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Negative Impact of Invasive Plants on Riverbank Vegetation

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Abstract. The research presented in this paper deals with the issue of invasive plant species. Invasive plants are characterized with the high regeneration potential and with a negative effect on populations of our native species and habitats. The occurrence of these plant taxon at a given site is not natural, and their appearance outside of their natural habitat is most often due to anthropogenic activity. Our research is focused on plant species *Fallopia japonica* and *Impatiens glandulifera*. The aim of the study is the determination of suppressing possibilities of their negative impact on riverbank vegetation. From the results of the first stage of the research, it is known that plant material is transported downstream, the ability of reproduction of the plant material maintain for at least for 4 weeks, and after being caught on the riverbank, it can establish a new population. The overgrowth of these invasive species presents a risk to the original riverbank vegetation, and the ecological stability is being disturbed. The eradication and prevention system is a necessary solution to this problem. The research is conducted on the Blatina River in Pezinok, Slovakia. The first method of eradication was the mechanical removal of *Fallopia japonica*. The two selected localities were cut. In the next growing season, an increase in the population of *Fallopia japonica* was recorded, and one new location was created. The second method of eradication was the chemical method. For chemical eradication, spraying based on the Invasive Plant Removal Guidelines for the Slovak Republic was used. An important finding was that the effectiveness of the chemical eradication is dependent on the area of the sprayed leaves and independent on the concentration of the solution. The next step was the comparison of vegetation cover after mechanical and chemical eradication. A soil probe was performed on two selected areas; area after the mechanical eradication and the area after chemical eradication. A root sample was taken from both areas. Subsequently, the viability of the root system and its stabilizing function with respect to bank erosion were evaluated. The effectiveness of chemical eradication was much stronger. The most optimal way is to remove the plant at their early stage of the growing cycle when the leaf area is smaller. The result is then ecologically and economically more advantageous. After chemical eradication, it is necessary to remove dead plant residues in the autumn to create optimal light and wet conditions for the growth of potential natural vegetation. Invasive plants in riverbank vegetation have a negative impact on stability and potential natural vegetation. The best way to control their incidence is eradication.

1. Introduction

This work deals with the negative impact of invasive plant species on the riverbank vegetation in Slovakia. Invasive plants are non-native taxons that spread uncontrollably and suppress the existence of native species. When there is an invasion of allochthonous plant species, we can speak about the attachment of the species in a new region, its movement, or the movement of a lower taxon, and its

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reproduction outside its natural area. [1] The process of becoming a plant an invasive has multiple stages. The initial phase is the introduction, transport, subsequent establishment of the population and the spread of the species, followed by a phase where colonization occurs. As a result of the individual phases is the ecological and economic impact itself.

2. Invasive plants

Invasive species are plants that invade, so they take a root in a new area than its natural habitat. In the new area, they are growing and spreading. As soon as the plant begins to have a more significant negative impact on native species and their habitats and begins to change the landscape, it gets to the list of invasive plant species in Slovakia, the so-called "National list". According to the law, it follows that every landowner, administrator or user of the land is obliged to take care of the land so that the invasive plants do not spread on the land and they are obliged to remove it.

Figure 1. *Fallopia japonica*

In Slovakia, 10 invasive species, of which 6 are herbs, are defined and registered in the law. Herbs include the species *Ambrosia artemisiifolia, Asclepias syriaca, Heracleum mantegazzianum,* (known for its poisonous effects), *Impatiens glandulifera*, which is the subject of our research, *Solidago canadensis, Solidago gigantea* and the wood species *Ailanthus altissima, Amorpha fruticose, Lycium barbarum* and *Negundo aceroides*. We also include the entire genus *Fallopia sp.*. The most common species in our territory is *Fallopia japonica*. *Impatiens glandulifera* and *Fallopia japonica* are the most abundant in watercourses. The attachment of the plant to the river bank depends on the nature of the plant itself and its demands for natural conditions. The decisive factors are soil conditions, climate, etc. The appearance of the species at the site outside their natural habitat is most often conditioned by anthropogenic activity. Anthropogenic activity in the introduction of invasive plants may be intentional or unintentional. The studied species can also serve as a food source. For example, young shoots of *Fallopia japonica* can be consumed. [2] In the past, individual species have been deliberately imported into parks and gardens. Unintentional anthropogenic activity may result in the introduction of a non-native species, e.g., together with the import of other goods. Many invasive plants are still unconsciously grown today, such as ornamental plants in parks, gardens, open spaces in towns and villages, as well as pet food. [3]

