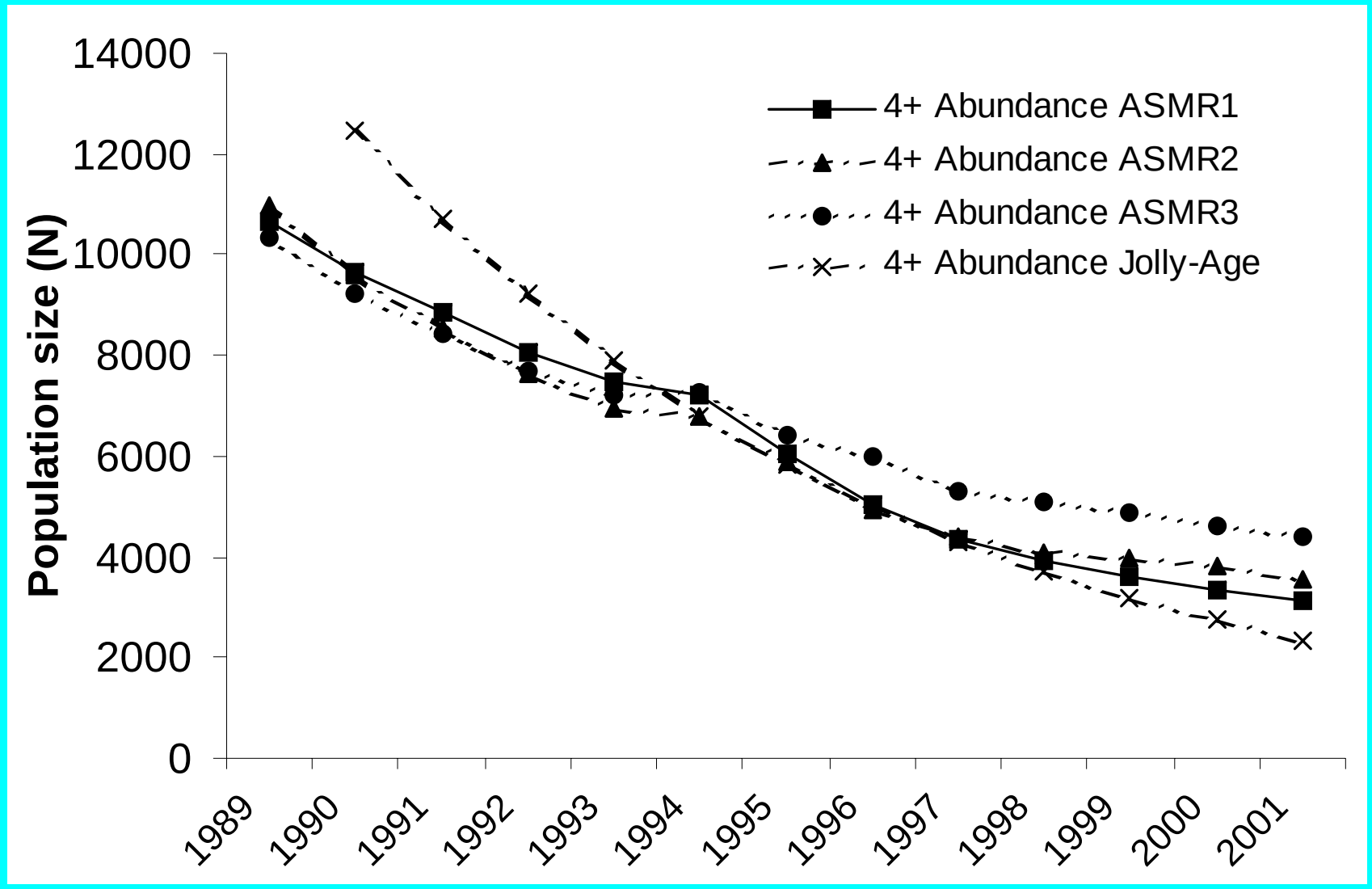
Data Related to our MATA Discussions on MLFF and Fishery Responses



