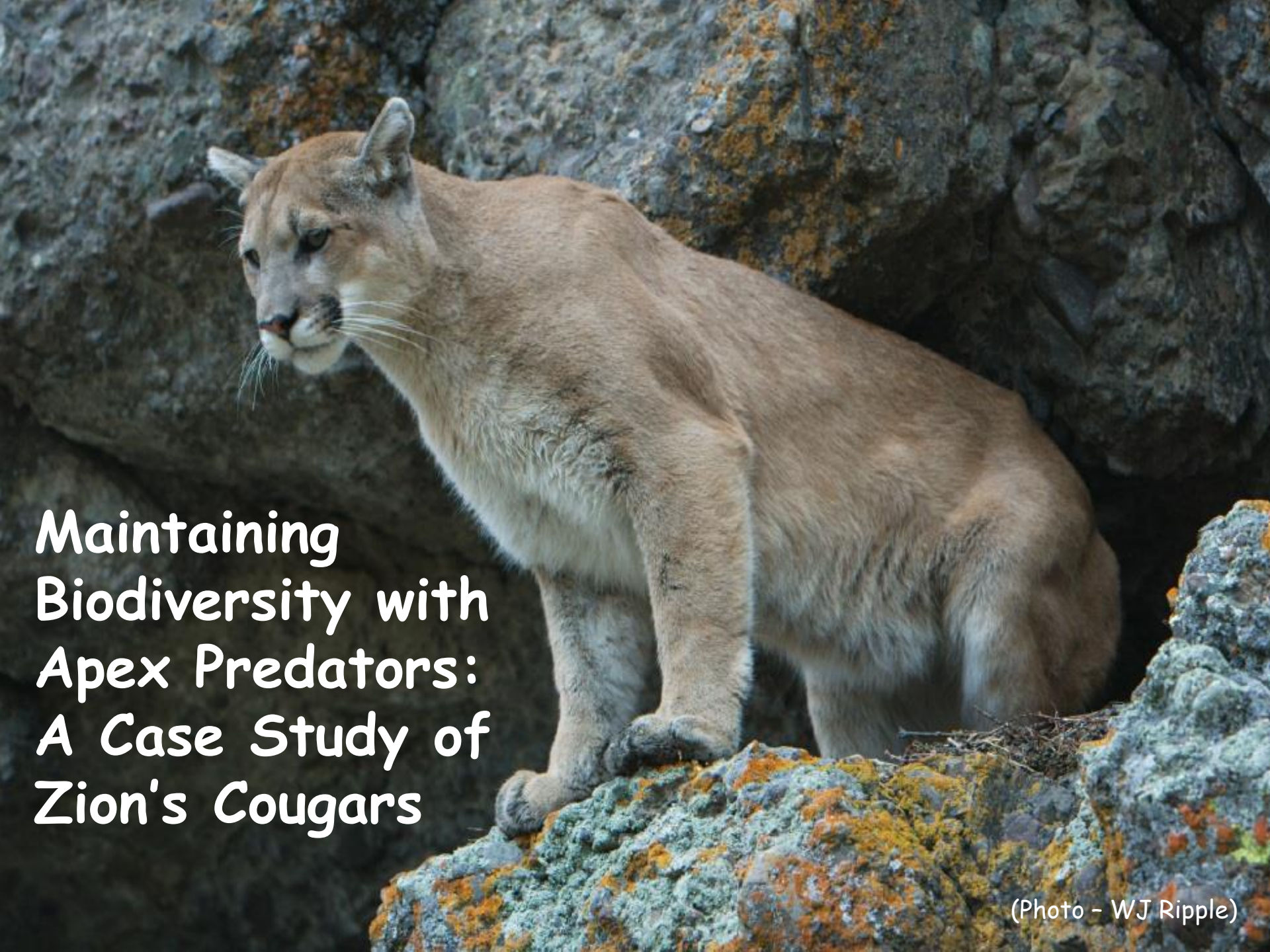
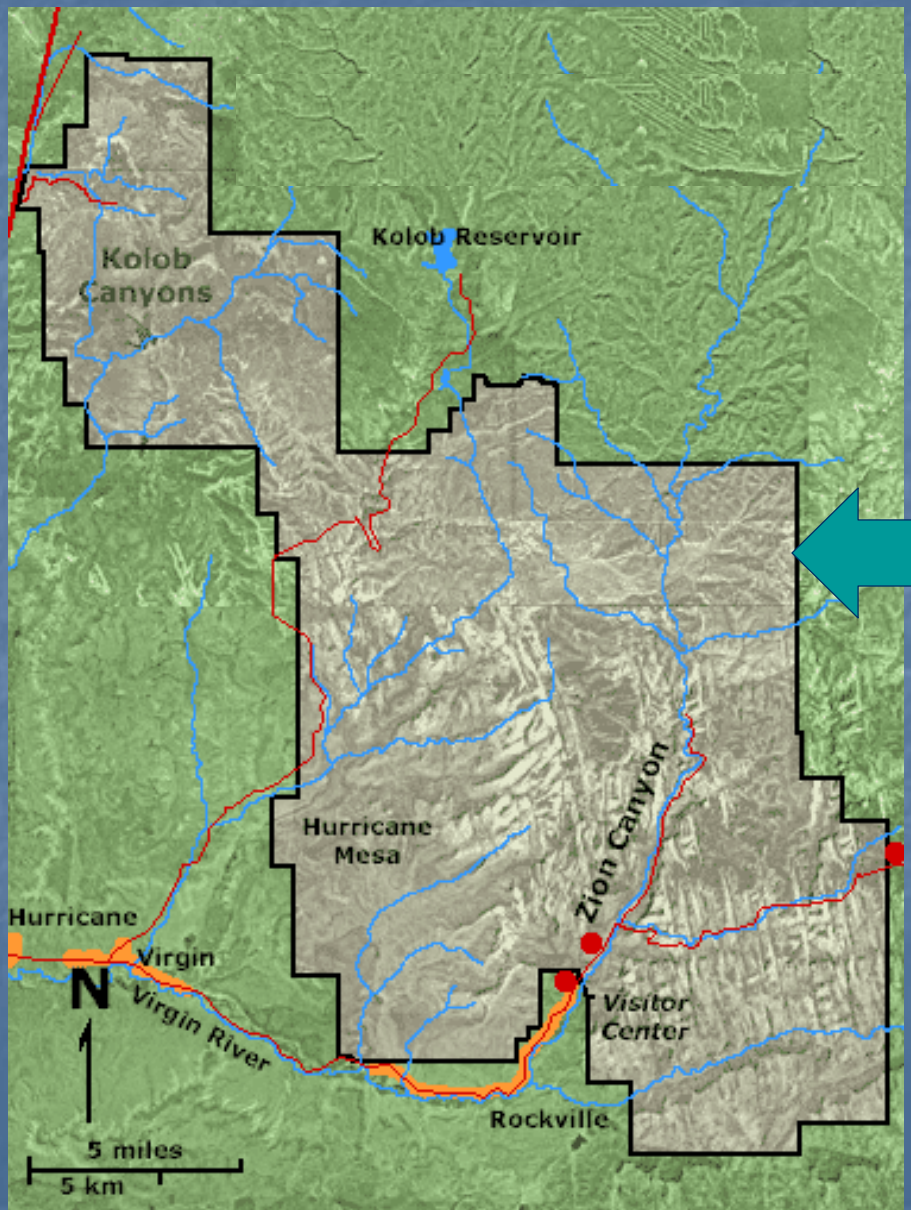
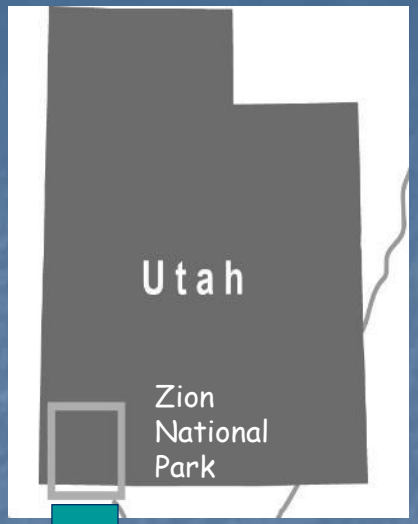

Maintaining Biodiversity with Apex Predators: A Case Study of Zion's Cougars
(Photo - WJ Ripple)

A Study from Zion National Park in Southwest Utah





A Background Note

Mule deer are the primary prey of Zion National Park's apex predator, the cougar.


