

Comparing narratives on carnivore management in a dryland ecosystem: a case study of state-backed lethal control

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ABSTRACT

Lethal control of native carnivores as a principal management strategy can have unforeseen ecological consequences and is often of questionable efficacy. Using as a case study a region where the lethal control of native puma and culpeo foxes has been incentivised via legislation for over 50 years, we examined how this policy has affected institutional narratives in the region. We conducted four key informant interviews with members of relevant institutions to establish their perspectives on carnivore management. We also examined the informational basis for the current legislative approach to predation, and identified topics for discussion surrounding legislation and its formation for decision-makers in the province. We identified a duality where two branches of government have contradictory policies regarding livestock production and carnivore management. All institutions involved in predation management in rural landscapes produced narratives supporting sustainable development, and suggested, in varying degrees, that alternatives to lethal control would be positive. Interviewees stated that modification of the existing laws require livestock producers to demand a change from policy-makers, who generally view carnivores poorly. Furthermore, there is evidence that discussions surrounding management strategies suffer from cultural bias, with rural inhabitants finding themselves marginalised from the decision-making process. We identified a need for empathy regarding the adverse situation of rural inhabitants facing the impacts of predation, and an appreciation of the role that carnivores play within their environments, so as to change the negative discourse surrounding human–carnivore interactions.

Keywords: carnivores, interviews, lethal control, livestock, management, marginalisation, policy, predator control, semiarid zones.

Introduction

After habitat loss and degradation, actions arising in response to negative human–wildlife interactions are one of the principal causes of carnivore population decline (Redpath *et al.* 2013), and often lead to potentially devastating results for vulnerable carnivore species. Carnivores perform a fundamental role in ecosystems, not least as regulators of prey populations; however, damage to livestock and livelihoods is undeniable (Inskip and Zimmermann 2009). This damage and human responses depend on many factors, such as carnivore size, non-domestic prey availability and frequency of encounters (Amit *et al.* 2013; Dickman *et al.* 2014; Eklund *et al.* 2020). Human–carnivore interactions are especially common in dryland regions where livestock production is common as carnivores, livestock and humans occupy the same space.

Dryland ecosystems are home to over 1 billion of the world's population and are important for biodiversity and agricultural productivity (Middleton *et al.* 2011). Nonetheless, these environments have historically received less attention than have more traditionally attractive ecosystems such as forests (Durant *et al.* 2012). Evidence suggests that within drylands multiple interacting features produce a particular socio-ecological context called 'desert syndrome'. These features are climate variability, scarce resources, sparse population, remoteness, social variability, local knowledge and cultural

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differences (Stafford Smith 2008). The variability and unpredictability generated by these features can explain why remote, resource-poor regions often receive less attention from governments and other institutions.

The Sustainable Development Goals (SDGs) aim to address many of these challenges through poverty eradication and food security, citing sustainable agriculture's importance, and mitigating desertification. One option for food security is domestic livestock production, which can contribute to three major pathways out of poverty by (1) increasing resilience, (2) improving smallholder productivity and (3) increasing market participation (International Livestock Research Institute 2002). However, hurdles exist to achieving sustainability, including environmental trade-offs, social equity, and a lack of adequate policies, market access and land tenure (Mottet et al. 2018). A further barrier to food security through livestock production is carnivore predation (Baker et al. 2008).

Current strategies for managing carnivores comprise both lethal (e.g. toxic baits or poisons, traps, hunting) and non-lethal (e.g. enclosure of livestock, livestock-guard dogs, collars, repellents) methods and vary in their effectiveness (Fernandez-Arhex et al. 2016; Miller et al. 2016; van Eeden et al. 2018). Although being highly variable, responses of authorities and farmers to carnivore predation have evolved from a traditional top-down, command and control approach, for example, through lethal control (Holling and Meffe 1996) to aspirations of co-existence (Dickman et al. 2011; Bergstrom 2017). For example, in the United States, wolf populations were decimated in the 20th century by a state policy of lethal control (Zimmermann et al. 2009). In 1995, they were reintroduced to Yellowstone National Park, but further range expansion continues to prove controversial (Blossey and Hare 2022). Other examples of lethal control policies in response to livestock predation are those of wild dogs in Africa (Gusset et al. 2008; Nicholson et al. 2020) and dingoes in Australia (van Eeden et al. 2020a).

