

# Andean bear–livestock conflicts: a review

Isaac Goldstein<sup>1,7</sup>, Susanna Paisley<sup>2</sup>, Robert Wallace<sup>3</sup>, Jeffrey P. Jorgenson<sup>4,8</sup>,  
Francisco Cuesta<sup>5</sup>, and Armando Castellanos<sup>6</sup>

<sup>1</sup>Wildlife Conservation Society Venezuela Program, Edificio General Masini,  
Piso 3 Avenida 4 entre Calles 18 y 19, Mérida, Venezuela

<sup>2</sup>Durrel Institute of Conservation and Ecology, University of Kent, Canterbury, Kent CT2, England

<sup>3</sup>Wildlife Conservation Society Bolivia Program, Casilla 3-35181, San Miguel, La Paz, Bolivia

<sup>4</sup>Wildlife Conservation Society Ecuador Program, Casilla 17-21-168, Quito, Ecuador

<sup>5</sup>Fundación Ecuatoriana de Estudios Ecológicos (EcoCiencia), Casilla 17-12-257, Quito, Ecuador

<sup>6</sup>Fundación Espíritu del Bosque, Barcelona 311 y Tolosa, Quito, Ecuador

**Abstract:** We review the state of knowledge regarding conflicts between the Andean bear (*Tremarctos ornatus*) and livestock. Information was gathered from the current known geographic range of the species (Venezuela, Colombia, Ecuador, Peru, and Bolivia). Andean bears are perceived as livestock predators where herding is common; bears are frequently blamed for any livestock disappearance or death. This negative perception often leads to the poaching of Andean bears by local residents and to a disregard of protected areas and conservation efforts. We found no systematic documentation of conflicts in any Andean country. Carcass dragging, feeding signs, and presence of tree and ground nests were common features of livestock depredation sites. Direct observation of cattle depredation by Andean bears was reported at 3 sites in Colombia and Ecuador. No seasonal or cyclic patterns of depredation were discerned, and evidence suggested that bear–livestock conflicts were restricted to particular sites and involved problem bears. The conservation of Andean bears requires research on rapid ways of dealing with problem bears, as well as mitigation techniques designed to reduce perceived and actual conflicts between bears and livestock.

**Key words:** Andean bear, Bolivia, Colombia, conflict, depredation, Ecuador, livestock, management, Peru, spectacled bear, *Tremarctos ornatus*, Venezuela

*Ursus* 17(1):8–15 (2006)

Livestock depredation is a significant problem wherever livestock and predator distributions overlap (Kharel 1997, Sekhar 1998, Stein 2000). When livestock depredation occurs, local residents may have to invest significant resources to protect their property, and frequently they come to oppose wildlife conservation (Hill 1997). In extreme cases they may even seek to extirpate potentially damaging wildlife (Conover 1994). As a result of human-induced mortality and the destruction of bear habitat throughout the world, bear populations have diminished or become locally extinct in many areas (Servheen 1999, Mattson and Merrill 2002).

Even though global bear populations today are only a fraction of what they were in the past, livestock-based conflicts continue to be a problem wherever bears and livestock coexist. Even small populations of bears can cause significant damage to livestock. For example, the western Cantabrian brown bear (*Ursus arctos*) population in Spain, estimated at 50–60 individuals, was attributed with depredation resulting in 1,076 claims for damage compensation between 1973 and 1990 (García-Gaona et al. 1993). There are also recent reports of bear–livestock conflicts in the Austria, Bulgaria, Canada, China, Finland, France, Greece, India, Italy, Japan, Mexico, Norway, Poland, Romania, Russia, Slovakia, Sweden, Spain, United States, and the former Yugoslavia (Servheen et al. 1999).

Until the early 1990s, the only readily available information about conflicts between Andean bear (*Tremarctos ornatus*) and livestock were second-hand, anecdotal data gathered by researchers where Andean

<sup>7</sup>igoldstein@wcs.org

<sup>8</sup>Present address: US Fish and Wildlife Service, Endangered Species Program, Sacramento Fish and Wildlife Office, 2800 Cottage Way, Suite W-2605, Sacramento, CA 95825, USA.

bears occur (Mondolfi 1971, 1989; Peyton 1980). These reports were treated as part of local bear folklore, and chroniclers frequently commented on the exaggeration of the meat-eating behavior of the Andean bear. This perceived exaggeration was mainly due to studies that documented the Andean bear diet as primarily vegetarian and composed of terrestrial and epiphytic Bromeliaceae plants, Bambusaceae shoots, and fruits of Lauraceae and Moraceae plants (Mondolfi 1971, 1989; Peyton 1980; Suárez 1989). Nevertheless, livestock have been reported as a component of Andean bear diet in Venezuela (Mondolfi 1971, Goldstein 1991a), Colombia (Rodríguez 1991, Poveda 1999), Ecuador (Suárez 1989), Peru (Peyton 1980), and Bolivia (Rumiz et al. 1997a,b; Paisley 2001).

