

Final Evaluation Report

Your Details	
Full Name	Andjelina Tatović
Project Title	"Endangered freshwater snail (<i>Theodoxus transversalis</i>) in Serbia - distribution, population status and conservation"
Application ID	41198-1
Date of this Report	15 June 2025

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Assessing the current distribution of <i>Theodoxus transversalis</i> populations in Serbia and assessing its ecological/biological status			X	<p>The current distribution of <i>Theodoxus transversalis</i> and the potential range expansion of its populations in Serbia were assessed through systematic seasonal field surveys conducted in summer and autumn 2024, and spring 2025. Based on the data obtained, combined with historical data, we produced an up-to-date distribution map of <i>T. transversalis</i> in Serbia. This map is included in our recently published scientific paper (see Marković et al., 2025). It is worth mentioning that during this study we found 6 new localities inhabited by <i>T. transversalis</i>, which are shown on the map. Ecological status of <i>T. transversalis</i> populations was assessed on the field. Population density was estimated at each site by using metal square measuring frame (1 m²) and expressed as low (<10 individuals per m²), moderate (11-100 individuals per m²), and high (<100 individuals per m²). Living <i>Theodoxus transversalis</i> were found at 15 sites, while only empty shells were found at three localities. Most sites were in the Velika Morava-Južna Morava-Nišava catchment. <i>Theodoxus transversalis</i> was estimated to be</p>

				<p>common (high population density) at five sites (four in the Velika Morava-Južna Morava-Nišava catchment). In contrast, the species was assessed as less common (low population density) at six localities, most noticeably in the Danube River.</p>
Assessing ecological status of its habitats and identifying the main threats			X	<p>To assess the ecological status of sites inhabited by <i>Theodoxus transversalis</i>, we used data on physico-chemical water parameters and calculated biotic indices. The results indicated that the ecological status of these sites can be classified as good to moderate (Class II and III) according to national legislation.</p> <p>As the main threats for the species and its habitats we identified anthropogenic stressors, such as: hydromorphological alterations, municipal and industrial waste, sediment extraction, mini-hydropower plants, mining activities, and invasive species.</p> <p>We collected 12 water samples for additional chemical analysis conducted in a specialized laboratory, where further analysis of certain heavy metals, nitrite and phosphate compounds, water hardness, and alkalinity were conducted.</p>

				<p>Basic physico-chemical parameters of water, such as water temperature, pH, electrical conductivity (EC), dissolved oxygen concentration (DO) expressed in mg/l, and oxygen saturation in water expressed as a percentage, were measured directly in the field at all localities using appropriate probes.</p> <p>When it comes to macroinvertebrate samples, we collected samples from all localities and all seasons — 36 in total. Further analysis and identification we carried out at our faculty- Faculty of Biology.</p>
Comparing obtained distribution data with literature data to obtain more detailed knowledge necessary for assessing its recent status as a basis for adequate conservation measures			X	<p>In comparison with historical data (collected more than a decade ago), current observations suggest that <i>Theodoxus transversalis</i> populations have remained relatively stable despite ongoing negative environmental pressures. This could suggest that the species is somewhat more resilient than previously assumed based on earlier literature. Nevertheless, given the inherent vulnerability of freshwater ecosystems and the increasing intensity of anthropogenic pressures, there is no room for undue optimism.</p>

<p>Raising Public Awareness on Biodiversity Conservation and protection of endangered species and fragile freshwater habitats, and Strengthening Environmental Awareness through Education campaigns</p>				<p>We conducted 10 lectures for 10 groups of approximately 20 first- and second-grade primary school pupils, as well as for four groups of 20 first- and second-year students from the Faculty of Biology, University of Belgrade. In total, we reached approximately 200 primary school children and around 80 university students.</p> <p>We initially distributed promotional materials to some of our colleagues, some of whom had previously participated in Radford-funded projects. We also displayed A0-format posters in prominent locations at the faculty and at the Experimental Centre "Radmilovac." Additionally, after the lectures, we handed out promotional materials to both pupils and students.</p> <p>In total, we distributed 35 T-shirts, 40 tote bags, 200 pencils, 200 bookmarks, and 5 posters.</p>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--	--	--	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

2. Describe the three most important outcomes of your project.

a). Based on data obtained from field research conducted during the summer and autumn 2024, and spring 2025, combined with historical data, we created a distribution map of *Theodoxus transversalis* populations in Serbia, which is included in our recently published paper (see Marković et al., 2025).

