Bears, Berries, and Trophic Cascades in Yellowstone National Park

(Photo – USFS)

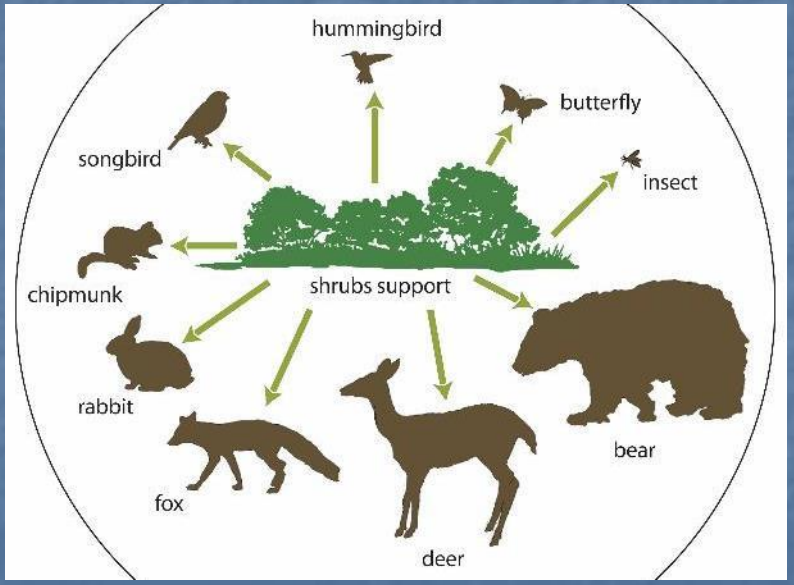
Bears and Berries: A Complex Web

In the following we will explore some of the connectivity and complexity of food-webs as they relate to bears and berries in northern Yellowstone National Park. We will also consider how a trophic cascade of wolves, elk, and plants interact with Yellowstone's bears.

(Photo – National Park Service)

The Berries

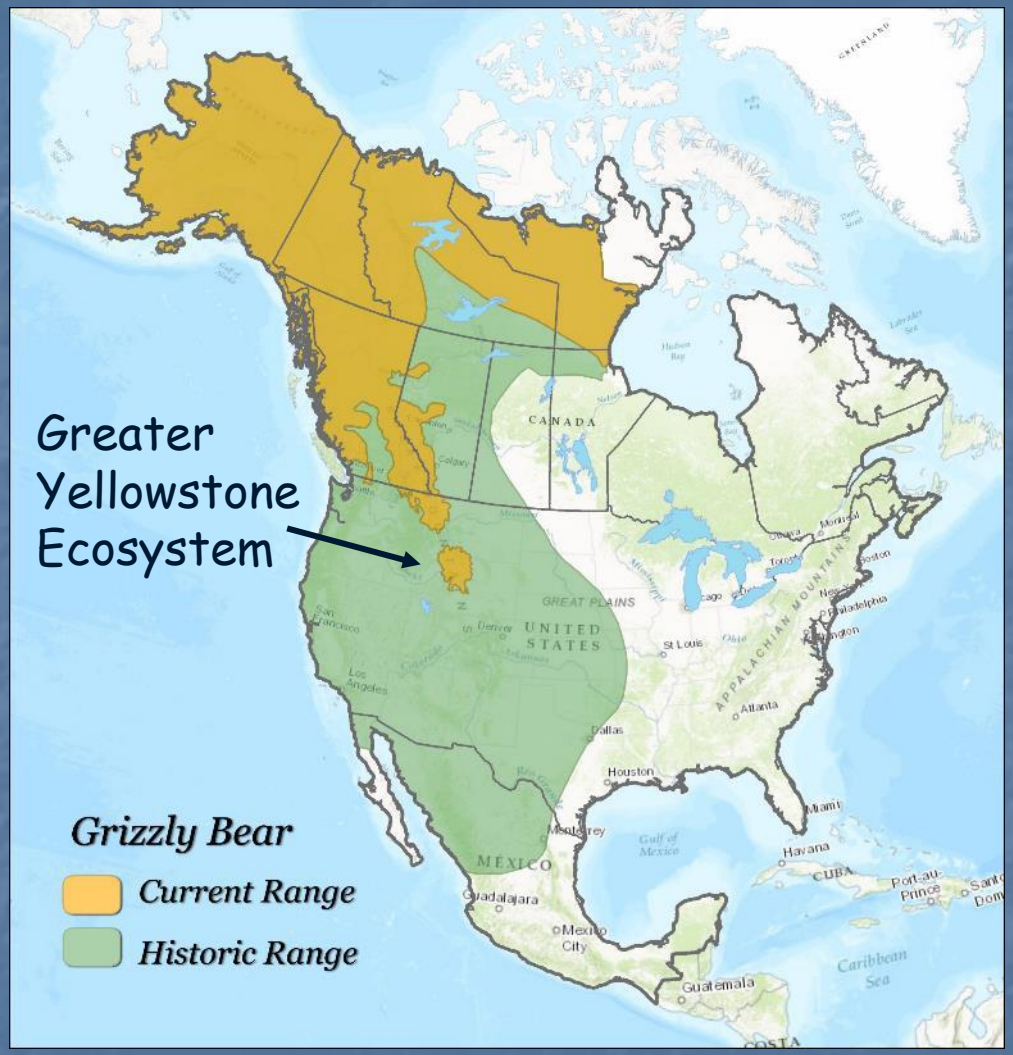
Yellowstone National Park was established in 1972 and historical accounts indicate that berries during the late 1800s and early 1900s were common in the area of the park. For example, Skinner (1928) indicated: "towards the end of summer when the berries begin to ripen, bears may desert other banquets to luxuriate in the numerous beds of fragrant, juicy, and toothsome berries".



