- 1 Title: **Is the raccoon (*Procyon lotor*) out of control in Europe?**
- 2 Running title: **Raccoon invasion of Europe**
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Abstract

The northern raccoon (*Procyon lotor*) is an invasive species in Europe and poses a serious threat to indigenous biodiversity and human health. Raccoons can also cause important economic losses. Despite the risks, no comprehensive report on the status of the raccoon in Europe is available. In this article, I estimate the raccoon invaded range and population trends, and evaluate the impacts on native ecosystems and wildlife to (1) determine the status of the raccoon and discuss the invasion process on a continental scale, (2) identify the threats, and (3) propose guidelines to design strategies for managing raccoon populations. Raccoons have been introduced in Europe since the late 1920s but the raccoon population growth and range expansion rates have been increasing since 1970s after a lag period. In addition, recent introductions through the pet trade have resulted in the establishment of new feral raccoon populations. Therefore, the raccoon spatial distribution is a result of multiple introductions and range expansion from the primary raccoon populations in central and eastern Europe over the last 40 years. The first individuals escaped from fur farms or were released for hunting. Nowadays, the pet trade is the major introduction pathway. Raccoons have adapted to different environments, even urban and residential areas. In central Europe, the raccoon population has increased by over 300% and grows at exponential rates since the 1990s. The raccoon is out of control in Europe because of increasing population trends, range expansion and no efficient management strategy. However, no impacts have still been reported through an evidence-based approach. There is a pressing need for a long-term strategy for managing raccoon populations in Europe.

Keywords: biological invasions, introduced species, pet trade, wildlife management

Introduction

Biological invasions are a principal component of global change (Vitousek et al. 1997), since invasive species are recognised as a threat to biodiversity and natural resources on a global scale (Millennium Ecosystem Assessment 2005). Introduced species may disrupt local ecosystems and eliminate native species through predation and herbivory, competition, transmission of pathogens, or hybridisation (Parker et al. 1999). Besides ecological effects, invasions may affect human health (Crowl et al. 2008; Mazza et al. 2014) and have important economic costs (Pimentel et al. 2005; Vilà et al. 2010).

The northern raccoon (*Procyon lotor*) is an abundant and widespread mesocarnivore in North and Central America (Gehrt 2003) and could become invasive in most recipient ecosystems because is an opportunistic species, adapts to most habitats in the native range (except deserts, the Rocky Mountains and the boreal forest) and exploits nearly all the available resources, even garbage (Prange et al. 2004). The raccoon is also commensal with the human population in some urban and suburban areas (Prange et al. 2003). Furthermore, only large carnivores predate on raccoons and the raccoon is not excluded by competition with other medium-size carnivores such as the coyote (*Canis latrans*; Gehrt and Prange 2007).

The raccoon is native to North and Central America but has been introduced throughout Europe during the past century (Kauhala 1996). Non-native raccoon populations have also been reported in Alaska (MacDonald and Cook 1996), the Antilles (Helgen et al. 2008) and Japan (Ikeda et al. 2004). The raccoon constitutes a potential threat to biodiversity because competes with and predate on native fauna (Kauhala 1996). Moreover, raccoons are host to several pathogens transmissible to humans, domestic and wild animals (Beltrán-Beck et al. 2012; Popiolek et al. 2011). The natural range expansion from central and eastern Europe (the locations of first establishments: Aliev and Sanderson 1966; Lutz 1984) during

the last 40 years (Biedrzycka et al. 2014) and recent introductions in other countries (Canova and Rossi 2008; Ćirović and Milenković 2003; García et al. 2011) should be cause for concern.

The status of the raccoon in Europe has not been evaluated yet. In this article, I determine the status of the raccoon as an invasive species in Europe by: (1) estimating the current invaded distribution area and the range expansion during the last 30 years; (2) describing the population trends in central Europe over the last 20 years; and (3) identifying the potential threats to native ecosystems and wildlife. Moreover, I discuss the invasion process on a continental scale and propose guidelines for managing non-native raccoon populations. This article provides the most complete large-scale assessment of the status of the raccoon in Europe, as it has been done for other introduced carnivores (Bonesi and Palazón 2007; Kauhala and Kowalczyk 2011).

