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Don't judge habitat on its novelty: Assessing the value of novel habitats for an endangered mammal in a peri-urban landscape

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ABSTRACT

Novel ecosystems are increasingly common worldwide, particularly in areas heavily impacted by humans such as urban and peri-urban landscapes. Consequently, interest in their potential contribution to biodiversity conservation is growing, including their ability to sustain populations of threatened species. However, few studies have explored whether novel habitats can support viable populations over time and how they compare to less modified, remnant habitats.

We investigated the capacity for novel habitats to support an endangered mammal, the southern brown bandicoot (*Isoodon obesulus obesulus*: Peramelidae), in a highly-modified landscape near Australia's second largest city, Melbourne. We compared bandicoot abundance and body condition between five novel and two remnant sites, and examined whether novel sites support residency and key demographic processes necessary for bandicoot population persistence. We found that bandicoot abundance was higher at novel than remnant sites, with the highest abundance at the novel site with the most urbanised surroundings. Female body condition was similar between novel and remnant sites. The majority of bandicoots at novel sites were resident, and breeding activity, recruitment of first-year adults, and survival of mature adults were observed at all novel sites.

Our results demonstrate the potential significance of novel habitats for conserving threatened species within heavily-modified landscapes, and encourage us not to judge the quality of habitats on their novelty alone. Broadening our appreciation of the potential value of novel ecosystems could increase off-reserve species conservation opportunities, a key priority within the context of the Anthropocene and unprecedented global change and biodiversity loss.

1. Introduction

Traditional conservation practice places strong emphasis on the retention or restoration of historically continuous ecosystems, while generally conferring lower value upon those that have been altered by humans (Heller and Hobbs, 2014; Hobbs, 2016). There is an underlying assumption that species of conservation interest will fare more poorly as human dominance of land use increases - coined the 'Human Threat Hypothesis' by Lawson et al. (2008). However, these traditional approaches are of questionable value when faced with the prospect of "novel" ecosystems - which, by definition, have been fundamentally altered by humans (whether advertently or inadvertently) and now cannot feasibly be returned to their historical states (Hallett et al., 2013; Hobbs et al., 2006).

In today's rapidly-changing world, no part of the Earth's surface is free of human influence and novel ecosystems are increasingly prevalent (Ellis et al., 2010; Vitousek et al., 1997). They are characterised by new species compositions (resulting from species invasions and local extinctions) and/or new abiotic settings (resulting from climate and land use change) (Hallett et al., 2013; Hobbs et al., 2006), and are hence particularly common in areas of heavy human impact such as urban and peri-urban landscapes (Kowarik, 2011). Along with the proliferation of novel habitats has come an increasing demand to consider their potential importance for biodiversity conservation (Daily, 2001; Ellis et al., 2010; Hobbs et al., 2006; Hobbs et al., 2013).

An important conservation role that novel ecosystems might play is in supporting populations of rare or threatened species (Dearborn and Kark, 2010; Kennedy et al., 2012; Kowarik, 2011). Various studies have shown that threatened species can sometimes occur in novel habitats. For example, Ives et al. (2016) found that areas within and surrounding Australian cities support a greater richness of threatened species than non-urban areas on a unit-area basis, even after accounting for factors such as net primary productivity and distance to the coast. Similarly, Shwartz et al. (2014) found 80 papers documenting the presence of rare

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Fig. 1. Location of novel (Sites A–E) and remnant (RBG Cranbourne and Quail Is. NCR) field sites. Stippled area represents the estimated extent of the former Koo-Wee-Rup Swamp (from the reconstruction by Yugovic and Mitchell (2006). Modelled native vegetation cover (DSE, 2005) is shown in light grey and nature conservation reserves are shown in darker grey. Current urban growth boundaries are represented by a heavy grey line. Inset: location of the study area within Australia.

or threatened species in urban environments. The potential for novel ecosystems to support threatened species therefore warrants serious consideration.

However, species occurrence alone is insufficient to ascertain whether novel habitats are supporting self-sustaining populations, since they could represent ecological "sinks" or "traps" where survival and/or reproductive rates are too low to sustain viability over time (Battin, 2004; Johnson, 2007; Pulliam, 1988; Van Horne, 1983). For example, Isaac et al. (2014) found that urban environments may act as an ecological trap for the threatened Powerful Owl (*Ninox strenua*), which appears to use habitat and food availability (arboreal mammals) as cues for settlement, despite a lack of tree cavities that are essential for breeding and therefore population persistence. Thus, to truly evaluate the potential of novel habitats to support threatened species, studies need to go beyond simple documentation of species occurrence and quantify more informative metrics of individual- and/or population-level fitness such as condition, survival, reproduction and demographic features (Johnson, 2007; Van Horne, 1983).

Comparative studies can provide a direct contrast of the performance of threatened species in novel vs. historically intact habitats; however, few have been conducted. In a meta-analysis conducted by Shwartz et al. (2014), only three out of 80 studies (~4%) documenting threatened species presence in urban environments explicitly tested the performance of urban populations in comparison to those in nearby more intact remnant habitats. Further research is therefore required to build general understanding of the comparative performance of threatened species between novel and more historically intact habitats.

We investigated the capacity of novel habitats to support an endangered mammal, the southern brown bandicoot (*Isoodon obesulus obesulus*: Peramelidae), in a peri-urban landscape near Melbourne, Australia. Bandicoots occur at both novel (narrow linear strips of vegetation retained along roads and other linear infrastructure) and remnant sites (large patches of native vegetation retained within conservation reserves) across this region, providing an ideal opportunity to study their performance in relation to habitat novelty. Our study thus aimed to: (i) compare bandicoot abundance and body condition between novel and remnant sites; and (ii) determine whether novel sites were capable of supporting residency and key demographic processes (breeding, recruitment and survival) necessary for population persistence.

Based on the Human Threat Hypothesis (Lawson et al., 2008), we predicted that novel sites would offer lower quality habitat than remnant sites, and that bandicoots at novel sites would thus demonstrate: (i) lower abundance and female body condition than at remnant sites; (ii) low levels of residency (as individuals continued to seek better quality habitat); and (iii) compromised breeding, recruitment and survival. Better understanding the capacity of novel sites to support *I. o. obesulus* will assist in determining management priorities for this threatened species in this unique landscape, and more broadly, improve knowledge regarding the conservation potential of novel ecosystems to conserve species amidst ongoing and widespread environmental change.

2. Materials and methods

2.1. Study species & study area

The southern brown bandicoot (hereafter, "bandicoot") is a medium-sized (≤1600 g) ground-dwelling marsupial endemic to south-eastern Australia. Listed nationally as "endangered", the species was once considered common but has suffered significant decline over the past ~230 years since European settlement, now occupying a patchy and reduced distribution within its former range (Brown and Main, 2010). Previously associated with a range of native vegetation types with dense understory vegetation, suitable habitat is now defined as any patches of native or exotic vegetation within the species' distribution with understorey vegetation structure having 50–80% average foliage density in the 0.2–1 m height range (DOEE, 2017).

Approximately 70 km south-east of Melbourne, bandicoots now occur within the area once covered by the "Koo-Wee-Rup" or "Great" Swamp, which was the largest swamp in Victoria prior to being drained from the 1870s to allow agricultural use of the fertile lands (Yugovic and Mitchell, 2006). This novel landscape now comprises a matrix of small townships, grazing pastures and intensive-use cropping, traversed by a network of drainage channels. Remaining vegetation, which includes a high proportion of exotic plant species, is concentrated in