

Indicators by Slope Class

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Objectives

- ✦ Examine indicators in different gradients.
 - ✦ Does gradient make a difference with respect to protocol execution?
 - ✦ Is there evidence in the data to support stratification within a watershed by gradients?



Objectives, cont.

- ☀ Compare the lowest most non-constrained reach with the remaining random sites.
 - ✿ Does the data indicate a physical, chemical, and/or biological difference between these two types of reaches?
 - ✿ Are resultant indicator values different between these two types of reaches?

A vertical photograph of a waterfall cascading down a rocky cliff face, with water splashing and creating white foam. The background is a lush green forest.

Different Gradients

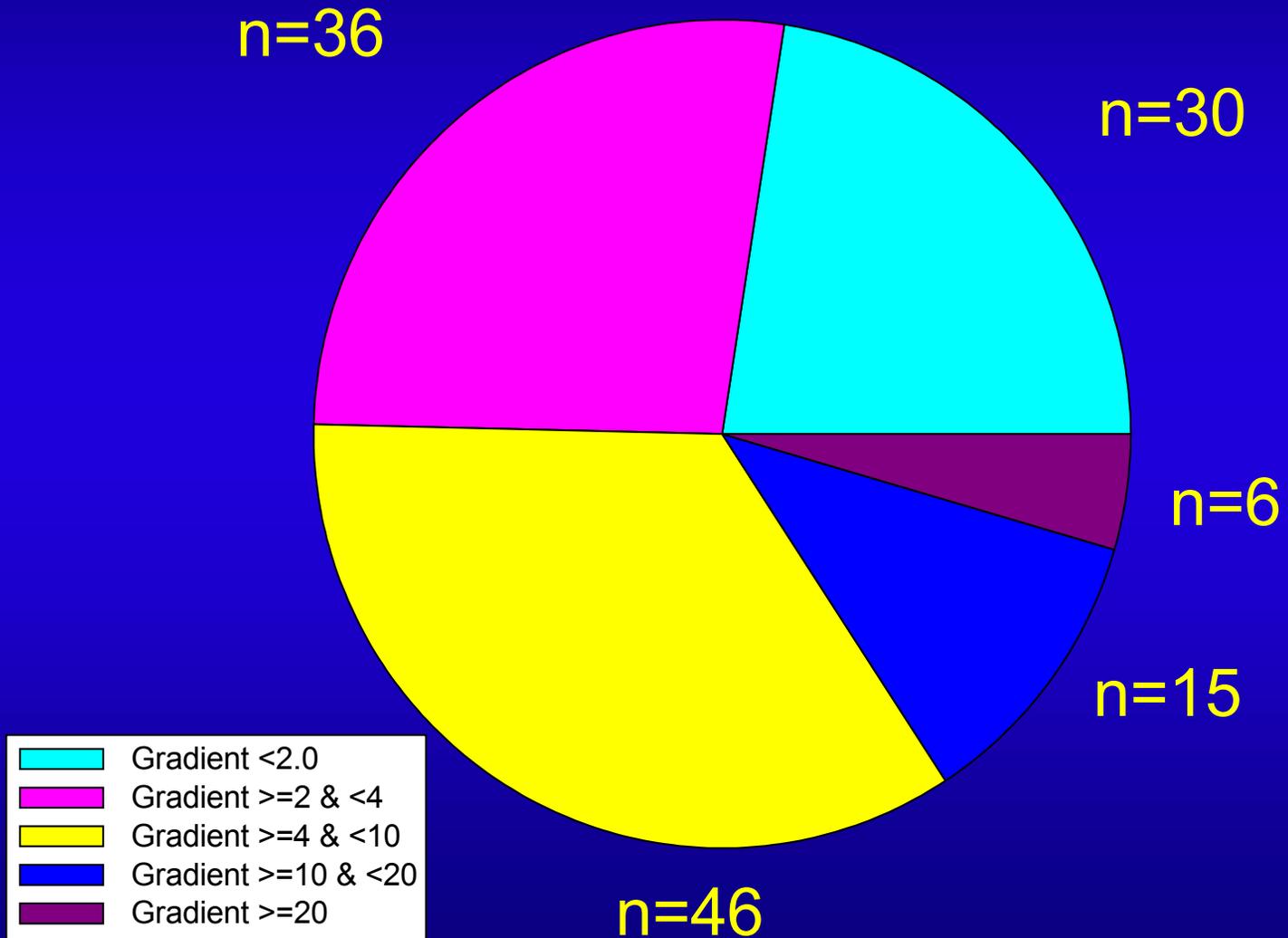
- ✦ Indicators split by gradient into classes (akin to Rosgen channel types)
- ✦ Decomposed the variation into:

$$\textit{Indicator} = \textit{Creek} + \textit{Site}(\textit{Creek}) + \varepsilon$$