Our research focused on plant species *Fallopia japonica* and *Impatiens glandulifera*. *Fallopia japonica* is one of the invasive plants that compete strongly with domestic species. [4] It often attacks shore streams in rivers. It undermines ecological balance. It grows to a height of 3m, has straight upright stems of bamboo shape. [5] Spring shoots are reddish. The leaves are all-round, usually heart-shaped or rounded, heart-shaped. The flowers are paniculate with tiny cream flowers. Even at the water flow, *Fallopia japonica* grows in open areas, not as an undergrowth, because it requires a solar habitat. [6] It is most common in Slovakia along streams and roads, in synanthropic habitats, in urban and urban areas.

The *Impatiens glandulifera* is an annual herb, reaching a height of up to 2.5 meters at the time of flowering. It comes from the Himalayas. In Europe, it is mainly linked to coastal vegetation, human-made areas with damp climates, the edges of forests and roads, or the surroundings of human-made water bodies. [7] The impatiens are propagated by seeds that are fired from the fruit by a mechanism called balochorion (a mechanism typical of all non-stalking species). Fired seeds are transported for long distances due to the water flow in which they flow (hydrochorion). However, they are not able to stay on the surface for a long time, so they sink to the bottom but do not lose their viability. If they get ashore again, along with sand and gravel from the watercourse, they can germinate (bathizochorion). The *Impatiens glandulifera* reproduces generatively. There is a risk of soil erosion, due to a weak root system that does not reach sufficient depth. [8]

3. Riverbank vegetation

The ecosystem formed by riparian vegetation is a natural bio-corridor connecting biocentres. The shoreline vegetation has a stabilizing function, protects the water body from a landslide, protects the river bed from uncontrolled overgrowth and subsequent clogging of the trough. Higher bank vegetation prevents overheating of water during hot summer when vegetation obscures the surface. Water-level shading eliminates the lack of oxygen that occurs when water plants overgrow at the bottom of the bed as a result of overheating the water. The line of bank vegetation itself is an important landscaping element that can have a positive impact on the flow and the surrounding agricultural landscape. The structure of the bank vegetation has different degrees of stand height. If there is a tree deck, it can also serve as a windbreak. Windbreaks protect agricultural land. Their vegetation line should be perpendicular to the direction of the prevailing winds. [9]

4. Negative impact

The negative consequences of the spread of *Fallopia japonica* and *Impatiens glandulifera* can be divided into three categories: environmental, health, and economic. Our research is most interested in the impact of the spread of invasions on the environment, i.e., the environmental aspect of impacts and impacts. The subject of the research is, therefore, the search for ways to prevent their negative impact. They negatively affect and fundamentally alter the original species composition and can create new types of communities in the short term. Invasive plants form continuous growths on the banks of watercourses. They deteriorate the light-warming conditions for the native species of the shoreline vegetation and hence prevent their growth. Thanks to the water regime, they quickly occupy new locations from the source area to the delta. Stands situated directly on the slope causes soil erosion because of their shallow root system. As a result, there is water concealment in the shoreline. The erosion is also intensified by their drying in the winter months, causing the soil surface to become exposed and unstable. [10]

5. Field measurements

The research was based on data obtained in the first stage of field measurements. In the observations, we came to the conclusions:

- the plant material of the seeds of Impatiens glandulifera and the vegetation fragments of *Fallopia japonica* is transported along the stream due to the water regime

- vegetation fragments of *Fallopia japonica* can retain their reproductive capacity for at least 4 weeks, then the attachment of the fragment in the substrate is necessary
- after being caught on the river bank, the plant can establish a new habitat through the seed or vegetation fragment. [11]

Excessive and uncontrolled spreading of *Fallopia japonica* and *Impatiens glandulifera* poses a risk to native shore vegetation. Biological balance, as well as overall ecological stability, may be impaired. [12]

6. Objective

We know from the literature that the best way to counter the problem of the spread of *Fallopia japonica* and *Impatiens glandulifera* is their eradication. [13] The aim of the research was to verify the methods of eradication of the selected species in the reference stream section. The methods were based on predetermined plant predispositions. [14] Based on proven methods, further management of the treatment of the given invasive species can be determined.

