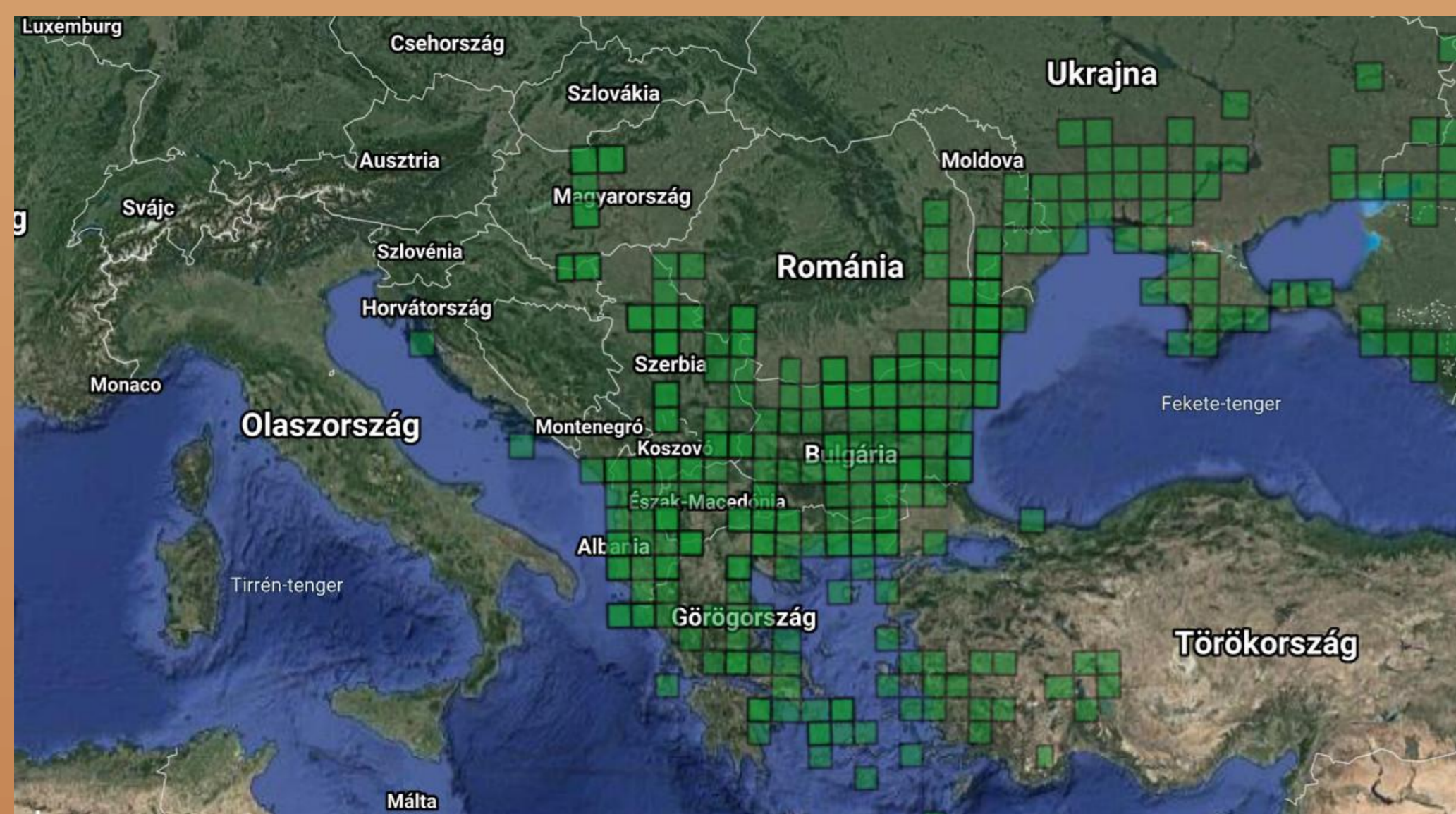


Caspian Whipsnake populations along the Danube: meeting the Green Belt, but separated from each other

Ecological connectivity and conservation proposals

THE CASPIAN WHIPSNAKE (*DOLICHOPHIS CASPIUS*)

