



Original Research Paper

Microhabitat Preferences and Survival Rates of Amphibians in Artificially Restored Wetlands in Subtropical Zones

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Key Words	Abstract
Amphibians, Restored wetlands, Microhabitat preference, Survival rate, Subtropical zones, Habitat restoration, Wetland conservation.	Conservation habitats in artificially restored wetlands are vital for amphibians' survival in subtropical regions since natural wetlands experience various anthropogenic threats such as deforestation, pollution, drainage, and climate variability. Therefore, the present research will examine the amphibians' habitat choice and survival rates within restored wetlands. The study considered five major microhabitats: emergent vegetation, shallow waters, shaded edges, muddy banks, and open water. The abundance, stages of development, distribution, and mortality of amphibians in the mentioned habitats were identified based on direct observations, visual surveys, call surveys, and repeated sampling. It is evident that the amphibian populations were more numerous in the emergent vegetation and shallow water because these habitats could provide suitable conditions for breeding, humidity, shelters, prey organisms, and protection against predators. Emergent vegetation demonstrated the highest percentage of survival among the examined microhabitats, which was equal to 88%. Shallow waters and shaded edges had relatively high survival rates of 82% and 79%, respectively. At the same time, the lowest survival rate of amphibians was identified within open water patches, and it was equal to 61%. Thus, it becomes clear that artificial wetlands require not only water restoration but also the creation of multiple microhabitats.

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Introduction

Natural wetlands serve as some of the best habitats for amphibians in terms of offering appropriate breeding grounds, prey abundance, cover from predators, and sufficient moisture levels. In subtropical areas, however, natural wetlands have been affected by various anthropogenic activities such as agricultural expansion, drainage, pollution, development, and climate variability (Veerappan, 2024). Such disturbances have negatively impacted many amphibian populations through habitat degradation, poor breeding, and high mortality rates (Matthews & Popovich, 2025). Artificially created wetlands have emerged as a useful means of restoring degraded habitats and saving amphibian diversity (Christen et al., 2022; Shrirao & Mishra, 2025).

Amphibians exhibit considerable sensitivity to small-scale habitat features such as water depth, vegetation cover, soil moisture, canopy cover, temperature, and refuges. Microhabitat factors play a major role in the breeding, larval development, antipredatory behaviors, movement patterns, and survival rates of amphibians (Alias et al., 2022). Hence, knowledge of microhabitat preferences is fundamental to determining the suitability of restored wetlands as amphibian habitats.

The objective of this research is to investigate the connection between microhabitat traits and amphibian survival rates in artificially constructed wetlands within the subtropical ecosystem (Dixit & Raje, 2024). In particular, the study considers how amphibians utilize shallow water habitats, emergent plants, mud banks,

shaded habitats, and areas of open water. Furthermore, this research aims to find out whether there is a link between preferred microhabitats and higher survival rates of amphibians.

Key Contributions

- Identification of key characteristics of microhabitats affecting the distribution of amphibians in artificial wetlands.
- A comparison of survival rates of amphibian species in varying microhabitats of artificial wetlands.
- Practical suggestions for improving amphibian habitat through better restoration practices.

The second II includes a literature review on past studies about amphibians, microhabitat selection criteria, survival parameters, and restoration issues. Section III describes details about the study area, sampling procedure, microhabitat selection and evaluation, and survival rate determination. Section IV analyzes the results obtained in relation to the distribution of amphibians, variations in their survival rates, and the relationship between microhabitat and survival rate. Section V concludes the study.

Literature Review

Amphibians and Wetland Ecosystems

Amphibians are intimately related to wetlands due to their need for an environment where breeding, oviposition, larval development, feeding, and protection against dehydration occur. Wetlands provide shallow water, muddy banks, vegetated patches, shaded edges, and

aquatic vegetation for various amphibian activities. In sub-tropical environments, rainfall, relative humidity, and variations in temperature play critical roles in amphibian activity, vocalizing, breeding, and survival. Consequently, amphibians are excellent biological indicators of wetland ecosystem integrity and health (Kavitha, 2024).

Restored wetlands represent areas where habitats that have been affected by drainage, agricultural practices, urban sprawl, and changes in land use are recreated (Wang et al., 2024; Varela & Drexler, 2021). Restoration projects are generally based on the presence of water and vegetation. However, amphibian habitat requirements include appropriate microhabitats, such as moist conditions, refugia, and sufficient food availability (Wenner et al., 2025). A restored wetland might appear healthy, but inadequate microhabitat quality can affect amphibian survival rates (Oro et al., 2024).

