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Prevention of Turtle's Access to the Road: Specifics of the Environmental Impact Assessment Conditions and Measures Issued for the Priority Objects from the National Linear Infrastructure Network in Bulgaria

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Abstract: Mortality by vehicular traffic is a well-documented, worldwide threat to chelonian populations. We present a detailed analysis of the conditions and measures for prevention of turtle mortality included in the Environmental Impact Assessment (EIA) decisions for important road constructions issued between 2008 and 2016 by the competent authority (the Ministry of the Environment and Waters, MoEW) of Bulgaria. We identified seventeen EIAs issued for priority objects of the national road network that have been finalized or are currently under construction. All EIA decisions contained specific instructions for protecting the turtle populations, including avoiding damage to eggs, nests or adults during the construction phase, avoiding fragmentation of the populations, limiting access of animals to the road to prevent direct collisions with vehicles. We focused on the instructions included in every EIA decision concerning the design of the constructions preventing access of turtles to the road. Most EIA decisions issued between 2008 and 2010 provide very detailed prescriptions for the design of solid barriers made of wood plates, or long and solid concrete walls. During the execution of the measures by the contractors, some severe technical flaws of both designs were identified. Therefore, alternative projects for implementation of the mitigation measures have been proposed. The competent authority (MoEW) had followed the local legislation requirements and issued additional ordinations for the design changes. We comment on the technical characteristics of the barriers for turtles and discuss on the functionality of some proposed and some already build constructions.

Key words: chelonians, impact mitigation, transport network, road mortality, vehicle-wildlife collision (VWC), EIA decision

Introduction

Bulgaria has an extensive network of Natura 2000 protected sites (see Natura 2000) and a substantial territory is under protection by the EPA (EPA 2015). However, as a result of joining the European Union in 2007 and thus an access to additional funds, the construction of new elements of the linear infrastructure in Bulgaria has been rather intensive since 2009, a tendency likely to continue in the future (OPTTI 2014). Because of their large size and continuity, the elements of the linear infrastructure may represent a threat for some elements of the ecosystem (for overview see Van der Ree et al. 2015). According to the Bulgarian legislation, every investment proposal is subject to a combined procedure of an Environmental Impact Assessment (EIA) and an Appropriate Assessment (AA) before an EIA

decision and a Construction permit can be issued (BDA 2013, EPA 2015). The EIA decision issued by the Ministry of Environment and Waters (MoEW) serves to impose the investor to implement conditions and measures to mitigate or remove the negative impacts of the new infrastructure on key elements of the environment.

The EIAs of the newly realized roads in Bulgaria prescribe measures for prevention of chelonian access to the road surface. Bulgaria is inhabited by four native species of turtles, all under legislative protection: two terrestrial species (*Testudo hermanni* and *T. graeca*) and two aquatic (*Emys orbicularis* and *Mauremys rivulata*) (Stojanov et al. 2011). The allochthonous *Trachemys scripta* is also widely spread but not of conservation value (Tzankov et al. 2015) and will not be further discussed. For all four species, terrestrial migrations (between seasonal habitats; searching for food, mates or egg laying locations, etc.) are very important element of their ecology (Pritchard 1979, Ernst & Barbour 1989, Bonin et al. 2006, Orenstein 2012).

Road mortality is a widely recognized threat to turtles (for overview see Bush et al. 1991, Borman et al. 1997, Aresco 2005, Crawford & Andrews 2016). The building of barrier constructions is very effective strategy for reducing the road mortality in cold bloodied tetrapods (Dodd et al. 2004, Aresco 2005, Andrews et al. 2015). In many countries, special construction to prevent the access of turtles on the road were built and these constructions vary in their design (Huijser et al. 2008a,b). In this article, we analyze the specifics of the prescriptions in the EIAs, which regulate the design of the measures for prevention of turtle mortality on the roads in Bulgaria. We discuss the changes in the construction of facilities since 2008 and the tendencies toward generalization of the instructions in the texts of the EIA reports, related to the increased dynamic of road building in Bulgaria.

Materials and Methods

For our analysis, we selected 17 EIA and AA decisions, which were issued for linear infrastructure object (roads) of national priority between 2008 and 2016. Paragraphs from these documents were used as an instruction source for the design of the protecting barriers for turtles. According to the Bulgarian legislation (EPA 2015), the validity of an EIA decision is limited to a period of 5 years, i.e. the realization of the investment proposal has to start within that period. That clause made older decisions irrelevant for our discussion.

