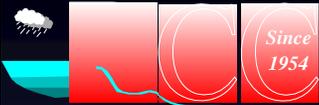


Missouri River Basin



Water Management Division



US Army  
Corps of Engineers

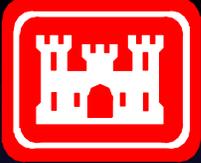
# *Missouri River Mainstem System*



## *Fall 2009 - 2010 Draft AOP Meetings*

<i>October 5, 2009</i>	<i>7 p.m.</i>	<i>Nebraska City, Nebraska</i>
<i>October 6, 2009</i>	<i>1 p.m.</i>	<i>Kansas City, Missouri</i>
<i>October 6, 2009</i>	<i>7 p.m.</i>	<i>Jefferson City, Missouri</i>
<i>October 7, 2009</i>	<i>1 p.m.</i>	<i>Fort Peck, Montana</i>
<i>October 7, 2009</i>	<i>7 p.m.</i>	<i>Bismarck, North Dakota</i>
<i>October 8, 2009</i>	<i>11 a.m.</i>	<i>Pierre, South Dakota</i>

*Off Duty Hours Telephone Contact 402-659-7170*



*US Army  
Corps of Engineers*

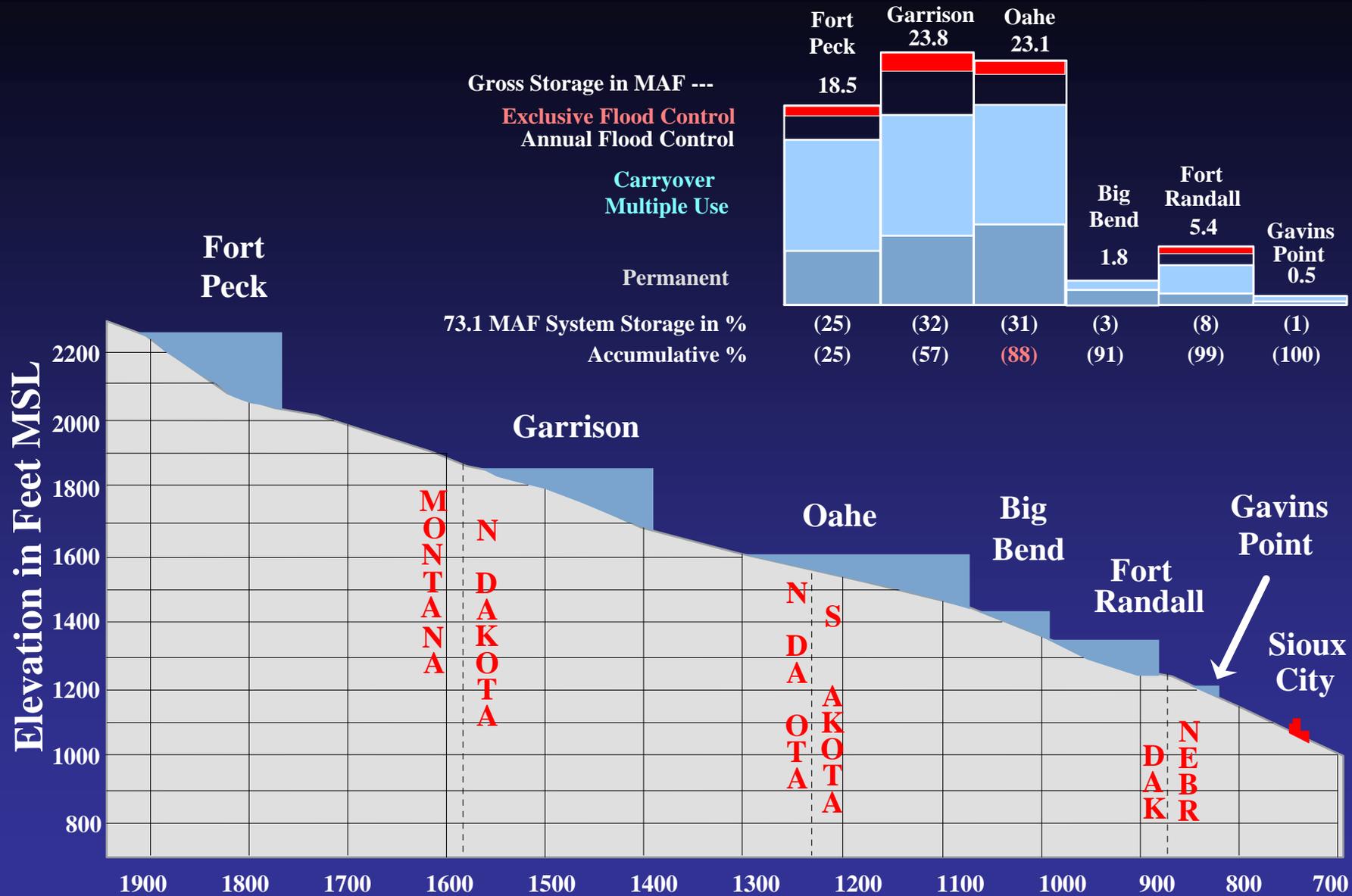
# *Missouri River Mainstem System*



Water Management Office, 1616 Capitol Avenue, Suite 365, Omaha, NE. 68102 - 4909

Internet Address: <http://www.nwd-mr.usace.army.mil/rcc>

# Mainstem Project Storage



Distance in Miles above the Mouth from St. Louis, Mo. (1960)

## Profile of Missouri River Mainstem Reservoir System

# *Mainstem System Congressionally Authorized Project Purposes*

**Flood Control**

**Navigation**

**Hydroelectric Power**

**Irrigation**

**Water Supply and Water Quality**

**Recreation**

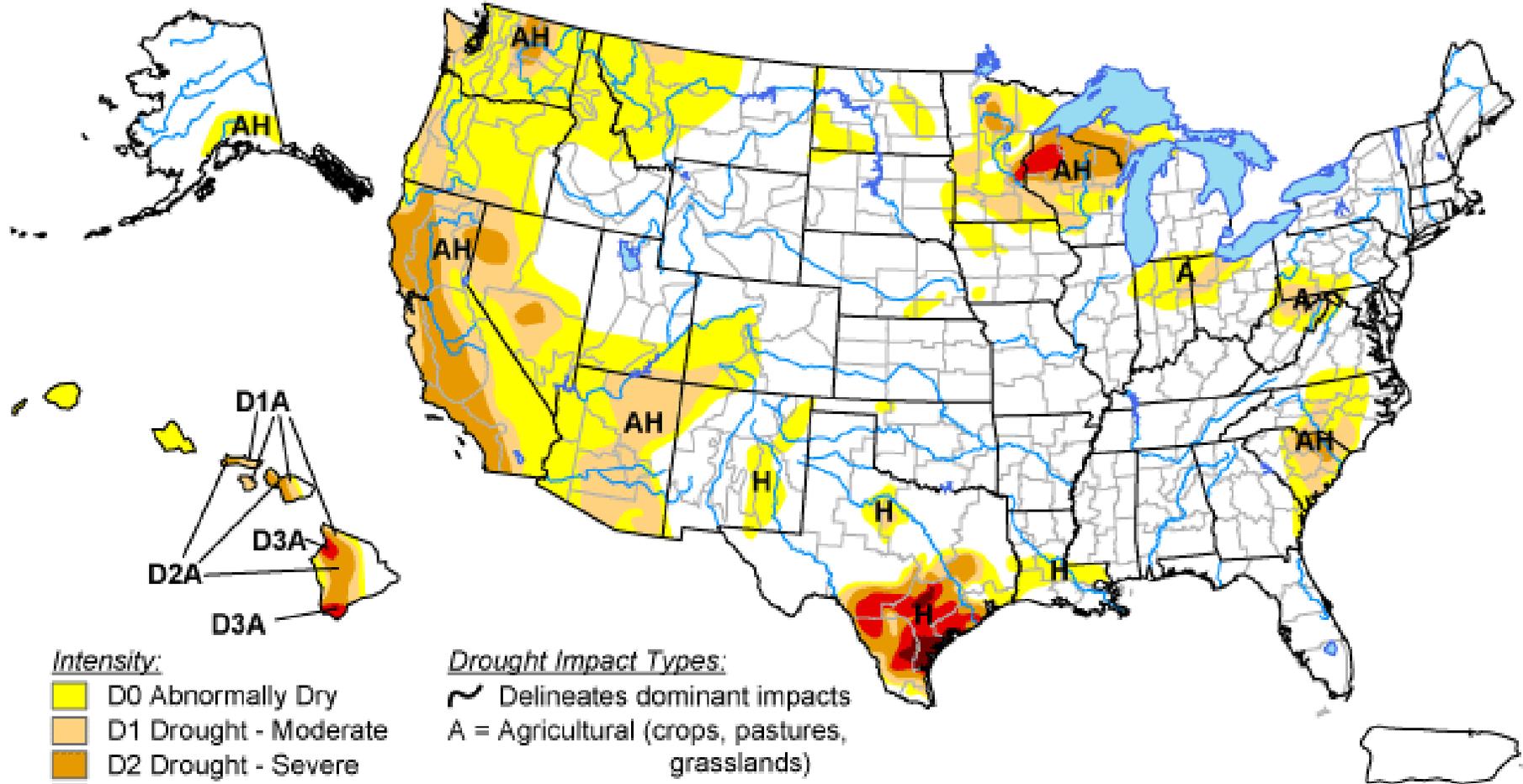
**Fish and Wildlife**

**Endangered Species**

# U.S. Drought Monitor

September 29, 2009

Valid 8 a.m. EDT



## Intensity:

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

## Drought Impact Types:

-  Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

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

<http://drought.unl.edu/dm>



Released Thursday, October 1, 2009

Author: David Miskus, JAWF/CPC/NOAA

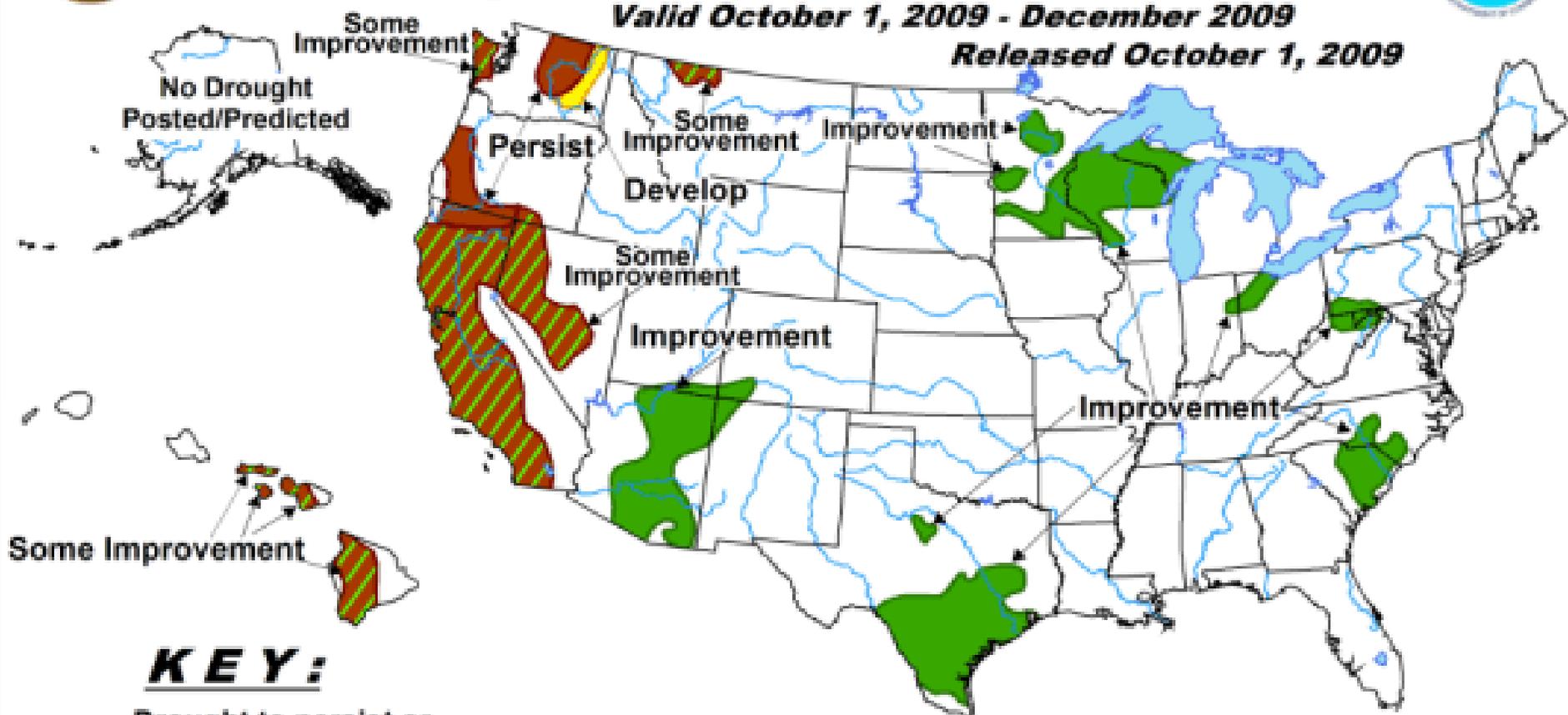


# U.S. Seasonal Drought Outlook

## Drought Tendency During the Valid Period

Valid October 1, 2009 - December 2009

Released October 1, 2009



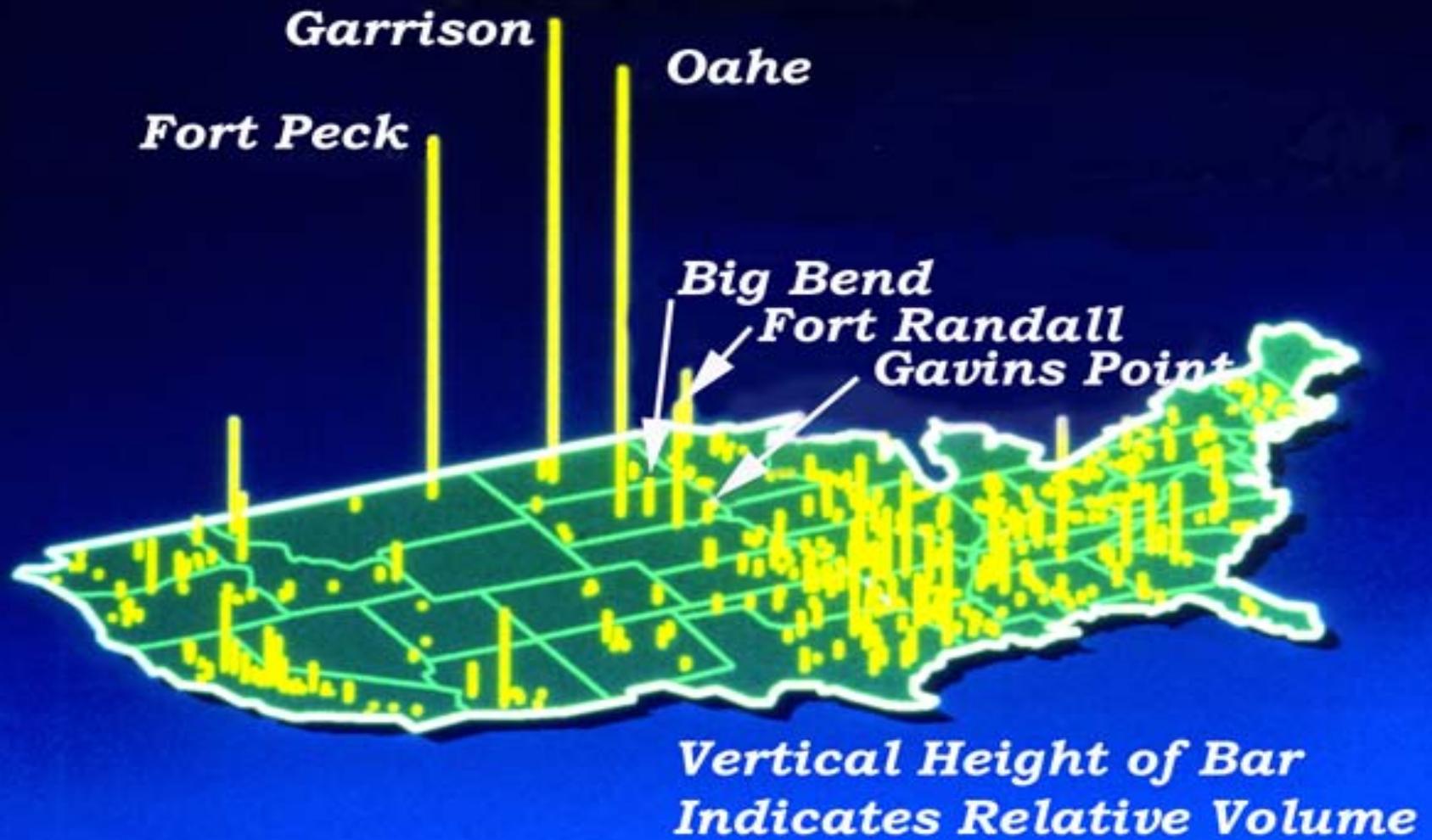
### **KEY:**

-  Drought to persist or intensify
-  Drought ongoing, some improvement
-  Drought likely to improve, impacts ease
-  Drought development likely

No Drought  
Posted/Predicted

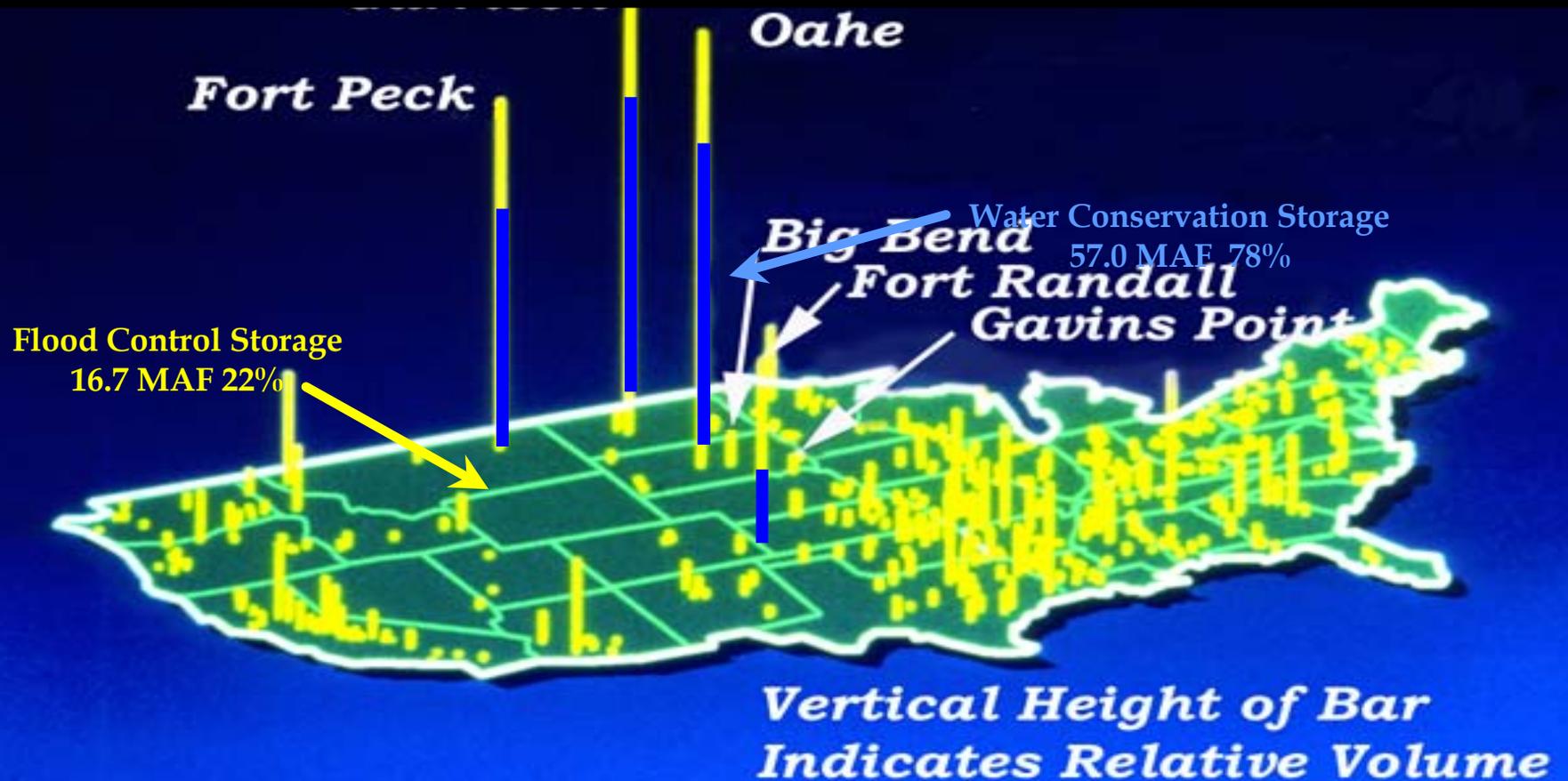
Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events – such as individual storms – cannot be accurately forecast more than a few days in advance. Use caution for applications – such as crops – that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.

