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Managing Water in the West

Implementing the Interim Guidelines for Colorado River Operations and Assessing the Sensitivity of Hydrologic Variability in the System

2008 Annual RiverWare User Group Meeting
August 14, 2008

U.S. Department of the Interior
Bureau of Reclamation

Outline

- Current and Projected System Conditions
- Overview of the Interim Guidelines and Water Year 2008 Operations
- Assessing the Sensitivity of Hydrologic Variability in the System

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Current and Projected Colorado River System Conditions

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Colorado River Basin Hydrology

- 16.5 million acre-feet (maf) allocated annually
- 13 to 14.5 maf of consumptive use annually
- 60 maf of storage
- 15.1 maf average annual “natural” inflow into Lake Powell over past 100 years
- Inflows are highly variable year-to-year

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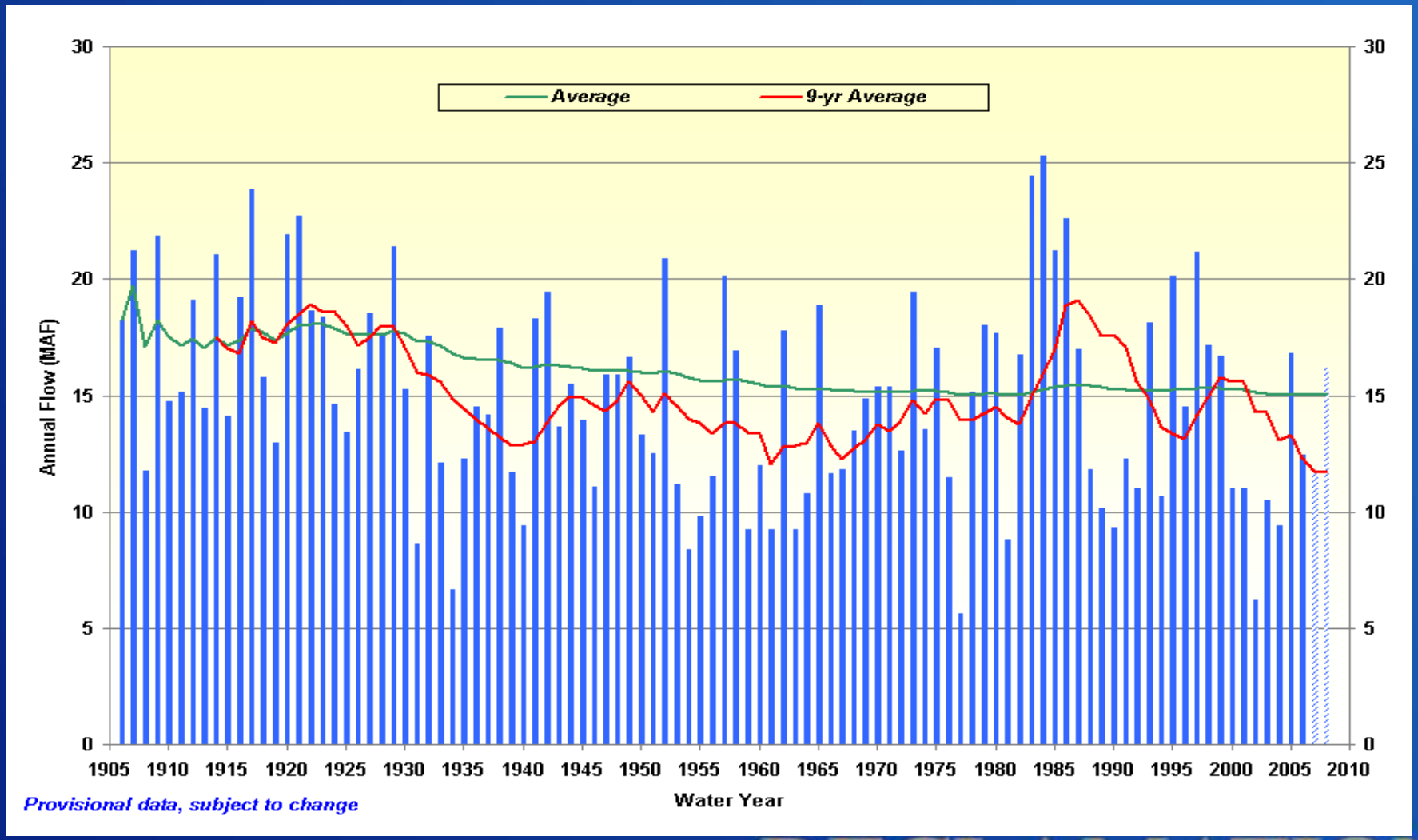
Natural Flow
Colorado River at Lees Ferry Gaging Station, Arizona
Water Year 1906 to 2008



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Colorado River Drought

- 2000-2007 was the driest 8-year period in the 100-year historical record
- Tree-ring reconstructions show more severe droughts have occurred over the past 1200 years (e.g., drought in the mid 1100's) 
- Although projected 2008 runoff forecast is 105% of average, it's not unusual to have a few years of above average inflow during longer-term droughts

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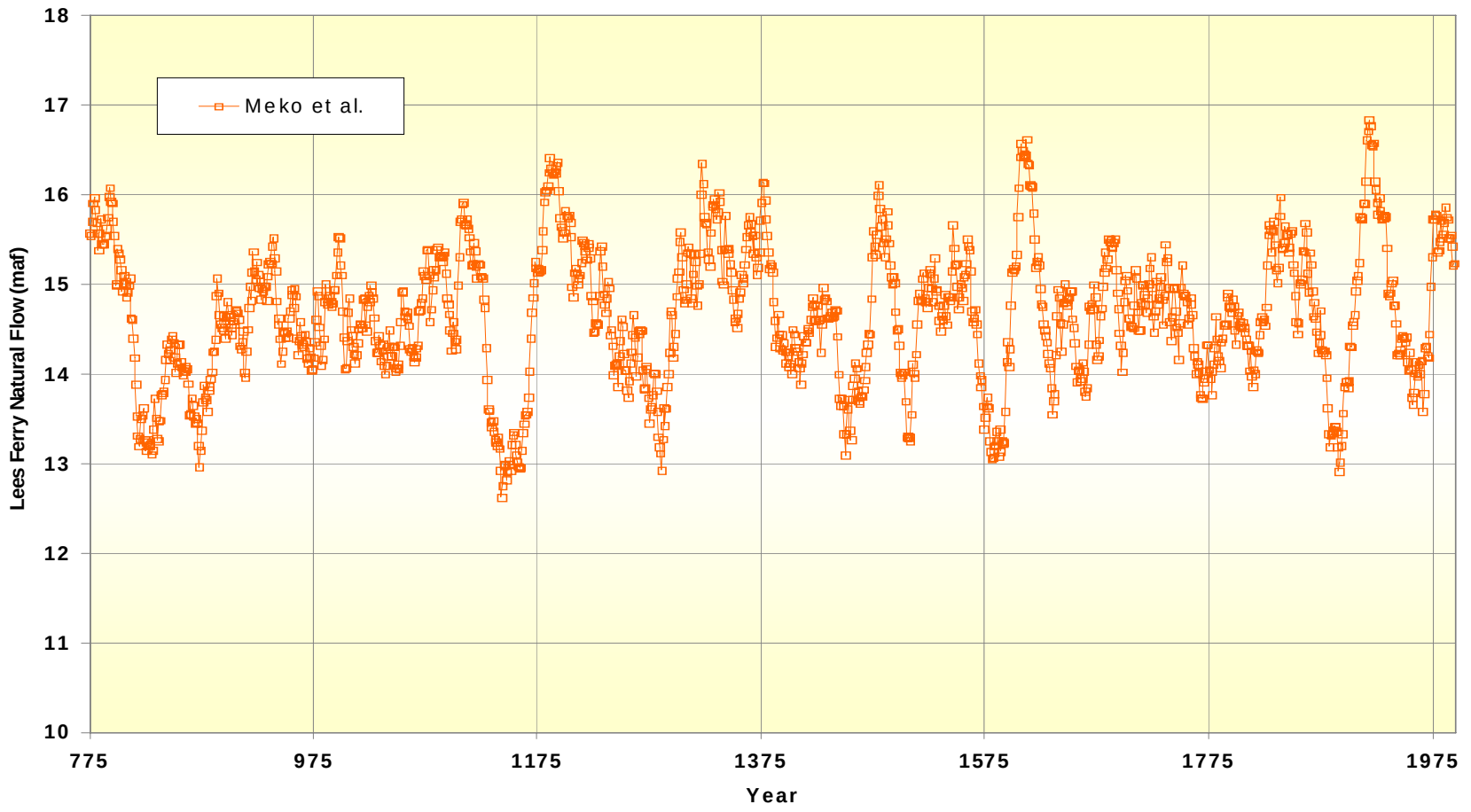
Annual Natural Flow at Lees Ferry
Tree-ring Reconstruction (Meko et al., 2007)
25-Year Running Mean