7. Locality

Research is conducted on the Blatina River in Pezinok, Slovakia. The reference section is located on the border of the built-up area of Pezinok. The individual sites of occurrence of the investigated invasive plant were targeted. The data obtained from the measurements were used to create map data.

Figure 2. Blatina River, Pezinok, Slovakia

The LeicaVIVA GPS locator was used for field measurements. Only the presence of *Fallopia japonica* was targeted. Locations that had a surface area of up to 1m^2 were pointed. Other locations with extensions over 1m^2 were focused as polygons around the perimeter of the stand. We measured from the source area downwards. The length of the reference section was 1km. The measurements were repeated in three replicates within the plant's growing season. Area coverage on both shores was recorded.

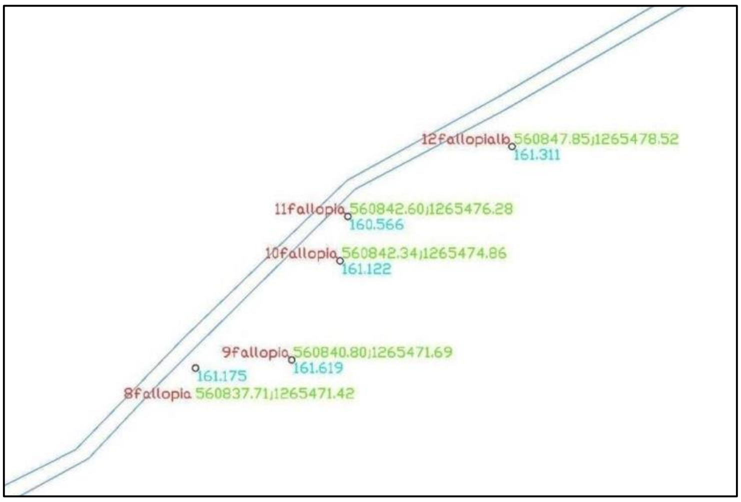

Figure 3. Selected locations on the Blatina River

The natural vegetation of the Blatina River is formed by floodplain forests, where several species of higher plants are represented, such as alder, cherry and white poplar.

8. Eradication

In the reference section of the Blatina River, we used two methods of eradication: mechanical and combined chemical-mechanical eradication.

8.1. Mechanical eradication

The first method was mechanical removal of the *Fallopia japonica* species by beveling. The selected location with a surface area of about 150m^2 was mown. The site consisted of two areas, one on the right, on the left bank of the Blatina River. The drooping parts of the plants were left in place, not buried. In mowing, there was an effort to minimize plant material being carried away by water downstream. It was necessary to eliminate the possibility of further spreading by rooting vegetation debris.

8.2. Combined chemical-mechanical eradication

As a second method, a combined chemical-mechanical method of removing *Fallopia japonica* was carried out at the time of the plant's top. The selected site with a surface area of about 50m^2 was applied Spraying Roundup Biaktiv. Roundup Biaktiv has been developed for the needs of water management and agriculture. It immediately decomposes and leaves no harmful residues, does not pollute water and soil. Its main advantages are high efficiency, non-toxic effect, high productivity, and the possibility of its application close to the water level or directly on the surface without any harmful effect on water fauna. [15] This combined method is unique in its own way. The mechanical removal occurred only after the death of the above-ground parts of the plants. The aim of mechanical removal, in this case, was not to eliminate the sprayed area but to create optimal light and moisture conditions for the growth of natural herbaceous vegetation.

Chemical spraying was used based on the Invasive Plant Removal Guidelines for the Slovak Republic. [1]

