

A Scoping Review of Conservation Genomics for Assessing Genetic Connectivity and Pathogen Resistance in Namibia's Isolated Desert-Dwelling Black Rhinoceros Populations

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| Abstract

The black rhinoceros (*Diceros bicornis*) is a critically endangered species. In Namibia, fragmented populations persist in the hyper-arid Namib Desert, experiencing extreme isolation. This presents dual conservation threats: diminished genetic connectivity, which may reduce adaptive potential, and increased susceptibility to novel pathogens due to possible inbreeding depression. Conservation genomics provides tools to assess these risks, but a synthesis of its application in this specific context is absent. This scoping review aims to map and synthesise existing literature on the use of conservation genomics to assess genetic connectivity and pathogen resistance in Namibia's isolated desert-dwelling black rhinoceros populations. It seeks to identify key research themes, employed methodologies, and critical knowledge gaps. A systematic search of peer-reviewed and relevant grey literature was conducted following established scoping review frameworks. Databases included Web of Science, Scopus, and specialist conservation repositories. Studies were screened and selected based on pre-defined inclusion criteria focusing on genomics, the black rhinoceros, and the arid environments of Namibia. The review identified a limited but growing body of literature. A prominent theme was the use of single nucleotide polymorphisms (SNPs) to quantify low levels of gene flow between desert sub-populations. Studies consistently reported moderate to high genetic differentiation, indicating significant isolation.

Research on pathogen resistance was notably scarce, with genomic investigations into immune gene diversity being virtually absent from the retrieved literature. Genomic studies confirm that Namib Desert black rhinoceros populations are genetically isolated, which could compromise long-term viability. The near-total lack of research on the genomic basis of pathogen resistance represents a critical gap, leaving a key threat unassessed. Future research must prioritise genomic scans for adaptive variation, particularly within major histocompatibility complex (MHC) and other immune-related genes. Conservation management should integrate genomic data to evaluate the feasibility and design of genetic rescue interventions, such as managed translocations, to mitigate isolation.

conservation genomics, genetic connectivity, pathogen resistance, black rhinoceros, Namib Desert, population isolation, genetic rescue. This review provides a consolidated evidence map that clarifies the current state of genomic research for Namib Desert black rhinoceros. It highlights the urgent need to expand genomic inquiry beyond neutral genetic structure to include adaptive genetic variation critical for disease resilience.
