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On the Raccoon (*Procyon lotor*) invasion threat to Lithuania

Key words: *Procyon lotor*, alien species, invasion threat, Lithuania

Status and short history in Europe and part of Asia

Data on raccoon distribution and abundance status in Europe are rather scanty and somewhat contradicting. One source provides information that raccoons are found in 22 countries of Europe including Lithuania (CANOVA, ROSSI 2008). Instead, the other review mentions only 8 countries of Europe owning this species (BARTOSZEWICZ 2006). At the same time, there is no doubt about the largest population of naturalized raccoon. Raccoon population in Germany is the largest one in Eurasia – the new environment for this animal originating from North America.

Raccoon introduction (naturalization) success was very variable among different parts of Europe and Asia (Table 1). Two spread centres occurred in Germany in 1927–1945 (GRUMMT 1989). It is interesting to note that size of founder groups here was relatively small. In Hessen, raccoon population started from 10 inds, and in Berlin from 25 inds. Nevertheless, raccoon naturalization success was high. Nowadays, the hunting bag in Germany reaches 70,000 and the whole population – about 1,000,000, maximum density reaching 100 ind.km⁻².

A completely different situation was observed about raccoon introduction in the former USSR

(Table 1). In 1936–1962, more than 1,200 inds were deliberately released in nine geographical regions, however, only in six of them raccoons have established viable local populations. Even exceptionally large groups of founders have failed in Primorskyj Kraj (Far East), Uzbekistan and Kirgistan (Middle Asia) (TUMANOV 2009). In Byelorussia, raccoon introduction was considered successful and local population was growing up to 1500–2000 inds. However, latest publications provide data about sharp decline up to possible raccoon extinction in Byelorussia (SAVITSKYJ et al. 2005; SAVARIN 2007). Despite relatively high efforts to acclimatize raccoon in the former USSR, naturalized populations are local and maximum densities reaching only 3 ind. km⁻² (SAVITSKYJ et al. 2005; TUMANOV 2009).

Case of Lithuania

Raccoons are occasionally observed in natural conditions of Lithuania during the period of 2001–2016 (Fig. 1). However, data about locally established raccoon populations do not exist. All registered observations deal with solitary animals or maximum with small groups up to three individuals. For the first time, a single adult individual was observed in dis-

Table 1 Raccoon introduction trials in the USSR (TUMANOV 2009) and Germany (GRUMMT 1989)

Region	Year of release/escape	Number of released/ escaped individuals	Introduction success
Primorskyj Kraj, USSR	1937	4	Failed
	1954	486	
Uzbekistan, USSR	1953	43	Failed
Kirgistan, USSR	1936	22	Failed ?
	1952	33	
Kabardino-Balkaria, USSR	?	16	Failed
Dagestan, USSR	1950	3	?
	1965	30	Naturalized
Byelorussia, USSR	1954	51*	Naturalized, local
	1958	76*	
Stavropol', USSR	1954	59+41	Naturalized, local
Krasnodar, USSR	1951	28	Naturalized, local
	1957	15	
	1958	112	
Azerbajdzhan, USSR	1936	21	Naturalized
Berlin, Germany	1945	25	Naturalized
Hessen, Germany	1927	6	Naturalized
	1934	4	
*(SAVITSKYJ et al. 2005)			

trict of Ignalina in 2001 (co-ordinates: 55° 27' 46.23", 26° 4' 0.13" (WGS)). The largest group of three individuals were hunted in Rokiškis district in November 2010 (co-ordinates: 55° 55' 53.6", 25° 30' 54.04" (WGS)). More regularly raccoons are observed in the western part of the country, namely in the Curonian Spit Peninsula. All cases are thought to be deliberate releases of solitary nuisance animals from the captivity. Breeding facts in the wild are purely documented. Two cases of observations of pregnant females do not mean breeding in the wild. They could get pregnant in captivity. However, successful rearing of cubs in the wild rises the probability of establishment of a local population and strict preventive means have to be taken.

Despite absence of viable populations, raccoon is preventively included into the List of Game Animals of Lithuania and must be hun-

ted throughout the year. Since 2012, breeding at home conditions and trade on raccoon as a pet is forbidden.

However, some illegal market still probably exists. An experiment was done by putting to the internet an illegal advertisement about raccoons on sale (ČEKAS 2014). During one month have responded 60 persons who asked for possibility to buy a raccoon. These persons were asked: "What would you do if raccoon became nuisance?" Answers were as follows: 1) released to the wild - 50 %; 2) kept at home anyway - 50 %. Additionally, the WEB stores are full of advertisements suggesting to purchase these animals in neighboring countries.

Part of society supports arrival of raccoon. Analysis of comments on internet from 87 unique IP addresses showed: 40 comments (46 %) – exhibit positive attitude towards arrival of raccoons mainly for aesthetic reasons, and in 47

