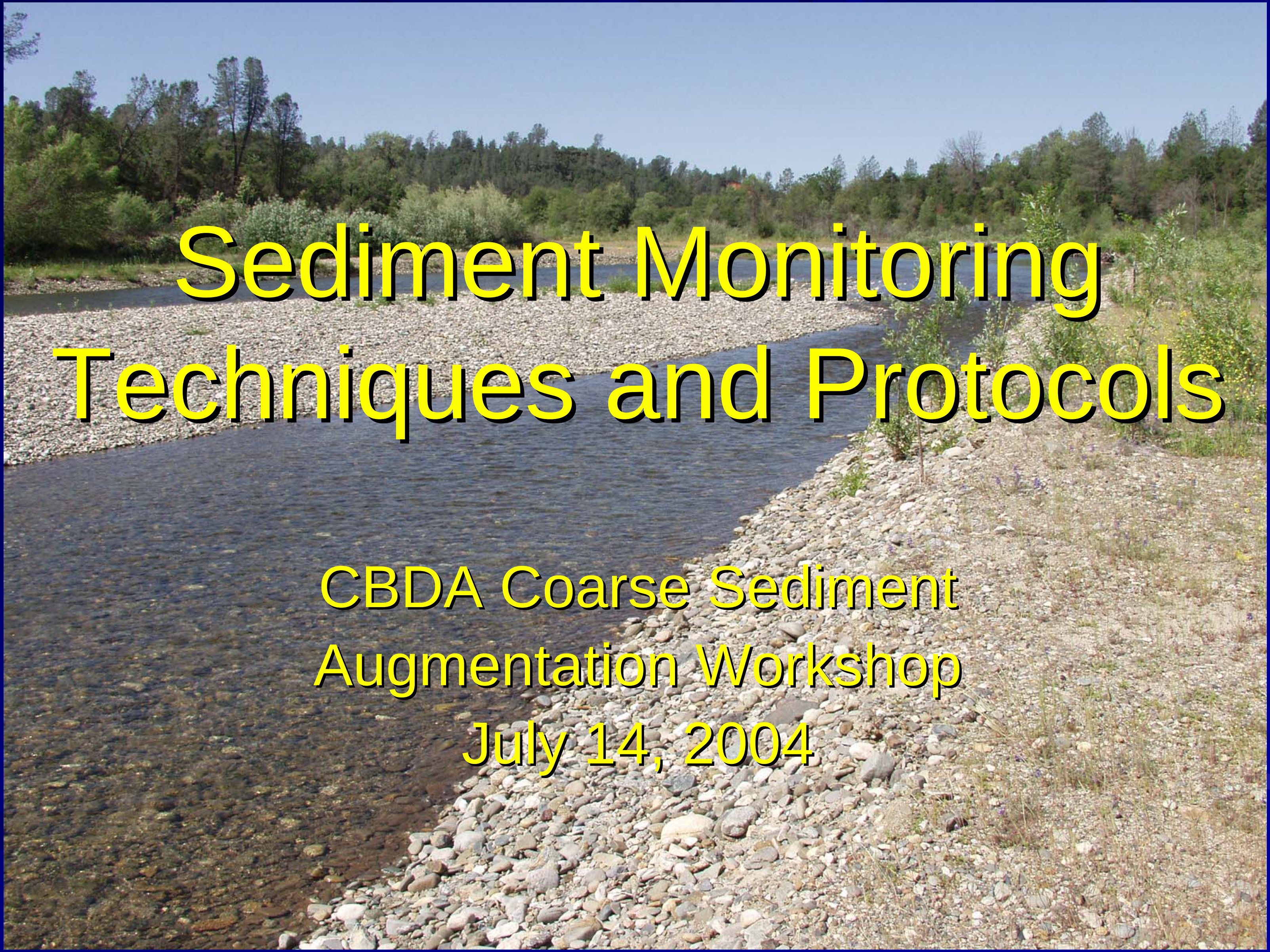


# Sediment Monitoring Techniques and Protocols

CBDA Coarse Sediment Augmentation Workshop

July 14, 2004

# Monitoring Objectives

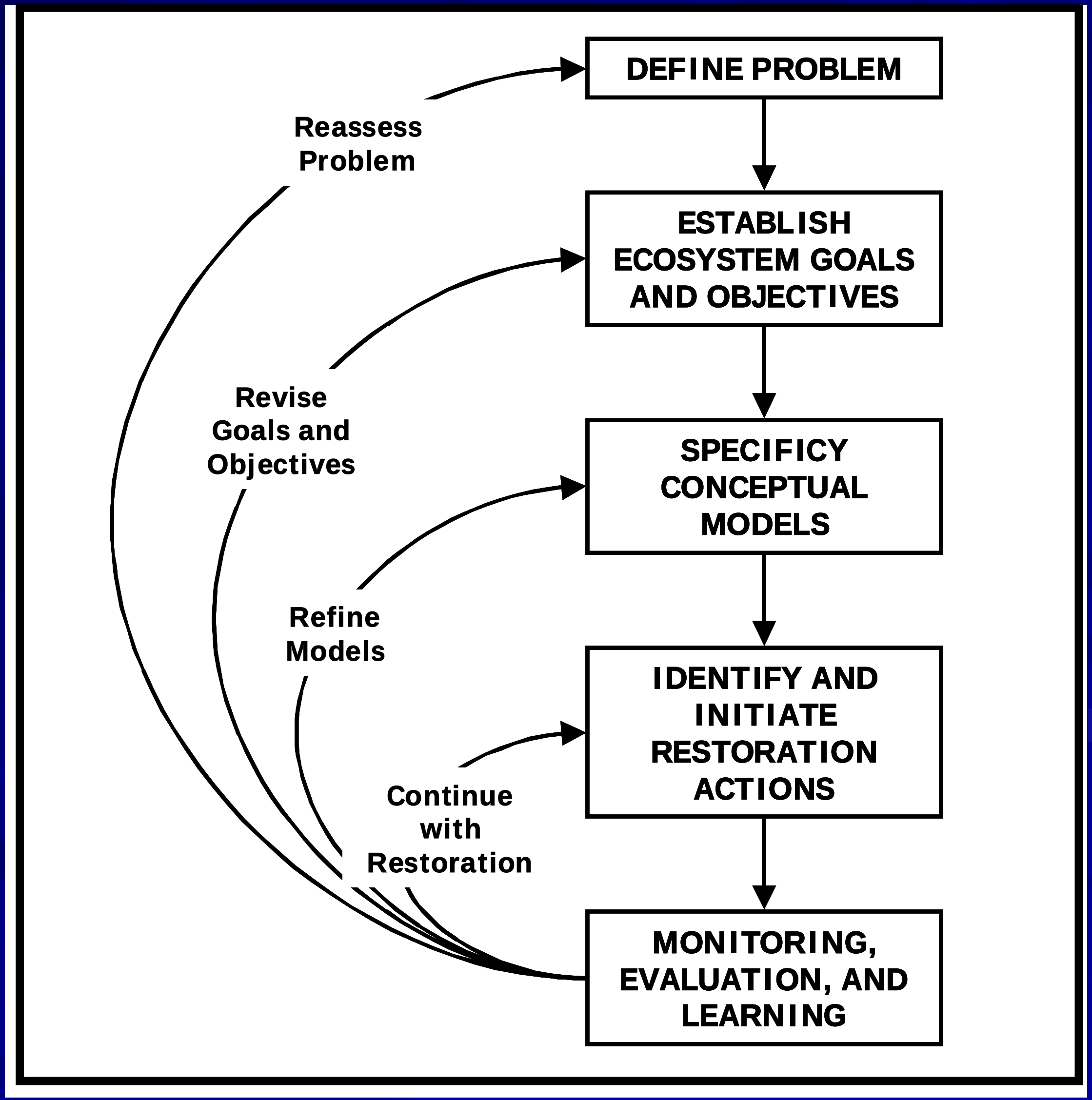
- Implementation Monitoring:

  Document as-built conditions

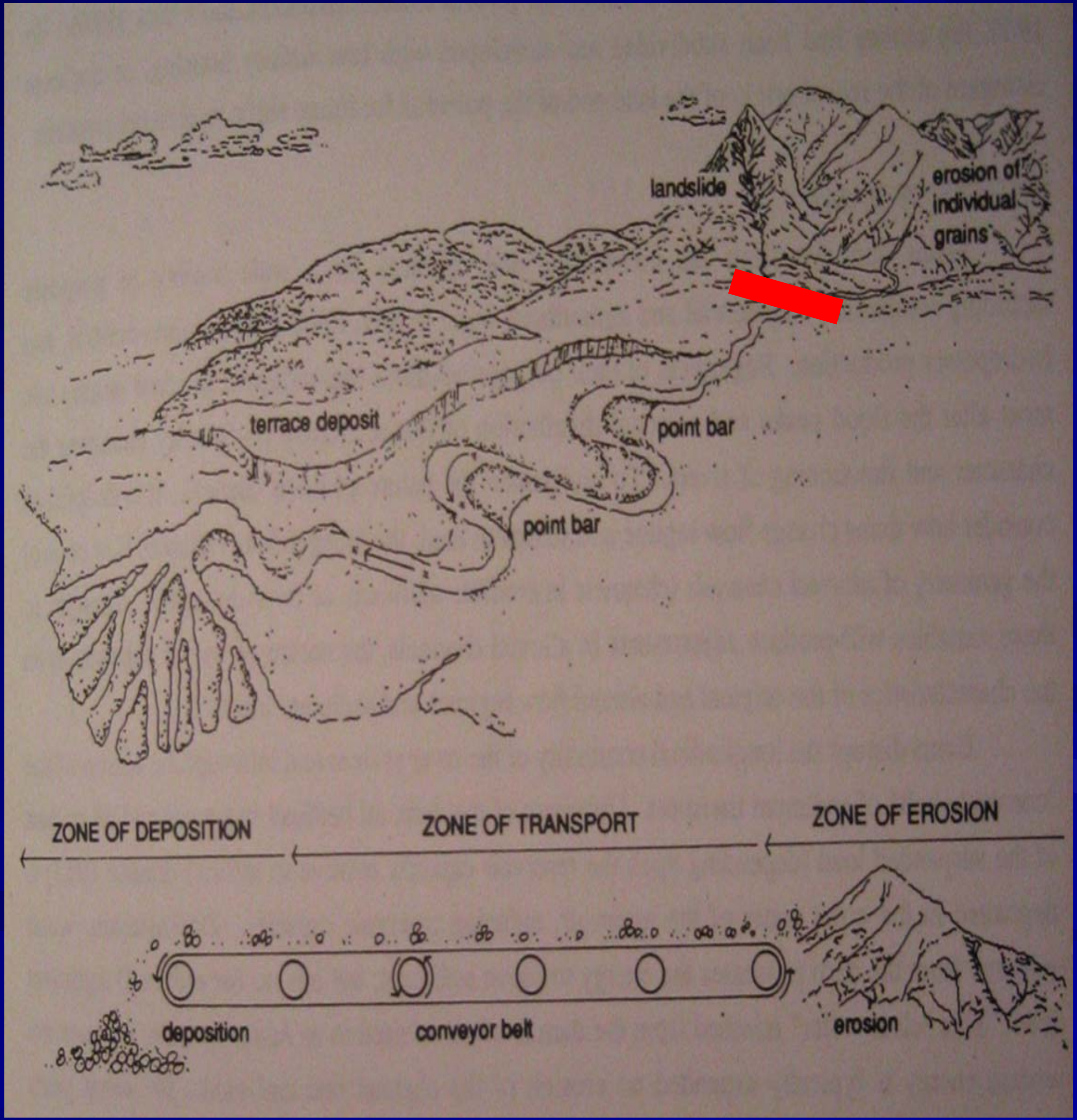
- Effectiveness Monitoring:

  Document whether/to what extent project objectives were met

# Monitoring Strategies: One Size Does Not Fit All



# Hypothetical Case Study



# Objectives/Hypotheses

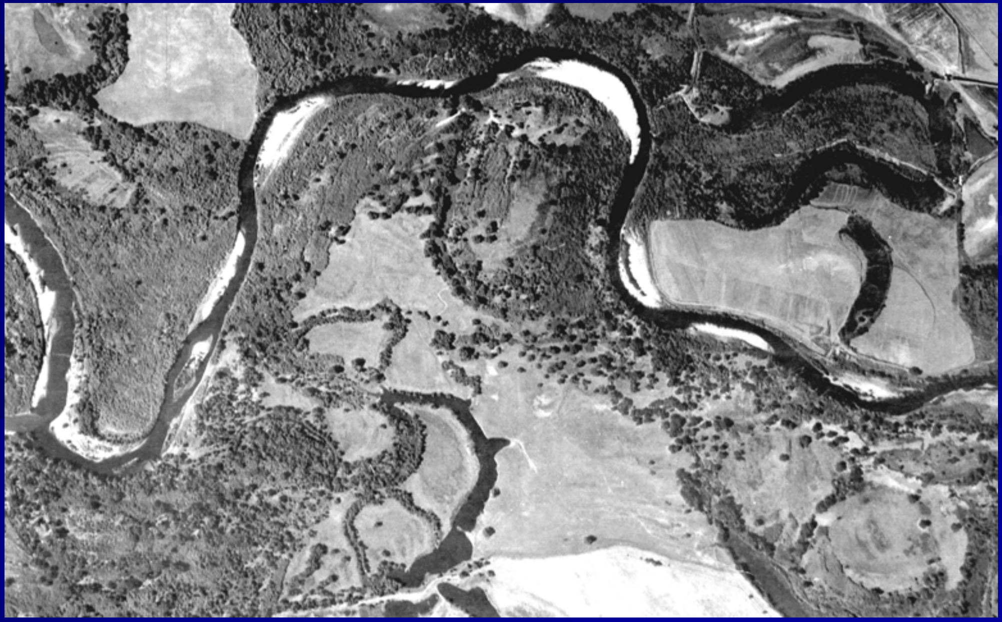
Introducing coarse sediment finer than the existing bed surface (i.e., with a $D_{84}$ that is mobilized by the $Q_{1.5}$) at a rate equal to predicted annual transport will …

- Increase the volume of alluvial sediment storage in the channel;
- Result in fining of the bed surface at and downstream of the introduction site;
- Reduce the bed mobilization and scour threshold;
- Increase sediment transport rates; and
- Reduce the relative volume of fine sediment (<2 mm) in the bed.