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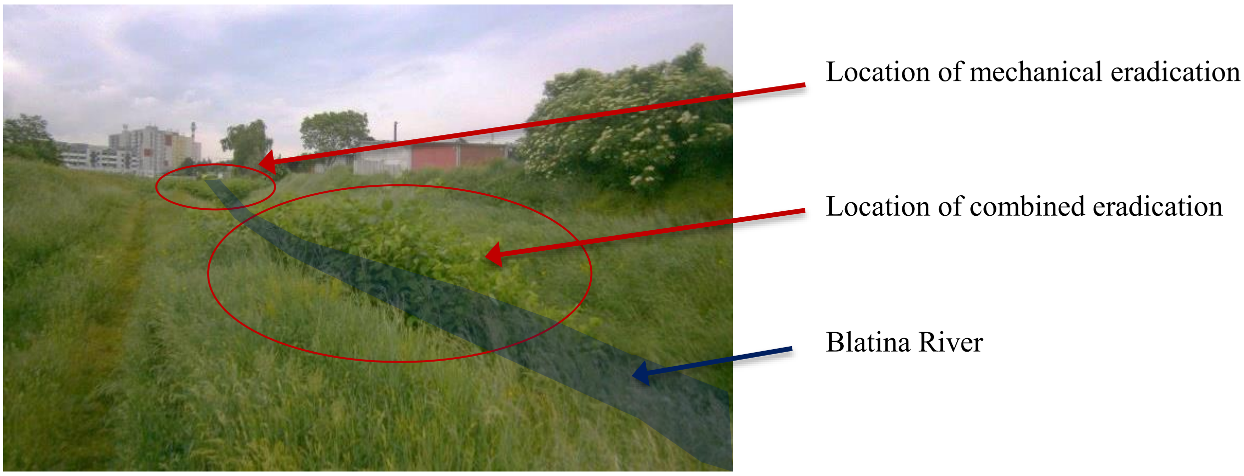

Figure 4. Territory before eradication

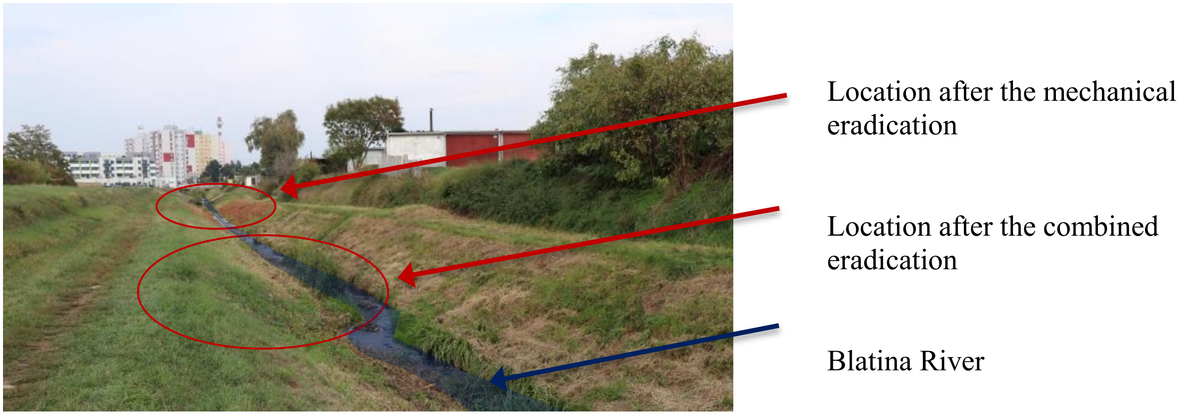

Figure 5. The area of the Blatina River after the eradication

9. Results and discussions

The consequences of mechanical removal were measured in the next growing season. An increase in the new population was recorded. There has been a slight widening of the overgrown area. The total area has increased. One new location was created. The advantage of mechanical removal of the species was the immediate effect, the environmental friendliness of the solution and the economic simplicity of the solution. To be effective, repeat it several times a year, preferably once every 14 days during the entire growing season. Plants are cut either 10-15 cm below the ground to destroy the root head. In our case, we applied the first way to keep the shore stable as it was a slope.

An important finding was that the effectiveness of the chemical eradication is dependent on the area of the sprayed leaves, independent of the concentration of the solution. The larger the area is dewy, the better the substance will enter the plant. The solution is most suitable at a concentration of 5%. The practical application was more demanding on the top stage of the plant because the individuals reached 2.5m. In the case of closed stands, it is not possible to spray well the inner parts of the stand. From a practical point of view, it is, therefore, more optimal to remove the plant at the initial stage of the vegetation cycle when the leaf area is smaller, and it is sufficient to wet the smaller area.

