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Riparian Resilience in the Face of Interacting Disturbances

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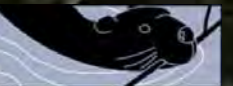
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Riparian Resilience in the Face of Interacting Disturbances



Alexa Whipple

**METHOW
BEAVER
PROJECT**



Advisor: Dr. Rebecca Brown

Photo Source: Methow Valley News



Riparian Resilience in the Face of Interacting Disturbances



Wildfire



Stream Channel
Erosion



Beaver

Methow River Watershed



4727 km²
~80cm annual precipitation

Wildfire

2014 Carlton Complex

Recent Fire Patterns

- Frequent-suppressed
- Larger scale
- Higher severity

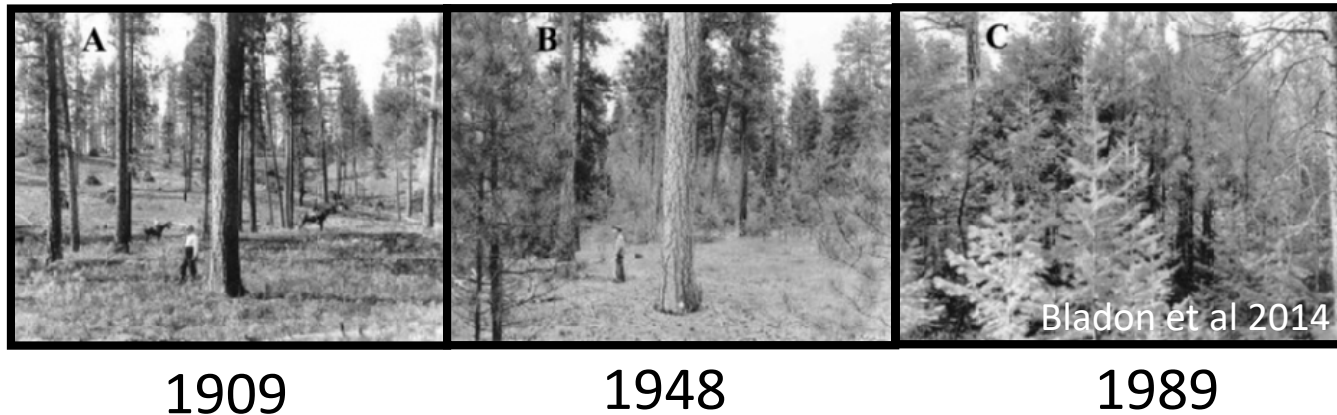
O'Connor et al 2014

Historic Fire Patterns

- Frequent
- Smaller scale
- Low severity



Photo source: Brick & Woodruff 2019



Bladon et al 2014

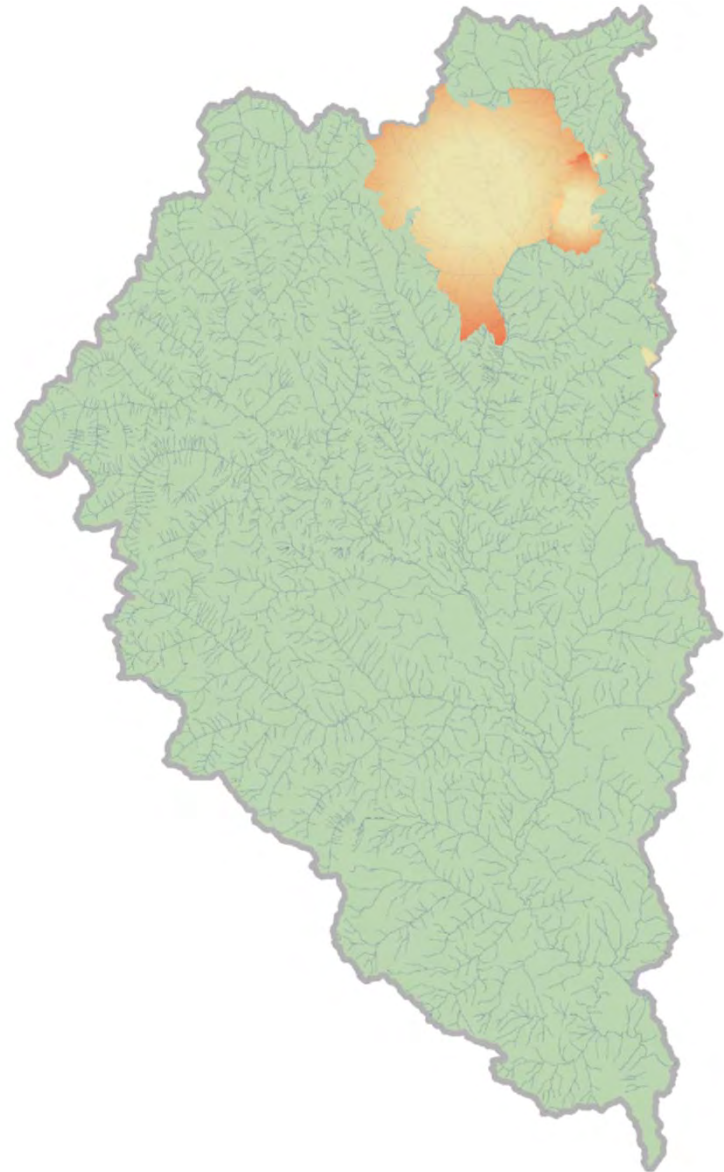
1909

1948

1989

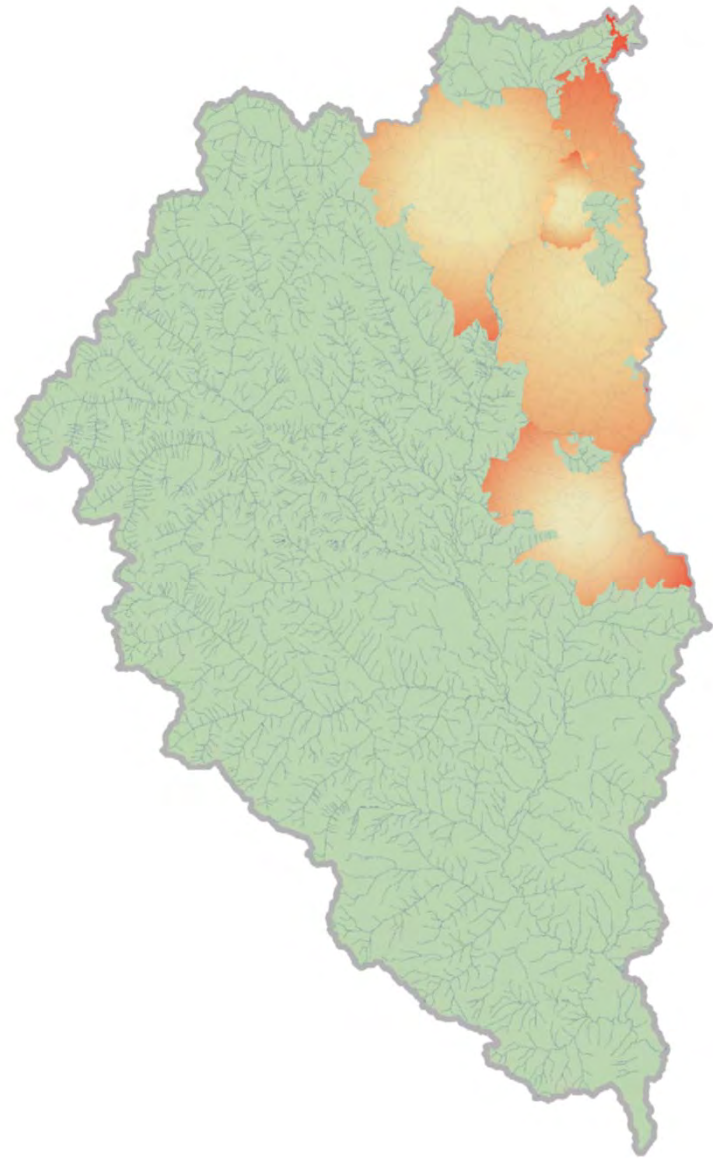
Methow River Watershed
~20 year fire history tableau

2000-2003



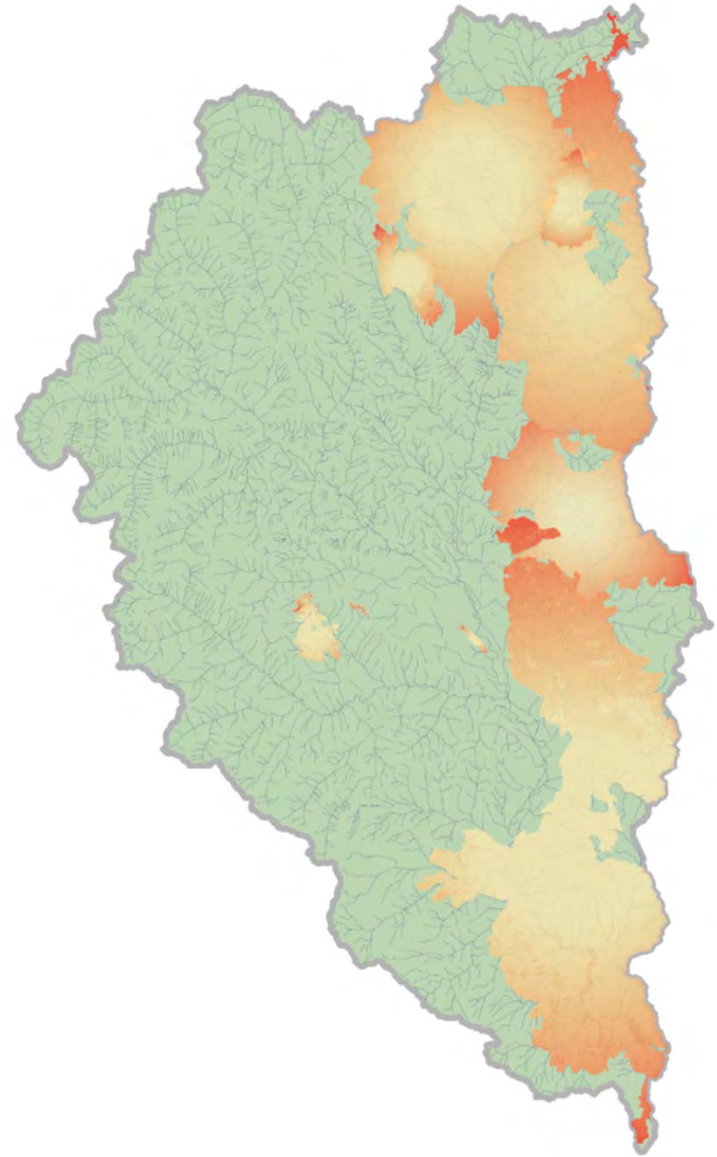
Methow River Watershed
~20 year fire history tableau

