Action Plan for *Rhampholeon acuminatus*

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Background

The Nguru Spiny Pygmy Chameleon (*Rhampholeon acuminatus*) is one of smallest and most range-restricted chameleon species in Africa. It is entirely endemic to the Nguru Mountains, a part of the Eastern Arc Mountains in Morogoro Region, Tanzania. These mountains are recognized as a global biodiversity hotspot due to their exceptional levels of endemism and ecological uniqueness. The *R. acuminatus* is categorized by the IUCN Red List as Critically Endangered, occupies a habitat of less than 28 km² in total area. This habitat is characterized by tropical montane forest with dense canopy cover, moist leaf litter and a complex forest floor structure, all of which are essential for its survival. Despite its range falling partially within protected forest reserves, its survival is still at risk due to ongoing threats that disproportionately affect this forest-floor-dwelling species.

Unlike some arboreal chameleons that can survive in altered or fragmented forest habitats, *R. acuminatus* is highly sensitive to microhabitat changes. It relies on the intactness of the forest floor, which is increasingly disturbed by agricultural activities such as the cultivation of shade crops (e.g. cardamom), selective logging and illegal collection for the exotic pet trade. The removal of even small amounts of vegetation or leaf litter can render areas unsuitable for the species, making its conservation particularly challenging. Its cryptic coloration, small size and secretive behavior make it difficult to detect, which has historically hindered conservation efforts and ecological studies. However, recent interest in the Eastern Arc herpetofauna has brought renewed attention to the species, underscoring the need for targeted conservation planning, habitat protection and community engagement.

This action plan outlines a framework for ensuring the long-term survival of *Rhampholeon acuminatus* in the wild, integrating conservation strategies, community-based conservation, research priorities and sustainable financing mechanisms.

Distribution, Population Size and Trends

Rhampholeon acuminatus is endemic to the Nguru Mountains in Morogoro Region, Tanzania, where it inhabits the Mkingu Nature Forest Reserve (MNFR). The species has an extremely narrow geographic distribution, with an estimated extent of occurrence under 28 km². A comprehensive survey conducted from March to May 2023 within MNFR confirmed that the species is confined to a very limited elevational and ecological range within the montane and sub-montane forests.

During the field survey, a total of 57 individuals were observed across nine systematically selected plots spanning different elevations. Of these, 50 individuals were located in montane forest zones above 1400 meters above sea level, seven were in sub-montane zones (700-1400 m) and none were recorded in lowland forests (< 700 m). This indicates a clear ecological preference for cooler, more humid and densely vegetated montane environments. The lack of sightings in lowland areas suggests physiological and ecological intolerance to the warmer and drier conditions at lower elevations.

The population was composed of 34 males and 23 females, with a notable skew toward sub-adults (37 individuals), followed by adults (19) and only one juvenile. The limited number of juveniles observed raises concerns about reproductive success and recruitment rates, which could have long-term consequences for population viability. Trends over the past decade point to a continuous decline, driven by habitat degradation from activities such as cardamom and banana farming, which disturb the forest understory and leaf litter the primary habitat layer for this chameleon.

The survey also confirmed that areas with denser canopy cover, cooler air temperatures and higher humidity levels supported more individuals, highlighting the reliance of this species on stable microclimates. Given the small population size, fragmented distribution and ongoing anthropogenic pressures, the long-term survival of *R. acuminatus* is under considerable threat. Immediate conservation actions are needed to stabilize and restore the remaining suitable habitat, reduce further degradation and explore ex situ reinforcement options if necessary.

Habitat and Ecology

The *Rhampholeon acuminatus* inhabits tropical montane forest environments, with a clear preference for intact, moist leaf litter and dense canopy cover. Data collected from the Mkingu Nature Forest Reserve (MNFR) show that the species is more abundant in montane forest areas (above 1400 m elevation) characterized by cooler temperatures, higher humidity and complex vegetation structures. These environmental conditions support essential physiological functions and provide suitable microhabitats for foraging, thermoregulation and shelter. Field surveys conducted by the project team during the phase one (March to May 2023) revealed that *Rhampholeon acuminatus* is significantly associated with areas that have dense canopy cover and high humidity, while being negatively correlated with temperature and dense understory vegetation. The species was largely absent from lowland forests, where conditions were warmer and drier. Sub-montane forests hosted fewer individuals, suggesting a gradient of habitat suitability strongly influenced by elevation.

