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Burning season influences the response of bird assemblages to fire in tropical savannas

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ABSTRACT

Fire plays a pivotal role in structuring ecosystems and often occurs as a human-mediated disturbance for land management purposes. An important component of fire regime is the season of burn. In tropical savannas, most fire management occurs during the dry season; however, wet season burning is often used for pastoral management and may be useful for controlling introduced plant species. We used replicated, experimental fire treatments (unburnt, dry season burnt and wet season burnt), spanning two habitats (riparian and adjacent open woodland), to examine the short- (within 12 months of fire) and longer-term (within four years of fire) changes of bird assemblages in response to wet and dry season burning in tropical savannas of northern Australia. Within 12 months of fire, we observed higher abundances of birds in the burnt treatments, although some species (e.g., red-backed fairy-wren, *Malurus melanocephalus*) were rarely observed in burnt sites. Dry season burnt sites contained higher abundances of insectivores and granivores, while wet season burnt sites had more carnivores. Four years following burning, dry season burnt sites were characterized by lower abundances, especially of nectarivores and granivores. Dry season burnt sites also contained a different assemblage than wet season burnt sites, but few differences were observed between wet season burnt and unburnt sites. Our results confirm that differences in fire regimes can substantially alter bird assemblages, especially in riparian zones, and emphasize the importance of incorporating burning season in fire management strategies.

1. Introduction

Fire often occurs as a human-mediated disturbance and is frequently used as a land management tool. Disturbances, like fire, influence the structure of many ecosystems (see Whelan, 1995; Bond and Van Wilgen, 1996) by playing a pivotal role in determining environmental and biological heterogeneity (Brawn et al., 2001). Variations in the temporal and spatial aspects of disturbances alter the environment in dissimilar ways (Sousa, 1984), and thus, may consequentially influence fauna that are susceptible to changes in the environment, including birds. Bird assemblages are strongly influenced by habitat structure (MacArthur and MacArthur, 1961) and variations in the type of fire an area receives may govern the response of bird assemblages in the post-fire habitat (Smucker et al., 2005). Hence, the widespread use of fire as a land management tool will have important ramifications for conservation of biodiversity.

Previous studies in a variety of habitats have observed every possible bird assemblage response to fire [e.g., grasslands:

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Pons et al. (2003); tropical savannas: Woinarski (1990), Woinarski et al. (1999), Mills (2004); oak savannas and forests: Artman et al. (2001), Brawn (2006); conifer and pine forests: Hutto (1995), Saab et al. (2005); and rainforests: Barlow et al. (2002), Barlow et al. (2006)]. The responses of birds to fire are often related to changes in vegetation structure and the availability of resources in the post-fire environment (Woinarski and Recher, 1997; Davis et al., 2000; Brawn et al., 2001). Because the post-fire environment is influenced by fire regime, (Whelan, 1995), the responses of birds may also be dependent on fire regime (Woinarski and Recher, 1997; Smucker et al., 2005). Given that humans alter fire regimes by using fire as a land management tool, understanding how birds respond to fire regimes, including variations in intensity, frequency and season of burn, is crucial for conservation purposes.

1.1. *Season of burn: Fire in Australian savannas as a model system*

Fire influences the structure of many biomes, and is a key component in the maintenance of grassland and savanna ecosystems (Gillon, 1983), including Australian tropical savannas. Prior to human arrival in Australia, some 45 000 years ago (O'Connell and Allen, 2004), fire occurred via lightning strikes in the late dry or early wet season (Kershaw et al., 2002). However, Australian landscapes have been influenced by human-mediated fire for at least 5000 years (Bowman, 1998; Johnson, 2006), and fire is an important contemporary land management tool (Russell-Smith et al., 2003). The distinct wet and dry seasons of tropical savannas ensure that fires are frequent events (Russell-Smith et al., 1997) and season of burn is an essential component of fire regime. Fire potential increases as the dry season progresses, and the habitat is extremely fire prone late in the dry season, when fuel moisture contents is low (Gill et al., 1996). In contrast, fires in the early dry and wet seasons are usually of lower intensity and more patchy (Braithwaite and Estbergs, 1985).