All of the analyzed decisions were available for free access at the site of MoEW, except the EIA № 1-1 Struma Motorway "Dolna Dikanya - Kulata" (2008). This decision was issued in the first days of 2008 and, according to the then current legislation, MoEW was not obliged to publish these documents. All 17 EIA reports that we had analyzed include the Appropriate Assessments (as required by the Bulgarian legislation); most of these documents are publicly available along the EIA decisions at the website and the offices of the Bulgarian MoEW.

For a better understanding of the trade-offs of the different solutions for preventing vehicle-wildlife collision, in addition to the EIA decisions and reports (including the AA reports), we investigated multiple other documents (e.g., construction schemes, projects for different design solutions, technical specifications blueprints). These additional technical materials had helped us to form a detailed overview on many technical issues; however, these papers do not represent citable sources and are not part of our discussion and reference list, as they cannot be cited precisely and some of these materials are even already destroyed. We had limited our discussion only to the designs of the fencing facilities for turtles and tortoises that were prescribed by the publicly available EIA decisions and on the actual constructions, which were realized after meticulous coordination procedures implemented by the MoEW.

Results and Discussion

We noticed a clear difference in the design requirements in the EIA decisions issued between 2008 and 2010 and in these issued after 2010. In the older EIA decisions (e.g. EIA Decision № 1-1 2008, EIA Decision № 5-3 2010), rather strict and rigorous instruction concerning the materials and the design of the barrier constructions were fixed. One exception is EIA Decision № 2-2 (2009), which allowed the position and the construction of the barrier devices to be an object of consultations between the experts from MoEW's regional directorate in Burgas and experts from Natural Park "Strandzha". It is important to note that the designer of the project was not included in the consultations process.

According to EIA Decision № 1-1 (2008), the protecting devices for turtles should be made of wooden plates dug in the soil. As another variant, concrete walls along the road were proposed; these had to be with a height of 45 cm, with the bottom 15 cm buried in the substrate, as the whole construction should be tilted 30–45° outwards from the road. Another important aspect is that the EIA decision

Fig. 1. Concrete walls for protection of vehicular turtle mortality at Trakiya Motorway. Note the gap in the wall where the service door is mounted

Fig. 2. Close-up of the service door built in the concrete walls for protection from vehicular turtle mortality at Trakiya Motorway

Fig. 3. Glass Fiber Reinforced Polymer (GFRP) plates used as barrier for preventing vehicular turtle mortality at the "Trakiya" motorway. Note the stable mounting of the plates to each other and to the metal pole

Fig. 4. Close-up of the fences constructed at Lot 1 of the Struma Motorway. The fine net is buried deep in the substrate and firmly fixed at the basis of the standard rabbit fence

stated that the walls have to be constructed in a way to prevent collection of water. The instructions were rather contradictive and unreasonable from an engineering perspective. We consider the strict execution of both designs inappropriate. Actually, wood is not a long lasting material and the maintenance of wooden structures would be complicated, time consuming, and labor intensive. On the other hand, building concrete walls causes a set of different problems. Concrete is a heavy and relatively fragile material. Thus, the concrete walls have to be relatively thick, thus the tilting outwards would be very complicated; therefore, such construction would be rather unstable. The actual height of a 30 cm, 45°-tilted concrete wall will be just over 21 cm; adult tortoises will likely be able to cross such an obstacle (but see Kornilev et al. 2005 for a discussion on turtles crossing railways). Furthermore, the tilted walls will collect rainwater at their basis. In case the foundation is drained, the construction will not hold firm and will be soon damaged; otherwise, if the foundation is solid, the walls have to be perforated for water drainage. These draining perforations cannot be kept under several cm in diameter, because otherwise they will clog regularly; therefore, they will still allow young turtles to penetrate the construction and appear on the road.

Other older documents also prescribe the construction of extended concrete walls to stop turtles (EIA Decision № 14-2 2009, AA Decision № 104 2009, EIA Decision № 5-3 2010). Actually, according to our experience, building of concrete walls has proven impractical and has a lot of disadvantages. In fact, the concrete walls suffer severe construction flaws. The long walls have to be periodically disrupted by "expansion joints". These joints are necessary, because concrete is not thermally stable and shrinks and swells depending on the climatic conditions. Another downside of the concrete walls is shown on Fig. 1 and 2. These figures represent the only ever build concrete walls for turtle protection in Bulgaria. The obligate "rabbit nets" along motorways should be equipped with both small and large hinged doors for access by maintenance vehicles (LoR 2012). Since such equipment cannot cross the concrete walls, the walls are interrupted in uneven sections. We assess the efficiency of such constructions in preventing turtles to appear on the asphalt as very low. We also have to stress that

concrete walls may be dangerous in cases of vehicular accidents on the road.

