Gravel supply, bed mobility, and scour of salmonid redds

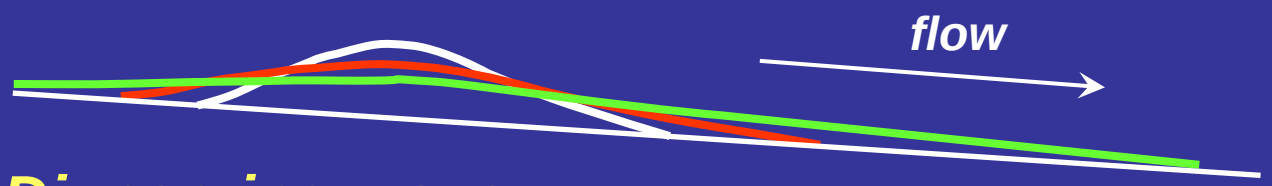
Thomas E. Lisle

USDA Forest Service

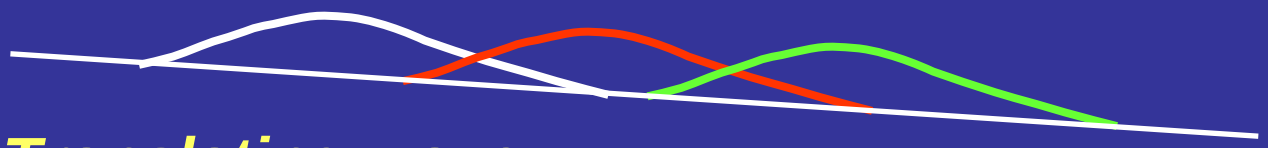
Pacific Southwest Research Station

Arcata, California, USA

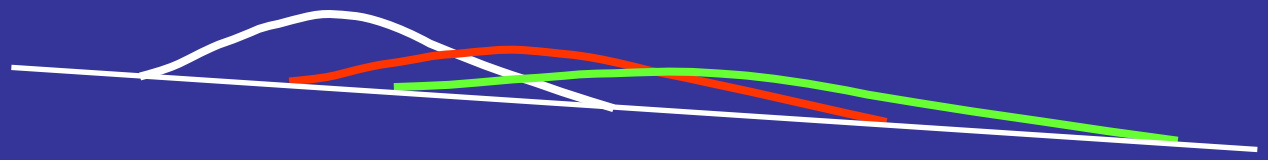
SEDIMENT WAVE TYPES



