

# **Biology and Conservation of Wild Felids**

Edited by

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## Pumas and people: lessons in the landscape of tolerance from a widely distributed felid

*Tucker Murphy and David W. Macdonald*



Camera-trap photograph of a puma living in close proximity to human settlement in the Araucanía Lake District of Chile. © Nicolás Gálvez, Darwin Initiative.

Amigo del cristiano, cougar, catamount, chim blea, puma, panther, pangi, mountain lion, mountain screamer, deer tiger, ghost cat—these names represent some of the multiple attempts people have made to encapsulate and describe this elusive and solitary felid over the time they have shared the American landscape. In total, 42 different names for *Puma concolor* have been identified in English (Barnes 1960) and a similar number exist in both Spanish and Native American languages (Young and Goldman 1946). Perhaps these varied monikers hint at the ambivalence people have experienced in defining this cryptic and crepuscular cat; pumas have been perceived as the friend of humans by some cultures, and persecuted for the threat they pose to livestock and

people by others (Anonymous 1892; Young and Goldman 1946; Barnes 1960). Certainly, these numerous names reflect the extensive range of pumas, which has brought them into contact with diverse cultures. Their range stretches from the Straits of Magellan to the Canadian Yukon and is the broadest of any New World terrestrial mammal, except humans. Within this range, pumas vary in body size, and are immensely adaptable, such that they occupy almost every type of biogeographic zone from tropical rainforest to desert (Young and Goldman 1946). As a result, pumas are an ideal model organism to examine how culture and context shape our relationship with large felids. In this case study, we investigate how the exigencies of depredation, as well as the threat pumas pose to humans, are

managed and perceived at study sites in both North America (Montana) and South America (Chile).

## Biological characteristics

Pumas have not always occupied such an extensive range. Since they evolved in North America from a common ancestor with the American jaguarundi (*Herpailurus yaguaroundi*) and the African cheetah (*Acinonyx jubatus*) 5–8 million years ago (Janczewski *et al.* 1995; Johnson and O'Brien 1997; Werdelin *et al.*, Chapter 2, this volume), pumas' evolutionary



**Figure 20.1** Map showing pumas' extensive range and depredation studies. A and B indicate our two study sites, in Montana and Chile, respectively. All other numbers mark sites referred to in the text, where puma depredation has been studied. 0, California (Torres *et al.* 1996); 1, south-east Arizona and north-west Mexico, respectively (Cunningham *et al.* 1995; Rosas-Rosas *et al.* 2008); 2, Venezuelan Llanos (Polisar *et al.* 2003; Scognamillo *et al.* 2003); 3, central-western Brazil (Palmeira *et al.* 2008); 4, Bolivian Altiplano (Pacheco *et al.* 2004); 5, southern Brazil (Mazzolli *et al.* 2002); 6, Andean foothills of Patagonia (Franklin *et al.* 1999).

history has been characterized by colonization, extinction, and recolonization events. Approximately 3 million years ago, when the Panamanian land bridge formed, pumas crossed from North to South America during the Great American Interchange (Marshall *et al.* 1982). Subsequently, the North American population of pumas was extirpated in the Pleistocene mass extinction event (10,000–12,000 years ago) and replaced by a founding population of South American pumas. According to mitochondrial gene sequence and microsatellite loci evidence, the current North American population of pumas derives from a core of genetic diversity in eastern South America (Culver *et al.* 2000).

Throughout their range (Fig. 20.1), puma body size and diet vary with latitude. They are the fourth largest felid, and are generally comparable in size to snow leopards and African leopards (Logan and Sweanor 2001); however, pumas closer to the equator have a lower average body weight (<35 kg between latitudes of 0° N/S to 20° N/S), than those at the far north and south of their distribution (>50 kg at latitudes >40° N/S; Kurtén 1973; Iriarte *et al.* 1990). Populations of pumas in temperate habitats favour larger prey (>30 kg at latitudes >40° N/S; e.g. ungulates in North America) from a smaller number of taxa (Iriarte *et al.* 1990). In contrast, puma populations in tropical habitats subsist on smaller, more varied prey (<15 kg between a latitude of 0° N/S to 20° N/S; Iriarte *et al.* 1990). Since mean body mass of prey has been positively correlated with puma body mass, prey size is believed to have imposed selective pressures on puma size. Difference in diet is largely dictated by prey availability and vulnerability, as well as habitat characteristics. Preference of smaller prey in the tropics may also reflect resource partitioning with larger sympatric jaguars (*Panthera onca*; Scognamillo *et al.* 2003).

## Conflict

Regardless of latitude, pumas prey on domestic animals or livestock wherever they range adjacent to or within puma habitat. Studies from areas as varied as the Sonoran Desert (Cunningham *et al.* 1995; Rosas-Rosas *et al.* 2008), the Bolivian Altiplano (Pacheco *et al.* 2004), the Venezuelan Llanos (Polisar *et al.* 2003; Scognamillo *et al.* 2003) and the grasslands,

and Andean foothills of Patagonia (Franklin *et al.* 1999) have all reported a high incidence of livestock loss. Sheep or goats are often the primary victims of depredation (e.g. southern Brazil, Mazzolli *et al.* 2002; southern Chile, Rau and Jimenez 2002), though pumas will opportunistically attack other livestock, hobby animals and pets (California, Torres *et al.* 1996). Occasionally, depredation of adult cattle weighing up to 130 kg has been recorded (Cougar Management Guidelines Working Group 2005). However, pumas generally favour smaller prey and cattle losses are greatest when calves are born in puma habitat (e.g. calves 0–6 months old accounted for 100% of puma depredation on kills checked in southern Brazil, Palmeira *et al.* 2008; see also Cunningham *et al.* 1995; Crawshaw and Quigley 2002). Depredation may also be greater in areas with low abundance of native prey (Crawshaw and Quigley 2002; Polisar *et al.* 2003; Loveridge *et al.*, Chapter 6, this volume).

Several trends combine to create a global challenge for big cats in general and pumas in particular. Conservation efforts are intensifying, sometimes leading to increasing numbers of pumas. However, numbers of humans and their environmental footprint are also increasing almost everywhere, so these modern pumas almost always live alongside people. As a result, opportunities for puma depredation on livestock and domestic animals may increase. In fact, over the past 30 years depredation incidents in the western United States have multiplied (Padley 1997). Though the root cause is unknown, factors such as declining deer numbers, elimination of bounties, increasing puma numbers and changes in land use have been suggested (Cougar Management Guidelines Working Group 2005).

Often the outcome of these depredations is conflict between pumas and people. Conservationists consider conflict as one of the three major threats facing felids globally; the other two linked concerns being a diminishing prey base and habitat modification (Mazzolli *et al.* 2002; see also Macdonald *et al.*, Chapter 29, this volume). Conflict was at the root of the extirpation of the Zanzibar leopard (*Panthera pardus adersi*) and Barbary lion (*Panthera leo leo*) and it has led to the elimination of tigers (*Panthera tigris*) from most of China, the lion (*Panthera leo*) from North Africa and south-west Asia, and the puma

from the entire eastern half of the United States and parts of Argentina (Young and Goldman 1946; Nowell and Jackson 1996). The likelihood of conflict between humans and felids may be increased by the threat these large cats pose to public safety and human life. Puma attacks on humans occur rarely; for instance Beier (1991) documented nine fatal attacks and 44 non-fatal attacks in North America from 1890–1990. However, when they do occur they receive substantial publicity and accounts in the popular press may be prone to hyperbole (e.g. Baron 2004).

## Human values

Methods of resolving environmental problems have often been weighted towards ecological approaches (Riley 1998). In the context of human–felid conflict, ecological approaches usually centre on reducing depredation through mitigation efforts, such as improving livestock husbandry (Mazzolli *et al.* 2002; Rosas-Rosas *et al.* 2008). However, human values also play a considerable role in conflict. In *The Strategy of Conflict*, game theorist and economist Thomas Schelling (1960) contends that situations of pure conflict in which two human antagonists are completely opposed are rare, and arise only in wars of complete extermination. As a result, ‘winning’ in human conflict does not have the strictly competitive meaning of winning relative to one’s adversary; rather, it means gaining relative to one’s value system (Schelling 1960).

The importance of understanding human values in situations of human–carnivore conflict is increasingly reflected in the literature of conservation biology (see Cavalcanti *et al.*, Chapter 17, this volume). Macdonald and Sillero-Zubiri (2004b) point out that ‘prejudices cannot be changed until they are first identified and second—if possible—debunked’. Decker and Chase (1997) add further support to this idea and argue that a human–wildlife problem could only be considered solved when stakeholders believe it to be so. Of course, in the past, common ground has not always been found between humans and carnivores, and ‘wars of complete extermination’ have occurred (e.g. the Falkland Island wolf, *Dusicyon australis*). Nevertheless, a step

towards devising solutions is to understand such animosity, particularly considering the role of perception—as distinct from evidence—in the deaths of many felids and carnivores in general (Cavalcanti *et al.*, Chapter 17, this volume). Studies of the human dimension of conflict have also revealed that stakeholders' tolerance of felids may be increased through education, even in the absence of a reduction in overall depredation rates (Marker *et al.* 2003c).