Methods

The information on the raccoon in Europe was collected through expert consultation and literature review. The literature search strategy consisted of three stages. First, I conducted a search of published scientific literature on the raccoon in Europe (book chapters, research articles and conference proceedings) on *Web of Science*, *Google Scholar* and publisher databases (Springer, Elsevier, Wiley). Also, I performed a web search on *Google* to find grey literature such as unpublished research and technical reports, theses and conference papers. Some of these documents were available on personal web pages. The search terms included “*Procyon lotor*”, “raccoon” and “Europe” in most European languages and the queries were entered into the search engines. Then, I checked the reference lists of the research articles to find additional studies. At last, I contacted raccoon experts to provide unpublished literature. This comprehensive literature search resulted in 93 documents on the raccoon as an invasive species in Europe (all the references are listed in the Online Appendix

1). Furthermore, I sent out a detailed questionnaire to members of the Invasive Species Specialist Group (ISSG, a specialist group of the IUCN Species Survival Commission; www.issg.org) and other knowledgeable experts such as researchers and wildlife managers (Online Appendix 2). In total, 28 raccoon experts were contacted (see Acknowledgements). They compiled the most up-to-date and accurate data from their country by accessing results not only from national and regional invasive species monitoring programs and official statistics but also from ongoing research and conservation projects. This method has been used to determine the status of large carnivores in Europe (Chapron et al. 2014).

Presence records were classified as introduction events (survival in the wild; free-ranging individuals), established (reproduction; population growth) or invasive (dispersal; range expansion) populations; based on the framework for biological invasions proposed by Blackburn et al. (2011). The invasion status of the raccoon was defined by distribution (local vs. widespread), abundance (rare vs. common), population trends (increasing, stable or decreasing) and impacts on native ecosystems (high or low).

Raccoon occurrence data were pooled on a 2.5×2.5 km (i.e. 6.25 km²) grid basis because the raccoon home range in Europe is about 10 km² (Hohmann et al. 2000). Therefore, the average raccoon home range is likely to cover one to several grid cells. Moreover, this spatial resolution is fine enough to estimate species ranges at a continental extent (Chapron et al. 2014). A distribution map was then estimated by using a kernel density function in ArcGIS 10 (ESRI 2011).

Hunting bags are often used as an abundance index to monitor mammal populations (e.g., Virgos et al. 2007; Ferreira et al. 2010; Massei et al. 2015). Hunting records from Germany (raccoon hunting is allowed since 1954) were used to calculate an abundance index and infer the raccoon population trends in central Europe for the period 1994–2014, since Germany is the core area of the European raccoon population. Hunting bags were corrected

for hunting effort (i.e. the number of hunting licenses) and multiplied by 100 (i.e. the harvest rate). Systematic bias may be introduced if hunting effort is not controlled for (McDonald and Harris 1999; Cattadori et al. 2003; Imperio et al. 2010). For example, Fischer et al. (2016) did not correct raccoon hunting bag data for hunting effort and thus inferences on population trends may be misleading. Time series data were analyzed by TRIM software (*Trends and Indices for Monitoring Data*; Pannekoek and Van Strien 2005) to estimate population trends and assess how the raccoon affects the populations of a native (the Eurasian badger, *Meles meles*) and an alien (the raccoon dog, *Nyctereutes procyonoides*) species, both potential competitors. The raccoon dog and badger population trends also derived from German hunting statistics. TRIM software computes between-year changes in abundance to estimate population trends from monitoring data, such as hunting statistics (Grauer et al. 2015). Count data are fitted by a log-linear Poisson regression model that adjust for overdispersion and temporal correlation. Model fit is assessed by the Chi square and likelihood ratio or deviance tests. The Wald test is used to test for significance of deviations from linear trend. Moreover, the annual population growth rate was estimated by dividing the raccoon harvest by the previous year's one. Hunting statistics were obtained from the homepage of the German Hunting Association at <https://www.jagdverband.de/>. It is assumed that potential biases of the annual hunting bags are constant over time. These data provide the best available indicators of population trends.