Latest Chub Population Estimates

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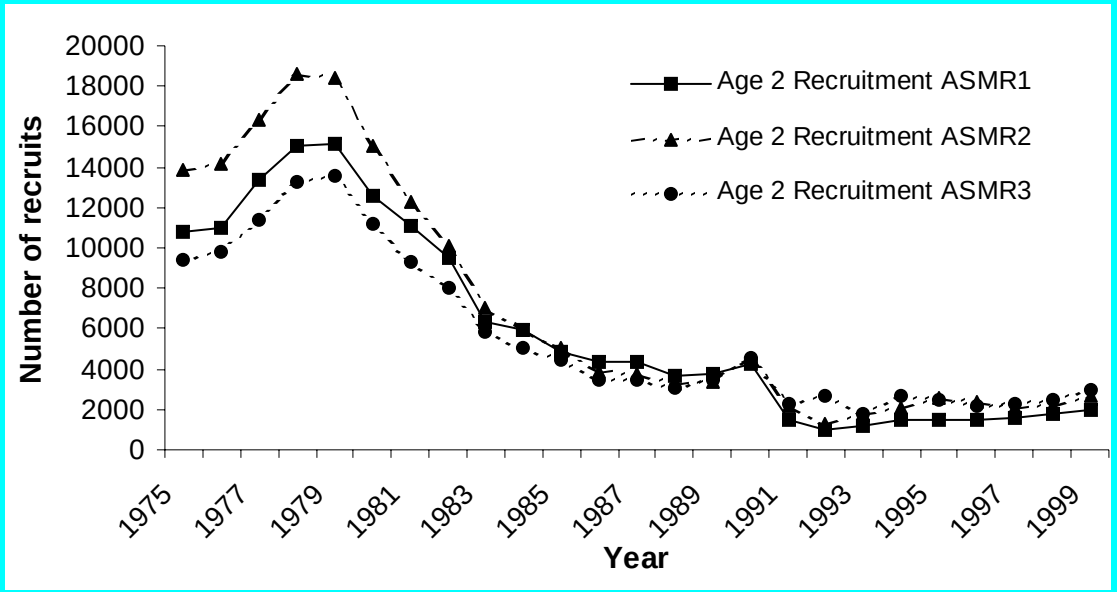
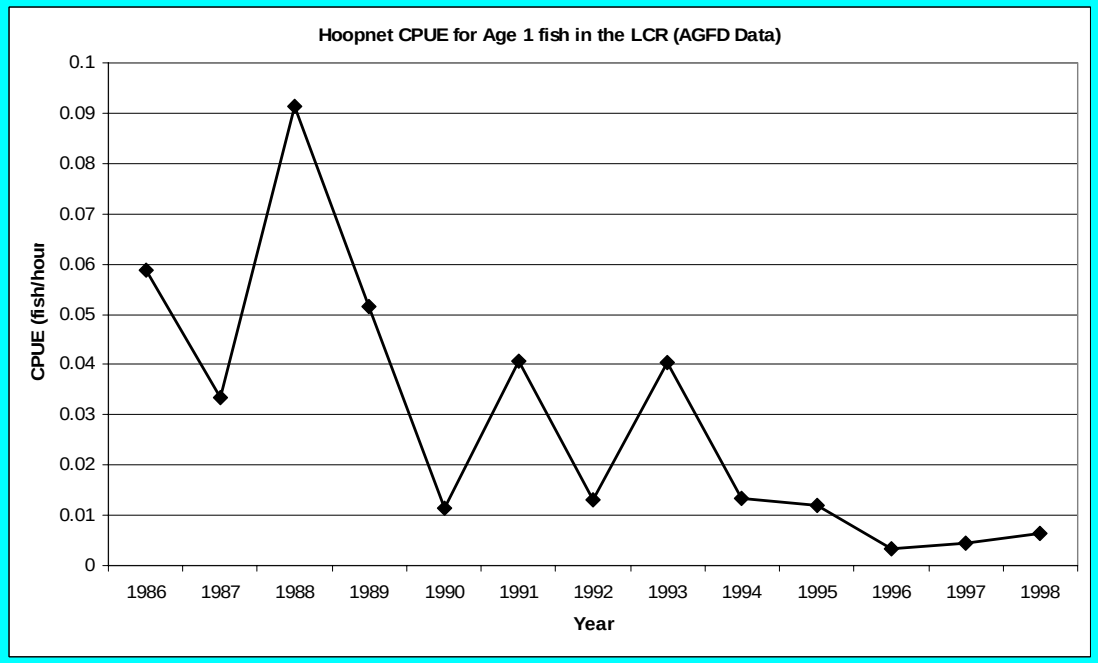
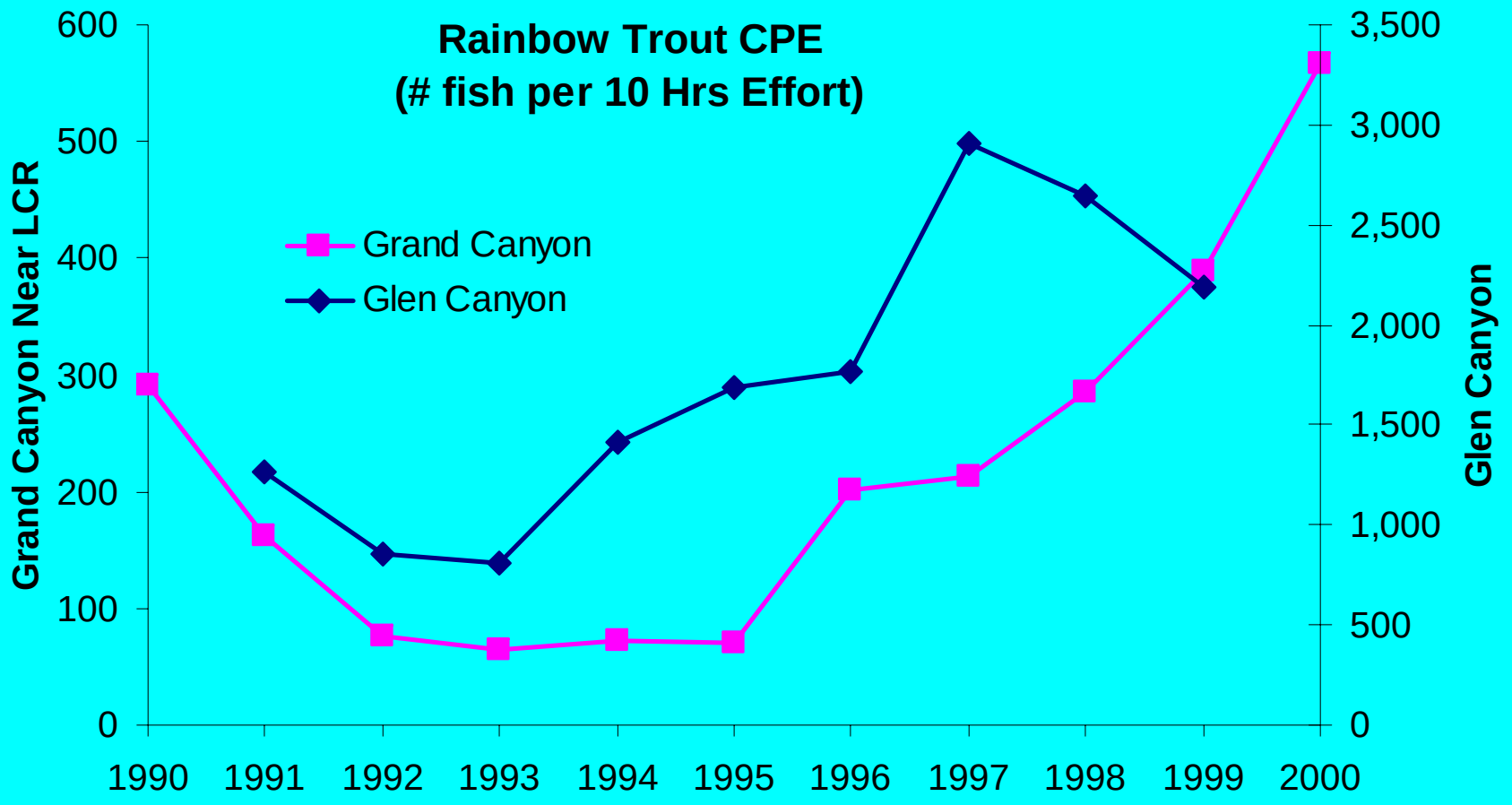




