US Army Corps
of Engineers

Northwestern Division

Missouri River Mainstem Reservoir System

Summary of Actual 2010 Regulation

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

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LIST OF ABBREVIATIONS AND ACRONYMS

ACHP	Advisory Council on Historic Preservation
AOP	annual operating plan
AF	acre-feet
B	Billion
BiOP	2003 Amended Biological Opinion
BOR	U.S. Bureau of Reclamation
cfs	cubic feet per second
COE	Corps of Engineers
Council	National Council Lewis and Clark Expedition Bicentennial
CWA	Clean Water Act
CY	calendar year (January 1 to December 31)
DMS	Data Management System
EA	Environmental Assessment
EIS	Environmental Impact Statement
elev	elevation
ESA	Endangered Species Act of 1973
ft	feet
ft msl	feet above mean sea level
FTT	Flow-to-Target
FY	fiscal year (October 1 to September 30)
GIS	Geographic Information System
GWh	gigawatt hour
KAF	1,000 acre-feet
Kcfs	1,000 cubic feet per second
kW	kilowatt
kWh	kilowatt hour
M	million
MAF	million acre-feet
MISO	Midwest Independent Transmission System Operator
MRBA	Missouri River Basin Association
MRNRC	Missouri River Natural Resources Committee
MRBWM	Missouri River Basin Water Management
msl	mean sea level
MV	motor vessel
MW	megawatt
MWh	megawatt hour
M&I	municipal and industrial
NEPA	National Environmental Policy Act
NOHRSC	National Operational and Hydrologic Remote Sensing Center
OPPD	Omaha Public Power District
PA	2004 Programmatic Agreement

LIST OF ABBREVIATIONS AND ACRONYMS (cont'd)

plover	piping plover
pp	powerplant
P-S MBP	Pick-Sloan Missouri Basin Program
RM	river mile
ROD	record of decision
Service	U.S. Fish and Wildlife Service
SHPO	State Historic Preservation Officer
SR	Steady Release
SRST	Standing Rock Sioux Tribe
SR-FTT	Steady Release – Flow-to-Target
SWE	snow water equivalent
System	Missouri River Mainstem Reservoir System
tern	interior least tern
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Load
TRO	temporary restraining order
tw	tailwater
T&E	Threatened and Endangered
USBR	U.S. Bureau of Reclamation
USGS	United States Geological Survey
VERS	Visitation Estimation Reporting System
WCSC	Waterborne Commerce Statistics Center
Western	Western Area Power Administration
yr	year

DEFINITION OF TERMS

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

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

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

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

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

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

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

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

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

MISSOURI RIVER MAINSTEM RESERVOIR SYSTEM

Summary of Actual 2010 Regulation

I. FOREWORD

This document contains a summary of the actual regulation of the Missouri River Mainstem Reservoir System (System) for the 2010 Calendar Year (CY). Two other reports related to System regulation are also available, the "System Description and Regulation", and "Final 2009-2010 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 is shown on ***Plate 2*****.**

II. REVIEW OF REGULATION – JANUARY-DECEMBER 2010

A. General

During 2010 the System was regulated in accordance with the Master Water Control Manual (Master Manual) and the applicable provisions of the Final 2009-2010 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 2010 is given in the following paragraphs.

B. Precipitation and Water Supply Available in 2010

The 2010 runoff year marked the third year in a row of above average runoff conditions following the drought of 2000-2007 in the Missouri River basin. Runoff during the 2010 runoff year was 38.7 MAF, 156% of normal, the third highest year of runoff on record (1898-2010). Runoff is discussed in more detail in Section II.B.4 of this report. Reference for average conditions for plains and mountain snowpack, precipitation, and temperature is 1971-2000.

1. Plains Snowpack

At the end of 2009 the Missouri River basin was almost entirely covered by plains snowpack as a result of October and early December snowfall in the plains coupled with colder than normal temperatures. Snow water equivalent (SWE) on December 31, 2009, modeled by NOAA's National Operational and Hydrologic Remote Sensing Center

(NOHRSC), estimated a broad area of two to three inches extending from eastern Nebraska into eastern Montana (***Figure 1***). Three to four inches of SWE existed in northwest Iowa and southeast South Dakota with four to five inches in the headwaters of the Little Sioux River basin in northwest Iowa. Furthermore, three to four inches of SWE were estimated in central North Dakota and South Dakota.

The active winter weather continued into the first week of January with snow occurring in northeast Montana, southern North Dakota, southeast South Dakota, and northwest Iowa. Moderate snowfall occurred again during the last 10 days of the month. Precipitation departures for January in these areas were greater than 200% of average.

Snowfall in the first two weeks of February occurred frequently with overall moderate monthly accumulations from central North Dakota to northwest Iowa. Some monthly accumulations were: 12.6 inches in Bismarck, ND; 11.9 inches in Aberdeen, SD; 18.0 inches in Watertown, SD; 10.2 inches in Pierre, SD; 16.9 inches in Sioux Falls, SD; and 10 inches in Sioux City, IA. At the end of the month NOHRSC SWE estimates showed heavy coverage ranging from four to six inches from western North Dakota through much of South Dakota to northwest Iowa, and three to four inches in surrounding regions of Montana, Nebraska and southwest Iowa (see ***Figure 2***). Some areas in the headwaters of the Big Sioux River and the Little Sioux River basins had six to eight inches of SWE.

At the beginning of March, average daily temperatures were below freezing in the Dakotas. However, by March 5 average daily temperatures rose above freezing as far north as Williston and Bismarck, ND, initiating the plains snowmelt. In southeast Nebraska, southern Iowa, and Missouri, the plains snowpack began to melt March 6 and finished on March 10. Some additional snow accompanied by rain occurred in central North Dakota with mostly rain in South Dakota. March 15 plains snowpack (see ***Figure 3***) modeled by NOHRSC indicated that five to six inches of SWE existed in a large portion of North Dakota, the northern half of South Dakota, and portions of northwest Iowa and southwest Minnesota. The plains snow finished melting on March 18 at Sioux Falls, on March 22 at Aberdeen and Pierre, on March 26 at Jamestown, and on March 29 at Bismarck. The melt occurred gradually due to slowly increasing temperatures, resulting in moderate soil infiltration and more manageable runoff rates than occurred in 2009.

2. Mountain Snowpack

a. Fall 2009

In Montana, the mountain snowfall season was quite variable early, but statewide mountain SWE was above average early in the season and then fell below average beginning mid-December. December precipitation was 69% of normal. Mountain SWE was 82% of average.

In Wyoming, mountain SWE across the state was 76% of average. In December, mountain precipitation in the state ranged from 39% of average to 131% of average.

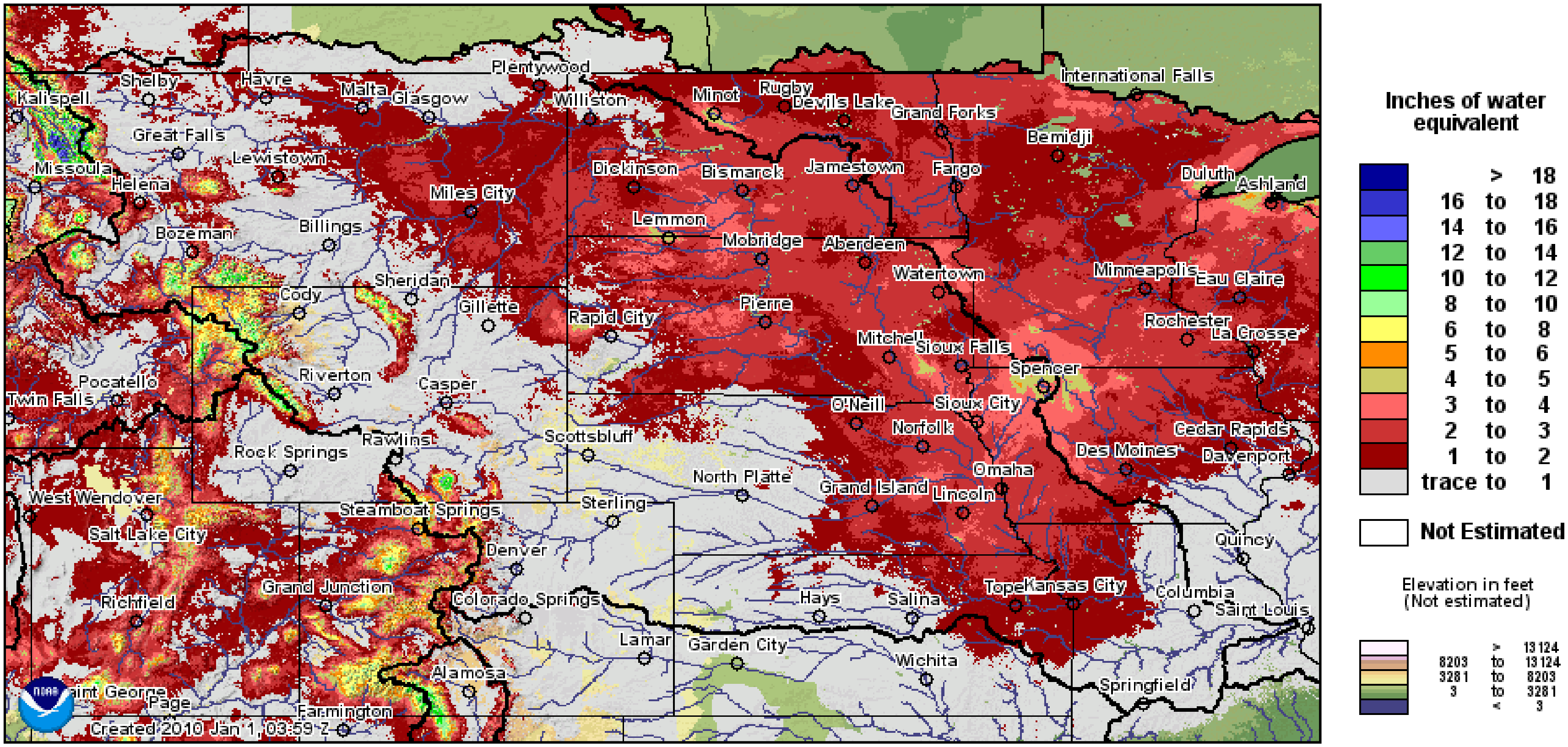


Figure 1. December 31, 2009 plains snow water equivalent (inches) modeled by NOAA NOHRSC.

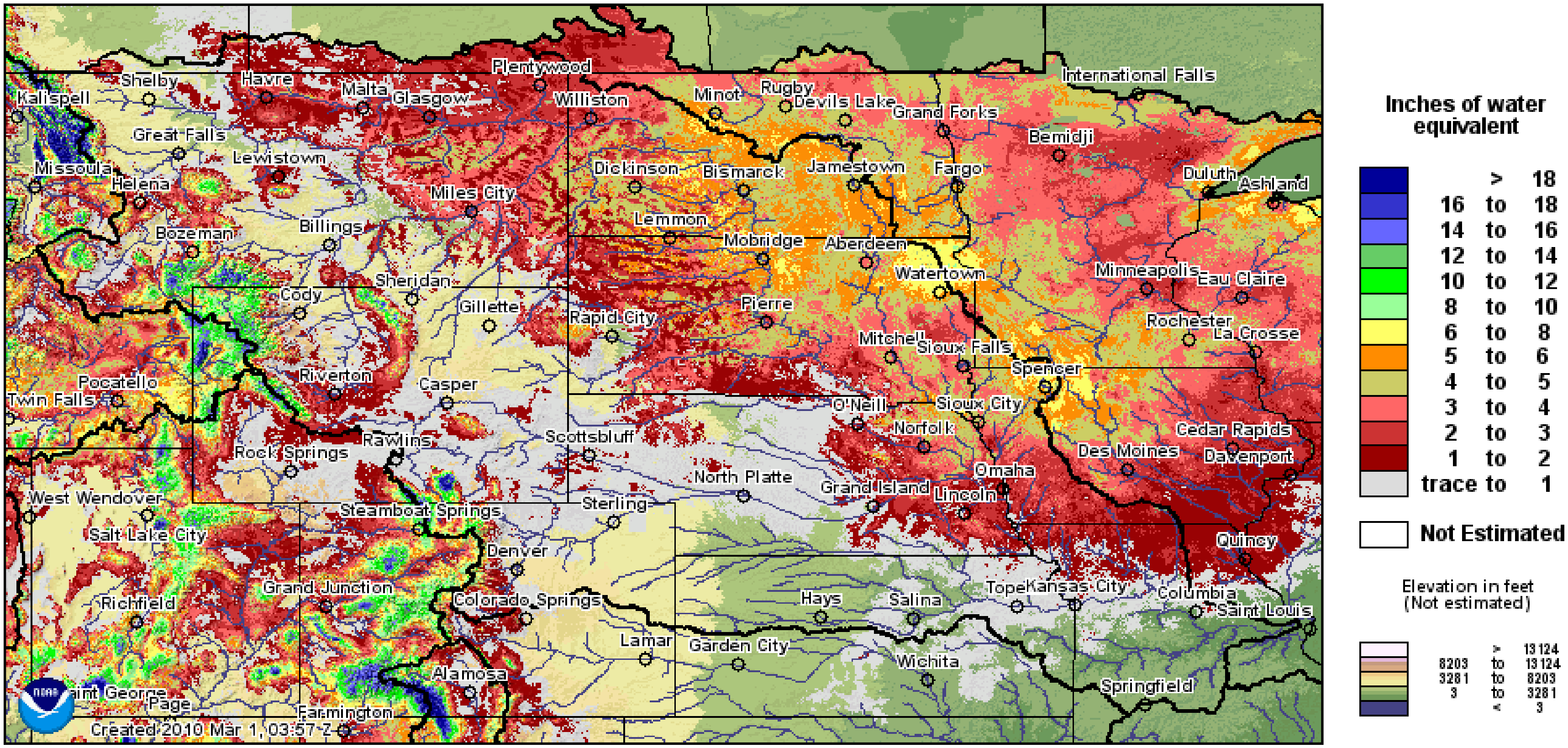


Figure 2. February 28, 2010 plains snow water equivalent (inches) modeled by NOAA NOHRSC.

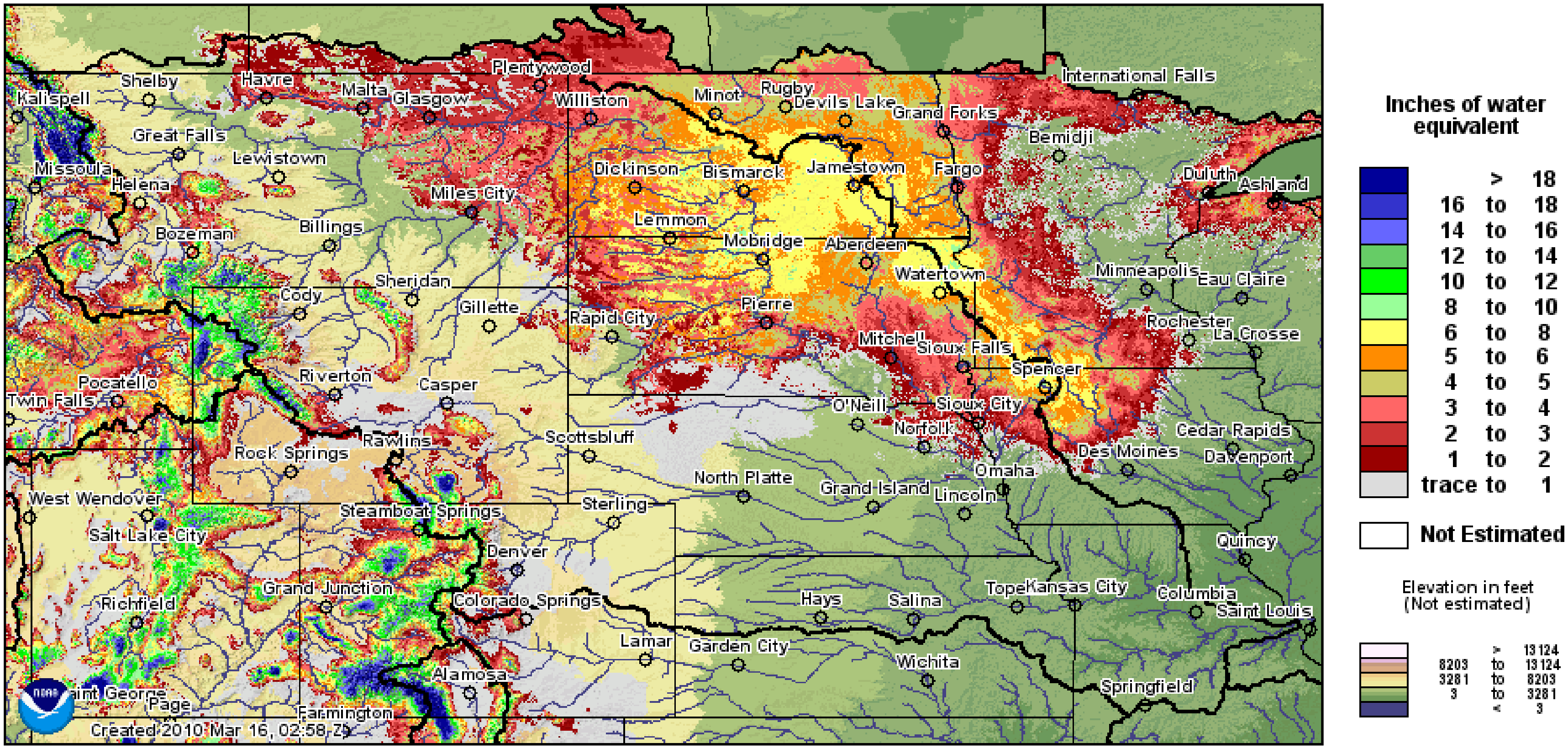


Figure 3. March 15, 2010 plains snow water equivalent (inches) modeled by NOAA NOHRSC.

The 2009 year ended with the mountain SWE 86% of average in the reach above Fort Peck and 80% of average in the reach from Fort Peck to Garrison.

b. January 2010

In Montana, January mountain precipitation was 98% of average. At the end of January, Montana mountain SWE was 93% of average. Normally about 60% of the seasonal snowpack is in place by the end of January.

Generally, the SWE across Wyoming was below average for January. The SWE in the northwestern portion of the state was about 62% of average, and the northeastern portion of the state was 75% of average. The southeastern area was 81% of average and the southwestern area was 66% of average.

The month of January ended with the mountain snowpack 80% of average in the reach above Fort Peck and 72% of average in the reach from Fort Peck to Garrison.

c. February 2010

In Montana, February mountain precipitation was 45% of average. Statewide snowpack was 68% of average. Even though the overall snowpack was below average, a couple of small basins, including the Milk, Smith, Judith and Musselshell River basins, were above average.

In Wyoming, February precipitation was below average across most of Wyoming. The SWE across the state were near average for February, at 71% of average. The SWE varied from 57% of average in the northwestern portion of the state to 83% in southeastern Wyoming.

The month of February ended with the mountain SWE 73% of average in the reach above Fort Peck and 69% of average in the reach from Fort Peck to Garrison.

d. March 2010

In Montana, mountain precipitation during March was 64% of average. March was the fifth consecutive month with below to well below average mountain precipitation. Mountain SWE statewide was 65% of average.

During March, precipitation was below average across most of Wyoming. The mountain SWE across Wyoming was below average at 73% of average. The SWE in the northwestern portion of the state was only 59% of average, and the northeastern portion was 76% of average. The mountain SWE in the southeast and southwest areas was 87% and 68% of average, respectively.

The month of March ended with the mountain SWE 71% of average in the reach above Fort Peck and 70% of average in the reach from Fort Peck to Garrison.

e. April 2010

In Montana, mountain precipitation during April was 129% of average. April mountain precipitation was the wettest month since October 2009. As a result, mountain SWE increased in April to 68% of average.

Generally, the SWE across Wyoming was below average for April, about 74% of average. Across the state SWE was 64%, 68%, and 70% in the northwest, northeast, and southwest portions of the state, respectively. Mountain SWE was 93% in the southeast part of Wyoming. April's precipitation was above average across most of Wyoming.

The month of April ended with the mountain snowpack at 71% of average in both the reach above Fort Peck and the reach from Fort Peck to Garrison. Snowpack peaked at 77% of the average April 15 peak on April 15 for the reach above Fort Peck.

f. May 2010

In Montana, May mountain precipitation was 133% of average. May's cool wet weather contributed to the mountain snowpack conditions for the Fort Peck to Garrison reach. Mountain SWE ended the month 112% of average.

The SWE across Wyoming was above average at 124%. The SWE in the northwestern portion of the state was 100% of average and the northeastern portion was 105% of average. The southeast and southwest areas were 121% and 105% of average, respectively. May's precipitation was above average across all of Wyoming.

The month of May ended with the mountain SWE 67% of the average April 15 peak in the reach above Fort Peck and 71% of the average April 15 peak in the reach from Fort Peck to Garrison. In the Fort Peck to Garrison reach, mountain SWE peaked at 88% of the average April 15 peak on May 13.

g. Summary

Over the course of the winter season, the mountain snowpack began just above average until early December, when it fell below average and remained there for the season. A cool and wet April and May revived the snowpack accumulation in the reach from Fort Peck to Garrison and delayed the peak mountain SWE until May 13, almost one month from the average April 15 peak. The mountain SWE in the reach between Fort Peck and Garrison peaked on May 13 at 88% of the average peak accumulation. The above Fort Peck reach mountain SWE peaked on April 15 at 77% of average, which is the average date for snow accumulation to peak. The 2009-2010 mountain snow accumulation and melt for the reaches above Fort Peck and Fort Peck to Garrison are illustrated in ***Figure 4***.

3. Weather Conditions

In general the precipitation during the 2010 calendar year was above average in the Missouri River basin. ***Figure 5*** depicts percent of average precipitation for the three-month periods of January-March, April-June, July-September, and October-December 2010 in the Missouri River basin. Areas of the Missouri River basin received well-above average precipitation in all periods; however, much greater than 100% of average precipitation occurred in April-June and July-August. Montana, parts of North Dakota, and the Rocky Mountain Front Range in Wyoming and Colorado received above average precipitation in the October-December period. In January-March much of Montana and Wyoming were drier than average. From October-December, drier than average conditions occurred in southern South Dakota, Nebraska, Kansas and Missouri.
The weather summaries in the following sections describe significant weather events by month in the Missouri River basin.

Figure 6 depicts drought magnitudes as defined by the National Drought Mitigation Center at the beginning of January, April, July and October 2010. From January 5, 2010, to April 6, 2010, abnormally dry conditions in portions of Montana and Wyoming deteriorated to moderate and severe drought categories in the Rocky Mountains. Following a wet spring and early summer, conditions improved to traces of abnormally dry conditions in portions of Wyoming and Montana. Through the summer, drier conditions prevailed in Wyoming, Colorado and western Nebraska, allowing abnormally dry conditions to develop in those areas.

a. January

During January, precipitation accumulations were generally above average in the Rocky Mountains and in the Big Sioux River basin. Other regions that received above average precipitation included northeast Montana and south central North Dakota. Monthly temperatures were 3-5 degrees Fahrenheit (^{o}F) above average in the mountains and the Dakotas, while in the plains, temperatures were 3-4^{o}F below average. Major snow accumulations occurred during two winter weather systems on January 6–7 and January 23-24.

b. February

During February, no significant plains accumulations occurred and the mountain snow accumulation was below average. Precipitation accumulation continued to be above average in the Big Sioux River basin, the Platte River basin and the Missouri River reach from Kansas City, MO to St. Louis, MO. Average monthly temperatures were influenced by cold Arctic outbreaks throughout the Plains. Temperature departures were 5-7^{o}F below average in central South Dakota and a large area extending from Sioux City, IA to Kansas City, MO.

Missouri River Basin
Mountain Snowpack Water Content
2009-2010

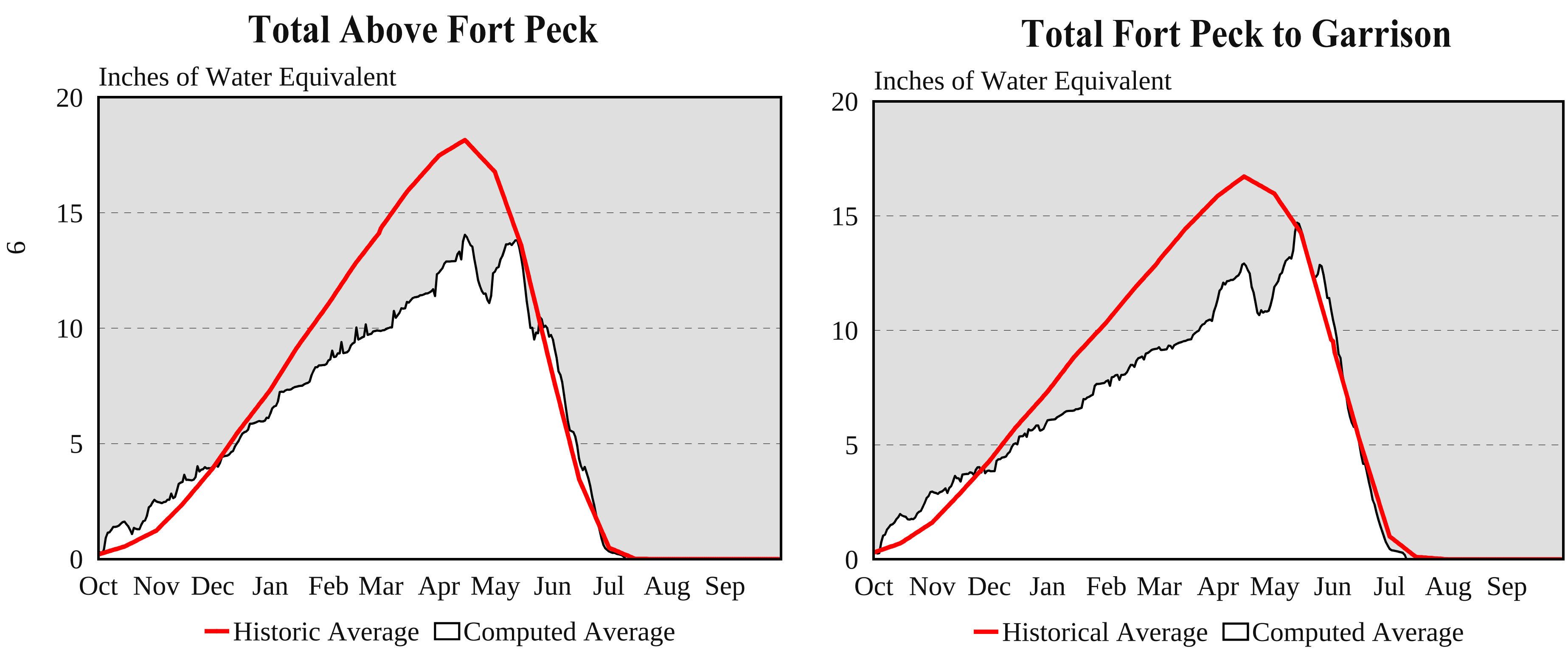


Figure 4. The mountain snowpack in the reach above Fort Peck peaked on April 15 at 77% of the normal peak accumulation. The mountain snowpack in the reach between Fort Peck and Garrison peaked on May 13 at 88% of the normal peak accumulation. The Missouri River basin mountain snowpack normally peaks near April 15.

