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Post-fire recovery of eastern bristlebirds (Dasyornis brachypterus) is context-dependent

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Abstract

In late December 2003, a wildfire in the Jervis Bay region of New South Wales burned through an area that previously supported a large population of the endangered eastern bristlebird (Dasyornis brachypterus). The eastern bristlebird has been described as fire-sensitive, and fire is implicated in the decline of the species. The frequency of occurrence of bristlebirds was investigated in the second week after the fire in a range of sites varying in fire intensity. Bristlebirds were found in burned habitats but were less common in the sites that were more intensely burnt. Bristlebirds had been surveyed along transects in this area two months before this fire and were surveyed again 1, 9 and 13 months after the fire. Compared with prefire numbers, bristlebird numbers decreased in burnt areas after the fire and increased in unburnt areas. This pattern was evident for up to nine months after the fire, after which bristlebird numbers returned towards prefire levels in both burnt and unburnt vegetation. This is in contrast to some previous research on bristlebirds and fire. We suggest that bristlebirds avoided the fire by moving to unburnt areas and returned later when conditions were more suitable. We consider that the apparently slight impact of this fire on bristlebirds was due to the close proximity of unburnt habitat and other refuges. The response of bristlebirds and presumably other birds to fire is likely to be strongly context-dependent, so fire management may be able to be designed so as to be compatible with the conservation of local bristlebird populations.

Keywords

Post, fire, recovery, eastern, bristlebirds, Dasyornis, brachypterus, context, dependent

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Post-fire recovery of eastern bristlebirds (*Dasyornis brachypterus*) **is context-dependent**

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Key Words: fire, eastern bristlebird, recolonisation, habitat,
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Abstract

In late December 2003, a wildfire in the Jervis Bay region of NSW burned through an area that previously supported a large population of the endangered eastern bristlebird (*Dasyornis brachypterus*). The eastern bristlebird has been described as fire-sensitive, and fire is implicated in the decline of the species. The frequency of occurrence of bristlebirds was investigated in the second week after the fire in a range of sites varying in fire intensity. Bristlebirds were found in burned habitats but were less common in the sites that were more intensely burned. Bristlebirds had been surveyed along transects in this area two months prior to this fire and were surveyed again 1, 9 and 13 months post-fire. Compared with pre-fire numbers, bristlebird numbers decreased in burnt areas after the fire and increased in unburnt areas. This pattern was evident for up to nine months post-fire, after which bristlebird numbers returned towards pre-fire levels in both burnt and unburnt vegetation. This is in contrast to some previous research on bristlebirds and fire. We suggest that bristlebirds avoided the fire by moving to unburnt areas and returned later when conditions were more suitable. We consider that the apparently slight impact of this fire on bristlebirds was due to the close proximity of unburnt habitat and other refuges. The response of bristlebirds and presumably other birds to fire is likely to be strongly context-dependent, so fire management may be able to be designed so as to be compatible with the conservation of local bristlebird populations.

Introduction

Fire has been present in Australia since the Tertiary Period (Kemp 1981) and much of the flora of Australia has evolved characteristics that allow survival after this disturbance (Gill 1981). Much of Australia's fauna has also evolved with the influence of fire, resulting in a range of responses from avoidance to exploitation (Keith *et al.* 2002; Whelan *et al.* 2002). The variation in response to fire among Australia's fauna can be explained by a combination of life history, biology and fire regime (Whelan *et al.* 2002), and escape behaviours are expected to become less effective as the size, frequency or intensity of fire increases.

Many species, including some bird species, take advantage of post-fire conditions. Loyn (1997) found that birds that feed in open ground, such as the flame robin (*Petroica phoenicea*), scarlet robin (*Petroica multicolor*), buff-rumped thornbill (*Acanthiza reguloides*) and superb fairy-wren (*Malurus cyaneus*), thrived for three years post-fire by exploiting low shrub regrowth. Some insectivores and raptors respond immediately, to take advantage of easy hunting of prey disturbed by fire (Woinarski and Recher 1997).

The change in population size after a single fire cannot be viewed as indicating a 'typical' response, because response will depend on specific fire characteristics such as intensity and extent, the time since the previous fire and on long-term fire histories (Bradstock *et al.* 2005). For example, variation in response to fires was recorded in the splendid fairy-wren; there was no direct mortality as a result of a fire after a six-year fire-free period (Rowley and Brooker 1987), but two more fires in the ensuing three years each caused a decline in numbers (Russell and Rowley 1993).

