The role of large predators in maintaining riparian plant communities and river morphology

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In each of these national parks, extirpation or displacement of apex predators occurred by the early 1900s.

- Yellowstone
- Olympic
- Wind Cave
- Zion
- Yosemite
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- Yellowstone
- Olympic
- Wind Cave
- Zion
- Yosemite
Willows  Gallatin Elk Winter Range

Wolves extirpated by the mid-1920s
Trophic Cascades

- Predators
- Prey
- Plants
- Other Ecosystem Responses
Trophic Cascades

Wolves extirpated

Elk browse woody species unimpeded by predation risk

Decreased recruitment of woody browse species (aspen, cottonwood, willows, & others)

Loss of riparian functions

Loss of riparian beaver

Loss of food web support for aquatic, avian, and other fauna

Channel incision & widening, loss of wetlands, loss of hydrologic connectivity between streams and floodplains
In 1995-96, wolves were reintroduced into Yellowstone National Park.

Have willows in the Gallatin Elk Winter Range begun to recover?
Willows

1948 Elk Exclosure
Gallatin Elk Winter Range

1969

1999

2003

Plant Height (cm) Stems Browsed (%)

1998 1999 2000 2001 2002
## Trophic Cascades

<table>
<thead>
<tr>
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<tr>
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</tr>
<tr>
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**“Passive Restoration”**
Yellowstone National Park
Change in aspen canopy coverage

1954 1992

(Larsen & Ripple, 2005)
Note lack of young trees in upland aspen & riparian cottonwood
Age structure results

(a) Aspen

(b) Riparian cottonwoods

Expected age structure

Missing age classes

Establishment Dates (decades)

(Ripple and Beschta 2005)
Age structure results

(Ripple and Beschta 2005)
Decline in woody plant recruitment following loss or displacement of apex predator

Based on data from Olympic, Wind Cave, Yellowstone, Yosemite, and Zion National Parks (Beschta & Ripple 2009)
Cottonwood (1970s)
Lamar Valley
In 1995-96, gray wolves were reintroduced into Yellowstone NP.
Elk are the primary prey of gray wolves in the western US.
Wolves (predation risk) → Trophic Cascades in Yellowstone
→ A hypothesis

Elk (browsing changes)

→ Aspen (regeneration)
Are Northern Range plant communities recovering following the 1995-96 reintroduction of wolves?

Aspen?
Cottonwoods?
Willows?
Two tiered stands

Northern Range Aspen Stands (2008-09)
Study of aspen recruitment

(Ripple and Beschta 2007)
Cottonwoods
Soda Butte Creek

Heavily browsed seedlings <1 m tall
(Ripple & Beschta 2003)

5+ m tall cottonwoods

1993

2011
Willows
Soda Butte Creek floodplain

1997

2011
Riparian forests normally contain a diversity of woody species.
Wolves extirpated from Olympic NP in the early 1900s

Potential effects of wolf extirpation:

1. Increased Elk foraging in riparian areas
2. Decreased recruitment of woody browse species
3. Increased streambank erosion and altered channel morphology
“...unless some substitute for this now absent controlling factor [wolves] is provided, serious destruction of certain plants and even there total elimination in certain places ...will no doubt occur.”

(Sumner 1938)
Today, there is a lack of tree recruitment and understory shrubs. Black Cottonwood and "grazing lawn." 

Bigleaf Maple and "fern prairie."
After plant communities became degraded by herbivory, streambanks began to erode.
Today, rivers are wide, braided, and eroding.

Hoh River
Olympic NP
Widening active channels indicate floodplains, terraces, and ancient riparian forests are being lost.
Active channels visible from space
Cougar were displaced from Zion Canyon in the early 1930s. Mule deer populations irrupted causing significant impacts to riparian plant communities and initiated a period of accelerated channel erosion.
North Fork of Virgin River
in Zion Canyon (cougar rare) 2005
North Fork of Virgin River in Zion Canyon (cougar rare) 2005
East Fork of Virgin River
(Cougar common) 2005
Three distinctly different riverine ecosystems, yet each was dramatically impaired (by herbivory) following the loss of an apex predator.

Hoh River
Olympic NP

Gallatin River
Yellowstone NP

Virgin River
Zion NP
## Trophic Cascades

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**Summary**

In the absence of apex predators (e.g., wolves, cougar), wild ungulates can degrade woody plant communities over time, thus reducing biodiversity and altering river morphology.

The reintroduction of wolves into Yellowstone is allowing (via trophic cascades) formerly impacted upland and riparian plant communities (and stream channels) to begin recovering.

Significantly reducing the effects of ungulates on plant communities is the key to recovery of herbivory-altered terrestrial and aquatic ecosystems.
Publications - Trophic Cascades and Rivers


Is the concept of “trophic cascades” applicable only to National Parks?

What about the other ~1 million square kilometers of public land in the western US?
Even if large predators, such as wolves, return to part of their former range in the American West, long-term effects of herbivory from domestic livestock represent a major impediment to maintaining or recovering resilient ecosystems on vast areas of public lands.
BLM, National Forest and National Grassland Grazing Allotments

- BLM, National Forest and National Grassland grazing allotments
- Ungrazed BLM, National Forest and National Grassland
Trophic Cascades Conclusion:
Unless we limit the impacts of livestock and hyper-abundant wild ungulate populations on public lands, many riparian areas and stream systems in the western US will continue to be degraded (regardless of what the climate does)
Thank you!

Research publications available via google search:
Trophic cascades articles
Oregon State University
Trophic cascades publications available at: Http://www.cof.orst.edu/cascades/articles.php
Two examples of ecologically “simplified” riparian and aquatic ecosystems, one from cattle grazing and the other from elk (both occurred in the absence of wolves).
Riparian and aquatic ecosystems with "high resiliency"

East Fork Virgin River, Southern Utah

Blacktailed Deer Creek, Northwestern Wyoming
Yellowstone National Park
Change in aspen canopy coverage

1954
2009
Range contractions in “red”

(Laliberte and Ripple 2004)
Lamar River
Yellowstone’s Northern Range
Is the concept of “trophic cascades” applicable only to National Parks?

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