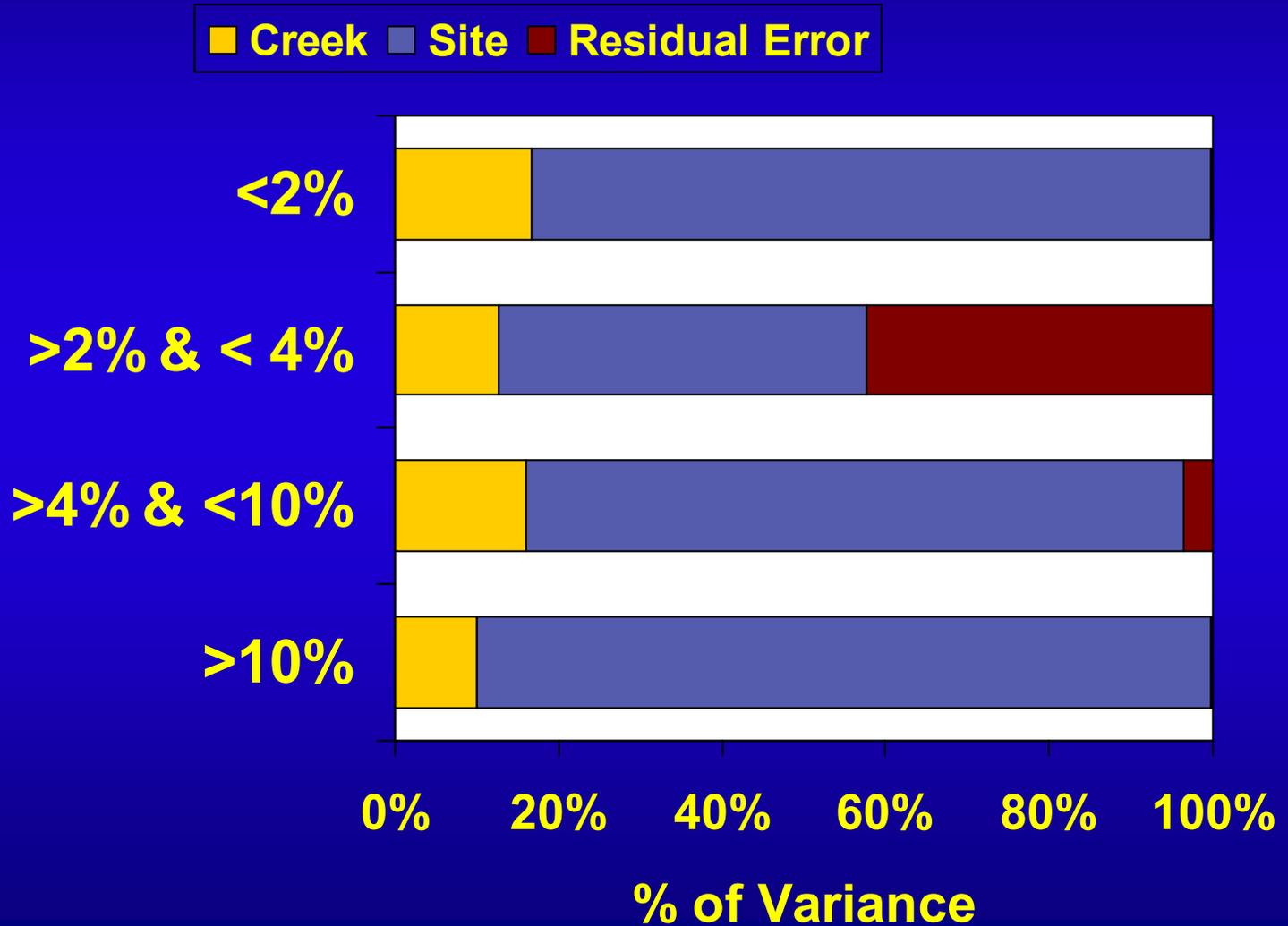
- ✦ Signal:Noise

$$S : N = \frac{\textit{Creek} + \textit{Site}}{\textit{Error}}$$

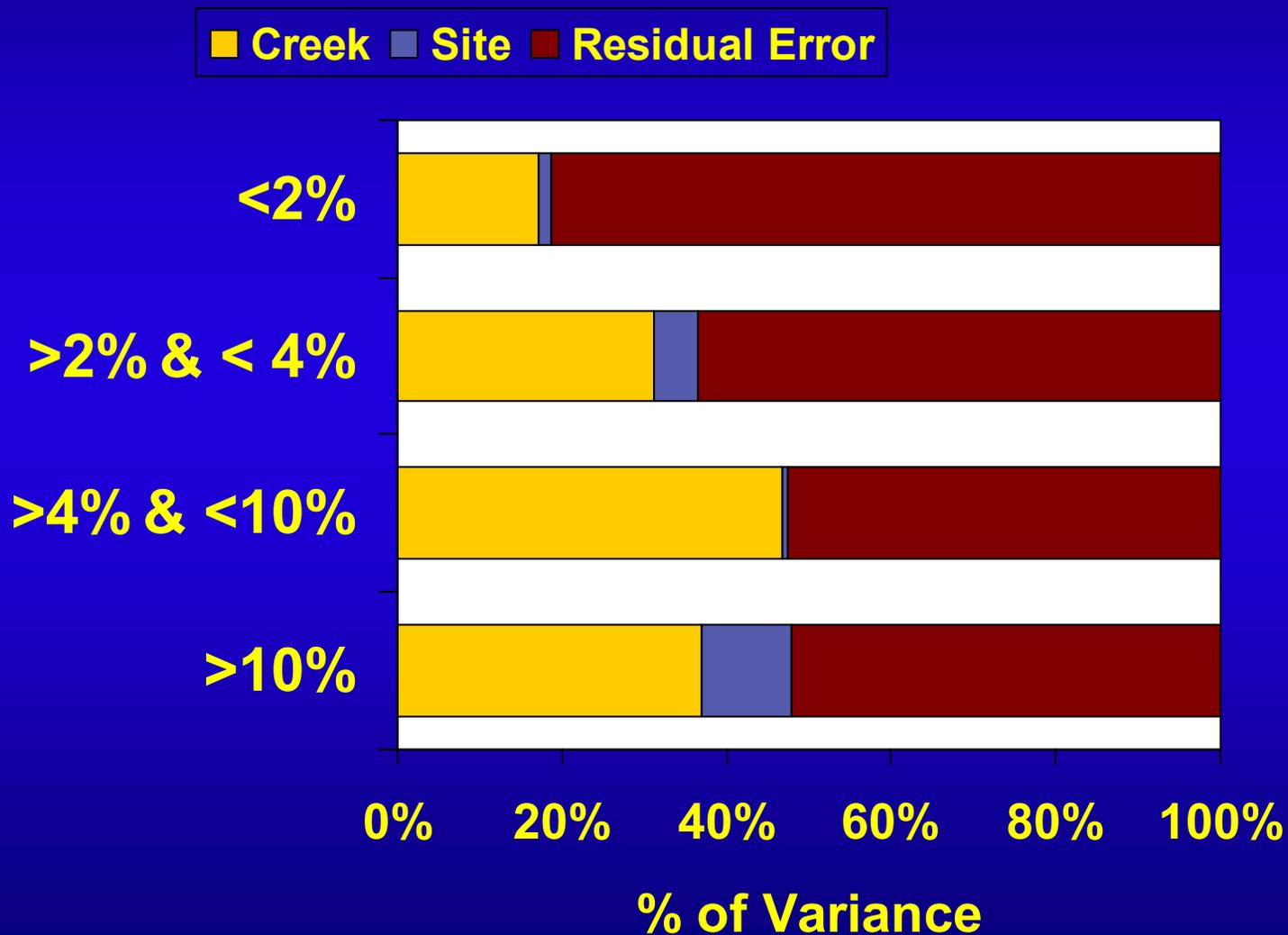
Gradient Distribution



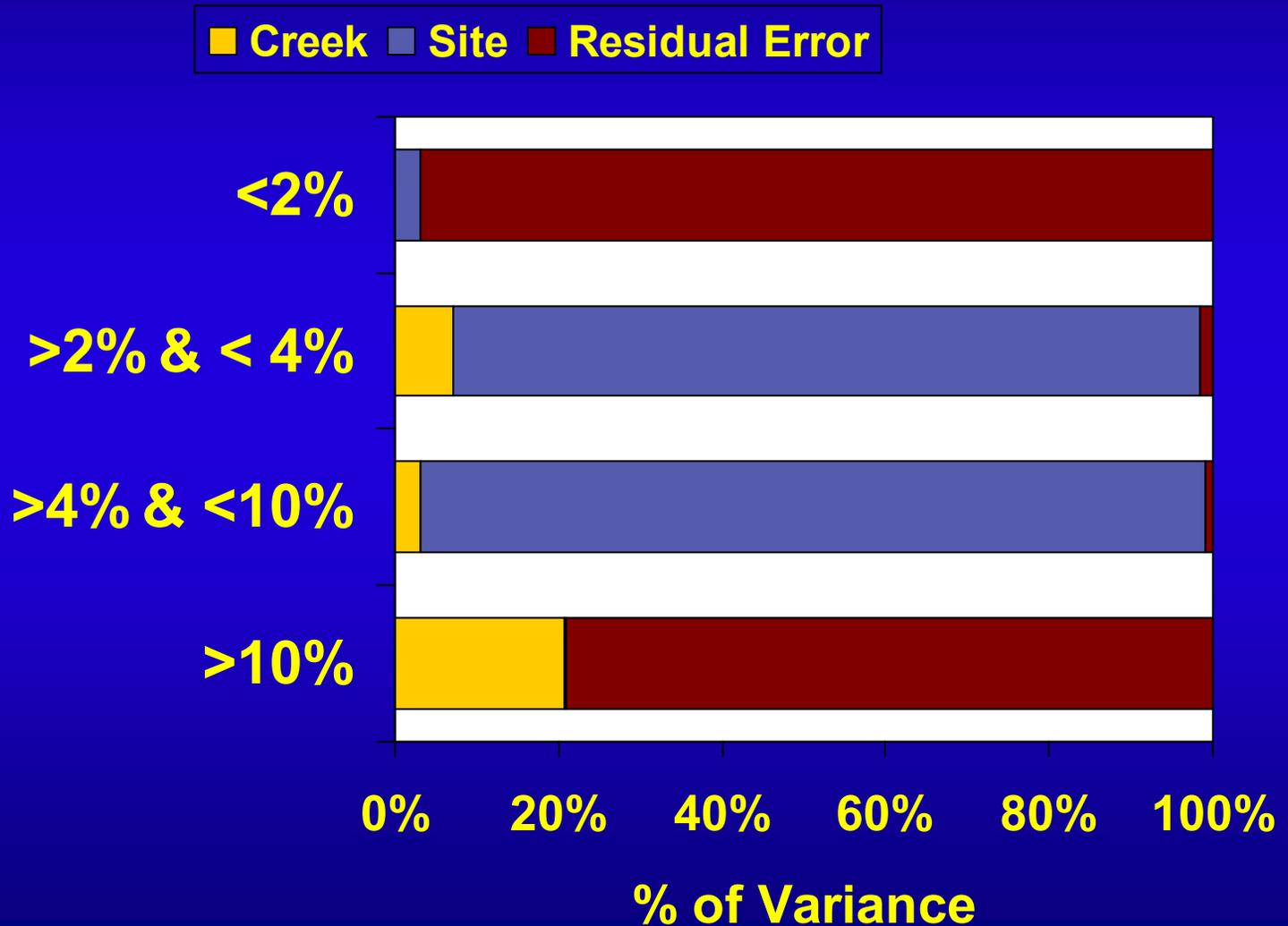
% Pool Tail Crest Fines



