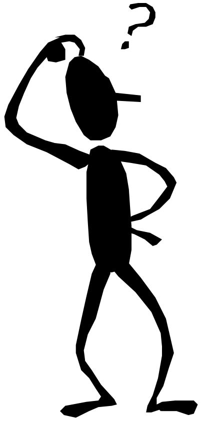
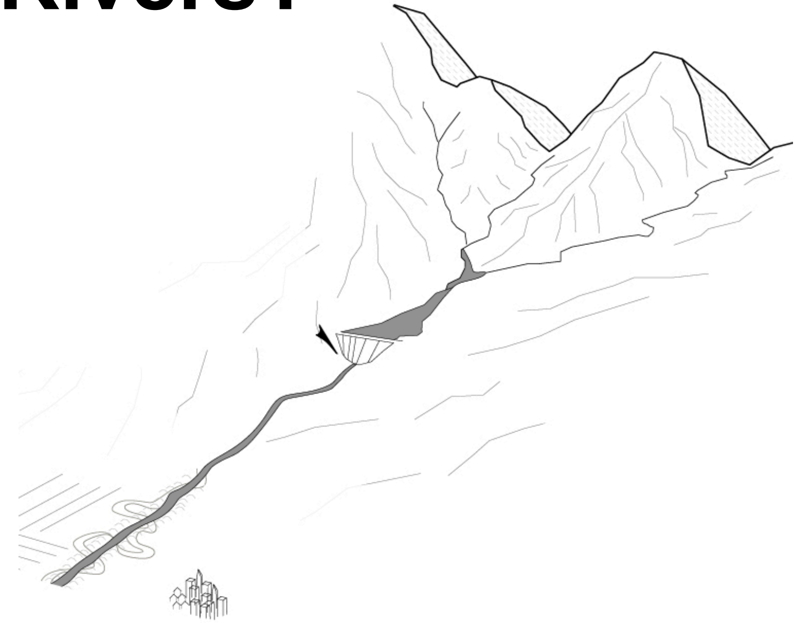
Spatial Structure Framework

How Should We Assess Rivers?





