International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

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BIODIVERSITY AS AN ORGANIZING PRINCIPLE: A THEORETICAL FRAMEWORK FOR SUSTAINABLE TOURISM AND HEALTH PROMOTION IN THE GUAMUHAYA GEOPARK, CUBA

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International Journal of Science and Research Archive, 2026, 21(02), 224–234

Publication history: Received on 28 September 2026; revised on 07 November 2026; accepted on 09 November 2026

Article DOI: https://doi.org/10.30574/ijsra.2026.21.2.1982

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ABSTRACT

The biodiversity of the Guamuhaya Geopark represents an exceptional heritage that transcends mere geodiversity, incorporating ecological values characterized by a high degree of endemism. However, its tourism management lacks a theoretical framework that explicitly connects biological richness with human well-being. The objective of this study was to propose an interdisciplinary conceptual framework linking the Geopark's biodiversity with sustainable tourism and holistic health. Through documentary research integrating a literature review on cultural ecosystem services, biophilia, and the WHO definition of health, alongside an analysis of the Cuban legal framework for protected areas and the Geopark itself an operational model was developed. This model posits that biodiversity which can be observed and experienced in ecosystems such as the cloud forests of Topes de Collantes or Lake Hanabanilla serves as a foundational resource that, when managed through scientific and wellness-oriented ecotourism, generates positive impacts. Three pathways for benefit are identified: psychological (anxiety reduction through the fascination sparked by the complexity of life), physical (activity within environments with high atmospheric quality), and immunological (exposure to forest-derived phytochemicals). The model integrates four constructs biodiversity, sustainable tourism, holistic health, and the local community within the context of the national development strategy. Hypotheses are derived regarding the relationship between the perception of biodiversity, visitor motivation, and improvements in well-being. This study lays the groundwork for future empirical research and aims to guide the management of the Geopark by positioning its biological capital as a vehicle for regenerative physical and mental health.

Keywords: Biodiversity; Guamuhaya Geopark; Holistic Health; Sustainable Tourism; Theoretical Framework

1 INTRODUCTION

The concept of geoparks emerged in the mid-1990s as a response to the need for conservation and enhancement of certain areas of geological importance (Mc Keever & Zouros, 2005; Hose, 2011). However, it wasn't until 2000 that the first geopark network, the European Geoparks Network (EGN), was established. Subsequently, in 2004, with UNESCO support, the current Global Geoparks Network (GGN) was created, initially comprising 17 European geoparks and eight Chinese geoparks (Mc Keever & Zouros, 2005; Pilogallo *et al*., 2019; Arrage, 2024). Crucially, in November 2015, the 195 Member States of UNESCO, at the UNESCO General Council, established the UNESCO Global Geoparks Programme, which currently includes 140 territories with this designation, distributed across 38 countries (Sánchez, 2011; Carrión *et al*., 2021; Arrage, 2024).

These precedents indicate that the use of geological resources as a source of sustainable economic development is showing an upward trend, which goes hand in hand with the implementation of geopark projects worldwide (Azman *et al*., 2010; Yang *et al*., 2011; Lincango & Pazmiño, 2025). Nations in Europe and Asia are the main exponents of geoparks; in Latin America this process is not indifferent and there is a similar interest, despite it being a foreign model that needs contextual evaluation (López *et al*., 2008; Sánchez, 2011; Lincango & Pazmiño, 2025).

In Latin America, there has been a growing interest in developing new geopark projects, and more and more territories are interested in promoting them, given their significant geological, geomorphological, and scenic attributes; many of which are regional tourist icons (Azman *et al*., 2010; Sánchez, 2011; Carrión *et al*., 2021). These characteristics can be leveraged to promote geotourism strategies that improve the quality of life in rural communities, while also strengthening the cultural principles that shape the territory (Farsani *et al*., 2010; Azman *et al*., 2010; Carrión *et al*., 2021).

Geotourism has been conceived as a tourism modality distinct from mass tourism, with the purpose of highlighting the value of geological and geomorphological resources within a sustainable cultural and environmental context (Hose, 2011; Hose, 2012; Arrage, 2024). Geotourism emerged as an alternative for disseminating geological knowledge and ensuring that these resources are understood and interpreted for conservation purposes [16-18]. Thus, tourism linked to geological heritage, or geoheritage, has acquired a multidisciplinary and holistic definition that converges on three elements: geoeducation, geoconservation, and sustainable development (Coutinho *et al*., 2019; UNESCO, 2021; Arrage, 2024). Geotourism has therefore become an engine of economic and social growth for territories with geological heritage of particular rarity, beauty, or scientific importance (Brilha *et al*., 2018; Pilogallo *et al*., 2019; Lincango & Pazmiño, 2025).

