Onderstaande tekst is een review (overzicht, samenvatting) van alles wat bekend is over de wasbeerhond in Europa. Het wordt een hoofdstuk in een internationaal boek over exotische zoogdieren, dus over alle zoogdieren die ergens in de wereld een rol als (invasieve) exoot spelen. Het wordt naar verwachting in de loop van 2026 of 2027 gepubliceerd. Deze tekst is voor uw informatie, maar kan nog niet verder verspreid worden. Te verschijnen in: Bertolino, S. (In prep.). Invasive Mammals: Trends, Impacts and Management. CABI.
(Jaap Mulder, 15 februari 2026)

15. Raccoon dog (*Nyctereutes procyonoides* Gray, 1834)

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15.1. Taxonomy

The raccoon dog is a member of the dog family, the *Canidae* (*Carnivora*), and the only extant representative of a genus which may have comprised five to nine species in the Pliocene (Lucenti *et al.*, 2018; Daguenet and Sen, 2019). Taxonomically it is quite an isolated species. According to DNA analysis, its nearest relative is the African bat-eared fox *Otocyon megalotis* (Wayne *et al.*, 1997; Bardeleben *et al.,* 2005). Seven different subspecies of the raccoon dog have been described on the continent of Asia, although Corbet (1978) lumps all these into one subspecies: *N. p. procyonoides* (Gray, 1834). Two other subspecies occur on different Japanese islands: *N. p. viverrinus* (Temminck, 1844) on Honshu, Shikoku and Kyushu, and *N. p. albus* (Beard, 1904) on Hokkaido (Corbet, 1978). Since the raccoon dogs found on the Asian mainland and Japan differ in their number of chromosomes (54 and 38 respectively, Kim *et al.*, 2015), as well as in some morphological and ecological traits, they should better be considered as different species (Kauhala and Saeki, 2004). Therefore, this review does not use data relating to the Japanese raccoon dog.

The raccoon dogs which have been introduced into Europe originate from Siberia, from the Amursk-Ussuria region north of Vladivostok and belong to the (former) subspecies *N. p. ussuriensis* (Nowak, 1993; Horecka *et al.*, 2022).

15.2. Description

15.2.1. Morphology

The raccoon dog is a smallish dog, around the same size as the red fox (*Vulpes vulpes*). It has characteristically long winter fur with guard hairs of up to 12 cm, in a mixture of black, grey, brown and white. Its striking face resembles that of a raccoon (*Procyon lotor*): with black eye-pads, a grey or whitish nose and long whitish side-whiskers, hence its name. The ears are short and rounded. The tail is short (15-22 cm), does not reach the ground and is light-coloured with a blackish dorsal side. The legs are short and black and the belly is black. From

nose to tail base the raccoon dog measures 50 to 85 cm. Its height is only 37 to 39 cm (Nowak, 1993). The short legs, wide body and long hair sometimes give the animal the appearance of a European badger (*Meles meles*), especially in winter. Females are on average slightly smaller and weigh less (except when pregnant) than males (Kauhala, 1993). From September to January, Polish males weigh 8.63 kg on average (range 6.10 –11.00 kg, n = 53), females from the same months 7.40 kg (5.50-8.90, n = 34) (Wlodek and Krzywinski, 1986).

15.2.2. Physiology

The raccoon dog can cope with a variety of climatic circumstances, including severe winters. It displays autumnal hyperphagia and fattening. It may be 50-70% heavier in late autumn than in spring (Kauhala, 1993). Its weight decreases during winter, and starts to increase in March or April, reaching maximum values from August to November (Nowak, 1993). However, in areas with mild winters, the weight fluctuations throughout the year are much less pronounced: in the Danube delta, late autumn weight was less than 10% higher than spring weight (Barbu, 1972). The activity of raccoon dogs is dependent on temperature, with very low activity below -3 °C and above 25 °C (Jasiulionis *et al.*, 2023). Long periods of freezing and deep snow are survived in shallow winter dormancy, preferably in an underground burrow, for weeks, or even months, on end. In dormancy, body temperature drops at most 2 °C relative to periods of activity, allowing for rapid arousal if disturbed. During the periodic arousals between bouts of winter sleep the raccoon dog may search for food. When a food source is available, e.g. an ungulate carcass or a feeding site, a raccoon dog may stay active in very cold weather (Selonen *et al.*, 2024b). Weight loss over winter is the result of burning the fat reserves, whereas protein-rich tissues and bones are spared, allowing reproduction shortly after hibernation (Mustonen and Nieminen, 2018).

15.3. Ecology

15.3.1. Habitat

As an omnivorous species, the raccoon dog can live in a wide variety of habitats in Europe. Available food resources and the raccoon dog’s tendency to remain in the cover of vegetation are key factors influencing habitat selection. The species shows a marked preference for marshy areas; however, once local populations reach saturation point, the raccoon dog may occupy a wide range of habitats, with the exception of higher altitudes, generally above 800 m in Europe, where winters are severe or snow cover is excessive (Nowak, 1993). In general, raccoon dogs prefer habitats that provide both cover and food, such as marshes, woodlands with dense undergrowth, agricultural fields (e.g. maize and cereal crops) and the shores of lakes and rivers. By contrast, they tend to avoid large coniferous and broadleaf forests on dry soils with sparse undergrowth (Nasimovič and Isakov, 1985, Kauhala and Auttila, 2010), as well as large-scale open agricultural fields and meadows (Drygala et al., 2008a). A study in a boreal landscape in Finland with industrial forests, small pine swamps and many small lakes and streams, found the raccoon dog to prefer shore areas, especially during early summer. It also found that moist heathlands were favoured in autumn, probably due to their abundant supply of berries (mainly *Vaccinium* spp.), which raccoon dogs exploit intensively to accumulate fat reserves in preparation for winter dormancy (Kauhala, 1996a).