Dispersing wave



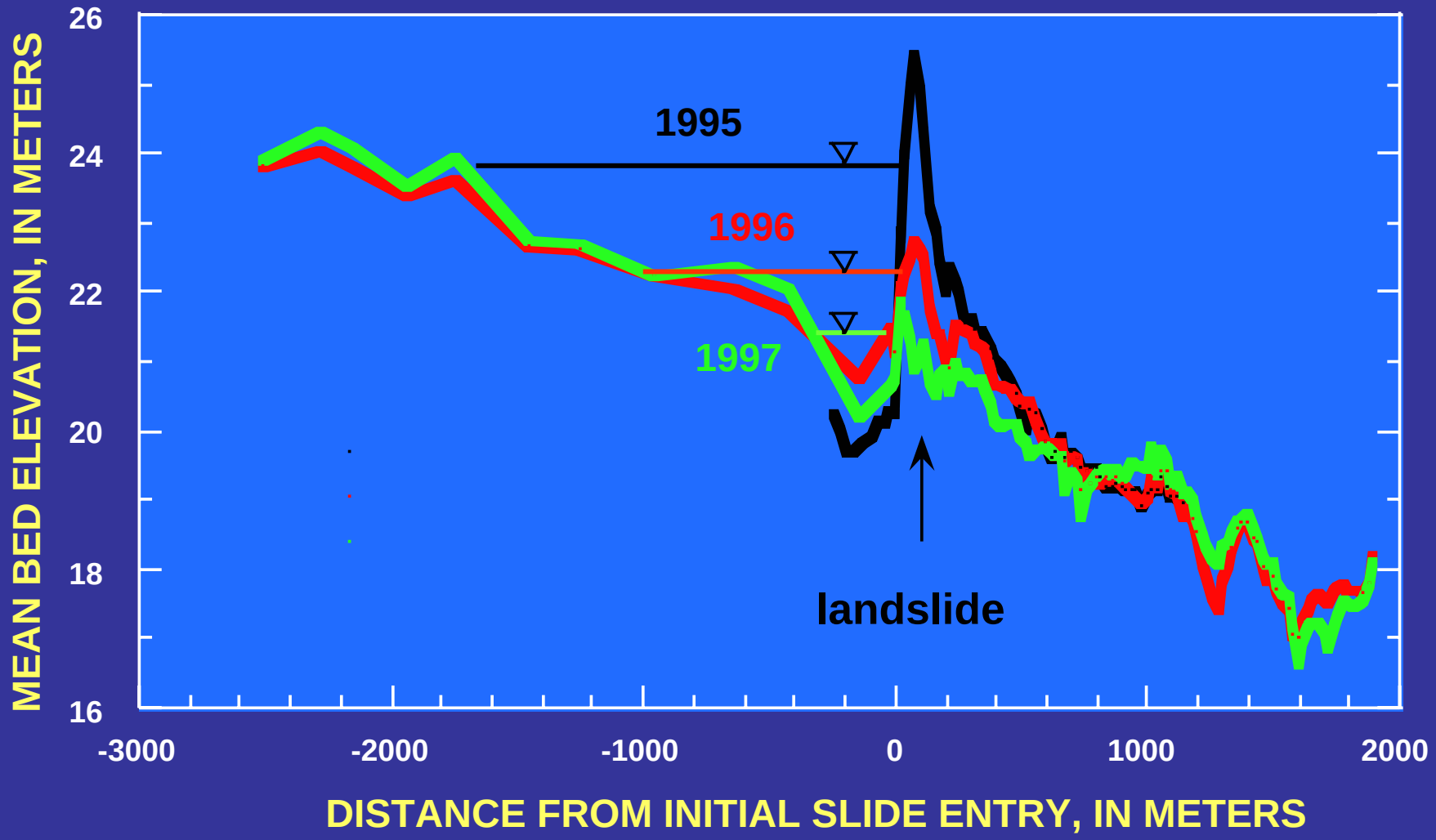
Translating wave



Translating and dispersing wave

Navarro River

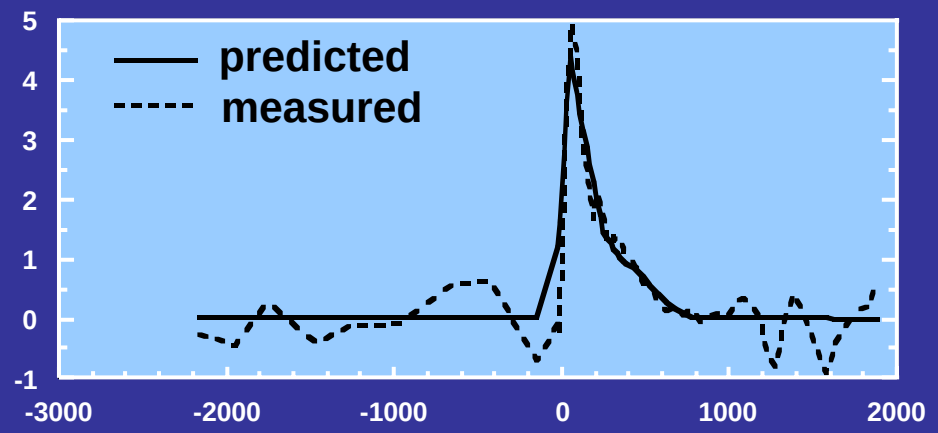
NAVARRO RIVER PROFILES



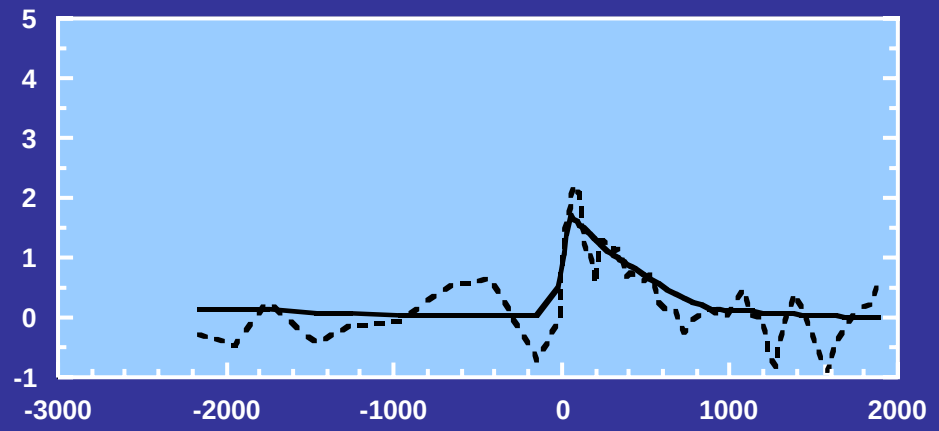
Assumtions:

- Former bed was winnowed and stable.
- Input gravel is mobile.

