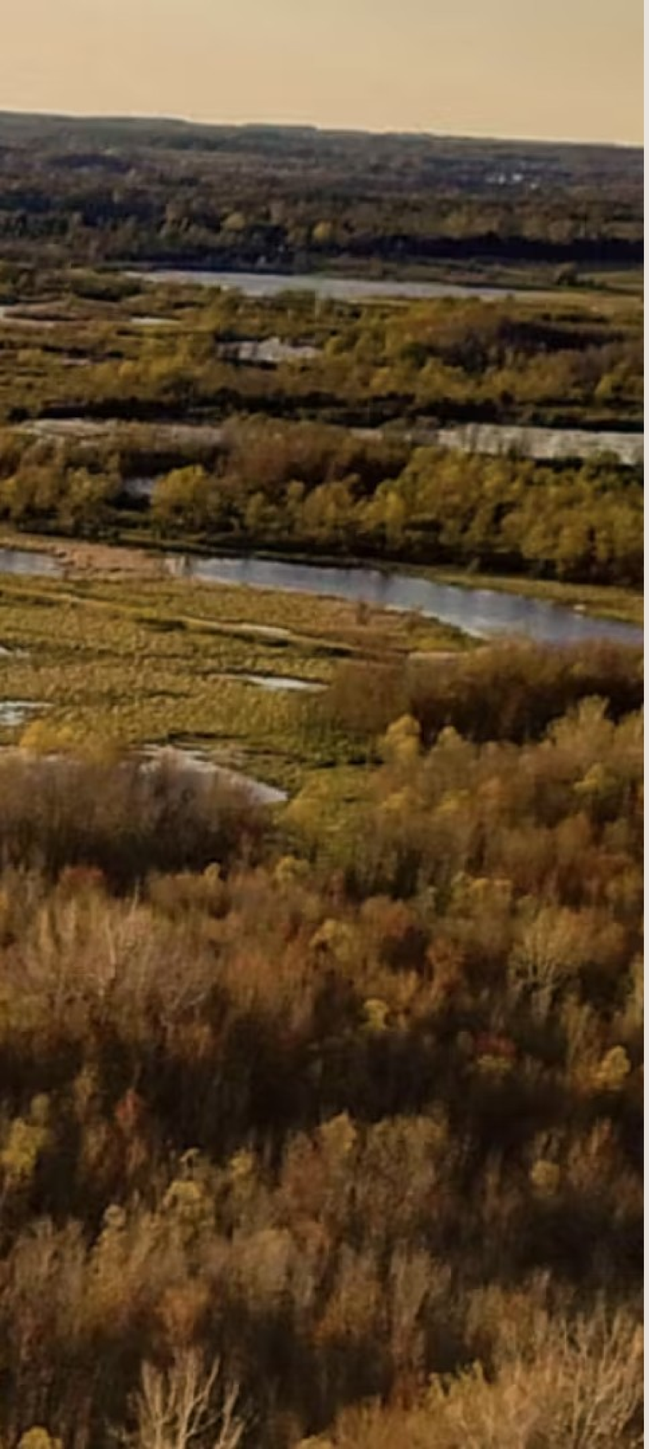
Welcome

Riparian Book Club: The Natural Sediment Regime with Dr. Sara Rathburn

Host: Colin Barry, PG, CFM (Ayres) | Geomorphologist
Tech: Maria Brandt | Coalitions & Collaboratives (COCO) | Outreach & Development Director



Riparian Book Club

Bridging the gap between academic research on stream/wetland systems and applied restoration design. These book club discussions are targeted toward those tasked with stream-wetland restoration design and project planning, to seminal/pivotal scientific papers that can help them in daily work tasks.

Previous: The Natural Flow Regime
Today: The Natural Sediment Regime
November 5: The Natural Wood Regime

CO-CO.org > Resilient Communities > Riparian Book Club

Colorado Riparian Association

Formed in 1989 by a small group of dreamers who believed that our riparian zones should not become sacrifice areas.

Promoting the conservation, restoration, and preservation of Colorado's riparian areas and wetlands.

Coalitions & Collaboratives

We believe in working together. No single individual, business, organization, or government can fix the difficulties facing our planet and its people, but by working together, we can drive positive change for people and the planet. This includes as much open access to resources and information sharing as possible.

To advance healthy and resilient communities through collaborative conservation and restoration.