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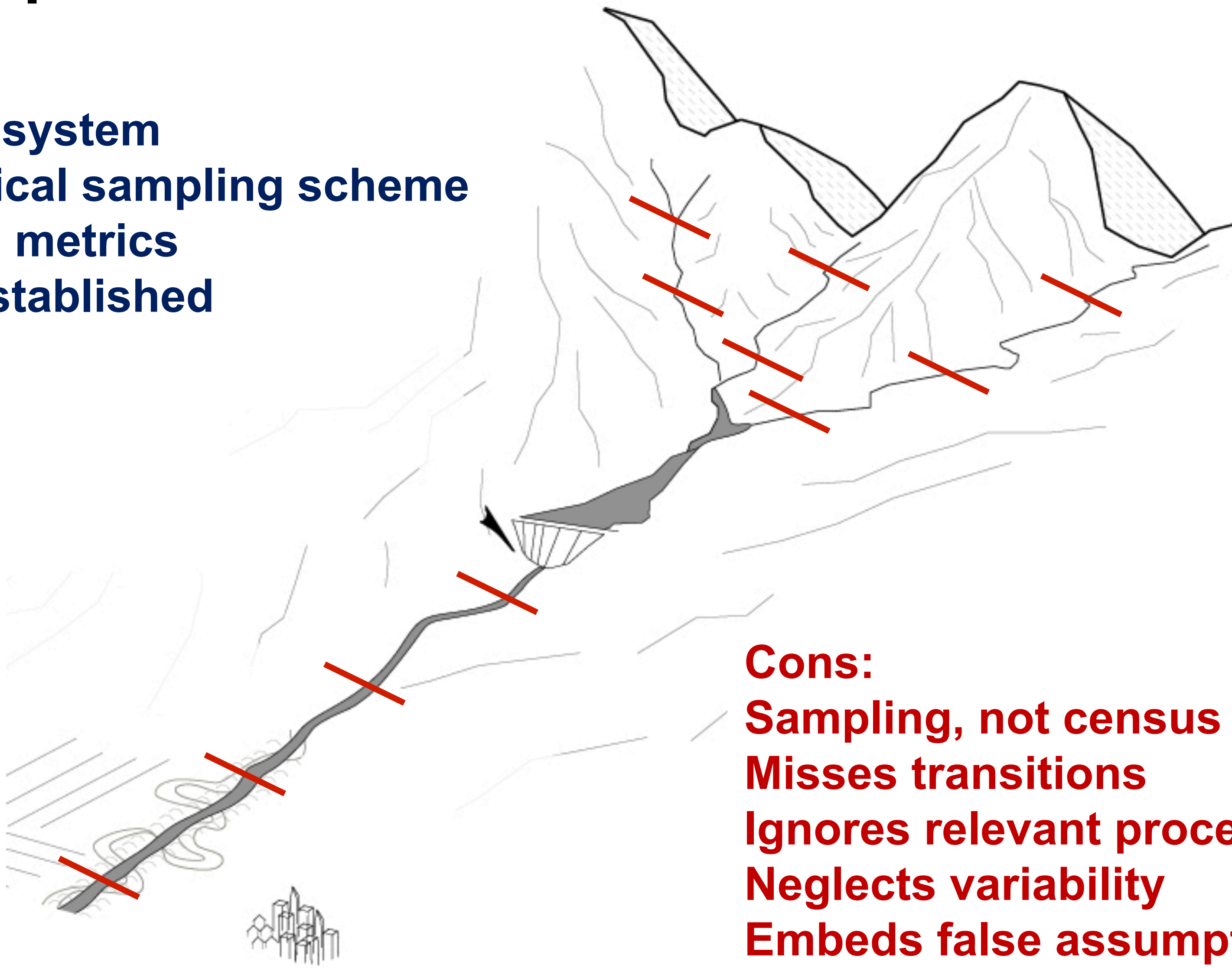
- **Quantitative physical habitat and habitat utilization questions**
  - What are the geographic distributions of organisms' lifestages in the LYR?
  - What is the quantity, quality, and spatial pattern of physical attributes (depth, velocity, substrate, and cover) of the LYR for the range of flows managed under the Yuba Accord at different spatial scales?
  - How strongly do LYR salmonid freshwater lifestages align with physical variables?

- **Fluvial geomorphic dynamics (that sustain biota) questions**
  - Does the LYR have persistent and organized fluvial landforms as well as multiple spatial scales of landform heterogeneity to provide sufficient habitat stability and diversity for VSP?
  - Does the LYR have a sufficiently dynamic wet-season flood regime to promote fluvial rejuvenation (e.g. submerge the floodplain, drive channel migration and avulsion, and prevent willows from encroaching on the bankfull channel, which constrains channel dynamics)?

Spatial Structure Framework

Interpolate Between Measured Cross-Sections?

Pros:
Spans system
Statistical sampling scheme
Simple metrics
Well-established



Cons:
Sampling, not census
Misses transitions
Ignores relevant processes
Neglects variability
Embeds false assumptions