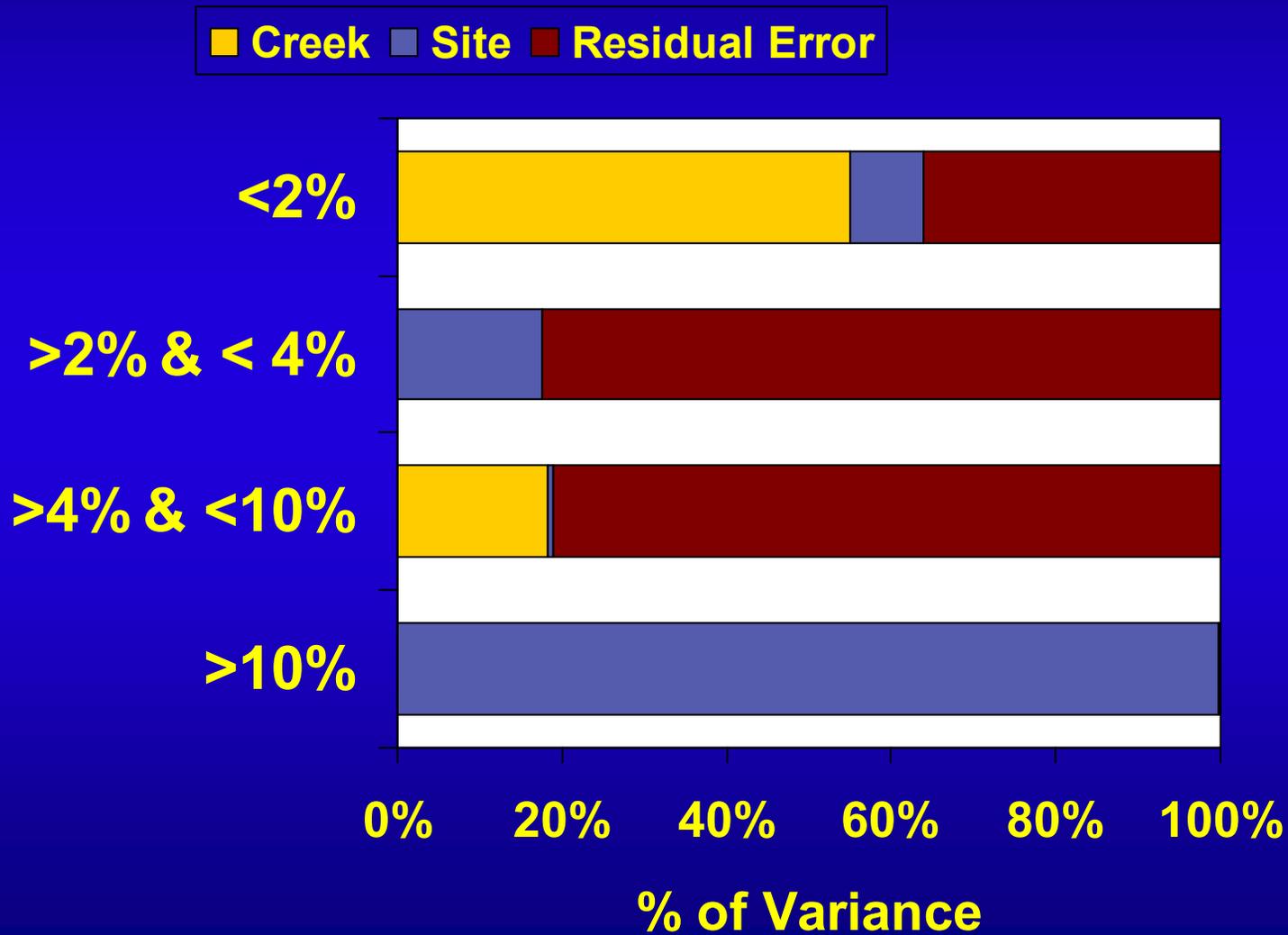
Average Bankfull Width



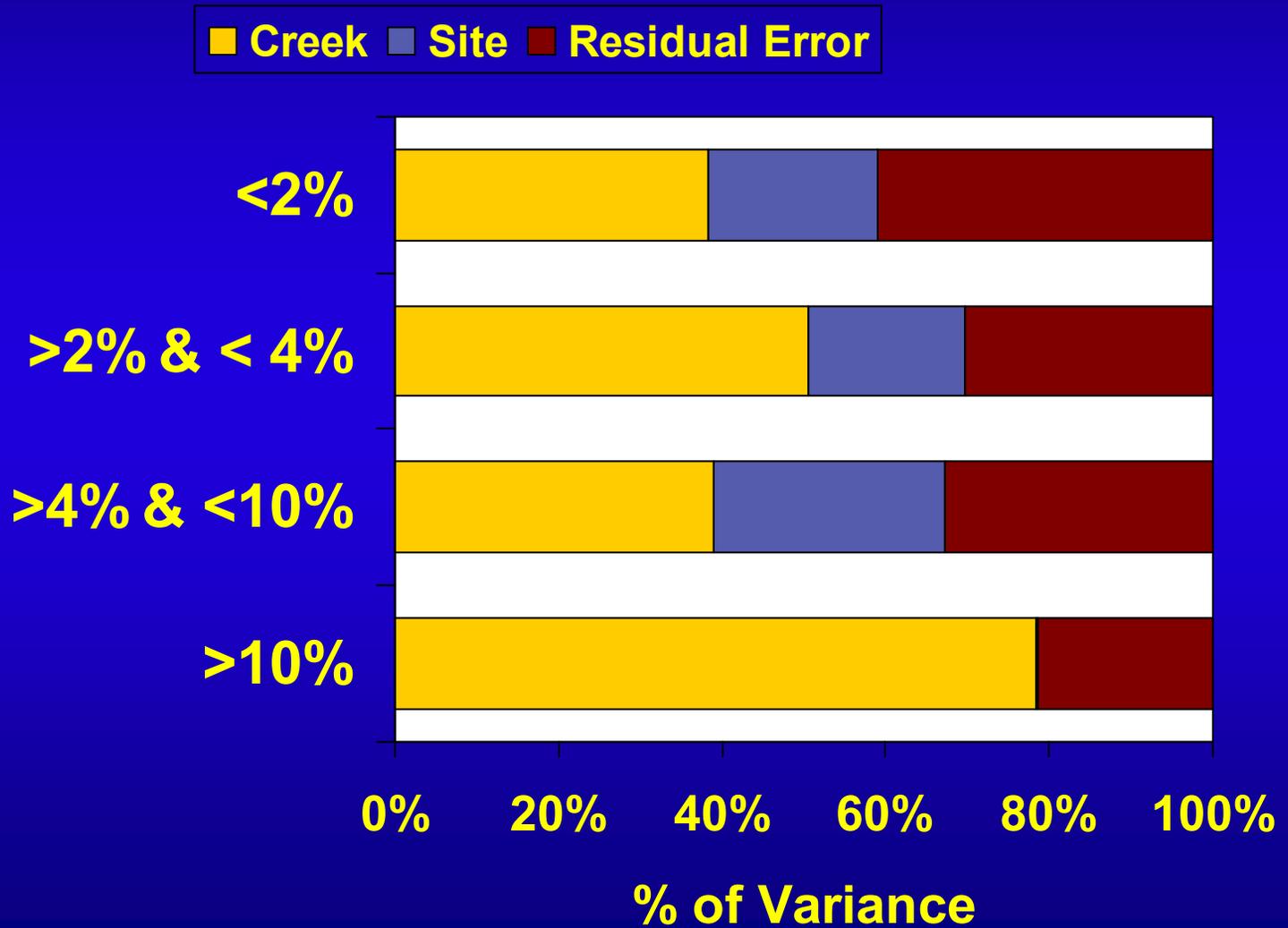
Average Bankfull Width:Depth



Gradient

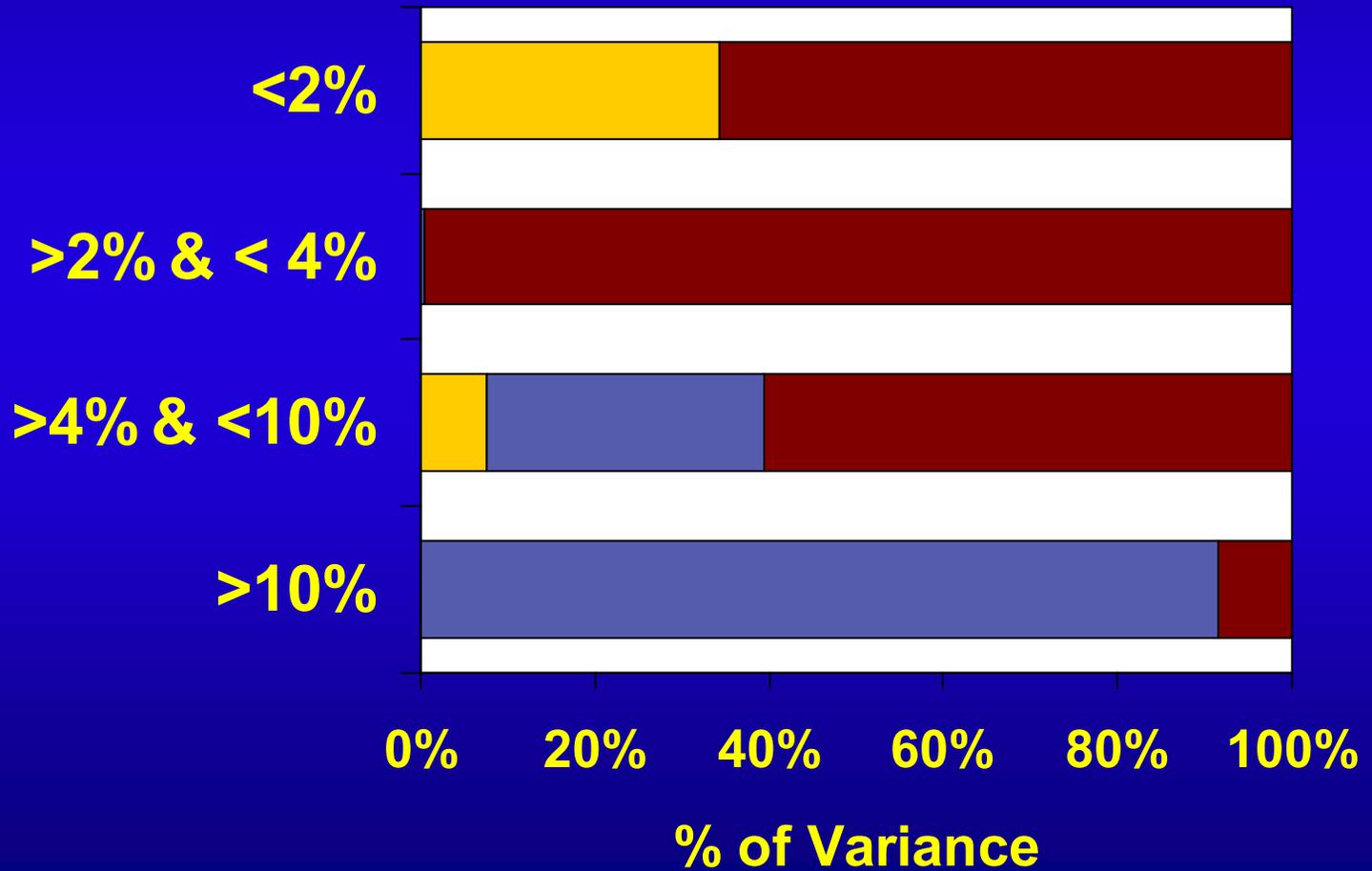


Pool Frequency

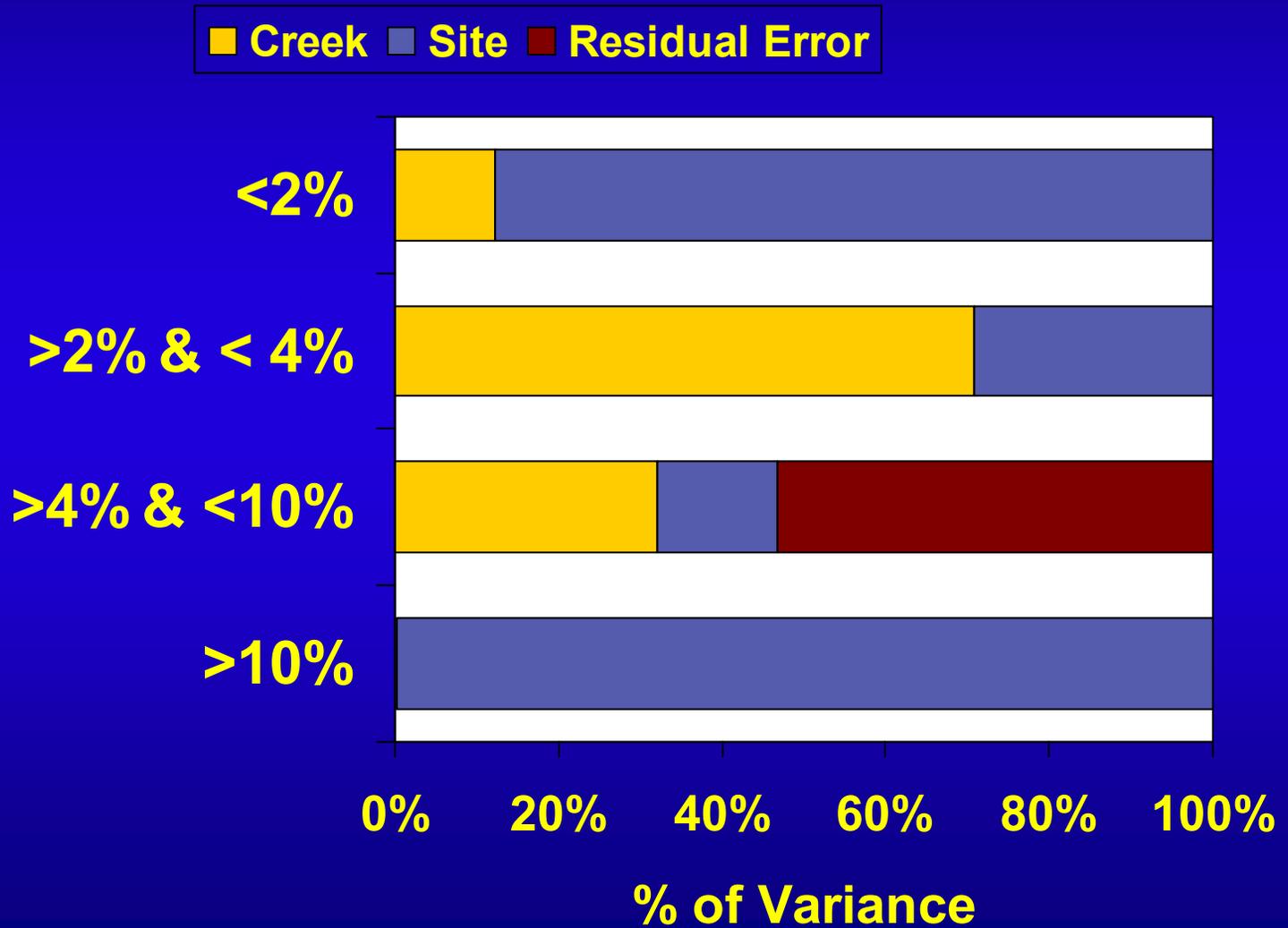


Sinuosity

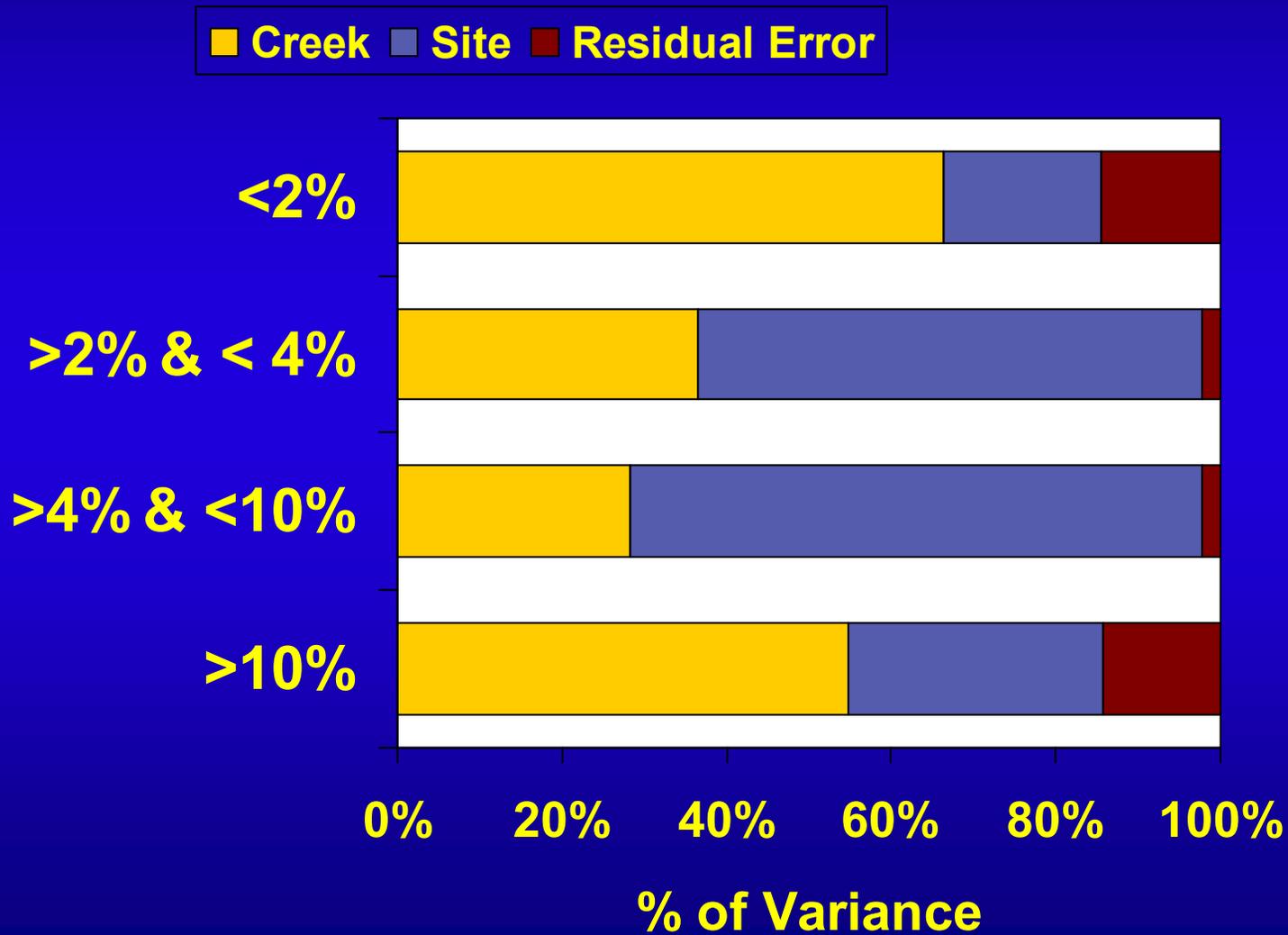
