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Bird use of almond plantations: implications for conservation and production

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Methods S1

Target bird species

Bird species that have previously been recorded eating almonds and which were the focus of our study were as follows: sulphur-crested cockatoo (*Cacatua galerita*); galah (*Eolophus roseicapillus*); corella spp. (long-billed corella (*Cacatua tenuirostris*) and little corella (*Cacatua sanguinea*)); regent parrot (*Polytelis anthopeplus*); yellow rosella (*Platycercus elegans flaveolus*); eastern rosella (*Playtcercus eximius*); Australian ringneck (*Barnardius zonarius*); blue bonnet (*Northiella haematogaster*); red-rumped parrot (*Psephotus haematonotus*); mulga parrot (*Psephotus varius*); Australian raven (*Corvus coronoides*); and little raven (*Corvus mellori*).

Crop damage

We developed a method to estimate the total number of nuts on an almond tree based on tree structure, following Krueger et al. (1996) (Figure S2). In Step 1, we measured 200 randomly selected trees in November 2010, following early nut drop by almond trees, to obtain the mean values for the following structural components: 1) the number of nuts on a lateral branch (a); 2) the number of lateral branches on a secondary scaffold branch (b); 3) the number of secondary scaffold branches on a primary scaffold branch (c); and 4) the number of primary scaffold branches on the tree (d). Fruiting shoots and spurs (shoots) were included in the counting of nuts on lateral branches (lateral and tertiary scaffold branches were combined under lateral branches), which were treated as the sample unit for the rapid damage assessment, as they contained a sufficient number of almonds to detect damage by birds (shoots were too small a unit).

In Step 2, we calculated the total number of nuts on an almond tree (N) as follows:

$$N = a \times b \times c \times d$$

The values for a–d were based on the mean values (± 1 s.e.) for the 200 sampled trees and were as follows: a = 37.47 (± 1.11); b = 5.57 (± 0.08); c = 2.02 (± 0.01); and d = 3 (± 0.01). Therefore, N = 1268.02 (± 43.57). In Step 3, the mean estimated damage per tree from the rapid damage assessment was calculated as a percentage of all nuts on the tree by counting the number of nuts damaged on the sampled lateral branch and extrapolating using the above equation.

Observations of birds feeding on almonds and the collection of damaged almonds post feeding assisted in attributing particular types of damage to particular species. Cockatoos split the almond most often vertically (i.e. length wise) with a single incision (Figure S3a).

Regent parrots damaged almonds primarily by a horizontal split and one to three large bites to gain access to the inner kernel (Figure S3b). Small parrot damage was identifiable by many small bites to the almond, particularly the outer fruit (Figure S3c, d).

Reference

Krueger, W., Connel, J.H., and Freeman, M.W. (1996). Pruning bearing trees. In ‘Almond Production Manual’. (Ed W.C. Micke.) pp. 125–131. (University of California: Oakland.)

Table S1. Details of transects at each plantation including the season surveyed, damage intensity rankings assigned by Select Harvests, and length of transect.

Transect number	Plantation	Almond ripening seasons surveyed	Damage intensity ranking	Transect length (km)
1	Wandown	2009/10, 2010/11	Low	1.6
2	Wandown	2009/10, 2010/11	High	2.2
3	Wandown	2009/10, 2010/11	Moderate	2.8
4	Wandown	2009/10, 2010/11	Low	2.5
5	Wandown	2010/11	High	1.7
6	Boundary Bend	2009/10, 2010/11	Moderate	0.7
7	Boundary Bend	2009/10, 2010/11	Low	0.7
8	Boundary Bend	2009/10, 2010/11	Moderate	1.1
9	Kyndalyn Park	2010/11	High	1.5
10	Kyndalyn Park	2010/11	Low	2.4
11	Kyndalyn Park	2010/11	High	1.5
12	Lake Powell	2010/11	High	2.1
13	Lake Powell	2010/11	Low	3.0
14	Lake Powell	2010/11	Low	2.4
15	Lake Powell	2010/11	Moderate	1.4
16	Lake Powell	2010/11	High	1.4
17	Carina	2009/10, 2010/11	High	1.5
18	Carina	2009/10, 2010/11	Low	2.5
19	Carina	2009/10, 2010/11	Low	1.7
20	Carina	2009/10, 2010/11	High	1.3
21	Carina	2010/11	Low	1.7
22	Wemen	2010/11	High	1.5
23	Wemen	2010/11	Low	0.9
24	Wemen	2010/11	Moderate	0.8
25	Liparoo	2009/10, 2010/11	Low	2.6
26	Liparoo	2009/10, 2010/11	Moderate	2.1
27	Liparoo	2009/10, 2010/11	High	1.3
28	Liparoo	2009/10, 2010/11	Moderate	2.5
29	Liparoo	2010/11	Low	2.0
30	Hattah	2010/11	Low	1.3
31	Hattah	2010/11	High	0.7
32	Hattah	2010/11	Moderate	2.3

