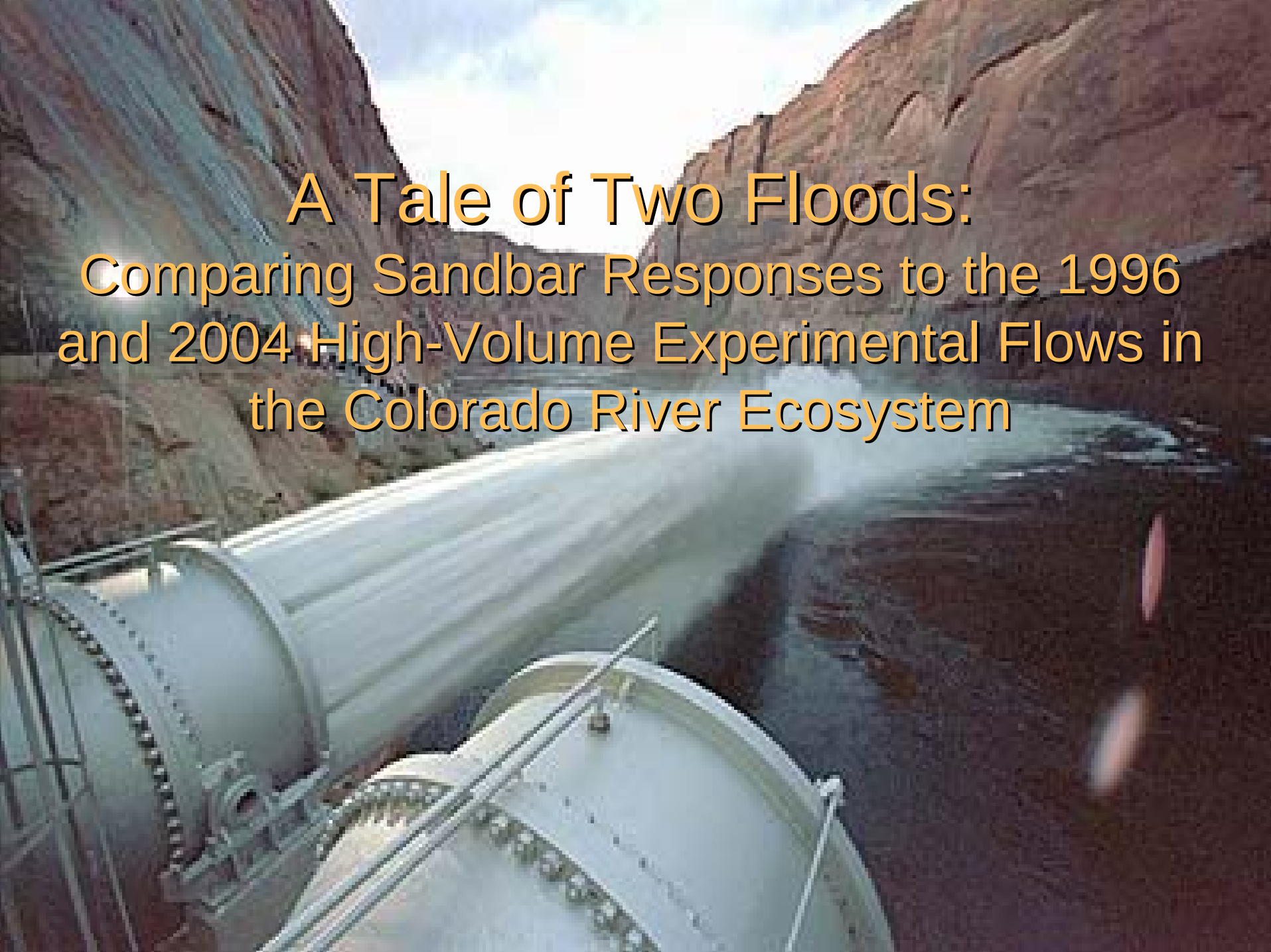

A Tale of Two Floods:
Comparing Sandbar Responses to the 1996 and 2004 High-Volume Experimental Flows in the Colorado River Ecosystem

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Rod Parnell

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Jack Schmidt,

Mike Breedlove

US Geological Survey

Dave Rubin,

Dave Topping

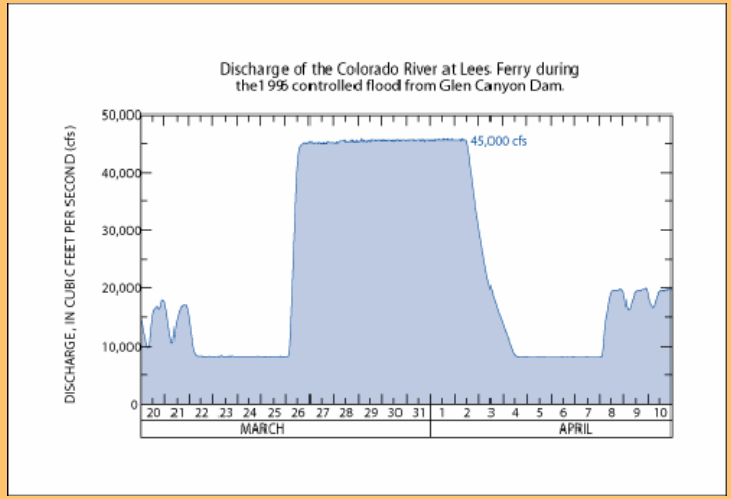
why study sand bars ?

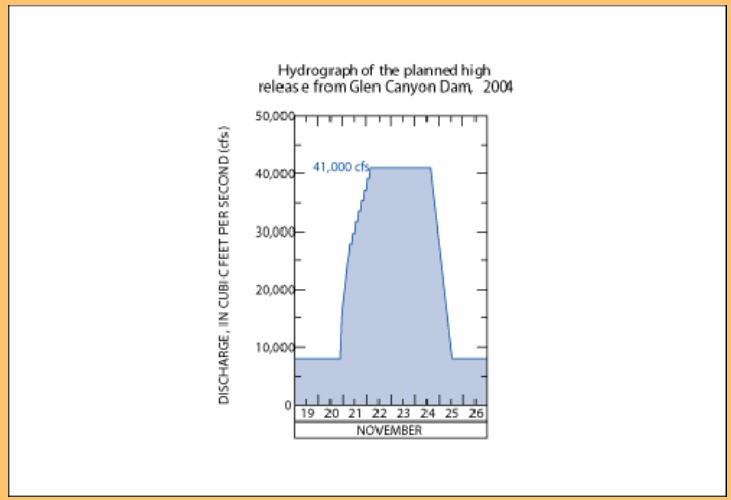
- emergent bars
  - create terrestrial, riparian habitat
  - create zones of low/stagnant flow for critical native fish habitat
  - provide recreational resources (campsites for river runners and hikers)
  - contain and preserve archeological resources