# Hypothesis 1:
# Increase the volume of alluvial sediment storage in the channel

- Aerial photographs
- Topographic surveys

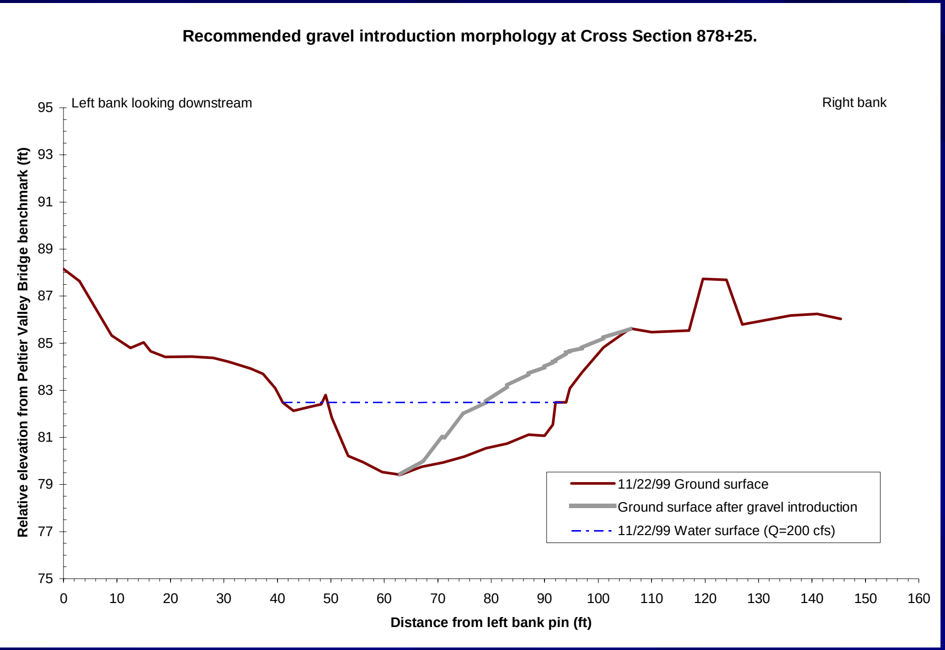
1997

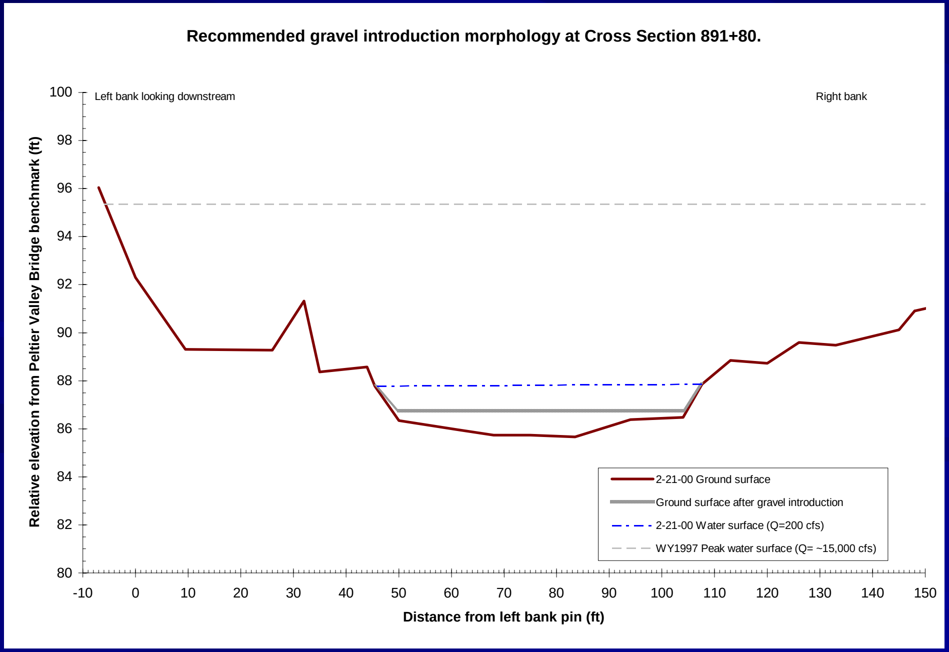


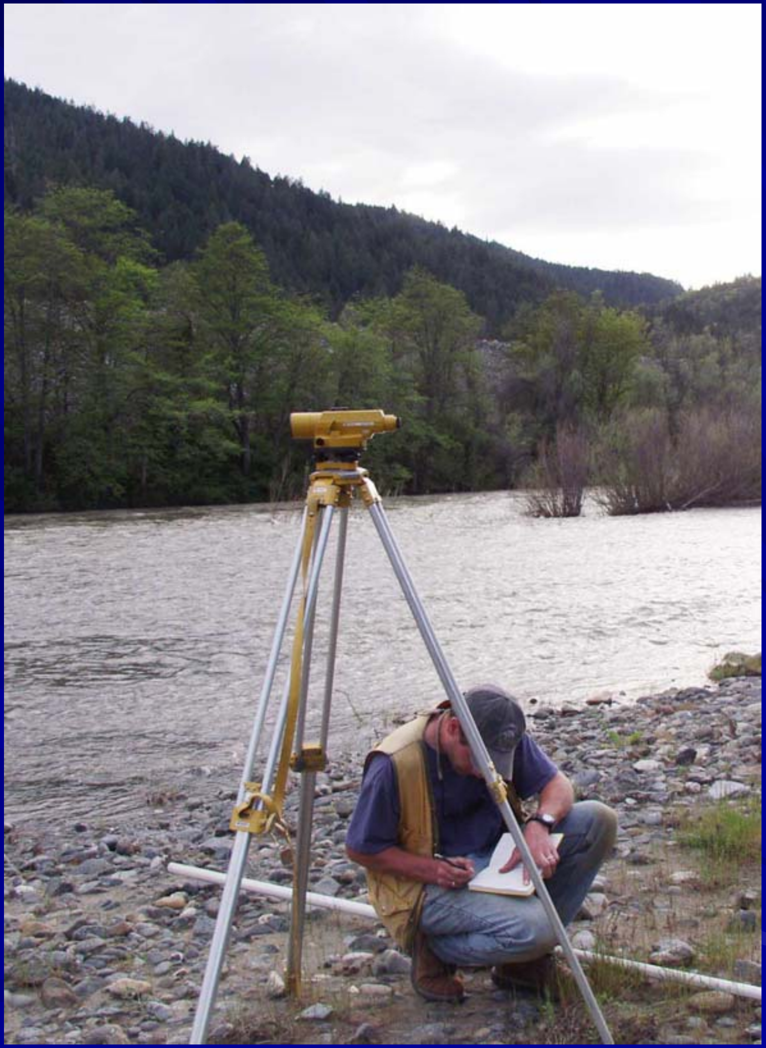
1937

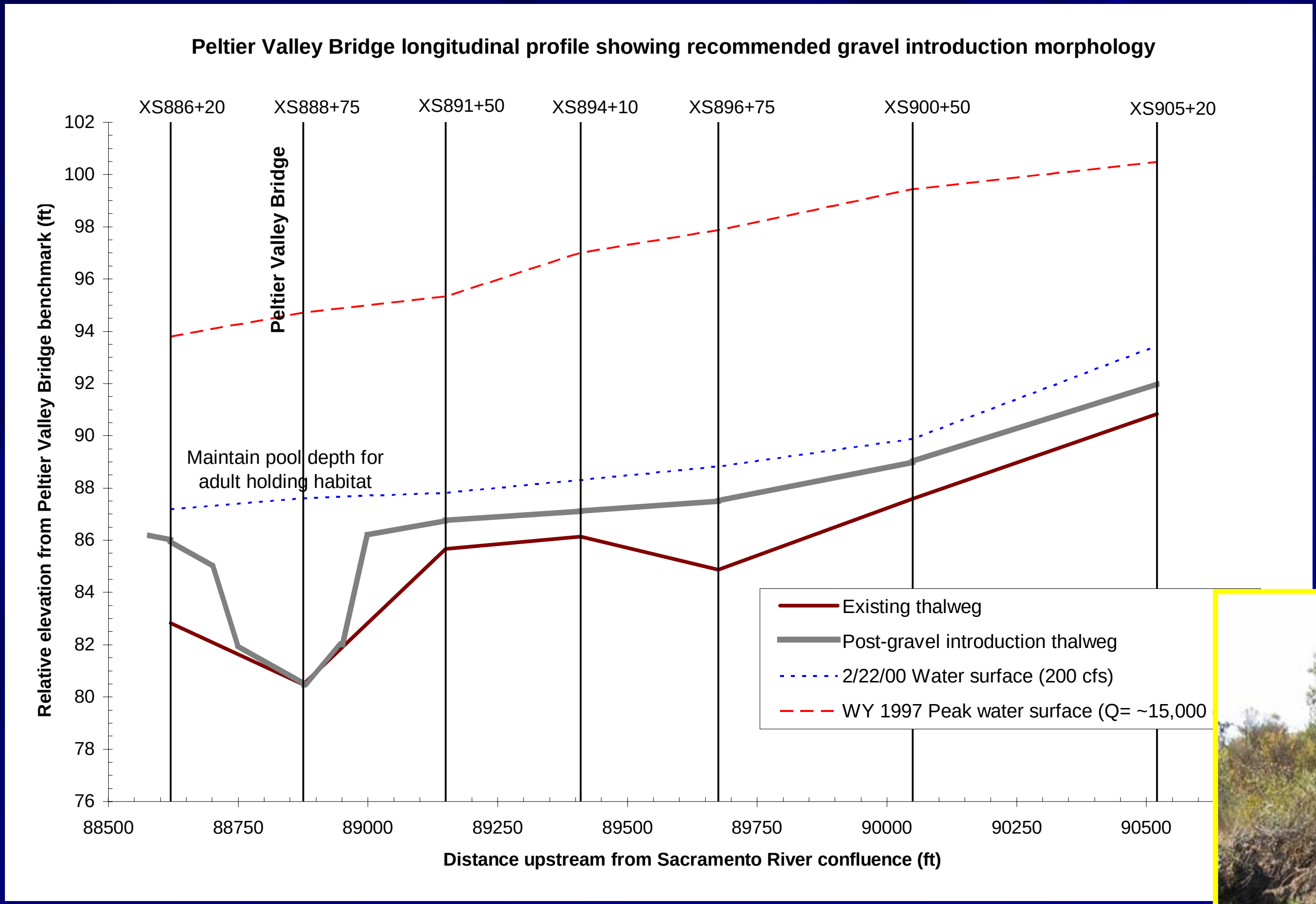
# Low Altitude Aerial Photographs and Small Channels with Dense Cover

# Topographic Surveys: Cross Sections and Profiles

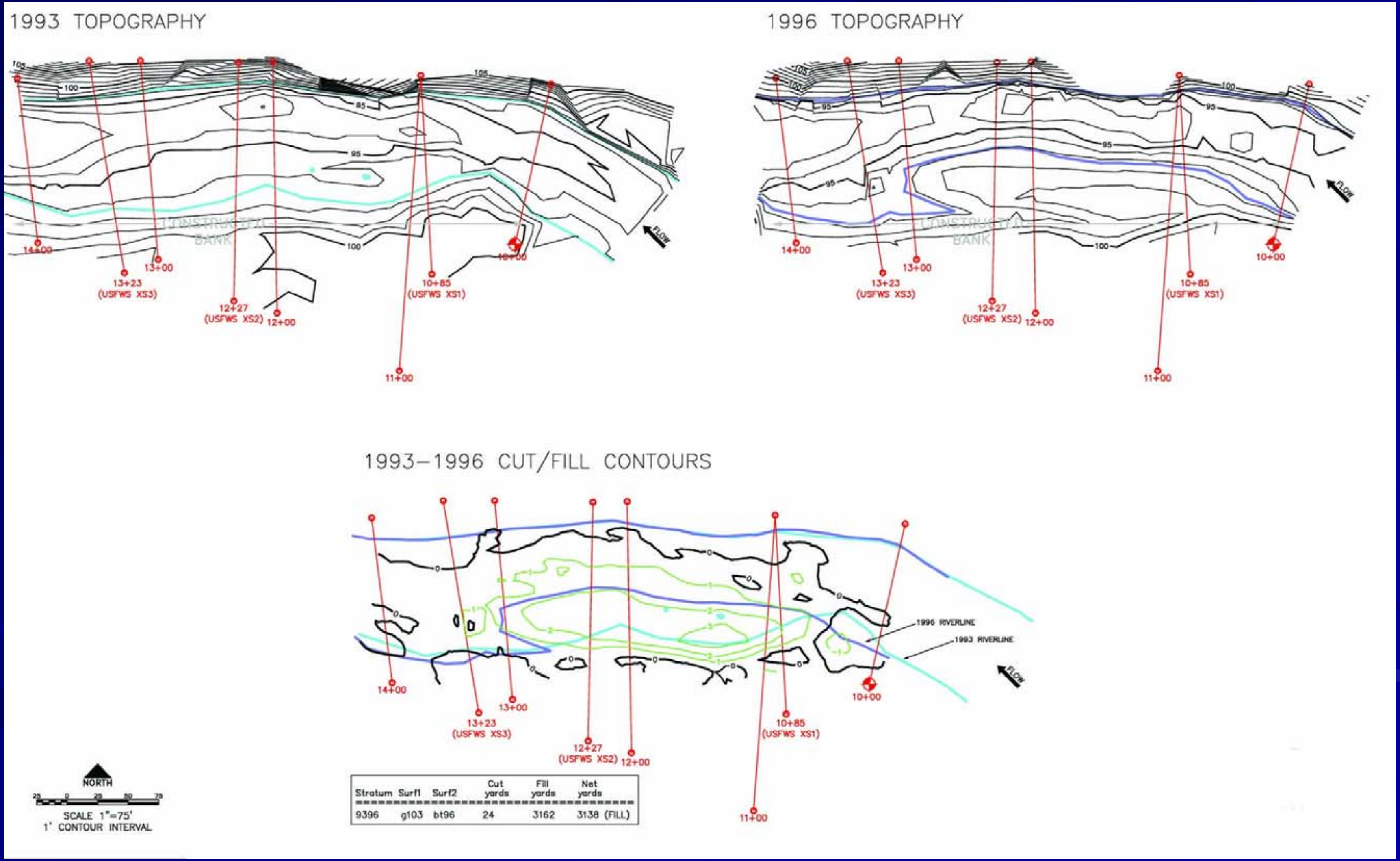

Recommended gravel introduction morphology at Cross Section 878+25.
Left bank looking downstream
Right bank
Relative elevation from Peltier Valley Bridge benchmark (ft)
95
93
91
89
87
85
83
81
79
77
75
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
Distance from left bank pin (ft)
11/22/99 Ground surface
Ground surface after gravel introduction
11/22/99 Water surface (Q=200 cfs)


