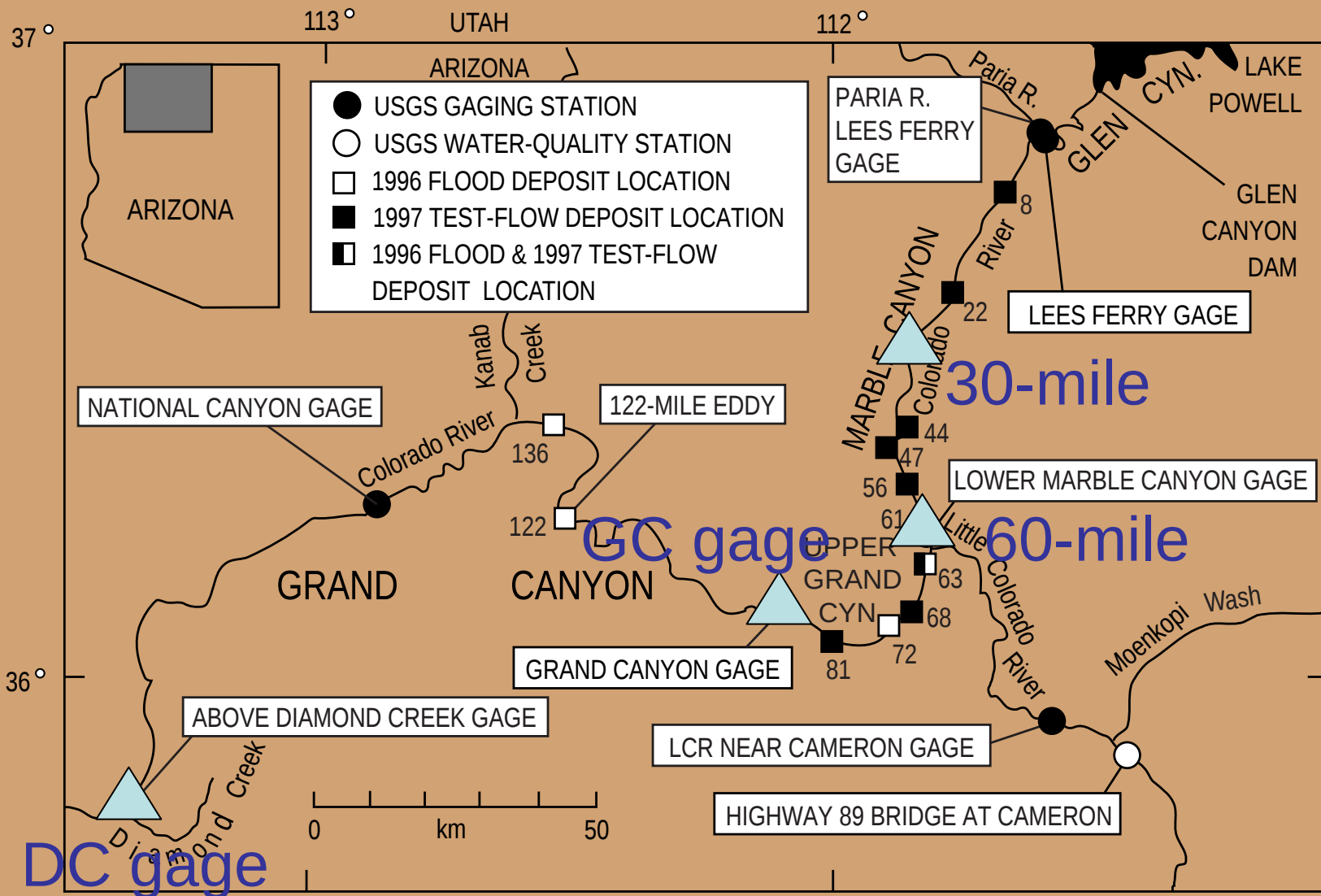


Sediment mass balance in Marble and upper Grand Canyons using laser and acoustic technologies

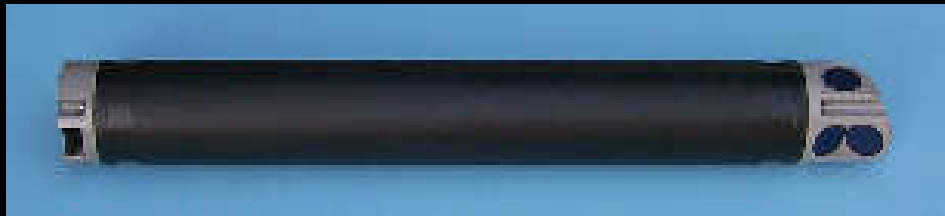
David J. Topping, Theodore S. Melis, and David M. Rubin





Equipment at each station

- Sequoia Scientific LISST-25X type C connected to ISCO pump sampler, sampler is triggered by the LISST when laser transmission drops below user-defined threshold and then samples at a user-defined rate
- Sequoia Scientific LISST-100 type C (at Grand Canyon gage only, to be installed also at 60-mile station)
- Nortek EZQ acoustic-doppler current meter connected to 2 OBS sensors





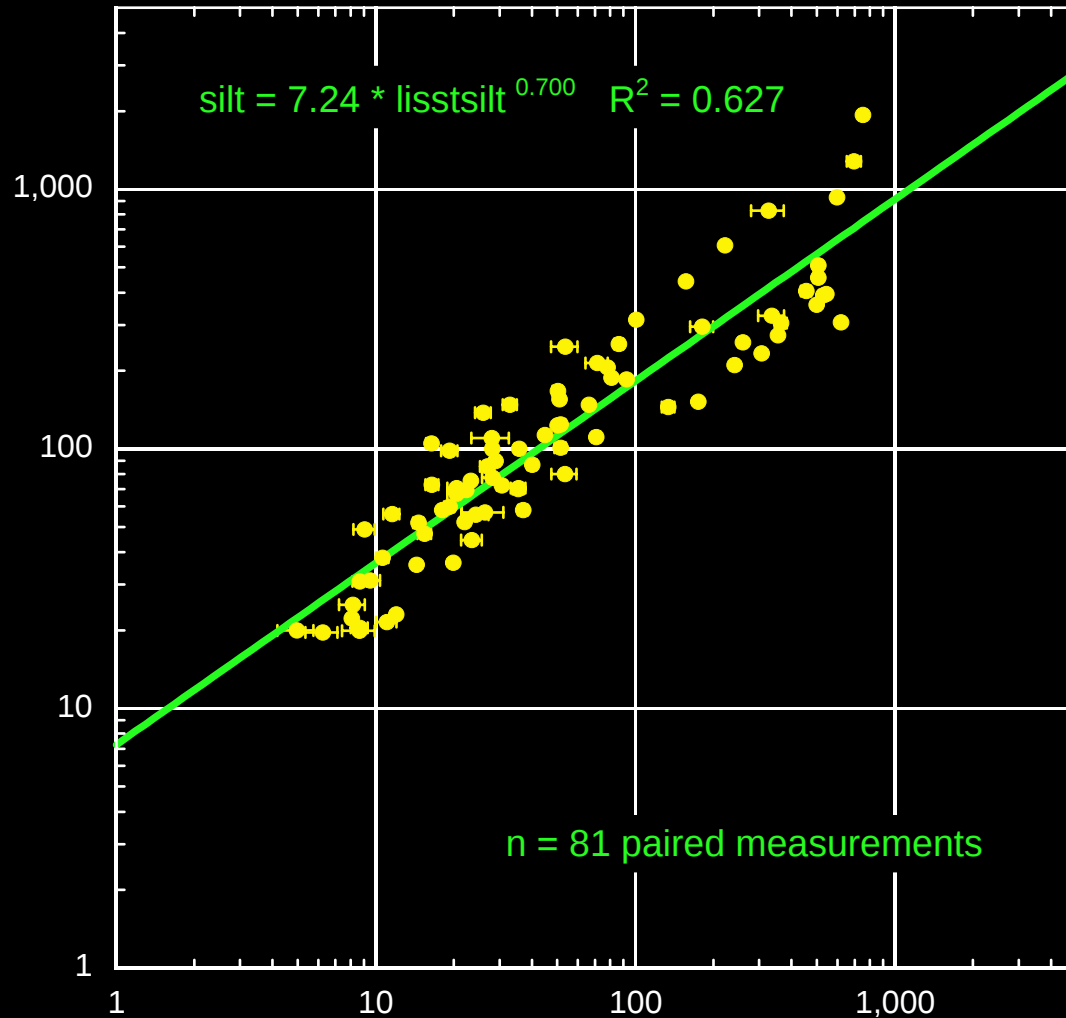
Sequoia Scientific

LISST 100 and LISST 25X

- swimming on clothesline
- path length = 1 cm
- LISST 100 averages over 100 samples collected over 30 seconds out of every 15 minutes; output is concentration of sediment in 32 log-spaced size classes from 2.5 to 500 microns
- LISST 25X averages over 1000 samples collected over 1 minute 50 seconds out of every 15 minutes; output is concentration of total sediment, concentration of sand, and mean size of total sediment and sand

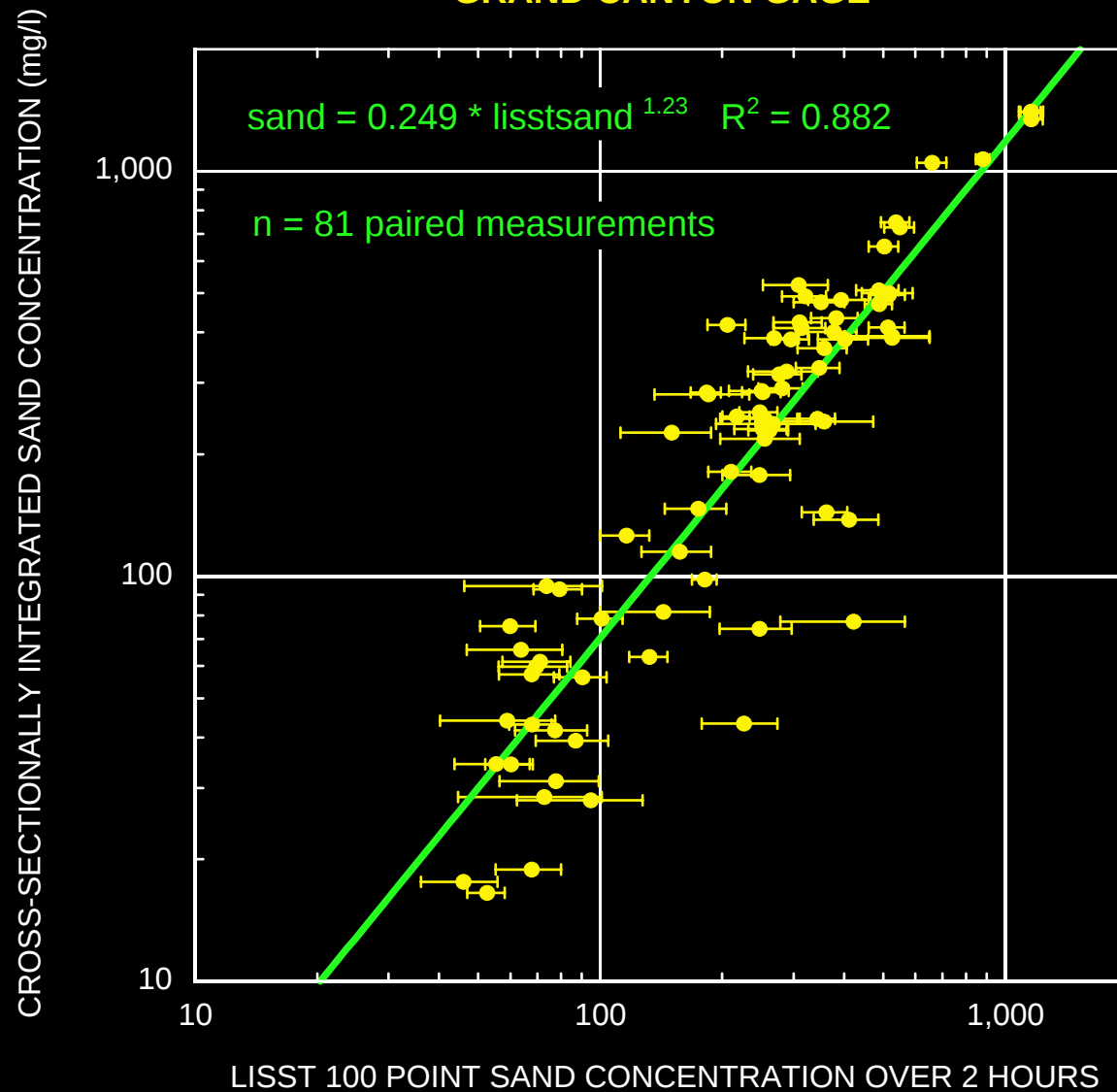
CROSS-SECTIONALLY INTEGRATED SILT&CLAY CONCENTRATION (mg/l)