There are species that are fire-sensitive because they are unable to avoid the direct effects or they depend on resources that are removed by fire, such as dense vegetation. For example, the rufous bristlebird (*Dasyornis broadbenti*) was not recorded in the area of a single large fire in eastern Victoria until two years post-fire (Reilly 1991). Western bristlebirds (*Dasyornis longirostris*) took 2 - 6 years to recolonise moister areas after a

fire, and up to 14 years to recolonise some drier areas (Smith 1987; Burbidge 2003). Another fire-sensitive species, the noisy scrub-bird (*Atrichornis clamosus*) took 4 - 10 years to begin recolonising burnt areas (Danks 1997).

Both individual wildfires and altered fire regimes have been identified as threats facing many species in Australian birds (Garnett and Crowley 2000). Of Australia's 155 threatened bird species, 47% have wildfire and/or inappropriate fire regimes identified as current threats to their long-term survival (Garnett and Crowley 2000). The eastern bristlebird (*Dasyornis brachypterus*) is listed as threatened in all jurisdictions of its range: nationally endangered under the *Environment Protection and Biodiversity Conservation Act 1999*, endangered in New South Wales under the *Threatened Species Conservation Act 1995*, endangered in Queensland under the *Queensland Nature Conservation Act 1992* and threatened in Victoria under the *Victorian Flora and Fauna Guarantee Act 1988*. The main threats have been identified as habitat loss and fragmentation, introduced predators, and inappropriate fire regimes (Garnett and Crowley 2000; DEC 2004).

The eastern bristlebird is a cryptic, ground-dwelling, insectivorous and semi-flightless passerine. It is described as fire-sensitive, based primarily on the work of Baker (1997; 2000; 2003). From various studies, Baker (2003) concluded that fire was implicated in the extinction of at least 12 populations of eastern bristlebirds in the last three decades. Fire temporarily removes dense understorey vegetation, which is a critical component of the preferred habitat of the eastern bristlebird. Being semi-flightless and cover-dependent, the eastern bristlebird is not expected to be able to colonise new areas readily or to recolonise areas after disturbances (Smith 1977; Baker 2000). Being semi-flightless may also expose the species to higher mortality during fires.

Various studies of fire responses of eastern bristlebird populations have shown an array of results. Eastern bristlelbirds were known from 11 sites in 1978 near Mallacoota in Victoria but by 1994, as a result of fires, eastern bristlebirds were only found at 1 of those 11 sites (Clarke and Bramwell 1998). In 1992, Lamb (1993) surveyed 88 eastern bristlebird territories that had been defined in 1989 near the New South

Wales/Queensland border and found that only 36 % of them contained birds. Declines in these populations on the NSW/QLD border have been attributed to inappropriate fire regimes (Hartley and Kikkawa 1994; DEC 2004). In the populations in south east NSW, after five fires within 13 years at Barren Grounds Nature Reserve, eastern bristlebird densities increased with increasing time since last fire from zero birds to approximately 2 birds per 5 hectares after 11 - 16 years (Baker 1997; 2003). At Booderee National Park, Pyke *et al.* (1995) found no significant difference between the numbers of eastern bristlebirds detected in habitat 0-7 years post-fire and habitat 13-14 years post-fire. At Nadgee Nature Reserve, large-scale wildfires in 1972 and 1980 burnt most of the eastern bristlebird habitat. By seven years post-fire, eastern bristlebirds had colonised only a few of the areas burned in 1980 (Woinarski and Recher 1997). Baker (1997) proposed that the Nadgee population was, at that time, recovering from near extinction after the fire in 1980 because the two fires had left few unburnt refuges.

In late December 2003, a wildfire burned through approximately 3000 ha of Booderee National Park and adjacent parts of NSW on Bherwerre Peninsula at Jervis Bay on the New South Wales south coast (Fig 1). It was estimated that Bherwerre Peninsula at that time had population of eastern bristlebirds in excess of 700 (D. Bain and J. Baker, unpublished data). The eastern bristlebird was being surveyed here prior to 2003 as part of other research. This fire provided an opportunity to examine the direct effects of a summer wildfire on eastern bristlebirds, because two transects had been surveyed two months prior to the wildfire and parts of them were affected to different degrees by the fire. Thus, there was the opportunity to estimate eastern bristlebird numbers after fire in a range of locations of varying fire intensity and different distances to unburned vegetation. The aims of this study were to determine the effects of fire intensity on the eastern bristlebird population in the immediate aftermath of the fire, and to estimate changes in the population over the first 13 months post-fire.

