Animal Diversity, Distribution and Conservation

Ricardo Baldi, Germán Cheli, Daniel E. Udrizar Sauthier, Alejandro Gatto, Gustavo E. Pazos and Luciano Javier Avila

Abstract In this chapter, we summarize the ecological information available on the species of arthropods, reptiles, terrestrial birds and mammals known to occur at Península Valdés, within the context of the Monte and Patagonia eco-regions. Two hundred species of insects and spiders, 12 species of reptiles, 139 species of birds and 23 species of native mammals inhabit today the island-like peninsula. We describe the community structure, distribution and abundance of the different taxa according to current knowledge. As the Península Valdés region is a World Natural Heritage Site and a provincial protected area of high importance for the conservation of biodiversity and the regional economy, we found relevant to summarize knowledge on the effects of human activities on different components of biodiversity. Habitat degradation, grazing by domestic sheep and poaching are major

R. Baldi (✉) · G. Cheli · D.E. Udrizar Sauthier · G.E. Pazos · L.J. Avila
Instituto Patagónico para el Estudio de los Ecosistemas Continentales (IPEEC), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET)—CCT Centro Nacional Patagónico (CENPAT), Boulevard Brown 2915, ZC: U9120ACD, Puerto Madryn, Chubut, Argentina
e-mail: rbaldi@cenpat-conicet.gob.ar

G. Cheli
e-mail: cheli@cenpat-conicet.gob.ar

D.E. Udrizar Sauthier
e-mail: dsauthier18@gmail.com

G.E. Pazos
e-mail: gpazos@cenpat-conicet.gob.ar

L.J. Avila
e-mail: avilacnp@gmail.com

A. Gatto
Centro para el Estudio de Sistemas Marinos (CESIMAR), Centro Nacional Patagónico—CONICET, Boulevard Brown 2915, 9120 Puerto Madryn, Chubut, Argentina
e-mail: alegatto@cenpat-conicet.gob.ar

G.E. Pazos
Facultad de Ciencias Naturales, Universidad Nacional de la Patagonia San Juan Bosco, Boulevard Brown 3051, 9120 Puerto Madryn, Chubut, Argentina

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threats to wildlife, although Península Valdés still harbours some of the most abundant populations of wild species in Patagonia. It is a priority to implement the management plan available for Península Valdés, taking into account the interactions between biodiversity, the different human activities and the physical environment. At the same time, it is necessary to identify and implement actions to conserve wild species and habitats, and also to develop programmes for the coexistence of responsible human activities and healthy wildlife populations.

Keywords Biodiversity · Human activities · Conservation · Península Valdés · Patagonia

1 Introduction

Península Valdés is a provincial protected area "with managed resources" according to the criteria of the International Union for the Conservation of Nature (IUCN). It was declared a World Natural Heritage Site by UNESCO in 1999 and is intended to protect the landscape, natural and cultural patrimony of the area, as well as to facilitate research, promote sustainable activities compatible with conservation and maintain representative samples of terrestrial coastal and marine ecosystems (Plan de Manejo del Área Protegida Sistema Península Valdés 1999).

Península Valdés is located in the southeastern part of the Monte eco-region (Burkart et al. 1999) which comprises shrublands, grasslands and scattered, mainly temporary inland-wetlands (see Chapter "Vegetation of Península Valdés: Priority Sites for Conservation"). In terms of vegetation physiognomy and floristic composition, the Península is considered an ecotone (León et al. 1998), containing elements from both the Monte and Patagonian phytogeographic provinces (Soriano 1956; Roig et al. 2009). Accordingly, some of the major taxa of terrestrial animals found in Península Valdés are represented by species associated either to the Monte or Patagonia biota.

As an arid land, Península Valdés is home to a diverse and abundant group of arthropods—including insects and spiders—which play an important role across the trophic web. They represent a mosaic of species from both Patagonia and Monte biogeographical regions, although the arthropod assemblage as a whole is most representative of the latter.

The herpetofauna is also representative of the Monte, with some widespread species, that are common in the Patagonian steppe. Whereas, most of the birds described in the area occupy the southern part of the extensive Monte ornithological eco-region. Mammalian diversity in the Península Valdés region is today the result of a dynamic interchange of species from the two eco-regions which has taken place during the last few hundred years, being dominant Monte species.

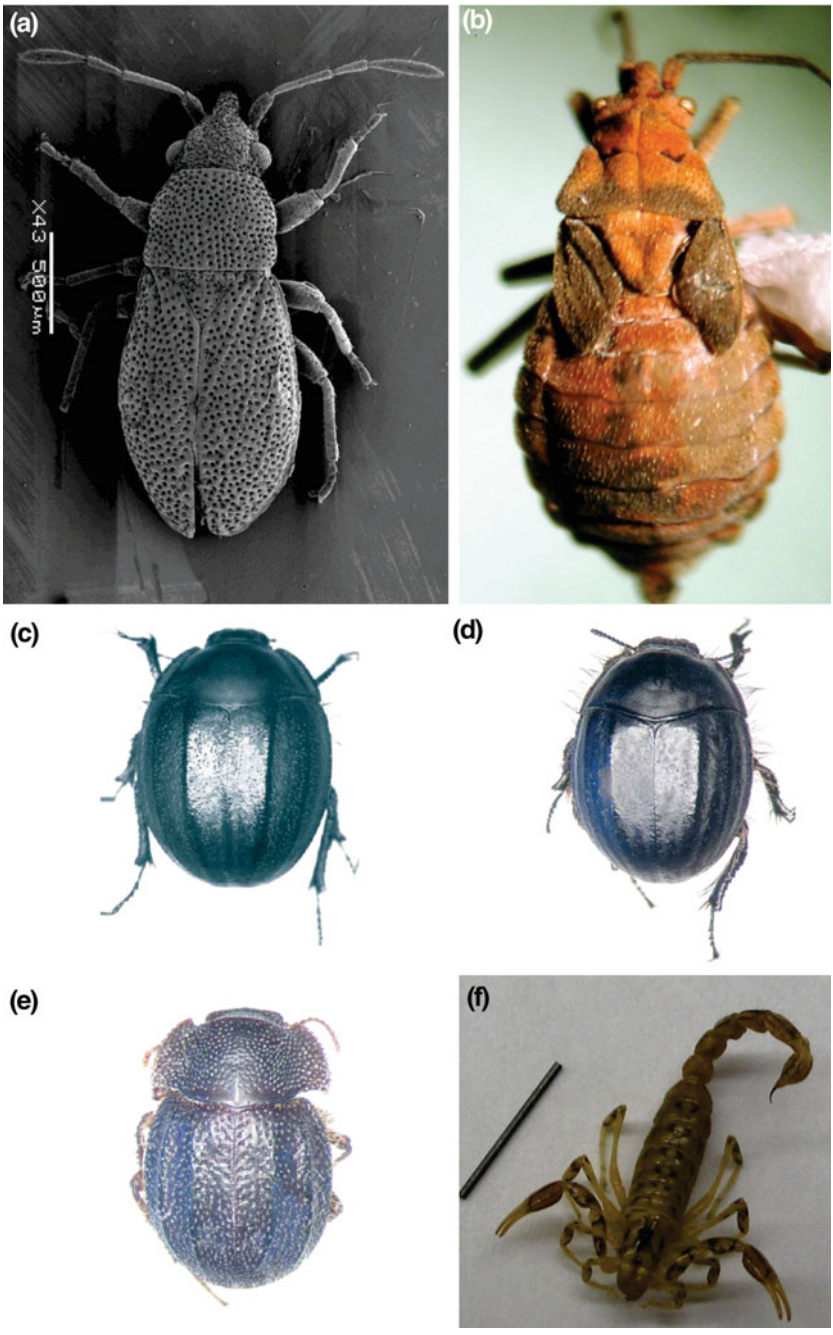
In this chapter, we summarize the available information on the arthropods, reptiles, birds and mammals that inhabit Península Valdés, while providing an insight on the main issues resulting from the interactions between human activities and wildlife which ultimately affect ecosystem functioning and conservation.

2 Patterns of Animal Diversity and Distribution

2.1 Arthropods

The terrestrial arthropods—insects and arachnids—are the most diverse and abundant animals in arid lands worldwide (Polis 1991; Ayal 2007). They act either as herbivores, predators or decomposers and thus play multiple roles across the trophic web (Flores 1998; Ayal 2007). In the Península Valdés region, around 200 arthropods species or *morphospecies* have been recorded. The use of morphospecies is the most common method implemented to improve the cost efficiency in the assessment of invertebrate biodiversity. A *morphospecies* consists of a non-formal taxonomical identity arising from invertebrate specimen sorting, using external morphological features by personnel with minimal training in formal taxonomy (non-specialist personnel), but validated by the input from specialists on critical phases of the process (Oliver and Beattie 1993, 1996, 1997; Pik et al. 1999). Several authors have shown that estimates of species richness and species turnover produced using morphospecies can be very similar to formal species estimates for a number of arthropod taxa (Oliver and Beattie 1993, 1996, 1997; Pik et al. 1999). The arthropods morphospecies comprise 18 orders and approximately 60 families of insects and arachnids (Appendix 1). Ants (Hymenoptera, Formicidae) are the most abundant arthropod taxa of Península Valdés, a group which is known by their remarkable breeding success associated with their social behaviour. Ants are followed in terms of abundance by a co-dominance of spiders (Aranea) and beetles (Coleoptera), then by *grasshoppers* and crickets (Orthoptera), *springtails* (Collembola) and sun spiders or *solifuges* (Solifugae). This pattern is coincident with the findings across other arid lands of Argentina like Chaco and Mendoza provinces, and other continents such as in South Africa and Australia (Gardner et al. 1995; Bromham et al. 1999; Molina et al. 1999; Seymour and Dean 1999; Lagos 2004). *Co-dominance patterns* are similar at lower taxonomic levels, as 60% of the hexapod abundance is accounted for by only six taxa: Sminthuridae, Tenebrionidae, Acrididae, Phloeothripidae, Carabidae y Mummusidae (Cheli et al. 2010, 2013).

