## SUMMARY

Invasions of alien species are considered one of the most serious threats to global biodiversity. Despite this problem currently affects nearly one fifth of the Earth's surface, and the range and number of new alien species introductions continue to grow, the biological mechanisms determining invasions are not fully understood. A particularly important issue that has not yet been clarified is the effect of landscape structure on the occurrence of invasive alien plant species. Also, there is insufficient knowledge regarding the relative role played by a number of other factors in the invasion processes of these species, such as human impacts, climatic conditions, soil properties, or biotic interactions between alien species. As a result, the development of effective methods to reduce the negative effects of the spread of invasive alien plant species and prevent new invasions is considerably difficult.

The aim of the study was to determine the relationships between selected environmental and anthropogenic factors and the occurrence of invasive plant species in Poland. As model species, two North American goldenrods were used: the Canadian goldenrod (*Solidago canadensis*) and the giant goldenrod (*S. gigantea*). These plants are widespread in European agricultural landscapes and significantly affect local biodiversity. Given roads are one of the key corridors for their spread, a novel method using panoramic images of roadsides available in Google Street View was applied to perform a large-scale inventory of the studied species. Since this method has not been empirically verified so far, in the first part of the study it was validated by field observations, assuming that Google Street View images would be a reliable and useful source of information on the actual occurrence of the studied species. Next, using this method, an inventory of invasive goldenrods was conducted along 1347 randomly selected transects in Poland and the relationship between the abundance of studied species and landscape heterogeneity characterized by two measures: configuration and composition was examined. It was expected that these two components may have different effects on goldenrod invasions, and that these relationships may be further dependent on the spatial scale considered. To verify these hypotheses, parameters describing landscape structure were determined at different spatial scales (i.e., buffers with a radius ranging from 0.25 km to 5 km of the study locations). Moreover, it was predicted that distribution patterns of invasive species may be simultaneously shaped by a number of other environmental and anthropogenic factors, which also change in importance with spatial scale. Therefore, using available geospatial data and machine learning algorithms, the relative importance of nearly 50 factors characterizing the study locations in predicting the occurrence of invasive goldenrods at different spatial scales was analyzed.

The verification of the method using Google Street View images to study the occurrence of invasive goldenrods at roadsides confirmed its high effectiveness, thus allowing for its application in the main part of the study. The level of landscape heterogeneity, both in terms of configuration and composition, was shown to have a positive effect on the abundance index of invasive goldenrods, but the size of this effect depended on the spatial scale: compositional

heterogeneity was the most important for predicting the occurrence of the studied species at large scales, whereas an opposite association was observed for configurational heterogeneity. It was also found that local distribution patterns of invasive goldenrods are determined by a number of factors, among which those describing human impacts, climatic conditions, soil properties and landscape structure are the most important. Similarly to measures of landscape heterogeneity, the role of many other characteristics in predicting the occurrence of invasive goldenrods was shown to change with spatial scale.

The study demonstrates how the available geospatial data resources can be used to advance our knowledge of large-scale ecological phenomena, such as biological invasions. The validation of the method that enables tracking of invasive plant species distributions based on the analysis of Google Street View images allows for its subsequent use in other roadside vegetation studies. The obtained results provide a better understanding of the mechanisms of biological invasions occurring in agricultural landscapes and the role that landscape structure plays in this process. The positive association between measures of landscape heterogeneity and abundance index of invasive goldenrods has important practical implications. This result suggests that the implementation of biodiversity conservation strategies aimed at supporting high levels of heterogeneity in agricultural landscapes, which is currently being applied e.g. in the European Union, may simultaneously support the spread of invasive alien plants. Consequently, controlling populations of these species seems especially important in the most diverse landscapes. The research also demonstrates the importance of spatial context in studying invasion processes. Since different factors potentially affecting invasions of alien plant species were shown to operate at different spatial scales, detecting and properly interpreting the associations between studied variables and distribution of invasive species requires consideration of an appropriate scale. Moreover, the study shows that the processes of biological invasions are highly complex, and multiple factors can simultaneously influence the success of invasive species. Therefore, understanding the mechanisms of biological invasions and setting priorities for alien species management requires a comprehensive approach that incorporates multiple factors and spatial scales.