Recommended gravel introduction morphology at Cross Section 891+80.
Left bank looking downstream
Right bank
Relative elevation from Peltier Valley Bridge benchmark (ft)
100
98
96
94
92
90
88
86
84
82
80
-10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150
Distance from left bank pin (ft)
2-21-00 Ground surface
Ground surface after gravel introduction
2-21-00 Water surface (Q=200 cfs)
WY1997 Peak water surface (Q= ~15,000 cfs)




Peltier Valley Bridge longitudinal profile showing recommended gravel introduction morphology
XS886+20
XS888+75
XS891+50
XS894+10
XS896+75
XS900+50
XS905+20
Peltier Valley Bridge
Maintain pool depth for adult holding habitat
Existing thalweg
Post-gravel introduction thalweg
2/22/00 Water surface (200 cfs)
WY 1997 Peak water surface (Q= ~15,000
Relative elevation from Peltier Valley Bridge benchmark (ft)
102
100
98
96
94
92
90
88
86
84
82
80
78
76
88500
88750
89000
89250
89500
89750
90000
90250
90500
Distance upstream from Sacramento River confluence (ft)

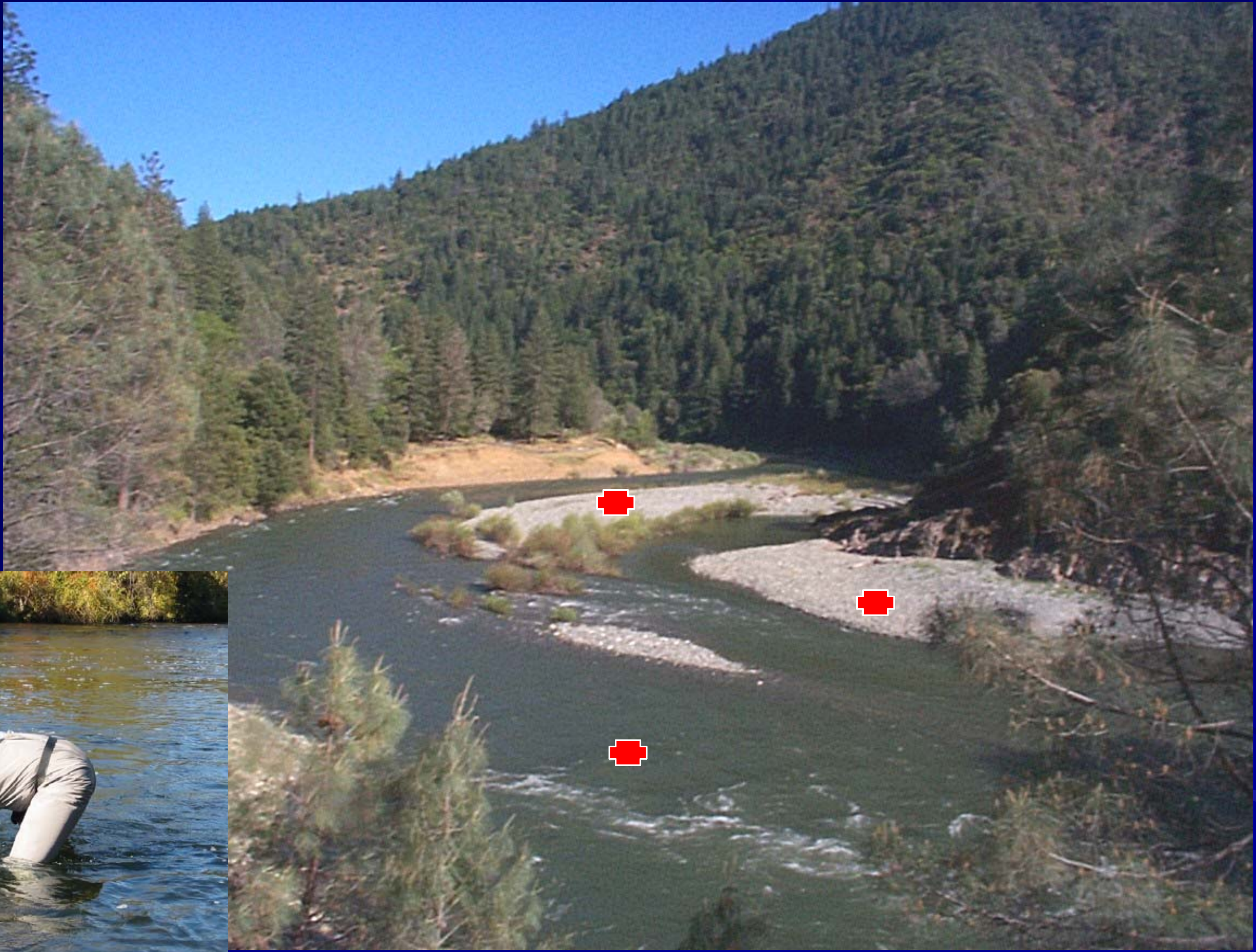
# Topographic Surveys: Contour Mapping



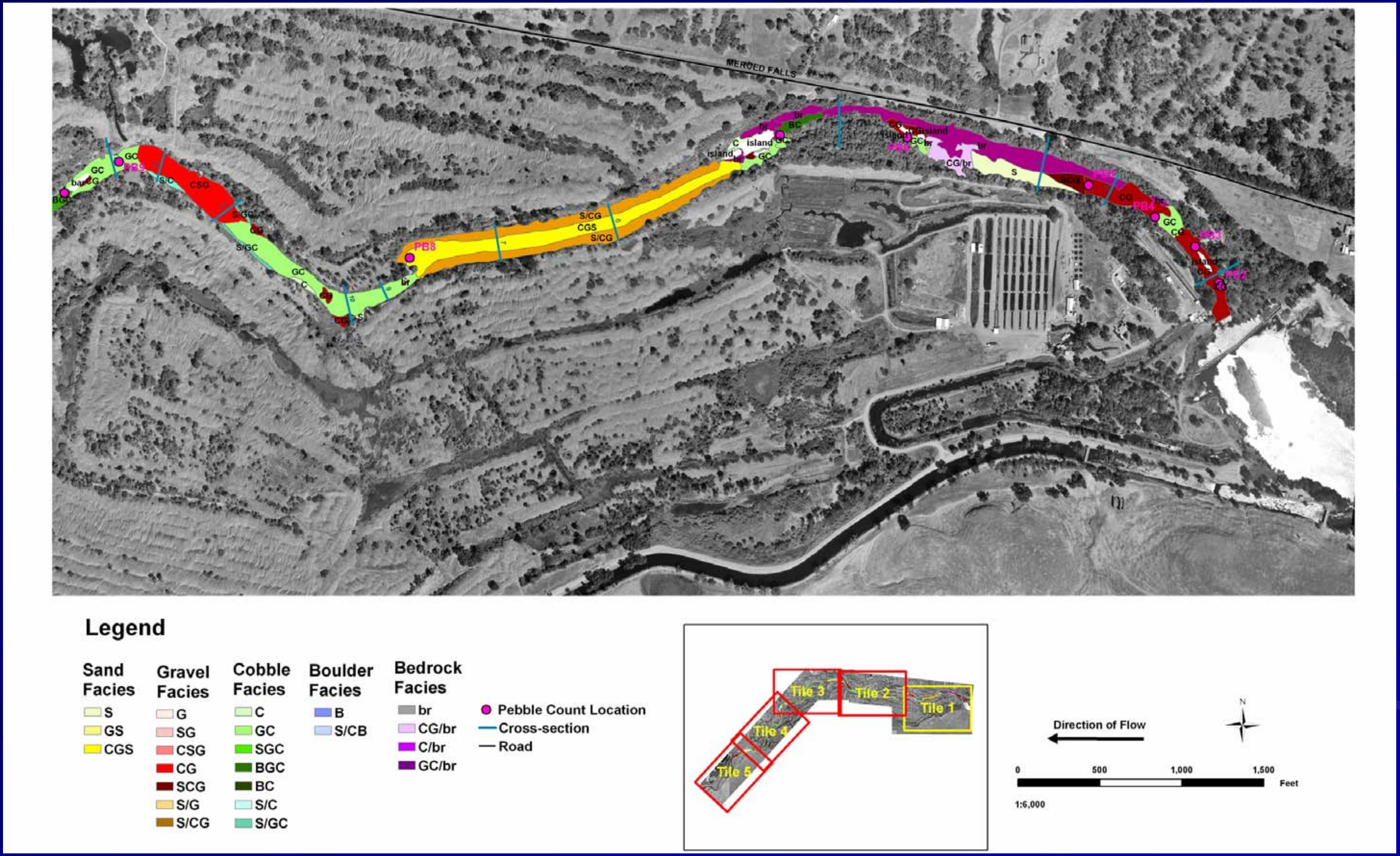
# Hypothesis 2:
# Result in fining of the bed surface at and downstream of the introduction site