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Colorado River Basin Storage
(as of August 10, 2008)

Current Storage	Percent Full	MAF	Elevation (Feet)
Lake Powell	62%	15.09	3632
Lake Mead	46%	11.95	1105
Total System Storage	59%*	34.87	NA

*Total system storage was 33.06 maf or 56% this time last year

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State of the System (1999-2008)

WY	Unregulated inflow into Powell % of Average	Powell and Mead Storage, maf	Powell and Mead % Capacity
1999	109	47.59	95
2000	62	43.38	86
2001	59	39.01	78
2002	25	31.56	63
2003	52	27.73	55
2004	49	23.11	46
2005	104	27.24	54
2006	72	25.80	51
2007	68	24.43	49
*2008	105	27.05	54

*Based on July 24 Month Study and August final inflow forecast

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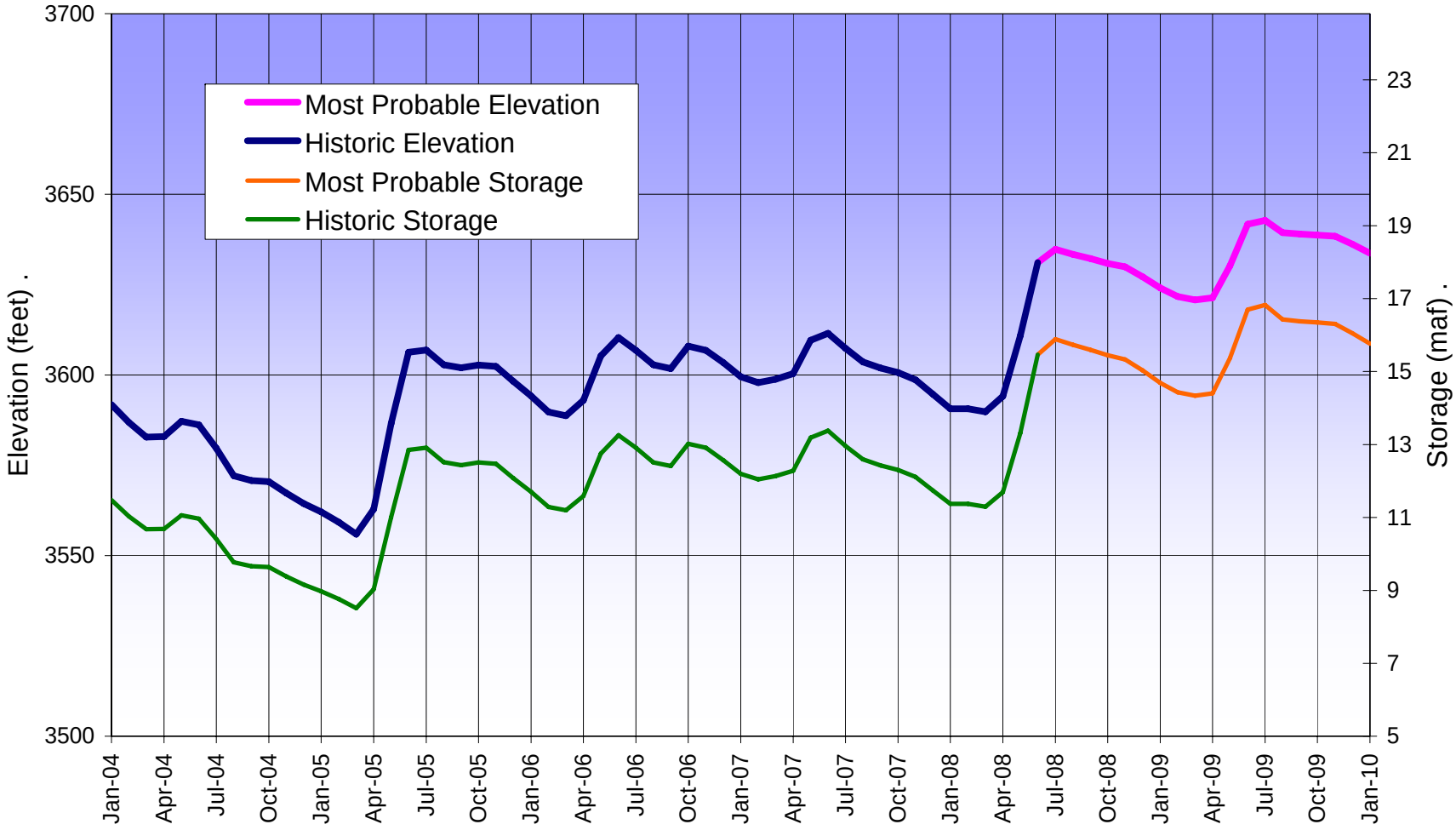
Lake Powell Projected EOM Water Surface Elevation and Storage
July 24 Month Study



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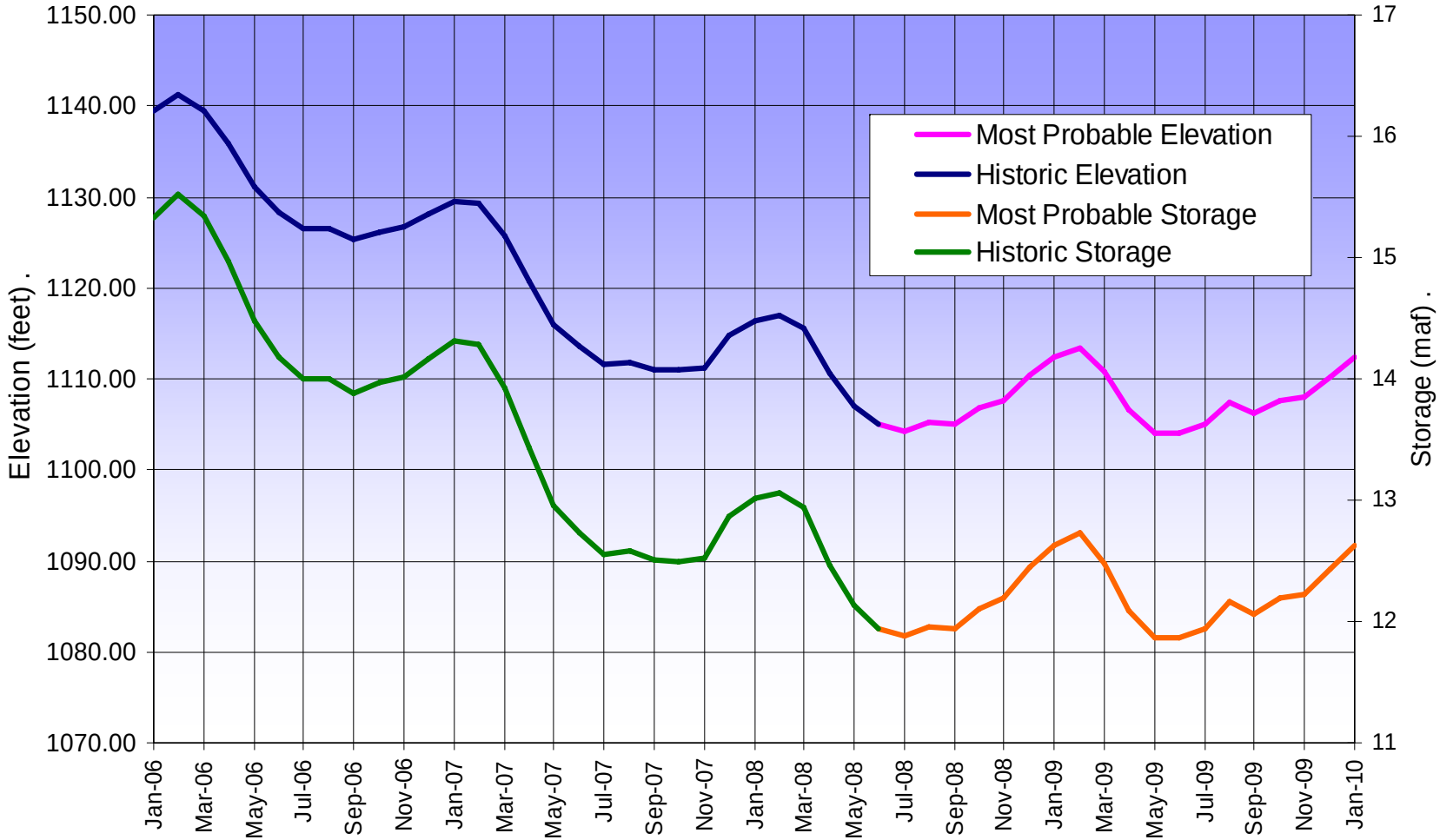
Lake Mead Projected EOM Water Surface Elevation and Storage
July 24 Month Study



