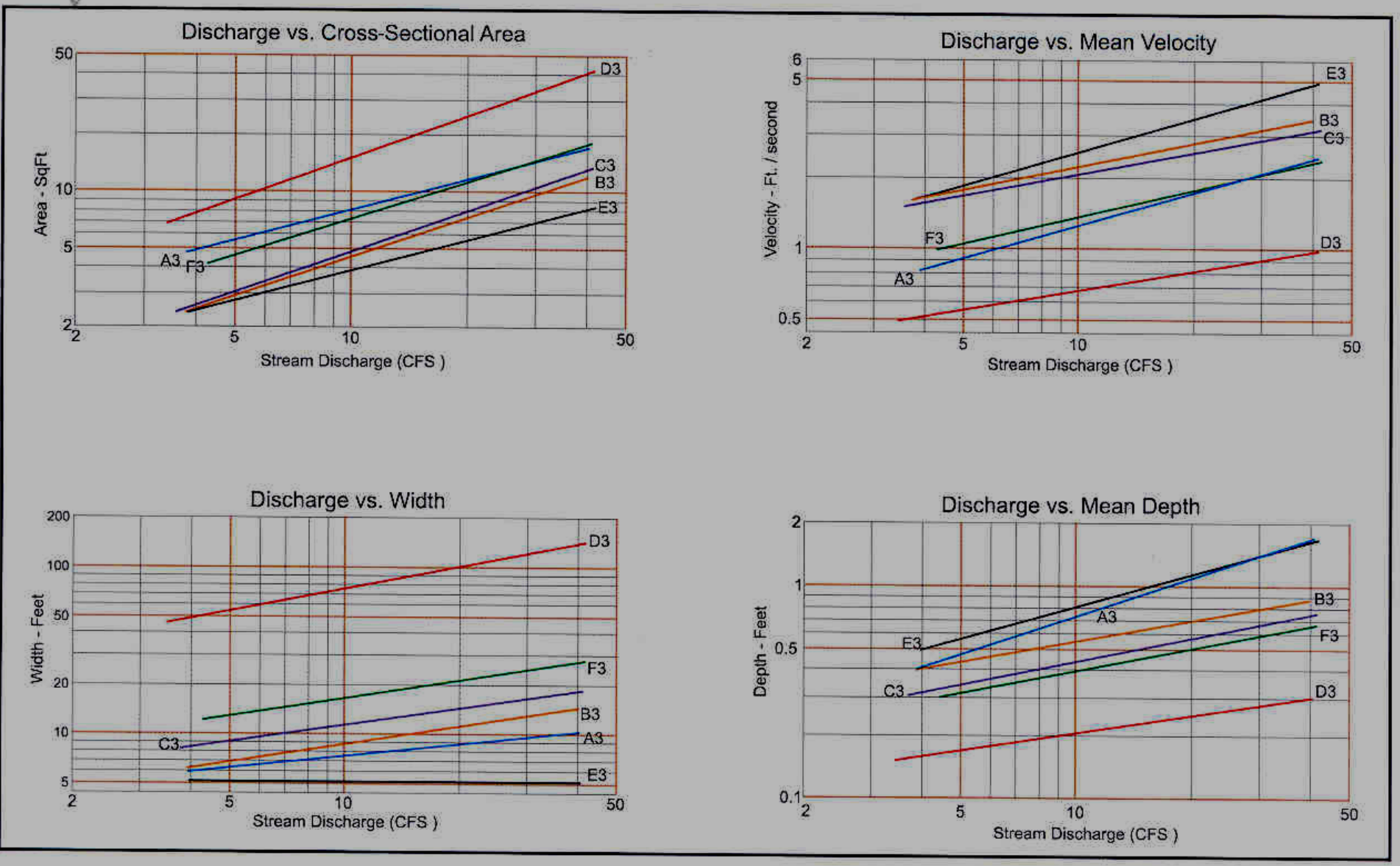
Does stream type matter?

If your interested in hydraulic geometry it does



Use and Limitations of CEM

- Excellent tool for developing a management strategy for incised stream systems
- Indicates condition of floodplain attachment and potential for riparian restoration
- Indicates threshold changes in cost of physical treatment
- Sometimes base-grade has been manipulated by entities such as county road departments, municipalities, or others. Short-term alterations may confuse casual observer. (e.g. hard checks put by road departments)
- Enough history of perturbations have passed that there are no reference sites to build upon for stage I of the Schumm Model
- Some Stage Vs are natural

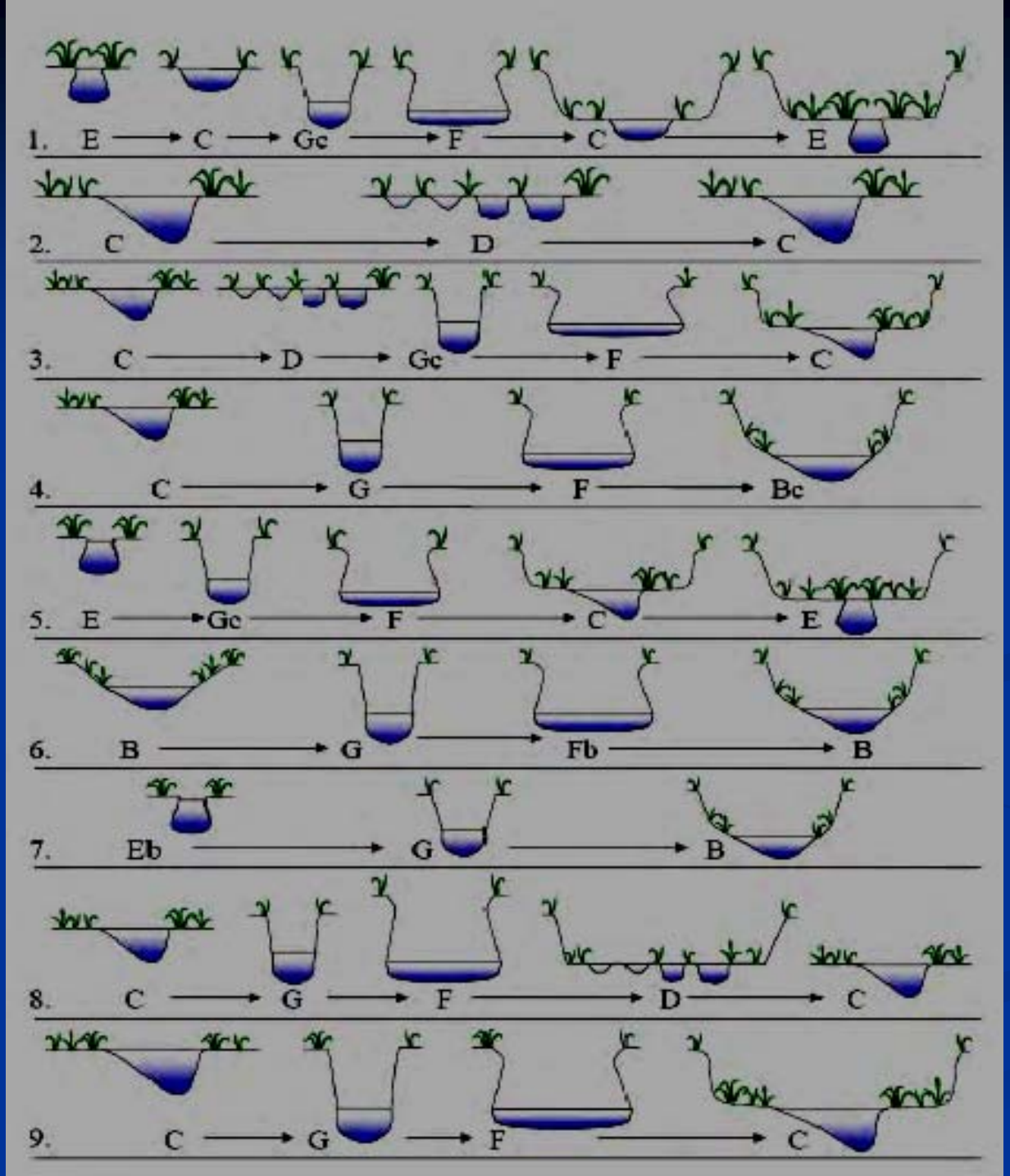
Use and Limitations Rosgen's Classification System

UPSIDE

- System is morphometric based and results are reproducible
- Stratification into correct stream type leads to a more appropriate planning and design
- We can talk in common terms about stream types instead of a wordy complicated description
- System is Robust

DOWNSIDE

- Bankfull Indicators can be difficult to find
- Bankfull regional curves are recommended but they can be time consuming and data may be limiting
- Mis-use of system
- Validation process may be time consuming



Schumm CEM*

Schumm CEM

Schumm CEM

Schumm CEM

Schumm CEM

Schumm CEM

Schumm CEM

Schumm CEM*

How good are we at observation?

