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Guardians of the Forest Floor: Learning Conservation from the Asian Forest Tortoise (*Manouria emys*)

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SYNOPSIS

Deep within the tropical forests of Southeast Asia, the Asian forest tortoise (*Manouria emys*) moves with the quiet memory of millions of years. Yet today, its path is threatened by deforestation, illegal trade, and a warming climate. In Bengkulu, Indonesia, the University of Bengkulu's ex-situ program has successfully increased the survival and breeding success of rescued tortoises, providing controlled habitats where health, behavior, and reproduction can be monitored. Supported by collaboration with the University of North Carolina Greensboro, the program rehabilitates confiscated individuals and prepares them for long-term population recovery. Beyond protecting a species, this initiative transforms conservation into education, where the tortoise becomes a living teacher of patience, empathy, and coexistence.

INTRODUCTION

The Ancient Guardian Under Threat

The Asian forest tortoise (*Manouria emys*), also known in Indonesia as kura-kura baning coklat, is the largest terrestrial tortoise in Southeast Asia and one of the region's most ancient reptiles. Once abundant across tropical forests from Myanmar to Sumatra, this species now faces a perilous decline. It is currently listed as Critically Endangered by the International Union for Conservation of Nature (IUCN), with populations estimated to have dropped by as much as 80% over the last three generations due to illegal trade and habitat loss. Expanding agriculture, deforestation, and wildlife trafficking have pushed *M. emys* to the brink of extinction, making conservation efforts both urgent and complex.

In Indonesia, the University of Bengkulu has emerged as a pioneering institution addressing these challenges through innovative ex-situ conservation. Its program is built on three pillars: (1) animal care and breeding, (2) international collaboration, and (3) community-based education. Within the university's captive facilities, individuals of *M. emys* are monitored for growth, behavior, and reproductive success. Although advanced genetic studies have yet to be fully implemented, the initiative has already shown promising outcomes, particularly in improving breeding success and maintaining population stability.

A crucial factor supporting this progress is the university's partnership with the University of North Carolina at Greensboro (UNCG). This collaboration strengthens technical capacity in animal health management, husbandry, and monitoring, illustrating how scientific exchange can elevate conservation practice.



Figure 1 *Manouria emys* at The University of Bengkulu (UNIB)
Source: Turtle Learning Center (TLC) University of Bengkulu, 2025.

Yet the fight against illegal trade remains formidable. Between 2000 and 2015, CITES recorded more than 500 *M. emys* individuals seized from illegal markets, many originating from Sumatra. In response, the University of Bengkulu has expanded its role beyond the laboratory, engaging local communities through environmental education and legal awareness programs. These efforts reflect a broader transformation: from species protection to integrated conservation learning, where research, education, and advocacy merge to safeguard one of Southeast Asia's last living forest guardians. This article highlights how Bengkulu's ex-situ program, supported by international collaboration and community engagement, provides a practical and educational pathway for sustaining the future of *Manouria emys*.



ARTICLE CONTENT

Ex-Situ Conservation: A Beacon from Bengkulu

In Bengkulu, on the western coast of Sumatra, conservationists have found new purpose in protecting *Manouria emys*, the Asian forest tortoise. Once roaming freely beneath the rainforest canopy, the species now finds refuge within the care of researchers and students. The University of Bengkulu's ex-situ conservation program has become a small but vital sanctuary where this ancient reptile is studied, bred, and nurtured under controlled yet naturalistic conditions. The program follows a clear conservation method: rescued or confiscated individuals are placed in semi-natural enclosures, monitored daily for health and behavior, supported with regulated diet and microclimate, and gradually rehabilitated to ensure stability before potential reintroduction.

The facility focuses on three major aspects: animal maintenance, breeding management, and behavioral observation. Through careful daily monitoring, researchers track growth, diet composition, soil temperature, and microclimate, ensuring that captive conditions mimic the tortoise's natural habitat. Reproductive biology and hormonal cycles are studied to optimize egg production and hatching rates, while health screening helps prevent common reptilian diseases that could threaten population recovery.

Recent research underscores that understanding the tortoise's physiology is key to sustaining a viable captive population. Studies worldwide (such as those by Cigler *et al.* and Gallardo-Alvarez *et al.*) have shown how hormonal analysis and genetic monitoring can maintain reproductive health and genetic diversity, reducing the risk of inbreeding. While such advanced technologies are still developing in Indonesia, the University of Bengkulu is laying the groundwork for their implementation, bridging local fieldwork with global scientific standards.

