Warm Water? Science Plan

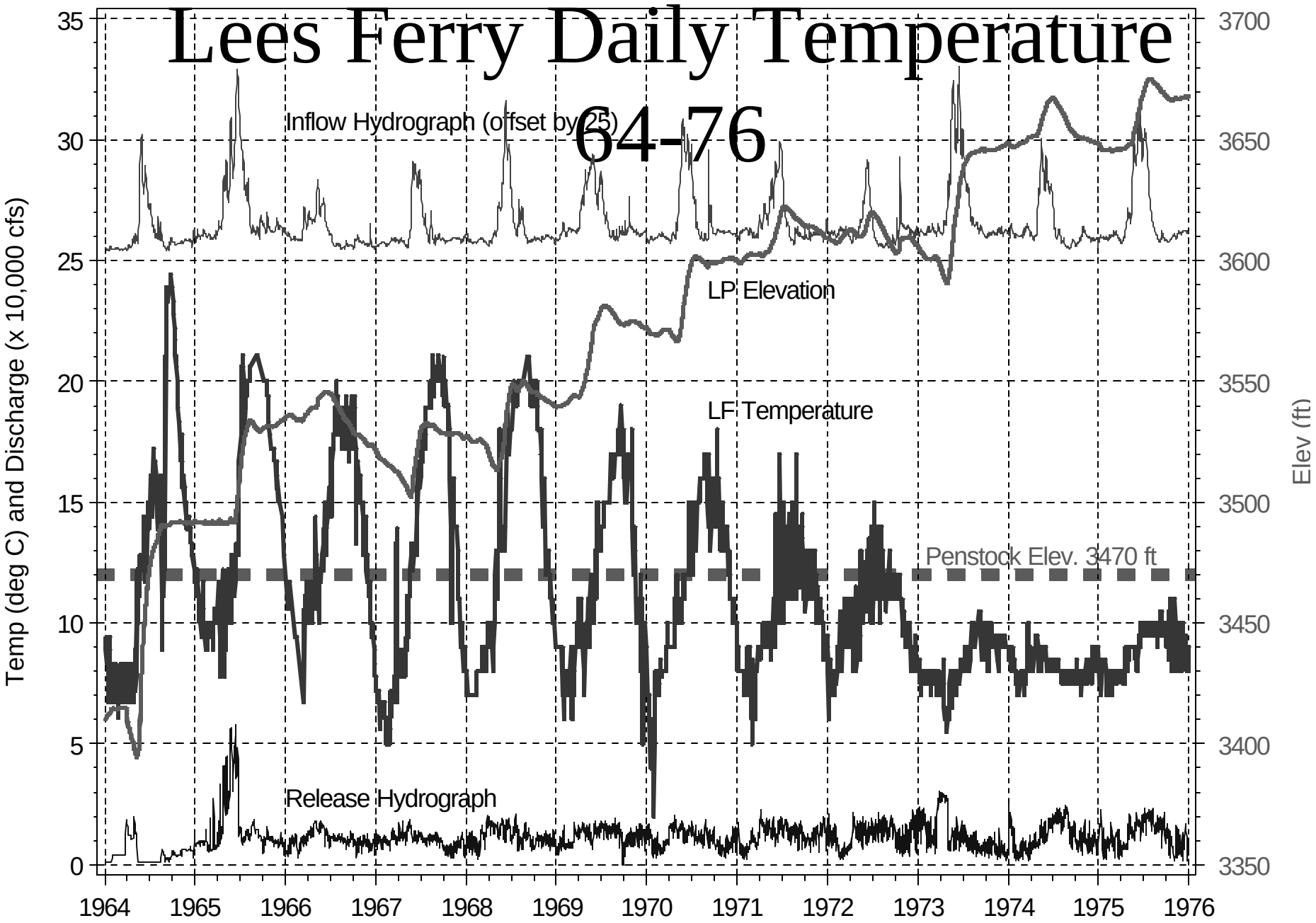
Temperature Monitoring

GCMRC Thermal Monitoring

- Glen Canyon Dam Forebay
  - Monthly full water quality profiles
  - Continuous monitoring at various depths since 2000
- Glen Canyon Dam Tailwater
  - Continuous full water quality monitoring
    - Draft Tubes
    - Immediately below dam
    - Lees Ferry
- Grand Canyon Thermal Monitoring
  - 10 mainstem sites in Grand Canyon

Lees Ferry Daily Temperature

Lake Powell Initial Filling Stage

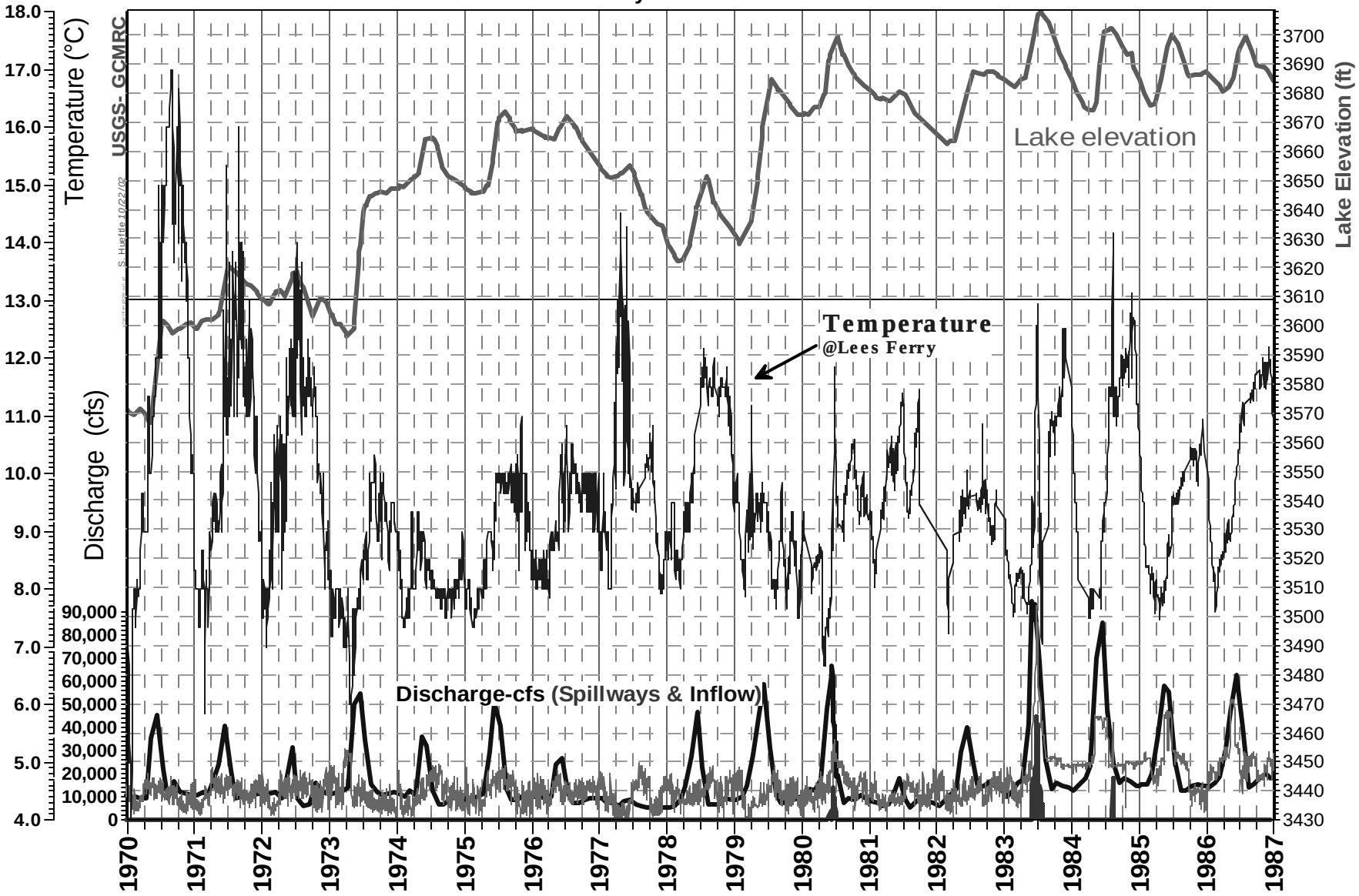


Filling Period 1964-1976

- Summer withdrawals from epilimnion
  - Ended with filling to 3645 ft. in 1973
- Maximum temperatures in September
  - Due to epilimnetic withdrawal
- Maximum temperatures reduced as reservoir filled
- High inflows in 1973 raised surface elevation away from penstock levels