Berries can provide important nutrition in late summer and early fall for bears, as they prepare for hibernation. In addition, the foliage, flowers, and fruit of berry-producing shrubs can have a significant role in supporting an array of avian and terrestrial wildlife.

(Graph- Beschta & Ripple 2012)

Grizzly Bear Range



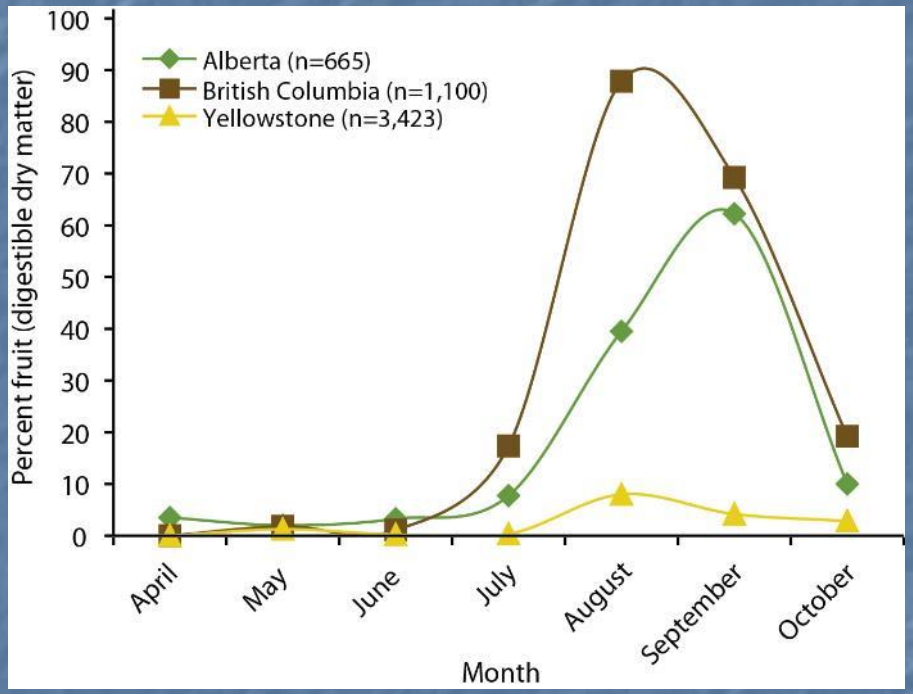
As a EuroAmerican culture spread west during the 1800s, the historic range of grizzly bears contracted dramatically.

In the conterminous 48 states, one of the major remaining concentrations of grizzly bears is that found in Yellowstone National Park, contained within the Greater Yellowstone Ecosystem.

(Map – US Geological Survey)

The Diet of Yellowstone's Grizzlies – A Conundrum

Around the world it is common for bears to consume large quantities of berries in late summer and early fall, as they put on fat reserves for hibernation.



Data Years – Alberta, 2002-2003; British Columbia, 1979-1991; Yellowstone, 1977-1987.

(Graph – Ripple et al. 2013, Online Support)

Analyses of grizzly bear scat in the northern Rocky Mountains of Alberta and British Columbia, as an example, indicated that berries were a major portion of their diet in August and September, a typical pattern.

Yet, Yellowstone's grizzlies were different, and berries were a very small percentage of the diet for grizzly bears in Yellowstone. Why?