As shown in figures 4,5, due to the removal of dead plants, the herbaceous plant has been restored, while the increase in the herbal tray is suspended compared to purely mechanical removal. The status after eradication was evaluated as a percentage. On average, every third individual had the ability to germinate again, representing 1.5% of the observed area at this vegetation stage, the remaining 98.6% of the area remaining empty. After the combined chemical-mechanical removal, we noted a 0% ability to germinate again. From this, we conclude that even the subterranean organs of the plant have died. Cleaned areas after chemical removal of invasive plants began to replace natural vegetation in the same year. Combined chemical-mechanical eradication is more effective in this case.

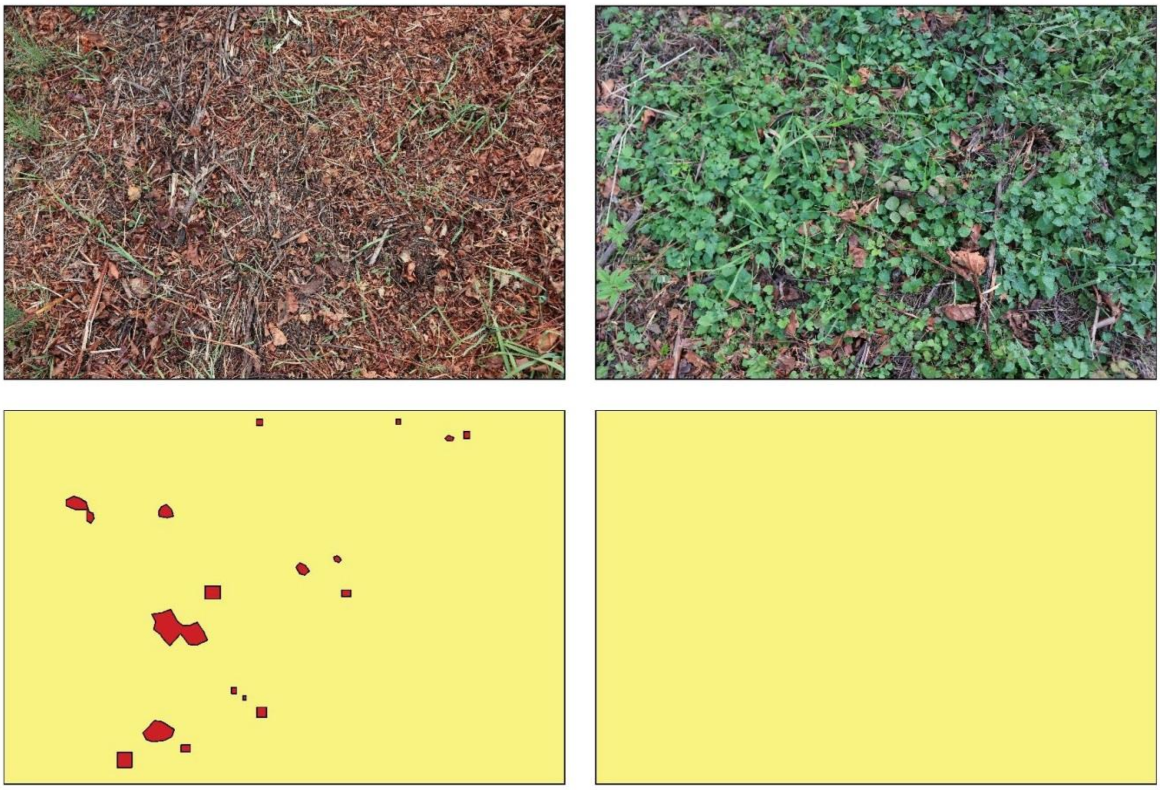

Figure 6. Comparison of vegetation cover after mechanical and combined chemical-mechanical eradication

To verify the impact of eradication on bank stability, a soil probe was conducted at two selected sites. One area was drawn on site after mechanical eradication and the other after combined chemical-mechanical eradication. A root sample was taken from both areas. Subsequently, the viability of the root system and its stabilizing function concerning the bank erosion were evaluated. Both ways of eradication have not had a negative impact on the shore erosion in our case.

10. Conclusions

Invasive plants in bank vegetation have a negative impact on shore stability and potential natural vegetation. The best way to control their incidence is eradication. Two methods of eradication were verified: mechanical and combined chemical-mechanical. Removal methods were applied to the invasive *Fallopia japonica* species. The research site was the reference section of the Blatina River. The method of eradication described in this paper does not affect the deterioration of bank erosion and opens the door to the restoration of potential natural vegetation.

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