The presence of fewer juveniles compared to sub-adults and adults suggests potential reproductive or survival challenges in disturbed environments. Furthermore, the species' preference for specific microclimatic conditions underlines its vulnerability to even subtle changes in forest structure and quality, reinforcing the urgency for habitat protection and restoration.

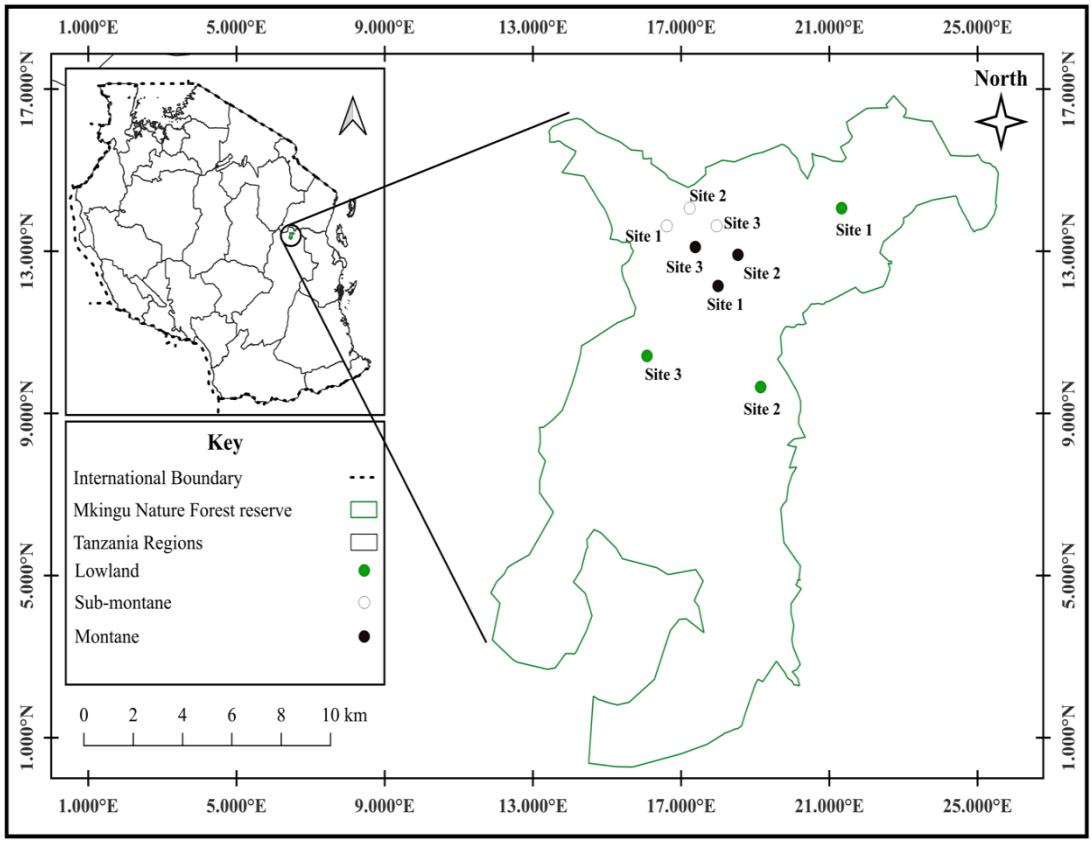

Figure 1: Map showing Mkingu Nature Forest Reserves with respect to the Eastern Arc Mountains, Tanzania with the 9 surveyed sites indicated as circles. Mon = Montane, Low = Lowland and Sub = Submontane.

Primary Threats

The survival of *Rhampholeon acuminatus* is critically threatened by a combination of anthropogenic activities that degrade and fragment its specialized montane forest habitat in the Nguru Mountains. Key threats include:

(i) Habitat degradation from shade crop cultivation such as cardamom, bananas and yams within the Mkingu Nature Forest Reserve (MNFR) is a major threat. These crops require partial forest clearing, especially of the understory vegetation, which directly disturbs the forest floor - the primary habitat of *R. acuminatus*. Cardamom farming, in particular, has rapidly expanded in the southern Nguru Mountains and the practice of removing leaf litter and ground vegetation creates unsuitable conditions for this leaf-litter-dwelling species.

