

Josh Wyrick, PhD
Greg Pasternack, PhD



Spatial Structure

delineating the Lower Yuba River at the
segment, reach, and morphologic scales

What are the different scales?

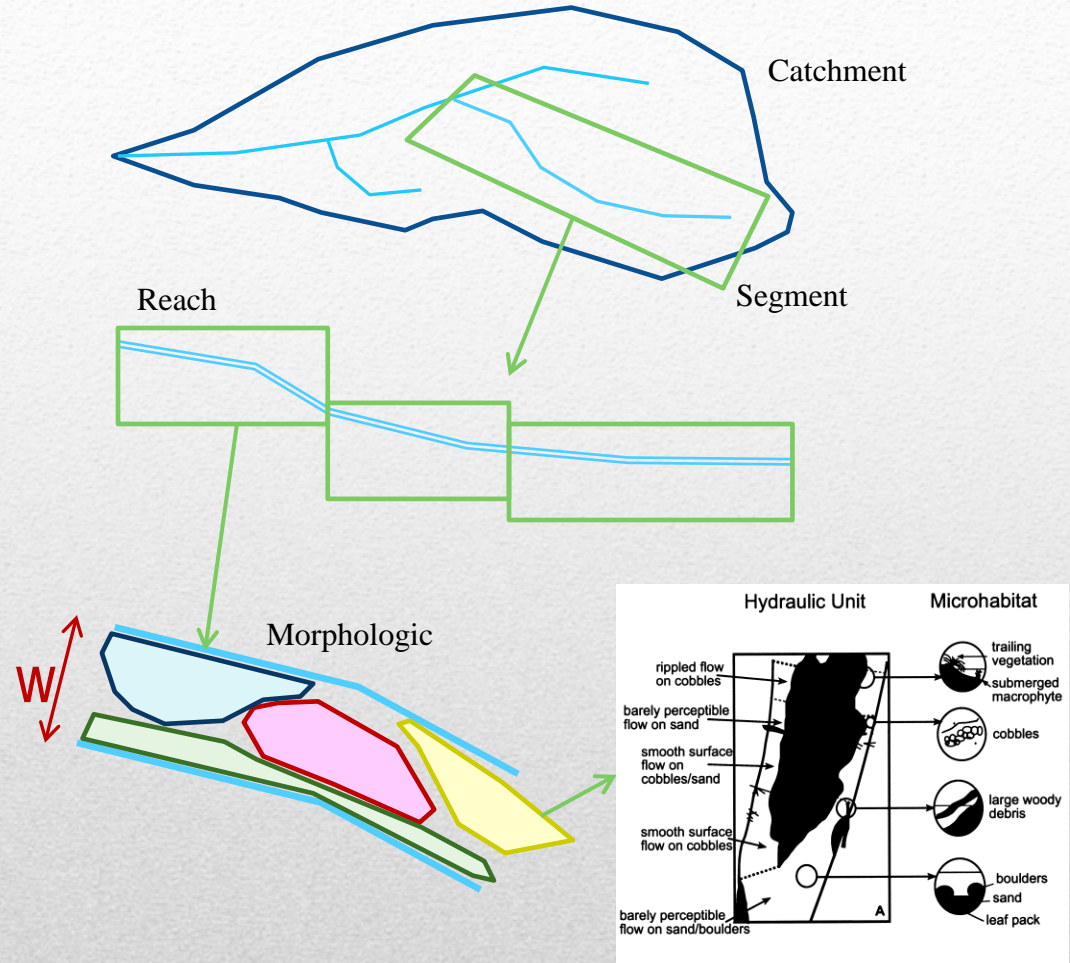
Catchment: all watershed

Segment: $\sim 10^3 - 10^4$ W

Reach: $\sim 10^2 - 10^3$ W

Morphologic: $\sim 10^0 - 10^1$ W

Hydraulic: $\sim 10^{-1} - 10^0$ W



Thomson et al., 2001

River Scales

- What are the segment scale characteristics?
- What is the delineation of reaches within the segment?
- What are the reach scale characteristics?
- Does the study segment exhibit geometric organization at the reach scale?

Geomorphic Questions

- Can 2D model results be used to rationally delineate morphological units?
- What morpho unit types are present in the LYR?
- What is the natural organization of the morpho units?
- Do the morpho units exhibit longitudinal and lateral variability?

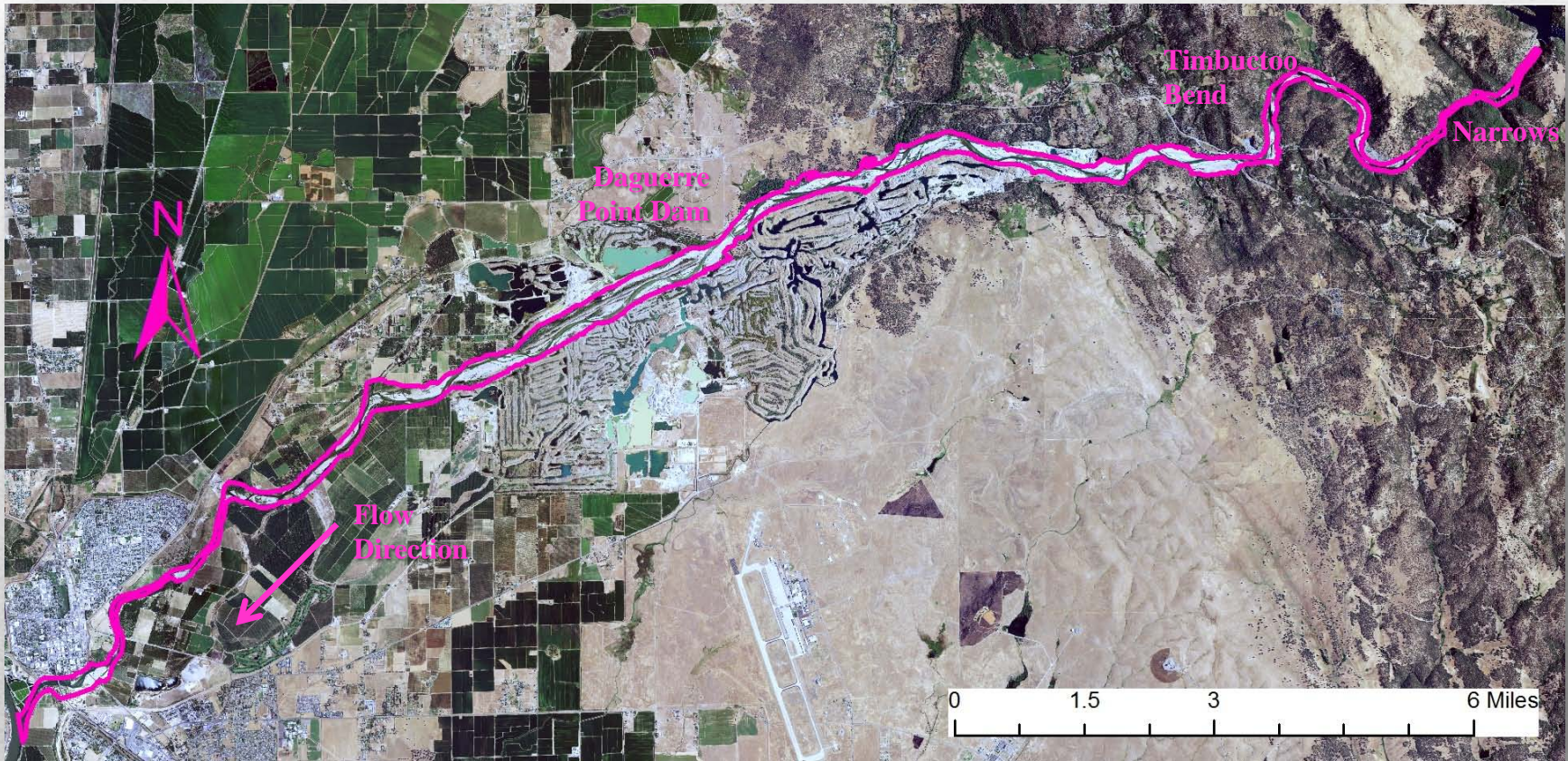
Geomorphic Questions

What is the segment scale?



