BioInvasions Records (2025) Volume 14, Issue 4: 871–882

Research Article

Discovery of a new non-native aquatic plant in the Kolkheti Lowland, Georgia: implications for biodiversity

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Citation: Tedoradze G, Bakhia A, Gugutishvili N, Khuskivadze D, Mikeladze G, Kikvidze Z (2025) Discovery of a new non-native aquatic plant in the Kolkheti Lowland, Georgia: implications for biodiversity. *BioInvasions Records* 14(4): 871–882, https://doi.org/10.3391/bir.2025.14.4.10

Received: 10 March 2025
Accepted: 19 July 2025
Published: 17 October 2025

Handling editor: Tatenda Dalu
Thematic editor: Kenneth A. Hayes

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Abstract

Myriophyllum aquaticum (parrot's feather) is one of the most notorious aquatic invasive plant species. Native to the Amazonian regions of South America, including tropical and subtropical areas of Brazil and Argentina, *M. aquaticum* has now been documented in the natural environment of the Kolkheti (Colchis) Lowland in Georgia. This discovery raises an alarm, alerting researchers and managers to the potential threats to the natural aquatic ecosystems of the Kolkheti Lowland, an important refugial area and biodiversity hotspot. The plant forms dense mats on water surfaces, blocking sunlight and reducing the growth of native aquatic vegetation. This harms biodiversity by limiting space and nutrients for native species and disrupting food webs. The mats also hinder the movement of fish and amphibians, interfere with predator-prey interactions, and slow water flow, causing sediment buildup, flooding, and changes in water quality. Additionally, stagnant water created by these mats can promote mosquito breeding and raise the risk of vector-borne diseases.

Key words: aquatic environments, invasive species, the south Caucasus, Colchis, wetland ecosystems, biodiversity monitoring

Introduction

Invasive ornamental species pose a serious threat to freshwater environments globally (U.S.FWS 2015). In many cases, invasive aquatic plants affect species composition and ecosystem function, which might further lead to the local extinction of native taxa (Rojas-Sandoval 2024). Early detection of invasive or potentially invasive species is necessary to inform preventive measures against these species, and to contribute to future research and sustainable environmental management (Wersal and Madsen 2011).

Myriophyllum aquaticum (Vell.) Verdc. (1973) (parrot's feather) is one of the most notorious aquatic invasive plant species (Rojas-Sandoval 2024). It is native to the Amazonian regions of South America, including the surrounding tropical and subtropical areas of Brazil and Argentina. Within its native range, *M. aquaticum*, as a natural part of freshwater ecosystems, does not pose any apparent threat to the local biodiversity (Becker and Wong 2023). This plant was likely introduced to North America in the late

1800s, and in 1890 it was documented in collections in Washington DC. By 1906, it had naturalized in Florida. It was reported in South Africa in 1919, likely as an ornamental plant, and in Japan in 1920, spreading through the aquarium trade. By 1929, it had reached New Zealand, followed by Australia in the 1960s. In Europe, it was first recorded in Britain in 1960 and has since established at approximately 300 sites in the UK (Rojas-Sandoval 2024). This species, widely used as an aquarium and garden plant, can escape cultivation and spread through its fragments or through intentional plantings. While *M. aquaticum* offers habitat for some aquatic organisms, it also disrupts ecosystems by shading algae, altering water chemistry, and providing mosquito breeding grounds. It also reduces the recreational value of affected water bodies (GISD 2015).

Myriophyllum aquaticum is a monoecious or dioecious aquatic perennial herb with a submerged or shortly emergent lifestyle. The stem is soft, with few to many branches and rhizomatous. Submerged leaves, which are rarely alternate, are pectinate, ovate to oblong in outline. Emergent leaves are smaller, with the uppermost ones sometimes undivided, reducing to the bracts of the inflorescence. Male and female flowers are tetramerous (Rojas-Sandoval 2024). *Myriophyllum aquaticum* is a robust aquatic or marsh-dwelling herb with stems that can reach up to 2 m in length. Its aerial parts can grow up to 30 cm in height above the water's surface, resembling small fir trees (Figure 1). The plant is easily recognized by its distinctive, blue-green tinted, feather-like aerial leaves (U.S.FWS 2015; GISD 2015). *Myriophyllum aquaticum* often forms dense floating mats that choke waterways and hinder navigation (Figure 2). The plant grows vigorously during spring and summer, particularly in warm temperate and tropical regions. It typically flowers from late spring to early summer, though the timing can vary based on climate and environmental conditions. The plant bears small, inconspicuous flowers ranging from whitish to pale yellow, emerging from the axils of its emergent leaves. In introduced populations, only female flowers are commonly observed, while male flowers are rare. In many areas, *M. aquaticum* primarily reproduces through vegetative propagation via stem fragmentation, as seed production is uncommon outside its native range. Its ability to form dense mats and reproduce vegetatively often contributes to its invasive behavior in non-native areas. In colder climates, the plant may die back in winter, with its submerged portions persisting until warmer temperatures return (U.S.FWS 2015; Becker and Wong 2023; GISD 2015).