Materials and methods

Post-fire survey

Within 2 weeks of the fire, call playback throughout the burnt area was used to elicit calls from eastern bristlebirds. Ninety-two playback points were surveyed in 3000 ha of burnt vegetation (Fig 1). Areas known to have supported eastern bristlebirds before the fire were targeted for playback. At each call playback point, a tape of eastern bristlebird 'duets' was played for two minutes, followed by a five-minute listening period. All eastern bristlebirds heard or seen were recorded, and their location estimated. Due to variation in landscape and burnt vegetation characteristics, some playback locations were only approximately 100 m apart. In these cases, a bird was recorded only if one had not been recorded at the previous point, as judged by direction to the call. All eastern bristlebirds heard were assumed to be in the same burnt habitat as the call playback location. Burnt habitat was assessed in a radius of 150 m from the playback point and was grouped into one of four categories:

1. High-intensity burn: canopy and understorey completely burnt.
2. Moderate-intensity burn: canopy scorched/burnt but some leaves remaining and possibly green; understorey completely burnt.
3. Low-intensity burn: canopy with unburnt patches; understorey generally burnt with occasional patches unburnt.
4. Burnt edge: any burnt habitat within 150 m of the fire boundary.

A χ^2 contingency analysis was used to test the hypothesis that the frequency of occurrence of eastern bristlebirds after the fire was independent of fire intensity category. Some of the call playback locations were on the same transects as the following study but these studies were not conducted at the same time so the call playback was not expected to interact with the following listening surveys.

Before-and-after surveys

Two transects affected by the 2003 fire, one 4.5 km, the other 3.4 km long had been surveyed two months prior to the wildfire. Both transects were within 800 m of what

became the edge of the burnt area, with neither penetrating into the middle of the burnt area (Fig 1). These two transects were subsequently surveyed 1, 9 and 13 months after the fire. Surveys involved a standard listening technique used previously in eastern bristlebird research (Baker 1997; Bain and McPhee 2005). At each survey period, transects were walked slowly, at 2-4 km/h, and the locations of all eastern bristlebirds heard or seen were mapped. The direction and distance of an eastern bristlebird call can be mapped reliably by a competent observer (Bain and McPhee 2005).

The transects were divided into segments based on the condition of the post-fire vegetation. Each segment was classed as either burnt, burnt edge, or unburnt. The 'burnt edge' category consisted of burnt vegetation at the fire boundary. At each survey period, transects were walked on four separate mornings within four weeks, with the direction of travel reversed each time. The survey (of the four conducted) that had the maximum number of records was used in data analysis, as this number represents the maximum number of birds 'known to be alive' for that transect over that survey period. As surveys utilised call vocalisations as the method of detection, we assumed that there was no difference in detectability between burnt and unburnt habitat.

There were two segments in vegetation classified as 'burnt' two in 'unburnt' and three in 'burnt edge'. A repeated measures, general linear model was used to test the hypotheses that eastern bristlebird numbers changed over time and that the nature of the change depended on the location of the birds in relation to burnt vegetation. The burnt edge category was not independent of the other two categories, as it is adjacent to them both. Therefore, the burnt edge category was not included in this analysis but analysed alone for any influence of time since fire on eastern bristlebird numbers.

There was only one pre-fire survey in this study. However, the variability of eastern bristlebird numbers before the fire was expected to be low because numbers in one of these transects, which were estimated several times over two years prior to this study, only varied between 2.4 and 2.5 birds/500 m (D. Bain, unpublished data).

FIGURE 1

Results

Post-fire survey

The occurrence of eastern bristlebirds in the second week after the fire was dependent on fire intensity ($\chi^2_3 = 11.8$, $P < 0.01$). The frequency of survey sites with birds present was much lower in intensely burnt areas than less intensely burnt areas. In the areas burnt with high-intensity, eastern bristlebirds were recorded in only 4 % of sites but in the areas burnt with low-intensity, eastern bristlebirds were recorded in 50 % of sites (Table 1).

TABLE 1

Before-and-after surveys

The impact of the fire on eastern bristlebird numbers over the 15 months from the pre-fire survey to 13 months post fire was different in burnt and unburnt vegetation categories (Fig 2). The interaction between survey period and burn category was significant ($F_{3, 6} = 8.1$, $P = 0.016$). Table 2 outlines the repeated measures tests performed.

