



Conservation of a threatened mammal species through domestic tourism in Chile

Numerous case studies have shown that international tourism can contribute to the successful conservation of threatened mammal species in developing (Buckley 2010, 2014; Naidoo *et al.* 2016) and newly industrialized (Buckley and Pabla 2012) nations. Such findings are supported by population accounting approaches and population viability models (Buckley *et al.* 2012, 2016). Similar outcomes have not previously been demonstrated, however, for domestic tourism in either developed or developing nations (Wardle *et al.* 2018).

Here we describe what appears to be the first documented example of a net positive conservation outcome from domestic tourism for an imperiled mammal, the native huemul deer (*Hippocamelus bisulcus*) (Figure 1). The site is Huilo Huilo (<https://huilohuilo.com/reserva-biologica>), a 1000-km² private reserve in Chilean Patagonia, which was purchased for conservation purposes in the 1990s and 2000s (Vidal *et al.* 2018). The reserve

predominantly supports primary cool temperate rainforest, including old-growth *Nothofagus dombeyi*. During site visits from the 1990s to 2019, we audited conservation and tourism activities and facilities at Huilo Huilo, and interviewed conservation staff, tourism staff, and tourists. We also analyzed published and unpublished documents on tourism and conservation in the reserve and the surrounding region, and reviewed information on corporate structures and finances provided by the reserve's owners.

The current range of the huemul is in southern Chile and Argentina (Black-Decima *et al.* 2016; Briceño *et al.* 2013; Garay 2018; Rosas *et al.* 2017). Its global population has been reduced by anthropogenic impacts to ~1000–1500 individuals, representing 1% of its historical abundance, spread across ~100 small subpopulations (Black-Decima *et al.* 2016). Huilo Huilo supports one subpopulation, the offspring of a founder group reintroduced to the site from a national park. This subpopulation currently comprises 22 individuals, ~1.5–2.2% of the huemul's global population, and is increasing. Here, the huemul are protected within a 1-km² fenced enclosure, which is subject to 24-hour patrols by park rangers. Recently, five radio-tracked individuals were released from the enclosure into the reserve (Vidal *et al.* 2018). To minimize huemul preda-

tion by puma (*Puma concolor*) outside of the enclosure, reserve staff also raise guanaco (*Lama guanicoe*) as a more plentiful alternative prey item (Vidal *et al.* 2018). To date, these conservation efforts for the huemul have proved both successful and ecologically important.

We examined whether, and to what extent, huemul conservation relies on tourism. The Huilo Huilo complex has four interlinked hotel buildings, with a total guest capacity of ~400, in addition to restaurants and cafes that are open to both overnight and one-day visitors. The clientele is largely domestic, and pricing is aimed at the family market. A mid-scale hydropower plant is under construction, to provide power to operate ski and mountain-bike lifts. The reserve is managed by three corporate entities, responsible for tourism, land management, and conservation and community projects, respectively. The conservation entity is set up as a foundation, which operates small-scale tourism ventures in parallel with the main tourism enterprise. Deconstructing its financial links, and considering only net revenues, we found that the foundation receives 62% of its annual income from tourism and 38% from donations, principally from large corporate partners. After accounting for administration costs, the foundation allocates 44% of its income to huemul conservation, 12% to other conservation projects, and 44% to community projects, which contribute to conservation by generating goodwill and engagement.

Overall, we conclude that Huilo Huilo represents a successful example of conservation tourism relying on domestic family tourism, with moderate numbers of tourists and moderate prices. Its conservation achievements are ecologically important. It can serve as a model for other conservation tourism enterprises in cool temperate regions within South America, such as those in the Ibera Provincial Reserve (www.proyectoibera.org/parqueibera_reservaprovincial.htm) in Argentina, with reintroduced jaguar (*Panthera onca*), and Parque Nacional Pumalin Douglas Tompkins (www.parquepumalin.cl) in Chile. Relative to some of its counterparts on other continents, Huilo Huilo's conser-



Figure 1. Radio-collared huemul (*Hippocamelus bisulcus*).

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vation programs are smaller in economic scale, but similar in the proportions of species global populations that are protected, and in reliance on donations as well as tourism-based income.

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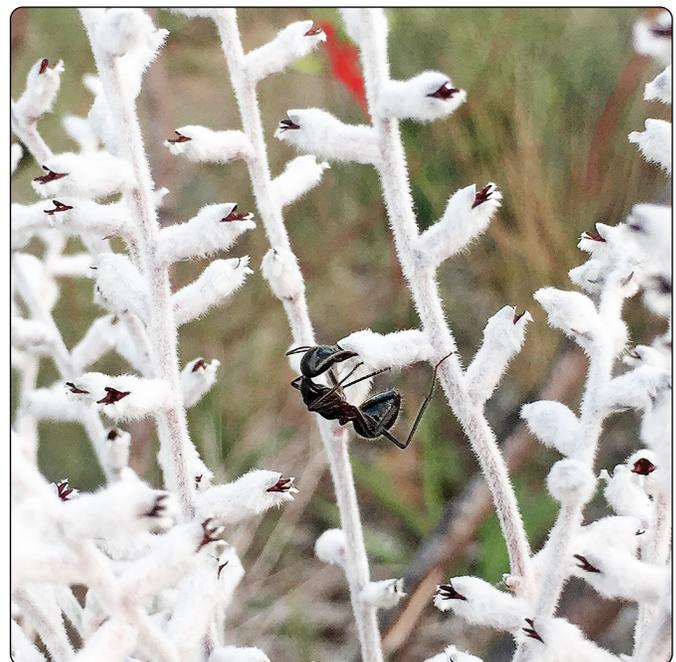
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Tales of the unexpected – ant pollination mutualism

South-western Australia constitutes a biodiversity hotspot where plants and animals have coevolved over long time frames, resulting in exceptionally specialized interactions. The shrub *Conospermum undulatum*, also known as smokebush because it presents white, woolly flowers covered in white hairs that resemble drifting smoke when seen en masse, has developed a pollination mutualism with the native ant *Camponotus molossus*. Pollination by ants is extremely rare, with only about 40 convincing examples observed to date. Insects visiting smokebush flowers for nectar trigger the stigma, which flicks away from the anthers toward the lower tepals (outer part of flowers with no differentiation between petals and sepals) to make contact with the insect; simultaneously, the fertile anthers cast new pollen onto the visitor. The stigma strikes with such a force that most dipterans visiting the flowers remain fatally trapped, making these generalist pollinators ineffective.

The hymenopteran *C. molossus* is an exception; this ant is large enough to escape such a fate and also facilitates pollination by feeding on smokebush. While the cuticular secretions of many ants are known to drastically reduce the pollen viability of most plants, laboratory experiments assessing the effect of ant secretions on pollen viability showed that smokebush pollen is resistant to these secretions. Moreover, mutualistic services by ants are important for maximizing the seed output of this endangered plant, which is threatened by urbanization across its limited distribution. Is the pollen tolerance to ant secretions present in other phylogenetically related taxa? Where



and when did this trait evolve? Thousands of plant and animal species and their interactions have been described in this global biodiversity hotspot, but how many more are still to be discovered?

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