Conservation Ecology Research Unit
University of Pretoria

Elephant Conservation

Megaparks for Metapopulations

Our 'megaparks for metapopulations' research initiative aims to develop novel solutions to manage and maintain southern Africa's elephant population. The initiative guides the implementation of ecological principals to ameliorate impact and conflict as well as allow populations to be limited by natural forces. We consider southern African elephant populations as sub-units that make up a series of metapopulations. Populations are seen as part of a greater spatial and temporal whole. This holistic view calls for a landscape approach to conservation management and suggests that ecological linkages may induce metapopulation dynamics. Linking increasing (source) and decreasing (sink) populations should induce regional stability, despite local population fluctuations. Additionally, megaparks should provide for seasonal changes in elephant impacts across space and aid in the maintenance of biological diversity.

We study the demographic variables and landscape dynamics of elephant populations in eight clusters of conservation areas across southern Africa. For practical reasons we consider each of these clusters a megapark. Our research focuses on (1) what determines how elephants range both within and between conservation clusters, (2) how to apply range use information to link conservation areas; (3) what drives age-specific survival and reproductive variables in the megaparks; and (4) how to best deal with conflicts between elephants, people and components of biological diversity in each megapark. We use this information to test the metapopulation metaphor and to outline megaparks to stabilise elephant populations and their impact.

CERU supports research on these key topics as well as opportunities to develop conservation capacity and influence political and management decisions in seven southern African countries encompassing the study area. Not only should this approach benefit elephants, but by using elephants as a flagship of conservation, it should benefit the conservation of biological diversity throughout southern Africa.

The science behind these ideas is available from the publications section of our website, while we provide a more popular treatment of the same ideas through editions of popular magazine publication available for download.

Coastal dune forest restoration

In South Africa, coastal dune forests form an ecotype within the Maputaland centre of plant endemism. These forests are limited to the coastal dunes of north-eastern KwaZulu-Natal and have a long history of fragmentation through natural and human-induced disturbances. Though not supporting endemic species, they appear to form a protective buffer along the coastal boundary of Maputaland. Portions of these forests are mined for heavy minerals such as rutile, ilmenite and zircon. For some 30 years, this mining has been followed by a continuous process of dune rehabilitation directed at restoring indigenous dune forest along part of the former mining pathways. This provides us with an outdoor laboratory for research into the ecological processes that induce forest community development.

Our research on coastal dune restoration commenced in 1991, with the support of Richards Bay Minerals, and we now maintain an extensive database on the chronosequential development of tree, understory vegetation, millipede, bird and small mammal assemblages of known ecological history. This enables us to 1) evaluate rehabilitation success and 2) develop and test hypotheses related to self-induced community development across temporal and spatial gradients. Studies underway in this outdoor laboratory include the following:

The Ecological Monitoring Program

The restoration goal of this disturbed coastal dune forest is to re-create a forest that is similar to relatively intact forests in the region. Successful dune forest rehabilitation should predictably be associated with structural and functional development of both the biotic and abiotic components of the ecosystem towards a benchmark, in this instance an area of undisturbed forest. CERU has been monitoring ecological development in assemblages of plants and animals, as well as in soil variables (nutrient and fertility levels) that reflect ecosystem function. The Ecological Monitoring Program evaluates the trajectory of development in ecological variables, comparing them both to trajectories obtained during previous years, and to trajectories across a chronosequence of naturally regenerating forest patches in the region. The program also evaluates the predicted endpoints of development. The program is, therefore, an important tool for mining companies (such as Richards Bay Minerals) that need to meet the objective of ecological sustainability.

Forest community convergence theory

Principles of succession predict that disturbances, such as those induced by mining, may bring about the development of biotic communities through primary succession. This is characterised by local colonisations and extinctions that take place in stages and result in the natural regional and local species pools being indistinguishable. The decay of differences in these species pools is expected to follow negative exponential trends.

Rehabilitation does not always follow a deterministic trend. The existence of multiple stable states, chaotic or non-equilibrium dynamics, continuous disturbances and the vagaries of climate, to name a few, all prevent predictable change in groups of forest species. We are assessing the empirical evidence in support of current restoration models, using data accumulated during some 15 years of regular Surveying of plant, millipede, bird and rodent assemblages.