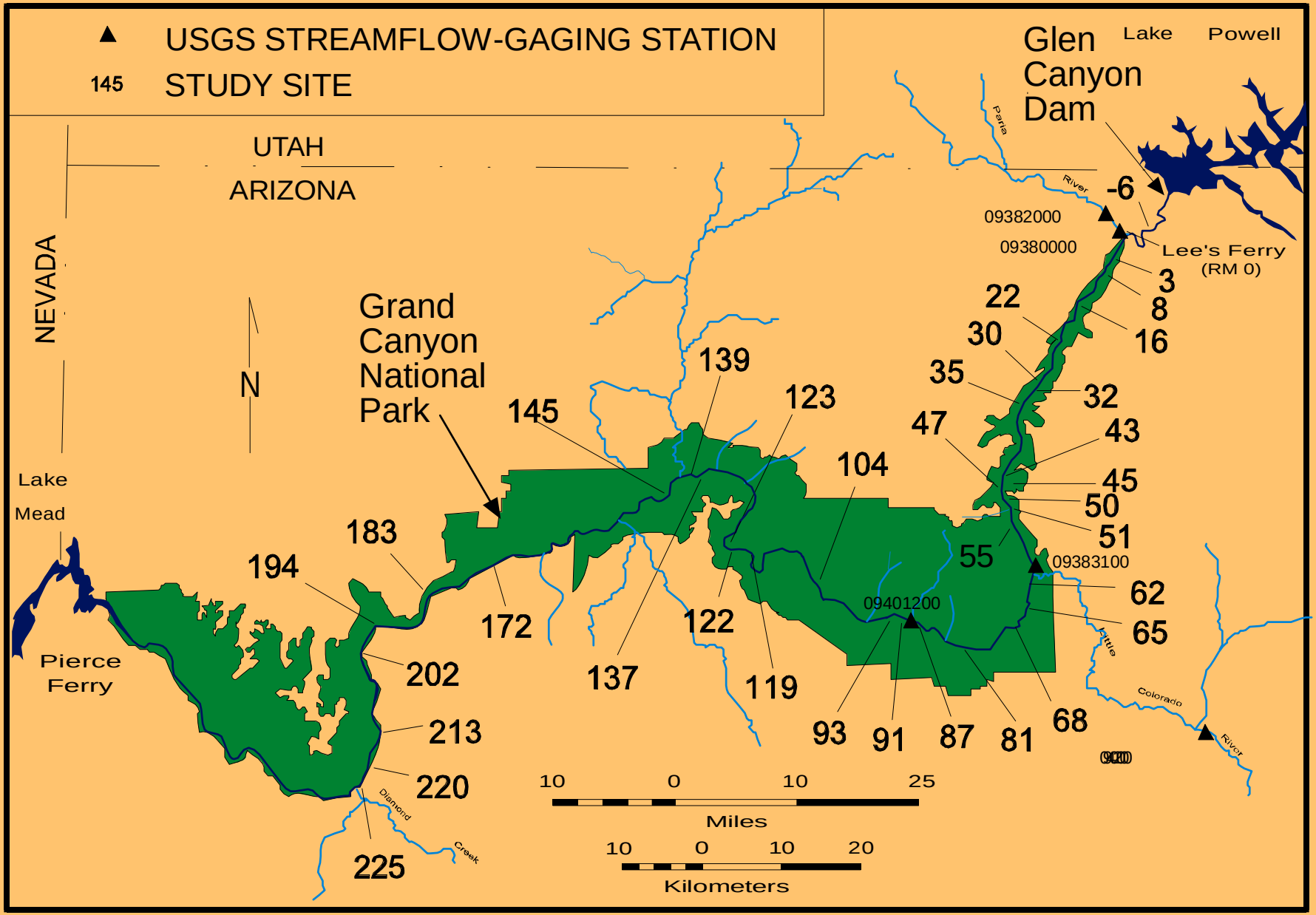
so, restoration & maintenance of sand resources is a fundamental management objective of NPS and GCMRC

Overview

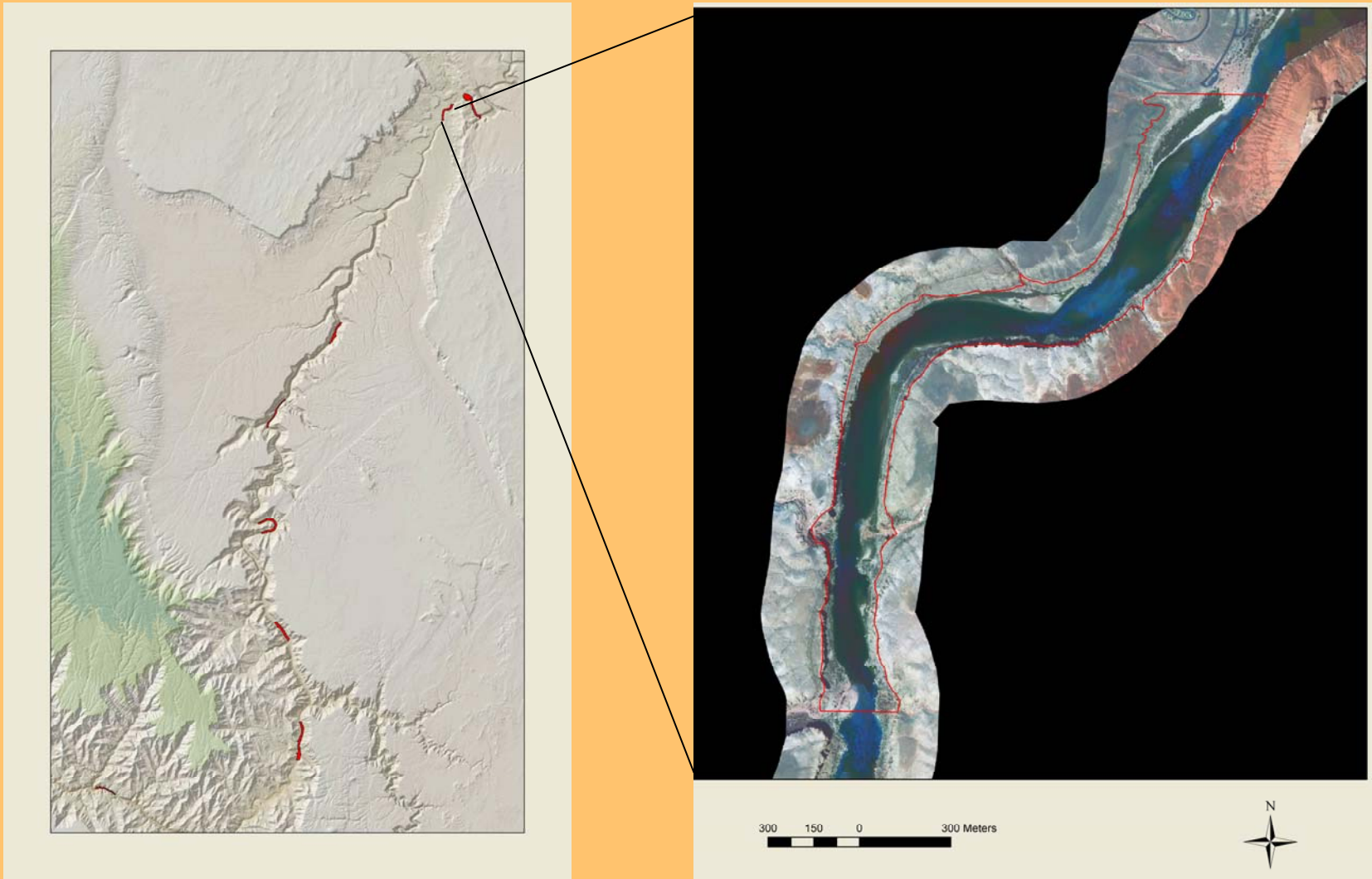
- The 1996 Beach/Habitat Building Flow (1996 BHBF)
- Sand bar topographic response was determined by direct measurement at single sites (Andrews, et al., 1999; Hazel et al., 1999) and aerial photograph analysis (Schmidt et al., 1999)
- A reach-based approach was implemented in 2002
- A new, potentially improved flood design, the November 2004 High Experimental Flow (HEF).
- Comparing the two flood experiments required a revisit to the single site measurements