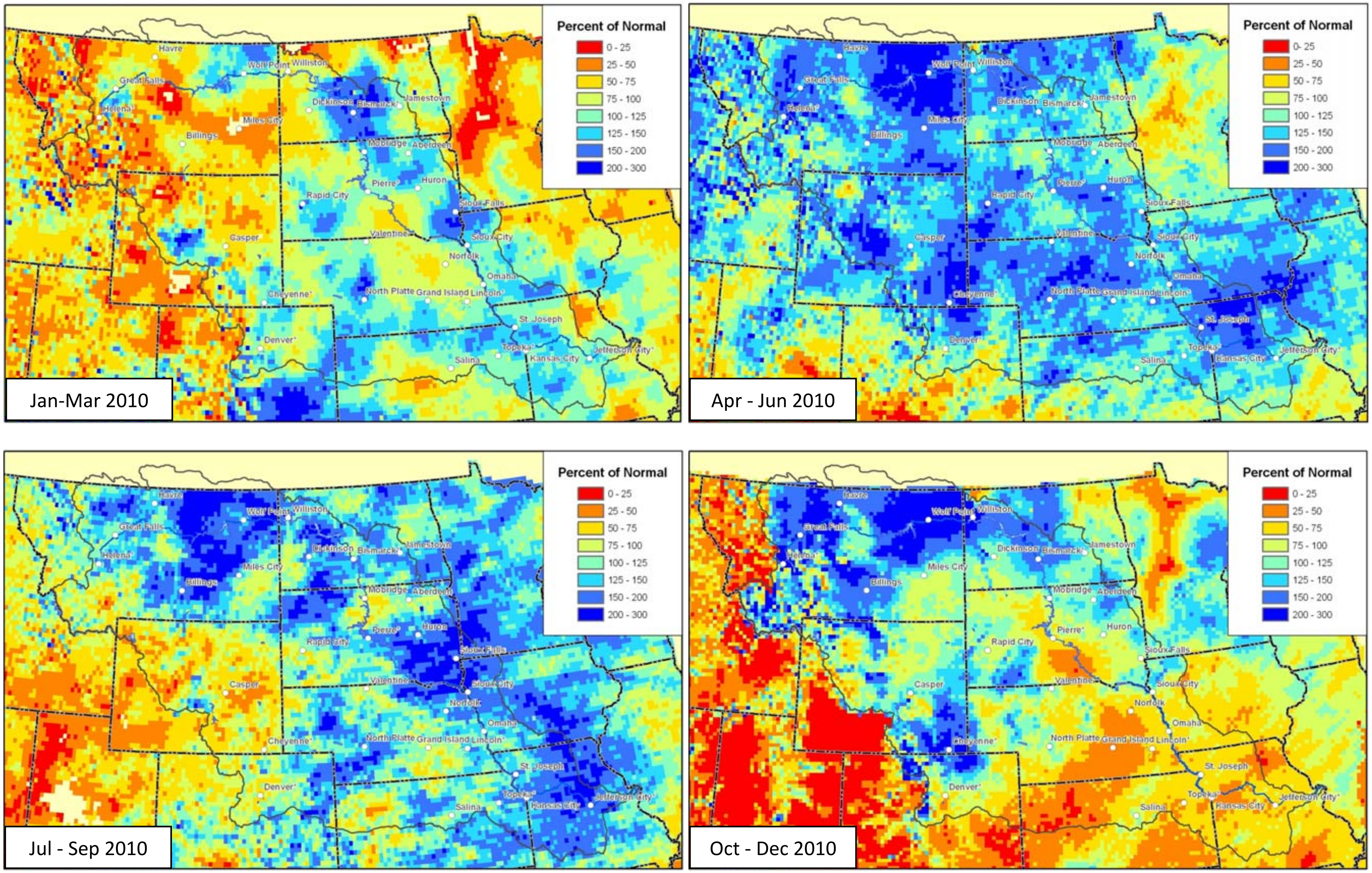


Figure 5. Percent of normal precipitation maps for the 2010 three-month periods: Jan – Mar, Apr – Jun, Jul – Sep and Oct – Dec.

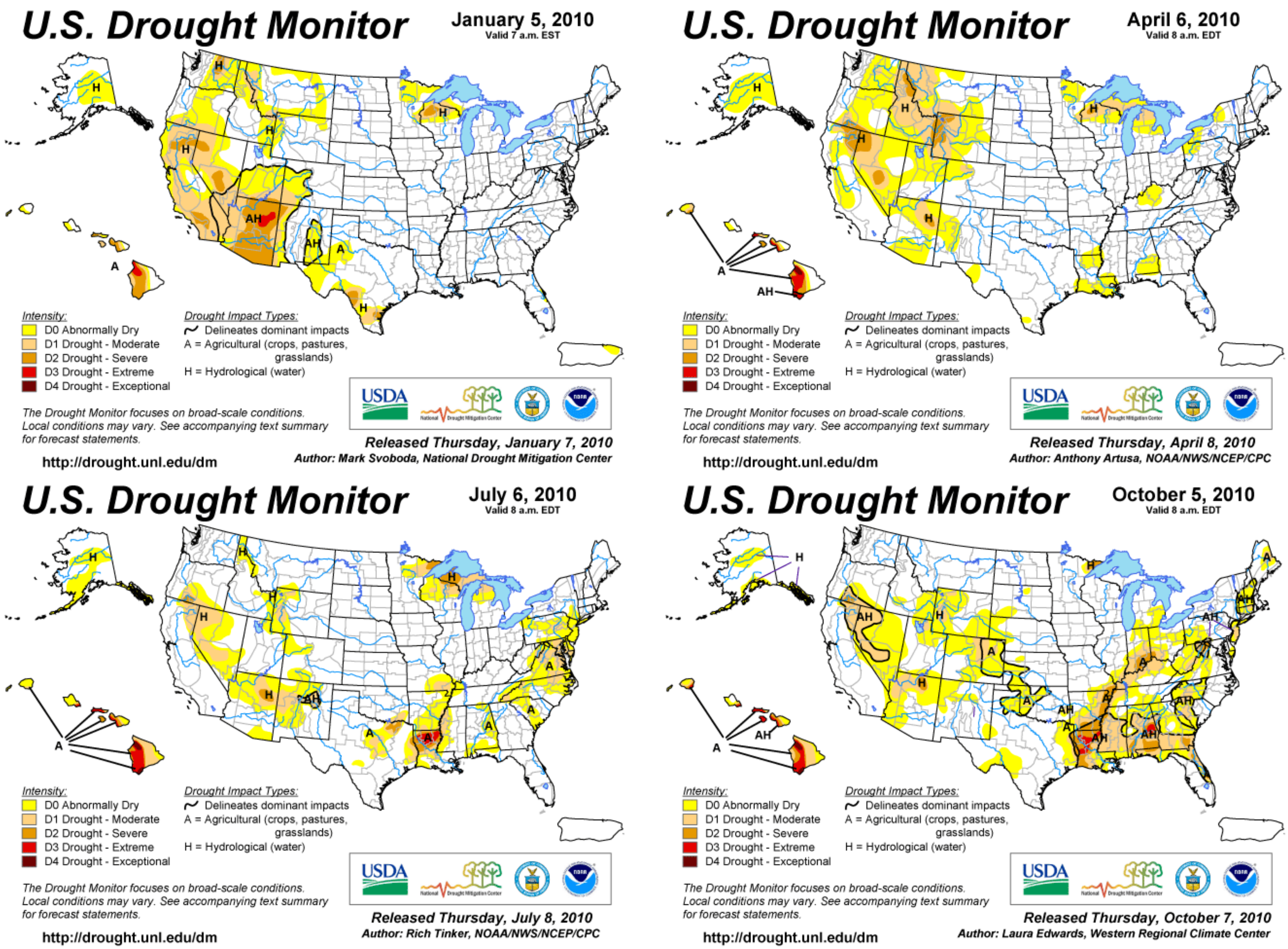


Figure 6. The National Drought Mitigation Center's drought maps for early January, April, July and October 2010.

c. March

Precipitation in Montana was well below average, while the Missouri River reach extending from Garrison to Oahe and the upper James River basin received greater than 200 percent of average precipitation. Monthly accumulations as SWE in the latter area were 0.5-2.0 inches. In addition, major accumulations of snow occurred in the Wind River and Middle North Platte River basins in Wyoming. In the Missouri River basin below Nebraska City, NE, precipitation accumulation ranged from 2-4 inches of rain, which was near average. Temperatures, though colder than average to begin the month, were above average much of the month.

A significant winter storm developed in the central Rocky Mountains on March 8 and produced very widespread precipitation in excess of 1.0 inch in western Nebraska, with amounts in excess of 0.5 inch into north central South Dakota on March 9-10. North Platte, NE recorded 1.44 inches of mostly rain from March 8-10; Jamestown, ND recorded 1.42 inches of precipitation from March 9-11, and Bismarck, ND recorded 0.89 inch from March 9-11.

At the beginning of the month average daily temperatures were below freezing in the Northern Plains; however, by March 5 temperatures rose above freezing, initiating snowmelt in the Plains. In southeast Nebraska, southern Iowa, and Missouri, the plains snowmelt began on March 6 and finished on March 10. Throughout the next two weeks, average daily temperatures were consistently several degrees above freezing, resulting in a slow snowmelt across the plains. Snowmelt ended on March 10 at Sioux City, IA, on March 18 at Sioux Falls, SD, on March 22 at Aberdeen and Pierre, SD, on March 26 at Jamestown, ND, and on March 29 at Bismarck, ND.

d. April

April was a very wet month, especially in north central Montana, central North Dakota, southwest South Dakota, western Nebraska, and much of the South and North Platte River basins, all of which received greater than 150% of average precipitation. Temperatures during the month were 2-6^{o}F above average in the Plains. In the mountains, temperatures were slightly below average, helping to preserve the mountain snowpack.

Precipitation in the Missouri River basin occurred during four major weather systems. The first system produced heavy precipitation in the form of wet snow from central Wyoming though western South Dakota into central North Dakota. Notable April 1-2 precipitation amounts were 1.68 inches (5 inches of snow) at Bismarck, ND; 0.45 inch (7 inches of snow) at Lander, WY; 0.65 inch (4 inches of snow) in Rapid City, SD; and 0.95 inch in Chadron, NE. As this system exited the Missouri River basin on April 2, a front moved through the state of Missouri producing moderate rainfall amounts of 0.55 inch at Kansas City International Airport and 1.13 inches in Columbia, MO.

A second system moved from Wyoming and Colorado through Iowa and Missouri April 5-8, producing heavy precipitation in Wyoming, northern Colorado, and western Nebraska, with moderate precipitation in Iowa and Missouri. Lander and Riverton, WY, received 11.5 and 9.1 inches of snow, respectively. After the snow, warmer average daily temperatures ranged from 35-45^{o}F, causing the snow to melt within two days. Heavy rainfall amounts occurring in western Nebraska included 1.45 inches in North Platte and 0.79 inch in Chadron.

A third system moved through the Missouri River basin April 13-14 producing heavy snow in western and northern Montana along with a band of moderate rain extending from western Kansas to North Dakota. Great Falls, MT received 1.37 inches of precipitation (13.2 inches of snow) while Havre, MT received 1.06 inches of precipitation (3 inches of snow). Amounts in the Dakotas, Nebraska and Kansas were generally 0.5-1.0 inch.

A fourth spring storm originating over California produced 1.0-2.5 inches of rain and snow in northeast Colorado and southeast Wyoming April 22-23, 1-2 inches of rain throughout the plains April 23-24, and very heavy rain ranging from 1.5-4 inches over northern Missouri April 24-25.

e. May

In May, most of the Missouri River basin received above average precipitation including greater than 200% of average in the Wind and Bighorn River basins, 200-400% of average from Fort Peck to Garrison Dams, and greater than 150% of average from Garrison to Oahe Dams. Observed precipitation totals were 3-10 inches on the plains in the Fort Peck to Garrison reach, 5-8 inches in the Lower Yellowstone River basin, 5-8 inches in the Cheyenne River tributary to Oahe Lake, 4 inches or more throughout the Plains, 5 inches in eastern Kansas and Missouri, and greater than 10 inches in some parts of the Grand and Chariton River basins in Missouri. Temperatures were generally 3-6^{o}F below average in the mountain states, which proved to be an important factor influencing the late timing of the peak snow accumulation and snowmelt runoff.

Major rainfall events occurred in May about every five days, so the entire Missouri River basin was impacted by about six storm systems. During the first seven days of the month, rainfall was primarily limited to Montana, Wyoming and the Dakotas with the exception of 1-2 inches rainfall that fell from south central Nebraska into northern Missouri.

A large spring storm May 10-11 affected an area extending from the Wind River Mountains, across South Dakota into Iowa and northern Missouri with widespread amounts of 1-2 inches of rainfall. From May 10-11, thunderstorms impacted an area extending from southern Iowa to central Missouri with 1.5-3.0 inches of rain. The following day, 2-3 inches of precipitation occurred east of the Wind River mountain range, 1.0-1.5 inches occurred over the Upper North and South Platte basins, while intense rainfall amounts over 4 inches occurred in the Osage River basin. On May 13, the northern Plains received 0.5-0.75 inch over a very broad area, while 2.5-4.0 inches of rain occurred over eastern Kansas and northern Missouri affecting the lower Kansas River, the Platte River in Missouri, the Grand River in Missouri and the Chariton River.

Later in the month light to moderate rain continued throughout the basin, including a large storm over Nebraska, Kansas and Missouri on May 20. In the Osage and Gasconade River basins, rainfall ranged from 1.0-2.5 inches with as much as 4 inches occurring locally in the Osage River basin.

The final 10 days of May were very wet in the Northern Plains and Rocky Mountains while the lower basin received only light, scattered rainfall. The first storm produced locally heavy rain in South and North Dakota through May 23. Aberdeen, SD and Jamestown, ND both recorded about 1.3 inches of rain on May 22. The second system affected a broad region from central Wyoming through the Dakotas, with the largest area of rain occurring on May 25 over eastern Montana with amounts in excess of 2 inches. Notable May 25-26 rainfall amounts included 2.13 inches in Jamestown, ND, 1.72 inches in Rapid City, SD, 2.05 inches in Gillette, WY, 1.72 inches in Williston, ND, 2.79 inches in Miles City, MT, and 1.99 inches in Glasgow, MT. The third system, which occurred in the final 10 days of May, first produced several inches of SWE in the Northern Rockies before producing 1-2 inches of rain in the lower mountain elevations and plains in western Montana. This was followed by heavy rain in South Dakota and Nebraska on May 29-30. Areas within the Niobrara River basin and the incremental drainage area between the Fort Randall and Gavins Point dams received 2-3 inches of rain.

f. June

The wet pattern continued in June with large storms and thunderstorms causing rainfall in all areas of the Missouri River basin ranging from 150-200% of average. Many areas, including the North Platte River basin in western Nebraska and eastern Wyoming, the Upper Missouri River basin in Montana, and the Missouri River below Oahe, received 200-300% of average precipitation. Precipitation in some regions of the Platte River basin in Nebraska and Grand River basin in Missouri exceeded 300% of average. Temperatures throughout the month were near average in the eastern Dakotas, 1-2^{o}F above average in the lower Missouri River basin below Sioux City, IA, and 1-2^{o}F below average in the basin above Oahe Dam.

Heavy rain occurred on June 2 in the Nebraska City, NE to Kansas City, MO reach of the Missouri River basin. Rainfall amounts exceeding 4 inches occurred in northwest Missouri, including amounts of 4.4 inches in Gallatin, MO, and 3.5 inches in St. Joseph. Another band of heavy rain extended from central Nebraska to north central Missouri producing up to 1.0 inch in a broad area along with reports of over 3.0 inches in north central Missouri and southern Iowa.

On June 8, a large storm moved across Nebraska with average rainfall amounts of 0.75-1.5 inches and up to 2.5 inches falling over the Platte and Loup Rivers before moving into central Missouri where it produced 2-3 inches.

A series of storms that occurred from June 10-15 produced very heavy rain over South Dakota, Nebraska, Iowa, and Kansas. These storms produced very heavy rainfall amounts in the Niobrara River basin and other sub-basins in the incremental drainage area between the Fort Randall and Gavins Point dams. Amounts ranging from 4-5 inches, most of which occurred June 10-11, fell over portions of the middle Niobrara River basin while 5-8 inches occurred in the lower Niobrara River basin and areas between the Fort Randall and Gavins Point dams.

In South Dakota, the James and Big Sioux River basins endured six consecutive days of rainfall from June 10-15, with the heaviest rainfall occurring June 10-12. Some notable June 10-15 rainfall totals in South Dakota included 6.1 inches at Chamberlain, 8.0 inches at Carthage, 6.58 inches at Forestburg, 5.74 inches at Winner, 8.9 inches at Pickstown, 7.8 inches at Wagner, and 6.85 inches at Mitchell.

Over the Elkhorn, the Lower Platte and the upper Loup River basins, tremendous amounts of rain fell in the five-day period from June 10-14. In Nebraska, some very notable five-day totals included 8.4 inches at Elsmere, 8.8 inches at Taylor, 7.4 inches at Neligh, 6.9 inches at Tekamah, 6.6 inches at West Point, 7.9 inches at Howells, and 5.8 inches at Norfolk.

Western Iowa was also impacted by these storms June 11-14. On June 11, rainfall amounts of 1.5-3.0 inches were recorded over the Floyd, the Little Sioux, and the upper Nishnabotna River basins, followed by lighter rainfall not exceeding an additional 2.0 inches in these areas June 12-14. Thunderstorms producing rainfall amounts ranging from 1.0 to 4.0 inches occurred over an area extending from eastern Kansas into northern Missouri June 13-14.

Another system generated thunderstorms throughout the basin June 20-23; however, the heaviest rainfall in amounts ranging from 3–4 inches fell over northern Kansas June 20, 3-4 inches in eastern and southeast Nebraska and east central South Dakota June 21. Several 2-day rainfall amounts recorded on June 20-21, indicated very heavy and intense rain occurred over several counties in southeast Nebraska that drain into the Missouri River between Nebraska City and Rulo, NE. Amounts in Nebraska towns included 3.56 inches at Raymond, 3.25 inches at Utica, and 8.04 inches at Weeping Water.

A final outbreak of heavy rain occurred in the Little Sioux River basin June 27 with rainfall amounts ranging from 2.5-5.0 inches over a majority of the basin, with Cherokee, IA recording 6.15 inches.

Monthly totals in many locations ranked in the top five rainiest Junes on record such as in Norfolk, NE, which received 10.71 inches, 6.46 inches above average. Omaha, NE received 9.25 inches, 5.3 inches above average, and was the seventh wettest June on record. Mitchell, SD received 9.92 inches of rain, 6.44 inches above average.

g. July

Rainfall in July occurred as a result of convective storms that occurred throughout June; therefore, heavy precipitation was more localized. Above average departures of 150-200% occurred throughout much of eastern Montana, northeast Nebraska, northwest Iowa and southeast South Dakota. Within these regions of Nebraska, Iowa, and South Dakota more localized accumulations ranging from 5-10 inches occurred, with some areas in the lower Big Sioux, Floyd, and Little Sioux River basins receiving over 10 inches of rain. Temperatures during the month were average in the Missouri River basin downstream of Gavins Point Dam and 1-2^{o}F below average above Gavins Point Dam.

An outbreak of thunderstorms occurred on July 3-4 in South Dakota, Nebraska, Iowa, Kansas and Missouri. Heavy rain totaling up to 4 inches occurred locally over southeast Nebraska and northeast Kansas.

Later in the month two storms similar in rainfall amount occurred over southeast South Dakota, northeast Nebraska and western Iowa. The first, occurring July 21-22, produced 3-5 inches over the lower Niobrara River with localized amounts estimated over 6 inches. These storms continued across the lower Vermillion, lower Big Sioux, Floyd, and Little Sioux River basins with similar amounts. A number of locations reported 3-5 inches of rain including Verdel, NE, with 5.3 inches, and Sanborn, IA, with 6.6 inches. The second storm occurred July 29-30. Sioux Falls, SD, recorded between 4.4 and 5.5 inches, while a report of 7.4 inches came from Wessington Springs, SD.

In southern Iowa and northern Missouri, heavy precipitation in excess of 6 inches occurred over a large portion of the Chariton River basin on July 20. Precipitation reports ranged from 3-6 inches including 6 inches at Livonia, MO, and 6.2 inches at Novinger, MO.

h. August

Precipitation was generally average throughout much of the basin with pockets of 200-300% above average precipitation in eastern Montana. Temperatures during the month were 1-2^{o}F above average except for Montana and Wyoming, which were 1-2^{o}F below average.

Significant rainfall did not occur in the basin below Gavins Point Dam until late August. On August 21 a storm centered directly over the Missouri River in Missouri produced 3.0-4.5 inches of rain in areas that included Boonville and Waverly, MO. On August 23 and August 31, two separate storms each produced 0.5-1.0 inch of rainfall in Montana, North Dakota and South Dakota with areas of 1.5-2.0 inches over the James and Big Sioux River basins. The August 31 storm produced 1.5-3.0 inches in the lower Missouri River basin and 3-4 inches between St. Joseph and Kansas City, MO.

i. September

Precipitation was 200-300% of average in the Northern Plains, while the basin downstream of Sioux City, IA received 150-200% of average. In contrast, the Rocky Mountains in Wyoming and Colorado were very dry, receiving less than 50% of average precipitation. Temperatures in much of the basin were 1-3^{o}F below average in the Plains, and 1-3^{o}F above average in the Rockies.

Several significant rainfall events occurred throughout the basin in September. On September 7, an intense storm extending from central North Dakota southward to the state line produced greater than 2 inches of rain with locally heavy amounts of 4 inches.

On September 14-16, very intense rainfall occurred at locations in central and eastern South Dakota, central and eastern Kansas, and western Missouri. On September 14, 2-4 inches of rain occurred over northeast Kansas. On September 15, 3-4 inches occurred over central Kansas. On September 16, 2 inches of rain occurred over eastern South Dakota, while the heaviest rain ranging from 3-5 inches occurred in the Osage River basin in eastern Kansas and western Missouri.

On September 22 and 23, heavy rain occurred over the Grand and Chariton River basins in Missouri. Some notable rainfall totals were 5.7 inches at Blue Lick, 5.1 inches at Princeton, and 4.1 inches at Sumner. Also on September 23, heavy rain of 1.5 to 4.0 inches occurred over the Big Sioux River basin with locally heavy amounts of 5.5-6.5 inches in Worthington, MN, and 4.8 inches in Rock Valley, IA. In addition, rainfall amounts exceeded 3 inches from Gavins Point Dam to Sioux City.

j. October

October precipitation was less than 25% of average over a majority of the basin downstream of Sioux City, IA. In the basin upstream of Sioux City, precipitation was roughly 50% of average with some localized areas of above average precipitation. Temperatures in October were 3-5^{o}F above average throughout the basin.

k. November

November was a wet month in portions of the Northern Plains with 150% of average precipitation in much of northern Wyoming and western North Dakota, and greater than 200% of average in most of Montana. In contrast, conditions were very dry in the region extending from western Kansas to eastern North Dakota. Precipitation was generally less than 50% of average in much of north central Nebraska and southern and eastern South Dakota.

Snowfall began relatively early in the Northern Plains, and was much above average in Montana and western North Dakota. During the month, Glasgow, MT received 12.6 inches, Great Falls, MT received 19.5 inches, Billings, MT received 23.3 inches, Williston, ND received 15.5 inches and Bismarck, ND received 10.1 inches. In contrast, very little snow occurred in eastern North Dakota and South Dakota.

l. December

December was a very wet month across much of the basin above Sioux City, IA. Precipitation departures over much of the Dakotas was greater than 200% of average, and greater than 400% of average in eastern South Dakota, central North Dakota and Montana. This pattern occurred as a direct result of La Nina influenced weather patterns and a moist southern jet stream. Temperatures throughout the basin were much warmer than average in the Rocky Mountains by 3-6^{o}F. In the Northern Plains, temperatures were 1-2^{o}F below average as a result of the frequent winter storms that affected the area.

Significant plains snowfall (precipitation) totals at several locations were 24.7 inches (1.5 inches) at Glasgow, MT; 24.6 inches (1.6 inches) at Great Falls, MT; 35.5 inches (2.0 inches) at Williston, ND; 21.1 inches (1.4 inches) at Bismarck, ND; 24.6 inches (1.8 inches) at Aberdeen, SD; 29.0 inches (2.5 inches) at Watertown, SD; and 17.9 inches (1.5 inches) at Sioux Falls, SD.

4. 2010 Calendar Year Runoff

Runoff for the period January through December 2010 for the basin above Sioux City, IA, totaled 38.7 MAF, 156% of normal runoff based on the historical period of 1898-2009, as shown in ***Table 1***. The 38.7 MAF in 2010 represents the third highest runoff in 113 years of record (1898-2010) as shown on ***Figure 7***. Monthly runoff during 2010 above Sioux City, IA varied from a low of 96% in November to a high of 206% in July. ***Figure 8*** indicates the monthly variation of runoff for CY 2010.

The runoff in the Gavins Point Dam to Sioux City, IA reach was 10.6 MAF, which was the highest in 113 years. The previous high was 8.5 MAF in 1993. The 2010 runoff amount exceeded the previous high by more than the yearly average, which is 2.0 MAF.

The observed monthly runoffs for 2010 from Fort Peck downstream to Sioux City, IA by major river reach are presented in ***Table 2***. The table lists the runoff by month and reach and is the basic compilation of the runoff into the System. 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 and the actual runoff accumulates, 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 1
2010 Calendar Year Runoff for Selected Reaches

Reach	1898 – 2009 Average Runoff Volume (in 1000 AF)	Calendar Year 2010 Runoff Volume (in 1000 AF)	Percent of Average Runoff
Above Fort Peck	7,213	7,646	106
Fort Peck to Garrison	10,612	11,113	105
Garrison to Oahe	2,373	4,408	186
Oahe to Fort Randall	883	2,275	258
Fort Randall to Gavins Point	1,681	2,677	159
Gavins Point to Sioux City	2,023	10,557	522
TOTAL ABOVE SIOUX CITY	**24,785**	**38,676**	**156**
	1967–2010 Average Runoff		
Sioux City to Nebraska City*	7,600	7,410	98
Nebraska City to Kansas City*	11,970	26,900	225
Kansas City to Hermann*	24,240	36,820	152
TOTAL BELOW SIOUX CITY*	**43,810**	**71,140**	**162**

** Runoff in the reaches from Sioux City to Hermann is not adjusted to 1949 depletion levels. Averages are taken from USGS Water Data Reports for the period 1967-2010.*

C. System Regulation – January to December 2010

1. System Regulation January to December 2010

The System storage increased through the first seven months of 2010 and peaked on July 23, 2010 at 65.9 MAF. The System storage began the year at the annual minimum of 53.3 MAF on January 1. This was 9.4 MAF above the January 1, 2009 System storage of 43.9 MAF, which also happened to be the previous year's annual minimum. The March 1 system storage was above 40.0 MAF, the storage level required to run the March spring pulse.