Arthropod taxa *endemic* of the Península Valdés have been described recently, such as the beetle-like true bug *Anomaloptera patagonica* (Hemiptera, Oxycarenidae) (Fig. 1a) (Dellapé and Cheli 2007) and a new genus and species *Valdesiana curiosa* (Hemiptera, Miridae) (Fig. 1b) (Carpintero et al. 2008). As a result of the same investigations, a new species of scorpion, *Urophonius martinezi* (Scorpiones, Bothriuridae) (Fig. 1f) (Ojanguren-Affilastro and Cheli 2009) was described for the Península Valdés region and found outside the protected area afterwards. More recently, Flores et al. (2011) have described a new species endemic to Península Valdés, *Calymmophorus peninsularis* (Fig. 1e), and two subspecies of *Praocis* (*Hemipraocis*) *sellata* Berg 1889 [*P.* (*H.*) *sellata granulipennis* (Fig. 1c) and *P.* (*H.*) *sellata peninsularis* (Fig. 1d)], the first is distributed throughout northern Patagonia while the second is endemic to the peninsula. In fact, the knowledge of the arthropods of Península Valdés has increased significantly as a result of recent work. Studies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◀ **Fig. 1** Arthropod taxonomic novelties recorded in Península Valdés. **a** *Anomaloptera patagonica* (Hemiptera, Oxycarenidae; previously published in Dellapé and Cheli (2007), Zootaxa 1528: Fig. 1; copyright Magnolia Press, reproduced with permission); **b** The remarkable new monospecific genus of true bug *Valdesiana curiosa* (Hemiptera, Miridae; previously published in Carpintero et al. 2008, Zootaxa 1672: Fig. 1; copyright Magnolia Press, reproduced with permission); **c** *Praocis (Hemipraocis) sellata granulipennis* (Coleoptera, Tenebrionidae), paratype (previously published in Flores et al. 2011, Zootaxa 2965: Fig. 5; copyright Magnolia Press, reproduced with permission); **d** *Praocis* (*Hemipraocis*) *sellata peninsularis*, holotype (previously published in Flores et al. 2011, Zootaxa 2965: Fig. 3; copyright Magnolia Press, reproduced with permission); **e** *Calymmophorus peninsularis* (Coleoptera, Tenebrionidae), paratype (previously published in Flores et al. (2011), Zootaxa 2965: Fig. 6; copyright Magnolia Press, reproduced with permission); **f** *Urophonius martinezi* (Bothriuridae), the only scorpion species of the peninsula found to be active during the winter

conducted by Dellapé and Cheli (2007), Carpintero et al. (2008), Cheli (2009), Ojanguren and Cheli (2009), Cheli et al. (2010), Carrara et al. (2011) and Flores et al. (2011) have contributed to the first species lists of terrestrial arthropods (Appendix 1) and to the understanding of their biological diversity.

Similar to the patterns of co-dominance, diversity of terrestrial arthropods described for Península Valdés is similar to other arid lands of Argentina, such as the arid Chaco (Gardner et al. 1995; Molina et al. 1999) and Central Monte (Lagos 2004). Nevertheless, species and family richness are lower in Península Valdés than in the other areas, while the dominance of some taxa is higher—hence evenness is lower—at both taxonomic levels. Lower richness of species and families together with a higher dominance could be the result of the harsh climatic conditions prevailing in Patagonia during the last 10,000 years, which would impose limits to the survival of some of the northern species, and at the same time would favour the ability of other species like the beetle *Blapstinus punctulatus* (Coleoptera, Tenebrionidae) to use more efficiently the limited resources (Cheli et al. 2010). By applying theoretical models, Cheli et al. (2010) described a system in which an unsaturated habitat would have favoured the occupation by species with intermediate levels of niche preferences, while the intensity of migration between communities should have been important (Magurran 2004).

Studies on the theoretical distribution of species abundances suggest that few factors are dominating the ecological interactions among the arthropods in the Península Valdés region (Cheli et al. 2010). In the arid Patagonia, as in other arid lands, the main factors modelling the structure of the arthropod communities are related to the vegetation. The influence of vegetation is well documented for both Península Valdés (Cheli 2009; Martínez 2013) and other sites (Farji-Brener et al. 2002; Folgarait and Sala 2002; Mazía et al. 2006; Martínez Román 2014). Across deserts and semi-deserts, the diversity, dominance and abundance of epigeal arthropods (i.e. arthropods whose main activities are conducted above the surface of the ground, similar sense than "epigean", "epigeic", "epigeous" or "ground-dwelling") are strongly correlated with plant cover (Crawford 1988; Seymour and Dean 1999). Usually, vegetation structure is determinant of the arthropod assemblage, as it provides shelter, food, microsites for oviposition and other resources (Dennis et al. 1998; Seymour and Dean 1999; Mazía et al. 2006).

Spatial heterogeneity strongly influences the distribution of the arthropods within Península Valdés, showing different assemblages in different habitats. For example, the shrublands of the central Península Valdés region represent the most xeric environment in the area (see Chapter "Vegetation of Península Valdés: Priority Sites for Conservation"), adapted to lower rainfall. Consequently, the soils are characterized by the presence of argillic horizons of hard consistence in dry conditions (see Chapter "Soil–Geomorphology Relationships and Pedogenic Processes in Península Valdés") and support a low primary productivity, dominated by a low and homogeneous shrubland. This vegetation community is associated with a particular arthropod assemblage where the beetle *Nyctelia darwini* (Tenebronidae) is a species found solely in the central shrublands of Península Valdés. In contrast, the highest diversity of arthropods is found in coastal zones and the southern part of the area, where the precipitation is higher, and the sand-dominated soils sustain higher plant productivity (Carrara et al. 2011; Martínez 2013).

2.2 Reptiles

The knowledge on reptile diversity in Patagonia has increased considerably in recent decades after numerous studies carried out across the Monte and Patagonian steppe regions (see Minoli et al. 2015 for a general review), although Península Valdés is still not well known. After the pioneering publication by Scolaro (1976) on lizard species, Daciuk and Miranda (1980) added information about snakes and amphisbaenians. However, there is still a lack of well-designed studies to survey the herpetofauna and obtain accurate information about species diversity and distribution. In addition, the knowledge of reptiles was blurred by confusing nomenclatural problems or the lack of appropriate systematic studies for some groups, and in the last years due to changing taxonomy. The studies by Scolaro (1976), Daciuk and Miranda (1980) and Cruz et al. (1999) were affected by these changes although they are useful for a general introduction on the herpetofauna of the Península Valdés region. Recently, Minoli et al. (2015) made comments about the present status of some species in Chubut province and rectified some mistakes related to previous taxonomical classification, although the work is still at an early stage.

A total of 12 species of reptiles belonging to six families were registered in the Península Valdés region so far, including an *amphisbaenian*, five lizards and six snakes (Appendix 2). They belong to the families Amphisbaenidae (1 sp.), Liolaemidae (or clade Liolaemini, 3 spp.), Leiosauridae (1 sp.), Phyllodactylidae (1 sp.), Dipsadidae (4) and Viperidae (1). To our knowledge, most of the reptiles of Península Valdés are characteristic of the Monte biogeographic region, probably with the exception of *Homonota darwinii* and *Leiosaurus belli* (Fig. 2c) which seem to be very common across the Patagonian steppe.

Amphisbaenians are secretive, burrowing animals that usually live in bare soils. They seem to be very common in more temperate areas but surprisingly two species

Fig. 2 Most common species of reptiles found in Península Valdés: **a** *Phylodrias trilineata*; **b** *Liolaemus melanops* (male); **c** *Liolaemus darwinii* (male); **d** *Liolaemus gracilis*; **e** *Phylodrias patagoniensis*; **f** *Leiosaurus bellii*. Pictures (**b**) and (**f**) by Jared A. Grummer, all others by Grupo de Herpetología Patagónica

reach Patagonia, *Anops kingii* and *Amphisbaena plumbea*. The first species, *A. kingii* is the only amphisbaenian ever registered in Península Valdés, as Daciuk and Miranda (1980) recorded this small, fossorial, earthworm-like reptile at the Istmo Carlos Ameghino. *A. kingii* is usually found in bare soil sites, and frequently along the sandy coastal areas. The other amphisbaenean species, *A. plumbea*, is slightly larger and was registered as far as Punta Tombo—over 200 km south from Península Valdés—by Cruz et al. (1999) and in northern Chubut by Avila et al. (2007) but never around the Península Valdés, although this could be a matter of lack of collected specimens rather than the absence of suitable habitats.

Other Squamata of Península Valdés belong to three families: Phyllodactylidae (*H. darwinii*), Leiosauridae (*L. belli*) and Liolaemidae (*Liolaemus melanops*, *L. darwinii* and *L. gracilis*, Fig. 2b, c, d). All species are common in sandy habitats along the coastal areas (i.e. Coastal Zone system; see Chapter "Late Cenozoic Landforms and Landscape Evolution of Península Valdés"), but less common in the central areas of the peninsula (i.e. Upland and plains system and Grreat endhoreic basin system; see Chapter "Late Cenozoic Landforms and Landscape Evolution of Península Valdés"). However, this could result from an insufficient sampling effort, the lack of suitable sites or else habitat modification after overgrazing by the domestic sheep. *Homonota darwinii* is a small, crepuscular, oviparous and insectivorous species that is usually found below natural or artificial objects, but probably lives in burrows, in cavities around roots of shrubs or grass bunches, as well as in rock crevices on coastal cliffs. Nominal species have a wide geographic distribution across Patagonia, spanning from Santa Cruz to Mendoza provinces, but recent studies evidence highly fragmented populations, as populations from the Atlantic coast north of the Río Chubut—which reachs the sea 100 km south from Península Valdés—showed clear genetic differences with the southernmost Patagonian Steppe populations (Morando, unpublished data). The only representative of the Leiosauridae family is a large, stout, oviparous, insectivorous and diurnal but very inconspicuous species of Leiosaurus, *L. belli* (Fig. 2f). It is common in shrub-dominated areas where numbers can be very high (Udrizar Sauthier et al. 2007) but difficult to detect due to its behaviour and well-adapted body coloration to shrubby habitats. As described for *H. darwinii*, *L. belli* has a wide geographic distribution across the Austral Monte and the Patagonian Steppe. Liolaemids are the most important group of lizards of southern South America in terms of species richness, but species diversity and population densities seem to be higher in the central plateaus of Patagonia than in the Atlantic coast. Despite the citations of several other species for Península Valdés, only three are confirmed: *L. melanops*, *L. darwinii* and *L. gracilis* (Fig. 2b, c, d). The first two species belong to the Eulaemus subclade (or subgenera), while *L. gracilis* is part of the *Liolaemus* sensu stricto clade or subgenera (or *chiliensis* group), all species endemic to the Austral Monte biogeographical region. As well as the majority of the species of this group they are diurnal, insectivorous, and oviparous species, the first two showing a remarkable sexual dichromatism almost unnoticeable in *L. gracilis*. Usually, the five species of lizards (Squamata) can be found together in the same location when conditions seems to be suitable, mainly at sites where dunes or sandy soils are

combined with the presence of well preserved grasses and shrubs, but is more common to observe only one or sometimes two species in syntopy (i.e. the joint occurrence of two species in the same habitat o geographic place at the same time).