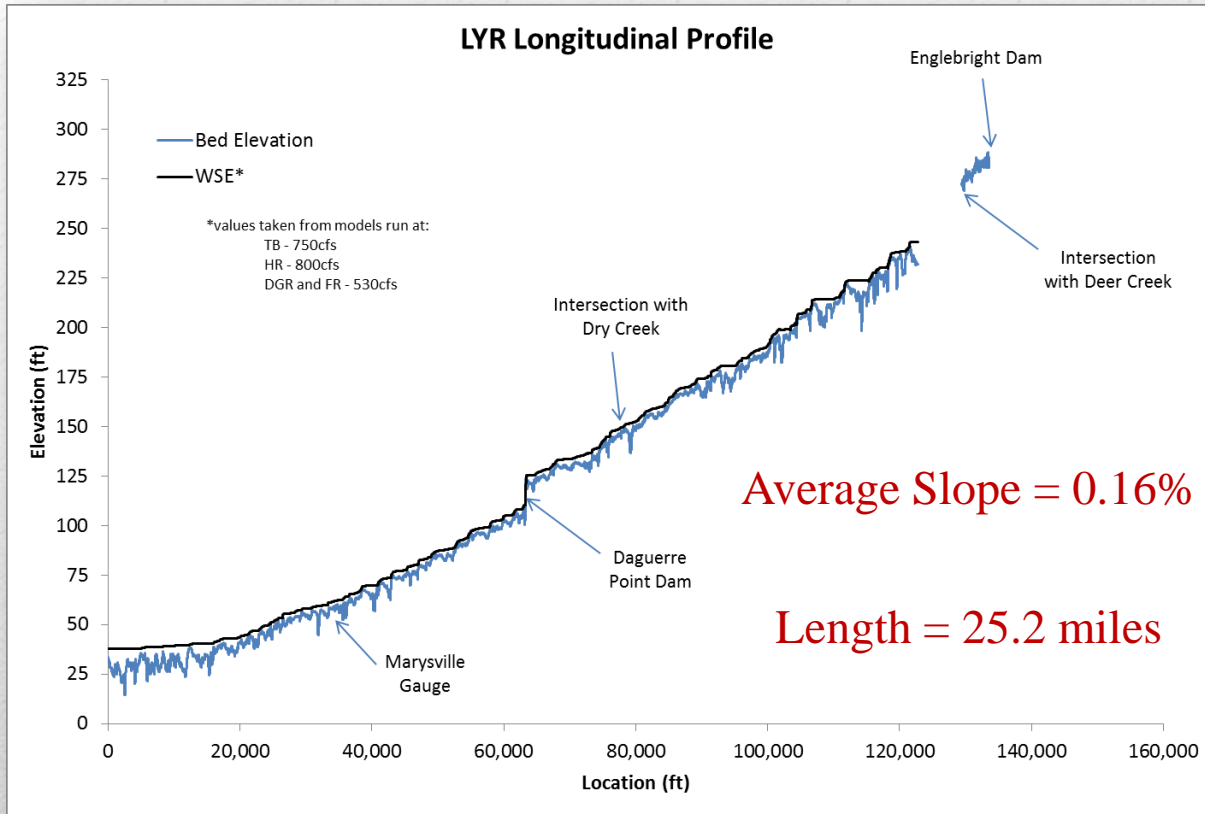
Segment Scale

What is the segment scale?



Segment Scale

What are the hydro-geomorphic characteristics at the segment scale?



Segment Scale

What are the hydro-geomorphic characteristics at the segment scale?

Flow*	Wetted Area (acre)	Average Width (feet)
Baseflow	510	195
Bankfull	813	313
Valley	2,369	852

* Baseflow = 880/530 cfs

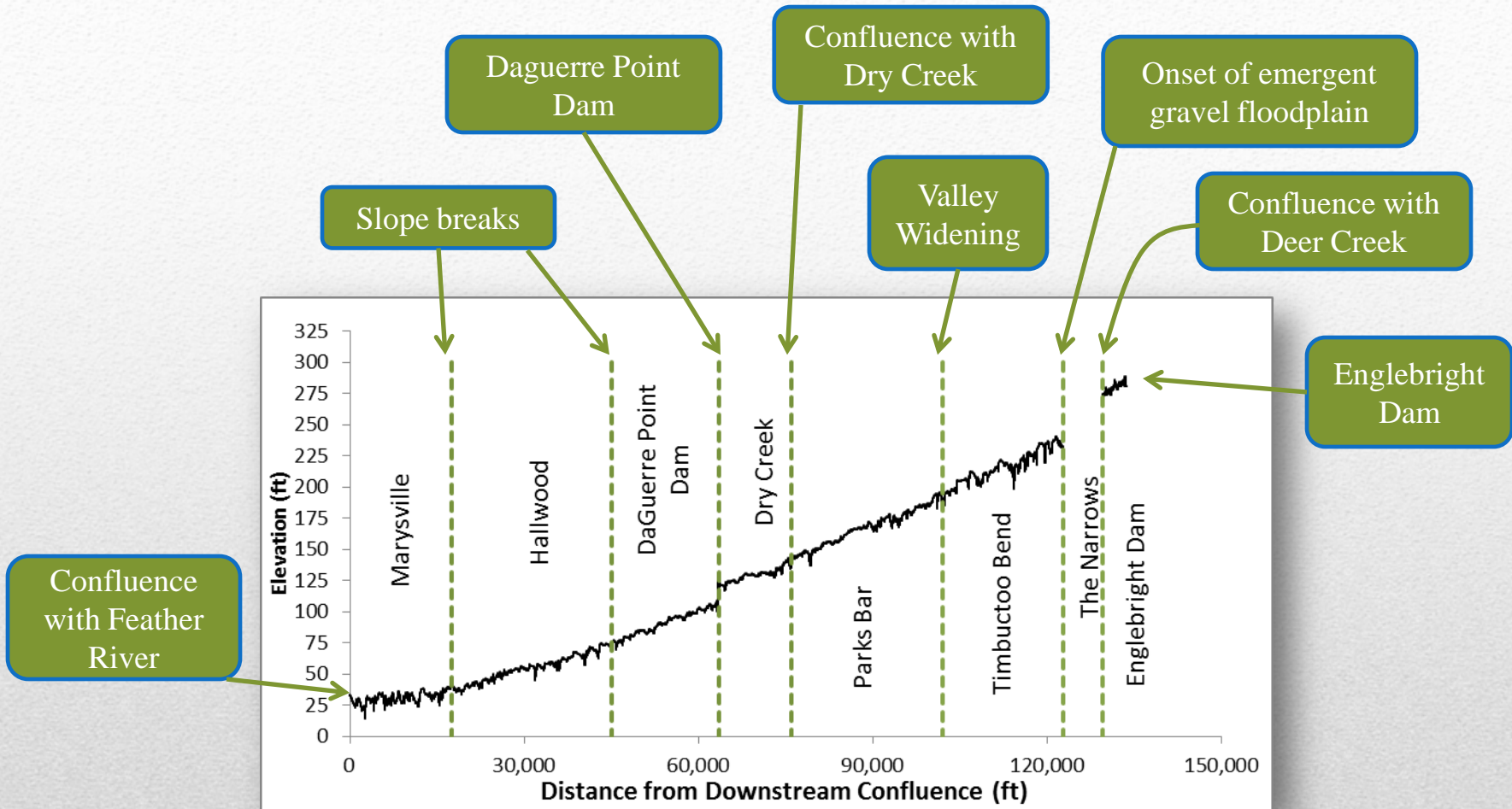
Bankfull = 5,000 cfs

Valley = geomorphically active corridor



Segment Scale

What is the delineation of reaches within the segment?