The March 15 System storage was 55.9 MAF, which was above the navigation season preclude level of 31.0 MAF. Per the Master Manual, since the March 15 storage level was above 54.5 MAF, the navigation service level was set to full service.

The plan for the System releases to support the 2010 navigation season during the threatened and endangered (T&E) tern and plover nesting season was the Steady Release – Flow-to-Target (SR-FTT) plan. The SR-FTT release plan calls for the Gavins Point

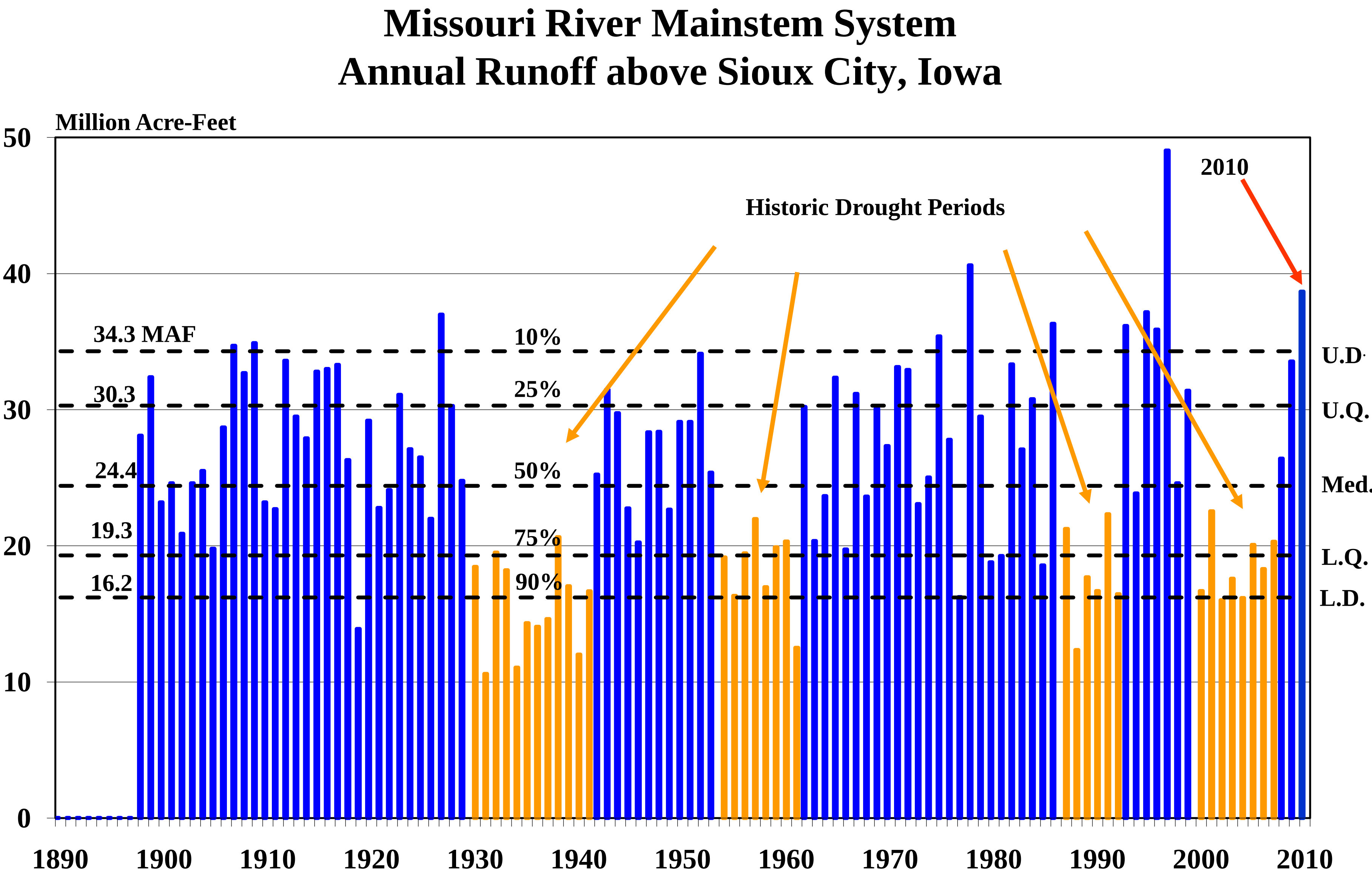


Figure 7. Missouri River annual runoff above Sioux City, Iowa.

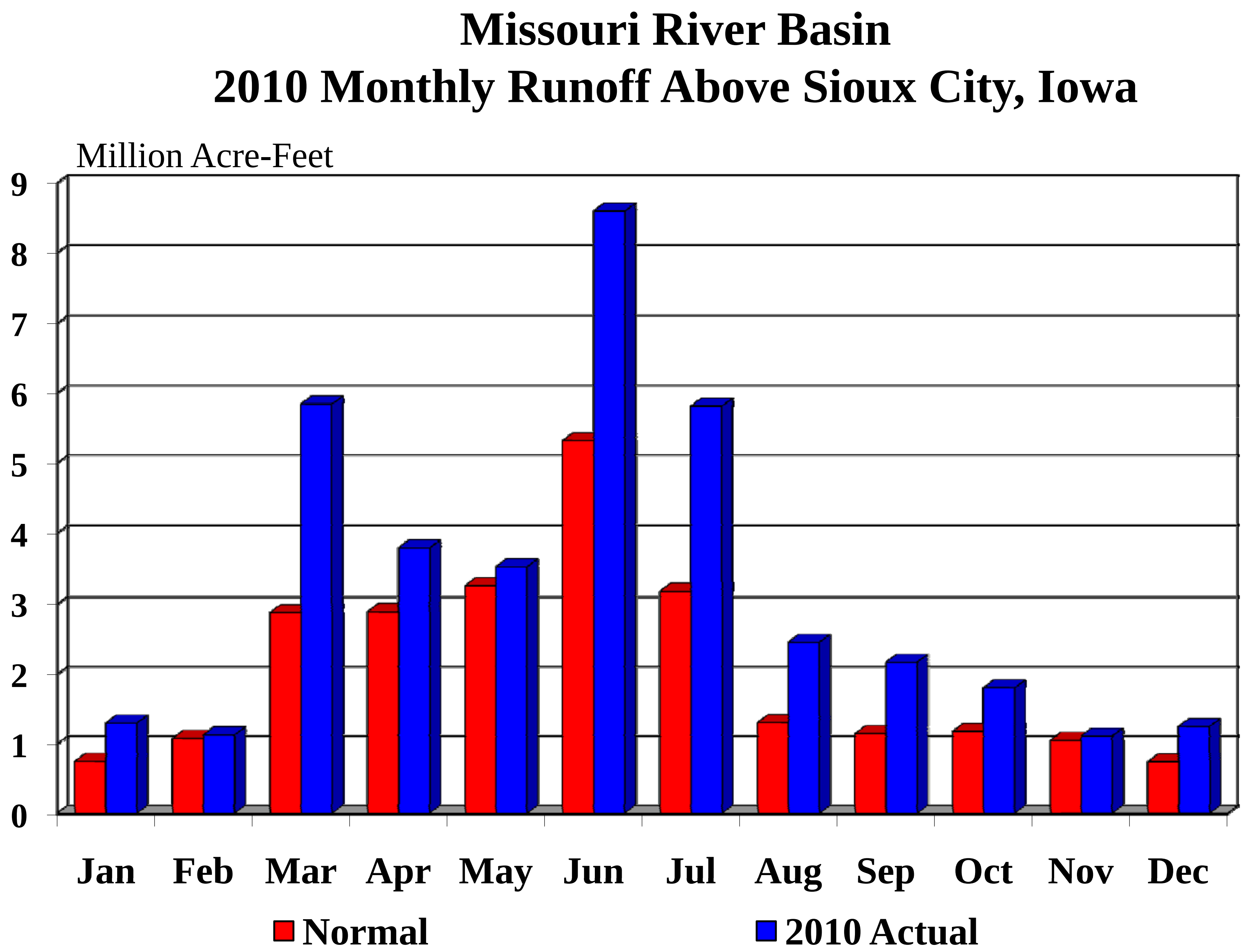


Figure 8. Missouri River Basin 2010 Monthly Runoff Above Sioux City, Iowa.

Table 2
Missouri River Basin
Calendar Year 2010 Runoff above Sioux City, Iowa

Values in 1000 Acre Feet

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
	(Actual)								
JAN 2010	330	319	38	176	176	262	1,039	1,301	1,301
NORMAL	312	261	12	25	100	40	710	750	750
DEPARTURE	18	58	26	151	76	222	329	551	551
% OF NORM	106%	122%	317%	704%	176%	655%	146%	173%	173%
FEB 2010	319	285	69	119	149	188	941	1,129	2,430
NORMAL	360	356	90	49	130	92	985	1,077	1,827
DEPARTURE	-41	-71	-21	70	19	96	-44	52	603
% OF NORM	89%	80%	77%	243%	115%	204%	96%	105%	133%
MAR 2010	582	754	1,378	955	496	1,675	4,165	5,840	8,270
NORMAL	596	1,003	567	209	206	299	2,581	2,880	4,707
DEPARTURE	-14	-249	811	746	290	1,376	1,584	2,960	3,563
% OF NORM	98%	75%	243%	457%	241%	560%	161%	203%	176%
APR 2010	395	695	1,013	272	198	1,211	2,573	3,784	12,054
NORMAL	649	1,080	481	144	180	360	2,534	2,894	7,601
DEPARTURE	-254	-385	532	128	18	851	39	890	4,453
% OF NORM	61%	64%	211%	189%	110%	336%	102%	131%	159%
MAY 2010	892	980	592	140	175	738	2,779	3,517	15,571
NORMAL	1,081	1,245	312	147	186	292	2,971	3,263	10,864
DEPARTURE	-189	-265	280	-7	-11	446	-192	254	4,707
% OF NORM	83%	79%	190%	95%	94%	253%	94%	108%	143%
JUN 2010	1,975	3,365	661	440	567	1,580	7,008	8,588	24,159
NORMAL	1,612	2,667	423	152	178	286	5,032	5,318	16,182
DEPARTURE	363	698	238	288	389	1,294	1,976	3,270	7,977
% OF NORM	123%	126%	156%	289%	319%	552%	139%	161%	149%
JUL 2010	1,253	2,527	307	124	249	1,460	4,460	5,920	30,079
NORMAL	819	1,776	179	57	137	218	2,968	3,186	19,368
DEPARTURE	434	751	128	67	112	1,242	1,492	2,734	10,711
% OF NORM	153%	142%	172%	218%	182%	670%	150%	186%	155%
AUG 2010	459	616	175	39	127	1,272	1,416	2,688	32,767
NORMAL	353	604	65	39	115	131	1,176	1,307	20,675
DEPARTURE	106	12	110	0	12	1,141	240	1,381	12,092
% OF NORM	130%	102%	269%	100%	110%	971%	120%	206%	158%
SEP 2010	425	507	129	7	198	831	1,266	2,097	34,864
NORMAL	333	452	111	38	111	99	1,045	1,144	21,819
DEPARTURE	92	55	18	-31	87	732	221	953	13,045
% OF NORM	128%	112%	116%	18%	178%	839%	121%	183%	160%
OCT 2010	353	538	-55	-8	104	830	932	1,762	36,626
NORMAL	385	523	66	5	120	78	1,099	1,177	22,996
DEPARTURE	-32	15	-121	-13	-16	752	-167	585	13,630
% OF NORM	92%	103%	--	--	87%	1064%	85%	150%	159%
NOV 2010	329	219	42	8	118	295	716	1,011	37,637
NORMAL	384	398	67	6	118	76	973	1,049	24,045
DEPARTURE	-55	-179	-25	2	0	219	-257	-38	13,592
% OF NORM	86%	55%	63%	133%	100%	388%	74%	96%	157%
DEC 2010	334	308	59	3	120	215	824	1,039	38,676
NORMAL	329	247	0	12	100	52	688	740	24,785
DEPARTURE	5	61	59	-9	20	163	136	299	13,891
% OF NORM	102%	125%	--	25%	120%	413%	120%	140%	156%
Calendar Year Totals									
	7,646	11,113	4,408	2,275	2,677	10,557	28,119	38,676	
NORMAL	7,213	10,612	2,373	883	1,681	2,023	22,762	24,785	
DEPARTURE	433	501	2,035	1,392	996	8,534	5,357	13,891	
% OF NORM	106%	105%	186%	258%	159%	522%	124%	156%	

releases to be set at an initial steady rate and then adjusted higher or lower during the nesting season to meet downstream flow targets, if necessary. Depending on where the initial steady release is set, this regulation can provide more T&E habitat early in the nesting season and saves additional water in the upper three reservoirs when compared to a Steady Release (SR) plan. The SR-FTT plan also reduces the potential for flooding nests and exceedance of the anticipated incidental take for listed terns and plovers when compared to a Flow-to-Target (FTT) plan.

Flow support for the 2010 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. Due to plains snowmelt runoff from unregulated tributaries downstream from Gavins Point Dam, System releases during April were held at 15,000 cfs until April 29 when releases were increased to 18,000 cfs and then to 22,000 cfs on the following day. Downstream tributary inflow between Nebraska City and Kansas City was significant from March through December. The full service flow targets at Sioux City (31,000 cfs), Omaha (31,000 cfs), Nebraska City (37,000 cfs), and Kansas City (41,000 cfs) were met throughout the navigation season.

The April 1 System storage was 58.2 MAF, 9.3 MAF more than the previous year's April 1 System storage. The May 1 System storage was 59.4 MAF, 19.4 MAF above the 40 MAF storage preclude level for the May spring pulse.

Early spring rainfall and plains snowmelt produced a March through May runoff of 13.1 MAF above Sioux City, which was 145% of normal. Runoff volumes above Sioux City for June and July were higher than normal: 8.6 MAF (161% of normal) and 5.9 MAF (186% of normal), respectively. The June-July runoff was a result of mountain snowpack runoff as well as significant rainfall runoff. Mountain snowpack peaked at 77% of normal above Fort Peck on April 15 and 88% of normal between Fort Peck and Garrison on May 13.

Per the Master Manual, the July 1 System storage check of 65.0 MAF resulted in the navigation flow support remaining at full service, and the navigation season extended 10 days to December 10 near the mouth at St. Louis, MO. System storage peaked on July 23 at 65.9 MAF, 8.1 MAF higher than the 2009 peak. The end-of-July System storage was 65.7 MAF, 8 MAF higher than the 2009 end-of-July System storage and 7.3 MAF more than 1967-2009 end-of-July average (58.4 MAF). System storage declined steadily through the remainder of the year. End-of-month storages were: August, 63.9 MAF; September, 62.1 MAF; October, 59.8 MAF; November, 57.6 MAF; and December, 57.0 MAF. The end-of-December System storage was 2.8 MAF more than the previous year and 4.4 MAF more than 1967-2010 end-of-December average. In early July the Fort Peck pool elevation reached the carryover multiple use zone for the first time since 2000. Garrison and Oahe continued to gain storage and reach exclusive flood control pool levels in July and June, respectively.

2. Fort Peck Regulation – January to December 2010

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 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 3 lists the average monthly inflows and releases and the end-of-month (EOM) pool elevation for Fort Peck for 2009 and 2010 as well as the averages since the System first filled in 1967.

Table 3
Fort Peck – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation (ft msl)		
	2010	2009	1967-2010	2010	2009	1967-2010	2010	2009	1967-2010
January	7,000	7,000	7,200	4,700*	6,000	10,600	2221.8	2209.9	2227.1
February	6,600	8,200	8,600	4,300*	5,900	10,900	2222.4	2210.5	2226.4
March	9,900	8,900	11,800	4,400	4,200	7,900	2224.2	2212.1	2227.5
April	7,100	10,000	10,200	4,700	4,100	7,400	2224.9	2214.1	2228.2
May	14,200	16,300	15,100	6,000	5,900	9,000	2227.4	2217.6	2229.8
June	25,600	13,100	18,900	4,900*	6,200	9,600	2233.3	2219.8	2232.3
July	15,200	9,600	12,200	5,700	6,500	9,900	2235.8	2220.5	2232.6
August	7,600	7,400	7,800	6,400	6,500	9,900	2235.7	2220.4	2231.5
September	8,500	6,900	7,800	6,100	5,400	8,700	2235.9	2220.0	2230.7
October	7,800	8,700	7,400	6,100	4,200	7,900	2235.8	2220.5	2230.2
November	6,900	6,800	7,100	6,200	4,200	8,300	2235.5	2220.9	2229.5
December	8,200	6,000	6,600	7,800	4,300*	9,400	2235.4	2221.1	2228.4

* monthly minimum of record

b. Winter Season 2010

The Fort Peck reservoir level began 2010 at elevation 2221.1 ft msl, 12.9 feet below the base of annual flood control zone and 11.5 feet higher than the previous year. The annual minimum reservoir level occurred on January 1 at 2221.1 ft msl, 11.5 feet higher than the 2009 annual minimum, which was 2209.6 ft msl on January 1, 2009.

c. Winter River and Ice Conditions Below Fort Peck

No special release reductions were required to prevent ice-jam flooding downstream of Fort Peck Dam. The average monthly discharges for December 2009 and January and February were all record lows with monthly averages of 4,700 cfs, 4,300 cfs, and 4,400 cfs, respectively. Ice-cover formation on the Missouri River began on December 4, 2009 when the Missouri River stage rose over 3.5 feet in the Wolf Point, MT area. The stage at Wolf Point peaked near 4.8 feet on March 28, which is well below the flood stage of 13.0 feet. The Missouri River at Culbertson, MT peaked on March 28 at a stage of 6.9 feet, which is well below the flood stage of 19.0 feet. No reports of ice-affected flooding on the Missouri River below Fort Peck Dam were recorded during the 2010 winter season. The Fort Peck reservoir (Fort Peck Lake) froze over on December 28, 2009 and was free of ice on April 13.

A severe ice storm in the Dakotas and Montana on January 24 caused downed transmission lines and disruption to the integrated power system. As a result, Western made significant adjustments to power production at several of the mainstem power plants to cover the load and prevent blackouts. Fort Peck was used for needed power and voltage control for areas west of Williston, ND. This required Fort Peck to significantly increase its energy production from January 24-29. Releases from Fort Peck peaked as high as 11,500 cfs during that period. There was a concern that this significant increase in releases had the potential to cause lowland flooding downstream since the river below Fort Peck had froze over weeks earlier at a much lower release. A press release was put out to the local area to alert the public. In addition, Fort Peck project personnel contacted local landowners and observers below the project about impacts from the higher releases. There were no reports of any downstream impacts.

d. Spring Open Water Season 2010

Releases averaged 4,700 cfs in April, 6,000 cfs in May, and 4,900 cfs in June. The June average release set a minimum of record for the month. For 2010, Fort Peck and Oahe were given priority for steady or rising pools during the forage fish spawn in April and May. During May and June, a combination of normal to above normal runoff into Fort Peck, high flows on the Milk River, and below normal releases resulted in the pool rising over 9 feet, from 2224.2 ft msl at the end of March to 2233.3 ft msl at the end of June, during the forage fish spawn. High flows on the Milk River, combined with the low Fort Peck releases, were adequate to meet the minimum flow requirements for downstream irrigation.

e. Summer Open Water Season 2010

Summer release rates, which are generally higher than spring releases due to the increased demand for hydropower, averaged 5,700 cfs in July and rose to 6,400 cfs from August through mid-September as flows from the Milk River receded. These below average releases were set to meet minimum requirements for downstream irrigation. Inflows were near normal to above normal for July, August, and September. On July 5, the Fort Peck pool reached 2234.0 ft msl, the base of the flood control pool, for the first time since June 2000. This marked Fort Peck's recovery from the 2000-2007 drought. The reservoir level rose from 2233.3 to 2235.8 ft msl during July and then stayed nearly steady during August and September and ended the month at 2235.9 ft msl, which was also its annual peak elevation.

f. Fall Open Water Season 2010

Releases were reduced from approximately 6,500 cfs to near 6,000 cfs in early September when irrigation ceased for the season. Releases were maintained near this level during October and November and were then increased to 7,000 cfs on November 29 and then to 8,000 cfs on December 7 to continue evacuation of the remaining water in the annual flood control and multiple use zone. The average release for December was 7,800 cfs. Inflows for October, November, and December were about average. The average inflows coupled with slightly lower than average releases resulted in the pool elevation falling slightly during these three months to 2235.4 ft msl by the end of December.

g. Summary

The highest Fort Peck reservoir level during 2010 occurred on September 25 at 2235.9 ft msl. The lowest reservoir level during 2010 occurred on January 1 at 2221.1 ft msl. The average daily inflow of 10,400 cfs during 2010 was 104% of average (1967-2010). The average daily release of 5,600 cfs during 2010 was 62% of average (1967-2010) and was the second lowest average annual minimum release since the System filled in 1967. In 2010, Fort Peck rose 1.9 feet into the annual flood control and multiple use zone, which extends from 2234.0 to 2246.0 ft msl, for the first time since June 2000.

3. Garrison Regulation – January to December 2010

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 4 lists the average monthly inflows and releases in cfs and the EOM pool elevation in ft msl for Garrison for 2009 and 2010 as well as the averages since the System filled in 1967.

Table 4
Garrison – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation(ft msl)		
	2010	2009	1967-2010	2010	2009	1967-2010	2010	2009	1967-2010
January	11,000	13,300	15,200	17,700	15,700	22,500	1838.6	1824.0	1831.6
February	10,600	13,000	18,400	16,400	16,100	23,600	1837.5	1823.4	1830.6
March	17,400	22,500	26,600	12,600	10,000*	19,100	1838.3	1826.2	1832.1
April	14,000	27,200	22,300	10,100	9,000*	18,600	1839.1	1830.1	1832.6
May	25,800	27,700	28,300	14,500	13,300	20,700	1841.0	1833.0	1834.1
June	54,000	45,700	45,700	14,800	15,900	22,600	1847.7	1838.8	1838.3
July	34,100	35,000	32,200	14,600	15,700	23,900	1850.8	1842.3	1839.6
August	15,500	18,500	18,000	16,300	16,000	23,700	1850.2	1842.2	1838.0
September	17,800	14,400	16,500	26,900	14,800	20,500	1848.2**	1841.6	1836.8
October	16,100	14,500	17,200	29,500	12,600	19,000	1845.4	1841.5	1836.1
November	12,900	14,900	15,900	27,400	12,800	19,800	1842.4	1841.4	1834.9
December	15,100	8,500	13,700	17,800	15,100	20,100	1841.7	1840.0	1833.4

* monthly minimum of record ** monthly maximum of record

b. Winter Season 2010

Releases from Garrison were below normal for a tenth consecutive winter season. Garrison began 2010 at 1840.0 ft msl, 15.3 feet higher than the previous year's elevation of 1824.7 ft msl. The 1840.0 ft msl elevation was 2.5 feet above the base of the annual flood control and multiple use zone. The reservoir level declined throughout the winter season and ended February at 1837.5 ft msl, the base of the annual flood control and multiple use zone, before dropping to an annual minimum elevation of 1837.0 ft msl on March 17. The Garrison reservoir (Lake Sakakawea) froze over on January 2 and was free of ice on April 19.

c. Winter River and Ice Conditions Below Garrison

The Missouri River in the Bismarck, ND area rose nearly 5 feet from December 9-13, 2009 during river ice cover formation. The ice-cover conditions were generally continuous from the middle of December through mid-March when the ice broke up. The winter peak ice-affected Missouri River stage at Bismarck was 10.7 feet on January

12. This was 5.3 feet below the Bismarck flood stage of 16 feet and 2.3 feet below the Corps' winter freeze-in maximum stage target of 13 feet.

d. Spring Open Water Season 2010

Spring runoff into Garrison started the season below normal in April and steadily increased to above normal by June. This, coupled with below normal releases, resulted in Garrison reservoir pool levels rising during the critical fish spawning period. The reservoir level on April 1, the beginning of the navigation season, was 1838.3 ft msl. This elevation was 12.1 feet higher than the level at the start of the 2009 navigation season. The Garrison pool level rose steadily during the April to May period, 1838.3 to 1841.0 ft msl, before rising significantly to 1847.7 ft msl by the end of June. The significant pool rise in June was due to a combination of above normal inflows coupled with below normal releases. Releases were reduced in order to reduce high flows in the lower reaches of the Missouri River downstream of the System. Average inflows for April of 14,000 cfs (63% of average) were well below normal, while inflows for May of 25,800 cfs (91% of average) were near normal and inflows for June of 54,000 cfs (118% of average) were above normal. Releases were all well below normal for all three months: 10,100 cfs (54% of average) in April, 14,500 cfs (70% of average) in May, and 14,800 cfs (65% of average) in June.

e. Summer Open Water Season 2010

During June and July the mountain snowpack runoff and the lower-than-normal releases resulted in the Garrison pool entering the exclusive flood control zone (1850.0-1854.0 ft msl) for the first time since 1997. During July the pool rose 3.1 feet from 1847.7 to 1850.8 ft msl, 0.8 feet into the 4-foot exclusive flood control zone. The pool level remained in the exclusive flood control zone until September 3 and ended the month at 1848.2 ft msl. This tied for the highest end of month pool elevation on record for September. Releases during the summer months of July (14,600 cfs, 61% of average), and August (16,300 cfs, 69% of average) were below normal. Releases in September averaged 26,900 cfs (131% of average) as the evacuation of stored flood waters in Garrison were started. July, August, and September inflows were about normal. A daily peaking pattern was established at Garrison during the nesting season to protect T&E nesting habitat in the river reach below the project. With continued normal to above normal pool elevations in Lake Sakakawea in 2010, water quality management measures to assist with coldwater fishery habitat in the Garrison reservoir were not required.

f. Fall Open Water Season 2010

Fall releases were increased to 30,000 cfs in October and 31,000 cfs at the start of November to evacuate water from the annual flood control and multiple use zone. Releases were reduced to 22,000 cfs starting in late November in anticipation of the December freeze-in downstream of Garrison between Washburn and Bismarck, ND. Flows were decreased in early December to a low of 16,000 cfs to allow for the river to ice over. Once the ice stabilized, releases were increased about 1,000 cfs every three to four days starting on December 20, ending the year at 21,000 cfs. Garrison ended December at an elevation of 1841.7 ft msl, 4.2 feet above the base of the annual flood control and multiple use zone.

g. Lake Audubon / Snake Creek Embankment

During the 2000-2007 drought, a 43-foot maximum water level difference between Lake Audubon and Lake Sakakawea was put in place. This restriction requires a pool restriction for Lake Audubon and is a result of an underseepage evaluation of the Lake Audubon embankment by the Omaha District. Since that time relief wells have been installed and underseepage 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 since 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 ft msl in the fall.