As discussed by Minoli et al. (2015), previous records of species such as *L. boulengeri*, *L. kingii*, *L. xanthoviridis* or *L. goestchi* at Península Valdés are erroneous. Likewise, species found at very close localities in the continental area were not found in the peninsula, such as *Cnemidophorus longicauda* which is probably the most austral teiid lizard in the world (Yokes et al. 2006). Although the southernmost record is relatively recent (Frutos et al. 2005), the species was observed several years ago in coastal dunes of Golfo Nuevo close to Puerto Madryn (Avila, unpublished data). Thus, we can expect to find the species in similar habitats along Península Valdés; however, populations of this species seem to be very small and difficult to find. *Liolaemus boulengeri* was cited by Scolaro (1976) for Salina Grande but never recorded afterwards. *Liolaemus boulengeri* was observed along the coast of Puerto Madryn over 20 years ago (Avila, unpublished data) but was extirpated by human development, although today it is present in some locations next to the city (Cruz et al. 1999). There is no evidence of the presence of the species in the Península Valdés region.

Snakes in Península Valdés belong to two families, Dipsadidae (*Clelia rustica*, *Pseudotomodon trigonatus*, *Phylodrias trilineata* (Fig. 2a), *P. patagoniensis*) (Fig. 2e) and Viperidae (*Bothrops ammodytoides*). The last three species are commonly found in Península Valdés. Previous work indicates that the first two reach only the isthmus (Daciuk and Miranda 1980). However, this could be due to the lack of sampling instead of a real absence of *C. rustica* and *Pseudotomodon* from Península Valdés. *Phylodrias* species are diurnal, oviparous and active hunters, they feed on small mammals, birds and lizards, preys that are very common around the area. *Bothrops ammodytoides* is the southernmost Viperidae snake of the world and seems to be very common in this region, but southern populations of this species are barely known. In general, snake populations occur at very low densities in Patagonian habitats, records of *C. rustica* and *P. trigonatus* are scarce and limited to the isthmus region, as stated above. Other species were registered along the years in continental localities very close to Península Valdés but never found inside the area, as *Phalotris bilineatus*, *Oxyrhophus rhombifer* and *Erythrolamprus saggitifer saggitifer* (Cei 1986; Scolaro and Cei 1979; Avila et al. 2001; Scolaro 2006; Carrera and Avila 2008a, b; Avila 2009).

2.3 Birds

Although the Monte and Patagonian Steppe eco-regions are arid ecosystems which differ in terms of physiognomy and dominant plant species (see Chapter "Vegetation of Península Valdés: Priority Sites for Conservation"), they do not impose geographic barriers for birds. Thus, several bird species common to both regions can be found at Península Valdés (Haene 2004). Terrestrial birds of these

environments are coloured similar to the landscape which is dominated by patterns of browns and greys; they rarely form aggregations but occur generally dispersed, showing evasive behaviours. In contrast, diverse and coloured waterbird species—some of them forming large flocks—can be found associated with the inland-wetlands across the landscape.

There are no published studies assessing the occurrence of land bird species throughout Península Valdés, and most of the available information is limited either to non-exhaustive checklists, studies restricted to some particular groups (e.g. Pruscini et al. 2014) or species (e.g. Daciuk 1978; Baldi et al. 2015), restricted to limited areas (e.g. Daciuk 1977, 1979; Codesido et al. 2005; Krapovickas et al., unpublished data), or species observed occasionally or potentially present in the area due to their expected distribution ranges (Narosky and Izurieta 2004; Kovacs et al. 2005; Harris 2008; De la Peña 2013). We provide a plausible and updated list of terrestrial and inland-wetland birds for the Península Valdés region by integrating published and unpublished sources (see Appendix 3). It is important to note that the species of seabirds, shorebirds and water birds that usually occur in salt marshes, intertidal zones and adjacent marine habitats were not included in this list. There are 139 species of birds registered regularly in Península Valdés, belonging to 36 families and 18 orders [following the systematic by Remsen et al. (2015)]. The most represented families are Tyrannidae, Furnariidae and Thraupidae for terrestrial birds and Anatidae and Scolopacidae for inland-wetlands birds. The shrublands and grasslands of Península Valdés offer a suitable habitat for ratite birds like the lesser rhea (*Rhea pennata*) (Fig. 3e) and tinamous (Fig. 3g), insectivorous birds like Earthcreepers (Fig. 3c, d), Canasteros and Monjitas; granivorous birds like finches and the Rufous-collared sparrow (*Zonotrichia capensis*) (Fig. 3b); and several species of diurnal and nocturnal raptors. Salinas (Playa lake; see Chapter "Late Cenozoic Landforms and Landscape Evolution of Península Valdés") are regularly deluged attracting water birds like flamingos and phalaropes, while the adjacent wetlands or 'mallines' associated with the drain systems offer habitat for geese and ducks. After rainfall, several temporary ponds and small lagoons (i.e. small to medium closed basins; see Chapter "Late Cenozoic Landforms and Landscape Evolution of Península Valdés") become flooded and it is possible to find several anatids, grebes and coots. Some persistent ponds and permanent water points provide habitat for birds as aquatic plants are well established and it is likely to observe rails, such as the Austral Rail (*Rallus antarticus*) which was rediscovered in Patagonia and reported for Península Valdés (Mazar Barnett et al. 1998; Pugnali et al. 2004).

Four endemic bird species are commonly found in Península Valdés: the Band-tailed Earthcreeper (*Ochetorhynchus phoenicurus*) (Fig. 3d), the Patagonian Canastero (*Pseudasthenes patagonica*), the White-throated Cacholote (*Pseudoseisura gutturalis*) (Fig. 3a) and the Rusty-backed Monjita (*Xolmis rubetra*), which make up 25% of the bird species endemic of Argentina (see López-Lanús et al. 2008). Approximately 70% (100 species) of the species recorded at Península Valdés are considered resident, while three show partial, seasonal movements, mainly northwards during the autumn (see Appendix 3). The other 36 species are

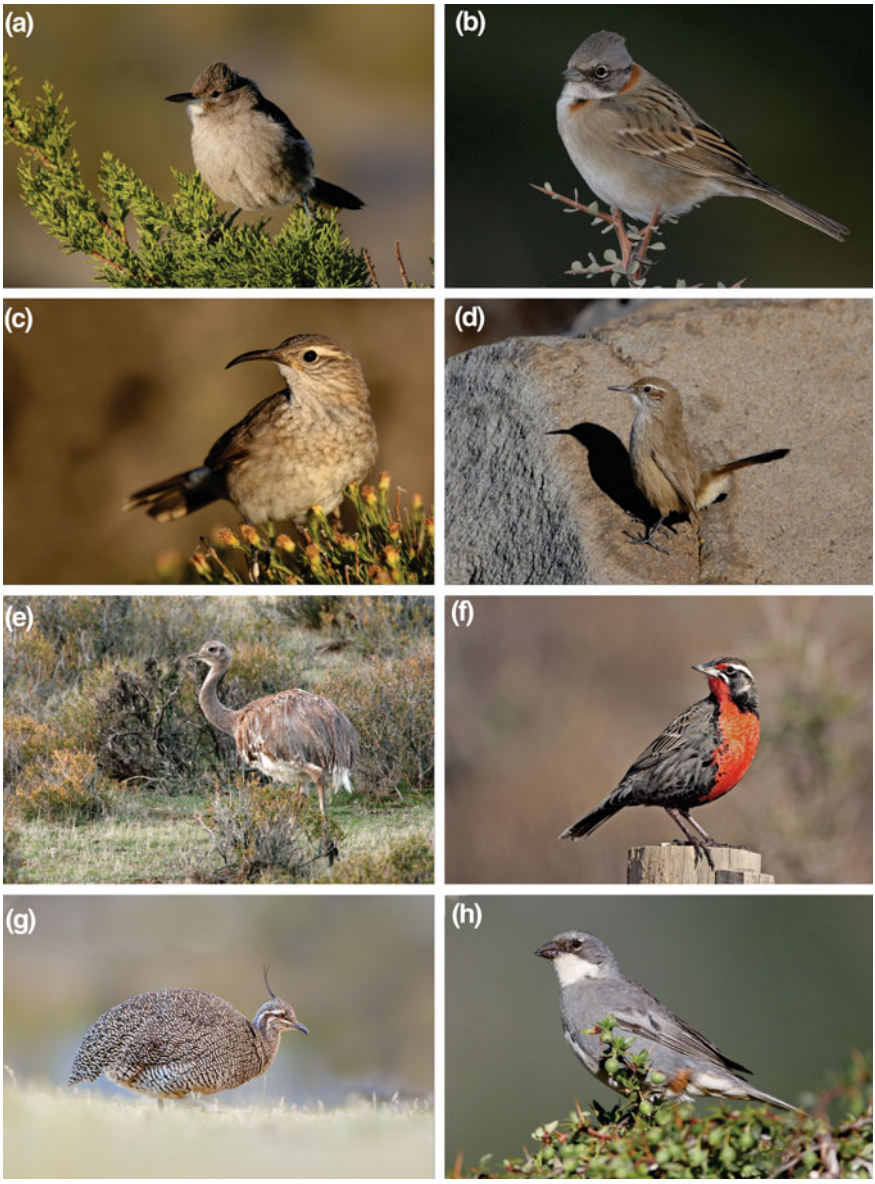

Fig. 3 Representative land birds of Península Valdés. **a** White-throated Cacholote (*Pseudoseisura gutturalis*); **b** Rufous-collared Sparrow (*Zonotrichia capensis*); **c** Scale-throated Earthcreeper (*Upucerthia dumetaria*); **d** Band-tailed Earthcreeper (*Ochetorhynchus phoenicurus*); **e** Lesser Rhea (*Rhea pennata pennata*); **f** Long-tailed Meadowlark (*Sturnella loyca*); **g** Elegant Crested-Tinamou (*Eudromia elegans*). Photographs by Darío Podestá

migratory: ten Neoartic, four Neotropical and 22 Austral migrants (see Appendix 3). At least two species found in the Península Valdés region fall within the range of categories of conservation concern according to the *IUCN criteria* (López-Lanús et al. 2008), as the Austral rail and the Yellow cardinal (*Gubernatrix cristata*) are classified as endangered (BirdLife International 2012). Although classified as of least concern, the Ruddy-headed goose (*Chloephaga rubidiceps*), the Ashy-headed Goose (*Chloephaga poliocephala*), the Rufous-chested dotterel (*Charadrius modestus*), the Upland goose (*Chloephaga picta*), the Elegant crested-tinamou (*Eudromia elegans*) (Fig. 3g), the Hudson's black-tyrant (*Knipolegus hudsoni*), the White-throated cacholote and the Rusty-backed monjita were reported to be decreasing (BirdLife International 2012). There are two introduced species forming wild populations associated to human settlements, like the Rock pigeon (*Columba livia*) and the House sparrow (*Passer domesticus*). Other species, like thrushes, are currently expanding their distribution southwards due mainly to habitat modification by humans (Pérez et al. 2006; Veiga et al. 2010).