2006



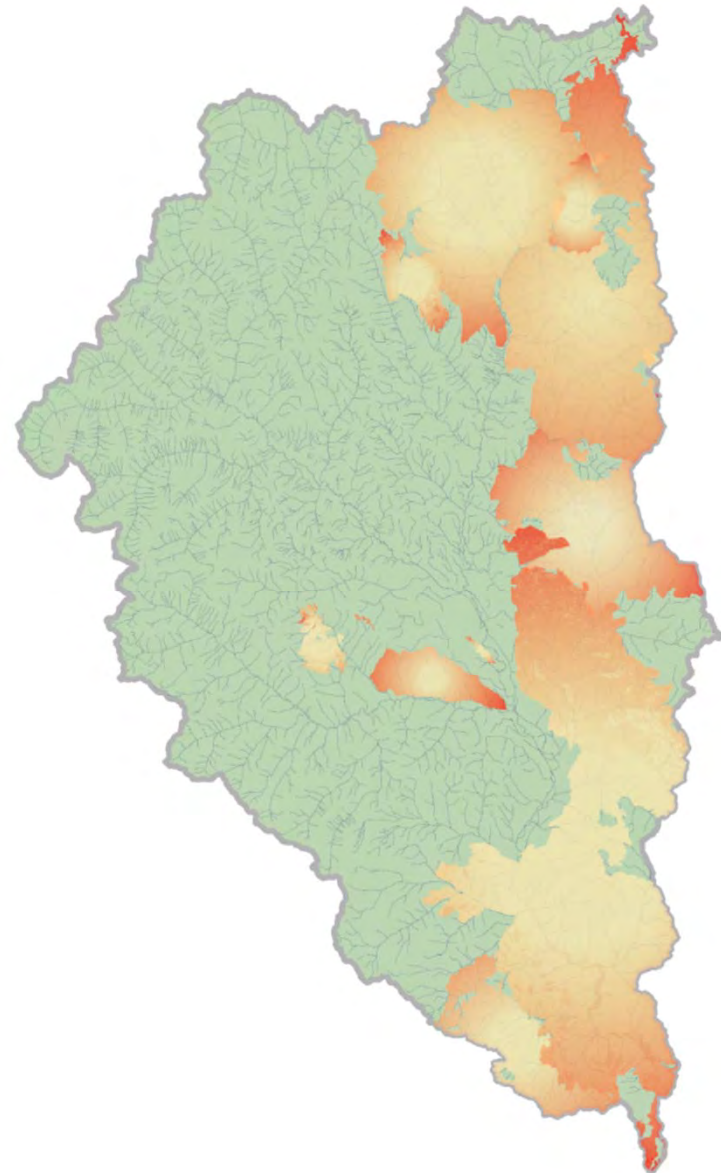
Methow River Watershed
~20 year fire history tableau

2014



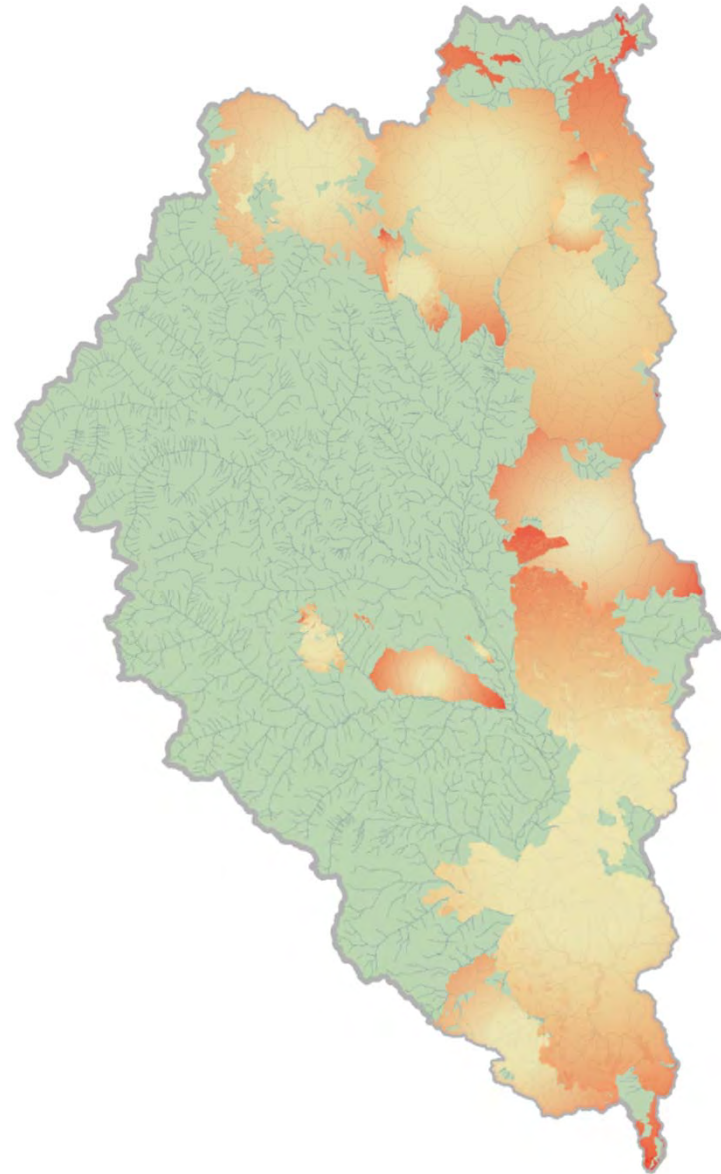
Methow River Watershed
~20 year fire history tableau

2015



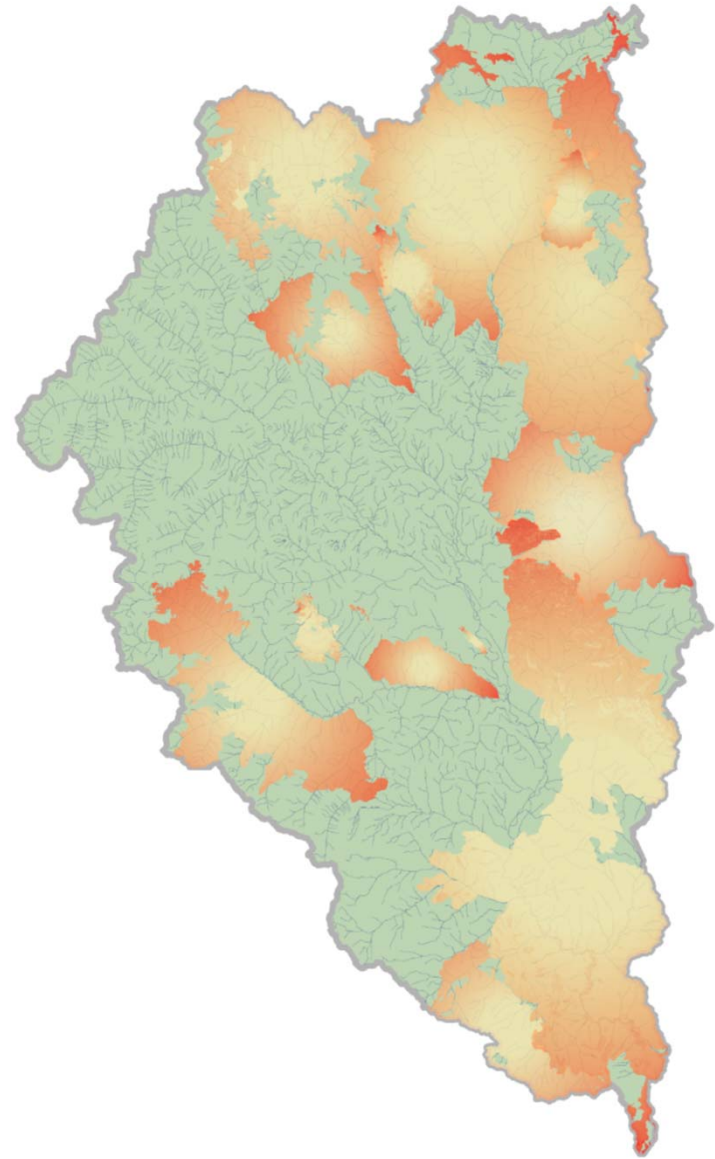
Methow River Watershed
~20 year fire history tableau

2017



Methow River Watershed
~20 year fire history tableau

2018



Increasing wildfire scale
& burn severity



Increasing soil erosion &
channel incision



Severe channel incising events after Wildfire

- ↓ Floodplain connectivity
- ↓ Flood control
- ↓ Water storage
- ↓ Stream complexity
- ↓ Habitat/Biodiversity
- ↓ Water table



