

# Ecosystems

## TROPHIC CASCADES

Reintroduction of the grey wolf to Yellowstone National  
Park



# Wolves

## and the

### *Landscape of Fear*



# Trophic Cascades:

According to Ripple *et al.* 2016

- ‘We propose that trophic cascades specify the effects of predators that propagate **downward** through food webs across multiple trophic levels’
- Trophic cascades can be triggered by *consumptive* interactions between predators and prey **and** *non-consumptive* effects due to perceived predation risk by prey (fear).
- Various ‘**knock-on effects**’, initiated by trophic cascades and propagating laterally or upward from the main interaction chain, should **not** be thought of as part of the trophic cascade

# Trophic Cascades

## Definitions of Terms (2)

- Direct Consumptive effect: lethal effect of a predator on prey due to predation mortality.
- Indirect Non-consumptive effect: non-lethal effect of a predator on prey due to changes in prey behaviour or other traits in response to perceived predation risk by prey (e.g. fear)

Ripple et al. (2016). What is a Trophic Cascade? *Trends in Ecology & Evolution* **31**:841-848

# Trophic Cascades



- Grey Wolf (*Canis lupus*)
- Became extinct in Yellowstone National Park (US) 1926
- Re-introduced in 1995
- Predator – likes Elk (Red deer subspecies) *Cervus canadensis*



# Trophic Cascade

(Direct effects of Wolf re-introduction)

Wolf



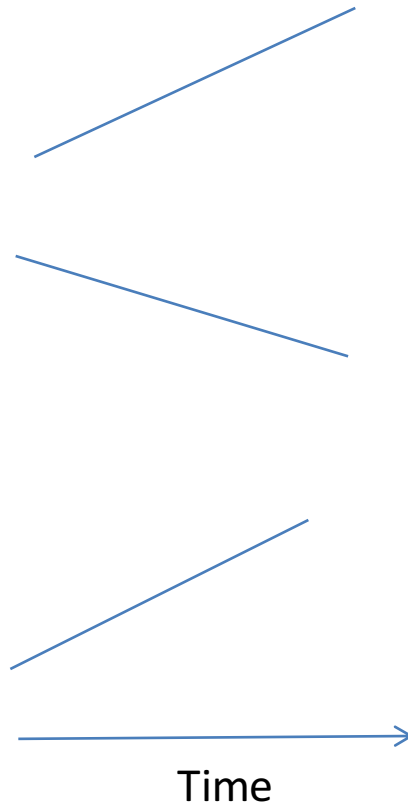
Elk



Trees

(Aspen, Willow,  
Cottonwood)

