



Update on Water Quality of Lake Powell and Glen Canyon Dam Releases

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Technical Work Group Meeting

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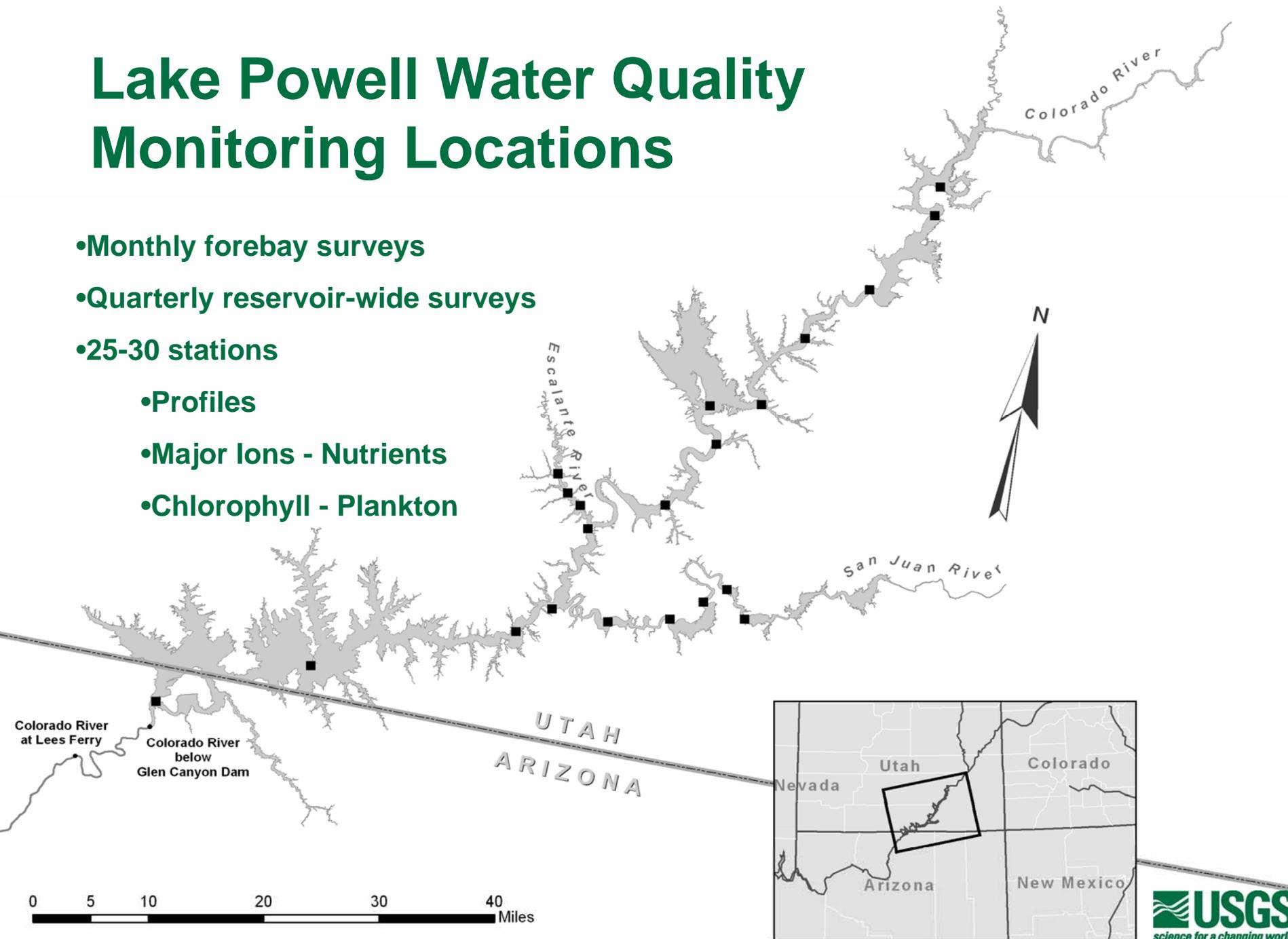
2005 Glen Canyon Dam Releases

Two Unusual Events

- **Highest Release Temperature Since 1971**
 - 16°C (61°F) on October 8, 2005
- **Lowest Dissolved Oxygen on Record**
 - 3.3 mg/L on October 8, 2005 from draft tubes
 - (Data since 1990 – no evidence of prior hypoxia)

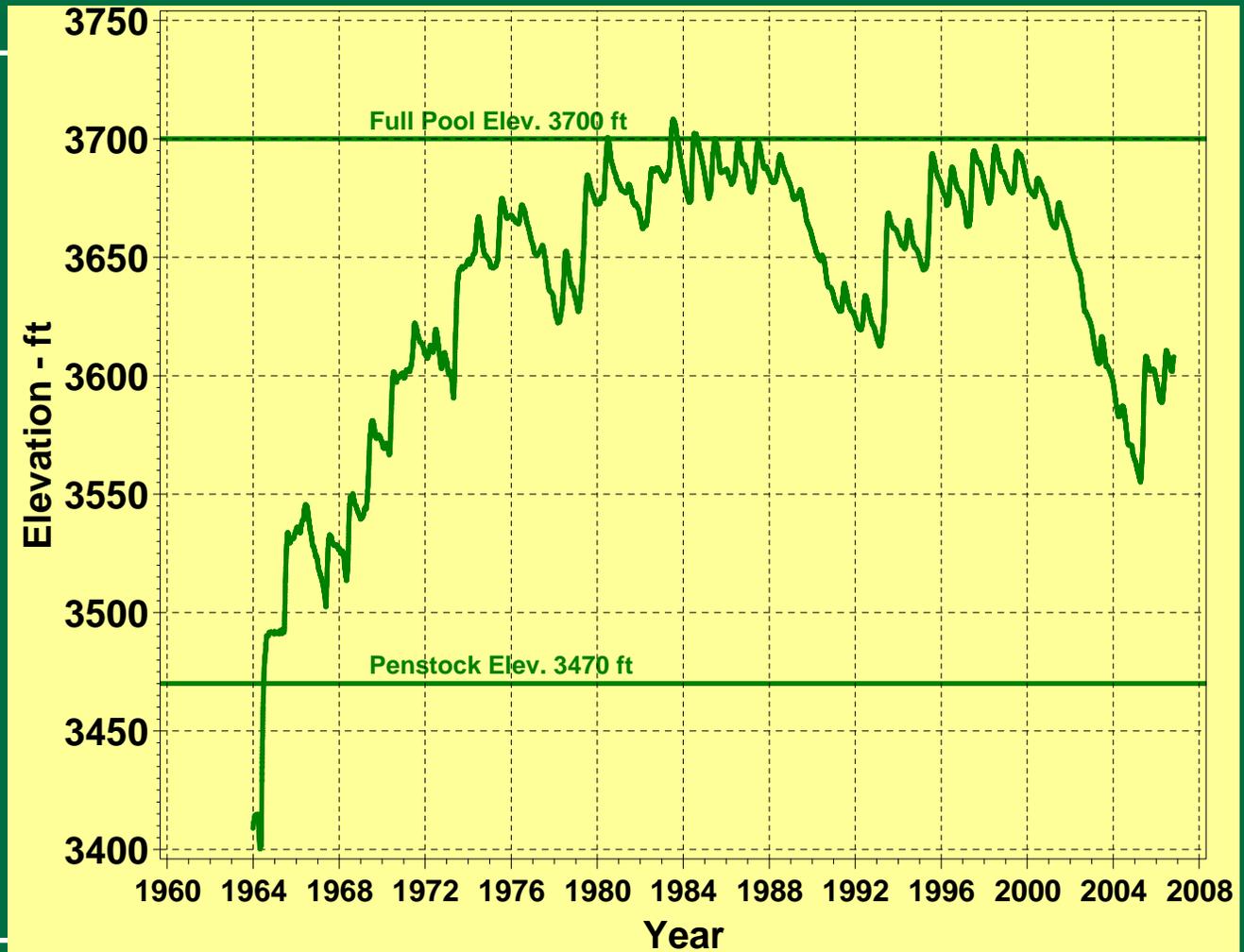
Lake Powell Water Quality Monitoring Locations

