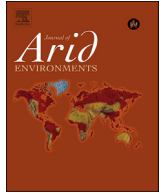




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## Combining ecological aspects and local knowledge for the conservation of two native mammals in the Gran Chaco

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## ABSTRACT

Land use changes in the South American Gran Chaco affect native fauna and the ecosystem services (ES) they provide. The consequences of defaunation and the empty forest syndrome have been identified in tropical and subtropical forests, including the Gran Chaco. Local knowledge regarding native species and the provision of ES can be integrated with scientific research for a better understanding of the system and the consequences of species loss. The aim of this study was to explore whether the Pampas fox (*Lycalopex gymnocercus*) and the collared peccary (*Pecari tajacu*) use six distinct natural and modified habitat types available in the arid Chaco, their role as seed dispersers, and the rural community's perception. We found that the Pampas fox used all habitat types except intensive annual cropland, while the collared peccary used only primary forest within a protected area. Both species exhibited a highly frugivorous diet and were seed dispersers of several native plant species. Interviewees hunted both species; they perceived the Pampas fox as a pest and the collared peccary as a source of food or income. The campesino's perception and involvement is essential for the conservation of the Chacoan forest and the ES provided.

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### 1. Introduction

The Gran Chaco has a long history of colonization, changes in land use and interactions between wildlife and humans (Morello and Saravia Toledo, 1959). In Argentina, the Chaco is considered one of the poorest regions where small scale farmers and local people (also called criollos or campesinos), live in ranches interspersed throughout the forest, maintaining a subsistence economy based on goats, cattle and hunting of wild animals (Bucher and Huszar, 1999; Altrichter, 2005, 2006; Camino et al., 2016). The recent rapid expansion of the agricultural frontier has caused the loss and fragmentation of the native forest with deforestation rates as high or higher than any recorded worldwide (Zak et al., 2004;

Boletta et al., 2006; Hoyos et al., 2012). As a consequence of these rapid changes, the associated fauna and local people that depend on forest resources are also affected (Cáceres et al., 2010).

Some scientific studies carried out in the Gran Chaco have included indigenous communities and their relationship with the environment (Martínez, 2013; Camino et al., 2016), while a few have also incorporated the knowledge of campesinos (Altrichter, 2005, 2006). In this region of Argentina, campesinos still live from the collection and consumption of different forest fruits and wildlife and the local fauna is an important source of protein for many groups living outside urban areas (Barbarán, 2003; Altrichter, 2006). Previous studies have been oriented to evaluate which fauna species are hunted and their importance in campesino reproduction strategies, providing valuable data on socio-economic aspects and uses of the different animal species by indigenous and rural populations (Barbarán, 2003; Altrichter, 2006). In this sense, the knowledge of a natural system, its components and species, acquired through extensive observation, utilization and management, derived from the experience and traditions of long-time

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users and residents, is interesting to complement ecological studies. This traditional ecological knowledge refers to all types of experiences and ideas learned about the environment, which are passed down through oral tradition or shared among users of a resource (Huntington, 2000). This knowledge of the role of animals in ecosystems, which reflects the values and attitudes adopted by a community regarding their local fauna, should be considered especially when designing conservation strategies (Camino et al., 2016; de Melo et al., 2014). Multidisciplinary studies generate ethno-ecological knowledge that is important in understanding the interests of local communities, and at the same time, broaden the ecosystem view of human actions in the territory (Renoux and de Thoisy, 2016).

Native mammals provide different ecosystem services (ES) to humans, including food, cultural values, as well as the regulation of ecosystem dynamics (Carpenter et al., 2009), for example as predators or dispersers of seeds in the landscape (Cardinale et al., 2012; Galetti and Dirzo, 2013). The loss of these ES is a consequence of rapid land use changes taking place in forests worldwide, with defaunation and the empty forest syndrome being widely documented (Redford, 2009; Wilkie et al., 2011; Corlett, 2012; Dirzo et al., 2014), including for the Gran Chaco (Periago et al., 2015). Hunting and habitat loss are the main threats to Chacoan mammals, with most medium-to large-sized mammals suffering from some level of threat internationally or nationally, and negative population trends (Periago et al., 2015). Subsistence hunters in the Chaco prefer peccaries, deer and armadillos, among several other species (Bolkovic, 1999), whereas foxes and other carnivores are heavily hunted because they attack domestic species and, historically, for their skins when these were commercially valuable (Periago et al., 2012; Tamburini and Cáceres, 2012).

However, there is a lack of information regarding the presence of native mammals and the functional roles they play in the Chaco, as well as the consequences of their potential loss. Local knowledge regarding these species and their relationship with the provision of different ES can be integrated with scientific research for a better understanding of the ecosystem and the consequences of species loss. Two species that provide ES in the Chaco that are currently threatened by habitat loss and hunting in the Chaco are the Pampas fox *Lycalopex gymnocercus* and the collared peccary *Pecari tajacu*.

