Landscape and Urban Planning 159 (2017) 42–47

Contents lists available at ScienceDirect

Landscape and Urban Planning

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

Research paper

Joggers cause greater avian disturbance than walkers

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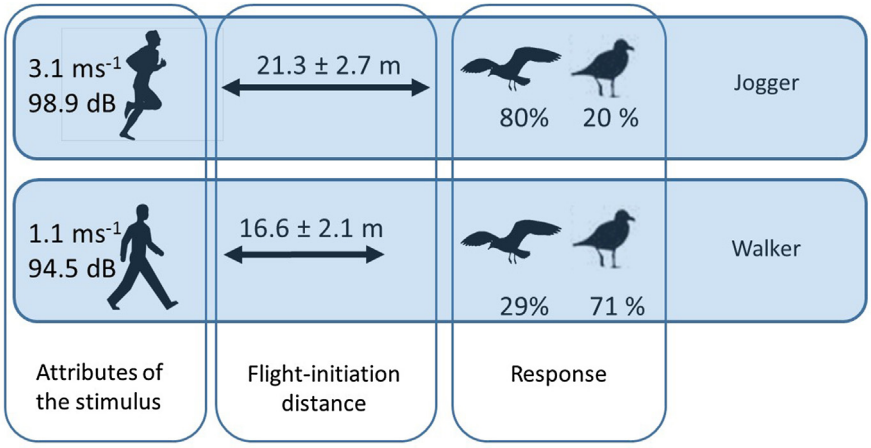
HIGHLIGHTS

- Joggers loom faster in an animal's visual field and make more noise than walkers.
- Joggers evoke escape responses of birds at longer distances than for walkers.
- Escape responses were more intense when birds encountered joggers.
- Risk perception in birds does not always accord with human preconceptions.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 2 July 2016
Received in revised form 18 August 2016
Accepted 22 August 2016

Keywords:
Running
Jogging
Flight-initiation distance
Escape
Recreation
Birds

ABSTRACT

Human recreational activities are increasing in natural areas where they potentially disturb the normal activities of wildlife. Prolonged disturbance can be detrimental to animals and may ultimately lead to decreasing wildlife populations in highly disturbed areas. However, little is known regarding how wildlife assesses the risk of human-related activities and whether escape responses are accordingly modulated. For example, although walking is the most common pastime in many natural areas, jogging is becoming increasingly common. Joggers move faster than walkers and may therefore be perceived by wildlife as a greater threat. However, this concept has rarely been tested. In addition, the specifics of how joggers and walkers are visually and acoustically perceived by wildlife are unknown. We predict: 1) that joggers loom more rapidly in the animal's field of view than walkers, and they also create more noise, especially on certain substrates; and, 2) that joggers will evoke escape responses at longer distances and/or of greater intensity than walkers. We demonstrate that joggers loom more rapidly, and they also create more noise, especially on gravel surfaces. For eight of the ten bird species tested, individuals fled earlier and/or displayed more intense escape responses (e.g. flying instead of walking away) to joggers than walkers. These findings suggest that land managers should not only regulate the type of stimulus that may disturb wildlife,

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http://dx.doi.org/10.1016/j.landurbplan.2016.08.020
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but also the speed at which they move through the environment. Activities such as jogging, which are generally regarded as low impact, may create more wildlife disturbance than previously thought.
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1. Introduction

Anthropogenic disturbance to wildlife can constitute a conservation problem (Burger, 1981; Weston & Elgar, 2005). A growing human population with increasing mobility, access and use of open public space, will likely result in increased disturbance to wildlife worldwide (Gill, Sutherland, & Watkinson, 1996). The response of an animal to the presence of a stimulus, such as a human, results in behavioral and physiological disruption referred to as disturbance (Weston, McLeod, Blumstein, & Guay, 2012). Disturbance is detrimental and can result in the displacement of wildlife from preferred habitats, increased energy expenditure associated with escape responses, decreased foraging time and interrupted behavioral displays, among other effects (Blumstein, 2003; Burger, 1995; Pienkowski, 1992; Sutherland, 2007; Weston & Elgar, 2005; Weston & Elgar, 2007). Increased human disturbance has been linked to species declines (Dowling & Weston, 1999) and, on several continents, species that are more sensitive to human disturbance are more likely to experience population declines (Møller, Samia, Weston, Guay, & Blumstein, 2014). Given that exclusion of humans from many natural areas is not viable, the need to facilitate coexistence (human use of habitats which also harbor viable wildlife populations) between humans and wildlife is intensifying.