Over the time-span between two months before the fire to one month after, there was a marked decrease in eastern bristlebird occurrence in burnt vegetation, from 2.18 ± 1 (sd) to 1.35 ± 0.5 birds/500 m. In unburnt vegetation, there was a large increase from 0.58 ± 0.8 to 2.35 ± 0.5 birds/500 m over this same time span. This interaction between survey period and burn category was significant during this period ($F_{1, 2} = 40.1$, $P = 0.024$) (Table 2).

From 1 to 9 months, there was very little change in eastern bristlebird numbers in either burnt or unburnt vegetation categories. By months 9 to 13, numbers in the burnt vegetation had increased to more than pre-fire numbers and numbers in the unburnt vegetation had returned towards pre-fire numbers. The interaction between survey period and burn category during this period was not statistically significant ($F_{1, 2} = 7.6$, $P =$

0.111) (Table 2). It is noted that if numbers of birds in both the burnt and the adjacent burnt-edge categories are combined, then by 13 months post-fire numbers had only returned to 75% of pre-fire numbers, not the 121% of the burnt category alone. The likely interaction between the burnt-edge category and the other two burn categories makes this difficult to interpret.

There was no significant effect of survey period on numbers of birds in the vegetation category 'burnt edge' ($F_{3, 6} = 1$, $P = 0.469$) (Table 2). This burn category showed the most variability in eastern bristlebird numbers over the 15 months (Fig 2).

FIGURE 2

TABLE 2

Discussion

Fire intensity influenced the frequency of occurrence of eastern bristlebirds at Booderee National Park. Two weeks after the fire, the more intensely burnt areas had fewer eastern bristlebirds than the less intensely burnt areas. In forests in south-eastern New South Wales, Smith (1989) found a similar relationship for 10 bird species that are associated with dense understorey shrubs. There were fewer records in the more intensely burnt areas for species such as the white-browed scrubwren (*Sericornis frontalis*) and brown thornbill (*Acanthiza pusilla*). A similar relationship has also been described for the western bristlebird, where individual birds survived a mild-intensity fire but mortality occurred in a more intense wildfire (Burbidge 2003).

Fire was followed by a decrease in eastern bristlebird numbers in the burnt and burnt edge sites. This probably reflects the mortality and displacement of birds that often occurs in recently burned habitat (McFarland 1988; Smith 1989; Burbidge 2003). The concomitant increase in density in unburnt habitat suggests that some eastern bristlebirds moved from burnt to unburnt habitat, and avoided the burnt habitat for some months.

Burbidge (2003) found that western bristlebirds survived some milder fires and subsequently set up home ranges in nearby unburnt vegetation. The findings of the present study suggest that this may also happen after higher-intensity fire.

Prior to the fire, eastern bristlebird densities varied between the sites. In particular, the unburnt sites had very few birds. This may be due to differences in habitat attributes, although all sites were located in a continuous stretch of habitat that appeared not to differ among sites. This low density in the unburnt habitat almost certainly contributed to the results of this study. These low-density, unburnt areas may have provided eastern bristlebirds escaping fire with available habitat to occupy before returning to pre-fire home ranges. The differences in pre-fire densities between the burnt and unburnt sites impose limitations on the generalities of this study. The low number of replicates in this study almost certainly contributed to high variance in eastern bristlebird densities among sites.

It is generally considered that good quality habitat occupied by territorial species will be saturated (Newton 1992). This suggests that individuals forced to move into occupied habitat would be resisted by residents. However, results from this study implied that individuals escaping the fire resided, albeit temporarily, in occupied unburnt habitat. Two explanations may account for this observation. As outlined above, the unburnt habitat may have had habitat attributes, which led to it not being saturated. Furthermore, eastern bristlebirds are not considered an aggressively territorial species, having highly overlapping home ranges (Baker 2001), and thus, individuals moving to unburned areas may not have been excluded.

Although the differences between burnt and unburnt vegetation from 9 to 13 months post-fire were not significant, the return towards pre-fire numbers of eastern bristlebirds from 1 to 13 months post-fire may represent the return of displaced individuals back to pre-fire home ranges or dispersal of juveniles following breeding season (Higgins and Peter 2002). As there were more birds in unburnt vegetation than before the fire (Fig 2), all available unburnt habitat may have been filled, so the adjacent burnt habitat may be the

only area available to juvenile birds. Larger sample sizes may have distinguished whether these changes were significant.

The numbers of eastern bristlebirds in the burnt edge category were more variable than in the other two burn categories, at each of the time periods (Fig 2). This variation may reflect movement of eastern bristlebirds across the boundary between burnt and unburnt vegetation following the fire.

