US Army Corps
of Engineers

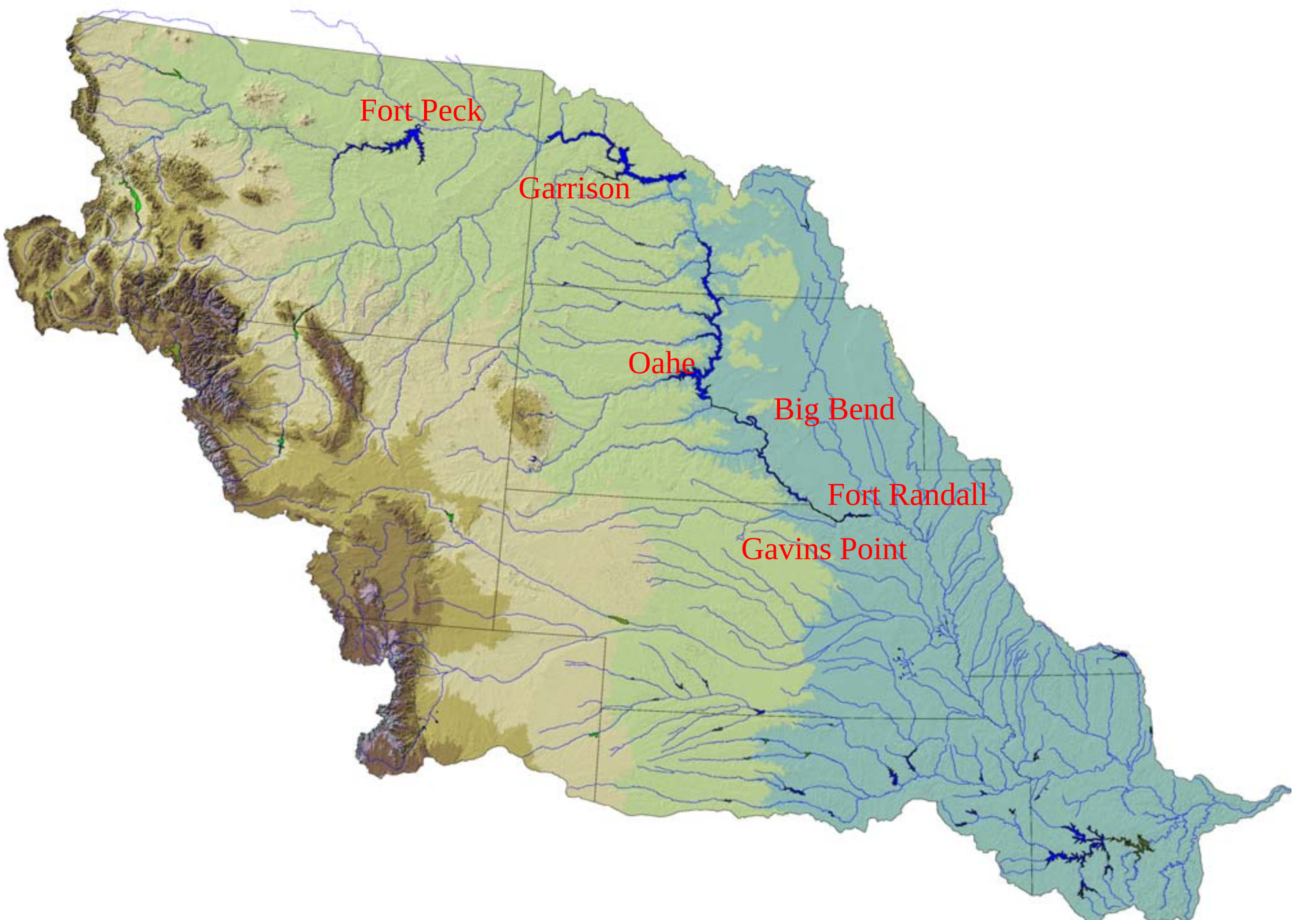
Missouri River Region
RCC
Reservoir Control Center

Northwestern Division

Missouri River Mainstem Reservoir System

Summary of Actual 2014 Regulation

Missouri River Basin



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

July 2015

Missouri River Mainstem Reservoir System

Summary of Actual 2014 Regulation

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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 2014 Regulation

I. FOREWORD

This document contains a summary of the actual regulation of the Missouri River Mainstem Reservoir System (System) for the 2014 Calendar Year (CY). Two other reports related to System regulation are also available, the ***System Description and Regulation*** and ***Final 2013-2014 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, NE 68102-4909, phone (402) 996-3841. The reports are also available on the MRBWM website at www.nwd-mr.usace.army.mil/rcc.

A 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 2014

A. General

This report summarizes the System regulation as it pertains to all eight congressionally-authorized purposes. During 2014 the System was regulated in accordance with the Master Water Control Manual (Master Manual) and the applicable provisions of the Final 2013-14 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 2014

Plains snowpack, mountain snowpack and general weather conditions in the Missouri River Basin (Basin) during the 2014 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

Extremely cold weather entered the Basin in early December 2013. End-of-November soil moisture conditions, as shown in ***Figure 1***, were wetter than normal in the upper Basin, especially in Montana, Wyoming and the western Dakotas. Fall soil moisture is important 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.

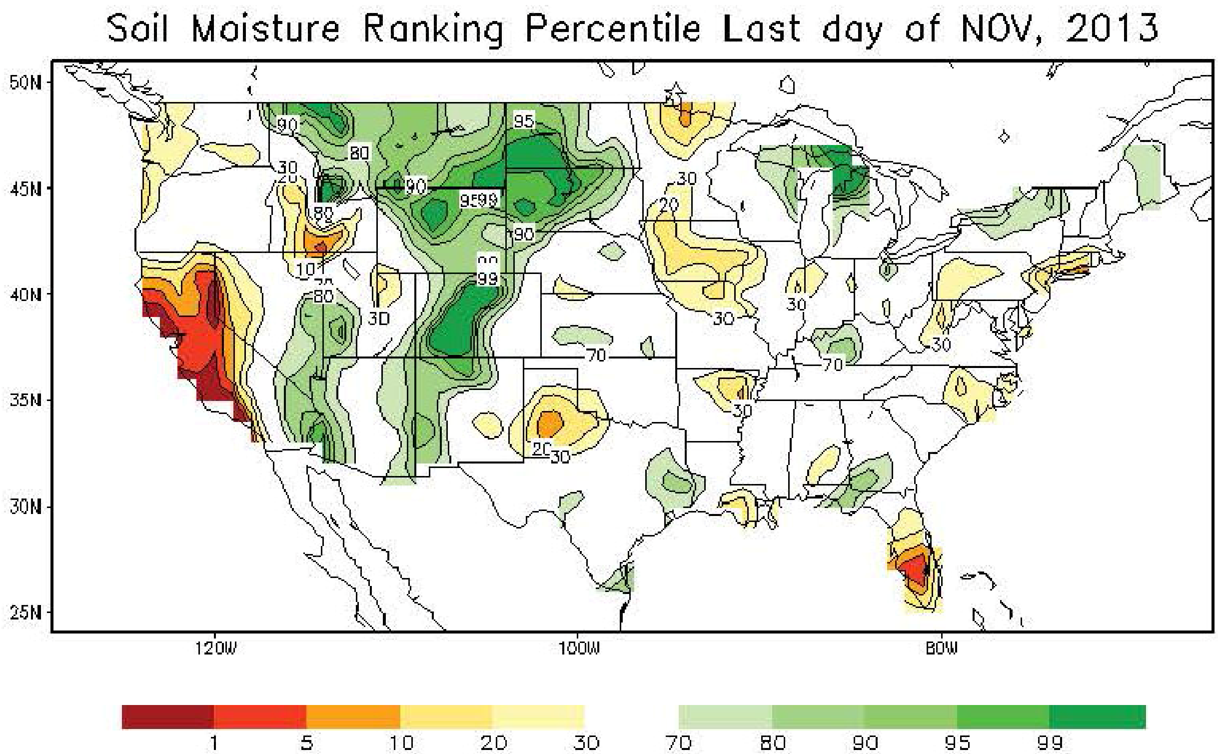


Figure 1. Soil moisture as percent of normal, November 30, 2013. Source: NOAA CPC

The snowpack across the Northern and Central Plains began accumulating in early December 2013. Daily-record snowfall totals for December 2 reached 6.2 inches in Billings, MT. From December 2-4, 11.2 inches blanketed Billings. Daily-record totals for December 3 include 8.0 inches in Valentine, NE. As seen in ***Figure 2***, most of entire Basin was covered with snow on December 10, 2013.

By the second week of December, frigid weather conditions persisted across the Northern Plains and Midwest holding temperatures at least 10 to 20 degrees Fahrenheit (deg F) below normal (see ***Figure 3***). On December 8, temperatures in Montana plunged to daily-record low levels in Havre (-37 deg F) and Miles City (-29 deg F).

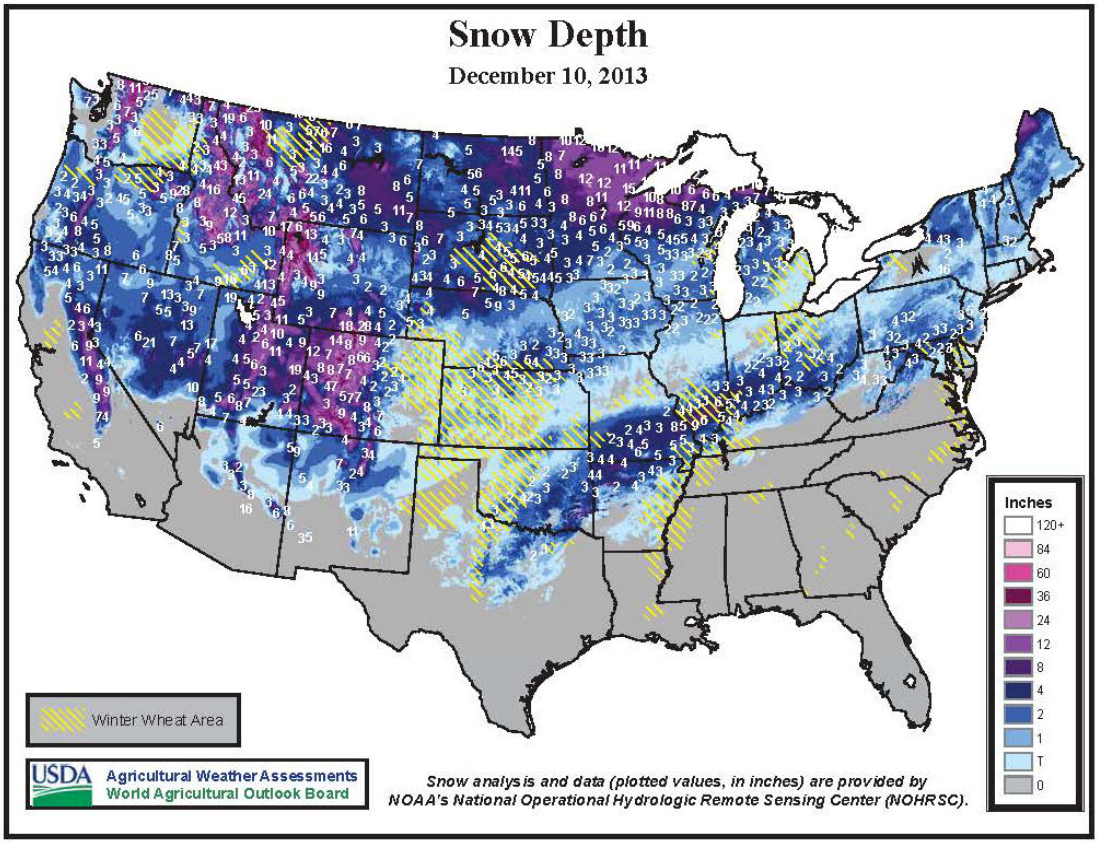


Figure 2. Snow depth in inches on December 10, 2013.

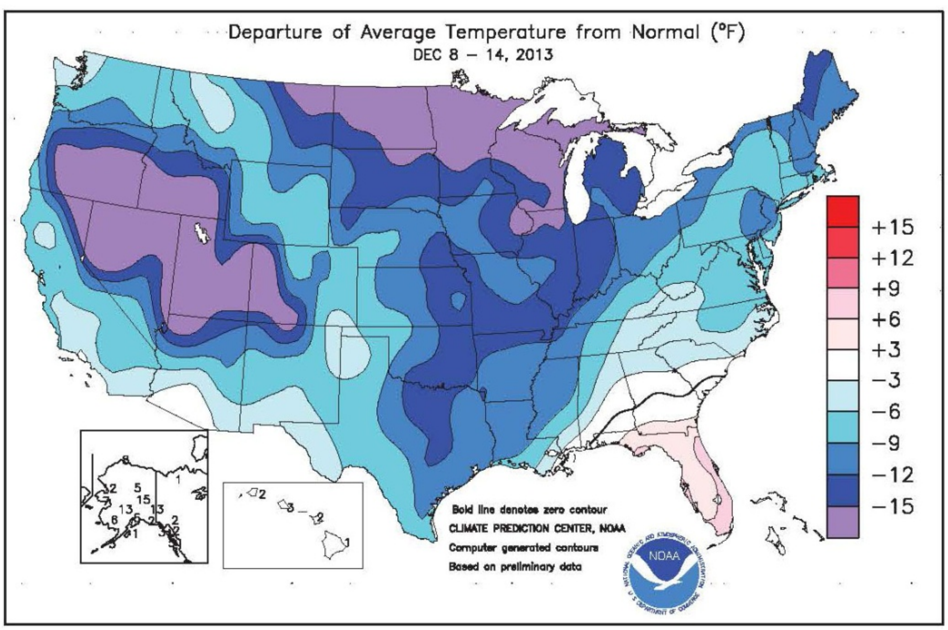


Figure 3. Departure from normal temperature, December 8-14, 2013.

In stark contrast to the first half of December, the second half was much warmer in the lower Basin and resulted in some melting of plains snow. Grand Island, NE recorded a daily high temperature of 67 deg F on December 18. In the upper Basin temperatures remained below freezing and precipitation fell as snow. Havre, MT received a daily record of 5.0 inches of snowfall on December 18. Casper, WY and Rapid City, SD received 7.1 inches and 5.5 inches of snowfall on December 19, respectively.

During the last few days of 2013 bitterly cold conditions intensified over the Northern Plains, holding temperatures 10 to 20 deg F below normal. On January 1 and 4, daily-record snowfall totals of 5.0 inches and 3.8 inches, respectively, were recorded in Billings, MT. See ***Figure 4*** for a plains snow depth map for January 5, 2014.

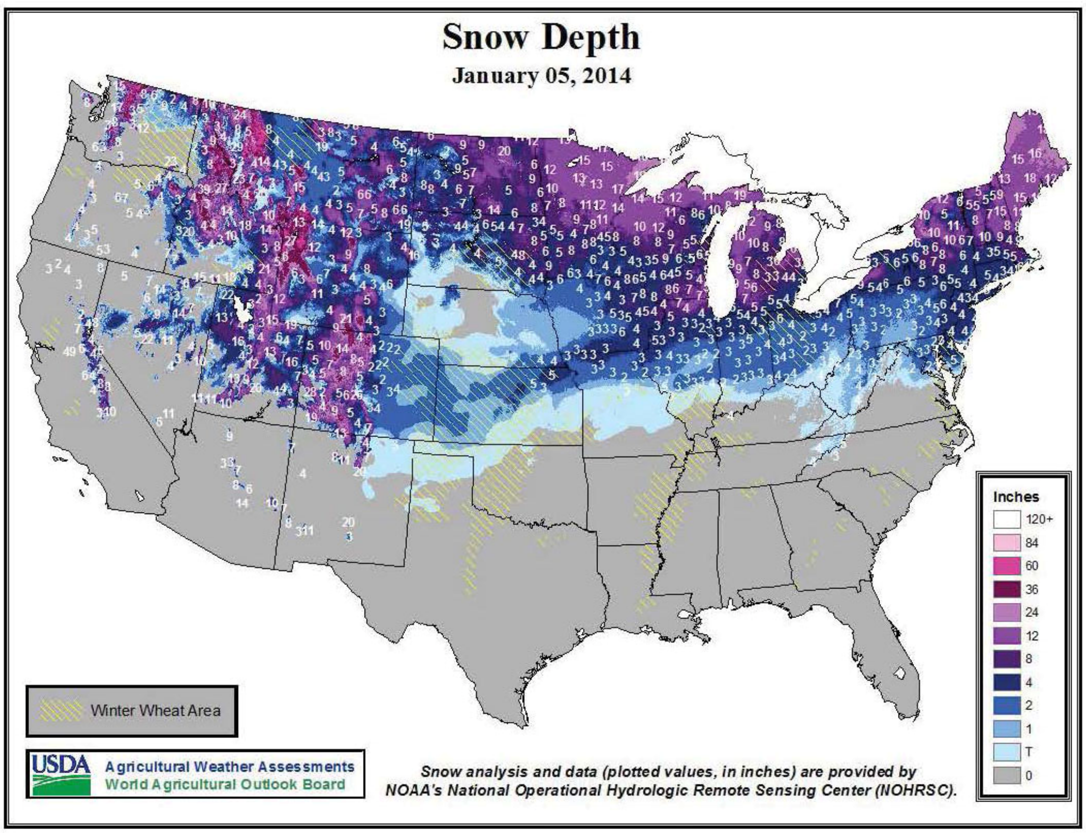


Figure 4. Snow depth in inches on January 5, 2014.

Another brutal cold wave entered the upper Basin in early January. At the height of the cold wave, wind chill temperatures of -45 to -60 deg F were common across the upper Midwest. Readings below -20 deg F stretched across Montana and North Dakota while temperatures were only slightly warmer in the rest of the Basin. During this cold spell, very little snow accumulated in the Basin. However, the warmer-than-normal temperatures and drier-than-normal precipitation in the latter half of January resulted in melting of most of the plains snow in the Basin.

In early February frigid temperatures returned to the Northern Plains where temperatures averaged 20 to 30 deg F below normal. During this period, a storm brought a wintery mix of heavy snow and ice into the upper Basin. Snow coverage in the contiguous U.S., which had been just 34 percent on January 28, topped 50 percent on February 1 and peaked at 67 percent on February 7. ***Figure 5*** shows the snow depth as of February 9, 2014, which was near the peak coverage period.

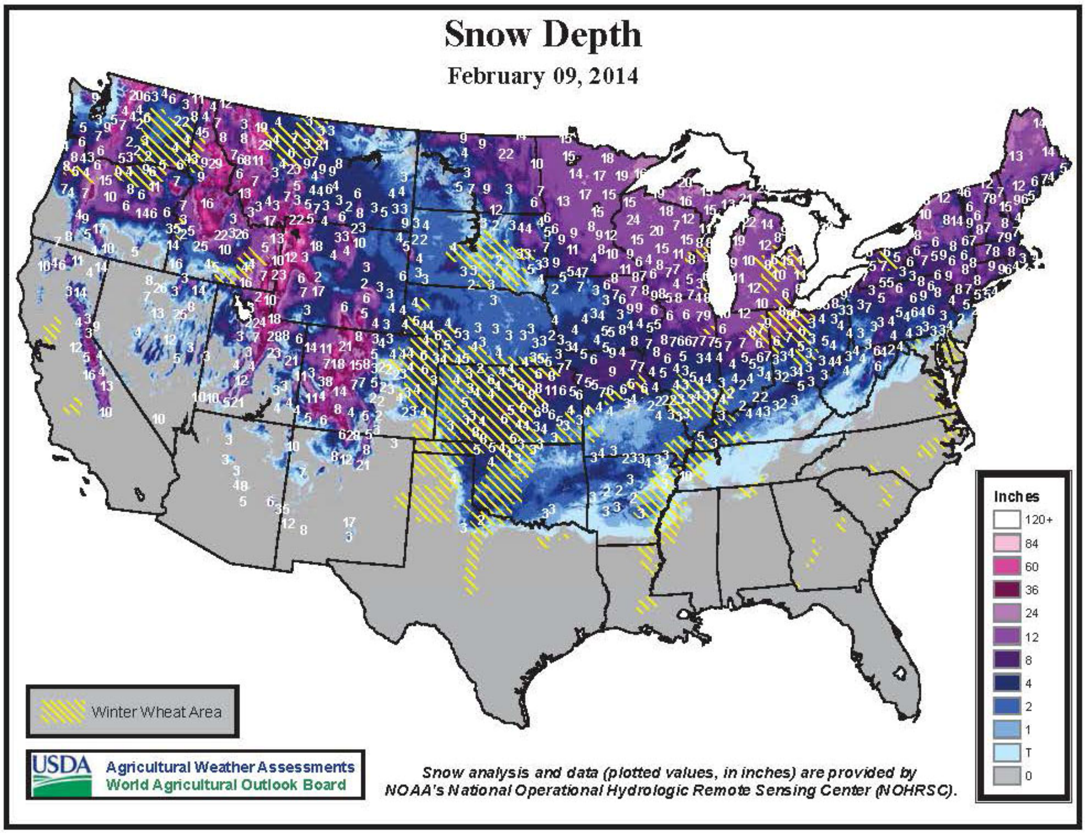


Figure 5. Snow depth in inches on February 9, 2014.

Figure 6 shows the modeled snow water equivalent (SWE) for February 9, 2014, which coincides with the estimated date of peak plains SWE in the Basin. The 2014 peak plains SWE was less than 1 inch in large portions of the upper Basin. SWE amounts in the eastern Dakotas varied from 1 to 3 inches. Overall, 2014 peak plains snow was less than what was observed in 2013 and significantly less than observed in the 2009-2011 period.

During the last week of February additional snow accumulated in the upper Basin. Billings, MT received 8.8 inches of snow on February 23 and recorded its snowiest February on record with 37.0 inches. The cold weather persisted through February into early March. In early March weekly temperatures averaged more than 20 deg F below normal in the Northern Plains. In South Dakota, Pierre experienced record-low temperatures of -20 deg F on March 1-3. Billings, MT experienced a record low of -18 deg F on March 1.

Plains snow accumulations in the upper Basin did not change appreciably during February through the early part of March. However, by the second week in March, a warm period with temperatures reaching as high as 70 deg F in Pierre, SD on March 9 resulted in the vast majority of the plains snow melting.

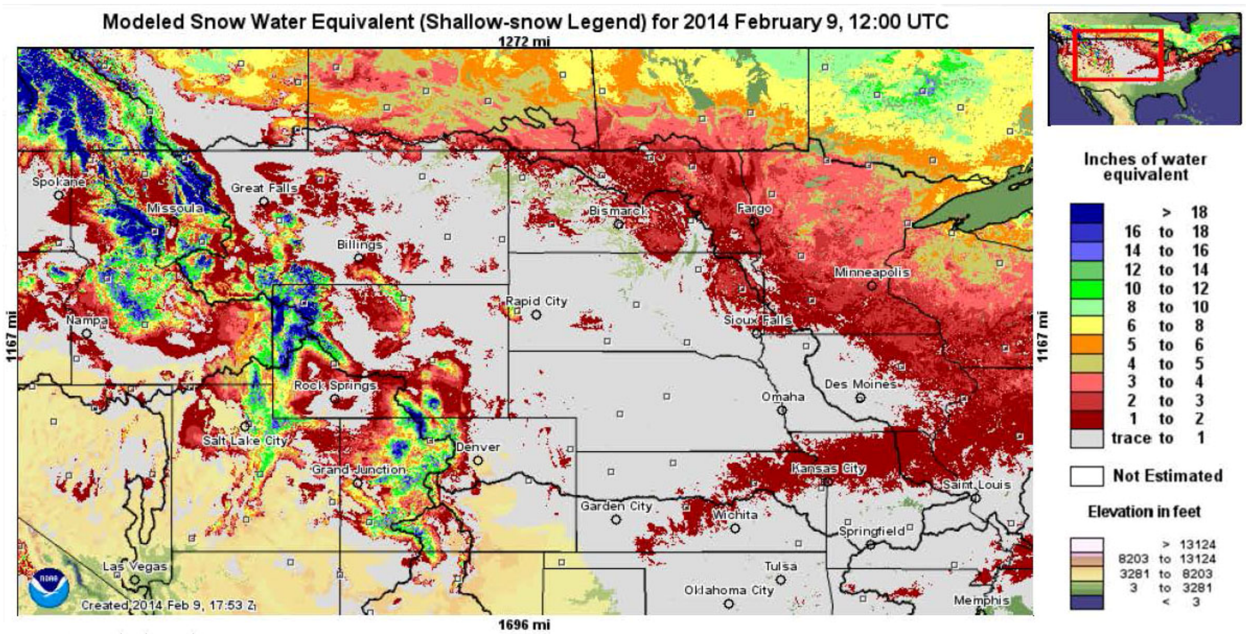


Figure 6. Missouri River Basin SWE on February 9, 2014. Source: NOAA National Operational Hydrologic Remote Sensing Center (NOHRSC).

Table 1 shows the seasonal snowfall totals during the winters of 2011-12, 2012-13 and 2013-14 in comparison to 1981-2010 seasonal average snowfall. Seasonal snowfall in this report is defined as the total snowfall from July to June of the following year. Of particular note is the significant snowfall in the Billings, MT area. While most areas of plains received near average snowfall in 2013-14, Billings received nearly twice its average annual snowfall. The 2013-14 total of 103.5 inches is the maximum amount of snowfall recorded at the Billings Logan International Airport monitoring location since record-keeping began in 1933.

Table 1
Missouri River Basin - Plains Snowfall (inches)

Location	2011-12 Total	2012-13 Total	2013-14 Total	Annual Average (1981-2010)
Billings, MT	38.6	40.4	103.5*	55.1
Glasgow, MT	25.7	62.3	30.4	34.6
Great Falls, MT	39.5	75.3	74.6	63.2
Bismarck, ND	13.6	57.3	40.5	51.2
Aberdeen, SD	17.5	62.8	32.7	38.1
Sioux Falls, SD	15.9	43.3	45.3	44.5
Watertown, SD	19.6	47.1	28.2	35.9
Sioux City, IA	18.3	45.1	23.8	34.8
Omaha, NE	20.4	35.7	17.8	26.4
Kansas City, MO	3.9	31.8	26.1	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 2013-14 mountain snowpack accumulation and melt pattern for each of the two reaches is illustrated in ***Figure 7***. 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***.

In both reaches the mountain snowpack accumulated at near average levels through the first several months, October through early February. The February 1 SWE amounts were 107 percent and 113 percent of average in the Total above Fort Peck and Total Fort Peck to Garrison reaches, respectively. During the last half of February, mountain snowfall significantly increased. The change in SWE was almost 2.5 inches, nearly 1 inch more than average. The March 1 SWE amounts were 121 percent and 131 percent of average in the Total above Fort Peck and Total Fort Peck to Garrison reaches, respectively. The SWE peaked at 133 percent and 141 percent of the average April 15 peak in the two reaches, respectively.

