Journal of Threatened Taxa

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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

Communication

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26 April 2018 | Vol. 10 | No. 5 | Pages: 11566-11573
10.11609/jott.4030.10.5.11566-11573

COMMUNICATION

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 April 2018 | 10(5): 11566–11573

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OPEN ACCESS

Contrasting human perceptions of and attitudes towards two threatened small carnivores, *Lycalopex fulvipes* and *Leopardus guigna*, in rural communities adjacent to protected areas in Chile

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Abstract: The interaction between humans and small carnivores is a phenomenon especially frequent in rural fringes, as is the case of communities surrounding natural areas. In Chile, two species of threatened carnivores, the Darwin's Fox and the Guigna, have increased their contact with humans due to human-induced changes in their habitat. The objective of this study was to characterize the interactions of these species with humans by assessing human perceptions and attitudes toward them, and to assess livestock and poultry ownership and management practices in local communities to evaluate their possible roles in the phenomenon. We conducted semi-structured interviews in rural communities adjacent to natural protected areas of two different regions in southern Chile. We found that people have a more positive perception of Darwin's Foxes than Guignas, but both species are considered damaging due to poultry attacks. Livestock and poultry management was generally deficient. Improvements in animal management and education programs could lead to a significant decrease in negative interactions.

Keywords: Carnivore conservation, human-small carnivore interaction, *Leopardus guigna,* livestock and poultry depredation, *Lycalopex fulvipes.*

DOI: http://doi.org/10.11609/jott.4030.10.5.11566–11573

Editor: Jim Sanderson, Small Wild Cat Conservation Foundation, Hartford, USA. **Date of publication:** 26 April 2018 (online & print)

Manuscript details: Ms # 4030 | Received 26 January 2018 | Final received 01 March 2018 | Finally accepted 12 April 2018

Citation: Sacristan, I., A. Cevidanes, F. Acuña, E. Aguilar, S. Garcia, M.J. Lopez, J. Millán & C. Napolitano (2018). Contrasting human perceptions of and attitudes towards two threatened small carnivores, *Lycalopex fulvipes* and *Leopardus guigna*, in rural communities adjacent to protected areas in Chile. *Journal of Threatened Taxa* 10(5): 11566–11573; http://doi.org/10.11609/jott.4030.10.5.11566-11573

Funding: FONDECYT Iniciación Nº 11150934 (CONICYT); FONDECYT Regular Nº 1161593 (CONICYT); Morris Animal Foundation (MAF) Fellowship Training Award (D15ZO-413); National Geographic Society Conservation Trust Fund (C309-15); Mohamed bin Zayed Species Conservation Fund (152510351); Fondo interno UNAB DI-778-15/R; Morris Animal Foundation (MAF) D16ZO-825; Wild Felid Association Grant.

Competing interests: The authors declare no competing interests.

For **Author Details, Author Contribution, Acknowledgements** & **Spanish abstract** see end of this article.

INTRODUCTION

During the last two centuries, many carnivores experienced substantial population declines (Ripple et al. 2014). Some of the major threats faced by carnivores include habitat loss and fragmentation, human population growth and persecution by humans associated with livestock and poultry depredation (IUCN 2016). The interaction between human and small- or medium-sized carnivores is a frequent phenomenon in rural fringes. This is accentuated by the increasing human population and the associated rise in rates of natural habitat loss worldwide, which are forcing carnivores to live in increasing proximity to humans (Manfredo & Dayer 2004). In Chile, natural landscape transformation has increased in the last decades (Echeverria et al. 2006; Schulz et al. 2010). This phenomenon mainly affects species that are highly dependent on dense vegetation cover and closely associated with forest habitat, such as the Darwin´s Fox *Lycalopex fulvipes* and the Guigna *Leopardus guigna*. Both species are threatened carnivores that inhabit southern Chile and live in close proximity to humans, thus creating instances for human-carnivore interaction (Sanderson et al. 2002; Gálvez et al. 2013).

The Darwin's Fox (Image 1) is a canid endemic to southern Chile that inhabits a large portion of Chiloé Island (8,394km^2), in the Nahuelbuta Mountain Range National Park and the continental Valdivia Coastal Range (Jiménez & MacMahon 2004; Farias et al. 2014). The Darwin's Fox is classified as Endangered by the IUCN (Silva-Rodriguez et al. 2016). The main threats faced by Darwin's Fox populations are the risk of disease spillover transmission from dogs (mainly canine distemper virus) (Jiménez & McMahon 2004) and deforestation, but may also include human-caused mortality in retaliation for their attack against domestic animals (Espinosa 2011; Stowhas 2012).