Information on the abundance of terrestrial and inland-wetland birds of Península Valdés is scarce, and limited to conspicuous species like the lesser rhea. Recently, Baldi et al. (2015) found that the abundance of this species in the Península Valdés region was low, averaging 0.28 adults/km^2. Lesser rheas tended to be more common in open grasslands than in shrublands, and also where sheep ranching does not take place (Baldi et al. 2015). For example, ongoing work conducted at a sheep-free site —a private reserve (San Pablo de Valdés)—estimates densities between 2.2 and 3.6 rheas/km^2 (Fernández and Geremías Toscano, unpublished data). The Elegant crested-tinamou appears to be much more abundant than the lesser rhea although this is to be expected as the body size of the tinamou is much smaller than that of the rhea. Densities of passerines found in southwest of the Península Valdés were estimated in 10–160 individuals/km^2 (Krapovickas et al. unpublished data), lower to the estimates available for the central part of the Monte eco-region (131–1091 indivuduals/km^2, Lopez de Casenave 2001). The most abundant passerines in Península Valdés included the Rufous-collared sparrow, the Patagonian mockingbird (*Mimus patagonicus*), the Plain-mantled Tit-spinetail (*Leptasthenura aegithaloides*), the Short-billed pipit (*Anthus furcatus*), the Common miner (*Geositta cunicularia*), the Long-tailed Meadowlark (*Sturnella loyca*) (Fig. 3f) and the austral migrant Common Diuca-finch (*Diuca diuca*) (Pruscini et al. 2014; Krapovickas et al. unpublished data). There is no information on the abundance neither of raptors nor inland-wetlands birds in Península Valdés. However, some of the species commonly observed include the Variable hawk (*Geranoaetus polyosoma*), the American kestrel (*Falco sparverius*), the Chimango caracara (*Milvago chimango*), the Burrowing owl (*Athene cunicularia*), the Chilean flamingo (*Phoenicopterus chilensis*) and the Crested duck (*Lophonetta specularioides*).

Independently of the season, the mixed steppes of shrublands and grasslands showed the highest species richness and abundance (Krapovickas et al. unpublished data). In contrast, the herbaceous steppes appeared associated with the lowest species richness and abundance, possibly due to the limited availability of perching and nesting substrates (Pruscini et al. 2014; Krapovickas et al. unpublished data).

Seasonal and inter-annual fluctuations in the structure and abundance of birds assemblages found in the southwestern part of Península Valdés are remarkable (Krapovickas et al. unpublished data). Spring is the most diverse season, as it includes the presence of several migrant species. Although restricted to one spring season studied, Pruscini et al. (2014) found two different assemblages of passerines which could be characterized, one for the herbaceous steppe and another for the shrub steppes, while two additional assemblages combining species from the former two were described for mixed steppes. Nevertheless, it is important to notice that the natural history of the birds of Península Valdés is poorly known, and it is a priority to increase the scientific knowledge on these species' ecology, their adaptations to a rigorous environment, and to assess the threats they are facing to plan appropriate conservation actions.

2.4 Mammals

Twenty three species of native terrestrial mammals have been recorded in Península Valdés, as well as five species of wild introduced mammals (Appendix 3). The native mammals comprise 6 orders and 12 families. Rodents are the most diverse group with 10 species, there are seven species of carnivores, two species of bats, two species of armadillos, one species of marsupial and one species of artiodactyl (Nabte 2010). According to recent studies, the mammalian assemblage of the Península Valdés region has changed significantly during the last 1000 years (Udrizar Sauthier 2009; Udrizar Sauthier and Nabte 2012; Abba et al. 2014; Prevosti et al. 2015; Formoso et al. 2015). Moreover, substantial changes in species composition involved different groups without close phylogenetic relationship among them like the marsupials, carnivores and armadillos.

Almost 1600 years ago, the southernmost living marsupial, the Patagonian opossum (*Lestodelphys halli*), inhabited Península Valdés since its osteological remains were frequent in Holocene mammal assemblages (Udrizar Sauthier 2009; Formoso et al. 2015). Although *L. halli* is still common across the Patagonian steppe, it is not part of the extant mammalian fauna of Península Valdés (Massoia et al. 1988; Pardiñas et al. 2001; Nabte et al. 2008; Udrizar Sauthier and Pardiñas 2006; Trejo and Lambertucci 2007). Among the carnivores, the Patagonian weasel (*Lyncodon patagonicus*) is frequently associated with Patagonian steppes (Schiaffini et al. 2013) but it has not been recorded at Península Valdés recently, despite intensive surveys and interviews to local residents. Instead, the Patagonian weasel was abundant in Península Valdés a few hundreds to a few thousands years ago (Udrizar Sauthier and Nabte 2012). The fox *Dusicyon avus* became extinct in South America during the last few hundred years (Prevosti et al. 2015) and it is the canid most frequently found in the Holocene assemblages of the Península Valdés region (Carrera and Udrizar Sauthier 2011), sharing the area with other two foxes, the South American grey fox (*Lycalopex gymnocercus*) (Fig. 4c) and the culpeo (*Lycalopex culpaeus*) are both present in Península Valdés today (Nabte 2010).

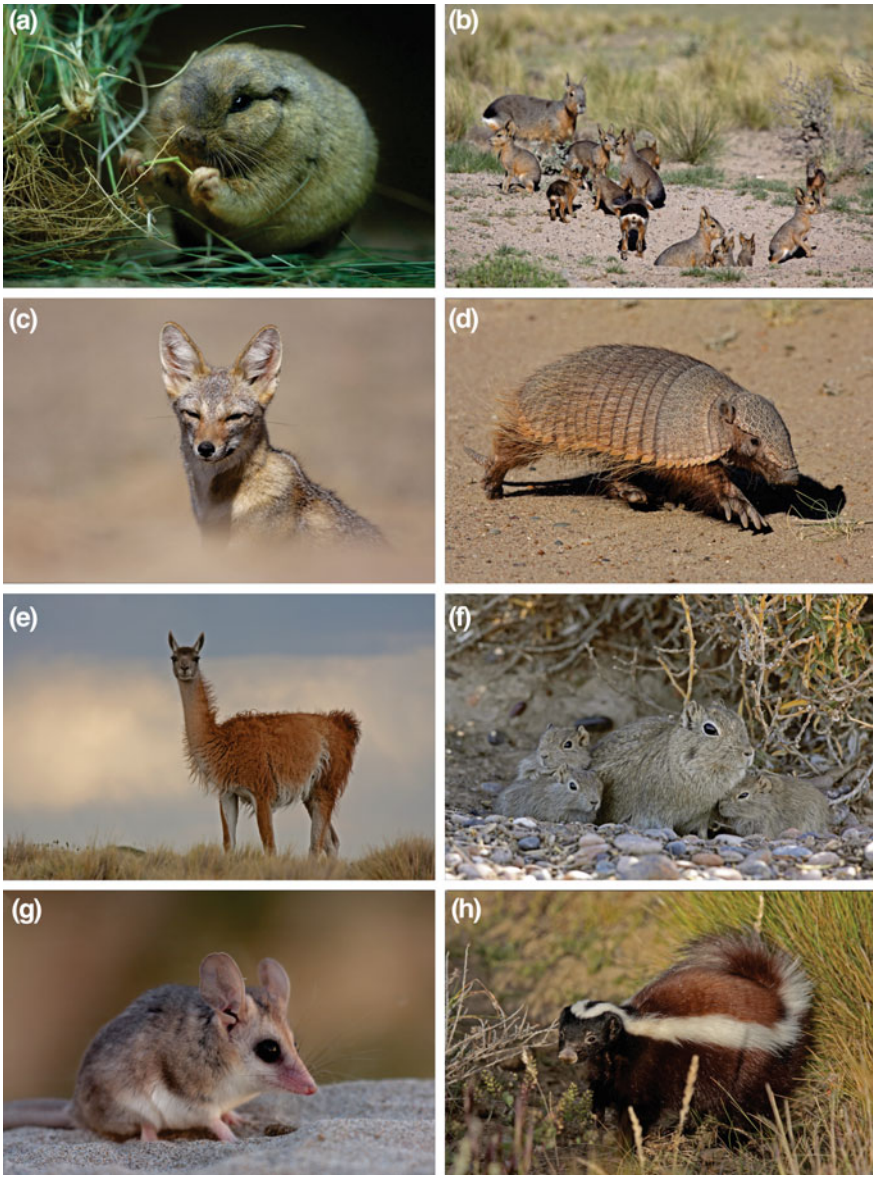

Fig. 4 Charismatic terrestrial mammals of Península Valdés. **a** Tuco-tuco (*Ctenomys* sp.); **b** Mara (*Dolichotis patagonum*); **c** South american grey fox (*Lycalopex gymnocercus*); **d** Big hairly armadillo (*Chaetophractus villosus*); **e** Guanaco (*Lama guanicoe*); **f** Southern mountain cavy (*Microcavia australis*); **g** Palid fat-tailed opossum (*Thylamys pallidior*); **h** Molina's hog-nosed skunk (*Conepatus chinga*). Photographs by Darío Podestá

The culpeo fox would have occupied Península Valdés a few hundred years ago, as suggested by its absence or occasional presence in the carnivore assemblages of the past, and in accordance with the hypotheses of a recent expansion of the species towards eastern Patagonia (Crespo and de Carlo 1963; Novaro 1997). The other recent incomer in the Península Valdés region is the Big hairy armadillo (*Chaetophractus villosus*) (Fig. 4d), perhaps sometime during the last 300 years as suggested by historic data and the study of remains from the Holocene (Crespo 1974; Abba et al. 2014), sharing the area with the other armadillo species, the pichi (*Zaedyus pichiy*), which is apparently declining in numbers (Nabte 2010).

Although there is no evidence of changes in the composition in the assemblages of rodents, some species often related to the Monte Province like the Eastern Patagonian laucha (*Eligmodontia typus*), the Drylands vesper mouse (*Calomys musculinus*), the dolores grass mouse (*Akodon dolores*) and the grey leaf-eared mouse (*Graomys griseoflavus*) have increased their abundance in present times, while others like the Bunny rat (*Reithrodon auritus*) and the Tuco-tucos (*Ctenomys* spp.) (Fig. 4a) have decreased compared to their abundance in the assemblages of the past, 1000 year ago (Udrizar Sauthier 2009, unpublished data).

