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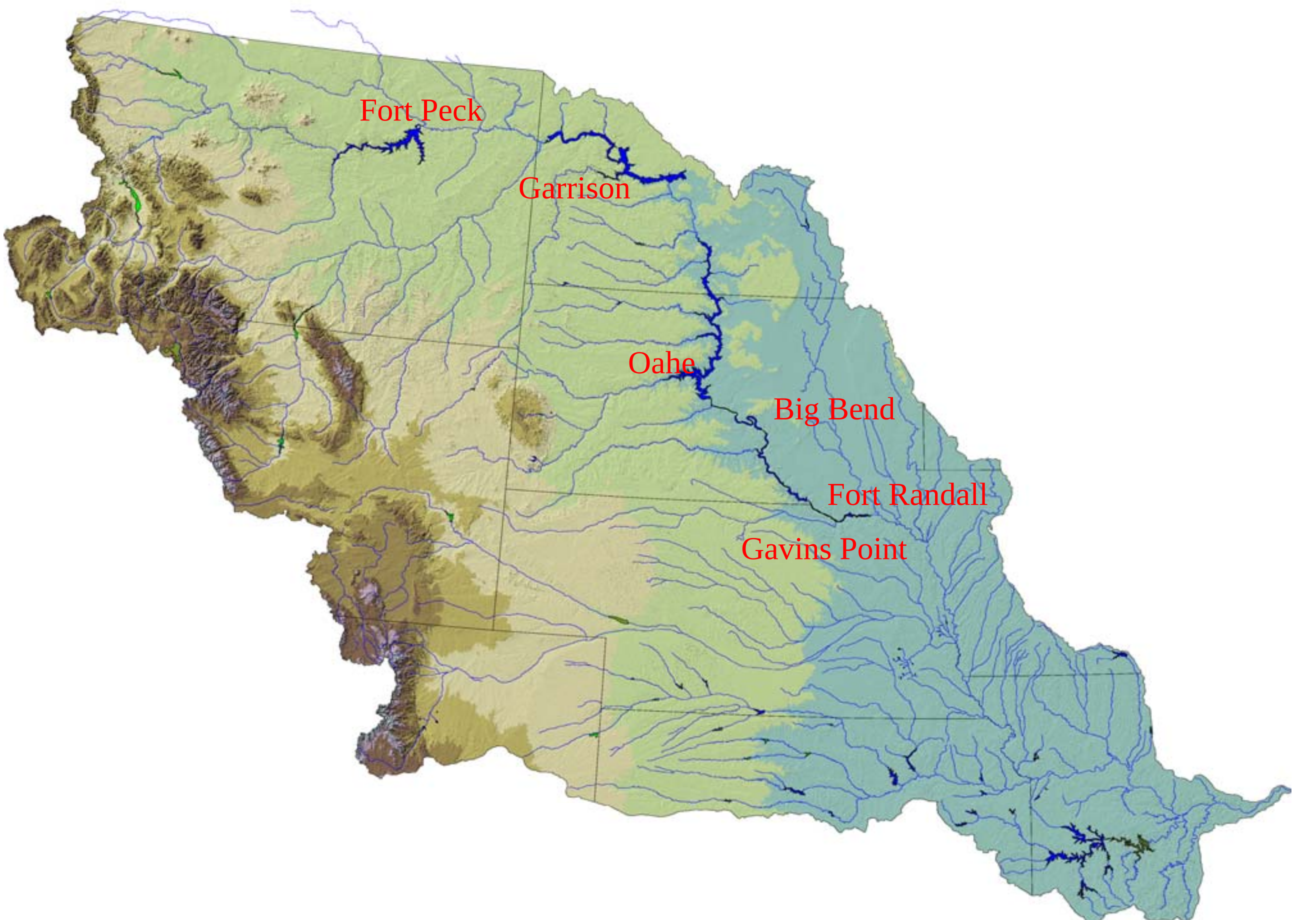
Missouri River Mainstem Reservoir System

Summary of Actual 2013 Regulation



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

July 2014

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Missouri River Mainstem Reservoir System

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LIST OF ABBREVIATIONS AND ACRONYMS

AOP	annual operating plan
AF	acre-feet
cfs	cubic feet per second
CPC	National Oceanic and Atmospheric Administration Climate Prediction Center
CPFLP	coldwater permanent fish life propagation
CY	calendar year (January 1 to December 31)
DMS	Data Management System
C	degrees Celsius
F	degrees Fahrenheit
EA	Environmental Assessment
ENSO	El Nino Southern Oscillation
EOM	End of Month
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
NOAA-NWS	National Oceanic and Atmospheric Administration - National Weather Service
NOHRSC	National Operational and Hydrologic Remote Sensing Center
NRCS-SNOTEL	Natural Resources Conservation Service SNOwpack TELemtry
NWD	Corps' Northwestern Division
NWK	Corps' Kansas City District
NWO	Corps' Omaha District

LIST OF ABBREVIATIONS AND ACRONYMS (cont'd)

OPPD	Omaha Public Power District
PA	2004 Programmatic Agreement
plover	piping plover
P-S MBP	Pick-Sloan Missouri Basin Program
RM	river mile
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
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.

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Missouri River Mainstem Reservoir System

Summary of Actual 2013 Regulation

I. FOREWORD

This document contains a summary of the actual regulation of the Missouri River Mainstem Reservoir System (System) for the 2013 Calendar Year (CY). Two other reports related to System regulation are also available, the ***System Description and Regulation*** and ***Final 2012-2013 Annual Operating Plan.*** All three reports can be obtained by contacting the Missouri River Basin Water Management Division (MRBWM), Northwestern Division, U.S. Army Corps of Engineers at 1616 Capitol Avenue, Suite 365, Omaha, Nebraska 68102-4909, phone (402) 996-3841. The reports are also available on the MRBWM website at www.nwd-mr.usace.army.mil/rcc.

A basin map is presented on ***Plate 1***, and the pertinent data for the System are shown on ***Plate 2.***

II. REVIEW OF REGULATION

A. General

This report summarizes the System regulation as it pertains to all eight Congressionally-authorized purposes. During 2013 the System was regulated in accordance with the Master Water Control Manual (Master Manual) and the applicable provisions of the Final 2012-2013 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. A summary of the significant events during 2013 follows.

B. Precipitation and Water Supply Available in 2013

Plains snowpack, mountain snowpack and general weather conditions in the Missouri River Basin (Basin) during the 2013 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

In a significant contrast from conditions 12 months earlier, the snowpack across the Northern and Central Plains was quite extensive at the beginning of 2013. In fact, a series of winter storms during the latter half of December 2012 combined with colder than normal temperatures ensured that even the far lower portion of the Basin had a snowpack by early January 2013. The greatest amounts of snow water equivalent (SWE) at that time were found in far northeastern Montana (2 to 4 inches in the Milk River basin), western North Dakota (1 to 2 inches), and eastern South Dakota (1 to 2 inches in the lower James River and upper Big Sioux River basins).

While the plains snowpack was quite extensive at the beginning of February 2013, it was rather limited in depth for most locations. The highest amounts of SWE were found in the Milk River basin in northeastern Montana, with 4 to 6 inches estimated near and north of Glasgow. Coincidentally, the National Weather Service office in Glasgow had measured 13.2 inches of snowfall for the month of January or 165 percent of the climatological average.

Generally an estimated 1 to 3 inches of SWE covered the plains on February 1 over much of North Dakota into eastern South Dakota. Above average snowfall was reported during January in South Dakota at Mobridge (10.5 inches or 202 percent of normal), Pierre (9.4 inches or 200 percent of normal), and Aberdeen (9.6 inches or 150 percent of normal). While several intense systems with brief periods of near-blizzard conditions moved through the upper Basin during January, the expansion of the plains snowpack was generally due to periodic light to moderate snowfall (2 to 4 inch totals) combined with below average temperatures. The latter ensured that any significant snowmelt was limited to the lower portion of the Basin from the Central Rockies eastward through Nebraska.

While the plains snowpack increased slightly over much of the upper portion of the Basin during February 2013, milder temperatures and an overall limited number of winter storms in the Northern Rockies and adjacent High Plains resulted in significant melting across southeastern Montana by the beginning of March. The most powerful system to move through this region February 9-11 dropped heavy mountain snowfall in central and southern Wyoming, then moved from the Nebraska panhandle through the eastern Dakotas. Snowfall totals in eastern South Dakota included 13.2 inches at Aberdeen, 9.6 inches at Mitchell, and 9 inches at Huron.

The remainder of February was noted for two unusually strong winter storms that occurred over the lower portion of the Basin and produced record snowfall totals for several locations. The first of these two winter storms, February 20-22, moved from the Central Rockies eastward through Kansas, Missouri, and Nebraska and dropped 4 to 8 inches of snow around Denver before intensifying in the plains and producing 8 to 9 inches around Omaha, 8 to 10 inches in northeastern Kansas, and 9 to 13 inches around Kansas City. This was followed just days later by another winter storm that formed east of the Southern Rockies before moving northeastward across many of the same locations. Heavy snowfall and blizzard conditions were observed February 24-27 from Colorado through Kansas, Missouri and parts of Iowa with an additional 9 to 12 inches of snowfall around Denver and 8 to14 inches around Kansas City. Although the plains snowpack reached its peak extent and water equivalent around March 1, 2013 (***Figure 1***), heavy snowfall events interspersed with snowmelt occurred through early May.

An Arctic cold front dropped through the upper portion of the Basin March 3-5 and produced light to moderate snowfall from eastern Montana through the Dakotas. Amounts were greatest in Montana around Nashua and Glasgow (3 to 5 inches) and in North Dakota from Williston to Jamestown (5 to 6 inches).

A much more powerful winter storm moved out of the Southern Rockies March 7-11 and brought a wintry mix to much of the Central Rockies and Central Plains. Seasonably mild temperatures at the onset of the storm combined with heavy rainfall to initiate rapid melting of part of the plains snowpack in eastern South Dakota and northwestern Iowa. This resulted in several tributaries, particularly the upper Little Sioux and lower Big Sioux Rivers, to briefly climb into minor flood stage in far northwestern Iowa. On the back end of the storm, blizzard-like conditions occurred over eastern Nebraska, western Iowa, and far southeastern South Dakota. The heaviest snowfall totals were found in eastern Nebraska with 6 to 11 inches common from Lincoln to Omaha. The high water content of the snow along with near to above normal temperatures following the snowstorm limited the duration for most of the snowcover in this region to less than a week. Therefore, the greatest concentrations of SWE in the plains region by mid-March 2013 remained in the lower Milk, James, and Big Sioux River basins.

The strongest storm to move through the upper Basin at the end of winter produced moderate snowfall and blizzard-like conditions from Montana through the Dakotas and into the upper midwest March 16-17. Snowfall totals were greatest in eastern Montana (5 to 6 inches around Glasgow), western North Dakota (4 to 5 inches around Williston), and near the Black Hills in South Dakota (7 inches at Rapid City). Another powerful early spring snowstorm moved through the lower portion of the Basin March 21-25 with moderate to heavy snowfall from the Central Rockies eastward through Nebraska, Kansas, and Iowa. Snowfall totals around the Denver area were 6 to 9 inches with nearly a foot reported in the higher elevations north and west of Denver. This storm produced wintry weather around the Kansas City area with 6 to 10 inches of snowfall from Kansas City to northeastern Kansas.

Outside of some minor snow depths, generally less than a quarter of an inch, the only significant plains snowpack by the beginning of April 2013 was confined to the same regions as the previous month. While major snowstorms did not directly impact those tributary basins during the latter half of March, below average temperatures limited the amount of runoff that would have normally occurred during early spring.

A couple of unusually powerful early spring snowstorms moved through the upper portion of the Basin during the first half of April and resulted in an extensive plains snowpack by mid-month. The first produced moderate to heavy snowfall with blizzard-like conditions from the Central Rockies eastward through western Nebraska and South Dakota. Some of the snowfall totals included 18.6 inches at Lander, WY; 16.1 inches at Thermopolis, WY ; 20.9 inches at Rapid City, SD; 9.5 inches at Watertown, SD; 8 inches at Brookings, SD; and 5.7 inches at Sioux Falls, SD. Heavier rainfall and severe thunderstorms limited the snowfall totals across the eastern half of Nebraska.

The second storm was farther north and dropped the heaviest snowfall from far eastern Montana across much of North Dakota. In fact, the 24-hour total of 17.3 inches at Bismarck, ND on April 14 exceeded the previous daily record (15.5 inches on March 3, 1966) and contributed to a new monthly record for April of 21.8 inches (18.7 inches in 1984). Other significant totals included 7.5 inches at Glasgow, MT; 16 inches at Garrison, ND; 15.5 inches at La Moure, ND; and 9.5 inches at Aberdeen, SD. The two rounds of heavy snowfall combined with below normal temperatures contributed to a plains snowpack that had SWE of an inch or greater across almost all of North and South Dakota and SWE in excess of 2 inches for the eastern halves of both states. The greatest amounts of SWE (approaching 3 inches) were found in the James River and upper Big Sioux River basins. Unusual winter-like conditions continued into the latter half of April with another snowstorm April 15-18 that spread totals of 8 to 16 inches from the Central Rockies eastward across South Dakota in the same trajectory as another storm the previous week.

In addition to Bismarck, ND, near record snowfall was reported across South Dakota during April 2013. Pierre received 20.8 inches in April 2013, which exceeded the previous record of 17.5 inches set in 1986. Aberdeen and Watertown both observed their second snowiest April on record with 21.8 inches and 17.4 inches, respectively. The third snowiest April on record was observed at Sioux Falls (14.8 inches) and Huron (19.7 inches).

Warmer temperatures during the final week of April caused a rapid decrease in plains snowpack over portions of northeastern Montana and North Dakota by the beginning of May 2013. A notable caveat was an unusually late season snowstorm that moved through the nation's mid-section May 1-3. This system, while delivering heavy rainfall of 1 to 3 inches across the lower portion of the basin ahead of a cold front, was responsible for snowfall totals of 2 to 4 inches around Omaha and 1 to 3 inches around Kansas City.

Table 1 shows seasonal snowfall totals during the winters of 2011-2012 and 2012-2013 in comparison to 1981-2010 seasonal average snowfall. In general 2012-2013 snowfall was near average at most locations listed in ***Table 1***. Glasgow, MT and Aberdeen, SD recorded well above normal snowfall totals, with departures of 23.9 inches and 26.3 inches, respectively. The Aberdeen, SD snowfall departure was 26.3 inches above normal, while other locations in South Dakota were near normal. Kansas City, MO received 15 inches of snowfall in excess of normal.

Table 1
Missouri River Basin - Plains Snowfall (inches)

Location	**2011-2012 Total**	**2012-2013 Total**	**Annual Average (1981-2010)**
Billings, MT	38.6	59.1	55.1
Glasgow, MT	25.7	58.5	34.6
Great Falls, MT	40.0	66.8	63.2
Bismarck, ND	13.6	52.2	51.2
Williston, ND	7.5	47.3	45.3
Aberdeen, SD	17.5	64.4	38.1
Sioux Falls, SD	15.9	50.0	44.5
Watertown, SD	19.6	31.4	35.9
Sioux City, IA	18.3	38.3	34.8
Omaha, NE	20.4	31.8	26.4
Kansas City, MO	7.5	33.8	18.8

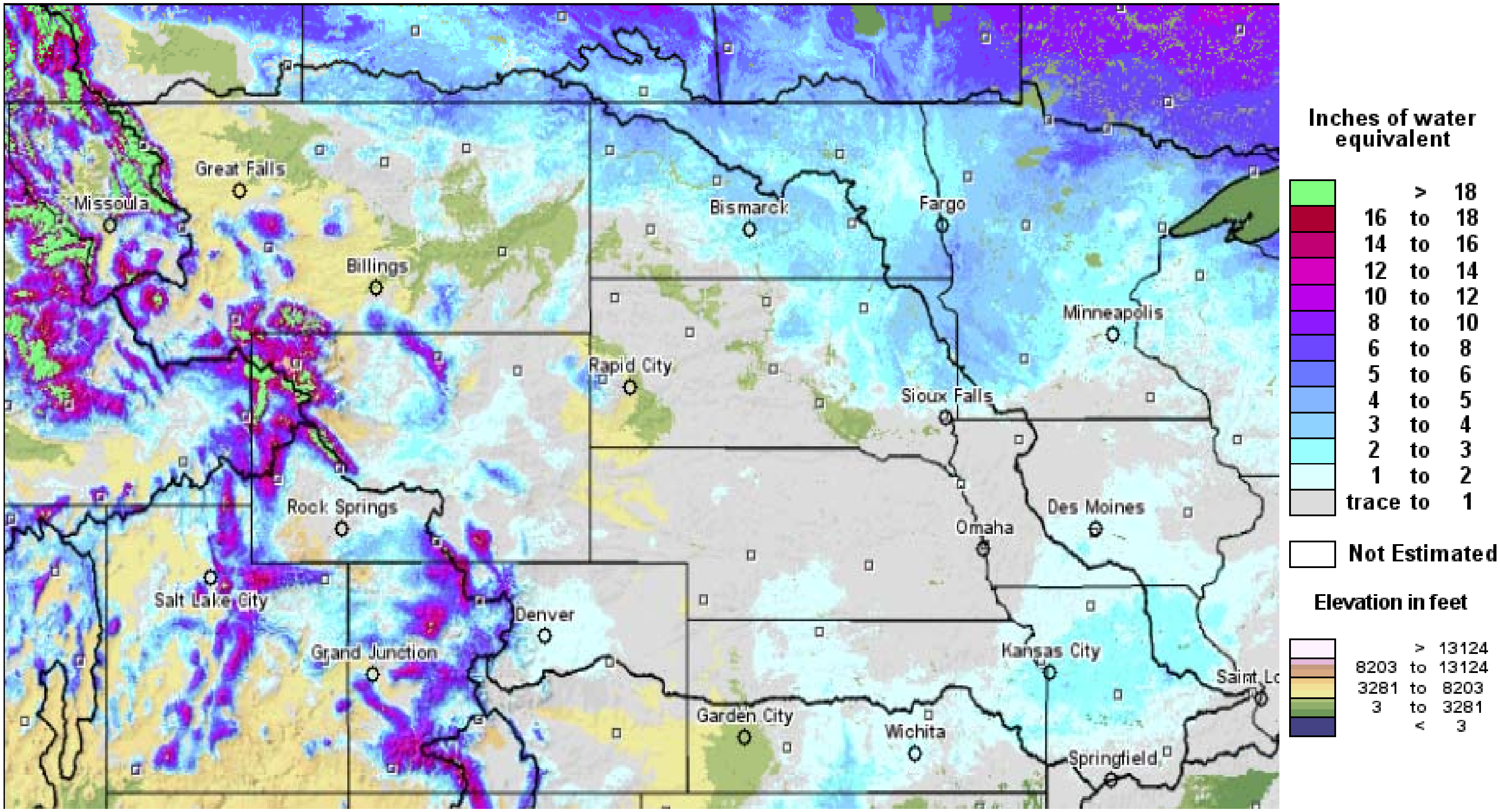


Figure 1. March 1, 2013 plains snow water equivalent (inches) modeled by NOAA NOHRSC.

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 2012-2013 mountain snowpack accumulation and melt pattern for each of the two reaches is illustrated in ***Figure 2***. 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***.

a. Accumulation and Melt

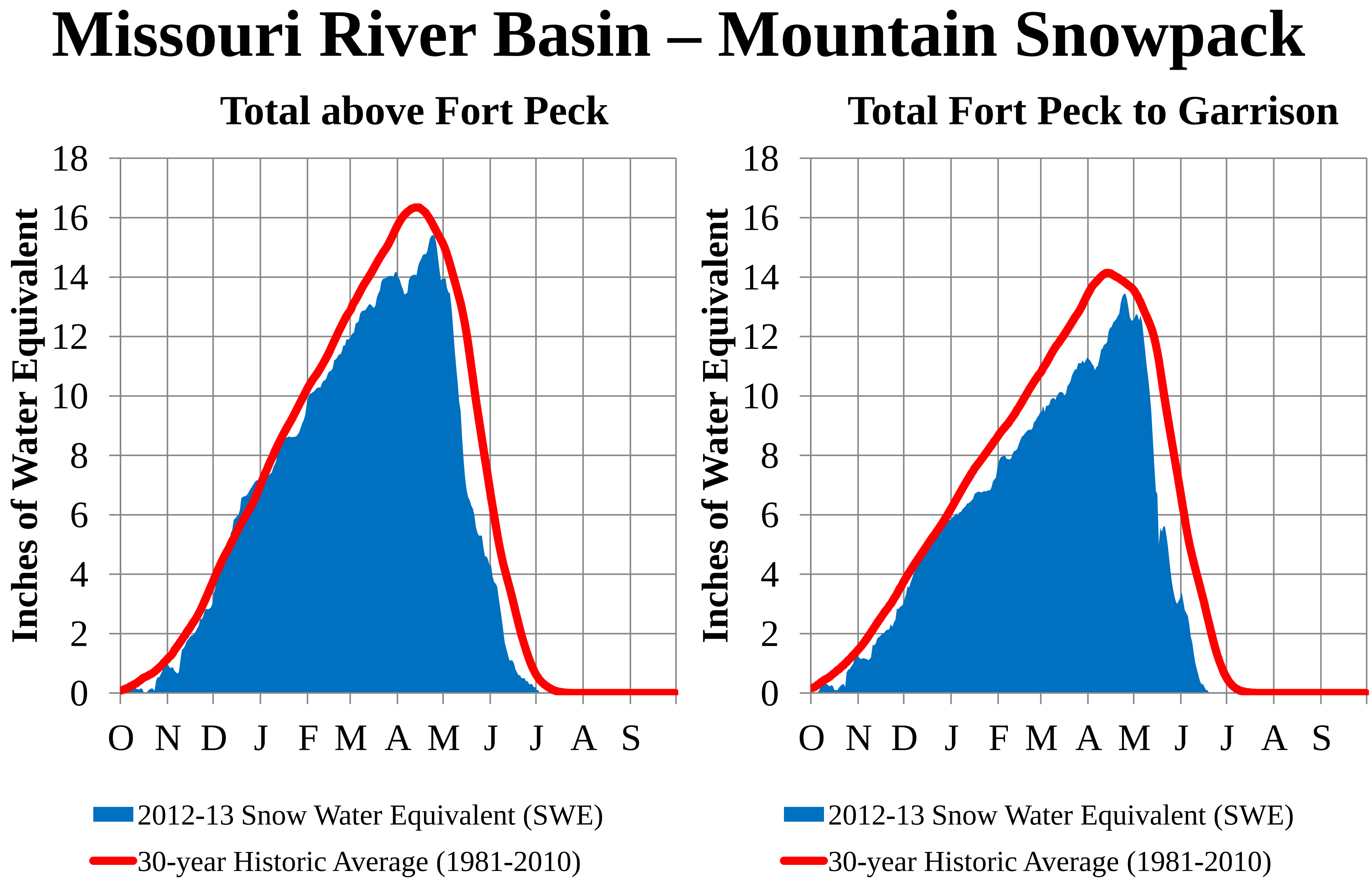
The mountain snowpack for both the Fort Peck and Fort Peck to Garrison reaches in the upper Basin was below average from late fall 2012 until mid-spring 2013. The mountain snowpack began to accumulate in October 2012 with a snowstorm that moved through the Central Rockies and adjacent High Plains. November was relatively free of mountain snowstorms within the upper Basin. The trend of periodic snowstorms in the Northern Rockies and limited activity in the Central Rockies continued into December. Mountain snowfall within the upper Basin during the month of January 2013 was below average until the final week. Moderate to heavy snowfall occurred during the final week of January, particularly in the far upper portion of the Basin with 10 to 14 inch totals common in the higher elevations along the Montana-Wyoming border.

The largest snowfall event during February was a powerful winter storm February 9-11 that dropped heavy snowfall in central and southern Wyoming. March 2013 saw near to below average snowfall for much of the Northern and Central Rockies. In a dramatic departure from much of the snow accumulation season, April 2013 was quite active throughout most of the Basin including the Northern and Central Rockies. This brought the annual peak in the reservoir reaches above Fort Peck and between Fort Peck and Garrison close to normal (see ***Figure 2*** and ***Table 2***).

A gradual return of near to above normal temperatures in May resulted in an acceleration of mountain snowmelt in both the Northern and Central Rockies, particularly across Montana and Wyoming.

b. Summary

Over the course of the winter season, the mountain snowpack began accumulating at a below-average rate; however, accumulations increased by January to near-normal snowpack levels over the upper Basin. During the months of January, February and March, accumulations generally occurred at lower than normal rates. The peak accumulation above Fort Peck occurred on April 23 at 95 percent of the normal peak accumulation, while the peak accumulation in the Fort Peck to Garrison reach occurred on April 25 at 95 percent of normal. Mountain snowpack normally peaks on April 15.



The mountain snowpack in the "Total above Fort Peck" reach peaked on April 23 at 15.4 inches, 95% of the historic average peak accumulation. The mountain snowpack in the "Total Fort Peck to Garrison" reach peaked on April 25 at 13.5 inches, 95% of the historic average peak accumulation. The Missouri River basin mountain snowpack normally peaks on April 15.

Figure 2. Missouri River Basin mountain snowpack water content 2012-2013.

Table 2
Mountain Snow Water Equivalent Accumulation 2012-2013

Month	Above Fort Peck Percent of Historic Apr 15 Peak	Fort Peck to Garrison Percent of Historic Apr 15 Peak	Percent of Actual Peak Accumulation
November 1	69	75	7
December 1	86	82	23
January 1	101	93	45
February 1	96	89	61
March 1	93	85	74
April 1	89	83%	87
Peak	April 23, 95	April 25, 95	100
May 1*	94 / 86	94 / 90	87*
June 1*	69 / 26	54 / 24	25*
July 1*	27 / 1	7 / 0	0*
Melt-out	July 8	July 8	0

*Percent of May 1 or June 1 or July 1 historic accumulation / Percent of historic average April 15 peak

3. Weather Conditions

Following dry and warm weather conditions in 2012, the basin experienced above normal precipitation and cooler weather conditions in 2013. Precipitation rankings by state as shown in ***Figure 3*** indicate that North Dakota experienced its wettest year in 119 years of record. Precipitation was well above normal in South Dakota (8th wettest) and above normal in Montana (18th wettest), Missouri (22nd wettest), Colorado (30th wettest), Iowa (33rd wettest), and Kansas (37th wettest). Near normal precipitation was recorded in Wyoming (43rd wettest) and Nebraska (44th wettest). Temperature rankings by state in ***Figure 4*** indicate that temperatures were near normal in Colorado (59th coolest) as well as Montana and Wyoming (both 77th coolest) in 119 years of record. Temperatures were below normal in Missouri (23rd coolest), Iowa (26th coolest), North Dakota (33rd coolest), South Dakota (35th coolest), Kansas (36th coolest), and Nebraska (37th coolest).

Figure 5 depicts percent of normal precipitation for the 3-month periods of January through March, April through June, July through September, and October through December 2013 in the central U.S. The trends of above and below normal precipitation varied throughout the calendar year. The January through March period was mostly below normal. During the April through June period large areas of Montana and North Dakota received 150 to 200 percent of normal precipitation. During the July through September period the western half of the Basin received largely above normal precipitation while the eastern half of the Basin received below normal precipitation. The Colorado floods in September produced an area exceeding 300 percent of normal. The final period of 2013 saw a large part of western South Dakota above 300 percent of normal precipitation. Much of South Dakota and North Dakota were above 200 percent of normal; and, southern Montana, Wyoming, and eastern Nebraska also saw above normal precipitation.

Figure 6 depicts temperatures that did not stray far from normal during 2013 throughout the Basin. January through March temperatures were close to normal throughout most of the Basin; however, average temperatures were 4 to 6 degrees F below normal in isolated areas of North Dakota and South Dakota. During the April through June time period North Dakota and South Dakota had temperatures 3 to 5 degrees F below normal while the rest of the basin was close to normal. From July through September temperatures averaged 0 to 4 degrees F above normal throughout the basin. The October through December period had cooler than normal temperatures with Montana, North Dakota, and South Dakota averaging 2 to 6 degrees F below normal. The rest of the basin averaged 2 to 4 degrees F below normal.