GRAND CANYON GAGE

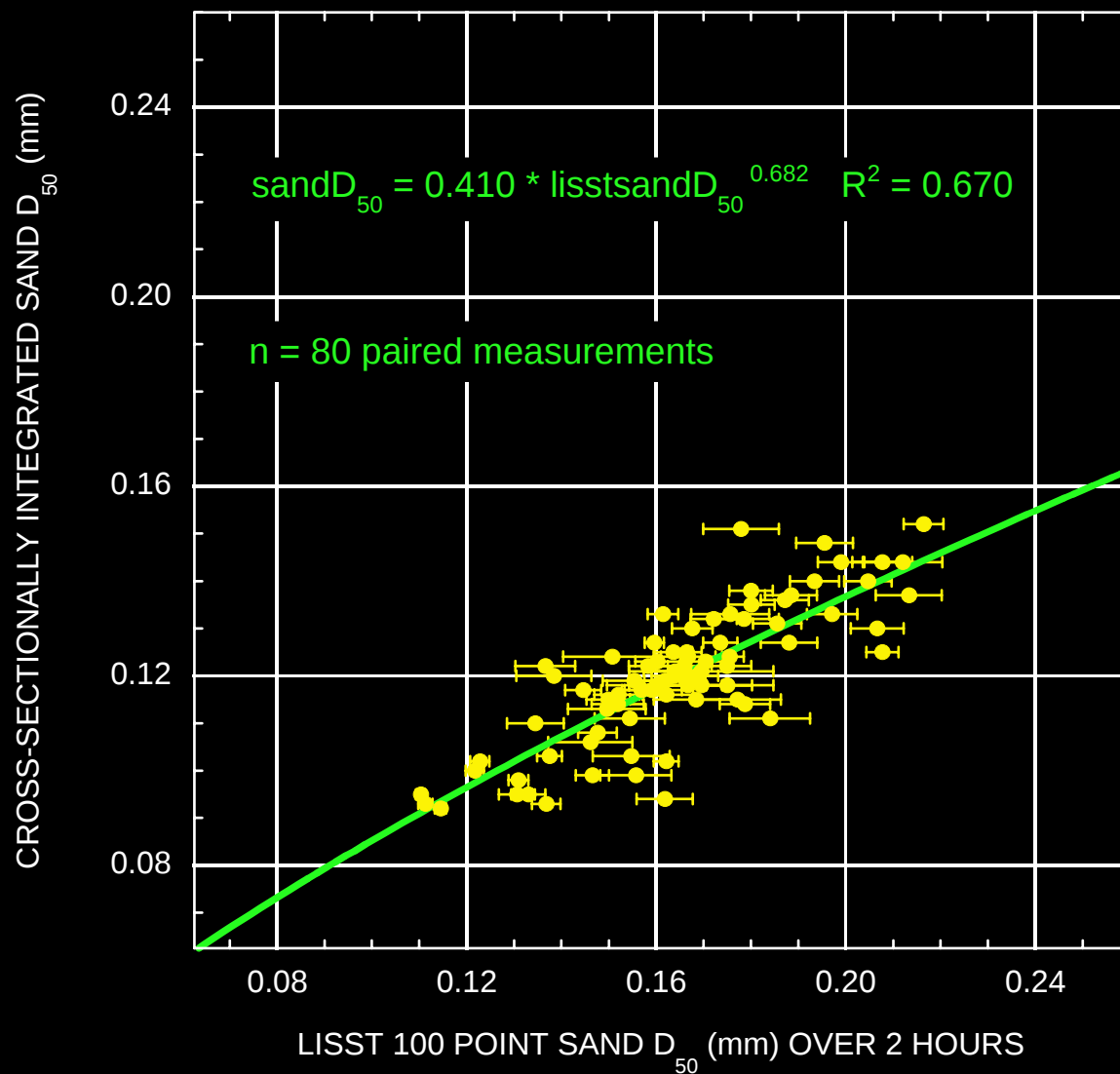


LISST 100 POINT SILT&CLAY CONCENTRATION OVER 2 HOURS

GRAND CANYON GAGE



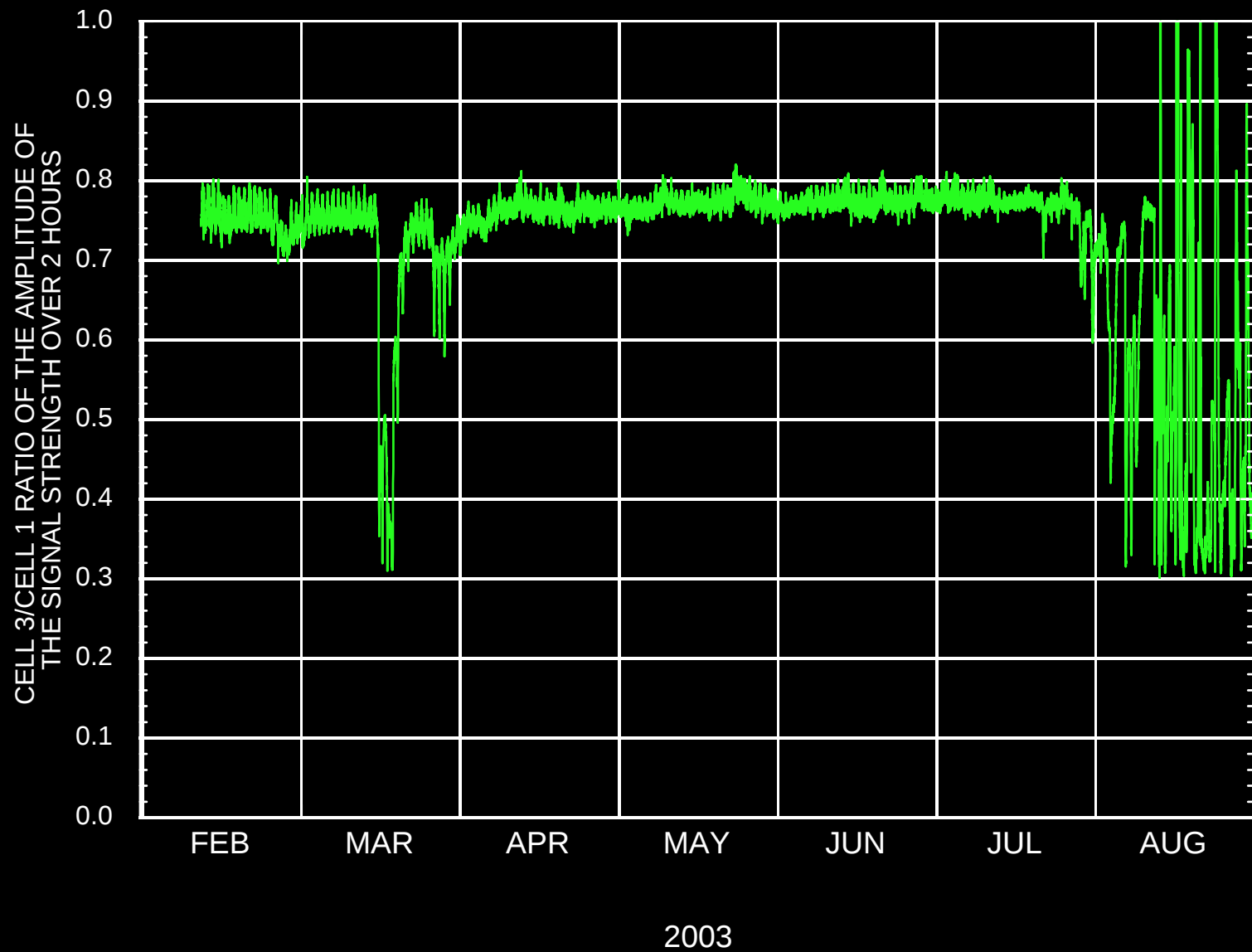
GRAND CANYON GAGE



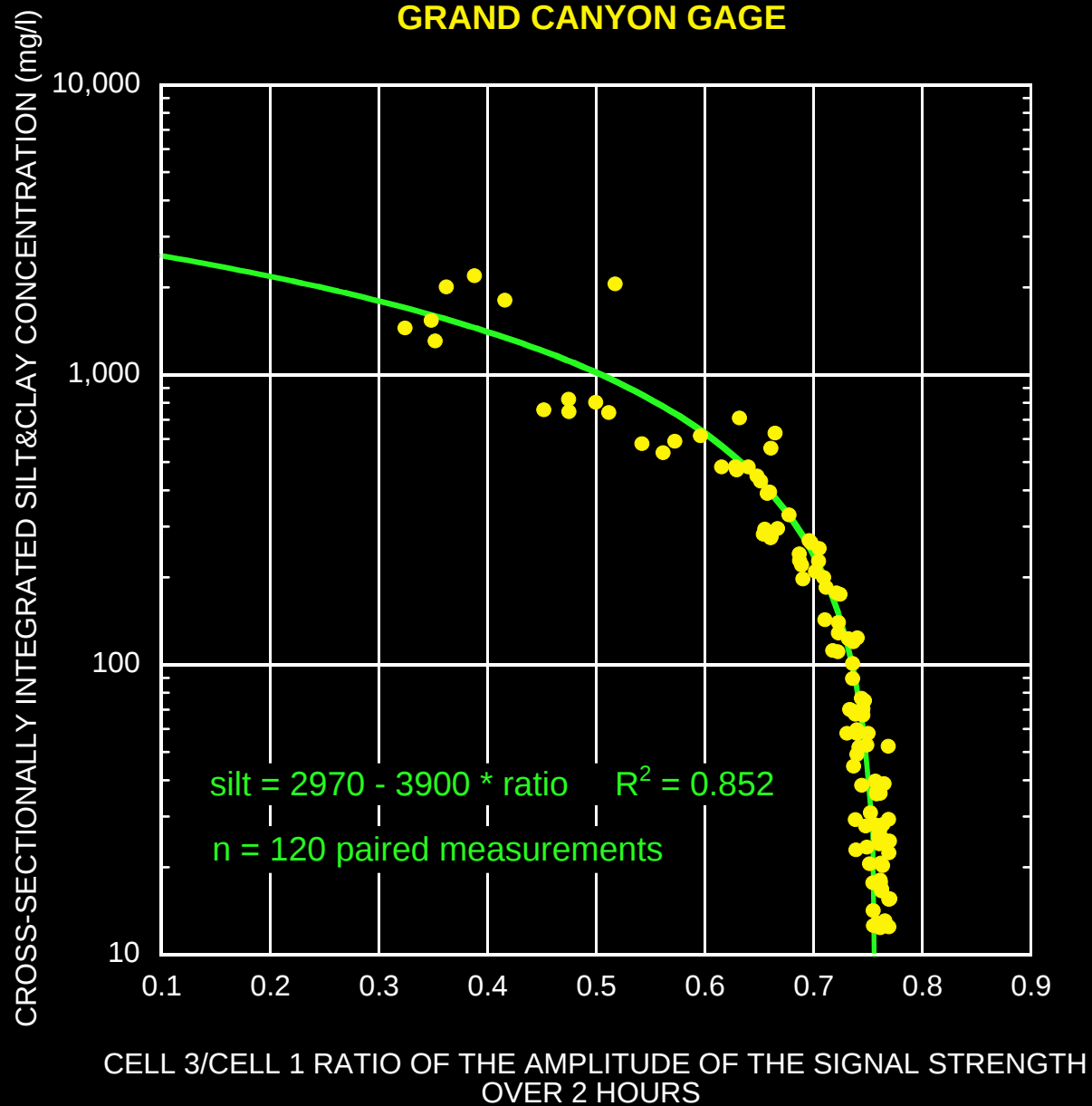
Nortek EZQ acoustic-doppler current meter and stage sensor