- Monthly forebay surveys
- Quarterly reservoir-wide surveys
- 25-30 stations
 - Profiles
 - Major Ions - Nutrients
 - Chlorophyll - Plankton



Lake Powell History

- Glen Canyon Dam completed in 1963
- Full pool in 1980
- Droughts in late 1970s, early 1990s, and 2000-2004

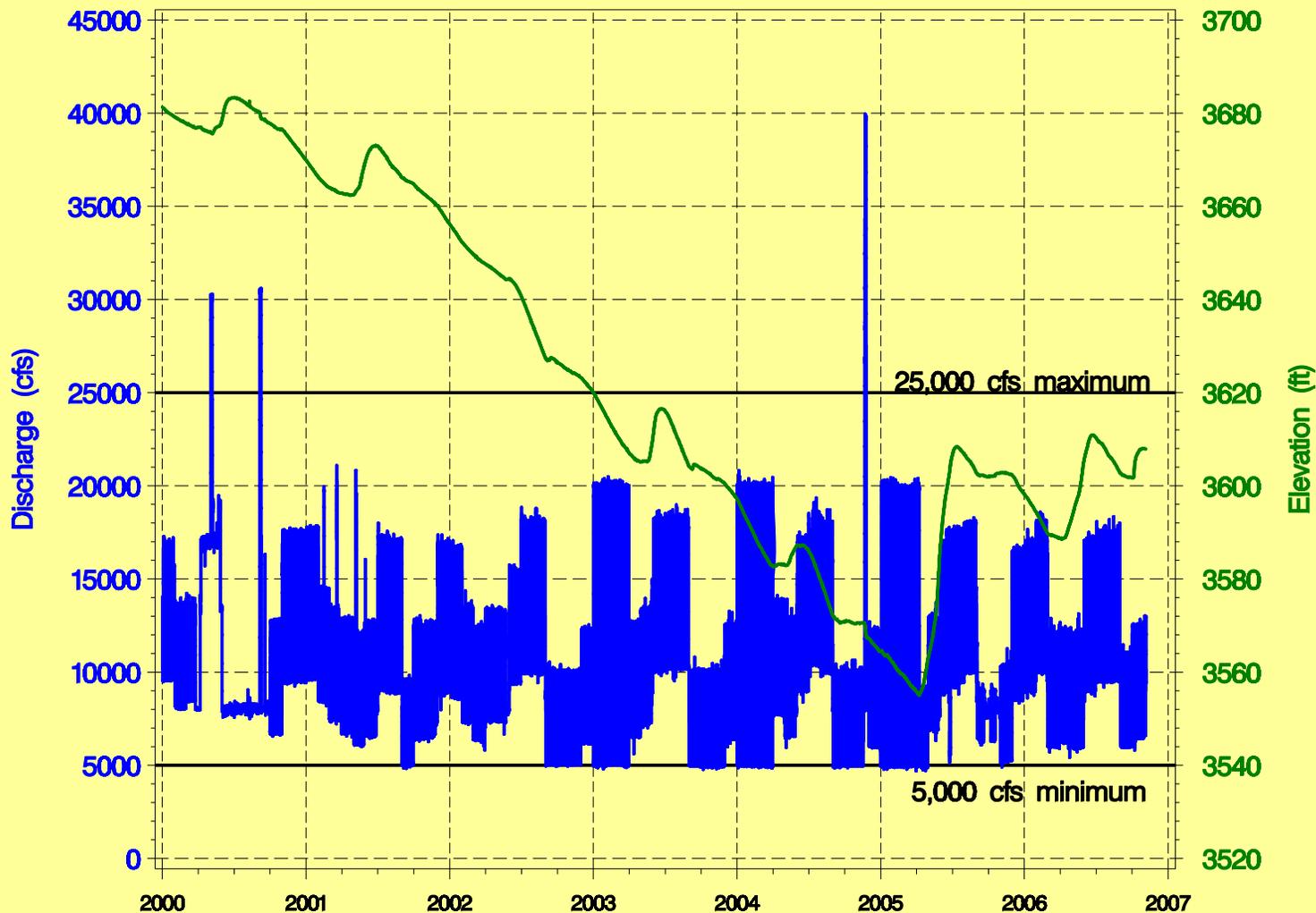


Recent Drought

- 1999 – 97% capacity - 3695 ft – 25.5 MAF
- **Five consecutive years of low inflow**
 - 2000 – 62%
 - 2001 – 59%
 - 2002 – 25%
 - 2003 – 51%
 - 2004 – 49%
- 2005 – 38% capacity – 3555 ft – 9.9 MAF
 - 2005 – 105%
 - 2006 – 73%
- Currently – 55% capacity - 3608 ft – 14.4 MAF