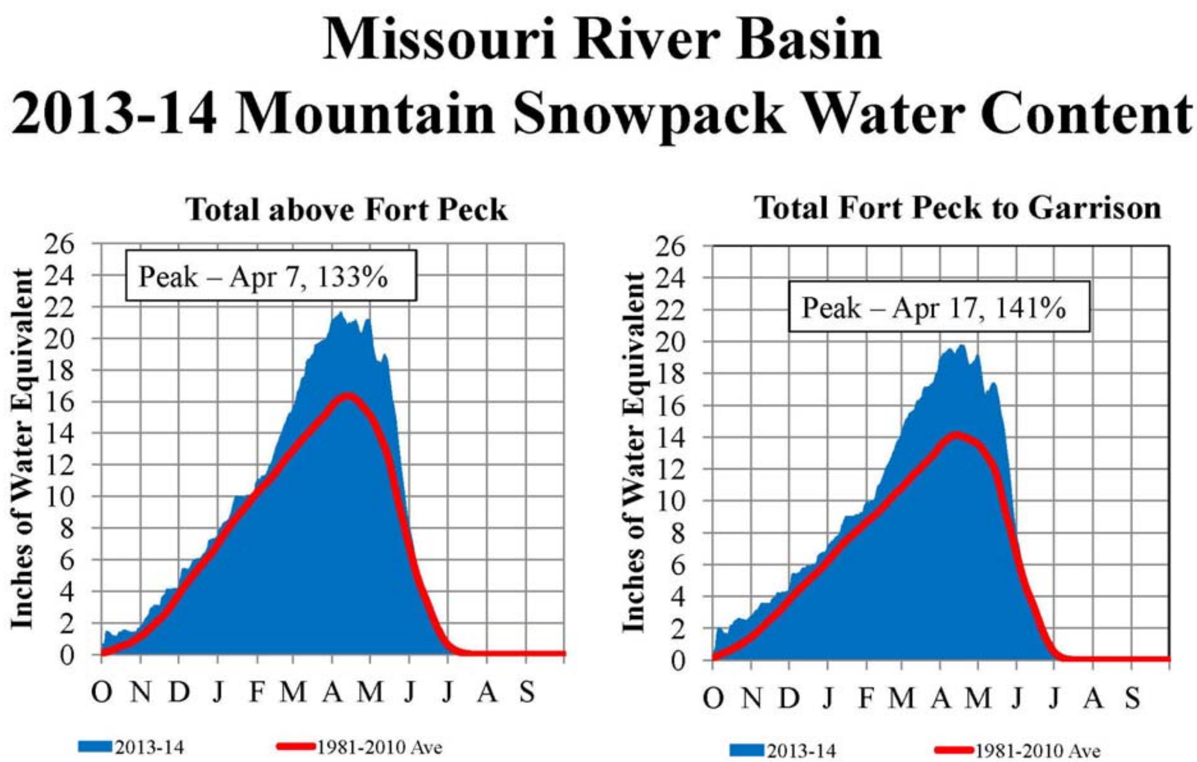


Figure 7. Missouri River Basin 2013-14 mountain SWE. Source: USDA-NRCS National Water and Climate Center.

Table 2
Mountain SWE Accumulation, 2013-14

Month	Above Fort Peck % Average	Fort Peck to Garrison % Average	Percent of Actual Peak Accumulation
November 1	146	180	9
December 1	115	115	26
January 1	110	113	44
February 1	107	113	64
March 1	121	131	79
April 1	132	139	97
Peak	April 7, 133	April 17, 141	100
May 1*	138 / 127	142 / 135	92
June 1*	128 / 49	120 / 53	39
July 1*	162 / 5	89 / 2	3
Melt-out	July 7	July 7	

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

3. Weather Conditions

The Basin experienced above normal precipitation in 2014 accompanied by warmer-than-normal temperatures in the western part of the Basin and cooler-than-normal temperatures in the eastern part of the Basin. Precipitation rankings by state are shown in ***Figure 8*** and indicate that Montana, Wyoming and Nebraska received above normal precipitation, while North Dakota and South Dakota received near-normal precipitation, compared to 120 years of statewide precipitation records. Precipitation was also near average in Kansas and Missouri. Temperature rankings by state are shown in ***Figure 9*** and indicate that Montana and Wyoming experienced above normal temperatures, while North Dakota and South Dakota experienced below normal temperatures. Nebraska and Kansas experienced normal temperatures compared to 120 years of statewide temperature records, while Iowa and Missouri experienced much below average temperatures.

Although 2014 precipitation ranged from near to above normal, the 3-month percent of normal precipitation images in ***Figure 10*** indicate substantial variation in precipitation both regionally and seasonally. During January-March precipitation in the Rocky Mountains of Montana and Wyoming was more than 150 percent of normal and was a major factor leading to the late increase in mountain snowpack in the upper Basin. In most of northeast Montana, North Dakota, South Dakota, Nebraska, Iowa, Kansas and Missouri precipitation ranged from 25 to 70 percent of normal resulting in low plains snowpack accumulation. El Niño/Southern Oscillation (ENSO) conditions during January-March were classified as ENSO-neutral by NOAA, though sea surface temperature anomalies were negative at that time.

During April-June, precipitation accumulations were generally drier than normal in Montana, Wyoming, eastern Kansas and Missouri and wetter than normal in North Dakota, South Dakota, Nebraska and Iowa. One notable event caused by very heavy late June precipitation was the record flooding in the Big Sioux River Basin. During July-September precipitation accumulations were below normal in eastern North Dakota, eastern South Dakota, Kansas and central Missouri. Accumulations were much wetter than normal in Montana, Wyoming, western North Dakota, western South Dakota and western Nebraska. Very heavy precipitation focused in Montana and the western Dakotas caused departures to be above 150 percent of normal. During October-December the upper Basin was much drier than normal in the plains including eastern Montana, eastern Wyoming, North Dakota, South Dakota, Nebraska and northwest Iowa. Only a few isolated areas received above normal precipitation during the three-month period including northwest Montana, northwest Wyoming, southeast Nebraska, northeast Kansas and central Missouri.

Temperatures also exhibited both regional and seasonal variation in the upper Basin as shown in the 3-month departure from normal temperature images in ***Figure 11***. Colder-than-normal temperatures occurred over the upper Basin during January-March, ranging from 2 deg F below normal in the Rocky Mountains to more than 6 deg F below normal in the plains. During April-June temperatures ranging from 1 to 4 deg F below normal continued to persist in the upper Basin, while temperatures were near normal in the lower Basin. During July-September temperatures were 2 to 4 deg F above normal in the Rocky Mountains and 2 to 6 deg F below normal in the plains extending from northeast Montana through Missouri.

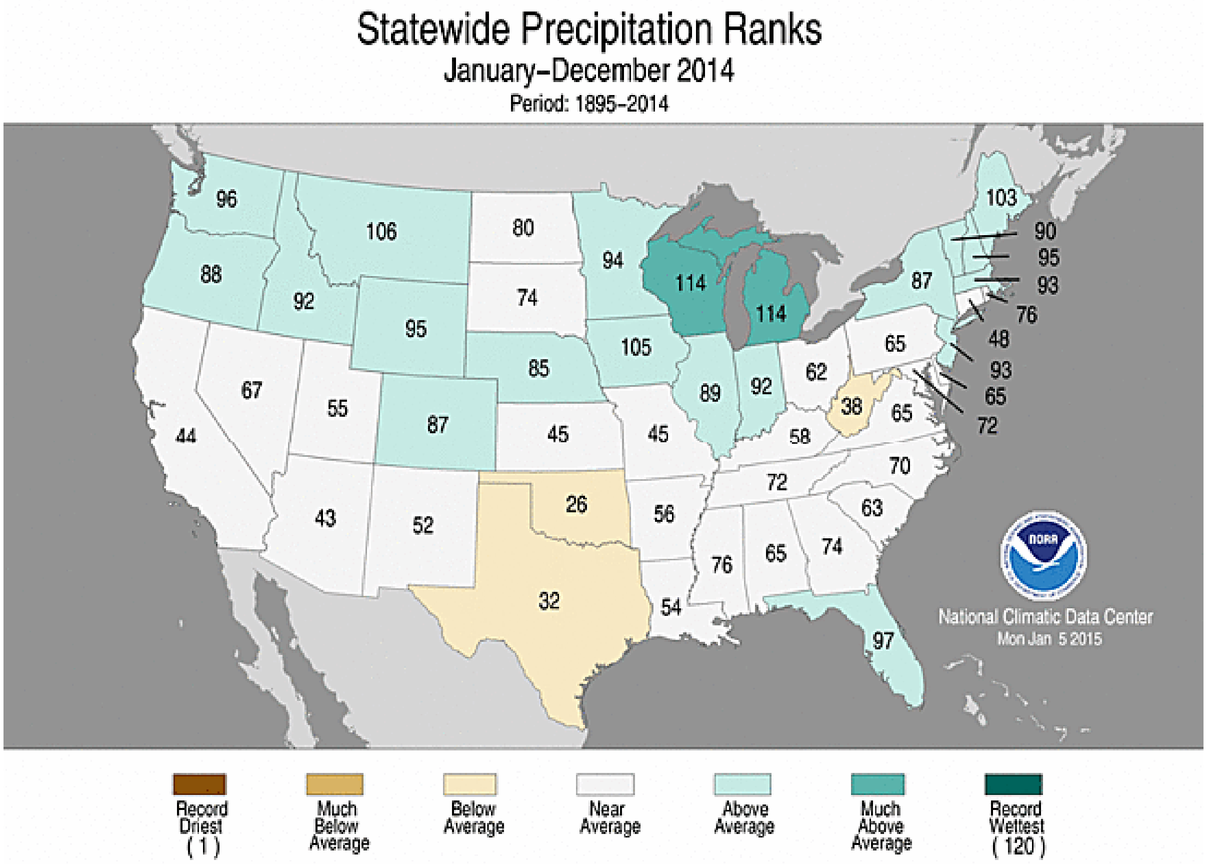


Figure 8. January-December 2014 statewide precipitation ranks. Source: NOAA NCDC

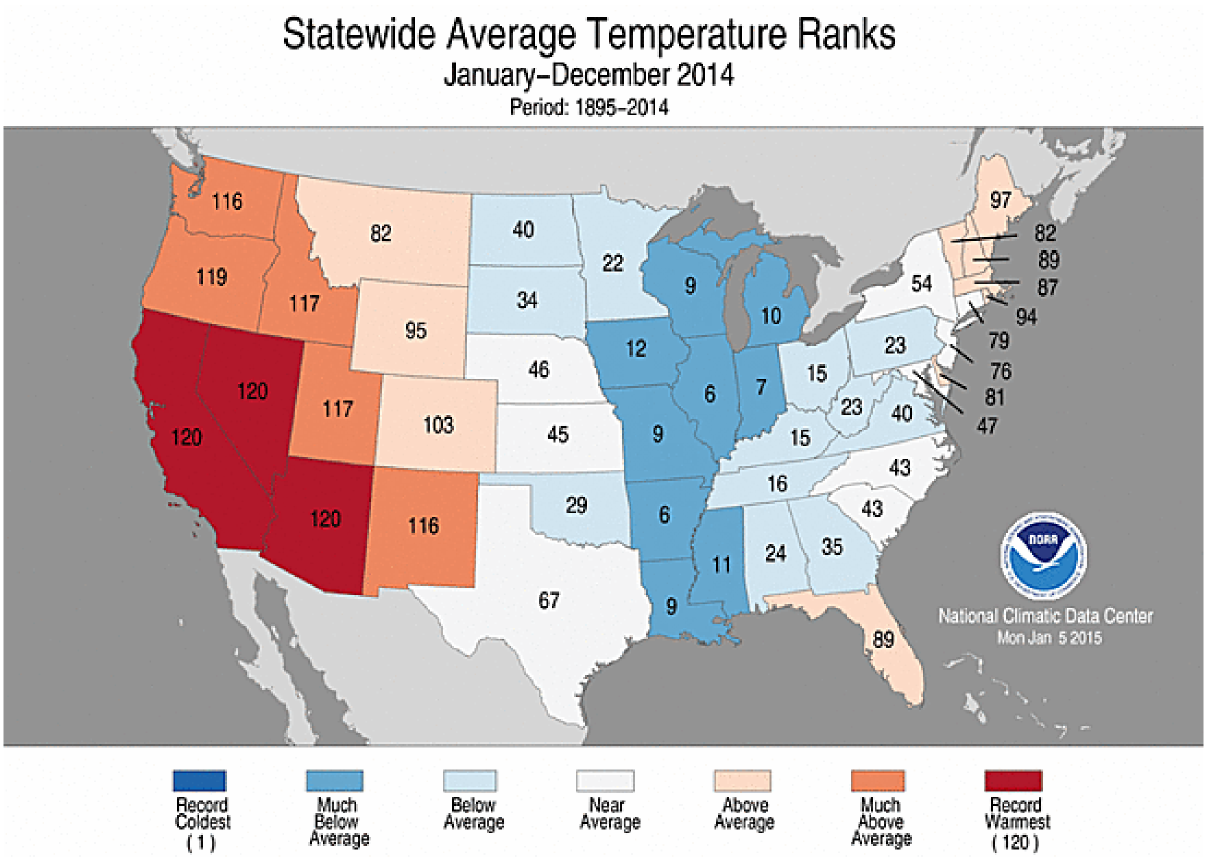


Figure 9. January-December 2014 statewide temperature ranks. Source: NOAA NCDC

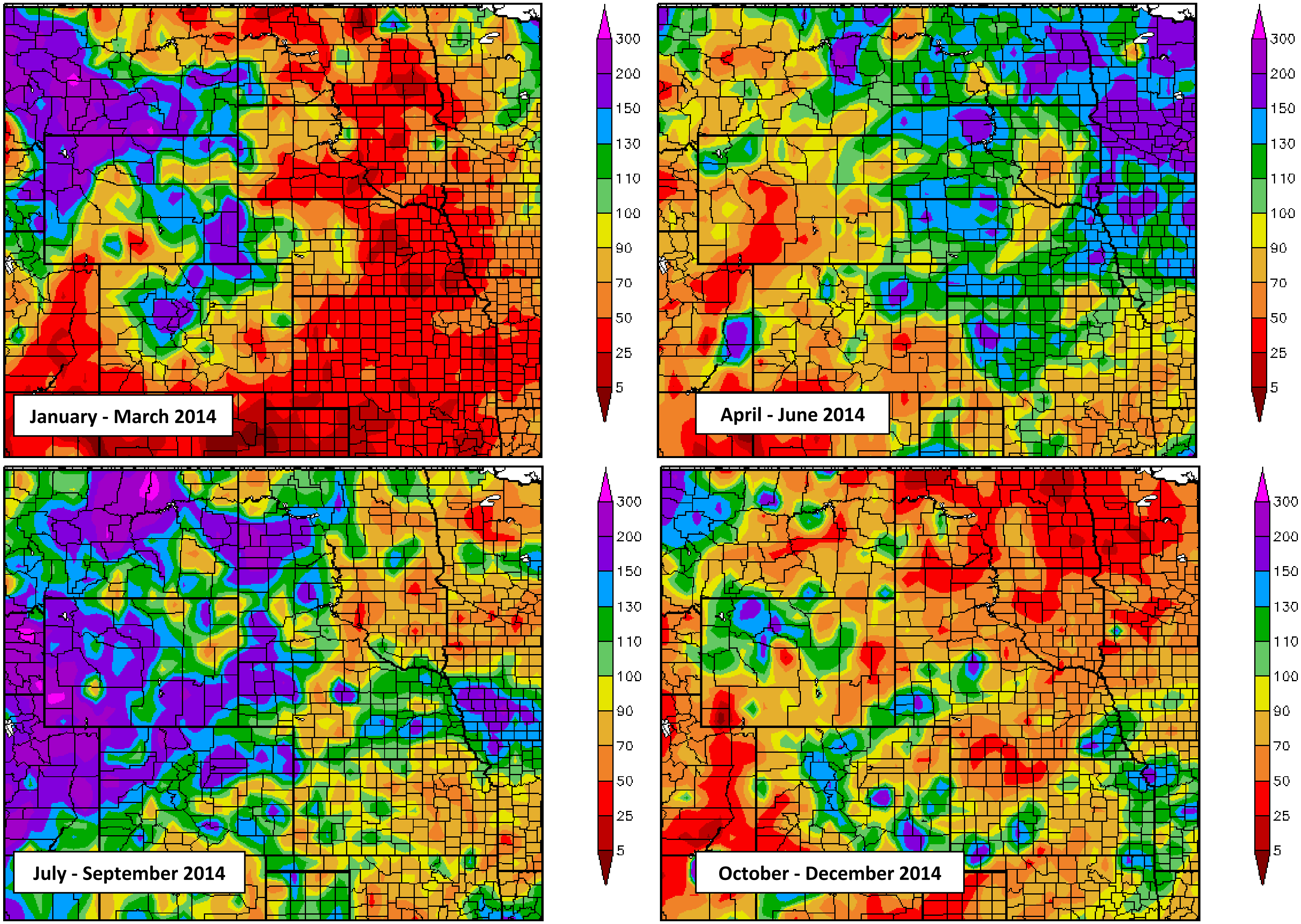


Figure 10. Percent of normal precipitation maps for the 2014 three-month periods: January-March, April-June, July-September and October-December. Reformatted from the High Plains Regional Climate Center Climate Summary Maps.

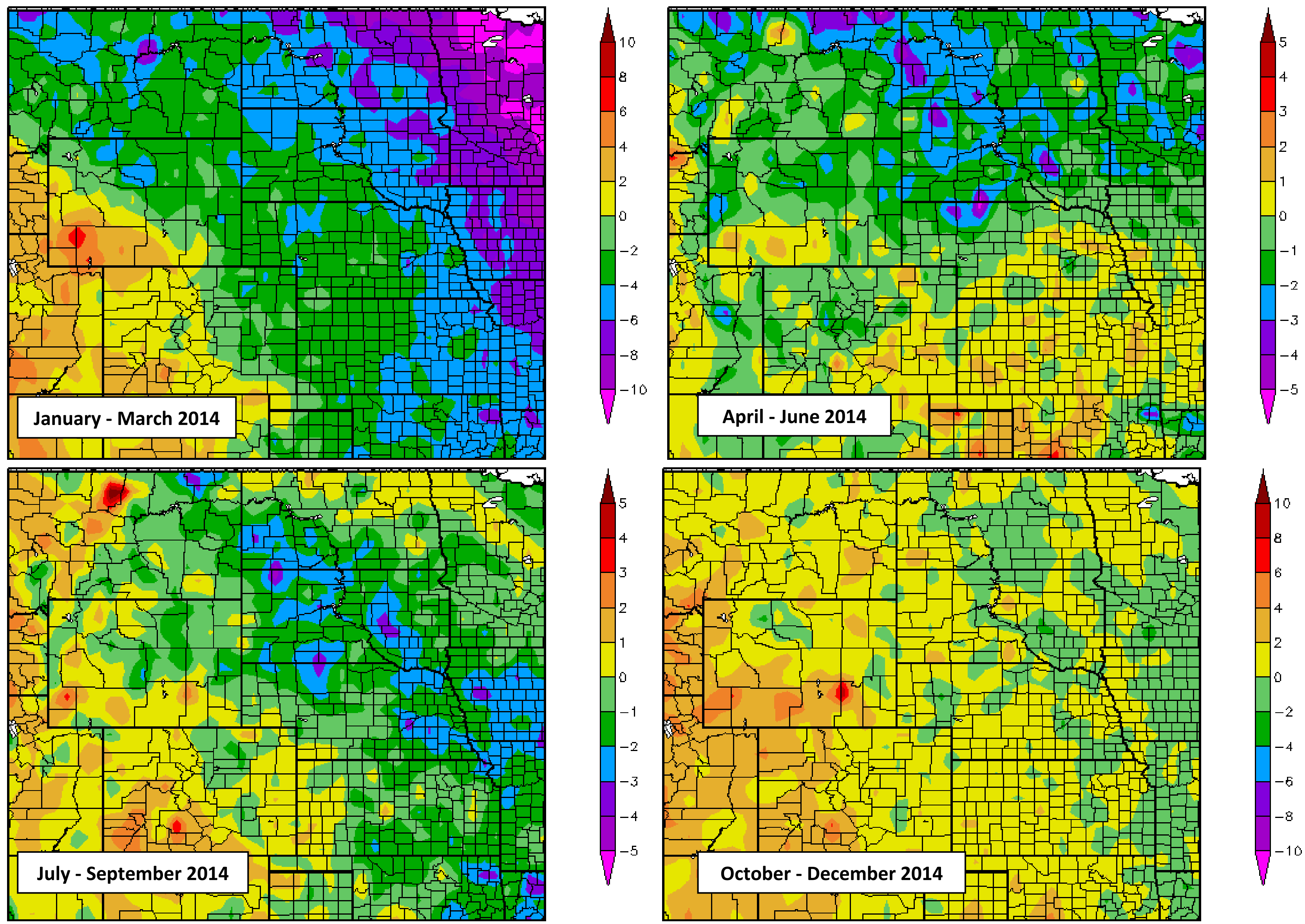


Figure 11. Departure from normal temperature (degrees F) for the 2014 three-month periods: January-March, April-June, July-September and October-December. Reformatted from the High Plains Regional Climate Center Climate Summary Maps.

During October-December, temperatures were warmer than normal in western portions of the upper Basin and near normal in eastern portions of the upper and lower Basin.

Figure 12 depicts drought magnitudes as defined by the National Drought Mitigation Center in January, April, July, and October 2014. Most of the upper Basin was not experiencing drought in January 2014; however, much of the lower Basin was in Abnormally Dry (D0) to Severe Drought (D2) conditions. Above average precipitation during January-March improved conditions in southwest Montana leaving a small area of Abnormally Dry (D0) conditions by April 8, 2014 and all drought conditions in Wyoming were removed. Below average precipitation in South Dakota and Nebraska caused a slight expansion of D0 conditions in southern and southeastern South Dakota and northern Nebraska, while drought conditions worsened in the lower Basin.

Drought conditions in the upper Basin in Montana and Wyoming did not change from April 8 to July 8. Above normal precipitation in June erased all drought conditions in far eastern portions of South Dakota, eastern Nebraska and western Iowa; however, continued dryness in central South Dakota, Nebraska and the lower Basin allowed drought conditions to persist. By October 7 some D0 conditions and a small area of D1 drought had developed in southwest Montana, while D0 conditions were beginning to develop in central and northeastern South Dakota. By October 7, nearly all signs of drought in Nebraska and northern Missouri had been erased, through drought conditions persisted in Kansas.

The following four sections provide descriptions of significant weather events that had an impact on System storage and releases.

a. January – March

Although temperatures during December 2013 were much colder than normal, January 2014 temperatures in Montana and Wyoming were 3 to 9 deg F above normal throughout the Rocky Mountains, slowing the accumulation of mountain snowpack despite above normal precipitation in the mountains. There were no significant plains snow accumulations events in January; however, periods of very cold temperatures caused rapid ice formation and stage reductions on the lower Missouri River several times. The first period of very cold temperatures and Missouri River ice formation occurred January 1-8. Overnight low temperatures at Sioux City, IA reached -11 deg F on January 2, -10 deg F on January 5, -13 deg F on January 6, and -9 deg F on January 7. The average temperature departure from January 1-8 was 14 deg F below normal. Two more periods of very cold temperatures occurred January 21-23 and January 27-28. Overnight low temperatures ranging from -3 to -6 deg F occurred at Sioux City from January 21-23 preceded by high winds with gusts of 41 mph. The January 27-28 cold period produced overnight low temperatures of -11 and -15 deg F and average daily temperature departures of -22 and -20 deg F, respectively. At Bismarck, ND the overnight low reached -23 deg F on January 2, and overnight low temperatures continued to dip below 0 deg F through January 8. Very cold temperatures returned during the final two weeks of January.

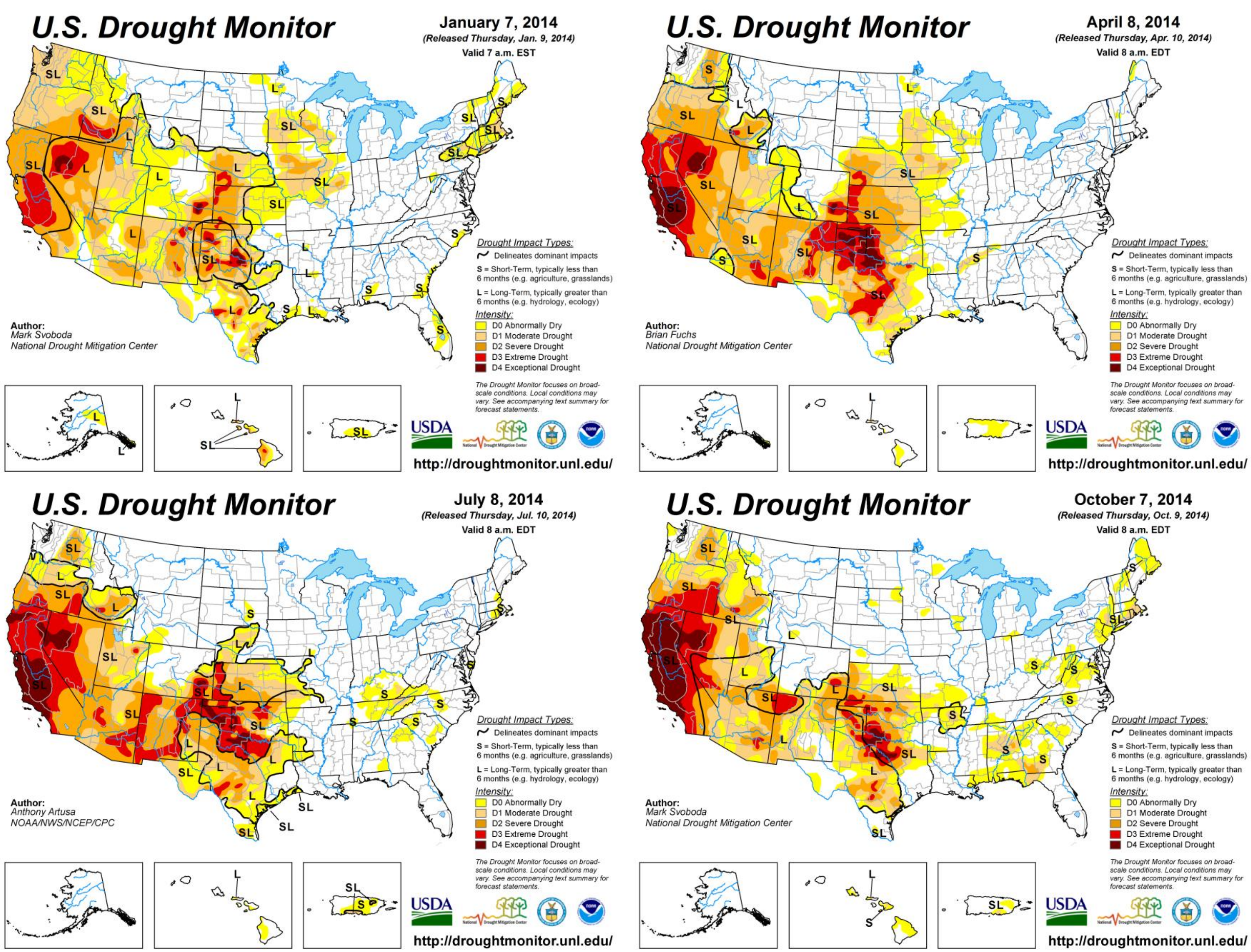


Figure 12. The National Drought Mitigation Center's drought maps for early January, April, July and October 2014.

February precipitation was above normal in the Rocky Mountains and below normal in the plains. February temperatures were well below normal throughout the entire month. Monthly departures ranged from 8 deg F below normal in southern South Dakota and Nebraska to more than 10 deg F below normal in Montana and North Dakota. Temperatures in the central Rockies were less severe; however, the rate of mountain snowpack accumulation increased due to the combination of above normal precipitation and below normal temperatures. Despite the cold temperatures in the plains, very little plains snow accumulated in February.

Periods of very cold temperatures in the plains during February caused additional ice formation on the mainstem of the Missouri River. The first significant February cold period occurred February 5-10. Overnight low temperatures at Sioux City, IA fell below -10 deg F February 6, 7, and 10 with average daily temperature departures of 23, 20 and 22 deg F below normal, respectively, being recorded. At Bismarck, ND the February 2014 temperature was 8.5 deg F below normal, and negative temperature departures occurred 22 of 28 days in February. The coldest overnight low temperature at Bismarck in February was -18 deg F on February 10. A second severe cold outbreak occurred from February 25 through March 8. Daily temperature departures ranged from 11 to 22 deg F below normal at Sioux City, IA through the end of February, and 22 to 34 deg F below normal from March 1-3. At Bismarck, daily temperature departures ranged from 13 to 26 deg F below normal February 24-28, and 16 to 33 deg F below normal March 1-3.