- Pebble Counts
- Facies Mapping
- Isohyetal Mapping

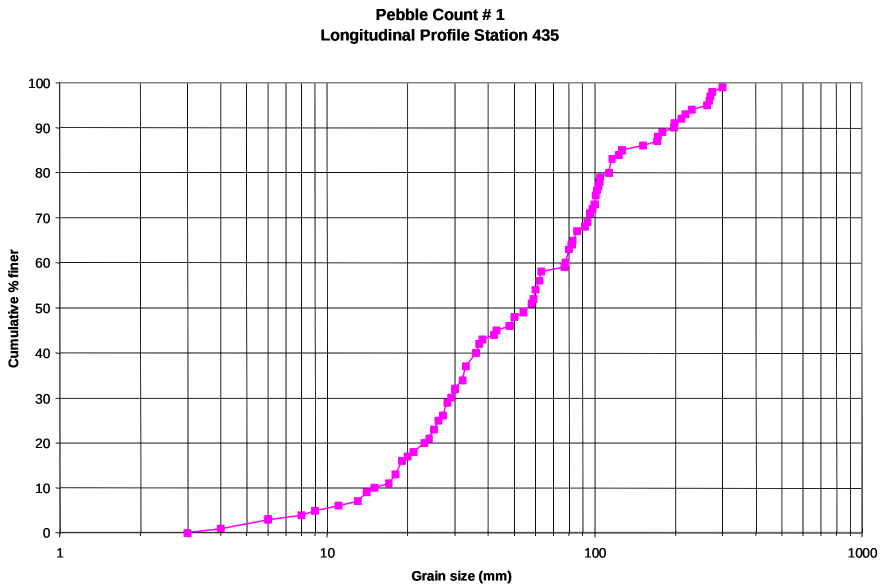
# Pebble Counts

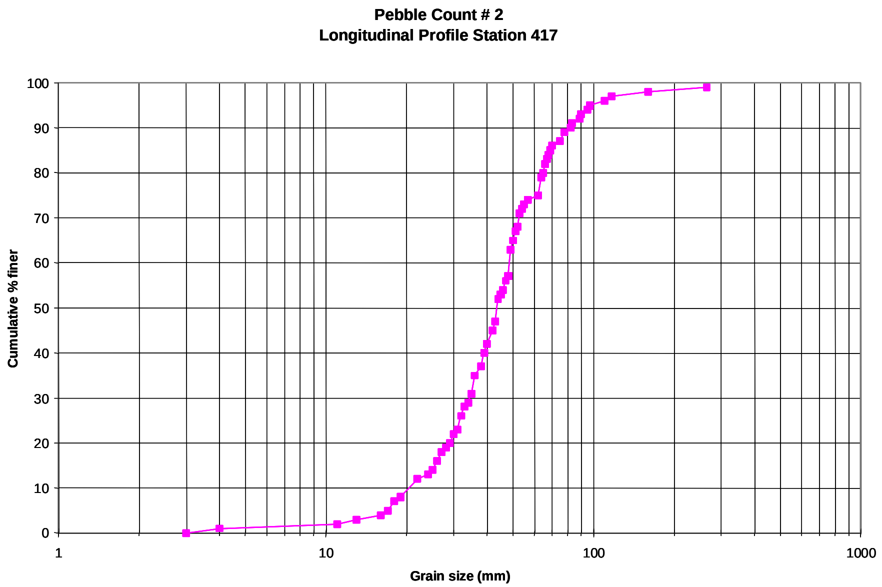


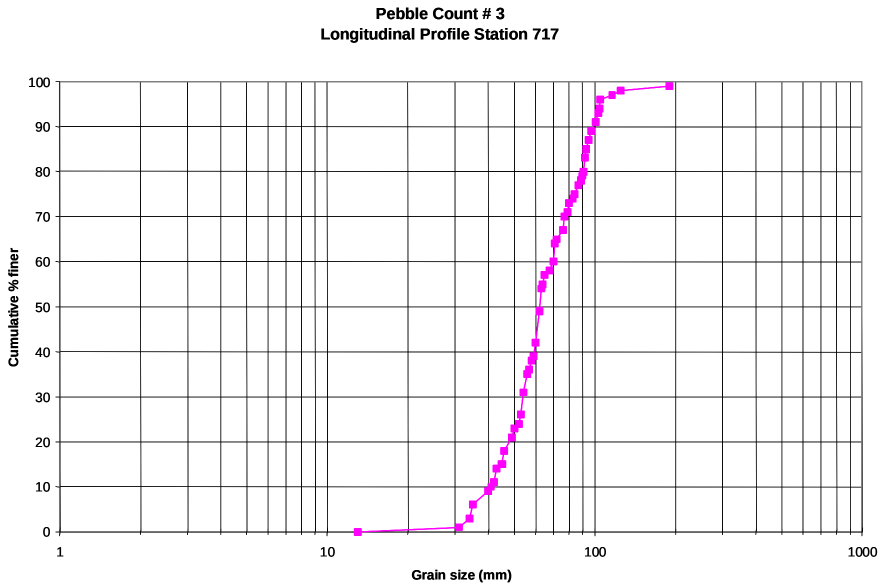
# Facies Mapping with Pebble Counts

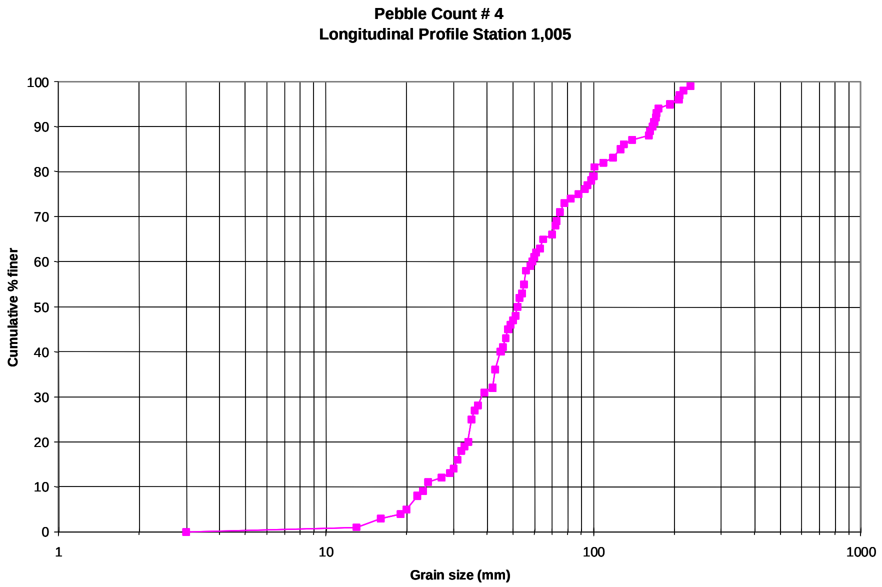



Source: Stillwater Sciences

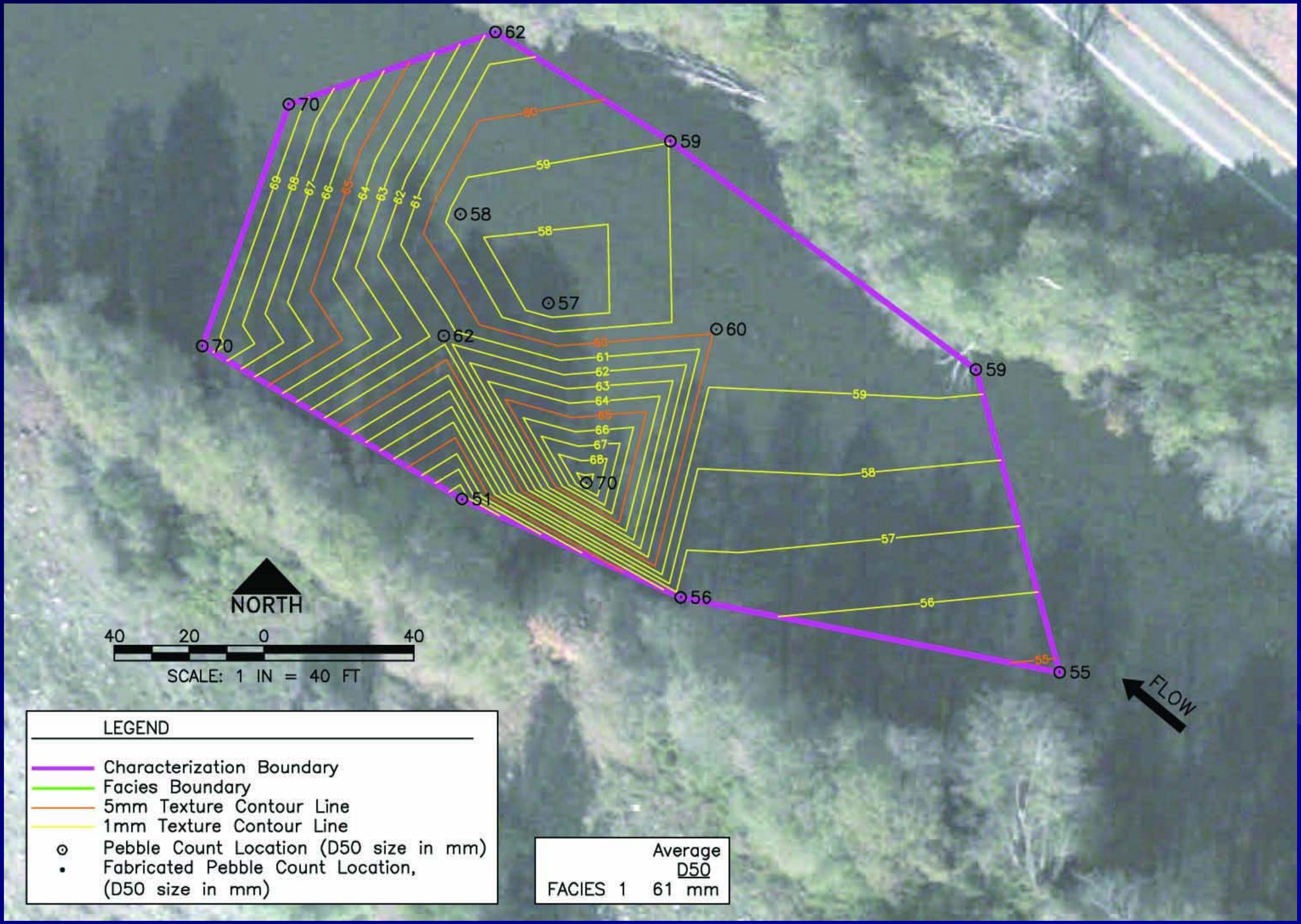

Pebble Count # 1
Longitudinal Profile Station 435
Cumulative % finer
Grain size (mm)
0
10
20
30
40
50
60
70
80
90
100
1
10
100
1000


Pebble Count # 2
Longitudinal Profile Station 417
Cumulative % finer
Grain size (mm)
0
10
20
30
40
50
60
70
80
90
100
1
10
100
1000


Pebble Count # 3
Longitudinal Profile Station 717
Cumulative % finer
Grain size (mm)
0
10
20
30
40
50
60
70
80
90
100
1
10
100
1000


Pebble Count # 4
Longitudinal Profile Station 1,005
Cumulative % finer
Grain size (mm)
0
10
20
30
40
50
60
70
80
90
100
1
10
100
1000

