

Environmental Studies FACT SHEET



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Number 140

Ecological impacts of reintroducing wolves

The last wolf in Yellowstone National Park (Fig.1) was killed in the 1930s.

Fig. 1 Yellowstone National Park



Almost immediately the population of elk started to increase. Although the elk were still preyed upon by black and grizzly bears and cougars, the removal of the wolves was a huge reduction in predatory pressure.



Elk behaviour changed too; the elk stopped moving around the Park as much in winter and this, accompanied by their increasing population, resulted in heavy browsing of aspen, willow and cottonwood trees.



The elk population rose above the **carrying capacity** – the maximum number that can be sustainably maintained. As the condition of the trees deteriorated, there was less material for beavers, whose population fell.

Predators such as wolves can have a “top-down” effect that ripples down through lower trophic levels. The predator significantly affects consumer populations, which in turn causes significant changes at the producer level. This sequence of events is known as a **trophic cascade** (Fig. 2).

Fig. 2 Trophic cascade caused by wolf extinction

Removal of wolves → ↓ predation of elk → ↑ elk population
→ ↑ browsing of trees → ↓ population of beavers

Three packs of wolves (21 individuals) were controversially reintroduced to Yellowstone in 1994. Predation of elk increased and elk spent more time being vigilant and moving around rather than browsing. Even though the elk population is still high, the decreased browsing pressure on particular stands of trees has meant that the overall health of the willow trees has improved. Furthermore, beaver numbers have increased significantly – and they too are having unforeseen ecological effects.

The beavers have spread and built new dams and ponds throughout the Park. This has created new wet areas and willow stands for songbirds and invertebrates, provided cold, shaded water for fish, has raised the water table and reduced seasonal runoff by effectively acting as stores.

Scientists are now studying the effect of the reintroduction of wolves on the populations of scavengers in the Park. Wolves are now once again the main predators of the elk. Before wolf reintroduction the main cause of elk mortality were deep snowdrifts into which they fell. Predation by wolves means that there is now a more even, year-round source of elk carcasses.

The scavengers that once relied on winter - killed elk for food – bears, coyotes, eagles, ravens and magpies - now depend on elk killed by wolves.

There is a long and growing list of species that appear to be benefiting from the reintroduction of the wolves. Ed Bangs, wolf recovery coordinator for the U.S. Fish and Wildlife Service: “It turns out that the Indian legends of ravens following wolves are true - they do follow them because wolves mean food.”

Typical Exam Question

A trophic cascade is the sequence of events at lower trophic levels that results from the introduction or removal of a predator.

Wolves were reintroduced to Yellowstone National Park in 1994. Scientists monitored the populations of wolves and their prey, elk and the degree of feeding damage caused by the elk to aspen tree saplings. The table shows the results.

Year	Wolf population	Elk population	Feeding damage to aspen/%	Average aspen sapling height/cm
1994	21	17,500	Data unavailable	Data unavailable
1997	24	13,000	95	30
2001	74	12,000	80	50
2005	82	9,000	20	170

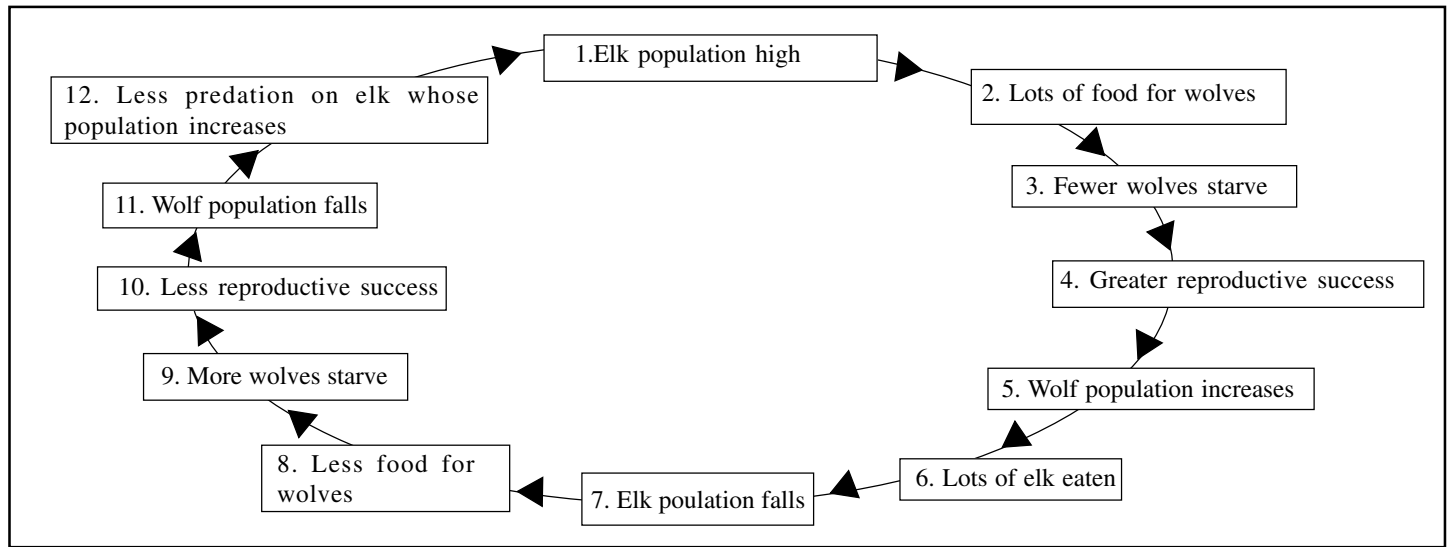
- (a) Describe the trophic cascade that resulted from the reintroduction of wolves to Yellowstone National Park. (3)
(b) Comment on the percentage change in the populations of wolves and elk. (4)