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Overview of the Interim Guidelines and Water Year 2008 Operations

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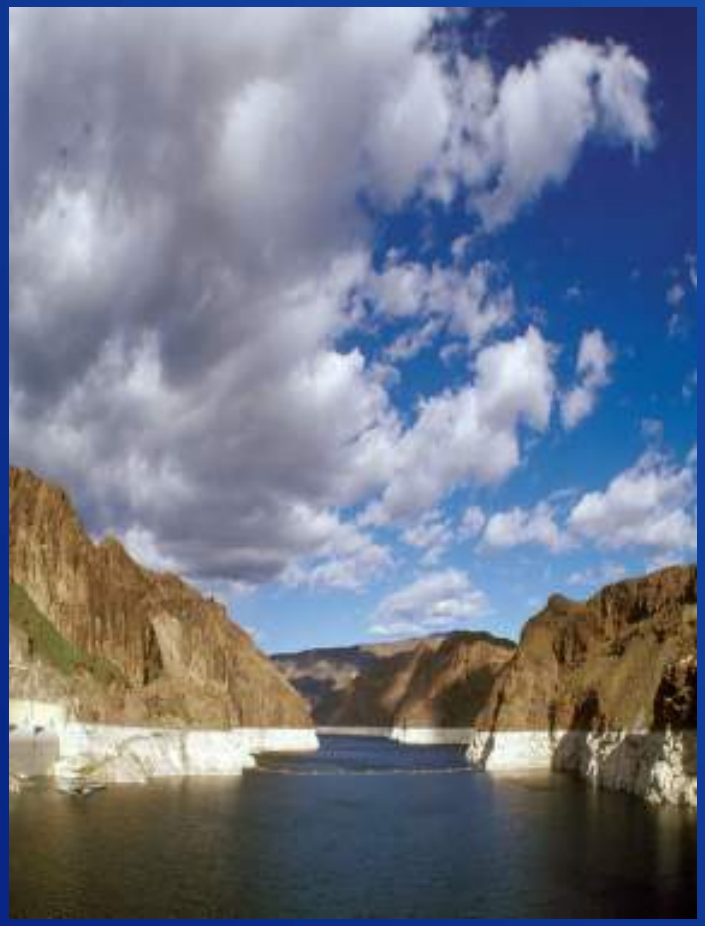
Impetus for the Interim Guidelines[1]



- Eight years of unprecedented drought
- Increased water use
- To date, there has never been a shortage in the Lower Basin and there were no shortage guidelines
- Operations between Lake Powell and Lake Mead were coordinated only at the higher reservoir levels ("equalization")
- A U.S. action only – Mexico deliveries in accordance with Treaty

[1]Issued in Record of Decision, dated December 13, 2007; available at http://www.usbr.gov/lc/region/programs/strategies.html

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Project Background

- In 2004, the Secretary challenged the Basin States to develop a drought mitigation plan for the Colorado River Basin
- May 2005 – Secretary tasked states to come up with a consensus plan and publicly committed to developing guidelines with or without state consensus

✓ **Summer 2005**
  – Solicited public comments on proposed content, format, mechanisms and analysis

✓ **Fall 2005**
  – Announced intent to initiate NEPA process, solicited public comments on scope and alternatives development

✓ **March 2006**
  – Published Scoping Summary Report

✓ **June 2006**
  – Published the proposed alternatives

✓ **February 2007**
  – Published Draft EIS

✓ **June 2007**
  – Published the preferred alternative

✓ **November 2007**
  – Published Final EIS

✓ **December 2007**
  – Record of Decision

✓ **Water Year 2008**
  – Guidelines used in operations

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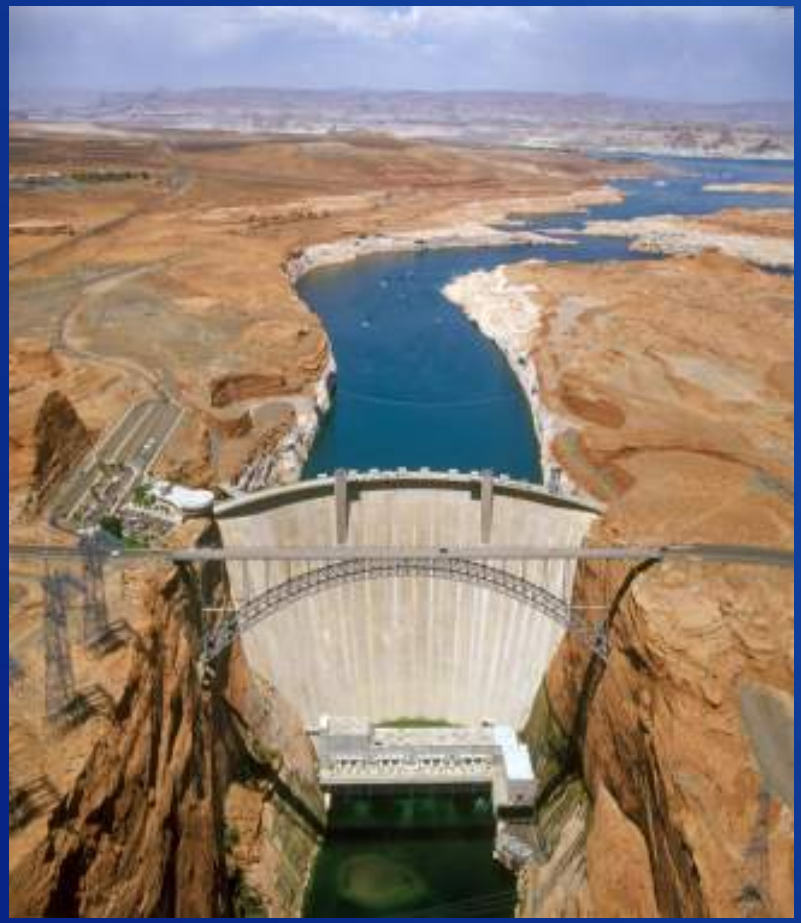
Key Considerations in Developing the Interim Guidelines

(Identified through NEPA Scoping Process)



- Importance of encouraging conservation of water
- Importance of considering reservoir operations at all operational levels
- Guidelines for an interim period (2008 through 2026)

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Consultation and Coordination

- Cooperating Agencies (Western Area Power Administration, National Park Service, Bureau of Indian Affairs, Fish and Wildlife Service, and U.S. Section of International Boundary and Water Commission)
- Basin States
- Consortium of environmental organizations (Environmental Defense, Pacific Institute, Sonoran Institute, Nature Conservancy, National Wildlife Federation, Defenders of Wildlife)
- U.S. Tribal Nations
- General Public

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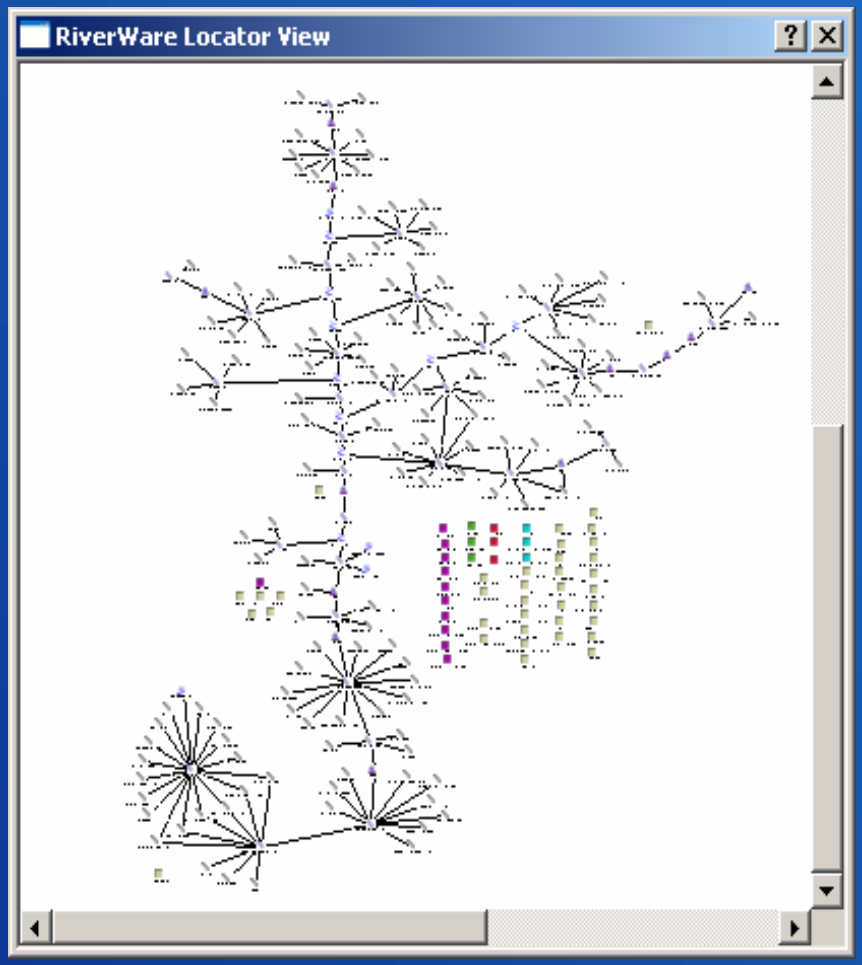
Role of RiverWare in Developing the Interim Guidelines