## **Management in North and South America**

At the intersection between conflict and human values is puma management. In its essence management is an attempt to influence puma behaviour and populations in a way that accords with human desires. However, the Cougar Management Guidelines Working Group (2005) point out that given pumas' secretive nature, their low population densities, their impact on wild and domestic prey, and the threat they pose to human safety 'public attitudes about them differ widely'. As a result, management strategies also vary considerably. Certainly, broad differences exist in the management of pumas between North and South America.

In North America, puma hunting is legal except in the eastern United States, where pumas have been extirpated everywhere but Florida and are listed under the Endangered Species Act (Cougar Management Guidelines Working Group 2005). Wildlife managers in the United States often issue depredation permits or employ lethal means to resolve human–puma conflict. In theory, management decisions in the United States are made democratically at a regional (or state) level and diverse stakeholder groups, often with limited direct contact with pumas, may influence decisions about the management and control of their populations. In practice, since appointed game commissions make most regulatory decisions, they may be biased towards protecting the harvest of revenue-generating species such as deer and elk. The interests of agricultural communities, which may be less favourable towards predators, also tend to be strongly represented on game

commissions (H. Quigley, personal communication 2008). Nevertheless, throughout the United States, groups as varied as hunters (of both pumas and their ungulate prey), livestock owners, conservationists, and homeowners have a stake in decisions about puma management.

Throughout South and Central America killing pumas is prohibited (except in Peru, and in El Salvador, where pumas have been nearly extirpated; Lopez-Gonzalez 1999; Logan and Sweanor 2001). Protection of pumas in South America is often mandated at a national level and entails very little stakeholder input (C. Bonacic, personal communication 2008). Therefore only those stakeholders in direct contact with pumas are capable of influencing their future populations by illegally killing them. However, if stakeholders retaliate against pumas they are at risk of suffering legal consequences.

## **Stakeholders in North and South America**

Thus far, the most comprehensive studies of the human dimension of human–puma conflict have been limited to North America (Kellert *et al.* 1996; Riley 1998). We sought to expand the scope of understanding by investigating human dimensions in Chile. To highlight some of the broad differences in relevant stakeholder groups in North America and South America we compared their involvement and beliefs in Chile to published results for Montana (Riley 1998).

In Montana, Riley (1998) used a self-administered questionnaire to assess the human dimension of puma management and conflict. In total, 1378 questionnaires were delivered to randomly selected households throughout Montana. The questionnaire was concerned mainly with stakeholder involvement with pumas, their beliefs about pumas, and their assessment of the risks posed by pumas. Since management decisions are made democratically, questionnaires were not targeted at any sector of stakeholder. In the Araucanía Lake Region of Chile stakeholders were asked the same set of questions. Those stakeholders in closest contact with pumas, who posed the greatest direct threat to them, and

consequently held sway over their future, were targeted for interviews. This group was comprised mainly of owners of small livestock holdings.

We employed chi-square tests to determine whether a significant difference existed between the interactions or beliefs of Montanan stakeholders and Chilean stakeholders. In cases where expected values were <10 and did not meet the restrictions of standard chi-square test, we applied Yate's correction for continuity. Since we were only interested in understanding broad distinctions between the two study areas and different methodologies necessarily applied to each area (possibly compromising some assumptions of the chi-square test), significance was treated as a rough indicator of differences. All tests were performed in SPSS (version 16.0 for Macintosh).

The most common form of involvement among Montanan stakeholders with pumas was to have read or heard of encounters between pumas, pets, live-

stock, or people, or to have read or heard of their control by management authorities (Table 20.1a). In contrast, most Chilean stakeholders claimed to have observed a puma or knew a friend or neighbour who had had contact with one. Among Chilean livestock owners, even second-hand information on pumas was rarely derived from newspapers or reading; instead it was passed by word of mouth. Overall, more Chilean than Montanan stakeholders responded positively to the presence of pumas in their country. However, they were more negative about the presence of pumas near their houses (Table 20.1b). Chilean stakeholders also believed that encounters between pumas and people showed a decreasing trend, whereas, Montanan stakeholders perceived an increasing trend. Each group exhibited significantly different beliefs about whether risks were well understood by experts, with Chileans believing they were not and Montanans believing that they were (Table 20.1c).

**Table 20.1a** Table comparing the involvement of Montanan (Riley 1998) and Chilean stakeholders with pumas. Results listed as not available (NA) were either considered not relevant or not translatable to a particular study area.

Involvement	Chile (%)	Montana (%)	Statistic
Observed a puma in the wild	75	36.3	$\chi^2 = 29.976$ $P \ll 0.0001$
Read or heard of a puma being killed by authorities	0	70.1	$\chi^2 = 120.805$ $P \ll 0.0001$
Read or heard of a puma being killed in the area	43	NA	NA
Read or heard of a puma being liberated by authorities	55	NA	NA
Had a pet threatened or attacked by a puma	15	2.0	$\chi^2 = 29.21$ $P \ll 0.0001$
Had livestock threatened or attacked by pumas	65	2.0	$\chi^2 = 29.21$ $P \ll 0.0001$
Have been personally threatened by a puma	2	3.3	$\chi^2 = 0.085$ $P = 0.7703$
Read or heard of pets being threatened/attacked by a puma	40	68.4	$\chi^2 = 17.321$ $P \ll 0.0001$
Read or heard of people being threatened/attacked by a puma	42	65.5	$\chi^2 = 13.696$ $P = 0.0002$
Know a friend/neighbour who had an encounter with a puma	94	26.9	$\chi^2 = 113.897$ $P \ll 0.0001$

Note: NA not available.

**Table 20.1b** Table showing the response of Chileans and Montanans (Riley 1998) to belief statements. Attitudes in Chile and Montana mirrored one another to a large extent, except in regard to the presence of pumas within the country or state and the presence of pumas near a stakeholder's house. Results listed as not available (NA) were either considered not relevant or not translatable to a particular study area.

Belief statements	Study Site	Disagree (%)	Neither (%)	Agree (%)	Statistic
The presence of pumas is a sign of a healthy environment?	Chile	17	8	75	$\chi^2 = 3.2094$ $P = 0.2010$
	Montana	14.2	16.7	69.1	
Pumas help to maintain prey populations in balance with their environment?	Chile	10	5	85	$\chi^2 = 3.966$ $P = 0.1377$
	Montana	13.0	12.7	74.3	
The presence of pumas in Chile/Montana increases my overall quality of life?	Chile	10	14	66	$\chi^2 = 29.929$ $P \ll 0.0001$
	Montana	29.5	30.6	39.9	
The presence of pumas near my home increases my overall quality of life?	Chile	75	12	13	$\chi^2 = 14.32$ $P = 0.0008$
	Montana	49.9	28.4	21.7	
Pumas should have the right to exist wherever they may occur?	Chile	NA	NA	NA	NA
	Montana	44.8	11	44.2	
I enjoy having pumas . . .	Chile	24	11	65	$\chi^2 = 1.6900$ $P = 0.4295$
	Montana	17.9	14.6	67.5	
But I do worry about the problems pumas may cause	Chile	27	9	64	$\chi^2 = 3.5447$ $P = 0.1699$
	Montana	33.6	14.6	51.8	

Note: NA, not available.

## Case studies

Since the stakeholder groups able to exert influence over puma populations in North and South America differ widely in their involvement with this felid, to further unravel human values in relation to pumas and people in each place we drew on different methods and data sources. We will now follow the thread of these different data sources through each study area before weaving them together to suggest more comprehensive conclusions about the relevance of management and education in mitigating conflict.

### Case 1: second-hand sources in Montana

In Montana, Riley (1998) has shown that the perception of current puma populations, attitudes towards

pumas, and beliefs about risks predict stakeholder desires about future puma populations. Since the majority of stakeholders in Montana (and in North America) may influence management decisions despite having only read or heard of pumas, we sought to understand the information sources, such as newspapers, that may shape their perceptions, attitudes, and beliefs about risks. The anthropologist Lévi-Strauss (1987) contends that our perceptions and the values we place on nature are shaped by the stories we tell. Therefore the stories chosen by newspaper editors, presumably because they will sell, are also likely to be the stories that strike the most powerful chords in the human psyche. Since newspaper articles convey important cultural values and events, sociologists have used newspaper archives as representations of how animals become problems within a culture (Jerolmack 2008). Furthermore, with the shift of human populations from rural to

**Table 20.1c** Table showing the comparison of the risk beliefs of stakeholders in Chile and Montana. Respondents indicated the number between the two words that best represented their opinion. Riley’s original 5-point scale (1998) was combined into a 3-point scale in order to be more comprehensible during oral interviews with stakeholders in Chile.

Risk statement			1&2	3	4&5	Statistic	
Encounters between pumas and people are . . .	Chile (%)	<b>Decreasing</b>	65	11	23	<b>Increasing</b>	$\chi^2 = 61.78$ $P \ll 0.0001$
	Montana (%)		12.01	17.9	69.9		
You are . . . to live with the risk associated with pumas	Chile (%)	<b>Unable</b>	22	10	68	<b>Able</b>	$\chi^2 = 4.38$ $P = 0.1117$
	Montana (%)		21.4	21.0	57.6		
The risks from pumas . . . well understood by experts	Chile (%)	<b>Are not</b>	42	30	27	<b>Are</b>	$\chi^2 = 10.302$ $P = 0.0058$
	Montana (%)		28.7	21.9	49.5		

urban environments, the role of the media (and scientists) in conveying information about a species is becoming increasingly influential.