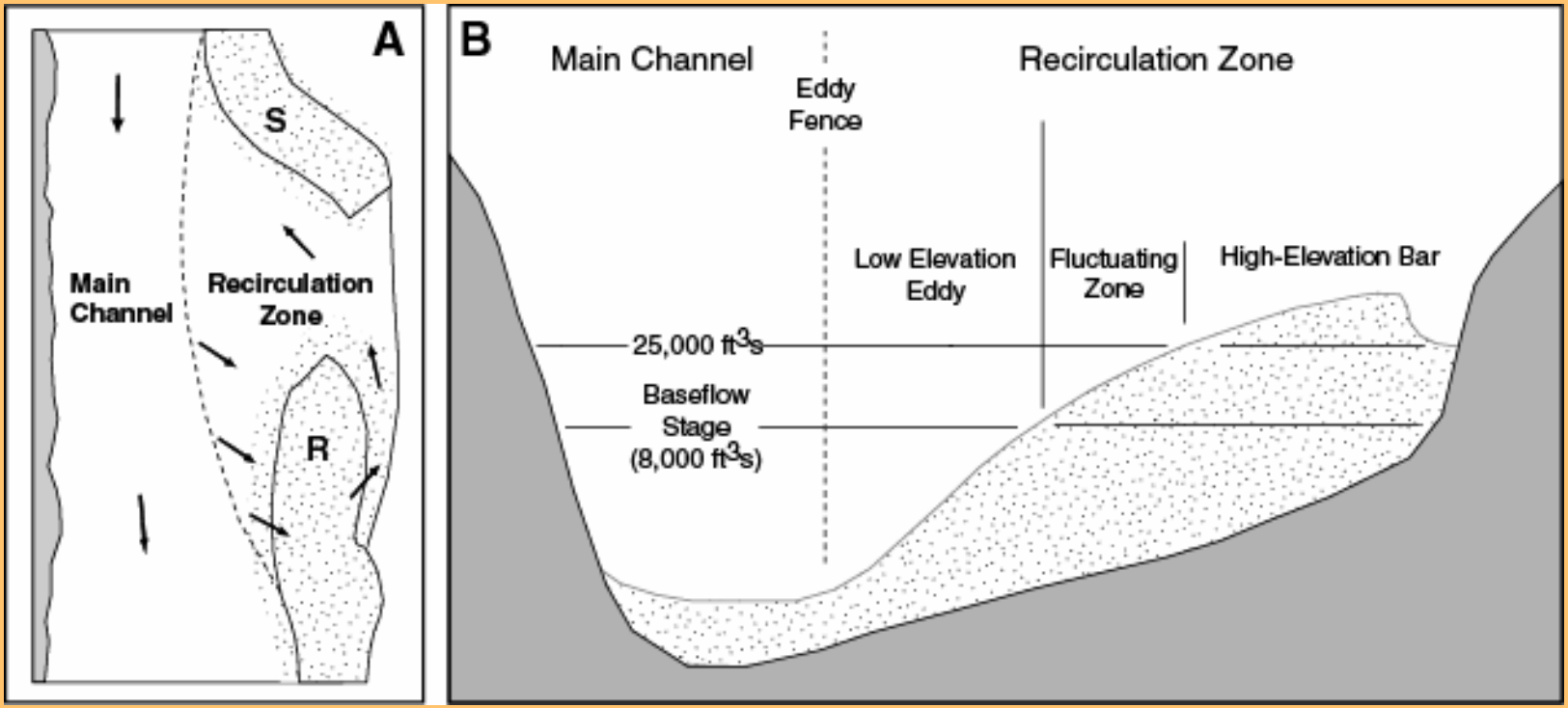



USGS STREAMFLOW-GAGING STATION
145 STUDY SITE
UTAH
ARIZONA
NEVADA
N
Glen Canyon Dam
Lake Powell
Paria River
-6
09382000
09380000
Lee's Ferry (RM 0)
3
8
16
22
30
35
32
47
43
45
50
51
55
09383100
62
65
09401200
Little Colorado River
68
81
87
91
93
119
122
137
139
123
104
145
Grand Canyon National Park
183
194
172
202
213
220
225
Diamond Creek
Lake Mead
Pierce Ferry
10 0 10 25
Miles
10 0 10 20
Kilometers