Effects of Lake Elevation And Dam Operations on Discharge Temperature

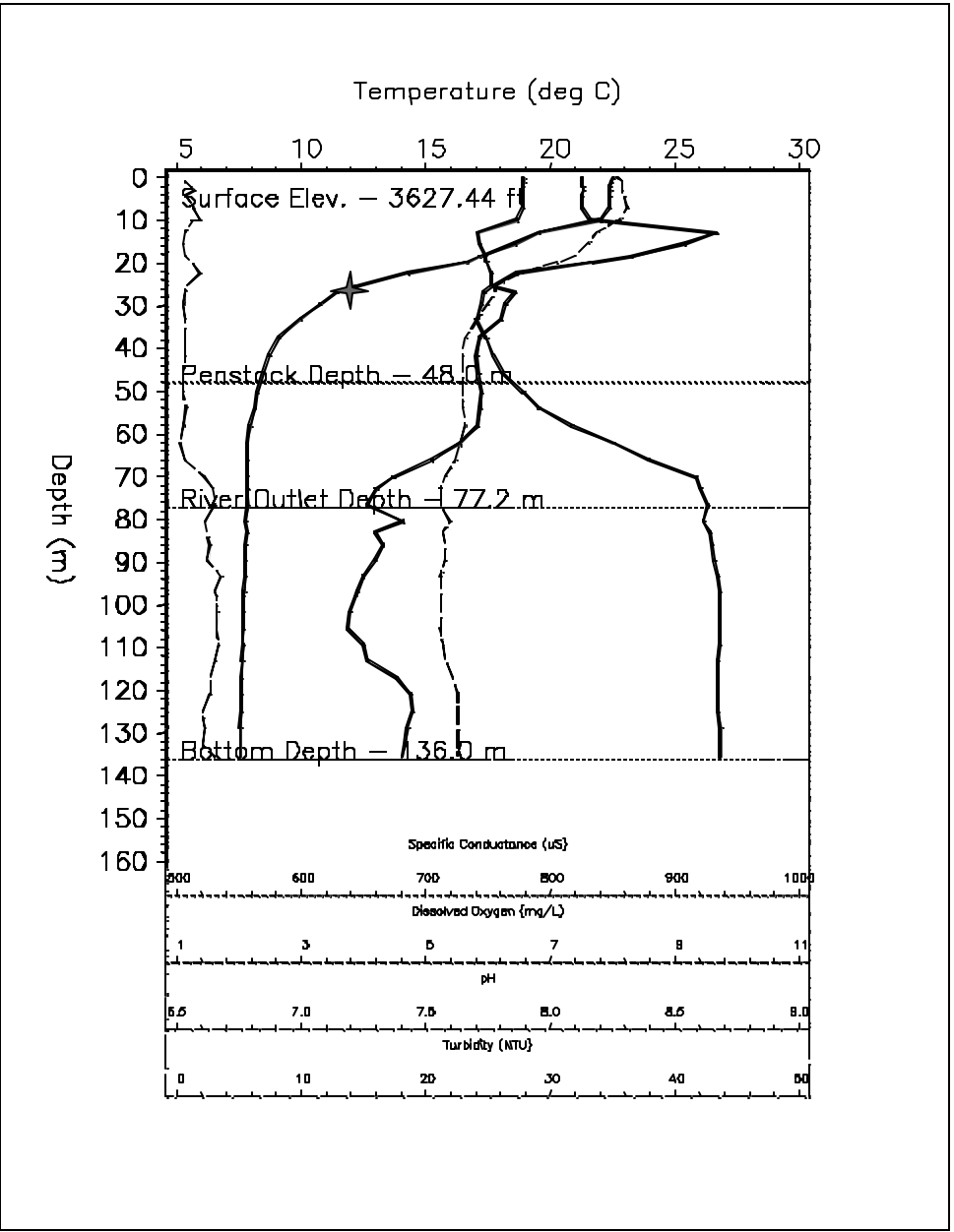
Lees Ferry: 1970 to 1987



Current Conditions 1993-2003

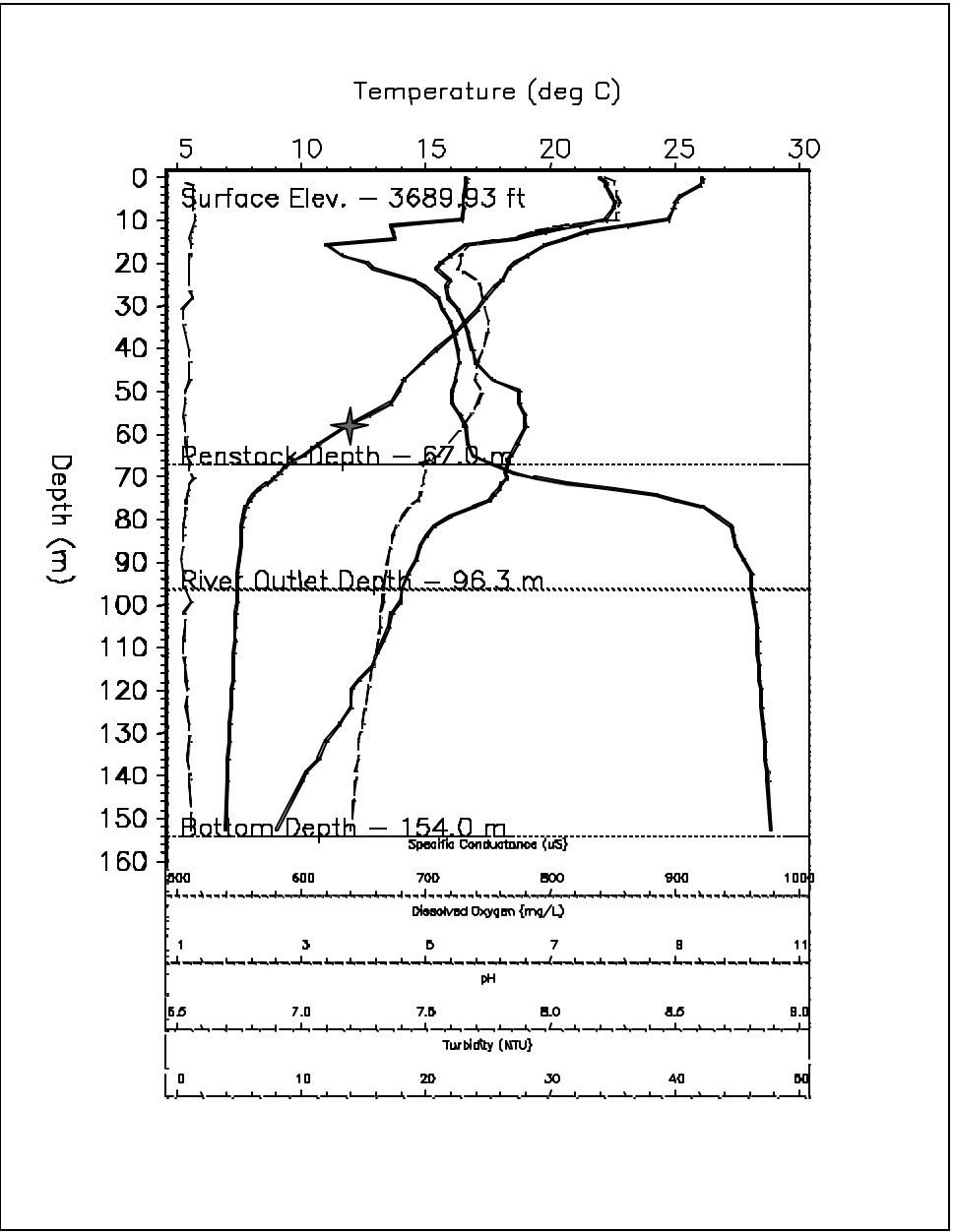
- Summer withdrawals from hypolimnion
- Maximum temperatures in December
  - Due to convective mixing of epilimnion
- Maximum winter temperatures affected by previous spring runoff volume
- 1999-2000 had similar inflow patterns as 1971-1972 (but different lake elevations)
  - Could serve as model for 2003 – similar projections