Bear–human conflict studies subsequently have evolved to include information on attacks and feeding sites (Goldstein 1991a, Castellanos 2002, Galasso 2002), their geographic extension (Paisley 2001, Jorgenson and Sandoval 2005), the intensity of damage inflicted (Poveda 1999, Paisley 2001, Galasso 2002), and human perceptions of the conflict (Torres et al. 1995). The documentation of Andean bear–livestock conflicts was based on interviews with residents and subsequent visits to depredation sites. In most cases, researchers arrived at conflict areas weeks after the last depredation event, when only data related to carcass feeding behavior could be collected (Goldstein 1991a, Poveda 1999, Paisley 2001). Indirect evidence such as bear tracks and scats, repeated cattle deaths at particular sites, signs of struggle surrounding carcasses, and the ending of cattle disappearances after an Andean bear death supported the bear depredation hypothesis. A lack of direct observational or solid forensic evidence, however, did not eliminate the possibility of a bear scavenging interpretation. Reports by Castellanos (2002) and Galasso (2002), however, described Andean bears being observed attacking cattle and linked these attacks to the types of wounds observed on surviving cattle after a presumed Andean bear attack. Andean bear–livestock conflicts are a poorly understood problem that is becoming an important wildlife management issue in 5 Andean countries.

The main objective of this paper is to review the state of our knowledge regarding Andean bear–livestock conflicts by (1) summarizing information on cattle depredation across the Andean bear distribution, (2) characterizing depredation events and describing known conflict areas, and (3) describing strategies used to reduce cattle depredation. Through this analysis we aim to highlight information gaps, identify key research

priorities, and propose actions required to develop or improve husbandry and management guidelines to avoid or reduce Andean bear–livestock conflicts in the future.

This paper is a synthesis of findings from our work on the bear–cattle conflicts along with information from other sources. It is problematic that studies thus far have not used common methodologies. We have dealt with this by examining all available data first by country, then by the thematic groupings which arose from our analysis. Based on patterns and our collective experiences, we developed research and management priorities.

This work covers the entire Andean bear distribution along the 3 ranges of the Andes, from the Cordillera de Mérida and Perijá in Venezuela, south to the Argentina–Bolivia border (Peyton 1999).

## Andean bear conflicts reports

There is no systematic long-term documentation of Andean bear–livestock conflicts by any governmental or non-governmental organizations (NGOs). Reports on bear–livestock conflicts generally have been compiled incidental to other short-term studies. The lack of medium or long-term data on Andean bear–livestock conflicts makes it extremely difficult to discern conflict patterns or identify successful practices that might be applied to other areas to reduce bear–livestock conflicts.

Andean bear–livestock conflict information has mainly been collected by researchers and by representatives of national and local NGOs. Efforts to synthesize conflict information have been made in Venezuela (Goldstein 1991a) with countrywide field surveys, Colombia (Jorgenson and Sandoval 2005) with an interview survey, and Bolivia (S. Paisley, unpublished data) within the framework of a national Andean bear workshop. Locally, new approaches to the collection of Andean bear–livestock conflict data have been initiated by an alliance of local NGOs and provincial environmental offices, such as Fundación Wii and Chingaza National Park in Colombia, and Wildlife Conservation Society–Bolivia Program and the Apolobamba Protected Area in Bolivia (Gomez et al. 2002).

Data gathered from national surveys provide limited and descriptive information about the temporal and spatial distribution of conflicts. However, for many of these surveys, the interviewees who occupied relevant wildlife and protected area management positions had their offices in cities far from the areas where the conflicts occurred. In addition, the turnover in personnel in governmental positions is high, resulting in limited institutional memory concerning wildlife–livestock issues. Moreover, in many cases, officials lack basic

information about wildlife–livestock conflict, so relevant details are not collected when depredation incidents are reported.

The level of public awareness about bear–livestock conflicts has recently improved as many national parks and protected wilderness areas have been declared in Andean countries (Peyton 1999). Even though these protected areas almost invariably have small budgets and few park wardens, protected area authorities are often viewed by the local residents as being answerable for wildlife conflict arising within or adjacent to protected areas (Paisley 2001). As a result, during the past few years and despite the limited ability of government officials to respond effectively, complaints about livestock depredation and crop destruction by wildlife—including bears—increasingly are filed with appropriate government officials at several locations (Poveda 1999, Paisley 2001, Galasso 2002).

