Legacy of Natural Dams Removed

Denise Burchsted and Mark Green
Plymouth State University, Center for the Environment
March 18, 2012

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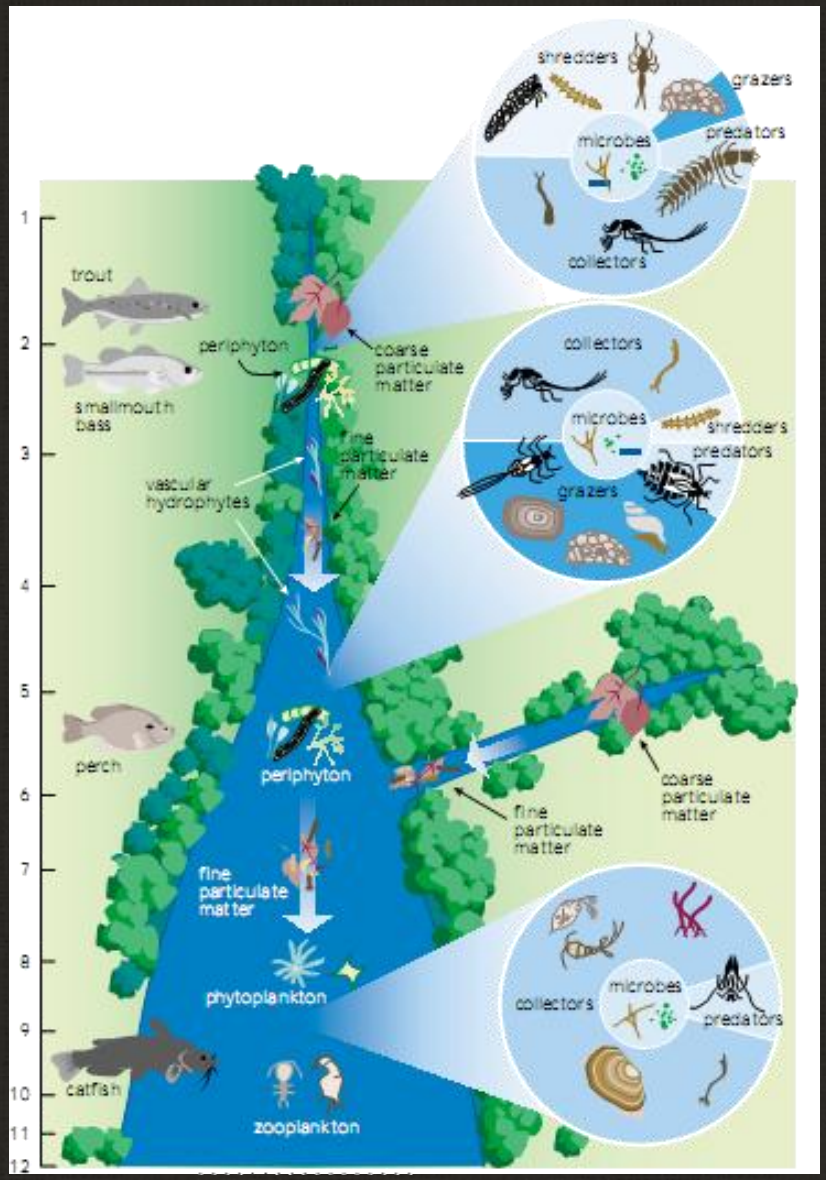
Outline

- Definition and examples
- Implications for sediment storage and transport:
  - heterogeneity
  - loss of heterogeneity
- Implications for restoration

Natural dams create discontinuities

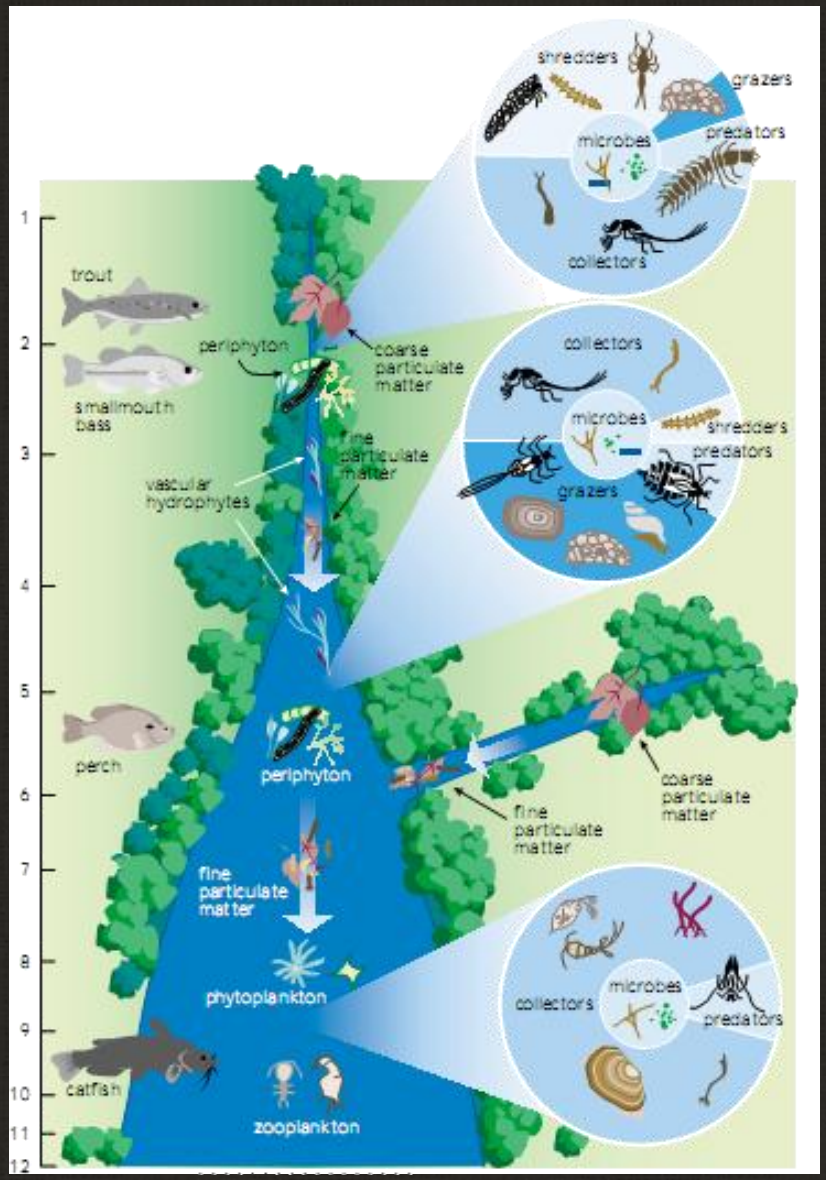


Fluvial discontinuity

Barrier to downstream water and sediment transport that alters the longitudinal flux of these materials by storing or releasing them, or by changing their flow path, depending on the current and antecedent flow conditions.