Forebay Profile – September 18, 2002



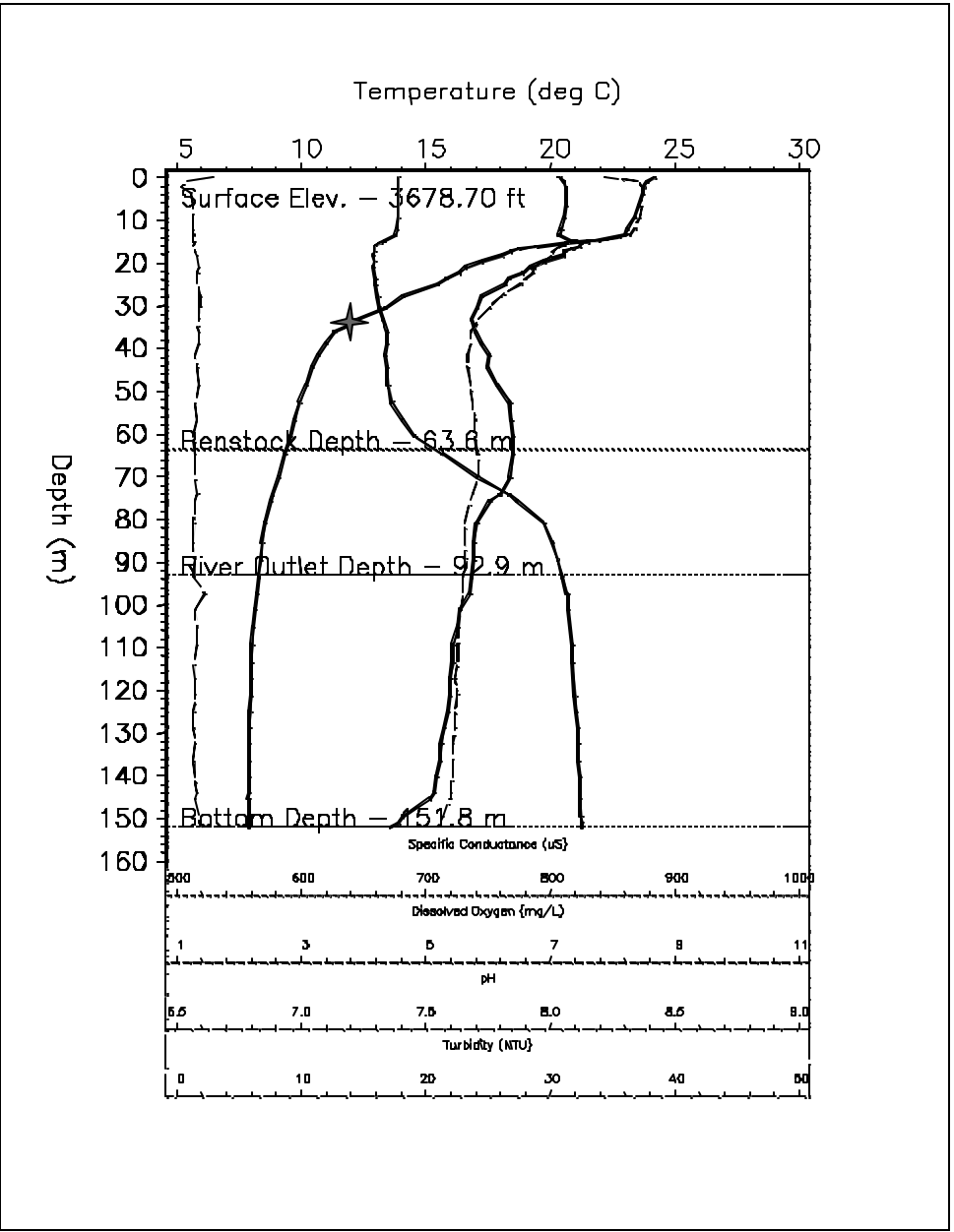
- Apr-Jul runoff 1.45 MAF
- **Lowest** runoff volume on record
- Very thin epilimnion
- 12°C water at 27 m ✦

Forebay Profile – September 12, 1995



- Apr-Jul runoff 10.62 MAF
- **Highest** runoff volume since 1986
- Very thick epilimnion
- 12°C water at 59 m ✦
- 1995 conditions at 2002 lake levels would have resulted in ~14°C releases