Reach Scale

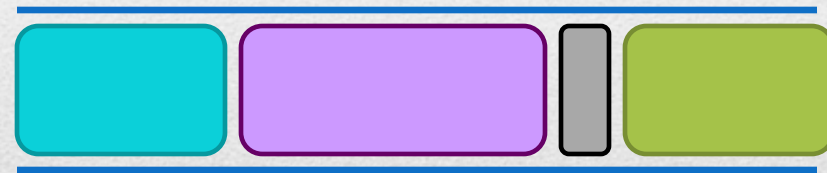
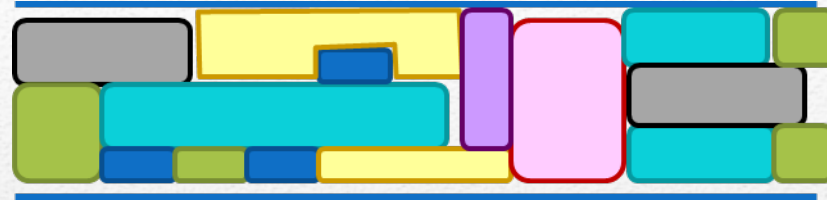
What are the hydro-geomorphic characteristics at the reach scale?

Reach	Baseflow Width (ft)	Bankfull Width (ft)	Valley Width (ft)	Thalweg Slope (%)	Length (ft)
Englebright Dam	120	169	415	0.31	4,130
Narrows	<i>n/a</i>	<i>n/a</i>	298	<i>n/a</i>	6,700
Timbuctoo Bend	205	273	544	0.20	20,790
Parks Bar	199	307	976	0.19	25,980
Dry Creek	248	419	1,009	0.14	12,470
Daguerre Point Dam	197	379	1,472	0.18	18,500
Hallwood	183	330	889*	0.13	27,500
Marysville	174	231	562*	0.05	17,500

Reaches

Can 2-D model results be used to rationally delineate morphological units?

Two-dimensional



One-dimensional

Morphological Unit Delineation Methods

Low flow hydraulics
best reflect underlying
topographic variability

Increasing discharge
drowns out topography

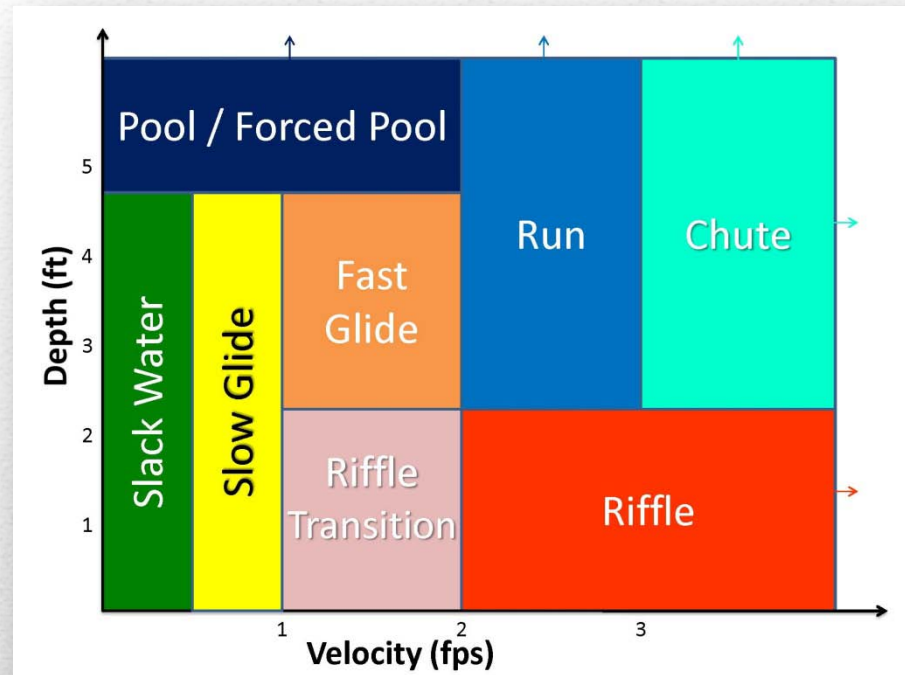


Hydraulics & Landforms

In-Channel Units:

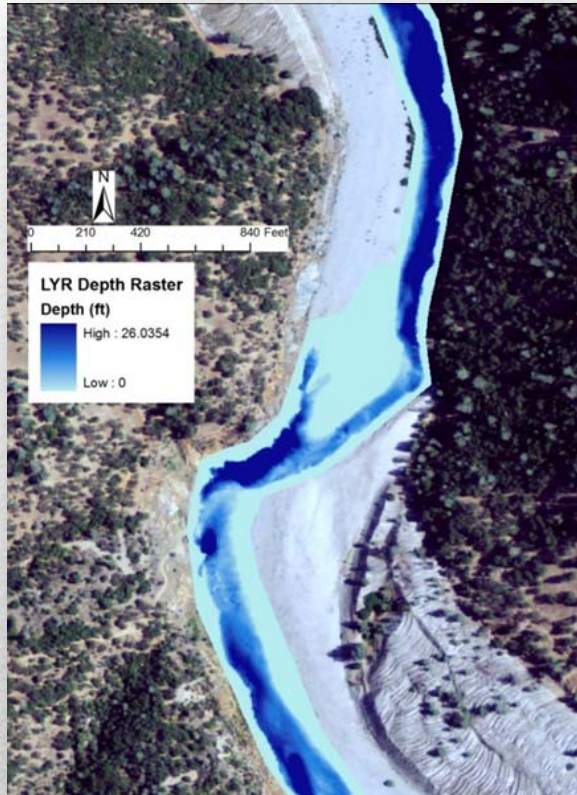
Quantified and delineated from baseflow hydraulics

