Department of Sustainability and Environment

Community finding fauna – naturalist groups contributing to research on the response of fauna to fire

Black Saturday Victoria 2009 – Natural values fire recovery program

Phoebe Macak, Matthew Bruce, Richard Loyn

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Community finding fauna – naturalist groups contributing to research on the response of fauna to fire

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This project is No. 26 of the program 'Rebuilding Together' funded by the Victorian and Commonwealth governments' Statewide Bushfire Recovery Plan, launched October 2009.

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Front cover photographs: Main image: a Black Wallaby in front of a bait cage, photographed by an automated survey camera. Small images: top, an automated camera being retrieved from a study site (Matt Bruce); middle, installing a bat detector unit (Joan Broadberry); bottom, an Australian Magpie photographed by an automated survey camera.

Contents

List of tables and figures

Tables

Figures

Acknowledgements

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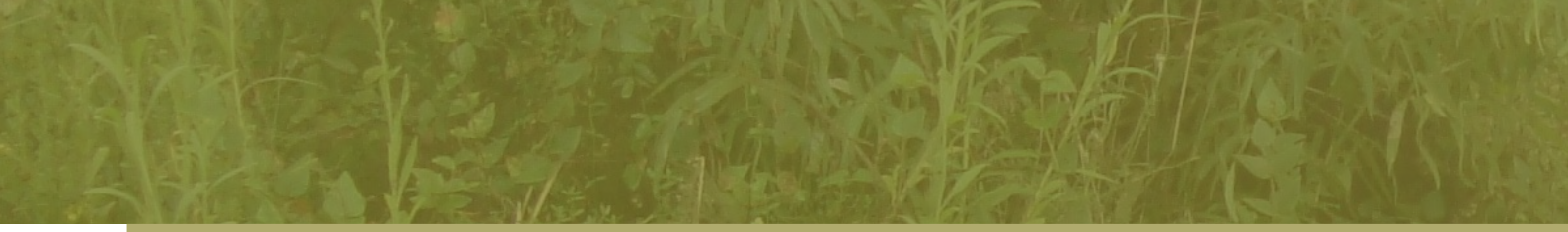
Summary

Scientists at the Department of Sustainability and Environment's Arthur Rylah Institute (ARI) collaborated with three Melbourne-based, non-government naturalist groups to contribute to research on responses of fauna to various fire histories, and to build capacity for such work in the community. Members of the Field Naturalists Club of Victoria (FNCV), Bird Observation and Conservation Australia (BOCA) and Birds Australia (BA), guided and supported by ARI staff, conducted fauna surveys in 2009 fire-affected areas (burnt once or twice in the last 40 years) and nearby long-unburnt forest. The study was designed to evaluate the effects of time since fire (2 versus 30+ years) and fire frequency (0, 1 or 2 fires recorded in the last 40 years) on various fauna species or groups.

Forty, two hectare sites were selected in two study areas in north-east Victoria, near Taggerty and Beechworth. All sites were in Herb-rich Foothill Forest and were surveyed during two camps in January and March 2011. Surveys were conducted for the abundance and species richness of diurnal birds using timed area counts, the presence of ground-foraging mammals using automated cameras, and activity levels of insectivorous bats using echolocation call detectors. A total of 46 individual naturalist group members took part in the two survey camps. Camera and detector equipment were collected from sites after three weeks *in situ.*

Eighteen mammal and fifty-eight bird species were recorded from sites during formal surveys, with an additional eleven bird and one reptile species recorded outside of these surveys either on site or close by. Some of these records were of species that had only been previously recorded from the area on a few occasions (e.g. Bush Rat, Dusky Antechinus and Long-nosed Bandicoot near Beechworth). Mammal and bird data were summarised across fire history categories and examined visually, with tentative interpretations of differences discussed pending further statistical analysis. Birds were about two thirds as abundant in recently burnt forest as in long-unburnt forest, and responses varied between species. Some mammal species were encountered more often in long-unburnt forest, notably the Common Brushtail Possum and European Rabbit, whereas others (e.g. Black Wallaby and Common Wombat) showed little difference. Bat activity was a third as high in recently burnt forest as in long-unburnt forest.

The project exposed a large number of people to research on the impact of fire on fauna and the methods used to collect data. However, site selection and survey design was influenced and constrained by the requirements associated with using a large number of volunteers to collect data within a short space of time. These constraints included confining sites to a short distance off highly accessible forest tracks in localities of gentle to moderate terrain, and to forest close to camp sites. The project also highlighted the time and resource investment required for such an undertaking. On the other hand, the benefits to participants were wide-ranging and included improving and learning new fauna survey skills that will be applied elsewhere. Participants indicated that involvement in the project made people feel that their skills and experience were valuable, leading to a sense of personal satisfaction in what was achieved. The opportunity to learn new skills, visit fire-affected areas, and contribute to research was appreciated. The use of automated cameras in particular, resulted in many people experiencing a new survey technique and allowed some species to be found (during photo processing) that may not have been observed otherwise.



1 Introduction

Bushfires in February 2009 (the 'Black Saturday' fires) burnt approximately 430,000 ha of Victoria. In the areas of this study, to the north and north-east of Melbourne, the Kilmore-Murrindindi fire burnt 168,542 ha and the Beechworth-Mudgegonga fire burnt 33,577 ha (Teague *et al.* 2010). Approximately half of all areas burnt were at high severity (Department of Sustainability and Environment unpub.data). It has long been recognised that fire is an important part of Australian landscape ecology, particularly in the south-east (Gill 1975, Whelan *et al.* 2002). The vegetation is well adapted to fire events, and different plant species respond by flowering, regenerating from canopy or soil-stored seed, and/or resprouting from epicormic buds or underground stems (Costermans 2009). Fauna have also developed strategies to survive and recover after fires, including sheltering in unburnt patches (Banks *et al.* 2011a). The rate of recovery of different types of flora and fauna can vary according to how severe and widespread the fire was, and how often and when it occurs (Whelan *et al.* 2002). However, these processes are poorly understood and there is limited information on how fire regimes impact on regional flora and fauna (Whelan *et al.* 2002, Clarke 2008, MacHunter *et al.* 2009). This presents a challenge for those attempting to manage the landscape for fire prevention and control in conjunction with the ecological needs of the biota.

The Arthur Rylah Institute for Environmental Research (ARI), a research arm of the Department of Sustainability and Environment (DSE), together with three non-government naturalist groups, collaborated on a project aimed at contributing to fire-related knowledge while drawing on and enhancing the skills of naturalist group members. The collaboration was based on existing strong links between ARI and the Field Naturalists Club of Victoria (FNCV), Bird Observation and Conservation Australia (BOCA) and Birds Australia (BA). Members of these naturalist groups have a high interest in the natural environment and many actively engage in a wide range of field excursions, either those organised by the group they belong to, and/or privately. Members also have a wide range of skills in flora and fauna survey techniques, including bird and mammal identification.

Numerous ecological studies word-wide have involved members of the public in the collection of scientific data with many apparent benefits for the participants, the environment and the wider community (Conrad and Hilchey 2011). Such studies can allow environmental science to become more accessible to those that may not be exposed to the design and methodology required to conduct ecological research. In addition, scientists can be made more aware of the expertise available in the community (Carolan 2006) and the potential to draw on that expertise. This can have on-going benefits where participants build confidence in their knowledge and skills and continue to apply it within an environmental framework. There is a proud tradition of citizen science among field naturalists globally, and amateur naturalists have made outstanding contributions, especially for groups of organisms that can be observed readily in the field, including plants, birds and mammals. In Australia, the three organisations involved in this study have played leading roles in this respect, as evident in numerous papers in the respective journals published by these organisations. Some major projects have been designed specifically to harness the skills of amateur naturalists, including two distributional Atlases of Australian birds (Blakers *et al.* 1984; Barrett *et al.* 2003), surveys of threatened species such as Orange-bellied Parrot (Starks *et al.* 1994) and numerous studies of waterbirds (Loyn *et al.* 2001; BOCA 2003; Minton 2006). Involving members of the community also comes with various challenges which may limit the type and use of collected data (Conrad and Hilchey 2011).

The current project had the following objectives:

1. to build the capacity of naturalist groups and the local community to improve knowledge of the survival and current status of populations of selected fauna species in 2009 fire-affected regions;
2. to provide expert guidance and survey equipment to carry out ecological research on responses of fauna to fire;
3. to empower naturalist groups and local community members to contribute to further work to help conserve fauna in the face of changing fire regimes;
4. to collect data on fauna in fire-affected areas and conduct preliminary analyses on responses of fauna to fire history.

The project was designed to complement concurrent fire research program at ARI which aims to characterise how flora and fauna respond to varying fire regimes in a range of vegetation types across the eastern part of Victoria. This research focuses primarily on the mixed-species forests in the foothills of the Great Dividing Range, where fire regimes are highly variable and amenable to manipulation by land managers. It also focuses on two key processes – time since fire and fire frequency. In view of this, the current study examined the effects of time since fire (2 versus 30–40 years) and fire frequency (0, 1 or 2 fires recorded in the last 40 years) on diurnal birds, small to large terrestrial mammals and insectivorous bats.

Results are discussed in the context of the process of involving the three naturalist groups in collecting scientific data, a summary of fauna found in areas burnt in 2009, and a preliminary exploration of the influence of fire on the presence and abundance of fauna. A comprehensive evaluation of the costs and benefits of utilising large numbers of volunteers in scientific studies is not included here. Where appropriate, data collected during this project will also be used for future analyses in other fire projects at ARI. In particular, the use of automated cameras will be examined to assess their effectiveness in measuring the responses of fauna to ecological disturbances.

2 Methods

2.1 Naturalist group engagement

Key members of three naturalist groups—Field Naturalists Club of Victoria (FNCV), Bird Observation and Conservation Australia (BOCA), Birds Australia (BA)—were approached at the inception of this project and invited to participate. Several meetings were held at various stages to communicate and develop the project including study design, target fauna groups, survey methods and equipment required. Discussions about training needs and the logistics of data collection and analysis led to significant alterations in the study design to allow for constraints around time and participant capacity. Wider project communication between ARI and the naturalist groups mainly involved key members of the groups disseminating information to the broader membership.

It was determined that the most effective way that the naturalist group members could be involved in data collection would be during two coordinated camps held over weekends associated with week-day public holidays. This would enable a large group of people to come together and carry out surveys over several consecutive days, allowing sufficient time to complete survey tasks while providing the opportunity for members of each of the groups to carry out their own activities and mix with each other. The FNCV is especially experienced in conducting and organising group activities during overnight camps, and were keen to carry out additional surveys separate to the current study during the camps. FNCV members involved in the project were from the organisation's Fauna Survey Group. The first camp was regarded as a pilot with the intention of holding a follow up meeting afterwards to discuss any operational aspects that could be improved for the second camp. Project funds were available to participants to cover the cost of petrol, food and camp ground accommodation during the data collection periods. As well, some people received remuneration for roles in project coordination and data entry.

Naturalist groups local to the study areas were contacted and invited to participate prior to the camps.