■ Creek ■ Site ■ Residual Error



Thalweg Length

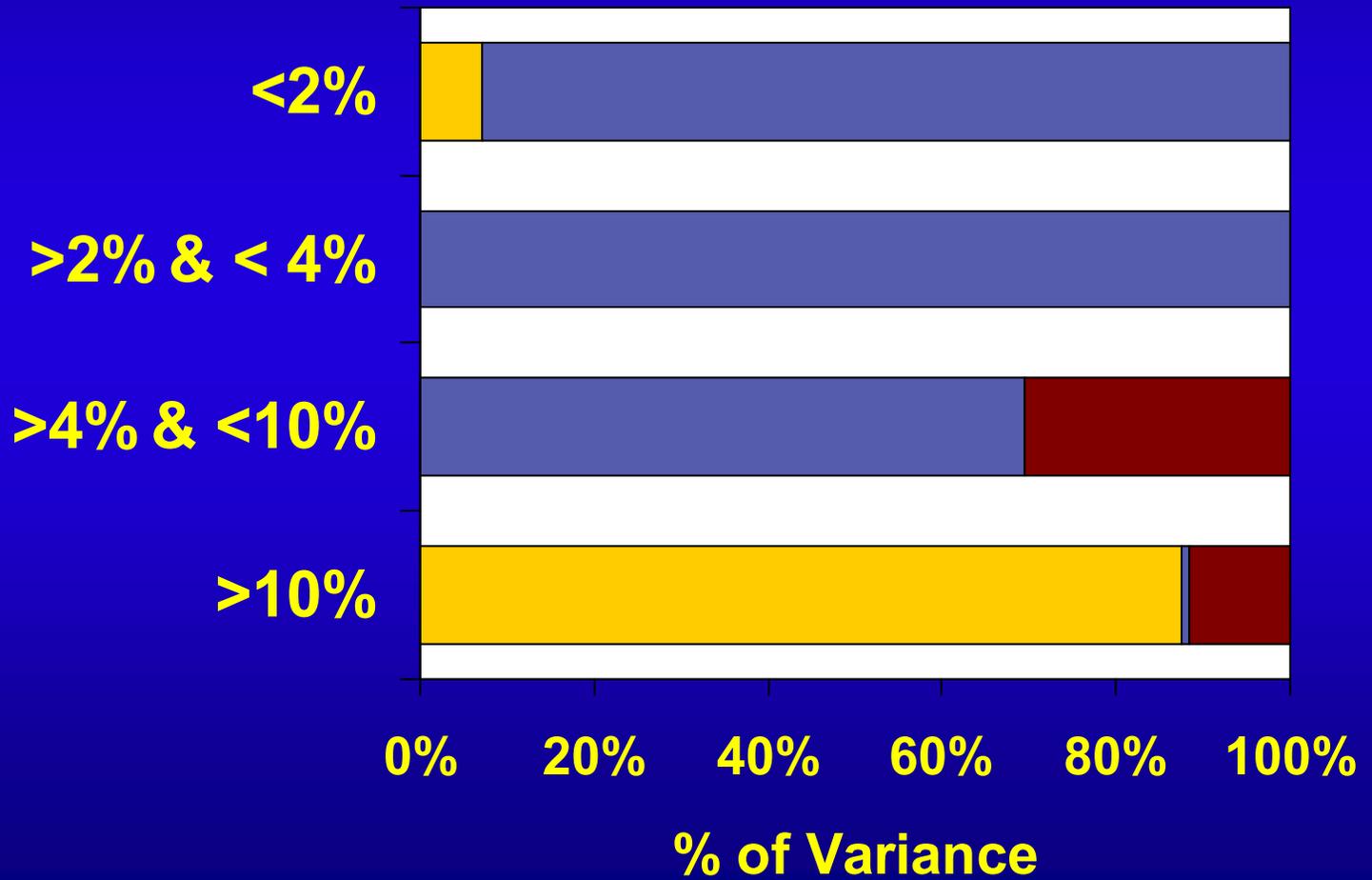


Wood Frequency



D_{50}

■ Creek ■ Site ■ Residual Error



Crew Error Patterns

	<2	2-4	4-10	>10
% PTC Fines	😊	😞	😐	😊
Ave BF Width	😞	😐	😐	😐
Bankfull W:D	😞	😊	😊	😞
Gradient	😐	😞	😞	😊