However, common narratives do not always correlate directly with actual puma behaviour (Kellert *et al.* 1996). For example, early European and Asian settlers in North America suffered from a lack of direct and accurate knowledge about this secretive species, which they had never encountered in the Old World. Instead, their beliefs about pumas were often rooted in stories and observations related to African lions (Young and Goldman 1946; Bolgiano 1995). Perhaps no better example exists of narratives departing from biological reality than the American President and political father of conservation, Theodore Roosevelt calling pumas ‘The big horse-killing cat, the destroyer of the deer, the lord of stealthy murder—with a heart both craven and cruel.’ Later, without any apparent irony, he went on to claim that, ‘No American beast has been the subject of so much loose writing or of such wild fables as the cougar’ (Bolgiano 1995; Kellert *et al.* 1996).

To investigate how common narratives portray puma biology and behaviour we examined the representation of pumas in newspaper archives of Montana. Do certain narratives appear more frequently than others? Are particular narratives deemed more

important than others? In what direction might these narratives skew human perceptions?

In order to deepen our understanding of how newspapers portray pumas, we also compared their representation to that of other predators. Past studies suggest that where pumas are sympatric with other predators such as wolves in North America (Kellert *et al.* 1996) or jaguars in Central and South America, they are often ignored or considered culturally less important (Conforti and Azevedo 2003; S. Marchini, personal communication 2007). Kellert *et al.* (1996) argued that, ‘Perhaps strong attitudes towards mountain lions tended to develop only when wolves were not common enough to be culturally relevant.’ As evidence they cited the fact that many of the cultures that venerated pumas lived beyond the historic range of grey wolves (Mech 1981). Of the Cherokee, Creek, Chickasaw, Seminole, Zuni, and several cultures in South America that revered pumas or considered them friendly to humans (Young and Goldman 1946; Wright 1959; Barnes 1960; McMullen 1984) only the Zuni also shared their territory with wolves (Kellert *et al.* 1996). In Montana newspapers, we compared the categories of narratives written about pumas to those written about wolves. We also investigated whether pumas became more culturally relevant over a short time period when wolves were removed from the ecosystem.

**Study area**

Montana, the fourth largest state in the United States (381,156 km<sup>2</sup>), is illustrative of some of the broader principles of North American puma management. Here, in western North America (Fig. 20.1) pumas and other carnivores (such as wolves and coyotes) were historically killed under a bounty system in which hunters received payment for skins brought to authorities (Cougar Management Guidelines Working Group 2005). Since 1971, pumas have been classified as 'game species', to be hunted under a quota system. Although, puma populations are notoriously difficult to census and collecting demographic information requires intensive long-term studies (e.g., Logan and Sweanor 2001), based on (less reliable) removal records, there is speculation that puma populations in western North America have increased from historically low levels in the 1900s (Padley 1997; Riley 1998; Cougar Management Guidelines Working Group 2005). If an increase in pumas did occur, it may plausibly be attributed to an increase in the abundance of ungulate prey, which have benefited from favourable habitat conditions and conservative management (Riley 1998; Cougar Management Guidelines Working Group 2005).

In frequency and biomass, white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), and elk (*Cervus elaphus*) comprise the majority of pumas' prey in Montana (Murphy 1983; Hornocker *et al.* 1992; Williams 1992). However, their prey choice may vary with location. One study on the eastern front of the Rockies found that pumas' diet consisted of 43% deer, 27% elk, and 18% bighorn sheep (*Ovis canadensis*; Williams 1992). In another study in northern Yellowstone National Park, elk were preferred over deer (Hornocker *et al.* 1992).

Depredation of domestic sheep by pumas in Montana is low. From 1989 to 2007, on average, pumas accounted for less than 2% (542) of sheep killed by predators, whereas coyotes accounted for approximately 73% (19,726) of sheep killed and wolves for 0.6% (170; US Department of Agriculture National Agricultural Statistics Service 2008a). Since sheep holdings in Montana are typically comprised of range flocks (>500 sheep) that graze on native and unimproved farmland, puma depredation events are unlikely to have a large proportional impact on the

holdings of individual livestock owners. Domestic sheep numbers in Montana have also been on the decline (from 3,462,000 in 1940 to 265,000 in 2008; US Department of Agriculture National Agricultural Statistics Service 2008b).

Similar to pumas' depredation of sheep, their depredation of cattle is also low compared to other predators. In a 2001 study, 71.9% of calves (2300 heads) and 33.3% of cattle (200 heads) lost to depredation were attributed to coyotes, whereas <3% (100 heads) of calf losses were attributed to pumas. Losses of adult cattle to pumas and wolves experienced by livestock owners were so low as to go unrecorded by the US Department of Agriculture (US Department of Agriculture National Agricultural Statistics Service 2001). In contrast to domestic sheep, cattle numbers have been on the rise in Montana (from 1,148,000 in 1940 to approximately 2,600,000 in 2008; US Department of Agriculture National Agricultural Statistics Service 2008c).

Since 1890, there have also been one fatal and at least five non-fatal puma attacks on humans recorded in Montana. All of these attacks occurred within the last 20 years (Beier 1991; Etling 2004; Cramer 2007).

Though debate may exist over changes in puma populations, human populations in Montana unquestionably have been on the rise. During the 1990s, the mountain West was the fastest-growing region of the United States, with a population growth rate of 25.4%. Montana still has one of the lowest population densities (2.51 people km<sup>-2</sup> in 2006) in the United States; however, as it undergoes rapid urbanization the nature and localization of these populations has shifted. Cities in Montana are growing much faster than the rural population. Simultaneously, a demographic movement out of the prairie and into the mountainous regions is occurring as people are attracted to natural amenities (Riebsame *et al.* 1997; Hansen *et al.* 2002). One consequence of these changes is that natural buffers around national parks, wilderness areas, and nature reserves may be shrinking (Hansen *et al.* 2002). Another consequence of increased urbanization and shifts in demography may be an alteration in the cultural landscape and associated shifts in beliefs and attitudes towards the environment and land-use practices (Riebsame 1997; Riley 1998; Rasker *et al.* 2006).

## Methods

We collected archives from a group of editorially independent newspapers in the Montane region of Montana: the *Missoulian*, *Daily Inter Lake*, *Glendive Independent*, *Glendive Times/Ranger-Review*, *Yellowstone Monitor*, and the *Whitefish Pilot*. Each newspaper served a community in Montana ranging from approximately 5000 to 65,000 inhabitants and generally reflects local issues over national concerns. The *Missoulian* had the largest circulation of any paper sampled (32,378) and is currently Montana's third largest newspaper. The span of articles included in our analysis ranged from 1883 to 2007.

In order to develop a concept of the relative importance of particular themes to stakeholders, we classified newspaper articles into different narrative categories based on common subject matter and storylines. We then quantified the total frequency of particular narrative categories. We used frequency of appearance of a story on the front page as a proxy for the importance of specific narratives. Although this frequency may vary on any particular day based on other newsworthy events, over time we expect the narratives considered to be of greater consequence to appear more frequently on the front page. We compared the frequency of particular narratives on the front page to the frequency of articles in less prominent sections of the newspaper. The frequency of front-page puma narrative categories was also compared to the frequency of front-page wolf narrative categories. Since the frequency of articles on the inside of the newspaper exhibited right skew, we  $\log_{10}$ -transformed these data, so that they better approximated a normal distribution. The difference in frequencies was analysed using a paired *t*-test (SPSS version 16.0 for Macintosh).

To test the hypothesis that pumas become more culturally relevant when wolves are not present, we divided articles on pumas and wolves into groups, consisting of a period corresponding to pre-extirpation of wolves (1883–1930), the period post-extirpation but prior to reintroduction of wolves (1948–95), and the period following the reintroduction of wolves (1995–2007). The period post-extirpation but prior to reintroduction corresponded with a time in which wolves were almost non-existent in Montana, though pumas were still present (Riley 1998). Within this period, we compared the number

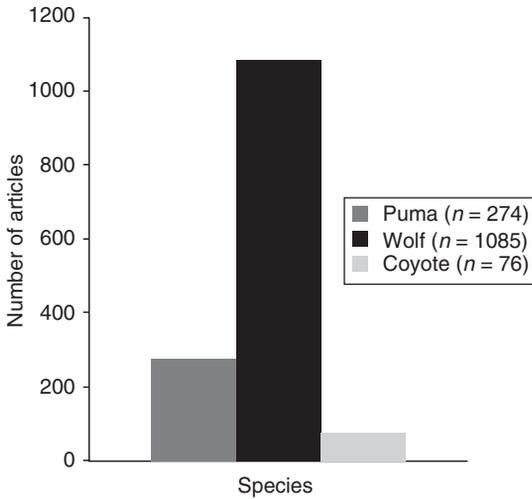
of articles about pumas to the number of articles about wolves. In our analysis, we also included the number of articles about another canid predator responsible for the majority of sheep depredation in Montana, the coyote (*Canis latrans*).

