

GEOMORPHIC CHANGE DETECTION

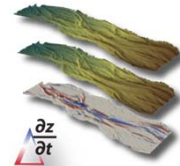
Q. INTERPRETATION & BUDGET SEGREGATION



USACE Workshop

Kansas City





May 30- June 1, 2012



**US Army Corps
of Engineers®**



WORKSHOP PLAN – DAY 2... (Afternoon)

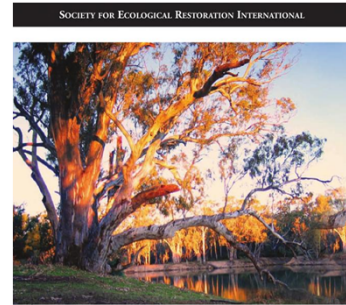
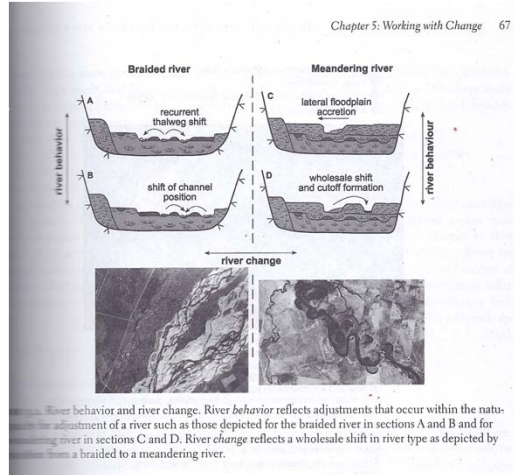
- | | | |
|---|--|-------------------|
|  | Q. GCD Budget Segregation | 13:30 to 14:30 |
|  | R. Budget Segregation Exercise | 14:30 to 15:30 |
| | <i>Break 15:30 – 15:45</i> | |
|  | S. Guided Examples with ACE's OWN Data | 15:45 to 16:45 |
|  | T. Workshop Synthesis | 16:45 to 17:00ish |



A Plan.. Not a Contract



CHANGE VS. BEHAVIOR



River Futures

An Integrative Scientific Approach to River Repair

Edited by Gary J. Brierley and Kirstie A. Fryirs



SEDIMENT BUDGET

Components:

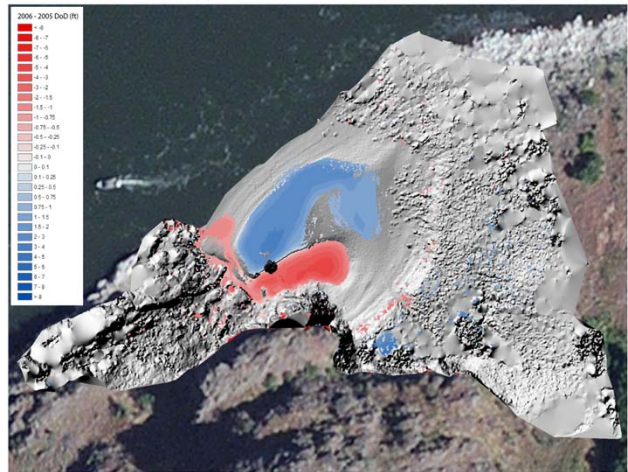
- Areal/Volumetric
- Raw/Thresholded
- +/- Estimates
- Percentages
- ECDs
- Change in Storage

Morphological Sediment Budget:

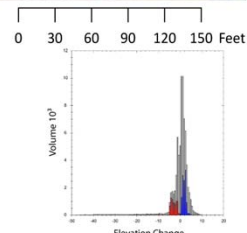
$$Q_{b\text{IN}} - Q_{b\text{OUT}} = \frac{\Delta V_{\text{DoD}}}{\Delta t}$$

Bedload Flux Difference Change in Storage

$$\Delta V_{\text{DoD}} = \Sigma V_{\text{Deposition}} - \Sigma V_{\text{Erosion}}$$

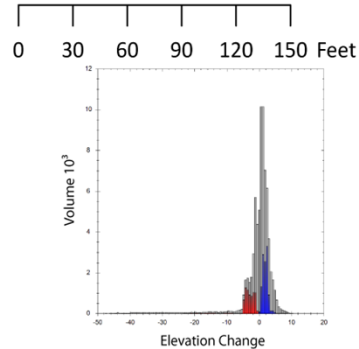


Attribute	Raw	Thresholded DoD Estimate:	
AREA:			
Total Area of Erosion (ft²)	30,009	3,895	
Total Area of Deposition (ft²)	46,330	6,425	
VOLUMETRIC:			
Total Volume of Erosion (ft³)	25,188	7,629 ± 1,164	15%
Total Volume of Deposition (ft³)	48,105	11,462 ± 2,323	20%
Total Volume Difference (ft³)	23,917	19,051 ± 1,958	18%
Total Net Volume Difference (ft³)	73,763	3,834 ± 2,599	68%
PERCENTS (BY VOLUME)			
Percent Erosion	34%	40%	
Percent Deposition	66%	60%	
Percent Imbalance (separation from equilibrium)	16%	10%	



THAT SUMMARY.XML FILE...

Attribute	Raw	Thresholded DoD Estimate:		
AREAL:				
Total Area of Erosion (ft²)	30,009	3,895		
Total Area of Deposition (ft²)	46,330	6,425		
VOLUMETRIC:				
			± Error Volume	% Error
Total Volume of Erosion (ft³)	25,108	7,629 ± 1,164		15%
Total Volume of Deposition (ft³)	48,855	11,462 ± 2,323		20%
Total Volume of Difference (ft³)	73,963	19,091 ± 3,488		18%
Total Net Volume Difference (ft³)	23,747	3,834 ± 2,599		68%
PERCENTAGES (BY VOLUME)				
Percent Erosion	34%	40%		
Percent Deposition	66%	60%		
Percent Imbalance (departure from equilibrium)	16%	10%		



- What's here? Where did it come from?



ACROSS MULTIPLE YEARS...

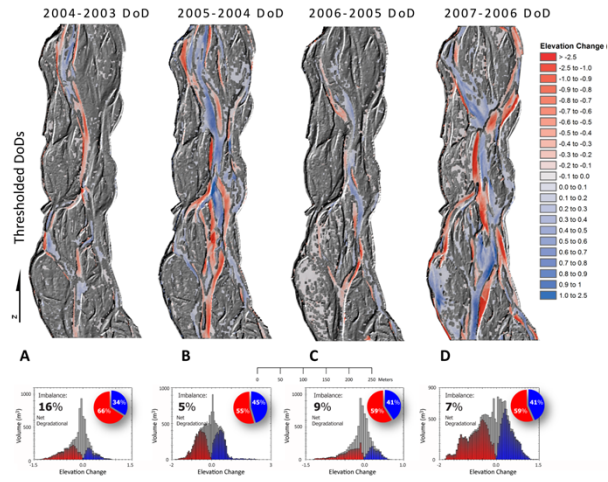
- Is budget indeterminate, equilibrium, degradational or aggradational?

EPOCH:	EROSION			DEPOSITION			NET CHANGE			
	Volume (m ³)		Vol Error as a %	Volume (m ³)		Vol Error as a %	Volume (m ³)		Vol +/- Error as a %	Vol % Imbalance
2004-2003	2,268	± 1,592	70%	1,156	± 700	61%	-1,112	± 1,739	51%	-16%
2005-2004	5,794	± 2,097	36%	4,811	± 1,752	36%	-983	± 2,732	26%	-5%
2006-2005	1,858	± 1,504	81%	1,289	± 765	59%	-569	± 1,687	54%	-9%
2007-2006	8,581	± 2,978	35%	6,605	± 2,424	37%	-1,976	± 3,840	25%	-7%
TOTAL	18,501	± 8,171	44%	13,861	± 5,640	41%	-4,640	± 9,999	NA	-7%
Average	4,625	± 2,043	56%	3,465	± 1,410	48%	-1,160	± 2,500	39%	-9%



WHAT MORE CAN WE SAY OR ASK?

Best estimate
of gross
reach-scale
sediment
budget

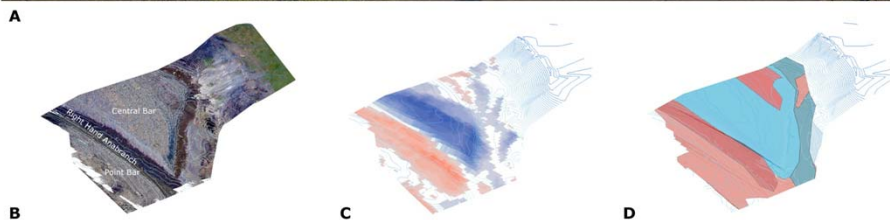


e.g. What is the dominant mechanism of change?