# **Storage Capacity of Corps Lakes**



# *Two Significant Parts: Flood Control and Drought*

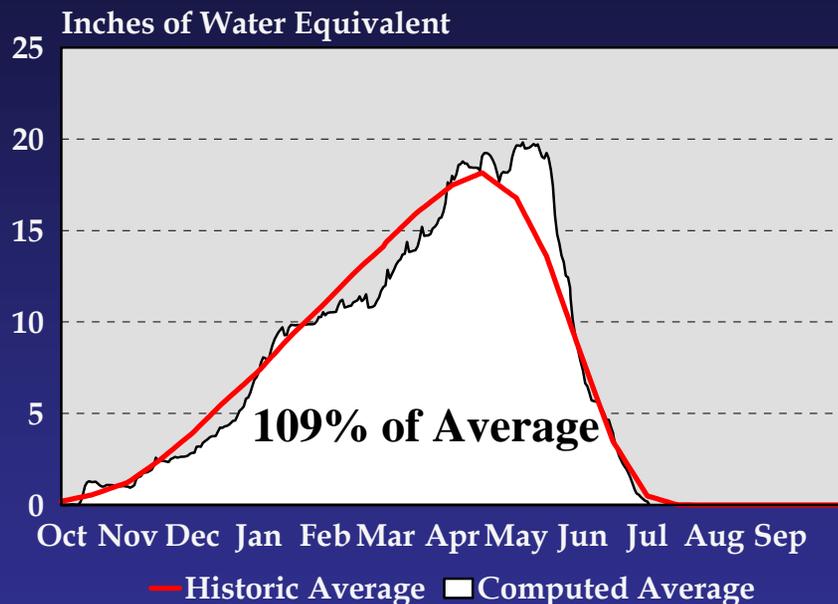
## *Storage Capacity of Corps Reservoirs*



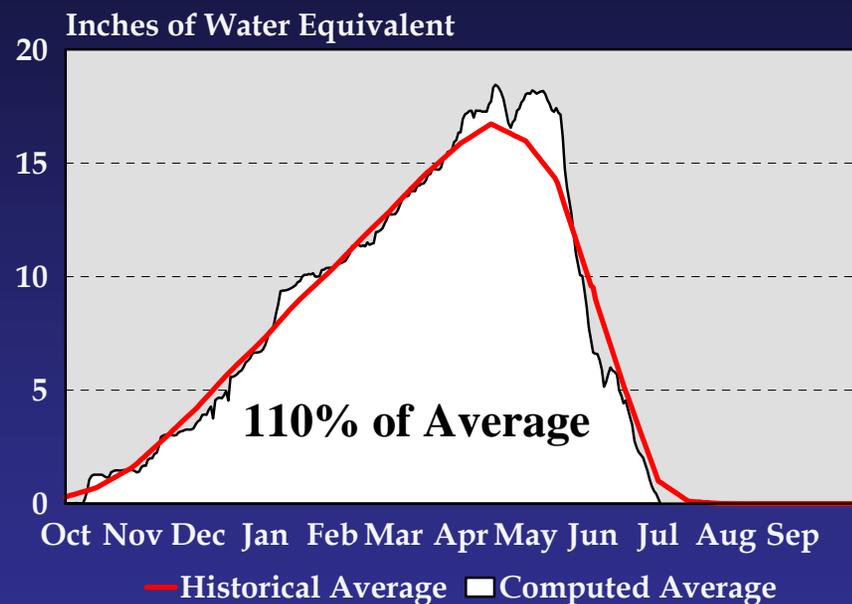
Over 650 Corps of Engineer Reservoirs

# Missouri River Basin Mountain Snowpack Water Content 2008-2009

*Total Above Fort Peck*



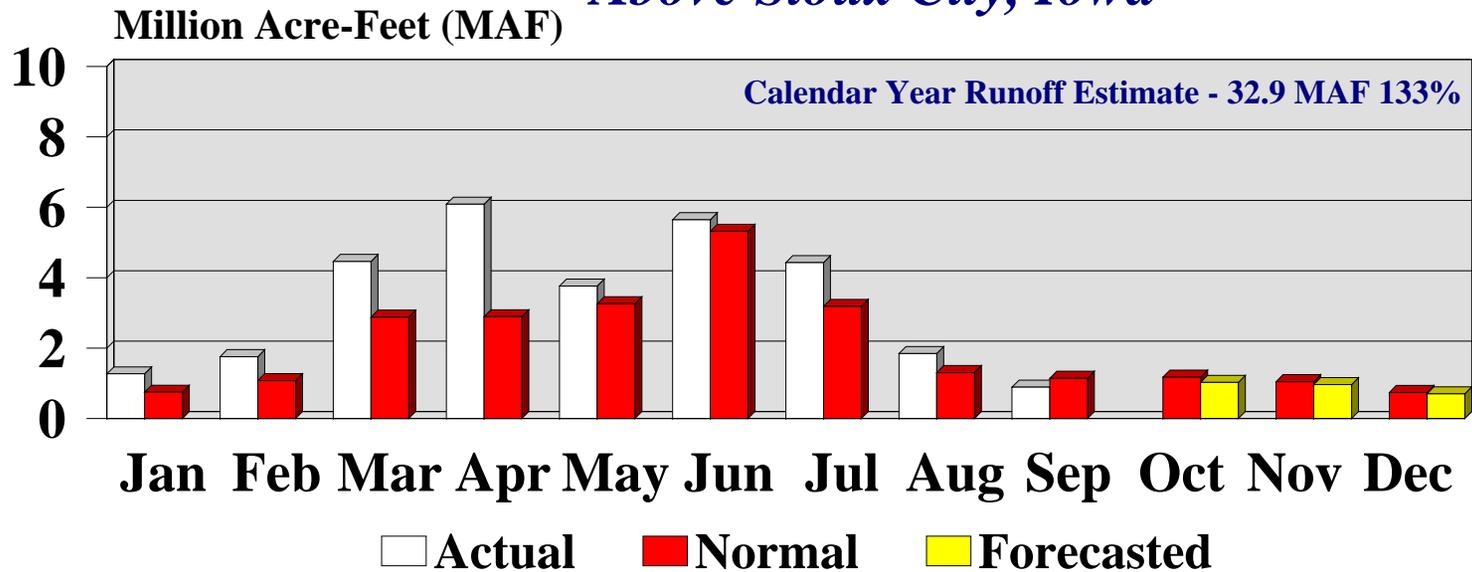
*Total Fort Peck to Garrison*



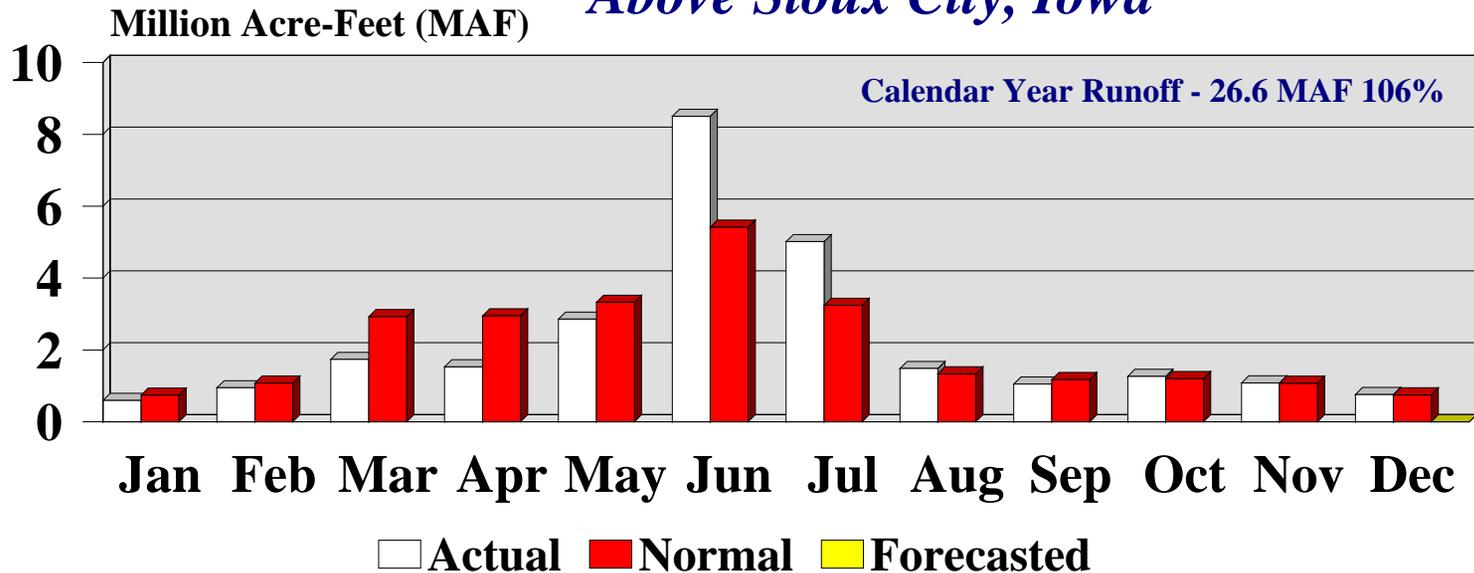
The Mountain Snowpack in the reach above Fort Peck peaked at 109% of the normal peak accumulation on May 4. The Mountain Snowpack in the reach between Fort Peck and Garrison peaked at 110% of the normal peak accumulation on April 17. The Missouri River basin Mountain Snowpack normally peaks near April 15 and 5% normally remains on July 1

July 1, 2009

## *2009 Missouri River Runoff Above Sioux City, Iowa*

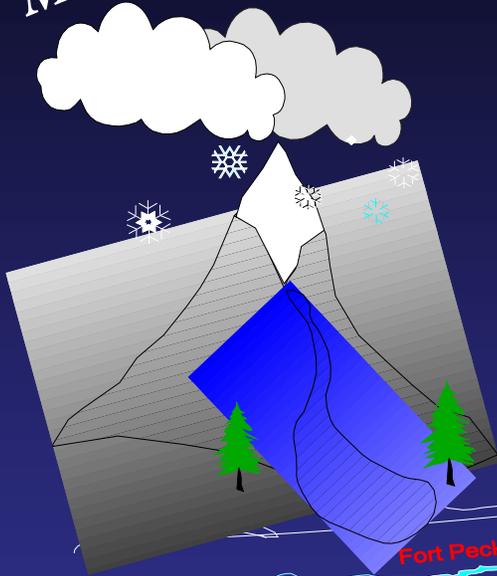


## *2008 Missouri River Runoff Above Sioux City, Iowa*



# Types of Missouri River Basin Runoff

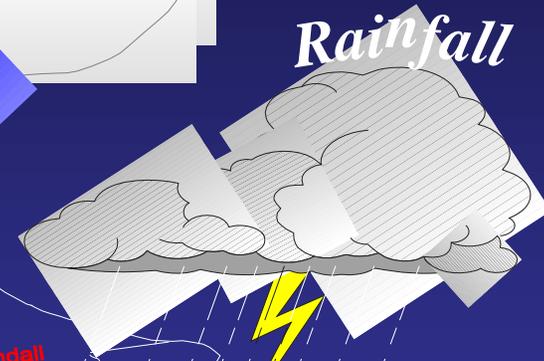
Mountain Snowmelt



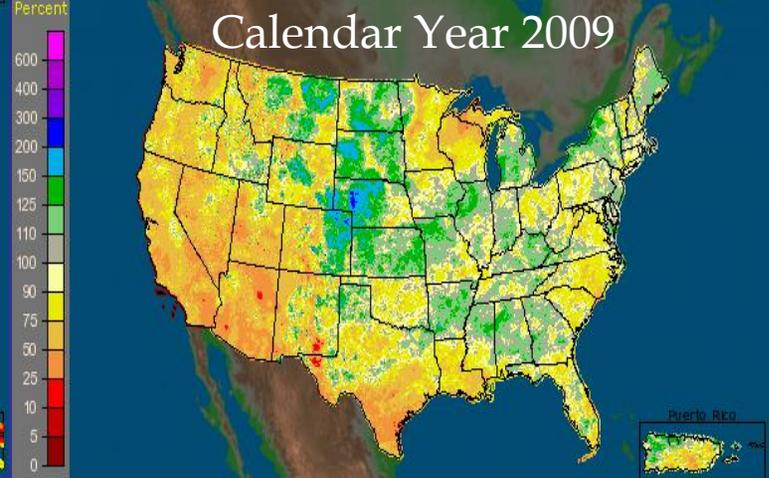
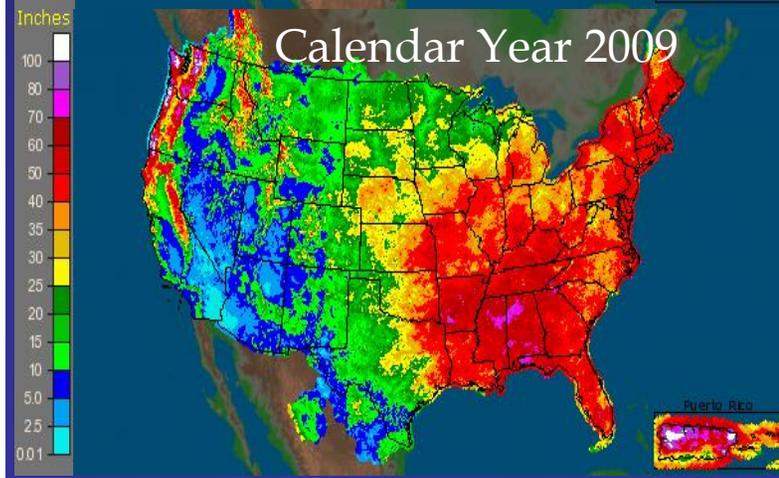
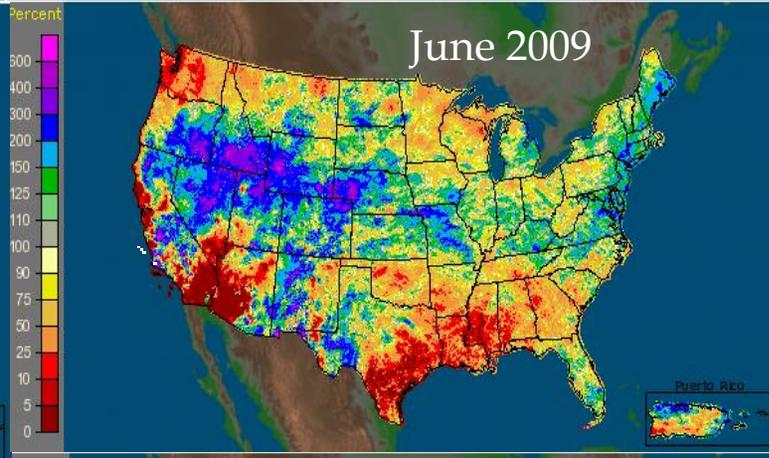
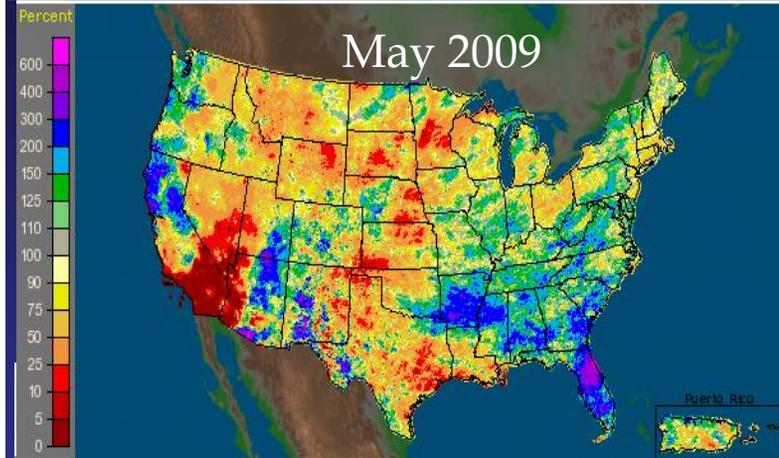
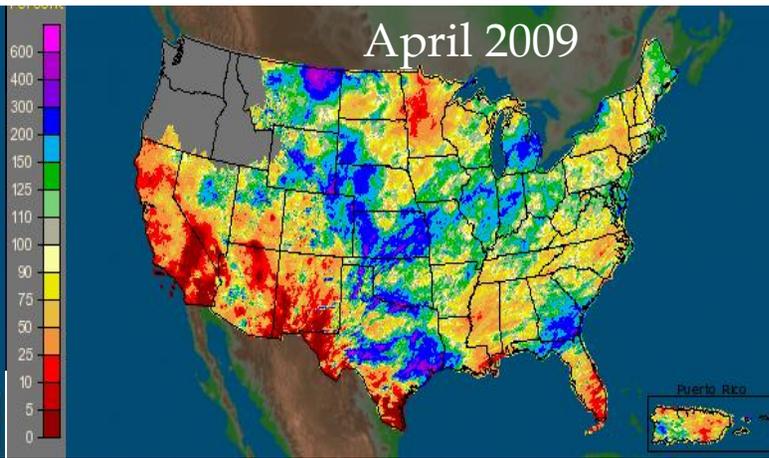
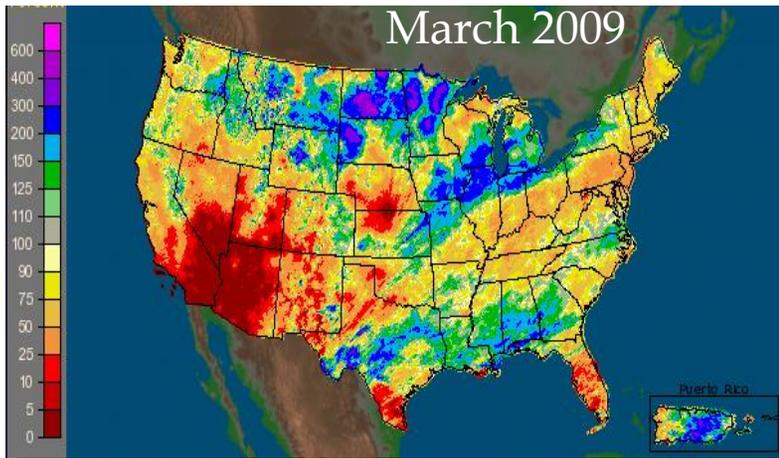
Plains Snowmelt



Rainfall



**Mountain Snow** + **Plains Snow** + **2009 Rainfall** = **32.9 MAF**  
**109% & 110% = 110%**    **significant plains snow**    **Wet above and below System**    **133% of Normal**

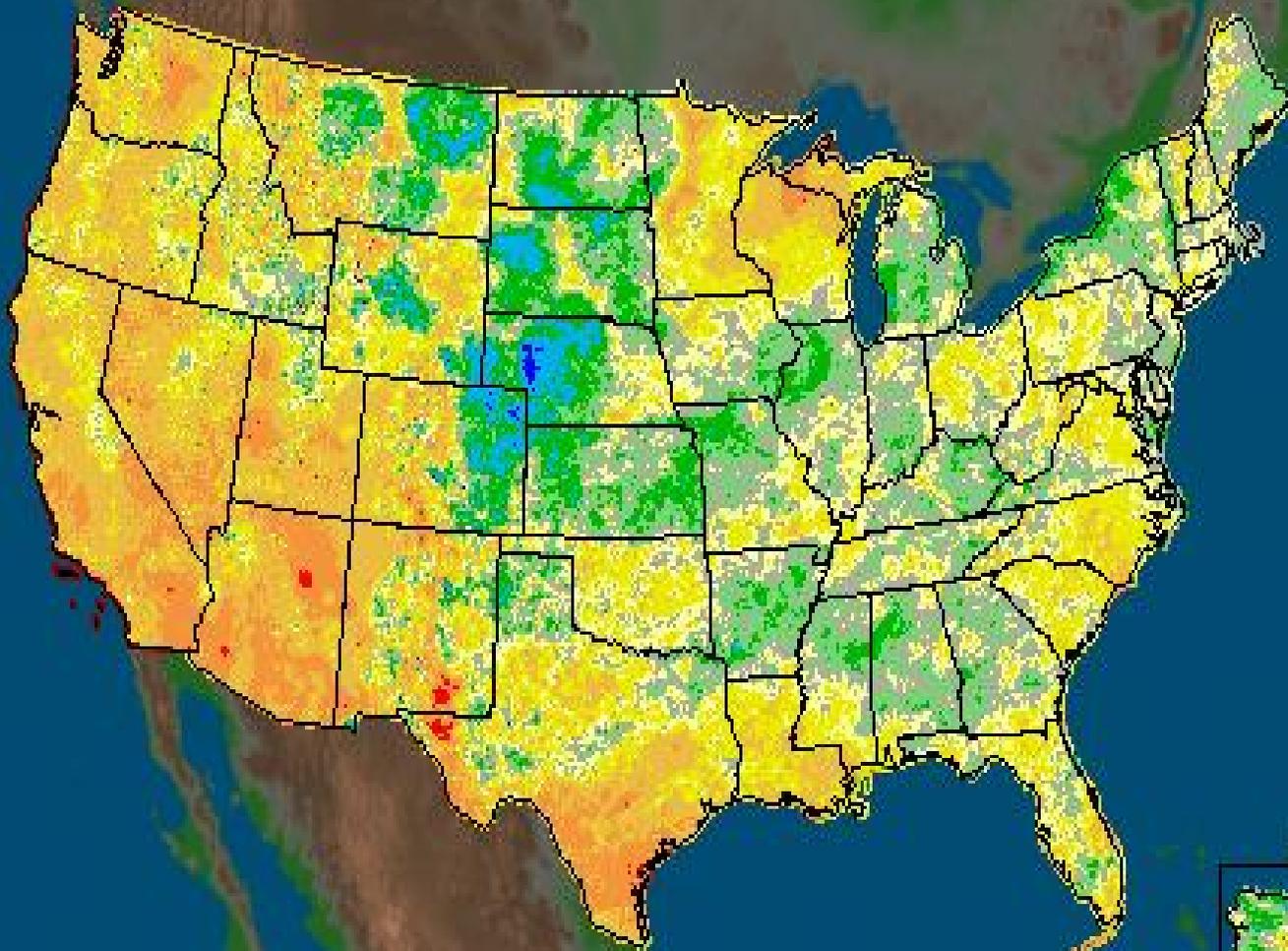
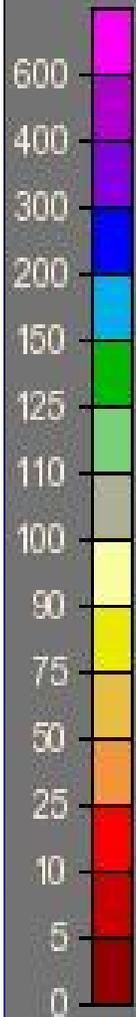


Precipitation  
2009

NWS-AHPS

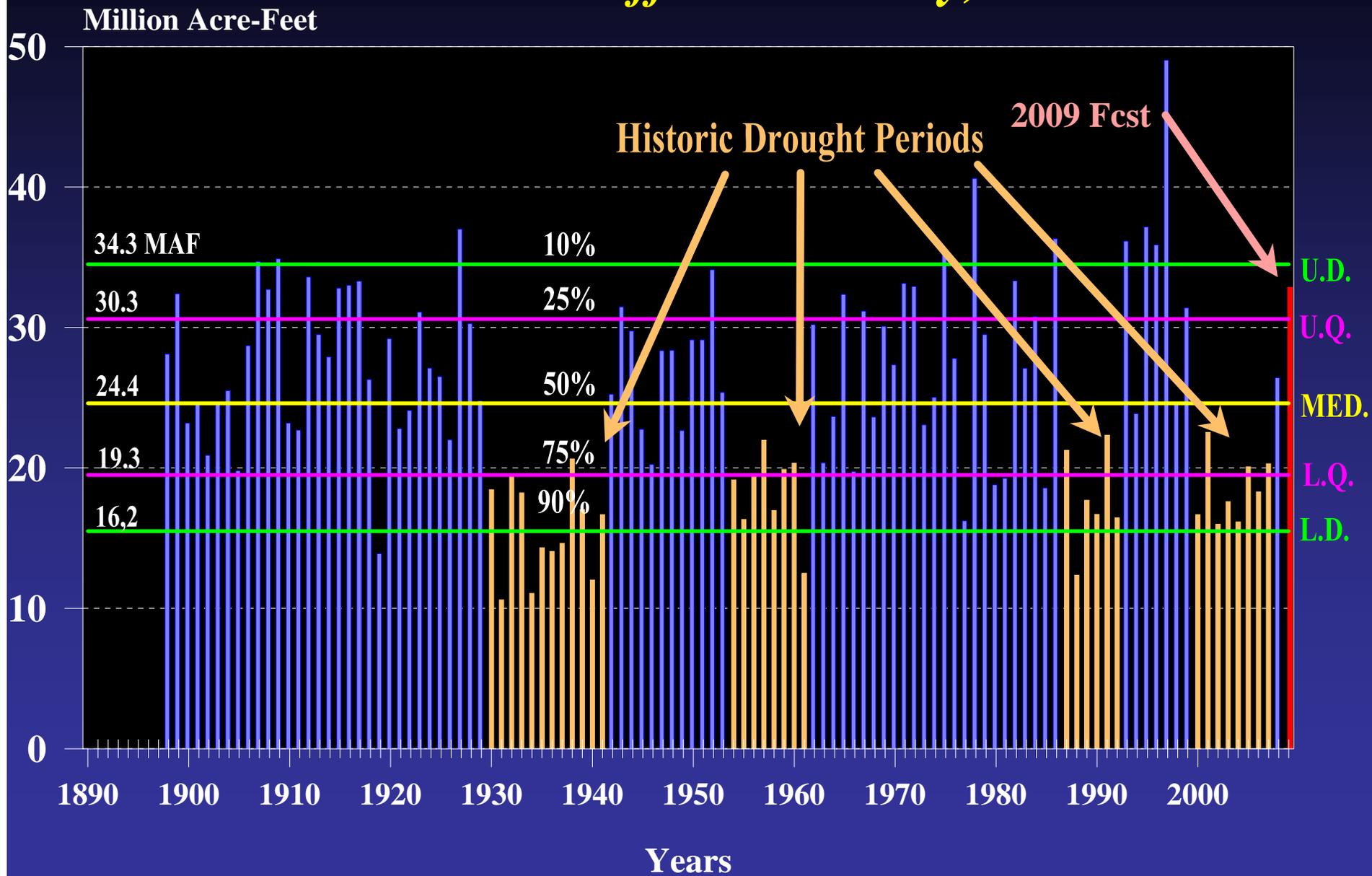
Valid at 9/30/2009 1200 UTC - Created 9/30/09 18:40 UTC