Pool Frequency	😞	😐	😐	😊
Sinuosity	😞	😞	😞	😊
Thalweg Length	😊	😊	😞	😊
Wood Freq	😊	😊	😊	😊
D ₅₀	😊	😊	😞	😊

Crew Error Patterns

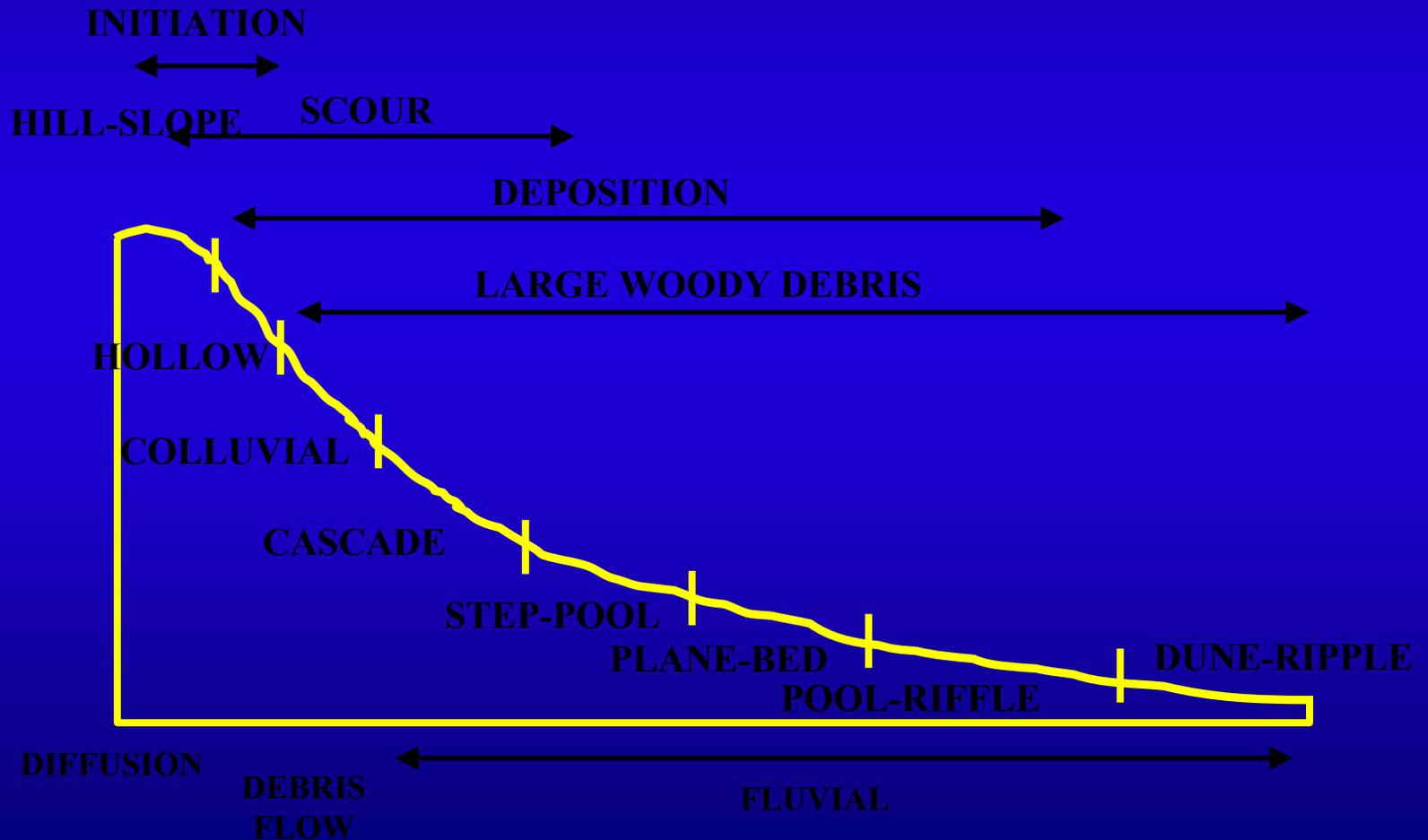
	<2	2-4	4-10	>10
% PTC Fines	😊	😞	😐	😊
Ave BF Width	😞	😐	😐	😐
Bankfull W:D	😞	😊	😊	😞
Gradient	😐	😞	😞	😊
Pool Frequency	😞	😐	😐	😊
Sinuosity	😞	😞	😞	😊
Thalweg Length	😊	😊	😞	😊
Wood Freq	😊	😊	😊	😊
D ₅₀	😊	😊	😞	😊

Crew Error Patterns

	<2	2-4	4-10	>10
% PTC Fines	😊	😞	😐	😊
Ave BF Width	😞	😐	😐	😐
Bankfull W:D	😞	😊	😊	😞
Gradient	😐	😞	😞	😊
Pool Frequency	😞	😐	😐	😊
Sinuosity	😞	😞	😞	😊
Thalweg Length	😊	😊	😞	😊
Wood Freq	😊	😊	😊	😊
D ₅₀	😊	😊	😞	😊