(ii) The illegal collection of *Rhampholeon acuminatus* for the international pet trade poses a significant threat to its survival. Despite its Critically Endangered status, the species continues to be targeted and due to its restricted range and already small population, even minimal levels of harvesting can severely undermine population viability and erode genetic diversity.

(iii) Forest fragmentation and encroachment for human settlement and agricultural expansion around the forest edges contribute to further fragmentation of suitable habitats. This not only reduces the available habitat but also isolates populations, making them more vulnerable to stochastic events and reducing gene flow.

(iv) The species' strong dependence on cool, moist microclimates and intact leaf litter makes it particularly vulnerable to subtle habitat changes. Activities that alter canopy cover, increase ambient temperature, or reduce humidity (such as selective logging and unmanaged fire use) can render previously suitable habitat uninhabitable.

(v) Weak enforcement of protection measures despite the fact that the MNFR is legally protected, on-the-ground enforcement is often insufficient to prevent unauthorized farming, logging and species collection. The lack of consistent patrols and community-based surveillance allows threats to persist and intensify.

Conservation Actions

(a) Current protection

Rhampholeon acuminatus is found in Mkingu Nature Forest Reserve (MNFR), a protected area within the Nguru Mountains. Despite its official protection status, enforcement remains challeninging and illegal activities such as encroachment for shade crop cultivation and harvesting of forest products continue. The forest reserve lacks a comprehensive, species-specific management plan that addresses the microhabitat needs of this Critically Endangered chameleon.

(b) Recommended conservation measures

(i) Strengthening community forest management structures

- Establish or reinforce Village Forest Resource Committees (VFRCs) around the MNFR, with a focus on building institutional capacity, transparency and enforcement capability.
- Develop and formalize forest management bylaws in collaboration with community leaders to support sustainable use while protecting key habitat areas.
- Provide regular training for VFRC members on forest monitoring, biodiversity conservation and community-based enforcement.

(ii) Habitat protection and restoration

- Enforce a strict ban on shade crop cultivation (e.g. cardamom) in core areas known to harbor *R. acuminatus*.
- Implement habitat restoration activities, particularly in areas degraded by agriculture or understory clearing, with support from organizations such as PAMS Foundation.
- Prioritize montane forest zones for protection, as these host the highest densities of *R. acuminatus*.
- Map and establish microhabitat refugia to protect moist leaf litter and dense canopy areas critical for the species' survival.

(iii) Targeted law enforcement

- Collaborate with TFS and local law enforcement agencies to increase patrols in areas prone to illegal logging, poaching and encroachment.
- Monitor and prevent illegal capture and trade of *R. acuminatus*, particularly for the exotic pet market.
- Introduce penalties for violators and support anonymous community reporting systems for forest crimes.

(iv) Public awareness and conservation education

- Conduct structured awareness campaigns in local communities, schools and religious institutions to increase knowledge about the ecological importance and conservation status of *R. acuminatus*.

- Produce and distribute visual materials in Swahili that showcase the uniqueness of the chameleon and its threatened status.
- Engage local youth and schools in environmental education programs tied to forest conservation efforts.

(v) Sustainable livelihood alternatives

- Promote agroforestry and conservation agriculture outside forest core zones to reduce the need for further encroachment.
- Support the development of nature-based livelihoods (e.g. beekeeping, eco-tourism, NTFP collection) that are compatible with forest conservation goals.
- Explore payment for ecosystem services (PES) schemes or small grants to incentivize conservation behaviors among local stakeholders.

(vi) Monitoring and evaluation

- Design and implement a long-term monitoring program for *R. acuminatus* populations and habitat conditions using standardized transects and environmental metrics.
- Use satellite imagery (e.g. Global Forest Watch) to track deforestation and forest degradation trends.
- Establish a local biodiversity database to centralize observations, threats and habitat quality indicators for adaptive management.

(vii) Research and knowledge building

- Conduct genetic studies to assess the genetic diversity between isolated sub-populations and inform any future translocation or ex situ efforts.
- Research the species' reproductive ecology, juvenile survival rates and microhabitat thresholds to guide more tailored interventions.
- Investigate climate resilience measures that could buffer *R. acuminatus* habitats against future warming trends.

