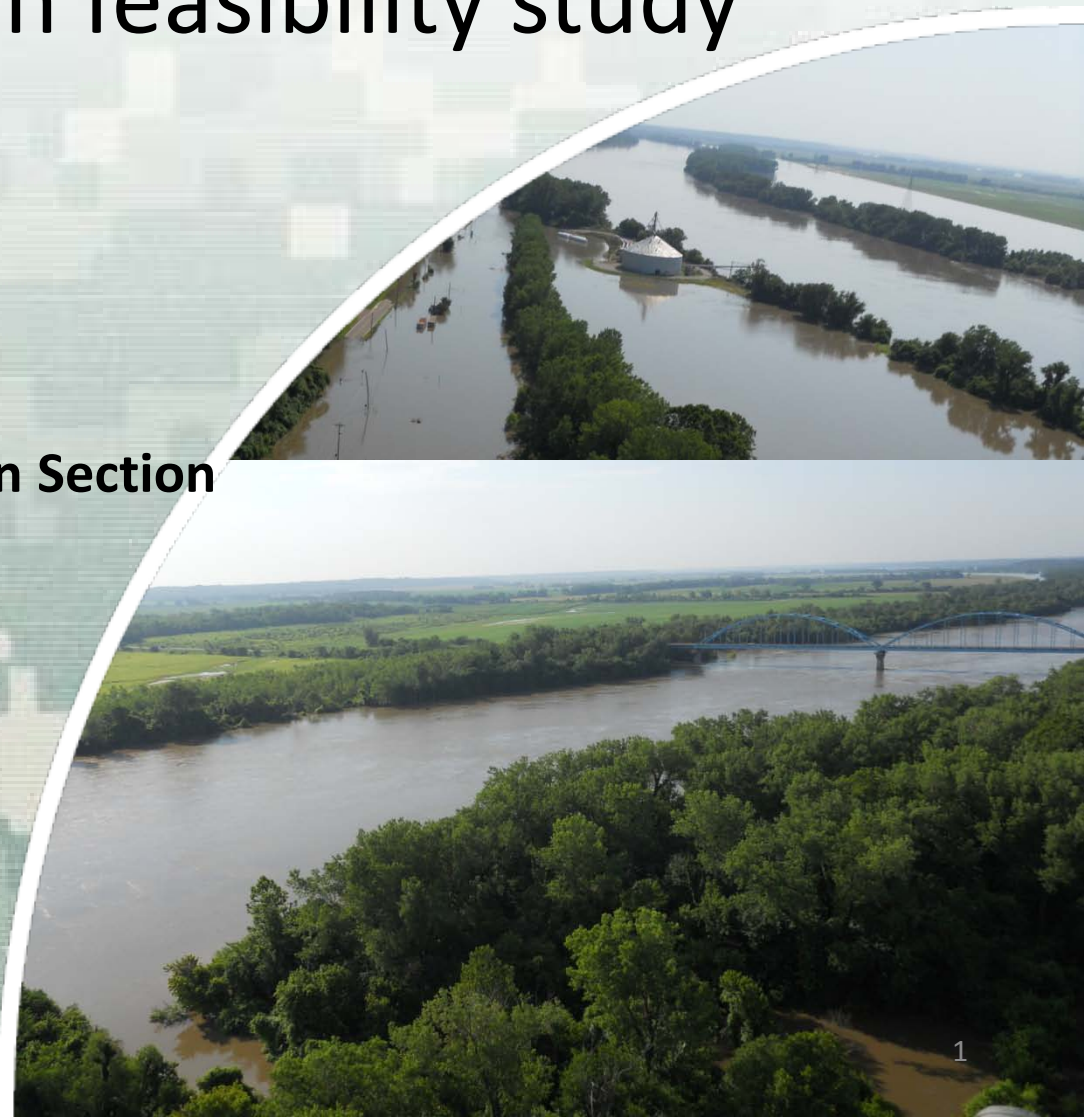
Assessing changes to the river channel - bed degradation feasibility study