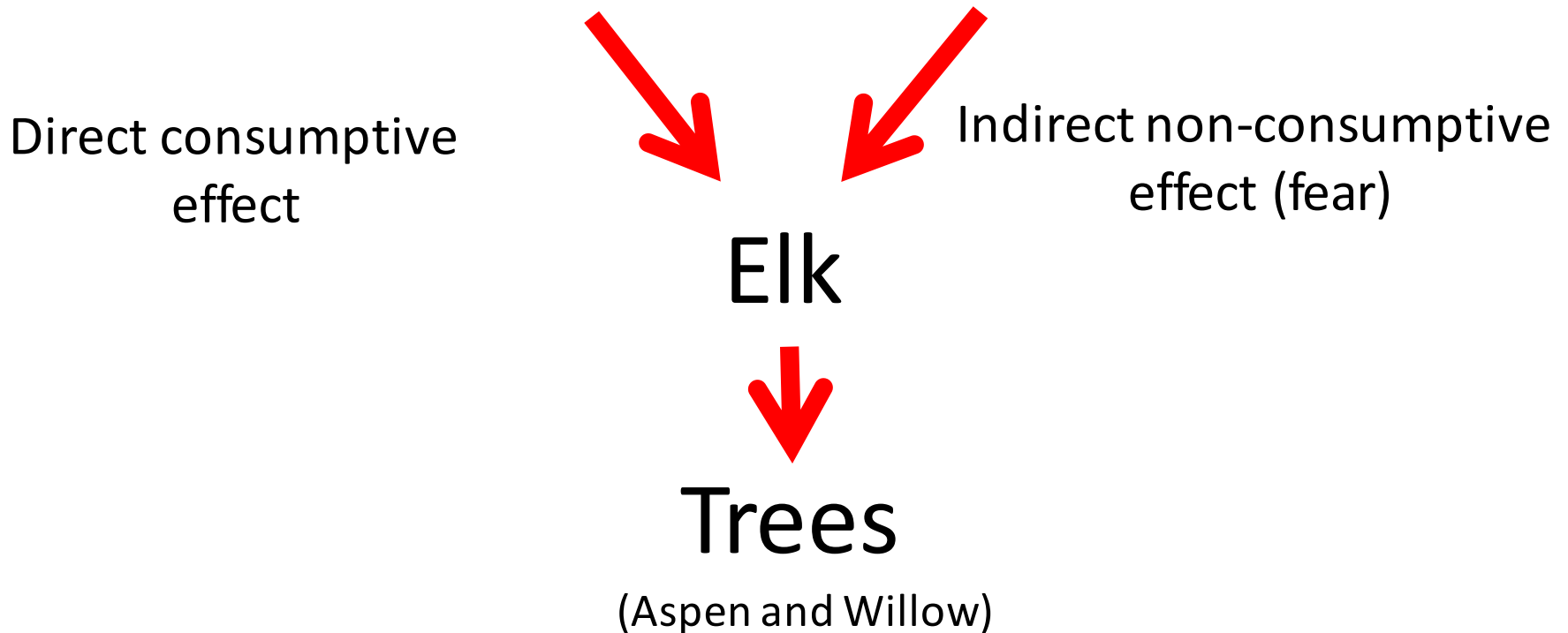
Effect over time



- As wolf population rises the elk population falls due to direct predation.
- Reduced browsing of tree saplings by elk increases number and size of trees;
- Note: Elk (*Cervis elaphus*) are European Red deer subspecies

# Trophic Cascade

## Wolf Reintroduction



Combined Direct and Indirect effects  
of Wolf re-introduction

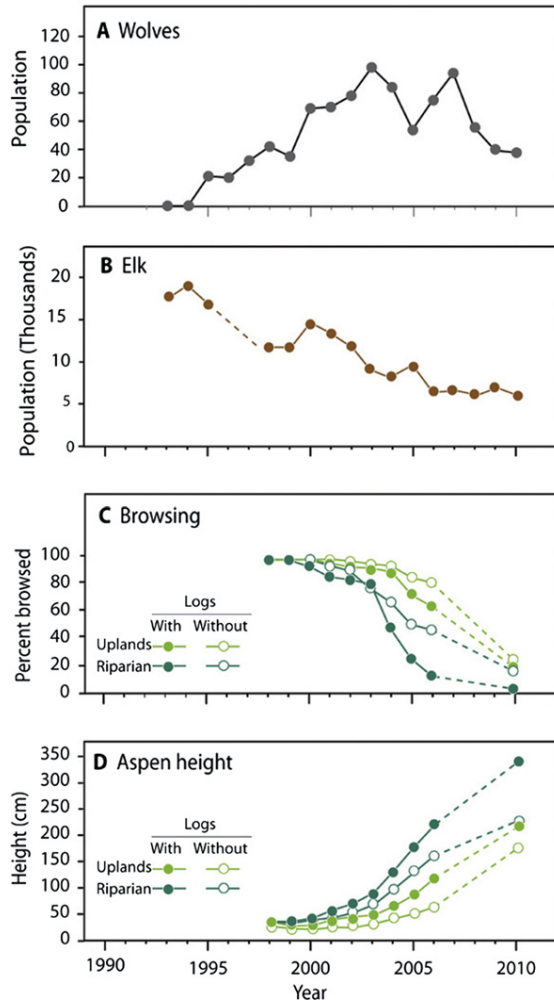
# Trophic Cascades

- The indirect effect of wolves creating 'fear' has changed the winter distribution of Elk so that many river valleys and gorges are now 'Elk-free';
- Elk move in to higher forested areas in regions where wolf numbers are high and avoid the valleys;
- This has enabled willows and other trees to be 'released' from browsing pressure and grow taller and have greater biomass.