Elk altered their feeding strategies to become more vigilant etc;
Increasing vegetation so plenty of food for elk;
Young wolves take other prey;
Wolves preyed on weak/sick/reproductively irrelevant elk;
Elk have high reproduction rate;
Elk: $8500/17500 \times 100 = 49\%$ decrease;
(b) Wolves: $61/21 \times 100 = 290\%$ increase;
Aspen able to grow taller;
Less feeding damage to aspen;
(a) Elk population fell due to predation;

Markscheme

However, an increasing number of scientists are pointing out that the story almost certainly doesn't end there. Populations of predators and their prey inevitably fluctuate (Fig. 3)

Fig. 3 Predator – prey fluctuations



But there is evidence that when the elk population falls, the wolves, instead of starving, may increase predation of beavers. In southern Quebec, beavers were found to be making up 29 – 44% of wolves diet between May and November.

Other scientists are sceptical about the reasons for the improvement in the condition of the aspen and willow forests, suggesting several other possible causes:

- Rebound effect from the 1988 Yellowstone fire
- The survival of drought-tolerant individuals
- Warmer and drier winters

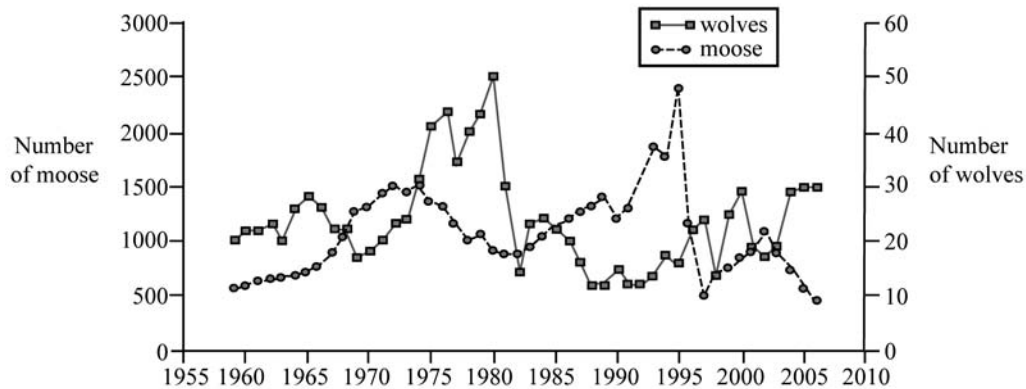
They argue that before any more money is spent on such reintroductions – and many are planned – there is a need to set up control groups. This would involve monitoring similar tree populations in areas where there are no wolves or beavers.

The anti-wolf lobby is growing!

Typical Exam Question

Isle Royale is an 544 km² island in the middle of Lake Superior. It lies about 25 km from the Canadian shore but becomes connected in extremely cold winters by ice bridges.

It is a National Park, hunting and logging are prohibited and the island is mostly covered by climax forest of spruce, birch and aspen. Moose colonized the island at the beginning of the 20th century. Wolves reached the island via an ice bridge in the severe winter of 1948-9 and prey on the herbivorous moose. The graph shows the numbers of moose and wolves on the island over a 50-year period.



