

Streambank erosion downstream of a flood control dam: Processes, rates, and management



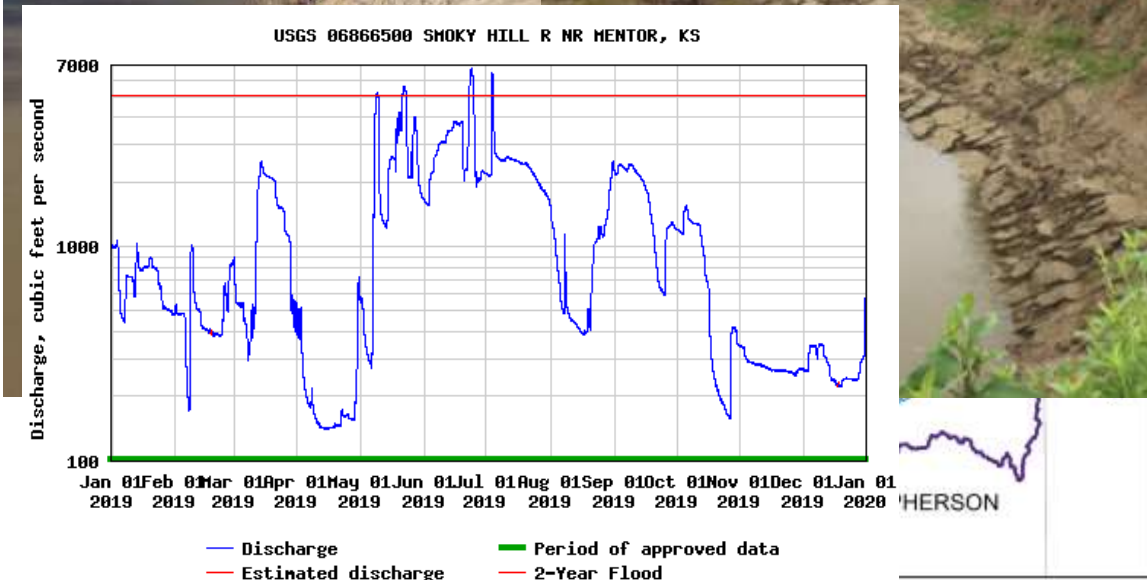
Image from: <https://allthepages.org/archives/2018/10/high-waters-at-kanopolis/>

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What drove this research?

- Began monitoring woody revetment design in 2016 downstream of Kanopolis Dam on the Smoky Hill River
- In 2019, they failed – why?
 - Insufficient anchoring?
 - Lack of early-stage protection?
 - Construction disturbance?
 - **What about dam operation?**

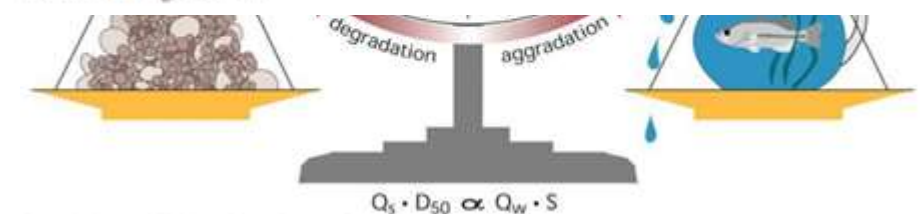


Downstream Geomorphic Effects of Dams

- Alters the flow and sediment regime (Leopold et al., 1964; William & Wolman, 1984; Schmidt & Wilcock, 2008)
- Channel changes
 - Bed degradation immediately downstream of the dam (William & Wolman, 1984)
 - Channel migration decreases (Shields et al., 2000)
 - Braided channels tend to narrow, single-threaded channels tend to widen (Petts & Gurnell, 2005; Collier et al., 2000)
 - Bank erosion rates are likely affected but depend on dam operation, channel boundary conditions, distance from dam, and time (Hupp et al., 2009; Williams & Wolman, 1984)



axis of Figure 5.



From Rosgen (1996), from Lane, Proceedings, 1955.
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Can we manage the impact of large dams on downstream channel erosion?