Birds as dispersers of tree seeds

Dispersal is a key process in the restoration of any ecosystem. Within dune forests, frugivorous birds consume a wide range of fruit - some 59 percent of all dune forest trees are bird dispersed. Effective restoration management therefore depends on birds as agents of tree dispersal. Our research focuses on questions such as, which bird species disperse which tree species? Does the geographic distribution of a tree species, even on a small scale, depend on the movements of birds? To determine whether the distribution of tree species is related to the distribution of bird species, we record, both "ends" of tree dispersal, the consumption of fruit of some forest tree species by birds and the deposition of tree seed in their faeces.

Colonisation constraints of birds and trees

Eminent ecological theories dictate that landscape pattern influences colonisation and extinction dynamics and, therefore, determines biological diversity and species composition within a habitat patch. This is not just of theoretical importance, as habitat fragmentation continues to be a major threat to biological diversity. Since 1977, Richards Bay Minerals has been mining for minerals on the dunes to the north of Richards Bay Town. The mining process results in a mosaic of remnant forest, bare sand, commercial forestry, and regenerating indigenous forest. Restoration ecology addresses spatial and temporal influences on how plants and animals reach a disturbed site and survive there. Therefore, an understanding of the constraints to community assembly in a fragmentation metaphor is imperative. We are investigating the influence of the spatially and temporally changing landscape pattern of the mining lease area on colonisation and extinction dynamics in forest birds and trees and the consequences thereof for habitat restoration.

Life history variables of local plant colonisation

Reproductive characters of plants, including seed type, seed size, reproductive strategy, age at first reproduction and phenology, play a role in determining species-specific dispersal distances, dispersal rates and dispersal frequencies. Together, these factors influence the likelihood of a species dispersing to a new habitat and are therefore important for the outcome of a restoration effort. In this study on coastal dune forest trees, we quantify the relationship between life history characteristics that are closely associated with dispersal and the pattern of colonization in new habitats.

Millipede colonisation constraints

Human-induced fragmentation of landscapes disrupts the spatial arrangement of habitats. This may reduce biodiversity and disturb ecological processes. Fragmentation of potential source habitat may also reduce species richness and inhibit colonisation of rehabilitating habitats, thereby disrupting restoration programmes that aim to recover disturbed areas. However, there is a lack of consensus on the consequences of fragmentation for species in the literature. Following island biogeography theory, we anticipate that a reduction in dune-forest fragment size and increased distance from continuous dune forest will reduce millipede species richness and abundance in fragments and patches of rehabilitating dune vegetation. We also expect that due to varying responses of species to fragmentation the millipede community composition in these fragments will differ from that in a continuous dune forest. We are currently investigating the distribution of millipede species across the RBM lease area, in remnant and intact coastal dune forest, as well as regenerating patches of various ages. This project will give us

insight into the consequences of fragmentation for the rehabilitation and eventual restoration of the coastal dune forest millipede community.

Maputaland Biodiversity Assessment

Threats and opportunities

Our 'threats and opportunities of biodiversity in Maputuland' research programme aims to inform decisions on conservation, wildlife management, and restoration without impinging on the livelihoods of people. People in southern Mozambique live mostly off the land and share resources with wildlife. This may create conflict between people, wildlife, and natural resources. The programme is therefore designed to conduct ecological research on forests of Maputaland and provide information on how different policies may influence the integrity of forest habitats in this region. Maputaland in Southern Mozambique forms part of a regional centre of species endemism and is known worldwide for its diverse landscapes and species richness.

We use forests in Maputaland as a platform form which we decribe the response of plants and animals to landscape conditions. The forests in Maputaland are fragmented, and this allows us to use principles of Island Biogeography and metapopulation dynamics to test existing ecological theory. We describe the spatial and temporal dynamics of the forest fragments in line with landscape ecological themes. Attributes such as landscape classification and fragment dynamics are based on recent developments in remote sensing and Geographical Information Systems. The taxa that we study include the large and small mammals, trees, birds and dung beetles that live in these forests. We describe species assemblages and structure against the spatial and temporal attributes of the forest fragments.

CERU also provides opportunities for post-graduate research on the relevant topics under this banner and links up with stakeholders in Mozambique to build capacity in the implementation and application of the management in this unique landscape. Read recent publications and reports relevant to this initiative.

(The above summaries were copied from the CERU Website (www.ceru.up.ac.za), with permission of Prof Rudi van Aarde; photographs by Rudi van Aarde)