

A review of introduced cervids in Chile

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Abstract. We review the extent of exotic deer distributions in Chile, which are encountered in all provinces, including Tierra del Fuego, except for possibly Region III; many deer are contained in at least 107 enclosures. Red deer (*Cervus elaphus*) by far has the largest feral population of exotic cervids in southern South America, providing source animals that can easily cross the Andes between Chile and Argentina. Red deer was introduced from Europe to the central valley of Chile in 1928. Since the 1940s, feral populations have also expanded from Argentina into Chile, by way of easily accessible, low-elevation mountain passes of the Andes, accompanied by further direct shipments from Argentina. The area occupied by 1990 was estimated at 3400 km², whereas an analysis in 2003 estimated an area of 7700 km². The overall area invaded by 2003 was between 37°42'S and 54°55'S, and 73°36'W and 69°50'W (Argentina and Chile combined, although non-contiguous). Ecological impact of the red deer in Chile has been described since 1981, and red deer features in the Chilean Pest Manual. A conservative rate for the red deer expansion was estimated at 1 km/year, but likely is more rapid where habitat modifications facilitate movement. The pre-Columbian northern limit of the native cervid huemul (*Hippocamelus bisulcus*) was 30°S, and because red deer has occupied all habitat types currently used by huemul, it could thus spread >750 km further north. To the south, all areas are suitable for red deer. Invasion patterns will depend on additional intentional introductions and enclosures on both sides of the Andes because of the omnipresent risk of escapes. Fallow, axis and roe deer (*Dama dama*, *Axis axis*, *Capreolus capreolus*, respectively) also have been introduced to Chile and occur in many enclosures. Fallow deer recently escaped on Chiloé Island, became established and raised concerns because of its potential impacts on several endemic species on the island. The striking lack of information on feral deer may relate to policies and laws about firearms and restricted access to hunting areas, resulting in the apparent absence of popular hunting, which, nevertheless, could be a potential tool should the invasion continue and lead to future deer overabundance.

Additional keywords: exotic deer, distribution, *Cervus elaphus*, *Dama dama*, *Axis axis*, *Capreolus capreolus*.

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Introduction

Phoenicians and Romans likely perceived only positive outcomes when translocating fallow deer (*Dama dama*) and, for the same reasons, Acclimatisation Societies everywhere were going strong until the early 20th century. Releasing ungulates allowed alternative production systems, including hunting, and thus presented economic benefits. However, releases were also carried out without economic motives, sometimes to add to depauperate local fauna and improve sport-hunting opportunities. Such motives resulted in releases of several ungulate species in southern South America, which intensified in the early 1900s (Flueck and Smith-Flueck 1993). Interest in impacts from releases of cervids began 7–8 decades ago in New Zealand, with government-supported control efforts since 1923 (Caughley 1983). Thereafter, as the economic liability

became apparent, global research efforts and publications on invasive species increased exponentially (Kolar and Lodge 2001). According to IUCN (www.issg.org, verified April 2012), invasive alien species include animals introduced by man into places that are out of their natural range of distribution, and where they become established and disperse, generating a negative impact on the local ecosystem and species. Currently, awareness concerning the impacts of invasive species has increased, and exotic species have been recognised as a leading global threat to native biodiversity and ecosystem function (Pimentel *et al.* 2000; Sala *et al.* 2000; Olson 2006). Exotic deer may have undesirable impacts even at a low density, and overt problems are certain when they become overabundant. By definition, overabundance arises wherever deer have unwanted impacts on biodiversity and ecosystem

services, where their numbers exceed thresholds desired by hunters or land managers, and where they cause direct conflict with humans, most particularly via vehicle collisions. For a recent workshop on overabundant deer, held during the 7th International Deer Biology Congress in Chile (Nugent *et al.* 2011), we reviewed information on exotic deer present in Chile.

Results and discussion

We reviewed all sources of information available to us, to provide an update on exotic cervids in Chile. Exotic cervids are encountered in all provinces, including Tierra del Fuego, except for possibly Region III (Fig. 1); from limited information, many of the deer in these provinces live in captive herds, which total at least 107 (Tala *et al.* 2004; Registro Nacional de

Tenedores de Fauna Silvestre, www.sag.cl, verified November 2011).