The reporting of the annual pumping costs for Buford-Trenton is no longer required. In October 2008 the Secretary of the Army transferred ownership of the two drainage pump units to the Buford Trenton Irrigation District and provided a lump sum payment for operation of the pumps. This was in accordance with the provisions of Section 336(b) of the Water Resources Development Act of 1996 (Public Law 104-303).

h. Summary

The highest Garrison reservoir level during 2010 occurred on July 29 at 1851.4 ft msl (wind affected), which was 1.4 feet into the exclusive flood control zone. The reservoir was 8.6 feet higher than the 2009 peak and the highest peak since 1997. The lowest Garrison reservoir level during 2010 occurred on March 17 at 1837.0 ft msl. The average annual inflow of 20,400 cfs was 91% of average (1967-2010). The average annual release of 18,200 cfs was 86% of average (1967-2010). In 2010, Garrison rose 1.4 feet into the exclusive flood control zone utilizing 35% of that zone's available storage, which extends from 1850.0 to 1854.0 ft msl.

4. Oahe and Big Bend Regulation – January to December 2010

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 5 lists the average monthly inflows and releases and the EOM pool elevations for Oahe for 2009 and 2010 as well as the averages since the System first filled in 1967.

Table 5
Oahe – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation (ft msl)		
	2010	2009	1967-2010	2010	2009	1967-2010	2010	2009	1967-2010
January	18,700	16,100	23,000	17,800	14,800	20,700	1607.6	1593.1	1598.5
February	16,900	25,200	27,000	14,000	10,600*	18,200	1608.0	1596.2	1600.2
March	39,000	47,400	31,100	6,800*	12,600	18,100	1613.9	1603.7	1602.8
April	23,300	59,300**	26,900	10,200	12,000	20,700	1616.1	1612.5	1603.8
May	26,000	19,500	27,200	19,100	13,000	21,500	1617.2	1613.8	1604.7
June	23,100	21,000	28,100	19,700	21,000	24,700	1617.6	1613.5	1604.9
July	17,000	18,700	26,400	25,000	23,600	29,000	1616.2	1612.7	1604.0
August	17,900	18,800	25,000	32,100	25,600	32,200	1613.0	1610.4	1602.0
September	29,800	15,900	22,000	39,200	29,500	28,800	1610.7	1607.6	1600.3
October	29,500	15,100	20,300	38,100	16,700	23,900	1608.7	1606.8	1599.1
November	29,000	15,200	21,100	37,800	6,800	22,300	1606.5	1608.1	1598.6
December	18,900	16,000	20,400	24,800	17,500	21,000	1605.3	1607.4	1598.2

* monthly minimum of record ** monthly maximum of record

A settlement agreement was approved in an order of dismissal by the United States District Court, District of South Dakota on August 8, 2003, in the case of Lower Brule Sioux Tribe et al. v. Rumsfeld, et al. (Civil No. 02-3014 (D.S.D.)). The agreement provides that the Corps will consult with the Lower Brule Tribe and the Crow Creek Sioux Tribe during any review and revision of the Missouri River Master Water Control Manual. This agreement also provides that the Corps will coordinate the regulation of Big Bend and the water level of Lake Sharpe with the two Tribes to include the following: the Corps will normally strive to maintain a reservoir level at Lake Sharpe between elevation 1419 ft msl and 1421.5 ft msl; when the level of Lake Sharpe drops below elevation 1419 ft msl or exceeds elevation 1421.5 ft 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 ft msl or rise above 1422 ft msl, or, in the event the water level falls below 1418 ft msl or rises above 1422 ft msl, the Commander, Northwestern Division, or his designee, shall immediately contact the Chairpersons of the Tribes or their designees to notify them of the situation and discuss proposed actions to remedy the situation. During 2010 the Big Bend reservoir level varied in the narrow range between elevations 1419.4 to 1421.4 ft msl. As per the settlement agreement no additional coordination was necessary.

Table 6 lists the average monthly inflows and releases in cfs and the EOM pool elevations in ft msl for Big Bend for 2009 and 2010 as well as the averages since the System first filled in 1967.

Table 6
Big Bend – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation (ft msl)		
	2010	2009	1967-2010	2010	2009	1967-2010	2010	2009	1967-2010
January	17,700	13,800	20,500	16,800	14,000	20,400	1421.1	1420.2	1420.5
February	14,300	11,600	18,300	14,500	11,200	18,300	1420.8	1420.6	1420.4
March	13,200	12,600	18,900	13,100	12,200	18,800	1420.7	1421.0	1420.4
April	10,400	12,000	21,000	10,300	12,500	20,700	1420.6	1420.1	1420.5
May	18,200	11,400	21,800	17,900	10,700	21,600	1420.5	1420.7	1420.4
June	19,400	19,700	25,000	19,400	19,700	24,700	1420.3	1420.1	1420.3
July	23,600	22,100	28,400	23,100	21,700	27,900	1420.2	1420.3	1420.3
August	30,100	23,700	31,600	29,600	23,100	31,100	1420.0	1420.3	1420.3
September	36,600	27,600	28,400	36,300	27,000	28,000	1419.8	1420.2	1420.3
October	35,500	16,800	23,700	34,700	16,200	23,200	1420.6	1420.8	1420.5
November	35,500	6,400	23,700	35,700	6,800	22,100	1420.1	1420.2	1420.4
December	22,500	17,300	20,800	22,400	17,400	20,600	1420.1	1420.2	1420.5

b. Winter Season 2010

Flooding in the Pierre-Fort Pierre area, especially at street intersections in the Stoeser Addition, has been a recurring problem since 1979. High Oahe releases, coupled with the formation of river ice cover in the LaFrambois Island area, have historically caused water to back up into a storm sewer outlet flooding street intersections. The city of Pierre installed a valve on the Stoeser Addition storm sewer in the fall of 1998 to prevent winter flooding; however, Oahe releases will continue to be constrained at times to prevent flooding at other locations. A study, referred to as the Pierre/Fort Pierre Flood Mitigation Project, was initiated by the Omaha District in the late 1990's and finalized approximately five to seven years later. This project involved the purchase or flood-proofing of homes along the Missouri River that may be impacted by ice-affected Missouri River flows. Approximately 100 homes were purchased and removed and about 20 were flood-proofed. Some home owners chose not to participate in the voluntary project.

No flooding problems were experienced in this area during the winter of 2010. Due to the cold temperatures and ice formation on the Missouri River, a 1 unit minimum was implemented for Oahe several times over the winter. The 1 unit minimum, which is approximately 7,000 cfs, ensures that water is always flowing in the river downstream of Oahe Dam in order to lessen river ice-forming. The ice pack on the Missouri River approached as far upstream as river mile 1066.0, which is near the Missouri River at Pierre streamflow gaging station and just downstream of the Hwy 14/83 bridge. The Oahe reservoir (Lake Oahe) froze over on January 8 and was free of ice on March 31.

On January 24, a severe ice storm over the northern Plains resulted in downed transmission lines and disruption to the integrated power system. During the storm, five of the nine transmission lines out of Oahe were lost, including all four Fort Thompson lines and the Oahe to Eagle Butte/Faith line. On January 25 Oahe's generation was limited by MISO (Midwest Independent Transmission System Operator) to 50 MW. In order not to make releases of non-hydropower-generating water, the total release was reduced to a maximum hydropower release of 50 MW. This was increased to 90 MW, which was approximately 7,000 cfs, by late morning. This low release, coupled with cold temperatures and high winds, had the potential to cause ice-induced flooding in the Pierre-Fort Pierre area. Project personnel monitored the ice conditions below the project. As the downed transmission lines were repaired, the generation restriction was increased to 140 MW on the afternoon of January 26, 200 MW on January 27, and 300 MW on January 28. The generation restriction was removed on January 29. No ice-induced flooding was noted during this time.

Big Bend was regulated in the winter season to follow power peaking requirements with hourly releases varying widely. The daily average flow in 2010 varied between 0 and 56,700 cfs. The Big Bend reservoir (Lake Sharpe) froze over on December 16, 2009 and was free of ice on April 6.

c. Spring Open Water Season 2010

The melting of the above normal plains snowpack starting in early March resulted in an average monthly inflow to Oahe of 39,000 cfs (125% of average), while the releases were only 6,800 cfs (38% of average). This set a minimum average monthly release record for the month of March. Oahe releases were kept very low in March due to high tributary inflows to Fort Randall and Gavins Point and on the Missouri River downstream of Gavins Point. The combination of above normal inflows and much below normal releases caused the reservoir to rise 5.9 feet in March to 1613.9 ft msl. Average monthly releases for April (10,200 cfs, 49% of average) were below normal, while the May releases (19,100 cfs, 89% of average) were closer to normal. The average monthly inflows for April (23,300 cfs, 87% of average) and May (26,000 cfs, 96% of average) were near normal. The combination of below normal releases and average inflows resulted in the reservoir to continue to rise over the period and end May at 1617.2, 0.2 feet into the 3-foot exclusive flood control zone, which extends from 1617.0 to1620.0 ft msl. The reservoir had last been in the exclusive flood control zone in August 1999.

For 2010, Fort Peck and Oahe were given priority during the forage fish spawn in April and May. The Oahe pool level rose steadily during the critical forage fish spawn period.

d. Summer Open Water Season 2010

With average inflows for June of 23,100 cfs, still greater than the average releases of 19,700 cfs, the Oahe pool continued to rise and eventually reached its peak elevation of 1617.9 ft msl on June 26, which was 0.9 feet into the exclusive flood control zone. As inflows declined and releases were increased, the pool level then steadily declined through July, August, and September as stored flood waters in the exclusive and annual flood control and multiple use zones were evacuated. Average monthly releases for July (25,000 cfs, 86% of average) and August (32,100 cfs, 100% of average) were at or just below normal. The August 1 elevation was 1616.2 ft msl. The September 1 pool elevation was 1613.0 ft msl, 2.6 feet higher than the September 1, 2009 elevation.

e. Fall Open Water Season 2010

Fall releases from Oahe reservoir were well above normal as the evacuation of water from the annual flood control and multiple use zone continued. Average releases for September (39,200 cfs, 136% of average), October (38,100 cfs, 159% of average), and November (37,800 cfs, 170% of average) were considerably higher than the average monthly releases. In September, in response to lower than normal energy demand and transmission restrictions, the outlet tunnels were used to supplement power releases from Oahe. Starting in mid-September, water was released from the outlet works from 6:00 p.m. through 6:00 a.m. each day. This schedule was used to minimize the impacts to smelt and other forage fish species, which are light sensitive and remain on the bottom of the reservoir during daylight hours. Releases from the outlet tunnels were discontinued on November 27.

Releases were reduced in December in conjunction with the reduction in System releases at the end of the 10-day extended navigation season. Oahe ended 2010 with the pool elevation at 1605.3 ft msl, 2.2 feet below the base of the annual flood control and multiple use zone.

f. Summary

The highest Oahe reservoir level during 2010 occurred on June 26 at 1617.9 ft msl. The peak reservoir elevation was 4.0 feet higher than the 2009 peak and the highest peak since 1999. The annual minimum pool elevation of 1604.7 ft msl occurred on December 25. This was over 12 feet higher than the 2009 minimum elevation of 1592.5 ft msl. The average annual inflow to Oahe of 24,100 cfs was 97% of average (1967-2010). The average annual release from Oahe of 23,700 cfs was 101% of average (1967-2010). In 2010, Oahe rose 0.9 feet into the 3-foot exclusive flood control zone utilizing 32% of the available storage, which extends from 1617.0 to 1620.0 ft msl. Big Bend ended the year at 1420.1 ft msl, within the normal regulating range.

5. Fort Randall Regulation – January to December 2010

a. General

Fort Randall, the fourth largest System reservoir, serves all authorized purposes. Fort Randall's primary functions are: (1) to capture snow and localized rainfall runoffs in the drainage area between the Big Bend and Fort Randall dams, which are metered out at controlled release rates to meet the authorized purposes while reducing flood damages in the Fort Randall reach where several areas have homes and cabins in close proximity to the river; (2) to serve as a primary storage location along with the upstream projects for water accumulated in the System when System releases are reduced due to major downstream flood control regulation, thus helping to alleviate large pool increases in the very small Gavins Point Project; (3) to 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 7 lists the Fort Randall average monthly inflows and releases in cfs and the EOM pool elevation in ft msl for 2009 and 2010 as well as the averages since the System was first filled in 1967.

b. Winter Season 2010

The Fort Randall daily winter releases ranged from 1,400 to 17,400 cfs. The Fort Randall reservoir (Lake Francis Case) froze over on December 29, 2009 and was ice free on March 31.

c. Spring Open Water Season 2010

A combination of above normal runoff from the melting of the plains snowpack and below normal releases in March caused the Fort Randall pool to rise from a March 1 pool of 1349.0 ft msl to 1361.1 ft msl on April 1, an increase of 12.1 feet. 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 6,800 cfs was 44% of normal; the average April release of 12,500 cfs was 59% of normal; and the average May release of 22,800 cfs was 92% of normal. These below normal releases corresponded with inflows of 23,500 cfs in March (109% of normal), 14,000 cfs in April (60% of normal) and 21,300 cfs in May (87% of normal).

d. Summer Open Water Season 2010

In June, with near normal inflows (28,400 cfs, 103% of normal) and reduced releases (18,800 cfs, 70% of normal), the Fort Randall pool entered into the exclusive flood control zone for the first time since May 2001. The Fort Randall pool reached its peak elevation of 1368.2 ft msl on June 23, 3.2 feet into the 10-foot exclusive flood control zone, which extends from 1365.0 to 1375.0 ft msl. The Fort Randall summer releases were well above average: July (31,700 cfs, 104% of average), August (40,900 cfs, 122% of average), and September (44,800 cfs, 133% of normal) as releases were increased to evacuate the flood water stored in the System from the spring and summer floods.

Table 7
Fort Randall – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation (ft msl)		
	2010	2009	1967-2010	2010	2009	1967-2010	2010	2009	1967-2010
January	20,300	17,400	21,800	14,100	10,900	15,100	1345.5	1346.8	1347.2
February	16,300	14,500	20,000	11,600	6,000	13,200	1349.0	1352.8	1352.1
March	23,500	15,100	21,500	6,800	10,800	15,500	1361.1	1355.7	1356.3
April	14,000	16,600	23,400	12,500	12,700	21,100	1362.0	1358.3	1357.8
May	21,300	12,700	24,400	22,800	16,400	24,700	1360.8	1355.5	1357.4
June	28,400	22,100	27,500	18,800	22,500	26,700	1366.5	1355.0	1357.6
July	26,700	24,600	29,300	31,700	24,400	30,500	1363.1	1355.0	1356.4
August	32,400	25,700	32,400	40,900	25,600	33,400	1356.7	1354.5	1355.3
September	39,400	29,200	28,900	44,800	28,700	33,800	1352.3	1354.5	1351.1
October	37,900	17,300	23,300	47,100	26,000	32,100	1344.1	1347.4	1343.2
November	38,100	5,200	22,000	43,900	15,700	28,500	1338.3	1337.3	1336.7
December	25,000	16,600	21,700	22,800	14,300	17,200	1340.5	1339.7	1341.1

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 April 29 and ceased on August 10. Initially, peaking was limited to a continuous 6-hour time frame. On June 29, the 6-hour limit was removed since no birds were found nesting in the Fort Randall reach downstream of the dam. However, a 350 MW generation maximum was kept in place until August 10 at which time all restrictions were lifted.

e. Fall Open Water Season 2010

Normal regulation of Fort Randall includes the lowering of the pool level at the end of the navigation season to 1337.5 ft 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 ft msl through the Labor Day weekend before starting the lowering of the pool. On September 1, the pool level was at 1356.7 ft msl. The lowering of Fort Randall was started after Labor Day and was extended into December due to the 10-day extension of the navigation season. Fort Randall reached its lowest level of 1337.3 ft msl on December 6.

f. Summary

The highest Fort Randall reservoir level during 2010 occurred on June 23 at 1368.1 ft msl. The lowest reservoir level during 2010 occurred on December 6 at 1337.3 ft msl. The average annual inflow to Fort Randall of 27,000 cfs and the average annual release of 26,500 cfs were both 109% of average (1967-2010). In 2010, Fort Randall rose 3.2 feet into its 10-foot exclusive flood control zone, which extends from 1365.0 to 1375.0 ft msl.

6. Gavins Point Regulation – January to December 2010

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 less than 500,000 acre-feet, it provides only a small amount of flood control and is generally maintained in a narrow reservoir elevation band between 1205.0 and 1208.0 ft 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 power plant capacity, near 35,000 cfs, are passed through the spillway.

Table 8 lists the Gavins Point average monthly inflows and releases in cfs and the EOM pool elevation in ft msl for 2009 and 2010 as well as the averages since the System was filled in 1967.

b. Winter Season 2010

The Gavins Point average daily release was below the normal winter release rate for the entire winter season. The Gavins Point winter releases varied between 14,700 cfs to 18,500 cfs in December; 14,700 cfs to 17,000 cfs in January; and 15,000 cfs to 15,500 cfs in February. The Gavins Point reservoir (Lewis and Clark Lake) froze over on December 14, 2009 and was free of ice on April 1. Gavins Point reservoir reached the year’s lowest elevation of 1204.7 ft msl on January 1, 2010.

c. Winter River and Ice Conditions Below Gavins Point

The first signs of floating ice on the Missouri River during the 2010 winter season were noted on December 7, 2009 in the reach from Sioux City, IA downstream to

Table 8
Gavins Point – Inflows, Releases, and Elevations

Month	Ave Monthly Inflow (cfs)			Ave Monthly Release (cfs)			EOM Elevation (ft msl)		
	2010	2009	1967-2010	2010	2009	1967-2010	2010	2009	1967-2010
January	17,000	13,200	17,200	15,900	12,900	17,100	1207.4	1208.0	1207.6
February	14,300	9,300	16,400	15,000	10,300	17,200	1205.9	1205.7	1205.7
March	15,100	13,900	19,600	15,000	13,400	19,600	1206.1	1207.2	1205.6
April	15,400	16,900	25,000	15,300	17,000	24,800	1206.2	1206.4	1205.8
May	25,600	18,700	28,400	25,200	18,600	28,100	1206.8	1206.4	1206.0
June	27,400	24,800	30,000	27,700	24,500	29,800	1205.6	1206.7	1206.2
July	35,400	26,800	32,700	35,100	26,500	32,200	1206.0	1206.9	1206.7
August	42,300	27,500	35,100	41,900	27,300	34,600	1206.3	1206.8	1207.3
September	48,200	30,500	35,900	47,200	30,100	35,500	1208.1	1206.8	1207.7
October	48,700	29,200	34,500	48,700	28,700	34,300	1207.6	1208.1	1207.8
November	46,100	19,300	30,900	46,100	19,600	30,900	1207.2	1207.3	1207.6
December	25,700	14,800	19,300	25,200	15,800	19,400	1207.8	1204.5	1207.3

Omaha, NE. The report showed 0 to 75% floating ice with pads ranging from 5 to 10 feet. On December 6 the Gavins Point releases were increased from 15,000 cfs to 17,000 cfs for two days to offset the loss in downstream flow. During this cold period, with air temperatures in the teens, an ice bridge formed upstream of Sioux City. The winter season's largest drop in stage of over 4 feet occurred at Sioux City, reaching the season's lowest stage of 7.0 feet on December 10. This dip in the Missouri River stages and flows migrated downstream. On December 15 stages at Kansas City, MO dropped less than a foot to its season low of 6.0 feet. Gavins Point releases were reduced to 15,000 cfs on December 24, 2009 and were kept at that rate until January 2, 2010. In late December, another round of extreme cold temperatures, and the affects of an upstream ice bridge, resulted in a stage reduction at Sioux City of over 3 feet and drop of stage to 9.1 feet.

Gavins Point releases were stepped up in early January from 15,000 to 17,000 cfs by January 6, 2010 and remained at that rate for six days as a round of extreme cold temperatures arrived on January 2 and stayed through January 8. During this period, the season's largest volumes and extent of floating ice was noted on the Missouri River. The observers from Sioux City, IA downstream to Glasgow, MO reported 35 to 90% floating ice with pads ranging in size from 5 to 45 feet. The reports of floating ice on the lower Missouri River were less than 20% ice coverage from January 14-28, with pads less than 10 feet when warmer temperatures were noted. The volumes of floating ice picked up the last three days of January for the Sioux City, IA to Nebraska City, NE reach of the

Missouri River, when some single digit to low-teen temperatures were experienced. Gavins Point releases were increased to 17,000 cfs on January 26 in anticipation of the colder temperatures and potential for floating ice formation. Observations of 5 to 40% floating ice were reported with pad size ranging from 5 to 10 feet. On January 29, an ice bridge with a small open channel was reported in the Ponca, NE area. The Missouri River stage and flows were not impacted by the reported ice bridge. Another round of sub-zero temperatures arrived on February 9 and produced some small volumes of floating ice from 5 to 40% near Sioux City, IA with pads 5 to 20 feet in size. During the remainder of the month, the floating ice reports showed 20% or less for the Sioux City, IA to Omaha, NE reach of the Missouri River. The floating ice pad sizes were 5 to 15 feet in size and no major changes in stages occurred on the Missouri River. The winter's final round of below freezing temperatures came in early March with volumes of 10 to 20% with small pad sizes ranging from 5 to 15 feet. The season's last report of floating ice on the Missouri River was made on March 10. River conditions at Omaha, NE consisted of 2- to 5-foot broken ice blocks that were flushed from upstream tributaries.

d. Spring Open Water Season 2010

On March 1, 2010 the System storage was 54.6 MAF, which was 14.6 MAF above the minimum storage level of 40 MAF required to conduct a March pulse as per the Master Manual. The March spring pulse from Gavins Point was not conducted in 2010 because of the high downstream flows. The combination of melt of the plains snowpack in eastern South Dakota, eastern Nebraska and western Iowa and heavy localized rain over eastern South Dakota raised the Missouri River levels well above the downstream flow limits. The magnitude of the March pulse is 5,000 cfs minus the flow on the James River just above its confluence with the Missouri River upstream from Sioux City, IA. The James River flows were above 5,000 cfs until May 27 and then declined to 4,800 cfs for 10 days before another round of rain caused a rise. Flows peaked on the James River at Scotland, SD at 27,500 cfs on March 19, and the flows gradually dropped to 17,000 cfs by March 23 and remained at a high level for the rest of March. The Missouri River flows at Omaha were above the flow limit of 41,000 cfs from March 12 to April 14; Nebraska City was above the flow limit of 47,000 cfs from March 10 through December 13, except for 8 hours on April 22 when it dropped to 46,700 cfs. The much above average spring, summer, and fall rainfall events in the lower basin resulted in flows at Kansas City, MO exceeding the flow limit of 71,000 cfs from March 8 through November 28. The downstream Missouri River flow limits are the safeguards to reduce or eliminate the pulse to ensure that the two day pulse does not cause downstream flooding of agricultural land along the Missouri River.

Flow support for the 2010 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.

The March, April and May average monthly releases were all below normal, though not as low as the historic low levels experienced in 2007. Average monthly releases of 15,000 cfs for March were 76% of average, 15,300 cfs for April were 62% of average, and 25,200 cfs for May were 90% of average. The System releases were maintained at below normal levels through June to decrease the risk of downstream flooding. During the late summer and fall, System releases were gradually increased to above normal levels to evacuate the flood waters from the flood control zones at Fort Peck, Garrison, Oahe and Fort Randall.

On May 1, cycling of Gavins Point releases was initiated. Cycling of releases is conducted in order to encourage the T&E birds to nest on the higher elevation areas of downstream sandbars. This allows for future System release increases to support navigation. In this case, the cycling was targeted at the reach from Gavins Point Dam to the confluence of the James and Missouri River. Releases were varied from 22,000 cfs up to 28,000 cfs for eight hours every other day. Starting on May 18 the lower level system releases were gradually increased from 22,000 to 26,000 cfs.

The May Spring Pulse was not conducted in 2010**.** System storage was the only one of the three requirements met to run the May Spring Pulse. On May 1, the System storage of 59.4 MAF exceeded the minimum 40 MAF required storage by 19.4 MAF. The second requirement is the downstream Missouri River flow limits. The flow limits of 41,000, 47,000 and 71,000 cfs were exceeded the entire month of May at Omaha, Nebraska City, and Kansas City, respectively. The third requirement is the Missouri River water temperature at Yankton, SD of 16^{o}C or warmer. The Missouri River water temperature at Yankton did not exceed 16^{o}C until May 21. All three requirements must be met between the dates of May 1 and May 19 in order for the Corps to run the May Spring Pulse.

e. Summer Open Water Season 2010

The average June System release of 27,700 cfs was 93% of normal. For the first eleven days of June the System releases continued the cycling that was started in May. The releases were increased to 28,000 cfs for eight hours every other day with the low days at 26,500 cfs. On June 10-11, heavy summer rainfalls of 5-8 inches fell over the lower Niobrara River basin, which drains into the Missouri River downstream of Fort Randall dam. In addition heavy rains fell in areas of southwestern South Dakota upstream of both Gavins Point and Fort Randall. These rains produced large volumes of runoff into both Gavins Point and Fort Randall reservoirs. Gavins Point releases were increased to a steady 33,000 cfs on June 15 due to high inflows between Fort Randall and Gavins Point. Due to extreme rainfall in the incremental drainage area between Fort Randall and Gavins Point, the Gavins Point reservoir (Lewis and Clark Lake) reached its annual peak elevation of 1209.7 ft msl on June 14. The top of the exclusive flood control zone is 1210.0 ft msl, the elevation of the top of the spillway gates when closed. The System releases were held at 33,000 cfs for five days to evacuate the water out of the Gavins Point exclusive flood control zone. By June 20 the Gavins Point reservoir reached the month’s minimum elevation of 1205.2 ft msl. A 18,000 cfs reduction in System releases was made on June 22, and the releases were held for two days at 15,000 cfs, in order to reduce peak stages in the lower Missouri River. As the downstream stages declined, the releases were gradually increased over a five-day period ending June 27 to near full power plant release of 33,500 cfs.

The July 1 System storage check resulted in an 10-day extension of the navigation season to December 10. The average monthly July release of 35,100 cfs was 2,900 cfs above the normal monthly July release. The Gavins Point releases were held at near full power plant release capacity, about 33,500 cfs, until July 19 when additional water was released through the spillway. During August, releases ranged from 39,500 to 46,100 cfs in order to evacuate stored flood waters from the upstream reservoirs. The average monthly August release of 41,900 cfs was 7,300 cfs above the average. Powerhouse releases range from 33,400 to 33,600 cfs and the spillway release increased from 5,900 to 12,600 cfs by the end of August.

f. Fall Open Water Season 2010

System releases were maintained in the 42,000 to 49,000 cfs range in September through the first of December to continue evacuation of stored flood water from the System. These flood evacuation releases were reduced beginning on December 8 and by December 16 the minimum winter release of 17,000 cfs was reached. This year's navigation season was the first year for a full season length with a 10-day extension since 1999.

g. Summary

On June 14 the Gavins Point reservoir level reached 1209.7 ft msl, a record high since the System was filled in 1967. The lowest reservoir level during 2010 occurred on January 1, at 1204.7 ft msl. The average annual inflow to Gavins Point of 30,100 cfs was 111% of average (1967-2010). The 2010 average annual release from Gavins Point of 29,900 cfs was 111% of average (1967-2010).