Figure 7 depicts drought magnitudes as defined by the National Drought Mitigation Center in January, April, July, and October 2013. While many locations within the Basin were still experiencing Extreme (D3) to Exceptional (D4)drought conditions throughout winter 2012-13, marked improvement had occurred during that time in the far upper portion of the Basin. On January 1 Exceptional (D4) drought conditions were in place across much of Nebraska as well as southern South Dakota, eastern Wyoming, and northwestern Kansas. Extreme (D3) drought conditions were present in much of Wyoming along with northeastern Colorado, southern Montana, South Dakota, eastern Nebraska, and western Iowa. Severe (D2) drought conditions radiated outward from the more severe areas of drought in most states in the basin. Abnormally

Dry (D0) conditions were limited to central Montana and western North Dakota. By late February 2013, drought classifications were no longer given to northern Montana and most of the western half of North Dakota.

The Drought Monitor on April 2 represented conditions very similar to January 1. There was slight improvement in the Extreme (D3) drought conditions in southern Montana and northwest Iowa.

Above average precipitation for much of Montana and the Dakotas during spring 2013 resulted in significant improvement to the drought conditions both in areal coverage and intensity, particularly across Montana, the Dakotas, Iowa and Missouri. In fact, drought conditions were no longer observed by late May across northern Montana, North Dakota, eastern South Dakota, Iowa, and Missouri. The worst conditions continued to be found in western Nebraska and Kansas, where Severe (D2) to Extreme (D3) drought conditions persisted. The July 2 map shows the improved conditions including the removal of drought conditions in the northern and eastern parts of the Basin. Exceptional (D4) drought conditions were limited to a small area in central Nebraska and northwestern Kansas, and Extreme (D3) drought conditions were reduced to western Nebraska, northeastern Colorado, and southeastern Wyoming. Moderate (D1) and Severe (D2) drought conditions were present in Wyoming, Colorado, eastern Nebraska, and southwestern South Dakota. Abnormally Dry (D0) conditions were present in southern Montana, northeastern Wyoming, and northwestern South Dakota.

Above average rainfall for parts of the Basin during the 2013 summer resulted in continued improvements to the drought conditions across the Rockies and adjacent High Plains. This was most visible from the Central Rockies eastward through western Nebraska and Kansas and was almost solely due to a period of record rainfall that occurred in the region during mid-September 2013. Farther east, however, the drought intensified during the summer months from eastern South Dakota and Nebraska into much of Iowa and northern Missouri. This followed a wetter than normal spring for the lower portion of the Basin. The October 1 map shows removal of all Exceptional (D4) drought conditions and a reduction of Extreme (D3) drought conditions to isolated areas of central Nebraska, northwestern Kansas, and eastern Wyoming. Severe (D2) drought conditions were limited to western Nebraska and eastern Wyoming. Moderate (D1) and Abnormally Dry (D0) drought conditions crept back into eastern North Dakota, South Dakota, eastern Nebraska, western Iowa and Wyoming. During the October through December period, precipitation was above normal providing removal of all drought conditions in North Dakota, South Dakota, and Montana, and improvement to drought conditions in Wyoming, western Iowa, and eastern Nebraska.

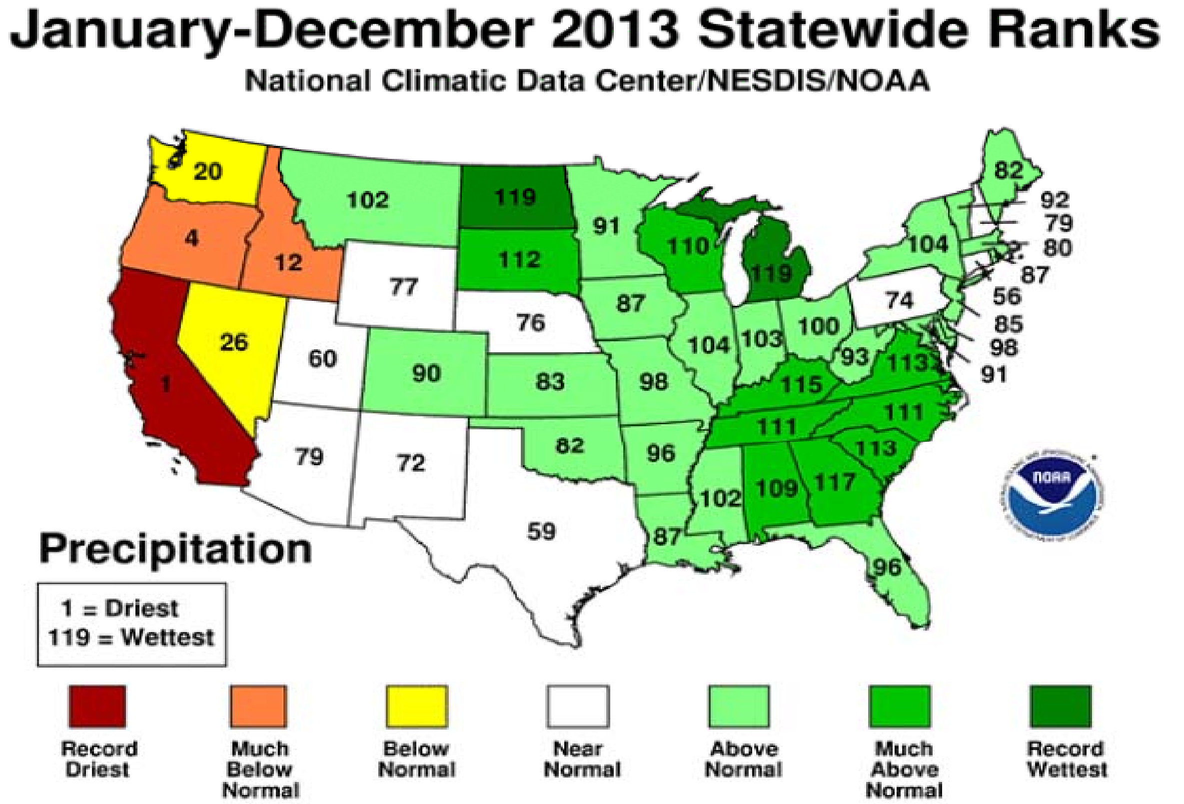


Figure 3. January-December 2013 statewide precipitation ranks. Source: NOAA NCDC

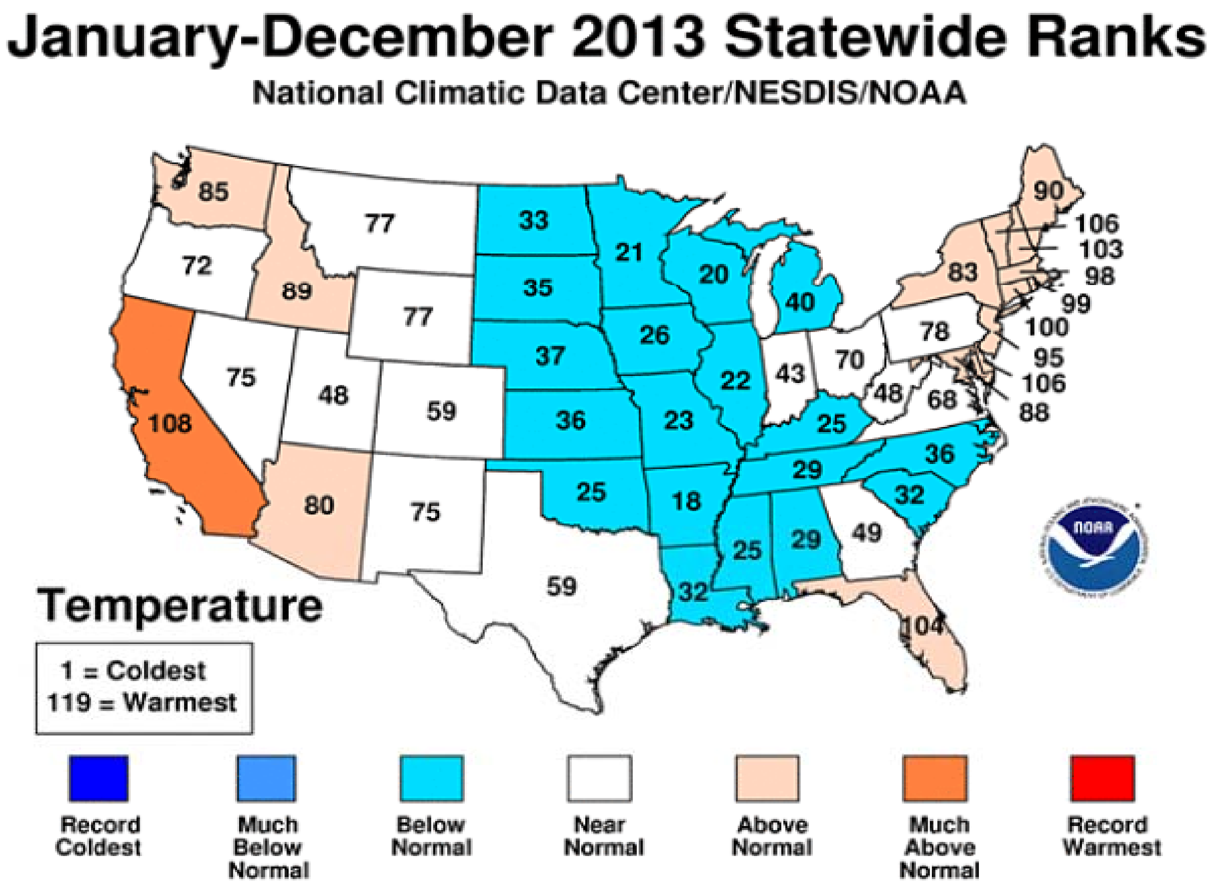


Figure 4. January-December 2013 statewide temperature ranks. Source: NOAA NCDC

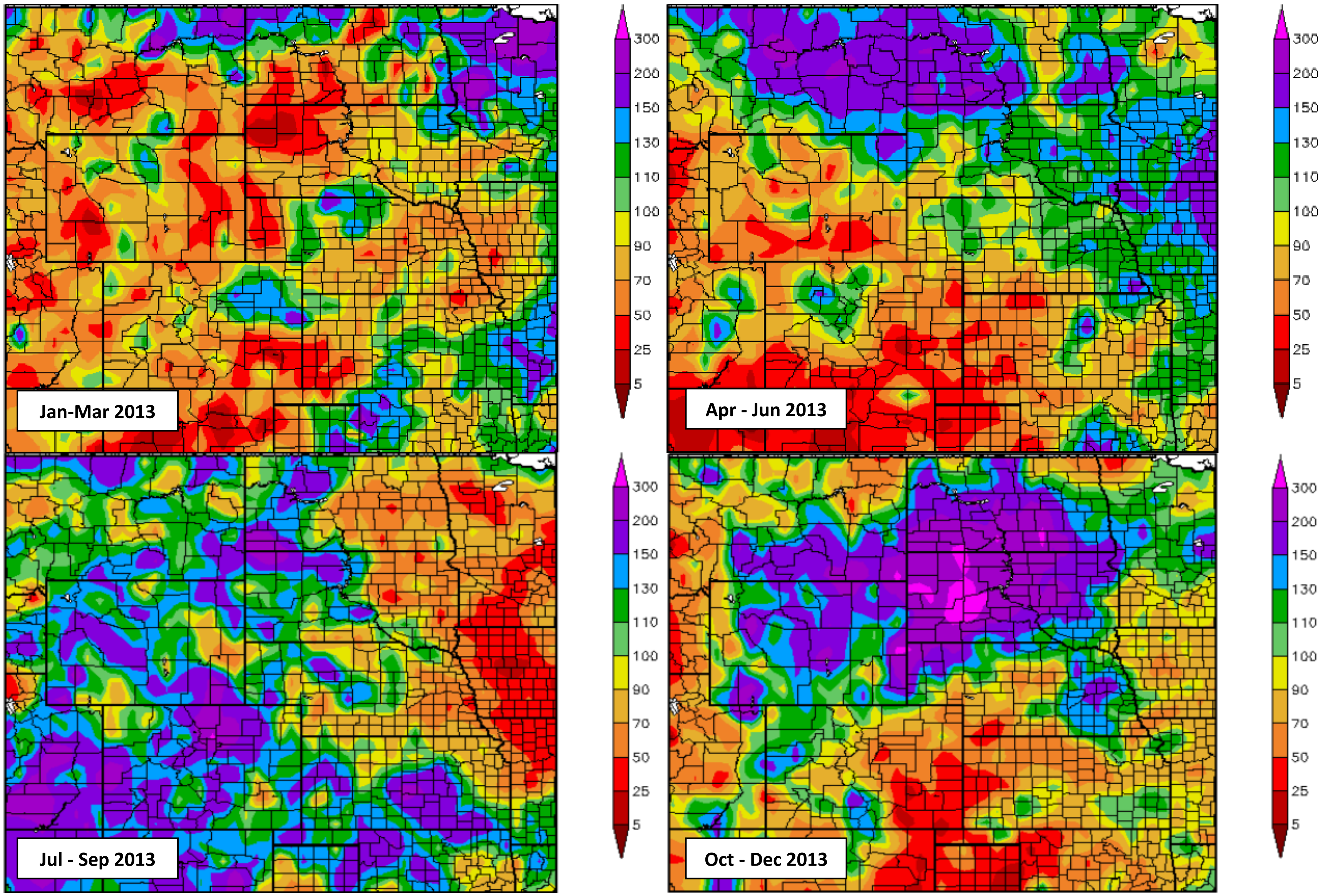


Figure 5. Percent of normal precipitation maps for the 2013 3-month periods: Jan-Mar, Apr-Jun, Jul-Sep and Oct-Dec. Reformatted from the High Plains Regional Climate Center Climate Summary Maps.

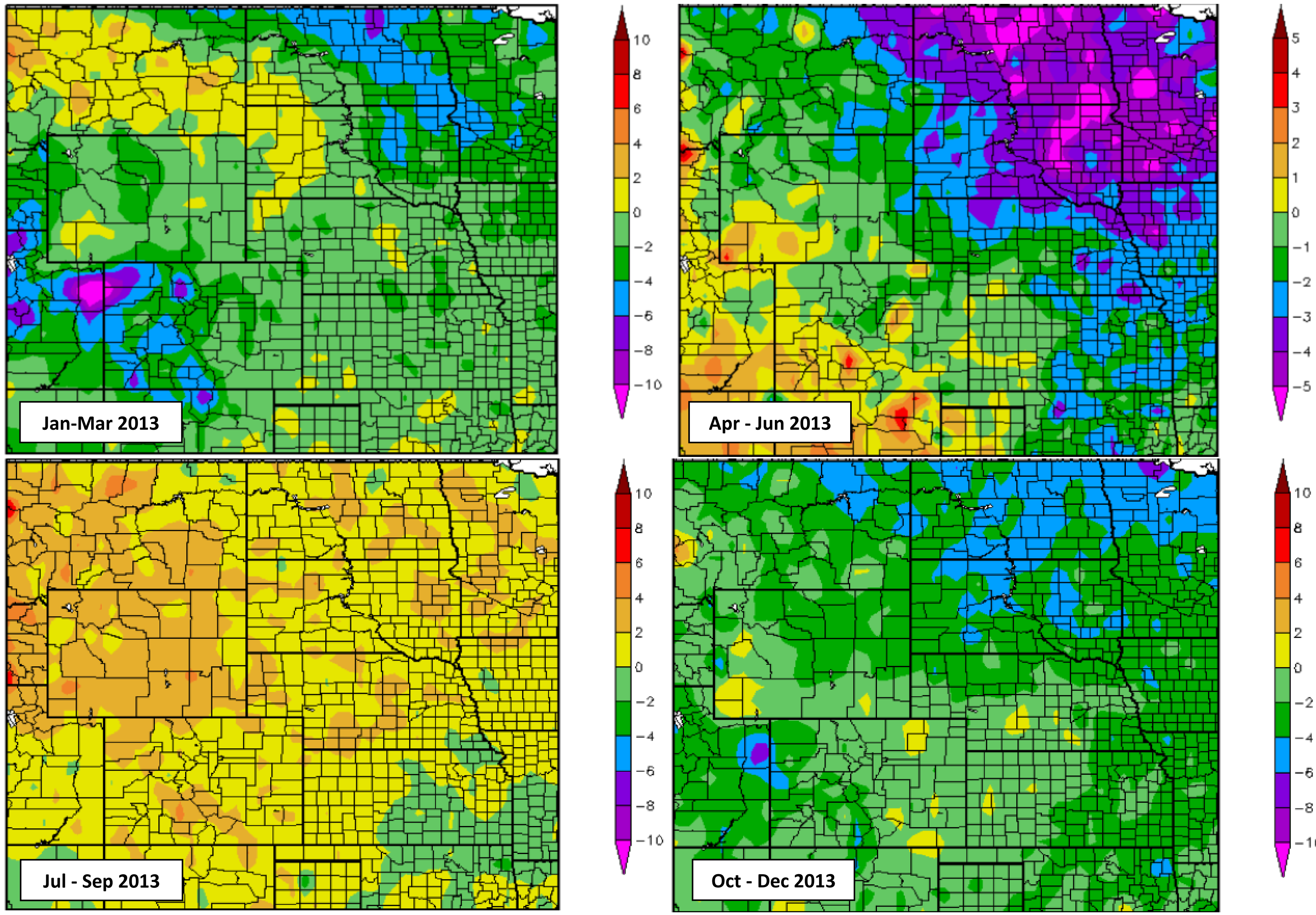


Figure 6. Departure from normal temperature (degrees F) for the 2013 3-month periods: Jan-Mar, Apr-Jun, Jul-Sep and Oct-Dec. Reformatted from the High Plains Regional Climate Center Climate Summary Maps.

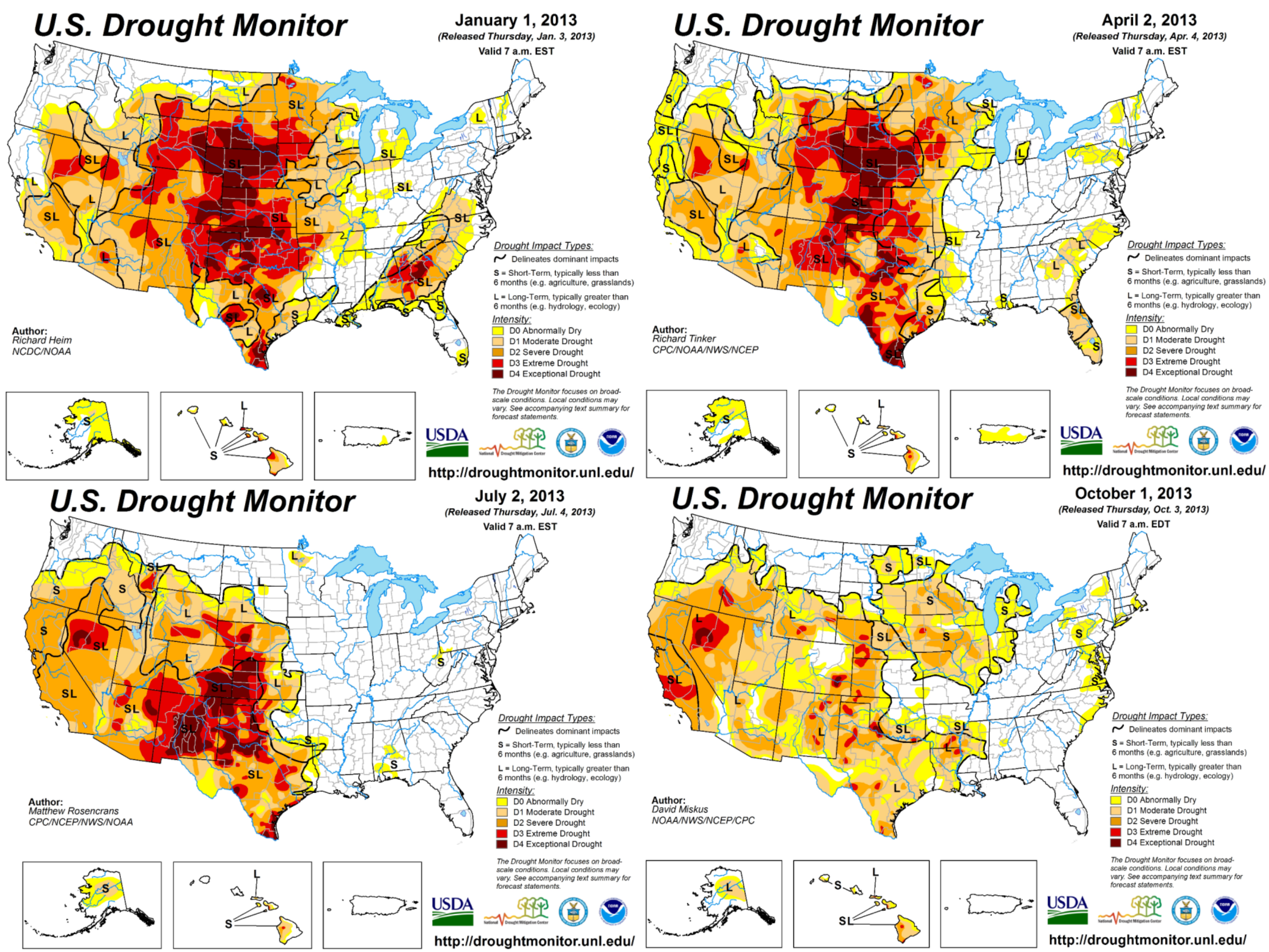


Figure 7. The National Drought Mitigation Center's drought maps for early January, April, July and October 2013.

a. January - March

While the first three months of 2013 were not quite as abnormally dry across the Basin as the last quarter of 2012, most locations still received below average precipitation during that time period as shown in ***Figure 5***. The driest conditions were generally found in the Northern Rockies eastward into the High Plains of the Dakotas and the Nebraska panhandle. Western Montana and northwestern South Dakota reported less than 25 percent of normal precipitation for January through March. The only locations with significantly above average precipitation were found in northeastern Montana, north-central Nebraska, and around the Denver metropolitan area. The three-month totals in these latter locations were 130-200 percent of the climatological average.

The first snowstorm of 2013 arrived January 1-2 as 10 to16 inches of snowfall was observed in the northern Black Hills of South Dakota and Wyoming. From January 26-31, a series of surface lows moved out of the Rockies and produced a wintry mix of rain, sleet, and snow to the lower portion of the Basin along with moderate to heavy snowfall from the Northern Rockies eastward through the Dakotas. Snowfall totals included 3 to 6 inches around Omaha, NE and 6 to 8 inches around Aberdeen, SD. The heaviest amounts were found at the higher elevations in the Rocky Mountains in Montana (13.5 inches at Lodge Grass and 12 inches at Fort Smith) and Wyoming (34 inches near Lovell).

Isolated rainfall occurred across northern Kansas February 6-7, but the biggest winter storm during the first half of the month was farther north. A powerful winter storm February 9-11 dropped heavy snowfall in central and southern Wyoming before creating blizzard conditions from the Nebraska panhandle through the eastern Dakotas. Mountain snowfall totals in Wyoming included 16 inches at Casper Mountain and 15.7 inches at Lander, and in South Dakota measured 13.2 inches at Aberdeen and 9.6 inches at Mitchell.

Several winter storm systems, including two unusually strong snowstorms, impacted the lower portion of the basin during late February. The first occurred February 20-22 and brought snowfall totals of 4 to 8 inches around Denver, CO before dropping 8 to 9 inches around Omaha, NE and 9 to 13 inches around Kansas City, MO. Less than a week later, some of the same locations were impacted by another winter storm February 24-27. Snowfall totals in the Central Rockies included 10 inches at Casper Mountain (Wyoming) and 9 to 12 inches around Denver, CO with 8 to 14 inch totals across northeastern Kansas and western Missouri.

While periodic snowfall continued in the upper portion of the Basin during March, the largest storms of the month continued to occur farther south. Several rounds of precipitation March 7-11 brought heavy rainfall and scattered thunderstorms to much of the Central Rockies and Central Plains before giving way to blizzard-like conditions across the middle-Missouri River Basin. Some of the heaviest snowfall totals in Nebraska were 11 inches at Fremont and 9 inches at Omaha. The rainfall and a quick partial melting of the plains snowpack resulted in the Big and Little Sioux Rivers rising to minor flood stage in northwestern Iowa. The lower portion of the Basin continued to see the bulk of the storm activity March 21-25 that produced 6 to 10 inches of snow from the Kansas City metro area westward into northeastern Kansas.

The first three months of 2013 were normal to cooler than normal for most of the central United States. Some of the coldest conditions over that period were found in the upper to middle portions of the James River basin and contributed to a delayed melting of the snowpack in that region during the month of March. Most of the Basin had temperatures anomalies that were within 2 degrees F of normal (***Figure 6***).

b. April - June

A wide disparity in precipitation was observed across the Basin during spring 2013 as shown on ***Figure 5***. Parts of the upper portion of the Basin, particularly across Montana and western North Dakota received greater than 150 percent of the normal precipitation. Drought conditions, however, continued in the Central Rockies and adjacent High Plains. Parts of Wyoming, Colorado, and western Kansas received less than 50 percent of normal precipitation from April through June. Many of the same locations that were wetter than normal were also cooler than normal as shown in ***Figure 6***. In fact, almost the entire Basin averaged below normal temperatures for April - June. This was most pronounced across North Dakota, South Dakota, eastern Nebraska, and Iowa as much of this region was 2 to 5 degrees F below normal. Temperatures across the Rockies were closer to average, though slightly below average.

A series of late season snowstorms, some producing blizzard-like conditions, proceeded to move through the Basin during the second week of April. While moderate to heavy snowfall was observed from the Central Rockies eastward through western Nebraska and South Dakota, April 8-11, severe storms were reported in the lower portion of the Basin. Precipitation totals of 1 to 3 inches were common from southern South Dakota through Nebraska and into northwestern Missouri on April 9. A record snowstorm moved through the Dakotas April 13-14 with 15 to 20 inches common across southern North Dakota and northern South Dakota.

An area of low pressure in the southwestern United States April 15-18 caused an extended period of rainy and snowy conditions in the Central Rockies, with periods of precipitation moving eastward through Nebraska, Kansas, and Missouri. The heaviest snowfall ranging from 8 to16 inches occurred from central Wyoming through the Nebraska panhandle as well as across South Dakota.

A mix of rain and snow fell in the upper Basin April 20-23 along with areas of heavy rainfall and strong storms in Kansas and Missouri. Rainfall totals of 1 to 2 inches were observed in eastern Nebraska and western Iowa with 8 to 12-inch snowfall totals from northeastern Colorado to Rapid City, SD. A much more powerful spring snowstorm impacted the Basin a week later as a large upper level low pressure system remained nearly stationary in the central United States May 1-5 and dropped areas of heavy rainfall mixed with light snow from Omaha, NE through Missouri. Rainfall totals of 2 to 3 inches were widespread in far southeastern Nebraska, southwestern Iowa, eastern Kansas, and Missouri. The snowfall totals were impressive in the Central Rockies with 12 to 24 inches measured from near Cheyenne, WY to Denver, CO.

In May periodic storm systems with moderate to heavy rainfall continued to impact parts of the Basin. A slow moving system of storms in the Central Plains May 7-11 brought 1 to 2 inches of rainfall from southeastern South Dakota through eastern Nebraska and northern Kansas. Heavier rainfall was observed May 16-21 from the Dakotas southeastward into eastern Nebraska and Iowa. Localized rainfall amounts in excess of 5 inches around Bismarck and Jamestown resulted in minor flooding for parts of North Dakota, with 1 to 3 inch totals common elsewhere.

The unusually wet pattern in the lower portion of the Basin continued May 24-27 producing 3-5 inch rainfall totals in parts of the Dakotas, Nebraska, and Iowa. The highest totals on May 25 were at Raleigh, ND (4.7 inches); Tea, SD (4.8 inches); and Granville, IA (4.6 inches). Rainfall totals on May 26 included 5.3 inches near Hudson, SD; 2.6 inches at Lincoln, NE; and 2.7 inches at Mound City, MO. The final day of heavy rainfall on May 27 produced 2-inch totals in many locations throughout South Dakota, Iowa, Kansas and Missouri.

The heaviest rainfall totals at the end of May were found in the far upper and lower portions of the Basin. Widespread rainfall on May 29 produced significant amounts including 2.3 inches at Jordan, MT; 4.9 inches near Rapid City, SD; 3.8 inches at Harvard, NE; and 2.9 inches at Shenandoah, IA. On May 30, precipitation reports included 4.0 inches near Ashland, MT; 2.6 inches at Rhame, ND; and 4.5 inches at Overland Park, KS. The next day brought 3.0 inches at Spearfish, SD.

As a ridge of high pressure intensified across the western U.S. for the remainder of June, the bulk of the storm activity and associated heavy rainfall was relegated to a trajectory that extended from Montana through North Dakota before arching southeastward through eastern Nebraska and Iowa. This resulting precipitation caused elevated stream levels on several tributaries, including the Milk, James, Big Sioux, and Little Sioux Rivers during the latter half of the month.