The Guigna (Image 2) is the smallest wild felid in the Americas (Nowell & Jackson 1996) and has the most restricted distribution among New World feline species - approximately 160,000km^2 located in central and southern Chile (30–48 ^{0}S), including Chiloé Island, and a narrow strip in southwestern Argentina (39–46 ^{0}S west of 70^{0}W) (Nowell & Jackson 1996; Quintana et al. 2000). Considered one of the most endangered cats in South America, the Guigna is classified as Vulnerable by the IUCN (Napolitano et al. 2015b). The main threats against this species include habitat loss and fragmentation, and direct human persecution (Napolitano et al. 2015a,b).

Human interaction with these threatened carnivore species is a very important threat to their survival. Therefore, understanding such interaction and collecting broad information about the species biology and behavior and how people respond to their predation on domestic animals is critical for their conservation (Manfredo & Dayer 2004). Despite the importance of addressing human dimensions in this interaction in order to promote and implement successful conservation measures, the issue has been scarcely studied in Chile. Furthermore, most studies in South America have mostly focused on conflicts involving large carnivores (Silva-Rodriguez et al. 2007; Inskip & Zimmermann 2009).

With the goal of filling in this research gap, we studied the interaction between humans and Darwin's Foxes and Guignas by assessing human perceptions and attitudes towards these carnivores in rural communities adjacent to protected areas. We also compared human perception and attitudes between both carnivore species and the study areas, and assessed livestock and poultry management practices of local communities to

