

Extreme flows and possible threats to small populations of the European pond turtle

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Introduction

Global decline of many species of animals is currently widely studied. The most significant threats for animals populations are: habitat loss and degradation, introduction of invasive species, pollution, unsustainable use and global climate change (e.g. McCarty 2001). Many species live in ecosystems that are maintained also by natural disturbances. Small and isolated populations are particularly vulnerable to natural catastrophic events such as flood, fire, drought or hurricanes (Bennett and Saunders 2010). The impact of climate change on floods frequencies and magnitudes are still under discussion (Kundzewicz et al. 2008) and depend on ways the climate change affect flood generating mechanisms like rainfall or snowmelt (Kundzewicz et al. 2010). Influence of such flows on animals populations is not well known, and it is difficult to study it. However, the floods could have an effect on some populations of animals, thus they should be taken into consideration when the species conservation actions are planned.

The European pond turtle (*Emys orbicularis*) is a species endangered in many parts of its territorial range, mostly because of changes in its natural habitats. It is unquestionable that water habitats are important for the turtle. Water habitats are used by the turtle for migrations, feeding, mating and overwintering (e.g. Fritz 2003; Ficetola and De Bernardi 2006; Mitrus 2010). Habitats preservation is one of the most important factors for the turtle preservation, and numerous authors discuss negative impacts of drying (or other ways of destroying) water bodies on populations of the species (e.g. Fritz 2003; Ficetola et al. 2004). However, any possible influence of water level on the species other than destroying water habitats is rarely discussed.

The European pond turtle spends most of time in water or close to water bodies (e.g. on banks and logs during basking), but it lays eggs on land (Ficetola and De Bernardi 2006; Mitrus 2010). Nest site has a direct influence on the surviving of eggs (Spencer 2002; Weisrock and Janzen 1999; Kolbe and Janzen 2002). Development of embryos of the turtle takes place in land environment. Typically, the turtle lays eggs close to, or not very far from, the water bodies (Ficetola and De Bernardi 2006; Mitrus 2010). Part of nests could be destroyed by predators or humans, but in literature there is lack of information whether nests of the turtle could be flooded. However, it is known that at least for several freshwater turtles nest loss caused by flooding could be very high and flood can destroy part or even all of annual reproductive output (Moll and Moll 2000), because eggs of most of the turtle species tolerate only short period of submergence (Ewert 1989; Moll and Moll 2000). For instance, for the turtle *Podocnemis erythrocephala* nest loss from flash floods reached 70% (Batistella and Vogt 2008), and for *Podocnemis unifilis* – 63% (Caputoa et al. 2005). In this paper data on influence of extreme flows on nest of freshwater European pond turtle was gathered. Other possible effects of such flows on the species' populations are also discussed.

Material and Methods

Population of the European pond turtle in central Poland was studied during long time (Mitrus 2000 and 2006). The population inhabits lower part of the Zwoleńska river valley (central Poland the Radom District, e.g. Borowiec Nature Reserve), not far from the Vistula river valley (Figure 8.1). Zwoleńska river is a typical non-regulated small

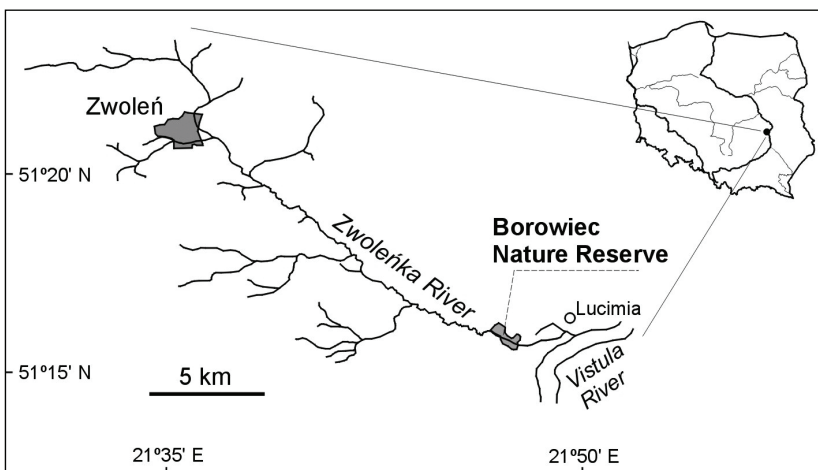


FIGURE 8.1. Location of the Borowiec Nature Reserve

lowland river. Floodbanks are constructed along most part of Vistula river, however, at the mouth of Zwoleńka there is no such protection against flood. Thus, influence of flooding on nest of the turtle could be observed in the area. More details about the Borowiec Nature Reserve is available in Zemanek (1992).

