

KOALAS AND CLIMATE CHANGE

Hungry for CO₂ cuts



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Summary

- Koalas are iconic animals native to Australia. They are true habitat and food specialists, only ever inhabiting forests and woodlands where *Eucalyptus* trees are present.
- Increasing atmospheric CO₂ levels will reduce the nutritional quality of *Eucalyptus* leaves, causing nutrient shortages in the species that forage on them. As a result, Koalas may no longer be able to meet their nutritional demands, resulting in malnutrition and starvation.
- Increasing frequency and intensity of droughts can force Koalas to descend from trees in search of water or new habitats. This makes them particularly vulnerable to wild and domestic predators, as well as to road traffic, often resulting in death.
- Koala populations are reported to be declining probably due to malnutrition, the sexually-transmitted disease chlamydia, and habitat destruction.
- Koalas have very limited capability to adapt to rapid, human-induced climate change, making them very vulnerable to its negative impacts.

The IUCN Red List of Threatened Species™

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- Koalas are particularly vulnerable to the effects of elevated CO₂ levels on plant nutritional quality, as they rely on them for food. The potential impacts of these changes on the world's food chains are enormous.

Australian icon, the Koala (*Phascolarctos cinereus*), is a tree-dwelling marsupial found in eastern and southern Australia. Marsupials are mammals whose young are born at a very undeveloped stage before completing their development in a pouch. The Koala is not a bear, though this name has persisted outside Australia since English-speaking settlers from the late 18th century likened it to a bear.

What do we know about Koalas?

Koalas are native to Australia and are present in four Australian states: Queensland, New South Wales, South Australia and Victoria. They are commonly found in southern and eastern coastal regions from Adelaide to Cairns, and further inland where the landscape and climate can support woodlands. Koalas forage mainly at night and typically sleep and rest for a minimum of 16 hours a day.

Koalas are true habitat and food specialists, only ever inhabiting forests and woodlands where eucalypts are present. Of the 600+ eucalypt species present in Australia, Koalas feed only on the leaves of a few tens of species. Further, Koalas in different regions also show preferences for different species.

The nutritional quality of eucalypt leaves is very poor, and an individual Koala may have to consume 500g of leaves or more each day in order to grow and survive. All *Eucalyptus* leaves contain tannins, which are chemicals that attach to leaf proteins and make them highly indigestible. Plants produce tannins to deter herbivores, and Koalas choose their preferred eucalypt species based on a trade-off between nutrient and tannin concentrations within their leaves.

The Koala's choice of specific eucalypt species may also allow it to minimize competition with other marsupials, such as the Greater Glider and Common Ringtail Possum, which also feed on *Eucalyptus* leaves.

Koalas usually live between 10 and 14 years. Females reach sexual maturity at about three years old and males at four. Mating takes place during the Australian summer between December and March, and usually just one juvenile, called a 'joey', is born each year per female. The joeys remain in the females' pouch and feed on her milk for about six months before beginning to explore the outside world.

Nursing mothers produce a special form of faeces, known as 'pap'. Pap contains the specific micro-organisms essential for digesting *Eucalyptus* leaves. After consuming the pap, the joey is able to slowly switch its diet from milk to leaves. Joeys usually stay with their mothers for about a year, or until a new joey is born and requires the pouch. The young Koala then disperses in order to find its own territory.



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How is climate change affecting koalas?

Climate change is predicted to include an increase in drought frequency and high-fire-danger weather in many parts of Australia, owing to reduced rainfall levels, increased evaporation rates and an overall temperature increase of about 1°C by 2030, according to a CSIRO report.

CO₂ concentrations globally have increased from 280 ppm to 387 ppm since the Industrial Revolution. Projections for 2050 suggest that CO₂ concentrations are likely to increase markedly to between 500 and 600 ppm, depending on future emissions scenarios.

Elevated CO₂ levels:

Increased atmospheric CO₂ levels tend to result in faster plant growth through a process known as 'CO₂ fertilisation'. However, while plants grow faster, experiments have shown that it also reduces protein levels and increases tannin levels in plants' leaves. As CO₂ levels continue to rise, Koalas and other browsers will need to cope with increasingly nutrient-poor and

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tannin-rich *Eucalyptus* leaves. Scientists suggest that Koalas could respond in two ways.