Image 1. Darwin´s Fox *Lycalopex fulvipes*

Image 2. Guigna *Leopardus guigna*

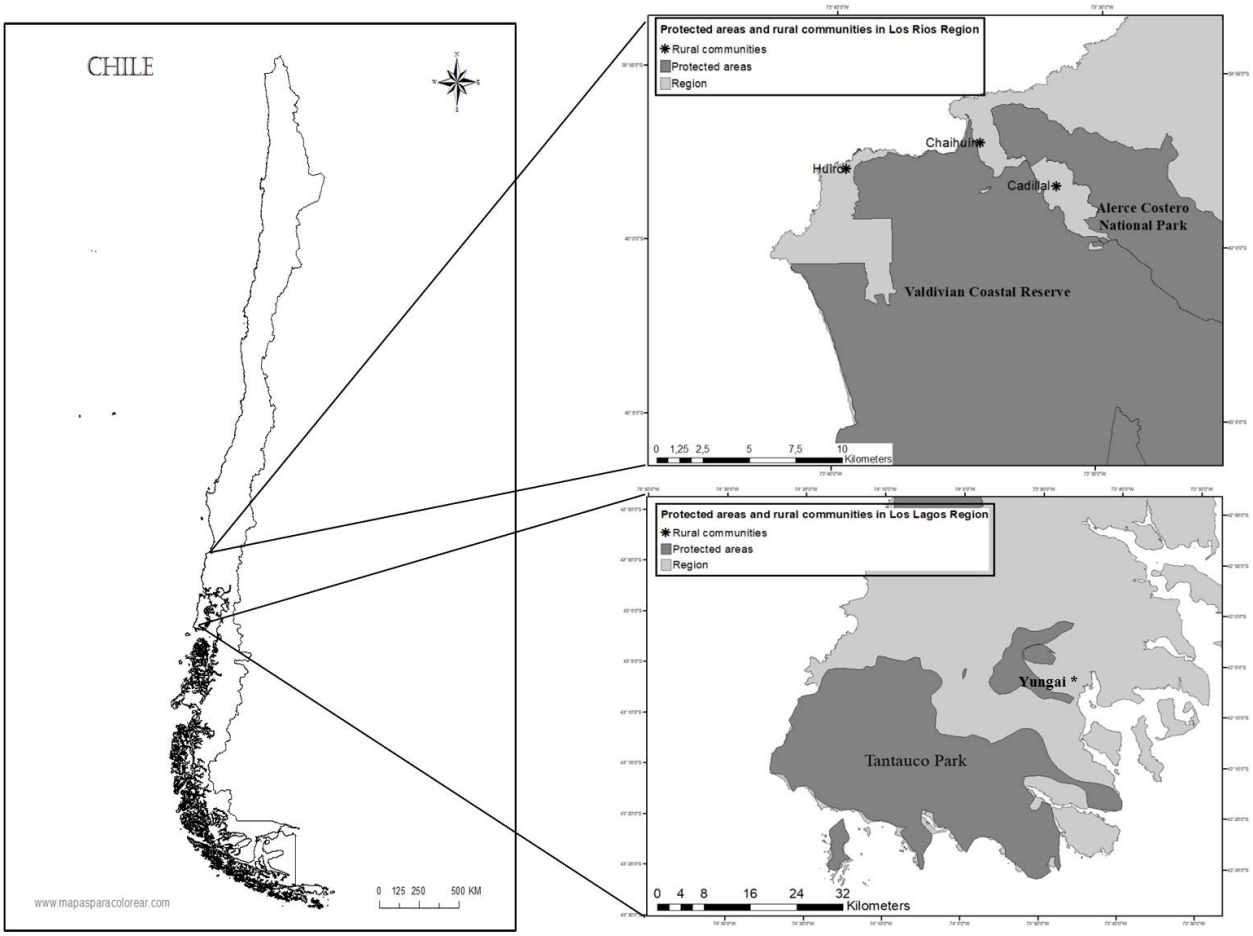

Figure 1. Location of rural communities and study areas in southern Chile.

evaluate their possible roles in these human-carnivore interactions.

To our knowledge, this is the first study to compare human perceptions and attitudes towards the Darwin's Fox and the Guigna; thus it is a descriptive and exploratory study aimed on gaining a first set of data regarding the human dimension context.

MATERIAL AND METHODS

The study was conducted in two regions of southern Chile: Los Ríos and Los Lagos. The study areas encompassed rural communities adjacent to Alerce Costero National Park and the Valdivian Coastal Reserve in Los Rios Region; and Tantauco Park, in Chiloé Island, Los Lagos Region (Fig. 1). Both regions are representative of the Valdivian Temperate Rainforest, recognized by the Global 2000 initiative as an ecoregion with high conservation priority (Olson et al. 2001; Delgado 2010).

The studied communities subsist on cattle and poultry breeding and fishing (Delgado 2010), the distance to protected areas is between 0.2–7.0 km, and they have similar ecological and geographic topographies: both are located in the temperate rainforest of southern Chile, 200m altitude, and with pluviometry levels between 1,700-2,000 mm per year. The protected areas located in Los Ríos Region cover 83,700ha (Delgado 2010). The Darwin´s Fox was recently discovered in the Valdivian Coastal Reserve, being the second confirmed area in the entire Chilean continent area where this species occurs (Farías et al. 2014). Such findings highlight the relevance of assessing baseline human dimension information for this species in the area. Tantauco Park comprises 118,000ha and is situated in southwestern Chiloé Island. This island stands out for harboring highly dense populations of Guignas and Darwin's Foxes, which are the only wild felid and wild canid species inhabiting the island (IUCN 2016).

During 2015 and 2016 we conducted semi-structured interviews composed of eleven multiple choice questions, in rural communities adjacent to the

protected areas. Interviews were conducted face-to-face with the household heads only. As the reliability of informants can be affected by their degree of familiarity with the study area, we only selected the resident population (Turvey et al. 2014). Hunting these species is illegal in Chile (Agriculture and Livestock Service, SAG, Hunting Act 2012), so we began interviews by clarifying that we were a non-governmental organization and that all information provided would be treated anonymously. To ensure that all interviewees knew these two carnivores, a detailed description of both species was requested prior to the interview, to check whether or not the interviewees actually recognized them. All interviews followed the ethical guidelines of the Social Research Association (SRA 2003). To compare the results of the different questionnaires between the two regions and between the two species, a chi-square test was performed comparing the frequency of each answer with the R program (R Core Team 2013).

RESULTS

A total of 111 households were surveyed; 54 in the Valdivia area and 57 in Chiloé Island. In regards to the question on whether interviewees liked the studied carnivores or not (Table 1, question 1), 57.6% (SD= 0.49) and 26.1% (SD= 0.44) answered that they liked Darwin's Foxes and Guignas, respectively. Interviewees had a significantly more positive perception of Darwin's Foxes than Guignas (p = 0.0001).

Regarding carnivore population numbers (Table 1, question 2), 56.7% (SD = 0.49) and 46.8% (SD = 0.5) of the interviewees would like to maintain Darwin's Fox and Guigna populations, respectively, to the number it is today; with significantly greater local support Darwin's Fox populations (p=0.001). A higher proportion of people in Valdivia wanted both species to decrease in number or disappear, (Darwin's Fox 29.6% (SD = 0.46), Guigna 42.5% (SD = 0.49)) in comparison to Chiloé (Darwin's Fox 10.5% (SD = 0.30), Guigna 31.4% (SD = 0.46)); these differences were significant for both species (p = 0.005). When inquired on whether these species are damaging (Table 1, question 3), most respondents considered them damaging (50.4% (SD = 0.50)) or very damaging (57.5% (SD = 0.49)), but there were no significant differences between the two species or study areas.