Cougar

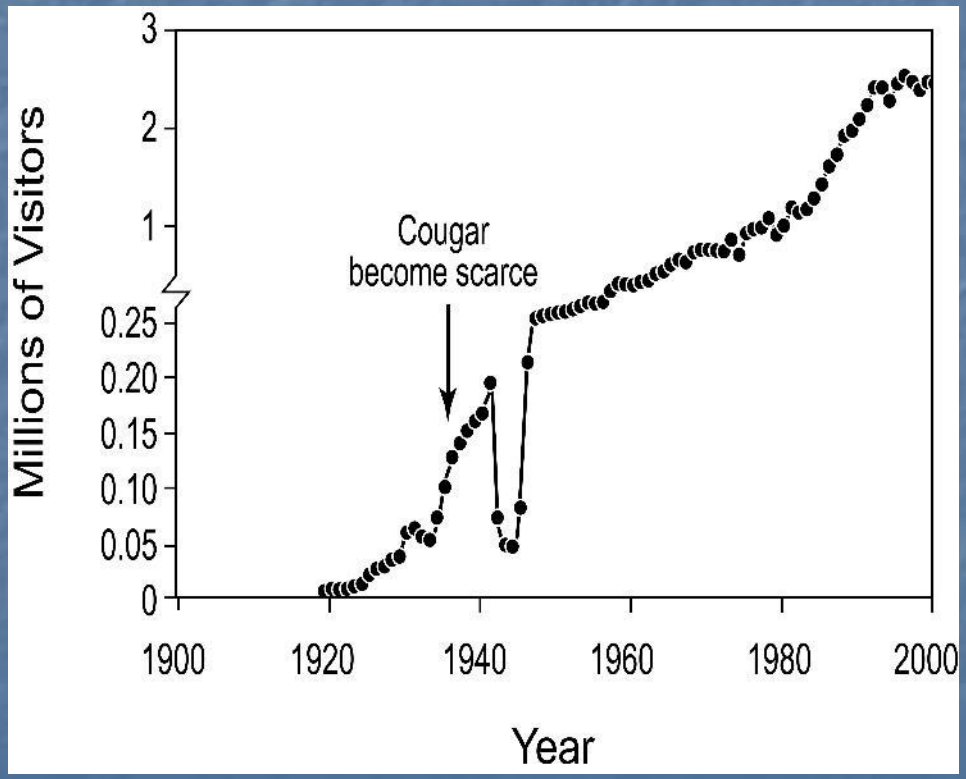

Mule deer

The phrases "cougars common" and "cougars rare" that are used in the subsequent commentary denote relative differences in cougar densities between study sites. These qualitative descriptors are used because information on actual cougar densities is not available.

(Photos – National Park Service)

A Brief History

Zion National Park was established in 1918. The number of park visitors increased during the early 1930s and by 1938 Park Naturalist C.C. Presnall noted a reduction in the number of cougars in Zion Canyon. The following year, Park Service biologists J.S. Dixon and E.L. Sumner indicated "The presence of these hundreds of human visitors tended to drive out the cougars…"

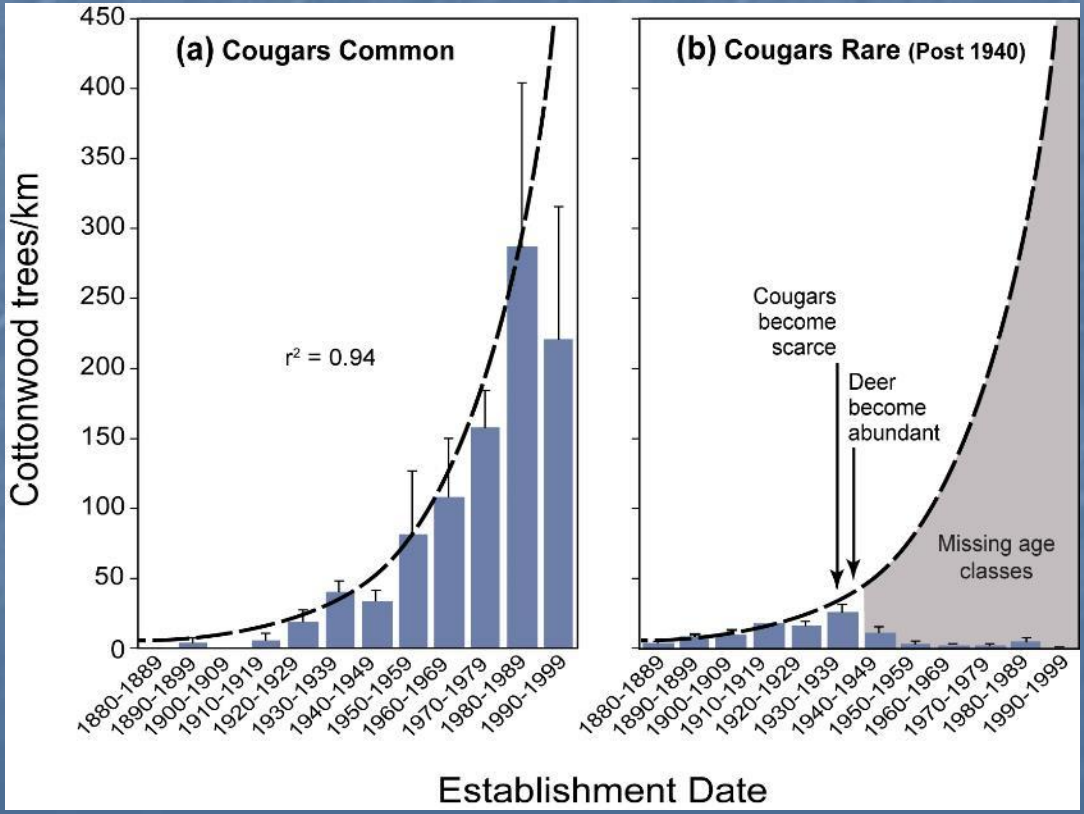


(Graph – Ripple & Beschta 2006)

Today, park visitations number in the millions each year, thus generally ensuring that cougars remain relatively rare in Zion Canyon, the park's most accessible canyon.

Cottonwoods Decline after Cougar Become Scarce

Relatively long-lived Fremont cottonwoods commonly occur in riparian areas and are thus an important indicator of long-term changes in riparian plant communities. In areas where cougars have been relatively common (a), cottonwood recruitment has been nearly continuous since the late 1800s, with increasing numbers of established plants over time. This age structure is a normal feature of healthy riparian cottonwood forests.



(Graph – Ripple & Beschta 2006)

For areas where cougars have been relatively rare since the early 1940s (b), cottonwood recruitment has almost ceased.