The Guamuhaya Geopark, officially designated as Cuba's third national geopark under Agreement 10240/2025 of the Council of Ministers, spans 2,143 km^2 within the central mountain massif. While its designation is a response to its exceptional geodiversity, the area is simultaneously a biodiversity hotspot (Decree 331/2015; Decree 11/2020; Brilha *et al*., 2018). It encompasses the Lomas de Banao Ecological Reserve, the Topes de Collantes Protected Natural Landscape, and the surroundings of Lake Hanabanilla, ecosystems that harbor a very high rate of endemic flora and fauna (López *et al*., 2009; Decree 11/2020). The exuberance of its evergreen forests, tree ferns, endemic birdlife, and local endemic species (such as tomeguín de la tierra or various orchids) constitute a biological landscape of universal value (López *et al*., 2009; Decree 11/2020; Agreement 10240/2025).

The study aimed to develop an interdisciplinary theoretical framework that establishes the role of biodiversity in the Guamuhaya Geopark as a health asset, mediated by a sustainable tourism model.

2 THE CONCEPTUAL GAP: HEALTH AS AN ABSENT PILLAR

Although the geopark's management model encompasses conservation and sustainable tourism, there is no formalized theoretical framework explaining how the contemplation and interaction with this biological richness translates into tangible benefits for the holistic health (physical, mental, and social) of both visitors and the communities that act as its custodians. Management tends to focus on geological interpretation and the protection of abiotic resources, often underestimating the specific salutogenic power of wildlife and pristine ecosystems.

2.1 Objectives and Research Question

Central research question: How can a theoretical framework be structured to explain the relationship between the biodiversity of the Guamuhaya Geopark, the practice of sustainable tourism, and the generation of holistic health?

2.1.1 General objective:

To construct an interdisciplinary theoretical framework that establishes the role of the Guamuhaya Geopark's biodiversity as a health asset, mediated by a sustainable tourism model.

2.1.2 Specific objectives:

- To synthesize scientific literature on cultural ecosystem services, the biophilia hypothesis, and evidence regarding the impact of biodiversity on health.
- To characterize the biodiversity of the Guamuhaya Geopark as a distinctive tourism resource and its associated salutogenic potential (e.g., forest bathing, wildlife observation, ecological interpretation).
- To propose a conceptual model that integrates the constructs of biodiversity, sustainable tourism, community, and holistic health.
- To derive testable hypotheses to guide future empirical research on wellness tourism within the destination.

3 LITERATURE REVIEW (PILLARS OF THE THEORETICAL FRAMEWORK)

3.1 Biodiversity and cultural ecosystem services

Biodiversity not only fulfills supporting ecological functions but also provides cultural ecosystem services (CES) that are essential to human beings (Kozlowski, 2004; Leff, 2005; Jumbo *et al*., 2021). The literature categorizes these services into recreation, aesthetic value, inspiration, and a sense of belonging (Martínez, 2013; Ólafsdóttir & Tverijonaite, 2018; Arévalo, 2024).

In Guamuhaya, the high species diversity and the uniqueness of the landscape featuring cloud (forests and waterfalls such as El Nicho) offer a profound aesthetic and spiritual experience, in which the tourist does not merely observe but becomes immersed in a complex, living system. Authors such as Chan *et al*. (2012) argue that CES are deeply linked to psychological well-being.

3.2 Sustainable tourism through the lens of Scientific Ecotourism

The World Tourism Organization (UNWTO) defines sustainable tourism based on criteria such as resource optimization, sociocultural respect, and economic viability. In regions with high biodiversity, this model manifests as ecotourism (WTO, 2006). However, this text proposes an evolution toward "Ecological Well-being Tourism," in which the scientific interpretation of wildlife serves as the foundation of the experience (Dowling, 2013; Arévalo, 2024; Naranjo *et al*., 2024). Visiting the trails of Guamuhaya transcends mere visual pleasure, becoming an interpretive immersion with therapeutic potential (ecosystem-based education).