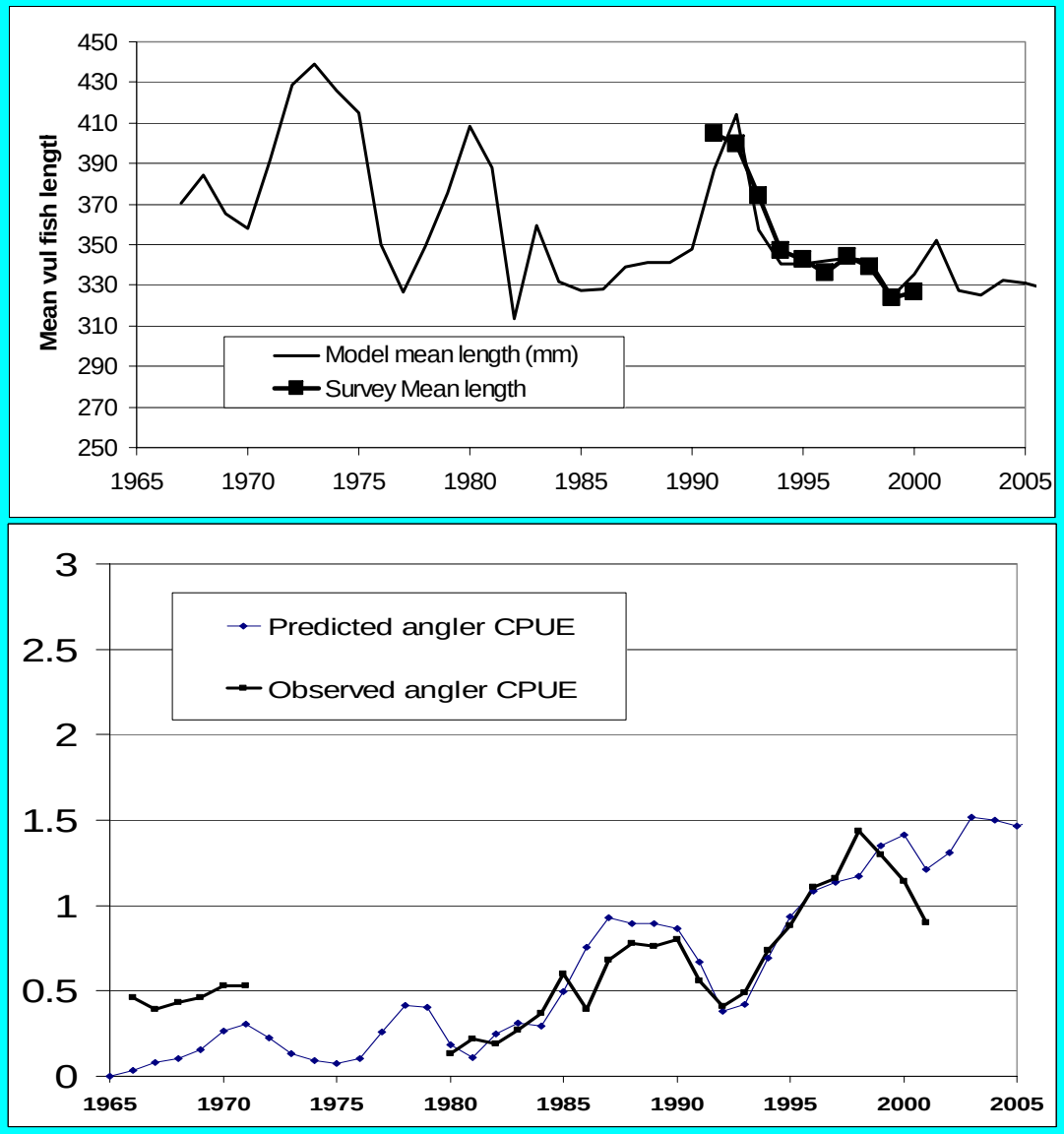
Chub Recruitment Estimates

USGS science for a changing world

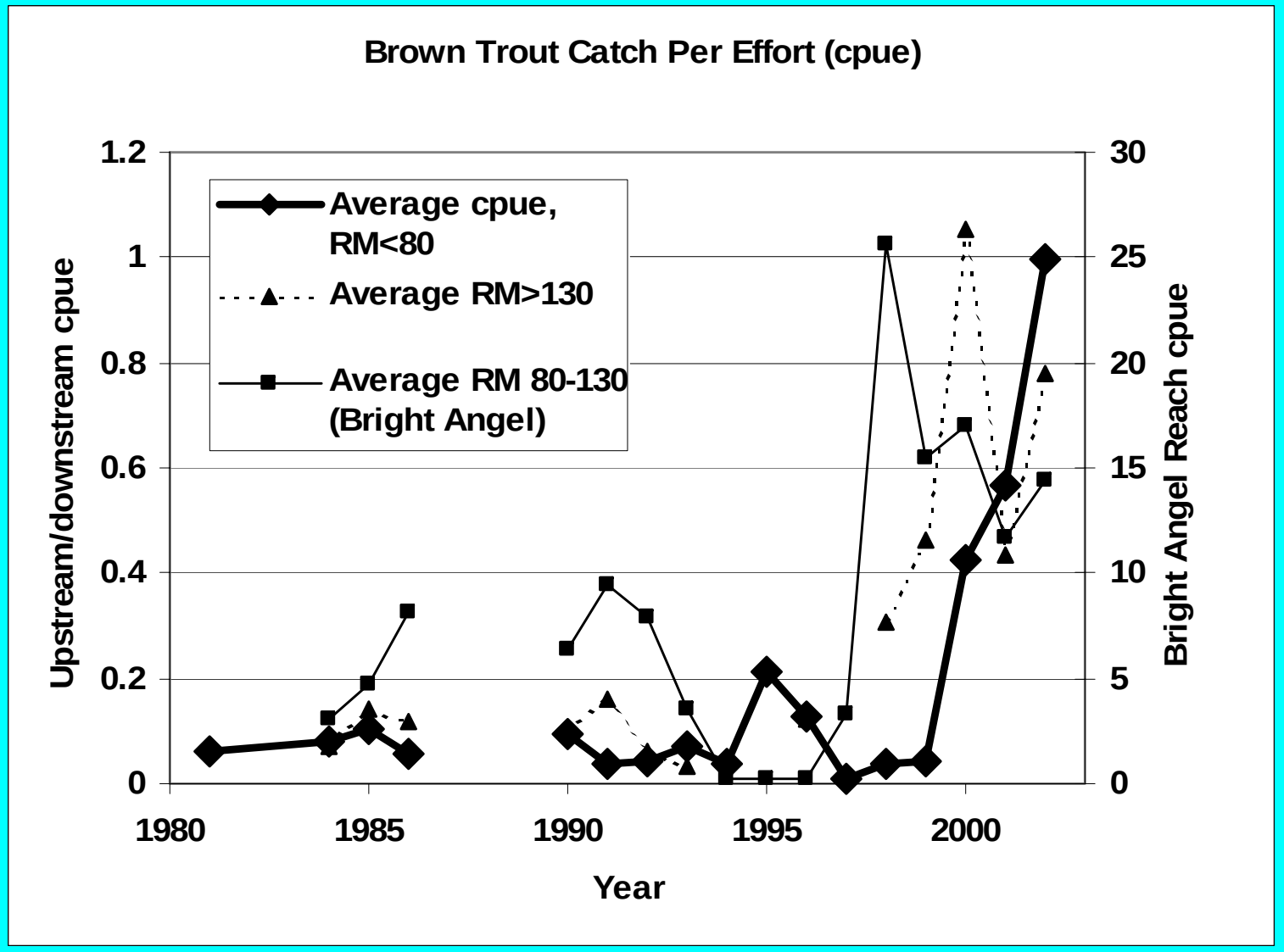


Rainbow Trout Estimates

USGS science for a changing world



Rainbow Trout Predicted vs. Observed under MLFF



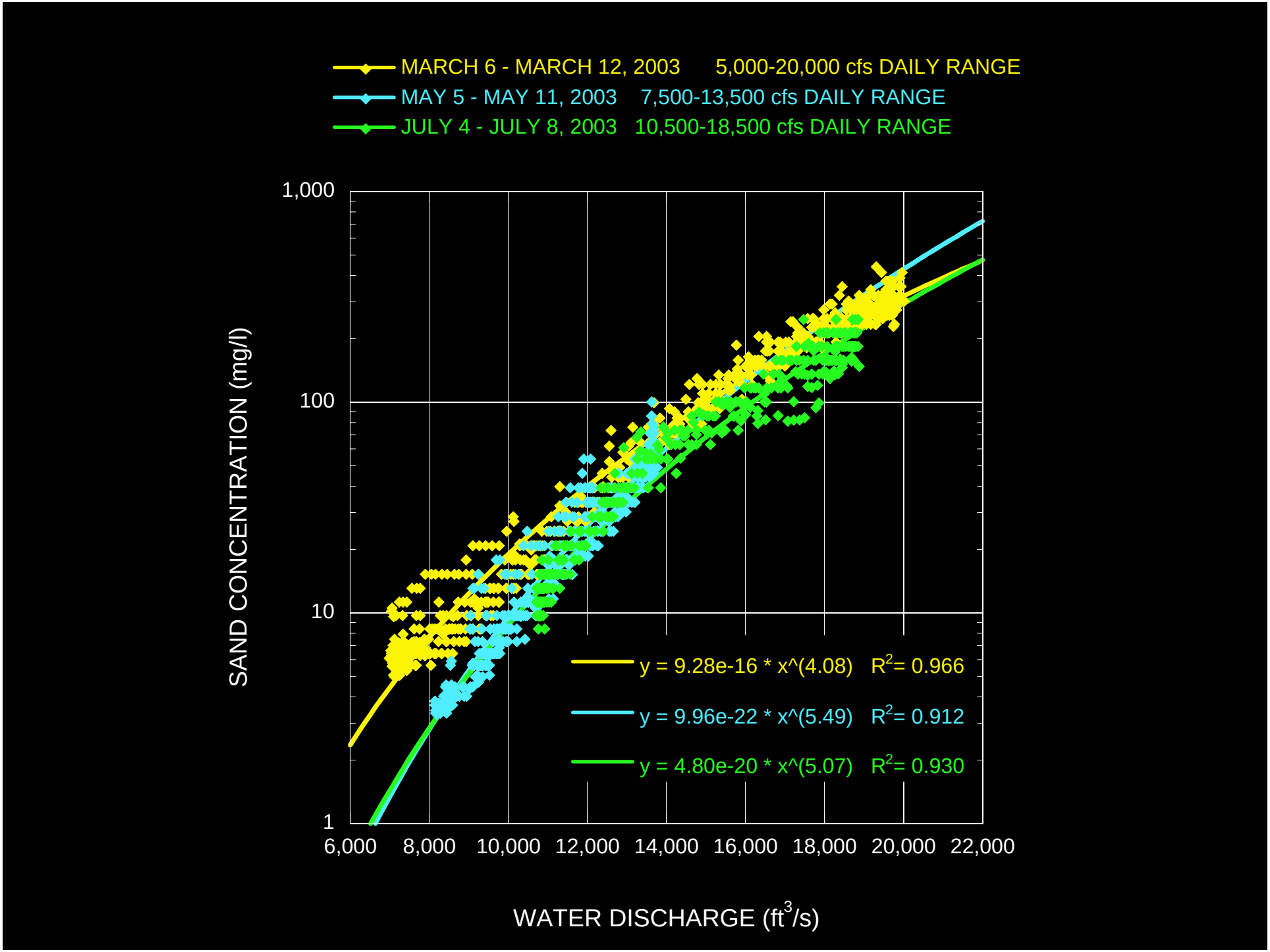
Brown Trout & MLFF

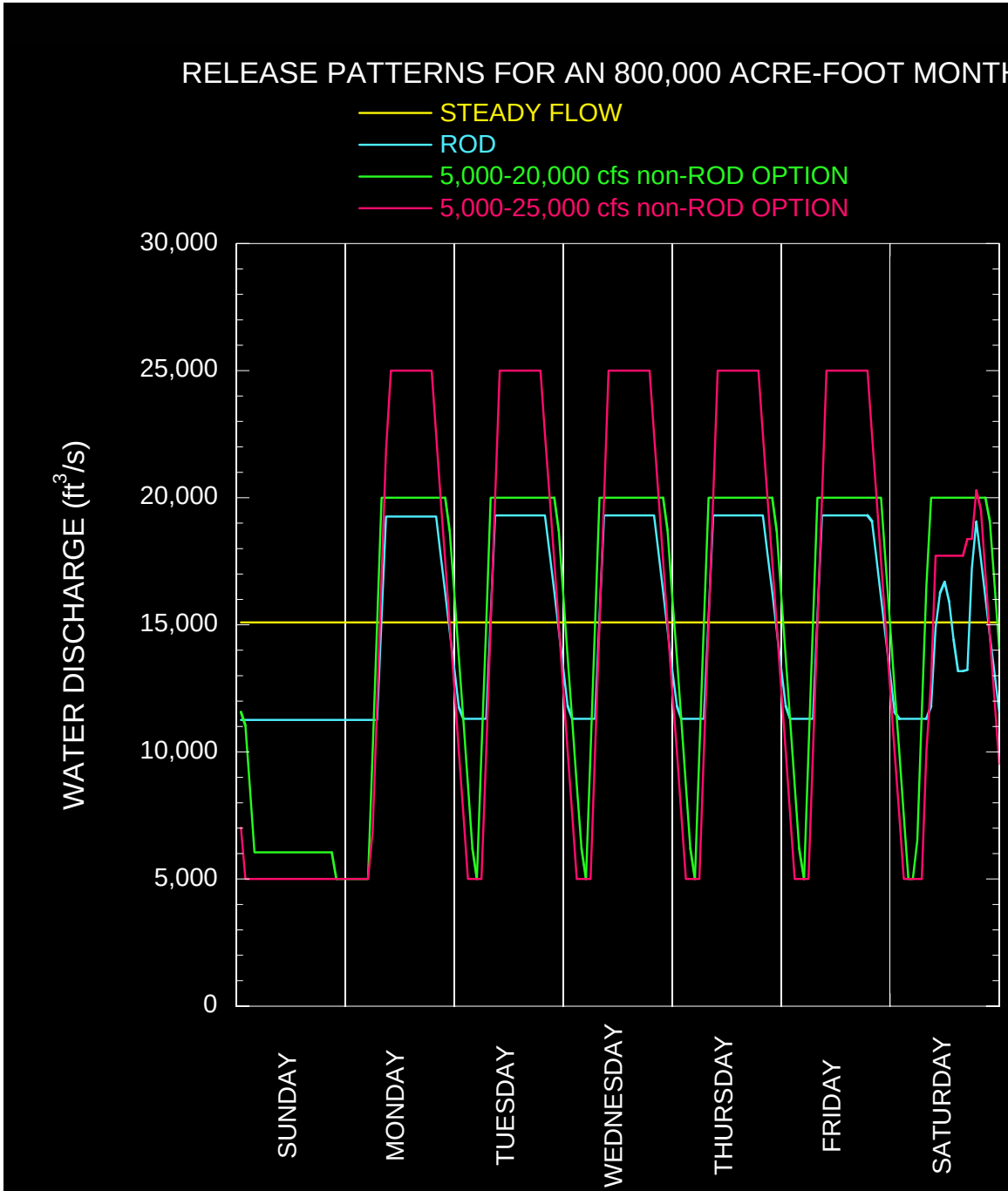
Data Related to our MATA Discussions on MLFF and Sand Resource & Habitat Responses

$$C \propto u_*^4 D_b^{-1}$$

Engelund and Hansen (1967),
Rubin and Topping (2001)

effect included in EIS


MARCH 6 - MARCH 12, 2003 5,000-20,000 cfs DAILY RANGE
MAY 5 - MAY 11, 2003 7,500-13,500 cfs DAILY RANGE
JULY 4 - JULY 8, 2003 10,500-18,500 cfs DAILY RANGE
1,000
100
10
1
SAND CONCENTRATION (mg/l)
y = 9.28e-16 * x^(4.08) R2= 0.966
y = 9.96e-22 * x^(5.49) R2= 0.912
y = 4.80e-20 * x^(5.07) R2= 0.930
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
22,000
WATER DISCHARGE (ft3/s)



- STEADY-FLOW SAND EXPORT = 60% OF ROD SAND EXPORT
- 5,000-20,000 cfs OPTION SAND EXPORT = 150% OF ROD SAND EXPORT
- 5,000-25,000 cfs OPTION SAND EXPORT = 290% OF ROD SAND EXPORT

Known

- Effects of tributary floods on suspended-sand concentration and grain size in the Colorado River
- Effects of high dam releases on suspended-sand concentration and grain size
- Effects of BHBFs and power plant capacity releases conducted during sand-depleted periods

Current sediment component of the experiment

- Can average or larger inputs of Paria River sand, silt, and clay be managed (by sequences of dam releases) to offset the ongoing erosion of fine-grained sediment from Marble and Grand Canyons?…to increase turbidity over longer periods to help benefit native fish?
- WE ARE STILL WAITING FOR NATURE TO COOPERATE