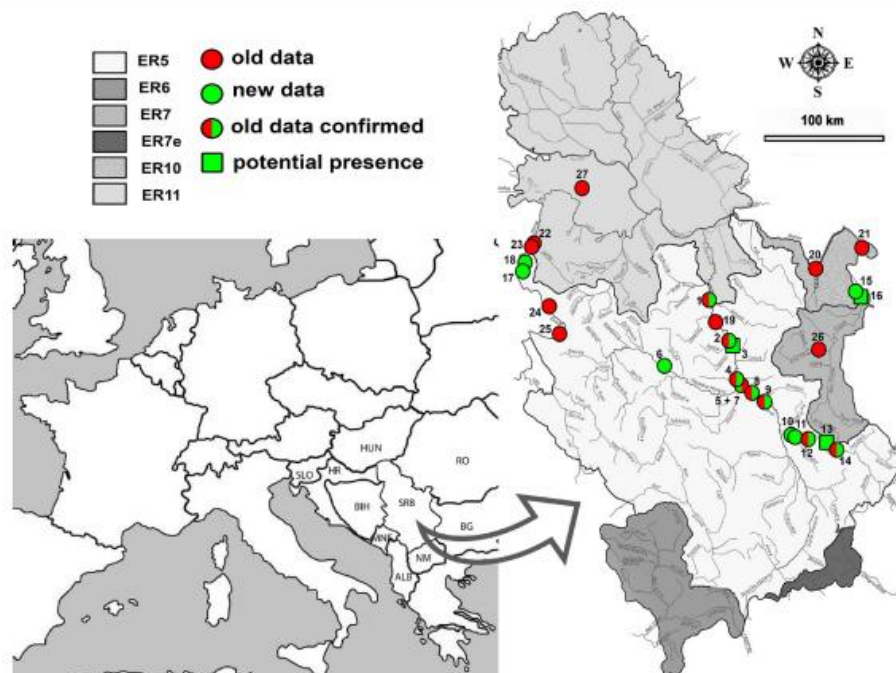


Figure 1. *Theodoxus transversalis* findings during the 2023–2024 survey (green circles) and findings from 1994–2013 surveys (red circles); mixed circles represent continuous presence/confirmed findings. Localities are numbered as in Tables 1 and 2. Ecoregion codes (ER) are as used by Paunović et al. (2012).

Along with the distribution of *T. transversalis* populations, its ecological status was also assessed. The following populations of *T. transversalis* were evaluated as the most stable: Gornja Koviljača (Drina River), Varvarin (Velika Morava River), and Brzi Brod (Nišava River). Across three sampling campaigns (summer, autumn and spring), these localities consistently showed the highest snail abundances—particularly at Varvarin—along with a notable presence of egg clusters and juvenile individuals. If we compare these data with historical data, we can conclude that the Velika Morava and Nišava Rivers remain the most important habitats for the species, especially the Nišava River. It even appears that the population from its main refuge in the Sicevo Gorge is expanding downstream toward the city of Niš.

The populations in the Velika Morava River remain stable, with population in Varvarin emerging as the most stable of all. There is also evidence suggesting potential dispersal from this site toward the Južna and Zapadna Morava Rivers, given the proximity of their confluence—only a few kilometers away. The dispersal into the Zapadna Morava is of particular interest, as there were no previous records of the species in this river. In addition to the confluence site, a population was observed upstream near Kraljevo; however, this is likely an incidental occurrence, as described in Marković et

al. (2025).

Due to elevated water levels during the spring of 2025, the status of the Kraljevo population could not be fully assessed, thus further investigation is needed to confirm whether this was an isolated finding or a more stable population that has managed to establish itself despite its presumed accidental origin.

Theodoxus transversalis has not been recorded in the Serbian section of the Danube for a considerable time. Therefore, the recent discovery of a population at the Prahovo site (Lower Serbian Danube) is of particular significance. Although the number of individuals is low, the population appears stable, as live specimens were recorded during all field campaigns. At the nearby site of Radujevac, no live snails were observed, although empty shells were found.

Considering the species' presence in the Lower Bulgarian Danube, it is plausible that populations in the lower Danube region are gradually recovering. This potential recolonization may be linked to improved habitat conditions (assessed as good to moderate ecological status in this study). Continued monitoring will be essential to track population dynamics and assess long-term trends in this region.

b). Based on the physico-chemical parameters of the water and biotic indices (macroinvertebrates), the ecological status of sites with *Theodoxus transversalis* populations can generally be classified as good to moderate (Classes II and III), in accordance with national legislation. According to the same classification system, most sites inhabited by this snail species fall under water body type 2 (large rivers with medium substrate, excluding Pannonian watercourses) such as sites on the Drina, Velika Morava, Južna Morava, Zapadna Morava and Nišava Rivers. Sites located along the Danube belong to type 1 watercourses (large lowland rivers with fine substrate), while the upstream section of the Nišava River (above the settlement of Brzi Brod) is categorized as type 3 (small and medium-sized watercourses at elevations up to 500 meters above sea level, with coarse substrate).

With the exception of the Stalać–Mojsinje site, all locations are situated along heavily modified (canalized) watercourses. In addition to hydromorphological alterations, the main anthropogenic stressors affecting these habitats include municipal waste water (particularly in the Nišava, Južna Morava, and Velika Morava rivers), industrial effluents (notably at some sites on the Nišava and Južna Morava rivers), sediment extraction (especially

along the Velika Morava), and the presence of invasive species (particularly in the Danube, Drina, and Velika Morava rivers).

Despite their generally favorable ecological status (ranging from very good to good), sites along the Drina River are also potentially threatened by mining activities — a risk that could increase significantly if the proposed Jadarko mining project is realized.