- Colorado River Simulation System (CRSS)
  - Used to model 6 complex operational alternatives
  - Resource analysis in EIS based on CRSS results
  - Used to model 3 alternate hydrologic inflow scenarios
- CRSS-Lite
  - Annual timestep version of CRSS
  - Used to develop the 6 alternatives
  - Basin States and Conservation Before Shortage Alternatives
- RiverWare was critical in the success of the Guidelines
- Over 275 operational scenarios tested



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Elements of the Interim Guidelines

- A shortage strategy tied to Lake Mead elevations
  - 333, 417, 500 kaf at elevations 1075, 1050, and 1025 feet (amounts of shortage for US only)
  - Initiate efforts to develop additional guidelines for shortages if Lake Mead falls below elevation 1025 feet (includes re-consultation)
- Release from Lake Powell determined by storage of Lake Powell and Lake Mead
  - Under high reservoir conditions, minimum objective release of 8.23 maf from Lake Powell unless storage equalization releases are required
  - Under lower reservoir conditions, either reduce Lake Powell release or balance volumes depending upon elevations at Lake Powell and Lake Mead

Elements of the Interim Guidelines
(continued)

- Storage and delivery of conserved system and non-system water through Intentionally Created Surplus (ICS)
  - Implemented a maximum total ICS credits of 2.1 maf
  - Analyzed a maximum quantity of up to 4.2 maf
  - System assessment of 5% when ICS is created
  - ICS credits remaining at year end diminished by 3% annual evaporation losses
- Interim Surplus Guidelines modified to eliminate Partial Domestic Surplus condition and extended through 2026

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Lake Powell & Lake Mead Operations

Lake Powell Elevation (feet)	Lake Powell Operational Tiers	Lake Powell Storage (maf)
3,700	**Equalization Tier** Equalize, Avoid Spills or Release 8.23 maf	24.3
3,636 - 3,666 (2008-2026)		15.5 - 19.3 (2008-2026)
	Upper Elevation Balancing Tier[1] Release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	
3,595		11.3
3,575		9.5
3,560	**Mid-Elevation Release Tier** Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	8.3
3,525		5.9
3,490	**Lower Elevation Balancing Tier** Balance contents with a min/max release of 7.0 and 9.5 maf	4.0
3,370		0

Lake Mead Elevation (feet)	Lake Mead	Lake Mead Storage (maf)
1,220	**Flood Control or 70R Surplus**	25.9
1,200		22.9
	Domestic Surplus	ICS Surplus
1,145		15.9
	Normal Operations	
1,125		13.9
1,100		11.5
1,075		9.4
	Shortage 333 kaf[2]	
1,050		7.5
	Shortage 417kaf[2]	
1,025		5.8
	Shortage 500 kaf[2] **and Consultation**[3]	
1,000		4.3
895		0

[1] Subject to April adjustments that may result in balancing releases or releases according to the Equalization Tier.

[2] These are amounts of shortage (i.e., reduced deliveries in the United States).

[3] If Lake Mead falls below elevation 1,025 ft msl, the Department will initiate efforts to develop additional guidelines for shortages at lower Lake Mead elevations.

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Water Year 2008 Operations

- Lake Powell operation according to Upper Elevation Balancing Tier to start year
- April adjustment to Equalization Tier at Lake Powell due to relatively high inflow forecast
- Additional equalization releases required to bring Lake Mead to elevation 1105 ft. by end-of-water-year
- ICS Surplus condition declared for Lower Basin
- ICS delivery to CA
  - AZ,NV: none scheduled for WY 2008

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Interim Guidelines
A Robust Solution

- Operations specified through the full range of operation for Lake Powell and Lake Mead
- Encourage efficient and flexible use and management of Colorado River water through the ICS mechanism
- Strategy for shortages in the Lower Basin, including a provision for additional shortages if warranted
- In place for an interim period (through 2026) to gain valuable operational experience
- Basin States agree to consult before resorting to litigation

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Assessing the Sensitivity of Hydrologic Variability in the Colorado River System

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Potential Impacts of Changing Climate

- Historical data shows slight change in mean annual flows over time and large variability year-to-year
- Potential for decreased mean annual flow as well as increased variability
- Recent publications project a wide range of potential impacts (from 0 to up to 45% decrease in the mean annual flow)
- Additional research needed to better quantify uncertainties and improve understanding of risks
- Research Efforts
  - Climate Technical Workgroup (NOAA, UCAR, CU, UNLV, UA, Reclamation, AMEC) advised recent EIS efforts
  - On-going research and development in order to use climate change scenarios in our decision-making
- Information in Section 4.2, Appendix N and U available at:

  http://www.usbr.gov/lc/region/programs/strategies.html

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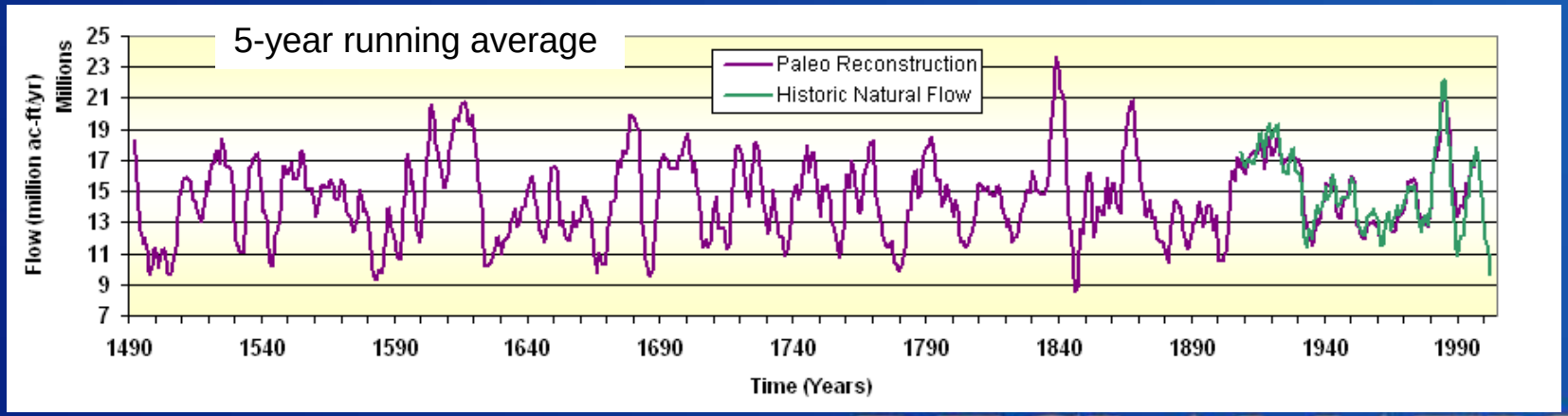
Hydrologic Sensitivity Runs

3 hydrologic inflow scenarios analyzed in Appendix N :

- Direct Natural Flow Record
  - ISM applied to natural flow record (1906-2005)
    - 100 traces
- Direct Paleo
  - ISM applied to Meko - paleo flow (762-2005) (Meko et al., 2007)
    - 1244 traces
- Nonparametric Paleo Conditioned
  - Meko - paleo conditioned (Prairie, 2006)
    - 125 traces