To date, only a few studies of the racoon dog have been conducted in the agricultural landscapes of central and western Europe. Drygala et al. (2008a) followed 26 resident raccoon dogs in a study area in north-eastern Germany. Several habitats were used in the same proportion as they were available: forests, reedbeds, small woods and hedges. The animals avoided open farmland except from May to July. Human settlements were clearly avoided all year, and open meadows were less visited than expected. Forests were preferred in autumn and winter, the period of intensive foraging and fat accumulation. Sutor and Schwarz (2013) followed nine raccoon dogs in a similar landscape in eastern Germany. They found a preference for grassland, the habitat with the highest food availability in their study area, and coniferous forest (because there were the badger dens they used), although the analysis but did not take small structures (hedges, ditches, etc.) into account.

Melis et al. (2015) found that, in northern Sweden, raccoon dogs selected agricultural areas and wetlands, lower altitudes, and shallow slopes, while avoiding forests, open natural areas and areas close to water and roads; in winter they used forests more, and wetlands less, than tin he rest of the year. Toivonen et al. (2024) studied the habitat preferences of GPS-collared animals in three different regions in Finland; in spring and summer the raccoon dogs showed clear preferences for wetlands and for treeless peatlands, in all three regions, and for field edges and wooded peatlands in two of the regions. There was no clear avoidance of any other habitat other than open rock areas. In the northern regions, the raccoon dogs strongly favoured riverbanks. According to an analysis of thousands of GPS-locations from May to July, the raccoon dogs within a large eutrophic marshland in the Netherlands showed a strong preference for reed lands and swamp forests while foraging. Areas with less cover were crossed at higher speeds (Mulder and Ten Den, own data).

In Denmark, Wooldridge et al. (2024) studied the habitat preferences of 129 raccoon dogs using a large dataset of fixes collected with GPS-GSM-collars. The animals showed an overall preference for peat bogs, marshes and broadleaf tree cover, and an avoidance of built-up areas, bare natural surfaces (e.g., river pebble banks, beaches and sand dunes), cultivated areas, coniferous tree cover and herbaceous vegetation. Mean movement speed also varied according to habitat type, with raccoon dogs moving more slowly, probably while foraging, in preferred habitats and more rapidly in less preferred ones. The results indicate that raccoon dogs adjust their habitat selection and movement patterns throughout the year, with a general preference for moist and high tree coverage areas.

15.3.2. Diet

The raccoon dog is an opportunistic and omnivorous ‘gatherer’ rather than a ‘hunter’ (Kauhala *et al.* 1993b). It eats everything it can find on and just below ground level, while slowly walking through dense vegetation and along shores, preferably in marshy areas. In most studies, the dominant food categories are small mammals, amphibians, carrion, birds, insects, berries and cultured fruits and cereals, including maize. The raccoon dog profits greatly from game management practices where entrails are left in the field and wild boar are fed with maize and offal, promoting the spread of trichinellosis (Süld *et al.*, 2014). When available, fish and reptiles are also commonly consumed (Sutor *et al.*, 2010). Overall, the raccoon dog’s diet reflects the availability of easy-to-get food categories (Baltrunaite, 2005; Sidorovich *et al.*, 2008).

In north-east Germany and Denmark, the diets of fox and raccoon dog are fairly similar. Nevertheless, the level of competition between the two species is assumed to be limited, as clear differences do exist: foxes consume more small mammals (i.e. voles) and less edible plant material (i.e. fruits and maize) than raccoon dogs. Moreover, raccoon dogs use food resources (e.g. amphibians, invertebrates and shrews) that are mostly avoided by red foxes (Drygala *et al.,* 2013; Elmeros *et al.*, 2018). These findings are consistent with a study in Finland where the red fox was identified as a more active predator, consuming a high proportion of vertebrate prey (mammals and birds), whereas the raccoon dog fed more frequently on shrews, invertebrates, carrion, plants and amphibians (Kauhala, 1996b).

15.3.3. Population ecology and behaviour

Raccoon dogs live in stable pairs and occupy permanent home ranges, usually with an intensively used core area, surrounded by a more occasionally used peripheral zone. During the cub-rearing season, the core areas generally do not overlap with those of neighbouring pairs, indicating a degree of territoriality. In contrast, the peripheral zones show substantial overlap among adjacent home ranges (Kauhala *et al.*, 1993a). Home range size varies with habitat type and food resources. In temperate zones it is usually between 0.5 and 3.5 km^2 for the core area and up to 6 km^2 for the total area (Kauhala *et al.*, 2010; Sutor and Schwarz, 2012; Drygala *et al.*, 2008b; Schwemmer *et al.*, 2021). In northern (boreal) areas home ranges are generally much larger, with core areas up to 8 km^2 (Toivonen *et al.*, 2024). Home ranges may shift slightly over the years, for instance as a result of annual changes in agricultural land use patterns (Sutor and Schwarz, 2012).

Raccoon dogs are mostly active in the darkest hours of the day, except during pup rearing when the activity is more evenly spread over the day (Zoller and Drygala, 2013). The male and female of a pair spend most of their time together, walking and foraging within 50 m from each other, at speeds of up to 0.5 km/hr (Fig. 15.1). They seldom leave the cover of dense vegetation. In summer and autumn, raccoon dogs walk 6 to 10 km each night within their home range, in winter much less (Mulder and Ten Den, own data). They defecate in fixed latrines, along their routes and near their resting places, piling up tens to hundreds of faeces over time. Raccoon dogs rarely dig or climb, but swim readily; they may even take to water when disturbed. The longest swimming distance recorded was 1.2 km, between islands in the north of the Baltic Sea (Dahl and Åhlén, 2019).

In its favourite habitat, marshland, the raccoon dog uses dense vegetation, hollow trees, the cover of fallen trees and accumulated dead vegetation as resting places and even as dens for raising cubs. The great tussock sedge (*Carex paniculata*) offers optimal cover (Mulder and Ten Den, personal observation). On dry land, dense vegetation is also important, but vacant badger or fox dens are often used for shelter (mostly only in winter) and for raising cubs (Drygala *et al.*, 2008b; Kowalczyk and Zalewski, 2011). Cubs are rarely left alone and are mainly cared for by the male (Kauhala *et al.,* 1998; Drygala *et al.*, 2008c). The male also carries prey to the den for female and cubs (Drygala *et al.*, 2008c). At approximately six weeks of age, cubs leave the den and start wandering around with their parents; shortly thereafter, they increasingly move independently, either alone or in small sibling groups of two or three. The first cubs start to disperse at the age of 15 weeks, still only half the adult size, while the last cubs leave in early spring, before the birth of the next litter. Most cubs disperse between July and September (Drygala *et al.*, 2010). There is no difference in distance covered between the sexes (Herfindal *et al.*, 2016). During dispersal, raccoon dogs move

faster (1 to 2 km/hr, up to 7.5 km per night, Mulder and Ten Den, own data) and may settle up to 100 km from their birthplace (Drygala *et al.*, 2010).