March precipitation in the Rocky Mountains and much of Wyoming was greater than 150 percent of normal, while in the Dakotas and the lower Basin, precipitation was less than 50 percent of normal. The above normal precipitation in the Rocky Mountains combined with below normal temperatures and caused snowpack accumulation rates to increase during March.

Temperatures were below normal I March; however warm temperatures March 10-20 caused most of the plains snowpack to melt. The highest temperatures observed during this time period were 64 deg F at Glasgow, MT; 62 deg F at Bismarck, ND; and 69 deg F at Sioux City, IA, all on March 13. As a result of this warm period and spring snowmelt event, reservoir inflows and unregulated runoff increased from late March through the middle of April. The unregulated versus observed flow for the Missouri River at Wolf Point, MT; Bismarck, ND; Sioux City, IA; and St. Joseph, MO is discussed in Section II.F.1. of this report.

b. April – June

During April, precipitation was generally below normal in central Montana, central Wyoming, southeastern South Dakoata, northeast Nebraska, northwest Iowa and central Kansas. Some areas, including northern Montana, northwestern Wyoming, and northern and eastern North Dakota, received greater than 150 percent of normal precipitation. Cooler-than-normal temperatures continued in northeast Montana and the Dakotas, while all other areas in the Basin experienced near normal temperatures.

May precipitation generally ranged from 70 percent of normal to less than 50 percent of normal. The driest regions were centered near western Montana, Wyoming, central North Dakota, central Nebraska, northwest Iowa, central Kansas and central Missouri.

June precipitation was above normal across much of North Dakota, South Dakota, Nebraska, Iowa, Kansas and isolated areas of Montana and Wyoming. Departures over large areas of the Basin ranged from 150 to 200 percent of normal. Several significant rainfall events in June impacted System inflows and flows on the lower Missouri River below Sioux City, IA including rainfall on June 4, June 9-10, June 15, June 17-19 and June 21.

A significant severe weather event moved through the lower Basin on June 3. The greatest impact was observed in eastern Nebraska, Iowa, and northern Missouri. Rainfall amounts for the previous 24 hours ending on June 4 included 5.3 inches at Omaha, NE; 4.0 inches at Fort Calhoun, NE; 3.6 inches at Bellevue, NE; 5.0 inches at Council Bluffs, IA; 3.0 inches at Red Oak, IA; 2.7 inches at St. Joseph, MO; and 3.3 inches at Kirksville, MO. This rainfall event increased flows significantly on the Platte River, lower Missouri River tributaries in southwest Iowa and northwest Missouri, and the Missouri River at St. Joseph, MO.

A second storm on June 9 produced heavy rain in western and central Nebraska. Significant rainfall amounts included 3.7 inches at Stapleton, NE; 3.5 inches at Valentine, NE; 3.0 inches at North Platte, NE; and 2.6 inches at Pickstown, SD. Heavy rainfall amounts from this storm occurred in the lower Kansas River Basin the following day, and included 4.7 inches at Lawrence, KS; 3.3 inches at Topeka, KS; and 2.9 inches at Overland Park, KS.

The most significant rainfall occurred in the lower Basin June 15-21. Rainfall ending on June 15 ranged from 2.5 to over 5 inches over a large area extending from central Nebraska to southwest Minnesota. The heaviest amounts of rain occurred in southeast South Dakota, southwest Minnesota, northeast Nebraska and northwest Iowa in the Big Sioux and Little Sioux River basins. Some notable rainfall amounts ending on June 15 included 6.4 inches at Correctionville, IA; 6.2 inches at Sioux City, IA; 5.6 inches at Wayne, NE; 4.1 inches at Sioux Falls, SD; and 3.7 inches at Worthington, MN. The next significant rainfall ending on June 17 produced rainfall amounts generally ranging from 2.5 to more than 6 inches in southeast South Dakota, northwest Iowa and northeast Nebraska. Significant rainfall amounts ending on June 17 included 8.4 inches in Canton, SD; 4.7 inches at Rock Rapids, IA; 4.5 inches at Akron, IA, 3.8 inches at Sioux Falls, SD; and 3.1 inches at Sioux City, IA. This rainfall produced the flood of record on the Big Sioux River at Akron, IA, and prompted a reduction in discharge from Gavins Point Dam. See Section II.C.6.d. for more discussion regarding how the Big Sioux River flood peak was observed in the lower Missouri River. The Platte River also reached significantly higher streamflow levels but resulted in only minor flooding.

While heavy rain was occurring in the lower Basin, the upper Basin states were also receiving moderate to heavy rainfall, which increased June reservoir reach runoff. On June 17, western Montana and northwest Wyoming received widespread amounts of 0.5 to 1.5 inches of rainfall. On June 18, intense rainfall occurred over northwest Montana, central and eastern Montana, and northwest South Dakota. Rainfall amounts ending on June 18 included 4.6 inches near Glacier National Park, MT; 3.7 inches at Belle Fourche, SD; 3.4 inches at St. Mary, MT; and 2.4 inches at Nashua, MT. By June 19 additional rainfall included 3.8 inches in North Platte, NE; 3.3 inches at Mobridge, SD; 2.8 inches at Aberdeen, 2.5 inches at Jamestown, ND; and 2.0 to 2.5 inches over a large area in northwest Montana. Heavy rainfall also occurred from June 20-21 over central and eastern Nebraska and western Iowa. Rainfall amounts ending on June 21 included 7 to 8 inches near Millard, NE; 7.7 inches at Papillion, NE; 4.2 to 5.3 inches in Omaha, NE; and 3.4 inches at Hastings, NE. The June 21 rainfall resulted in a significant increase in Platte River flows.

Accumulated precipitation in inches during June 2014 is listed in ***Table 3***. Significant monthly rainfall totals included 16.6 inches at Sioux City, IA; 13.7 inches at Sioux Falls, SD; 19.7 inches at Canton, SD; and 10.5 inches at Omaha, NE.

As discussed in more detail in Section II.F., the combination of high amounts of June rainfall and high mountain snowpack runoff resulted in high unregulated flow estimates during June. While the unregulated peak discharge at Wolf Point, MT was not the highest unregulated peak discharge event of 2014, the June unregulated peak discharge event was the highest unregulated discharge at Bismarck, ND; Sioux City, IA and St. Joseph, MO due to the combination of mountain snowpack and June rainfall.

Table 3. June 2014 rainfall totals and departures in inches.

Location	June Rainfall (inches)	Departure (inches)
Bozeman, MT	4.1	1.7
Great Falls, MT	4.2	1.7
Lewistown, MT	2.6	-0.4
Glasgow, MT	2.3	-0.1
Billings, MT	1.8	-0.4
Miles City, MT	4.3	1.8
Williston, ND	1.4	-1.1
Bismarck, ND	3.0	-0.2
Jamestown, ND	6.4	3.2
Canton, SD	19.7	n/a
Rapid City, SD	6.1	2.9
Mobridge, SD	7.9	4.8
Aberdeen, SD	3.3	-0.4
Watertown, SD	4.6	1.0
Sioux Falls, SD	13.7	9.8
Pierre, SD	4.4	0.8
Sioux City, IA	16.6	12.8
Omaha, NE	10.5	6.3

c. July – September

Although July through September precipitation was above normal in much of Montana, Wyoming and the western Dakotas (***Figure 10***), the 3-month period began with much drier-than-normal weather in July. Few significant precipitation events occurred in July, resulting in much of the upper and lower Basin receiving less than 50 percent of normal precipitation. Temperatures during July ranged from normal to 4 deg F above normal in central and western Montana and western Wyoming. Temperatures were 2 to 6 deg F below normal in the Dakotas, Nebraska, Iowa, Kansas and Missouri.

August precipitation was above normal in the upper Basin, Nebraska, southwestern Iowa, and northern Missouri due to a number of large precipitation events that occurred from the middle of August to the end of August. Precipitation in the upper Basin exceeded 200 percent of normal in large portions of Montana, Wyoming and the western Dakotas. Significant rainfall events included rainfall ending on August 16 in western North Dakota, southern Iowa and northern Missouri; on August 23-25 in Montana, North Dakota, South Dakota, Nebraska and western Iowa; and on August 28-29 in eastern Nebraska, southwestern Iowa, and northern Missouri. August temperatures were 1 to 3 deg F below normal in Wyoming, southeastern Montana, southern North Dakota and South Dakota. In all other areas temperatures ranged from normal to 2 deg F above normal.

Heavy rainfall reported on August 16 in western North Dakota included reports of 4.8 to 5.5 inches in the Heart River basin, 4.5 inches at Menoken, 4.2 inches near Dickinson and 3.8 inches at Medora. Very heavy rain also occurred in southern Iowa and northern Missouri with reports of 6.2 inches at Albany, MO; 5.7 inches at Maryville, MO; 4.7 inches at Kirksville, MO, and 4.8 inches at Lamoni, IA.

Widespread moderate to heavy rainfall occurred throughout the upper Basin on August 23. Amounts ranged from 0.75 to 2.0 inches across Nebraska and western Iowa, with similar amounts across all of Montana, northern Wyoming and north-central South Dakota. Rainfall reported on August 23 included 3.1 inches in Sundance, WY; 2 to 3 inches in Omaha, NE; 2.6 inches in Baker, MT; 2.3 inches in Frazier, MT; 2.5 inches in Whitehorse, SD; 2.3 inches in Red Oak, IA; and 1.8 inches at Judith Peak, MT. On August 24, heavy rainfall was reported across Montana upstream of Fort Peck Dam, in North Dakota and in northern South Dakota. Rainfall reported on August 24 included 5.4 inches at Judith Peak, MT; 4.8 inches near Winifred, MT; 4.7 inches at Landusky, MT; 3.6 to 4.4 inches at Aberdeen, SD; 4.2 inches at Lewistown, MT; 4.1 inches near Roundup, MT; 3.5 inches near Saco, MT; and 3.4 inches at Glasgow, MT. Heavy rainfall was reported again in north-central Montana on August 25 including reports of 3.3 inches near Lewistown, MT; 2.8 inches near Harlem, MT; 2.1 inches near Malta, MT; 2.1 inches near Saco, MT; and 1.3 inches at Judith Peak, MT. This rainfall significantly increased streamflow in northeast Montana, western North Dakota and western South Dakota tributaries to the Missouri River including the Milk, Knife, Heart, Cannonball, Grand and Moreau rivers. The greatest impact to the System was caused by the increase in Fort Peck inflow, which recorded a daily-average inflow of 100,000 cfs on August 24. The unregulated flow event computed for Wolf Point, MT was the highest unregulated flow event of 2014, while the computed unregulated event at Bismarck, ND was also notable (see Section II.F.1 and Figure 18A). Actual (regulated) flow coinciding with the unregulated flow event at these locations was well below flood levels because Fort Peck and Garrison Reservoirs stored this runoff.

Heavy rainfall August 27-29 occurred across Nebraska, western Iowa and northern Missouri causing lower Basin tributaries to rise again. August 27 rainfall reports included 4.6 inches near Tarkio, MO and 3.7 inches near Rockport, MO. August 28 rainfall reports included 4.5 inches in Papillion, NE; 4.2 inches in Gretna, NE; 3.6 inches in Seward, NE; 3.5 inches in Glenwood, IA; 3.3 inches in Lincoln, NE; 3.1 inches in Omaha, NE; and 2.1 inches in Council Bluffs, IA. Rainfall that followed on August 29 included reports of 1.5 to 2.5 inches in southwest Iowa and northwest Missouri.

September precipitation was more than 150 percent of normal in portions of western Montana, western and eastern Wyoming, western South Dakota, the Nebraska Panhandle, eastern Nebraska, Iowa and northern Missouri. Very dry areas that received less than 50 percent of normal precipitation included much of eastern Montana, southern North Dakota and eastern South Dakota. Average September temperatures were generally within 2 deg F of normal. Significant rainfall events occurred September 9-10 and September 27 through October 3.

Very heavy rain was reported September 10 in southern Iowa and northern Missouri including 10.3 inches near Browning, MO; 9.6 inches at Chillicothe, MO; 6.6 to 9.3 inches at Kirksville, MO; 4.7 inches at Oakland, IA; and 4.2 inches at Atlantic, IA. This heavy rain caused major flooding on the Grand and Chariton Rivers in northern Missouri.

From September 27 to October 3 a slow-moving weather system produced moderate to heavy precipitation from the Northern and Central Rockies in the upper Basin to the lower Basin. Rainfall reports for September 28 and 29 generally ranged from 0.5 to 1.5 inches of precipitation each day. Heavy rain was reported in eastern Wyoming, western South Dakota and western Nebraska on September 30, including 3 to 4 inches in the Black Hills of South Dakota, 3.2 inches at Rapid City, SD; and 2 to 3 inches in far eastern Wyoming and the Nebraska Panhandle.

d. October – December

During the October through December period, a majority of the upper Basin, especially the plains, received below normal precipitation. Areas that received above normal precipitation included western Montana, northwest Wyoming and southeast Nebraska. Temperatures for the period were near normal in the plains and normal to about 2 deg F above normal in the Rocky Mountain region.

October precipitation accumulations were less than 50 percent of normal across much of North Dakota and South Dakota, Wyoming, and Montana. The only area experiencing above normal precipitation was in southeast Nebraska, southwest Iowa and Missouri. The weather system that originated in the Rocky Mountains on September 27 continued to produce rain in the lower Basin October 1-3. Heavy rainfall reported on October 1 included 4.5 to 7 inches in Lincoln, NE, 2.5 to 3.5 inches in the Omaha area, and 1.5 to 3 inches in southwest Iowa. Heavy rainfall reported on October 2 included 3 to 5.5 inches in central Missouri, with additional reports in central Missouri of 1.5 to 3.5 inches on October 3. On October 14, widespread 1 to 2.5

inches of rain occurred over southern Iowa and northern Missouri. October temperatures were 4 to 6 deg F above normal in Montana; 2 to 4 deg F above normal in Wyoming, the Dakotas, and Nebraska; and, near normal in eastern Nebraska and Iowa.

November precipitation accumulations were less than 25 percent of normal in Iowa, Nebraska, Kansas, northwest Missouri, and a portion of southeast South Dakota. Precipitation accumulations were greater than 150 percent of normal in Montana and Wyoming, but no significant precipitation events occurred. Temperatures became drastically colder in November with near normal to 4 deg F below normal temperatures in the Rocky Mountain region, and 4 to 8 deg F below normal temperatures in the plains.

December precipitation accumulations were more than 150 percent of normal in portions of western Montana, most of central Wyoming, southern South Dakota and much of Nebraska; however, no significant precipitation events occurred. Precipitation accumulations were well below normal in northern and eastern Montana and North Dakota. In contrast to November, temperature departures were 2 to 6 deg F above normal.

4. 2014 Calendar Year Runoff

The 2014 unregulated runoff volume for the upper Basin above Sioux City, IA totaled 35.3 million acre-feet (MAF), 140 percent of average, based on the historical period of 1898-2013, as shown in ***Table 4*** and ***Figure 13***. ***Table 4*** 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. ***Table 4*** compares 2014 monthly and calendar year totals to the 1898-2013 historic period of record.

Total runoff in the lower Basin, from Sioux City, IA to Hermann, MO totaled 29.5 MAF, 67 percent of average. Of the six reaches in the Basin above Sioux City, IA outlined in ***Table 5***, all but one, Fort Randall to Gavins Point, were above average. Of the three reaches in the Basin below Sioux City, IA, only one, Sioux City, IA to Nebraska City, NE, was above average.

Figure 14 illustrates the monthly variation of the runoff summation above Sioux City, IA compared to the long-term average variation of runoff based on the 1898-2013 historical period. Runoff above Sioux City was predominantly above average each month during 2014. Runoff was well above average in June and August due to abundant rain during these months. August runoff was 3,270 thousand acre-feet (kAF), more than 2 times average, and the third highest August runoff summation during the 1898-2014 historical period. The two higher August runoff summations were 3,392 and 4,122 kAF, occurring in 2011 and 1993, respectively.

Table 4
Missouri River Basin
2014 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 2014	353	443	180	119	121	130	1,216	1,346	1,346
NORMAL	312	261	12	28	100	50	713	763	763
DEPARTURE	41	182	168	91	21	80	503	583	583
% OF NORM	113%	170%	1500%	425%	121%	260%	171%	176%	176%
FEB 2014	289	388	186	111	120	75	1,094	1,169	2,515
NORMAL	361	355	95	54	132	101	997	1,098	1,861
DEPARTURE	-72	33	91	57	-12	-26	97	71	654
% OF NORM	80%	109%	196%	206%	91%	74%	110%	106%	135%
MAR 2014	814	1,812	940	143	162	204	3,871	4,075	6,590
NORMAL	595	995	584	215	211	326	2,600	2,926	4,787
DEPARTURE	219	817	356	-72	-49	-122	1,271	1,149	1,803
% OF NORM	137%	182%	161%	67%	77%	63%	149%	139%	138%
APR 2014	584	1,201	543	113	98	218	2,539	2,757	9,347
NORMAL	641	1,079	508	144	181	385	2,553	2,938	7,725
DEPARTURE	-57	122	35	-31	-83	-167	-14	-181	1,622
% OF NORM	91%	111%	107%	78%	54%	57%	99%	94%	121%
MAY 2014	1,131	1,807	546	223	183	212	3,890	4,102	13,449
NORMAL	1,082	1,260	319	146	185	323	2,992	3,315	11,040
DEPARTURE	49	547	227	77	-2	-111	898	787	2,409
% OF NORM	105%	143%	171%	153%	99%	66%	130%	124%	122%
JUN 2014	1,621	3,850	962	182	254	1,213	6,869	8,082	21,531
NORMAL	1,640	2,710	440	160	184	317	5,134	5,451	16,491
DEPARTURE	-19	1,140	522	22	70	896	1,735	2,631	5,040
% OF NORM	99%	142%	219%	114%	138%	383%	134%	148%	131%
JUL 2014	875	2,640	599	27	78	496	4,219	4,715	26,246
NORMAL	831	1,815	185	58	139	244	3,028	3,272	19,763
DEPARTURE	44	825	414	-31	-61	252	1,191	1,443	6,483
% OF NORM	105%	145%	324%	47%	56%	203%	139%	144%	133%
AUG 2014	907	1,160	697	118	101	287	2,983	3,270	29,516
NORMAL	356	609	71	41	116	148	1,193	1,341	21,104
DEPARTURE	551	551	626	77	-15	139	1,790	1,929	8,412
% OF NORM	255%	190%	982%	288%	87%	194%	250%	244%	140%
SEP 2014	434	1,043	323	53	-7	270	1,846	2,116	31,632
NORMAL	330	448	110	37	111	107	1,036	1,143	22,247
DEPARTURE	104	595	213	16	-118	163	810	973	9,385
% OF NORM	132%	233%	294%	143%	-6%	252%	178%	185%	142%
OCT 2014	382	704	108	-19	8	112	1,183	1,295	32,927
NORMAL	380	527	72	5	120	89	1,104	1,193	23,440
DEPARTURE	2	177	36	-24	-112	23	79	102	9,487
% OF NORM	101%	134%	150%	--	7%	126%	107%	109%	140%
NOV 2014	307	189	147	-1	38	150	680	830	33,757
NORMAL	381	393	67	4	118	81	963	1,044	24,484
DEPARTURE	-74	-204	80	-5	-80	69	-283	-214	9,273
% OF NORM	81%	48%	219%	--	32%	185%	71%	80%	138%
DEC 2014	471	516	196	74	148	123	1,405	1,528	35,285
NORMAL	327	249	1	12	100	58	689	747	25,231
DEPARTURE	144	267	195	62	48	65	716	781	10,054
% OF NORM	144%	207%	--	617%	148%	212%	204%	205%	140%
				Calendar Year Totals					
	8,168	15,753	5,427	1,143	1,304	3,490	31,795	35,285	
NORMAL	7,236	10,701	2,464	904	1,697	2,229	23,002	25,231	
DEPARTURE	932	5,052	2,963	239	-393	1,261	8,793	10,054	
% OF NORM	113%	147%	220%	126%	77%	157%	138%	140%	

Table 5
2014 CY Runoff Volumes for Selected Reaches (1,000 acre-feet)

Reach	1898-2013 Average Runoff	2014 CY Runoff	% of Average Runoff
Above Fort Peck	7,236	8,168	113
Fort Peck to Garrison	10,701	15,753	147
Garrison to Oahe	2,464	5,427	220
Oahe to Fort Randall	904	1,143	126
Fort Randall to Gavins Point	1,697	1,304	77
Gavins Point to Sioux City	2,229	3,490	157
TOTAL ABOVE SIOUX CITY	**25,231**	**35,285**	**140**
	1967-2013 Average Runoff	**2014 CY Runoff**	**% of Annual Runoff**
Sioux City, IA to Nebraska City, NE*	7,790	8,380	108
Nebraska City, NE to Kansas City, MO*	12,070	8,450	70
Kansas City, MO to Hermann, MO*	23,930	12,702	53
TOTAL BELOW SIOUX CITY*	**43,790**	**29,532**	**67**

** Runoff in the reaches from Sioux City, IA to Hermann, MO is not adjusted to 1949 depletion levels. Annual monthly averages are taken from the USGS Water Data Reports for the period 1967-2013.*

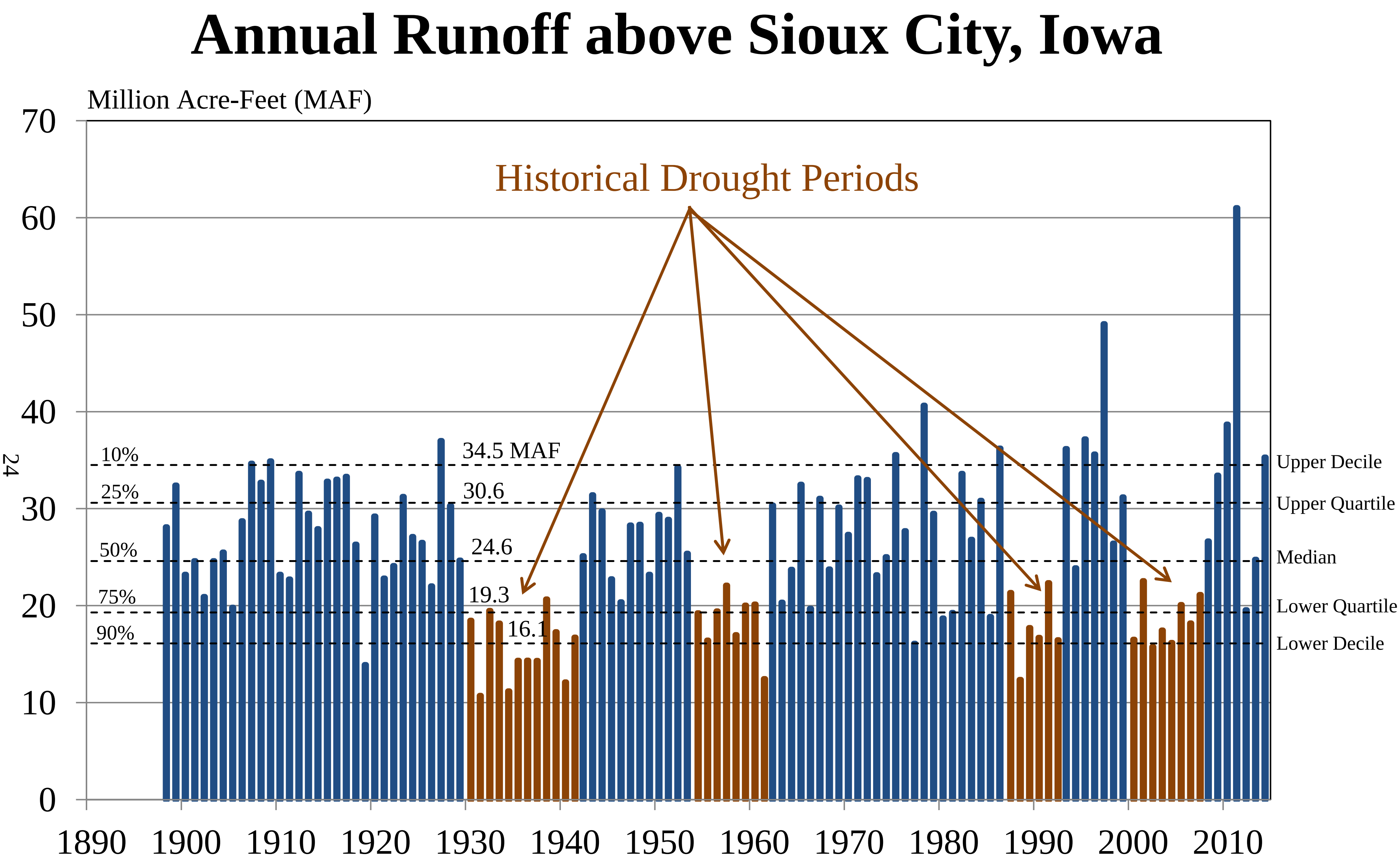


Figure 13. Missouri River Basin annual runoff above Sioux City, IA.

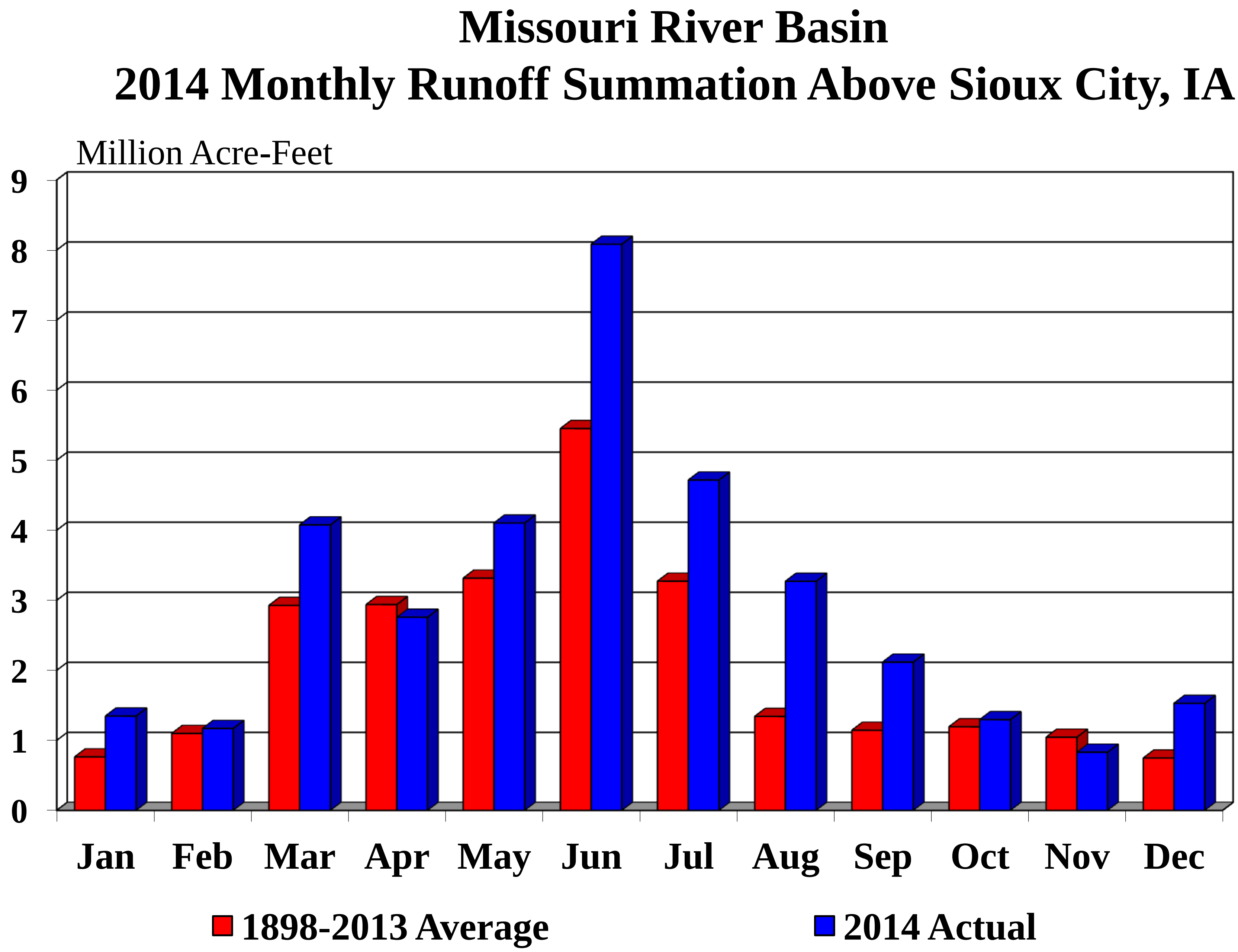


Figure 14. Missouri River Basin 2014 monthly runoff summation above Sioux City, IA.