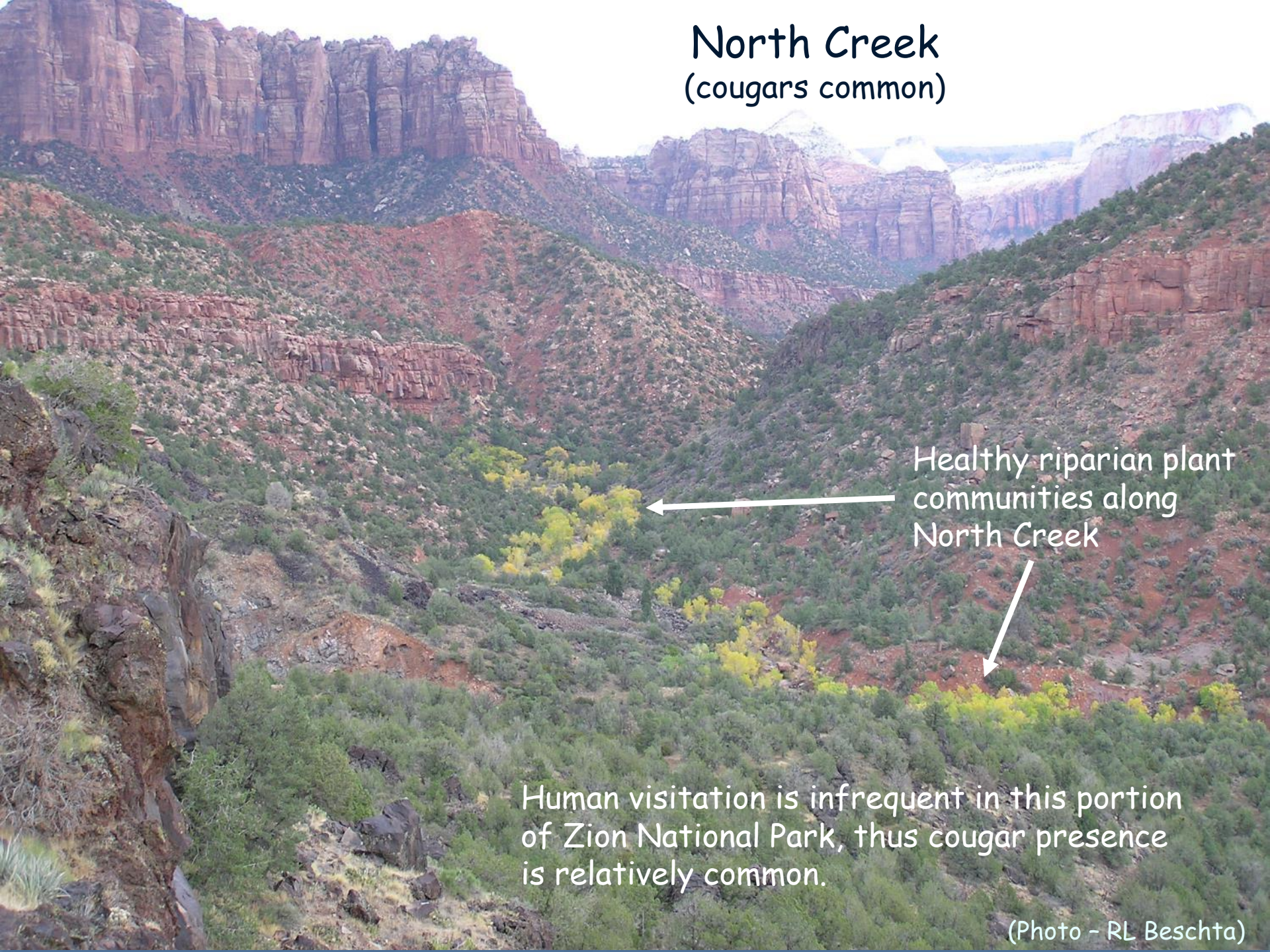
Cottonwood seedlings are highly palatable to mule deer and, in the absence of cougar, such seedlings are readily browsed by these deer and unable to grow into trees.

Study Site Locations

North Creek (cougars common)

North Fork of the Virgin River in Zion Canyon (cougars rare)

East Fork of the Virgin River (cougars common)


North Creek
(cougars common)
Healthy riparian plant communities along North Creek
Human visitation is infrequent in this portion of Zion National Park, thus cougar presence is relatively common.
(Photo – RL Beschta)

East Fork of the Virgin River

(cougars common)

Human access in this area is restricted and thus this area has few visitors each year.

Healthy riparian plant communities along the river.

(Photos – RL Beschta)


North Creek


East Fork of the Virgin River

(Photos – RL Beschta)

Healthy Riparian Vegetation and Narrow Channels

(Cougars Common)

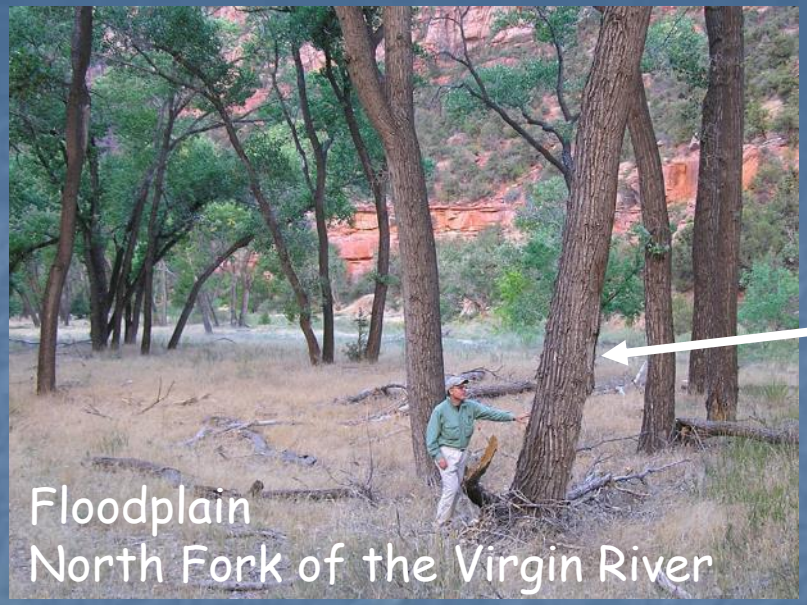
Both North Creek and the East Fork of the Virgin River have a full range of Fremont Cottonwood age classes occurring along their channels, and a diversity of understory plant species. Furthermore, cover from willows and other water-loving vegetation is nearly continuous along their banks, and channels are relatively deep and narrow.

These riparian areas provide excellent habitat for birds, lizards, amphibians, butterflies, and other wildlife.


Zion Canyon
(cougars rare)
Many people visit Zion Canyon each year, thus cougar presence in this canyon is relatively rare.
Altered riparian plant communities and eroding riverbanks are common along the North Fork of Virgin River
(Photo – RL Beschta)

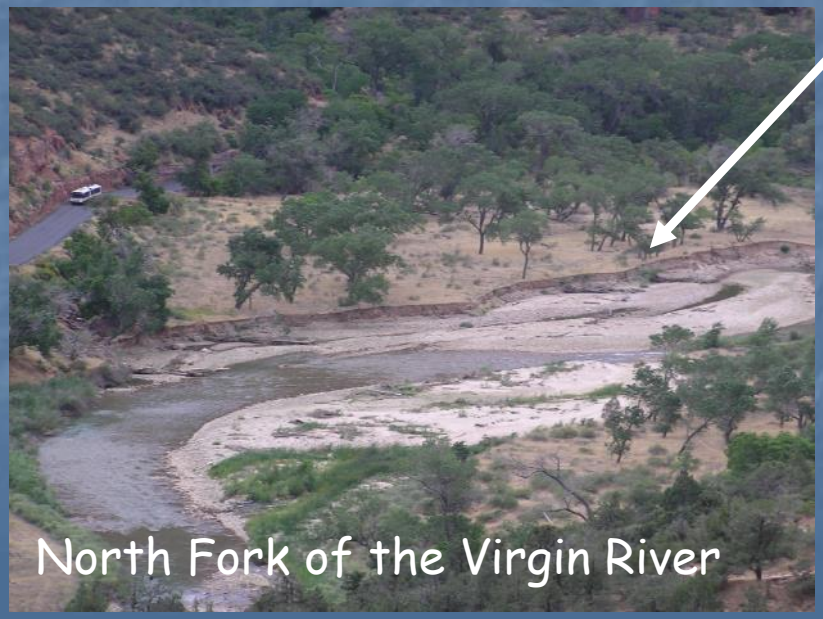
Old Cottonwoods and An Eroding Channel

(Cougars Rare)



Floodplain
North Fork of the Virgin River

Only large cottonwoods are found on floodplains, confirming a lack of recruitment for many years. Understory vegetation is sparse.