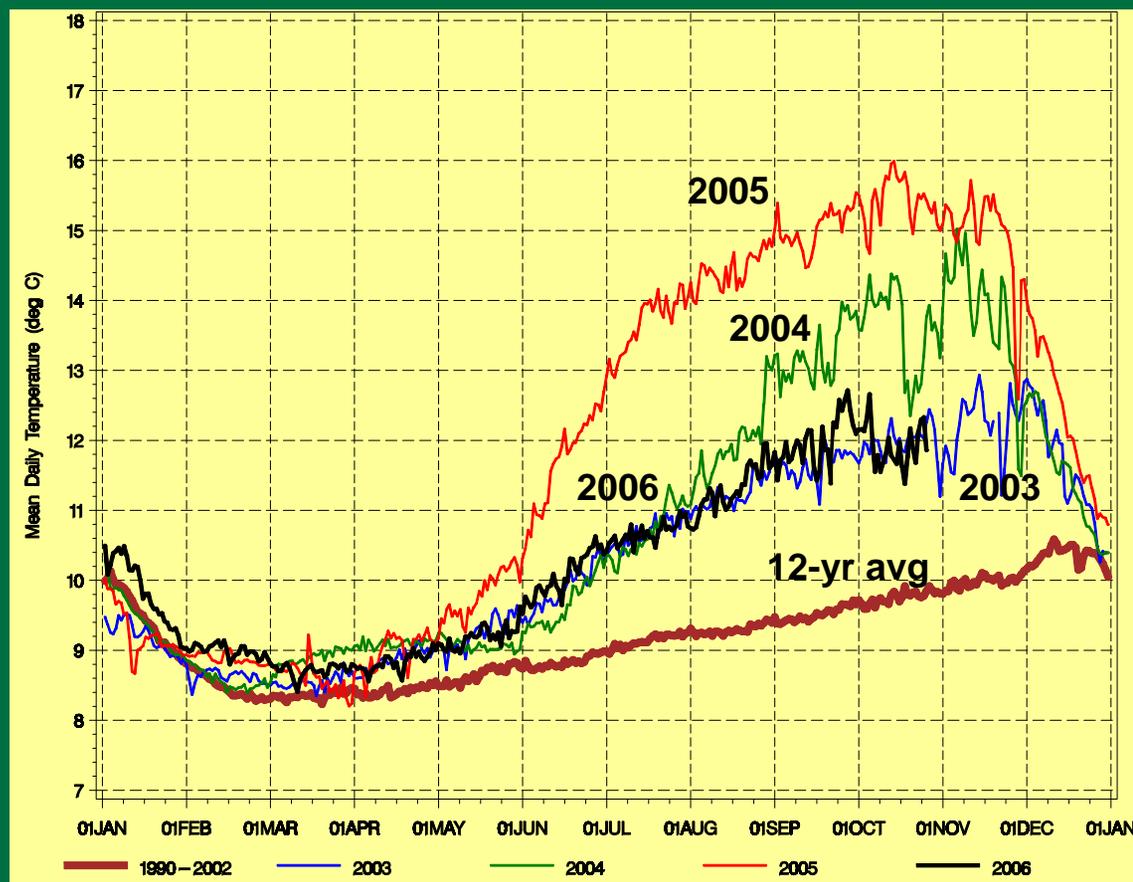


Glen Canyon Dam Powerplant Releases and Lake Powell Surface Elevation
01jan2000 to 01jan2007



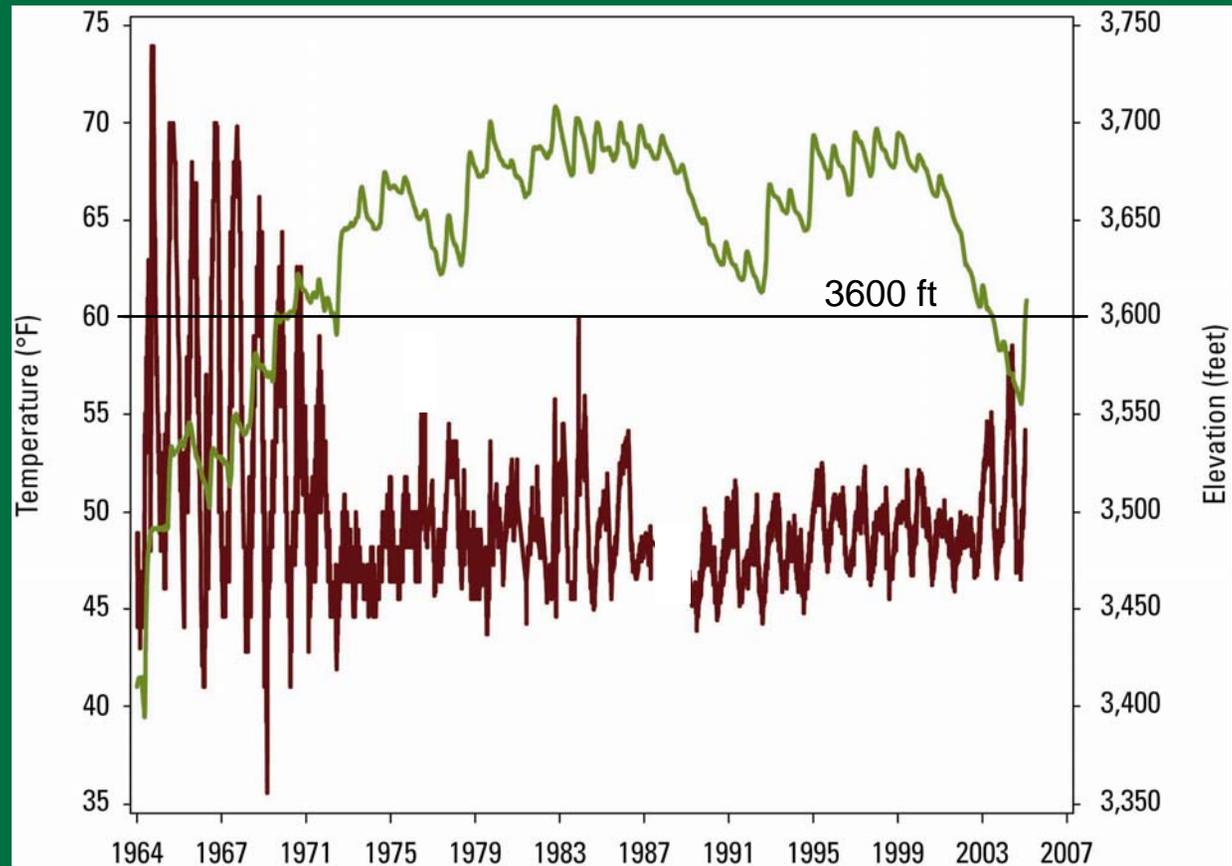
Glen Canyon Dam Release Temperature

- Low reservoir brings warmer surface water closer to penstocks
- Warmest releases since 1971
- 16°C (61°F) on October 8, 2005
- 6°C above 12-yr average (1990-2002)
- 2006 showing similar pattern to 2003



Glen Canyon Dam Release Temperature

- Temperature fluctuations confined at higher reservoir levels
- Warmest temperature in winter from reservoir mixing
- Recent release temperatures highest since 1971
- Current 2005 temperature 60 °F