Although Indonesia's current ex-situ initiatives remain limited compared to large-scale programs in Madagascar or Mexico, Bengkulu's efforts stand out for their integration of science, ethics, and education. As one researcher remarked, "Each hatchling born here is more than a number, it's a story of survival, hope, and human responsibility". This section presents how the program operates and highlights its significance as a model for community-based conservation in Indonesia.



Figure 2 The International Project Team for the Conservation of Sumatran Turtles, The University of Bengkulu
Source: Ruyani et al., 2022.

Science Without Borders: Collaboration Across Continents

Behind every successful conservation program lies collaboration. The University of Bengkulu's partnership with the University of North Carolina Greensboro (UNCG) represents an exemplary model of knowledge exchange and international solidarity. This partnership has opened opportunities for joint studies on animal health management, breeding techniques, and conservation education.

Through this collaboration, staff and students have gained access to modern tools and methods, ranging from genetic data analysis to standardized animal care protocols. International researchers, in turn, learn from Bengkulu's experience in managing tropical ecosystems and engaging local communities. These reciprocal exchanges demonstrate how conservation thrives through cooperation, not isolation.

Global networks such as the Global Species Management Plan (GSMP) and ASEAN Wildlife Enforcement Network (ASEAN-WEN) have also played a role in supporting these local efforts. They facilitate the sharing of data, training resources, and conservation policies across nations. Researchers like Roberts and Mo have noted that such transnational collaboration strengthens ecological resilience and enhances species management across borders.

Still, the journey is not without obstacles. Differing national regulations, funding limitations, and sociocultural contexts often challenge implementation. Yet, as Prof. Aceng Ruyani emphasizes, "Every step we take together, no matter how small, connects our science to a shared moral purpose: to protect life itself."

In these collaborations, students and researchers alike learn that conservation is not just about saving species; it is about connecting people, ideas, and values. The story of *M. emys* becomes a story of collective learning of science that crosses oceans and builds bridges between cultures.



Figure 3 *Manouria emys*, Asian forest tortoise - Kaeng Krachan National Park
Source: Rushenb, CC BY-SA 4.0 <<https://creativecommons.org/licenses/by-sa/4.0/>>, 2016.

Fighting the Silent Trade

Illegal wildlife trade remains one of the most persistent threats to *M. emys* across Indonesia and Southeast Asia. Despite its full protection under national law and CITES Appendix II, black markets continue to supply forest tortoises as exotic pets or food. Between 2000 and 2015, CITES reported over 500 individuals confiscated from illegal trade networks, with many cases traced back to Sumatra. The demand for *M. Emys*, often driven by curiosity, status, or traditional beliefs, has led to unsustainable harvesting and the loss of countless wild individuals.

Weak law enforcement, overlapping authorities, and insufficient public awareness allow the trade to persist. However, in Bengkulu, change begins with education. The University of Bengkulu has expanded its conservation mission beyond the pen enclosures into classrooms and

villages. Law and biology students collaborate to design community outreach programs that promote wildlife awareness and legal literacy.

Public campaigns, local school visits, and conservation workshops are held to teach why the tortoise belongs in the forest, not in cages. These activities, often led by university volunteers, have reached hundreds of students and local residents, turning awareness into advocacy. Strengthening enforcement through inter-agency coordination and cross-border monitoring remains vital, but as the program's motto reminds: "Knowledge is the first defense against extinction."

When communities understand the ecological and cultural importance of *M. emys*, they become allies, not adversaries. Empowered by science and empathy, local people begin to see the tortoise not as a commodity, but as a companion in preserving the forest's balance.

Table 1 Key Threats and Conservation Responses

Major Threats to <i>Manouria emys</i>	Impacts	Conservation Responses
Illegal wildlife trade	Rapid population decline, loss of genetic diversity	Strengthened law enforcement, awareness campaigns
Deforestation and habitat fragmentation	Loss of nesting and feeding sites	Reforestation, habitat protection
Climate change	Disrupted breeding cycles	Monitoring and adaptive management
Low public awareness	Weak conservation participation	Education and outreach programs by universities

Table 2 Educational Integration of *M. emys* in Conservation Learning

Learning Aspect	Activity Example	Intended Outcome
Inquiry-based learning	Field observation of <i>M. emys</i> behavior and microhabitat	Strengthen scientific inquiry and data literacy
Local wisdom integration	Connecting traditional forest knowledge with ecological principles	Deepen ethno-STEM understanding
Community engagement	School-based conservation and awareness projects	Foster environmental empathy and shared responsibility

When Conservation Becomes a Classroom

At the heart of Bengkulu's initiative lies a conviction that conservation is not only a scientific responsibility, it is an educational journey. Within the university's field station, rows of semi-natural enclosures provide students with living laboratories. Here, future teachers and researchers observe *M. emys* as it feeds, digs, and rests beneath the shade of tropical trees.