NAVARRO RIVER

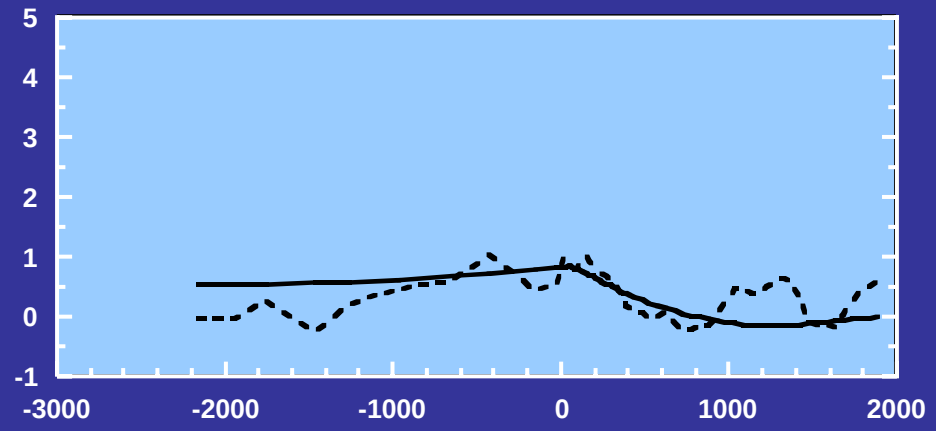


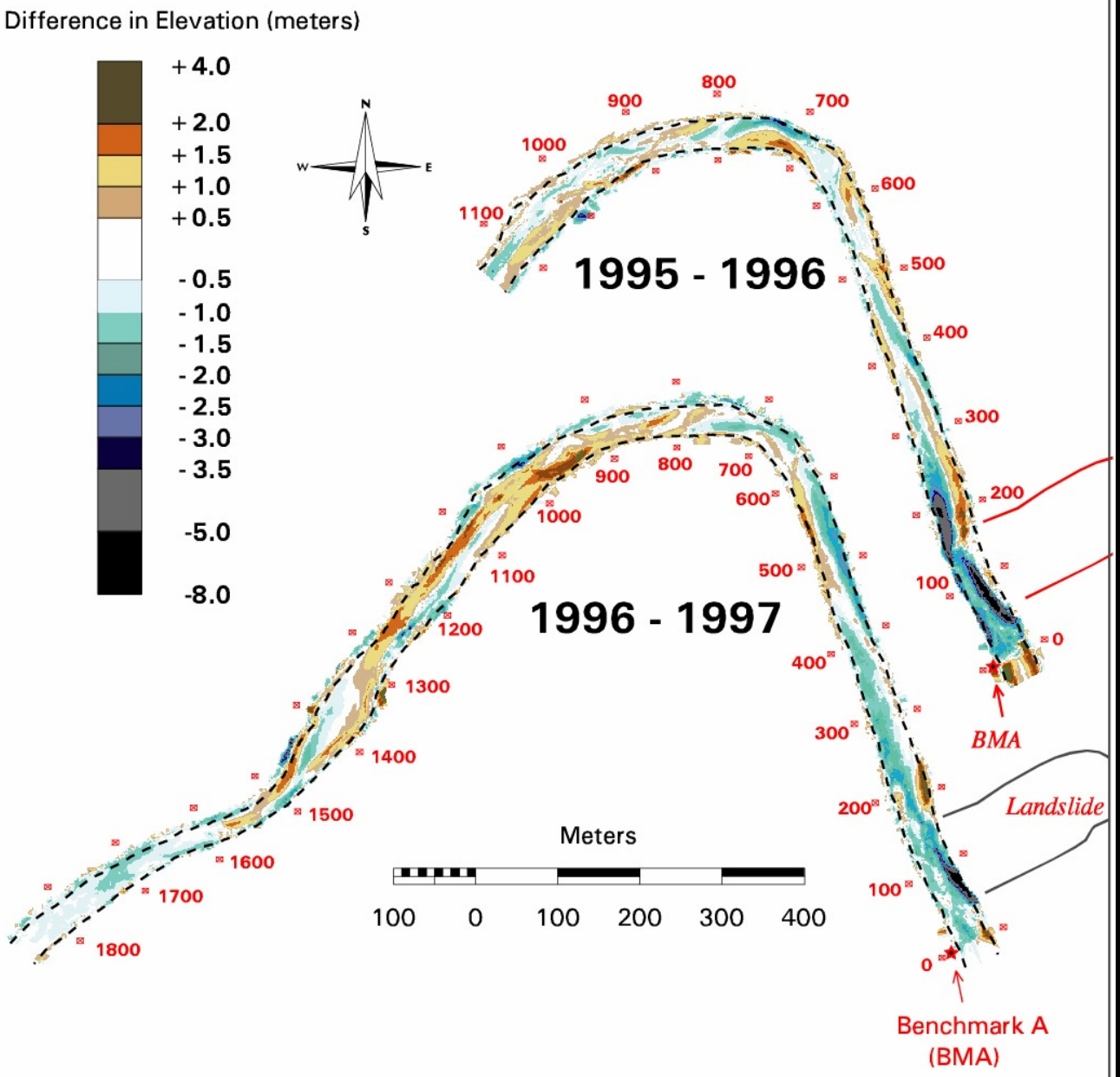
1995



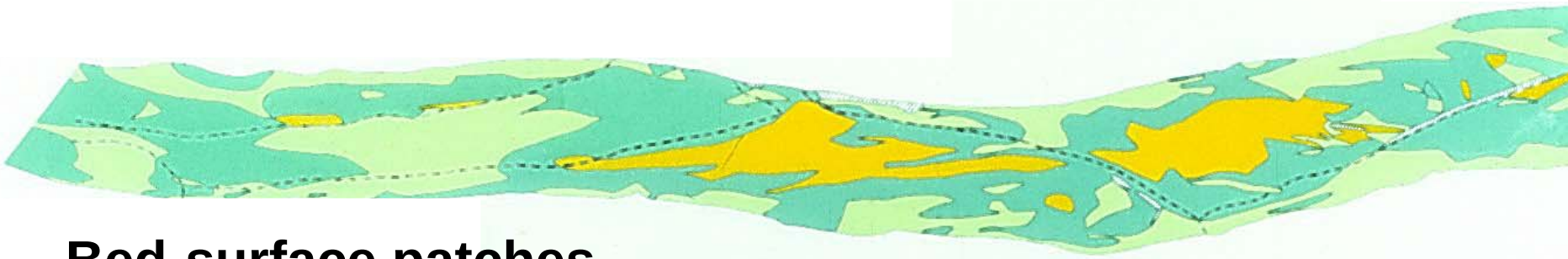
1996

1999



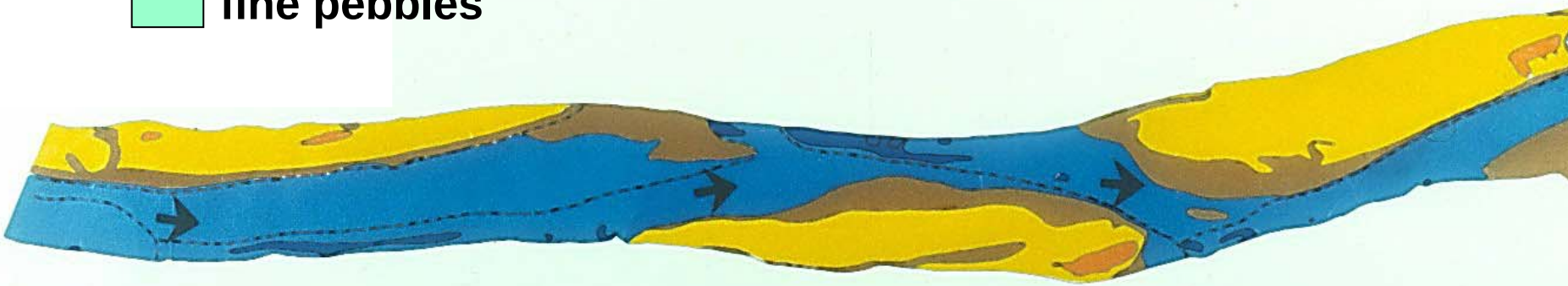

Difference in Elevation (meters)
+4.0
+2.0
+1.5
+1.0
+0.5
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-5.0
-8.0
N
W
E
S
1995 - 1996
1996 - 1997
Meters
100 0 100 200 300 400
BMA
Landslide
Benchmark A
(BMA)