A working Hypothesis:

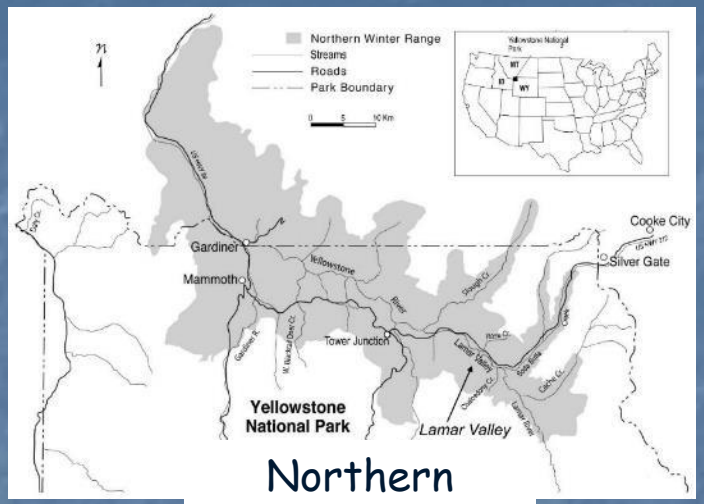
Wolves and Elk have Affected the Availability of Berries via a Trophic Cascade

Gray wolves

Rocky Mountain Elk

(Photos – National Park Service)

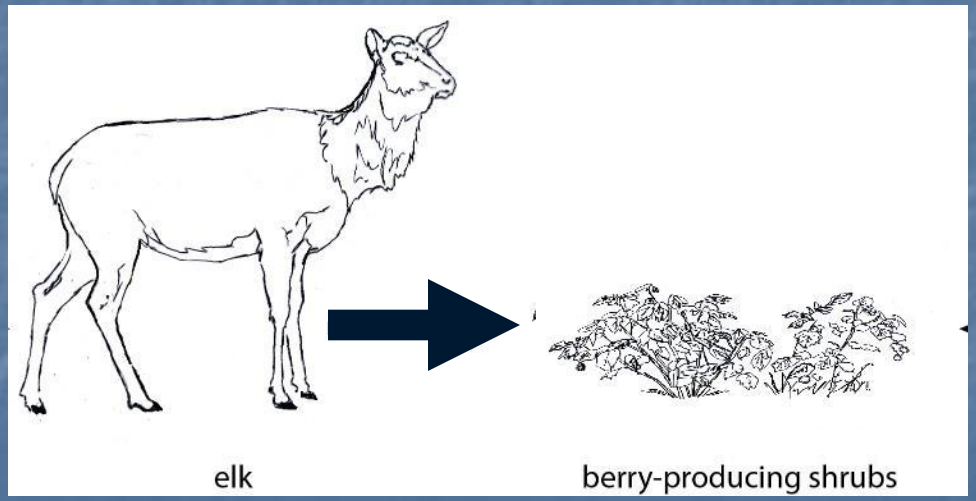
Wolves and Elk in the Northern Range - 1900s



Northern Range

Wolves, and cougars, were extirpated from Yellowstone in the 1920s. As a result, wintering elk had few predator concerns and could forage freely. Park biologists soon noticed increased elk browsing of vegetation in the northern winter range, or "northern range", located in the north-central part of the park.

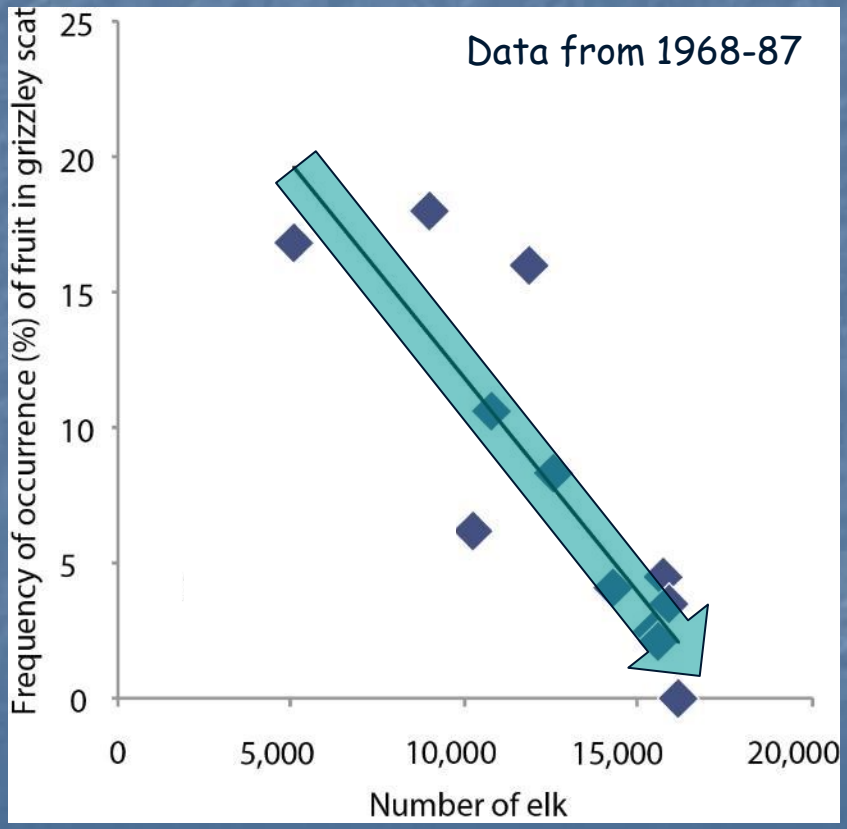
The suppression of young woody plants from increased browsing, particularly in the late 1900s, has been well documented for quaking aspen, cottonwoods, willows, thinleaf alder, and various berry-producing shrubs.