Heavy rainfall was observed June 19 within the upper James River basin at La Moure, ND (4.0 inches) and Hecla, SD (2.2 inches). The brunt of the storm activity shifted into eastern South Dakota on June 21 with 2-3 inches of rain in South Dakota and Minnesota. Strong storms on June 22 originated in eastern Montana and Wyoming before moving through the Dakotas and Nebraska. One to two inch rainfall totals were common and widespread with the largest accumulation being 3.3 inches at Bruce, SD.

c. July - September

While unusually dry conditions were widespread across the far eastern portion of the Basin from July through September 2013, much of the Rockies and western Plains (***Figure 5***) received above normal precipitation during that time period. The region with the driest conditions was from eastern South Dakota through Iowa and into northern Missouri, where less than 50 percent of normal precipitation was observed. The wettest conditions were in the Central Rockies from Casper, WY southward to Colorado Springs, CO, although this was almost entirely due to record rainfall that occurred during one week in early September.

A large ridge of high pressure that enabled record setting heat over the western United States was persistent through much of July and resulted in spotty thunderstorms rotating across the upper portion of the Basin for much of the month. While heavy rainfall was not widespread, localized totals were impressive with several storm systems.

Severe weather reports during the following week reported 2.8 inches of heavy rainfall near Pringle, SD and 5.6 inches near Parkston, SD on July 8. Localized heavy rainfall in the same region on the following day included 4.5 inches at Witten, SD. This pattern continued through the end of July with moderate to localized heavy rainfall along with isolated severe storms in the Rockies and adjacent High Plains.

The upper level ridge remained entrenched across the western half of the continental United States into August and gradually expanded eastward during the latter half of the month. This resulted in the bulk of the rainfall occurring along the northern tier states and in the Colorado Rockies. Much like in the previous month, the lack of widespread rainfall was accompanied by heavy localized totals.

Montana was a frequent recipient of the storms moving over the western ridge in early August. Also, the area from the Black Hills southward through western Nebraska was more active August 5-7 with rainfall totals of 3.2 inches at Hot Springs, SD and 2.6 inches near Stratton, NE. Localized amounts less than 1.5 inches were frequent through the remainder of the month from the front range of the Central Rockies across South Dakota, Nebraska, and Kansas. Otherwise, the bulk of the Basin received below normal precipitation during August.

A relatively quiet start to the month of September gave way to greater frequency of storm systems as the weather pattern became more active by mid-month. The rainfall totals were further enhanced, particularly across the Central Rockies, by the development of a late season monsoonal flow out of the southwestern U.S. Storm events from September 6-8 were temporarily rotated to the Northern Rockies and the Dakotas with 3.5 inches near Baker, MT, 2.7 inches at Bowman, ND, and 4.6 inches near Bison, SD. Rainfall totals on the morning of September 9 included 4.3 inches at Marshall, ND. Events in the Central Rockies over the following week, however, would far supersede these amounts.

The first round of heavy rainfall in Colorado occurred on September 9, with totals of 2.3 inches at Wheat Ridge, 2.1 inches at Longmont, 1.7 inches at Golden, and 1.7 inches at Boulder. Several storm cells maintained their intensity as they progressed eastward and dropped 1.8 inches at Sidney, NE. Totals the following day in Colorado included 2.0 inches at Aurora and 1.7 inches at Boulder. Rainfall amounts on September 10 in Nebraska were 2.3 inches at Ceresco and 2.1 inches at Blue Hill. Flash flooding became more widespread in northeastern Colorado on September 11 as 24-hour rainfall totals included 8.7 inches at Boulder, 6.6 inches at Louisville, 5.7 inches at Aurora, 2.9 inches at Fort Collins, and 2.0 inches at Cherry Creek Reservoir. Heavy rainfall farther east that same day was observed in Nebraska (2.0 inches at Humboldt and 1.4 inches at Falls City) and Kansas (3.3 inches at Plainville, 2.0 inches at Abilene, and 1.6 inches at Salina). The heavy rainfall was observed in Wyoming on September 11 including 2.6 inches near Cheyenne and 2.2 inches near Wheatland.

The persistence of the monsoonal flow pattern resulted in another round of very heavy rainfall on September 12 in Wyoming (2.7 inches near Warren Air Force Base) and Colorado (8.2 inches at Colorado Springs, 7.3 inches at Boulder, 6.8 inches at Aurora, 4.0 inches at Estes Park, 3.7 inches at Cherry Creek Reservoir). This rainfall extended eastward into Kansas with observations of 4 to 8 inch totals in northwest Kansas. Twenty-four hour rainfall totals on

September 13 were still significant, but substantially less than the previous day's amounts with over 2 inches around Cheyenne, WY and around one inch in the Denver metro area.

That respite was short-lived as rainfall totals on September 14 included 1 to 3 inches around Cheyenne, WY along with 2.8 inches at Aurora, CO and 2 inches at Denver International Airport. These storms extended eastward into Nebraska with totals of 2.8 inches at North Platte and 2.3 inches at Sidney. One final day of heavy rainfall in the Central Rockies occurred the next day with totals in Colorado of 2.2 inches at Loveland and 1.7 inches at Boulder. For the remainder of September 2013, heavy rainfall events within the Basin were less frequent and increasingly localized.

With the exception of far southeastern Nebraska and central Missouri, almost the entire Basin was warmer than normal during summer 2013 (***Figure 6***). The anomalies were greatest in the Northern Rockies with temperatures generally 2 to 4 degrees above the 30-year climatological average.

d. October - December

A large portion of the Basin received higher than normal precipitation from October through December. Southern Montana, northern Wyoming, North Dakota, and much of South Dakota received up to 200 percent of normal precipitation. Areas in western South Dakota received over 300 percent of normal precipitation due to heavy snowstorms.

A strong low pressure system brought an intense winter storm to southern Montana, northeast Wyoming and western South Dakota October 3-5. Rain soaked the region October 3 before changing to snow over southern Montana, northeastern Wyoming, and the Black Hills overnight and on the plains of western South Dakota on October 4. Very heavy snowfall and strong winds continued through midday October 5 and spread into central North Dakota. In south central Montana the Placer Basin SNOTEL site recorded 30 inches of snow depth while Red Lodge had 22 inches of snow. Significant snowfall in Wyoming included 16 inches at Casper, 24 inches at Sheridan, and up to 3 feet in the Big Horn Range. North Dakota had 6 to 12 inches of snow highlighted by 18 inches in Hettinger, ND.

The biggest single day snowfall total in South Dakota was 42 inches at Lead on October 4. Six locations in the state recorded new two-day records over October 4-5 including Ft. Meade with 35 inches, while four locations recorded new single day records including 35 inches at Pactola Dam west of Rapid City on October 5. Rapid City set a new record for maximum snowfall on a single October day with 19 inches on October 4, and it also broke the record monthly snowfall total with the October 4-5 total of 23.1 inches.

The plains snowpack began to melt in the days following the storm and was mostly gone before two storms brought heavy rain to North and South Dakota October 11-12 and October 14-15. As a result of these two systems, the majority of North and South Dakota received over 2 inches of rain with isolated parts seeing up to 4 inches of rain. The highest single day report was 3.4 inches at Watertown, SD on October 15. From October 1-16, Hettinger, ND received 5.7 inches.

Following an active month, November 2013 precipitation was near normal across the Basin. Temperatures were normal to 2 degrees F cooler than normal for most of the Basin and normal to 2 degrees F warmer than normal for Wyoming, southern Montana, and northeast Colorado.

A snowstorm pushed through the Basin December 3-4 and was followed by Arctic air with some areas of Yellowstone reporting overnight lows near -40 degrees F by December 4. Some mountain locations had accumulated over 2 feet of snow, while areas in the plains of Montana, South Dakota, and Nebraska had accumulated up to 1 foot of snow.

The departure from average temperature in North Dakota for the first 10 days of December was 17.6 degrees F below normal at Hettinger, 14.9 degrees F below normal at Williston, and 13.9 degrees F below normal at Bismarck. The coldest temperature during this time was -29 degrees F at Hettinger on December 7. In South Dakota the first 10 days of December were 7.9 degrees F below normal at Sioux City and for the month, 4.6 degrees F below normal. These large negative departures led to rapid ice formation on the Missouri River at both Bismarck, ND and from Gavins Point Dam to Sioux City, IA.

The majority of the Basin experienced temperatures 2 to 4 degrees F below normal from October through December. Parts of Montana, North Dakota, and South Dakota were colder with areas averaging 6 degrees F below normal.

4. 2013 Calendar Year Runoff

The unregulated runoff volume for the period January through December 2013 for the upper Basin above Sioux City, IA totaled 24.7 MAF, 98 percent of average, based on the historical period of 1898-2013, as shown in ***Table 3*** and ***Figure 8***. ***Table 3*** 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 forecast 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 3*** compares 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 36.4 MAF, 91 percent of average. Of the nine reaches in the entire Missouri River Basin outlined in ***Table 4***, only three reaches, Garrison to Oahe, Gavins Point to Sioux City and Kansas City to Hermann were above average. Runoff in all other reaches was below average including above Fort Peck and Oahe to Fort Randall, which were 78 percent of normal. Runoff was also notably low in the Sioux City to Nebraska City reach (78 percent of normal) and the Nebraska City to Kansas City reach (53 percent of normal).

Figure 9 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 below normal during 2013, including March, April, May and July. Runoff was well above normal in June and October due to abundant rain during these months. October runoff shown in Table 3 was 2,698 kAF (226 percent of normal) and the second highest October runoff summation during the 1898-2013 historical period. The highest October runoff summation was 3,196 kAF (268 percent of normal) and occurred in 1923.

Table 3
Missouri River Basin
2013 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 2013	278	199	14	33	156	49	680	729	729
NORMAL	312	261	12	28	100	50	713	763	763
DEPARTURE	-34	-62	2	5	56	-1	-33	-34	-34
% OF NORM	89%	76%	117%	118%	156%	98%	95%	96%	96%
FEB 2013	335	347	108	94	145	120	1,029	1,149	1,878
NORMAL	361	355	95	54	132	101	997	1,098	1,861
DEPARTURE	-26	-8	13	40	13	19	32	51	17
% OF NORM	93%	98%	114%	174%	110%	119%	103%	105%	101%
MAR 2013	416	619	158	37	142	211	1,372	1,583	3,461
NORMAL	595	995	584	215	211	326	2,600	2,926	4,787
DEPARTURE	-179	-376	-426	-178	-69	-115	-1,228	-1,343	-1,326
% OF NORM	70%	62%	27%	17%	67%	65%	53%	54%	72%
APR 2013	386	1,085	215	113	151	243	1,950	2,193	5,654
NORMAL	641	1,079	508	144	181	385	2,553	2,938	7,725
DEPARTURE	-255	6	-293	-31	-30	-142	-603	-745	-2,071
% OF NORM	60%	101%	42%	78%	83%	63%	76%	75%	73%
MAY 2013	567	1,108	416	141	171	453	2,403	2,856	8,510
NORMAL	1,082	1,260	319	146	185	323	2,992	3,315	11,040
DEPARTURE	-515	-152	97	-5	-14	130	-589	-459	-2,530
% OF NORM	52%	88%	130%	97%	92%	140%	80%	86%	77%
JUN 2013	1,726	3,144	818	128	160	528	5,976	6,504	15,014
NORMAL	1,640	2,710	440	160	184	317	5,134	5,451	16,491
DEPARTURE	86	434	378	-32	-24	211	842	1,053	-1,477
% OF NORM	105%	116%	186%	80%	87%	167%	116%	119%	91%
JUL 2013	610	1,440	260	35	91	333	2,436	2,769	17,783
NORMAL	831	1,815	185	58	139	244	3,028	3,272	19,763
DEPARTURE	-221	-375	75	-23	-48	89	-592	-503	-1,980
% OF NORM	73%	79%	141%	60%	65%	136%	80%	85%	90%
AUG 2013	371	534	203	94	120	241	1,322	1,563	19,346
NORMAL	356	609	71	41	116	148	1,193	1,341	21,104
DEPARTURE	15	-75	132	53	4	93	129	222	-1,758
% OF NORM	104%	88%	286%	229%	103%	163%	111%	117%	92%
SEP 2013	188	414	204	-3	50	159	853	1,012	20,358
NORMAL	330	448	110	37	111	107	1,036	1,143	22,247
DEPARTURE	-142	-34	94	-40	-61	52	-183	-131	-1,889
% OF NORM	57%	92%	185%	-8%	45%	149%	82%	89%	92%
OCT 2013	251	898	1,138	135	105	171	2,527	2,698	23,056
NORMAL	380	527	72	5	120	89	1,104	1,193	23,440
DEPARTURE	-129	371	1,066	130	-15	82	1,423	1,505	-384
% OF NORM	66%	170%	1581%	--	88%	192%	229%	226%	98%
NOV 2013	286	358	176	-54	107	107	873	980	24,036
NORMAL	381	393	67	4	118	81	963	1,044	24,484
DEPARTURE	-95	-35	109	-58	-11	26	-90	-64	-448
% OF NORM	75%	91%	263%	--	91%	132%	91%	94%	98%
DEC 2013	261	282	3	-46	77	127	577	704	24,740
NORMAL	327	249	1	12	100	58	689	747	25,231
DEPARTURE	-66	33	2	-58	-23	69	-112	-43	-491
% OF NORM	80%	113%	--	-383%	77%	219%	84%	94%	98%
				Calendar Year Totals					
	5,675	10,428	3,713	707	1,475	2,742	21,998	24,740	
NORMAL	7,236	10,701	2,464	904	1,697	2,229	23,002	25,231	
DEPARTURE	-1,561	-273	1,249	-197	-222	513	-1,004	-491	
% OF NORM	78%	97%	151%	78%	87%	123%	96%	98%	

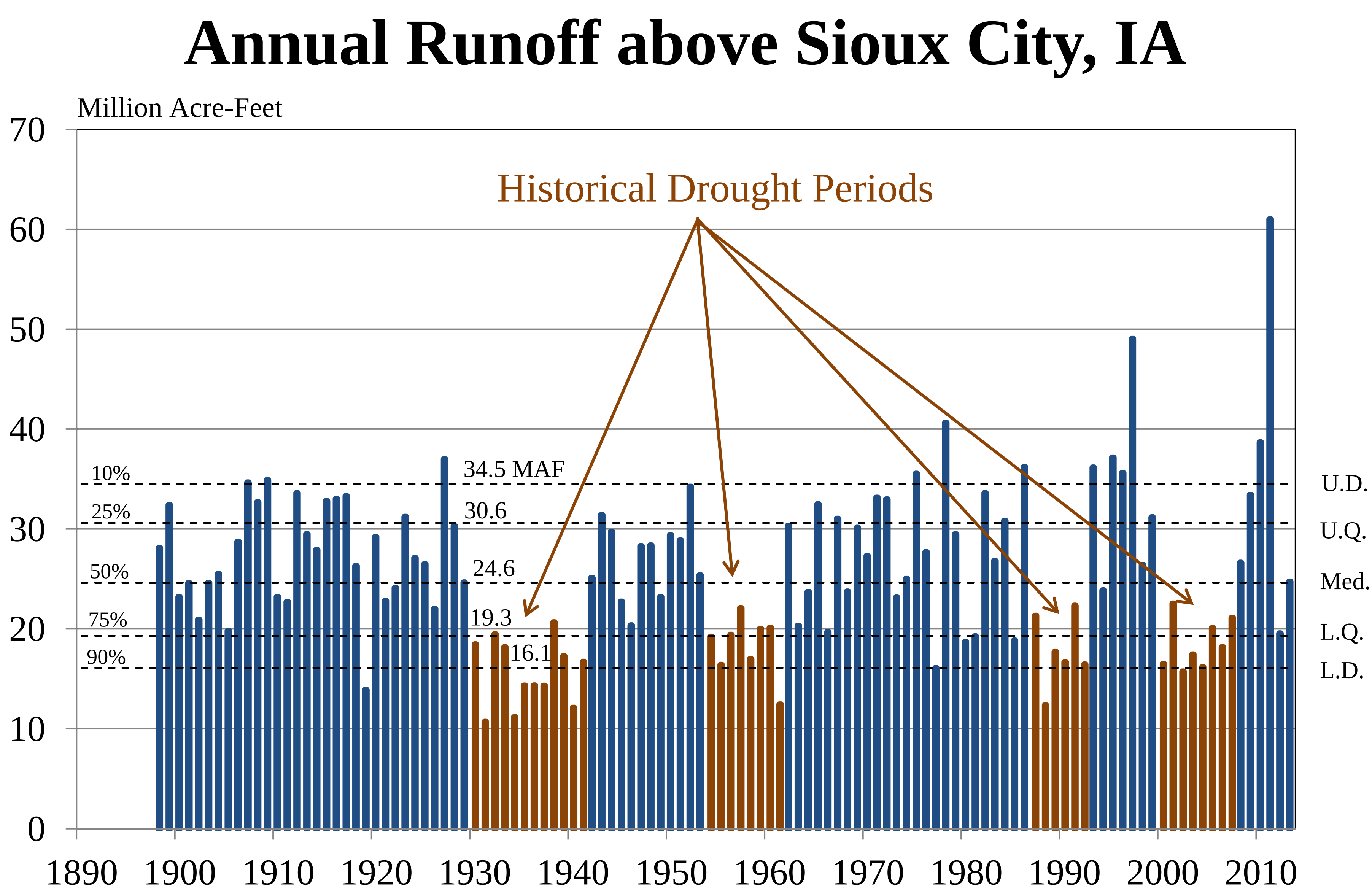


Figure 8. Missouri River Basin annual runoff above Sioux City, IA.

Table 4
2013 CY Runoff Volumes for Selected Reaches (1,000 acre-feet)

Reach	1898-2013 Average Runoff	2013 CY Runoff	% of Average Runoff
Above Fort Peck	7,234	5,675	78
Fort Peck to Garrison	10,702	10,428	97
Garrison to Oahe	2,465	3,713	151
Oahe to Fort Randall	905	707	78
Fort Randall to Gavins Point	1,696	1,475	87
Gavins Point to Sioux City	2,229	2,742	123
TOTAL ABOVE SIOUX CITY	**25,231**	**24,740**	**98**
	1967-2013 Average Runoff	**2013 CY Runoff**	**% of Annual Runoff**
Sioux City, IA to Nebraska City, NE*	7,600	5,930	78
Nebraska City, NE to Kansas City, MO*	11,700	6,190	53
Kansas City, MO to Hermann, MO*	20,600	24,230	118
TOTAL BELOW SIOUX CITY*	**39,900**	**36,350**	**91**

** 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.*

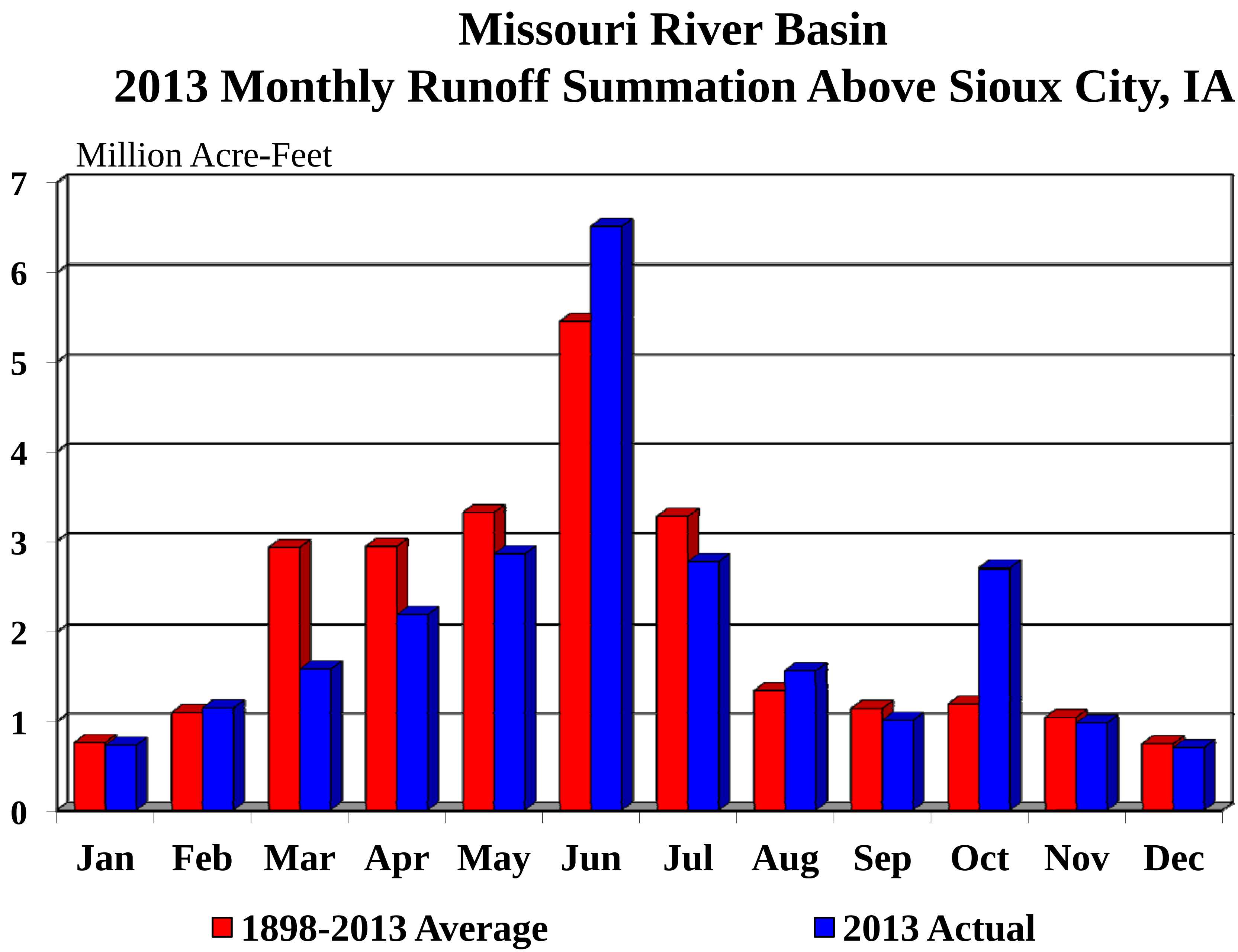


Figure 9. Missouri River Basin 2013 monthly runoff summation above Sioux City, IA.

C. <u>System Regulation – January to December 2013</u>

1. Basin Conditions and System Regulation

Runoff above Sioux City in 2013 was 24.7 MAF, 98 percent of normal. This followed 2012, in which runoff above Sioux City was 19.5 MAF, 78 percent of normal.

a. Conditions on March 1

During the 2009, 2010 and 2011 winters the upper Basin had experienced significant plains snow accumulation. The 2012 winter was very mild throughout the entire upper Basin and very little plains snow had been observed. The 2013 winter brought more moderate snowfall to the Northern Plains region of the upper Basin. Upper Basin runoff above Sioux City, IA was 96 percent of normal in January and 105 percent of normal in February.

The March 1 plains snow coverage (***Figure 1***) indicated moderate SWE in the Northern Plains, especially northeast Montana, North Dakota and eastern South Dakota. Very light SWE covered the remainder of Montana, Wyoming, western South Dakota and Nebraska. Furthermore, soil moisture conditions were very dry and drought conditions covered most of the upper Basin. The mountain SWE was 93 percent of the 1981-2010 March 1 average SWE in the reach above Fort Peck and 85 percent of the 1981-2010 March 1 average SWE in the Fort Peck to Garrison reach (***Table 2***). The March 1 annual inflow forecast was 20.0 MAF (79 percent of normal). As a result of very dry conditions and full service navigation releases in 2012, System storage was drawn down into the Carryover Multiple Use Zone in 2012. On March 1, 2013, System storage was 48.5 MAF. At the time, this was 8.3 MAF below the 56.8 MAF base of the Annual Flood Control and Multiple Use Zone, providing an additional 50 percent more flood control storage for anticipated spring and summer runoff.

Based on the March 15 System storage of 48.9 MAF, which is below the 49.0 MAF minimum service storage level, System (Gavins Point) releases were set to support a minimum service navigation level for the first part of the navigation season. Flow support for the 2013 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.

b. Conditions on April 1

Although temperatures during the January through March period were generally warmer than normal in the upper Basin, temperatures were below normal as April began. Furthermore, drought conditions continued to range from Moderate (D1) to Exceptional (D4) throughout a majority of the upper Basin (***Figure 7***) and soil moisture conditions were drier than normal. As a result, March runoff was 54 percent of normal (***Table 3***). On April 1 the mountain SWE was 89 percent of the April 1 normal in the reach above Fort Peck and 83 percent of normal in the Fort Peck to Garrison (***Table 2***). Following below normal runoff in March, the April 1 annual inflow forecast was 20.5 MAF (81 percent of normal). System storage on April 1 was 48.7 MAF, 8.1 MAF below the base of the Annual Flood Control and Multiple Use Zone.

c. Conditions on May 1

Precipitation was near to below normal in April while temperatures were below normal across the upper Basin. The combination of near to below normal precipitation and dry soil moisture conditions led to 75 percent of normal April runoff (***Table 3***). The mountain SWE in the reach above Fort Peck peaked on April 23 at 95 percent of normal (***Table 2***). The mountain SWE in the Fort Peck to Garrison reach peaked on April 25 at 95 percent of normal. Despite a near-normal peak SWE accumulation in the mountains, the May 1 annual inflow forecast was reduced to 20.0 MAF (79 percent of normal). System storage on May 1 was 49.6 MAF, 7.2 MAF below the base of the Annual Flood Control and Multiple Use Zone, providing minimal recovery to System storage despite minimum service releases.

Accumulated precipitation in May was well-above normal throughout much of the upper Basin, particularly in central and eastern Montana and much of North Dakota, while temperatures were relatively normal. The May runoff summation above Sioux City, IA was just 86 percent of normal, highlighted by 52 percent of normal runoff above Fort Peck (***Table 3***).

d. Conditions in June and July

System storage recovered slightly to a June 1 level of 51.1 MAF, 5.7 MAF below the base of the Annual Flood Control and Multiple Use Zone. The June 1 annual inflow forecast was increased to 21.2 MAF (84 percent of normal). Normal temperatures occurred during the month of June, while precipitation was well below normal in the mountains and the plains. In contrast, much of Montana, northern North Dakota and the eastern Dakotas experienced well-above normal precipitation. With the additional runoff due to this precipitation coinciding with the mountain snowpack runoff, June runoff was 119 percent of normal (***Table 3***). As of July 1, System storage was 54 MAF, 2.8 MAF below the base of the Annual Flood Control and Multiple Use Zone. Most significantly, the July 1 water-in-storage check resulted in providing navigation flow support 3,000 cfs below the full service level for a full 8-month season. The July 1 annual inflow forecast was increased to 22.3 MAF (88 percent of normal). July temperatures were near normal in the plains but above normal in the mountains, while Basin precipitation was below normal. As a result, July runoff was 85 percent of normal (***Table 3***).

e. Conditions in August through December

Reservoir elevation-capacity relationships based on recent reservoir sedimentation surveys were updated for Garrison, Oahe, Fort Randall and Gavins Point on August 1, 2013. Rule curves related to System storage checks conducted during the calendar year did not change as a result of the updated elevation-capacity relationships. A more detailed description of the updated elevation-capacity relationships is provided in section II.E. Gross System storage as a result of the implemented elevation-capacity curves was lowered by 0.7 MAF (671 kAF). August 1 System storage was 53.0 MAF, 3.1 MAF below the base of the Annual Flood Control and Multiple Use Zone, which had been adjusted from 56.8 MAF to 56.1 MAF. The August 1 annual inflow forecast was 22.7 MAF (90 percent of normal). Although extremely dry conditions occurred in some regions of the upper Basin, well-above normal precipitation occurred in eastern Montana, the western Dakotas and western Nebraska. Calculated runoff in August was 117 percent of normal (***Table 3***), resulting in a September 1 System storage of 52.1 MAF, 4.0 MAF below the base of the Annual Flood Control and Multiple Use Zone. The September 1 water-in-storage check determined that a minimum winter release of 12,000 cfs would be targeted from Gavins Point during the 2013-2014 winter season for a second consecutive winter.