Percent



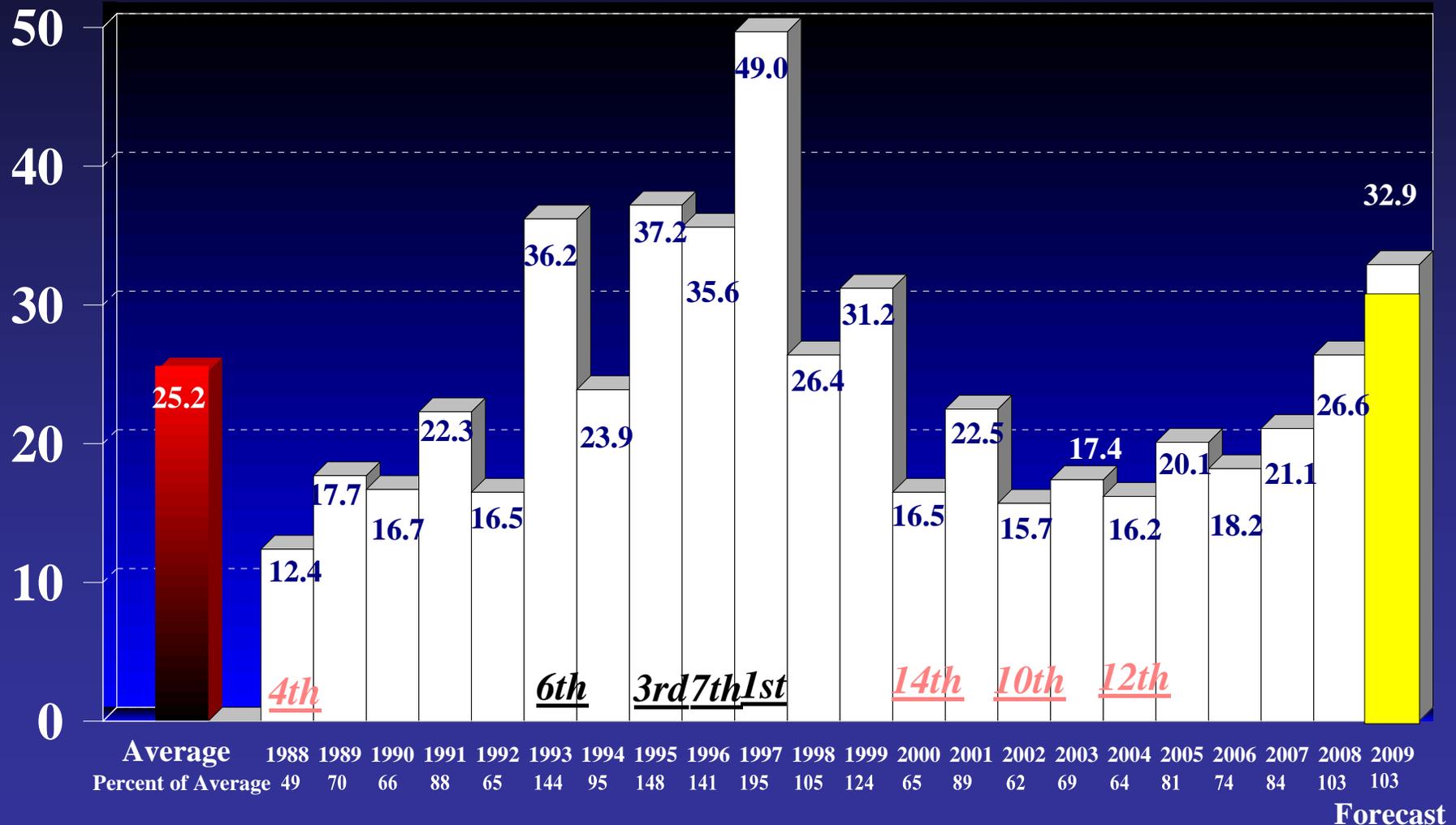
Calendar Year 2009 to date  
Precipitation in Percent of Normal

# Missouri River Mainstem Annual Runoff at Sioux City, Iowa



# Missouri River Runoff Above Sioux City CY 1988-2009 vs Average

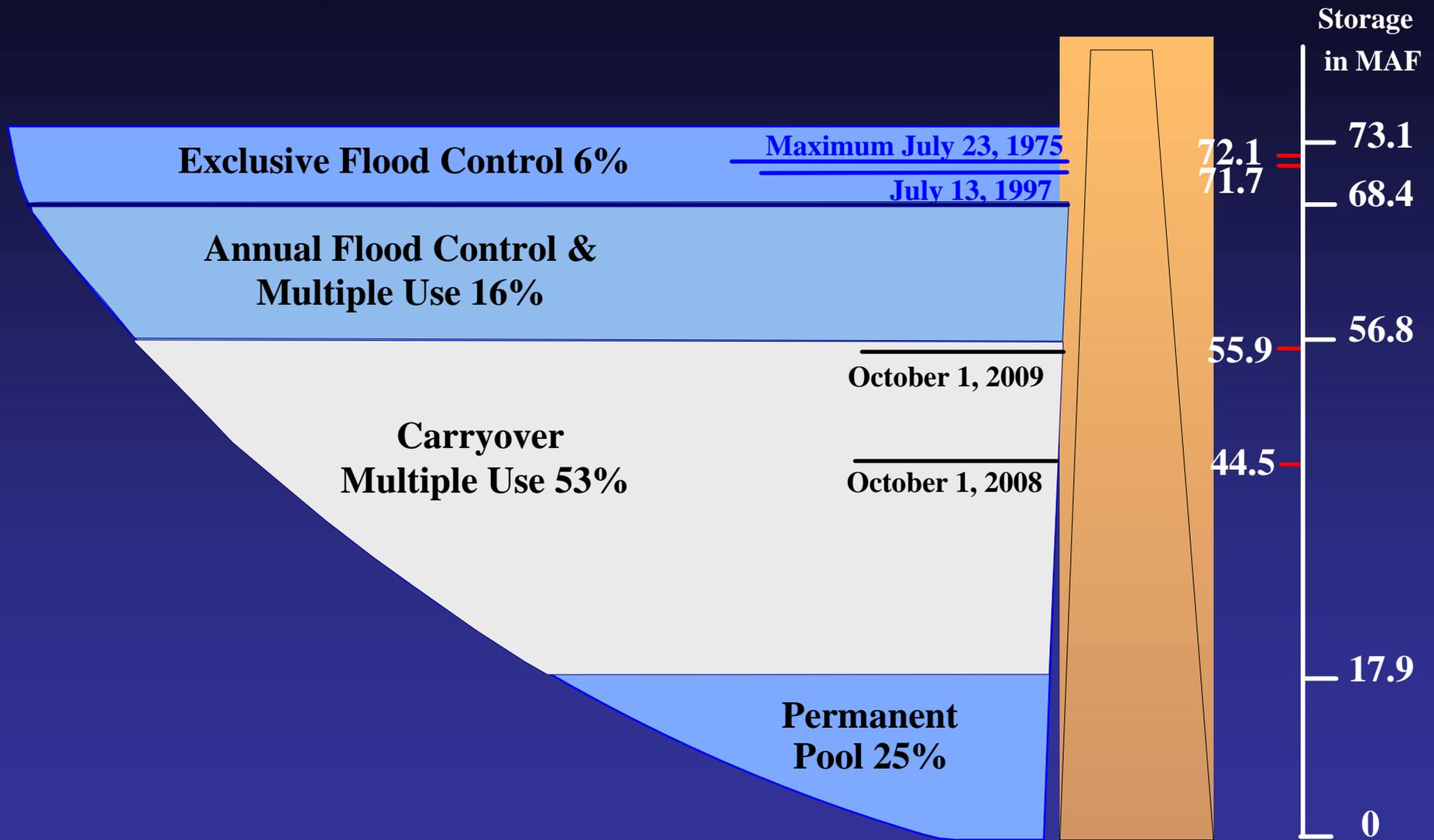
Million Acre Feet



October 2009

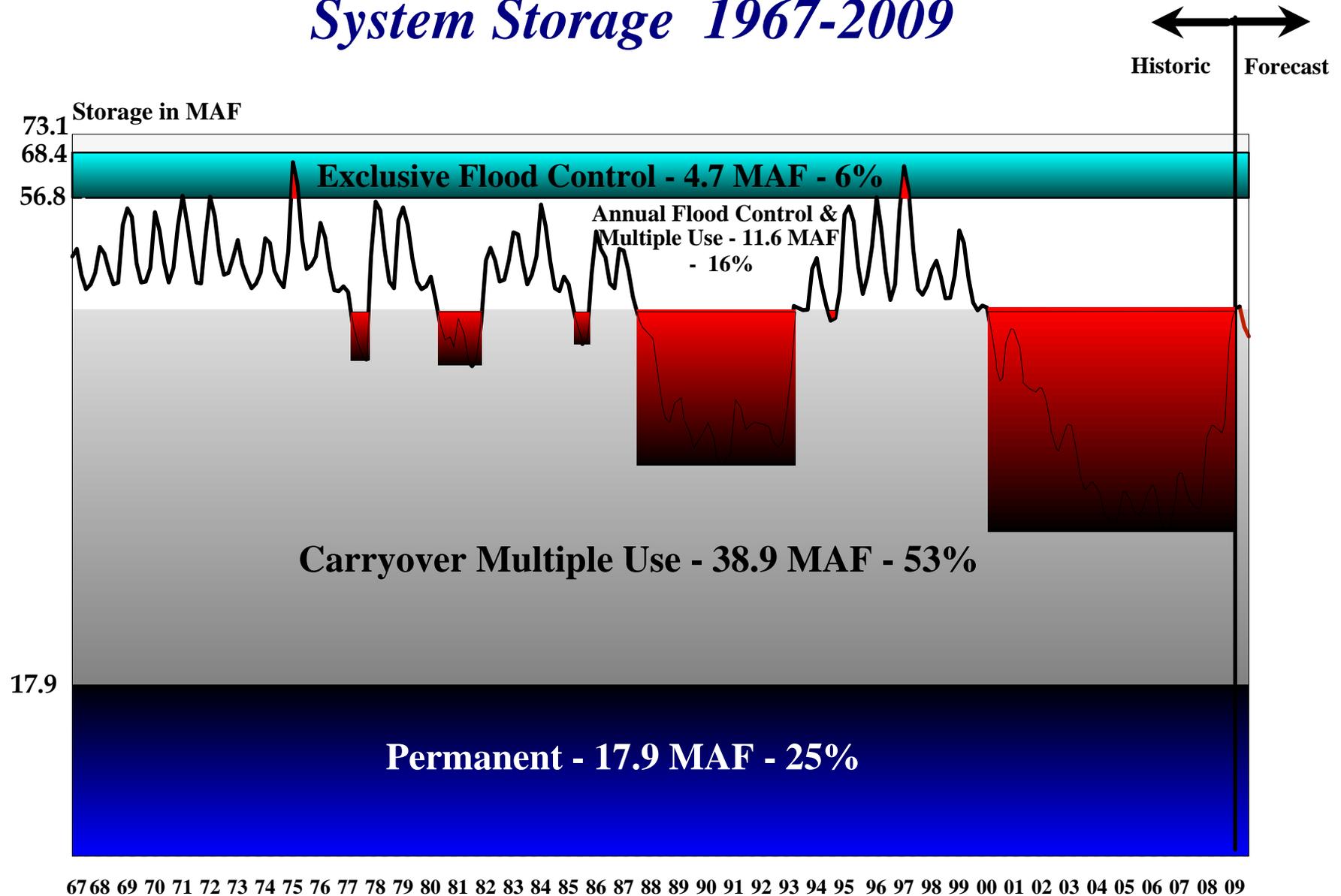
Forecast

# Missouri River Mainstem System Storage Zones and Allocations



**Total Storage = 73.1 MAF**

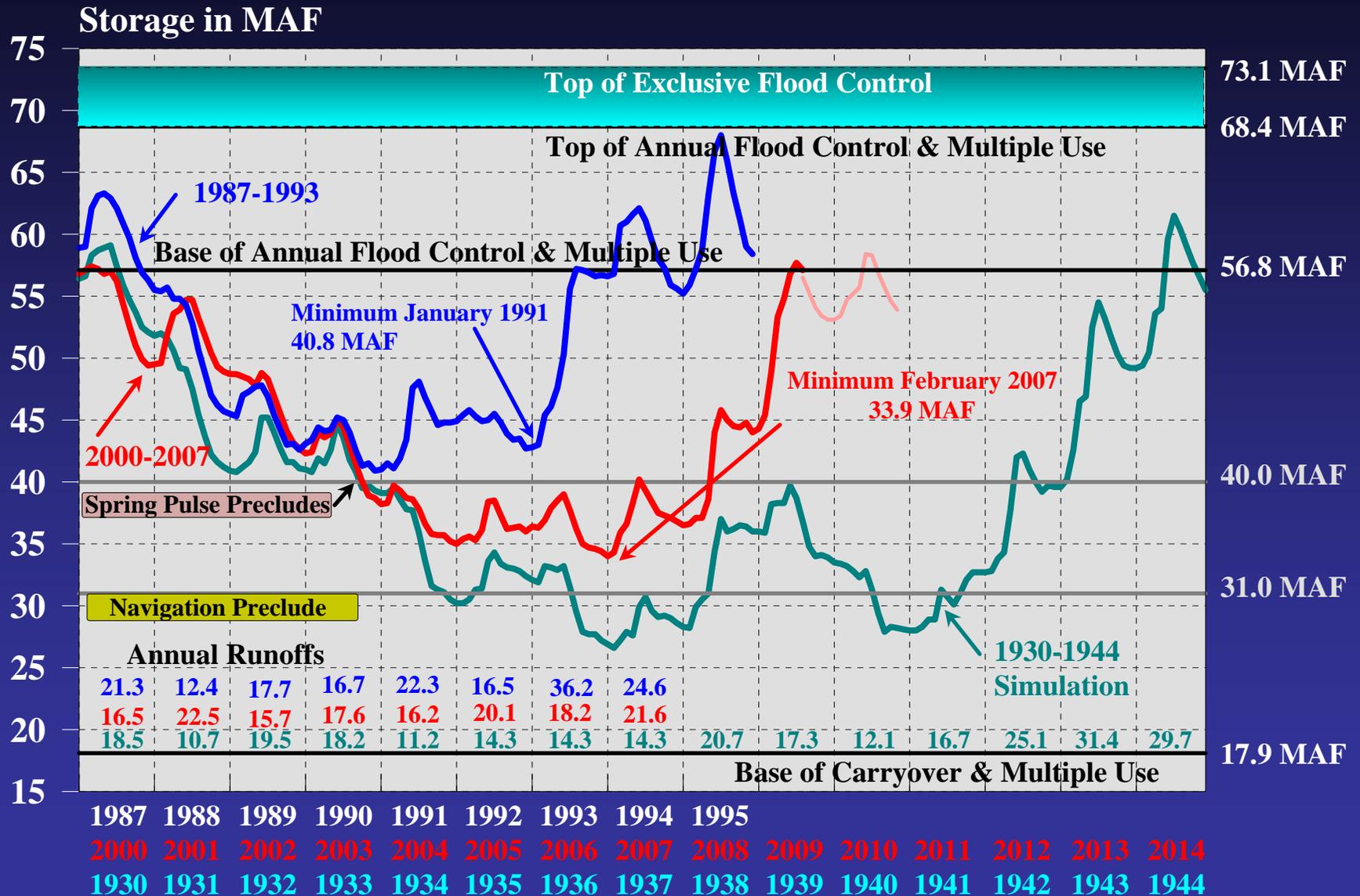
# Missouri River Mainstem System Storage 1967-2009