John Shelley

River Engineering and Restoration Section

Kansas City District

18 January 2012

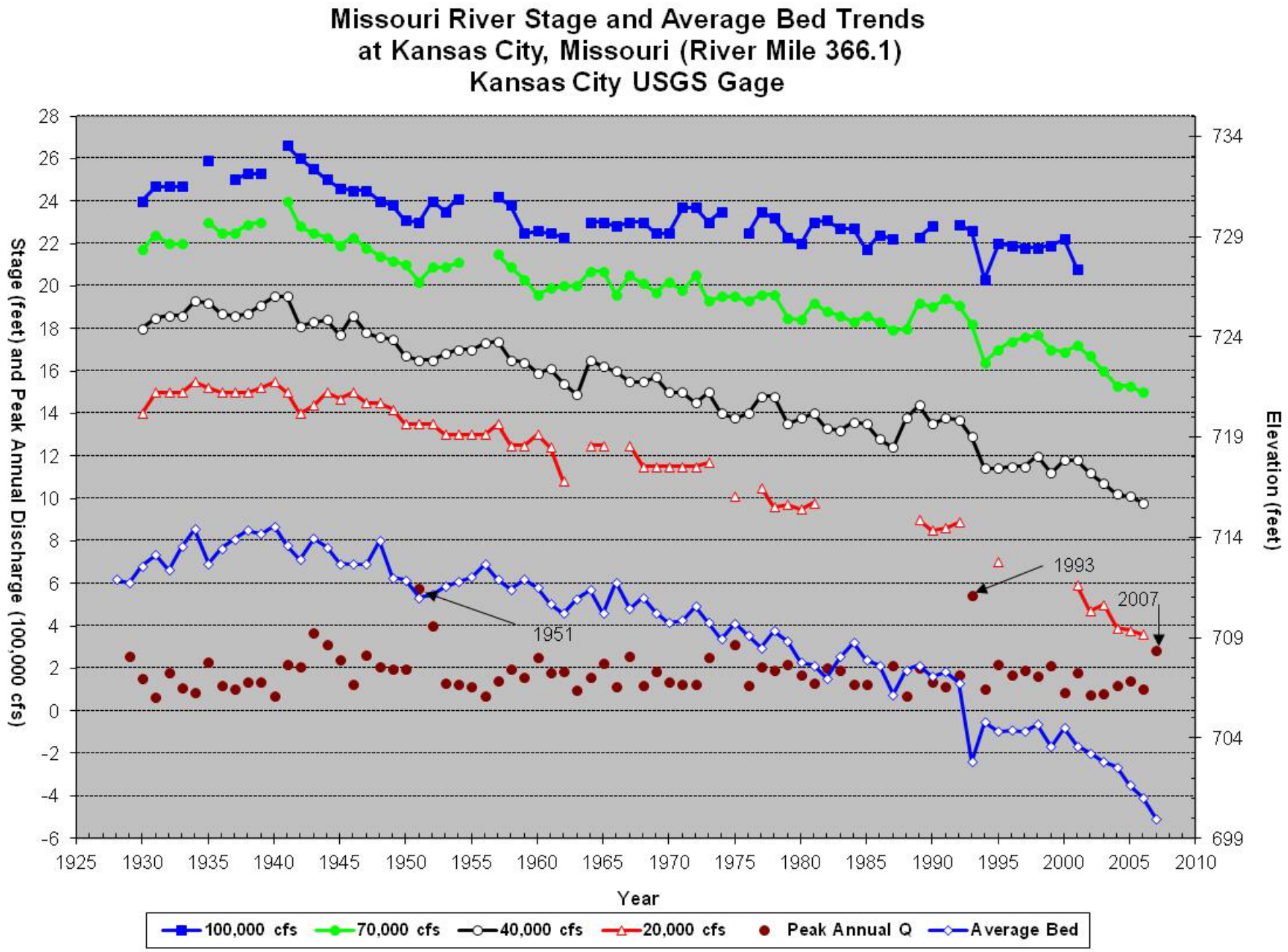
US Army Corps of Engineers

BUILDING STRONG®

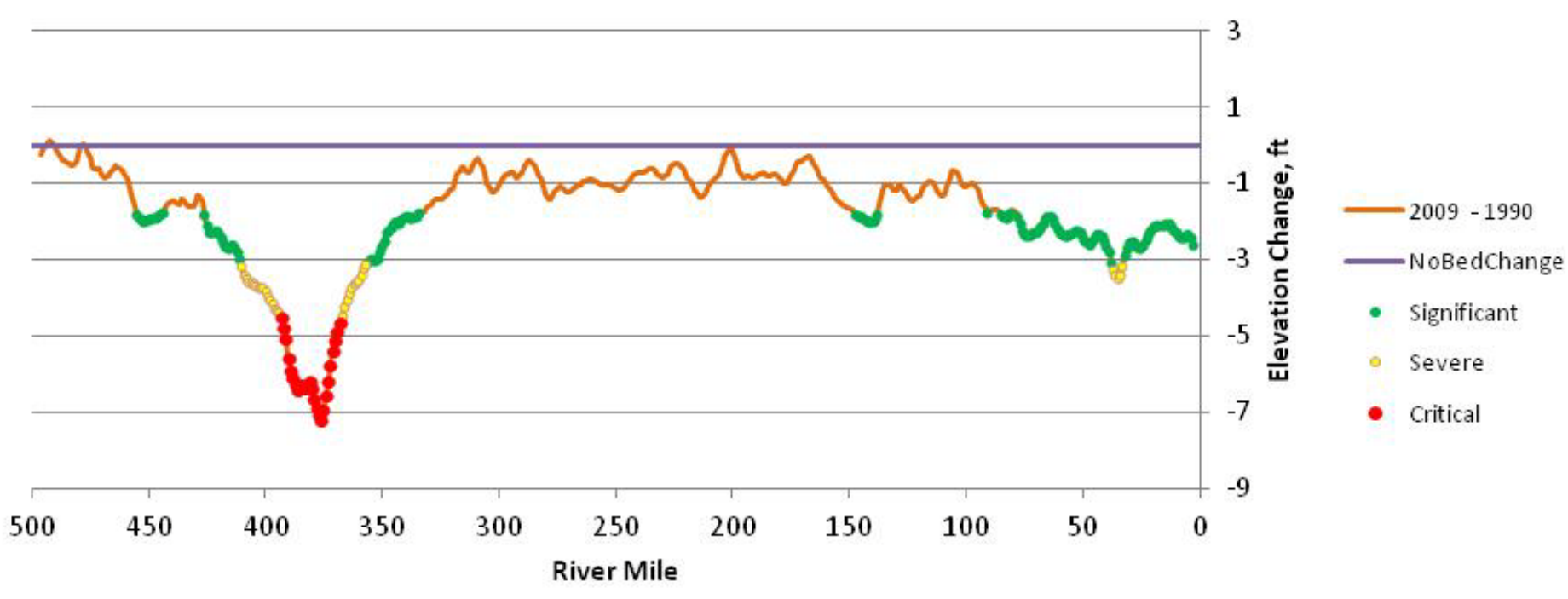
Outline

- How we know the river is dropping
  - Gages
  - Water surface indications
  - Bathymetric survey indications
- MR Degradation Feasibility Study
  - Hydraulic modeling
  - Sediment modeling
- Degradation and conveyance
- Data uses, data gaps

BUILDING STRONG®

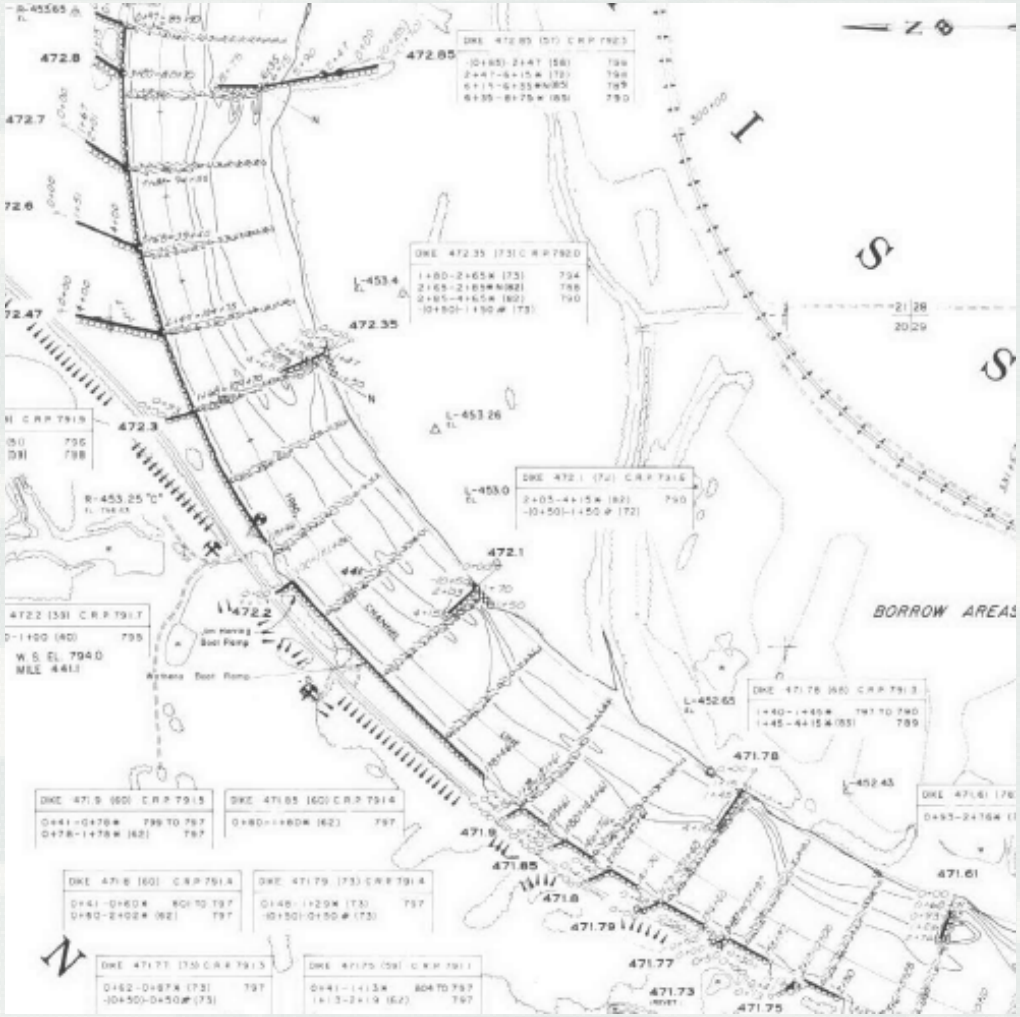

Missouri River Stage and Average Bed Trends
at Kansas City, Missouri (River Mile 366.1)
Kansas City USGS Gage
Stage (feet) and Peak Annual Discharge (100,000 cfs)
Elevation (feet)
Year
1951
1993
2007
100,000 cfs
70,000 cfs
40,000 cfs
20,000 cfs
Peak Annual Q
Average Bed