~3 meters of erosion following rain events
2014 Carlton Complex fires, WA

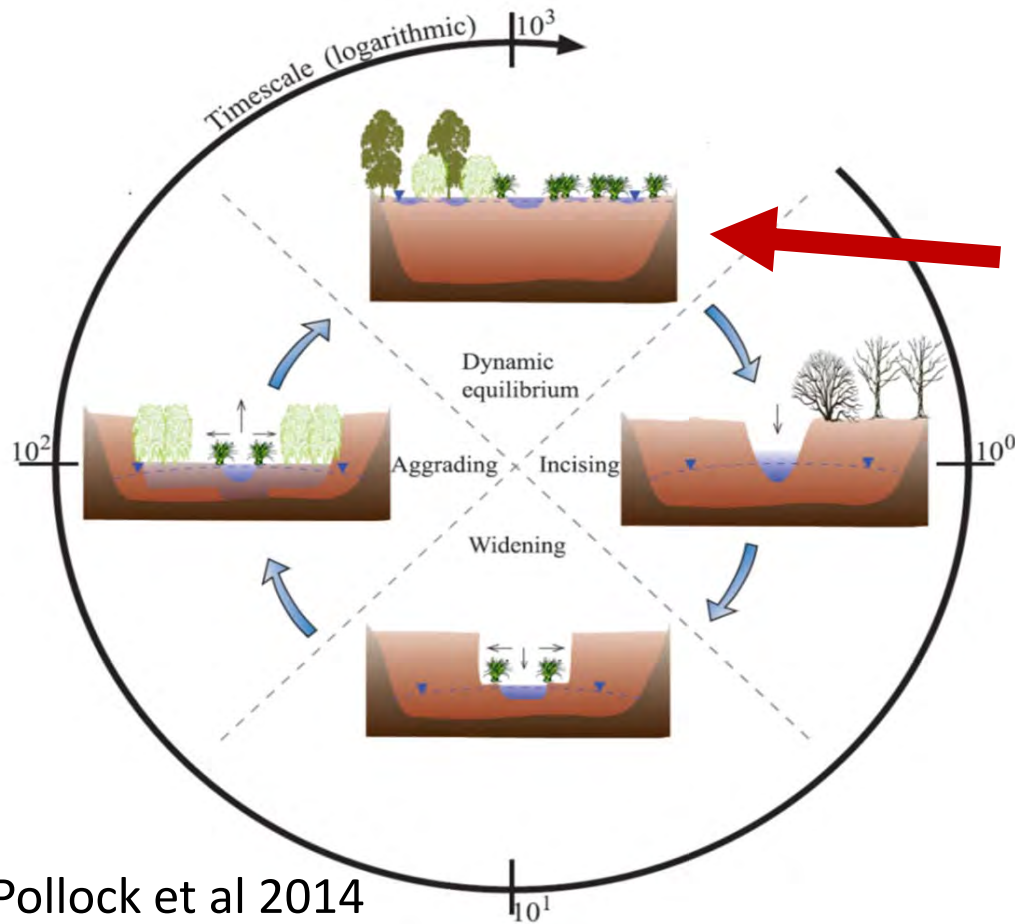
Severe channel incising events after Wildfire

- ↓ Floodplain connectivity
- ↓ Flood control
- ↓ Water storage
- ↓ Stream complexity
- ↓ Habitat/Biodiversity
- ↓ Water table



Time?

Time?

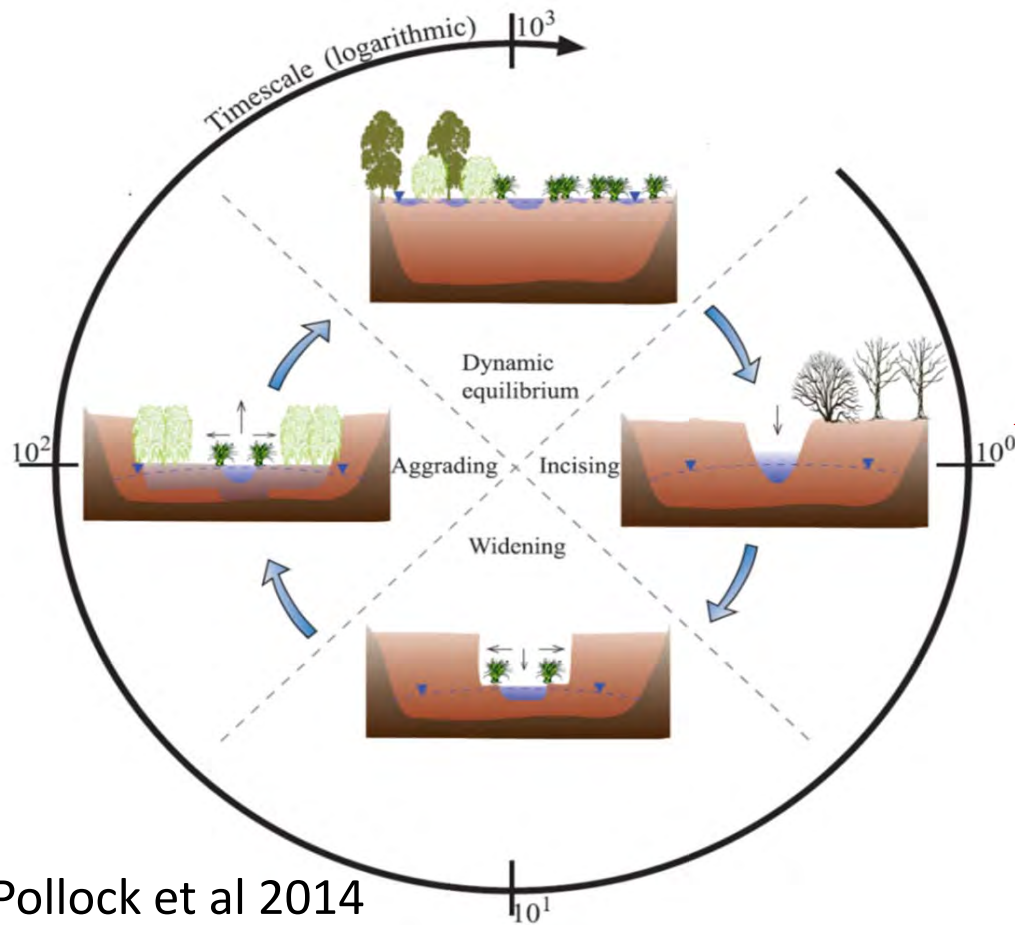


Stream Evolution Model

Dynamic Equilibrium
or complex channel form

Pollock et al 2014
Cluer & Thorne 2013

Time?



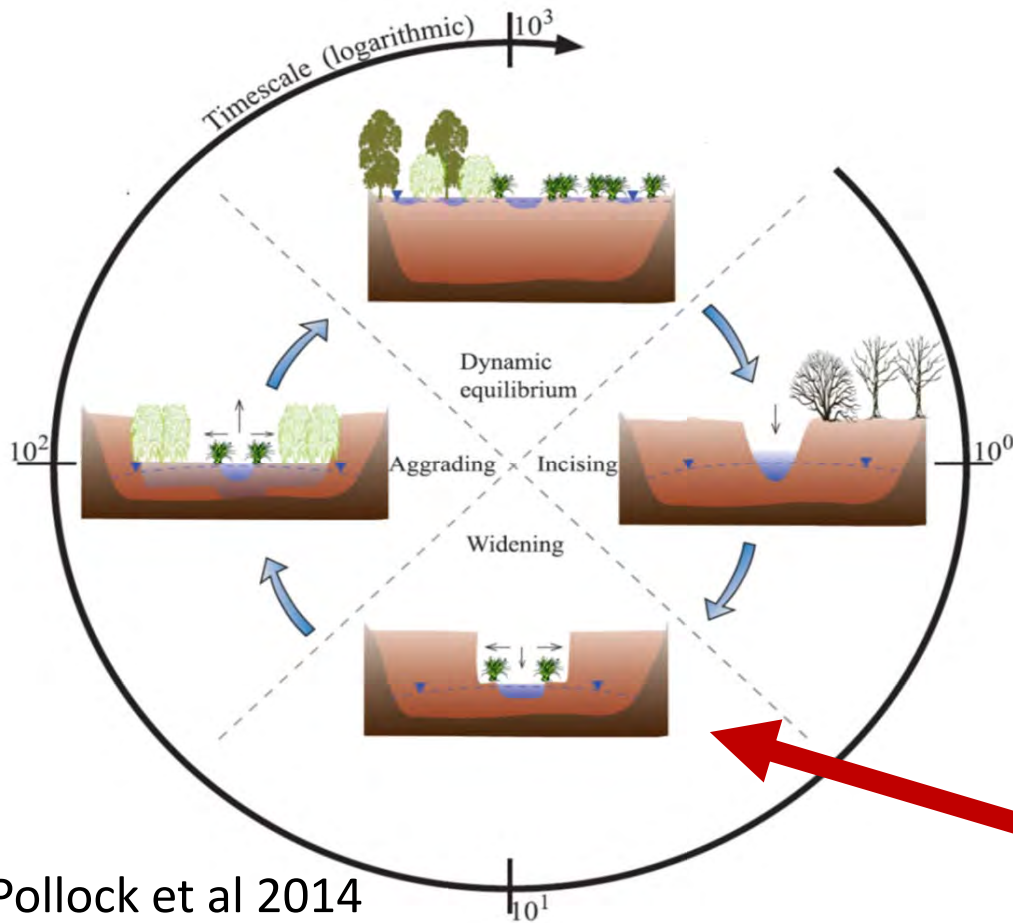
Stream Evolution Model

Incising event

Pollock et al 2014
Cluer & Thorne 2013

Time?