Partially known

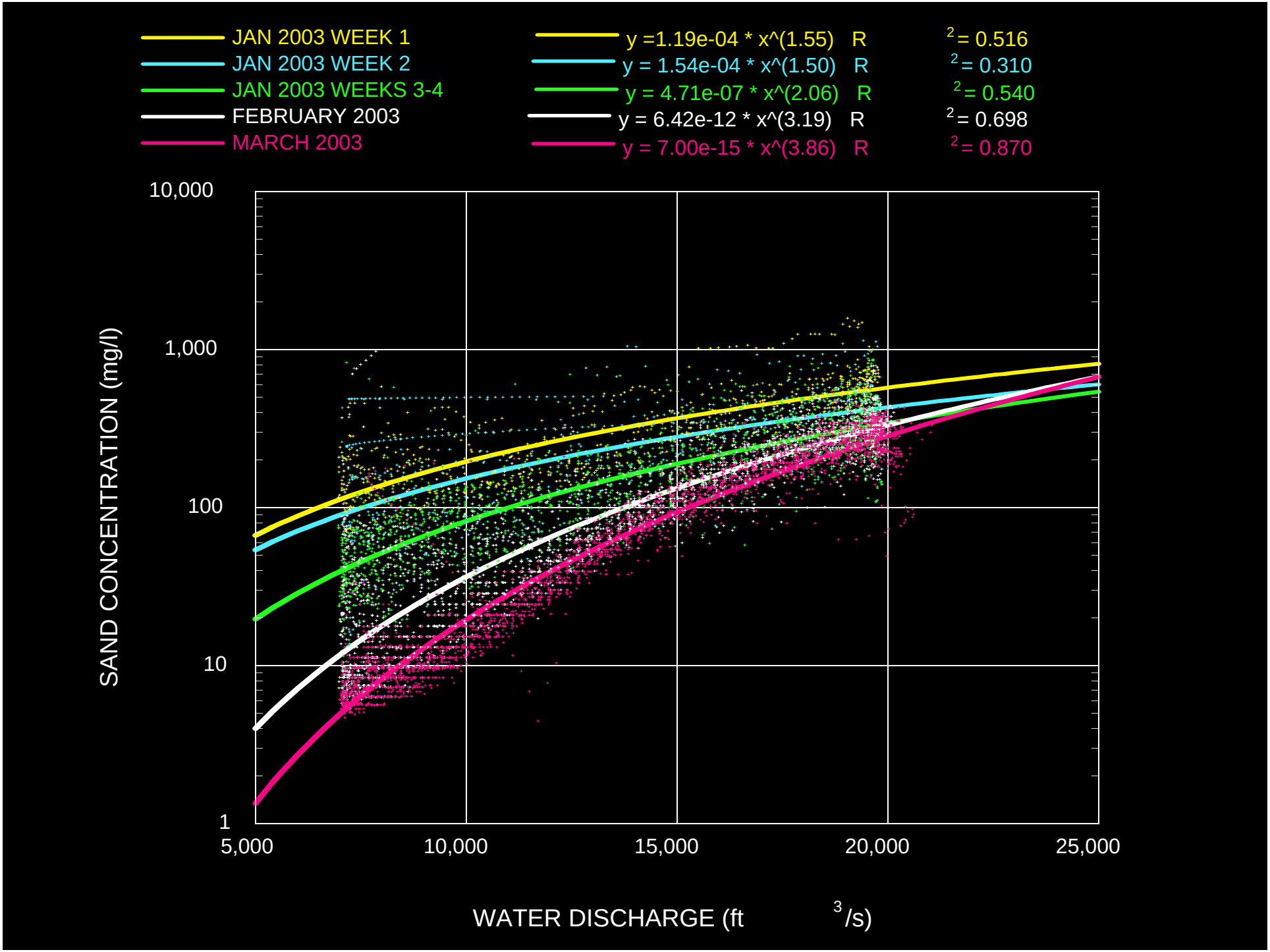
- Effect of daily range on sand concentration
- Effects of ramping rates on sand concentration

Unknown

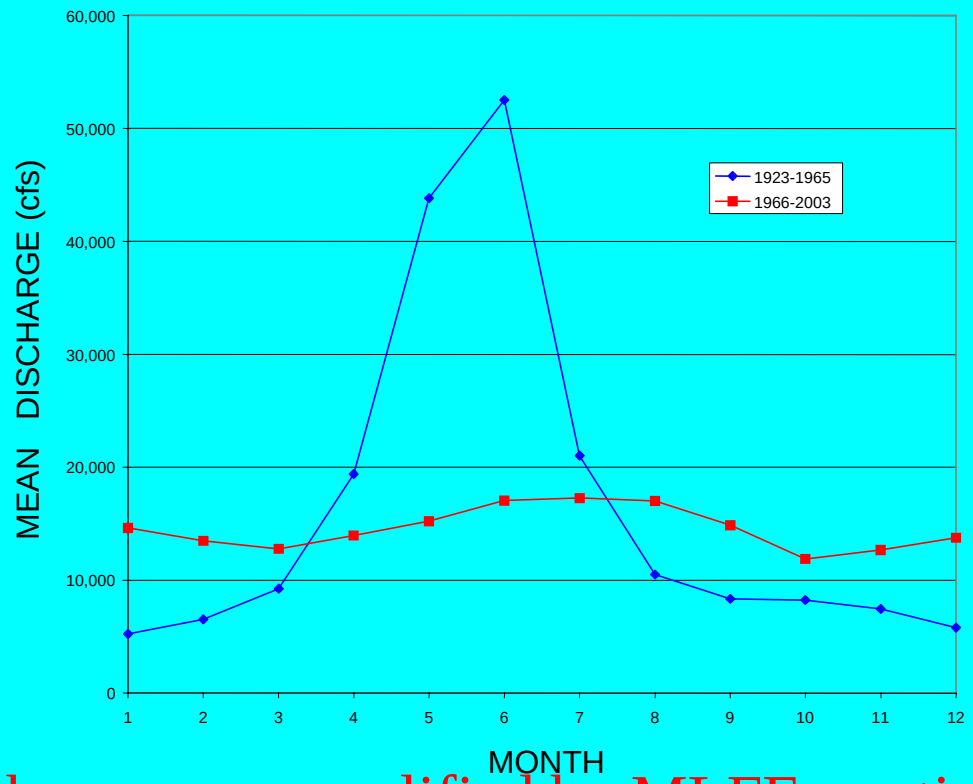
- Sand transfer between eddies and channel during the various experimental flow options (though most eddies will lose sand during larger fluctuations, some key eddies may actually gain sand)
- Maintenance of sandbars and backwaters by the various experimental flow options
- Importance of seepage erosion as a function of down ramping rate
- Sandbar-terrestrial biological linkages under the various experimental flow options (coupled to carbon and nutrient-budgets)

The big question

If Paria River sediment inputs can be managed to offset erosion…can hydropower constraints be relaxed and fluctuating, “steady”, and BHBF flows be seasonally sequenced (a.k.a. designer flows) to achieve multiple management objectives (sandbars, turbidity, etc.) ???


JAN 2003 WEEK 1
JAN 2003 WEEK 2
JAN 2003 WEEKS 3-4
FEBRUARY 2003
MARCH 2003
y =1.19e-04 * x^(1.55) R 2 = 0.516
y = 1.54e-04 * x^(1.50) R 2 = 0.310
y = 4.71e-07 * x^(2.06) R 2 = 0.540
y = 6.42e-12 * x^(3.19) R 2 = 0.698
y = 7.00e-15 * x^(3.86) R 2 = 0.870
10,000
1,000
100
10
1
SAND CONCENTRATION (mg/l)
5,000
10,000
15,000
20,000
25,000
WATER DISCHARGE (ft 3 /s)

Dam closure dramatically compressed flood frequency and Shifted high flows from spring to summer months – so that the highest annual monthly volumes now coincide with the warm-season, sand production period from July through September. . .



Additionally, while the high-flow periods were decreased in magnitude, The low-flow periods were reduced such that the mean daily flow nearly doubled. . . .

The net change was amplified by MLFF - optimizing FOR sand transport, AND against maintenance of sand bars!