Colorado River at Lees Ferry, AZ

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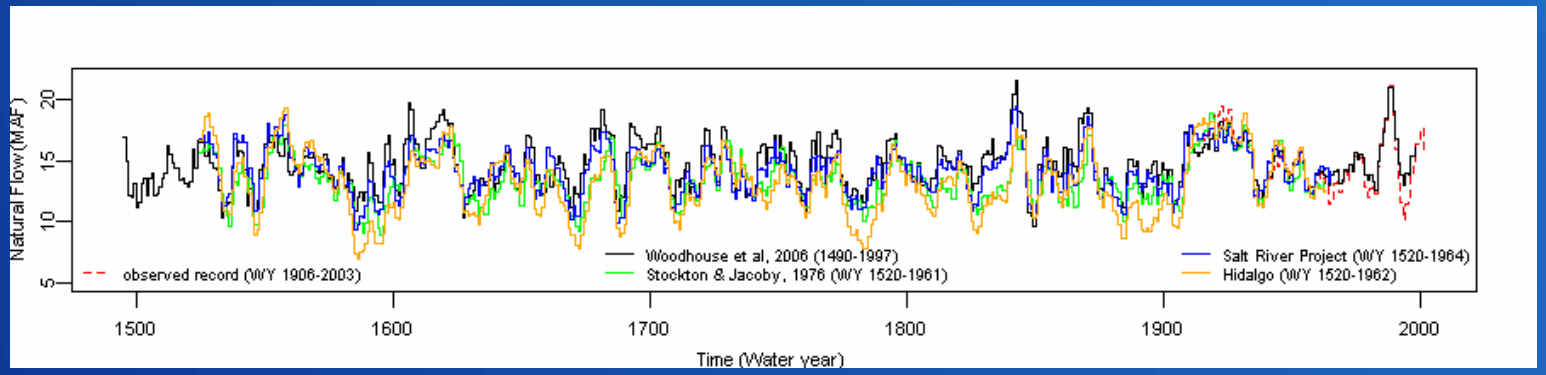


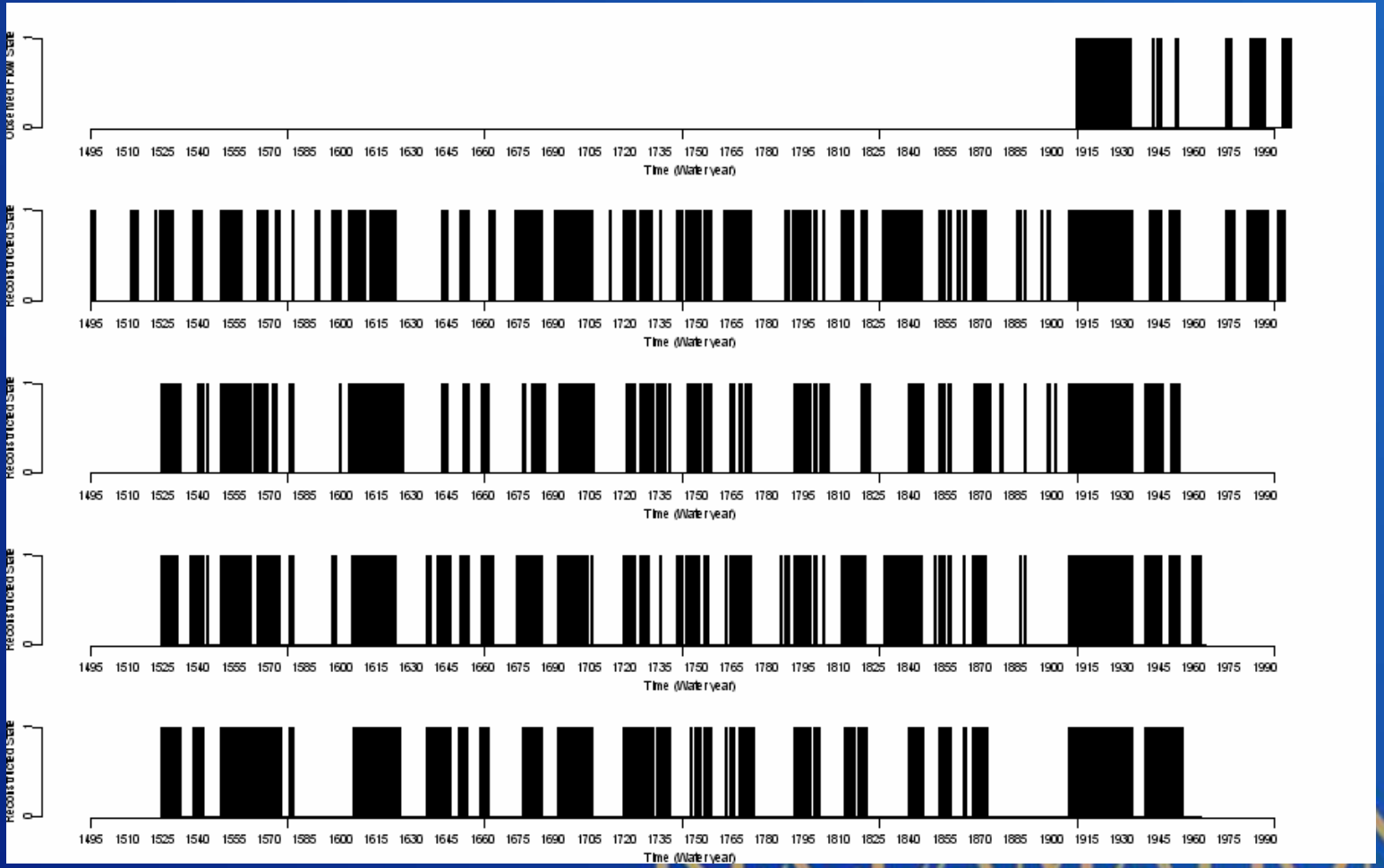
Observed Record

Woodhouse et al. 2006

Stockton and Jacoby, 1976

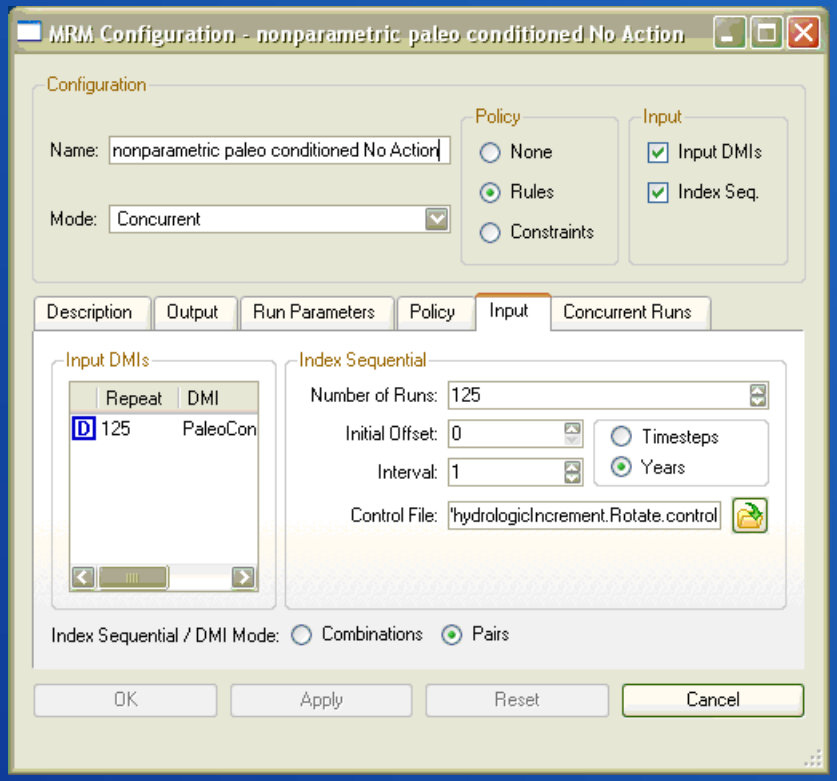
Hirschboeck and Meko, 2005

Hildalgo et al. 2002



Alternate Stochastic Techniques

- Paleo conditioned
  - Combines observed and paleo streamflows
  - Generates
    - Observed flow magnitudes
    - Flow sequences similar to paleo record