Calibrated with field-based knowledge

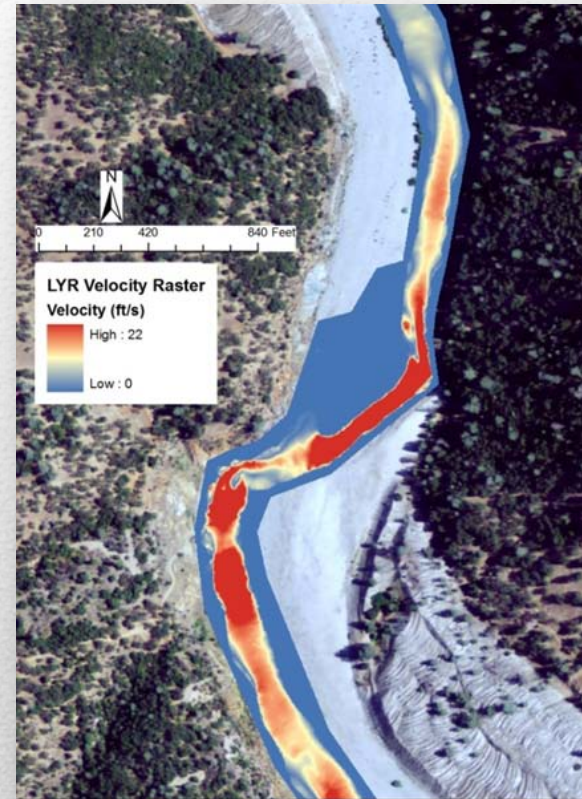


Morphological Units

Model Depths

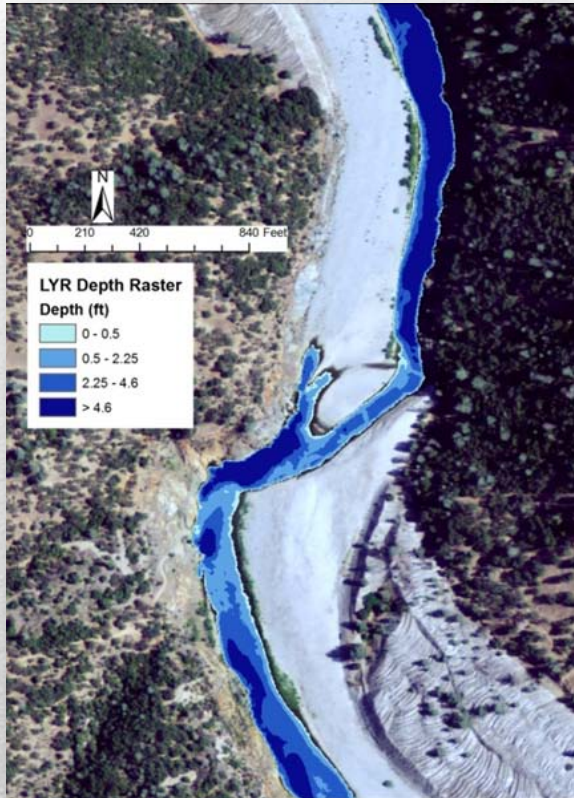


Model Velocities

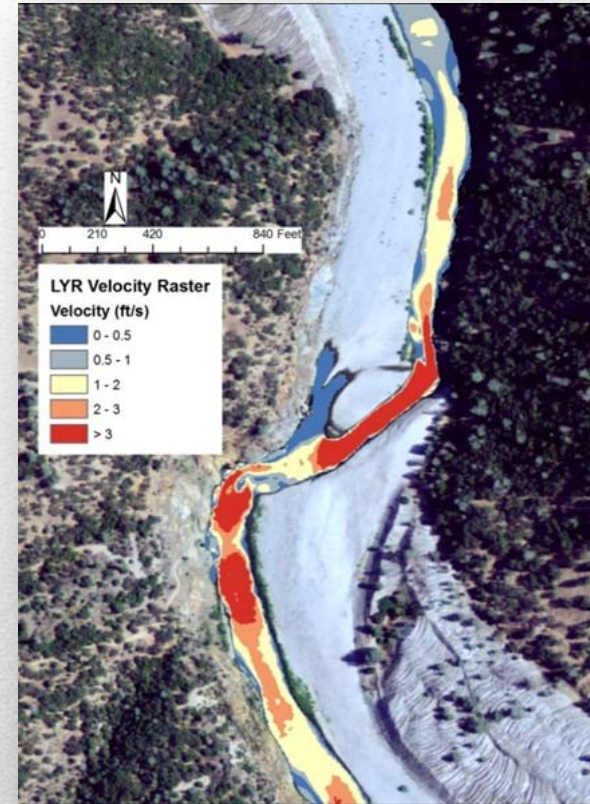


MU – Model Results

River Depths

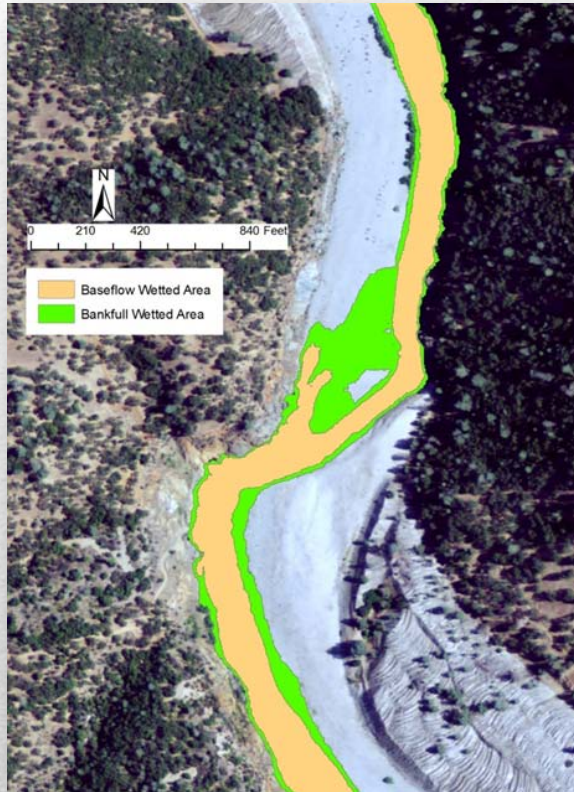


River Velocities

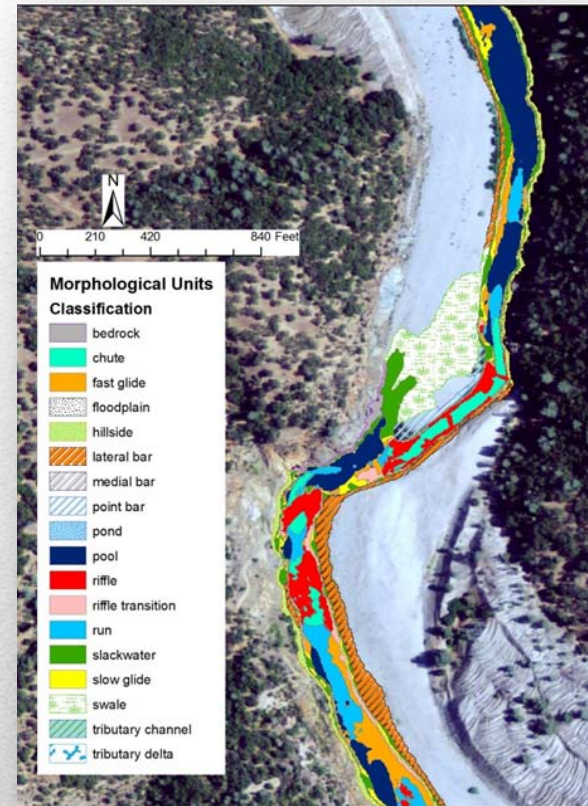


MU – Model Discretization

Wetted Areas

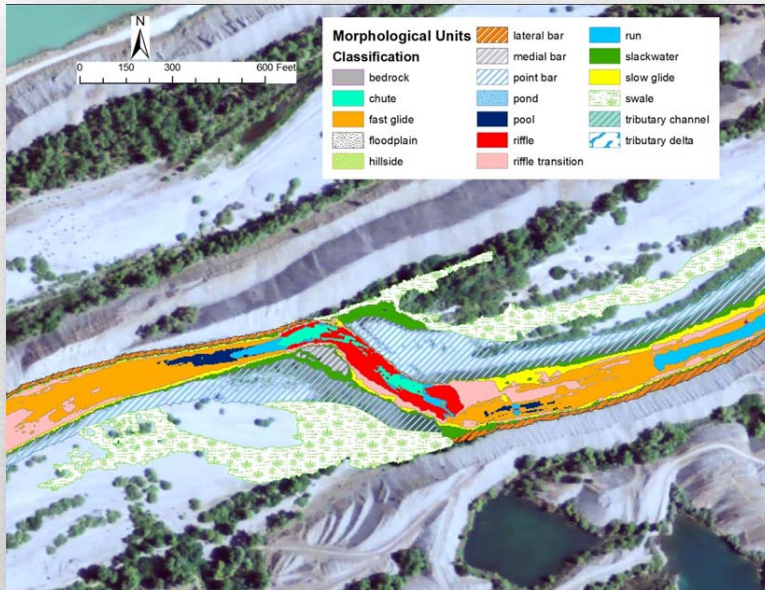


MU Delineations

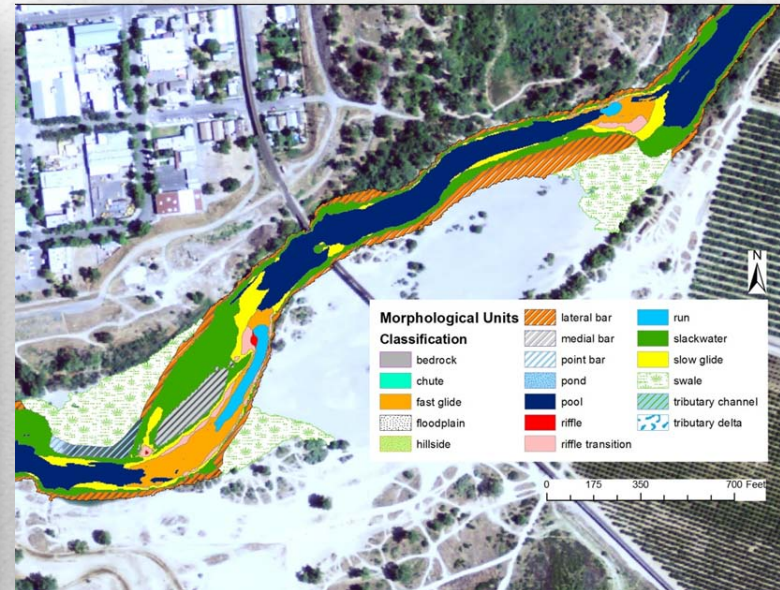


MU – Delineations

DPD Reach



Marysville Reach



MU - Examples

In-Channel Bed

- Chute
- Run
- Pool
- Riffle
- Riffle Transition
- Fast Glide
- Slow Glide
- Slackwater