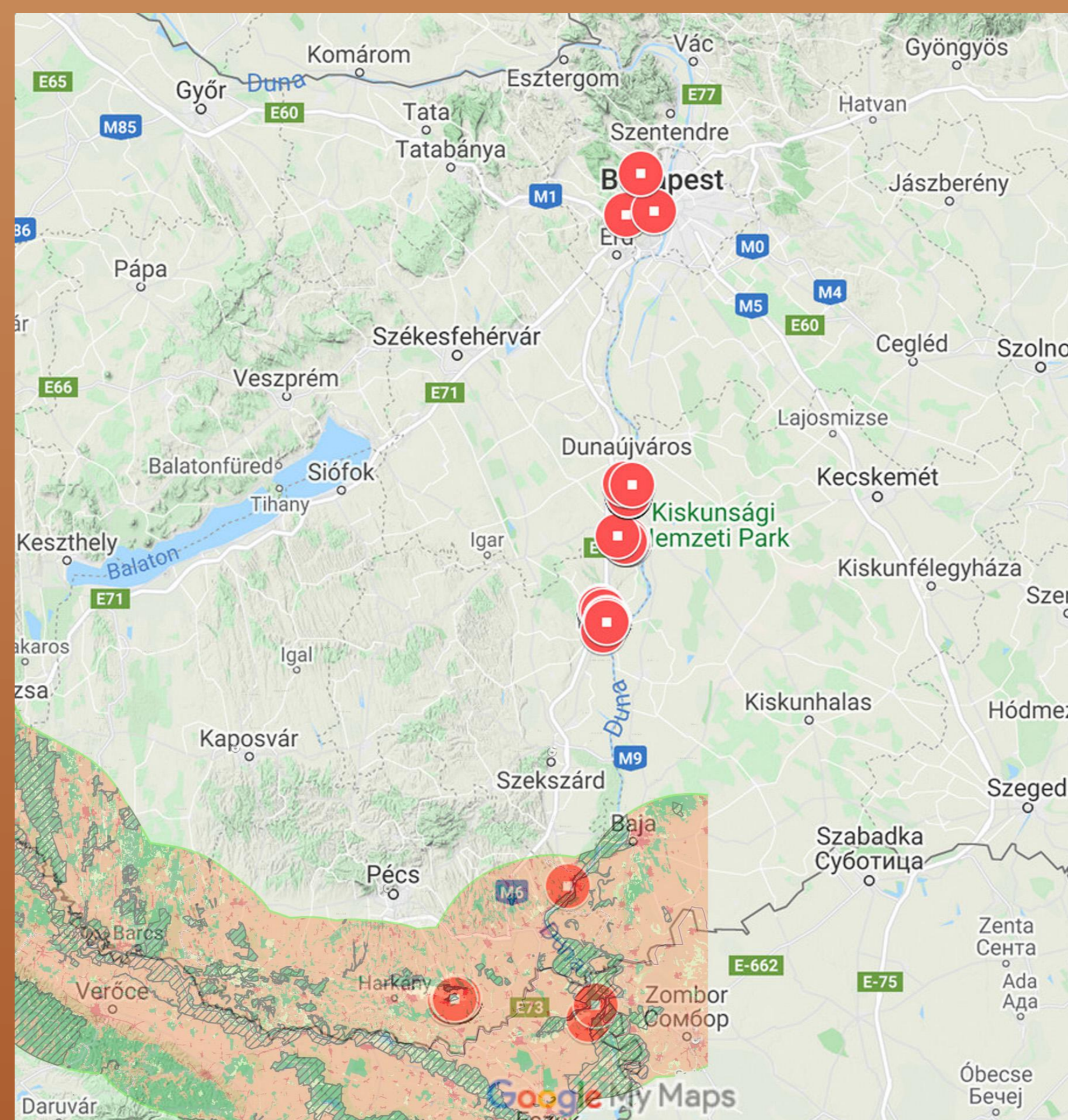
The Caspian Whipsnake is one of the rarest reptiles in Hungary, comprising the northwestern extreme of the species' European range, otherwise found on the Balkan Peninsula, the Greek islands, Turkey and the shore of the Black Sea extending until the Caucasus. It prefers steep, sunny and rocky hillsides with eastern loess steppe vegetation, bushy crevices, and also abandoned quarries. The Caspian Whipsnake is listed in the EU Habitat Directive (Annex IV), the EC Bern Convention (Appendix II), and the IUCN Red List (Least Concern). It is strictly protected by law and appears in the Red Data Books of Hungary, Croatia, Serbia and Romania.