### Carcass feeding and depredation sign

In Venezuela, Goldstein (1991a, 2002) visited numerous sites where bear–livestock conflicts had been reported. Bear and cattle tracks related to carcass-feeding always started in an open *páramo* (open high altitude Andean grasslands) area near a tract of forest. The carcass was frequently dragged into forest cover, usually a forested ravine, where feeding occurred. The carcass typically was moved 3–8 times within the forest from one feeding site to another until it was completely consumed. Bear scats, tree nests, ground beds, and cattle bones were frequently found at or near the feeding sites. Feeding sites were often connected by clearly visible bear trails.

Carcass dragging and feeding behaviors were also observed in Colombia (Poveda 1999), Ecuador (Castellanos et al. 2001, Castellanos 2002), and Bolivia (Paisley 2001, Goldstein 2002). Exceptions to this pattern were reported in Venezuela (Goldstein 2002) and Ecuador (F. Cuesta, unpublished data), where carcass feeding was documented at cliffs in open *páramo* areas. Density of tree nests or ground beds associated with carcass feeding was often quite high, and more than 10 tree nests or ground beds have been found frequently within 100 m of a feeding site (Goldstein 1991a,b, 2002; Poveda 1999; Castellanos 2002).

The first direct observation of Andean bear attack on cattle and subsequent feeding on a carcass was made in 1997 by park warden E. Reinoso at Rio Blanco, Chingaza National Park, Colombia (C. Lora, Director, Chingaza National Park, personal communication, 2002). Subsequent observations were made in Ecuador

(Castellanos 2002; Galasso 2002; F. Cuesta, unpublished data). Cattle wounds noted from attacks were consistent with injuries described from other bear species (Mysterud 1973, Wade and Browns 1985, Acorn and Dorrance 1990) and with wounds observed on cattle presumably attacked by Andean bears in Colombia (E. Payan Garrido, Instituto Humboldt, Villa de Leyba, Colombia, personal communication, 2003). Bite and claw marks were also clearly visible on the head, neck, and rump of cattle that had been attacked at Cosanga, Ecuador (Castellanos 2002). In September 2003, near Chaupiloma at the Oyacachi River Valley, biologists S. Espinosa and L. Aigaje observed a bear feeding on a live, immature bull that presented deep wounds on the rump (H. Parion, cattle owner, Oyacachi, Ecuador, personal communication, 2003). These observations confirmed earlier reports of livestock depredation by Andean bears.

Cattle carcasses on which bears have fed are easily identified by experienced personnel due to characteristics that are fairly constant across countries and common to other bear species. However, unless witnesses arrive upon the scene shortly after depredation occurs, it is difficult to distinguish between depredation and scavenging. Typically, researchers arrive at conflict areas weeks after the last depredation, when the only evidence left was that related to carcass feeding behavior (Goldstein 1991a, Poveda 1999, Paisley 2001). Even though indirect evidence such as bear tracks, bear scats, repeated cattle deaths at particular sites, signs of struggle surrounding carcasses, and the end of cattle disappearances after an Andean bear death in an area suggest depredation, the lack of solid evidence leaves open the possibility of scavenging (Acorn and Dorrance 1990).

### Public perception of the Andean bear as predator

People who live far from conflict areas often view large carnivores such as Andean bears as charismatic symbols of wilderness (Jacobson 1995). To these *ex situ* residents, the Andean bear is generally seen as a non-aggressive vegetarian animal, and complaints about conflicts or cattle depredation are often viewed as a ruse by complainants to gain benefits or justify the killing of bears. To such a mindset, environmental education campaigns featuring the Andean bear are the best way of rectifying the bear's undeserved bad reputation.

People who live in areas where cattle are unattended in the mountain pastures for weeks at a time often perceive Andean bears as cattle predators (Goldstein 1991a, Poveda 1999, Paisley 2001, Figueroa and

Stucchi 2002). To these *in situ* residents cattle losses are often automatically attributed to bear depredation. Bears in those areas can be perceived as pests that should be killed as a preventive measure. Even in localities with no recent history of bear–cattle conflicts, as soon as a problem develops and bears are associated with the disappearance of cattle, the formerly positive perception is reversed and bears become subject to persecution and poaching (Castellanos 2002, Galasso 2002). Typically, however, researchers find that the perceived conflict is greater than the real conflict (Torres et al. 1995).

### Spatio-temporal patterns of conflicts

During 1986–89 and 1996–2000, Goldstein (1991a, 2002) investigated claims of cattle depredation by Andean bears in 140 Venezuelan villages. Only 12 localities reported cattle depredation by bears during the first survey, and of these only 7 reported new cattle depredation during the follow-up survey (Goldstein 1991a, 2002). This evidence suggests that cattle depredation problems were restricted to certain areas such as Chingaza National Park, Colombia (Poveda 1999) and Apolobamba Protected Area, Bolivia (Paisley 2001). Moreover, if cattle were the preferred prey for Andean bears in general, as is the case with the western Cantabrian brown bear population in Spain (García-Gaona et al. 1993), we would have expected cattle losses in the Andes to be greater than those reported. We need only consider the quantity of livestock present in the extensive herding grounds in the Andean *páramos* (Molinillo and Monasterio 1997) and the overlap of those herding grounds with the distribution of the Andean bear. Cattle are clearly not a preferred prey item; livestock appears in the Andean bear diet only at specific localities and times (Goldstein 1991a, 2002).

