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Indigenous forests of Mpumalanga Province (South Africa); patterns and processes for inclusion in a systematic conservation plan

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ABSTRACT

Systematic conservation planning (SCP) relies fundamentally on spatial information about the distribution of biodiversity, and applying the principles of conserving a representative sample of biodiversity pattern that can persist over time, and the translation of conservation objectives into explicit quantitative targets. My thesis focuses on the development of appropriate data sets to include Mpumalanga Province's indigenous forests (South Africa) within a regional SCP. My aim is to investigate and describe forest pattern and ecological processes at appropriate scales to inform a provincial SCP assessment. A large data set consisting of 506 plots of 20 m x 20 m sampled the indigenous forests in and around Mpumalanga to inform the identification of SCP forest features and conservation targets. The current National Forest Classification (NFC) identifies forest types at a national scale, inappropriate for a regional assessment. I identified a hierarchy of forest subtypes, nested within the NFC based on Flexible beta ($\beta = -0.25$) clustering and Bray-Curtis resemblance measure. This classification procedure is selected after a detailed evaluation of available methods to identify a robust numerical classification technique, optimising on statistically identified faithful species. Fourteen forest subtypes are distinguished within three national forest types. I propose that the Wakkerstroom Midlands Forest Subtype be embedded within the Northern Highveld Forest Type, and not the Low Escarpment Mistbelt Forest Type as is currently recognised in the NFC. The proposed forest subtypes are described in terms of dominant plant families and genera, growth forms, seasonality or leaf retention characteristics, and the proportion of forest dependant species. A total of 125 plant families, 375 genera and 619 species are identified to occur in the Mpumalanga forests, with the most abundant species per family being Rubiaceae (33 plant species), Fabaceae (26), Celastraceae (25), Orchidaceae (23), Euphorbiaceae (22), Aspleniaceae (21) and Apocynaceae (20). 76% of all forest plant species are obligate forest species and 80% of all tree cover is evergreen. The identification and understanding of underlying ecological processes is informed by the analysis of three scales of environmental variables and geographic space on forest composition using variation partitioning and ordination. I propose the application of semivariogram analysis to categorise environmental variables into three scales of influence (local, regional and supra-regional scales). The largest fraction of variation is explained by the regional variables (45%), followed by the effects of supra-regional (21%) and local variables (19%). Using the full floristic data, both the environmental and geographic variable matrices accounted for 55% of observed variation. Geographic space (23%) partially explains the important role of dispersal in influencing variation in species patterns across all forest strata, even in the herbaceous stratum where the substantial contribution of dispersal is unexpected. My analysis provides insight into the relative contributions of environmental variables and the scale of their influence, and highlights the importance of dispersal in explaining forest vegetation patterns in Mpumalanga. The use of

ecological processes within SCP is still in its infancy, particularly in light of the threat of climate change. I propose a new method based on graph theory that incorporates dispersal distance to identify connectivity importance values for each forest patch based on their contribution towards landscape connectivity. Minimum patch distance is informed through a dispersal range ensuring 75% of flora can disperse between patches. The connectivity analysis supports resilience and persistence in SCP scenarios. Finally I needed to set quantitative targets for the pattern and process features for their inclusion within a SCP. With an overarching goal of ensuring that at least 75% of all species are represented by at least one individual within each forest subtype in a SCP, I utilised the Species Area Relationship (SAR) to determine the slope of the relationship and to estimate the proportion of area required to represent 75% of species. The number of plots in my data set was low for certain forest subtypes, which necessitated an approach of utilising highest values from estimators of species richness and integrating forest subtype targets with those for forest types of a higher level in the NFC. I integrate forest connectivity into pattern targets as a precautionary approach given the vulnerability of naturally disconnected forest patches and the importance of emigration and immigration of plant diaspores in maintaining forest composition across a network of small forest patches. The resulting forest pattern targets ranged between 24.9% and 49.7% for forest subtypes, with a mean value of 34.8%. I also propose forest process targets for more spatially fixed processes, such as the important forest patches supporting connectivity, as well as the spatially flexible buffers around each priority forest patch. Spatially fixed forest process targets are set at 100% and for spatially flexible forest processes the targets are set at 60% of original extent. Consideration also needs to be given to design criteria that can assist in developing a framework for prioritising conservation actions based on vulnerability and irreplaceability.