A. TROPHIC CASCADES
Video: How Wolves Change Rivers. https://www.youtube.com/watch?v=ysa5OBhXz-Q

1. "Thus the Yellowstone has lost its wolves and cougars, with the result that elk are ruining the flora, particularly on the winter range". Recent research indicates that predation by large carnivores, may be crucial for the maintenance of biodiversity. With the Congress authorized elimination of wolves and other predators from 1915 through the 1930's, ungulate irruptions, primarily of deer, began to occur, with most of the western irruptions (80 percent) taking place between 1935 and 1945. Such irruptions ultimately led to overbrowsing of woody species and subsequent ecosystem damage, such as reduced diversity of flora and fauna, widespread loss of habitat for nongame species, and accelerated soil erosion.

Similarly, the removal of gray wolves from Yellowstone effectively eliminated any wolf-driven trophic cascades that had historically influenced elk number and foraging patterns, which, in turn, maintained a healthy distribution and structure of deciduous woody plant communities. Results from YNP are consistent with other documented cases of trophic cascades in the Rocky Mountains, involving wolves, moose, willow, and birds in Grand Teton National Park and wolves, elk, and aspen in the Canadian Rocky Mountains.
Linking Wolves and Plants: Aldo Leopold on Trophic Cascades.
https://academic.oup.com/bioscience/article/55/7/613/306776

2. Wolves can help restore a natural balance. Through trophic cascades wolves have been shown to enhance biological diversity and restore a natural balance to wildlands. Carnivores, such as gray wolves, that are at the top of the food chain, are known as **apex carnivores**. They can cause ecological effects that ripple through an ecosystem, called "trophic cascades". A growing number of studies globally have documented trophic cascades generated by apex, keystone, carnivores.
CSU extension. Ecological effects of wolves.
https://extension.colostate.edu/topic-areas/people-predators/ecological-effects-of-wolves-8-005/

3. Wolves and other carnivores are essential to the health of wild ecosystems. John A. Vucetich who has been studying wolves and moose for 25 years at Isle Royale National Park writes "The health of ecosystems inhabited by large herbivores depends on the cascading effects of predation. When asked "What are carnivores good for?" He responds "They're good for humans. Conflicts are exaggerated, so two-thirds of the world's carnivore species are threatened with extinction. "
Restoring the Balance: What wolves tell us about our relationship with nature. John A. Vucetich. 2021. Johns Hopkins University Press.

4. Large carnivores play essential roles in ecosystem structuring and stability through both indirect and direct trophic effects. However, "Large carnivores face serious threats and are experiencing massive declines in their populations and geographic ranges around the world. Significant cascading trophic interactions, mediated by their prey or sympatric mesopredators, arise when some of these carnivores are extirpated from or repatriated to ecosystems. Unexpected effects of trophic cascades on various taxa and processes include changes to bird, mammal, invertebrate, and herpetofauna abundance or richness; subsidies to scavengers; altered disease dynamics; carbon sequestration; modified stream morphology; and crop damage.

Status and Ecological Effects of the World's Largest Carnivores.
https://www.academia.edu/5658242/Status_and_Ecological_Effects_of_the_World_s_Largest_Carnivores