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 2010 that may be considered unusual, or recently have come to the attention of MRBWM, are discussed in the following paragraphs.

1. Lawsuits

There were no lawsuits related to regulation of the Missouri River Mainstem System in 2010.

2. Intrasystem Unbalancing and Fort Peck Mini-Test

As described in the 2009-2010 AOP, the unbalancing of the three large upper reservoirs and Fort Peck "mini-test" have not been implemented in previous years due to low System storage. By late 2009, the System storage had recovered sufficiently that the Corps planned on transitioning to unbalancing in 2010 to benefit reservoir fisheries. However, the 2009 and 2010 runoff events provided more variability of reservoir levels than was required by the current Missouri River Natural Resources Committee (MRNRC) guidelines (see Plate 3, 2009-2010 AOP). Additionally, experience in previous years has shown that storing water in the annual flood control and multiple use zone, particularly at Oahe, as the current criteria requires in order to implement unbalancing, is undesirable due to the flood control impacts. The Corps will work with each of the appropriate state agencies in 2012 to determine a modified version of unbalancing that may be implemented in the future that does not adversely impact flood control.

The endangered species modified flow "mini-test," which was designed to monitor the effects of higher spring releases and warmer water released from the Fort Peck spillway, requires a reservoir elevation of approximately 2229 ft msl to avoid unstable flows over the spillway. In previous years, the "mini-test" was not possible because reservoir elevations during May and June were below the spillway crest elevation of 2225 ft msl. Fort Peck reservoir reached elevation 2229 feet msl in June 2010. However, in 2009, a priority for pallid sturgeon recovery has been placed on the Lower Yellowstone Project at Intake, MT. The Fort Peck mini-test and full test flows will be deferred until the efficacy of the Lower Yellowstone Project has been assessed as discussed in the 2010-2011 AOP. The groundbreaking for this project took place in August 2010.

3. Summary of Drought Impacts

Above normal runoff in 2008 ended the 8-year drought in the Missouri River basin. During this drought the System storage set a new record low of 33.9 MAF on February 8, 2007, 6.9 MAF below the record low of 40.8 MAF set in the previous drought in January 1991. System storage ended 2009 at 54.3 MAF, 10.3 MAF higher than the previous year. Because the bulk of the carryover multiple use storage is in the upper three reservoirs, Fort Peck, Garrison, and Oahe reservoirs set new record low pool levels during the 2000-2007 drought. The increase in storage during 2008 and 2009 was an improvement from the drought, and greatly reduced the drought impacts that had been felt across the basin. During the drought some of the municipal, rural, industrial, and irrigation water intakes in the reservoirs and along the river reaches were forced to make modifications to maintain access to the water. Many of the boat ramps were extended, relocated or closed as the reservoir levels declined. During the drought significantly lower than normal storage in the upper three reservoirs affected the coldwater habitat, specifically in the Garrison reservoir. During the 2010 runoff year, Fort Peck, the last project to fully recover from the drought, reached 2234 ft msl on July 5, the base of its annual flood control and multiple use zone.

4. Summary of Flood Events below Gavins Point

The flooding in the lower Missouri River was caused by two factors, an above average plains snowpack, which contributed to peak discharges on the James and Vermillion Rivers, and multiple severe thunderstorms in areas that drain into the Missouri River downstream of Gavins Point. As the spring and summer runoff season was completed, 11 of 21 major tributary streams between Gavins Point Dam and Hermann, MO experienced flows that ranked within the historical top ten discharges for each respective stream. See ***Figure 9A*** and ***Table 9*** for a graphical representation and a listing of peak flows, respectively.

In southern South Dakota the spring snowmelt began in early March and was essentially completed after two weeks. By March 18 the snowpack was completely melted in the Big Sioux River basin near Sioux Falls, SD. The James River at Scotland, SD peaked on March 19 at 27,500 cfs due to snowmelt runoff. This was the third highest measured discharge at Scotland in 81 years of record. The James River at Scotland remained above flood stage of 13.0 feet from March 11 through August 20. The Vermillion River at Vermillion, SD peaked on March 19 at a discharge of 10,900 cfs, the second highest recorded discharge since 1984. The Missouri River at Omaha, NE peaked on March 21 as result of the spring snowmelt runoff and a lower basin late winter rainstorm on March 9-11. The peak discharge at Omaha of 103,000 cfs was the fifth highest since 1967 and the highest since the April 15, 1997 peak of 110,000 cfs. The Missouri River stage for the peak discharge on March 21 was 27.6 ft, 1.4 feet below flood stage. The annual peak stage at Omaha occurred on July 1 at 28.7 ft, 0.3 feet below the 29.0 ft flood stage. ***Figure 9B*** shows 2010 peak stage reductions due to System operations at Missouri River gaging locations from Sioux City, IA to Hermann, MO.

End-of-month March System storage was 58.2 MAF, 107% of normal. March daily releases from Gavins Point averaged 15,000 cfs, 4,600 cfs below the average release of 19,600 cfs (***Table 8***). A more detailed discussion on average releases can be found in Section II.C.6 of this report. This release was equivalent to 55% of the peak discharge from the James River at Scotland and 20% of the monthly peak daily discharge of 75,100 cfs for the Missouri River at Sioux City on March 19.

No major runoff events occurred in April, although two strong storm systems delivered heavy rains throughout the Plains at the end of April. This resulted in an increase in both soil saturation conditions and flows on the tributaries. The month of May was a particularly wet month in the Missouri River basin with major rainfalls occurring about every five days. Intense thunderstorms occurred on May 10-13 over the State of Missouri and delivered in excess of 4 inches of rain over a very large area. On May 15 the Missouri River at Boonville, MO experienced the sixth highest recorded discharge since the System was filled in 1967.

Missouri River and Major Tributaries below Gavins Point Dam

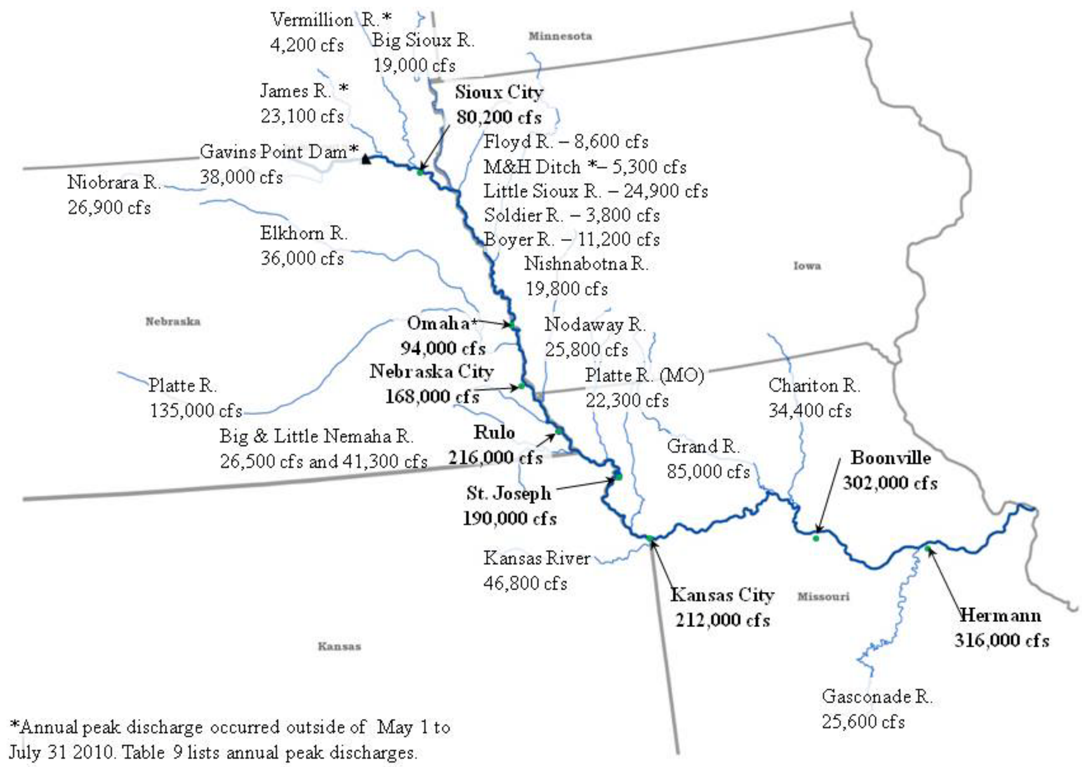


Figure 9A. May June and July 2010 Annual Peak Discharges below Gavins Point Dam.

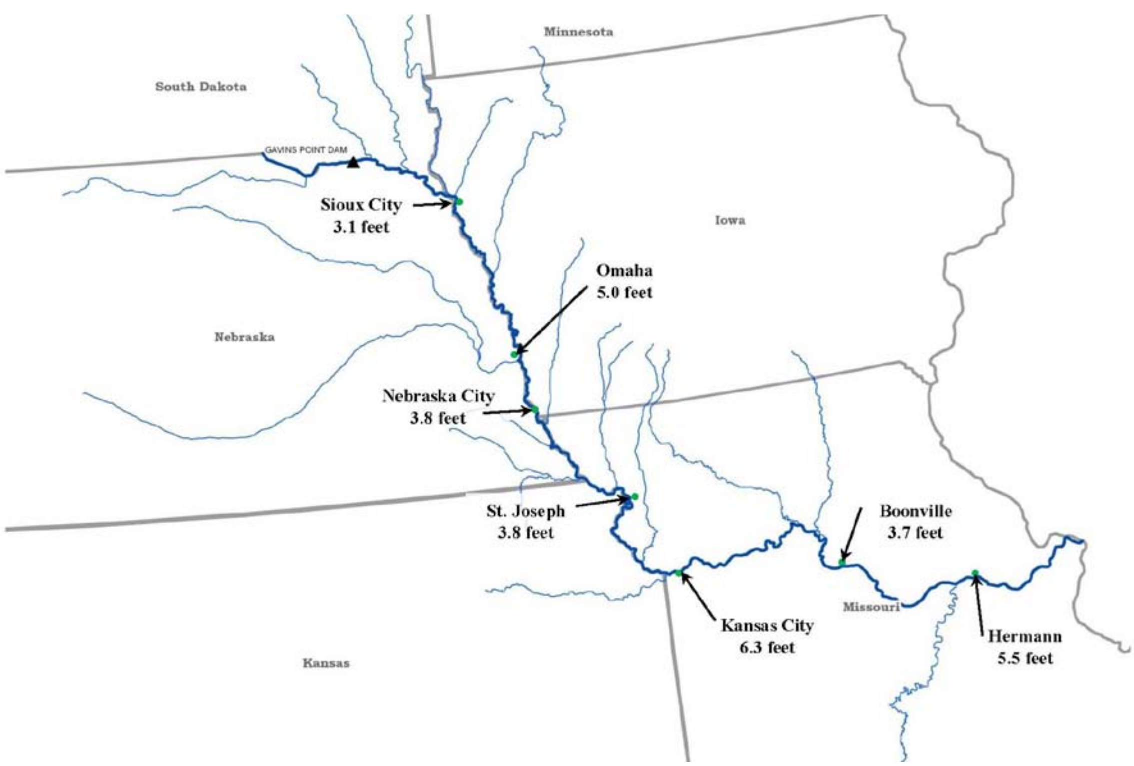


Figure 9B. Missouri River Peak Stage Reductions Due to Corps Reservoir Operations in 2010

Table 9
2010 Peak Discharges Below Gavins Point Dam

River	Site	Station ID	Historic Rank of Event	2010 Annual Peak Discharge	2010 Annual Peak Discharge Date	May-July Peak Discharge	May-July Peak Discharge Date
Niobrara	Verdel, NE	VRNE	3/55	26,900	22-Jul	26,900	22-Jul
James	Scotland, SD	SCSD	3/82	27,500	19-Mar	23,100	15-Jun
Vermillion	Vermillion	VRSD	2/27	10,600	19-Mar	4,200	30-Jul
Big Sioux	Akron, IA	AKIA	7/82	38,300	27-Sep	19,000	1-Aug
Floyd	Alton, IA	ANIA	5/76	8,580	23-Jul	8,600	23-Jul
M&H Ditch	M&H Ditch, IA	MHIA	34/71	5,740	15-Mar	5,300	13-Jun
Little Sioux	Turin, IA	TUIA	5/71	24,900	30-Jun	24,900	30-Jun
Soldier	Pisgah, IA	PSIA	55/71	3,770	30-Jul	3,800	30-Jul
Boyer	Logan, IA	LGIA	41/82	11,200	27-Jun	11,200	27-Jun
Elkhorn	West Point, NE	WTNE	33/66	36,000	7-Jun	36,000	7-Jun
Platte (NE)	Louisville, NE	LUNE	2/59	135,000	14-Jun	135,000	14-Jun
Nisnabotna	Hamburg, IA	HAIA	30/85	19,800	14-Jun	19,800	14-Jun
Nodaway	Graham, MO	GRAM	8/28	25,800	14-Jun	25,800	14-Jun
Platte (MO)	Sharps Station, MO	SSMO	8/31	22,300	18-Jun	22,300	18-Jun
Grand	Sumner, MO	SMNM	17/90	85,000	14-May	85,000	14-May
Chariton	Prairie Hill, MO	PRIM	4/82	34,400	23-Jul	34,400	23-Jul
Kansas	Desoto, KS	DESO	26/37	46,800	17-Jun	46,800	17-Jun
Osage	Bagnell Dam, MO	BAGL	53/79	50,500	28-May	50,500	28-May
Gasconade	Rich Fountain, MO	RIFM	17/71	25,600	22-May	25,600	22-May
Little Nemaha	Auburn, NE	AUNE	8/61	41,300	21-Jun	41,300	21-Jun
Big Nemaha	Falls City, NE	FLNE	29/68	26,500	2-Jun	26,500	2-Jun
Missouri	Gavins Point, SD	GAPT	-----	50,900	November	38,000	July
Missouri	Sioux City, IA	SUX	4/43	86,600	30-Sep	80,200	30-Jul
Missouri	Omaha, NE	OMA	5/43	103,000	21-Mar	94,000	1-Jul
Missouri	Nebraska City, NE	NCNE	4/43	168,000	15-Jun	168,000	15-Jun
Missouri	Rulo, NE	RUNE	4/43	216,000	24-Jun	216,000	24-Jun
Missouri	St. Joseph, MO	STJ	4/43	190,000	25-Jun	190,000	25-Jun
Missouri	Kansas City, MO	MKC	7/43	212,000	18-Jun	212,000	18-Jun
Missouri	Boonville, MO	BNMO	6/43	302,000	15-May	302,000	15-May
Missouri	Hermann, MO	HEMO	17/43	316,000	17-May	316,000	17-May

The wet cycle continued into the month of June and the majority of tributaries experienced peak flows during this time. This series of intense thunderstorms contributed 200-300% of normal monthly precipitation totals across Nebraska, Kansas and Missouri. On June 14, the Platte River at Louisville, NE experienced the second largest measured streamflow, a discharge of 135,000 cfs, in 59 years of record. The Nishnabotna River at Hamburg in southwest Iowa (19,800 cfs), the Nodaway River at Graham in northwest Missouri (25,800 cfs), and the Platte River in northwest Missouri at Sharps Station (22,300 cfs) also peaked on June 14 due to heavy thunderstorms.

Other notable peak discharges occurring due to the June thunderstorms include the Little Nemaha River at Auburn in southeast Nebraska, on June 21, at 41,300 cfs, its eighth largest discharge in 61 years of record. The Little Sioux River basin in northwest Iowa received 5.0 to 6.15 inches of rain on June 27. At Turin, IA the Little Sioux River crested at 24,900 cfs on June 30, the fifth largest discharge in 71 years at this location.

The Missouri River from Nebraska City, NE to Kansas City, MO peaked between June 15 and 25. The reach between Nebraska City and Rulo, NE experienced the fourth largest discharge on record, and the largest since the 1993 flood, at both Nebraska City (168,000 cfs on June 15) and Rulo (216,000 cfs on June 24). Of note at Rulo is the change in river channel-conveyance conditions that resulted in a record stage of 26.6 feet, with a USGS-measured flow of approximately 205,000 cfs, on June 23. The previous record stage at Rulo was 25.6 feet with a flow of 305,000 cfs, 1 foot lower and 100,000 cfs higher, set in April 1952, prior to the Missouri River Mainstem System being in place. Several of the Federal levees in this reach experienced peak stages very near the crests, in particular L550 near Rockport, MO. At Nebraska City, the Missouri River remained above the 18.0-foot flood stage for 62 of 69 days from June 11 to August 18. Further downstream, Rulo was above its 17.0-foot flood stage for 71 days from June 12 through August 21.

At St. Joseph, the Missouri River peak discharge of 190,000 cfs occurred on June 15 and crested on June 25 at 26.2 feet, 9.8 feet above flood stage. Downstream at Kansas City, the peak discharge of 212,000 cfs was the seventh largest since the Missouri River System filled in 1967.

As shown in ***Figure 10***, during the month of June, the major sources of incremental flows at Hermann, MO were primarily from the tributaries in the reaches of Omaha, NE to Nebraska City, NE and Waverly, MO to Boonville, MO. Releases from Gavins Point contributed 27,700 cfs (12%) of the daily mean discharge of 230,000 cfs for June at Hermann. Tributary flows, primarily the James and the Big Sioux Rivers, between Gavins Point Dam and Sioux City, accounted for 10% of the discharge. The Platte River in Nebraska was the largest contributor of flow with 45,400 cfs, or 20%, of the flow at Hermann. Downstream, inflows from the Grand, Chariton and Gasconade Rivers contributed 44,000 cfs (18%) between Boonville and Hermann, MO.

In an effort to maintain System releases as low as possible to reduce downstream stages, two of the three large upper mainstem reservoirs, Garrison (Lake Sakakawea),

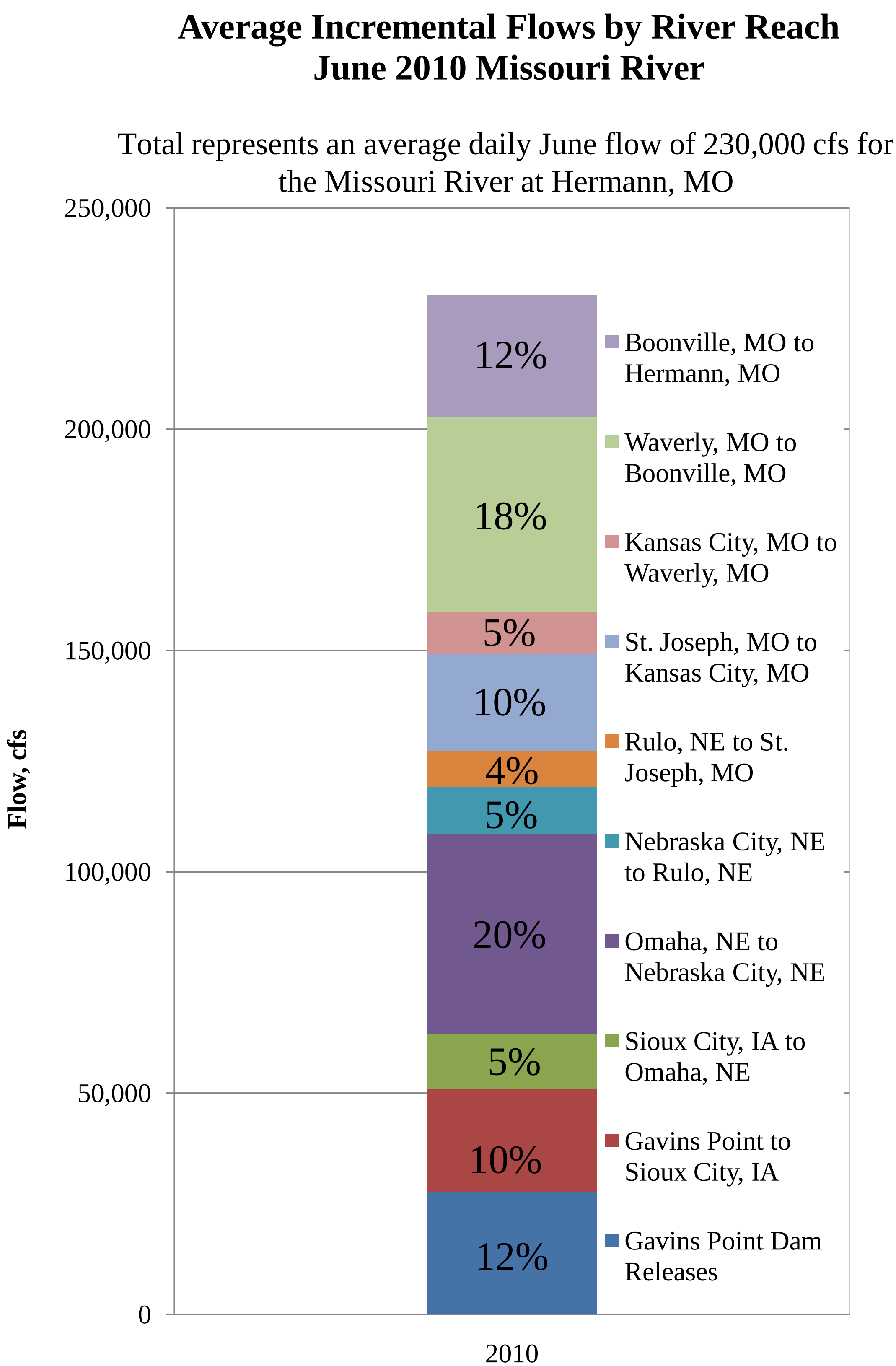


Figure 10. Average Incremental Flows for June 2010 for the Missouri River from Gavins Point Dam to Hermann, MO.

Oahe (Lake Oahe) and Fort Randall (Lake Francis Case), would rise into their exclusive flood control pools during the 2010 open water season. The Oahe reservoir was the first to enter its exclusive flood control zone at the end of June. The Garrison reservoir would enter its exclusive flood control zone soon after in early July. These rises in the exclusive flood control pools were due to both plains and mountain snowmelt runoff and regulation of the projects to help endangered species nesting downstream of the reservoirs. Further detail on individual regulation for these reservoirs is found in Sections II.C.3 and II.C.4 of this report.

E. Reservoir Elevations and Storage

Reservoir elevations and storage contents of the System reservoirs at the end-of-July 2010 are presented in ***Table 10*** and the same information for end-of-December 2010 is presented as ***Table 11***. The 12-month change columns indicate significant increases in the elevations and respective storages in the upper three large storage reservoirs with two of the three reservoirs, Garrison and Oahe, rising into their exclusive flood control zones.

Table 10
Reservoir Levels and Storages – July 31, 2010

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	2235.8	+15.3	15,172	11,084	+3,019
Garrison	1850.8	+8.5	22,629	17,649	+3,019
Oahe	1616.2	+3.5	21,673	16,300	+1,146
Big Bend	1420.2	-0.1	1,641	20	+1
Fort Randall	1363.1	+8.1	4,248	2,731	+720
Gavins Point	1206.0	-0.4	344	37	-20

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

Table 11
Reservoir Levels and Storages – December 31, 2010

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	2235.4	+14.3	15,074	10,986	+2,808
Garrison	1841.7	+1.7	19,409	14,429	+559
Oahe	1605.3	-2.1	18,059	12,686	-748
Big Bend	1420.1	-0.1	1,631	10	+3
Fort Randall	1340.5	+0.8	2,468	951	+53
Gavins Point	1207.8	+3.2	388	81	+78

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

Figure 11 shows the end-of-July pool elevations for Fort Peck, Garrison, and Oahe plus total System end-of-July storage for 2008 through 2010. Individual tables with the historic maximum, average, and minimum pool elevations for each reservoir are also shown on ***Figure 11*****.** During 2010, the upper three reservoirs all had higher July 31 pool levels than 2009. 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. On July 31 Fort Peck Lake was at elevation 2235.8 feet msl, 15.3 feet higher than at the same time in 2009. On July 31 Lake Sakakawea was at elevation 1850.8 feet msl, 0.8 foot into the exclusive flood control zone, and 8.5 feet higher than at the same time in 2009. Lake Oahe was at elevation 1612.2 on July 31, 3.5 feet higher than at the same time in 2009.

F. Summary of Results

1. Flood Control

Releases during 2010 were influenced by flood reduction efforts downstream of the System. The storage of flood waters resulted in the use of the exclusive flood control zone in four projects – Garrison, Oahe, Fort Randall and Gavins Point. The above average runoff and low Fort Peck releases resulted in Fort Peck fully recovering from the 2000-2007 drought.

The estimated total flood damages prevented by all Corps projects in the basin during 2010 exceeded $3.1 billion ($598 million Omaha District; $2.56 billion Kansas City District). The estimated total flood damages prevented by the Mainstem System during 2010 were $2.34 billion (***Figure 12A***). The total damages prevented by the Mainstem System in the Missouri River basin included $415 million in the Omaha District and $1.92 billion in the Kansas City District. The unindexed flood damages prevented by the Mainstem System since its construction now total $27.2 billion, the bulk of which was prevented during the six-year period from 1993 to 1999 (see ***Figure 12B***). ***Figure 12B*** indicates the flood damages prevented indexed to 2010. For comparison purposes, the ***Figures 12A*** and ***12B*** include the construction cost of the dams.

Figure 13 shows the actual or regulated Missouri River flows that were experienced at Sioux City, IA, Nebraska City, NE and St. Joseph, MO and the unregulated flows that would have been experienced if the Missouri River Mainstem System and tributary reservoirs had not been in place.

2. Irrigation

Federally developed irrigation projects are not being served directly from the Mainstem 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. Releases from the six mainstem reservoirs during 2010 generally met the needs of the irrigators. For the reach downstream from Fort Peck, the summer releases in recent years were held to a daily average of 6,500 cfs with a minimum hourly release of 4,500 cfs to meet the needs of irrigators. In 2010, Fort Peck daily average summer releases ranged from 4,500 cfs to 6,500 cfs. Daily average flows from Fort Peck were set below 6,500 cfs only when flows from the Milk River, in central Montana, provided the additional flow required to meet the needs of the irrigators. At some intakes below Fort Peck dredging was necessary to maintain access to the water.

3. Water Supply and Water Quality Control

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. In emergency situations, short-term adjustments to protect human health and safety would be considered to keep M&I intakes functioning. Low reservoir levels during the 2000-2007 drought contributed to both intake access and water quality problems for intakes on Garrison and Oahe reservoirs, including several Tribal intakes. In 2010, pool levels for all three upper reservoirs were between 25 and 35 feet higher than the record lows set in the current drought and no problems were experienced.