Water Surface Changes



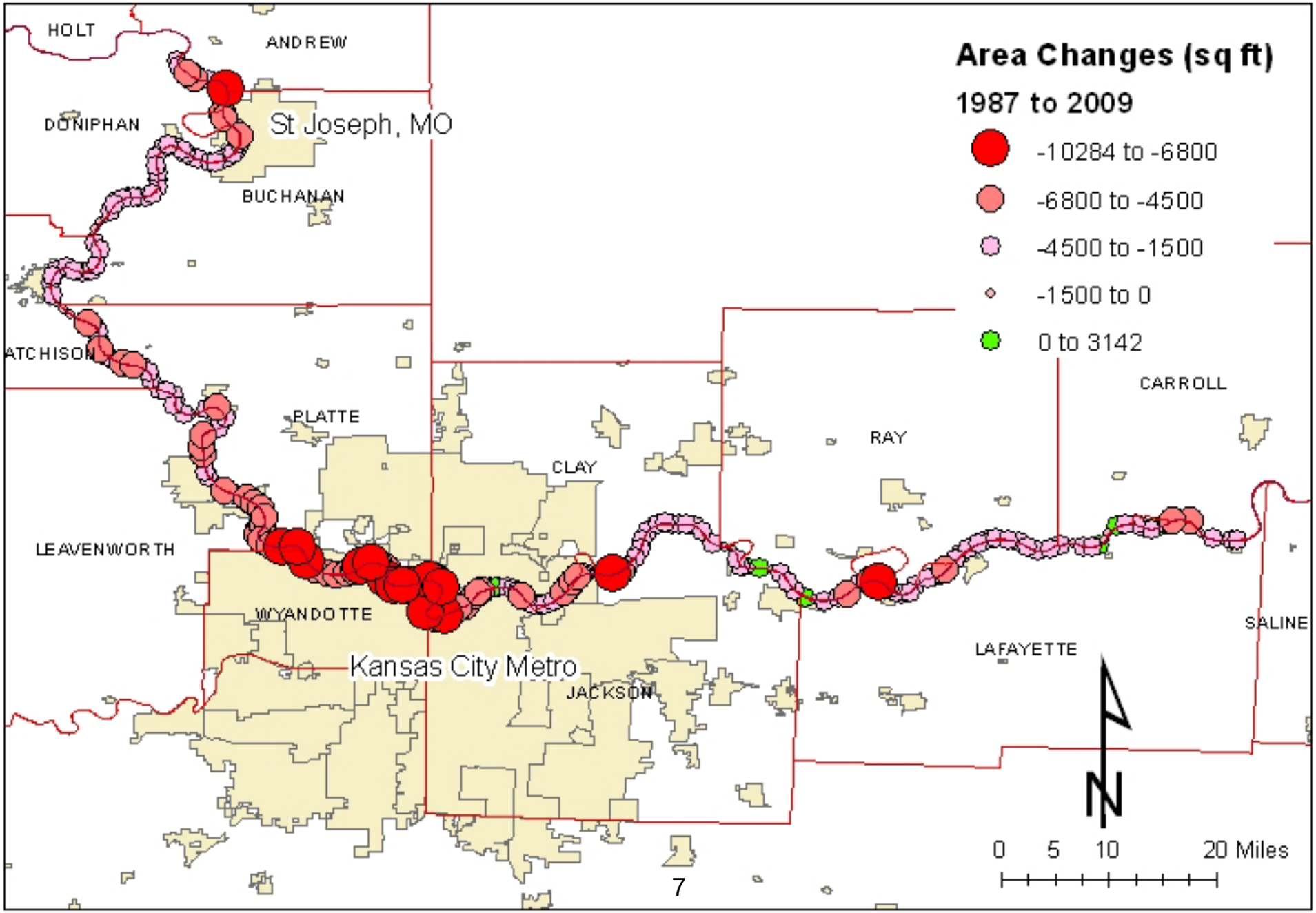
BUILDING STRONG®

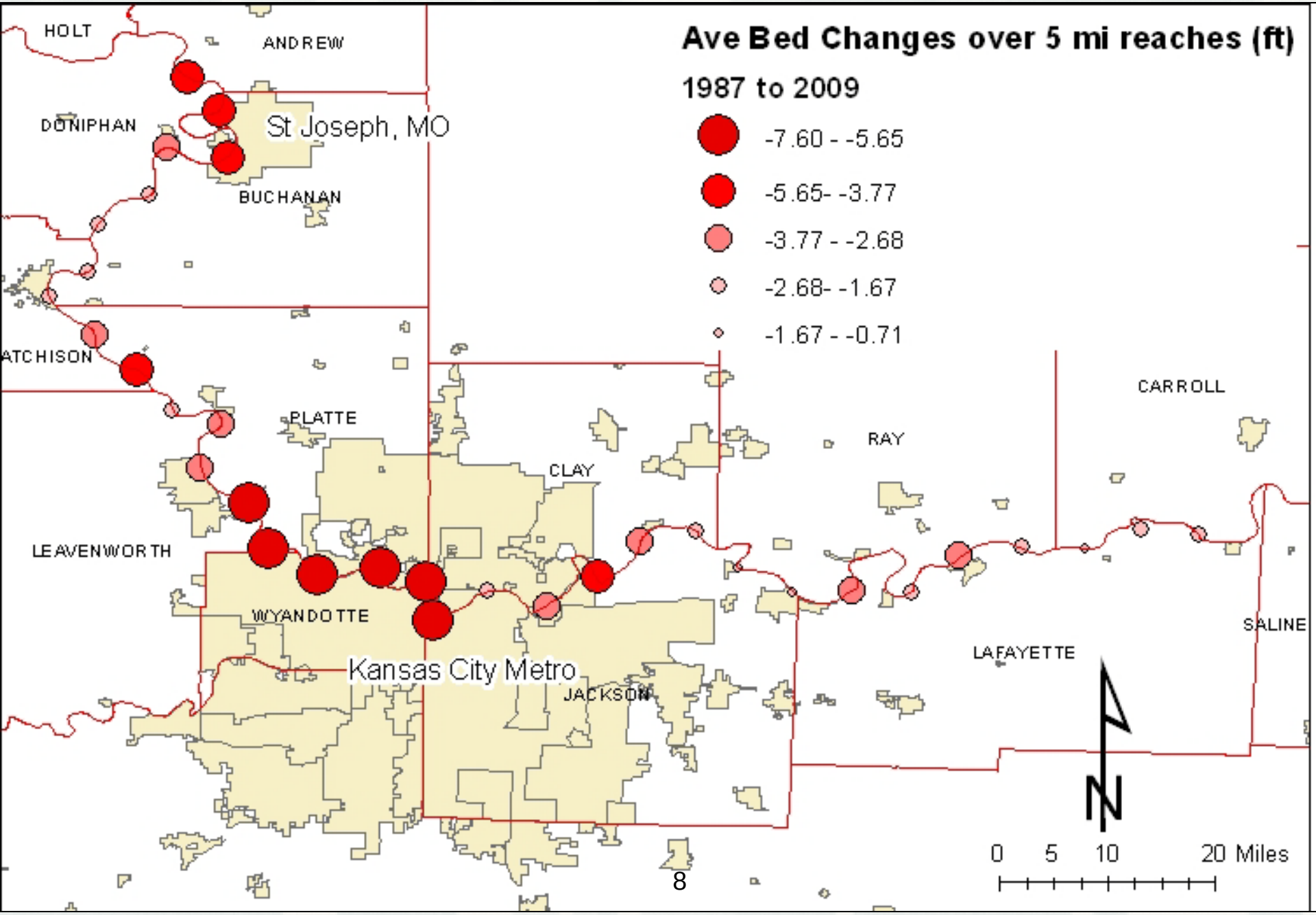
Bathymetric Surveys

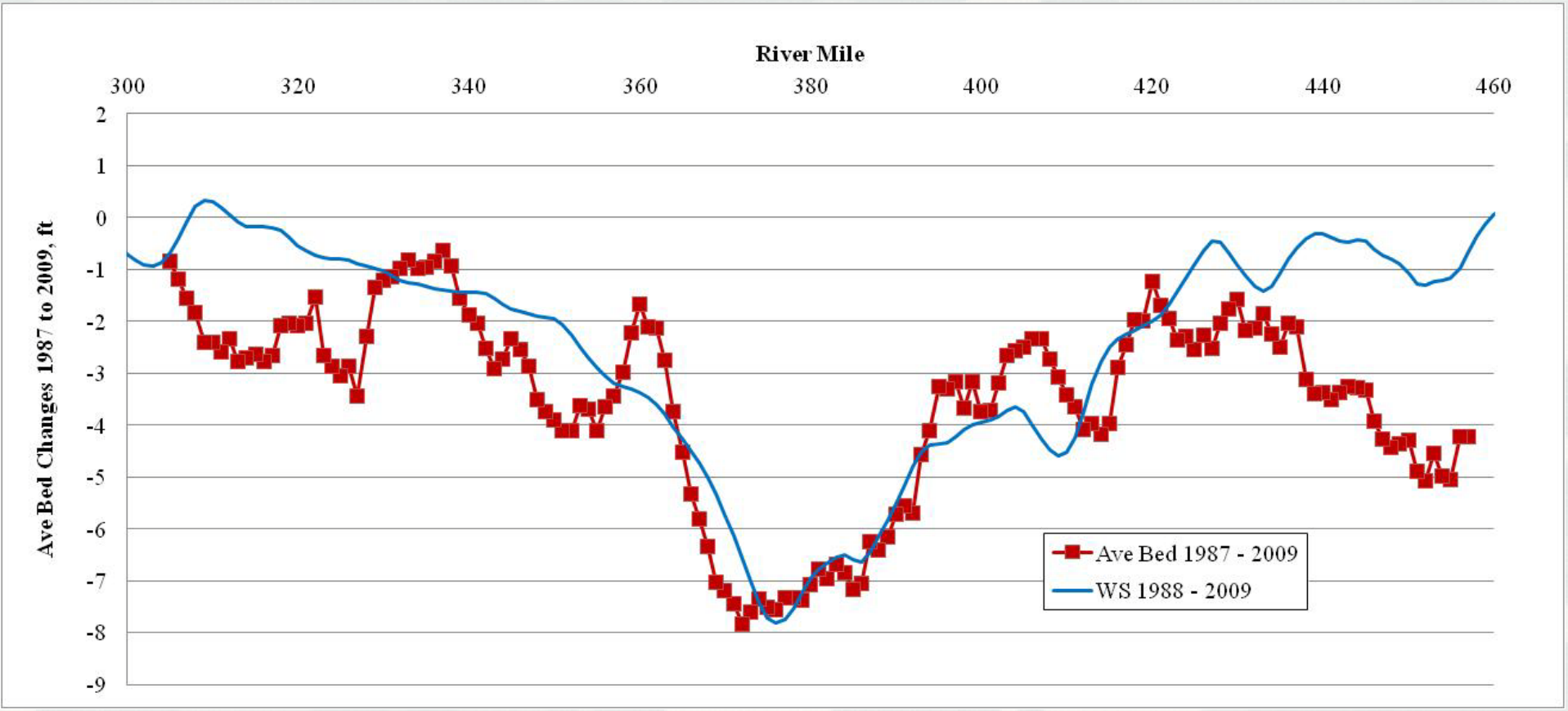


1987 Hydrographic Survey

250 ft-spaced transects:
2007, 2008, 2009


Area Changes (sq ft)
1987 to 2009
-10284 to -6800
-6800 to -4500
-4500 to -1500
-1500 to 0
0 to 3142
HOLT
ANDREW
DONIPHAN
St Joseph, MO
BUCHANAN
ATCHISON
PLATTE
CLAY
RAY
CARROLL
LEAVENWORTH
WYANDOTTE
Kansas City Metro
JACKSON
LAFAYETTE
SALINE
N
0 5 10 20 Miles


Ave Bed Changes over 5 mi reaches (ft)
