	18,200	1420.4	1420.4	1420.4
March	21,800	18,000	18,800	21,600	17,600	18,800	1420.4	1420.7	1420.4
April	24,900	26,700	21,200	24,700	26,500	20,900	1420.6	1420.7	1420.5
May	21,000	24,400	22,300	20,000	24,100	22,200	1421.2	1420.8	1420.4
June	21,300	18,700	27,100	21,500	18,200	26,800	1420.7	1420.8	1420.3
July	19,200	22,500	30,500	19,600	22,800	30,100	1419.8	1420.0	1420.2
August	22,500	26,200	33,100	21,200	25,300	32,600	1420.5	1420.3	1420.2
September	21,700	35,400	29,400	21,300	34,800	28,900	1420.2	1420.4	1420.3
October	16,300	35,900	23,900	15,600	36,000	23,400	1420.8	1420.0	1420.5
November	16,100	29,300	23,900	16,000	28,600	22,400	1420.6	1420.6	1420.4
December	13,800	17,300	20,500	14,100	17,300	20,200	1420.2	1420.5	1420.5

* monthly minimum of record ** monthly maximum of record

b. Winter Season

No ice-induced flooding problems were experienced downstream of the two projects during the winter of 2014-15. A 90 MW minimum, which is approximately a one unit release of 7,000 cfs, was implemented at Oahe from January 6-13. The one unit minimum ensures that water is always flowing in the river downstream of Oahe Dam to reduce river ice formation directly below the dam.

Morning temperatures on January 7 dropped as low as -7 deg F in the Pierre-Fort Pierre, SD area. The Missouri River stages at Farm Island approached the notification level of 23 feet. The Missouri River conditions were closely monitored by the Corps staff. No release and/or hydropower restrictions were implemented and no flooding issues were reported during the winter season.

The Oahe Reservoir froze over on January 10 and was free of ice on March 18.

Big Bend was regulated in the winter season to follow power-peaking requirements and thus hourly releases varied widely. The average daily release during the winter season varied between 0 cfs and 29,800 cfs. Big Bend Reservoir froze over on December 30, 2014 and was free of ice on March 16.

c. Spring Open Water Season

Oahe inflows for March and April were below average due to a light plains snowpack and less-than-normal precipitation. May inflows were above average due to above-normal precipitation in western South Dakota, which was more than two times normal, in the Garrison to Oahe reach. March and April average monthly inflows were 23,600 cfs (76 percent of average) and 21,400 cfs (79 percent of average), respectively. May inflows were 37,100 cfs (132 percent of average). Oahe releases were above average in March and April with a combined average of 25,200 cfs (129 percent of average) before the releases were reduced to near-average levels in May (average of 21,500 cfs, 97 percent of average). Oahe Reservoir rose 1.8 feet during the critical fish spawning period from 1608.1 feet msl (April 1) to 1609.9 feet msl (May 31).

d. Summer Open Water Season

Oahe inflows remained above average for June before trending to below-average levels from July through September. Oahe's 2015 peak elevation was 1613.5 feet msl on July 23, 6.0 feet above the base of the 9.5-foot Annual Flood Control and Multiple Use Zone. June releases were 20,700 cfs, 77 percent of average; July releases were 20,800 cfs, 66 percent of average; August releases were 24,100 cfs, 71 percent of average; and September releases were 23,800 cfs, 79 percent of average. The reservoir pool declined 2.4 feet from its July 23 peak to 1611.1 feet msl on September 30.

e. Fall Open Water Season

Oahe inflows and releases were below average for October through December. Inflows in October were 13,900 cfs (67 percent of average), 15,100 cfs in November (71 percent of average), 15,500 cfs in December (77 percent of average). Average monthly releases for October were 17,200 cfs (71 percent of average), 16,900 cfs in November (74 percent of average) and 14,600 cfs in December (71 percent of average). The December 31 pool elevation was 1609.2 feet msl, 1.7 feet above the base of the Annual Flood Control and Multiple Use Zone.

f. Summary

The highest 2015 Oahe pool level of 1613.5 feet msl occurred on July 23. The 2015 minimum pool elevation of 1606.8 feet msl occurred on January 19. Oahe's 2015 average annual inflow was 23,100 cfs, 91 percent of average. Oahe's 2015 average annual release was 21,000 cfs, 87 percent of average. Big Bend was operated within its average regulating range of 1419.5 feet msl to 1421.5 feet msl.

5. Fort Randall Regulation – January to December 2015

a. General

Fort Randall, the fourth largest System reservoir, serves all authorized purposes. Fort Randall's primary functions are: (1) to capture snow and localized rainfall runoffs in the drainage area between Big Bend and Fort Randall dams, which are metered out at controlled release rates to meet the authorized purposes while reducing flood damages in the Fort Randall reach where several areas have homes and cabins in close proximity to the river; (2) to serve as a primary storage location along with the upstream projects for water accumulated in the System when System releases are reduced due to major downstream flood control regulation, thus helping to alleviate large pool increases in the very small Gavins Point Project; (3) to store the water necessary to increase winter hydropower energy by implementing an annual fall drawdown of the reservoir with a winter reservoir refilling that is unique to Fort Randall; and (4) to provide water needed to meet all authorized purposes, particularly navigation and downstream water supply, that draft storage during low-water years.

Table 11 lists the Fort Randall average monthly inflows and releases in cfs and the EOM pool elevation in feet msl for 2014 and 2015 as well as the historic averages since the System was first filled in 1967.

Table 11
Fort Randall – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2015	2014	1967-2014	2015	2014	1967-2014	2015	2014	1967-2014
January	22,800	19,600	21,900	17,600	12,700	15,100	1346.1	1344.7	1347.1
February	21,300	17,900	20,100	16,300	12,400	13,300	1349.7	1349.0	1351.9
March	23,800	20,500	21,600	19,800	17,300	15,700	1352.8	1351.8	1356.1
April	27,200	29,500	23,600	22,900	25,600	21,200	1355.8	1354.3	1357.6
May	25,900	28,500	25,100	25,100	26,700	25,200	1356.0	1355.3	1357.4
June	28,500	21,700	29,800	21,800	19,000	28,700	1360.2	1357.2	1357.8
July	23,300	25,000	31,700	25,300	25,800	32,900	1358.4	1356.1	1356.6
August	24,100	29,000	34,200	25,500	27,900	35,200	1356.9	1356.4	1355.4
September	24,400	38,300	30,100	27,000	44,500	35,000	1354.4	1351.4	1351.2
October	16,100	38,700	23,600	27,500	45,600	32,500	1344.7	1344.9	1343.3
November	17,500	30,700	22,400	22,700	37,800	28,900	1339.4	1337.8	1336.9
December	15,500	20,000	21,400	15,000	16,900	17,200	1339.8	1341.1	1341.0

* monthly minimum of record ** monthly maximum of record

b. Winter Season

No reports of ice-affected flooding on the Missouri River below Fort Randall were recorded during the 2014-15 winter season. The Fort Randall average daily winter release ranged from 13,600 cfs to 32,800 cfs. The Fort Randall reservoir froze over on December 30, 2014 and was free of ice on March 17.

c. Spring Open Water Season

The Fort Randall pool elevation was 1349.7 feet msl on March 1. The pool level rose to its typical spring and summer pool of 1355.2 feet msl by mid-April. Releases were adjusted as needed to back up System releases from Gavins Point and to maintain the Gavins Point pool in the desired range. The average March release of 19,800 cfs was 126 percent of average and the average April release of 22,900 cfs was 108 percent of average. These releases corresponded with inflows of 23,800 cfs in March (110 percent of average) and 27,200 cfs in April (115 percent of average). During May, Fort Randall average inflows were 25,900 cfs (103 percent of average) and releases averaged 25,100 cfs (100 percent of average).

d. Summer Open Water Season

Inflows averaged 28,500 cfs in June (96 percent of average), 23,300 cfs in July (74 percent of average), and 24,100 cfs in August (70 percent of average). Releases from Fort Randall averaged 21,800 cfs in June (76 percent of average), 25,300 cfs in July (77 percent of average), and 25,500 cfs in August (72 percent of average). September releases averaged 27,000 cfs (77 percent of average) to back up System releases from Gavins Point. September inflows averaged 24,400 cfs (81 percent of average). The Fort Randall reservoir reached its annual peak elevation of 1360.7 feet msl on June 26.

A daily hydropower peaking pattern was established at Fort Randall during the nesting season to provide flexibility to regulate over a range of releases while minimizing impacts to endangered birds nesting below the project. Hydropower peaking started on May 14. Because one unit was not operational at the start of the nesting season, peaking was limited to 295 MW for a continuous 8-hour time frame. The hydropower peaking pattern was maintained until September 1, at which time all restrictions were lifted.

e. Fall Open Water Season

Normal regulation of Fort Randall includes the lowering of the pool level at the end of the navigation season to 1337.5 feet msl, 17.5 feet below the normal summer level, to make room for capture of winter powerplant releases from the upper reservoirs. During a full navigation season, the pool is maintained above 1353.0 feet msl through the Labor Day weekend before starting the lowering of the pool. Inflows and releases were below average from October through December. On September 1, the pool level was 1356.9 feet msl. The lowering of Fort Randall pool started after Labor Day and reached its lowest annual level of 1338.5 feet msl on November 23.

f. Summary

The highest 2015 Fort Randall pool level of 1360.7 feet msl occurred on June 26. The lowest 2015 pool level was 1338.5 feet msl on November 23. The average annual inflow was 22,500 cfs, 89 percent of average, and the average annual release of 22,200 cfs was 88 percent of average.

6. Gavins Point Regulation – January to December 2015

a. General

Gavins Point, the most downstream of the System projects, is primarily used for flow re-regulating to smooth out the release fluctuations of the upper projects to better serve downstream purposes. With a total storage of 428,000 acre-feet (AF), it provides only a small amount of flood control and is generally maintained in a narrow reservoir elevation band between 1205.0 and 1208.0 feet msl. Due to the limited storage, releases from Gavins Point must be backed up with releases out of the upper reservoirs. Gavins Point is the key location in the initiation of release reductions for downstream flood control. Even though it has only a small amount of storage space for flood control, this volume is usually adequate to perform significant downstream flood control by coordinating Gavins Point release reductions with the upstream projects. Releases greater than the powerplant capacity, normally near 35,000 cfs, are passed through the spillway.

Table 12 lists the Gavins Point average monthly inflows and releases in cfs and the EOM pool elevation in feet msl for 2014 and 2015 as well as the historic averages since the System was first filled in 1967.

Table 12
Gavins Point – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2015	2014	1967-2014	2015	2014	1967-2014	2015	2014	1967-2014
January	19,900	14,900	17,200	19,100	14,800	17,100	1208.1	1207.6	1207.5
February	18,600	14,500	16,500	19,000	15,100	17,300	1206.8	1206.2	1205.8
March	21,800	19,500	19,700	21,900	19,500	19,700	1206.4	1206.6	1205.7
April	24,900	27,500	25,100	24,900	27,400	24,900	1206.2	1206.5	1205.8
May	27,700	29,200	28,800	27,400	29,100	28,500	1206.5	1206.4	1206.1
June	24,700	23,100	32,000	24,600	22,800	31,700	1206.2	1206.8	1206.2
July	27,200	26,100	35,100	27,000	26,100	34,600	1206.4	1206.4	1206.7
August	26,600	28,900	36,900	26,400	28,500	36,500	1206.2	1206.9	1207.3
September	28,800	43,700	37,000	28,100	43,700	36,600	1207.4	1206.3	1207.6
October	28,900	45,900	34,800	28,500	45,500	34,500	1207.8	1206.6	1207.8
November	25,200	39,000	31,200	25,200	38,300	31,200	1207.6	1207.7	1207.6
December	17,100	19,500	19,300	17,000	19,700	19,400	1207.7	1206.5	1207.3

* monthly minimum of record ** monthly maximum of record

b. Winter Season

The Gavins Point average daily release was above average in December 2014 and January and below average in February. Winter releases varied from 16,900 cfs to 36,100 cfs in December, from 18,000 cfs to 20,100 cfs in January and from 18,900 cfs to 19,100 cfs in February. The Gavins Point reservoir froze over on December 29, 2014 and was free of ice on March 16.

c. Winter River and Ice Conditions below Gavins Point

The first signs of floating ice on the Missouri River during the 2014-15 winter season were noted on November 18, 2014 from Sioux City, IA downstream to Decatur, NE. Ice pans were estimated to be about 3 to 8 feet in diameter and the river was about 40 percent covered with floating ice. Reports of floating ice were reported in the Sioux City area on two different periods in December. From December 3-4 and on December 17 ice reports indicated pan sizes ranging from 3 to 10 feet and river ice covering 30 to 60 percent of the river. A round of cold weather entered the region near the end of December and lingered through January 20. On December 30, 2014, the Gavins Point release was increased from 17,000 cfs to 20,000 cfs over a 5-day period. The slight increase in System releases was made in anticipation of the arrival of colder weather and ice formation. As a result of this prolonged cold weather, ice pans ranging from 3 to 30 feet covering 10 to 75 percent of the river were observed from Sioux City, IA downstream to the Chamois Power Plant in Missouri. The Gavins Point release was maintained at 20,000 cfs until January 12. From January 13 to March 13, a Gavins Point release of 19,000 cfs was maintained. The Missouri River at Sioux City, IA stage declined to 6.1 feet on the morning of January 5, which was the lowest Sioux City stage recorded during the 2014-15 winter season. The Sioux City stage rebounded to around 8.2 feet three days later and stayed near that level for the remainder of the winter season. No reports of ice-affected flooding or lack of water supply on the Missouri River below Gavins Point were recorded during the 2014-15 winter season.

d. Spring Open Water Season

The bimodal spring pulse from Gavins Point was not conducted in 2015. Since 2012 the Corps and the U.S. Fish and Wildlife Service (USFWS) have been working collaboratively with the Missouri River Recovery Implementation Committee (MRRIC) to set up the timeline, roles and responsibilities for accomplishing recommendations made by the Independent Science Advisory Panel (ISAP) through the Missouri River Recovery Management Plan (Management Plan). The end result will be the selection of a management strategy for the pallid sturgeon that will include a structured decision support process that looks at ongoing science and makes necessary adjustments to the current management actions through an adaptive management process. Therefore, the Corps deferred implementing the flow modifications in 2015 below Gavins Point while the agencies follow the process laid out by the ISAP concurred with by MRRIC. If, during this process, a flow component is identified as critical to species survival, the Corps will work with USFWS to readdress this deferment.

Per the Master Manual, the March 15 System storage check of 57.4 MAF set navigation flow support to the full service level for the first half of the navigation season. Since no commercial navigation was expected to initially occur on the Missouri River above Nebraska City, NE, the full service target was not initially met at Sioux City, IA. System releases were made to keep the Missouri River flow at Omaha within 500 cfs of the full service target of 31,000 cfs. Flow support for the 2015 navigation season began on March 25 at Omaha, NE; March 26 at Nebraska City, NE; March 28 at Kansas City, MO; and April 1 at the mouth of the Missouri River near St. Louis, MO.

Cycling of Gavins Point releases was conducted for two weeks in June 2015. Cycling of releases has been conducted in previous years in early May to encourage the threatened and endangered (T&E) birds to nest on the higher elevation areas of downstream sandbars in the reach. This allows for future System release increases to support navigation. Cycling was conducted from June 5-17 as a flood risk management measure because the Kansas City full service target flow was being exceeded by more than 60,000 cfs, which is the flood target criteria in Table VII-8 of the Master Manual. System releases were cycled by means of a 2-day steady release of 22,000 cfs and then a 1-day steady release of 28,000 cfs. Cycling was discontinued on June 17 and a steady System release of 24,000 cfs was maintained until the end of June.

e. Summer Open Water Season

Based on the July 1 System storage check of 61.7 MAF, full service navigation support was continued during the second half of the navigation season. In addition, the July 1 System storage check called for a normal 8-month navigation season length. The Gavins Point release was increased to 27,000 cfs on July 2 to provide full service flow support for all four navigation targets for a commercial shipment to Sioux City, IA. The System release of 27,000 cfs was maintained until August 16. Starting on August 16, the System release was reduced over a 3-day span to 23,000 cfs to assist in the recovery of a drowning victim downstream of the dam. Flow targets were met in reaches of the lower Missouri River where there was commercial navigation. The System release was steadily increased through the rest of August to meet downstream targets and was 28,000 cfs on August 28.

f. Fall Open Water Season

Based on the September 1 System storage check of 60.3 MAF, the 2015-16 winter release rate from Gavins Point was set at no lower than 17,000 cfs. The fall release rate of 28,500 cfs was maintained from September 22 until November 20, then reduced 3,000 cfs per day to the 17,000 cfs winter release rate on November 24.

g. Summary

System releases during the 2015 navigation season served a full length 8-month navigation season with full service flows in Missouri River reaches where commercial navigation was present. Gavins Point steady releases during the bird season protected threatened and endangered birds nesting on sandbar habitat in the Missouri River reach from Gavins Point Dam to Ponca, NE. Finally, downstream flood reduction was provided through reduced releases from Gavins Point Dam during June.

The highest Gavins Point pool level in 2015 was 1208.4 feet msl reached on November 18. The lowest pool level in 2015 was 1205.8 feet msl reached on August 27. The average annual inflow to Gavins Point was 24,300 cfs, 3,500 cfs below the average inflow of 27,800 cfs. The average annual System release was 24,100 cfs, 3,600 cfs below the average release of 27,700 cfs.

