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Heavy traffic, low mortality - tram tracks as terrestrial habitat of newts

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Abstract. Amphibian mortality caused by rail traffic has not attracted much attention in comparison to road mortality. Density of railways in landscape, as well as traffic intensity, is usually much lower than in case of roads. As a consequence, their overall effect on amphibian populations is tacitly assumed to be less negative. To test whether very intensive rail traffic can cause substantial mortality in population of a small amphibian, we investigated a Smooth newt *Lissotriton vulgaris* population located in the city of Poznań, W Poland, where tram tracks border isolated breeding ponds. We performed controls during the peak of autumn migratory activity along the tracks. Less than 1% of all individuals found during the survey were killed by rail traffic. Observed mortality was very low despite large number of individuals present on the track and intensive tram traffic. As negative effects of traffic are low, rail or tram embankments can provide an important terrestrial habitat for small European newts.

Keywords. Amphibian, *Lissotriton vulgaris*, mortality, railway, Smooth newt, traffic.

Amphibian mortality caused by rail transport has not attracted much attention in comparison to road mortality, which is investigated by a growing number of papers (Coffin, 2007; Elzanowski et al., 2009; Glista et al., 2009; Cayuela et al., 2015; Franch et al., 2015). Density of railways in landscape, as well as traffic intensity, is usually much lower than in case of roads. As a consequence, their overall effect on amphibian populations is tacitly assumed to be less negative. Despite that, amphibians crossing the railway line suffer from mortality by train collisions (Budzik and Budzik, 2013) or turbulence effect (Barandun, 1991). Railway infrastructure can block or hinder migration, especially in case of large newts or toads (Etienne et al., 2003). However, the structure of a typical railway track could enable small, crawling amphibians, like European *Lissotriton* newts, to move under the rails, therefore minimizing the risk of collision. On the other hand, in case of small species, dead individuals are more likely to disappear quickly after death, because of scavenging (Beckmann and Shine, 2014), drying (Budzik and Budzik, 2013) or physical destruction by traffic (Hels and Buchwald, 2001). As a consequence, rail traffic mortality rates for species like *Lissotriton* newts are likely to be underestimated, just as they are for road traffic (Elzanowski et al., 2009; Cayuela et al., 2015). To verify whether very intensive rail traffic can cause substantial mortality in populations of a small amphibian, we investigated a Smooth newt *Lissotriton vulgaris* Linnaeus, 1758 population located in the Poznań city, Poland (52°23'31.1"N, 16°58'33.5"E), where the breeding site is located near double tram tracks with very heavy traffic load. Smooth newt is considered the most widespread newt of the Old World (Arntzen et al., 2009; Sparreboom, 2014). Although *L. vulgaris* is a common species, detailed analyses show that it undergoes a broad decline in Western Europe, analogous to that of other newt species (Denoël, 2012; Denoël et al., 2013). It breeds in a vast diversity of water bodies and is generally associated with different kinds of wetlands (Bell, 1977). The breeding sites are two small ponds (about 700 m^2 and 900 m^2,

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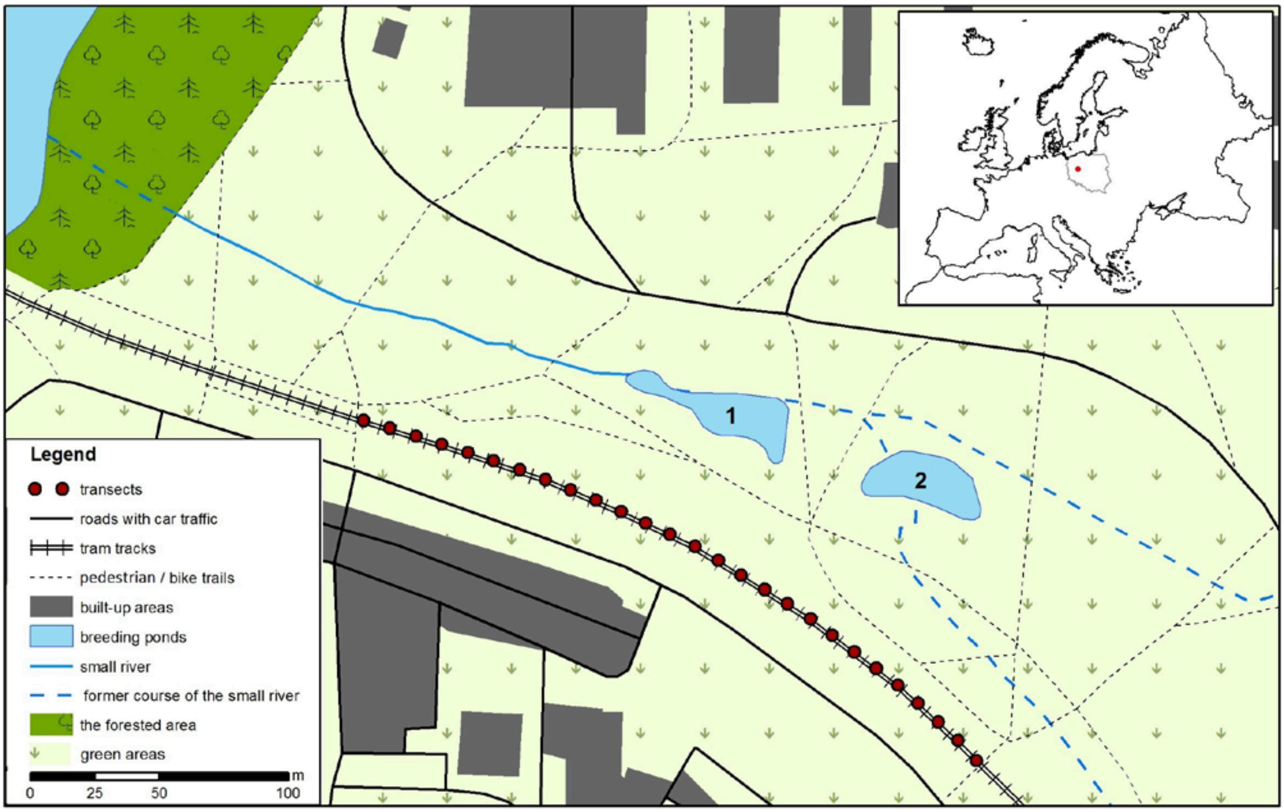