This hands-on approach transforms theory into experience. Students measure environmental variables, document behavioral patterns, and design small experiments under supervision. They learn about adaptation, energy flow, and ecological balance, not from textbooks, but from life itself. Through inquiry-based learning, *M. emys* becomes more than a study object; it becomes a mentor.

The program also embraces ethno-STEM, connecting scientific concepts to local wisdom. Traditional ecological knowledge from Bengkulu's surrounding communities, such as recognizing forest microclimates or understanding soil fertility, is integrated into coursework. In this way, conservation becomes both culturally grounded and scientifically rigorous.

For many students, these encounters mark their first real connection to biodiversity. They begin to see the forest not as a distant concept, but as a living classroom, an ecosystem in which humans are active participants. "The tortoise teaches us patience," says one education student. "It moves slowly, but every step has purpose. That's how we should approach conservation, slowly, carefully, but never stopping."

Through this fusion of conservation and education, the University of Bengkulu demonstrates how a single species can ignite a movement of learning, empathy, and environmental stewardship. In saving *Manouria emys*, they are also nurturing the next generation of eco-literate citizens, proof that science and compassion can indeed share the same shell.

Altogether, these findings illustrate why ex-situ conservation, collaboration, and education form the backbone of Bengkulu's efforts to protect *Manouria emys*. This section underscores the article's purpose: to show how science and community partnerships can sustain the future of this ancient tortoise.



Figure 4 The Area of Turtle Learning Center (TLC)

Source: The University of Bengkulu, 2025.

FUTURE DIRECTIONS

The road to safeguarding *Manouria emys* is long and challenging, but its journey mirrors the patience and resilience of the tortoise itself. As conservationists, educators, and policymakers look ahead, the future of this ancient species depends on how well science, policy, and education can unite in purpose.

1. Advancing Ex-Situ Science and Genetic Research

Future conservation must deepen understanding of *M. emys* biology especially genetics, hormonal cycles, and behavioral ecology to improve captive breeding. Integrating molecular tools like microsatellites or mtDNA analysis will help maintain genetic diversity, vital for reintroduction success. This approach also supports alignment with international conservation standards and fills regional research gaps.

2. Expanding International Collaboration and Policy Harmonization

Collaborations, such as between the University of Bengkulu and UNCG, show how shared knowledge boosts husbandry and species management. Going forward, harmonizing regulations through platforms like ASEAN-WEN and GSMP is key. Strengthening regional enforcement and securing long-term funding will transform temporary partnerships into sustainable conservation networks.

3. Fostering Environmental Literacy through Education

Beyond labs and field stations, *M. emys* can catalyze biodiversity-based science learning. Using living species in curricula promotes empathy and ecological awareness. Universities must expand inquiry-based education and partnerships with communities to localize conservation messages. When people learn to care, they are more likely to act.

Ultimately, the survival of *Manouria emys* symbolizes a broader human responsibility. Conservation cannot be achieved by scientists alone; it requires communities that understand, governments that support, and learners who are inspired. As we look toward the future, every new hatchling and every educated mind represents hope, slow, steady, and enduring, just like the tortoise itself. “True conservation begins when knowledge finds its heart in compassion.” Many of us still see turtles as creatures whose presence does not complete us and whose absence does not diminish us. This article calls on readers to help shift that mindset by refusing to purchase wildlife, reporting suspected illegal trade, supporting community-based conservation and rehabilitation programs, participating in environmental education efforts, and promoting habitat restoration initiatives that keep *Manouria emys* in the forests where it belongs.

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A biology educator and graduate student in Science Education at the University of Bengkulu, his research focuses on biodiversity conservation, science literacy, and ethno-STEM integration. He believes that every local species offers lessons for sustainable living and that conservation can become a bridge between science and society.

Aceng Ruyani

A Professor of Developmental Biology at the University of Bengkulu, Indonesia. A pioneer in conservation-based science education, he integrates molecular biology, biodiversity conservation, and informal learning. His research and outreach have advanced freshwater turtle conservation and environmental literacy across communities and schools.