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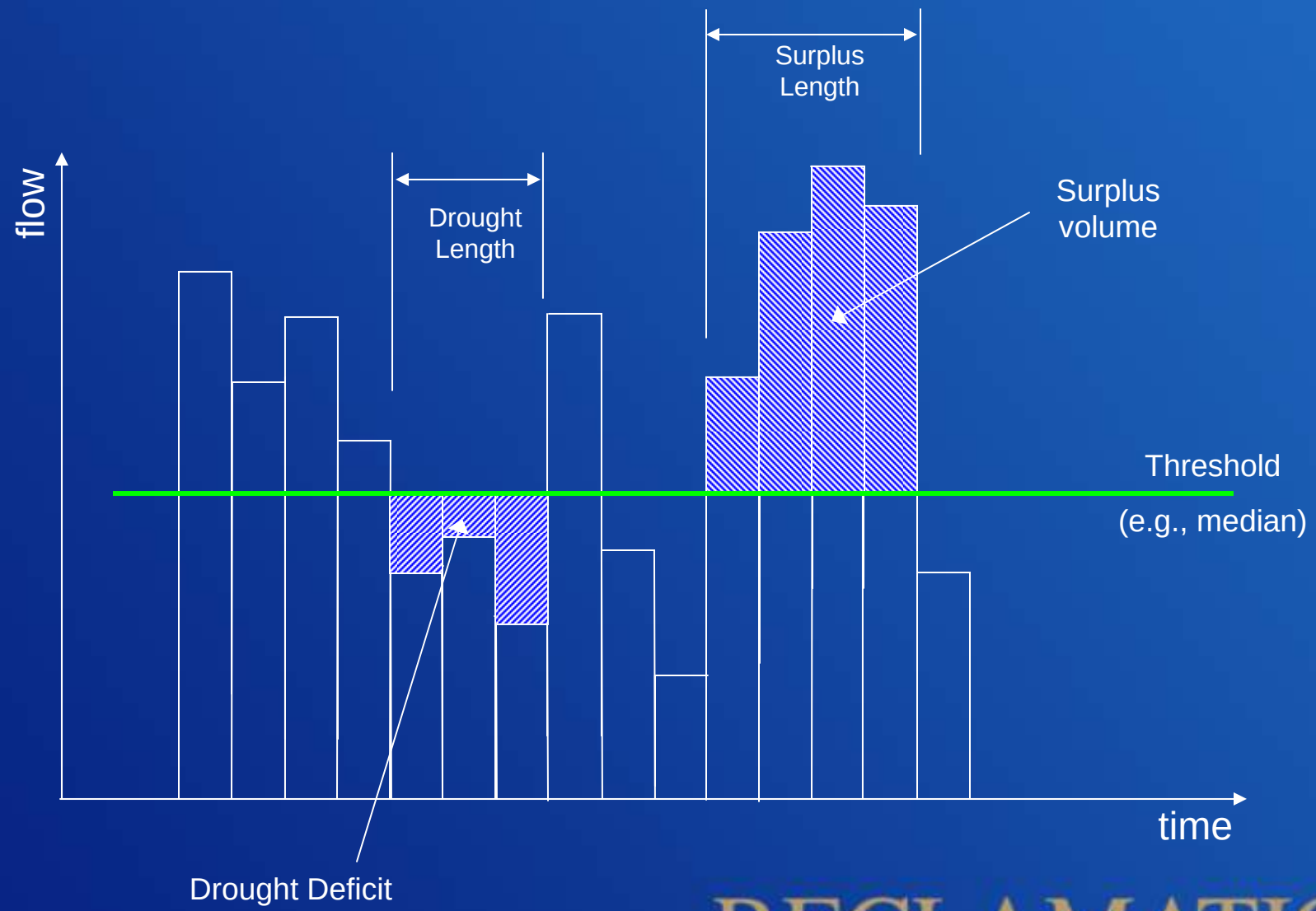
Drought and Surplus Statistics



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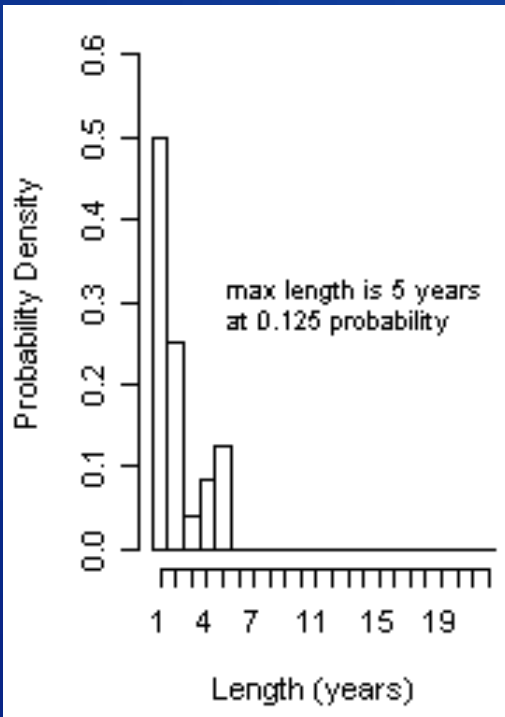
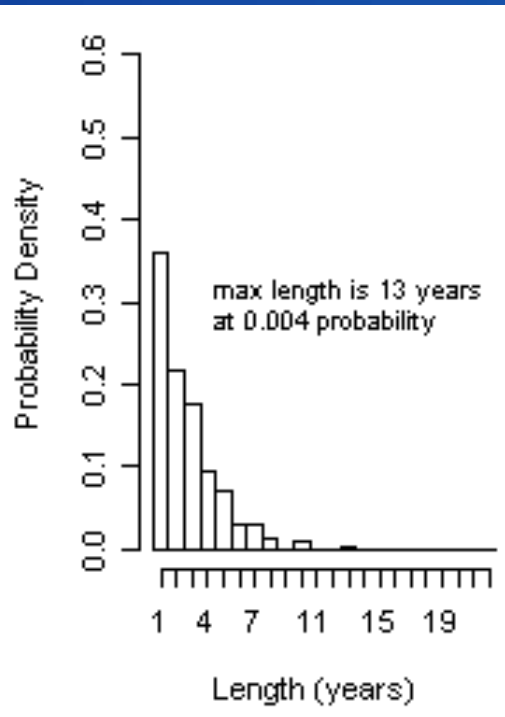
Histograms of Dry Periods

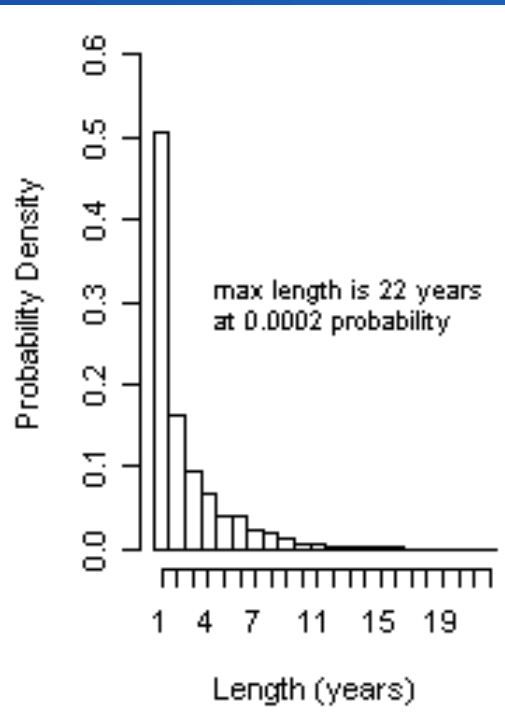
Direct Natural Flow



Direct Paleo - Meko 2007



Paleo Conditioned - Meko 2007



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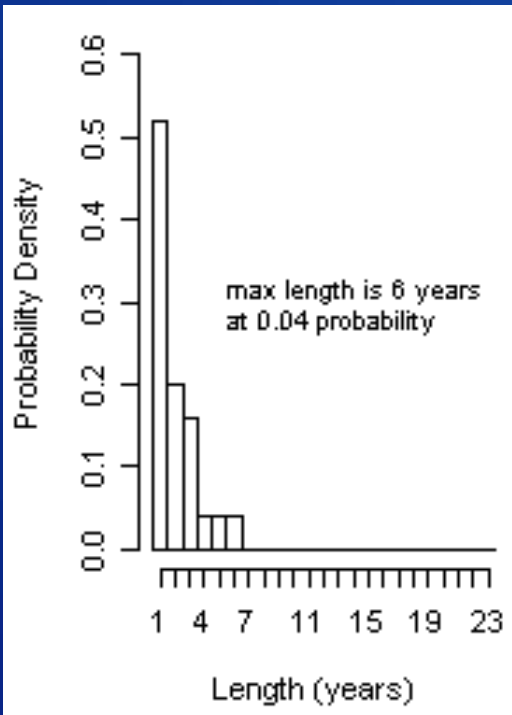
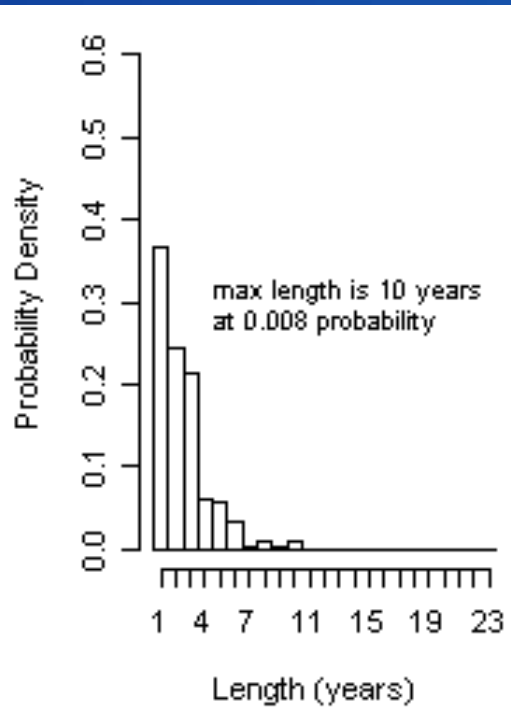
Histograms of Wet Periods

