Landscape and Urban Planning 146 (2016) 43–50

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Crowned eagle nest sites in an urban landscape: Requirements of a large eagle in the Durban Metropolitan Open Space System

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HIGHLIGHTS

- Eagle nest site preferences were examined on a landscape scale.
- Nearest neighbour distances were less than in natural landscapes within the Region.
- Most nests were in green-space zones near an interface with formal residential areas.
- An exotic invasive *Eucalyptus* tree was the most frequently used nest tree species.

ARTICLE INFO

Article history:
Received 14 July 2014
Received in revised form 12 June 2015
Accepted 17 October 2015
Available online 9 November 2015

Keywords:
Crowned eagle
Stephanoaetus coronatus
Urbanisation
Nest site preference
Raptor

ABSTRACT

Globally, dramatic land use change typical of urbanisation negatively affects biodiversity, especially for top predators. The Durban Metropolitan Open Space System (D'MOSS), South Africa, faces the challenge of conserving biodiversity in a regional hotspot in the face of rapid urban growth in one of Africa's major commercial hubs. Consequently, we investigated nest site selection of crowned eagles (*Stephanoaetus coronatus*) on various spatial scales within this urban mosaic. Unexpectedly the inter-nest distances were small in this human-dominated landscape. However, breeding sites were not evenly distributed through the landscape and were closely associated with natural forest, while nest trees were most frequently in patches of exotic large riverine Sydney blue gum (*Eucalyptus saligna*, Smith 1797) within the D'MOSS planning zones. Crowned eagles showed a strong tendency to avoid informal settlement areas; however they were tolerant of proximity to established formal settlements and occupied dwellings. Consequently, continued protection of the D'MOSS system, and a considered approach to management of *E. saligna* are necessary for the persistence of the crowned eagle in this landscape. Future research should focus on food requirements, post-fledging survival, and recruitment to determine which nest sites are most productive and whether this population is acting as a source or a sink.

1. Introduction

With the extensive and rapid land transformations of urban growth there is an increasing urgency to protect indigenous biodiversity, either by urban densification or optimal integration of wildlife habitats into urban sprawl (Dallimer, 2011; Ramalho & Hobbs, 2012). Raptors are widely considered as an indicator clade for ecosystem health (Sergio, Newton, Marchesi, & Pedrini, 2006; Sergio et al., 2008). Raptor populations are important for regulating food webs and are a visible indicator of trophic dynamics in ecosystems (Faeth, Warren, Shochat, & Marussich, 2005; Sekercioglu, 2006). Many raptors have more sensitive requirements for nesting resources and lower tolerance of human disturbance than their prey species (Tapia, Kennedy, & Mannan, 2007; Møller, 2008). Similarly, small-sized raptor species are more able to adapt to the fragmented urban landscape than larger species (Chace & Walsh, 2006). By considering the preferences of sensitive raptors, particularly those of threatened species, landscape planning strategies can be optimised to enable the richest biodiversity and conservation benefits (Cade, Martell, Redig, Septon, & Tordoff, 1996; Simmons, Rodrigues, Woodcock, Steyn, & Jenkins, 2007; Sanderson & Huron, 2011; Isaac, White, Ierodiaconou, & Cooke, 2013).

The crowned eagle (Gill & Donsker, 2014) (*Stephanoaetus coronatus*, Linnaeus 1766) is the third largest predatory raptor in Africa (*ca.* 3.6 kg, Hockey, Dean, & Ryan, 2005). Its status has recently been revised to Near Threatened globally (IUCN, 2013), which aligns with a long standing regional status of Near Threatened (Barnes, 2000).

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http://dx.doi.org/10.1016/j.landurbplan.2015.10.004
0169-2046/

Regionally, the crowned eagle is expected to soon be uplisted to Vulnerable (Martin Taylor, pers. comm.). The crowned eagle has a long reproductive cycle, producing one young per breeding attempt either biennially (Brown, 1976; Tarboton & Allen, 1984; Swatridge, 2009), or annually in cases of abundant prey and/or juvenile mortality (Fannin & Webb, 1975; Vernon, 1984; Malan, 2005; Oatley, 2008). Their nests are vast structures at established sites (over 2 m in diameter and 3 m deep), with new material added every breeding season (Tarboton, 2001). In many cases, they show high site fidelity using particular locations for decades and perhaps even generations (Brown & Amadon, 1989). In indigenous forests, their nests are positioned in a canopy-isolated emergent tree; however, in South Africa a variety of other nest locations are known including forested cliffs and exotic trees such as *Eucalyptus* spp. and conifers (*Pinus* spp.) (Tarboton & Allen, 1984; Malan & Shultz, 2002). To date, the major natural threat to their breeding success is antagonism by primates, especially baboons (*Papio* spp.) which disturb brooding females and kill undefended nestlings (Brown, 1971; Hockey et al., 2005). The most important microhabitat variable driving their nest site position is flight accessibility, particularly the need for an easy approach for nest building, prey delivery, and nest defence (Tarboton & Allen, 1984; Skorupa, 1989; Malan & Shultz, 2002). Meanwhile, their nest site selection on a landscape scale have been scarcely.