1987 to 2009
-7.60 - -5.65
-5.65- -3.77
-3.77 - -2.68
-2.68- -1.67
-1.67 - -0.71
HOLT
ANDREW
DONIPHAN
St Joseph, MO
BUCHANAN
ATCHISON
PLATTE
CLAY
RAY
CARROLL
LEAVENWORTH
WYANDOTTE
Kansas City Metro
JACKSON
LAFAYETTE
SALINE
N
0 5 10 20 Miles



BUILDING STRONG®

Argosy Road Bridge Pier Exposure

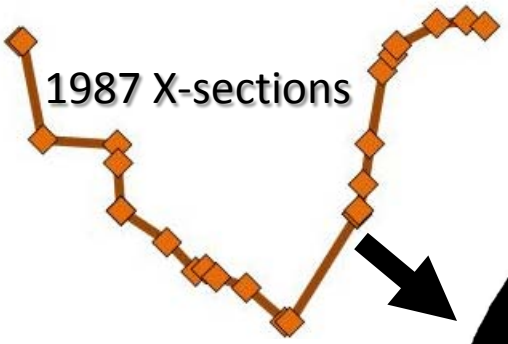
Missouri River Bed Degradation Feasibility Study

- Costs of doing nothing
  - Predict degradation for 50 years into the future
  - Assess increased costs to infrastructure (levees, dikes, bridges, water intakes, etc.)