C. System Regulation – January to December 2014

1. Basin Conditions and System Regulation

Runoff above Sioux City, Iowa in 2014 was 35.3 MAF, 140 percent of average (see ***Table 4***). This followed 2013, which had produced 24.7 MAF of runoff, 98 percent of average. Runoff in 2014 was well above average and greater than the annual Upper Decile runoff volume (34.5 MAF) based on the 1898-2011 runoff record. Runoff in 2014 resulted in nearly a full recovery from the 2012 drought. While the System storage did reach the base of the System Annual Flood Control Zone, Fort Peck's elevation was slightly below the base of its Annual Flood Control Zone.

a. Conditions on March 1

The February 28 System storage was 50.7 MAF, 5.4 MAF below the base of the Annual Flood Control and Multiple Use Zone and 2.2 MAF more than the previous year.

The plains snow coverage on March 1 did not vary much from the February 9 peak (see ***Figure 6***). The NOHRSC model indicated light plains SWE in most of the Northern Plains, with moderate coverage in portions of central North Dakota and eastern South Dakota. End-of-February soil moisture conditions were very wet in Montana and Wyoming and the western portions of the Dakotas (see ***Figure 15***). As an indicator of early snowmelt and precipitation runoff, soil moisture conditions suggested that runoff, with normal precipitation, would be above normal in the upper portions of the Basin and about normal for the lower Basin.

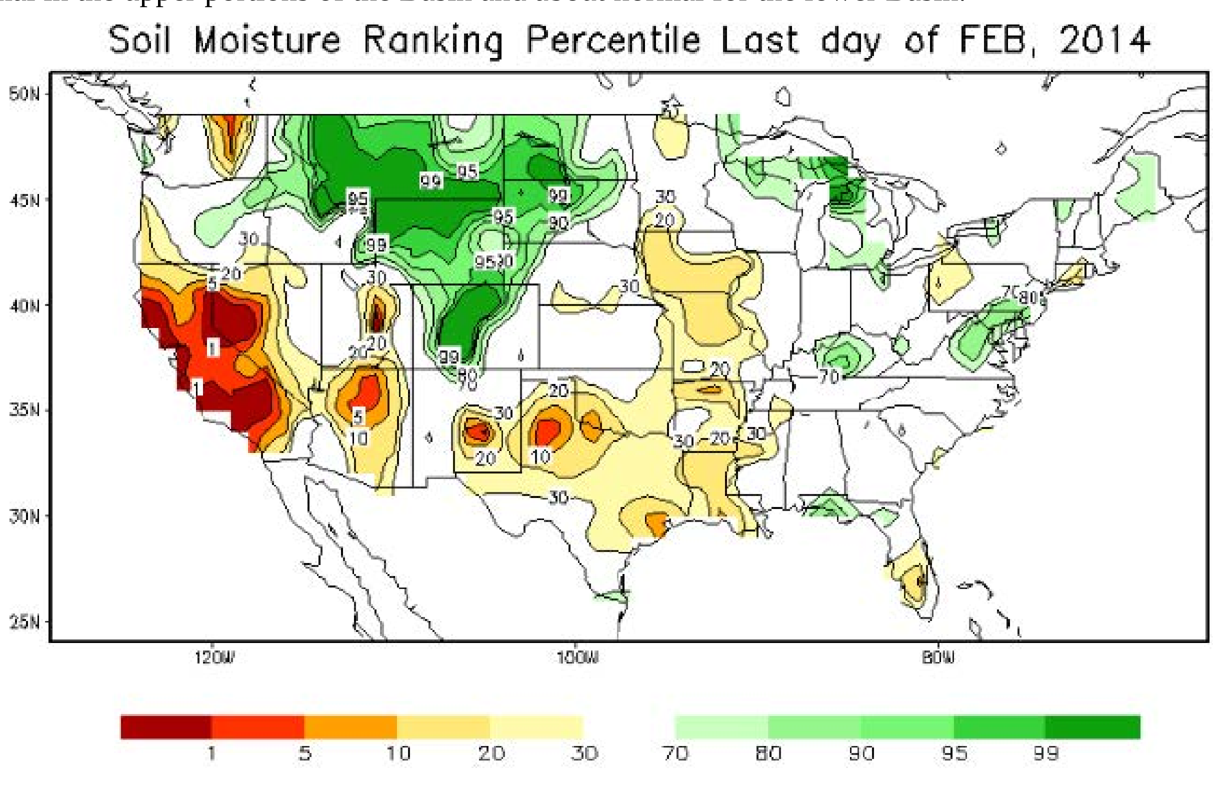


Figure 15. Soil moisture as percent of normal, February 28, 2014. Source: NOAA CPC

Significant mountain snow accumulation occurred during February. The February 1 mountain SWE levels were 107 percent of average in the reach above Fort Peck and 113 percent of average in the Fort Peck to Garrison reach (see ***Table 2***). By March 1, mountain SWE had increased to 121 percent of average and 131 percent of average in the Fort Peck and Garrison reaches, respectively. The March 1 annual runoff forecast was 30.6 MAF, 121 percent of average. Per the Master Manual, the March 15 System storage check of 51.6 MAF set navigation flow support to an intermediate service level of 3,000 cfs below the full service level for the first half of the navigation season.

b. Conditions on April 1

System storage on March 31 was 53.2 MAF, 2.9 MAF below the base of the Annual Flood Control and Multiple Use Zone. Temperatures during the January-March period were generally colder than normal in the upper Basin (see ***Figure 11***). During that same 3-month period, precipitation was well above normal in central Montana and portions of Wyoming, while it was well below normal throughout the Dakotas and the lower Basin (see ***Figure 10***). Accumulated 2014 runoff above Sioux City, IA during January-March was 6.6 MAF (138 percent of average). As shown on the April 8, 2014 graphic in ***Figure 12***, drought conditions in the upper Basin no longer existed and drought conditions in the lower Basin generally ranged from Abnormally Dry (D0) to Moderate (D1) with western Nebraska and Kansas indicating Severe (D2). The mountain SWE was 132 percent of the April 1 average in the reach above Fort Peck and 139 percent of average in the Fort Peck to Garrison reach (see ***Table 2***). The April 1 annual runoff forecast was 32.0 MAF, 127 percent of average.

c. Conditions on May 1

April precipitation in the upper Basin was generally below normal; some areas in North Dakota and north central South Dakota received above normal precipitation. Soil moisture conditions at the end of April were similar to conditions at the end of February 2014 (***Figure 15***). Near to below normal precipitation led to below normal April runoff (94 percent of normal). The mountain SWE in the reach above Fort Peck peaked on April 7 at 133 percent of the average peak accumulation. The mountain SWE in the Fort Peck to Garrison reach peaked on April 17 at 141 percent of the normal (April 15) peak accumulation. As a result of the high peak SWE accumulation and below normal April runoff, the May 1 annual runoff forecast was revised to 31.7 MAF, 125 percent of average. System storage on April 30 was 54.3 MAF, 1.8 MAF below the base of the Annual Flood Control and Multiple Use Zone.

Accumulated precipitation in May was below normal in the mountainous regions of the upper Basin, while it was variable throughout the plains region. Combined with runoff from well above normal mountains snowpack, May runoff above Sioux City, IA was 124 percent of normal.

d. Conditions in June and July

System storage continued to increase to a May 31 level of 56.3 MAF, 0.2 MAF above the base of the Annual Flood Control and Multiple Use Zone. The June 1 annual inflow forecast was 31.1 MAF, 123 percent of normal. Although May precipitation in Montana and Wyoming was below normal, June precipitation accumulations ranged from 150 to 200 percent of normal across much of North Dakota, South Dakota, Nebraska, Iowa and isolated areas of Montana and Wyoming. Several significant rainfall events in the middle of June impacted System inflows and flows on the lower Missouri River. Mid-month rainfall caused a record flood event on the Big Sioux River, which is an unregulated tributary that enters the Missouri River at Sioux City, IA. The Gavins Point release was reduced from 30,000 cfs to 10,000 cfs from June 19-22 to reduce peak flows on the lower Missouri River during the Big Sioux River flood. Refer to Section II.C.6.d. for additional information on the Big Sioux River flood.

Due to the well above average rainfall and mountain snowpack runoff, June runoff above Sioux City, IA was 8.1 MAF, 148 percent of average. With the exception of runoff above Fort Peck, which was near average, runoff in all other reaches was above average, highlighted by 142 percent of average runoff from Fort Peck to Garrison, 219 percent of average runoff from Garrison to Oahe, and 383 percent of average runoff from Gavins Point to Sioux City, IA. June runoff from Gavins Point to Sioux City was the third highest on record.

As of June 30, System storage was 60.1 MAF, 4.0 MAF above the base of the Annual Flood Control and Multiple Use Zone. The July 1 System storage check resulted in the Corps providing full service navigation flow support for the second half of the navigation season as well as a 10-day extension to the navigation season length. The July 1 annual runoff forecast was increased to 33.0 MAF, 131 percent of average, primarily due to abundant rainfall that increased June runoff. July precipitation was well below normal in the upper Basin, accompanied by above normal temperatures in Montana and Wyoming, and below normal temperatures in the plains. Despite dry conditions, July runoff above Sioux City, IA was 144 percent of average as a result of continued high volumes of runoff from the mountain snowmelt and the June plains precipitation.

e. Conditions from August through December

July 31 System storage was 60.7 MAF, 4.6 MAF above the base of the Annual Flood Control and Multiple Use Zone. The August 1 annual inflow forecast was 32.5 MAF, 129 percent of average. In contrast to dry conditions in July, August precipitation exceeded 200 percent of normal in very large portions of Montana, Wyoming and the western Dakotas. The most significant rainfall event occurred from August 23-25 in Montana, North Dakota, and South Dakota, causing high inflows into Fort Peck, Garrison and Oahe. The computed average daily inflow into Oahe on August 23 was 73,000 cfs while the average daily inflow into Fort Peck on August 24 was 100,000 cfs. Reservoir inflows during the following week were very high; the August 24 daily System storage increase was 253 kAF. August runoff above Sioux City, IA was 244 percent of average. Runoff was 255 percent of average above Fort Peck, 190 percent of average from Fort Peck to Garrison and nearly 10 times average from Garrison to Oahe. August runoff above Fort Peck was the second highest August runoff of record, while August runoff from Garrison to Oahe was the highest August runoff of record. The August summation of runoff above Sioux City, IA was the third highest on record.

August 31 System storage was 61.3 MAF, 5.2 MAF above the base of the Annual Flood Control and Multiple Use Zone.   Based on the September 2014 reservoir monthly study, the System release from Gavins Point Dam was increased to 45,500 cfs to continue evacuating this additional stored floodwater from the Annual Flood Control and Multiple Use Zone. Furthermore, the September reservoir monthly study indicated the need a winter release rate from Gavins Point Dam of 20,000 cfs in addition to the previously announced 10-day extension to the navigation season.

The September 1 and October 1 annual inflow forecasts were 35.6 MAF, 141 percent of average, and 35.5 MAF, 141 percent of average, respectively. Precipitation accumulations during September varied from well below normal accumulations in the plains, to well above normal accumulations in the Rockies and Black Hills. Due to high streamflow that persisted from August and above average precipitation in the aforementioned areas, September runoff above Sioux City, IA was 185 percent of average. Precipitation was below normal in October, resulting in 109 percent of average runoff in October. As a result of declining runoff in October, the November 1 annual inflow forecast was 34.7 MAF, 138 percent of average.

The System release of 45,500 cfs resulted in a System storage decline to 60.0 MAF on September 30, and to 58.1 MAF by October 31, which is 2.0 MAF above the base of the Annual Flood Control and Multiple Use Zone. Due to the effective decline in System storage, the System release from Gavins Point Dam was reduced to about 36,000 cfs based on the November monthly studies for the remainder of November.

November 30 System storage was 56.5 MAF, 0.4 MAF above the base of the Annual Flood Control and Multiple Use Zone.   Very cold temperatures in November froze many of the of the Missouri River tributary flows and reduced monthly runoff above Sioux City, IA to 80 percent of average. The December 1 annual inflow forecast was 34.5 MAF, 137 percent of average. Starting on December 2, the Gavins Point release was reduced by 3,000 cfs per day until the winter release was reached to end flow support for the navigation season at the mouth of the Missouri River on December 11. The December reservoir monthly study indicated the Gavins Point winter release from December through February would be set at 17,000 cfs.

While November runoff was 80 percent of average due to colder-than-normal temperatures, warmer-than-normal December temperatures resulted in monthly runoff of 205 percent of average. The December temperatures melted the tributary ice formed during November and resulted in more than two times average runoff to enter the System. The 2014 annual runoff was 35.3 MAF, 140 percent of average, and the System storage on December 31 was 56.4 MAF, 0.3 MAF above the base of the Annual Flood Control and Multiple Use Zone.

2. Fort Peck Regulation – January to December 2014

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 6 lists the average monthly inflows and releases and the end-of-month (EOM) pool elevation for Fort Peck for 2013 and 2014 as well as the averages since the System first filled in 1967.

Table 6
Fort Peck – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2014	2013	1967-2013	2014	2013	1967-2013	2014	2013	1967-2013
January	6,100	6,100	7,200	6,900	12,300	10,600	2222.8	2224.0	2227.4
February	6,200	6,800	8,700	6,900	12,500	10,900	2222.5	2222.2	2226.7
March	13.700	7,900	11,800	7,000	6,600	7,800	2224.6	2222.6	2227.8
April	11,700	6,700	10,200	7,600	6,000	7,300	2225.8	2222.7	2228.5
May	17,000	10,400	15,600	8,700	8,000	9,100	2228.3	2223.4	2230.3
June	15,100	20,600	19,700	8,900	7,900	10,500	2230.0	2227.1	2232.7
July	8,800	6,100	12,200	7,500	8,000	10,600	2230.1	2226.1	2232.8
August	15,900**	6,400	7,800	7,300	8,000	10,200	2232.2	2225.1	2231.6
September	8,500	5,500	7,700	5,400	6,400	9,000	2232.7	2224.3	2230.8
October	7,800	5,400	7,300	5,100	5,000	8,000	2233.0	2224.0	2230.2
November	7,200	5,300	7,100	5,000	5,000	8,300	2233.2	2223.6	2229.5
December	7,800	5,500	6,600	5,700	6,300	9,400	2223.5	2223.1	2228.4

* monthly minimum of record ** monthly maximum of record

b. Winter Season 2013-14

The Fort Peck Reservoir level was at elevation 2223.1 feet msl on January 1, 10.9 feet below the base of the Annual Flood Control and Multiple Use Zone and 2.9 feet lower than the previous year. The annual minimum reservoir level occurred February 15 at 2222.3 feet msl, 0.1 feet lower than the 2013 annual minimum, which was 2222.2 feet msl on March 5, 2013.

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 2013 and January and February were below average at 6,300, 6,900, and 6,900 cfs, respectively. Ice-cover formation on the Missouri River downstream of Fort Peck occurred December 5, 2013 and resulted in the Missouri River stage rising over 2 feet in the Wolf Point, MT area. The stage at Wolf Point peaked at 16.5 feet on March 19, 6.5 feet below the 23-foot flood stage. This was the highest Missouri River stage at Wolf Point in 2014. No reports of ice-affected flooding on the Missouri River below Fort Peck were recorded during the 2014 winter season. The Fort Peck Reservoir froze over on December 23, 2013 and was free of ice on April 22.

d. Spring Open Water Season 2014

Inflows into Fort Peck were above average during April and May and below average in June. Releases were near average in April and May and below average in June. In May and June, average monthly inflows to the reservoir were 17,000 cfs (109 percent of average) and 15,100 cfs (77 percent of average), respectively. Fort Peck releases were near average at 8,700 cfs (96 percent of average) in May and 8,900 cfs (85 percent of average) in June. Fort Peck reservoir rose 5.4 feet from its April 1 elevation of 2224.6 feet msl to 2230.0 feet msl near the end of June, 4.0 feet below the base the Annual Flood Control Zone.

e. Summer Open Water Season 2014

Average monthly release rates from Fort Peck were below average (68 percent of the July-September average) during the summer with 7,500, 7,300, and 5,400 cfs in July, August, and September, respectively. A dry July produced below average inflows (72 percent of average) of 8,800 cfs. A large rainfall event in late August quickly increased inflow into Fort Peck, reaching a peak average daily total of 100,000 cfs on August 24. Average daily inflows in August and September were 15,900 cfs (204 percent of average) and 8,500 cfs (110 percent of average), respectively. The August average daily inflow is the highest Fort Peck August inflow since the System has filled (1967-2014). Over the 3-month period the reservoir level increased 2.7 feet from 2230.0 feet msl (June 30) to 2232.7 feet msl (September 30) with most of the increase occurring after the August rainfall event.

f. Fall Open Water Season 2014

Releases during the fall continued well below average with 5,100 cfs in October (64 percent of average), 5,000 cfs in November (60 percent of average) and 5,700 cfs in December (61 percent of average). The lower releases minimized the unbalanced condition in storage for the upper three reservoirs. Inflows for October, November and December were near average to above average, ranging from 101 percent to 118 percent of average. The pool elevation rose 0.8 foot over the 3-month period from 2232.7 feet msl (September 30) to 2233.5 feet msl (December 31), still 0.5 foot below the base of the Annual Flood Control Zone.

g. Summary

The highest Fort Peck Reservoir pool elevation during 2014 occurred on December 26 at 2233.6 feet msl, 0.4 foot below the base of the Annual Flood Control and Multiple Use Zone. The lowest reservoir level during 2014 occurred on February 13 at 2222.3 feet msl. The average daily inflow of 10,500 cfs during 2014 was 103 percent of average. The average daily release of 6,800 cfs during 2014 was 73 percent of average.

3. Garrison Regulation – January to December 2014

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 7 lists the average monthly inflows and releases and the EOM pool elevation for Garrison for 2013 and 2014 as well as the averages since the System first filled in 1967.

Table 7
Garrison – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation(ft msl)		
	2014	2013	1967-2013	2014	2013	1967-2013	2014	2013	1967-2013
January	14,900	16,200	15,200	17,800	21,500	22,500	1832.4	1828.3	1831.9
February	14,600	19,000	18,500	17,900	22,900	23,600	1831.7	1827.5	1830.9
March	37,000	17,500	26,400	16,500	17,500	19,100	1835.9	1827.3	1832.3
April	29,800	23,700	22,800	22,100	19,100	18,700	1837.3	1828.3	1832.9
May	41,700	27,400	29,500	28,300	20,200	21,500	1839.8	1829.7	1834.4
June	60,500	50,400	47,700	29,700	19,900	25,000	1845.3	1835.8	1838.6
July	35,100	21,000	33,500	28,500	19,200	26,000	1846.1	1836.1	1839.7
August	23,500	14,700	18,600	28,000	19,200	25,100	1844.9	1834.8	1838.0
September	23,300	15,700	16,900	24,800	16,300	20,900	1844.3	1834.0	1836.7
October	17,800	17,800	17,300	21,500	13,000	19,000	1842.7	1834.6	1836.1
November	11,900	13,200	16,000	20,300	13,200	19,800	1841.1	1834.1	1834.9
December	14,700	12,200	13,800	16,100	15,800	19,900	1840.5	1833.0	1833.4

* monthly minimum of record ** monthly maximum of record

b. Winter Season 2013-14

The Garrison Reservoir level was at elevation 1833.0 feet msl on January 1, 2014, 3.5 feet above than the previous year's elevation of 1829.5 feet msl. This elevation was 4.5 feet below the base of the Annual Flood Control and Multiple Use Zone. Releases from the Garrison reservoir were below average for December, January, and February. The reservoir level declined throughout the winter season and ended February at 1831.7 feet msl, which was 4.2 feet above the previous year's elevation and 5.8 feet below the base of the Annual Flood Control and Multiple Use Zone. Garrison Reservoir froze over on December 26, 2013 and was free of ice on April 28.

c. Winter River and Ice Conditions Below Garrison

The Missouri River in the Bismarck, ND area rose over 5 feet from December 3-9 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 6, 2013 through March 19, 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 8.7 feet on December 9, 2013. This was 5.8 feet below the Bismarck flood stage of 14.5 feet and 4.3 feet below the Corps' winter freeze-in maximum stage target of 13 feet. In early January through March, there was an open channel along the right bank of the Missouri River while the left bank remained ice-covered. The winter peak stage at Bismarck was 9.9 feet and occurred on March 9. The stage increase was due to a combination of an ice-affected channel and runoff from snowmelt.

d. Spring Open Water Season 2014

Above average mountain and plains snowpack resulted in above average March-June inflows. Releases from Garrison were above average from April-June. The above average inflows resulted in Garrison pool levels increasing 9.4 feet, from 1835.9 feet msl (April 1) to 1845.3 feet msl at the end of June, 7.8 feet above the base of the Annual Flood Control Zone. Inflows were 29,800 cfs (131 percent of average) in April, 41,700 cfs (141 percent of average) in May and 60,500 cfs (127 percent of average) in June. Releases were above average in response to the above average inflows and water in storage. The April-June releases averaged 123 percent of average.

e. Summer Open Water Season 2014

Inflows into Garrison Reservoir remained above average during July (35,100 cfs; 105 percent of average), August (23,500 cfs; 126 percent of average) and September (23,300 cfs; 138 percent of average). Releases during the 3-month period remained above average. During the 3-month period, the pool crested at 1846.5 feet msl on July 26, 9.0 feet into the 12.5-foot Annual Flood Control and Multiple Use Zone. Following the crest, the Garrison pool slowly declined 2.2 feet to 1844.3 feet msl at the end of September. A daily peaking pattern was established at Garrison from May 15 through August 28 to protect endangered birds nesting on sandbars below the project.

f. Fall Open Water Season 2014

Above average releases continued through October and November to evacuate flood control storage. October-December inflows averaged 94 percent of average as inflows dropped during cold periods and recovered as temperatures moderated. Releases averaged 20,900 cfs from October through November. Releases were lowered to 16,000 cfs in early December in anticipation of the December freeze-in between Washburn, ND and Bismarck, ND. The Missouri River froze over at Bismarck on December 30, 2014. The end-of-year Garrison Reservoir elevation was 1840.5 feet msl, 3.0 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 the Lake Audubon. In the event the pool difference approaches the 43-foot maximum that was in place in 2007, the Omaha District's Geotechnical Branch will be consulted as to whether or not the 43-foot maximum is still a consideration. Since the Garrison Reservoir has returned to more average elevations following the 8-year drought, this water level difference restriction has not been in effect. Lake Audubon was drawn down to the average winter level of 1845.0 feet msl in the fall.

h. Summary

The Garrison pool elevation peaked at 1846.5 feet msl on July 26, 9.0 feet above the base of the Annual Flood Control and Multiple Use Zone. The lowest Garrison Reservoir level during 2014 occurred on March 8 at 1831.4 feet msl or 6.1 feet below the base of the Annual Flood Control and Multiple Use Zone. The average annual inflow of 27,100 cfs was 118 percent of average. The average annual release of 22,600 cfs was 104 percent of average.

4. Oahe and Big Bend Regulation – January to December 2014

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 8 lists the average monthly inflows and releases and the EOM pool elevation for Oahe for 2013 and 2014 as well as the averages since the System first filled in 1967.

Table 8
Oahe – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2014	2013	1967-2013	2014	2013	1967-2013	2014	2013	1967-2013
January	20,100	22,300	22,900	17,200	17,300	20,800	1601.9	1594.9	1598.7
February	20,800	24,100	27,000	16,300	15,800	18,200	1602.8	1596.5	1600.4
March	31,100	20,400	31,100	18,600	19,500	18,100	1605.2	1596.6	1603.0
April	31,200	21,800	27,100	27,800	17,300	20,800	1605.9	1597.7	1604.0
May	35,800	28,100	28,000	25,000	15,900	22,100	1607.8	1600.4	1605.0
June	44,900	28,600	30,700	19,300	14,200	27,100	1612.5	1603.3	1605.2
July	33,000	20,000	28,500	24,800	20,800	31,400	1613.6	1602.6	1604.3
August	39,000	20,800	26,400	28,000	24,200	33,900	1615.3	1601.6	1602.2
September	28,800	19,500	22,500	38,200	29,000	29,800	1612.8	1599.1	1600.4
October	23,800	31,600	20,700	39,000	15,200	23,800	1609.3	1602.1	1599.3
November	23,100	15,500	21,200	31,300	18,300	22,600	1607.9	1601.0	1598.7
December	18,200	16,100	20,200	18,600	13,100*	20,800	1607.4	1601.4	1598.4

* 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 Missouri River Master Water Control 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 2014 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 9 lists the average monthly inflows and releases and the EOM pool elevation for Big Bend for 2013 and 2014 as well as the averages since the System first filled in 1967.

Table 9
Big Bend – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2014	2013	1967-2013	2014	2013	1967-2013	2014	2013	1967-2013
January	16,300	15,900	20,500	16,600	16,700	20,400	1420.2	1420.1	1420.5
February	15,400	15,000	18,200	15,100	14,400	18,200	1420.4	1420.4	1420.4
March	18,000	18,100	18,900	17,600	17,900	18,800	1420.7	1420.5	1420.4
April	26,700	16,700	21,200	26,500	16,100	20,800	1420.7	1420.8	1420.5
May	24,400	15,300	22,200	24,100	15,300	22,100	1420.8	1420.7	1420.4
June	18,700	13,200	27,300	18,200	12,600	27,000	1420.8	1421.0	1420.3
July	22,500	19,100	30,700	22,800	19,800	30,300	1420.0	1420.0	1420.2
August	26,200	22,100	33,200	25,300	22,000	32,700	1420.3	1419.9	1420.2
September	35,400	26,800	29,300	34,800	25,700	28,800	1420.4	1421.0	1420.3
October	35,900	15,300	23,600	36,000	15,300	23,100	1420.0	1420.5	1420.5
November	29,300	16,800	23,800	28,600	16,600	22,300	1420.6	1420.4	1420.4
December	17,300	12,200*	20,500	17,300	12,100*	20,300	1420.5	1420.5	1420.5

* monthly minimum of record ** monthly maximum of record

b. Winter Season 2013-14

No ice-induced flooding problems were experienced downstream of the two projects during the winter of 2013-14. A 90-100 MW minimum, which is approximately a one unit release of 7,000 cfs, was implemented at Oahe on several days during the period from December 7, 2013 through March 4. 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 6 ranged from -10 to -13 deg F in the Pierre-Fort Pierre, SD area. The Missouri River stages exceeded the notification levels at LaFramboise Island, Isaac Walton, and Farm Island, locations all immediately downstream of Oahe Dam. At the LaFramboise Island, the stage peaked near the notification level of 25 feet. At Isaac Walton, the stage peaked at 23.9 feet, 0.9 foot over the 23-foot notification level. The stage peaked at 23.8 feet at Farm Island, 0.8 foot over the notification level of 23 feet. During the first half of the day, hourly releases from Oahe ranged from near 19,000 to 38,000 cfs. The Oahe project staff reported that the head of ice was at River Mile (RM) 1062, which is between LaFramboise Island and Farm Island. There were ice pans forming near RM 1067, which is near the Pierre–Fort Pierre highway bridge. Oahe releases were reduced in response to high downstream stages. The Missouri River conditions were closely monitored by the Corps staff. No further actions were required and no flooding issues were reported during the winter season.

