Journal for Nature Conservation 40 (2017) 24–32

Contents lists available at ScienceDirect

Journal for Nature Conservation

journal homepage: www.elsevier.com/locate/jnc

Guidelines for managing captive Iberian ibex herds for conservation purposes

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ARTICLE INFO

Keywords:
Capra pyrenaica
Captivity management
Conservation program
Health protocol
Research
Wildlife enclosure

ABSTRACT

Overexploitation, pollution, habitat loss or emerging diseases have led to a large number of species to extinction. This has made zoos and wildlife enclosures expand their goals beyond entertainment and fun; their participation in conservation and research programs is important for the recovery of multiple species. To ensure success, staff need to know the specific requirements of each species. In case of the Iberian ibex (*Capra pyreanica*), a wild ungulate endemic to the Iberian Peninsula, different sarcoptic mange outbreaks caused dramatic declines of some ibex populations, which led managers and researchers to explore strategies aimed at preventing and controlling this disease and to reduce its impact on ibex populations. Such management plans included the creation of stock reservoirs as an *in-situ* conservation measure. The objective of the stock reservoir El Toril, as a key part of a general management plan, is to keep in captivity (in range) a sex and age structured representation of the free-ranging population, with most of its genetic variability, destined for conservation programs. However, under captivity conditions with potential for high concentration of animals, direct contact and stress occur and the appearance, transmission, and severity of diseases could be favored. Therefore, it is necessary to establish health protocols in order to guarantee animal welfare. Spanish Animal Health laws establish specific requirements and preventive measures for controlling diseases in captive populations: sarcoptic mange, tuberculosis, brucellosis and bluetongue are notifiable diseases, and the staff of the reservoir must apply specific diagnostic methods to detect them. The management recommendations presented here may be very useful for other managers involved in the conservation of wild ruminants.

1. Introduction

The loss of biological diversity is one of the major problems currently facing humankind, the cause of which is largely due to human activities (Cardinale et al., 2012). Extinction is a natural process, it is estimated that between 77 and 96% of all species that have existed have become extinct (Nicotra, Beever, Robertson, Hofmann, & O'Leary, 2015; Raup, 1991). The problem arises when the changes are so fast that the adaptation and evolution processes are eliminated. This is what has happened in the last 400 years, leading to a total of 784 extinct species and 23,675 threatened with extinction (IUCN, 2006). As the world has changed, zoos and wildlife reservoirs have had to adapt to these changes (Kleiman, Allen, Thompson, & Baer, 2010, Chap. 5).

Over 200 years ago, zoos and wildlife enclosures were established to house wild animals for entertainment and amusement of the public. Today, the focus has shifted from using wild animals not only as attractions to instead be used for education, conservation (*ex-situ* and *in-situ*) and research (West & Dickie, 2007). Although it is a utopia to seek

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http://dx.doi.org/10.1016/j.jnc.2017.09.002
Received 24 June 2017; Received in revised form 5 September 2017; Accepted 5 September 2017

to preserve all endangered species, effective conservation programs should be established especially when an organism has become scarce due to overexploitation, pollution, habitat loss or emerging disease (Rabb, 2004). Wildlife enclosures should maintain populations that are demographically stable, healthy and capable of self-sufficiency, with sufficient size to allow them to maintain high levels of genetic diversity (Willoughby et al., 2015). However, keeping wild animals in captivity involves a number of difficulties because of their different needs and preferences compared to "pre-adapted" domestic animals (Moberg & Mench, 2000).

To provide a good quality of life for captivity mammals, we need to understand the main determinant of well being for each species and, just as important, each individual (Gosling, 2001). An understanding of a species' behavioral ecology and natural history is fundamental to identifying those factors likely to be linked with the individual well-being (Kiley-Worthington & Randle, 2005). In this sense, facilities adapted to each species (e.g. subjected to environmental enrichment), management techniques and specific health programs or adequate diets are key aspects to avoid situations of acute or prolonged stress that results from a reduction of physical and mental health of the individual and/or population (Morgan & Tromborg, 2007).

On the other hand we should consider that some wildlife enclosure-based conservation programs (e.g. reintroduction programs) should involve welfare risks. Animals reared in captivity are 'softened' by a life relatively free of disease, predation, starvation or injurious conflict (Beck, Rapaport, Stanley Price, & Wilson, 1994). Hence, environments in wildlife reservoirs should include some of the challenges they will face in the wild, even those which cause poor welfare in the short-term, in order to promote good welfare- and survival- post- release (Swaisgood, 2010).

At present, besides some centers specialized in the breeding and conservation of endangered species, there is a large number of zoos distributed throughout the world, whose participation in conservation (in the context of World Zoo and Aquarium Conservation Strategy, W.Z.A.C.S) has been decisive in the last 30–40 years. Only considering mammal species, European zoos are involved in 71 captive breeding programs for endangered species. In the 1990s the Consortium of Aquariums, Universities, and Zoos (C.A.U.Z.) managed 74 projects on captive Artiodactyla, with over 55% of such projects focused on Bovidae species (Hardy, 1996).