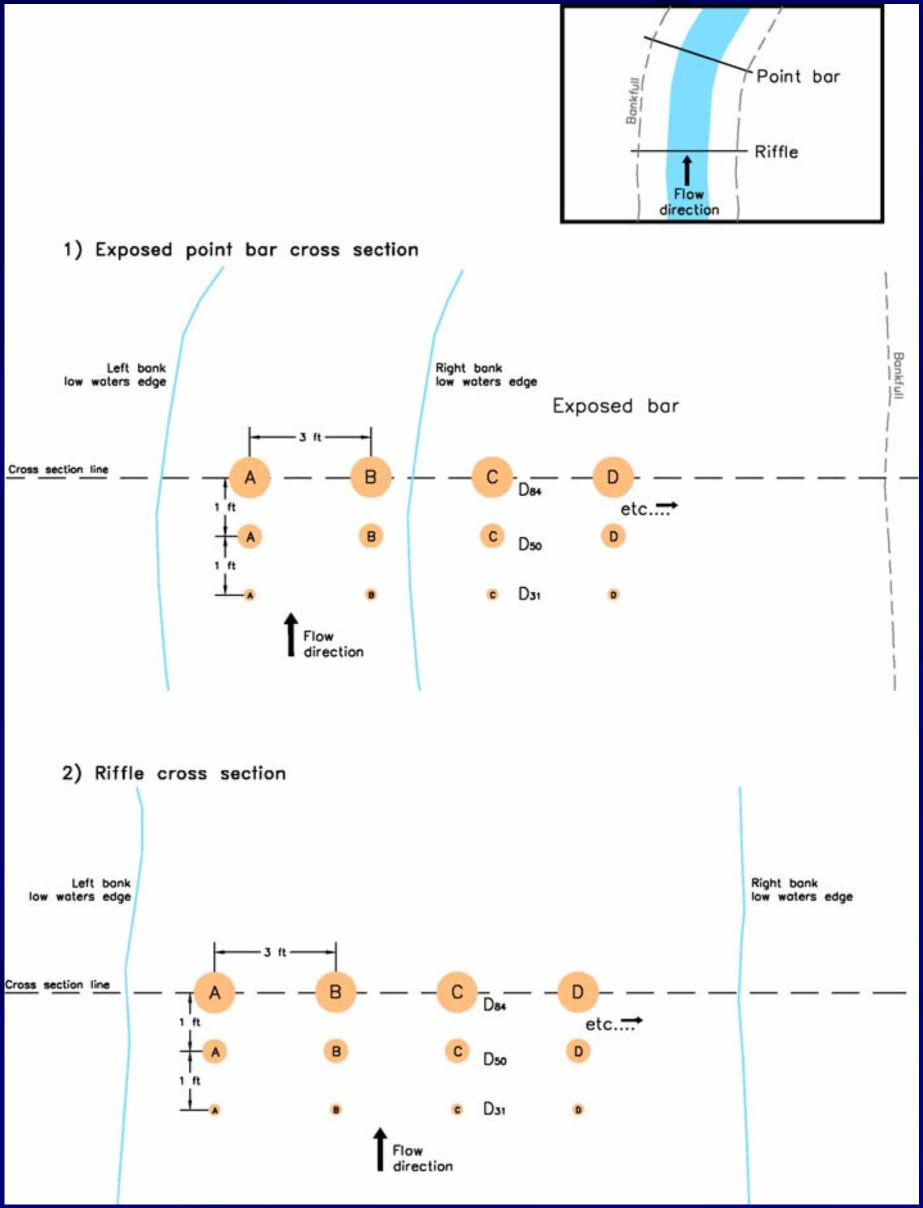
# Isohyetal Mapping

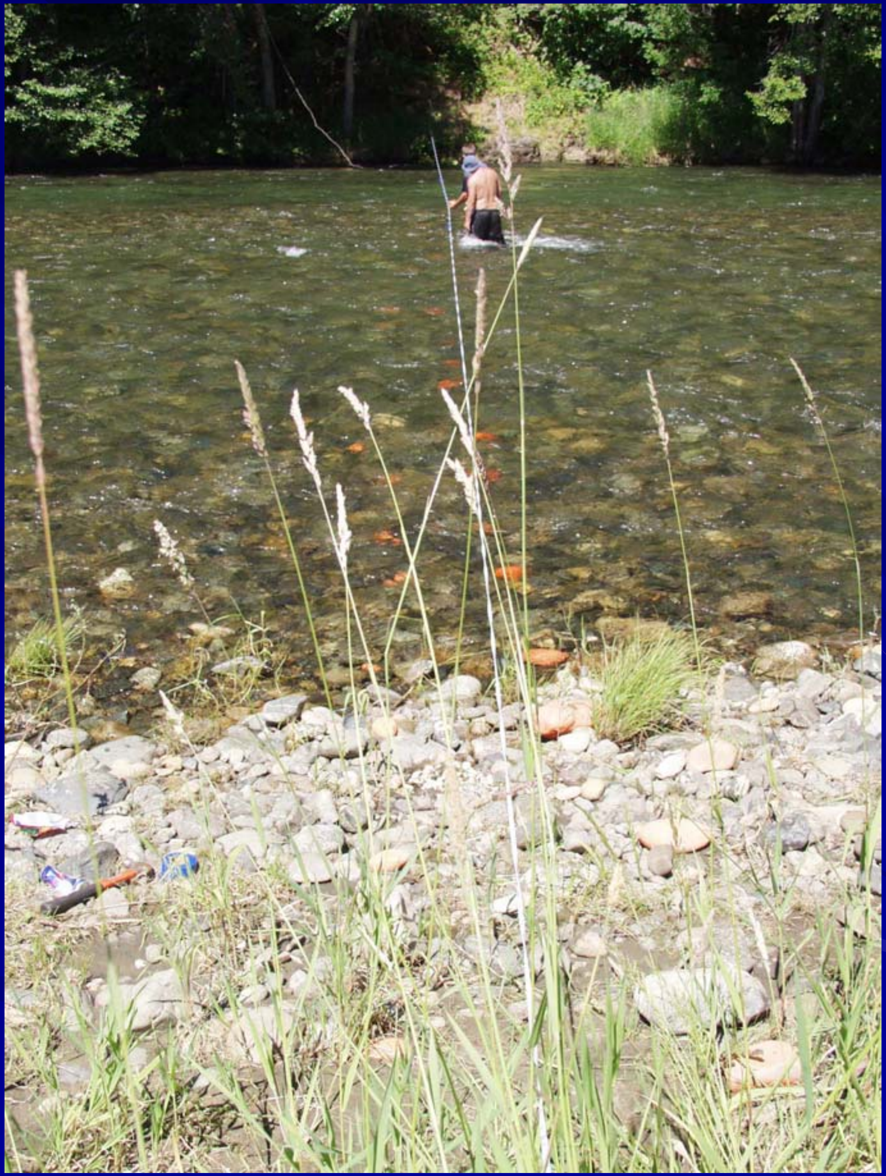


# Hypothesis 3:
# Reduce the bed mobilization and scour thresholds

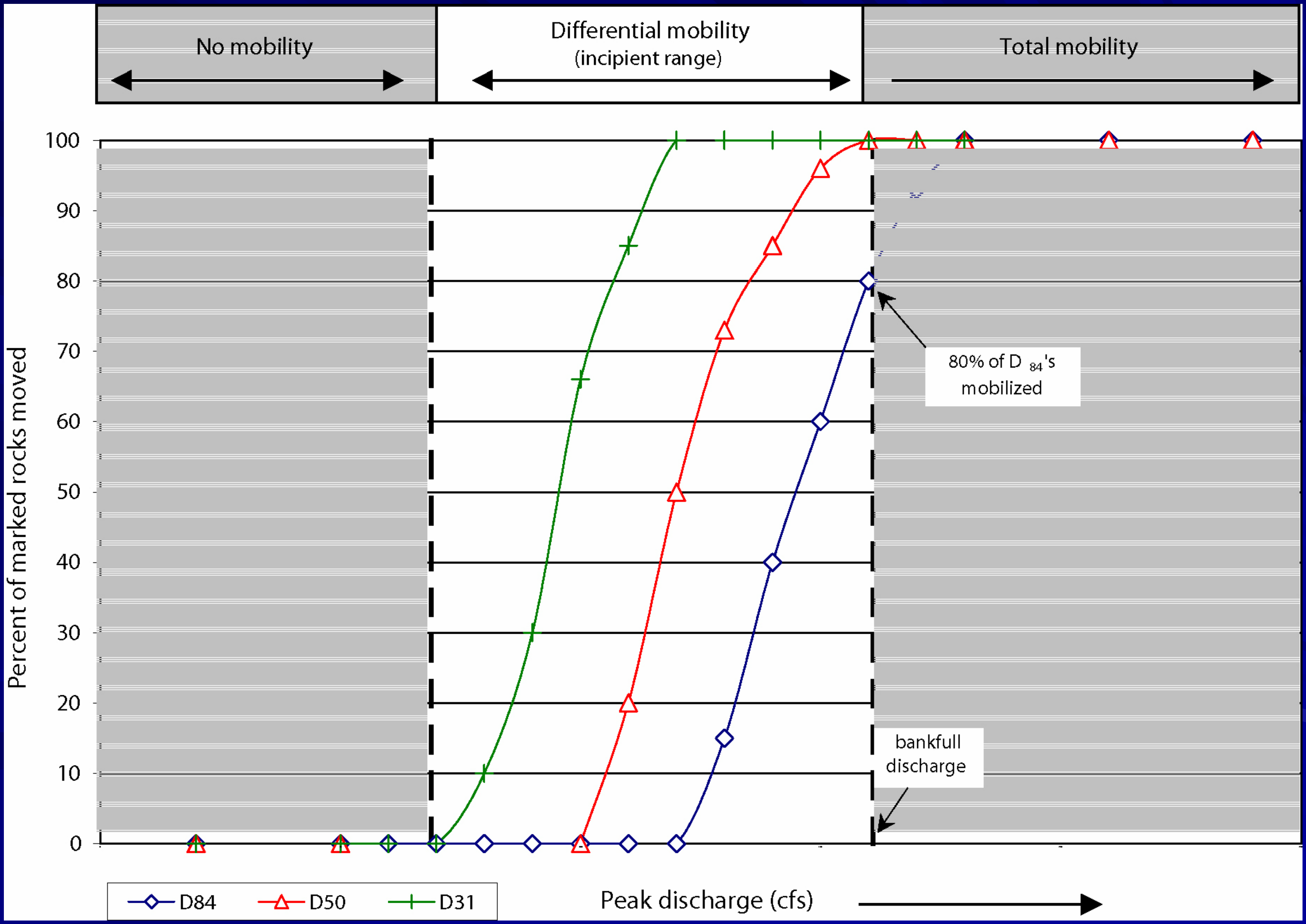
- Tracer rocks
- Scour cores
- Scour chains

# Tracer Rocks



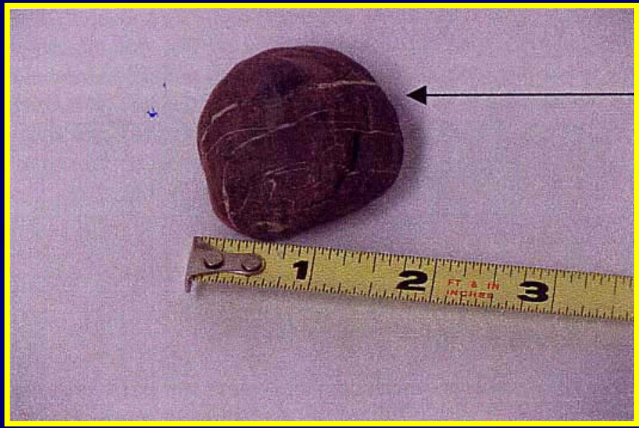



# Interpreting Tracer Rock Results



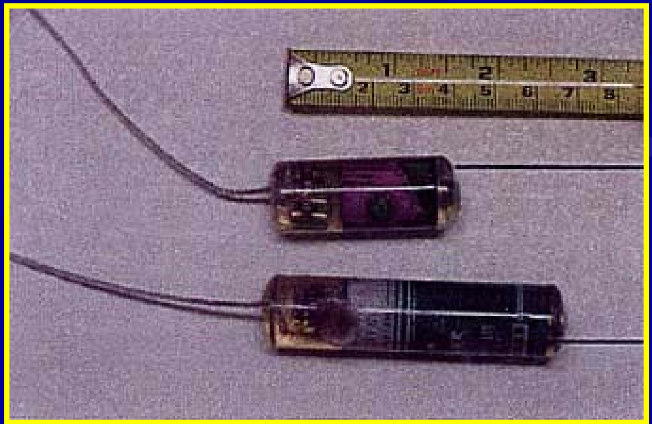
# Tracer Rock Options

LITHOLOGY

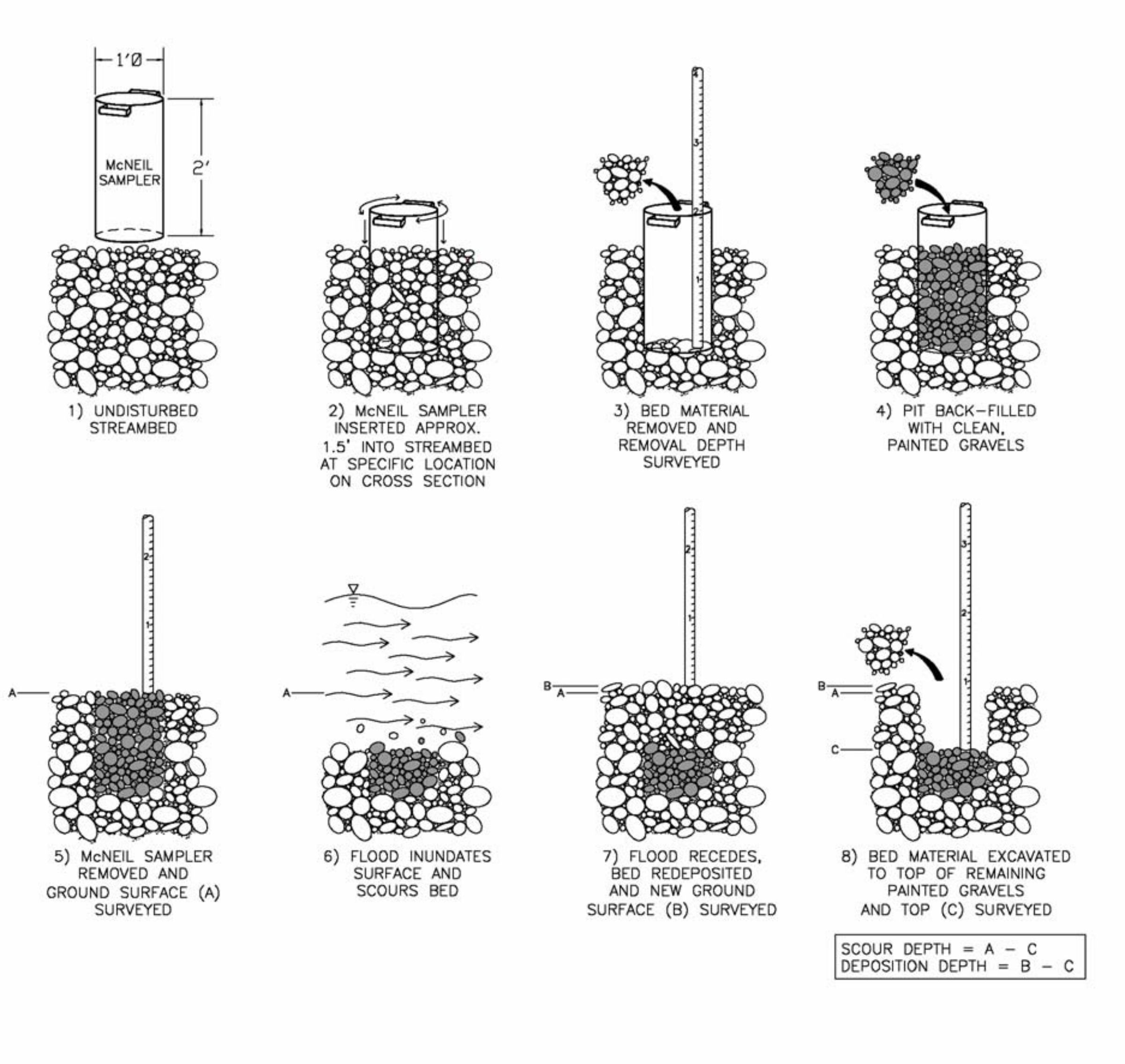


PAINT

MAGNETS/
RADIOTRANSMITTERS



# Scour Cores

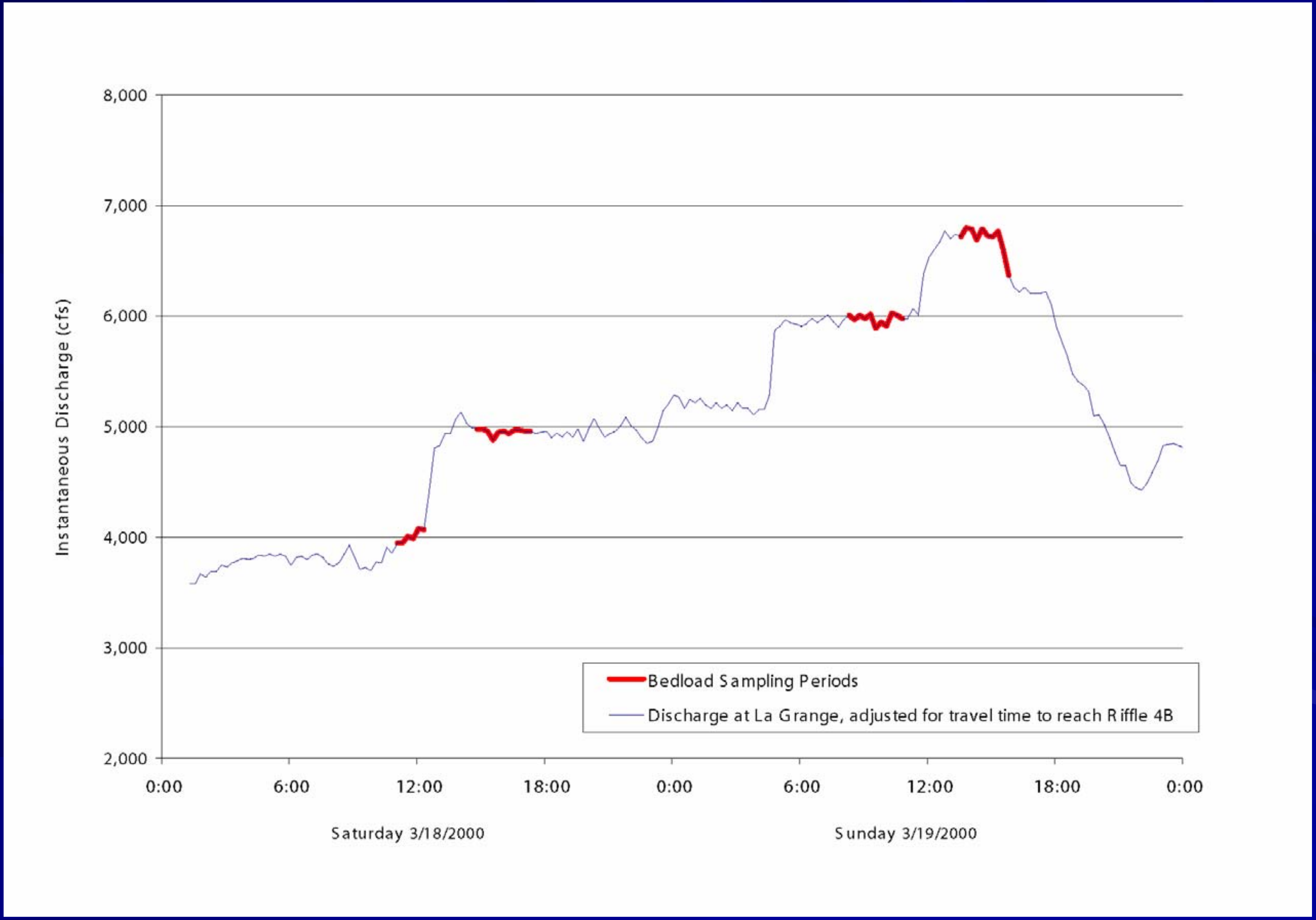


1'Ø
2'
McNEIL SAMPLER
1) UNDISTURBED STREAMBED
2) McNEIL SAMPLER INSERTED APPROX. 1.5' INTO STREAMBED AT SPECIFIC LOCATION ON CROSS SECTION
3) BED MATERIAL REMOVED AND REMOVAL DEPTH SURVEYED
4) PIT BACK-FILLED WITH CLEAN, PAINTED GRAVELS
A
5) McNEIL SAMPLER REMOVED AND GROUND SURFACE (A) SURVEYED
6) FLOOD INUNDATES SURFACE AND SCOURS BED
B
7) FLOOD RECEDES, BED REDEPOSITED AND NEW GROUND SURFACE (B) SURVEYED
C
8) BED MATERIAL EXCAVATED TO TOP OF REMAINING PAINTED GRAVELS AND TOP (C) SURVEYED
SCOUR DEPTH = A − C
DEPOSITION DEPTH = B − C