Where in the reach is contributing the most?



USE MASKS TO SEGREGATE DoD



What are the individual mechanisms of net change?

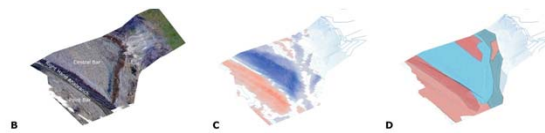
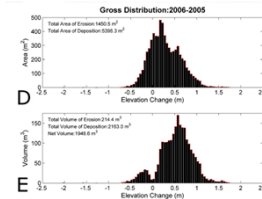


THREE TYPES OF MASKS

Just a way of spatially segregating budget to ask questions and query budget results.

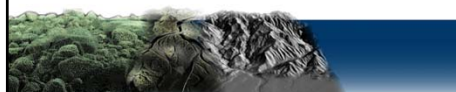
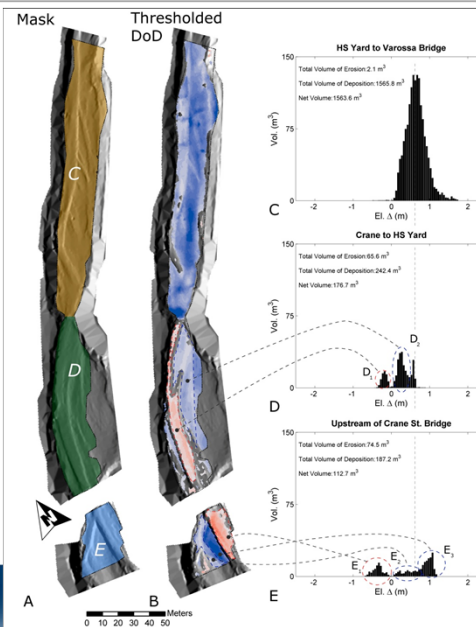
1. Standard Classification
 2. Classification of Difference
 3. Geomorphic Interpretation
- Just polygons...

Segregates both DoD & its Elevation Change Distribution...



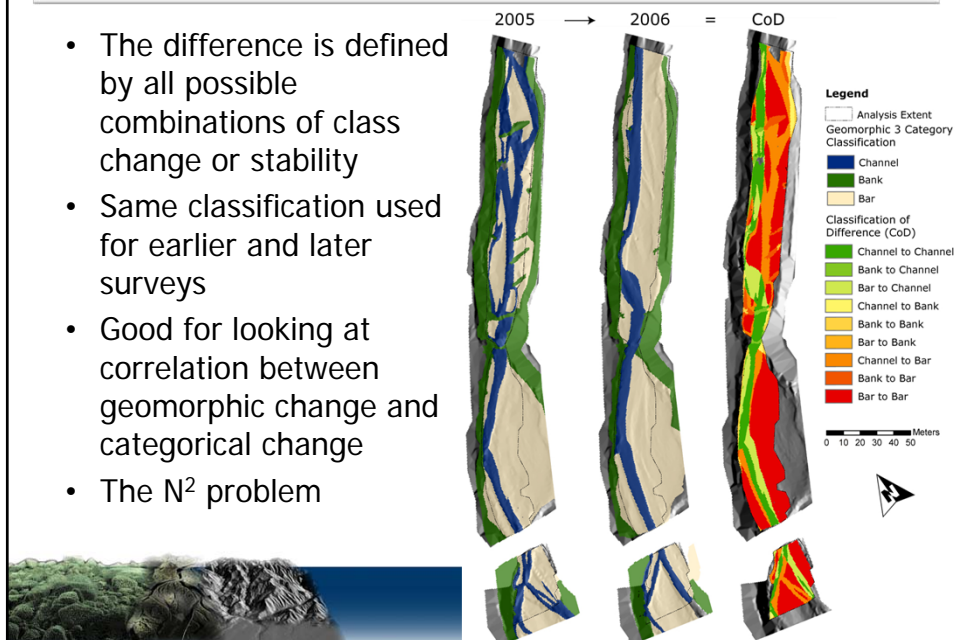
1. STANDARD CLASSIFICATION

- Any classification that is of:
 - The pre-survey
 - The post-survey
 - Or Time Independent
- Examples:
 - Morphological Units
 - Habitat Classification
 - Administrative Bndys
 - Reaches



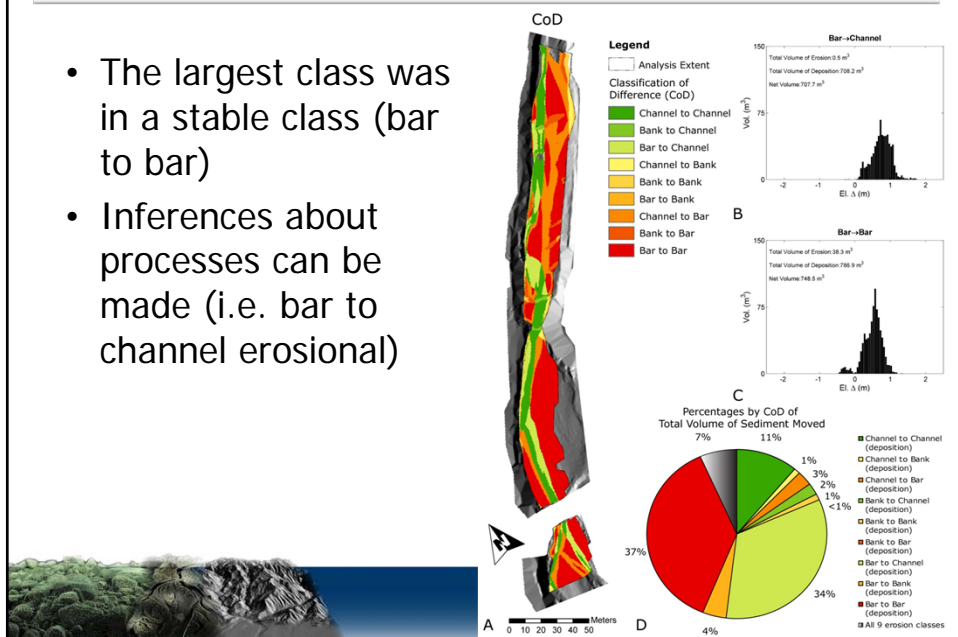
2. CLASSIFICATION OF DIFFERENCE

- The difference is defined by all possible combinations of class change or stability
- Same classification used for earlier and later surveys
- Good for looking at correlation between geomorphic change and categorical change
- The N^2 problem



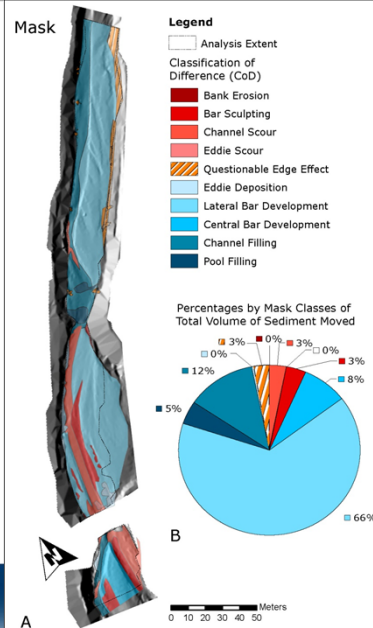
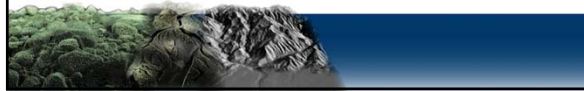
CoD APPLIED...