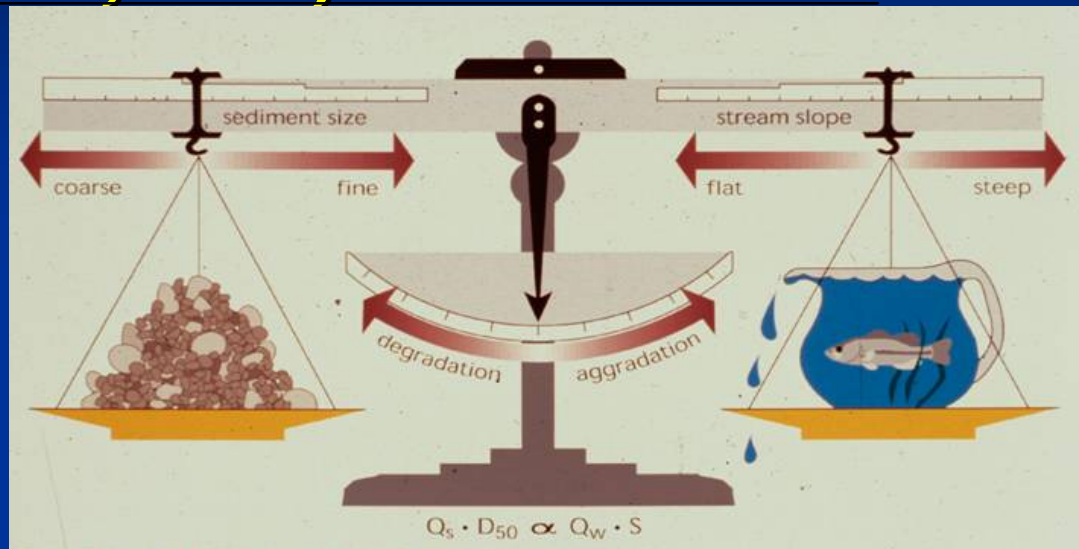
Geomorphic Threshold

Streams operating outside of their range of natural physical variability long enough to induce an evolutionary channel change. For example, the combination of poor lateral stability (reduction of critical native plants as in Carex) and a significant flood event can easily drive a pool:riffle gravel bed stream into a state beyond a threshold, inducing a new stream form striking off a new channel evolutionary path. State and transition assessments really needs to consider this.

Stream Balance Equation
(Lane, 1955)

Load ∝ Energy

$$Qs \cdot D50 \propto Q_w \cdot S$$



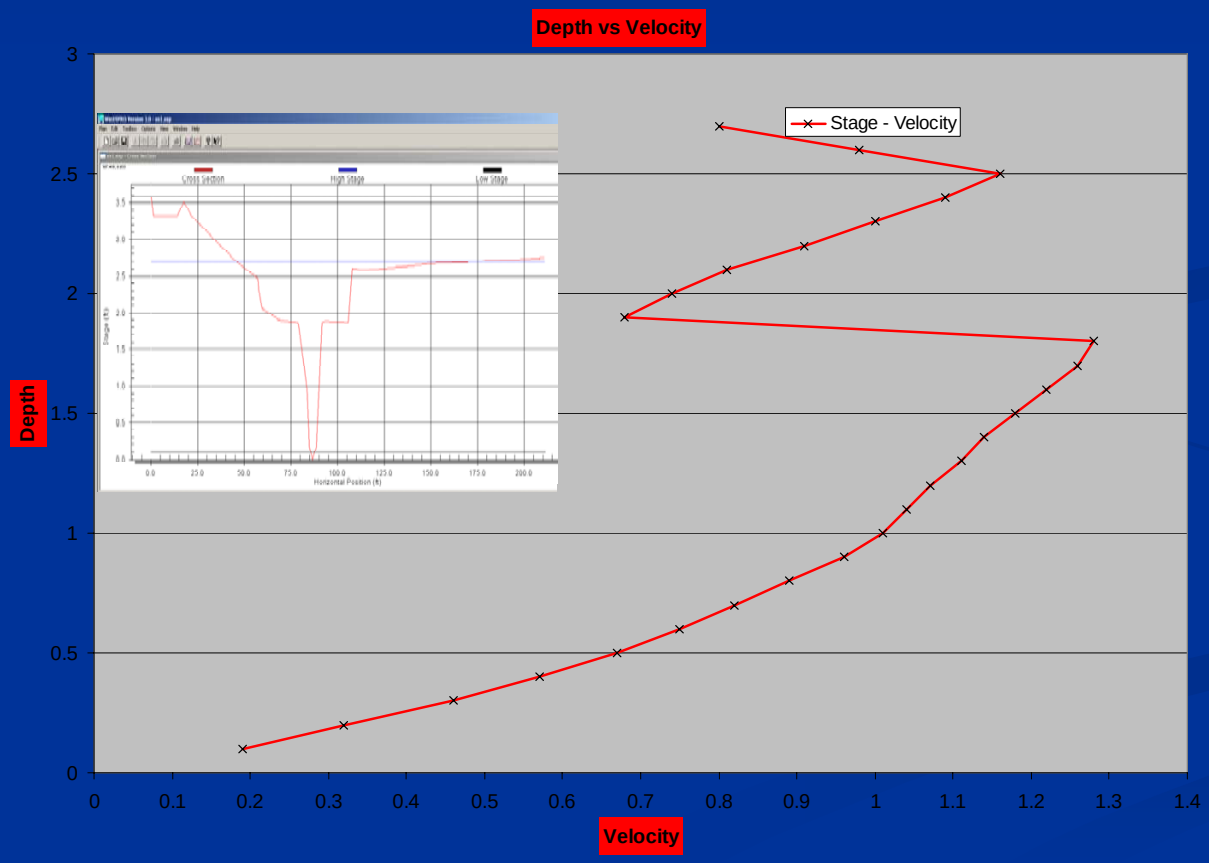
From Rosgen (1996), from Lane, Proceedings, 1955.
Published with the permission of American Society of Civil Engineers.

- Q_w = Stream Flow
- S = Stream Slope
- Q_s = Sediment Load
- D_{50} = Sediment Particle Size

Depth Velocity and Shear

$$v = 1.486 \frac{r^{2/3}}{n} \times \frac{s^{1/2}}{}$$

$$r = \frac{A}{WP}$$



Why Floodplains?

As WP goes up,

R goes down,

As R goes down,

Velocity goes down

Bed shear is less

Depth Velocity and Shear Related to Threshold

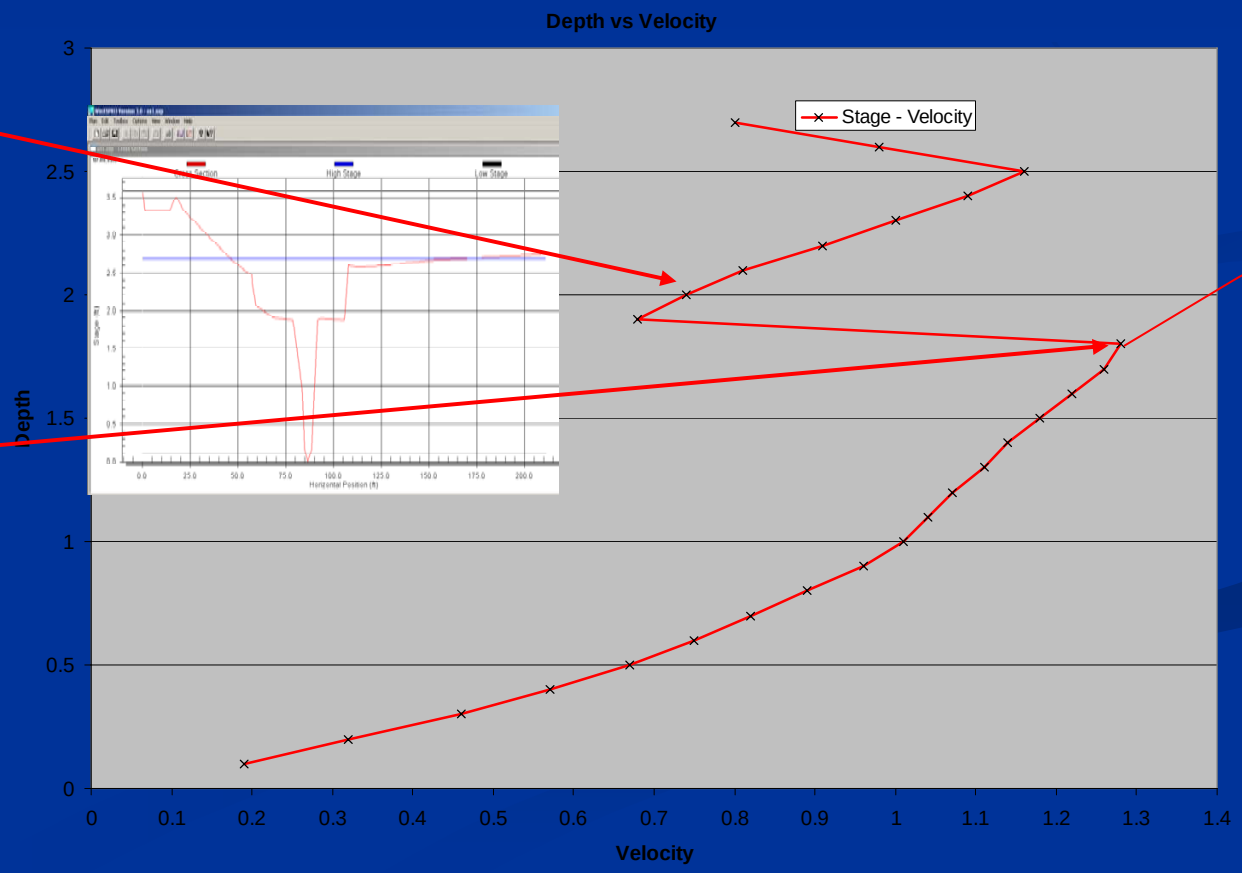
$$\tau \cong \frac{A}{WP} \times \gamma_w \times s$$