Forebay Profile – September 13, 2000

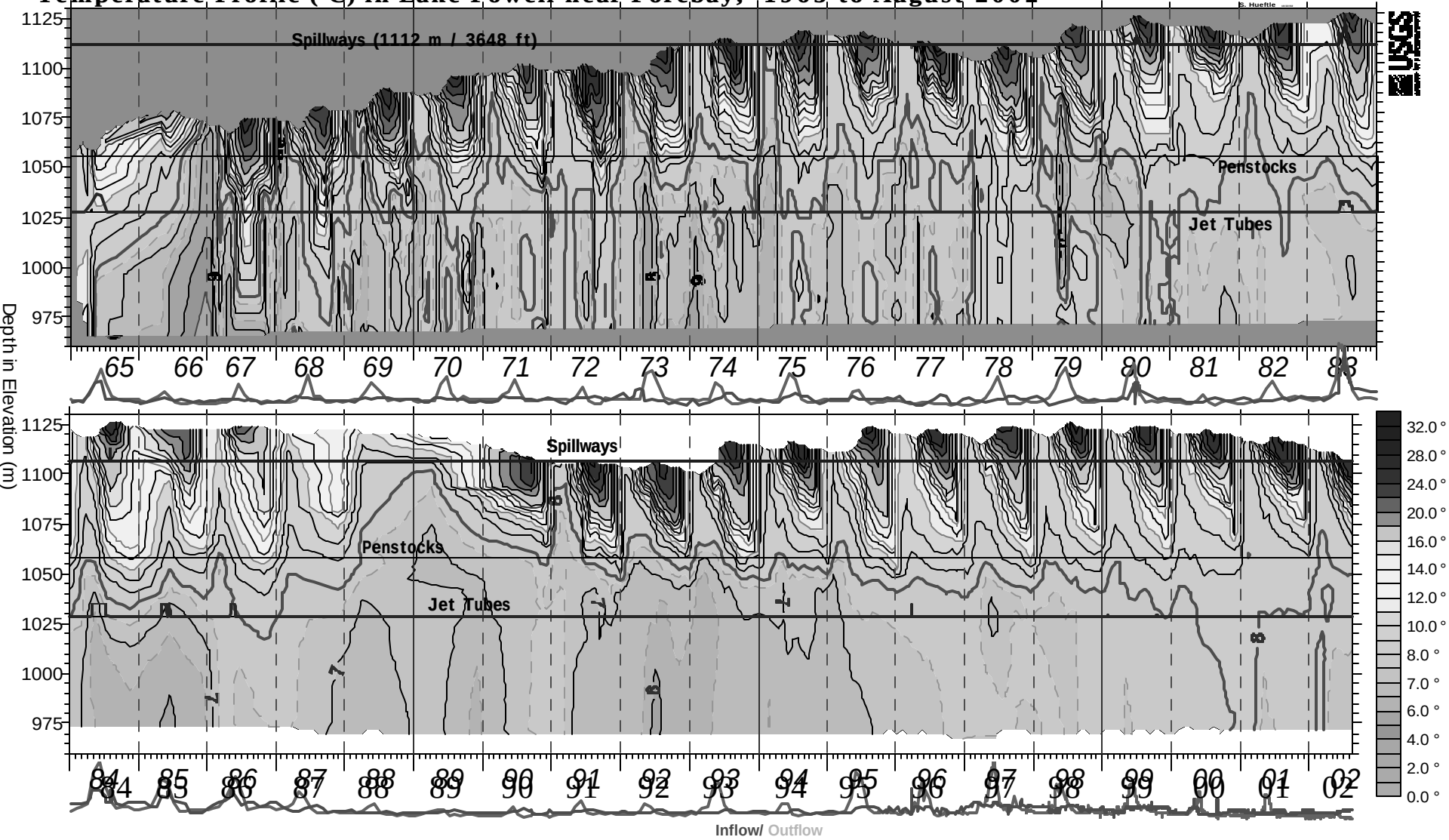


- Apr-Jul runoff 4.62 MAF
- **Intermediate** runoff volume
- Similar to 1972 runoff
  - 4.06 MAF in 1972
  - Last year of warm release
- Similar to projected 2003 runoff of 5.67 MAF
- 12°C water at 35 m ✦

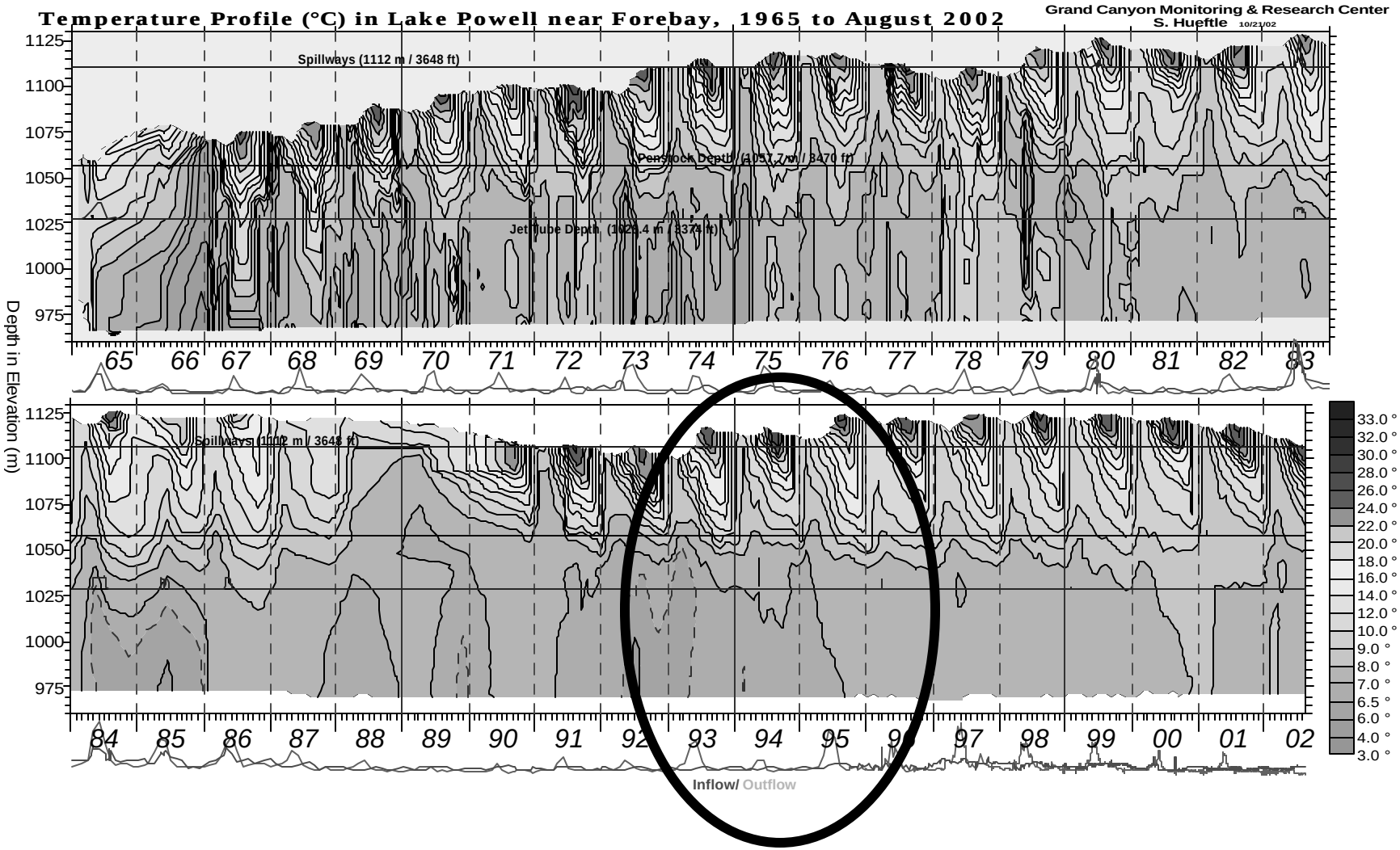
Temperature Profile (°C) in Lake Powell near Forebay, 1965 to August 2002