October 2009

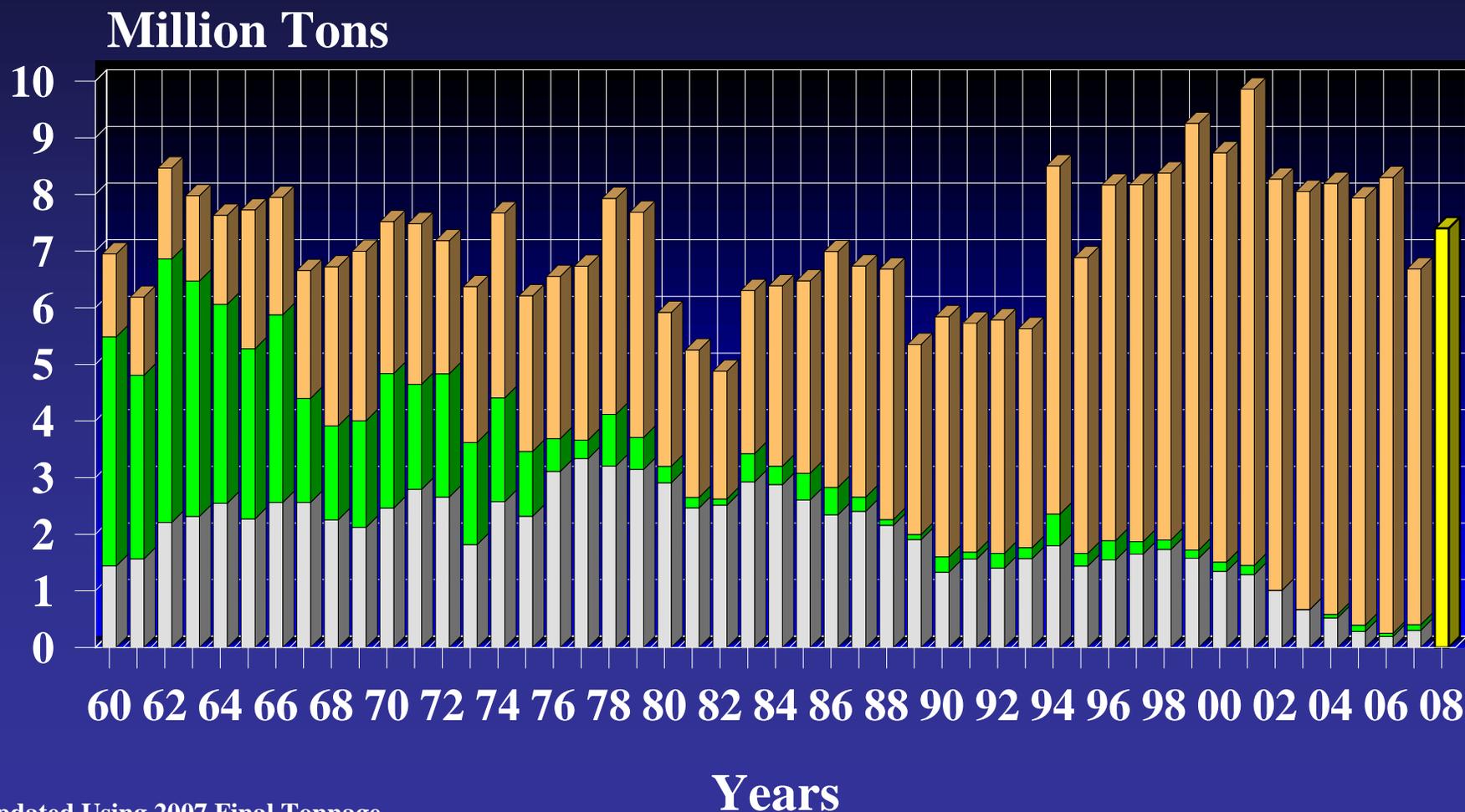
# Missouri River Mainstem

## Comparisons 1930-1943, 1987-1994 & 2000-current



# Missouri River Total Navigation Tonnage

Commercial Waterway Materials Sand and Gravel Estimated

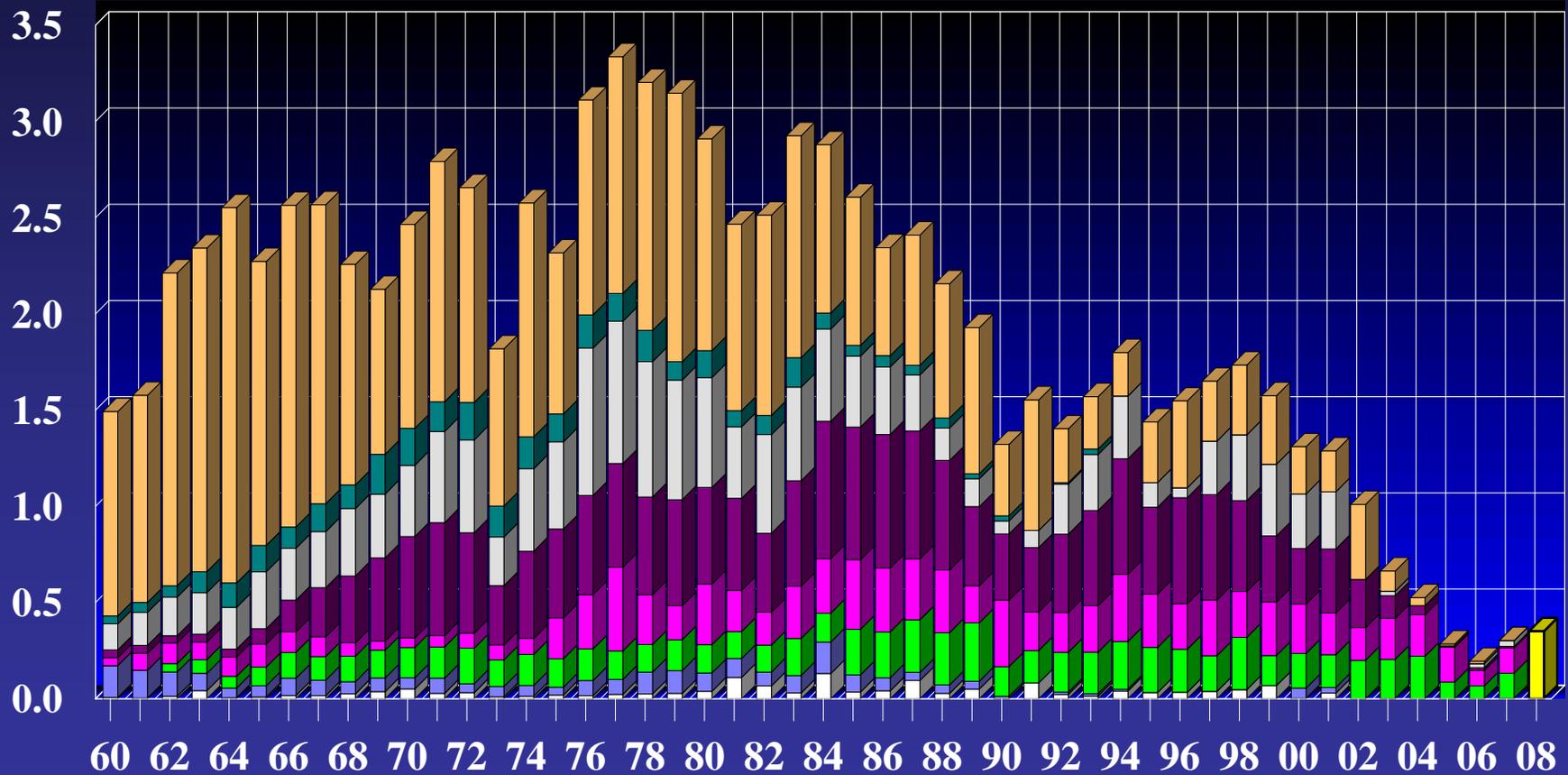


Updated Using 2007 Final Tonnage

# Commercial Navigation Tonnage

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

Million Tons



Excludes Sand, Gravel & Waterway Materials  
 Updated Using 2007 Final Tonnage

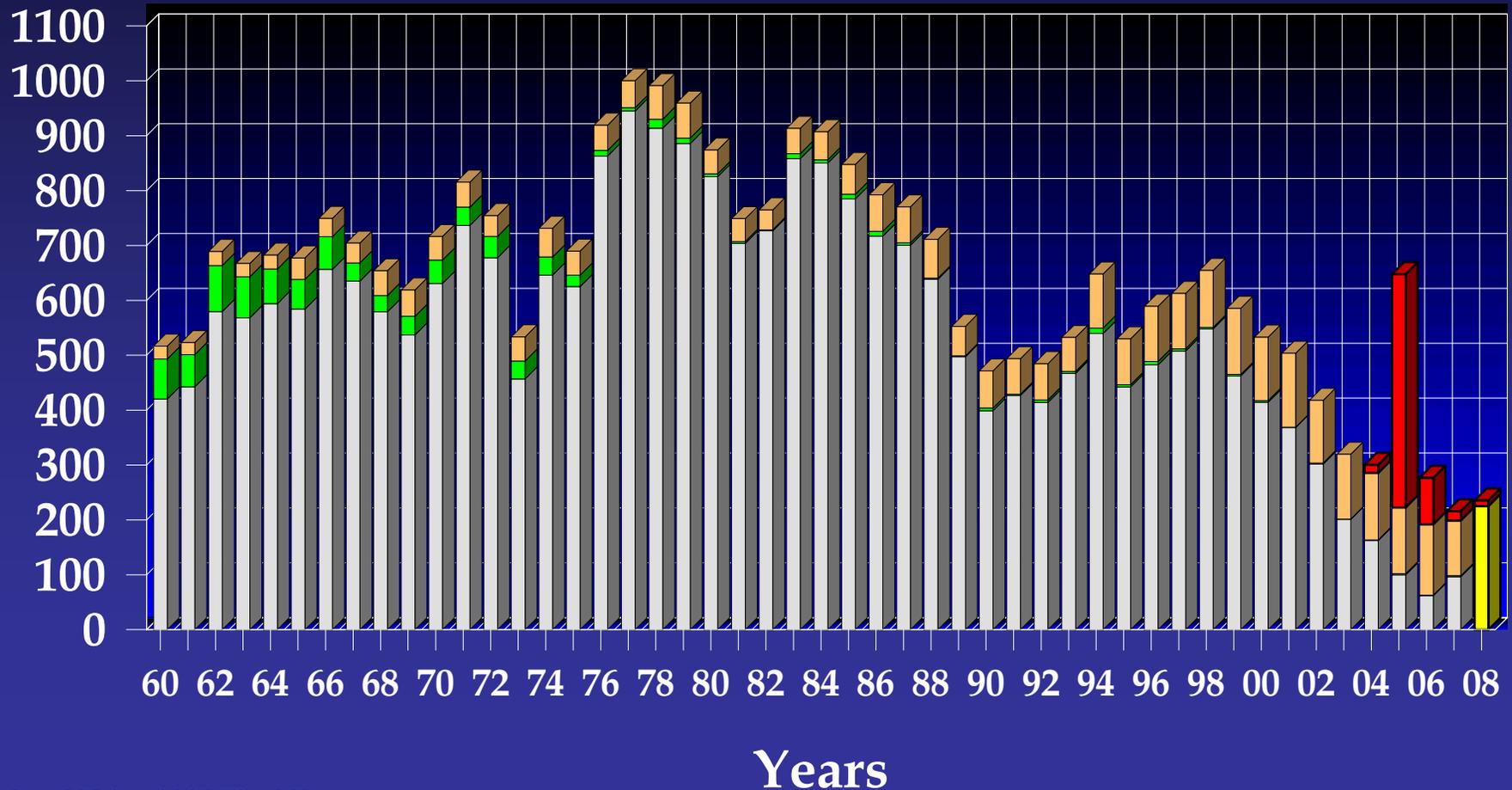
Years

# Missouri River Total Tonnage Value Based on 2009 Present Worth

Commercial
  Waterway Materials
  Sand and Gravel

Estimated
  Power Plant

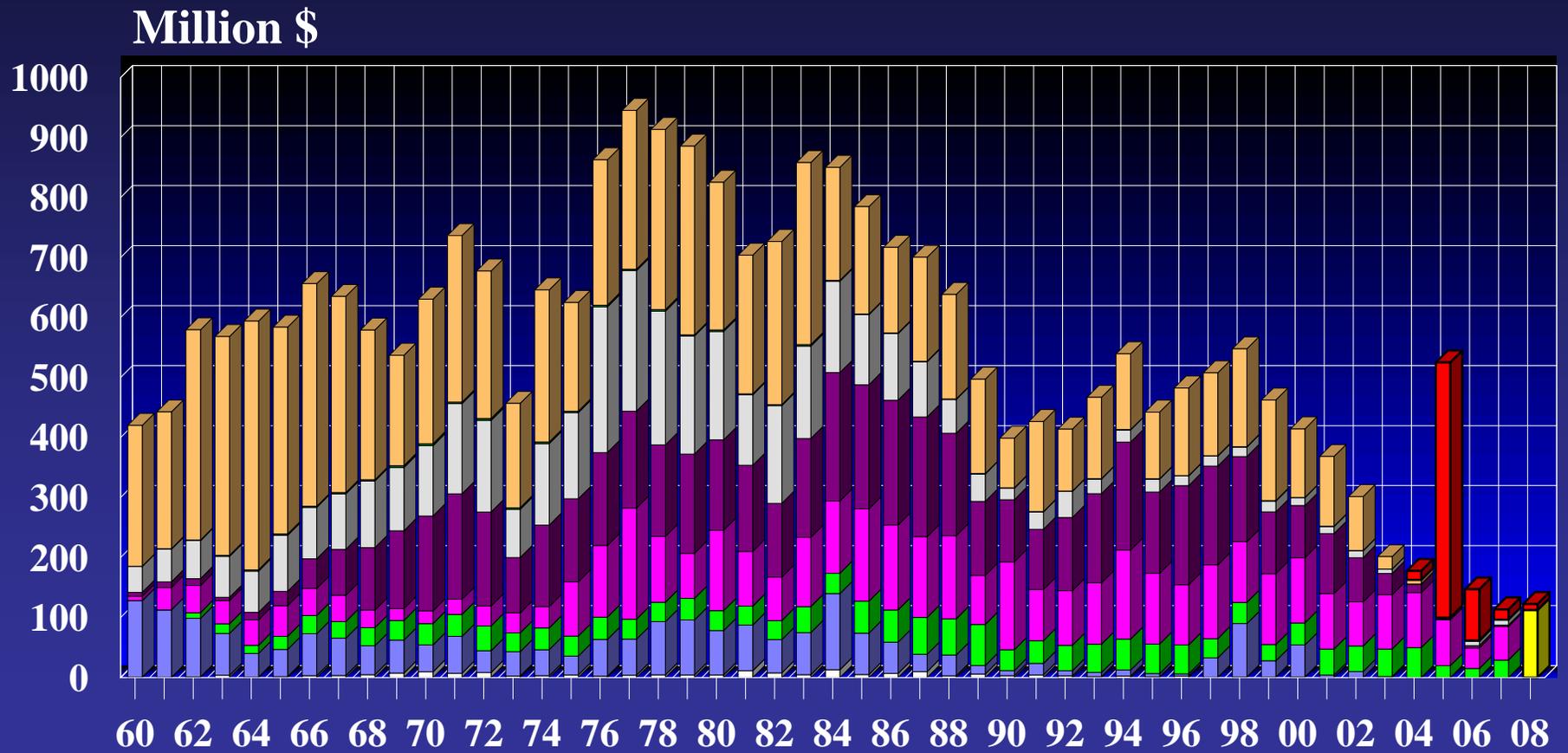
Million \$



Updated Using 2007 Final Tonnage

# Commercial Navigation Tonnage Value Based on 2009 Present Worth

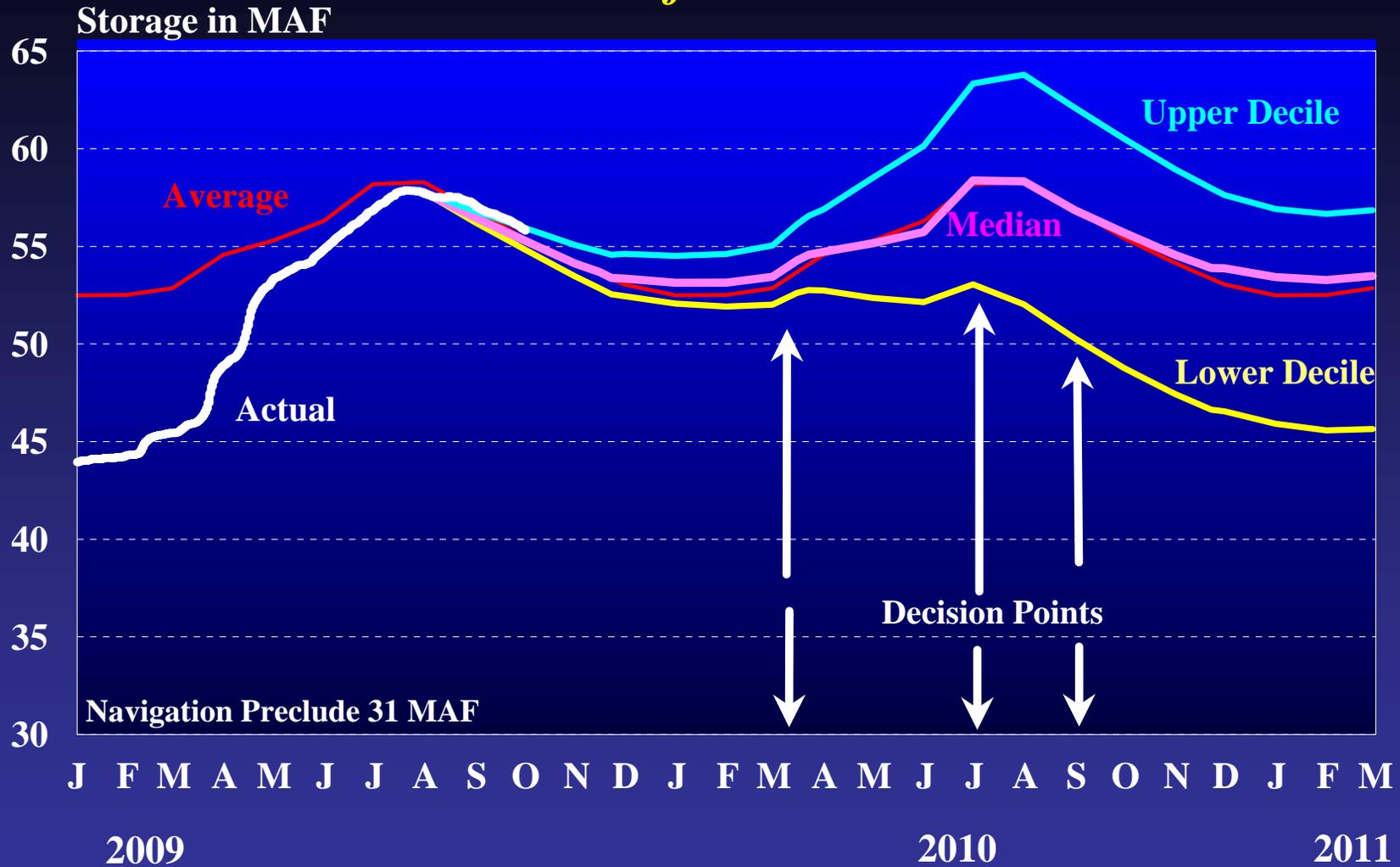
- All Others
  Primary Metal
  Stone, Clay, Cem
  Petro & Coke
- Chemicals
  Food & Kindred
  Non-Metallic
  Farm Products
- Estimated
  Power Plant



Excludes Sand, Gravel & Waterway Materials  
Updated Using 2007 Final Tonnage

# System Storage

## 2009-2011 Draft AOP vs Actual



# *Missouri River Mainstem Reservoirs*

## *2009 Downstream Flow Support Provided*

*Winter System releases provided above the minimum levels for water conservation (12,500 cfs) but levels were adequate in winter of 2008-2009.*

*Minimum service flows scheduled first half, then full service second half of 2009 navigation season.*

*Navigation Season full length as per master manual storage check a full season length in 2009.*

# *Missouri River*

## *2009 Navigation Season Closing Dates*

<b>Sioux City</b>	<b>November 22</b>
<b>Omaha</b>	<b>November 24</b>
<b>Nebraska City</b>	<b>November 25</b>
<b>Kansas City</b>	<b>November 27</b>
<b>Mouth near St. Louis</b>	<b>December 1</b>

**Gavins Point releases reduced at 3,000 cfs per day until winter flow rate reached**

# *Missouri River Downstream Flow Support*

## *Support for 2010 Navigation Season*

Runoff Scenario	Annual Runoff Volume (MAF)	July 1 System Storage (MAF)	Flow Level Above or Below Full Service (in CFS)		Length of Shortening (Days)
			Spring	Fall	
Upper Decile	34.3	63.3	0	0	0
Median	24.4	58.4	-200	0	0
Lower Decile	16.2	53.1	-2,100	-3,600	0

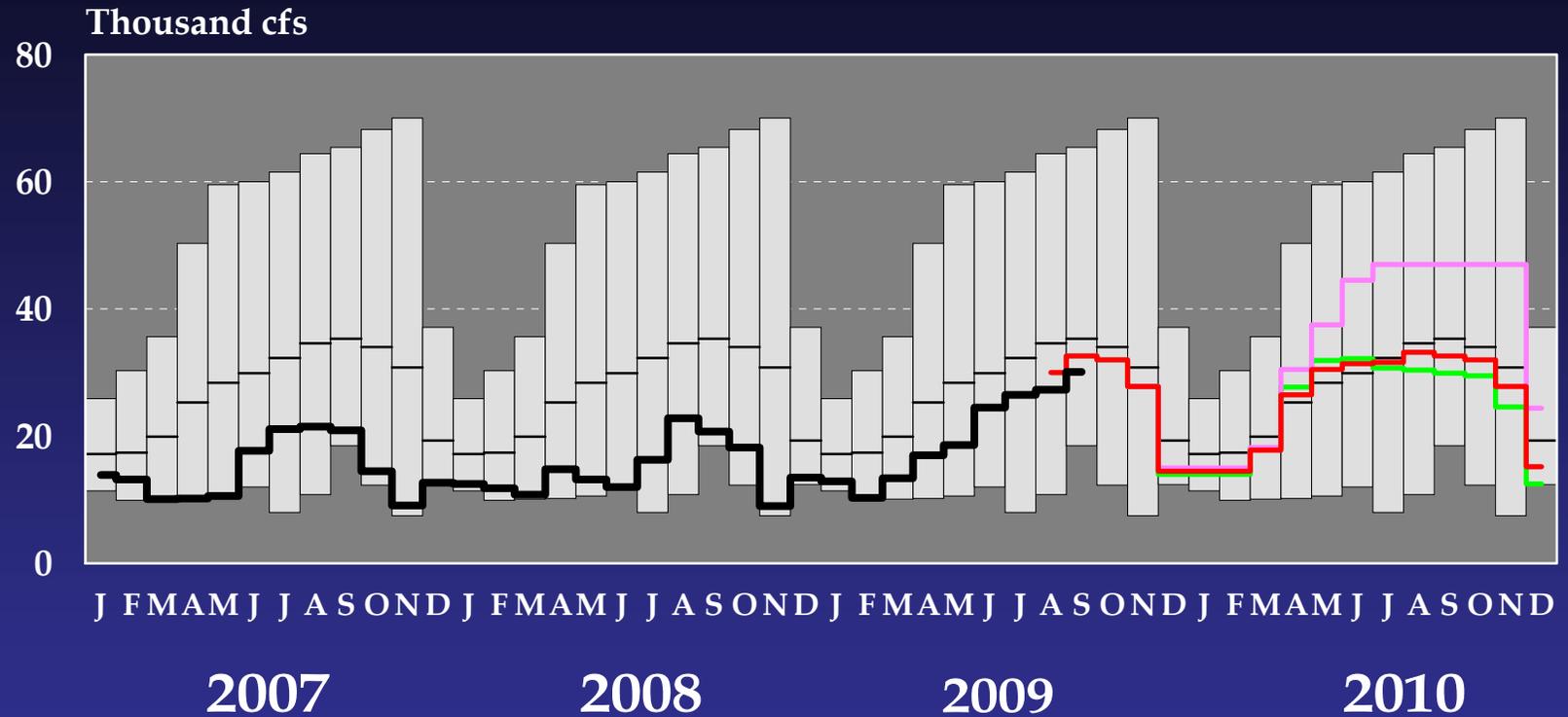
# *Missouri River 2010 Navigation Season*

## *Opening Dates & Full Service Flow Targets*

<b>Sioux City</b>	<b>March 23</b>	<b>31,000 cfs</b>
<b>Omaha</b>	<b>March 25</b>	<b>31,000 cfs</b>
<b>Nebraska City</b>	<b>March 26</b>	<b>37,000 cfs</b>
<b>Kansas City</b>	<b>March 28</b>	<b>41,000 cfs</b>
<b>Mouth near St. Louis</b>	<b>April 1</b>	

# Gavins Point Monthly Releases

## 2007 through 2009 Actual & 2009 -2010 AOP Releases



■ Max/Min    ▤ Average    — Actual    — Basic Forecast    — Upper Decile  
— Lower Decile

Max, Min, and Avg 1967-2008

# *Missouri River Mainstem Reservoirs*

## *2010 Draft AOP Downstream Flow Support*

*Winter System releases scheduled above levels (15,500 cfs) to conserve water but still met downstream requirements.*

*Full Service flows likely for navigation season unless very dry.*

*No Season shortening likely based on 1 July System storage check for runoff ranges used in 2009-2010 Draft AOP.*

*Navigation target flows not supported if commercial navigation is not using the reach to conserve main stem system storage.*

*Missouri River navigation flow support from Kansas River reservoirs could be utilized as water conservation measure.*

# *Estimated Missouri River Stages and Flows\**

## *For May - October 2010*

<i>Gage Location</i>	<i>River Stage</i>	<i>Flow in cfs</i>
Sioux City	13.7 - 17.0 feet	25-38,000 cfs
Decatur	20.7 - 23.7 feet	25-38,000 cfs
Omaha	14.0 - 18.6 feet	25-41,000 cfs
Nebraska City	8.1 - 12.5 feet	31-48,000 cfs
Rulo	7.7 - 12.1 feet	32-51,000 cfs
St. Joseph	7.1 - 11.6 feet	33-54,000 cfs
Kansas City	9.4 - 14.1 feet	41-64,000 cfs
Waverly	10.4 - 14.0 feet	41-65,000 cfs
Boonville	6.7 - 12.5 feet	42-76,000 cfs
Hermann	4.5 - 11.8 feet	43-99,000 cfs

*\* based on normal runoff conditions in all reaches and summer water temperatures and not supporting navigation in upper reaches if commercial navigation is not scheduled..*

# Missouri River Basin Intakes

<i>Location</i>	<i>Powerplant</i>	<i>Irrigation</i>	<i>Municipal</i>
<i>Above System</i>	7	786 (196)	38 (11)
<i>Below System</i>	18	105 (3)	19
<i>Total</i>	25	891 (199)	57 (11)

( ) denotes tribal intake

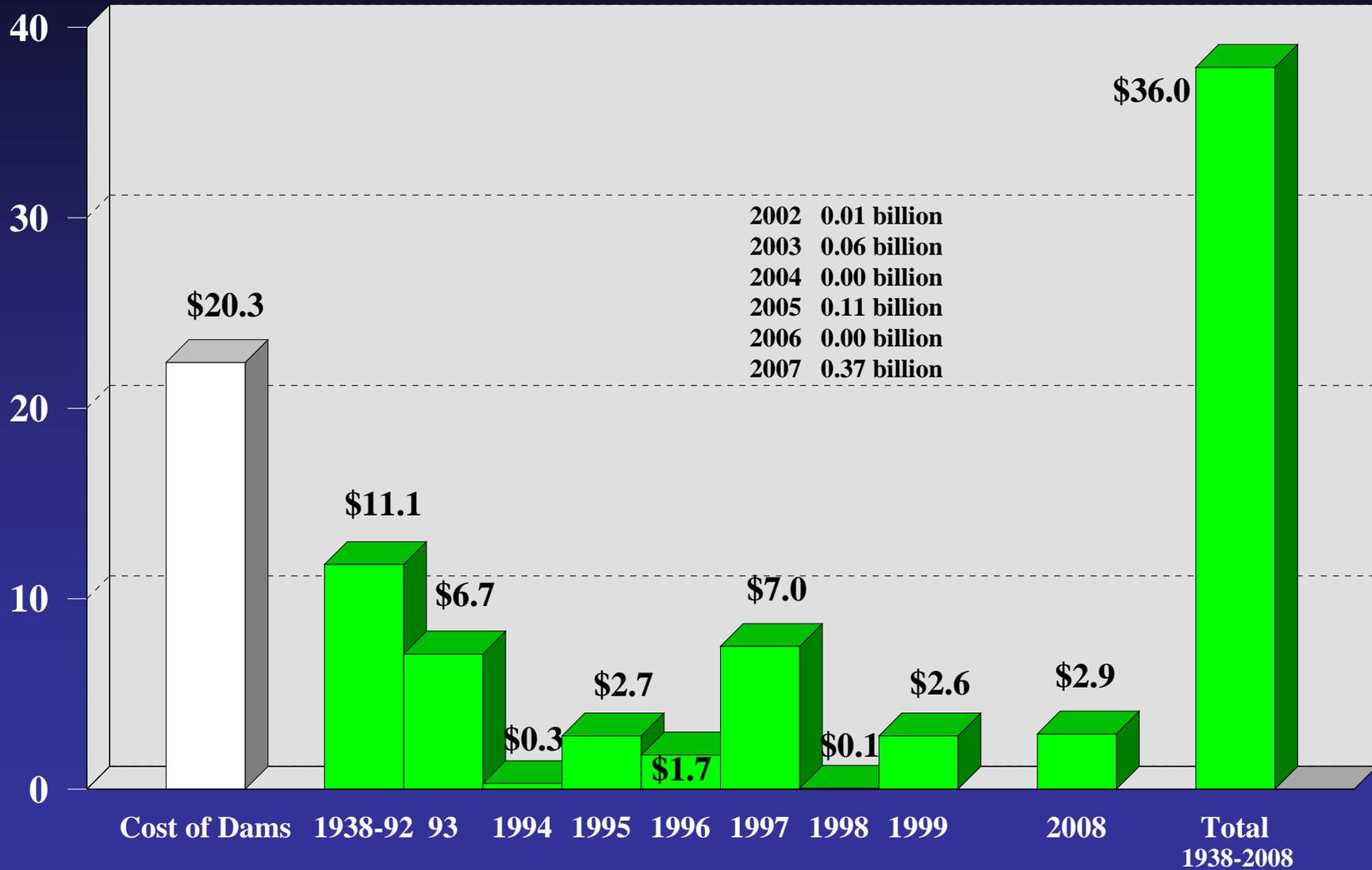
<i>Location</i>	<i>Powerplant</i>	<i>Capacity in MW</i>	<i>Percent</i>
<i>Above System</i>	7	4,026	27%
<i>Below System</i>	18	11,058	73%
<i>Total</i>	25	15,084	

<i>Location</i>	<i>Irrigation</i>	<i>Acres</i>	<i>Percent</i>
<i>Above System</i>	786 (196)	289,000	58%
<i>Below System</i>	105 (3)	209,600	42%
<i>Total</i>	891 (199)	498,600	

<i>Location</i>	<i>Municipal</i>	<i>Population</i>	<i>Percent</i>
<i>Above System</i>	38(11)	0.2 Million	6%
<i>Below System</i>	19	2.9 Million	94%
<i>Total</i>	57(11)	3.1 Million	

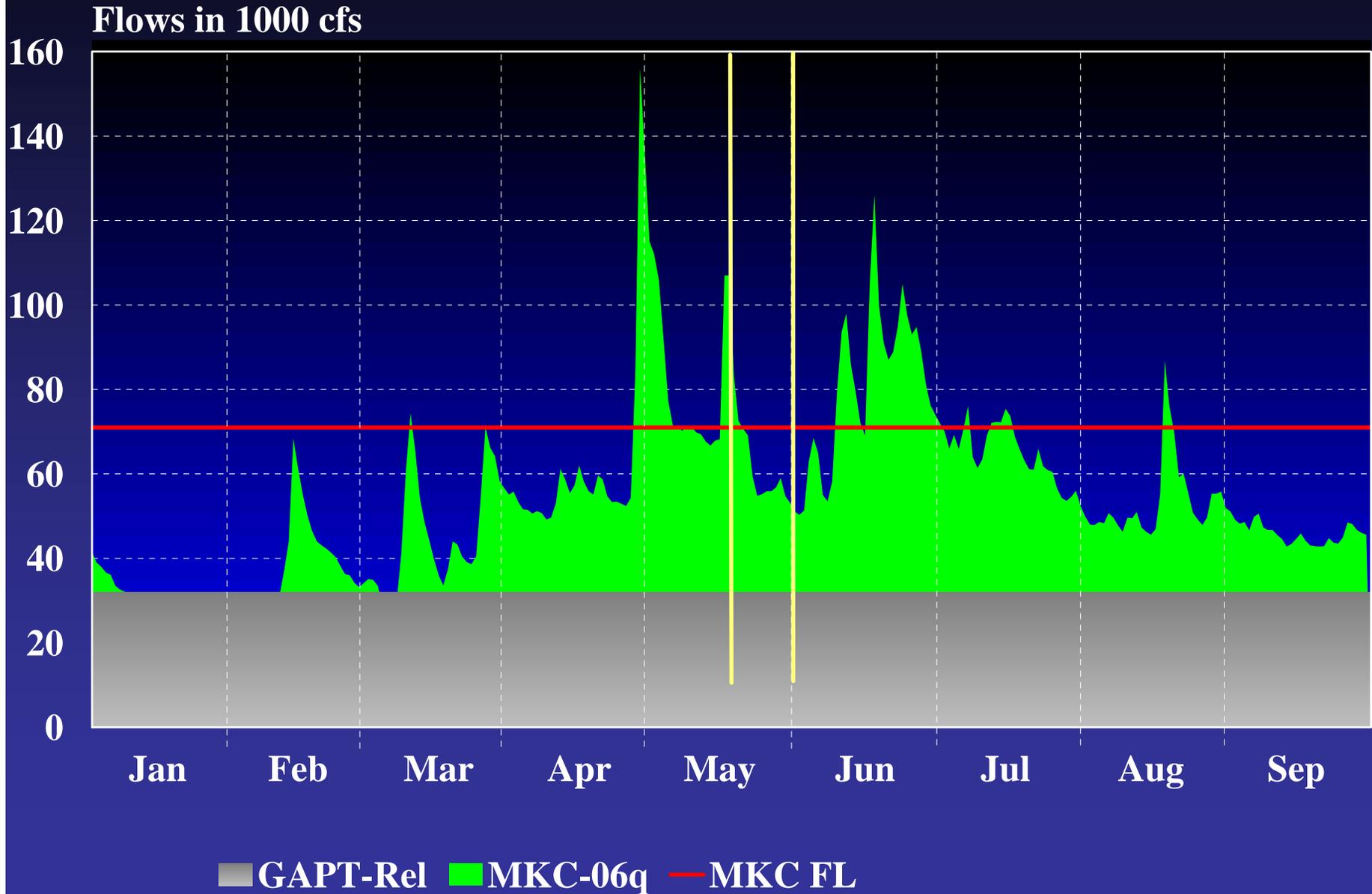
# Missouri River Main Stem Reservoirs Flood Damages Prevented Indexed to 2008