D. Non-Routine Regulation and Other Items Pertaining to System Regulation

Numerous regulation activities are performed each year that, although at one time may have been considered special, are now considered routine. These include release restrictions from a particular project for a period of time to permit hydrographic surveys, to facilitate limited construction within or adjacent to the downstream channel, and to pattern releases to facilitate measurements of downstream discharges and water surface profiles. Two events that occurred recently with a connection to regulation activities are discussed in the following paragraphs.

On March 5, 2014, a takings claim was filed in the United States Court of Federal Claims by approximately 200 plaintiffs against the U.S. Army Corps of Engineers (Corps) for alleged flooding along the Missouri River from 2007 to 2013 (Ideker Farms, Inc., et al. v. U.S.). The claim was amended on October 15, 2014 adding approximately 170 new plaintiffs and CY 2014 flooding claims. The plaintiffs allege that the Corps, in the operation of the Missouri River Mainstem Reservoir System since the Master Manual was updated in 2004 and 2006, in conjunction with habitat creation efforts to comply with the 2003 Amended USFWS Biological Opinion, has caused an increase in flooding along the Missouri River. Plaintiffs contend, therefore, that through these actions the U.S. government has "taken" their property, in violation of the Fifth Amendment of the U.S. Constitution, for which they are entitled just compensation. The litigation is currently in the fact discovery stage, which closes on May 2, 2016, with the first trials likely to begin early in 2017.

On February 2, 2015, Natural Resources Defense Council and Defenders of Wildlife filed suit alleging violations of the Endangered Species Act (ESA) by the Corps, USFWS, and U.S. Bureau of Reclamation (Reclamation) based on operations at Fort Peck on the Missouri River and the Intake Diversion Dam on the Yellowstone River. The plaintiffs later amended their complaint in early 2015 to include allegations of violations of the Clean Water Act and National Environmental Policy Act. Three irrigation districts in Montana joined the lawsuit as defendants. On September 4, 2015, the U.S. District Court granted plaintiffs’ motion to issue a preliminary injunction, prohibiting the Corps and Reclamation from proceeding with construction of a proposed fish by-pass channel at the Intake Dam on the Yellowstone River. On January 5, 2016, the U.S. District court approved the parties joint motion/agreement to stay (or put on hold) the litigation while the Corps and Reclamation complete an Environmental Impact Statement (EIS) on proposed fish passage at Intake dam, to include consideration of an open water fish passage alternative. The Notice of Intent for the EIS was issued in the Federal Register on January 4, 2016, and a public scoping meeting was held in Glendive, MT on January 21, 2016. The agencies are targeting to have a draft EIS released in July 2016 and a final issued in December 2016.

E. Reservoir Elevations and Storage

Reservoir elevations and storage levels of the System reservoirs at the end of July 2015 are presented in ***Table 13*** and the same information for the end of December 2015 is presented as ***Table 14***. The upper three reservoirs, Fort Peck, Garrison and Oahe, contain nearly 90 percent of the total System storage and pool levels can vary, especially during high inflow (flood) or low inflow (drought) periods. The lower three reservoirs are generally regulated in such a manner that their pool levels do not fluctuate much from year to year. For the upper three reservoirs, the 12-month change columns for the end of July elevations indicate that Garrison and Oahe had similar elevations when compared to the previous year's end of July while Fort Peck increased over 6 feet and was 2.2 feet above the base of its Annual Flood Control and Multiple Use zone. At the end of December, all three had some remaining stored flood waters to be evacuated through the winter.

Table 13
Reservoir Levels and Storages – July 31, 2015

Project	Reservoir Elevation		Reservoir Storage in 1,000 AF		
	Elevation (feet msl)	12-Month Change (feet)	Total	Above Min. Level*	12-Month Change
Fort Peck	2236.2	+6.1	15,267	11,179	+1,289
Garrison	1844.2	-1.9	19,952	15,158	-630
Oahe	1613.3	-0.3	20,576	15,261	-121
Big Bend	1419.8	-0.2	1,622	-9	-13
Fort Randall	1358.4	+2.3	3,707	2,238	+206
Gavins Point	1206.4	+0.0	336	41	+0

*Net usable storage above minimum reservoir levels established for power, recreation, irrigation diversions and other purposes.

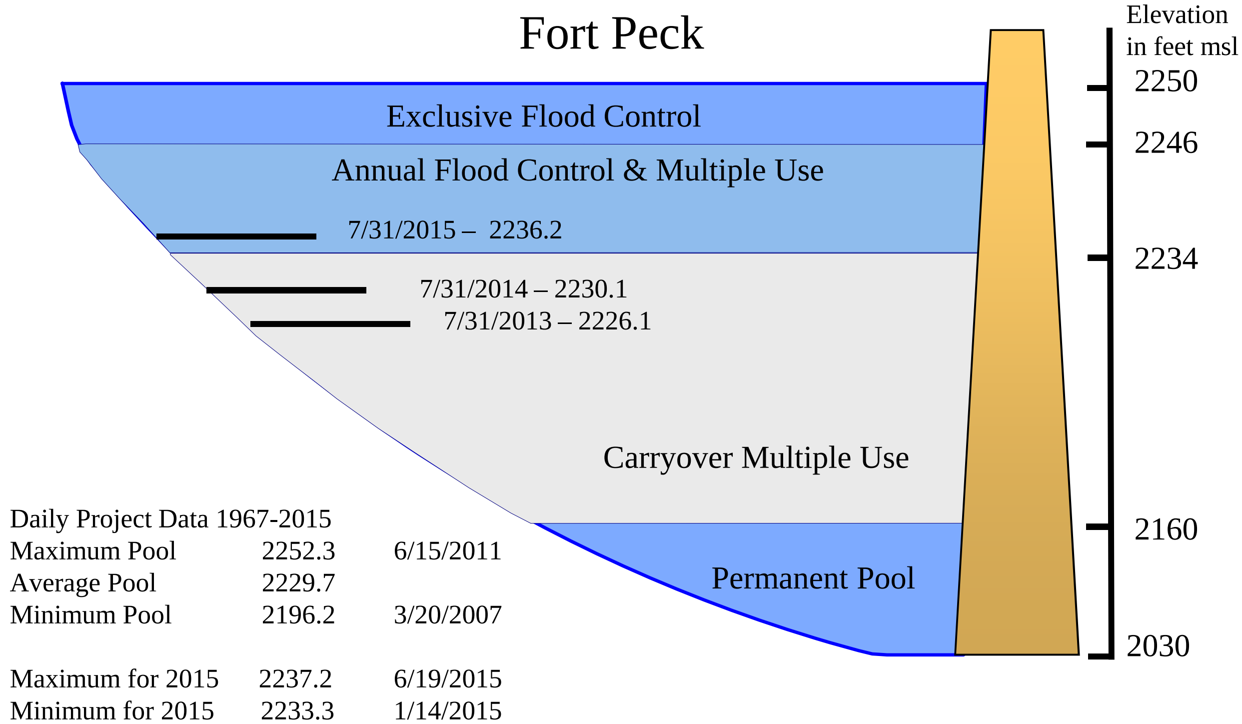
Table 14
Reservoir Levels and Storages – December 31, 2015

Project	Reservoir Elevation		Reservoir Storage in 1,000 AF		
	Elevation (feet msl)	12-Month Change (feet)	Total	Above Min. Level*	12-Month Change
Fort Peck	2234.3	+0.8	14,854	10,766	+169
Garrison	1840.0	-0.5	18,529	13,735	-128
Oahe	1609.2	+1.8	19,215	13,900	+586
Big Bend	1420.2	-0.3	1,644	13	-16
Fort Randall	1339.8	-1.3	2,317	848	-75
Gavins Point	1207.7	+1.2	368	73	+30

*Net usable storage above minimum reservoir levels established for power, recreation, irrigation diversions and other purposes.

Figure 19A and ***Figure 19B*** show the end-of-July pool elevations for Fort Peck, Garrison and Oahe plus total System end-of-July storage for 2013 through 2015. Individual tables with the historic maximum, average and minimum pool elevations for each reservoir are also shown.

Missouri River System Reservoirs
End-of-July Pool Elevations and Total System Storage



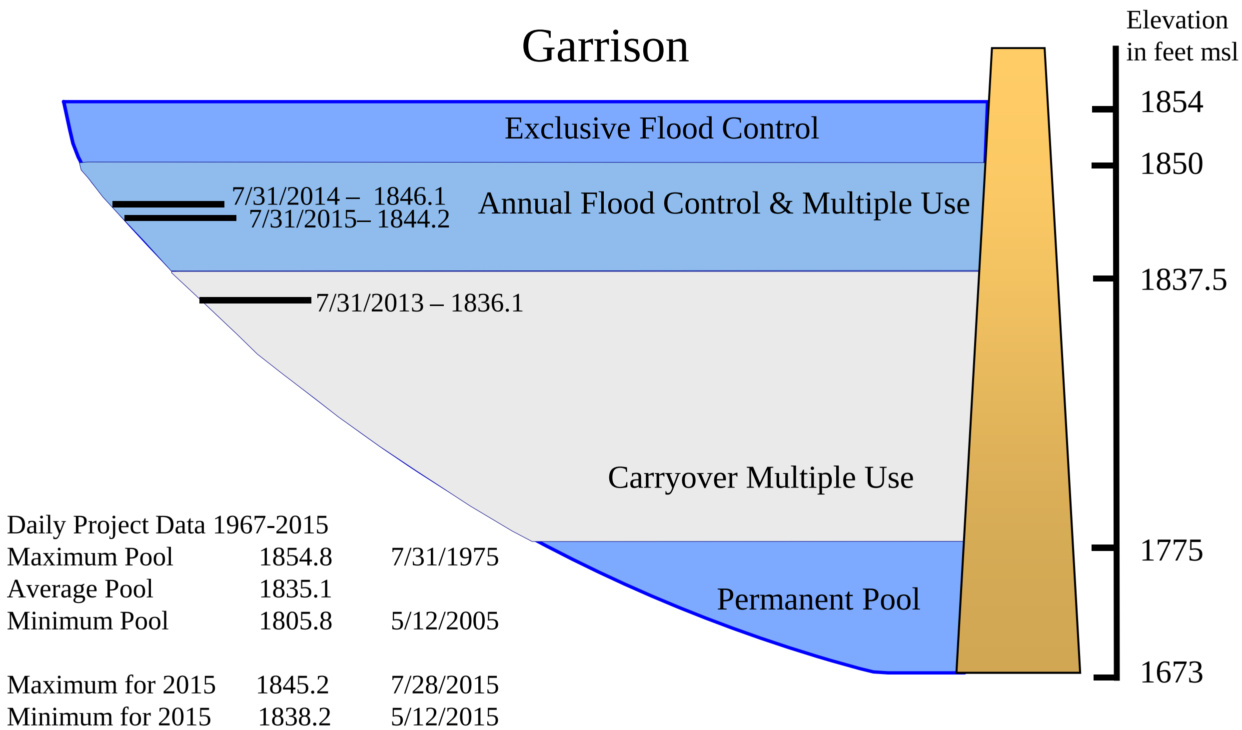
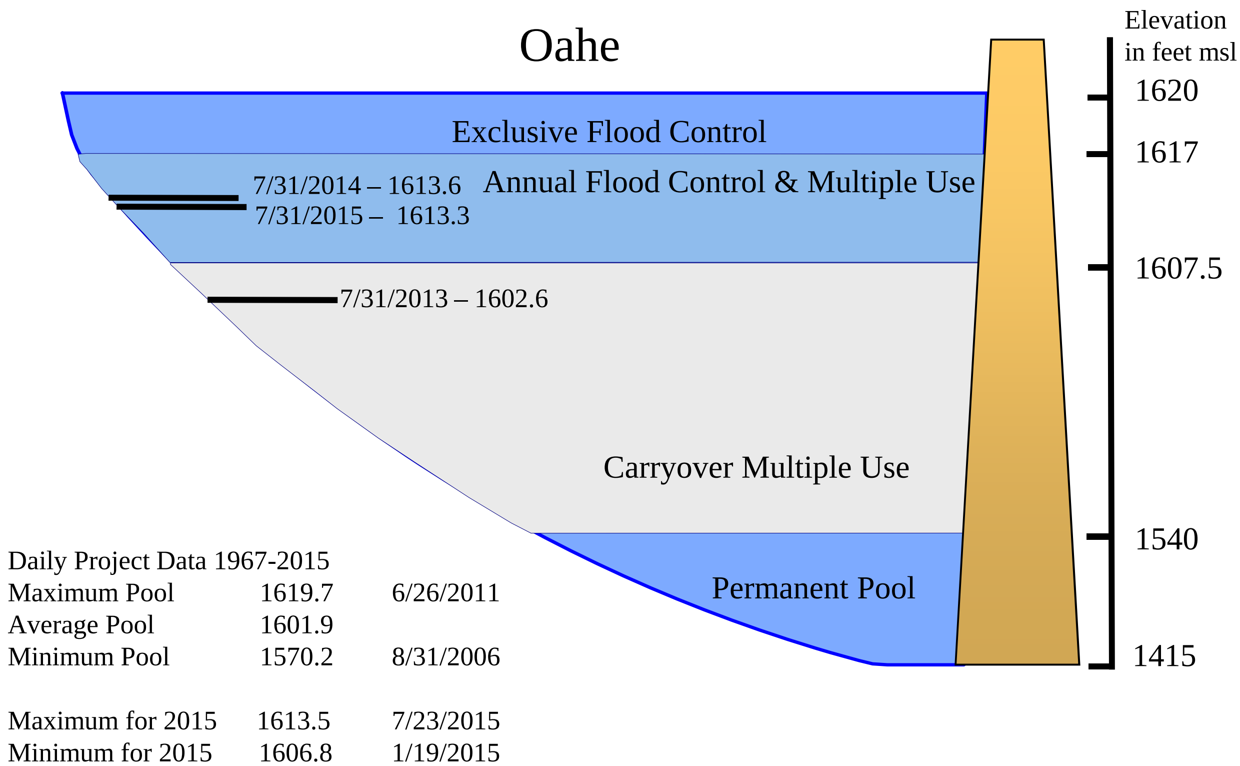


Figure 19A. End-of-July pool elevations for Fort Peck and Garrison.

Missouri River System Reservoirs
End-of-July Pool Elevations and Total System Storage



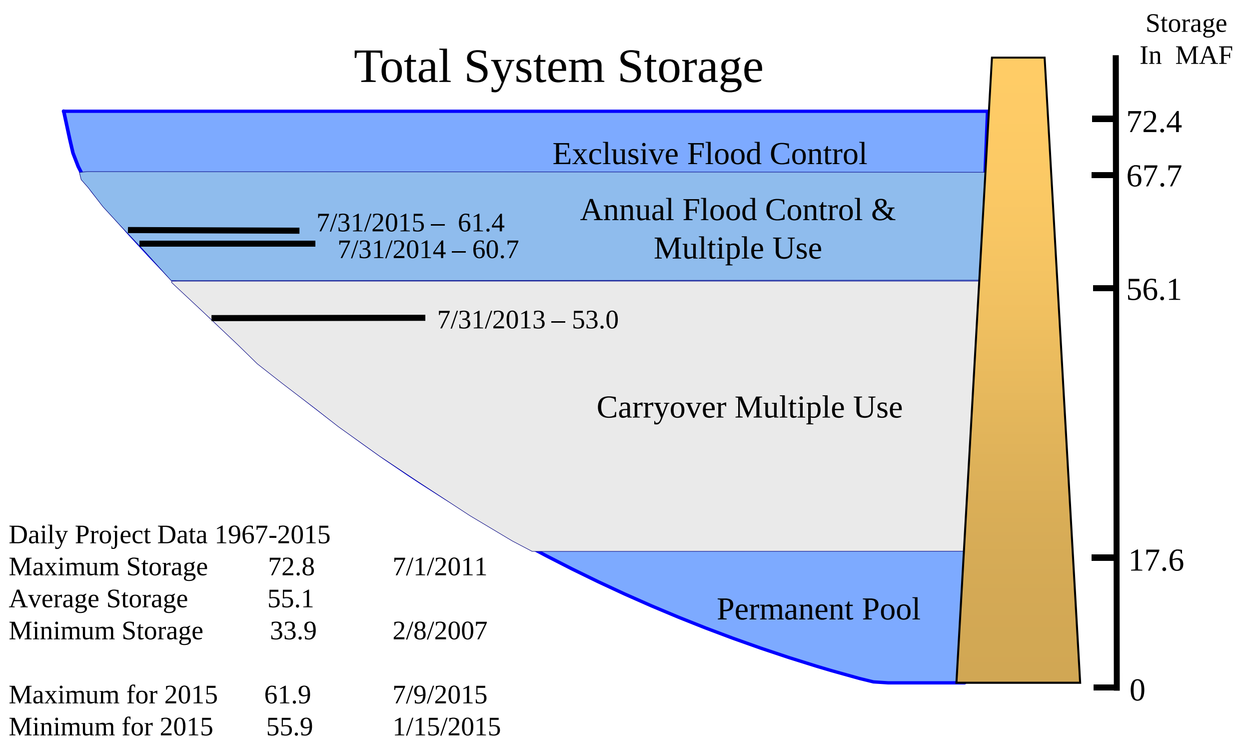


Figure 19B. End-of-July pool elevation for Oahe and total System storage.