In-Channel Bar

- Lateral Bar
- Point Bar
- Medial Bar
- Swale
- Hillside / Bedrock

Morphological Units

Morphologic Unit

- Independent of Flow
- Landform
- Geomorphic



794 cfs

Meso-Habitat

- Varies with Flow
- Depth, Velocity, Substrate
- Biologic



26,000 cfs

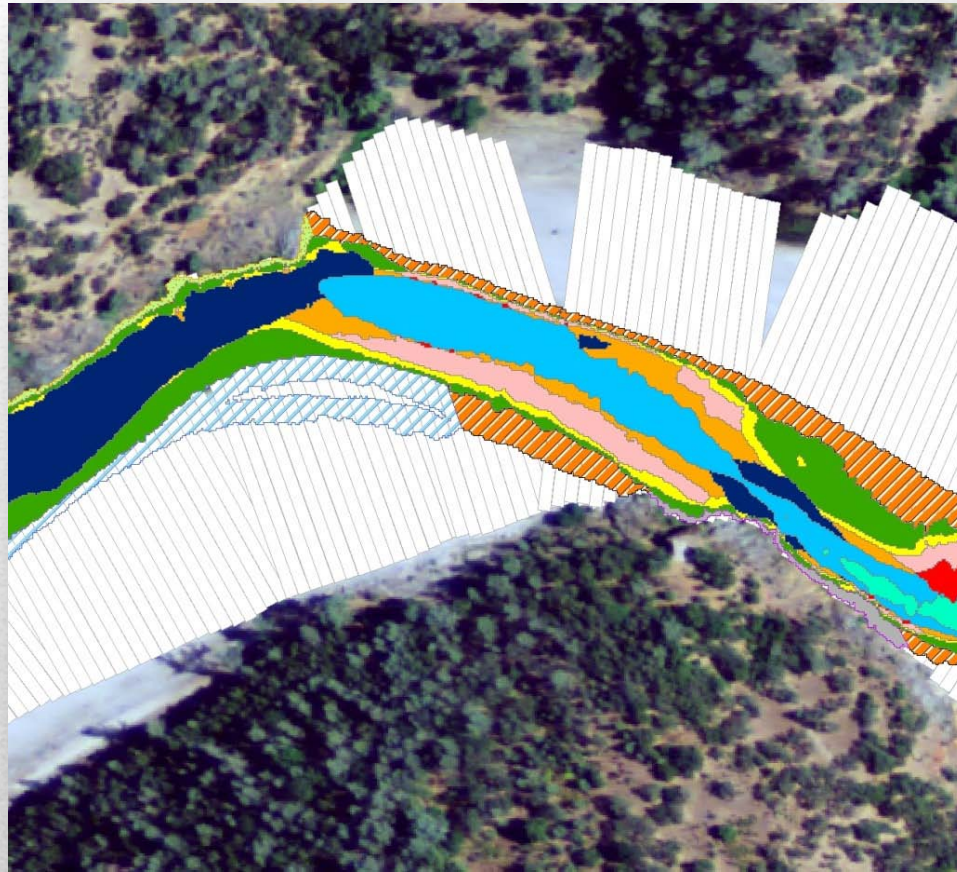
Definitions

What morphological unit types are present in the LYR?

MU	Marysville	Hallwood	DPD	Dry Creek	Parks Bar	Timbuctoo	Englebright	Total
Chute	0.4%	1.0%	1.1%	2.8%	6.3%	3.6%	4.6%	2.7%
Fast Glide	4.7%	11.5%	9.8%	11.2%	7.5%	8.6%	3.6%	9.0%
Pool	38.1%	4.9%	3.2%	3.7%	5.3%	14.5%	29.4%	10.1%
Riffle	1.6%	6.8%	7.7%	6.6%	12.0%	14.0%	4.0%	8.4%
Riffle Transition	2.7%	11.9%	15.2%	8.0%	9.4%	8.7%	1.8%	9.7%
Run	2.1%	2.8%	3.8%	8.0%	9.0%	6.6%	9.0%	5.5%
Slack-water	16.9%	9.0%	9.5%	11.0%	8.7%	10.0%	14.4%	10.4%
Slow Glide	6.1%	9.1%	5.9%	10.2%	5.6%	9.0%	6.3%	7.6%
Lateral Bar	16.6%	13.8%	15.9%	14.9%	13.2%	12.9%	10.2%	14.3%
Medial Bar	0.9%	6.9%	0.8%	9.7%	3.0%	3.9%	0.0%	4.3%
Point Bar	4.4%	4.0%	12.5%	6.2%	8.0%	2.4%	5.7%	6.3%
Hillside / Bedrock	0.0%	1.2%	0.0%	0.0%	2.0%	3.1%	11.1%	1.4%
Swale	5.5%	16.9%	14.6%	7.6%	10.1%	2.6%	0.0%	10.3%

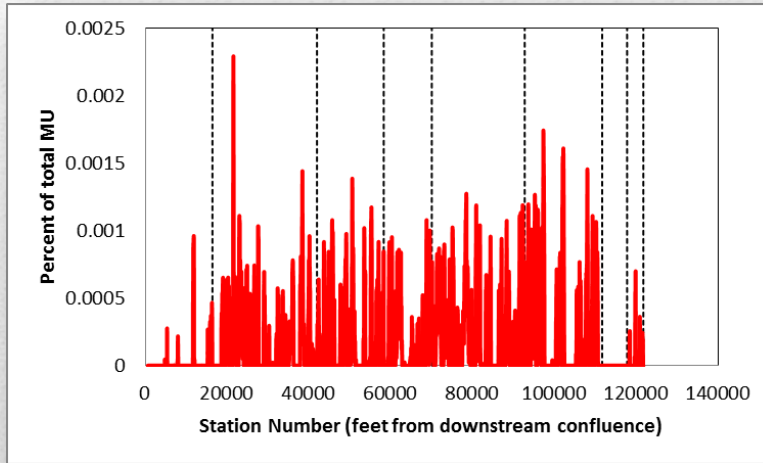
MU – Abundance

What is the natural organization of the morphological units?