Most females reproduce from their first year. They produce a relatively large litter, larger than would be expected for a medium-sized carnivore. The mean total litter weight in Finland is 21% of the mean weight of the female, whilst in the red fox it is only 10-13% (Kauhala, 1996b). Litter size is positively correlated with body condition. In a large sample from Finland average litter size at birth was 9.5 ± 3.2 (SD) in the south-west and 7.0 ± 2.6 in the north-east of the country (n=371). Embryonic litter size, however, was 10.4 ± 3.1 and 9.0 ± 3.4 respectively (n=430), showing an intra-uterine mortality of between 9 and 22%. Litter size ranged from 1 to 16 pups (Kauhala and Saeki, 2004). Data from Germany, Poland and Denmark show similar numbers of pups (Wlodek and Krzywinski, 1986; Ansorge and Stiebling, 2001; Pagh *et al.*, 2020). Pups may be killed by other predators, such as foxes and badgers, with which raccoon dogs often share dens (Nowak, 1993; Kowalczyk *et al.*, 2009). In Poland, golden and white-tailed eagles take raccoon dogs and their pups (Wlodek and Krzywinski, 1986). In the Danube delta, many pups in open lairs die as a result of exposure to rain and hail showers (Barbu, 1972).

Fig. 15.1. Raccoon dogs live in stable pairs and forage together most of the time. © Photograph: J.L. Mulder

Of 82 dead raccoon dogs recorded in the Bialowieza Forest, at least 55% died from natural causes: 27% by diseases such as sarcoptic mange and rabies, mainly from August to November, and 27% by predation by wolves and dogs, often near carcasses to which raccoon dogs are attracted. When killed by predators, raccoon dogs were rarely consumed (Kowalczyk *et al.*, 2009). Rabies has been eradicated from most of Poland and Europe and thus no longer constitutes a major mortality factor in raccoon dogs. In areas with denser human populations traffic is a major cause of death, to the extent that road kills can be used as a proxy for monitoring the species (Balčiauskas *et al.*, 2021).

In Bialowieza and southern Finland life tables constructed based on age at death of radio-collared animals and all other recorded deaths, suggests a mortality of 82% and 88% respectively in the first year of life and 50 to 68% in years 2 to 5; the maximum recorded life span was 7 to 8 years. Males and females run the same risk of dying, being shot or killed on the road, for instance. This is most probably the result of their similar lifestyle, activity, home range size and dispersal distance, which in other carnivore species generally differs considerably between the sexes (Helle and Kauhala, 1993; Kowalczyk *et al.*, 2009).

Based on a large telemetry study, Drygala *et al.* (2008b) calculated the pre-breeding population density in north-eastern Germany as 0.95 adults/km². In Brandenburg, eastern Germany, Sutor and Schwarz (2012) estimated the pre-breeding population density as 1.1 adults/km². In Finland, density estimates range between 0.8 and 2.2 ind./km² (Kauhala *et al.*, 2010). The raccoon dog is the most common mesopredator in southern and central Finland (Selonen *et al.*, 2022). A study with camera traps in southern Finland showed a much higher density estimate, of 3.7 ind./km² in prime habitat (Selonen *et al.*, 2024a). However, the novel methodical approach of this study has still to be evaluated. In Bialowieza Primeval Forest (Poland) raccoon dog density was 0.17 - 0.5 adults/km², as compared to 0.25 - 0.35 for foxes and 0.13 - 0.21 for badgers (Kowalczyk *et al.*, 2008). In Suwalki Landscape Park in north-eastern Poland, raccoon dog density has been estimated to be 0.37 adults/km² (Goszczyński, 1999). A study with GPS-collars in optimal habitat (eutrophic marshes) in the Netherlands yielded a population density of 1.8 adults/km² (Mulder and Ten Den, own data). In a camera trap study in Lithuania, raccoon dogs were twice as common where wolves or lynxes occurred than where these large predators were not recorded, presumably through a positive effect of the remnants of large ungulate carcasses that they provide (Jasiulionis *et al.*, 2023).

15.4. Native distribution

The raccoon dog has its original distribution in the far eastern part of Asia, in the woodland zone from south-eastern Siberia to northern Vietnam, as well as on the Japanese islands (Fig. 15.2). The climate in the original distribution area varies from the subtropical regions of Japan, northern Vietnam and southern China to a harsh continental climate with cold winters in Mongolia and southeast Siberia. Accordingly, raccoon dogs in different areas have adapted to different climates, habitats and diets, which can be seen in their body size, fat reserves, thickness of fur, and their behavioural and dental characteristics (Kauhala and Kowalczyk, 2011).