F. <u>Summary of Results</u>

1. Flood Control

The March 15 and July 1 System storages were 57.4 and 57.1 MAF, respectively. Per the criteria outlined in the Master Manual, full service flow support was provided for the entire 8-month 2015 navigation season. Operation of Federal projects during large runoff events in May-June and December resulted in significant flood damage reduction. As shown on ***Figure 15A*** and ***Figure 15B***, flows and stages at locations downstream of the mainstem projects were significantly reduced due to operation of the mainstem reservoirs.

The total flood damages prevented by all Corps controlled reservoir projects in the Basin during 2015 were estimated to be nearly $3.5 billion ($438 million Omaha District; $3.0 billion Kansas City District). Flood damages prevented by the System reservoirs during 2015 were estimated to be $980 million ($330 million Omaha District; $650 million Kansas City District). The System flood damages prevented indexed to the September 2015 price level is illustrated in ***Figure 20A.*** Since 1938, the total flood control damages prevented by the System were $58.2 billion, an annual average of $744 million, indexed to September 2015 price levels. The total un-indexed flood damages prevented at the original price levels is $34.9 billion, an annual average of $446 million (see ***Figure 20B***). The bulk of the damages prevented occurred during the 6-year period from 1993 to 1999 and the 4-year period from 2008 to 2011. For comparison purposes, ***Figure 20A*** and ***Figure 20B*** include the construction cost of the dams. Indexed to 2015 price levels, the dams cost approximately $26.2 billion, whereas the original un-indexed cost was $1.2 billion.

Figure 15A and ***Figure 15B*** shows the 2015 regulated (actual experienced) and unregulated (with no System reservoirs and tributary reservoirs) Missouri River flows downstream of Fort Peck Dam at Wolf Point, MT, downstream of Garrison Dam at Bismarck, ND, and downstream of Gavins Point Dam at Sioux City, IA and St. Joseph, MO.

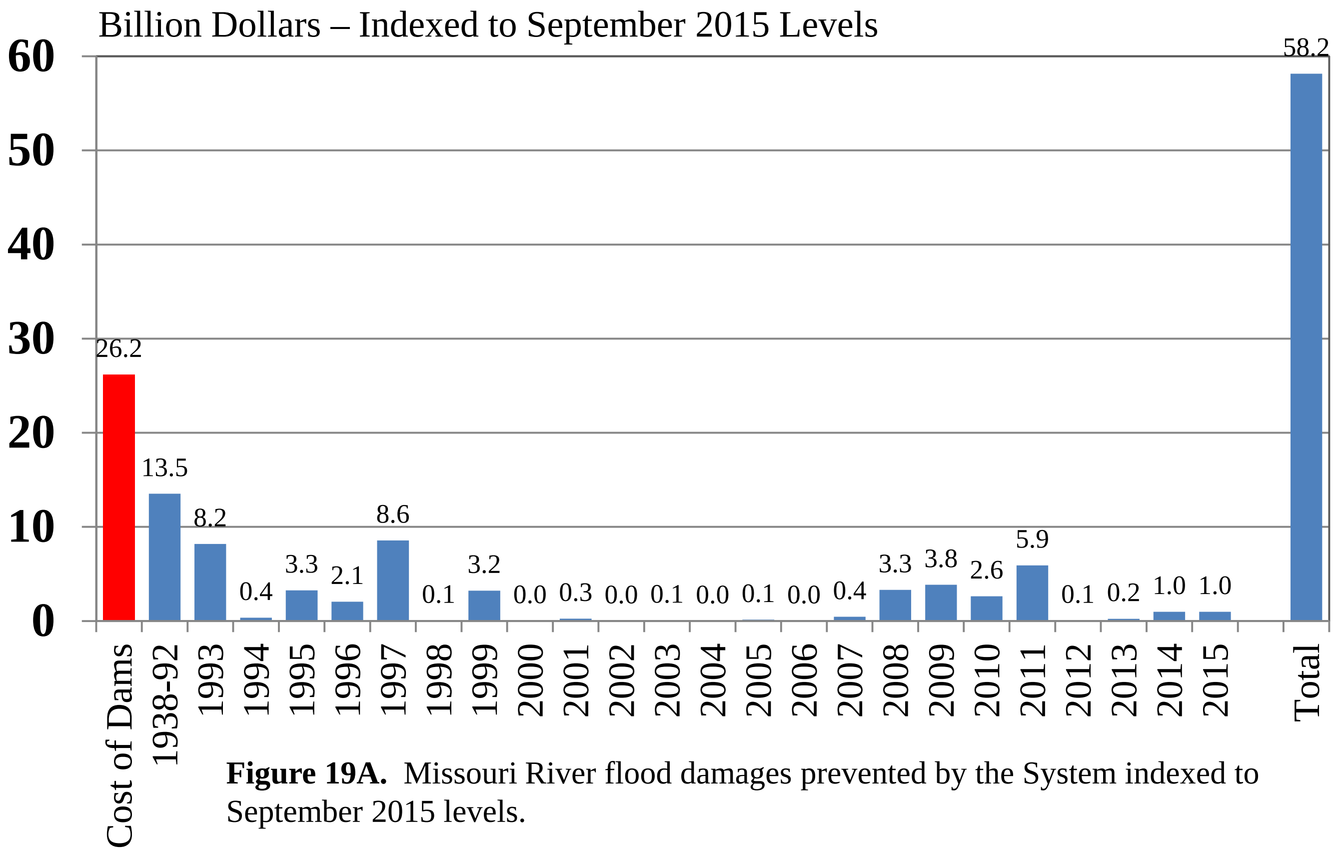


Figure 19A. Missouri River flood damages prevented by the System indexed to September 2015 levels.

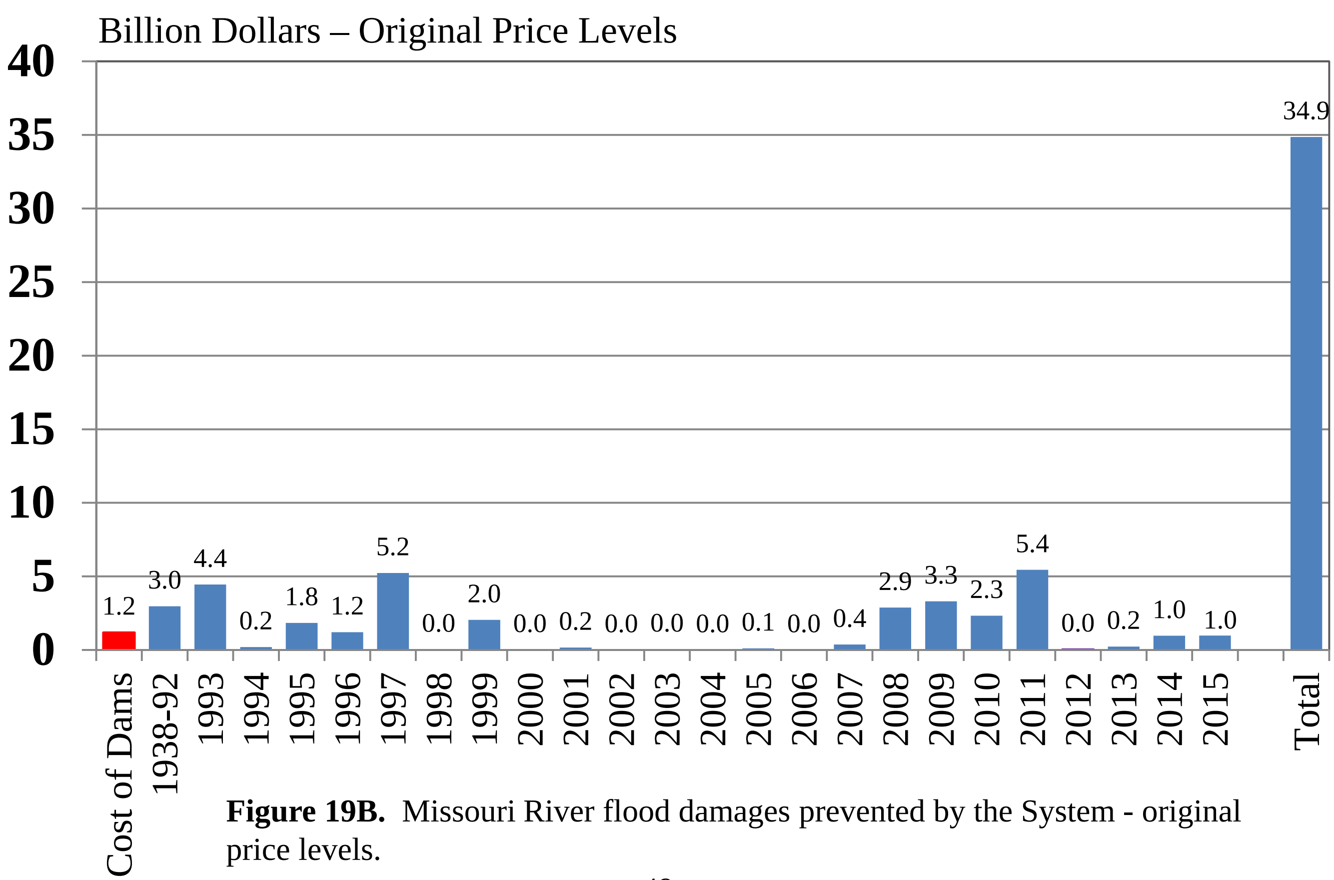


Figure 19B. Missouri River flood damages prevented by the System - original price levels.

2. Irrigation

Federally developed irrigation projects are not being served directly from the System reservoirs. The reservoirs, however, are being utilized by numerous private irrigators as well as Federally financed projects that take water from the Missouri River. About 900 private irrigators pump directly from the reservoirs or river reaches.

3. Water Supply

Problems at municipal and industrial (M&I) intakes located in the river reaches and System reservoirs are related primarily to intake or river access problems rather than inadequate water supply. Intake owners today are generally better prepared to handle periods of low water with adjustments to intakes or regulation procedures. Some of these adjustments involve using warm water to keep ice formation from building up on intake screens; installing new pumps; lowering intakes; installing sediment redirection vanes and ice deflectors; obtaining, or arranging to obtain, alternate sources of water; and cleaning screens more thoroughly and frequently. While these remedial actions are expensive to install and operate, they significantly improved the ability of the intakes to operate at lower river stages and reservoir levels.

Due to the historic releases in 2011, stretches of the Missouri River, specifically reaches directly downstream of the projects, experienced significant channel degradation. During the 2012-13 and 2013-14 winters, minimum releases required some additional coordination with downstream intake owners to ensure that their intakes were operational. The September 1 storage check indicated a winter release of no less than 17,000 cfs, which did not result in any intake access issues.

4. Water Quality Control

a. Overview

During 2015 the Omaha District (NWO) conducted fixed-station ambient water quality monitoring at the mainstem reservoirs and on the lower Missouri River. Water quality conditions of the water discharged through each of the mainstem dams was continuously monitored. An intensive water quality survey of the lower Missouri River, which has been conducted annually since 2010, was continued and implemented jointly with the Kansas City District (NWK) and extended from Gavins Point to the river's mouth at St. Louis, MO. More detailed water quality monitoring information is available in the NWO water quality reports on the NWO website at http://www.nwo.usace.army.mil/Missions/WaterInformation/WaterQuality/Reports.aspx

NWO has identified seven priority water quality issues that are relevant to the mainstem reservoirs. These identified priority issues are:

- Determine how regulation of the mainstem dams and reservoirs affect water quality in the impounded reservoirs. Utilize the CE-QUAL-W2 hydrodynamic and water quality model to facilitate this effort.
- Evaluate how eutrophication is progressing in the mainstem reservoirs, especially regarding the expansion of hypoxic conditions in the hypolimnion during summer stratification.
- Determine how flows released from mainstem reservoirs affect water quality in the downstream Missouri River. Utilize the HEC-RAS water quality model to facilitate this effort.
- Determine how current water quality conditions in the Missouri River (e.g. water temperature, turbidity) may be affecting pallid sturgeon populations in the Missouri River.
- Provide water quality information to support decision making [e.g. Corps reservoir regulation elements for effective surface water quality and aquatic habitat management, Tribes and States in the development of their Section 303(d) lists and development and implementation of total maximum daily loads (TMDLs) at NWO projects].
- Identify existing and potential surface water quality problems at NWO projects and develop and implement appropriate solutions.
- Evaluate surface water quality conditions and trends at NWO projects.

Table 15 provides a summary of water quality issues and concerns at each of the mainstem reservoirs and the lower Missouri River based on NWO monitoring and a review of current State integrated water quality reports.

b. Occurrence of "Two-Story" Fisheries at Mainstem Reservoirs

The Fort Peck, Garrison, and Oahe reservoirs maintain "two-story" fisheries that are comprised of warmwater and coldwater species. The ability of the reservoirs to maintain "two-story" fisheries is due to their thermal stratification in the summer that allows coldwater habitat to be maintained in the deeper, colder region of the reservoir (i.e. hypolimnion). Warmwater fish

Table 15
Water Quality Issues and Concerns

Project	Total Maximum Daily Load (TMDL) Considerations*				Fish Consumption Advisories		Other Potential Water Quality Concerns
	On 303(d) List	Impaired Uses	Pollutant/Stressor	TMDL Completed	Advisory in Effect	Identified Contamination	
Fort Peck • Fort Peck Lake	Yes (MT)	Drinking Water Supply	Lead Mercury	No	Yes	Mercury	---
		Recreation	Aquatic plants - native	NA**			
• Missouri River, Fort Peck Dam to the Milk River	Yes (MT)	Aquatic Life Cold Water Fishery	Water temperature	No	No	---	---
			Degraded riparian vegetation Other flow regime alterations	NA**			
• Missouri River, Milk River to the Poplar River	Yes (MT)	Aquatic Life Warm Water Fishery	Water temperature	No	No	---	---
			Degraded riparian vegetation Other flow regime alterations	NA**			
• Missouri River, Poplar River to North Dakota	Yes (MT)	Aquatic Life Warm Water Fishery	Water temperature	No	No	---	---
			Other flow regime alterations	NA**			
Garrison • Lake Sakakawea	Yes (ND)***	Fish Consumption	Methyl-mercury	No	Yes	Mercury	Coldwater fishery during drought conditions. Hypolimnetic dissolved oxygen levels.
• Missouri River, Garrison Dam to Lake Oahe	No	---	---	---	Yes	Mercury	Low dissolved oxygen in Garrison Dam tailwaters (associated with late summer hypolimnetic lake withdrawals).
Oahe • Lake Oahe	No	---	---	---	Yes	Mercury	Fish consumption advisory issued by the Cheyenne River Sioux Tribe for Lake Oahe within their tribal lands.
Big Bend • Lake Sharpe	Yes	Coldwater Permanent Fish Life	Temperature	No	No	---	TMDL completed for sediment. A nonpoint source management project is being implemented in the Bad River watershed.
Fort Randall • Lake Francis Case	No	---	---	---	No	---	Low dissolved oxygen in Fort Randall Dam tailwaters (associated with late summer hypolimnetic reservoir withdrawals).
• Missouri River, Fort Randall Dam to Lewis and Clark Lake	No	---	---	---	No	---	---
Gavins Point • Lewis and Clark Lake	Yes (NE)	Aquatic Life	Chlorophyll-a	No	No	---	Sedimentation. Emergent aquatic vegetation.
• Missouri River, Gavins Point Dam to the Big Sioux River	No	---	---	---	No	---	Reduced suspended sediment and turbidity impacts to pallid sturgeon. Assimilative capacity and flow reduction.
• Missouri River, Big Sioux River to Platte River	No	---	---	---	No	---	Reduced suspended sediment and turbidity impacts to pallid sturgeon. Assimilative capacity and flow reduction.
• Missouri River, Platte River (NE) to NE-KS Stateline	Yes (NE)	Recreation	*E. coli*	Yes	No	---	Reduced suspended sediment and turbidity impacts to pallid sturgeon. Assimilative capacity and flow reduction.

* Information taken from published state integrated water quality reports and impaired waters 303(d) listings as of January 1, 2015.
** Impairment identified in Montana's integrated report, but not on 303(d) list for development of a TMDL.
*** Delisted in 2010 for impairment of the designated use "Fish and other Aquatic Biota" (warm water temperature and low dissolved oxygen) when Lake Sakakawea pool elevations recovered from drought conditions.

species inhabit the warmer, shallower areas of the reservoirs (i.e. epilimnion), while coldwater fish species inhabit the colder, deeper areas of the reservoirs. Certain coldwater fish species are used extensively as forage by both coldwater and warmwater predator fish species in the reservoirs. Coldwater forage species that inhabit the reservoirs include the rainbow smelt (*Osmerus mordax*) and lake herring/lake cisco (*Coregonus artedi*). Maintaining healthy populations of these coldwater forage fish is important to maintaining both the coldwater and warmwater recreational fisheries in the three reservoirs.

c. Bottom-Withdrawal Reservoirs

Bottom-withdrawal reservoirs have outlet structures located near the deepest part of the reservoir. During the summer thermal stratification period, bottom withdrawal releases cold water from the deep portion of the reservoir that may be hypoxic during latter periods of stratification. Hypoxic conditions in the hypolimnion can result in the release of water with low dissolved oxygen and high levels of nutrients and other constituents. Bottom outlets can cause density interflows or underflows through the reservoir and generally provide little or no direct control over the quality of the water released through the bottom withdrawal. Garrison and Fort Randall are bottom withdrawal projects with both their power and flood tunnels drawing water from the bottom of the impounded reservoirs. Fort Peck Dam has a near-bottom withdrawal (i.e. 60 feet above the reservoir bottom) for the power and flood tunnels. The power tunnels at Oahe Dam draw water at a mid-depth elevation (i.e. 114 feet above the reservoir bottom); however, the flood tunnels draw water from the bottom of the reservoir. The Big Bend and Gavins Point powerplants both draw water from the bottom of the reservoir; however, these are shallower, run-of-the-river reservoirs and water drawn into the powerplants is usually fairly well mixed through the reservoir water column.

d. Fort Peck Reservoir

Fort Peck Reservoir is not assigned a coldwater fishery use by the State of Montana in their water quality standards. However, the reservoir supports a stocked put-grow-take salmon fishery and a naturally reproducing lake trout and lake cisco fishery; all are considered coldwater species. Since a coldwater fishery is currently supported in Fort Peck Reservoir, it is seemingly an existing use and is to be protected pursuant to the Federal Clean Water Act and antidegradation policy provisions (40 CFR 131.3).

