



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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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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## *Bubalus arnee bubalis* wild water buffalo, búfalo asiático

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**Resumen.** El búfalo de agua o búfalo asiático es un bóvido grande originario de Asia, con grandes cuernos y coloración oscura. Herbívoro y gregario, habita ambientes húmedos e inundables. En su distribución nativa las formas silvestres se encuentran amenazadas y en declinación. Las formas domésticas han sido introducidas en casi todo el mundo para la producción de carne, leche y cuero, y para la caza deportiva. Escapes y sueltas de cautiverio han permitido que se establezcan poblaciones silvestres. En Argentina se introdujo para fines productivos en la década de 1970 y hoy la presencia de búfalo de agua confinado atraviesa prácticamente todo el país. Las poblaciones asilvestradas detectadas representan puntos del espacio donde los individuos han sido soltados deliberadamente o han escapado del confinamiento. Los principales impactos de la especie se asocian al sobrepastoreo y pisoteo en suelos poco consolidados, típicos de los ambientes inundables que suele habitar, lo que deriva en impactos potenciales a la fauna, que ya han sido probados en otros países aunque todavía no en Argentina. Si bien algunas provincias poseen marcos legales que habilitan la caza de control y el consumo de su carne, no existen a la fecha planes de manejo que aborden las problemáticas asociadas a las poblaciones asilvestradas.

### General description of the species

The wild water buffalo (*Bubalus arnee bubalis*) is a large bovid with a body mass up to 800 kg for females and up to 1,200 kg for males (Fig. 1; Rodríguez Planes *et al.*, 2019). Its height at the shoulder can reach about 2 m. Both sexes carry half-moon shaped horns that can span 2 m wide from tip to tip. It also has a distinctive white “V” below the neck.



**Figure 1.** a. *Bubalus arnee bubalis* in Parque Nacional Iberá, Argentina. (Photo: Sebastián Cirignoli). b. Detail of a buffalo individual. (Photo: Carlos Carubia).

Its hide is covered by sparse, long gray to black hairs with gray “socks” below knees. Its tail is long and hairy at the tip.

The water buffalo is strongly associated with wet environments, such as forested rivers and wetlands, including swamps and flooded grasslands. It is generally found at low altitudes, except in Nepal, where it inhabits swamps at 2,800 or more meters over sea-level.

The species is a generalist herbivore that is mainly terrestrial and cathemeral. They live in groups of about 10–30 individuals, but occasionally may aggregate in herds of over 100 individuals.

Buffaloes have a polygynic mating system. Seasonality may occur only in some areas of its native distribution range. Females reach sexual maturity at about one and half years and males at three. Gestation extends for 312 to 334 days, and cows have one calf every two years (Tulloch, 1979).

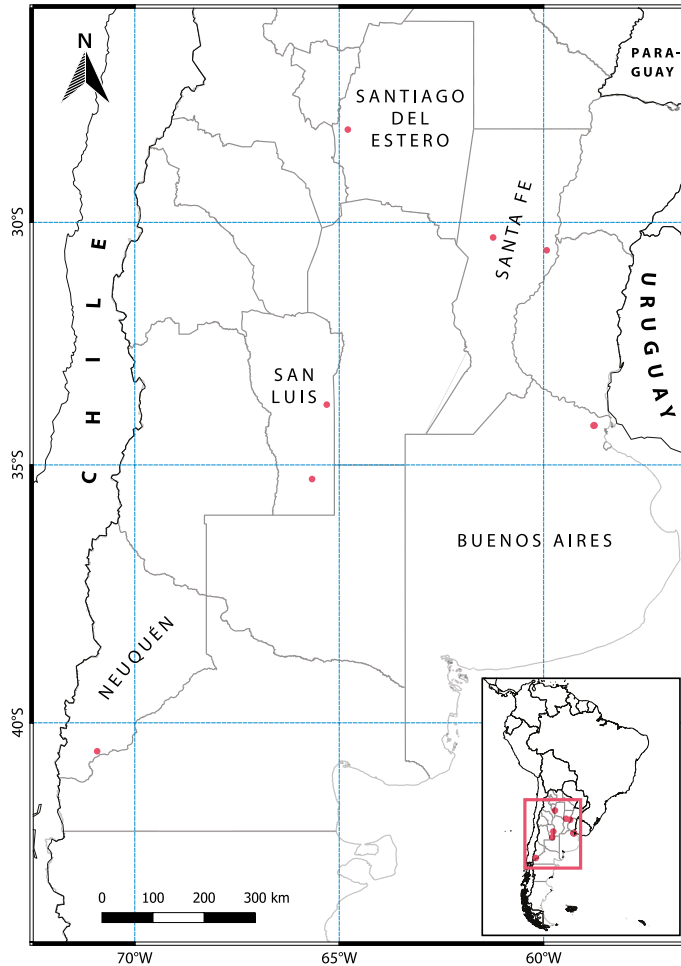
Remnant wild populations persist in India, Bhutan, southern Nepal, Thailand, Myanmar, and Cambodia. It is considered extinct in Bangladesh, Vietnam, parts of Malaysia, some islands around Sumatra, Java and Borneo, and probably Lao. *Bubalus arnee* is considered Endangered by the IUCN, and with a decreasing population trend (Hedges *et al.*, 2008).