3.3 Biodiversity as a determinant of health

This is the most novel section of the proposed framework, based on three scientific pillars:

- The Biophilia Hypothesis (Wilson, 1984): defines the innate human tendency to seek connections with nature and other forms of life. The perception of high biodiversity triggers an emotional response of fascination and a sense of security.
- Attention Restoration Theory (Kaplan & Kaplan, 1989): it has been shown that environments with greater biological richness are more effective at alleviating mental fatigue than monotonous green spaces. The "soft fascination" evoked by birds, insects, or the structure of a forest activates cognitive recovery processes.
- Phytochemistry and Immune Health (Forest Physiology): research on "forest bathing" (Shinrin-yoku) in Japan (Li, 2010; Chan *et al*., 2012) demonstrates that breathing the air in biodiverse forests, rich in phytoncides (volatile organic compounds emitted by trees), significantly increases the activity of the cells NK (Natural Killer), strengthening the immune system and reducing cortisol levels.

4 PROPOSED THEORETICAL FRAMEWORK: THE "BIO-HEALTH" MODEL

A conceptual model termed "Bio-Health Guamuhaya" is proposed, which integrates the following constructs:

4.1 Theoretical Constructs

- Construct 1:

Biological Capital (Biodiversity and Endemism): this encompasses not only the number of species but also the degree of uniqueness and ecological integrity of the cloud forest, including local orchids and avifauna which together constitute the primary resource for the visitor experience.

- Construct 2:

Immersive Sustainable Tourism (Ecotourism + Well-being): a tourism management approach that designs low-impact products centered on observation, ecological interpretation, nature photography, and digital disconnection.

- Construct 3:

Regenerative Holistic Health: this involves the improvement of physical health (e.g., blood pressure, immune function), mental well-being (e.g., stress reduction, creativity), and social health (e.g., community cohesion centered on the protection of species).

- Construct 4:

Custodial Community: local populations acting as specialized guides and guardians of ethnobiological knowledge, key elements within the well-being value chain.

4.2 Hypothetical relationships

The model posits that Perceived Biodiversity (a visitor's capacity to see and sense endemic wildlife) acts as an independent variable.

- H1 (Psycho-emotional pathway): a greater perception of biodiversity during the visit correlates with lower scores on perceived stress scales and greater mental clarity.
- H2 (Physiological pathway): the duration of a stay in the biodiverse forest of Topes de Collantes is positively associated with improvements in health markers (blood pressure and heart rate variability).
- H3 (Social pathway): the involvement of the local community in wellness-oriented ecotourism strengthens cultural identity and social cohesion, which in turn influences their own perception of health.