North Fork of the Virgin River

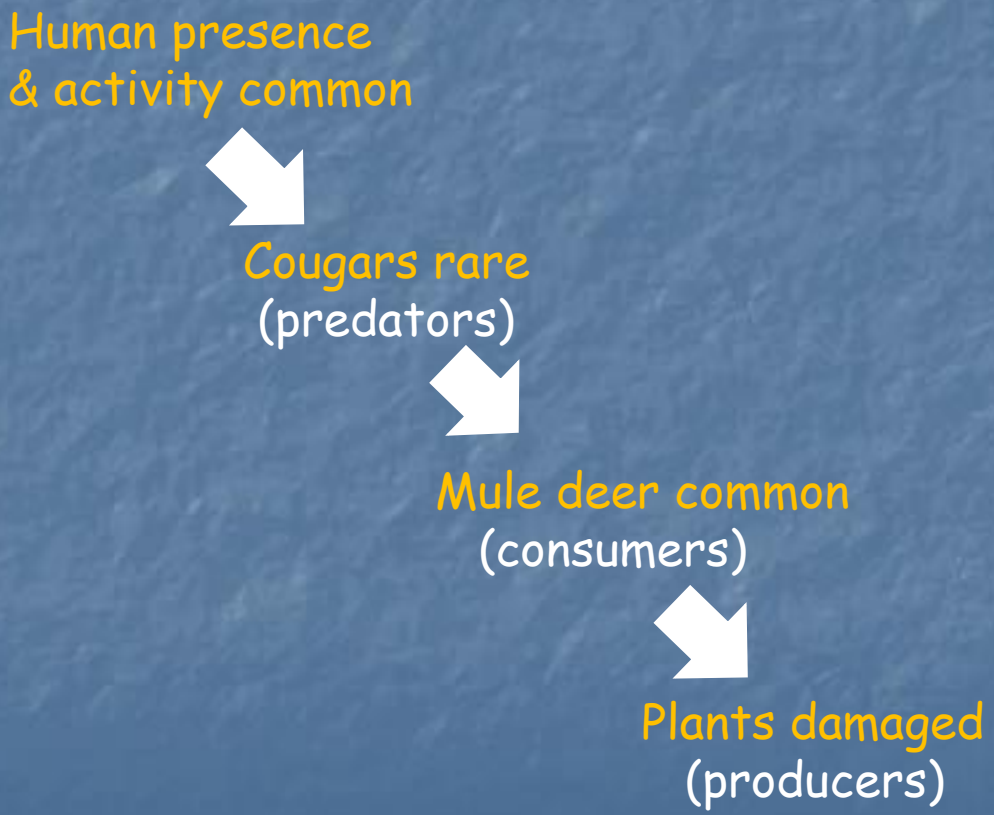
With a lack of streamside vegetation, accelerated riverbank erosion has allowed the channel to greatly widen and incise.

Riparian plant communities along the North Fork of the Virgin River, in Zion Canyon, exhibit the effects of intensive mule deer herbivory over a period of many years.

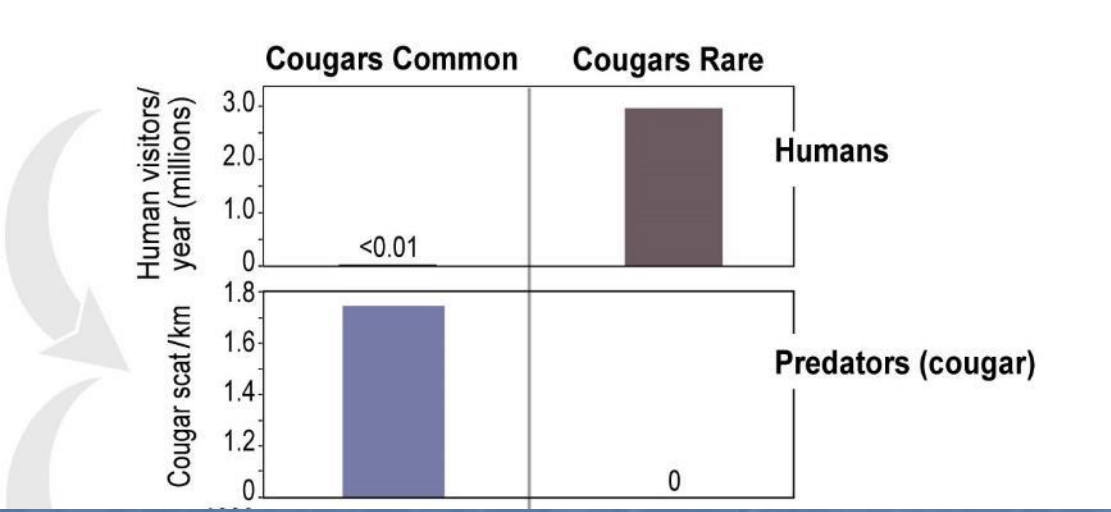
(Photos – Top, WJ Ripple, Bottom, RL Beschta)

Cascading Effects

The results that follow are framed in the context of a trophic cascade. Humans at the top of the cascade affect cougar densities, which in turn influences mule deer behavior and densities and, eventually, the character of plant communities:



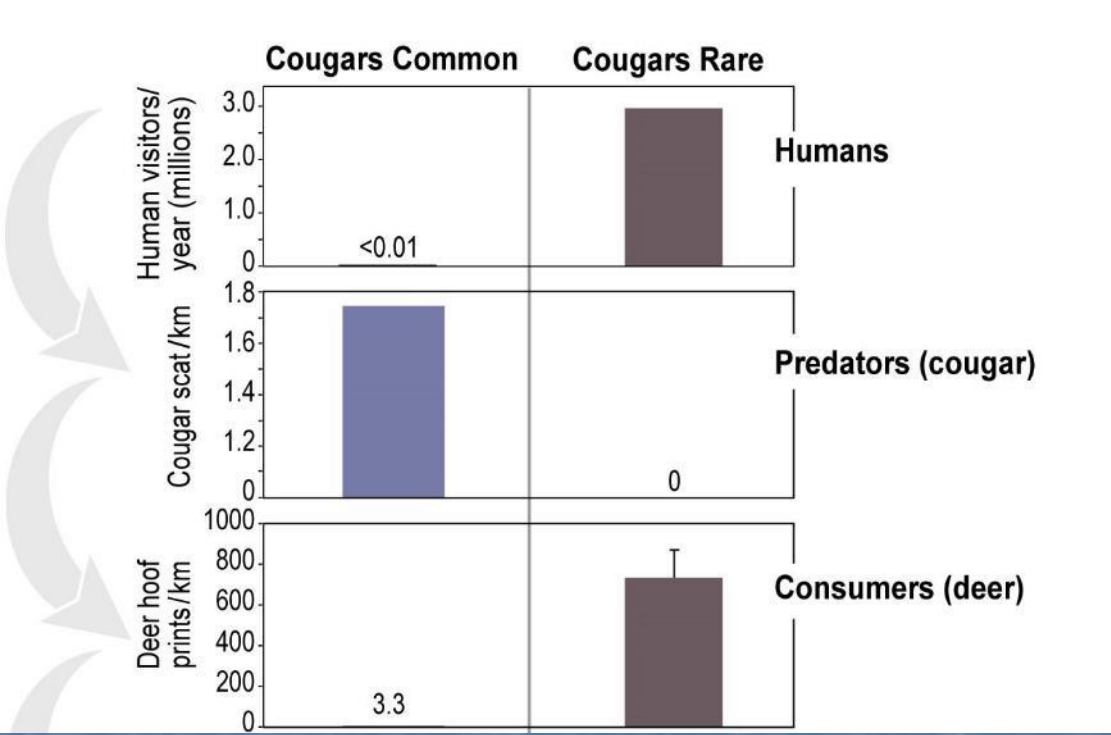
Humans Visitations affect Cougar Density



In areas where human visitation was low, cougars were relatively common. In contrast, where human visitation was high, cougars were relatively rare.