To gather data about nest localities, each year during the egg-laying period (depending on the weather since mid May to mid June), European pond turtle females were observed on their way to nesting areas or while nesting. Some open areas were raked so that the tracks of females could be followed easily. Nests were marked by placing four pegs at the corners of a 50 cm square with the nest in the centre. The sites were checked irregularly during spring and summer for signs of destroying (e.g. by humans, predation, or flood), and for signs of hatchling emergence (= moving from the nest chamber to ground level). In winter (depending on snow cover) and the following spring the remaining nests were checked irregularly. 118 nests sites were known, but two nests were protected against predators by wire netting, and in one case predated nest was found. Thus, data about nests of the turtle laid since 1987 to 2001 were analyzed; clutches deposited in 2001 were followed to spring 2002.

All other available data (field notes and data base about individual localities) from the reserve were also analyzed with special attention to influence of flooding on the turtles population.

Results

From 118 known nests only one was flooded – the nest with eggs laid in May 2001 was flooded in July 2001. The nest was deposited about 120 m from the nearest water bodies and about 200 m from Zwoleńka river (Figure 8.2), but it was located on shallow area. Two other nests were deposited on such hazardous areas (both laid in also in 2001; Figure 8.2), and during a little larger flood they could be destroyed. Generally, from 115 monitored nests 16/115 were destroyed during spring or summer (12 by predators, three accidentally by humans and the one in 2001 by flood), and 4/27 during winter (three by predators and one by humans).

After the flood in July 2001 one several-year old turtle was found about 2 km from the Borowiec Nature Reserve (it was caught near Lucimia village, close to Vistula river; Figure 8.1). In the valley turtles live also near Zastocze village, Siekierka village, Wysocin village. One female marked in 1987 in Borowiec Nature Reserve, since 1999 is watched near Barycz village (in the Zwoleńka river valley, about 10 km from Borowiec Nature Reserve; Mitrus and Zemanek 2000). However data, about migration between the localities are not available.

The Zwoleńka river catchment is not an observed river in a sense of hydrological investigations. However, due to precise long term observations at neighboring Zagożdżonka river and during relatively short – 3-year – observation in Zwoleńka river catchment, it is possible to estimate inter alia the changeability and monthly distribution of flow base on staff gauge relation. The most important for pond turtle reach of the Zwoleńka river – Borowiec is controlled by one staff gauge station close to the old water mill and the bridge (Figure 8.2).



FIGURE 8.2. Distribution of nest sites of the turtle *Emys orbicularis* from 1987 to 2002 in the Borowiec Nature Reserve (central Poland). Each circle represents a nest site. Some circles are obscured in densely nested areas. Arrows point to nest sites: flooded in 2001, and other two laid in hazardous site. Based on a 1997 aerial photo

Discussion

The percentage of destroyed nests of the European pond turtle in the Borowiec Nature Reserve is not high, and only one of the destroyed nests was flooded. There are no information about flooded nests of the turtle in other area at the Zwoleńka river valley (S. Mitrus – unpublished data), neither in other populations of the turtle in Poland or other central Europe countries. The turtle may even lays eggs far from water bodies (Mitrus 2010), thus in central Europe danger of nest flooding caused by extreme flows is probably very low.

Theoretically, nest located on dangerous areas could be transferred to safe ones (Mitrus 2008a), or in some cases hatchlings could be collected before flooding. However, carrying on such activities is difficult, because precise data about nest sites are necessary (and typically such data are no available when necessary). What's more, the results of the elasticity analysis showed, that for the European pond turtle, nest protection is an inefficient tool for increasing population size (Heppell et al. 1996; Heppell 1998; Mitrus 2008b). Thus, if frequency of extreme flows will increase in the future, it should have no large effect of the turtle population because of nest flooding.

The European pond turtle is able to migrate on long distances. Longer migrations on land even for adult individuals could be dangerous because of e.g. mortality on roads (Trakimas and Sidaravičius 2008). However, it is possible, because the turtle uses canals and other water bodies, also temporary flooded areas, as migrations routes (Mitrus 2010). It is known that high water level could help in dispersal of some animals because flooding could effect connectivity of water bodies (e.g. Roe et al. 2009). However, as populations of the turtle in central Europe are scarce, floods do not rather help with connecting different populations. Extreme flows could rather transfer individuals even on long distances to new areas. Cadi and Miquet (2008) showed that after experimental translocation the survival rate of adult individuals is high. Thus, transferred animals are able to survive in new places if they find suitable habitats, but they are lost for source populations.

Part of females of the turtle presents fidelity to the nesting areas (Mitrus 2006; Najbar and Szuszkiewicz 2007). During nesting migrations females use water bodies (Mitrus 2010). In the Zwoleńka river valley migrations are also cross Zwoleńka river – e.g. adults individuals were occasionally observed just flooding across the river. Extreme flows during egg laying period (May – June) could effect the turtle nesting migrations. However, it is difficult to determine if in such case females would lay eggs in different areas, and if it could effect the reproduction success.