(Figure – adapted from Ripple et al. 2013)

Elk, Berries, and Bear Scat

During the mid-1900s the Park Service reduced elk herd numbers in the northern range, by culling, in an attempt to decrease their browsing of plants. However, culling ceased in 1968 and elk numbers rapidly grew, attaining nearly 20,000 animals by the 1990s. As a consequence, the effects of elk browsing began to dominate plant communities.



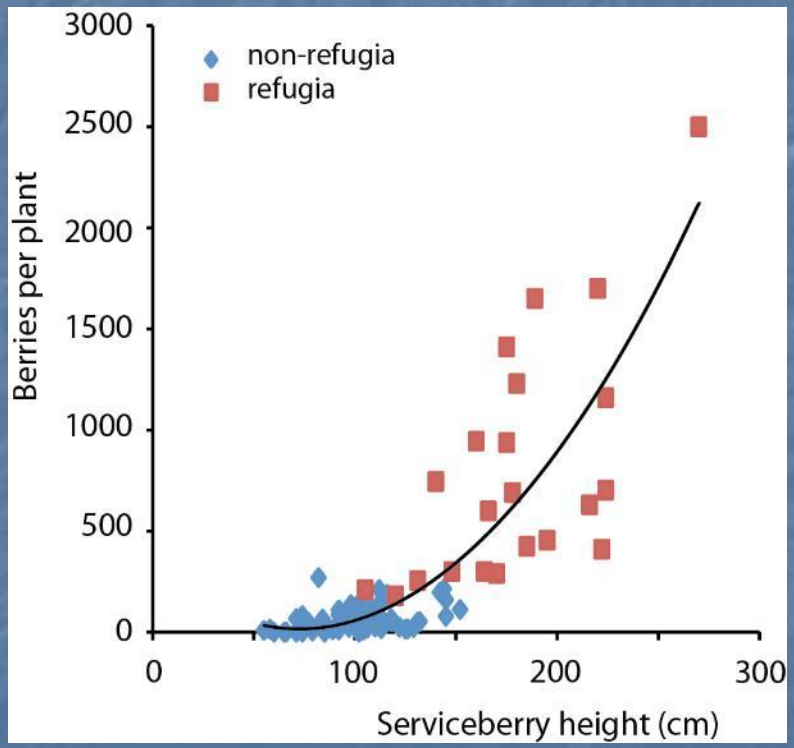
From 1968-87, when elk numbers were rapidly rising, the frequency of fruit in bear scats declined dramatically, as shown in this graph.

More browsing of berry-producing shrubs led to lower fruit production for bears and other wildlife.

(Graph – Ripple et al. 2013)

Shorter Plants have fewer Berries

Serviceberry is a common berry-producing shrub in the northern range. An exponential decrease in berry production, per plant, occurs with smaller plant heights, as indicted in the graph below for serviceberry.



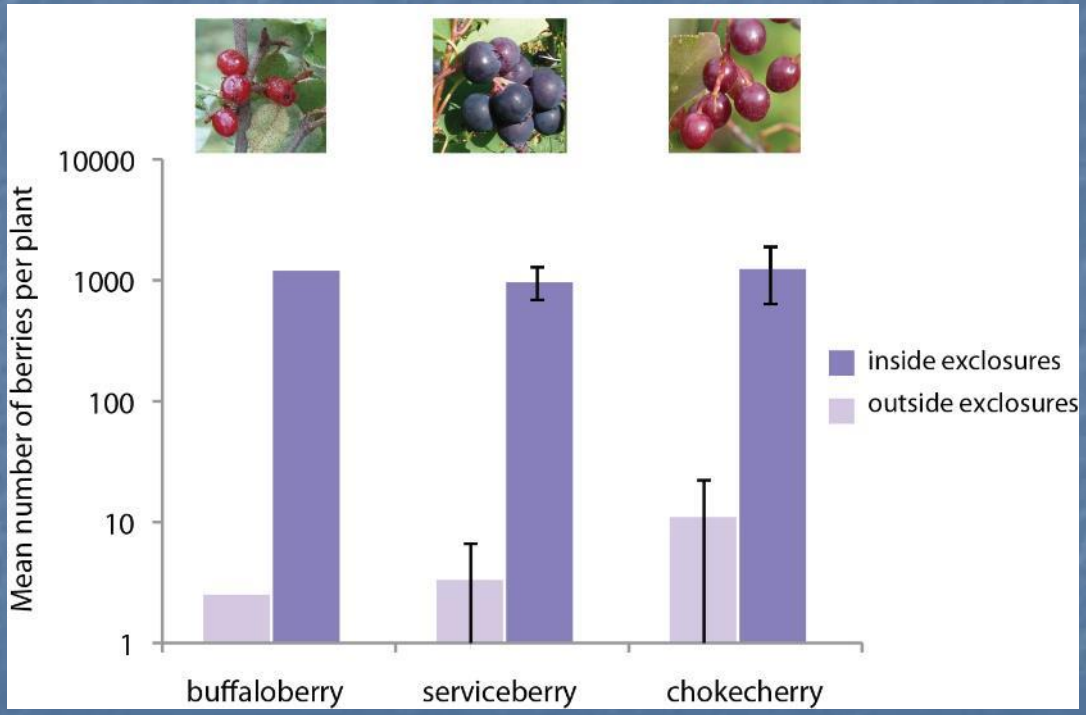
"Non-refugia" are sites where serviceberry plants were subject to elk browsing.