## Results

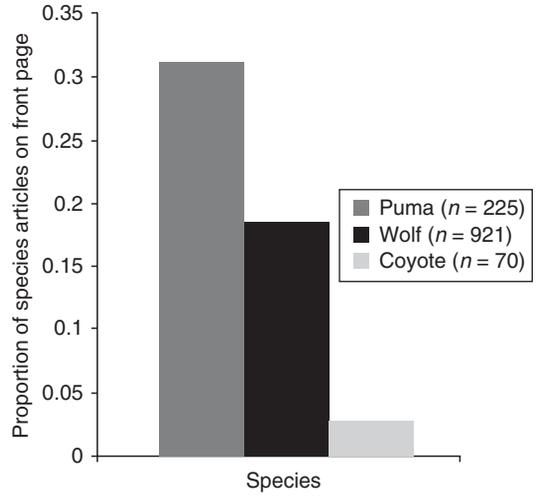
Over the entire time period analysed (1883–2007) many more articles were written about wolves (1085) than either pumas (274) or coyotes (76, Fig. 20.2a). Although, fewer articles appeared about pumas than wolves, within a subgroup for which newspaper section and page number were recorded (225) approximately 30% of the total number of articles written about pumas appeared on the front page of the newspaper. This result contrasted with the total proportion of wolf articles appearing on the front page, which was less than 20% ( $n = 921$ ) and proportion of front page coyote articles, which was 3% ( $n = 70$  Fig. 20.2b).

No difference was observed in the frequency of articles about pumas compared to wolves between the time periods of pre-extirpation and post-reintroduction ( $\chi^2 = 0.99$ ,  $P = 0.32$ ). The difference between the frequency of articles pre-extirpation and the period when wolves were absent was also not significant ( $\chi^2 = 0.39$ ,  $P = 0.53$ ). However, a significant difference was observed between the period when wolf populations were low (or non-existent) and post-reintroduction (Fig. 20.2c,  $\chi^2 = 12.86$ ,  $P = 0.0001$ ).

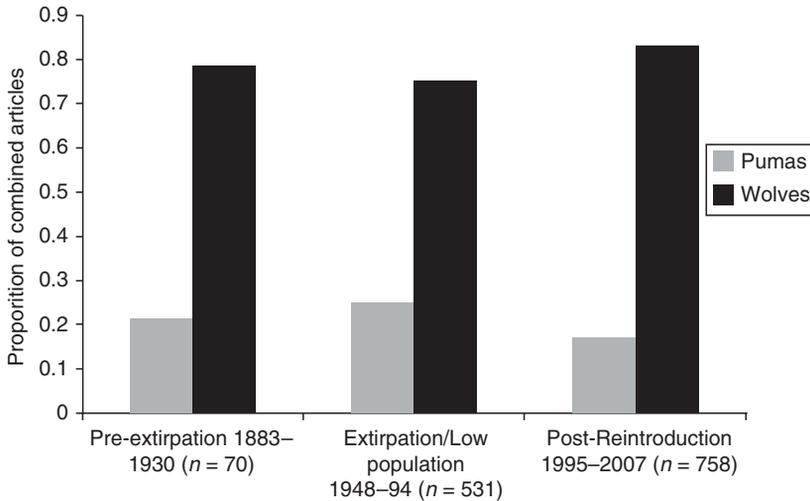
By narrative category the most prevalent articles on all pages of the newspaper relate to 'pumas killed in conflict', 'hunting and management', and 'sightings' (Fig. 20.3a). However, a comparison of the frequency of articles on front page of newspapers to articles on inside pages reveals that some of the most prevalent narrative categories are deemed significantly less important than other, much rarer, categories (Fig. 20.3b, Paired *t*-test:  $t_{12} = 13.562$ ,  $P = 0.000$ ,  $n = 12$ ). Narratives of 'conflict' and of puma attacks on humans dominate the front page, whereas stories of pumas killed in conflict (either by stakeholders or wildlife managers) tend to appear on the inside pages of the newspaper. Puma narratives on the front page also differed considerably in frequency and type from narratives about wolves on the front page (Fig. 20.3c).



**Figure 20.2a** Total number of articles appearing in six Montana newspapers (1883–2007) about three different predator species that come into conflict with humans: pumas (*Puma concolor*), wolves (*Canis lupus*), and coyotes (*Canis latrans*).



**Figure 20.2b** Proportion of total articles about a particular species that appeared on the front page of newspapers. Of the total articles written about a species, a much higher proportion of puma articles ran on the front page of the newspaper than articles about either wolves or coyotes.



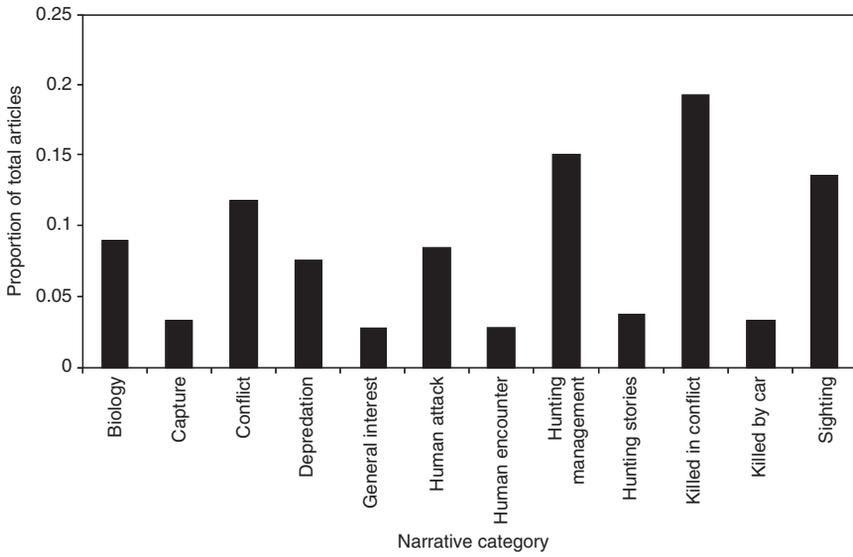
**Figure 20.2c** Frequency of articles about pumas in comparison to the frequency of articles about wolves over different time periods, which correspond to changes in wolf populations.

**Discussion**

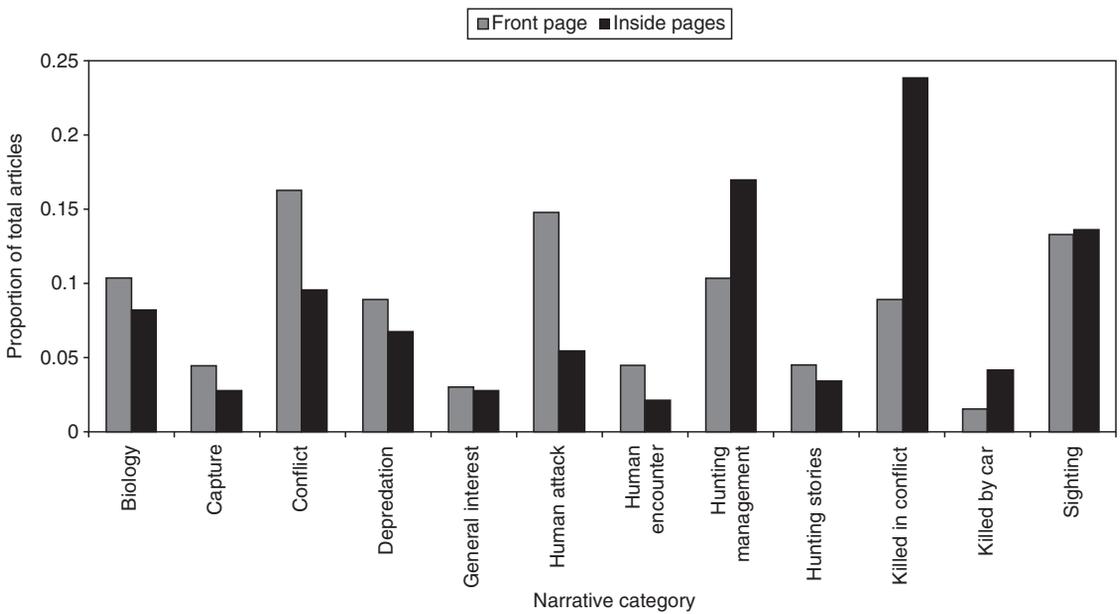
*Do second-hand sources give preference to particular narratives?*

On the front page of the newspaper dramatic narratives of conflict—such as stories ‘human encounters