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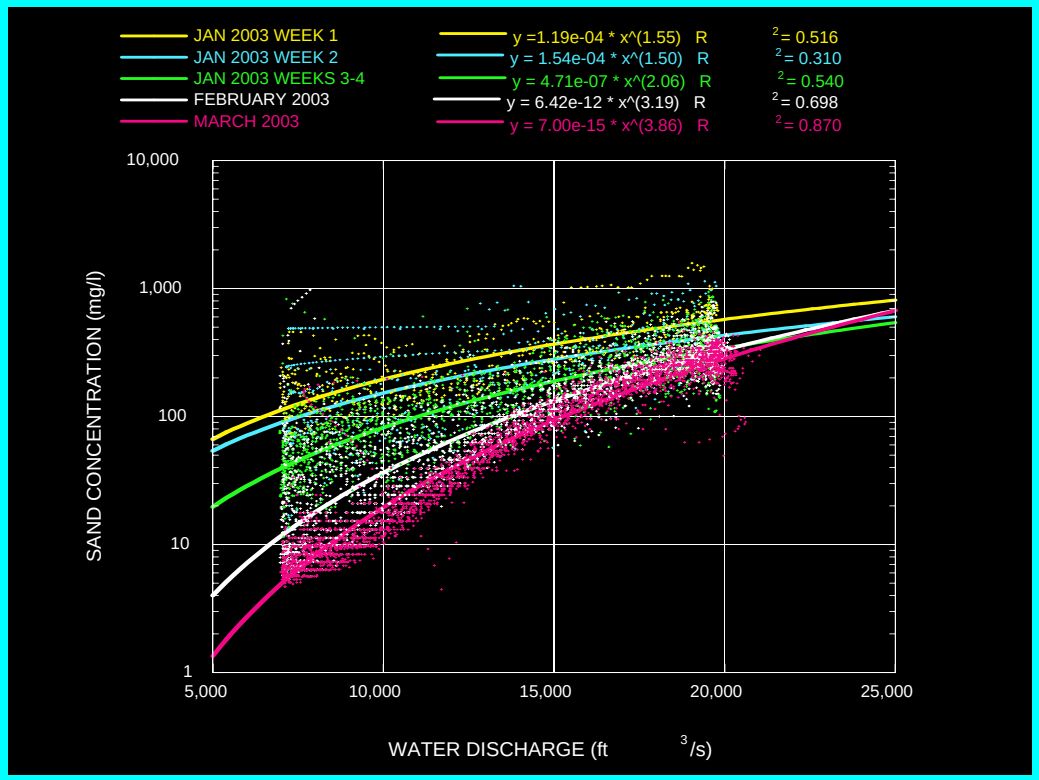
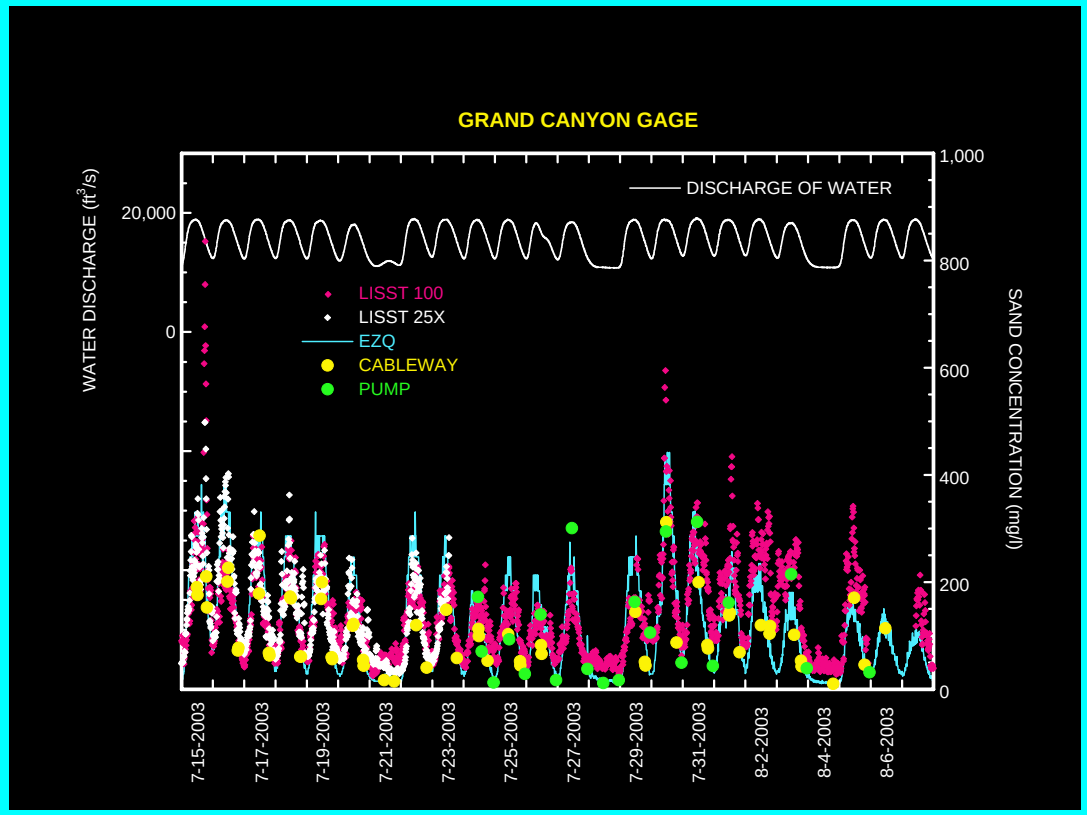
The combined influences of compressed flood frequency and elimination of about 93 percent of the sand supply, ensured that sand-transport relationships would shift dramatically in response To short-term sequences of enrichment and winnowing of the sand supply on the bed. . .



Evidence of this so-called "Hysteresis" is obvious over short periods during our recent fluctuating-flow experiments from winter 2003 . . . .

Yet, we failed to grasp these transport dynamics regulating export prior to completion of the EIS!

WHY DID WE MISS THIS NOW-OBVIOUS PHENOMENON?



We now have abundant post-dam suspended-sediment transport data related to concentration & grain size . . . . combined with detailed historical syntheses (Topping et al. 2000a; 2000b) of historical pre-dam data.

From 1972 until 1999, we typically only sampled on-average once every 8 weeks (compared to 96times/day now!)

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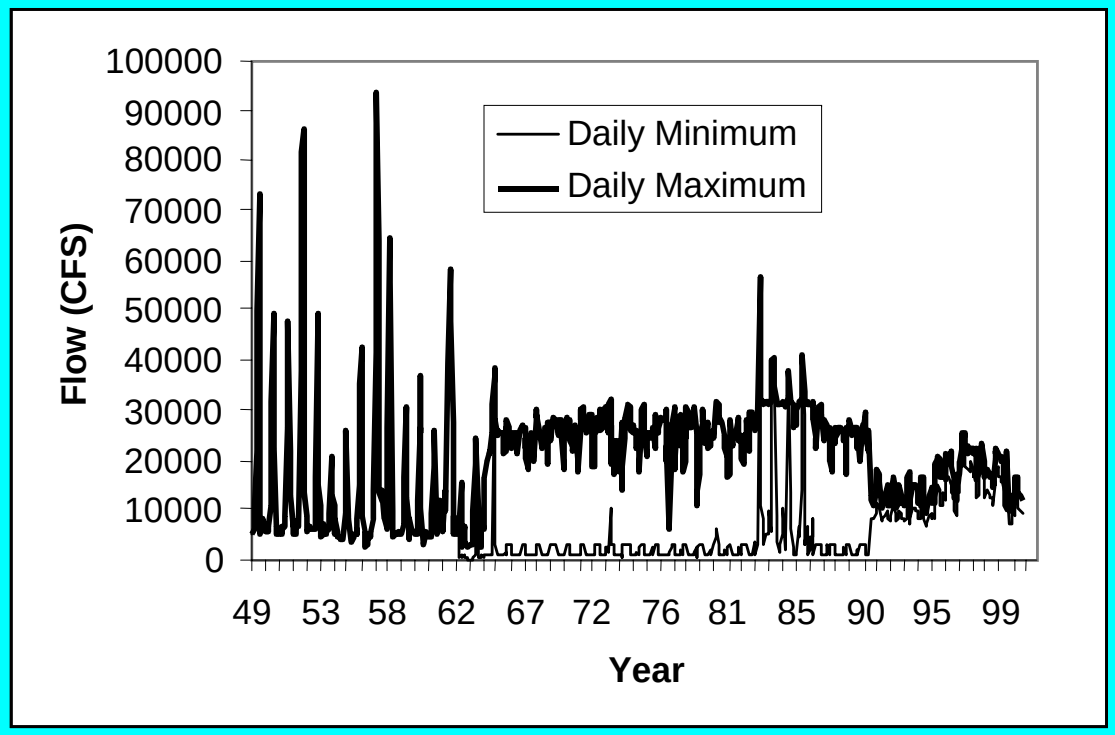
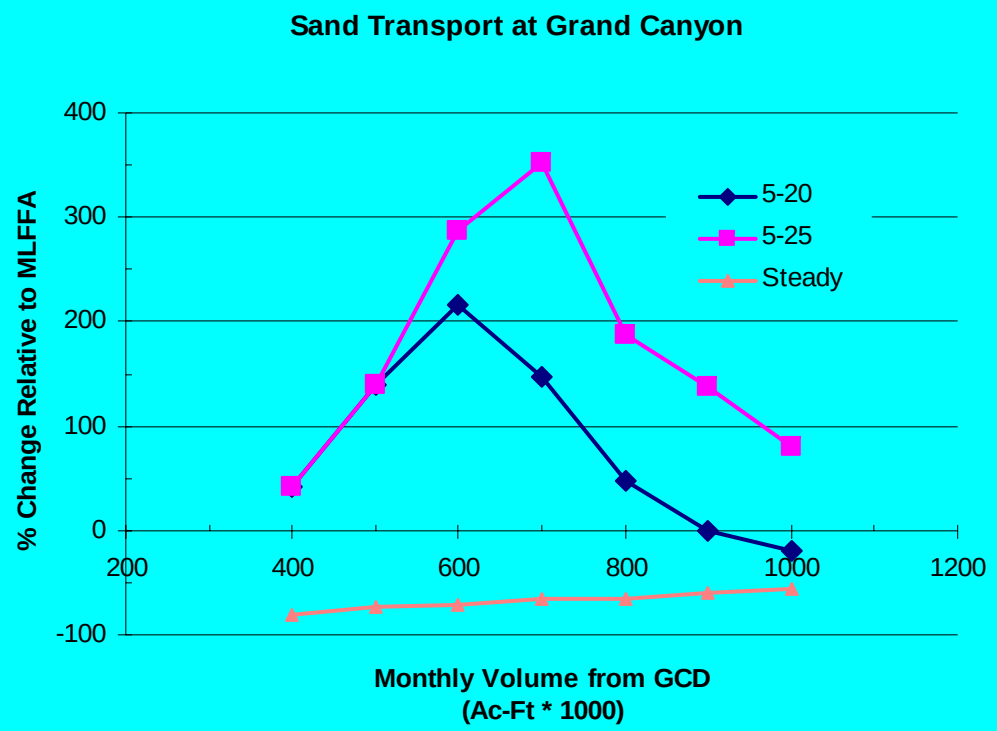
By Eliminating the Low Flows of the Pre-Dam and the of No-Action era . . .