2.2 Study area & camp locations

Surveys were conducted in forest within the 2009 Kilmore East-Murrindindi Complex and Beechworth fire-affected areas, north-east of Melbourne. Study areas close to camping grounds suitable for a large group of people were agreed upon amongst the naturalist groups and ARI, with surveys occurring during two camps over the Australia Day and Labour Day long weekends of 2011. The first camp was held between the 22–26 January at Ned's Gully camping ground in the Cathedral Range State Park near the township of Taggerty, 85 km from Melbourne. Survey sites were selected in the nearby Black Range (northern end) and Rubicon State Forests (referred to as the Taggerty study area). The second camp was held between the 11–14 March at Sambell Caravan Park, Beechworth, 225 km from Melbourne. Survey sites were located south-east of Beechworth within Stanley State Forest, Stanley Scenic Reserve, Beechworth Historic Area, on private land, and on public land east of Lake Kerferd (referred to as the Beechworth study area) (Figure 1). State forest in both study areas has been subjected to timber harvesting.

The dominant Ecological Vegetation Class (EVC) within both study areas was Herb-rich Foothill Forest (EVC No. 23) and site selection was confined to this EVC only, to exclude forest type as a factor potentially influencing the presence of fauna. Herb-rich Foothill Forest is characterised by a high cover and diversity of herbs and grasses in the ground layer. It consists of a medium to tall open forest of Narrow-leaf Peppermint *Eucalyptus radiata*, Messmate Stringybark *E. obliqua* and Mountain Grey-gum *E. cypellocarpa*. There is typically a large shrub or understorey tree layer and a sparse to dense medium shrub layer (DSE 2004).

2.2.1 Fire History – fire frequency and time since fire

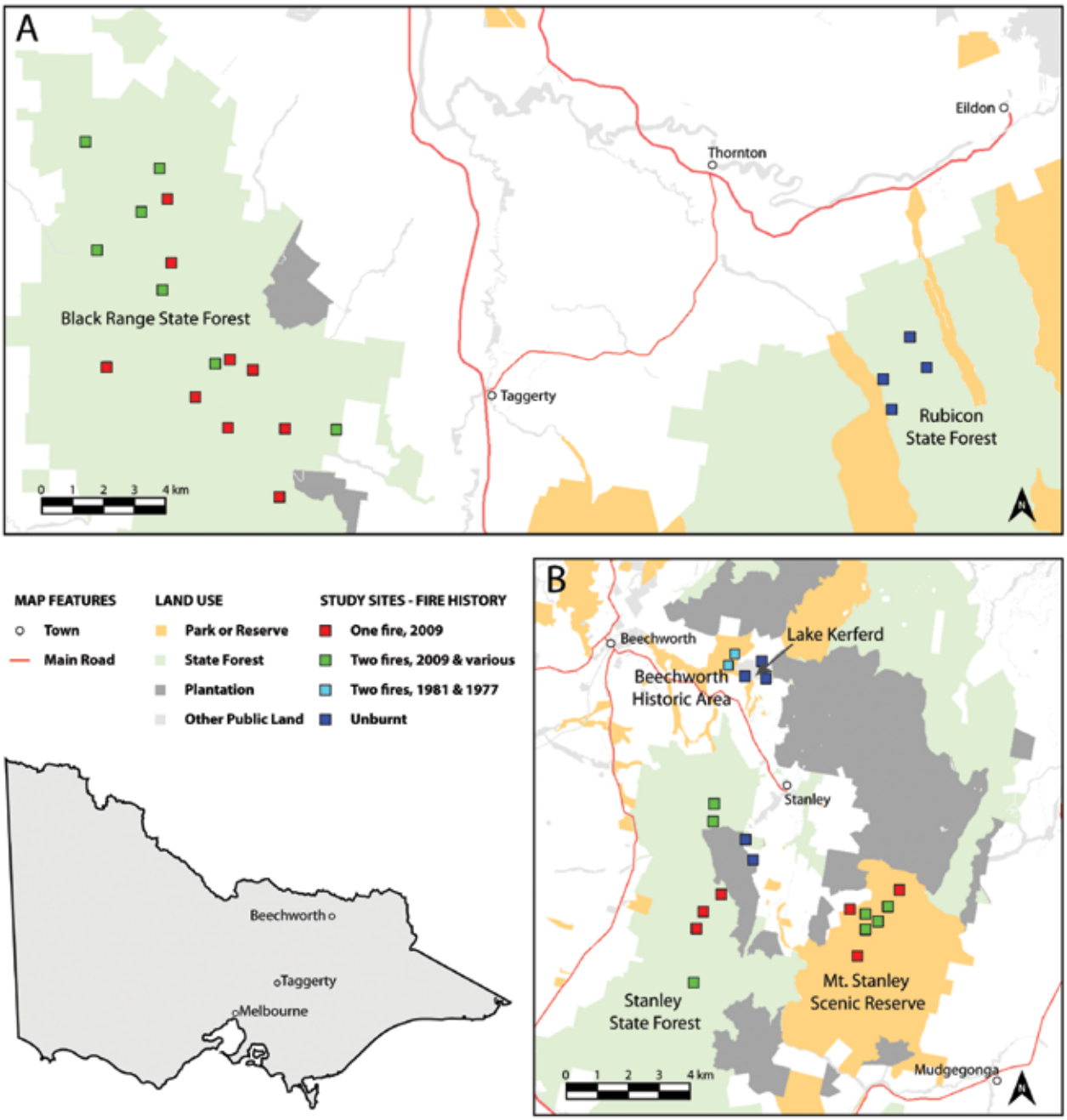
Fire history investigated for this project comprised combinations of fire frequency (or number of fires) and time since the last fire occurred within the 40 years between 1970 (when reliable records became available) and 2010 (when fire information was extracted from DSE databases). This approach is being used in other fire research programs at ARI and enables data collected during this project to contribute to these other studies.

Specific fire history categories used in the current study were chosen based on those available within the first study area (Taggerty), and then applied as closely as possible to the Beechworth study area site selection process. Three fire histories were available across both study areas: no fires since 1970; one fire since 1970 (in 2009) and two or more fires since 1970 (the last one being in 2009). In the Beechworth study area, an additional category was included as there was less forest available that consisted of the targeted fire categories, thus two sites were selected in forest burnt twice since 1970, in 1981 and 1977, such that the last fire was 30 years before the current study.

In the Taggerty study area (Figure 2) most of the accessible forest was in the northern end of the Black Range and had been burnt in 2009. Before being burnt in 2009, the forest had either not been burnt (since 1970) or had experienced fire once between 1970 and 2009. As there was little forest in the Black Range, that that had not been burnt at all in the last 40 years, the study was extended east into the nearby Rubicon State Forest which contained a mix of burnt and unburnt forest.

During the 2009 bushfires, the southern parts of the Black Range were burnt extremely severely with most of the canopy burnt. The fire intensity declined as it burned northwards in subsequent days and eventually stopped. Forest within most of the study area was observed to have experienced only an understorey fire which left the

Figure 1. Study area and study site locations in north-east Victoria investigated for the response of fauna to different fire histories January-April 2011 A = Taggerty study area; B = Beechworth study area.



tree canopy relatively intact. The areas in the south of the study area appeared more severely burnt, resulting in loss of the canopy, although it was starting to recover through epicormic growth at the time of the surveys. The understorey of most recently burnt sites was fairly open, and dominated by bracken. The unburnt forest contained more large trees and the understorey included dense thickets of tall shrubs and small trees in parts.

The Beechworth study area (Figure 2) had a more varied fire history, including some forest that had last been burnt in 1981 and 1977 as indicated above. Most of the recently burnt sites had burnt severely, with extensive canopy damage and epicormic regrowth, as in the southern parts of the Black Range. Understorey regrowth had become quite dense on many of these sites. Some parts of the study area were infested with patches of blackberry thickets, particularly where several of the long-unburnt sites were situated.

2.2.2 Weather

Weather data (daily rainfall, and maximum daytime and minimum overnight temperature) were obtained from the Bureau of Meteorology as follows: Taggerty study area rainfall from Taggerty, station number 088119, and temperatures from Eildon Fire Tower, station number 088164; Beechworth study area rainfall from Beechworth, station number 082201, and temperatures from Beechworth Woolshed, station number 082137.

Figure 2. Examples of recently burnt and long-unburnt forest surveyed during the Community Finding Fauna project
A = recently burnt forest, and B = long-unburnt forest near Taggerty; C = recently burnt forest, and D = long-unburnt forest near Beechworth. (Phoebe Macak and Matt Bruce).

2.3 Site selection

Site selection was carried out by ARI staff using a combination of computer-based software (ArcGIS and ArcView, ESRI and Biodiversity Interactive Mapping, DSE) and field checking. Due to the large number of participants, and the short time frame available during camps for setting up equipment and conducting surveys, it was anticipated that there would be little flexibility to deal with unpredictable complications, such as study sites turning out to be unsuitable due to lack of access. In addition, participants were expected to use their own vehicles which included two-wheel drive (2WD) vehicles and a range of four-wheel drive (4WD) vehicles. Four wheel driving experience and confidence also varied. Therefore, it was necessary for study sites to be on tracks suitable for 2WD vehicles. Rugged tracks requiring 4WD were avoided as much as possible. A reconnaissance trip to each study area prior to each camp was considered the best way to make sure study sites were suitable and tracks were accessible so that a final set of study sites could be selected with confidence and that little or no change would be required.

Spatial data within DSE databases containing information on EVCs, fire history combinations, land tenure and vehicle tracks, formed a basis for site selection. Fire history data were current as of late 2010. Using ArcGIS, a number of random points, in excess of what was required for the study, were generated throughout the study areas within the fire histories of interest, with coordinates positioned on vehicle tracks. ARI staff visited the study areas prior to each camp to check the suitability of the random points as potential sites, particularly in terms of vehicle access and terrain. Areas of thick vegetation or steep slopes were avoided as much as possible. A short list of potential sites was produced, with final site selection based on achieving geographic spread throughout the study area, and replication of fire histories. The size of the Taggerty study area did not allow for all potential sites to be visited during the time allocated for reconnaissance. Some of these unvisited sites were included in the final site selection.

Twenty sites were selected in each study area (Figure 1, Table 1, Appendix 1). Sites selected in the Taggerty study area were at least one kilometre apart to ensure sites were as independent from each other as possible, while working within the physical and logistical constraints of the area covered. However, due to the smaller study area at Beechworth and the limited suitable forest available via accessible tracks, sites here were a minimum of 500 m apart to enable the full complement of 20 sites to be selected. The following fire histories within both study areas were targeted:

- burnt once since 1970 with the last fire occurring in 2009;
- burnt twice since 1970 with the last fire occurring in 2009 and fires prior to this occurring in various other years (during the period 1972–2008);
- unburnt since 1970.

In Beechworth, there was a lack of accessible forest that was burnt in 2009, and a fourth category was used to reach the full complement of 20 sites—two sites were selected in forest that had been burnt twice since 1970 with the last fire occurring 30 years ago, in 1981. In this instance, the other of the two fires had occurred in 1977 (Table 1).

Detailed directions and maps showing the location of each study site on tracks, including geographic coordinates and track names, were provided to participants at the commencement of each camp. Site locations were marked on tracks with pink flagging tape prior to surveys by ARI staff and participants. Site coordinates were made available as electronic files for uploading into compatible privately owned global positioning system (GPS) units.