Here, we examine a case study of a dryland region in Patagonia, Argentina, where there is considerable demand to provide solutions to the damage caused to livestock and livelihoods by puma (*Puma concolor*; Guerisoli et al. 2017; Llanos et al. 2019) and culpeo foxes (*Lycalopex culpaeus*). The predominantly arid and semi-arid province of Río Negro, where livestock farming has been practiced for about 150 years, is characterised by a lack of services and infrastructure. The state-backed approach to carnivore management in the province is lethal control, promoted by an incentive scheme established by the provincial government 50 years ago.

While mitigation of livestock damage is in accordance with Goal 2 of the Sustainable Development Goals (SDGs) related to achieving food security (2030 Agenda for Sustainable Development 2015a), uncontrolled carnivore removal is not conducive to sustainable production patterns as presented in SDG 12 (2030 Agenda for Sustainable

Development 2015b). Furthermore, SDG 15.9 calls for the incorporation of ecosystem and biodiversity values into national and local planning sustainable use of terrestrial ecosystems (2030 Agenda for Sustainable Development 2015c) and Argentina has been party to the Convention on Biological Diversity since 1995 (Secretaría de Recursos Naturales y Desarrollo Sustentable 1998).

Despite previous research showing that uptake of this lethal control incentive program is low among smallholders (Gáspero et al. 2018), it is unclear what data inform this approach, how the program's impact is evaluated and how frequently this provincial carnivore management strategy is revised. Because this lethal control mandate is state-based, a paradoxical approach considering Argentina's commitment to sustainable development (Consejo Nacional de Coordinación de Políticas Sociales 2020), the way in which government legislation is produced should be considered.

Therefore, this study examines the way in which narratives about territory and predation have been constructed, and the implications for residents of a dryland ecosystem. To this end, we analysed and reflected on the narratives formed through State policies and laws in relation to predation. We hope this study can contribute to understanding the role of policies and narratives in carnivore management and provide suggestions for alternative management strategies.

Materials and methods

Study area

Livestock farming was initially practiced in Patagonia by native communities in the form of transhumant pastoralism (Bandieri et al. 1993). Argentina's military campaign into Patagonia towards the end of the 19th century introduced sheep production, killing or removing many indigenous communities and claiming their land for ranches (Coronato 2010). Since then, the widespread imposition of sheep production disrupted traditional livestock practices and has contributed to the desertification of Patagonia (Paruelo 2005).

Of particular interest is the *línea sur*, 60% of the land area and dominated by livestock farming, but which suffers many challenges common to drylands, such as lack of market access and infrastructure (Fig. 1). It is an area with challenging conditions for livestock production, with 150–300 mm of rain per year (Easdale et al. 2009) and poor-quality vegetation for livestock, where high-quality forage is restricted to small patches of wetlands (Villagra et al. 2013). In addition, there are extensive distances among settlements and many farmers have no access to electricity or running water. The *línea sur* is differentiated from the rest of the province by historical limitations related to service development and access to funds for local development (Núñez et al. 2016). The recurring argument for this is the limited economic value of small-livestock agriculture.



Fig. 1. Map showing the province of Río Negro with departmental division, main settlements and highlighting the National Route 23 that traverses the *línea sur*. Built using QGIS Desktop v3.22.8 and data from https://sipan.inta.gob.ar/sigt/sigt_descargas.php (date accessed 12 July 2022).

The livestock industry was affected by a drought from 2007 to 2012, with precipitation being as low as 29% of the annual historic mean (Easdale *et al.* 2014), as well as a volcanic eruption in 2011 causing mass livestock mortality because of reduced forage availability caused by ash fall. Pressure from livestock overgrazing has also led to a reduction in palatable grasses and soil functioning (Oliva *et al.* 2016; Gaitán *et al.* 2017). Despite these difficulties, in 2018 there were a total of 1763 agricultural establishments, 1297 of which produced sheep, with a total of 590 528 head (INDEC 2021).

Predominant carnivores are the culpeo fox and the puma, both classified as Least Concern on the IUCN Red List (Nielsen *et al.* 2015; Lucherini 2016). However, data are lacking on the state of local populations.

Sources

Legislation

In April 2020, details of existing and historic legislation were obtained through a keyword-based search, using terms related to livestock, carnivores, wild animals and management, of the provincial online database (<https://www.legisrn.gov.ar/DIGESCON/consudigwp.php>).

A final search, informed by the previous results, was conducted by exploring the relevant legislative sections of the same parent website (<https://www.legisrn.gov.ar/DIGESCON/desplitesawp.php>), and relevant laws or decrees were recorded.

Agricultural Census

The Agricultural Census is conducted every approximately 10 years in all agricultural holdings across Argentina, led by the National Statistics and Census Institute, and it provides information about the basic characteristics of agricultural, livestock, forestry and bio-industrial activities (<https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-8-87>).