# Hypothesis 4:
# Increase sediment transport rates

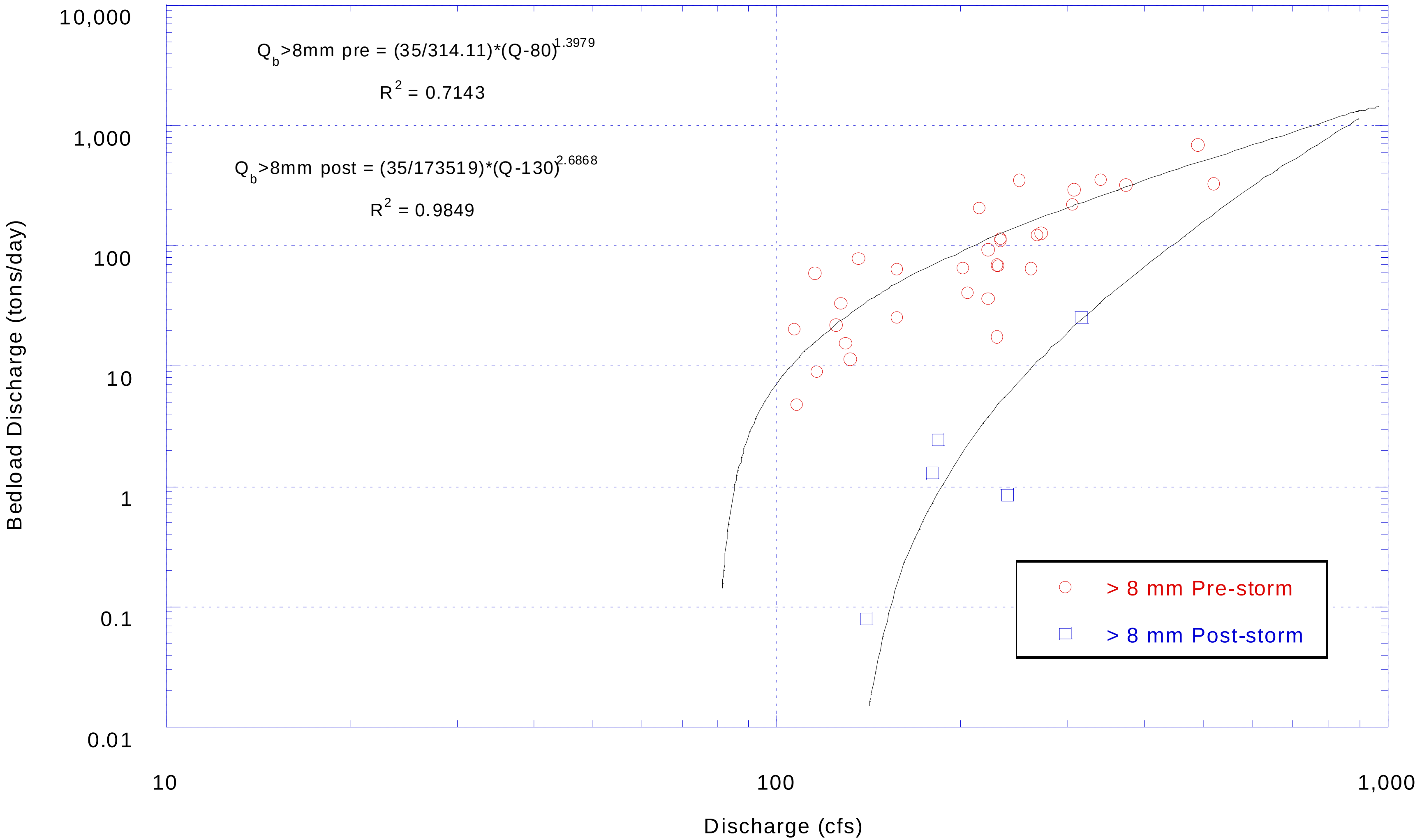
- Helley-Smith samples
- Sediment traps
- Reach-specific sediment budgets

# Transport Sampling

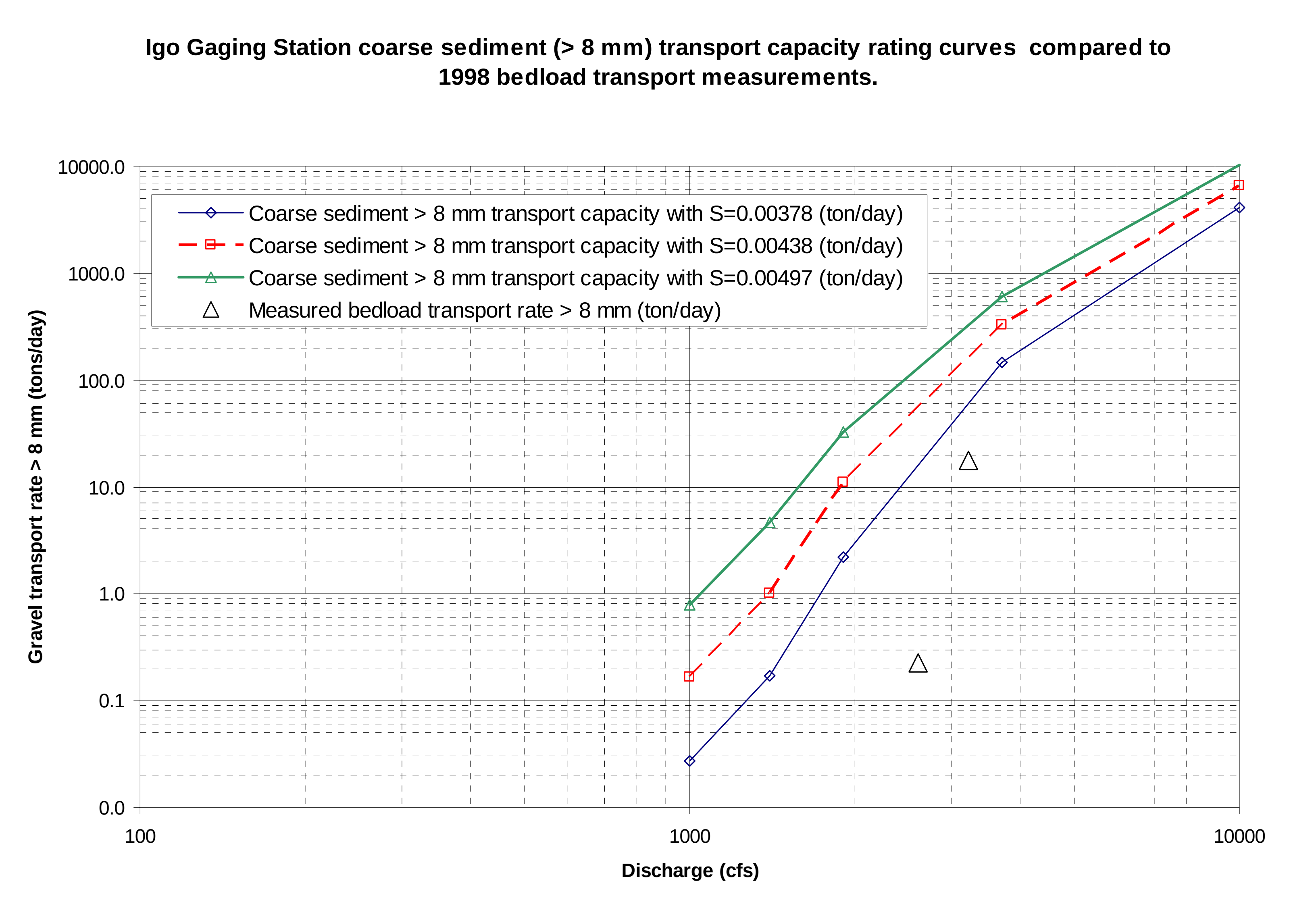


# Transport Sampling

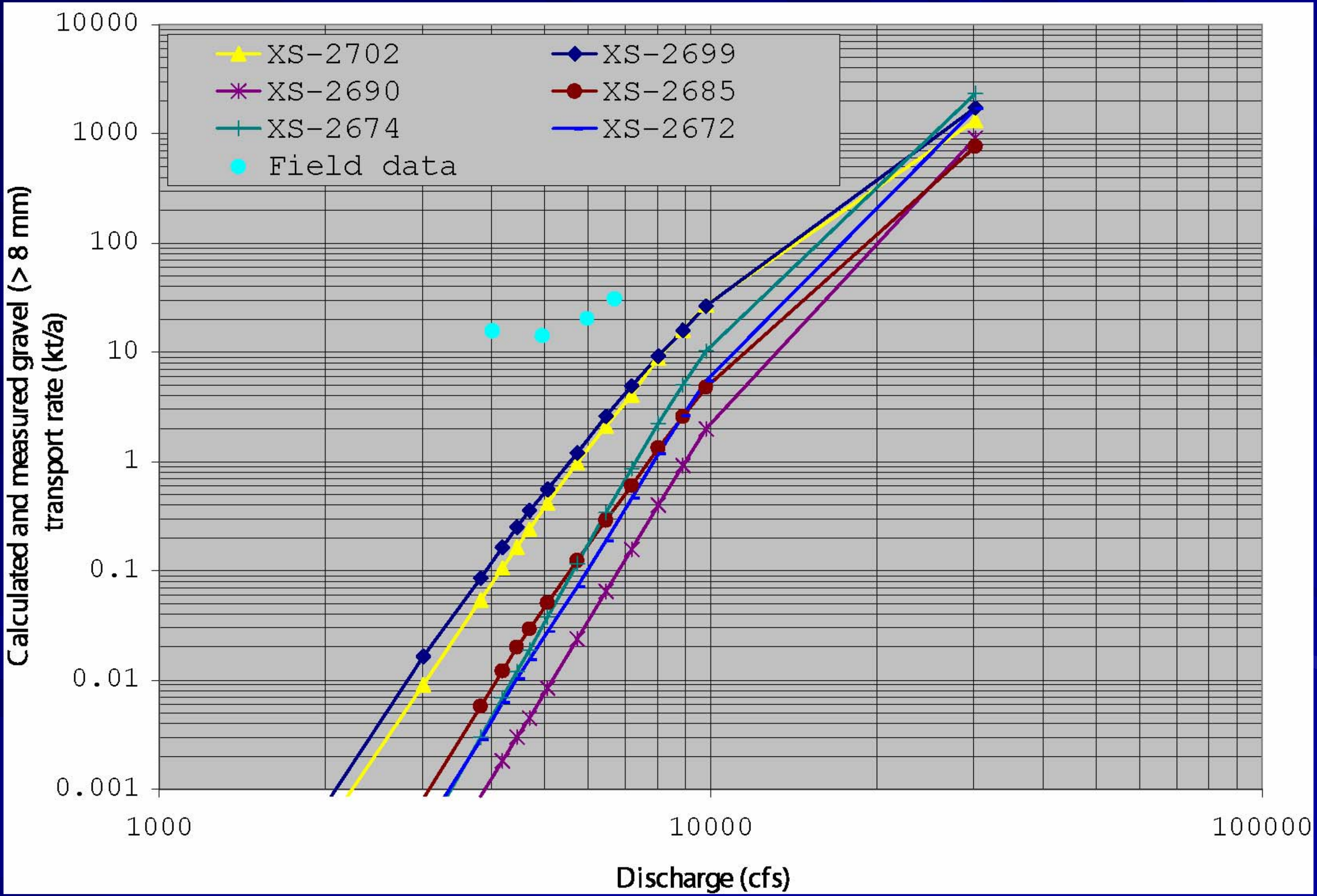
# INDIAN CREEK near LEWISTON
## Bedload > 8 mm  Non-Linear
## Pre- and Post-Storm - WY 98



# Predicting Pre- and Post-augmentation Transport Rates



# Calibrating/Testing Sediment Transport Models



# Reach-specific Sediment Budgets

## I – △S = O

Can combine transport monitoring with detailed topographic surveys to document total flux