Vannotte et al 1970;
FISRWG 1997

Natural dams create discontinuities



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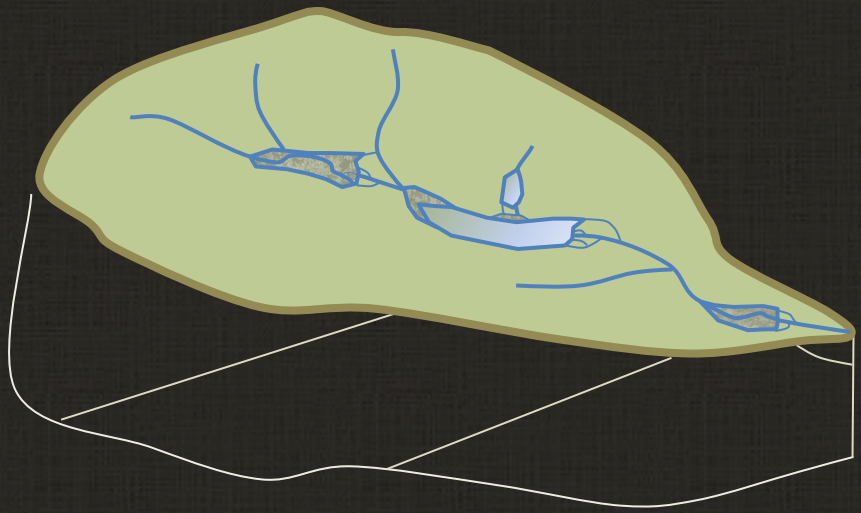
Network Scale