The distribution and abundance of mammals inside Península Valdés is not homogeneous and result from several factors such as vegetation structure, geomorphology and human activities among others interacting elements. For example the Pallid fat-tailed opossum *Thylamys pallidior* (Fig. 4g) occupies most of the area, although it is clearly more frequent in the western and northern parts of the peninsula where the Monte vegetation (see Chapter "Vegetation of Península Valdés: Priority Sites for Conservation") prevails (Formoso et al. 2011). While the Big hairy armadillo is more common in the north, the Pichi is more abundant in the southern portion of Penínusla Valdés (Abba et al. 2010), where grasslands are abundant (see Chapter "Vegetation of Península Valdés: Priority Sites for Conservation"). Instead, the distribution of the two species of bats *Tadarida brasiliensis* and *Histiotus montanus* is affected mainly by the availability of shelter sites which are mainly provided by human infrastructure like the shearing sheds, where these animals are commonly found (Udrizar Sauthier et al. 2013). While some carnivore species like the Grey fox, the Hog-nosed skunk (*Conepatus chinga*) (Fig. 4h) and the Lesser grison are widely distributed within Península Valdés (Carrera et al. 2012); the felids show a different pattern. For example, the Puma (*Puma concolor*) which occurs occasionally in Península Valdés, is restricted to sites where the topography is uneven, with canyons and ravines leading to the beaches surrounding the peninsula (D'Agostino et al. 2015) and avoids the more flat, central steppes. Instead, the smaller Geoffroy's and Pampas cats (*Leopardus geoffroyi* and *L. colocolo*) are distributed in the northern and southern sectors of the peninsula, respectively (Nabte 2010). Regarding the Culpeo fox, records are scarce and limited to the southern grasslands of Península Valdés (D'Agostino et al. 2015).

The small mammal assemblage is similar to that of the Monte eco-region (Udrizar Sauthier and Pardiñas 2014). Although species distribution and habitat selection patterns are not well known, ongoing studies by Udrizar Sauthier (unpublished data) are revealing that the Eastern Patagonia laucha (*Eligmodontia*

typus) is the most abundant and commonly distributed across the whole area. While the Bunny rat and Tuco-tucos are more abundant in the grass-dominated sandy soils of southern Península Valdés, the Grey leaf-eared mouse prefers the shrub-dominated communities of the west and north part of the peninsula. The Dolores grass mouse (*Akodon dolores*) is common in coastal halophytic shrublands of Península Valdés (Nabte et al. 2009), while other mouse species such as the Drylands vesper mouse (*Calomys musculinus*) and the Intelligent field mouse (*Akodon iniscatus*), which have been associated to the Monte eco-region (Pardiñas 2009; De Tommaso et al. 2014), are found in most habitat types across the peninsula (Udrizar Sauthier unpublished data). The small cavies *Galea leucoblephara* and *Microcavia australis* (Fig. 4f) are not very abundant and they are mostly found in shrub-dominated areas (Udrizar Sauthier et al. 2015), while the largest rodents, maras *Dolichotis patagonum* (Fig. 4b) are abundant across Península Valdés and prefer open grass-dominated sites to set their breeding dens (Baldi 2007). The only native ungulate is the guanaco (*Lama guanicoe*) (Fig. 4e) which is abundant and can be found in most of the area, although variation in numbers is mostly related to the presence of sheep and human activities (Baldi et al. 2001).

3 Human Activities and Their Effects on Wildlife Populations

The patterns of animal diversity and the ecological processes taking place today in Península Valdés cannot be described without considering the human factor. Although Península Valdés was inhabited by humans more than 5000 years ago (see Chapter "Archaeology of the Península Valdés: Spatial and Temporal Variability in the Human Use of the Landscape and Geological Resources"), a major transformation started in the 1880s when the first European settlers arrived to the area bringing the domestic sheep (Coronato 2010). Since then, sheep ranching has been the main economic activity carried out in the terrestrial ecosystems of the Península Valdés region. As for most of the arid Patagonia, the division of the land fenced into properties and paddocks (the minimum units of land divided by fences), and the extensive grazing by thousands of sheep on the native vegetation resulted in an entirely new environment, both in terms of habitat modification and the relationships between humans and wildlife. The native herbivores were perceived as potential competitors and the carnivores as predators of the sheep; therefore they were chased or hunted. The significant increase in the biomass of herbivores affected the vegetation, the soil and the major ecological processes as in other arid lands in the world (Milchunas and Lauenroth 1993; Reynolds and Stafford Smith 2002). However, during the 1960s Península Valdés became a world attraction for tourists and called the attention on its conservation values, which led to the creation of the first coastal reserves and subsequently to the declaration of UNESCO World Natural Heritage Site for the entire area. At the same time, the rapid growth of human populations in Puerto Madryn and Puerto Pirámides resulted in an increased

pressure for the recreational use of the area. Likewise, the conservation of its wildlife, the habitat and the ecological processes involved needs to be undertaken within the framework of a complex socio-ecological system, which is still unique for its wilderness and natural value.

In the Monte ecoregion, overgrazing by livestock is the main human-related factor causing ecosystem disturbance, followed by wildfires and logging (Pol et al. 2006). Although the effects of sheep grazing on the vegetation of Península Valdés have been scarcely addressed in the ecological literature, some studies allowed the identification of specific effects at different scales. Elissalde and Miravalles (1983) surveyed all the vegetation units (see Chapter "Vegetation of Península Valdés: Priority Sites for Conservation") and reported a reduction in the abundance of herbivore-preferred plant species at sites with higher sheep-stocking rates. On the basis of a four-category scale of vegetation condition, they concluded that more than 80% of the surveyed areas were either in poor or regular condition. These patterns at community scale are coincident with recent findings by Burgi et al. (2012), who found that ground cover and species richness of palatable grass species across four vegetation communities were higher in sites after 5 years of sheep exclusion than in neighbouring rangelands, where sheep grazing continued.

At landscape scale, two studies revealed patterns of environmental degradation related to the distance to artificial watering points [i.e. *piosphere* sensu Andrew (1988)]. Blanco et al. (2008) found that the abundance and spatial aggregation of blowouts occurring in grass steppes of the southern Península Valdés were higher near artificial water points, where grazing pressure is higher (see Chapter "Soil Degradation in Peninsula Valdes: Causes, Factors, Processes, and Assessment Methods"). Moreover, in northern shrub-grass steppes of the area, Cheli et al. (unpublished data) found increasing cover of perennial grasses, a higher vertical complexity of vegetation patches and microtopography with increasing distance from the water point. On the contrary, the cover of bare soil and soil compaction were higher in areas up to 800 m away from permanent water points.

The principal threats to native wildlife in the Península Valdés region are habitat degradation due to overgrazing by livestock, competition for resources with and disease transmission from livestock and poaching. Sheep ranching, including the direct effects of sheep on the habitat and the human activities associated with ranch and livestock management, is an important factor explaining patterns of animal abundance.

Habitat loss due to changes in vegetation communities and soil erosion, following sheep overgrazing or other human activities, are major threats for the arthropods of Península Valdés. Cheli et al. (2010) found that the communities of epigeal arthropods in the Península Valdés regions are dominated by predators. Comparative studies across areas with and without livestock grazing in Argentina have shown that the dominant arthropods are detritivorous and predators, respectively (Gardner et al. 1995; Molina et al. 1999; Lagos 2004). Thus, sheep grazing is likely to have had an important effect on the arthropod assemblage in Península Valdés. In fact, the general response in relation to grazing pressure appears to be an increase in the abundance of some taxa such as Coleoptera and Formicidae in areas

with higher sheep abundance, while community structure and diversity varied among the different groups of arthropods, probably due to the effects of habitat modification on the life strategies of different species (Cheli 2009).

In semiarid and arid ecosystems, the vegetation structure and composition, i.e. the architecture of shrubs, grass and herbaceous plants, offer a great variety of habitats and niches to sustain reptile diversity. However, intensive human land use practices like widespread sheep ranching and, at specific sites, use of all terrain vehicles and other recreational activities have altered the vegetation composition and structure in several places of Península Valdés. Extensive grazing leads to a reduction of the perennial and herbaceous vegetation cover, which results in an increased availability of bare soil, allowing for rapid wind and water erosion with the subsequent loss of habitat that can maintain populations of reptiles, arthropods, birds and small mammals. There are no assessments on the response of the reptile community of this region, but by inferring results obtained for other sites we can assume that wild populations are smaller and probably threatened in some areas.

As it was described above, lesser rheas are large, conspicuous birds for which recent estimates of abundance have been reported as low for Península Valdés and other sites in Patagonia (Baldi et al. 2015). Ongoing studies modelling the spatial variation in their abundance within Península Valdés are showing that human-related factors such as the distance to ranch buildings are negatively related to the abundance of lesser rheas (Antún and Baldi, unpublished data). The avoidance of human dwellings by lesser rheas could be associated with activities such as hunting and egg collection for consumption. Regarding smaller birds like the passerines, selective shrub logging for firewood could be affecting the abundance and quality of potential nest substrates. The annual rate of clearance of native vegetation in northeastern Patagonia has been estimated at 3.7%, a rate ten times higher than the average 0.4% rate of loss for global tropical rainforest (Balmford et al. 2003; Pezzola et al. 2004).

Studies on maras conducted in Península Valdés have shown that they are monogamous and *breed communally*, an unusual combination among mammals (Taber and MacDonald 1992a). Clusters of breeding warrens were associated with relatively large clearings, usually surrounding shepherds outstations (Taber and MacDonald 1992b). Although isolated warrens occurred also in shrubby areas, they were frequently located in small clearings in the bush (Taber and MacDonald 1992b). Also, mara pups born in warrens located in open habitats had higher survival than pups born in warrens located in closed habitats (Baldi 2007). More recently, it was shown that the location of breeding warrens was associated both with the presence of clearings and elements of infrastructure, but also close to shrub-dominated vegetation patches (Alonso Roldán 2012). Communal breeding at open sites would allow improved vigilance against predators and the early response both of mara pups to enter to the breeding warrens and the adults to run and hide in the bush. Thus, the availability of human dwellings and infrastructure could favour the local presence of maras in Península Valdés, although the costs associated with human activities are not yet known. Even when there is some evidence that maras

are hunted by locals (Taber and MacDonald 1992b), they are not perceived as a pest as other wild species like guanacos and carnivores.

