

Ecological niche differentiation and distribution patterns of invasive macrophyte species as a key to their control

PhD thesis-abstract

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Until recently, the spread of non-native aquatic plant species in Europe was uneven—most invasions occurred in Western and Southern Europe, while Central and Eastern European countries, such as Poland, were relatively less exposed to their pressure. It is important to emphasize that knowledge about the distribution, environmental conditions, and behavior of many non-native species in Poland remains insufficient. Therefore, understanding the biology and ecology of non-native aquatic plant species is crucial for uncovering the fundamental mechanisms behind their invasiveness.

The objectives of this doctoral thesis were: (1) to assess the species composition, distribution patterns, abundance, and dynamics of non-native aquatic plants across different types of aquatic ecosystems; (2) to identify environmental gradients along which non-native aquatic plants are distributed in various types of aquatic ecosystems; (3) to present the key abiotic parameters (climatic and physicochemical water parameters) that explain the variability in the occurrence of non-native aquatic plants and the temporal changes in their habitats; and (4) to determine habitat niche models for individual non-native aquatic plant species.

The research identified the presence of 15 non-native plant species across more than 300 locations throughout the country and revealed their distribution patterns in different aquatic environments, considering climatic and environmental factors. Additionally, the developed niche models demonstrated the critical role of increasing winter temperatures in the spread of most of the analyzed species.

To evaluate the growth response of four species (*Cabomba caroliniana*, *Elodea nuttallii*, *Azolla filiculoides*, and *Vallisneria spiralis*) to different temperature and light conditions, a series of laboratory and field experiments were conducted. Based on these experiments, conclusions were drawn not only about the environmental preferences and realized niches of the studied invasive

species but also about the impact of rising temperatures due to climate change on their future invasions. The studied species exhibited high tolerance to shading and rapid growth in water with elevated temperatures.

Understanding the biology of invasive non-native species was then the basis for planning and testing control methods with potential applicability in the conditions of Central European waters. For this purpose, both field and cultivation studies were conducted, testing the effectiveness of five different control methods. The tested methods showed that, although such methods require great precision, limiting the growth of non-native aquatic plant populations is possible. An additional outcome of this work was the creation of a unique and continuously expanded database that monitors the history of the spread of non-native aquatic plant species in Poland.

Keywords: invasive species, macrophytes, distribution, habitats, distribution patterns, ecological niches, control methods, underwater research