REDWOOD CREEK



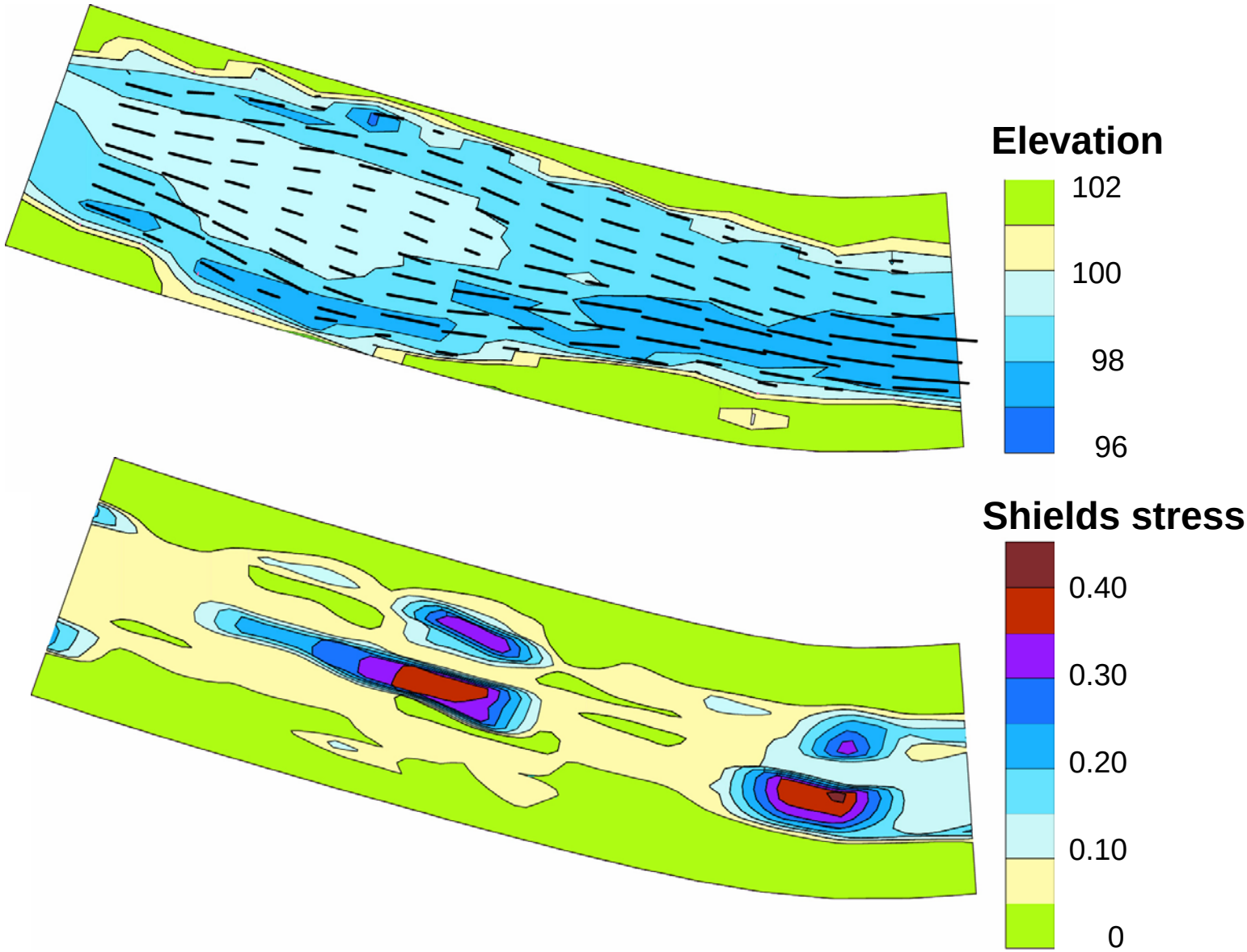
Bed-surface patches

- cobbles
- medium pebbles
- fine pebbles



Bed topography

