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The impact and legislative framework of invasive mammals on Portuguese Macaronesian islands: A case study on Corvo, Azores

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ABSTRACT

The Portuguese government has awarded islands with more protection statutes than continental ecosystems, so it seems to recognise the exceptional biodiversity of the insular regions. However, the effectiveness of these protection statutes is questionable since, in most cases, no measures are taken to guarantee the protection against invasive alien species (IAS). This study reviews the current legislative framework addressing IAS at national, regional and local levels. Information on ecological and socio-economic impacts of IAS was used to analyse whether regional laws covering island ecosystems are ensuring the protection of their biodiversity. We detected some weakness in the Portuguese legislation: IAS are not the main focus, inconsistent terminology, vectors not targeted, a few diversity of ecosystems covered, no coordination of actions and no enforcement of management plans. In addition, the uniqueness of biodiversity on Macaronesian islands is not protected by the regional legislation. Although some non-indigenous species introduced on islands are currently threatening the integrity of their fragile ecosystems and the socio-economic spheres, they are not considered as IAS. A stronger strategic framework to address the overall impacts of IAS is required mainly in these Macaronesian islands whose one of the most imposing threat is the presence of these introduced species.

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1. Introduction

The introduction of non-indigenous species by humans is one of the most important drivers of population declines and species extinctions overall on islands (Clout and Veitch, 2002; Reaser et al., 2007; Sax and Gaines, 2008). Invasive alien species (IAS) are a major threat not only to biodiversity but also to human well-being, and their ecological and socio-economic impacts are recognised worldwide (Nogales et al., 2006; Pejchar and Mooney, 2009; García-Llorente et al., 2011).

Oceanic islands are extremely vulnerable to disturbances caused by IAS due to their relatively simple trophic webs and high rates of endemism (Chapuis et al., 1995), and they present higher rate of species extinctions than that on continents (Vitousek et al., 1997). Within different IAS, mammals are among the most ecologically damaging on islands, especially when their ecological equivalents are naturally lacking in the host ecosystem (Clout and Veitch, 2002). Impacts of invasive mammals on native biodiversity not only include direct effects such as predation and competition but also disrupted patterns of nutrient flows and trophic cascades due to the ecological interactions between such mammals and the native biota (Russell et al., 2009; Hervías et al., 2014a).

In addition to impacts on biodiversity, invasive mammals impact directly on social and economic spheres by disrupting ecosystem services (Traveset and Richardson, 2006), damaging infrastructure and properties, degrading food crops, and transmitting diseases or causing allergies (Vilà et al., 2010). The effects of IAS on species and habitats might also indirectly influence local socio-economic activities but these impacts are more difficult to evaluate. For instance, Simberloff et al. (2013) observed that predation of seabirds by IAS may impoverish the transfer of nutrients from sea to land and therefore reduce the productivity of agricultural land. While this impact tends to pass unnoticed to the human community, agricultural losses caused by such soil impoverishment may affect local farmers. The non-obvious impacts of IAS need to be alerted to the public and decision-makers and, hence, it is important that scientists take part in the design of such laws.

On the other hand, some negative impacts for ecosystems are perceived as positive by some sectors of the economy. For example, the invasive tree *Melaleuca quinquenervia* has a positive impact on honey production in Florida at the detriment of a natural habitat (Serbesoff-King, 2003). Therefore, in the aftermath of limited support of the public and decision-makers, the conservation efforts are improbable to happen or to be successful (Campbell and Donlan, 2005). More studies evaluating together the ecological and socio-economic impact of IAS are required in order to find a common unit of measure for the socio-economic and the environmental costs (Pyšek et al., 2012).

The Macaronesian islands (the Portuguese Azores and Madeira and the Spanish Canaries) constitute a hotspot for biodiversity in Europe with a large number of the endemics due to their insularity, volcanic origin and a diverse landscape. No island in this region has escaped the problems caused by IAS (Monteiro et al., 1996; Medina and Nogales, 2009; Kueffer et al., 2010). Because of the vulnerability of the Macaronesian island ecosystems and the need to support the viability of human settlements, a high percentage of its territory (33.5% of total terrestrial area) is occupied by Natura 2000 network, which is an essential element for the protection of biodiversity in the European Union (EU). In Portugal, the Azores region has the highest number of sites ($n = 38$) designed under the Habitats Directive (92/43/EEC) and Birds Directive (79/409/EEC): 15 Special Protection Areas (SPAs) and 23 Special Areas of Conservation (SACs). In addition, some seabird species, such as Monteiro's storm petrel (*Hydrobates monteiroi*), roseate tern (*Sterna dougalii*) and Manx shearwater (*Puffinus puffinus*), listed in the Annex I of the Birds Directive breed in large numbers in the Azores, while they are rare in other areas of the North Atlantic (Monteiro et al., 1996).

The Azores and Madeira are autonomous regions with full legislative powers in the field of natural protected areas, whereas the control of external borders is the Portuguese State responsibility. For instance, Habitats and Birds Directives contain an obligation to prevent IAS, which is a responsibility of each Member States. Has the Portuguese government transposed the European directives into laws to protect biodiversity against IAS? Are these laws effective enough? Unfortunately, the answers are negative. In the Azores 10 mammal species were introduced, five of which are considered worldwide as IAS (Lowe et al., 2001), but only three are in the Black list (prohibited or strictly regulated species) (Table 1). In Madeira the Black list does not exist yet. Furthermore, although these mammals impact on biodiversity and local socio-economic activities, as we argue in the present article, the regional government has not yet created an effective instrument to prevent, control or eradicate them. This lack of legislative focus is surprising, given the important repository of biodiversity protected under the European directives and the importance of these ecosystems to the economy and human well-being.

This study aims at examining how well existing Portuguese legislation at national, regional and local levels addresses IAS.

Table 1 – Feral mammalian species introduced in the archipelagos of the Azores and Madeira. Those species that are included in the Black list of the Regional Legislative Decree (RLD) as IAS and/or are considered IAS by the IUCN (Lowe et al., 2001) are ticked.

		Introduced mammals	IUCN	RLD Azores	RLD Madeira
AZORES	MADEIRA	*Rattus norvegicus*		X	
		Rattus rattus	X	X	
		Mus domesticus	X	X	
		Felis silvestris catus	X		
		Oryctolagus cuniculus	X		
		Capra aegagrus hircus	X		
		Mustela furo			
		Ovis aries			
		Mustela nivalis			
		Erinaceus europaeus			