Response of White-winged Nightjars *Eleothreptus candicans* to a prescribed burn of cerrado grassland at Bosque Mbaracayú Biosphere Reserve, Paraguay

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SUMMARY

The White-winged Nightjar *Eleothreptus candicans* is a globally threatened nightbird of the open savannas of central South America. Previous observations, suggesting that the species has a preference for recently burnt habitats, have potentially been confounded by the increased detectability of individuals and the lack of availability of unburnt habitats following extensive wildfires. This study attempted to address these limitations by monitoring the response of three radio-tagged nightjars (which had already been tracked for ≥10 months) to an experimental burn, overlapping with 16–33% of their pre-burn home ranges, at Bosque Mbaracayú Biosphere Reserve in eastern Paraguay. Overall, 10 (24%) of the 42 nocturnal radio-tracking fixes obtained during eight weeks of post-burn monitoring were within the burnt area. One individual entirely avoided the burn parcel following the burn, but the other two showed no significant preference for the burnt area. None of the seven diurnal roost sites located during post-burn monitoring was within the burn parcel. This apparent lack of an active preference for burnt habitat, at least during the first two months immediately following a fire, adds weight to recommendations for more active fire management in the few protected areas where the species persists, in order to reduce the frequency of the periodic uncontrollable and extensive wildfires that typically occur at present.

BACKGROUND

The White-winged Nightjar *Eleothreptus candicans* (or *Caprimulgus candicans*) is a small caprimulgid of the open savannas of central South America, where it is currently known from just four sites in northern Bolivia, south-central Brazil and eastern Paraguay (Pople 2011). As a consequence of its restricted distribution and the ongoing degradation of its '*cerrado*' (savanna) habitat, the species is listed as globally 'Endangered' on the IUCN Red List (BirdLife International 2012).

Prior to the discovery of the species in Paraguay in 1995, the ecology and habitat requirements of the White-winged Nightjar were poorly known. Records from Brazil suggested that it preferred areas of open grassland, and possibly even made local movements in response to fires (Collar *et al.* 1992). This apparent preference for recently burnt areas was also noted during subsequent observations in Brazil (Rodrigues *et al.* 1999) and Paraguay (Lowen *et al.* 1997, Capper *et al.* 2000).

Fire is a natural process shaping tropical savannas around the world, and wildfires have been a significant factor in the cerrado for thousands of years (Mistry 1998). At present, most fires are the result of agricultural activities to clear land for crop planting or to

promote fresh regrowth for cattle pasture (Coutinho 1990, Mistry 1998). Although cerrado is fire-adapted vegetation, the frequency, timing and extent of modern burns may now pose a threat to the ecological equilibrium of the system (Eiten 1972, Coutinho 1990). Active fire management has traditionally been avoided in cerrado protected areas, but prescribed burns are increasingly being recognised as a suitable management tool that can help to maintain more open habitats, reduce the build-up of combustible material and minimise the risk of uncontrollable wildfires (Pivello & Norton 1996, Mistry 1998).

Previous records of White-winged Nightjar suggesting a preference for recently burnt habitats have potentially been confounded by two factors: the increased detectability of nightjars (which are often located by their reflective eyeshine in the beam of a torch) in areas with little or low vegetation; and the fact that many wildfires are so extensive that individuals are left with no 'choice' of unburnt habitats within their normal ranges. This study aimed to address these potential limitations by monitoring the response of radio-tagged White-winged Nightjars to a limited burn in part of their home ranges.

ACTION

Study site: Aguará Ñu (*c*. 5,500 ha; 24°10'S, 55°17'W) is an isolated fragment of open-country habitats on the eastern edge of the Bosque Mbaracayú Biosphere Reserve, Canindeyú department, Paraguay. It is a low plateau, 170–270 m above sea level, bounded on three sides by rivers, and surrounded by a mixture of forest and agricultural land. Its weathered, ultisol soils support a range of habitats, including xerophytic woodland, palm savanna, '*campo cerrado*' (open grassland with scattered shrubs, trees and palms), islands of forest, seasonally wet grassland, marshes and gallery forest.

The present study was focussed on a small area in the southern sector of Aguará Ñu where a series of shallow valleys drain southwards into one of the boundary rivers. The drier soils of the ridge tops and upper slopes support campo cerrado vegetation, consisting primarily of grasses and herbs, but with a scattering of shrubs (e.g. *Cochlospermum regium* and *Caryocar brasilense*), palms (*Butia paraguayensis*), saplings and the occasional fully grown tree (e.g. *Tabebuia ochracea* and *Annona* spp.). The seasonally wet grassland of the lower slopes and valley bottoms is dominated by grasses (e.g. *Paspalum* spp.) and sedges (e.g. *Rhynchospora* spp.).