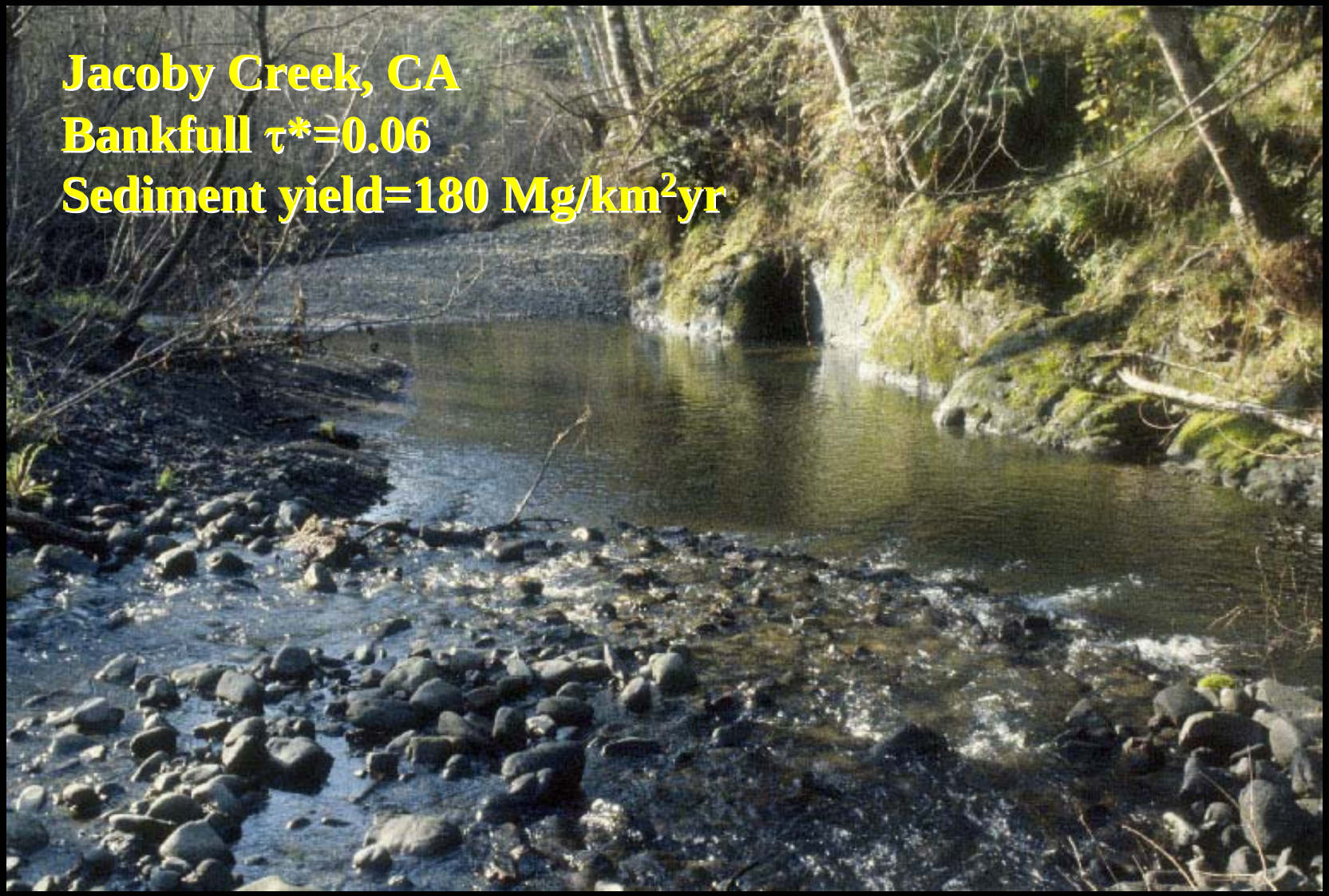
Redwood Creek (Elam Reach) at bankfull stage



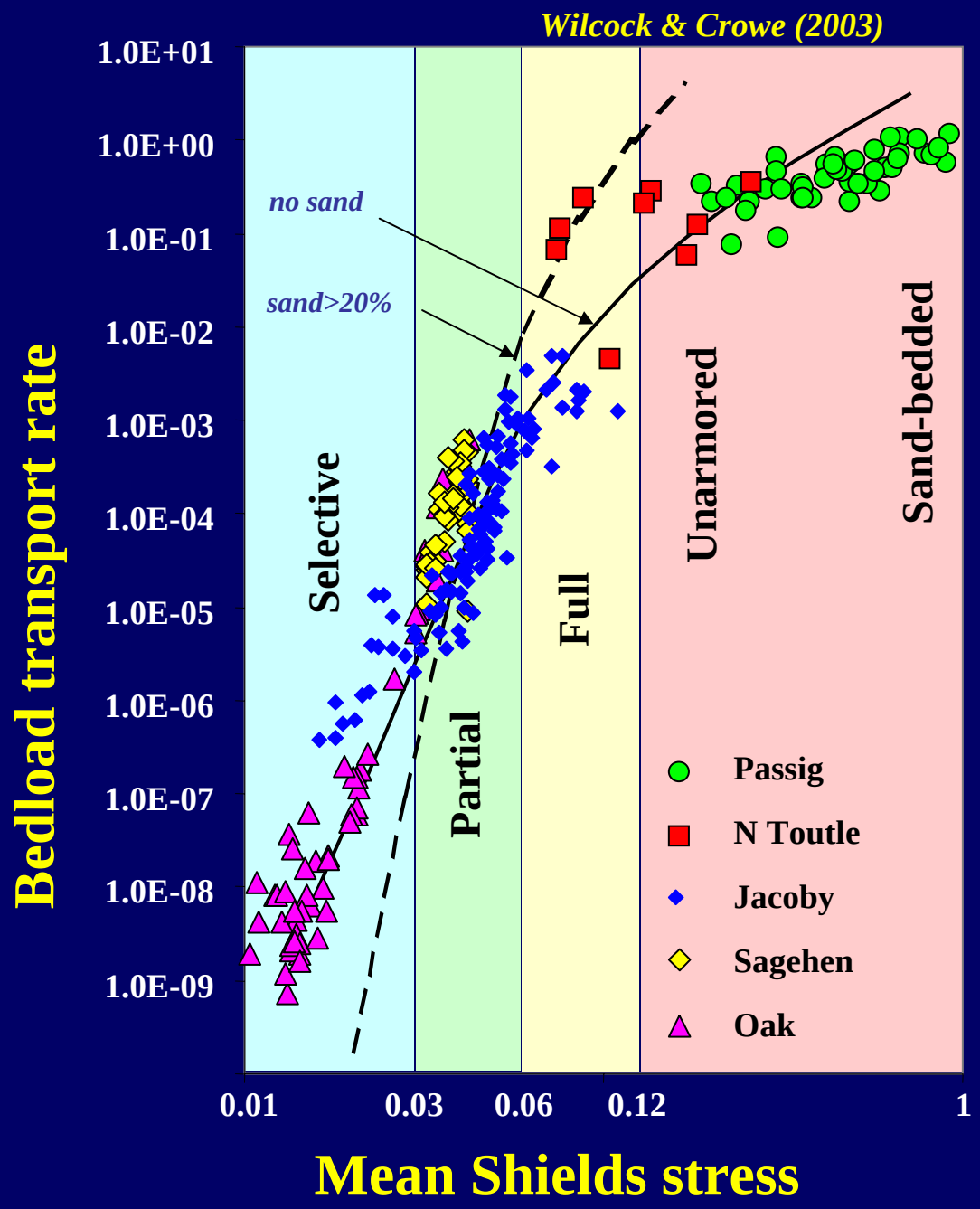
Sediment transport effects on spawning gravels