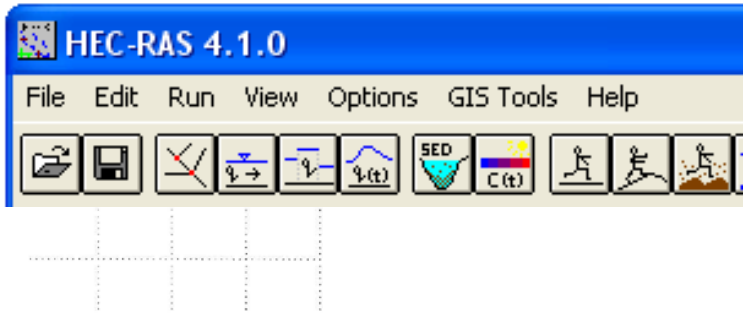
- Costs and benefits of alternatives
  - Predict bed change with alternative in place
  - Predict effects on infrastructure

BUILDING STRONG®

Mobile-bed Modeling



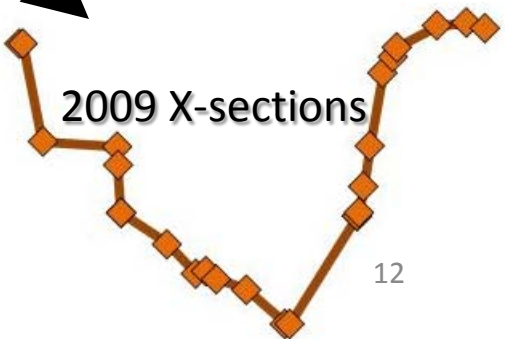
Hydraulic calculations



Sediment transport

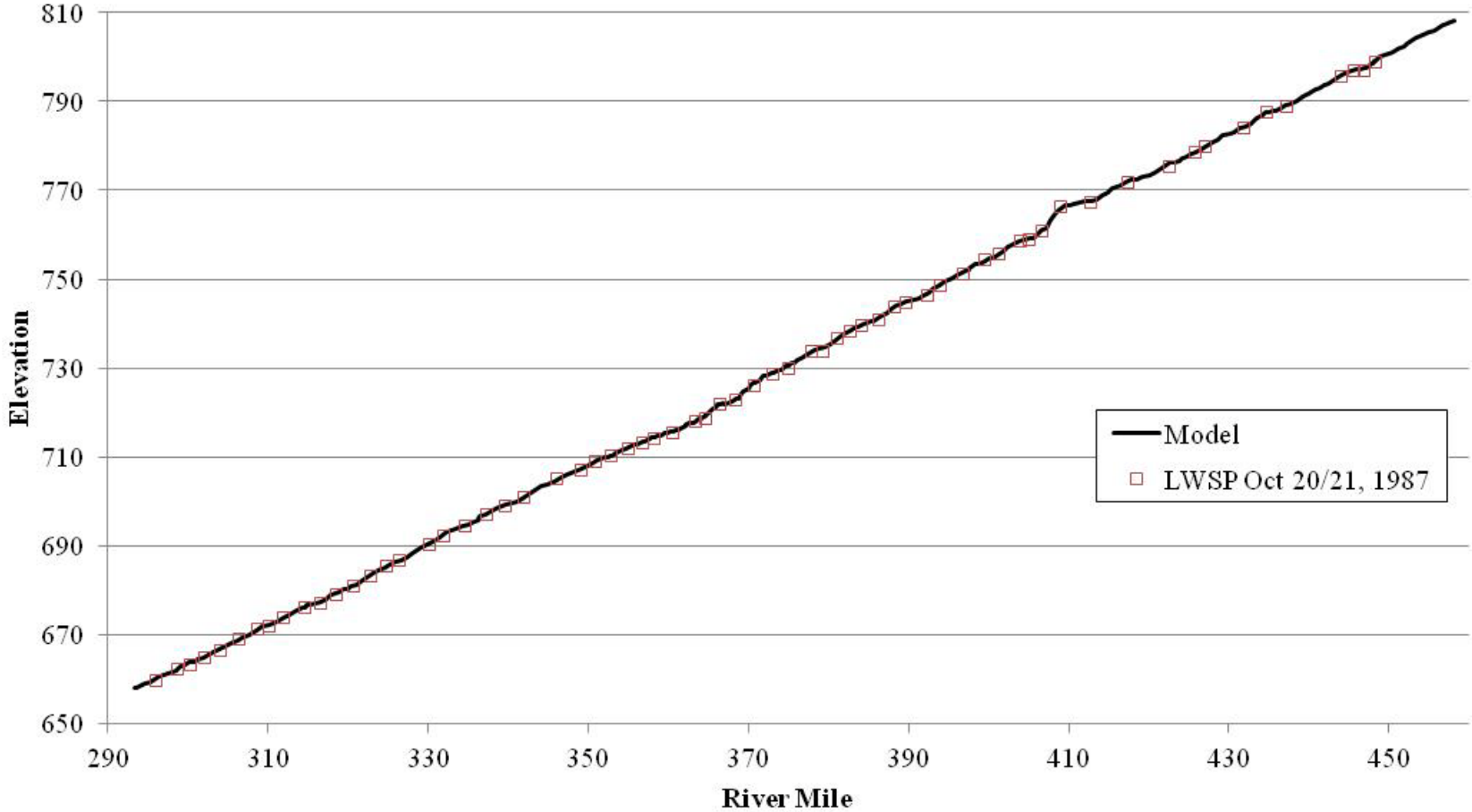
Daily flow

Update X-sections



Sediment input/extraction

Hydraulic Model Calibration



Hydraulic Calibration

	Flow at KC (cfs)	Average Error ±(ft)
Oct 20/21, 1987	51,900	0.18
May 17, 1988	44,700	0.51
September 6, 1988	41,000	0.55
1993 High Water Marks	529,000	1.47

River Miles	Manning's n
488.2 -366.2	0.018
366.2 -293.4	0.022

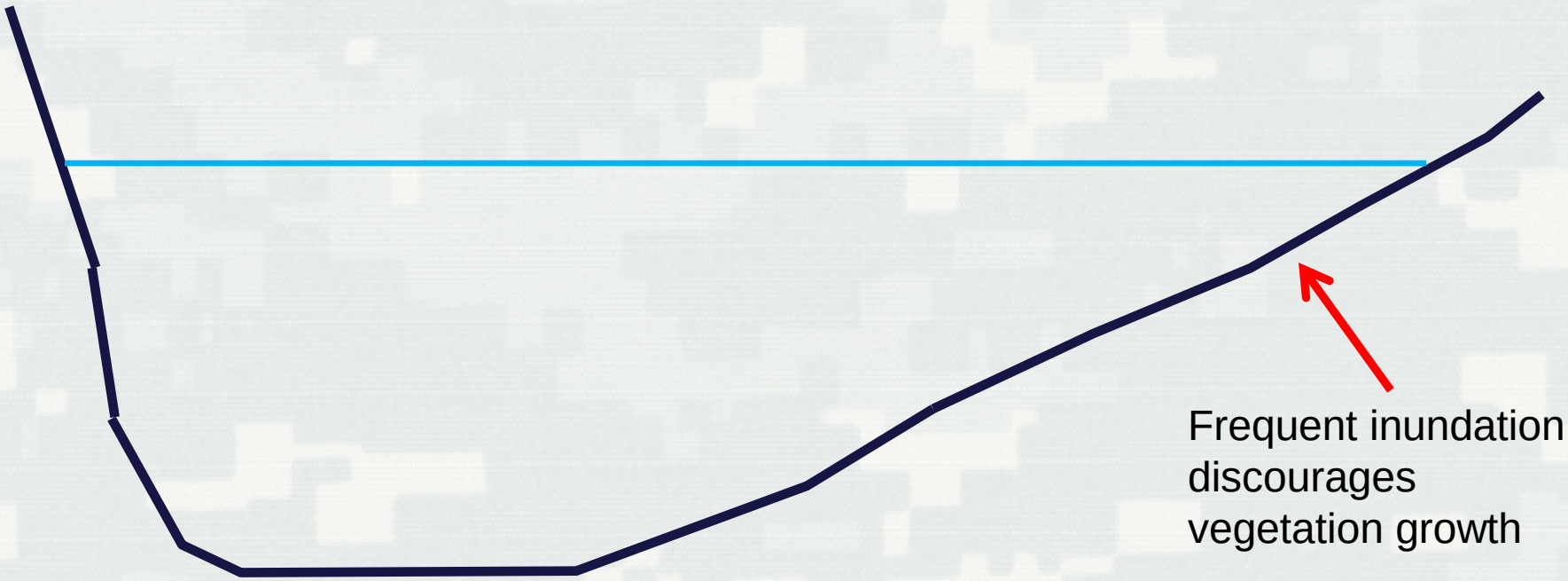
BUILDING STRONG®

The big question (for this group)…?