Stream Evolution Model

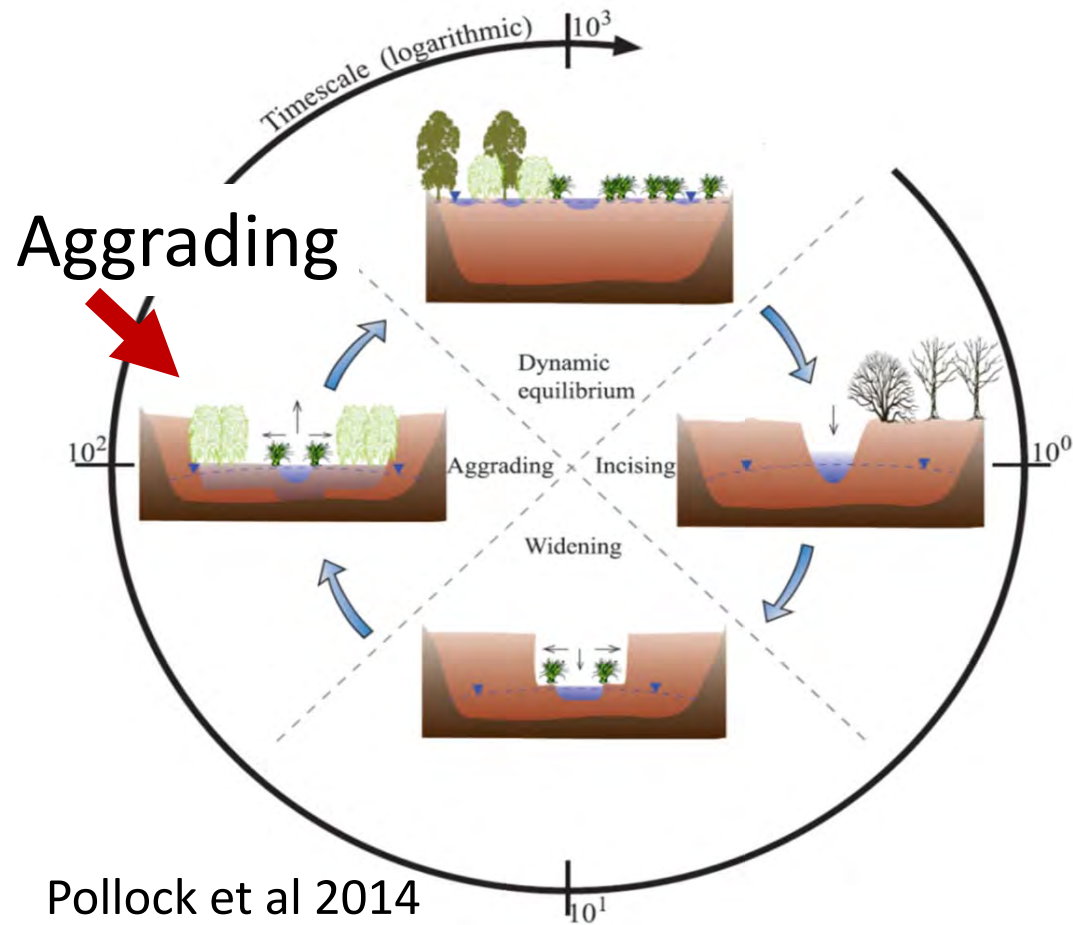


Widening of channel

Pollock et al 2014
Cluer & Thorne 2013

Time?

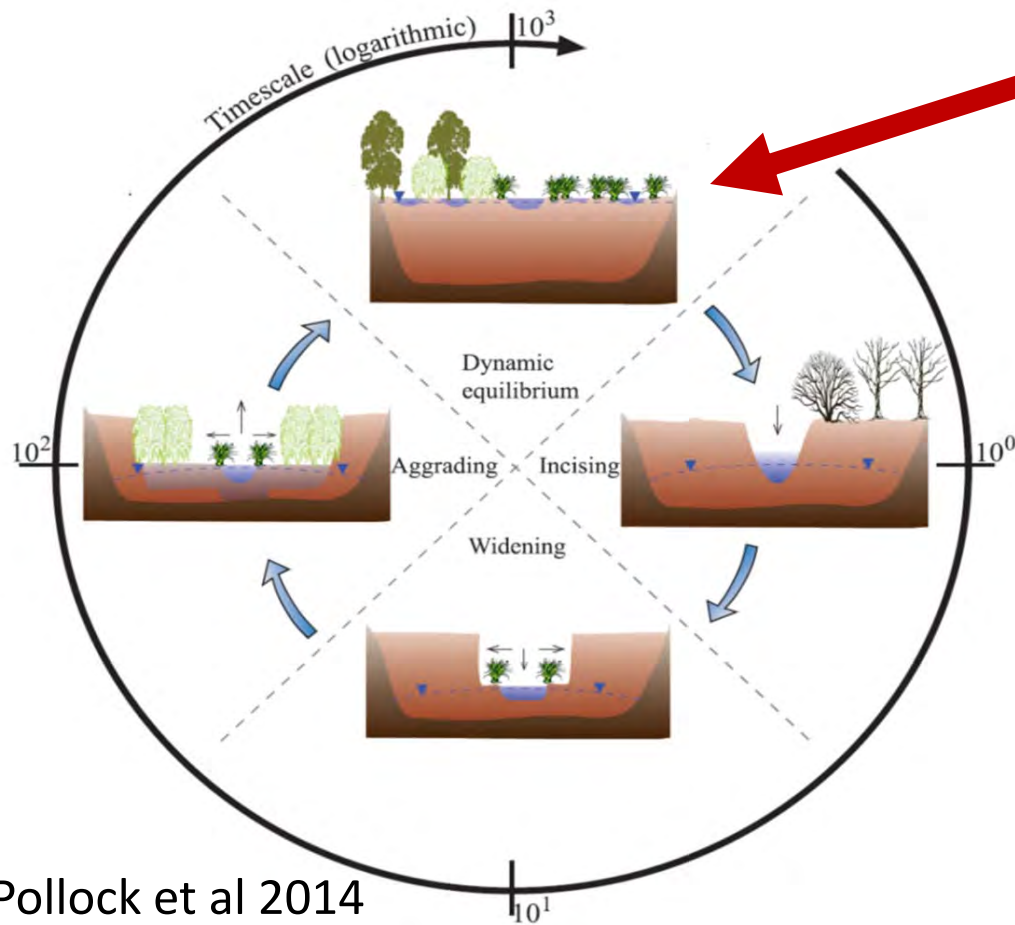
Stream Evolution Model



Pollock et al 2014

Cluer & Thorne 2013

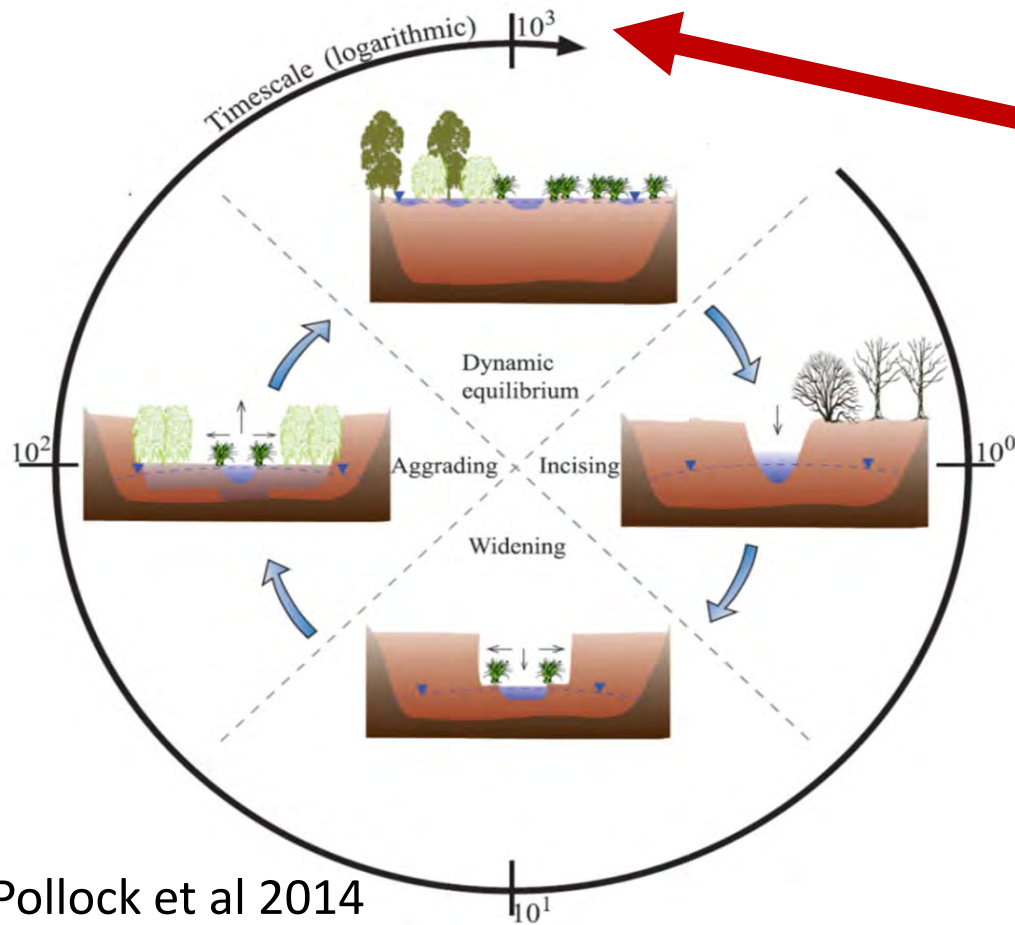
Time?



Return to complex
channel form

Pollock et al 2014
Cluer & Thorne 2013

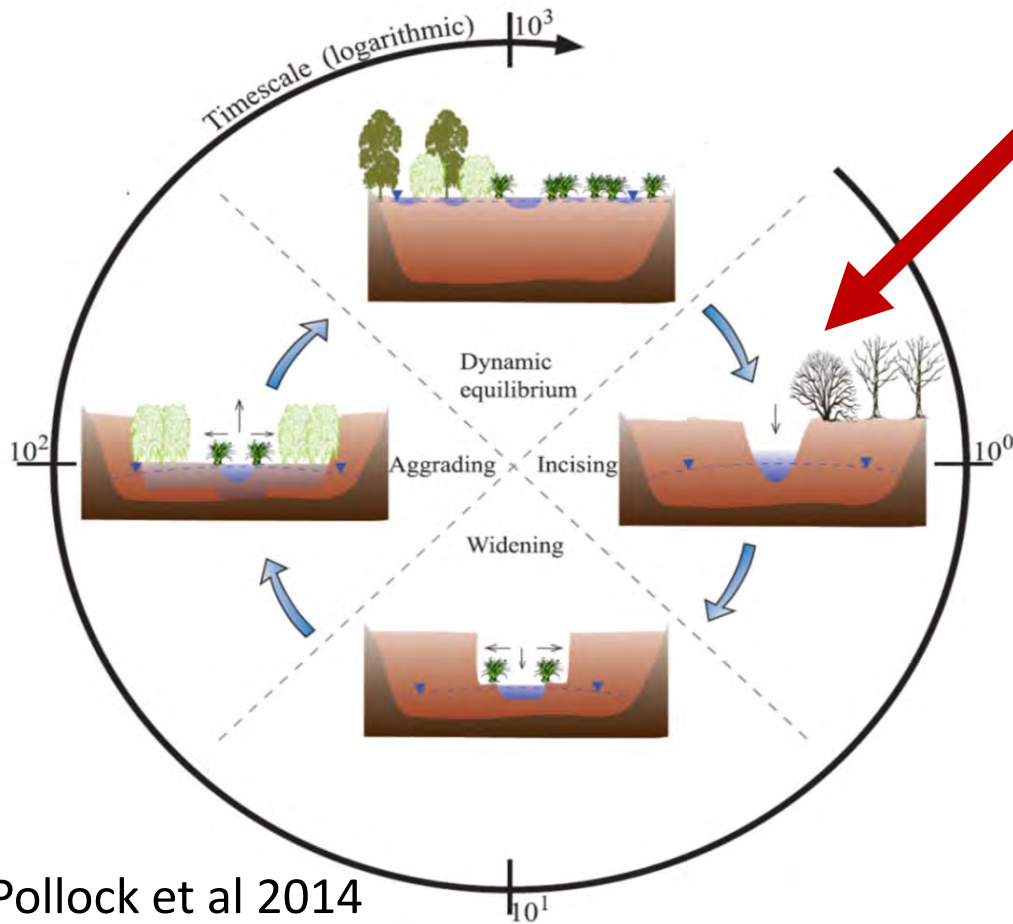
Time?



