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Human residential status and habitat quality affect the likelihood but not the success of lapwing breeding in an urban matrix

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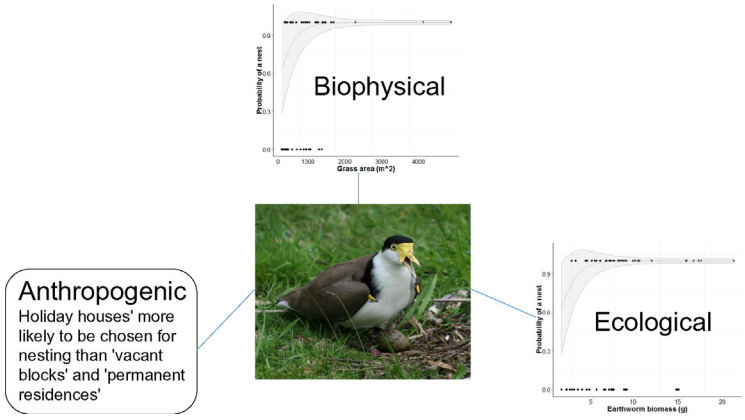
HIGHLIGHTS

- Lapwings nested less frequently in residential properties with greater human usage.
- Greater food availability and grass area increased nesting likelihood.
- None of these variables influenced clutch size or the probability of eggs hatching.
- Larger clutches and higher hatching rates tended to be associated with more food.
- Habitat quality is not homogenous at the scale of the house block.

GRAPHICAL ABSTRACT



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ABSTRACT

Wildlife living in the suburbs faces the challenge of dealing with human presence and yard management (including the occurrence of pets) which vary at the scale of the house block. This study examined the influence of ecological factors (e.g. extent of grass and food availability) and anthropogenic factors (e.g. human activity and garden usage) on breeding site choice and reproductive success of the ground-nesting masked lapwing *Vanellus miles* on Phillip Island, Australia. Lapwings nested less frequently in residential properties (high levels of human usage) compared with vacant blocks and holiday houses. They were also more likely to breed on properties with high food availability and larger areas of grass. None of these variables influenced clutch size or the probability of eggs hatching, although larger clutches and higher hatching rates tended to be associated with more food. This study shows that, for an urban exploiting species, habitat quality is not homogenous at the scale of the house block, and that human activity is avoided by a species generally considered highly tolerant of people.

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1. Introduction

In human-dominated or altered environments, animals may respond to both ecological and anthropogenic factors. Those species that cope may use evolved traits to deal with evolutionarily novel circumstances, such as urban habitats, traits which vary between species and circumstances and which themselves may be influenced by human imposed landscape change (Meffert and Dziock, 2013). One critical trait is the decision on where to breed. An animals' choice of breeding site has critical repercussions on foraging, reproduction and parental investment and individuals should preferentially be attracted to and choose the highest quality sites available (Barea, 2012; Clark and Shutler, 1999; Orians and Wittenberger, 1991). However, evolutionary (and ecological) traps can occur when anthropogenic disruption causes life-history or behavioural decisions to become maladaptive (Fletcher et al., 2012; Schlaepfer et al., 2002). While such processes essentially represent 'cue-disruption', the cues used by animals, such as birds, to choose breeding sites and the resulting fitness consequences are inadequately understood (Clark and Shutler, 1999; Kivelä et al., 2014). Many potential cues or factors might influence the selection of a breeding site, including ecological factors (e.g. food availability and microclimate) and anthropogenic factors (e.g. human presence and the presence of their companion animals) (Cuttriss et al., 2015; Mikula et al., 2014; Weathers and Sullivan, 1989; Weston et al., 2012b).

Within the broad nesting preferences of bird species, the physical structure of habitats is often associated with choice of a nest or breeding site. For example, birds may base their choice of breeding site on specific factors such as distance to water, nest substrate, tree type and height, canopy cover, field of view and aspect (Barea, 2012; Götmark et al., 1995; Makrigianni et al., 2008; Mikula et al., 2014; Misenhelter and Rotenberry, 2000). Biophysical attributes of a breeding site can influence critical parameters such as predation risk, provisioning efficiencies and microclimate (Martin, 1998). Microclimate is also an important predictor of breeding success, because nesting in an inadequate microclimate may upset incubation rhythms resulting in lowered hatching success and alter general activity at the nest which may attract predators (Smith et al., 2012; Weathers and Sullivan, 1989).

One of the most influential ecological factors in the selection of a breeding site is the availability of food, a critical resource for parental survival and the raising of young (Chalfoun and Martin, 2007; Orians and Wittenberger, 1991). Many studies conclude that food availability near the preferred breeding sites is a major influence on choice of breeding site because it can directly affect reproductive success (Barea, 2012; Crampton and Sedinger, 2011; Singh et al., 2010; Zanette et al., 2003). Higher food availability may also underpin greater parental investment in breeding, such as through increased clutch sizes (Hořák et al., 2015).