Billion Dollars



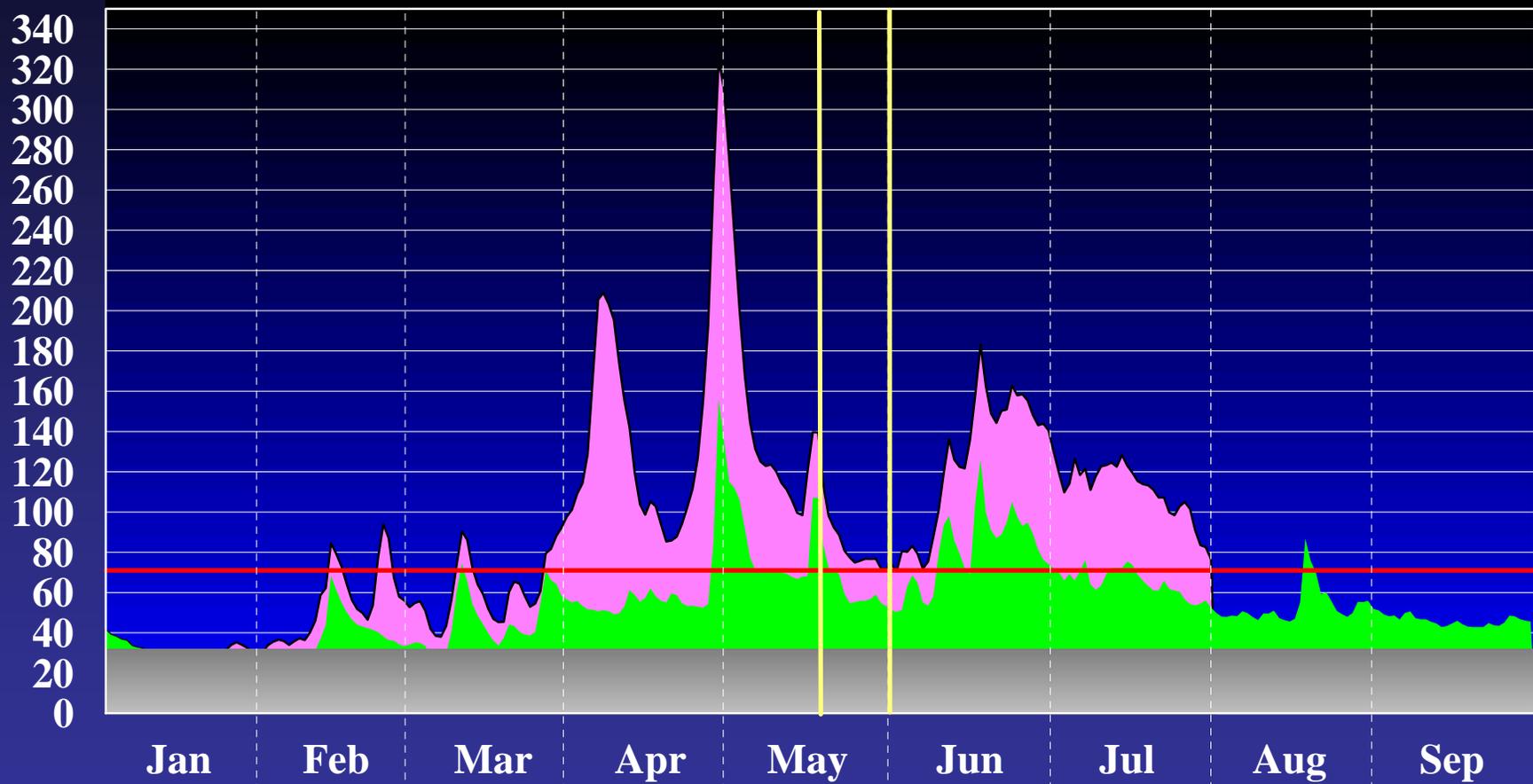
# 2009 Actual Flows

## Missouri River at Kansas City



# 2009 Actual & Unregulated Flows Missouri River at Kansas City

Flows in 1000 cfs



■ GAPT-Rel

■ MKC-06q

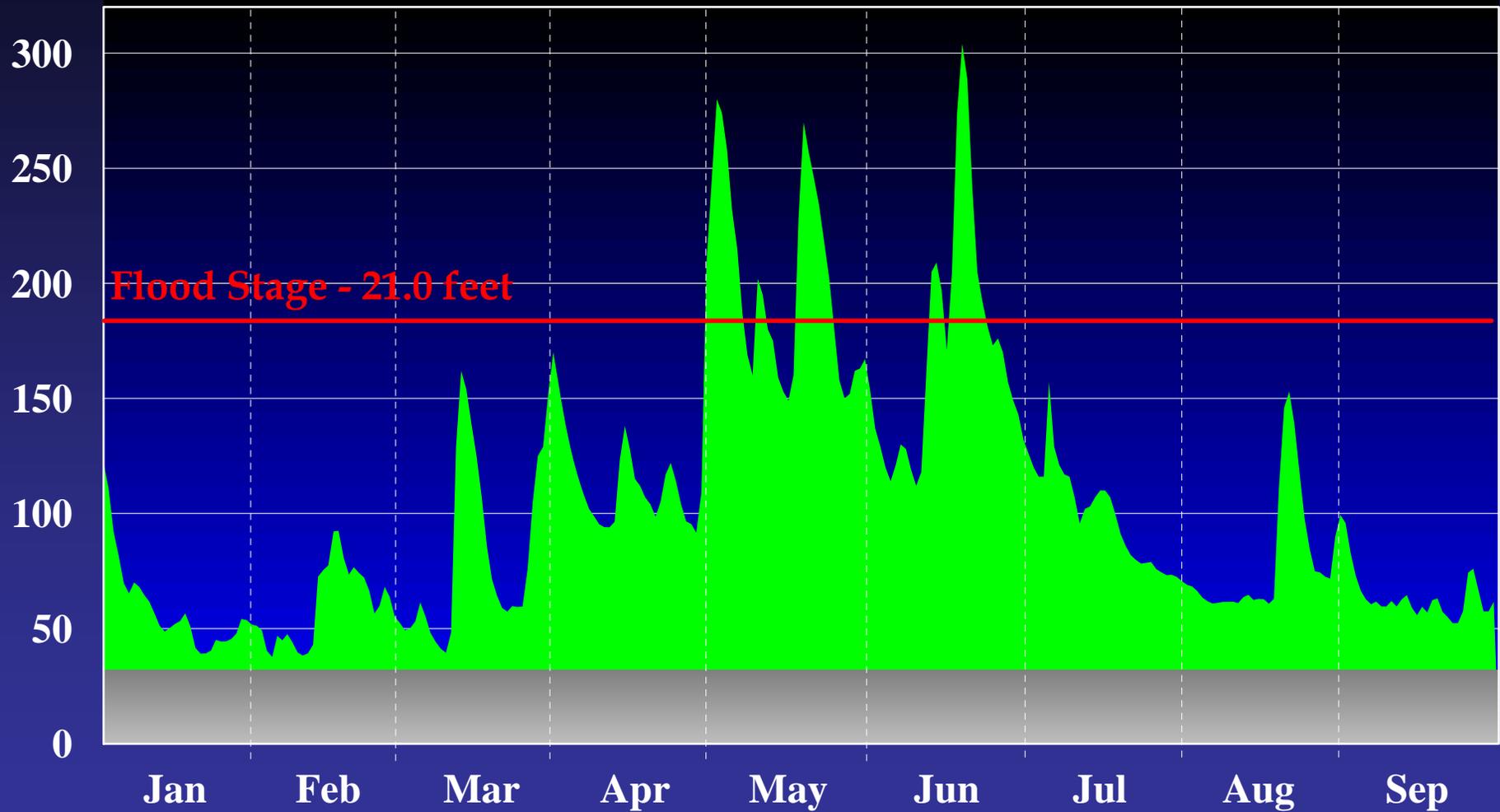
— MKC FL

■ Unregulated Flows

# 2009 Actual Flows

## Missouri River at Hermann

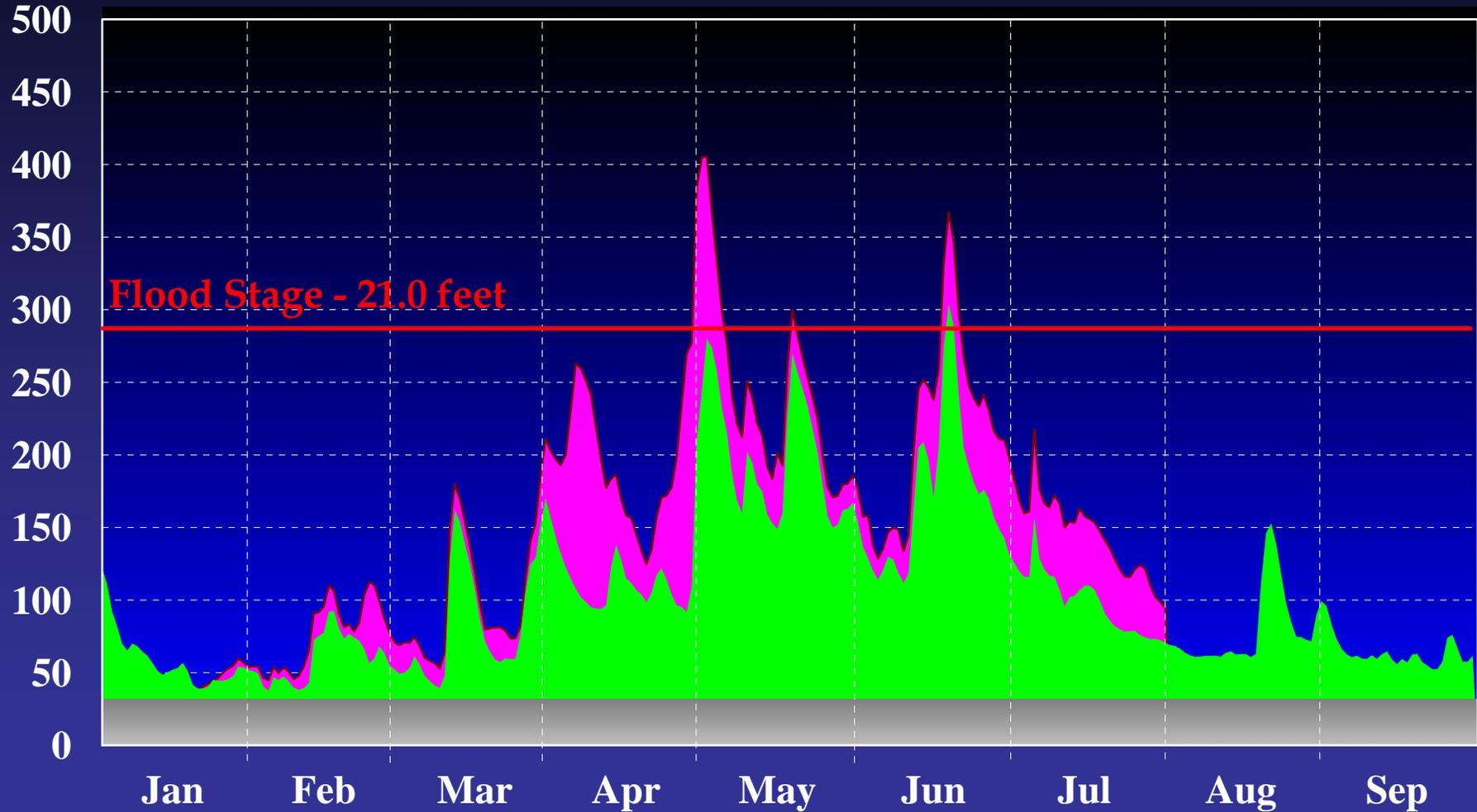
Flows in 1000 cfs



■ GAPT-Rel ■ HEMO-06q

# 2009 Actual Flows Missouri River at Hermann

Flows in 1000 cfs



■ GAPT-Rel ■ HEMO-06q ■ Unregulated Flows

## ***RCC Missouri River Flow Forecasting***

*Added NWS Multi-sensor Precipitation Estimates (MPE) into Corps' HMS forecasting procedures (Estimated Rainfall).*

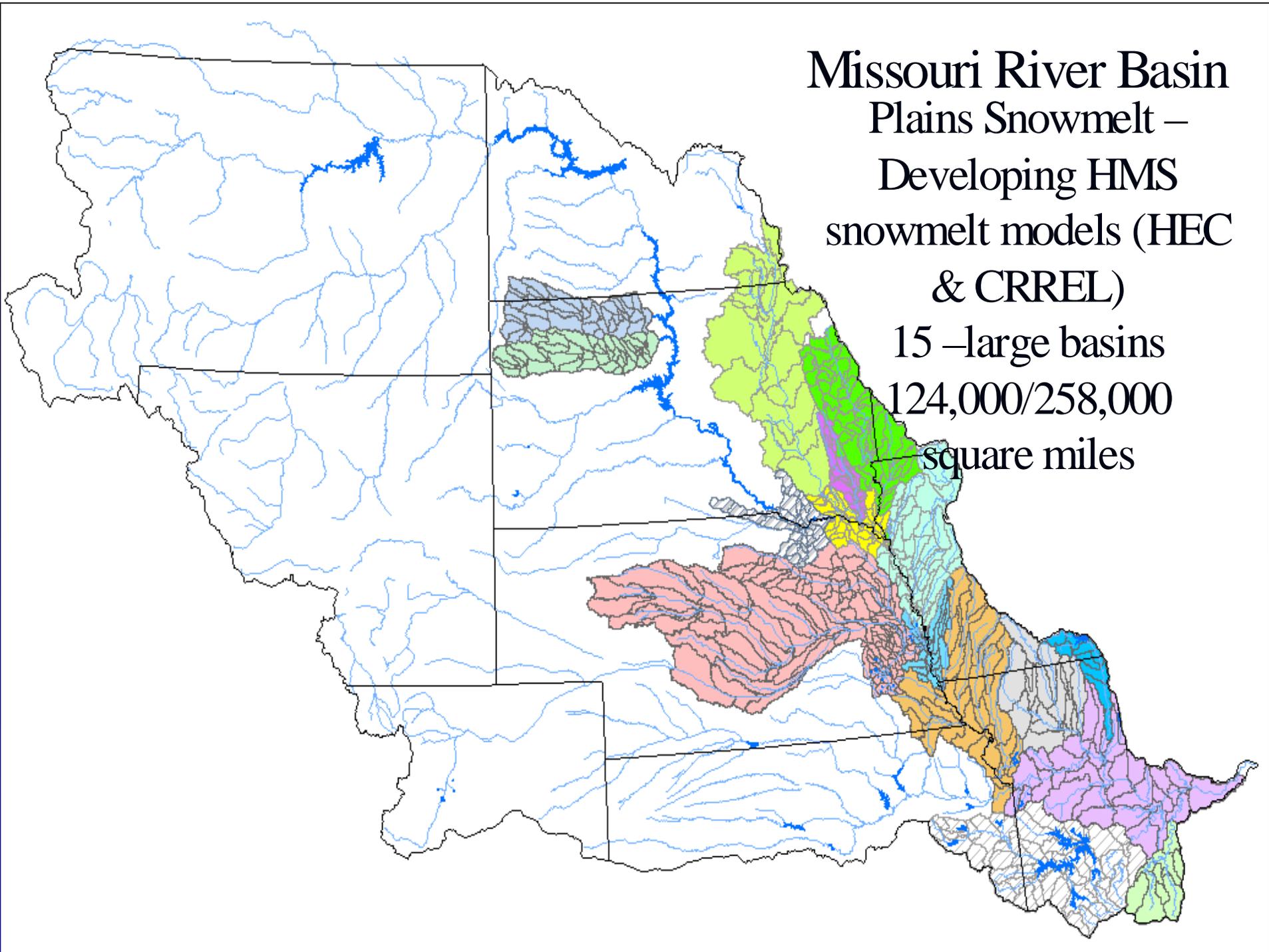
*Add 120 hours of NWS QPF data to Corps' HMS models during the Spring Pulse Periods and for downstream flood control situations.*

*Compare Corps' HMS forecast results with NWS forecast differences noted and coordinated.*

*Continue to seek cooperators on gaging stations required for modeling support throughout the basin. Budget reductions have reduced or eliminated some data collection for modeling.*

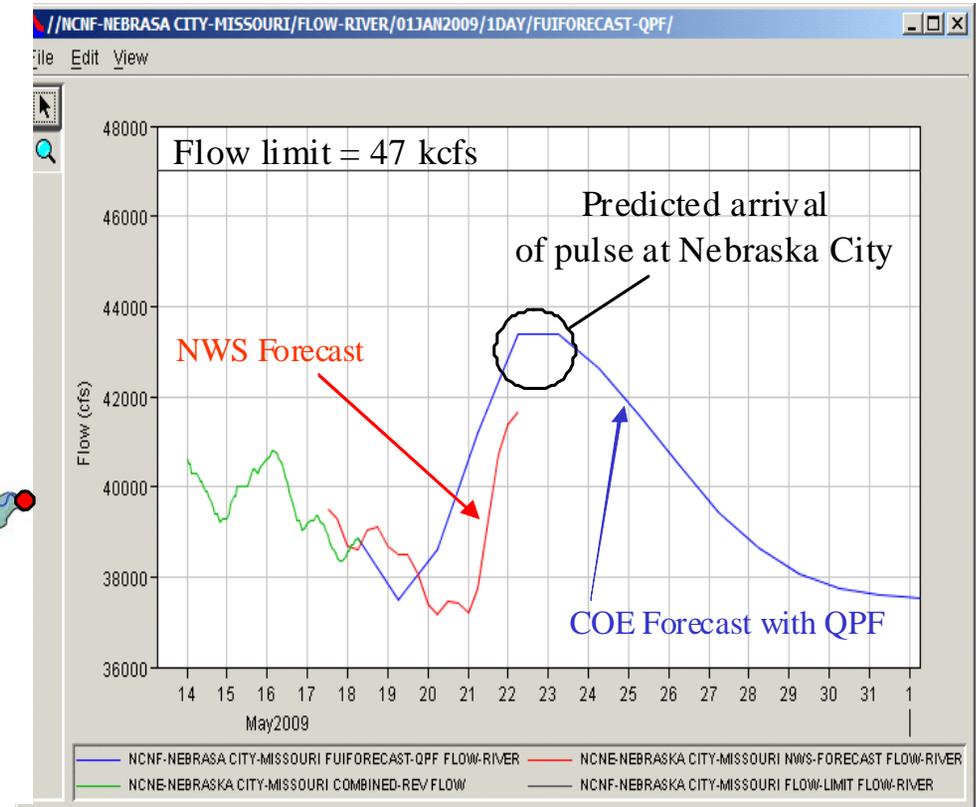
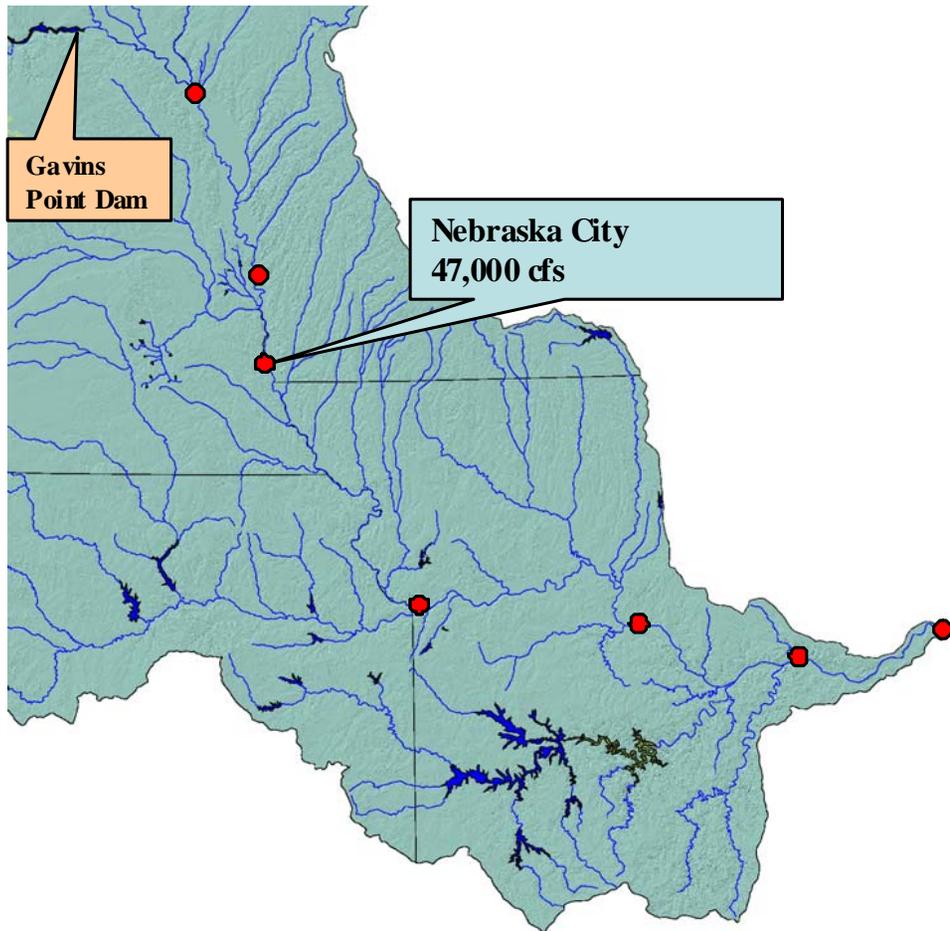
Missouri River Basin  
Plains Snowmelt –  
Developing HMS  
snowmelt models (HEC  
& CRREL)