As generally for European reptiles, habitat loss, degradation and fragmentation represent the greatest threats to the Caspian Whipsnake as well. Agricultural intensification, urban sprawl and infrastructure development are key drivers of habitat loss. Fragmentation of existing habitat and the abandonment of traditional agricultural practices and contingent loss of mosaic landscapes may result in population declines and even local extinctions.



Typical Caspian Whipsnake habitat along the Danube with steep loess bluff and rich Eastern European steppe meadow (Dunaújváros)



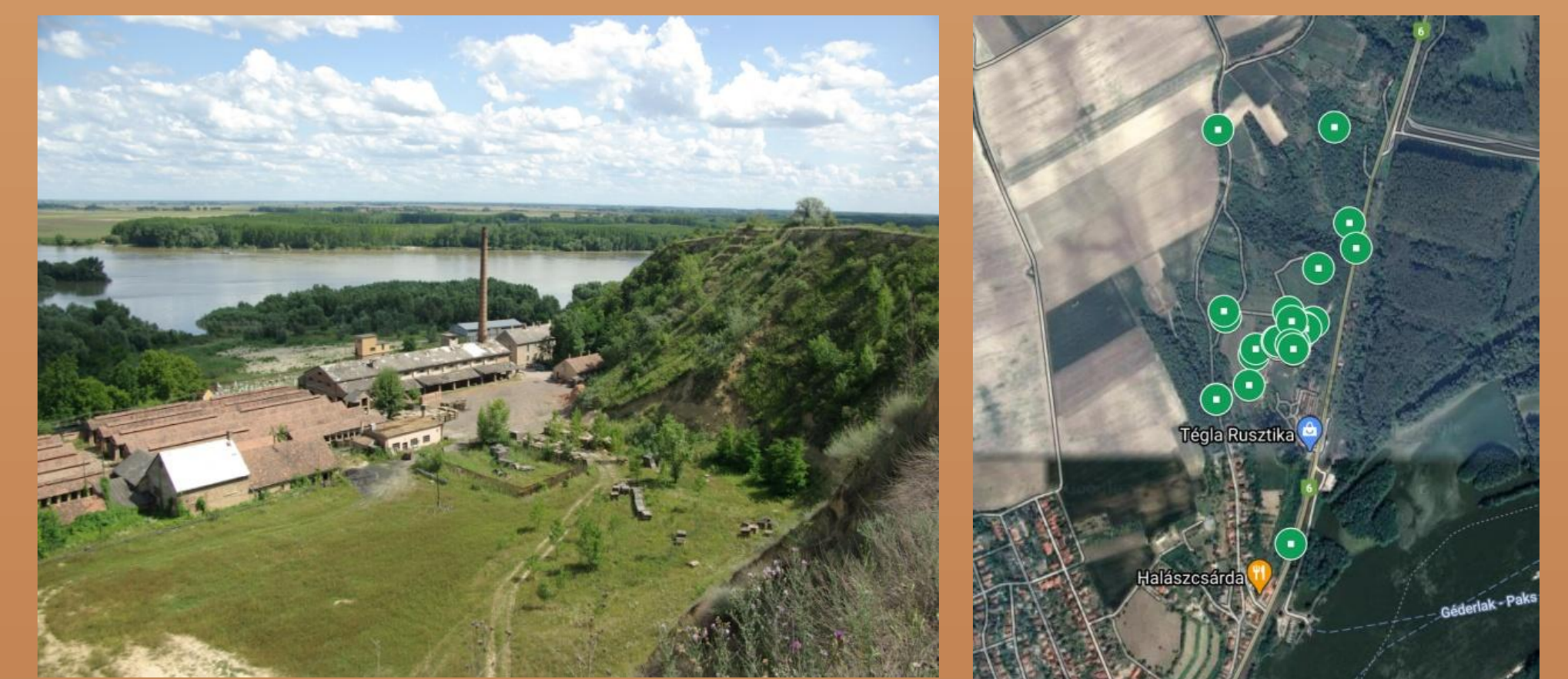
Distribution of Caspian Whipsnake population in Hungary and Croatia along the river Danube, meeting the European Green Belt at the Hungarian-Serbian-Croatian border. The localities are insular occurrences. Just like with the Green Belt, the connectivity of the habitats varies greatly, often totally blocked by infrastructure, agriculture and human disturbance.