# Trophic Cascade

## Direct and Indirect effect of wolf reintroduction in Yellowstone National Park



- (A) wolf populations
- (B) minimum elk populations from annual counts
- (C) percentage of aspen leaders browsed
- (D) mean aspen heights (early springtime heights after winter browsing but before summer growth)

Ripple & Beschta 2012. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. *Biological Conservation* 145:2015-213

# Trophic Cascade with *Knock-on* effects

## Wolf Reintroduction

Direct consumptive effect

Indirect non-consumptive effect  
(behavioural change (fear))

Main Trophic Cascade

Knock-on Effects

Elk

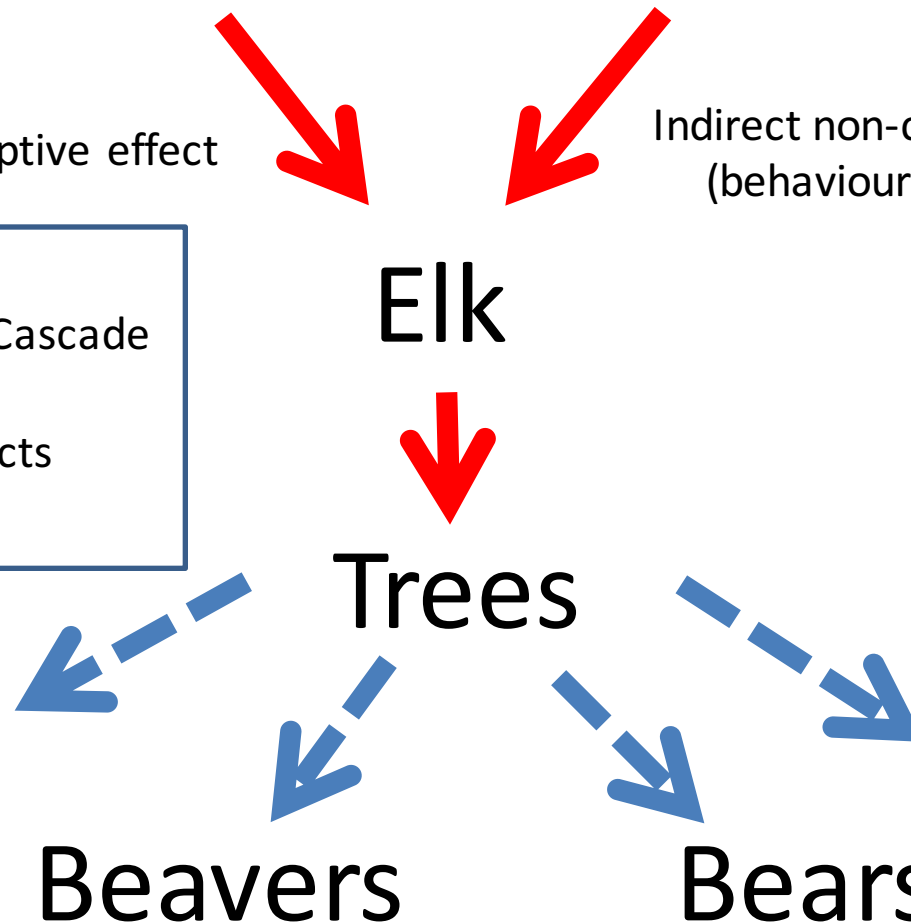
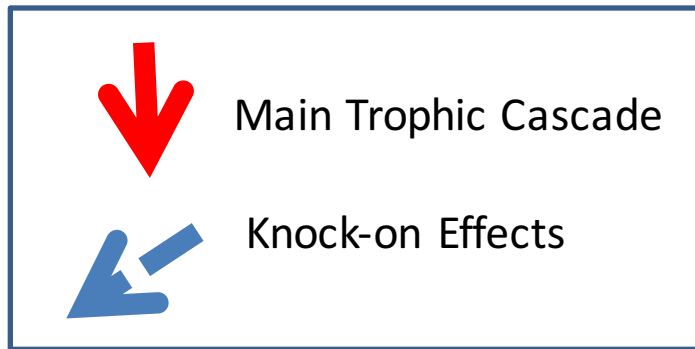
Trees