Fig. 1. Situational map showing the area of the research.

respectively) completely overgrown by *Phragmites australis* (Cav.) Trin. ex Steud, 1841 within an intensively managed urban park (Fig. 1). Until 1960s, the studied area was the part of suburban farmland with a small river valley; urban development in 1970-1980s isolated *L. vulgaris* from surrounding populations. The park borders with housing estates and a forested buffer of an industrial area, containing a fish-inhabited pond that is the breeding site for common toads *Bufo bufo* Linnaeus, 1758. The double tram track is located along the southern border of the park. Daytime traffic load is ca. 20 trams/hour, peaking at late evening and early morning hours (over 40 trams/hour). The structure of the tram track is analogous to a typical railway track: wooden sleepers (Fig. 2C) on crushed stone aggregate (Fig. 2A, B).

We performed 11 controls between 6^{th} and 19^{th} October 2014 (peak of autumn migratory activity). We searched for newts between 20:00 and 24:00 along the 300-m transect at the edge of the tram tracks in their section closest to the breeding ponds. We also searched for newts crossing pedestrian trails within the park and roads along park boundaries.

In total, 303 individuals were noted along tram tracks in the whole survey period. We found individuals of both sexes, as well as juveniles (Table 1). Captured individuals were measured (SVL, body mass) using digital caliper and electronic scale. However, we did not mark individuals, so numbers are given separately for each day, with the highest number of animals observed on October 15^{th} (68 individuals; Fig. 3). Only 3 individuals killed by tram were found during the survey period. Dead newts were found only at pedestrian crossings. Newts were observed at the edge of the track as well as between the rails (Fig. 3). No individuals were found elsewhere (forested area, park trails or roads along the park boundaries).

It has already been suggested that railway tracks do not necessarily block the migration efforts of newts. No significant genetic effects were found in populations of the Alpine newt *Ichtyosaura alpestris* Laurenti, 1768 at both sides of the 30-year old railway, which could have been a consequence of newt migration across the track (Prunier et al., 2014). In contrast, in case of North American salamander *Ambystoma opacum* Gravenhorst, 1807 a 100-years old railway led to total genetic isolation of two subpopulations divided by tracks (Bartoszek and Greenwald, 2009). Such difference could be ascribed to the time of isolation or the lesser mobility of *Ambystoma opacum* compared to European newts. Also, the popula-

Fig. 2. (A) Male Smooth newt *L. vulgaris* during the searching for prey among crushed stone aggregate; (B) crushed stone aggregate as newts habitat with the rail in the background; (C) female Smooth newt found feeding on earthworm on the surface of a wooden sleeper (October, 2014).

Table 1. Morphometric values of *L. vulgaris* from 14th October.

		x	min	max	SD	n
SVL [mm]	MM	38.78	31.03	45.07	3.17	25
	FF	38.82	29.67	46.11	4.36	28
	JUV	22.92	19.86	27.45	2.93	7
Body mass [g]	MM	1.79	1.18	2.93	0.40	25
	FF	1.91	0.72	3.12	0.58	28
	JUV	0.32	0.12	0.59	0.16	7

tion researched by Bartoszek and Greenwald (2009) was already isolated and had relatively low number of individuals, while Prunier et al. (2014) performed analysis on landscape scale with large number of interconnected populations. Another evidence for low level of isolation provided by railway lines is the work of Budzik and Budzik (2013), who found no dead newts along the 45-km transect along the railway line in SE Poland. Budzik and Budzik (2013) suggested that either newts disappear shortly after death due to their small body size, or they are not subject to mortality caused by rail traffic. Our results provide evidence for the latter hypothesis, as observed