In Península Valdés, the guanaco was the solely ruminant ungulate since the Pleistocene until the introduction of the domestic sheep. Although sheep of the merino breed weigh around 40–60 kg compared to 80–120 kg for adult guanacos, body sizes of both are well within the range of what Jarman (1974) defined as species of *intermediate selectivity* in terms of their foraging strategies. Both guanacos and sheep include important proportions of mono and dicotyledoneous plants —roughly, grasses and shrubs—in their diets. In a comparative study across different sites, some of them located in shrublands and grasslands of Península Valdés, Baldi et al. (2004) concluded that the potential for competition between guanacos and sheep was high, since the diet of both herbivores overlaps markedly, especially in summer when food resources are scarcer. Interspecific competition was evident since the spatial variation in guanaco abundance was negatively related to sheep density and, at some sites, shifts to "sheep-empty" habitats by guanacos occurred after landowners moved the livestock to other paddocks (Baldi et al. 2001). Sheep densities were found to be positively related to the abundance of key forage plants for both herbivore species, while guanaco densities, presumably as a result of competition, were negatively related to the abundance of the same plants (Baldi et al. 2001). Subsequent studies found different lines of evidence on the negative effects of sheep ranching on guanacos at different spatial scale, both for Península Valdés and other sites across Patagonia. For example, a large-scale survey conducted across Santa Cruz province has shown that sheep densities affected negatively the probability of finding guanacos, which were restricted to the less productive areas (Pedrana et al. 2010). In Península Valdés, Nabte et al. (2013) found that the abundance of guanacos was inversely related to sheep-stocking rates and correlates of primary productivity in multiple paddocks across the whole area.

As expected from the evidence on *interespecific competition* (Baldi et al. 2001), the removal of all the sheep from a former ranch that was converted into a wildlife reserve (San Pablo de Valdés) led to the steady increase in guanaco abundance up to the highest value reported for a site in Península Valdés within 10 years (Marino et al. in press). Recent surveys of guanacos and sheep in Península Valdés following a model-based analysis are showing that the abundance of guanacos is negatively affected by sheep numbers, and to a lesser degree by the distance to windmills and to the nearest fences. Also, they are more abundant as paddock area increases, and where mean annual plant productivity is lower (Antún et al. 2015).

Although guanacos still face several threats in Península Valdés, their numbers have increased markedly over the last 20 years. Available estimates for the entire area gave account of an average density of 0.6 guanacos/km^2 (Baldi et al. 1997) after legal commercial hunting terminated in 1992 and before Península Valdés was declared World Heritage Site in 1999. During the period following the termination of legal hunting, the highest densities within the area were estimated to be around 3 guanacos/km^2 (Baldi et al. 2001). The abundance of guanacos continued to increase, as the average density for the whole area was 4 guanacos/km^2 10 years

later (Baldi et al. 2009) and subsequently increased to 7 guanacos/km^2 recently (Antún et al. 2015).

The principal threat to carnivores is hunting, both retaliatory killing or to prevent predation or presumed predation on domestic animals, especially on lambs. However, there are no studies on the effects of sheep ranching and human activities on carnivores in Península Valdés. Predators like the culpeo fox are very rare in Península Valdés, and pumas are chased and killed when detected. Although the occasional presence of pumas does result in active persecution by ranchers allegedly to protect their sheep, the occurrence of attacks has not been documented in recent years. However, sheep were as important as guanacos in the diet of pumas at a coastal site in Golfo San Matías located at 60 km NW from Península Valdés, where *stocking rates* were similar to the density of guanacos. Within 3 years the sheep were removed from this ranch and pumas responded by increasing the number of smaller prey in their diet, while guanaco densities remained constant (Fernández and Baldi 2014). Some rural workers kill the smaller cats, foxes and mustelids, allegedly because they prey on lambs, although the impact has not been assessed in Península Valdés. Also, a common practice to kill predators is to spread poisoned meat and eggs which kills not only carnivores but also birds of prey, armadillos and scavengers.

For other sites across Patagonia, spatially heterogeneous hunting pressure affects the demography and dispersal patterns of Geoffroy's cats (Pereira and Novaro 2014) and culpeo foxes. Hunting pressure can affect recolonisation rates of the carnivores, and particularly for species with large home ranges and dispersal patterns like pumas which are under a regional system of bounty hunting in different Patagonian provinces (Novaro et al. 2005; Walker and Novaro 2010).

4 Perspectives and Future Work

4.1 Conservation and Management

Compared to other sites in the region, Península Valdés still harbours significant numbers of native herbivore species like the guanaco, the lesser rhea and the endemic mara. Also, two near-threatened felid species, the Geoffroy's and Pampas cats are present across the area, whereas the presence of pumas is occasional. Other small predators include the Grey fox, the lesser grison and, potentially, the very rare Patagonian weasel. Several arthropod species are endemic to the peninsula, as well as there are endemic birds including two endangered species. There are raptors such as eagles, harriers, kites and hawks, a seemingly diverse inland-wetland assemblage and several migrant species including passerines. Mammals have undergone substantial changes in species composition during the last 1000 years, including extirpations and colonisations which took place before the arrival of Europeans. The island-like geography of Península Valdés, connected to the mainland through the narrow isthmus, appears to contribute to shape its own dynamics in terms of

biological diversity and also in the different ways humans interact with the environment.

The implementation of the management plan in Península Valdés must take into account how the different human activities interact with biodiversity and the environment. It needs to address the sustainable use and protection of wild species and habitats, and also to develop programmes for the coexistence of sustainable livestock production, responsible tourism and healthy wildlife populations. Land management based mostly on traditional sheep ranching is usually in conflict with wild, native species. Today, average-sized ranches are not economically viable to sustain a family as they did decades ago. Land degradation due to overstocking, coupled with the severe droughts and low prices of wool in the international market, has resulted in substantial sheep losses. In addition, the lack of alternative options led to increased conflicts with wildlife as many landowners aim to restock their ranches, even within this unfavorable context to compensate reduced income per sheep by increasing sheep numbers.

While a few ranches were able to develop ecotourism based on coastal wildlife—such as penguins and elephant seals—and keep their sheep stocks, others were closed as they cannot afford the costs of maintenance. However, over 90% of the land in Península Valdés is still devoted to sheep ranching, although the overall stock is probably the lowest in decades (Evolución Existencia de Ganado Ovino 2005–2014 2016). As a result, pressure by some landowners on wildlife authorities to reduce guanaco densities and kill predators in particular areas of the peninsula has increased during the last few years. At the same time, other landowners have recently certified the wool they produce given that they coexist with the wild herbivores and predators, in order to add value to their production and gain access to markets of responsible consumers (Wildlife Friendly Enterprise Network 2015). Therefore, opportunities for the development and implementation of economic activities compatible with the conservation of biodiversity are priorities which need to be undertaken to increase the benefits for wild species, habitats and the people.

4.2 Research Priorities

Well designed studies on diversity, distribution and abundance of different taxa throughout Península Valdés are a key to make decisions on conservation-oriented management. Also, the identification and assessment of the effects of the multiple variables—physical, climatic, biological and human-related—on the distribution and abundance of different taxa, communities and populations is required to understand the resulting biodiversity patterns.

It is necessary to carry out a systematic survey of reptile diversity and its association with different habitats, as the information available is outdated and results from occasional observations. Aspects of the ecology and estimates of the abundance of birds such as raptors and inland-wetlands birds, are all needed to understand the dynamics of these diverse wildlife assemblages in Península Valdés.

It is also a priority to describe the composition of the mammalian predator assemblage across different sites within the peninsula, as well as to gain knowledge on the processes driving colonisation and extirpation of mammal populations.

Given the particular morphology and location of Península Valdés, we have the opportunity to study its animal diversity, distribution and ecological interactions in order to understand the ecological processes operating at different scales. It is desirable to coordinate survey and monitoring efforts to generate and maintain a biodiversity data-base for Península Valdés, essential to support proper management actions and decision-making about the protected area.

It is necessary to prioritize applied research and monitoring on the effects of human activities on different taxa. For example, it is known that the arthropods play multiple roles as detritivorous, herbivores and predators, hence they are key in nutrient cycles and the energy flux at multiple levels of the trophic web (Polis 1991; Flores 1998; Ayal 2007). Many arthropod species show high habitat fidelity and respond rapidly to changes in the surrounding environment (Cheli 2009; Cheli et al. 2010; Carrara et al. 2011; Flores et al. 2011; Martínez 2013). Thus, they can be good indicators of ecosystem changes. Variation in abundance, species composition and richness due to disturbance can be expressed either at the taxonomic or functional group level.

Future work needs to assess the consequences of habitat loss on the distribution and abundance of reptiles, birds and small mammals throughout Península Valdés. The consequences of habitat loss on wild populations inhabiting the Monte ecoregion remain unknown, but it may lead to species range contractions as it was documented for birds (Pezzola et al. 2004) and probably to local and/or regional population extirpations (Llanos et al. 2011). For reptiles, impacts of human population settlements and recreational activities could be significant, especially along sandy, coastal habitats which people tend to select. Increased vehicle traffic on the main roads results in roadkills for middle-sized mammals such as foxes, cats, maras, grisons and armadillos, and for birds like tinamous. The opening of new internal, dirt roads results in habitat loss to smaller species, and access to poachers. Therefore, it is important to assess the different impacts of humans on the habitat and wildlife and to implement actions to mitigate the effects.

Accurate estimates of the impact of predators on sheep are necessary to quantify the magnitude of the conflict, hence to plan and implement appropriate mitigation actions. Alternative, non-lethal methods to control predators using guarding animals such as dogs and donkeys are worth to explore as they can be effective (Andelt 2004; Novaro et al. 2016). As it was already described (see Sect. 4.1), human activities compatible with the persistence of wildlife populations can result in added value to local production. Although Península Valdés is internationally renowned for its marine and coastal biodiversity, terrestrial wildlife is diverse and attractive hence there is a potential to develop responsible, low-impact tourism activities. Also, sustainable use of guanaco fibre after herding, shearing and subsequent release of the animals is possible as an opportunity to diversify production and increase the value of wild species. Shearing of wild populations of guanacos has been developed and implemented at other sites in Argentina following protocols of

animal welfare and monitoring the effects on wild populations (Baldi et al. 2010; Rey et al. 2012). Therefore, work on specific actions to promote responsible, sustainable human activities compatible with biodiversity conservation needs to be continued and implemented on the basis of sound scientific knowledge.

4.3 Final Remarks

As it was suggested, the implementation of the management plan is a priority for the conservation of biodiversity and the ecosystems of Península Valdés. Among other steps to be taken, we find necessary to (a) assess the main, spatially explicit interactions between biodiversity and human activities; (b) assess specific threats to biodiversity and draft the priority actions to mitigate those threats; (d) identify a number of users willing to get involved in making their activities compatible with the conservation of biodiversity; and (e) develop standards for the different activities, promoting practices that benefit wildlife, while providing increased benefits to responsible users and promoting goodwill. The Provincial authorities, research institutions, nongovernmental organisations and the private sector are all part of the Península Valdés Administration. Therefore, there is a genuine opportunity to move forward towards a goal in which sustainable management and monitoring will be a key to achieve both the conservation of healthy wildlife and the improvement of human livelihoods.