Microhabitat Preferences of Amphibians

Microhabitat preference can be understood as the selection of certain microhabitats in the wetland. Amphibians choose specific areas depending upon factors like water depth, coverage by plants, soil moisture content, shade, soil type, food availability, and refuge. The shallow parts of the pond are chosen for laying eggs and nurturing tadpoles since they are easily reachable and warm in temperature. Thick vegetation is preferred for providing shelter, for mating purposes, food sources, and protection from direct sunrays. Amphibians need muddy banks and moist edges for moving between aquatic and terrestrial areas.

Amphibians prefer shaded edges to minimize stress and water loss from their body. Refuge areas such as leaves, rocks, root areas, logs, and clumps of plants can aid amphibians in avoiding predators. Open pools of water can help certain amphibians with movement and breeding. However, they will be easy prey for predators in such open pools. Since amphibians lack protective covering and are sensitive to moisture levels, microhabitat preferences play a crucial role in their survival. Hence, restoration projects need to restore various microhabitats.

Survival Rates in Restored Wetlands

Amphibian survival in restored wetlands will depend upon factors like hydroperiod, predation stress, water quality, temperature, food availability, and breeding habitat quality. Hydroperiod is critical for amphibians since their eggs and tadpoles require sufficient time to develop. Early drying out of wetlands will lead to high larval mortality rates, whereas persistent deep water may favor fish and other predatory species (Bolte et al., 2026).

A dense vegetation cover and moist refuges will increase survival rates due to reduced vulnerability to heat stress, desiccation, and predation. Water pollution from agricultural areas and adjacent human settlements will influence growth, immune system functioning, and reproductive potential. Larvae may use algae, organic material, and small invertebrates as food sources. Hence, survival depends not only on the wetland area itself but also on its microhabitat quality.

Research Gap

Studies undertaken before concentrated primarily on amphibian species richness, biodiversity, vocalizations, and population presence in wetlands. Nevertheless, the presence of amphibians in a wetland does not guarantee survival or even population increase. A species may inhabit the wetland in question, but eggs, larvae, and juveniles might die due to unsatisfactory conditions at the microhabitat level.

There are very few studies dealing with the connection between microhabitat preferences and survival rates in artificially restored subtropical wetlands. Restoration studies usually focus on structural characteristics of a wetland without highlighting which specific microhabitats contribute to the survival of amphibians in these ecosystems. The present study intends to fill in this knowledge gap by examining the distribution of amphibians in microhabitats and comparing survival rates for different species.

Methods

Study Area

The experiment took place in a number of artificially rehabilitated wetlands that have been selected from subtropical regions, where rainfall, warmth, and humid climate facilitate amphibian reproduction and migration. The wetlands contained shallow pools, swampy zones, zones with emergent vegetation, muddy banks, zones of open water, and shade areas. These areas were chosen since they reflected artificial wetland rehabilitation conditions, which are aimed at

enhancing the quality of the habitat for amphibians and other animals that depend on wetlands.

Wetlands were classified based on various characteristics such as water depth, vegetation cover, soil moisture, shade, and refuge availability. Shallow water, vegetation zones, muddy banks, zones with shade, open water pools, and refugia were taken as major categories of microhabitats.

Amphibian Survey

The amphibian survey was done using the visual encounter method, night survey, calling survey, and larva sampling. Amphibian surveying was done during evenings and nights since amphibians are most active when there is a higher moisture content and dim light in the environment. Every microhabitat zone was searched for the presence of eggs, larvae, juvenile stages, and mature amphibians.

Amphibians were identified by physical appearance, coloration, calls, and the location of their habitat. The number of individuals in every microhabitat was recorded independently. Repeated surveys were made to reduce errors in observation and track changes in amphibian populations over time.

Microhabitat Data Collection

The microhabitat parameters were noted at each location where amphibians were sighted. Some of the parameters considered were the depth of water, vegetation cover, moisture in soil, amount of shade from canopy cover, substrate type, water temperature, humidity, and availability of shelters. Vegetation cover was

noted as low, moderate, or high depending on the abundance of both the aquatic and emergent plants. The depth of water varied between shallow, moderate, and deep parts of the wetlands.

Availability of shelter depended on factors like the availability of leaf litter, rocks, tree roots, logs, bunches of grass, and cover by plants. This was crucial since it provided protection for the amphibians against predators, high temperatures, and excessive water evaporation.

Survival Rate Monitoring

Survival rates were measured through observation of eggs, tadpoles, juveniles, and adults within different microhabitats. Egg masses and tadpole groups were recorded initially and then again at intervals.

Survival was measured based on the ratio of the total number of survivors in relation to the total initially counted in the microhabitat.

$$\text{Survival Rate (\%)} = \frac{\text{Number of surviving individuals}}{\text{Initial number of recorded individuals}} \times 100 \quad (1)$$

Equation 1 presents a comparison of survival rates depending on different microhabitat types and species groups. High survival rates meant good habitat suitability, whereas low ones meant potential stressors such as predation, drying, lack of proper refuge, or poor water quality.