- rigid-mounted subaqueously on vertical wall
- blanking distance 8 m
- 3 10-meter-long cells, 50% overlap between cells
- frequency = 1 MHz
- beam width = 3.4 degrees
- EZQ samples 78,000 times and averages over 13 minutes out of every 15 minutes

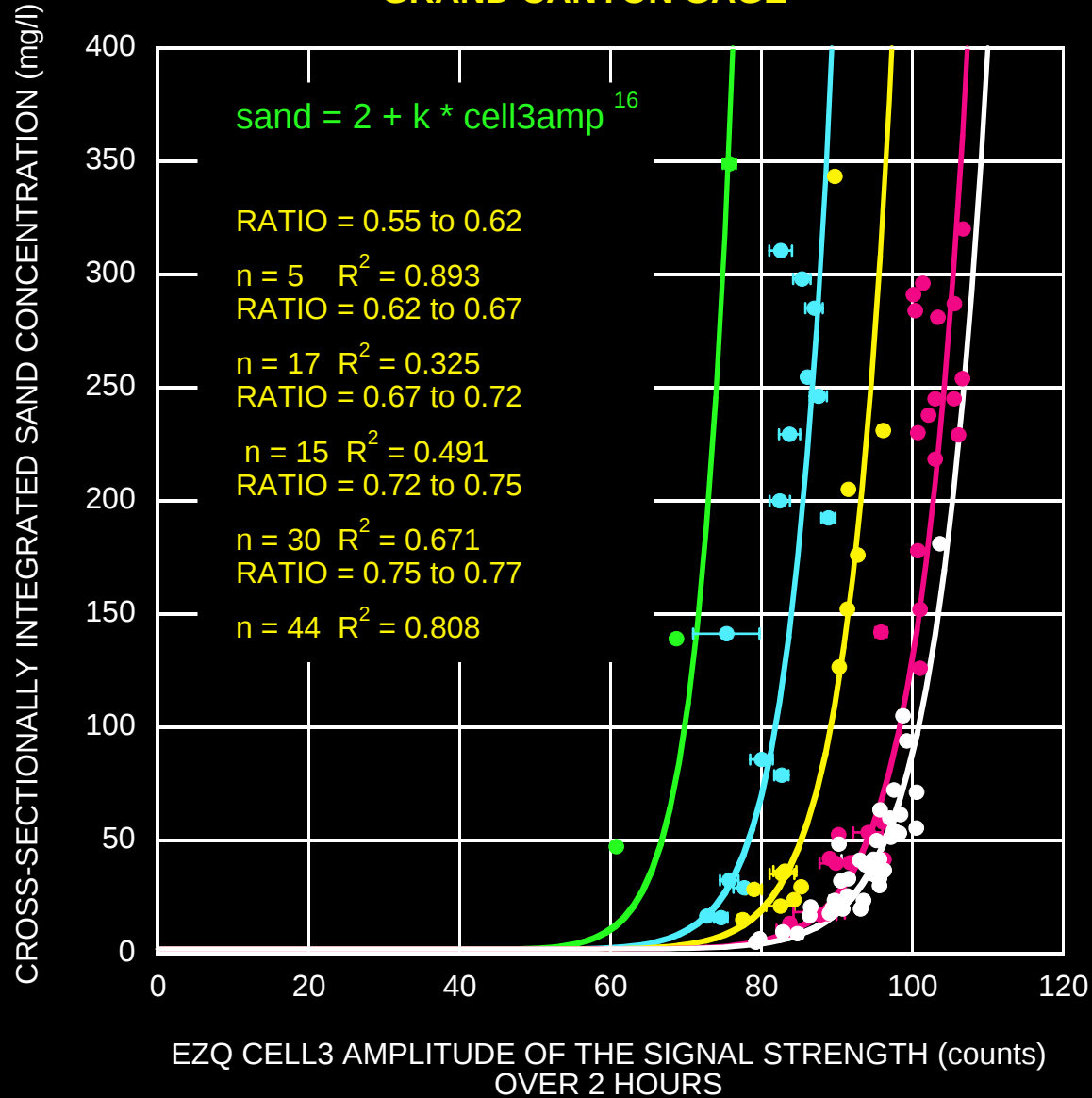