The cues used by animals to inform the choice of breeding site and the resulting fitness consequences are further complicated by the presence of humans in urban environments. For example, humans can directly destroy eggs and young (Sheldon et al., 2007; Weston and Elgar, 2005) and can have indirect effects, because birds respond to them as they would predators, and such responses can reduce the quality of parental care (Weston et al., 2012a). However, other studies have also shown that supplementary feeding by humans can benefit some species, especially in urban habitats (Tryjanowski et al., 2015). The effect of human presence on avian choice of breeding site is complicated and poorly understood, because studies have primarily focused on the effects of human disturbance on reproductive success (Chace and Walsh, 2006). Few studies examine the effect of human disturbance on avian breeding or courtship site selection (Burnside et al., 2014; Chen et al., 2011; Webber et al., 2013), and we know of few such studies for birds breeding in urban areas (e.g. Mikula et al., 2014).

Perhaps the fastest growing habitat type is suburban ecosystems (Grimm et al., 2008). For species which persist in urban areas, the urban matrix does not represent a habitat of homogenous quality. Instead, biophysical, ecological and anthropogenic factors vary at a human-specified scale, where homeowners intensively manage their properties in different ways such that they offer potential breeding sites of different quality (Loram et al., 2011; Mikula et al., 2014). The exact factors which are used by birds to select breeding sites in the urban matrix are unknown, however, such factors may include phenology of the environment and vegetational structure (Loram et al., 2011; Møller et al., 2015). Understanding such factors may enable the promotion of certain species over others, and potentially indicate ways in which the urban matrix can provide habitat for at least some species. This study characterises breeding sites of a common, urban exploiting, ground-nesting bird (the masked lapwing, *Vanellus miles*) that is subject to localised anthropogenic disturbance. The specific aims of the study were to examine whether lapwings exhibit a preference for particular breeding sites in the urban matrix, and if so, what factors influence breeding site selection. Such factors may include ecological (e.g. physical characteristics of breeding site and food availability) and anthropogenic factors (e.g. prevailing human occurrence and land usage). The influence of these factors on reproductive success is also examined.

2. Methods

2.1. Study area and species

Fieldwork was undertaken on Phillip Island, southern Victoria, Australia (38° 29.112′ S, 145° 13.787′ E) (Fig. 1) between May and September 2013. Masked lapwings are a common ground-nesting bird, regarded as an urban exploiter (Cardilini et al., 2013). Phillip Island harbours an abundant population of masked lapwings, many of which reside in urban areas (Cardilini et al., 2013; Lees et al., 2013). The island is effectively free of predatory red foxes *Vulpes vulpes* (Kirkwood et al., 2005). Human-masked lapwing interactions are common (usually bird aggression towards humans), especially on private residential properties (Lees et al., 2013). The urban areas are characterised by moderate-high density housing with 'house blocks' (i.e., standard-sized parcels of land with dwellings) interspersed with a smaller number of 'vacant blocks' (i.e., standard-sized parcels of land without dwellings). A high proportion of the houses on Phillip Island are 'holiday houses', meaning they are unoccupied for large proportions of the year, especially during winter when masked lapwings are breeding. The fundamental spatial unit adopted by this study is a 'site'. Sites consist of either a yard (an enclosed or demarcated front or backyard of a private property), or a vacant block, typically with an area of approximately 800 m^2.

2.2. Locating breeding pairs and nests

Systematic searches for nests occurred on private residential properties (vacant and house blocks) in the major urban areas including the townships of Cowes (38° 27′ 1.18″ S, 145° 14′ 20.93″ E), Ventnor (38° 27′ 54.05″ S, 145° 10′ 56.75″ E), Wimbledon Heights (38° 28′ 48.96″ S, 145° 14′ 4.09″ E), Surf Beach (38° 30′ 40.45″ S, 145° 17′ 41.39″ E), Sunderland Bay (38° 30′ 18.72″ S, 145° 16′ 42.49″ E) and Cape Woolamai (38° 31′ 30.25″ S, 145° 20′ 12.78″ E) (Fig. 1). Breeding pairs were found by searching from vehicle or foot, or by information provided by the public (advertising material was distributed). Upon discovery of a nest, location and number of eggs within a nest was recorded. Each egg was numbered with a non-toxic felt-tip permanent marker and age was estimated from the float angle (Liebezeit et al., 2007).

2.3. Experimental design

The purpose of the study was to compare breeding presence (i.e., 'nest') sites with breeding absence ('control') sites to identify