Data Analysis

The data gathered was subjected to statistical description and comparative analysis. The abundance of amphibians was compared to find preferred habitat areas. Then, survival rates were calculated depending on microhabitat and

species groups. Percentage values were utilized to determine differences in distribution and survival rates.

Correlation analysis was employed to analyze the correlation between microhabitat parameters and survival rates. For instance, vegetation cover, shallow water, shade, and refuge availability were correlated with survival percentage rates to find out what kind of microhabitat contributed to better survival rates in wetland restoration sites.

Results

Amphibian Distribution across Microhabitats

As seen in the survey, amphibians did not distribute themselves uniformly within the restored wetland microhabitats. High abundance of amphibians was noted within emergent vegetation and shallow water areas, while low abundance was noted in open water. Emergent vegetation had high use by amphibians due to the provision of shelters, food sources, calling sites, and shade from harsh sunlight. Shallow water areas were also preferred since they offered habitats during breeding and the initial development of amphibian larvae.

Muddy banks and shaded margins were mostly utilized by juvenile and adult amphibians for movement, resting, and the prevention of moisture loss. Open water areas were utilized by amphibians least of all due to a lack of cover and predator exposure. From these results, it is clear that restored wetlands with varying microhabitats can serve well as habitats for amphibians.

Table 1: Amphibian Distribution across Restored Wetland Microhabitats

Microhabitat Type	Main Life Stage Observed	Relative Abundance (%)	Habitat Use Pattern
Emergent vegetation	Eggs, tadpoles, adults	32	High breeding and shelter use
Shallow water zones	Eggs and tadpoles	27	High larval development use
Shaded edges	Juveniles and adults	18	Resting and moisture protection
Muddy banks	Juveniles and adults	15	Movement and refuge use
Open water patches	Tadpoles and adults	8	Low cover and high exposure

According to table 1, areas with emergent vegetation and shallow water had the greatest number of amphibians. This implies that vegetation cover and depth of water are essential microhabitat attributes that influence the distribution of amphibians within restored wetlands.

Survival Rates among Microhabitats

Amphibian survival differed based on the type of microhabitat, as demonstrated in figure 1. Amphibian survival was highest in emergent

vegetation, with a success rate of 88%, then in shallow water, with a survival rate of 82%, and in shady habitat, with a survival rate of 79%. Muddy habitat presented a relatively moderate rate of survival, 74%, while survival in open water was the least, with only a 61% survival rate. This could be attributed to a lack of cover and exposure to temperature changes.

From these findings, it is clear that amphibian survival depends largely on the suitability of the microhabitat conditions.

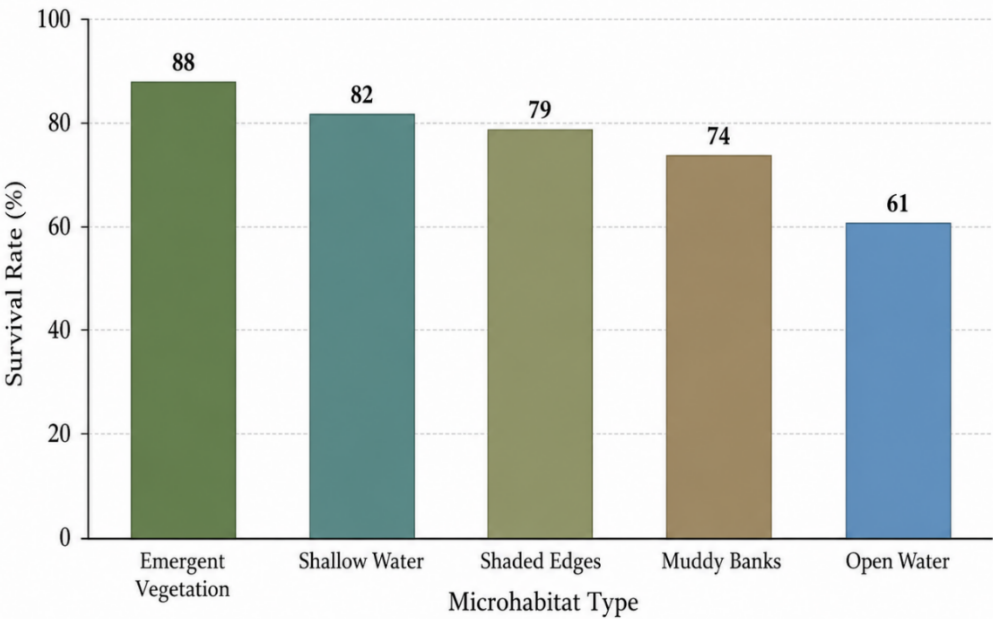


Figure 1: Survival Rate Of Amphibians Across Different Microhabitats

Species-Wise Survival Rate Comparison

Amphibians of different types exhibited differences in survival rates depending on their habitat requirements. The tree frogs exhibited better survival rates in emergent vegetation and shaded fringes because such microhabitats

offered vertical vegetation and moist surfaces to rest on. The pond frogs displayed better survival rates in shallow waters since they could breed and develop their tadpoles in such habitats. The toads had medium survival rates in the muddy banks and shaded fringes because they used such places for movement.