Lake Powell Hydrology - 2005

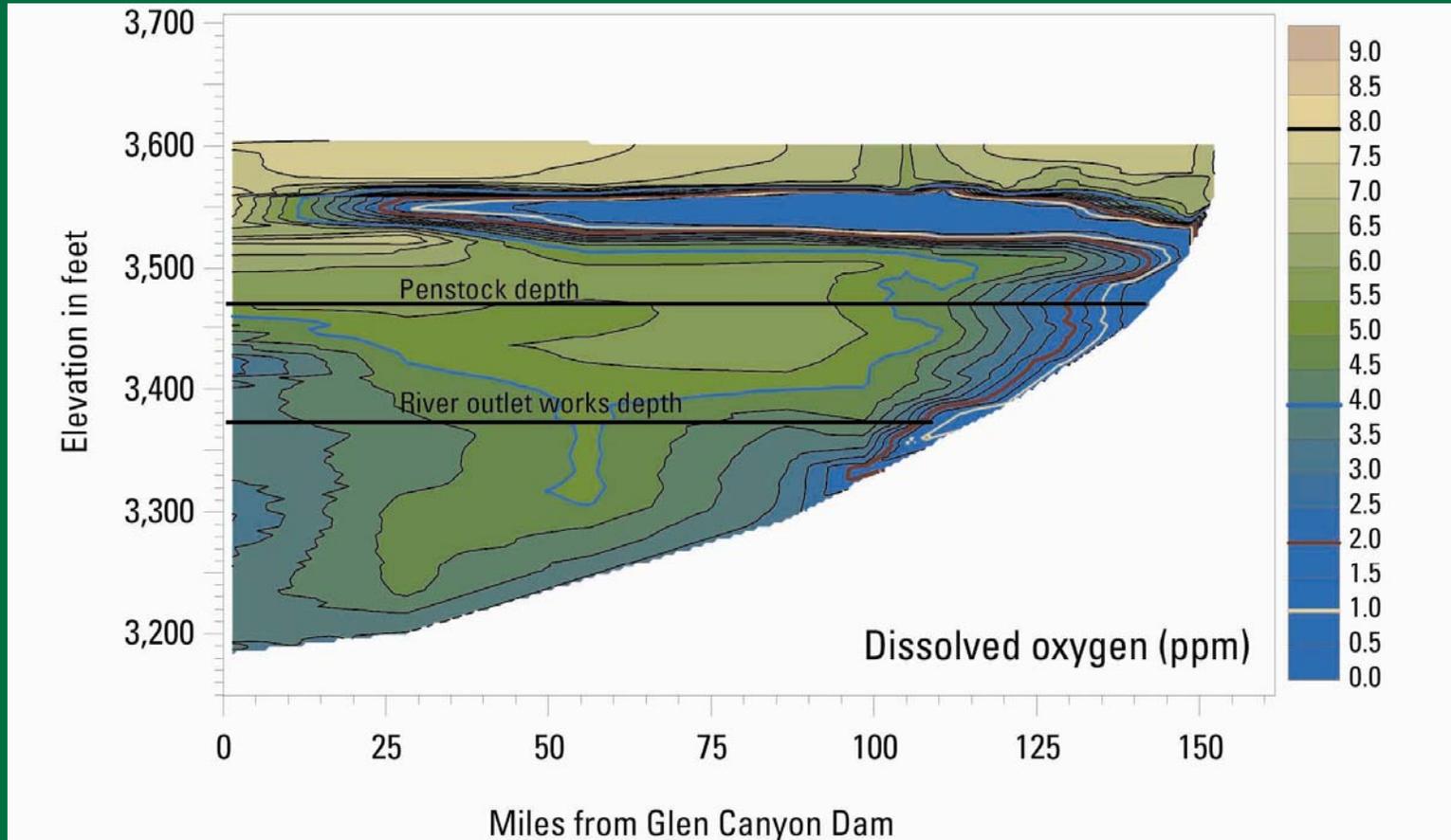
- **Pre-Runoff Conditions**
 - **Surface elevation - 3555 ft on April 8, 2005**
 - **Lowest elevation since May 1969**
 - **38 % of total capacity**
- **2005 Runoff**
 - **Apr-Jul 2005 unreg. inflow - 111% of normal**
 - **Surface elevation - 3608 ft on July 13, 2005**
 - **Runoff increased elevation by 53 ft in 2005**
 - **55% total capacity**

2005 Inflow to Lake Powell

- Above average inflows caused head cutting of exposed deltaic sediments
- Resuspension of large amount of sediment from inflow areas
- Resulted in low dissolved oxygen levels in inflow plume as it traveled through reservoir