It is important to note that although *T. transversalis* is a strictly protected and nationally endangered species in Serbia, only a small portion of its populations inhabit designated protected areas (e.g., Sićevo Gorge on the Nišava River). The majority of the populations are found in regions subjected to substantial anthropogenic pressure and high population density, such as the Pomoravlje region. Particularly notable is the largest known population, located at the Varvarin site, where it persists despite high levels of municipal and industrial pollution and intensive sediment extraction.

c). Comparing obtained distribution data with literature data, in our study, we were able to find considerable progress in the restoration of the former geographic range of *T. transversalis* in Serbia, and even its possible spread into new areas, the Zapadna Morava River catchment. We assume that the populations of this species are recovering, but stable populations are still mainly localized. Our data suggest that the species might be more resilient to anthropogenic threats and might have a more pronounced adaptive capacity than reported in the available literature. A more detailed ecological and genetic study focusing on the Velika Morava (and its tributaries), Danube, and Drina rivers would provide greater insight on the presence and prospects of *T. transversalis* in the region. Moreover, continued conservation efforts and protective measures are essential to ensure the long-term survival of this endangered species in Serbia. One potential conservation measure could be the relocation of certain populations to ecologically suitable habitats within protected areas or regions experiencing lower levels of anthropogenic pressure. In any case, continued research and long-term monitoring are needed.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

An unforeseen difficulty was the massive student protests across Serbia, which led to the suspension of lectures at all universities, including the University of Belgrade. All lectures during the current semester have been suspended

since December 2024, and the suspension is still ongoing. Although we had already conducted lectures related to our project for second-year students at the Faculty of Biology, as well as for first and second graders in primary schools, we had planned to hold an additional lecture for members of the Biological Society “Josif Pančić” at the Faculty of Biology, University of Belgrade. Given the great interest shown by students at our previous lectures, both in the project and the foundation itself, especially considering their potential applications as future PhD candidates, we have not abandoned our intention. We plan to hold this lecture later when it becomes feasible, that is, once lectures at the faculties resume.

4. Describe the involvement of local communities and how they have benefitted from the project.

During our fieldwork, we had the opportunity to speak with local residents, primarily fishermen, who showed great interest in our expedition. The vast majority of them were unfamiliar with the ecology of *Theodoxus transversalis* and its conservation status. Since we were wearing T-shirts with the Rufford Foundation logo, this sparked their curiosity and led to further discussion on the topic. We received very positive feedback, not only regarding our project, but also in terms of their own observations about environmental problems, including the anthropogenic pressures we had identified, as well as reports of certain animal species that were once common but are now no longer seen. On that occasion, we also distributed promotional materials that we had brought with us to the field.

5. Are there any plans to continue this work?

Yes, we would like to continue the periodic monitoring program in order to track the status of *Theodoxus transversalis* populations, as our research has shown that this is a very interesting and ecologically specific species. It would also be highly valuable to conduct genetic analyses of *T. transversalis* populations, particularly the isolated ones, as this would help determine whether the species has low genetic diversity. Such information is especially important for the species' long-term survival, as well as for implementing specific conservation measures such as population translocation, reintroduction, and similar actions.

6. How do you plan to share the results of your work with others?

One paper has already been published, and we plan to write another based on this research. In all publications, the Rufford Foundation has been, and will continue to be acknowledged.

7. Looking ahead, what do you feel are the important next steps?

Continuous monitoring of both, the populations and their habitats, along with the implementation of conservation measures where necessary, combined with appeals to the relevant authorities to reduce negative anthropogenic impacts.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

We used the Rufford logo on all materials related to this project. On the promotional materials, which included cotton T-shirts, tote bags, pens, and posters, the easily visible and recognizable Rufford logo was prominently displayed. It also appears on every slide of our PowerPoint presentation (photos are included in the previous report). We noticed great interest in the Rufford Foundation, especially among future PhD students at the Faculty of Biology, to whom we gave warm recommendations.

9. Provide a full list of all the members of your team and their role in the project.

All participants on this project are from the Faculty of Biology (University of Belgrade, Serbia).

Milenka Božanić, PhD in Biology, participated in the laboratory processing of collected macroinvertebrate samples and provided support during field research when needed.

Vanja Marković, PhD in Biology, participated in both fieldwork and laboratory processing and identification of macroinvertebrate samples. He also contributed to the interpretation of the results.

Vukašin Gojšina, PhD student specializing in malacology, made a valuable contribution during field investigations and was involved in organizing lectures and workshops.

Prof. Dr. Ivana Živić assisted with financial management and supported fieldwork when needed.

Anđelina Tatović, the project leader, was responsible for coordinating all project activities, managing both laboratory and fieldwork, delivering educational lectures, and processing and analyzing the main project results.

10. Any other comments?

Here is the reference and link of our published scientific paper:

Marković, V., Gojšina, V., Tomović, J., Novaković, B., Vujić, M., Ilić, M., ... & Tatović, A. (2025). *Theodoxus transversalis* (C. Pfeiffer, 1828)(Gastropoda: Neritidae) in the Western Balkans: an endangered freshwater snail bouncing back?. *Journal of Conchology*, 45(3).

<https://conchsoc.org/sites/default/files/jconch/45/3/2025-45303.pdf>