Thriving in tropical and subtropical climates, *M. aquaticum* tolerates mild frost but requires temperatures above freezing for sustained growth. It prefers nutrient-rich water bodies like ponds, lakes, reservoirs, and slow-moving streams, growing in both shallow and deep water. Optimal conditions include calm or stagnant waters, with silty, sandy, or muddy substrates

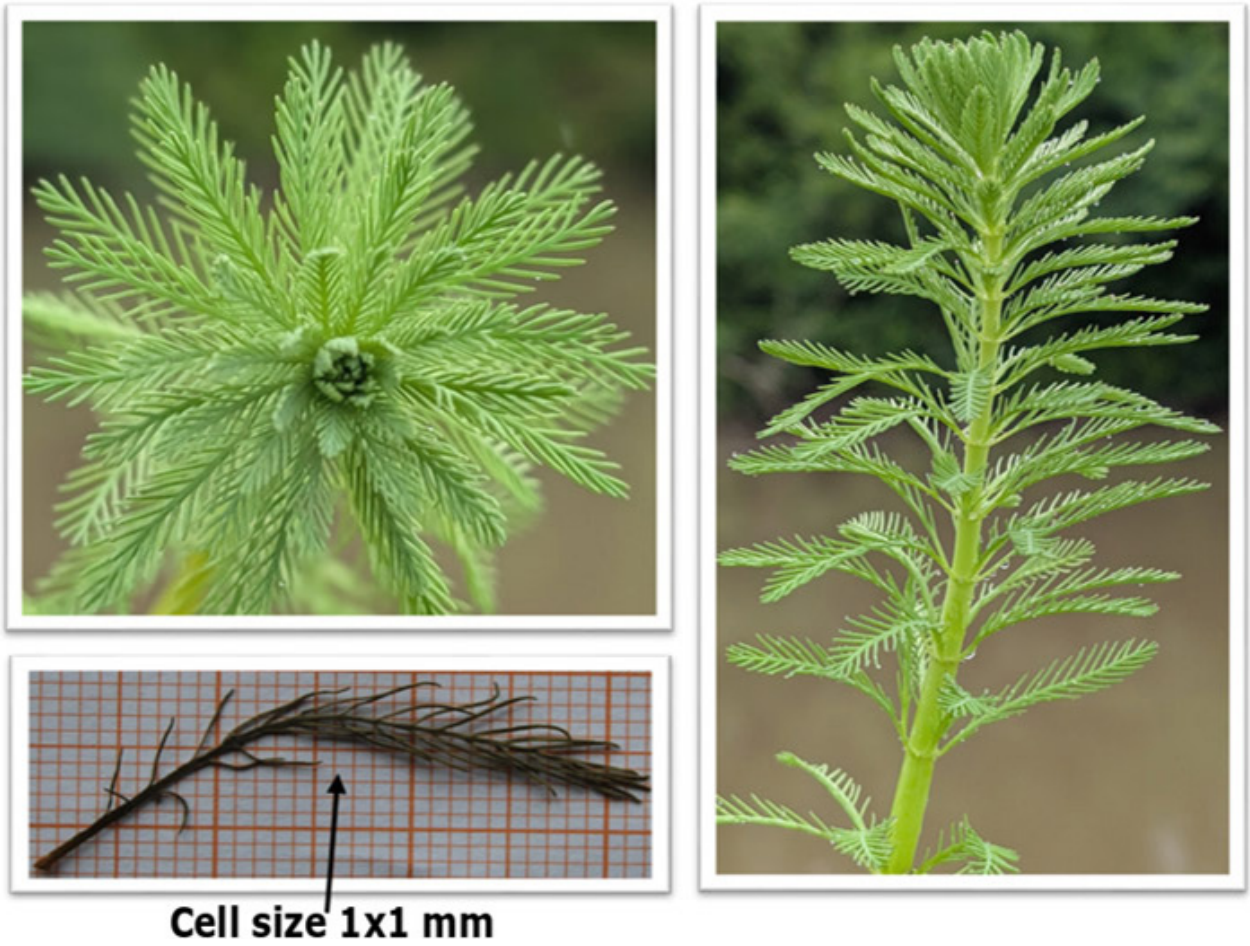


Figure 1. *Myriophyllum aquaticum*'s picture (1 July 2025; Magnetiti, river Sepa; Photo: Arsena Bakhia).



Figure 2. *Myriophyllum aquaticum*'s habitat picture (11 July 2024; Magnetiti, river Sepa; Photo: Giorgi Tedoradze).

(Wersal and Madsen 2011; Rojas-Sandoval 2024). While predominantly found in lowlands, it can survive at higher elevations with sufficient water. *M. aquaticum* adapts to fluctuating water levels, regenerating from root crowns or moist fragments. In its native habitat, it supports freshwater ecosystems by providing shelter and breeding grounds for aquatic organisms (Rumlerová et al. 2016; Rojas-Sandoval 2024).

Here, we report the discovery of the invasive species *Myriophyllum aquaticum* in the natural environment of the Kolkheti (Colchis) Lowland

near Ureki, Georgia. Known as an exceptionally noxious weed (Rojas-Sandoval 2024), the aim of our report is to alert both researchers and managers about the potential threats to the natural aquatic ecosystems of the Kolkheti Lowland, an important refugial area and biodiversity hotspot (Habel et al. 2019).

Materials and methods

Data collection and analysis

The information presented in this article was compiled during the summer of 2024 as part of the project titled "Risk Assessment of Invasiveness of Non-Native Aquatic Plants and Horizon Species in Georgian Wetlands", which received funding from the Shota Rustaveli National Science Foundation. The research specifically focused on the Kolkheti Lowland and the Javakheti Plateau, both of which are recognized for their rich aquatic and wetland ecosystems. Fieldwork was organized based on existing