Dissolved oxygen concentrations below Montana's 5 mg/L, 7-day mean minimum water quality standard were monitored at the Fort Peck powerplant for the first time in 2012. A special water quality study was conducted by NWO in 2012 to evaluate the situation. When monitored on September 25, the area immediately downstream of the dam to just beyond the energy dissipation structures was below 5 mg/L dissolved oxygen, while the area from just downstream of the energy dissipation structures through the dredge cuts area was just above 5 mg/L. During 2013-2015 dissolved oxygen in the water discharged through the Fort Peck powerplant remained above the 5 mg/L minimum water quality standard with minimum instantaneous values of 5.4 mg/L (2013), 6.1 mg/L (2014), and 5.9 mg/L (2015). The situation will continue to be evaluated to determine if corrective measures to meet State water quality standards may be needed.

e. Garrison Reservoir

The State of North Dakota's water quality standards classify Garrison Reservoir as a coldwater fishery. To protect the coldwater fishery use the State has promulgated the following water quality standards for Garrison Reservoir: a water temperature criterion of ≤ 59 deg F (or 15 deg C), a dissolved oxygen criterion of ≥ 5 mg/L, and a minimum reservoir volume of 500,000 AF (0.5 MAF).

Water temperature and dissolved oxygen depth profiles that were measured during water quality monitoring conducted at Garrison Reservoir over the 5-year period 2011 through 2015 were used to estimate the volume of water in the reservoir that meets the coldwater fishery habitat conditions defined by the State of North Dakota. ***Plate 3*** shows estimated reservoir and coldwater fishery habitat volumes, by year, for 2011 through 2015. Water quality monitoring in 2015 indicates that North Dakota's 0.5 MAF minimum water quality standards criterion for coldwater fishery habitat was seemingly met; however, temporal variability in data collected at Garrison does allow for some uncertainty in this measurement.

To better assess the occurrence and support of coldwater fishery habitat in Garrison Reservoir the NWO is currently updating their CE-QUAL-W2 hydrodynamic and water quality modeling of the reservoir. A comprehensive project-specific water quality report of Garrison Reservoir, including application of the CE-QUAL-W2 model and how Corps regulation of the dam and reservoir influence water quality conditions, is planned for completion by the end of 2016.

Dissolved oxygen concentrations below North Dakota's 5 mg/L water quality standard have been monitored in late summer at the Garrison powerplant. To date, there is no evidence of current or past fish kills in the Garrison tailwaters. A Special Water Quality Study of the situation is being considered, and the situation will continued to be evaluated to determine if corrective measures to meet State water quality standards may be needed.

f. Oahe Reservoir

South Dakota's water quality standards protect Oahe for a Coldwater Permanent Fish Life Propagation (CPFLP) use (i.e. coldwater fishery). As such, a water temperature criterion of ≤ 65 deg F (or 18.3 deg C) and a dissolved oxygen criterion of ≥ 6 mg/L have been promulgated by South Dakota to protect the coldwater fishery of Oahe.

The occurrence of coldwater fishery habitat (i.e. water temperature ≤ 18.3 degrees C and dissolved oxygen ≥ 6 mg/L) in the Oahe reservoir was estimated from water quality monitoring conducted over the 5-year period 2011 through 2015. ***Plate 4*** shows estimated summer reservoir and coldwater fishery habitat volumes, by year, for 2011 through 2015. Except for 2011, at least 2 MAF of coldwater fishery habitat was present in Oahe for all years. The 2011 record releases significantly reduced the hydraulic residence time (HRT) for Oahe. The lower HRT (i.e. faster flushing rate) in 2011 resulted in faster flow of water through the reservoir that resulted in greater dissolved oxygen degradation in the hypolimnion as hypoxic water was drawn from the upstream reaches of the reservoir to the dam. This situation was exacerbated by the extensive use of the bottom-withdrawal flood tunnels which tended to pull water along the bottom of the reservoir.

g. Big Bend Reservoir

The State of South Dakota classifies Big Bend for a CPFLP use and currently lists the designated coldwater fishery as impaired due to warm water temperatures. South Dakota should consider reclassification of Big Bend Reservoir from a coldwater fishery to a warmwater fishery based on a use attainability assessment of "natural conditions". Natural summer water temperatures of the Oahe powerplant discharge, especially during lower pool levels, do not meet the temperature requirements for a CPFLP use in Big Bend.

h. Fort Randall Reservoir

Hypoxic water is passed through Fort Randall during power production in the summer and dissolved oxygen levels in the Fort Randall tailwaters fall below South Dakota's water quality standards' minimum dissolved oxygen criterion of 5 mg/L for protection of the designated Warmwater Permanent Fish Life Propagation (WPFLP) use. The low dissolved oxygen levels in the tailwaters are not impairing the designated WPFLP use as regions of refugia exist in the impacted area and there is no evidence of current or past summer fish kills in the tailwaters attributable to hypoxic conditions. If warranted, dissolved oxygen conditions in the Fort Randall tailwaters, during periods of hypoxic dam releases, could be mitigated by spilling surface water with higher dissolved oxygen concentrations down the spillway. The situation will continue to be evaluated to determine if corrective measures to meet South Dakota's water quality standards may be needed.

i. Gavins Point Reservoir

Gavins Point is currently identified as impaired on the State of Nebraska's 303(d) listing of impaired waters. The identified impaired use is aquatic life and the identified cause is high chlorophyll-a levels. Of the six mainstem reservoirs, Gavins Point is exhibiting the most impact from nutrient loading and eutrophication. Eutrophication concerns at Gavins Point will likely increase as the reservoir continues to age. The current estimated volume loss of the Carry Over Multiple Use Pool Zone (28%) in Gavins Point exceeds the State of Nebraska's criterion (25% volume loss) for listing the reservoir as impaired for aesthetics. Gavins Point is not currently listed as impaired for sedimentation by the State of Nebraska.

5. Navigation

a. Barge Traffic

System releases provide navigation flow support in the Missouri River Bank Stabilization and Navigation Project (BSNP) during a normal 8-month season, which runs from April 1 to December 1 at the mouth of the Missouri River. Minimum navigation flow support, which is 6,000 cfs below full service, provides flow to ensure a minimum 8-foot channel depth. Full service navigation flow support provides flow to ensure a minimum 9-foot deep and 300-foot wide channel in the BSNP. Navigation flow support for the first half of the season is determined by the March 15 System storage check. Navigation flow support for the second half of the season, as well as season length, is determined by the July 1 System storage check. System releases are set to meet navigation target flows at four Missouri River locations – Sioux City, Omaha, Nebraska City, and Kansas City. Based on the March 15 System storage of 57.3 MAF, navigation flow support was set to full service level for the first half of the navigation season. Based on the July 1 System storage check of 61.9 MAF, System releases were maintained to provide full service flow support for the second half of the season with a normal 8-month season length.

The first commercial load on the Missouri River in 2015 was the *Motor Vessel (MV) Gerald F. Engemann*, operated by Hermann Sand and Gravel Company located in Hermann, MO at river mile (RM) 97. The *MV Gerald F. Engemann* entered the Missouri River on March 2 with a tow of four loaded fertilizer barges and one empty barge. The four barges were partially transferred to the empty barge at their homeport in Hermann, MO at RM 97 to allow for a 7-foot 6-inch draft, and the five fertilizer barges were then taken to the AgriServices Terminal in Brunswick, MO at RM 256. The *MV Gerald F. Engemann* reached the AgriServices Terminal on March 15. The last commercial tow taken off the Missouri River in 2015 was the *MV Mary Lynn* of Hermann Sand and Gravel Company on December 14.

There was special equipment transported during the 2015 navigation season. On May 4 the *MV Gerald F. Engemann* began to move a special shipment of equipment up the Missouri River to CF Industries at Port Neal, IA at RM 717, near Sioux City, IA. The equipment was for the CF Industries nitrogen plant expansion and was too large to be transported by rail or truck. The equipment was manufactured in Japan, shipped by an ocean-going vessel to Houston, TX, barged up the Mississippi River, and finally shipped up the Missouri River by the *MV Gerald F. Engemann*. In total, two shipments were placed to CF Industries in 2015.

One port that had not used the river for several years, Port of Kansas City, resumed barge shipments in 2015. The port, which is located at RM 367.1, received its first shipment since 2007 on August 17, with barges delivered by the *MV Gerald F. Engemann*. After the barges were unloaded, they were reloaded on August 21.

b. Tonnage

Table 16 shows the Missouri River tonnage data for 2010-2014 compiled by the Waterborne Commerce Statistics Center (WCSC). Final navigation tonnage data for 2015 is not currently available. The 2014 total of 4.671 million tons includes 4.072 million tons for sand and gravel, 0.305 million tons for waterways materials, and 0.293 million tons for long-haul commercial tonnage. In 2014 the total tonnage increased by 0.566 million tons compared to 2013. The long haul tonnage at 0.293 million tons increased by 0.048 million tons from 2013. The largest long-haul commercial tonnage, excluding sand, gravel and waterway material, occurred in 1977 at 3.34 million tons. ***Figure 21A*** shows total navigation tonnage on the Missouri River. ***Figure 21B*** shows the long-haul commercial navigation tonnage not including sand, gravel and waterway materials. The long-haul commercial tonnage in 2015 is estimated at 0.275 million tons, based on carrier interviews, towboat activity and barge counts from the Corps' daily boat reports. ***Figure 22A*** shows the navigation tonnage value of the commodities since 1960, using 2014 present-worth computations. ***Figure 22B*** shows the navigation tonnage value of long-haul commercial commodities since 1960. The ***Figures 21A***, ***21B***, ***22A*** and ***22B*** tonnages and tonnage values for 2015 are estimates and will change once final WCSC tabulations are available.

Table 16
Missouri River Tonnage by Commodity (1000 Tons)

Commodity Classification Group	2010	2011	2012	2013	2014
Farm Products	35	21	20	12	53
Corn	13	6	0	0	9
Wheat	0	0	0	0	0
Soybeans	23	15	20	12	44
Misc Farm Product	0	0	0	0	0
Nonmetallic Minerals	4388	3588	3479	3664	4113
Sand/Gravel	4346	3548	3421	3609	4072
Misc Nonmetallic	42	39	61	55	41
Food and Kindred	36	0	0	0	7
Pulp and Paper	0	0	0	0	0
Chemicals	72	49	34	53	64
Fertilizer	70	49	34	53	64
Other Chemicals	1	0	0	0	0
Petroleum (including coke)	118	44	6	54	44
Stone/Clay/Glass	76	77	79	71	85
Primary Metals	0	0	0	0	0
Waterway Materials	105	53	288	251	305
Other	0	0	0	0	0
Total Commercial	4831	3832	3906	4105	4671
Total Long-Haul Commercial	380	230	197	245	293

Navigation season target flows for past years are given in ***Table 17***. ***Table 18*** shows the scheduled lengths of past System-supported navigation seasons, with total tonnage and ton-miles for each year. ***Figure 23*** presents discharge data at Sioux City, IA; Nebraska City, NE and Kansas, MO, three of the four navigation flow-target locations for 2015. There was no navigation support from the Kansas River projects in 2015.

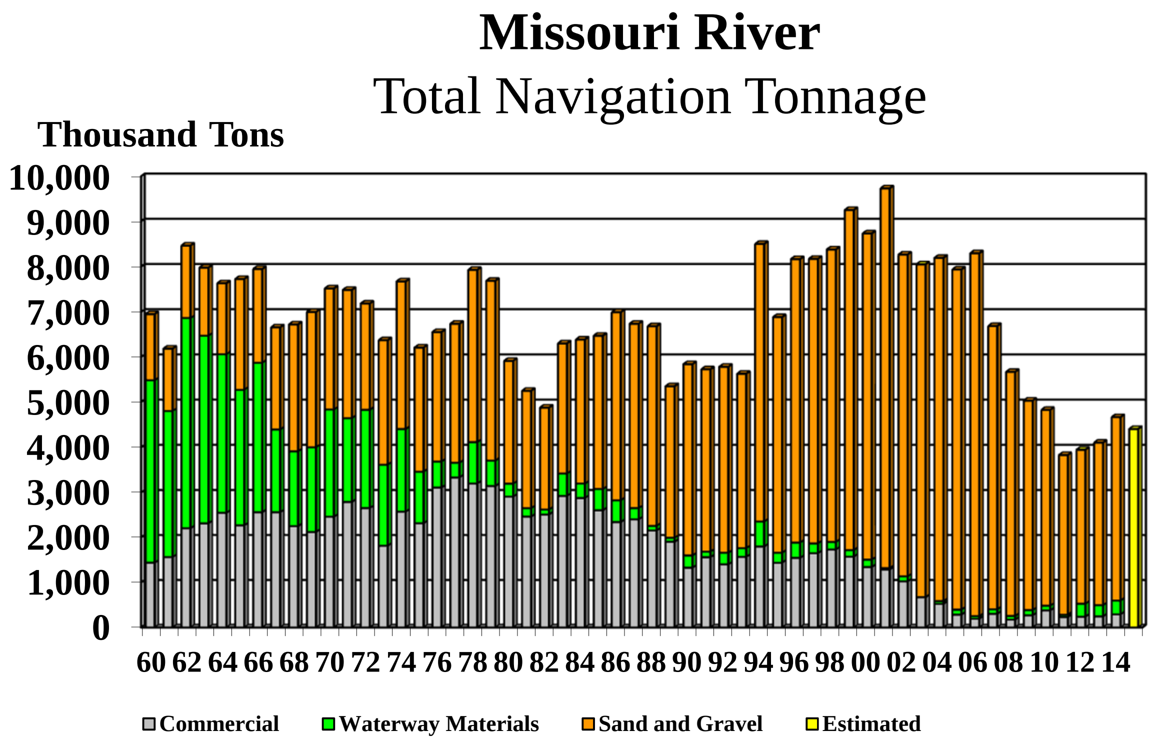


Figure 21A. Missouri River total navigation tonnage from 1960 to 2015 (estimated).

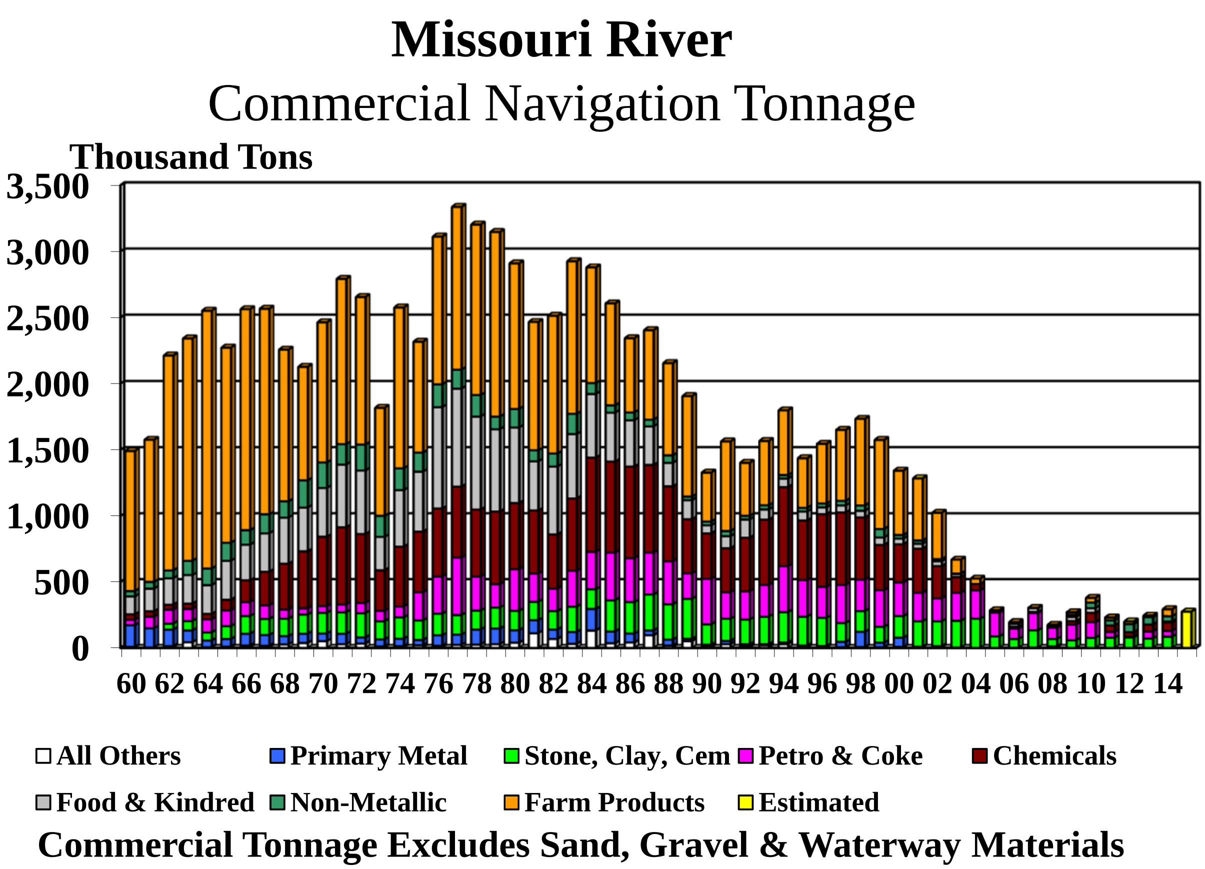


Figure 21B. Missouri River commercial navigation tonnage from 1960 to 2015 (estimated).