Grand Canyon Monitoring & Research Center

S. Hueftle



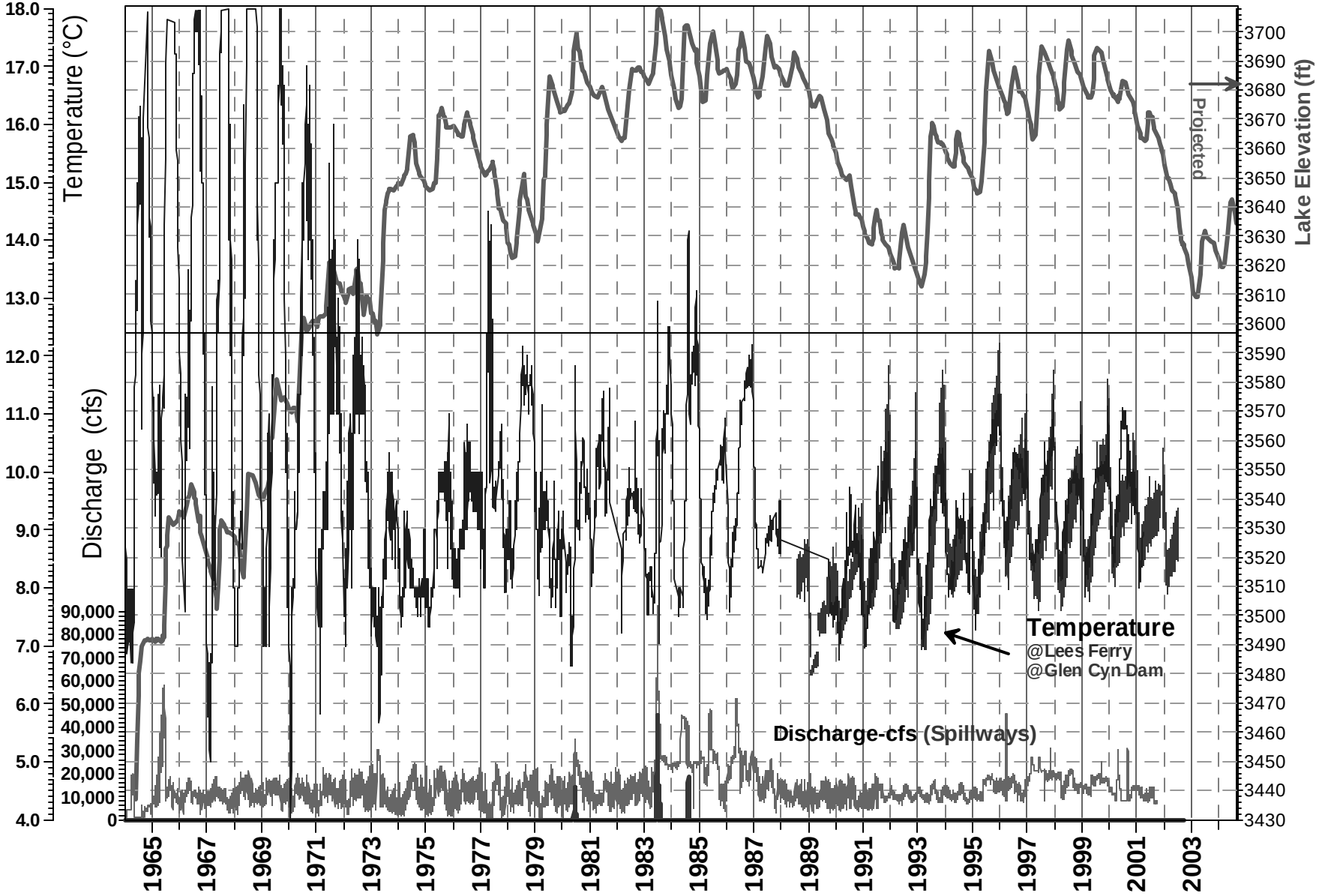
Lake Powell Thermal History



Note epilimnion thickness as related to inflow volume in 1993-1995

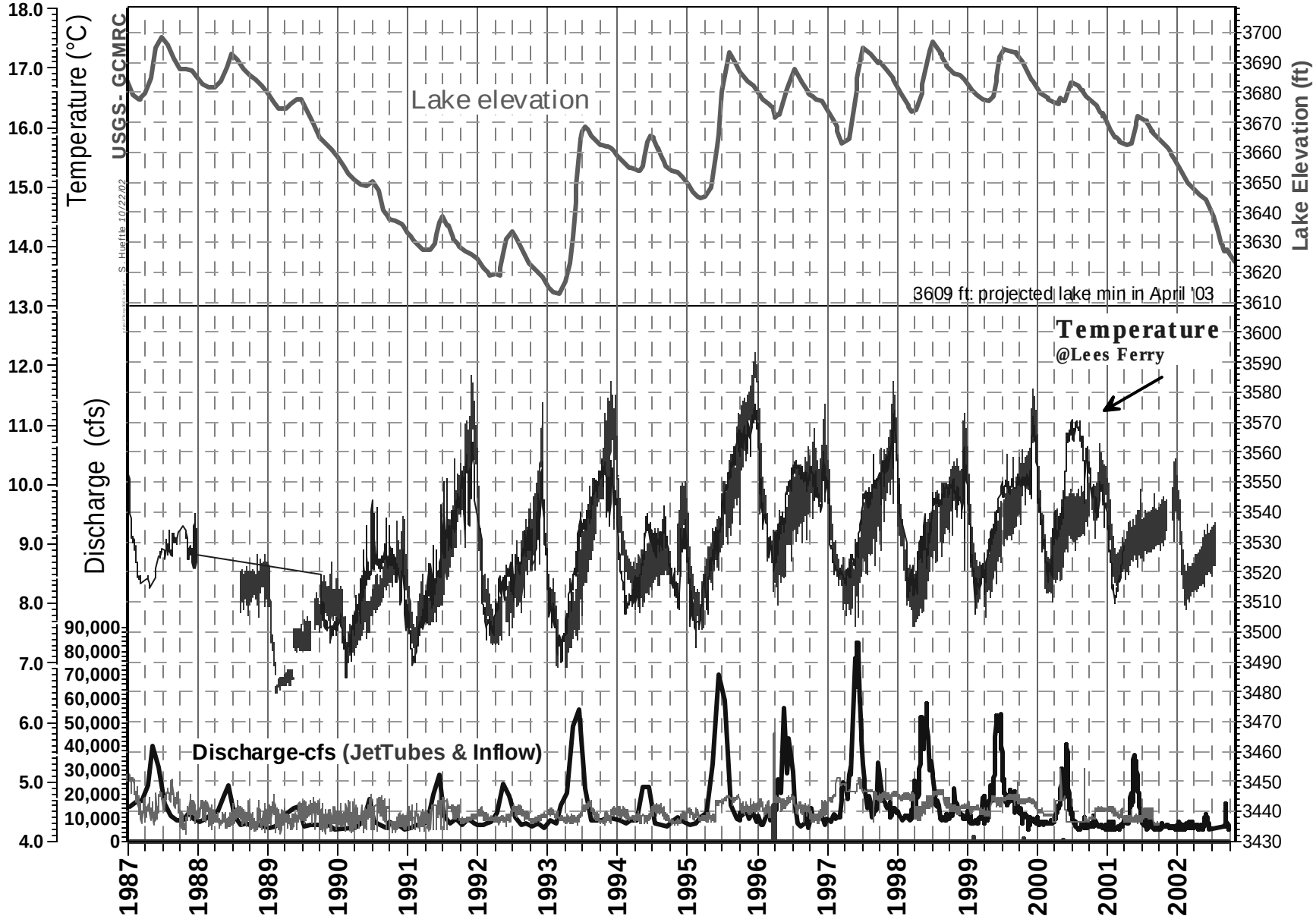
Effects of Lake Elevation And Dam Operations on Discharge Temperature