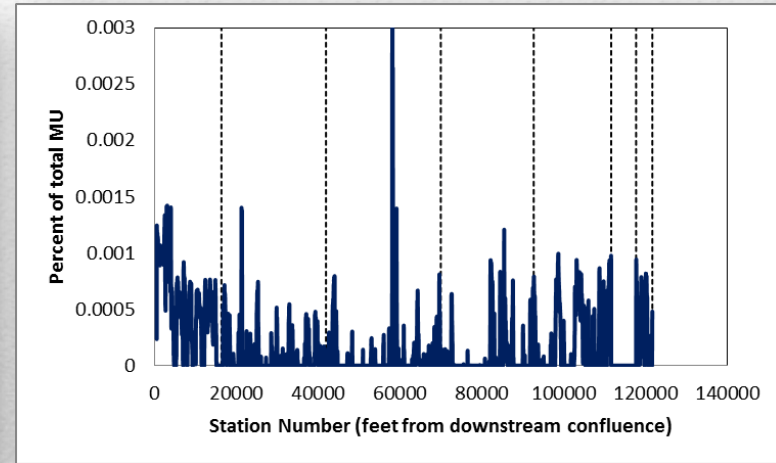


MU – Organization

Riffle PDF

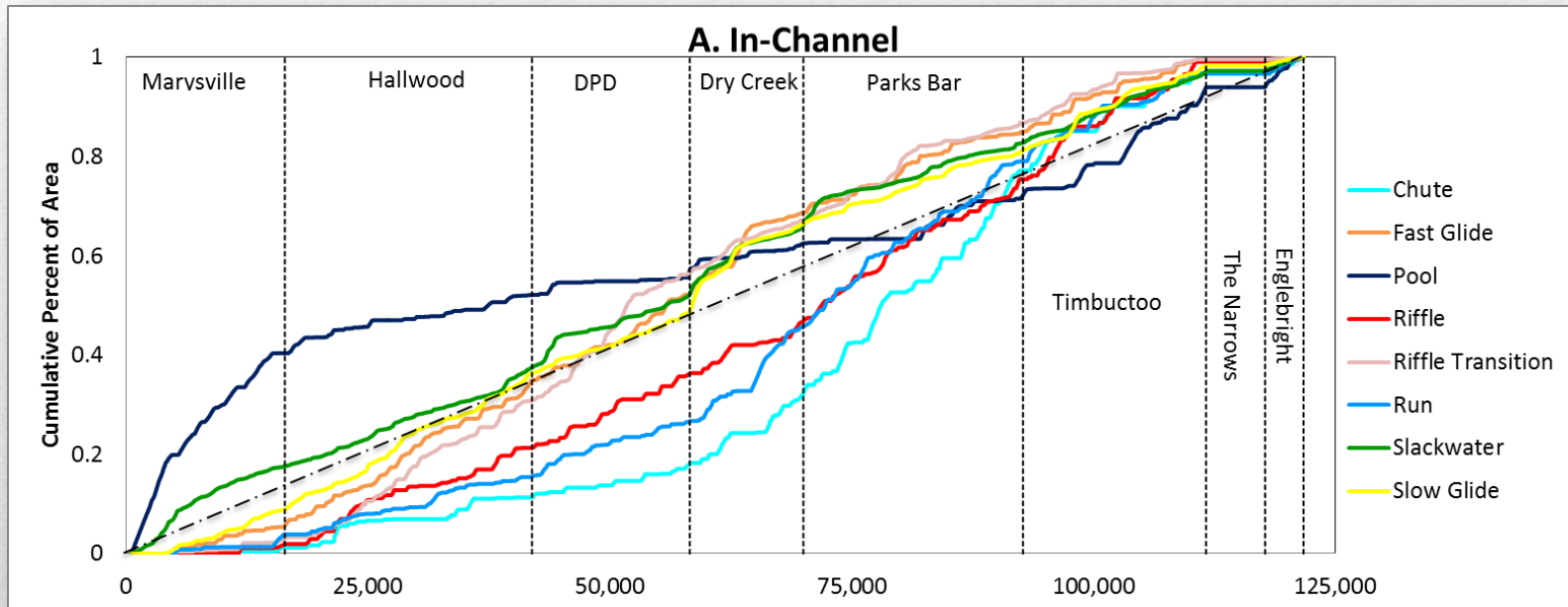


Pool PDF



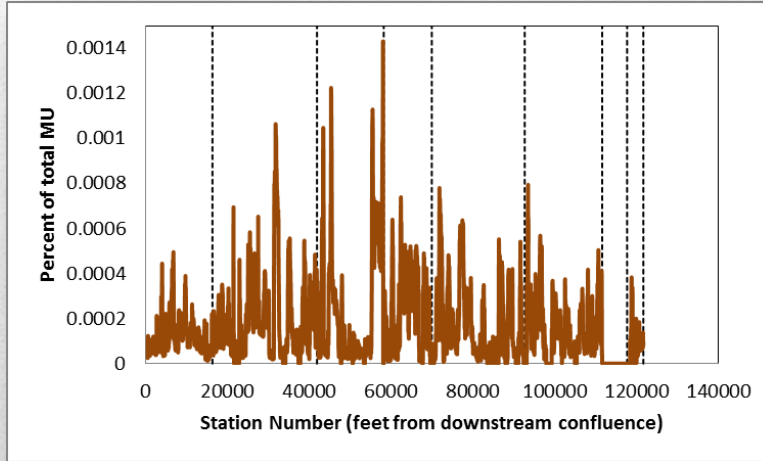
MU – Organization

What is the natural organization of the morphological units?

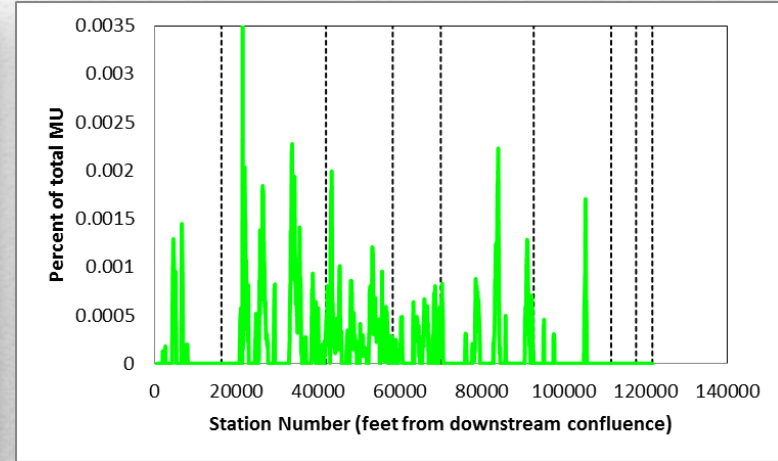


MU – Distribution

Lateral Bar PDF

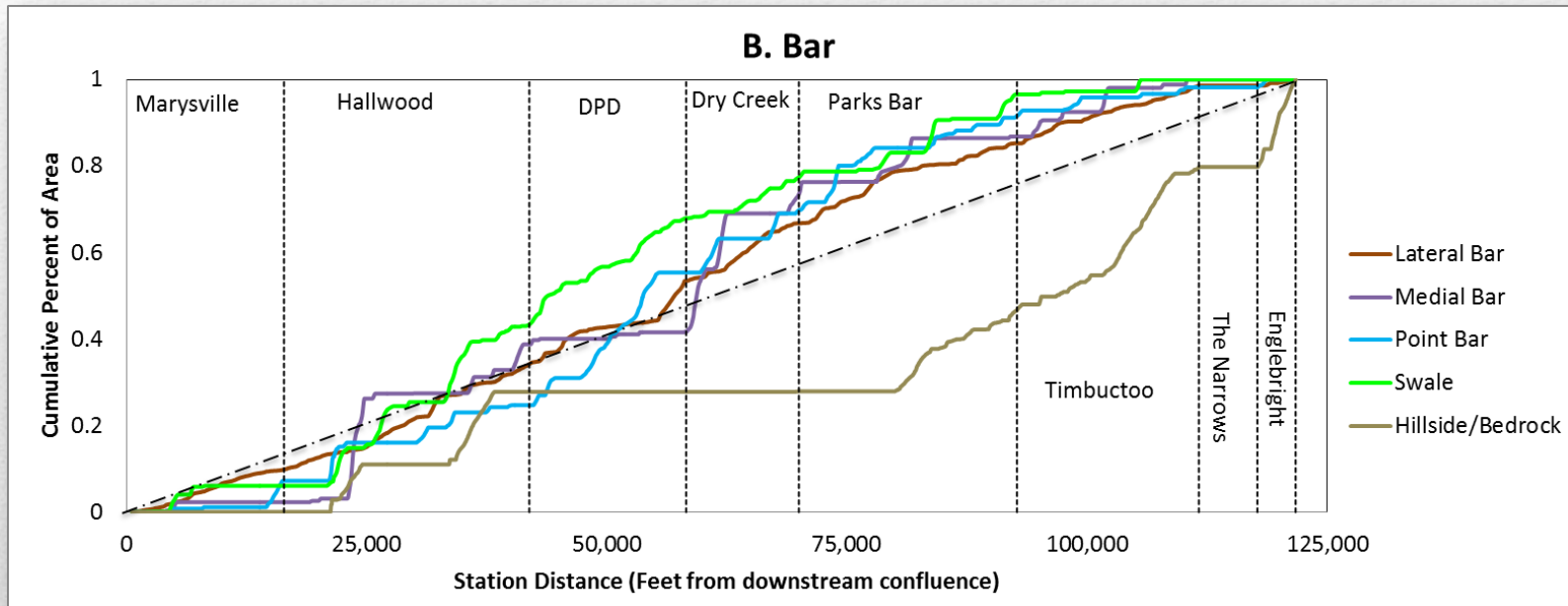


Swale PDF



MU – Organization

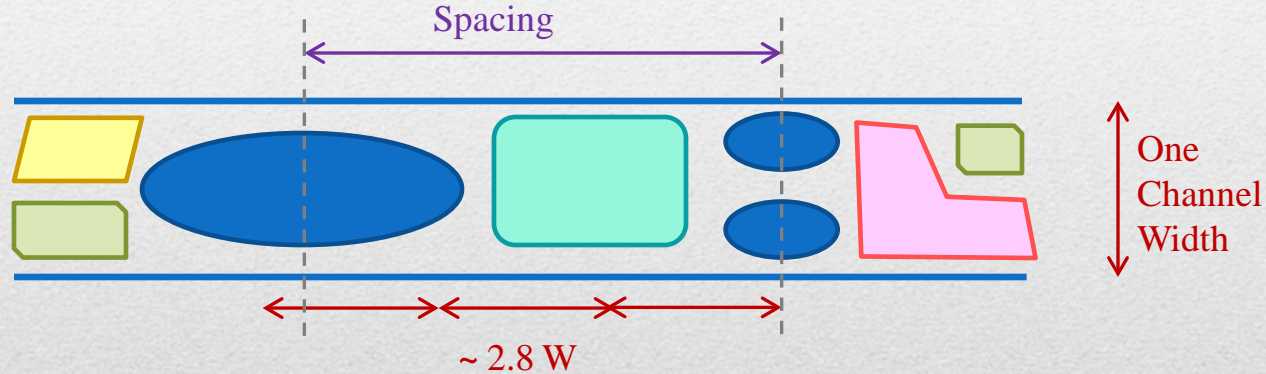
What is the natural organization of the morphological units?