In regards to animal ownership and management, 73.6% (SD = 0.44) of people surveyed owned livestock and 58.5% (SD = 0.49) poultry. Night confinement of

Table 1. Perceptions and attitudes towards Darwin's Fox and Guigna in the two study areas.

	Total		Valdivia		Chiloé	
	Darwin´s Fox	Guigna	Darwin´s Fox	Guigna	Darwin´s Fox	Guigna
	(%)	(%)	(%)	(%)	(%)	(%)
1. Do you like them or not?						
I do not like them at all	7.2	18.9	5	18.5	8.7	19.2
I do not like them	16.2	29.7	9.2	24	22.8	35
I do not care about them	18.9	22.5	24	29.6	14	15.7
I like them	57.6	26.1	61.1	27.7	54.3	24.6
Don't know/ Don't answer	0	2.8	0	0	0	5.5
2. Would you like for the population to:						
Disappear	9	17	14.8	18.5	3.5	15.7
Decrease	10.8	19.8	14.8	24	7	15.7
Be maintained as in the present	56.7	46.8	57.4	50	56	43.8
Increase	21.6	10	11.1	1.8	31.5	17.5
Don't know/ Don't answer	1.9	6.4	1.9	5.7	2	7.3
3. Guignas/Darwin´s foxes are:						
Very damaging	13.5	14.4	16.6	30.4	10.5	16.6
Damaging	36.9	43.1	38.8	39.1	35	58.3
I do not care about them	21.6	7.2	12.9	15.2	29.8	8.3
Beneficial	0	0.01	0	1.86	0	0
Don't know/ Don't answer	28	35.3	31.7	13.44	24.7	32.8

Table 2. Animal ownership and management practices by local communities.

	Total (%)	Valdivia (%)	Chiloé (%)
1. Do you have farm animals?			
No	26.4	24.5	30
Yes	73.6	75.5	70
Don't know/ Don't answer	0	0	0
2. Which animals?			
Ovine	34.2	43.9	35
Bovine	31.5	56	21
Avian	58.5	78	57.8
Porcine	16.2	5	28
Rabbit	1	2.4	1
Equine	7.2	19.5	0
3. How do you manage animals?			
Permanently unconfined	38.7	25	53.5
Night confinement	44.1	67.5	20.3
Permanent confinement	17.1	7.5	26.7
Don't know/ Don't answer	0	0	0
4. Which do you think is the best method to protect farm animals?			
Confinement	63.9	66.6	61.1
Use of guardian dogs	23.4	19.6	26.7
Remove predators	13.5	14.2	12.5
Don't know/ Don't answer	0	0	0

livestock (except bovine) and poultry was practiced by 44.1% (SD = 0.49) of the surveyed households; whereas 38.7% (SD = 0.48) managed their animals permanently unconfined, and only 17.1% (SD = 0.37) used permanent confinement. 63.9% (SD = 0.48) of the respondents, however, thought that the best method to protect livestock and poultry was indeed confinement. The majority of interviewees in Valdivia manage their animals with night confinement, 67.5%, whereas in Chiloé, the most common practice is for the animals to be permanently unconfined, 53.5% (SD = 0.50). No statistically significant differences were found between study areas.

Regarding attacks on farm animals, overall 14.4% (SD = 0.35) of people declared they have seen both species hunting or eating farm animals during previous years. Most interviewees (62.2% (SD = 0.48)) declared that the number of animals killed by Darwin's Foxes was between one and four, whereas for Guignas, it was greater than five animals (68.7% (SD = 0.46)). Darwin´s Foxes reportedly attacked both sheep and poultry, while Guignas attacked mainly poultry. The majority of people mentioned that winter (June-August) is the season with the highest frequency of livestock and poultry attacks, both by Darwin's Foxes and Guignas, 33% (SD = 0.47) in both areas. Most respondents declared that the most frequently observed behavior of Darwin's Foxes was attacking one animal and coming back later to attack more individuals, 33.3% (SD = 0.47); whereas Guignas' attacks occurred on several animals, during one or more attacks, 36.9% (SD = 0.48). The differences in the results between species and study areas were not statistically significant.