- The largest class was in a stable class (bar to bar)
- Inferences about processes can be made (i.e. bar to channel erosional)

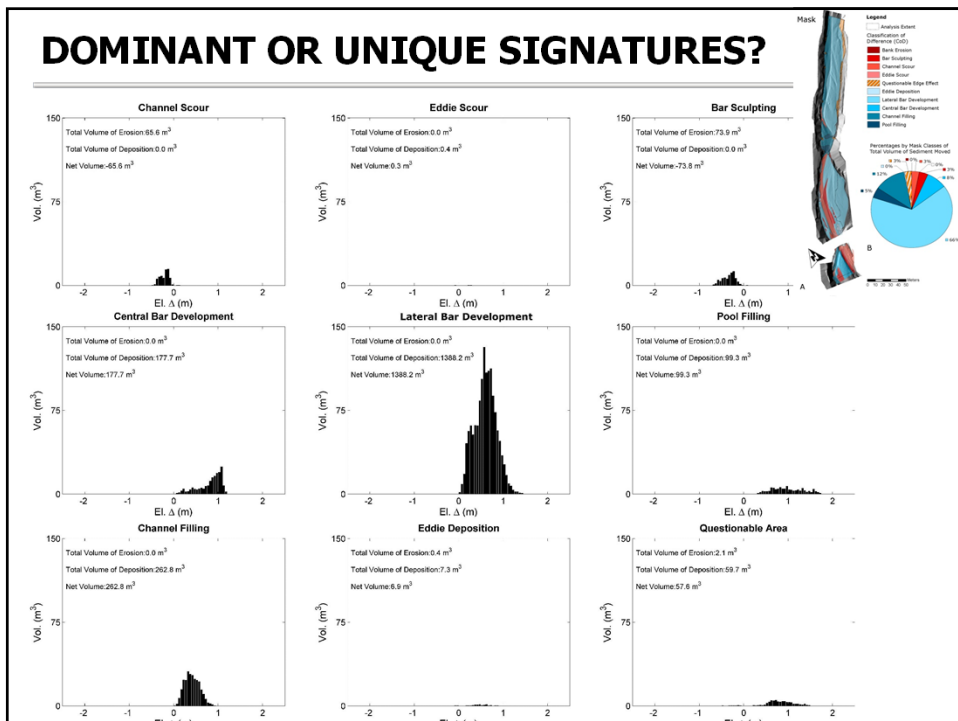


3. GEOMORPHIC INTERPRETATION

- Instead of mask being based on one point in time, this is based on the change surface itself (i.e. the DoD)
- Multiple lines of evidence can be used beyond DoD
- You define geomorphic processes of interest

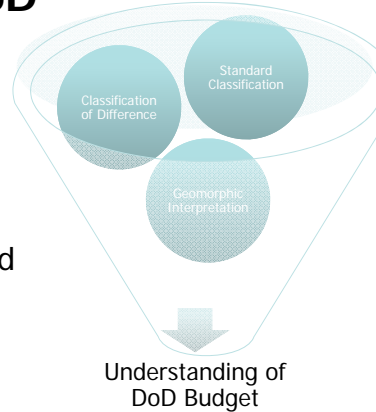


DOMINANT OR UNIQUE SIGNATURES?



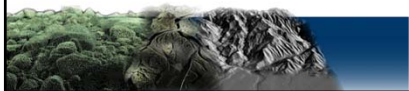
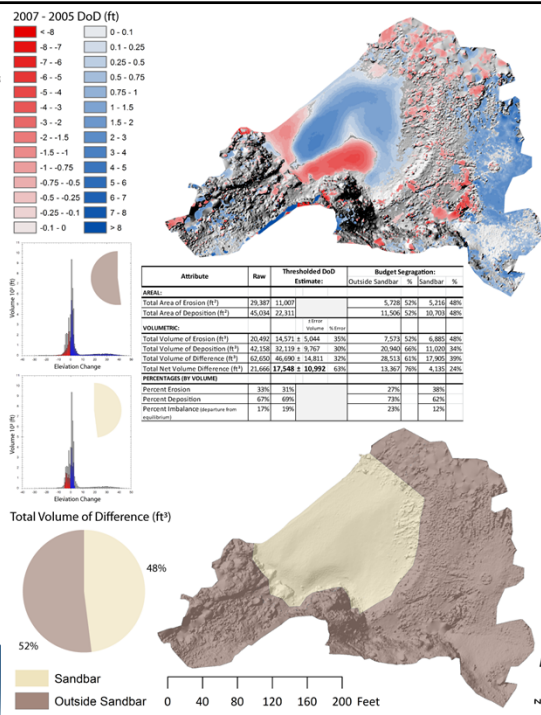
THREE DIFFERENT WAYS OF INTERPRETING SAME DoD

- Are the conclusions contradictory?
- Does the spatial masking/segregation tell us something that the gross analysis can not?
- Does this allow for more explicit and quantitative hypothesis testing?
- Are unique or distinctive signatures of change (in ECDs) present?
- Sensitivity to single interpretation..



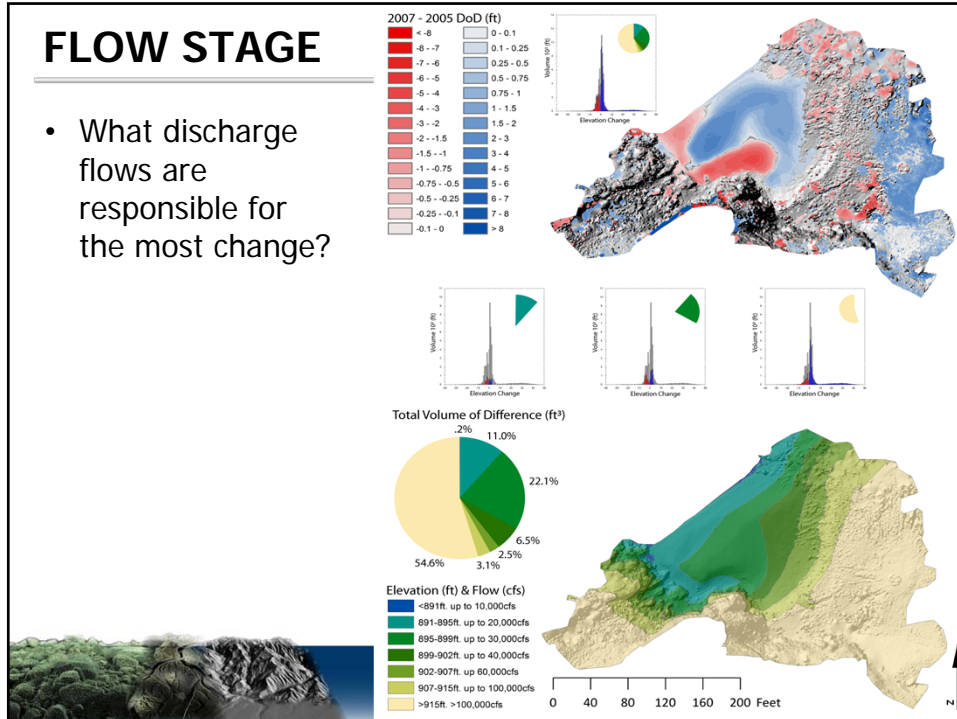
SIMPLE AREA MASK

- How much of change is in sandbar, or outside sandbar?



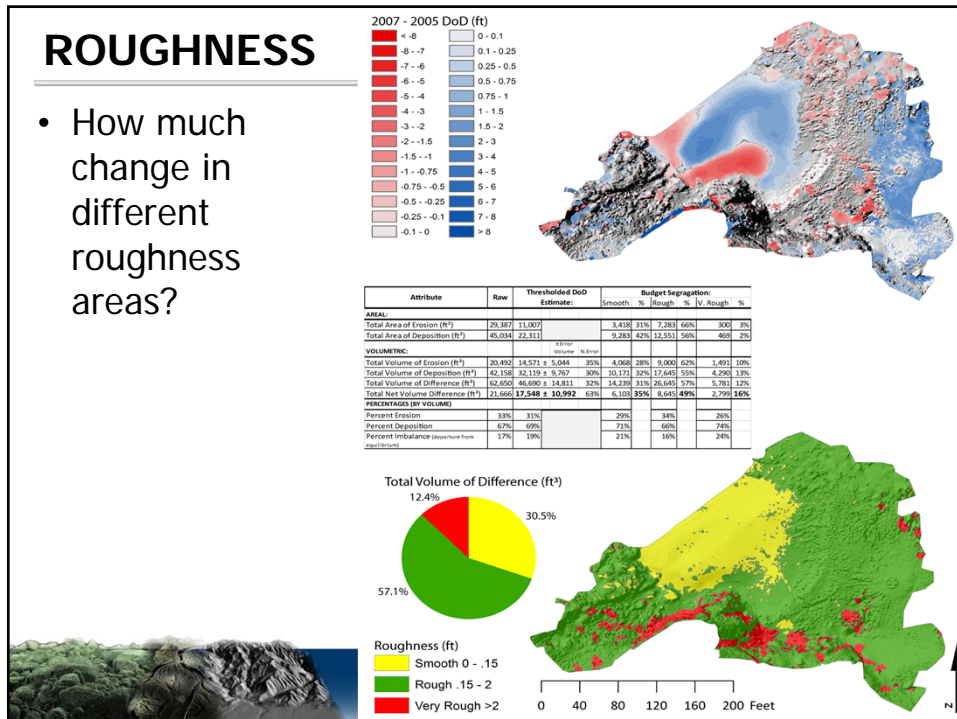
FLOW STAGE

- What discharge flows are responsible for the most change?