The Oahe Reservoir froze over on January 7 and was free of ice on April 13.

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 28,100 cfs. Big Bend Reservoir froze over on December 9, 2013 and was free of ice on April 9.

c. Spring Open Water Season 2014

A light plains snowpack coupled with consistent rainfall and above average Garrison releases produced average to above average Oahe inflows from March through May. March and April average monthly inflows were 31,100 cfs (100 percent of average) and 31,200 cfs (115 percent of average). May inflows were 35,800 cfs (128 percent of average). Oahe releases were above average from March through May, averaging 23,800 cfs (117 percent of average). Oahe Reservoir rose 2.6 feet during the critical fish spawning period from 1605.2 feet msl (April 1) to 1607.8 feet msl (May 31).

d. Summer Open Water Season 2014

Oahe inflows remained above average from June through September. Oahe peaked for the year at 1615.5 feet msl on September 4; 8.0 feet above the base of the 9.5-foot Annual Flood Control and Multiple Use Zone. June releases were 19,300 cfs, 71 percent of average; July releases were 24,800 cfs, 79 percent of average; August releases were 28,000 cfs, 83 percent of average; and September releases were 38,200 cfs, 128 percent of average. The reservoir pool declined from its peak to 1612.8 feet msl by September 30, 2.7 feet below its peak.

e. Fall Open Water Season 2014

Oahe fall inflows and releases were above average in October and November as stored flood water was evacuated from Garrison and Oahe. Inflows in October were 23,800 cfs (115 percent of average) and 23,100 cfs (109 percent of average) in November. December inflows were below average due to cold temperatures for much of the month. Average monthly releases for October were 39,000 cfs (164 percent of average), November releases were 31,300 cfs (138 percent of average) and December was 18,600 cfs (89 percent of average). Oahe ended 2014 with a pool elevation of 1607.4 feet msl, 0.1 foot below the base of the Annual Flood Control and Multiple Use Zone.

f. Summary

The highest Oahe Reservoir level of 1615.5 feet msl during 2014 occurred on September 4. The 2014 minimum pool elevation of 1601.2 feet msl occurred on January 12. The average annual inflow to Oahe of 29,100 cfs was 114 percent of average. The average annual release from Oahe of 25,300 cfs was 104 percent of average. Big Bend was operated within its average regulating range of 1420.0 feet msl to 1421.0 feet msl.

5. Fort Randall Regulation – January to December 2014

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 10 lists the Fort Randall average monthly inflows and releases in cfs and the EOM pool elevation in feet msl for 2013 and 2014 as well as the historic averages since the System was first filled in 1967.

Table 10
Fort Randall – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2014	2013	1967-2013	2014	2013	1967-2013	2014	2013	1967-2013
January	19,600	18,700	21,900	12,700	12,100	15,200	1344.7	1346.2	1347.1
February	17,900	17,200	20,100	12,400	11,000	13,300	1349.0	1350.8	1352.0
March	20,500	20,200	21,700	17,300	16,500	15,700	1351.8	1353.4	1356.2
April	29,500	18,900	23,500	25,600	15,200	21,100	1354.3	1356.0	1357.7
May	28,500	18,400	25,000	26,700	15,700	25,200	1355.3	1357.9	1357.4
June	21,700	15,700	30,000	19,000	18,900	28,900	1357.2	1355.3	1357.8
July	25,000	21,700	31,800	25,800	22,400	33,100	1356.1	1354.5	1356.6
August	29,000	25,500	34,300	27,900	23,700	35,400	1356.4	1355.4	1355.4
September	38,300	28,000	29,900	44,500	30,300	34,800	1351.4	1353.1	1351.2
October	38,700	17,800	23,300	45,600	25,800	32,200	1344.9	1346.5	1343.3
November	30,700	13,200	22,200	37,800	24,100	28,700	1337.8	1339.6	1336.9
December	20,000	12,200*	21,400	16,900	13,900	17,300	1341.1	1337.8	1341.0

* monthly minimum of record ** monthly maximum of record

b. Winter Season 2013-14

The Fort Randall average daily winter release ranged from 8,800 cfs to 20,100 cfs. Fort Randall reservoir froze over on December 24, 2013 and was free of ice on March 30.

c. Spring Open Water Season 2014

The Fort Randall pool started March at 1349.0 feet msl and rose to its typical spring and summer pool of 1355.2 feet msl in early May. 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 17,300 cfs was 110 percent of average and the average April release of 25,600 cfs was 121 percent of average. These releases corresponded with inflows of 20,500 cfs in March (94 percent of average) and 29,500 cfs in April (126 percent of average). During May, Fort Randall inflows were 28,500 cfs (114 percent of average) along with the releases of 26,700 cfs (106 percent of average).

d. Summer Open Water Season 2014

Inflows and releases were well below average from June through August as elevated downstream tributary flow triggered lower releases from Fort Randall and the upstream reservoirs. Inflows were 21,700 cfs in June (72 percent of average), 25,000 cfs in July (79 percent of average), 29,000 cfs in August (85 percent of average). Releases from Fort Randall were 19,000 cfs in June (66 percent of average), 25,800 cfs in July (78 percent of average), and 27,900 cfs in August (79 percent of average). Releases and inflows were increased in September to evacuate stored flood waters from the upstream projects. September releases averaged 44,500 cfs (128 percent of average) and inflows averaged 38,300 cfs (128 percent of average). The Fort Randall reservoir reached its annual peak elevation of 1357.7 feet msl on June 21.

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 18 and ceased on August 28. Initially, peaking was limited to 335 MW for a continuous 6-hour time frame. Peaking was temporarily suspended on June 17 due to low daily average releases. Fort Randall releases were lowered due to heavy rains downstream of the System that increased tributary flows and resulted in reduced releases from Gavins Point Dam. Partial hydropower peaking resumed on June 20 with the full pattern resuming on June 26 at 350 MW for 6 hours. This hydropower peaking pattern was maintained until August 28, at which time all restrictions were lifted.

e. Fall Open Water Season 2014

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. Both, inflows and releases were above average for October through November and below average in December. On September 1, the pool level was 1356.4 feet msl. The lowering of Fort Randall pool started after Labor Day and reached its lowest level of 1336.9 feet msl on December 1.

f. Summary

The highest Fort Randall Reservoir level during 2014 occurred on June 21 at 1357.7 feet msl. The lowest reservoir level was 1336.9 feet msl on December 1. The average annual inflow to Fort Randall of 26,600 cfs was 105 percent of average and the average annual release of 26,000 cfs was 104 percent of average.

6. Gavins Point Regulation – January to December 2014

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 11 lists the Gavins Point average monthly inflows and releases in cfs and the EOM pool elevation in feet msl for 2013 and 2014 as well as the historic averages since the System was first filled in 1967.

Table 11
Gavins Point – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2014	2013	1967-2013	2014	2013	1967-2013	2014	2013	1967-2014
January	14,900	14,700	17,300	14,800	14,800	17,200	1207.6	1207.3	1207.5
February	14,500	13,800	16,500	15,100	14,100	17,300	1206.2	1206.4	1205.7
March	19,500	18,300	19,700	19,500	18,600	19,700	1206.6	1205.8	1205.6
April	27,500	18,100	25,000	27,400	17,900	24,800	1206.5	1206.3	1205.8
May	29,200	18,700	28,800	29,100	18,300	28,500	1206.4	1207.0	1206.1
June	23,100	20,600	32,200	22,800	20,700	31,900	1206.8	1206.5	1206.2
July	26,100	23,200	35,300	26,100	23,200	34,800	1206.4	1205.9	1206.7
August	28,900	24,900	37,100	28,500	24,500	36,600	1206.9	1206.3	1207.3
September	43,700	31,200	36,800	43,700	30,500	36,400	1206.3	1207.7	1207.6
October	45,900	27,400	34,500	45,500	27,200	34,300	1206.6	1207.8	1207.8
November	39,000	26,500	31,000	38,300	26,400	31,000	1207.7	1207.6	1207.6
December	19,500	15,000	19,300	19,700	15,100	19,400	1206.5	1207.5	1207.4

* monthly minimum of record ** monthly maximum of record

b. Winter Season 2013-14

The Gavins Point average daily release was below the average winter release rate in December, January, and February. Winter releases varied from 13,000 cfs to 18,100 cfs in December, from 13,000 cfs to 16,100 cfs in January and from 14,000 cfs to 16,100 cfs in February. Gavins Point Reservoir froze over on December 6, 2013 and was free of ice on March 31.

c. Winter River and Ice Conditions Below Gavins Point

The first signs of floating ice on the Missouri River during the 2013-14 winter season were noted on December 6, 2013 from Sioux City, IA downstream to Nebraska City, NE. Ice pans were around 3 to 20 feet in diameter and the river was 30 to 70 percent covered with floating ice. Reports of floating ice reached as far downstream as the Chamois Power Plant near RM 117.1 on December 12, 2013. Ice reports continued through December ranging from 5 to 70 percent with pan sizes ranging from 1 to 20 feet.

In January the ice reports ranged from no ice to 100 percent floating ice with the report of an ice bridge across the Missouri River at RM 752.0, near Ponca, NE. The report showed that the ice bridge extended downstream to Miners Bend at RM 747.7. Gavins Point releases ranged from 13,000 to 18,000 cfs during the winter season. During the winter season Gavins Point releases were increased above 13,000 cfs on five separate occasions between early December and early March. Increasing Gavins Point releases was done in anticipation of the arrival of colder air and ice formation. The ice formation could potentially cause river stages downstream from Gavins Point to decline. The Sioux City stage dropped to a stage of 4.8 feet on the morning of December 30, 2013, the lowest Sioux City stage during winter season. The Sioux City stage rebounded to around 7.5 feet the next day. Portions of the ice bridge in the reach from Ponca downstream to Jackson, NE (near RM 739) remained in place until March 12. On March 13, the ice bridge on the Missouri River near Jackson, NE cleared and the river was free of all ice. From January through mid-March the ice reports below Sioux City indicated 10 to 80 percent floating ice with ice pans sizes up to 40 feet in diameter. The last ice report below Sioux City was made in early March and reported less than 1 percent floating ice.

The Gavins Point releases were below average the entire winter season. The Gavins Point release remained between 13,000 to 16,100 cfs for January-February, above the 12,000 cfs minimum winter release prescribed by the Master Manual.

d. Spring Open Water Season 2014

The bimodal spring pulse from Gavins Point was not conducted in 2014. 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 2014 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.

Flow support for the 2014 navigation season began on March 23 at Sioux City, IA; 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. Per the Master Manual, the March 15 System storage check of 51.6 MAF set navigation flow support to an intermediate service level of 3,000 cfs below the full service level for the first half of the navigation season.

No cycling of Gavins Point releases was conducted in 2014. 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 increases to support navigation. Cycling of releases has been conducted in previous years as a drought conservation measure as well as a flood risk management measure. Beginning in the second week of May, the Gavins Point release was increased to a steady release of 30,000 cfs necessary to meet the navigation flow targets at downstream navigation target locations during the summer.

Significant rainfall in the middle of June impacted tributary inflows into the lower Missouri River. Mid-month rainfall caused a record flood event on the Big Sioux River, with a peak discharge of 108,000 cfs occurring at Akron, IA on June 18, 2014. In order to alleviate flooding on the lower Missouri River, the Gavins Point release was reduced from 30,000 cfs on June 14 to 10,000 cfs by June 19. Beginning on June 23, the Gavins Point release was stepped up, reaching 22,000 cfs by June 28 in order to maintain downstream navigation flow targets. Because tributary contributions to Missouri River flows remained high, the Gavins Point release was not returned to 30,000 cfs.

e. Summer Open Water Season 2014

Based on the July 1 System storage check of 60.1 MAF, navigation flow support was increased to full service for the second half of the season, with a full 8-month season length. Tributary runoff during July and August continued at higher-than-normal levels on the lower Missouri River, allowing Gavins Point release rates to range from 24,000 cfs to 29,000 cfs to meet full service navigation targets at all locations on the Missouri River. For the first time in 11 years a commercial barge traveled to Sioux City, IA. In anticipation of required flood evacuation from the System Annual Flood Control and Multiple Use Zone due to heavy end of August rainfall in Montana, North Dakota and South Dakota, the Gavins Point release was incrementally stepped up beginning on August 30.

f. Fall Open Water Season 2014

Based on the September 1 System storage check of 61.3 MAF as well as the September reservoir monthly studies, the navigation season was extended 10 days to December 11 at the mouth, and the winter release rate from Gavins Point was set at 20,000 cfs based on the monthly studies. Most significantly, the reservoir monthly studies indicated increased System releases of 45,500 cfs would be required to evacuate floodwater stored in the System Annual Flood Control and Multiple Use Zone through the remainder of the navigation season. The 45,500 cfs System release was reached on September 11, 2014.

Due to less-than-forecasted September and October inflows, the System release from Gavins Point Dam was reduced to 36,000 cfs by November 10. On December 2, the Gavins Point release was reduced by 3,000 cfs per day to end navigation flow support at the mouth of the Missouri River on December 11. Furthermore, the December reservoir monthly study indicated the Gavins Point winter release from December through February would be set at 17,000 cfs, rather than 20,000 cfs.

g. Summary

The highest Gavins Point Reservoir level in 2014 was 1208.3 feet msl reached on December 15. The lowest reservoir level in 2014 was 1205.5 feet msl reached March 3. The 2014 average annual inflow to Gavins Point of 27,700 cfs was average. The 2014 average annual release from Gavins Point of 27,500 cfs was 99 percent of average.

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. One event that occurred in 2014 with a connection to regulation activities is discussed in the following paragraph.

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.

E. Reservoir Elevations and Storage

Reservoir elevations and storage levels of the System reservoirs at the end of July 2014 are presented in ***Table 12*** and the same information for the end of December 2014 is presented as ***Table 13***. The Fort Peck pool elevation was 0.5 foot below the base of the Annual Flood Control and Multiple Use zone on December 31, nearly recovering from the 2012 drought. All other projects were near their respective base of the Annual Flood Control and Multiple Use zone by December 31. The reservoir capacity table for Big Bend was updated on April 1, 2014. This update resulted in very minor storage changes at Big Bend as well for the System. Therefore, no adjustments to the System storage zones were necessary.

Table 12
Reservoir Levels and Storages – July 31, 2014

Project	Reservoir Elevation		Reservoir Storage in 1,000 AF**		
	Elevation (ft msl)	12-Month Change (ft)	Total	Above Min. Level*	12-Month Change
Fort Peck	2230.1	+4.0	13,978	9,890	+767
Garrison	1846.1	+10.0	20,582	15,788	+3,294
Oahe	1613.6	+11.0	20,697	15,382	+3,494
Big Bend	1420.0	+0.0	1,635	4	+9
Fort Randall	1356.1	+1.6	3,501	2,032	+136
Gavins Point	1206.4	+0.5	336	41	+12

*Net usable storage above minimum reservoir levels established for power, recreation, irrigation diversions and other purposes.
**Reservoir storage including 12-month reservoir storage change is determined using the new elevation-capacity curves for Garrison, Oahe, Fort Randall and Gavins Point, implemented August 1, 2013 and for Big Bend, implemented on April 1, 2014.

Table 13
Reservoir Levels and Storages – December 31, 2014

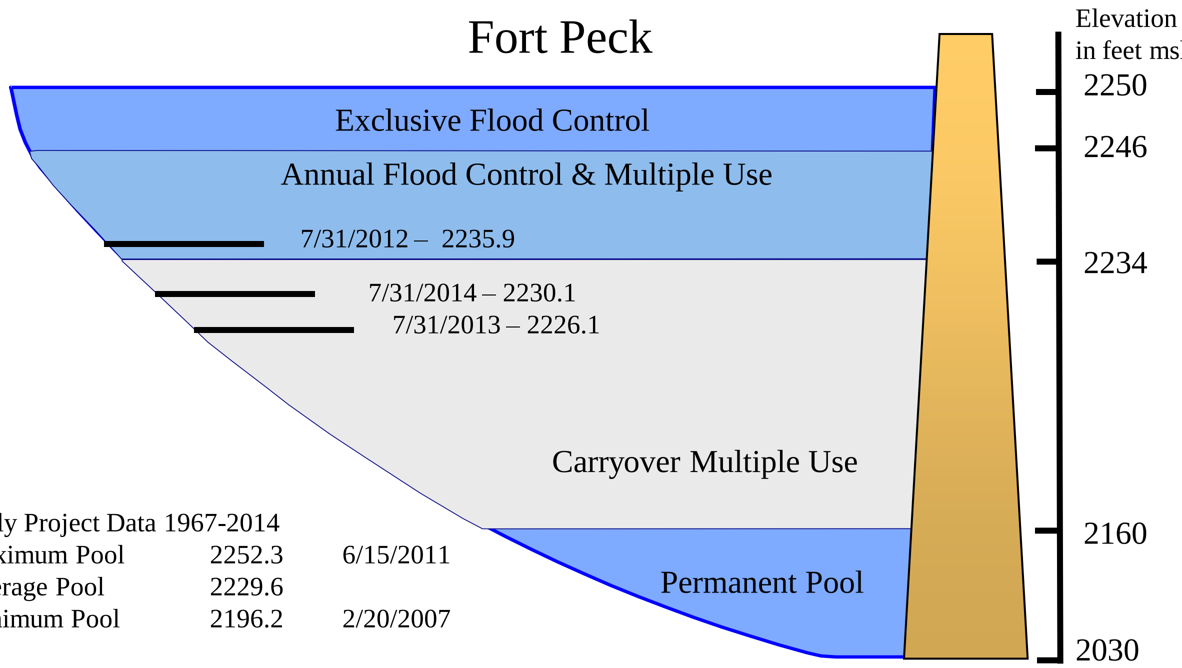
Project	Reservoir Elevation		Reservoir Storage in 1,000 AF		
	Elevation (ft msl)	12-Month Change (ft)	Total	Above Min. Level*	12-Month Change
Fort Peck	2233.5	+10.4	14,685	10,597	+2,061
Garrison	1840.5	+7.5	18,657	13,863	+2,266
Oahe	1607.4	+6.0	18,629	13,314	+1,800
Big Bend	1420.5	+0.0	1,660	29	+8
Fort Randall	1341.1	+3.3	2,392	923	+184
Gavins Point	1206.5	-1.0	338	43	-23

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

Figures 16A and ***16B*** show the end-of-July pool elevations for Fort Peck, Garrison and Oahe plus total System end-of-July storage for 2012 through 2014. Individual tables with the historic maximum, average and minimum pool elevations for each reservoir are also shown on ***Figures 16A*** and ***16B.***

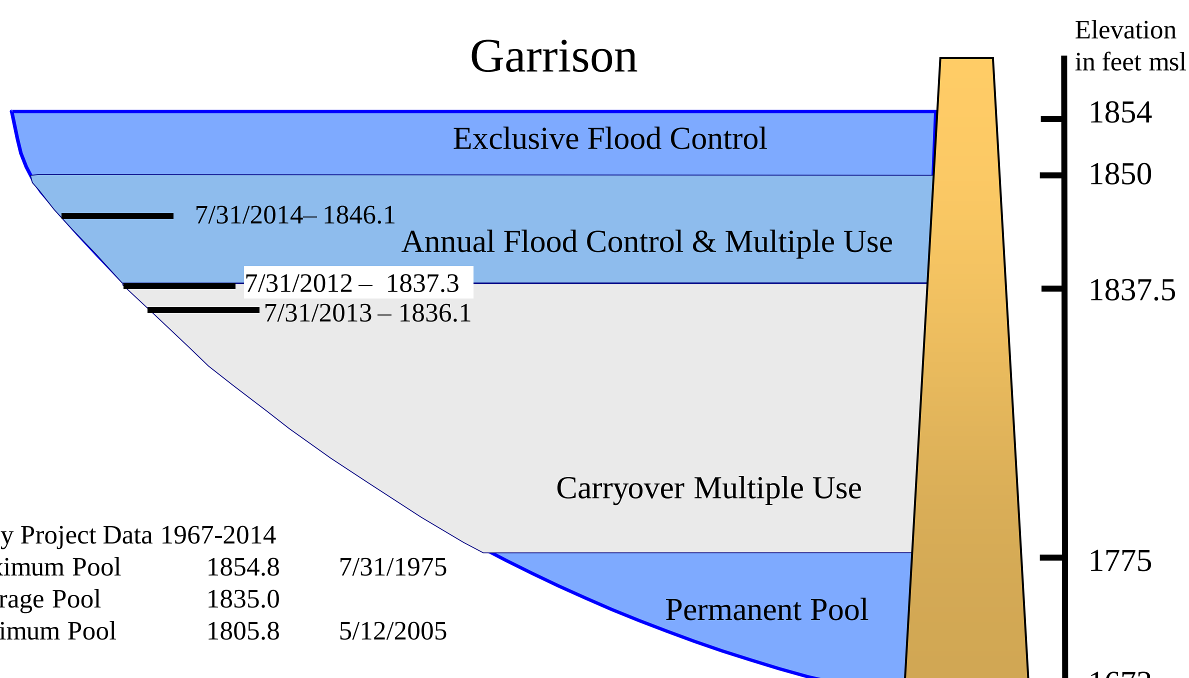
Missouri River System Reservoirs
End-of-July Pool Elevations and Total System Storage

Fort Peck



Daily Project Data 1967-2014		
Maximum Pool	2252.3	6/15/2011
Average Pool	2229.6	
Minimum Pool	2196.2	2/20/2007
Maximum for 2014	2233.6	12/26/2014
Minimum for 2014	2222.3	2/13/2014

Garrison

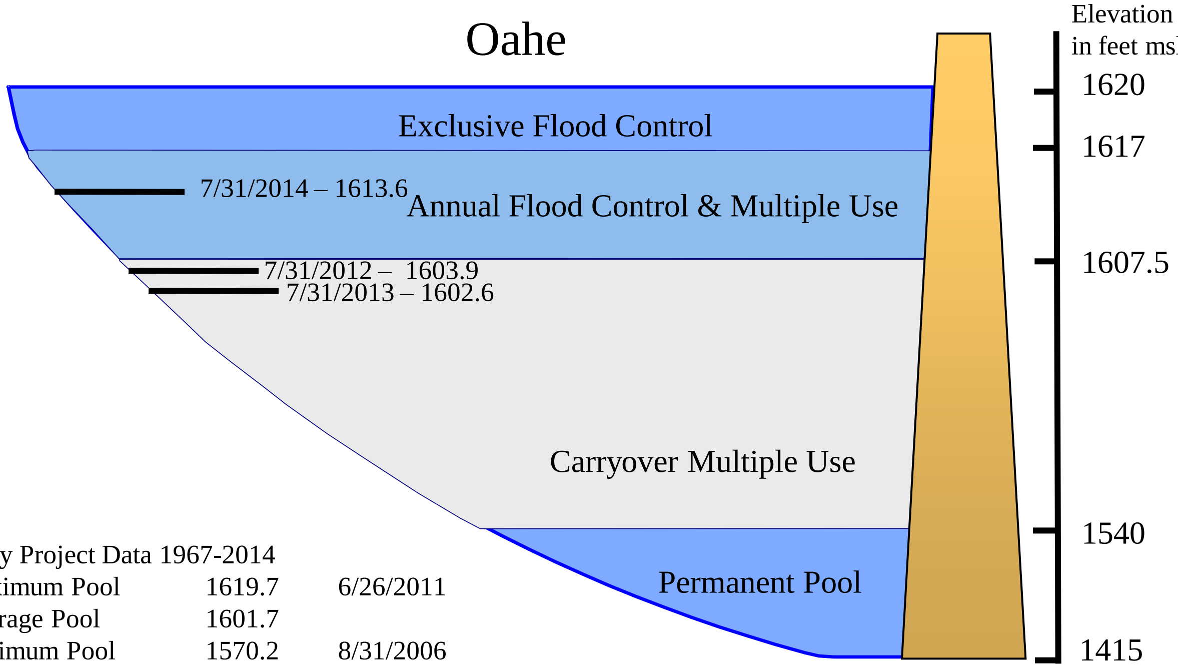


Daily Project Data 1967-2014		
Maximum Pool	1854.8	7/31/1975
Average Pool	1835.0	
Minimum Pool	1805.8	5/12/2005
Maximum for 2014	1846.5	7/26/2014
Minimum for 2014	1831.4	3/8/2014

Figure 16A. End-of-July pool elevations for Fort Peck and Garrison.

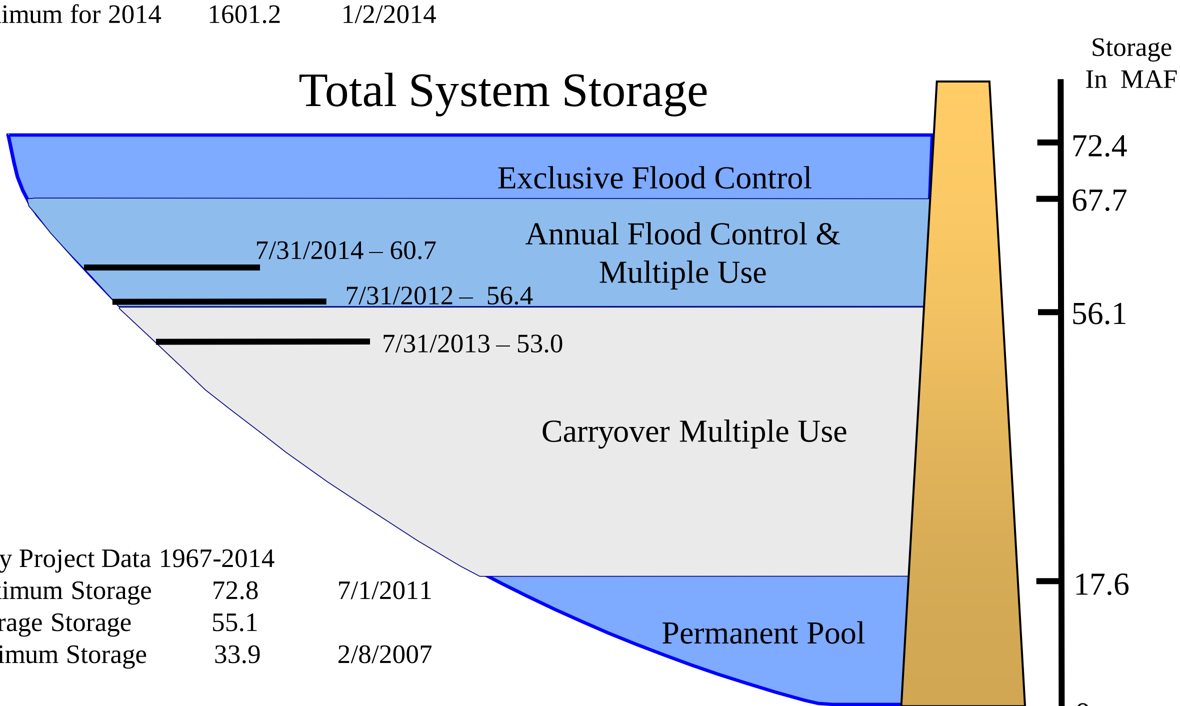
Missouri River System Reservoirs
End-of-July Pool Elevations and Total System Storage

Oahe



Daily Project Data 1967-2014		
Maximum Pool	1619.7	6/26/2011
Average Pool	1601.7	
Minimum Pool	1570.2	8/31/2006
Maximum for 2014	1615.5	9/4/2014
Minimum for 2014	1601.2	1/2/2014

Total System Storage



Daily Project Data 1967-2014		
Maximum Storage	72.8	7/1/2011
Average Storage	55.1	
Minimum Storage	33.9	2/8/2007
Maximum for 2014	61.3	9/1/2014
Minimum for 2014	50.0	1/7/2014

Figure 16B. End-of-July pool elevation for Oahe and total System storage.