15 –large basins  
124,000/258,000  
square miles



# Nebraska City, Nebraska

Forecast Assumes Spring Pulse  
Initiated on Monday, May 18

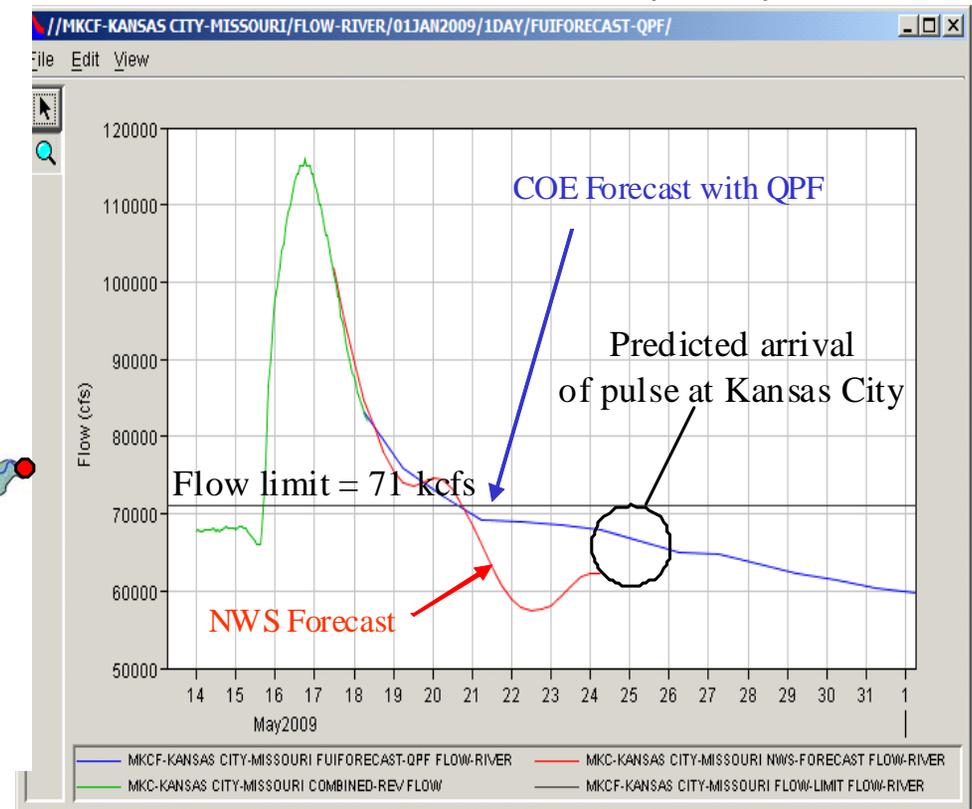
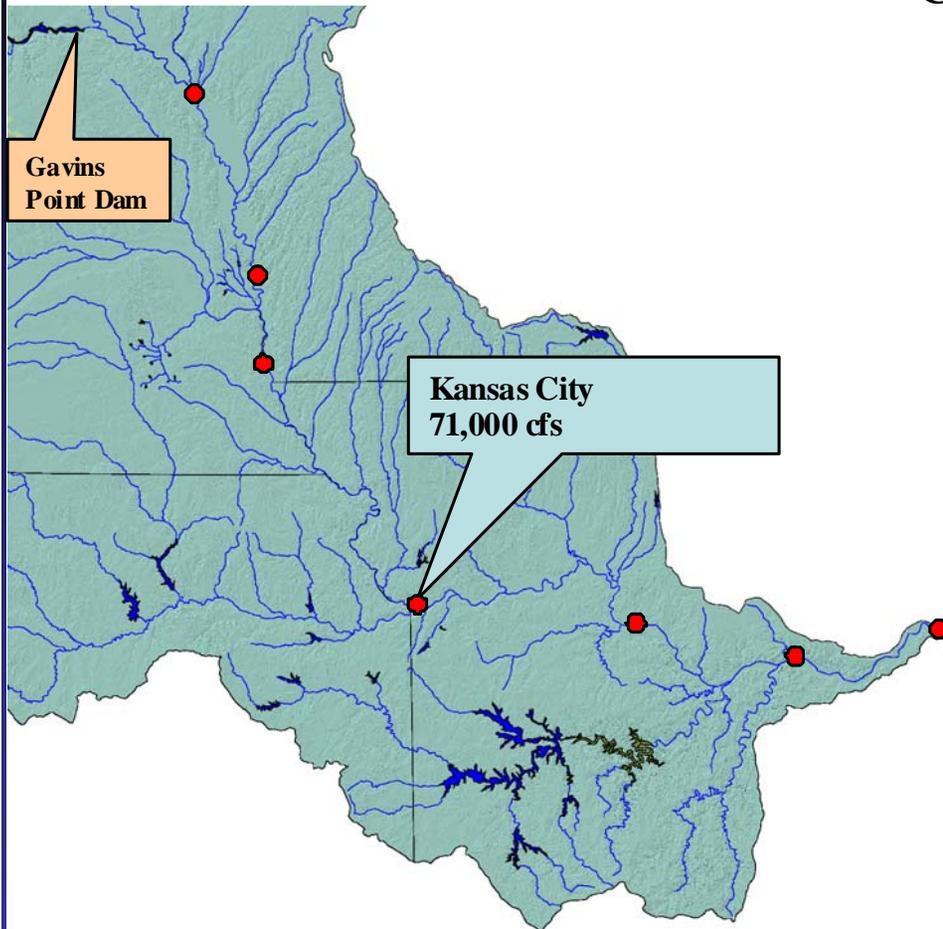


Flood Stage – 18 feet  
Approximate Flow – 85,000

# Kansas City, Missouri

Confluence of Missouri and Kansas Rivers

Forecast Assumes Spring Pulse  
Initiated on Monday, May 18



Flood Stage – 32 feet  
Approximate Flow – 249,000

# *Congressionally Authorized Project Purposes*

## *2009 - 2010 AOP Expected Results*

**Flood Control - significant flood control storage available**

**Navigation - full service & normal season.**

**Hydroelectric Power**

**Irrigation -**

**Water Supply & WQ - will meet downstream flow requirements with potential for some intake access problems during winter because of river ice conditions.**

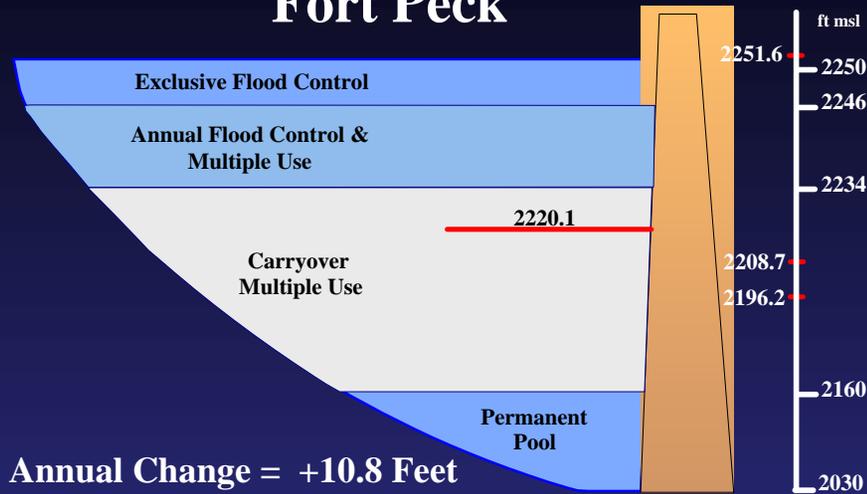
**Recreation (below System) - No significant issues expected with normal flows.**

**Fish and Wildlife -**

**Endangered Species**

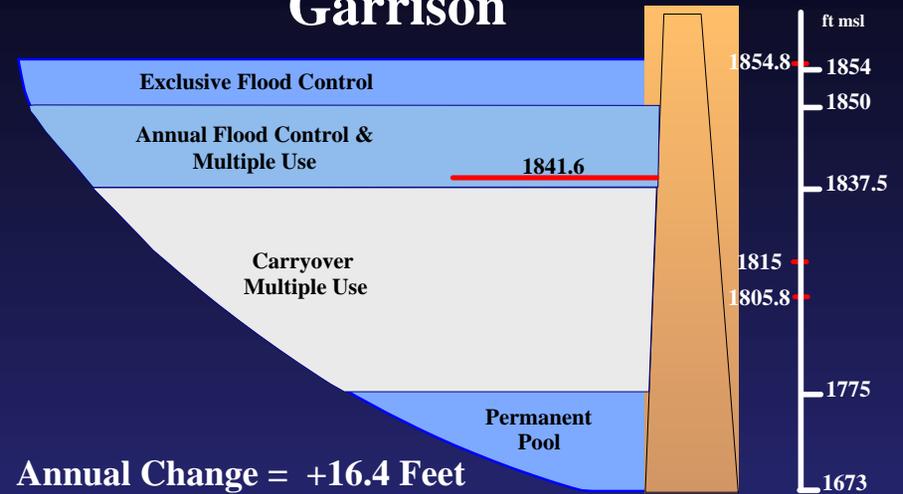
# Current Reservoir Levels - October 1, 2009

## Fort Peck



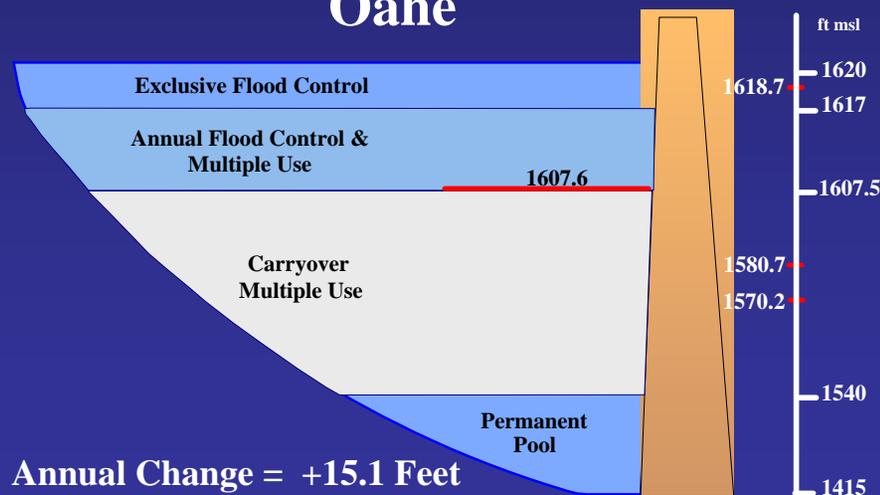
Annual Change = +10.8 Feet  
13.9 feet below desired

## Garrison



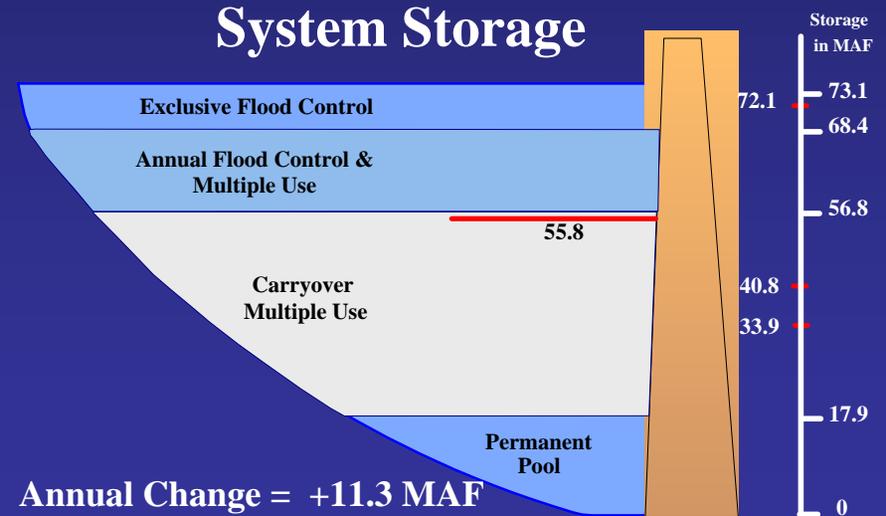
Annual Change = +16.4 Feet  
4.1 feet above desired