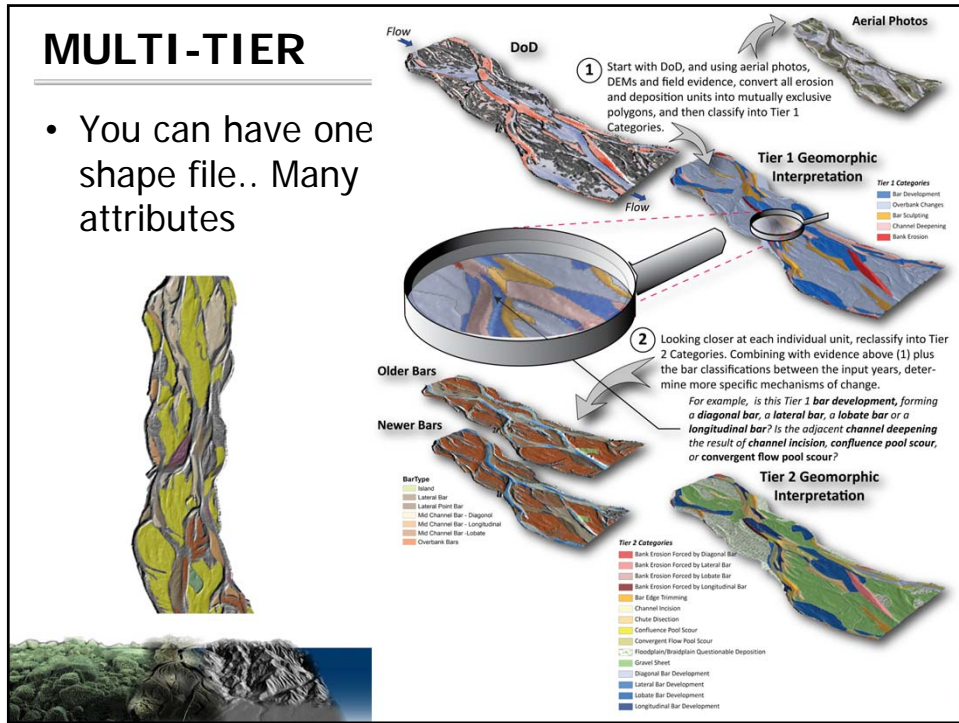
ROUGHNESS

- How much change in different roughness areas?

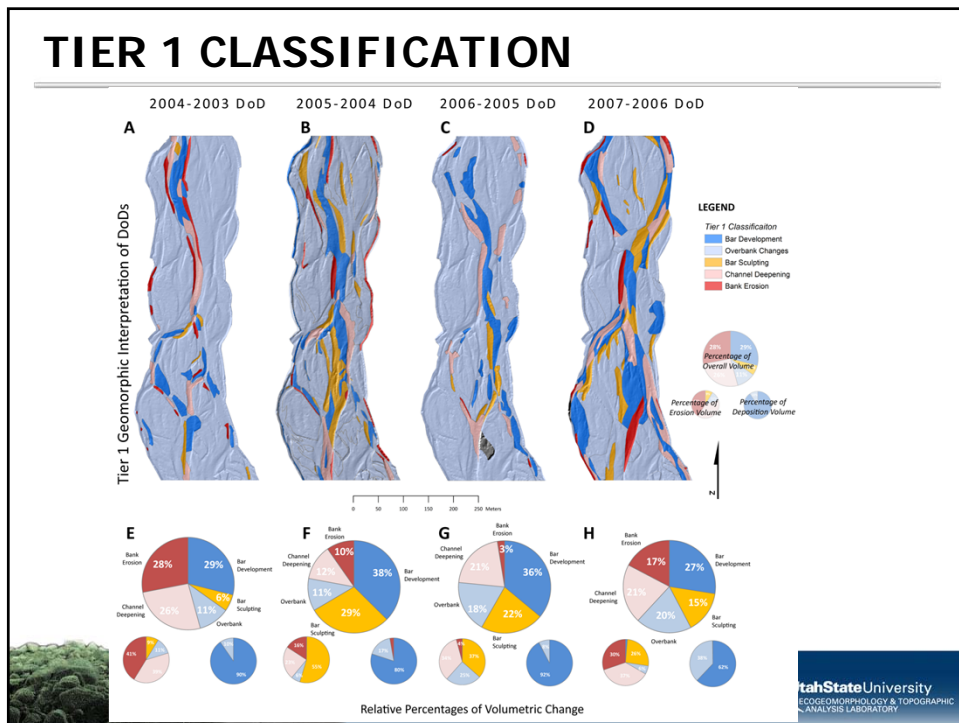


MULTI-TIER

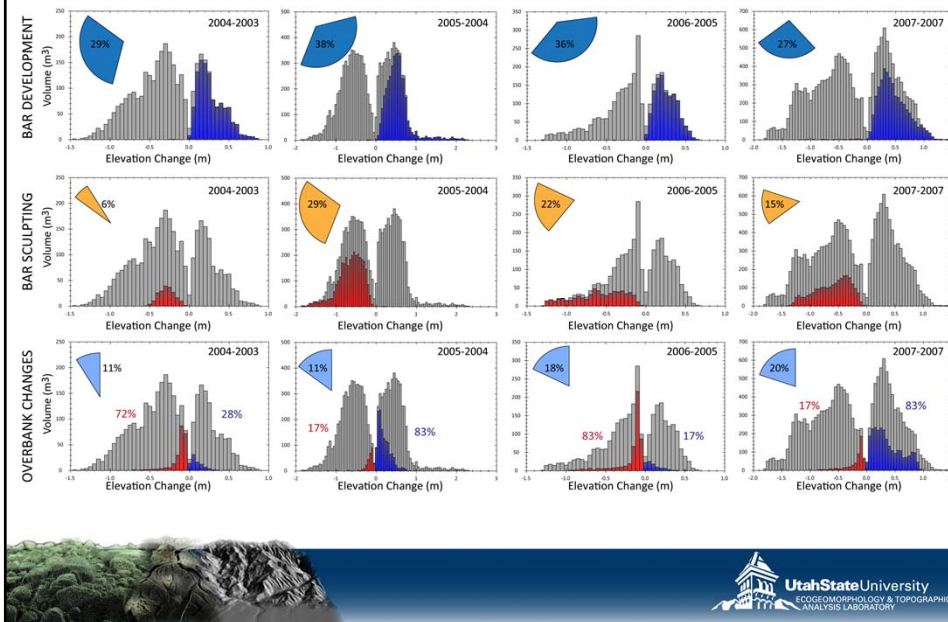
- You can have one shape file.. Many attributes