10^3 m, 10^5-10^6 yr



Burchsted et al 2010

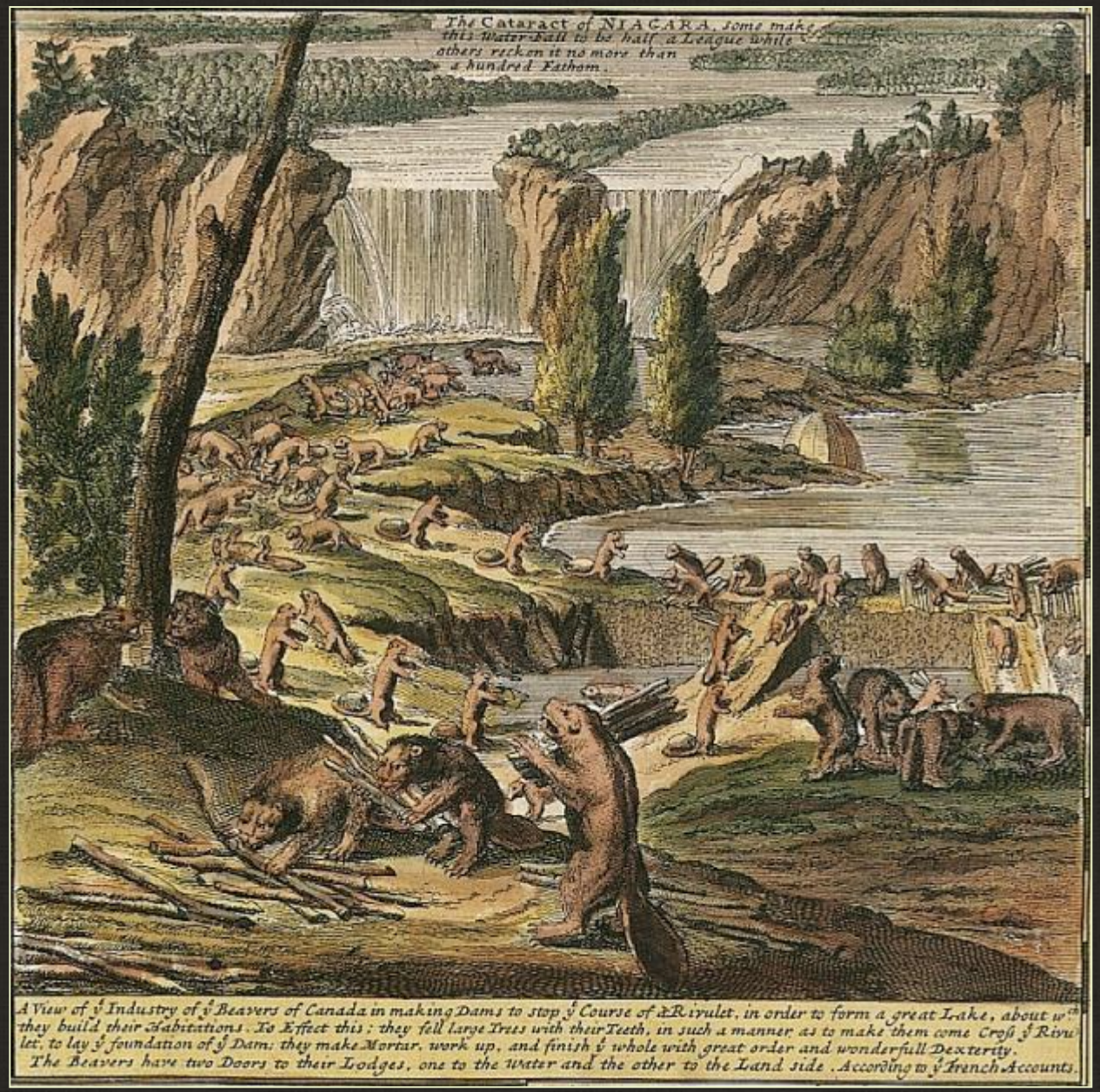
Log jam

Log jams removed

PSU Spinelli Archive:
Beyond Brown Paper

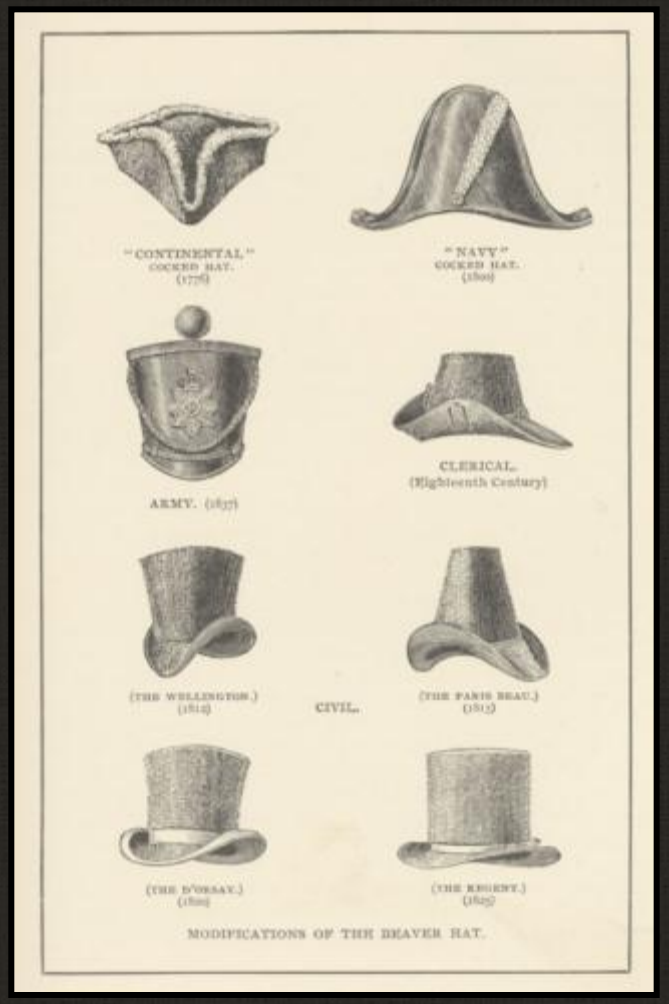
Log jam restoration

Beaver dams

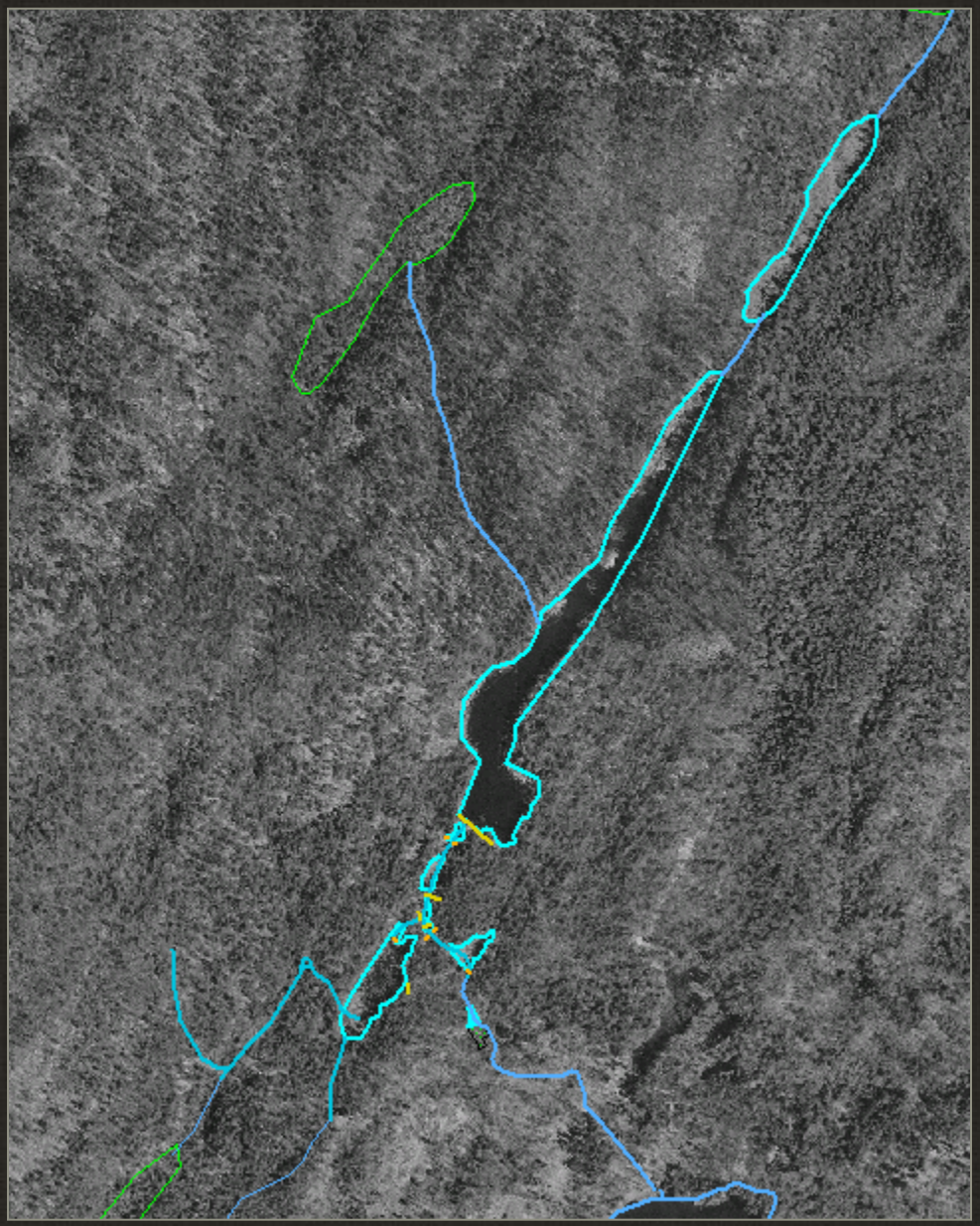


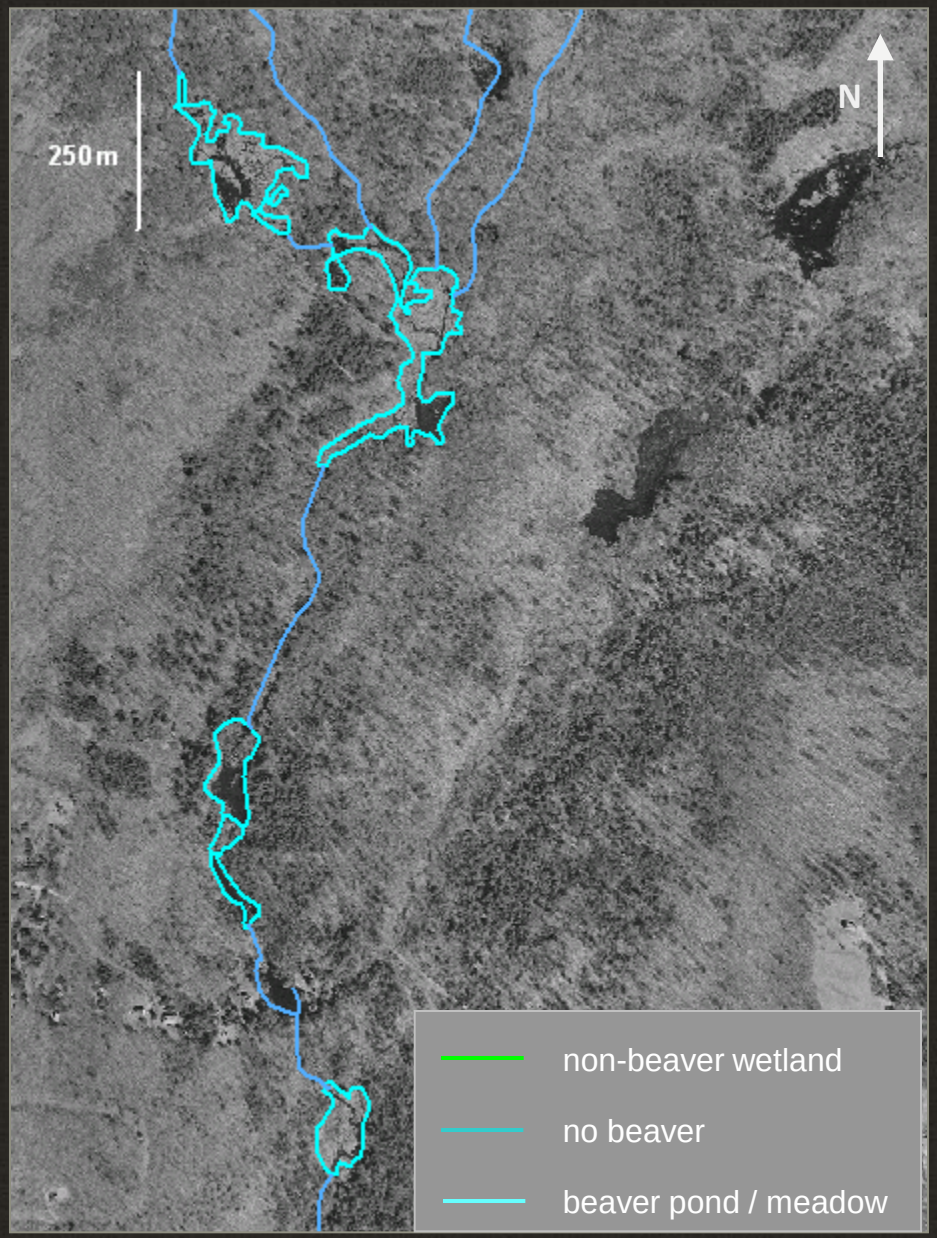
A View of ye Industry of ye Beavers of Canada in making Dams to stop ye Course of a Rivulet, in order to form a great Lake, about w^ch they build their Habitations. To Effect this; they fell large Trees with their Teeth, in such a manner as to make them come Cross ye Rivulet, to lay ye foundation of ye Dam: they make Mortar, work up, and finish ye whole with great order and wonderfull Dexterity.
The Beavers have two Doors to their Lodges, one to the Water and the other to the Land side. According to ye French Accounts.

Beaver dams removed



Beaver dam restoration





Bedrock constrictions

Bedrock constrictions

1869

(Hallworth Collection)

Livermore Falls, Pemigewasset River:

Constriction apparently unmodified during log drive, though flow was diverted around falls

Bedrock constrictions homogenized

1869

(Hallworth Collection)

post-1889

(UPHS)

photos.whitemountainhistory.org

Bedrock constrictions homogenized

1869

(Hallworth Collection)

1920

(Ralph Retsma)