The September 1 and October 1 annual inflow forecasts were 23.1 MAF (91 percent of normal) and 23.2 MAF (92 percent of normal), respectively. Extremely wet conditions in October fueled by heavy rainfall and heavy snowfall in southern Montana, Wyoming, the Dakotas and eastern Nebraska changed conditions in the upper Basin drastically. Most of this region received more than 150 percent of normal precipitation, while more than 300 percent of normal precipitation occurred in western South Dakota and northern North Dakota. As a result, October runoff above Sioux City was 2.7 MAF (226 percent of normal), and runoff above Gavins Point was 2.5 MAF (229 percent of normal). This was the second highest October runoff summation above Sioux City during the 1898-2013 historical period. Oahe received 1.1 MAF of runoff (***Table 3***), which was the highest October incremental runoff into Oahe, nearly double the previous high. Average October runoff into Oahe is 72 kAF. As a result of October runoff, System storage increased from 50.9 MAF on October 1 to 51.4 MAF on November 1 during a period when System storage normally declines.

Following the near record October runoff, the annual inflow forecast was revised to 25.9 MAF (102 percent of normal), and eventually the computed annual inflow at the end of 2013 was 24.7 MAF (98 percent of normal). The System storage on December 31, 2013 was 50.1 MAF, 6.0 MAF below the base of the Annual Flood Control and Multiple Use Zone.

2. Fort Peck Regulation – January to December 2013

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 5 lists the average monthly inflows and releases and the end-of-month (EOM) pool elevations for Fort Peck in 2012 and 2013 as well as the average monthly inflows, releases and EOM pool elevations since the System first filled in 1967.

Table 5
Fort Peck – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2013	2012	1967-2013	2013	2012	1967-2013	2013	2012	1967-2013
January	6,100	7,100	7,200	12,300	11,800	10,600	2224.0	2234.8	2227.4
February	6,800	9,000	8,700	12,500	10,800	10,900	2222.2	2234.3	2226.7
March	7,900	9,500	11,800	6,600	6,800	7,800	2222.6	2234.9	2227.8
April	6,700	10,100	10,200	6,000	6,900	7,300	2222.7	2235.7	2228.5
May	10,400	12,700	15,600	8,000	9,100	9,100	2223.4	2236.6	2230.3
June	20,600	14,000	19,700	7,900	10,000	10,500	2227.1	2237.4	2232.7
July	6,100	7,300	12,200	8,000	11,100	10,600	2226.1	2235.9	2232.8
August	6,400	5,700	7,800	8,000	10,900	10,200	2225.1	2233.8	2231.6
September	5,500	5,600	7,700	6,400	10,500	9,000	2224.2	2231.8	2230.8
October	5,400	5,600	7,300	5,000	10,100	8,000	2224.0	2230.0	2230.2
November	5,300	6,200	7,100	5,000	10,400	8,300	2223.6	2228.4	2229.5
December	5,500	4,800	6,600	6,300	11,100	9,400	2223.1	2226.0	2228.4

b. Winter Season 2012-2013

The Fort Peck Reservoir level was at elevation 2226.0 feet msl on January 1, 8.0 feet below the base of the Annual Flood Control and Multiple Use Zone and 10.2 feet lower than the previous year. The annual minimum reservoir level occurred March 5 at 2222.2 feet msl, 3.8 feet lower than the 2012 annual minimum, which was 2226.0 feet msl on December 31.

c. Winter River and Ice Conditions Below Fort Peck

No special release reductions were required to prevent ice-jam flooding downstream of Fort Peck. The average monthly discharges for December 2012 and January and February 2013 were above normal at 11,100, 12,300, and 12,500 cfs, respectively. Ice-cover formation on the Missouri River downstream of Fort Peck occurred December 24-30 and resulted in the Missouri River stage rising over eight feet in the Wolf Point, MT area. The stage at Wolf Point peaked at 20.4 feet on December 30, 2012, 2.6 feet below the 23-foot flood stage. This was the highest stage in 2013 at Wolf Point. The Missouri River at Culbertson, MT peaked on January 2 at a stage of 10.3 feet, well below the 19-foot flood stage. No reports of ice-affected flooding on the Missouri River below Fort Peck were recorded during the 2013 winter season. Fort Peck Reservoir froze over on January 14 and was free of ice on March 14.

d. Spring Open Water Season 2013

Inflows into Fort Peck were well-below normal during April and May before increasing to near normal June inflows. Releases were below normal for that same period. In May and June, average monthly inflows to the reservoir were 10,400 cfs (67 percent of normal) and 20,600 cfs (105 percent of normal), respectively. Fort Peck releases were below normal at 8,000 cfs (88 percent of normal) in May and 7,900 cfs (75 percent of normal) in June. Fort Peck Reservoir rose 4.6 feet from its April 1 elevation of 2222.6 feet msl to its peak elevation for the year of 2227.2 feet msl near the end of June.

e. Summer Open Water Season 2013

Average monthly release rates from Fort Peck were below normal (75 percent of the three-month normal) during the summer with 8,000, 8,000, and 6,400 cfs in July, August and September, respectively. Despite the inflows being just above normal in June, inflows quickly dropped off during the July through September period and were below normal (65 percent) at 6,100, 6,400 and 5,500 cfs, respectively. After peaking in late June, the reservoir pool level started a gradual decline through the remainder of the year. Over a 3-month period the reservoir level steadily dropped 2.9 feet from 2227.1 feet msl (July 1) to 2224.2 feet msl (September 30).

f. Fall Open Water Season 2013

Releases during the fall continued to be well-below normal with 5,000 cfs in both October (63 percent of normal) and November (60 percent of normal) and 6,300 cfs in December (67 percent of normal). The lower releases were continued in an effort to minimize the unbalanced condition in System storage for the upper three reservoirs. Inflows for October, November and December were also below normal, ranging from 74 percent to 83 percent of normal. The combination of below normal inflow and much below normal releases resulted in the pool elevation only declining 1.1 feet over the three-month period from 2224.2 feet msl (October 1) to 2223.1 feet msl (December 31).

g. Summary

The highest Fort Peck Reservoir level during 2013 occurred on June 26 at 2227.2 feet msl, 6.8 feet below the top of the Annual Flood Control and Multiple Use Zone. The lowest reservoir level during 2013 occurred on March 5 at 2222.2 feet msl. The average daily inflow of 7,700 cfs during 2013 was 76 percent of normal (1967-2013). The average daily release of 7,700 cfs during 2013 was 83 percent of normal (1967-2013).

3. Garrison Regulation – January to December 2013

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 6 lists the average monthly inflows and releases and the end-of-month (EOM) pool elevations for Garrison for 2012 and 2013 as well as the average monthly inflows, releases and EOM pool elevations since the System first filled in 1967.

Table 6
Garrison – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation(ft msl)		
	2013	2012	1967-2013	2013	2012	1967-2013	2013	2012	1967-2013
January	16,200	16,500	15,200	21,500	21,300	22,500	1828.3	1838.2	1831.9
February	19,000	21,700	18,500	22,900	22,600	23,600	1827.5	1838.0	1830.9
March	17,500	20,500	26,400	17,500	20,500	19,100	1827.3	1837.9	1832.3
April	23,700	16,300	22,800	19,100	26,600	18,700	1828.3	1835.8	1832.9
May	27,400	25,400	29,500	20,200	26,200	21,500	1829.7	1835.6	1834.4
June	50,400	36,800	47,700	19,900	25,400	25,000	1835.8	1837.7	1838.6
July	21,000	23,300	33,500	19,200	24,300	26,000	1836.1	1837.3	1839.7
August	14,700	15,500	18,600	19,200	24,600	25,100	1834.8	1834.8	1838.0
September	15,700	14,700	16,900	16,300	21,800	20,900	1834.0	1832.8	1836.7
October	17,800	17,400	17,300	13,000	19,700	19,000	1834.6	1831.6	1836.1
November	13,200	19,000	16,000	13,200	22,100	19,800	1834.1	1830.3	1834.9
December	12,200	14,600	13,800	15,800	17,400	19,900	1833.0	1829.5	1833.4

b. Winter Season 2012-2013

The Garrison Reservoir level was at elevation 1829.5 feet msl on January 1, 10 feet lower than the previous year's elevation of 1839.5 feet msl. This elevation was 8 feet below the base of the Annual Flood Control and Multiple Use Zone. Releases from the Garrison Reservoir were below normal for December, January, and February. The reservoir level declined throughout the winter season and ended February at 1827.5 feet msl, which is 10.5 feet below the previous year's elevation and 10 feet below the base of the Annual Flood Control and Multiple Use Zone. Garrison Reservoir froze over on December 26, 2012 and was free of ice on May 13, 2013.

c. Winter River and Ice Conditions Below Garrison

The Missouri River in the Bismarck, ND area rose over 4 feet on December 22-25 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 24, 2012 through March 5, 2013, at which time the river ice broke up due to warmer temperatures. The winter ice-affected Missouri River peak stage at Bismarck was 10.2 feet on January 19. This was 4.3 feet below the Bismarck flood stage of 14.5 feet and 2.8 feet below the Corps' winter freeze-in maximum stage target of 13 feet.

d. Spring Open Water Season 2013

After starting the year with near normal runoff into Garrison Reservoir, inflows dropped off in March, but then recovered in April and were near normal for the rest of the spring. Releases from Garrison were just above normal for April before starting to drop off through the remainder of spring. The releases ranged from 17,300 cfs to 20,900 cfs and were based on what was needed during the spring to maintain a steady-to-rising pool level in Oahe during the critical fish spawning period. The near normal inflows and slightly below normal releases resulted in Garrison pool levels increasing 8.5 feet, from 1827.3 feet msl on March 31 to 1835.8 feet msl at the end of June. Inflows for April, May and June were near normal at 104 percent, 93 percent and 106 percent of normal, respectively. Releases were near normal for April (102 percent of normal), and then began to decline in May (94 percent of normal) and June (80 percent of normal).

e. Summer Open Water Season 2013

Inflows into Garrison Reservoir were below normal during the three-month period of July (21,000 cfs; 63 percent of normal), August (14,700 cfs; 79 percent of normal) and September (15,800 cfs; 93 percent of normal). Releases during this three-month period continued to be slightly below normal. During this three-month period, the pool crested at 1836.7 feet msl on July 13, 0.8 foot below the Annual Flood Control and Multiple Use Zone. Following the July 13 crest, the Garrison pool slowly declined to 1834.0 feet msl at the end of September, 2.7 feet below the July 13 crest.

f. Fall Open Water Season 2013

Releases during the fall continued to be below normal, averaging 72 percent of normal over the October-December period. Inflows in October were near normal (103 percent of normal) before dropping off again in November and December, averaging 85 percent of normal in those two months. Releases were increased from 13,000 cfs starting in late November to 16,000 cfs in early December in anticipation of the December freeze-in downstream of Garrison Dam between Washburn and Bismarck, ND. The river froze over at Bismarck on December 8 and peaked at a stage of just over 8.5 feet. After the ice cover stabilized, releases from Garrison were held steady at 16,000 for the rest of December. The end-of-year Garrison Reservoir elevation was 1833.0 feet msl, 4.5 feet below 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 ft. This restriction, which required a pool limitation for Lake Audubon, was the 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 normal elevations following the 8-year drought, this water level difference restriction has not been in effect. Lake Audubon was drawn down to the normal winter level of 1845.0 feet msl in the fall.

h. Summary

The Garrison Reservoir elevation peaked at 1836.7 feet msl on July 13, 0.8 feet below the base of the Annual Flood Control and Multiple Use Zone. The lowest Garrison Reservoir level during 2013 occurred on March 29 at 1827.2 feet msl or 10.3 feet lower than the base of the Annual Flood Control and Multiple Use Zone. The average annual inflow of 20,700 cfs was 90 percent of normal (1967-2013). The average annual release of 18,200 cfs was 84 percent of normal (1967-2013).

4. Oahe and Big Bend Regulation – January to December 2013

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 7 lists the average monthly inflows and releases and the end-of-month (EOM) pool elevations for Oahe for 2012 and 2013 as well as the average monthly inflows, releases and EOM pool elevations since the System first filled in 1967.

Table 7
Oahe – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2013	2012	1967-2013	2013	2012	1967-2013	2013	2012	1967-2013
January	22,300	20,200	22,900	17,300	26,700	20,800	1594.9	1605.2	1598.7
February	24,100	25,200	27,000	15,800	22,400	18,200	1596.5	1605.6	1600.4
March	20,400	23,500	31,100	19,500	22,300	18,100	1596.6	1605.7	1603.0
April	21,800	27,900	27,100	17,300	24,800	20,800	1597.7	1606.4	1604.0
May	28,100	28,400	28,000	15,900	24,200	22,100	1600.4	1607.1	1605.0
June	28,600	26,900	30,700	14,200	29,400	27,100	1603.3	1606.5	1605.2
July	20,000	24,100	28,500	20,800	35,000	31,400	1602.6	1603.9	1604.3
August	20,800	23,800	26,400	24,200	38,100	33,900	1601.6	1600.5	1602.2
September	19,500	21,400	22,500	29,000	36,800	29,800	1599.1	1596.8	1600.4
October	31,600	19,500	20,700	15,200	27,200	23,800	1602.1	1594.7	1599.3
November	15,500	23,300	21,200	18,300	26,100	22,600	1601.0	1593.3	1598.7
December	16,100	17,500	20,200	13,100*	14,700	20,800	1601.4	1593.5	1598.4

* monthly minimum 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 Chairperson of the Tribes or their designees to notify them of the situation and discuss proposed actions to remedy the situation. During 2013 the Big Bend Reservoir level varied in the narrow range between elevations 1419.3 feet msl to 1421.4 feet msl. As per the settlement agreement, no additional coordination was necessary.

Table 8 lists the average monthly inflows and releases and the end-of-month (EOM) pool elevations for Big Bend for 2012 and 2013 as well as the average monthly inflows, releases and EOM pool elevations since the System first filled in 1967.

Table 8
Big Bend – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2013	2012	1967-2013	2013	2012	1967-2013	2013	2012	1967-2013
January	15,900	25,500	20,500	16,700	25,200	20,400	1420.1	1420.6	1420.5
February	15,000	21,000	18,200	14,400	21,000	18,200	1420.4	1420.5	1420.4
March	18,100	21,100	18,900	17,900	21,100	18,800	1420.5	1420.4	1420.4
April	16,700	23,700	21,100	16,100	23,000	20,800	1420.8	1420.8	1420.5
May	15,300	22,900	22,200	15,300	23,600	22,100	1420.7	1419.8	1420.4
June	13,200	27,200	27,300	12,600	26,400	27,000	1421.0	1420.3	1420.3
July	19,100	32,100	30,700	19,800	31,900	30,300	1420.0	1420.1	1420.2
August	22,100	35,400	33,200	22,000	34,700	32,700	1419.9	1420.1	1420.2
September	26,800	34,000	29,300	25,700	32,800	28,800	1421.0	1420.9	1420.3
October	15,300	25,100	23,600	15,300	25,200	23,100	1420.5	1420.4	1420.5
November	16,800	24,300	23,800	16,600	24,300	22,300	1420.4	1420.1	1420.4
December	12,200*	13,500	20,500	12,100*	12,900	20,300	1420.5	1420.8	1420.5

* monthly minimum of record

b. Winter Season 2012-2013

No ice-induced flooding problems were experienced downstream of the two projects during the winter of 2013 due to the warmer temperatures. In addition, it was not necessary to implement the one-unit-minimum release from Oahe. The one unit minimum, which is approximately 7,000 cfs, ensures that water is always flowing in the river downstream of Oahe Dam in order to reduce river ice-formation. Oahe Reservoir froze over on February 22, 2013 and was free of ice on March 14, 2013.

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 32,400 cfs. Big Bend Reservoir froze over on December 26, 2012 and was free of ice on April 8, 2013.

c. Spring Open Water Season 2013

The lack of plains snowpack resulted in less-than-normal March and April incremental inflow into Oahe Reservoir. In May, inflows to Oahe Reservoir improved to normal. March and April average monthly inflows of 20,400 cfs (66 percent of normal) and 21,800 cfs (80 percent of normal) were below normal while a normal inflow of 28,100 cfs (100 percent of normal) was observed during May. During this same time period, releases were 19,500 cfs in March (108 percent of normal), but then declined to 17,300 cfs in April (83 percent of normal), and 15,900 cfs in May (72 percent of normal). Oahe Reservoir rose 3.8 feet during the critical fish spawning period from 1596.6 feet msl (March 31) to 1600.4 feet msl (May 31).

d. Summer Open Water Season 2013

Both inflows and releases were below normal for the June through September period. Oahe peaked for the year at 1603.3 feet msl on July 14; 4.2 feet below the base of the Annual Flood Control and Multiple Use Zone. June releases were 14,200 cfs (52 percent of normal), July releases were 20,800 cfs (66 percent of normal), August releases were 24,200 cfs (71 percent of normal), and September releases were 29,000 cfs (97 percent of normal). The reservoir pool declined from its peak in mid-July through the end of September, ending the month at 1599.1 feet msl, 4.2 feet lower than at its peak.

e. Fall Open Water Season 2013

Fall releases from Oahe were below normal in October and November to accommodate the fall drawdown of the Fort Randall pool through late November when the navigation season ended. October inflow was well above normal (31,600 cfs, 153% percent of normal) due to record high runoff in western North Dakota and South Dakota. Inflow was well below normal in November (15,500 cfs, 73 percent of normal) and December (16,100 cfs, 80 percent of normal). Average monthly releases for October were 15,200 cfs (64 percent of normal), November releases were 18,300 cfs (81 percent of normal), and December releases were 13,100 cfs (63 percent of normal), which was the monthly minimum of record. The Oahe pool elevation at the end of 2013 was 1601.4 feet msl, 6.1 feet below the base of the Annual Flood Control and Multiple Use Zone.

f. Summary

The highest Oahe Reservoir level of 1603.3 feet msl during 2013 occurred on July 14, 4.2 feet below the base of the Annual Flood Control and Multiple Use Zone. The 2013 minimum pool elevation of 1593.6 feet msl occurred on January 4. The average annual inflow to Oahe of 22,400 cfs was 88 percent of normal (1967-2013). The average annual release from Oahe of

18,400 cfs was 76 percent of normal (1967-2013). Big Bend was generally operated within its normal regulating range of 1420.0 feet msl to 1421.0 feet msl. The average annual inflow to Big Bend of 17,200 cfs was 71 percent of normal (1967-2013). The average annual release from Big Bend of 17,000 cfs was 71 percent of normal (1967-2013).

5. Fort Randall Regulation – January to December 2013

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 runoff in the drainage area between the Big Bend and Fort Randall dams, which is 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 Gavins Point Reservoir; (3) to provide a location to store the water necessary to provide increased winter hydropower energy by allowing an annual fall drawdown of the reservoir to occur 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 9 lists the Fort Randall average monthly inflows and releases in cfs and the EOM pool elevation in feet msl for 2012 and 2013 as well as the average monthly inflows, releases and EOM pool elevations since the System first filled in 1967.

Table 9
Fort Randall – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2013	2012	1967-2013	2013	2012	1967-2013	2013	2012	1967-2013
January	18,700	28,600	21,900	12,100	20,100	15,200	1346.2	1346.1	1347.1
February	17,200	24,700	20,100	11,000	18,700	13,300	1350.8	1350.7	1352.0
March	20,200	24,400	21,700	16,500	21,100	15,700	1353.4	1353.0	1356.2
April	18,900	25,900	23,500	15,200	23,400	21,100	1356.0	1354.5	1357.7
May	18,400	26,600	25,000	15,700	25,400	25,200	1357.9	1355.2	1357.4
June	15,700	28,500	30,000	18,900	29,800	28,900	1355.3	1354.0	1357.8
July	21,700	33,600	31,800	22,400	32,400	33,100	1354.5	1354.5	1356.6
August	25,500	37,700	34,300	23,700	36,500	35,400	1355.4	1354.7	1355.4
September	15,800	37,000	29,700	30,300	37,600	34,800	1353.1	1353.6	1351.2
October	17,800	26,600	23,300	25,800	36,100	32,200	1346.5	1345.4	1343.3
November	13,200	25,300	22,100	24,100	30,600	28,700	1339.6	1340.2	1336.9
December	12,200*	14,100	21,400	13,900	14,200	17,300	1337.8	1340.0	1341.0

b. Winter Season 2012-2013

The Fort Randall average daily winter release ranged from 9,700 cfs to 17,500 cfs. Fort Randall Reservoir froze over on January 8 and was free of ice on April 1.

c. Spring Open Water Season 2013

The Fort Randall pool was 1350.8 feet msl at the end of February and rose to its typical spring and summer pool of 1355 feet msl during the month of April. Releases were adjusted as needed to back up System releases from Gavins Point and to maintain the Gavins Point pool in the desired range. The average March release of 16,500 cfs was 105 percent of normal and the average April release of 15,200 cfs was 72 percent of normal. These releases corresponded with average inflows of 20,200 cfs in March (93 percent of normal) and 18,900 cfs in April (80 percent of normal). During May, Fort Randall inflows continued to be below normal at 18,400 cfs (74 percent of normal) along with the releases of 15,700 cfs (62 percent of normal).

d. Summer Open Water Season 2013

Inflows and releases continued to track well below normal throughout the summer from June through September. Fort Randall releases were increased to back up System releases for navigation flow support as tributary inflows declined and the navigation service level was increased following the July 1 System storage check. Inflows were 15,700 cfs in June (52 percent of normal), 21,700 cfs in July (68 percent of normal), 25,500 cfs in August (74 percent of normal), and 15,800 cfs in September (53 percent of normal). Releases from Fort Randall were 18,900 cfs in June (65 percent of normal), 22,400 cfs in July (68 percent of normal), 23,700 cfs in August (67 percent of normal), and 30,300 cfs in September (87 percent of normal). Fort Randall reached its annual peak elevation of 1358.0 feet msl on June 6.

A daily 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 birds nesting below the project. Peaking started on May 10 and ceased on August 21. Initially, peaking was limited to 300 MW for a continuous 6-hour time frame. At the end of May, heavy rainfall downstream of Gavins Point caused increased flows on the Missouri River and its tributaries. As a result Gavins Point and Fort Randall releases were reduced to provide downstream flood control on the Missouri River; therefore, Fort Randall peaking was temporarily suspended on May 28. Peaking resumed on May 31 to 150 MW for a continuous 6-hour time frame and returned to 300 MW for 6 hours on June 3. On June 15 peaking was increased to 330 MW for a continuous 6-hour time frame. This peaking pattern was maintained until August 21 at which time all restrictions were lifted.

e. Fall Open Water Season 2013

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 the 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 pool lowering. On September 1, the pool level was 1355.4 feet msl. The lowering of Fort Randall was started after Labor Day and reached its lowest level of 1337.1 feet msl on November 21. During October, November and December, Fort Randall inflows were 76, 60 and 57 percent of normal, respectively. Releases in October, November and December were 80, 84 and 80 percent of normal, respectively.

f. Summary

The highest Fort Randall Reservoir level during 2013 occurred on June 6 at 1358.0 feet msl. The lowest reservoir level during 2013 was 1337.1 feet msl on November 21. The average annual inflow to Fort Randall of 17,900 cfs was 70 percent of normal (1967-2013), and the average annual release of 19,100 cfs was 76 percent of normal (1967-2013).

6. Gavins Point Regulation – January to December 2013

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 450,000 acre-feet (AF), it provides only a small amount of flood control storage 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 ranging from 33,000 cfs to 35,000 cfs, are passed through the spillway.

Table 10 lists the Gavins Point average monthly inflows and releases in cfs and the EOM pool elevation in feet msl for 2012 and 2013 as well as the average monthly inflows, releases and EOM pool elevations since the System first filled in 1967.

Table 10
Gavins Point – Inflows, Releases and Elevations

Month	Monthly Inflow (cfs)			Monthly Release (cfs)			EOM Elevation (ft msl)		
	2013	2012	1967-2013	2013	2012	1967-2013	2013	2012	1967-2013
January	14,700	21,800	17,300	14,800	21,900	17,200	1207.3	1207.2	1207.5
February	13,800	21,800	16,500	14,100	22,000	17,300	1206.4	1206.5	1205.7
March	18,300	23,600	19,700	18,600	23,900	19,700	1205.8	1205.9	1205.6
April	18,100	26,700	25,000	17,900	26,200	24,800	1206.3	1206.6	1205.8
May	18,700	27,900	28,800	18,300	28,000	28,500	1207.0	1206.1	1206.1
June	20,600	32,000	32,200	20,700	31,700	31,900	1206.5	1206.3	1206.2
July	23,200	34,300	35,300	23,200	34,000	34,800	1205.9	1206.3	1206.7
August	24,900	38,100	37,100	24,500	37,800	36,600	1206.3	1206.4	1207.3
September	31,300	38,800	36,800	30,500	38,200	36,400	1207.7	1207.0	1207.6
October	27,400	38,400	34,500	27,200	37,600	34,300	1207.8	1208.0	1207.8
November	26,500	34,400	31,000	26,400	34,200	31,000	1207.6	1207.6	1207.6
December	15,000	16,400	19,300	15,100	16,300	19,400	1207.5	1207.7	1207.4

b. Winter Season 2012-2013

The Gavins Point average daily release was below the normal winter release rate in December, January, and February. Winter releases varied from 14,000 cfs to 18,100 cfs in December, from 13,900 cfs to 18,000 cfs in January and from 13,900 cfs to 16,000 cfs in February. Gavins Point Reservoir froze over on December 21, 2012 and was free of ice on April 3, 2013.

c. Spring Open Water Season 2013

The bimodal spring pulse from Gavins Point was not conducted in 2013. On November 30, 2011 the Missouri River Recovery Program Independent Science Advisory Panel (ISAP) released its Final Report on Spring Pulses and Adaptive Management. This report, commissioned by the Missouri River Recovery Implementation Committee (MRRIC), evaluated the pulses that have been implemented to date in regards to the biological outcomes the United States Fish and Wildlife Service (USFWS) sought in the 2003 Amended BiOp. The ISAP concluded that spring pulses as currently implemented are not accomplishing their intended outcomes and provided recommendations towards achieving a new management paradigm for the Missouri River.

Based on this report, the Corps and USFWS agreed that aggressive pursuit of completing the recommendations laid out by the ISAP was the best path forward to continue ensuring they were using available scientific data to achieve the intent of the 2003 Amended BiOp and species recovery. Accordingly, while this was being pursued, the agencies believed it was prudent to forego a spring pulse during 2013.

Flow support for the 2013 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. Based on the March 15 System storage check of 48.9 MAF, minimum navigation flow support was provided for the first part of the navigation season.

In late April heavy rainfall caused flooding in the lower Missouri River below Kansas City; therefore, Gavins Point releases were decreased to 12,000 cfs April 19-21 and 14,000 cfs April 22-27 for flood control operations. Gavins Point releases were once again decreased to 12,000 cfs May 30 through June 3 for downstream flood control operations in the Missouri River from Rulo, NE to the mouth at St. Louis, MO.

No cycling of Gavins Point releases was conducted in 2013 due to concerns that cycling could erode sandbar habitat. 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 without impacting nests. Cycling of releases has been conducted in previous years as a drought conservation measure as well as a flood risk management measure. Starting in mid-May, Gavins Point steady releases of 23,000 cfs and above were generally needed to maintain the flow at the downstream navigation targets.

d. Summer Open Water Season 2013

Based on the July 1 System storage of 54.0 MAF, navigation flow was increased to 3,000 cfs above minimum service flow support for a full length (8-month) season. Tributary runoff below Nebraska City, NE including Kansas River project flood control storage releases allowed Gavins Point to limit releases through the end of July. Beginning in August, as Kansas River project releases were reduced, Gavins Point releases were gradually increased to 33,000 cfs for one day, then maintained at 32,500 cfs through the end of September in order to meet the Kansas City navigation target.

e. Fall Open Water Season 2013

Based on the September 1 System storage of 52.1 MAF, a minimum winter release of 12,000 cfs from Gavins Point was targeted per rule curves outlined in the Master Manual. During April, letters were sent to downstream intake owners asking them to adjust or modify their intakes to be able to operate at reduced release rates. It was decided that Gavins Point releases would gradually be reduced to determine if the minimum winter release of 12,000 cfs could be achieved while still keeping downstream intakes operational. In December cold temperatures were prevalent throughout the upper Basin causing rapid ice formation and minor blockages on most tributaries and the Missouri River from Gavins Point to Sioux City during several incidents. Reduced incremental flow and loss of discharge on the Missouri River caused several stage drops and prevented the Corps from reducing the Gavins Point release below 13,000 cfs.

f. Summary

The highest Gavins Point pool level in 2013 was 1208.4 feet msl, reached on October 16. The lowest reservoir level during 2013 occurred on March 27, at 1205.3 feet msl. The 2013 average annual inflow to Gavins Point of 21,000 cfs was 76 percent of normal based on the 1967-2013 period. The 2013 average annual release from Gavins Point of 20,900 cfs was 75 percent of normal.