Because of the drawbacks of concrete as a building material for protection walls, other designs were used during the building of later linear infrastructure objects. On particular sections of Lot 4 of Trakiya Motorway, flat and stiff barriers made of Glass Fiber Reinforced Polymer (GFRP) plates were constructed. The base of the plates was buried 15 cm in the substrate; the plates were connected to each other via metal pins and additionally stabilized by a pole (Fig. 3). The plates were fixed at the bottom of the rabbit fences and represent effective barrier for turtles. This construction is much more appropriate than the concrete walls. The mounting system allows for rapid and uncomplicated repair and exchange of damaged elements. Another important advantage of the plates is that they can also be mounted at the doors for the service vehicles. Despite being more appropriate than the concrete walls, the plate barriers also have some negative aspects. Plastic screens of this kind are vulnerable to mechanical damages (Huijser et al. 2008a). The plates also aid in the collection of water at their base (as they are usually lower than the road level and their foundations can be flooded by intensive rainfalls). This may result in destabilization of the rabbit fences and even of other elements of the construction bed including the road itself.

Fencing by using nets has proven a suitable tool for reducing road mortality in turtles (for overview see Aresco 2005, Huijser et al. 2008a,b). For Struma Motorway, a combined team of experts (including environmental specialists, engineers and designers) introduced to MoEW different designs for protection of turtles based on the use of nets. The approved design was implemented for the first time on Lot 1 of Struma Motorway. As a base, polymer coated sturdy metal nets with a mesh of 10 mm were used. The builders obtained net rolls with a width of 1 m. The rolls were half split in long sections of nets with a height of 50 cm. The net was buried 15 cm in the substrate and the remaining 35 cm were fixed to the standard rabbit nets and slightly tilted outwards from the road (Fig. 4).The design is rather similar to the devices build for protection of turtles (e.g. Gopher Tortoises *Gopherus* sp. and Alabama Red-Bellied Turtle *Pseudemys alabamensis*) in USA (Huijser et al. 2008a). This construction possesses several important advantages over the wooden, concrete and plastic alternatives. First, it is very strong and durable. It cannot be damaged by the turtles and other small animals, whilst it is flexible and can be adapted to the irregularities of the terrain. The net is protected from rust by a plastic coating and has a twelve-year warranty from the producer. The most important advantage of the net is that it does not collect rain water and there is no need of drainage system.

According to the results of Baxter-Gilbert et al. (2015), the net fences may not contribute significantly for preventing road accidents with turtles. We have to stress that the mentioned scientific team had used different constructions and different kind of nets made completely of plastic. This sort of nets can be torn apart by the turtles' claws and do not possess the rigidity of the metal nets used in the fencing facilities on the motorways in Bulgaria. In the EIA decisions from the last six years (EIA Decisions № 2-7 2010, № 13-4 2010, № 5-3 2010, № 29-11 2010, № 16-7 2011, № 4-2 2012, № 9-4 2012, № 5-3 2013, № 4-2 2013, № 1-1 2016, № 2-2 2016), net fences were the preferred design for building barriers preventing wildlife-vehicle collisions. Further experimental test and monitoring data will allow the scientific community to gain important information on the functionality of the different barrier constructions. However, we do not expect that one particular design would be suitable for all terrains and building conditions. We are convinced that the exact design and the precise length of the fences preventing the access of turtles on the road should not be prescribed in detail in the EIA decision but have to be additionally consulted during the "design and build" stage of the realization of the priority objects from the national road network in Bulgaria.

Conclusion

There is a clear tendency in the EIA prescriptions concerning the design of barrier constructions preventing road mortality of turtles. The older texts (EIA Decision № 1-1 2008, AA Decision № 104AA 2009, EIA Decisions № 14-2 2009, № 8-3 2009, № 5-3 2010), included rigid and often confusing instructions concerning the material and the technical specifics of the mitigation measures. In the texts of the more recent EIA decisions, such detailed obligations are missing. The modern documents allow a degree of flexibility for the design and position of the fencing devices. This change was conditioned by the fact that since the end of 2009 the intensity in the linear infrastructure building and especially the building of motorways increased enormously. The circumstances showed that the rigid prescriptions made by the environmentalists are not always implementable *in situ* road building. The Bulgarian EIA decisions for road infrastructure "evolved" in a direction to encourage involvement of designer and constructors besides the environment experts in the decision making process (see also Glista et al. 2009). The measures for prevention of vehicle-turtle

collisions have to be planned rationally in a manner to effectively prevent the road mortality but to keep the potential "corralling effect" (sensu Baxter-Gilbert et al. 2015) as low as possible.

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