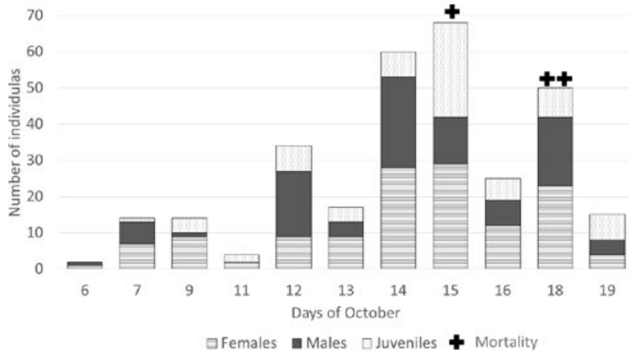

Fig. 3. Number of individuals during each day of our survey with mortality (15th October, one female; 18th October, one male and one juvenile).

mortality was low compared to high number of live specimens and great intensity of tram traffic, much exceeding the train traffic intensity in Budzik and Budzik (2013). Dead newts were found only at pedestrian crossings, where newt movement under the tracks is impossible, and animals are forced to move over instead of under the rails.

We confirmed that, in late autumn, *L. vulgaris* from the urban population use the tram track as their terrestrial habitat, and are not subject to extensive mortality. The timing of the controls enabled us to search for dead individuals just after the evening peak of tram traffic (and, presumably, the peak of newt activity and mortality). Temperature and humidity during all controls were likely to prevent the dead individuals from quick drying. As dead individuals were collected during the night, the risk of scavenging by birds was minimal. We could not exclude the possibility of scavenging by mammals (e.g., hedgehogs, feral cats, foxes, rats), but we treat it unlikely as the controls were performed early in the night when tram and human traffic was still relatively intensive, restricting the mammalian activity. Thus, we feel that the detection probability of dead newts was higher than usually assumed for estimating road mortality (Hels and Buchwald, 2001; Elzanowski et al., 2009). Although the length of the transect was short compared to some other studies (e.g., Budzik and Budzik, 2013), we stress that it was enough to cover most of the terrestrial habitat of the investigated population, as the surrounding areas are either build-up or do not provide enough shelter for the newts (Kaczmarek et al., 2014.). Therefore, we suggest that the rail aggregate consisting of sleepers and stones is a crucial winter habitat for the investigated population (Fig. 2). A large number of shelters within rail aggregate, providing humid and prey-rich terrestrial habitat, enable the persistence of a large newt population, despite isolation and deteriorating quality of the breeding pond. Additionally, driving trams directly scare away large predators, thus reducing predation risk. Easily warming up stone aggregate could also affect newt activity pattern, as active individuals were observed until the end of December (pers. comm.).

Presence of juvenile individuals (up to 38% in day-samples over 20 individuals) is interesting (Fig. 3). Malmgren (2002) showed that out of the pond movement of juvenile newts was more random than of the adult individuals, which is in accordance with theoretical framework presented by Pittman et al. (2014). However, the majority of juveniles in Malmgren (2002) chose similar direction as adults, i.e., towards the forest.

Abundance of juvenile individuals on the track suggests that their movements are nonrandom. If juvenile newts used 'normal' cues, signaling the proximity of optimal terrestrial habitat (e.g., humidity gradient, shadow, slope axis), they should move along the old riverbed and remain within the park. Therefore, we suppose that at least some juvenile individuals follow the adults using olfactory cues (Hayward et al., 2000).

In contrast to low rail traffic mortality, European newts are vulnerable to road traffic mortality (Denoël, 2012). For slow-moving newts, the probability of being killed is very high regardless of traffic intensity (Hels and Buchwald, 2001). In a setup similar to this study (500-m transect along a local road, breeding newt population migrating from pond located 300 m from the transect), the road kills-to-spawners ratio for *L. vulgaris* was higher than for any other amphibian, with more than half of the population killed each year (Elzanowski et al., 2009). In such a context, rail traffic seems much less detrimental for newt populations, despite potential mortality caused by herbicide spraying (Brühl et al., 2013). It seems that in the studied population, where the managed urban greenery does not provide a sufficient number of high-quality hibernation sites, cavities within the rail aggregate act as the key wintering habitat. It requires further investigation whether the rail/tram aggregate and sleepers are a suitable all-year habitat for juvenile newts. Whereas it is indisputable that roads and railways negatively affect animals, some positive effects on birds and reptiles were also reported (Morelli et al., 2014). We argue that for small, crawling amphibians like *L. vulgaris* the benefits from new habitats created by railway infrastructure can outweigh the potential costs of traffic-induced mortality.

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