(viii) Collaboration and partnerships

- Facilitate a conservation coalition involving government bodies (e.g. TFS), NGOs (e.g. PAMS Foundation), researchers and local communities to coordinate conservation actions.
- Seek support from international partners and funding bodies such as the Mohamed bin Zayed Species Conservation Fund, the Rufford Foundation, IUCN Save Our Species and local grant-making institutions.

Knowledge Gaps

Despite recent advances in understanding the distribution and habitat preferences of *Rhampholeon acuminatus*, several critical knowledge gaps remain that hinder effective conservation planning for this species:

(i) While short-term surveys have documented presence and relative abundance in specific habitats, there is no long-term monitoring data to assess population trends, reproductive success or mortality rates over time. This limits the ability to detect declines early or to evaluate the effectiveness of conservation interventions.

(ii) The species is confined to fragmented habitats in the Nguru Mountains. However, the genetic connectivity between sub-populations within these patches is unknown. Without genetic assessments, it is unclear whether isolated populations are suffering from inbreeding depression or loss of adaptive potential.

(iii) Field surveys have shown a low number of juveniles, suggesting possible bottlenecks in recruitment. The reproductive behavior, clutch size, breeding seasonality and juvenile survival rates are not yet studied, making it difficult to determine the reproductive health of the population.

(iv) Although canopy cover, humidity and temperature are known to influence distribution, the specific thresholds and tolerance ranges for *R. acuminatus* are not quantified. More research is needed on how habitat variables—especially microclimate and leaf litter conditions—affect its physiology and behavior.

(v) Some evidence suggests that the species is being harvested for the pet trade, but the scale, frequency and pathways of this threat remain poorly documented. Understanding the impact of illegal collection on wild populations is essential for crafting targeted protection policies.

(vi) As a montane forest specialist, *R. acuminatus* is likely sensitive to climate variability. However, models predicting the impact of rising temperatures and shifting rainfall patterns on its habitat suitability are currently lacking.

Challenges and Obstacles

The conservation of *Rhampholeon acuminatus* in the Nguru Mountains faces several interlinked challenges that hinder the effectiveness of current and proposed interventions:

(i) Despite the formal protection of the Mkingu Nature Forest Reserve, there is ongoing encroachment for the cultivation of high-value shade crops such as cardamom, banana and cocoa. These crops often require the clearing of understory vegetation—the very microhabitat essential for *R. acuminatus*. Unlike large-scale deforestation, this type of encroachment is less visible but equally destructive to forest floor-dwelling species. Its subtlety makes it difficult to regulate and enforce against.

(ii) While the MNFR is legally protected, on-the-ground enforcement remains inadequate. Local forest rangers often lack the resources, training, or personnel to patrol large and rugged forest areas effectively. This has led to unmonitored human activities within the reserve boundaries, weakening the rule of law and undermining conservation regulations.

(iii) Many local communities are unaware of the conservation status of the *R. acuminatus* i.e. critically endangered or its ecological significance i.e. endemic in Nguru Mountains. The lack of targeted education campaigns means that behaviors harmful to the species, such as clearing leaf litter or collecting chameleons for trade, often occur without malicious intent. Without community buy-in and understanding, sustainable conservation becomes difficult to achieve.

(iv) *Rhampholeon acuminatus* is under threat from illegal collection for the exotic pet trade. Due to its rarity and unique appearance, it is highly sought after by collectors. Since its wild population is already small and localized, even low levels of extraction can lead to severe demographic impacts, potentially reducing genetic diversity and reproductive success.

(v) Conservation initiatives in the Nguru Mountains are chronically underfunded. There is insufficient financial support for establishing and sustaining village forest resource committees (VFRCs), conducting regular ecological monitoring, or restoring degraded habitats. Additionally, there is a shortage of trained personnel in ecological monitoring, species handling and habitat assessment specific to micro-endemic reptiles.

(vi) *Rhampholeon acuminatus* is highly sensitive to changes in temperature and humidity. With climate change altering montane forest microclimates, the narrow ecological tolerance of the species could become a limiting factor for its long-term survival. Habitat shifts may occur faster than the species' ability to adapt or migrate, especially given its limited dispersal capability.

(vii) The chameleon's known distribution is confined to small, fragmented patches within a highly heterogeneous forest landscape. This isolation reduces gene flow, increases vulnerability to stochastic events and complicates any efforts for potential translocation or population reinforcement without thorough genetic studies.