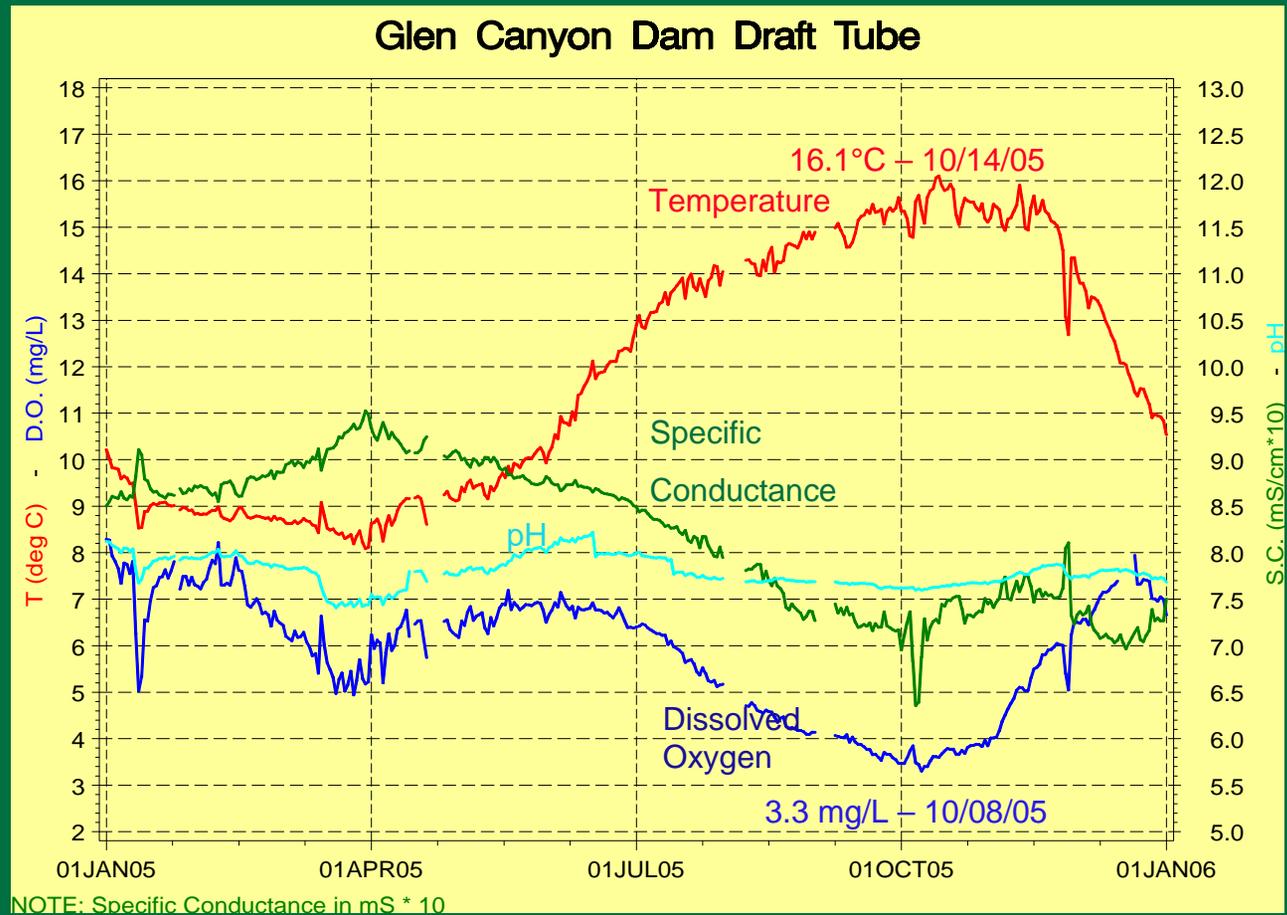
Effects of Reservoir Drawdown



Glen Canyon Dam Releases 2005

Mean daily values

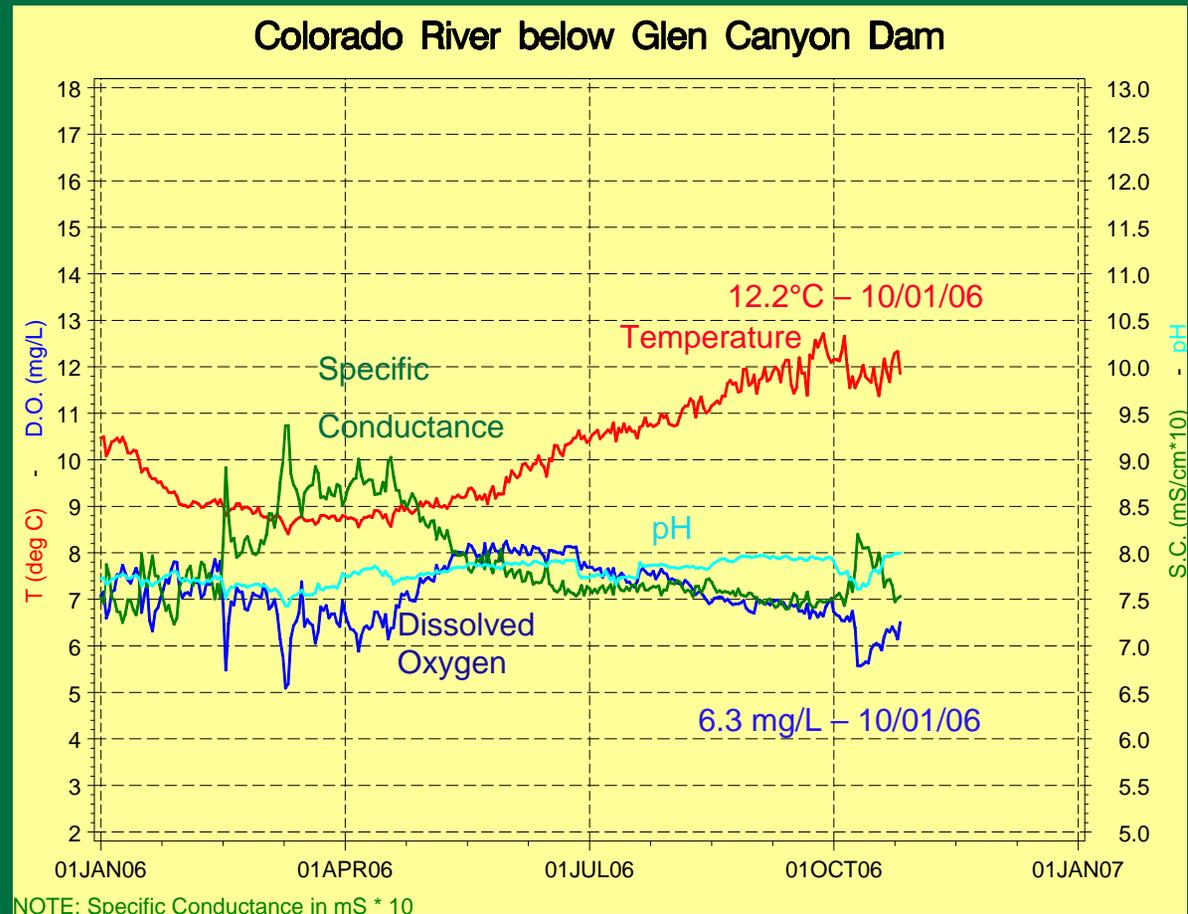
- Lowest dissolved oxygen on record (since 1990)
- 3.3 mg/L on October 8, 2005 from draft tubes
- Hypoxia dissipated by reservoir surface mixing
- Data since 1992 – no evidence of prior hypoxia