Bed mobility	*Shields stress*	*Active bed thickness*	*Effects on spawning and incubation*
Selective	<0.03	<1 surface layer	Compaction Surface seal
Partial	**0.03-0.06**	**~1 surface layer**	**Loose bed** **Deeper surface seal**
Full (plus bed deformation)	**>0.06**	**>1 surface layer**	**Loose bed** **Deep surface seal** **Lethal scour-fill**

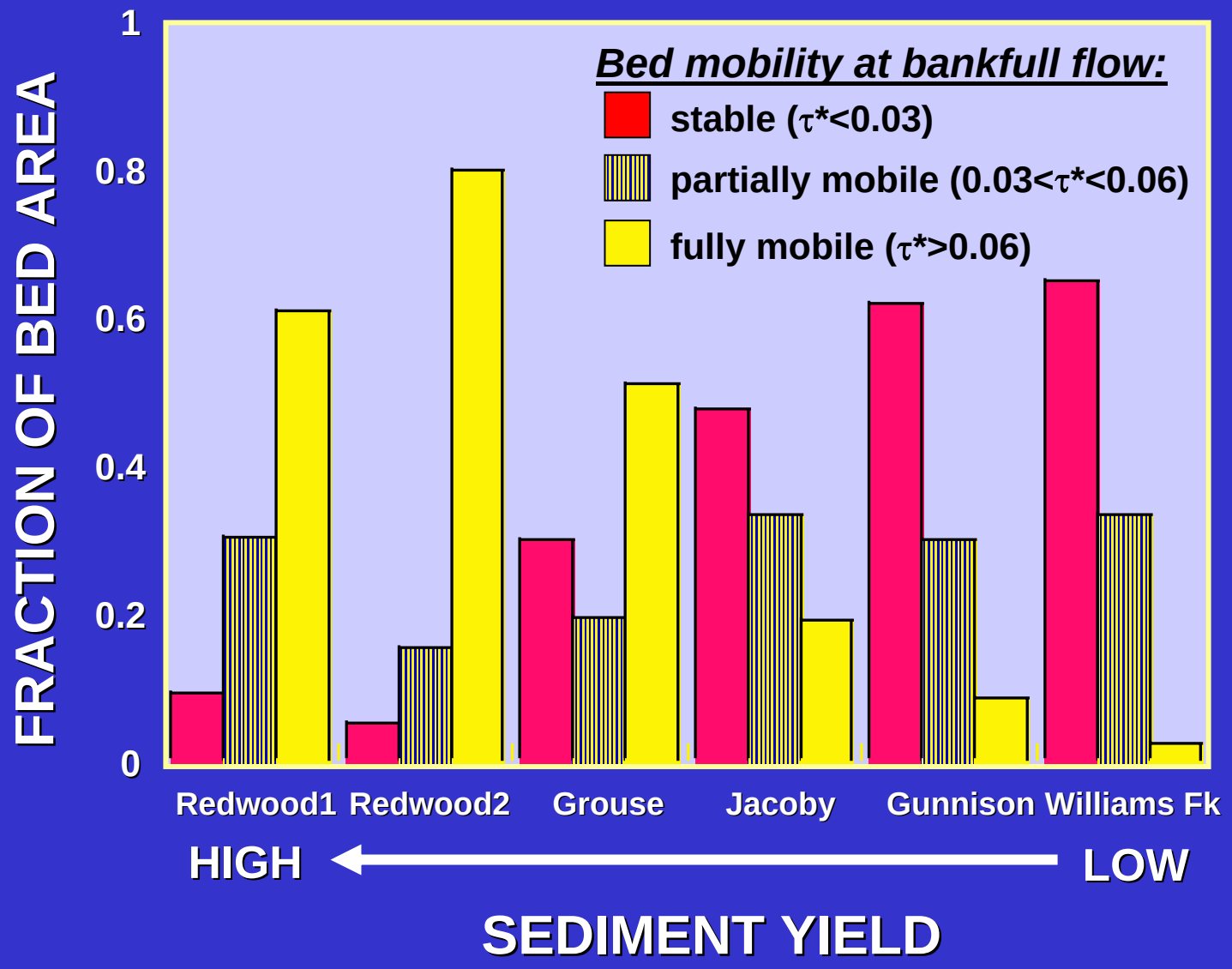
Redwood Creek, CA
Bankfull τ*=0.12
Sediment yield=1400 Mg/km²yr