photos.whitemountainhistory.org

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Store fine sediment

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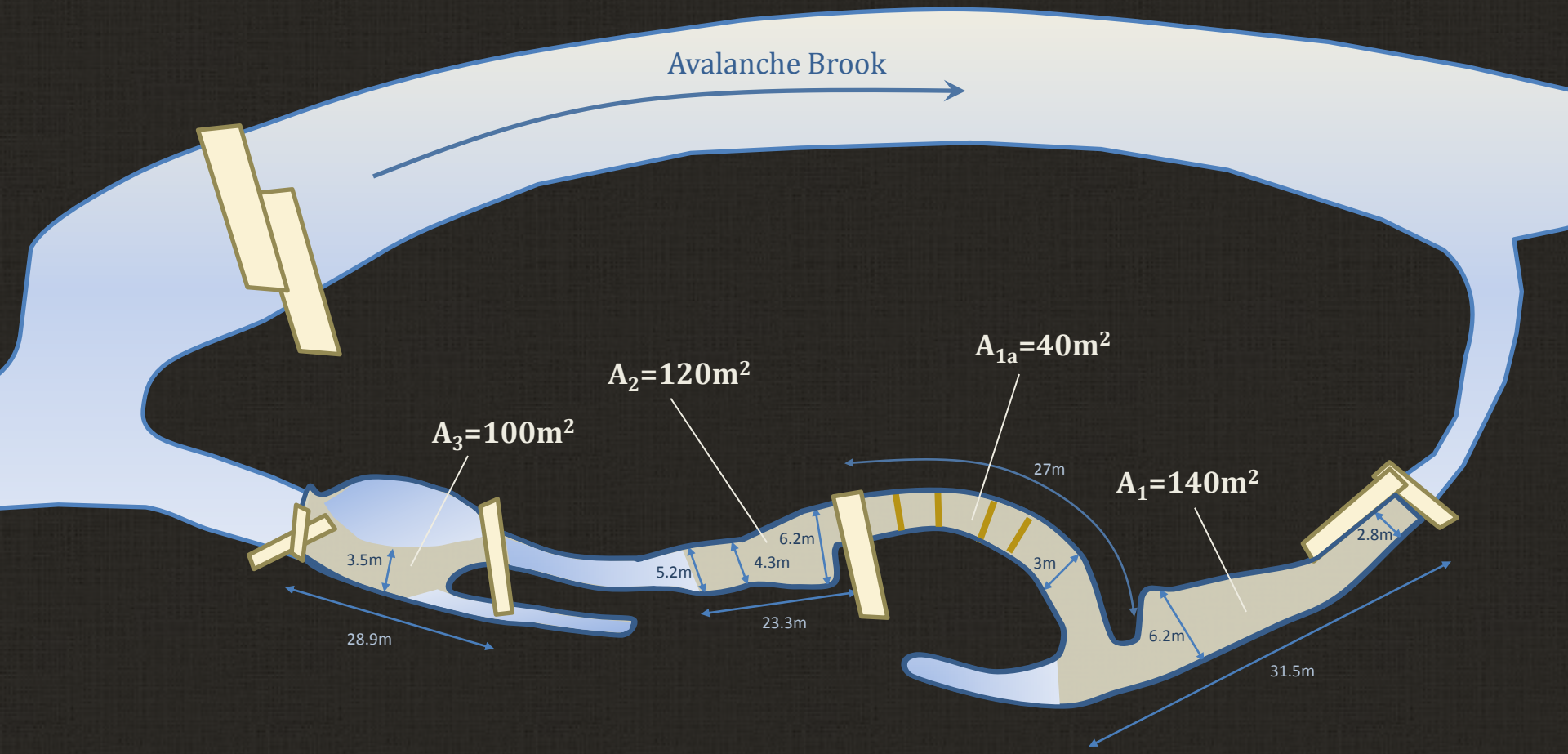

Store fine sediment

With log jam:

- Fine material: 0.25mm – 16mm
- Area of deposit: 400m^2

Store fine sediment

With log jam:

- Fine material: 0.25mm – 16mm
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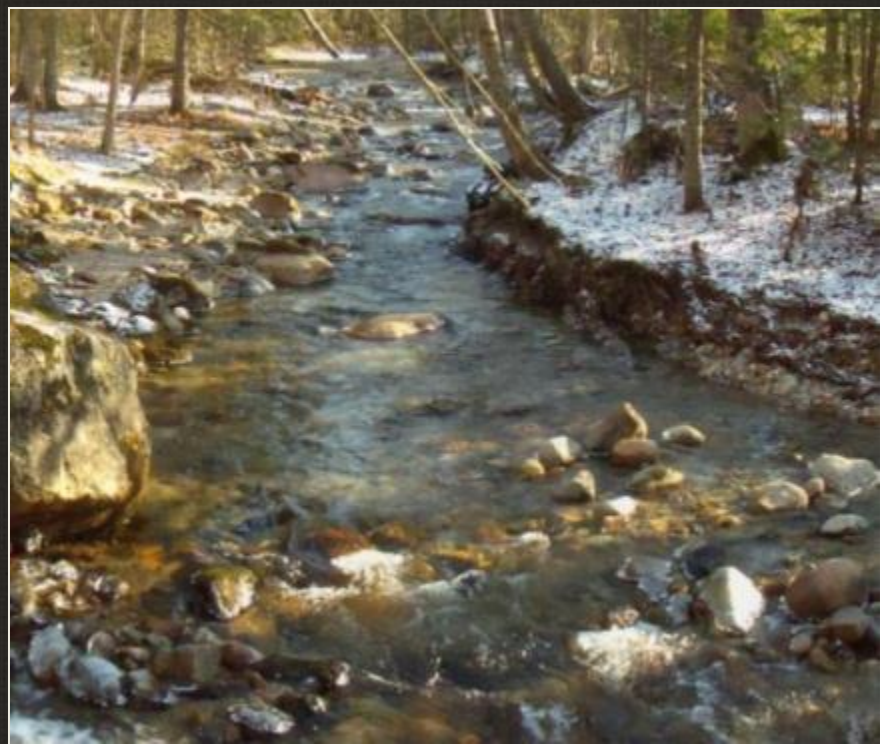
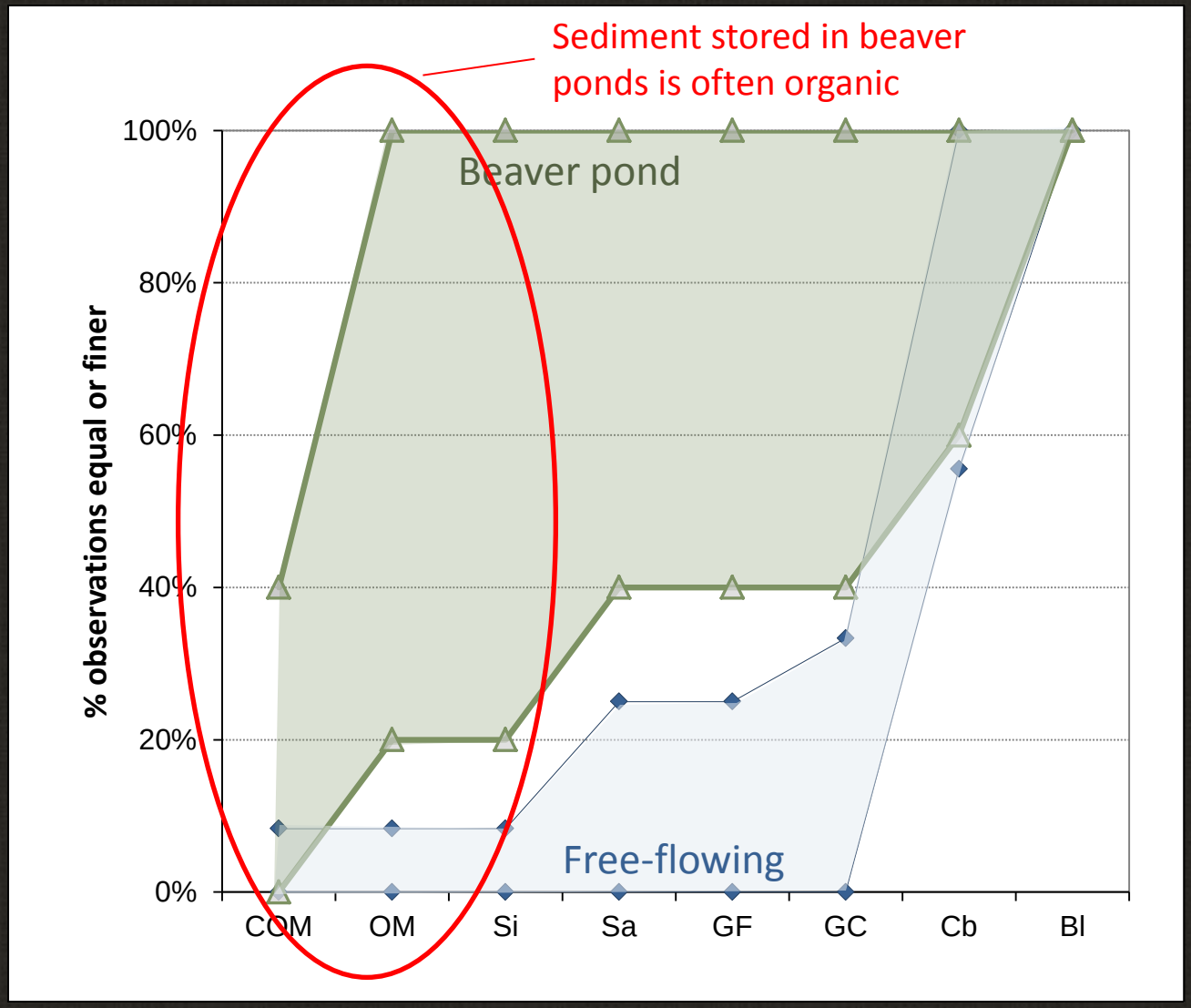
Without log jam:

- s = 0.07
- τ = 140N/m^2
- D = 190mm



Store fine sediment



Release water: sediment transport

Release water

$$Q \approx 0.607\ V^{0.295}\ h^{1.24}$$

(Froehlich 1997)

$$Q \approx 4\ m^3/s$$

=> 380 mm/d runoff

Release water

During breach:

runoff = 380 mm/d

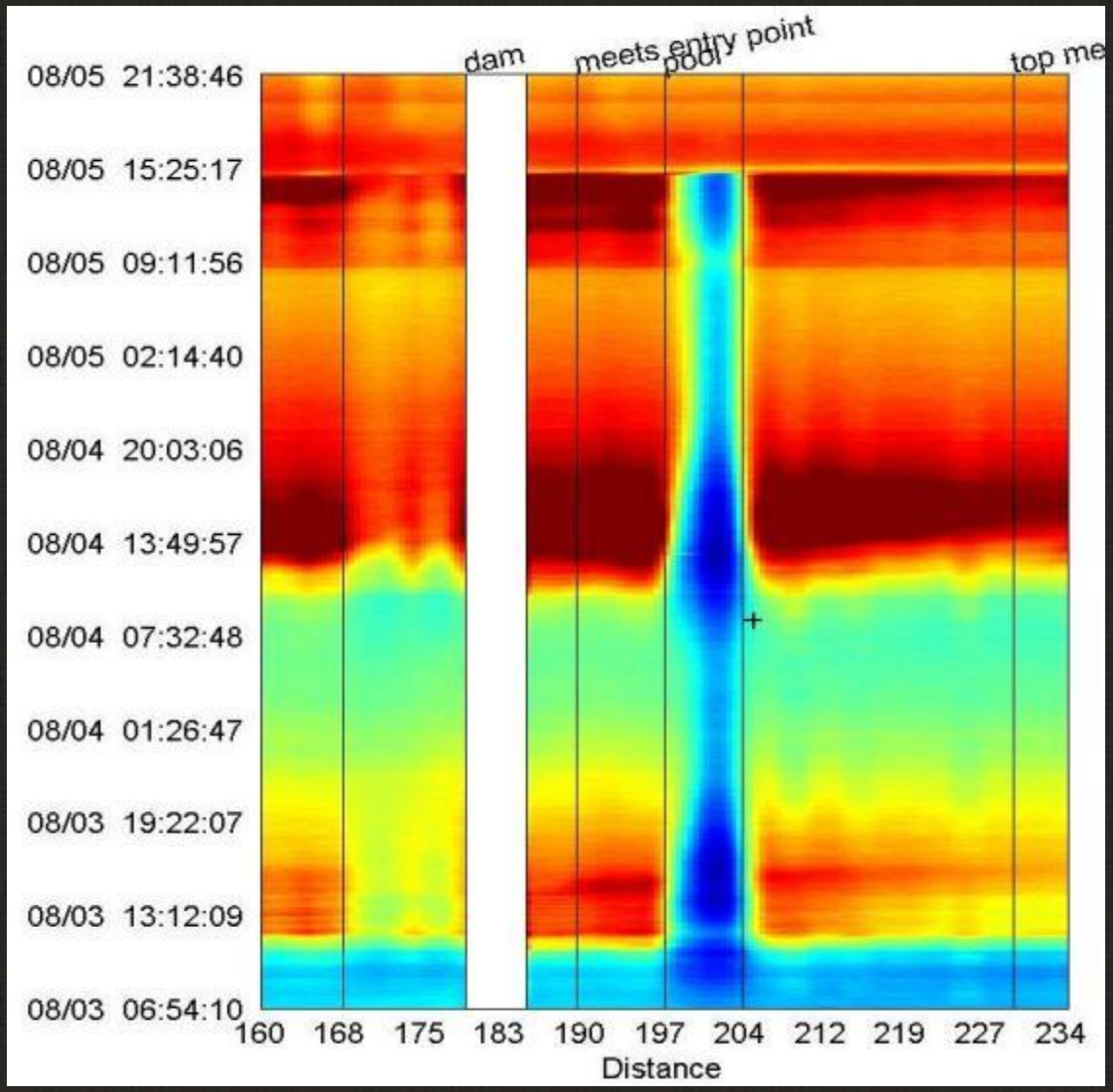
East Branch Pemigewasset:

runoff $_{max}$ = 246mm/d

Max runoff more than doubled during breach

Release water: scour pools

Release water: scour pools



Retain sediment after failure

Increase complexity

Increase complexity

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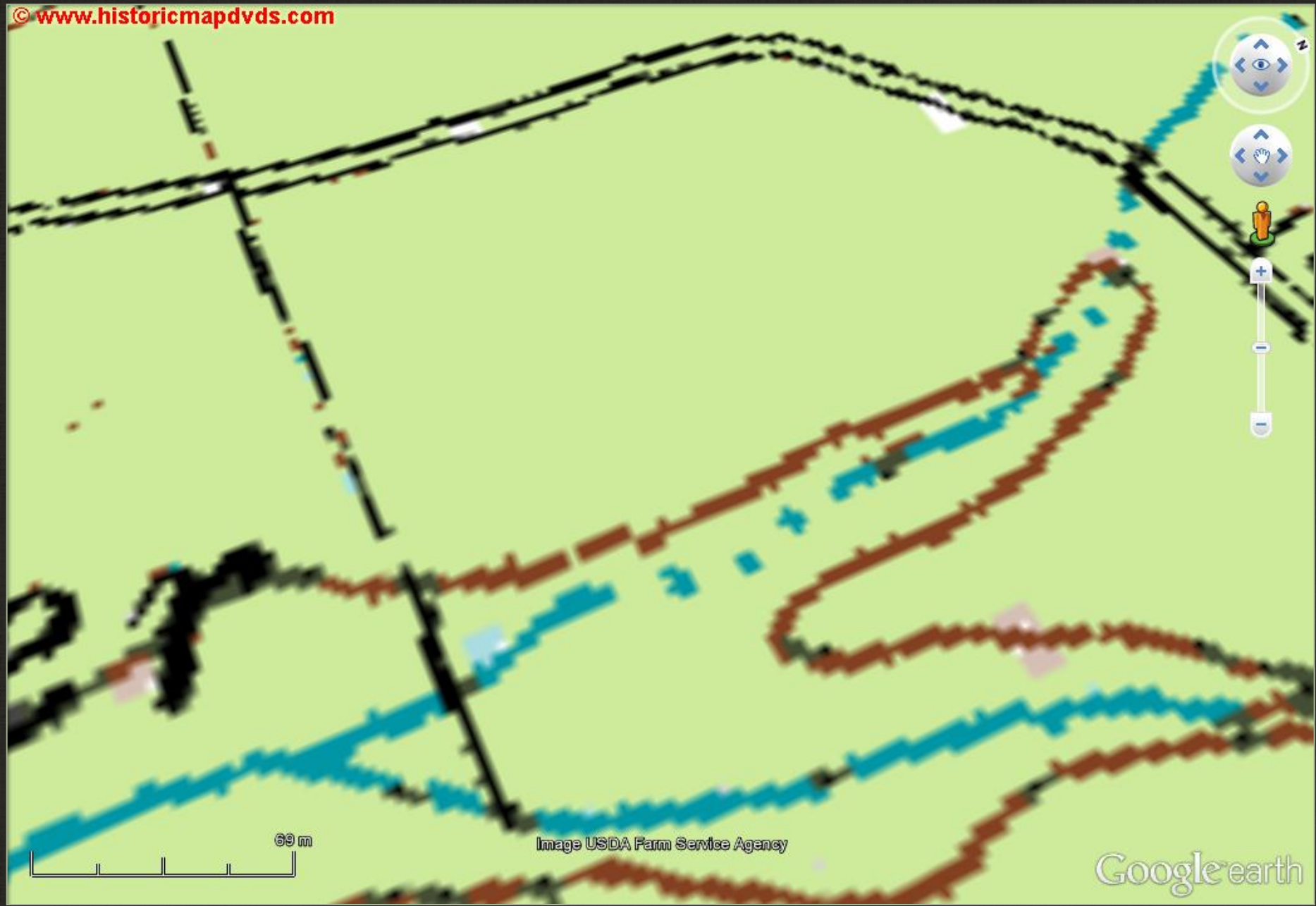
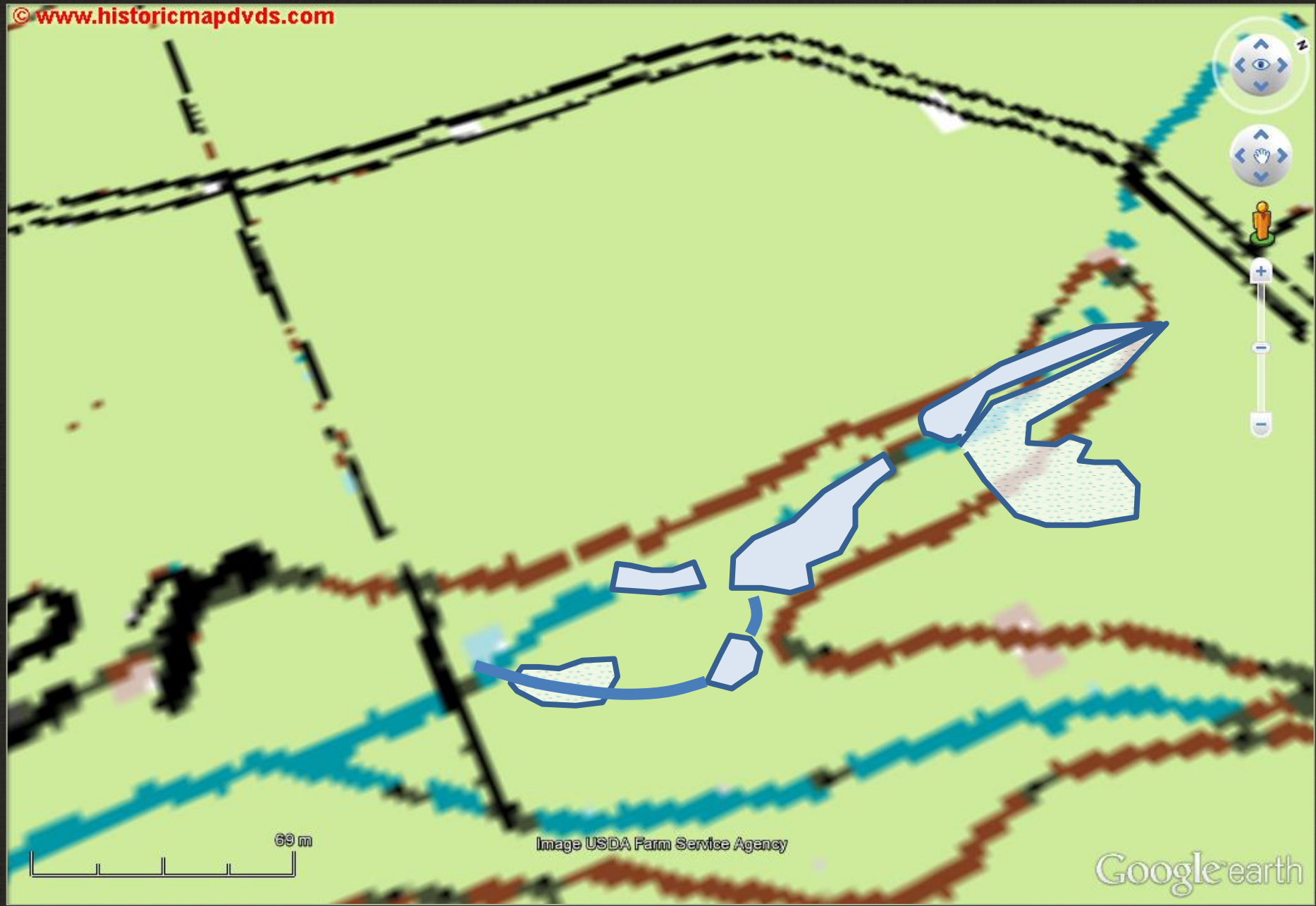