$$\tau \cong d \times \gamma_w \times s$$

BHR 1.2 – 1.4

Depends on bank stratigraphy and near bank stress

Floodplain



Bank Height Ratio – 1.3

Photo by W. Barry Southerland, 1998

Opposite Problems

Incised Stream – J-Bar - South Fork Asotin Creek

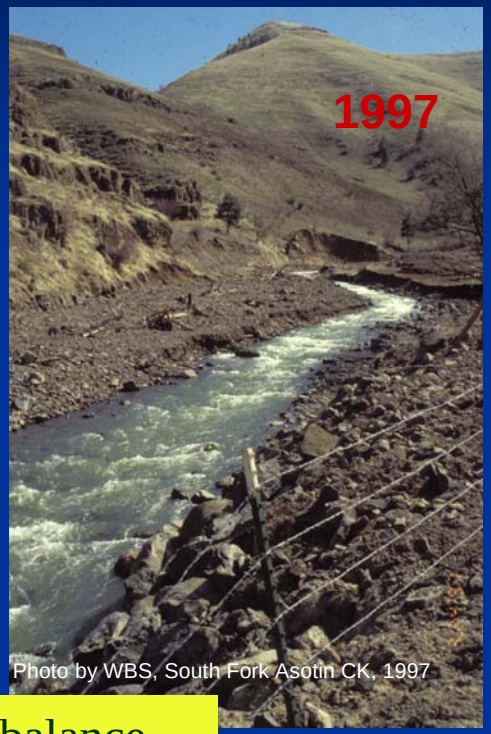


Photo by WBS, South Fork Asotin CK, 1997

Braided and Aggraded Stream – Koch - Asotin Creek

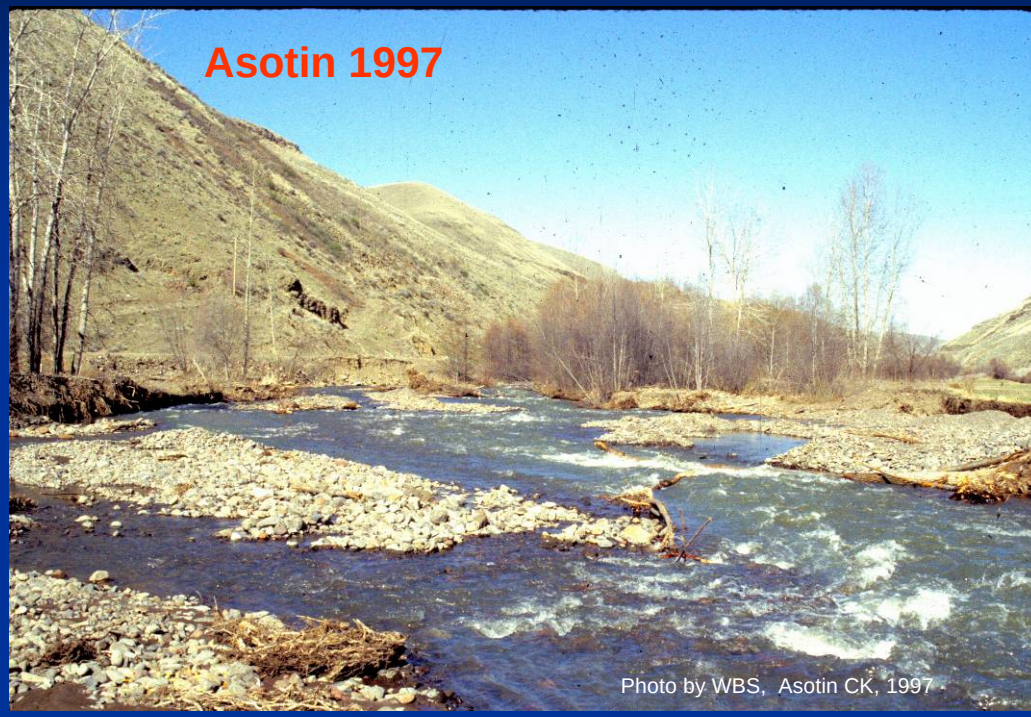
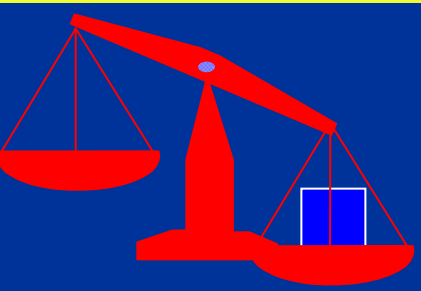


Photo by WBS, Asotin CK, 1997

Lane's balance

$Q_S * d_{50} \sim S * Q$



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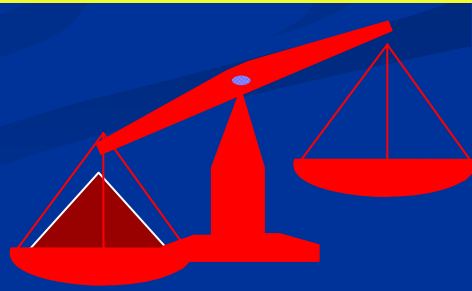
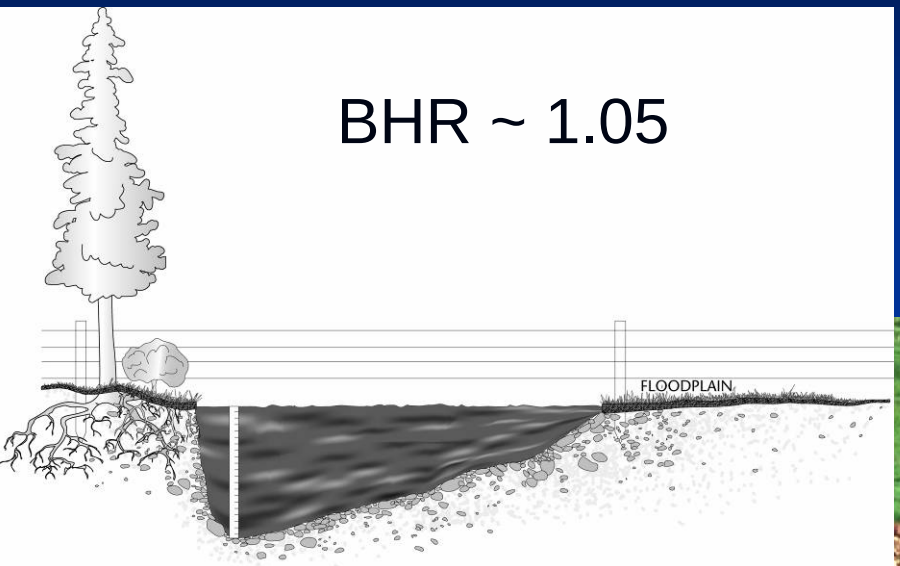
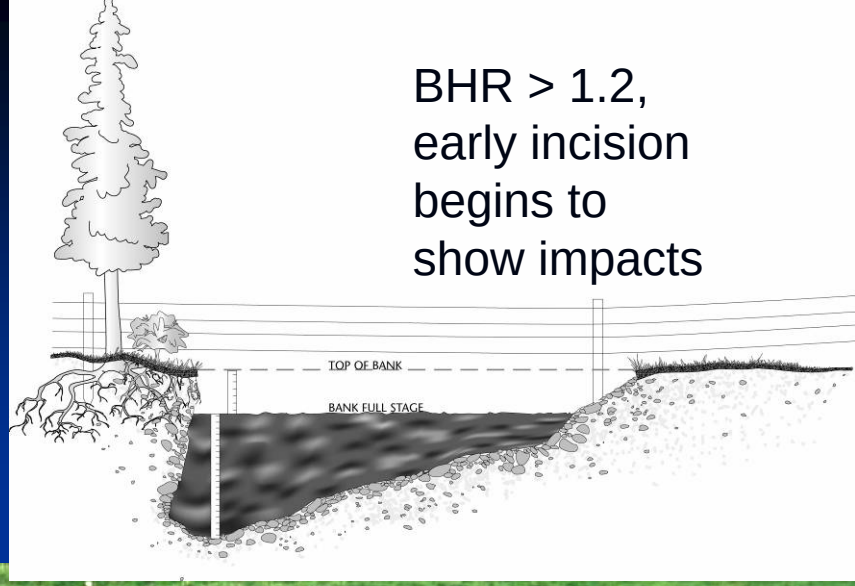
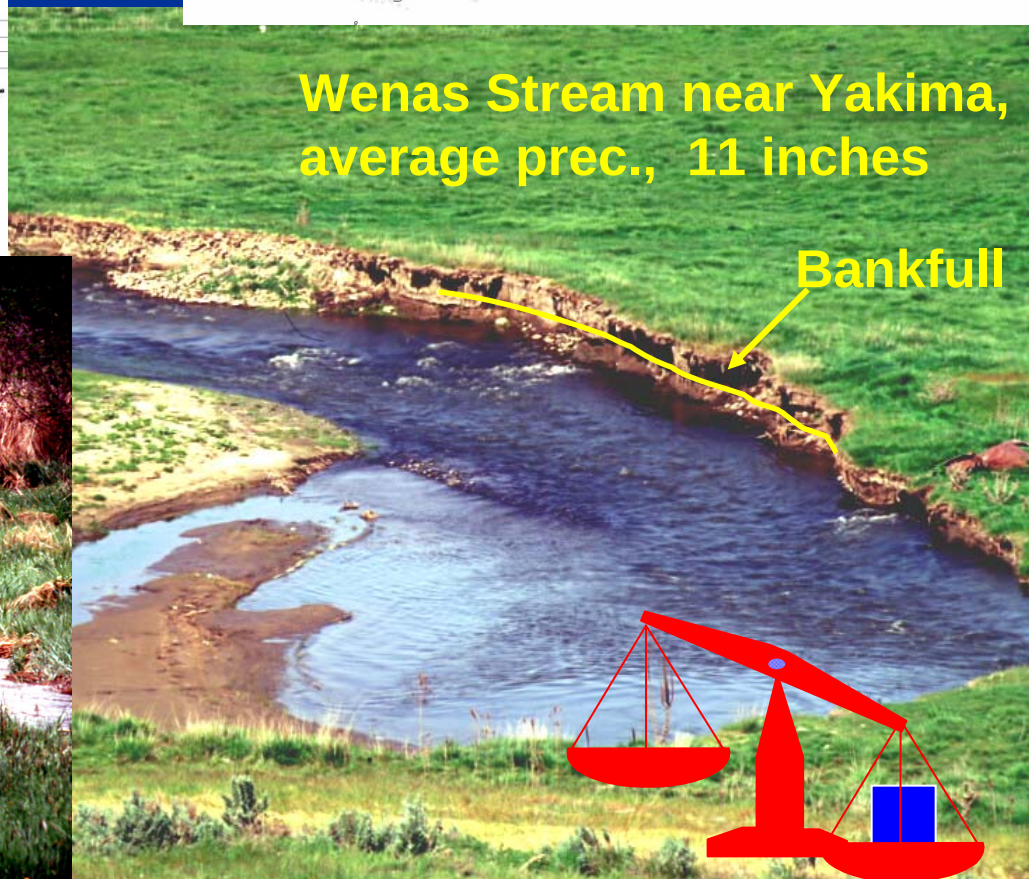


