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Priorities for the conservation of the pudu (*Pudu puda*) in southern South America

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Abstract. The southern pudu (*Pudu puda*) is a threatened deer that is endemic to the South American temperate forests. Despite its assumed threatened status, there is relatively little understanding on the ecology and conservation of this species. Considering this situation and the fact that there are some research groups currently working on this species, we organised a symposium to discuss research and management priorities – as well as to coordinate efforts – to move forward on the conservation of the pudu. We agreed that main research priorities should be to increase the understanding of the threats that jeopardize the viability of pudu populations, with a strong emphasis on research questions that will provide information for the management of these threats. The main management recommendations were to implement monitoring of pudu populations at least in protected areas, to implement specific actions to remove threats from protected areas and to start following internationally-accepted guidelines for the management of rescued and confiscated animals.

Additional keywords: Chile, conservation status, dog, forest, management, southern pudu.

Introduction

The southern pudu (*Pudu puda*) is a deer endemic to the temperate forests of South America. Its current status is judged as 'vulnerable' with population numbers believed fewer than 10,000 individuals.[1] However, this estimated population size is not supported by quantitative data and, to date, there are no definitive studies that have estimated its abundance or density.[2] This species is believed to be affected by forest loss and fragmentation, domestic dogs (*Canis lupus familiaris*), poaching, cattle, etc.,[1] but there is little substantial data supporting these claims. As a consequence, it is difficult to prioritize these threats to inform managers and to take appropriate action. Considering that pudus are cryptic and difficult to study, ecologists have chosen alternative methods to answer the questions of abundance and threats. Although few quantitative data exist, the consensus is that the pudu appears to be facing serious threats due to the expansion of human activities and their pets, but the species still remains almost unstudied in the wild.[2]

Considering the above situation we organised a symposium to address the 'Advances in the ecology and conservation of the southern pudu' within the framework of the 7th International Deer Biology Congress, held in Chile in August 2010. In this meeting we invited researchers and managers that are currently working with this species, to discuss the main gaps in knowledge that prevent pudu conservation progress and what type of management needs should be implemented in the near future. The main findings reported in the symposium can be found elsewhere (Fuentes-Hurtado *et al*., unpubl. data)[2,3] and are summarised here. The symposium received important feedback from more than 50 attendants that included international and Chilean deer experts and managers. Here, we present the main research and management priorities identified for the conservation of the southern pudu as conclusions derived from the symposium.

Current understanding and research needs

As hypothesised by Jiménez,[2] based on morphological and ecological data, the analysis of mtDNA has confirmed that there are at least two divergent lineages for pudu: one comprised by the population living on Chiloé Island and the other by that found on mainland Chile and Argentina

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(Fuentes-Hurtado *et al*., unpubl. data). The authors describe two subspecies for pudu: *P. p. puda* (mainland) *and P. p. chiloensis* (Chiloé Island, Fuentes-Hurtado *et al*., unpubl. data). Based on the current evidence, the main threats affecting the populations of both subspecies are forest loss and the attacks by domestic dogs.[1,3] Native forest has been massively lost within pudu distribution[4] and considering that pudus select for dense vegetation,[5,6] it is safe to assume that agricultural areas and those forests that, as a consequence of cattle grazing have thin or no understory, are unsuitable for this species. An increasing threat is the extensive expansion of exotic forest plantations. However, their suitability for the pudu is currently unknown and deserves urgent research. Considering that most forests in south-central Chile have been lost or fragmented, it is urgent to determine the current status and distribution of remaining populations in the northern part of pudu's distributional range. Forest fragmentation may also threaten pudu viability, by increasing their exposure to predators, such as dogs, which are highly associated with anthropogenic habitat types and roads. Predation and harassment by domestic dogs seem to be more important than alternative threats such as poaching and roadkills.[3] Although poaching is relatively frequent in areas where pudus are common, in many cases it seems to be a byproduct of dog attacks, rather than directed attempts to hunt pudus by country people. Future research needs to clarify the relative importance of these different threats to help allocate effectively the scarce conservation resources available.

The role of native predators on the current status of the pudu is unknown. Pumas (*Puma concolor*) are the only important native predator of pudu,[3] and inside native forests pumas lack an alternative prey. However, pumas rely heavily on non-native species that thrive in anthropogenic habitats, mainly the European hare (*Lepus europaeus*) and secondarily on livestock.[7] High densities of hares in anthropogenic habitats may sustain puma populations. Hare-subsidized pumas may keep elevated predation pressures on pudus using nearby native forest, without being affected by potential pudu declines. Coincidentally and in agreement with this hypothesis, pudus seem to be more frequent in Chiloé Island than in mainland,[2] the only area within pudu distribution where pumas are absent. However, although the potential threat of pumas deserves attention, it must be considered as a hypothesis, and not as a fact, until tested through rigorous scientific studies. The direction of hypothesised effects of different factors on pudu populations are diagramed in Fig. 1.