Wildfires are a regular occurrence at Aguará Ñu, particularly during the austral spring (e.g. August and September). Most are anthropogenic in origin – set by neighbouring landowners to clear cattle pasture and promote regrowth at the end of the dry season – but subsequently spread uncontrolled into the reserve. In August 1999, a particularly extensive and fast-moving wildfire burnt most of the campo cerrado and wet grassland habitat within the focal study area. A much smaller wildfire during October 2000 (re)burnt an area of approximately 15 hectares.

Experimental burn: The location of the experimental burn was selected to fall within the home ranges of three (two male, one female) radio-tagged White-winged Nightjars (hereafter 'nightjars') that had already been monitored for at least 10 months. The *c*. 9-hectare (*c*. 300 × 300 m) burn parcel was set up in a zone where the three ranges (as estimated by minimum convex polygons; MCPs) intersected, such that it overlapped with approximately 16% (M055), 26% (M057) and 33% (F066) of their MCPs (see also Fig. 2). The parcel primarily contained campo cerrado vegetation, with a small area (<2%) of wet grassland in the north-western corner. The controlled burn itself was carried out (later than initially planned) on 10 July 2001, towards the end of the non-breeding season for the study species.

Monitoring of nightjar habitat use: The three focal nightjars were each fitted with a TW-4 radio-transmitter with 20-cm flexible NiTi wire antenna (Biotrack Ltd., Dorset, UK). Radio-tags weighed *c*. 2 g, but did not exceed the recommended maximum of 5% of body weight (Kenward 2001). Tags were back-mounted, using a 'back-pack' harness design with two elastic wing loops, and had a battery life of from 18–25 weeks.

Radio-tagged nightjars were located using a Mariner M57 portable receiver (Mariner Radar Ltd., Suffolk, UK) and a hand-held 3-element Yagi aerial (Biotrack Ltd.). Because of the open habitat and relatively long distances from which nightjar eyeshine was visible, a 'homing' technique (White & Garrott 1990) was adopted, following transmitter signals until tagged individuals could be seen.

Although time-consuming, this method provides more reliable locational data than triangulation, and also allowed visual confirmation of the habitat used by individuals (as well as collection of behavioural data). All radio-tracking locations were recorded using a Magellan 2000 XL GPS receiver, which provided positional data to a precision of one metre.

A trial period of continuous radio-tracking during 1999 showed that the movement patterns of nightjars were ill suited to continuous monitoring, with radio-tracking locations temporally auto-correlated at sampling intervals of up to 150 minutes (the maximum tested; Pople 2003). As a consequence, a discontinuous radio-tracking regime was employed, with no more than one location collected per individual per night. Attempts were made to locate tagged individuals on 22 nights between 10 July and 2 September 2001, with searches also made for diurnal roost sites on six days during this period.

Analysis: As the purpose of the experimental burn was explicitly to investigate post-burn habitat selection by nightjars, habitats were simply categorised as 'burnt' or 'non-burnt' and post-burn patterns of usage were analysed using the exact binomial test for goodness-of-fit (McDonald 2009), with the 'expected' number of fixes within the burnt area based on the proportion of each individual's fixes that fell within the boundaries of the burn parcel during pre-burn monitoring (between August 2000 and June 2001).

CONSEQUENCES

During eight weeks of monitoring following the experimental burn, a total of 42 independent nocturnal radio-tracking fixes were obtained for the three focal nightjars (Table 1). Ten (24%) of these were within the burn parcel: two (for M055 and M057) on 20 July, 10 days after the burn, and eight (all for M055) in mid-August, 36–44 days after the burn. Of the seven diurnal roost sites also located during post-burn monitoring, none was within the burnt area.

The response of nightjars to the experimental burn appeared to differ between the three individuals (Fig. 1). In the case of M055, the number of post-burn nocturnal fixes in the burnt area did not differ significantly from that expected based on its pre-burn usage of the parcel (exact binomial test: $P = 0.78$). For M057, the spatial distribution of post-burn fixes did suggest some avoidance of the burnt area (Fig. 2b), but this was not found to be statistically significant ($P = 0.49$). In the case of F066, none of the post-burn fixes was in the burnt area, and the distribution was found to differ significantly from that expected based on its pre-burn usage of the parcel ($P = 0.018$; see also Fig. 2c).

Focal nightjars were observed actively foraging (e.g. flying from their perch) on only three occasions, all of which related to fixes outside the burnt area. Behavioural observations also revealed that several of the post-burn fixes obtained for the males from mid-August onwards (including the cluster of fixes for M055 within the burnt area; see Fig. 2a) were at or close to their nuptial 'display arenas' (see Discussion), with male display activity observed on at least four nights in late August and early September.

