

Bed Mobility and Scour Metrics Discussion



Scott McBain, Smokey Pittman



McBain Associates
APPLIED RIVER SCIENCES

July 16, 2020

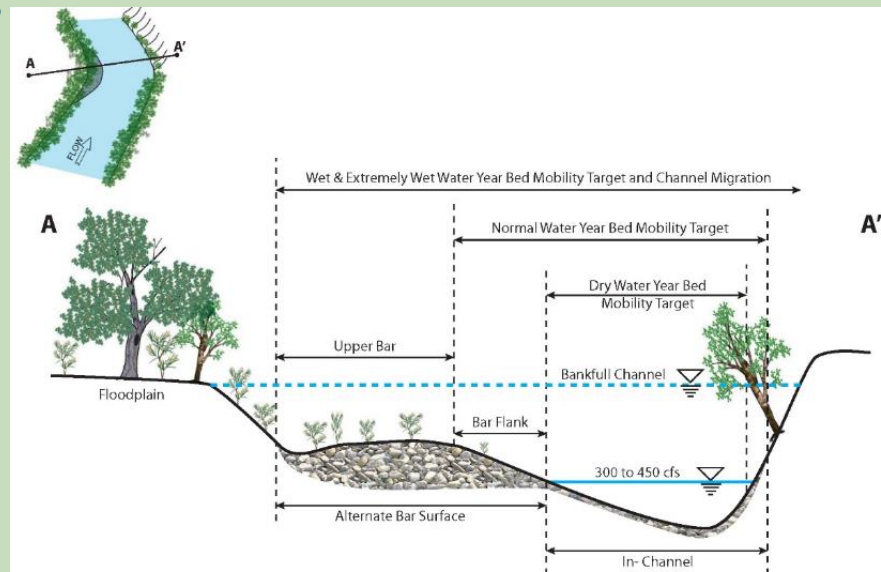
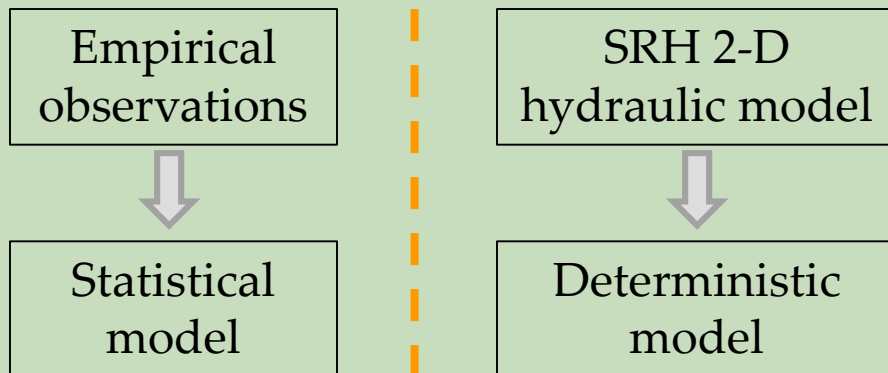
Bed Mobility and Scour: TRFE objectives

TRFE OBJECTIVES

- Mobilization of matrix surface particles (D_{84}) on alternate bar surfaces during Normal and wetter water years >6,000 cfs)
- Mobilization of subsurface particles ($\geq 1D_{84}$ depth) during Wet and Extremely Wet years
- Mobilization of subsurface particles ($\geq 2D_{84}$ depth) during Extremely Wet years