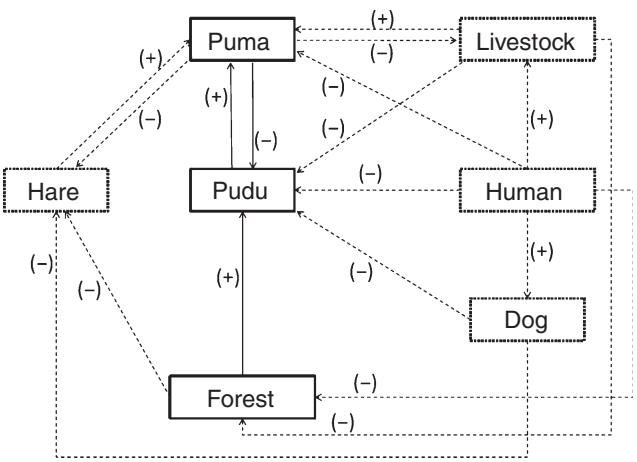

Fig. 1. Diagram showing the expected mechanisms that may affect the viability of the pudu (*Pudu puda*). Arrows indicate the effect of one element on another. Positive signs (+) indicates positive effects and negative signs (–) indicate negative effects. Boxes and arrows delimited by solid lines indicate native elements of the system whereas boxes and arrows delimited by dotted lines indicate non-native components of the system.

Management needs

Pudus are known to occur in several protected areas.[2] Many of them are large enough to contain viable populations of the species.[8] However, it is important to acknowledge that a small proportion of the protected areas constitute adequate habitat for pudus, as reserves include large extensions of non-forested terrains such as glaciers and volcanoes.[4] Furthermore, the species status is unknown in all of these areas and threats such as dogs and cattle still occur within most reserves.[3] To move pudu conservation forward, it is absolutely necessary to assess their status inside and outside protected areas. This includes the establishment of monitoring programs targeting pudus as well as other threatened species, including their predators. To date, this has not been possible due to the inherent difficulties of studying a highly cryptic species such as this deer.[2] However camera-trapping and recent advances in occupancy estimation and modelling[9] offer a very promising tool to monitor the pudu and other threatened mammals, if local authorities are willing to make the initial investment required.

Managers of protected areas should allocate important efforts to remove threats from protected areas. These efforts require forbidding the entrance of dogs (even those that are leashed) and livestock to protected areas. In the case of tourists, enforcement should be easy. In the case of free-ranging dogs (and cattle) owned by local people the problem is more complex, as decisions may conflict with local communities' interests. To avoid this conflict will require working with domestic animal owners to improve their management and reduce their wandering inside protected areas. We highlight that at this point in time, an emphasis on the risk that wandering pets impose to human health may be more effective as a conservation tool (i.e. convincing) than advocating for the welfare of wildlife (Silva-Rodríguez and Sieving, unpubl. data). Finally, we suggest that feral dogs should be captured and removed from protected areas, as they constitute an important threat for the welfare of wild animals in general and not only for the pudu.

The last management issue we would like to highlight relates to the high number of pudus received yearly at rescue centers throughout the pudu's distributional range. Mortality of these injured pudus is usually high,[3] but those that survive are often released to their presumed habitat with no further consideration. Up to date, aside from one case (Jiménez and Aleuy, unpubl. data), the fate of released animals in general is unknown in the southern forests. The IUCN reintroduction specialist group recommends avoiding releasing confiscated animals, unless several requirements are met.[10] These include, but are not limited to, certainty that the released animals will make a significant contribution to wild populations; that animals follow a comprehensive veterinary screening and quarantine;

and the existence of a management program with enough resources to be able to follow the IUCN Re-introduction Guidelines.[10] This is particularly important considering that pudus received at rescue centers may have direct or indirect contact with domestic animals. In this line, we suggest that pudus received by rescue centers and enforcement agencies, as well as individuals coming from breeding centers, should not be released to the wild unless a thorough clinical examination, quarantine, pre-release procedures, monitoring of released animals, and foremost, a good technical justification to supplement a wild population exist. These recommendations are not only based on the potential consequences for wild populations, but also on the welfare of the released animals. Considering the genetic makeup (Fuentes-Hurtado *et al*., unpubl. data) and the morphological differences,[2] pudus from insular populations should never be translocated to mainland and vice versa. Furthermore, captive-bred animals that come from breeding centers that mix, or are suspected to have mixed individuals from mainland and insular populations, should not be released into the wild, unless molecular methods identify the population of origin. Thus, proper management actions can avoid risks for the pudu populations such as the consequences of outbreeding depression. We emphasise that management decisions should avoid risking the welfare or viability of extant wild populations even if that means that rescued animals cannot return to their wild condition.

Keeping rescued animals in captivity is an alternative that should be considered for confiscated and rescued animals that do not meet all release requirements.[10] These animals may still be used to make important conservation contributions. For example, the pudu is a highly charismatic species that, unlike carnivores, are liked by urban and rural people.[11] Given this, the use of live individuals for environmental education offers a very powerful tool to foster the conservation of pudu and its associated ecosystems. Captive animals may also be used legitimately for research under welfare conditions.[10] For example, studies on reproductive physiology may help ex-situ conservation efforts.[12] Furthermore, these studies provide important insights on the proximate mechanisms of behaviour (such as space use), that are important for in-situ conservation planning. Whatever the final allocation of animals is, our intention is to advocate for a shift from well intentioned intuition-based to rigorous evidence-based decision-making.

The management and research recommendations stated above are not static, but should be updated and expanded as new data on the responses of pudus to different threats become available. For this purpose, it is fundamental to establish a strong collaboration between decision makers, wildlife ecologists, veterinarians, and other stakeholders. We believe however, that the implementation of the recommendations stated above should lead to significant improvements in the understanding and conservation status of the southern pudu.

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