literature and electronic data. In order to optimize time and resources, locations previously surveyed in prior years (Tedoradze et al. 2023) were excluded from our survey area. Furthermore, herbarium specimens and relevant literature were referenced to identify locations of non-native aquatic species (Kikodze et al. 2010; Ketskhoveli et al. 1971–2011). Additionally, we cross-referenced specific species locations with data obtained from Global Biodiversity Information Facility (GBIF, https://www.gbif.org/) and iNaturalist (2024) (https://www.inaturalist.org/). This comprehensive approach enabled us to visit 120 sites nationwide (Figure 3). We monitored the potential presence of non-native aquatic plants at all selected locations, categorizing them as existing (those already recorded within the country) and horizon (those not previously documented in the country but found in the immediate vicinity). We identified potential horizon species that may soon enter study areas by utilizing a scanning tool from the Centre for Agriculture and Biosciences International (CABI 2024) (www.cabi.org/horizonscanningtool) and conducting a literature search on Google Scholar. The assessment of species invasiveness was conducted using the Global Invasive Species Database (GISD at www.iucngisd.org) and the CABI Invasive Species Compendium (www.cabi.org/ISC). In deeper waters, species samples were collected using either an inflatable or a motorboat, as dictated by the specific location. The identification of plants was performed using keys and synopses from the following resources: the "Milfoil (*Myriophyllum* Species) Identification Guide" (OATA 2023) and "Parrotfeather (*Myriophyllum aquaticum*) Identification and Management in Waterways" (OATA 2023; Hadfield et al. 2024). A trinocular stereo microscope (AmScope SM-1T Series) equipped with 3.5X–90X magnification, mounted on a table pillar stand, facilitated detailed morphological examinations for precise species identification. The herbarium specimens collected during this study will be