MU – Distribution

What is the natural organization of the morphological units?

Total LYR	Chute	Fast glide	Pool	Riffle	Riffle Trans.	Run	Point bar	Swale
Spacing (ft)	1,390	959	1,365	1,059	1,014	840	3,651	2,423
# widths	4.4	3.1	4.4	3.4	3.2	2.7	11.7	7.7
# of spacings	82	121	91	106	111	139	30	36



MU – Longitudinal Spacing

What is the geometric organization at the reach scale?

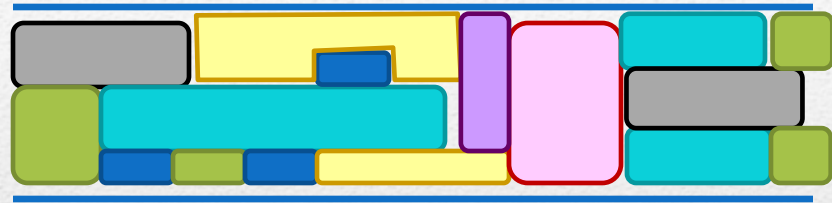
Timbuctoo Bend	Chute	Fast glide	Pool	Riffle	Riffle Trans.	Run	Point bar	Swale
Spacing (ft)	1,064	966	1,125	1,172	867	936	3,830	5,509
# widths	3.9	3.5	4.1	4.3	3.2	3.4	14.0	20.1
# of spacings	19	21	18	17	22	22	5	2

DPD	Chute	Fast glide	Pool	Riffle	Riffle Trans.	Run	Point bar	Swale
Spacing (ft)	1,617	1,010	1,847	1,173	1,380	985	2,652	1,492
# widths	4.3	2.7	4.9	3.1	3.6	2.6	7.0	3.9
# of spacings	11	18	10	15	12	18	5	11

MU – Reach Scale Spacing

How many **non-directional, unique transitions** exist between sets of morphologic units?

Do morphologic units exhibit a “**preference**” or “**avoidance**” for other unit types?



$$\text{cyan} \rightarrow \text{blue} = 3$$

$$\text{blue} \rightarrow \text{cyan} = 1$$

MU – Adjacency

What is the natural organization of the morphological units?

Starting Unit	HS/BR	Chute	Fast Glide	Lateral Bar	Medial Bar	Point Bar	Pool	Riffle	Riffle Trans	Run	Slack water	Slow Glide	Swale
HS/BR	0%	0%	1.75%	49.12%	0%	0%	0%	3.51%	5.26%	0%	17.54%	12.28%	10.53%
Chute	0%	0%	5.24%	0%	0%	0%	2.92%	51.37%	4.30%	32.99%	1.03%	2.15%	0%
Fast Glide	0%	1.57%	0%	0.12%	0%	0%	16.11%	7.29%	26.91%	21.54%	6.81%	19.64%	0%
Lateral Bar	14.41%	0%	0%	0%	0%	16.53%	0.85%	2.97%	8.05%	0%	20.76%	11.44%	25.00%
Medial Bar	0%	0%	0%	0%	0%	1.28%	0%	3.85%	14.10%	0%	46.15%	30.77%	3.85%
Point Bar	0%	0%	0%	41.27%	1.59%	0%	0%	0%	6.35%	0%	11.11%	9.52%	30.16%
Pool	0%	1.53%	38.57%	0.11%	0%	0%	0%	0.17%	4.20%	23.54%	13.10%	18.77%	0%
Riffle	0%	12.61%	9.24%	0.43%	0.04%	0%	0.06%	0%	28.95%	30.38%	7.46%	10.76%	0.02%
Riffle Transition	0%	0.73%	16.77%	1.62%	0.45%	0.07%	0.69%	22.17%	0%	5.98%	22.11%	29.05%	0.11%
Run	0%	23.48%	17.38%	0%	0%	0%	7.20%	31.19%	15.08%	0%	1.27%	4.41%	0%
Slackwater	0.56%	0.05%	2.42%	6.28%	1.36%	0.62%	1.95%	5.32%	33.97%	0.24%	0%	47.02%	0.20%
Slow Glide	0.39%	0.13%	7.33%	3.76%	0.91%	0.33%	4.47%	8.28%	35.76%	0.74%	37.78%	0%	0.12%
Swale	5.83%	0%	0%	54.37%	3.88%	23.30%	0%	0.97%	1.94%	0%	7.77%	1.94%	0%

Highest

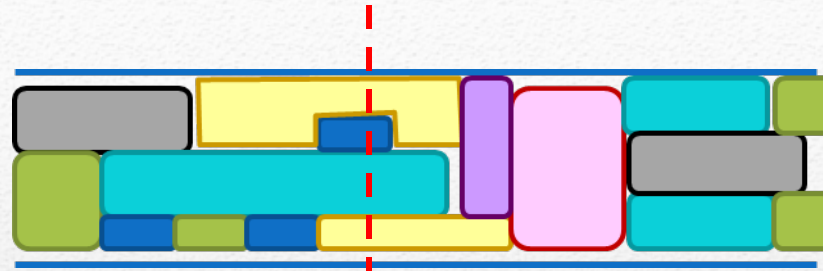
Preference

$$\frac{1}{13} = 7.7\%$$

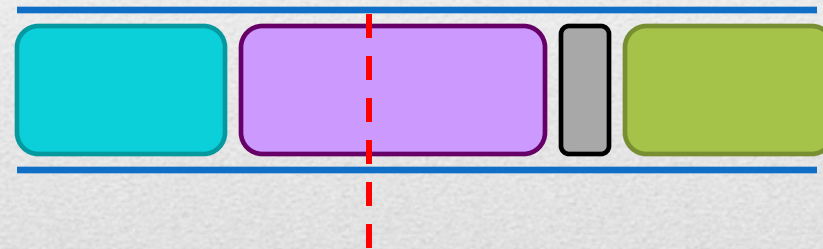
MU – Adjacency

Do the morphological units exhibit lateral variability?