# Hypothesis 5: Reduce the relative volume of fine sediment (<2 mm) in the bed

- Permeability
- Bulk Samples

# Permeability

# Spatial Variability in Permeability

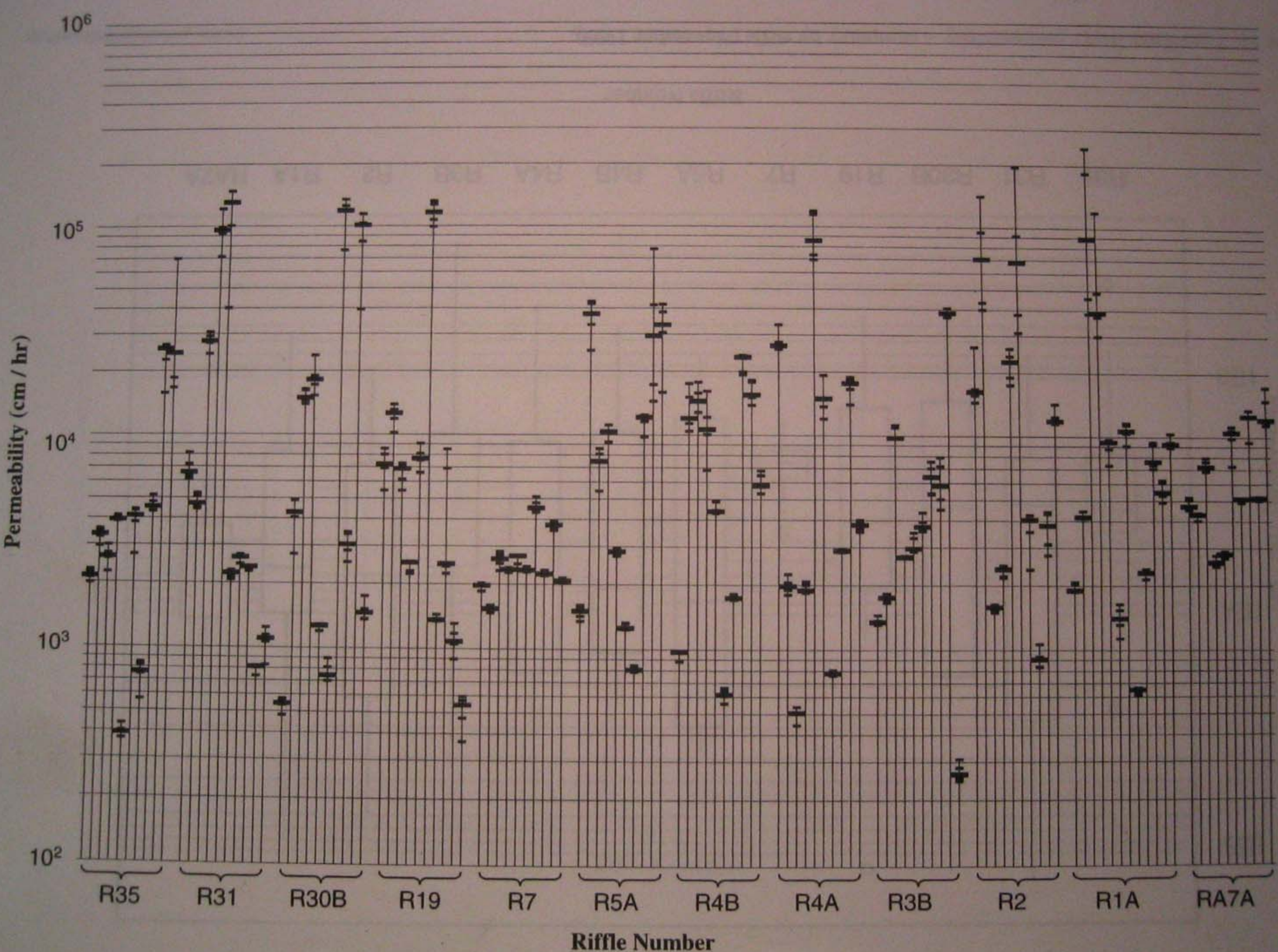



**Figure 10. Tuolumne River permeability (November 1999).**

# Spatial Variability in Permeability

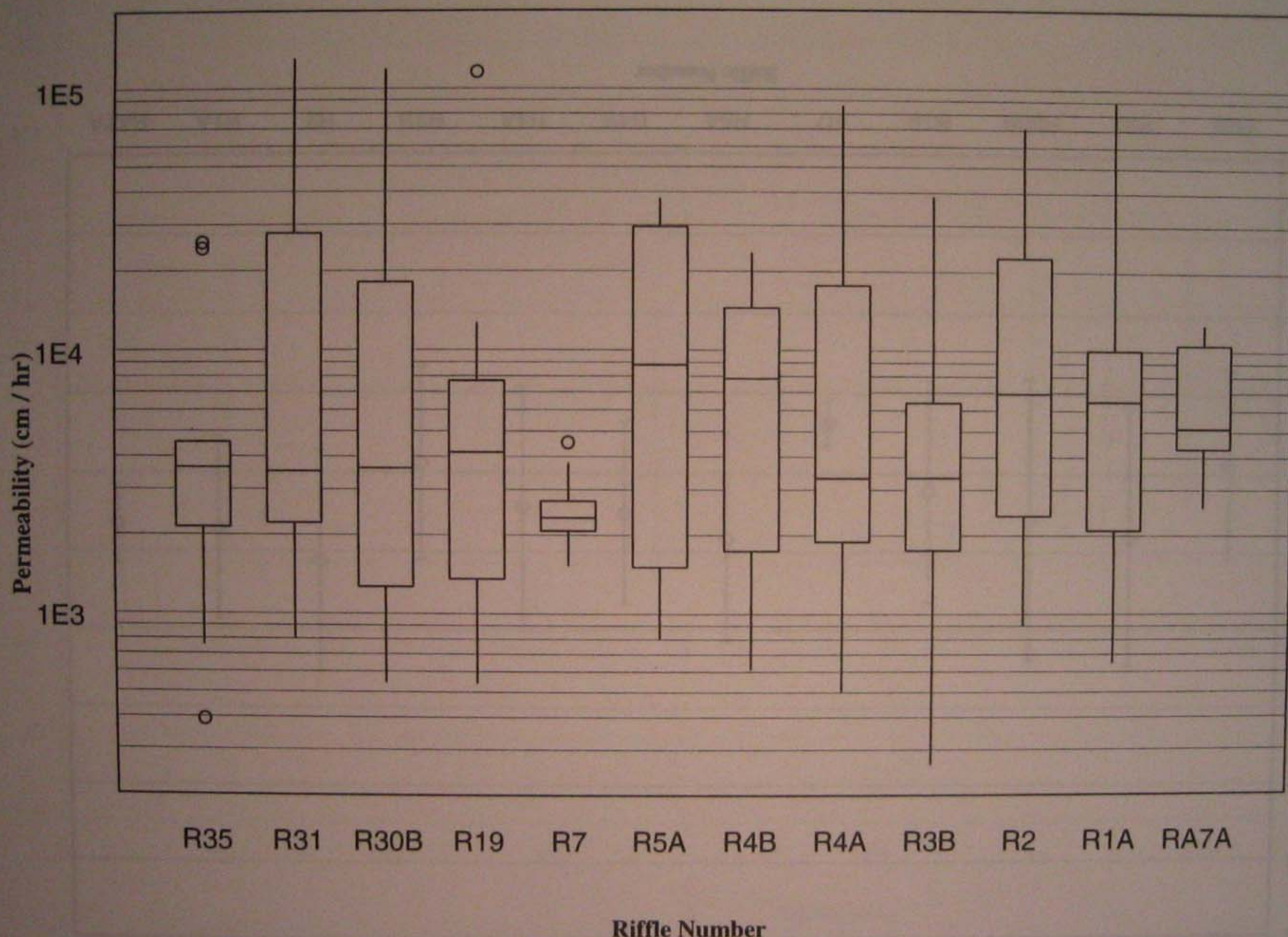
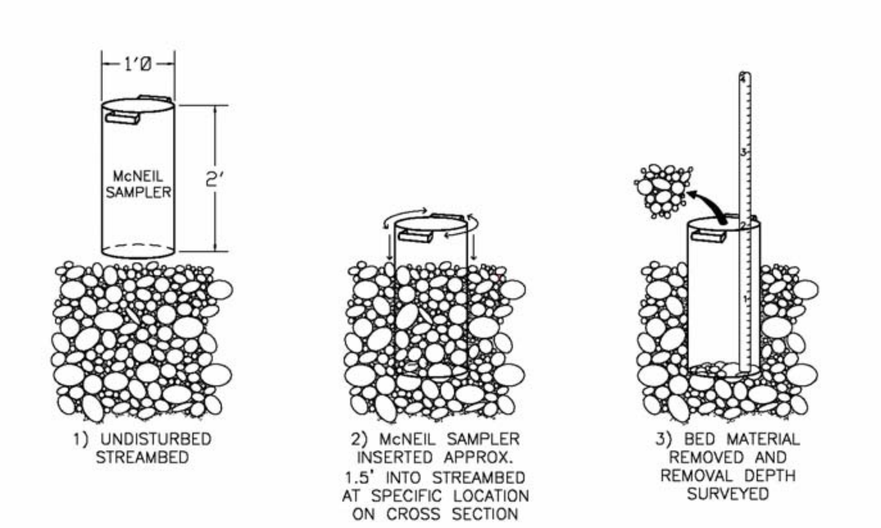
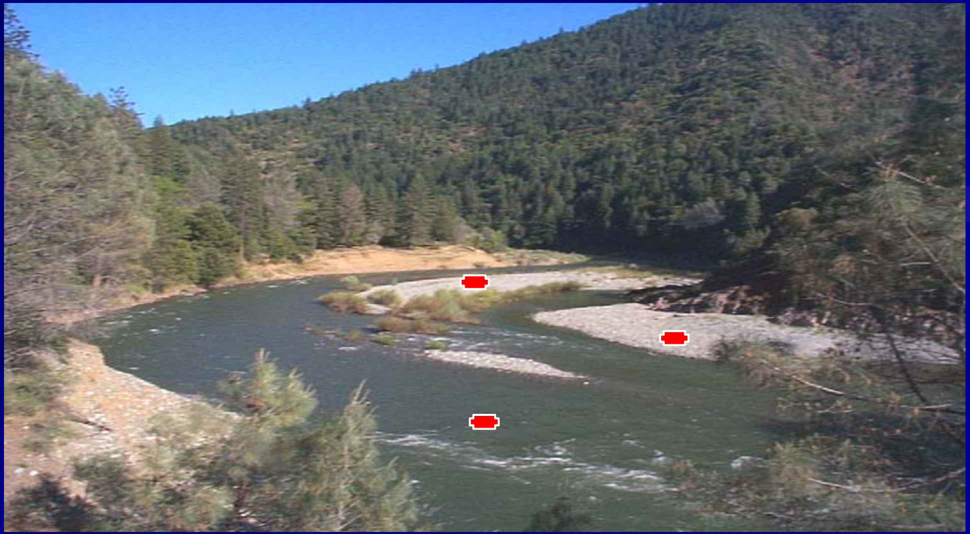



Figure 11. Tuolumne River permeability -- summary by riffle (November 1999).

f:\tid\tac-grv\analysis\2000\nov99.ppt

# Bulk Sampling



# Issues/Parting Thoughts

- One Size Does Not Fit All
- Good experimental design (i.e., spatial variability: need to understand sampling required for the desired analytical power)
- Need for adequate baseline data and/or control sites
- Must be threshold-driven (rather than calendar-driven) … funding cycles?
- Expect to require many years of effectiveness monitoring to test a sufficient range of flows
- Need for good field data to test physical-process models … test models of linkages between physical processes and biotic responses

# Acknowledgements

- Scott McBain, McBain and Trush
- Frank Ligon, Stillwater Sciences
- Yantao Cui, Stillwater Sciences
- Darren Mierau, McBain and Trush
- Zooey Diggory, Stillwater Sciences