4.3 Conceptual Diagram of the Theoretical Framework

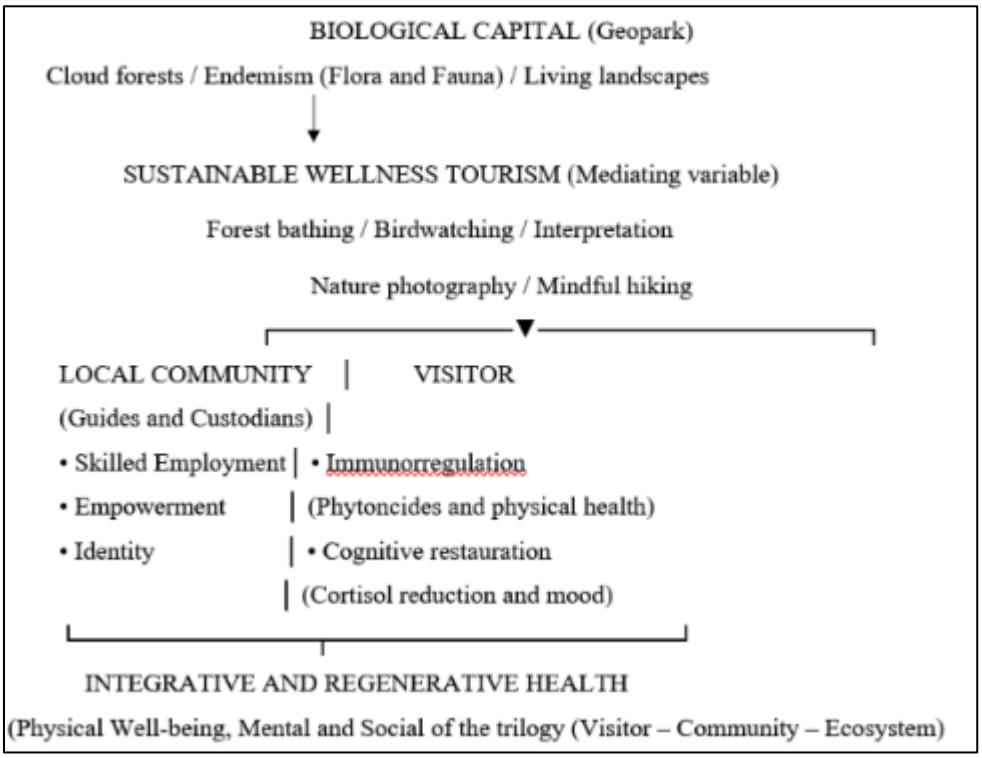


Figure 1: "Bio-Salud Guamuhaya" conceptual model: Biodiversity as the cornerstone of regenerative wellness tourism

4.4 Justification of relevance for Cuba

Cuba is currently focused on advancing its medical-pharmaceutical industry and health tourism sector (López *et al*., 2009; Falcón & Amador, 2024; Ministry of Energy and Mines, 2024). This framework links the nature-based tourism industry with health promotion and preventive medicine, aligning with the core objectives of the PNDES 2030, a national development plan that advocates for the diversification of tourism offerings and the enhancement of quality of life. With its convenient access from urban centers such as Trinidad or Cienfuegos, the Guamuhaya region is well-positioned to become a destination for science-based, ecological wellness.

5 PROPOSED METHODOLOGY FOR THE STUDY

A methodological design is proposed that combines the previously presented documentary analysis with future validation steps:

- Documentary Phase (Current): a systematic review of biophilia, cultural ecosystem services, and forest health (Toledo, 2005; Li, 2010; López *et al*., 2022). Mapping of endemic species and biodiversity hotspots within the geopark, using secondary sources from CITMA and the Flora of Cuba (López *et al*., 2009; Ministry of Energy and Mines, 2024).
- Theoretical Validation Phase (Future Proposal): Delphi panels involving ecologists, biologists, medical professionals, and tourism operators to validate the model.
- Empirical Phase (Suggested Future Design): Quasi-experimental research involving visitors, measuring physiological variables (blood pressure) and psychological variables (using the POMS or PANAS questionnaires) before and after a "forest bathing" experience on the geopark's trails.

Below, the key animal species present in the Guamuhaya Geopark are identified, with an emphasis on endemic species. This information directly complements the theoretical framework concerning biodiversity, sustainable tourism, and health, as each faunal group serves as a tangible resource for designing wellness-oriented tourism experiences (such as wildlife observation, nature interpretation, and mindful immersion).

6 REPRESENTATIVE FAUNA OF THE GUAMUHAYA GEOPARK

The Guamuhaya massif functioning as an "ecological island" within the island of Cuba, features mountainous terrain and a landscape of evergreen and cloud forests, harboring a fauna of great value due to its high levels of endemism and diversity. The most significant species are detailed below, organized by zoological group, with an emphasis on those that hold the greatest potential for nature and wellness tourism.

6.1 Birds (Avifauna)

This is, without a doubt, the group of greatest interest for ecotourism and mindful observation (Table 1). Guamuhaya is an Important Bird Area (IBA) and forms part of the migratory corridor of the insular Caribbean. Birdwatching is an activity documented to be associated with improved mental health, due to the focused attention and the gentle fascination it evokes.

Table 1: Representative avifauna of the Guamuhaya mountain massif

Species	Common name	Tourism and wellness potential status
Myadestes elisabeth	Nightingale	Endemic to Cuba, its melodious song in the cloud forests serves as an acoustic resource with high restorative value. Listening to it reduces the perception of stress.
Priotelus temnurus	Tocororo	Endemic to Cuba (National Bird). Observing its vivid colors (green, red, white, and blue) in flight evokes an immediate aesthetic response. It serves as a flagship species for heritage interpretation.
Tiaris olivaceus	Cuban grassquit	Endemic. Small and with a delicate song; spotting it in open areas rewards patience and close attention (mindfulness).
Buteogallus gundlachii	Roadside Hawk	Endemic (near-threatened). A bird of prey that can be observed in areas with mogotes (limestone hillocks) and along nearby coasts. Identifying it presents a stimulating cognitive challenge for the observer.
Falco sparverius sparveroides	Cuban Kestrel	Endemic. Easily observed perched on wires or dry branches. Ideal for introducing children and beginners to wildlife observation.
Catharus aurantiirostris	Orange-billed Thrush	An inhabitant of the undergrowth, observing it requires walking in silence, a practice that encourages digital disconnection and active listening.

