

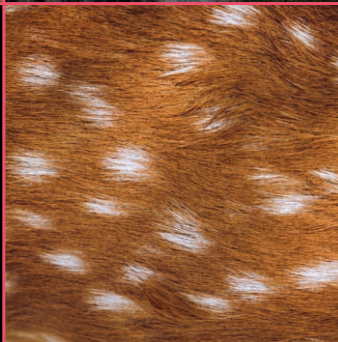


SAREM Series A  
Mammalogical Research  
Investigaciones Mastozoológicas

VOLUME 3

# INTRODUCED INVASIVE MAMMALS OF ARGENTINA

## MAMÍFEROS INTRODUCIDOS INVASORES DE ARGENTINA



Alejandro E. J. Valenzuela, Christopher B. Anderson, Sebastián A. Ballari and Ricardo A. Ojeda, EDITORS

**The Argentine Society for the Study of Mammals** (Sociedad Argentina para el Estudio de los Mamíferos – SAREM) was created in 1983, and currently has about 300 members from several countries. SAREM is an interdisciplinary society of natural sciences professionals whose main goals are the promotion of scientific and technical research, the consolidation of national collections and research centers, and the publication and diffusion of research on living and/or extinct mammals. SAREM has organized scientific meetings for mammal researchers since 1994, publishes the journals *Mastozoología Neotropical* and *Notas sobre Mamíferos Sudamericanos*, and has edited books on the systematics, distribution and conservation of the mammals of southern South America, including *Libro Rojo de los mamíferos amenazados de la Argentina* (first ed. 2000, second ed. 2012) and *Mamíferos de Argentina. Sistemática y distribución* (2006), as well as contributing to the *Libro Rojo de los mamíferos y aves amenazados de la Argentina* (currently out of print).

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**SAREM Series A**  
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Introduced invasive species are a major driver of local to global environmental change, including important negative impacts on biodiversity, ecosystem processes, economies, health and other social values. At the same time, however, different social actors can hold diverse representations of these species, particularly of introduced invasive mammals (IIMs). Such divergent values and perceptions can lead to conflicts regarding the management of IIMs, but also invite researchers and managers to be reflexive regarding their own work at a more fundamental level. Therefore, it is key that we advance towards a holistic understanding of IIMs and develop strategies to manage them based on solid technical information and plural perspectives regarding their multiple values. Despite a rich history of initiatives in Argentina to study and manage IIMs, until now there has not been an opportunity to assess the state-of-the-art knowledge in our country. This book seeks to provide rigorous, relevant and legitimate information to support research, policymaking and management decisions regarding IIMs in Argentina. With this objective in mind, the book presents a series of chapters selected to highlight priority topics concerning the conceptualization and implementation of IIM research and management. Then, fact sheets are provided for the different IIMs found in Argentina. Finally, beyond the realm of academic inquiry, the timing of this publication is ideal to re-enforce policy and decision-making, such as the recently approved National Invasive Exotic Species Strategy, which seeks to implement actions and enhance institutional capacities related to invasive species management in Argentina, and the Convention on Biological Diversity's new Global Biodiversity Framework, which also addresses biological invasions as part of broader efforts to attain the 2050 Vision for Living in Harmony with Nature.

Dr. Alejandro E.J. Valenzuela  
Dr. Christopher B. Anderson  
Editors, Vol. III SAREM Series A

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## FOREWORD

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Biological invasions by introduced species are one of the great changes rapidly transforming the globe today, with innumerable impacts on economics, human health, ecosystem services, and biodiversity. Mammals are among the most impactful of invasive species, transmitting diseases to humans, livestock, and native animals, trampling native grasslands, voraciously devouring vegetation from groundcover to saplings of forest trees, fouling water, causing erosion, and preying on and outcompeting native animals. They were among the first species humans introduced worldwide and in Argentina, both deliberately (*e.g.*, livestock) and inadvertently (*e.g.*, rats and mice). They have been introduced for sport (*e.g.*, deer, boar) and companionship (*e.g.*, cats, dogs), or simply as attractive ornamentals (*e.g.*, squirrels). Some that are meant to be kept in captivity, such as cats, dogs, and squirrels, escape and establish feral populations.