Using Mentimeter

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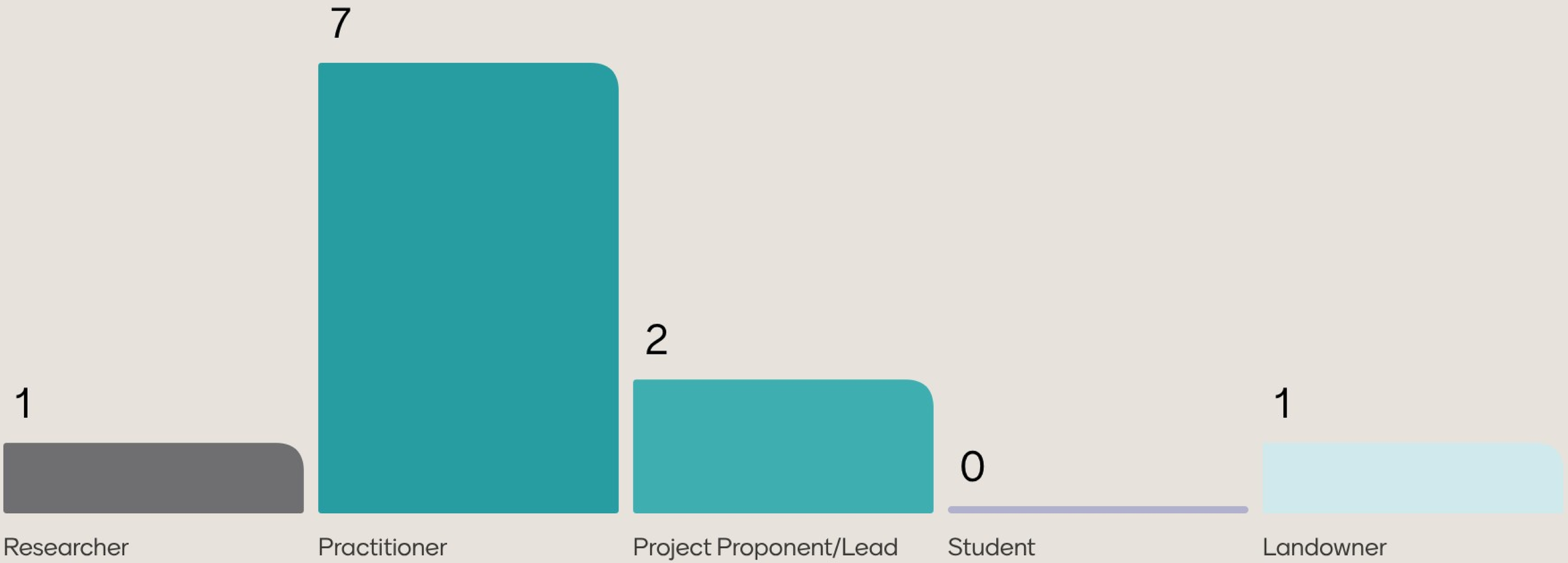
- Follow along and participate in the webinar
- Polling is anonymous. Please be respectful and professional.
- Using Menti and Zoom to engage
- Welcome to add questions to Menit during presentation

I'm a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Researcher
Practitioner
Project Proponent/Lead
Student
Landowner

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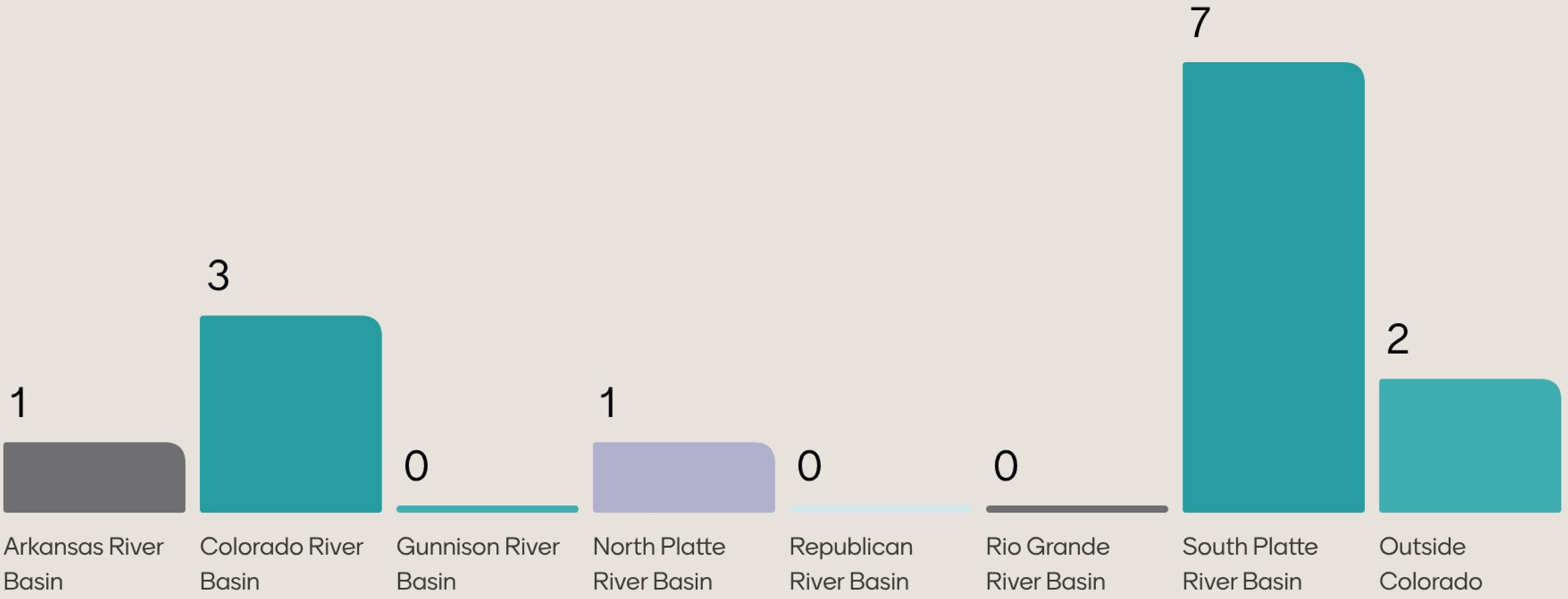
What geographic location are you joining us from?



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What do you hope to get from this online workshop?

Knowledge to inform project design and implementation

Tools to consider sediment during restoration design.

Just learnin :)

role of beaver and ltpbr in natural sediment regime!

New to the hydrology field. Hoping to learn new concepts about streamflow.

Just looking to learn

Increased knowledge of fluvial processes.

Tools for improving river restoration understanding, analysis, and design

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What do you hope to get from this online workshop?

How ditch infrastructure modifications can be beneficial or harmful to the sediment regime.

Deepen my understanding of the sediment regime

Dr. Sara Rathburn

Dr. Sara Rathburn is a fluvial geomorphologist and professor in the Department of Geosciences at Colorado State University. Sara's research focuses on river channel and floodplain processes, sediment transport, and watershed response to disturbances like wildfires, debris flow, and floods. More recently, in partnership with students, Sara has been evaluating the role of vegetation in fluvial environments and assisting with channel restoration and monitoring along tributaries of the Upper Colorado River in Rocky Mountain National Park. She's worked across the western U.S. and overseas and brings expertise in applying geomorphic principles to real-world river management and restoration.