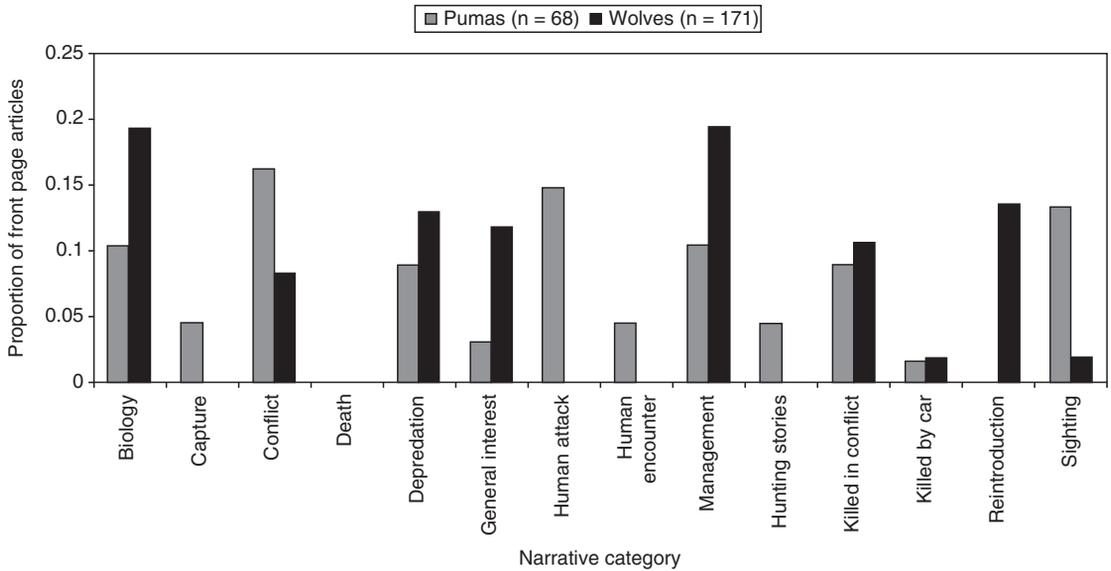
with pumas’ and ‘puma attacks on humans’—appear with significantly more frequency than articles concerning hunting and management. Articles about pumas killed in conflict are also relegated to the later pages of the newspaper. Thus, the narratives



**Figure 20.3a** Comparison between the frequency of narratives on the front page of the newspaper and the frequency of narratives on the inside pages of the newspaper. Articles were collected from the Montana archives of newspapers, for which page number was identified ( $n = 214$ ).



**Figure 20.3b** Chart showing the proportion of articles in Montana newspapers about pumas by narrative category ( $n = 214$ ).



**Figure 20.3c** Comparison between the puma narratives ( $n = 68$ ) on the front page of the newspaper and wolf narratives ( $n = 171$ ) on the front page of the newspaper. Puma narratives garnering front-page attention were dominated by conflict, human attacks, and sightings. On the other hand, wolf narratives were dominated by stories about wolf biology and management. Only one article relating to coyotes appeared on the front page (not shown here); it was about conflict.

of human–puma interaction given priority in newspapers are often fear-based stories of conflict, rather than the much commoner occurrence of puma control by wildlife authorities.

Unsurprisingly, issues of management and reintroduction were deemed culturally more important for wolves than pumas. More revealingly, a much larger proportion of wolf stories on the front page were written about their biology or for general interest than articles about pumas (e.g. ‘Wolf-watcher keeps ghostly vigil over orphaned pups,’ ‘Wolves, not bears, the rave at Yellowstone,’ and ‘Soul of the wolf’). The movement of wolves was also tracked on the front page, whereas ‘sightings’ of typically elusive pumas dominated front-page coverage. The fact that puma sightings draw attention may be of particular concern given that they are notoriously unreliable (Hamilton 2007; S. Riley, personal communication 2008). Beier and Barret (1993) describe three cases in which groups of two to five experienced witnesses with prolonged, repeated, daylight views of housecats and coyotes misidentified these animals as pumas. In both, the frequency of articles and narrative themes, newspapers selling stories of wildlife present a skewed portrayal of

pumas and may contribute to a distorted perception of pumas among North American stakeholders.

*Do pumas only gain cultural relevance when wolves are not present?*

Even during the years after wolves were mostly extirpated from the state of Montana and prior to their reintroduction (1948–94), Montana newspapers contained a much higher frequency of articles about wolves than pumas. Admittedly, during part of this period, much of the attention wolves attracted related to the raging debate over wolf reintroduction. In 1993, the Environmental Impact Statement for the reintroduction of wolves generated 160,000 public comments from 40 countries, one of the largest volumes of public comment received on a planned federal action up to that time (Bangs *et al.* 2005). The attention wolves attract may be attributed, in part, to their potency as a symbol of wilderness as well their perceived threat to ranchers (Kellert *et al.* 1996). However, the very fact that the potential benefits and costs of reintroducing wolves drew more attention than the existing threat of pumas, which were responsible for one fatal and two non-fatal attacks on humans in

Montana in the early 1990s, also reflects the extent to which pumas are often ignored. Since the frequency of puma articles in relation to wolf articles was significantly greater in the period of extirpation compared to the period of post-reintroduction, though not pre-extirpation, the hypothesis that pumas would assume greater cultural relevance when wolves were not present was only weakly supported.

Why do wolves attract such disproportionate attention in relation to pumas, even when they are not physically present? Perhaps the explanation rests, in part, with humans' ability to relate to this visible and social canid over more cryptic and solitary pumas. Human understanding and empathy for social canids is also evident in the domestication of dogs, which occurred as early as 130,000 years ago, long before the domestication of cats, approximately 9500 years ago (Wayne and Ostrander 1999; Kruuk 2002; Driscoll *et al.* 2007). However, not only was the number of articles written about wolves far greater than those written about pumas, it also far exceeded the number of articles written about another highly visible social canid species: coyotes. Although coyotes in Montana account for a disproportionate amount of cattle and sheep depredation in relation to other predators, they receive relatively little media attention compared to wolves. The fact that wolves culturally eclipse both pumas and coyotes may reflect wolves' long and layered history with humans in Old World landscapes. The relationship between wolves and the European settler of North America extends back thousands of years, whereas they have only had several hundred years of experience sharing landscapes with pumas and coyotes (Lopez 1978).

Though articles on pumas appear in newspapers far less frequently than those on wolves, a high proportion of puma interactions with humans that do appear are considered important. Perhaps, the prominence of puma articles simply reflects the tendency of newspapers to give importance to rare ('newsworthy') events. However, it may also imply that because of human cultural and psychological tendencies a much higher threshold exists for articles on pumas to appear in the newspaper than those on wolves; therefore the majority of puma interactions reported are those with the most dramatic narratives.

## Case 2: stakeholder tolerance in Chile

In Chile, only the views of stakeholders living in closest direct contact with pumas and suffering the highest costs of coexistence are relevant. Although second-hand information continues to play a role among this group it is mainly transmitted by word of mouth and is thus difficult to quantify. Most of the relevant Chilean stakeholders also claimed to have had first-hand experience with pumas. Since these stakeholders may influence population levels through their actions, it is essential to understand their tolerance for the costs of coexisting with pumas.

Decker (1994) argued that tolerance levels depend upon perceptions of what is at stake. What is at stake in turn is influenced by a host of other variables such as attitudes, beliefs, knowledge and experiences with wildlife, the aesthetic value of the referent species, the economic condition of the stakeholder, the economic dependency of the stakeholder on the resource being threatened, and stakeholders' attitudes towards management (Decker and Purdy 1988; Craven *et al.* 1992).

Our study aimed to understand the role of some of these variables in determining tolerance among Chilean livestock owners. We examined factors that our discussions with local people had indicated to be important in the Araucanía Lake Region of Chile. We investigated whether the tolerance of livestock losses was simply related to livestock holdings and other economic measures; or, whether variables such as stakeholder age or particular beliefs produce a good model for tolerance.

### Study area

Though in theory the protection of pumas may be considered an important step for their conservation, the reality is more complicated, as is illustrated at our study site in Pucón, Chile. One of the southernmost communes in the Cautín Province of the Araucanía Lake Region, Pucón covers an area of 1429 km<sup>2</sup> that due to past (and continuing) volcanic activity ranges widely in elevations (from 200 m to 3747 m). Historically, livestock has been the main industry in this area; as a result, puma depredation has always been a concern. Prior to the introduction of the *Ley de Caza*

(Hunting Law) that provided protection to pumas, livestock-owner response to depredation was simple. Darwin (1839) recorded that pumas in Chile were 'generally driven up bushes or trees, and then either shot or baited to death by dogs'. Though a minimum puma density of 2.5/100 km<sup>2</sup> has been estimated further south in the distinct ecoregion of Torres del Paine National Park (Fig. 20.1, site 6; Franklin *et al.* 1999), very little is known about puma populations and densities within the Araucanía Lake Region.

Puma diet in the Araucanía Lake Region of Chile, however, is better studied. Based on 62 scats collected opportunistically over 14 years, Rau and Jimenez (2002) have shown that 44.3% of pumas' diet consists of non-native European hares (*Lepus europaeus*), 20.2% rodents, and 19.0% native pudu (*Pudu pudu*; the world's smallest deer with an average adult weight of 8.5 kg; Iriarte *et al.* 1990). Also present, though less prevalent in puma diet were birds (5.1%) and marsupials (1.3%; Rau and Jimenez 2002). Based on this study, non-native wild boar (*Sus scrofa*) and carnivores including foxes (*Lycalopex culpaeus* and *Lycalopex griseus*), and introduced feral dogs (*Canis familiaris*), were not found in puma diet, though they are found throughout the Araucanía Lake Region. The high incidence of European hares in puma diet is a widespread phenomenon in southern South America (Yañez *et al.* 1986; Iriarte *et al.* 1990; Franklin *et al.* 1999) and Rau and Jimenez (2002) hypothesize that it results from either an increase in hare abundance or the almost complete extinction of pudus.