GRAND CANYON GAGE



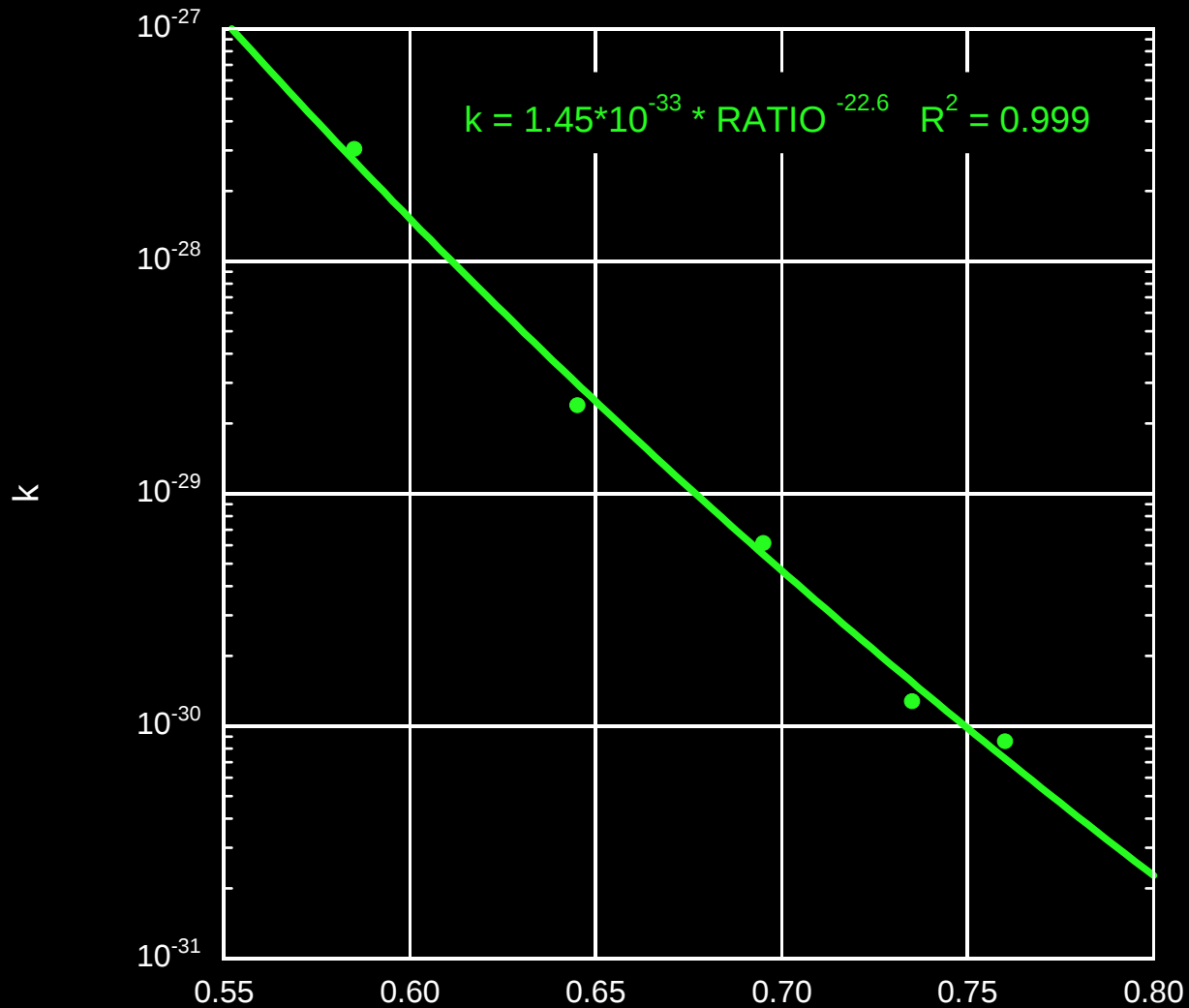
GRAND CANYON GAGE



GRAND CANYON GAGE

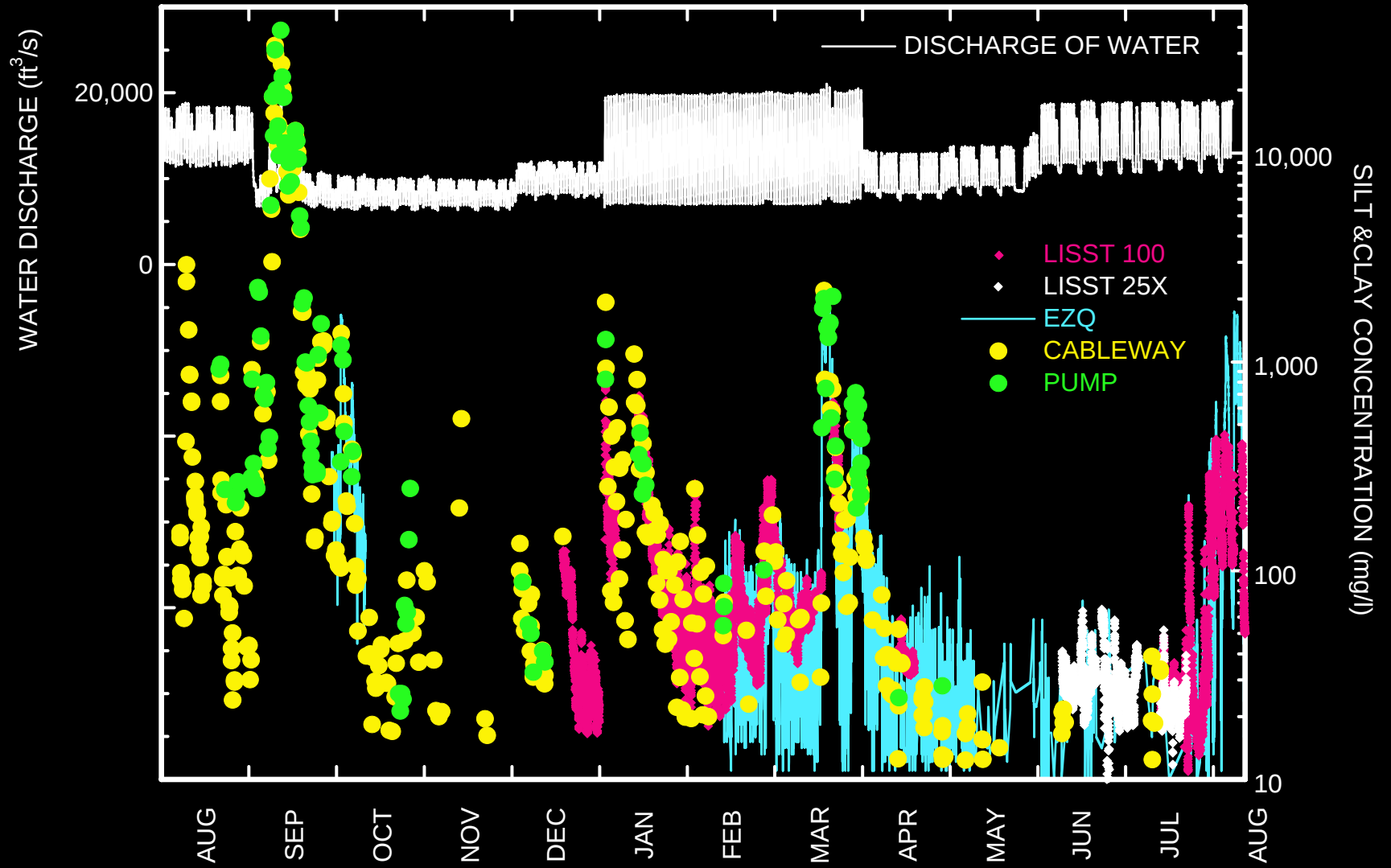


GRAND CANYON GAGE

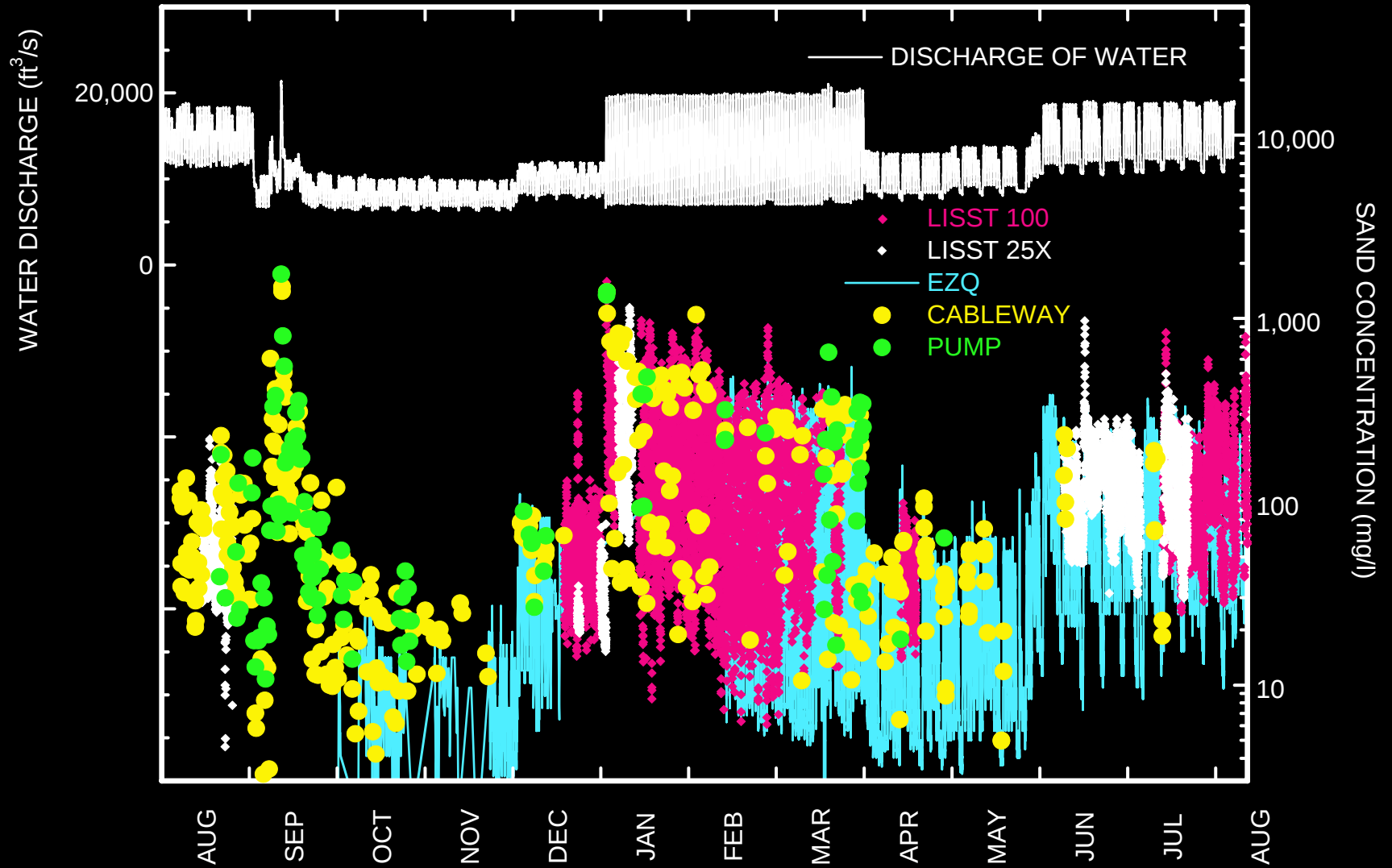


CELL 3/CELL 1 RATIO OF THE AMPLITUDE OF THE SIGNAL STRENGTH
OVER 2 HOURS