1964 to 2002, Project from 10/02 to 9/04 USGS- GCMRC S. Hueftle 10/22/02



Effects of Lake Elevation And Dam Operations on Discharge Temperature

Lees Ferry & Glen Cyn Dam: 1987 to 2002



Factors Affecting Possibility of Warm Water Release

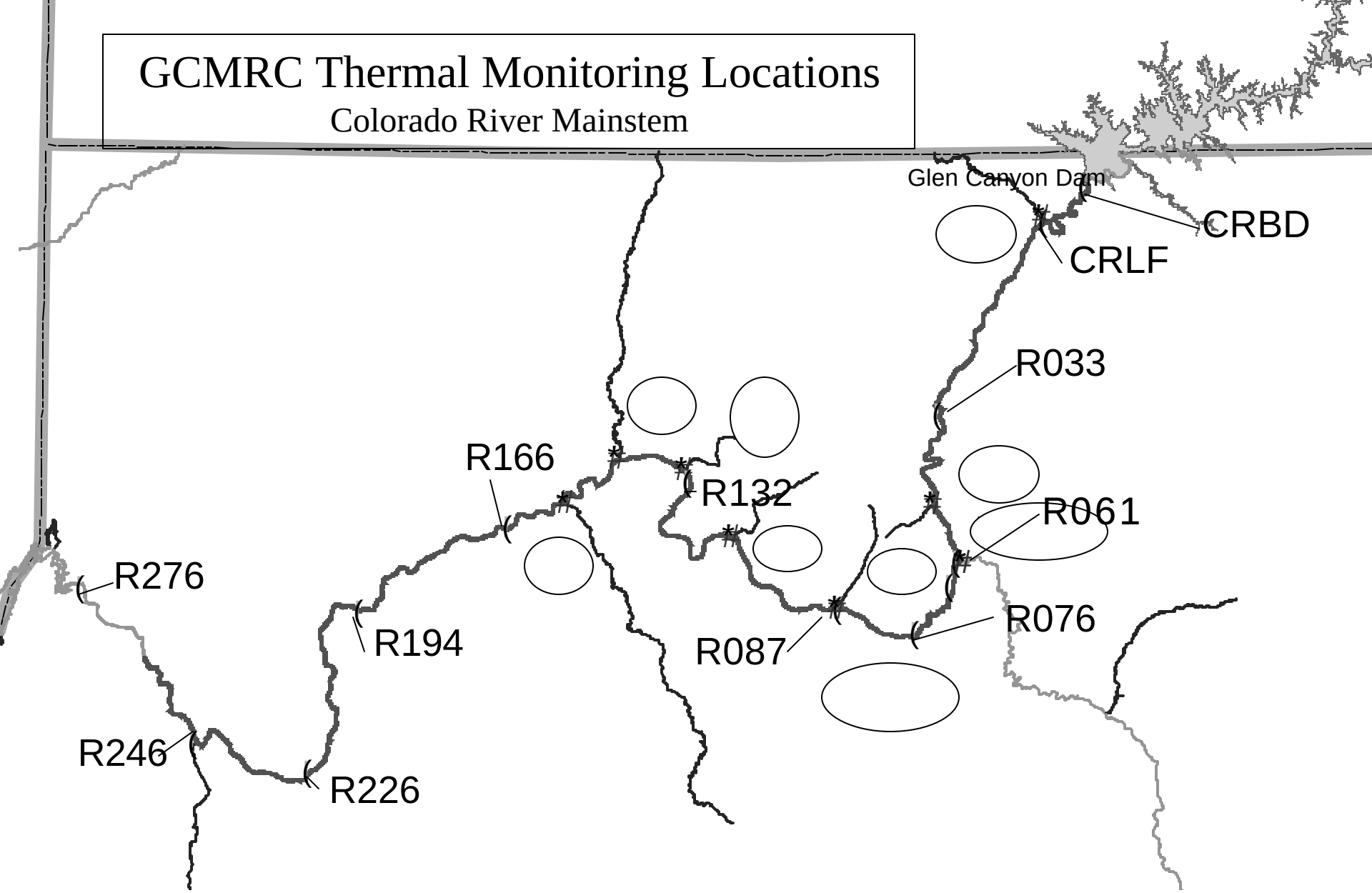
- Reservoir elevation
  - Proximity of thermocline to penstock depth
- Antecedent Hydrology
  - High runoff causes thick layer of warm water near dam (closer to penstocks)
- Timing
  - Maximum warming at depth occurs August-September

What are Chances of Warm Water Release in 2003?

- Probably LOW due to projected elevation and runoff
- Current projections:
  - 5.67 MAF runoff (moderate)
    - 12°C water expected at 35-40 meters
  - Reservoir elevation of 3629 ft by Sept. 2003
    - Penstock depth of ~47 meters
  - Higher runoff could warm to greater depths
    - But could raise thermocline away from penstocks
  - Lower runoff could bring thermocline lower
    - But would not allow as much warming at depth