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. Events that occurred in connection with regulation activities during 2013 that may be considered unusual, or recently have come to the attention of MRBWM, are discussed in the following paragraphs.

Following the flood of 2011, preliminary assessments of Gavins Point indicated minor damage sustained to a number of areas on the spillway slab. In order to properly evaluate the actual damage, Gavins Point releases were reduced to zero to dewater the uppermost portion of the spillway slab on May 9, 2012. This spillway assessment included the use of ground penetrating radar and other investigative methods. Repair work entailed additional subsurface investigations and included the installation of pressure transducers beneath the spillway chute to assess and monitor uplift pressures that may develop during the operation of the spillway. To gather further information and to test the installed instrumentation, additional investigations of the spillway structure were conducted in 2013. On March 12, releases were diverted from the powerhouse to the spillway for approximately 8 hours. Total releases were increased from 14,000 cfs to 26,000 cfs for most of the test period, with some short periods up to 40,000 cfs. Flows were lowered back to 14,000 cfs after the test. Stages at Yankton increased approximately 1.4 feet. On April 16, releases were again diverted from the powerhouse to the spillway for approximately 7 hours. Total releases were increased from 17,500 cfs to 26,000 cfs for the majority of the test period. Total releases reached 40,000 cfs for a short period. Releases were reduced to 17,500 cfs after the test. Stages at Yankton increased approximately 1.3 feet. In both cases, the stage increase lessened downstream and was difficult to discern from stage changes due to normal tributary flow variation.

Gavins Point releases and James, Vermillion and Big Sioux Rivers flows are shown on ***Plate 3***. Stage changes at Yankton, Sioux City, and Omaha are also shown on ***Plate 3***.

E. Reservoir Elevations and Storage

Reservoir elevation-capacity relationships based on recent reservoir sedimentation surveys were updated for Garrison, Oahe, Fort Randall and Gavins Point on August 1, 2013. Gross System storage based on the new relationships declined 671 kAF (0.7 MAF) from 73,087 kAF (73.1 MAF) to 72,416 kAF (72.4 MAF) as a result of reservoir sedimentation. Of the 671 kAF reduction in gross storage, 362 kAF (0.4 MAF) was lost in the Carryover and Multiple Use Zone and 304 kAF (0.3 MAF) was lost in the Permanent Zone. Storage lost in the Annual Flood Control and Multiple Use Zone was 5 kAF. Storage zone elevations did not change within the reservoirs as a result of the updated elevation-capacity relationships, nor did rule curves related to System storage checks.

Reservoir elevations and storage contents of the System reservoirs at the end of July 2013 are presented in ***Table 11.*** The 12-month-change columns for the end of July indicate decreases in the elevations and respective storages in the Fort Peck, Garrison and Oahe Reservoirs, with significant decreases of 9.8 ft and 1,980 kAF in elevation and storage, respectively, in Fort Peck. All three of the large storage reservoirs were below the base of their respective Annual Flood Control and Multiple Use Zones.

Reservoir elevations and storage contents at the end of December 2013 are presented in ***Table 12***. Since reservoir elevation-capacity relationships were changed on August 1, 2013, System and reservoir storage volumes on December 31, 2013 in Table 12 were determined by the new elevation-capacity relationships. In order to make an accurate comparison of 12-month storage change on December 31, 12-month storage change was based solely on the new elevation-capacity relationships. By the end of December (***Table 12***), Fort Peck, Garrison and Oahe were below the base of their respective Annual Flood Control and Multiple Use Zones; however, the Fort Peck level was lower than 12 months prior to December 31, 2013, while Garrison and Oahe were higher than the previous year.

Table 11
Reservoir Levels and Storages – July 31, 2013

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	2226.1	-9.8	13,211	9,123	-1,980
Garrison	1836.1	-1.2	17,647	12,667	-371
Oahe	1602.6	-1.3	17,360	11,987	-406
Big Bend	1420.0	-0.1	1,626	5	-3
Fort Randall	1354.5	-0.0	3,488	1,971	+2
Gavins Point	1205.9	-0.4	339	32	-11

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

Table 12
Reservoir Levels and Storages – December 31, 2013

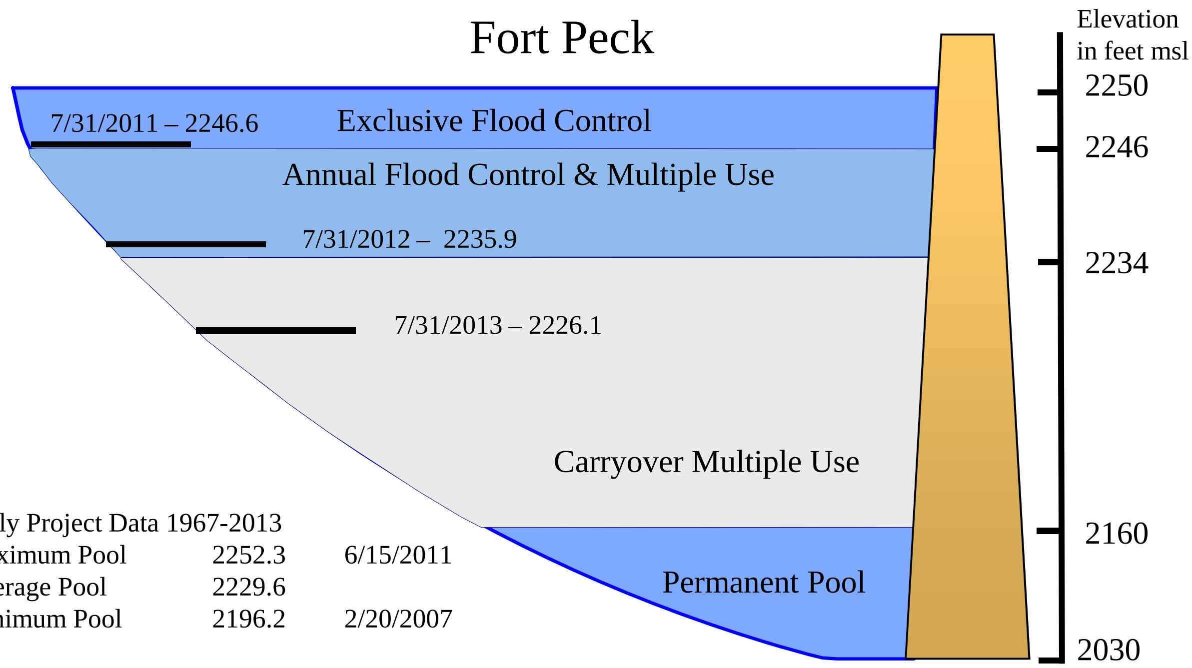
Project	Reservoir Elevation		Reservoir Storage in 1,000 AF**		
	Elevation (ft msl)	12-Month Change (ft)	Total	Above Min. Level*	12-Month Change**
Fort Peck	2223.1	-2.9	12,624	8,536	-586
Garrison	1833.0	+3.5	16,394	11,600	+997
Oahe	1601.4	+7.9	16,829	11,514	+2,084
Big Bend	1420.5	-0.3	1,652	31	-14
Fort Randall	1337.8	-2.2	2,208	739	-120
Gavins Point	1207.5	-0.2	361	66	-5

*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.

Figures 10A and 10B show the end-of-July pool elevations for Fort Peck, Garrison and Oahe plus total System end-of-July storage for 2011 through 2013. Individual tables with the historic maximum, average and minimum pool elevations for each reservoir are also shown on ***Figures 10A and 10B.*** During the 2000-2007 drought, all three reservoirs experienced their historical minimum record pool levels: Garrison in 2005, Oahe in 2006, and Fort Peck in 2007. During 2011 Fort Peck, Oahe and Fort Randall experienced their historical maximum pool levels in addition to the System experiencing its maximum storage of 72.8 MAF.

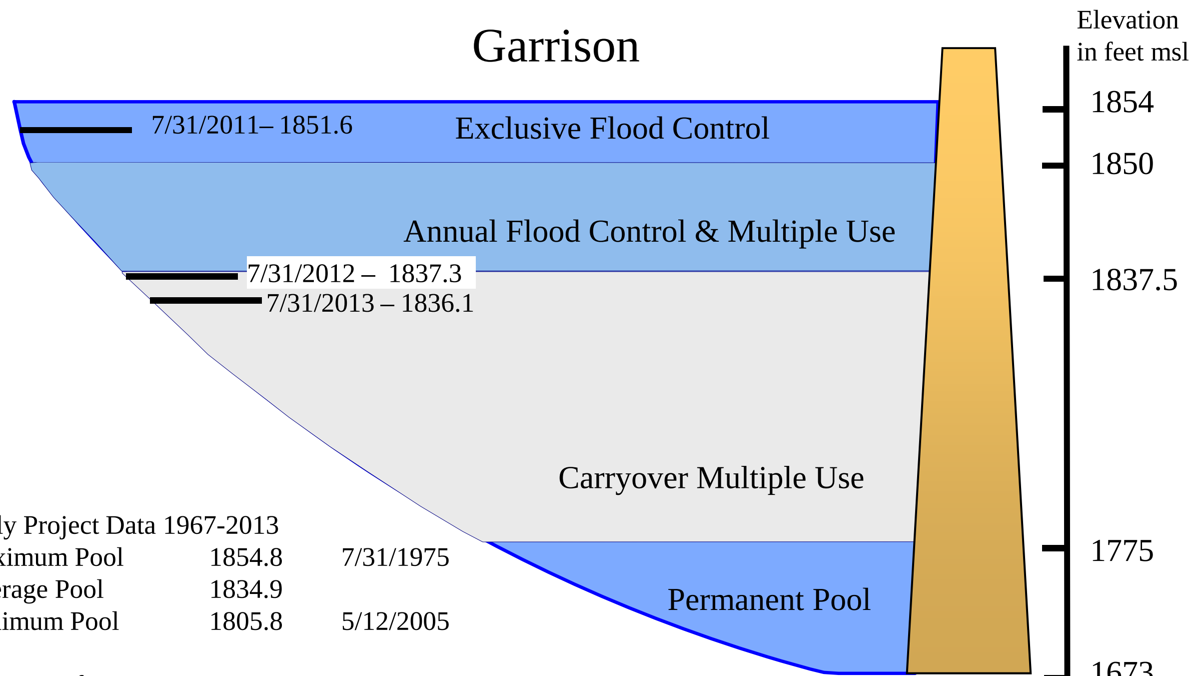
Missouri River System Reservoirs
End-of-July Pool Elevations and Total System Storage

Fort Peck



Daily Project Data 1967-2013		
Maximum Pool	2252.3	6/15/2011
Average Pool	2229.6	
Minimum Pool	2196.2	2/20/2007
Maximum for 2013	2227.2	6/26/2013
Minimum for 2013	2222.2	3/5/2013

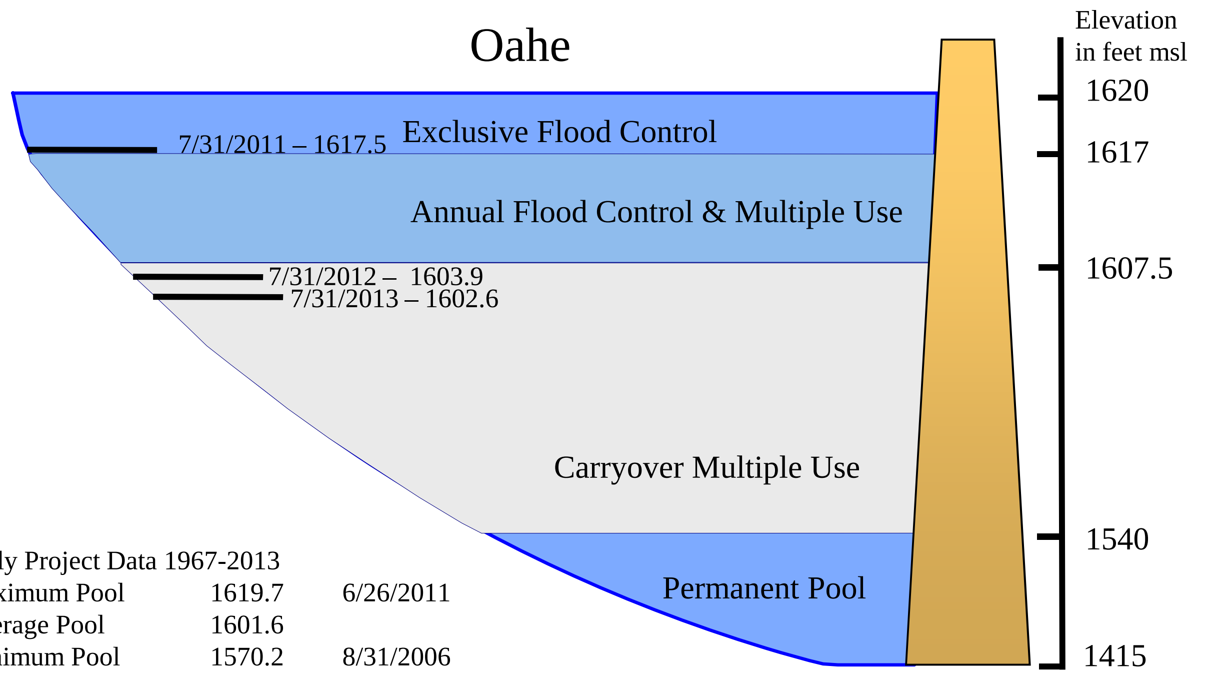
Garrison



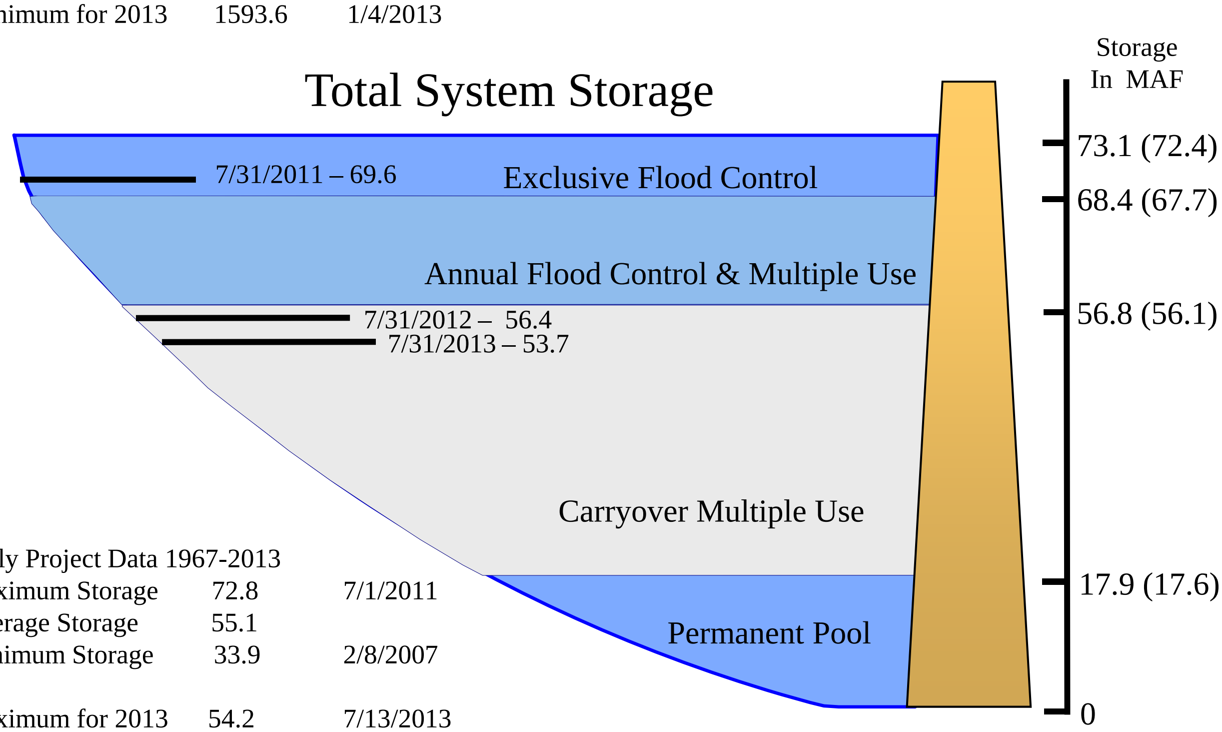
Daily Project Data 1967-2013		
Maximum Pool	1854.8	7/31/1975
Average Pool	1834.9	
Minimum Pool	1805.8	5/12/2005
Maximum for 2013	1836.7	7/13/2013
Minimum for 2013	1827.2	3/29/2013

Figure 10A. End of July pool elevations for Fort Peck and Garrison.

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



Daily Project Data 1967-2013		
Maximum Pool	1619.7	6/26/2011
Average Pool	1601.6	
Minimum Pool	1570.2	8/31/2006
Maximum for 2013	1603.3	7/14/2013
Minimum for 2013	1593.6	1/4/2013



Daily Project Data 1967-2013		
Maximum Storage	72.8	7/1/2011
Average Storage	55.1	
Minimum Storage	33.9	2/8/2007
Maximum for 2013	54.2	7/13/2013
Minimum for 2013	48.2	1/16/2013

Figure 10B. End of July pool elevation for Oahe and total System storage. System storage in parentheses is based on updated elevation-capacity relationships implemented August 1, 2013.

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

1. Flood Control

Following the 2012 low runoff year, System storage was 48.5 MAF, 8.3 MAF below the base of the Annual Flood Control and Multiple Use Zone on March 1, 2013. As a result minimum navigation service releases were implemented during the first part of the 2013 navigation season. Low volumes of spring runoff occurred due to low plains snowpack levels and dry soil conditions; however, a combination of near average mountain snowpack and above average spring precipitation produced above average runoff in Fort Peck, Garrison and Oahe during June and also in Oahe during May and July. All runoff into the System was stored in the Carryover Multiple Use Zone during 2013, and water in storage did not enter the System Annual Flood Control and Multiple Use Zone.

The total flood damages prevented by all Corps controlled reservoir projects in the Missouri Basin during 2013 were estimated to exceed $292 million ($244 million Omaha District; $48 million Kansas City District). The System flood damages prevented indexed to the September 2013 price level is illustrated in ***Figure 11A***. Flood damages prevented by the System reservoirs during 2013 were estimated to be $228 million ($217 million Omaha District; $11 million Kansas City District). Since 1938, the average annual flood damages prevented by the System were $53.6 billion or $705 million annually, indexed to September 2013 price levels. The total un-indexed flood damages prevented at the original price levels is $32.9 billion or $433 million annually (***Figure 11B***). 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 the purpose of comparison, ***Figures 11A*** and ***11B*** also include the construction cost of the dams. Indexed to 2013 price levels, the dams cost approximately $25 billion, whereas the original un-indexed cost was $1.2 billion.

Figure 12 shows the 2013 regulated (actual experienced) and unregulated (with no System reservoirs and tributary reservoirs) Missouri River flows at Omaha, NE; Nebraska City, NE and St. Joseph, MO. The unregulated peak flow as a result of upper Basin runoff would have occurred during the middle of June 2013 in the Missouri River at Sioux City, IA and Nebraska City, NE. The unregulated peak flow at St. Joseph, MO would have occurred at the beginning of June as a result of rainfall runoff in the lower Basin that occurred at the same time of the ascending limb of the unregulated upper Basin hydrograph.

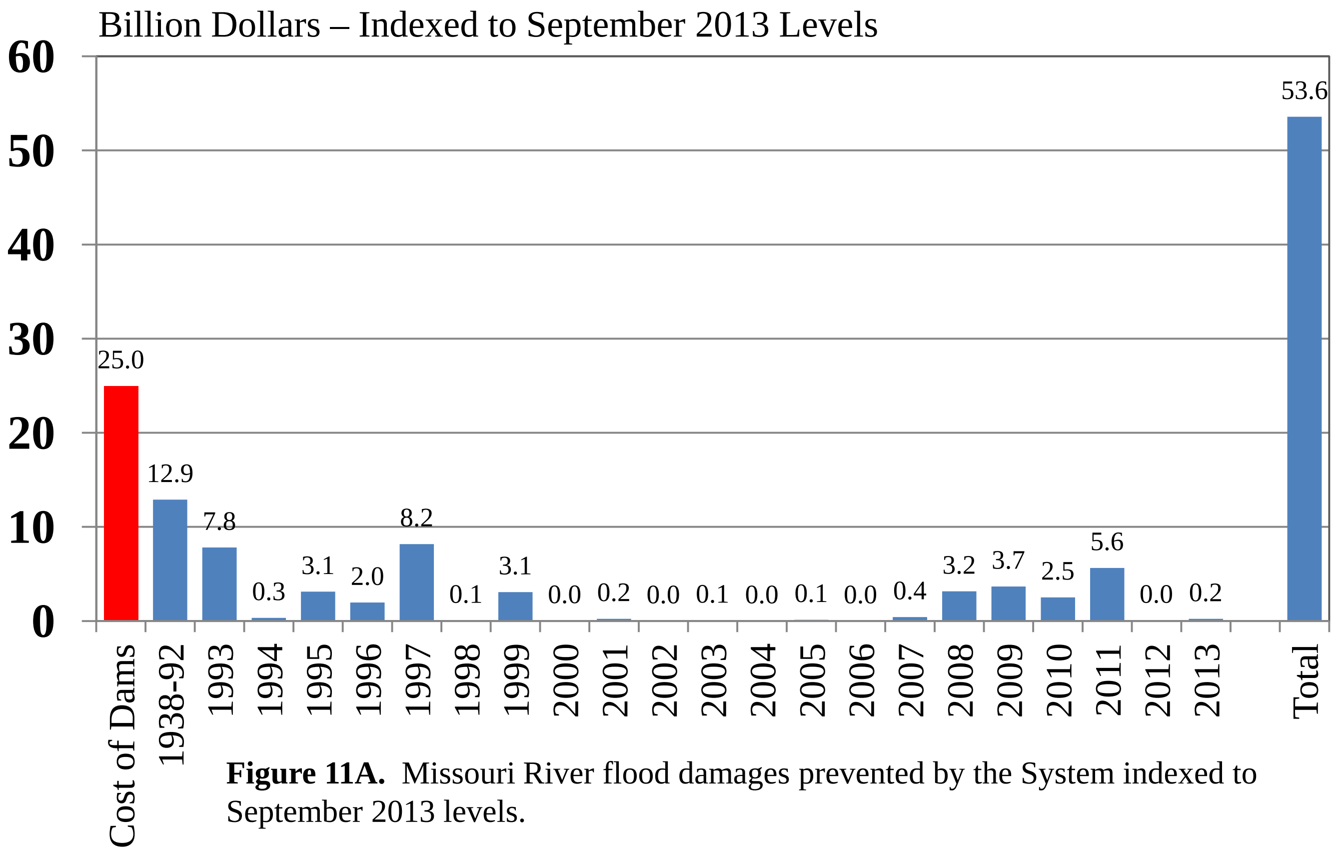


Figure 11A. Missouri River flood damages prevented by the System indexed to September 2013 levels.

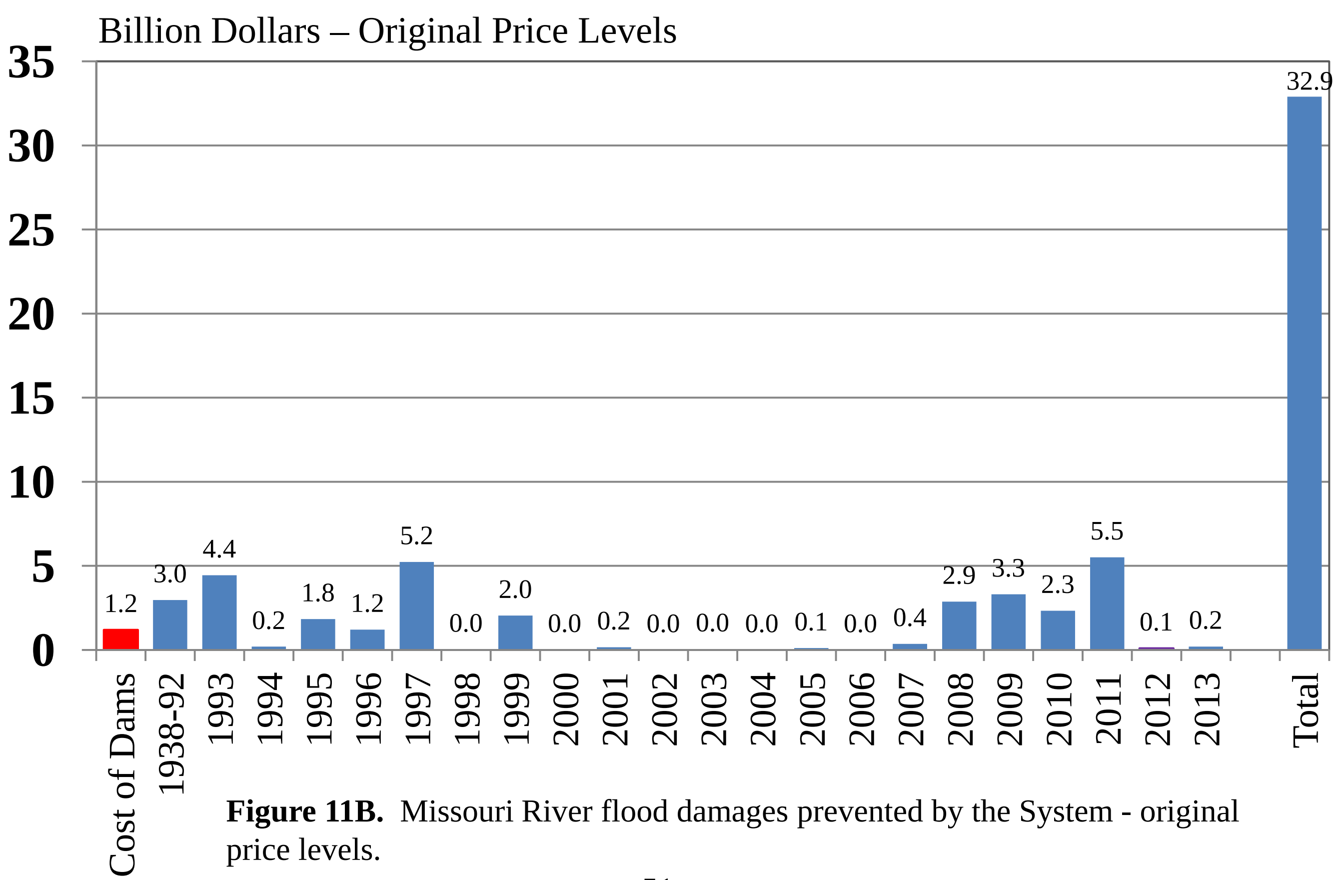
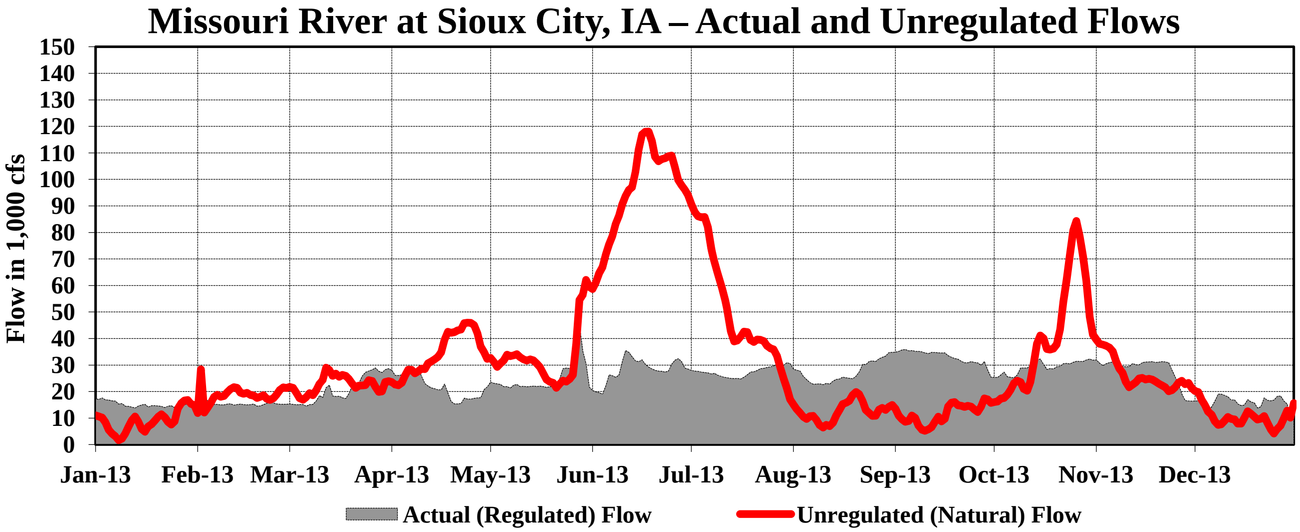
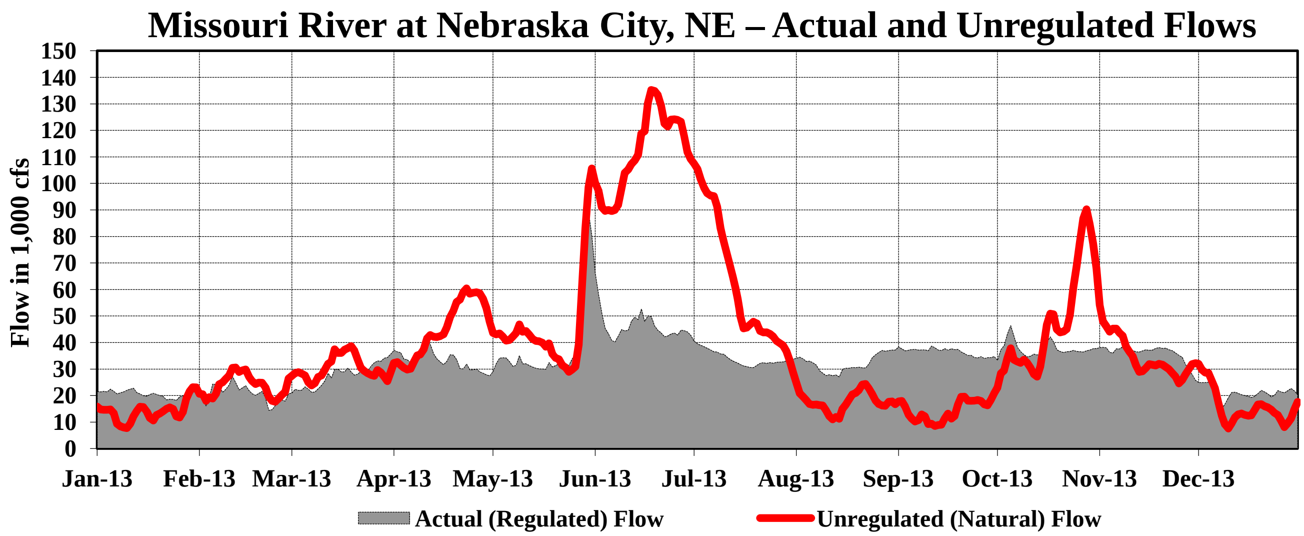


Figure 11B. Missouri River flood damages prevented by the System - original price levels.