Jacoby Creek, CA
Bankfull τ*=0.06
Sediment yield=180 Mg/km²yr

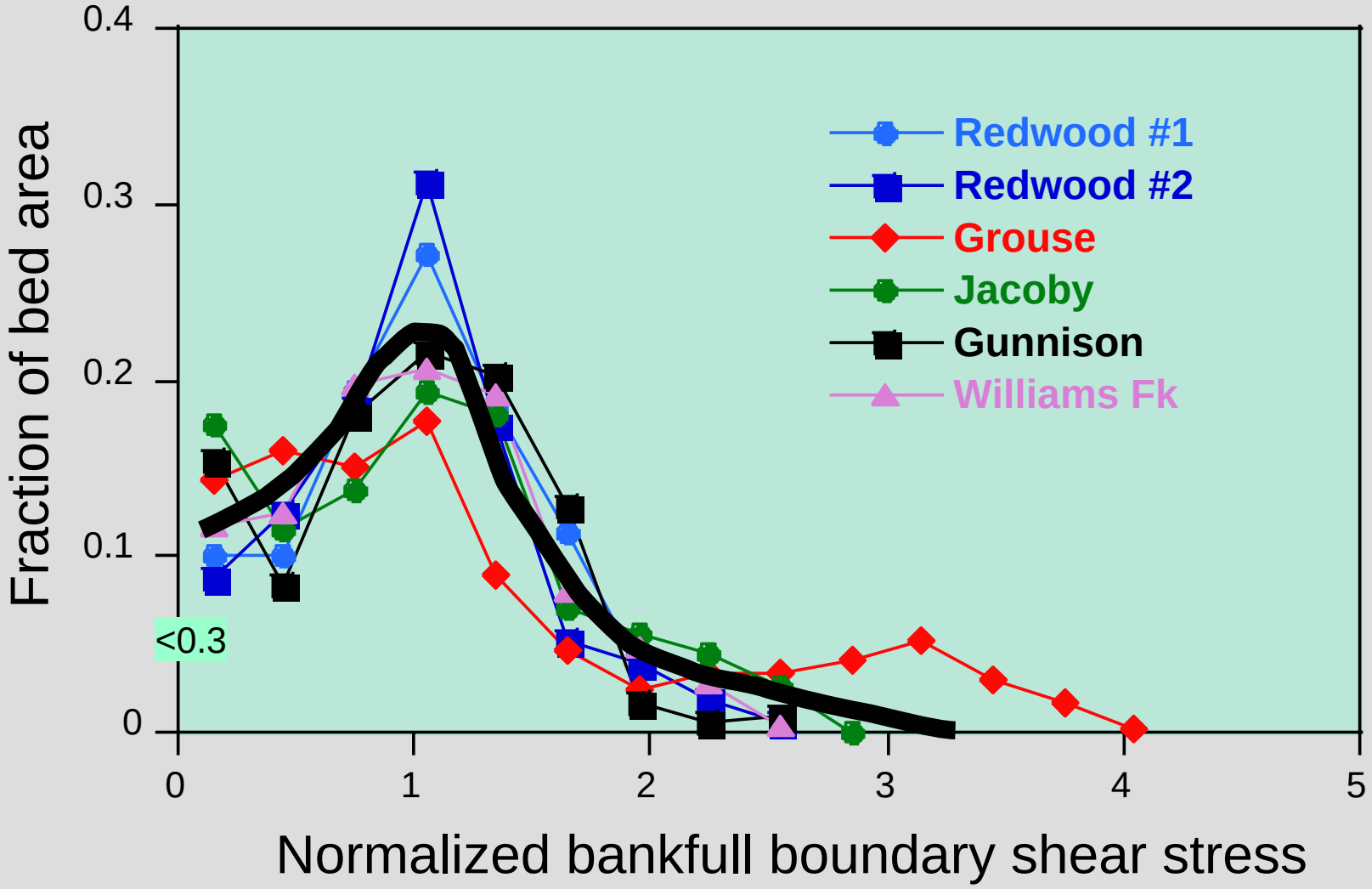
Williams Fork, CO
Bankfull τ*=0.025
Sediment yield=0.1 Mg/km²yr
Barkett (1998)