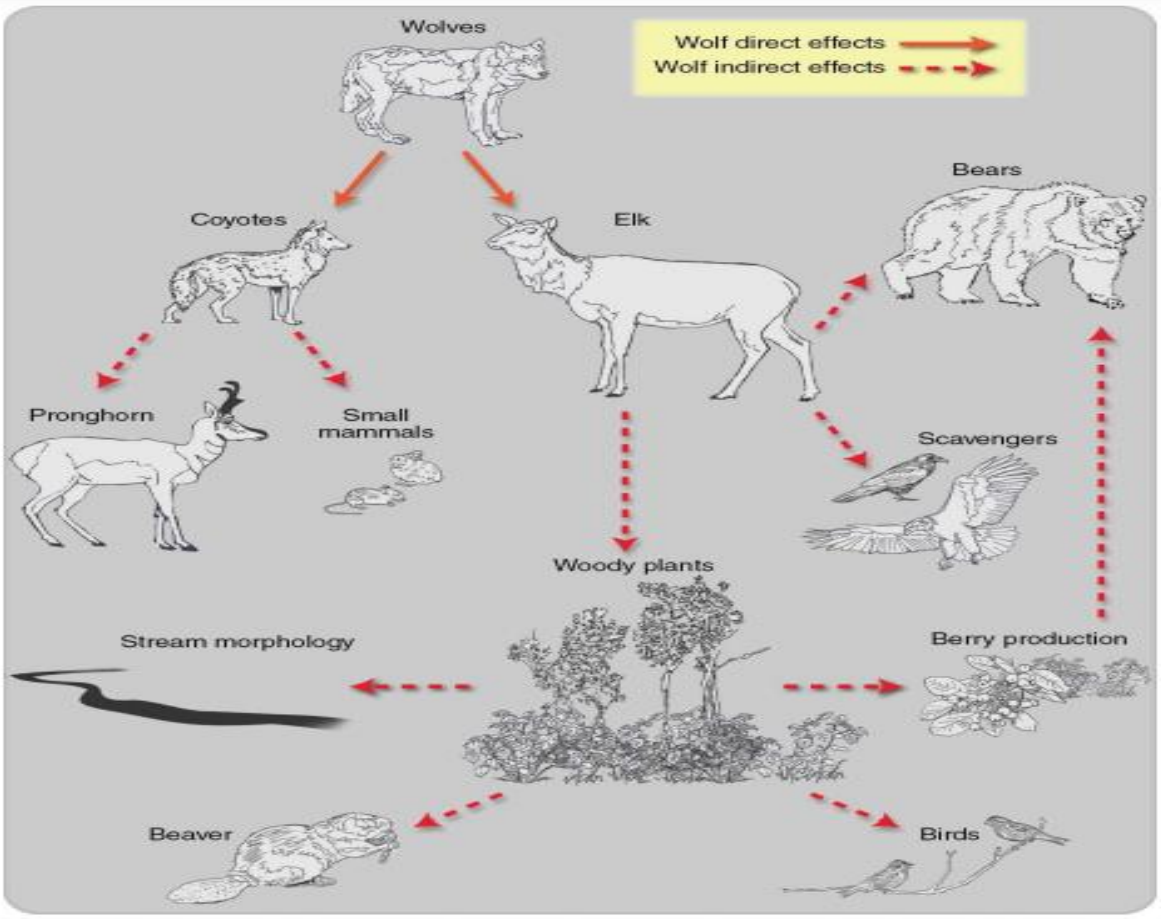

Fig. 4. Conceptual diagram showing direct (solid lines) and indirect (dashed lines) effects of gray wolf reintroduction into the Greater Yellowstone ecosystem. Wolf direct effects have been documented for elk (*96*) and coyotes (*97*), whereas indirect effects have been shown for pronghorn (*98*), small mammals (*99*), woody plants (*100*), stream morphology (*54*), beaver (*55*), birds (*101*), berry production (*63*), scavengers (*53*), and bears (*56*, *63*). This is a simplified diagram, and not all species and trophic interactions are shown. For example, the diagram does not address any potential top-down effects of pumas, bears, and golden eagles (*Aquila chrysaetos*), which are all part of the Yellowstone predator guild where juvenile or adult elk are prey.

5. Predation by wolves and other large carnivores on elk, reduce and redistribute elk population, thereby decreasing herbivory and increasing production of plant-based foods that may aid threatened grizzly bears.

Trophic cascades from wolves to grizzly bears in Yellowstone.

https://trophiccascades.forestry.oregonstate.edu/sites/trophic/files/Ripple_2013_JANE.pdf