Table 1. Number of survey sites selected within each fire history category for the two study areas (Taggerty and Beechworth) in the Community Finding Fauna project January–April 2011.

Study area\Fire history*	One fire, 2009	Two fires, 2009 & various	Two fires, 1981 & 1977	Unburnt
Taggerty	9	7	0	4
Beechworth	6	7	2	5
Total	15	14	2	9

*number of fires since 1970, year of most recent fire(s)

2.4 Survey techniques

Automated cameras were used to target native small, medium and large terrestrial mammals that forage at least some of the time on the ground. This technique identifies animals from photographs taken when they investigate bait. In this case, bait that predominately attracts herbivores and some omnivores (see 2.4.3), rather than carnivores, was used. Ultrasonic bat call detectors were used to survey insectivorous bats, and timed area counts were conducted to survey diurnal birds. Mammal survey equipment teams were coordinated by an ARI staff member and key FNCV members, while diurnal bird surveys were coordinated by experienced BOCA members.

2.4.1 Survey equipment training

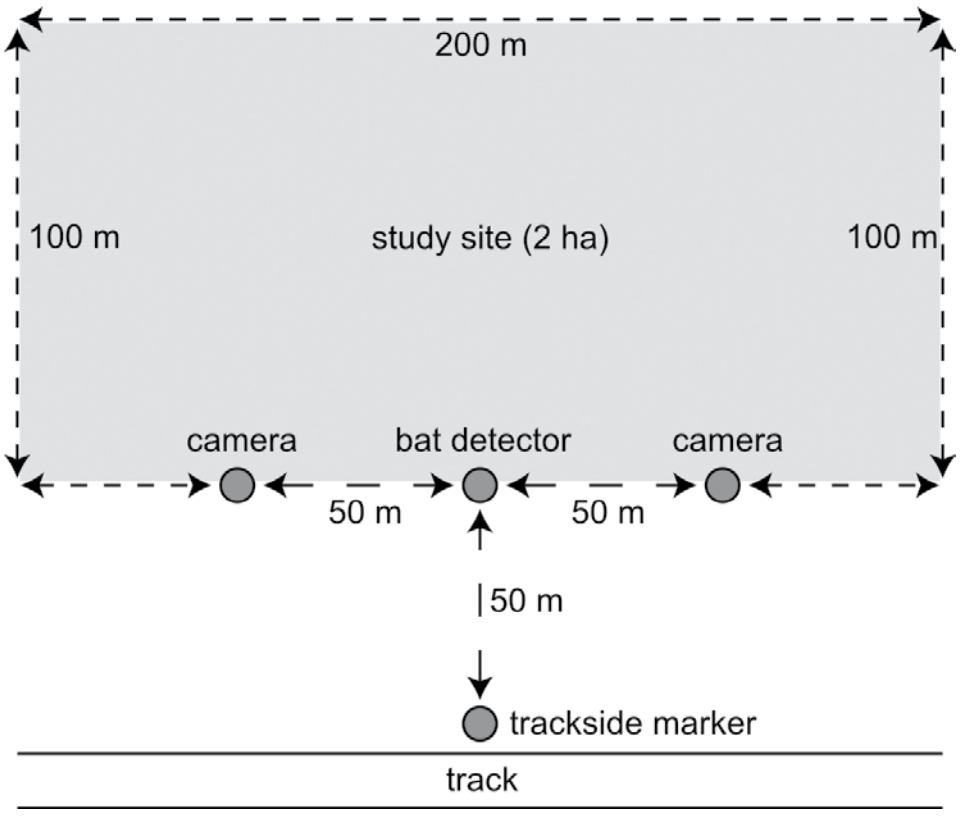
Automated camera training was held at ARI on 13th December 2010 and was attended by 12 FNCV members. Several ARI staff gave presentations on the history, operation, components and installation of cameras, photo processing techniques (including identifying animals from photos), data management and the rationale of data analyses. A component on the use of bat detectors was also included. This was followed by a practical demonstration in the grounds of ARI on how to install automated cameras and bat detectors in field situations. Material used in the presentations was distributed to the main contacts of each naturalist group via email for future reference.

A practical demonstration on installing automated cameras and bat detectors was also given at the first study site during the first camp (Taggerty study area), with detailed written instructions distributed to participants.

2.4.2 Configuration of site survey methods

Study sites consisted of a 2 ha bird survey area, with mammal survey equipment (one bat detector and two automated cameras) set along one edge (Figure 3). The bat detector was set 50 m perpendicular from the vehicle access track, measured from a trackside marker. Automated cameras were placed 50 m either side of the bat detector, parallel to the road. Diurnal bird surveys were conducted beyond the bat detector and cameras, roughly within a 200 x 100 m rectangle. Distances from tracks and between installed equipment were measured with a hand-held GPS unit (GPSmap 60CSx or GPSmap 62s, Garmin Ltd, Kansas, USA). Coordinates were recorded on GPS units for each bat detector (which was used as the official site coordinate) and automated camera to allow them to be located on completion of the survey.

Figure 3. Configuration of site survey methods in relation to tracks, showing the bird survey area and the position of the bat detector and two automated cameras.



2.4.3 General mammal surveys

Small to large mammals were surveyed using PixController DigitalEye™ 12.1 trail camera units. These comprised a weatherproof case containing a Sony white-flash 12.1 megapixel digital camera that is triggered when a passive infrared sensor detects a moving heat source, such as an animal (PixController Inc, Pennsylvania, USA). Sensors were powered by a 9 v battery and set to operate during the day and night, with the trigger mechanism set to take photos at a minimum time interval of every 30 seconds. Particular digital camera settings were chosen to obtain the highest quality photos, while using the least battery power as possible.

All digital camera settings were individually checked on site prior to installation. Camera units were fixed to a tree trunk about 50 cm above the ground with plastic-coated wire and secured with a cable-lock (Figure 4). Bait stations were used to attract animals to the camera. They were placed a minimum of 2 m directly in front of the camera units. Bait stations consisted of six stainless steel tea infusers, containing a mixture of rolled oats, golden syrup and peanut butter, placed into a wire mesh cage and fixed to a plastic tomato stake so that the bottom of the cage was about 20 cm off the ground. A molded metal lid covered the top of the bait cage to protect the bait from rain (Figure 5). The area on each side of the camera, between the camera and bait cage, and behind the bait cage, was cleared of vegetation. This was done to prevent animals from being obscured in photos and to reduce the likelihood of moving vegetation (particularly if heated up by the sun) causing 'false triggers', whereby the camera is triggered to take a photo by something other than an animal moving in front of it.

During installation the position and direction of the camera and sensor was checked by taking test photos. If necessary, the unit was adjusted to ensure the bottom of the bait cage was directly in the middle of the image. This points the sensor towards the bait cage in a way that maximizes the likelihood of a photo being taken when an animal investigates the bait. Camera units were turned on, and the in-built start up procedure observed to completion to verify the units were operating. This verification included triggering the camera to take photos of a 'camera sheet' that displayed information about the site and camera, including site name, camera number, date, coordinates of camera and cable-lock key number (Figure 6), to enable photos to be attributed to that particular location.

Two cameras were set at each site so that if one failed, data would still be collected from the site by the other one.

During the first camp, at the Taggerty study area, participants involved in setting up cameras and bat detectors initially gathered at the first site for a demonstration by an ARI staff member (Figure 7). Participants then split into two teams, one comprising naturalist group members, the ARI staff member, and an ARI volunteer, and the other comprising only naturalist group members. During the second camp at Beechworth, there was a third team comprising only naturalist group members. All these teams included people experienced at installing cameras (Figure 8) and bat detectors (through their involvement at the previous camp) who could train any newcomers.

Figure 4. Automated camera unit attached to a tree with a cable-lock at a study site in the Taggerty study area (Phoebe Macak).

Figure 5. A bait cage used to lure mammals in front of automated survey cameras, at one of the study sites (automated camera).

Figure 6. A 'camera sheet' used to record date and location information associated with individual automated cameras, being held up by Russell Thompson of the FNCV at one of the study sites (automated camera).

Cameras were left *in situ* for a minimum of three weeks. They were installed within the Taggerty study area between 23–25 January, and retrieved between 15–16 February, and installed within the Beechworth study area between 12–13 March, and retrieved on 2 April.

2.4.4 Insectivorous bat surveys

Insectivorous bats were surveyed by recording their ultrasonic echolocation calls using bat detector units. Units consisted of a waterproof Pelican box containing an Anabat™ SD2 detector (Titley Scientific, Ballina, Australia) that records bat calls onto a compact flash memory card, powered by a 12 v 7 Ah lead-acid battery. An external microphone and lead, housed in PVC piping for protection against rain and interference from animals, was placed next to the unit with the microphone approximately 90 cm off the ground (Figure 9). The microphone housing was positioned so that the entrance was pointing towards a gap in the surrounding vegetation. This gap effectively acts as a bat 'flyway', and placing the microphone here increases the likelihood of recording good quality calls of bats flying directly overhead. To prolong battery life the detectors were programmed to start recording shortly before dusk and finish recording shortly after sunrise. One detector was installed per site by the team setting up the automated cameras.

Bat detectors were installed at 39 sites across both study areas for 21–24 days at Taggerty and 21–22 days at Beechworth. Detectors were left *in situ* and collected at the same time as the automated cameras. Normally, detectors are not left out for this long but they were on this occasion to avoid additional trips. During the Beechworth camp one of the detectors failed to operate and one of the recently burnt sites ('two fires, 2009 & various') did not have a detector installed. Not all detectors operated properly due to unexpected technical difficulties. In addition, during the survey period at Beechworth the microphone leads of four of the detectors were damaged when an unknown animal chewed through them, after which no more bat calls were able to be recorded. In some cases this was quite early in the survey period. This limited the amount of usable data overall, with only 20 sites (13 from Taggerty and 7 from Beechworth) available for analysis.

Figure 7. Automated camera installation being demonstrated to camp participants by ARI staff at a study site in the Black Range near Taggerty (Sally Bewsher).

Figure 8. Camp participants installing an automated survey camera during the Beechworth camp (Sally Bewsher).

Figure 9. A detector unit used to record the ultrasonic echolocation calls of insectivorous bats, at one of the study sites (Phoebe Macak).

2.4.5 Collection of survey equipment

Automated cameras and bat detectors were collected from study sites about three weeks after each camp. One or two ARI staff joined a small group of FNCV members, forming 2–3 teams that retrieved the equipment over 1–2 days. Memory cards from half of the cameras were retained by the FNCV for data processing, as well as half of the bait cages for cleaning.

2.4.6 Diurnal bird surveys

Bird surveys were carried out by members of BOCA and BA, local naturalists and ARI staff during the camp weekends. In most cases surveys were conducted by a two-person team, including at least one experienced observer, to ensure correct bird identification, and to help less experienced observers to increase their skills. Observers walked slowly throughout the site recording the number and species of all individual birds seen and heard over a 20 minute period, as described by Loyn (1986). Birds observed nearby were recorded separately. Each site was surveyed a minimum of two times (up to five times for some sites), with effort made to conduct at least one of the surveys in the morning and, if possible, one in the afternoon. Surveys were conducted at 39 of the 40 designated sites, with one recently burnt site at Taggerty omitted because of access concerns. Several additional sites were surveyed at Taggerty but have not been considered further in this report.