The Natural Sediment Regime in Rivers: Broadening the Foundation for Ecosystem Management

ELLEN WOHL, BRIAN P. BLEDSOE, ROBERT B. JACOBSON, N. LEROY POFF, SARA L. RATHBURN, DAVID M. WALTERS, AND ANDREW C. WILCOX

Water and sediment inputs are fundamental drivers of river ecosystems, but river management tends to emphasize flow regime at the expense of sediment regime. In an effort to frame a more inclusive paradigm for river management, we discuss sediment inputs, transport, and storage within river systems; interactions among water, sediment, and valley context; and the need to broaden the natural flow regime concept. Explicitly incorporating sediment is challenging, because sediment is supplied, transported, and stored by nonlinear and episodic processes operating at different temporal and spatial scales than water and because sediment regimes have been highly altered by humans. Nevertheless, managing for a desired balance between sediment supply and transport capacity is not only tractable, given current geomorphic process knowledge, but also essential because of the importance of sediment regimes to aquatic and riparian ecosystems, the physical template of which depends on sediment-driven river structure and function.

Keywords: sediment, adaptive management, river restoration, sediment balance

River systems—rivers, riparian zones, and floodplains—around the world are undergoing enormous changes as a result of human influences. Efforts to balance water supply, navigation, power generation, and other river uses against the need to protect river communities and ecosystem services demand an understanding of physical processes in river systems. Water and sediment supplied to and transported by rivers are the fundamental drivers of river condition, affecting water quality, thermal regime, habitat and aquatic communities, river stability, and natural hazards. Effective management of river systems therefore requires knowledge of water and sediment interactions.

This article builds on Poff and colleagues' (1997) paper on the natural flow regime. Since the publication of that paper, management programs oriented around modifying flow releases from dams to restore some natural (preimpoundment) patterns and, therefore, to achieve downstream ecosystem objectives have been implemented in a number of rivers (e.g., Arthington et al. 2010, Shafroth et al. 2010, Olden et al. 2014) and have guided water management activities in some states (Kendy et al. 2012). Modified flow releases may seek to promote the recruitment of native riparian vegetation species, create new habitat, or increase lateral and longitudinal connectivity for organisms by facilitating migration to spawning areas or access to floodplain nursery habitat. Modified flow releases may achieve limited restoration success, however, if management does not include explicit consideration of sediment inputs to and transport within the river system.

Sediment regimes are crucial to aquatic and riparian ecosystems in many ways. The physical habitat template is a fundamental concept in ecology (e.g., Southwood 1977) that, in rivers, encompasses a range of sediment-related processes that determine channel morphology, bed conditions and heterogeneity, disturbance regime, community structure, and water quality. Many aquatic and riparian organisms depend on certain sizes and size distributions of bed materials for various life stages. For example, salmonids can be sensitive to excess fine sediment in the bed (as are other benthic organisms; Jones et al. 2011), and they require gravels in a suitable size range for spawning (Riebe et al. 2014) and that can provide interstitial spaces for juvenile rearing. Aquatic organisms may also be sensitive to the mobility of bed materials, such that life history timing may be adapted to the typical timing of bed disturbances (e.g., Lytle et al. 2008). Suspended sediment and turbidity can influence aquatic food webs—for example, by altering visibility for predators (Newcombe and MacDonald 1991). Sediment conditions are also important for riparian plants: Fine-sediment patches are commonly key colonization sites;

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1. Broad overview - BioScience 2015
2. Restoration considerations
3. Advances in last 10 years
4. Questions and discussion

Overview Articles

The Natural Sediment Regime in Rivers: Broadening the Foundation for Ecosystem Management

ELLEN WOHL, BRIAN P. BLEDSOE, ROBERT B. JACOBSON, N. LEROY POFF, SARA L. RATHBURN, DAVID M. WALTERS, AND ANDREW C. WILCOX

Expand Poff et al. (1997) to address limitations (Poff et al., 2006)

Examples of restoration without sediment regime considered

Objectives

1. Highlight challenges
2. Conceptual models
3. Increase awareness
4. Broaden flow regime paradigm to include balanced sediment regimes

Challenges

- Lack of long-term records. Expensive, time intensive and difficult to quantify. Q and Qs different temporal and spatial scales, processes.
- Hard to integrate into management.

  Jacobson et al. (2009 *GSA SP*), Sediment regime constraints on river restoration
- Limited restoration success without integrating a balanced sediment regime.

Challenges

- Lack of long-term records
  - ~1600 gages with >10 years data; 9 with >50 years