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

1. Flood Control

March 15 System storage was 51.6 MAF, 4.5 MAF below the base of the Annual Flood Control and Multiple Use Zone. Per the criteria outlined in the Master Manual, navigation flow support releases were at an intermediate level, 3,000 cfs below the full service level during the first half of the 2014 navigation season. During 2014 operation of Federal projects during significant runoff events in April, June and September resulted in significant flood damage reduction. As shown on ***Figures 17A*** and ***17B***, flows and stages at locations downstream of the mainstem projects were significantly reduced due to operation of the mainstem reservoirs. For example, the stages at Bismarck during the June event, with an unregulated peak of 116,000 cfs, were reduced by 11.1 feet due to the operation of all Federal reservoirs upstream of Bismarck and 6.8 feet solely due to the operation of the upstream System reservoirs, Fort Peck and Garrison.

The total flood damages prevented by all Corps controlled reservoir projects in the Missouri River Basin during 2014 were estimated to be nearly $1.4 billion ($1.3 billion Omaha District; $100 million Kansas City District). Flood damages prevented by the System reservoirs during 2014 were estimated to be $966 million ($870 million Omaha District; $96 million Kansas City District). The System flood damages prevented indexed to the September 2014 price level is illustrated in ***Figure 17A.*** Since 1938, the total flood control damages prevented by the System were $55.8 billion, an annual average of $734 million, indexed to September 2014 price levels. The total un-indexed flood damages prevented at the original price levels is $33.9 billion, an annual average of $440 million (see ***Figure 17B***). 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, ***Figures 17A*** and ***17B*** include the construction cost of the dams. Indexed to 2014 price levels, the dams cost approximately $25.5 billion, whereas the original un-indexed cost was $1.2 billion.

Figures 18A and ***18B*** shows the 2014 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. The unregulated peak flow, as a result of upper Missouri River Basin runoff, would have occurred in late August downstream of Fort Peck Dam and in June downstream of the Garrison and Gavins Point dams.

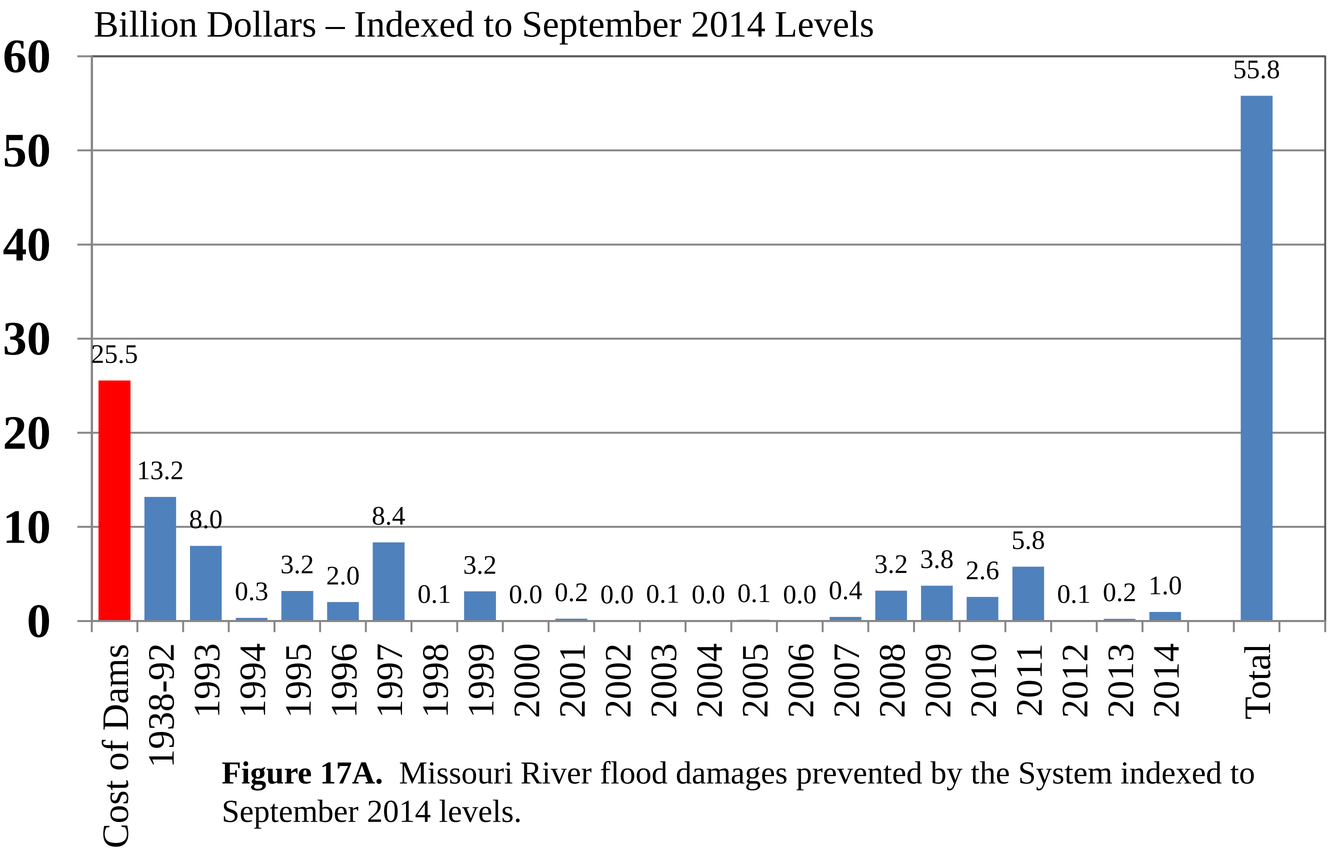


Figure 17A. Missouri River flood damages prevented by the System indexed to September 2014 levels.

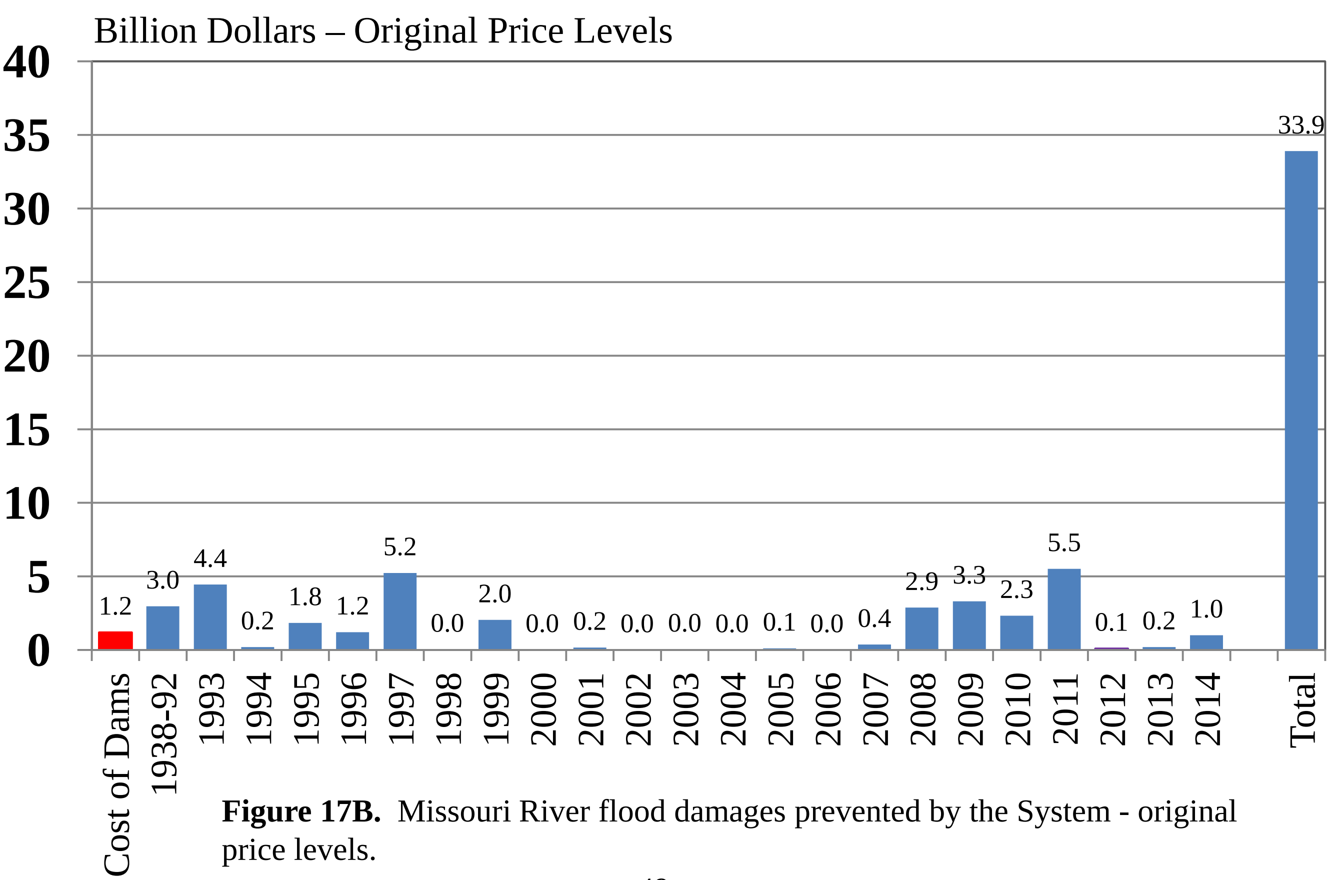
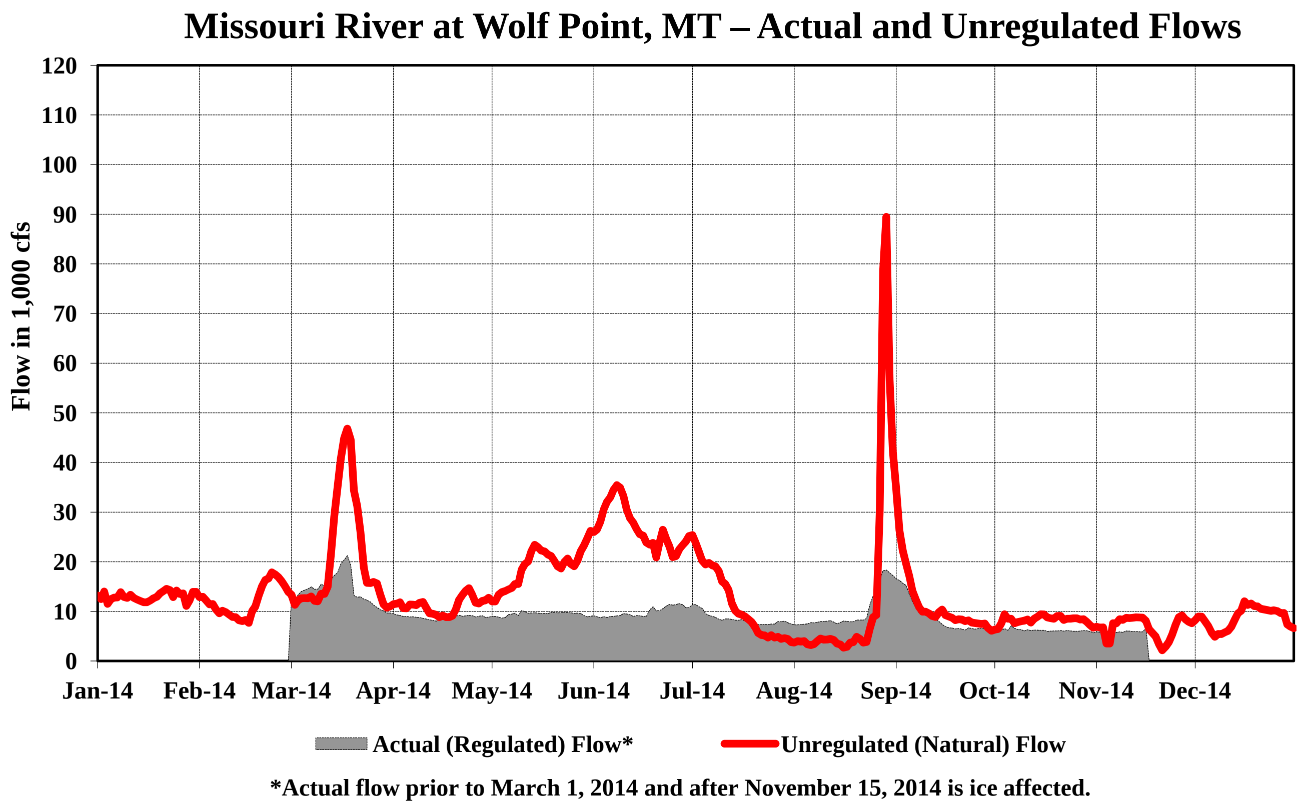


Figure 17B. Missouri River flood damages prevented by the System - original price levels.



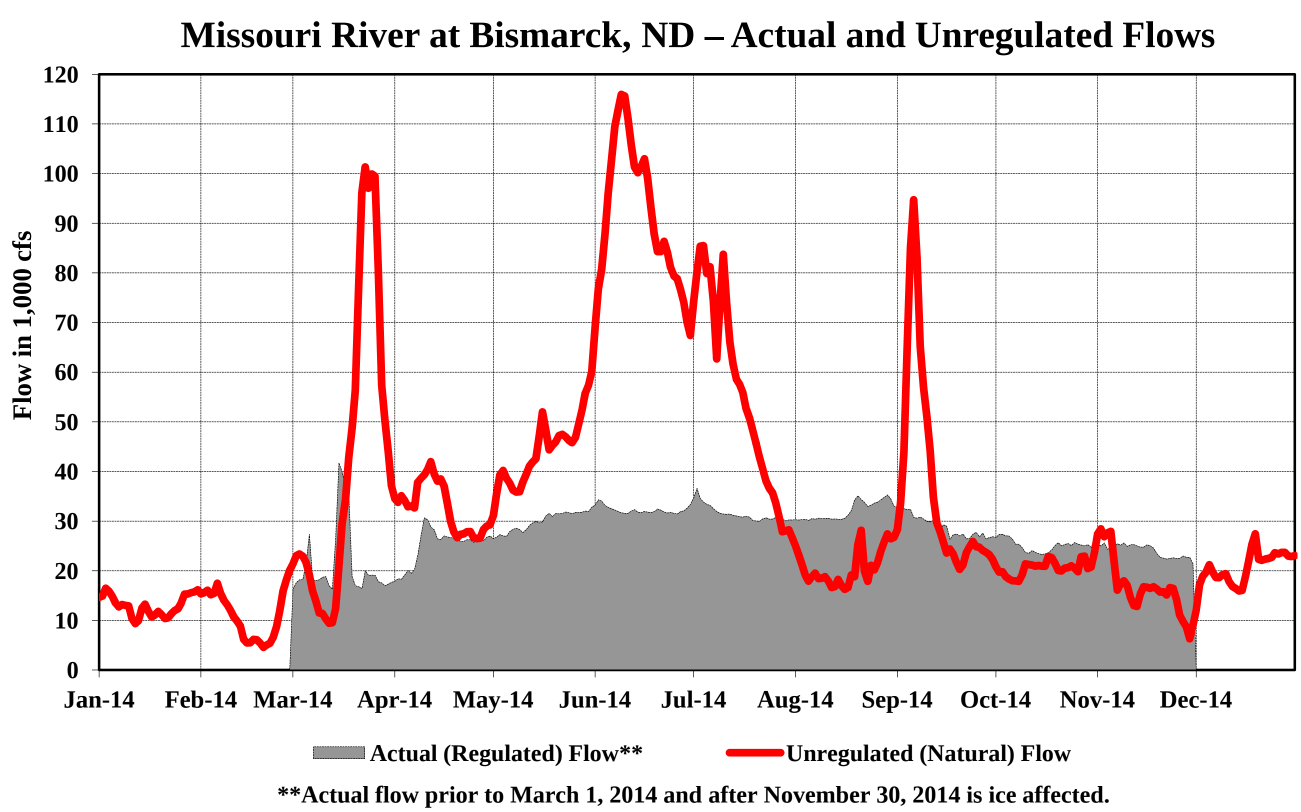
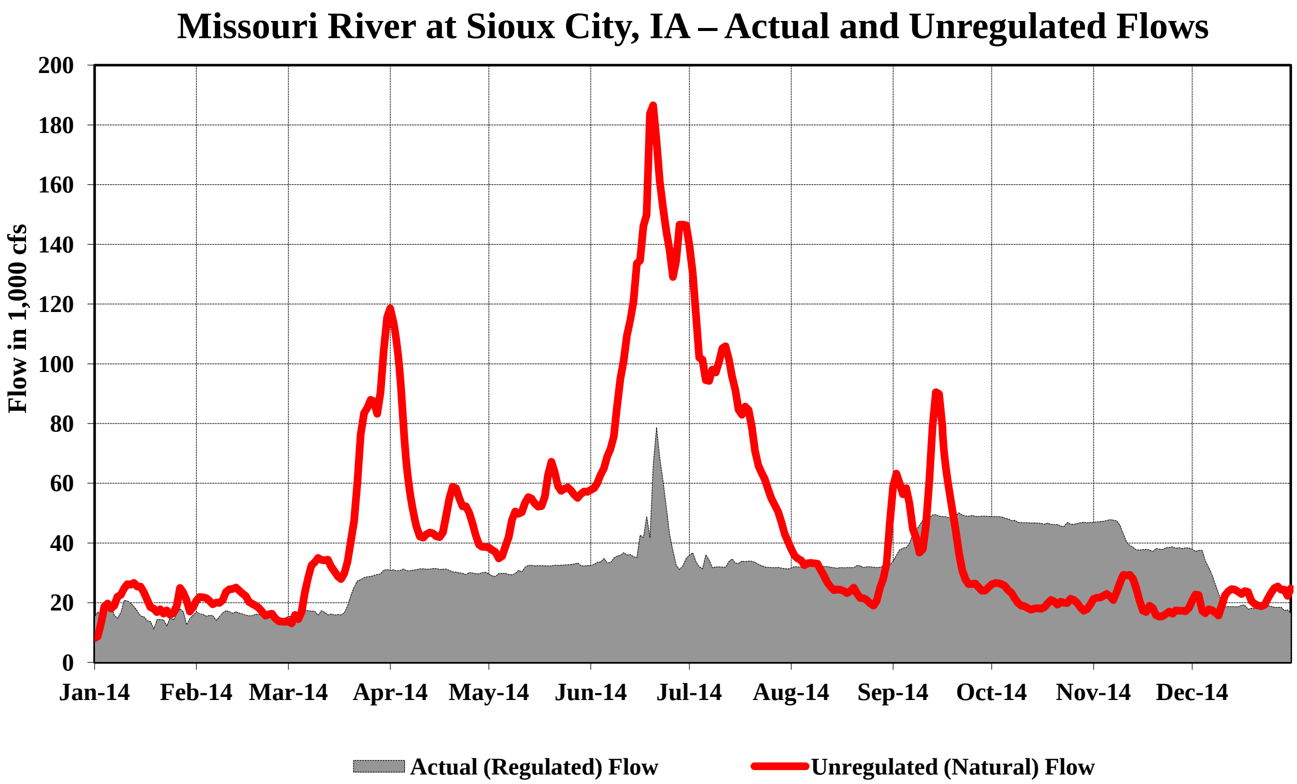


Figure 18A. Actual and unregulated flows – Wolf Point, MT and Bismarck, ND.



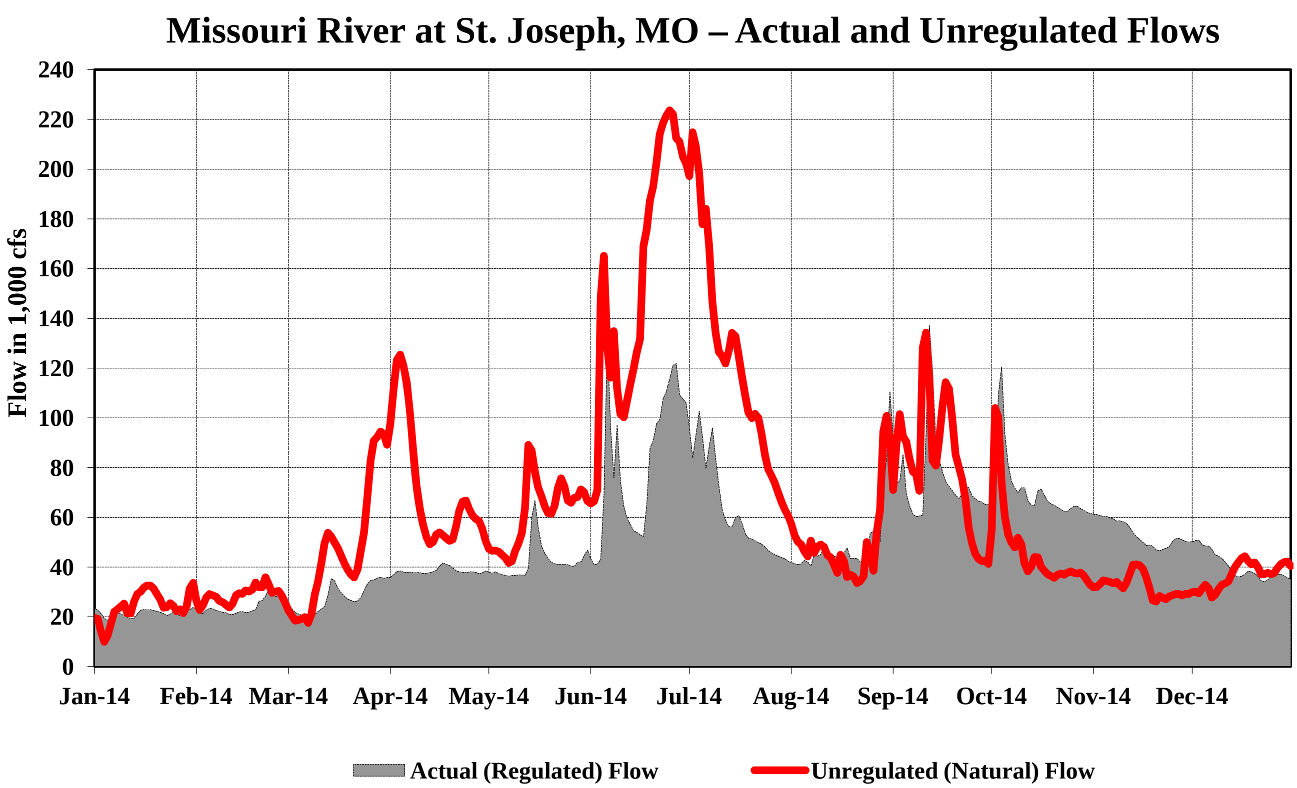


Figure 18B. Actual and unregulated flows – Sioux City, IA and St. Joseph, MO.

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 previous two winters, minimum releases during the winter did require some additional coordination with downstream intake owners to ensure that their intakes were operational. Due to the higher-than-normal runoff in 2014, the September 1 storage check indicated a winter release of 17,000 cfs, which did not result in any intake access issues.

4. Water Quality Control

a. Overview

During 2014 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 completed annually since 2010, was continued and conducted jointly with the Kansas City District (NWK) and extended from Gavins Point Dam 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 have relevance to the mainstem reservoirs. These identified priority issues are:

- Determine how regulation of the mainstem 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 flow regimes, especially the release of water from mainstem reservoirs, affects water quality in the 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 (e.g. to support Corps reservoir regulation elements for effective surface water quality and aquatic habitat management, to provide technical support to the 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 14 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-

Table 14
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	Nutrients (total phosphorus and total nitrogen)	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	Yes (NE)	Aquatic Life	Cancer risk and hazard index compounds (primarily PCBs and dieldrin)	No	Yes	Dieldrin Polychlorinated biphenyls (PCBs)	Reduced suspended sediment and turbidity impacts to pallid sturgeon. Assimilative capacity and flow reduction.
• Missouri River, Boyer River to Council Bluffs water supply intake	Yes (IA)	Drinking Water	Arsenic	No	No	---	---
• Missouri River, Platte River (NE) to Kansas	Yes (NE)	Recreation Aquatic Life	*E. coli* Cancer risk and hazard index compounds (primarily PCBs and dieldrin)	Yes (*E. coli*)	Yes	Dieldrin PCBs	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.

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 species inhabit the warmer, shallower areas of the reservoirs (i.e. epilimnion), while coldwater species inhabit the colder, deeper areas of the reservoirs. Coldwater fish species also provide forage that is used extensively by both the coldwater and warmwater fish species. These coldwater forage species include the rainbow smelt (*Osmerus mordax*) in Oahe and Garrison and lake cisco (*Coregonus artedi*) in Fort Peck. 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 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 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, 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 and 2014 dissolved oxygen conditions 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) and 6.1 mg/l (2014). 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 protect Garrison for a coldwater fishery use. As such, a water temperature criterion of ≤ 59 deg F (or 15 degrees C), a dissolved oxygen criterion of ≥ 5 mg/l, and a minimum volume of 500,000 AF (0.5 MAF) meeting those criteria have been promulgated by North Dakota to protect the coldwater fishery of Garrison.

Water temperature and dissolved oxygen depth profiles that were measured during water quality monitoring conducted at Garrison over the 5-year period from 2010 through 2014 were used to estimate the volume of water in the reservoir that meets the coldwater habitat conditions defined by the State of North Dakota. ***Plate 3*** and ***Plate 4*** show estimated reservoir and coldwater habitat volumes, by year, for 2010 through 2014. Water quality monitoring in 2014 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 address measurement uncertainty NWO is currently updating their CE-QUAL-W2 hydrodynamic and water quality modeling of the reservoir.

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 degrees 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 Oahe was estimated from water quality monitoring conducted over the 5-year period 2010 through 2014. ***Plate 5*** shows estimated summer reservoir and coldwater fishery habitat volumes, by year, for 2010 through 2014. Except in 2011, at least 1.0 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. However, during the next triennial water quality standards review, South Dakota may pursue reclassification of Big Bend from a coldwater fishery to a warmwater fishery based on a use attainability assessment of "natural conditions" (personal communication with South Dakota Department of Environment and Natural Resources). 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.

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 while 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 51.6 MAF, navigation flow support was set to an intermediate service level of 3,000 cfs below the full service level for the first half of the navigation season. Based on the July 1 System storage check of 60.2 MAF, System releases were set to provide full service flow support for the second half of the season. In addition, the July 1 System storage check called for a normal 8-month season length.

The first commercial load on the Missouri River in 2014 was the *Motor Vessel (MV) Mary Lynn*, operated by Hermann Sand and Gravel Company located in Hermann, MO at river mile (RM) 97. The *MV Mary Lynn* entered the Missouri River on March 25 with a tow of five loaded fertilizer barges and one empty barge. The empty barge was to be dropped off in Hermann, MO at RM 97, and the fertilizer barges were being taken to the AgriServices Terminal in Brunswick, MO at RM 256. The *MV Mary Lynn* reached the AgriServices Terminal on March 31.