Logarithmic timescale
100's-1000's of years

Pollock et al 2014
Cluer & Thorne 2013

Time?



Incised stable state

a. pre-incision

b. degrading

c. degrading & limited widening

d. aggrading/quasi equilibrium

Beechie et al 2007

Pollock et al 2014
Cluer & Thorne 2013

River engineering?



Source: Methow Salmon Recovery Foundation



Source: Clackamas Conservation District

Historically-3 beavers/stream km

Incised stream channel

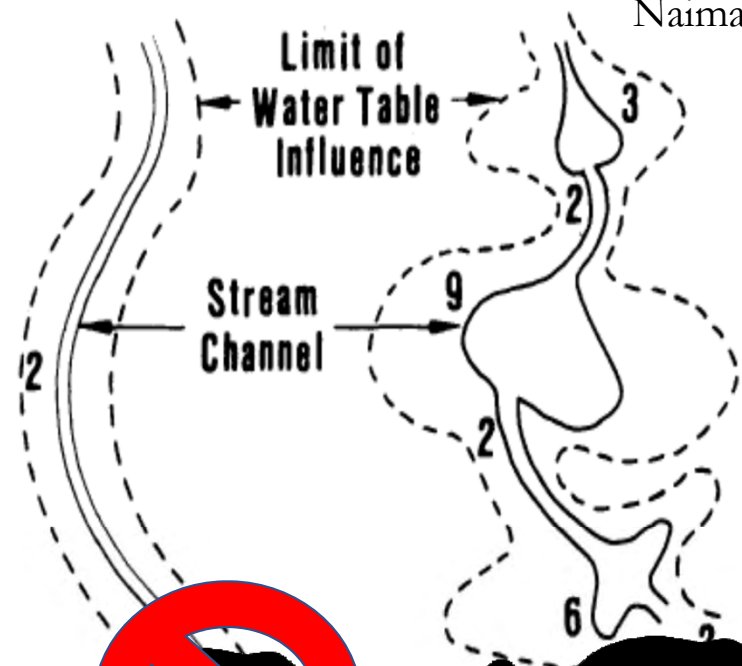


Chase Dekker via Shutterstock

Beaver dam building activity increases:

- Flood attenuation
- Water storage
- Stream complexity
- Habitat/Biodiversity
- Water table

Floodplain connectivity



Hawk Creek, WA www.fws.gov



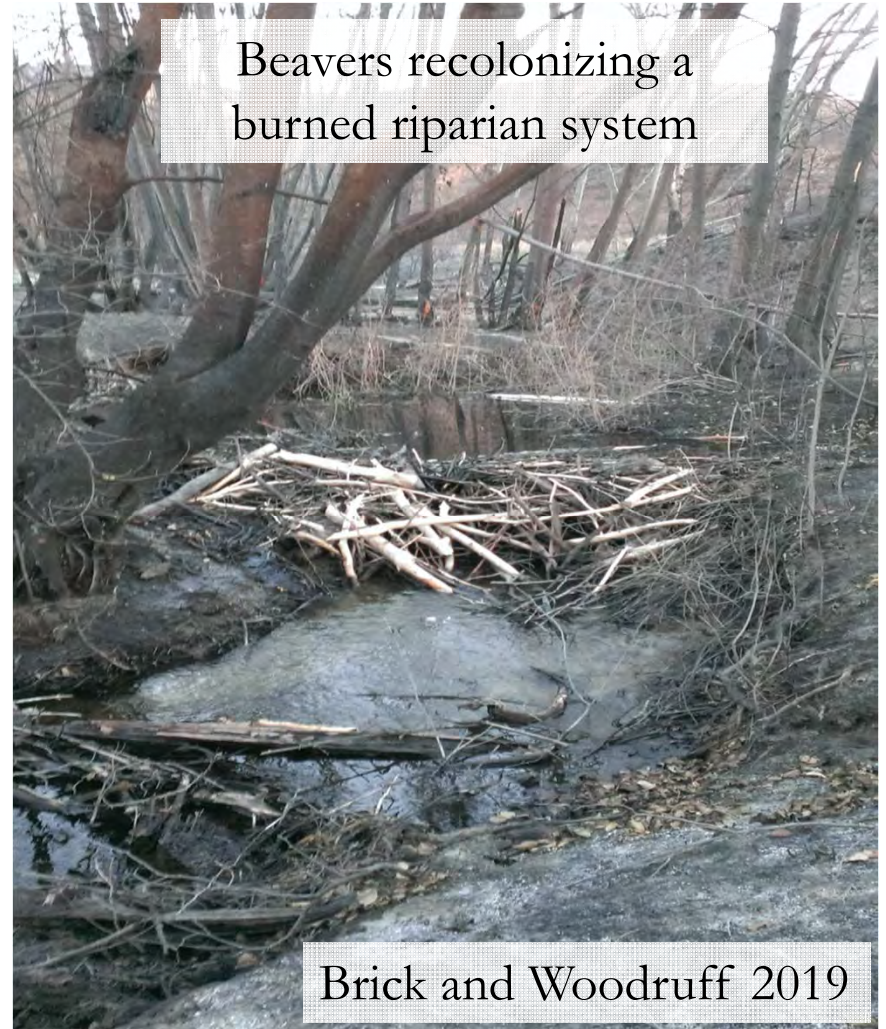
Wikipedia.com

Can beaver activity increase the resilience of burned & degraded riparian systems ?

Wildfire & storm erosion followed by incision





Beavers recolonizing a burned riparian system

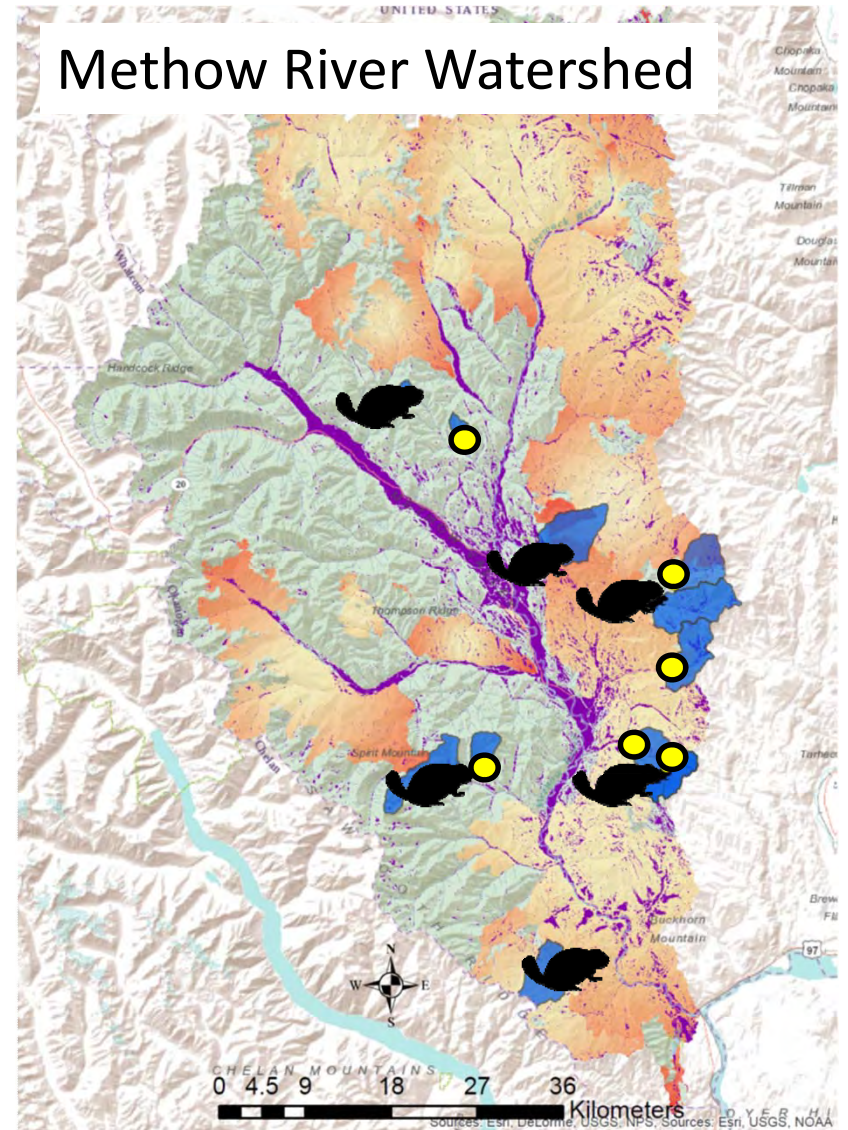


Study Design

12 sites	Beaver	No Beaver
Fire	3	3
No Fire	3	3

Data Collection:
July – Nov. 2018

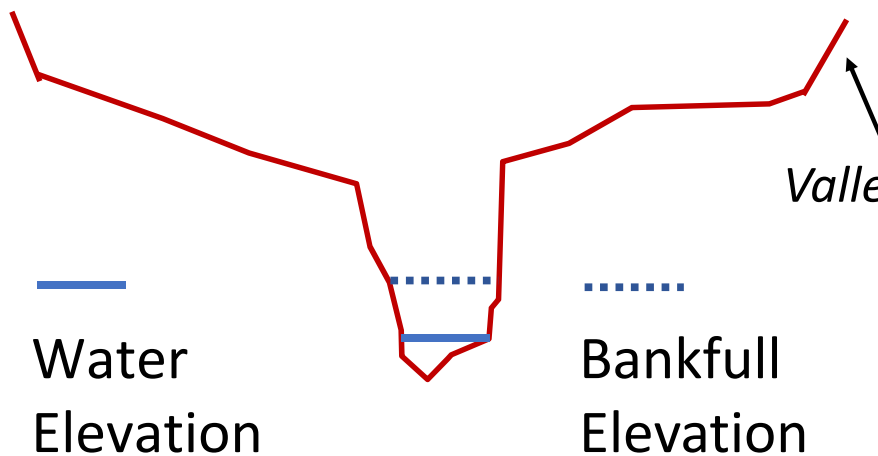
-  = <10% slope of stream
-  = Fires since 2001
-  = study site
-  = beaver site
-  = no beaver site