Long-Term Monitoring Reaches

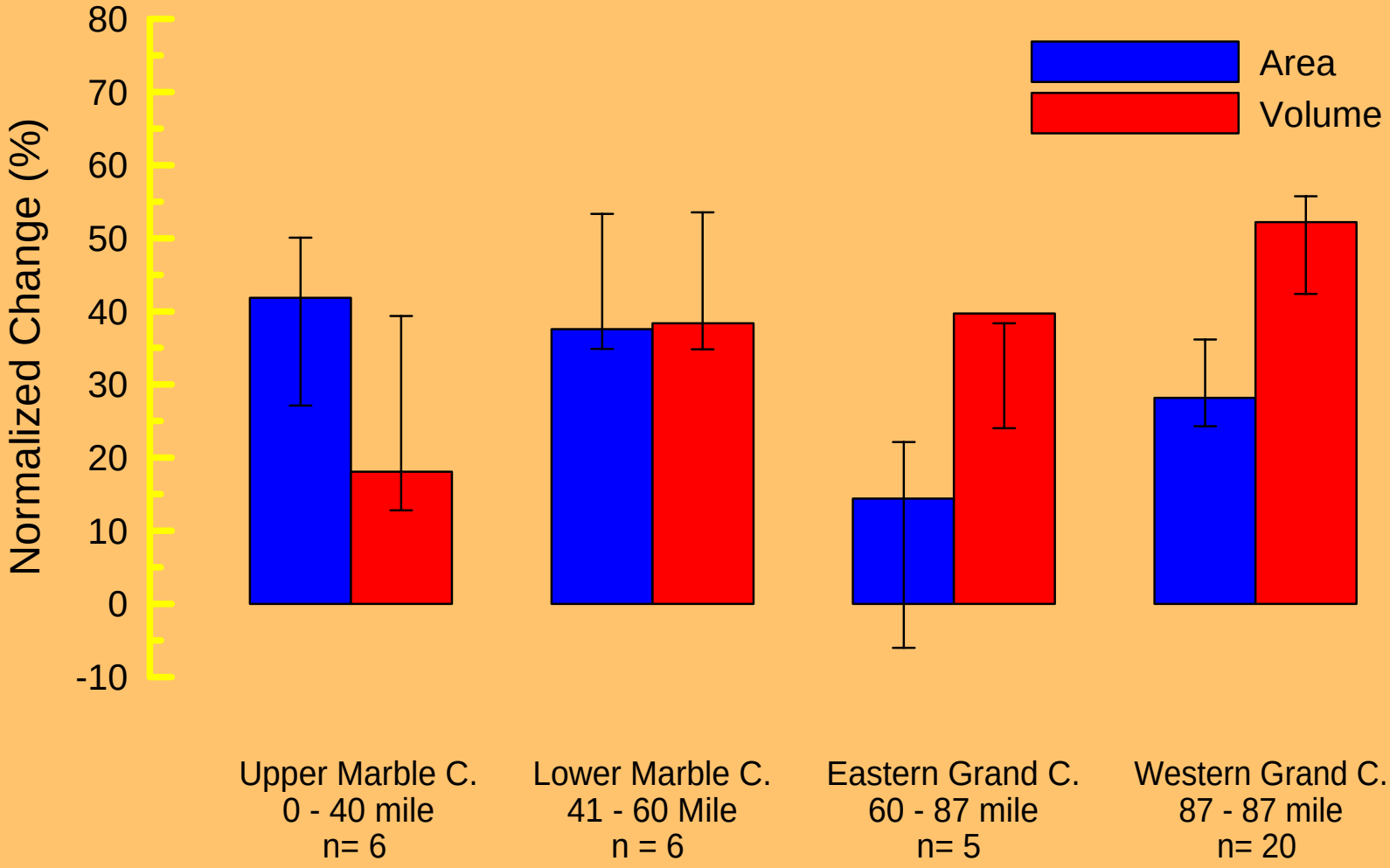


Computational boundaries



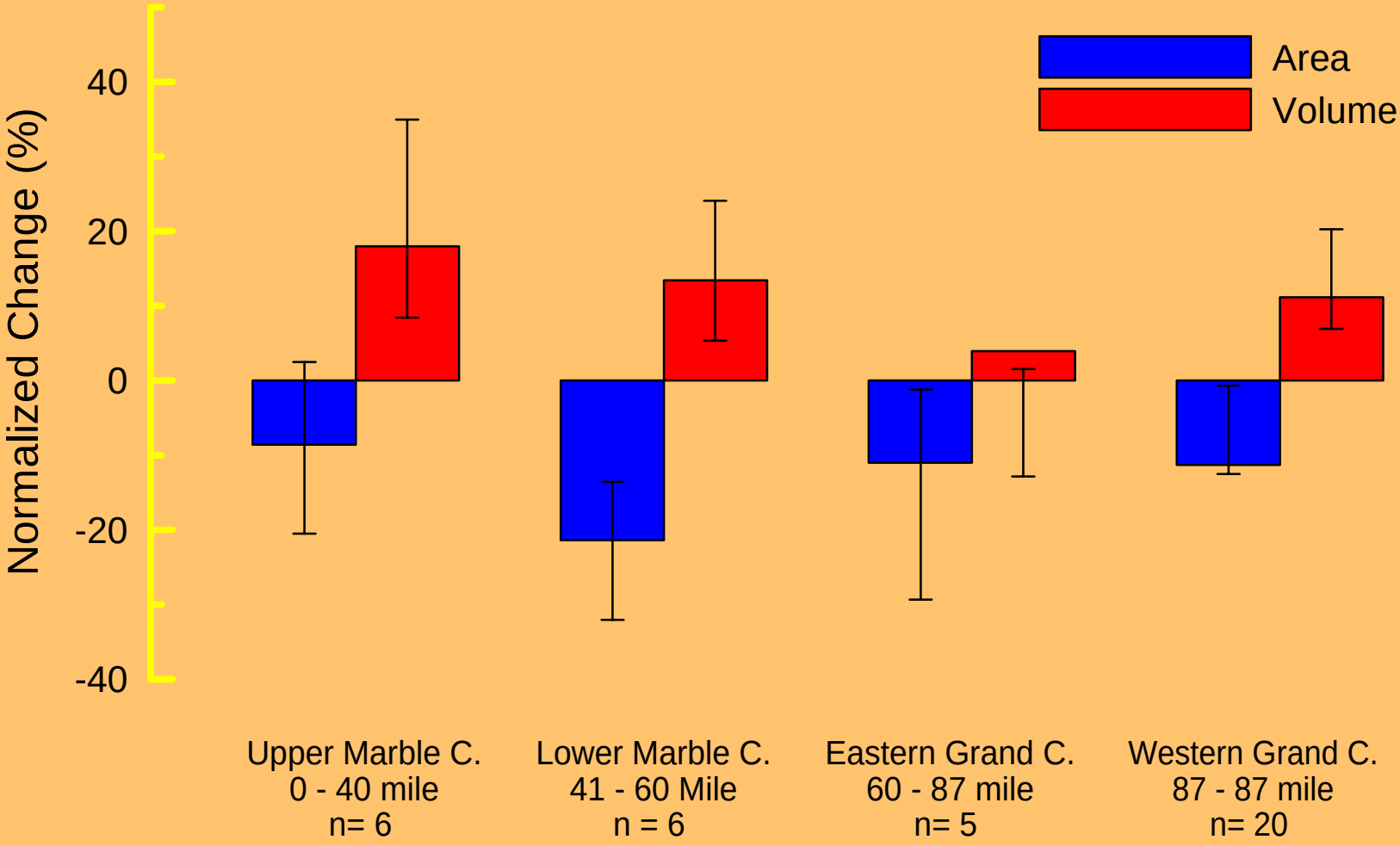
From Hazel et al. (1999)

1996 BHBF Median High Elevation Change (>25,000 ft^3/s)



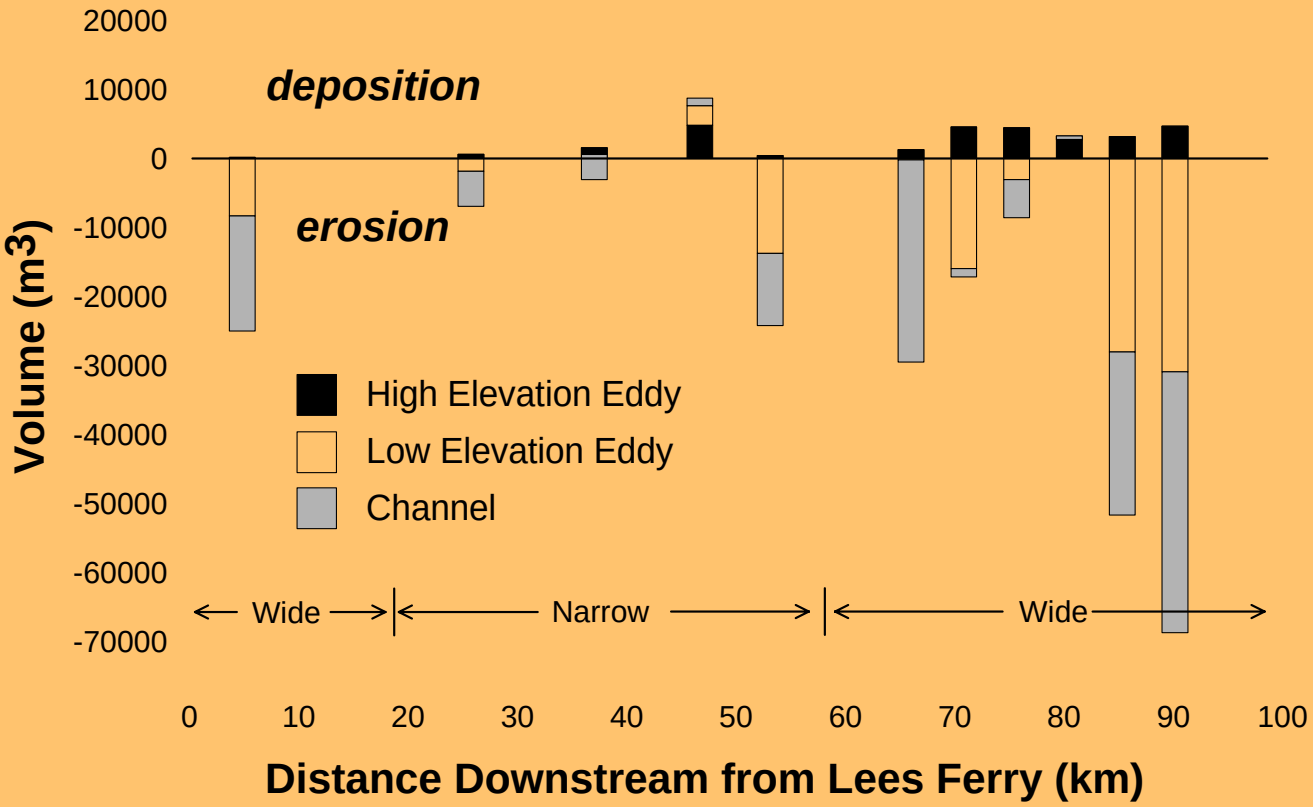
*Error bars are standard error about the mean.

1996 BHBF Median Change in the Fluctuating Zone (8,000-25,000 ft^3/s)



*Error bars are standard error about the mean.

Erosion of the lower parts of bars in 1996



- Net loss of sand in 8 of 11 eddies in Marble Canyon

Site 2.6L

3/23/96

4/06/96

Site 44.5L

3/23/96

4/07/96

Site 55.5R

3/26/96

4/07/96

lessons learned

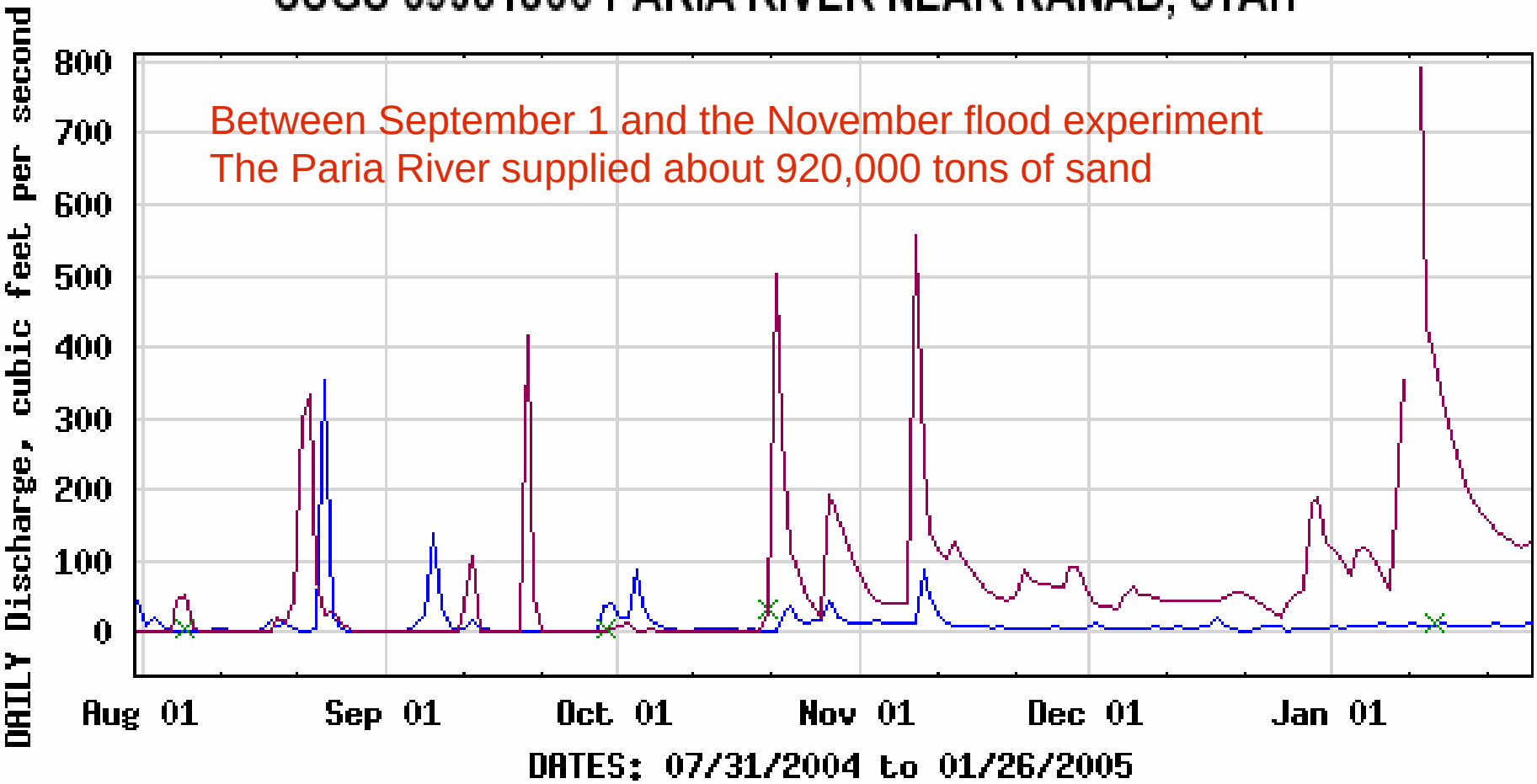
- Sand bars increased in area and volume only at higher elevations
- Area decreases in the fluctuating zone resulted from vertical aggradation or bar narrowing
- Bar narrowing was caused by erosion of the lower elevation parts of bars (Hazel et al., 1999; Schmidt, 1999)
- Approximately 90% of the sand exported from Marble Canyon was derived from eddy storage, rather than sandy deposits on the main channel bed (Hazel et al., in press)
- Eddies occupy a small percentage (~17%) of the total channel area in Marble Canyon (Schmidt et al., 2004)

