CERU abstracts for papers presented at the South African Wildlife Management Symposium: 13-16 September 2009, Protea Hotel Black Mountain, Thaba 'Nchu

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The megaparks for metapopulation research initiative: where are we and where are we going?

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The 'megaparks for metapopulations' metaphor provides a platform for conservation initiatives that integrates temporal and spatial dynamics. The metaphor relies on range expansion to activate spatial dynamics that allows for local instability, but regional stability in numbers driven by dispersal and resource related changes in birth and death rates induced by density dependence. Landscape fragmentation compressed most of southern Africa's elephants into eight clusters of conservation areas that account for almost 70% of Africa's elephants. A metapopulation perspective may accommodate this spatial structuring and allow for a regional conservation plan to moderate local impacts.

Our research suggests that the spatial structuring of elephants is a function of density. Density related differences in spatial activities impinge on demographic rates and provides a mechanism that can explain regional asynchrony and density dependence in population growth. The regional management of elephants may thus be modeled as a metapopulation, thereby providing an ecological basis for existing regional resource and conservation management initiatives.

Forest patchiness as a driver of bird diversity in Maputaland.

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The forest patches in southern Mozambique's Maputaland support high levels of diversity and endemism. The response of species to the fragmented nature of this forested landscape should be considered in conservation planning exercises. We used island biogeography and metapopulation theories to examine the response of bird assemblages to patchiness driven by natural forces.

We used a Bray-Curtis similarity index to compare the bird species composition of the four forest types and a power function to describe the relationship between number of bird species and fragment size and isolation separately for each forest type. We tested for modality in frequency occupancy of the bird species in forest fragments and used a Temperature Calculator to determine whether the bird assemblages had a nested structure.

We recorded 20 forest dependent and 69 forest generalist bird species at 220 survey points in 30 forest fragments that ranged in sizes from 5 ha to 7,432 ha and that were 100 to 5,100 m apart. Apart from the generalist species in the swamp forest, bird species composition was similar for the four forest types. Only in swamp forests did fragment size and isolation explain the number of forest dependent bird species per fragment. Occupancy models showed a random distribution for forest dependent birds and forest generalists had a uni-modal distribution. Both the forest dependent and generalist bird assemblages had a non-nested structure. The presence of eight rare forest dependent and four endemic bird species in 22 of the 30 fragments contributed to the non-nested nature of bird assemblages.

Forest patchiness did not induce expected responses to area and isolation, nor could we find evidence for metapopulation dynamics. Non-nestedness may be due to the few rare and endemic species occupying a wide range of patch sizes and isolation. All forest fragments in the region therefore should be included in a conservation network that will cater for rarity and endemicity typical of the Maputaland region.

An alarming decline of several coastal dune forest bird assemblages.

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Several recent reports reveal startling declines of bird populations in Australia, Europe, and North America. However, very little quantitative data exists for the rest of the world, where monitoring has not been a priority. We present perhaps the first community-wide assessment of an African bird assemblage based on a 15-year monitoring program in the coastal dune forests of South Africa. We calculated the trend in number of species recorded over time and assessed variables describing the local environment as determinants of community trend. We also calculated species population trends and evaluated aspects of each species' ecology as covariates of population trend.

Like elsewhere, this bird community is in trouble. It lost 5% of its species per year, representing a halving of the number of species over the 15-year study period. Similarly, 87% of species for which we could estimate reliable trends have declined. Habitat loss and rainfall apparently drive community trends. However, species trends were associated with range extent and clutch size. These results implicate both local and continent-wide drivers of population and community decline. Additionally, this study extends the widespread pattern of bird decline recognized in Australia, Europe, and North America to Africa.

Demographic support for metapopulation structure amongst southern Africa's elephants.

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Elephant conservation management is controversial. Where elephants occur at high densities, they may threaten biodiversity and the livelihoods of people, while at low densities they may face extinction with adverse consequences for ecosystems. Applying metapopulation theory may be an alternative to traditional management options to manipulate elephant numbers (i.e. culling, translocation and contraception). Metapopulation dynamics may induce local instability in numbers that lead to regional stability in numbers. Here we investigate whether elephant populations in southern Africa adhere to one of the criteria required for metapopulation dynamics. We test for demographic asynchrony reflected by growth rates for populations on a regional and local scale. We found spatial and temporal asynchrony among populations on both scales. Regionally (across southern Africa) elephant numbers were stable, while locally numbers fluctuate. We suggest that metapopulation processes, operating across an ecological gradient in a spatial matrix, within and among conservation clusters may stabilize elephant numbers on the sub-continent. Our results highlight the importance of space for elephant management and present options for an alternative solution to manage elephants.

Do historical changes in landscape patterns dictate colonization? A case study on regenerating coastal dunes.

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For decades, the spatial structure of habitats has been cited as an important factor contributing to the persistence of many species. However, human induced habitat loss and fragmentation alters the spatial structure of habitats and threatens biological diversity. This has stimulated much research on the distribution and dynamics of species in patchy landscapes. Fragmentation causes insularity and the Equilibrium Theory of Island Biogeography is frequently used to predict or explain the effects of fragmentation. Fragmentation of the Kwa-Zulu Natal coastal dune forests may have started during the Stone Age but more recent economic activities (mining, tourism, agriculture, silviculture) may have accelerated the rate of fragmentation. This may impair forest regeneration through rehabilitation efforts.

