Cantabrian brown-bear population: how climate change may endanger its long-term conservation, Spain

The impacts of climate changes can force animal- and, over a longer time period, plant species to shift their range. Forests in temperate regions, such as north-western Spain, will be increasingly exposed to drought over the next few decades, which is likely to cause geographical changes in their distribution and make-up. New patterns of plant occupancy or plant extinction have a bottom-up effect on animal species dependent on them, which can significantly impact on isolated or endangered populations of animals. This study sought to assess the potential impact of climate change on the brown-bear (Ursus arctos) population in the Cantabrian Mountains.

The Cantabrian Mountain bears are largely vegetarian in their diet and feed on blueberries and acorns, as well as several other plant species. The last few decades have seen warming temperatures in north-western Spain, where the Cantabrian Mountains are located. Temperature changes affect the foraging behaviour of the bears, so this warming causes concern for their conservation. It is likely these climate-change impacts will continue and deteriorate over time.

The researchers used field data from a long-term survey on bear distribution and considered two climate-change scenarios (pessimistic and moderate), for 2050 and 2070, applying both physical variables (climatic and geographic), as well as biotic variables (for example, fruit and acorn distribution) to bioclimatic models. This enabled them to forecast the effect of potential changes this century in the spatial distribution of bear-food resources and shelter on the Cantabrian bear population, and to evaluate what the implications might be.

Field data was collected in two locations: in Castilla y Leon between 1985 and 2017; and in Asturias between 1995 and 2016. In total, 8,784 geo-referenced bear locations were available. This data consisted of direct observation in the field but also indirect evidence, such as bear faeces (known as scat), footprints, fur and damage to beehives, crops and livestock. The presence data was coupled with 20,000 points of background/pseudo absence data — randomly generated data points providing information on the environmental conditions within the geographic region, where sightings of bears had not occurred — to enable the use of a presence/absence model. Seven woody plant species (blueberry, beech, chestnut, pedunculate oak, Pyrenean oak, sessile oak and Scot’s pine), important food sources for the brown bear, were analysed for presence/absence within the Cantabrian mountain geographic area; 8,185 sites were surveyed.

The reference period for the climate models is 1960–1990, using data for variables which included 19 climatic, 13 soil and 13 topographical/radiative, as well as seven species-distribution model variables for the tree species analysed. Random Forest, a machine-learning algorithm (a form of artificial intelligence used to mine a data set and create a model) was used to fit species-distribution models.

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The models reflected two climate-change scenarios. The moderate climate scenario suggests greenhouse-gas related emissions stabilising by 2100, without exceeding 4.5 watts per square metre (W/m²) (the CO₂ heating effect), 650 parts-per-million (ppm) CO₂ and a 1–2.6 °C temperature rise (based on scenario B1 of the International Panel for Climate Change (IPCC) Fourth Assessment (AR4) guidelines). The pessimistic climate scenario suggests increases in greenhouse gases, following recent trends, reaching a total radiative forcing — where heat energy becomes trapped in our climate rather than radiating back out into space — of 8.5 W/m², with 1350 ppm CO₂ and a 2.6–4.8 °C temperature increase by 2100 (based on scenario A1F1 of the 2007 IPCC Fourth Assessment (AR4) guidelines).

The modelling showed that plant distributions would be considerably affected by climate change, with beech forests reduced by 50% under the moderate scenario and almost gone under the pessimistic one. Similarly, the range of blueberries was reduced by 50% with sessile and pedunculate oak being reduced by more than 50% under the moderate scenario, but, again, almost disappearing under the pessimistic climate model.

As a consequence of the extensive range contractions of most of the forest cover and blueberries in the Cantabrian Mountains, the brown-bear population was greatly reduced — by approximately half under the moderate scenario for 2050 and 2070, with a worrying contraction under the pessimistic scenario by 2050, to only 24% of present range and, in 2070, only 12%. The brown-bear range shifted to the north in pursuit of the shift in chestnut range, leading them to lower altitudes — below 1000m above sea level. The researchers suggest this shift is likely to place bears in areas where there are more people, livestock and crops — increasing conflicts and resulting in increased bear mortality. In addition, the reduction in suitable vegetation may force the bears into greater interest in beehives, crops and meat, with a resultant further increased probability of conflict. This aspect of bear-population decline was not factored into the models of this study.

To conserve the brown-bear population, the researchers suggest that plant-distribution changes need to be taken into account in conservation planning, with a focus not only on the bears’ current protected range but an extension of the protected range to cover the area it will be shifted to under climate-change scenarios (due to the shift in forest plant species).

Conservation scientists are considering strategies to increase the resilience of tree species to the regional effects of climate change; these include intentionally moving species to climatically suitable locations outside of their current range, as well as assisted gene flow (e.g. introducing individual trees whose genes make them more resilient to climate change into populations that lack those traits). Also recommended for consideration are pre-emptive management of the areas to which the bears’ range will shift, alongside an extension of present protected areas to account for the change in plant ranges.


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