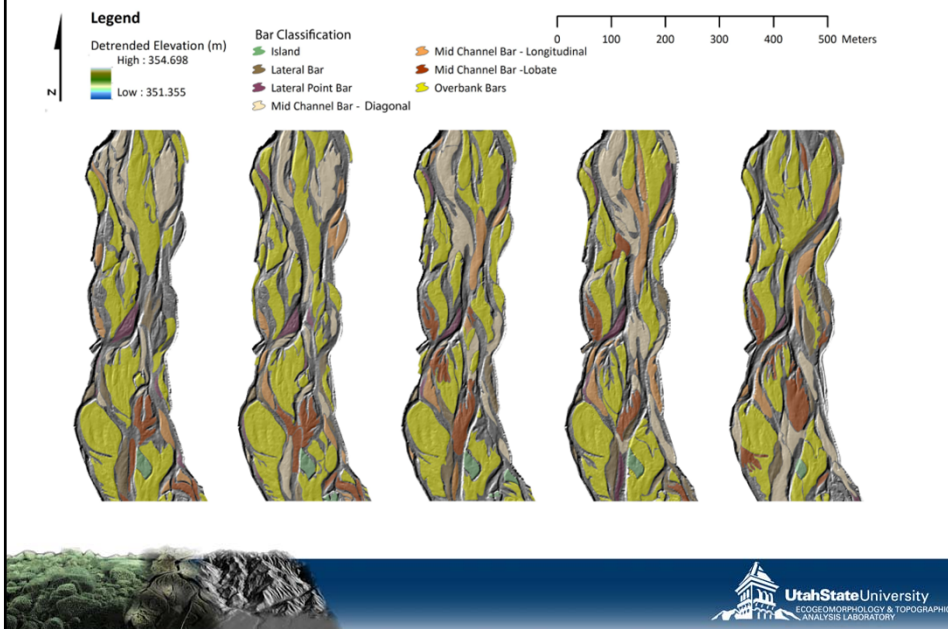
TIER 1 CLASSIFICATION



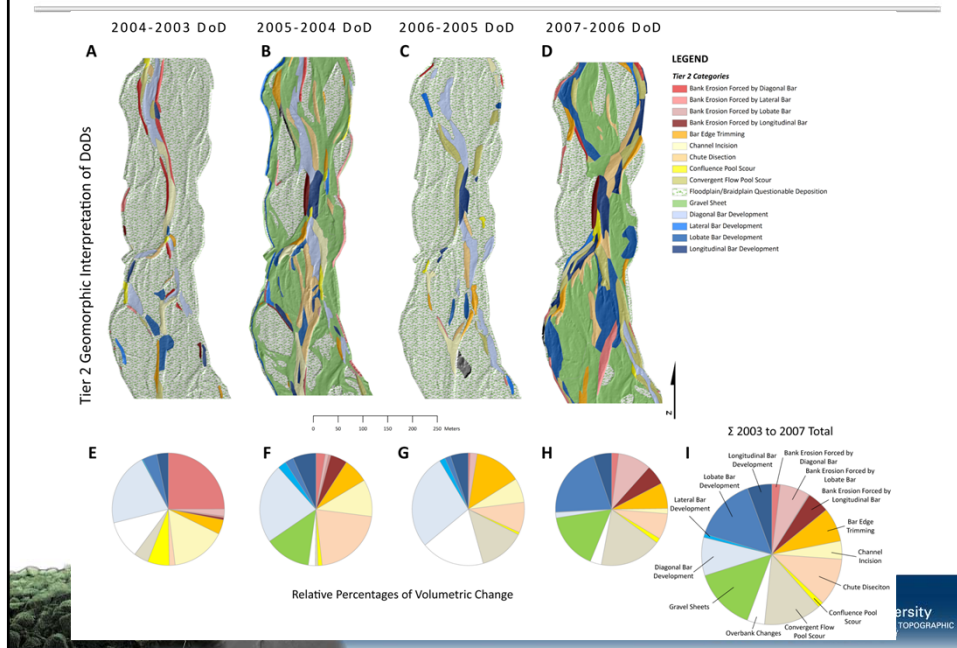
ARE SIGNATURES CONSISTENT?



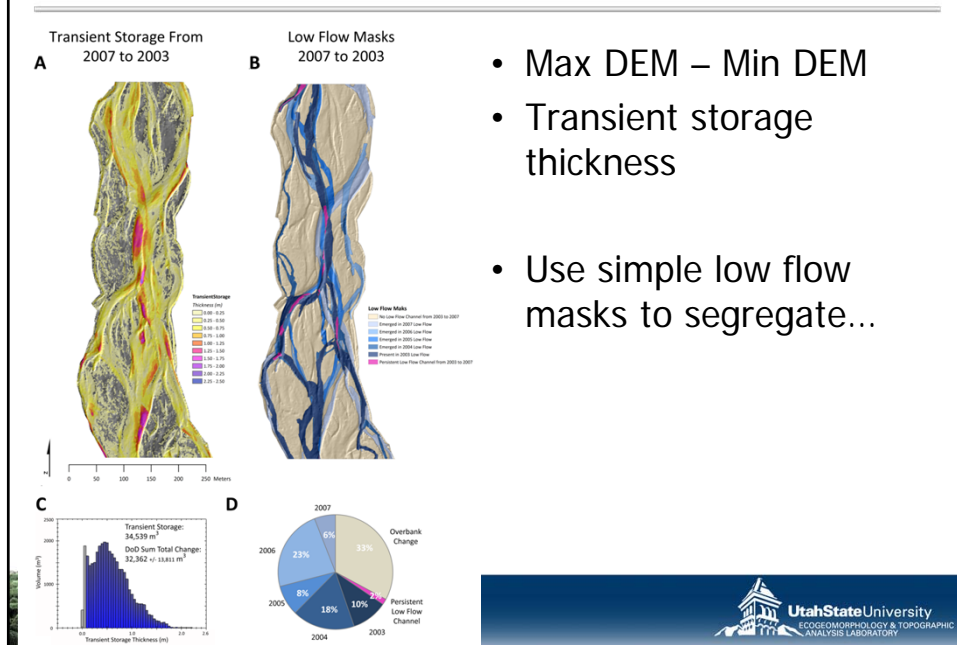
USE BAR TYPES TO HELP



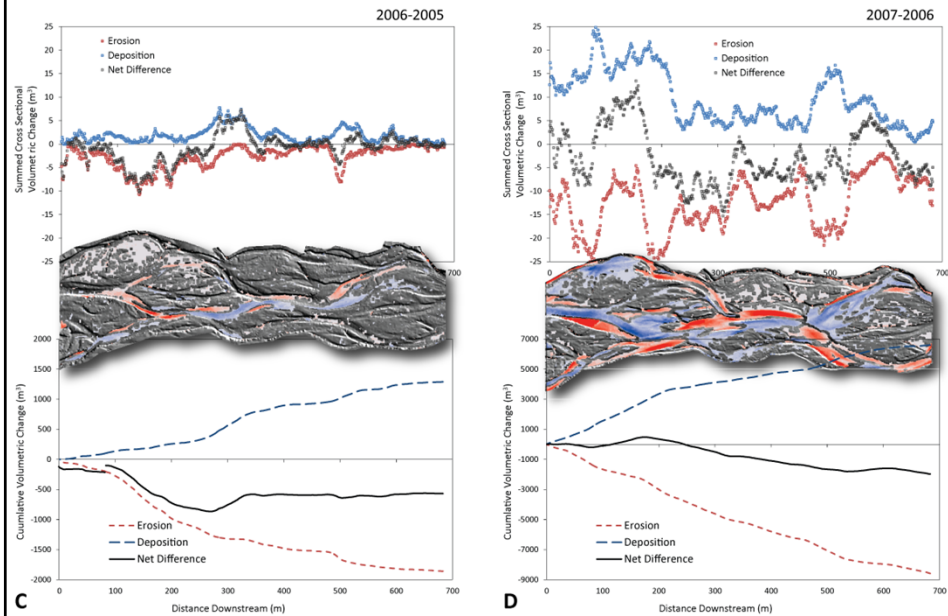
TIER 2 CLASSIFICATION



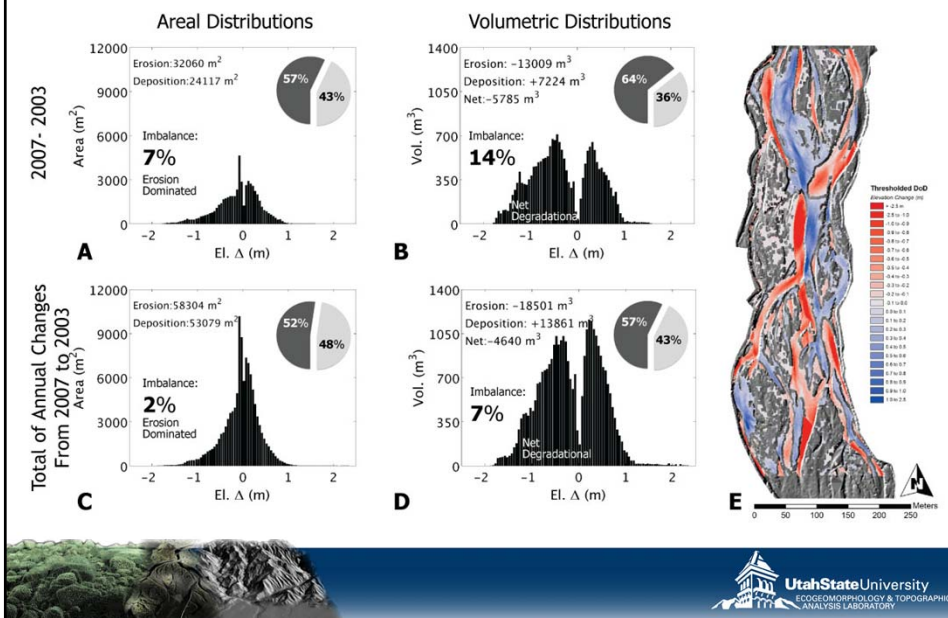
TRANSIENT STORAGE



LONGITUDINAL TRENDS

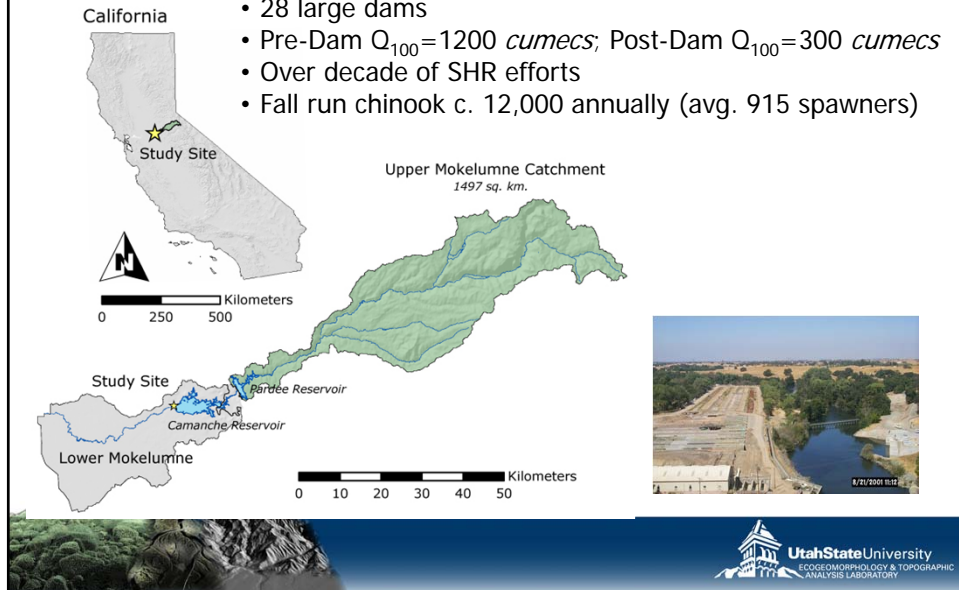


COMPENSATION IDEA...