Institutional key-informant interviews

Four institutions involved in carnivore management were identified following a review conducted via consultation with key individuals. To obtain further information about these institutions and their role in carnivore management, key individuals from each institution were contacted. Semi-structured interviews were conducted between November 2020 and March 2021 with one individual from each institution. Interviews were conducted either remotely through video-conferencing software or via phone calls, or in person. Free, prior and informed consent was obtained from all interviewees, in accordance with the Code of Ethics for Ethnobiological Investigation in Latin America (SOLAE 2016).

Several themes were covered during interviews, including each individual's professional background (e.g. academic degree, previous jobs), their current role and the roles of the institutions regarding livestock producers and carnivores, knowledge of current and historic legislation and their role in its formation, and, finally, challenges and potential solutions of carnivore management. Interviews were transcribed and analysed through an inductive cyclical

coding process (Thomas 2006; Saldaña 2013). Simultaneous coding was applied using a combination of descriptive, evaluation and value codes (Saldaña 2013). Manual coding was performed first on paper so as to increase familiarity with the material and to establish a draft codebook, followed by digital coding using the qualitative data-analysis package RQDA (Huang 2016) in R (version 3.6.1, <https://www.R-project.org>, R Foundation for Statistical Computing, Vienna, Austria). Conceptual content analysis was performed on the coded transcripts and links among categories and their codes were mapped out in RQDA.

Results

Legislation

In total, 28 laws and 62 decrees were identified and filtered to identify those either directly or indirectly related to carnivore management, livestock farmers in the *línea sur* and wildlife protection. There were 13 laws and eight decrees encountered and sorted into the following categories: carnivore control ($n = 6$), wildlife protection ($n = 6$), agricultural support ($n = 8$) and canine control ($n = 1$). Of the 21 pieces of legislation, 19 were provincial and two national.

Carnivore management

Legislation related to predator management began in 1958 with Law 12 and Decree 1710, establishing pumas, culpeo foxes, gray foxes (*Lycalopex griseus*) and wild boar (*Sus scrofa*) as species harmful to livestock. This established legal grounds and an incentive for lethal control through payment for animal skins. A provincial legislative landmark came in 1972 with Law 763, which replaced and expanded Law 12.

The fight against wild animal populations circumstantially harmful to livestock and agriculture is declared mandatory for land owners, tenants or occupants of lands in the territory of the Province, on a scale that avoids the inconvenience of rupturing the biological balance, according to the regulatory norms that are opportunistically dictated (Article 1, Law 763)

This legislation remains unchanged.

Wildlife protection

In 1985, the first provincial legislation related to wildlife protection, the Wildlife Law (Law 2056), was approved. This defined management as protection, preservation, conservation, propagation, re-population, restoration, control and rational use of the wildlife resource (Article 2). The responsible institution was the Office of Wildlife, within the Ministry of Production and Agroindustry (Article 7). An annual list is published of animals, including both puma

and culpeo foxes, for which hunting is prohibited via a resolution. However, such annual resolutions carry less legal weight and are superseded by protections or permits established directly via laws such as Law 763.

Agricultural support

National legislation in 2001 introduced the Law for the Recovery of Ovine Livestock (National Law 25422, 'Ley ovina'). This extensive law encompasses the various uses and activities of ovine livestock, aiming to ensure their sustainability over time and, subsequently, to promote rural employment and settlement (Articles 1 & 2, NLaw 25422). Similar provincial support funds were established in 2004 and 2005 for smallholders in the *línea sur*. Finally, in 2013 there was a provincial decree to approve a program for the mitigation of the effects of drought and volcanic ash on livestock (Decree 236).

Canine control

The single piece of legislation related to dog control (*Canis familiaris*) came in 2005, concerning ownership of potentially dangerous dogs to 'preserve the life and physical integrity of people' (Article 1, Law 4043). No legislation was found regarding control of domestic or wild dog with a negative impact on livestock, despite such an impact being real.

Agricultural Census

Within the Agricultural Census, conducted since 1998 (<https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-8-87>), no questions were found about the carnivore-management, predation or damage-mitigation strategies. Estimated livestock losses were covered but without inquiry as to potential causes of mortality. The only question regarding carnivores was found in the 2018 Census regarding whether foxes can be found within the productive establishment; pumas were not covered. Other animals whose presence could be recorded within productive establishments included deer, mink and wild boar (INDEC 2021, p. 176).