"Refugia" are sites where plants were protected from elk browsing, such as inside fenced ungulate exclosures.

(Graph – Ripple et al. 2013, Online Support)

Unbrowsed Plants have more Berries

Several fenced areas, or exclosures, are present in the northern range where plants are protected from browsing by elk and other large herbivores. These excluded areas are useful for discerning how elk herbivory influences berry production.



(Graph – Ripple et al. 2013)

For the three berry-producing shrub species illustrated on the left, fruit production outside of exclosures was much less than inside exclosures, where plants were protected from elk browsing.

Such results confirm that heavy elk browsing in the northern range has substantially reduced berry production.

The Conundrum Explained

Elk browsing significantly increased after culling ceased and the frequency of fruit in bear scat greatly declined, from nearly 20 percent in 1968 to almost zero by 1987.

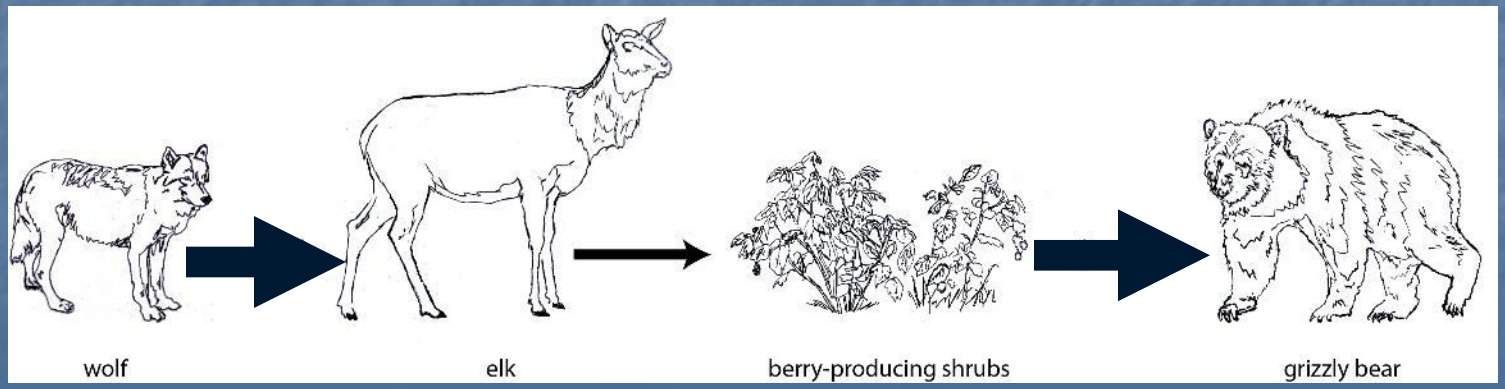
Why grizzlies in Yellowstone eat few berries in late summer/early fall, in comparison to bears elsewhere in the world, may be largely explained by the widespread loss of berry production due to high levels of elk browsing.

(Photo – National Park Service)

Going Forward - A Trophic Cascades Hypothesis

If the loss of an apex predator, such as the wolf, allows foraging elk to reduce berry production from shrubs, can the return of this predator initiate their recovery?

Below is a conceptual diagram showing a potential trophic cascade linking wolves to elk and berry-producing shrubs, and eventually to grizzly bears. Here wolves reduce elk browsing of these shrubs, by lowering elk densities or altering their behavior, thereby allowing these plants to grow tall and produce more berries. Bears indirectly benefit from this trophic cascade due to the increased berry production of taller plants.