Glen Canyon Dam Releases 2006

Mean daily values

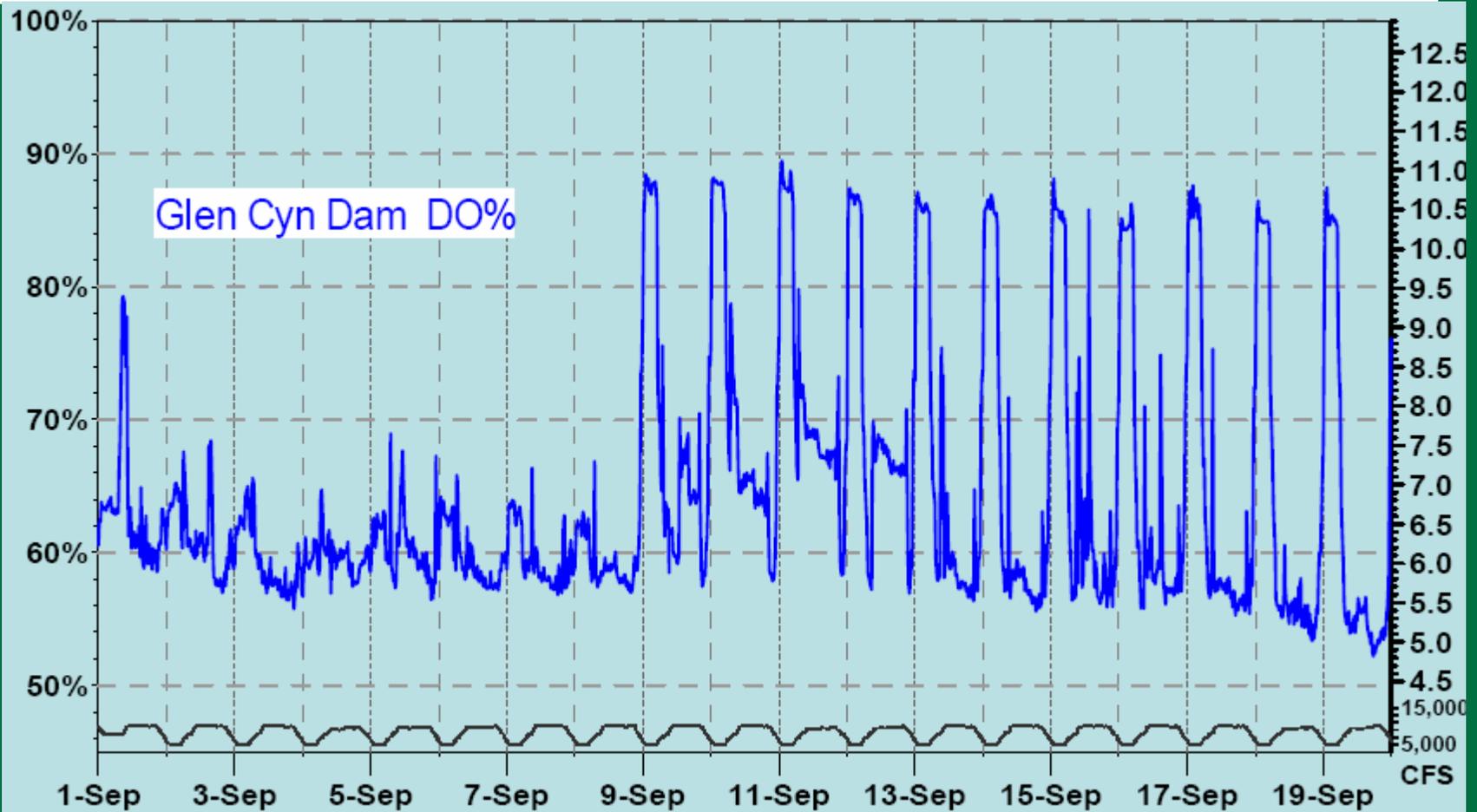
- Lower temperature, higher dissolved oxygen from higher reservoir levels
- 6.3 mg/L on October 1, 2006 from draft tubes
- Shows effect of localized inflows from October precipitation event



Reaeration of Dam Releases

- Past monitoring data has shown elevated dissolved oxygen levels in GCD tailwater during nighttime hours (~11 pm to ~7 am)
- **These spikes appear to be associated with low discharge levels from individual turbines**
- Reclamation experimented with various operational regimes during recent experimental flow period (9/3/06 to 10/31/06) to achieve optimal balance