2.4.7 Incidental observations

Participants made many observations of fauna in addition to those made during formal surveys, from both study sites (see Appendix 5 and 6) and surrounding areas (not included in this report).

2.4.8 Survey equipment preparation

ARI provided detailed maps and directions to study sites, GPS units containing study site coordinates, detailed instructions for installing automated cameras, automated cameras and associated equipment (bait, bait cages, poles, lids, camera sheets), bat detectors, permanent markers, pencils, clipboards, flagging tape, datasheets, and a number of communication devices (ultra high frequency radios, portable trunked radios). After the first camp, some FNCV members were involved in preparation of equipment for the second camp, including making bait and cleaning and preparing bait cages for the automated cameras.

2.5 Data processing and analysis

All records obtained during surveys will be submitted to DSE's Victorian Biodiversity Atlas database (formerly known as the Atlas of Victorian Wildlife).

Note that comparisons between fire histories for automated camera mammal data and diurnal bird count data were made via visual examination only and any differences or otherwise may not prove to be statistically significant.

2.5.1 Images from automated cameras

Photos from one camera at each site were reviewed by members of the FNCV, while ARI staff reviewed those from the second camera. Photos were visually inspected one by one and where possible, mammals, birds and reptiles were identified to species level. All records were entered into Microsoft Excel spreadsheets. Where there was doubt about the identity of a species the photo was referred to ARI for confirmation. ARI staff verified identifications made by the FNCV, particularly for those species that can be difficult to identify from photos, such as small mammals. In cases where specific identity could not be confirmed it was recorded under a more general label e.g. 'brushtail possum' or 'unknown small mammal'. The presence of each mammal species at each site, based on confirmed identifications only, was combined and presented for each study area separately, then combined and grouped into the fire history categories. Any birds or reptiles present in photos were recorded as incidental records and not considered as per mammals as this survey method was not designed to target these animal groups.

2.5.2 Ultrasonic bat calls

Bat detector data were downloaded from memory cards by ARI staff using specialised software (CFCRead – C.Corben/ Titley Scientific) which converts recorded information into an electronic file that can be viewed as a graph of frequency versus time. Downloading software grouped files for each site according to the overnight period during which they were recorded. A selection of four specific consecutive nights was chosen for further processing based on the total number of days each detector was functioning, minimum overnight and maximum daytime temperatures and daily rainfall. Four nights was considered a reasonable period to represent bat activity at a site while allowing sufficient time for data processing. The dates selected to obtain measures of bat activity for each study area were 25–28 January for Taggerty and 14–17 March for Beechworth, from 13 and 7 sites respectively. Detector files were processed manually using AnalookW software (C. Corben) to distinguish files containing bat calls, which appear as particular shapes, from files that only contain extraneous 'noise' (e.g. insect calls, electronic interference). Total numbers of files containing bat calls were used to give a measure of bat activity per night for each site, where one file is considered one bat call. Note that this is not a measure of bat abundance, as individual bats cannot be distinguished.

Activity data were analysed using R (version 2.13.0) (R Development Core Team 2011). The number of calls for each individual site was averaged over the four nights to allow a comparison of mean activity. These data were transformed using log(x+1). An ANOVA and planned contrast tests were used to determine whether or not bat activity differed significantly between fire history categories.

2.5.3 Diurnal bird counts

Data from diurnal bird surveys were entered by members of BOCA and provided to ARI as a Microsoft Access database with some data extracted into Microsoft Excel. Individual survey data were then summarised across all sites for each species and presented as mean abundance for each fire history category, combining the two study areas using only on-site records. Bird abundance data for each fire history were grouped into foraging, nesting, migration and status guilds (introduced or native species, with the latter designated common or uncommon in Victoria), and following classification by Loyn (1998) and Loyn and Kennedy (2009). One pair of observers, while recording how many individual birds they saw, did not record the number they heard and only noted that the particular species was present. These records were given a nominal value of 1, and included with the rest of the data. Off-site records were excluded from summaries. Records of swifts (White-throated Needletail) were all considered as off-site as these birds feed above the canopy and move too rapidly to be assigned accurately as on-site or off-site.

2.6 Participant feedback

Feedback was sought to gauge the success of the project in terms of meeting its objectives of involving naturalist group members in fire and ecological research while enhancing their skills in survey techniques and conducting research. A feedback form (Appendix 2) was distributed to participants after the camps and associated data processing had been completed. Additional feedback was noted opportunistically during camps or sought more directly during phone calls with key members after the camps.

2.7 Photo consent

Photos of participants were taken during the camps and equipment pick up period by the automated cameras and ARI staff and used in this report and other material associated with the 'Rebuilding Together' program. Written consent was obtained from people who can be identified in these photos.

3 Results

3.1 Survey camps and associated activities

A total of 46 individual naturalist group members took part in the two survey camps, with 23 attending the first camp at Cathedral Range (Taggerty study area) and 27 attending the subsequent Beechworth camp (Appendix 3). Some attended both camps. A small number of naturalists local to each study area joined the camps to take part in diurnal bird surveys and installing mammal survey equipment. Seven participants returned completed feedback forms (Appendix 4) while the experiences of others were conveyed less formally, either during or after the camps.

After completion of the first camp at the Taggerty study area, a meeting was held at ARI with the key contacts to discuss how the camp proceeded, and to identify any aspects that may need to be addressed before the commencement of the second camp. The rugged condition of some of the unsealed tracks was considered a concern for some, which led to a more conservative site selection process for the camp at Beechworth from this point of view. As the Beechworth camp was held over fewer days than at Taggerty, it was decided that sites should be marked earlier so that surveys could commence as soon as possible to ensure that everything was completed in time. Some members committed to getting to the area early to carry out site marking before the main contingent of participants arrived.

3.1.1 Capacity building

Taking part in the camps and associated activities resulted in people learning new fauna survey techniques and increasing their existing experience in others.

Those that were involved in installing cameras and bat detectors quickly became familiar with the many tasks required and were able to train less experienced participants during the course of the camps, especially those that were in teams without ARI staff. Sorting through the downloaded camera photos allowed some participants to apply and hone mammal identification skills. The FNCV were particularly keen to extend their experience in using cameras which resulted in a third camp, held over Easter in late April, during which they coordinated and undertook all surveys themselves. ARI staff conducted site selection, reconnaissance, and some equipment preparation but were present at the camp only briefly. The timing of this third camp meant that it was during a part of the year that was unsuitable for insectivorous bats and diurnal bird surveys, and these techniques were not included.

Novice birders improved their identification skills by working with more experienced observers, learning new calls and other characteristics of species with which they were unfamiliar.

3.1.2 Extra activities

During camps, participants carried out their own fauna and flora related activities outside of formal surveys, exploring the area in the vicinity of camp sites, or further afield. Small mammal, reptile and amphibian trapping, insectivorous bat trapping, spotlighting (the former all organised by the FNCV) and bird observations were carried out at the Cathedral Range State Park during the first camp. After experiencing the time and effort required for setting up automated cameras and bat detectors, participants decided to reduce most of these extra activities during the shorter second camp. A spotlighting survey was organised for one of the camp nights in nearby forest. With more time available over the third camp at Easter, most of these activities were resumed and many fauna species were recorded, including some that would not have been recorded during the formal survey effort.

3.1.3 Participant feedback

Completed feedback forms were received from six participants (see Appendix 4 for a selection of participant quotes). Other feedback was gained informally, both during and after the camps. Feedback covered three main themes: learning new skills, visiting fire-affected areas, and contributing to research. Overall, being involved made people feel that their skills and experience was valued, leading to a sense of personal satisfaction in what was achieved. Participants particularly appreciated the chance to learn and improve survey skills, with some highlighting that this was a challenge at times, but overall very rewarding. The FNCV considered that being familiar with using automated cameras provided a valuable new skill for their members, and was directly applicable to their usual activities.

Many forest species detected during bird surveys were particularly appreciated by those observers who spend little time in extensive forests, including Wedge-tailed Eagle, Australian Owlet-nightjar, Gang-gang Cockatoo, Yellow-tailed Black-Cockatoo, White-throated Needletail, Little Lorikeet, Superb Lyrebird, Cicadabird, Red-browed Treecreeper, Flame Robin, Scarlet Robin, Rose Robin, Satin Flycatcher, Leaden Flycatcher, Crested Shrike-tit, Lewin's Honeyeater and Satin Bowerbird.

Visiting 2009 bushfire-affected areas was considered a highlight. For many it was the first time they had seen these areas since the fire, and it gave people the opportunity to see how the forest was recovering. The presence of fauna in burnt areas, sometimes in high numbers, for example White-throated Treecreepers, added to this sense of ecosystem recovery. Most participants had not been involved in this type of research before and were grateful for the opportunity to do so. Socialising with people from other naturalist groups, as well as from within their own

group, was also appreciated as it allowed urban and rural experiences and knowledge to be shared.

The FNCV highlighted their involvement in the project in articles published in their monthly newsletter (Bewsher 2011, Harris 2011a, 2011b).

3.2 Automated cameras

Eighty automated cameras were successfully installed at a total of 40 study sites across the two study areas, with photos retrieved from 79 of these. There were technical problems with the memory card from one camera (Taggerty study area), from which no photos were able to be downloaded. Cameras operated for 6–24 days and took a total of 23,162 photos, ranging from 38 – 708 per camera. Of these photos, 6,010 (26%) contained an animal. FNCV members processed 10,395 photos from 18 cameras, identifying animals from 2,959 photos (28%). ARI staff processed 12,767 photos from 21 cameras, of which 3,051 photos (24%) contained animals. Most cameras were still operating when collected. False triggers can be common with this type of camera unit, and in some cases hundreds of such photos were taken, draining the camera battery and resulting in the camera not operating for the full survey period. In most cases the sensor, which uses less power, was still operating.

A total of 39 fauna species were identified from photos (for examples, see Figure 10) taken by the automated cameras across the two study areas, comprising 18 mammals, 1 reptile (Appendix 5) and 20 birds (Appendix 6). Eleven mammal species were detected at Taggerty, including eight native and three introduced, and eighteen were detected from Beechworth, including twelve native and six introduced (Table 2). The Black Wallaby and Common Wombat were recorded at the most sites overall (38 and 32 respectively), while all other mammal species occurred at less than half the total number of sites (Table 2) with Mountain Brushtail Possum and Eastern Grey Kangaroo present at 16 and 12 sites respectively. Introduced mammals detected included the Red Fox, House Mouse and European Rabbit (at 11, 9 and 6 sites respectively). One photo containing a deer was taken at Beechworth which was thought to be a Sambar Deer. However, only a portion of the animal was visible and a definitive identification could not be made. There were few differences between the two study areas in the presence of species that were detected at both, with most occurring at similar numbers of sites (Table 2). The most notable differences were for Common Brushtail Possum (at one site from Taggerty; at seven sites from Beechworth) and House Mouse (not detected at Taggerty; at six sites from Beechworth). Altogether, seven species were only found at Beechworth, in most cases at a small number of sites, including four native species: the Long-nosed Bandicoot (at 2 sites), Dusky Antechinus (1), Common Ringtail Possum (1) and Bush Rat (1). There were some records for species that are not usually expected to be recorded very often on cameras including the Koala (at 4 sites) and the Common Ringtail Possum (1). A small number of photos had animals in them that could not be identified with certainty, either due to the angle of the animal obscuring diagnostic features, or the quality of the photo not allowing a magnification that may allow such features to be clear.

