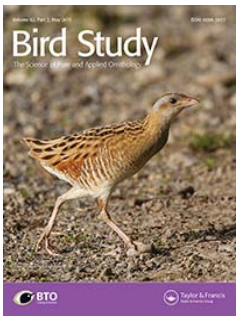

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SHORT REPORT

The height of approaching humans does not affect flight-initiation distance

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Capsule Responses of animals to anthropogenic disturbances are often quantified using flight-initiation distance, the distance at which an animal flees a stimulus such as a person. We showed that the height of 20 researchers, selected to represent a diversity of heights, did not affect estimates of flight-initiation distance of Black Swans *Cygnus atratus*, suggesting that the height of humans used to test hypotheses of flight-initiation distances is not a confounding variable.

The presence of threatening stimuli (e.g. predators or people) is typically associated with disturbance, i.e. potentially costly changes in physiological or behavioural states (Weston *et al.* 2012). The behavioural response of animals to stimuli typically involves multiple, escalating, stages which culminate in escape (Ydenberg & Dill 1986). The distance at which the animal flees is known as the 'flight-initiation distance', a metric commonly used by wildlife managers to create buffer zones that minimize human-induced disturbance (Weston *et al.* 2012) and by ecologists interested in optimal anti-predator escape strategies (Stankowich & Blumstein 2005). Indeed, flight-initiation distance may be associated with long-term population trends in birds (Møller *et al.* 2014).

The growing interest in flight responses has led to an increase in publications and data sets on flight-initiation distance for a range of species (Blumstein 2003, Glover *et al.* 2011, Møller 2008), including comparative studies using multiple data sets (Møller *et al.* 2014, Symonds *et al.* 2014) and the generalized application of estimates for species management (Burger 1998, Rodgers & Schwikert 2002, 2003). However, flight responses are highly labile and may correlate with a range of factors, including distance from the nearest refuge, perceived risk and previous experience with threats (Stankowich & Blumstein 2005). In addition, as estimates of flight-initiation distance are typically obtained by humans approaching the focal animal (henceforth 'researchers'), researcher attributes may also affect estimates. For example, flight-initiation distance varies with the type of stimulus used, clothing colour worn by the researcher, and the speed and angle of approach (Gutzwiller & Marcum 1993, McLeod *et al.* 2013, Møller & Tryjanowski 2014, Stankowich 2008). As multiple researchers are often required when collecting large data sets, biases in the data may occur as a result of these attributes, which may threaten the comparability of data sets.

Height is an attribute of researchers that may potentially affect flight-initiation distance estimates. Given that the size of predators typically influences their perceived threat (Palleroni *et al.* 2005, Stankowich & Blumstein 2005) and that distances may partly be judged by stimulus size (Dill 1974), animals may regard taller researchers as being more threatening. Larger objects may also be easier to detect. However, the effect of researcher height has not been previously explored in this context. We investigated the possible effects of researcher height on flight-initiation distance on a population of Black Swans *Cygnus atratus*. Black Swans typically forage on land, are easily observed at a distance and their flight-

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initiation distance is relatively easy to quantify making them an ideal species in which to study subtle influences of human morphology on responses. We recruited a group of novice researchers of differing heights. We have previously shown that inter-observer variation was low when estimating flight-initiation distance (Guay *et al.* 2013b). We predicted that flight-initiation distances to taller researchers would be greater than those of shorter researchers.

This study was conducted between July and September 2013 at Albert Park Lake, Victoria, Australia (37°50'S, 144° 58'E). The site contains a 48.5-ha artificial lake with extensive grassy areas around its perimeter, where the Swans often forage (Guay *et al.* 2013a). Most individuals at the study site had been fitted with neck collars displaying a unique identification number, allowing accurate individual identification at a distance (Guay & Mulder 2009, Mulder *et al.* 2010).

Twenty volunteers (16 females, 4 males) were recruited. We ensured that a wide range of heights was represented (155–192 cm, 170 ± 11 cm [mean ± sd throughout]), to maximize the possibility of detecting an effect of researcher height on flight-initiation distances. In contrast, the heights of volunteers used for our previous multi-researcher study (Guay *et al.* 2013b) were much less variable (171–179 cm, 174 ± 3 cm, $n = 5$). All researchers were trained in the protocols involved in effectively measuring flight-initiation distances, and all aspects were standardized.

Researchers were aware of the general study question and were asked to collect flight-initiation distance data in their own time. This was coordinated such that no two researchers were at the field site on the same day. To minimize the effect of researcher clothing all researchers wore similar clothing, i.e. long dark trousers and a dark long-sleeved top. Researchers circumnavigated the lake alone and randomly selected focal Swans that were foraging on land. Only Swans that were not currently disturbed and at least 10 m away from other people were sampled. Only Swans with neck collars were used in this study to allow the incorporation of Swan identity as a random effect in our statistical analyses.