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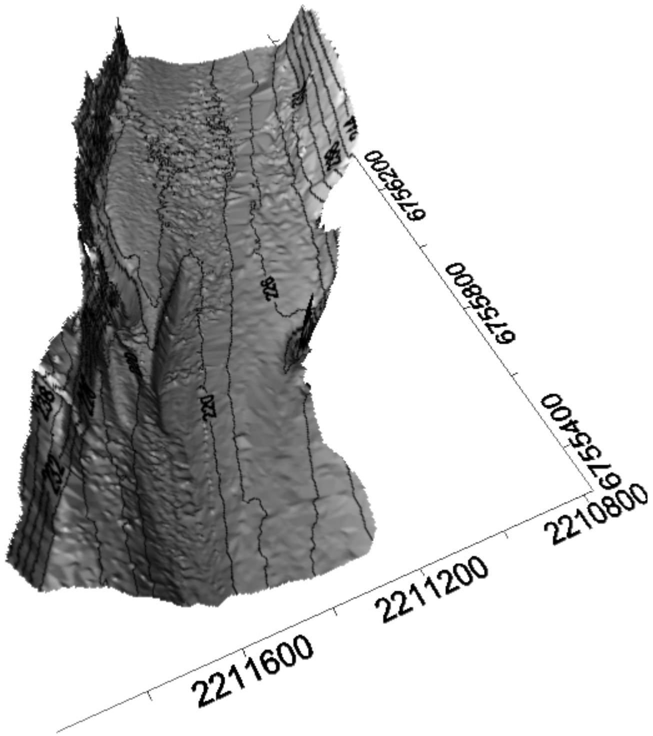
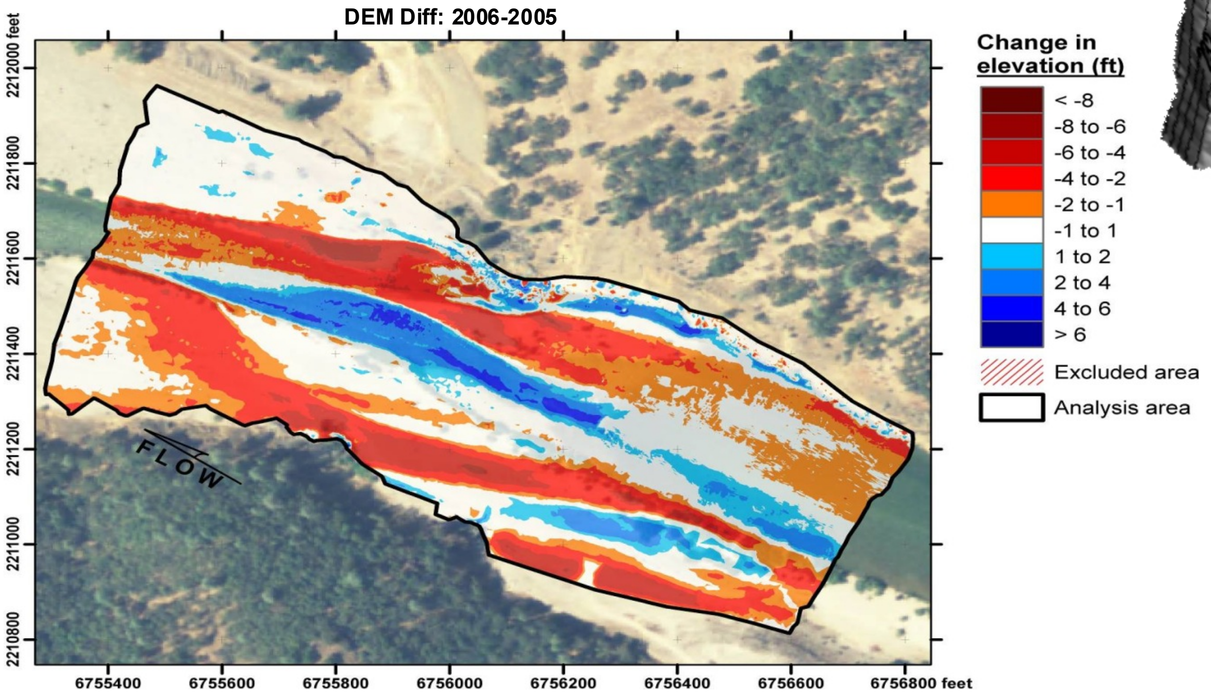
Extrapolate From Detailed Site Studies?

Pros:
Captures processes
More accurate predictions
Reveals transitions
Shows variability
Resolves relevant small scales