(Figure – adapted from Ripple et al. 2013)

Completing the Large Carnivore Guild

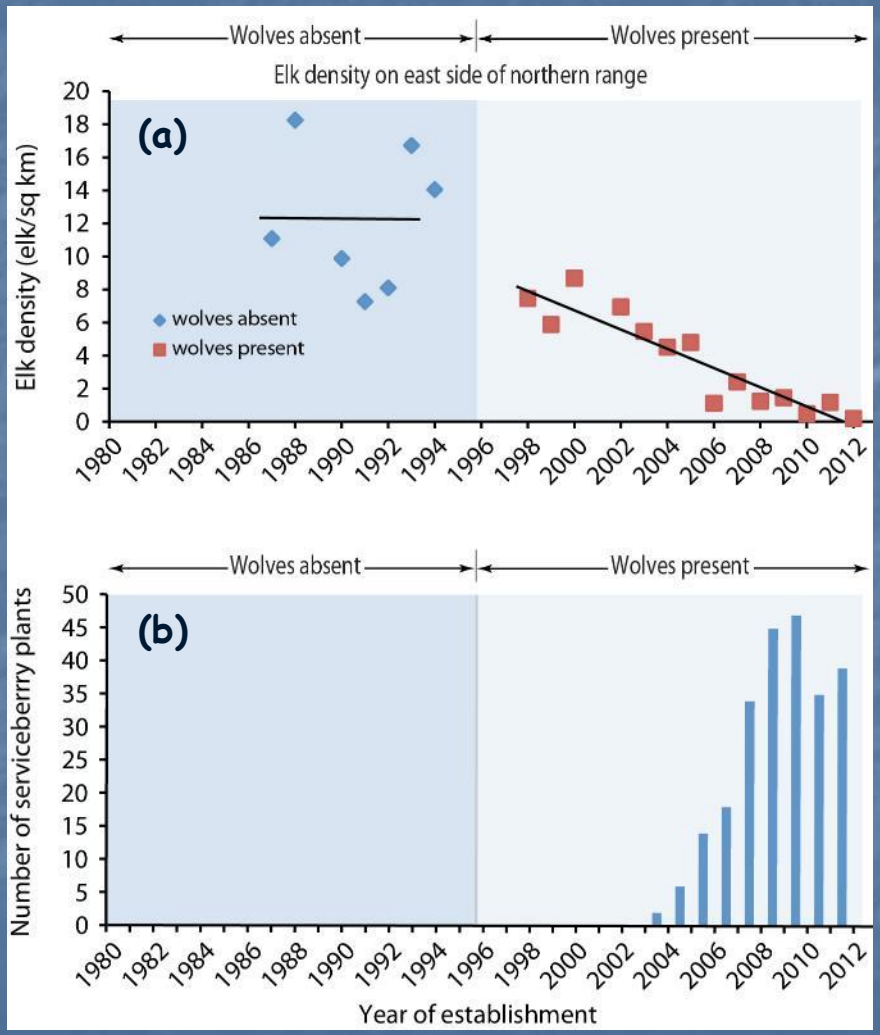
After seven decades of absence, gray wolves from Canada were reintroduced to Yellowstone's northern range in 1995-96, completing the park's large predator guild. Cougars had naturally returned to the northern range by the 1980s, perhaps earlier.

Following wolf reintroduction, behavioral changes in elk were soon observed (e.g., increased vigilance) and elk numbers began to decrease.

Sprouts and seedlings of woody plants such as those of aspen, cottonwoods, willows, and thinleaf alder that were formerly maintained in a suppressed state by intensive elk browsing, began growing taller in various portions of the northern range.

Studies that evaluated berry-producing shrubs also began to identify increased heights, recruitment, and the occurrence of berries.