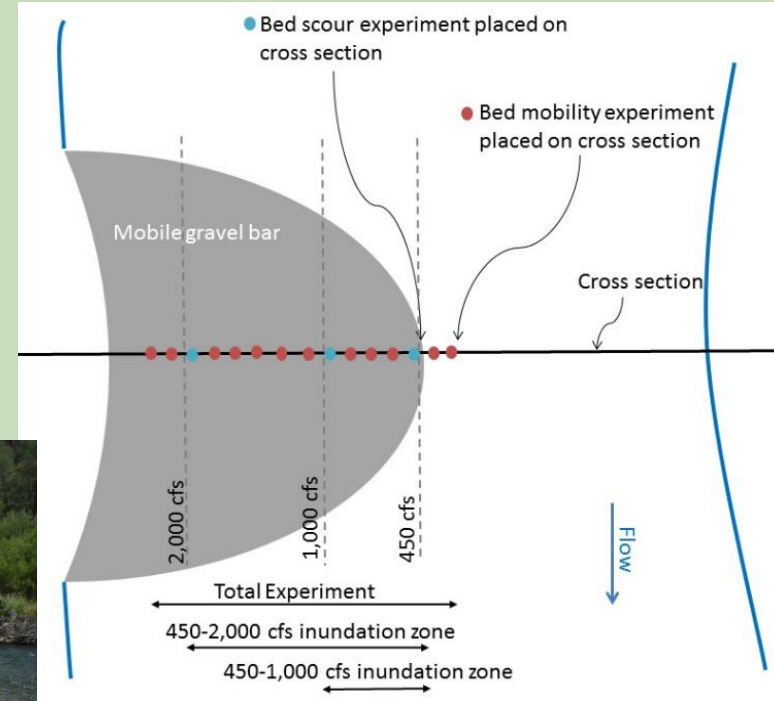
PURPOSE

- Prevent detrimental riparian encroachment of active bars to preserve healthy alluvial river attributes
- Maintain complex channel morphology
- Scour fine sediments