Key-informant interviews

In total, 133 distinct codes were identified, separated among nine categories established through a preliminary reading of the interviews and adjusted during the coding process. The most prevalent categories were legislation ($n = 32$), institutional roles ($n = 29$), challenges ($n = 27$) and carnivore management ($n = 24$). The total number of codes distributed among categories exceeded the number of distinct codes, because several codes were placed in more than one category.

Several themes were discussed in interviews regarding challenges related to the environment and the presence of carnivores, non-lethal carnivore control with a specific focus on livestock guard dogs and their limitations. Expanding on carnivores, interviewees referred to 'tensions and conflict'

Table 1. Institutions that are involved in carnivore management in Río Negro province, their main objectives and the narratives, challenges, challenges and solutions identified in each interview.

Institution	Main objective or focus	Salient narratives	Challenges	Solutions or tools
Ministry of Production and Agroindustry	The recovery of the agro-industrial and agro-food based economy.	<ul style="list-style-type: none"> Production over conservation Rural–urban divide Law 763 open to debate with farmers 	<ul style="list-style-type: none"> Rural abandonment Economic sustainability Poor infrastructure (communication, roads) 	<ul style="list-style-type: none"> Livestock guard dogs (LGDs) Lethal control Greater recognition of rural experiences
Secretary of Environment and Climate Change of the Province of Río Negro	Natural protected areas, environmental education, fauna, climate change, control and inspection, and waste	<ul style="list-style-type: none"> Wildlife conservation Farmer–carnivore conflict Law 763 unfit for purpose 	<ul style="list-style-type: none"> Livestock overgrazing Poison use 	<ul style="list-style-type: none"> Dissuasive (e.g. LGDs) Selective removal Adaptive management
Entity for the Development of the Southern Line and Region	Plan and coordinate the execution of all necessary actions for the comprehensive, economic and social promotion of the <i>línea sur</i>	<ul style="list-style-type: none"> Produce while conserving 	<ul style="list-style-type: none"> Rural abandonment Predation Contradictory legislation 	<ul style="list-style-type: none"> Lethal control Dissuasive (e.g. LGDs) Human presence Education/capacitation
National Institute for Agricultural Technology (INTA)	Contribute to the sustainable development of the agricultural, agro-food and agro-industry sector through investigation and outreach	<ul style="list-style-type: none"> Produce while conserving Rural–urban divide 	<ul style="list-style-type: none"> Poison use Marginalisation (geographical, commercial, cultural) 	<ul style="list-style-type: none"> Dissuasive (e.g. LGDs, lights) Targeted lethal control Wildlife population monitoring Adaptive management

between farmers and carnivores. Cultural differences were said to affect the debate around carnivores, i.e. rural vs urban perspectives. Finally, rural abandonment was recognised as favouring carnivore populations and increasing pressure on the remaining livestock farmers (Table 1).

Discussion

In this case study, there is an overarching narrative of lethal control of carnivores established over 50 years ago through state policy that is of questionable efficacy and supported by little to no data. We identified a duality where two branches of government have contrasting policies when it comes to the sustainable development of livestock production and carnivore management.

Two contradictory laws exist given current circumstances, one permitting hunting (Law 763), and another that confines it to hunting animals classified as harmful (Law 2056). Legislation for lethal control, Law 763, was seen as incorporated into rural inhabitants' carnivore management strategies and as difficult to change, perhaps a consequence of the longevity of the law or because exportation of fox skins was important from the 1970s to the 1990s, where it often represented 4–26% of individuals' annual income (Novaro 1995). Late in this period, there was a culpeo fox-monitoring program that ended when the export market collapsed (Funes *et al.* 2006). The current lack of carnivore population monitoring means that animals cannot be accurately classified as harmful. These two laws were accompanied by a duality in institutional narratives, namely, production and conservation. 'Production' represented the prioritisation of livestock production and improving rural livelihoods, whereas 'conservation' aimed to prioritise the conservation of carnivores through non-lethal management strategies.

Another narrative identified was a rural–urban divide. One interviewee suggested that the opinions of rural inhabitants should carry greater value on the subject of carnivore management as they are the people most affected by the damage. A contrasting reality was acknowledged, with another interviewee stating that urban-centric scientific opinion is often heeded more than that of farmers due to their isolation and marginalisation. Marginalisation can manifest not only socially, or physically through distance and environmental conditions, but also culturally as evidenced here. There is a need to recognise that experiences and values of rural inhabitants are no less valid than those of people who live in urban areas or are more 'educated' (Pascual *et al.* 2021). Furthermore, predation of livestock by large carnivores often occurs in marginal zones (Guerisoli *et al.* 2020).