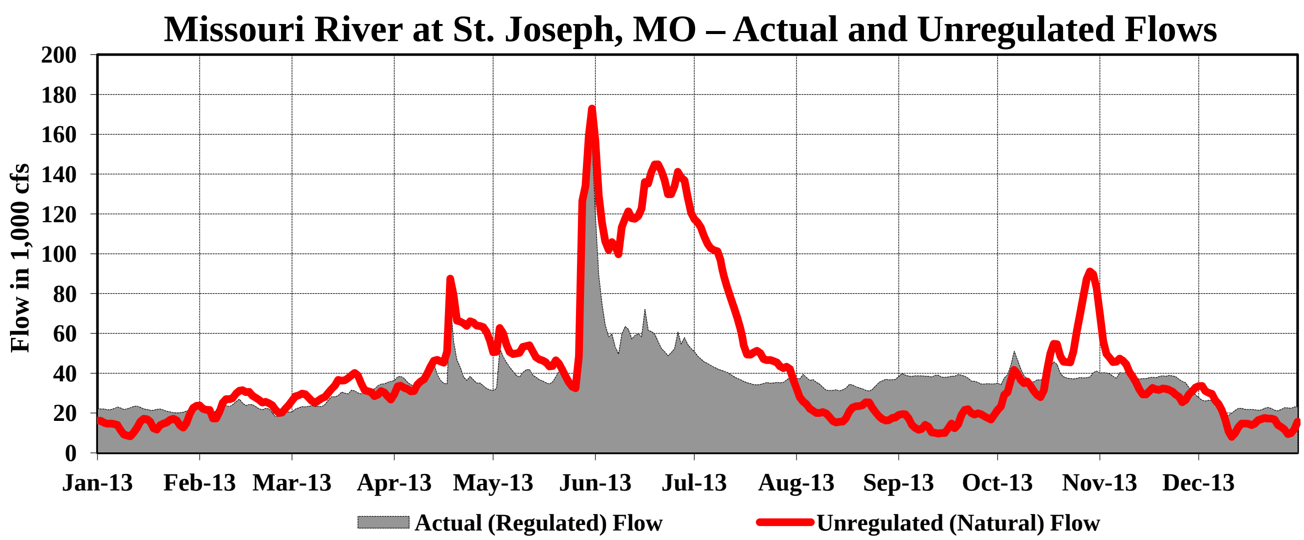


Figure 12. Actual and unregulated flows – Sioux City, IA, Nebraska City, NE and St. Joseph, MO.

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 experienced significant channel degradation. The September 1 storage check called for minimum winter System releases of 12,000 cfs. All intake owners on the Missouri River were notified by letter that the Corps would attempt to lower releases to 12,000 cfs during the 2013-1014 winter. All intake owners and operators were encouraged to take necessary action so that their intakes were operational for the minimum winter release rate of 12,000 cfs and the potential future fall non-navigation release rate of 9,000 cfs during shortened navigation seasons. Winter releases were slowly stepped down to 14,000 cfs; however, very cold winter temperatures and ice formation on the Missouri River below Gavins Point Dam caused several significant stage decreases in the river. A low release of 13,000 cfs was reached on December 19, 2013, but continued ice formation made it very difficult to maintain releases at or below13,000 cfs.

4. Water Quality Control

a. Overview

During 2013 the Omaha District conducted long-term, fixed-station ambient water quality monitoring at the System reservoirs and on the lower Missouri River. Water quality conditions of the water discharged through each of the System dams was continuously monitored. An intensive water quality survey of the lower Missouri River was continued and conducted jointly with the Kansas City District and extended from Gavins Point Dam to the river's mouth at St. Louis, Missouri. More detailed water quality monitoring information is available via the Omaha District water quality annual reports.

The Omaha District has identified eight priority water quality issues that have relevance to the System reservoirs. These identified priority issues are:

1. Determine how regulation of the System reservoirs affect water quality in the impounded reservoirs and downstream river reaches. Utilize the CE-QUAL-W2 hydrodynamic and water quality model to facilitate this effort.
2. Evaluate how eutrophication is progressing in the System reservoirs, especially regarding the expansion of anoxic conditions in the hypolimnion during summer stratification.
3. Determine how flow regimes, especially the release of water from System reservoirs, affects water quality in the Missouri River.
4. 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.
5. Provide water quality information to support Corps reservoir regulation elements for effective surface water quality and aquatic habitat management.
6. Provide water quality information and 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 Omaha District tributary projects.
7. Identify existing and potential surface water quality problems at Omaha District projects and develop and implement appropriate solutions.
8. Evaluate surface water quality conditions and trends at Omaha District projects.

Table 13 provides a summary of water quality issues and concerns at each of the System reservoirs based on Omaha District monitoring and a review of current State integrated water quality reports.

Table 13
Water Quality Issues and Concerns

Project	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	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 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 Total Maximum Daily Load (TMDL) 303(d) reports and listings as of January 1, 2014.
** Impairment identified in Montana's integrated report, but not on 303(d) list for development of a TMDL.
*** Was delisted in 2010 for impairment to Fish and other Aquatic Biota (water temperature and low dissolved oxygen) when Lake Sakakawea pool elevations recovered from drought conditions.

b. Occurrence of “Two-Story” Fisheries at System Reservoirs

Fort Peck, Garrison, and Oahe Reservoirs maintain “two-story” fisheries that are comprised of warmwater and coldwater species. The ability of the reservoirs to maintain “two-story” fisheries is due to their thermal stratification in the summer that allows coldwater habitat to be maintained in the deeper, colder region of the reservoir (i.e. hypolimnion). Warmwater 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, a bottom withdrawal outlet structure 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. 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 reservoirs 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 (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 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 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 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. The situation will continued 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 Coldwater Permanent Fish Life Propagation (CPFLP) use (i.e. coldwater fishery). As such, a water temperature criterion of ≤ 57 degrees F (or 15 degrees C), a dissolved oxygen criterion of ≥ 5 mg/l and a minimum volume of 500,000 AF 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 from 2003 through 2013 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 4*** and ***Plate 5*** show estimated reservoir and coldwater habitat volumes by year for 2003 through 2013. Water quality monitoring in 2013 indicates that North Dakota's 500,000 AF minimum water quality standards criterion for coldwater 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 the Water Quality Unit is currently updating the CEQUAL-W2 hydrodynamic and water quality model 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 CPFLP use. As such, a water temperature criterion of ≤ 65 degrees 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 from 2005 through 2013. ***Plate 6*** shows estimated summer reservoir and coldwater habitat volumes, by year, for 2005 through 2013. At least 1 MAF of coldwater fishery habitat was present in Oahe for all years except 2011. The high dam releases to manage flood conditions significantly increased the water flushing rate or greatly reduced the water residence time for Oahe in 2011. The increased flushing rate resulted in faster flow of water through the reservoir that seemingly 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 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, don’t meet the temperature requirements for a coldwater fishery use and allow for the support of coldwater fishery habitat in Big Bend during the summer.

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 6 mg/l. The low dissolved oxygen levels in the tailwaters are not seemingly impairing the designated Warmwater Permanent Fish Life Propagation (WPFLP) beneficial 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 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 continued to be evaluated to determine if corrective measures to meet South Dakota’s water quality standards may be needed.

5. Navigation

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 provides water to ensure a minimum 8-ft channel depth while full service navigation flow support provides water to ensure a minimum 9-ft channel depth in the BSNP. Navigation flow support and season length is determined by System storage checks on March 15 and July 1, and System releases are set to meet navigation targets at four locations on the Missouri River. Based on the March 15, 2013 System storage of 48.8 MAF, System releases were set to provide minimum navigation flow support during the first part of the 8-month navigation season. Based on the July 1, 2013 System storage of 54.0 MAF, System releases were increased to provide navigation flow support midway between minimum and full service flow support (3,000 cfs above minimum service flow support) for the remainder of the 8-month season ending on December 1 at the mouth of the Missouri River.

a. Barge Traffic

The first towboat using the Missouri River in 2013 was the *Motor Vessel (MV) Leslie Ann*, operated by Capital Sand Company of the Jefferson City River Terminal, which is located in Jefferson City, MO at river mile RM 143. The vessel left the terminal on March 6 as a light boat and headed downstream to retrieve loaded cement barges at RM 29 that had been secured there in December 2012 after having been stopped from proceeding due to a channel shoal after flow support for navigation had ceased. The *MV Leslie Ann* returned two of the four barges to Jefferson City River Terminal and headed back down for the last two March 11. The *MV Mary Lynn*, operated by Hermann Sand and Gravel Company, entered the Missouri River pushing six barges on March 8, four of these loaded with fertilizer, and was the first towboat to arrive at the AgriServices Terminal, Brunswick, MO (RM 256). On their third trip of the season the *MV Mary Lynn* entered the Missouri River on April 7 pushing six loads of fertilizer and one empty barge. The empty barge was dropped in Hermann (RM 97) on April 8, three loads of fertilizer were dropped at AgriServises Brunswick on April 10 and the last three loads passed Kansas City, MO (RM 367) and arrived at Nebraska City, NE (RM 562) April 14.

There were two special shipments during 2013. The *MV Tigre* moved a dinner cruise boat from RM 591 on June 27 upstream to RM 648.8. This boat was apparently stranded in a farmer's field during high water, sold and moved by the new owner. From where the boat sat in the field, this 100-foot boat was put on wheels and moved three miles to the launch ramp at RM 591 where it was put on steel beams and slid into the river where the *MV Tigre* caught it and secured it in tow and began its trip upstream to RM 648.8. On August 14 the *MV Allison Marie*, operated by Capital Sand Company of the Jefferson City River Terminal, began to move the Harrah's Casino boat from RM 615.9 arriving at the Jefferson City River Terminal (RM 143) August 19. Assisting with the removal from her moorings at RM 615.9 was *MV Ellen Marie* and *MV Tigre*, both owned by Newt Marine Service and operated by Dubuque Barge and Fleeting Service Company. The casino boat stayed at the Jefferson City River Terminal until November 5 when the *MV Jamie Leigh*, owned and operated by Jefferson City River Terminal, began pushing it toward the Mississippi River, leaving the Missouri River on November 7.

The *MV Ellen Marie* and *MV Tigre* were the last towboats to use the river during the calendar year leaving the Missouri on December 21.

b. Tonnage

Table 14 shows the Missouri River tonnage data for 2008 – 2012 compiled by the Waterborne Commerce Statistics Center (WCSC). The 2012 total of 3,906 thousand tons includes 3,421 thousand tons for sand and gravel, 79 thousand tons for waterways materials, and 197 thousand tons for long-haul commercial tonnage. In 2012 the total tonnage increased by 74 thousand tons compared to 2011. The long haul tonnage of 197 thousand tons decreased by 33 thousand tons from 2011. The largest long-haul commercial tonnage, excluding sand, gravel and waterway material, occurred in 1977 at 3,340 thousand tons. ***Figure 13A*** shows total navigation tonnage on the Missouri River. Tonnage for 2012 is preliminary waiting finalization in 2014; 2013 tonnage is estimated. ***Figure 13B*** shows the long-haul commercial navigation tonnage not including sand, gravel and waterway materials. The long-haul commercial tonnage in 2013 is currently estimated at about 250 thousand tons, based on carrier interviews, towboat activity and barge counts from the Corps' daily boat reports. ***Figure 14A*** shows the navigation tonnage value of the commodities since 1960, using 2013 present-worth computations. ***Figure 14B*** shows the navigation tonnage value of long-haul commercial commodities since 1960. The ***Figures 13A***, ***13B***, ***14A*** and ***14B*** tonnages and tonnage values for 2013 are estimates and will change once final WCSC tabulations are available.

Table 14
Missouri River Tonnage by Commodity (1,000 Tons)

Commodity Classification Group	2008	2009	2010	2011	2012
Farm Products	0	18	35	21	20
Corn	0	4	13	6	0
Wheat	0	0	0	0	0
Soybeans	0	14	23	15	20
Misc Farm Product	0	0	0	0	0
Nonmetallic Minerals	5,415	4,666	4,388	3,588	3,479
Sand/Gravel	5,415	4,649	4,346	3,548	3,421
Misc Nonmetallic	0	17	42	39	61
Food and Kindred	16	32	36	0	0
Pulp and Paper	0	0	0	0	0
Chemicals	5	26	72	49	34
Fertilizer	4	24	70	49	34
Other Chemicals	1	2	1	0	0
Petroleum (including coke)	87	120	118	44	6
Stone/Clay/Glass	55	57	76	77	79
Primary Metals	0	0	0	0	0
Waterway Materials	81	117	105	53	288
Other	12	0	0	0	0
Total Commercial	5,671	5,036	4,831	3,832	3,906
Total Long-Haul Commercial	175	270	380	230	197

Navigation season target flows for past years are given in ***Table 15***. ***Table 16*** shows the scheduled lengths of past System-supported navigation seasons, with total tonnage and ton-miles for each year.

c. Kansas River Projects

During two separate periods in late July and mid-August, supplemental flow support was provided out of the flood control pools at three Kansas City District Kansas River projects: Tuttle Creek, Perry and Milford, as noted in ***Table 17***. Storage in each of these three projects may also be used out of the conservation pools to supplement Missouri River navigation either: (1) as a drought conservation measure to minimize impact on the System reservoirs or (2) as a measure to minimize take of endangered species nesting below the System dams. According to the agreement with the State of Kansas, the Corps can use 3 feet of storage (from the base of the flood control zone into the conservation zone) out of each reservoir prior to October 1 and an additional 3 feet thereafter. During 2013, releases from flood control storage in the Kansas River projects were used to meet navigation targets solely as a measure to minimize take. On July 22 the Perry release was increased to 1,000 cfs for a total navigation target of 2,000 cfs on the Kansas River at DeSoto, KS; then discontinued on July 29. On August 9, Milford releases were increased while Tuttle and Perry releases were increased on August 11 to provide navigation support for meeting an August 13 DeSoto target. Kansas project releases were reduced from Perry on August 12, and from Tuttle and Milford beginning on August 19 and 21, respectively, discontinuing the navigation flow support target at DeSoto on August 25. At that time, Kansas project releases were made for the purpose of flood control evacuation.

Without the use of the Kansas River projects, several low elevation nests below Gavin Point would have been inundated with additional releases that were needed to meet the Kansas City navigation target. By late-August the eggs had hatched, the chicks were able to move themselves to higher ground and all downstream navigation targets were met with releases from the System projects.

Figure 15 presents discharge data at Sioux City, IA; Nebraska City, NE and Kansas City, MO, three of the four navigation flow-target locations for 2013. ***Figure 16*** presents the same information as ***Figure 15*** but focuses on a smaller flow range during the 8-month navigation season to better depict the Kansas River project flow support as well as the lack of incremental runoff at each of these locations from July to November.

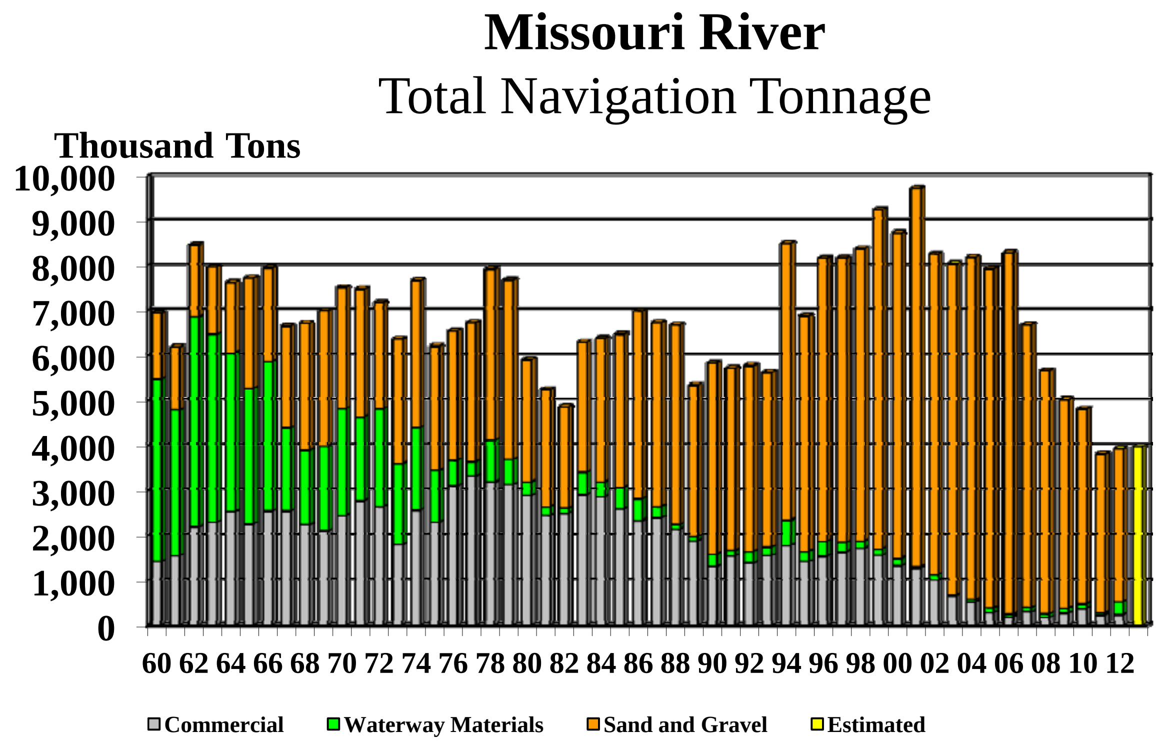


Figure 13A. Missouri River total navigation tonnage from 1960 to 2013 (estimated)

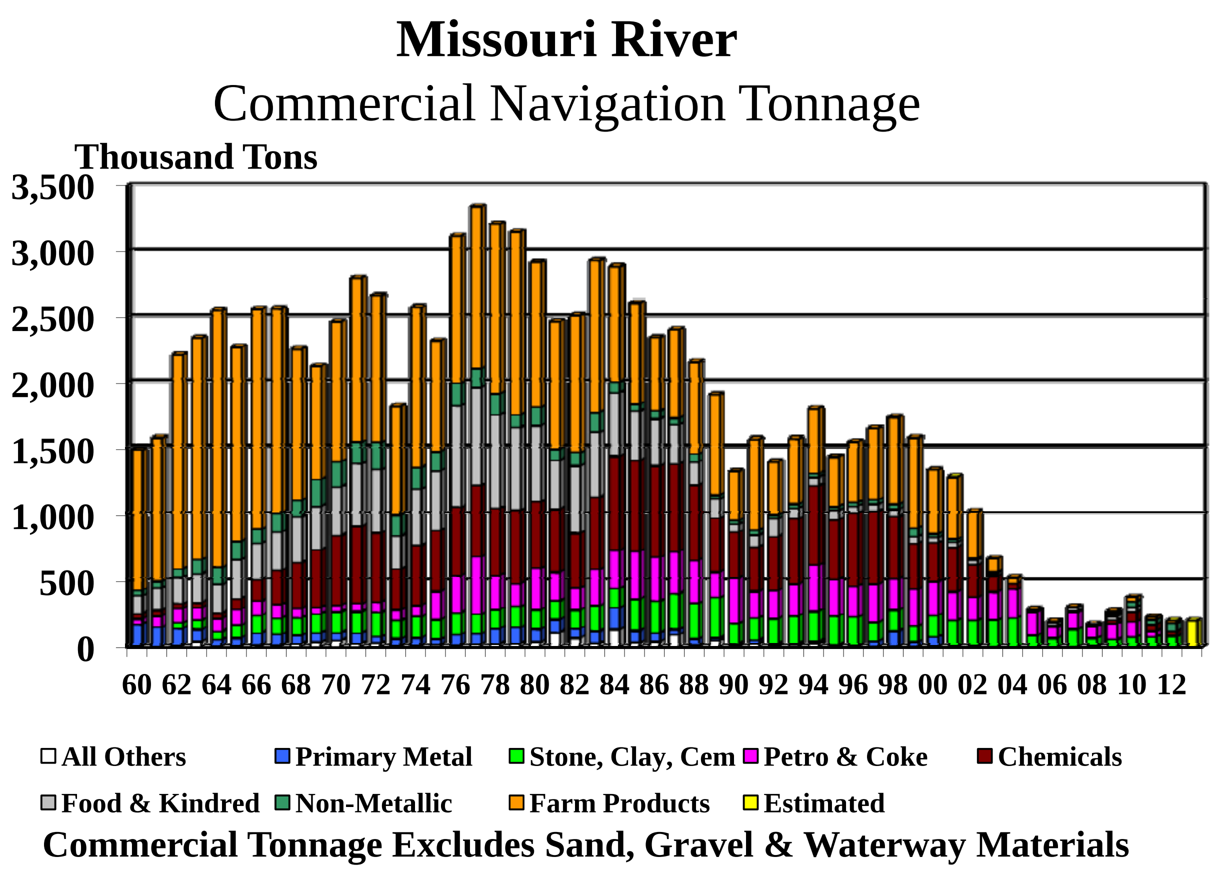


Figure 13B. Missouri River commercial navigation tonnage from 1960 to 2013 (estimated)

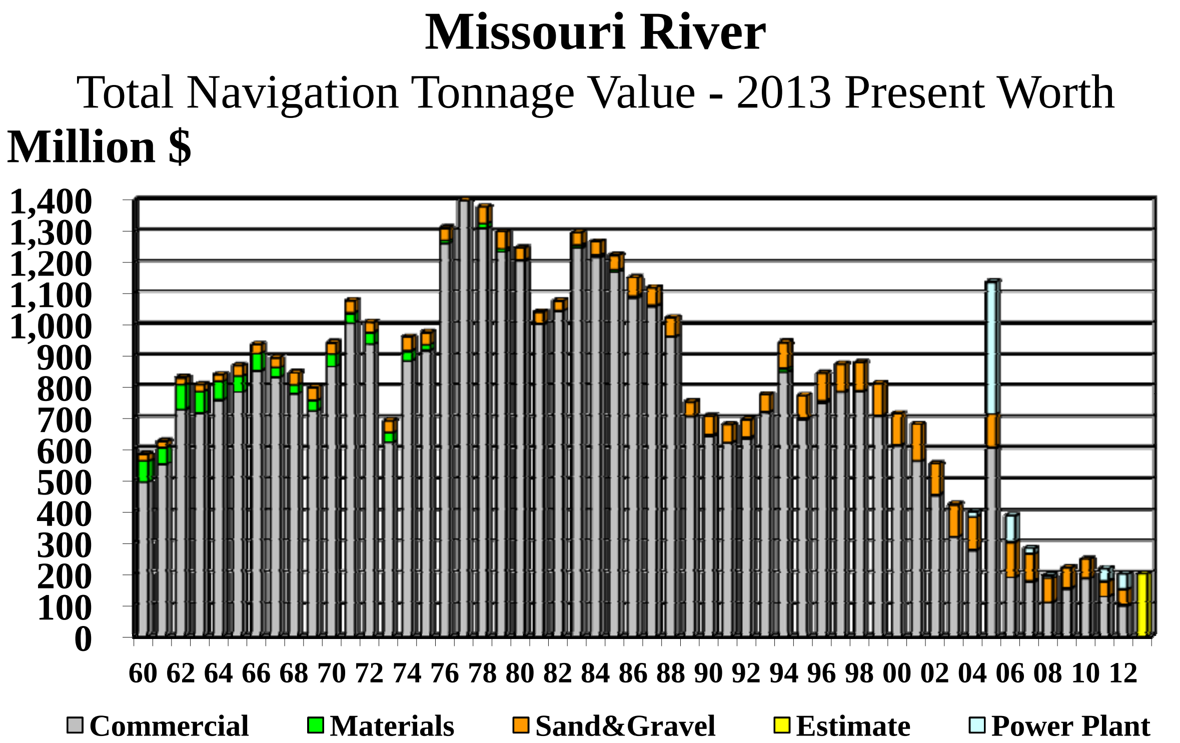


Figure 14A. Total navigation tonnage value using 2013 present worth computations

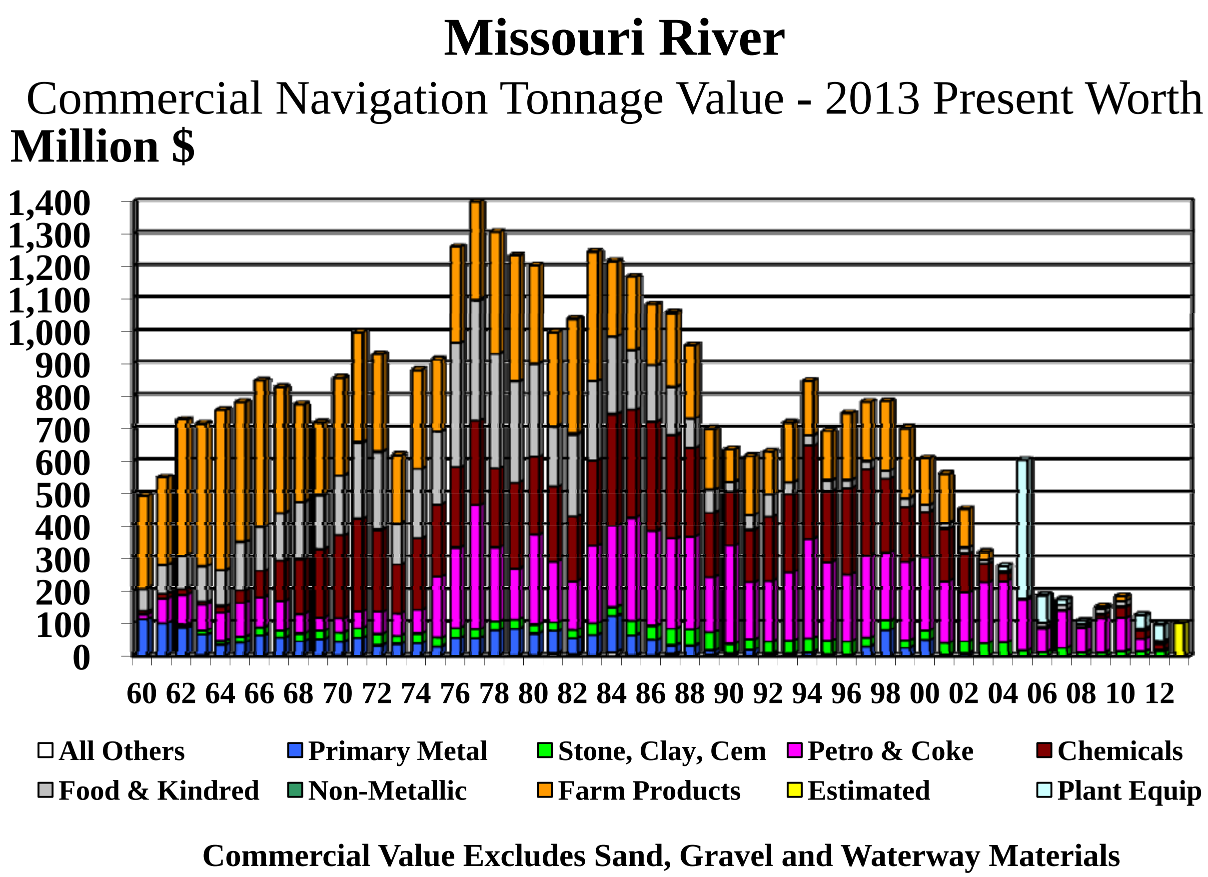


Figure 14B. Commercial navigation tonnage value using 2013 present worth computations

Table 15
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

(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 16
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	350,000(12)	4,350,000(12)	56,631
2013	8	200,000(13)	4,000,000(13)	60,000(13)

(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) Preliminary
(13) Estimated using boat report barge counts.

