Mapping Invasive Plants in Riverbank Vegetation

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Abstract. Invasive plants are naturalised plants that create populations that are spreading rapidly and to the long distances from parent plants. Invasive plants are occupying a large amount of space in invaded habitats, expected to impose a negative impact on the native vegetation. This study is focused on bearing the invasive plants close to the river. Based on the field work and measurements there can be seen relation between riverbank vegetation and river. We are mapping the occurrence Impatiens glandulifera and Fallopia japonica. They are invasive plants that threaten the natural riverbank ecosystems. We updated the database of localities showed in the research of State Nature Conservancy of the Slovak Republic and we identified a new locality of invasive plants. The focus of our research is the riverbank vegetation on the streams in region Malé Karpaty in Slovakia. Impatiens glandulifera and Fallopia japonica invade the riverbank vegetation very often. Natural vegetation is degraded and the balance state in nature is broken. The spread of the invasive plants is driven by the dispersal and the colonization capabilities of the vegetative and sexual propagules. Our study focuses on how the water dispersal of stem and rhizome fragments have a share of the colonization dynamics of riverbanks. Watercourses are powerful vectors of species colonizing riverbanks. Invasion by these species is therefore likely to seriously affect biodiversity and reduce the quality of the riparian ecosystems for amphibians, reptiles, birds and mammals whose diets are largely composed of arthropods. The biodiversity is rapidly decreasing and therefore it is very important to decelerate the invasive process.

1. Introduction

Invasive plants invade natural ecosystems; they are introduced and allochthonous; they act like dominant and aggressive plants at a new locality. These species inhibit autochthonous species. The situation is complicated when the invasive plants grow in riverbank vegetation. Uncontrolled growth of invasive plants is dangerous and there is need to find a solution for this issue. [1]

EU spends approximately 10-15 milliards Euros to control and eradicate invasive plants and to remove damages caused by the invasive species yearly. The USA spends even more, 80-100 milliards Euros, by the year. The trade, traffic and travel globalisation increase the random or focused spreadness risk of invasive plants. [2]

2. Invasive plants

We are mapping the following species Impatiens glandulifera and Fallopia japonica.
Impatiens glandulifera is an annual plant, reaching a height of 2.5 meters at the time of flowering. It comes from the Himalayas. In Europe, it is mainly part of riverbank vegetation, forest edges and roads, or surrounding artificial water areas. [3]

Impatiens glandulifera is reproduced generatively. The seeds are fired from the fruit by a mechanism called the *balochorion* (a mechanism typical of all these species). The shot seeds are transported over longer distances thanks to the water flow in which they flow (*hydrochorion*). But they are not able to keep on the surface for a very long time, so they fall to the bottom, but they do not lose their viability. If they get back to the shore, along with sand and gravel from the watercourse they are able to germinate (*bathizochorion*). The aggressive seed dispersal, coupled with high nectar production which attracts pollinators, often allows the *Impatiens glandulifera* to outcompete native plants. *Impatiens glandulifera* promotes riverbank erosion due to the plant dying back over winter, leaving the bank unprotected from flooding. [4] The plant has a weak root system, that does not run deep enough. There is a risk of soil erosion. [5]

*Fallopia japonica* is reproduced vegetatively. The plants are rapidly spreading and rapidly regenerating from the massive undergrowth system. The possibility of successful removal is dependent on the eradication of each individual plant, including underground organs. [6]

*Fallopia japonica* is an invasive rhizomatous perennial geophyte. The plant grows up to 3 m, with reddish brown spots, glaucous, erect, branched and strong stems. The stems arising from rhizomes are creating wide spread epicentres. [7] The sprouts are red in in first phase in the spring. The leaves are heartshaped green in the main vegetation season in the summer (figure 1). The leaves are changing the colour into red-brown in the autumn. Flowers grow on terminal and axillary panicles, small creamy – white colour. *Fallopia japonica* grows in full sunshine. [8]

