

New Trends and Issues Proceedings on Humanities and Social Sciences



Volume 6, Issue 2 (2019) 040-047
<https://doi.org/10.18844/prosoc.v6i2.4281>

www.prosoc.eu

Prevention of invasive species in the context of lower secondary education

Maria Balazova*, Department of Biology and Ecology, Faculty of Education, Catholic University in Ruzomberok, Hrabovska cesta 1, 034 01 Ruzomberok, Slovak Republic

Dana Blahutova, Department of Biology and Ecology, Faculty of Education, Catholic University in Ruzomberok, Hrabovska cesta 1, 034 01 Ruzomberok, Slovak Republic

Terezia Valaskova, Department of Biology and Ecology, Faculty of Education, Catholic University in Ruzomberok, Hrabovska cesta 1, 034 01 Ruzomberok, Slovak Republic

Suggested Citation:

Balazova, M, Blahutova, D. & Valaskova T. (2019). Prevention of invasive species in the context of lower secondary education. *New Trends and Issues Proceedings on Humanities and Social Sciences*.
<https://doi.org/10.18844/prosoc.v6i2.4281>

Received, 19 January 2019; Revised, 23 March; Accepted, 15 May 2019.

Selection and peer review under responsibility of Prof. Dr. Hafize Keser, Ankara University, Turkey

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Abstract

Biological invasions are recognised as a potentially major threat to biodiversity and may have considerable economic and social effects. Public, including pupils, attitudes may have large implications for invasive species management in terms of prevention, early warning and eradication success, but significant is the relations between the lay public's visions of nature, their knowledge about non-native species and their perceptions of invasive species management. The more direct experience people have with the impact of invasive species, the more likely they will be able to understand the potential benefits of management programmes. The aim of our work was to prepare educational materials about invasive organisms for elementary schools. Some of them were subsequently applied directly in practice as part of an excursion in a schoolyard in west Slovakia, where up to six species of invasive plants were identified in the close proximity to the school.

Keywords: Biological invasions, prevention, education, excursion.

* ADDRESS FOR CORRESPONDENCE: **Maria Balazova**, Department of Biology and Ecology, Faculty of Education, Catholic University in Ruzomberok, Hrabovska cesta 1, 034 01 Ruzomberok, Slovak Republic. *E-mail address:* maria.balazova@ku.sk

1. Introduction

1.1. *The treat of biological invasions*

Biological invasions are in worldwide a common phenomenon resulting from climate, geotectonic or other natural events (Arslan, 2019; Lodge, 1993). We consider invasive those organisms that successfully spread beyond their original area of occurrence and colonise new areas. However, at present time, invasions occur much more frequently than in the past, as increasing trade and tourism, together with overall globalisation, facilitate the accidental spread of non-native species. Increased biological invasions represent the least reversible global human-caused change (Kolar & Lodge, 2001). Human activity is actually considered as the major vector for the spread of these organisms (Grigorovich et al., 2003).

Without sufficient information, most of the consequences of invasive species are unpredictable (Williamson, 1993). Biological invasions are one of the greatest environmental and economic threats and, along with habitat destruction, a leading cause of global biodiversity loss (Mack et al., 2000). At the levels of communities or even ecosystems, invading organisms can completely change natural nutrient circulation, water regime and energy balance, significantly reduce the abundance or survival of native species, can even block direction and range of floods and fire regimes. They can alter ecosystem structure, functions and services, and the greatest environmental threat is, however, the disruption of entire ecosystems.

Invasive species are also important vectors of a variety of diseases and parasites threatening native species (Riccardi & Maclsaac, 2013). The effects on human health are indeed a major problem. They affect human health in several ways (Davis, 2009) alone as alien pathogens or invaders that bring parasites or produce toxins. Others cause malnutrition or exert displaced or deferred impacts. Biological invasions inflict also large economic costs reducing agricultural production or damaging infrastructures such as railways, roads, buildings or water systems. In the EU, around € 12 billion (Kettunen et al., 2008) is allocated annually to prevent the spread, regulation and elimination of invasive alien species, while in the US, it is over \$ 80 billion a year (Vilr & Hulme, 2017).