(Graph – Ripple & Beschta 2006)

Cougars affect Mule Deer

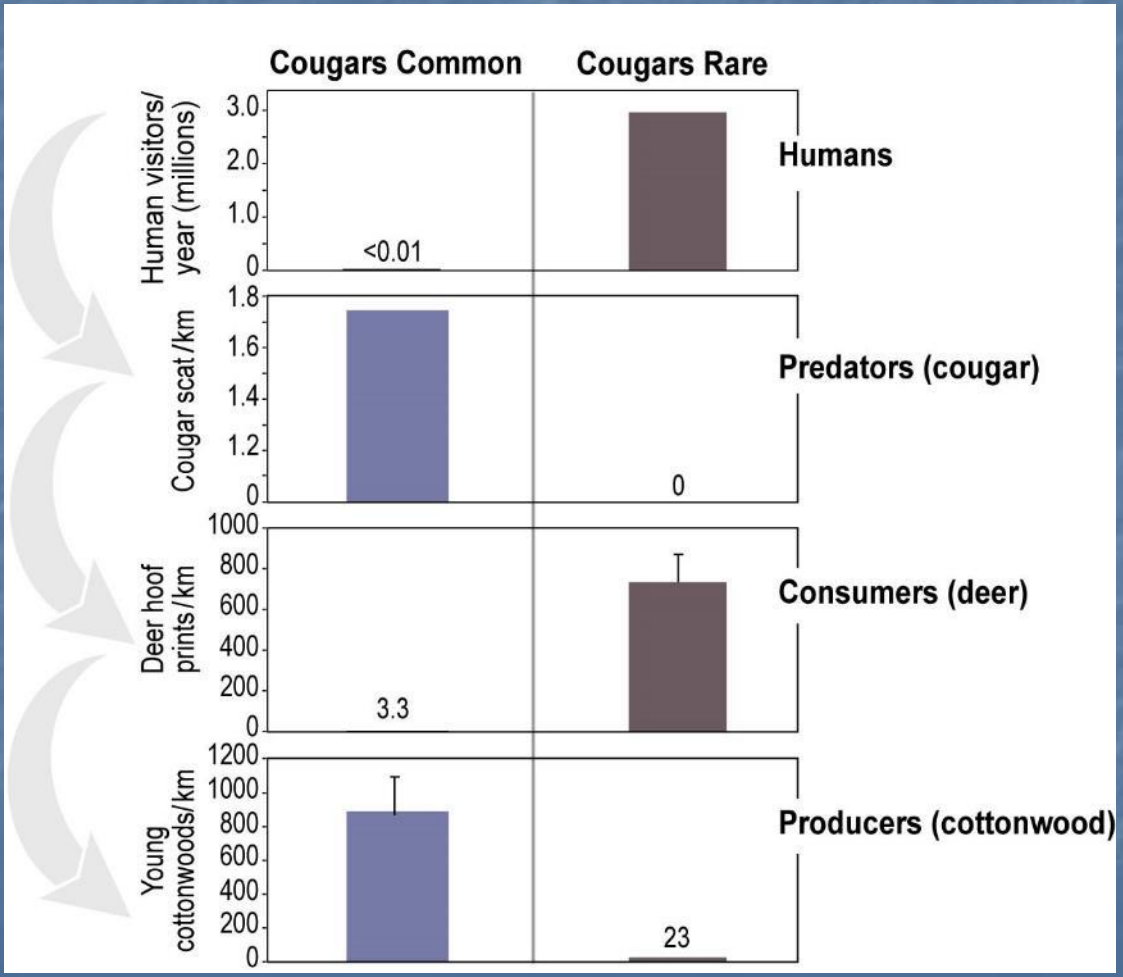


Where cougar were common, mule deer were relatively rare. In contrast, where cougar were rare, mule deer were relatively common.

(Graph – Ripple & Beschta 2006)

Mule Deer affect Cottonwoods

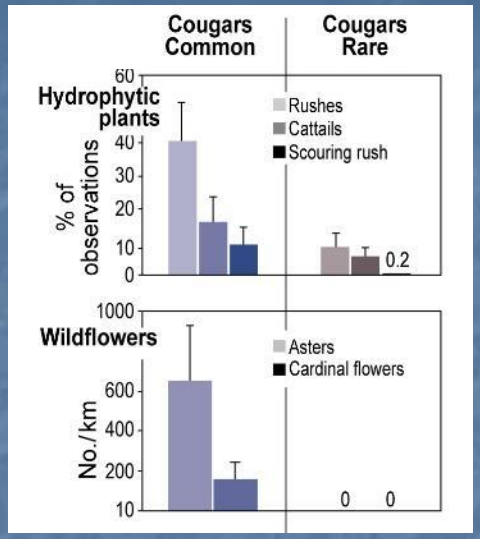
An inverse pattern between trophic levels (as shown below) is indicative of a trophic cascade.



(Graph – Ripple & Beschta 2006)

Where mule deer were rare, established cottonwood numbers were high. In contrast, where mule deer numbers were high, established cottonwood numbers were low.

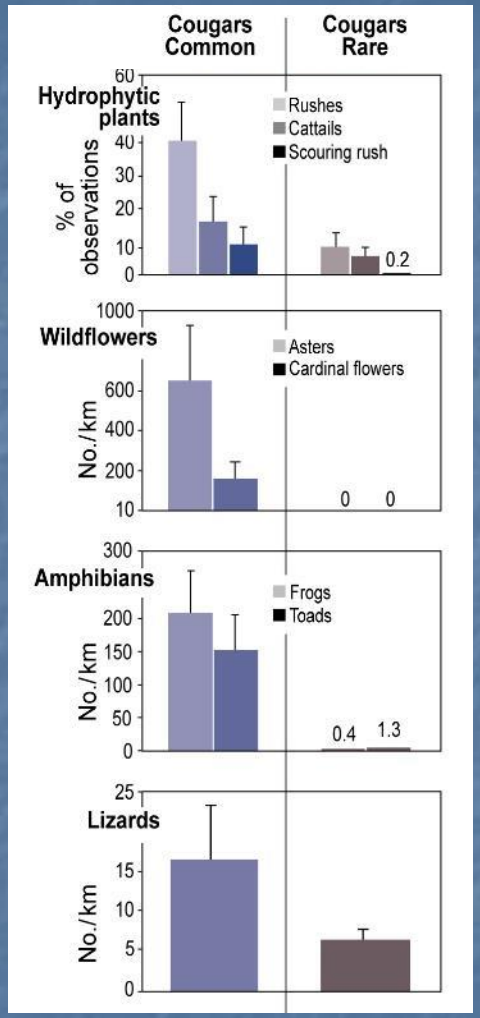
Species Abundance: Plants



Riparian areas where cougars were common consistently had a greater abundance of hydrophytic (water-loving) plants and wildflowers.

(Graph – Ripple & Beschta 2006; photo – WJ Ripple)