Design of the 2004 High Experimental Flow

- Keep dam releases relatively low (<9,000 ft^3/s) during Sept.-Nov. 2004 to allow the accumulation of new tributary sand inputs in the channel
- If >800,000 metric tons of new sand are retained in Marble Canyon, follow this period with a 60-hour release of 45,000 ft^3/s
- With an increased sand supply a shorter duration high-volume release should result in increased bar area and volume at all elevations, and
- reduce the amount of sand supplied by eddies to main-channel transport

USGS

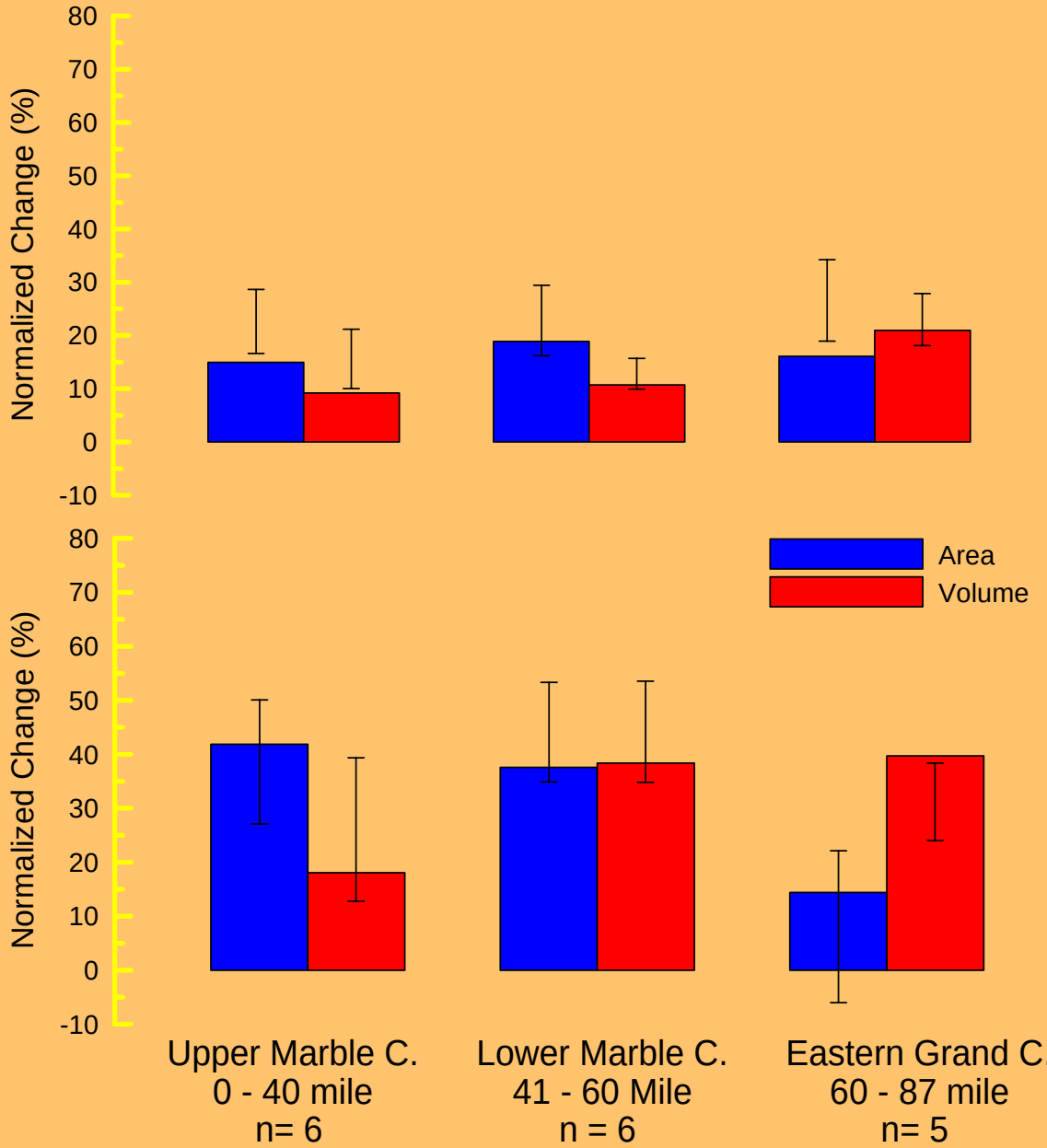
USGS 09381800 PARIA RIVER NEAR KANAB, UTAH



Median High Elevation Change (>25,000 ft^3/s)