Cons:
Poor coverage
No standards
No metrics
Interpretive
Time/cost/training

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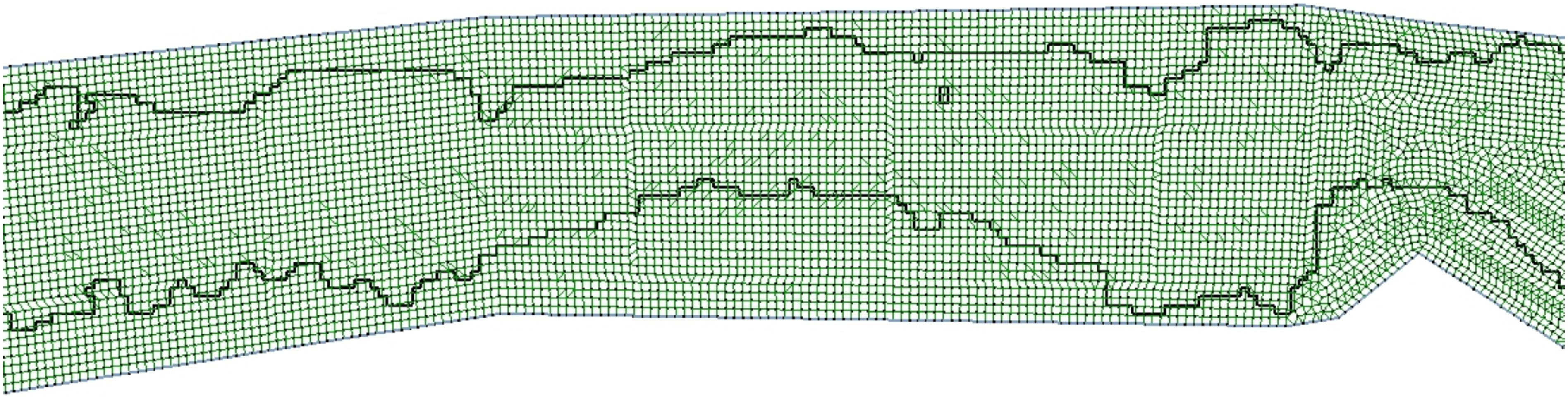
"Near-Census" River Assessment



- Use remote sensing methods to collect imagery and data at submeter resolution. At present, key hydraulic variables cannot be assayed remotely.
- Perform 2D hydrodynamic modeling to obtain the spatial pattern of hydraulic variables for relevant hydrological regimes.
- Perform scale-dependent analyses at multiple scales
  - Segment, reach, and morphological unit scales
- Synthesize results into methodological and management recommendations as well as scientific conclusions.

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Data Collection (topography, inflows, hydraulics substrate, cover)

Map Production

2D Hydrodynamic Modeling

Topographic Change Analysis

Hydraulics

GIS-Based Spatial Analysis

Morphological Units

Flow-Dependent Analysis

Physical Processes

Habitat Suitability

Integration with Biological Datasets

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Spatial Scales of Ecohydraulic Analysis

Segment
10^3-10^4 channel widths

Characterized by valley type, geological structure, and large man-made structures.

Reach
10^2-10^3 channel widths

Characterized by the balance of sediment transport capacity, sediment supply, and topography. Key variables: tributary confluences, significant man-made structures and activities, valley width, channel slope, and bed material.

Morphological Unit
10^0-10^1 channel widths

Visible landforms in the river corridor that reflect distinct form-process dynamics and whose size and shape is indicated by low-flow patterns of depth and velocity.

Hydraulic Unit
10^{-1}-10^0 channel widths

Uniform patches of flow and substrate within a morphological unit.

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Scale-Dependent Analysis Metrics

Segment
10^3-10^4 channel widths

Seasonal flow accretion; flow-dependent stats for wetted area, wetted width, hydraulics, sediment transport regimes, physical habitats; depth hypsograph

Reach
10^2-10^3 channel widths

Tributary effects, bed and water surface slopes, coherence between bed and width undulations, slope-detrended & standardized topographic relief, flow-dependent stats for hydraulics, sediment transport regimes, physical habitats

Morphological Unit
10^0-10^1 channel widths

Longitudinal and lateral MU structure, adjacency tendencies, depth v. velocity phase-space plots, stats on flow-dependent hydraulics, sediment transport regimes, meso-scale physical habitats.

Hydraulic Unit
10^{-1}-10^0 channel widths

Linking hydraulics and substrate patches, spatial patterns of micro-scale physical habitat, biotic energy usage minimization

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Linking Hydraulics to Geomorphic and Ecological Functions

- Hydraulics are often computed assuming steady flow, yielding a static characterization of river conditions.
- One approach is to do a series of steady simulations with different flows and assess incremental changes as a function of flow.
- Another approach is to specify a specific threshold function (e.g. bed overturning, survival in flood refugia, wood jamming) and contrast its presence/absence at key flows.