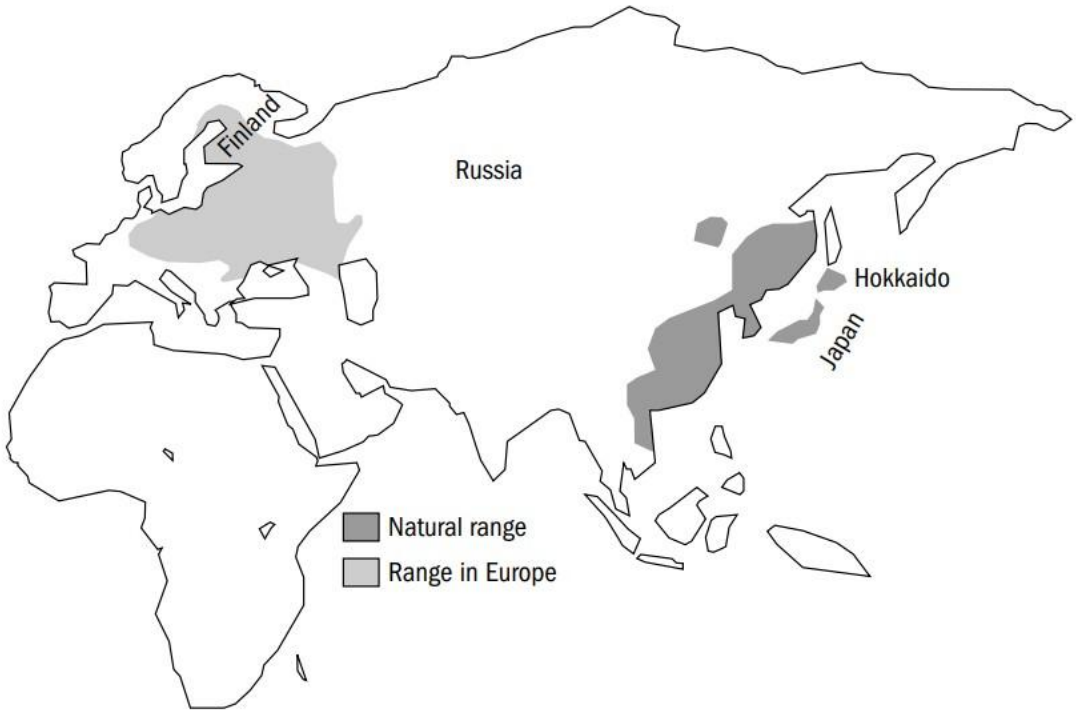

Fig 15.2. Global distribution of the raccoon dog showing native (green) and introduced (red) ranges. Map adapted from Kauhala and Saeki (2004).

15.5. Introduction and invasion pathways

From 1928-1957 approximately 9100 animals, mostly from captive-bred stock, were released in more than 70 areas of the former USSR, mainly in the European part (Lavrov, 1971; Helle and Kauhala, 1995). The aim was to enrich the fauna with a valuable fur animal. Introductions in very cold climates (Irkutsk, Transbaikal and Novosibirsk) and in mountainous areas (Caucasus, Transcaucasia and Central Asia) failed. In a later stage, raccoon dogs were captured and translocated from successfully settled populations to new areas in the Soviet Union (Lavrov, 1971). The raccoon dog spread at a steady speed to the north and west, less so to the south. In most European countries it took about 20 years before the pattern of isolated observations changed into a pattern of settlement and population growth (Mulder, 2013). The history of the introduction of the raccoon dog in Europe has been described in more detail by Kauhala and Kowalczyk (2011). The timing of its arrival in different European countries to date is illustrated in Fig. 15.3. Climatic conditions make most of Europe suitable for the raccoon dog, with the exception of the warmest southern regions (Kochmann *et al.*, 2021). Consequently, a further westward and southward expansion of its current range is likely. Climate warming has already facilitated a northward expansion of its reproductive range in Finland since 1990 (Dahl and Åhlén, 2019).

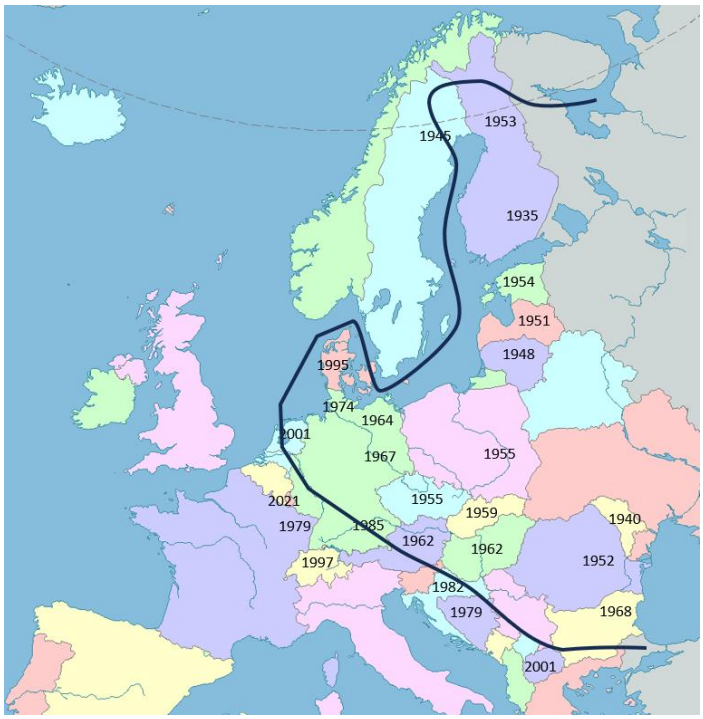

Fig.15.3. European countries with year of first observations of the raccoon dog. The black line roughly indicates the limit of reproduction in 2024. Sources: many authors.

15.6. Impacts

15.6.1. Introduction

Since its initial appearance in Europe, raccoon dogs have often been portrayed as harmful to game species and other native fauna and a vector of dangerous diseases and parasites. Now, approximately 70 years later, sufficient evidence has accumulated to allow a more comprehensive evaluation of their ecological role in European ecosystems and the risks they may pose to human and wildlife health. Elżanowski (2023) highlights the tendency in the literature to describe the raccoon dog as a species that should *a priori* be persecuted, leading to a pronounced bias in both research and the interpretation of results. This bias is reflected in the frequent neglect of any positive effects and the disproportionate emphasis on negative impacts of this non-native species. In this chapter, we aim to assess the available research evidence as objectively as possible, critically evaluating both positive and negative findings.

There are, as yet, no indications that raccoon dogs have a substantial impact, directly or indirectly, on ecosystems as a whole: for example by disrupting existing food webs. The exception may be on small islands or isolated areas, see below. To date, there is no record of raccoon dogs having an economic or social impact in Europe. They are shy and clumsy and largely avoid the vicinity of people and their infrastructures. Direct damage to property is not known, nor is there competition with economically important animals. Raccoon dogs do not climb and do not normally predate on pets or poultry. Theoretically, the raccoon dog might have some economic impact by eating from commercial crops of low-hanging fruit (strawberries, blueberries, blackberries etc.) and maize.