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Glossary

Amphisbaenian	A lizard clade with elongated, distinctly annulated body, limbs are not present as they evolved to reduced internal organs. Fossorial, secretive life style

Breed communally	When more than one pair raise their offspring in the same nest or den. In this case it is referred to the mara, the monogamous mammal endemic to Argentina. Several pairs can share the same den to raise their pups during the breeding season in Península Valdés
Co-dominance patterns	Refers to two or more species, or taxonomical entities, which are equally dominant—in terms of abundance—within a biotic community
Endemic	Inhabiting only a specific geographic area
Grasshopers	Insects of the order Orthoptera with powerful hind legs which enable them to escape from threats by leaping vigorously
Intermediate selectivity	It refers to the herbivore's ability to select particular parts of plants while foraging. For the case of guanacos and sheep mentioned in the text, they can select both grasses and parts of woody plants. Thus, they are *intermediate* rather than *non selective* (grazers) or *highly selective* (browsers) feeders
Interspecific competition	Is a form of competition in which individuals of different species compete for the same resource in an ecosystem (e.g. food or living space). If the resource cannot support populations of both species, then lowered fecundity, growth, or survival may result in at least one of the competing species
IUCN criteria	A globally used system for classifying species in terms of their risk of extinction. It provides the framework to elaborate the Red List, regularly updated by the International Union for the Conservation of Nature (IUCN) organized in specialists groups worldwide
Stocking rate	Relationship between the livestock (sheep for the case of Península Valdés) and the forage available. In other words, is the relationship between secondary production (animal biomass) and primary production (forage biomass) per unit of land
Springtail	Insects members of Collembola, usually found in leaf litter and other decaying material. They are primarily detritivores and one of the main biological agents responsible for the control and the dissemination of soil microorganisms
Solifuges	Although they belong to the class Arachnida and look like spiders, solifuges an order on their own as there are not true spiders or scorpions. Moderate to large-sized, solifuges or "sun spiders" are omnivorous, opportunistic feeders displaying an aggressive hunting behaviour

Appendix 1: List of Arthropods Recorded at Península Valdés

Subphylum	Class	Order	Family	Species
Chelicerata	Arachnida	Araneae	Amphinectidae	
			Gnaphosidae	
			Linyphiidae	
			Lycosidae	
			Philodromidae	
			Prodidomidae	
			Salticidae	
			Sicariidae	
			Sparassidae	
			Theriididae	
			Thomisidae	
			Trachelidae	
			Zodariidae	
		Pseudoscorpiones	Family 1	
		Scorpiones	Bothriuridae	*Bothriurus burmeisteri*
				Urophonius martinezi
				Brachistosternus alienus
				Brachistosternus angustimanus
		Solifuga	Ammotrechidae	
			Mummusidae	
Atelocerata	Insecta	Archaeognatha	Machilidae	
		Coleoptera (beetles)	Anobiidae	*Anobiidae* sp1
				Anobiidae sp1
			Anticidae	*Anthicidae* sp1
				Anthicidae sp2
				Anthicidae sp3
				Anthicidae sp4
			Apionidae	*Apion* sp1
			Carabidae	*Trirammatus* (*P.*) *vagans*
				Metius malachiticus
				Metius latemarginatus
				Metius caudatus
				Cnemalobus litoralis

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Subphylum	Class	Order	Family	Species
				Metius harpaloides
				Metius sp1
				Notiobia sp1
				Pseudoanisotarsus nicki
		Coleoptera (beetles)	Carabidae	*Metius* sp2
				Trirammatus (*F*) *striatula*
			Cerambycidae	*Cerambycidae* sp1
			Chrysomelidae	*Cryptocephalus patagonicus*
			Cleridae	*Cleridae* sp1
			Coccinellidae	*Coccinellidae* sp2
			Curculionidae	*Entiminae* sp1
				Eurymetopus oblongus
				Pantomorus ruizi
				Listroderes costrirrostris
Atelocerata	Insecta			*Chryptorhynchinae* sp1
			Elateridae	*Conoderus* sp1
				Conoderinae sp3
				Conoderus sp2
			Heteroceridae	*Efflagitatus* sp1
			Histeridae	*Euspilotus lacordaiere*
				Euspilotus sp3
				Euspilotus sp4
			Meloidae	*Epicauta* sp1
			Nitidulidae	*Nitidulidae* sp1
			Pselaphidae	*Pselaphidae* sp1
				Pselaphidae sp2
			Scaphidiidae	*Scaphidiidae* sp1
			Scarabaeidae	*Alidiostoma* sp1
				Scarabeidae sp2
				Eucranium dentrifrons
				Scylophagus lacordaire

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Subphylum	Class	Order	Family	Species
				Scylophagus patagonicus
			Staphylinidae	*Carpelimus* sp1
				Staphilinidae sp1
				Staphilinidae sp3
				Staphilinidae sp5
			Tenebrionidae	*Hylithus tentyroides*
				Epipedonota cristallisata
				Mitragenius araneiformis
				Nyctelia circumundata
				Nyctelia darwini
				Nyctelia dorsata
				Nyctelia nodosa
				Patagonogenius collaris
				Patagonogenius quadricollis
				Psectracelis sulcicollis
				Pimelosomus sphaericus
		Coleoptera	Tenebrionidae	*Calymmophorus patagonicus*
				Calymmophorus peninsularis
				Plathestes kuscheli
				Praocis argentina
				Praocis sellata granulipennis
				Praocis sellata peninsularis
				Praocis (*Hemipraocis*) sp.
				Ecnomoderes bruchi
				Salax lacordairei
Atelocerata	Insecta			*Blapstinus punctulatus*
				Emmallodera crenatocostata
				Emmallodera hirtipes

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Subphylum	Class	Order	Family	Species
				Leptynoderes strangulata
				Rhypasma cuadricoldis
			Trogidae	*Polynoncus* sp1
		Collembola	Family 1	
			Sminthuridae	
		Dictyoptera	Blatellidae	
			Blattidae	
			Mantidae	
		Heteroptera–Hemiptera	Blissidae	*Blissus parasitaster*
				Blissus sp1
			Cydnidae	*Cydnidae* sp2
				Cydnidae sp1
			Lygaeidae	*Nysius simulans*
				Lygaeus alboornatus
			Miridae	*Miridae* sp1
				Miridae sp2
				Miridae sp7
				Miridae sp3
				Valdesiana curiosa
				Miridae sp5
				Miridae sp6
			Nabidae	*Pagasa* sp.
			Oxycarenidae	*Anomaloptera patagonica*
			Pentatomidae	*Pentatomidae* sp1
			Reduviidae	*Reduvidae* sp3
				Reduvidae sp4
			Rhopalidae	*Rhopalidae* sp2
				Rhopalidae sp1
			Rhyparochromidae	*Erlacda argentinensis*
				Rhyparochromidae sp1
		Heteroptera	Rhyparochromidae	*Lethaeini* sp1
			Scutelleridae	*Scutelleridae* sp1
		Hymenoptera	Formicidae (ants)	*Pheidole aberrans*
				Acromyrmex striatus
				Pheidole bergi

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Subphylum	Class	Order	Family	Species
				Solenopsis patagonica
				Pheidole cf. P. spininodis
				Solenopsis sp1
				Acromyrmex sp4
				Acromyrmex lobicornis
				Pheidole cf. P. spininodis
				Acromyrmex cf. A. ambigeis
Atelocerata	Insecta			*Mycetophyllax* sp1
				Solenopsis sp4
				Solenopsis sp6
				Pogonomyrmex rastratus
				Solenopsis sp7
				Forelius chalybaeus
				Dorymyrmex breviscapis
				Dorymyrmex cf. D. ensifer
				Dorymyrmex hexanguis
				Forelius cf. F. grandis
				Dorymyrmex cf. D. silvestris
				Dorymyrmex wolffhügeli
				Forelius sp2
				Camponotus punctulatus
				Brachymyrmex sp2
				Brachymyrmex sp1
			Mutillidae	
			Pompilidae	
			Several families non-determined	
		Isoptera	Kalotermitidae	
			Termitidae	
		Neuroptera	Myrmeleontidae	

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Subphylum	Class	Order	Family	Species
		Orthoptera	Acrididae	
			Grillidae	
			Ommexechidae	
			Proscopidae	
		Phasmatodea	Phasmidae	
		Psocoptera	Family 1	
		Siphonaptera	Family 1	
		Thysanoptera	Phlaoeothripidae	

Appendix 2: List of Reptiles Recorded at Península Valdés

Order	Family	Name	Species
Squamata	Phyllodactylidae	Darwin's gecko	*Homonota darwinii*
	Leiosauridae	Great lizard	*Leiosaurus bellii*
	Liolaemidae	Black Head Lizard	*Liolaemus melanops*
		Darwin's lizard	*Liolaemus darwinii*
		Slender lizard	*Liolaemus gracilis*
	Viperidae	Snub-nosed yarará viper	*Bothrops ammodytoides*
	Dipsadidae	Patagonian green racer	*Phylodrias patagonicus*
		Mousehole snake	*Phylodrias trilineata*
		False yarará viper	*Pseudotomodon trigonatus*
		Brown Musurana	*Clelia rustica*

Appendix 3: List of Terrestrial and Inland-Wetlands Birds Recorded at Península Valdés

Order	Family	Name	Species
Rheiformes	Rheidae	Lesser Rhea	*Rhea pennata*
Tinamiformes	Tinamidae	Darwin's Nothura	*Nothura darwinii*
		Elegant Crested-Tinamou	*Eudromia elegans*
Anseriformes	Anatidae	Coscoroba Swan	*Coscoroba coscoroba*
		Black-necked Swan	*Cygnus melancoryphus*ND