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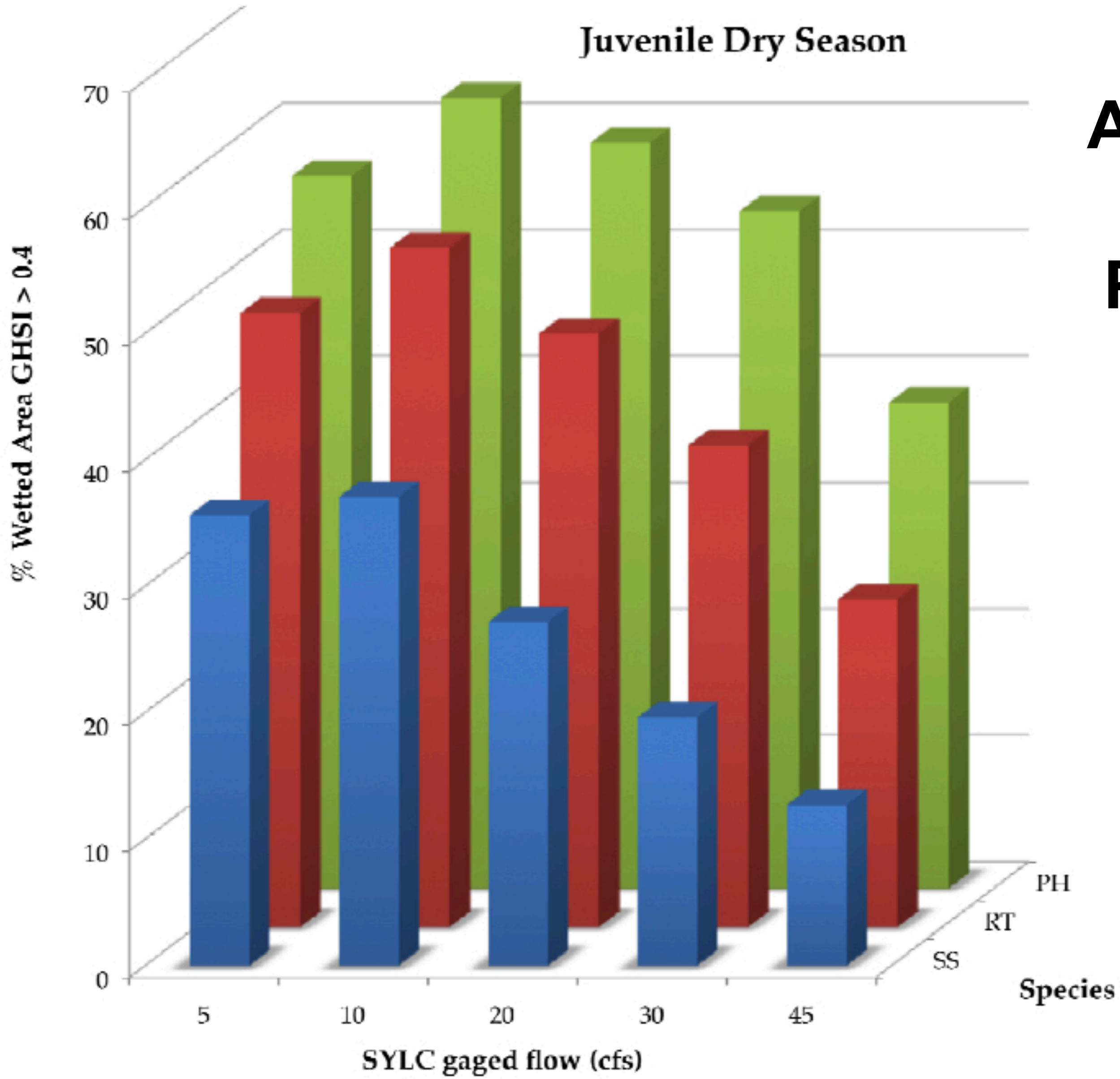

Segment-Scale Analysis of Flow-Dependent Physical Habitat

GHSI is "global habitat suitability index", a measure of the quality of a location to be utilized by an organism