In the Iberian Peninsula, in the case of wild ruminants, there are specific enclosures for the conservation, breeding and reintroduction of native species such as the Iberian ibex (*Capra pyrenaica*) or roe deer (*Capreolus capreolus*), as well as several North African species (Table 1). These have the participation of numerous scientific and zoological institutions.

The present work shows the management guidelines for a captive ibex population for conservation and scientific purposes. The management recommendations presented here may be very useful for other managers involved in the conservation of wild ruminants.

2. Iberian ibex conservation—background

The Iberian ibex is a wild ungulate endemic to the Iberian Peninsula which previously had a wider distribution range in almost all the Iberian Peninsula mountain ranges (Moreno-García, Davis, & Pimenta, 2003; Pérez et al., 2002). Threats such as fragmentation, competition with domestic livestock and other introduced wild ungulates, illegal hunting and especially diseases have been the main factors responsible for demographic changes in the recent history of this species (Acevedo & Cassinello, 2009; Herrero & Pérez,2014). The impact of sarcoptic mange, caused by *Sarcoptes scabiei*, has been of particular relevance. In fact, a mange outbreak caused the death of over 95% of Iberian ibex from the Sierras de Cazorla, Segura and Las Villas Natural Park population, southern Spain, in the late 1980s (Fandos, 1991; León-Vizcaíno et al., 1999). A few years later, something similar occurred with the neighboring ibex population from Sierra Mágina Natural Park (Palomares & Ruiz, 1993).

The Sierra Nevada Natural Space (SNNS) (36°00′–37°10′ N, 2°34′–3°40′ W) is very close to the above-mentioned parks and holds the largest, most genetically diverse and best known population of Iberian ibex in Andalusia (Granados, Pérez et al., 2001). In 1992 the first case of a sarcoptic mange outbreak in ibex from the SNNS was confirmed (Pérez, Ruíz-Martínez, Granados, Soriguer, & Fandos, 1997). Simultaneously, other mange outbreaks reached other Andalusian ibex populations (Arenas et al., 2001).

This situation and the lack of knowledge about the epidemiology and dynamics of the disease in wild hosts populations, and the strategies to cope with this emergency, concerned the Andalusian government, which funded one of the most ambitious research projects on ibex and mange in southern Spain (Pérez, 2001). At a local level, the challenge of preventing a massive ibex mortality event due to the disease emerged and the staff of the SNNS started to develop a global plan for managing both the ibex abundance and limiting the impact of mange.

Such a management plan in the SNNS included the creation of a stock reservoir as an *in-situ* (captivity in range) conservation measure (Granados, Montes et al., 2001). The stock reservoir El Toril (SRET) was created in 1992 and is located in Dílar, Granada (Spain) (37°02′-37°03′ N, 3°22′-3°33′ W), in the western limit of the SNNS (Granados, Ruiz-Martínez, Pérez-Alvarado, & Pérez, 1996). It must fulfill the conditions set by the Permanent Health Surveillance Program (Spanish Government, 2003), and the requirements for wild animal movements (Spanish Government, 2009).

The objective of the SRET is to keep in captivity a sex and age structured representation of the free-ranging ibex population, with most of its genetic variability, to support conservation programs. In addition, it facilitates scientific research on the biology and physiology of ibex, as well as management experience.

3. The stock reservoir El Toril

The SRET is registered in the regional and national catalogue of

Table 1
Enclosure reservoirs specialized in conservation programs of wild ruminants in Spain. Enclosures for cinegetic purposes have been excluded.

Species	Enclosures	Location
Iberian ibex (*Capra pyrenaica*)	The stock reservoir "El Toril"	Granada (Sierra Nevada Natural Space)
	The stock reservoir "Nava de San Pedro"	Jaén (Sierras de Cazorla, Segura y Las Villas Natural Park)
	The stock reservoir "El Juanar"	Málaga (Sierra de Ojen)
	The stock reservoir "Ports de Tortosa i Beseit"	Tarragona (National Game Reserve of the Ports de Tortosa i Beseit)
	"Salgueiros" and "Santa Eufêmia" enclosures	Orense (Baixa Limia – Serra do Xurés Natural Park)
Roe deer (*Capreolus capreolus*)	The stock reservoir "El Picacho"	Alcalá de Los Gazules (Sierra de Cádiz)
Nanger dama gazelle (*Gazella dama mhorr*)	Finca experimental "La Hoya"	Almería (Estación Experimental de Zonas Áridas)
Dorcas gacelle (*Gazella dorcas neglecta*)		
The Cuvier's gazelle (*Gazella cuvieri*)		
Barbary sheep (*Ammotragus lervia sahariensis*)		