Domestic livestock comprised 8.9% of pumas' diet, including 5.1% goats (*Capra hircus*), 2.5% sheep (*Ovis aries*), and 1.3% cattle (*Bos taurus*; Rau and Jimenez 2002). Because their study area was dominated by uncleared forest, Rau and Jimenez (2002) suggest that livestock as a percentage of pumas' diet may have been under-represented in their study compared to other areas of the Araucanía Lake Region (e.g. Muñoz-Pedrerros *et al.* 1995). Other studies have found that areas of uncleared forest contain a greater abundance of natural prey and have lower rates of livestock depredation (e.g. Crawshaw and Quigley 2002; Polisar *et al.* 2003). However, any depredation, no matter how small, may be of considerable concern to individual livestock owners, given that commercial farms are rare and most livestock owners

have smaller holdings on which they practice traditional techniques of husbandry. In contrast to Montana, a single puma depredation event may result in the loss of a considerable proportion of an individual owner's stock.

Records of puma attacks on people in South America are sparse and have not been systematically compiled, as they have in North America. Darwin (1839) reported hearing of two men and one woman killed by pumas. In modern times only one fatal attack has been documented in Chile: a fisherman was killed by a puma, in 1998, in Torres del Paine National Park (Franklin *et al.* 1999).

Currently, a shift is occurring from agriculture and animal husbandry to tourism, logging, and salmon farming in the Araucanía Lake Region. This shift is part of a larger trend in which natural habitat is converted into a more urban landscape that is threatening biodiversity throughout Chile and the Americas (Pauchard *et al.* 2006). Of the total population of 14,532 people in Pucón, approximately 8023 are urban dwellers and 6509 rural dwellers (45% of the population). Pucón's population density, of 10.16 km<sup>2</sup>, is higher than that of Montana.

Most of this population is concentrated in privately owned lowland forest areas, which have been cleared and fragmented and are under threat from logging, environmental degradation, and pressure from heavy tourism during certain parts of the year. National Parks and National Protected Areas (SNASPE) in the Araucanía Lake Region contain 80% of the remaining stands of araucaria (monkey-puzzle) trees and are located primarily above the winter snowline (approximately 1100 m above sea level, though as low as 800 m during harsh winters). As a result, these areas may provide insufficient winter range for pumas (and their prey). However, there is an absence of evidence to underpin the creation of new protected areas.

In the face of potential habitat limitations, the protection of pumas may increase conflict and lead to stronger negative perceptions of pumas among local stakeholders. Not only do livestock owners bear the economic costs of puma depredation, but also if they retaliate against pumas they are at risk of suffering legal consequences such as a heavy fine or prison term. If, on the other hand, stakeholders report puma depredation events to the Agriculture and

Livestock Service (SAG), the outcome for both human and puma interest is less certain. Upon receiving a depredation report, SAG's standard protocol has been to attempt to capture and translocate all pumas in the area. From 1991–2001, SAG captured 23 pumas in the Araucanía Lake Region and released them into protected areas. Of this group, 12 pumas were released into Conguillío National Park, an area with 256 km<sup>2</sup> of potential habitat, 8 pumas were released into Villarrica National Park (460 km<sup>2</sup>) and 1 puma each was released into the National Reserves, Malleco (139 km<sup>2</sup>), Malalcahuello (57 km<sup>2</sup>), and Alto Bio-Bio (39.55 km<sup>2</sup>, Fig. 20.4).

Nothing is known of the outcome of these expensive and time-consuming translocations. One hypothesis is that translocating so many pumas to protected areas with limited habitat is tantamount to killing them. A study in the San Andres Mountains of New Mexico showed that the survival rates of translocated pumas was lower than that of pumas in reference populations and that a translocated puma may travel as much as 494 km to return to the site of original capture (Ruth *et al.* 1998). Studies have also revealed that conflicts with carnivores recur in the same locations even after removal of a few individuals (Evans 1983). Currently, SAG feels it has few options in the management of puma-human conflict, and lacks the economic resources to study it, an issue to which our project is intended to contribute data and discussion.

## Methods

We used questionnaires to assess stakeholder beliefs and perceptions of the extent of conflict. We collected baseline data on perceptions of past puma depredation, seasonality of depredation events, and methods employed to prevent livestock losses. Based on local market value, the following cost per head estimates were applied in US dollars: horses \$320, cattle \$230, sheep \$50, goat \$50, swine \$60, and fowl \$5. We also assessed stakeholder opinions of current management policies of the Agricultural and Wildlife Services (SAG). Tolerance was measured following the index established by Romañach *et al.* (2007), asking respondents how many sheep they were willing to lose per year without killing the predator responsible. Variables such as number of live-

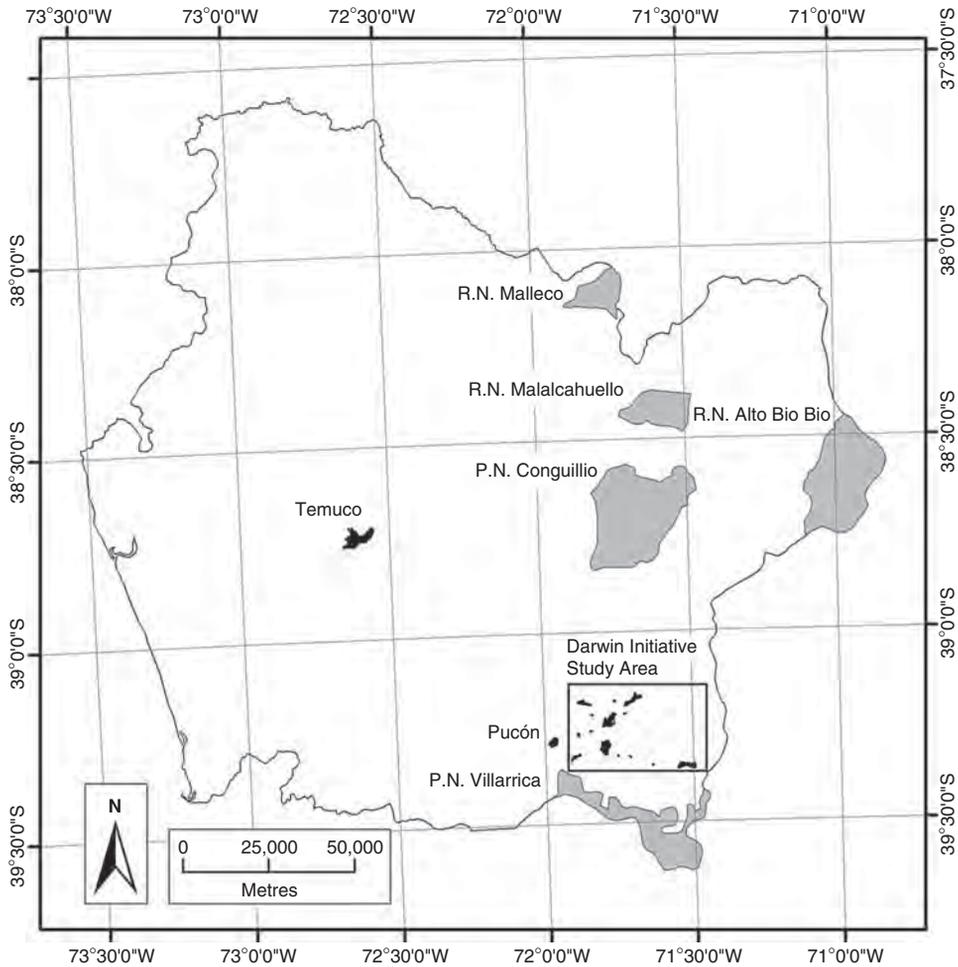
stock, sheep holdings as a percentage of total capital base, depredation history, stakeholders' age, and beliefs were tested for correlation with the index of tolerance. Since the dependent variable (tolerance) was not normally distributed, we used a nonparametric correlation test (Spearman's Rho).

A regression model was developed to explain tolerance. Because few livestock owners were willing to accept the loss of more than one sheep, we used a binary logistic regression. To meet the model's requirements categorical variables were transformed into dummy variables. All variables were selected *a priori* and tested individually in the logistic regression before being included in the model. The variables tested in the model were stakeholders' age, current number of sheep, whether stakeholders had suffered puma depredation in the past 10 years, whether stakeholders enjoy having pumas, and finally, whether stakeholders worried about the problems that pumas might cause. The best model was selected based on fit. Spearman's Rho correlations were also used to determine whether particular kinds of involvement appeared linked to belief statements. All analysis was carried out in SPSS (version 16.0 for Microsoft).

## Results

Overall, the sheep-holdings of stakeholders in the Araucanía Lake Region ranged from 3 to 120. On average, stakeholders owned 17 sheep (*Ovis ares*, SE = 2.25), 4 goats (*Capra hircus*, SE = 1.25), 8 cows (*Bos taurus*, SE = 1.18), 1 horse (*Equus caballus*, SE = 0.15), 23 fowl (SE = 2.95), and 1 pig (*Sus scrofa domestica*, SE = 0.29). Of these holdings, approximately 8% of sheep and lambs, 7% of goats, and less than 0.5% of cattle and calves were reported lost to pumas. Approximately 4% of sheep and lambs and less than 1% of cattle were also reported lost to feral dogs. Less than 0.5% of sheep and lamb losses were attributed to foxes (Fig. 20.5a).