Discussion: Previous records of White-winged Nightjars in recently burnt habitats (Lowen *et al.* 1997, Rodrigues *et al.* 1999, Capper *et al.* 2000) have all related to birds located by visual cues and/or following extensive wildfires. This

Table 1. Distribution of nocturnal radio-tracking fixes for three nightjars during an eight-week period following an experimental burn partially overlapping with their home ranges.

Individual	Total no. of nocturnal fixes	No. (%) of fixes in burn parcel	Expected no. (%) of fixes in burn parcel [a]
M055	13	9 (69%)	8.2 (63%)
M057	13	1 (8%)	2.7 (20%)
F066	16	0 (0%)	3.8 (24%)
Pooled	42	10 (24%)	

[a] See Analysis section for details.

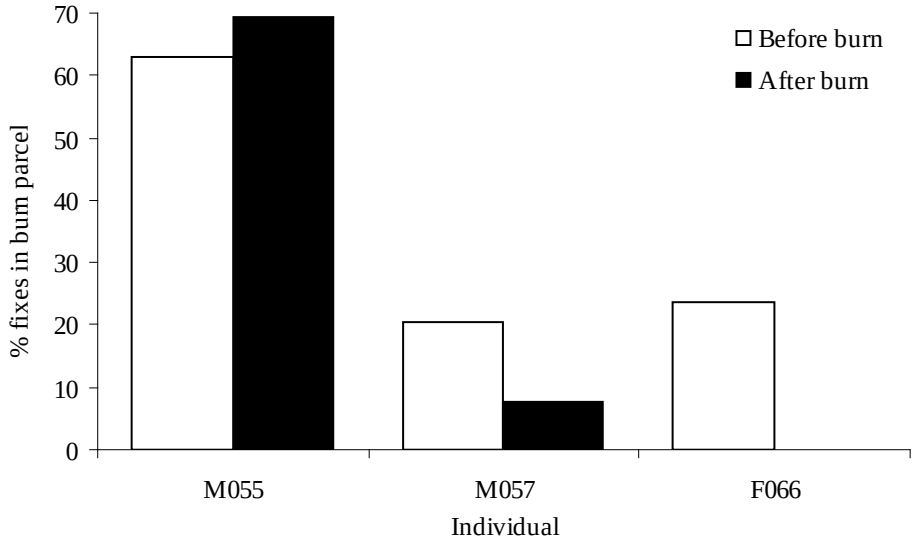

Figure 1. Proportion of radio-tracking fixes for three nightjars falling within the designated burn parcel before, and for eight weeks after, an experimental burn.

study is the first to have investigated the response of radio-tagged individuals to a managed burn, in an attempt to control for the potentially confounding factors of detectability and lack of habitat 'choice' (see Introduction). No evidence was found during the study for the active selection of recently burnt habitats by nightjars, at least not during the first two months immediately following the burn.

The apparent avoidance of the burnt area for diurnal roost sites was unsurprising given the almost complete lack of vegetation cover following a fire. Indeed, a more comprehensive analysis of roost-site selection suggested that, although individuals did on occasions use habitats that had burnt as little as two months previously, they generally avoided habitats burnt within the preceding six months when older vegetation was available (Pople 2003).

In the case of nocturnal radio-tracking locations, just two (of 14) fixes obtained during the first 30 days following the burn were in the burnt area, and the eight fixes inside the burn parcel during the second month (when nuptial activity started) all related to one male (M055) at or near its display arena. Other studies have shown that the locations of male display arenas may be traditional (Clay *et al*. 2000), and that, during the breeding season (late August to December), over 80% of fixes for males fell within 50 m of their display arenas (Pople 2003), so it is possible that the location of these post-burn fixes was influenced primarily by breeding-season territoriality.

By contrast, the focal female (F066) appeared to expand its home range following the burn (see Fig. 2c), and in the context of its complete avoidance of the burnt area, this could be interpreted as a response to the temporary 'loss' of suitable (foraging and roosting) habitat within its existing range. However, given that its pre-burn MCP was based on 63 fixes, obtained between August 2000 and June 2001 (and hence almost certainly an underestimate of the full extent of its range), and that this apparent expansion coincided with the onset of breeding activity (when females might be expected to range more widely, to visit male display arenas), this conclusion should be treated with caution.

Conclusions: A more extensive study of White-winged Nightjar habitat use (Pople 2003) found that individuals preferred younger, and avoided older, campo cerrado habitats when selecting foraging sites within their home ranges, possibly as a consequence of the abundant insect prey attracted to vegetation regrowing after fires (see also Rodrigues *et al*. 1999). However, the evidence from the current study suggests that there was no active preference for (and some, individual-specific, avoidance of) recently burnt habitats during the initial two months following a fire.