Budget and Funding Sources

The conservation of *Rhampholeon acuminatus* requires both immediate and sustained financial investment to address key threats, build local capacity and monitor ecological outcomes. An initial budget of USD 8300 (Project No. 222529461) and USD 4940 (Project No. 240533902) was secured from the Mohamed bin Zayed Species Conservation Fund to assess the species abundance, distribution, develop species action plan and provide conservation education to the communities around Nguru Mountains.

This foundational funding enabled:

- Data collection on population size and distribution
- Community meetings and preliminary awareness raising
- Data analysis and reporting to inform this action plan

To achieve the long-term goals of the action plan, additional funding is required to implement priority actions. An estimated supplementary budget of USD 25,000 is needed over a 12-month period, allocated as follows:

Activity	**Estimated Cost (USD)**
VFRC establishment and capacity building	3,000
Community sensitization and education programs	2,000
Habitat restoration and forest monitoring	15,000
Anti-poaching and trade surveillance measures	5,000
Total	**25,000**

Potential funding sources include:

- Mohamed bin Zayed Species Conservation Fund (for follow-up grants)
- Rufford Small Grants Foundation
- IUCN Save Our Species (SOS) Initiative
- Critical Ecosystem Partnership Fund (CEPF)
- Government of Tanzania (via Tanzania Forest Services)
- NGOs working in Eastern Arc biodiversity (e.g. PAMS Foundation, WWF)
- International herpetological societies and zoo conservation programs

A coordinated funding strategy is essential to scale up current efforts and ensure long-term viability of conservation interventions. Future proposals will emphasize multi-stakeholder collaboration and community co-management to increase fundability and sustainability.

Priority Actions

Objective 1: Safeguard and restore critical habitat in the Nguru Mountains

- Action 1.1: Establish and operationalize Village Forest Resource Committees (VFRCs) in all key forest-adjacent villages. These committees will be responsible for local enforcement, community sensitization and forest monitoring.
- Action 1.2: Implement participatory forest zoning and management plans that identify core conservation zones, buffer areas and permissible activity zones.
- Action 1.3: Launch habitat restoration programs in degraded patches of the Mkingu Nature Forest Reserve and adjacent village land, focusing on replanting native tree species and controlling invasive plants.

Objective 2: Reduce human-induced pressures on chameleon habitat

- Action 2.1: Promote agroecological practices outside core chameleon zones, such as agroforestry, conservation agriculture and soil erosion control to reduce the need for new farmland.
- Action 2.2: Introduce and support alternative livelihoods (e.g. eco-tourism, beekeeping, spice processing and non-timber forest product value chains) to shift dependence away from unsustainable practices like cardamom farming in forest understory.
- Action 2.3: Collaborate with local authorities to enforce restrictions on the cultivation of shade crops and illegal forest clearing inside MNFR.

Objective 3: Enhance species monitoring and ecological research

- Action 3.1: Establish a long-term population and habitat monitoring program using standardized protocols (e.g. transect surveys, camera traps and environmental data logging).
- Action 3.2: Conduct genetic studies to assess population structure and connectivity among isolated groups to inform potential supplementation or translocation.
- Action 3.3: Identify potential microrefugia and climate-resilient habitats within the Nguru Mountains for future conservation planning.

Objective 4: Address illegal pet trade threats

- Action 4.1: Strengthen patrols and develop a community-based alert system to monitor and report incidents of illegal collection.
- Action 4.2: Collaborate with wildlife authorities and customs agencies to improve surveillance and enforce national and international trade restrictions under CITES.
- Action 4.3: Launch public awareness campaigns targeting both local communities and exotic pet consumers to reduce demand and promote conservation.

Objective 5: Build community capacity and awareness

- Action 5.1: Integrate chameleon conservation into local school curricula and environmental clubs to raise awareness among youth.
- Action 5.2: Organize regular village workshops involving elders, religious leaders and farmers to foster stewardship of the forest.

- Action 5.3: Develop and distribute educational materials (e.g. posters, storybooks, local radio programs) highlighting the uniqueness and vulnerability of *Rhampholeon acuminatus*.