We inadvertently amplified the efficient export of new sand and erosion of existing sand bars that had previously been documented and predicted by Emmett Laursen in his 1976 engineering report to the NPS. . .

Laursen would have likely pointed this fact out, had he remain engaged in the EIS process, even in a review capacity.

New Sand Transport Rating Curves Suggest that 5,000 – 20,000 cfs Alternative Fluctuations

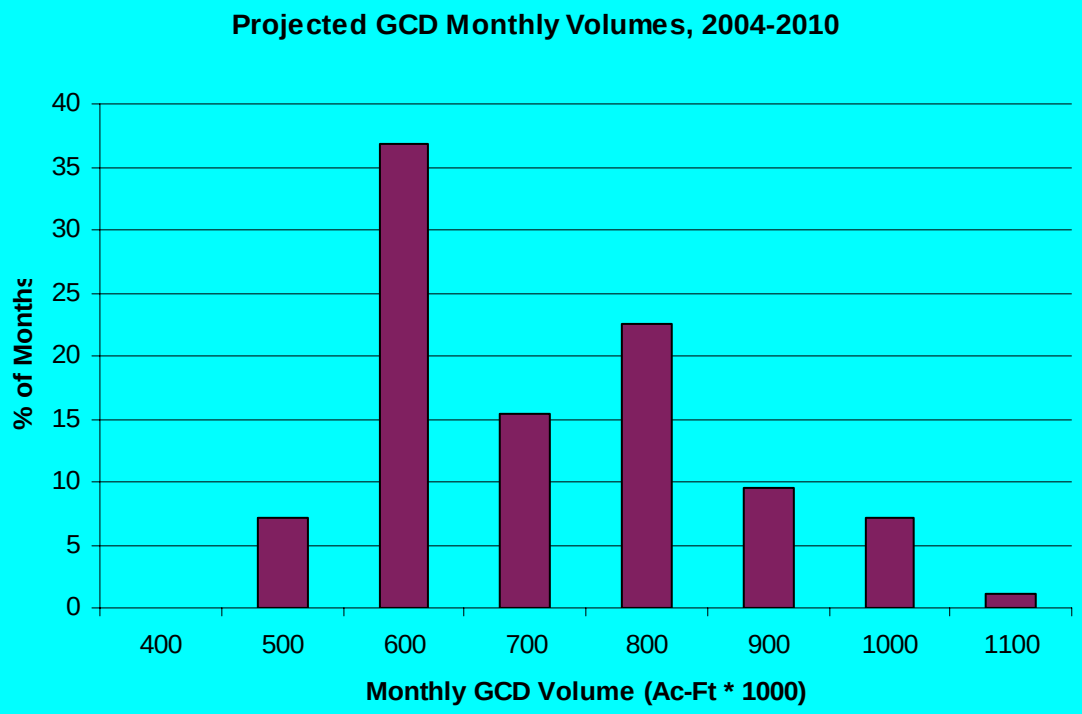


Increase transport for sand vs. MLFF under lower to moderate monthly volume releases, but that the experimental flows might transport less sand in high volume months – PERHAPS WE SHOULD TEST THIS PREDICTION. .

Stable Flows are Best for Limiting Sand Transport!

Fluctuations from 5,000 – 25,000 cfs with relaxed ramping and daily Range are always predicted to export more than MLFF.

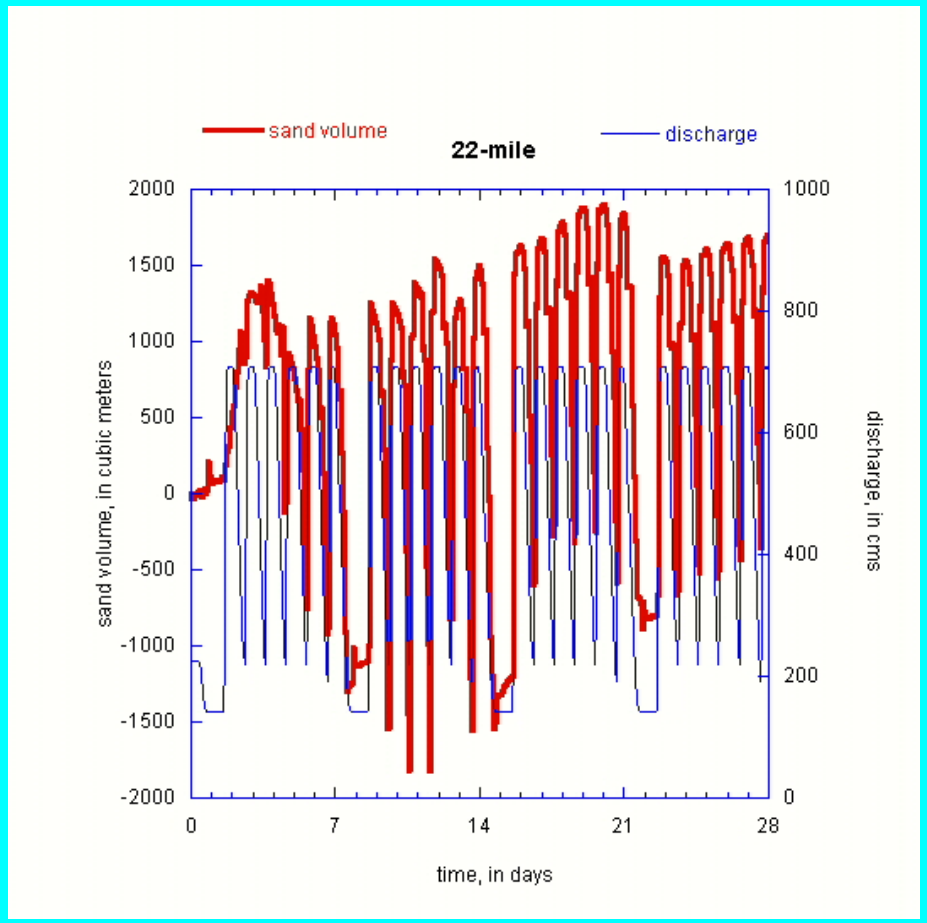
RiverWare Simulations indicate that the probability of having high Volume release months (1,000,000 ac/ft) is low for the time being. . .