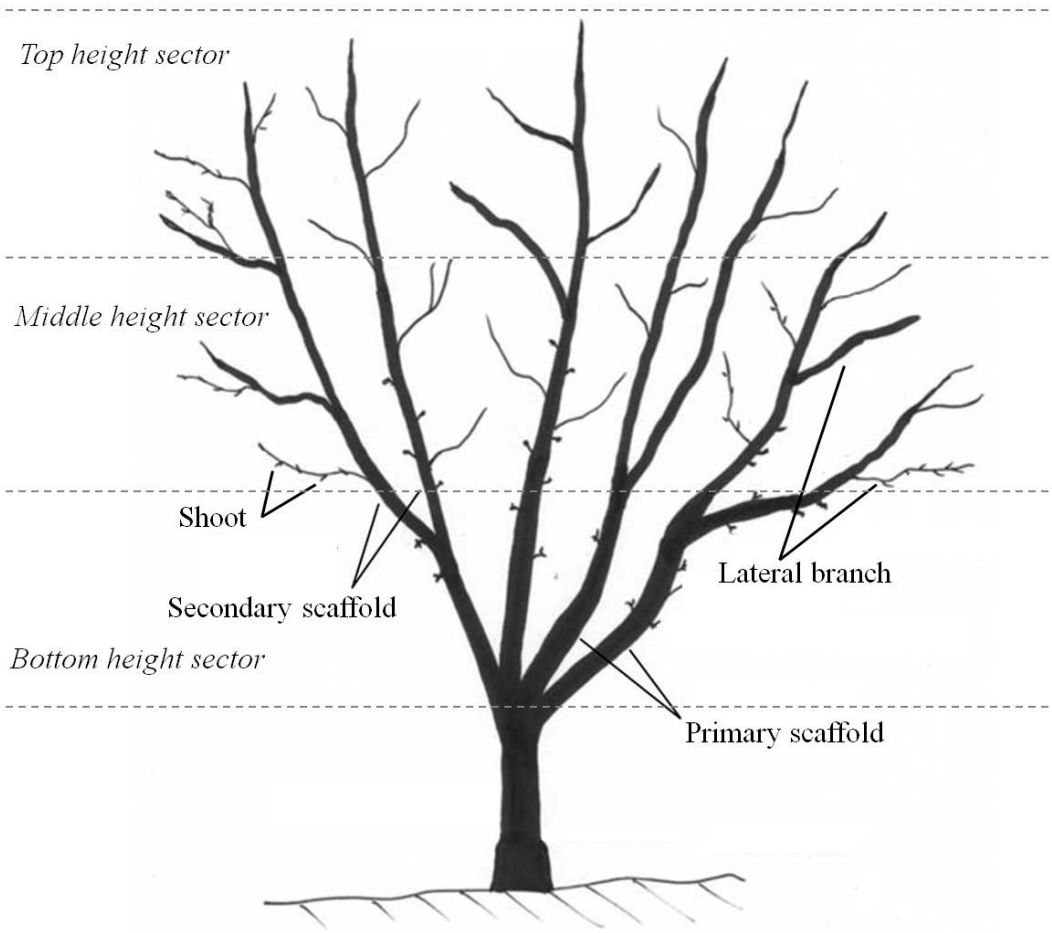

Figure S1. Almond trees were divided into a top, middle and bottom height sector of the canopy for sampling during rapid damage assessments. Structural branch components of primary scaffold, secondary scaffold, lateral branch, and shoot were counted to estimate the number of almonds on each tree damaged by birds (see ‘Crop damage’).

Figure S2. Damage to almonds attributed to the following bird species/groups: (a) cockatoos; (b) regent parrot; (c) small parrot – Australian ringneck; and (d) small parrot – yellow rosella.

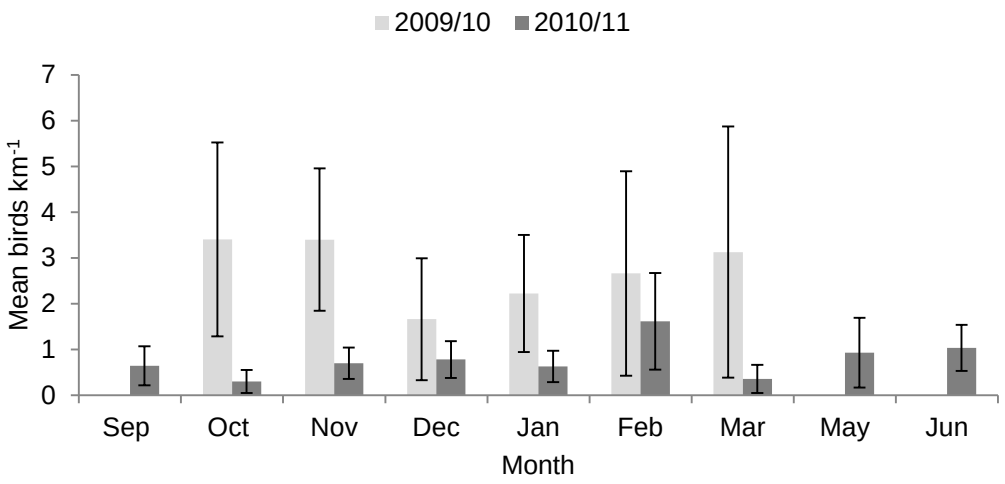

Figure S3. Mean frequency of occurrence (birds km^{-1}) of all bird species combined across all transects surveyed during the 2009/10 and 2010/11 almond ripening seasons. Error bars are 95% confidence intervals.