Missouri River

Total Navigation Tonnage Value - 2015 Present Worth

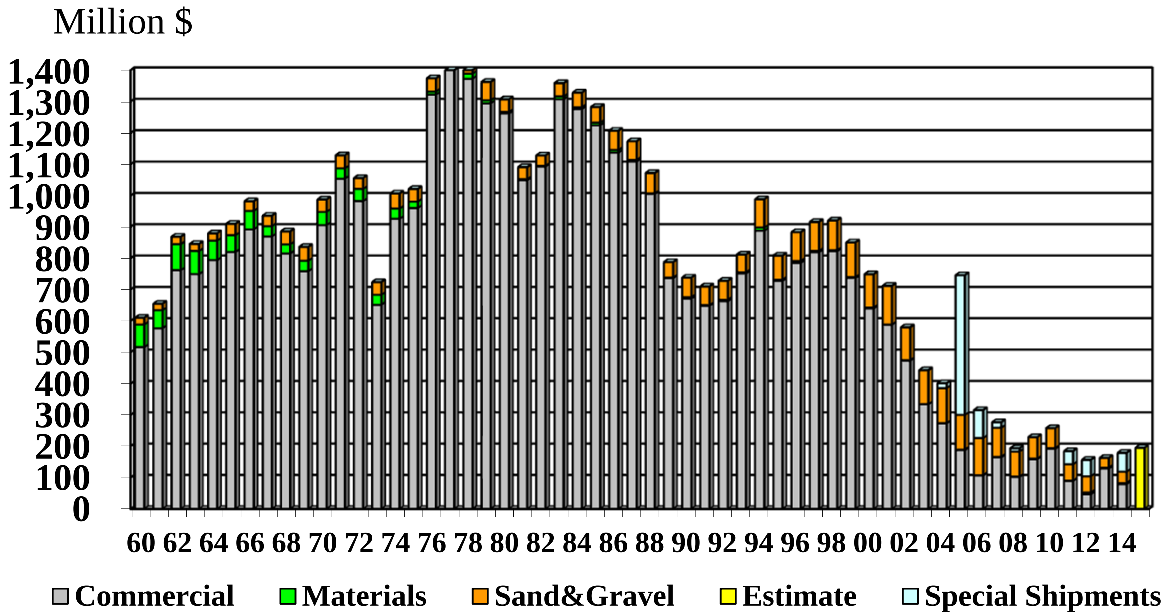


Figure 22A. Total navigation tonnage value using 2014 present worth computations.

Missouri River

Commercial Navigation Tonnage Value - 2015 Present Worth

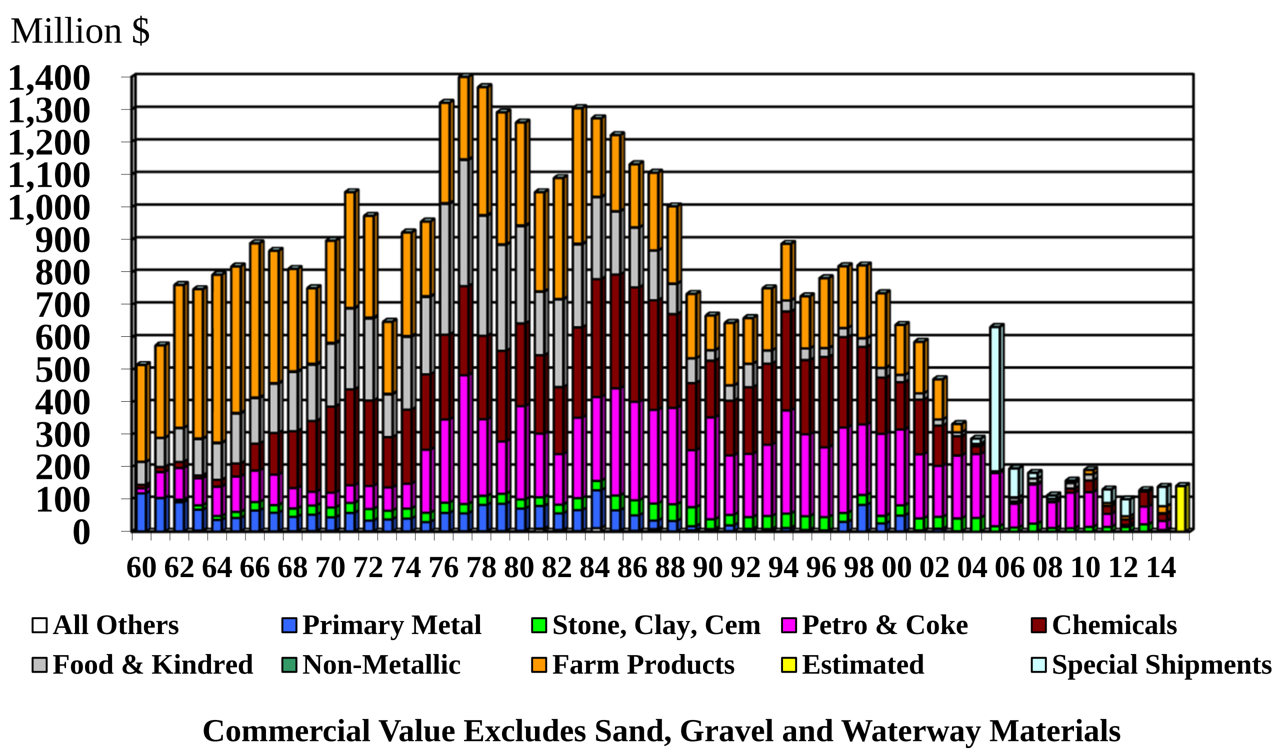


Figure 22B. Commercial navigation tonnage value using 2015 present worth computations.

Table 17
Navigation Season Target Flows
(1,000 cfs)

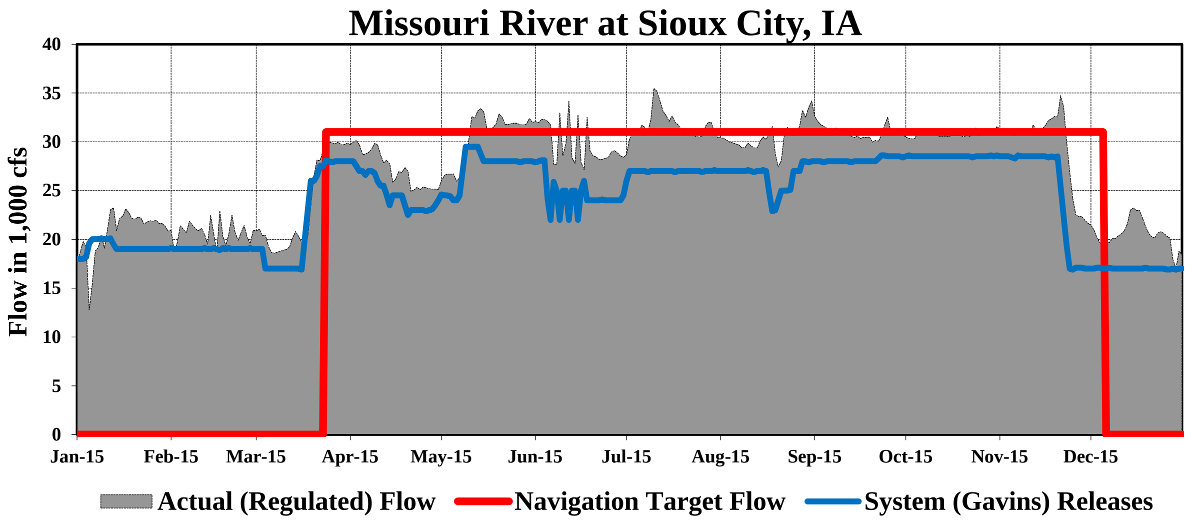
Year	Months	Sioux City	Omaha	Nebraska City	Kansas City
1967	Apr-Jun	28	28	34	38
	Jul-Nov	31	31	37	41
1968	Apr-Nov	31	31	37	41
1969	Apr-Jun(1)	35-40	35-40	41-46	45-50
	Jul(1)	36	36	42	46
	Aug-Sep(1)	50-55	50-55	55-60	55-60
	Oct-Nov(1)	40-45	40-45	45-50	50-55
1970	Apr-May	31	31	37	41
	May-Sep(1)	36	36	42	46
	Oct-Nov(1)	40	40	46	50
1971	Apr-May(1)	36	36	42	46
	May-Nov(1)	45-50	45-50	50-55	55-60
1972	Apr-Nov(1)	40-50	40-50	45-55	50-60
1973-74	Apr-Nov	31	31	37	41
1975	Apr	31	31	37	41
	May-Nov(1)	35-60	35-60	41-66	45-70
1976	Apr-Jul(1)	34-38	34-38	40-44	44-48
	Aug-Dec(1)	31-34	31-34	37-40	41-44
1977	Apr-Nov	31	31	37	41
1978	Apr	31	31	37	41
	May-Jul(1)	35-46	35-46	41-52	45-56
	Aug-Nov(1)	46-51	46-51	52-57	56-61
1979	Apr-Jul(1)	36-42	36-42	42-48	46-52
	Aug-Nov(1)	31-36	31-36	37-42	41-46
1980	Apr-Nov	31	31	37	41
1981	Apr-Nov(2)	31	31	37	41
1982	Apr-Sep	31	31	37	41
	Oct	31-36	31-36	37-42	41-46
	Nov-Dec(1)	36-46	36-46	42-52	46-56
1983	Apr-Jun	31	31	37	41
	Jul	31-36	31-36	37-42	41-46
	Aug-Nov(1)	36	36	42	46
1984	Apr-Jun	31	31	37	41
	Jul-Dec(1)	31-44	31-44	37-50	41-54
1985	Apr-Dec	31	31	37	41
1986	Apr(1)	36-41	36-41	42-47	46-51
	May-Dec(1)	41-46	41-46	47-52	51-56
1987	Apr-Nov	31	31	37	41
1988	Apr-Nov(2)	31	31	37	41
1989	Apr-Aug(3)	28	28	34	38
	Sep-Oct(3)	28	28	34	35
1990-93	Apr-Oct(4)	25	25	31	35
1994	Apr-Dec	31	31	37	41
1995	Apr-May	31	31	37	41
	Jun-Dec(1)	46-56	46-56	52-62	56-66
1996	Apr(1)	41	41	47	51
	May(1)	41-51	41-51	47-57	51-61
	Jun-Dec(1)	56	56	62	66
1997	Apr-Dec(5)	*	*	*	*
1998	Apr-Dec(5)	31	31	37	41
1999	Apr-Dec(1)	31-43	31-43	37-49	41-53
2000	Apr-Jun	31	31	37	41
	Jul-Dec(3)	29.5	29.5	35.5	39.5
2001	Apr-Dec(3)	28	28	34	38
2002	Apr-Jun(3)	27	27	33	37
	Jul-Dec(3)	25	25	31	35
2003	Apr-Nov(4)	25	25	31	35
2004-08	Apr-Oct(6)	25	25	31	35
2009	Apr-Nov(7)	25/31	25/31	31/37	35/41
2010	Apr-Dec(1)	31-43	31-43	37-49	41-53
2011	Apr(1)	31-41	31-41	37-47	41-51
	mid-Apr(1)	41-46	41-46	47-52	51-56
	May(1)	46-56	46-56	52-62	56-66
	mid-May(5)	*	*	*	*
2012	Apr-Dec	31	31	37	41
2013	Apr-Jun(6)	25	25	31	35
	Jul-Dec(3)	28	28	34	38
2014	Apr-Jun(3)	28	28	34	38
	Jul-Dec(1)	31-46	31-46	37-52	41-56
2015	Apr-Dec	31	31	37	41

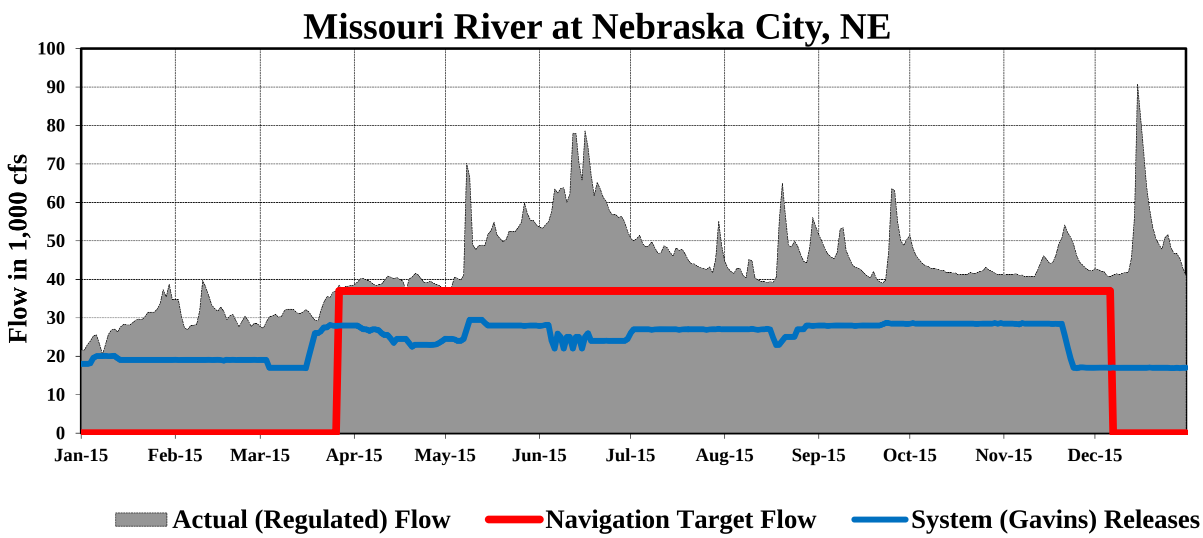
(1) Downstream flow targets above full-service navigation level as a flood control storage evacuation measure.
(2) Full service flows provided for shortened season.
(3) Navigation targets below full service as a water conservation measure.
(4) Navigation targets at minimum service as a water conservation measure.
(5) Releases determined by flood control storage evacuation critiera and not adjusted to meet specific navigation targets.
(6) Minimum service targets at Sioux City and Omaha not met during periods when there was no navigation in those reaches.
(7) Minimum service targets at Sioux City were not met during periods when there was no navigation in those reaches.

Table 18
Missouri River Navigation
Tonnage and Season Length

Year	Reservoir System Supported Length of Season (Months)	Commercial (Tons) (1)	Total Traffic (Tons) (2)	Total Traffic (1,000 Ton-Miles) (2)
1967 (3)	8	2,562,657	6,659,219	1,179,235
1968	8 (4)	2,254,489	6,724,562	1,047,935
1969	8 (4)	2,123,152	7,001,107	1,053,856
1970	8 (5)	2,462,935	7,519,251	1,190,232
1971	8 (4)	2,791,929	7,483,708	1,329,899
1972	8 (4)	2,665,579	7,182,841	1,280,385
1973	8	1,817,471	6,370,838	844,406
1974	8	2,576,018	7,673,084	1,227,525
1975	8 (4)	2,317,321	6,208,426	1,105,811
1976	8 (4)	3,111,376	6,552,949	1,535,912
1977	8	3,335,780	6,734,850	1,596,284
1978	8 (4)	3,202,822	7,929,184	1,528,614
1979	8 (4)	3,145,902	7,684,738	1,518,549
1980	8	2,909,279	5,914,775	1,335,309
1981	7 1/4 (6)	2,466,619	5,251,952	1,130,787
1982	8 (4)	2,513,166	4,880,527	1,131,249
1983	8 (4)	2,925,384	6,301,465	1,300,000
1984	8 (4)	2,878,720	6,386,205	1,338,939
1985	8 (4) (7)	2,606,461	6,471,418	1,201,854
1986	8 (4) (7)	2,343,899	6,990,778	1,044,299
1987	8	2,405,212	6,735,968	1,057,526
1988	7 1/2	2,156,387	6,680,878	949,356
1989	6 3/4	1,906,508	5,352,282	796,799
1990	6 3/4	1,329,000	5,841,000	552,509
1991	6 3/4	1,563,000	5,729,000	537,498
1992	6 3/4	1,403,000	5,783,000	593,790
1993	8 (8)	1,570,000	5,631,000	615,541
1994	8	1,800,000	8,501,000	774,491
1995	8 (4)	1,439,000	6,884,000	604,171
1996	8 (4)	1,547,000	8,165,000	680,872
1997	8 (4)	1,651,000	8,172,000	725,268
1998	8 (4)	1,735,000	8,379,000	777,727
1999	8 (4)	1,576,000	9,252,000	699,744
2000	8	1,344,000	8,733,000	628,575
2001	8	1,288,000	9,732,000	566,150
2002	8 (9)	1,009,000	8,266,000	409,980
2003	8 (10)	667,000	8,050,000	256,788
2004	6 1/2 (11)	525,498	8,192,219	181,995
2005	6 1/2 (11)	284,641	7,935,747	129,882
2006	6 1/2 (11)	195,290	8,295,226	84,483
2007	6 3/4 (11)	302,769	6,684,625	119,177
2008	7 (11)	174,800	5,670,968	86,203
2009	8	269,563	5,035,744	114,865
2010	8(4)	379,492	4,829,714	132,747
2011	8(4)	230,439	3,831,925	62,253
2012	8	197,000	3,906,000	56,631
2013	8	244,576	4,104,505	110,280
2014	8(4)	293,125	4,670,661	89,932
2015	8	275,000(12)	4,409,000(12)	95,000(12)

(1) Includes commercial tonnage except for sand and gravel or waterway materials. Tonnage compiled by Waterborne Commerce Statistics Center (WCSC).
(2) Includes commodities; sand, gravel, and crushed rock; and waterway improvement materials. Tonnage by WCSC.
(3) Mainstem Reservoir System first reached normal operating storage level in 1967.
(4) 10-day extension of season provided.
(5) 10-day extension and 10-day early opening provided.
(6) Full service flows for shortened season in preference to reduced service.
(7) 10-day extension provided for 1985 season in trade for 10-day delayed support of 1986 season.
(8) Lower Missouri River closed: 57 days in 1993, 20 days in 1995, and 18 days in 1999.
(9) To protect endangered shore birds below Gavins Point Dam, the Corps did not support navigation from July 3 to August 14, 2002. Average days towing industry off the river was 23 days.
(10) 6-day shortening of season to follow CWCP. From Aug 11 to Sep 1 Corps did not support navigation flows to comply with lawsuit to follow 2000 Biological Opinion. Navigation industry left the river during this period.
(11) Season shortening; 47-days, 2004; 48-days, 2005; 44-days, 2006; 35-days, 2007; 30-days, 2008
(12) Estimated using boat report barge counts.