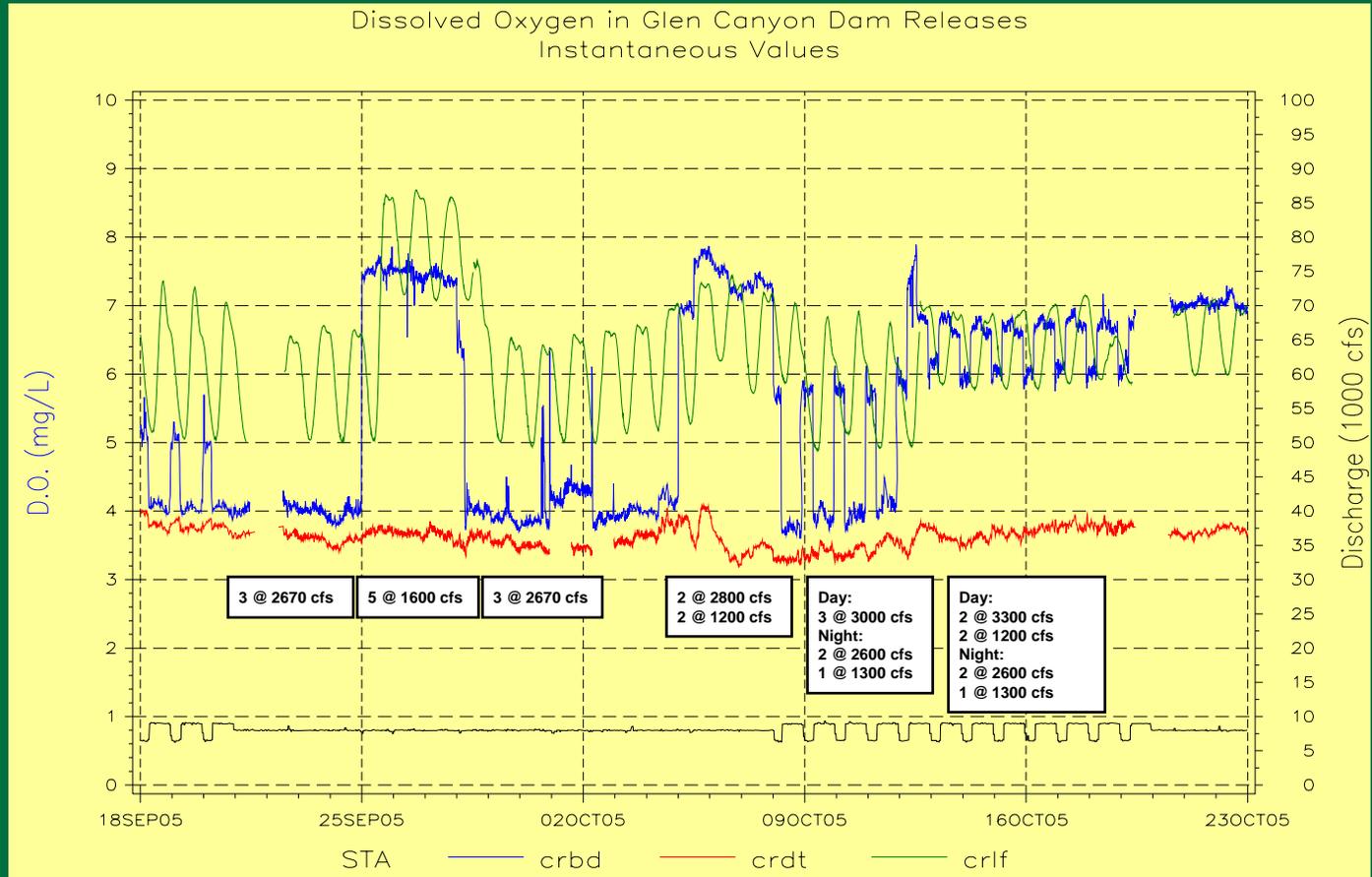
Nighttime Reaeration Spikes - 2005



Reaeration Experiment

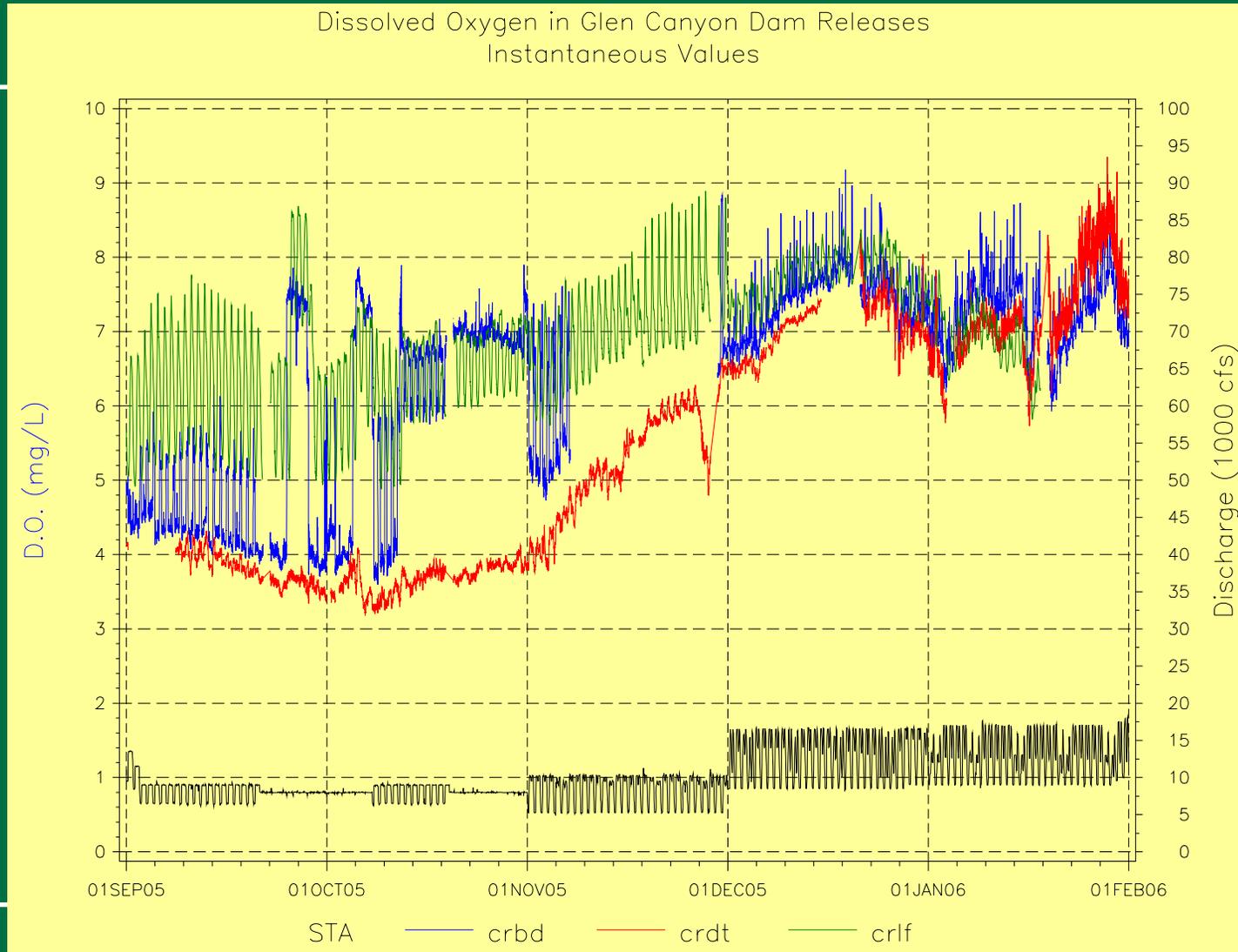
Long-term monitoring at three locations:

- CRDT (red)
GCD Draft Tube
- CRBD (blue)
GCD tailwater
- CRLF (green)
Lees Ferry



Dissolved Oxygen Patterns - 2005

- CRBD reaeration (blue line) reduced with cessation of experimental flows (10/31/06)
- Displaying nighttime D.O. spikes
- Increase in draft tube D.O. (red line) indicates reservoir mixing
- No CRBD data available Nov 8-28



Conclusions from Reaeration Experiment

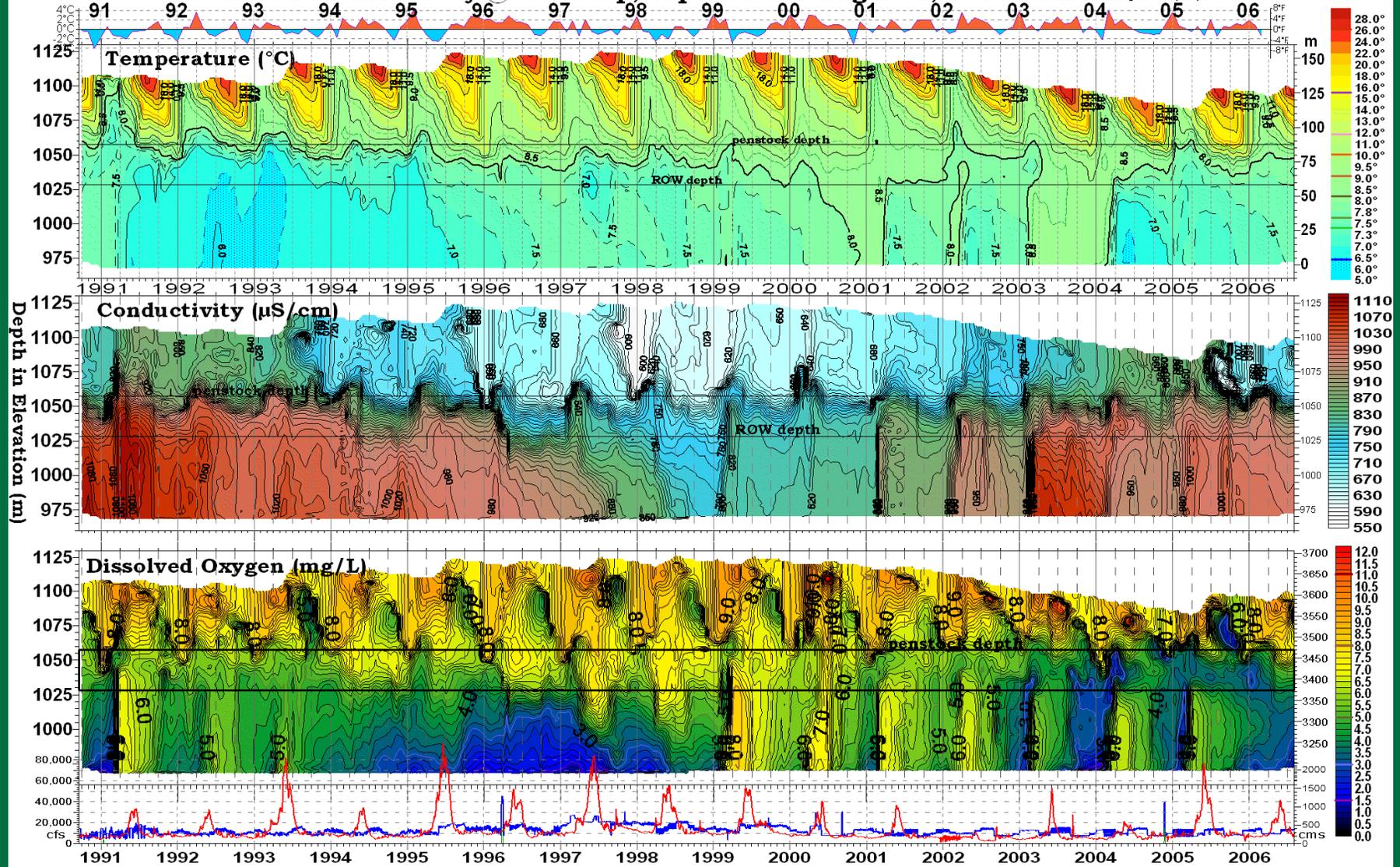
- D.O. in tailwater affected by
 - GCD release concentrations
 - turbine operations
 - atmospheric equilibration
 - photosynthetic productivity
- Certain aspects of dam operations can cause significant aeration in the GCD tailwater
- Concerns remain about low operating efficiency and damage to powerplant machinery