Argentina looms large in the history of biological invasions by introduced mammals. The earliest permanent European settlers of Buenos Aires in 1580 discovered huge herds of feral horses already on the pampas, and soon after, Vázquez de Espinoza described feral horses in Tucumán that were “in such numbers that they cover the face of the earth...”. Many sheep were in Tucumán as well at that time, and of course later sheep were enormously numerous in Patagonia, effecting huge changes in the vegetation and driving land degradation and desertification to this day. When Charles Darwin visited the La Plata region in 1832 during the voyage of the *Beagle*, he reported that “...countless herds of horses, cattle, and sheep, not only have altered the whole aspect of the vegetation, but they have almost banished the guanaco, deer and ostrich. Numberless other changes must likewise have taken place; the wild pig in some parts probably replaces the peccari; packs of wild dogs may be heard howling on the wooded banks of the less-frequented streams; and the common cat, altered into a large and fierce animal, inhabits rocky hills.”

Approximately 40 mammals have been introduced to South America, of which 25–30 have established populations; most of these are in the Southern Cone. In Argentina, I count 23 successfully introduced mammal species, including feral cats, dogs, and cows. Many, such as rats, rabbits, boar, and goats, are widely distributed around the world. By contrast, the hairy armadillo has been introduced nowhere else but from the mainland of Patagonia to Tierra del Fuego Island. Strikingly, except for the rats and house mouse, all these mammals were brought to Argentina deliberately; this is very different from, say, introduced insects. A few of these invasive mammals, like the squirrel, were not intended to be released, but I hesitate to term such invaders truly “accidental,” because the people who brought them should have realized that escapes or later releases were almost inevitable. Of course, almost all of these mammals were introduced before the late twentieth century, which was when most scientists and the public began to recognize the extent and importance of impacts of introduced species. However, the squirrel and armadillo introductions were recent enough that potential impacts should have been foreseen. Things could be worse, of course—mammals deliberately brought to Argentina that either were released, but did not establish persistent populations or have not yet escaped from hunting preserves include reindeer, silver fox, mule deer, African buffalo, white-tailed deer, Père David’s deer, thar, barbary sheep, wisent, mouflon, chamois, and ibex.



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The technology of eradicating introduced invasive mammals has made enormous strides in the last thirty years—at least 31 mammal species have been eradicated from islands worldwide, including relatively large islands like South Georgia. Both Norway and ship rats have been eradicated hundreds of times, and house mice about 100 times. Most large mammals, such as deer and horses, are technologically easier eradication targets—many can simply be tracked and shot, for instance. However, mammals more than any other introduced species pose the complication that many people—especially hunters—simply do not want to eradicate them, and many animal welfare advocates, even those recognizing the damage some invaders cause, object to eradicating them by the only currently feasible means—killing them, humanely if possible. Even rat eradication has been impeded on animal rights/animal welfare grounds, and free-ranging dog and cat populations frequently are seen more as animal welfare issues than as conservation problems to broad sectors of some societies. In Argentina, the problem of implementing feasible eradication programs for invasive mammals is epitomized by the rather schizophrenic attitude taken by the National Parks Administration (Administración de Parques Nacionales—APN) towards red deer. The APN's conservation imperative is supported by the section of Law #22,351 that forbids propagating introduced animals, yet red deer, known to damage native species and ecosystems, are managed in Lanín National Park to foster ongoing hunting, and even to improve the size and quality of the deer for better hunting trophies. Additionally, there is often inconsistent and inadequate funding for managing and eradicating invasive mammals in protected areas, almost always constituting a supervening impediment even when a rational and effective goal is stated.

Argentine scientists have participated heavily in the rapid growth of modern invasion science since its inception in the 1980s, and they and overseas colleagues have conducted substantial research on the biology and impacts of many of the introduced invasive mammals in Argentina, as well as other invasive species. Some of the threats posed by these mammals have even become widely known to the general public in Argentina and beyond—the spread of the beaver from Tierra del Fuego to the mainland has been an international news story. *Introduced Invasive Mammals of Argentina* is therefore an exciting and timely addition to the literature on invasions in southern South America for both the Argentine public (and its political representatives and environmental managers) and scientists worldwide. The many authors assembled for this book explore how these biological invasions happened in the first place, how they spread, what they do to biodiversity, ecosystems, and human enterprises, what has been done about them so far, what can be done about them now, and what might be done with them in the future. The editors and authors are to be congratulated for an excellent exposition of the Argentine part of a growing global phenomenon.