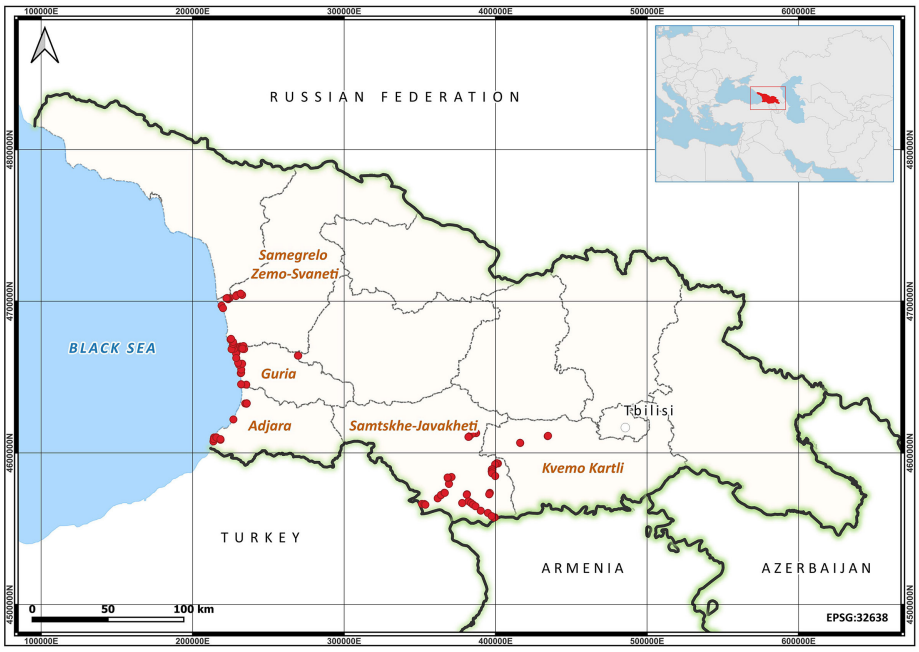


Figure 3. Map illustrating study locations in Georgia.

deposited in the National Herbarium of Georgia at the Institute of Botany (TBI) of Ilia State University, Georgia. The botanical nomenclature is primarily aligned with the standards set forth by GBIF (2025).

Results

Myriophyllum aquaticum was discovered in the Kolkheti Lowland (western Georgia) at point locations (41.97993, 41.76138–41.981339, 41.764245) in the summer of 2024 during routine botanical surveys along the banks of the small river Sepa, where it formed extensive monospecific, 300–400-meter-long stands (Figure 4). The finding of *M. aquaticum* in the western regions of Georgia confirms its ability to establish rapidly in new aquatic environments, particularly in eutrophic and altered habitats (Wersal and Madsen 2011; Becker and Wong 2023).

The floras of the South Caucasus countries (Armenia, Azerbaijan, Georgia) include only two native species of *Myriophyllum*: *M. spicatum* L. and *M. verticillatum* L. (Kariagin 1950–1961; Takhtajan 1954–2009; Ketskhoveli et al. 1971–2011). *Myriophyllum aquaticum* is not listed in any other regional floras of Kolkheti or nearby regions such as Abkhazeti and Adjara (Kolakovski 1980–1986; Dmitrieva 1990a,b). It is also absent from the list of Georgia's non-native flora (Kikodze et al. 2010) and the most recent checklist of wetland plants (Tedoradze et al. 2023). A thorough literature review revealed no published data about this species in the south Caucasus. To date, *M. aquaticum* is absent in the collections of the National Herbarium at the Institute of Botany, Ilia State University (TBI), Georgian National Museum Herbarium (TGM), and Batumi Botanical Garden Herbarium (BATU).