## Oahe



Annual Change = +15.1 Feet

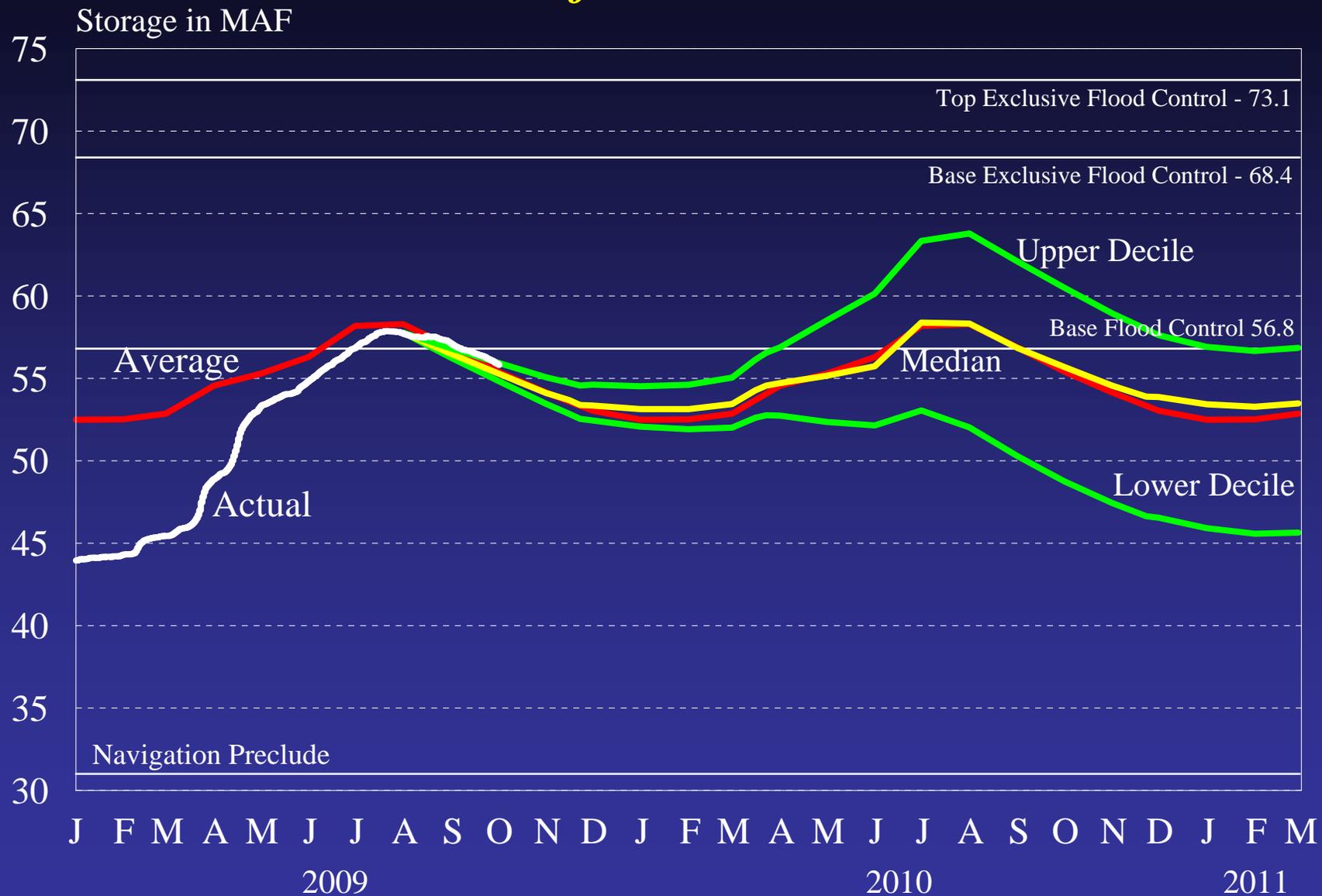
## System Storage



Annual Change = +11.3 MAF  
1.0 MAF below desired

# System Storage

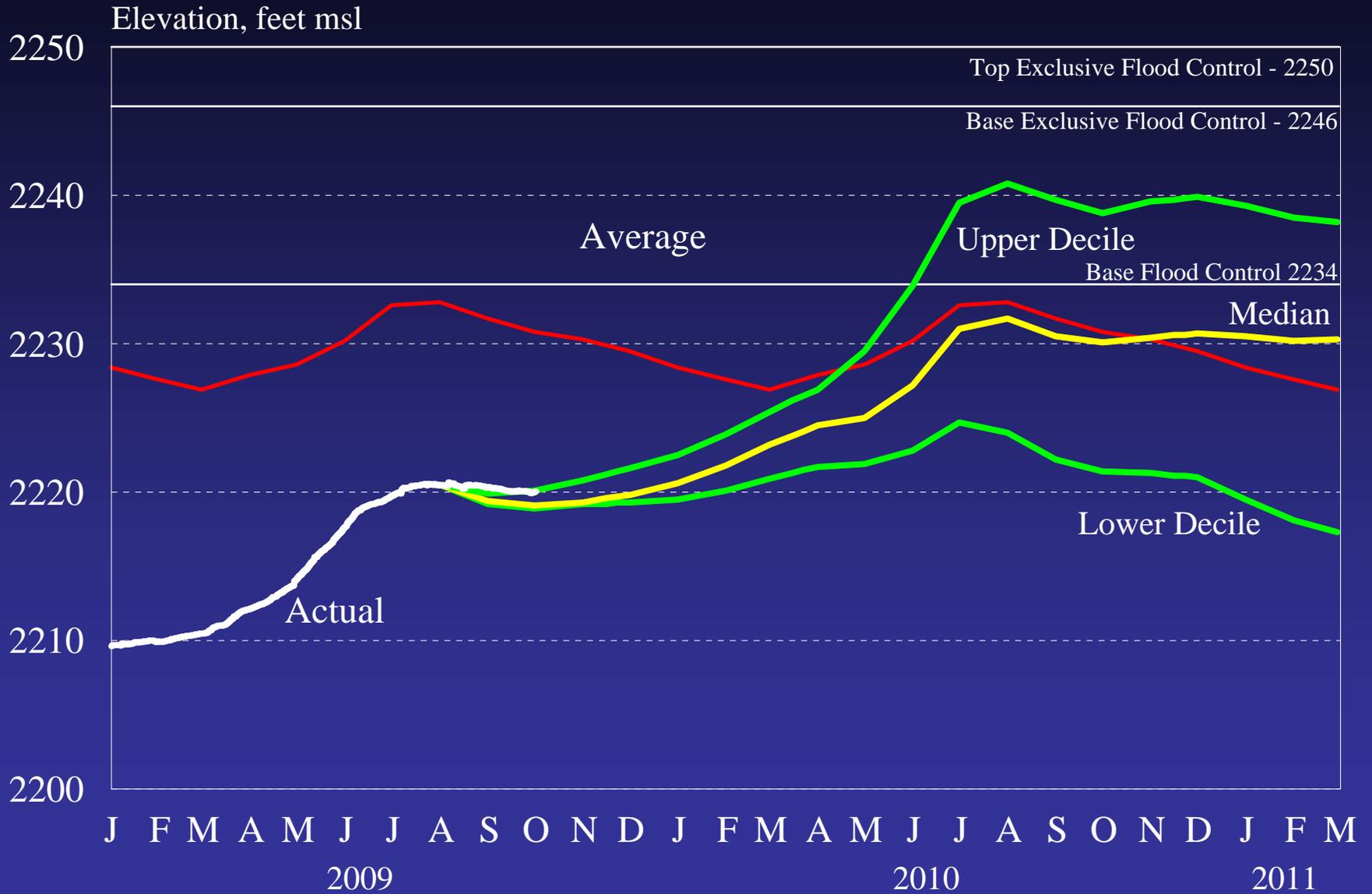
## 2009-2010 Draft AOP Simulations



Average: 1967-2008

# Fort Peck

## 2009-2010 Draft AOP Simulations

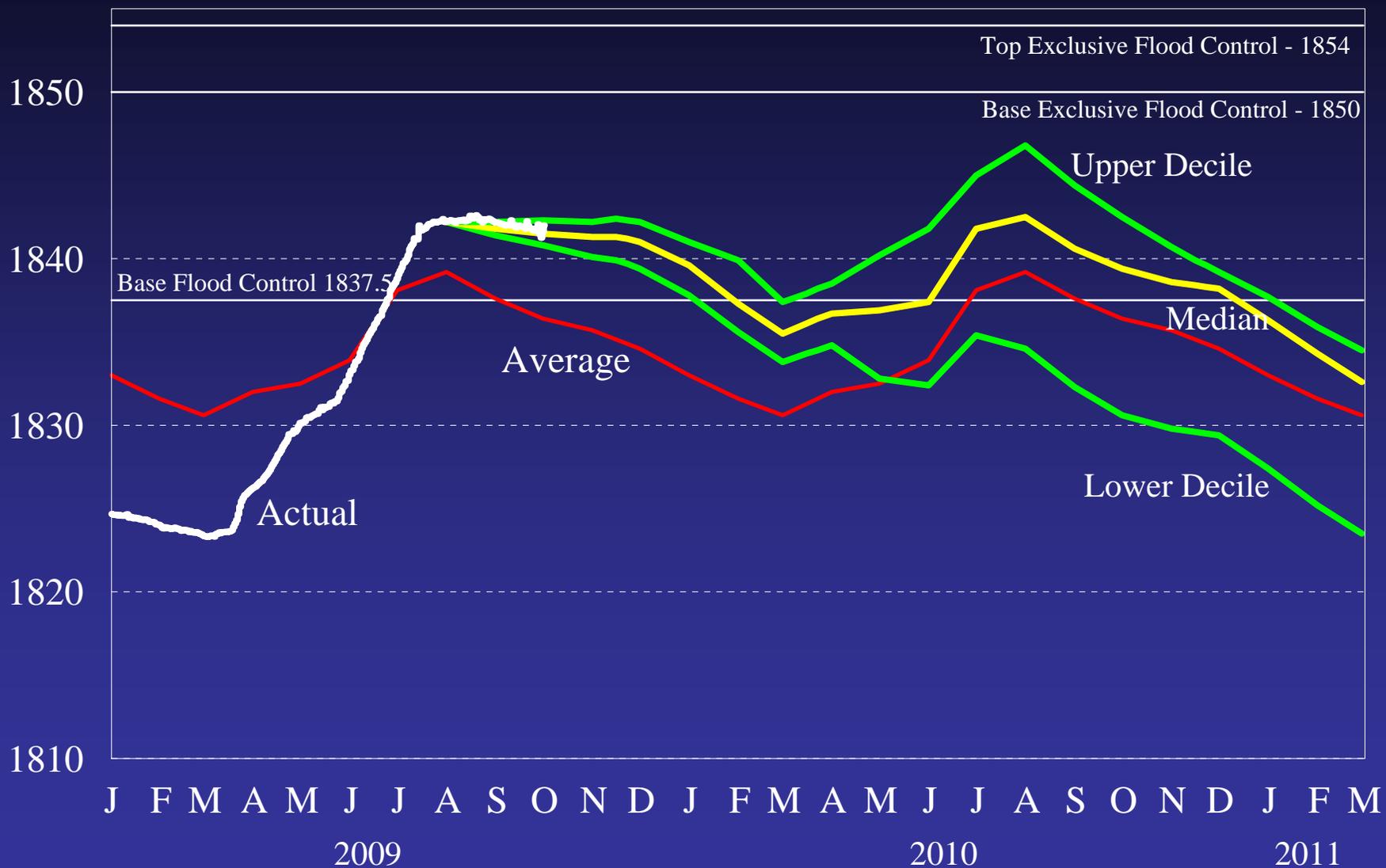


Average: 1967-2008

# Garrison

## 2009-2010 Draft AOP Simulations

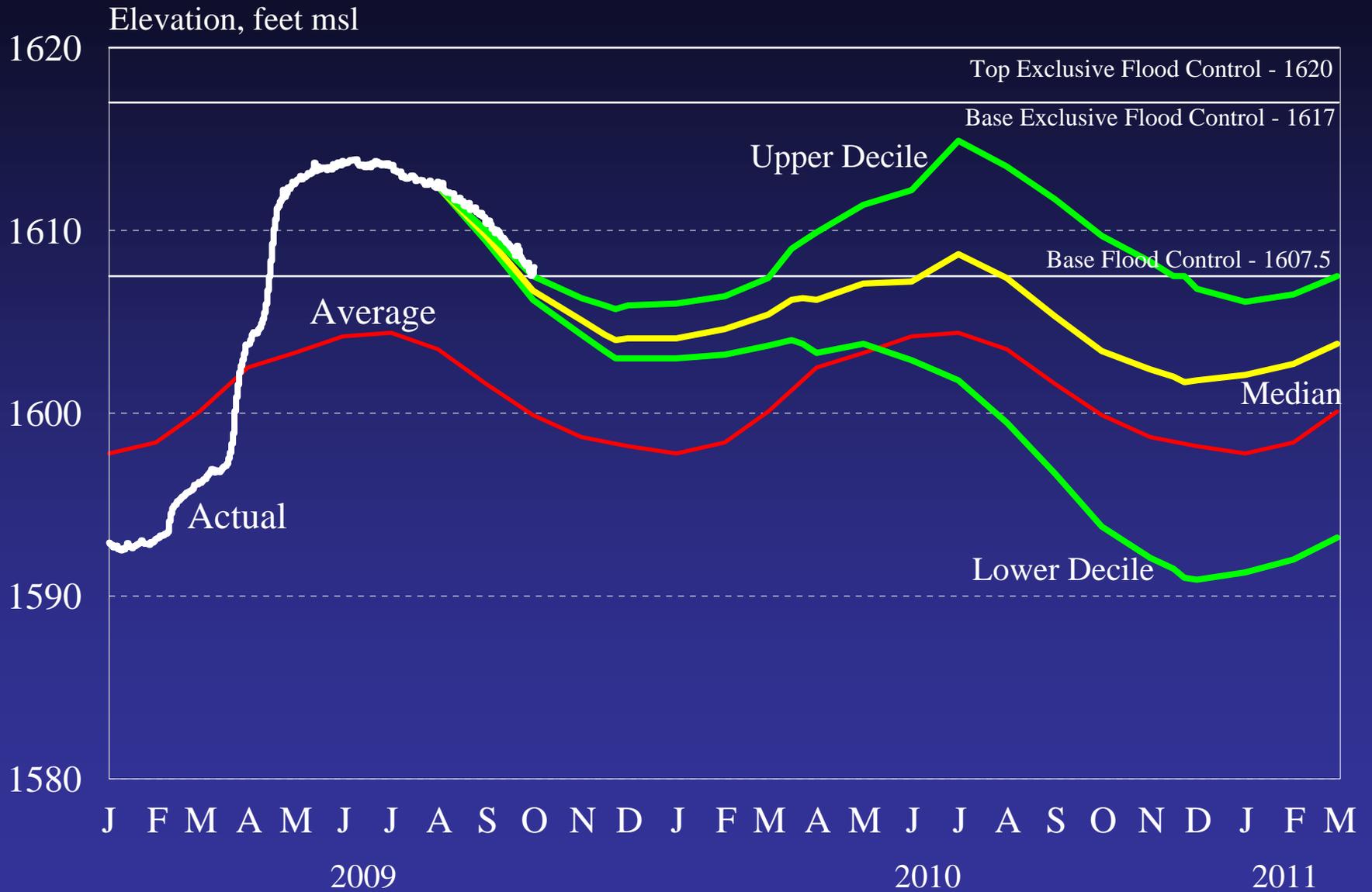
Elevation, feet msl



Average: 1967-2008

# Oahe

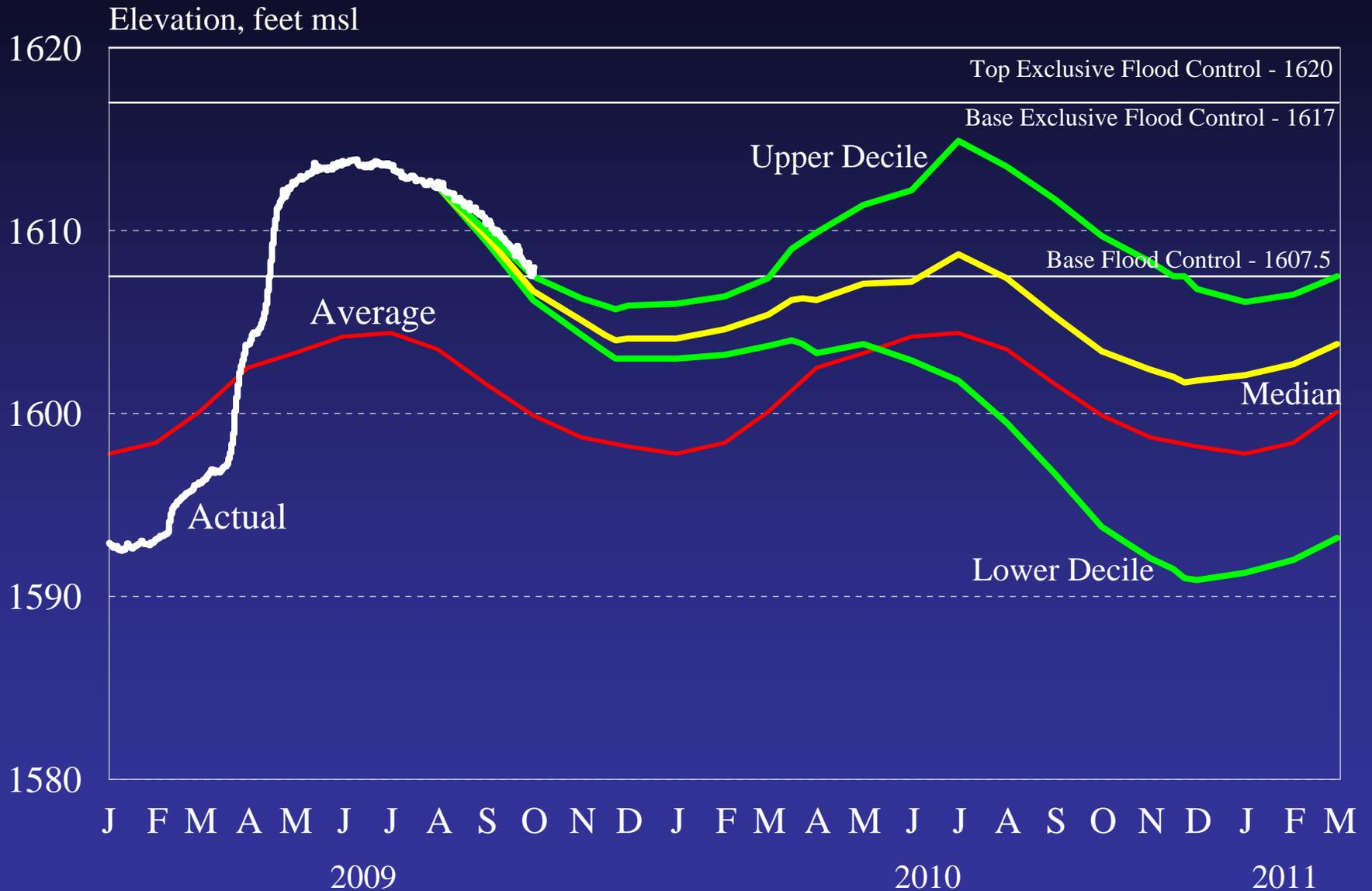
## 2009-2010 Draft AOP Simulations



Average: 1967-2008

# Oahe

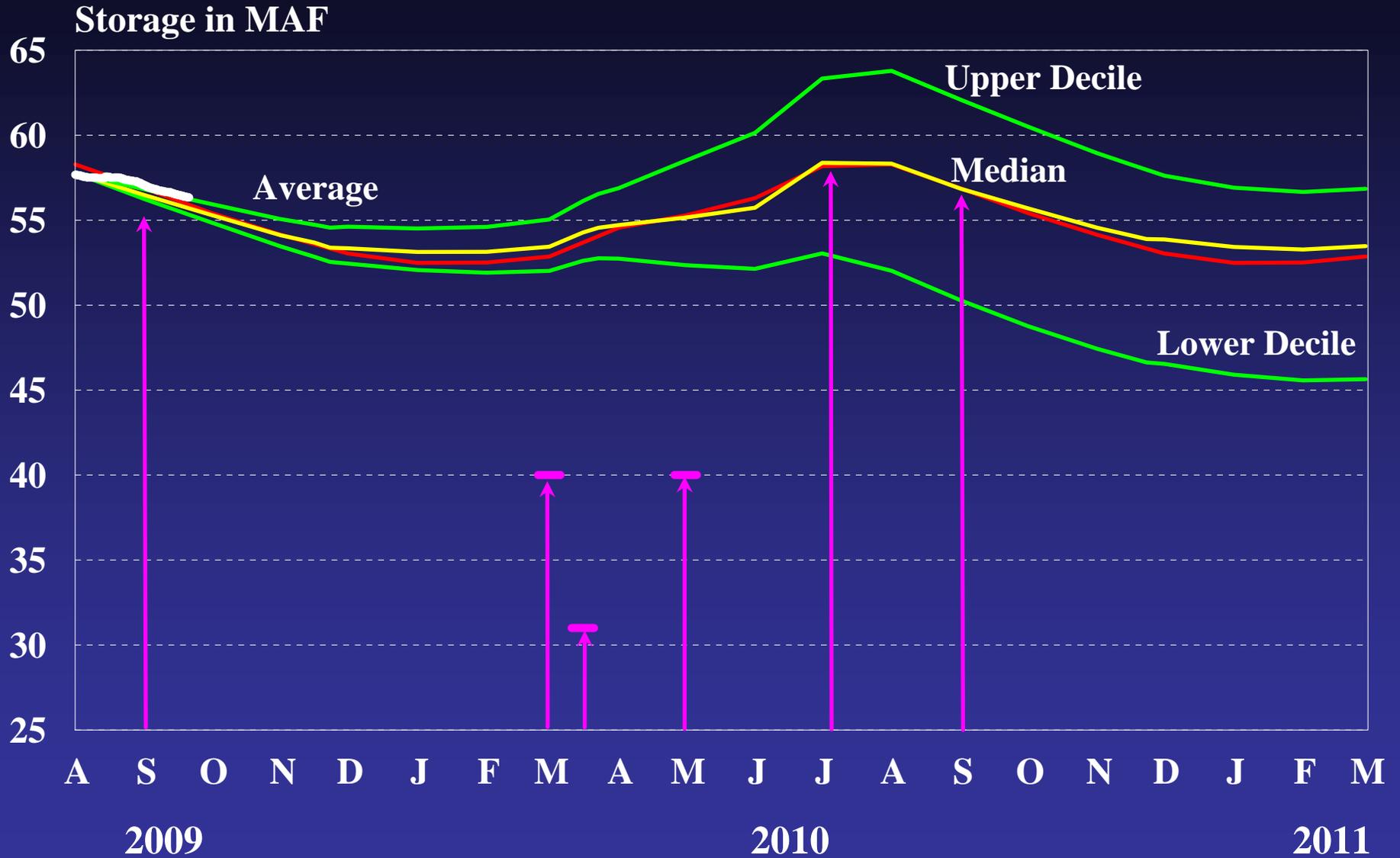
## 2009-2010 Draft AOP Simulations



Average: 1967-2008

# System Storage

## 2009 - 2010 AOP Decision Points



# *Water Supply & Water Quality*

All municipal water intakes remain operational throughout study period under all runoff scenarios

Fewer water quality issues expected on upper three reservoirs

Better access for irrigation

Winter releases from Gavins Point higher than in previous winters



# 2009 Reservoir Access Areas

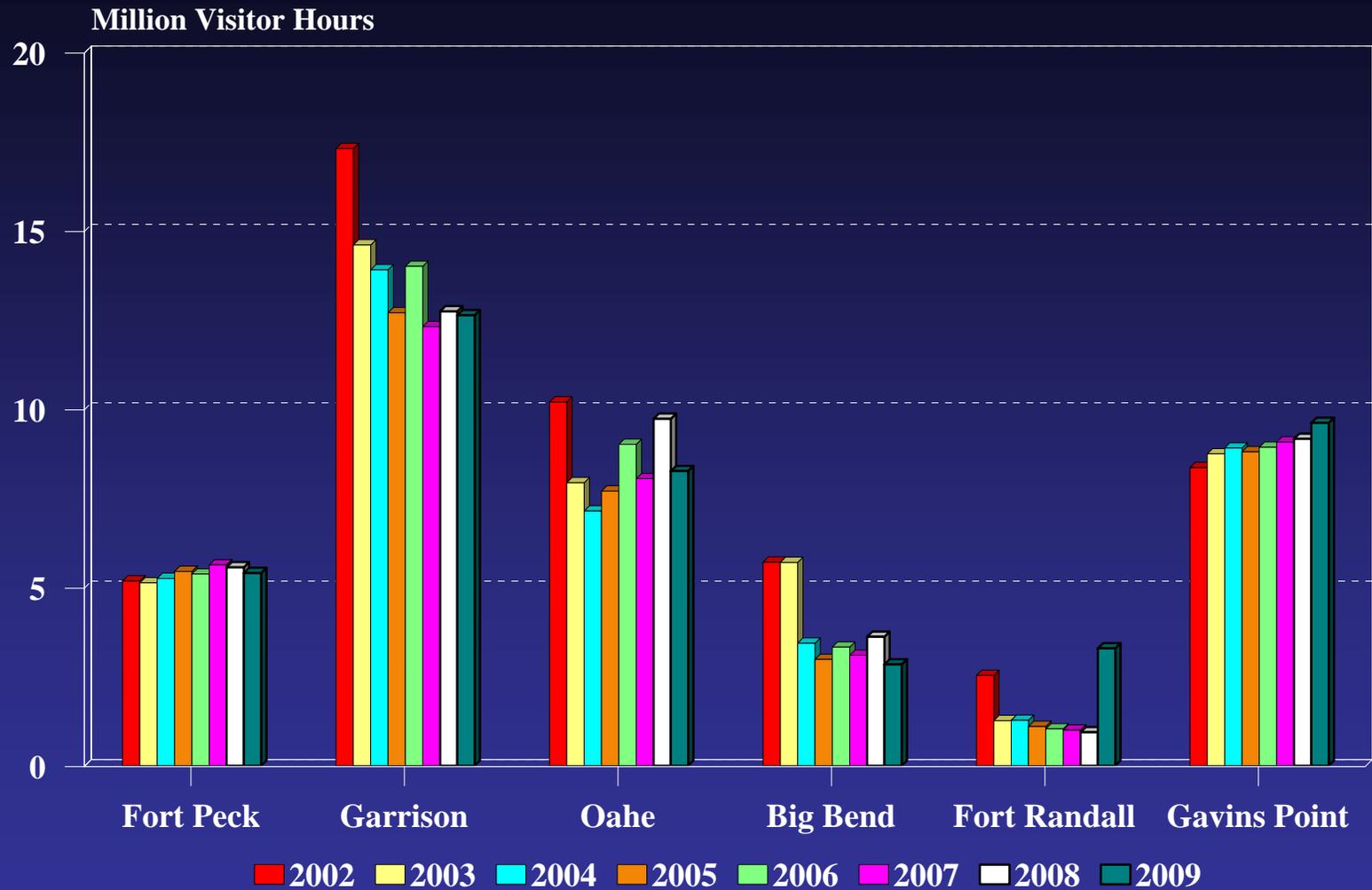
Higher reservoir levels on upper three projects result in better access than in previous several years.



	Usable	Total
<b>Fort Peck</b>	9	11
<b>Garrison</b>	36	36
<b>Oahe*</b>		
- North Dakota	18	18
- South Dakota	27	27

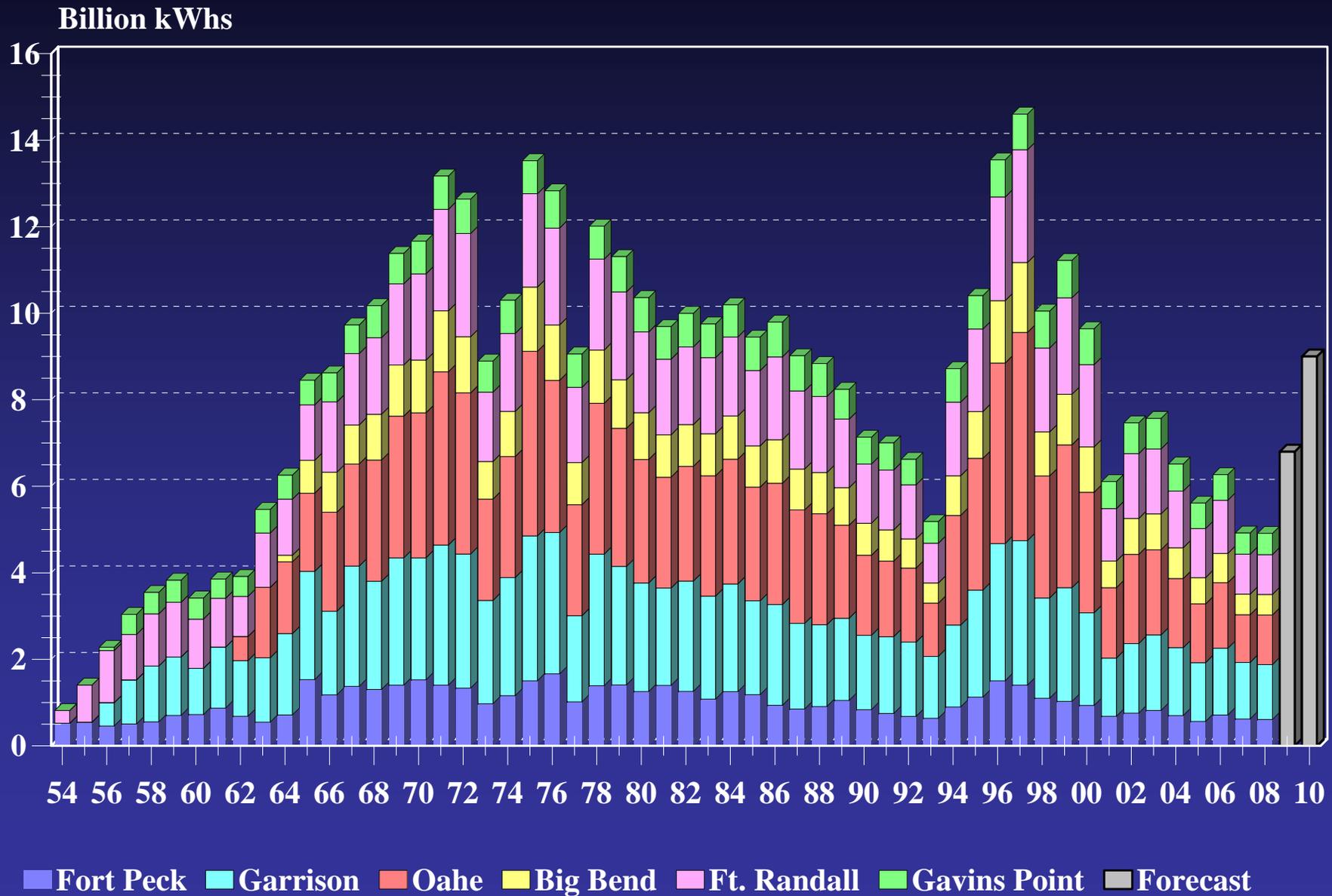
# *Mainstem Project Visits*

## *2002 - 2009*

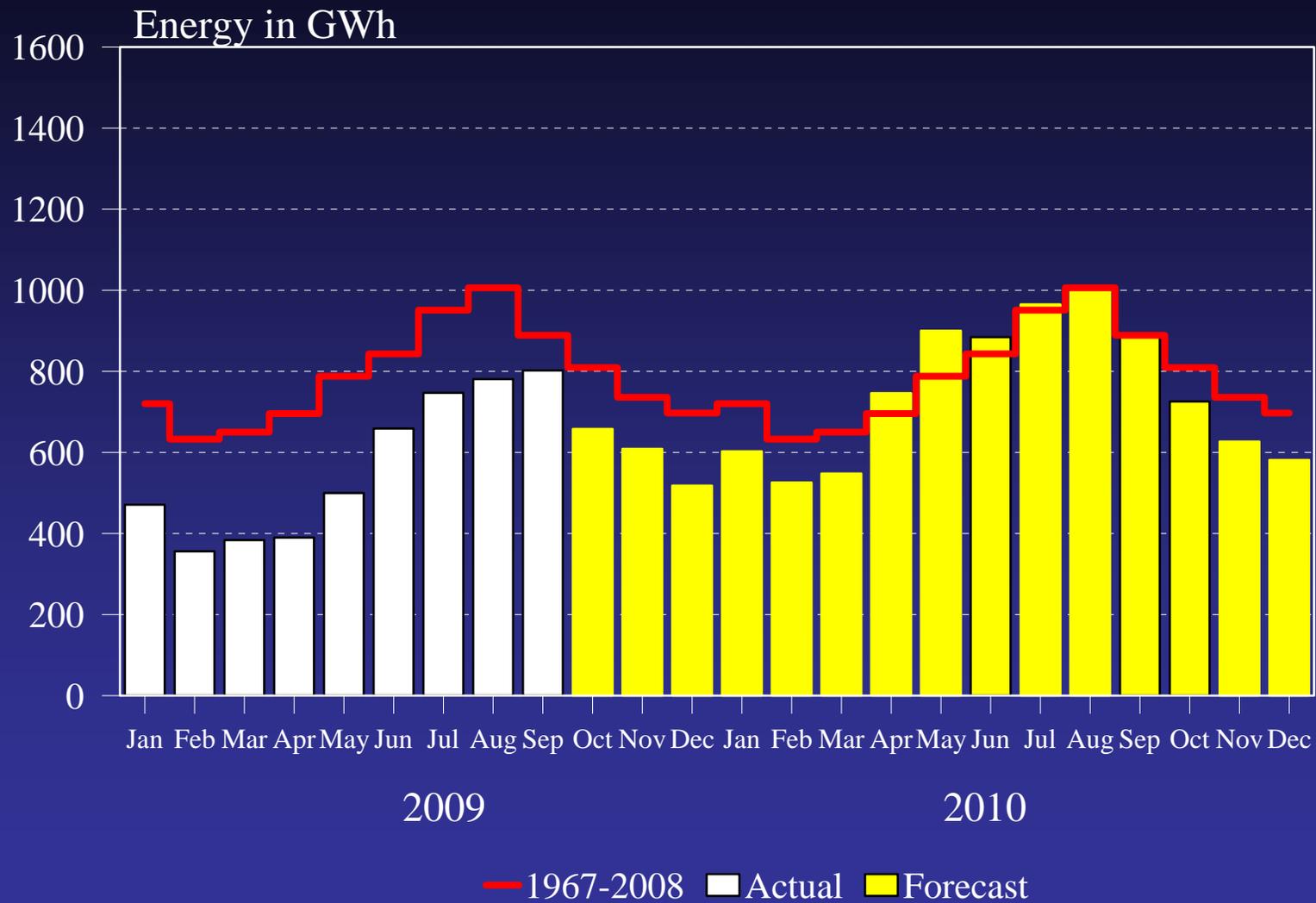


# Mainstem Hydropower Generation

## 1954 - 2010



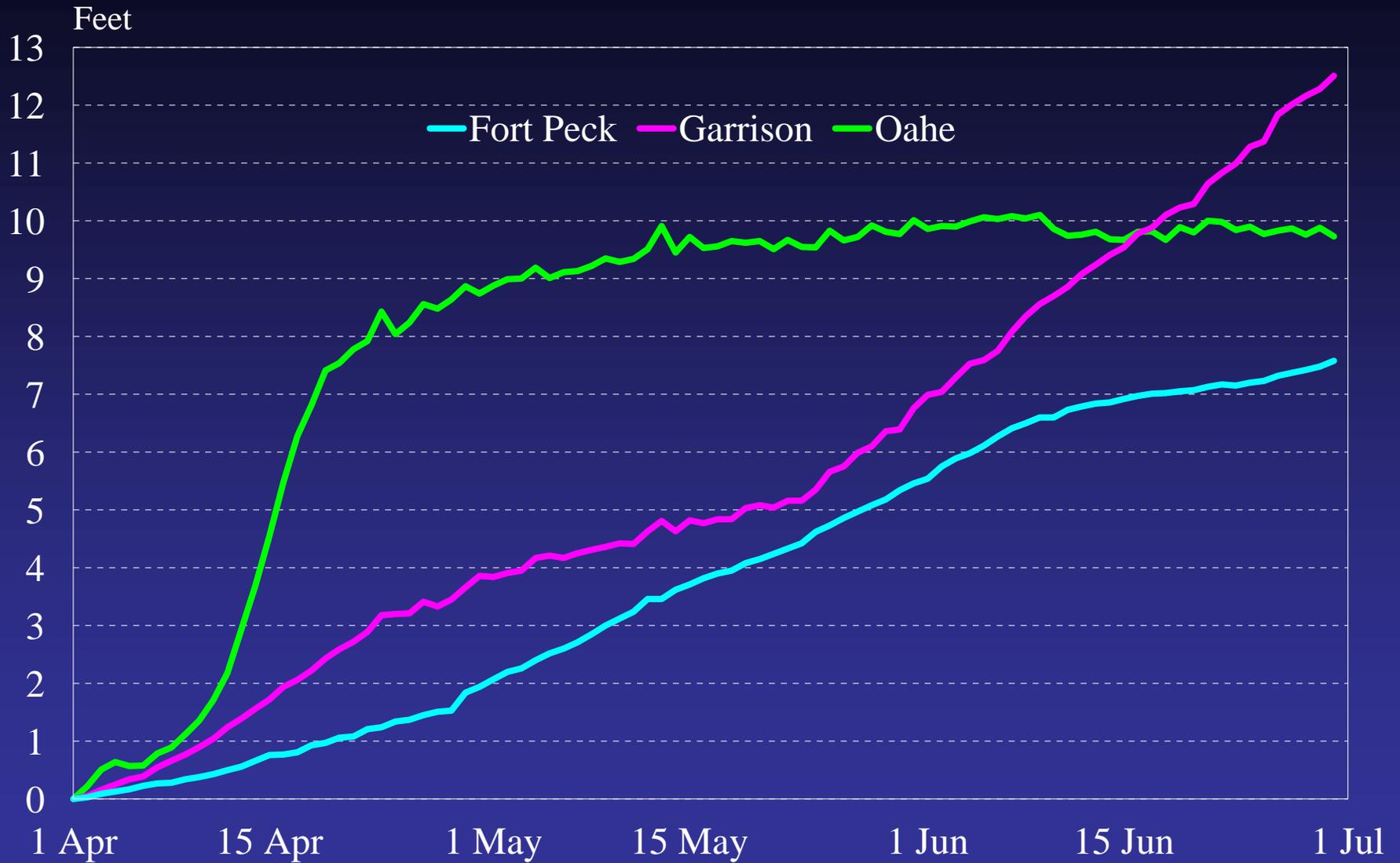
# Missouri River Mainstem System Actual & Forecasted Energy Generation