Consequently, especially because of invasive organisms, particularly ecological costs and the biological invasions have become important issues for researchers, environmental policy and management and even for governments (Essl et al., 2011). The biology of invasive organisms belongs currently to developing scientific disciplines with distinct ecological, social and economic implications. Despite considerable efforts and financial costs from scientific researchers, however, there is a significant gap between the general information gathered about invasive organisms and those needed for overall conservation management (McGeoch et al., 2010). Moreover, although attention for the role of stakeholders groups in relation to management and impacts has increased in the past decade, only limited knowledge about the lay public perception of non-native species exists (Sax & Brown, 2000).

Invasive organisms appear not only in the wild nature but also occur in various anthropogenic areas, including urban and suburban areas and are now commonly present on the daily routine movements of humans including children. Nevertheless, public information on the occurrence and consequences, or even the very existence of these organisms, is low or absent. In addition, invasive organisms are still spreading and occupying new areas. Preventing their spread to new areas is however much more effective than later eliminating after they established in new environments. Moreover, a recent survey among European citizens showed that biodiversity management that is strongly focused on nativeness might not always tally with public interests (Fischer et al., 2011).

The problem of implementing measures against biological invasions is, therefore, mainly due to the low public awareness, the small amount of scientific information for the detection and identification of these species, but also the lack of control measures and legislation and the overall poor interaction between authorities, states, scientists and citizens (Genovesi & Shine, 2003). Moreover, the most

appropriate approach to the management of invasive species is the prevention that aims to impede new establishments or further spreading of them. Such measures are applied only in a small scale because for these to be successful, public knowledge of risks and threats of invasive species as well as public support for eradications is important prerequisites. The overall public support for nature and wildlife protection is, therefore, increasingly a topical issue (Vaske, Donnelly, Williams & Jonker, 2011). Several research studies reveal that increasing environmental attitudes can be used as indicators of support also for non-native species management in public including pupils of school or even pre-school level (Sharp, Larson & Green 2011). Intentions to engage in non-native species management behaviours appear to be influenced by prior exposure to, and experience with, that species (Kalnicky, Brunson & Beard 2019). Thus, the level of knowledge is closely related to personal involvement in invasive species problems (Verbrugge, Van den Born & Lenders, 2013).

Important is the proper way of how to mediate information to the public, primarily through pro-environmental behaviour. Especially it is necessary to mitigate opposing views in areas where people do not perceive invasive species negatively, such as in the case of man ornamental plants (Shine & Doody, 2011). Thus, it is important to have an appropriate level, language and appropriate methods by which this information is given to the public with regard to age, education and cultural and historical background.

1.2. Experiential learning as a way to inform about biological invasions

Nowadays, some changes related to streamlining teaching methods are getting to the area of upbringing and education. Experiential learning tends to be an appropriate strategy for developing science literacy in students. Learning through experience is the creative process that leads to strong experiences and spontaneous learning (Kolb, 2015). Therefore, we implemented the given issue in the teaching process about invasive organisms. We used the excursion, which is one of the forms of teaching in the field and thanks to this method; the pupils have become familiar with the topic. Subsequently, processing of newly acquired knowledge and skills was done using project education.

Teaching in the field can be considered to be both an experience education and the activating teaching method (Rychnovsky, 2010). It has a strong integrative nature, as it links interdisciplinary relationships. Moreover, it develops different types of knowledge and skills in pupils, mainly related to practical focus. The role of pupils in the field is to observe subjects in their natural environment by measuring, observing and mapping (Hofmann, 2003). By observing the organisms in nature, pupils can perceive them with all their senses. This makes learning more vivid, more attractive and better remembered (Ajaja, 2010). Unlike teaching methods where pupils are directly instructed by teachers, pupils in the field are looking for information, sorting them, researching and experimenting and that making them more responsible and creative. Project teaching is also one of the activating methods in teaching, in which pupils acquire knowledge through the solution of given projects (Laur, 2013). The project is a complex work of the pupil, which focuses on practical use and brings an original solution or product (Capek, 2015). The basic requirement of project teaching is the pupil's internal motivation. The pupil has to decide and take on the task of having the goal of solving the problem and bringing the project to the final stage those results in a product. The product made by pupils should be the strong motivation for this form of education. The quality of student projects is increased by public presentation (to some experts, school or community), which motivates them to be more responsible and consistent. Moreover, it reinforces their self-esteem (Dvorakova, 2009). On the other hand, the disadvantage of this form of education is the financial intensity and time-consuming (Svecova, 2012).