Stream Channel Cross Sections after Wildfire

Bankfull elevation

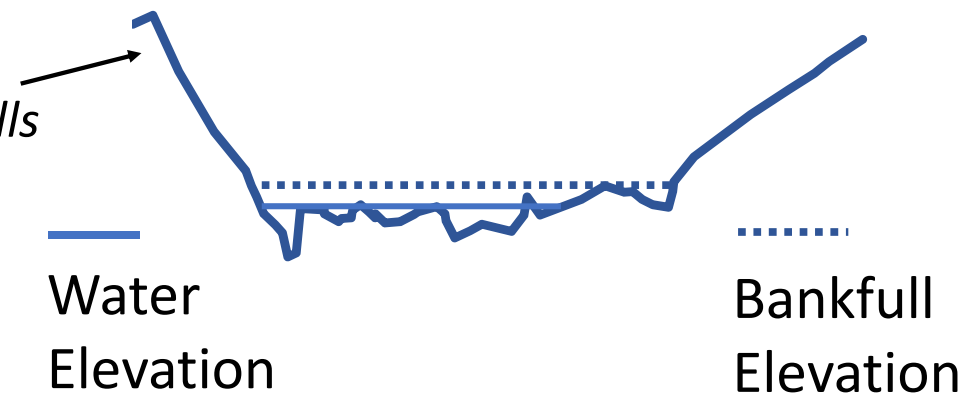
2 year high flow mark



Incised channel = low WD Ratio

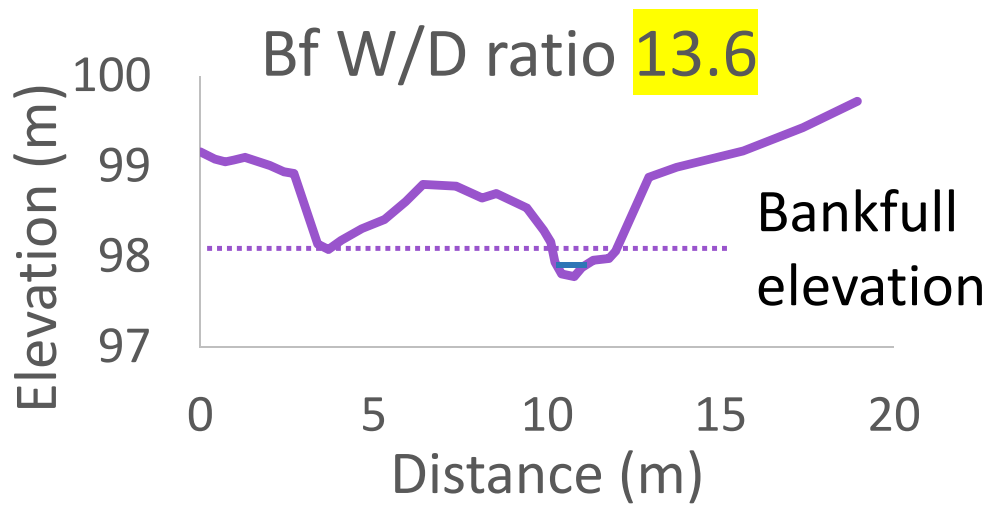
Bankfull Width/Depth (W/D) Ratio

- connection w/ floodplain
- stream evolution potential

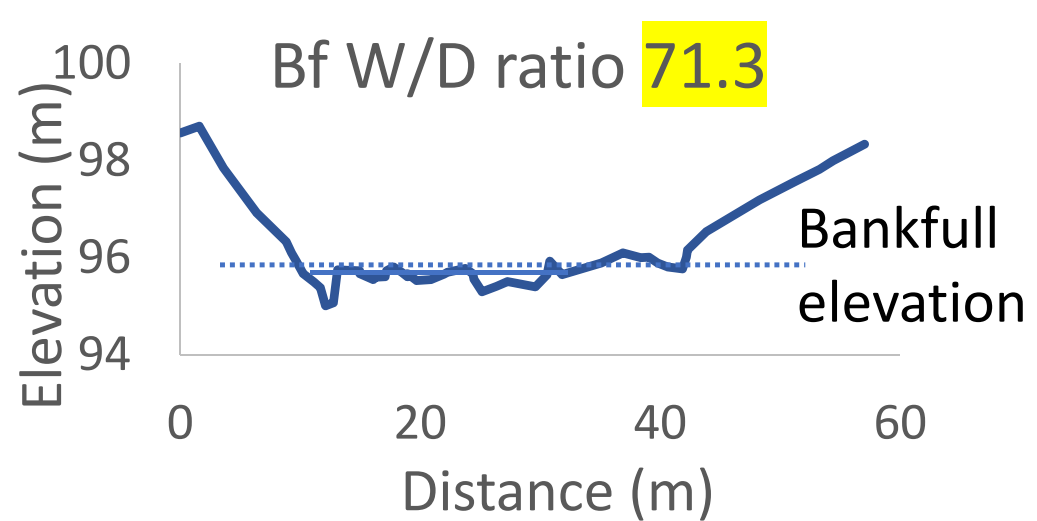


Complex channel = high WD Ratio

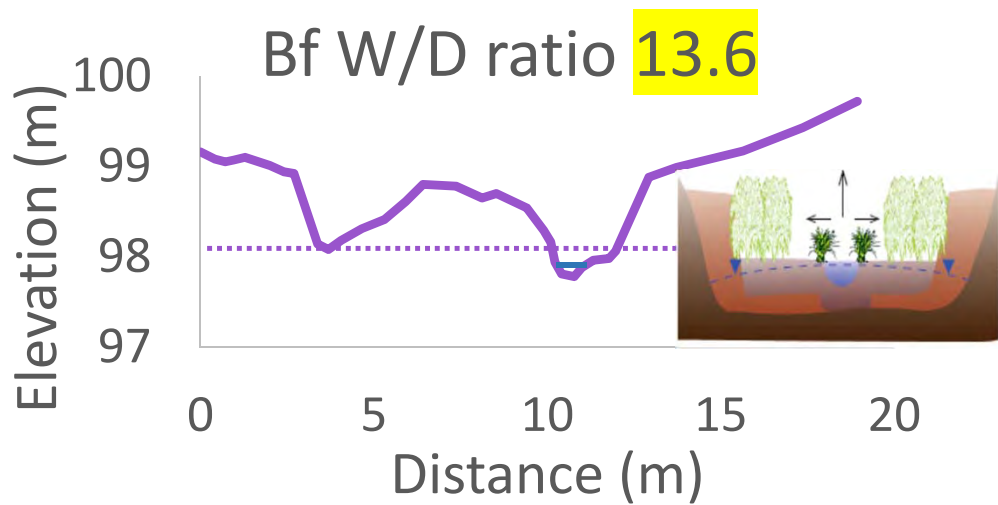
No Beaver/No Fire-Third Creek



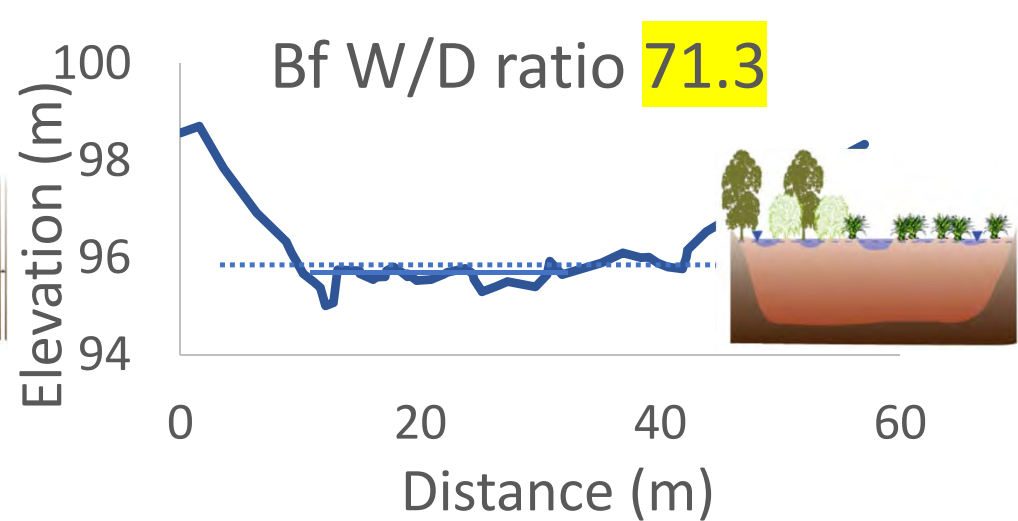
Beaver/No Fire-Cub Creek



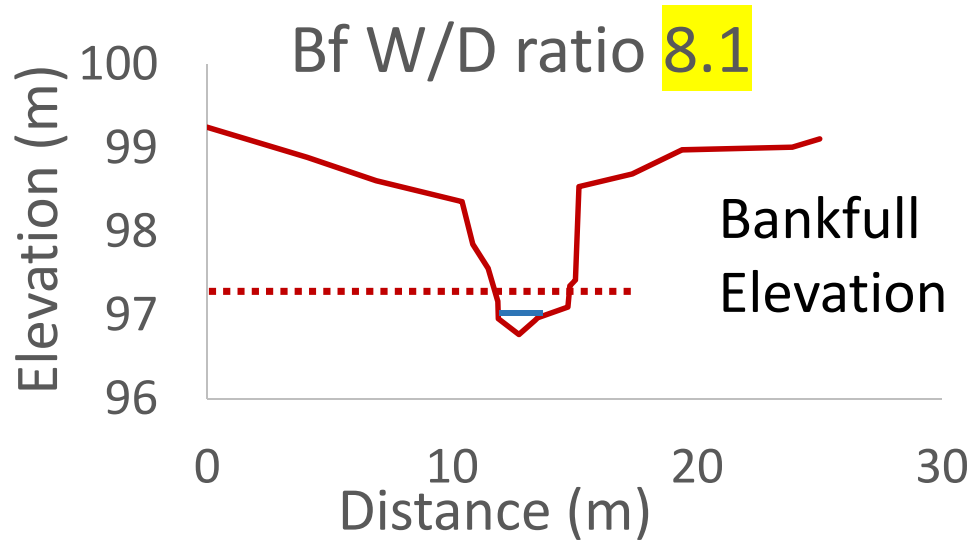
