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4 **Increased lyrebird and glossy black cockatoo presence in a post-fire landscape**

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9

10 **Abstract**

11 Prescribed fires for fuel reduction affect wildlife in several ways. We observed a marked  
12 increase in superb lyrebird (*Menura novaehollandiae*) numbers after a controlled burn in Guy  
13 Fawkes River National Park, New South Wales, in April and May 2014. The fire occurred  
14 during the winter breeding season; however, congregations of males were often seen together  
15 in the burnt landscape, indicating an opportunistic prioritisation of foraging. The low-  
16 intensity fire cleared brush and low-level vegetation, thus decreasing foraging effort and  
17 potentially attracting the species despite the need to seek mating partners. Controlled burns  
18 therefore have the potential to attract superb lyrebirds immediately after fire due to ease of  
19 movement and foraging effort.

20

21 **Main text**

22 Bird abundance and diversity in Australia following controlled burns show complicated  
23 relationships, heavily dependent on fire frequency, intensity, timing and location (Tingay and  
24 Tingay 1984; Loyn et al. 1992; Woinarski and Recher 1997; Andersen et al. 2005; Franklin et  
25 al. 2005; Clarke 2008). Response to controlled burns is largely species-dependent

26 (Christensen and Abbott 1989) and has been shown to result in both an increase (Woinarski  
27 1990; Woinarski et al. 2012) or decrease (Wooller and Brooker 1980; Murphy et al. 2010) in  
28 abundance of avifauna, although the response to low-intensity controlled burns is generally  
29 mild (Abbott et al. 2003). Both granivores and ground-feeding birds, such as cockatiels,  
30 galahs and red-tailed black cockatoos, tend to immediately increase in abundance after a low-  
31 intensity controlled burn (Christensen and Abbott 1989; Woinarski 1990).

32         We observed and recorded numbers of superb lyrebirds (*Menura novaehollandiae*)  
33 before and after a controlled burn. The superb lyrebird is a large, insectivorous bird  
34 inhabiting forests of south-eastern Australia. Superb lyrebirds breed in the winter and  
35 construct nests on the ground, at the base of trees or on ferns (Robinson and Frith 1981).  
36 They are also highly vulnerable to cat and fox predation due to their ground-dwelling nature  
37 (Lill 1980; Bradley and Bradley 1990). Because of a lack of information regarding immediate  
38 behavioural reaction of some birds to controlled burns, the aim of our study was to gain  
39 knowledge of the response patterns of superb lyrebirds to a low-intensity controlled burn in  
40 winter.

41         On 8 and 9 May 2014, a low-intensity fire was conducted in Guy Fawkes River  
42 National Park, New South Wales (30°04'58.6"S, 152°20'00.9"E) by National Parks and  
43 Wildlife Service staff. The controlled burn area (379 ha) was bordered on the west and north  
44 by an escarpment, a dirt road to the east, and a dirt fire trail to the south. The burn site was  
45 entirely restricted to the prescribed area. Beyond the roads, vegetation remained unburnt. The  
46 vegetation community in the study area varied from grassy woodland and open forest  
47 dominated by broad-leaved stringybark (*Eucalyptus caliginosa*), yellowbox (*E. mellidora*)  
48 and Blakely's redgum (*E. blakelyi*) to tableland open forest dominated by silvertopped  
49 stringybark (*E. laevopinea*), grey gum (*E. biturbinata*), broad-leaved stringybark (*E.*

50 caliginosa), New England blackbutt (*E. andrewsii*), mountain gum (*E. dalrympleana*) (Reid et  
51 al. 1996), *Allocasuarina* spp. and *Banksia* spp. (pers. obs. ).

