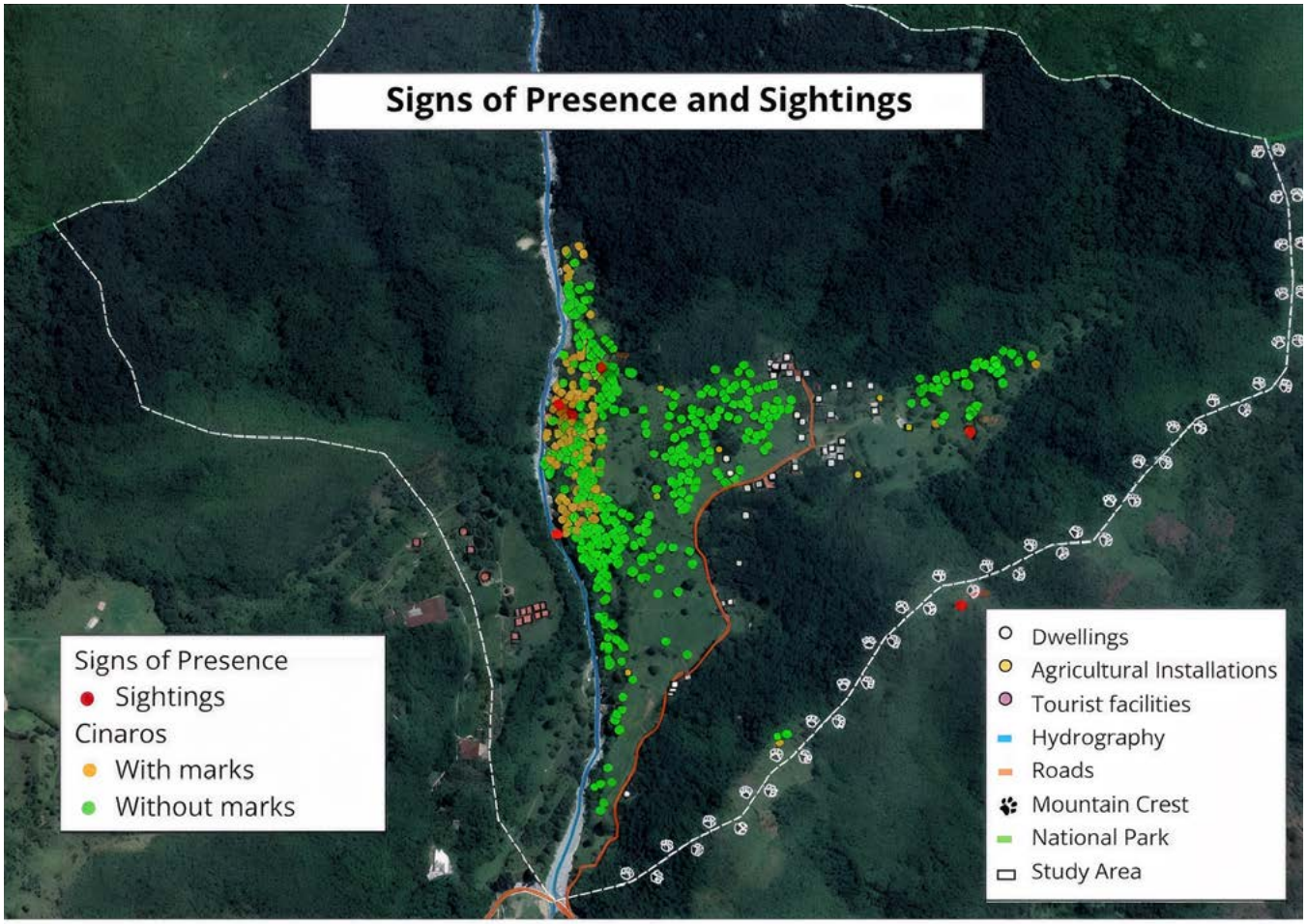
Ecosystem-Based Adaptation Strategies to Mitigate Human-Andean Bear Conflict in the Venezuelan Andes

Between the semi-deciduous and lower montane forest in the Venezuelan Andes, a conservation initiative is offering new hope for the endangered Andean bear (*Tremarctos ornatus*) through a pioneering effort to integrate tailored Ecosystem-Based Adaptation (EbA) strategies (IUCN 2021) into highland traditional dairy ranching systems known as the "Highland Ranching Program" (PROGAL), a government initiative during the 1970s to improve milk production over 1500 m in the Andean region (Castillo and Suniaga 2009).