6.2 Mammals

Although Cuba lacks large native land mammals, the region is home to highly unique species, primarily bats and hutias, the latter being of great value for nocturnal wildlife-watching tourism.

Table 2: Main mammal species of the Guamuhaya mountain massif

Species	Common name	Status	Tourism and wellness potential status
Mysateles prehensilis	Carabalí hutia	Endemic	An arboreal rodent with a prehensile tail. Spotting one in the treetops at twilight adds an element of adventure and childlike wonder.
Capromys pilorides	Cuban hutia	Endemic – Largest Cuban rodent	Common in rocky areas and forests. Spotting one connects the visitor to the island's prehistoric fauna.
Phyllonycteris poeyi	Poey's flower bat	Endemic	A key nocturnal pollinator for local flora. Explaining its ecosystem role during night-time talks enriches geo-education.

Artibeus jamaicensis	Fruit bat	Native	Common in caves and forested areas. Their mass emergence at dusk from caverns such as Martín Infierno is a spectacle of moving biomass.

6.3 Reptiles and Amphibians (Herpetofauna)

The herpetofauna of Guamuhaya is exceptionally rich in endemic species, particularly within the genera *Anolis* (lizards) and *Eleutherodactylus* (small frogs). Observing them fosters patience and sharpens visual acuity (Table 3).

Table 3: Key species of the herpetofauna of the Guamuhaya mountain massif

Species	Common name	Status	Tourism and wellness potential
Anolis guamuhaya	Guamuhaya Anolis	Locally endemic	A lizard discovered and described for science within this very massif. Searching for it among the leaf litter becomes a game of scientific exploration for the visitor.
Anolis allogus	Banao Anolis	Endemic to the Lomas de Banao Ecological Reserve	Ideal for macro photography outings and exploring the micro-world.
Diploglossus delasagra	Cupey, or the four-legged little snake	Endemic	A lizard with serpentine movements. It shatters the stereotype of a reptile; its discovery sparks surprise and admiration.
Eleutherodactylus limbatus	Pygmy frog	Endemic	One of the smallest frogs in the world. "Hearing" it without seeing it, or finding it on a leaf, is an exercise in concentration and connection with the minuscule.
Chilabothrus angulifer	Majá de Santa María	Endemic	A non-venomous constrictor snake. Spotting one is a memorable event that offers an opportunity to address the cultural fear of snakes through education and respect.

6.4 Invertebrates (Mollusks and Arthropods)

Invertebrates are often underestimated; yet, they are major sculptors of the geological landscape (as fossils), indicators of ecological health, intermediate hosts for various etiological agents, and biological control agents. The Guamuhaya region boasts an exceptional malacofauna both fossil and extant (Table 4).

Table 4: Main mollusk species of the Guamuhaya mountain massif

Species	Common name	Status	Tourism and wellness potential
Liguus fasciatus	Painted snail	Native (emblematic)	Conical shells with brightly colored spirals. Searching for them on tree trunks is a relaxing, almost meditative activity that connects one to an aesthetic heritage.
Polymita picta	Polymite	Endemic (Eastern region; at the limits)	Considered the most beautiful snail in the world. Although located further east, its potential presence along the edges of the massif serves as a major tourist attraction. Gazing at its multicolored spiral is a source of pure aesthetic delight.
Pomacea poeyana	River snail	Endemic	Considered the largest freshwater mollusk in Cuba's malacofauna, alongside the species *P. paludosa*, these specimens are a delight for visitors to behold.
Physa cubensis	River snail	Endemic	It is one of the most abundant mollusk species in Cuba. It is small in size, with a sinistral shell and a high spire.

Planorbella cubensis	River snail	Endemic	Flattened, coiled shell of great interest to those passionate about the study of the freshwater malacofauna.
Eupera cubensis	Two-valve snail	Endemic	Bivalve mollusk, typical of Cuban streams and rivers.
Viviparus bermondianus	River snail	Endemic	With an oval opening, semigloboso in shape. Type locality, Hanabanilla river.
Veronisella cubensis	Garden slug	Endemic	A land mollusk, typical of gardens and green spaces. Observing these specimens is both engaging and relaxing.
ARTHROPODS			
Greta cubana	Glass butterfly	Native	Transparent wings fluttering in forest clearings. Observing their ethereal flight induces a sense of calm and wonder—perfect for moments of mindfulness while on the move.
Scolopendra gigantea	Escolopendra	Native	Predatory myriapod. Its controlled presentation serves as an educational tool regarding the food chain and helps overcome phobias through knowledge.