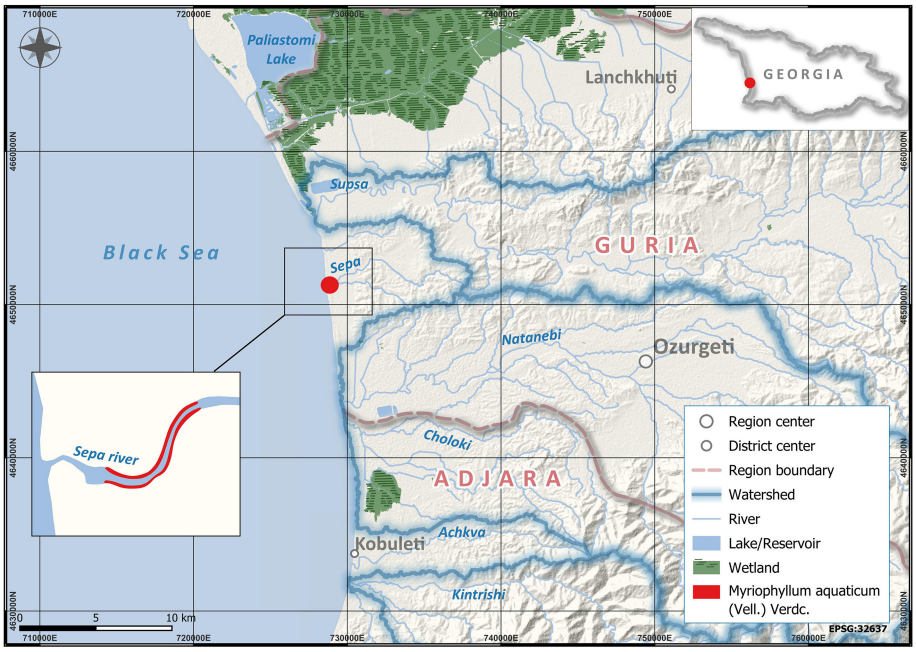


Figure 4. Map of distribution of *Myriophyllum aquaticum* in the Kolkheti Lowland (western Georgia) along the banks of the small river Sepa – 11 July 2024 (41.97993, 41.76138–41.981339, 41.764245).

The species was not included in the first edition of the Flora of the USSR by Czerepanov (1981). However, the second edition includes *Myriophyllum aquaticum* as a cultivated plant attributed to the Caucasus, though without specifying the exact region (Czerepanov 1995). Zernov (2006) identified the species as introduced in the northwestern Caucasus, specifically near ponds within gardens and parks. Based on this and the report of Kamnev et al. (2014), it is thus likely that the plant has already spread over the Tuapse-Adler region (northwestern Caucasus). The northwestern Caucasus border follows the Psou River and does not include the south Caucasus countries (Georgia, Azerbaijan, and Armenia) (Zernov 2006). *Myriophyllum aquaticum* is also noted in the occupied region of Georgia (Abkhazeti) in the 2004 checklist of the *Flora of Colchis*, which pertains to the eastern coast of the Black Sea from Tuapse to Trabzon; however, no specific details regarding its distribution are included (Chitanava 2004). All reviewed literary sources confirm the presence of this species in the northwestern Caucasus. Meanwhile, our findings now provide definitive evidence of *M. aquaticum* occurring along the eastern Black Sea coast in Georgia.

Discussion

Invasive potential and consequences

In some cases, *M. aquaticum* can stabilize sediments and provide habitat for certain aquatic organisms, though these benefits are outweighed by its invasive impacts in most non-native regions (Tunić et al. 2015). The plant forms dense mats on the surface of water bodies, blocking sunlight to native

aquatic plants. This reduces the growth of submerged vegetation, which is crucial for maintaining biodiversity in aquatic ecosystems. It aggressively competes with native species for space and nutrients, often leading to a decline and possible competitive exclusion of local species. The reduction of native plant species disrupts food webs and habitats and negatively impacts the organisms that rely on native plants for food or shelter. In the study area, species protected under the EUNIS (EEA 2025) framework may encounter similar threats, including *Nymphaea candida* C. Presl, *Salvinia natans* (L.) All., *Marsilea quadrifolia* L., *Potamogeton natans* L., and *Trapa natans* L.

The dense mats of *M. aquaticum* also obstruct the movement of aquatic animals, such as fish and amphibians, and interfere with predator-prey dynamics (U.S.FWS 2015). Further, this species slows down water flow in streams and drainage systems, leading to increased sedimentation, localized flooding, and changes in water temperature and oxygen levels, all to the detriment of native aquatic species (Rojas-Sandoval 2024). The resultant stagnant water pockets are ideal for mosquito breeding, which can increase the prevalence of vector-borne diseases in affected areas (GISD 2015).

Mechanisms of spread

Myriophyllum aquaticum is widely traded as an ornamental plant for its light foliage and aesthetic appeal (Pliszko 2024). It has also been used for water purification or erosion control, often with unintended ecological consequences (Rojas-Sandoval 2024). The most likely pathway of its widespread distribution is considered to be the irresponsible disposal into natural water bodies (Rojas-Sandoval 2024). Plant fragments can adhere to boats, fishing gear, machinery, or animals, facilitating spread to new locations.

