

6.3 Lessons for management

Effective management of the American bullfrog invasion requires a multifaceted approach. In Uruguay, early-stage invasions present an opportunity for cost-effective management, with eradication being a plausible option if localized populations are targeted. The use of environmental DNA (eDNA) barcoding has proven to be a valuable tool for early detection of bullfrogs at low densities, surpassing traditional survey methods in sensitivity and reducing control costs (Dejean et al., 2012). In the Pacific Northwest, understanding the reproductive characteristics of bullfrogs can inform management actions, such as adjusting the definition of reproductively active adults to increase the target population for culling (Urbina et al., 2020). Additionally, prioritizing conservation areas based on vulnerability to bullfrog invasion, as demonstrated in Mexico, can help in allocating resources effectively to protect native species (López et al., 2017).

7 Conservation and Management Strategies

7.1 Habitat restoration approaches

Reconnecting fragmented landscapes is crucial for reducing the risks of amphibian invasions. Habitat fragmentation often leads to isolated populations, which can be more vulnerable to invasions by non-native species. By enhancing connectivity between habitats, such as through the conservation of ephemeral wetlands, the movement of native amphibians can be facilitated, thereby reducing the likelihood of invasive species establishing themselves (Allen et al., 2020). This approach not only aids in maintaining genetic diversity but also supports the resilience of native populations against invasive threats.

Strengthening the resilience of native species involves enhancing their ability to withstand environmental changes and competition from invasive species. This can be achieved by maintaining habitat quality and connectivity, which are essential for the survival and reproduction of native amphibians (Wright et al., 2020). Conservation efforts should focus on protecting core habitats and creating buffer zones that reduce the impact of invasive species. Additionally, promoting landscape heterogeneity through small-scale agriculture can support diverse amphibian communities and enhance their resilience (Brüning et al., 2018).

7.2 Invasive species control measures

Implementing early detection and rapid response strategies is vital for controlling invasive species. By monitoring amphibian populations and their habitats, conservationists can quickly identify and address new invasions before they become widespread. This proactive approach requires collaboration between researchers, land managers, and policymakers to ensure timely and effective interventions.

Control methods for invasive species include physical removal, biological control, and chemical treatments. Physical removal involves manually capturing and removing invasive species from critical habitats, while biological control uses natural predators or competitors to manage invasive populations (Scroggie et al., 2019). Chemical treatments, although effective, should be used cautiously to avoid harming native species and ecosystems (Hamer and McDonnell, 2008). A combination of these methods, tailored to specific contexts, can provide a comprehensive approach to managing invasive species.

7.3 Policy recommendations

Strengthening land-use planning is essential to limit habitat fragmentation and its associated risks. Policies should prioritize the conservation of large, contiguous habitats and the restoration of fragmented landscapes to maintain ecological connectivity (Teixido et al., 2021). Effective land-use planning can mitigate the impacts of urbanization and agriculture on amphibian habitats, thereby reducing the potential for invasions.

International cooperation is crucial for managing invasive species, as these challenges often transcend national borders. Collaborative efforts can facilitate the sharing of knowledge, resources, and strategies to address invasions more effectively (Marvier et al., 2004). By working together, countries can develop coordinated policies and actions that enhance the resilience of amphibian populations and their habitats on a global scale.