This study is an example of the challenges of territorial planning and development in a remote arid region. Challenges identified in interviews were land ownership, education and the economic sustainability of productive establishments. In particular, a lack of channels for commercialisation and

communication were highlighted as key barriers to economic sustainability. An environmental context of increasing desertification in Patagonia appears to lead towards a general context of scarcity and precariousness as livelihoods based on livestock production are more vulnerable to disruption (Oliva et al. 2016; Gaitán et al. 2017). Rural abandonment was cited as being the result of many farmers being left with few animals, as well as the attraction of urban areas, especially to younger generations. This abandonment is a phenomenon exacerbated by difficulties with land titles and the inadequate management of carnivores themselves, the interactions of all of which result in a negative feedback loop similar to the spiral of desertification–marginalisation–impoverishment described by Easdale and Domp tail (2014). Furthermore, rural abandonment was considered to be a key factor for the presence of carnivores, despite inconclusive evidence of the effect this change may have on human–puma interactions (Ohrens et al. 2016).

Solutions proposed in this study included both lethal and non-lethal management strategies, including selective removal of problem animals and use of dissuasive measures such as livestock guard dogs (LGDs). A need to address poison use was identified, because it presents a risk to LGDs, the protected Andean condor and other species (Márquez et al. 2013; Plaza and Lambertucci 2020). Resumed monitoring of carnivore populations could benefit decision-making of carnivore management (Redpath et al. 2017). There were also calls for adaptive management and a greater recognition of the experiences of rural farmers, so as to breach the urban–rural cultural divide.

As carnivores present a threat to livestock and consequently to food security; they require effective management in a way that is in line with international and institutional commitments to sustainable development. Although human–carnivore interactions are often framed in light of only their negative impacts, there is a need to consider their full complexity (Pooley et al. 2017). It can be more apt to consider such situations of ‘conflict’ between humans and carnivores as rather a conflict between groups of people as to how to resolve the situation (Marchini 2014; IUCN 2022). Any proposal should avoid efforts to change values as to prevent unintended consequences such as destabilising social groups or disrupting traditions (Manfredo et al. 2017).

We suggest the development of a collaborative management strategy with an emphasis on participation and cooperation rather than coercion, equally valuing inputs and perspectives from livestock producers, scientists, and institutions (Zimmermann et al. 2009; Redpath et al. 2017), considering the role that identity can have in shaping attitudes towards wildlife management strategies (van Eeden et al. 2020b). Lessons can be learned from Kenya about how to approach holistic management (Bond 2014) and from Australia about the possibilities of effecting changes in behaviour through Theory of Change (van Eeden et al. 2020a).

While it is difficult to imagine legislation that entirely prevents conflict, participatory engagement could inform modifications to the current law (Lovan et al. 2017). Further legislation could also be introduced to provide financial assistance for smallholders to access damage mitigation tools such as livestock guard dogs. Other livestock guard animals, such as donkeys or llamas, could be trialled with smallholders as a cheaper alternative (Smith et al. 2000; Macon et al. 2018). An increase in human presence may serve to reduce predation but would require a governmental campaign to re-populate rural areas that is accompanied by improvements to basic infrastructure (e.g. access to electricity). This could have the unintended side-effect of increasing livestock presence and, consequently, grazing pressure, when efforts should be made to alleviate grazing pressure. This could be achieved by calculating and enforcing the livestock carrying capacity of ranches (Scarnecchia 1990; McKeon et al. 2009). Finally, alternatives to sheep production should be considered, such as the raising of guanaco, as has already been trialled in the country (Lichtenstein and Carmanchahi 2012).

Conclusions

We identified a duality where two branches of government have contrasting policies when it comes to the sustainable development of livestock production and carnivore management, a contrast evidenced in their respective legislation. This duality represents human–human conflict related to livestock predation in a marginalised rural region. Despite legislative differences, similar challenges and potential solutions were identified through dialogue with institutions, presenting the potential for collaboration to address the lack of a coordinated carnivore management program. Future studies could evaluate the potential impacts, benefits and feasibility of a holistic management strategy informed by carnivore population monitoring that could implement selective lethal control, complemented by local innovation and empowerment through alternatives to traditional management strategies such as the use of livestock guard dogs. In addition, changes to current dominance of sheep production should be considered.

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Data availability. The data that support this study will be shared upon reasonable request to the corresponding author.

Conflicts of interest. The authors have no competing interests to declare.

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