![Figure 1. Fallopia japonica - leaves](image)

Each species has a characteristic habitat despite their general wide ranging occurrences, thus, *Fallopia japonica* is more commonly associated with the banksides of higher energy streams at higher altitudes and with larger bed substrates e.g. gravels or cobbles, artificial sections or more modified sections of streams. *Impatiens glandulifera* is more often associated with rivers of lesser stream power, lower altitudes and with finer channel and bank materials, but all are found existing over a wide range of conditions presumably indicating their ability to colonise most habitats if they can initially gain access. [9]

### 3. Riverbank vegetation

Riparian zones (the fringes of rivers or streams) are the interface between aquatic and terrestrial ecosystems. [10, 11]. They are affected by fluvial processes such as flooding and deposition of alluvial soil, and typically support a distinctive flora that differs in structure and function from adjacent terrestrial vegetation. [12, 13, 14,15]. Riparian vegetation fulfils or influences various important ecological functions in relation to aquatic habitats, including the provision of food, moderation of
stream water temperature via evapotranspiration and shading, providing a buffer zone that filters sediments and controls nutrients, and stabilization of stream banks [16, 17] (figure 2). It also provides a corridor for the movement of biota [18] and serves many important roles for humans [19].

![Figure 2. Example of stabilization of stream banks](image)

4. Database of State Nature Conservancy of the Slovak Republic
We searched the specific localities, where the presence of *Fallopia japonica* and *Impatiens glandulifera* was monitored between the years 1988-2016 based on the Database of State Nature Conservancy of the Slovak Republic (ŠOPSR). (Table 1)

| Locality                      | Date     | distribution | X_JTSK | Y_JTSK | area | unit |
|-------------------------------|----------|--------------|--------|--------|------|------|
| Majere, Podrybníkorn          | 20.8.2015| <1 %         | -322976.98 | -1101100.95 | 115.79 | m²   |
| Majere, Dunajec               | 20.8.2015| <1 %         | -323283.41  | -1159852.35  | 39696.68 | m²   |
| Lesnica, Lesnicky potok       | 6.8.2015 | 2 - 1% - 50% | -317477.74  | -1159855.50  | 4795.19  | m²   |
| Spisska Stará Ves, Rieka      | 27.8.2014| 2 - 1% - 50% | -324347.65  | -1162186.98  | 90669.80 | m²   |
| Kameničná říčka              | 1.8.2014 | <1 %         | -485962.70  | -1194442.58  | 6080.68  | m²   |
| Starinovany                   | 17.10.1997| normal       | -195391.77  | -1237026.03  | 5384.09  | m²   |
| Euboča                       | 15.8.2006 | normal       | -248298.66  | -1249659.60  | 1748.00  | m²   |
| Kralovany, druhá strana Vlhú  | 30.9.1999 | normal       | -346954.86  | -1251313.12  | 6983.00  | m²   |
| Suščan, Střiž pri Vlhú        | 4.9.2000  | normal       | -424737.51  | -1106856.70  | 400.00  | m²   |

5. Field work and measurements
The stream was chosen based on its characteristics (length, flow). These factors showed that the stream is appropriate for the research. The following methods were used in the research:
summarization of the materials (maps, databases and the selection of appropriate materials), field work, measurements, photodocumentation, laboratory experiment, analysis of the results and its final comparison.

The selected reference reach was chosen outside the main urbanised area. It is located in the industrial area, surrounded by wild nature. The length of the all reference reach is 5 km.

![Reference reach in Pezinok](image)

**Figure 3.** Reference reach in Pezinok

The localisation and area of each *Impatiens glandulifera* and *Fallopia japonica* was measured by Leica VIVA GPS locator. Each stand was documented by the photos at the same time. Locations where the invasive species were more widespread, were measured as polygons (figure 3). The solitaire individuals were measured as points. In some places, parts of the plants directly touch the water level (figure 4, 5).