Firstly, Koalas could meet their nutritional needs by spending more time feeding and thus eating more. However, there is a limit to how much Koalas can increase the size of their guts. In addition, eating more leaves causes them to pass more quickly through the Koala's digestive system, resulting in less thorough digestion and decreased nutrient uptake.

Secondly, the above strategy could be combined with greater selectivity in leaf and tree choice. Younger, more nutritious leaves, however, also tend to possess more tannins. Koalas could also be more selective about the trees they select, though this would involve greater travelling time to find the best trees.

Koalas travelling in search of food are at an increased risk of predation and road accidents. Dispersing Koalas often find themselves having to cross main roads and coming into contact with domestic animals. It is estimated that around 4,000 Koalas are killed each year by dogs and cars alone.

The difficulties of digesting *Eucalyptus* leaves, combined with limitations on how much Koalas can increase the size of their gut, means that Koalas may no longer be able to meet their nutritional demands, ultimately resulting in malnutrition and starvation.

The nutritional demands of breeding female Koalas are higher than non-breeding individuals, providing an insight into challenges faced by all Koalas under higher CO₂ conditions. Lactating female Koalas have already been observed adopting the above strategies in attempts to meet the extra nutritional requirements demanded for the production of milk for their young. Unfortunately, if the quality of their food declines, they have limited options for further changing their behaviour. If females are unable to produce joeys to replace Koalas that die of old age, populations will dwindle and eventually disappear.

Increasing droughts and bushfires:

Koalas' warm fur and thick skin enables them to endure cold conditions in southern Australia, but they do not cope well with extreme heat. Unlike most other arboreal marsupials, Koalas do not use nest hollows, which also contributes to their greater susceptibility to extreme temperatures and drought. During particularly hot periods, Koalas descend to the ground and go in search of water. When at ground level, Koalas are significantly more exposed to their predators, which include dingoes and dogs.

Bushfires, which have already wiped out considerable populations of Koalas, are likely to increase in both frequency and severity with climate change. Koalas are particularly vulnerable to bushfires as their slow movement and tree-dwelling lifestyle makes it difficult for them to escape and their food supply can be destroyed.

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Can Koalas adapt to climate change?

Koalas' possible behavioural adaptations to decreasing food quality are discussed above. However, scientists are not optimistic of the ability of this highly specialised species to adapt to a changing climate, particularly as changes are occurring faster than Koalas are likely to have experienced in the past.

Koalas' potential for adaptation is also limited by the low levels of genetic variation within their populations. This is primarily due to a large reduction in their numbers in the early 20th century due to hunting for the fur trade. This brush with extinction was followed by a subsequent increase from a very small founder population and, as a result, most current Koala populations are highly inbred.

On some islands, such as Kangaroo Island in southern Australia, Koalas can achieve very high population densities. However, current reductions in food quality mean that Koala habitats will become increasingly poor in quality. As these populations are unable to disperse to new habitats, current densities will ultimately become unsustainable and we may expect to see increased levels of starvation.

Other threats

Reports of large population declines over the past decade have prompted reassessments of the Koala's threat status by the Australian government. In addition to climate change-related declines in Koala nutrition, declines are attributed to disease and habitat destruction. *Chlamydia* is a sexually-transmitted disease that causes blindness, pneumonia, and urinary and reproductive tract infections and death in Koalas. Destruction and degradation of Koala habitat is particularly prevalent in the coastal regions of Australia where urban development is rapidly encroaching on *Eucalyptus* forests. In addition, habitat fragmentation limits Koalas' ability to disperse to suitable areas and can intensify inbreeding problems.

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Koala geographical range – © IUCN Red List

"My view of koalas is that the strong connection between food quality and demography means that they are particularly vulnerable to climate change. Elevated atmospheric CO₂ reduces the amount of protein available from Eucalyptus leaves for animals. This Eucalyptus-marsupial system is one of the very few examples in which the direct effects of CO₂ can be linked to populations of wild mammals."

- William Foley