Based on information from areas that reported bear–livestock conflicts in the Venezuelan Andes, Goldstein (1991a) reported an interval of 6–12 years between periods with high levels of bear–livestock conflicts. Seasonal as well as annual variation in conflicts were reported by the residents of Santa Ana and La Ciénaga in Venezuela (Goldstein 2002), areas surrounding Chingaza National Park in Colombia (Poveda 1999), and at localities surrounding Pelechuco in Bolivia (Paisley 2001, Nallar et al. 2003). No seasonality or time cycle was reported at Cosanga or Oyacachi, Ecuador (Castellanos 2002).

### Problem bears

Anecdotal information about predatory bears in Venezuela, Colombia, Ecuador, Peru, and Bolivia always

presumes that a so-called problem bear—generally an adult male—was exclusively responsible for livestock depredation. After the removal or disappearance of the problem bear, depredation usually stopped, thus confirming the problem bear hypothesis, until a new problem bear appeared. For example, during the first Venezuelan national survey (Goldstein 1991a), 34 cattle depredation claims were investigated, and in 23 cases the depredation events were reported to have stopped after the removal of a single male bear.

Similar evidence exists for other sites. At Cosanga, Ecuador, a large male bear was supposedly responsible for a series of depredations and was poached (A. Castellanos, unpublished data). Before that animal was killed, however, several other bears—males and females—were also poached (Castellanos 2002, Galasso 2002) until the “right” bear was killed. Also in Ecuador, a big male bear was poached at Oyacachi during a sheep depredation spree in 2001. The depredations in Oyacachi stopped, but only for about one year.

!Although we lack data to support the evidence that males are most frequently involved in Andean bear–cattle conflicts, anecdotal data coincides with the general trend of males being overrepresented among carnivores shot or trapped following depredation events (Linnell et al. 1999).

### Environmental and husbandry factors

At all localities except 1 in Venezuela (Goldstein 1991a, 2002) and 1 in Bolivia (Paisley 2001) where bear–livestock conflicts were reported and cattle carcass feeding by bears was studied, similar livestock management practices were implemented. In those *páramo* or *puna* areas, small herds of cattle (5–30 animals) of young or unproductive individuals were usually left unguarded in high elevation pastures at great distances (more than 5 hours walk) from any permanent human dwelling or settlement. The cattle were visited every 3–4 weeks and given salt. Cattle under these management practices suffered high mortality, and their carcasses were usually left to rot. This practice obviously invites scavenging of this protein-rich food source by opportunistic omnivores like bears. Within those *páramo* and *puna* areas, the sites where bear–livestock conflicts occurred were mainly located at the grassland–forest ecotone, far from human settlement. However, at Páramo Los Torres, Trujillo State, Venezuela, conflicts were reported at grazing near inhabited houses at least 8 km away from any tract of forest (Goldstein, unpublished data).

In Ecuador, bear–livestock conflicts locations presented a much greater diversity than in Venezuela or Bolivia. At the Oyacachi river basin, bear–cattle conflicts were reported at sites with the same remote, forest edge, low-input husbandry pattern as described in Venezuela and Bolivia. The observed bear–sheep conflicts, however, took place at areas near the town of Oyacachi (P. Aigaje, local resident, Oyacachi, Ecuador, personal communication, 2003). Moreover, at the Cosanga River Watershed, bear–cattle conflicts occurred at intensive grazing areas in a very patchy environment of pastures and open areas interspersed with forest (Castellanos 2002, Galasso 2002).

### Conflict management strategies

Livestock owners who have conflicts with Andean bears tend to deal with the problem on their own, by guarding their cattle, moving cattle to a different site for a period of time, or attempting to kill the “problem” bear. Even though in most cases killing bears is illegal, most frequently people killed bears indiscriminately in the conflict area until cattle losses ceased (Goldstein 1991a, Castellanos 2002, Galasso 2002). Clearly this strategy is detrimental to a species considered vulnerable to extinction such as the Andean bear (IUCN 2004). At some sites local residents also mentioned community drives throughout the countryside to detect and kill large carnivores (Nallar et al. 2003).

Contemporary management strategies used throughout the world to help people coexist with large carnivores include 3 main approaches: eliminating specific problem animals, improving livestock management practices including anti-predator measures, and providing compensation for livestock losses (Mishra 1997). Of these strategies, only elimination of problem animals has been tried in the Andes. This is normally carried out illegally, but involvement of authorities have been documented in Ecuador and Bolivia. In Ecuador, A. Castellanos was commissioned by the Ministry of the Environment to trap and relocate an offending bear at the Cosanga Basin. However, people from the community poached the bear before Castellanos could trap it. In Bolivia, at Cordillera de Tiraquein in the Department of Cochabamba, personnel of the Forestry Development Office killed an adult male in 1990 because it allegedly attacked cattle (Rumiz and Salazar 1999).