Thus, we used excursion to teach the topic 'Invasive plants'. We made prior field survey to identify appropriate localities before the date of the excursion. The locality for the excursion was situated directly in the school area (school playground, park and garden) and consisted of seven stations. It was realised for pupils of 6th grade of grammar school in NW Slovakia and it took two school lessons during regular teaching (90 minutes). It was realised during the flowering period (18th June 2018) and

most of the observed plants were just blooming. Pupils used the camera to document individual species of the invasive plants.

2. Results and discussion

2.1. Presentation about biological invasions to pupils of 6th grade of elementary school

This type of excursion is suitable for pupils of the 6th grade of grammar school and it can be used as the practical application of theoretical knowledge gained within the topic 'Life with human and life in human settlements'. Moreover, pupils of this grade have knowledge of the topic 'Plant body plan'. Thank to this knowledge; they should be able to work in the field to notice specific characters of invasive plants and to recognise invasive and alochtone plants.

The invasive plant species identified during our excursion can be considered as the neofytes (Medvecká et al. 2012). Only one species—*Robinia pseudoacacia* was determined in the tree layer. Much more numerous was the group of the invasive species in shrub and ground layer (*Erigeron annuus*, *Fallopia japonica*, *Impatiens parviflora*, *Lupinus polyphyllus* and *Parthenocissus quinquefolia*).

Due to the excursion, the pupils have learned to determine these species of invasive plants and they should be able to identify them later in other localities. They could find them near their residence or during wandering nature and they could contribute to knowledge about the distribution of these plant species. The free app Visitor has introduced them. This app is used by the public who are helping with collecting the data on the invasive species distribution. Moreover, pupils were warned about the danger of planting of this species as the risk of their expansion to the wild.

At the beginning of the excursion, the pupils determined the geographical coordinates and the altitude using GPS positioning. This part of the work was especially interesting for boys. Girls usually have less positive attitudes towards information and communication technologies in school but also in everyday life. However, social media and programmes designed to create are more popular with girls (Enochsson, 2005; Volman, van Eck, Heemskerk & Kuiper, 2005). The pupils had almost no problems with identifying the plants in the field. Only one pair of pupils made a mistake with identifying yellow blooming *Lysimachia nummularia* and they mistook them for *Chelidonium majus* with the same flower colour. However, they did it right with a little help and guidance. The pupils got maps and they were instructed how to work with it after completing this task. The map can be considered as an important didactic tool which can be used for interesting activities for pupils. The pupils have to know how to read the map, to understand all the marks and objects and to navigate through the map (Balazovic, 2014, Capek, 2015). The pupils were highly interested to be a navigator. Finally, we chose a boy who was considered to be 'problematic' by his teacher. But he was very responsible in his role. Moreover, he was attentive during the work at the stop points and he was active in solving tasks. The pupils also got the worksheet which was prepared in advance according to the route. The worksheets help to make pupils more active. This education method helps to develop their self-activity, higher cognitive abilities, creativity and it increases the interest of the particular subject (Harausova, 2011; Osvaldova, 2017).

The exercise at the first stop point was aimed at reading with understanding. Pupils solved it correctly.

They wrote to their worksheet the name of countries from which the invasive plants came from and the most frequently the ways how they came to our area. Boys and girls showed similar interest in reading the prepared text. Nowadays, when the high number of information is all around, it is very important to pupils be able to process the gained information and to apply them when they are solving tasks (Zapotocna, 2012).

At the stop-point where the *Erigeron annuus* grew, the pupils should dig out the whole plant with the root. The manual work was attractive also for pupils who usually achieve poor results in this school

subject. The pupils answered correctly the questions about the particular parts of this plant species. That is the result of good knowledge of the topic 'Plant body plan'.

The most difficult task for pupils was at the stop-point 3. The pupils had many doubts about which plant species are allowed to plant in the garden and which one not. All plant species were visually attractive for the pupils, mainly those ones with coloured flowers. That was why the pupils considered these species to be not dangerous. We were expecting this result, so we prepared auxiliary questions to help pupils to find the correct answer. The pupils were highlighted that even if plants like them and aren't worried about them, they can be very dangerous for our plant communities. Mostly first they were planted in gardens and parks as alien ornamental plant species and subsequently begun invasive spread in our area (Nentwig 2014). The owner (manager, user) of the land where these species grow is required to destroy them. The invasive plant species are listed in legislative documents of particular countries. Mainly, the species which cause the biggest problems or the species which have the most negative impact on the autochtone plant species and their biotopes and change the country were included to this list.