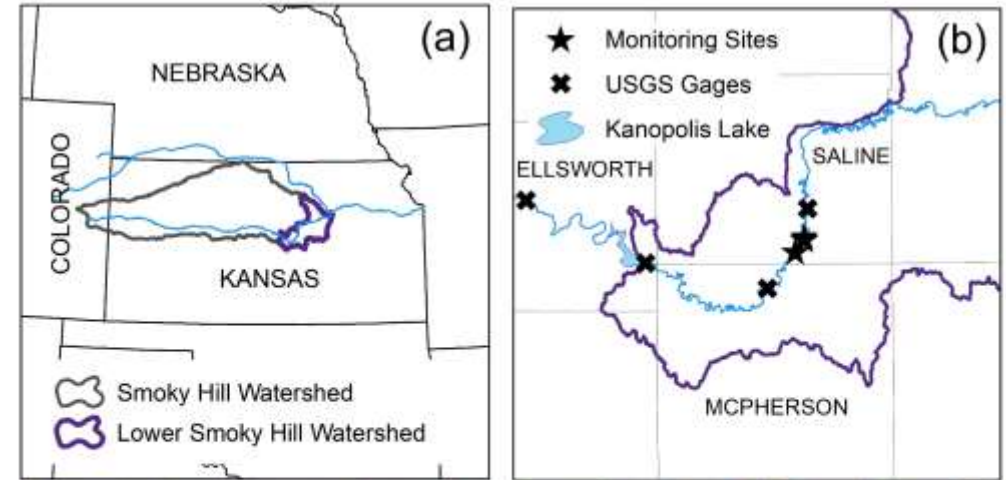


Study Objectives

Evaluate the effects Kanopolis Dam closure (Feb. 17, 1948) has had on:

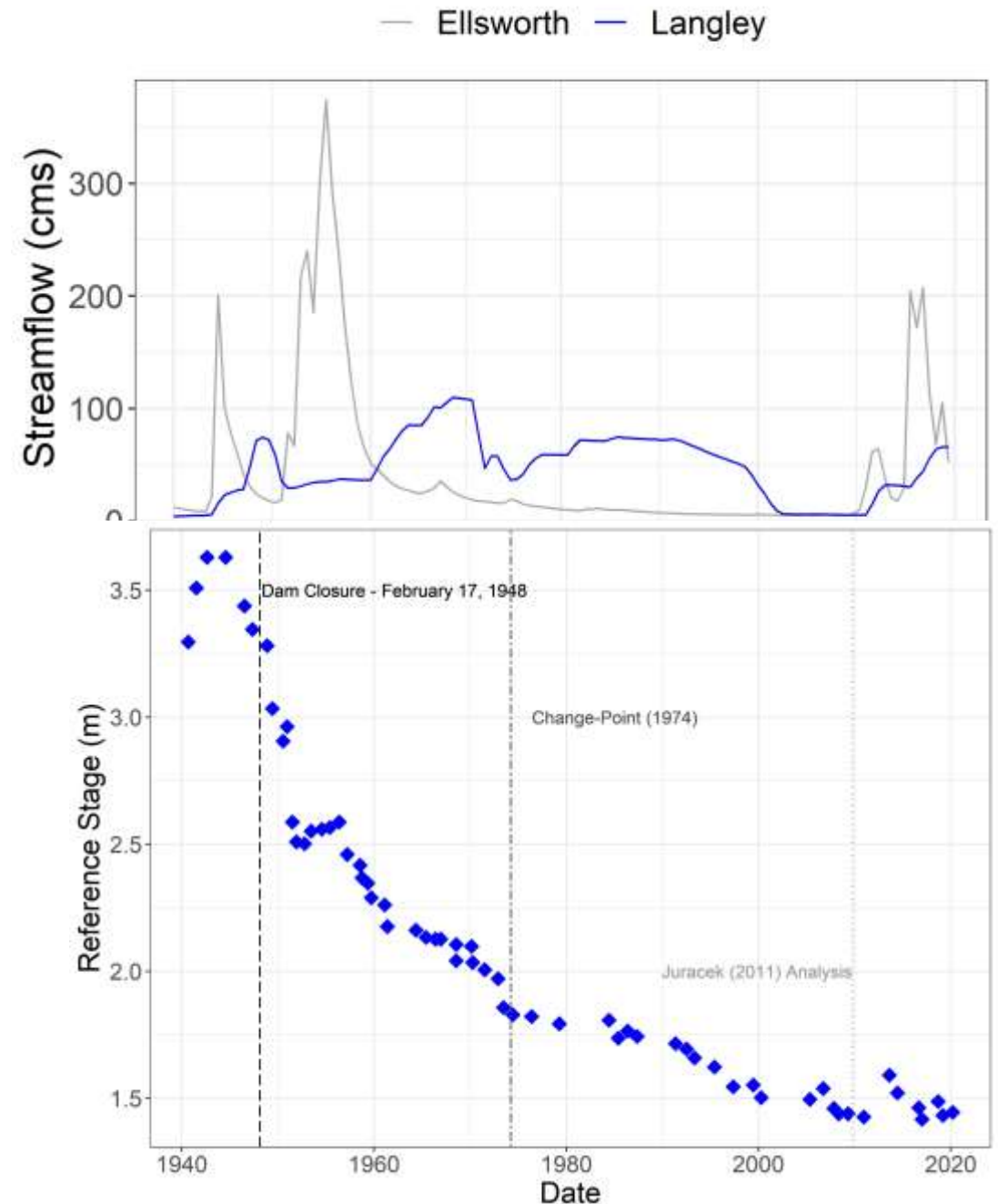
1. Flow & channel bed stability
2. Channel planform
3. Streambank erosion processes & rates