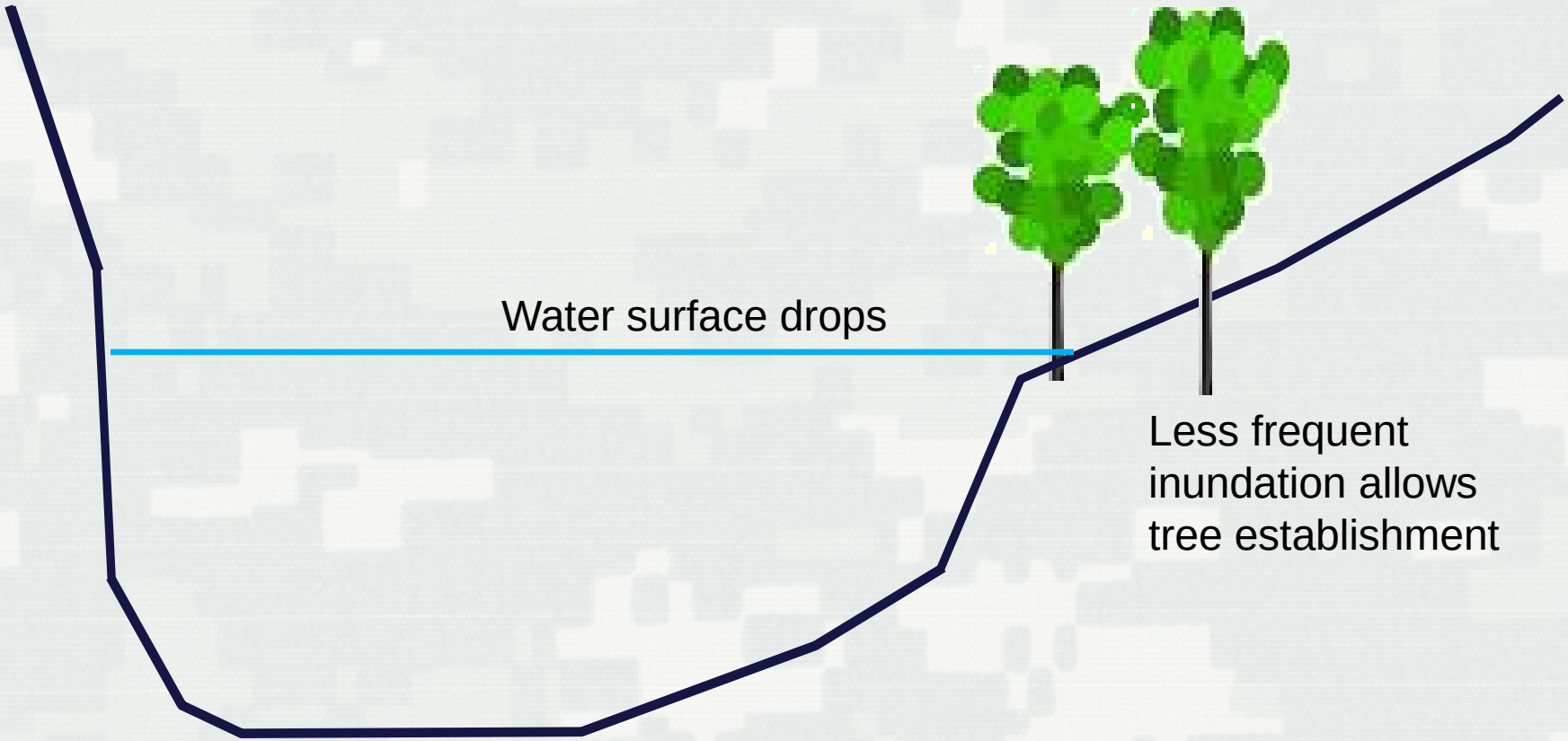
- Does degradation cause increased or decreased flood conveyance capacity?