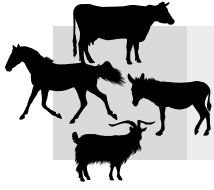
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## Feral livestock Ganado cimarrón

*Equus ferus caballus*  
**feral horse, caballo cimarrón**

*Equus africanus asinus*  
**feral donkey, burro orejano**

*Bos primigenius taurus*  
**feral cattle, vaca**

*Capra aegagrus hircus*  
**feral goat, cabra**

---

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**Resumen.** El ganado doméstico fue introducido en la Argentina en el siglo XVI por los colonizadores españoles. Caballos, burros, vacas y cabras se trajeron con el propósito de criarlos de manera extensiva, para usar sus cueros, grasa, carne, o para usarlos como animales de trabajo. Se dispersaron ampliamente y originaron numerosas poblaciones cimarronas. A fines del siglo XIX la mayoría de las poblaciones de ganado cimarrón habían desaparecido. El ganado criado en forma extensiva es una importante fuente de animales escapados que pueden formar poblaciones cimarronas. Actualmente existen poblaciones de caballos, burros y vacas cimarronas en varias áreas protegidas del país. Su impacto sobre la biodiversidad ha sido muy poco estudiado, excepto el caballo en Parque Provincial Tornquist y el burro en varias áreas protegidas de Cuyo. Recientemente se manejó ganado cimarrón en algunas áreas naturales protegidas: caballos en el Parque Provincial Tornquist, vacas en el Parque Nacional El Rey y burros en Parque Nacional Los Cardones. El manejo ha sido esporádico y sin planes de manejo organizados. Para un manejo adecuado del ganado cimarrón en Argentina sería importante conocer mejor la distribución de las especies y su abundancia. Integrar su manejo a la Estrategia Nacional de Especies Exóticas Invasoras (ENEI) resulta un imperioso desafío.

## General description of the species

### Feral horse

Horses (*Equus ferus caballus*) are large mammals, members of the family Equidae and the order Perissodactyla (Fig. 1). They are herbivorous and cecal digestors (Long, 2003). Adults of the Argentine Criollo breed are on average 1.45 m in height and weigh about 450 kg. They have numerous coat colors. Horses' ears are short, and their mane is long and lies flat along their neck. Their gestation period is 315–387 days. Mares usually have one



Figure 1. Feral horse population in Parque Provincial Tornquist, Argentina. (Photo: Alberto Scorolli).

foal during each reproductive season. Horses are gregarious, and their social organization type is female-defense polygyny, forming stable harem-bands with overlapping home ranges (Long, 2003). Annual population growth rate averages 1.18, and longevity is up to 25 years (NRC, 2013).

### Feral donkey

As with horses, donkeys or burros (*Equus africanus asinus*) are Equids and cecal digestors (Long, 2003). Their height at the shoulder is lower, ranging between 1.10–1.50 m. The predominant coat color is grey, but it can also be black, brown and dun. Their ears are longer than those of horses; their mane is thin; their hooves are narrow; and their tail is tufted (Long, 2003). They are more adapted to arid environments than other equids, because they are highly tolerant to dehydration and thirst. Burros are grazers and browsers and can shift their diet seasonally. Gestation last about 365 days. Females usually have one foal. Longevity in the wild is 10–15 years. Their social organization type is territorial with resource defense polygyny (Long, 2003). Donkey population growth rate is high under good environmental conditions and averages 1.19 (NRC, 2013).

### Feral cattle

Cattle (*Bos primigenius taurus*) are large ruminants, members of the family Bovidae and the order Artiodactyla. Adults of the Argentine Criollo breed weigh about 400 kg and the height at shoulder averages around 1.30 m (Martínez *et al.*, 1998). Coat color varies from whitish to black, with also red and brown. Their habits are diurnal. They graze and

browse and have a broad diet. Cattle are gregarious and form large unstable herds and also bachelor groups. They breed all year round, with a 9.5-month gestation period, usually producing one calf, rarely two. Cow longevity in feral populations can be 20 years (Long, 2003).

### Feral goat

Goats (*Capra aegagrus hircus*) are medium-sized ruminants, and as are cattle, they are Bovids (Fig. 2). Adults of the Criollo breed weigh an average of 45 kg, and the height at the shoulder is about 0.65–0.75 m. Coat colors of the Argentine Criollo breed are very variable, but usually black or brown with white patches (Capote and Fresno, 2016). Goats are diurnal with a main crepuscular activity peak. They feed on many plant species, grasses, forbs and browse. They are sedentary and loyal to a home range. This species breeds all year, with 150 days of gestation; usually two kids are born. Their longevity in feral populations is around 12–13 years (Long, 2003).