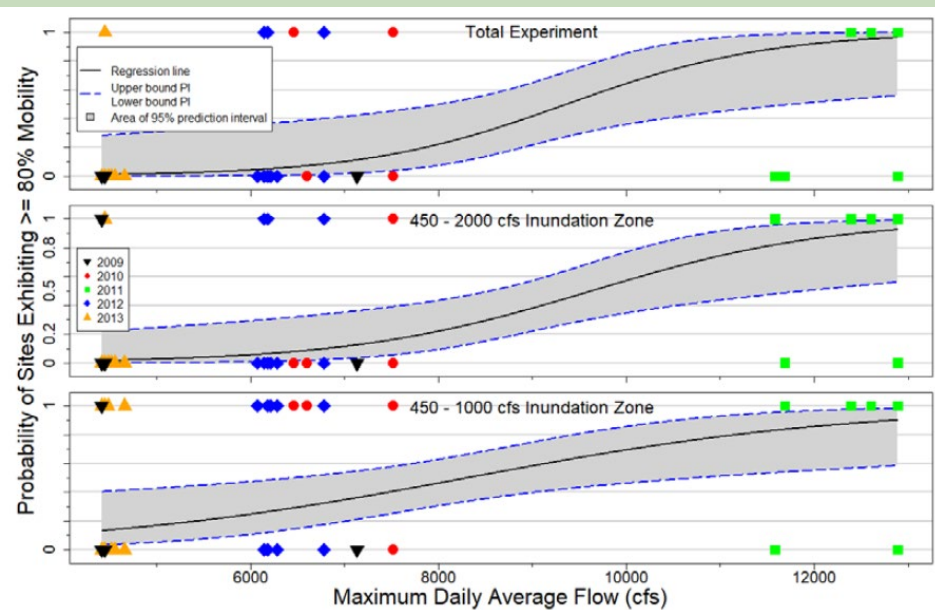
2009-2014 Empirical Observations

- Tracer Rocks
- Scour Cores
- Scour Chains

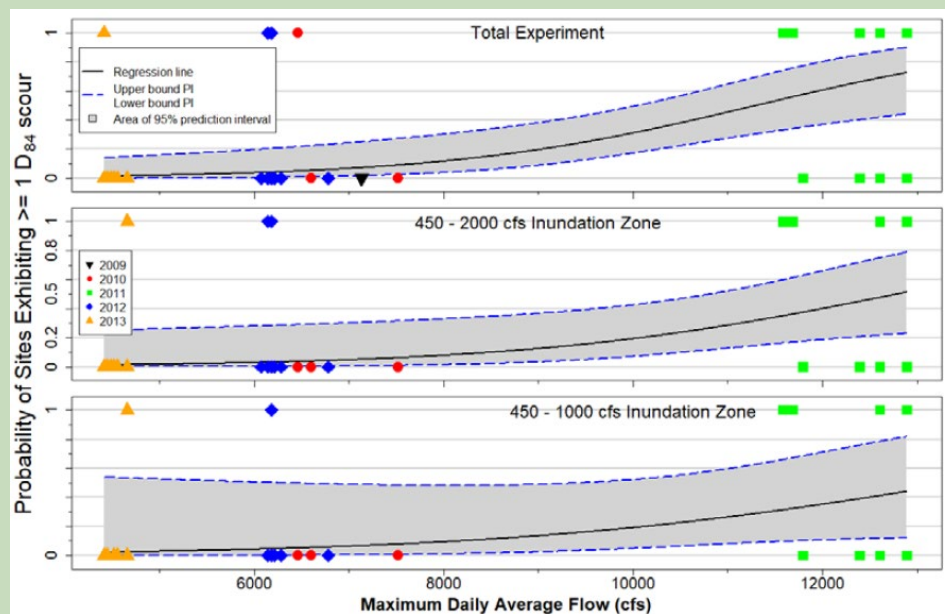


Statistical model based on 2009-2014 field data

Bed Mobility of bars >80% of tracers



Bed Scour of sites >1D₈₄

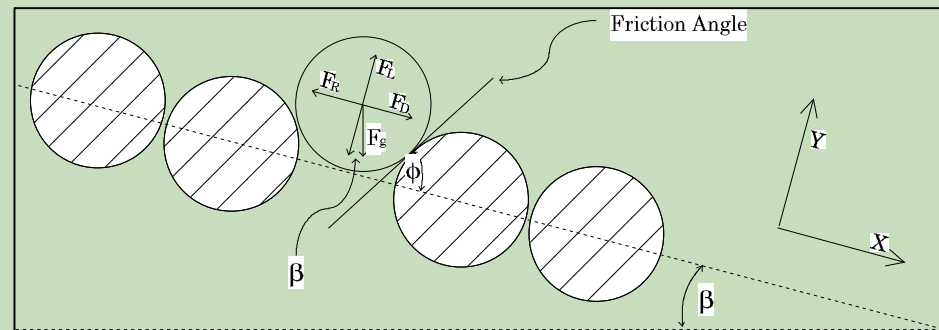


- Bed Mobility, Scour $\geq 1D_{84}$
- Only predicts where bed mobility and scour monitoring has occurred (active bars)
- Subdivided by reaches and by inundation zone, but...
- Not spatially explicit beyond reaches and inundation zones
- Draft analysis and report completed, needs a collaborative discussion on finalization

SRH 2-D hydraulic model: bed mobility

Deterministic Model Assumptions

- Use 1-D or 2-D hydraulic models to predict boundary shear stress (force to move particle)
- Use bed mobility model to predict dimensionless critical shear stress to move D_{84} (force resisting movement)
- If ratio of force moving particle/force resisting movement is greater than 1, then movement
- If ratio of force moving particle/force resisting movement is greater than ~ 1.25 , then moderate scour
- If ratio of force moving particle/force resisting movement is greater than ~ 1.5 , then deeper scour