Results and Discussion

Raccoons were introduced into the wild in Germany during the late 1920s (Lutz 1984) and in the former USSR between 1936 and 1958 (Aliev and Sanderson 1966) for fur farming, hunting and “fauna improvement” (i.e. deliberate species introduction to “enrich” native ecosystems). After 1970s, raccoons colonized the neighbouring countries from the primary populations and also were again introduced as a game and furbearing species (Kauhala 1996;

Léger and Ruetten 2014). The pet trade is nowadays the major introduction pathway through the release or escape of individuals (García et al. 2011; Mori et al. 2015; Table 1). Feral raccoons have been reported in at least 27 European countries, although the raccoon is not known to be established in all of them (Table 1). The raccoon distribution area has increased over the last 30 years, as a result of multiple introductions and range expansion (Fig. 1). Therefore, a large central expanding (core) and other small marginal isolated (border) patches determine a disjunct spatial distribution pattern, typical of species invasions (Guo 2014).

The raccoon is widespread and common in central and eastern Europe (the core area) but is still local in southern Europe (the marginal area). In northern Europe and British Isles the raccoon has not established yet, although free-ranging individuals escaped from or released by pet owners are occasionally detected and captured near residential areas.

The raccoon population stayed small for years (the so-called lag phase; Sakai et al. 2001; Crooks 2005) and then exploded in the mid 1990s (Fig. 2). The lag effect may simply be the result of the normal population growth and range expansion (Mooney and Cleland 2001). In central Europe (the location of first introduction), the raccoon population has increased by over 300% and has been growing at exponential rates since 1990s (the log phase, a J-shaped growth curve; Fig. 2a). The raccoon population growth rate (λ) was lower than 1 ($\lambda = 1$: stable population) only in 4 years, while it ranged between 1.03 and 1.79 in all other years (Fig. 2b). As population size increases and resources become limited, growth rate slows. The raccoon population is expected to stabilize (i.e. $\lambda = 0$) at carrying capacity (K , the upper asymptote of the growth curve) because of density-dependent factors (the stationary phase). Invasive species populations are thus described by a logistic (S-shaped) growth curve (Williamson 1996). The question is how large the raccoon population can be and how it will affect native wildlife and ecosystems.

In Europe, most raccoon populations have been founded by a few individuals (Alda et al. 2013; Frantz et al. 2013; Fischer et al. 2015, 2017). Despite low genetic diversity, as a result of the founder effect and population bottleneck, introduced raccoons have become invasive (Alda et al. 2013; Frantz et al. 2013; Fischer et al. 2015, 2017). Moreover, high propagule pressure (i.e. many introductions and founder events; Alda et al. 2013; Fischer et al. 2015, 2017) and gene flow (by connecting populations through metapopulation processes; Biedrzycka et al. 2014; Fischer et al. 2015, 2017) may have increased the effective population size and enhanced the adaptability, and therefore the likelihood of invasion success (Sakai et al. 2001).

Despite a strong habitat preference for deciduous forests near water in both the native and invaded ranges (Table 1), the raccoon may adapt to new environments and exploit a wide range of resources (Lutz 1980; Bartoszewicz et al. 2008; García et al. 2011). The raccoon is an opportunistic species; wetlands and riparian habitat provide abundant food (fish, crabs, amphibians, tortoises and birds eggs, fruits) and shelter (underground burrows, large tree hollows or thickets as sleeping, winter and litter dens). The raccoon is omnivorous and uses almost any available trophic resource (Lutz 1980; Bartoszewicz et al. 2008; García et al. 2011). The raccoon diet must be examined to identify key resources facilitating invasion. For example, the North American red swamp crayfish (*Procambarus clarkii*), an invader in the Iberian peninsula, has become a main food item for the community of semi-aquatic carnivores (e.g. Barrientos et al. 2014). Indeed, the Eurasian otter (*Lutra lutra*) recovery and the American mink (*Neovison vison*) invasion have been linked to the crayfish availability (Almeida et al. 2012; Melero et al. 2014), and may also be facilitating the raccoon population growth and range expansion.