2004 HEF

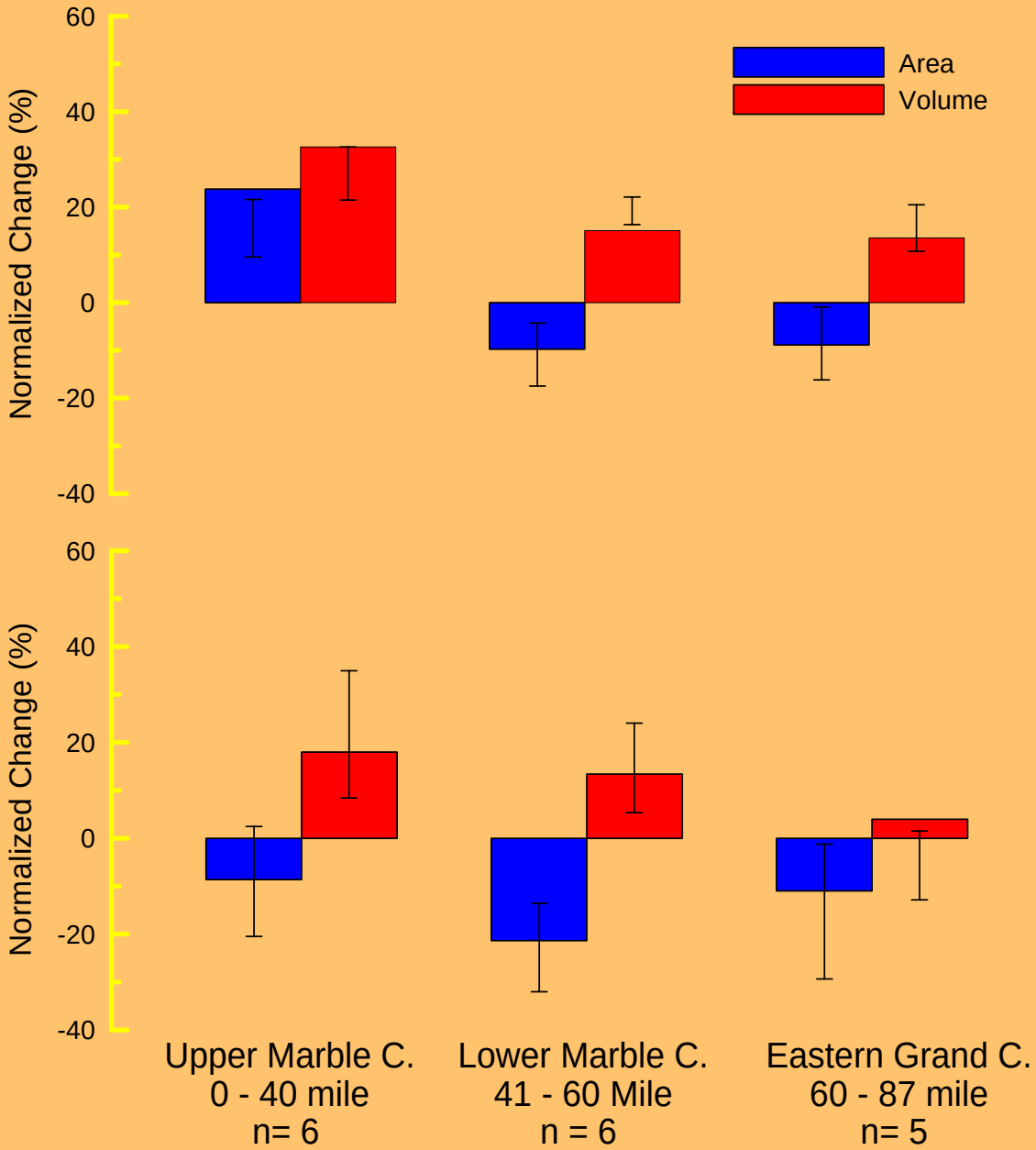
1996 BHBF



Median Change in the Fluctuating zone (8,000-25,000 ft^3/s)

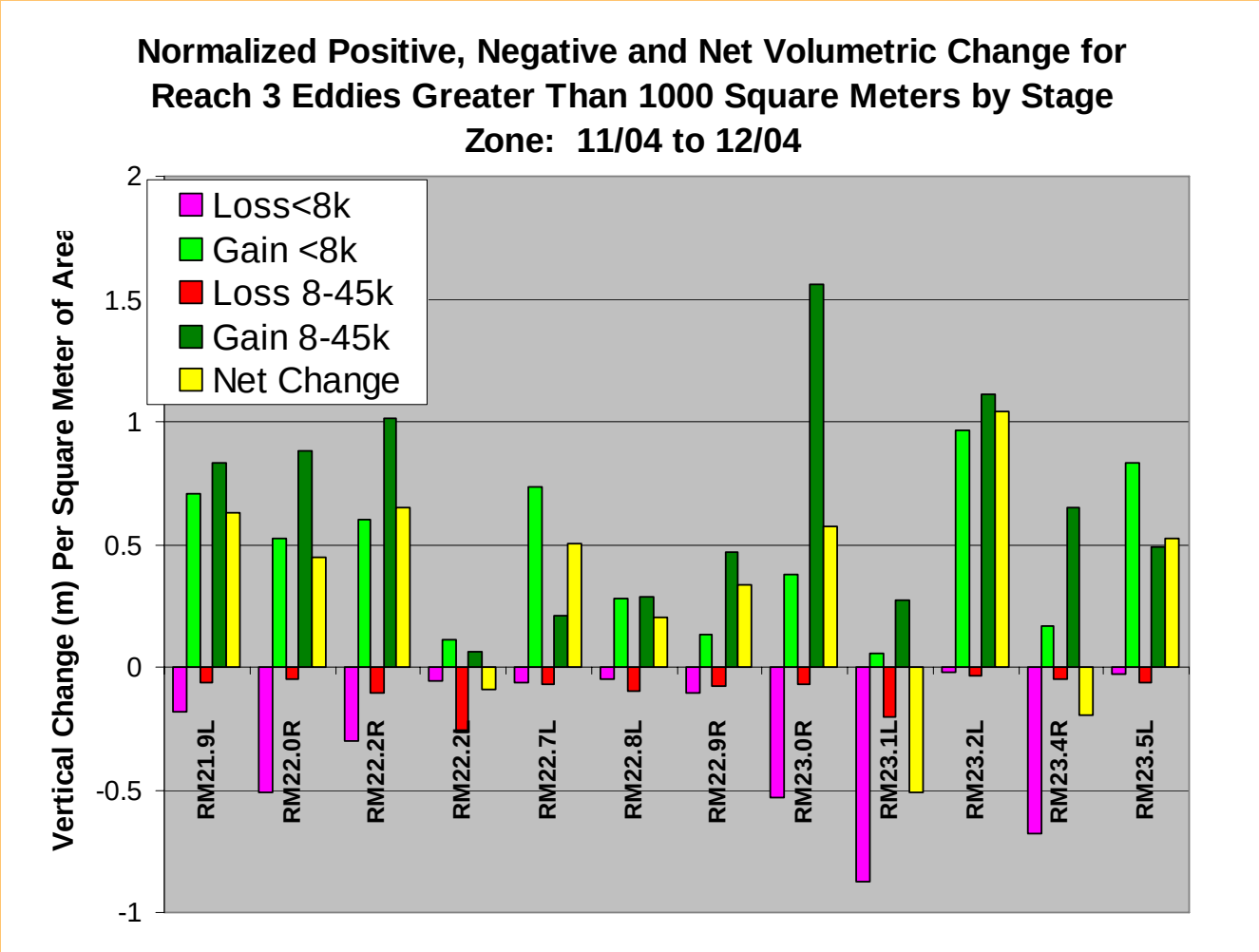
2004 HEF

1996 BHBF



LTM Reach 3 (river miles 21.9-23.5)