Table 2: Species-Wise Survival Rates in Restored Wetlands

Amphibian Group	Preferred Microhabitat	Survival Rate (%)	Main Survival Support
Tree frogs	Emergent vegetation and shaded edges	86	Moist vegetation and shelter
Pond frogs	Shallow water zones	83	Breeding and larval growth
Toads	Muddy banks and shaded margins	76	Moist soil and refuge sites
Marsh frogs	Dense vegetation and shallow pools	81	Cover and stable water
Open-water users	Open water patches	63	Movement space but low cover

According to table 2, amphibian assemblages in vegetation-dominated and shallow water areas survived better compared to those that mainly relied on open water areas. It shows that habitat complexity leads to increased survival in restored wetlands.

Microhabitat Preference and Survival Relationship

The results revealed a positive correlation between microhabitat preference and survival rate. Microhabitats that have dense vegetation, good water depth, a shaded environment, and shelters helped increase both abundance and survival rate. Emergent vegetation proved to be the microhabitat with the highest relative abundance and survival. It means that amphibians prefer microhabitats that improve

breeding chances and help protect their population.

Open water areas had low abundance and survival rates since they lacked the shelter required by amphibians. The research reveals that microhabitat preference plays a significant role in increasing survival. Therefore, restored wetlands should have a mix of vegetation, shallow waters, shaded areas, and moist banks for successful population recovery.

Discussion

The findings show that amphibian survival in artificially restored wetlands is strongly linked with microhabitat quality. Emergent vegetation and shallow water zones supported the highest amphibian abundance and survival rates because these habitats provided breeding space, shelter, food resources, and protection from predators.

The high survival rate in emergent vegetation indicates that plant cover plays an important role in reducing environmental stress and supporting different life stages of amphibians. Shallow water zones were also important because eggs and tadpoles require stable and accessible aquatic conditions for development.

The presence of shady margins and muddy banks played a role in increasing the chance of survival for amphibians, which offered cool resting places and paths between land and water. This was particularly beneficial for young amphibians and adults, who were able to avoid heat and dehydration thanks to this feature. Conversely, the highest mortality rate was found in open water, as there was little hiding from predators present in these areas. Therefore, restoring wetlands with only open water patches will prove insufficient for amphibian conservation.

From the study, we learned that when undertaking wetland restorations, it is important to provide multiple elements in order to improve the chances of success. The elements which need to be included are shallow ponds, emergent vegetation, shady margins, muddy banks, and structures such as piles of leaves, stones, logs, and other types of refuge and food sources for amphibians. It is no longer sufficient to measure the success of a project by only considering its area or the amount of water present.

Some limitations of this study can be noted as well. There might be differences related to season, rain levels, the age of the wetland itself, predators, and other environmental factors such as the land use around it. Seasonal studies over

an extended period of time, analyses of water quality, predator studies, and comparisons between artificial and natural wetlands are necessary in future research.

Conclusion

This study illustrates that microhabitat conditions are crucial for the presence and viability of amphibians in restored wetlands in the subtropical region. The reason behind amphibians preferring emergent vegetation, shallow water zones, shaded edges, and muddy banks was that such habitats offered breeding grounds, moisture, protection, food availability, and defense against predators. Of all the microhabitats considered in this research, the emergent vegetation habitat exhibited the highest survival rate, while the shallow water and shaded edge habitats were secondary in terms of amphibian survival. In comparison, the amphibian population was less in open water patches because of the lack of cover. The study reveals that wetland restoration should not just involve the restoration of water pools. Microhabitats with diversity in structure that cater to all life stages of amphibians must be present for their successful conservation. Restoration schemes could have features like shallow ponds, thick aquatic plants, moist edges, shady edges, and natural refuge elements like wood, leaf litter, rocks, and root cavities. The above characteristics have the potential to increase breeding success, larval development, juvenile recruitment, and ultimately the survival of amphibian species. More research is required to conduct season-long investigations, evaluate water quality parameters, analyze predation

impact, and contrast restored wetlands against natural habitats. Such studies will give more credence to improving wetland restoration theory and models. In general, knowledge of the microhabitat needs of amphibians is important in designing restored wetlands that serve as successful conservation habitats.

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