

Road mortality threatens small northern populations of the European pond turtle, *Emys orbicularis*

GIEDRIUS TRAKIMAS¹, JONAS SIDARAVIČIUS²

¹ Center for Ecology and Environmental Research, Vilnius University, M.K. Čiurlionio 21/27, LT-03101, Vilnius, Lithuania. Corresponding author. E-mail: giedrius.trakimas@gf.vu.lt

² Veisiejai Regional Park, Santarvės 9, LT-67340, Veisiejai, Lithuania.

Submitted on 2008, 2nd January; revised on 2008, 22nd January; accepted on 2008, 20th May.

Abstract. Little is known about road mortality and the effects to European pond turtle *Emys orbicularis* populations at the northern border of its range. Survival of the turtle populations in suboptimal conditions depends heavily on longevity, regular annual breeding and relatively large clutch sizes, but additional unnatural mortality could alter their survival rates. Loss of only single turtle in majority of northern populations could mean a loss of 3-20% of subpopulation. But due to comparative rarity of the road accidents the effects of individual road mortality to the turtle populations might not be recognized. We discuss possible effects of road-associated mortality, and suggest that precautionary measures as setting of the buffer zones with low road density and possibility of lowering of traffic volume must be considered during the planning of the species conservation actions.

Keywords. Freshwater turtles, conservation, road ecology, small populations, threats.

Road networks and traffic have diverse and complex ecological effects to animal populations (reviewed in, Forman and Alexander, 1998; Trombulack and Frissell, 2000). They fragment habitats and create barriers (Mader, 1984; Andrews and Gibbons, 2005), increase human use of the landscape that leads to negative effects to populations (Findlay and Houlihan, 1997) and can cause significant mortality of individuals (Ashley and Robinson, 1996; Aresco, 2005). Slow-moving species such as ranid frogs, snakes and freshwater turtles are suspected to be especially affected by the road mortality (Smith and Dodd, 2003).

European pond turtle (*Emys orbicularis* Linnaeus, 1758) is widely distributed species in Europe, but it has become rare in most of the countries where it occurs (Fritz and Andreas, 2000; Ficetola et al., 2004). Several anthropogenic threats are supposed to be the cause of this decline. The most frequently cited are habitat loss, poaching for food or commercial purposes and introduction of exotic species (Arvy and Servan, 1998; Cadi and

Joly, 2003; Kotenko, 2004; Puky et al., 2004; Rivera and Fernandez, 2004). The negative effects of road mortality has been widely described for freshwater turtles in North America (see Haxton, 2000; Gibbs and Shriver, 2002; Marchand and Litvaitis, 2004; Steen et al., 2006), but was rarely mentioned among the *E. orbicularis* threats in Europe.

Schneeweiss (2002) reported six known road casualties of *E. orbicularis* that lead to immediate death or animals died from injuries within few days, during period 1980-2000 in Brandenburg, Germany. These casualties made up 31.6% of all known direct losses caused by human during this period. In South Lithuania near Veisiejai, three *E. orbicularis* road kills were observed in 2004-2005 (our data). Two killed pond turtles were adults. One of them was male found dead on busy state road no. 134 (average daily traffic: mean \pm SD = 1550.7 \pm 179.0), another was reported as killed near Mikabaliai. The third was a juvenile killed on the gravel road (ADT: mean \pm SD = 10.7 \pm 2.08) 12 meters away from the hatchling site. All three cases appeared in May, in small local populations. In Poland, during the long-term field surveys, some adult individuals were reported to be killed on roads (Najbar, 2005).

Most of the *E. orbicularis* populations distributed nearly northern border of its range are small and scattered (Jablonski, 1992; Vaičiūnaitė, 1992), sometimes they are considered to be too small to recover themselves (Schneeweiss, 2004a) or only single, old individuals occur (Balčiauskas et al., 1999). Though only a few reports on road mortality of this species in the northern populations are available, careful evaluation is needed in determining whether the road mortality considerably affects present local populations and their future survival.