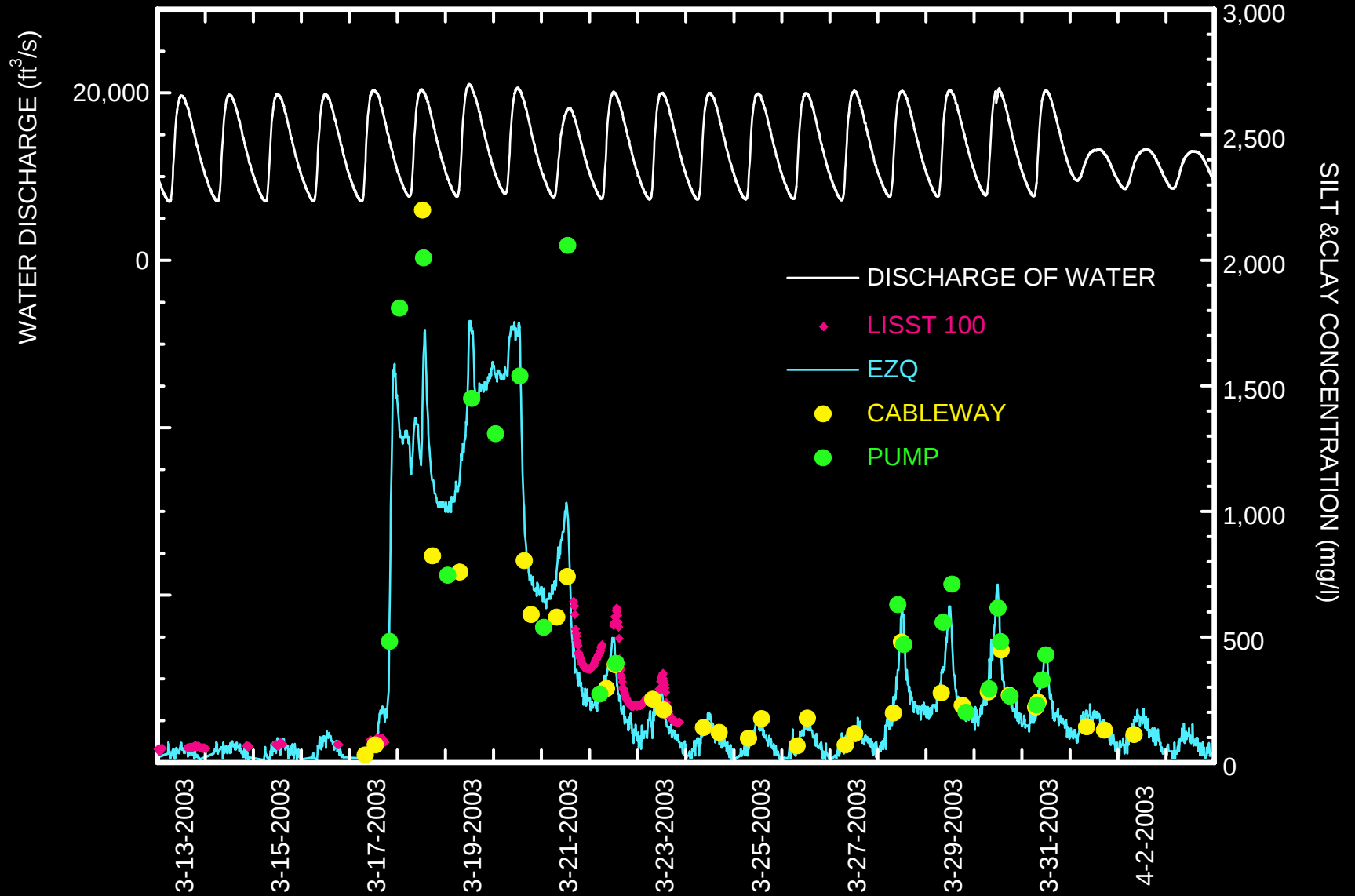
GRAND CANYON GAGE



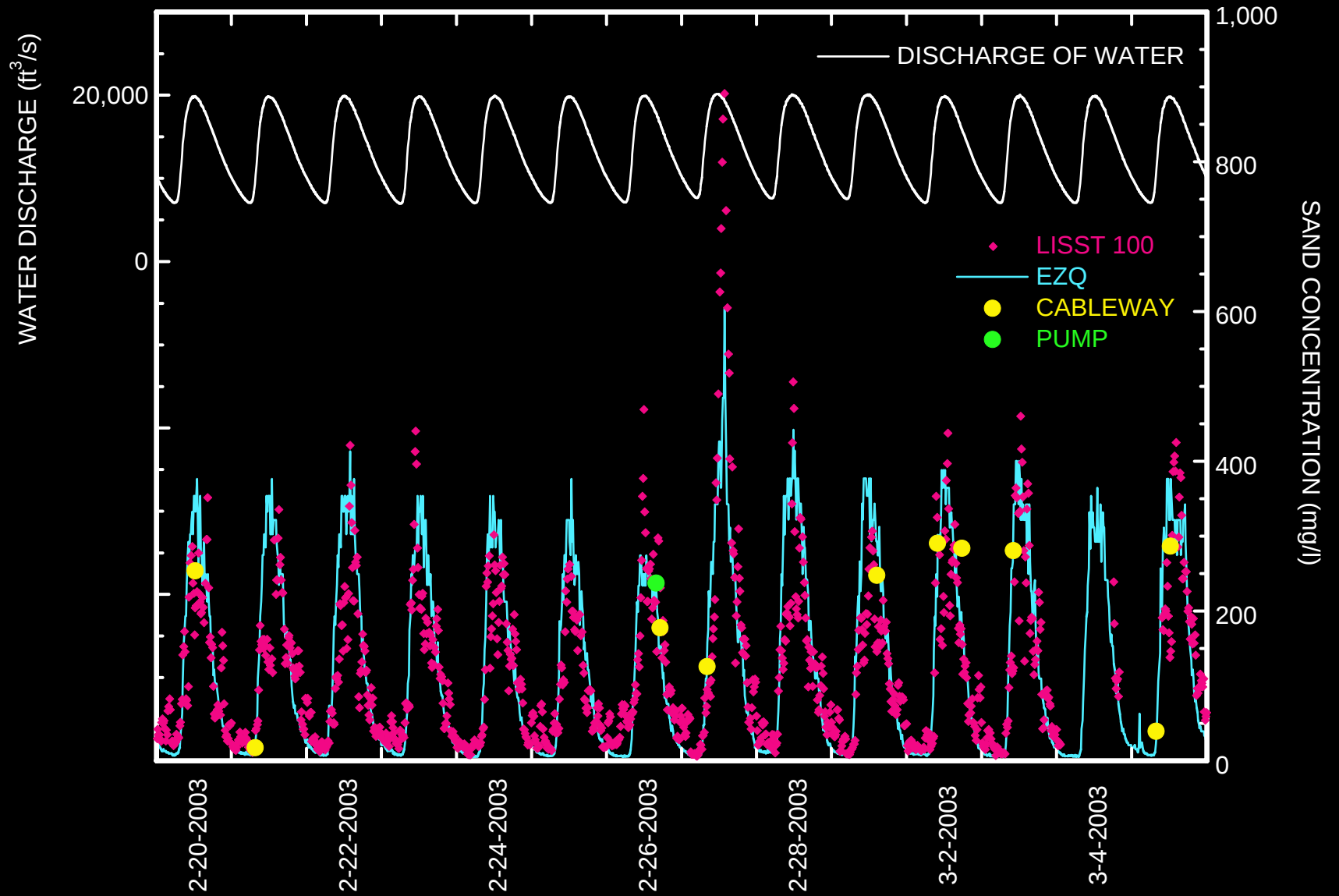
GRAND CANYON GAGE



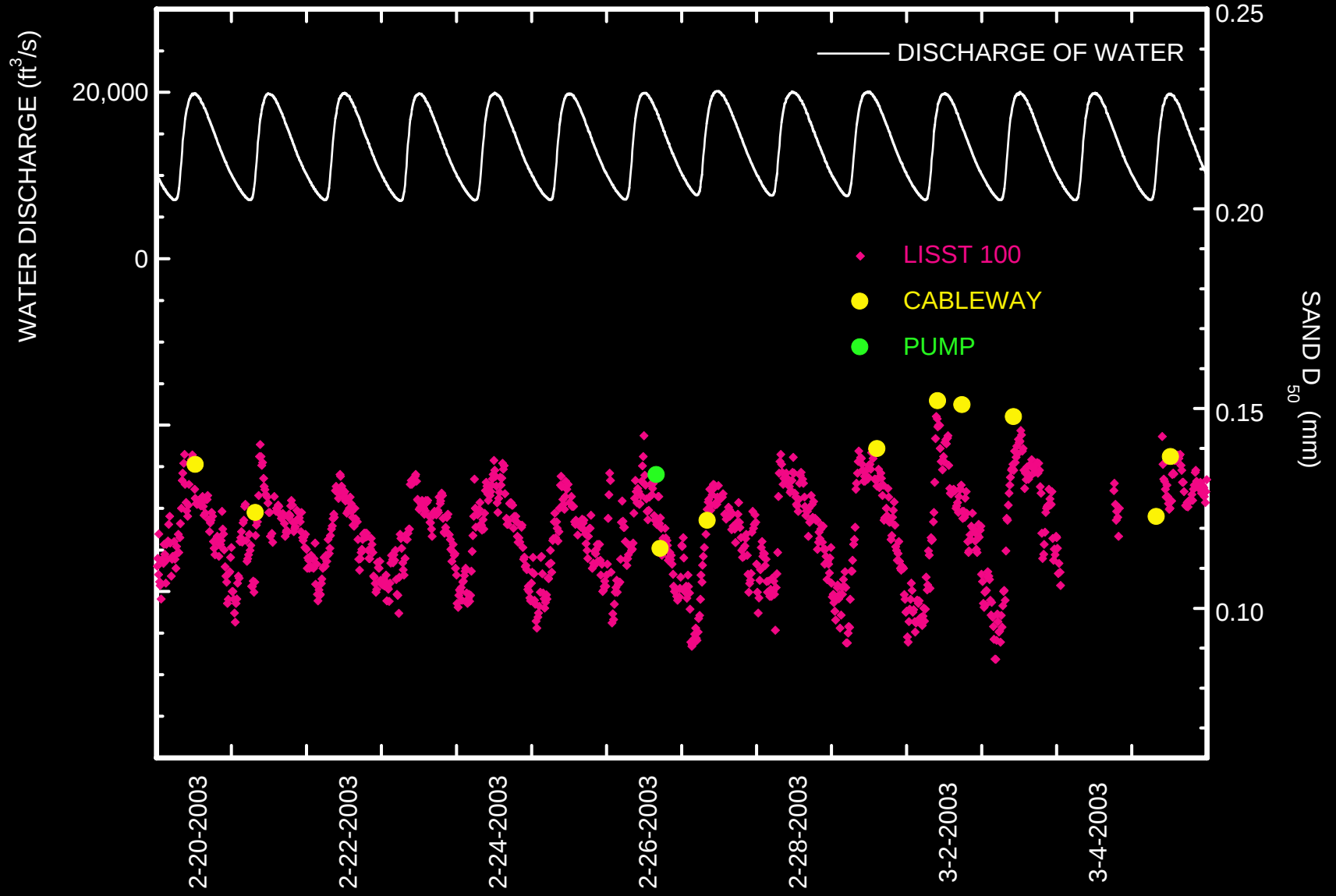
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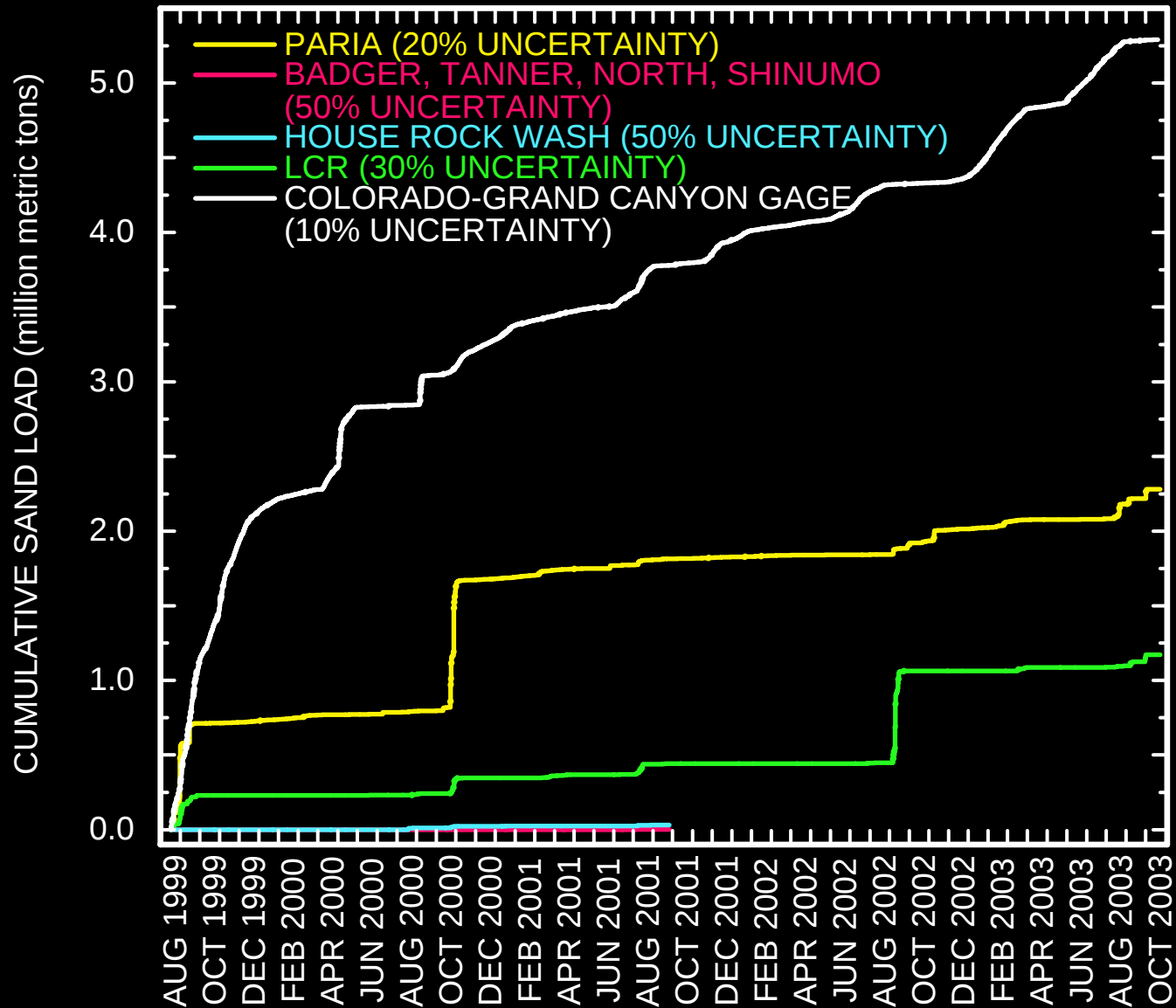
GRAND CANYON GAGE