BUILDING STRONG®

Degradation and Flood Stages



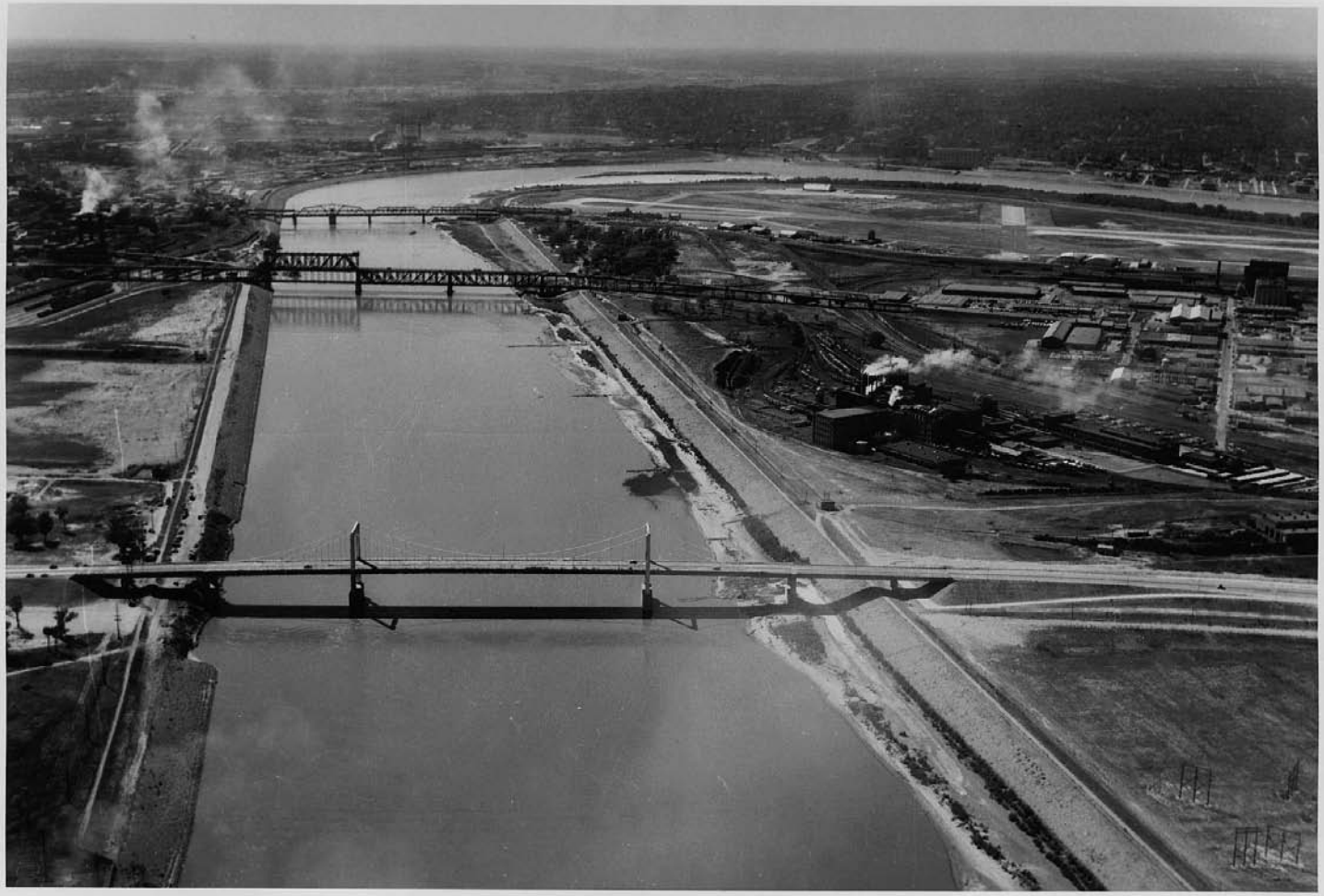
BUILDING STRONG®



BUILDING STRONG®

Vegetation slows water and encourages deposition from moderate/high flow events, resulting in land accretion