15.6.2. Predation

Raccoon dogs mainly eat what edible items they can find on ground level, while slowly walking through dense vegetation. They rarely chase after prey, as foxes do. In Poland, Reig

and Jedrzejewski (1988) found that, while red foxes frequently prey on birds, raccoon dogs do so only occasionally. They may eat the eggs of ground-nesting birds, but only rarely capture adult breeding birds, as most of them leave the nest when a raccoon dog approaches (Dahl and Åhlén, 2019). Within hunter communities, there is concern that raccoon dogs may have a substantial impact on grouse and waterfowl populations through nest predation. The low frequency of eggshell remains found in scats and stomach contents in many studies does not necessarily indicate low egg consumption. Rather, it reflects the feeding behaviour of raccoon dogs, which often consume eggs by carefully lapping up the contents and leaving the shells behind (Dahl and Åhlén, 2019). A study of the stomach contents of 63 raccoon dogs from southern and central Finland, collected in spring and summer, revealed no remains of waterfowl, while grouse remains were detected relatively frequently (16%) (Kauhala *et al.* 1993b). However, grouse populations in southwest Finland had already begun to decline in the 1960s, prior to the arrival of the raccoon dog in the area (Helle and Kauhala, 1991). Similarly, Naaber (1971) concluded that raccoon dogs have had little impact on grouse or hare populations in Estonia.

Waterfowl reports show contrasting conclusions. According to Naaber (1971, 1984), raccoon dogs preyed on 85% of waterfowl nests in some areas of Estonia. Ivanova (1962) found remains of birds (mainly waterfowl) in 45% of raccoon dog scats collected in a river valley in Voronez, 500 km south of Moscow. When the raccoon dog population increased rapidly in Russia, they were widely perceived as highly harmful; however, according to Lavrov (1971), this assessment was not supported by empirical evidence. In Latvia, of 1059 duck nests destroyed by predators in a eutrophic wetland, only 0.6% were attributed to raccoon dogs; the main predators were marsh harrier (*Circus aeruginosus*) (53.7%), corvids (14.7%) and American mink (*Neovison vison*) (9.0%) (Opermanis *et al.*, 2001). A large-scale predator removal experiment in southern Finland (removal from 55 km², non-removal from 48 km²), over five years, found no evidence of the raccoon dog having a negative impact on the breeding success of dabbling ducks (*Anatinae*) (Kauhala, 2004). Another removal experiment, in the surroundings of Helsinki, on a much smaller scale (too small, in fact, to be valid) yielded inconclusive results (Nummi *et al.*, 2019). A study on coot (*Fulica atra*) breeding performance in Poland showed the raccoon dog to be an insignificant predator of nests (Ręk, 2009). A recent study using DNA-metabarcoding of faeces, especially aimed at water birds in southern Finland in May, found a low level of DNA traces of water birds and eggs, not higher than in earlier studies with poorer detectability of birds and eggs, implicating that raccoon dogs do not specialize in nest predation (Tuomikoski *et al.*, 2024). Finally, an extensive study of the contents of 578 stomachs from raccoon dogs in Denmark, 525 of which were collected in wetland areas, revealed that ducks were mainly eaten during autumn and winter (8.9% of all the biomass consumed by raccoon dogs in wetland areas). eDNA-analysis established that eggs of ground-nesting birds made up only a negligible part of the raccoon dog's diet (with remains in only 4.8% and 2.3% of 105 spring stomachs and 128 summer stomachs respectively) and found no trace of shorebirds. The authors conclude that their study provided no evidence that raccoon dogs are a threat to ground-nesting birds (nor to endangered amphibians) in Danish wetlands (Pagh *et al*., 2025).

Several studies have used artificial nests to measure predation rates by different predators (Holopainen *et al.*, 2020; Krüger *et al.*, 2018; Brzezinski *et al.*, 2024). Artificial nests cannot be used to estimate predation rates of natural nests but may reveal certain patterns in predation (Krüger *et al.*, 2018). A large-scale camera-trap study conducted across a variety of habitats in Denmark and Finland identified the raccoon dog as the most frequent visitor to artificial nests (Holopainen *et al.*, 2020). The authors concluded that predation by raccoon dogs was additive

to that of native predators. They also reported a decreasing trend in duck breeding numbers in two of their five study areas. Similarly, a study with artificial nests in reedbeds in Poland also found the raccoon dog to be the main predator, with water depth negatively correlated to predation risk (Brzezinski *et al.*, 2024).

A lower breeding success due to nest predation and a population decrease are two different parameters and are not necessarily correlated. In Germany trends in waterfowl breeding numbers following the arrival of the raccoon dog are either stable (four species) or increasing (n=2), with only the common pochard (*Aythia farina*) showing a decrease (DDA, 2024). Similarly, Baltrūnaitė (2010) reported that the abundant raccoon dog population in Lithuania has not resulted in a clear decline of native species. In contrast, Pöysä *et al.* (2023) suggested that the decrease in breeding pairs of some vulnerable water bird species in Finland since the 1980s may be attributable to the increase of introduced predators such as mink and raccoon dog.

Recently the impact of raccoon dogs on meadow birds (waders) has been studied with wildlife cameras in Germany and the Netherlands. Although the raccoon dog does not like to leave the cover of dense vegetation, it appears to do so in some meadow bird areas adjacent to marshland with cover. Meadow bird populations have steadily decreased in the last decades, due to the intensification of agricultural practices. In the last remaining meadow bird areas predation of nests and chickens, mainly by foxes and martens, has become a problem, recently aggravated by raccoon dogs. Salewski and Schmidt (2019) report a total predation rate of 49%, on 405 nests of the black-tailed godwit (*Limosa limosa*) in two areas in northern Germany. Of all predated nests, 21% (42 nests) were preyed upon by raccoon dogs, whereas foxes and polecats accounted for 35% and 14% of nest predation, respectively. In a meadow bird area in the north of the Netherlands, 36 nests of four bird species were monitored in 2023. Of these, 20 nests were predated, 15 of which by raccoon dogs (Hofstee, 2023, unpublished report). However, all other meadow bird areas in the north of the Netherlands together have shown only one case of nest predation by the raccoon dog, although almost 7000 nests were being surveyed with wildlife cameras over the years (many unpublished reports). This suggests that this case of high predation on meadow bird nests represents a site-specific issue rather than a general pattern in the extensive open meadow bird areas in the Netherlands.