Serviceberry Before and After Wolves

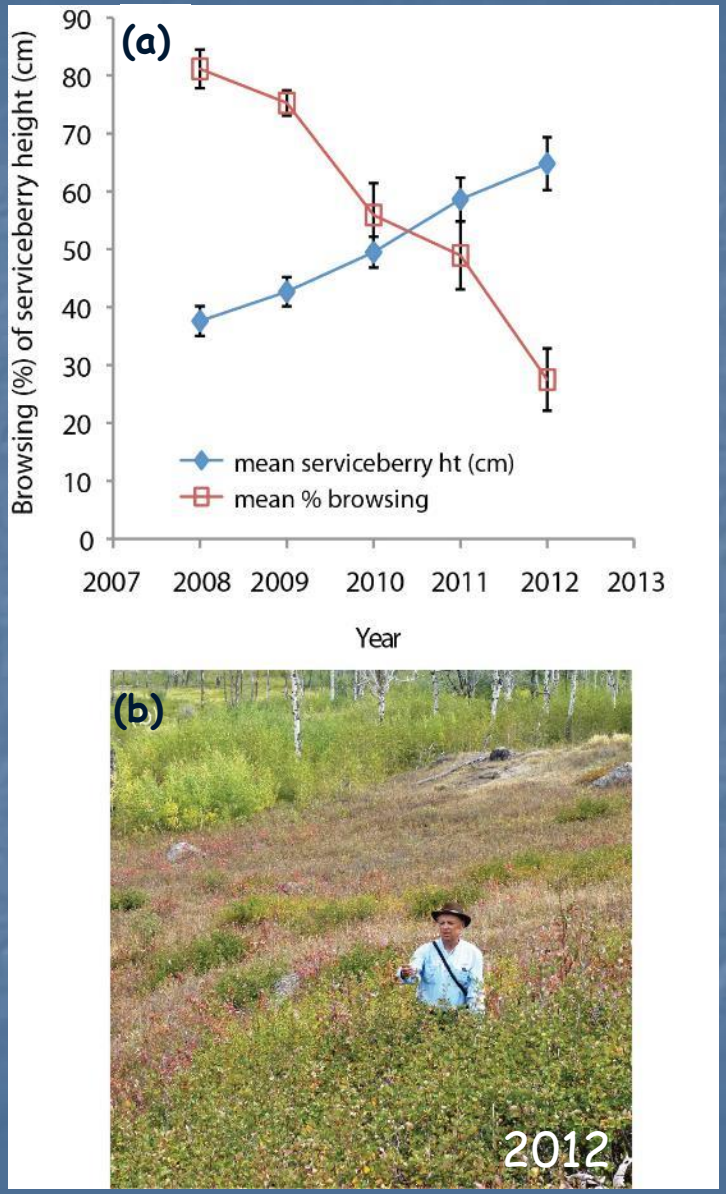


(a) When wolves were absent, elk densities were relatively high in the eastern portion of the northern range, but densities declined after the reintroduction of wolves.

(b) Serviceberry plants were unable to establish and grow when wolves were absent, due to high levels of elk herbivory. However, as browsing decreased over time the number of serviceberry plants increased.

(Graphs – Ripple et al. 2013)

Reduced Herbivory and Taller Plants



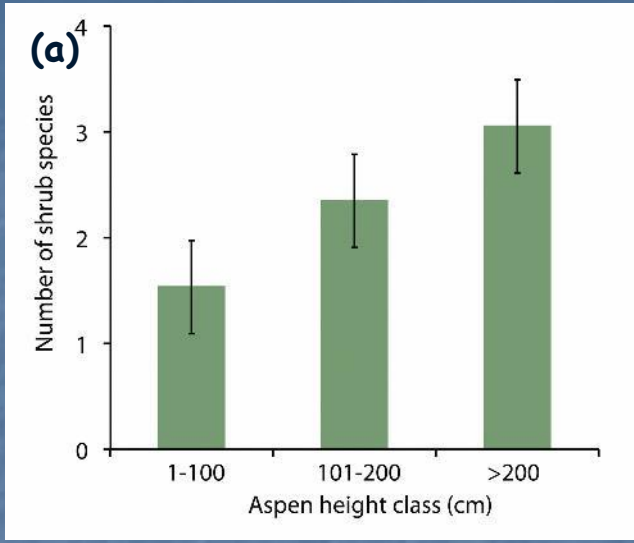
(Graph/photo – Ripple et al. 2013)

(a) If browsing decreases over time, then previously suppressed plants may begin to grow taller, as occurred here for serviceberry plants.

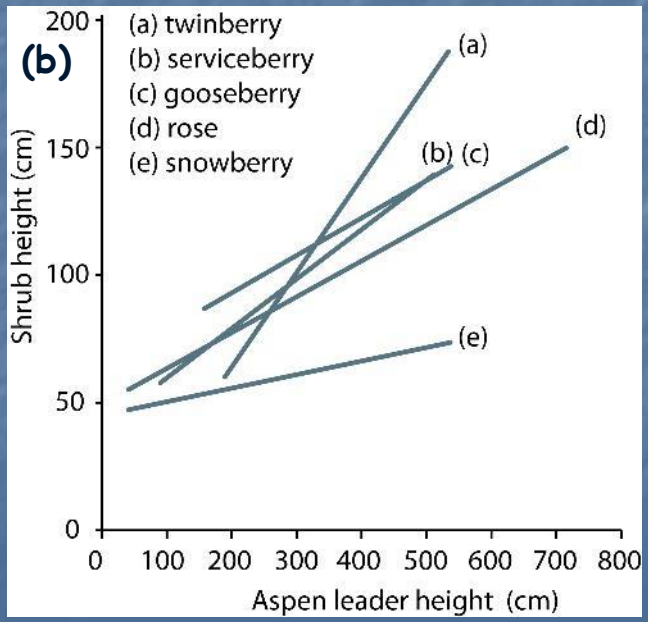
(b) The waist-high serviceberry plants in this photo were previously kept short by intensive elk browsing but have recently begun to release, i.e., grow taller, as browsing rates declined.

Young aspen in the background are also releasing.