Red deer (*Cervus elaphus*) was introduced to central Argentina in 1906 and then taken to the Andean foothills in Argentina in the early 1920s (Flueck and Smith-Flueck 1993). In 1928, a shipment of red deer from Europe arrived to the central valley of Chile (Wollenhaupt 1983). Since the 1940s, red deer has also expanded from Argentina into Chile, by way of easily accessible, low-elevation mountain passes of the Andean range, accompanied by further direct shipments from Argentina. The area occupied by 1990 in Chile was estimated at 3400 km², whereas an analysis in 2003 estimated the area of red deer occupation to be 7700 km² (Flueck *et al.* 2003). Across the area occupied by 2003, average density was estimated to be

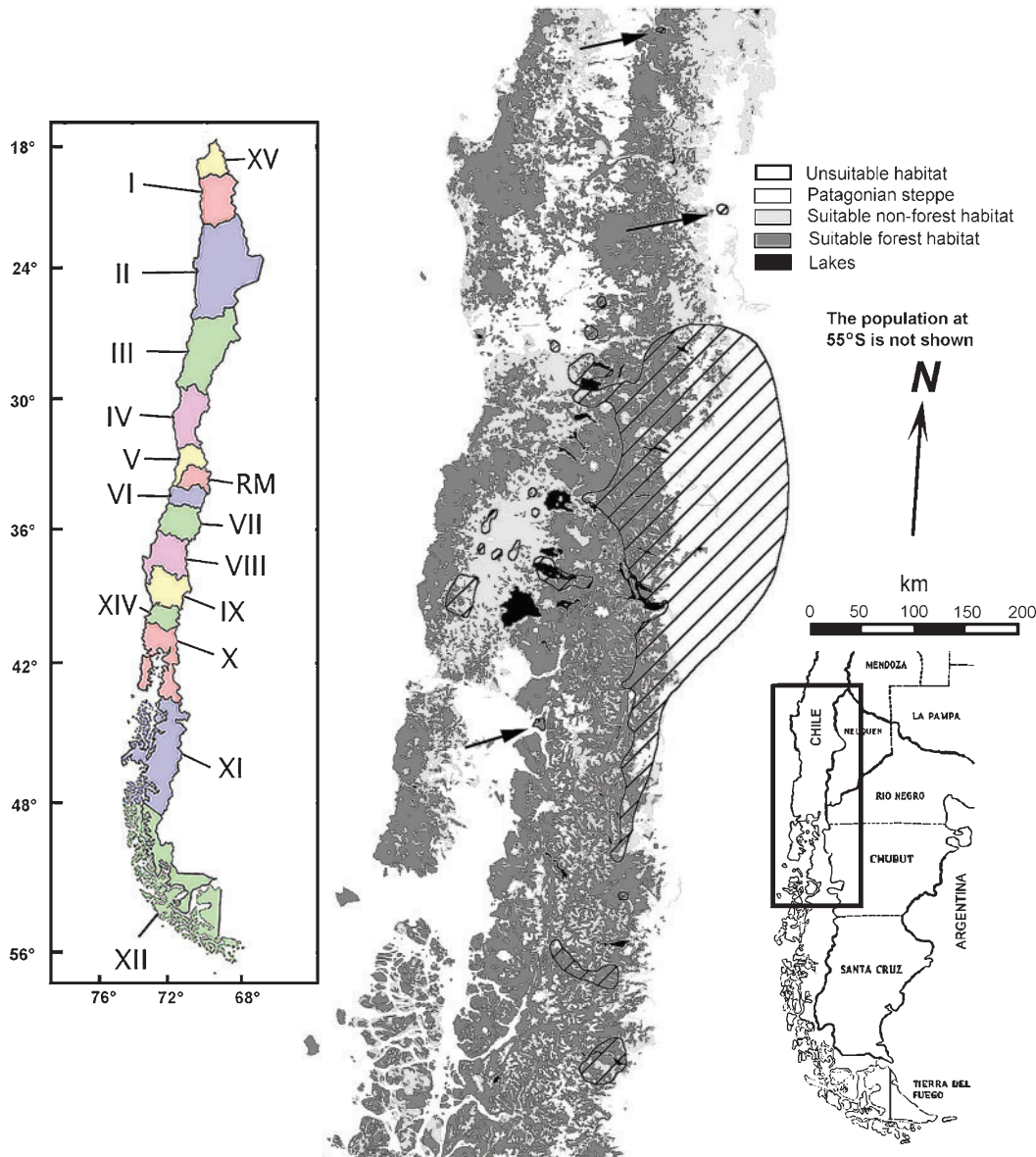


Fig. 1. Geographical location of Chile. The internal division into regions (left), bulk of red deer distribution and habitats (without showing populations on Staten Island, or recent enclosures in Region XI and in Tierra del Fuego) (centre) and the Southern Cone (right).

