

# Invasion of non-indigenous carnivores in Austria – the current status of the raccoon (*Procyon lotor*) and the raccoon dog (*Nyctereutes procyonoides*) and prospects of their future distribution



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## Keywords

non-indigenous species, raccoon, *Procyon lotor*, raccoon dog, *Nyctereutes procyonoides*

## Summary

The spread of invasive alien species (IAS) is a key factor for the worldwide decrease in biodiversity. Consequently, the prevention, monitoring, and regulation of IAS are major goals of many international commitments, including the new EU regulation 1143/2014. The non-indigenous carnivore species raccoon (*Procyon lotor*) and raccoon dog (*Nyctereutes procyonoides*), occurring in Austria since 1974 and 1983 respectively, were classified as invasive according to this regulation and have to be monitored and managed appropriately. Within the present study 149 raccoon records and 121 raccoon dog records of different categories were documented between the years 2009 and 2016. These records show a wide distribution of both species throughout Austria, particularly in the lowlands and river valleys. However, we failed to estimate their population densities since both raccoon and raccoon dog are not very common, yet. Low population densities (showing an increasing trend) are also indicated by hunting bag data of several Austrian provinces.

In view of a further spread of these successful and highly adaptable invaders it makes sense to identify the focal areas for future management, e.g. with the help of species distribution models (SDMs). Thus, we used a presence-only model (MaxEnt) to predict the probability of the raccoon's and the raccoon dog's presence in Austria. The expected core areas of raccoon colonization are mainly located in big cities and in large river valleys (Danube, Rhine, Inn, Salzach, Mur, Drau). Furthermore, the predicted probability of presence was relatively high along the northern border of the Alps, e.g. in the Vienna Woods, as well as in the Muehl- and Innviertel in the north-west of Austria and in the Klagenfurt Basin and the Graz Basin in the south. In contrast, the modelling of the raccoon dog's distribution prefigures a population increase in the eastern and northern parts of Austria, particularly in the Pannonian as well as the pre-alpine regions and the Austrian part of the Bohemian Massif (forest quarter). The predicted probability of presence is also comparatively high in the Klagenfurt Basin as well as in the Rhine Valley and the Bregenz Forest in western Austria.

With the aid of the modelling we also managed to determine the environmental drivers of those alien carnivores' distribution. The further spread of the raccoon seems to be influenced by climate as well as land cover data - with temperature parameters (number of hot days, mean temperature in January etc.), proportion of coniferous forests and of settlements, as well as elevation being the main drivers. In contrast, the raccoon dog's distribution seems to be mainly limited by climatic factors (snow depth, duration of snow cover, winter precipitation and mean annual temperature) and is consequently strongly linked to elevation. As a result, we assumed the Alps to be a certain barrier for the spread of the raccoon and especially of the raccoon dog throughout Europe. Due to climate change, the ecological permeability of this barrier is expected to increase. Moreover, we have managed to exemplify, that habitat requirements of adaptive generalists such as the raccoon may change depending on the stage of invasion. It can thus be concluded that the importance of elevation as an ecological driver will decrease in influence with the ongoing colonization.

We investigated the parasitic fauna of the raccoon and the raccoon dog in order to determine its impact on human health. The eight examined raccoons were found nearly free of pathogens including the raccoon roundworm *Baylisascaris procyonis*. Therefore, raccoons can be assumed to have a low epidemiological impact at this stage. Out of ten raccoon dog specimens we found one from western Austria to be infected with the fox tapeworm *Echinococcus multilocularis* and another three from the eastern wetland regions to harbour adults of the Duncker's muscle fluke *Alaria alata*. Thus, the raccoon dog seems to be a relevant host, at least for these zoonotic pathogens and we suggest further monitoring of the raccoon dog's parasitic fauna.

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