OBSERVATIONS IN HUNGARY

Region (from north to south)	Number of specimens (2003–2009)				total	Region (from north to south)	Number of specimens (2014–2020)				total
	live	adult	juv.	slough			carcass	live	adult	juv.	
Dunaújváros	7	4	1		8	Dunaújváros	1		1		2
Dunaújváros	7	4	1		11	Kisapostag	1		1		12
Paks and Dunakömlőd together	9		5		14	Dunaújváros	4	1	1	1	7
Dunakömlőd	6	1	23	1	31	Dunakömlőd	6	1	23	1	31
Dunaszekcső	2	1			3	Paks	30	4	30	4	68
Grand total	25		11		36	Grand total	42	6	66	6	120

Caspian Whipsnake records along the Danube by M. Bellaagh and Z. Korsós (left), and the volunteers of the Amphibian and Reptile Conservation Group of MME BirdLife Hungary (right).

During the past almost 20 years, more than 150 recordings were made in the Danube-adjacent sites in Hungary, excluding the Buda Hills and the Szársomlyó. In the latter place the Caspian Whipsnake population size is estimated to be between 250-350 individuals.

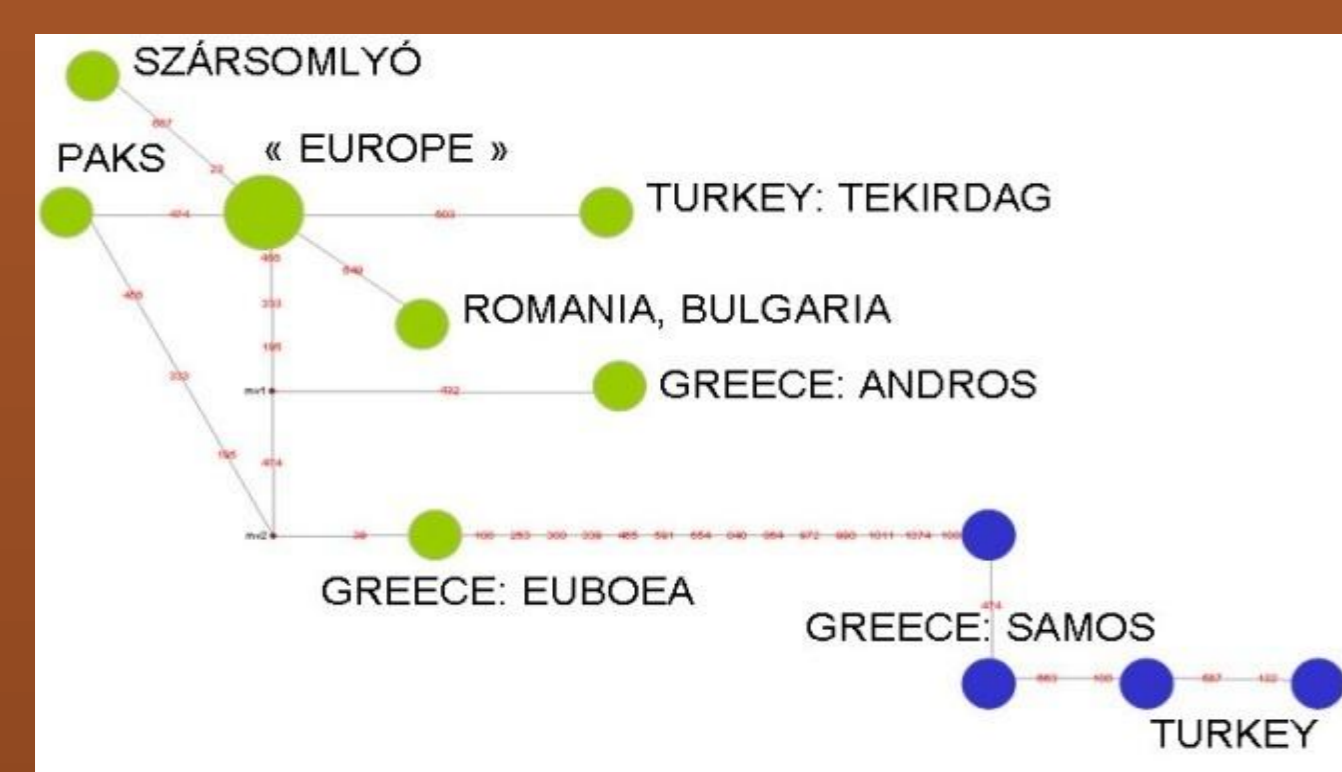


The population discovered in 2000 in the former brick factory at Paks initiated a thorough research in the suitable habitats along the Danube. Due to the effort of the Amphibian and Reptile Conservation Group of MME BirdLife Hungary further records of 120 specimens became known between 2013 and 2020.