about two deer/km², which appears to be a conservative estimate considering that favourable ecotonal habitats have revealed densities of ~100 deer/km², whereas in drier grasslands, the numbers reached 40–50 deer/km² (Flueck *et al.* 2003). The overall area invaded by 2003 was located between 37°42'S and 54°55'S, and 73°36'W and 69°50'W (Fig. 1, Argentina and Chile combined, although a non-contiguous distribution). On the basis of linear rates of expansion reported for Chile (Wollenhaupt 1983), a conservative rate of 1 km/year for the north–south and east–west dispersals can be assumed in Chile, but is likely to be often more rapid, particularly due to the substantial presence of livestock and settlers, which have opened up forests through cattle use and intentional fires, thus allowing red deer to advance more efficiently. The pre-Columbian northern limit of the native cervid, huemul (*Hippocamelus bisulcus*), was 30°S, and because the red deer has invaded all other known habitat types used by huemul, the potential northern limit for red deer could be >750 km further north of the present distribution. To the south, all areas are suitable for red deer. Overall, invasion patterns in Chile will depend on additional local introductions on both sides of the Andes and human population density. Already, there are several major focal populations from which the invasion is progressing simultaneously in various directions. Intentional introductions still occur, but of more concern are new approved deer enclosures and the omnipresent risk of escapes. Captive enclosures represent high risk due to escapees, which would provide source animals for new feral populations. Whereas escapees on the continent would mainly modify the overall spacio-temporal pattern of the ongoing invasion, the impact on islands without prior presence of exotic deer, such as Fireland or Chiloe, could be more important due to native endemism. Enclosures in Argentina present the same risk for Chile, because deer can easily cross the Andes. Red deer by far has the largest feral population of exotic cervids in southern South America, and in Chile it has been registered from the area of Bullileo (Parral, Region VII) ~35°S, and then in all regions southward including Tierra del Fuego (Jaksic *et al.* 2002; Iriarte 2008; Urrutia and Ojeda 2008).

Fallow deer first came to Chile in 1887 and were released to several sites (Lever 1985), currently occurring in Regions IX, X, XI, and more recently they have appeared by the coast in Region V where their numbers are 6–800. Recently, fallow deer were also taken to an enclosure on Chiloé Island, from where they escaped and have subsequently established themselves in the surrounding area. Total numbers in Chile were estimated at more than 8000 deer (Iriarte 2008). Axis deer (*Axis axis*) are found in semi-captive enclosures in Regions VII and XI where hunting opportunities are provided (Iriarte 2008); we are not aware of any feral populations. Roe deer (*Capreolus capreolus*) were brought to a semi-captive hunting ranch in 1990 in the Region X (Jaksic *et al.* 2002; Iriarte 2008) and also appear to be confined. There were 28 game hunting ranches in 2004 based on red, fallow and roe deer (Tala *et al.* 2004).

Fallow deer escaping and establishing feral populations recently on Chiloé Island might be of more immediate concern, considering that this island has several endemic species, including medium-sized mammals. Otherwise, fallow, axis and roe deer have apparently not been reported as problems, in part, because most may be under confined conditions.

Red deer placed recently in enclosures on Tierra del Fuego for farming and also for hunting reserves further presents an environmental risk in the case of escapees from the current enclosures, given that fencing consists of five strings added to existing seven-strand cattle fences to reach 2.4 m in height (Navarro *et al.* 2009). The invasion of this island would be especially fast because no large predators exist. Due to the lack of physical barriers between Chile and Argentina, Jaksic *et al.* (2002) suggested that the two countries should coordinate such policy moves so as to prevent the entry of unwelcomed invaders. We are not aware of any previous attempts in Chile to eradicate island populations of feral deer, and the only attempt in Argentina to rid an island (Isla Victoria, 3100 ha) was unsuccessful.

The list of worrisome invasive species provided by Jaksic *et al.* (2002) now also includes Himalayan tahr (*Hemitragus jemlahicus*), which was introduced to Argentina in 2000 and to Andean foothills a few years later (Flueck 2010).

Among the exotic cervids in Chile, the feral state of the red deer is much more advanced than for other species, both geographically and numerically. Although substantial local information regarding red deer is likely to exist, there is a striking absence of well founded published information in Chile. Even presence/absence data are very rudimentary, especially for more remote areas, and we are not aware of any population- or individual-based studies on free-ranging red deer, although ecological impacts from these deer in Chile have been described since 1981, and red deer features in the Chilean Pest Manual (Urrutia and Ojeda 2008). The lack of information about feral deer population may also relate to strict policies and laws about firearms and limited access to hunting areas. One result is the apparent absence of a popular large game-hunting industry which, if active, would generate various lines of information, including presence/absence, age structure, diseases and progress of the invasion. This is because popular hunting would concentrate on public land or other available large tracts of land. Instead, large game such as exotic deer and boar (*Sus scrofa*) can be hunted only on privately owned land, or with the permission of another private landowner, and hunting on public land is non-existing (SAG 2004). Consequently, deer hunting in Chile is currently aimed mainly at clients using game-hunting ranches. When private land suffers from over-abundance of deer, frequently, the owners will find a way to correct the situation. In contrast, overabundance problems on public land depend on government intervention, and although a popular hunting industry often is a primary tool to implement management, it is practically absent in Chile. The continuation of the invasion by exotic deer is likely to remain a future challenge for Chile.

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