This sort of response should be taken seriously if we are to learn from a North American example in which a policy of protecting problem grizzly bears (*Ursus arctos*) led to the illegal destruction of more animals

than if problem bears had been removed as soon as they were identified (Meagher and Fowler 1989). When problems involving a few individuals are not resolved rapidly and effectively, animosity on the part of community members may increase to include all bears and protected areas (Tilson and Nyhus 1998). In the case of the Andean bears, innocent as well as problem bears have been poached by livestock owners seeking to protect their herds (Castellanos 2002, Galasso 2002).

Victim compensation is an option when an endangered species with a restricted distribution is the source of the conflict (Linnell et al. 1999, Mishra 1997). To our knowledge this has not been implemented in Latin America. However, even costly compensation programs do not always reduce conflicts, lower animosity levels, or prevent poaching (Ciucci and Boitani 1998). Moreover, under certain conditions compensation may encourage permanent conflict (Van Eerden 1990).

Modification of husbandry and grazing practices can also be effective in reducing depredation of livestock by large carnivores (Cozza et al. 1996; Linnell et al. 1999; Smith, et al. 2000a,b; Ogada et al. 2003). Traditional, extensive herding in the *páramos* and *punas* will be difficult to eliminate. Because of its low operation costs, livestock that are reared in the highlands represents a financial reserve for local residents (Molinillo and Monasterio 1997). To reduce conflicts, some herders move cattle to safer herding areas (Venezuela and Ecuador), place guards in herding areas (Venezuela), or use firecrackers as repellents (Bolivia). However, these actions are not economically sustainable in the mid- or long-term, and bear–livestock conflicts frequently recur. Nevertheless, other practices developed to protect livestock from carnivores (Smith et al. 2000a,b; Andelt 2001) could be tried in the Andes.

### Recommendations

The principal mortality factor in many endangered bear populations is human-inflicted death resulting from human–bear conflict (McLellan et al. 1999, Pease and Mattson 1999). This is likely true for some Andean bear populations as well (Peyton 1999, Rodriguez et al. 2003), and strategies to reduce conflict between Andean bears and people are needed to improve the viability of Andean bear populations.

This review highlights the need for more in-depth ecological and sociological information to better understand Andean bear–livestock conflicts. For example: Which areas are more prone to conflicts? What is the intensity of the problem? What age and sex classes of

bears are involved? What is the area of influence of a problem animal? When do conflicts normally occur? How does this depredation behavior develop in individual bears? What factors are associated with higher tolerance of bears in conflict areas? How can the control of problem bears be brought under the auspices of the conservation authorities? We recommend the following priority research and management actions.

First, what are the most important factors (livestock densities, herding practices, lack of wild food resources, distance to forested areas, etc.) that trigger cattle depredation by Andean bears? This information is needed to focus our attention on areas prone to develop Andean bear–cattle conflicts. Second, we need to understand the extent and location of predatory and scavenging behaviors of the Andean bear to develop realistic management strategies.

The systematic collection of conflict reports by government authorities would provide baseline information. To this end, efforts must be made to inspect conflict sites as soon as the conflict is reported and to compile detailed information in a systematic manner (Jorgenson and Sandoval 2005). A depredation inspection manual could help inspectors and residents identify the predator involved, collect data in a methodical manner, and determine the nature and extent of the problem.

At the same time, we have to start developing and testing practical and effective improvements to livestock husbandry practices appropriate for *páramo* and *puna* areas. In addition, more research into the causes of natural cattle mortality and better veterinary assistance to address them could increase resident tolerance of bears, and hence reduce poaching.

Introduced livestock are far more numerous than native livestock throughout the range of the Andean bear, and abandoning introduced livestock altogether is not plausible. In some regions of Ecuador, Peru, and Bolivia, however, people could be encouraged to resume husbandry of camelids in place of the introduced cattle, sheep, and horses. Camelids, such as llamas have many biological and ecological advantages over sheep and cattle in terms of adaptations to the *puna* environment (Fjeldsa and Kessler 1996). Evidence suggests that camelids carcasses are not attractive to scavenging Andean bears (Paisley 2001).

Any proposed Andean bear control actions should be applied to problem bears. Research is needed to determine how problem bears develop, as well as to rapidly identify them. Remote cameras and genetic markers may provide answers to these questions, although the time

required for these techniques to be adequately developed may preclude this technology as a short-term solution.