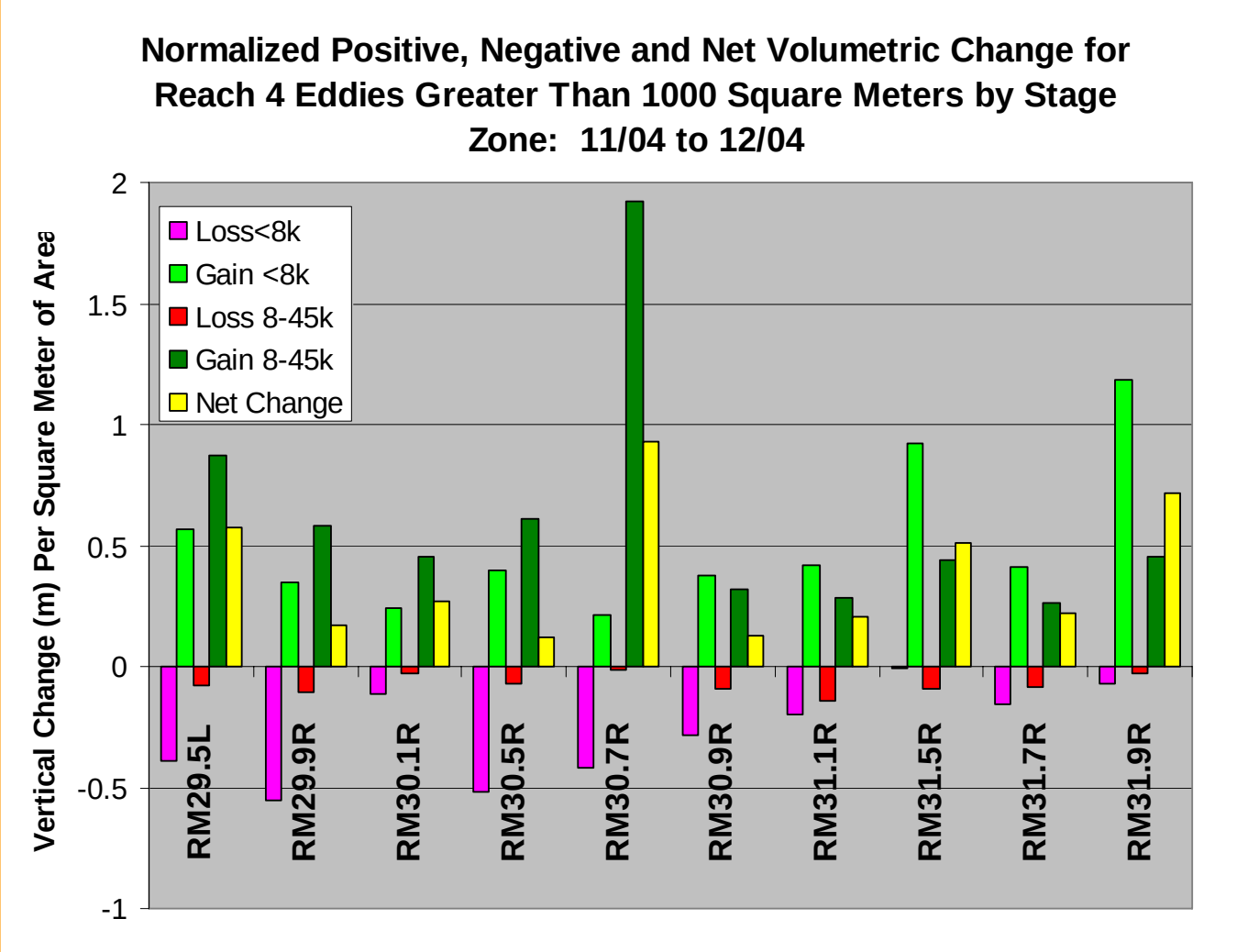
9 out of 12 eddies were net positive



Breedlove, et al. this symposium

LTM Reach 4 (river miles 29.5-31.9)

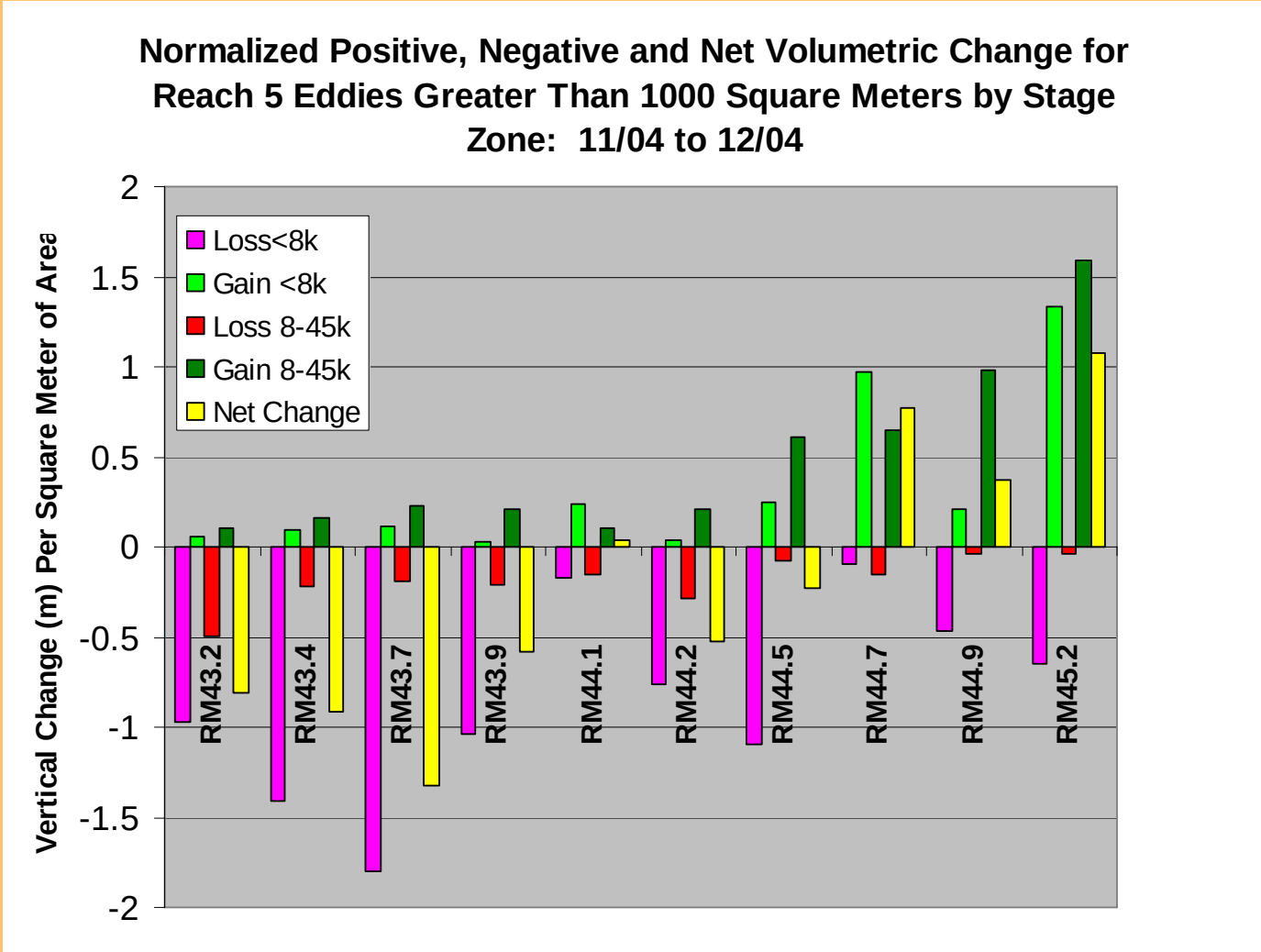
10 out of 10 eddies were net positive



Breedlove, et al. this symposium

LTM Reach 5 (river miles 42-45.2)