Birds

Beavers

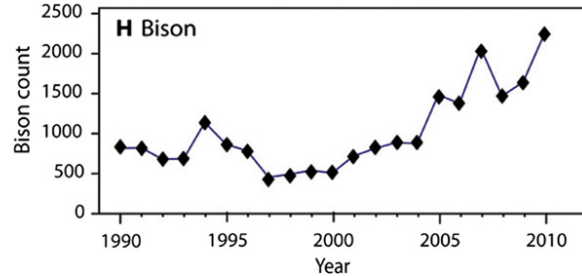
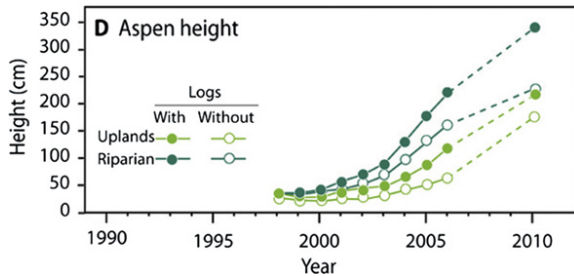
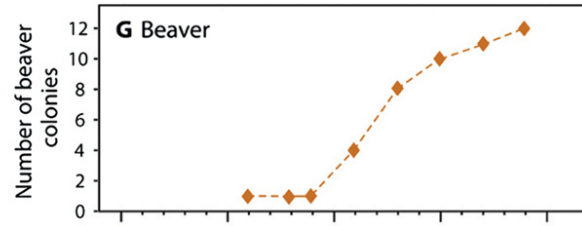
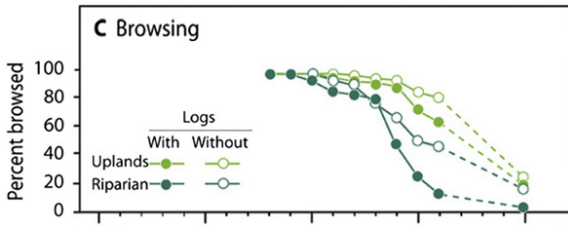
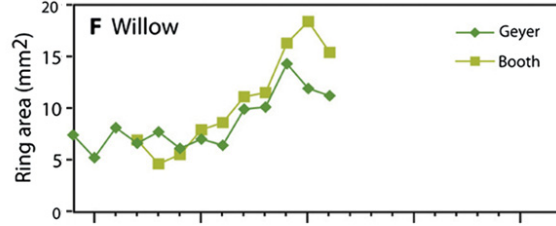
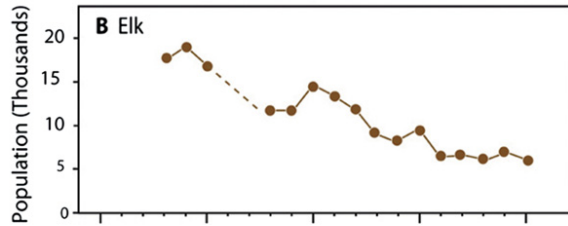
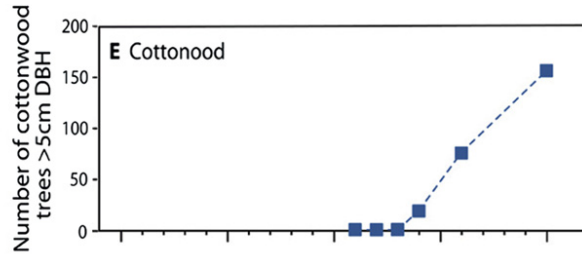
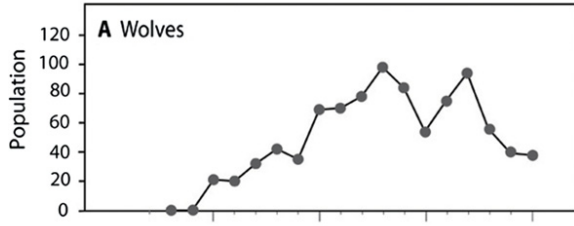
Bears

Bison



# Trophic Cascades and Knock-on Effects

## Effects of wolf reintroduction in Yellowstone National Park



Which are direct consumptive effects and which are indirect knock-on effects?