Table 17
Navigation Flow Support – Kansas River Projects

Date*	Increase (cfs)	DeSoto target flow (cfs)	Decrease (cfs)	DeSoto target flow (cfs)
July 23	1,000	2,000		
July 30			500	1500
August 13	1,000	2,100		
August 14	1,000	3,100		
August 15	3,000	6,100		
August 16	700	6,800		
August 20			700	6,100
August 21			300	5,800
August 23			2,000	3,800
August 25			1,000	n/a

*Indicates when releases from projects arrived at DeSoto, KS. Travel times from Milford, Tuttle Creek and Perry to DeSoto are approximately 4-6, 3-5 and 1-1.5 days, respectively. Travel time from DeSoto to the Missouri River at Kansas City target location is approximately 1 day.

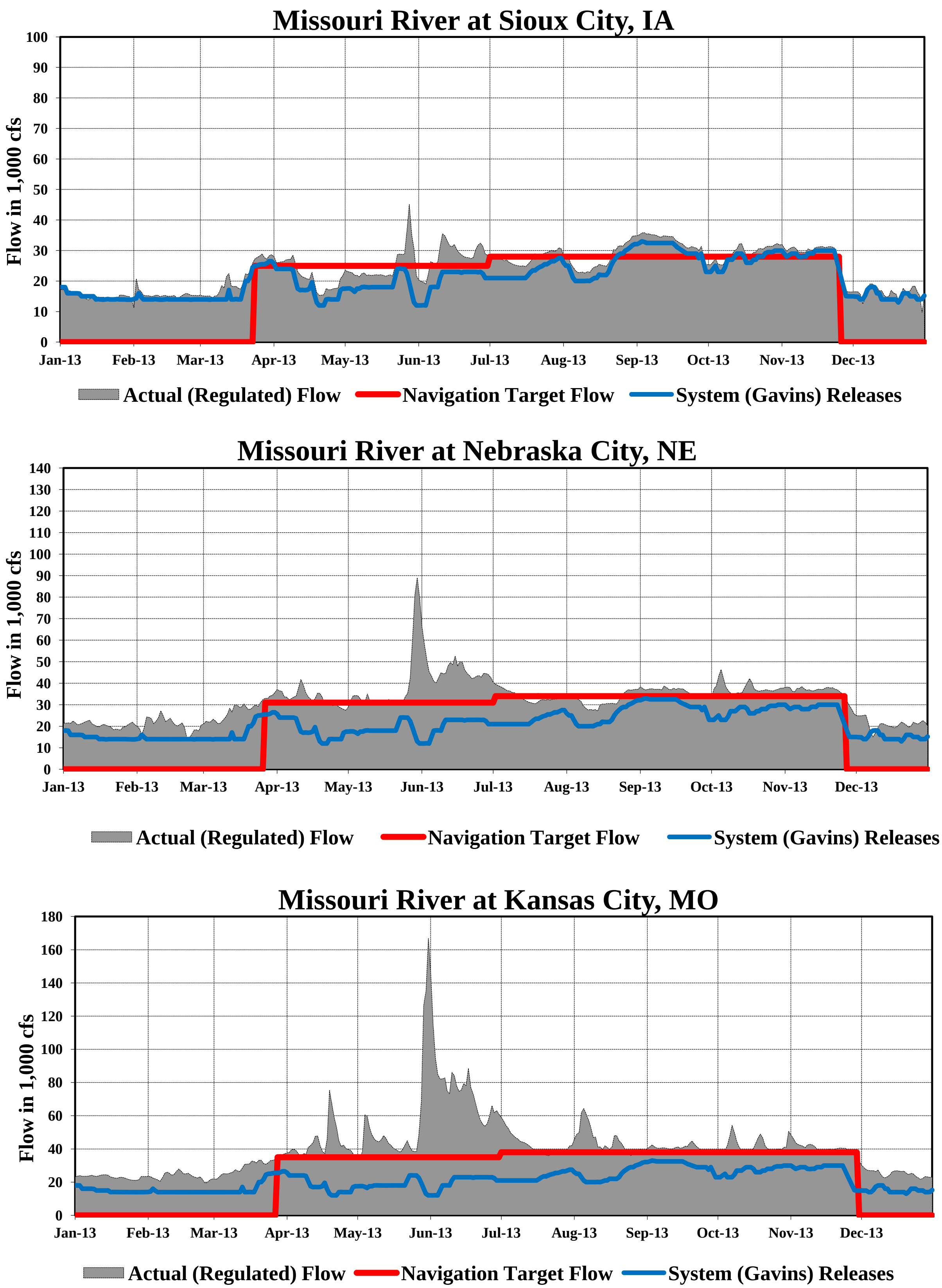


Figure 15. Actual flow, System releases and navigation target flows – Sioux City, IA; Nebraska City, NE and Kansas City, MO (calendar year).

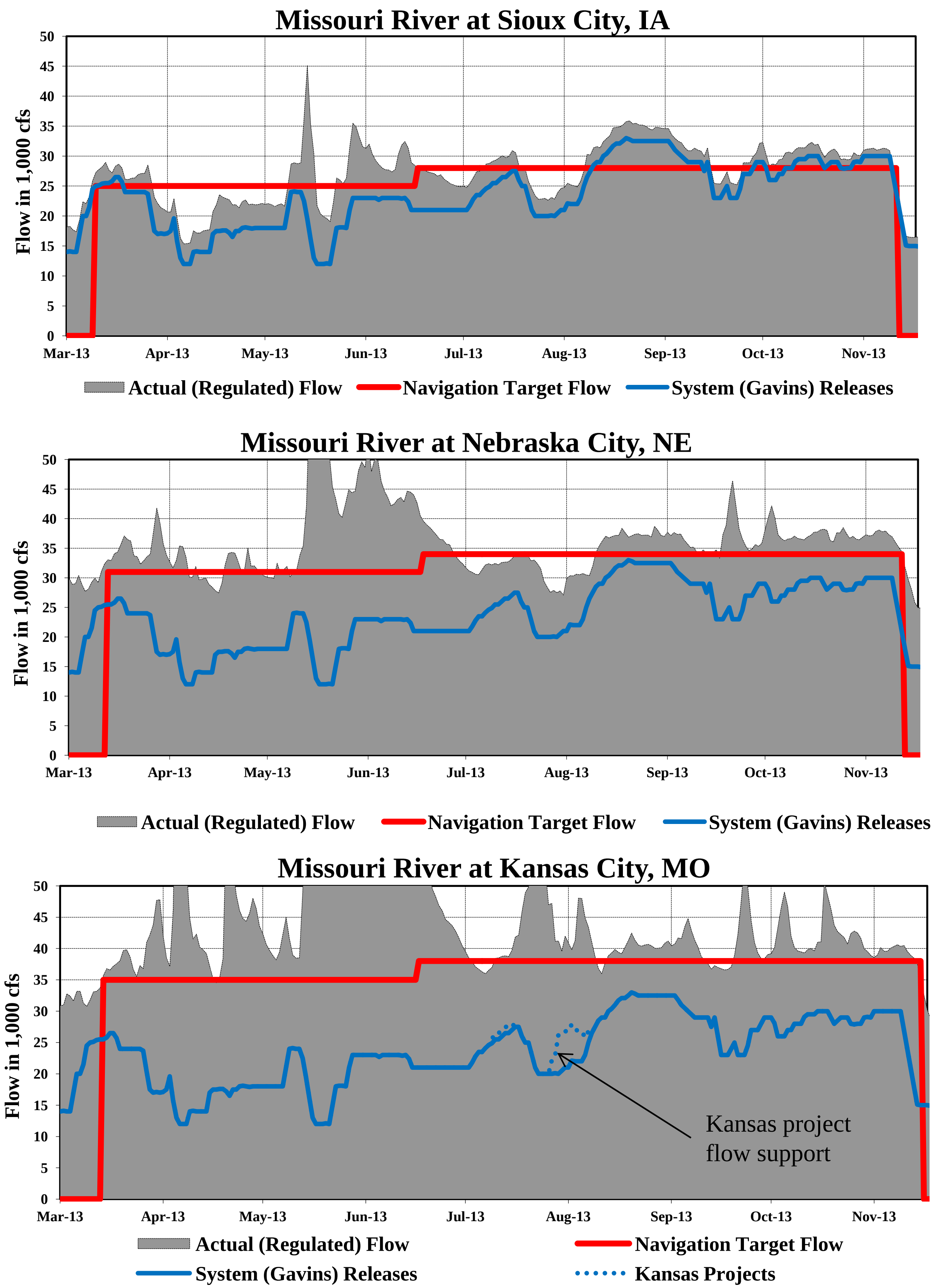


Figure 16. Actual flow, System releases and navigation target flows – Sioux City, IA; Nebraska City, NE and Kansas City, MO (navigation season).

6. Hydropower Generation

The hydropower energy generated by the System is transmitted over a Federal transmission system that traverses 7,886 circuit miles. During 2013, service was provided to over 360 wholesale customers. Customers receiving service includes 200 municipalities, 3 Federal agencies, 30 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.

Per the Omaha Public Power District (OPPD) statistics, the average OPPD customer uses approximately 11,650 kilowatt hours (kWh) of energy annually. Based upon the total System generation of 7.6 billion kWh, the energy generated in 2013 by this portion of the Federal power system could have supplied all of the yearly needs of about 650,000 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 meet full load in five minutes or less. Large coal-fired and nuclear units are reinforced by idle hydropower units, typically in five minutes or less. Outside utilities benefit through reserve sharing by calling on the hydropower capability within several minutes of a known problem. 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 excellent reliability of System hydropower is indicated by having to maintain adequate reserves in both the Northwest Power Pool in the Western Upper Great Plains West Region and South-West Power Pool Reserve Share Group in the Western Upper Great Plains East Region. 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 2013 was 7.6 billion kWh, which was 81 percent of average since the System first filled in 1967. The 2013 generation was 2.8 billion kWh less than the 2012 generation of 10.4 billion kWh and 2.7 billion kWh more than the record low of 4.9 billion kWh, set in 2008. Generation was below average in 2013 due to decreased releases from the System projects to support less than full navigation service level flows for the year along with higher tributary flows downstream of Gavins Point as drought conditions largely improved. Western purchased about 3.7 billion kWh between January 1 and December 31 at a cost of $119.9 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 17***. The total generation from the Federal system (peak capacity and energy sales) for 2013 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, Pick-Sloan Missouri Basin Program (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.

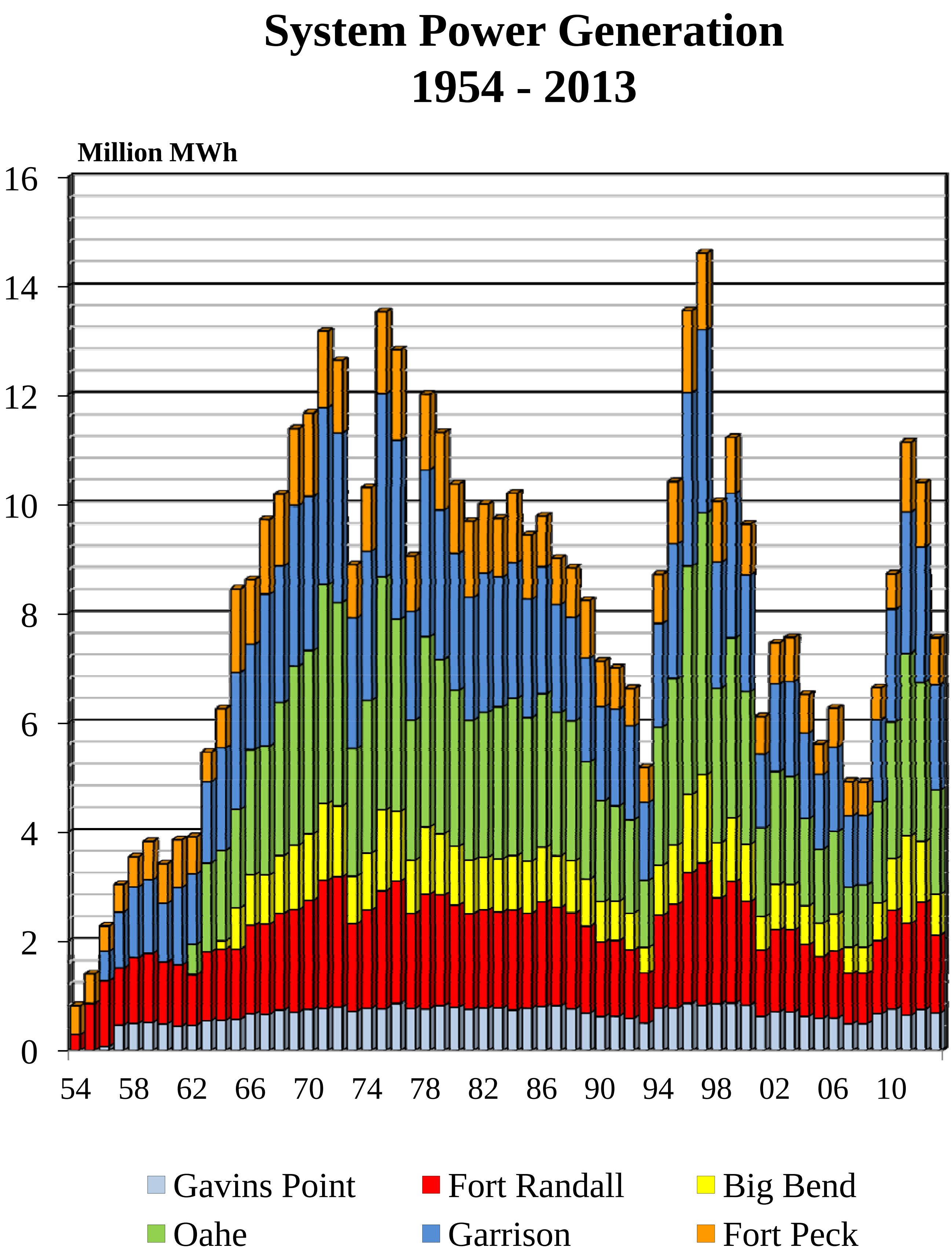


Figure 17. System power generation by project from 1954 to 2013.

Table 18
Gross Federal Power System Generation, Upper Missouri River Basin
January 2013 through December 2013

	Energy Generation 1000 kWh	**Peak Hour kW**	**Generation Date**
Corps Powerplants – Missouri River Mainstem System			
Fort Peck	872,323	186,000	January 12
Garrison	1,919,490	468,000	August 28
Oahe	1,907,853	657,000	September 1
Big Bend	749,636	470,000	August 28
Fort Randall	1,425,686	346,000	August 28
Gavins Point	688,471	117,000	September 17
Corps Subtotal	**7,563,458**	**2,151,000**	August 28
USBR Powerplants			
Canyon Ferry	266,162	51,000	February
Yellowtail*	237,172	79,500	December
USBR Subtotal	**503,334**	**130,500**	
Federal System Total	**8,066,792**	**2,281,500**	

* 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, 2013 through December 31, 2013

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	1,576		73		1,649		853		2,502	Jan 22	700
February	1,389		79		1,468		619		2,087	Feb 04	900
March	1,505		66		1,571		394		1,965	Mar 25	800
April	1,428		67		1,495		195		1,690	Apr 01	800
May	1,315		69		1,384		129		1,513	May 26	1100
June	1,455		69		1,524		202		1,726	Jun 26	1400
July	1,866		67		1,933		298		2,231	Jul 30	1600
August	2,151		63		2,214		744		2,958	Aug 28	1700
September	1,888		68		1,956		149		2,105	Sep 02	1700
October	1,345		65		1,410		529		1,939	Oct 30	800
November	1,652		61		1,713		763		2,476	Nov 23	1000
December	1,305		61		1,366		1,084		2,450	Dec 20	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, 2013 through December 31, 2013

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	745,167		45,204		790,371		446,100		1,236,471
February	557,120		40,378		597,498		371,542		969,040
March	611,850		41,381		653,231		345,085		998,316
April	567,053		40,360		607,413		234,081		841,494
May	608,358		40,974		649,332		138,041		787,373
June	593,603		42,688		636,291		212,050		848,341
July	725,656		39,678		765,334		234,366		999,700
August	774,247		43,114		817,361		219,246		1,036,607
September	812,394		40,614		853,008		132,724		985,732
October	597,785		43,806		641,591		227,338		868,929
November	590,134		44,844		634,978		389,438		1,024,416
December	491,426		46,400		537,826		649,628		1,187,454

*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 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 2 to 7 feet below average levels through the 2013 recreation season, but average annual runoff above Sioux City and storage conservation measures slightly improved recreation access.

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).

At the time this report was being prepared, visitation data was only available for the January through September period of 2012. Furthermore, the standard method used by the Corps to determine visitation hours is under revision; therefore, no data is available for 2013. The annual visitation data will be updated when the 2013 data becomes available. Visitor attendance figures at the System reservoirs from 2008 through 2012 are shown in ***Table 21***. ***Figure 18*** 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 18*** 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 18*** 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 Missouri River Mainstem System Reservoirs (Visitor Hours)

System Project	2009	2010	2011	2012*	2013**
Fort Peck	5,820,400	6,173,900	6,455,300	6,666,900	n/a
Garrison	13,773,900	15,698,700	14,190,300	15,233,400	n/a
Oahe	9,322,300	9,503,100	6,964,900	10,863,700	n/a
Big Bend	3,210,200	3,346,500	2,528,100	2,651,700	n/a
Fort Randall	1,030,900	1,067,000	1,108,500	860,300	n/a
Gavins Point	8,880,300	9,410,000	10,737,500	8,877,500	n/a
System Total	**42,038,100**	**45,199,200**	**41,984,600**	**45,153,500**	n/a

*2012 Visitor hours are for January to September only.
**Data is not available due to a change in the visitation hour method.

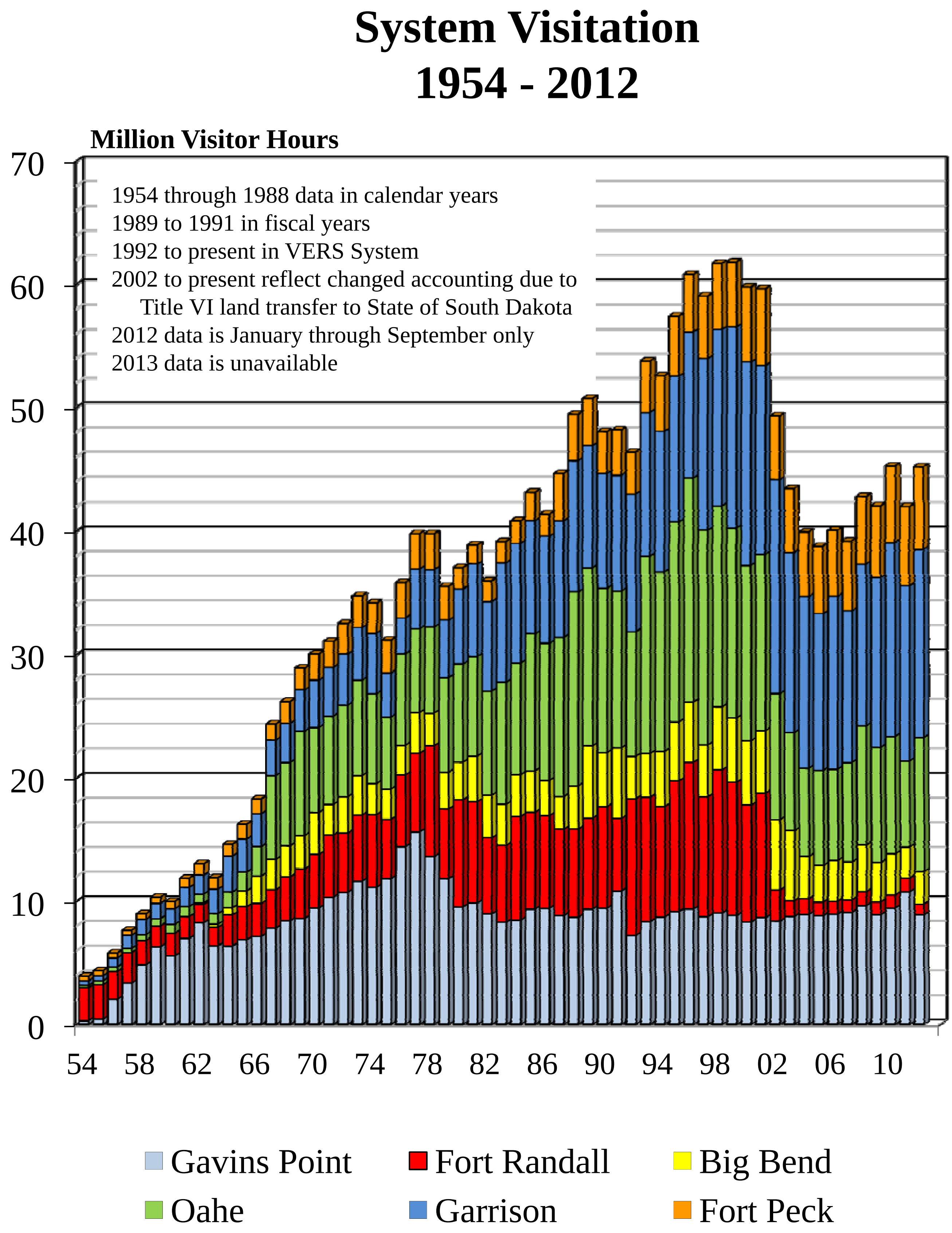


Figure 18. System visitation by project from 1954 to 2012 (2013 data is unavailable).

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 1.0 foot deep and are subject to desiccation through wave action and slight drops in water level.

Forage fish production in the upper three reservoirs was again a concern in 2013, because of high entrainment experienced during the flood of 2011 coupled with lower reservoir levels in 2012. Rising reservoir pools were attained in Fort Peck, Garrison and Oahe 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

The bimodal spring pulse from Gavins Point was not conducted in 2013, 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 needs 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 reservoirs.

During 2013, a revised sampling design was implemented based on a sub-sampling of river reaches. With the concurrence of the USFWS, reservoirs were not surveyed; therefore, survey results cannot be directly compared to results presented previously in this summary report. A detailed description of the factors affecting tern and plover nesting, fledge ratios and habitat conditions and creation activities can be found in the Missouri River Recovery Program 2013 (MRRP 2013) Annual Report (*www.moriverrecovery.org*). The report was made available in April 2014.

The population distribution and productivity for terns and plovers for 1986 through 2012 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. Results for 2013 are not comparable to the results in this table because of the change in survey methodology. The estimates can be found in the MRRP 2013 Annual Report.

Table 22
Missouri River System
Interior Least Tern Survey Data

		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013***
Fort Peck Lake																													
	Adults	-	4	3	4	6	10	0	7	9	2	0	0	4	0	0	0	0	2	0	0	2	2	0	0	0	0	0	
	Fledglings/Pair	-	-	0	3.00	-	0.40	{}	0	0.44	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0		
Fort Peck to Lake Sakakawea																													
	Adults	-	-	18	48	92	66	110	31	58	95	128	162	25	40	13	39	34	38	48	34	36	77	22	46	26	0	0	
	Fledglings/Pair	-	-	0.33	0	0.17+	0.55+	0.25+	0.45+	1.41+	0.99+	0.33	0.53	.1.52	1.70	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	
Lake Sakakawea																													
	Adults	-	-	7	15	6*	8	29+	17	35	7	27	2	23	9	10	34	21	25	16	26	48	53	14	15	11	3	14	
	Fledglings/Pair	-	-	0	0	-	-	0.83+	0.12+	0	0	0.15	0	1.04	0.67	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	
Garrison to Lake Oahe																													
	Adults	171	175	142	121	174	195	198	145	217	284	105	41	141	105	105	125	126	144	142	157	139	123	73	108	134	0	105	
	Fledglings/Pair	-	-	0.93	0.43	0.44+	0.58	0.48	0.28	0.54	0.91	0.08	0.39	1.52	1.50	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	
Lake Oahe/Lake Sharpe																													
	Adults	16*	21*	82	97	100	143	124	125	160	84	74	101	110	57	85	94	106	70	73	131	128	186	111	71	48	39	100	
	Fledglings/Pair	0.75	1.62	0	0	-	-	0.42	0	0.06	0	0.24	0.16	1.29	0.88	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	
Ft. Randall to Niobrara																													
	Adults	25	60	0	4	26	32	13	38	43	10	2	0	64	124	72	71	84	50	71	76	55	74	58	23	10	0	87	
	Fledglings/Pair	0.48	0.43	0	0	0.31+	0.63	0.46	0	0	0	0	0	0.94	1.03	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	
Lake Lewis and Clark																													
	Adults	0	0	45	29	63	55	29	76	44	16	28	60	120	76	44	58	46	46	13	4	0	85	225	214	272	231	211	
	Fledglings/Pair	-	-	0.13	0.62	0.35+	0	1.59	0.97	0	0	0	1.57	2.33	0.21	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	
Gavins Point to Ponca																													
	Adults	181	232	252	210	167	193	187	272	211	93	82	115	148	161	149	232	314	366	359	476	383	410	278	211	159	0	209	
	Fledglings/Pair	0.26	0.46	0.49	0.55	0.46+	0.26	0.21	0.83	0.48	0.49	0.27	0.90	2.27	2.41	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	
Total Adults		393	492	549	528	634	702	690	711	777	591	446	481	635	572	551	653	731	741	722	904	802**	1,010	781	696	650	273	726	
Fledglings/Pair		0.26	0.46	0.59	0.54	0.38	0.41	0.42	0.50	0.41	0.67	0.21	0.66	1.73	1.42	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	

5-Year Running Average Interior Least Tern Fledge Ratio Goal = 0.94

-   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 MRRP Annual report for 2013

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.