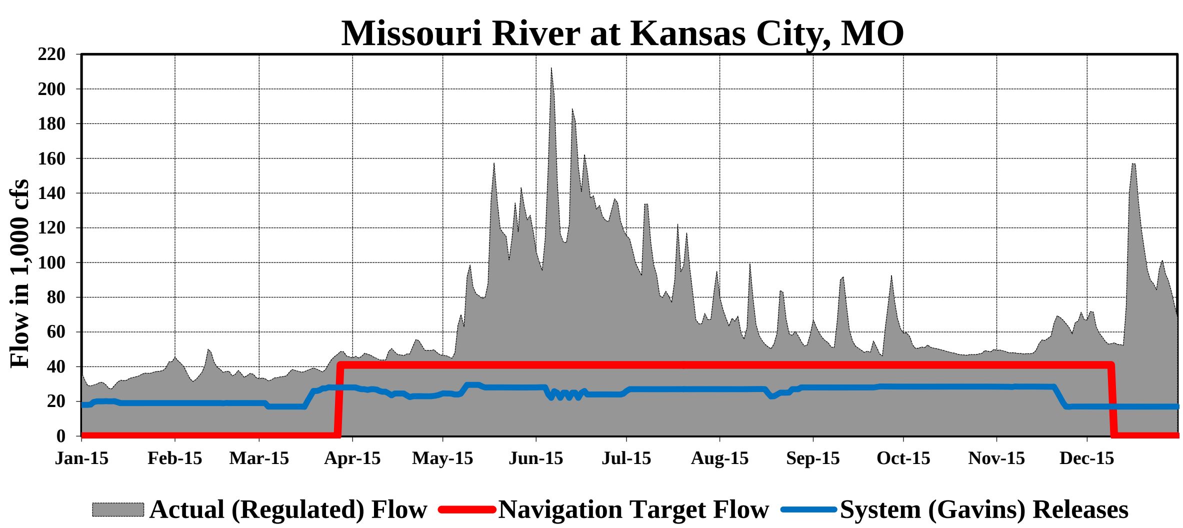


Figure 23. Actual flow, System releases and navigation target flows – Sioux City, IA; Nebraska City, NE and Kansas City, MO (calendar year).

6. Power – Eastern Division, Pick-Sloan Missouri Basin Program (P-S MBP)

The hydropower energy generated by the system is transmitted over a Federal transmission system that traverses 7,875 circuit miles. On October 1, 2015 Western's transmission system became integrated with the Southwest Power Pool (SPP) regional transmission organization. During 2015, service was provided to over 350 wholesale customers. Customers receiving service include 200 municipalities, 2 Federal agencies, 30 state agencies, 24 USBR projects, 5 irrigation districts, 36 rural electric cooperatives, 6 public utility districts, 9 private utilities, 25 Native American services and 18 power marketers. Additional marketing benefits have been realized with Western becoming an asset-owning market participant within the SPP integrated market place in 2015.

Per the Omaha Public Power District (OPPD) statistics, the average OPPD customer uses approximately 11,650 kilowatt hours (kWh) of energy annually. Based on the total System generation of 8.5 billion kWh, the energy generated in 2015 by this portion of the Federal power system could have supplied all of the yearly needs of about 732,000 residential OPPD customers. In addition to the clean, renewable energy supplied to our customers, system hydropower provides an added measure of stability to the SPP regional power system. Large coal-fired and nuclear units are backed up by other SPP member resources and the Federal hydropower generation. Members of the SPP market benefit by being able to call for reserves during emergency events. In addition, hydropower and other SPP generation are integrated with wind generation to provide balance to the SPP system.

The reliability of System hydropower helps to maintain adequate reserves in both the Northwest Power Pool in Western Area Power Administration, Upper Great Plains West (WAUW) and the SPP.

Hydropower generation in 2015 was 8.5 billion kWh, which was 91 percent of average since the System first filled in 1967. The 2015 generation was 1.1 billion kWh less than the 2014 generation of 9.6 billion kWh and 3.6 billion kWh more than the record low of 4.9 billion kWh, set in 2008. Total generation was below average in 2015 despite runoff being just above average for the upper Basin. This was due to the distribution of runoff being well above average in the Oahe to Sioux City reach and below average in the Fort Peck and Garrison reaches. Western purchased about 2.5 billion kWh between January 1 and December 31 at a cost of $116.2 million to supplement System hydropower production.

System generation with individual project distribution for each calendar year in million megawatt hours (MWh) since 1954 is shown on ***Figure 24***. The total generation from the Federal system (peak capacity and energy sales) for 2015 is shown in ***Table 19***. The tabulations in ***Table 20*** and ***Table 21*** summarize the total gross generation and power regulation for the Eastern Division, P-S MBP marketing area system for the past operating year. Actual settlement figures at the end of the billing periods differ somewhat from the calendar month figures shown.

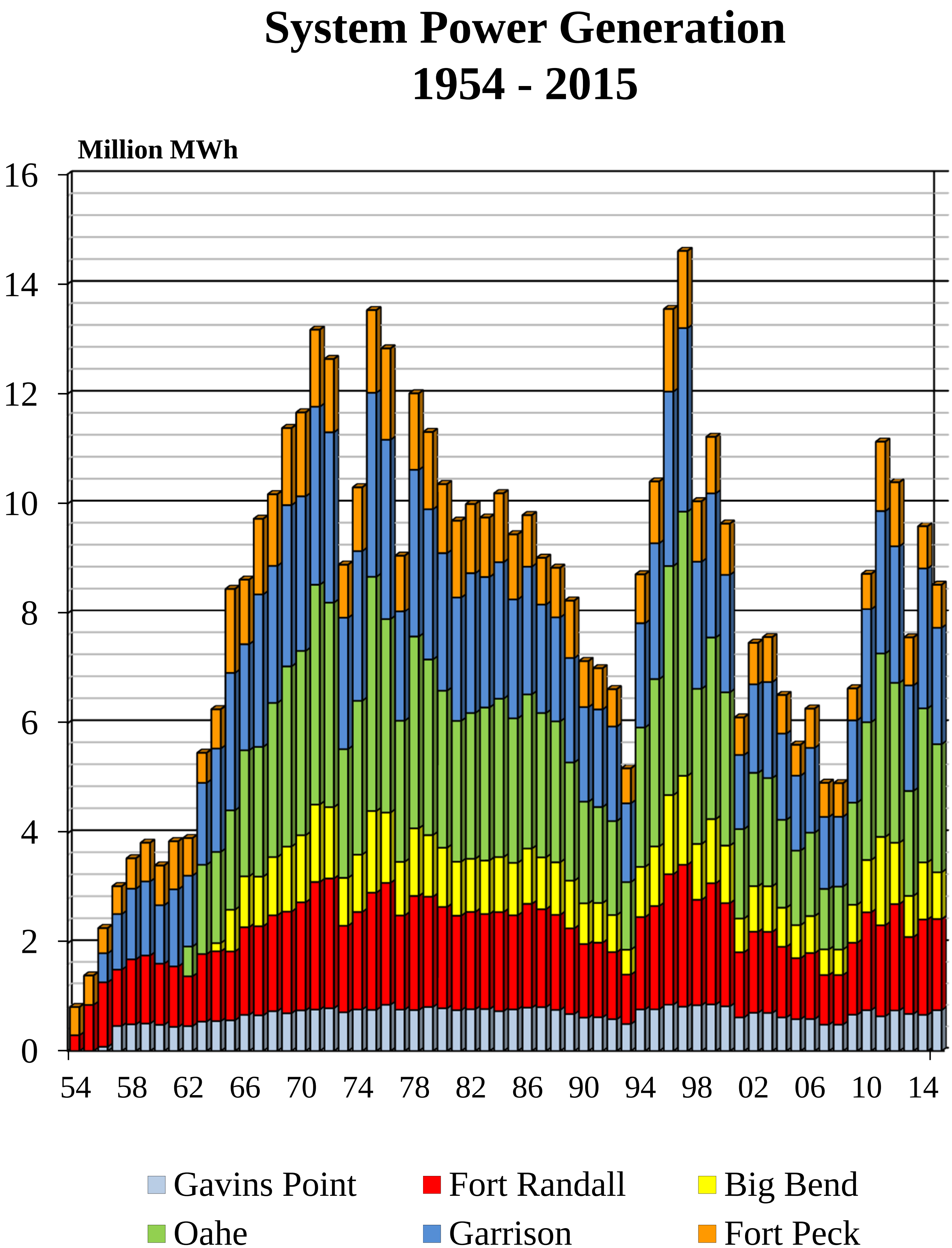


Figure 24. System power generation by project from 1954 to 2015

Table 19
Gross Federal Power System Generation – January 2015 through December 2015

	Energy Generation 1000 kWh	Peak Hour kW	Generation Date
Corps Powerplants – Mainstem			
Fort Peck	788,876	161,000	Aug 28
Garrison	2,117,199	462,000	Apr 27
Oahe	2,330,322	636,000	Feb 18
Big Bend	850,758	415,000	Feb 23
Fort Randall	1,683,153	320,000	Jul 18
Gavins Point	758,257	112,000	Oct 6
Corps Subtotal	8,528,565	1,799,000	Apr 7
USBR Powerplants			
Canyon Ferry	304,422	56,000	Jun
Yellowtail*	373,571	91,000	Mar
USBR Subtotal	677,933		
Federal System Total	9,206,558		

* Includes only half of total Yellowtail generation, which is marketed by the Eastern Division, P-S MBP.

Table 20
Historical Generation and Load Data – Peaks
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at Plant (1000 kW)
January 1, 2015 through December 31, 2015

Period	Corps of Engineers Hourly Generation (Gross)**	(plus)	USBR Hourly Generation (Gross)**	(equals)	Federal Hour Generation (Gross)**	(plus)	Interchange and Purchases Received**	(equals)	Peak Total System Load	Peak Date	Peak Hour
January	1,064		84		1,148		1,008		2,156	Jan 05	1800
February	1,086		80		1,166		739		1,905	Feb 26	900
March	1,371		64		1,435		708		2,143	Mar 05	800
April	1,619		93		1,712		442		2,154	Apr 07	1200
May	1,518		70		1,588		26		1,614	May 18	1300
June	1,354		108		1,462		208		1,670	Jun 29	1700
July	1,396		111		1,507		26		1,533	Jul 13	1800
August	1,671		86		1,757		85		1,842	Aug 14	1700
September	1,667		71		1,738		639		2,377	Sep 02	1900
October	1,329		72		1,401		0		1,401	Oct 28	2000
November	990		71		1,061		519		1,580	Nov 25	1900
December	1,146		71		1,217		409		1,626	Dec 21	1900

* This tabulation summarizes the total gross generation and power operations for the Eastern Division marketing area system shown on Table 19.

** During hour of peak total system load.

Table 21
Historical Generation and Load Data – Total
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at Plant (1000 kWh)
January 1, 2015 through December 31, 2015

Period	Corps of Engineers Generation (Gross)	(plus)	USBR Generation (Gross)	(equals)	Federal Generation (Gross)	(plus)	Scheduled Interchange and Purchases Received	(equals)	Total System Load
January	680,771		61,941		742,712		346,143		1,088,855
February	637,179		51,191		688,370		211,653		900,023
March	744,673		60,553		805,226		214,284		1,019,510
April	803,853		50,517		854,370		170,487		1,024,857
May	810,469		49,589		860,058		110,913		970,971
June	755,186		83,284		838,470		103,133		941,603
July	798,866		76,163		875,029		114,477		989,506
August	820,723		59,588		880,311		120,040		1,000,351
September	729,297		50,839		780,136		133,905		914,041
October	650,696		49,979		700,675		50,224		750,899
November	571,081		47,775		618,856		172,398		791,254
December	525,579		48,240		573,819		326,847		900,666

*Powerplants from Table 19.

7. Recreation

The System reservoirs provide outstanding opportunities for boating, fishing, swimming, camping and other outdoor recreation pursuits. Tourism related to the reservoirs is a major economic factor in all of the states adjoining the System. However, when the reservoirs are drawn down due to extended drought periods, as they were in some recent years, recreation may be adversely affected primarily due to access issues. Most of the recreational impacts of a drought are experienced at the upper three large reservoirs – Fort Peck, Garrison and Oahe. Due to the manner in which they are regulated, the lower three reservoirs are not significantly impacted by drought. Reservoir levels were at near normal levels through the 2015 recreation season and no accessibility problems were reported at mainstem projects boat ramps.

Access areas at the upper three reservoirs include Corps-owned as well as Tribal, state and privately-owned facilities. In 2002, many of the Federal recreation areas and boat ramps in South Dakota were turned over in fee title to the State of South Dakota and the Bureau of Indian Affairs through the Title VI process. Since the land transfer, both the Federal treasury and the Corps have provided money to the South Dakota Game Fish and Parks, Cheyenne River Sioux Tribe and Lower Brule Sioux Tribe for operations and stewardship of the Title VI lands they received. Congress is also capitalizing a trust fund to cover these costs in the future.

The methodology used for the Corps to determine visitation hours has been under revision since 2013. The new methodology will leverage metered data that is collected as vehicles enter and exit the recreation areas. Since 1992, all Corps projects, including the mainstem projects, report visitation using the Visitation Estimation Reporting System (VERS). Currently no visitation data is available since 2012. The annual visitation data for 2013 to current will be updated in future summary reports when it becomes available. Another change to the data reporting is attributed to the associated with the South Dakota Title VI land transfer mentioned previously. Since the land transfer occurred, the Corps has not collected visitation data consistent with previous years at the recreation sites in South Dakota. The visitation data in South Dakota reported in future reports will reflect water-related use on the reservoirs but not the visitation at the campgrounds that were turned over to the State of South Dakota and the Tribes.

8. Fish and Wildlife

a. Fish Management

Rainbow smelt are the primary forage species in both Garrison and Oahe reservoirs. Successful rainbow smelt reproduction is dependent on many factors including stable reservoir levels during the smelt spawning period, generally in April and early May. Most eggs are laid in water less than a foot deep and are subject to desiccation through wave action and slight drops in water level.

The near-average 2015 runoff resulted in steady-to-rising pools in the Fort Peck, Garrison, and Oahe reservoirs throughout the spring and early summer. Gizzard shad have been stocked in Oahe reservoir to supplement the rainbow smelt forage base.

b. Threatened and Endangered Species (T&E)

(1) Pallid Sturgeon

The bimodal spring pulse from Gavins Point for the benefit of the pallid sturgeon was not conducted in 2015, as detailed in section II.C.6.d. of this report.

(2) Piping Plovers and Least Terns

Since 1986 the System has been regulated for the piping plover (plover, threatened) and least tern (tern, endangered), when they were federally listed as T&E species. The terns and plovers nest on sparsely vegetated sandbars, islands and shoreline of the Missouri River and the reservoirs. Real-time telemetered streamgaging stations have been installed along the Missouri River to monitor river stages and flows during the nesting season. These gages provide a check, as well as a stage history, throughout the season to help relate the effects of regulation and natural events at intervals along the river. The gage data must be supplemented with observations of nesting activities and conditions to provide the information that is needed for regulation of the reservoirs. A dynamic flow routing model has been developed to predict river stages along the river reaches downstream from the Fort Peck, Garrison, Fort Randall, and Gavins Point dams for different combinations of daily and hourly power peaking.

Beginning in 1999, Omaha District created a computerized T&E species Data Management System (DMS). Report data, which is updated daily, includes nest records, census and productivity data, site descriptions, field journals and field observations. This database is a valuable tool in aiding regulation decisions benefiting the terns and plovers in years when the reservoirs are regulated to protect nesting terns and plovers.