### History of the invasion

While the water buffalo is native to Asia, they were imported from Romania to southern Entre Ríos province in Argentina for meat production in the early 20th century (Crudeli *et al.*, 2004). After the intended crossbreeding with *Bos taurus* failed, a few individuals were released for hunting (Crudeli *et al.*, 2014). Earlier introduction events have been mentioned in the literature, mainly for hunting purposes, around 1900 in Corrientes province, but these apparently did not establish viable feral populations (Petrides, 1975).

### Spread pattern and current distribution

Spread of water buffalo is spatially associated with its main productive use: cattle raising and sport hunting. The current free-ranging distribution is mostly based on escapes from captivity, either from pastures or game reserves (Fig. 2). Such events have occurred re-



**Figure 2.** Distribution of *Bubalus arnee bubalis* in Argentina. Modified from Rodríguez Planes *et al.* (2019). Mapping: Alfredo Claverie and Ian Barbe.

cently on some islands in the Paraná River delta (Buenos Aires province) and also in Parque Nacional El Palmar (Entre Ríos province), where they have been controlled. Individuals from an illegal game reserve in central-western Argentina (Santiago del Estero province) were released near Guampacha after a legal intervention in January of 2018. Raising water buffalo is an emerging productive activity in Argentina, promoted by the Asociación Argentina de Criadores de Búfalos and has been considered “the new livestock revolution,” which is

driving the proliferation of pastures with captive buffalos throughout Argentina. These and the numerous hunting reserves where the species can be found represent potential sources for new escapes (Petrides, 1975).

## Impacts

### Ecological impact

Environmental impacts have been documented outside of Argentina, including overgrazing that significantly modifies vegetation structure and composition (Skeat *et al.*, 1996; Alho *et al.*, 2011; Michels *et al.*, 2012; Bisaggio *et al.*, 2014), trampling that entails compacting soil and generating wallows and accelerated erosion, affecting the quality of water and wetlands (Skeat *et al.*, 1996), and favoring the spread of introduced weeds (Cowie and Werner, 1993). These changes in turn may negatively affect the associated fauna, as it was seen for caimans and storks in Brazil (Campos, 1993; de Moraes *et al.*, 2016) and geese in Australia (Corbett *et al.*, 1996). The buffalo's spread throughout the Paraná River delta may also affect native deer populations (*Blastocerus dichotomus*), as has already occurred in Brazil (Rodríguez-Planes *et al.*, 2019). Mixed buffalo-cattle pastures in Venezuela have discouraged the attack of big predators, such as jaguar *Panthera onca* and cougar *Puma concolor*, diminishing human-fauna conflicts, which may be considered a positive effect of well-managed buffalo herds (Hoogesteijn and Hoogesteijn, 2008). Environmental impacts have not yet been assessed in Argentina, where no extant literature is available.