Increase complexity



Summary

"Natural" dam impacts on geomorphology

- Store fine sediments and water
- Catastrophic release of water
- Scour downstream channels
- Generate multiple channel threads

Legacy of natural dams removed

- Decreased water storage
- Homogenized channel shape
- Homogenized sediment size
- Smoothed sediment delivery
- Decreased riparian zone
- In large grain-size headwaters: static channels

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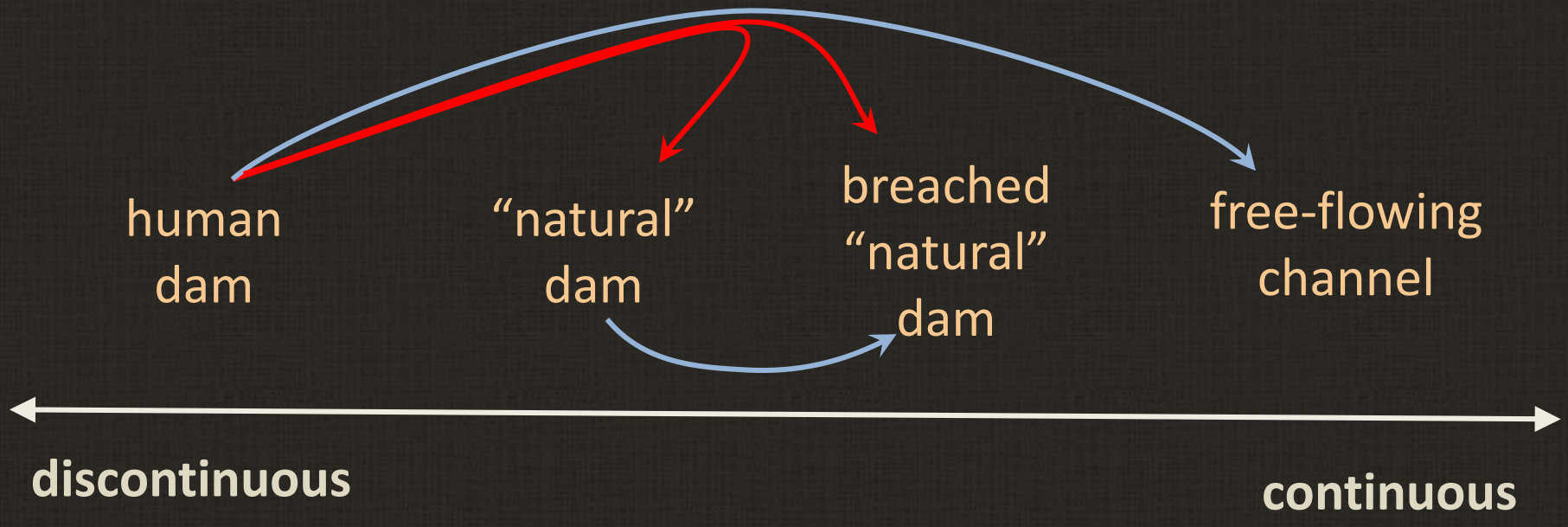
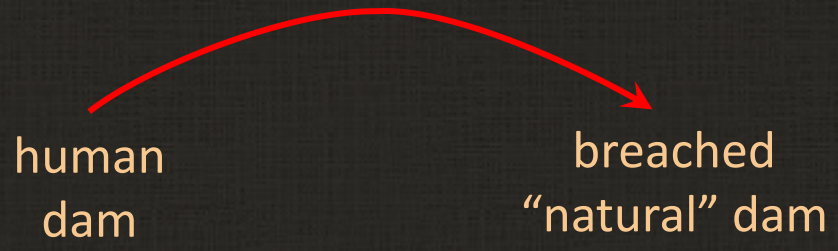
Restoration recommendations



Suggested restoration alternatives dam removal



- Leave part of spillway in place to retain water
- Decrease water levels slowly prior to breach
- Add wood to impoundment
- Leave sediment in place
- Create pools downstream of the dam
- Create alternate stream paths

Acknowledgements

- USEPA Science To Achieve Results (STAR)
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