We also need to understand the relationship between the conflict extent and intensity and people's perception of such conflicts, including how perceptions of conflicts develop and change both locally and regionally and within groups of people. Moreover, we need to understand and quantify the economic cost and effects of depredation to ranchers and affected communities.

Finally, it is vital that all parties be treated as equal partners when developing tools and strategies to cope with Andean bear–livestock conflicts. A partnership between residents, scientists, and administrators would give much-needed credibility to management strategies, as all parties would share equally in the success or failure of the partnership. If we fail to establish a sense of mutual trust and understanding, we risk creating a situation where rural residents perceive conservation actions as another punitive land-use measure imposed on them by governments and environmental groups who they already distrust and resent (Kellert 1994). Clearly a positive and proactive strategy is indicated, taking into account local needs and perceptions, if we are to achieve long-term conservation of the Andean bear and its habitat.

## Acknowledgments

Andean bear research and human–animal conflict studies and management in the region were made possible through support from the following agencies and institutions: The Center for Environmental Research and Conservation (CERC), Department of International Development Program of the British Embassy in Quito, MacArthur Foundation, Schweitzer Foundation, The Nature Conservancy, US Agency for International Development, and the Wildlife Conservation Society. The opinions expressed here represent the authors and do not necessarily reflect any financing agencies or institutions. We also thank those who helped in the field and with office work: C. Aigaje, H. Aigaje, L. Aigaje, P. Aigaje, V. Aigaje, H. Gomez, V. Guerrero, R. Marquez, A. Morales, R. Nallar, L. Parion, B. Rios, and H. Ticona. We thank the personnel and the permission from the Bolivian Protected Area Service (SERNAP).

## Literature cited

- ACORN, R.C., AND M.J. DORRANCE. 1990. Methods of investigating predation of livestock. Alberta Agriculture, Edmonton, Alberta, Canada.