Birds display a variety of responses to fire regimes in tropical savannas (Woinarski, 1990; Woinarski et al., 1999; Mills, 2004); although late dry season fires tend to detrimentally affect more bird species than early dry season fires. Additionally, inappropriate fire regimes have been linked to the decline of granivorous birds (Franklin, 1999; Franklin et al., 2005). As land managers increasingly use early-mid dry and wet season fires to reduce the potential of destructive late dry season fires (Crowley and Garnett, 2000; Williams et al., 2003), understanding how season of burn influences bird assemblages is critical.

In Australia, fire may be an important management tool for controlling the spread and extent of invasive plant species, including the globally distributed wood weed, rubber vine (*Cryptostegia grandiflora* R. Br.). Endemic to Madagascar, rubber vine damages the agricultural, economic and biodiversity values of northern Australia (Tomley, 1998; Valentine, 2006; Valentine et al., 2007). Fire can significantly reduce rubber vine survival, density, and vegetative growth, and may inhibit seed germination (Grice, 1997; Bebawi and Campbell, 2002). As rubber vine grows most prolifically in riparian zones (Tomley, 1998), the use of fire in these environments may increase. Riparian environments are an important element of tropical savannas, often characterized by a distinct bird fauna (Woinarski et al., 2000), and may be inappropriately disturbed by management burning (Andersen et al., 2005). We experimentally examined the short and longer term changes of bird assemblages, in riparian and non-riparian habitat, in response to wet and dry season burning for weed control in tropical savannas in north-eastern Australia.

2. Methods

2.1. *Study site and experimental design*

The study took place in the Einasleigh Uplands bioregion (Sattler and Williams, 1999), 110 km south of Townsville in north-eastern Queensland, Australia (Fig. 1). All sites were located in open eucalypt woodland, along three seasonally dry watercourses: Bend Creek (20°16′07″S, 146°37′48″E). One Mile Creek (20°14′10″S, 146°40′35″E) and Cornishman Creek (20°12′18″S, 146°27′15″E), all sub-catchments of the Burdekin River on lease-hold grazing properties (Fig. 1). The study was carried out in three stratified, replicate, experimental blocks, each of which encompassed approximately 3 km of watercourse. The experimental design was initially established by the Commonwealth Scientific and Industry Research Organisation – Sustainable Ecosystems (CSIRO – SE) and Tropical Savannas Cooperative Research Centre (TS – CRC) in 1999 for investigating the effectiveness of fire regimes to control rubber vine.

Experimental plots were established along each creek and included both riparian and adjacent non-riparian open woodland habitat. Riparian vegetation consisted of fringing woodland dominated by *Melaleuca fluviatilis, M. leucodendra, M. bracteata, Casuarina cunninghamiana* and *Corymbia tessellaris*. Adjacent non-riparian habitat, henceforth referred to as woodland, was dominated by *Eucalyptus crebra, E. brownii* and *Corymbia erythrophloia* with a predominantly grassy understorey of *Bothriochloa pertusa* and *Heteropogon contortus*. Rubber vine occurred in low to moderate infestations in both habitats, but was more prolific in the riparian habitat. Each plot was approximately 20 ha (10 ha either side of the watercourse) and plots were separated from each other by double fire breaks, spaced at least 50 m apart. At each creek, the same experimental treatments were randomly imposed and included: (i) an unburnt control plot; (ii) a dry season burnt plot, fire imposed August 2000; and (iii) a wet season burnt plot, fire imposed December 1999 (Fig. 1). Henceforth, time since fire will describe the time interval elapsed since the wet season fire. Two additional experimental treatments were imposed at each creek, but these were part of a larger study and were not included in analysis in the present study. In this paper we refer to site as either the riparian or woodland habitat of each fire treatment.

2.2. *Sampling strategy*

Data were collected during the wet season, following the first rains of the season, between January and March 2001 and 2004. Sampling tropical savannas during the wet season is ideal, as faunal activity is high. Plots were surveyed randomly in each creek. Bird assemblages were surveyed using