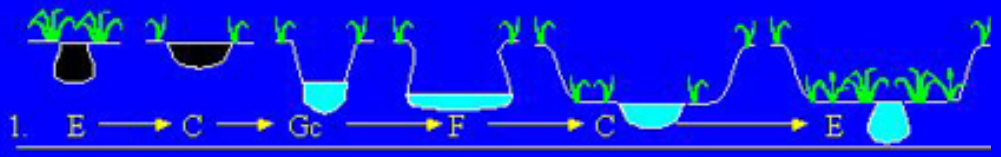
Why Bank Height ratio (BHR)?







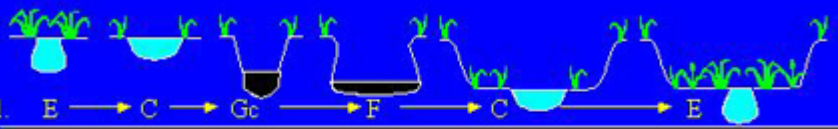
Channel Succession



E

E → C

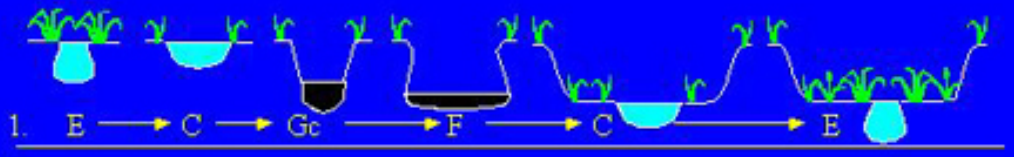
Channel Succession



G_c

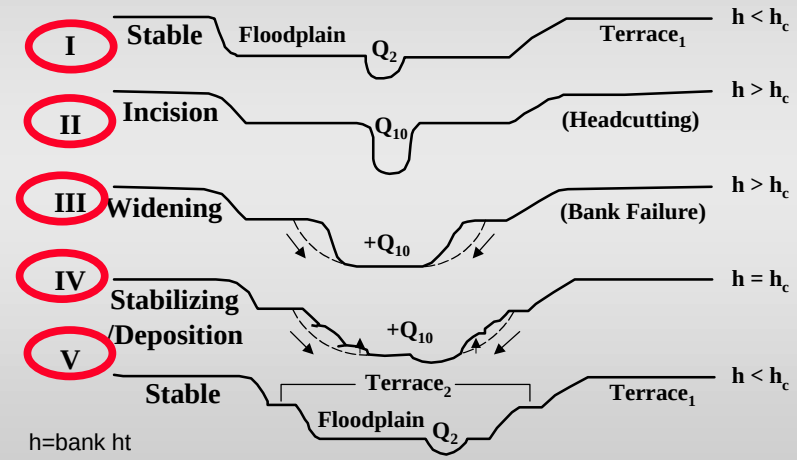
F

Channel Succession



Channel Evolution Models

Schumm, Harvey, Watson (1984):



h=bank ht

hc=critical bank ht.

Slide modified from Lyle Steffen

"Natural stream channel stability is achieved by allowing the river to develop a stable dimension, pattern, and profile such that, over time, the stream system neither aggrades or degrades (incision). For a stream to be stable it must be able to consistently transport its sediment load, both is size and type, associated with local deposition and scour."

Entiat Reference Reach

Width Depth Ratio = 20

Entiat Immediately Upstream

Width Depth Ratio = 48

A Practical Approach to Assessing Stream Stability Using Geomorphic Reference Sites
Chapter 4

Entiat Reference Reach

Width Depth Ratio = 20

Entiat Immediately Upstream

Width Depth Ratio = 48

Percent Departure from Reference Reach

Percent departure from reference condition

Measured Feature	Reference Reach	Reach of Interest	Erosion Potential	Percent Departure
Bank Height Ratio	**1.07**	**1.25**	**Moderate**	17%
Root Density	**70%**	**25%**	**High**	64%
Root Matrix	**.78**	**.30**	**High**	62%

Dimensionless Ratios

Dimensionless ratios, C4 stream type on Cascade East slope in Glacial-Fluvial Valleys	Mean	Range
LONG. PROFILE		
Pool bankfull depth/Average bankfull depth, ft/ft	2.2	1.6-3.2
Riffle bankfull depth/Average bankfull depth, ft/ft	0.85	0.59-0.92
Run bankfull depth/Average bankfull depth, ft/ft	1.4	1.2-1.6
Glide bankfull depth/Average bankfull depth ft/ft	1.2	1.1-1.5