Almost 50% of stakeholders were willing to accept the loss of  $\geq 1$  sheep but  $< 4$  to pumas per year without seeking retribution against pumas (Fig. 20.5b). The mean number of sheep stakeholders were willing to lose per year was under one (0.79, SE = 0.122). However, 5% of stakeholders were willing to lose three sheep per annum. The percent of total sheep

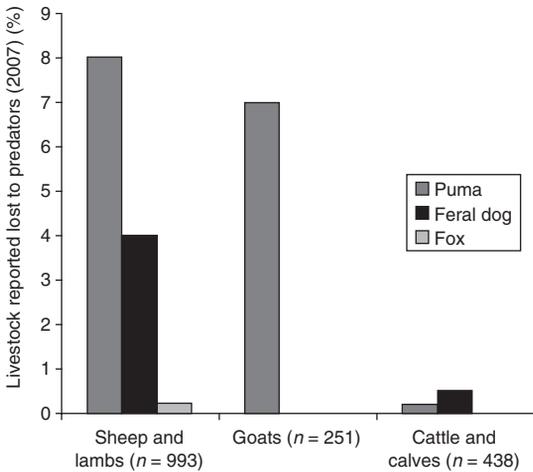


**Figure 20.4** Map of study area in Chile, showing the location and size of surrounding national parks (P.N.) and national reserves (R.N.) where pumas have been translocated in the past. © Robert Petitpas.

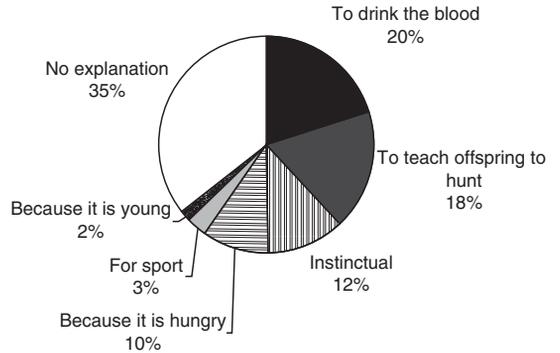
holdings such a loss represented varied. The highest proportion of total holdings a stakeholder was willing to tolerate losing was 100%; however, this was an exceptional case in which total holdings were small ( $n = 2$ ). On average, tolerant stakeholders were willing to lose approximately 15% (SE = 2.5) of their total sheep holdings to pumas per annum, without seeking retribution. Though many stakeholders tolerated the loss of one sheep per year, all of those interviewed believed that pumas may attack more than one sheep in a single depredation event. They offered predominantly two explanations for this behaviour: pumas killed numerous sheep to drink

their blood or in order to teach their young to hunt (Fig. 20.5c).

Tolerance was strongly correlated with stakeholders' age (Fig. 20.6a; Spearman's correlation:  $-0.331$ ,  $N = 58$ ,  $P = 0.011$ ), the extent that livestock owners worry about the problems that pumas might cause (Spearman's correlation:  $-0.366$ ,  $N = 58$ ,  $P = 0.005$ ), and whether they enjoyed the existence of pumas (Spearman's correlation:  $0.280$ ,  $N = 58$ ,  $P = 0.034$ ). A binary regression model containing these three independent variables provided the best fit for the dependent variable of how many sheep losses livestock owners would tolerate in a year



**Figure 20.5a** Percent of livestock reported lost to different species during 2007. Livestock owners reported considerably fewer attacks on cattle than on sheep. Though reported losses give an indication of the total percent of livestock lost to each predator, depredations by pumas and feral dogs are difficult to distinguish and may be conflated.

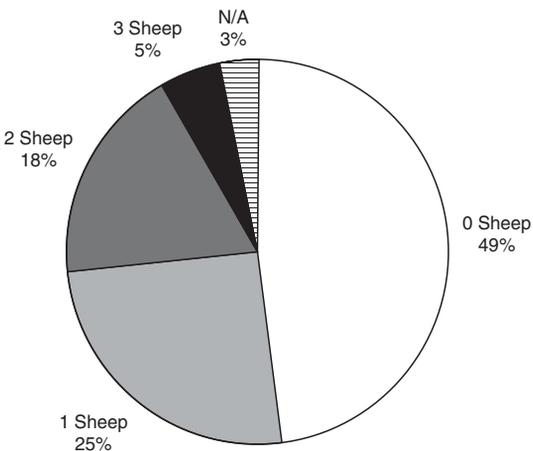


**Figure 20.5c** One hundred percent of livestock owners (n = 60) believe that pumas attack >1 sheep in a single depredation event, and this chart shows the most common reasons they proposed to explain this behaviour. Of stakeholders who offered an explanation, the majority believed that pumas attack >1 sheep to drink their blood or in order to teach their young to hunt.

(Binary regression:  $F_{1,58}$ ,  $\chi^2 = 12.926$ , Nagelkerke  $R^2 = 0.2665$   $P = 0.009$ ).

Whether stakeholders had previously suffered puma depredation had little bearing on tolerance (Binary regression:  $F_{1,58}$ ,  $\chi^2 = 0.140$ , Nagelkerke  $R^2 = 0.003$ ,  $P = 0.708$ ). The number of sheep owned by a stakeholder did not explain tolerance (Binary regression:  $F_{1,58}$ ,  $\chi^2 = 1.010$ , Nagelkerke  $R^2 = 0.023$ ,  $P = 0.315$ ). The total economic value of sheep-holdings as percentage of the total value of livestock holdings also was not linked to tolerance (Binary regression:  $F_{1,58}$ ,  $\chi^2 = 0.019$ , Nagelkerke  $R^2 = 0.000$ ,  $P = 0.890$ ).

The greatest proportion of Chilean stakeholders liked having pumas, but worried about the problems they might cause (Fig. 20.6b). Stakeholders' tendency to worry about the problems pumas may cause was negatively correlated with whether they believe the existence of pumas near their house increased their quality of life (Spearman's correlation:  $-0.328$ ,  $N = 60$ ,  $P = 0.010$ ). Also, whether a stakeholder worried about the problems pumas may cause was positively correlated with whether a stakeholder had read or heard of a person being attacked by a puma (Spearman's correlation:  $0.311$ ,  $N = 60$ ,  $P = 0.040$ ). A positive correlation existed between stakeholder enjoyment of having pumas and their belief that the presence of pumas is a sign of a



**Figure 20.5b** Number of sheep losses livestock owners are willing to accept per year without seeking retribution against pumas. Almost 50% of stakeholders are willing to accept  $\geq 1$  sheep but <4 lost to pumas per year. The mean number of sheep stakeholders were willing to lose per year was under 1 ( $0.79 \pm 0.122$ ). This measure was used as a proxy for tolerance.

as six sheep; while stakeholders with smaller holdings rarely tolerated the loss of more than one sheep. However, variation in sheep holdings among stakeholders in Chile was much lower than between commercial farmers and community members in Kenya (Romañach *et al.* 2007).

The relationship between tolerance and age, with older stakeholders exhibiting less tolerance for pumas, is consistent with the findings of other studies (Fig. 20.6a). For example, in a study of jaguar–human conflict in the Pantanal of Brazil, Zimmerman *et al.* (2005a) found that respondents >60 years old held more negative views towards jaguars than younger respondents. Williams *et al.* (2002b) observed a similar trend for stakeholders in relation to wolves. They suggest that '[n]egative attitudes associated with age are probably a cohort effect, and we should not expect the aging populations in the United States and Europe to lead to more negative wolf attitudes'. Whether values are different in younger age cohorts of Chilean stakeholders as the result of more diverse educational opportunities or different priorities is difficult to determine (and our study was not designed to investigate this relationship). Increasing opportunities in urban areas, and in tourism may also lead younger generations to place less value on livestock holdings. Another possible explanation for age-related differences in tolerance is that older stakeholders have a different baseline for conflict. Most stakeholders claim that puma encounters were higher in the past than they are currently. Perhaps older stakeholders recollect a higher rate of encounter and therefore perceive that pumas pose a considerable threat to their livestock and livelihood.

Beliefs about pumas appear to play a greater role in whether livestock holders are willing to tolerate losses than economic concerns. We found that both, whether stakeholders enjoy having pumas *and* worry about the problems they may cause, were significant factors in our model explaining tolerance of livestock losses. Since most stakeholders enjoy having pumas and like the existence of pumas in their country but not near their house, these worries need to be addressed. Often Chilean stakeholders were ambivalent about their beliefs in relation to pumas (Fig. 20.6b) and justified their continued tolerance of pumas with more philosophical statements, such as 'Dios

los dejó en la Tierra' (God put them on Earth) or 'Siempre han existido' (They've always been here).

