Conservation Challenges and Management Actions for the Freshwater Crab *Barytelphusa cunicularis* in a Small Constructed Pond: Implications for Ex-Situ Conservation

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Abstract
Barytelphusa cunicularis is an ecologically significant species that inhabits freshwater and moist environments. Small constructed ponds may suit ex situ conservation of this species; however, their limited size may pose challenges for water quality, temperature fluctuations, food availability, predation, burrowing, and population density. This paper will analyse the challenges of assessing major threats and developing management strategies for B. cunicularis in a small constructed pond. We will examine population density, survival rate, growth, molting, breeding, burrowing, and water quality. We will discuss habitat enrichment methods, including appropriate substrates, shelters, vegetation, and artificial feeding, to conserve this species. This study aims to develop a simple, low-cost management approach to maintain viable crab populations under ex situ conditions and provide a practical framework for freshwater crab conservation and sustainable culture.
Keywords: *Barytelphusa cunicularis, freshwater crab, constructed pond, ex-situ conservation, habitat management, survival*

Introduction

Freshwater crabs are important components of freshwater ecosystems and contribute to aquatic food webs, organic-matter processing, sediment bioturbation, and nutrient cycling. Freshwater crab diversity is particularly high in tropical regions, where many species have restricted geographical distributions and specialized habitat requirements (Yeo et al., 2008). Their limited dispersal ability, direct development, and dependence on freshwater habitats make many freshwater crab populations vulnerable to environmental change and habitat fragmentation (Cumberlidge et al., 2009). A global assessment indicated that many freshwater crab species face elevated extinction risk, with habitat destruction, drainage-system alteration, pollution, and other anthropogenic disturbances identified as major threats (Cumberlidge et al., 2009).

Barytelphusa cunicularis (Westwood, 1836) is an Indian freshwater crab associated with freshwater and moist terrestrial habitats. The species exhibits a distinct burrowing habit, and the distribution of its burrows varies seasonally with environmental conditions. Sinha and Pati (2008) investigated the spatial and temporal distribution of *B. cunicularis* burrows and demonstrated that burrow characteristics and their distribution are important components of the species' ecology. Such burrows may provide protection and suitable microhabitats during periods of environmental fluctuation, emphasizing the importance of maintaining appropriate substrate and shelter in managed habitats.

Burrowing activity can also influence ecosystem processes. Burrowing crabs are considered ecosystem engineers because their excavation and sediment displacement modify the physical environment. Jones et al. (1994) established the ecosystem-engineering concept for organisms that directly modify habitat structure, while Kristensen (2008) demonstrated the importance of crab burrowing in sediment modification and biogeochemical processes. More recently, Rinehart et al. (2024) showed through a systematic meta-analysis that burrowing crabs can rework and oxygenate sediments and influence nutrient cycling, although the magnitude of these effects depends on crab traits and environmental conditions.

Freshwater ecosystems are increasingly exposed to habitat modification, pollution, water extraction, hydrological alteration and other anthropogenic pressures. These changes can reduce suitable feeding, shelter, and breeding habitats and may isolate crab populations. Cumberlidge et al. (2009) emphasized that conservation measures for freshwater crabs need to be implemented before populations decline to levels from which recovery becomes difficult. Consequently, conservation of *B. cunicularis* requires both protection of natural habitats and development of supplementary conservation approaches.

Ex-situ conservation can provide controlled or semi-natural conditions for maintaining viable populations and for investigating species-specific requirements. Such approaches are

particularly useful for studying survival, growth, moulting, feeding, behaviour and reproduction under controlled management. A small constructed pond can provide a semi-natural habitat when suitable substrate, water quality, shelter, food availability and population density are maintained. Importantly, constructed habitats can permit regular monitoring of population condition and natural behaviours such as burrowing while reducing some of the pressures experienced in degraded natural habitats.

Therefore, evaluating management effectiveness in a constructed pond is important for developing practical conservation protocols for *B. cunicularis*. The present study investigates the conservation challenges and management actions for *B. cunicularis* in a small constructed pond, with particular emphasis on survival, mortality, active burrowing, growth, moulting, and reproductive performance. The study further evaluates the potential of a managed constructed pond as a practical supplementary system for the ex-situ conservation and long-term maintenance of *B. cunicularis*.

2. Materials and Methods

2.1 Study Area and Experimental Setup

The study was conducted in a small constructed freshwater pond maintained for the ex-situ conservation of *Barytelphusa cunicularis* (Westwood, 1836). The pond was prepared with a muddy substrate, stones, and suitable shelters to provide conditions for burrowing, feeding, and moulting. Twenty healthy crabs were introduced and allowed to acclimatize before observations began.

The experiment consisted of a pre-management assessment followed by a 90-day post-management monitoring period. Based on baseline observations, management measures including improvement of shelter and substrate, removal of organic waste, regulated feeding and maintenance of suitable water quality were implemented. Crab survival, mortality, active burrows, feeding, moulting and general health were recorded at 30-day intervals. Water-quality and habitat conditions were monitored throughout the study to evaluate the effectiveness of management measures for ex-situ maintenance of the species.

2.2 Crab Population and Monitoring

A population of healthy *Barytelphusa cunicularis* individuals was maintained in the constructed pond and monitored throughout the study period. Crabs were observed at regular intervals, particularly during morning and evening hours. The number of live and dead individuals, sex, body weight, carapace length, and carapace width were recorded periodically. General health, feeding activity, burrowing behaviour, moulting, injuries and abnormal behaviour were also documented. Mortality and survival were recorded throughout the study, and the survival rate was calculated from the initial and final population. All observations were made with minimum disturbance to the crabs, and individuals were returned to their respective habitats after measurements.

