

# Behavioral heat-stress compensation in a cold-adapted ungulate: forage-mediated responses to warming Alpine summers

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## Abstract

Alpine large herbivores have developed physiological and behavioral mechanisms to cope with fluctuations in climate and resource availability, but climate warming might induce behavioral maladaptation. We verified this hypothesis in female Alpine ibex (*Capra ibex*) by modelling seasonal and daily movement and activity patterns in function of temperature and vegetation productivity, based on bio-logging data and climate change projections. In late spring, ibex moved upslope, tracking the green-wave in plant phenology. Ibex sharply decreased diel activity above a threshold mean daily temperature of 13°C, indicating thermal stress, but compensating behaviorally by foraging earlier at dawn, and later at dusk, and by moving upslope higher than on cooler days. This temperature threshold will be exceeded more than three times as often under climate change projections. In such scenarios, the imperative requirement for thermal shelter may force Alpine ibex towards topographic edges, impacting individual performance and population distribution of this emblematic mountain ungulate.

## *Statement of the authorship:*

FC and MR conceived and designed the study. ES, MR, and PS organized and managed animal marking. PS collected and managed the bio-telemetry and observational data. EE processed climate warming projections. PS, FC and MR designed statistical analyses. PS analyzed the data. PS and FC wrote the first draft of the manuscript, with comments from NM, AJMH, FO and MR. All co-authors revised further versions of the manuscript. MR competitively obtained funds to support the study, with contributions from FC.

Data accessibility statement:

Data are currently stored in the Euroungulates database ([www.euromammals.org](http://www.euromammals.org)) and access can be provided after log in. Dataset used for analysis can be further stored on a d.o.i. repository upon acceptance of the manuscript.

## *Article title:*

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