# Elk browsing on aspen



- A: 2006 showing a lack of recent aspen recruitment ( aspen <1 m tall) due to elk browsing;
- B: Aspen recruitment (some aspen >2 m tall) in same upland site, due to fewer elk;
- The dark, furrowed bark comprising approximately the lower 2 m of aspen boles represents long-term damage due to bark stripping by elk.



**A 1997**



## Soda Butte Creek with the Lamar River

Wolves were introduced in winters  
1995-96.

These photos show vegetation since.  
Examine these photos closely and  
make a note of any changes

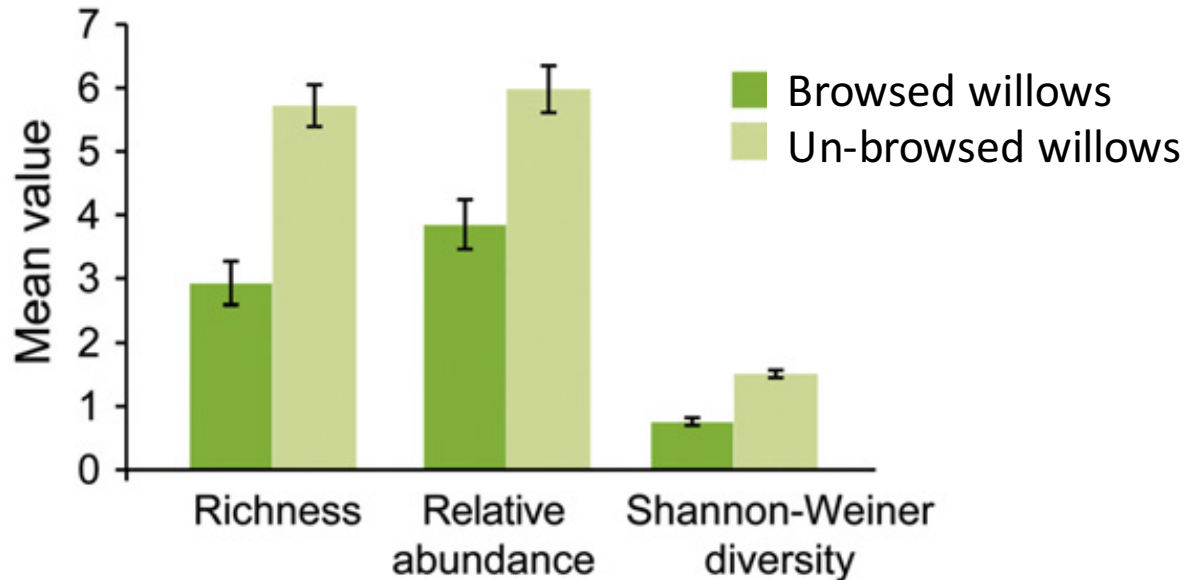
**B 2001**



**C 2010**



# Impact of elk browsing on bird species richness



Bird species richness, relative abundance, and Shannon-Weiner diversity in grazed versus un-browsed willows in Yellowstone National Park (Baril,2009). Error bars represent standard errors.

- Explain in your own words the impact of elk browsing on bird species richness.
- Which comparisons appear to be statistically significant?