DISCUSSION

The occurrence of human-carnivore interaction in southern Chile involving rural communities, Darwin's Foxes and Guignas, has been previously reported (Díaz 2005; Silva-Rodríguez et al. 2007, 2009; Zorondo et al. 2014). These studies, however, did not contrast human attitudes and experiences between these two carnivores or between different geographic areas. The majority of interviewees in this study declared that they liked Darwin's Foxes better than Guignas. This could be explained by the intrinsic and esthetic value rural communities give to the former species in southern Chile and also for the decreased damage they cause to farm animals in comparison to Guignas. Although a higher proportion of people would prefer Darwin's Fox and Guigna populations to be maintained at their current numbers, Darwin's Fox had higher local support than Guigna populations, especially in Chiloé Island. This may be due to the fact that Chiloé people proudly recognize the Darwin's Fox, also locally called "Chilote" Fox (i.e., native of Chiloé Island), as their own heritage species. In contrast, a third of the people interviewed in Chiloé Island wanted Guigna populations to decrease or disappear. In Chiloé, guignas have a mythological and superstitious aura; local farmers believe they are vampires that bite their prey's neck and subsequently suck their blood (Sanderson et al. 2002), which confers Guignas with magical abilities, possibly amplifying their negative perceptions. Other explanation could be that Guignas kill more animals than Darwin´s Foxes and can repeat predation events on poultry, thus providing people with a negative perception towards them. When inquired about damage caused by poultry depredation, most respondents in both study areas considered both Darwin's Foxes and Guignas to be damaging or very

Table 3. Attacks on farm animals by Darwin's Fox and Guigna.

	Total		Valdivia		Chiloé	
	Darwin´s Fox (%)	Guigna (%)	Darwin´s Fox (%)	Guigna (%)	Darwin´s Fox (%)	Guigna (%)
1. Have you seen them eating or hunting farm animals during the last year?						
Yes	14.4	14.4	22.2	12.9	7	15.7
No	85.6	85.6	77.8	87.1	93	84.3
Don't know/ Don't answer	0	0	0	0	0	0
2. How many animals did they eat or hunt?						
1–4	62.2	31.2	66.6	0	75	11.1
5–10	18.7	50	16.6	14.2	25	77.7
>10	18.7	18.7	16.6	28.5	0	11.1
Don't know/ Don't answer	0	0	0	57.3	0	0
3. Which season has more farm animal attacks?						
Winter	33.3	33.3	37	40.7	29.8	26.3
Spring	10.8	12.6	20.3	16.6	1.8	8.8
Summer	7.2	4.5	7.4	1.8	7	7
Autumn	1.8	1	0	0	3.5	1.8
All of them	9	12.6	16.6	14.8	1.7	10.5
Don't know/ Don't answer	37.8	36	18.5	25.9	56.2	45.6
4. Which one of these better explains their behavior with respect to the losses of farm animals:						
Hunt one animal and disappear	8	0	14.8	0	1.7	0
Hunt one animal and come back for more	33.3	13.5	42.5	7.4	24.6	19.3
Hunt several animals and disappear	2.7	13.5	3.7	22.2	1.75	5.3
Hunt several animals and come back for more	14.4	36.9	22.2	46.2	7	28
Don't know/Don't answer	41.6	36	16.6	24	65	47.4

damaging, not making any difference between them. Nevertheless, real attacks seem to be sporadic, since a low proportion (14.4%) of people claimed to have seen a Darwin's Fox or a Guigna actually hunting or eating livestock or poultry during the last year. Farm animal predation by carnivores is deeply rooted in the cultural history of rural communities (Molina 1795), even though comparatively fewer real incidents occur nowadays. The high proportion of negative attitudes reported in some studies (Stowhas 2012; Herrmann et al. 2013) seems unjustified or at least not proportionally linked to the amount of the currently caused damage, considering that the reported attacks performed by Guignas and Darwin's Foxes seem to be rare events and that the actual livestock and poultry losses are low. This suggests that negative attitudes are based mostly on popular knowledge and cultural beliefs, and perhaps even past experiences, than on actual losses (Silva-Rodriguez et al. 2007).

