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Behavioural responses of feral goats (*Capra hircus*) to helicopters

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Abstract

Helicopters are commonly used for managing wildlife populations, but their effect on wildlife behaviour is poorly understood and often ignored by managers. Changes in behaviour can adversely affect wildlife, compromise assumptions of survey methods, and reduce the effectiveness of management operations. In this study, we investigated the behavioural responses of free-ranging feral goats to helicopters and the main determinants of alert behaviour in response to helicopters. Ground-based reporters made 784 observations of feral goat groups during 34 standardised helicopter surveys used to estimate abundance. Feral goats were often alert (44% of observations) and, in 31% of observations, moved (up to 1.5 km) in response to helicopter over-flights but no feral goats were observed to be injured nor did any post-partum females desert their young in response to over-flights. Regression analyses indicated that the distance from the helicopter and prior activity were the most important factors influencing the extent of alert behaviour and the distance moved in response to helicopter disturbance. The responses of herds of goats in different home ranges were variable, and cumulative survey time, type of helicopter and the density of herds also influenced behavioural responses. Results indicated that, while long-term effects of helicopter disturbance on feral goat behavioural ecology are minimal, short-term changes in behaviour frequently occur and should be considered when using helicopters to manage feral goats.
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Keywords: Aerial survey; Alert behaviour; Anti-predator response; Aversion; *Capra hircus*; Feral goats; Helicopters

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1. Introduction

Any activities that involve low-flying aircraft, particularly helicopters, may affect the behaviour and ecology of wildlife both during and after over-flights. Such activities include recreation (Stockwell et al., 1991), exploration (Cote, 1996), infrastructure maintenance (e.g. electrical power lines, Whitworth et al., 2001), mustering of livestock (Fleming et al., 2002), the monitoring of wildlife population density (Pople, 1999), and management of pests by shooting (Bayne et al., 2000) and baiting (Fleming et al., 2000).

Mustering and shooting from aircraft can be considered as 'intrusive', causing changes in behaviour that can reduce the effectiveness of future management by targeting or removing a biased proportion of the population (Bayne et al., 2000), causing injury (Cote, 1996) and reducing detectability (Saunders, 1988). The use of aircraft for surveying, tourism or exploration is often assumed to be 'non-intrusive'. However, these uses can also potentially result in short-term or long-term changes in animal welfare (e.g. Cote, 1996), movement patterns (Linklater and Cameron, 2002), foraging behaviour (Stockwell and Bateman, 1987; Stockwell et al., 1991) and breeding behaviour (Fjeld et al., 1988). These changes in behaviour can compromise assumptions when surveying from a helicopter (Bleich et al., 1990): an alert or flight response may cause animals to hide reducing detectability; resultant movement between transects can result in recounting (Linklater and Cameron, 2002); and induced movement into denser vegetation can bias assessments of habitat use.

Behavioural responses of ungulates to disturbance by helicopters are essentially equivalent to anti-predator responses, such as increased vigilance, altered group sizes and movement to adjacent habitat (FitzGibbon and Lazarus, 1995; Hunter and Skinner, 1998). Anti-predator responses to disturbance by helicopters can potentially cause a range of negative impacts to ungulates including; immediate physical injury (Cote, 1996), increased energy expenditure (Stockwell et al., 1991), changes in physiological condition (MacArthur et al., 1979), and long-term changes in behaviour, such as shifts to poorer feeding sites (Calef et al., 1976; Larkin, 1996).

Temporal changes in the responses of wildlife to noise disturbance are well known (Koehler et al., 1990). Most animals become less responsive to sounds emitted at regular intervals and where the apprehended threat is not reinforced, a process referred to as habituation (Thompson and Spencer, 1966). Habituation to aircraft over-flights has been reported in muskoxen (*Ovibos moschatus*) experiencing frequent flights of helicopters (Miller and Gunn, 1980), desert mule deer (*Odocoileus hermionus*) exposed to low-flying single-engined aeroplanes (Krausman et al., 1986) and pronghorn (*Antilocapra americana sonoriensis*) on an air force base (Krausman et al., 2004).

The converse of habituation, aversion, is usually associated with a threat or apprehended threat. Saunders (1988) found a significant decrease in the number of feral pigs (*Sus scrofa*) observed in aerial surveys subsequent to harassment by a helicopter where shooters aimed close to but not at feral pigs. A marked increase in evasive behaviour of feral goats was observed after a program of shooting from a helicopter (Bayne et al., 2000). Calef et al. (1976) observed that caribou (*Rangifer tarandus*) were more responsive to non-intrusive' helicopter flights in a subsequent year and suggested that animals became sensitised to aircraft as a result of frequent flights.

The responses of wildlife to aircraft over-flights range from slightly increasing vigilance (e.g. mink [*Mustela vison*] response to jet aircraft, Brach, 1983) to panic response, where animals flee over large distances for extended periods (e.g. mountain sheep [*Ovis canadensis*] in response to helicopters, Bleich et al., 1990). The severity of response to disturbance may vary with species (Miller and Gunn, 1979), group size (Czech, 1991), social groups (Miller and Gunn, 1980), sex and age (Lenarz, 1974), vegetation cover (Krausman et al., 1986), season (Stockwell et al., 1991),

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