# Have wolves changed rivers?



1924



1949



1961



2003

Wolves returned to this catchment in mid 1990s

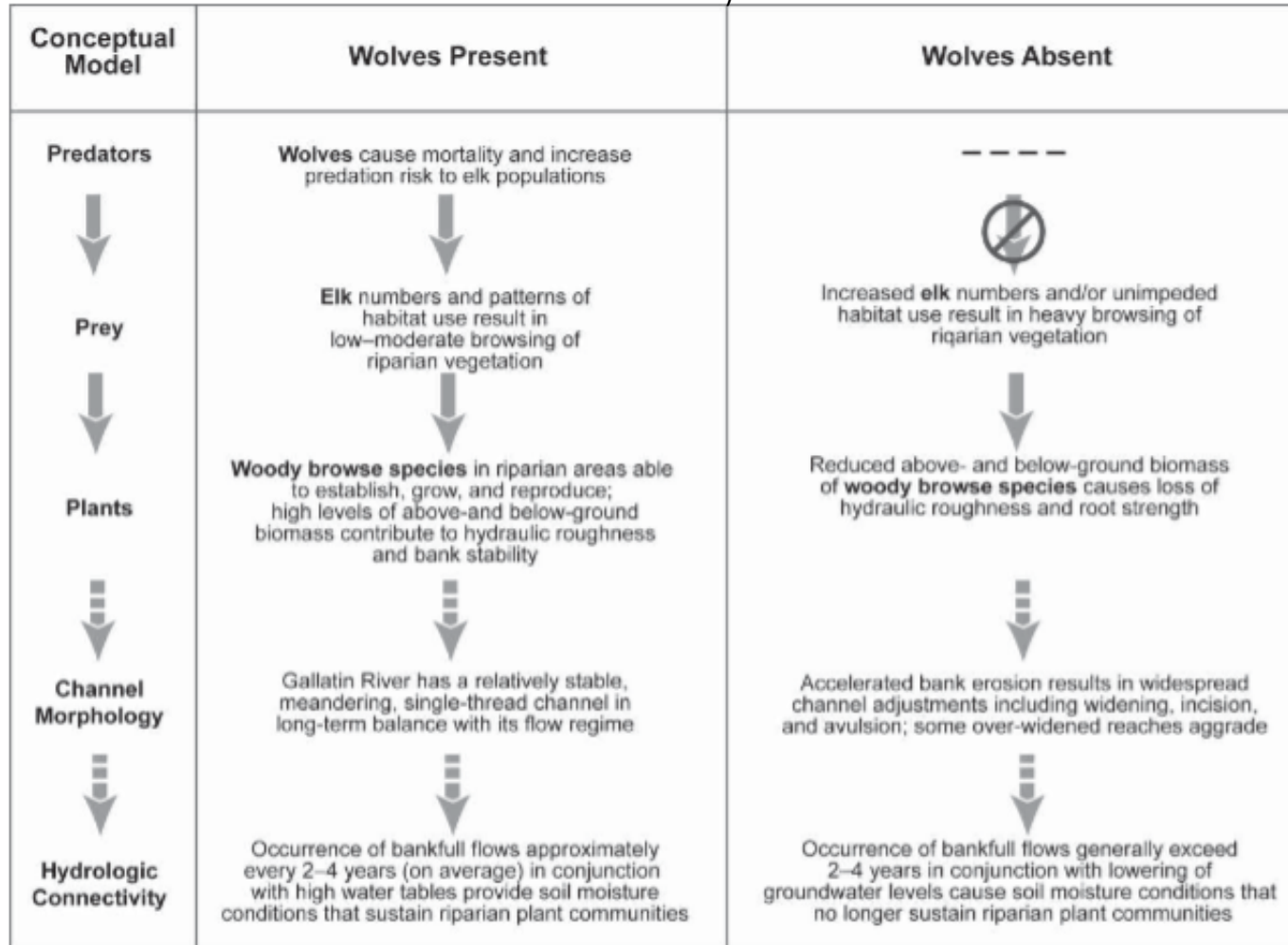
Which of any observed differences in the vegetation and landscape features are possibly as a result of wolf reintroduction?



# Conceptual Model of ‘top-down’ trophic cascades and hydrogeomorphic processes with and without wolves for floodplain riparian systems in the upper Gallatin elk winter range.

## Yellowstone NP

(Beschta & Ripple (2006) Earth Surf. Process. Landforms, 31: 1525–1539; Bescheta et al. (2018), Forest Ecology & Management, 413, 62–69)





# Video

4 .5 mins

<https://www.youtube.com/watch?v=ysa5OBhXz-Q>

Great Story - but is it all true?

What else has changed in Yellowstone NP over past  
70 years?

<https://strangebehaviors.wordpress.com/2014/03/10/maybe-wolves-dont-change-rivers-after-all/>