Bioacoustics survey to detect alien green frogs across an urban gradient

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The introduction and spread of alien amphibians represent a major threat to native biodiversity, particularly in vulnerable and human-impacted ecosystems. Among these, alien green frogs have become a significant conservation concern in Southern Europe due to their high ecological plasticity, competitive behavior, and potential to cause genetic pollution through hybridization with native taxa.

In this study, we employed bioacoustic surveys to investigate the distribution and habitat associations of the alien *Pelophylax ridibundus* across an urban gradient in the metropolitan area of Firenze (central Italy), where the species determination has been previously confirmed through genetic analyses. A total of 47 wetland sites, spanning a continuum from highly urbanized to more natural environments, were surveyed monthly during the breeding seasons of green frogs for two years. Nocturnal surveys were conducted to record spontaneous frog vocalizations, which were then used to model species occupancy through single-season occupancy models, accounting for imperfect detection.

Our results revealed that *P. ridibundus* occupied approximately 50% of the surveyed wetlands, indicating a widespread presence within the study area. Occupancy was significantly influenced by the interaction between aquatic vegetation cover and proximity to human-modified environments, suggesting that the species benefits from both structurally complex habitats and anthropogenic disturbance. Detection probability was relatively high ($p = 0.66$), and our analysis indicated that four nocturnal survey visits are sufficient to reliably confirm the presence of the species at a given site.

These findings highlight the remarkable adaptability of alien species and in particular of *P. ridibundus* to urban and peri-urban environments, and suggest that wetlands located in suburban and urban contexts, particularly those characterized by dense aquatic vegetation, are especially vulnerable to invasion. Considering the potential ecological impacts of this species on native amphibian communities, e.g., competition for resources and genetic introgression, early detection and continuous monitoring are crucial.