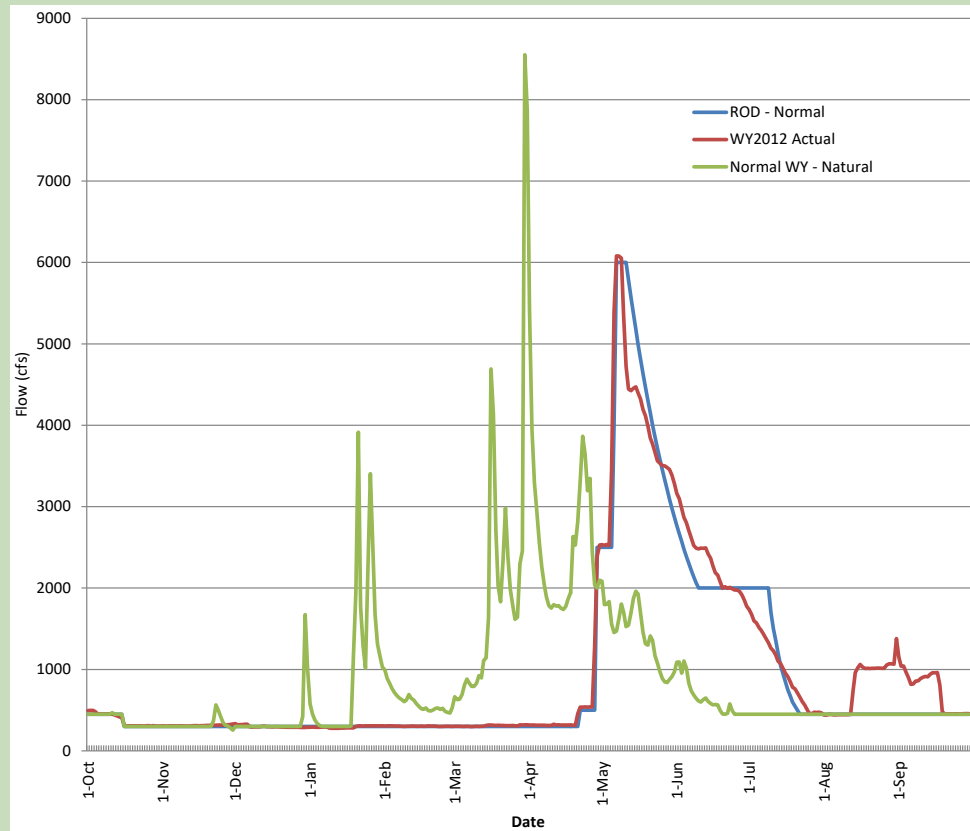
Shields parameter $\sim \frac{\text{mobility force}}{\text{grain resisting force}}$



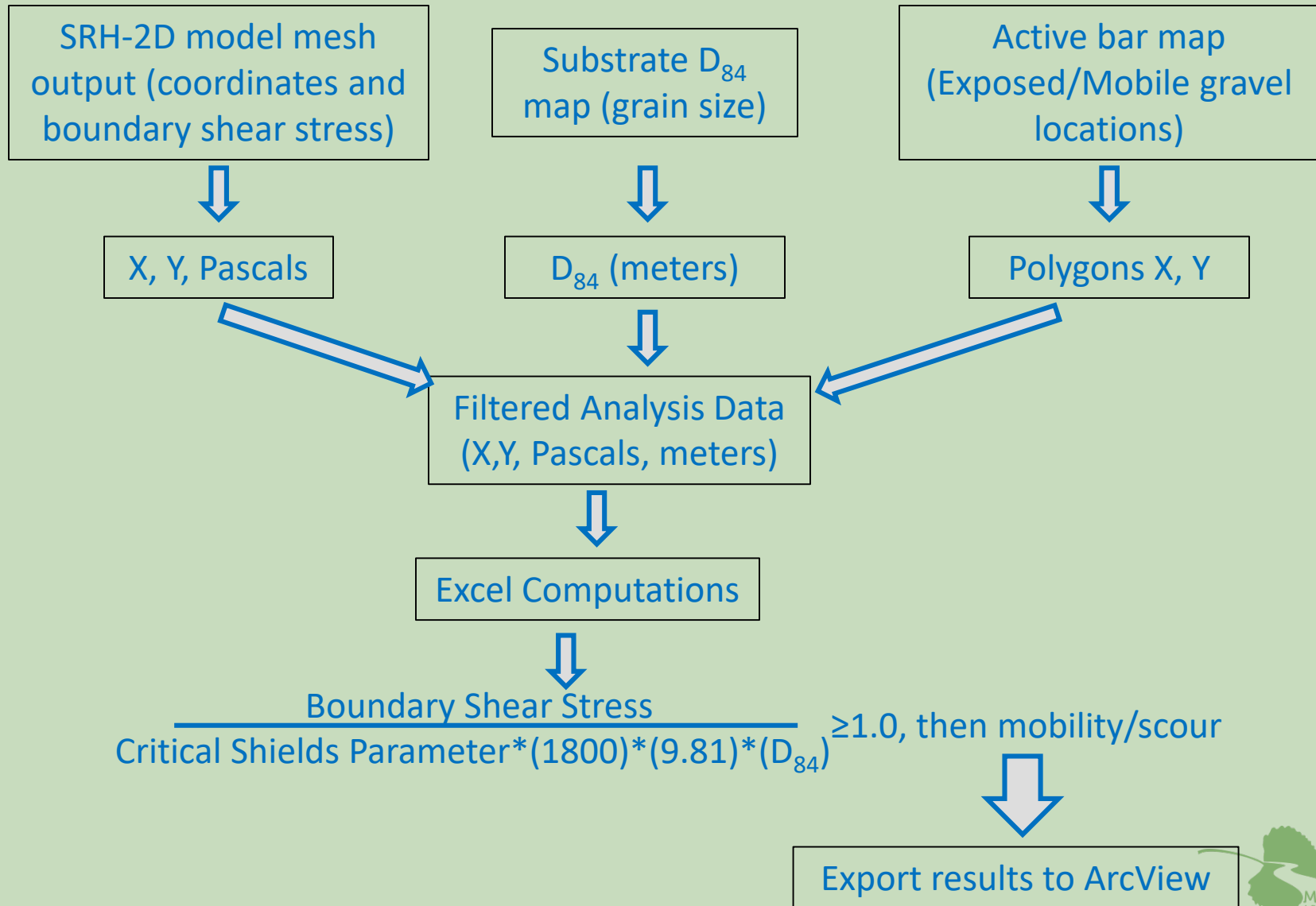
$$\tau^*_{D_i} = \frac{\tau_b}{(\rho_s - \rho_w)gD_i}$$