The raccoon often occurs at high density in urban areas (> 100 individuals/km²; Michler et al. 2004) due to aggregated and abundant anthropogenic resources, such as garbage

and man-made structures (Prange et al. 2003, 2004). Indeed, the raccoon population density is higher in urban than in rural areas (Šálek et al. 2015). Likewise, the raccoon home range is smaller in urban areas (Bartoszewicz et al. 2008). Once established, the raccoon spreads along the riverbanks. Valleys may play the role of dispersal corridors (García et al. 2011; Mori et al. 2015), and large rivers and high mountain ranges might be natural barriers to dispersal (Fischer et al. 2015; Mori et al. 2015). Therefore, at least in southern Europe, the internal structure of the raccoon invaded range fits to a linear spatial pattern (Alda et al. 2013; Mori et al. 2015).

The raccoon is listed as invasive in most European countries because of high rates of population growth and range expansion. The raccoon may impact on native wildlife by predator-prey interactions (predation on rare and endangered species) and competition (with native medium-size carnivores and raptors for resources, food and den site) but no evidence of negative ecological impacts on European ecosystems has yet been reported (Kauhala 1996; Lutz 1996; Michler and Michler 2012). The raccoon may become overabundant and then small local populations of native prey species may decline or even become extinct because of high predation pressure. In the native range, the raccoon density on islands and coastal areas correlates with the nest predation rates of ground and burrow nesting birds (Davis et al. 2001; Erwin et al. 2001) and sea turtles (Stancyk et al. 1980; Ratnaswamy and Warren 1998; Engeman et al. 2003, 2006). However, the raccoon can impact on native fauna even at low density (Ellis et al. 2007; Hartman et al. 1997), especially on islands because prey populations are more vulnerable to non-native predators in insular than in mainland ecosystems (Courchamp et al. 2003). In the Canary Islands, one raccoon preyed on over one hundred Cory's shearwaters (*Calonectris diomedea*) in a few months (García et al. 2011). Moreover, the impact of non-native predators on prey species can also be magnified under certain conditions (e.g., mesopredator release or subsidization; Crooks and Soulé 1999; Gompper and

Vanak 2008). No large predators limit raccoon populations in the European invaded range by top-down regulation. The raccoon may also compete with endangered medium-size carnivores such as the European mink (*Mustela lutreola*) or the polecat (*Mustela putorius*). However, the raccoon is not likely to affect the Eurasian badger and the raccoon dog (Table 2; Fig. 3). The raccoon dog population decline since 2007 was not due to interspecific competition with the raccoon but to a canine distemper outbreak (Mulder 2012, 2013). The raccoon may compete with native carnivores not only by limiting resources (exploitation competition) but also through aggression (interference competition), as do other invasive species. For example, some polecat populations in Europe are male-biased because American minks exclude polecat females, smaller than males, and adult sex-ratio alteration could result in local extinctions due to low effective population size (Barrientos 2015).

Management recommendations

The most efficient strategy for managing the raccoon is prevention through legislation on pet trade and awareness campaigns about biological invasions (Tollington et al. 2016). The raccoon and other potential carnivore invaders, such as the raccoon dog or the coati (*Nasua nasua*), are still imported and traded as pets in some European countries (Lehtiniemi 2016; Pergl et al. 2016).

An early detection (through sign surveys and camera trapping) and rapid response (by live trapping and hunting) system must be activated to eradicate newly established populations and slow the spread of the raccoon in Europe. Moreover, identifying threats and measuring impacts (i.e. a risk assessment) is central to recognize target species and locations, and design efficient management strategies.

Control is a long-term management strategy, expensive and requiring stable funding. Thus, the objectives must be measurable (e.g. keeping raccoon populations at low density or

in a limited area), the actions evaluated and the management strategy adjusted (i.e. adaptive management approach; Lindenmayer and Likens 2009). Long-term management aims to reduce population size, limit range expansion and protect specific species, habitats or resources. Marginal populations must be eradicated to limit range expansion and avoid genetic admixture (Fischer et al. 2017), whereas core populations must be kept at low density to prevent negative impacts. Nowadays, the management of the raccoon in the invaded range is not usually effective because of insufficient knowledge of population ecology outside the native range. Therefore, managing raccoon populations requires site-specific information on demographic parameters (survival, recruitment, population growth rate, age structure, sex ratio) and processes (movements, dispersal), population genetics, diet and habitat selection for building models to predict potential invasion, quantify impacts on biodiversity, estimate economic costs, evaluate epidemiologic risks, and thus facilitate decision making.