Table 2. Number of sites where each mammal species was identified from automated cameras. Cameras were installed at 20 sites near Taggerty in January–February and at 20 sites near Beechworth in March–April, 2011.

Common name	Taggerty	Beechworth	Total
Native species			
Short-beaked Echidna	6	3	9
Agile Antechinus	4	4	8
Dusky Antechinus	0	1	1
Long-nosed Bandicoot	0	2	2
Koala	1	3	4
Common Wombat	16	16	32
Mountain Brushtail Possum	9	7	16
Common Brushtail Possum	1	7	8
Common Ringtail Possum	0	1	1
Eastern Grey Kangaroo	3	9	12
Black Wallaby	18	20	38
Bush Rat	0	1	1
Introduced species			
Black Rat	0	3	3
House Mouse	0	6	6
Red Fox	4	7	11
House Cat	1	3	4
European Rabbit	3	6	9
Deer sp.	0	1	1

Figure 10. Examples of photos taken of fauna by the automated cameras during the surveys. Study sites were surveyed near Taggerty and Beechworth, January-April 2011. A=Long-nosed Bandicoot, B=Agile Antechinus, C=Mountain Brushtail Possum, D=Red Fox, E=Superb Lyrebird, F=Laughing Kookaburra.

Many species were recorded in similar frequencies on recently burnt or long-unburnt sites (Table 3). Of the species recorded on more than 5 sites, only four showed differences between fire histories. One native species (Common Brushtail Possum) and one introduced species (European Rabbit) were recorded on higher proportions of long-unburnt sites than recently burnt sites (Table 3). Two introduced species (Red Fox and House Mouse) showed the reverse effect, and were respectively recorded mainly or solely on recently burnt sites.

In general, species presence did not differ with fire frequency on areas burnt in 2009 (Table 3). A possible exception was the Short-beaked Echidna, which was found at six of 15 sites that had been burnt only once since 1970, and only on one of 14 sites that had been burnt twice over that period.

Table 3. Percentage and number of sites across fire history categories where each mammal species was identified from automated cameras. Fire history categories denote the number of fires since 1970, and the year of the most recent fire(s). Cameras were installed at 20 sites near Taggerty in January–February and at 20 sites near Beechworth in March–April, 2011.

	% of sites per combined fire categories [number of sites]		number of sites per fire categories				
Common name	Recently burnt* (n=29)	Long-unburnt^ (n=11)	One fire, 2009 (n=15)	Two fires, 2009 & various (n=14)	Two fires, 1981 & 1977~ (n=2)	Unburnt (n=9)	Total (n=40)
Native species							
Short-beaked Echidna	24 [7]	18 [2]	6	1	1	1	9
Agile Antechinus	21 [6]	18 [2]	3	3	0	2	8
Dusky Antechinus	3 [1]	0 [0]	1	0	0	0	1
Long-nosed Bandicoot	0 [0]	18 [2]	0	0	0	2	2
Koala	3 [1]	27 [3]	1	0	0	3	4
Common Wombat	79 [23]	81 [9]	12	11	2	7	32
Mountain Brushtail Possum	38 [11]	45 [5]	6	5	0	5	16
Common Brushtail Possum	14 [4]	36 [4]	1	3	0	4	8
Common Ringtail Possum	0 [0]	9 [1]	0	0	0	1	1
Eastern Grey Kangaroo	28 [8]	36 [4]	5	3	1	3	12
Black Wallaby	93 [27]	100 [11]	14	13	2	9	38
Bush Rat	3 [1]	0 [0]	1	0	0	0	1
Introduced species							
Black Rat	10 [3]	0 [0]	1	2	0	0	3
House Mouse	21 [6]	0 [0]	4	2	0	0	6
Red Fox	31 [9]	18 [2]	5	4	1	1	11
House Cat	3 [1]	27 [3]	0	1	0	3	4
European Rabbit	14 [4]	45 [5]	3	1	0	5	9
Deer sp.	3 [1]	0 [0]	0	1	0	0	1
Summary							
Total native species	**10**	**10**	**10**	**7**	**4**	**10**	**12**
Total introduced species	**6**	**3**	**4**	**6**	**1**	**3**	**6**
Overall total	**16**	**13**	**14**	**13**	**5**	**13**	**18**

* combination of the two categories burnt in 2009

^ combination of the Two fires, 1981 & 1977 and Unburnt categories

~ this fire category was used at the Beechworth study area only

3.3 Insectivorous bats

Nightly bat activity varied greatly across the twenty sites for which data were analysed (Appendix 7). The ANOVA revealed that there was a significant effect of fire history on mean bat activity ($F_{3,17}$ = 307, p<0.001). Planned contrast tests showed that activity was significantly higher at long-unburnt sites than at recently burnt sites (t_{17}=2.53, p=0.02) (Figure 11): mean bat activity on long-unburnt sites was about three times as high as on recently burnt sites. There was no effect of fire frequency for areas burnt in 2009 (t_{17}=-0.30, p=0.77). The volume of data was too low to enable further analysis that would test whether there were any significant differences in activity between the two study locations.

3.4 Diurnal birds

Fifty-eight species were recorded during 107 timed bird counts within the designated 2 ha site areas (Table 4). A further 11 species were recorded incidentally (Appendix 6), including the Yellow-rumped Thornbill and Bassian Thrush that were only recorded from automated survey cameras. The most common species recorded were Brown Thornbill, Grey Fantail, Crimson Rosella, Silvereye, Superb Fairy-wren, White-throated Treecreeper, White-browed Scrubwren and Striated Thornbill (in decreasing order of abundance). Together they constituted 63% of the bird population, based on counts from the study sites (Table 4). These species were also the most widespread, recorded at over 50% of the study sites, along with Grey Shrike-thrush, Laughing Kookaburra and Yellow-faced Honeyeater (Appendix 6). The most widespread species was the White-throated Treecreeper, recorded at 37 of the 39 sites surveyed. Thirteen species were only recorded from single sites during bird counts, including Sacred Kingfisher and Rainbow Bee-eater. Only one introduced species (Common Blackbird) was observed from one site, constituting 0.08% of the bird population.

Figure 11. Insectivorous bat activity per night at 20 study sites across three fire history categories. Fire history categories denote the number of fires since 1970, and the year of the most recent fire(s). Activity was measured from 13 sites near Taggerty in January-February and from 7 sites near Beechworth in March-April, 2011.

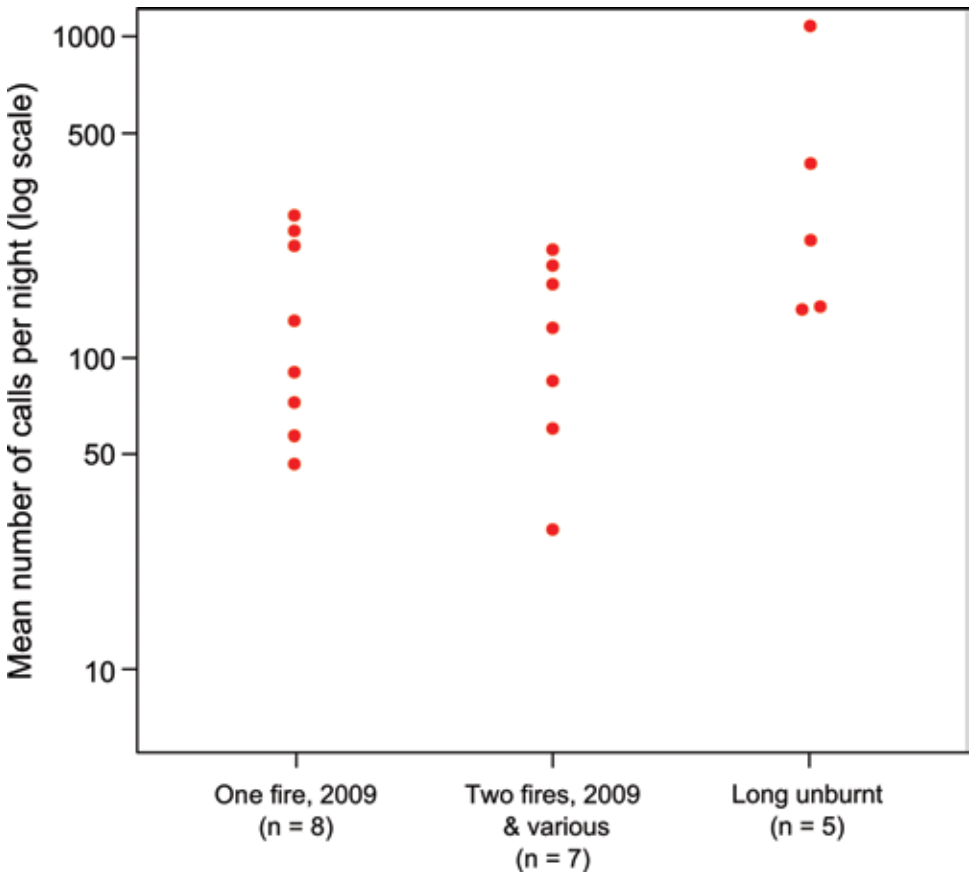


Table 4. Mean abundance of bird species per count in each fire history category, and guild allocations. Fire history categories denote the number of fires since 1970, and the year of the most recent fire(s). Birds were surveyed from 19 study sites near Taggerty in January and from 20 sites near Beechworth in March, 2011. Counts (20 minutes 2 ha) were conducted 2–5 times per site.