Releasing Aspen and Berry-Producing Shrubs



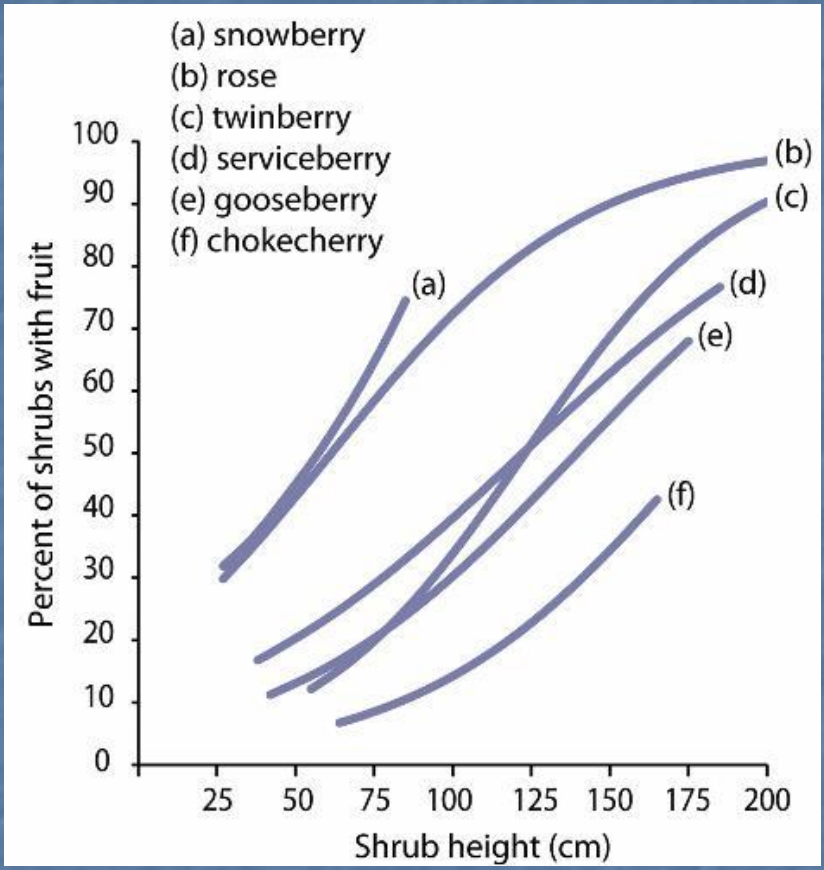
(a) As young aspen heights in various aspen stands increased in recent years, so to has the number of berry-producing shrub species.



(b) Additionally, berry-producing shrub heights increased as young aspen grew taller.

(Graphs - Beschta & Ripple 2012)

Taller Shrubs means more Berries



The percentage of plants with fruit increased as berry-producing shrubs grew taller, improving food supplies for bears and other wildlife.

(Graph - Beschta & Ripple 2012)

Summary

Early Years of the Park - In the late 1800s and early 1900s, berries were common in Yellowstone National Park — and in bear's diets.

The Reign of Elk – Wolves, and cougars, had been extirpated by the mid-1920s and elk herbivory soon after began to increase across the northern range. After culling of elk inside the park ceased in 1968, the elk population rapidly increased and the proportion of fruit in bear scat declined, from approximately 20 percent to zero.

A Restored Large Carnivore Guild – Following the return of wolves in the mid-1990s, the intensity of elk browsing began to decline in various portions of the northern range allowing for the beginning of recovery of woody species, including aspen, cottonwoods, willows, thinleaf alder, and berry-producing shrubs, consistent with a trophic cascade.

If berry-producing shrubs continue to grow taller, greater fruit production should allow bears and other wildlife to increasingly utilize the fruits of these plants to help meet their nutritional needs.

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Cited Literature

Beschta RL, & Ripple WJ. 2012. Berry-producing shrub characteristics following wolf reintroduction in Yellowstone National Park. Forest Ecology and Management 276: 132-138.

Ripple WJ, Beschta RL, Fortin JK, & Robbins CT. 2013. Trophic cascades from wolves to grizzly bears in Yellowstone. Journal of Animal Ecology 83: 223-233.

Skinner MP. 1928. The elk situation. Journal of Mammalogy 9: 309-317.

Related Literature

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

Ripple WJ, & Beschta RL. 2004. Wolves and the Ecology of Fear: Can Predation Risk Structure Ecosystems? BioScience 54: 755-766.

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

Chokecherry – *Prunus virginiana*
Cottonwoods – *Populus* spp.
Gooseberry – *Ribes lacustre and R. oxyacanthoides*
Quaking aspen – *Populus tremuloides*
Rose – *Rosa woodsia and R. acicularis*
Serviceberry – *Amelanchier alnifolia*
Snowberry – *Symphoricarpos albus and S. oreophilus*
Twinberry – *Lonicera involucrata*
Willows – *Salix* spp.

Animals

Cougar – *Puma concolor*
Gray wolf – *Canis lupus*
Grizzly bear – *Ursus arctos*
Rocky Mountain elk – *Cervus canadensis*

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.

Plant release – When woody plants that had previously had their height suppressed by browsing begin to increase in height.

Recruitment – Growth of woody plants above the reach of ungulates. In northern Yellowstone, recruitment is assumed to occur when these plants exceed a height of ~2 m (6.5 ft), the normal upper browse level of elk.

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