There were two special types of shipments during the 2014 navigation season. On July 10 the *MV Mary Lynn* 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 Mary Lynn*. This was the first barge in the Sioux City area in 11 years. In total, seven shipments and eight barges were placed to CF Industries in 2014 and at least three shipments are expected in 2015. On July 30, the *Argosy* riverboat casino, located near Sioux City, IA at RM 731.5, closed and its assets, including the riverboat and a barge containing 1920s-era river walk buildings, were sold to a marine business in Illinois. On October 7, the *Argosy* riverboat casino was motored downriver and reached its destination near Wood River, IL (on the Mississippi River) on October 20. On November 6, *MV Gerald F. Engmann* departed from RM 731.5 with the barge containing the 1920s-era buildings.

Three grain elevators that had not used the river for several years began shipping grain by barge in 2014. The Glasgow, MO river terminal, RM 226, sent its first shipment on October 27 with two barges of grain in tow of the *MV Leslie Ann*. The Jefferson City, MO river terminal, RM 143, shipped out its first load on October 28 with six loads of grain going downstream in tow of the *MV Jamie Leigh*. The Lexington, MO river terminal at RM 318 sent its first load on October 30 with one barge downstream in tow of the *MV Mary Lynn*.

b. Tonnage

Table 15 shows the Missouri River tonnage data for 2009-2013 compiled by the Waterborne Commerce Statistics Center (WCSC). The 2013 total of 4.105 million tons includes 3.609 million tons for sand and gravel, 0.251 million tons for waterways materials, and 0.245 million tons for long-haul commercial tonnage. In 2013 the total tonnage increased by 0.199 million tons compared to 2012. The long haul tonnage at 0.245 million tons increased by 0.048 million tons from 2012. The largest long-haul commercial tonnage, excluding sand, gravel and waterway material, occurred in 1977 at 3.34 million tons. ***Figure 19A*** shows total navigation tonnage on the Missouri River. ***Figure 19B*** shows the long-haul commercial navigation tonnage not including sand, gravel and waterway materials. The long-haul commercial tonnage in 2014 is estimated at 0.255 million tons, based on carrier interviews, towboat activity and barge counts from the Corps' daily boat reports. ***Figure 20A*** shows the navigation tonnage value of the commodities since 1960, using 2014 present-worth computations. ***Figure 20B*** shows the

Table 15
Missouri River Tonnage by Commodity (1000 Tons)

Commodity Classification Group	**2009**	**2010**	**2011**	**2012**	**2013**
Farm Products	18	35	21	20	12
Corn	4	13	6	0	0
Wheat	0	0	0	0	0
Soybeans	14	23	15	20	12
Misc Farm Product	0	0	0	0	0
Nonmetallic Minerals	4666	4388	3588	3479	3664
Sand/Gravel	4649	4346	3548	3421	3609
Misc Nonmetallic	17	42	39	61	55
Food and Kindred	32	36	0	0	0
Pulp and Paper	0	0	0	0	0
Chemicals	26	72	49	34	53
Fertilizer	24	70	49	34	53
Other Chemicals	2	1	0	0	0
Petroleum (including coke)	120	118	44	6	54
Stone/Clay/Glass	57	76	77	79	71
Primary Metals	0	0	0	0	0
Waterway Materials	117	105	53	288	251
Other	0	0	0	0	0
Total Commercial	5036	4831	3832	3906	4105
Total Long-Haul Commercial	270	380	230	197	245

navigation tonnage value of long-haul commercial commodities since 1960. The ***Figures 19A***, ***19B***, ***20A*** and ***20B*** tonnages and tonnage values for 2014 are estimates and will change once final WCSC tabulations are available.

Navigation season target flows for past years are given in ***Table 16***. ***Table 17*** shows the scheduled lengths of past System-supported navigation seasons, with total tonnage and ton-miles for each year. ***Figure 21*** presents discharge data at Sioux City, IA; Nebraska City, NE and Kansas, MO, three of the four navigation flow-target locations for 2014. There was no navigation support from the Kansas River projects in 2014.

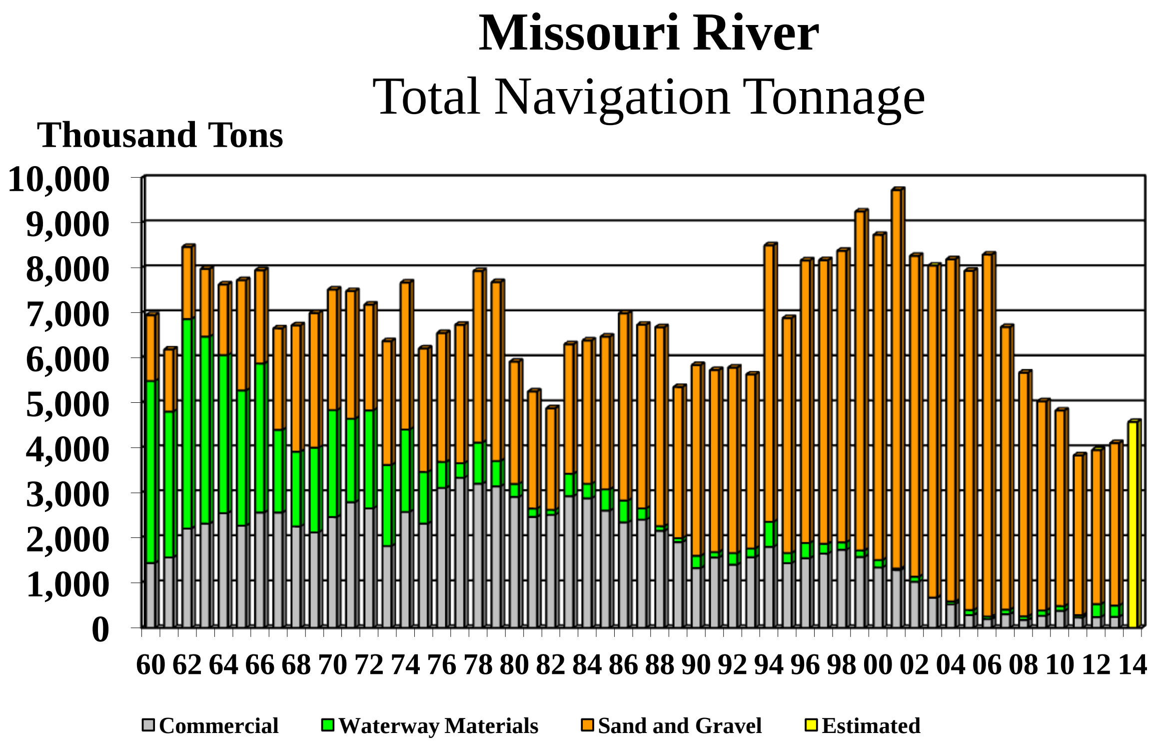


Figure 19A. Missouri River total navigation tonnage from 1960 to 2014 (estimated)

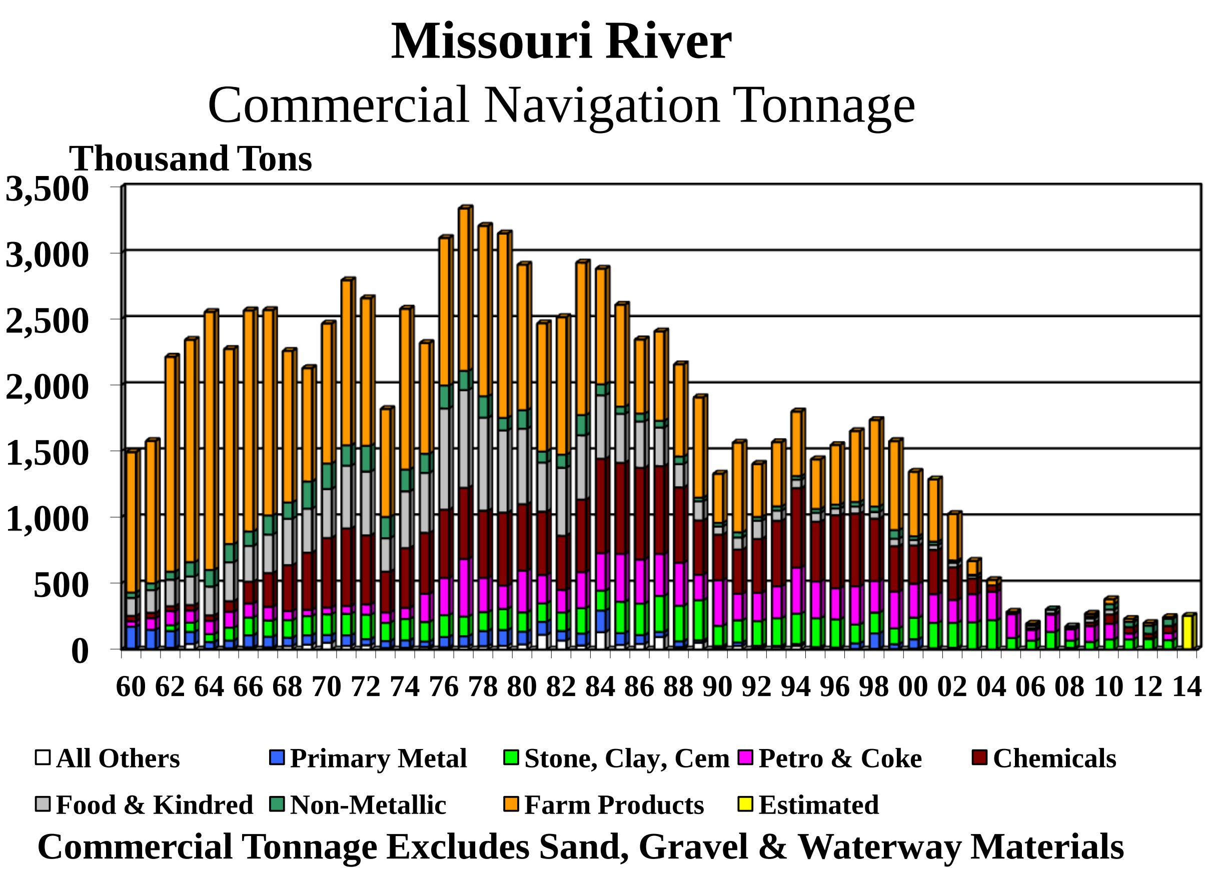


Figure 19B. Missouri River commercial navigation tonnage from 1960 to 2014 (estimated)

Missouri River

Total Navigation Tonnage Value - 2014 Present Worth

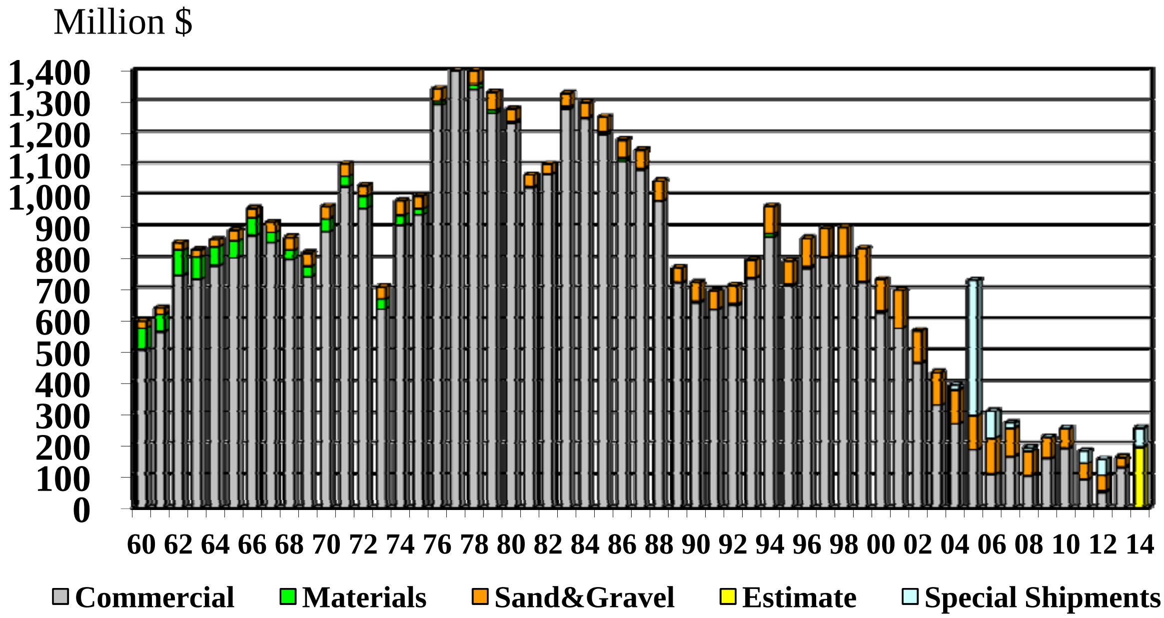


Figure 20A. Total navigation tonnage value using 2014 present worth computations

Missouri River

Commercial Navigation Tonnage Value - 2014 Present Worth

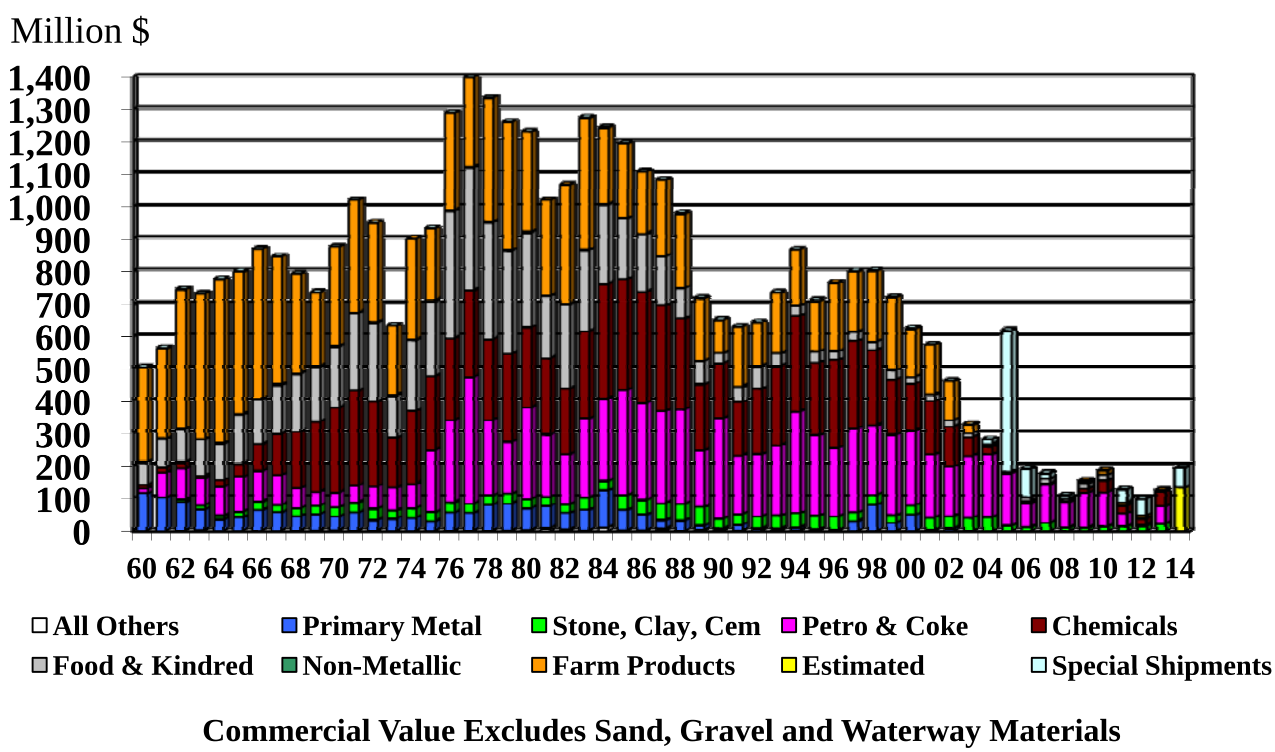


Figure 20B. Commercial navigation tonnage value using 2014 present worth computations

Table 16
Navigation Season Target Flows
(1,000 cfs)

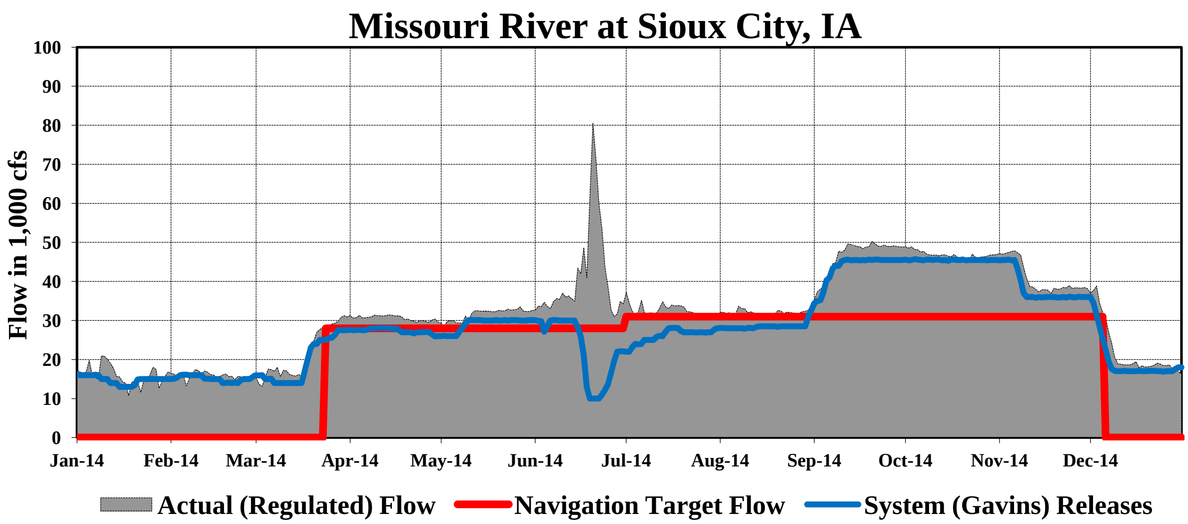
Year	Months	Sioux City	Omaha	Nebraska City	Kansas City
1967	Apr-Jun	28	28	34	38
	Jul-Nov	31	31	37	41
1968	Apr-Nov	31	31	37	41
1969	Apr-Jun(1)	35-40	35-40	41-46	45-50
	Jul(1)	36	36	42	46
	Aug-Sep(1)	50-55	50-55	55-60	55-60
	Oct-Nov(1)	40-45	40-45	45-50	50-55
1970	Apr-May	31	31	37	41
	May-Sep(1)	36	36	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

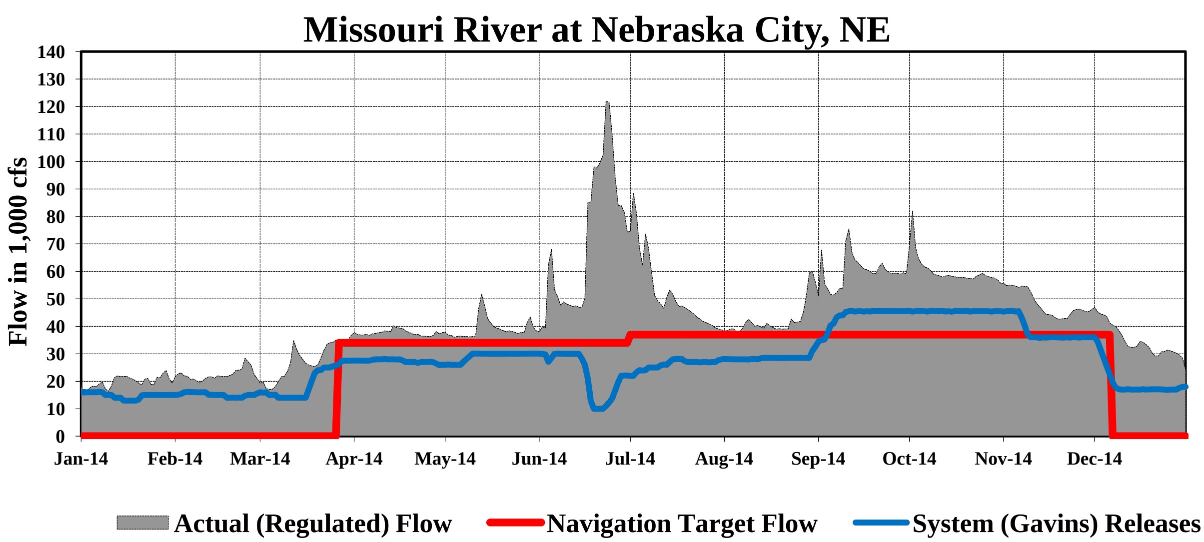
(1) Downstream flow targets above full-service navigation level as a flood control storage evacuation measure.
(2) Full service flows provided for shortened season.
(3) Navigation targets below full service as a water conservation measure.
(4) Navigation targets at minimum service as a water conservation 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 17
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)	255,000(12)	4,569,000(12)	120,000(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.





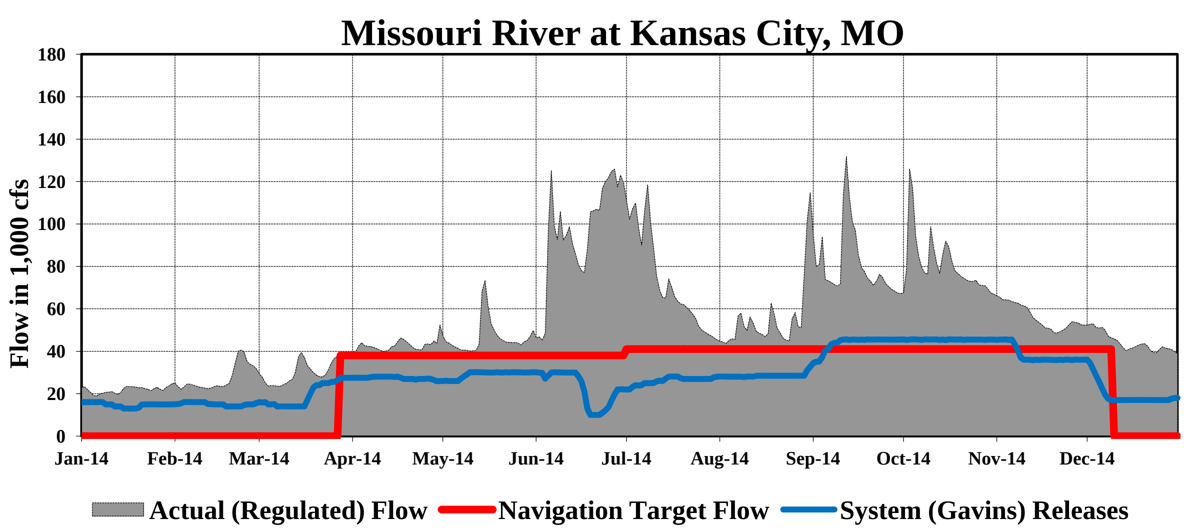


Figure 21. Actual flow, System releases and navigation target flows – Sioux City, IA; Nebraska City, NE and Kansas City, MO (calendar year).

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. During 2014, service was provided to over 360 wholesale customers. Customers receiving service include 200 municipalities, 3 Federal agencies, 31 state agencies, 26 USBR projects, 5 irrigation districts, 36 rural electric cooperatives, 6 public utility districts, 11 private utilities, 25 Native American services and 19 power marketers. Additional benefits were provided by the interconnections to the Southwestern Power Administration (SWPA) and Western Area Power Administration (Western) Rocky Mountain Region (RMR).

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 9.6 billion kWh, the energy generated in 2014 by this portion of the Federal power system could have supplied all of the yearly needs of about 825,000 residential OPPD customers. In addition to the clean, renewable energy transmitted to the Midwest area, System hydropower provides an added measure of stability to the regional power system with the ability to respond to system emergencies. Large coal-fired and nuclear units are backed up by other reserve sharing group members and the Federal hydropower units, typically within 5 minutes or less. Members of the reserve sharing group benefit by being able to call for reserves during emergency events. In addition, hydropower generation can be integrated with wind generation to provide balance to the regional power system. This balance is achieved by using hydropower to rapidly respond to the increased power system variation and forecast errors caused by wind. Currently, there is approximately 806 MW of wind generation capability in Western's balancing area.

The reliability of System hydropower is indicated by having to maintain adequate reserves in both the Northwest Power Pool in Western Area Power Administration, Upper Great Plains West (WAUW) and Southwest Power Pool Reserve Share Group in Western Area Power Administration, Upper Great Plains East (WAUE). Although the Federal hydropower that serves the Missouri River region accounts for only 9 percent of the region's energy, it is large enough to fill gaps and provide a positive benefit to the integrated system.

Hydropower generation in 2014 was 9.6 billion kWh, which was 102 percent of average since the System first filled in 1967. The 2014 generation was 2.0 billion kWh more than the 2013 generation of 7.6 billion kWh and 4.7 billion kWh more than the record low of 4.9 billion kWh, set in 2008. Total generation was near average in 2014 due to a higher runoff year in the basin that refilled the System storage and required flood storage evacuation releases from the System in the fall. 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 22***. The total generation from the Federal system (peak capacity and energy sales) for 2014 is shown in ***Table 18***. The tabulations in ***Table 19*** and ***Table 20*** 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.

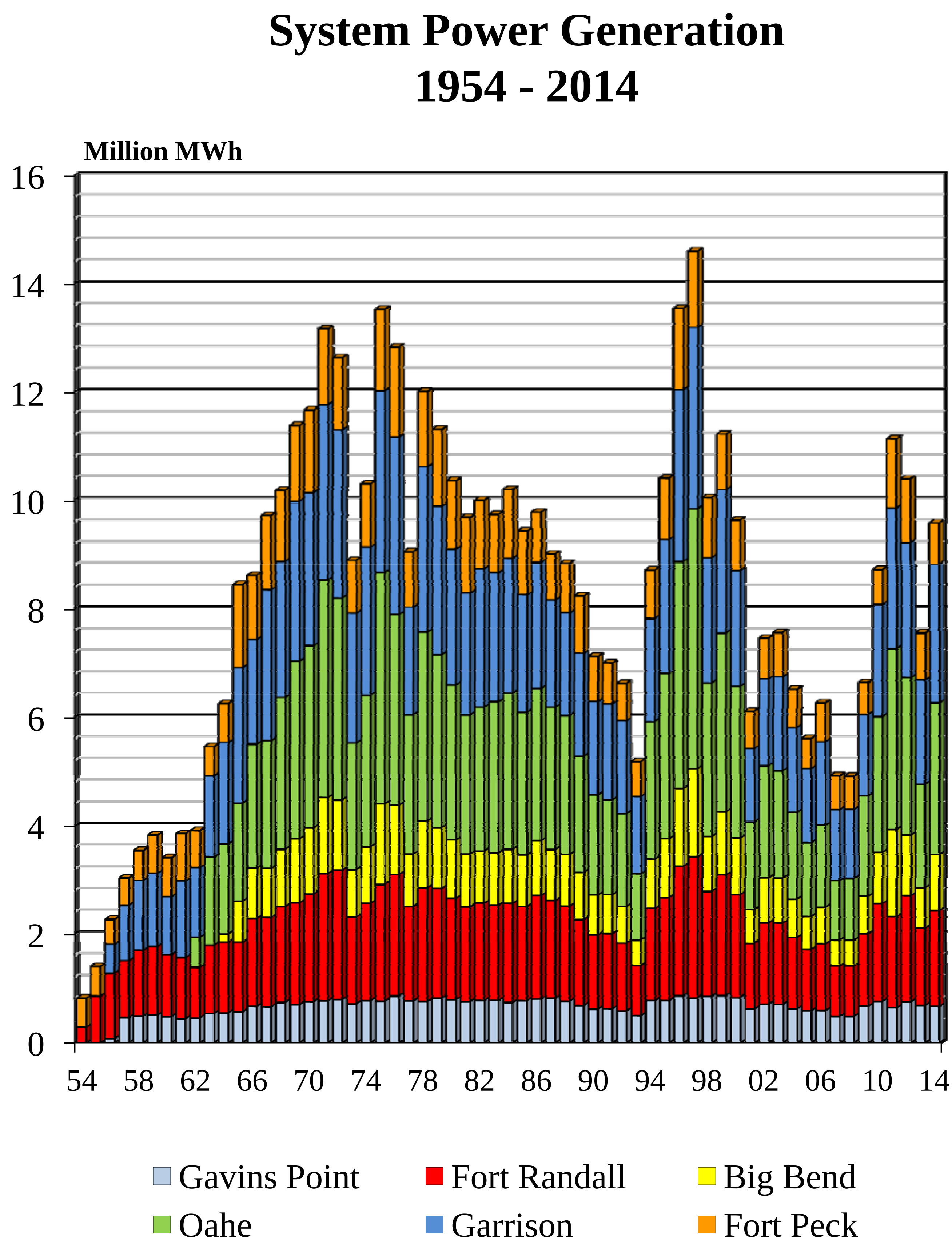


Figure 22. System power generation by project from 1954 to 2014.