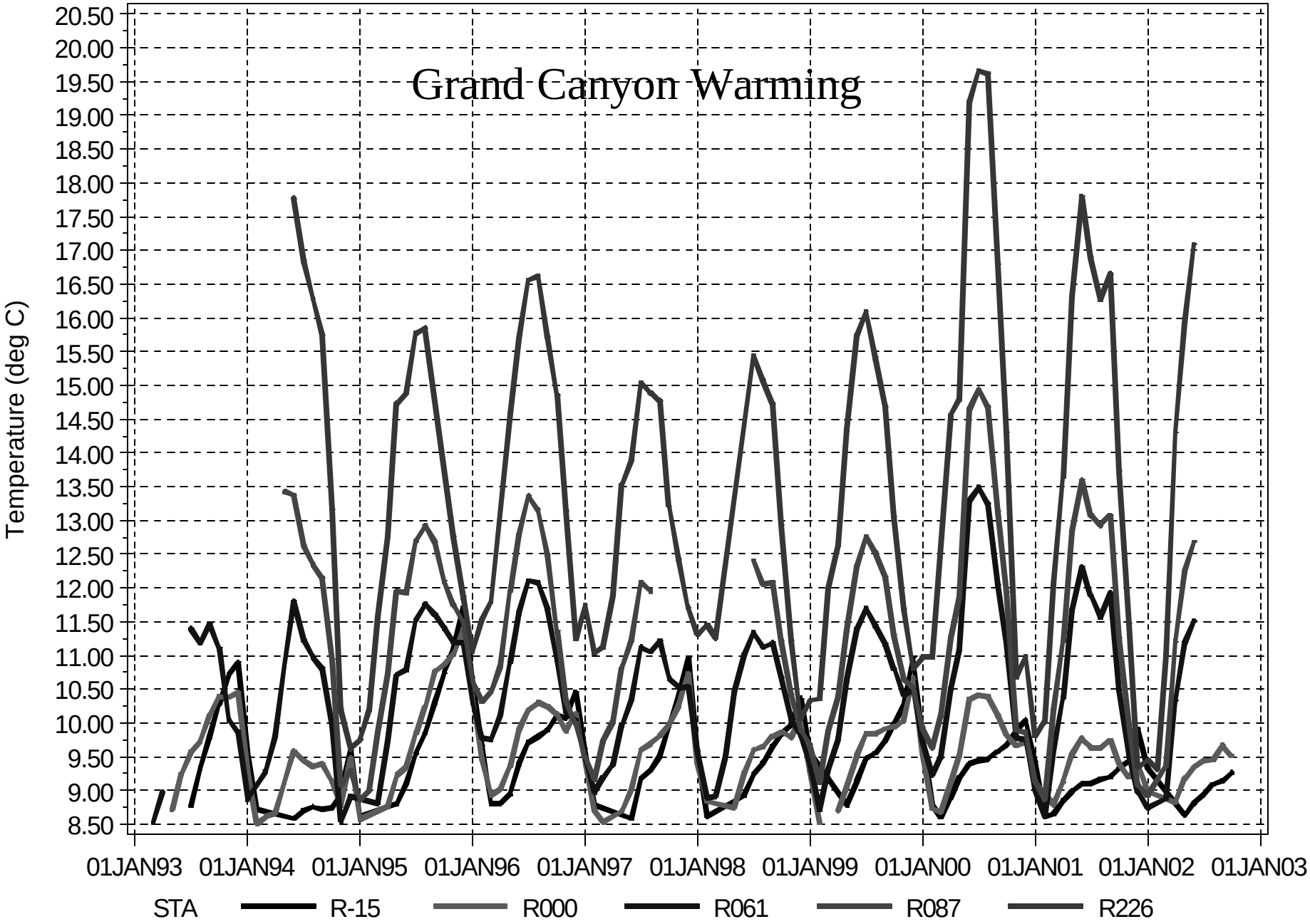
GCMRC Thermal Monitoring Locations

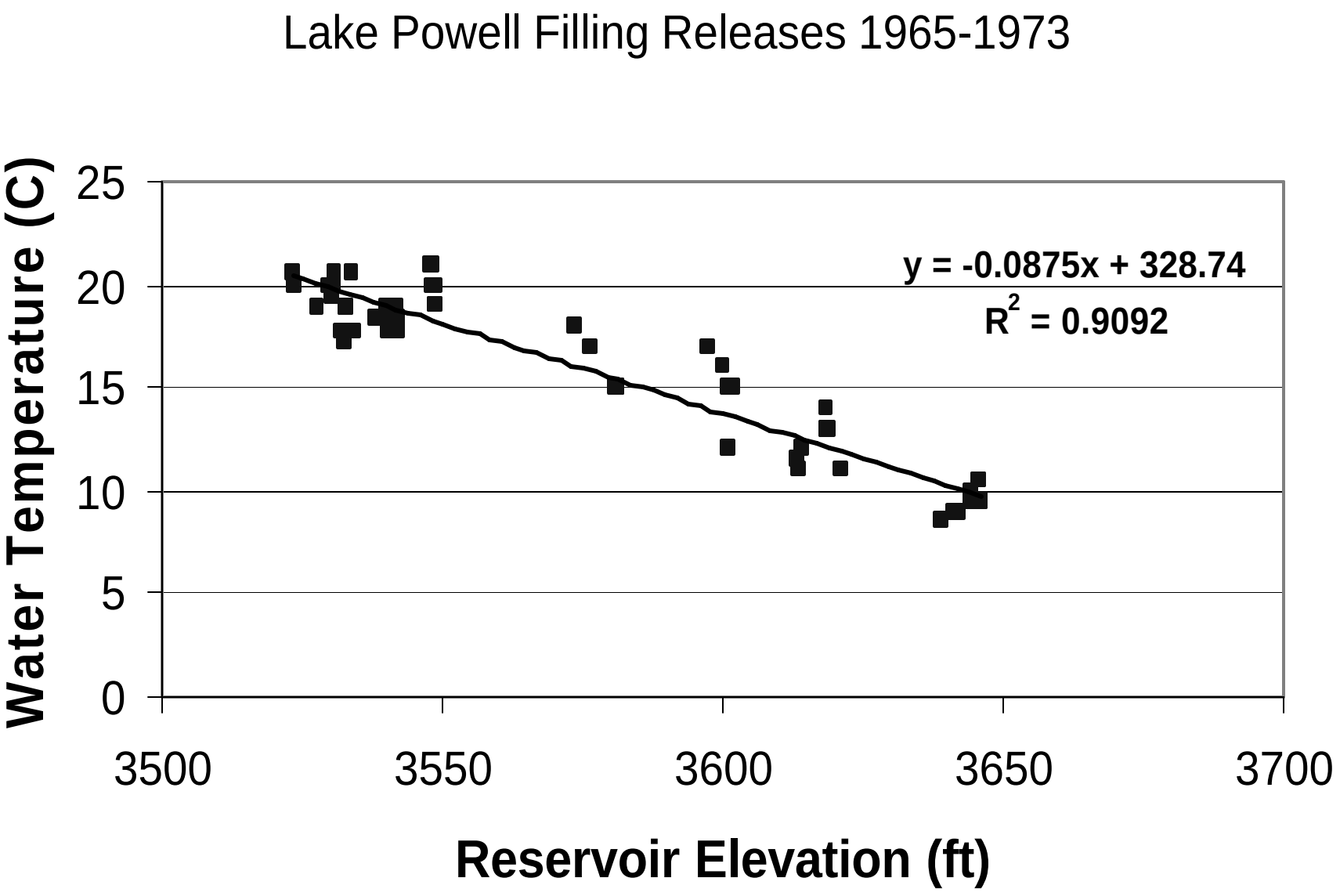
Colorado River Mainstem

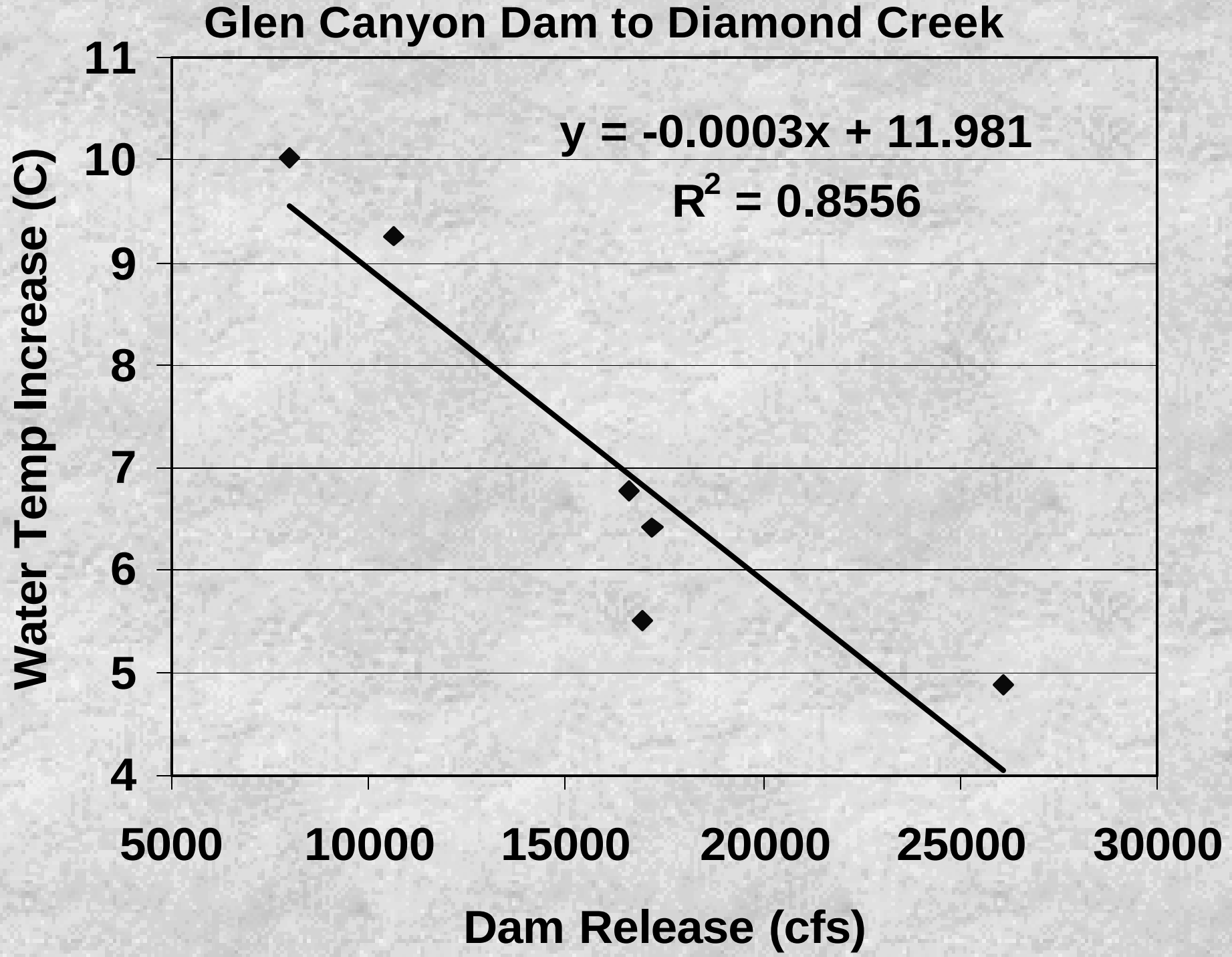


Grand Canyon Warming

(Selected Stations)