There are examples of birds returning to previously occupied sites soon after a fire. Woinarski and Recher (1997), for example, reported silvereyes (*Zosterops lateralis*) foraging in burnt habitat within minutes of an intense fire that burned a relatively small area. In a low to moderate intensity fire in heathland near Sydney, birds avoided flames by moving to adjacent unburnt habitat then immediately returned after the fire had passed (Recher and Christensen 1981). At a longer time frame, marked white-browed scrubwrens and inland thornbills (*Acanthiza apicalis*) were re-caught in the same areas in the months after fuel reduction burns in Karri and Jarrah forests (Wooller and Brooker 1980; Wooller and Calver 1988). In the present study, the changing patterns of eastern bristlebird abundance suggest that eastern bristlebirds took over nine months to return to original areas post-fire, perhaps spending the winter and non-breeding season surviving in areas other than their pre-fire home ranges.

The apparently short-term impact of the fire on eastern bristlebird occurrence on Bherwerre Peninsula after one year differs from the results from Barren Grounds Nature Reserve (Baker 1997; 2003), which implied that fire can devastate eastern bristlebird populations and recovery of the population may take over ten years. However, Pyke *et al.* (1995) found that fire-age did not have a significant effect on eastern bristlebird occurrence at Booderee National Park, although his sample sizes were small and results were confounded by the proximity of unburnt vegetation.

We suggest that the presence of nearby unburnt habitat for a refuge is an important landscape component for the survival of eastern bristlebirds following fire; a concept

suggested previously (Pyke *et al.* 1995; Baker *et al.* 1997; Baker 1997). As with the work of Pyke *et al.* (1995), the two transects we used were close to the fire boundary, due to the opportunistic nature of this study. The greatest distance between a surveyed eastern bristlebird and the fire boundary was only 900 m. The eastern bristlebird is capable of travelling at least 300 metres per hour during daily activities (Baker and Clarke 1999). Post-fire, there were numerous lightly burned and unburnt patches of vegetation throughout the study sites, as a result of fire and topography (Whelan 1995) which could potentially serve as refuges.

Lack of suitable refuges due to frequent burning are likely to be devastating. It is possible that the difference in eastern bristlebird response between Barren Grounds and the Booderee studies is the high fire frequency combined with the area of each burn at Barren Grounds. The fire in Booderee National Park was the first large fire in 32 years. In 1972/73, about half of the Park burned and, since then, there has been a series of only small fires, many of which were prescribed fuel-reduction burns (Pyke *et al.* 1995; Taws 1998). In contrast, there have been five large fires, each burning 10-50% of available habitat at Barren Grounds Nature Reserve during 1979-1991 (Baker 1997). Similarly, after large-area fires in 1972 and 1980 burnt most of the eastern bristlebird habitat in Nadgee Nature Reserve, eastern bristlebirds had only colonised a few of the burnt areas after seven years (Woinarski and Recher 1997).

Studies have reported little impact of a single fire on populations of some small bird species such as superb fairy-wrens, after a fire-free period of many years (Rowley and Brooker 1987). However, frequent fires were shown to have caused declines in the same population (Russell and Rowley 1993). Cowley (1974) also found that individuals of two small cover-dependent passerine species, brown thornbills and white-browed scubwrens managed to survive a single high-intensity fire and continued to use the same areas as before the fire.

The observed recovery of the eastern bristlebird population at Booderee National Park compared to Barren Grounds and Nadgee Nature Reserves may have been facilitated by

lower predation pressure. While it is suggested that fire can increased predation (Recher and Christensen 1981; Brooker and Brooker 1994; Loyn 1997) intensive baiting of foxes (*Vulpes vulpes*) since 1999 at Booderee National Park and immediately after the fire in 2003 (Nick Dexter pers. comm.) may have reduced predation by this species. However, it would have had no effect on native predators such as snakes, goannas and birds of prey or on some other feral predators such as cats and rats. The interaction between feral predator control and post-fire responses of cover-dependant species such as the eastern bristlebird requires investigation.

There were differences in impacts to eastern bristlebird occurrence as a result of different fire intensities. There were also differences in the reported impacts to and recovery of eastern bristlebird populations after fire from different studies at Barren Grounds Nature Reserve and Jervis Bay. The results of this study support a statement by Bradstock *et al.* (2005) that the response of a species to fire will be highly variable and strongly context-dependent. Post-fire trends can not be viewed as repeated responses, even in two sites which have the same time elapsed since last fire, as fire histories of the sites are almost certainly going to be different along with the intrinsic landscape features and vegetation features of the habitat (Bradstock *et al.* 2005).