Based on hydrological investigations the average (Figure 8.3) and maximum (Figure 8.4) monthly distribution of flow at Borowiec gauge has been calculated. The average flow distribution based on 10-year data indicate the high flows occurrence during spring months basically in February, March and April. The May and June, which is important for pond turtle, do not show significant increase even in year 2001, when

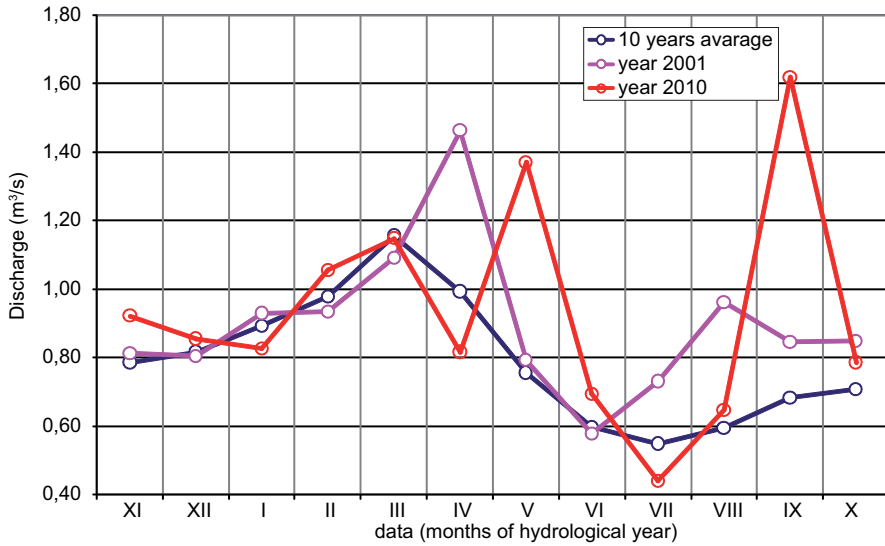


FIGURE 8.3. Average monthly distribution of flow at Borowiec gauge

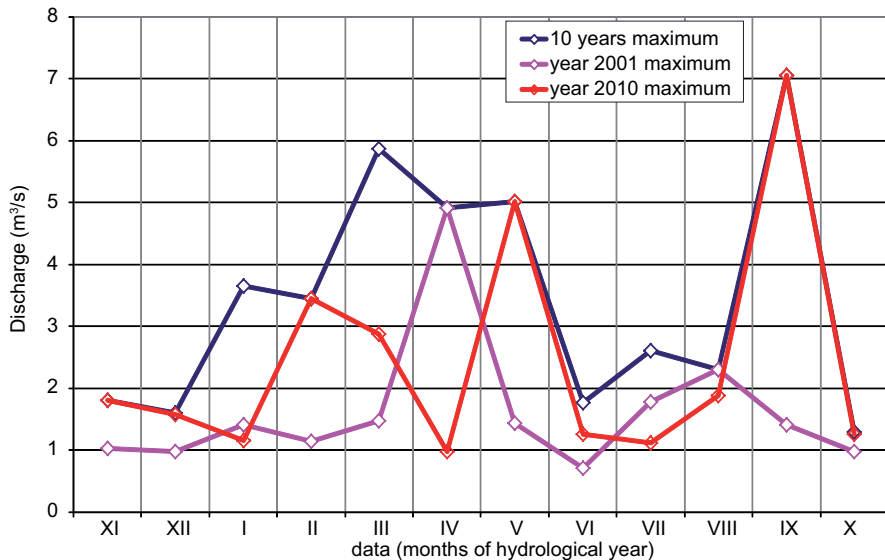


FIGURE 8.4. Monthly distribution of maximum flows at Borowiec gauge

the nest were destroyed by flood. It is possible, that the nests were impacted by back-water flow from Vistula river. More important are actually the maximum flows which can reach the nesting areas. In case of Borowiec, the highest flow (Figure 8.4) was estimated during September 2010, so it has no impact on pond turtle breeding period. In May 2010, when the highest flows were calculated for period 2001–2010, there was no nest damages, even though the bank flows (4.44 m³/s) were exceeded. The nests area in case of Zwoleńka river are placed above the river valley, so only extremely high flood can harm them.

During flood, turtles could be swept down the river. In central Poland once such accident was observed (results of the study), but it is difficult to find transferred animals, as they could be more frequent then reported in the study. Such transferring (even rare) could be dangerous for small populations. It is because elasticity for nest survival is low, compared to adult and subadult individuals (elasticity analysis allows one to indicate which life history parameters are critical to population growth, and help to plan the most efficient conservation activities; Heppell 1998). For the European pond turtle the crucial for surviving of the population is adult and subadults mortality rate (Paul 2004; Mitrus 2008b), and transferring of even some individuals could be dangerous for small populations.

Flooding could also have an effect on food availability (Keller et al. 1998) and on overwintering areas. However, there are no data on the subject for population of the European pond turtle.

Conclusion

The European pond turtle *Emys orbicularis* is a freshwater animal. It is a threatened species in many areas of its distribution. Preservation of water bodies is considered the most important for the species conservation. Little is known about influence of such flows on the turtle population. However, especially for small population existing in river valleys, problem of extreme flows should be taken into consideration in plan of protection of the turtle. Based on available data, nest flooding probably will have no significant negative impact on population of the turtle, but the danger of transferring of adult individuals by water flows could be crucial.

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