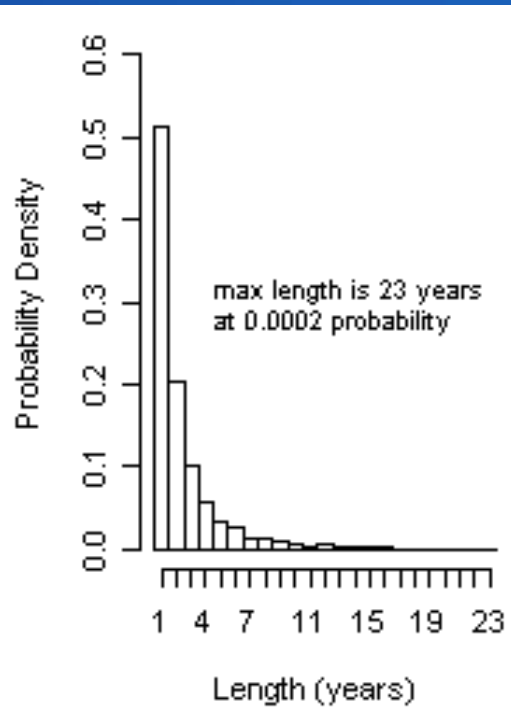
Direct Natural Flow



Direct Paleo - Meko 2007



Paleo Conditioned - Meko 2007



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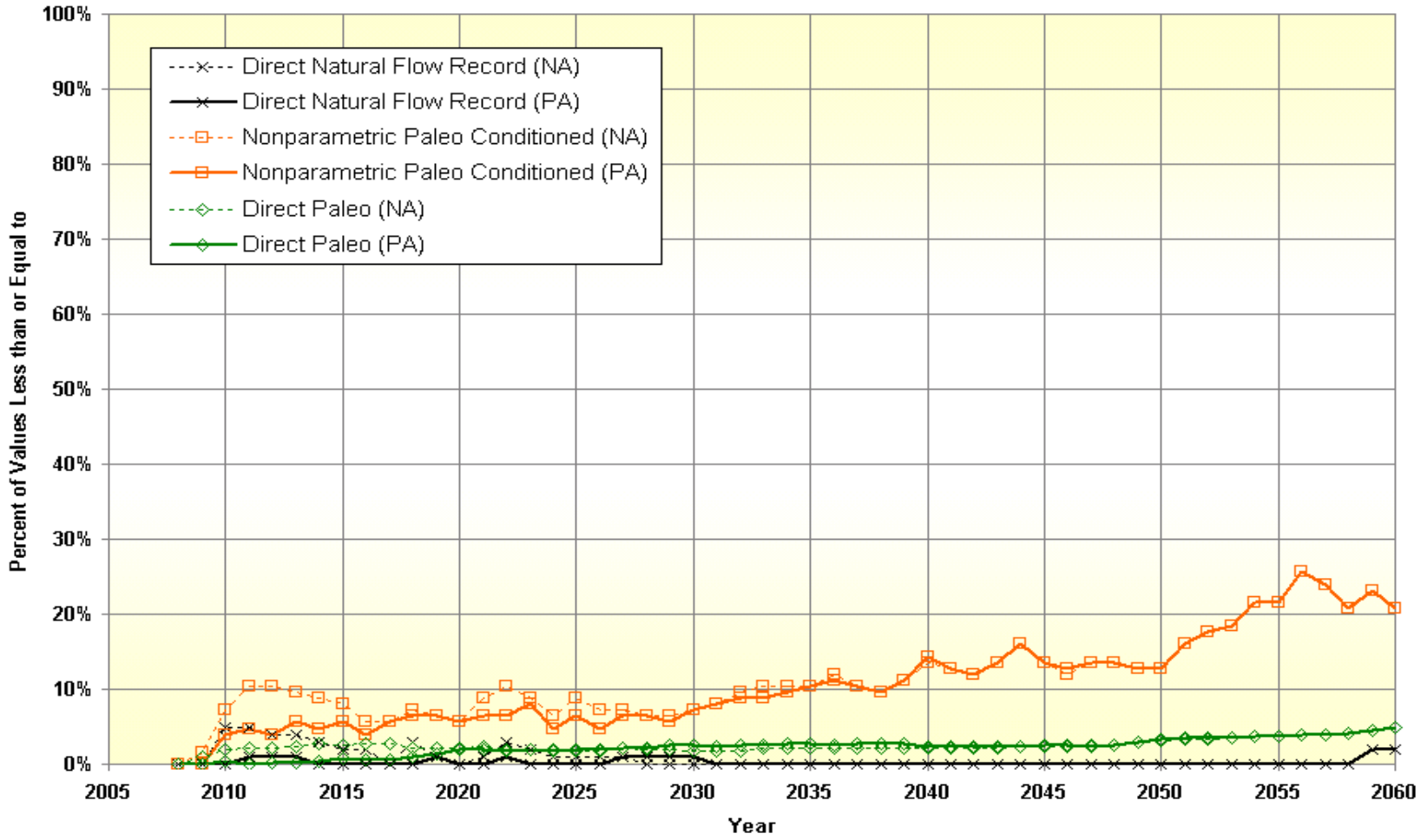
Lake Powell End-of-December Water Elevations Probability of Being Below Minimum Power Pool

(*Percent of Values Less than or Equal to Elevation 3,490 feet msl)*



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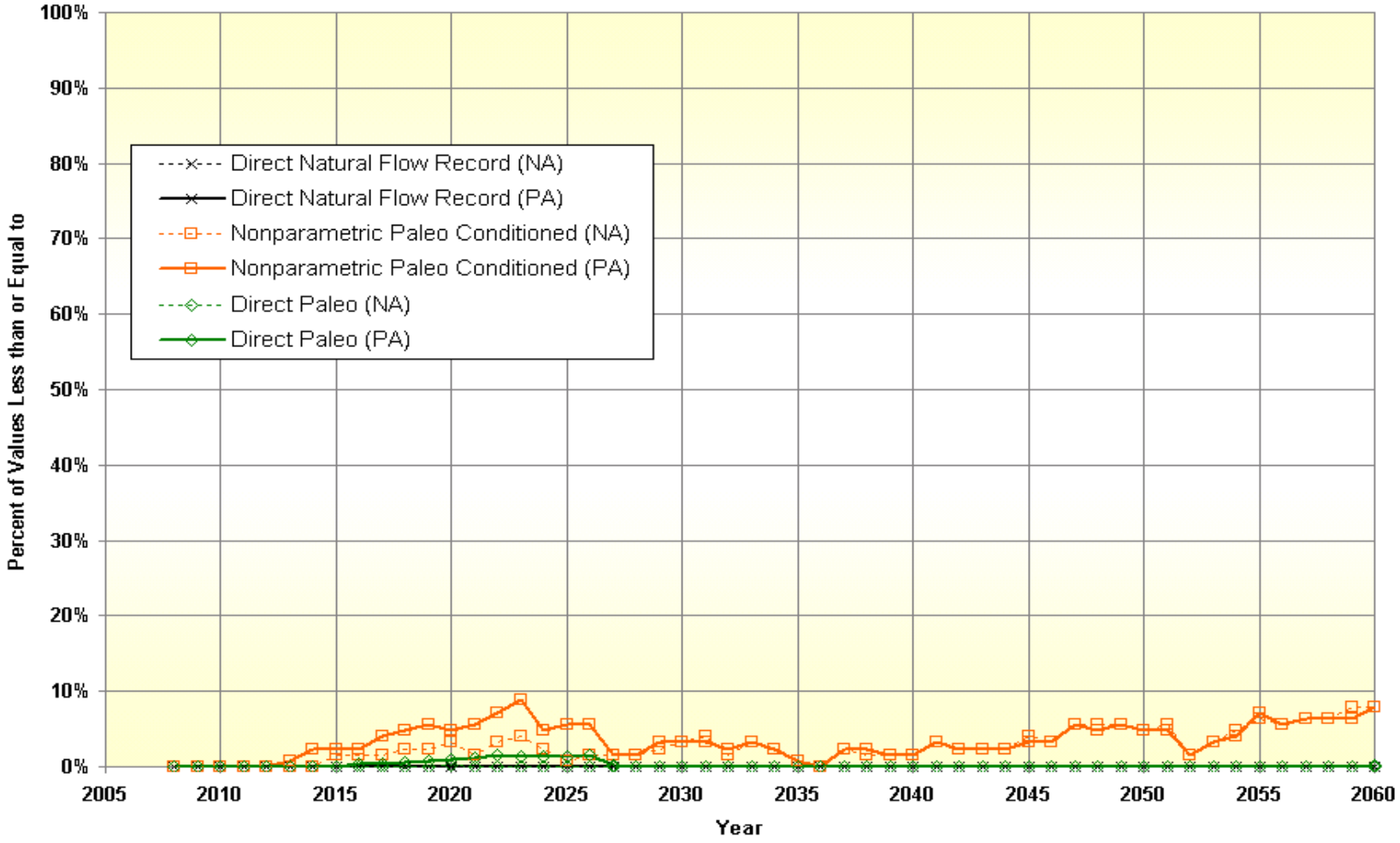
Lake Mead End-of-December Water Elevations Probability of Being Below SNWA Intakes