At the fourth stop-point, the pupils worked independently and the memory game was used to find the correct answer. This task was solved correctly. Not only the cards of the memory game helped them to solve this task but also the own knowledge and skills gained in creating a tree herbarium in biology lessons.

At the stop-point five was the task to draw a leaf of *Fallopia japonica*. Girls were significantly more active in this activity, whereas boys initially had some problems. They solved it with using a natural leaf; they traced the contour of it and then indicated only the venation and marked the individual parts of the leaf.

Correct answers to each task helped the pupils to solve the cipher which brought them to the 'WANTED' plant. Pupils took the bark prints out of it and drawn a leaf shape into the worksheet. At the beginnings of the survey, they get help in the form of a teat. Now they are evidence of the correctness of pupil finding by comparing them with those growing on the tree. We pointed out to pupils that another invasive plant is growing in the undergrowth. It was a small balsam, *Impatiens parviflora*. Pupils monitored how many individuals of this species grow in the area and get to know how specific it spread seeds. After the excursion was realised, the second phase of acquaintance with biological invasions in the form of project education. Pupils worked in groups on the processing of knowledge and skills acquired on the excursion. They could choose the issue, way and methods on their own. The results of their work were posters or herbaria, which they also made from their own materials (photographs, herbarium items, nature items), obtained during the excursion. With these activities, pupils developed creativity, autonomy, responsibility and ability to solve problems. Together with the use of various information sources, they were able to turn the acquired knowledge into concrete and useful products (Dvorakova, 2009).

2.2. Presentation about biological invasions to pupils of 2nd grade of elementary school

In the context of the classical Learning pyramid (Treichler, 1967) assuming that we achieve most information (more than 90%) when we teach others, we decided that pupils will introduce acquired knowledge, skills and created products about invasive organisms to pupils of the 2nd year of primary school, thus to pupils in the age of 7–8 years.

The presentation took place on 19 October 2018 and 18 pupils were present at the lesson. The topic was presented during the two lessons in the Science for primary schools course. Actual theme in the course was 'My School and its surroundings'. The 6th-grade pupils in this way developed their communication skills, learned to perform in front of the audience and explained clearly and adequately the issue to the pupils of the 2nd grade.

At the beginning of this lesson, we first introduced the concept of invasive plants adequately to their age. We presented it through an activity that approximates the behaviour of an invasive plant. Pupils were able to understand this issue very quickly and their interest in this topic was surprising. According to them, invasion 'is forcibly entering foreign territory and is not right'; 'invasive plant is like a bad warrior fighting to those who are not going to aware him' or 'invasive plant behaves like a weed that we have to remove from the garden in order not to harm other plants and to suffocate them'.

Children appreciated presented real natural products and herbariums. In some plants, there were poison leaves or fruits. We poured them into the foil so they did not pose any danger and the pupils could see them in detail. After we showed them the herbarium, they wondered how the individual plants were dried, labelled and deposited; they were interested in making their own herbarium.

The individual invasive plant species were presented to the pupils by below-prepared posters, jigsaws and also through the creation of head masks.

The pupils were acquainting to used methods, it was very close to their usual education process. The results of their work were excellent. They worked in groups, were concentrated to details and in addition to the leaves they created even flowers, fruits or tendrils. At the end of the presentation, we taught them a song about an invasive plant for the melody of a popular and famous children song. Working with music brings to the lessons experiences which, in addition to knowledge, develop pupils' aesthetic and creative abilities (Čapek 2015).

3. Conclusion

The biological invasions process takes place at global, regional as well as at local scales. At the last-mentioned level, individual schools should be involved in pupils and thus overall public awareness.

In this issue, there may be used methods like lectures, prepared information materials and discussions, but also process an excursion. We believe that the proposed excursion will be an inspiration for other Biology teachers and, according to the field, technical and material conditions; they will also properly transfer it to the education process. Problems associated with biological invasion cannot be solved without cooperation with the public. Schools are the place, where the next generation grows up and needs to take the right attitude to them.

Acknowledgements

This study was funded by the Faculty of Educatio CU Grant Agency, grant number 2/19/2018.

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