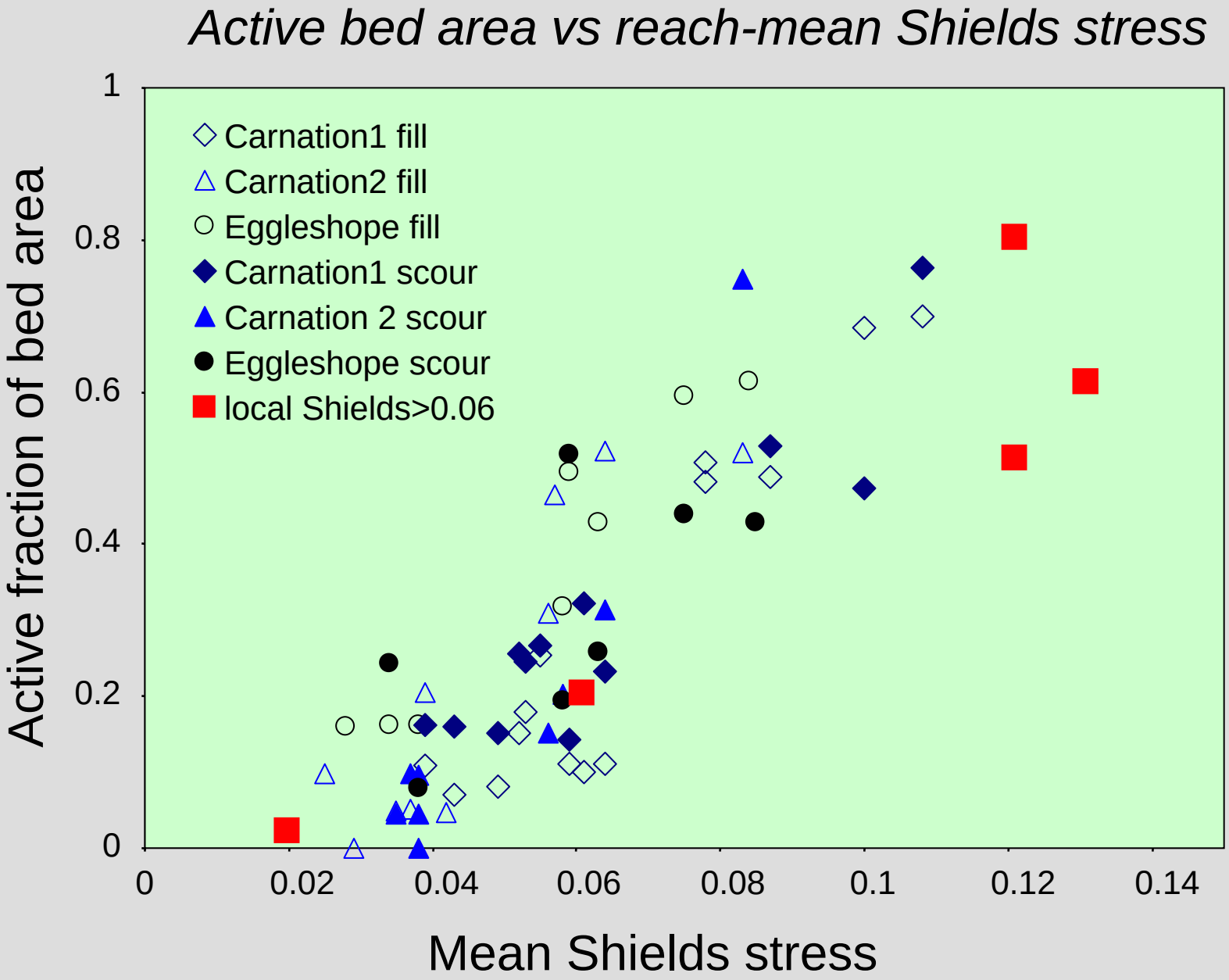

Wilcock & Crowe (2003)
1.0E+01
1.0E+00
1.0E-01
1.0E-02
1.0E-03
1.0E-04
1.0E-05
1.0E-06
1.0E-07
1.0E-08
1.0E-09
Bedload transport rate
no sand
sand>20%
Selective
Partial
Full
Unarmored
Sand-bedded
Passig
N Toutle
Jacoby
Sagehen
Oak
0.01
0.03
0.06
0.12
1
Mean Shields stress

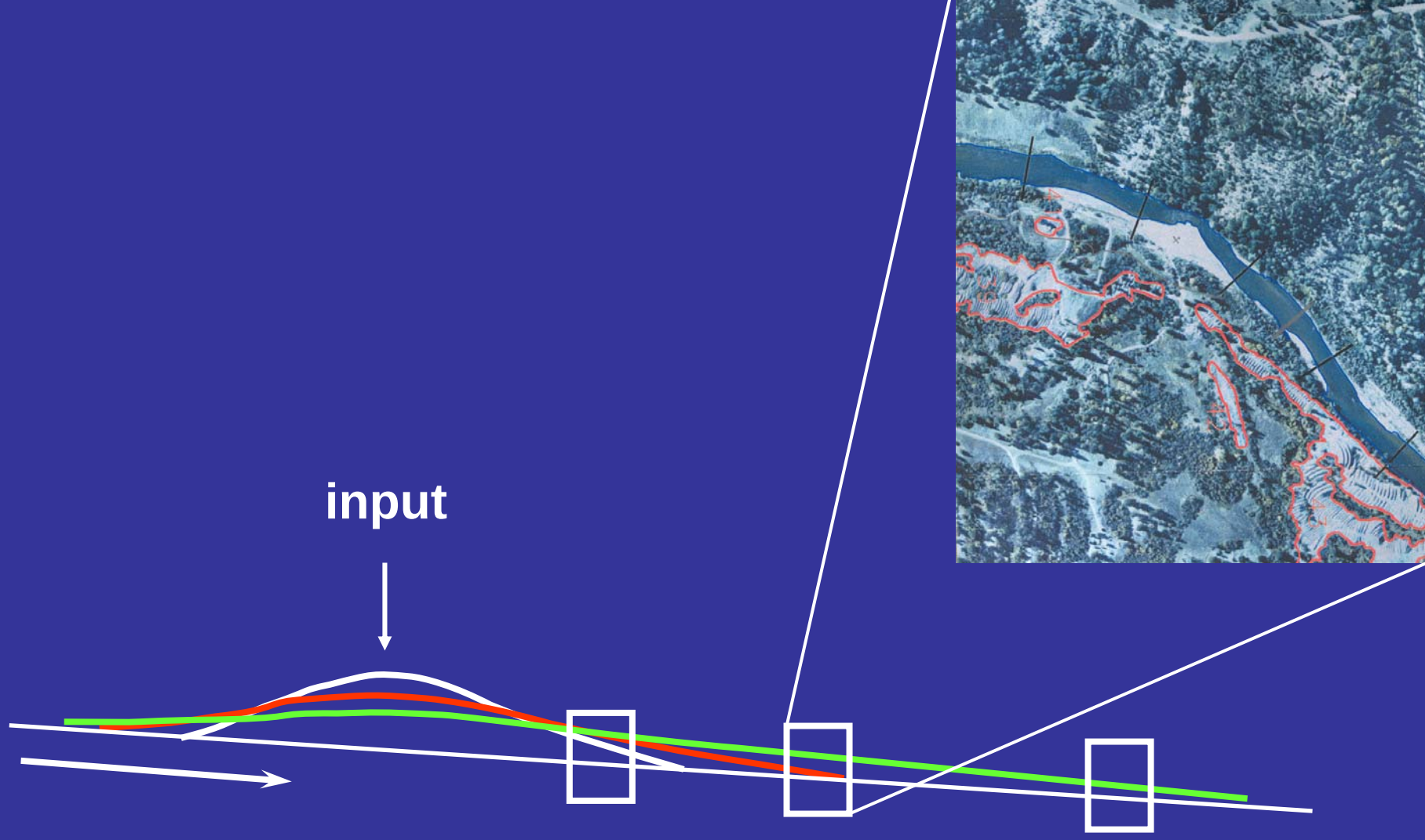
SPATIAL FREQUENCY OF BED MOBILITY



FREQUENCY DISTRIBUTION OF NORMALIZED SHEAR STRESS




Active bed area vs reach-mean Shields stress
Carnation1 fill
Carnation2 fill
Eggleshope fill
Carnation1 scour
Carnation 2 scour
Eggleshope scour
local Shields>0.06
Active fraction of bed area
Mean Shields stress
0
0.2
0.4
0.6
0.8
1
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14


input