6.5 Hanabanilla river. Aquatic and Underwater Fauna

River and lake systems (such as Lake Hanabanilla and rivers including the Caburní, Guairabo, and Black River) are home to species of interest for sustainable fishing tourism (catch and release), shoreline observation, and scientific research (Table 5).

Table 5: Main fish and turtle species present in the Guamuhaya mountain massif

Species	Common name	Status	Tourism and wellness potential
Gambusia punctata	Guajacon	Endemic	A small, live-bearing fish. Observing schools of them in the crystal-clear river waters helps to slow the heart rate and connect with the transparency of the environment. An excellent natural regulator of mosquito larvae populations.
Gambusia puncticulata	Guajacon	Endemic	A small, live-bearing fish. Typically found in the crystal-clear waters of rivers, it helps to slow the heart rate and foster a connection with the transparency of the environment. It also serves as an excellent natural regulator of mosquito larval populations.
Limia vittata	Guajacon	Endemic	A small fish with a deep, robust body; the male has a very short gonopodium. It features colored spots ranging from black to orange and yellow. An excellent biological control agent for mosquito larvae populations.
Cichlasoma tetracanthus	Cuban cichlid	Endemic	A species distributed throughout Cuba, including the Isla de la Juventud. It inhabits freshwater and brackish-water environments. It is considered an effective biological regulator of mosquito populations during their larval stage.
Agonostomus monticola	Dajao	Native	A migratory fish that travels upstream in rivers. Seeing it leap through the rapids is a display of vitality that energizes the observer.
Trachemys decussata	Cuban slider	Endemic	A freshwater turtle basking on logs that protrude from the water. Observing it quietly from a distance conveys a sense of peace and longevity.

6.6 Integration with the "Bio-Health" Theoretical Model

The precise identification of this fauna is not merely an inventory; rather, it serves as the operational foundation for the "Biological Capital" construct within the proposed model. To transform this capital into "Integral Health," the following direct applications are proposed:

- Soft Fascination Therapy (based on Kaplan): designing stations for the passive observation of the Cuban Trogon (Tocororo) and the Cuban Solitaire (Zorzal), where tourists can simply sit, listen, and observe without the need to "do" anything thereby activating the brain's default mode network.
- Regenerative Micro-adventures: implementing an "Endemism Challenge," in which visitors attempt to identify 3 or 4 endemic species (such as the *Anolis guamuhaya* lizard, the Cuban today, or the hutia) with the assistance of a local guide. Successfully completing this search triggers a positive dopaminergic reward.
- Nocturnal Biophilia: utilizing the emergence of bats from the Martín Infierno cave as a sensory immersion experience (involving both sight and sound) that helps overcome the fear of darkness and fosters a connection with biological cycles.
- Whisper Trails: leveraging the sound of flowing water and the song of the Cuban Solitaire Ruiseñor (*Myadestes elisabeth*) in waterfall areas (such as El Nicho) for guided sound-meditation sessions.
- Ultimately, this fauna constitutes the geopark's visual and acoustic pharmacopeia, a renewable, scientifically validated resource for the promotion of integral health.

7 MANAGEMENT RECOMMENDATIONS

- Implement "Nature Prescription" pilot programs, in which local physicians recommend specific routes within the geopark.
- Train local guides as "forest therapists," capable of leading sessions focused on mindful immersion in biodiversity.
- Develop interpretive trails that highlight the symbiotic relationship between geology, endemic plant species, and pollinators, fostering both scientific wonder and mental well-being.

8 CONCLUSIONS

The proposed theoretical framework redefines the value of the Guamuhaya Geopark by positioning its biological richness as a determinant of health. It is argued that the "Bio-Health" model offers a unique competitive advantage: transforming a visit to the geopark into a preventive intervention for physical and mental well-being.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Acknowledgments

To Prof. David del Valle Laveaga, Ph.D., for his generosity and high altruism in assuming the payment of the manuscript without hesitation.

Funding Source

Professor David del Valle Laveaga, Ph.D.

Disclosure of conflict of interest

The authors have declared that no competing interests exist.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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