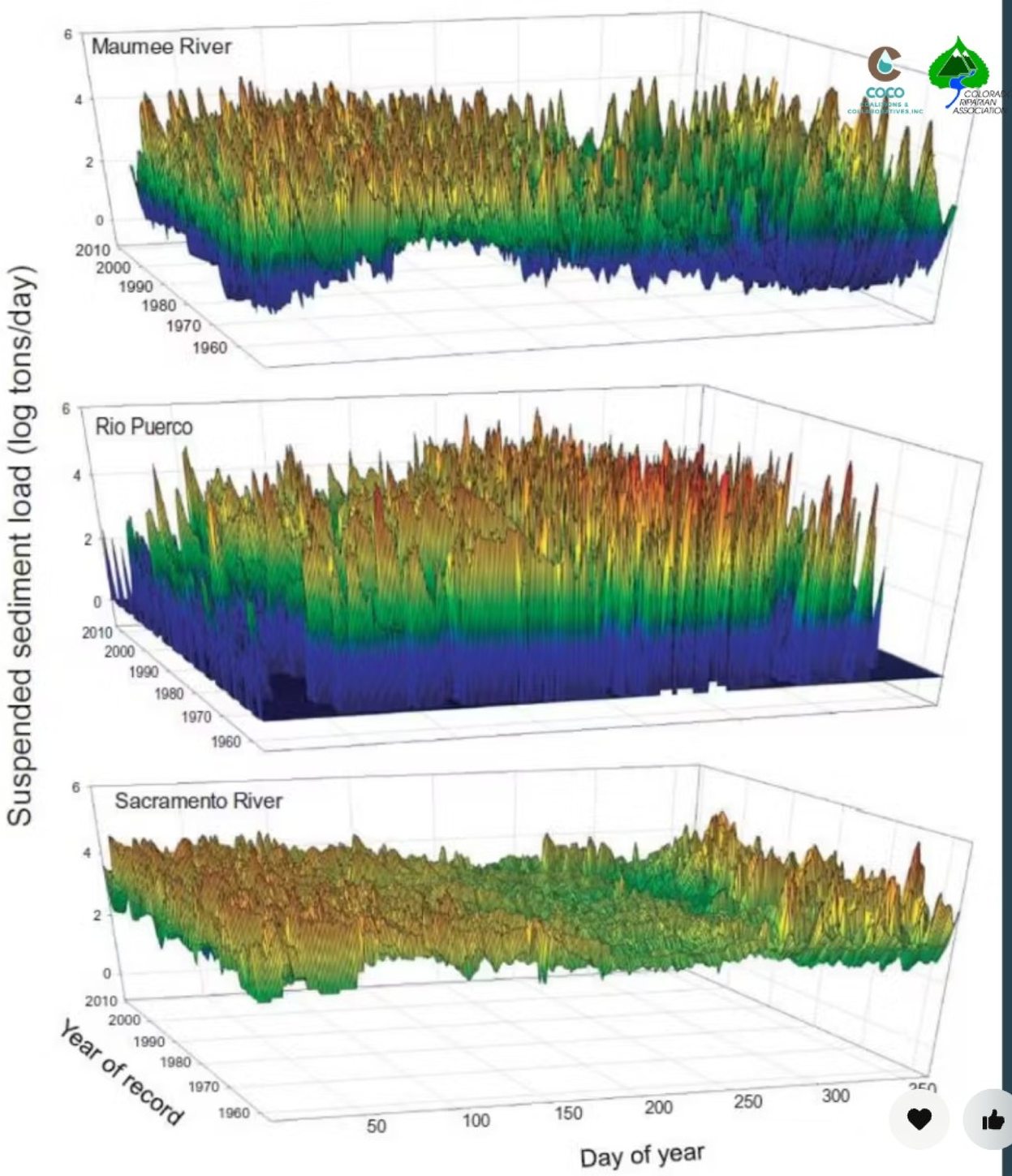


Figure 1

Conceptual Framework

+ Sediment budget
  + Inputs, outputs, storage

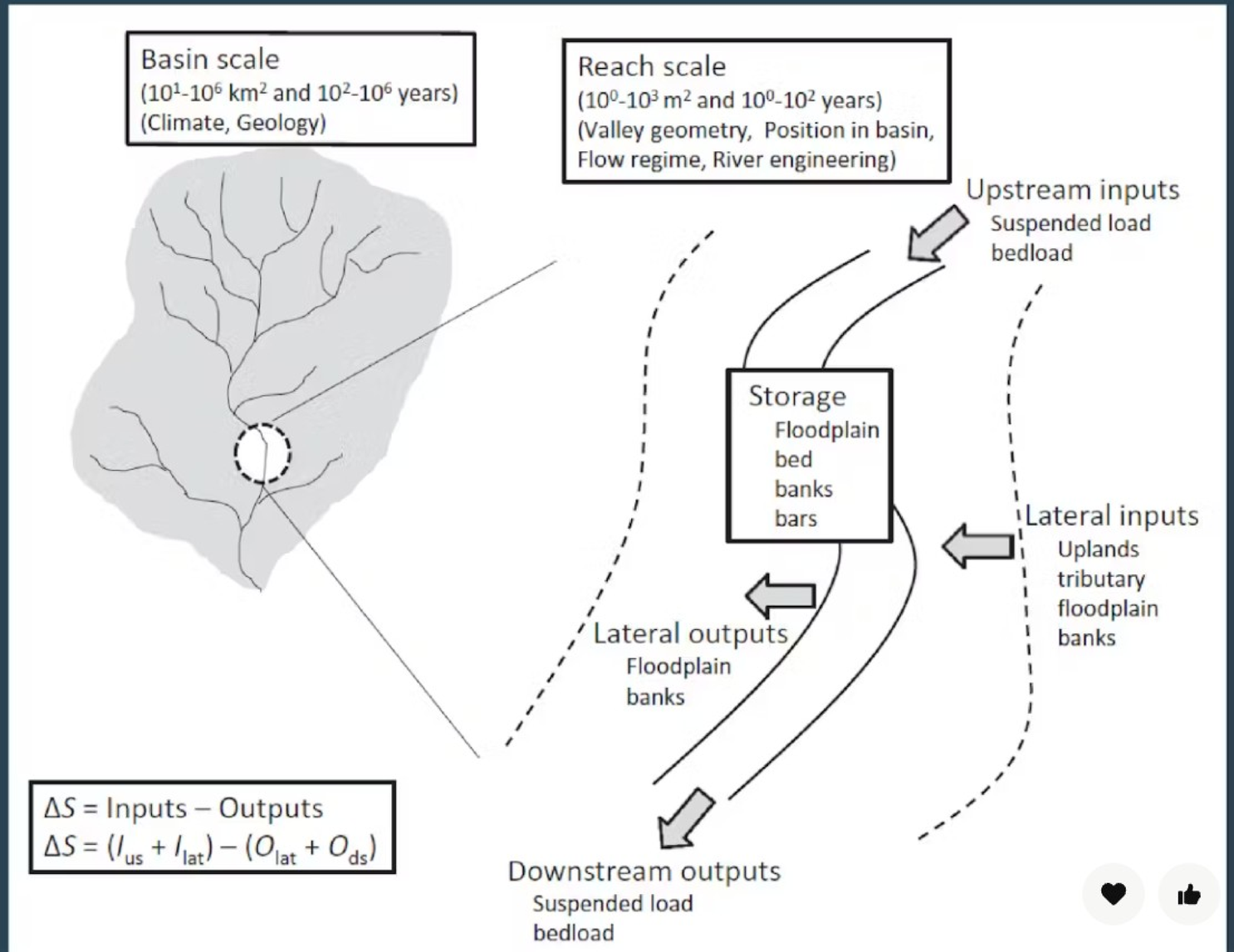


Figure 2

Conceptual Framework

+ Relative importance for unaltered and altered.