Flight-initiation distance (FID) is the distance at which an animal initiates escape behavior in response to an approaching threat, such as a human. It is used as a quantitative index of the degree of perceived risk posed by the stimulus (Weston et al., 2012). Land and conservation managers can develop buffer zones that exclude human-activities from sensitive wildlife habitat (e.g. Rodgers & Schwikert, 2002; Rodgers & Smith, 1995). The size of these buffers should ideally be based on the FIDs of species that are to be protected (Fernández-Juricic, Venier, Renison, & Blumstein, 2005; Weston et al., 2012). FIDs can also be used to identify the zone of disturbance associated with the stimulus or define minimum approach distances (MADs) to animals by wildlife enthusiasts (Guay, van Dongen, Robinson, Blumstein, & Weston, 2016; Holmes, Giese, & Kriwoken, 2005; Schlacher, Weston, Lynn, & Connolly, 2013; Weston, Antos, & Glover 2009; Weston et al., 2012).

A diverse range of anthropogenic stimuli can disturb wildlife. These stimuli differ markedly in form and approach speeds, which may influence the distance at which they are tolerated by wildlife. For example, birds modulate their FID in response to various human-associated stimuli (Burger, 1981; McLeod, Guay, Taysom, Robinson, & Weston, 2013; Weston et al., 2012). Birds can also vary responses based on subtle aspects of human behavior (Ristau, 1992). However, to date, available FIDs are overwhelmingly derived from single walkers and comparatively few from other human activities, such as groups of walkers, walkers with dogs, joggers, buses, cars, bicycles, canoes, and boats (but see Glover, Weston, & Maguire, 2011; Glover, Guay, & Weston, 2015; Lord, Waas, Innes, & Whittingham, 2001; McLeod et al., 2013). Given the current skew in FID data towards single walkers, the application of existing FID data to manage disturbance may underestimate the distances required to mitigate disturbance. A comprehensive understanding of which stimuli elicit more frequent or intense avian responses will aid conservation decisions and determine whether specific management of different stimuli could reduce disturbance (Glover et al., 2011; Weston et al., 2012).

Jogging is a common recreational activity where a person often moves substantial distances at a speed above walking pace. Joggers use natural areas extensively (Knight & Gutzwiller, 1995) and thus theoretically interact with many bird species, with the potential of causing disturbances. However, little research has targeted the impact of jogging on wildlife. Only 2% of a comprehensive dataset on the FIDs of Australian birds to a range of human-associated stimuli currently contains responses to joggers (Guay et al., 2016). In addition, experiments using jogging/running as a stimulus type (Glover et al., 2011; Lord et al., 2001) make up only 2% of FID studies (see McLeod et al., 2013), and these mostly focus on shorebirds. Glover et al. (2011) reported that joggers were more threatening than walkers for three of eight shorebirds, whilst Lord et al. (2001) found that the speed at which the investigator was travelling had no significant effect on measured responses of incubating New Zealand Dotterels *Charadrius obscurus*.

Despite some research demonstrating that joggers may be more threatening to birds than walkers, little is known regarding why this pattern may arise. Joggers approach wildlife more rapidly than walkers which presumably results in quicker looming i.e. the rate of increase within the visual field (see, for example, Dill, 1974). However, joggers may also produce more noise than walkers and therefore be more acoustically detectable or threatening. If wildlife detect approaching threats acoustically, or if volume is perceived to be associated with more risk, the substrate upon which the approach occurs may also influence FIDs. Some substrates commonly used by humans (e.g. gravel paths) may produce louder sounds than others (e.g. grass). These hypotheses have yet to be tested but have important implications for management regimes in areas with diverse human activities and substrates.

This study compares the responses of Australian bird species to joggers versus walkers, with a view to informing management of avian disturbance. We experimentally characterize the visual and acoustic attributes of walkers and joggers, from the point of view of wildlife, as they approach on either a grassed or gravel surface. Specifically, we expect more rapid looming and more noise by joggers than walkers, with both walkers and joggers making more noise on gravel over grass. We then quantify differences in FIDs of birds in response to joggers and walkers and document whether escape strategies differ between the two stimuli. We expect joggers are perceived as more threatening and will evoke longer FIDs. As flying is more costly than walking (Bautista, Tinbergen, & Kacelnik, 2001), and is thus a more intense escape response, we predict that birds are more likely to fly away in response to jogging.

2. Methods

2.1. Acoustic and visual characterization of stimuli

We characterized attributes of the stimuli, in terms of acoustic and visual cues. Such cues were measured during walking and jogging mock approaches. Starting Distance (SD, the distance at which an approach commences) was 50 m on both grass and gravel substrates. Mock approaches were conducted by a jogger and walker on gravel (N = 7 and 8, respectively) and grass (N = 10 and 8, respectively). Approaches were made toward recording equipment (Roland R-26 portable digital recorder, sensitivity set to high, and ME62/K-6 omni-directional Sennheiser microphone), securely

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