- ANDELT, W.F. 2001. Effectiveness of livestock guarding animals for reducing predation on livestock. *Endangered Species UPDATE* 18(4):182–185.
- CASTELLANOS, A., M. ALTAMIRANA, AND G. TAPIA. 2001. Ecología y comportamiento de Osos Andinos reintroducidos en la Reserva Biológica Maquipucuna, Ecuador: Implicaciones en Conservación. UKUKU, Boletín Informativo sobre la Conservación del Oso Andino Año 3(2). (In Spanish.)
- . 2002. Ataques de oso Andino a ganado vacuno en la Cuenca del Río Cosanga, Ecuador. UKUKU, Boletín Informativo sobre la Conservación del Oso Andino, Año 4(1). (In Spanish.)
- CIUCCI, P., AND L. BOITANI. 1998. Wolf and dog depredation on livestock in central Italy. *Wildlife Society Bulletin* 26: 504–514.
- CONOVER, M.R. 1994. Perceptions of grass-roots leaders of the agricultural community about wildlife damage on their farms and ranches. *Wildlife Society Bulletin* 22:94–100.
- COZZA, K., R. FICO, M.L. BATTISTINI, AND E. ROGERS. 1996. The damage–conservation interface illustrated by predation on domestic livestock in central Italy. *Biological Conservation* 78:329–336.
- FIGUEROA, J., AND M. STUCCHI. 2002. Situación del oso Andino en el santuario histórico de Machu Picchu y zonas adyacentes, Cusco-Perú. Proyecto FANPE, Cooperación Técnica Alemana (GTZ), Proyecto Oso Andino-Perú, Lima, Perú. (In Spanish.)
- FJELDSA, J., AND M. KESSLER. 1996. Conserving the biological diversity of *Polylepis* woodlands of the highland of Peru and Bolivia: a contribution to sustainable natural resource management in the Andes. NORDECO, Copenhagen, Denmark.
- GALASSO, L. 2002. The spectacled bear's impact on livestock and crops and use of remnant forest fruit trees in a human altered landscape in Ecuador. Thesis, University of Wisconsin, Madison, Wisconsin, USA.
- GARCIA-GAONA, J.F., E. ROY, AND J.C. BLANCO. 1993. Daños del oso en la Cordillera Cantábrica. Pages 288–309 in J. Naves and G. Palomero, editors. *El oso pardo en España*. Colección Técnica, ICONA, Madrid, Spain. (In Spanish.)
- GOLDSTEIN, I. 1991a. Spectacled bear predation and feeding behaviour on livestock in Venezuela. *Studies on Neotropical Fauna and Environment* 26:231–235.
- . 1991b. Are spectacled bear's tree nests feeding platforms or resting places? *Mammalia* 55:433–434.
- . 2002. Spectacled bear–cattle interactions and tree nest use in Bolivia and Venezuela. *Ursus* 13:369–372.
- GÓMEZ, H., R. NALLAR, A. MORALES, H. TICONA, J. QUISBERT, AND A. BARRERA. 2002. Evaluación del impacto por depredación de animales silvestres sobre el ganado doméstico en la comunidades de la Segunda Sección Municipal de Curva, Prov. Bautista Saavedra, Área Natural de Manejo Integrado Nacional Apolobamba. Informe inédito, Programa Paisaje, WCS-Bolivia, La Paz, Bolivia. (In Spanish.)
- HILL, C.M. 1997. Crop-raiding by wild vertebrates: The farmer's perspective in an agricultural community in western Uganda. *International Journal of Pest Management* 43:77–84.
- IUCN. 2004. 2004 IUCN Red List of threatened species. International Union for Conservation of Nature and Natural Resources, Cambridge, UK. <http://www.iucnredlist.org>, accessed 30 August 2005.
- JACOBSON, S. 1995. *Conserving wildlife: International education and communication approaches*. Columbia University Press, New York, New York, USA.
- JORGENSEN, J.P., AND S. SANDOVAL. 2005. Andean bear management needs and interactions with humans in Colombia. *Ursus* 16:108–116.
- KELLERT, S.R. 1994. Public attitudes towards bears and their conservation. *International Conference on Bear Research and Management* 9(1):43–50.
- KHAREL, F.R. 1997. Agricultural crop and livestock depredation by wildlife in Langtang National Park, Nepal. *Mountain Research and Development* 17(2):127–134.
- LINNEL, J.D.C., J. ODDEN, M.E. SMITH, R. AANES, AND J.E. SWENSON. 1999. Large carnivores that kill livestock: do “problem individuals” really exist? *Wildlife Society Bulletin* 27:698–705.
- MATTSON, D.J., AND T. MERRILL. 2002. Extirpations of grizzly bears in the contiguous United States, 1850–2000. *Conservation Biology* 16:1123–1136.
- MCLELLAN, B., F. HOVEY, R. MACE, J. WOODS, D. CARNEY, D. GILBEAU, W. WAKKINEN, AND W. KASWORM. 1999. Rates and causes of grizzly bear mortality in the interior mountains of British Columbia, Alberta, Montana, Washington, and Idaho. *Journal of Wildlife Management* 63:911–920.
- MEAGHER, M., AND S. FOWLER. 1989. The consequences of protecting problem grizzly bears. Bear–people conflicts: a symposium on management strategies. Northwest Territories Department of Renewable Resources, Yellowknife, Northwest Territories, Canada.
- MISHRA, C. 1997. Livestock depredation by large carnivores in the Indian Trans-Himalaya: conflict perception and conservation prospects. *Environmental Conservation* 24:338–343.
- MOLINILLO, M., AND M. MONASTERIO. 1997. Pastoralism in paramo environments: practices, forage, and impact on vegetation in the Cordillera of Mérida, Venezuela. *Mountain Research and Development* 17(3):197–211.
- MONDOLFI, E. 1971. El oso frontino (*Tremarctos ornatus*). *Defensa de la Naturaleza*, 1(2):31–35. (In Spanish.)
- . 1989. Notes on the distribution, habitat, food habits, status and conservation of the spectacled bear (*Tremarctos ornatus*) in Venezuela. *Mammalia* 53:525–544.
- MYSTERUD, I. 1973. Bear management and sheep husbandry in Norway, with a discussion of predatory behaviour significant for evaluation of livestock losses. *International*