The crowned eagle is adapted to primary afro-tropical forest, but can occupy marginal woodland mosaic habitats where suitable nesting trees are available such as riverine and gallery forest patches (Tarboton & Allen, 1984). In southern Africa, a contiguous population of crowned eagles along the eastern escarpment region occupies *Eucalyptus* timber plantations, nesting in mature 'escapee' *Eucalyptus* and indigenous trees in riparian patches surrounded by forestry plantations (Swatridge, Monadjem, Steyn, Batchelor, & Hardy, 2014). Minimum nearest neighbour distances between nests are variously reported as; "1 mi" (1.6 km Kenya, rounding not specified), 2 km (Eastern Cape), 2.5 km (Mpumalanga), 6 km (Western Cape), and 4 km in Zimbabwe (Tarboton & Allen, 1984; Shultz, 2002; Hockey et al., 2005). The most thorough local-scale population study calculating minimum home range requirements, estimated breeding pair density at 6.5 km^2 in pristine afro-tropical forest, with mean nearest neighbours 1.81 km apart (Shultz, 2002).

A population of crowned eagles has been documented breeding in close proximity to urban settlements of southern KwaZulu-Natal (KZN) province of South Africa, the location of the large cities of Durban and Pietermaritzburg, and a series of coastal towns and resorts (Malan & Shultz, 2002; Hoffman & Hoffman, 2009; McKibbin, 2009). This is the largest population known to the authors in high association with urban landscapes. The city of Durban faces the challenge of conserving biodiversity in a regional hotspot in the face of rapid urban growth in one of Africa's major commercial hubs. The Durban Metropolitan Open Space System (henceforth D'MOSS) has been demarcated by the municipal authority as a network of green spaces of high importance for ecosystem services and biodiversity. The objective of this study was to define the limiting factors of crowned eagle nest sites on a landscape scale, and inform the future planning strategies of the metropolitan area to enable persistence of the crowned eagle population. Based on the requirements of crowned eagles for suitable nest trees (Malan & Shultz, 2002), and the effects of tolerance thresholds in a landscape of anthropogenic disturbance (Møller, 2008), we predict that in the urban environment, nest sites would be close to streams inside large patches of natural forest, while being further from roads, occupied dwellings, and human land cover classes than random locations.

2. Methods

2.1. Study site

The wider area of interest included 20,000 km^2 of KZN, South Africa, south and east of the coordinate S29° E30° (Fig. 1, inset). The western majority of this area is comprised of inland

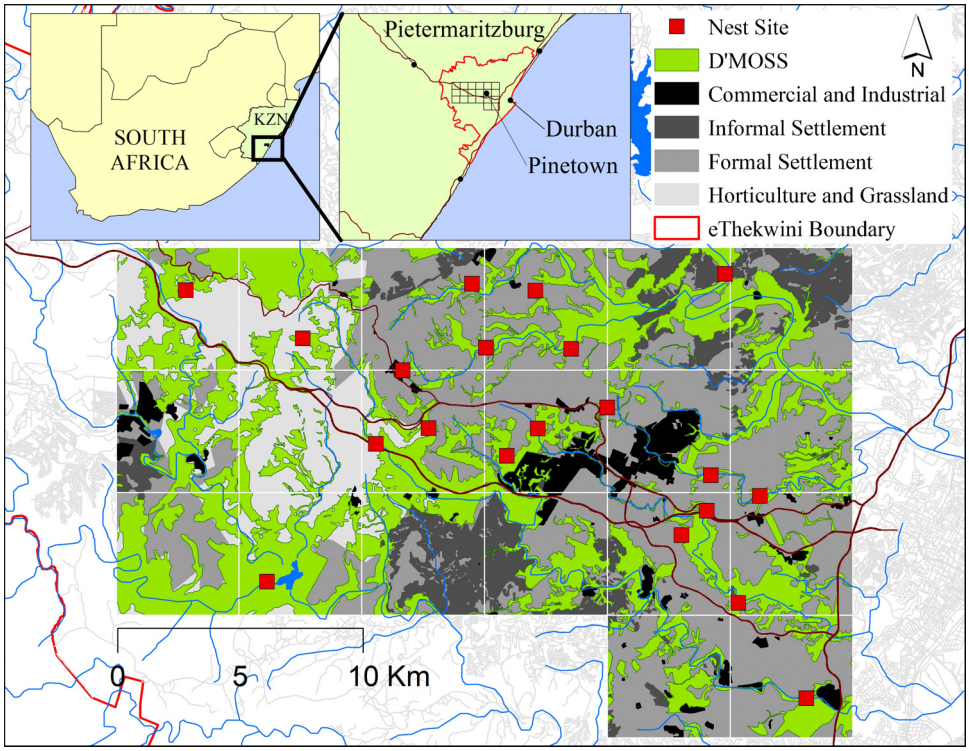

Fig. 1. The 500 km^2 study area within the eThekwini Municipality (inset). Crowned eagle nest sites presented in relation to a set of twenty 25 km^2 grids and aggregated land cover classes.