Intake owners today are generally better prepared to handle periods of low water due to adjustments made to intakes or regulations procedures. The intake owners have made various adjustments to their operations to account for low water levels. 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 were expensive, they have significantly improved the ability of the intakes to operate at lower river stages and reservoir levels.

During 2010, the Omaha District conducted long-term, fixed-station ambient water quality monitoring at the System reservoirs and the lower Missouri River. Water quality conditions of the water discharged through each of the System dams was continuously monitored. Intensive water quality surveys were conducted at Big Bend, Gavins Point, and the lower Missouri River. The intensive survey of the lower Missouri River was conducted jointly with the Kansas City District and extended from Gavins Point Dam to the river's mouth at St. Louis. A special water quality study was conducted at the Fort Randall Dam tailwaters.

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

1) Determine how regulation of the System affects water quality in the impounded reservoir and downstream river. 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.

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

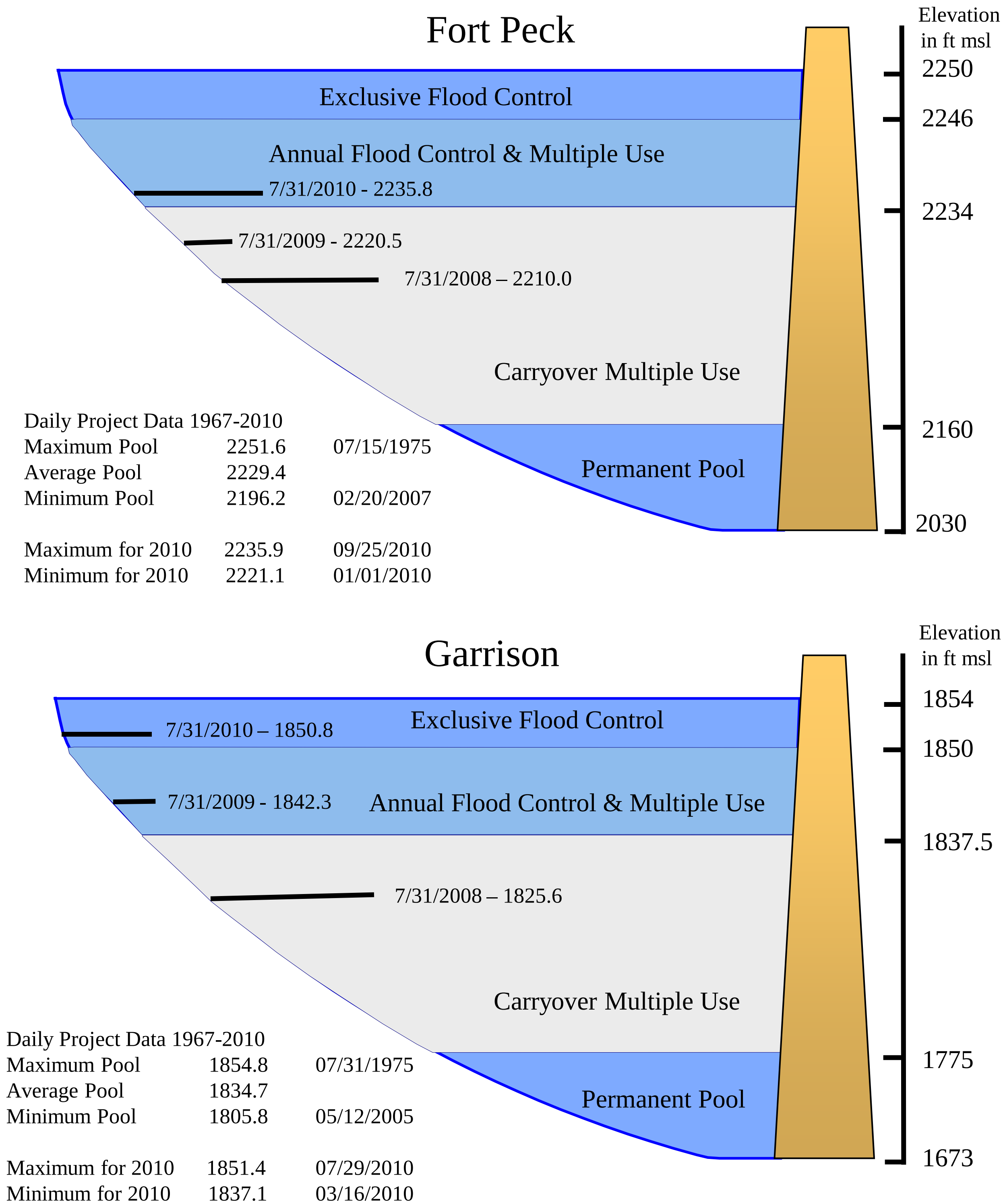
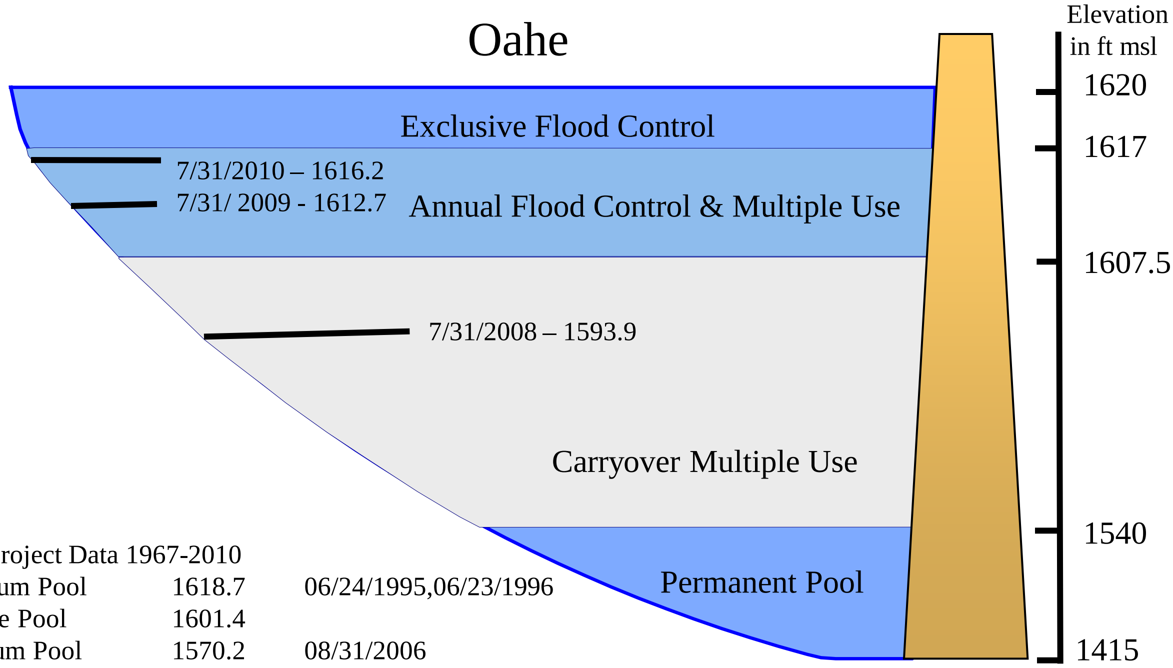


Figure 11A. End of July pool elevations for Fort Peck and Garrison.

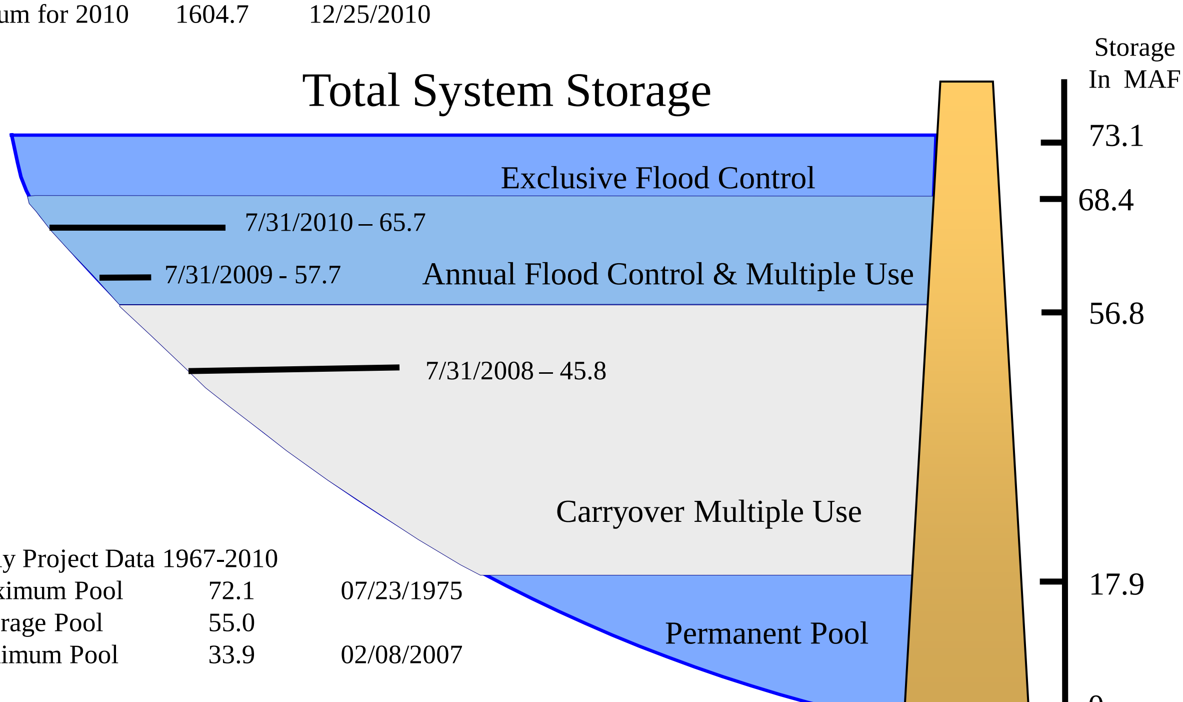
Missouri River System Reservoirs
End of July Pool Elevations and Total System Storage

Oahe



Daily Project Data 1967-2010		
Maximum Pool	1618.7	06/24/1995,06/23/1996
Average Pool	1601.4	
Minimum Pool	1570.2	08/31/2006
Maximum for 2010	1617.9	06/26/2010
Minimum for 2010	1604.7	12/25/2010

Total System Storage



Daily Project Data 1967-2010		
Maximum Pool	72.1	07/23/1975
Average Pool	55.0	
Minimum Pool	33.9	02/08/2007
Maximum for 2010	65.9	07/23/2010
Minimum for 2010	54.3	01/08/2010

Figure 11B. End of July pool elevation for Oahe and Total System Storage.

Missouri River Mainstem Reservoirs Flood Damages Prevented

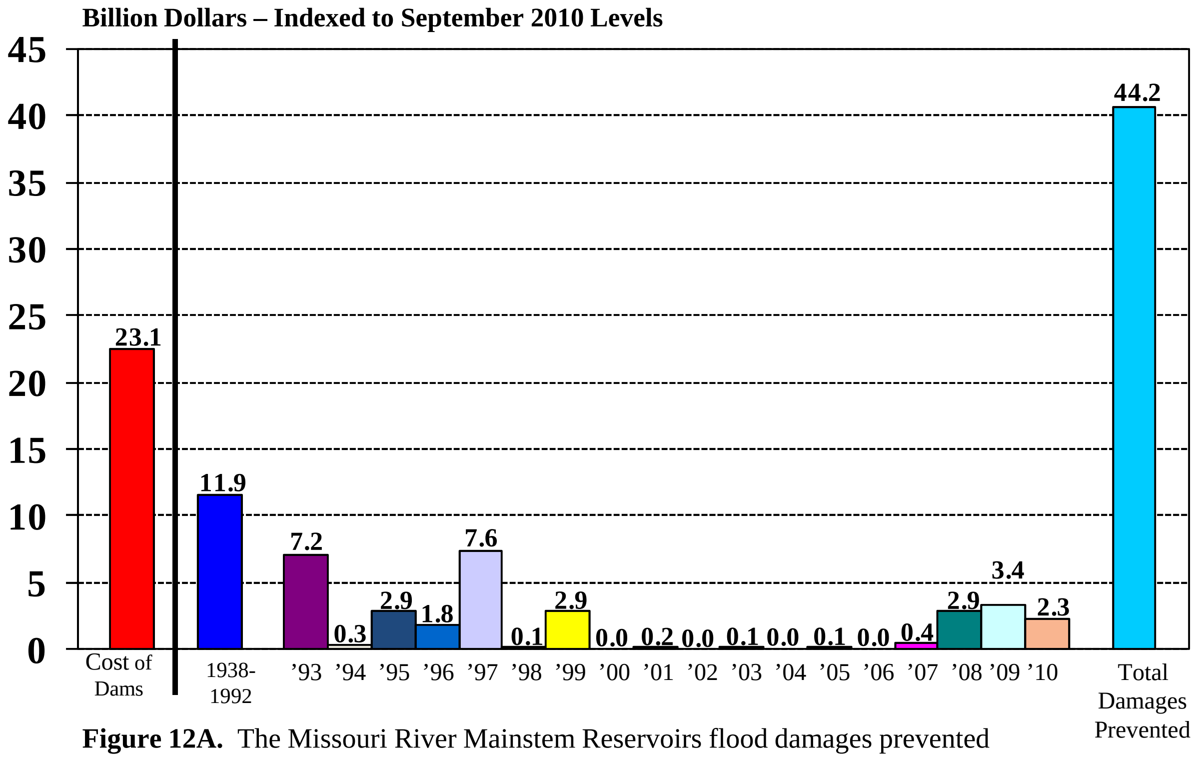


Figure 12A. The Missouri River Mainstem Reservoirs flood damages prevented indexed to September 2010 levels.

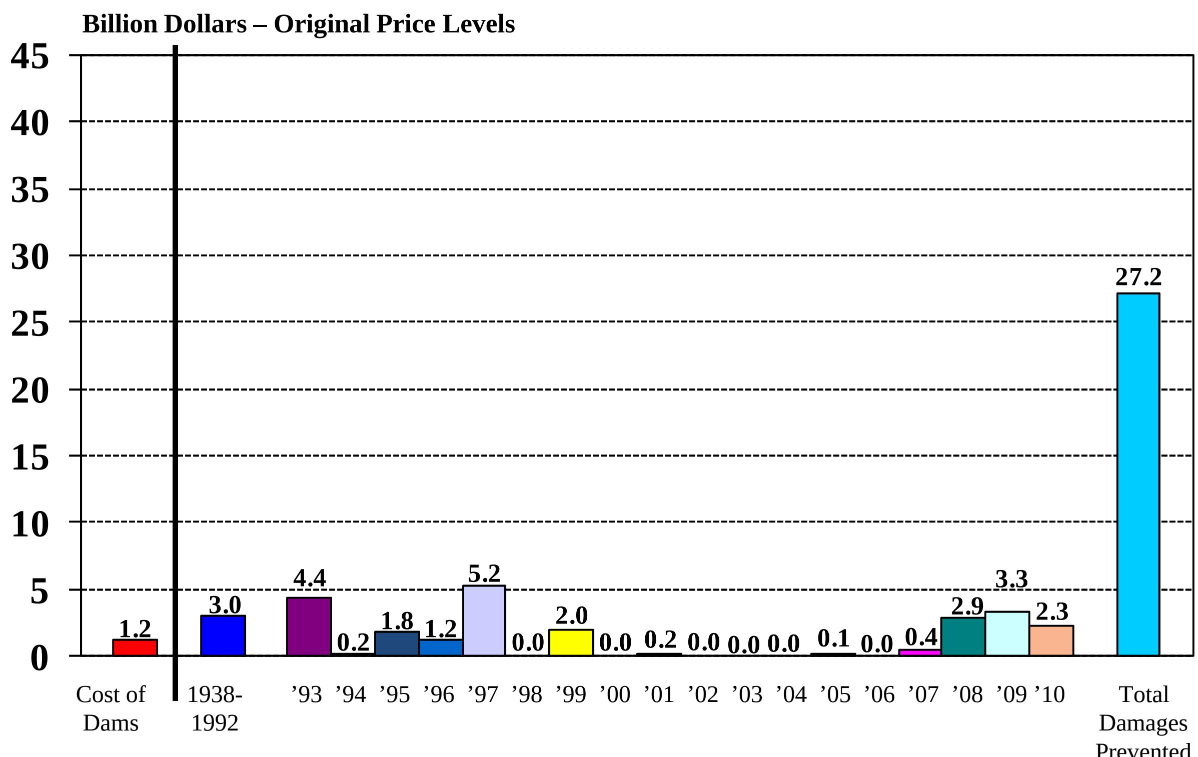
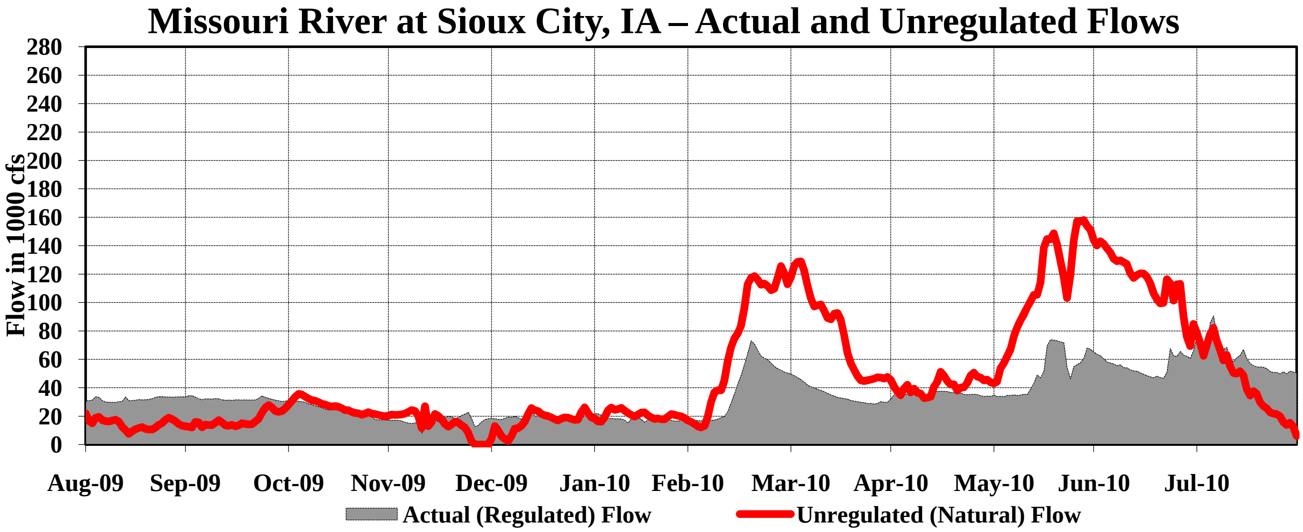
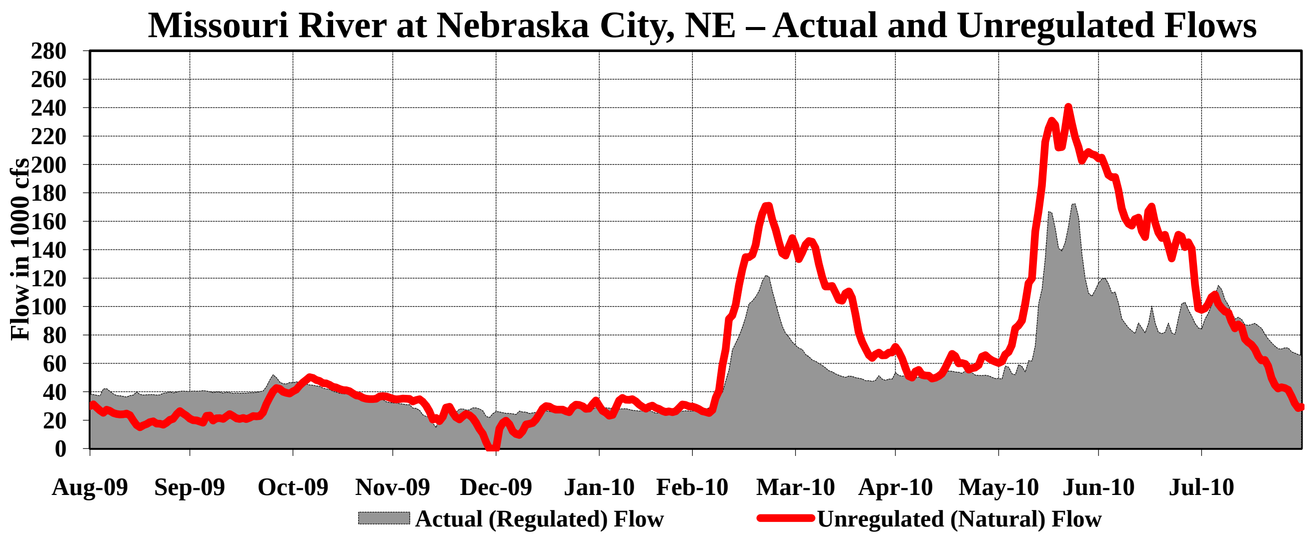


Figure 12B. The Missouri River Mainstem Reservoirs flood damages prevented - original price levels.





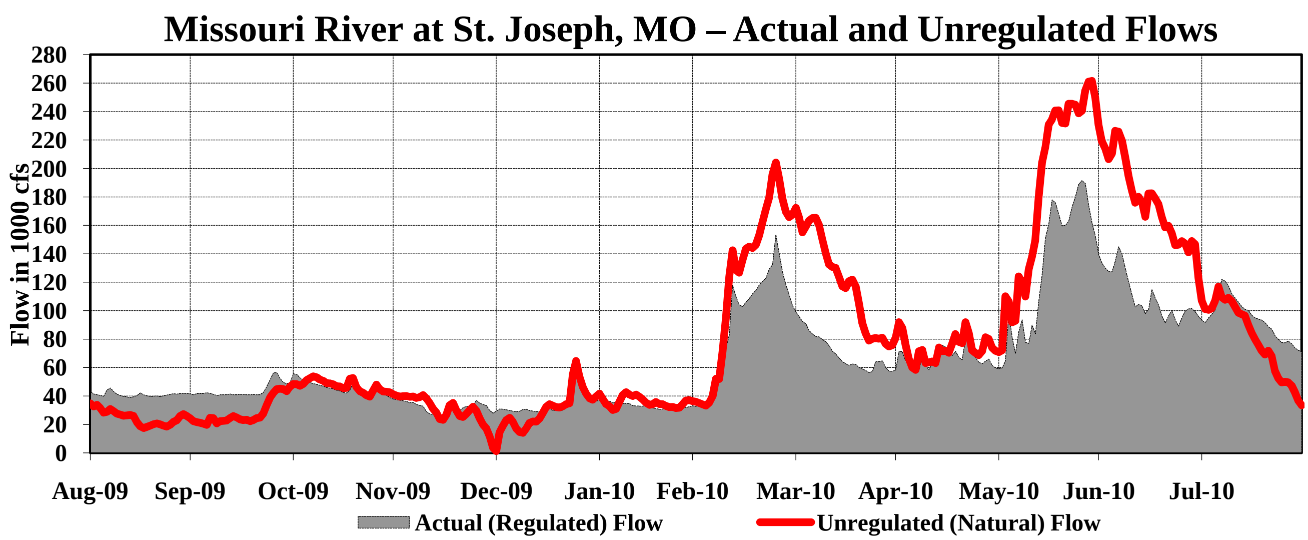


Figure 13. Actual and unregulated flows – Sioux City, IA, Nebraska City, NE and St. Joseph, MO.

3) Determine how flow regime, especially the release of water from System projects, affects water quality in the Missouri River.

4) Determine how current water quality conditions in the Missouri River (e.g., water temperature, turbidity, etc.) may be affecting pallid sturgeon populations in the System.

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 TMDLs at Omaha District 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 12 provides a summary of water quality issues and concerns at each of the System projects, based on Omaha District monitoring and a review of current State integrated water quality reports.

The State of North Dakota's water quality standards protects the Garrison reservoir (Lake Sakakawea) for a coldwater fishery. Water temperature and dissolved oxygen levels are primary water quality factors that determine the suitability of water for coldwater aquatic life. The State of North Dakota has defined coldwater fish habitat in Lake Sakakawea as being ≤15°C and having dissolved oxygen levels ≥ 5 mg/l. The State recently promulgated the following water quality standards to protect coldwater habitat in Lake Sakakawea:

- A hypolimnetic maximum temperature criterion of 15°C for Class 1 lakes and reservoirs, including Lake Sakakawea, that are thermally stratified.
- Lake Sakakawea must maintain a minimum volume of water of 500,000 acre-feet that has a temperature of 15°C or less and a dissolved oxygen concentration of not less than 5 mg/l.

Maintaining coldwater habitat in Lake Sakakawea over the past 10 years proved to be a challenge during drought years. Coldwater habitat in Lake Sakakawea is supported by thermal stratification that allows a quiescent, coldwater zone (i.e., hypolimnion) to exist in the lower depths of the reservoir during the summer. Lake Sakakawea is a bottom-withdrawal reservoir and the invert elevation of the intake portals to the powerplant is 2 feet above the reservoir bottom. Thus, during the summer thermal stratification period, water is drawn from the coldwater habitat volume of the reservoir and discharged through the powerplant. Lower pool levels resulting from drought conditions (i.e., 2003 through 2008) also reduced the hypolimnetic volume of Lake Sakakawea. During the recent drought years, the lower pool elevations reached a point where the reduced hypolimnetic volume of cold water, in concert with the degradation of dissolved oxygen in the deeper water of the reservoir, limited the maintenance of coldwater habitat through the end of the summer thermal stratification period. During this period, North Dakota listed Lake

Table 12
Water Quality Issues and Concerns in the Omaha District

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	---
• Missouri River, Fort Peck Dam to the Milk River	Yes (MT)	Aquatic Life Cold Water Fishery	Water Temperature Degraded riparian vegetation Other flow regime alterations	No	No	---	---
• Missouri River, Milk River to the Poplar River	Yes (MT)	Aquatic Life Warm Water Fishery	Water Temperature Degraded riparian vegetation Other flow regime alterations	No	No	---	---
• Missouri River, Poplar River to North Dakota	Yes (MT)	Aquatic Life Warm Water Fishery	Water Temperature Other flow regime alterations	No	No	---	---
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	---	---	---	No	---	---
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 lake 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 December 1, 2010.
** 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.
*** Based on Nebraska's draft 2010 303 (d) list. List still to be approved by U.S. EPA.

Sakakawea as impaired for Fish and Other Biota on the State's 303(d) list due to warm water temperatures and low dissolved oxygen levels. The new 2010 North Dakota Integrated Water Quality Report delists Lake Sakakawea. The delisting seemingly was based on the 500,000 ac-ft requirement for coldwater habitat being met with a return to "normal" pool levels.