About half of the projected monthly release volumes will likely be between 600,000 and 800,000 ac/ft and would therefore increase sand export under alternate fluctuating flows relative to MLFF. . . .

Perhaps this impact is not critical if strategic BHBF's are found to Result in sustainable sand-bar restoration under relaxed constraints?

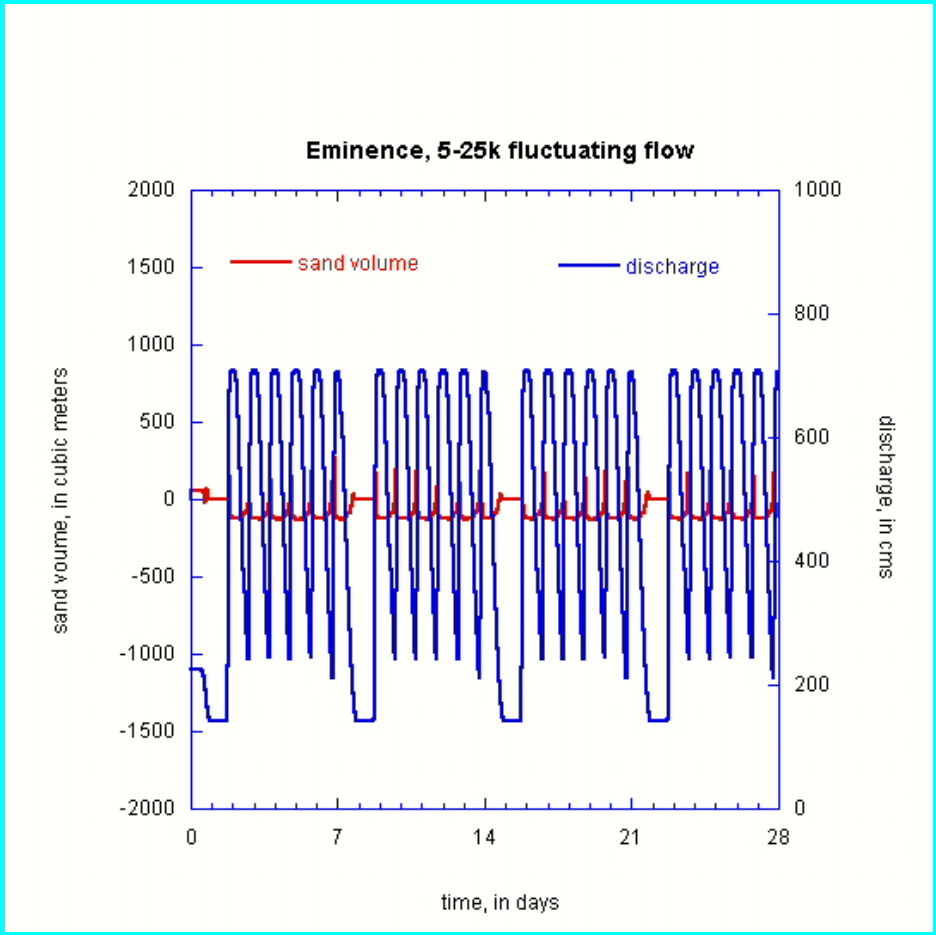
Steve Wiele's Preliminary Sand-Bar Simulations suggest. . .



that some sites might actually be able to store a little more sand under expanded fluctuating flows. . . This would seem to be supported by 1990 sand-bar and backwater data suggesting we had more after No-Action

However, without a sustainable bar strategy, the sand mass-balance data and transport relationships would predict ongoing erosion ?

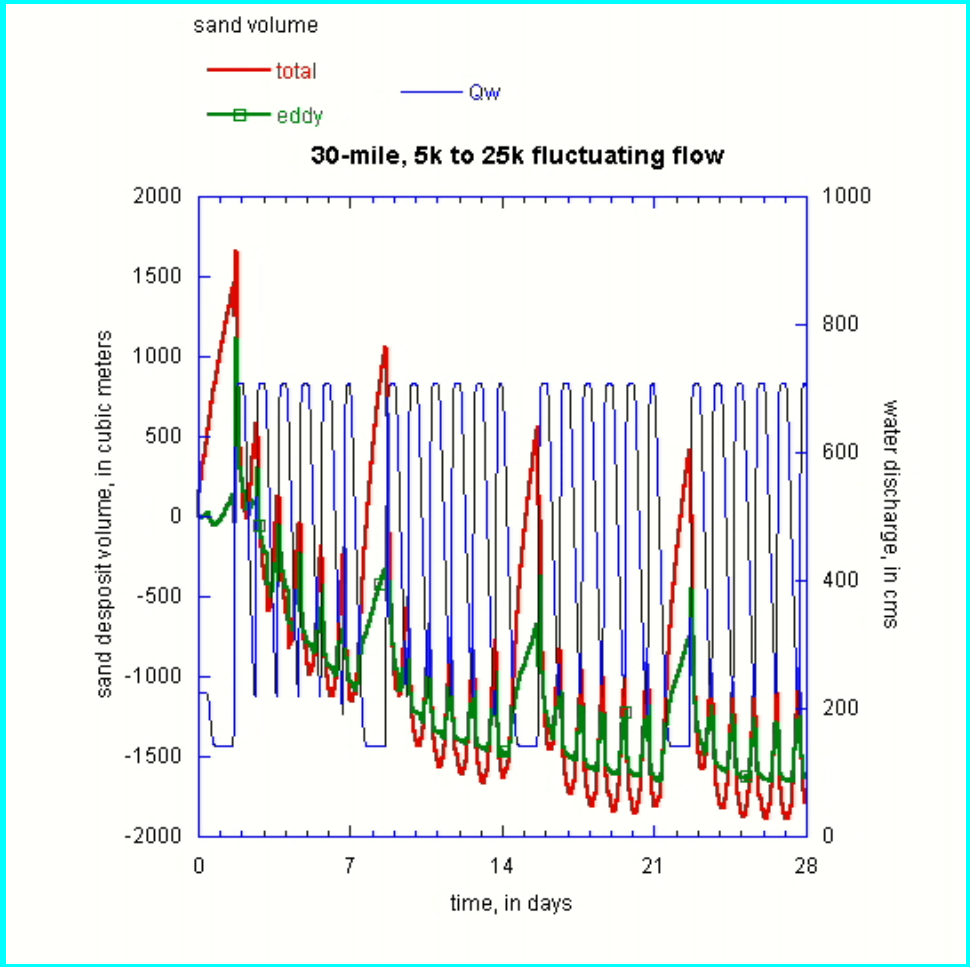
Other Sand-Bar Simulations suggest. . .



that some sites might actually be somewhat stable under alternate fluctuations, but could be subject to slow, but continual sand losses over time until restored by repeated, strategically timed BHBF release

If bars prove to be sustainable through relaxed implementation of BHBF's, then perhaps their erosion also manages for turbidity?

Could “Sustainable” Sand-Bar Erosion Provide Benefit to Native Fish?



Trade off assessments might continue to be useful in planning experimental sequences where strategic “designer” flows turn resource restoration and sustainability into opportunities for multiple benefits. . .

We cannot explore the full range of options without taking some risks and moving forward with experimentation to facilitate learning. . .