Being a semi-aquatic species, *E. orbicularis* is potentially in danger to the road mortality during its terrestrial activity. Females within the nesting season, while searching for suitable nesting site near the road or crossing the roads during migration, could be subjects of increased danger from vehicles and interruption from human. Thus, increased sex-specific mortality could alter demographic structure of local populations that was demonstrated with North American freshwater turtle species (Steen et al., 2006). Though, lack of evidence on altered population structure for northern *E. orbicularis* populations, data on nesting behaviour show that females perform long distance migrations during the nesting season. In Lithuania female turtles move up to 1 km to nesting places (Meeske, 1997), in Germany up to 1.5 km (Schneeweiss et al., 1998), in Poland even more than 4 km (Jablonsky and Jablonska, 1998). When such movements intersect with roads turtles are potentially vulnerable to road associated mortality.

Additionally, danger from the road-associated mortality could be potentially higher when females choose to nest near the roads, and when the nesting areas are in dense rural or forest road network. In northern populations of *E. orbicularis* female's nesting activity (searching of nesting site and construction of the nest) can last several days (Meeske and Mühlenberg, 2004). They usually start to search for the nesting site between 1700 h and 1800 h, it can last several hours or more than one day, then spend 70-250 min for nest's construction: for excavation, laying of eggs and closing the nest (Meeske, 1997). Moreover, sometimes they dig their nests on the field roads (Mitrus, 2006; our data). Even if females build the nests in the environment with low traffic volume, prolonged staying near the roads during the nesting activities could higher the risk for *E. orbicularis* females to be disturbed, taken away from the population or killed. Similarly, hatchlings from nests neighboring to the roads could be affected by the same threats.

Understanding that *E. orbicularis* is not strictly aquatic species (Ficetola and De Bernardi, 2006) suggests that potential risk from the road mortality previously might be

underestimated. Since both sexes performed frequent overland movements in Lithuania (e.g., Meeske, 2000), similarly in Italy (Lebboroni and Chelazzi, 1991) together with data on killings of *E. orbicularis* males in Brandenburg (Schneeweiss, 2002), where at least two males (30%) were killed, and our data from Veisiejai, at least one male found dead on the road, illustrate that not only females could contribute to the road casualties of small northern populations of pond turtles.

Studies of relict northern populations of *E. orbicularis* in East Germany showed that hatchlings survive hibernation in nests only under favorable weather conditions (Schneeweiss and Jablonsky, 2000). But longevity of pond turtles and the regular annual clutch size can compensate climate losses (Schneeweiss, 2002). Nevertheless, complicated natural history, characterized by delayed maturity and high adult survival rates (e.g., Mitrus and Zemanek, 2004), makes the *E. orbicularis* extremely vulnerable against direct and indirect human pressure, that caused the collapse of the species population in Brandenburg (Schneeweiss, 2004b).

Road mortality is suspected to be one of the factors for decline of freshwater turtles in USA (Gibbs and Shriver, 2002). Turtle demography is unusual to such a degree that slight increases in adult mortality can lead large declines in populations (e.g., Congdon et al., 1993). According to Brooks et al. (1991) less than 10% annual mortality of matured females may lead to population declines. *E. orbicularis* populations at the northern edge of distribution are small and scattered. For example in Southern Lithuania 70% of populations consist under 30 individuals, and 50% have five or less individuals (Meeske et al., 2006). For such small local populations, loss of only single turtle of specific age and gender could mean a loss of 3-20% of whole subpopulation, and may shift demographic structure of the population. Together with other negative factors as predation and limited recruitment due to the climate losses, this may contribute to the local extinction.

The estimation of declines and the detection of threats for small northern populations of *E. orbicularis* may be difficult without long-term monitoring, thus the effects of individual road mortality might not be recognized, due to comparative rarity of the road accidents. Nevertheless, precautionary measures as setting the buffer zones with low road density and possibility of lowering of traffic volume at *E. orbicularis* habitats must be considered during the planning of conservation actions.

ACKNOWLEDGEMENTS

We thank Jurgis Klimas for field assistance, Martina Anne-Claire Meeske, Sławomir Mitrus, Norbert Schneeweiss and Alius Ulevičius for their help. Gentile Francesco Ficetola and Rimvydas Juškaitis provided helpful comments on the manuscript.

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