Objective 6: Promote stakeholder collaboration and policy support

- Action 6.1: Form a multi-stakeholder conservation taskforce involving TFS, NGOs, researchers and community representatives to coordinate conservation actions.
- Action 6.2: Advocate for the formal integration of *Rhampholeon acuminatus* conservation needs into national and district-level forest management and land-use planning frameworks.
- Action 6.3: Pursue funding opportunities from international donors and conservation funds to implement and sustain the action plan.

Figure 2: Illegal farms in Nguru Mountains

Education and Awareness

Education and public awareness are vital components of the long-term conservation strategy for *Rhampholeon acuminatus*. Despite its Critically Endangered status and ecological uniqueness, the species remains relatively unknown to many local communities and stakeholders in the Nguru Mountains. Targeted educational efforts are needed to bridge this knowledge gap and foster a conservation ethic that can support habitat protection and reduce harmful activities such as forest floor disturbance and illegal collection for the pet trade.

Key strategies include:

(i) Develop a curriculum-integrated conservation education program focused on endemic species of the Nguru Mountains, especially *Rhampholeon acuminatus*. School-based activities may include nature clubs, storytelling sessions, biodiversity-themed art competitions and guided forest visits. Teachers who participated in earlier workshops have expressed interest and can serve as ambassadors for these programs.

(ii) Conduct regular awareness meetings with farmers, traditional leaders, women's groups and youth associations to discuss the importance of conserving forest microhabitats. These meetings should emphasize the uniqueness of *Rhampholeon acuminatus*, its ecological role and the broader benefits of maintaining healthy montane forests (e.g. water catchment, climate regulation).

(iii) Produce and distribute posters, brochures and fact sheets in Kiswahili highlighting the biology, status and threats facing the species. These materials should be visually engaging and include messages that link species conservation with local well-being and cultural pride.

(iv) Collaborate with local radio stations and community theatre groups to disseminate conservation messages about *Rhampholeon acuminatus* through storytelling, skits and interviews. Traditional music and drama can be particularly effective in reaching a wide audience.

(v) Install interpretive signage at entry points to the Mkingu Nature Forest Reserve and other key forest access areas. These signs should explain the importance of forest floor integrity and discourage activities that degrade the chameleon's microhabitat.

(vi) Train selected village leaders, forest scouts and community-based organizations to serve as "conservation champions" who will help monitor and promote adherence to conservation-friendly practices, report illegal activities and guide visitors in responsible forest use.

Exit Strategy

The long-term goal of this action plan is to establish a self-sustaining conservation framework that ensures the continued survival of *Rhampholeon acuminatus* without external intervention. The exit strategy is centered around building institutional, community and ecological resilience to maintain conservation gains over time.

(i) Triggers for exit

The phasing out of intensive conservation interventions will be considered once the following conditions are met:

- Functional Village Forest Resource Committees (VFRCs) are established, fully trained and operational in managing and protecting critical habitats.
- There is demonstrable and sustained reduction in habitat degradation and illegal activities (e.g., encroachment and poaching), verified through satellite imagery and ground surveys.
- A community-based monitoring system is active, with local stakeholders regularly tracking the status of the species and habitat health.
- Alternative livelihoods are in place and contributing to a measurable decrease in forest dependency among local communities.

(ii) Management of captive individuals (if any)

If an ex situ component is initiated, the captive population will be transitioned to long-term care either through government facilities, partner NGOs, or international institutions with expertise in chameleon husbandry. Genetic and health data will be used to assess the feasibility of potential reintroductions or population supplementation.

(iii) Monitoring after exit

Even after the withdrawal of direct interventions, monitoring will continue through:

- Annual community-led habitat and population assessments using simple, standardized tools.
- Periodic external audits (every 3–5 years) to verify conservation outcomes and recommend adaptive strategies if necessary.
- Remote sensing (e.g., Global Forest Watch) to track forest cover trends.

(iv) Sustaining conservation gains

To ensure long-term sustainability, the exit strategy includes:

- Embedding conservation priorities in district land-use planning and policy frameworks.
- Establishing trust funds or benefit-sharing mechanisms from income generating activities, eco-tourism, carbon projects etc to finance forest protection.
- Integrating conservation education into local school curricula to support continued community interest.

This phased and criteria-based exit strategy ensures that conservation actions transition from externally driven to locally owned, enhancing the long-term protection of *Rhampholeon acuminatus* and its habitat.