In conclusion, the raccoon is out of control in Europe because of population growth, range expansion and new introductions, and no efficient management strategy. The raccoon is already listed as an invasive species in most European countries (Table 1) and may be considered to be a new species of the European fauna, hence long-term management strategies must be implemented at the international level (Regulation EU No.1143/2014; Tollington et al. 2016).

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461 **Table 1** Invasion status of the raccoon in Europe based on distribution and relative
 462 abundance: *local and rare* (introduction; free-ranging individuals); *widespread and rare*
 463 (multiple introductions); *local and common* (establishment; feral population); and *widespread*
 464 *and common* (invasion; range expansion).
 465 Introduction pathway: *FF* fur farming (escape from fur farms), *G* game (release into the wild
 466 for hunting), *PT* pet trade (released or escaped from pet owners and zoos), *C* colonization
 467 (natural range expansion). Habitat: *DF* deciduous forest, *MF* mixed forest, *RF* riparian forest,
 468 *W* wetlands, *AA* agricultural area, *UA* urban area. Management strategies: *P* prevention
 469 (legislation and education programs), *C/E* control and eradication (trapping or hunting)

Country	First record	Pathway	Habitat preference	Distribution	Abundance	Population trends	Impact	Status	Management
Germany	1927	FF, G, PT	DF, MF, RF, W, UA	Widespread	Common	Increasing	Low	Invasive	P, C/E
France	1934	PT, C	DF, MF, RF, W, AA, UA	Widespread	Common	Increasing	Low	Invasive	P, C/E
Azerbaijan	1941	G	DF, RF, W	Widespread	Common	Increasing	Unknown	Invasive	C/E
Poland	1945	FF, C	DF, MF, RF, W, AA, UA	Widespread	Common	Increasing	Unknown	Invasive	P, C/E
Russia	1950	G	DF, RF, W	Local	Common	Unknown	Unknown	Established	–
Czech Republic	1952	FF, PT, C	MF, RF, W, AA,	Widespread	Common	Increasing	Unknown	Invasive	C/E
Belarus	1954	G, PT	DF, RF, W	Local	Common	Unknown	Unknown	Established	–
Netherlands	1960	PT, C	DF, MF, UA	Widespread	Rare	Unknown	Unknown	Established	P, C/E
Austria	1974	FF, PT, C	DF, MF, RF, W	Widespread	Common	Unknown	Unknown	Invasive	P, C/E
Switzerland	1975	PT, C	DF, MF, W, UA	Widespread	Common	Increasing	Unknown	Invasive	P, C/E
Denmark	1978	PT, C	AA, UA	Widespread	Common	Unknown	Unknown	Invasive	P, C/E
Luxemburg	1979	C	DF, MF, RF	Widespread	Common	Increasing	Low	Invasive	P, C/E
United Kingdom	1980	PT	UA	Local	Rare	Unknown	–	Introduced	P
Hungary	1982	C	–	Local	Common	Unknown	Unknown	Established	P, C/E
Belgium	1986	PT, C	DF, MF, RF, W, AA, UA	Widespread	Common	Increasing	Low	Invasive	P, C/E
Slovenia	1990s	PT	–	Local	Rare	Unknown	–	Introduced	–
Slovakia	1993	FF	MF, RF	Local	Rare	Unknown	–	Introduced	P, C/E
Serbia	1998	PT	–	Local	Rare	Unknown	–	Introduced	–
Spain	2001	PT	RF, W	Local	Common	Increasing	Unknown	Established	P, C/E
Italy	2004	PT, C	RF, AA	Local	Common	Unknown	Unknown	Established	P, C/E
Norway	2010	PT	UA	Local	Rare	Unknown	–	Introduced	P
Sweden	2010	PT	UA	Local	Rare	Unknown	–	Introduced	P
Ireland	2011	PT	UA	Local	Rare	Unknown	–	Introduced	P
Lithuania	2011	C	DF, MF	Local	Common	Unknown	Unknown	Established	P, C/E
Armenia	?	C	DF, RF, W	Local	Common	Unknown	Unknown	Established	–
Georgia	?	C	DF, RF, W	Local	Common	Unknown	Unknown	Established	C/E
Ukraine	?	G	–	Local	Common	Unknown	Unknown	Established	–