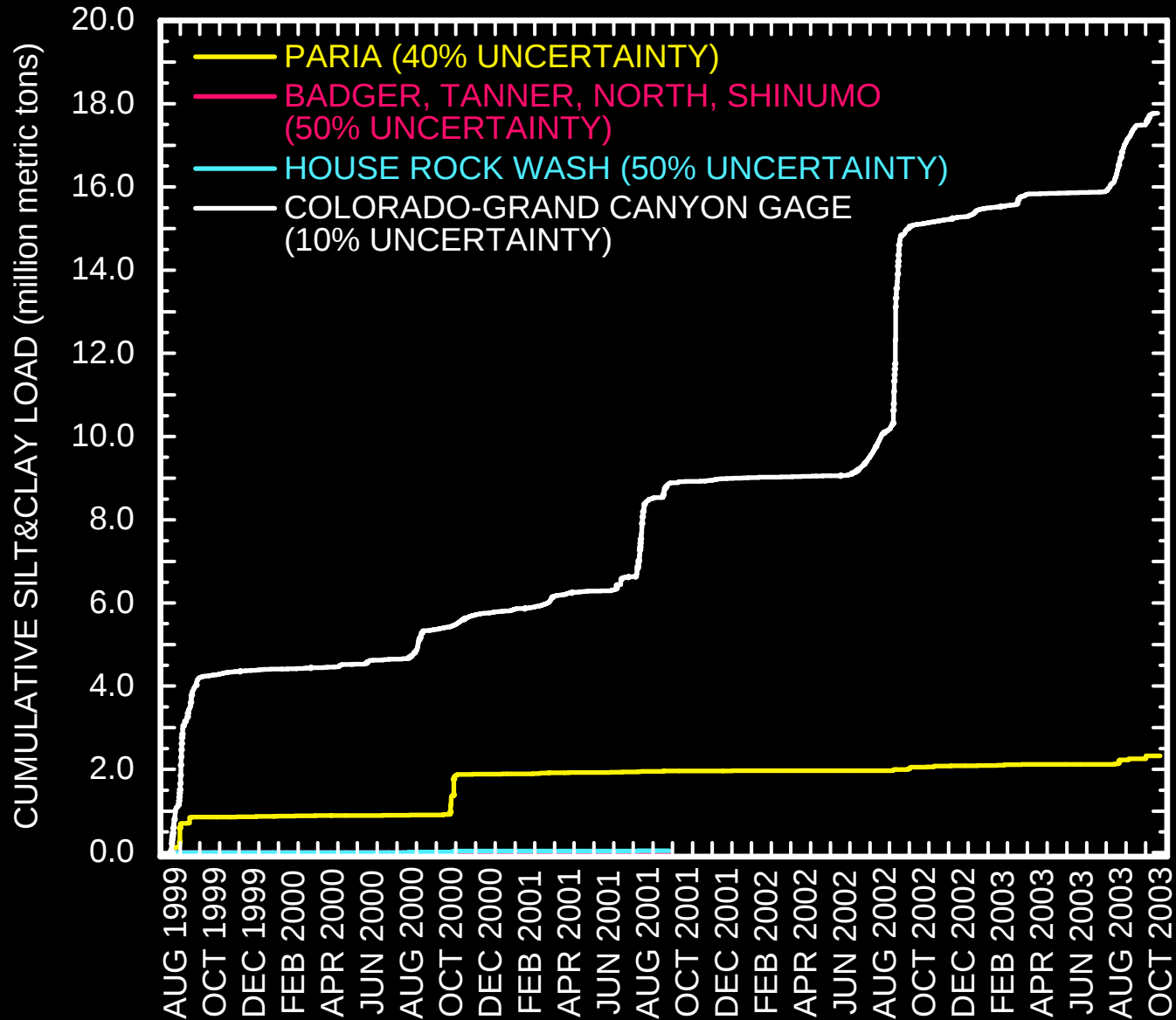
GRAND CANYON GAGE



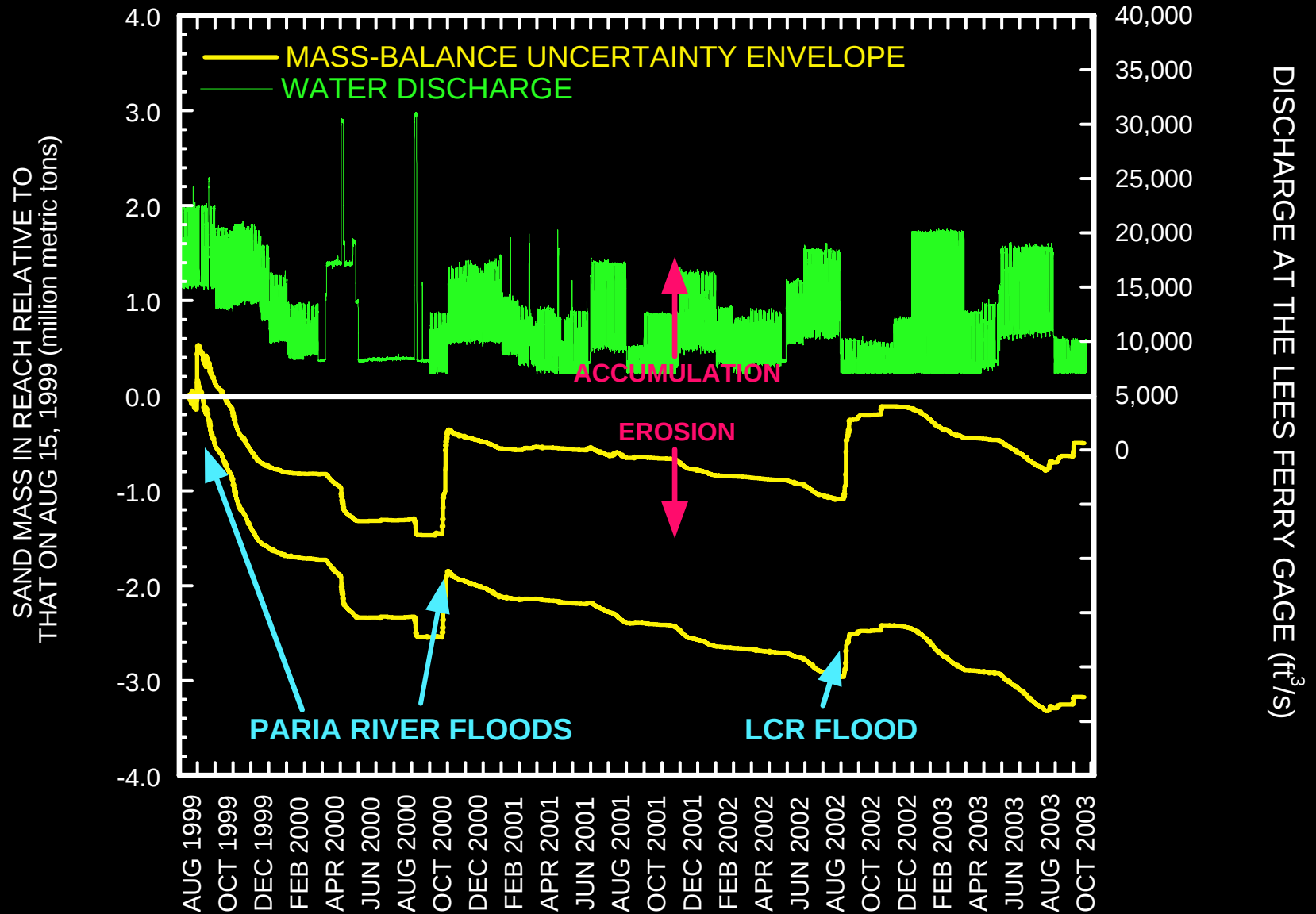
SAND SUPPLY TO AND EXPORT FROM THE REACH BETWEEN THE LEES FERRY AND GRAND CANYON GAGES