### Economic impact

Bubaline husbandry produces mainly meat, but also milk and leather. Bubaline milk accounts for 7% of global milk production, but this amount rises to 70% in India. Bubaline milk is less allergenic than cattle milk (Plana, 2005). Currently almost every Argentine province has this kind of productive activity, especially Formosa and Corrientes, which have over 30,000 head of livestock each. Meat has been exported to Brazil and Chile since December 2017, and recently, also to Italy and Vietnam, consolidating the water buffalo as a true livestock revolution. Sport hunting tourism has developed numerous game reserves in La Pampa, Neuquén and Santa Fe provinces (see Ballari *et al.*, this volume).

### Health impact

Water buffalo may host some pathogens shared with cattle and fauna (see also Uhart *et al.*, this volume). Pathogens isolated from water buffalo in Argentina include the following: *Brucella abortus*, *Mycobacterium bovis*, *Neospora caninum*, *Toxoplasma gondii* and *Leptospira* in Corrientes, Chaco and Formosa (Campero *et al.*, 2007; Crudeli *et al.*, 2007; Guanziroli Stefani *et al.*, 2008; Konrad *et al.*, 2013), and *Fasciola hepatica* in Corrientes (Racioppi *et al.*, 2009) and Misiones (Lobayan *et al.*, 2016). Antibodies against bovine viral diarrhea (BVDV-1 and BVDV-2) have also been found at north-eastern Argentina (Craig *et al.*, 2015, Pecora *et al.*, 2017). In addition, virus isolated from buffalo encompass bovine

parainfluenza 3 virus (Maidana *et al.*, 2012), Herpesvirus bubaline 1 (BuHV1) (Maidana *et al.*, 2014), shared with cattle (Maidana *et al.*, 2016), and rabies virus (Delpietro *et al.*, 1997).

In addition, water buffalo milk experimentally decreased the development of bowel cancer on rats (Ramírez *et al.*, 2012), which may be considered as a potential positive effect for healthcare industry.

## Management

Programs promoting the breeding of water buffalo exist throughout Argentina, especially in marginal and less productive areas like wetlands on Paraná River islands (Steverlynck, 2014). In contrast, 50 feral buffalos were successfully eradicated from the Esteros del Iberá wetland (Corrientes province) after four years of exhaustive control and monitoring of introduced species (Cirignoli, 2010a, b). Santa Fe and Entre Ríos provinces have regulation policies that enable hunting for control and meat consumption. Only Corrientes, Neuquén and San Luis provinces have some kind of policy to regulate sport hunting, despite game reserves occurring in many other provinces (see Ballari *et al.*, this volume). No national management strategy has been conducted so far.

## References

- Alho, C.J.R., Mamede, S., Bitencourt, K. and Benites, M. 2011. Introduced species in the Pantanal: implications for conservation. *Brazilian Journal of Biology* 71: 321–325.
- Ballari, S.A., Barrios-García, M.N., Sanguinetti, J., Pastore, H. and Cuevas, M.F. This volume. Hunting as a driver of mammal introductions, pp. 75–93.
- Bisaggio, E.L., Alves, S.L., Júnior, C.C.S. and Rocha, C.H.B. 2014. Búfalos ferais (*Bubalus bubalis*) em áreas protegidas: um estudo de caso na Reserva Biológica do Guaporé, RO. *Biodiversidade Brasileira* 2: 243–260.
- Campero, C.M., Pérez, A., Moore, D.P., Crudeli, G., Benitez, D., Draghi, M.G., Cano, D., Konrad, J.L. and Odeón, A.C. 2007. Occurrence of antibodies against *Neospora caninum* in water buffaloes (*Bubalus bubalis*) on four ranches in Corrientes province, Argentina. *Veterinary Parasitology* 150: 155–158.
- Campos, Z. 1993. Effect of habitat on survival of eggs and sex ratio of hatchlings of *Caiman crocodylus yacare* in the Pantanal, Brazil. *Journal of Herpetology* 27: 127–132.
- Cirignoli, S. 2010a. El peligro de la fauna silvestre invasora en el Iberá: El enemigo fantasma. *Boletín de los Esteros* 8: 8–10.
- Cirignoli, S. 2010b. [Informe sobre las actividades de control de fauna exótica invasora en la reserva Iberá, Corrientes, Argentina. The Conservation Land Trust, 9 pp. Unpublished report.]
- Corbett, L., Hertog, A.L. and Muller, W.J. 1996. An experimental study of the impact of feral swamp buffalo *Bubalus bubalis* on the breeding habitat and nesting success of magpie geese *Anseranas semipalmata* in Kakadu National Park. *Biological Conservation* 76: 277–287.
- Cowie, I.D. and Werner, P.A. 1993. Alien plant species invasive in Kakadu National Park, tropical northern Australia. *Biological Conservation* 63: 127–135.
- Craig, M.I., König, G.A., Benitez, D.F. and Draghi, M.G. 2015. Molecular analyses detect natural coinfection of water buffaloes (*Bubalus bubalis*) with bovine viral diarrhoea viruses (BVDV) in serologically negative animals. *Revista Argentina de Microbiología* 47: 148–51. [doi: 10.1016/j.ram.2015.03.001](https://doi.org/10.1016/j.ram.2015.03.001).
- Crudeli, G.A., Patiño, E.M., Cedrés, J.F., González Fraga, J., Maldonado Vargas, P., Racioppi, O., Zava, M.A., Pellerano, G.S. 2004. *Buffaloes in Argentina*. Corrientes, Moglia Ediciones: el autor.
- Crudeli, G.A., Campero, C.M., Moore, D.P., Benitez, D., Draghi, G., Polich, D., Konrad, J., Cano, D., Leunda, M.R., Arzeno, M. and Odeón, A. 2007. High prevalence of *Neospora caninum* antibodies in