No Beaver/No Fire-Third Creek



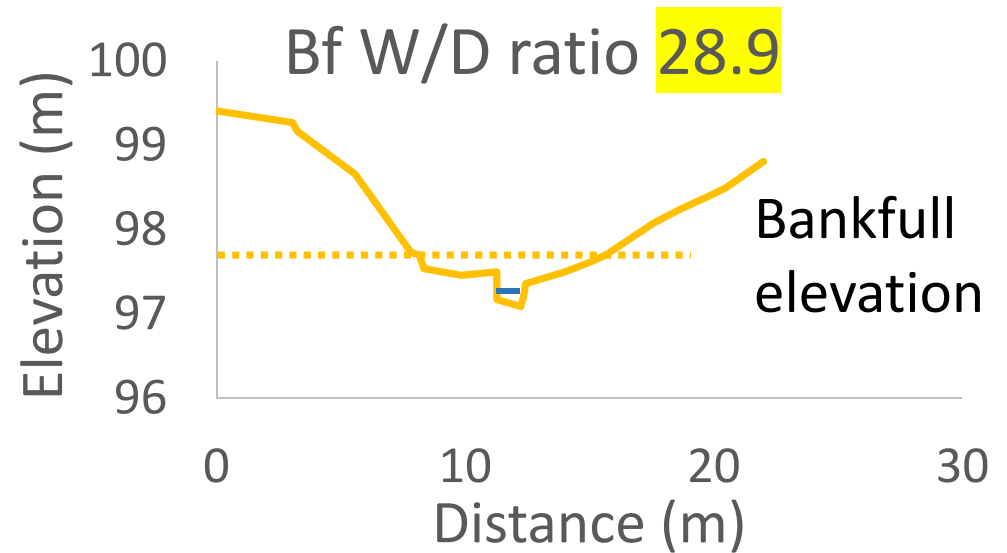
Beaver/No Fire-Cub Creek



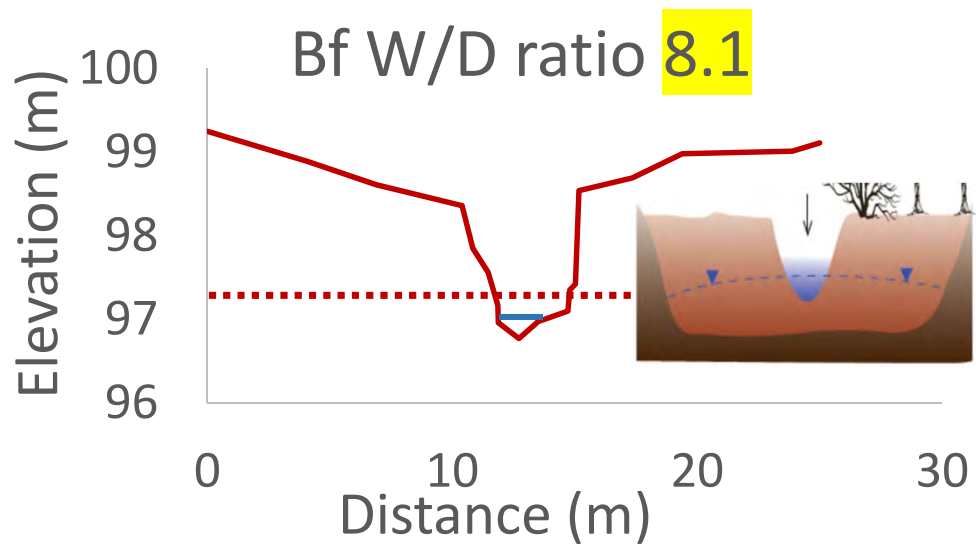
No Beaver/Fire-NF Benson Creek



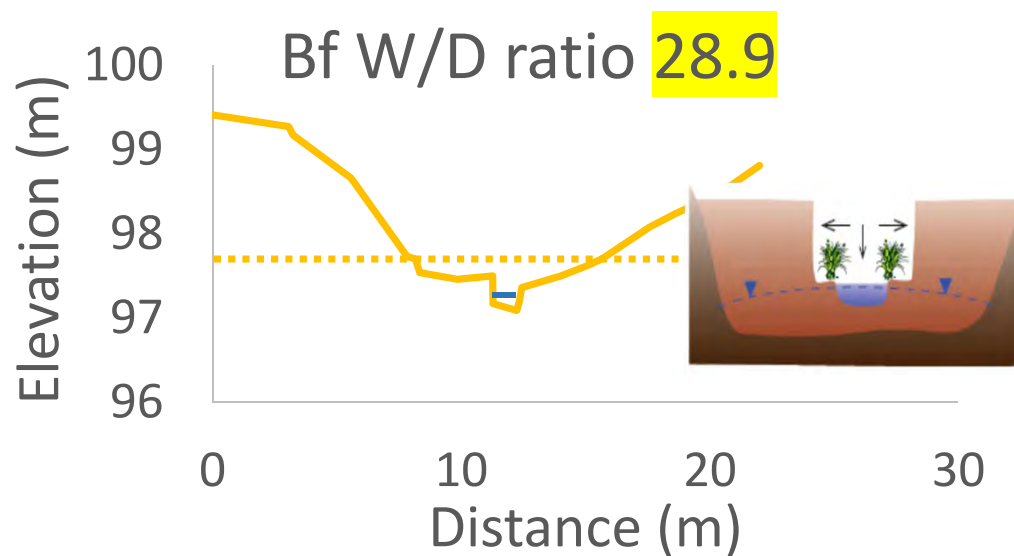
Beaver/Fire-SF Benson Creek



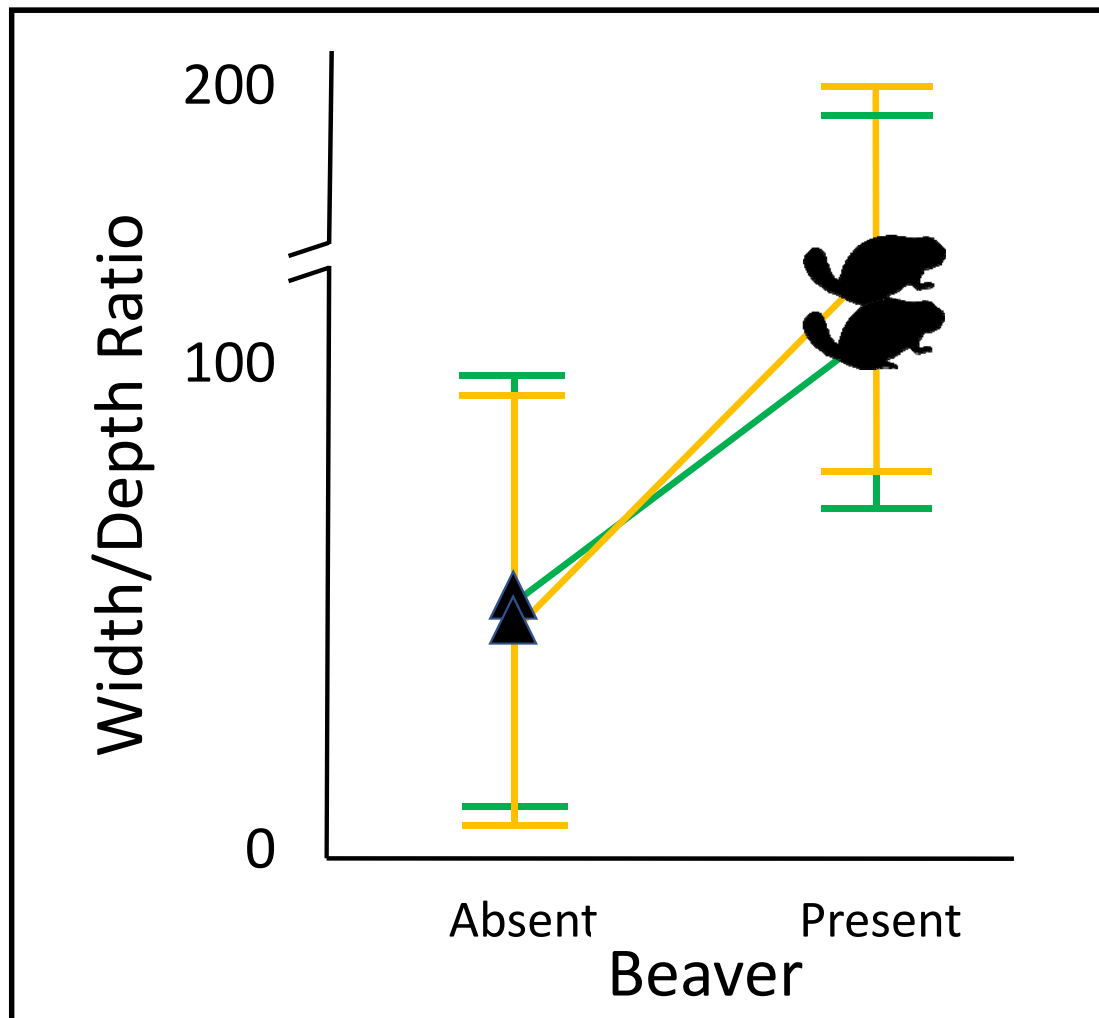
No Beaver/Fire-NF Benson Creek



Beaver/Fire-SF Benson Creek



Beavers increase Width/Depth ratios in burned watersheds



— Burned
— Not burned

Beaver presence/absence
p-value = 0.0416

Do beavers increase riparian resilience after Wildfire?