Departure Analysis

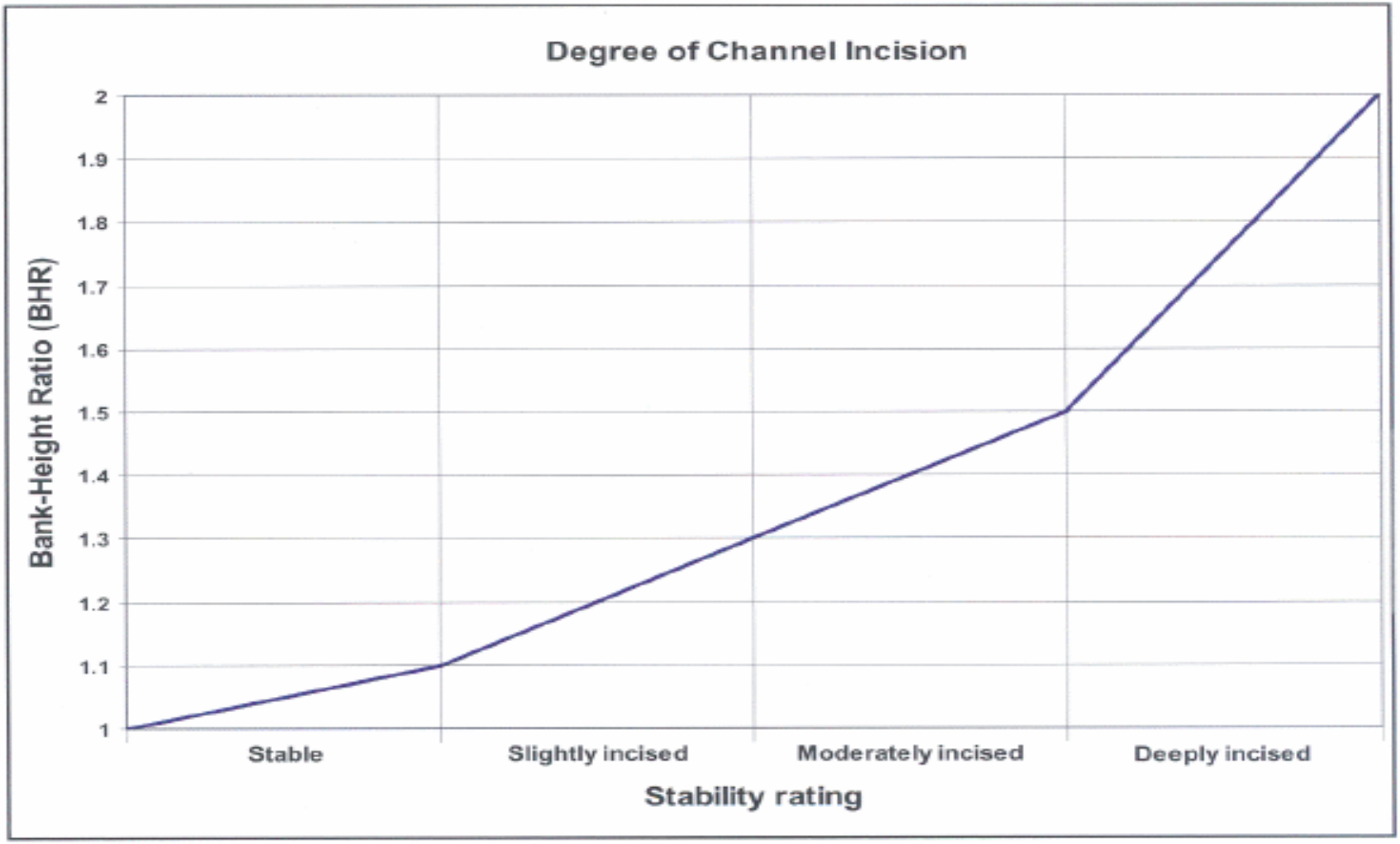


Figure 5-15. Relationship of BHR ranges to corresponding stream stability ratings (Rosgen, 2001b).

Width Depth Ratio Departure Analysis

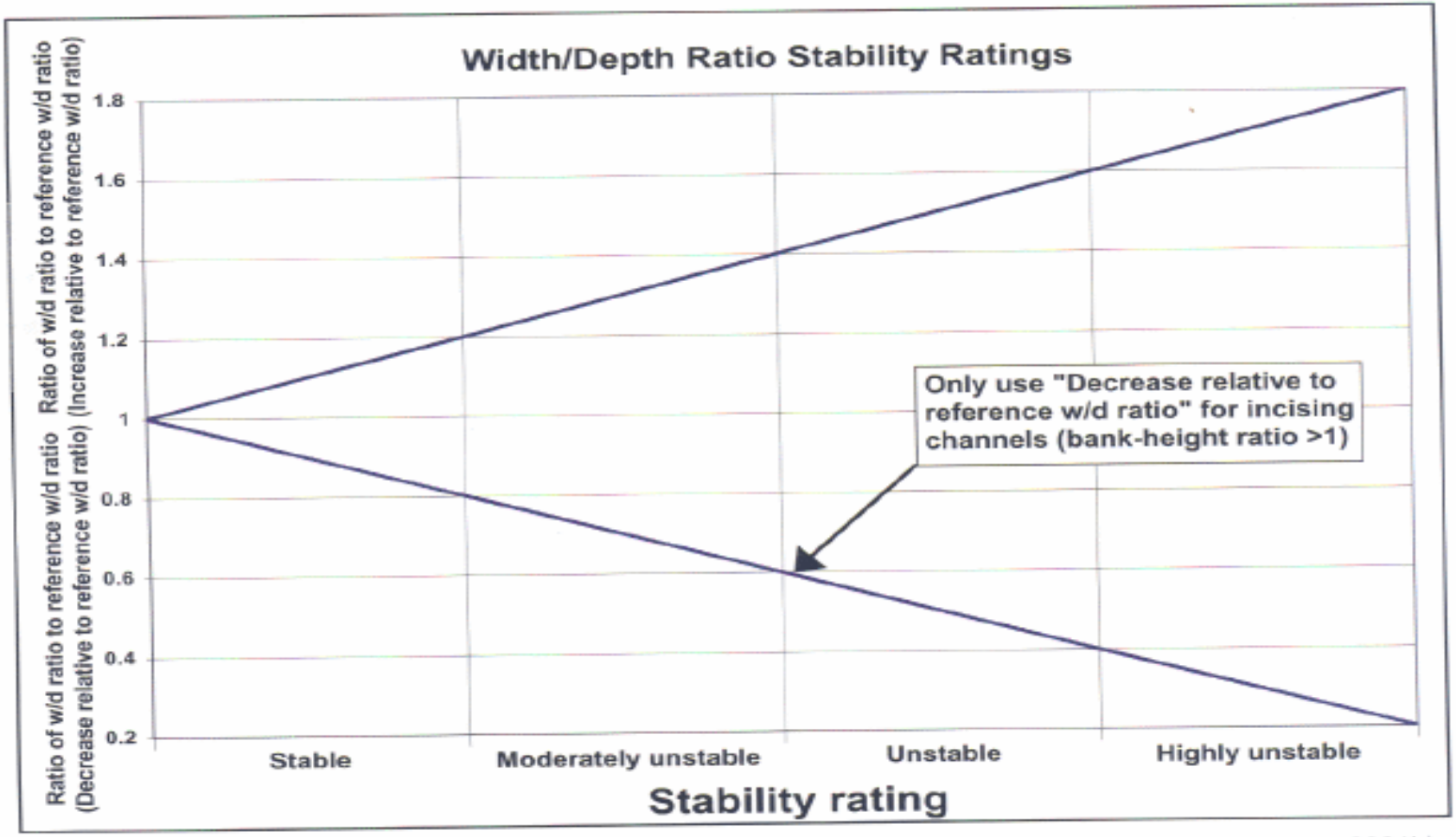


Figure 5-13. Stability ratings based on departure of width/depth ratio from reference condition (Rosgen, 2001b).

Departure Analysis Continued

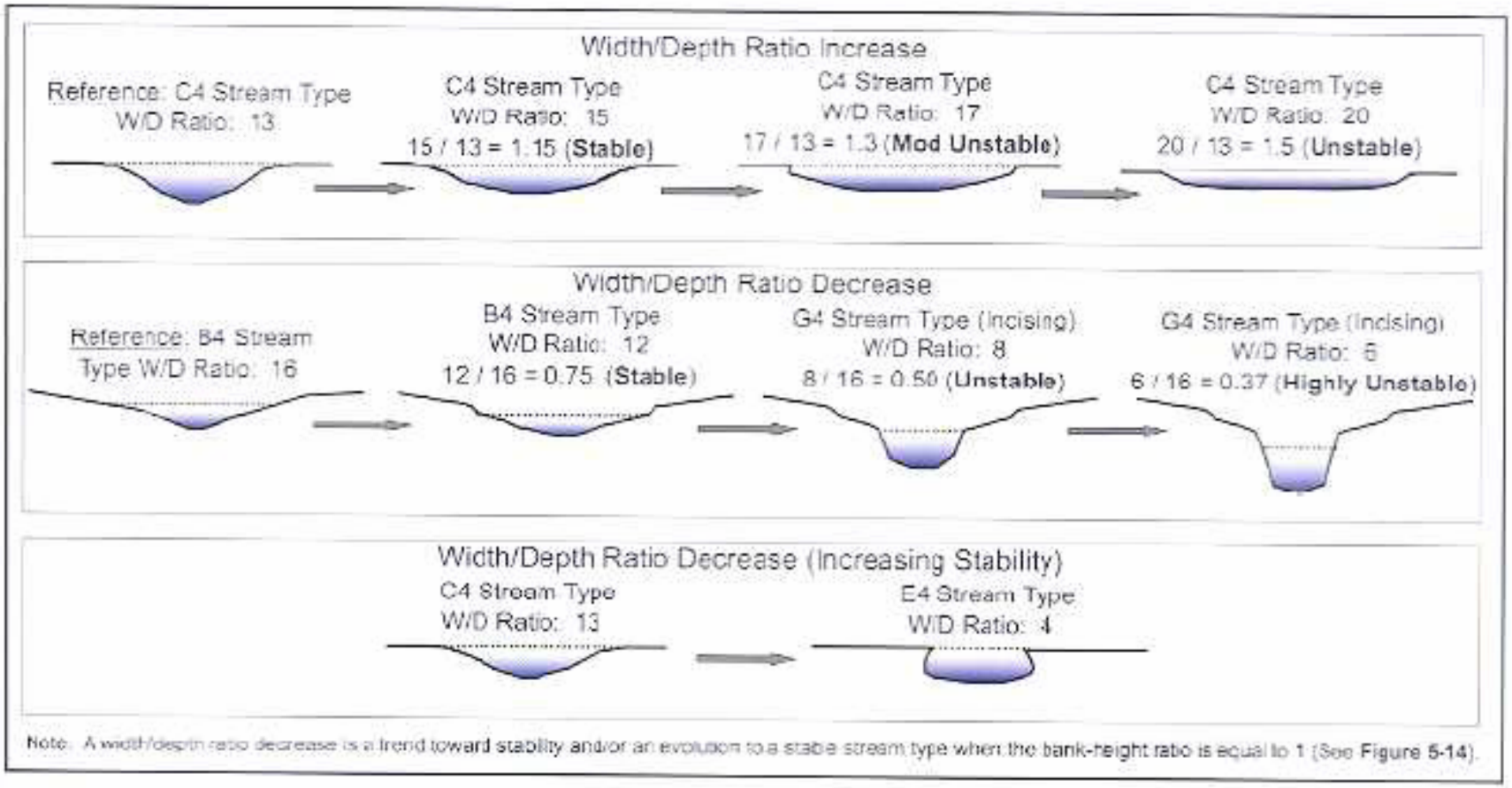


Figure 5-12. Width/depth ratio stability descriptions.