470 **Table 2** Annual changes in the raccoon (*Procyon lotor*), raccoon dog (*Nyctereutes procyonoides*)
471 and badger (*Meles meles*) populations in central Europe before (1994–2007) and after (2007–2016)
472 a canine distemper outbreak, estimated by TRIM population trends models

	Annual population change (%)	95% CI	
Before (1994-2007)			
<i>Procyon lotor</i>	31.01*	7.25	54.77
<i>Nyctereutes procyonoides</i>	51.09*	50.97	51.21
<i>Meles meles</i>	6.62*	1.74	11.50
After (2007-2016)			
<i>Procyon lotor</i>	14.91*	9.81	20.01
<i>Nyctereutes procyonoides</i>	−3.01 ns	−12.08	6.06
<i>Meles meles</i>	2.26 ns	−4.11	8.63
1994-2016			
<i>Procyon lotor</i>	22.41*	14.32	30.50
<i>Nyctereutes procyonoides</i>	19.29*	4.55	34.03
<i>Meles meles</i>	4.08*	2.04	6.12

Significance codes: ns ($P > 0.05$); * $P < 0.05$

473 **Fig. 1** Distribution of the northern raccoon (*Procyon lotor*) in Europe. Both records of established
 474 (reproduction) and invasive (range expansion) populations were used to build the species
 475 distribution map. The striped area represents the raccoon invaded range in central Europe estimated
 476 by Lutz (1984)

477 **Fig. 2** Raccoon population trends in central Europe (the location of first introduction), derived from
 478 German hunting statistics. **a** The raccoon population grows at exponential rates (J-shaped growth
 479 curve). The dashed line represents an exponential function fitted to data. The abundance index is
 480 defined as a hunting bag corrected for hunting effort (i.e. the number of hunting licenses). **b** A
 481 regular population growth rate pattern of peaks and troughs at 1–3 year intervals. The population
 482 growth rate (λ) was estimated by dividing the raccoon harvest by the previous year's one. The
 483 dashed line indicates population stability ($\lambda = 1$)

Fig. 3 Raccoon, raccoon dog and badger population trends in central Europe, derived from German hunting statistics. **a** Temporal variation in abundance of the raccoon, raccoon dog and badger. The abundance index is defined as a hunting bag corrected for hunting effort (i.e. the number of hunting licenses). **b** TRIM model population indexes for each species (in the y-axis, 1 is the baseline index and represents the initial population size). The dashed line indicates a population trends shift. Significance codes: ns ($P > 0.05$); $*P < 0.05$

Electronic Supplementary Material

Research article: **Is the raccoon (*Procyon lotor*) out of control in Europe?**

Journal: **Biodiversity and Conservation**

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Appendix 2: Questionnaire on the status and management of the *Procyon lotor* in Europe

Personal information

Name and surname:

Affiliation:

City:

Country:

E-mail address:

0. COUNTRY:

1. INTRODUCTION

1.1 First record Date: Location:

1.2 Pathway (you can select more than one check box):

- ☐ Pet trade (animals released by or escaped from pet owners)
- ☐ Zoos and wildlife parks (animals escaped from zoos or wildlife parks)
- ☐ Fur farming (animals escaped from fur farms)
- ☐ Game (animals released into the wild for hunting)
- ☐ "Fauna enrichment" (animals released into the wild to enrich the local fauna)
- ☐ Colonisation from (please, specify which countries):
- ☐ Other (please, specify):

1.3 Reference (research article, technical report or personal communication):

2. RANGE

2.1 Please, attach a map of the current range of the raccoon at the highest possible spatial resolution, separating between records of introduced animals (free-ranging individuals) and established or invasive populations (established populations), if possible. Please, provide any other information about the historical distribution of the raccoon, such as old distribution maps or atlases

2.2 Range is: ☐ Expanding ☐ Contracting ☐ Stable ☐ Unknown

2.3 Data source:

- ☐ Governmental agencies
- ☐ Research centers
- ☐ NGOs
- ☐ Other:

3. ABUNDANCE

3.1. Estimated population size (individuals) or density (individuals/km²):

3.2 Method:

- ☐ Capture-Mark-Recapture (CMR)
- ☐ Hunting bag statistics
- ☐ Camera-trapping
- ☐ Genetic sampling
- ☐ Road-kill survey
- ☐ Density extrapolation
- ☐ Guesstimate
- ☐ Other (please, specify):

3.3 Geographic area: ☐ National ☐ Regional ☐ Local

3.4 Data source:

- ☐ Governmental agencies
- ☐ Research centers
- ☐ NGOs
- ☐ Other:

3.5 Please, give a table with estimates per years if possible. Indicate area name and size, population size and density, method and reference

4. DEMOGRAPHIC PARAMETERS

4.1 Population growth rate (please, provide an estimate if possible):

- ☐ Increasing
- ☐ Decreasing
- ☐ Stable
- ☐ Unknown

4.2 Sex ratio (please, provide an estimate if possible):

- ☐ Male biased
- ☐ Female biased
- ☐ Close to 1
- ☐ Unknown

4.3 Age structure (%): Adults: Juveniles:

4.4 Data source:

- ☐ Governmental agencies
- ☐ Research centers
- ☐ NGOs
- ☐ Other:

5. INVASION STATUS

5.1 Invasion stage:

- ☐ Introduction (survival in the wild; free-ranging individuals)
☐ Establishment (reproduction; population growth)
☐ Invasion (dispersal; range expansion)

5.2 Distribution and relative abundance:

- ☐ Local and rare
☐ Widespread and rare
☐ Local and common
☐ Widespread and common

6. SPACE USE AND HABITAT SELECTION

6.1 Home range size (km²): **6.2 Method:** ☐ MCP ☐ Kernel

6.3 Where do raccoons live? (you can select more than one check box):

- ☐ Deciduous forest ☐ Mixed forest ☐ Riparian forest ☐ Wetlands ☐ Agricultural area ☐ Urban area

7. IMPACT (please, fill out the following tables)

7.1 Predation on:

Species	Effects		Local extinction?	Reference
	On individuals ^a	On populations ^b		
			☐	
			☐	
			☐	
			☐	

a: Survival, Reproduction, Habitat use, Diet, Activity patterns, Unknown

b: Distribution, Abundance, Sex ratio, Age structure, Unknown

7.2 Competition with:

Species	Effects		Local extinction?	Reference
	On individuals ^a	On populations ^b		
			☐	
			☐	
			☐	
			☐	

a: Survival, Reproduction, Habitat use, Diet, Activity patterns, Unknown

b: Distribution, Abundance, Sex ratio, Age structure, Unknown

7.3 Introduction of parasites and pathogens:

Species	Effects		Local extinction?	Reference
	On individuals ^a	On populations ^b		
			☐	
			☐	
			☐	
			☐	

a: Fatal disease, Body condition

b: Distribution, Abundance, Sex ratio, Age structure, Unknown

8. MANAGEMENT STRATEGIES

8.1 Legal status:

8.2 Management strategies (you can select more than one check box):

- ☐ Prevention ☐ Legislation
☐ Education programs
☐ Other (please, specify):
- ☐ Control: restricting raccoons to a limited area (containment) or reducing raccoon population density.
Period:
Method: ☐ Hunting ☐ Trapping Other (please, specify):
Outcome: ☐ Success ☐ Failure
- ☐ Eradication: removing raccoons from an area.
Period:
Method: ☐ Hunting ☐ Trapping Other (please, specify):
Outcome: ☐ Success ☐ Failure

8.3 Are there measurable objectives for the size and distribution of the population (e.g. keeping raccoon population at low density or restricting raccoon distribution to a limited area)? If so, what are the objectives? Is the management effectiveness evaluated?

8.4 Are there any transboundary arrangements concerning cooperation in raccoon management? If so, please elaborate.

8.5 How many individuals are known to be harvested each year? Please, give a table with estimates per years if possible.

9. ADDITIONAL COMMENTS

Please, provide any other information that you consider important:

Thank you very much for your collaboration!

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