up to 111 river km downstream on the Smoky Hill River.



Flow & Bed Stability

- Dampened peak flows by 72%
- Increased moderate flows (5-90% DEP)
- Bankfull discharge decreased by 50%; annual return interval remains the same
- Resulted in up to 60 years of bed instability up to 10 river km downstream



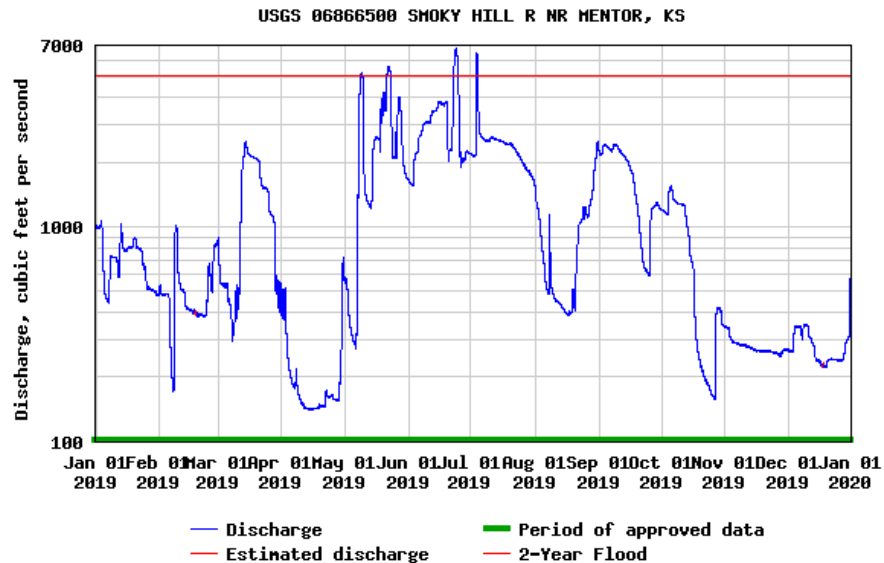
Channel Planform

- Channel migration rates decreased by 66%
- Sinuosity increased by 5%

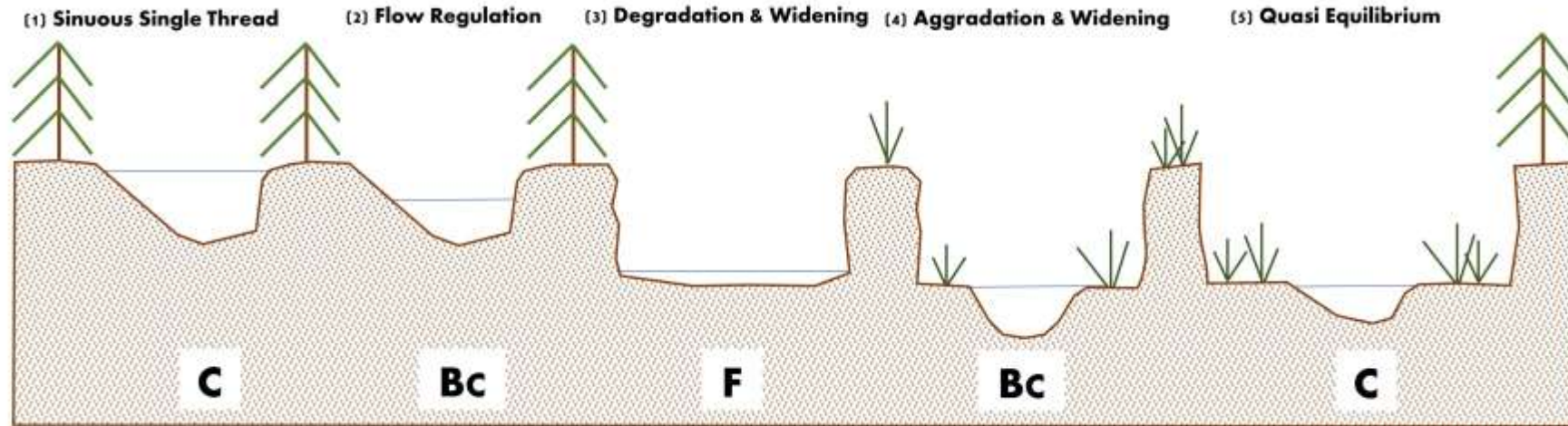


Streambank Erosion

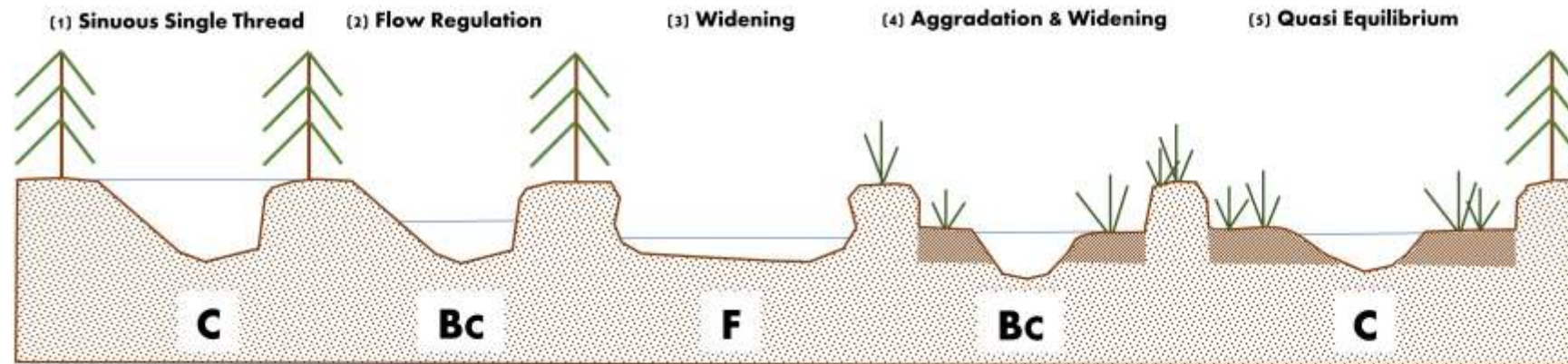
- Induced toe erosion over a larger spatial scale and longer temporal scale
- Periodically damages riparian vegetation



Channel Evolution



Downstream
of Dam (0 -
10 river km)



Downstream
of Dam
>10 km)

Bigham, K.A., T. Moore, T. Keane, D. Rosgen (2022). *Observed Channel Evolution Downstream of a Flood Control Dam*. Manuscript submitted for publication.

Why did these projects fail?

- Insufficient anchoring? ✓
 - Lack of early cover? ✓
 - Construction disturbance? ✓
 - Dam operation? ✓
- **We failed to get to know the system first.**
 - Flow & sediment regime
 - Channel evolution phase
 - Channel form and process
 - Field work + modeling



Can we manage the impact of large dams on downstream channel erosion?

- *Likely* if we can paint a clearer picture of the river's past, present, and future.
- Different design developed, now to test it.



Design completed by Phil Balch
Photos taken by Andy Klein

Acknowledgments

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- Research Assistants
- Many others...



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