Myriophyllum aquaticum primarily spreads through vegetative fragmentation, making it highly resilient. Even small plant fragments can regenerate and establish new populations, leading to rapid colonization. Outside its native range, there are no natural predators or pathogens to regulate its population, allowing it to grow unchecked. The species thrives in a variety of aquatic habitats, including eutrophic and nutrient-rich conditions. Its tolerance for fluctuating water levels and ability to grow both submerged and emergent makes it highly adaptable. Human activities, such as the ornamental plant trade and improper disposal, accelerate its spread to new water bodies (U.S.FWS 2015; GISD 2015). As in numerous comparable cases, the aquarium trade is the most likely factor that contributed to the invasion of *M. aquaticum* in Georgia.

In addition to the extensively documented role of horticultural trade and human-mediated fragmentation, the dissemination of *Myriophyllum aquaticum* is further facilitated by the interconnectedness of freshwater systems. Rivers, canals, drainage ditches, and irrigation networks function as dispersal corridors that facilitate the passive movement of plant fragments between

various locations. Within agricultural landscapes, irrigation infrastructure and runoff from fields may transport fragments over considerable distances, particularly during flood events. Recreational activities such as boating and fishing can also contribute to the dispersal of fragments, especially in regions characterized by a significant human presence near aquatic environments. These natural and anthropogenic vectors collectively establish a complex network of pathways that substantially enhance the species' capacity to colonize new habitats and broaden its distribution (U.S.FWS 2015; GISD 2015).

Conservation and management efforts

Myriophyllum aquaticum is commonly managed by physically removing its mats from water bodies using machinery or manual labor. This method, though effective in the short term, increases the risk of further spread of the plant through the dispersal of its small fragments, which can easily re-establish (Becker and Wong 2023). Herbicides like glyphosate and diquat have also been used to control the plant, yet these chemicals can harm non-target species and require careful application to minimize ecological damages. In the UK, the use of herbicides is restricted due to potential impacts on native ecosystems and water quality (Becker and Wong 2023).

The potential of biological control agents, such as weevils or other herbivorous insects, is under study in Australia and North America. These agents target *M. aquaticum* while sparing native plants. However, the success of biological controls is mixed and requires rigorous testing to avoid unintended ecological consequences. Continuous monitoring of infested water bodies helps track the spread of *M. aquaticum* and assess the effectiveness of management strategies, while ongoing studies focus on understanding its reproductive biology, growth rates, and interactions with native species to improve management approaches (U.S.FWS 2015; GISD 2015).

Educational programs aimed at informing the public about the risks of releasing aquarium plants into the wild and promoting proper disposal methods can be helpful (U.S.FWS 2015; GISD 2015). Several countries have restricted or banned the sale of *M. aquaticum* as an ornamental plant. Enforcement of these regulations helps reduce its intentional introduction (Rojas-Sandoval 2024).

Installing physical barriers in waterways can help contain infestations and limit the plant's ability to spread downstream. Preventing fragments from entering nearby water bodies during removal operations is also a critical strategy. Collaborative efforts between countries, including shared research and policy frameworks, aim to tackle the global spread of *M. aquaticum*. For example, the European Union has listed it as a species of concern under the EU Invasive Alien Species Regulation, requiring member

states to take action against its spread (Xie et al. 2013). These conservation and management efforts focus on reducing the ecological and economic impacts of *M. aquaticum* while promoting sustainable strategies for long-term control. Preventive measures, public engagement, and continued research are vital to curbing its spread and mitigating its invasive potential.

The significance of early detection

The Kolkheti Lowland is a biodiversity hotspot with unique flora and fauna adapted to wetland habitats and a humid, warm temperate, almost subtropical climate (Habel et al. 2019). *Myriophyllum aquaticum* must be considered a highly invasive species as it is able to grow rapidly, slow down water flow, and suppress native aquatic vegetation (Becker and Wong 2023). Consequently, the invasion of *M. aquaticum* in the Kolkheti Lowland is a serious threat to the biological diversity of this hotspot. Native and endemic aquatic species are under particularly high threat due to the aggressive growth and dense mats formed by *M. aquaticum*. The Kolkheti Lowland wetlands are essential for water flow regulation, carbon sequestration, and as habitats for migratory birds. The invasion of *M. aquaticum* could impact these ecosystem services by reducing oxygen levels in water bodies due to dense vegetation mats. The stagnant water can increase sedimentation and alter flood regimes, leading to degraded habitat quality for aquatic and semi-aquatic organisms.