(Percent of Values Less than or Equal to Elevation 1,000 feet msl)



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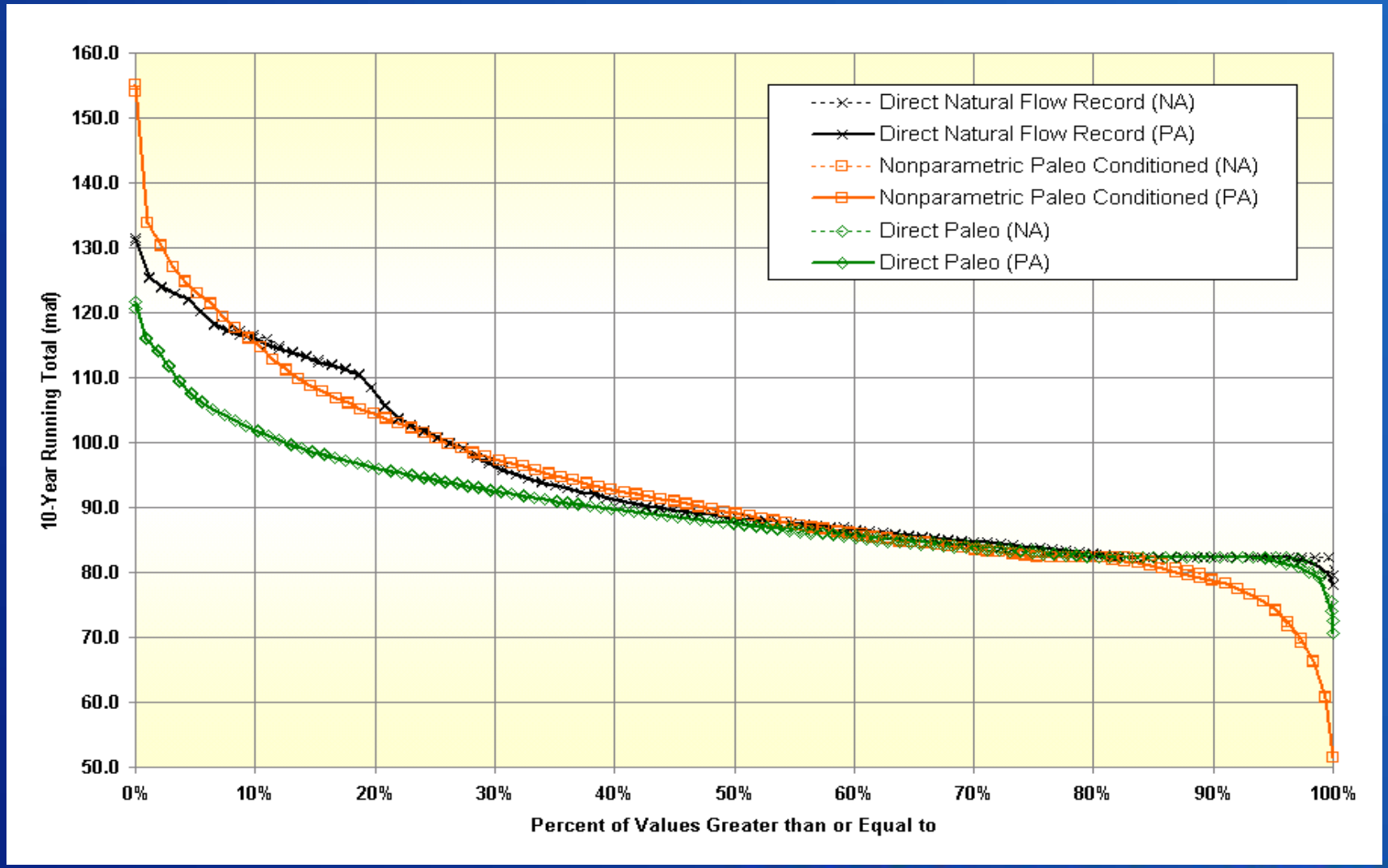
Glen Canyon Dam 10-Year Release Volume

Water Years 2009-2060



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Future Direction

- Reconcile range of runoff reduction at Lees Ferry for many climate projections
- Lower Basin focused paleo streamflow reconstruction
- Blending climate projection data distribution with sequences generated from paleo and observed data
- Conditioning future scenarios on large scale climate features (i.e., ENSO, PDO)
- Colorado River Basin Hydrology Work Group

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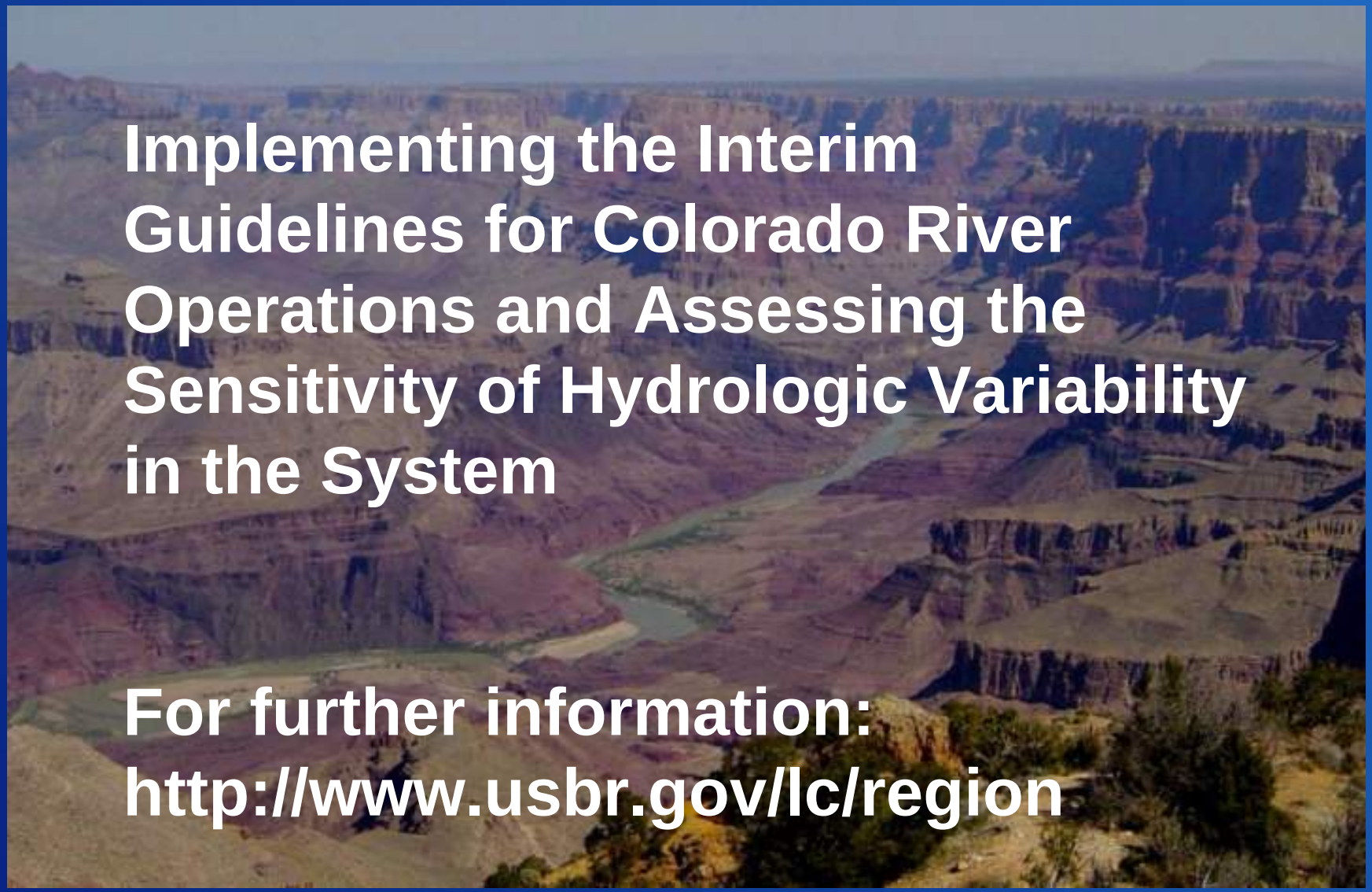

Implementing the Interim Guidelines for Colorado River Operations and Assessing the Sensitivity of Hydrologic Variability in the System

For further information:
http://www.usbr.gov/lc/region

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