Species Abundance: Amphibians and Lizards



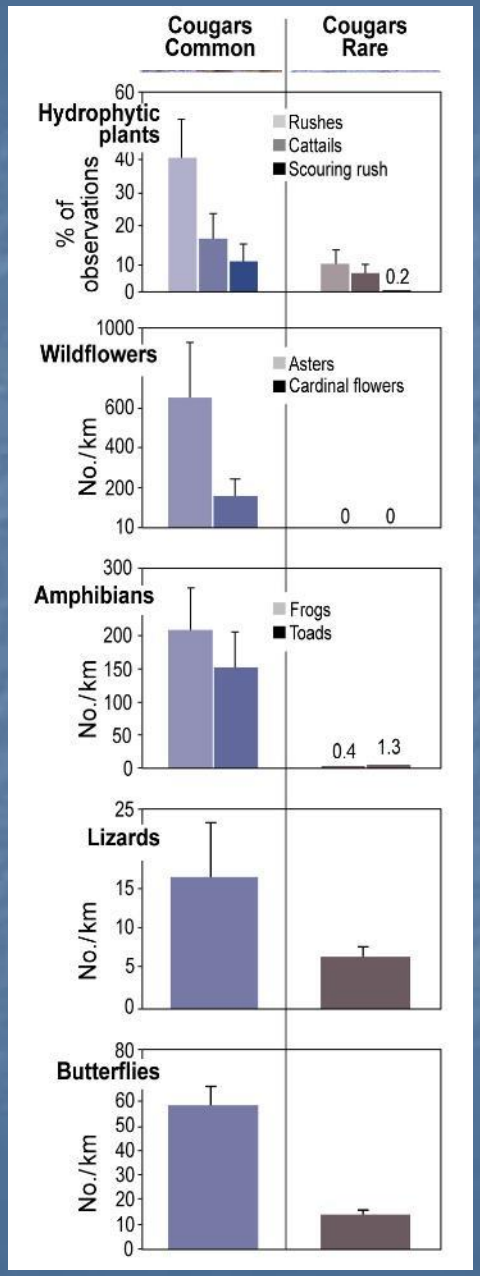

Canyon tree frog

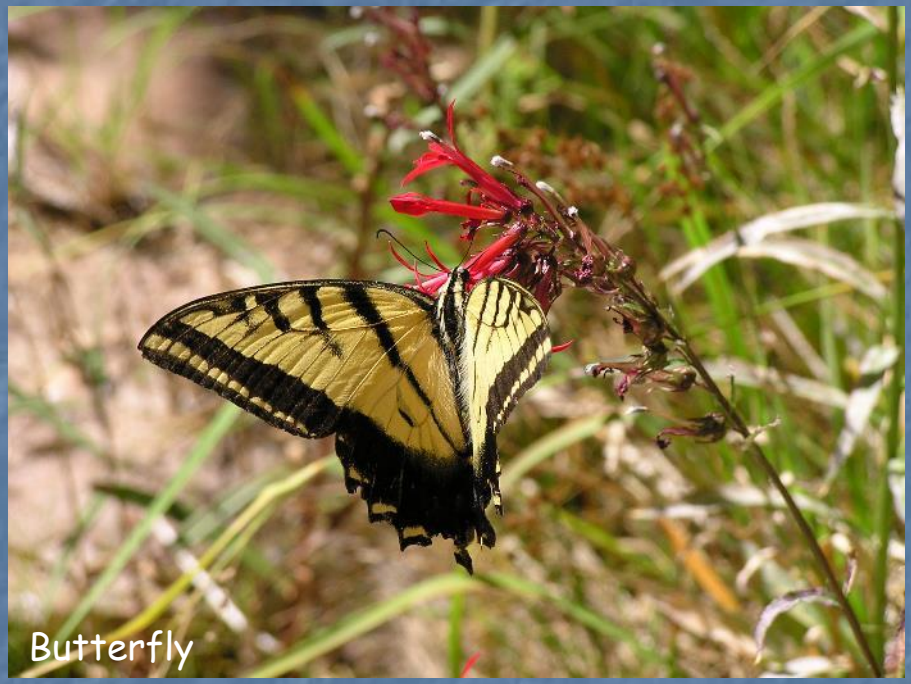

Lizard

Riparian areas where cougars were common consistently had a greater abundance of amphibians and lizards.

(Graph – Ripple & Beschta 2006; photos – WJ Ripple)

Species Abundance: Butterflies

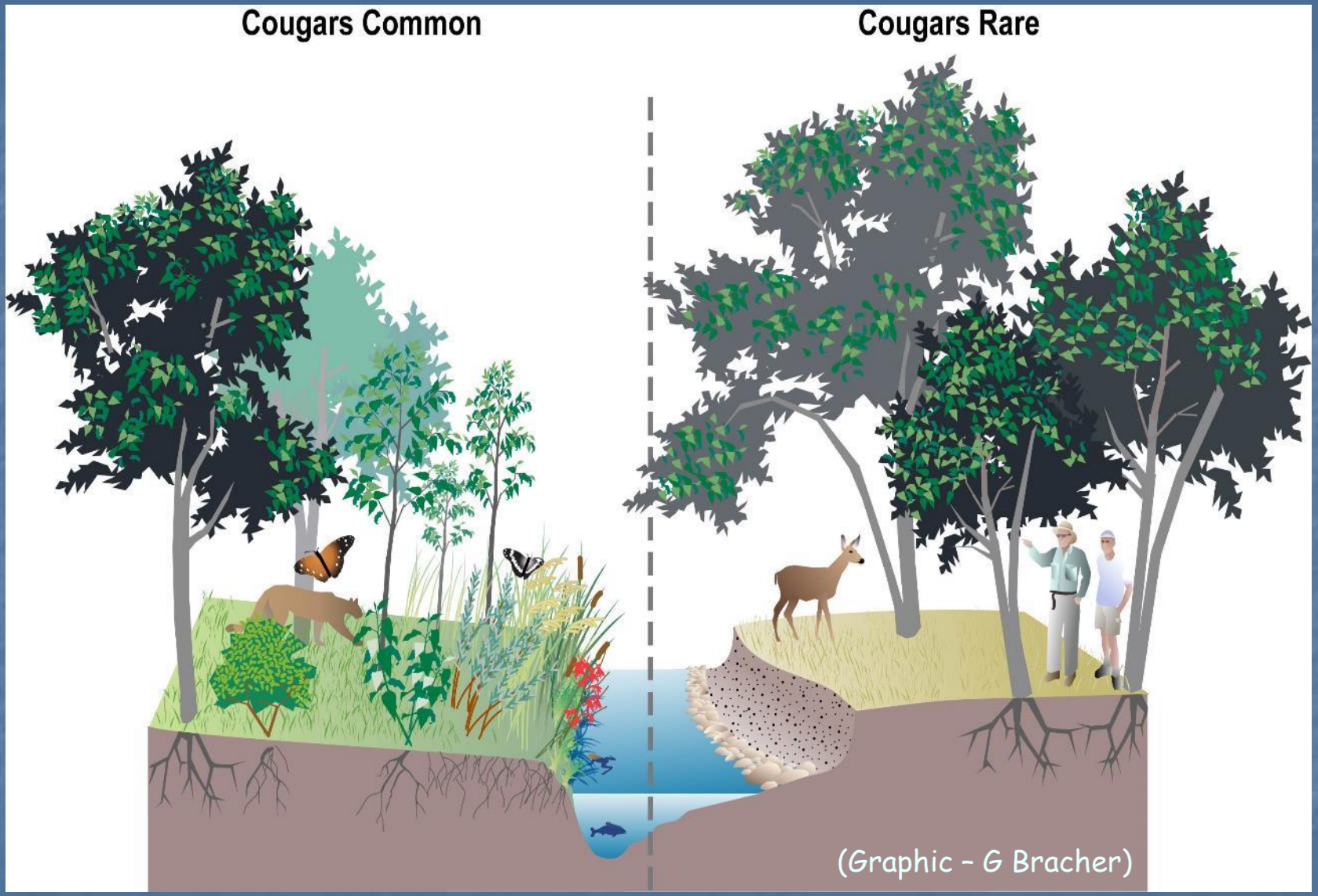



Butterfly

Riparian areas where cougars were common consistently had a greater abundance of butterflies.

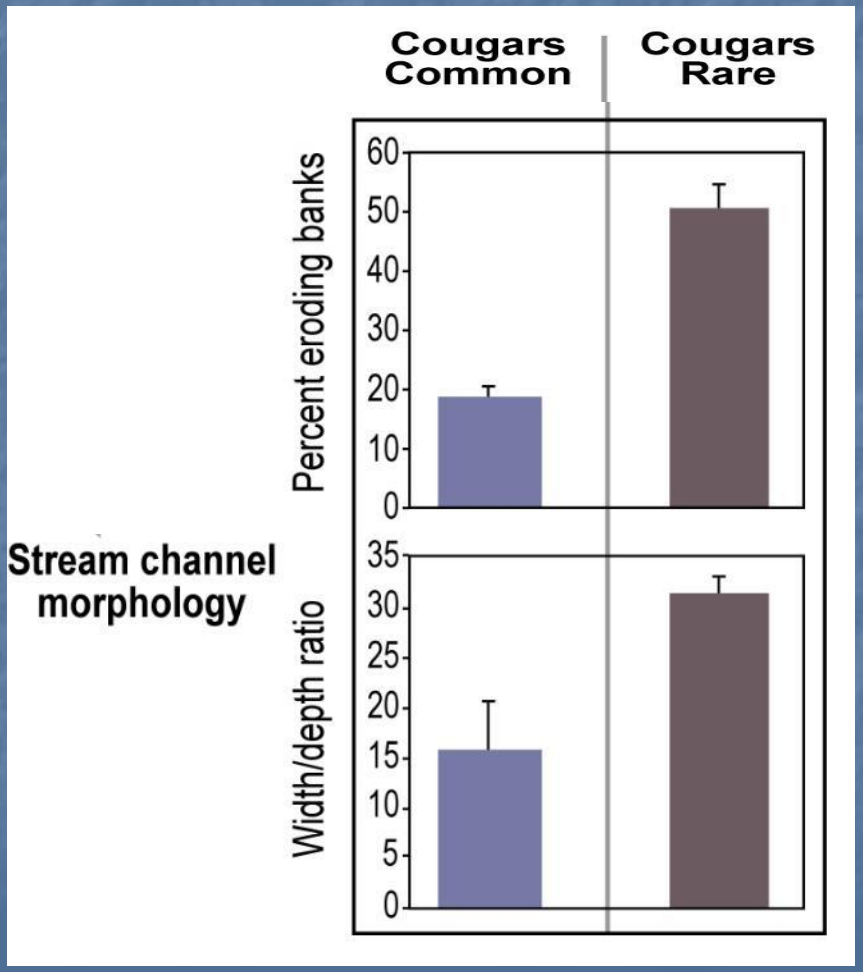
(Graph – Ripple & Beschta 2006; photo – WJ Ripple)

Riparian Ecosystems Diverge



An artist's view of species diversity and abundance for riparian ecosystems where cougars are common and where cougars are rare.