Water temperature and dissolved oxygen concentration depth profiles that were measured during water quality monitoring conducted at Lake Sakakawea over the 8-year period 2003 through 2010 were used to estimate the volume of water in the reservoir that meets the coldwater habitat conditions defined by the State of North Dakota. ***Plate 3*** shows estimated reservoir and coldwater habitat volumes by year for 2003 through 2010. Coldwater habitat estimated in the Lake Sakakawea during 2009 and 2010 was significantly greater compared to the earlier years, and were the only years during the 8-year period that the 500,000 AF minimum water quality standards criterion for coldwater habitat was met.

Thermal stratification of the Fort Randall reservoir (Lake Francis Case) during the summer results in the development of hypoxic conditions in the reservoir's hypolimnion. Lake Francis Case is a bottom-release reservoir, and hypoxic water is passed through Fort Randall Dam during power production during July and August. Under these conditions, dissolved oxygen levels in areas of the Fort Randall tailwaters fall below South Dakota's water quality standards' minimum dissolved oxygen criterion of 5 mg/l. Conditions monitored in 2010 indicated that the low dissolved oxygen levels in the tailwaters are not seemingly impairing the designated Warmwater Permanent Fish Life Propagation beneficial use as regions of refugia exist in the impacted area. In addition, there is no evidence of current or past summer fish kills in the Fort Randall tailwaters attributable to hypoxic conditions. If warranted, dissolved oxygen conditions in the Fort Randall tailwaters, during periods of hypoxic dam releases, could be mitigated by drawing water from the reservoir's surface and spilling it down the spillway.

At this time, Nebraska does not have approved nutrient criteria in the State's water quality standards. In the interim, the Nebraska Department of Environmental Quality (NDEQ) of the U.S. Environmental Protection Agency have agreed to nutrient and chlorophyll targets for beneficial use support assessments. The interim targets for chlorophyll *a*, total phosphorus, and total nitrogen are, respectively, 10 µg/l, 50 µg/l, and 1,000 µg/l; and apply to a lake growing season of May through September. If the growing seasons mean concentrations exceed any of these three targets, an impaired status to the Aquatic Life use will be noted and the cause of this impairment will be listed as "nutrients". The Aquatic Life use of the Gavins Point reservoir (Lewis and Clark Lake), for the first time, has been identified as impaired due to nutrients (chlorophyll *a*, total phosphorus, and total nitrogen) based on these criteria.

4. Navigation

The first towboat using the Missouri River in 2010 was the *MV Butch Bowman*, owned by Excell Marine. The towboat entered the Missouri River on March 10 with four loaded barges headed to Brunswick Terminal, MO (River Mile 256). The *MV Butch Bowman* was also the first towboat to travel upstream of Kansas City, MO, which occurred on April 11. The tow consisted of four loaded barges; two headed for Nebraska City, NE and two headed for Omaha, NE. When unloaded the two Omaha barges were retrieved and taken to Consolidated Blenders terminal at Blair, NE (River Mile 648) arriving on April 18 to load alfalfa pellets. There were no tows with a Sioux City, IA (River Mile 735) destination during 2010. The *MV Mary Lynn*, owned by Missouri River Towing, made five more trips to Blair during 2010 to load alfalfa pellets. The final barge shipping destination for the alfalfa pellets was Guntersville, AL on the Tennessee River. The last towboat to use the Missouri River was the *MV Leslie Ann*, owned by Jefferson City River Terminal, moving two empty barges and two loaded barges to Jefferson City, MO on December 21, 2010. She was moored there for the winter.

Since July 1, 2009 reservoir releases have provided full service navigation flows, which provides for the full authorized 9 ft deep x 300 ft wide channel. The increase of System storage due to the storage of floodwaters resulted in a 10-day extension to the 8-month navigation season ending at the Missouri River mouth on December 10.

Table 13 shows the Missouri River tonnage data for 2006 – 2009 compiled by the Waterborne Commerce Statistics Center (WCSC). The 2009 total of 5.036 million tons includes 4.649 million tons for sand and gravel, 0.117 million tons for waterways materials, and 0.270 million tons for long-haul commercial tonnage. The reduction of total tonnage of 0.635 million tons compared to 2008 was due to permit restrictions on the sand and gravel mining companies and also the 2007-2008 economic downturn that caused a drop in concrete demand from the housing construction business. In 2009, the 270,000 tons of long haul commercial tonnage increased by 95,000 tons from 2008. The largest total tonnage year was 2001 at 9.73 million tons. The largest long-haul commercial tonnage year, excluding sand, gravel, and waterway material, occurred in 1977 at 3.34 million tons. ***Figure 14A*** shows total navigation tonnage on the Missouri River and ***Figure 14B*** shows the long-haul commercial navigation tonnage. The Missouri River long-haul commercial tonnage in 2010 is currently estimated to total about 334,000 tons, based on carrier interviews and towboat activity and barge counts from the Corps' daily boat reports. ***Figure 15A*** shows the navigation tonnage value of the commodities since 1960, using 2010 present-worth computations. ***Figure 15B*** shows the navigation tonnage value of long-haul commercial commodities since 1960. The ***Figures 14A, 14B, 15A,*** and ***15B*** tonnages and tonnage values for 2010 are estimates and will change once final WCSC tabulations are available.

Navigation season target flows for past years are given in ***Table 14***. ***Table 15*** shows the scheduled lengths of past reservoir system supported navigation seasons with total tonnage and ton-miles for each year.

Table 13
Missouri River Tonnage by Commodities (In Thousands of Tons)

Commodity Classification Group	2006	2007	2008	2009
Farm Products	12	0	0	18
Corn	12	0	0	4
Wheat	0	0	0	0
Soybeans	0	0	0	14
Misc Farm Product	0	0	0	0
Nonmetallic Minerals	8043	6283	5415	4666
Sand/Gravel	8043	6281	5415	4649
Misc Nonmetallic	0	2	0	17
Food and Kindred	21	28	16	32
Pulp and Paper	0	0	0	0
Chemicals	14	7	5	26
Fertilizer	12	5	4	24
Other Chemicals	2	2	1	2
Petroleum (including coke)	81	132	87	120
Stone/Clay/Glass	67	130	55	57
Primary Metals	0	0	0	0
Waterway Materials	57	101	81	117
Other	0	3	12	0
Total Commercial	8295	6684	5671	5036
Total Long-Haul Commercial	195	303	175	270

Figure 16 presents discharge data at Sioux City, IA; Nebraska City, NE; and Kansas City, MO, three of the four navigation flow target locations, for the August 2009 through December 2010 period. The three graphs demonstrate that actual flows at these locations are influenced considerably by System releases. Tributaries between Gavins Point and Kansas City continued significant inflow during the navigation season. Supplemental Missouri River navigation support from the Kansas River reservoir projects was not required during the 2010 navigation season.

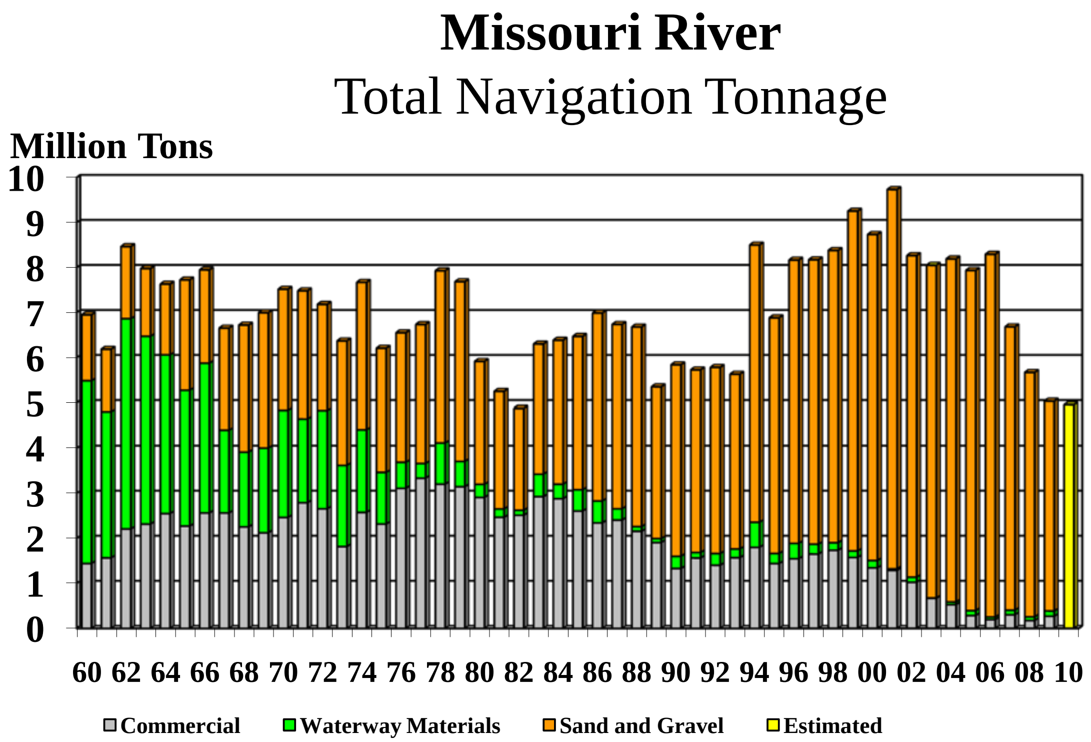


Figure 14A. Missouri River total navigation tonnage from 1960 to 2010 (estimated)

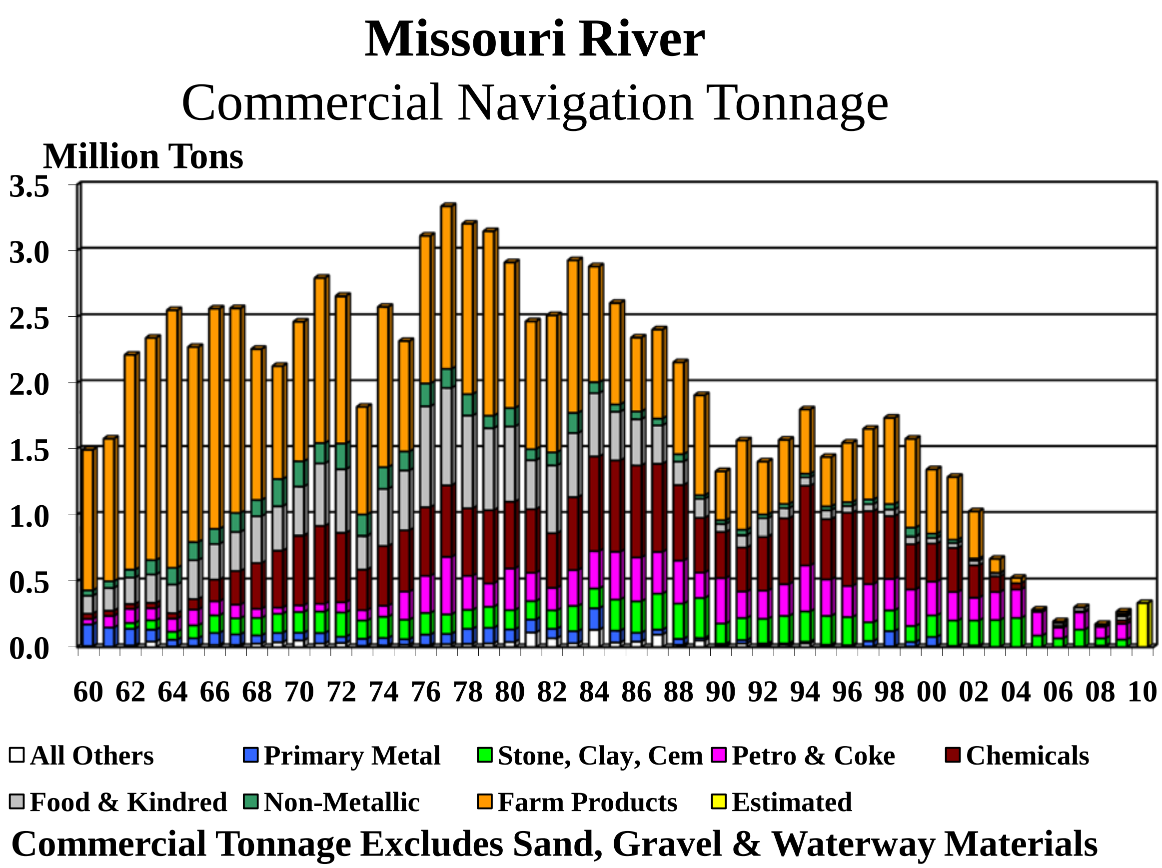


Figure 14B. Missouri River commercial navigation tonnage from 1960 to 2010 (estimated)

Missouri River

Total Navigation Tonnage Value - 2011 Present Worth

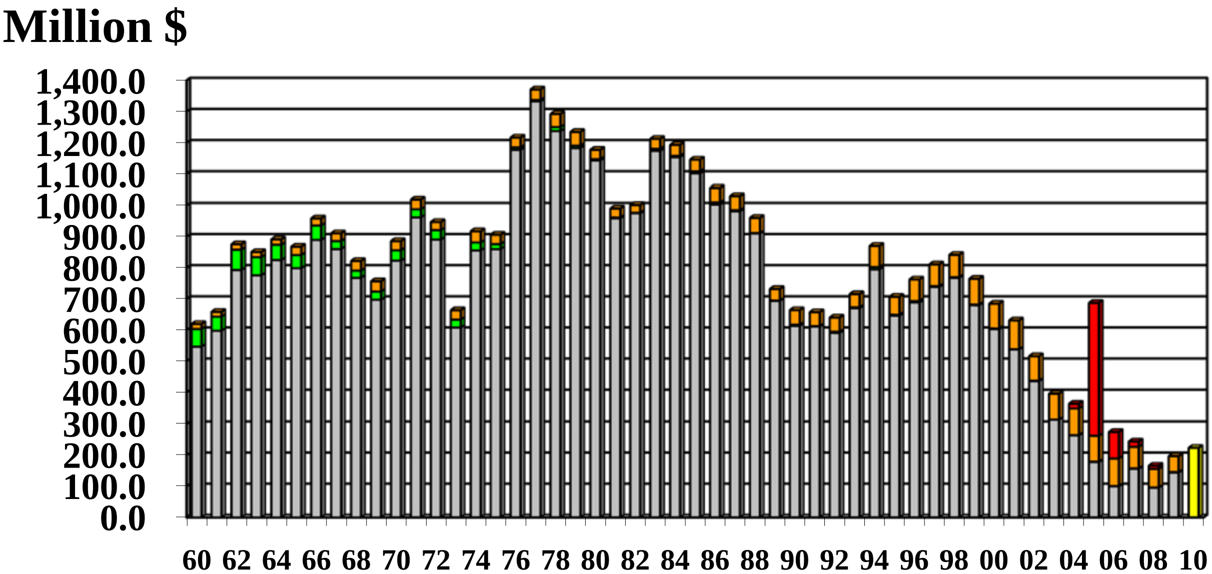
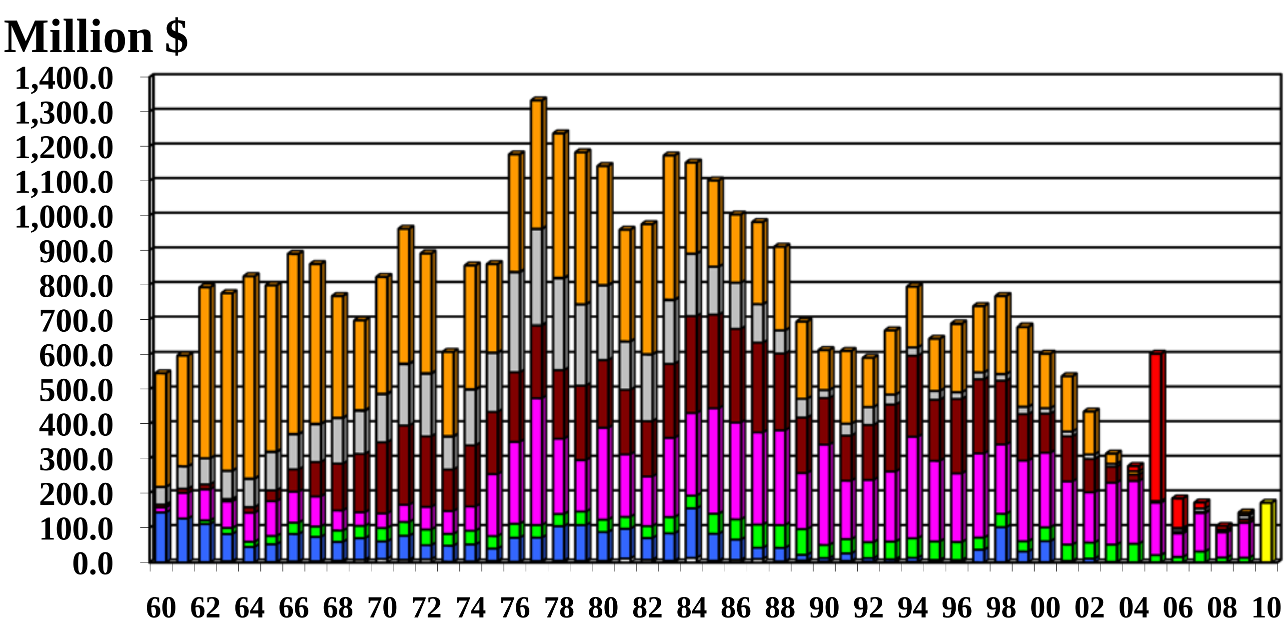


Figure 15A. Total navigation tonnage value using 2011 present worth computations

Commercial Waterway Materials Sand and Gravel Estimated Power Plant

Missouri River

Commercial Navigation Tonnage Value - 2011 Present Worth



All Others Primary Metal Stone, Clay, Cem Petro & Coke Chemicals
Food & Kindred Non-Metallic Farm Products Estimated Power Plant

Commercial Value Excludes Sand, Gravel & Waterway Materials

Figure 15B. Commercial navigation tonnage value using 2011 present worth computations

Table 14
Navigation Season Target Flows
in 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)	35.0-40.0	35.0-40.0	41.0-46.0	45.0-50.0
	Jul(1)	36	36	42	46
	Aug-Sep(1)	50.0-55.0	50.0-55.0	55.0-60.0	55.0-60.0
	Oct-Nov(1)	40.0-45.0	40.0-45.0	45.0-50.0	50.0-55.0
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)	45.0-50.0	45.0-50.0	50.0-55.0	55.0-60.0
1972	Apr-Nov(1)	40.0-50.0	40.0-50.0	45.0-55.0	50.0-60.0
1973-74	Apr-Nov	31	31	37	41
1975	Apr	31	31	37	41
	May-Nov(1)	35.0-60.0	35.0-60.0	41.0-66.0	45.0-70.0
1976	Apr-Jul(1)	34.0-38.0	34.0-38.0	40.0-44.0	44.0-48.0
	Aug-Dec(1)	31.0-34.0	31.0-34.0	37.0-40.0	41.0-44.0
1977	Apr-Nov	31	31	37	41
1978	Apr	31	31	37	41
	May-Jul(1)	35.0-46.0	35.0-46.0	41.0-52.0	45.0-56.0
	Aug-Nov(1)	46.0-51.0	46.0-51.0	52.0-57.0	56.0-61.0
1979	Apr-Jul(1)	36.0-42.0	36.0-42.0	42.0-48.0	46.0-52.0
	Aug-Nov(1)	31.0-36.0	31.0-36.0	37.0-42.0	41.0-46.0
1980	Apr-Nov	31	31	37	41
1981	Apr-Nov(2)	31	31	37	41
1982	Apr-Sep	31	31	37	41
	Oct	31.0-36.0	31.0-36.0	37.0-42.0	41.0-46.0
	Nov-Dec(1)	36.0-46.0	36.0-46.0	42.0-52.0	46.0-56.0
1983	Apr-Jun	31	31	37	41
	Jul	31.0-36.0	31.0-36.0	37.0-42.0	41.0-46.0
	Aug-Nov(1)	36	36	42	46
1984	Apr-Jun	31	31	37	41
	Jul-Dec(1)	31.0-44.0	31.0-44.0	37.0-50.0	41.0-54.0
1985	Apr-Dec	31	31	37	41
1986	Apr(1)	36.0-41.0	36.0-41.0	42.0-47.0	46.0-51.0
	May-Dec(1)	41.0-46.0	41.0-46.0	47.0-52.0	51.0-56.0
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)	46.0-56.0	46.0-56.0	52.0-62.0	56.0-66.0
1996	Apr(1)	41	41	47	51
	May(1)	41.0-51.0	41.0-51.0	47.0-57.0	51.0-61.0
	Jun-Dec(1)	56	56	62	66
1997	Apr-Dec(5)	*	*	*	*
1998	Apr-Dec(5)	31	31	37	41
1999	Apr-Dec(1)	31.0-43.0	31.0-43.0	37.0-49.0	41.0-53.0
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)	31-43.0	31.0-43.0	37-49.0	41-53.0

(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 15
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(12)	5,035,744(12)	114,865(12)
2010	8(4)	334,000(13)	4,954,000(13)	120,000(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.

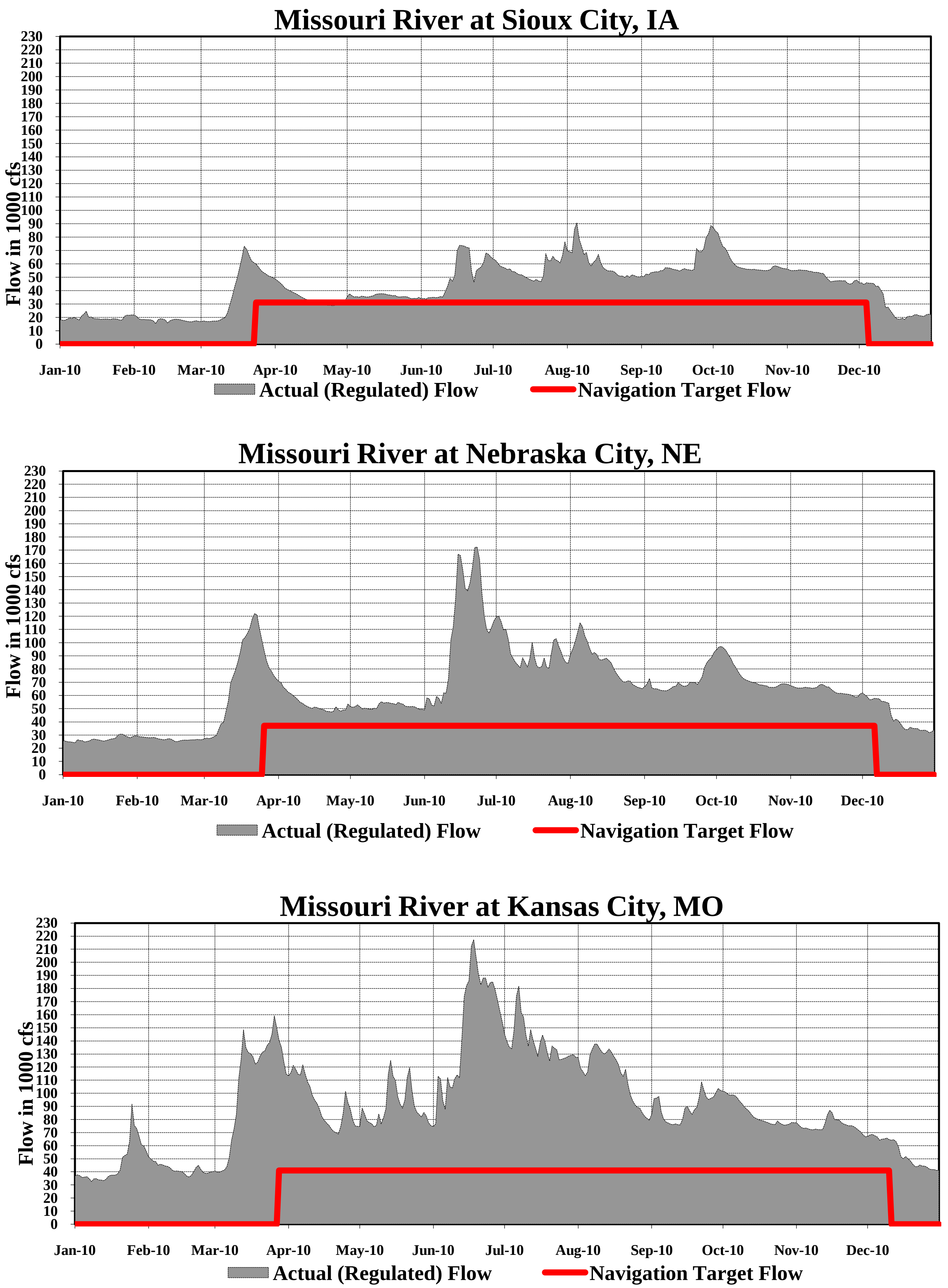


Figure 16. Actual and navigation target flows – Sioux City, IA, Nebraska City, NE, and Kansas City, MO.

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

The energy generated in 2010 was transmitted over a Federal transmission system that traverses 7,920 circuit miles. This past year, service was provided to over 360 wholesale customers. Customers in a 6-state area receiving direct service include 198 municipalities, 2 Federal agencies, 29 state agencies, 26 BOR projects, 5 irrigation districts, 36 rural electric cooperatives, 5 public utility districts, 13 private utilities, 26 Native American Services, and 22 power marketers. Additional benefits were provided by the interconnections to the Southwestern and Bonneville Power Administrations and other areas of the Western Area Power Administration (Western). Statistics from the Omaha Public Power District (OPPD) show that the average customer uses approximately 11,750 kilowatt hours (kWh) of energy annually. Based upon the total System generation of 8.7 billion kWh, the energy generated in CY 2010 by this portion of the Federal power system could have supplied all of the yearly needs of about 743,000 residential OPPD customers. In addition to the clean, renewable energy transmitted to the Midwest area, the hydropower system provides an added measure of stability to the regional power system with the ability to meet full load in 5 seconds or less. Large coal-fired and nuclear units are reinforced by idle hydropower units, typically in 30 seconds. Outside utilities can have access to the hydropower capability within several minutes of a known problem.

The excellent reliability of the hydropower system is indicated by having to maintain a 10% reserve, while thermal power must maintain a 15% reserve. Although the Federal hydropower system that serves the Missouri River region accounts for only 9% of the region's energy, it is large enough to fill gaps and provide a positive benefit to the integrated system.

Hydropower generation in 2010 was 8.7 billion kWh, which was 93% of average since the System first filled in 1967. The 2010 generation was 2.1 billion kWh more than the 2009 generation of 6.6 billion kWh and 3.8 billion kWh more than the record low of 4.9 billion kWh, set in 2008. Generation was much higher in 2010 due to the increased releases from the System projects. Western purchased about 3.8 billion kWh between January 1, 2010 and December 31, 2010, at a cost of $129.0 million to supplement System hydropower production.