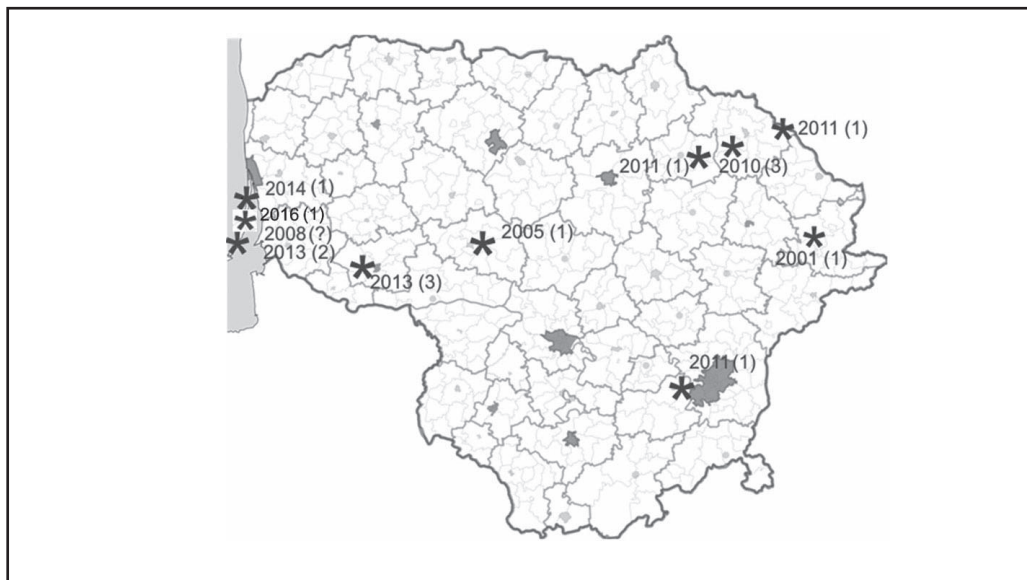


Fig. 1 Raccoon observations in Lithuania (2001–2016). Asterisks show approximate locations of observations; year and number of observed animals (in parentheses) are provided.

comments (54 %) – raccoons were regarded very dangerous for Lithuanian ecosystems.

These facts show that society factor could be a threat of raccoon invasion to Lithuania. In time and space concentrated deliberate releases can rise risk of establishing local populations of raccoon though such events hardly probable. Positive attitude of society towards raccoon as a pet could rise the frequency of deliberate releases.

Can such releases be a real threat of raccoon invasion? Rather not, if releases will be limited to solitary individuals and scattered in time and space throughout the country. A local reproductive population should establish at first. As noted above, even quite large groups of founders failed to establish local populations during intentional introduction trials in the former USSR.

Critical minimum density (CMD) concept seems to be applicable for raccoon as a species tending to aggregation and exhibiting strong Allee effect (DEREDÉ, COURCHAMP 2007). Raccoons are polygynous (a male often mates with at least two females) or promiscuous (males and females mate with various partners during breeding season). Lower density than

CMD supposes negative recruitment rate and leads to extinction of small groups of founders. Analyzing successful introductions of raccoons, CMD lies somewhere between 10–30 inds to establish a local population, but seems to be very floating and sensitive to stochasticity. Solitary deliberate releases would not present real threat of raccoon invasion in Lithuania but they would become significant at front of expansion wave from western Poland (in fact population of German origin). The expansion wave has to cover about 500 km towards harsher Lithuanian environments compared to those the existing population is adapted.

From 1980s to 1990s the German raccoon population has expanded its range about 100–150 km eastwards. Regular observations in the north-western part of Poland dated back to the beginning of 1990s (OKARMA et al. 2012). Phylogenetic analysis supposes raccoons are spreading from Germany through Poland towards the Czech Republic (BIEDRZYCKA et al. 2014).

The eastward part of Poland is scattered by many observations of raccoons but without a significant spatial extent of any of them (ATLAS SSKOW POLSKI, 2010). This supposes a rather

slow movement of the expansion wave to the east and nord.

What risk of the expansion wave to reach Lithuania? There are some negative factors that slow down the expansion: 1. Females and their daughters are sedentary and philopatric; 2. Individuals are tolerant and home ranges overlap up to 80 %, this assumes aggregation tendencies among individuals and slow filling of carrying capacity of environment; 3. Big carrying capacity of Polish landscape for this synanthropic species; 4. Harsher climat conditions east-northwards from western Poland (not very important in the context of climate warming).

At the same time there also positive factors that would facilitate the expansion: 1. High ecological plasticity; 2. High reproduction potential (2–8 cubs, mean generation time 1–2 years); 3. Synanthropic species; 4. Deliberate releases in front of expansion wave can rise genetical diversity and thus adaptability to new environment conditions. The last two factors would be especially actual for Lithuania.

The synanthrophism of raccoon would play an important role in the relatively anthropogenized and moderately forested landscapes of Lithuania. Expanding German-Polish population of raccoons exhibits different habitat preferences throughout its range which shows high ecological plasticity of this species. In Germany raccons inhabit mainly two habitats: housing estates and mixed forests with a large proportion of hard-wood trees, such as beeches and oaks, whereas in western Poland raccoons prefer wetlands with old willow trees, willow shrubs and reedbeds (BARTOSZEWICZ 2011). In Belarus, raccoons highly preffered large mature forests with prevailed oak and hornbeam in the Pripjat' valley (SAVITSKYJ et al., 2005).

Summary

We have analyzed information about the raccoon (*Procyon lotor*) introduction and acclimatization progress in the former Soviet Union and Middle Europe with respect of the invasion threat of this alien species to ecosystems of Lithuania. Many intentional releases of raccoons in the former Soviet Union usually have failed to establish local populations even in cases of

large founder groups. On the other hand, small groups of animals that escaped from captivity have founded the current raccoon population in Germany which is the biggest in Europe. The known cases of raccoon observation in Lithuania in the last decade allow to conclude that they all likely originate from captivity. Keeping raccoons as pets and the consequent deliberate releases to the wild after they become nuisance (or animals ocssasionally escape from captivity) is one of two threats of raccoon invasion. However, viable local populations of raccoons are still not known. Solitary deliberate releases would present rather low threat of raccoon invasion in Lithuania but they would become significant at expansion wave front from western Poland (in fact population of German origin). The second threat – the expansion wave – has to cover about 500 km towards harsher Lithuanian environments. Factors that would solw and facilitate this expansion are discussed.

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Artikel/Article: [On the Raccoon \(*Procyon lotor*\) invasion threat to Lithuania 257-261](#)