2.3 Monitoring of Survival and Mortality

The crab population was monitored at regular observation intervals. The numbers of live and dead crabs were recorded.

Survival percentage was calculated as:

$$\text{Survival (\%)} = \frac{\text{Number of live crabs}}{\text{Initial number of crabs}} \times 100$$

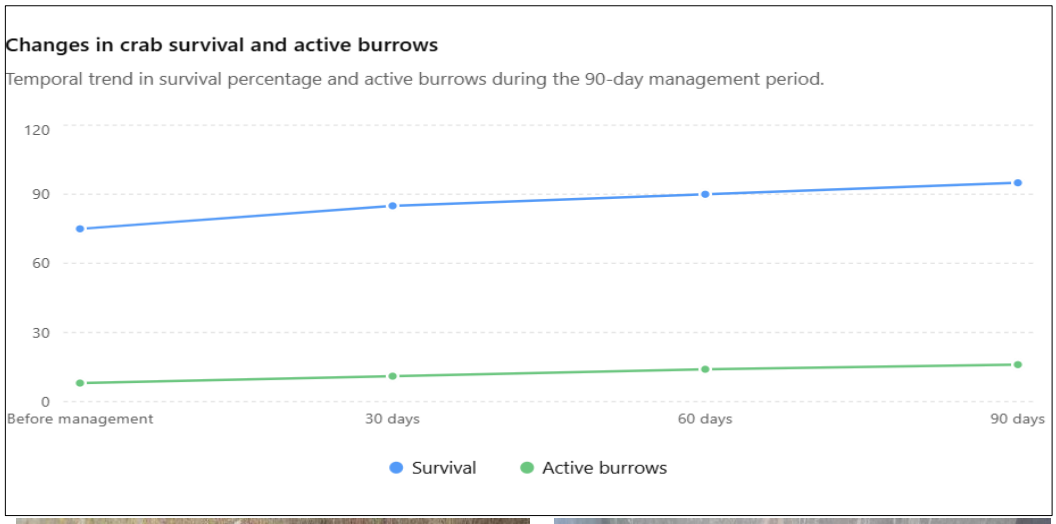
Mortality percentage was calculated as:

$$\text{Mortality (\%)} = \frac{\text{Number of live crabs}}{\text{Initial number of crabs}} \times 100$$

3. Results & Observations:

Table 1. Observation of crab population before and after management

Observation period	Initial crabs	Live crabs	Dead crabs	Survival (%)	Mortality (%)	Active burrows
Before management	20	15	5	75.0	25.0	8
After 30 days	20	17	3	85.0	15.0	11
After 60 days	20	18	2	90.0	10.0	14
After 90 days	20	19	1	95.0	5.0	16





a) Small constructed pond



b) Showing habitat provided



c) Active burrows



d) Successful molting of crab

Discussion:

The present study indicates that appropriate habitat management can improve the survival and habitat use of *Barytelphusa cunicularis* in a small constructed pond. Survival increased from 75.0% before management to 95.0% after 90 days, while mortality declined from 25.0% to 5.0%. During the same period, active burrows increased from 8 to 17, suggesting improved habitat suitability and greater expression of natural burrowing behaviour.

Burrowing is an important behavioural adaptation in freshwater crabs, providing shelter from predators, environmental fluctuations, and physical disturbance. Jones et al. (1994) described burrowing organisms as ecosystem engineers because their activities modify the physical characteristics of their habitats. Similarly, *Kristensen* (2008) reported that crab burrowing can alter sediment structure, aeration, and nutrient processes. The increasing number of active

burrows observed in the present study therefore suggests that habitat complexity may have contributed to improved crab survival.

The decline in mortality following management indicates that providing suitable substrate, shelter, and favourable environmental conditions can reduce stress and improve persistence in captivity. Freshwater crabs are increasingly threatened by habitat degradation, pollution, and alteration of freshwater ecosystems (*Cumberlidge et al.,* 2009). Therefore, small constructed ponds with appropriate habitat conditions may provide useful supplementary refuges for maintaining local crab populations.

The increase in active burrows from 8 to 17 represents a 112.5% increase, indicating progressive utilization of the managed habitat. However, burrow number should be considered an indicator of habitat use rather than a direct measure of population size, because individual crabs may construct, modify, or abandon burrows.

Overall, the findings suggest that habitat-oriented management can improve survival, reduce mortality and promote natural burrowing activity in *B. cunicularis*. Small constructed ponds may therefore serve as practical ex-situ conservation units, particularly when they provide suitable substrate, shelter, water quality and adequate space. Long-term studies incorporating growth, molting, reproduction, water quality and population recruitment are recommended to evaluate the sustainability of this conservation approach.

Conclusion

The present study demonstrates that appropriate management of a small constructed pond can improve the survival and habitat utilization of *Barytelphusa cunicularis*. Improvements in habitat conditions were associated with increased crab survival and active burrow formation during the study period. These findings suggest that well-managed constructed ponds can serve as useful **ex-situ conservation units** for freshwater crabs. Regular monitoring, maintenance of suitable water quality, provision of shelter and substrate, and protection from disturbances are essential for successful long-term conservation and captive maintenance of *B. cunicularis*.

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