Cascading Effects to Streams

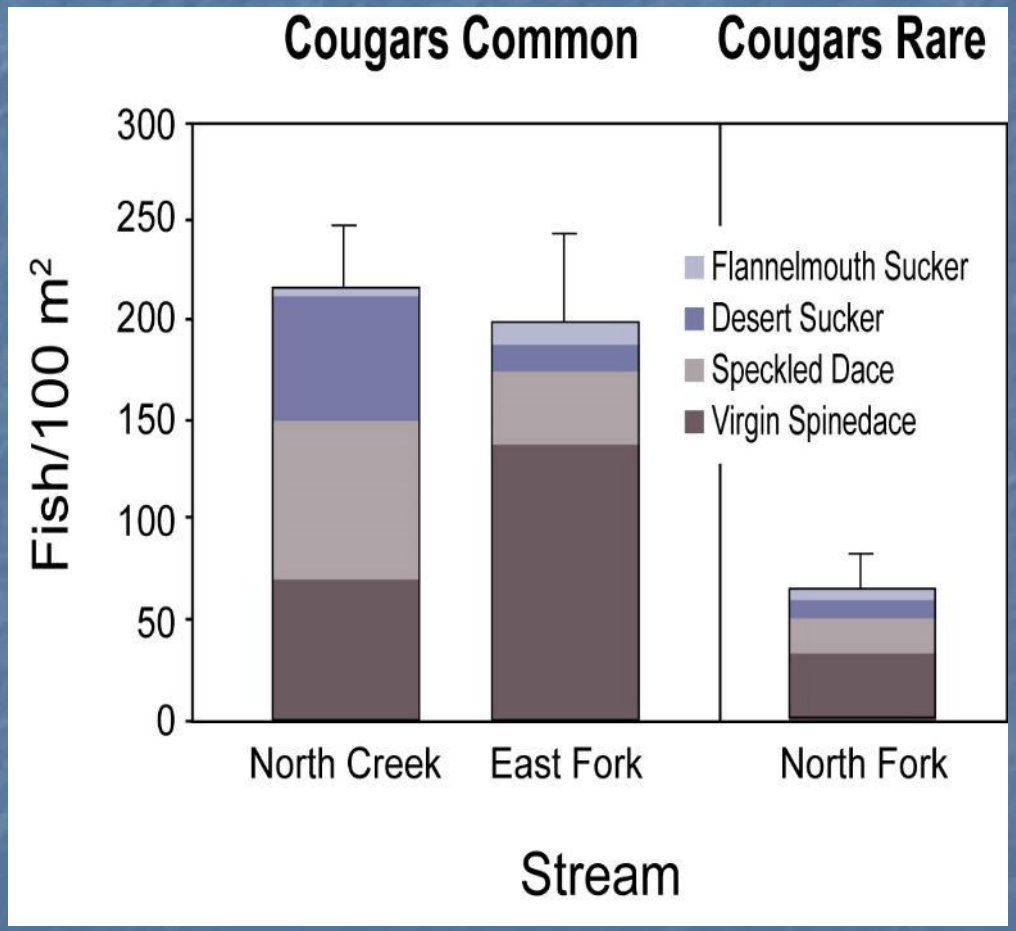


(Graph – Ripple & Beschta 2006)

Streams in cougar common areas had a much lower percentage of eroding banks and smaller width/depth ratios, indicating channels were relatively stable, narrow, and deep. Such channels normally provide habitat that is more beneficial to aquatic organisms.

Streams in cougar rare areas had more eroding banks and were relatively wide and shallow.

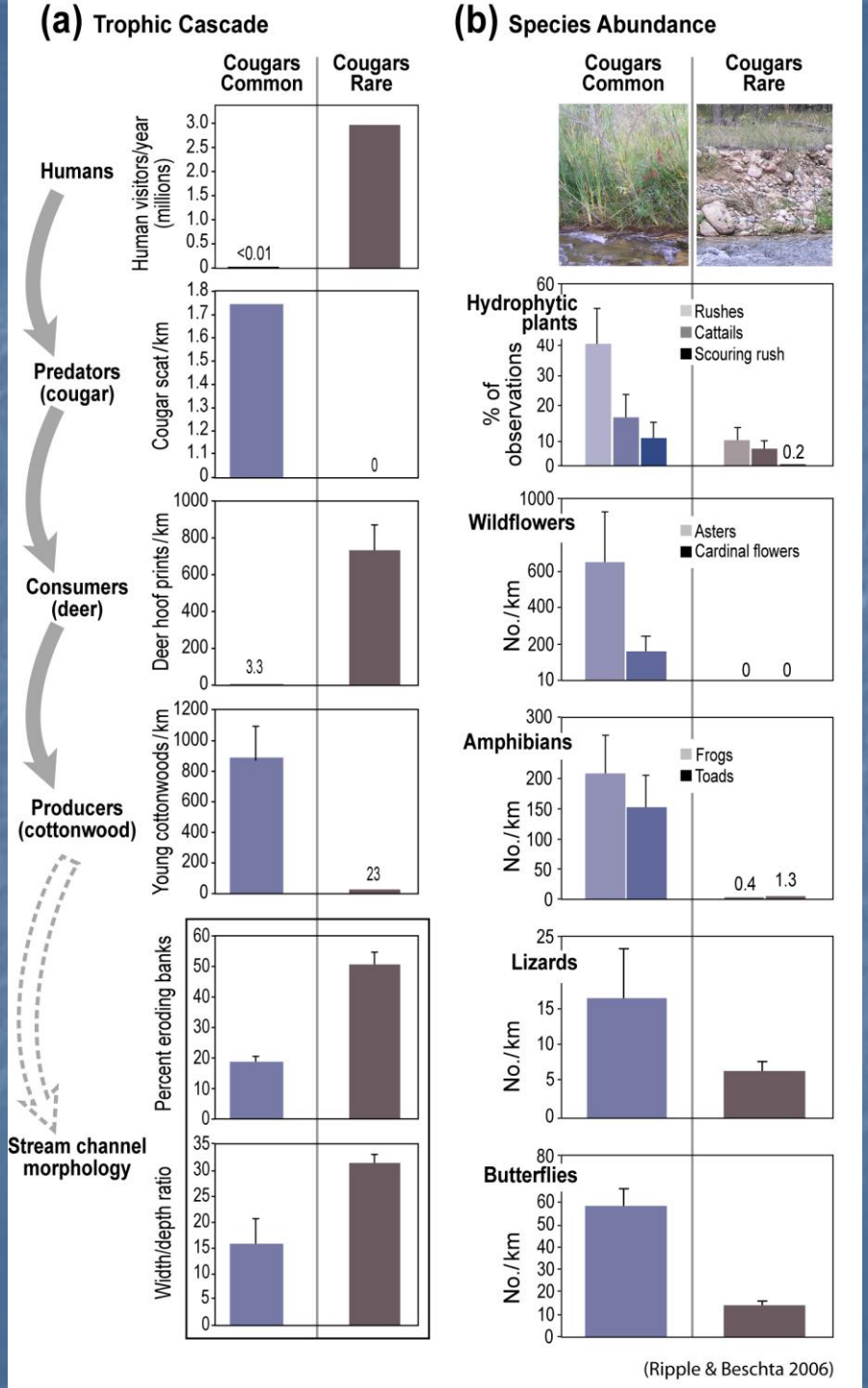
Cougar Help Native Fish



The ecosystem benefits of cougars appear to extend to aquatic species.

Streams in areas where cougars were common had much greater densities of native fish species than those where cougars were rare.