2009 Forecast = 6.8 BKWh

2010 Median Forecast = 9.0 BKWh

# *Reservoir Levels During 2009 Forage Fish Spawn Change from April 1 Elevation*



## *2010 Forage Fish Spawn*

Provide steady to rising reservoir levels at the upper three reservoirs from April to June

Favor Fort Peck and Oahe from April 20 to May 20, if runoff is not sufficient to keep all three reservoirs rising

All reservoirs higher than previous years inundating vegetation

Initial analysis indicates no issues with cold water habitat at Garrison due to higher reservoir level



# *Reservoir Unbalancing*

First implementation of MRNRC recommendation

	Fort Peck	Garrison	Oahe
Implement if March 1 pool above	2234	1837.5	1607.5
Implement if March 1 greater and pool expected to rise 3 ft after 1 March	2227-2234	1827-1837.5	1600-1607.5

Transition to unbalancing during 2010

Median Runoff - March 1, 2011

Fort Peck +1.0 feet, Garrison -1.0 feet, Oahe balanced

Upper Quartile, Upper Decile - March 1, 2011

Fort Peck +4.2 feet, Garrison -3.0 feet, Oahe balanced



Interior Least Tern



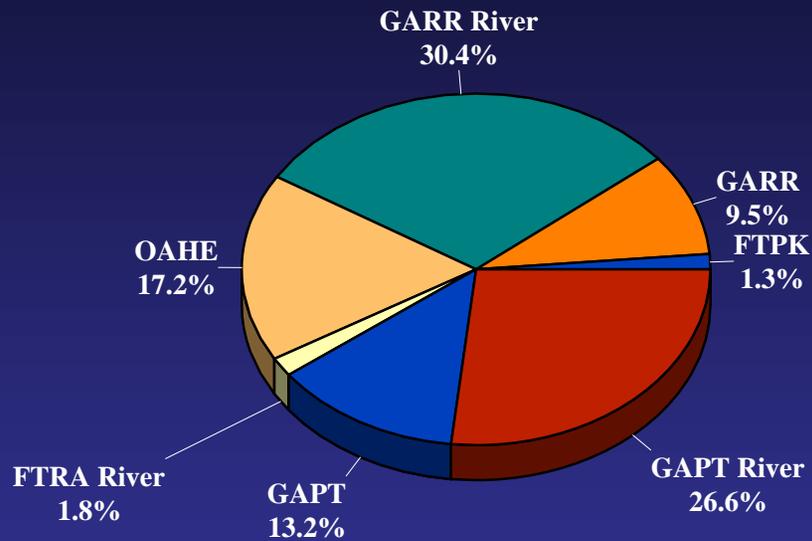
Piping Plover



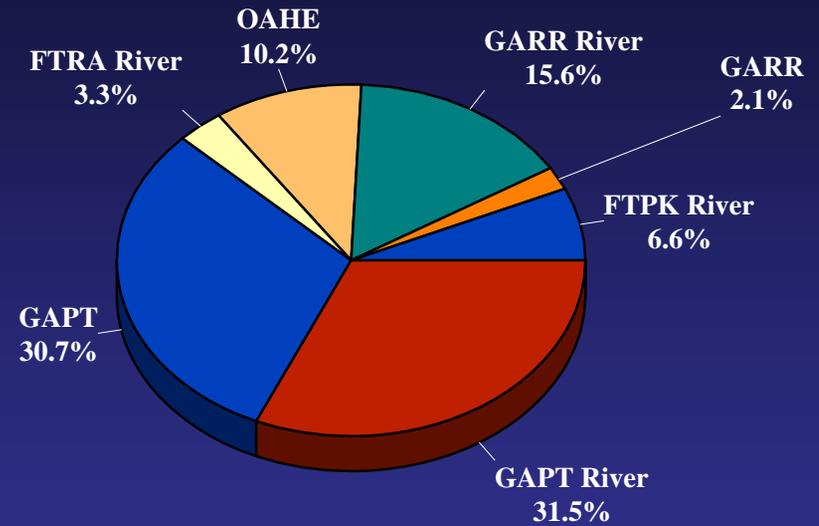
Pallid Sturgeon

# 2009 Nesting Locations

## Piping Plovers

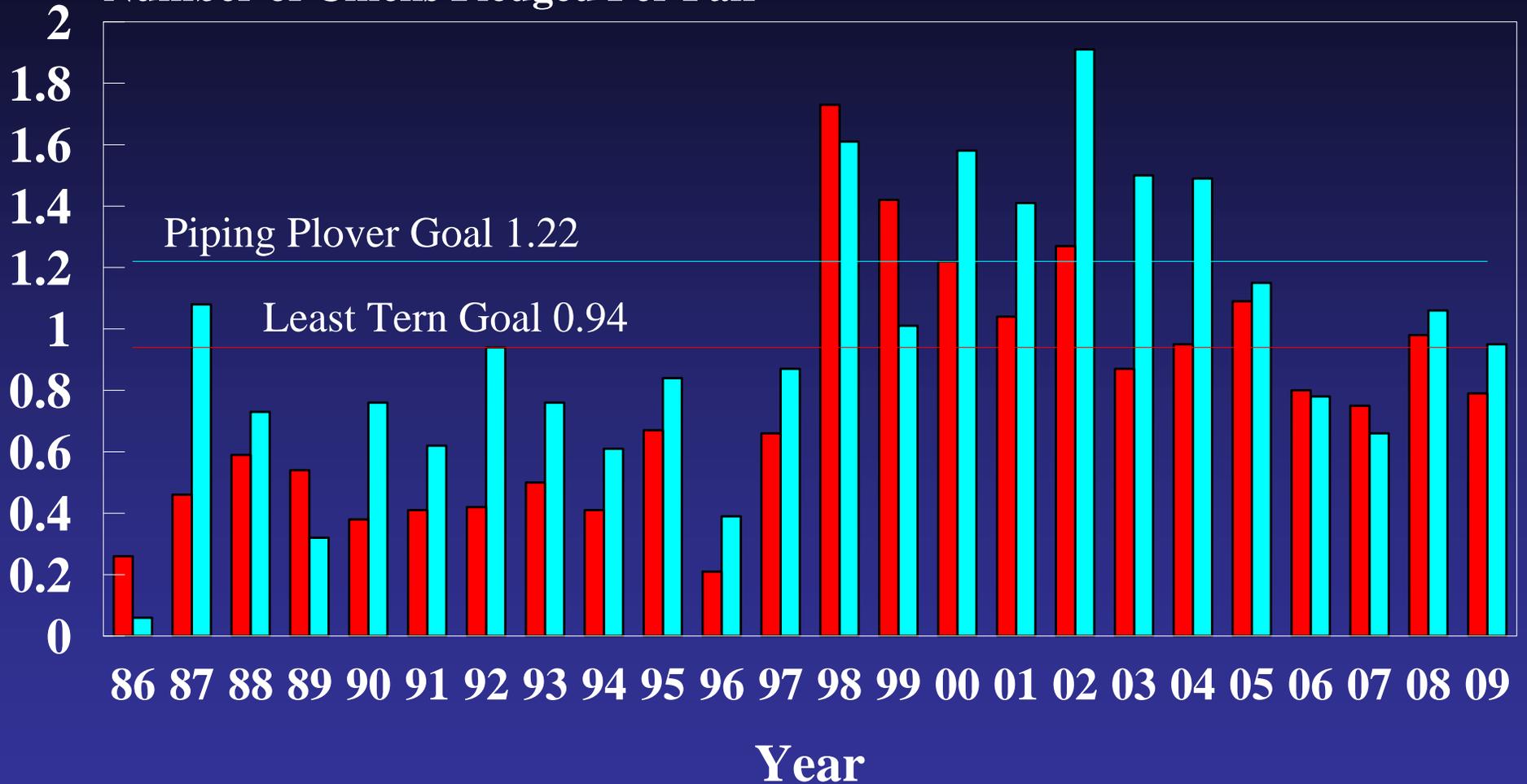


## Least Terns



# *Fledge Ratios - Missouri River 1986-2009*

Number of Chicks Fledged Per Pair



■ Least Tern ■ Piping Plover

# Adult Census - Missouri River 1986-2009



# *Summary of 2009 Incidental Take*

## Reservoirs

Fort Peck: 4 plover eggs

Garrison: 97 plover eggs and 1 tern eggs

Oahe: 3 plover eggs

Fort Randall: 2 tern eggs

Gavins Point: 6 plover eggs and 4 tern eggs

## River Reaches

Garrison: 2 tern eggs

Gavins Point: 47 plover eggs

<b>Total Incidental Take:</b>	<b>157 plover eggs</b>
	<b>0 plover chicks</b>
	<b>9 tern eggs</b>
	<b>0 tern chicks</b>

## *2010 Tern and Plover Nesting Seasons*

Steady release - flow to target

Spring pulse from Gavins Point in May

Cycle Gavins Point releases: 1 day of higher releases followed by 2 days of navigation flows

Intra-day peaking patterns established at Garrison and Fort Randall

Target flows may not be met in reaches without commercial navigation

Utilize Kansas River projects as authorized

# *Spring Pulses from Gavins Point Dam*

Part of a Reasonable and Prudent Alternative (RPA) in the USFWS 2003 Amended Biological Opinion to avoid jeopardy to the pallid sturgeon

Master Manual revised in 2006 to include bimodal spring pulse from Gavins Point dam

# *Spring Pulses from Gavins Point Dam*

First ever May spring pulse in May 2006

Peak magnitude of 9,000 cfs for 2 days

First ever March spring pulse in March 2008

Peak magnitude of 5,000 cfs for 2 days

Pulse eliminated downstream of the  
confluence with the Kansas River

# *Spring Pulses from Gavins Point Dam*

March 2009 pulse cancelled due to high downstream flows

May pulse implemented beginning May 18

Peak magnitude of 6,000 cfs for 2 days

Pulse tail shortened to minimize take of nesting piping plovers

Pulse essentially eliminated downstream of the confluence with the Kansas River

March and May pulses planned in spring 2010 under all runoff scenarios

# *2010 Spring Pulses from Gavins Point*

March

Estimated peak magnitude

5,000 cfs for 2 days

Timing at start of navigation season

May

Estimated peak magnitude

11,600 to 20,000 cfs for 2 days depending on 1 May  
system storage and runoff forecast

Timing between 1 May and 19 May

Water temperature

Nesting terns and plovers

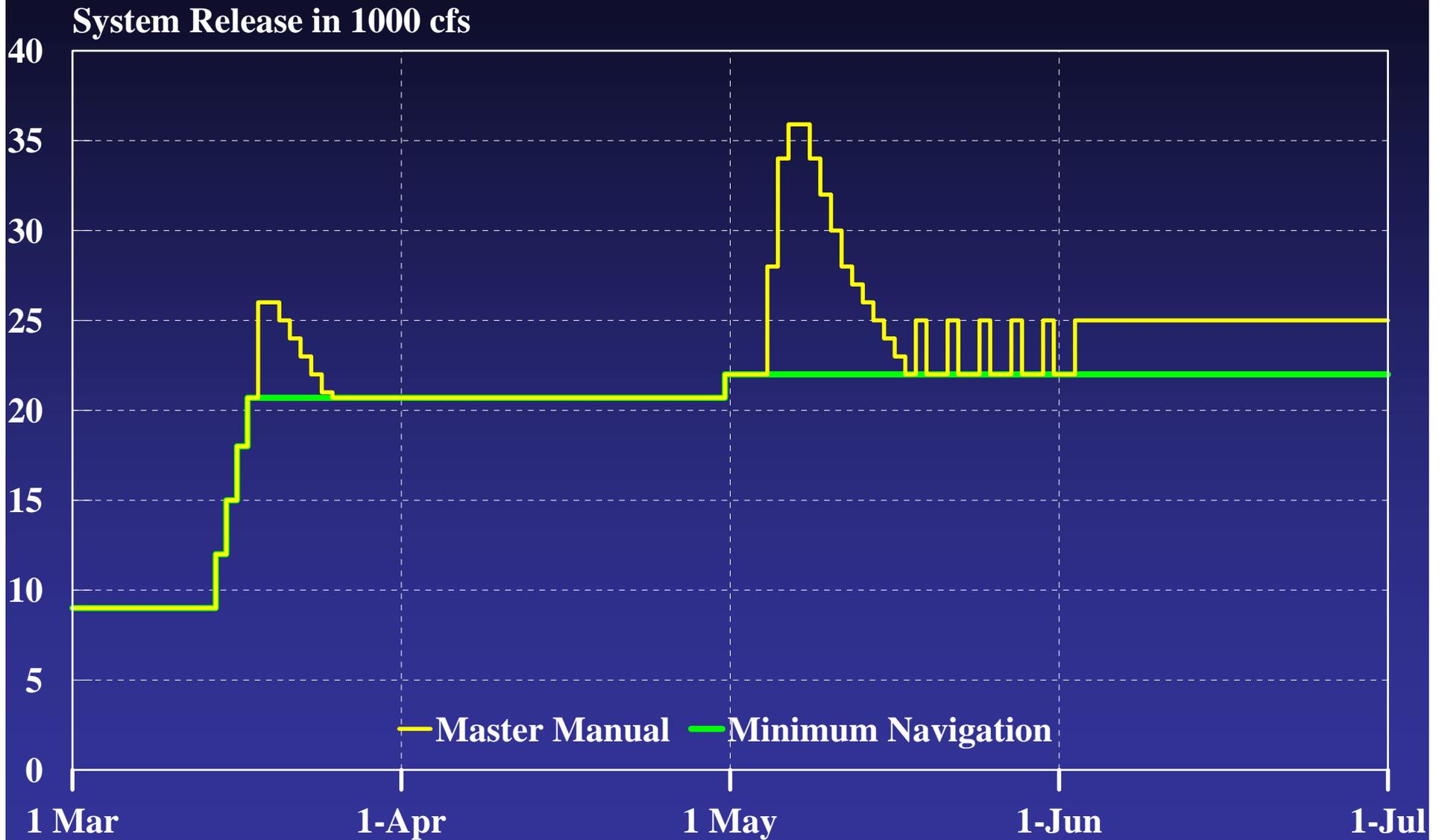
Downstream flow limits

Impact at end of water year

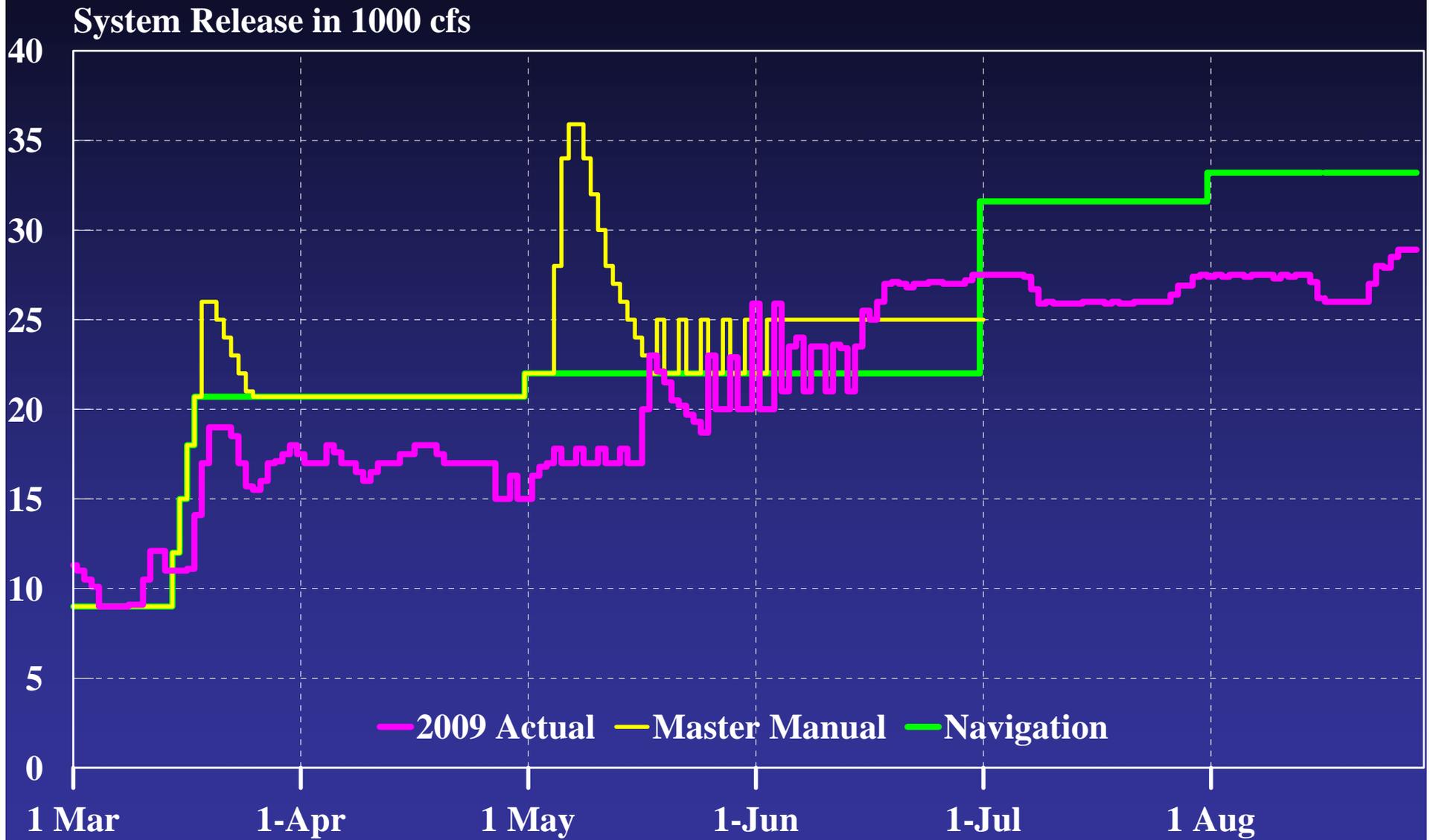
Balance impact among upper three reservoirs

0.2 to 0.3 foot lower than without May pulse

# *Gavins Point Spring Pulse Releases*



# Gavins Point Releases



# *Navigation Targets and Downstream Flow Limits during Spring Pulses*

	Minimum Service	Full Service	Downstream Flow Limit
Omaha	25 kcfs	31 kcfs	41 kcfs
Nebraska City	31 kcfs	37 kcfs	47 kcfs
Kansas City	35 kcfs	41 kcfs	71 kcfs

# *Congressionally Authorized Project Purposes 2010 Expected Results*

**Flood Control**

**Navigation**

**Hydroelectric Power**

Forecast 90% of normal in 2010

**Irrigation**

Improved access due to higher reservoir levels and releases.

**Water Supply & Water Quality**

Improved access & water quality due to higher reservoir levels.

**Recreation**

Near normal access due to higher reservoir levels and releases.

**Fish and Wildlife**

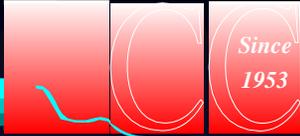
**Endangered Species**

March and May spring pulses from Gavins Point dam.

Releases adjusted when birds begin nesting activities.

Attempt to keep lakes steady to rising during fish spawn;  
favor Fort Peck and Oahe if necessary.

Missouri River Basin

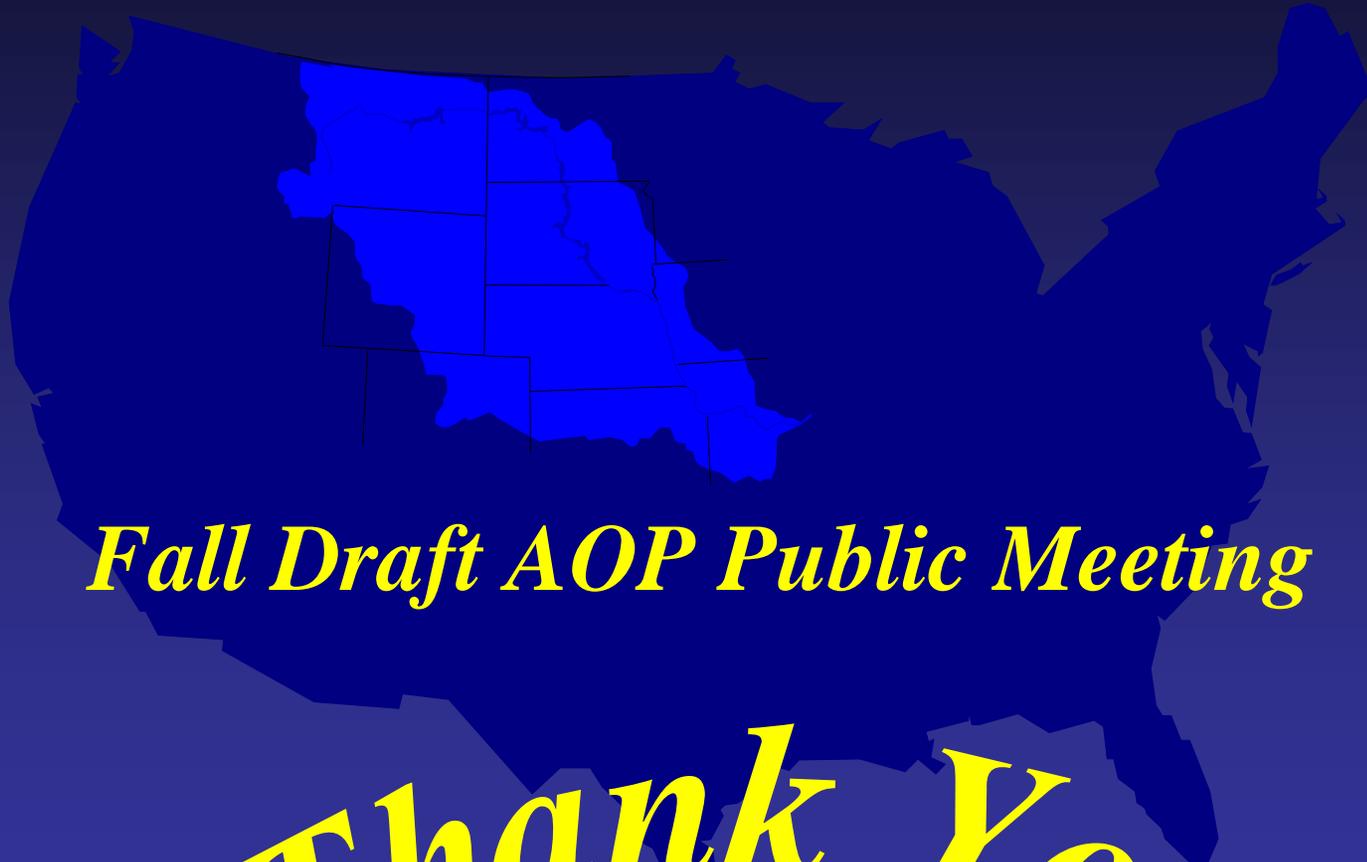


Water Management Division



US Army  
Corps of Engineers

# *Missouri River Mainstem System*



*Fall Draft AOP Public Meeting*

*Thank You*