Table 18
Gross Federal Power System Generation – January 2014 through December 2014

	Energy Generation 1000 kWh	**Peak Hour kW**	**Generation Date**
Corps Powerplants – Mainstem			
Fort Peck	767,402	139,000	May 9
Garrison	2,552,034	495,000	April 24
Oahe	2,799,063	731,000	September 7
Big Bend	1,040,001	421,000	September 16
Fort Randall	1,764,613	341,000	May 27
Gavins Point	670,128	119,000	November 26
Corps Subtotal	**9,593,241**		September 5
USBR Powerplants			
Canyon Ferry	364,364	57,000	March and June
Yellowtail*	549,336	123,500	April and May
USBR Subtotal	**913,700**		
Federal System Total	**10,506,941**		

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

Table 19
Historical Generation and Load Data – Peaks
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at Plant (1000 kW)
January 1, 2014 through December 31, 2014

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	1,579		76		1,655		503		2,158	Jan 23	800
February	1,767		79		1,846		568		2,414	Feb 05	800
March	1,654		156		1,810		445		2,255	Mar 25	800
April	1,805		172		1,977		156		2,133	Apr 14	800
May	1,547		170		1,717		0		1,717	May 30	1500
June	1,133		84		1,217		577		1,794	Jun 25	1500
July	1,593		124		1,717		440		2,157	Jul 21	1700
August	1,855		89		1,944		337		2,281	Aug 19	1700
September	1,842		116		1,958		0		1,958	Sep 26	1700
October	1,391		70		1,461		176		1,637	Oct 29	900
November	1,184		93		1,277		818		2,095	Nov 30	1900
December	1,028		99		1,127		409		1,536	Dec 30	1800

* This tabulation summarizes the total gross generation and power operations for the Eastern Division marketing area system shown on Table 18.
** During hour of peak total system load.

Table 20
Historical Generation and Load Data – Total
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at Plant (1000 kWh)
January 1, 2014 through December 31, 2014

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	564,371		48,944		613,315		555,483		1,168,798
February	499,271		44,635		543,906		597,076		1,140,982
March	618,546		81,293		699,839		331,094		1,030,933
April	827,758		113,254		941,012		89,324		1,030,336
May	879,703		117,010		996,713		60,121		1,056,834
June	752,003		88,481		840,484		99,479		939,963
July	903,652		88,561		992,213		103,601		1,095,814
August	962,267		61,812		1,024,079		98,937		1,123,016
September	1,043,027		69,895		1,112,922		18,154		1,131,076
October	1,046,479		75,350		1,121,829		17,970		1,139,799
November	890,129		63,419		953,548		215,198		1,168,746
December	606,029		62,622		668,651		345,432		1,014,083

*Powerplants from Table 18.

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 above average levels through the 2014 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.

In 1987 the reporting method was changed from recreation days to visitor hours. All Corps projects, including the System projects, are now reporting visitation using the Visitation Estimation Reporting System (VERS).

The standard method used for the Corps to determine visitation hours is under revision. For 2012, visitation data is only available for the January through September period. No visitation data is available for 2013 or 2014. The annual visitation data for 2012-2014 will be updated in future summary reports when it becomes available. Visitor attendance figures at the System reservoirs from 2009 through 2012 are shown in ***Table 21***. ***Figure 23*** displays recreation-related visitor hours at each of the six System projects for the years 1954 through 2012. Although the drought had an impact on visitation during the years from 2000-2007, much of the reduction shown in ***Figure 23*** is attributed to the data collection changes 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 2012 visitation in South Dakota presented in ***Table 21*** and ***Figure 23*** reflects 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.

Table 21
Visitation at System Reservoirs (Visitor Hours)

Mainstem Project	2010	2011	2012*	2013**	2014**
Fort Peck	6,173,900	6,455,300	6,666,900	n/a	n/a
Garrison	15,698,700	14,190,300	15,233,400	n/a	n/a
Oahe	9,503,100	6,964,900	10,863,700	n/a	n/a
Big Bend	3,346,500	2,528,100	2,651,700	n/a	n/a
Fort Randall	1,067,000	1,108,500	860,300	n/a	n/a
Gavins Point	9,410,000	10,737,500	8,877,500	n/a	n/a
System Total	**45,199,200**	**41,984,600**	**45,153,500**	n/a	n/a

*2012 visitor hours are for January to September only.

**Data is not available due to a change in the visitation hour methodology.

System Visitation
1954 - 2014

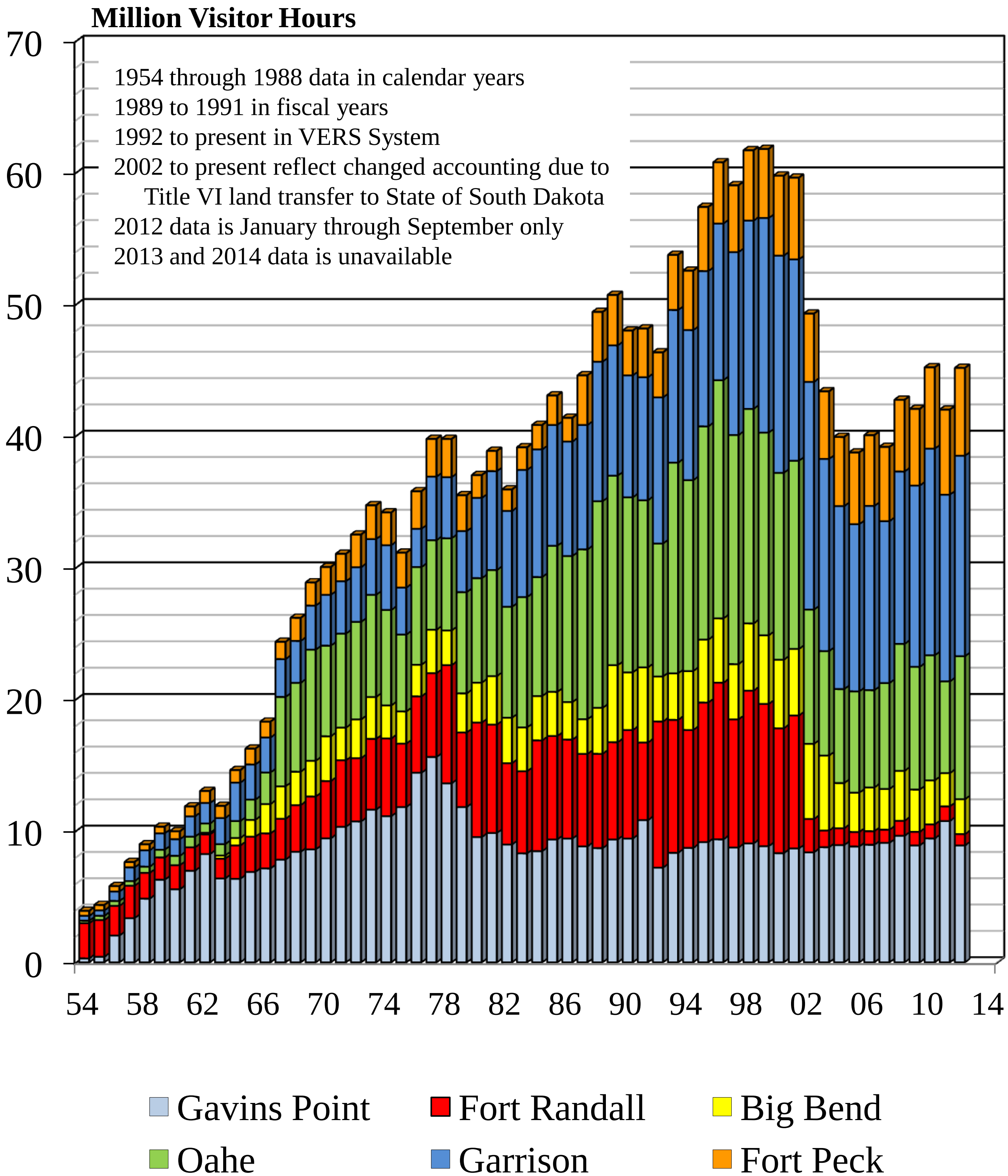


Figure 23. System visitation by project from 1954 to 2014.

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 greater-than-normal 2014 runoff resulted in steady-to-rising reservoir pools in the three large reservoirs throughout the spring and 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

This was the ninth year of operating for the endangered pallid sturgeon (pallid sturgeon) per the revised Master Manual. The bimodal spring pulse from Gavins Point was not conducted in 2014, as detailed in section II.C.6.a. 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; however, the cross-sectional data still need to be updated following the 2011 Flood.

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 higher-than-normal 2014 runoff 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 2014 Annual Report (*www.moriverrecovery.org*).

The population distribution and productivity for terns and plovers for 1986 through 2014 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
Fort Peck Lake																
	Adults	0	0	0	2	0	0	2	2	0	0	0	0	0		0
	Fledglings/Pair	0	0	0	0	0	0	3	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
	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
Lake Sakakawea																
	Adults	10	34	21	25	16	26	48	53	14	15	11	3	14		19
	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
Garrison to Lake Oahe																
	Adults	105	125	126	144	142	157	139	123	73	108	134	0	105		131
	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
Lake Oahe/Lake Sharpe																
	Adults	85	94	106	70	73	131	128	186	111	71	48	39	100		89
	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
Ft. Randall to Niobrara																
	Adults	72	71	84	50	71	76	55	74	58	23	10	0	87		99
	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
Lake Lewis and Clark																
	Adults	44	58	46	46	13	4	0	85	225	214	272	231	211		131
	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
Gavins Point to Ponca																
	Adults	149	232	314	366	359	476	383	410	278	211	159	0	209		243
	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
Total Adults		551	653	731	741	722	904	802**	1,010	781	696	650	273	726		720
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

- 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
Fort Peck Lake																
	Adults	0	4	2	17	9	26	20	16	9	12	3	2	0		0
	Fledglings/Pair	0	1	2	0.35	2.22	1.08	1.2	0.5	0.22	0.33	0	0	0		0
Fort Peck to Lake Sakakawea																
	Adults	4	3	2	6	0	2	5	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
Lake Sakakawea																
	Adults	277	424	469	528	738	746	430	399	363	85	38	24	200		155
	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
Garrison to Lake Oahe																
	Adults	99	149	119	149	164	220	175	222	218	275	287	0	98		221
	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
Lake Oahe/Lake Sharpe																
	Adults	141	184	203	301	372	364	331	273	281	158	44	20	125		210
	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
Ft. Randall to Niobrara																
	Adults	62	38	35	37	42	42	37	21	26	16	6	0	43		106
	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
Lake Lewis and Clark																
	Adults	28	34	44	14	0	24	4	20	57	122	152	134	179		186
	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
Gavins Point to Ponca																
	Adults	186	218	260	286	262	340	309	300	320	238	74	2	137		238
	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
Total Adults		797	1054	1134	1338	1587	1764	1311	1251	1274	906	604	182	782		1116
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

- 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 affects 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 2014 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 September 12, 2014, was sent to the Missouri River Basin Tribes offering consultation on the 2014-2015 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. No Tribes were recorded participating in the fall AOP public meetings in October 2014.

The Corps actively addresses shoreline erosion which can damage or significantly alter cultural resource sites. During the 2014 reporting period, Omaha District completed construction on two large cultural resource shoreline protection projects at Gavins Point and Fort Randall and anticipated the completion of two more at Oahe and Big Bend in 2015.

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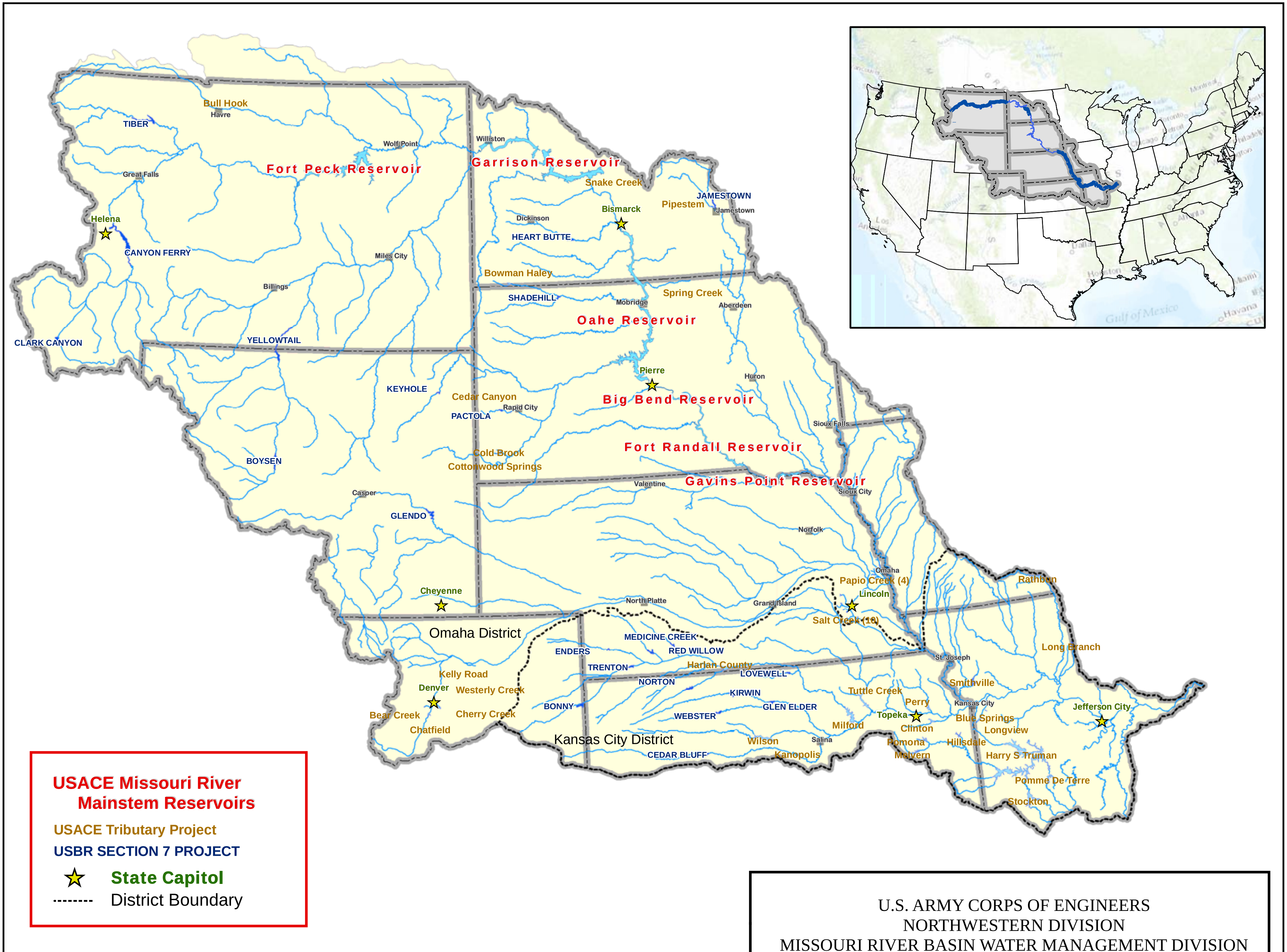

PLATE 1. Missouri River Basin Map.

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)	1,046	2,251	2,625
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	633,000 at elev 1379.8	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
981	1,726	725	9,354 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) 1967-2013 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
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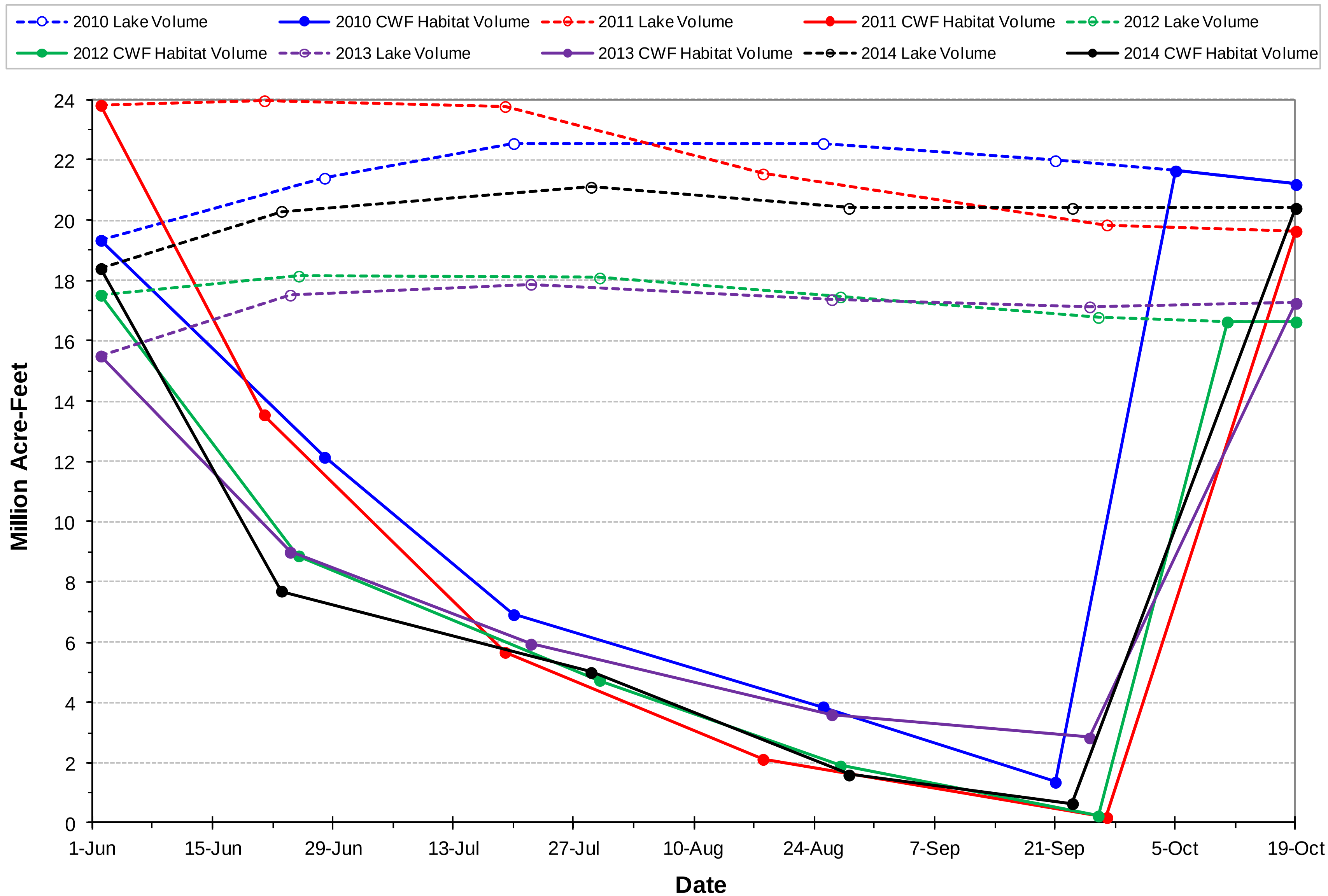

Plate 3. Garrison Reservoir - estimated reservoir and coldwater fishery (CWF) habitat 2010 through 2014.

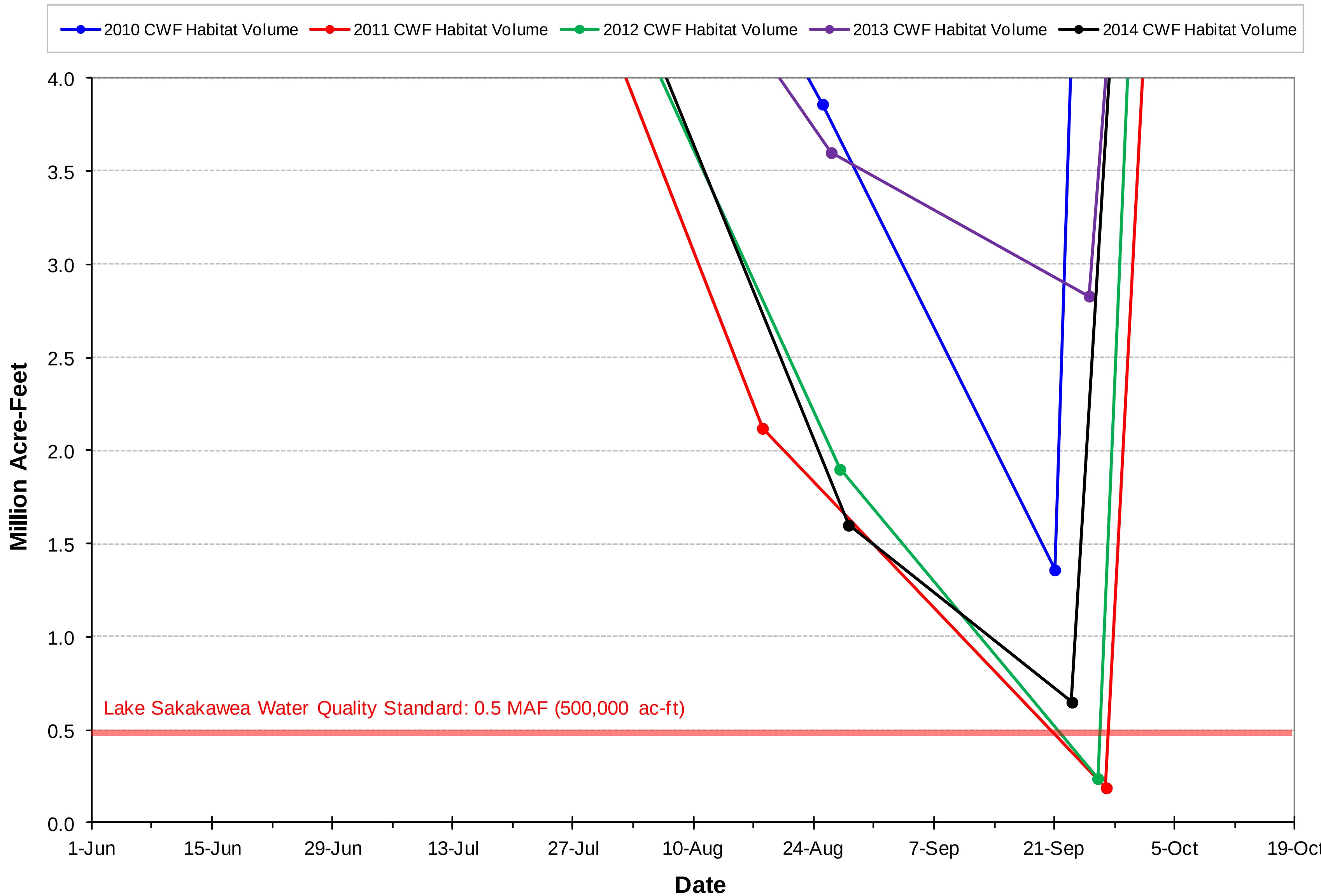

Plate 4. Garrison Reservoir - estimated reservoir and coldwater fishery (CWF) habitat 2010 through 2014 (exploded view).

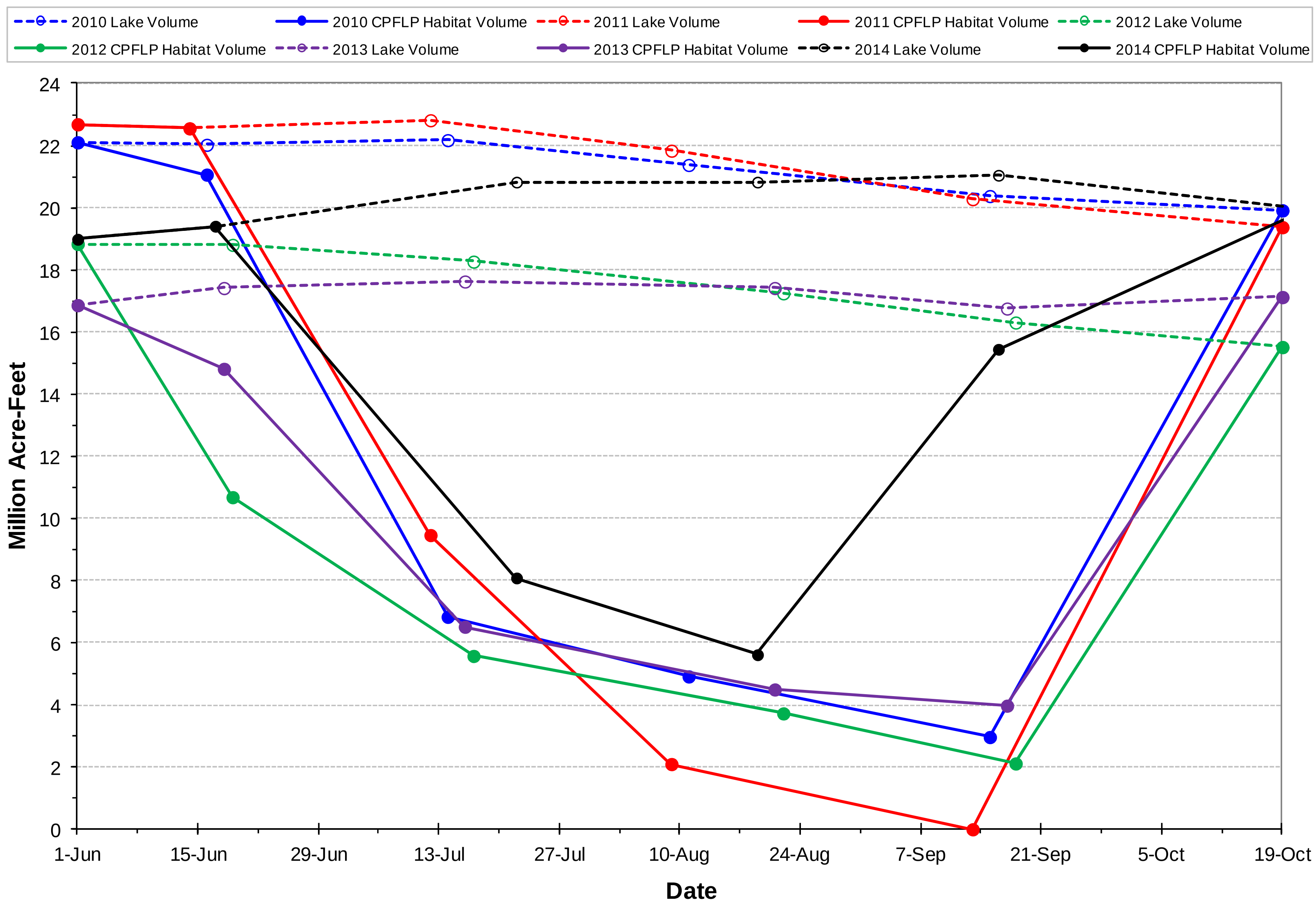

Plate 5. Oahe Reservoir - estimated reservoir and coldwater fishery (CWF) habitat 2010 through 2014.