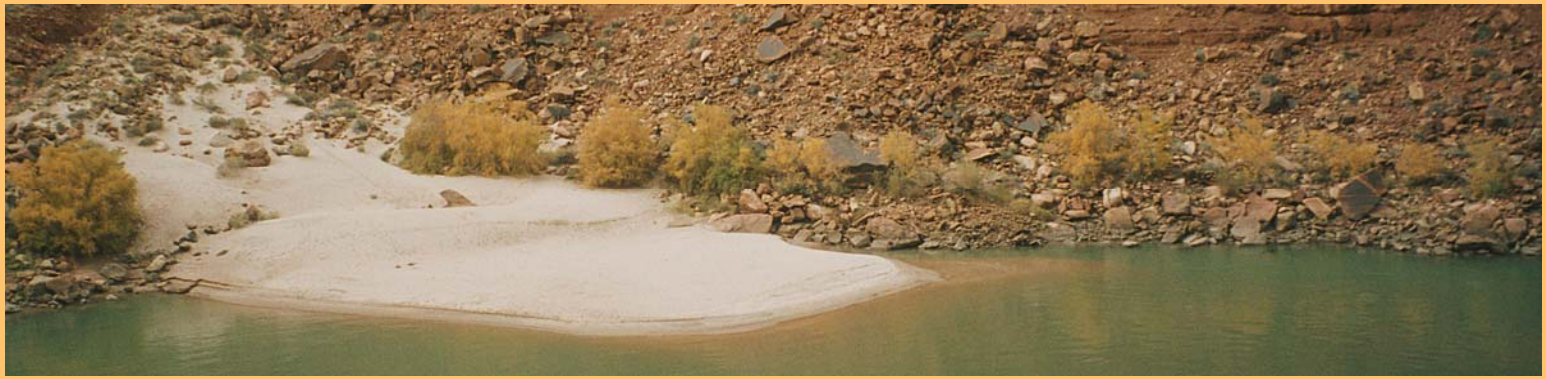
6 out of 10 eddies were net negative



Breedlove, et al. this symposium

Site 21.8R

11/20/04



11/27/04

12/27/04

Site 30.1R

11/20/04

11/27/04

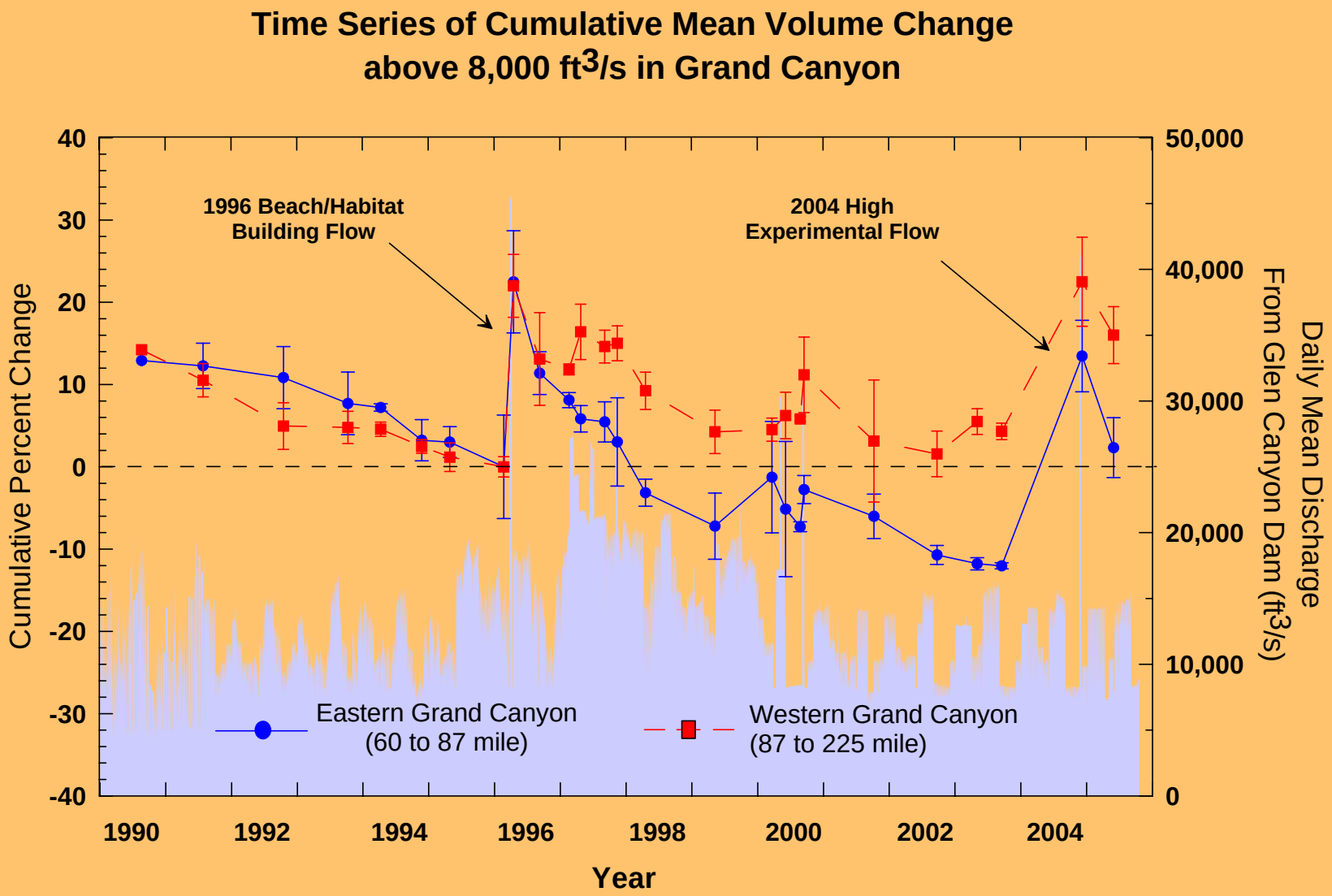
12/27/04

Site 55.5R

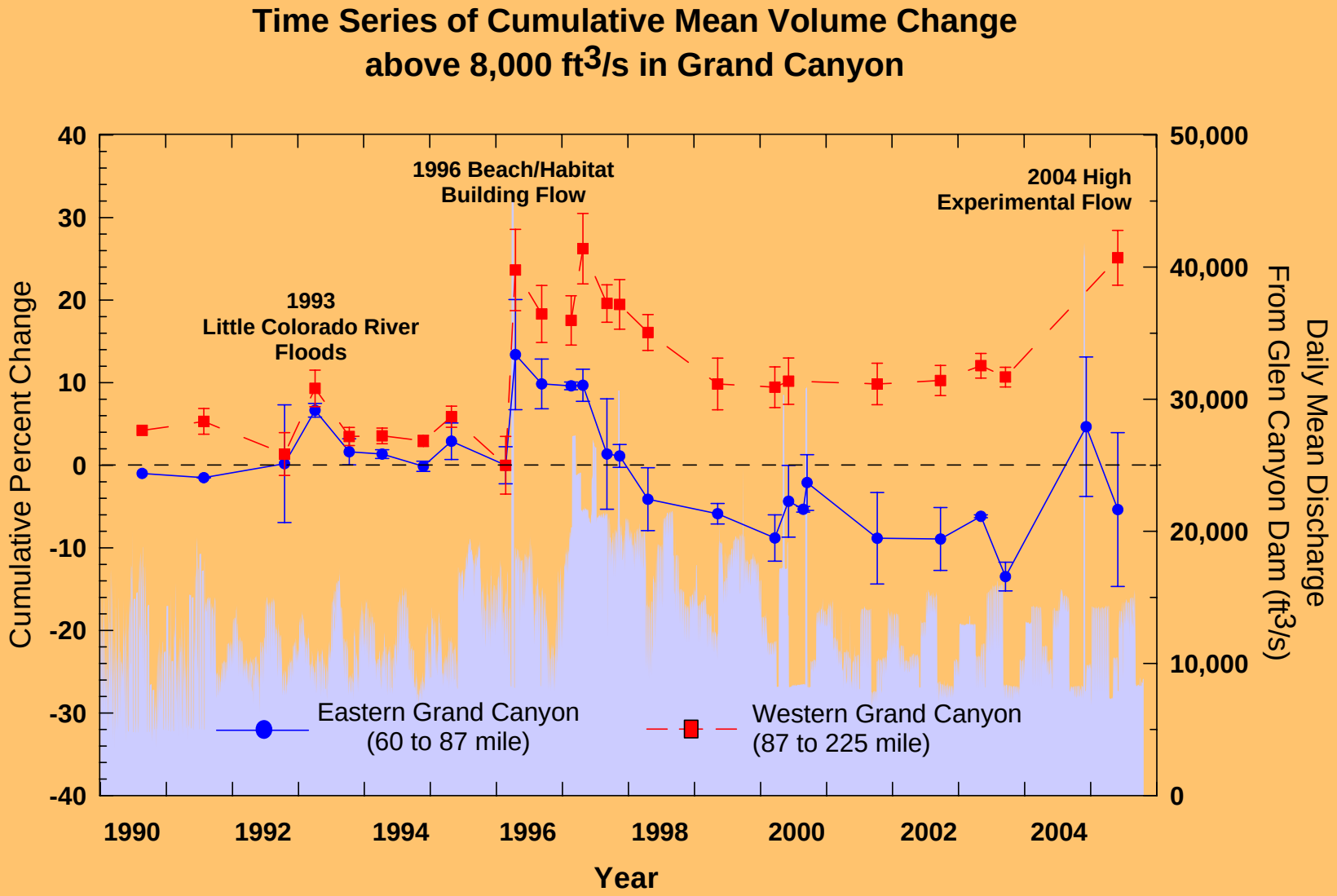
11/20/04

11/28/04

How much was left 6 months after the 2004 Experiment?



How much was left 6 months after the 2004 Experiment?



Site 21.8R

12/27/04

5/11/05

7/07/05

Site 30.1R

12/27/04

5/11/05

7/07/04

Conclusions

- Greater bar building in upper Marble Canyon in 2004 than in 1996
  - -50% of the bars were larger in both area and volume above the stage elevation of 8,000 ft^3/s than they were following the 1996 BHBF
  - -Reach results indicate that there was a net increase in eddies in reaches 3 (river miles 22-25) and 4 (river miles 29-33)

- During the 1996 BHBF sand bars increased in area and volume only at high elevation
  - -Same trend observed in 2004 downstream from upper Marble Canyon
  - -Erosion of the lower elevation parts of bars results in net eddy loss

- In the planning of future controlled floods, more sand is required to achieve increases in total area and volume of eddy sandbars throughout Marble and Grand Canyons