- Association for Bear Research and Management 4: 233–241.
- NALLAR, R., H. ARANIBAR, AND A. MORALES. 2003. Evaluación del impacto por depredación de animales silvestres sobre el ganado doméstico en la comunidades de la Segunda Sección Municipal de Pelechuco, Prov. Bautista Saavedra, Área Natural de Manejo Integrado Nacional Apolobamba. Informe inédito, Programa Paisaje, WCS-Bolivia, La Paz, Bolivia. (In Spanish.)
- OGADA, M.O., R. WOODROFFE, N.O. OGUGE, AND L. FRANK. 2003. Limiting depredation by African carnivores: the role of livestock husbandry. *Conservation Biology* 17: 1521–1530.
- PAISLEY, S. 2001. Andean bears and people in Apolobamba, Bolivia: culture, conflict and conservation. Dissertation, Durrel Institute of Conservation and Ecology, University of Kent, Canterbury, UK.
- PEASE, C.M., AND D.J. MATTSON. 1999. Demography of the Yellowstone grizzly bears. *Ecology* 80:957–975.
- PEYTON, B. 1980. Ecology, distribution, and food habits of spectacled bears, *Tremarctos ornatus*, in Perú. *Journal of Mammalogy* 61:639–652.
- . 1999. Spectacled Bear Conservation Action Plan. Pages 157–198 in C. Servheen, S. Herrero, and B. Peyton, compilers. Bears—status survey and conservation plan. IUCN/SSC Bear and Polar Bear Specialist Groups. IUCN, Gland, Switzerland and Cambridge, UK.
- POVEDA, J. 1999. Interacciones ganado-oso en límites de 5 municipios con el Parque Natural Chingaza: una aproximación cartográfica. Tesis de Grado Pontificia Universidad Javeriana, Bogotá, Colombia. (In Spanish.)
- RODRÍGUEZ, E.D. 1991. Evaluación y uso del hábitat natural del oso andino *Tremarctos ornatus* (F. Cuvier, 1825) y un diagnóstico del estado actual de la subpoblación del Parque Nacional Natural de las Orquídeas, Antioquia, Colombia. Tesis de Grado. Universidad Nacional de Colombia, Facultad de Ciencias, Departamento de Biología, Bogotá, Columbia. (In Spanish.)
- RODRÍGUEZ, D., F. CUESTA, I. GOLDSTEIN, A.E. BRACHO, L.G. NARANJO, AND O.L. HERNANDEZ. 2003. Estrategia Ecorregional para la Conservación del Oso Andino en los Andes del Norte. WWF Colombia, Fundación Wii, Ecociencia, and Wildlife Conservation Society, Cali, Columbia. (In Spanish.)
- RUMIZ, D., C. EULERT, AND R. ARISPE. 1997a. Situación del Oso Andino (*Tremarctos ornatus* Cuvier) en los Parques Nacionales Amboro y Carrasco, Bolivia. Memorias del III Congreso Internacional sobre Manejo de Fauna Silvestre en la Amazonia, Santa Cruz de la Sierra, Bolivia. (In Spanish.)
- , ———, AND ———. 1997b. Estado actual del conocimiento y prioridades de conservación del Oso Andino (*Tremarctos ornatus* Cuvier) en Bolivia. Memorias del Taller realizado dentro del marco del III Congreso Internacional sobre Manejo de Fauna Silvestre en la Amazonia, Santa Cruz de la Sierra, Bolivia. (In Spanish.)
- , AND J. SALAZAR. 1999. Status and management of the spectacled bear in Bolivia. Pages 164–168 in C. Servheen, S. Herrero, and B. Peyton, compilers. Bears—status survey and conservation plan. IUCN/SSC Bear and Polar Bear Specialist Groups. IUCN, Gland, Switzerland and Cambridge, UK.
- SEKHAR, N.U. 1998. Crop and livestock depredation caused by wild animals in protected areas: the case of Sariska Tiger Reserve, Rajasthan, India. *Environmental Conservation* 25(2):160–171.
- SERVHEEN, C. 1999. Status and management of grizzly bear in the lower 48 United States. Pages 50–54 in C. Servheen, S. Herrero, and B. Peyton, compilers. Bears—status survey and conservation plan. IUCN/SSC Bear and Polar Bear Specialist Groups. IUCN, Gland, Switzerland and Cambridge, UK.
- , S. HERRERO, AND B. PEYTON. 1999. Bears—status survey and conservation plan. IUCN/SSC Bear and Polar Bear Specialist Groups. IUCN, Gland, Switzerland and Cambridge, UK.
- SMITH, M.E., J.D.C. LINNELL, J. ODDEN, AND J. E. SWENSON. 2000a. Review of methods to reduce livestock depredation. I: Guardian animals. *Acta Agriculturae Scandinavica Section A – Animal Science* 50:279–290.
- , ———, ———, AND ———. 2000b. Review of methods to reduce livestock depredation. II: Aversive conditioning deterrents and repellents. *Acta Agriculturae Scandinavica Section A – Animal Science* 50:304–315.
- STEIN, J.T. 2000. From extermination to reintroduction: a snapshot of North American large carnivore conservation at the millennium. Thesis, Yale School of Forestry and Environmental Studies, New Haven, Connecticut, USA.
- SUAREZ, L. 1989. Seasonal distribution and food habits of the spectacled bear (*Tremarctos ornatus*) in the highlands of Ecuador. *Studies on Neotropical Fauna and Environment* 23(3):133–136.
- TILSON, R., AND P. NYHUS. 1998. Keeping problem tigers from becoming a problem species. *Conservation Biology* 12: 261–262.
- TORRES, D., A. LOBO, R. ASCANIO, AND G. LOBO. 1995. Monitoring the spectacled bear (*Tremarctos ornatus*) populations in the watershed of the Capaz River, Mérida State, Venezuela. *MEMORIA Sociedad de Ciencias Naturales La Salle* 143:25–40.
- VAN EERDEN, M.R. 1990. The solution of goose damage problems in the Netherlands, with special reference to compensation schemes. *Ibis* 132:253–261.
- WADE, D.A., AND J.E. BROWNS. 1985. Procedures for evaluating predation on livestock and wildlife. Texas Agricultural Extension Service, San Angelo, Texas, USA.

Received: May 15, 2004

Accepted: November 8, 2005

Associate Editor: R. Harris