# Conceptual framework of geomorphic and biotic relationships on alluvial rivers

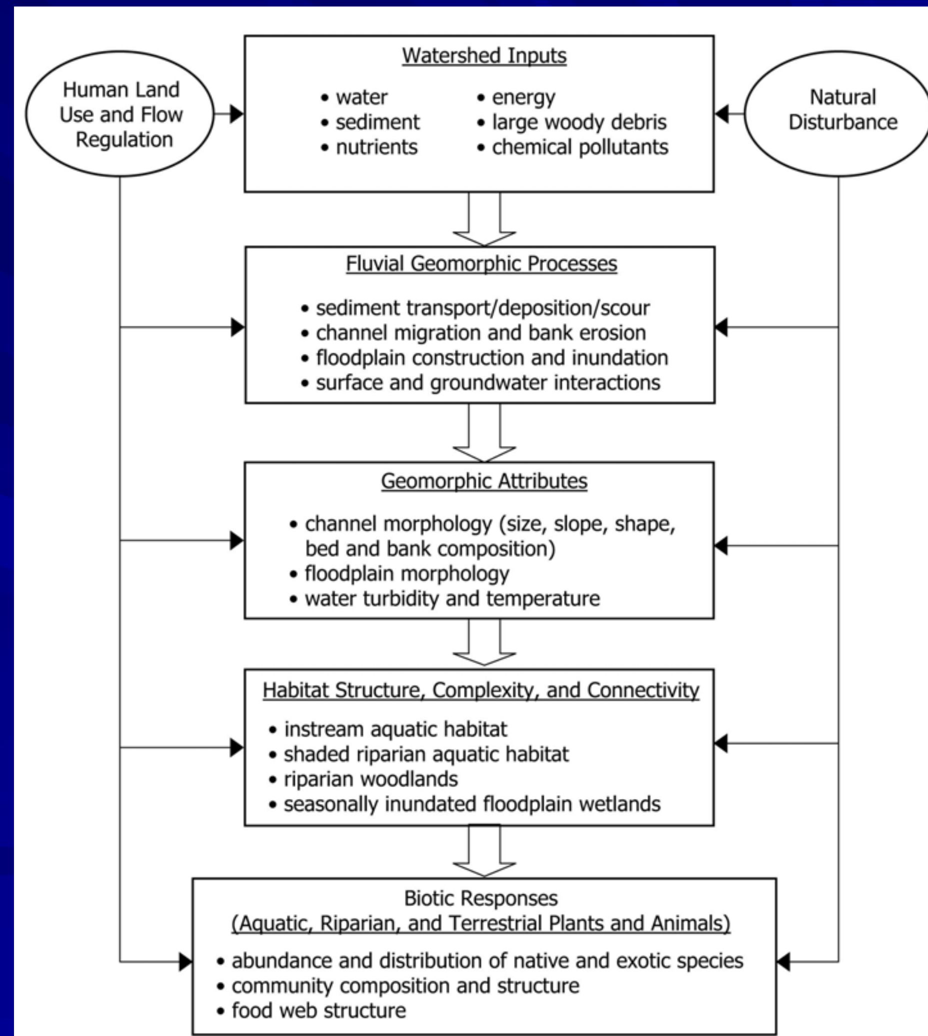
SUPPLY/CONTROL

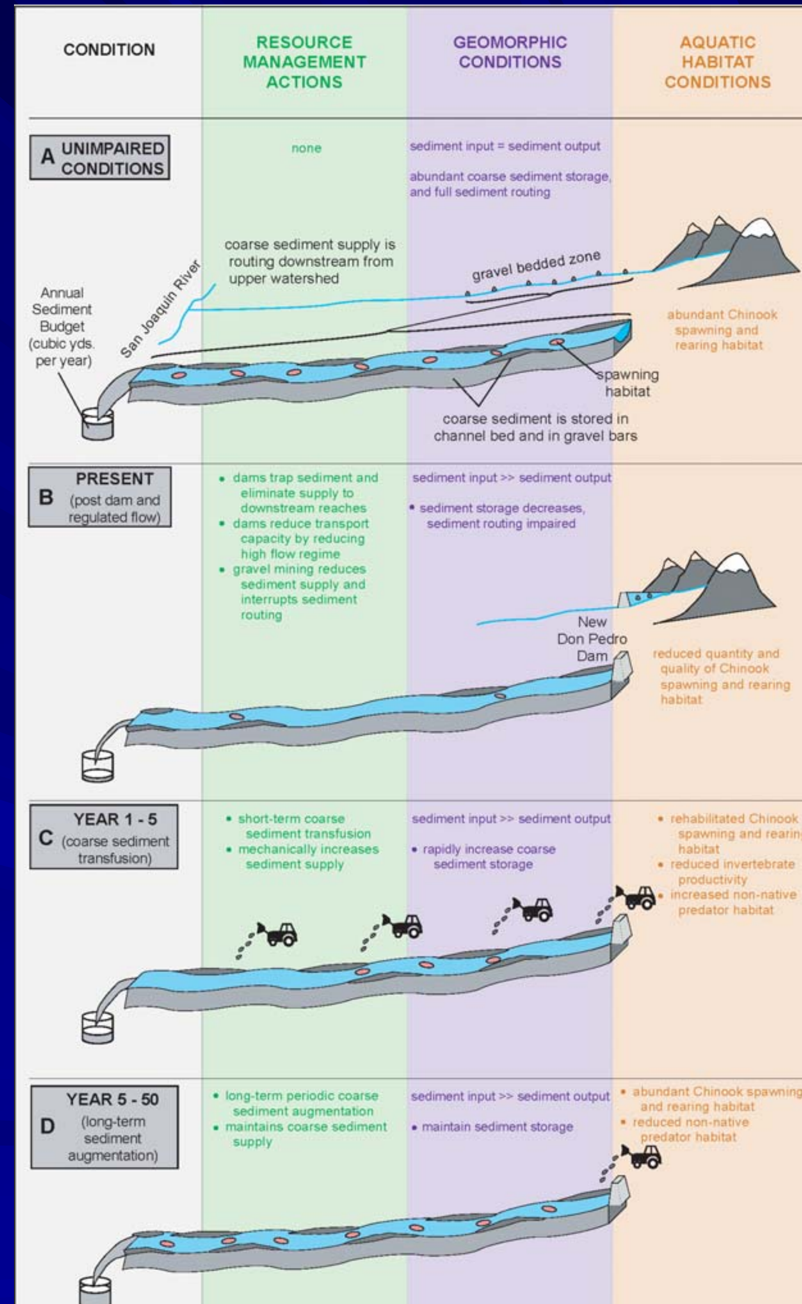
PROCESSES

FORM

HABITAT

BIOTA




CONDITION
RESOURCE MANAGEMENT ACTIONS
GEOMORPHIC CONDITIONS
AQUATIC HABITAT CONDITIONS
A UNIMPAIRED CONDITIONS
none
sediment input = sediment output
abundant coarse sediment storage, and full sediment routing
coarse sediment supply is routing downstream from upper watershed
gravel bedded zone
San Joaquin River
Annual Sediment Budget (cubic yds. per year)
abundant Chinook spawning and rearing habitat
spawning habitat
coarse sediment is stored in channel bed and in gravel bars
B PRESENT (post dam and regulated flow)
• dams trap sediment and eliminate supply to downstream reaches
• dams reduce transport capacity by reducing high flow regime
• gravel mining reduces sediment supply and interrupts sediment routing
sediment input >> sediment output
• sediment storage decreases, sediment routing impaired
New Don Pedro Dam
reduced quantity and quality of Chinook spawning and rearing habitat
C YEAR 1 - 5 (coarse sediment transfusion)
• short-term coarse sediment transfusion
• mechanically increases sediment supply
sediment input >> sediment output
• rapidly increase coarse sediment storage
• rehabilitated Chinook spawning and rearing habitat
• reduced invertebrate productivity
• increased non-native predator habitat
D YEAR 5 - 50 (long-term sediment augmentation)
• long-term periodic coarse sediment augmentation
• maintains coarse sediment supply
sediment input >> sediment output
• maintain sediment storage
• abundant Chinook spawning and rearing habitat
• reduced non-native predator habitat

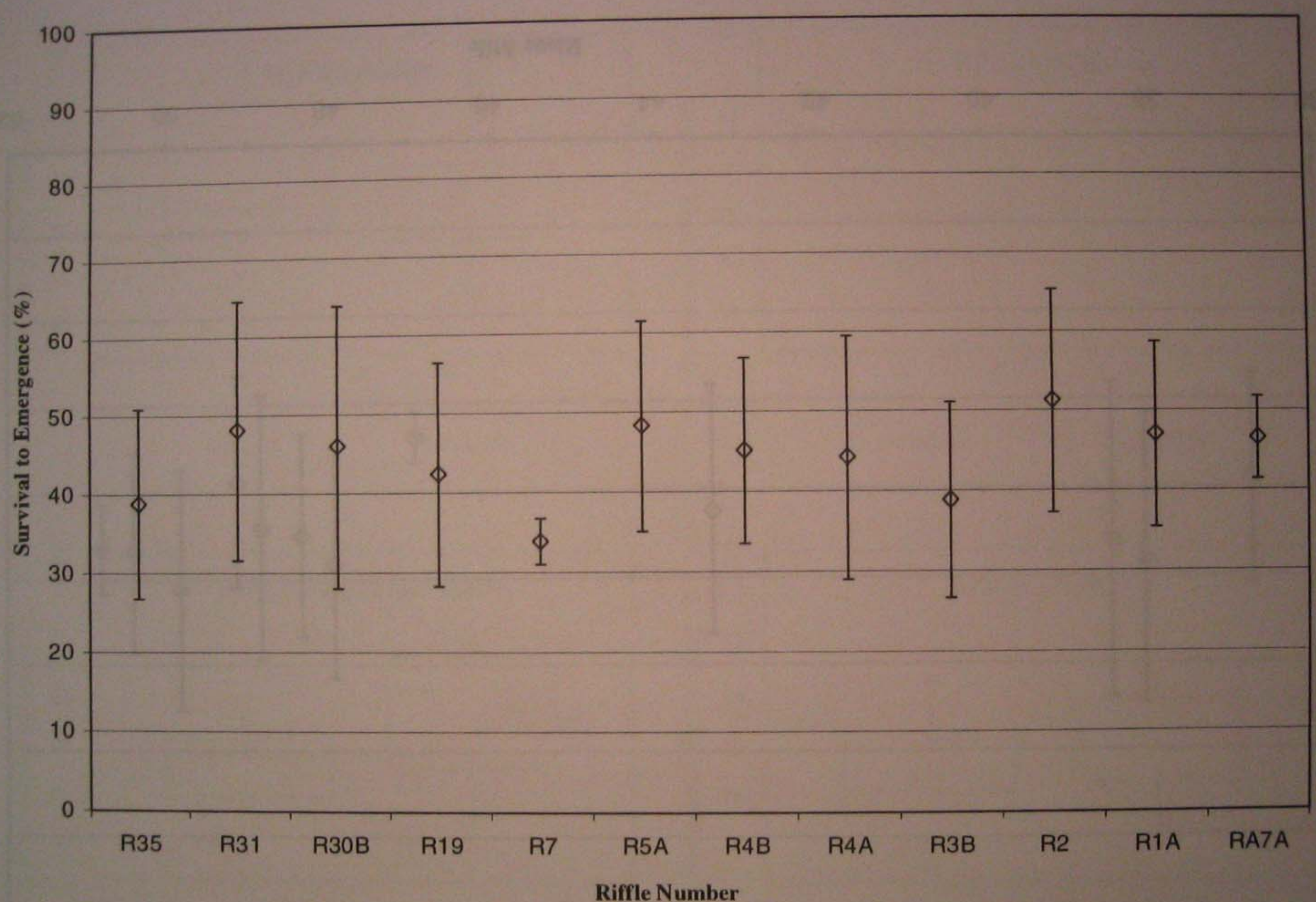
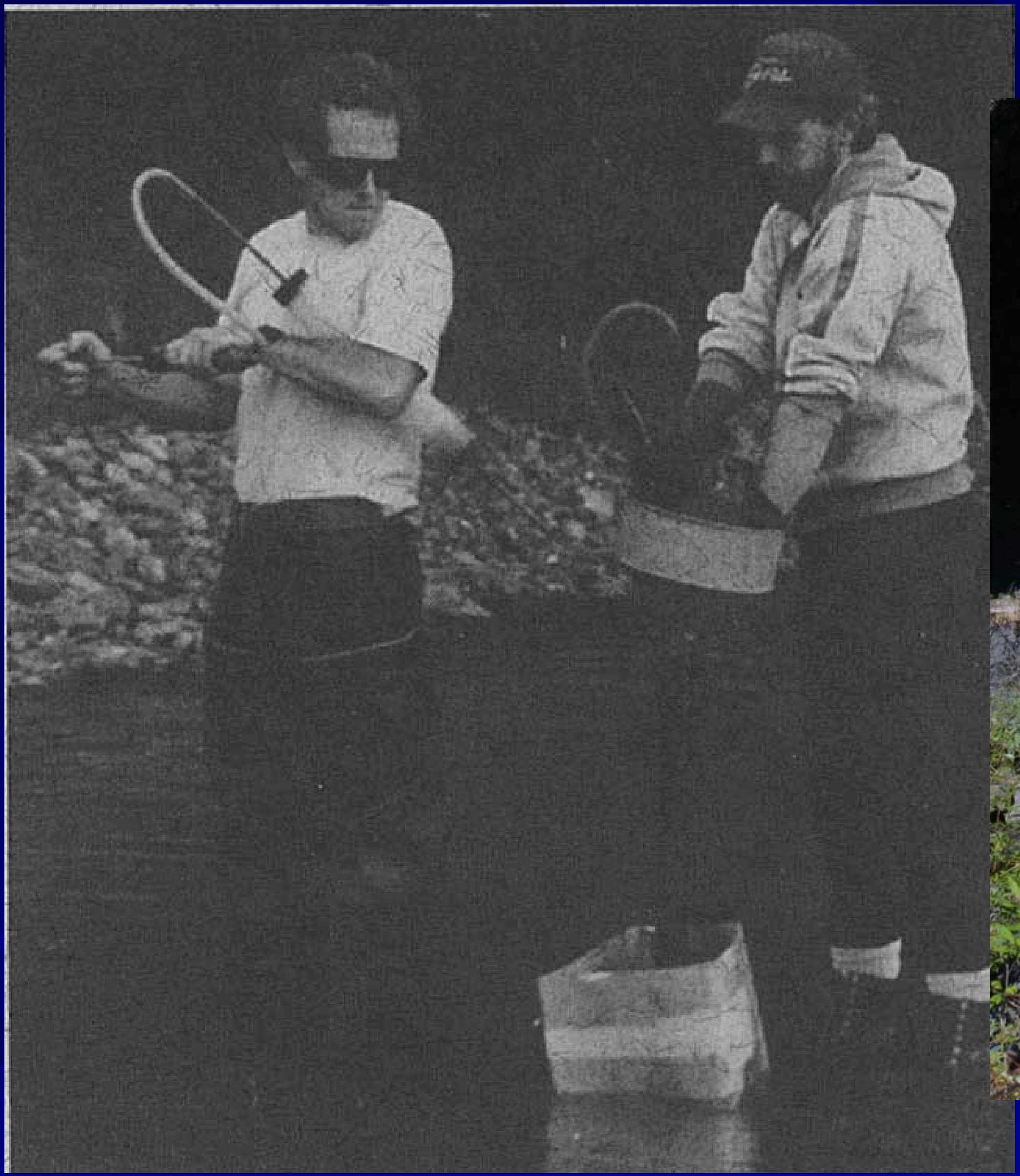
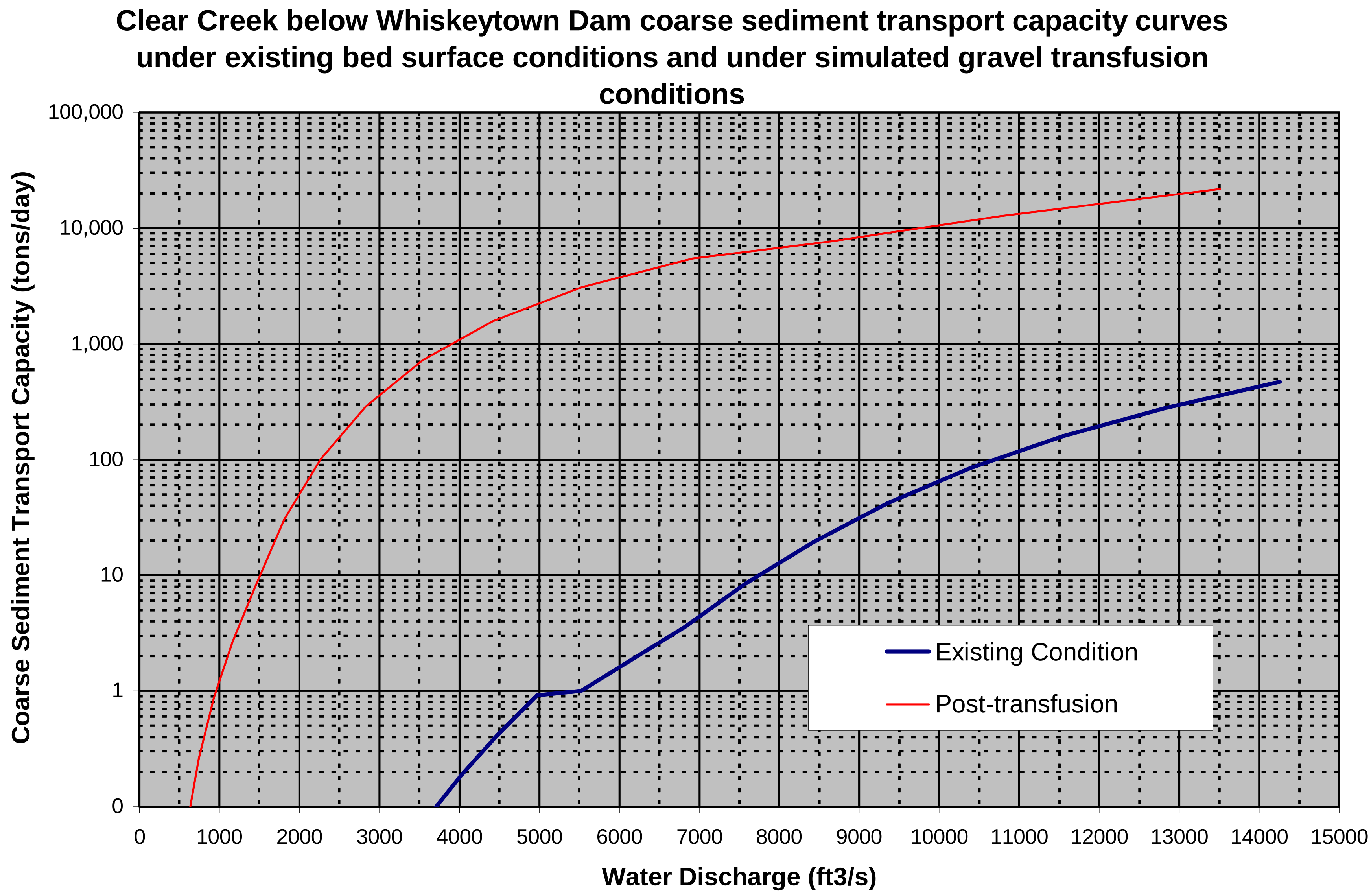



**Figure 12. Predicted mean survival-to-emergence (+/- 1.96 S.E.) - November 1999.**




Clear Creek below Whiskeytown Dam coarse sediment transport capacity curves under existing bed surface conditions and under simulated gravel transfusion conditions
Coarse Sediment Transport Capacity (tons/day)
100,000
10,000
1,000
100
10
1
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
Water Discharge (ft3/s)
Existing Condition
Post-transfusion