MOKELUMNE RIVER STUDY SITE

- Spring Snow-melt dominated flow regime
- 28 large dams
- Pre-Dam $Q_{100}=1200$ *cumecs*; Post-Dam $Q_{100}=300$ *cumecs*
- Over decade of SHR efforts
- Fall run chinook c. 12,000 annually (avg. 915 spawners)



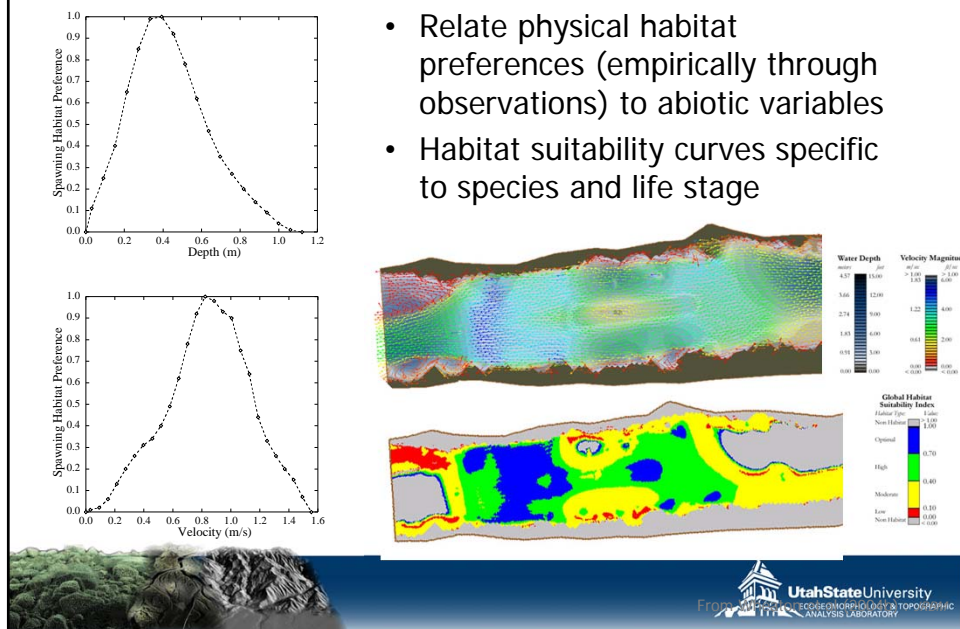
UtahStateUniversity
ECOLOGICAL MORPHOLOGY & TOPOGRAPHIC
ANALYSIS LABORATORY

SHR?

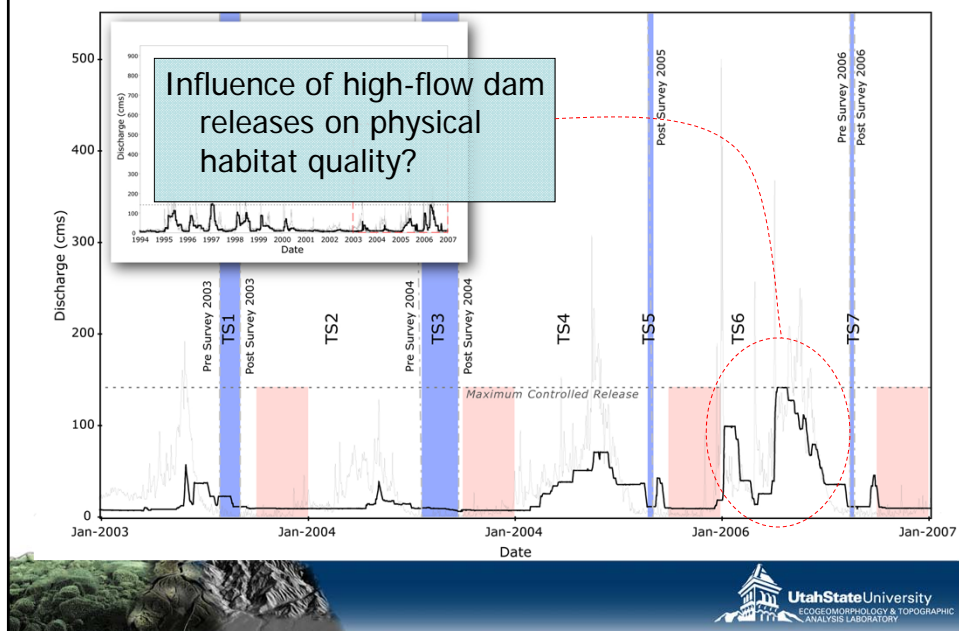
- Spawning habitat rehabilitation
- Placement of optimally sized spawning gravels downstream of dams to recreate suitable spawning habitat

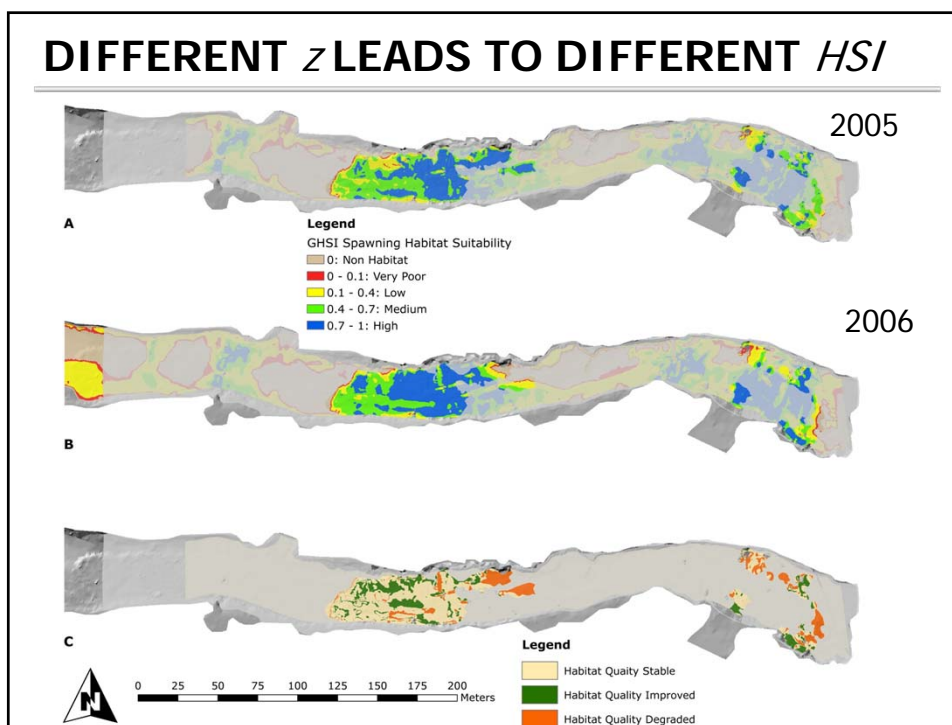
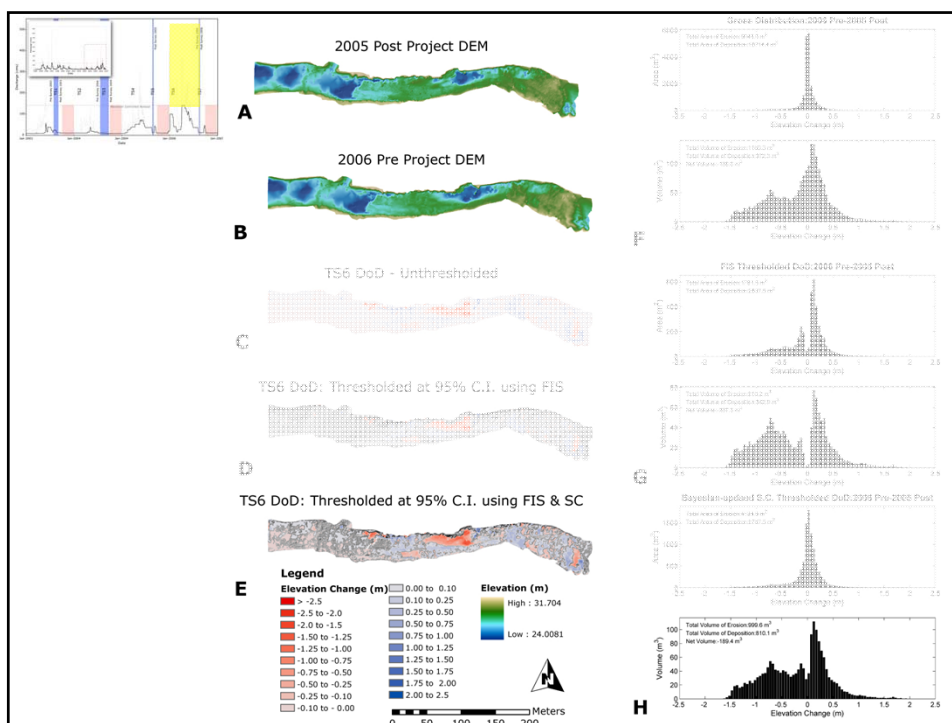