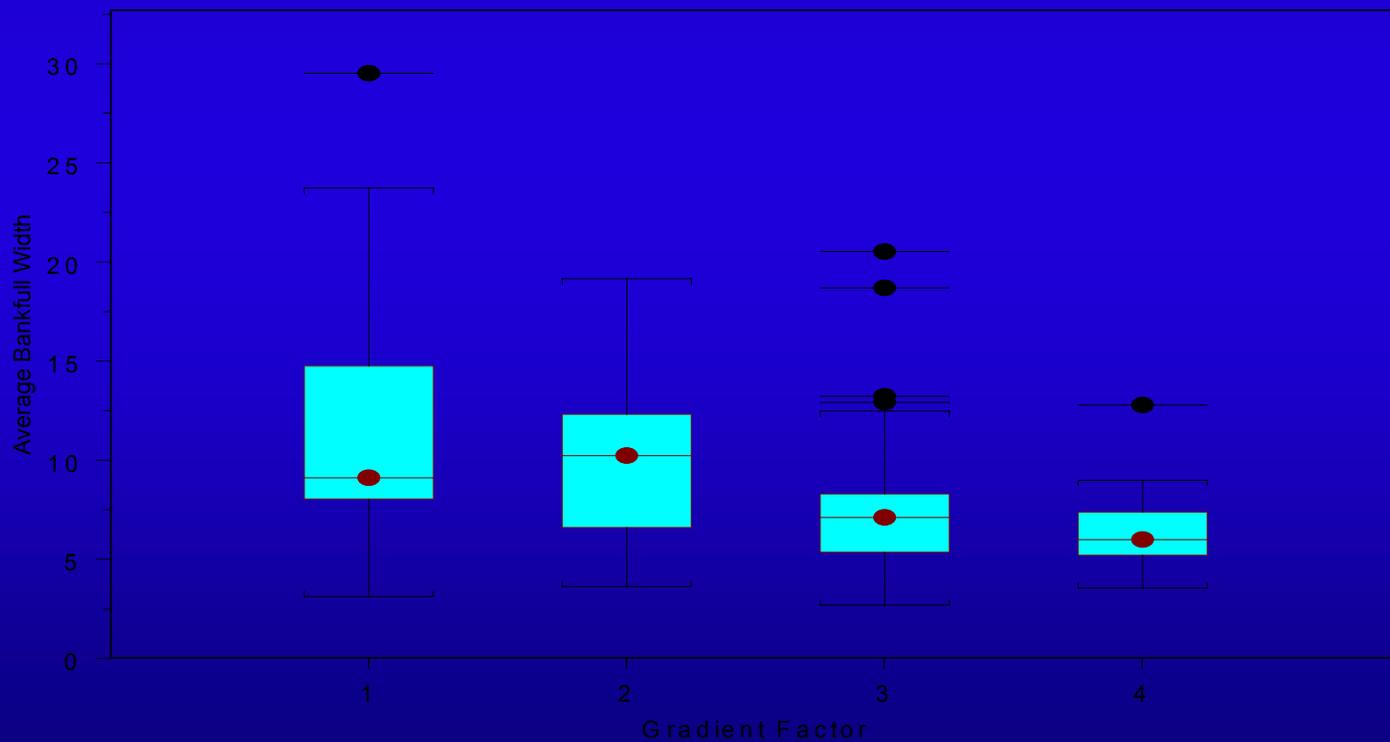


Evidence for Stratification by Gradient?