The Pampas fox inhabits the grasslands, wooded savannas, deserts and open forests of Argentina, southern Bolivia and Brazil, Paraguay and Uruguay (Jiménez et al., 2008). Despite its occurrence all over Argentina, few studies describe its general ecology, habitat use and diet in the Chaco (Varela et al., 2008). Its diet includes invertebrates, fruits of domestic as well as native wild plants, carrion, and household refuse (Lucherini et al., 1995; Varela et al., 2008). Foxes are considered legitimate dispersers, since germination is often found to be equal or higher among seeds defecated by foxes (Bustamante et al., 1992; Campos and Ojeda, 1997; Varela, 2004). Foxes are intensively hunted as a means of reducing predation on domestic animals and small livestock, and to a lesser extent for their skins, although the latter depends on hunting regulations at the national level and international market prices (Funes et al., 2006; Ramadori, 2006; Porini and Ramadori, 2007; Tamburini and Cáceres, 2012). For example, during 2006, the exports of hides of several species of foxes increased significantly, with approximately 30,000 of the 334,000 fox skins exported corresponding to *L. gymnocercus*, obtained mostly from the central and northern regions of the country, including Córdoba Province, and the species is currently listed in Appendix II of the CITES Convention (Porini and Ramadori, 2007). However, foxes have shown resilience to intense hunting pressure in some areas (Funes et al., 2006) and the Pampas fox is listed as of “least concern” in national and international Red Lists (Jiménez et al., 2008; Ojeda et al.,

2012). In Córdoba province, hunting of foxes for skins is practically non-existent since the commercial value of fox skins has decreased and there are more government controls based on national regulations (Tamburini, 2016).

The collared peccary is distributed from southwestern United States to central Argentina, with records in all countries except Chile and Uruguay, and in a variety of environments from deserts to tropical forests (Gongora et al., 2011). It is currently found in the north and center of Argentina, particularly in forests, humid savannas and dry forests of the Chaco and Monte ecoregions (Ojeda et al., 2012). However, peccary populations are declining throughout the Neotropics (Beck, 2005), with hunting and deforestation in the Argentine Chaco threatening populations in their southernmost distribution (Altrichter, 2005). Therefore, while the collared peccary is considered of “least concern” at an international level (Gongora et al., 2011), it is considered “vulnerable” at a national level (Ojeda et al., 2012). Despite being considered an omnivorous species, the collared peccary has a preference for food of plant origin, particularly in the forested parts of its distribution (Keuroghlian and Eaton, 2008). Throughout its distribution, the species consumes fruits, leaves, flowers, stems and roots of various native, and sometimes cultivated plant species, with a marked selection of succulent plants in drier regions (Beck, 2005). Across its distribution, the collared peccary is considered both a seed predator and disperser, depending on the size of the seed consumed (Beck, 2006; Keuroghlian and Eaton, 2008; Lazure et al., 2010). However, the role of the collared peccary as a seed disperser in the Gran Chaco has not been evaluated.

Peccary species (*Catagonus wagneri*, *P. tajacu* and *Tayassu pecari*) are most commonly hunted for food and hides by rural and indigenous people of Latin America (Altrichter, 2006). In the Argentine Chaco, studies have found that habitat destruction and hunting can devastate peccary populations, especially when acting together (Altrichter, 2005). The presence of the collared peccary in the Argentine Chaco has been associated with high forest cover and low number of settlements (Altrichter and Boaglio, 2004), with mean population density more than three times higher within protected sites (Altrichter, 2005).

The aim of our study was to gather information regarding ES provided by the Pampas fox and the collared peccary, using a combination of evidence-based science and surveys to local people. Our specific objectives were: (1) to explore whether different habitat types available in the arid Chaco, with varying degrees of human intervention, are used by populations of the Pampas fox and the collared peccary; (2) if so, to determine if the species are seed dispersers; and (3) to incorporate local knowledge regarding the Pampas fox and the collared peccary, including the habitat types they occupy and the ecosystem services they provide.

## 2. Methods

The study area covers approximately 2100 km<sup>2</sup> and is in western Córdoba Province, Argentina (Fig. 1). It is located in the southwestern semi-arid portion or “arid Chaco” (Cabido et al., 1994), with a large water deficit and a climate characterized by high summer temperatures and mild winters with broad thermal amplitude. The original vegetation is dry woodland with predominance of woody evergreen and deciduous species (Cabido and Pacha, 2002). Six habitat types present in the study area were included, identified as being derived from a matrix of vegetation, topography and soils that were initially homogeneous and then subjected to different land use regimes (Conti and Díaz, 2013). Habitat types were identified by vegetation structure, composition and biomass: primary forest (PF), secondary forest (SF), closed species-rich shrubland (CS), *Larrea* shrubland (LS), logged pastureland (LP) and intensive

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