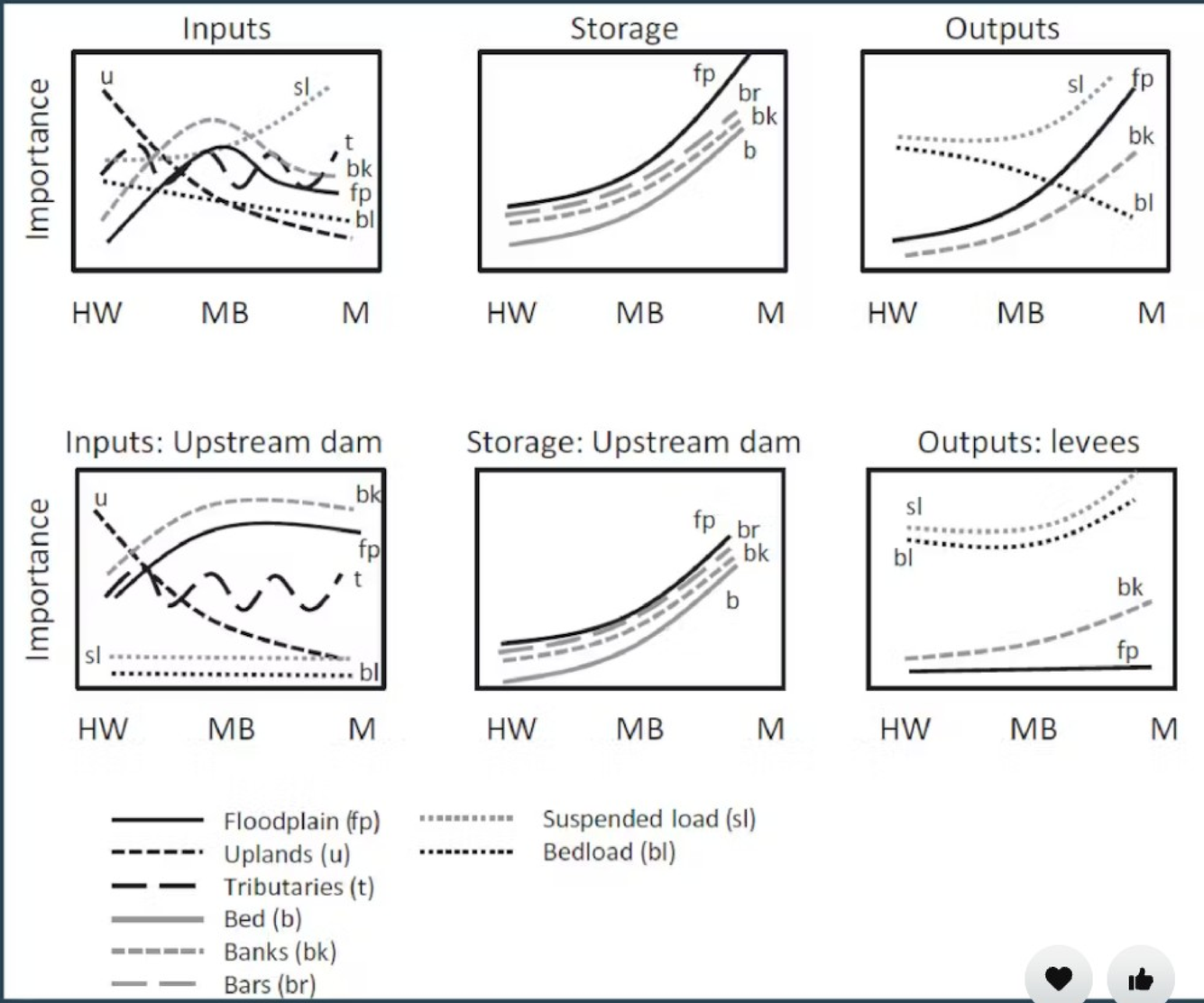


Figure 3

Conceptual Framework

+ Interactions between Q and Qs
+ Valley geometry, substrate, veg
+ Manipulate top rows to influence river geometry.