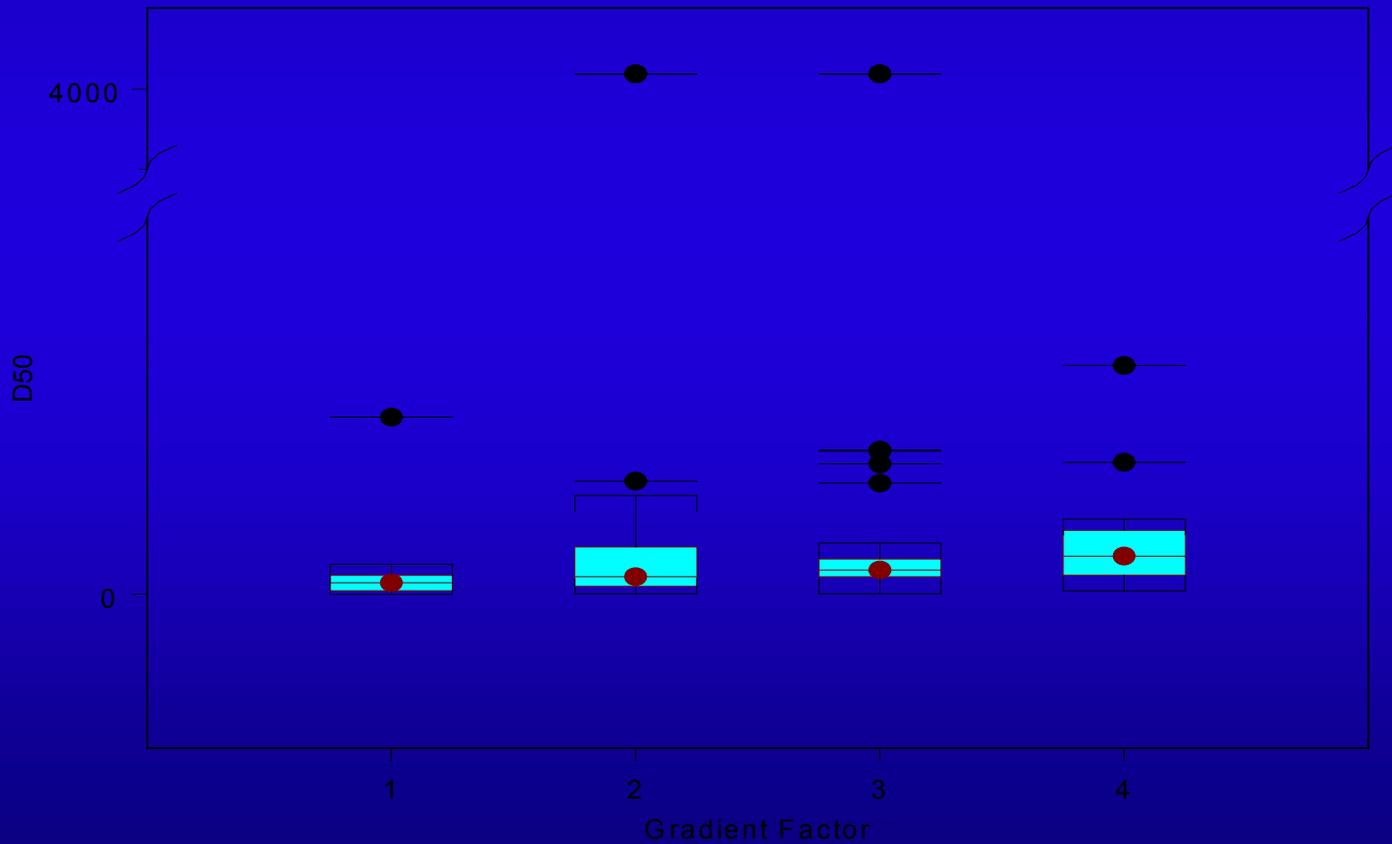


MONTGOMERY AND BUFFINGTON

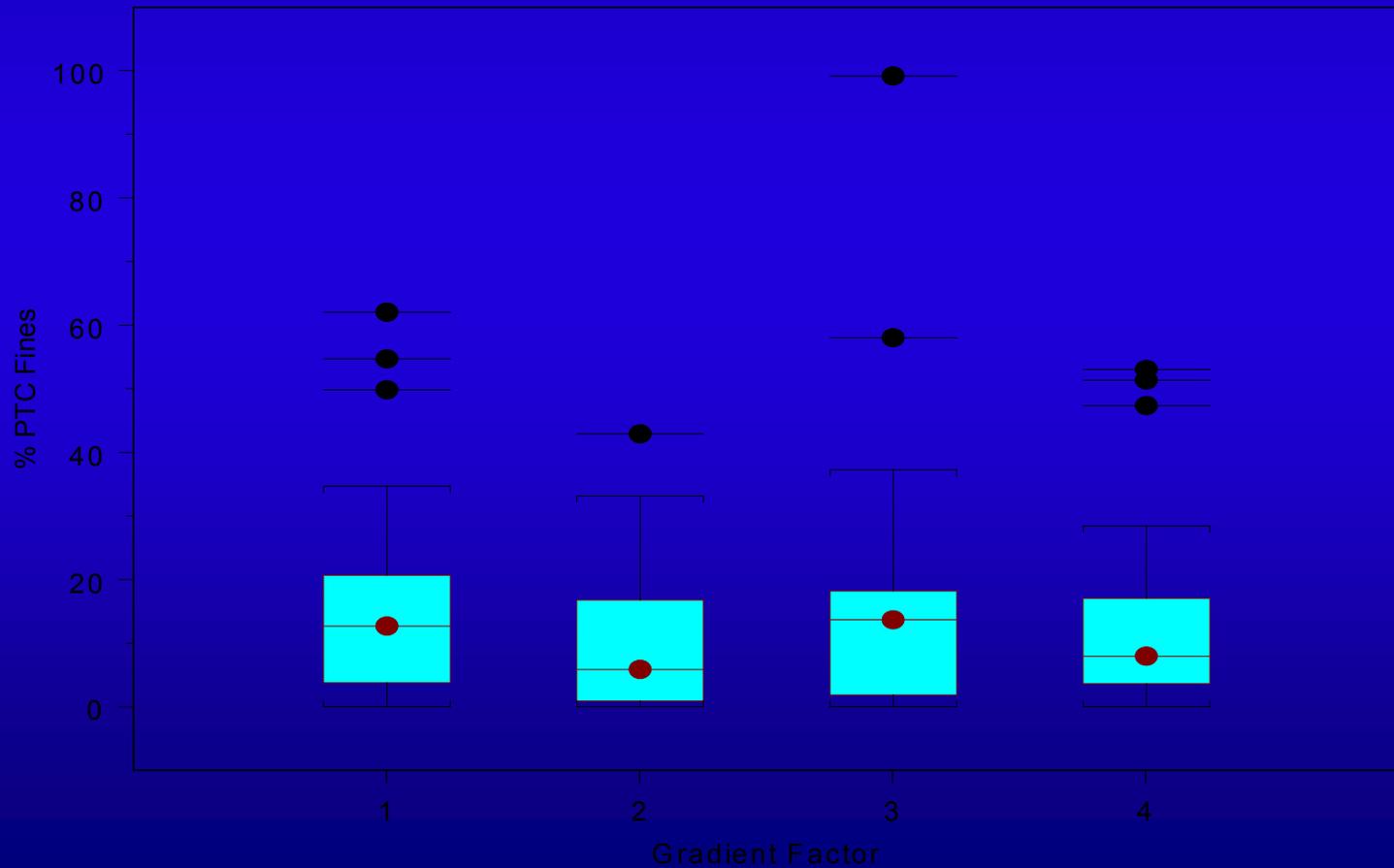
Average Bankfull Width



Substrate – D₅₀



Substrate - % PTC Fines



Sensitivity to Change

Response Variable	C	SP	PB	PR
Bankfull Width	●	●	●	■
Thalweg Profile	●	■	●	◆
D ₅₀	●	●	◆	◆
Percent Fines	■	■	◆	◆
Habitat Units	●	●	●	■

- ◆ Very Responsive
- Secondary Response
- Little Response



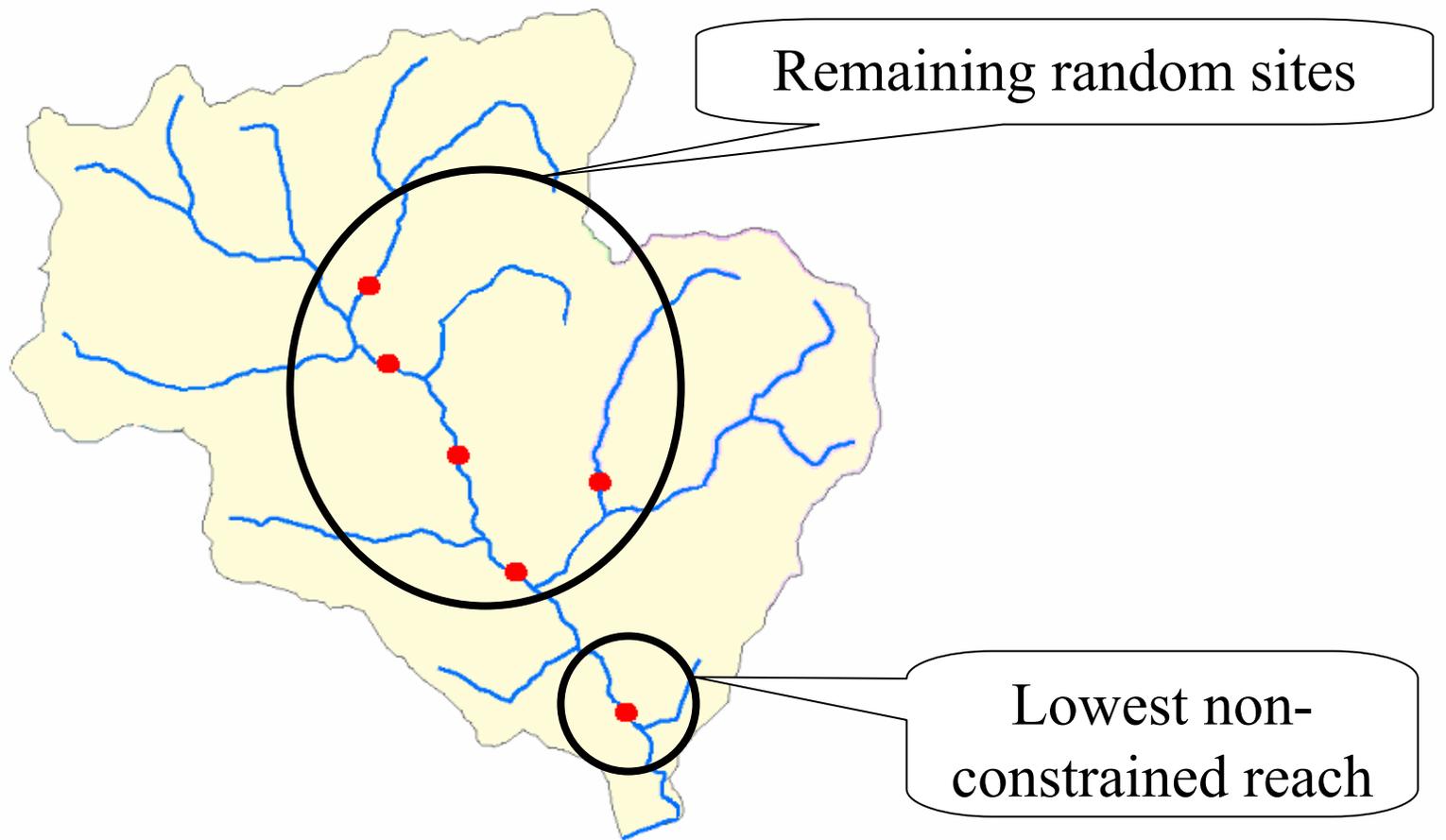
Sensitivity to Change?

Response Variable	>10	4-10	2-4	<2
Bankfull Width	288%	173%	288%	169%
Thalweg Profile				
D ₅₀	103%	185%	208%	133%
Percent Fines	104%	70%	79%	80%
Habitat Units				

- ◆ Very Responsive
- Secondary Response
- Little Response



Lowest Site Comparison



Physical & Chemical Indicator Differences...

	Lowest Non-Constrained Reach (n=8)		Remaining Random Sites (n=38)	
	Mean	Variance	Mean	Variance
Site Length	283.0	18952.6	203.5	3048.7
Bankfull Width	11.9	32.3	8.5	5.5
Bankfull Width:Depth	23.4	65.6	20.8	28.0
Gradient	1.15	0.37	5.57	11.74
Sinuosity	1.48	0.11	1.30	0.01
Percent Fines	19.6	240.2	11.3	70.8
D_50	22.2	433.4	59.8	1533.7
Pool Frequency	1.01	0.54	1.75	0.59
Wood Frequency	7.2	23.6	6.3	18.7
Dissolved Oxygen	8.24	6.60	9.49	2.75
pH	7.11	1.03	7.30	0.61
Conductivity	68.7	2199.2	66.5	1972.9



Aquatic Biota Indicator Differences...

Creek Name	Lowest Non-Constrained Reach (n=6)	Remaining Random Sites (n=31)	Predicted # of Species (remaining random sites)
Upper Cow Creek	5	7	7
Still Creek	4	6	7
Summit Creek	0	1	1
Hamma Hamma River	3	1	15
Swauk Creek	2	4	4
Silver Creek	2	4	6
	x = 2.6	x = 3.8	x = 6.7



Conclusions...

- ★ Gradient does impact the crew contribution to the overall variance.
- ★ There is no evidence that stratification by gradient improves the minimum detectable difference.
- ★ Lowest non-constrained reaches do appear to have different characteristics.
- ★ Indicator values are, in some instances, different.