- water buffaloes (*Bubalus bubalis*) in ranches of Corrientes, Chaco and Formosa provinces, Argentina. *Italian Journal of Animal Science* 6: 945–947.
- Crudeli, G.A., Patiño, E.M., Maldonado Vargas, P., and Konrad, J.L. 2014. Pasado, presente y futuro del búfalo en Argentina. *Revista Veterinaria* 25: 140–145.
- de Moraes, J.P., de Araújo Pereira, R.G., Da Silva, M.G. and Nogueira, A.E. 2016. Impactos ambientais causados pelos Búfalos (*Bubalus bubalis*) mestiços de Carabao × Jafarabadi no Vale Do Guaporé–Rondônia. *Revista Científica da Faculdade de Educação e Meio Ambiente* 7: 126–135.
- Delpietro, H.A., Gury-Dhomen, F., Larghi, O.P., Mena-Segura, C. and Aabramo, L. 1997. Monoclonal antibody characterization of rabies virus strains isolated in the River Plate Basin. *Zentralblatt für Veterinärmedizin B* 44: 477–483.
- Guanzioli Stefani, M.C., Cicutta, M.E., Zumárraga, M.J. and Romano, M.I. 2008. Primer aislamiento de *Mycobacterium bovis* de búfalo del nordeste argentino. *Revista Veterinaria* 19: 143–146.
- Hedges, S., Sagar Baral, H., Timmins, R.J. and Duckworth, J.W. 2008. *Bubalus arnee*. *The IUCN Red List of Threatened Species* 2008: e.T3129A128960945. doi: [10.2305/IUCN.UK.2019-1.RLTS.T3129A46364616.en](https://doi.org/10.2305/IUCN.UK.2019-1.RLTS.T3129A46364616.en). Accessed on 11 August 2018.
- Hoogesteijn, R. and Hoogesteijn, A. 2008. Conflicts between cattle ranching and large predators in Venezuela: could use of water buffalo facilitate felid conservation? *Oryx* 42: 132–138.
- Konrad, J.L., Campero, L.M., Caspe, G.S., Brihuega, B., Draghi, G., Moore, D.P., Crudeli, G.A., Venturino, M.C. and Campero, C.M. 2013. Detection of antibodies against *Brucella abortus*, *Leptospira* spp., and Apicomplexa protozoa in water buffaloes in the Northeast of Argentina. *Tropical Animal Health and Production* 45: 1751–1756.
- Lobayan, S.I., Tuzinkievicz, T.M., Cetrá, B.M., Nápoli, J.N. and Dalzotto, A.P. 2016. Presence of *Fasciola hepatica* in slaughtered buffaloes from Misiones (Argentina). *Revista Veterinaria* 27: 66–67.
- Maidana, S.S., Delgado, F., Vagnoni, L., Mauroy, A., Thiry, E. and Romera, S. 2016. Cattle are a potential reservoir of bubaline herpesvirus 1 (BuHV1). *Veterinary Record Open* 3: e000162. doi: [10.1136/vetreco-2015-000162](https://doi.org/10.1136/vetreco-2015-000162).
- Maidana, S.S., Konrad, J.L., Craig, M.I., Zabal, O., Mauroy, A., Thiry, E., Crudeli, G. and Romera, S.A. 2014. First report of isolation and molecular characterization of bubaline herpesvirus 1 (BuHV1) from Argentinian water buffaloes. *Archives of Virology* 159: 2917–2923. doi: [10.1007/s00705-014-2146-8](https://doi.org/10.1007/s00705-014-2146-8).