The occurrence of *M. aquaticum* in the Kolkheti Lowland might be indicative of broader changes in regional climate and human activity. For example, warmer temperatures and increased eutrophication from agriculture and urban runoff create ideal conditions for establishment and further spread of invasive species like *M. aquaticum*. With predicted global warming, the environmental conditions of freshwater ecosystems in the study area may become even more favorable for *M. aquaticum* (Rodríguez-Merino et al. 2018). The presence of *M. aquaticum* in Georgia also underscores its potential to invade diverse habitats worldwide. This reinforces the need for international cooperation on managing invasive species and the pathways of their spread, such as ornamental plant trade and accidental transport.

Management implications and regional outlook

To mitigate the proliferation of *Myriophyllum aquaticum* in Georgia, it is imperative to establish an Early Warning and Rapid Response (EWRR) system, particularly in ecologically sensitive regions such as the Kolkheti Lowland. Such a framework would facilitate the prompt detection of new infestations and the swift implementation of interventions, thereby minimizing ecological and economic detriment. The integration of EWRR within national conservation planning could substantially enhance the outcomes of invasive species management (Reaser et al. 2020).

Public engagement likewise assumes a critical role in prevention efforts. Awareness campaigns directed towards aquarium hobbyists, horticultural suppliers, and local communities should underscore the ecological hazards associated with the release of ornamental plants into natural environments. The promotion of responsible disposal practices and the enforcement of restrictions on the sale of invasive species constitute essential measures in the effort to limit further introductions (Netherland and Schardt 2009).

The findings derived from this study also possess broader regional implications. The south Caucasus, noted for its rich biodiversity and transboundary ecosystems, confronts common challenges concerning invasive species (Habel et al. 2019). The reinforcement of cross-border collaboration and the harmonization of invasive species policies among Georgia, Armenia, Azerbaijan and Turkey could significantly enhance regional capacities for monitoring, prevention, and management.

Lastly, the invasion of *M. aquaticum* should be contextualized within the framework of climate change. Increasing temperatures and heightened nutrient loads resulting from agricultural and urbanization activities foster conducive environments for tropical and subtropical invasive species. Consequently, climate-resilient management strategies that account for impending trends of warming and eutrophication will be essential to safeguarding wetland ecosystems from further degradation.

Conclusions

We report the finding of the notorious aquatic invasive plant *Myriophyllum aquaticum* in the Kolkheti Lowland (western Georgia) at point locations (41.97993, 41.76138–41.981339, 41.764245) along the banks of the small river Sepa, where it formed extensive monospecific, 300–400-meter-long stands. This occurrence highlights the vulnerabilities of critical wetland ecosystems and serves as a call to action for preventive conservation efforts. Intensive research is also required to improve our knowledge of the ecology of this plant, its monitoring, and management practices. This case exemplifies the global challenge of invasive species in the context of environmental change.

Author's contribution

GT planned the fieldwork; GT, AB, NG, and DK conducted the fieldwork; GM created the maps; ZK and GT led the writing; all authors critically revised the manuscript.

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Acknowledgments

We sincerely thank the contributors of iNaturalist.org for their invaluable observations that facilitated this discovery. In particular, we are grateful to the user "arvidas" (https://www.inaturalist.org/observations/223098312), whose verification of the provided coordinates led

to the identification of a new species record for the country. We express our sincere gratitude to the Georgian National Museum, represented by Dr. M. Mosulishvili, and to the Batumi Botanical Garden, represented by Dr. D. Kharazishvili, for their invaluable support in verifying the existing herbarium specimens. Our appreciation also extends to Dr. L. Mumladze for correction of the text and Dr. R.L. Stubbs for her meticulous proofreading. Finally, we sincerely thank the anonymous reviewers for their valuable feedback and insightful comments, which have significantly improved the quality of this manuscript.

Funding declaration

This research was conducted as part of a project funded by the Shota Rustaveli National Science Foundation of Georgia, titled "Risk Assessment of Invasiveness of Non-Native Aquatic Plants and Horizon Species in Georgian Wetlands" (Project ID: YS-23-996).

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