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Order	Family	Name	Species
		Upland Goose	*Chloephaga picta*[AUS]
		Ashy-headed Goose	*Chloephaga poliocephala*[AUS]
		Ruddy-headed Goose	*Chloephaga rubidiceps*[AUS]
		Crested Duck	*Lophonetta specularioides*
		Chiloe Wigeon	*Anas sibilatrix*[ND]
		Yellow-billed Pintail	*Anas geórgica*
		Yellow-billed Teal	*Anas flavirostris*
		Red Shoveler	*Anas platalea*
		Cinnamon Teal	*Anas cyanoptera*
		White-cheeked Pintail	*Anas bahamensis*
		Rosy-billed Pochard	*Netta peposaca*
		Black-headed Duck	*Heteronetta atricapilla*
		Lake Duck	*Oxyura vittata*
Podicipediformes	Podicipedidae	White-tufted Grebe	*Rollandia rolland*
		Silvery Grebe	*Podiceps occipitalis*
		Great Grebe	*Podiceps major*
Phoenicopteriformes	Phoenicopteridae	Chilean Flamingo	*Phoenicopterus chilensis*
Ciconiiformes	Ciconiidae	Maguari Stork	*Ciconia maguari*[a]
Pelecaniformes	Ardeidae	Great Egret	*Ardea alba*
		Snowy Egret	*Egretta thula*
		Cattle Egret	*Bubulcus ibis*
		Cocoi Heron	*Ardea cocoi*
		Black-crowned Night-Heron	*Nycticorax nycticorax*
	Threskiornithidae	Black-faced Ibis	*Theristicus melanopis* [AUS]
		White-faced Ibis	*Plegadis chihi*
		Roseate Spoonbill	*Platalea ajaja*[a]
Cathartiformes	Cathartidae	Turkey Vulture	*Cathartes aura*[ND]
		Black Vulture	*Coragyps atratus*[a]
Accipitriformes	Accipitridae	White-tailed Kite	*Elanus leucurus*
		Long-winged Harrier	*Circus buffoni*
		Cinereous Harrier	*Circus cinereus*
		Black-chested Buzzard-Eagle	*Geranoaetus melanoleucus*
		White-tailed Hawk	*Geranoaetus albicaudatus*

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Order	Family	Name	Species
Accipitriformes	Accipitridae	Variable Hawk	*Geranoaetus polyosoma*
Gruiformes	Rallidae	Plumbeous Rail	*Pardirallus sanguinolentus*
		Austral Rail	*Rallus antarcticus*
		Red-gartered Coot	*Fulica armillata*
		White-winged Coot	*Fulica leucoptera*
		Red-fronted Coot	*Fulica rufifrons*
Charadriiformes	Recurvirostridae	Black-necked Stilt	*Himantopus mexicanus*
	Charadriidae	Southern Lapwing	*Vanellus chilensis*
		American Golden-Plover	*Pluvialis dominica*^{NEA}
		Black-bellied Plover	*Pluvialis squatarola*^{NEA}
		Tawny-throated Dotterel	*Oreopholus ruficollis*^{AUS}
		Two-banded Plover	*Charadrius falklandicus*^{AUS}
		Rufous-chested Dotterel	*Charadrius modestus*^{AUS}
	Scolopacidae	Greater Yellowlegs	*Tringa melanoleuca*^{NEA}
		Lesser Yellowlegs	*Tringa flavipes*^{NEA}
		Pectoral Sandpiper	*Calidris melanotos*^{NEA}
		Baird's Sandpiper	*Calidris bairdii* ^{NEA}
		White-rumped Sandpiper	*Calidris fuscicollis*^{NEA}
		Hudsonian Godwit	*Limosa haemastica*^{NEA}
		Wilson's Phalarope	*Phalaropus tricolor*^{NEA}
	Thinocoridae	Least Seedsnipe	*Thinocorus rumicivorus*^{AUS}
		Grey-breasted Seedsnipe	*Thinocorus orbignyianus*
	Laridae	Kelp Gull	*Larus dominicanus*
		Brown-hooded Gull	*Chroicocephalus maculipennis*
Columbiformes	Columbidae	Rock Pigeon	*Columba livia*^{I}
		Eared Dove	*Zenaida auriculata*
		Picui Ground Dove	*Columbina picuí*
Cuculiformes	Cuculidae	Guira Cuckoo	*Guira guira*
		Dark-billed Cuckoo	*Coccyzus melacoryphus*^{NEO,a}
Strigiformes	Tytonidae	Barn Owl	*Tyto alba*
	Strigidae	Burrowing Owl	*Athene cunicularia*
		Great Horned Owl	*Bubo virginianus*
		Short-eared Owl	*Asio flammeus*

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Order	Family	Name	Species
Caprimulgiformes	Caprimulgidae	Band-winged Nightjar	*Systellura longirostris*
Falconiformes	Falconidae	Southern Caracara	*Caracara plancus*
		Chimango Caracara	*Milvago chimango*
		Peregrine Falcon	*Falco peregrinus*
		Aplomado Falcon	*Falco femoralis*
		American Kestrel	*Falco sparverius*
Psittaciformes	Psittacidae	Burrowing Parakeet	*Cyanoliseus patagonus*
		Monk Parakeet	*Myiopsitta monachus*
Passeriformes	Furnariidae	Common Miner	*Geositta cunicularia*
		Scale-throated Earthcreeper	*Upucerthia dumetaria* [AUS]
Passeriformes	Furnariidae	Band-tailed Earthcreeper	*Ochetorhynchus phoenicurus*
		Buff-winged Cinclodes	*Cinclodes fuscus*[AUS]
		Rufous Hornero	*Furnarius rufus*
		Wren-like Rushbird	*Phleocryptes melanops*
		Sharp-billed Canastero	*Asthenes pyrrholeuca*[AUS]
		Cordilleran Canastero	*Asthenes modesta*
		Patagonian Canastero	*Pseudasthenes patagónica*
		White-throated Cacholote	*Pseudoseisura gutturalis*
		Plain-mantled Tit-Spinetail	*Leptasthenura aegithaloides*
	Tyrannidae	Grey-bellied Shrike-Tyrant	*Agriornis micropterus* [AUS]
		Lesser Shrike-Tyrant	*Agriornis murinus*[AUS]
		Chocolate-vented Tyrant	*Neoxolmis rufiventris*[AUS]
		Rusty-backed Monjita	*Xolmis rubetra*[AUS]
		White Monjita	*Xolmis irupero*
		Black-crowned Monjita	*Xolmis coronatus*[AUS]
		Austral Negrito	*Lessonia rufa*[AUS]
		Dark-faced Ground-Tyrant	*Muscisaxicola maclovianus*[AUS]
		Spectacled Tyrant	*Hymenops perspicillatus*
		White-winged Black-Tyrant	*Knipolegus aterrimus*
		Hudson's Black-Tyrant	*Knipolegus hudsoni*[AUS,a]
		Many-coloured Rush Tyrant	*Tachuris rubrigastra*
		Great Kiskadee	*Pitangus sulphuratus*

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Order	Family	Name	Species
		Fork-tailed Flycatcher	*Tyrannus savana*[NEO]
		Vermilion Flycatcher	*Pyrocephalus rubinus*[NEO]
		Yellow-billed Tit-Tyrant	*Anairetes flavirostris*
		Tufted Tit-Tyrant	*Anairetes parulus*
		Straneck's Tyrannulet	*Serpophaga griseicapilla*[a]
		White-crested Elaenia	*Elaenia albiceps*
	Cotingidae	White-tipped Plantcutter	*Phytotoma rutila*
	Hirundinidae	Barn Swallow	*Hirundo rustica*[NEA,a]
		Southern Martin	*Progne elegans*[NEO]
		Chilean Swallow	*Tachycineta meyeni*[AUS]
		Blue-and-white Swallow	*Pygochelidon cyanoleuca*
	Troglodytidae	House Wren	*Troglodytes aedon*
	Turdidae	Austral Thrush	*Turdus falcklandii*
		Chiguanco Thrush	*Turdus chiguanco*
	Motacillidae	Short-billed Pipit	*Anthus furcatus*
		Correndera Pipit	*Anthus correndera*
		Hellmayr's Pipit	*Anthus hellmayri*
	Mimidae	White-banded Mockingbird	*Mimus triurus*[AUS]
		Chalk-browed Mockingbird	*Mimus saturninus*
		Patagonian Mockingbird	*Mimus patagonicus*
	Thraupidae	Common Diuca-Finch	*Diuca diuca*[AUS]
		Grassland Yellow-Finch	*Sicalis luteola*
Passeriformes	Thraupidae	Patagonian Yellow-Finch	*Sicalis lebruni*
		Grey-hooded Sierra-Finch	*Phrygilus gayi*
		Mourning Sierra-Finch	*Phrygilus fruticeti*
		Carbonated Sierra-Finch	*Phrygilus carbonarius*
		Yellow Cardinal	*Gubernatrix cristata*[a]
	Emberizidae	Rufous-collared Sparrow	*Zonotrichia capensis*
	Icteridae	Shiny Cowbird	*Molothrus bonariensis*

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Order	Family	Name	Species
		Greyish Baywing	*Agelaioides badius*
		Yellow-winged Blackbird	*Agelasticus thilius*
		Long-tailed Meadowlark	*Sturnella loyca*
	Fringillidae	Black-chinned Siskin	*Sporagra barbata*
		Hooded Siskin	*Sporagra magellanica*[a]
	Passeridae	House Sparrow	*Passer domesticus*[I]

NEA Neartic Migrant, *NEO* Neotropical Migrant, *AUS* Austral Migrant, *ND* Northward Dispersion, *I* Introduced
[a]Rarely observed

Appendix 4: List of Native Terrestrial Mammals Recorded at Península Valdés

Order	Family	Name	Species
Didelphimorphia	Didelphidae	Pallid fat-tailed opossum	*Thylamys pallidior*
Cingulata	Dasypodidae	Big hairy armadillo	*Chaetophractus villosus*
		Pichi	*Zaedyus pichiy*
Chiroptera	Vespertilionidae	Small big-eared brown bat	*Histiotus montanus*
	Molossidae	Brazilian free-tailed bat	*Tadarida brasiliensis*
Carnivora	Canidae	Culpeo fox	*Lycalopex culpaeus*
		South american grey fox	*Lycalopex gymnocercus*
	Felidae	Geoffroy's cat	*Leopardus geoffroyi*
		Pampas cat	*Leopardus colocolo*
		Puma	*Puma concolor*
	Mephitidae	Molina's hog-nosed skunk	*Conepatus chinga*
	Mustelidae	Lesser grison	*Galictis cuja*
		Patagonian weasel	*Lyncodon patagonicus*[a]
Artiodactyla	Camelidae	Guanaco	*Lama guanicoe*
Rodentia	Cricetidae	Dolores grass mouse	*Akodon dolores*
		Intelligent grass mouse	*Akodon iniscatus*
		Drylands vesper mouse	*Calomys musculinus*
		Eastern patagonian laucha	*Eligmodontia typus*
		Grey leaf-eared mouse	*Graomys griseoflavus*

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Order	Family	Name	Species
		Bunny rat	*Reithrodon auritus*
	Caviidae	Common yellow-toothed cavy	*Galea leucoblephara*
		Southern mountain cavy	*Microcavia australis*
		Mara	*Dolichotis patagonum*
	Ctenomyidae	Tuco-tuco	*Ctenomys* sp.

[a]Presence needs to be confirmed

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