52         Between 25 April and 26 May 2014, records were made of superb lyrebird sightings.  
53 Observations were not recorded during 8–11 May as access was not permitted during and  
54 immediately after the fire. Sampling occurred along all roads and trails bordering the  
55 potential prescribed burn area. Observation effort on superb lyrebirds was consistent, as sites  
56 were visited daily in the mornings (06:00–12:00 hours) and afternoons (15:00–18:00 hours).  
57 These sightings were recorded during a study focusing on the behavioural and physiological  
58 patterns of Australian mammals before and after a controlled fire, so lyrebird sightings were  
59 made opportunistically. The study commenced 10 days before the controlled burn and  
60 extended through 26 May, 17 days after the controlled burn. Owing to the difficulty of  
61 distinguishing individual lyrebirds, all observations were recorded; therefore repeat sightings  
62 may have occurred.

63         No observations of superb lyrebird were reported in the two weeks prior to the fire  
64 (25 April – 7 May). In contrast, a large number of sightings ( $n = 76$ ) were made immediately  
65 after the fire. Sightings were highest for the first five observational days after the fire, with  
66  $10.8 \pm 1.5$  sightings per day and an average of  $5.1 \pm 4.6$  sightings per day over the entire  
67 post-fire observational period. The greatest number of sightings of superb lyrebirds on a  
68 single observational day ( $n = 13$ ) was recorded on Day 5 after the fire. Sightings decreased  
69 with an increase in time after fire (Fig. 1). Most superb lyrebird sightings were of males ( $n =$   
70 51), with occasional observations of females ( $n = 15$ ) or individuals of an unknown sex ( $n =$   
71 6). Most sightings occurred between 06:00 and 13:00 hours, when the study site was visited.  
72 Superb lyrebirds were exclusively observed moving out of the burnt area, across the road and  
73 into the unburnt area. Lyrebirds were always observed running very quickly or darting across  
74 the road, often in small groups. Most observations ( $n = 65$  of 76) were recorded along a 2-km

75 fire trail, a border infrequently visited by people, and recordings generally occurred in the  
76 same areas. Other areas in which lyrebirds were observed included a wide dirt road (n = 7)  
77 leading to a campsite that bordered the burnt area, and on the campsite itself (n = 4).

78 Our study shows a significant increase in sightings of superb lyrebirds in a post-fire  
79 landscape. To our knowledge, this is the first study to note the behavioural response of superb  
80 lyrebirds immediately following a low-intensity controlled burn. The removal of the grass  
81 layer after a fire has been found to attract ground-feeding avifauna (Woinarski 1990);  
82 therefore, the apparent ease of movement and foraging effort in the absence of grass in the  
83 burnt landscape was most likely an attractant. A study conducted by Nugent et al. (2014)  
84 found that, on a long-term scale, lyrebirds favoured foraging in unburnt patches over ground-  
85 burnt patches, and were not present in canopy-burnt areas. This indicates that lyrebirds may  
86 only favour foraging in a post-burn landscape on a short temporal scale. Lyrebirds have been  
87 found to decrease in abundance in the absence of regular fires (Smith 1994), which suppress  
88 the spread of wiregrass. Superb lyrebirds spend more than 80% of their foraging time digging  
89 for soil invertebrates, and little discrimination is found in prey choice (Lill 1996). Fire may  
90 therefore expose more bare ground readily available for digging and thus result in a decrease  
91 in foraging effort. Opportunistic foraging by superb lyrebirds in the burnt area apparently was  
92 disrupted by vehicle presence and resulted in darting behaviour into the unburnt area. The  
93 major reduction in ground cover may have triggered a heightened predatory awareness and  
94 thus resulted in rapid movement from the more exposed burnt area to the more densely  
95 vegetated and covered area. The marked decrease of lyrebird sightings with time since fire  
96 may have been due to a reduction in visible insect abundance in the burnt area resulting from  
97 heavy foraging. As foraging effort potentially grew less rewarding, lyrebirds most likely  
98 moved back into their respective territories.