Although the Corps prevented inundation of nests where possible and created habitat following the listing, fledging ratios continued to be lower than predicted by the USFWS 1990 Biological Opinion until 1998, when fledge ratios exceeded the goal for both species. Predation, habitat degradation, severe weather, nest inundation, record runoff and other factors contributed to the low fledging rates. The record fledging that occurred for both species between 1998 and

2005 is primarily attributed to the large amount of habitat created by the high runoff years of 1995, 1996 and 1997 and the declining reservoir levels during the 2000-2007 drought. The creation of additional habitat has also allowed greater flexibility in the release levels at Fort Randall and Gavins Point, the lower two System projects.

The 2011 flood created large amounts of high elevation habitat. Since 2011 some of this habitat has eroded and vegetated. However, in 2015 a sufficient quantity remained to support high populations of breeding adults, which resulted in high fledge ratios.

The near-average runoff in 2015 resulted in rising pools during the nesting season, limiting habitat on the reservoirs and flooding nests. A detailed description of the factors affecting tern and plover nesting, fledge ratios and habitat conditions and creation activities by reservoir and river reach can be found in the Missouri River Recovery Program 2015 Annual Report (*www.moriverrecovery.org*).

The population distribution and productivity for terns and plovers for 2000 through 2015 are shown in ***Table 22*** and ***Table 23***, respectively. Productivity estimates for these birds on the Missouri River do not include terns and plovers raised in captivity from 1995 to 2002. Adult bird totals listed in ***Table 22*** and ***Table 23*** are considered breeders even though they may not have had nesting success. The term "fledglings/pair" refers to the number of young birds produced per breeding pair. The fledge ratio is an estimate, as the fate of every single fledgling is impossible to ascertain. Numbers for 2013 were not comparable to the numbers in this table because of the change in survey methodology. However, the estimates can be found in the MRRP 2013 Annual Report.

Table 22
Missouri River System - Interior Least Tern Survey Data

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013***	2014	2015
Fort Peck Lake																	
	Adults	0	0	0	2	0	0	2	2	0	0	0	0	0		0	0
	Fledglings/Pair	0	0	0	0	0	0	3	0	0	0	0	0			0	0
Fort Peck to Lake Sakakawea																	
	Adults	13	39	34	38	48	34	36	77	22	46	26	0	0		8	12
	Fledglings/Pair	0.15	0.97	0.59	0.63	0.50	2.18	1.17	1.38	1.45	0.87	1.00	0.00	0.00		0.00	0
Lake Sakakawea																	
	Adults	10	34	21	25	16	26	48	53	14	15	11	3	14		19	18
	Fledglings/Pair	0.20	0.76	0.86	0.56	0.88	0.31	0.71	0.72	2.57	1.07	0.00	0.00	0.29		0.11	0.89
Garrison to Lake Oahe																	
	Adults	105	125	126	144	142	157	139	123	73	108	134	0	105		131	157
	Fledglings/Pair	1.03	1.26	1.83	1.28	1.13	0.73	0.81	1.06	1.34	0.48	1.36	0.00	0.99		0.55	1.06
Lake Oahe/Lake Sharpe																	
	Adults	85	94	106	70	73	131	128	186	111	71	48	39	100		89	93
	Fledglings/Pair	1.01	1.34	1.32	1.20	1.26	0.87	1.14	0.48	0.58	0.96	0.17	1.33	1.06		0.29	0.49
Ft. Randall to Niobrara																	
	Adults	72	71	84	50	71	76	55	74	58	23	10	0	87		99	155
	Fledglings/Pair	1.26	0.14	0.71	0.92	0.37	0.47	0.69	0.30	1.14	0.43	0.00	0.00	1.10		0.73	1.63
Lake Lewis and Clark																	
	Adults	44	58	46	46	13	4	0	85	225	214	272	231	211		131	164
	Fledglings/Pair	0.38	1.17	1.04	0.39	0.00	0.00	0.00	1.58	0.67	0.76	1.01	0.15	1.43		0.52	1.46
Gavins Point to Ponca																	
	Adults	149	232	314	366	359	476	383	410	278	211	159	0	209		243	318
	Fledglings/Pair	1.72	1.09	1.32	0.75	1.04	1.34	0.63	0.59	1.14	1.00	1.17	0	1.2		0.79	1.46
Total Adults		551	653	731	741	722	904	802**	1,010	781	696	650	273	726		720	917
Fledglings/Pair		1.22	1.04	1.27	0.87	0.95	1.09	0.80**	0.75	0.98	0.80	1.02	0.32	1.19		0.6	1.31

- Data not collected
* Partial Survey Results
{} No Birds Found
\+ Subsampling of Selected Nesting Areas
** Includes adults and fledglings from Lake Francis Case
*** 2013 data is not added due to survey methodology change. See 2013 MRRP Annual Report for additional information.

Notes: The data do not include least terns and piping plovers raised in captivity from 1995 to 2002. The data represent only wild fledged birds.
From 1990 to 2003 the 10-Year Least Tern Fledge Ratio was 0.70 (1990 and 2000 Biological Opinions).
From 2004 to current 5-year running average goal is 0.94 (2003 Amended Biological Opinion)
Data in this table may differ from previous reports. As information becomes available, this table is updated.
Refer to previous MRBWM Summary Reports for 1986-1999 data.

Table 23
Missouri River System - Piping Plover Survey Data

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013**	2014	2015
Fort Peck Lake																	
	Adults	0	4	2	17	9	26	20	16	9	12	3	2	0		0	4
	Fledglings/Pair	0	1	2	0.35	2.22	1.08	1.2	0.5	0.22	0.33	0	0	0		0	0
Fort Peck to Lake Sakakawea																	
	Adults	4	3	2	6	0	2	5	0	0	0	0	0	0		0	0
	Fledglings/Pair	0	1.33	0	2.67	0	4	0.4	0	0	0	0	0	0		0	0
Lake Sakakawea																	
	Adults	277	424	469	528	738	746	430	399	363	85	38	24	200		155	252
	Fledglings/Pair	1.61	1.25	1.65	1.06	1.5	0.89	0.61	0.7	0.68	0.21	0.89	1.67	1.4		0.48	0.73
Garrison to Lake Oahe																	
	Adults	99	149	119	149	164	220	175	222	218	275	287	0	98		221	392
	Fledglings/Pair	1.41	1.53	2.03	1.66	1.16	0.8	0.77	0.97	1.37	0.94	0.84	0	1		2.05	1.26
Lake Oahe/Lake Sharpe																	
	Adults	141	184	203	301	372	364	331	273	281	158	44	20	125		210	251
	Fledglings/Pair	1.45	1.41	2.16	1.84	1.41	1.21	0.99	0.62	0.9	0.47	0.1	0.4	1.76		0.45	0.49
Ft. Randall to Niobrara																	
	Adults	62	38	35	37	42	42	37	21	26	16	6	0	43		106	145
	Fledglings/Pair	0.87	0.74	1.03	1.46	0.71	0.81	0.38	0	1	1	0	0	1.81		1.08	2.34
Lake Lewis and Clark																	
	Adults	28	34	44	14	0	24	4	20	57	122	152	134	179		186	188
	Fledglings/Pair	0.5	0.71	1.68	1.57	0	0.17	0.5	1.8	1.37	1.8	1.25	0.22	1.35		0.57	1.37
Gavins Point to Ponca																	
	Adults	186	218	260	286	262	340	309	300	320	238	74	2	137		238	380
	Fledglings/Pair	2.17	1.85	2.29	1.9	1.87	1.97	0.78	0.39	1.39	1.09	1.86	0	1.82		1.73	2.23
Total Adults		797	1054	1134	1338	1587	1764	1311	1251	1274	906	604	182	782		1116	1612
Fledglings/Pair		1.58	1.41	1.91	1.5	1.49	1.15	0.78	0.66	1.06	0.94	1.01	0.43	1.49		1.12	1.4

- Data not collected
* Partial Survey Results
{} No Birds Found
+ Subsampling of Selected Nesting Areas
** 2013 data is not added due to survey methodology change. See 2013 MRRP Annual Report for additional information.

Notes: The data do not include least terns and piping plovers raised in captivity from 1995 to 2002. The data represent only wild fledged birds.
From 1990 to 2000 the 15-Year Piping Plover Fledge Ratio Goal was 1.44 (1990 Biological Opinion).
From 2001 to 2003 the goal was 1.13 (2000 Biological Opinion)
From 2004 to current the 10-year running average goal is 1.22 (2003 Amended Biological Opinion)
Data in this table may differ from previous reports. As information becomes available, this table is updated.
Refer to previous MRBWM Summary Reports for 1986-1999 data.

9. Cultural Resources

As acknowledged in the 2004 Programmatic Agreement (PA) for the Operation and Management of the Missouri River Main Stem System, wave action and the fluctuation of reservoirs levels results in erosion along the banks of the reservoirs. Shoreline erosion can have severe effects on cultural resources. During drought conditions, cultural resource sites are exposed as the pool levels decline.

The PA established a shared stewardship philosophy of protection of historic properties. The objective of a PA is to address "…potential adverse effects of complex projects or multiple undertakings…" and to collaboratively develop a preservation program that would avoid, minimize and mitigate the effects of the System regulation. All Tribes, whether signatory to the PA or not, may request government-to-government consultation on System regulation and the resulting effect on historic and cultural properties and other resources.

A Cultural Resource Program Five Year Plan was developed in consultation with Tribes, States, Agencies and interested parties. This plan outlines how the Corps will accomplish its responsibilities under the National Historic Preservation Act and the PA. The plan includes inventory, testing and evaluation, mitigation and other specific activities that will allow the Corps to avoid, minimize and mitigate the adverse effects to cultural sites on the Corps' lands within the System. The "Final Five Year Plan", dated February 2012 (see website http://www.nwo.usace.army.mil/Missions/CivilWorks/CulturalResources.aspx) is currently being implemented.

Consultation meetings on the PA were held during the 2015 reporting period. The purpose of consultation meetings is to engage in communications and discuss whether operational changes are likely to affect historic and cultural properties, identify those properties and discuss how to address those affects.

A letter, dated August 28, 2015, was sent to the Basin Tribes offering consultation on the 2015-2016 AOP. To date, no Tribes have requested consultation nor provided verbal or written comments on the AOP. The Corps has semi-annual public meetings where Basin stakeholders provide input on the upcoming year's reservoir operations. One Tribe was represented in the fall AOP public meetings in October 2015.

The Corps actively addresses shoreline erosion which can damage or significantly alter cultural resource sites. During the 2015 reporting period, Omaha District completed construction on two large cultural resource shoreline protection projects at Big Bend and Oahe and anticipates the completion of two more at Gavins Point and Garrison in 2016.

This page intentionally left blank.

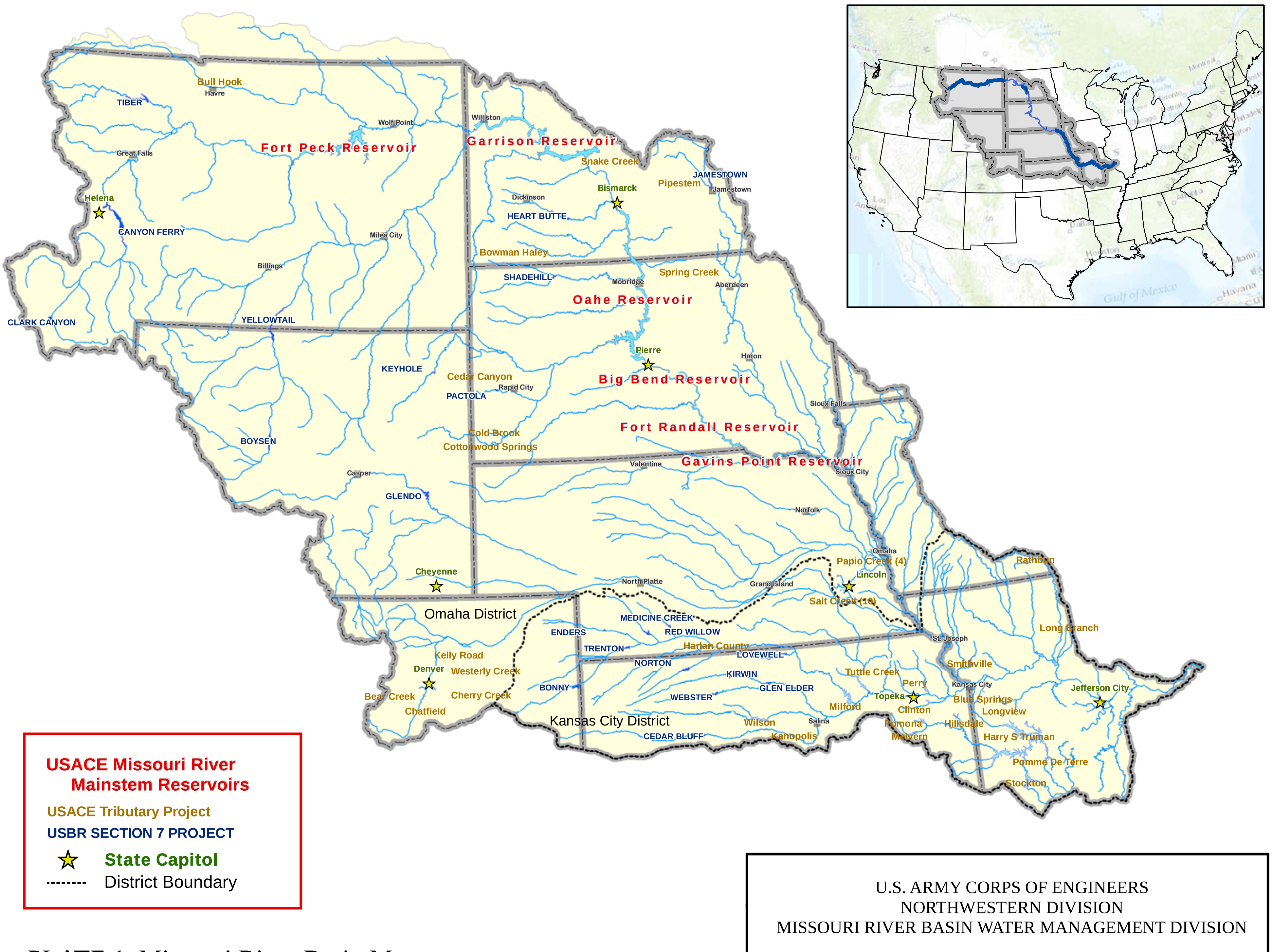


PLATE 1. Missouri River Basin Map.