System generation with individual project distribution for each calendar year since 1954 is shown on ***Figure 17***. The total generation from the Federal system (peak capacity and energy sales) for 2010 is shown in ***Table 16***. The tabulations in ***Table 17*** and ***Table 18*** summarize the total gross generation and power regulation for the Eastern Division, P-S MBP marketing area system for the past operating year. Actual settlement figures at the end of the billing periods differ somewhat from the calendar month figures shown.

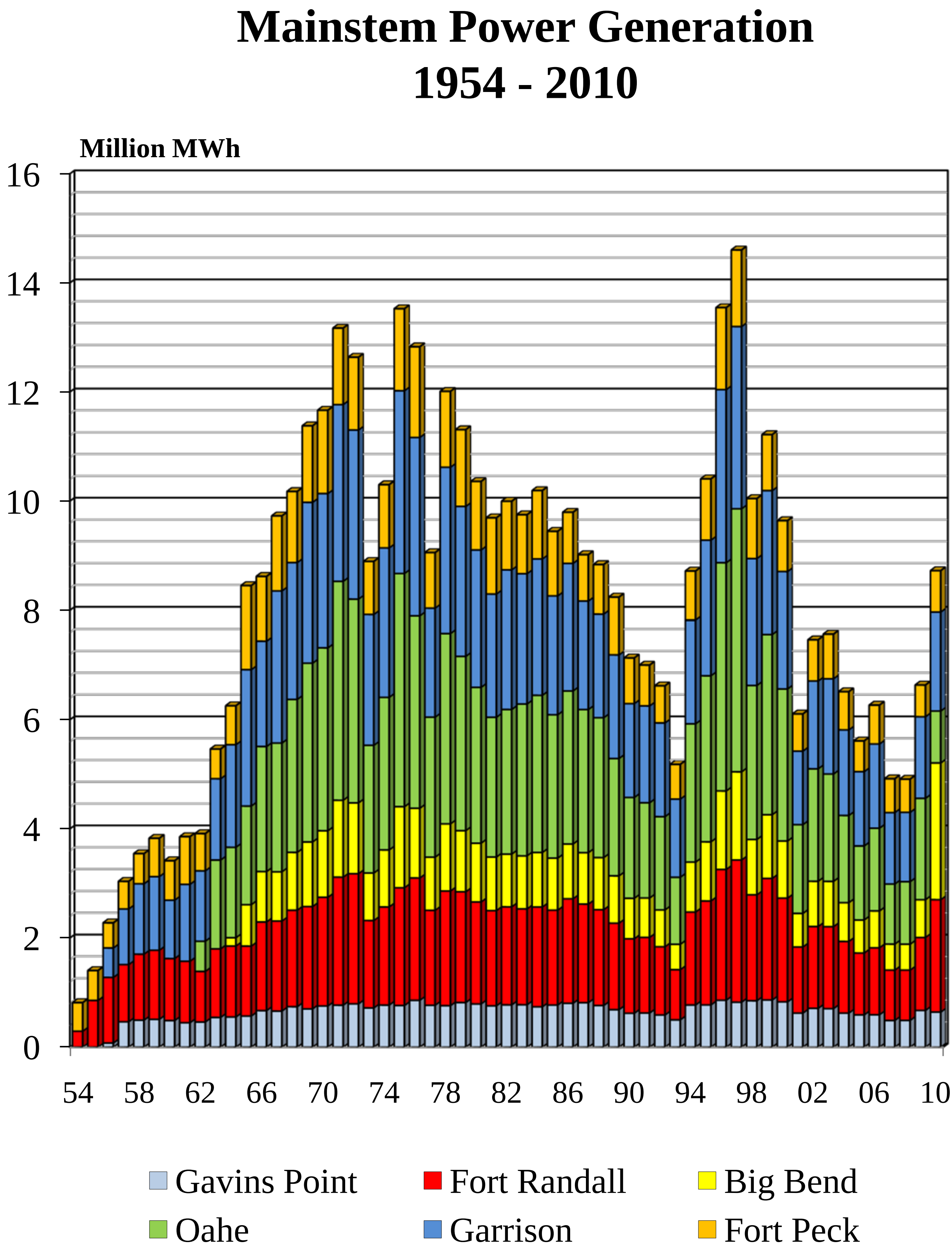


Figure 17. Mainstem power generation by project from years 1954 to 2010.

Table 16
Gross Federal Power System Generation – January 2010 through December 2010

	Energy Generation 1,000 kWh	**Peak Hour kW**	**Generation Date**
Corps Power Plants – Mainstem			
Fort Peck	642,510	158,000	07 Dec
Garrison	2,060,633	528,000	30 Sep
Oahe	2,506,684	734,000	31 May
Big Bend	951,588	484,000	01 Dec
Fort Randall	1,805,799	362,000	17 Aug
Gavins Point	758,692	121,000	14 Jun
Corps Subtotal	**8,725,906**	**2,039,000**	29 Aug
USBR Power plants			
Canyon Ferry	371,869	58,000	Jun
Yellowtail*	417,879	129,500	Jul
USBR Subtotal	**789,748**	**187,500**	
Federal System Total	**9,515,654**	**2,226,500**	

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

Table 17

Historical Generation and Load Data - Peaks
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at plant - 1,000 kW
January 1, 2010 through December 31, 2010

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	1,463		87		1,550		675		2,225	13-Jan	20:00
February	1,368		57		1,425		592		2,017	17-Feb	8:00
March	1,144		69		1,213		325		1,538	3-Mar	10:00
April	1,189		68		1,257		50		1,307	13-Apr	20:00
May	1,693		146		1,839		50		1,889	31-May	19:00
June	1,775		176		1,951		150		2,101	11-Jun	13:00
July	1,946		117		2,063		517		2,580	27-Jul	13:00
August	2,039		100		2,139		250		2,389	29-Aug	19:00
September	2,003		99		2,102		901		3,003	11-Sep	22:00
October	2,039		94		2,133		50		2,183	7-Oct	11:00
November	1,818		77		1,895		159		2,054	13-Nov	9:00
December	1,811		67		1,878		225		2,103	1-Dec	8:00

* This tabulation summarizes the total gross generation and power operations for the Eastern Division marketing area system shown on Table 16.
** During hour of peak total system load

Table 18

Historical Generation and Load Data - Total
Eastern Division, Pick-Sloan Missouri Basin Program*
Data at plant - 1,000 kWh
January 1, 2010 through December 31, 2010

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	558,331		59,795		618,126		417,111		1,035,237
February	441,640		50,750		492,390		532,101		1,024,491
March	351,855		46,854		398,709		282,617		681,326
April	384,309		43,969		428,278		82,350		510,628
May	663,449		77,541		740,990		150,310		891,300
June	625,702		114,704		740,406		86,809		827,215
July	815,798		105,401		921,199		107,170		1,028,369
August	969,940		67,126		1,037,066		83,595		1,120,661
September	1,094,229		60,687		1,154,916		350,757		1,505,673
October	1,081,306		55,698		1,137,004		93,145		1,230,149
November	1,000,884		57,568		1,058,452		113,381		1,171,833
December	738,404		62,635		801,039		235,441		1,036,480

*Powerplants from Table 16

6. 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-foot deep and are subject to desiccation through wave action and slight drops in water level. In the Fort Peck reservoir, a forage fish spawn normally occurs between April 15 and May 30. As per the 2009-2010 AOP, if runoff was not sufficient to keep all pool levels rising during the fish spawn in 2010, the Corps would, to the extent reasonably possible, set releases to result in a steady-to-rising pool level in Oahe and Fort Peck from April 1 to May 10 in Oahe and through the entire month of May at Fort Peck. Due to significant plains and mountain snowmelt runoff, Fort Peck, Garrison and Oahe rose steadily from April through June.

As mentioned in Section II.C.4.e. of this report, releases were made through the flood tunnels at Oahe beginning on September 15 through November 17. Releases were restricted to nighttime hours to reduce the likelihood of flushing smelt from the reservoir.

7. Threatened and Endangered Species

This was the 25th year of reservoir regulation since the piping plover and least tern were Federally listed as threatened and endangered species, respectively. This was the fifth year of operating for the endangered pallid sturgeon per the revised Master Manual. No March pulse from Gavins Point was released in 2010 due to forecasted flows in excess of the downstream flow limits and the James River flows were in excess of 5,000 cfs. There was no May pulse because actual and forecasted downstream flows were in excess of the downstream flow limits and water temperatures were not sufficient as outlined in the 2003 Amended Biological Opinion (BiOP).

The least terns and plovers nest on sparsely vegetated sandbars, islands, and shoreline of the Missouri River and the reservoirs. Stream gages have been installed on 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. A dynamic flow routing model has been developed to accurately predict river stages along the river for different combinations of daily and hourly power peaking.

Beginning in 1999, the 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 messages. This database provided vital information during the 2010 nesting season and proved to be a valuable tool in aiding regulation decisions benefiting the 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 previously disappointing low fledging. The record fledging that occurred for both species between 1998 and 2005 can be attributed to the large amount of habitat created by the high runoff years of 1995, 1996 and 1997 and the declining reservoir levels during the 2000-2007 drought. The creation of additional habitat has also allowed greater flexibility in the release levels at Fort Randall and Gavins Point, the lower two System projects.

During 2010 the majority of plovers were found on the river reaches below Garrison and Gavins Point and in the Gavins Point reservoir (Lewis and Clark Lake). In recent years, the majority of plovers were found on the shoreline of Garrison (Lake Sakakawea) and Oahe (Lake Oahe) reservoirs and below Gavins Point. Higher pool levels at Garrison and Oahe reduced habitat in those reservoir areas. The majority of the terns nested on habitat in Lewis and Clark Lake and in the river reaches below Gavins Point Dam, and to a lesser extent, the river reach below Garrison Dam. The 2003 Amended BiOp described an anticipated level of loss of tern and plover eggs and chicks due to management of the Missouri River reservoirs. The loss due to reservoir operations in 2010 was less than anticipated in the BiOp. A total of 22 least tern and 43 piping plover eggs were determined to be lost due to water management operations. No chicks were determined to be lost due to water management operations. The rise in the Garrison and Oahe reservoir elevations due to mountain snowmelt and reduced System releases caused the majority of the plover losses. A detailed description of the factors affecting tern and plover nesting, fledge ratios, habitat conditions and creation activities can be found in the Missouri River Recovery Program 2009 Annual Report (*www.moriverrecovery.org*).

The population distribution and productivity for terns and plovers for 1986 through 2010 are shown in ***Table 19*** and ***Table 20***. Productivity estimates for these birds on the Missouri River does not include least terns and piping plovers raised in captivity. The captive rearing facility has not been utilized since 2002. Adult bird totals listed in ***Table 19*** and ***Table 20*** 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. This ratio is an estimate, as the fate of every single fledgling is impossible to ascertain.

Table 19
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
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
	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
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
	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
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
	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
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
	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
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
	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
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
	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
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
	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
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
	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
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
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

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
The data does not include least terns and piping plovers raised in captivity. The data represents 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 20
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
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
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
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
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
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
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
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
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
Lake Oahe / Lake Sharp																									
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
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
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
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
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
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
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
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
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
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

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

The data does not include least terns and piping plovers raised in captivity. The data represents 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.

8. **Recreation and Resource Management**

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. In early 2010, only Fort Peck had not recovered from the recent drought. Due to the manner in which they are regulated, the lower three reservoirs are not significantly impacted by the drought.

Due to the improved runoff over the last several years recreational access at the upper three reservoirs has improved since the drought of 2000-2007. Of the 11 reservoir access areas located on the Fort Peck reservoir, 9 ramps were usable for all of 2010, with the last 2 ramps becoming usable as the reservoir filled in mid-summer. The Corps spent approximately $387,373 to update and extend the Crooked Creek boat ramp in 2010. At Garrison, all of the 36 reservoir access areas were available for the majority of the recreation season. At Oahe, all 49 access areas in North Dakota and South Dakota were available. At Garrison, Oahe, and Fort Randall, some recreation areas were temporarily impacted by the high reservoir elevations during the summer. 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.

During 2010, public use at these reservoirs totaled 45,199,200 visitor hours, an 8% increase from 2009. Visitor attendance figures at the System projects from 2007 through 2010 are shown in ***Table 21***. ***Figure 18*** displays recreation related visitor hours at each of the six mainstem projects for the years 1954 through 2009. 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 2010 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 System Reservoirs in Visitor Hours

Mainstem Project	2007	2008	2009	2010	Percent Change 2009-2010
Fort Peck	5,630,400	5,443,000	5,820,400	6,173,900	+6 %
Garrison	12,309,600	13,121,800	13,773,900	15,698,700	+14 %
Oahe	8,045,400	9,641,300	9,322,300	9,503,100	+2 %
Big Bend	3,096,900	3,794,000	3,210,200	3,346,500	+4 %
Fort Randall	1,000,100	1,139,800	1,030,900	1,067,000	+4 %
Gavins Point	9,075,100	9,612,300	8,880,300	9,410,000	+6 %
System Total	**39,157,500**	**42,752,300**	**42,038,100**	**45,199,200**	**+8 %**

The reporting method was changed from recreation days to visitor hours in 1987, and the reporting period was changed from calendar year to fiscal year in 1989 for all Corps projects. All Corps projects, including the System projects, are now reporting visitation using the Visitation Estimation Reporting System (VERS).

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. During drought conditions cultural resource sites are exposed as the pool levels decline. Despite higher reservoir levels in 2010 a number of sites were affected. The Corps will continue to work with the Tribes utilizing 36 CFR Part 800 and the PA to address the exposure of sites. The objective of a programmatic agreement is to deal "…with the potential adverse effects of complex projects or multiple undertakings…" The objective of the PA was to collaboratively develop a preservation program that would avoid, minimize, and/or mitigate the adverse effects of the System regulation. All Tribes, whether signatory to the PA or not, may request government-to-government consultation on the regulation of the System and the resulting effect on historic and cultural properties and other resources.

The planned preservation program is outlined by multiple stipulations in the PA. One of the stipulations, or program components, is the 5-year plan. This plan outlines how the Corps will accomplish its responsibilities under the PA and National Historic Preservation Act. The "Draft Five Year Plan, dated February 2005" (see website ***https://www.nwo.usace.army.mil/CR***) is currently being implemented.

The plan includes inventory, testing and evaluation, mitigation, and other specific activities that will allow the Corps to avoid, minimize, and/or mitigate the adverse effects to cultural sites on the Corps' lands within the System.

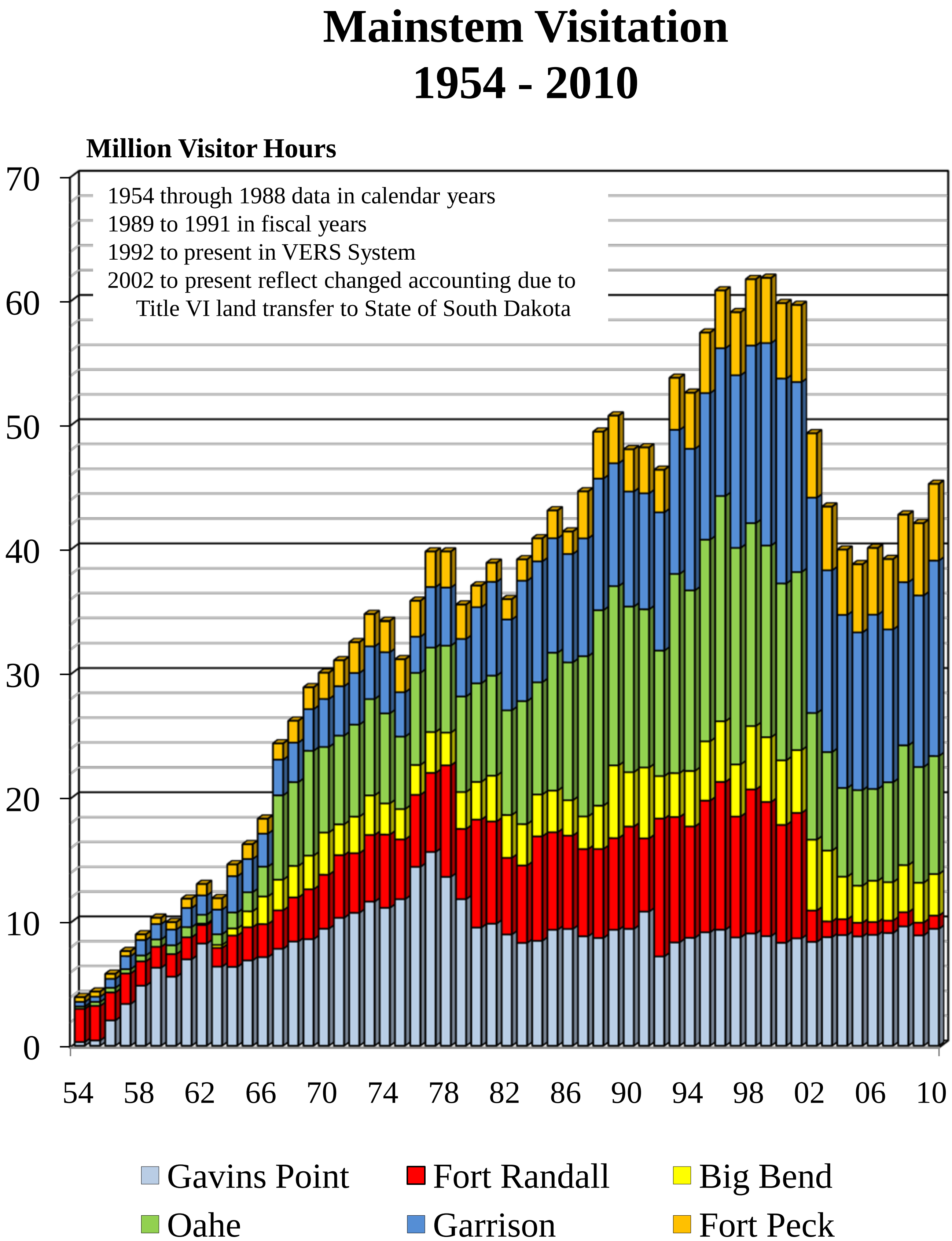


Figure 18. Mainstem visitation by project from years 1954 to 2010.

Under the terms of Stipulation 18 of the PA the Corps has agreed to consult/meet with the affected Tribes and Tribal Historic Preservation Officers (THPO's), State Historic Preservation Officers (SHPO's), the Advisory Council on Historic Preservation (ACHP) and other parties on the draft AOP. The purpose of this consultation/meeting is to determine whether operational changes are likely to cause changes to the nature, location or severity of adverse effects to historic properties or to the types of historic properties affected and whether amendments to the Corps' Cultural Resources Management Plans and Five-Year Plan are warranted in order to better address such effects to historic properties. A letter, dated September 10, 2010, was sent to the Missouri River basin Tribes offering consultation on the 2010-2011 AOP. To date, no requests for consultation have been received; however three Tribes participated in the fall AOP public meetings in October 2010 and the Standing Rock Sioux Tribe provided written input on the draft AOP.

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PLATE 1. Missouri River Basin Map.

Item No.	Subject	Fort Peck Dam - Fort Peck Lake	Garrison Dam - Lake Sakakawea	Oahe Dam - Lake Oahe
	Summary of Engineering Data -- Missouri River Mainstem System			
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 1,489,000 a.f.	1620-1617 1,102,000 a.f.
31	Flood control & multiple use	2246-2234 2,704,000 a.f.	1850-1837.5 4,222,000 a.f.	1617-1607.5 3,201,000 a.f.
32	Carryover multiple use	2234-2160 10,700,000 a.f.	1837.5-1775 13,130,000 a.f.	1607.5-1540 13,461,000 a.f.
33	Permanent	2160-2030 4,088,000 a.f.	1775-1673 4,980,000 a.f.	1540-1415 5,373,000 a.f.
34	Gross	2250-2030 18,463,000 a.f.	1854-1673 23,821,000 a.f.	1620-1415 23,137,000 a.f.
35	Reservoir filling initiated	November 1937	December 1953	August 1958
36	Initially reached min. operating pool	27 May 1942	7 August 1955	3 April 1962
37	Estimated annual sediment inflow	17,700 a.f. 1030 yrs.	25,900 a.f. 920 yrs.	19,800 a.f. 1170 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)	1,052	2,250	2,621
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

Plate 2. Summary table contains the engineering data for the Missouri River Mainstem system.

Summary of Engineering Data -- Missouri River Mainstem System

Big Bend Dam - Lake Sharpe	Fort Randall Dam - Lake Francis Case	Gavins Point Dam - Lewis & Clark Lake	Total	Item No.
21 miles upstream Chamberlain, SD	Near Lake Andes, SD	Near Yankton, SD		1
Mile 987.4	Mile 880.0	Mile 811.1		2
249,330 (1) 5,840	263,480 (1) 14,150	279,480 (1) 16,000		3
80, ending near Pierre, SD	107, ending at Big Bend Dam	25, ending near Niobrara, NE	755 miles	4
200 (elevation 1420)	540 (elevation 1350)	90 (elevation 1204.5)	5,940 miles	5
28,900	30,000 1,100	32,000 2,000		6
440,000 (April 1952)	447,000 (April 1952)	480,000 (April 1952)		7
1959	1946	1952		8
1964	1953	1955		9
1440	1395	1234		10
10,570 (including spillway)	10,700 (including spillway)	8,700 (including spillway)	71,596	11
78	140	45	863 feet	12
95	165	74		13
1200, 700	4300, 1250	850, 450		14
Pierre shale & Niobrara chalk	Niobrara chalk	Niobrara chalk & Carlile shale		15
Rolled earth, shale, chalk fill	Rolled earth fill & chalk berms	Rolled earth & chalk fill		16
17,000,000	28,000,000 & 22,000,000	7,000,000	358,128,000 cu. yds	17
540,000	961,000	308,000	5,554,000 cu. yds.	18
24 July 1963	20 July 1952	31 July 1955		19
Left bank - adjacent	Left bank - adjacent	Right bank - adjacent		20
1385	1346	1180		21
376 gated	1000 gated	664 gated		22
8 - 40' x 38' Tainter	21 - 40' x 29' Tainter	14 - 40' x 30' Tainter		23
390,000 at elev 1433.6	620,000 at elev 1379.3	584,000 at elev 1221.4		24
270,000	508,000	345,000		25
1423 msl 61,000 acres	1375 msl 102,000 acres	1210 msl 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 985,000 a.f.	1210-1208 57,000 a.f.	4,664,000 a.f.	30
1422-1420 117,000 a.f.	1365-1350 1,309,000 a.f.	1208-1204.5 86,000 a.f.	11,639,000 a.f.	31
	1350-1320 1,607,000 a.f.		38,898,000 a.f.	32
1420-1345 1,621,000 a.f.	1320-1240 1,517,000 a.f.	1204.5-1160 307,000 a.f.	17,886,000 a.f.	33
1423-1345 1,798,000 a.f.	1375-1240 5,418,000 a.f.	1210-1160 450,000 a.f.	73,087,000 a.f.	34
November 1963	January 1953	August 1955		35
25 March 1964	24 November 1953	22 December 1955		36
5,300 a.f. 430 yrs.	18,400 a.f. 250 yrs.	2,600 a.f. 180 yrs.	89,700 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
969	1,727	727	9,345 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) 1967-2009 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 2010

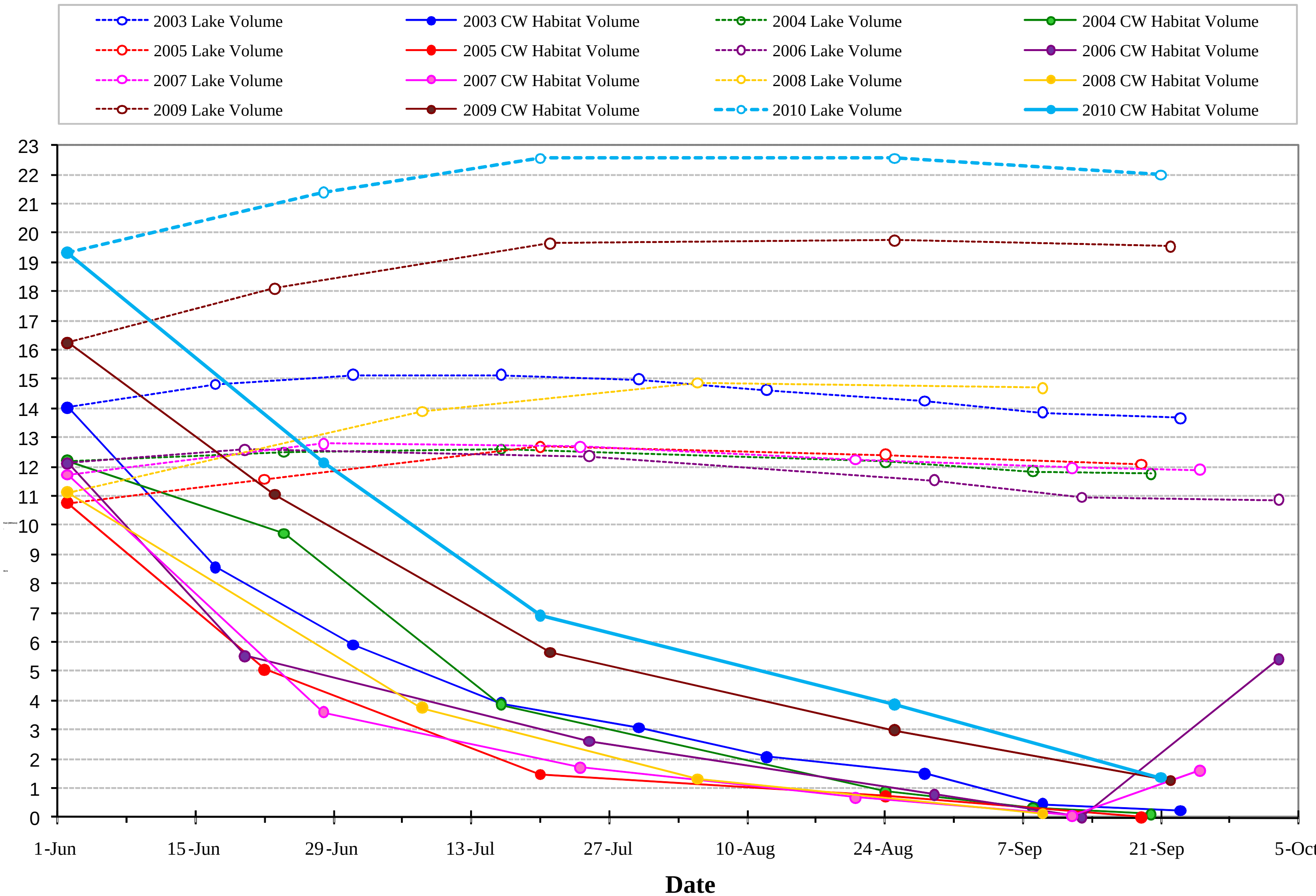

Plate 3. Estimated volume of coldwater habitat in Lake Sakakawea during the 8-year period 2003 through 2010.