Common Name	Foraging guild[&]	Nesting guild[%]	Migration guild[+]	Status guild[#]	One fire, 2009 (n=15)	Two fires, 2009 & various[~] (n=13)	Two fires, 1981 & 1977 (n=2)	Unburnt (n=9)	Overall mean (n=39)	Recently burnt* (n=28)	Long-unburnt^ (n=11)
Wonga Pigeon	SG	N	N	U	0.00	0.03	0.00	0.00	0.01	0.01	0.00
Australian Owlet-nightjar	OT	LH	N	U	0.00	0.00	0.00	0.07	0.02	0.00	0.06
Wedge-tailed Eagle	V	N	N	N	0.03	0.00	0.00	0.00	0.01	0.01	0.00
Yellow-tailed Black-cockatoo	ST	LH	N	N	0.00	0.12	0.00	0.00	0.04	0.06	0.00
Gang-gang Cockatoo	ST	LH	N	N	0.08	0.06	0.00	0.00	0.05	0.07	0.00
Galah	SG	N	N	N	0.00	0.00	0.50	0.07	0.06	0.00	0.17
Sulphur-crested Cockatoo	SG	LH	N	N	0.26	0.09	0.00	0.00	0.12	0.18	0.00
Australian King-Parrot	F	LH	N	N	0.00	0.00	0.00	0.07	0.02	0.00	0.06
Crimson Rosella	ST	LH	N	N	1.82	1.38	4.38	3.19	2.21	1.61	3.46
Eastern Rosella	SG	N	N	N	0.00	0.00	0.00	0.07	0.02	0.00	0.06
Fan-tailed Cuckoo	TS	BP	S	N	0.03	0.00	0.00	0.11	0.04	0.01	0.09
Laughing Kookaburra	V	LH	N	N	0.66	0.47	0.25	0.56	0.54	0.57	0.49
Sacred Kingfisher	V	SH	S	N	0.03	0.00	0.00	0.00	0.01	0.01	0.00
Rainbow Bee-eater	A	B	S	N	0.00	0.18	0.00	0.00	0.06	0.08	0.00
Superb Lyrebird	DG	N	N	N	0.08	0.03	0.00	0.04	0.05	0.06	0.03
White-throated Treecreeper	B	SH	N	N	1.42	1.35	1.75	2.22	1.63	1.39	2.11
Red-browed Treecreeper	B	SH	N	U	0.13	0.06	0.13	0.15	0.11	0.10	0.14
Satin Bowerbird	F	N	N	N	0.03	0.06	0.00	0.07	0.05	0.04	0.06
Superb Fairy-wren	OT	N	N	N	1.42	1.50	2.63	2.30	1.76	1.46	2.37
White-browed Scrubwren	DG	N	N	N	1.34	1.65	0.63	1.78	1.50	1.49	1.51
Striated Thornbill	C	N	N	N	1.50	0.94	1.50	1.30	1.27	1.24	1.34
Buff-rumped Thornbill	OT	N	N	N	0.03	0.00	0.00	0.00	0.01	0.01	0.00
Brown Thornbill	TS	N	N	N	2.24	2.44	2.75	3.89	2.76	2.33	3.63
Spotted Pardalote	C	B	N	N	0.24	0.29	0.00	0.52	0.31	0.26	0.40
Striated Pardalote	C	SH	N	N	0.42	0.59	0.00	0.37	0.43	0.50	0.29
Eastern Spinebill	N	N	N	N	0.05	0.00	0.00	0.56	0.16	0.03	0.43
Yellow-faced Honeyeater	N	N	S	N	0.47	0.76	0.13	1.41	0.78	0.61	1.11
White-eared Honeyeater	N	N	N	N	0.05	0.12	0.00	0.04	0.07	0.08	0.03
Red Wattlebird	N	N	N	N	0.42	1.15	0.25	0.15	0.57	0.76	0.17
Crescent Honeyeater	N	N	N	N	0.00	0.03	0.00	0.04	0.02	0.01	0.03
Brown-headed Honeyeater	N	N	N	N	0.03	0.15	0.25	0.00	0.07	0.08	0.06
White-naped Honeyeater	N	N	N	N	0.05	0.38	0.88	1.04	0.47	0.21	1.00

Continued on next page

Table 4. continued

Common Name	Foraging guild[&]	Nesting guild[%]	Migration guild[+]	Status guild[#]	One fire, 2009 (n=15)	Two fires, 2009 & various[~] (n=13)	Two fires, 1981 & 1977 (n=2)	Unburnt (n=9)	Overall mean (n=39)	Recently burnt[*] (n=28)	Long-unburnt[^] (n=11)
Noisy Friarbird	N	N	S	N	0.00	0.09	0.13	0.00	0.04	0.04	0.03
Eastern Whipbird	DG	N	N	N	0.03	0.00	0.00	0.04	0.02	0.01	0.03
Varied Sittella	B	N	N	N	0.00	0.03	0.00	0.00	0.01	0.01	0.00
Black-faced Cuckoo-shrike	C	N	S	N	0.03	0.00	0.00	0.07	0.03	0.01	0.06
Crested Shrike-tit	B	N	N	N	0.00	0.00	0.00	0.26	0.07	0.00	0.20
Golden Whistler	TS	N	N	N	0.18	0.15	0.13	0.63	0.28	0.17	0.51
Rufous Whistler	C	N	S	N	0.16	0.15	0.25	0.59	0.27	0.15	0.51
Grey Shrike-thrush	G	N	N	N	0.53	0.41	0.38	0.70	0.52	0.47	0.63
Grey Butcherbird	V	N	N	N	0.00	0.06	0.00	0.00	0.02	0.03	0.00
Australian Magpie	OG	N	N	N	0.05	0.35	1.38	0.37	0.33	0.19	0.60
Pied Currawong	V	N	N	N	0.26	0.62	0.00	0.26	0.36	0.43	0.20
Grey Currawong	V	N	N	N	0.00	0.06	0.00	0.04	0.03	0.03	0.03
Rufous Fantail	TS	N	S	N	0.03	0.03	0.00	0.04	0.03	0.03	0.03
Grey Fantail	C	N	N	N	1.63	2.06	3.00	3.37	2.31	1.83	3.29
Australian Raven	V	N	N	N	0.08	0.06	0.63	0.11	0.12	0.07	0.23
Little Raven	V	N	N	N	0.00	0.00	0.25	0.00	0.02	0.00	0.06
Leaden Flycatcher	C	N	S	U	0.03	0.00	0.00	0.00	0.01	0.01	0.00
White-winged Chough	OT	N	N	N	0.26	0.35	0.00	0.00	0.21	0.31	0.00
Scarlet Robin	OT	N	N	N	0.00	0.03	0.25	0.04	0.04	0.01	0.09
Flame Robin	OT	N	S	N	0.08	0.06	0.00	0.00	0.05	0.07	0.00
Eastern Yellow Robin	DG	N	N	N	0.24	0.38	0.00	0.96	0.45	0.31	0.74
Silvereye	F	N	N	N	1.50	0.79	0.50	4.19	1.88	1.17	3.34
Common Blackbird	DG	N	N	I	0.00	0.00	0.00	0.07	0.02	0.00	0.06
Mistletoebird	F	N	N	N	0.05	0.03	0.13	0.00	0.04	0.04	0.03
Red-browed Finch	SG	N	N	N	0.05	0.03	0.00	0.00	0.03	0.04	0.00
Summary											
Number of counts					**38**	**34**	**8**	**27**	**107**	**72**	**35**
Total mean abundance					**18.00**	**19.56**	**23.00**	**31.74**	**22.34**	**18.74**	**29.74**
Species per site					**7.47**	**8.32**	**9.25**	**8.05**	**7.98**	**7.87**	**8.27**

[&] A = aerial insectivore; B = bark insectivore; C = canopy forager; DG = damp-ground insectivore; F = frugivore; G = generalist insectivore; N = nectivore; OG = open-ground insectivore; OT = open-ground-among-trees insectivore; SG = seed-eater close to the ground; ST = seed-eater at all levels; TS = tall shrub insectivore; V = carnivore

[%] B = burrow or ground nesting; BP = brood parasite; LH = large hollow nester; N = normal nester; SH = small hollow nester; X = does not nest in Australia

[+] N = non-migrant; S = summer migrant;

[#] I = introduced; N = native (not uncommon); U = uncommon native

[~] this fire category was used at the Beechworth study area only

[*] combination of the two categories burnt in 2009

[^] combination of the Two fires, 1981 & 1977 and Unburnt categories

More birds, both species and numbers, were found at long-unburnt sites than on recently burnt sites (Table 4): mean total bird abundance was ~1.5 times as high in long-unburnt sites as in recently burnt sites. Most species showed a similar pattern to that for total bird abundance, with more found in long-unburnt sites than those burnt in 2009. Silvereye, Crimson Rosella, Grey Fantail, Brown Thornbill, Superb Fairy-wren, White-naped Honeyeater, White-throated Treecreeper and Yellow-faced Honeyeater were much more numerous in long-unburnt than recently burnt forest. Some species were more numerous in recently burnt forest than long-unburnt forest including Red Wattlebird, Pied Currawong and Striated Pardalote. Several species were only found in burnt forest (Table 4), including Sulphur-crested Cockatoo and White-winged Chough, although these species were only recorded from a low number of sites overall.

Within forest last burnt in 2009, there was little difference in mean bird abundance between areas that had been burnt once or twice since 1970. The largest differences for these categories in recently burnt forest were for Red Wattlebird and Pied Currawong, which were more numerous in twice burnt areas, and for Silvereye and Striated Thornbill, both more numerous in forest burnt once.

Nearly all feeding and nesting guilds were more numerous in long-unburnt forest than in recently burnt forest, with the largest difference for frugivores and hollow nesters (Table 5, for species guild allocations see Table 4). There was little difference among guilds when comparing recently burnt forest that was burnt once or twice since 1970. The largest difference was for normal nesters, common native species and nectarivores, which were more numerous in twice-burnt forest.

Some bird species were recorded from sites other than those where they were detected during bird surveys. For example, Wonga Pigeons were observed during counts at one site but were also identified in automated cameras photos from another three sites (Appendix 6).

Table 5. Mean abundance of bird guilds per count in each fire history category. Fire history categories denote the number of fires since 1970, and the year of the most recent fire(s). Bird surveys were conducted at 19 study sites near Taggerty in January and from 20 sites near Beechworth in March, 2011. Counts (20 minutes, 2 ha) were conducted 2–5 times per site.

Guild	One fire, 2009 (n=15)	Two fires, 2009 & various (n=13)	Two fires, 1981 & 1977~ (n=2)	Unburnt (n=9)	Overall mean (n=39)	Recently burnt* (n=28)	Long-unburnt^ (n=11)
Foraging guilds							
Aerial insectivores	0.00	0.18	0.00	0.00	0.06	0.08	0.00
Bark insectivores	1.55	1.44	1.88	2.63	1.81	1.50	2.46
Canopy insectivores	4.00	4.03	4.75	6.22	4.63	4.01	5.89
Damp-ground insectivores	1.68	2.06	0.63	2.89	2.03	1.86	2.37
Frugivores	1.58	0.88	0.63	4.33	1.98	1.25	3.49
Generalist insectivores	0.53	0.41	0.38	0.70	0.52	0.47	0.63
Nectarivores	1.08	2.68	1.63	3.22	2.17	1.83	2.86
Open-ground insectivores	0.05	0.35	1.38	0.37	0.33	0.19	0.60
Open-ground-among-trees insectivores	1.79	1.94	2.88	2.41	2.07	1.86	2.51
Seed-eaters close to the ground	0.32	0.15	0.50	0.15	0.23	0.24	0.23
Seed-eaters at all levels	1.89	1.56	4.38	3.19	2.30	1.74	3.46
Tall-shrub insectivores	2.47	2.62	2.88	4.67	3.10	2.54	4.26
Carnivores	1.05	1.26	1.13	0.96	1.10	1.15	1.00
Nesting guilds							
Brood parasites	0.03	0.00	0.00	0.11	0.04	0.01	0.09
Burrow or ground nesters	0.24	0.47	0.00	0.52	0.36	0.35	0.40
Large hollow nesters	2.82	2.12	4.63	3.89	3.00	2.49	4.06
Normal nesters	12.92	14.97	16.50	24.48	16.76	13.89	22.66
Small hollow nesters	2.00	2.00	1.88	2.74	2.18	2.00	2.54
All hollow nesters	4.82	4.12	6.50	6.63	5.18	4.49	6.60
Migration guilds							
Non-migrants	17.16	18.29	22.50	29.52	21.04	17.69	27.91
Summer migrants	0.84	1.26	0.50	2.22	1.30	1.04	1.83
Status guilds							
Introduced	0.00	0.00	0.00	0.07	0.02	0.00	0.06
Native (not uncommon)	17.84	19.47	22.88	31.44	22.17	18.61	29.49
Uncommon native	0.16	0.09	0.13	0.22	0.15	0.13	0.20

~ this fire category was used at the Beechworth study area only

* combination of the two categories burnt in 2009

^ combination of the Two fires, 1981 & 1977 and Unburnt categories

4 Discussion

The two long weekend camps, the equipment collection trips and subsequent data processing by the naturalist group members have allowed a large amount of information to be collected on the presence and abundance of target fauna groups in forest burnt during the 2009 wildfires, and in nearby long-unburnt forest. In the process, participants built on their capacity by using existing naturalist skills, learning new skills and applying them, and passing those skills on to others.