J-Bar Ranch Case Study

J-Bar Ranch, Jake Schlee's cattle winter feeding area, is located on the floodplain adjacent to the South Fork of Asotin Creek in the Blue Mountains of Washington. The South Fork is a 3rd order perennial stream and a tributary to the Main Stem of Asotin Creek. The South Fork of Asotin is an important summer steelhead habitat severely lacking in pool quantity and quality, Juvenile steelhead are abundant on the South Fork when pools are present. Streambank stability was a major concern. Temperature is also a concern.

Types of Alternatives

- Move channel back to previous flood channels and rip rap in place – most expensive - $45,000
- Centerline channel relative to valley, rock toes relative to the needed hydraulic geometry, pull back banks, bioengineer several vegetative layers, irrigate plant materials first three years. Est. $18,000
- Rebuild stream relative to similar current stable analog located in similar valley and stream types within the watershed. Re-establish-pools, riffles, glides, and run. Address resting, hiding, and spawning for salmonids. Re-establish floodplain at lower elevation. Est. $20,000, Actual cost $15,000
- Keep channel as is: Threat to bridge downstream and winter feeding shed.

Incised Stream Description

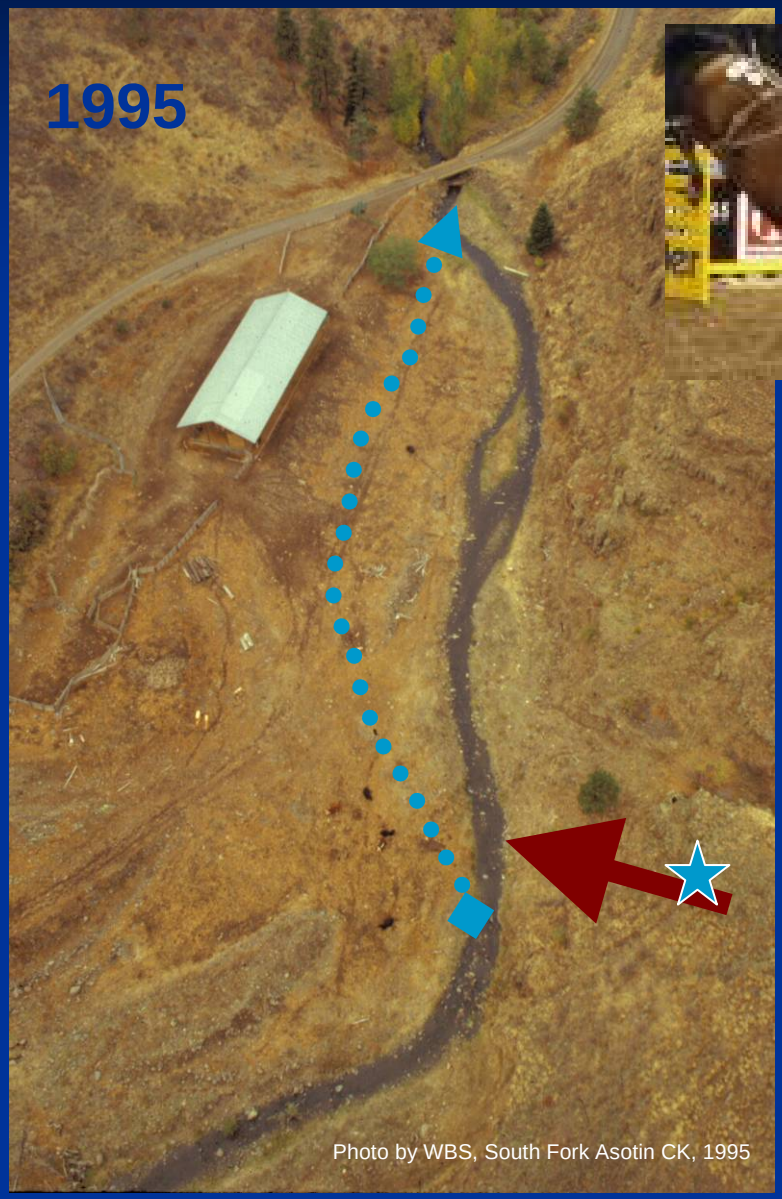


Photo by WBS, South Fork Asotin CK, 1995

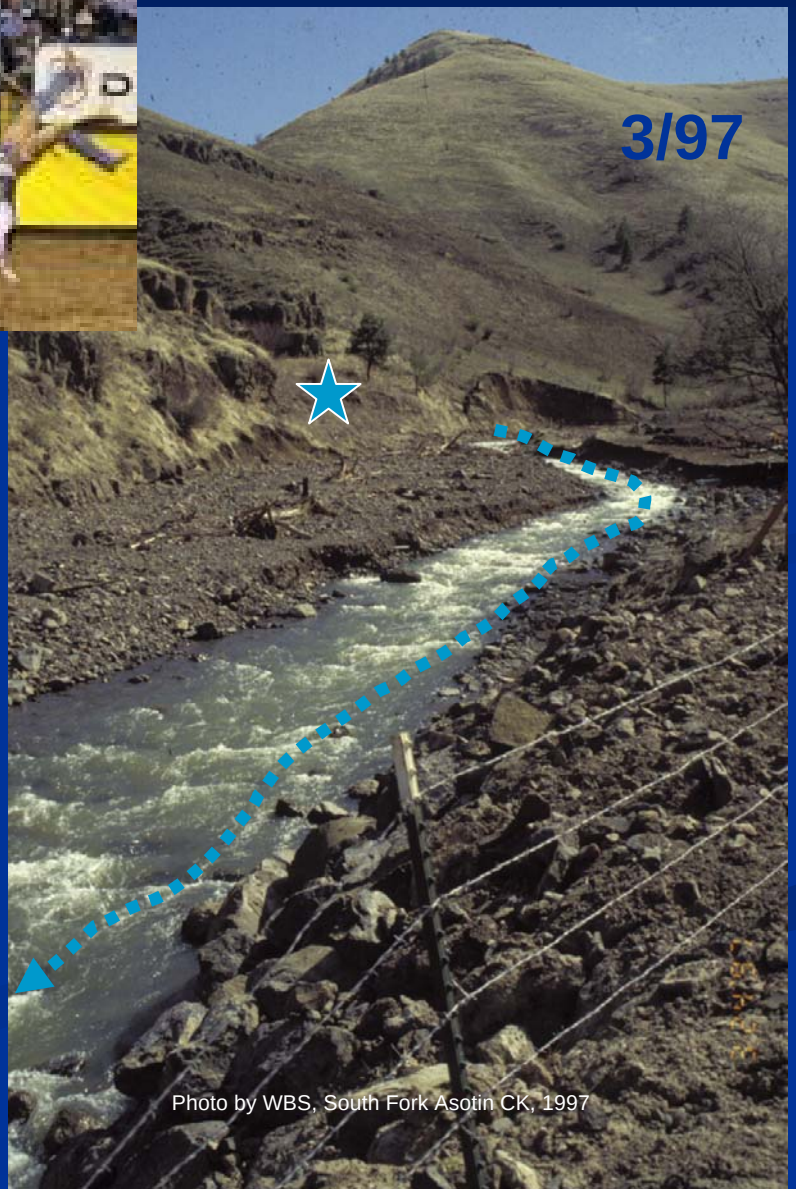


Photo by WBS, South Fork Asotin CK, 1997

J-Bar Ranch Case Study

- Watershed size: 37 m^2, perennial stream
- BFQ (Channel forming Q): 75cfs
- CEM Stage: III with some II
- BHR 2.7
- 12 inches annual precipitation
- Important steelhead rearing area

Photo by WBS, South Fork Asotin CK

Photo by WBS, South Fork Asotin CK, 1997

Problems

- No resting and hiding refugia for salmonids
- Highly unstable banks – excessive bank failure. **Establish riparian plant community**
- Poor low flow conditions for salmonids and poor bedform condition for macroinvertebrate population
- Temperature for salmonid habitat
- No diversity
- Aesthetically, not pleasing
- Winter feeding area w/ concentrated livestock

Morphometry and Morphology

- Water surface slope 2.7%
- K-before = 1.02 Incised
- MWR = 1.3
- Watershed size: 37 m^2, perennial stream
- (Channel forming Q): 75cfs (14.8 ft^2)
- CEM Stage: III with some II
- BHR 2.7
- 12 inches annual precipitation
- Degraded Stream type: G3 & F3b
- D_{50} = 68mm
- LPT (Dmax) = 190mm

Goal and Objective

- Transport bedload in a stable manner while maintaining local deposition and scour (bedload competence)
- Reduce streambank erosion
- Re-attach floodplain to provide water table for riparian plants
- Restore salmonid habitat (steelhead)
- Increase hyporeic zone
- Cost effectiveness

Alternatives generated in 1997 after planning process

- Move back to pre-channel and riprap – plane bed profile – $45,000
- Move back to center of small valley, rock the toes, lay back banks for planting facines, willow and cottonwood root stock – $24,000
- reconstruct channel to natural channel characteristics but at a lower floodplain level – priority 3 or confined floodplain approach –
- $ 14,000 – Priority III – floodplain - confined