![Field work and measurements](image)

**Figure 4, 5.** Field work and measurements

Laboratory experiment was performed. The fragment plants about 3-10cm were taken from reference reach on the stream Blatina. We are simulated wet conditions, close to the natural conditions. The germination process of stamps is displayed on figure 7-9. Photodocumentation was performed during three weeks. After each week it can be seen significant growth. The small fragment plants have high regeneration potential. (figure 6,7,8,9).
6. Results and discussions
Due to the repeated measurements, we have found that the reproductive material is transported. The fragments of plants and shot seeds are transported over longer distances downstream, thanks to the water flow in which they flow. The transport of fragments is dependent on the water-level and the flow speeds. Flooding is an important factor affecting the abundance of Impatiens glandulifera and accounts for its spread and dominance along river corridors probably due to spreading the seeds, increasing nutrient availability and disturbing native vegetation. The research suggests that the optimal way to control the spread is the prevention, care and eradication. With increased flow rates, the quantity of material transported is upped. Invasive plants spread not only in the direction of flow but also in a particular location. Mapped areas expanded to width after year. The biodiversity is rapidly decreasing and therefore it is very important to decelerate the invasive process.

The best solution to the problem of invasion is to eradicate the species completely. In Slovakia it is used the Methodology of the Guidelines for the Removal of Invasive Plants [20, 21].

It is necessary to create a proposal for measures covering several factors. Stabilization of banks prevent erosion of the floors, and spoil the banks are important. For the overall ecological concept of the problem of invasive plants, secondary uses of the removed parts of plants are used.

7. Conclusions
The prevention, care and eradication invasive species is extremely time consuming, hard and expensive process. However, it is necessary to fight against it intensively. Ignoration of this issue can lead into a complete change of our natural riverbank ecosystems. The further results of this research will show the most effective ways, how to eradicate invasive plants from the riverbank vegetation.

Marginally it can be said, that invasive plants have also positive aspect. In case that they are already growing on an area, we should think more about the practical use of these species. We can find many benefits within the group of invasive plants in a riverbank vegetation and we should think more complex about this issue. We can divide invasive species benefits that are presented in a riverbank vegetation into some basic groups such as benefits to environment by providing food for animals, the possibility to use the invasive species as biofuel, providing shades for rivers, protection of rivers.
against overheating, providing a higher roughness of a riverbank surface, health benefits for people, the possibility to use some invasive species in a kitchen and aesthetic value [22].

The process of the research is progress. The further results will be visible in the next vegetation periods. The behaviour of the species will be monitored. Time flow is very important in this research because the plants are alive organisms. The vegetation periods in the future will show the success.