Probably the most viable Caspian Whipsnake population in Hungary inhabits the southern slope of the Szársomlyó Hill

PHYLOGEOGRAPHIC RELATIONSHIPS



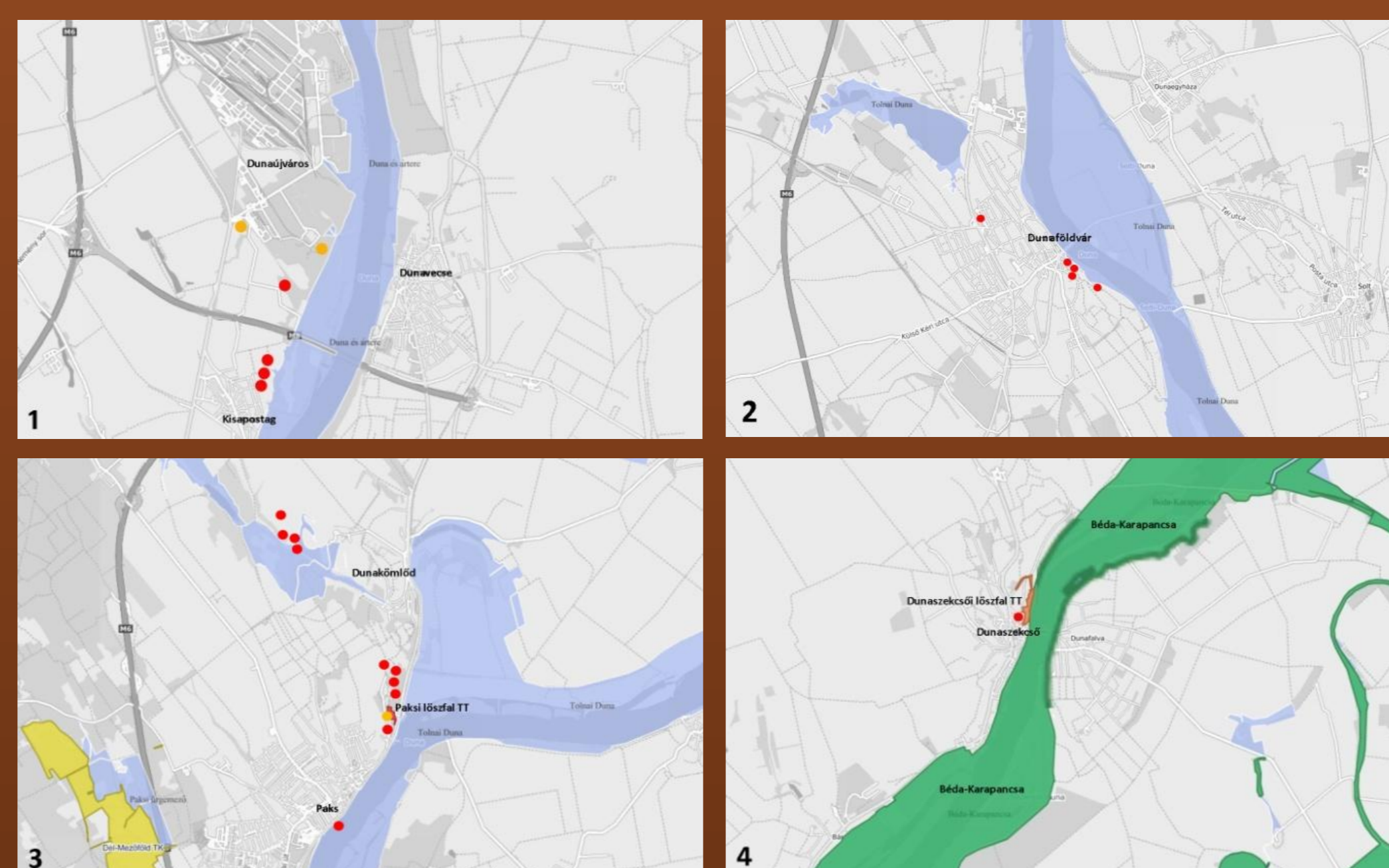
According to the phylogeographic study by Nagy et al. (2010), based on a data matrix of 44 specimens and DNA sequences of 1117 bp, clear mitochondrial divergence was found in Europe. The two main groups (marked by green and blue spots) are separated by at least 14 substitution steps in their cytochrome *b* sequence, and physically by the Aegean Sea as well as probably by the Bosphorus. The majority of the screened samples from the eastern group (green spots) are characterized by sharing the same single cytochrome *b* haplotype. These localities cover a wide geographic range from mainland Greece, Serbia, Croatia, Romania, Macedonia, Ukraine and Hungary (in the latter case, only some populations along the Danube river).