In Bulgaria, concerns have arisen about the raccoon dog as a threat to breeding colonies of the Dalmatian pelican *Pelecanus crispus*, based on camera observations. Raccoon dogs ate several eggs and disturbed part of a breeding colony (Koshev *et al.*, 2020). However, the Dalmatian pelican population has been stable or slightly increasing in recent years in most breeding areas (Bugariu *et al.*, 2025).

There are also concerns that the raccoon dog might be important as a predator of the European pond turtle (*Emys orbicularis*) and of isolated populations of several rare amphibian species (Schneeweiss and Wolf, 2009; Sutor *et al.*, 2010), but data are lacking to date. Pagh *et al.* (2025) found only common amphibian species in the stomachs of 525 raccoon dogs from wetlands in Denmark.

15.6.3. Island ecology

On islands, particularly where mammalian predators were previously absent, populations of prey animals are generally more vulnerable to predation by raccoon dogs. Such islands are

often deliberately selected by many bird species as safe nesting places and the arrival of predators, such as the raccoon dog, can therefore have considerable impact (Kauhala, 1996c). Kauhala and Auniola (2001) reported that, across different summers, 2 - 67% of raccoon dog faeces from the Finnish archipelago contained waterfowl remains (mainly eider, *Somateria mollissima*), although most of these were likely scavenged carcasses. Raccoon dogs were estimated to kill only 1.2 - 3.5% of nesting female eiders each year. A higher proportion of scats (11 - 40%) contained eggshells, with egg remains more frequently detected in July, after eider chicks had hatched, than earlier in spring. Predatory impacts varied among islands, depending on food availability and the local fauna composition (Kauhala and Auniola, 2001). Intensive removal of mink and raccoon dogs on small Finnish islands improved the breeding performance of eiders (Jaatinen *et al.*, 2022). On very small islands raccoon dogs were able to locate both artificial and natural bird nests rapidly (Dahl and Åhlén, 2019).

Frogs have disappeared from some small islands off the south-west coast of Finland following the arrival of raccoon dogs in the 1970s, whereas frog populations have persisted on the outer islands where raccoon dogs are absent (Kauhala 1996c; Kauhala and Auniola, 2001; Salo, 2009).

In conclusion, raccoon dogs can affect the breeding success of ground nesting birds, mostly in wetland areas and especially in bird colonies. They eat the eggs and chicks, but only rarely the breeding adults. However, from population trends and other data, there is little evidence yet that they have an impact on the population size of ground-breeding birds. However, there is still a lack of well-designed studies to investigate the effect of raccoon dog predation on ground-nesting birds.

15.6.4. Competition

Medium-sized predators may compete with each other for resources such as food or dens. They may also kill each other's cubs. In North-eastern Germany the diet of raccoon dogs and foxes overlapped to a considerable degree, both predators being omnivorous and opportunistic. However, since these species are sympatric in the original distribution area, competition between the species, if it takes place at all, is not intense (Drygala *et al.*, 2013). In northern Belarus, there seemed to be little resource competition between these generalist predators in the warm season. However, raccoon dogs substantially depleted ungulate carrion resources, elk (*Alces alces*) and boar (*Sus scrofa*), at the onset of winter, before their own winter dormancy began. This depletion affected native predators later in the winter, particularly the polecat (*Mustela putorius*). Over a 14 year-period during which raccoon dog snow-tracks count increased, polecat track counts declined significantly (Sidorovich *et al.*, 2000).

Kowalczyk *et al.* (2008) postulate a positive effect of badger burrows on raccoon dogs, facilitating their success. Raccoon dogs do not dig burrows themselves. Badgers are prolific diggers, and their burrows are an important resource for foxes and raccoon dogs, for reproduction, winter rest and daytime shelter. Often the three species share the same setts. In the Bialowieza Forest in Poland cohabitation of badger setts was found to be very common in winter, much less common in summer (Kowalczyk *et al.*, 2008). Occupation of badger setts by raccoon dogs or foxes never led to the departure of badgers. No evidence of aggression of raccoon dogs or foxes against badgers was found. Some predations on each other's cubs occurred, and badgers probably killed some adult foxes and raccoon dogs (*ibid*.). The cohabitation of badgers and foxes or raccoon dogs in the same burrows did not affect the litter

sizes of the three species (Nowakowski *et al.*, 2020). Elsewhere badger burrows were also found to be important for raccoon dogs. In a Lithuanian nature reserve, in spring, 8% of badger burrows were used by raccoon dogs for reproduction (Ulevicius, 1997). In south eastern Finland radio-collared badgers and raccoon dogs were detected wintering or resting together in 24% of 135 locations in winter and 12.5% of 124 locations in summer (Kauhala and Holmala, 2006). Badgers and raccoon dogs in southern Finland showed different habitat preferences, making it unlikely that they competed with each other for food (Kauhala and Auttila, 2010).

Kauhala (1995), Kowalczyk *et al.* (2000) and Sidorovich *et al.* (2000) all found no link between the invasion of raccoon dogs and the densities of badgers in the Bialowieza Primeval Forest and other European localities It appears that these two species can coexist and utilize available resources with minimal competition (Jędrzejewska and Jędrzejewski, 1998). The same is true for the fox. Baltrunaite (2006) and Drygala and Zoller (2013) both concluded that the impact of raccoon dog on red fox (and pine marten) in Lithuania and north eastern Germany was insignificant, because of differences in diet, hunting tactics and their specific use of some habitats. However, because fox and raccoon dog population indices correlated negatively during a five-year predator removal experiment, Kauhala (2004) thinks that competition between these two species is possible and, if hunting pressure on one of them is high, the other species may benefit and increase in numbers. In Lithuania, the increase in the abundance of the raccoon dog did not result in a distinct decline of native medium-sized predators, also suggesting weak or no competition between them (Baltrunaite, 2010). Another form of possible competition between raccoon dog and red fox may be an enhanced mortality in the red fox by sarcoptic mange since the arrival of the raccoon dog, due to a higher incidence of mange in this species than in the red fox (see below; N. Stier, personal communication).