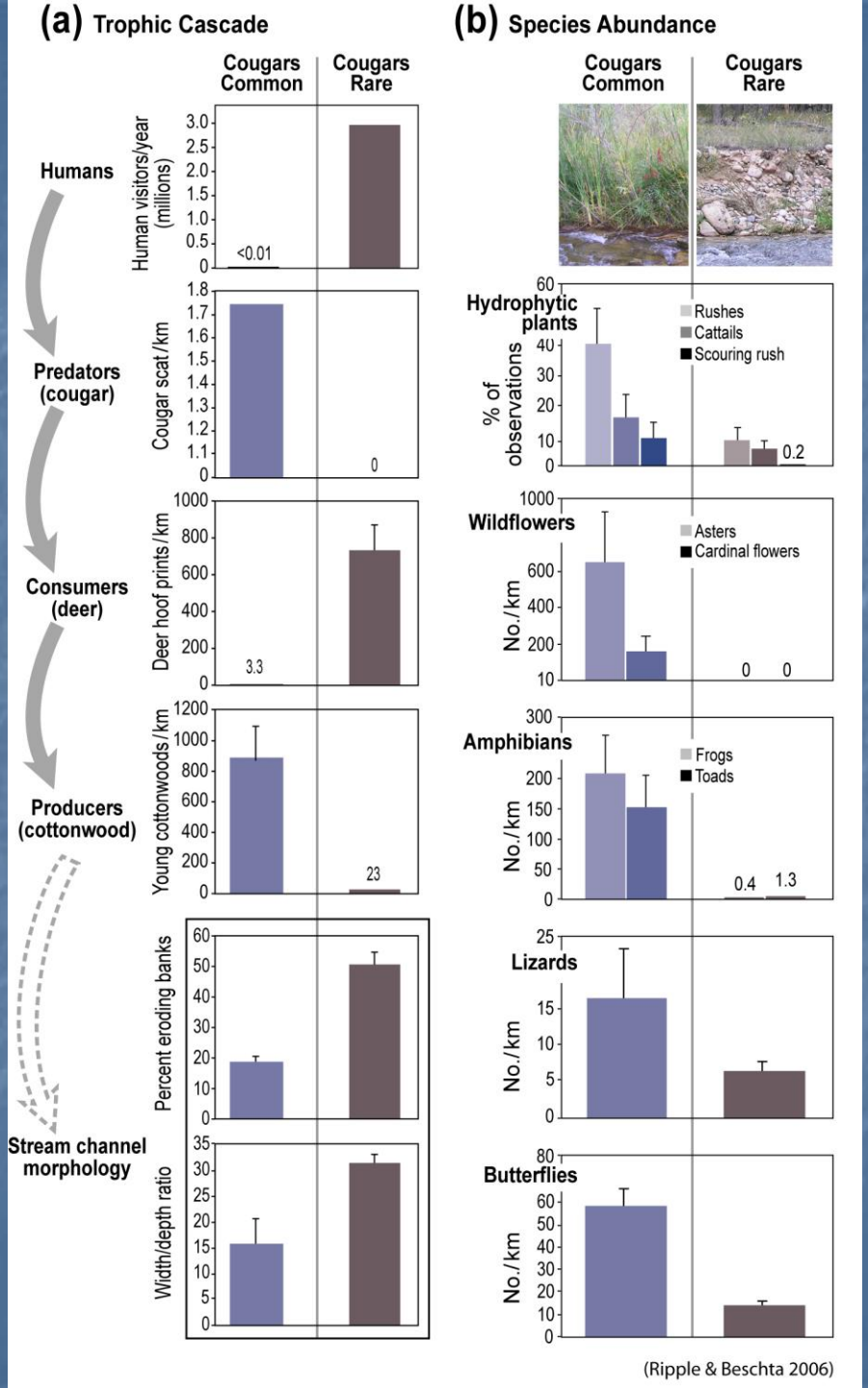
(Graph – Ripple & Beschta 2006)



Conclusions

In Zion National Park, human visitation numbers appear to determine whether an apex predator is common or rare.

Where cougars are common (low visitation) they trigger a trophic cascade that maintains relatively high abundances of plant and wildlife species, as well help maintain stable, narrow, and deep channels.



Conclusions
(continued)

However, where human visitations are high, cougars were relatively rare and, as a result, native ungulates had a major effect on plant communities.

High rates of mule deer herbivory greatly decreased species abundance for both plants and animals, leading in some cases the local extirpation of a species and reducing biodiversity.

These results strongly indicate a need for human actions to decrease the effects of ungulate herbivory in Zion Canyon if its biodiversity is to be conserved.

Is Zion's Cougar Cascade Unique?

Results of this study from Zion National Park are consistent with other studies in western North America regarding the important role of apex predators in trophic cascades. Various studies indicate that ecosystems can be profoundly altered by ungulates after large carnivores are displaced or extirpated. For example, research has connected the importance of another apex predator, gray wolves, in maintaining riparian plant communities and the stability of stream channels. Alternatively, the loss of wolves has been shown to allow native ungulates to heavily browse upland and riparian vegetation. Changes in riparian vegetation from such herbivory, in turn, generates major changes in channel morphology, floodplain functions, and habitat for beaver. Other studies have documented a reduction in abundance and diversity of birds in areas where wolves have been removed. In general, increased herbivory from native ungulates following the loss of large predators, such as cougars or wolves, has been widely found to alter the composition, structure, and function of plant communities, with consequent effects on biodiversity.*

Cougars, like wolves, are wide-ranging predators whose geographic distribution and predation effects have been greatly reduced by humans in vast areas of the United States. This begs the question—in the absence of cougars to what extent have these ecosystems been altered by ungulate herbivory?

* Ripple & Beschta 2006

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(May,2021)

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Dixon JS, & Sumner EL. 1939. The deer problem, deer trapping, and deer removal at Zion Canyon, Utah. Pp. 231-236 in: Transactions of the 4th North American Wildlife Conference, February 13–15, 1939, Detroit, MI.

Presnall CC. 1938. A survey of the deer situation in Zion Canyon, Utah. Proceedings of the Utah Academy of Sciences, Arts, and Letters 15: 107–110.

Ripple WJ, & Beschta RL. 2006. Linking a cougar decline, trophic cascade, and catastrophic regime shift in Zion National Park. Biological Conservation 133: 397-408.

Related Literature

Beschta RL, & Ripple WJ. 2009. Large predators and trophic cascades in terrestrial ecosystems of the western United States. Biological Conservation 142: 2401-2414.

Beschta RL, & Ripple WJ. 2012. The role of large predators in maintaining riparian plant communities and river morphology. Geomorphology 157-158:88-98.

Beschta RL, & Ripple WJ. 2016. Riparian vegetation recovery in Yellowstone: The first two decades after wolf reintroduction. Biological Conservation 198: 93-103.

Scientific literature associated with wolves, elk, and vegetation in northern Yellowstone, as well as other literature on trophic cascades and related topics, can be accessed at:

http://trophiccascades.forestry.oregonstate.edu/publications

Scientific Names of Plant and Animal Species

Plants

Cardinal flower – *Lobelia cardinalis*
Cattails - *Typha* spp.
Fremont cottonwood – *Populus fremontii*
Rushes - *Juncus* spp.
Scouring rush - *Equisetum hyemale*
Welsh aster – *Aster welshii*

Animals

Canyon tree frogs – *Hyla arenicola*
Cougar – *Puma concolor*
Gray wolves – *Canis lupus*
Red-spotted toads – *Bufo punctatus*

Glossary of Selected Terms

Herbivory – The feeding or foraging of animals on living plants; browsing is used in reference to their feeding on woody plants.

Large predator – A predator is an animal that lives by killing and eating other animals. A "large predator" is one that normally exceeds 15 kg (33 lbs) at maturity.

Plant community – A group of interacting plants sharing a common environment, for example: aspen community, willow community, sagebrush community.

Recruitment – Growth of a woody plants above the normal upper browse level of ungulates.

Riparian areas – Lands and associated plant communities immediately adjacent to creeks, streams, and rivers that are influenced by these waters. Plant communities in riparian areas are often diverse and highly productive, thus important as physical habitat and food for a wide range of aquatic and terrestrial biota.

Ungulates – Hooved animals, such as elk, deer, moose, and bison.