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Wildlife Conservation in Pakistan: Integrating Science, Policy, and Community for Sustainable Futures

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Pakistan boasts varied links in the ecosystem, most belonging to the alpine, arid regions, which sustain plentiful fauna and flora, such as a variety of endemic and other keystone species, such as the snow leopard, common leopard, large mountain ungulates, Himalayan brown bear, Indus blind dolphin, green sea turtles, among other toads and frogs, which include the Hazara torrent frog. All are severely endangered species in their respective habitats, such as loss/degradation of habitats, global warming, anthropogenic wildlife conflict, and illegal trade. In the present situation of the dynamics of climatic conditions, there is a greater pressing need for wildlife conservation in Pakistan, and the combination of scientific revolution, community-based conservation, and good policy models is needed to tackle this. Effective conservation programs, especially those that include the local communities, show that sustainable biodiversity management is a possibility. Ex-situ conservation by incorporation of contemporary tools like geographic information systems (GIS), molecular genetics, camera trapping, radio telemetry, environmental DNA (eDNA), and semen banking can also be used to increase conservation results. Also, the One Health framework offers an interdisciplinary perspective in the comprehension of the inter-relationship between human, animal, and ecosystem health. To achieve the long-term conservation of the wildlife in Pakistan, it is important to strengthen institutional capacity, enhance policy implementation, and conduct interdisciplinary research. Markhor: The Journal of Zoology is crucial to developing research on the region and worldwide cooperation in the conservation sciences.

Pakistan urgently requires wildlife preservation for biodiversity, socio-economic development, and environmental sustainability. It has a great number of species that are of global interest: snow leopards, common leopards, large mountain ungulates, Himalayan brown bears, Indus Blind dolphins, green sea turtles, and numerous species of toads and frogs, including the Hazara torrent frog, due to its geographical location and its ecological diversity. Nevertheless, the pace of changes in the environment as humans take initiatives has enhanced the pressures on wildlife, increasing the need to have integrative and adaptive conservation mechanisms.

One of the most severe forms of threats to wildlife in Pakistan is habitat degradation. Habitat fragmentation and loss as a result of deforestation, agricultural growth, infrastructure growth, and urbanization have a direct effect on the survival of species. Climate change makes matters worse by altering ecological patterns with sudden changes in the rain patterns and extreme temperatures in winter and summer. Ecosystems in the Northern mountains of Pakistan are one that is especially susceptible to major species like Markhor, Himalayan brown bear, and Snow leopard. The freshwater biodiversity is also threatened, as species such as the Indus River dolphin are exposed to habitat disruption through water management and water pollution.

Through community-based conservation efforts, Pakistan has enjoyed more success with regard to the preservation of different species. Markhor conservation is among the community-based conservation strategies that entail trophy hunting

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and the use of awareness programs. Gilgit-Baltistan Community-based conservation initiatives and Khyber Pakhtunkhwa have shown that compatibility between conservation and the economic interests of those living in a community can lead to sustainable results [1, 2]. Through such community-controlled conservation programs, wildlife is not only boosted, but also the livelihood of the locals is massively enhanced at the same time.

Pakistan shares conservation efforts, such that institutional and governance problems are the major limitations. Poor implementation of laws that regulate wildlife, inadequate funding, and coordination among the agencies are the factors that hamper the successful execution of the conservation policies. Hence, institutional strengthening and improved coordination among the federal and provincial governments are highly significant in ensuring better conservation performance. Transparent management practices should be prioritized, as well as evidence-based policymaking to ensure long-term sustainability.

Advancements in scientific research provide a greater chance to play an effective role in conservation efforts by using the latest tools like GIS, camera traps, radio tracking, and remote sensing, which not only help to monitor wildlife species in their natural habitats but also record numbers with greater accuracy. Other latest tools include non-invasive assessment of genetic diversity through DNA barcoding, eDNA isolation, and analysis with the use of the latest bioinformatics tools for interaction of animals with their habitats and making conservation efforts more effective [3]. Similarly, these in situ conservation actions can be linked with ex-situ conservation actions such as semen banking and captive breeding, which can improve the precision and effectiveness of conservation strategies, especially for elusive endangered or rare species.

Furthermore, research on reproductive biology/physiology has a great effect on the conservation of rare and endangered species, besides ecological monitoring. Reproductive physiology not only helps to assess oxidative stress but also helps to improve captive breeding and species recovery programs [4]. Using this kind of knowledge in conservation strategies will help make both in situ and ex situ efforts stronger so that threatened populations can survive for a long time.

Similarly, Human–wildlife conflict in Pakistan is an insistent issue, particularly in rural and mountainous regions. People living in mountain areas have a negative attitude toward wildlife because wildlife species not only prey on livestock but also cause significant damage to their crops. This leads to the retaliatory killing of rare and endangered wildlife species. These conflicts must be solved with the help of providing a set of compensation schemes, better resource allocation, and community education. The effectiveness of these strategies can be further improved by including traditional ecological knowledge in conservation planning.

The One Health framework offers a relevant outlook to the conservation of wildlife in Pakistan. Instead, human, animal, and environmental health are growing to be more interconnected, especially concerning zoonotic illnesses. The development of stronger human-wildlife contacts and environmental degradation increases the chances of infection by new diseases; new interventions should be considered both in conservation and in the interest of the country's population [5]. Multi-disciplinary teamwork is necessary to deal with these intricate issues.

In the future, conservation of wildlife in Pakistan needs to use adaptive approaches that would take into account the environmental and socio-economic dynamics. The expansion of the areas of protection, better connection of habitats, and a consideration of climate resilience into the conservation plan are all essential priorities. The education, research, and capacity-building investment shall also work towards enhancing conservation.

In that regard, Markhor: The Journal of Zoology becomes a significant avenue for furthering the research in the field of wildlife in Pakistan and elsewhere. The journal promotes the creation of strong conservation plans through high-quality scientific contributions and encourages cross-disciplinary work. With the world facing bigger and ever-growing threats to its biodiversity, science, policy, and community engagement are needed to secure a sustainable future for the field.

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