

## Winter sleep with room service: denning behaviour of brown bears with access to anthropogenic food

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hibernation; denning behaviour; supplemental feeding; anthropogenic food; *Ursus arctos*; meta-analysis; brown bear.

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### Abstract

Large quantities of food subsidies provided by humans to animal communities have the potential to change a variety of animal life traits, including denning behaviour of facultative hibernators like bears. Brown bears *Ursus arctos* regularly use anthropogenic food, but it has remained unclear if human food subsidies affect their hibernation and denning behaviour, despite the consequences this could have for bear interactions with humans and other species. We studied denning behaviour of European brown bears in Slovenia, where intensive supplemental feeding with corn is practiced throughout the year, including winter. We used GPS telemetry data to locate den sites and to monitor bear denning chronology. We conducted a meta-analysis to compare our results with other bear populations across Europe, Asia and North America. A consistent relationship between latitude and time spent denning was observed for male and female brown bears across the species' range (for each degree of latitude northwards, denning period increased for 3.1 days), and males on average denned 10.3 days longer than females throughout the latitudinal gradient. However, our study area deviated strongly from regions where supplemental feeding was not practiced. In Slovenia, denning period averaged 82 days for females and 57 days for males, which was 45 and 56% shorter compared to the time predicted for this latitude, respectively. We also observed regular den abandonments (61% of bears abandoned dens, on average 1.9 times per winter). During the winter period bears increased use of supplemental feeding sites for 61% compared to the non-denning period. We conclude that the availability of anthropogenic food is an important driver of denning behaviour in brown bears. Reduction in the denning period increases the potential for bear interactions with other species, including humans, and we highlight possible management and ecological implications of this human-caused perturbation to denning behaviour of wild ursids.

### Introduction

Several mammalian species have evolved unique physiological adaptations to conserve energy when food supplies are scarce and ambient temperatures are low (Florant & Healy, 2012). In some species hibernation is maintained even when food is available (obligate hibernators), whereas other species remain active in response to increased food availability (facultative hibernators) (Harlow, 1995).

Large amounts of food subsidies provided intentionally or unintentionally by humans to animal communities across the world ecosystems (Oro *et al.*, 2013) have the potential to modify hibernation patterns in facultative hibernators. There is increasing evidence that anthropogenic food sources change a variety of animal life traits, including genetic and reproductive parameters, abundance, survival, spatial distribution as well as intra- and inter-specific interactions (for review see Oro *et al.*, 2013; Newsome *et al.*, 2015). However, effects of this relatively novel food resource on facultative hibernators in the

wild remain poorly understood and often overlooked when wildlife feeding practices are designed.

Ursids are among the most studied facultative hibernators, but despite decades of extensive research, complex mechanisms that drive bear denning behaviour in the wild remain unclear (Hellgren, 1998; Manchi & Swenson, 2005; Graham & Stenhouse, 2014). Bears exhibit several characteristics, such as lower reduction in body temperature, that separate them from the deep hibernation of many other mammals (Hissa, 1997; Hellgren, 1998; Evans *et al.*, 2016). Hibernation typically takes place in winter dens, which bears use to reduce energy loss when food is inadequate (Tietje & Ruff, 1980) and for pregnant females to give birth (López-Alfaro *et al.*, 2013).

A large range distribution and persistence in a variety of ecological settings makes the brown bear *Ursus arctos* a suitable species for studying denning behaviour and factors affecting it. Latitude explains part of the variability in the length of denning period, but additional intrinsic (e.g. sex, age, reproductive state, fat reserves) and external factors also play a role