4.1 Building capacity within naturalist groups

The success of capacity building within naturalist groups through participation in this project was demonstrated by how well the project was able to progress and what it was able to achieve. Important in that success was that most people came to the project with an appreciation and interest in ecological issues and familiarity with being in the bush, gained through prior involvement in various field-based surveys, individually or through their respective organisations. Participants brought other skills to the project that also proved valuable, for example, the logistical coordination by key people within the naturalist groups was crucial for the successful completion of survey activities during camps. This, and the appreciation participants felt at being involved in fire research and having the opportunity to learn new skills, all contributed to the successful completion of the data collection and processing, using the particular survey techniques within the given timeframe. This also allowed participants to carry out activities with a large degree of independence. The application of skills learnt was demonstrated further with the successful running of the third camp, which was specifically requested by the FNCV and where ARI staff had minimal involvement during the camp itself.

4.1.1 Survey techniques and support

The particular survey techniques used to collect data influenced the level of individual participation during the camps and skills gained over the course of the project. The automated cameras used for mammal surveys were ideally suited to this exercise as they involved a degree of training and therefore the potential to learn a new skill. This was considered particularly valuable as most participants had little or no prior experience with using cameras in this way. The various components of automated cameras and the procedure for their installation created opportunities for a small group of people to be involved in different tasks at the same time creating a high level of engagement. In addition, data processing allowed existing skills to be applied in new ways, for example using fauna recognition skills to identify mammals and birds from photos. The use of cameras was also perceived by participants as something that they could apply to their future activities, particularly those that already engage in mammal surveys, such as the FNCV.

The bat detectors were a less interactive survey technique as participants were only involved in their installation and collection. Although detectors are relatively simple to install, they require precise instructions to be followed if they are to function properly, and need fewer people to do so. Processing data from detectors involves the use of specialist software, and although bat call files can be readily distinguished from other recorded data if they are of good quality, a significant proportion are usually less clear and require an experienced person to process them. In this case the necessary resources to provide sufficient instruction and support that would enable participant involvement in this aspect of the project were not available.

For those less experienced at bird identification, it was an opportunity to enhance their skills by accompanying observers with more experience.

The successful application of the mammal and bat survey techniques was facilitated by the level of instruction provided by ARI staff (one staff member and a volunteer), and the presence of these staff during the camps. Automated cameras need to be installed in a precise manner for them to operate effectively, and it is important that accurate associated information (e.g. location coordinates, dates, site name) is recorded to be able to match photos with particular cameras. Comprehensive instructions provided with equipment and a continued presence of an experienced ARI staff member ensured a high level of installation quality was achieved. This also meant that the mammal component required a large investment of ARI staff time, including preparation of equipment leading up to camps. In comparison, the bird survey component required much less involvement of ARI staff in terms of training, supply of equipment, coordination and implementation. Although some of the surveys were conducted in conjunction with two ARI bird ecologists, this component relied heavily on the existing bird identification skills of the participants.

The opportunity for participants to engage in their own fauna and flora related activities outside of formal surveys was an important attraction in terms of their involvement in the project. The Fauna Survey Group of the FNCV, for example, usually undertake a variety of surveys during the many organised camps they run for their members each year and were keen to do the same during the project camps.

4.1.2 Constraints

Although the involvement of naturalist groups resulted in a large amount of data collection, there were some compromises made to the study design that were necessary to make the project a success. The various limitations associated with involving non-professionals meant that some aspects of conducting the project needed to be

modified from usual practices. In particular, the condition of forest tracks influenced the location of study sites and the overall size of study areas. The vehicles used by participants combined with occupational health and safety considerations about their use on unsealed tracks, reduced the area that is normally accessible by research scientists who are provided with training and vehicles appropriate for use on a range of track conditions. Extra effort was required to judge the suitability of forest tracks for inclusion in the study areas. As much as possible, teams were allocated to sites based on track condition and vehicle capability. However, not all access issues were avoided and, as a result, one study site was not surveyed for birds. Extra effort was made during the second camp to choose sites along tracks suitable for two-wheel drive vehicles, especially in anticipation of wet weather. The maximum distance from tracks that people were expected to walk to complete surveys, and the level of ruggedness of the terrain, was also limited to take into account time constraints and occupational health and safety considerations. This limited the area available to carry out the study, and combined with the short distance that the sites were situated away from tracks, biased the survey data towards these features. Whether this had an effect on the nature of the data that were collected is unknown but this needs to be considered when extrapolating results to the wider landscape. These constraints also limited the number of overall study sites surveyed, the number of fire categories investigated and the number of sites within each fire category, with a higher survey effort in recently burnt areas, which has consequences for data analyses.

4.2 Response of fauna to fire

The fauna data collected during this project has been summarised to allow a basic comparison between areas burnt in 2009 and those long-unburnt, with some exploration of fire frequency. Further statistical analysis of these aspects is planned and will be incorporated into reports for other fire ecology studies being conducted by ARI.

Data from cameras have given an indication of the presence of certain species within the study areas, confirming their persistence at sites of a particular fire history. The proportion of sites where particular species were detected during this study is likely to be an underestimate of the true proportion as it is possible that species may not be photographed despite actually being present (Nelson and Scroggie 2009). Further analyses are planned to quantify this effect.

Given the preliminary nature of the data analyses it should be noted that interpretations of the results are tentative, and a more comprehensive exploration may lead to different conclusions.

4.2.1 Ground-foraging mammals

All 18 mammal species detected during automated camera surveys are generally widespread and common in Victoria (Menkhorst 1995e). Many of the records obtained during this study have added valuable information about the distribution and occurrence of particular species in the areas surveyed. The Mountain Brushtail Possum, Bush Rat, Dusky Antechinus and Long-nosed Bandicoot have been recorded within the Beechworth study area at only a few locations prior to the current study. Their detection during this study is an important confirmation of their presence in the area, as these records fall along the north-western edge of their known range in Victoria. The Common Brushtail Possum has not been previously recorded in the Beechworth forests surveyed during this study, although they are known to be present in the wider area.

A higher diversity of mammals was detected in the Beechworth area than at Taggerty. However, all of these species have also previously been recorded from the Taggerty area (DSE 2007). Indeed, existing records suggest that the Bush Rat, Dusky Antechinus and Long-nosed Bandicoot are more widespread near Taggerty, but they were not detected by the survey cameras on this occasion. This may be due to images in photos not being clear enough for identification, cameras not being triggered, or their absence from the site.

A study conducted in the southern end of the Black Range found densities of Bush Rats and Agile Antechinus to be much reduced in areas burnt in 2009 compared to adjacent unburnt forest (Banks *et al.* 2011a).

Cameras may have been situated in non-preferred habitat for some species, decreasing the likelihood of detection. The Dusky Antechinus is known to prefer damp habitats with a dense vegetation cover (Menkhorst 1995b), which was not targeted during this study. Most of the areas surveyed would also not be considered preferred habitat for the Long-nosed Bandicoot, which is found in areas where there is a dense understorey or ground cover usually associated with damp or riparian areas including thickets of introduced species such as blackberry (Menkhorst and Seebeck 1995). During the current study, this species was recorded close to Lake Kerferd where there were scattered dense thickets of blackberry.

Mountain Brushtail Possums were recorded at more sites than Common Brushtail Possums near Taggerty, reflecting previous records in the area. Although these two possum species do sometimes occur together, their habitat preferences differ in that the Mountain Brushtail Possum is usually found in wetter forest types than the Common Brushtail Possum, or in gullies in drier forests (Menkhorst 1995a, 1995f).

There have been no formal records of House Mouse and deer from the Beechworth forests surveyed (DSE 2007), which undoubtedly reflects a lack of survey effort. Sambar Deer have been recorded 35 km to the south, near Bright, and anecdotal evidence suggests they are becoming more common in the broader area.

Most species were recorded from only a small number of sites, in both recently burnt and long-unburnt forest, which makes comparison between fire histories difficult. This small number of site records could be due to low detection probabilities, low animal densities, or unsuitable bait used to attract fauna to the cameras. For example, carnivores such as House Cats may be more readily attracted to bait containing meat rather than the herbivore bait used here.

Sixteen of the species recorded were found in areas burnt in 2009, demonstrating their ability to persist after these fires. Mammals may survive during fire by sheltering in vegetation, burrows, hollow trees and logs or in unburnt patches, or by avoiding the fire front. They may then recolonise an area after fire by moving in from nearby unburnt areas (Whelan *et al.* 2002, Garvey *et al.* 2010). Herbivores, such as macropods, can take advantage of regrowth as a food source soon after fire (Christensen and Kimber 1975), which may help them recolonise or reach areas where food is more plentiful. The Common Wombat and Black Wallaby were present at nearly every site, suggesting little or no preference between unburnt habitat and areas burnt in the 2009 fires. Common Wombats increased their home range in burnt alpine areas and foraged further from their burrows when food was scarce (Green and Sanecki 2006) and may have adopted a similar strategy here. Black Wallabies have been found to move away from approaching fires and either take refuge in creeklines or double back through the fire front to find shelter in areas already burnt. The severity of the fire may determine whether they remain in the area post-fire or migrate to other areas, with low intensity fire less likely to result in individuals moving away (Garvey *et al.* 2010). Most of the sites surveyed in the current study were not severely burnt, and those that were severely burnt were not far from such areas.

Fire can reduce the availability of tree hollows which may have particular consequences for hollow-dependant possums (Inions *et al.* 1989). However, in certain situations some species may be more flexible to changes in resources than others. In 2009, burnt Mountain Ash *Eucalyptus regnans* near Camberville, Mountain Brushtail Possums were observed to find sufficient hollows in the short term by altering den preferences (Banks *et al.* 2011b). This was after a reduction in available hollows of over 80%. Both Common and Mountain Brushtail Possums have been known to use other habitat for shelter when hollows are limited, such as logs and burrows made by other animals (Menkhorst 1995a, 1995f). In contrast, both Brushtail species were not detected from sites within Bunyip State Park after the sites had been burnt during the 'Black Saturday' fires (E. McNabb pers. comm.). During the current study Common Brushtail Possums were at more long-unburnt sites compared with recently burnt areas, while Mountain Brushtail Possums showed no discernible difference.