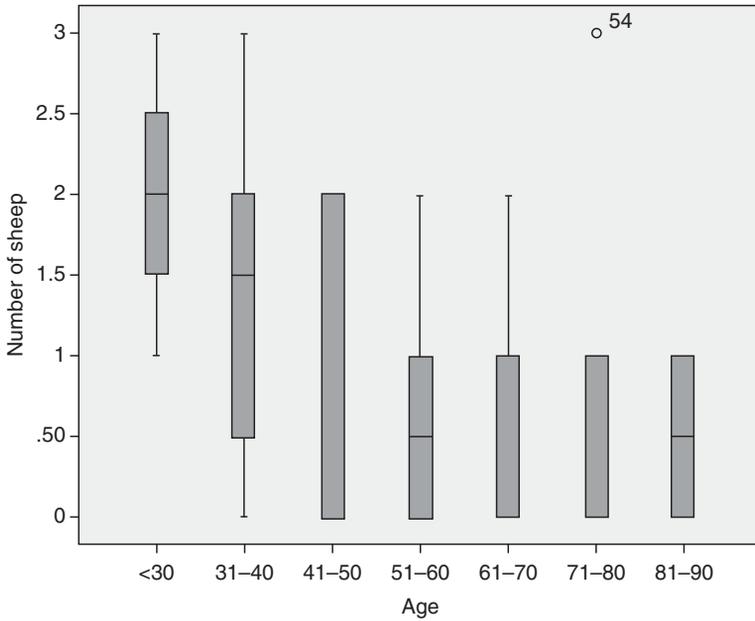
## Conservation conclusions

### What role can management play in increasing tolerance of pumas?

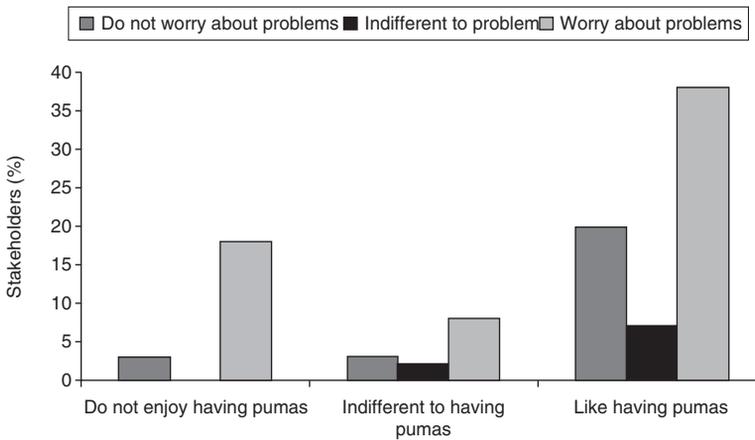
Macdonald and Sillero-Zubiri (2004b) observed that some problems associated with human–wildlife conflict cannot just be talked out of existence. In situations where reserves are unlikely to be expanded to provide better biological 'savings accounts' and stakeholders must coexist with pumas, good management will likely be the tipping point for tolerance. To be effective, management cannot just take into account the ecological requirements of a species. It must be calibrated contextually and developed in collaboration with stakeholders.

Management of conflict should be directed towards the problems that have been identified as most critical based on surveys of stakeholders. For example, of the livestock owners interviewed in Chile none was willing to accept the loss of more than three sheep a year (worth approximately US \$150 and representing 18% of average ovine capital and approximately 7% of average total capital base). Yet all stakeholders in Chile reported that pumas are capable of killing more than three sheep in a single night, and believed that they often do. This behaviour, known as surplus killing (Kruuk 1972), is close to universal among carnivores (and is associated with food caching and other means of using the opportunistic additional kills; Macdonald 1976). Among felids it has been reported in lynx (*Lynx lynx*; Odden *et al.* 2002) and leopards (*Panthera pardus*; Sangay and Vernes 2008).

Not only could surplus killing decimate livestock holdings within a single night, but Chilean stakeholders also struggled to understand these events and created intensely negative narratives to explain their occurrence. Most commonly, the reason stakeholders offered for surplus killing was that pumas drank the blood of the sheep or were teaching their young to hunt (Fig. 20.6a). These explanations portray pumas as either bloodthirsty creatures (similar to the mythical 'chupacabra') or animals that use the



**Figure 20.6a** Association between age and the number of sheep livestock stakeholders were willing to lose without seeking retribution against pumas. Stakeholders >40 years old tolerated fewer livestock losses per year than those in lower age brackets.



**Figure 20.6b** Relationship between liking of the presence pumas and worrying about the problems they might cause. The greatest proportion of Chilean stakeholders enjoys having pumas, but worries about the problems they might cause.

healthy environment (Spearman’s correlation: 0.464,  $N = 60$ ,  $P = 0.000$ ).

Only 5% of livestock owners interviewed in Chile were willing to call the Agricultural and Wildlife Services (SAG) in the event of depredation. The most common explanation (58% of stakeholders) offered for not calling SAG was ‘no vale la pena’ (it was not worth the trouble). Forty-three percent of stakeholders said that they had heard of a puma being killed in the area.

**Discussion**

*What economic conditions and social beliefs increase tolerance of the costs of coexisting with pumas?*

The total number of sheep owned by stakeholders did not have bearing on their tolerance of losses. Nor did the economic value of sheep holdings as a percentage of the value of stakeholders’ total holdings affect tolerance. This trend differed from Romanach *et al.*’s findings (2007) that stakeholders with large holdings were willing to tolerate the loss of as many

livelihood of livestock owners in order to train their offspring how to attack and kill prey. A key factor in improving perceptions and increasing the likelihood of tolerance of pumas will be to focus on reducing the amount of surplus killing through management practices. In order to achieve this goal, it is crucial to investigate and verify cases of surplus killing, especially considering that feral dogs may also be responsible for these events, though pumas receive the blame (Nicolás Gálvez, personal communication 2008). A further important area of investigation will be to determine whether management practices have an effect on the number of stock killed per depredation event.

Simultaneously, better management has the potential to improve stakeholders' perceptions of wildlife authorities. Most Chileans have heard that wildlife managers release pumas near livestock holdings (Table 20.1a). As a result, they believe that wildlife authorities do not understand the risk associated with living in proximity to pumas and are unwilling to call authorities in the event of depredation. Therefore, better management in Chile may involve the allocation of funds currently used in translocation to test other solutions (e.g. guard dogs, covered corrals or, as a last resort, lethal control).

### **How can education shape future human values?**

Better management of pumas may limit livestock losses and improve the efficiency of husbandry practices; however, as long as pumas and people inhabit the same areas, some level of depredation will likely occur. The risk pumas pose to human safety can also be reduced by providing empirically based information about appropriate behaviour in the case of an encounter (e.g. Beier 1991); however, it will never be eliminated completely. Therefore, conservation biologists have no choice but to seek to understand and promote beliefs that lead to a landscape of tolerance.

To achieve tolerance, compensation schemes have been employed by conservationists throughout the world with mixed success (Nyhus *et al.* 2005). However, this approach may not be suitable for livestock owners in the Araucanía Lake Region with limited

holdings, since we found that beliefs played a greater role in the tolerance of minor losses than economics. In their study of conflict between jaguars and livestock owners in Brazil, Cavalcanti *et al.* (Chapter 17, this volume) demonstrated a similar disjunction between economics and killing jaguars: the intent to kill was only loosely linked with depredation on livestock. Though both studies approach the issue of conflict from different perspectives, they illustrate the importance of the stakeholder's value system. Whether stakeholders intend to kill felids regardless of losses or whether they tolerate losses without seeking retribution, they are hoping to 'win' relative to their own value system, not relative to pumas or jaguars.

Perhaps, the best recourse available to influence culture and value systems is education. Since stakeholder involvement with pumas may vary greatly, education campaigns must be targeted towards the particular concerns and preoccupations of different groups. Macdonald and Sillero-Zubiri (2004b) also suggest that the education that is appropriate in the developed world may differ from what is appropriate in the developing world.

For those living in close proximity to pumas beliefs are influential, as evidenced by the fact that in Chile those who enjoyed having pumas in the area were more tolerant of livestock losses. Also, whether stakeholders enjoyed having pumas was positively correlated with the belief that the presence of pumas was a sign of a healthy environment. However, for those who must coexist in close proximity to pumas highlighting shared benefits or positive qualities of pumas is certainly not enough; combating worries and negative perceptions must also be a part of education. Accurate information about the risks of puma attack as well as measures for preventing livestock predation may help allay fears. To ensure that depredation is not misattributed to pumas, it is essential that stakeholders in Chile are provided with information about distinguishing puma kills from feral dog kills. Thus, wildlife managers must also be good communicators, whose role is to provide practical education that empowers stakeholders to improve husbandry and identify the animal responsible for depredation events.

Education directed at more urbanized groups, less directly involved with pumas, must combat the most common fears and misperceptions associated with this

species. Willingly or not, conservation biologist and wildlife managers have no choice but to deal with the media. Therefore, knowing the cultural relevance of a species and human narrative tendencies related to it is essential. In the face of such tendencies and concerns for human safety, managers are responsible for creating messages to reassure the public. Presenting scientific facts, data, or analysis in the form of anecdote may increase the appeal of the message (Hamilton 2007). For example, in Montana one approach towards education may be to publish stories of human–puma interactions in which attacks did not occur or examples of ‘sightings’ of pumas that were proven to be housecats, dogs, or other animals. Here, again, managers should function as educators. If they are to have success in communicating their message they must be viewed by the public as both a reliable source for information about pumas and the first recourse in dealing with problems related to pumas.

In the future, this form of education and the presentation of scientific fact in an appealing and engaging manner will likely become increasingly relevant as the nature of human–puma conflict comes to reflect areas such as Montana. The trend towards greater urbanization is already occurring; in 2007, for the first time in history, the majority

of people in the world were living in towns and cities, rather than rural areas (UN-Habitat 2006). In this changing landscape, only by developing a deeper understanding of human values and tendencies may conservationists foster the management strategies and cultural values under which the existence of pumas is both a tenable and tolerable option for stakeholders.

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