↑ Width/Depth ratios
in burned channels

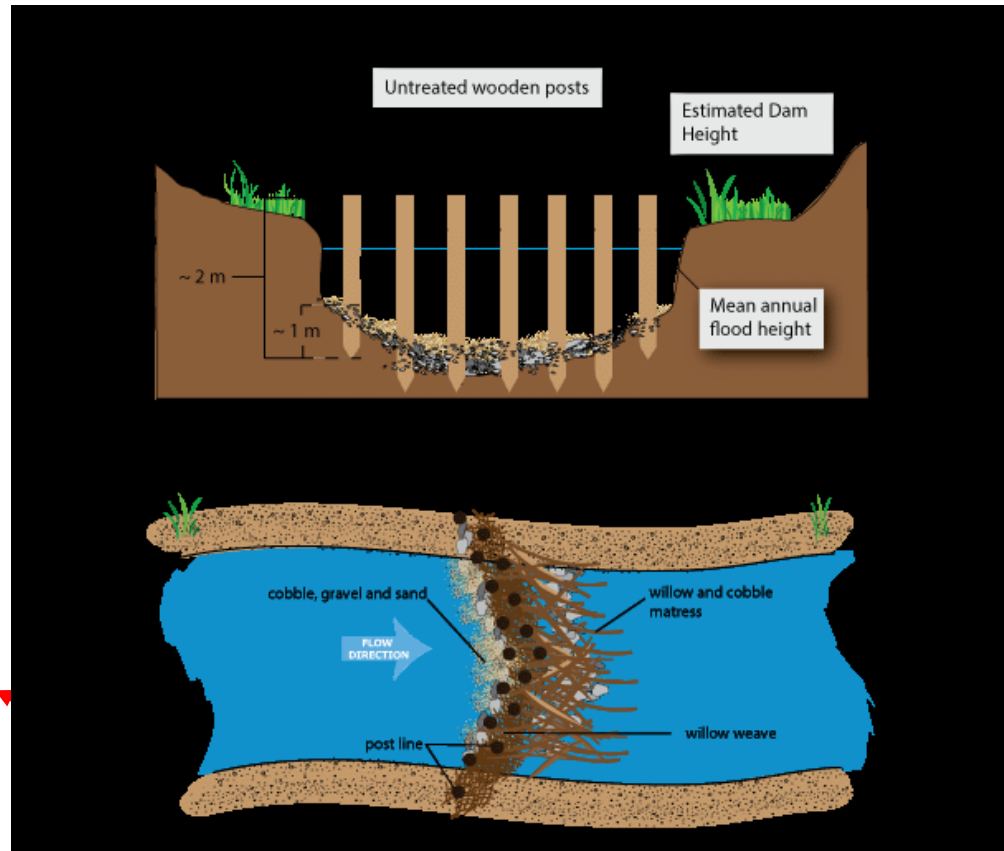
Additional thesis results:

- Decreased Phosphorus in burned systems with beaver
- Decreased pH in burned systems with beaver
- Fewer introduced veg. spp. in burned systems with beaver
- And more.....



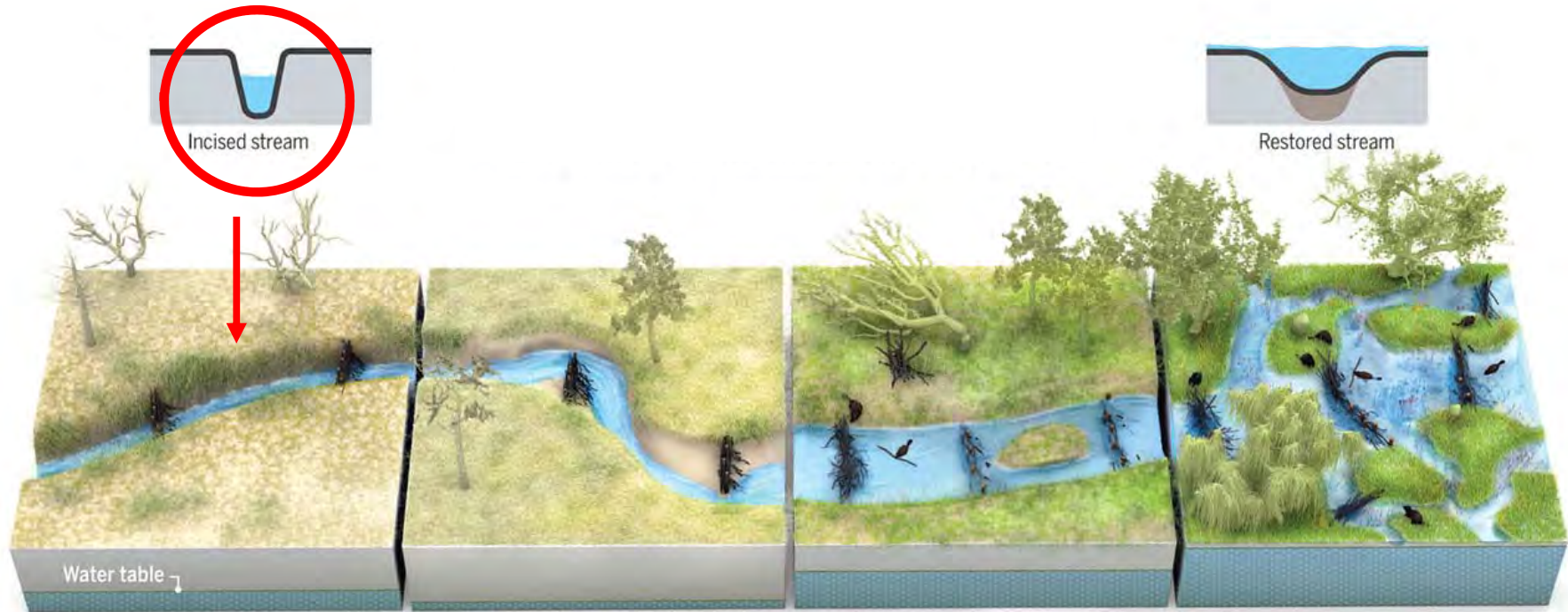
Lightning Creek - Burned in 2006 Tripod Fire
2008 Beavers reintroduced, occupied 10 years

Future Directions – beaver dam analogs (BDA's)



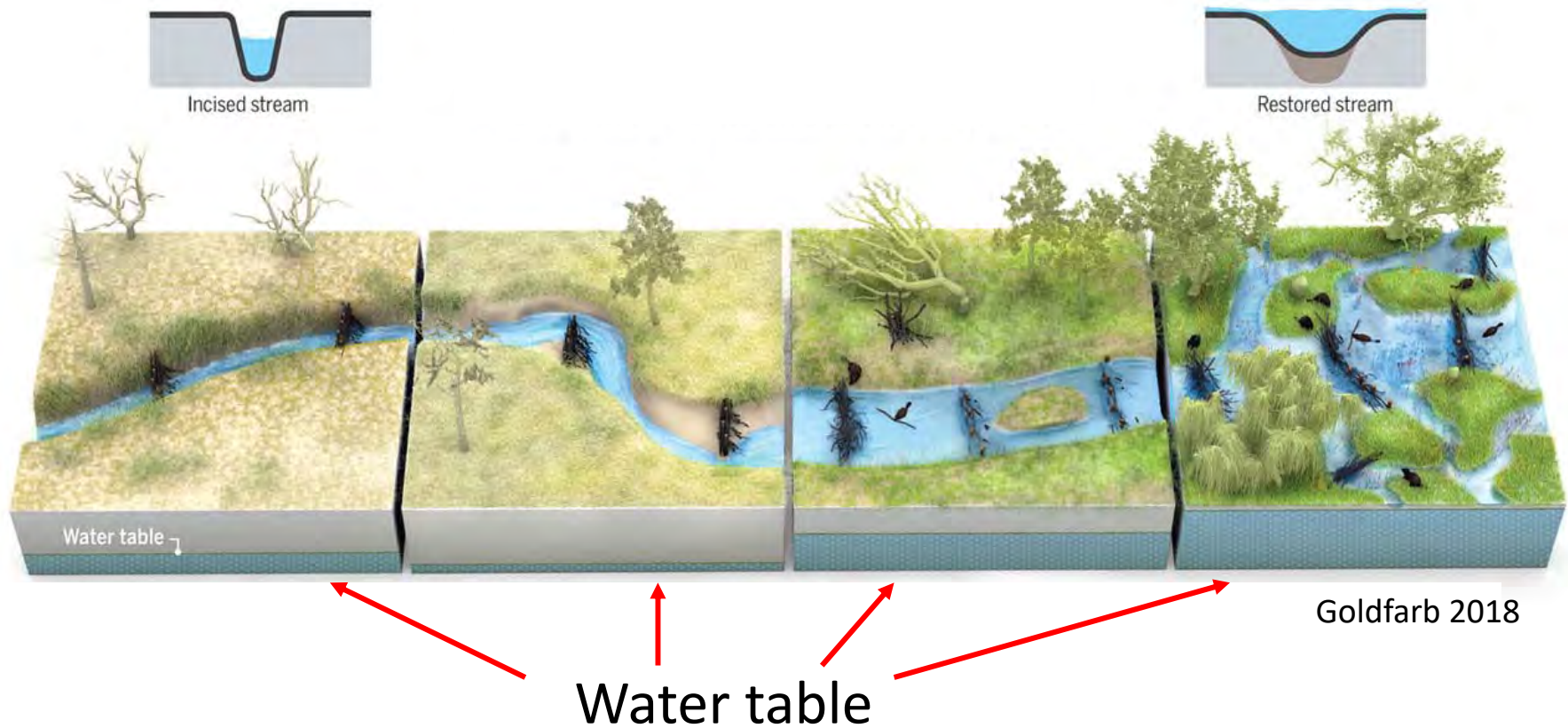
Source: Anabran Solutions, LLC

Future Directions – beaver dam analogs (BDA's)



Goldfarb 2018

Future Directions – beaver dam analogs (BDA's)





Acknowledgements



- My dear family and Beavers!
- Rebecca Brown, Margaret O'Connell, Lauren Stachowiak, Stacy Warren, Camille McNeely - EWU
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Questions?

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