Focusing on Hungary, three different haplotypes were detected in close geographic proximity, but they were clearly linked to discrete localities; Paks, Szársomlyó (these two populations possessing unique haplotypes which were not found anywhere else), and the populations along the Danube river.

THREAT FACTORS AND CONSERVATION PROPOSALS

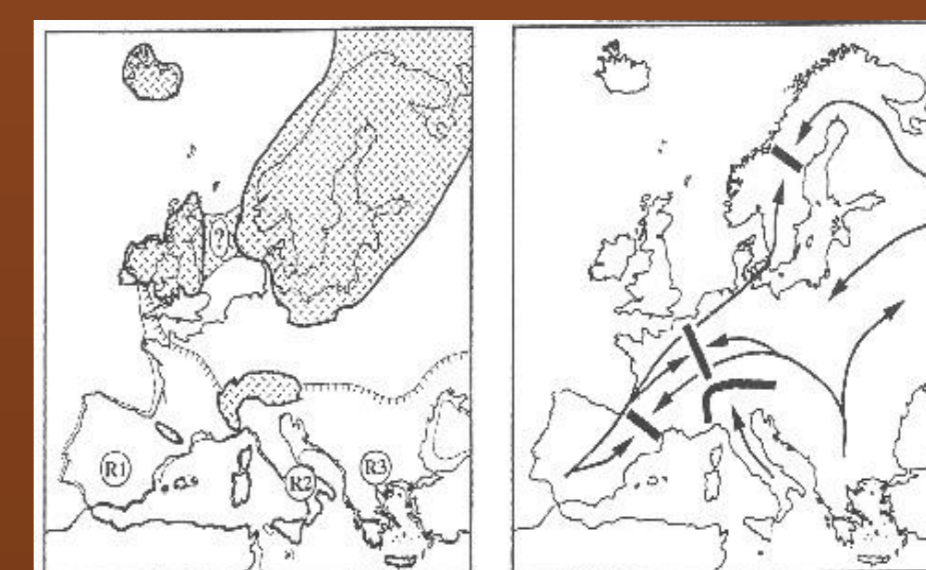
The most important threatening factors to the Caspian Whipsnake populations are habitat degradation caused by alien invasive plants, feral dogs and cats, illegal collection and killing, human disturbance, mountain bike, motocross and paragliding activity, and of course extensive agriculture and industrial use. A more strict action against who breaks the law could prevent some of this damage.

On the four maps to the right we show that none of the main Hungarian whipsnake occurrences (red dots) along the Danube belong to Natura 2000 (light blue) or other protected (green, yellow, and orange) areas. Our proposal is to extend the protected areas to the habitats of the Caspian Whipsnake, and also to try to investigate the possibilities of creating connecting green corridors between the close habitats.



POSTGLACIAL RECOLONIZATIONS

It is surprising that Hungary – at the edge of the species' distribution range – is inhabited by populations with three different haplotypes. Moreover, all currently known localities in Hungary are situated on the right bank of the Danube River. The fact that no specimens or fossils of the species were found on the left bank so far may indicate that the species probably colonized the Carpathian Basin after the streambed of Danube has reached its current position, i.e., around 10,000 years ago. This does not exclude the possibility, however, that "insular" populations could have persisted under much favourable microclimatic conditions during glacials, and therefore they may be older than populations established by later (re)colonization events. In that context, the population of Paks may represent a genetic link between the basal Greek populations and the most common European haplotype. On the other hand, the isolated South Hungarian calcareous Szársomlyó Hill characterized by Mediterranean-like climate conditions unlike other parts of Hungary, might have acted as an ideal spot for retraction in moderately cold periods.



Main refuges (R1, R2, and R3) in southern Europe, and possible post-glacial recolonization routes from south to north (arrows) with contact zones and main mountain barriers (Nagy et al. 2010).

Several studies show that roadkill plays also an important role in diminishing the Caspian Whipsnake populations. Motorways with heavy traffic also separate the appropriate habitats, and prevent any connections between the populations which causes genetic depression and ultimate extinction.