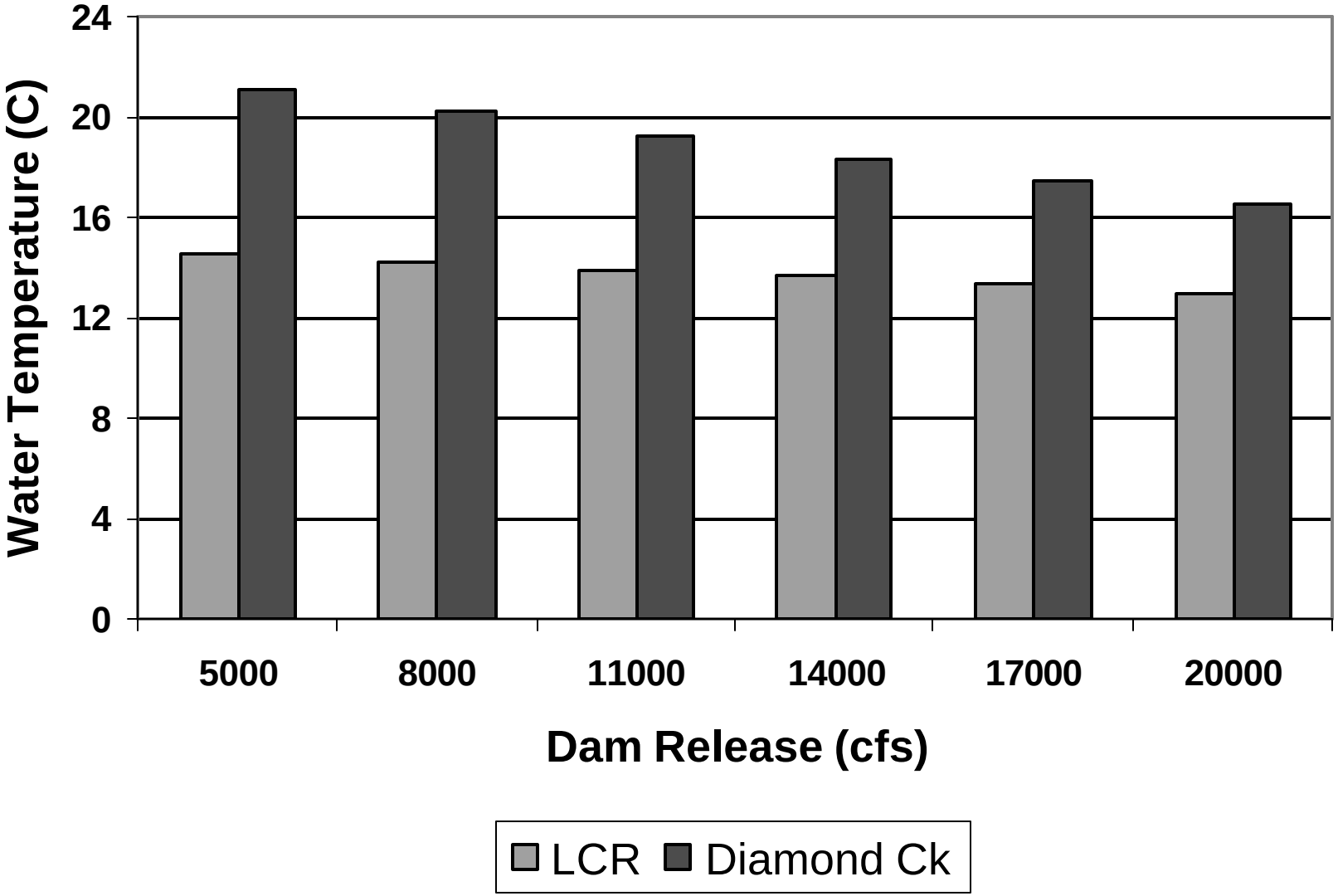


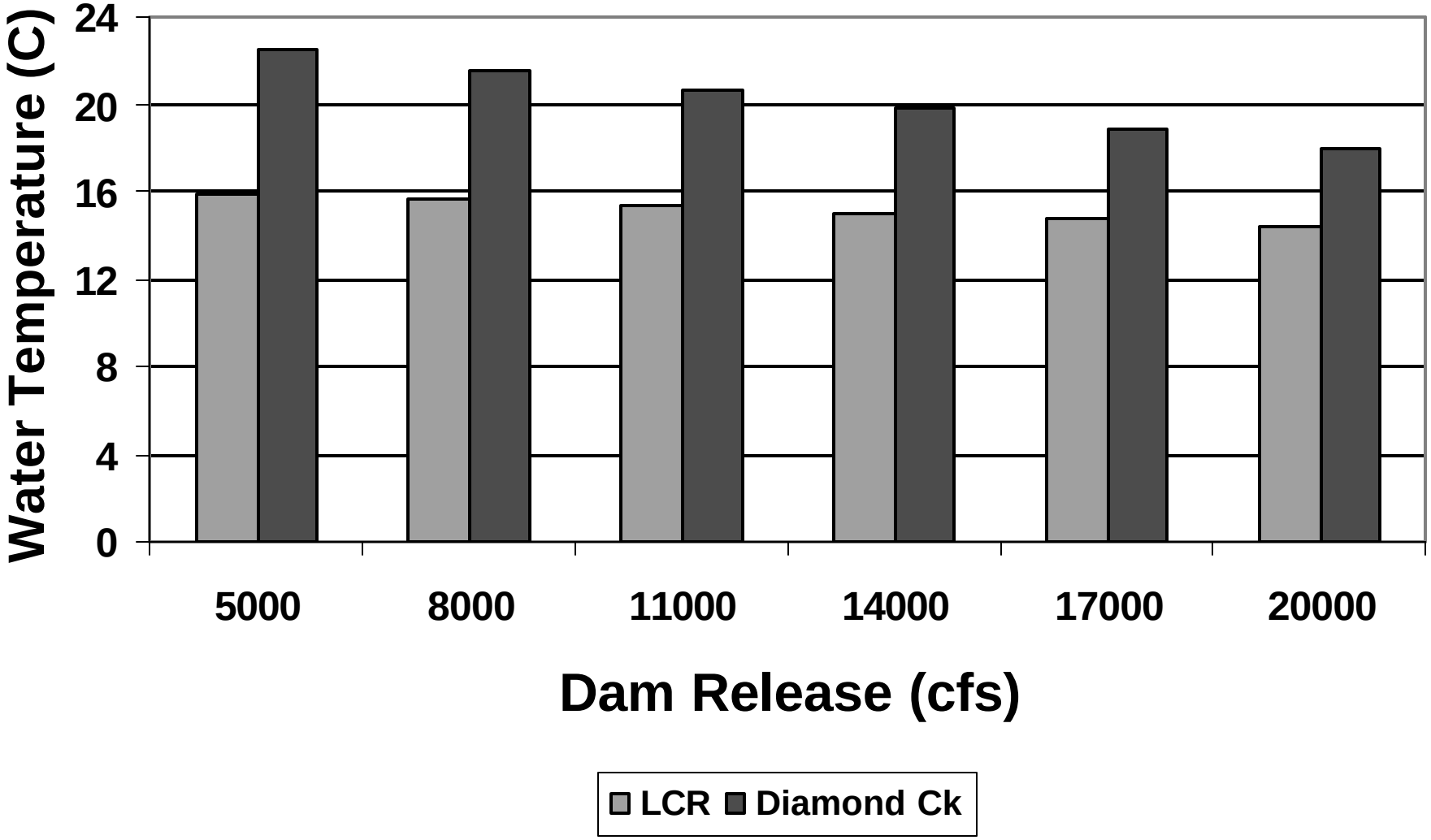

Lake Powell Filling Releases 1965-1973
Water Temperature (C)
25
20
15
10
5
0
3500
3550
3600
3650
3700
Reservoir Elevation (ft)
y = -0.0875x + 328.74
R2 = 0.9092


Glen Canyon Dam to Diamond Creek
y = -0.0003x + 11.981
R2 = 0.8556
Water Temp Increase (C)
11
10
9
8
7
6
5
4
5000
10000
15000
20000
25000
30000
Dam Release (cfs)

Predicted Water Temperatures June 2004

Reservoir Elevation 3636'



Predicted June Water Temperatures

Reservoir Elevation 3620'