Two-dimensional

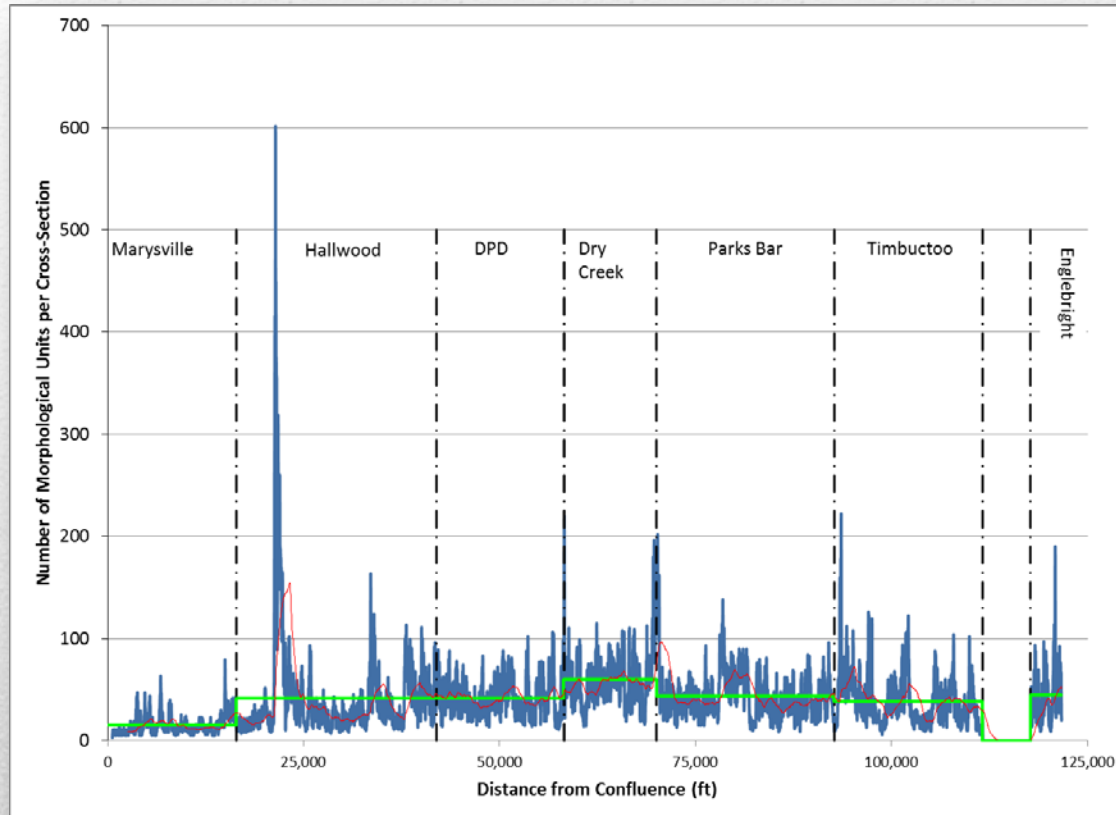


One-dimensional



MU – Lateral Variability

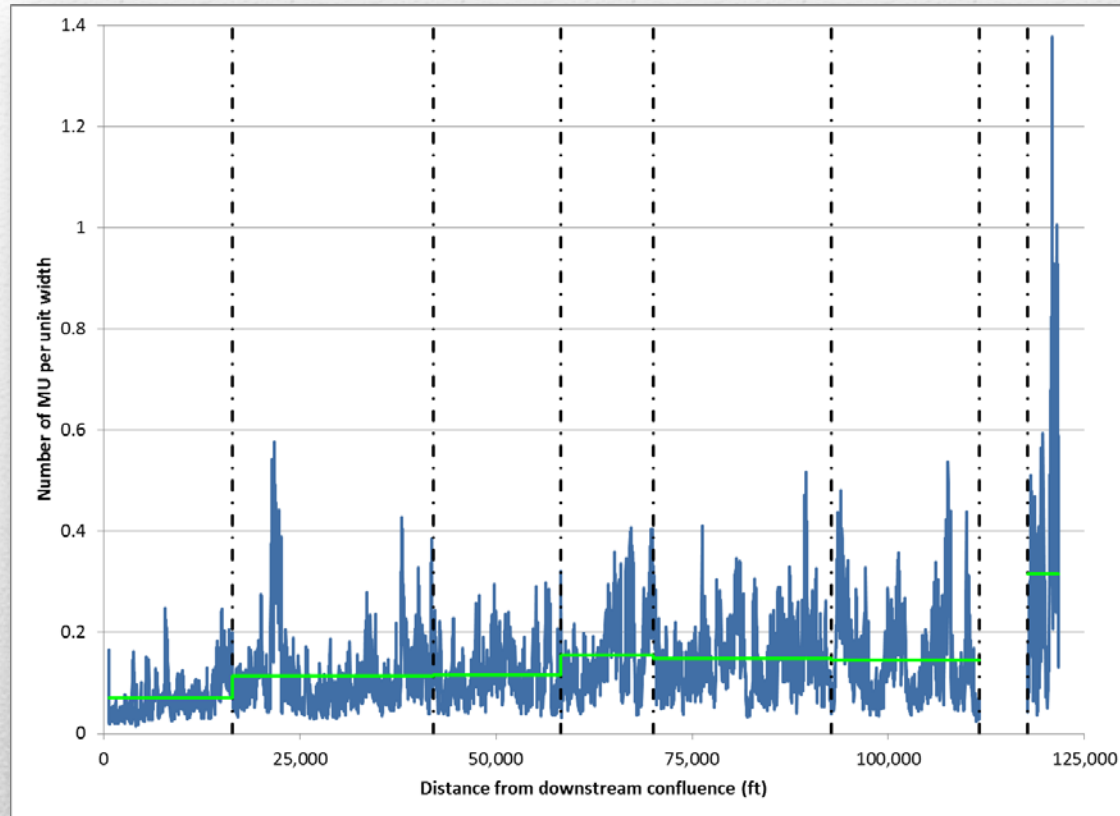
Do the morphological units exhibit lateral variability?



$$MU = \sim 10^0 - 10^1 W ?$$

MU – Lateral Variability

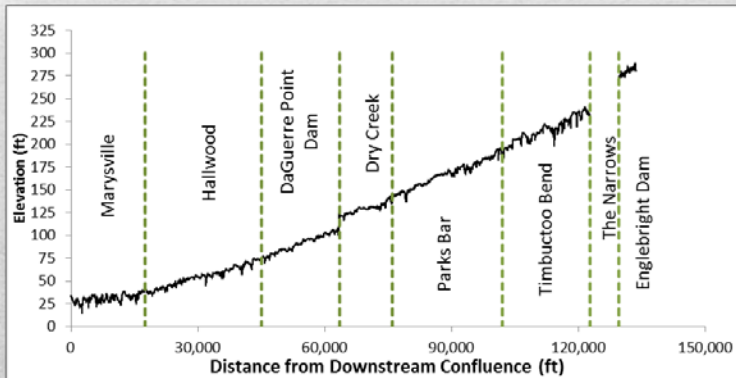
Do the morphological units exhibit lateral variability?



MU – Lateral Variability

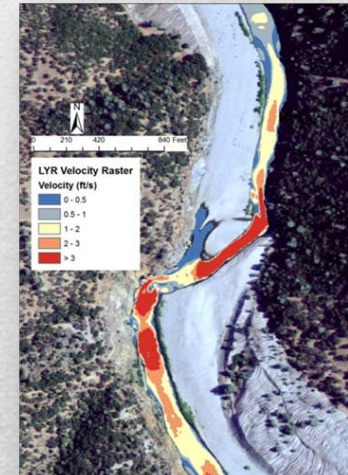
Reaches

- 7 geomorphically distinct reaches
- Transparent delineation method



New Methodology

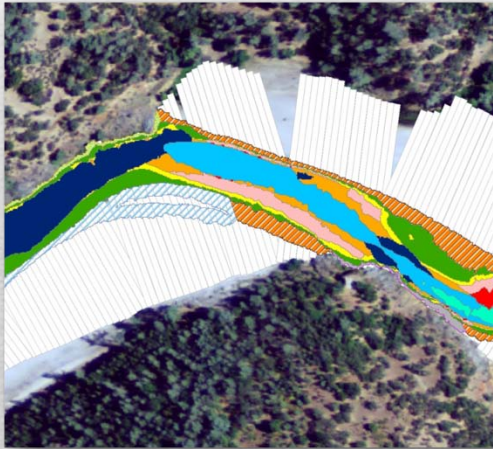
- Use of 2D model results to map in-channel landforms
- Objective method



Summary

Morphological Units

- Distinct hydraulic and geomorphic metrics
- 8 in-channel bed units
- 5 bankfull bar units



Spatial Organization

- Non-random structure
- Longitudinal location ‘preference’
- Longitudinal spacing
- Adjacency ‘preference’
- Lateral variability

Summary

- Stratify with biologic data (e.g. redds, vegetation, etc.)
- Topographic change processes
- Flow-dependent hydraulics & habitat
- HSC & microhabitat maps

Future Goals

- Acknowledgements
 - Anne Senter
 - Dylan Garner
 - RMT Members



Thank you