Meander Reconstruction
Rebuilding bankfull channel and floodplain w/i incised system

Bankfull channel and floodplains rebuilt. Late fall 1997 before planting

After Riparian Plantings

2001

2002

Before and After

1997 G3

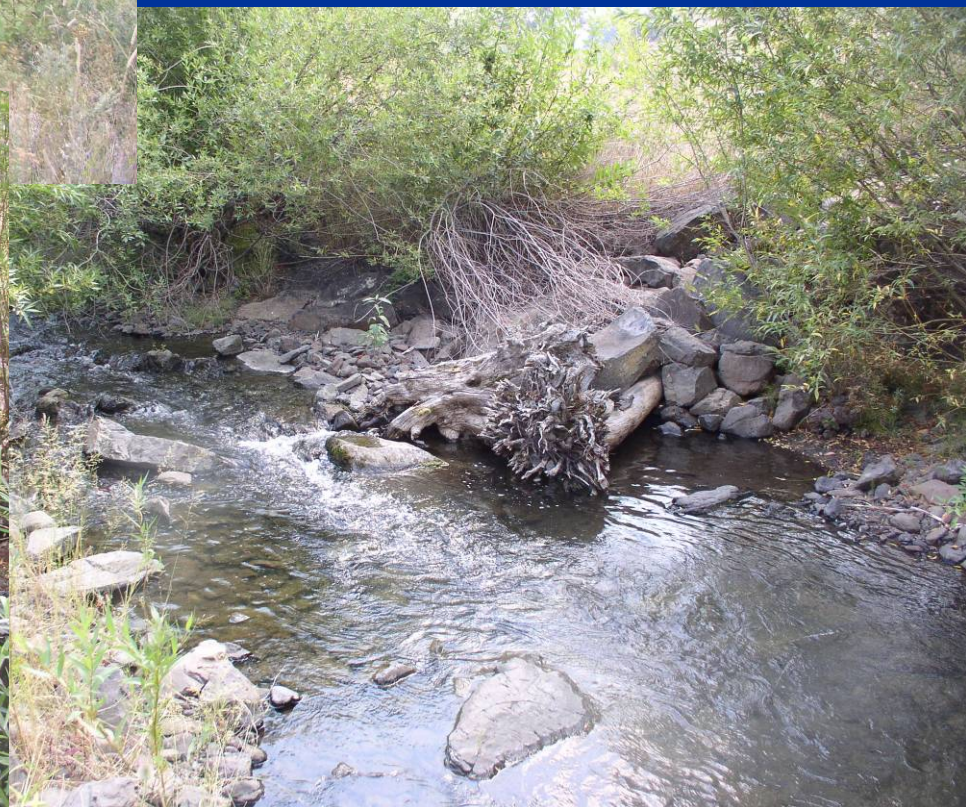
2002 B4

Six years and two large floods later

Pages 5-22 and 5-23 in SCRM

J-Bar – 2006 – 9 years later

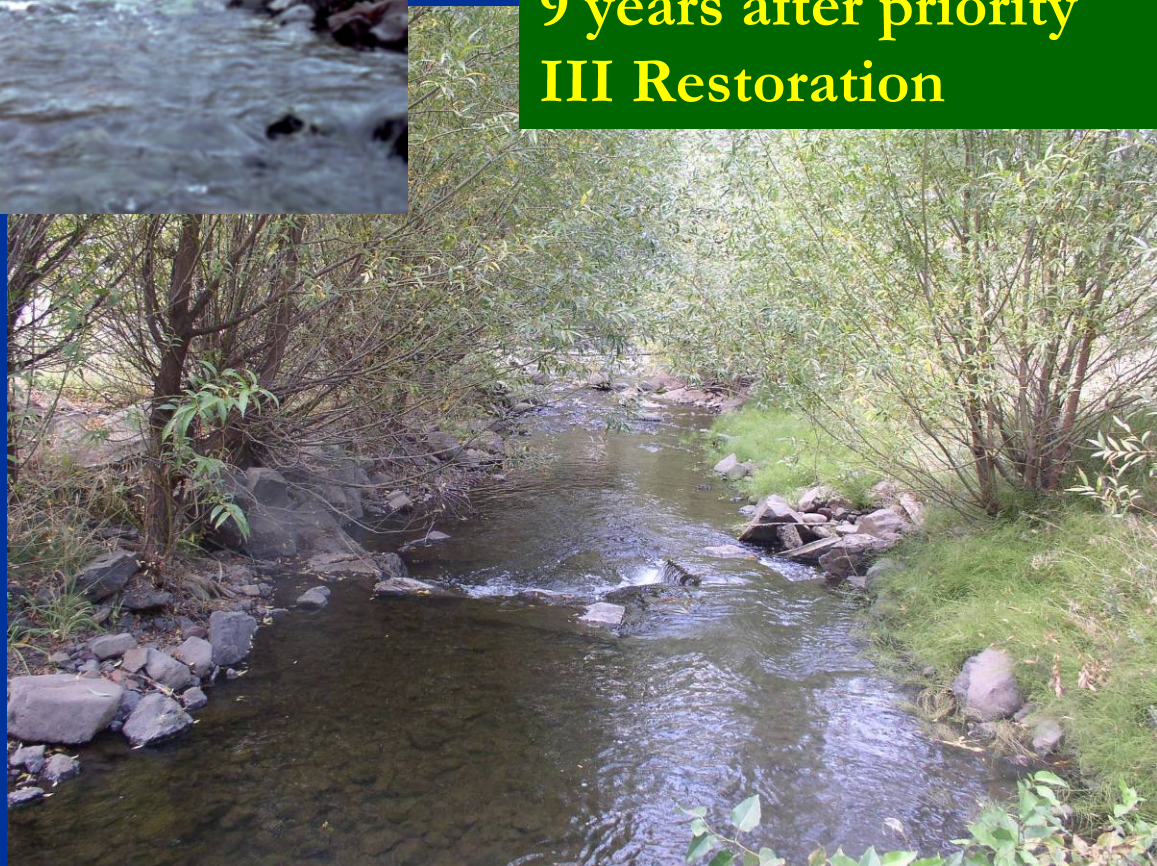
Steelhead
1996 no redds
2002 three redds
2006 five redds