Describe and suggest an explanation for the relationship between the numbers of wolves and moose over the period shown. (4)

Moose population much greater than wolf population;
 Ref to pyramid of numbers/loss of energy at each trophic level;
 As wolf population falls, moose population increases;
 Ref to less predation;
 As wolf population increases, moose population falls;
 Ref to increased predation;

Case Study: Zion National Park

Fig. 4 Zion National Park

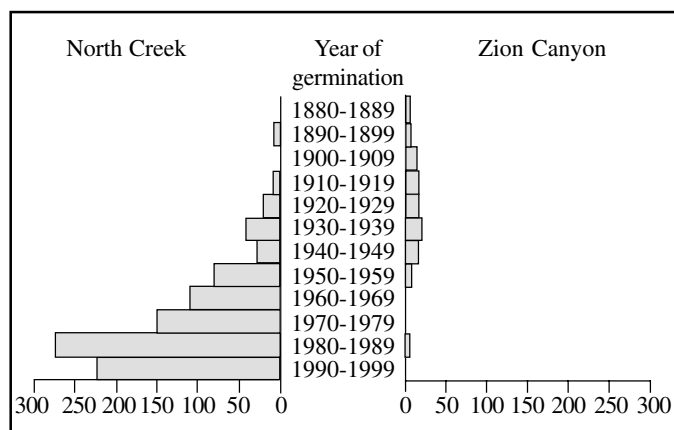


Scientists investigated a trophic cascade in two adjacent canyons in Zion National Park, Utah. The two canyons have similar geology and plant assemblages. However, North Creek attracts very few tourists whilst Zion Canyon has for many years attracted large numbers of tourists.

Scientists investigated whether the large number of tourists was influencing a trophic cascade in Zion Canyon. They recorded the age structure of cottonwood trees and estimated the populations of cougars and of their main prey, deer. The results are shown in the table and diagram.

Species	Canyon	
	North Creek (few tourists)	Zion Canyon (many tourists)
Cougar/scats km ⁻¹	1.75	0
Deer/h hoof prints km ⁻¹	3.3	700
Cottonwood saplings/km	900	23

Fig. 5 Age structure of Cottonwood trees

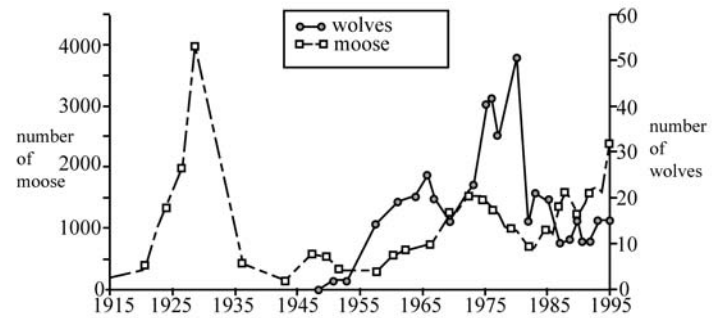


In North Creek cougars were still present and the deer population was much smaller than in Zion Canyon. Consequently, there was much less grazing pressure and the number of young cottonwood trees was high. In Zion Canyon, the many visitors have effectively eliminated cougars. Thus, the deer population is high and there are very few cottonwood saplings. The scientists concluded that tourists were influencing the trophic cascade.

Practice Question

Isle Royale is an 544 km² island in the middle of Lake Superior. It lies about 25 km from the Canadian shore but becomes connected in extremely cold winters by ice bridges. Moose colonized the island at the beginning of the 20th century. Wolves reached the island in the severe winter of 1948-9 and prey on the herbivorous moose as well as other species.

The graph shows estimated numbers of moose and wolves between 1915 and 1995.



- (a) Suggest why moose populations fluctuated before wolves reached the island (3)
- (b) Between 1965-7 the wolf population declined after it became infected with a virus. Is this a density dependent or independent factor? Explain your answer. (2)
- (c) The moose and wolf populations on Isle Royale are often used as an example of a predator-prey relationship in which the population of predators control the population of prey.

Explain how the data in the graph:

- (i) support this hypothesis.(2)
- (ii) do not support this hypothesis. (2)

- (a) disease/parasites; changes to food availability; carrying capacity exceeded; death from cold winters;
- (b) Density dependent; Virus spreads faster the greater the population density; proportion of wolves that die increases at higher population densities;
- (c) (i) moose population more stable after arrival of wolves; moose population doesn't increase as rapidly after the arrival of the wolves; Fall in wolf population is followed by a rapid increase in moose population; Wolf peak follows moose peak;
- (ii) 1946-1980 wolf population increases as a trend even though moose numbers often low; in 1966 wolf population peaked before moose; poor correlation between rises and falls of wolves and moose;

Answers

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