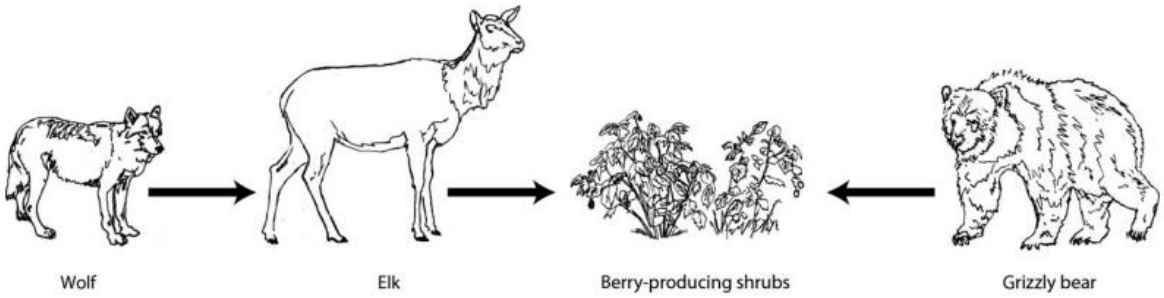

Fig. 1. Conceptual diagram showing a potential trophic cascade linking wolves to grizzly bears. The presence of wolves could reduce elk browsing, via reduced elk densities or altered elk foraging behaviour, on berry-producing shrubs allowing for increased berry production and a corresponding increase in the quantity of berries consumed by grizzly bears. This is a simplified diagram and other food web linkages are not shown.

6. Wolves are apex predators that self-regulate their own populations and influence ecosystems in profound ways, both by limiting the density of their prey and controlling populations of smaller mesopredators such as coyotes. The loss of apex predators has led to a global outbreak of mesopredators, a process known as ‘ mesopredator release ’ that increases predation pressure and diminishes biodiversity. Apex predators are distinguishable by a capacity to limit their own population densities (self-regulation), by slow reproductive rates and development, extended parental care, sparsely populated territories, and a propensity towards infanticide, reproductive suppression, alloparental care and cooperative hunting . These traits that contribute to self-regulation (e.g. reproductive suppression) depends on social stability and ensure that the largest and the fiercest do not overexploit their resources.

What is an apex predator? https://trophiccascades.forestry.oregonstate.edu/sites/trophic/files/Oikos_2015.pdf

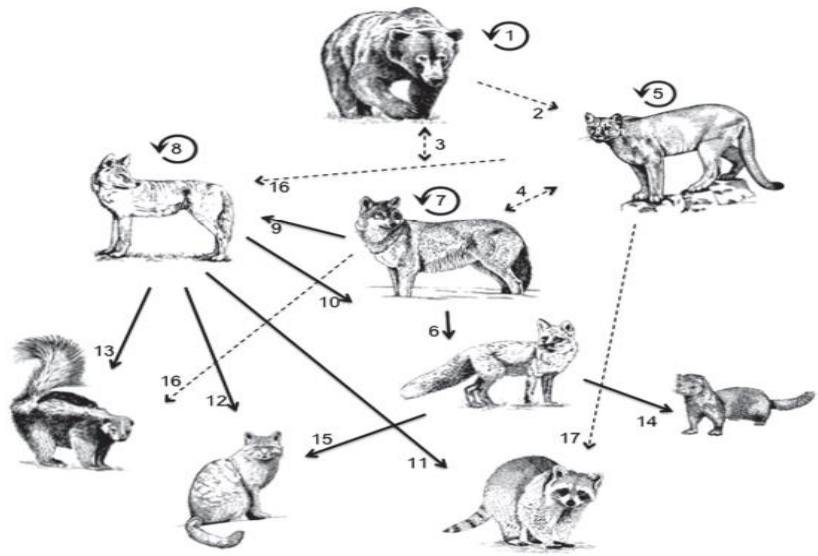

Figure 1. Apex- and meso-predator status are fixed ecological categories: apex predators are self-regulated and smaller predators are extrinsically regulated. Antagonistic interactions (dashed arrows) and top–down forces (thick arrows) exist within and across both groups, but the ability to self-regulate (circular arrows) is unique to large predators. Citations for interactions are: 1, 5, 7, 8 – Supplementary material Appendix 1 Table A1; 2 - Murphy et al. 1998; 3, 4, 16, 17 - Palomares and Caro 1999, Gunther and Smith 2004, Jimenez et al. 2008; 6 - Letnic et al. 2011; 9 - Ripple et al. 2013; 10–13 - Crooks and Soulé 1999; 14 - Carlsson et al. 2010; 15 - Glen and Dickman 2005. Artwork by J. Parkhurst.