99            Male superb lyrebirds are highly territorial, usually displaying on mounds, rocks or  
100 trees (Kenyon 1972; Lill 1979). Despite the occurrence of the fire during the lyrebird  
101 breeding season, males were often seen together in groups, indicating that an increase in  
102 available resources overshadowed their perceived need for typical territorial behaviours.  
103 Male lyrebirds maintain territories of up to 3.7 ha (Robinson and Frith 1981; Lill 1996). Up  
104 to six male lyrebirds were seen running together at once, signifying that males with territories  
105 further away may have had to travel up to 1.3 km to forage in the burnt area. An alternative  
106 explanation is that some of the birds were displaced from the burn area and returned to their  
107 previous territories to forage. However, considering the large number of birds we observed,  
108 this was probably only a minority of individuals.

109            Observations from this study therefore indicate that low-intensity fires often result in  
110 an immediate increase in abundance of some granivorous and omnivorous birds and/or  
111 sustained populations from an increase in food availability despite a visibly burnt landscape.

112

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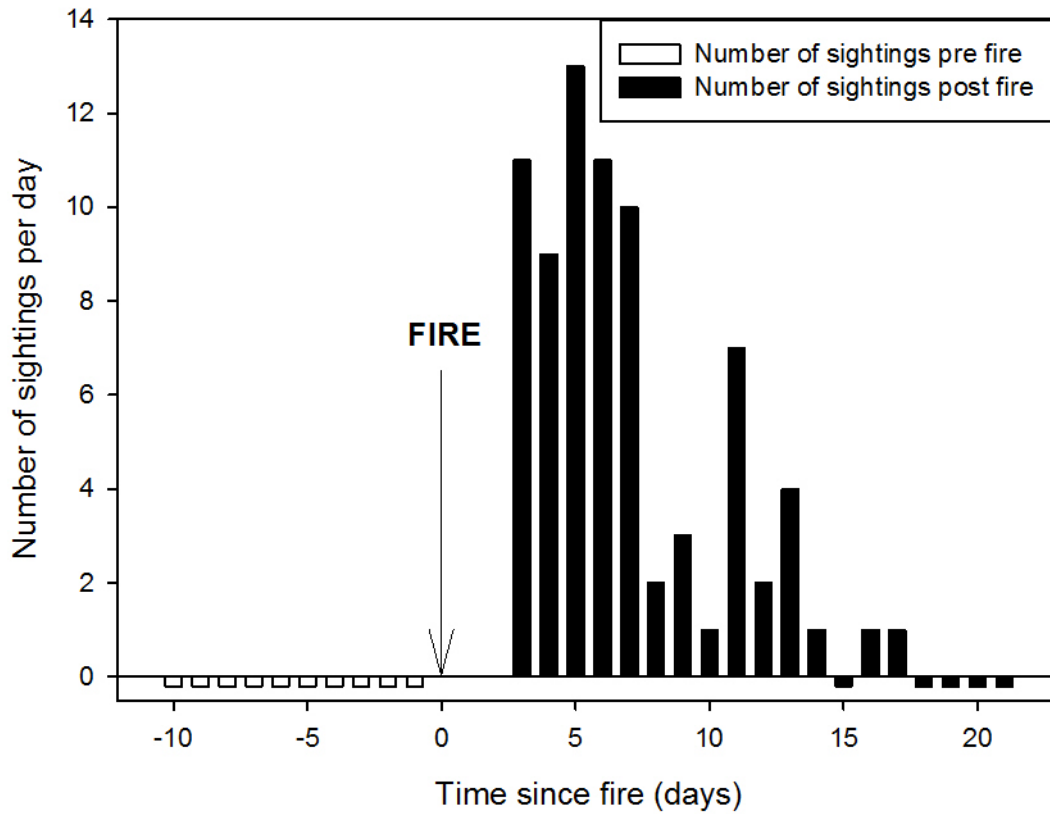
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179

180 **Fig 1.** Number of sightings of *M. novaehollandiae* per day before and after a control burn.

181 Vertical bars below zero on the x-axis indicate zero sightings for that day. Sightings

182 decreased significantly with time since fire ( $r^2=0.71$ ,  $p<0.01$ , described by the equation  $y= -$

183  $0.682x + 12.19$ ).