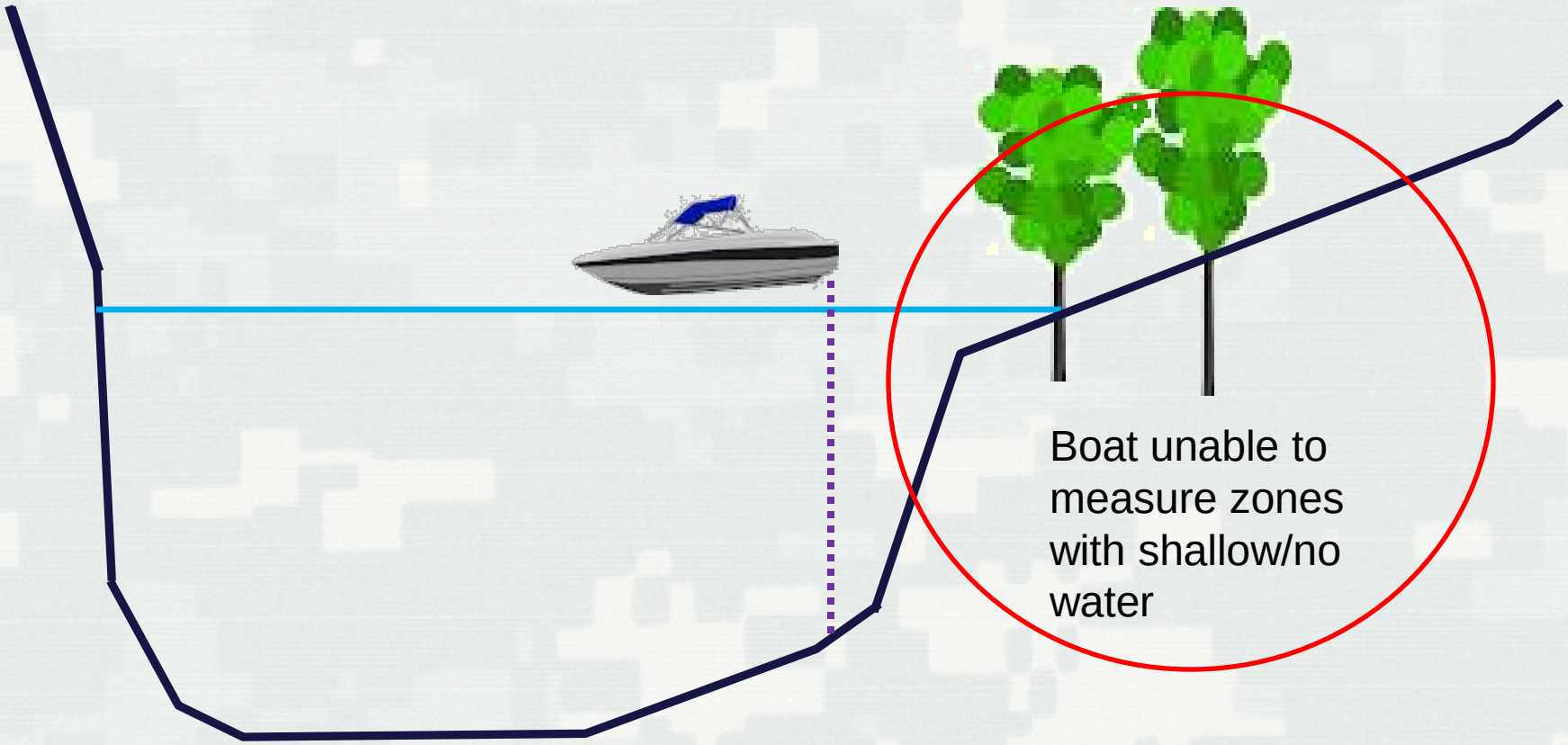
September 23, 1954 Q = 36,200 cfs



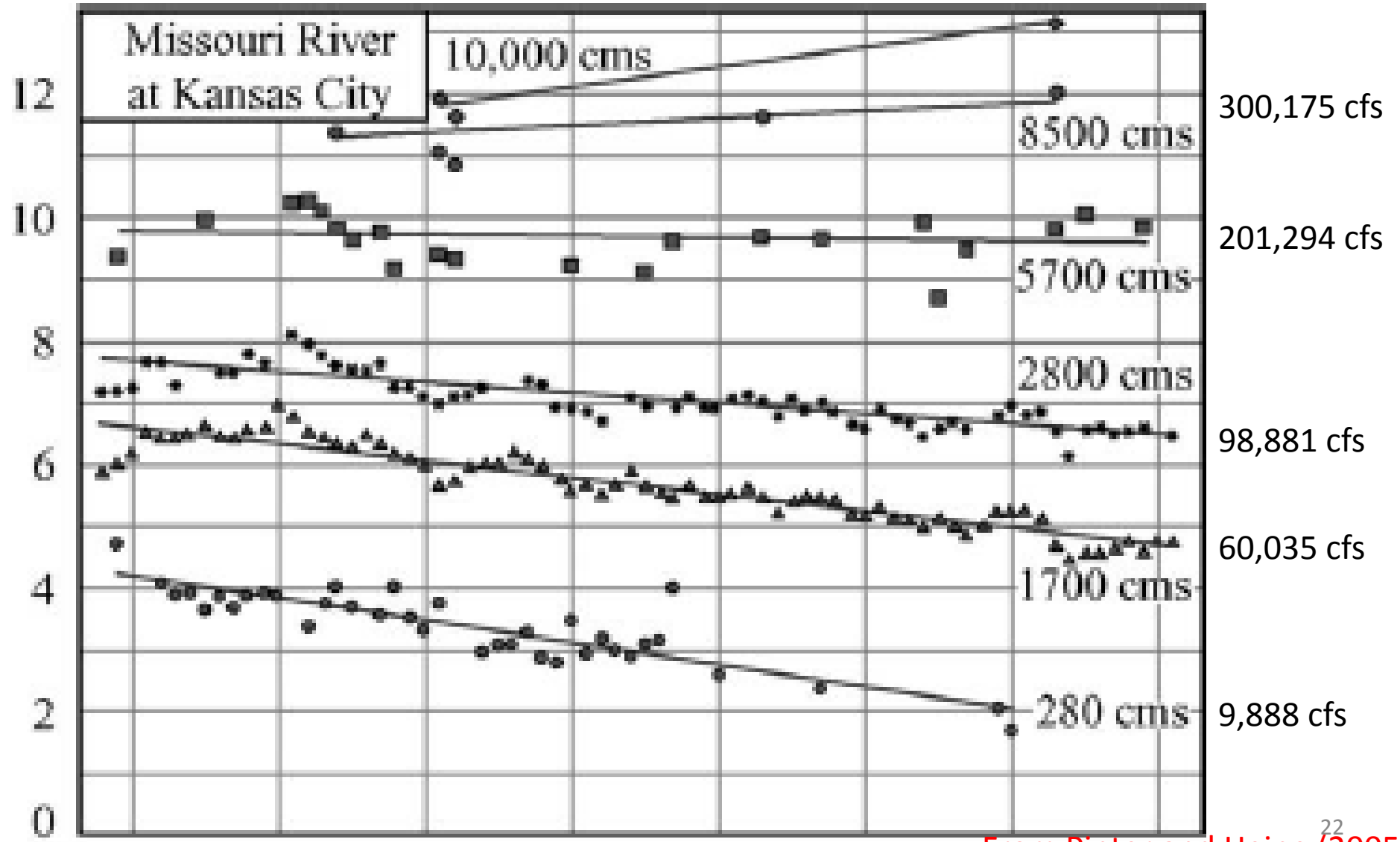
MISSOURI RIVER IMPROVEMENT
KANSAS CITY DISTRICT CHANNEL STABILIZATION AND NAVIGATION PROJECT KANSAS CITY, MISSOURI
AERIAL VIEW WEST (UPSTREAM) FROM APPROXIMATE RIVER MILE 376, SHOWING PORTION OF RIVER FROM KANSAS CITY REACH TO KANSAS RIVER BEND. LEVEE AND BANK PROTECTION ALONG LEFT BANK IN NORTH KANSAS CITY UNIT, LEVEE AND BANK PROTECTION ON RIGHT BANK IN EAST BOTTOMS UNIT. BRIDGES FROM BOTTOM UP ARE: NEW PASEO BRIDGE; (A.S.B.) HIGHWAY & RAILWAY BRIDGE AND C.B. & Q. R.R. (HANNIBAL) RAILWAY AND HIGHWAY BRIDGE. CONFLUENCE OF KANSAS AND MISSOURI RIVERS IN CENTER BACKGROUND.
23 SEPTEMBER 1954 NEG. NO. 61775

March 30, 2008
Q = 40,800 cfs

Problem!

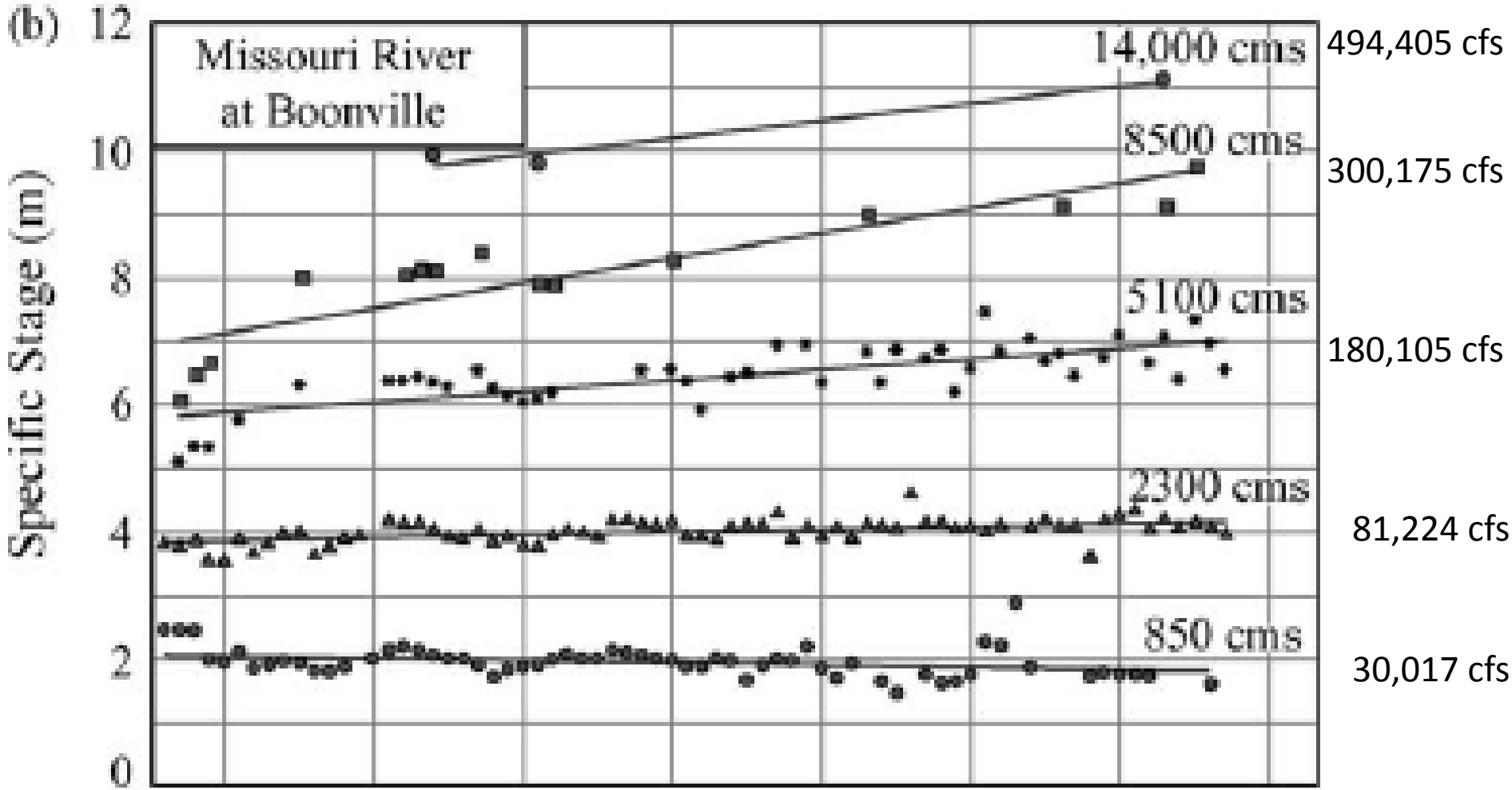


Rising Flood Stages and Degradation?



From Pinter and Heine (2005)

Rising Flood Stages and No Degradation



From Pinter and Heine (2005)

What we have the do/don't have the data to do

Data Available To

- Show changes in bed elevations over time
- Show changes in low water surface elevations over time
- Show changes in high water surfaces at gages
- Show high water elevations between gages for 2011 flood and 1993 flood

Data Not Available To

- Show land accretion over time
- Show vegetation establishment over time
- Link changes in flood conveyance to bed degradation