The direct effects of traditional livestock farming on climate change through greenhouse gas emissions, deforestation to create pastures, the impact on water sources, and soil degradation due to overgrazing, result in a transformation of natural habitats and ecosystems, directly affecting biodiversity. This overlap of human activity and bear habitat has also dramatically increased the chances of human-bear conflict posing a direct threat to the survival of the Andean bear, not only in Venezuela but across the region (Márquez and Goldstein 2014).

Our study was conducted in a small (2.5 km²), but very intense bear activity area northwest of Ejido city, focusing on the remnant forests of *Calycolpus moritzianus*, locally known as cínaro. For unknown reasons, cínaro have survived overgrazing activity to become the predominant species throughout the paddocks of dairy farms in the hill range. In our study area, we tracked bear activity between 2008 and 2021, identifying 145 bear-marked trees out of a georeferenced inventory of 612 cinaros. At least 9 individual bears were also identified over the study period, consistently



F. Pereira, O. Duran, L. Vielma

Study area of the grazing zones.

Fruiting season of cinaro *(Calycolpus moritzianus)* attracts Andean bears during April–May and October–December. This northern Andean tree is related to the guava *Psidium guajava*. It also has wonderful medicinal uses. Photo Credit:Felipe Pereira

A climbing mark left behind on a cinaro tree by an Andean bear. Photo Credit: Felipe Pereira

occurring during the cinaro fruiting season (April–May and September–October), underscoring the ecological importance of the site as a feeding ground and refuge (Pereira 2018).

Statistical analysis revealed a strong correlation between bear detection and mature forest characteristics: trees averaging 11 m in height, over 60 cm in circumference, and forest densities near 59 trees per hectare. These findings suggest that such structural features may serve as reliable site covariates for bear detection and help identify other priority conservation zones, as those proposed by MacKenzie et al. (2017). Beyond ecological data, the study incorporated socio-ecological surveys adapted from the Andean Bear Conservation Alliance (Corponariño 2016). A comparative logistic regression analysis of 30 farms revealed that key livestock management practices, such as subdivision in smaller landholdings (≤30 ha), frequent herd monitoring, and proximity between homes and livestock, were significant factors in minimizing bear damage, but only when implemented in combination.

Based on these insights, we developed a regionally tailored Ecosystem-based Adaptation (EbA) strategy using the IUCN's *Adaptación basada en Ecosistemas* (AbE) Canvas Model. The plan centers on 30-hectare silvopastoral units that enrich cínaro forests with native species such as Andean alder (*Alnus acuminata*) and Humboldt's willow (*Salix humboldtiana*), while incorporating productive forages like Kikuyu grass (*Chencrus clandestinum*), mulberry (*Morus nigra*), and Mexican sunflower (*Tithonia diversifolia*). Additional features include live fences, rotational grazing, and forest patch protection, all designed to benefit bears and reduce greenhouse gas emissions, enhance ecological corridors, and create, in what has been until now a traditional male activity, gender equity and economic opportunities for women in foraging, ecotourism, and conflict monitoring.

With adequate funding, the model is projected to reach financial equilibrium within 3 years, potentially doubling milk yields and lowering operational costs. This model could also be adapted to higher altitudinal zones like paramos, where other factors, like grazing in national parks and protected areas, play an important role in human-bear conflict.

To ensure successful implementation, the study proposes a multi-level governance framework between Venezuela's environmental ministry (MINEC), other government agencies like CORPOANDES and INPARQUES, the scientific community (universities and local conservation organizations), and local highland dairy producers (Pereira 2024).

A female Andean bear is sighted and lets us admire her for a while. Photo Credit: Author Gabriel La Cruz

This marks the first documented application of EbA to mitigate human-Andean bear conflict in Venezuela. As global demand for food increases, this strategy offers a replicable model for enhancing ecosystem services, promoting food security, and protecting a keystone species. With evidence-based planning and inclusive governance, silvopastoral EbA could become a powerful bridge between conservation and rural resilience, ensuring that both people and wildlife thrive in the Venezuelan Andes.

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Cinaro trees can grow very robustly over 12 meters and have a lifespan of over 40 years. Their wood is very resistant and durable, and is used for fencing purposes. Photo Credit: Felipe Pereira

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Felipe Pereira, DVM. M.Sc.
Biocontacto Mérida, Venezuela
felipeapereirap@gmail.com