- Maidana, S.S., Lomonaco, P.M., Combessies, G., Craig, M.I., Diodati, J., Rodríguez, D., Parreño, V., Zabal, O., Konrad, J.L., Crudeli, G., Mauroy, A., Thiry, E. and Romera, S.A. 2012. Isolation and characterization of bovine parainfluenza virus type 3 from water buffaloes (*Bubalus bubalis*) in Argentina. *BMC Veterinary Research* 20: 83. doi: [10.1186/1746-6148-8-83](https://doi.org/10.1186/1746-6148-8-83).
- Michels, G.H., Vieira, E.M. and De Sá, F.N. 2012. Short-and long-term impacts of an introduced large herbivore (buffalo, *Bubalus bubalis* L.) on a Neotropical seasonal forest. *European Journal of Forest Research* 131: 965–976.
- Pecora, A., Pérez Aguirreburualde, M.S., Malacari, D.A., Zabal, O., Sala, J.M., Konrad, J.L., Caspe, S.G., Bauermann, F., Ridpath, J. and Dus Santos, M.J. 2017. Serologic evidence of HoBi-like virus circulation in Argentinian water buffalo. *Journal of Veterinary Diagnostic Investigation* 29: 926–929. doi: [10.1177/1040638717720246](https://doi.org/10.1177/1040638717720246).
- Petrides, G. 1975. The importation of wild ungulates into Latin America, with remarks on their environmental effects. *Environmental Conservation* 2: 47–51.
- Plana, T. 2005. *Bubalus bubalis*, una especie salvajemente dócil y útil. *Revista de la Asociación Cubana de Producción Animal (ACPA)* 1: 41–43.
- Racioppi, O., Alvarez, J.D., Moriena, R.A., and Pintos, L.A. 2009. *Fasciola hepatica* in buffaloes from Corrientes province, Argentina. *Revista Veterinaria* 20: 128–129.
- Ramírez, G.V., Villordo, G., Montenegro, M.A., Catuogno, M.S. and Sánchez Negrette, M. 2012. Disminución del desarrollo de cáncer experimental del colon en ratas alimentadas con leche de búfala. *Revista Veterinaria* 23: 15–19.

- Rodríguez-Planes, L.I., Cirignoli, S., Varela, D., Monteverde, M. and Kin, M.S. 2019. *Bubalus arnee bubalis*. 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/bubalus-arnee-bubalis>.
- Skeat, A.J., East, T.J. and Corbett, L.K. 1996. Impact of feral water buffalo. In: C.M. Finlayson and I. Von Oertzen (eds.), *Landscape and vegetation ecology of the Kakadu Region, Northern Australia*. *Geobotany*, 23: pp. 155–177, Springer, Dordrecht.
- Steverlynck, A.E. 2014. [*Alternativa de producción sustentable en los humedales del Delta del Paraná: búfalos (Bubalus bubalis sp.)*]. Bachelor Thesis. Facultad de Ciencias Agrarias. Universidad Católica Argentina. Unpublished.]
- Tulloch, D.G. 1979. The water buffalo, *Bubalus bubalis*, in Australia: reproductive and parent-offspring behaviour. *Australian Wildlife Research* 6: 265–287.
- Uhart, M.M. This volume. Disease risks from introduced mammals, pp. 143–172.

# 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.

**Alejandro E. J. Valenzuela, Christopher B. Anderson, Sebastián A. Ballari  
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