ECOHYDRAULIC MODELS

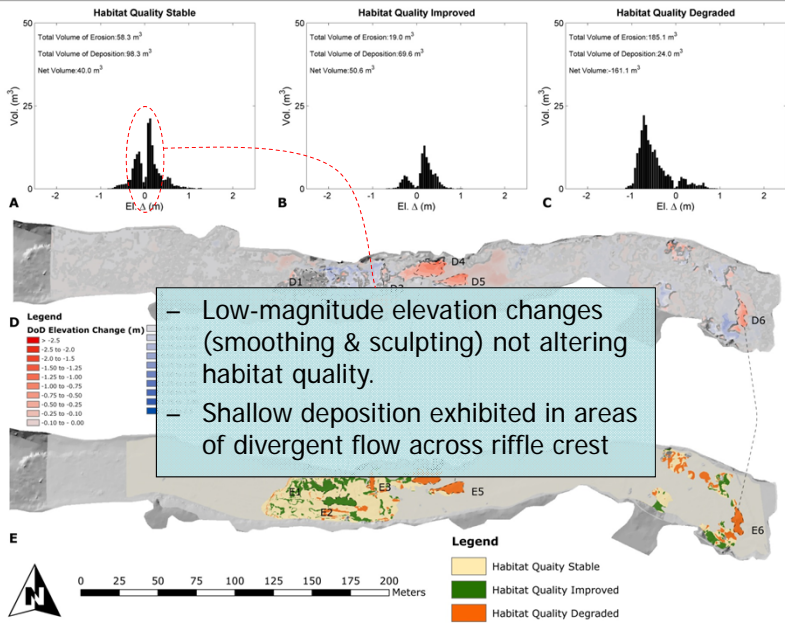


MOKELUMNE FLOW REGIME

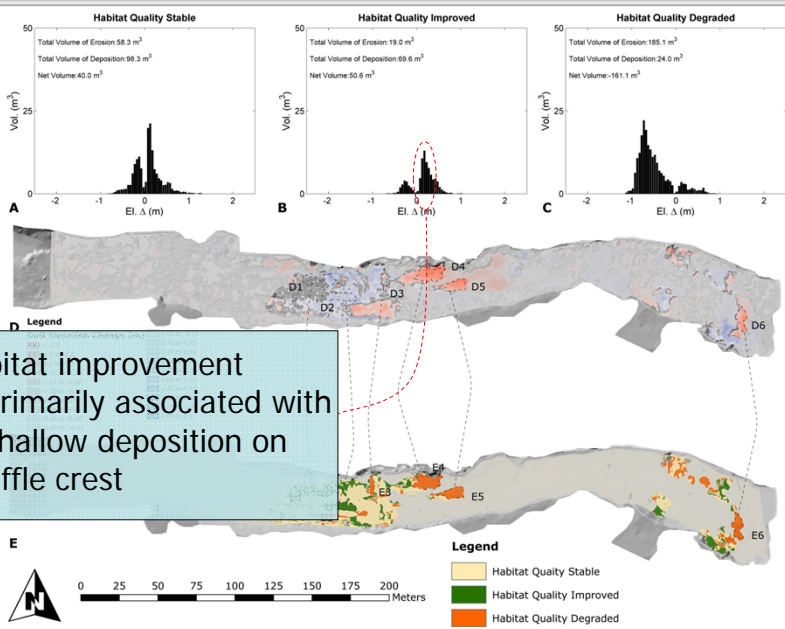




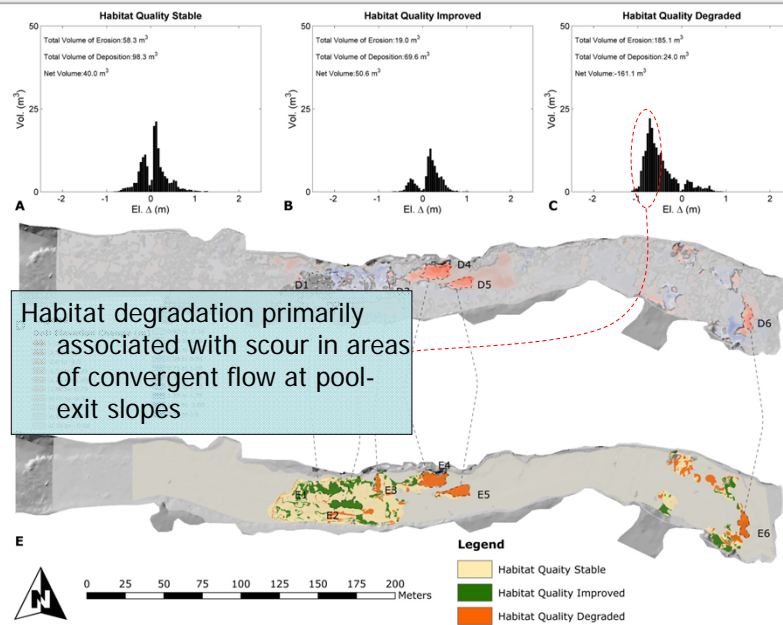
EXPLAIN 👉 HSC IN TERMS OF $c z / c t$



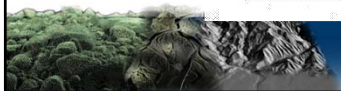
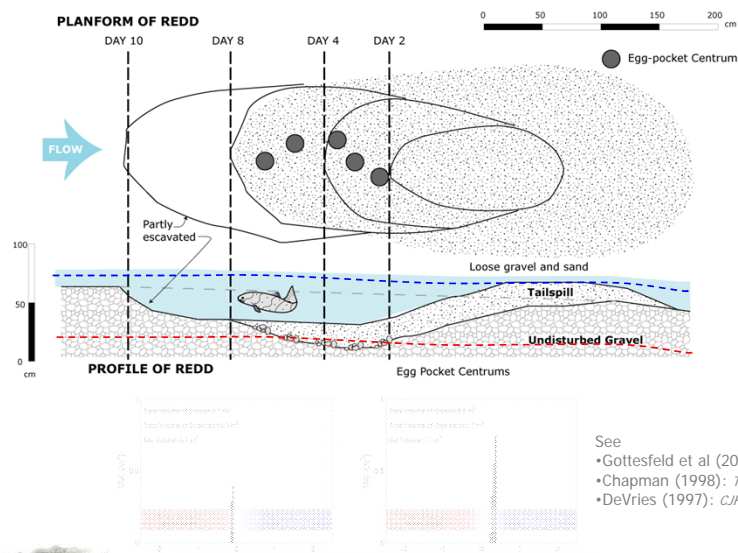
EXPLAIN 👎 HSC IN TERMS OF c_z/c_t



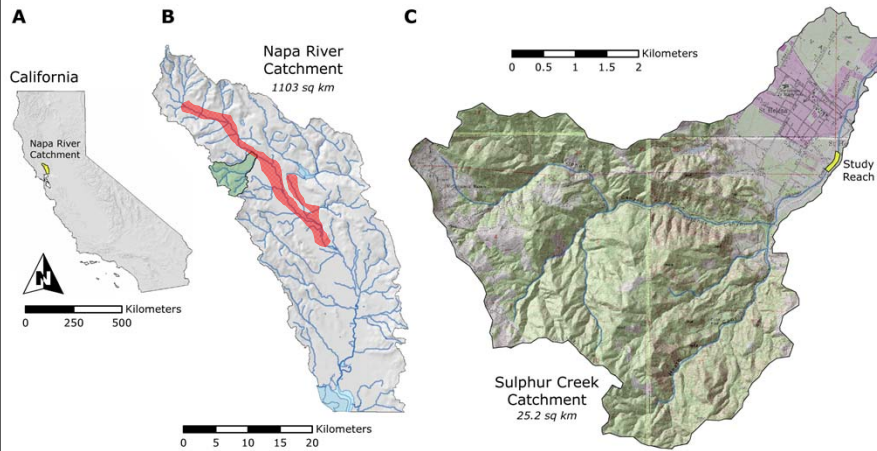
EXPLAIN HSC IN TERMS OF c_z/c_t



Does c_z/c_t matter?