Overall, it is generally acknowledged that competition from raccoon dogs is unlikely to be sufficiently strong to cause significant impacts on populations of native carnivore species.

15.6.5. Parasites and diseases

The introduced raccoon dog has not brought new parasites or diseases to Europe. Instead, being a canid, it shares the same parasites and diseases of the red fox, jackal and wolf. Some of these parasites or diseases are zoonotic and can be dangerous for humans, for example, rabies. Rabies is a prominent viral disease in areas where it still persists, mainly in Eastern Europe (RBE, nd). The baits that are used to control rabies in foxes can be consumed by raccoon dogs, but it is necessary to adapt the rabies control strategy to the higher vector population (fox plus raccoon dog) in areas where raccoon dogs are common (Robardet *et al.*, 2016), as well as to the hibernation behaviour of the raccoon dog (Singer *et al.*, 2009).

The fox tapeworm *Echinococcus multilocularis,* which is widespread among foxes in central Europe is a parasite that is dangerous to humans. This tiny endoparasite has been found in several surveys of the intestines of raccoon dogs, with its prevalence ranging from 2.5 to 28% (Oksanen *et al.*, 2016). Generally, the proportion of affected raccoon dogs is much lower than that of foxes (Laurimaa *et al.*, 2015). While the raccoon dog is a competent host species for *E. multilocularis*, the red fox remains the main vector. Only where the prevalence in foxes is higher than 3%, are other vectors, such as raccoon dog, jackal and wolf also infected. In areas where the prevalence in foxes is lower than 3%, there is no indication that the life cycle of *E. multilocularis* is maintained by host species other than the fox (Oksanen *et al.*, 2016). Foxes

defecate throughout their whole territory, while raccoon dogs concentrate their faeces in a few latrines, thus contaminating far fewer spots with *Echinococcus* eggs and playing a more limited role in the transmission to humans (Al-Sabi *et al.*, 2013).

Humans can be infected by eggs of *E. multilocularis* that are shed with the faeces, in the field, or via their own domestic dog, which may have fox tapeworms if it has eaten infected voles. In the five years from 2018 to 2022, a total of 761 cases of human alveolar echinococcosis were reported across the whole of Europe (ECDC, 2022). Alveolar echinococcosis is characterised by tumour-like growth in internal organs, mainly the liver, but develops very slowly; it may take ten years before problems arise. If left untreated, it can be fatal. For an early diagnosis, the doctors in areas where the tapeworm is common must be vigilant and aware of the possibility of echinococcosis in patients with internal organ problems. Preventive measures include avoiding contact with wild animals such as foxes and raccoon dogs, as well as domestic dogs, and their faeces, and limiting the interactions between dogs and rodents. Control options for *E. multilocularis* in the wild animal population are limited. The usual culling of foxes and raccoon dogs does not affect the distribution and prevalence of this tapeworm; to have effect the necessary intensity of culling is unrealistically high. The occurrence of the parasite in the field can be suppressed by distributing anthelmintic baits for foxes (and presumably raccoon dogs), but to have sufficient effect baiting campaigns must be very intensive and long-lasting, and are thus costly (Hegglin and Deplazes, 2013).

The raccoon dog is a suitable indicator species and a well-adapted host for *Trichinella* species circulating in Europe. It plays an important role, especially in spreading *T. spiralis* and *T. britovi* through the sylvatic cycle in north eastern European countries. The prevalence of *Trichinella* infection in raccoon dogs varies widely between different European regions, from 0% in Denmark and Austria to 1.9–4% in Germany, about 32-55% in Finland, Lithuania, and Latvia, and 57.5% in Estonia (Veronesi *et al.*, 2023). In Finland, red foxes and raccoon dogs are the main vectors of sylvatic *trichinella* infections (Airas *et al.*, 2010). Humans may develop trichinellosis by eating raw or undercooked meat from infected domestic pigs (mostly if they have access to outdoor pens) or game animals. Several carnivore or omnivore wildlife species (red fox, raccoon dog, wild boar, rats and other rodents) can be carriers of *Trichinella*, and if pigs eat their carcasses, they become infected. In western and northern Europe trichinellosis is a now a rare disease, as a result of stricter control measures in the meat industry (Airas *et al.*, 2010). However, in Germany and Eastern Europe, the infection rate of wild boar is increasing, most probably due to the spread of raccoon dogs and wolves (Johne *et al.*, 2025). Pigs should be prevented from eating uncooked meat, scraps, or carcasses of any animals, including rats, to break the oral ingestion cycle of infection.

Alaria alata, a trematode, is a parasite detected in raccoon dogs and foxes, with increasing frequency in some European countries, with a prevalence ranging from 4.7% in Croatia to 96.5% in Lithuania, mainly in wet areas. The larval stage is pathogenic. In humans, the symptoms of alariosis are usually mild, and the diagnosis is difficult, but it can occasionally be quite harmful and even cause death. Humans can be infected by ingesting *Alaria* larvae when eating undercooked frog, goose, boar or pig meat (Korpysa-Dzirba *et al.*, 2021).

Raccoon dogs can also carry many non-zoonotic parasites (those not affecting humans) and diseases, some of which some may have a substantial impact on the raccoon dog populations themselves. Sarcoptic mange, caused by the mite *Sarcoptes scabie* var. *vulpesi* is rather common in raccoon dogs (Stier, 2006). The mite lives in the skin, causing bare patches, severe itching and, if the infection is severe may, in a few weeks, lead to death from exposure and

organ failure. Free-running domestic dogs can be infected by contact with mangy foxes or raccoon dogs (Süld *et al.*, 2017). Sarcoptic mange sometimes comes in 'waves', decimating the populations of red foxes (Lindström, 1992). In some cases, it is permanently present at low intensities (up to 25%) in fox, raccoon dog and other wildlife populations, although leaving relatively few victims (Kołodziej-Sobocinska, 2014).