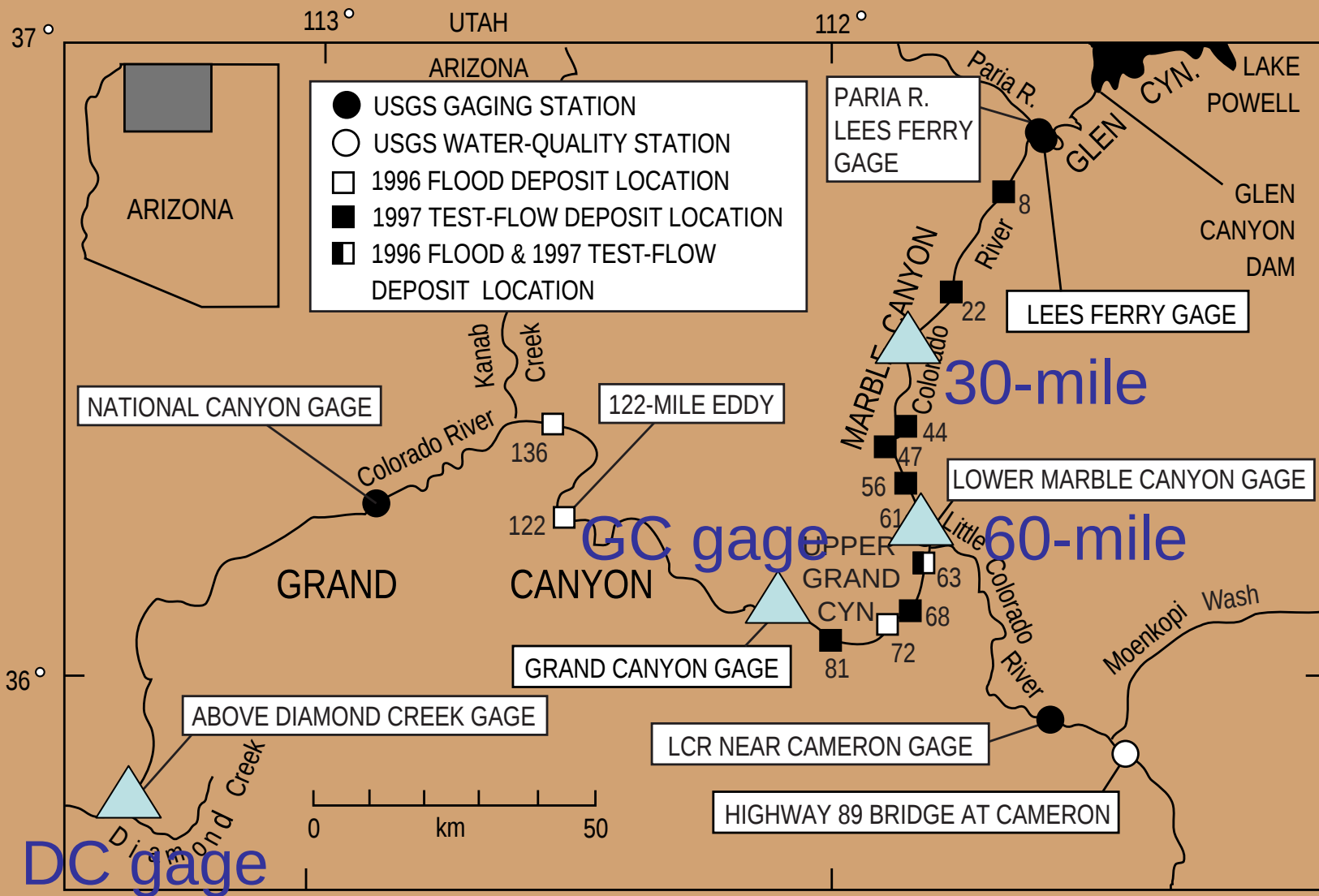


SILT & CLAY SUPPLY TO AND EXPORT FROM THE REACH BETWEEN THE LEES FERRY AND GRAND CANYON GAGES

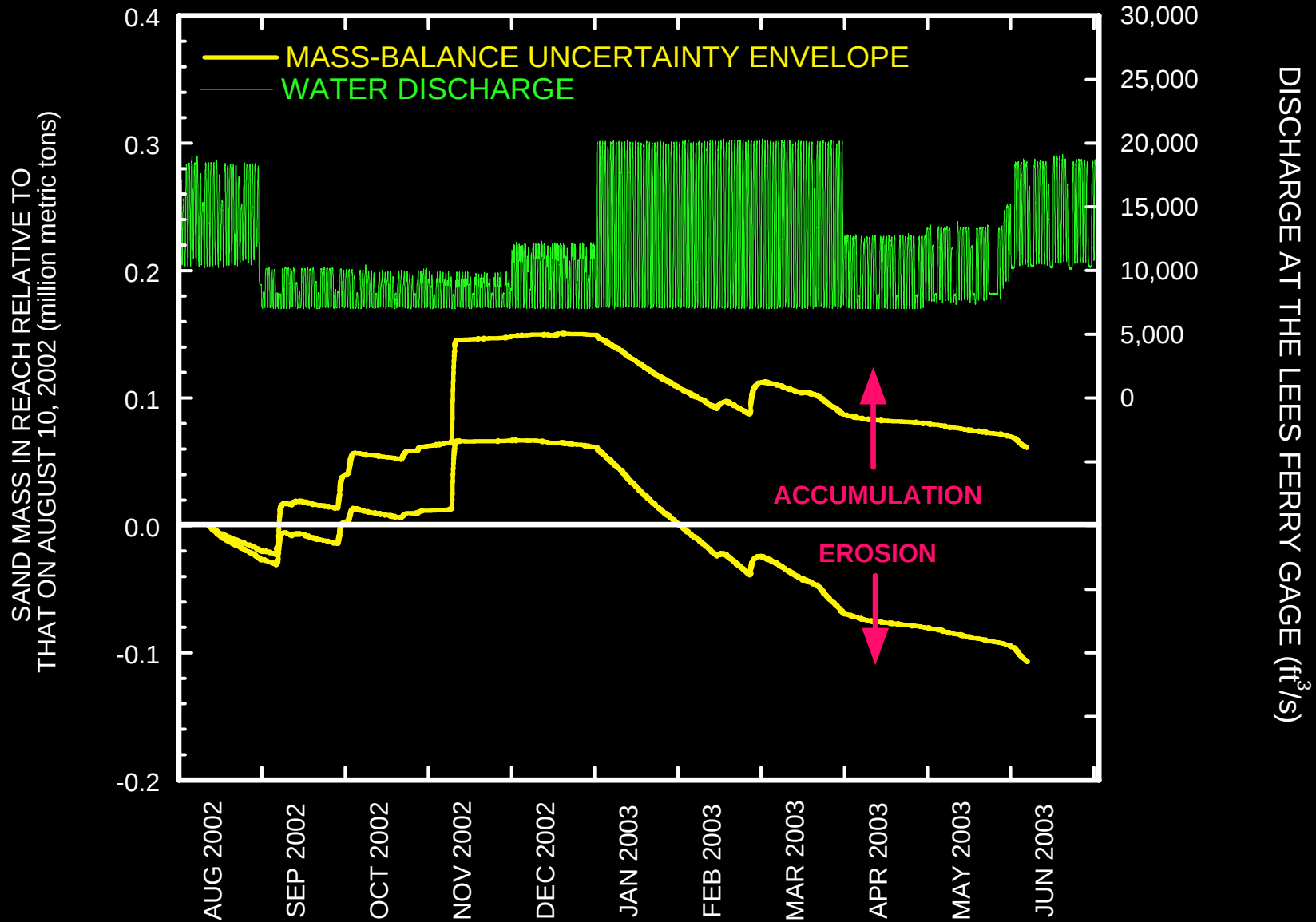


MASS-BALANCE SAND BUDGET BETWEEN LEES FERRY AND THE GRAND CANYON GAGE

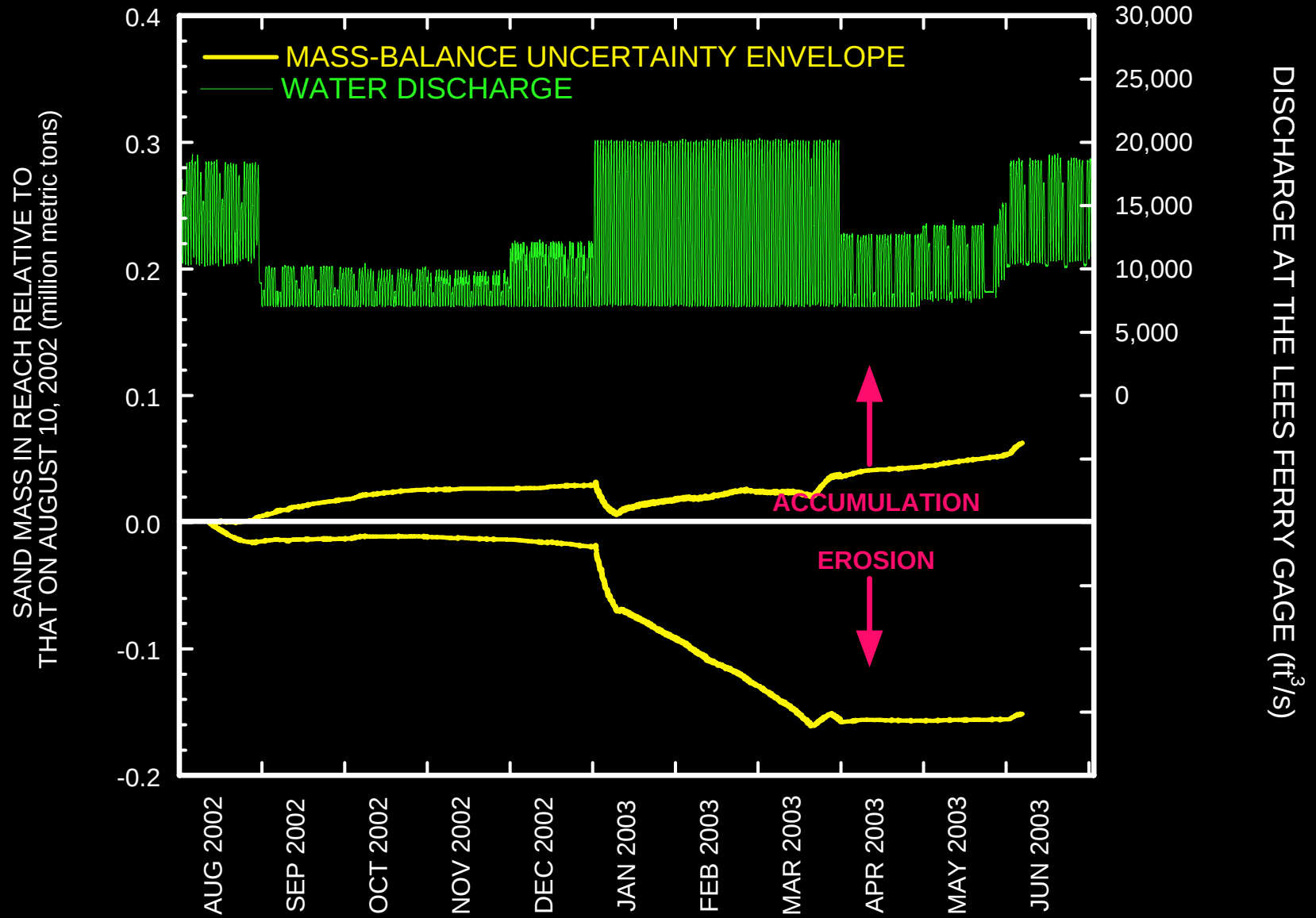




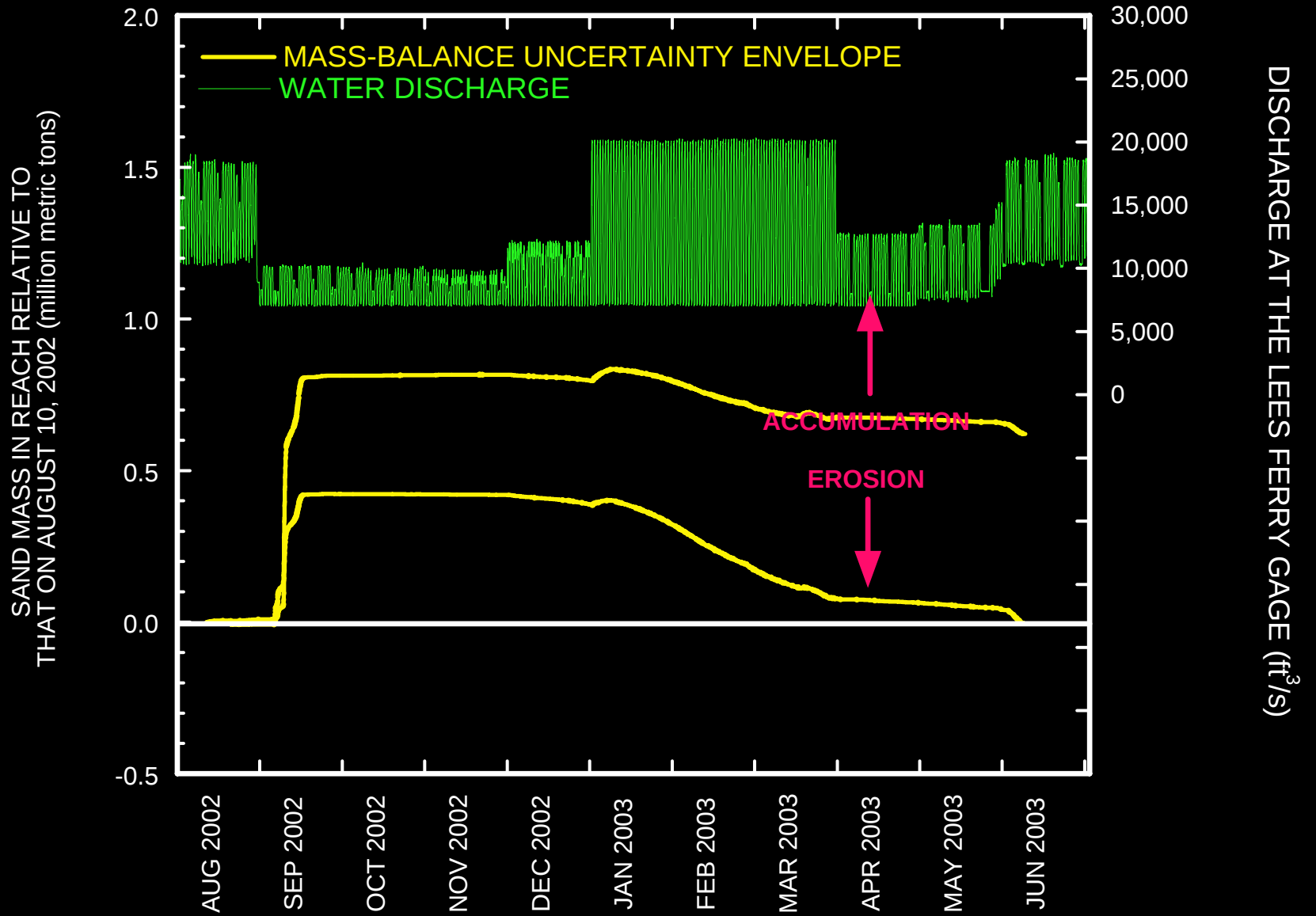
MASS-BALANCE SAND BUDGET FOR UPPER MARBLE CANYON (0-30 mile)