Summary of Engineering Data -- Missouri River Mainstem System

Item No.	Subject	Fort Peck Dam - Fort Peck Lake	Garrison Dam - Lake Sakakawea	Oahe Dam - Lake Oahe
1	Location of Dam	Near Glasgow, Montana	Near Garrison, ND	Near Pierre, SD
2	River Mile - 1960 Mileage	Mile 1771.5	Mile 1389.9	Mile 1072.3
3	Total & incremental drainage areas in square miles	57,500	181,400 (2) 123,900	243,490 (1) 62,090
4	Approximate length of full reservoir (in valley miles)	134, ending near Zortman, MT	178, ending near Trenton, ND	231, ending near Bismarck, ND
5	Shoreline in miles (3)	1520 (elevation 2234)	1340 (elevation 1837.5)	2250 (elevation 1607.5)
6	Average total & incremental inflow in cfs	10,200	25,600 15,400	28,900 3,300
7	Max. discharge of record near damsite in cfs	137,000 (June 1953)	348,000 (April 1952)	440,000 (April 1952)
8	Construction started - calendar yr.	1933	1946	1948
9	In operation (4) calendar yr.	1940	1955	1962
	Dam and Embankment			
10	Top of dam, elevation in feet msl	2280.5	1875	1660
11	Length of dam in feet	21,026 (excluding spillway)	11,300 (including spillway)	9,300 (excluding spillway)
12	Damming height in feet (5)	220	180	200
13	Maximum height in feet (5)	250.5	210	245
14	Max. base width, total & w/o berms in feet	3500, 2700	3400, 2050	3500, 1500
15	Abutment formations (under dam & embankment)	Bearpaw shale and glacial fill	Fort Union clay shale	Pierre shale
16	Type of fill	Hydraulic & rolled earth fill	Rolled earth filled	Rolled earth fill & shale berms
17	Fill quantity, cubic yards	125,628,000	66,500,000	55,000,000 & 37,000,000
18	Volume of concrete, cubic yards	1,200,000	1,500,000	1,045,000
19	Date of closure	24 June 1937	15 April 1953	3 August 1958
	Spillway Data			
20	Location	Right bank - remote	Left bank - adjacent	Right bank - remote
21	Crest elevation in feet msl	2225	1825	1596.5
22	Width (including piers) in feet	820 gated	1336 gated	456 gated
23	No., size and type of gates	16 - 40' x 25' vertical lift gates	28 - 40' x 29' Tainter	8 - 50' x 23.5' Tainter
24	Design discharge capacity, cfs	275,000 at elev 2253.3	827,000 at elev 1858.5	304,000 at elev 1644.4
25	Discharge capacity at maximum operating pool in cfs	230,000	660,000	80,000
	Reservoir Data (6)			
26	Max. operating pool elev. & area	2250 msl 245,000 acres	1854 msl 383,000 acres	1620 msl 386,000 acres
27	Max. normal op. pool elev. & area	2246 msl 240,000 acres	1850 msl 365,000 acres	1617 msl 362,000 acres
28	Base flood control elev & area	2234 msl 211,000 acres	1837.5 msl 308,000 acres	1607.5 msl 311,000 acres
29	Min. operating pool elev. & area	2160 msl 89,000 acres	1775 msl 125,000 acres	1540 msl 115,000 acres
	Storage allocation & capacity			
30	Exclusive flood control	2250-2246 971,000 a.f.	1854-1850 1,495,000 a.f.	1620-1617 1,107,000 a.f.
31	Flood control & multiple use	2246-2234 2,704,000 a.f.	1850-1837.5 4,211,000 a.f.	1617-1607.5 3,208,000 a.f.
32	Carryover multiple use	2234-2160 10,700,000 a.f.	1837.5-1775 12,951,000 a.f.	1607.5-1540 13,353,000 a.f.
33	Permanent	2160-2030 4,088,000 a.f.	1775-1673 4,794,000 a.f.	1540-1415 5,315,000 a.f.
34	Gross	2250-2030 18,463,000 a.f.	1854-1673 23,451,000 a.f.	1620-1415 22,983,000 a.f.
35	Reservoir filling initiated	November 1937	December 1953	August 1958
36	Initially reached min. operating pool	27 May 1942	7 August 1955	3 April 1962
37	Estimated annual sediment inflow	17,200 a.f./year 1073 yrs.	21,600 a.f./year 1,086 yrs.	14,800 a.f./year 1553 yrs.
	Outlet Works Data			
38	Location	Right bank	Right Bank	Right Bank
39	Number and size of conduits	2 - 24' 8" diameter (nos. 3 & 4)	1 - 26' dia. and 2 - 22' dia.	6 - 19.75' dia. upstream, 18.25' dia. downstream
40	Length of conduits in feet (8)	No. 3 - 6,615, No. 4 - 7,240	1529	3496 to 3659
41	No., size, and type of service gates	1 - 28' dia. cylindrical gate 6 ports, 7.6' x 8.5' high (net opening) in each control shaft	1 - 18' x 24.5' Tainter gate per conduit for fine regulation	1 - 13' x 22' per conduit, vertical lift, 4 cable suspension and 2 hydraulic suspension (fine regulation)
42	Entrance invert elevation (msl)	2095	1672	1425
43	Avg. discharge capacity per conduit & total	Elev. 2250 22,500 cfs - 45,000 cfs	Elev. 1854 30,400 cfs - 98,000 cfs	Elev. 1620 18,500 cfs - 111,000 cfs
44	Present tailwater elevation (ft msl)	2032-2036 5,000 - 35,000 cfs	1669-1677 15,000- 60,000 cfs	1422-1427 20,000-55,000 cfs
	Power Facilities and Data			
45	Avg. gross head available in feet (14)	194	161	174
46	Number and size of conduits	No. 1-24'8" dia., No. 2-22'4" dia.	5 - 29' dia., 25' penstocks	7 - 24' dia., imbedded penstocks
47	Length of conduits in feet (8)	No. 1 - 5,653, No. 2 - 6,355	1829	From 3,280 to 4,005
48	Surge tanks	PH#1: 3-40' dia., PH#2: 2-65' dia.	65' dia. - 2 per penstock	70' dia., 2 per penstock
49	No., type and speed of turbines	5 Francis, PH#1-2: 128.5 rpm, 1-164 rpm , PH#2-2: 128.6 rpm	5 Francis, 90 rpm	7 Francis, 100 rpm
50	Discharge cap. at rated head in cfs	PH#1, units 1&3 170', 2-140' 8,800 cfs, PH#2-4&5 170'-7,200 cfs	150' 41,000 cfs	185' 54,000 cfs
51	Generator nameplate rating in kW	1&3: 43,500; 2: 18,250; 4&5: 40,000	3 - 121,600, 2 - 109,250	112,290
52	Plant capacity in kW	185,250	583,300	786,030
53	Dependable capacity in kW (9)	181,000	388,000	534,000
54	Avg. annual energy, million kWh (12)	1,040	2,258	2,629
55	Initial generation, first and last unit	July 1943 - June 1961	January 1956 - October 1960	April 1962 - June 1963
56	Estimated cost September 1999 completed project (13)	$158,428,000	$305,274,000	$346,521,000

Summary of Engineering Data -- Missouri River Mainstem System

Big Bend Dam - Lake Sharpe	Fort Randall Dam - Lake Francis Case	Gavins Point Dam - Lewis & Clark Lake	Total	Item No.
21 miles upstream Chamberlain, SD	Near Lake Andes, SD	Near Yankton, SD		1
Mile 987.4	Mile 880.0	Mile 811.1		2
249,330 (1) 5,840	263,480 (1) 14,150	279,480 (1) 16,000		3
80, ending near Pierre, SD	107, ending at Big Bend Dam	25, ending near Niobrara, NE	755 miles	4
200 (elevation 1420)	540 (elevation 1350)	90 (elevation 1204.5)	5,940 miles	5
28,900	30,000 1,100	32,000 2,000		6
440,000 (April 1952)	447,000 (April 1952)	480,000 (April 1952)		7
1959	1946	1952		8
1964	1953	1955		9
1440	1395	1234		10
10,570 (including spillway)	10,700 (including spillway)	8,700 (including spillway)	71,596	11
78	140	45	863 feet	12
95	165	74		13
1200, 700	4300, 1250	850, 450		14
Pierre shale & Niobrara chalk	Niobrara chalk	Niobrara chalk & Carlile shale		15
Rolled earth, shale, chalk fill	Rolled earth fill & chalk berms	Rolled earth & chalk fill		16
17,000,000	28,000,000 & 22,000,000	7,000,000	358,128,000 cu. yds	17
540,000	961,000	308,000	5,554,000 cu. yds.	18
24 July 1963	20 July 1952	31 July 1955		19
Left bank - adjacent	Left bank - adjacent	Right bank - adjacent		20
1385	1346	1180		21
376 gated	1000 gated	664 gated		22
8 - 40' x 38' Tainter	21 - 40' x 29' Tainter	14 - 40' x 30' Tainter		23
390,000 at elev 1433.6	620,000 at elev 1379.3	584,000 at elev 1221.4		24
270,000	508,000	345,000		25
1423 msl 61,000 acres	1375 msl 102,000 acres	1210 msl 29,000 acres	1,206,000 acres	26
1422 msl 60,000 acres	1365 msl 94,000 acres	1208 msl 25,000 acres	1,146,000 acres	27
1420 msl 57,000 acres	1350 msl 76,000 acres	1204.5 msl 21,000 acres	984,000 acres	28
1415 msl 51,000 acres	1320 msl 36,000 acres	1204.5 msl 21,000 acres	437,000 acres	29
1423-1422 61,000 a.f.	1375-1365 986,000 a.f.	1210-1208 54,000 a.f.	4,674,000 a.f.	30
1422-1420 118,000 a.f.	1365-1350 1,306,000 a.f.	1208-1204.5 79,000 a.f.	11,626,000 a.f.	31
	1350-1320 1,532,000 a.f.		38,536,000 a.f.	32
1420-1345 1,631,000 a.f.	1320-1240 1,469,000 a.f.	1204.5-1160 295,000 a.f.	17,592,000 a.f.	33
1423-1345 1,810,000 a.f.	1375-1240 5,293,000 a.f.	1210-1160 428,000 a.f.	72,428,000 a.f.	34
November 1963	January 1953	August 1955		35
25 March 1964	24 November 1953	22 December 1955		36
5,300 a.f./year 430 yrs.	15,800 a.f./year 334 yrs.	2,700 a.f./year 159 yrs.	77,400	37
	Left Bank			38
None (7)	4 - 22' diameter	None (7)		39
	1013			40
	2 - 11' x 23' per conduit, vertical lift, cable suspension			41
1385 (11)	1229	1180 (11)		42
	Elev 1375 32,000 cfs - 128,000 cfs			43
1351-1355(10) 25,000-100,000 cfs	1228-1237 10,000-60,000 cfs	1153-1161 15,000-60,000 cfs		44
70	117	48	764 feet	45
None: direct intake	8 - 28' dia., 22' penstocks	None: direct intake		46
	1,074		55,083	47
None	59' dia, 2 per alternate penstock	None		48
8 Fixed blade, 81.8 rpm	8 Francis, 85.7 rpm	3 Kaplan, 75 rpm	36 units	49
67' 103,000 cfs	112' 44,500 cfs	48' 36,000 cfs		50
3 - 67,276, 5 - 58,500	40,000	44,100		51
494,320	320,000	132,300	2,501,200 kw	52
497,000	293,000	74,000	1,967,000 kw	53
982	1,727	724	9,360 million kWh	54
October 1964 - July 1966	March 1954 - January 1956	September 1956 - January 1957	July 1943 - July 1966	55
$107,498,000	$199,066,000	$49,617,000	$1,166,404,000	56

Remarks

(1) Includes 4,280 square miles of non-contributing areas.
(2) Includes 1,350 square miles of non-contributing areas.
(3) With pool at base of flood control.
(4) Storage first available for regulation of flows.
(5) Damming height is height from low water to maximum operating pool. Maximum height is from average streambed to top of dam.
(6) Based on latest available storage data.
(7) River regulation is attained by flows over low-crested spillway and through turbines.
(8) Length from upstream face of outlet or to spiral case.
(9) Based on 8th year (1961) of drought drawdown (From study 8-83-1985).
(10) Affected by level of Lake Francis case. Applicable to pool at elevation 1350.
(11) Spillway crest.
(12) 1967-2014 Average
(13) Source: Annual Report on Civil Works Activities of the Corps of Engineers. Extract Report Fiscal Year 1999.
(14) Based on Study 8-83-1985

Corps of Engineers, U.S. Army
Compiled by
Northwestern Division
Missouri River Region
April 2015

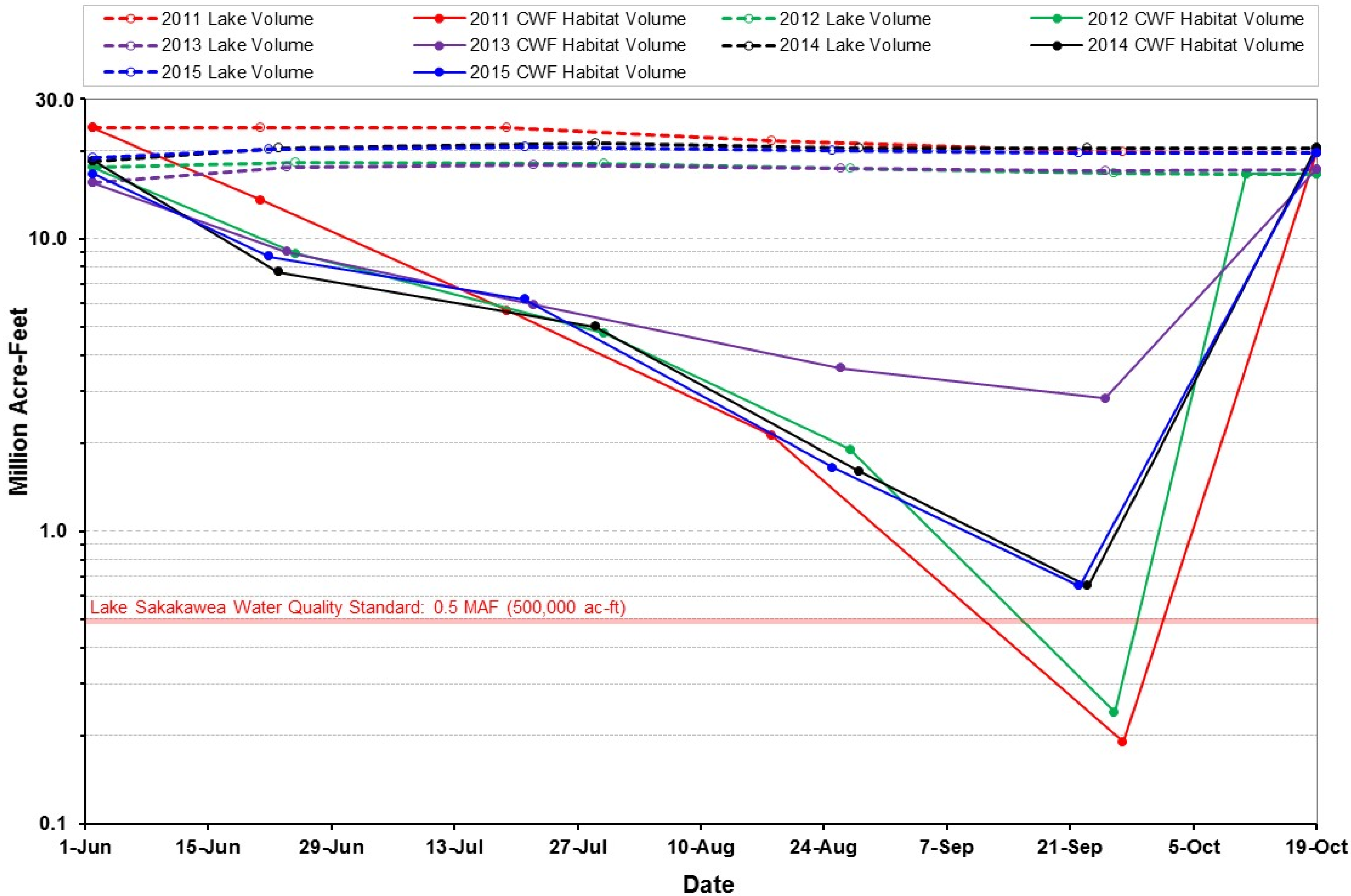


Plate 3. Garrison Reservoir - estimated reservoir and coldwater fishery (CWF) habitat 2011 through 2015.

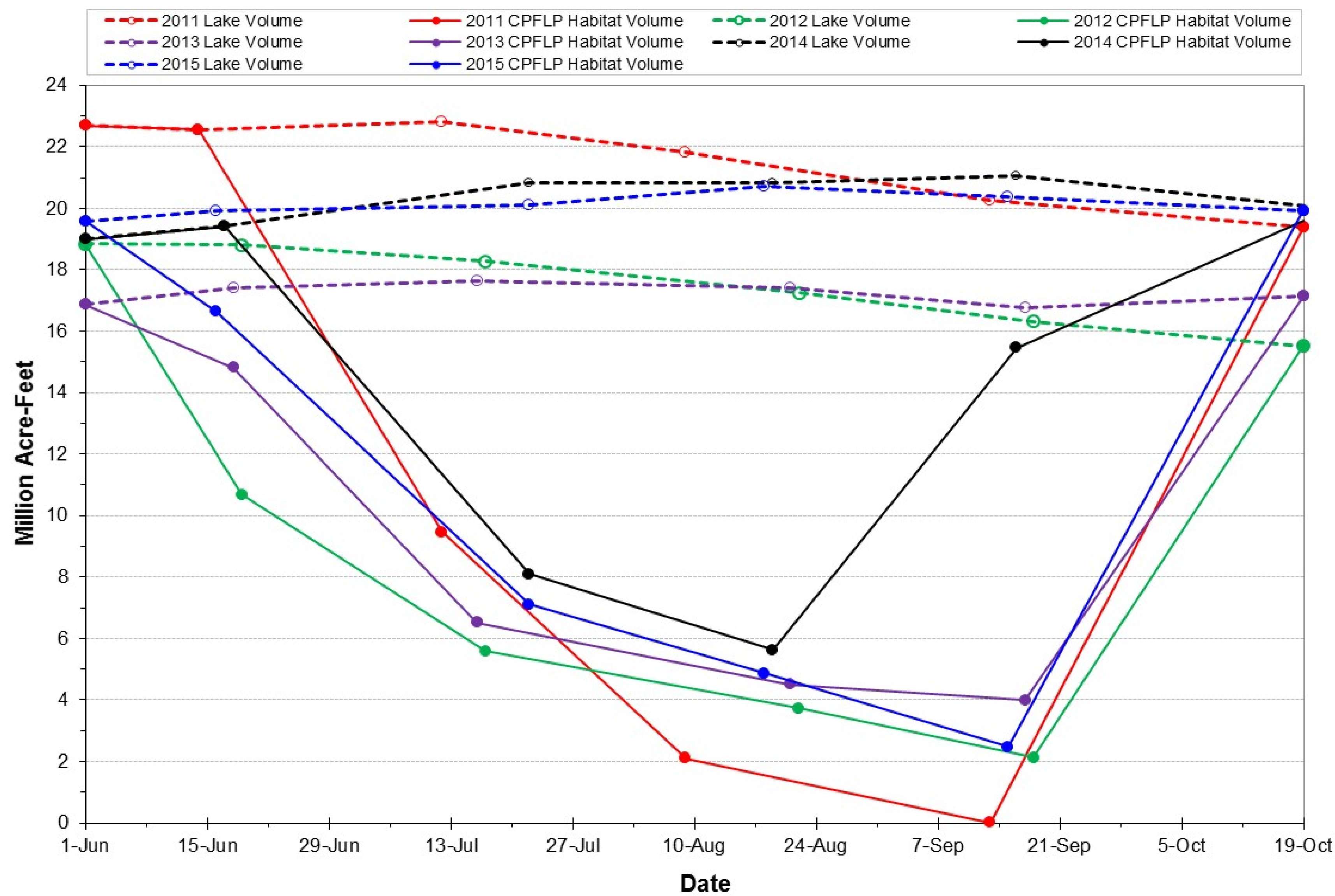


Plate 4. Oahe Reservoir - estimated reservoir and coldwater fishery (CWF) habitat 2011 through 2015.

This page intentionally left blank.