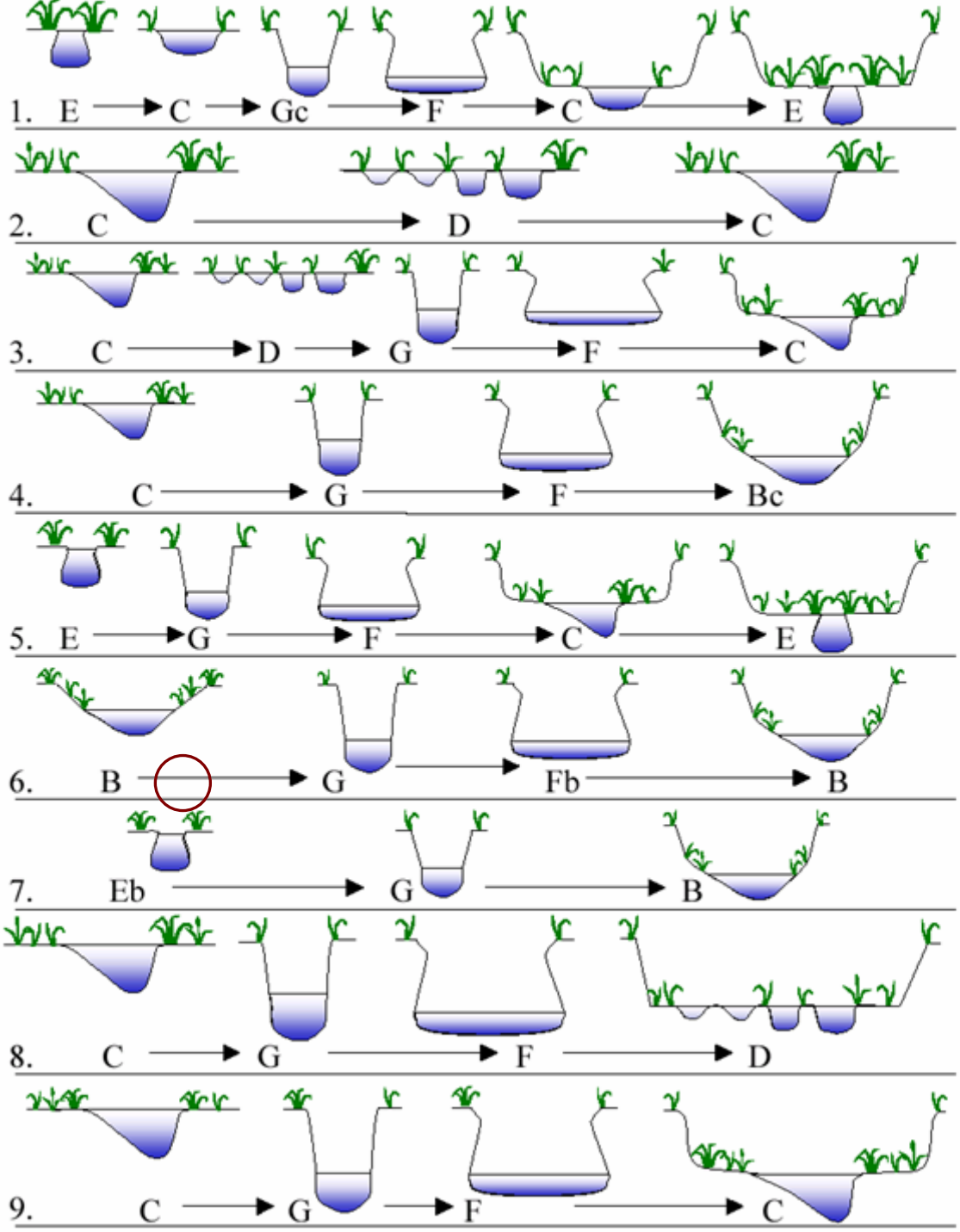


Before

J-Bar Ranch
Before and after

9 years after priority III Restoration





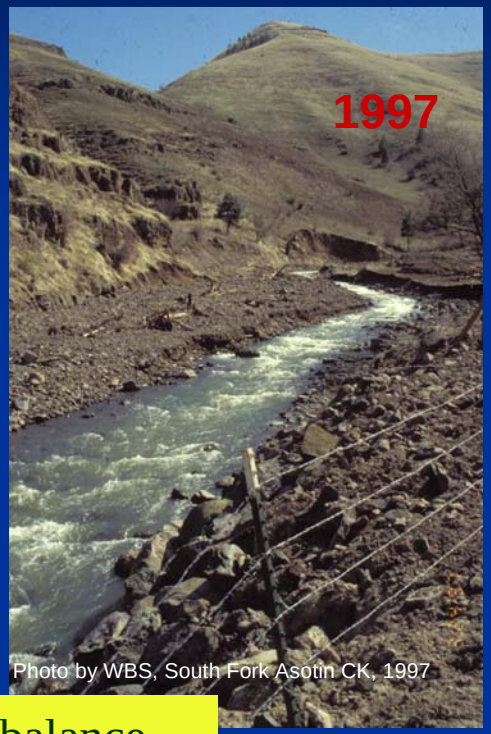
Stream Channel Evolutionary Path for J-Bar Ranch

Aquatic Habitat Response to Stream Type Change

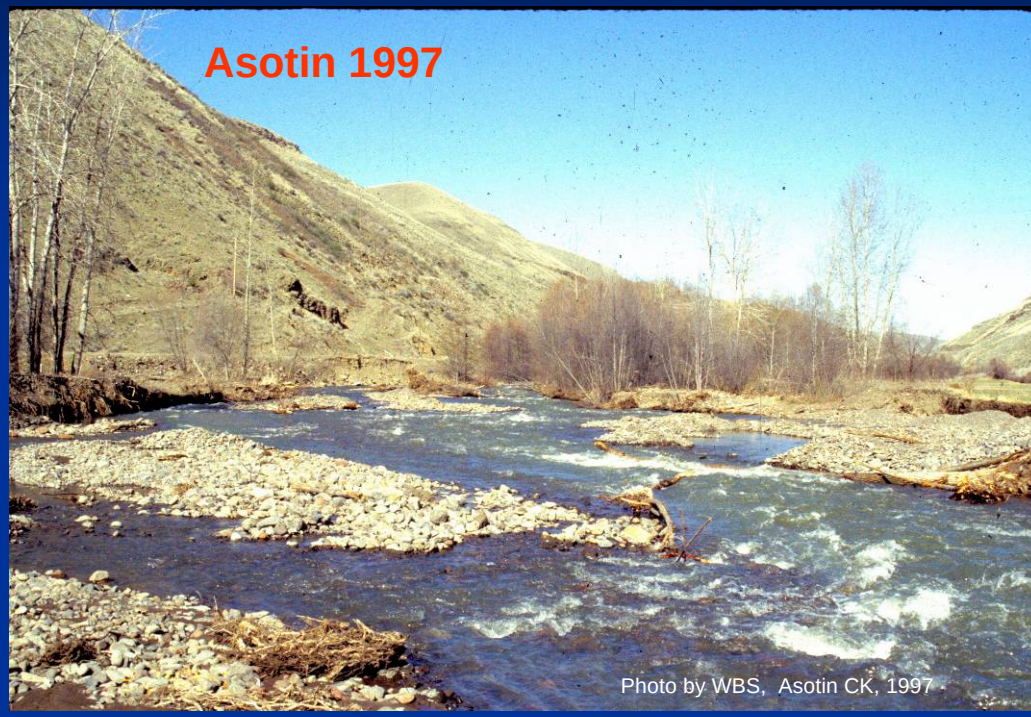
Variable	Stage II or III fix in place- Priority 4		Priority I, II, or III restore floodplain and long profile
	Stage II	Stage III	
Instream Cover	↓	↓	↑
Overhead Cover	↓	↓	↑
Substrate Composition	↑	↓	↑
Pool Quality	↓	↓	↑
Holding Cover Velocity	↓	↓	↑
Temperature	→	↑	↓
Oxygen	→	↓	↑
Macro Invertebrates	↓	↓	↑
Spawning Habitat	↓	↓	↑
Diversity	↓	↓	↑
Rearing	↓	↑	↑
IBI Score	↓	↓	↑

Opposite Problems

Incised Stream – J-Bar - South Fork Asotin Creek

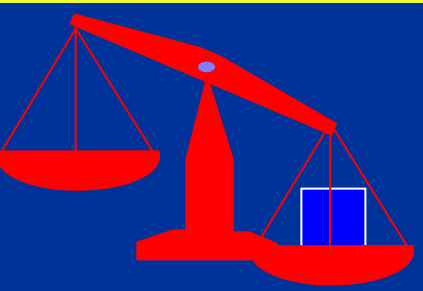


Braided and Aggraded Stream – Koch - Asotin Creek



Lane's balance

$Q_S * d_{50} \sim S*Q$



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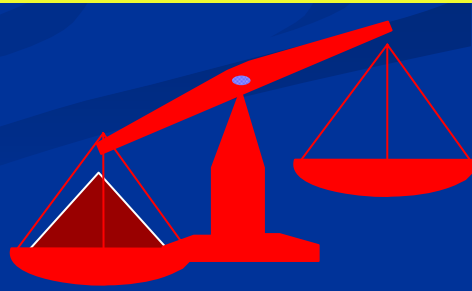
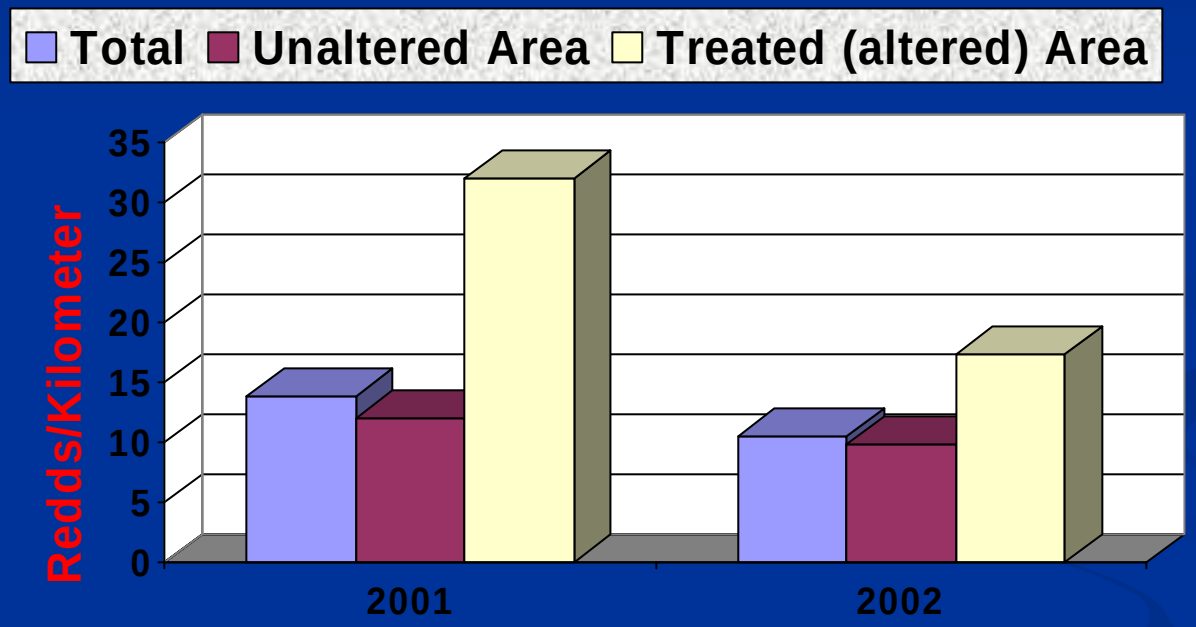


Example of Dimensionless Ratio and Regional Bankfull Discharge Based Design

6 YEARS LATER

Asotin Creek Red Counts

- No Redds Observed at Koch Project in 1997



(9.9 redds/km) unaltered to (17.6 redds/km) treated

Components of the system 2005, 7 years and three floods later

Deep pools with riffles, glides, and runs

What it is really all about?

"Protect the best, restore the rest"

Thank you for your attendance.
Any Questions?