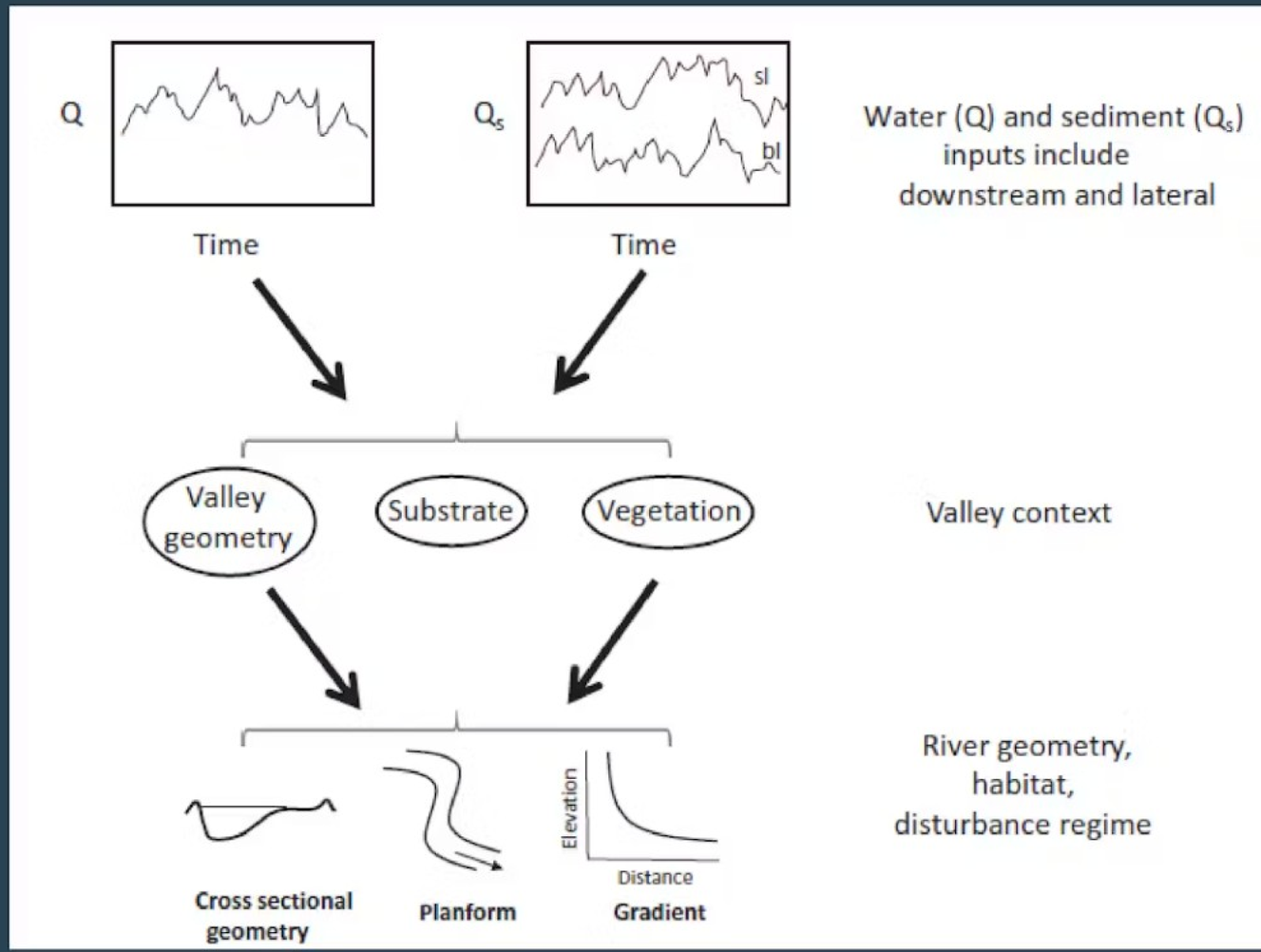


Figure 4

Conceptual Framework

+ Hypothetical responses

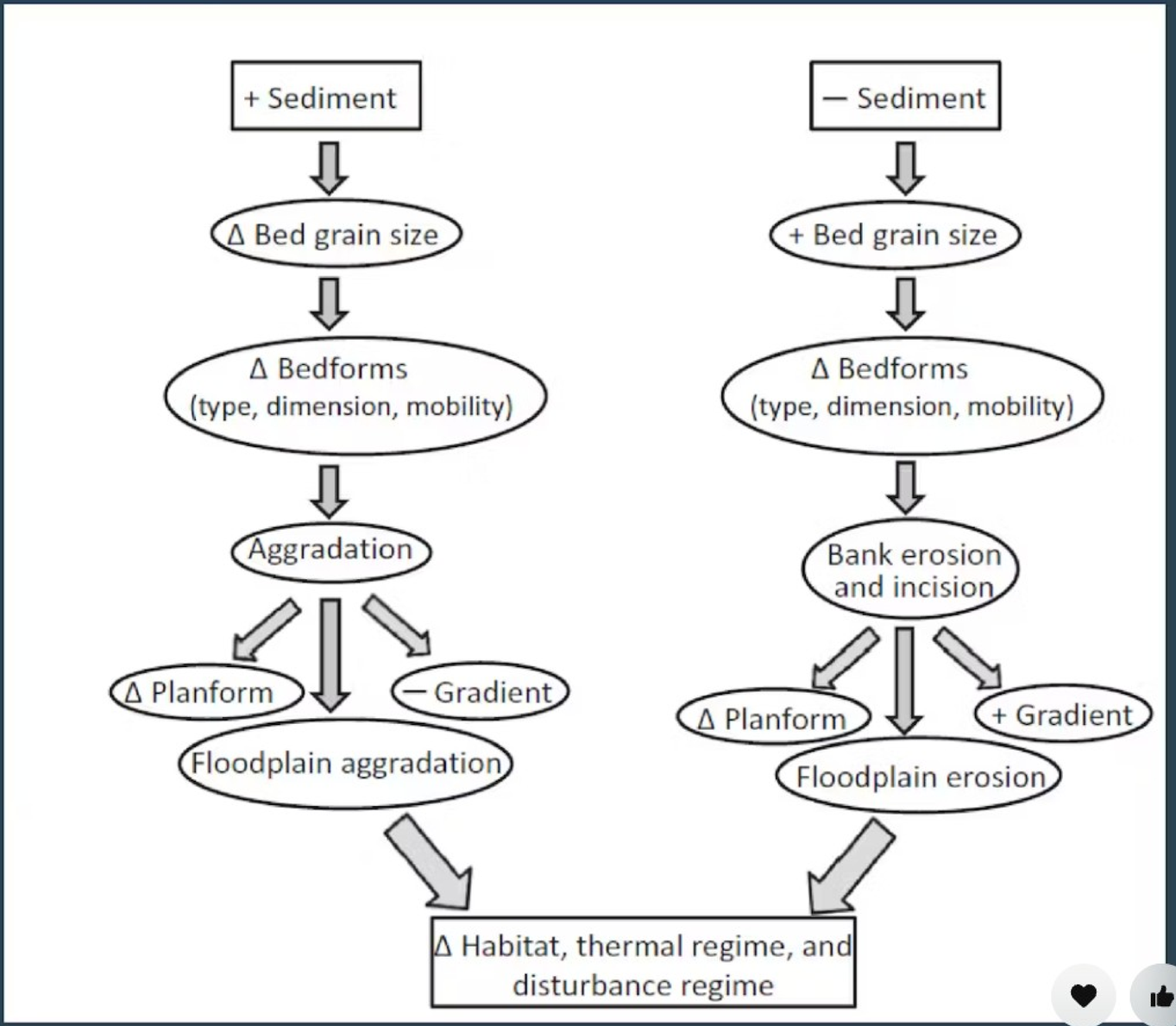


Figure 5

Restoration considerations

(because sediment data deficits are common!)

- How to assess sediment dynamics without direct measurements?
  - Net changes to channel geometry, vegetation patterns, etc. ?
  - Assess remotely from historical data or other?
- Think about sediment source, point source or distributed?
- Flows sufficient to rework? Sediment balance approach - capacity supply ratio? (Soar & Thorne, 2001; Stroth et al., 2017)

Advances

+ Passive sediment monitoring (seismic impact plates; Downs and Soar, 2020 *WRR*)

+ Vegetation establishment (Kemper et al., 2022 *ESPL*)

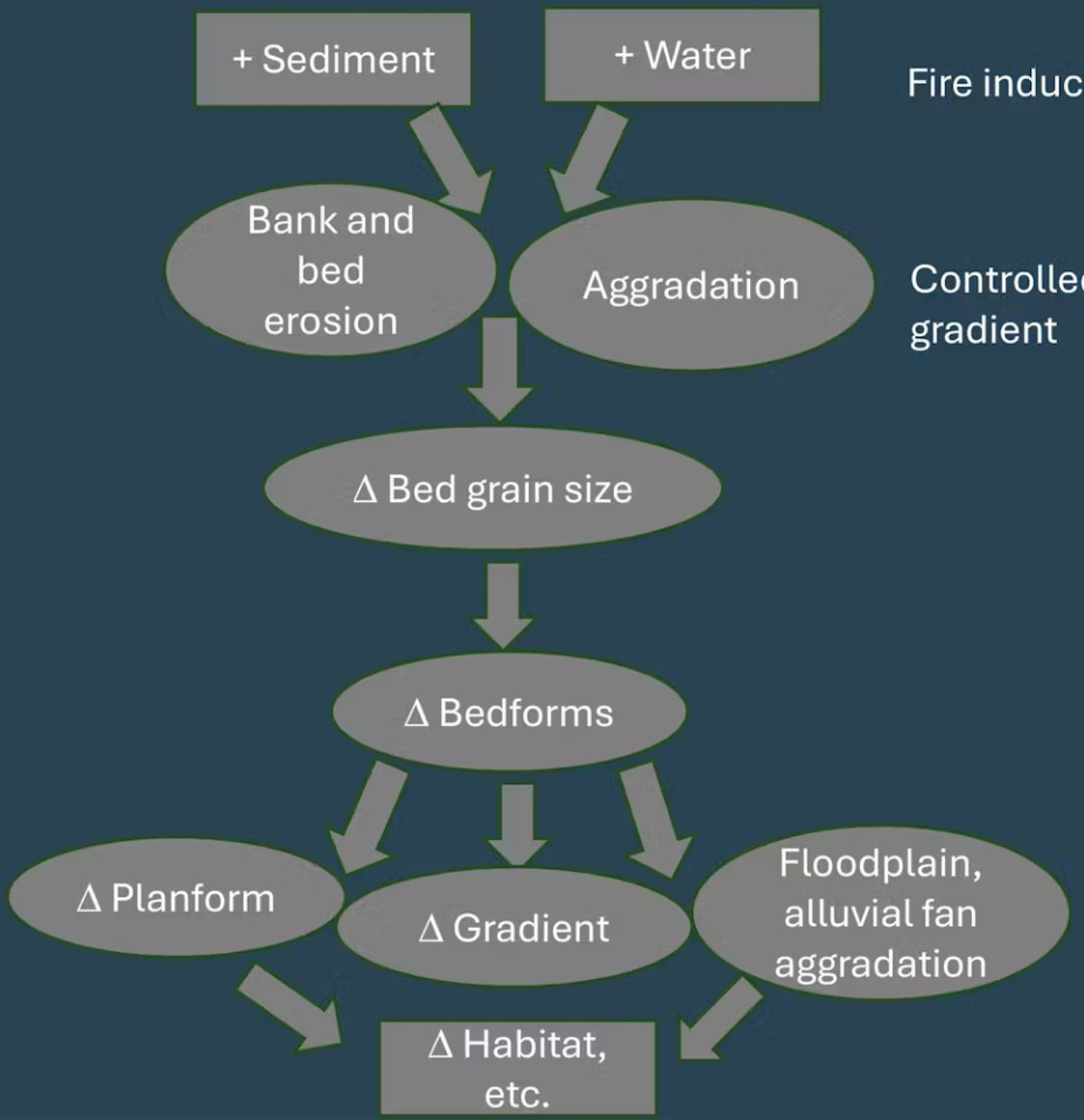
+ Modeling – Sediment routing and floodplain exchange (SeRFE; Gilbert and Wilcox, 2020 *J Adv Modeling Earth Systems*)

+ Mapping river barriers (Sun et al., 2025 *Nature Water*)

+ Biomonitoring of invertebrates (PSI – proportion of sediment sensitive invertebrates; Turley et al., 2015 *Ecological Indicators*)

Questions and discussion

Question – Figure 5 revisited



Increased fluxes of sediment and water to a system after a fire change the response (as depicted in original Figure 5), with erosion and aggradation occurring on hillslopes and channels depending on gradient. Changes in bed grain size (both fining and coarsening), bedforms, planform , and gradient will result, in addition to aggradation on floodplains or as alluvial fans at trib confluences. Finally, changes in habitat, thermal regime, and disturbance regime will result.