Figure 2. Feral goats in Reserva Provincial Isla de los Estados, Argentina. (Photo: Ulises Balza).

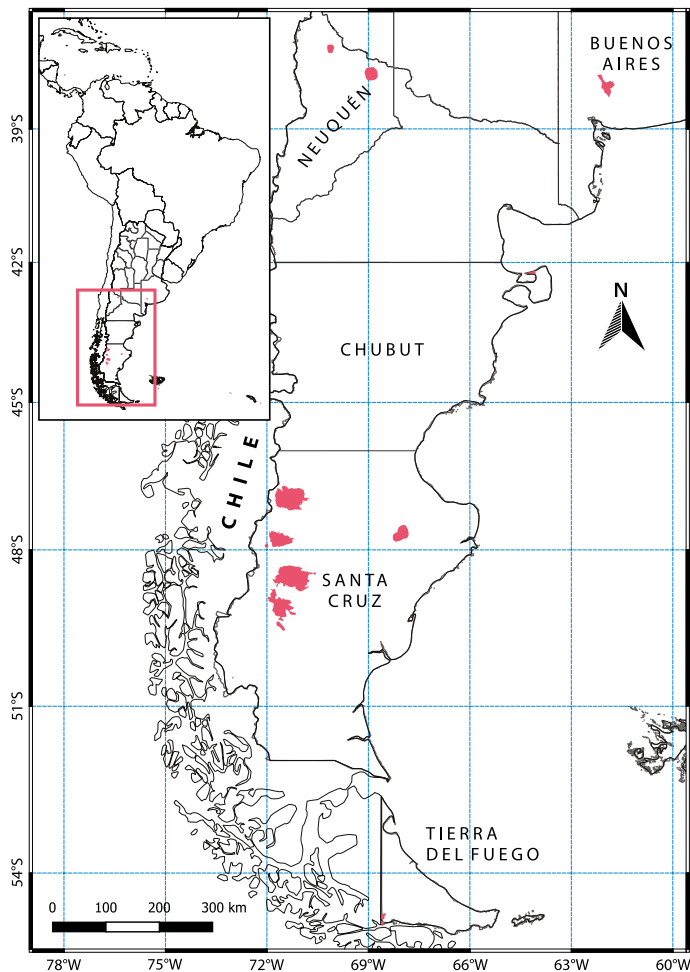
### History of the invasion

Eurasian livestock were introduced by the Spanish colonizers during the 16th century with the purpose of breeding them for meat, hide, fat, milk and wool. Horses, donkeys, cattle and goats from Spanish breeds were introduced, and in the following centuries gave rise to the Argentine Criollo breeds of these species, which then dispersed widely and also formed feral populations (Brailovsky and Foguelman, 1991; Martínez *et al.*, 1998; Capote and Fresno, 2016).

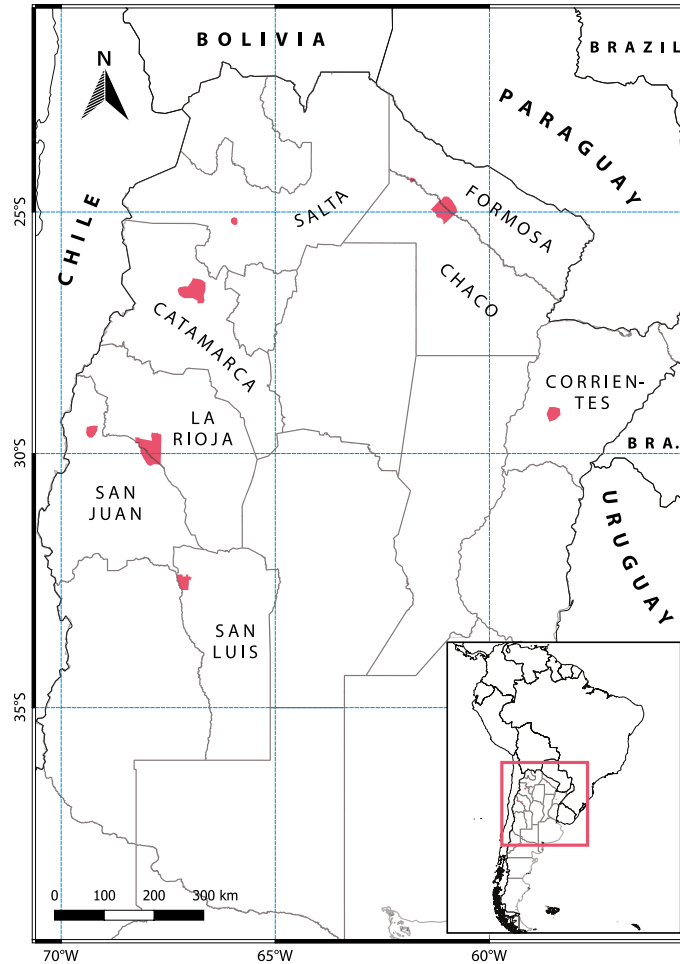
### Patterns of expansion and current distribution