Winter Underflows in Lake Powell

- 2005 – Seventh consecutive year of winter underflows, no underflow in 2006
- Winter underflows displace hypolimnetic water upward to be entrained in dam releases
- Hypolimnion contains lower dissolved oxygen, higher nutrient concentrations
- Winter underflows appear in forebay March-April

Lake Powell Forebay @ Wahweap, Sept 1990 to August 4, 2006

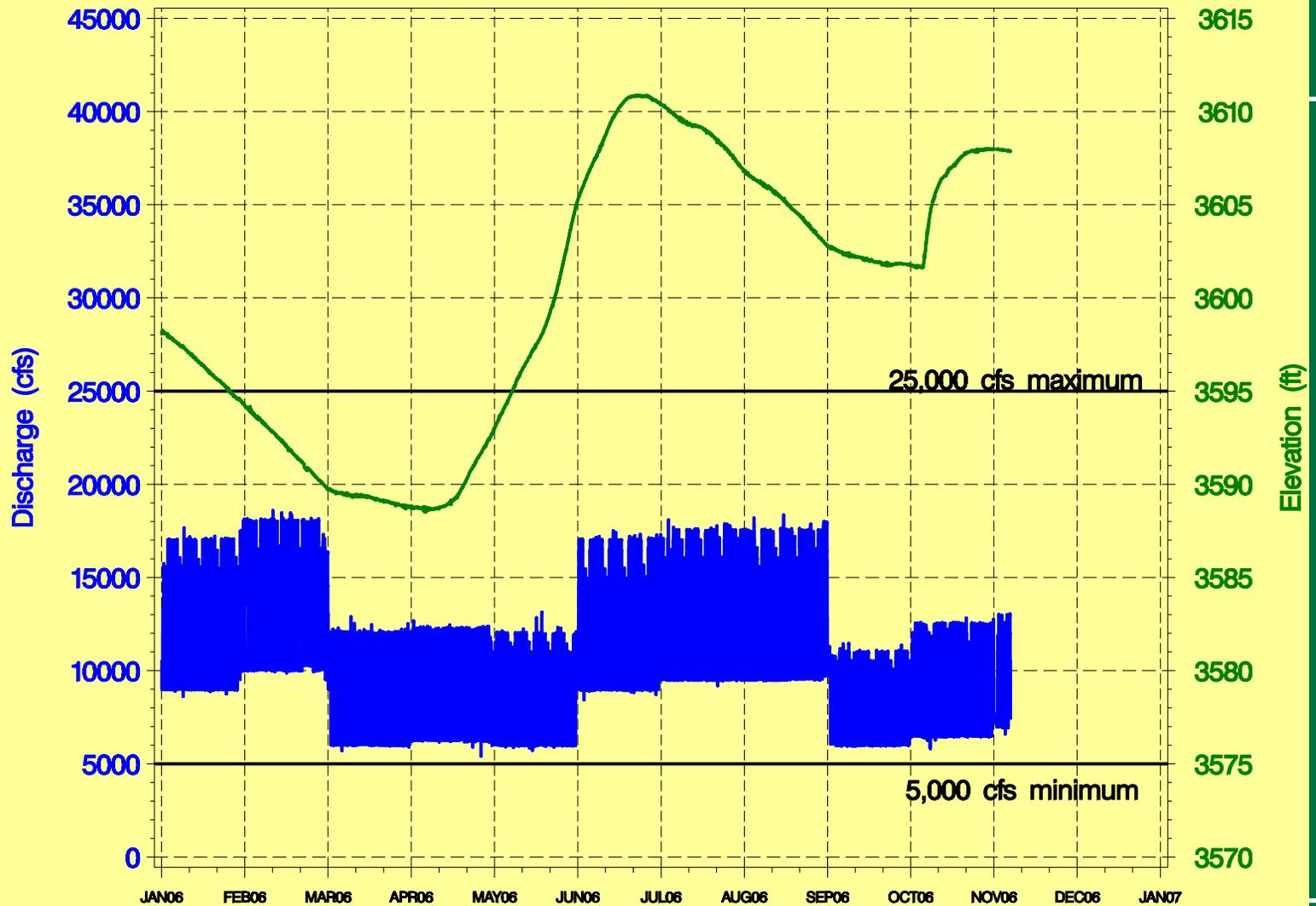
GCRMC S. Huettle 09/13/06



Recent inputs to Lake Powell

- **Extraordinary precipitation in October 2006**
 - **October precipitation - 235% of normal**
 - **October inflows 1.02 MAF – 184% of average**
 - **Does not include localized inflow (~0.35 MAF)**
- **Basinwide and localized inflows**
- **Storms raised Lake Powell elevation 6.4 ft**
 - **0.644 MAF**
 - **Similar event in October 1972 - 5.7 ft increase**
- **Effects seen in Glen Canyon Dam releases**

Glen Canyon Dam Powerplant Releases and Lake Powell Surface Elevation 01jan2006 to 01jan2007





Dirty Devil River October 2006



Dirty Devil River October 2006