Once a focal Swan was chosen, a marker was dropped on the ground to indicate the starting position. The focal Swan was then approached parallel to the shore and at a slow walking pace (c.1 ms^{-1}). Flight-initiation distance and starting distance were defined after Weston *et al.* (2012). Distances (±1 m) were measured using a Bushnell Elite 1500 range finder. Individual Swans were not approached multiple times on the same day. When Swans occurred in a flock, the closest Swan to the researcher was chosen for the approach, and no others in the flock were approached that day. Data were collected under Victoria University Animal Ethics Committee Permit AEETH 15/10, National Parks DEPI Scientific Permit 10005536.

Flight-initiation distance depends on both starting distance (Blumstein 2003) and the distance from the closest refuge (Guay *et al.* 2013a), we included starting distance and distance from the shoreline as covariates in our models. Standardization of starting distances was deemed unfeasible, so we statistically controlled them as is commonly done (McGiffin *et al.* 2013, Rodriguez-Prieto *et al.* 2009). We also included the sex of the focal Swan in our model (after Guay *et al.* 2013a). Our analyses included an average of 14.4 ± 5.7 (3–22) observations of flight-initiation distance per researcher. Flight-initiation distance was estimated for each Swan used in this study by an average of 3.0 ± 1.8 researchers (1–10 flight-initiation distance estimates per Swan, $n = 97$ Swans). We therefore conducted generalized linear mixed models (GLMMs) incorporating both researcher ID and Swan ID as random effects. Response variables followed a Poisson (with logit link) distribution. When estimating the means of the response variables across all trials, we avoided using repeated measures from the same researcher or Swan as independent data points. Instead, we first calculated an average value for each researcher (when calculating starting distance means) or for each Swan (when calculating flight-initiation distances) and then used these researcher- or Swan-specific means to calculate global means across all trials.

The starting distance of all trials was 34 ± 13 m (11–60 m; $n = 20$). Focal Swans initiated a flight response at an average of 7 ± 5 m from the researcher (0.3–28 m; $n = 97$). Starting distances did not vary with researcher height (GLMM: effect = −0.009 ± 0.009, $F_{1,282} = 1.0$, $P = 0.32$). Similarly, the height of the approaching researcher did not correlate with flight-initiation distance of the focal Swans, nor did Swan sex or distance from the shoreline (Table 1). Flight-initiation distance was strongly positively associated with starting distance.

The height of approaching researchers did not influence the flight-initiation distance of Swans at an urban lake. This suggests that the use of multiple researchers of various heights is unproblematic when collecting flight-initiation distance data and that researcher height probably does not need to be taken

Table 1. GLMM showing the effects of researcher height, starting distance, distance from the shoreline and focal bird sex on the flight-initiation distances of Black Swans. Researcher and Swan identities were included as random effects. The intercept was not significant (effect = 1.220 ± 0.913, $t = 1.4$, $P = 0.18$).

Factor	Effect	*F*	df	*P*
Height	−0.001 ± 0.005	0.1	1,282	0.80
Starting distance	0.022 ± 0.003	50.1	1,282	<0.01
Distance from shoreline	−0.001 ± 0.001	1.1	1,282	0.30
Sex (male/female)	0.000/0.164 ± 0.105	2.5	1,282	0.12

into account for cross-database or cross-researcher comparisons.

The absence of a height effect may arise for several reasons. First, the large size of Swans or their low levels of responsiveness at the study site may mean that they do not perceive approaching humans as a significant threat and therefore do not pay attention to differences in human height. However, Dill & Houtman (1989) demonstrate that highly habituated Grey Squirrels *Sciurus carolinensis* still modulate their escape response with different stimuli. Second, the range of heights of the researchers may not have been variable enough to elicit detectable differences in flight-initiation distances. In our study, the coefficient of variation of researcher heights was only 6%; in previous studies demonstrating variation in anti-predator behaviour in response to predator size, the sizes of predators were much more variable (e.g. coefficients of variation in predator lengths of 34–44%; Palleroni *et al.* 2005, Templeton *et al.* 2005). However, the range of heights used in this study (155–192 cm) is very representative of natural variation in human heights (Australian Bureau of Statistics 2012) and therefore likely to be typical of most studies of flight-initiation distance evoked by approaching humans.

This study provides evidence that the height of researchers used to collect data on flight-initiation distances in Black Swans does not affect the response of the focal individual. Although the generality of these results is unknown (i.e. across different populations or species) they indicate that the use of multiple researchers of varying heights is probably justified when collecting data sets. This is in contrast to other researcher-related attributes, such as clothing colour, and the speed and angle of approach, all of which are known to affect estimates of flight responses.

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