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References
[1] B. Vaseková, M. Majorošová, “Steps in the process of eradicating Fallopia japonica in areas close to river” HydroCarpath 2017. Catchment Processes in Regional Hydrology: Experiments, Patterns and Predictions, Sopron: University of Sopron Press, 2017. – ISBN 978-963-359-092-8
[2] M. Maľová, K. Sujová, V. Longauerová, “Invasive plant species in forest ecosystems.” In: Kunca, A. (Ed.), Aktuálne problémy v ochrane lesa 2014, Zborník referátov z 23. medzinárodného konferencie konaného 23.-24.4.2014 v Kongresovom centre Kúpeľov Šmokovec, a.s., Národne lesnické centrum, Zvolen, pp 98-107, 2014 (in Slovak).
[3] D. J. Beerling, J. M. Perrins, “Impatiens glanduliferaRoyle (Impatiens royleiWalp.).” Journal of Ecology, 1993, 81.2: pp 367-382.
[4] P. Greenwood, W.Fister, N. Wolfgang; Kuhn, "The potential influence of the invasive plant, Impatiens glandulifera (Himalayan Balsam), on the ecohydromorphic functioning of inland river systems" (PDF). Geophysical Research Abstracts. Retrieved 14 May 2015. 2014
[5] I. Ružek, M. Noga, “Invasive plant species in Central Europe,” Univerzita Komenského v Bratislave 2015, ISBN: 978-80-227-4039-7 (in Slovak).
[6] B. Mandáš, P. Pyšek, 1997. "Species of the genus Reynoutria in the Czech Republic."Zprávy Čes. Bot. Společn., Praha, 32, Mater. 14: pp 45 – 57, 1997 (in Czech).
[7] D. J. Beerling, J.P. Bailey, A. P. Conolly, “Fallopia japonica (Houtt.) RonseDecraene.” Journal of Ecology, 1994, 82.4: pp 959-979, 1994.
[8] B. Vaseková, “Invasive plants and their eradication,” KOMVY 2017,KZEI, Bratislava, 2017, ISBN 978-80-227-4749-3, pp 150-156, 2017
[9] F. H. Dawson, D. Holland, “The distribution in bankside habitats of three alien invasive plants in the UK in relation to the development of control strategies.” In: Biology, Ecology and Management of Aquatic Plants. Springer Netherlands, 1999. p. 193-201.
[10] S.V., Gregory, Swanson, F.J., McKee, W.A., K.W. Cummins, “An ecosystem perspective of riparian areas.”Biological Science, 41, 540–551. 1991.
[11] R.J., Naiman, H., Dé camps, M.E. McClain, “Riparian: ecology, conservation, and management of streamside communities.”Elsevier, Amsterdam. 2005.
[12] R.J., Naiman, H., Dé camps, M. Pollock, “The role of riparian corridors in maintaining regional biodiversity.”Ecological Applications, 3, 209–212. 1993.
[13] S.M.Tang,D.R.Montgomery, “Riparian buffers and potentially unstable ground.”Environmental Management, 19, 741–749. 1995.
[14] K. Prach, J. Jeník, A.R.G. Large, “Floodplain ecology and management. The Lužnice River in the Treboň Biosphere Reserve, Central Europe.”SPB Academic Publishing, Amsterdam. 1996.
[15] R.J. Naiman, H. Dé camps, “The ecology of interfaces: riparian zones.”Annual Review of Ecology and Systematics, 28, 621–658. 1997.
[16] R.D. Barling, I.D. Moore, “Role of buffer strips in management of waterway pollution: a review.”Environmental Management, 18, 543–558. 1994.
[17] W.G.Hood, R.J. Naiman, “Vulnerability of riparian zones to invasion by exotic vascular plants.”Plant Ecology, 148, 105–114. 2000.
[18] D. M. Richardson, P. M. Holmes, K. J. Esler et col., “Riparian vegetation: degradation, alien plant invasions, and restoration prospects.” In: Diversity and Distributions, 13: pp 126-139, 2007.

[19] N. P. Kemper, “RVI: Riparian vegetation index.” WRC Report 850/3/01. Water Research Commission, Pretoria, South Africa. 2001.

[20] A. Cvachová, E. Gojdičová, “Guidance on removal of invasive plant species.” Štátnaochranaprírody SR. Centrum ochranyprírody a krajiny. BanskáBystrica. p. 18. ISBN 80 – 89035 – 25 – 6, 2003 (in Slovak).

[21] Z. Černý, J. Neruda, F. Václavík, “Invasive plants and basic ways of their disposal” Inst. výchovy a vzdělávání MZ ČR, Praha, p. 42, 1998 (in Czech).

[22] M. Majorošová, B. Vaseková, “Positive aspects of the presence of invasive plants in the riverbank vegetation.” In Veda mladých 2017 - Science of Youth 2017 [elektronický zdroj]: proceedings. June 26 - 28, 2017, Ráztocno, Slovakia. 1. vyd. Nitra: Slovenská poľnohospodárska univerzita v Nitre, 2017, online, p. 64-70. ISBN 978-80-552-1688-1. 2017.