PH=pikeminnow/hardhead
RT=rainbow trout
SS= Sacramento sucker

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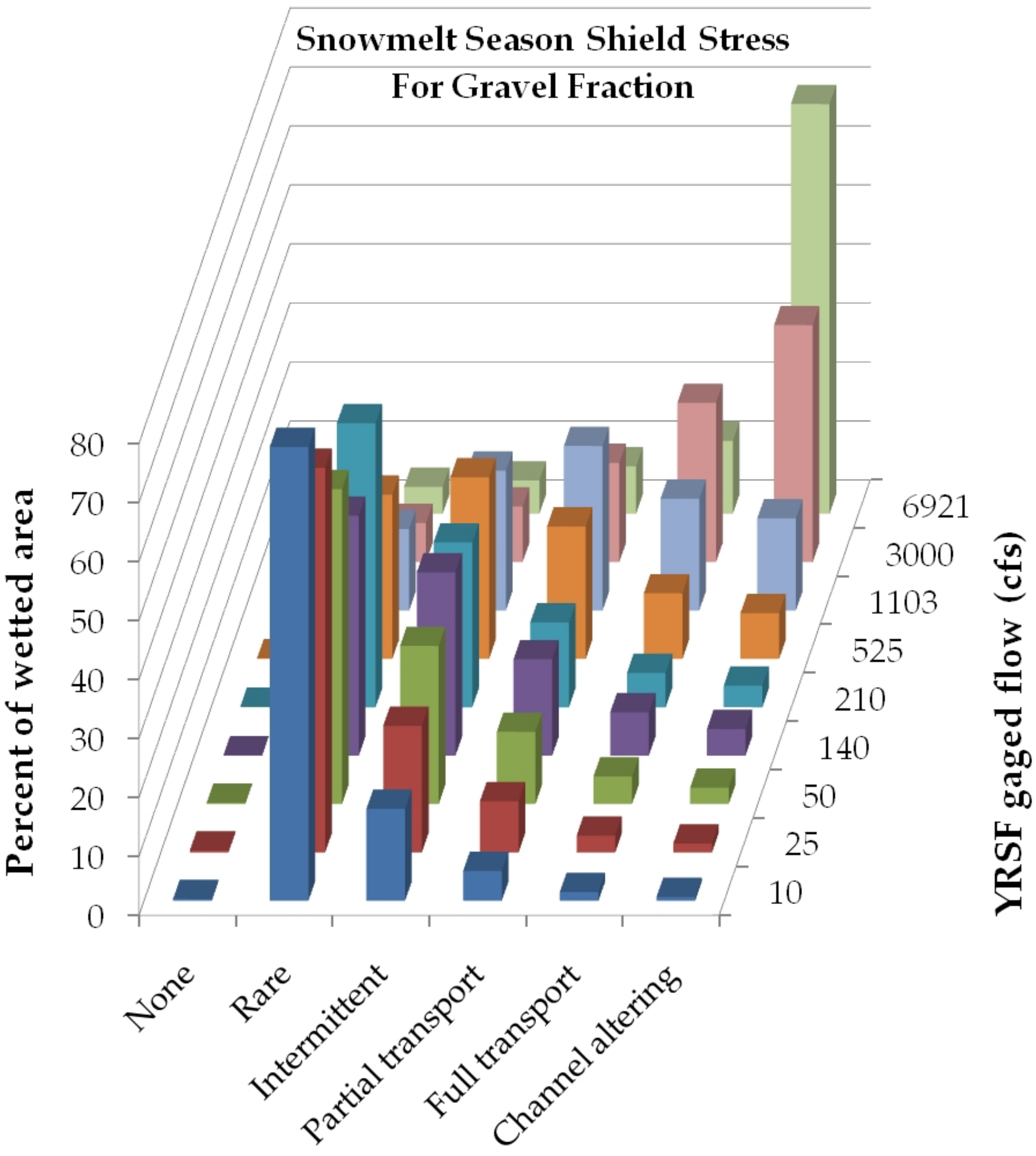

Segment-Scale Analysis of Flow-Dependent Geomorphic Dynamism

Percent of river predicted to be experiencing the specified sediment transport regime for available spawning gravel