In the 19th century, when land use changed and fields became parceled, feral horse and cattle were almost eradicated in the country (Brailovsky and Foguelman, 1991; Martínez *et al.*, 1998). Only small populations of feral horses persisted in the Andean portion of southern Patagonia, until the present time. Feral horse populations of more recent origin inhabit some natural protected areas, such as Parque Nacional Bosques Petrificados de Jaramillo, Parque Nacional Los Glaciares and Parque Provincial E. Tornquist (Fig. 3; Scorlli, 2016, this volume). Some populations also exist in the Patagonian steppe and Cuyo region, but their geographic location and size are not well described (Scorlli *et al.*, 2019).

Donkeys were introduced mainly in the Cuyo region and parts of the Northwest as pack animals, and also with the purpose of mule breeding. They probably became feral in earlier



**Figure 3.** Distribution of *Equus ferus caballus* in Argentina. Modified from Scorlli *et al.* (2019). (Mapping: Ian Barbe and Alfredo Claverie).



**Figure 4.** Distribution of *Equus africanus asinus* in Argentina. Modified from Borghi *et al.* (2019a). (Mapping: Alfredo Claverie and Ian Barbe).

times, but there are no good historic records. Only recently, their populations have been surveyed and reported in many areas like Parques Nacionales Los Cardones, Ischigualasto, and Talampaya in the northwestern region, and Parques Nacionales El Impenetrable and Iberá in the northeastern region (Fig. 4; Novillo and Ojeda, 2008; Merino *et al.*, 2009; Borghi *et al.*, 2019a).

At present, feral cattle are reported for many locations and national parks in the Yungas, Arid and Humid Chaco, and Patagonian Forest and Steppe ecoregions of Argentina (Aprile *et al.*, 2019). The better known locations of these invasive populations include Parque Nacional El Rey in northwest Argentina and Parque Nacional Los Glaciares in southwest Patagonia (Fig. 5).

Given that goats were bred extensively in many regions of Argentina, it is highly likely that some feral population exist, but there is no information about this. Only one

population of feral goats has been described as invasive at Reserva Provincial Isla de los Estados in Tierra del Fuego province (Novillo and Ojeda, 2008; Borghi *et al.*, 2019b), where goats were introduced in 1886 in an area that in the 1990s was declared provincial reserve.