Canine distemper, caused by the canine distemper virus (CDV), is an important disease in domestic dogs and other canids and has been observed in raccoon dogs as well. Foxes are the main vector in wildlife in Europe, but there is a lack of research in raccoon dogs.

In conclusion, the raccoon dog is a reservoir of several zoonotic and non-zoonotic diseases and parasites but has not substantially aggravated the human health risk situation in Europe. However, the establishment of a raccoon dog population may require the adaptation of some disease management strategies. Continued monitoring is recommended for rabies, *Echinococcus*, *Trichinella* and *Alaria* in raccoon dogs.

15.7. Management

The primary measure to prevent the raccoon dog from colonising new areas is to prevent all keeping, importing, selling and breeding of the species. In Denmark the entire population originates from escaped captive animals (Nørgaard *et al.*, 2017), as did the population in central Netherlands (Mulder, 2013). It is therefore essential to strictly enforce bans on keeping and trading the species. The inclusion of the raccoon dog on the list of Invasive Alien Species of Union Concern under Regulation (EU) No 1143/2014 prohibits any form of possession, transport, trade, breeding and release within European Union Member States. In addition, the establishment of early warning systems along potential invasion routes is strongly recommended, as has already been implemented in northern Sweden (Dahl and Åhlén, 2017). Such systems would be particularly relevant in areas such as north eastern Italy along the Adriatic Sea, and on islands. Since the raccoon dog is a proficient swimmer – considerably more than the red fox – it poses a particular risk for islands hosting important bird populations. An early warning system based on wildlife cameras installed at bait stations, which transmit images to operators in real time, could facilitate a rapid response when raccoon dogs arrive in new areas (Dahl and Åhlén, 2017).

Where raccoon dog populations are already established and widespread, it has proved to be impossible to eradicate them or even to reduce their numbers considerably. In all European countries where raccoon dogs are living today, they have been hunted and otherwise persecuted from the moment of their arrival. Despite the high numbers of raccoon dogs killed by hunters each year (Finland: 200,000; Germany: 30,000), their expansion has not been limited anywhere and there are no indications that the population density has decreased as a result of hunting. Just to limit the population growth it is necessary to annually remove at least the numbers produced each year in excess of the annual mortality. Stier (2006) argued that although the hunting bag in Germany may appear substantial, a two- to threefold increase in hunting pressure would be required to achieve a reduction in the breeding population of the raccoon dog. In addition, rabies, formerly a major natural cause of mortality, has been eliminated from Western Europe, thereby increasing the species' potential for expansion. Such a dramatic intensification of hunting pressure is, however, unrealistic and, given the favourable conditions in terms of habitat suitability and food availability, would likely still have only a limited effect on raccoon dog populations in central and northern Europe.

A locally effective management strategy is the employment of so-called Judas animals. Raccoon dogs are captured, sterilised, fitted with a GPS-GSM-collar and released into areas where their presence is undesired. As solitary individuals, they will search for a mate. When its movement data and behaviour indicates settlement, the animal is located in the field (often with the assistance of trained hunting dogs) and its newly acquired partner is either killed or captured and subsequently used as a Judas in another area. This method has been successfully applied in northern Sweden and Finnish Lapland to control the influx of raccoon dogs from Finland, since 2008. At the start of the Judas-project, in 2012-2014, approximately 80 raccoon dogs were removed annually in Sweden, with this and other methods, whereas between 2020 and 2023 on average about 15 animals were killed annually with the same management effort (SAHWM, 2022, 2023). About half of the Judas animals succeeded in finding one or more new partners (Herfindal *et al.*, 2016). In the adjacent Finnish Lapland region, the yearly number of animals killed dropped from about 200 to 75 during the same ten years. At the same time, the appearance of raccoon dogs on wildlife cameras dropped significantly as well, indicating the success of the Judas project, alongside intensified culling using other methods (FWA, 2024).

The apparent success of this relatively costly management method (in Finnish Lapland costs are approximately € 150,000 annually) is largely due to its application at the northern edge of the raccoon dogs´ distribution range, where climatic conditions with long winters limit population density. In addition, the method was implemented within a relatively narrow invasion corridor around the Bothnic Gulf. By contrast, when the same approach was applied on the Danish mainland between 2010 and 2015 it failed to curb the rapidly increasing raccoon dog population (Sunde and Elmeros, 2016). A further drawback of this method is that the Judas animals themselves continue to forage and prey upon local fauna.

In conclusion, the employment of Judas animals can be effective in maintaining raccoon dog populations at low levels in areas where the natural population density is very low (Dahl and Åhlén, 2017). This approach may also be successful on islands or at the entrances to peninsulas, where the invasion front is narrow, but it is unlikely to be effective within the core of a well-established population. In Italy, this method could potentially be useful to prevent the raccoon dog from entering the country via the Alpine region.

Stier (2006) and Mulder (2013) recommended addressing specific problems caused by raccoon dogs (and other predators), such as predation on bird colonies, at a local scale. To achieve meaningful reductions in spring population size within a target area, very intensive control must be applied annually between December (end of dispersal) and April (start of reproduction). This target area should remain relatively small to ensure effectiveness by concentrating management there. As is often the case in predator management, a combination of control methods yields the best results. These include the use of large wire cages to capture inexperienced young animals, monitoring and hunting at feeding stations during darkness using infrared illumination or thermal imaging devices, hunting dogs, snow tracking, and the excavation of dens. Fish, meat and dog biscuits are commonly used as effective baits.

To prevent raccoon dogs from visiting small, high-value target areas, such as fruit crops, bird breeding colonies, or ponds hosting rare amphibians, electric fencing can be an effective measure, as has already been demonstrated for fox control. Across the vast majority of the raccoon dog’s expanding range, however, active management is generally not required.

15.8. References

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