SRH 2-D hydraulic model: Hydrology

- Uses shear stress output from SRH 2-D model for peak ROD flows.
- Analyses performed to date for 40 miles: $Q_{\text{peak}}=6,000$ cfs and $Q_{\text{peak}}=8,500$ cfs
- Assume no tributary accretion, but could be added



Computational Process

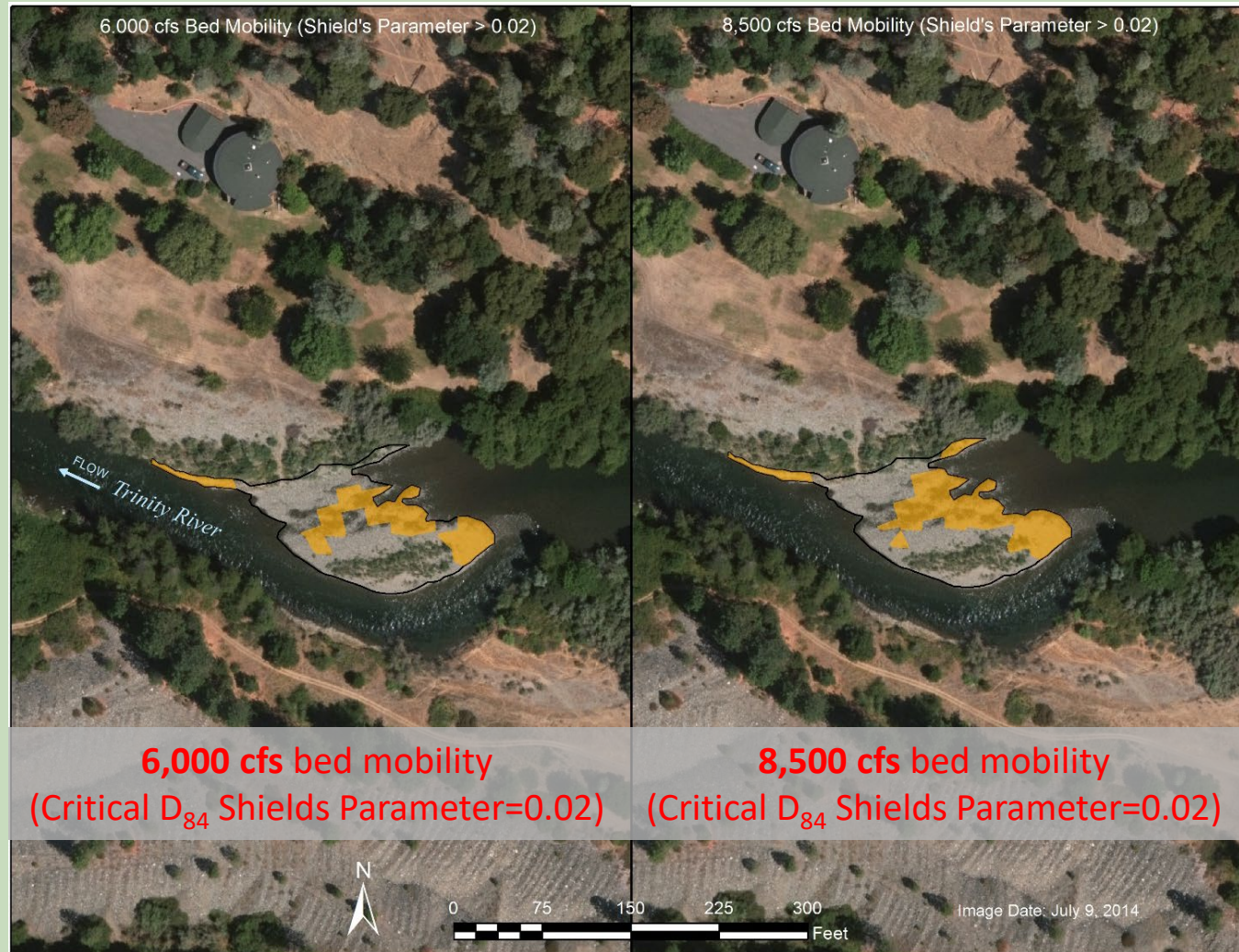


Bed Mobility Model Output: 6,000 cfs and 8,500 cfs on mid-channel bar

Predicted D_{84} Bed Mobility

Predicted $>1D_{84}$ Bed Scour

Predicted $>2D_{84}$ Bed Scour



Bed Scour and Mobility Model Output: Comparison of Results for all Active Bars in 3-mile reach

Total Active Bar Area (sq ft)	Peak Flow	Predicted Active Bar area <u>mobilized</u> by peak flow, D84 Shields parameter > 0.02 (sq ft)	Percent of total Active Bar area mobilized by peak flow	Predicted Active Bar area with <u>shallow scour</u> (>1D84) by peak flow, D84 Shields parameter > 0.025 (sq ft)	Percent of total Active Bar area scoured by peak flow	Predicted Active Bar area with <u>deeper scour</u> (>2D84) by peak flow, D84 Shields parameter > 0.030 (sq ft)	Percent of total Active Bar area scoured by peak flow
33,480	6,000 cfs	16,229	48.5%	5,828	17.4%	3,297	9.8%
33,480	8,500 cfs	20,169	60.2%	9,090	27.2%	5,617	16.8%

- Model predicts bed mobility objective are partially met during Normal year release (6,000 cfs) and shallow bed scour objective not met for Wet year (8,500 cfs) release