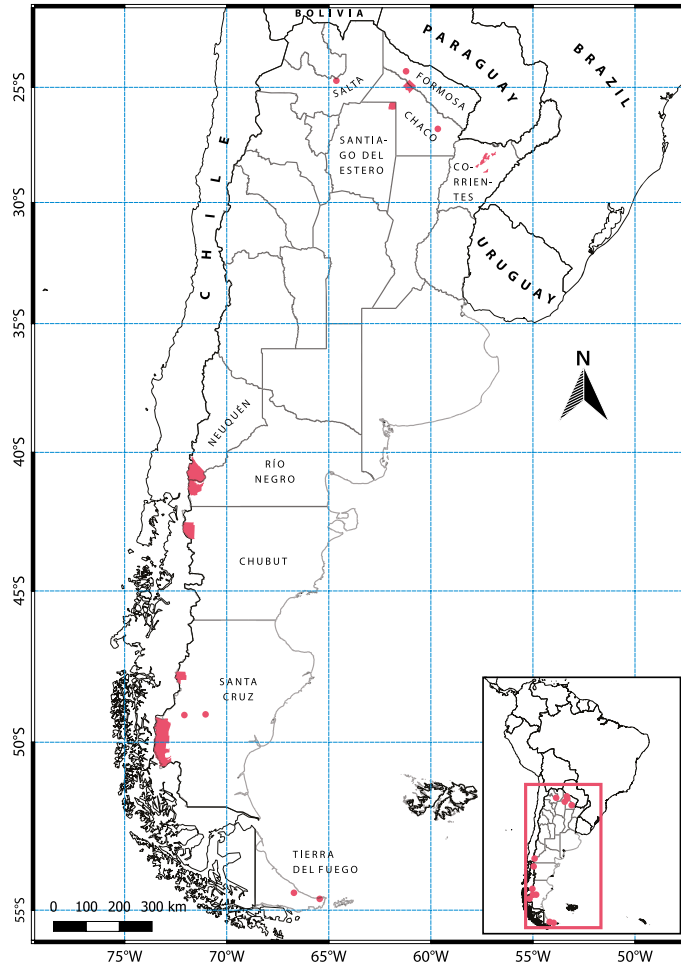
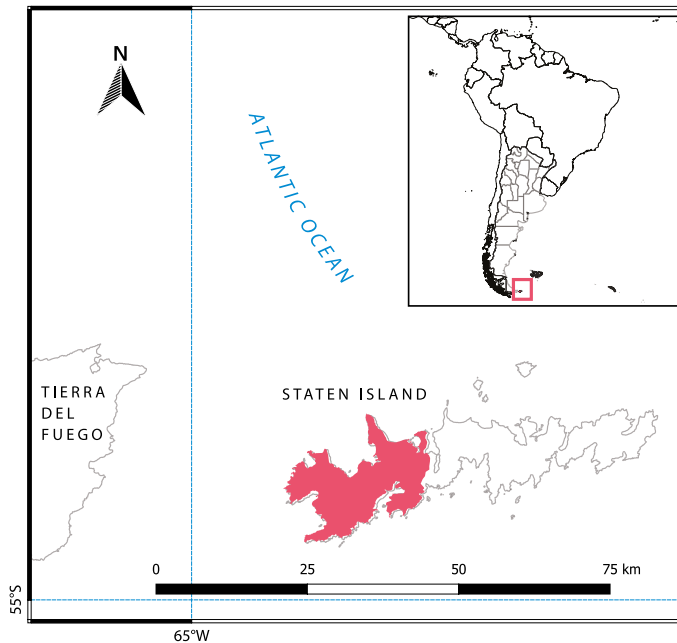


Figure 5. Distribution of *Bos primigenius taurus* in Argentina. Modified from Aprile *et al.* (2019). (Mapping: Alfredo Claverie and Ian Barbe).

## Impacts

In Argentina, the impacts of feral livestock are still not well quantified. There are only some recent local scale projects and much remains to be studied. To date, the feral horse's impact on biodiversity has only been studied in Parque Provincial Tornquist in Buenos Aires province. The results suggest significant changes in vegetation structure and composition, facilitation of invasive plants and alteration of the bird community (Scorlli, 2016, this volume). Feral donkey impacts have been described for some populations in

national parks, mostly affecting columnar cacti (Malo *et al.*, 2011), and competing for food with native camelids (Borgnia *et al.*, 2008; Reus *et al.*, 2014). In other countries, a significant impact on vegetation and accelerated soil erosion have been reported as well (Abella, 2008). For their part, the feral cattle in Parque Nacional El Rey modified the woody habitats and affected ecosystem structure (Giménez *et al.*, 2010). In many areas where feral cattle populations exist, a significant impact on vegetation structure and composition was reported (Long, 2003). Finally, feral goats are known worldwide to have severe environmental impacts (Long, 2003). On Reserva Provincial Isla de los Estados, they probably have affected the grasslands and the animals living there, but the impact on biodiversity is only recently being studied.



**Figure 6.** Distribution of *Capra aegagrus hircus* in Argentina. Modified from Borghi *et al.* (2019b). (Mapping: Alfredo Claverie and Ian Barbe).

## Management

Management of feral livestock in Argentina has been discontinuous and unorganized. Only some populations have been controlled in natural protected areas. For example, feral horses were managed in Parque Provincial Tornquist, where the population was reduced by 50% in 2006–2007 and 220 horses were live-trapped with mobile-corrals. Since 2008, however, the management was suspended, and the population recovered and reached a size similar to that before the control (Scorrolli, 2016, this volume).