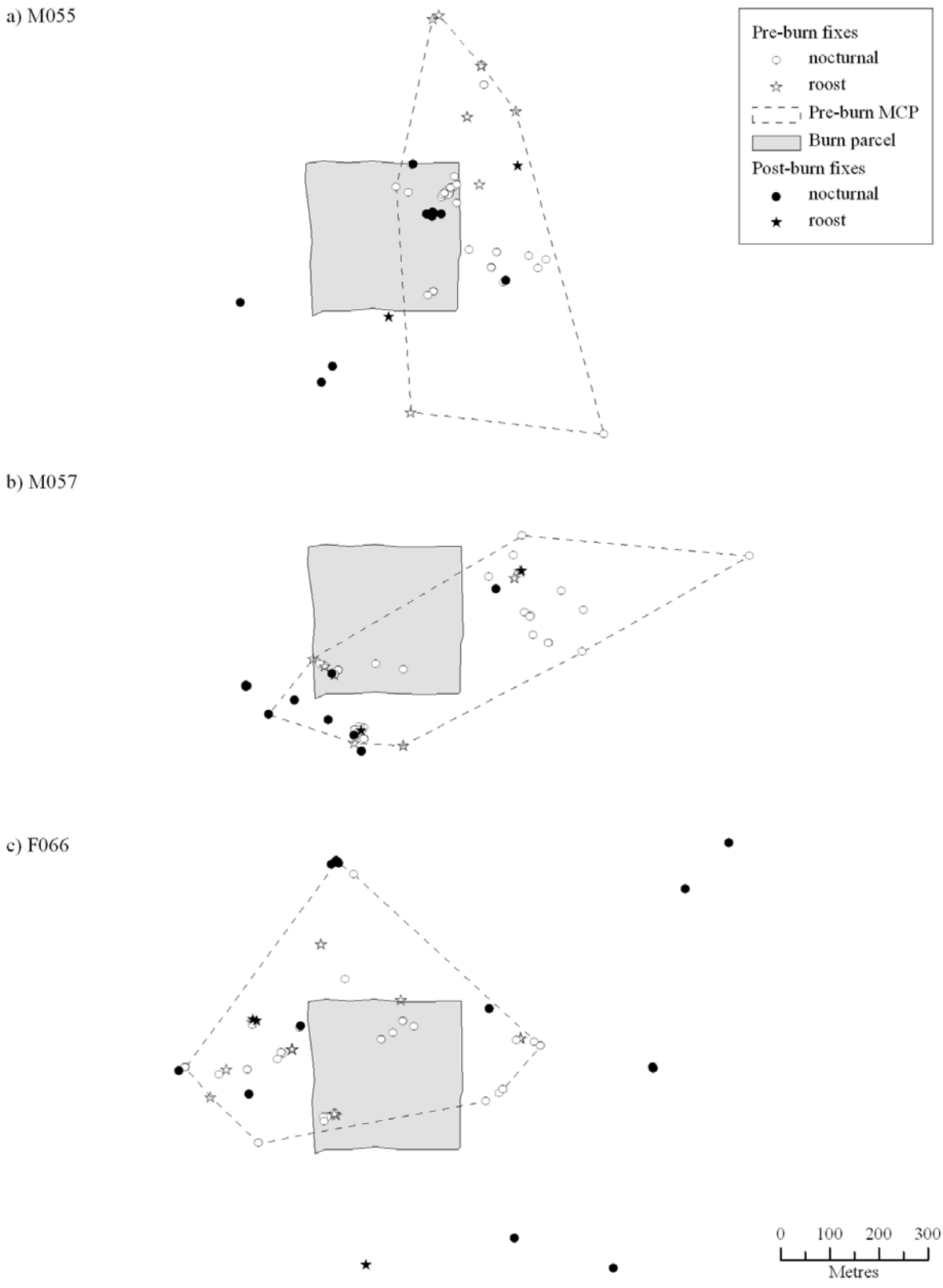

Figure 2. Distribution of nocturnal radio-tracking fixes and daytime roost sites for three radio-tagged nightjars before, and eight weeks after, an experimental burn partially overlapping with their pre-burn (minimum convex polygon; MCP) home ranges.

These findings lend weight to recommendations for more active fire management – including periodic prescribed burns – in the few protected areas where this globally threatened species is known to persist (e.g. Rodrigues *et al*. 1999, Capper *et al*. 2000), in order to maintain a 'mosaic' of different vegetation ages, and minimise the risk of uncontrollable and more extensive wildfires, which may have an adverse impact on the species (particularly during the nesting season).

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