Regarding animal ownership and management practices aiming on preventing the attacks, the majority of people used only night confinement in Valdivia, whereas in Chiloé, the majority of interviewees kept animals permanently unconfined. Despite permanent confinement is an uncommon practice, the majority of people in both areas reported that the best way to protect their animals from attacks was confinement (a few thought it was the use of guardian dogs or removal of predators). A closer look at henhouses and confinement structures in different rural communities revealed very precarious and poor construction, not totally effective against carnivore attacks. The lack of adequate structures might increase negative attitudes towards predatory species, because even when people try to protect them, their animals suffer predation. This is possibly the reason behind the greater negative perception towards these carnivores in Valdivia.

The potential conflict between rural farmers and wild carnivores in southern Chile could have negative effects for the long-term conservation of these threatened

species, and requires an immediate solution. Indirect conflict resolution methods have been used in other countries, such as translocation of problem individuals, loss compensation (Treves & Karanth 2003) and the use of guardian dogs (Silva-Rodríguez et al. 2009; Sepúlveda et al. 2015). Given that in this study poultry predation was the main reason for people to hold negative attitudes towards carnivores, conflict resolution should focus on poultry attack prevention. The construction of adequate, good quality coops, along with proper animal management practices and the use of permanent confinement or close supervision, particularly during the winter (the season with the highest number of attacks), should lead to a reduction in the damage caused, and therefore the human-carnivore conflict. People seem to be aware of these measures, however, the main problem to implement them is their cost being too high for the local residents. Thus, developing affordable measures could be an option. Cultural beliefs are deeply embedded in the studied areas, so it is also crucial to change human attitudes and people's perceptions through the implementation of environmental education programs. In some countries, a better understanding of the wild beneficial function of carnivores in the ecosystem promoted wildlife recovery with significant citizen participation (Treves & Karanth 2003).

Next steps will be to increase the number of communities and households interviewed throughout the distribution of both species, in order to better understand the differences in human perceptions and attitudes regarding these endangered species and incorporate this information into adaptive management plans.

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Spanish abstract: La interacción entre humanos y carnívoros de pequeño tamaño es un fenómeno especialmente frecuente en los límites de las áreas rurales, como es el caso de las comunidades que se encuentran bordeando zonas naturales. En Chile, existen dos especies de carnívoros amenazados, la güiña y el zorro de Darwin, cuyo contacto con los seres humanos ha incrementado en los últimos años debido principalmente a la modificación humana de su hábitat. El objetivo de este estudio fue caracterizar la interacción de estas especies con los humanos mediante la evaluación de la percepción y actitud humana hacia ellos, y evaluar cómo el manejo y la gestión del ganado y las aves de corral pueden jugar un rol en este fenómeno. Para ello realizamos entrevistas semiestructuradas en comunidades rurales adyacentes a áreas naturales protegidas situadas en dos regiones del sur de Chile. Hallamos que las personas tienen una percepción más positiva hacia el zorro de Darwin que hacia la güiña, si bien, ambas especies se consideran perjudiciales debido a los ataques a aves de corral. El manejo del ganado y las aves de corral fue generalmente deficiente. Mejoras en la gestión del ganado y las aves de corral, así como también la implementación de programas de educación ambiental podrían conducir a una importante disminución en las interacciones negativas entre estas especies y el ser humano.

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Author Contribution: Conceived and designed the study: IS, CN, JM. Performed the surveys and data collection: IS, AC, FA, EA, SG, MJL, JM. Analyzed the data: IS, JM, CN. Manuscript revision: IS, AC, FA, EA, SG, MJL, JM, CN. Wrote the manuscript: IS, CN.

Acknowledgements: The authors wish to thank the local communities who kindly agreed to be interviewed for this study for their generous collaboration. We are grateful to the Corporación Nacional Forestal CONAF Los Ríos office and staff at the Alerce Costero National Park, especially to Patricio Contreras and Patricia Barría for invaluable logistical support. Thanks to the staff and park guards from the Valdivian Coastal Reserve (The Nature Conservancy) for their helpful support. We thank Parque Tantauco, especially Alan Bannister for facilitating logistical support. We are grateful to Mario Alvarado, Carlos Canales, Elfego Cuevas, Diego Pérez, Nicolás Latorre, Eduardo Laguna, Diego Maturana, Diego Peñaloza and Gonzalo Canto for assistance with data collection. Special thanks to Eduardo Silva, Jim Sanderson, Javier Cabello (Chiloé Silvestre), Ezequiel Hidalgo (Buin Zoo), John Organ and Felipe Cecchi for providing valuable support and input during the project.

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OPEN ACCESS

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

April 2018 | Vol. 10 | No. 5 | Pages: 11551–11702
Date of Publication: 26 April 2018 (Online & Print)
DOI: 10.11609/jott.2018.10.5.11551-11702

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