Remnant forest patches may serve as source patches for fragments earmarked for rehabilitation through ecological succession. However, the increased distances between source and regenerating patches may impair dispersal. Using GIS and remote sensing we documented how the shape, size and distribution of forest and regenerating patches changed over 70 years along 24 km of coastline. We then related these changes to the presence of forest specialist millipede, bird and tree species as recorded over the past 15 years.

We expected fewer forest-specialists in regenerating patches that were further away from source patches, had more edge, and were small than in patches that were close to sources, had less edge, and were large. We also predicted an increase in specialist species richness as regenerating patches increased in age and connectivity.

Patch characteristics alter the likelihood of colonization and thus have implications for restoration planning. This also holds for our study area, which is part of the Maputaland-Pondoland Biodiversity Hotspot and is experiencing increased economic development initiatives.

Dealing with human-elephant conflict; a landscape approach in Mozambique.

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Conservation Areas in Mozambique are embedded in human-dominated landscapes where people and elephants share several resources. Conservation efforts that take a landscape approach may accommodate the diverse needs of both species. We developed resource selection function (RSF) models based on landscape features and resources to characterize the distribution of both people and elephants and that may predict the probability of human-elephant conflict (HEC) across space and time. We overlaid locations of both species onto the landscape map with a set of specific features and resources in the ArcGIS environment and then ran GLM to build a RSF model that use 5 X 5 km grid cells. We validated our models with observed species-occurrence records and questionnaires for HEC assessment.

Human and elephant resource selection models overlapped in space and time and predicted HEC in the landscape. Anthropogenic landscape features (e.g. roads) followed by habitat characteristics and finally, the frequency of occurrence of preferred food species, explained elephant distribution. The distribution of people depended on subsistence economy landscape features in accordance to Central Place Theory. The latter best predicted HEC. The elephant range predictive model was best explained by distance to settlements and to water. The predictive power of our HEC model was supported by a Kappa Statistic of 0.83. The elephant range RSF model agreed with the Futi Corridor boundaries that have been proposed by Mozambican government. We argue that our landscape approach to elephant conservation adds to conservation planning in human dominated landscapes.

Stranger danger? Non-native plant invasion in habitat restoration.

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The presence of non-native species has the potential to disrupt ecological succession and may derail restoration efforts. However, successional systems may be able to filter out non-natives that generally adopt a ruderal life-history. We describe the temporal trends of the native and non-native plant community in the herbaceous layer of a chronosequence of regenerating coastal dune forest. Our results indicate several barriers to non-native invasion exist at different stages of regeneration, but only after the colonisation window closes at seven years of regeneration. Non-native life-history can explain their ability to persist and spread within regenerating coastal dune forest. Our work suggests that the combined effects of non-native life-history and successional changes in the resident community structure can reduce non-native invasion and despite increases in abundance, eventually non-native spread.

Environmental determinants of spatial use by elephants: a case study in Zambia.

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The distribution of water, rainfall, primary productivity, topography, and proportions of different vegetation types drive spatial utilization by savannah elephants. However, spatial use is altered by human densities, roads and fences that either restricts range utilization and/or dispersal. Such modifications have implications for human-elephant conflict and for the impact that elephants may have on vegetation.

We initiated a study that uses natural and anthropogenic variables to explain elephant spatial utilization in Zambia based on satellite GPS location data from five bull and fifteen cow elephants in the Luangwa valley and the Kafue National Park. In this ongoing study distance to water, amount of rainfall, NDVI as a measure of primary productivity, altitude, vegetation type, human density, and distance to roads and fences are recorded for each location point and for a similar number of randomly located points in each of the study areas. Logistic regression models will be used to define the relationship between groups of independent variables and the response variable (elephant presence or absence). The resulting candidate models will be assessed using Akaike information criterion (AIC). We predict that the best model to explain elephant spatial utilization will consist of natural and anthropogenic variables. This may explain regional heterogeneity in elephant distribution that may drive metapopulation dynamics in a landscape matrix that includes human activities.

Elephants and people in the landscape: a case study in the Caprivi region.

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The distribution of key resources and the presence/absence of people dictate landscape utilization patterns of elephants. Elephants prefer habitats with high vegetation heterogeneity and appear to use space in a way that reduces contact with people. The increase in people and elephant numbers in the Caprivi region of Namibia may impair transfrontier conservation initiatives in the KAZA region. This honours project aims to relate spatial utilisation patterns to human densities across a part of the Caprivi that links elephant sub-populations in the KAZA region.

We use data from nine elephants satellite tracked from 1993-1995 and six elephants tracked from 2007-2009, as well as human density and distribution data. We calculated human density within and beyond each elephant's utilization distribution (90% Kernel home range) and then compared these values for the early period to that in the later period. Because the density of people in the area has increased over time, a decrease in the human density ratios of utilized and non-utilized areas suggests that elephants avoid landscapes dominated by people. A constant density ratio shows that elephants may not be selecting, or may be selecting at a finer scale (requiring within home range location analysis). An increase in the density ratio suggests that elephants may not be affected by human density, or may use other methods to avoid contact with people (altering seasonal or temporal behaviour).

Understanding how humans dictate landscape utilization of elephants contributes to conservation and management, specifically through a better understanding of metapopulation dynamics, and is necessary if the future needs of both humans and elephants are to be met.