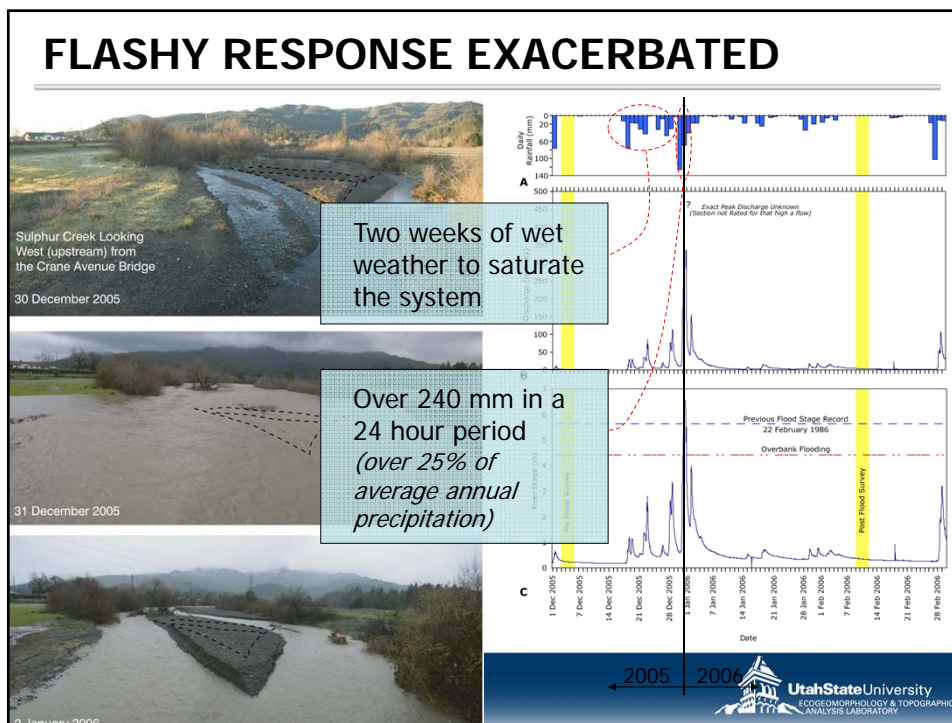
SULPHUR CREEK STUDY SITE



SULPHUR CREEK STUDY SITE



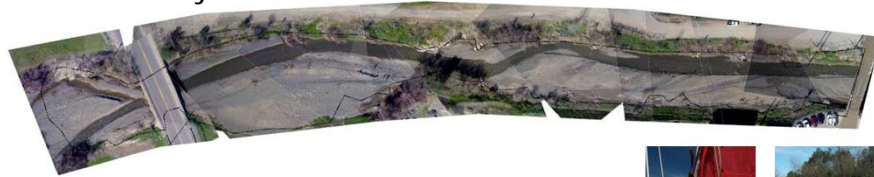
NEW YEAR'S EVE STORM - 2005



BEFORE & AFTER



Although there is an interesting geomorphic story here...



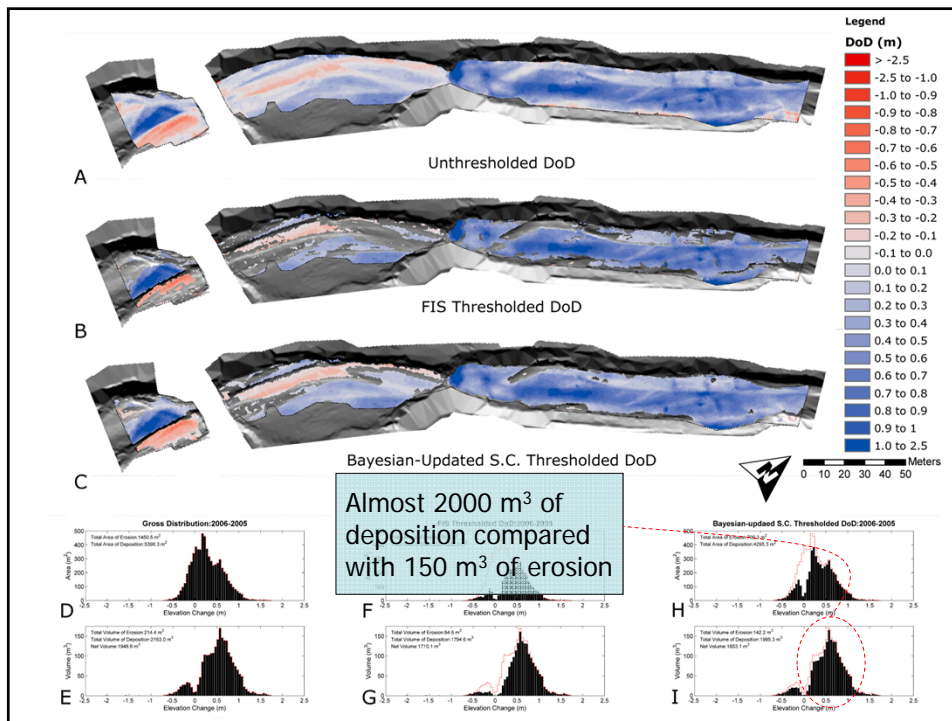
0 10 20 30 40 50 Meters

Legend

Analysis Extent

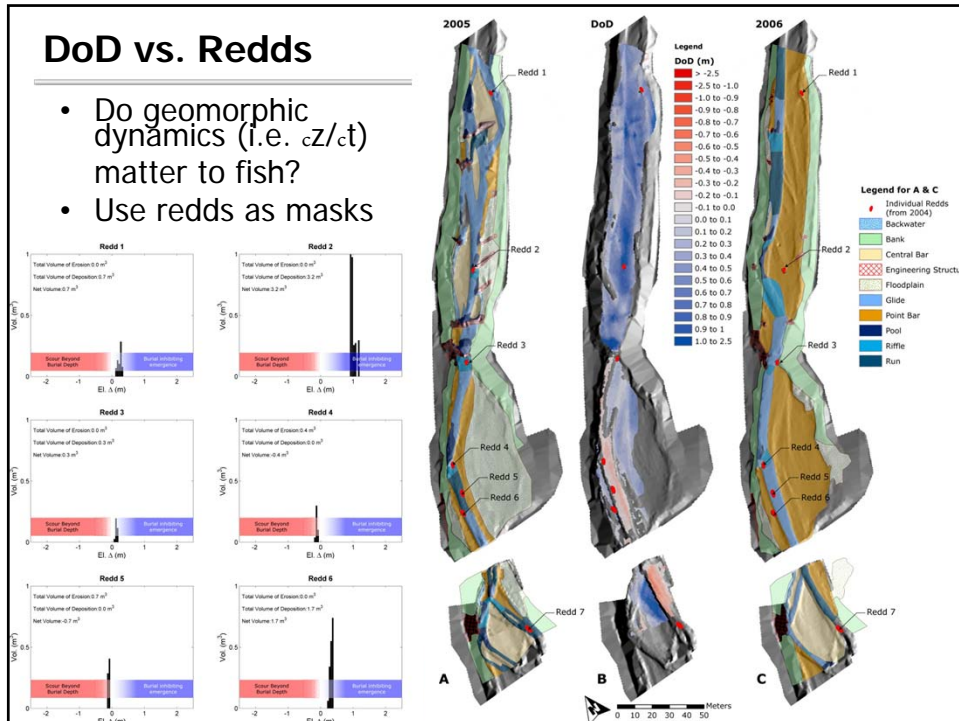


Imagery acquired with the 'Open University
photography' (i.e. blimp, duct tape, digital camera)







DoD vs. Redds

- Do geomorphic dynamics (i.e. $\frac{dz}{dt}$) matter to fish?
- Use redds as masks



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