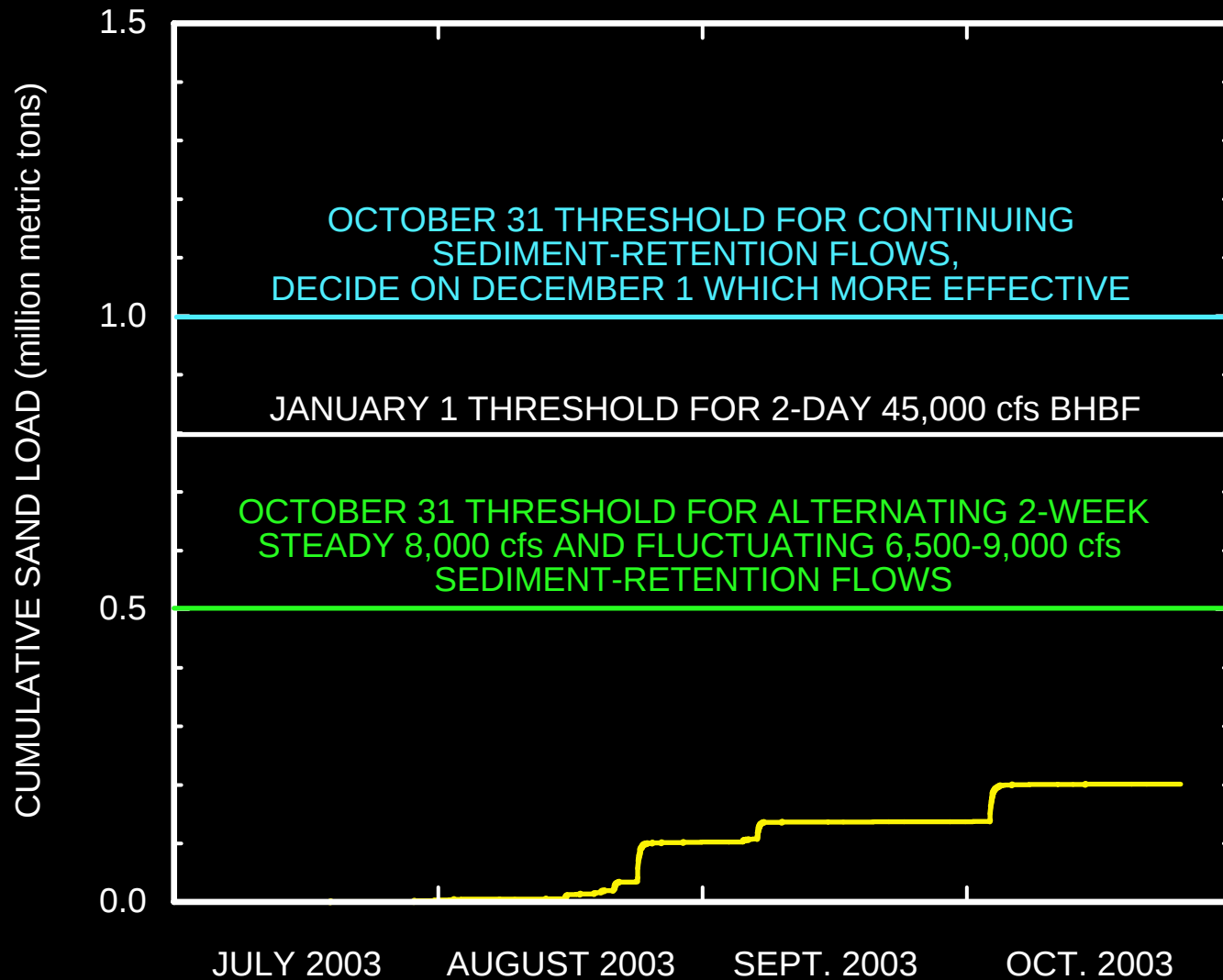
MASS-BALANCE SAND BUDGET FOR LOWER MARBLE CANYON (30-mile to LCR)



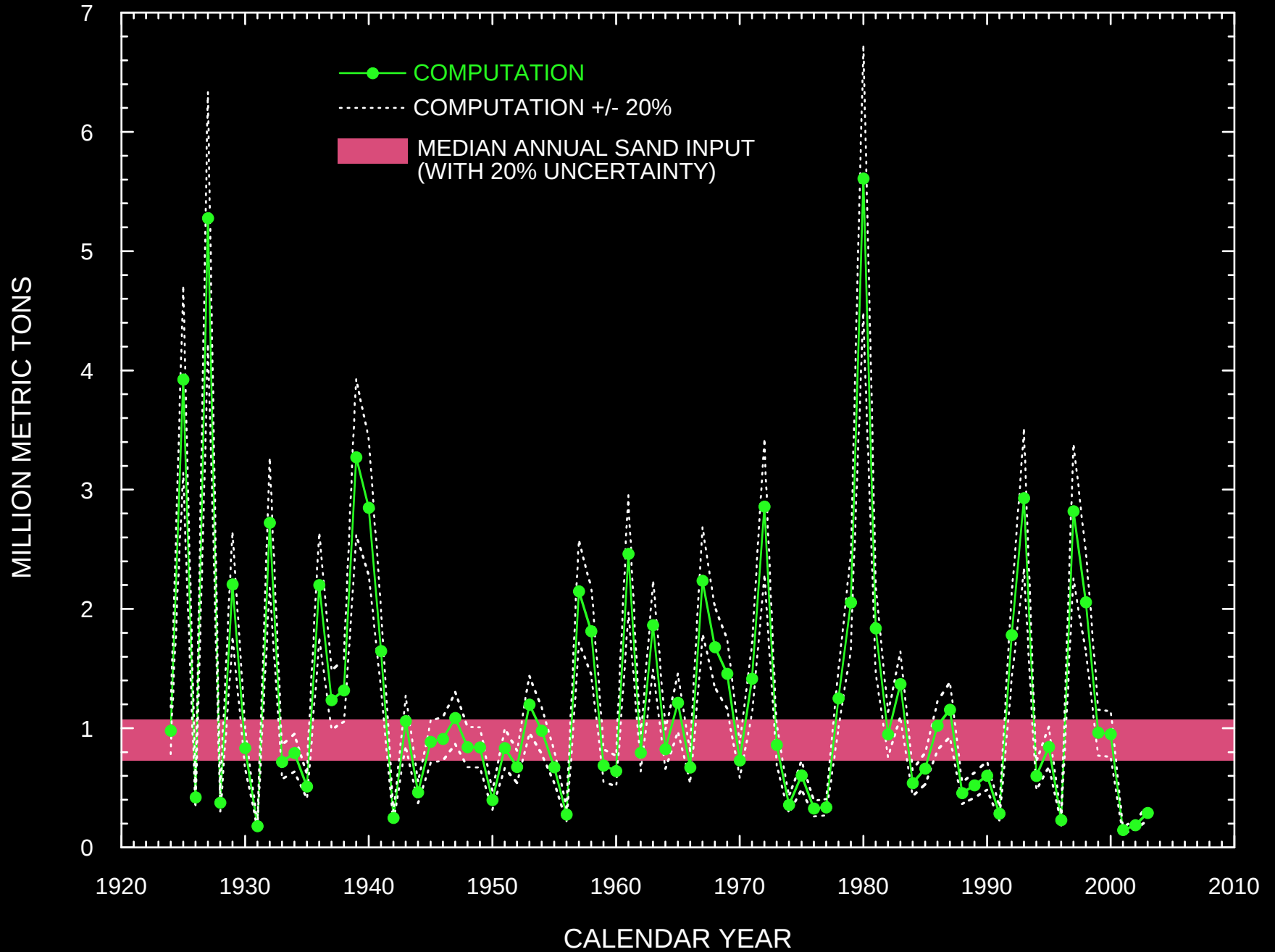
MASS-BALANCE SAND BUDGET FOR UPPER GRAND CANYON (LCR to GC GAGE)



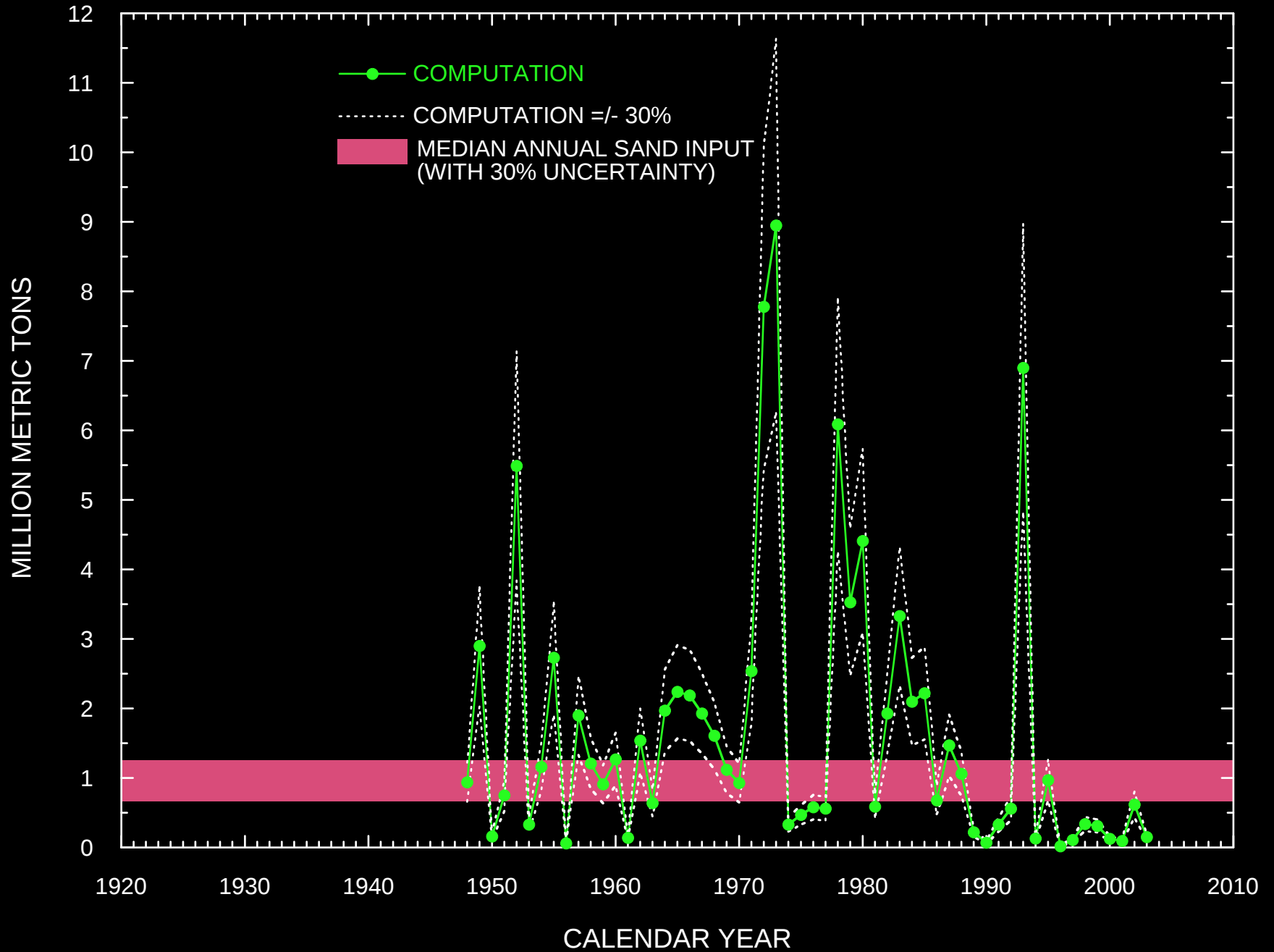
PARIA RIVER EXPERIMENT UPDATE



PARIA RIVER ANNUAL SAND INPUT



LITTLE COLORADO RIVER ANNUAL SAND INPUT



Conclusions

- Under powerplant releases $>9,000$ - $10,000$ cfs, tributary sand inputs are exported within months
- 0.5 to 3.2 million metric tons less sand now than there was between Lees Ferry and the Grand Canyon gage in August 1999
- Sand accumulated in upper Marble Canyon and upper Grand Canyon during September-November 2002 (dam releases were $<10,000$ cfs)

- Sand eroded from upper Marble Canyon and upper Grand Canyon during January-July 2003 (when dam releases were higher)
- No demonstrable change in sand volume in lower Marble Canyon during August 2002 - June 2003
- If funding permits (????), FY 2005 is the next likely opportunity for BHBF test under sediment-enriched conditions