For their part, feral donkeys were controlled in Parque Nacional Los Cardones, where they were captured in corrals by horse driving. A total of 571 individuals were removed.



After the management, recovery of the vegetation and native ungulates populations was observed (Moschione *et al.*, 2010). Feral cattle also have been managed recently in Parque Nacional El Rey. In 2001–2010 a reduction in population size was implemented. Cattle were hunted using trained dogs and later euthanized; a total of 727 animals were eliminated, 70% of the estimated population (Giménez *et al.*, 2010). Management was not continued and the population slowly recovered (Giménez *et al.*, 2010). In Parque Nacional Los Glaciares an eradication plan of feral cattle has been implemented since 2015 (Aprile *et al.*, 2019). Finally, to date, there has been no attempt to manage feral goats on Reserva Provincial Isla de los Estados.

In contrast, studies and experiences regarding the management of feral livestock have been intense in other countries like USA, Australia, New Zealand, Ecuador and France. In these countries management plans with goals of eradication or control have been implemented (Tab. 1).

**Table 1.** Examples of feral livestock management plans in different countries.

Species	Country	References
Horse	USA	NRC, 2013
	Australia	Dawson <i>et al.</i> , 2006; OEH NSW, 2017
	New Zealand	DOC NZ, 2012
Donkey	USA	NRC, 2013
	Ecuador	Carrion <i>et al.</i> , 2007
Cattle	France	Micol and Jouventin, 1995
Goat	New Zealand	Forsyth <i>et al.</i> , 2003
	Ecuador	Campbell and Donlan, 2005

## References

- Abella, S.R. 2008. A systematic review of wild burro grazing effect on Mojave desert vegetation, USA. *Environmental Management* 41: 809–819.
- Aprile, G., Borghi, C.E., Chalukián, S., Lartigau, J.M., Relva, M.A. and González-Rivas, C. 2019. *Bos primigenius taurus*. In: SAyDS–SAREM (eds.), *Categorización 2019 de los mamíferos de Argentina según su riesgo de extinción. Lista Roja de los mamíferos de Argentina*. <https://cma.sarem.org.ar/es/especie-exotical/bos-primigenius-taurus>.
- Borghi, C.E., Cirignoli, S., Aprile, G., Monteverde, M., Borgnia, M., Giménez, S.R. and Chalukián, S. 2019a. *Equus africanus asinus*. In: SAyDS–SAREM (eds.), *Categorización 2019 de los mamíferos de Argentina según su riesgo de extinción. Lista Roja de los mamíferos de Argentina*. <https://cma.sarem.org.ar/es/especie-exotical/equus-africanus-asinus>.
- Borghi, C.E., Valenzuela, A.E.J. and Kin, M.S. 2019b. *Capra aegagrus hircus*. In: SAyDS–SAREM (eds.), *Categorización 2019 de los mamíferos de Argentina según su riesgo de extinción. Lista Roja de los mamíferos de Argentina*. <https://cma.sarem.org.ar/es/especie-exotical/capra-aegagrus-hircus>.
- Borgnia, M., Bilá, V.L. and Cassini, M.H. 2008. Interaction between wild camelids and livestock in an Andean semi-desert. *Journal of Arid Environments* 72: 2150–2158.