The response of eastern bristlebirds to fire in this study was unexpected. The results suggest that eastern bristlebirds may survive fire if in proximity to unburnt vegetation and refuges and following fire, can survive amongst recently burnt vegetation. The results suggest that cover-dependant birds may escape fire by temporarily moving to nearby unburnt vegetation and then return when conditions are suitable.

Management issues

Eastern bristlebirds live in fire-prone vegetation and fire management is of high priority in many of these areas for property protection and conservation. The general recommendations for eastern bristlebird management is currently fire exclusion (Baker 2000). However, in many areas this is not satisfactory for other fire management goals such as property protection. It may also be inappropriate for other species of co-occurring

fauna or flora which may prefer more open vegetation. The results of the present study indicate that the impact of fire on eastern bristlebirds should be further investigated to help address the environmental and social conflicts that are present in and around eastern bristlebird habitat.

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Figure 1: Bherwerre Peninsula, Jervis Bay. The area of the 2003 fire is shaded, the thick black lines are the two transects and the grey dots are the 92 call playback locations.

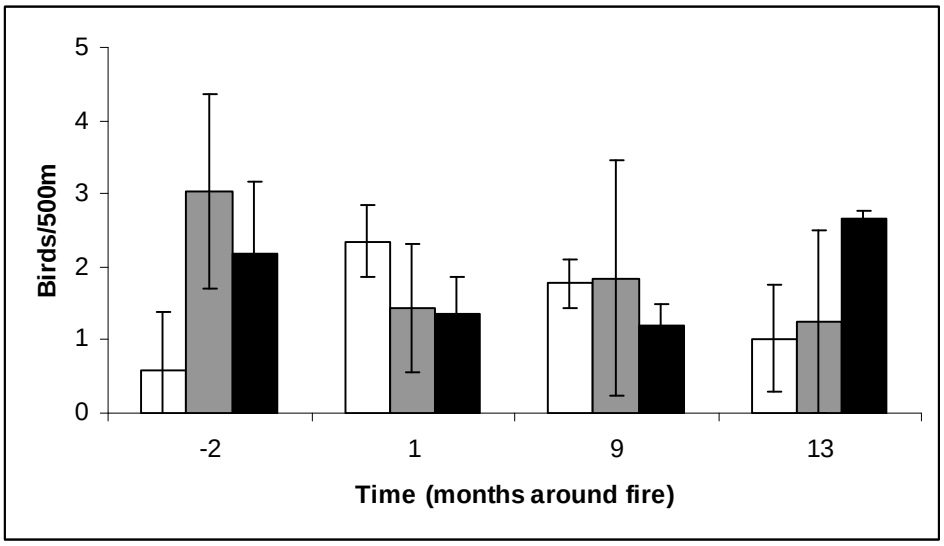

Figure 2: Number of eastern bristlebirds (± sd) observed per 500 metres in the months around the fire. □ unburnt habitat (following the fire), ■ burnt edge habitat (following the fire), ■ burnt habitat (following the fire). Data are means of 2 (unburnt), 3 (burnt edge) and 2 (burnt) replicate segments over both transects.

Table 1: Comparison among fire categories in the numbers of sites with eastern bristlebirds.

Surveys were conducted two weeks post-fire and the number of eastern bristlebirds expected was obtained from a contingency table. Surveyed column indicates the total number of sites surveyed in each fire intensity category.

Vegetation category	Sites with birds	Expected	Surveyed
High-intensity	1	6	24
Moderate-intensity	11	9	35
Low-intensity	8	4	16
Burnt edge	3	4	17

Table 2: Repeated measures tests of effects of burning and survey period on eastern bristlebird numbers.

Burnt vs Unburnt Categories	F value	P value
Burn category * Survey period (-2 months to 13 months)	$F_{3, 6} = 8.1$	0.016
Burn category * Survey period (-2 months to 1 month)	$F_{1, 2} = 40.1$	0.024
Burn category * Survey period (1 month to 9 months)	$F_{1, 2} = 0.5$	0.552
Burn category * Survey period (9 months to 13 months)	$F_{1, 2} = 7.6$	0.111
Edge burn Category		
Survey period (-2 months to 13 months)	$F_{3, 6} = 1$	0.469