Table 23
Missouri River System
Piping Plover Survey Data

		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013**
Fort Peck Lake																													
	Adults	16	10	20	12	22	25	26	30	4	5	0	0	4	2	0	4	2	17	9	26	20	16	9	12	3	2	0	
	Fledglings/Pair	-	-	1.70	1.50	3.18	1.20	1.00	0.60	1.50	1.20	0	0	0	2.00	0	1	2	0.35	2.22	1.08	1.2	0.5	0.22	0.33	0	0	0	
Fort Peck to Lake Sakakawea																													
	Adults	-	-	5	11	17	13	0	4	9	20	24	23	4	5	4	3	2	6	0	2	5	0	0	0	0	0	0	
	Fledglings/Pair	-	-	0	0.18	0	0	{}	0+	0	3.50	1.00	0.87	1.00	0	0	1.33	0	2.67	0	4	0.4	0	0	0	0	0	0	
Lake Sakakawea																													
	Adults	-	-	143	57	132	150	108	8	45	24	70	3	119	83	277	424	469	528	738	746	430	399	363	85	38	24	200	
	Fledglings/Pair	-	-	0	0	-	-	1.50	8.5+	1.24	0	0.57	0.67	1.24	1.25	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	
Garrison to Lake Oahe																													
	Adults	139	160	113	84	71	124	77	127	119	261	45	6	74	139	99	149	119	149	164	220	175	222	218	275	287	0	98	
	Fledglings/Pair	-	-	0.97	0.26	1.04+	1.13+	1.06+	0.54+	0.87	0.87	0.09	0	1.84	0.88	1.41	1.53	2.03	1.66	1.16	0.8	0.77	0.97	1.37	0.94	0.84	0	1	
Lake Oahe/Lake Sharpe																													
	Adults	4*	4*	55	140	88	87	143	66+	85	30	21	31	98	46	141	184	203	301	372	364	331	273	281	158	44	20	125	
	Fledglings/Pair	-	2.50*	0	0	-	-	0.97+	0.33	0.09	0.93	0.29	1.29	1.06	0.30	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	
Ft. Randall to Niobrara																													
	Adults	11	16	0	0	12	25	8	12	17	0	3	0	33	51	62	38	35	37	42	42	37	21	26	16	6	0	43	
	Fledglings/Pair	0.18	0.13	0	0	0.67*	0.48	0.75	0	0	0	0	0	1.27	1.02	0.87	0.74	1.03	1.46	0.71	0.81	0.38	0	1	1	0	0	1.81	
Lake Lewis and Clark																													
	Adults	0	0	31	18	30	33	6	32	12	4	6	32	84	67	28	34	44	14	0	24	4	20	57	122	152	134	179	
	Fledglings/Pair	-	-	0.06	0.56	0.67+	0	0	0.06	0.33	0	0	1.25	2.45	0.30	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	
Gavins Point to Ponca																													
	Adults	172	177	212	122	148	166	112	109	62	63	22	22	49	141	186	218	260	286	262	340	309	300	320	238	74	2	137	
	Fledglings/Pair	0.05	1.13	0.62	0.21	0.39+	0.35	0.34	1.06	0.61	0.16	0	0	2.20	1.60	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	
Total Adults		342	367	579	444	521	623	480	388	353	407	191	117	465	534	797	1054	1134	1338	1587	1764	1311	1251	1274	906	604	182	782	
Fledglings/Pair		0.06	1.08	0.73	0.32	0.76	0.62	0.94	0.76	0.61	0.84	0.39	0.87	1.61	1.01	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	

10-Year Running Average Piping Plover Fledge Ratio Goal = 1.22

- 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 MRRP Annual report for 2013

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.

9. Cultural Resources

As acknowledged in the 2004 Programmatic Agreement (PA) for the Operation and Management of the Missouri River Mainstem 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 for protection of historic properties. The objective of the 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 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 were held during the 2013 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 17, 2013, was sent to the Missouri River Basin Tribes offering consultation on the 2013-2014 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. The meetings scheduled for October were canceled due to a lapse in Federal appropriations. In lieu of the public meetings, a conference call was held in late October to discuss plans for regulating the reservoir system in the upcoming year. No tribal request or input has been received as a result of the conference call.

Additionally, the Corps actively addresses shoreline erosion which can damage or significantly alter cultural resource sites. During the 2013 reporting period, Omaha District began four large cultural resource shoreline protection projects: three on the Fort Randall Project and one on the Big Bend Project.

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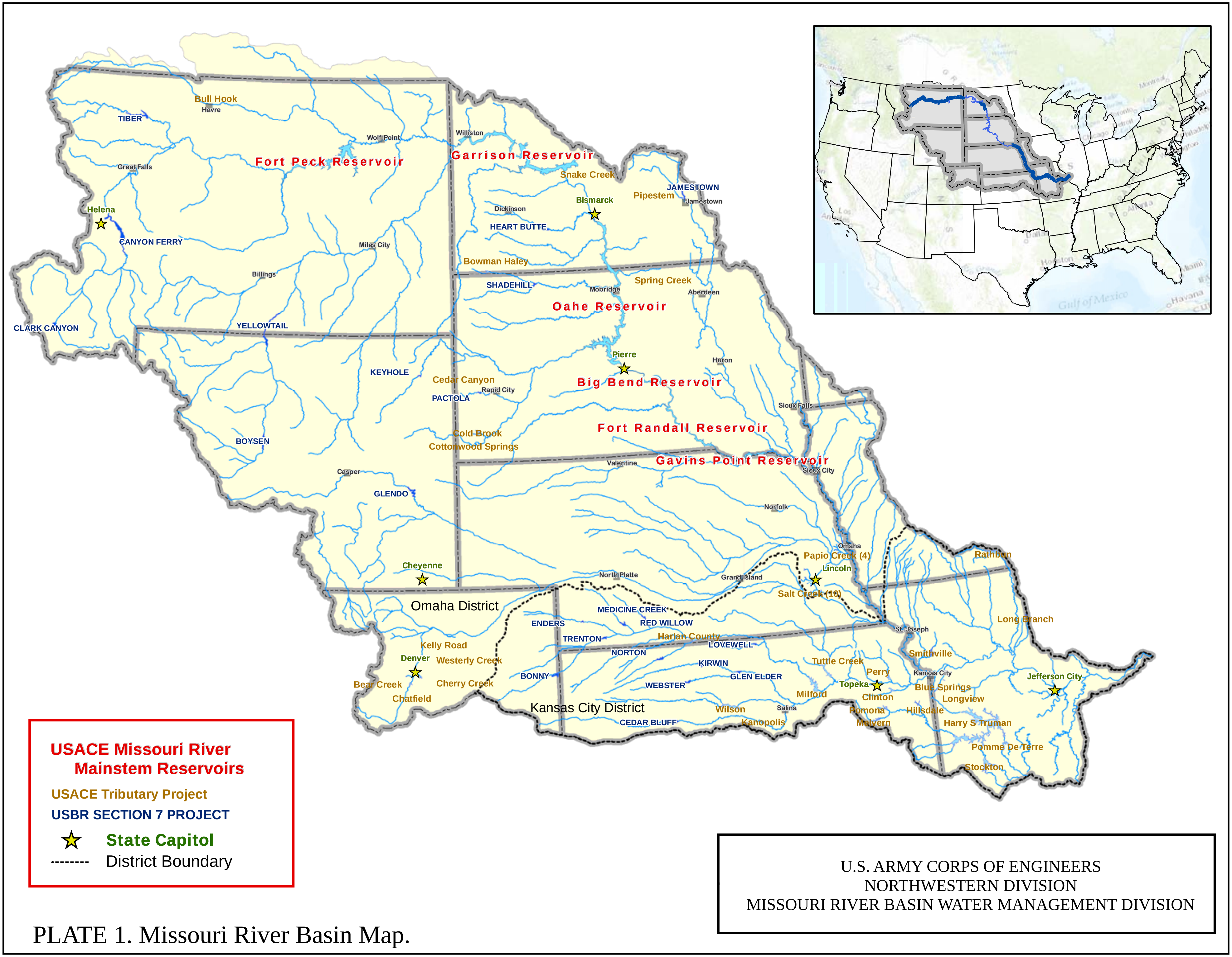


PLATE 1. Missouri River Basin Map.

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 241,000 acres	1854 msl 380,000 acres	1620 msl 374,000 acres
27	Max. normal op. pool elev. & area	2246 msl 234,000 acres	1850 msl 364,000 acres	1617 msl 360,000 acres
28	Base flood control elev & area	2234 msl 210,000 acres	1837.5 msl 307,000 acres	1607.5 msl 312,000 acres
29	Min. operating pool elev. & area	2160 msl 89,000 acres	1775 msl 128,000 acres	1540 msl 117,000 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	15,600 a.f. 1180 yrs.	21,600 a.f. 1080 yrs.	17,800 a.f. 1560 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	1670-1680 15,000- 60,000 cfs	1423-1428 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)	1,048	2,259	2,641
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

.

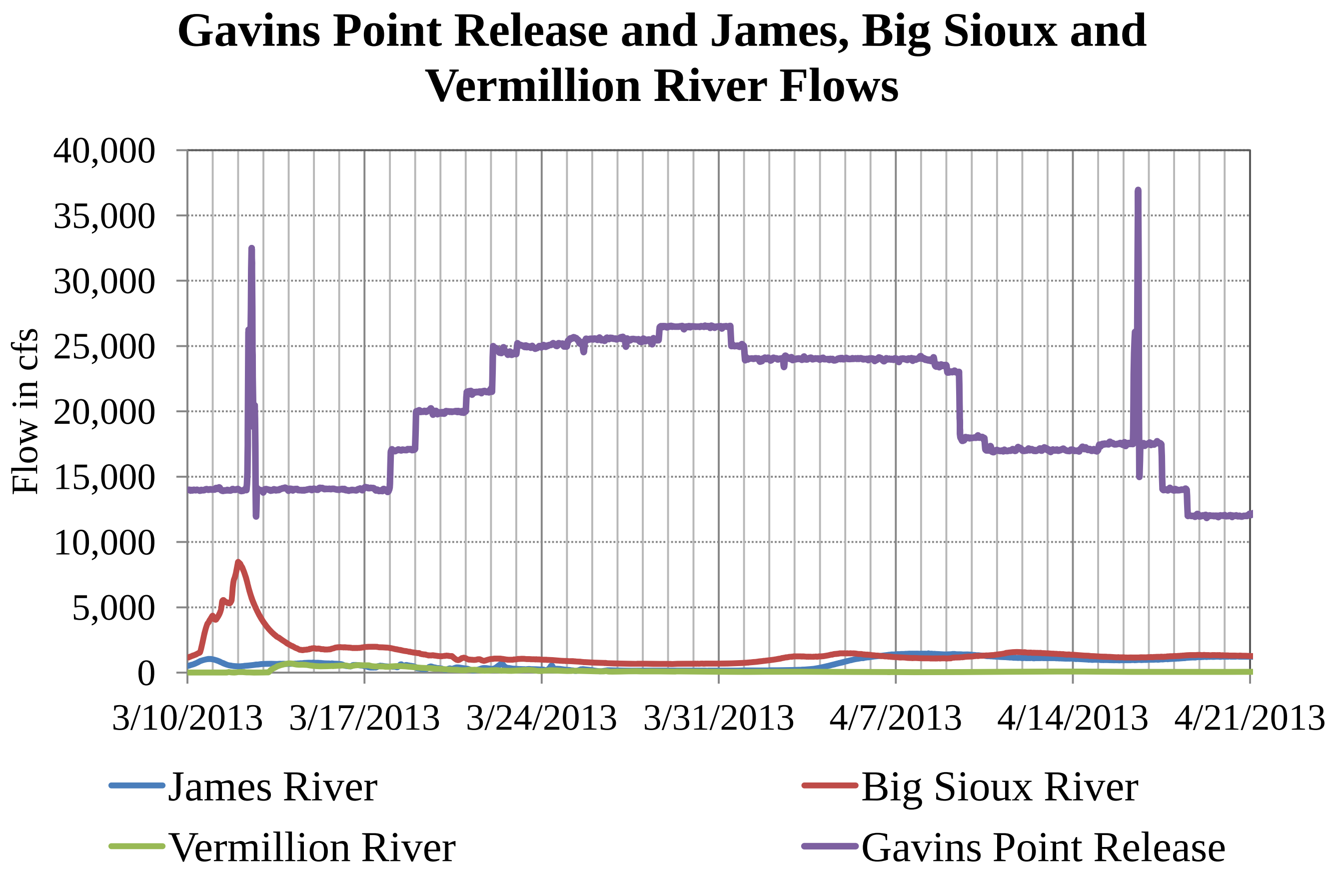
Summary of Engineering Data -- Missouri River Mainstem System

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 30,000 acres	1,188,000 acres	26
1422 msl 60,000 acres	1365 msl 95,000 acres	1208 msl 27,000 acres	1,140,000 acres	27
1420 msl 57,000 acres	1350 msl 77,000 acres	1204.5 msl 23,000 acres	986,000 acres	28
1415 msl 51,000 acres	1320 msl 38,000 acres	1204.5 msl 23,000 acres	446,000 acres	29
1423-1422 60,000 a.f.	1375-1365 986,000 a.f.	1210-1208 54,000 a.f.	4,673,000 a.f.	30
1422-1420 117,000 a.f.	1365-1350 1,306,000 a.f.	1208-1204.5 79,000 a.f.	11,625,000 a.f.	31
	1350-1320 1,532,000 a.f.		38,536,000 a.f.	32
1420-1345 1,621,000 a.f.	1320-1240 1,469,000 a.f.	1204.5-1160 295,000 a.f.	17,582,000 a.f.	33
1423-1345 1,798,000 a.f.	1375-1240 5,293,000 a.f.	1210-1160 428,000 a.f.	72,416,000 a.f.	34
November 1963	January 1953	August 1955		35
25 March 1964	24 November 1953	22 December 1955		36
5,300 a.f. 340 yrs.	15,800 a.f. 340 yrs.	2,600 a.f. 160 yrs.	78,700 a.f.	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			43
1351-1355(10) 25,000-100,000 cfs	32,000 cfs - 128,000 cfs 1228-1239 5,000-60,000 cfs	1155-1163 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
986	1,733	726	9,367 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) 1967-2012 Average
(13) Source: Annual Report on Civil Works Activities of the Corps of Engineers. Extract Report Fiscal Year 1999.
(14) Based on Study 8-83-1985

Corps of Engineers, U.S. Army
Compiled by
Northwestern Division
Missouri River Region
August 2013



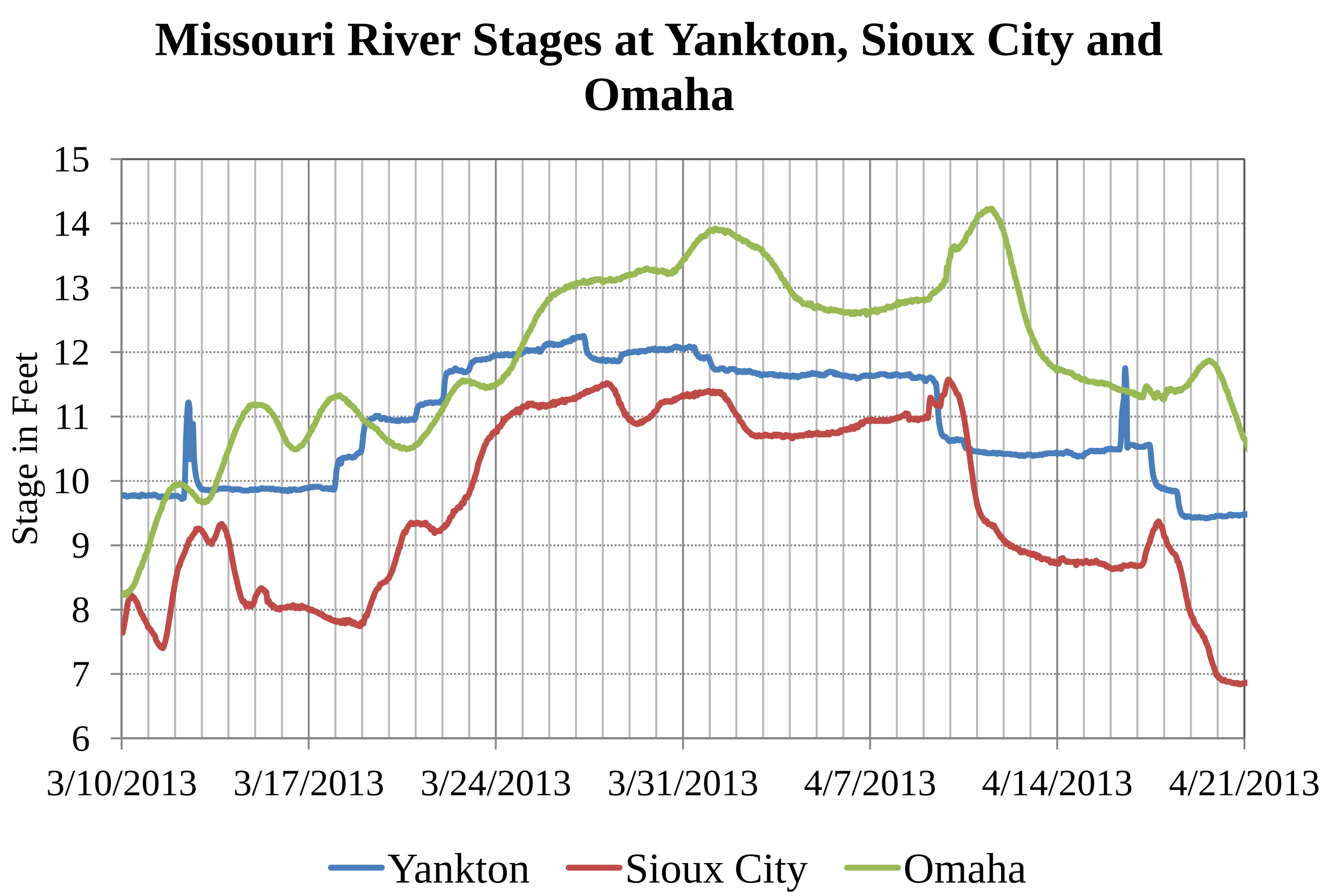


Plate 3. Gavins Point Spillway Slab Assessment – Downstream Flows and Stages

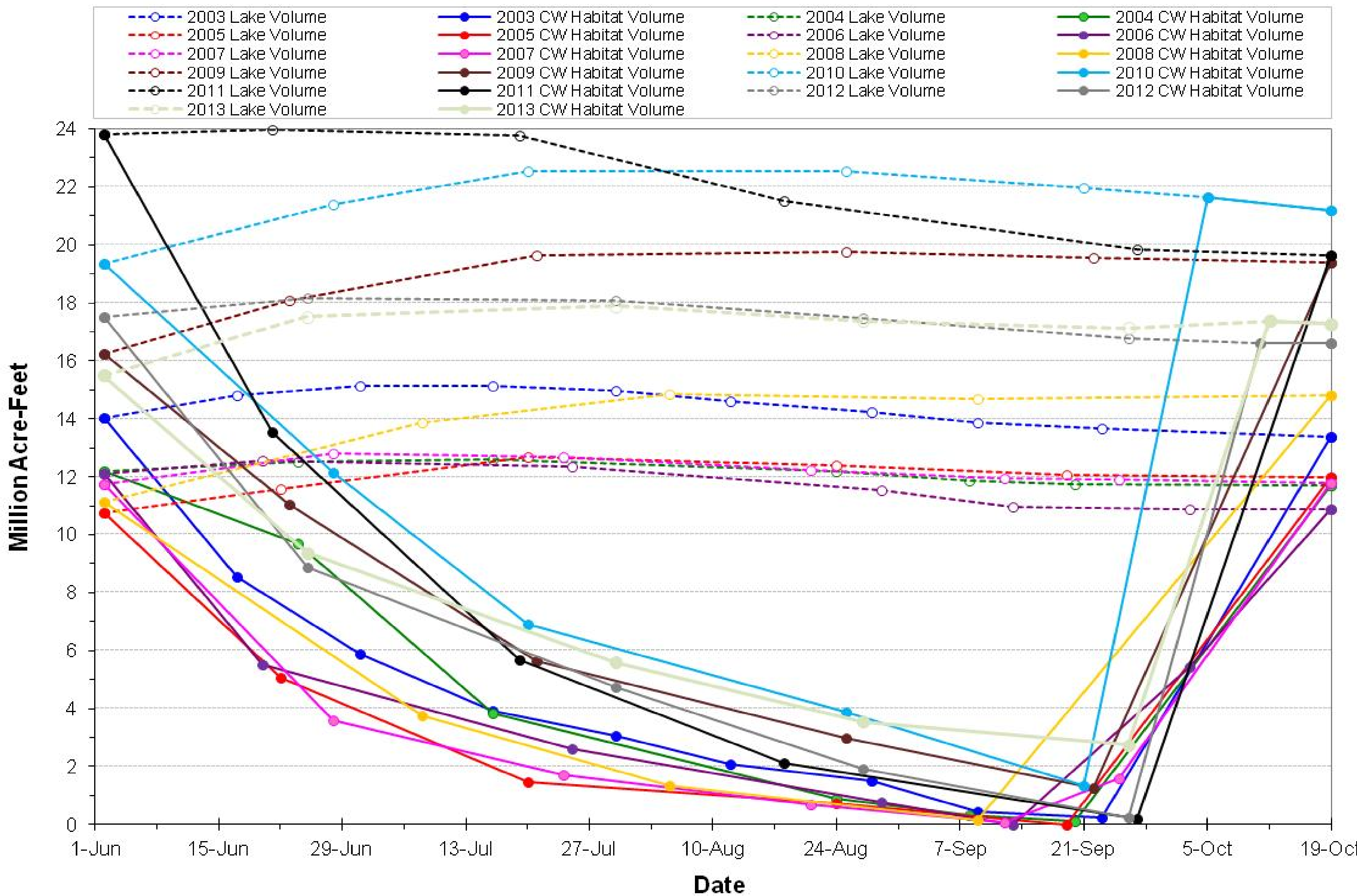


Plate 4. Garrison Reservoir - estimated reservoir and coldwater habitat 2003 through 2013.

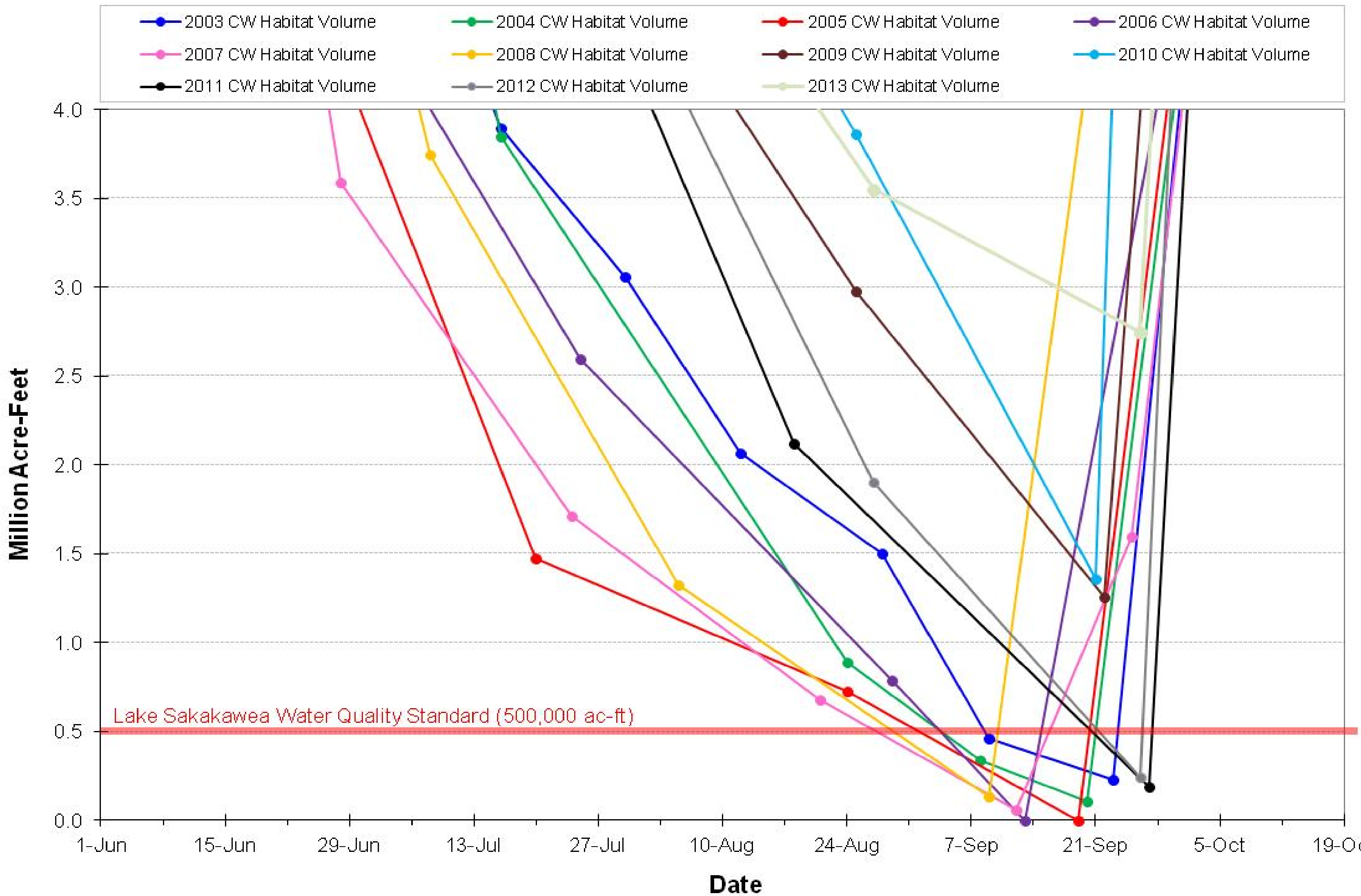


Plate 5. Garrison Reservoir - estimated reservoir and coldwater habitat 2003 through 2013 (exploded view).

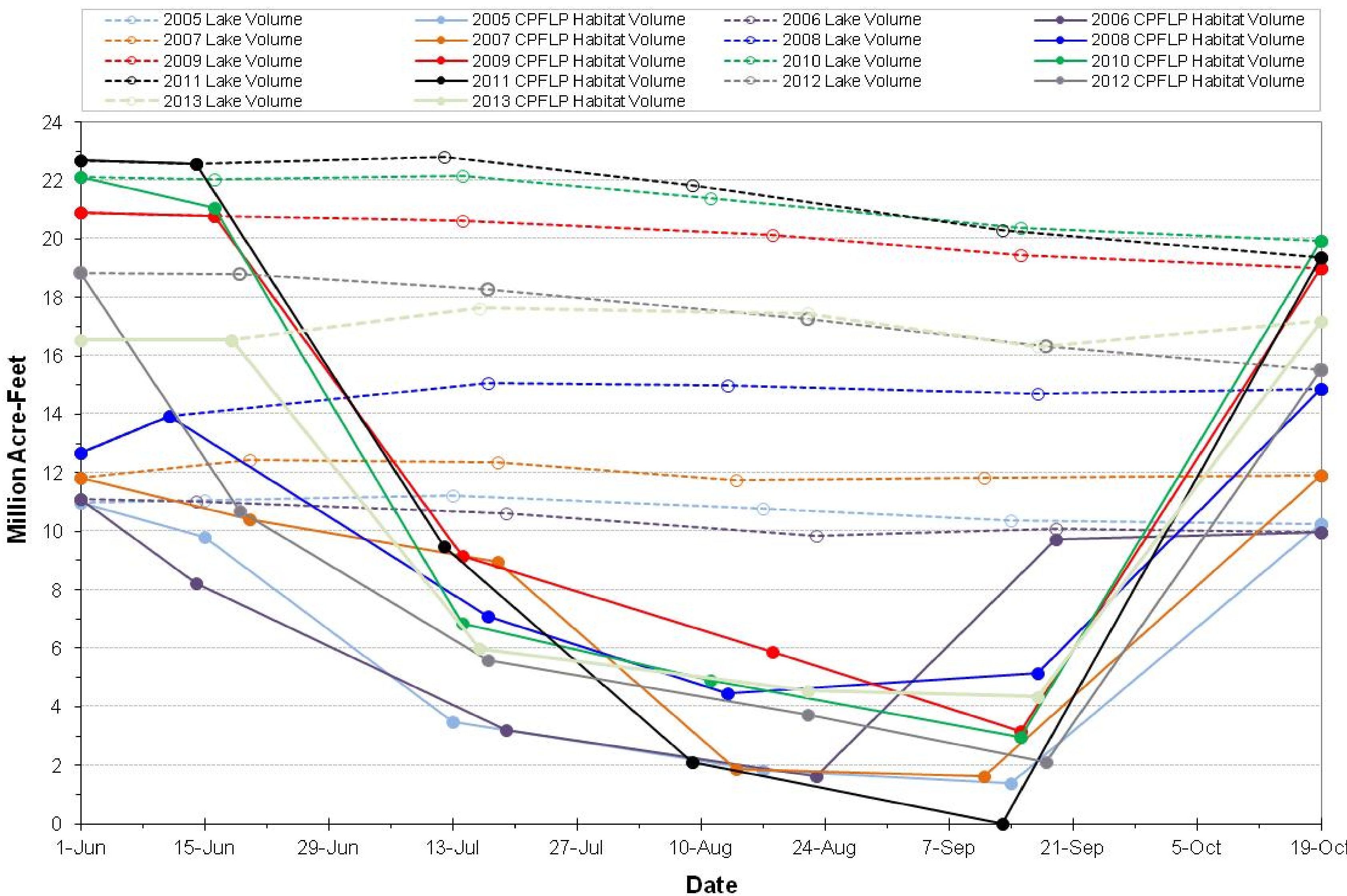


Plate 6. Oahe Reservoir - estimated reservoir and coldwater habitat 2005 through 2013.