- Brailovsky, A. and Foguelman, D. 1991. *Memoria verde. Historia ecológica de la Argentina*, pp. 375. Editorial Sudamericana, Buenos Aires.
- Campbell, K. and Donlan, J.C. 2005. Feral goat eradications on islands. *Conservation Biology* 19: 1362–1374.
- Capote, J. and Fresno, M. 2016. La colonización americana y el ganado caprino. In: J.E. Vargas Bayona, L. Zargosa Martínez, J.V. Delgado Bermejo and G. Rodríguez Galván (eds.), *Biodiversidad caprina iberoamericana*, pp. 7–12. Ediciones Universidad Cooperativa de Colombia, Bogotá.
- Carrion, V., Donlan, J.C., Campbell, K., Lavoie, C. and Cruz, F. 2007. Feral donkey (*Equus asinus*) eradications in the Galapagos. *Biodiversity and Conservation* 16: 437–445.
- New Zealand Department of Conservation. 2012. *Kaimanawa Wild Horse Working Plan 2012–2017*. <http://www.doc.govt.nz/about-us/science-publications/conservation-publications/threats-and-impacts/animal-pests/kaimanawa-wild-horses-working-plan-2012-2017>.
- Dawson, M.J., Lane, C. and Saunders, G. 2006. *Proceedings of the National Feral Horse Management Workshop*, 89 pp. Invasive Animals Cooperative Research Centre, Canberra.
- Forsyth, D.M., Hone, J., Parkes, J.P., Reid, G.H. and Stronge, D. 2003. Feral goat control in Egmont National Park, New Zealand, and implications for eradication. *Wildlife Research* 30: 437–450.
- Giménez, S.R., Chalukian, S.C., Lizarraga, L. and de Bustos, S. 2010. Erradicación y control de ganado vacuno asilvestrado (*Bos taurus*) en el Parque Nacional El Rey, Salta: diez años de trabajo. *XXIII Jornadas Argentinas de Mastozoología* (Bahía Blanca). *Acta*: 56.
- Long, J.L. 2003. *Introduced mammals of the world. Their history, distribution and influence*, 589 pp. CSIRO Publishing, Collingwood.
- Micol, T. and Jouventin, P. 1995. Restoration of Amsterdam Island, South Indian Ocean, following control of feral cattle. *Biological Conservation* 73: 199–206.
- Malo, J.E., Acebes, P., Giannoni, S.M. and Traba, J. 2011. Feral livestock threaten landscapes dominated by columnar cacti. *Acta Oecologica* 37: 249–255.
- Martínez, R.D., Fernández, E.N., Rumiano, F.J. and Pereyra, A.M. 1998. Medidas zoométricas de conformación corporal en bovinos criollos argentinos. *Zootecnia Tropical* 16: 241–252.
- Merino, M.L., Carpinetti, B.N. and Abba, A.M. 2009. Invasive mammals in the national parks system of Argentina. *Natural Areas Journal* 29: 42–49.
- Moschione, F.N., Menvielle, M.F. and Bikauskas, J.S. 2010. Manejo de especies exóticas invasoras en Parques Nacionales: estrategia de control de burros silvestres *Equus asinus* en PN Los Cardones. *XXIII Jornadas Argentinas de Mastozoología* (Bahía Blanca). *Acta*: 58.
- National Research Council (NRC). 2013. *Using science to improve the BLM Wild Horse and Burro Program: a way forward*, 436 pp. The National Academies Press, Washington.
- Novillo, A. and Ojeda, R.A. 2008. The exotic mammals of Argentina. *Biological Invasions* 10: 1333–1344.
- Office of Environment and Heritage, New South Wales. 2017. *Kosciuszko National Park Wild Horse Management Plan*. <http://www.environment.nsw.gov.au/protectsnowies>.
- Reus, M.L., Cappa, F.M., Andino, N., Campos, V.E., de los Ríos, C. and Campos, C.M. 2014. Trophic interactions between the native guanaco (*Lama guanicoe*) and the exotic donkey (*Equus asinus*) in the hyper-arid Monte desert (Ischigualasto Park, Argentina). *Studies on Neotropical Fauna and Environment* 41: 159–168.
- Scorolli, A.L. 2016. Manejo de caballos cimarrones: la situación en la Argentina. *Mastozoología Neotropical* 23: 325–333.
- Scorolli, A.L., Borghi, C.E., Aprile, G. and Lartigau, J.M. 2019. *Equus ferus caballus*. In: SAyDS–SAREM (eds.), *Categorización 2019 de los mamíferos de Argentina según su riesgo de extinción. Lista Roja de los mamíferos de Argentina*. <https://cma.sarem.org.ar/es/especie-exotica/equus-ferus-caballus>.

# INTRODUCED INVASIVE MAMMALS OF ARGENTINA

Introduced Invasive Mammals (IIMs) are a major driver of global and local environmental change, including negative impacts on biodiversity, ecosystem processes, economies, health and other social values. However, as complex social-ecological systems, invasive species cannot be conceived solely as “negative,” nor merely as “biological” invasions. This book presents conceptual and practical perspectives from 49 authors with expertise in communication, ecology, education, genetics, history, philosophy, social sciences and veterinary medicine to better understand and manage IIMs in Argentina. It concludes by providing updated information on Argentina's IIM assemblage, which includes 23 species.

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and Ricardo A. Ojeda, EDITORS**



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