References

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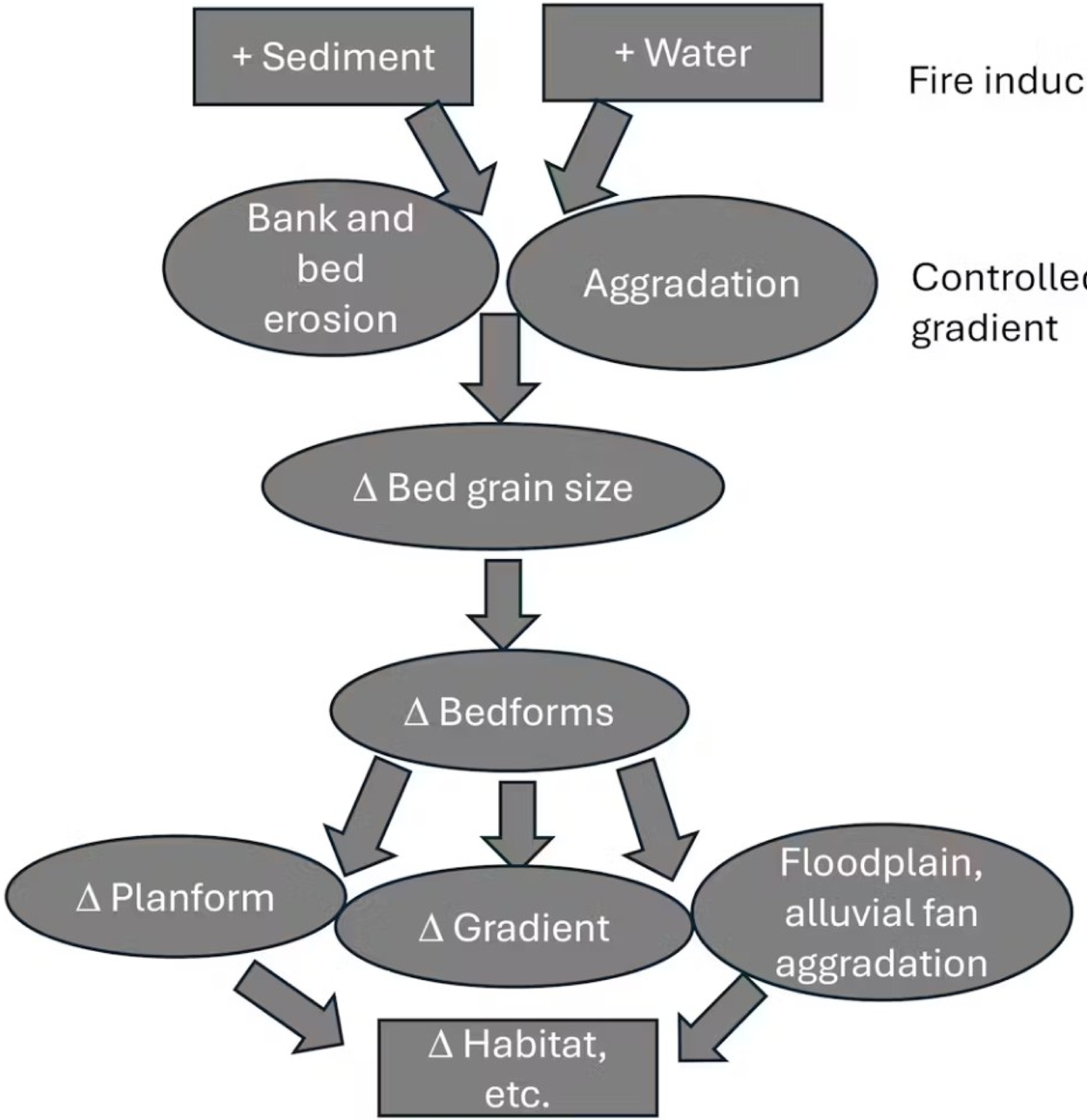
Question – Figure 5 revisited



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Riparian Book Club Discussion

Can you expand on figure 5 in the example of a post fire system where there is an increase in both sediment and discharge?

Do you think it's even more critical to understand sediment regime when you're working in fine-grained systems (eg for specifying treatments that are successful long-term)?

Do you see opportunities for projects to partner with researchers to expand project ability to invest in better understanding sediment regime?

Any talk of another "Natural Regime" paper to dig deeper into the effects of streamside and floodplain vegetation (or lack of veg)?

Are you aware of recent papers or practical knowledge on sediment dynamics proximate to infrastructure? Specifically, how can managers manage the imbalance that occurs around infrastructure...

(Expanded in Zoom) Can you comment on this potentially new paradigm of stream restoration and headwaters and the natural sediment regime for these streams? -Joel

Paper(s) or can you speak to our snowmelt driven rivers, the historical sediment regime what we stand to lose with its alteration, critical items like with increasing alteration to peak flows?

My question with the obvious answers to snowmelt systems is base on a current effort to try to connect this to arguing for instream flow rights connected to unappropriated flows or the "peak flows"

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Thank You

A recording of this webinar will be available at CO-CO.ORG -> Resilient Communities ->Riparian Book Club

The Natural Wood Regime: Wednesday, November 5, 2025, 12:00 PM - 1:00 PM MT