- Portion of bar area mobilized increases by 24% between 6,000 and 8,500 cfs
- Portion of bar area with shallow scour increases by 56% between 6,000 and 8,500 cfs
- Portion of bar area with deeper scour increases by 70% between 6,000 and 8,500 cfs
- Critical Shields parameter values used needs further review/calibration/discussion

Potential Metrics

1. If we use historic empirical data and statistical model:

For each water year type or flow magnitude, at least an X% probability that 80% of the active bar D_{84} in the 450-1,000 cfs inundation zone is mobilized (e.g., 11,000 cfs should have 100% of sites having 100% D_{84} mobility within the 450-1,000 cfs inundation zone)

2. If we use annual empirical data (tracer rocks and scour chains):

For each water year type or flow magnitude, at least 80% of the sites have D_{84} mobilization over X% of active bar tracer gravels in the 450-1,000 cfs inundation zone. (e.g., 11,000 cfs should have at least 80% of sites having 100% D_{84} mobility within the 450-1,000 cfs inundation zone)

3. If we use 2-D hydraulic model:

For each water year type or flow magnitude, at least X% of the total active bar area should have D_{84} mobilization in the 450-1,000 cfs inundation zone. (e.g., 11,000 cfs should have at least 80% D_{84} mobility of all active bar area within the 450-1,000 cfs inundation zone)