Although the Long-nosed Bandicoot and Common Ringtail Possum were only recorded from unburnt sites, they were recorded from too few sites to be able to attribute this as an effect of fire. Common Ringtail Possums are not as readily captured on automated cameras as some other species and they were known to occur at several locations within the study areas before 2009 (DSE 2007). Their current status at these locations is unknown.

The House Mouse is known to successfully colonise areas soon after fire (Friend 2003, Kelly *et al.* 2011). Although they were only present at a low number of sites during the current study, all these sites were in recently burnt forest. Their colonisation of recently burnt areas is thought to be due to their ability to survive in burrows, their high reproductive rate and their generalist foraging (Menkhorst 1995d), and ability to take advantage of high seed fall after fire (Friend 2003). However, the exact nature of the relationship between time since fire and their presence is sometimes unclear (Kelly *et al.* 2011). The Red Fox was also found at more sites that were recently burnt than long-unburnt, suggesting that native species in burnt areas may be under increased predation pressure. The European Rabbit showed the opposite response to fire than the other introduced species discussed above, appearing at proportionally more sites in long-unburnt forest. There are many records of rabbits within the Black Range prior to the 2009 fires however, none were recorded there during our study. It is unclear whether fire has been a major factor in their distribution across the current study areas or whether location also had some influence. Within Taggerty, rabbits were only recorded from unburnt forest sites, which were also close to grassed areas (camping grounds or a fuelbreak). At Beechworth, they were found at both unburnt and recently burnt sites, particularly from several sites that were within a few kilometres of each other. European Rabbits are widespread throughout Victoria and spread into forests particularly via roads, feeding on grassy verges and making burrows where the soil conditions are suitable (Menkhorst 1995c). Although rabbits disperse readily and recolonise formerly occupied areas (Parer 1982, Menkhorst 1995c), their relationship with fire-affected areas is unclear.

Fire frequency within recently burnt forest did not appear to have an effect on the presence of mammals detected during this study, with the possible exception of the Short-beaked Echidna. This species is well adapted to a wide range of habitats and conditions, including those brought on by disturbances such as fire (Menkhorst 1995g), although a reduction in logs may have a negative impact (Tolsma *et al.* 2007).

4.2.2 Insectivorous bats

There is little information about the influence of fire events on insectivorous bat activity in Australian forests. Limited research overseas has focused mainly on prescribed burning and suggests that bat responses are linked to flight manoeuverability and prey availability. These studies showed either an increase in bat activity levels in burnt areas, which was thought to be related to a more open forest structure (Smith and Gehrt 2010) or no difference between burnt and unburnt areas (Loeb and Waldrop 2008). The density and structure of forest vegetation can influence how individual bat species fly and navigate through their habitat with some species favouring more open areas (Law and Chidel 2002). Radiotracking of foraging bats found them more often in burnt than unburnt habitats, and coincided with differences in insect abundance (Lacki *et al.* 2009), although the exact nature of these relationships remains unclear. Bat activity as measured near Taggerty and Beechworth showed the opposite effect, with unburnt areas supporting higher bat activity. Although fire may simplify the understorey in the short term, subsequent regrowth can impede the mobility of bats, and they may avoid such areas. In addition, mortality and injury during and immediately after a bushfire is likely to reduce wildlife populations (Whelan *et al.* 2002), and bat numbers in these areas may not have recovered to pre-fire levels.

Another study, project 29 within the 'Rebuilding Together' program has also explored the impact of the 2009 fires on bat activity, with over 60 sites surveyed (Jemison *et al.* in prep.). Analysis from that study supports the findings of those presented here.

4.2.3 Diurnal birds

Previous studies in Victorian forests have shown that birds generally decline soon after severe fire (Reilly 1991, Loyn 1997) and then return at varying rates as habitat regenerates. Birds that favour open understorey may prosper in the early years, moving into habitats such as gullies where unburnt vegetation is usually too dense to accommodate them. However, those same species may subsequently decline as prolific shrub regrowth leads to a much more densely vegetated habitat (Loyn 1997). These responses can be discerned in results of the current study, which was conducted two years after the 2009 fires. By this time, the understorey had become dense at some sites but remained sparse at others, and responses varied accordingly. In general the study shows that bird populations were reduced by fire in the short term, in line with previous work. Hence frequent fire is likely to be detrimental to bird populations as a whole, and this also applies to the majority of bird species and guilds. However, some species appeared to favour recently burnt sites, admittedly in such low numbers that results are unlikely to prove statistically significant. For some of those species there is corroborating evidence that they may favour recently burnt habitats. For example, White-winged Choughs were only found in recently burnt sites in similar Forby Forest in the Wombat State Forest (Loyn *et al.* 2003), although they are widespread regardless of fire history in drier types of forest such as Box-ironbark (Loyn 1985). Sulphur-crested Cockatoos are usually associated with open country, and it is likely that fire has opened up the forest sufficiently to allow them to occupy it in the early years after fire. Species such as these may be expected to benefit from frequent fires in parts of the forest.

The study produced no evidence that introduced birds proliferate after fire. On the contrary, the only records of introduced birds during formal counts were of Common Blackbirds at one long-unburnt site at Taggerty with dense thickets of introduced blackberry. Other species were seen nearby (e.g. flocks of European Goldfinches in cleared pine plantations), but not in burnt or unburnt forest. Introduced birds are generally common in farmland and towns but not in forest (Loyn 1985), and this study shows that this remains the case in terms of forest even when it is burnt.

4.3 Concluding remarks

This project has built the capacity of and empowered skilled members of the community. Naturalist groups were able to contribute to fire research given a defined project structure and coordination, survey design and GIS expertise, site selection processes, access to a large quantity of costly survey equipment and expertise in its operation. The project exposed a large number of people to research on the impact of fire on fauna and the methods used to collect data that will go towards providing insights into this subject. The benefits to participants were wide-ranging and included improving and learning new fauna survey skills that will be applied elsewhere. The project also highlighted that the time and resource investment required for such an undertaking can be significant.

Despite the constraints around data collection and the implications for analyses, the information collected during this project has made a worthy contribution to what is known about the responses of fauna to fire.

References

Banks, S.C., Dujardin, M., McBurney, L., Blair, D., Barker, M., and Lindenmayer, D.B. (2011a). Starting points for small mammal population recovery after wildfire: recolonisation or residual populations. Oikos **120**, 26–37.

Banks, S.C., Knight, E.J., McBurney, L., Blair, D. and Lindenmayer, D.B. (2011b). The effects of wildfire on mortality and resources for an arboreal marsupial: resilience to fire events but susceptibility to fire regime change. *PLoS ONE* **6**, e22952.

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003) *The New Atlas of Australian Birds*. Royal Australasian Ornithologists Union, Melbourne

Bewsher, S. (2011). Fauna survey group – Beechworth and Lake Eildon post-fire surveys. *Field Nats News* **209**, 6.

Blakers, M., Davies, S. and Reilly, P. (1984) *The Atlas of Australian Birds 1977–81*. Melbourne University Press, Melbourne

BOCA (2003) *Wings over Western Port: three decades of surveying wetland birds 1973–2003*. Bird Observers Club of Australia Report No. 10.

Christensen, P.E. and Kimber, P.C. (1975). Effect of prescribed burning on the flora and fauna of south-west Australian forests. *Proceedings of the Ecological Society of Australia* **8,** 85–106.

Carolan, M. S. (2006). Science, expertise, and the democratization of the decision-making process. *Society & Natural Resources* **19**, 661–668.

Clarke, M.F. (2008). Catering for the needs of fauna in fire management: science or just wishful thinking? *Wildlife Research* **35**, 385–394.

Conrad, C.C. and Hilchey, K.G. (2011). A review of citizen science and community-based environmental monitoring: issues and opportunities. *Environmental Monitoring and Assessment* **176**, 273–291.

Costermans, L. (2009). *Native trees and shrubs of south-eastern Australia.* New Holland Publishers, Frenchs Forest.

DSE. (2004). *EVC 23: Herb-rich Foothill Forest Highlands – Southern Fall bioregion*. Department of Sustainability and Environment, Melbourne, Victoria.

DSE. (2007). *Atlas of Victorian wildlife electronic database.* Department of Sustainability and Environment, East Melbourne, Victoria.

Friend, G. (2003). Impact of fire on small vertebrates in mallee woodlands and heathlands of temperate Australia: A review. *Biological Conservation* **65**, 99–114.

Garvey, N., Ben-Ami, D., Ramp, D. and Croft, D.B. (2010). Survival behaviour of swamp wallabies during prescribed burning and wildfire. *Wildlife Research* **37**, 1–12.

Gill, A.M. (1975). Fire and the Australian flora: a review. *Australian Forestry* **38**, 4–25.

Green, K. and Sanecki, G. (2006). Immediate and short-term responses of bird and mammal assemblages to a subalpine wildfire in the Snowy Mountains, Australia. *Austral Ecology* **31**, 673–681.

Harris, J. (2011a). Fauna survey group – Cathedral Ranges post-fire survey 22nd–26th January. *Field Nats News* **207**, 8.

Harris, J. (2011b). From the president. *Field Nats News* **209**, 1–5.

Inions, G.B., Tanton, M.T. and Davey, S.M. (1989). Effect of fire on the availability of hollows in trees used by the Common Brushtail Possum, *Trichosurus vulpecula* Kerr, 1792, and the Ringtail Possum, *Pseudocheirus peregrinus*. *Wildlife Research* **16**, 449–458.

Jemison, M.L., Lumsden, L.F., Nelson, J.L., Scroggie, M.J. and Chick, R.R. (in prep.). *Assessing the impact of the 2009 Kilmore East-Murrindindi Complex fires on microbats: Black Saturday Victoria 2009 – Natural values fire recovery program*. Department of Sustainability and Environment, Heidelberg, Victoria.

Kelly, L.T., Nimmo, D.G., Spence-Bailey, L.M., Haslem, A., Watson, S.J., Clarke, M.F. and Bennett, A.F. (2011). Influence of fire history on small mammal distributions: insights from a 100-year post fire chronosequence. *Diversity and Distributions* **17**, 462–473.

Lacki, M.J., Cox, D.R., Dodd, L.E. and Dickinson, M.B. (2009). Response of Northern Bats (*Myotis Septentrionalis*) to prescribed fires in eastern Kentucky forests. *Journal of Mammalogy* **90**, 1165–1175.

Law, B. and Chidel, M. (2002). Tracks and riparian zones facilitate the use of Australian regrowth forest by insectivorous bats. *Journal of Applied Ecology* **39**, 605–617.

Loeb, S.C. and Waldrop, T.A. (2008). Bat activity in relation to fire and fire surrogate treatments in southern pine stands. *Forest Ecology and Management* **255**, 3185–3192.

Loyn, R.H. (1986). The 20-minute search – a simple method for counting forest birds. *Corella* **10**, 58–60.

Loyn, R.H. (1985). Ecology distribution and density of birds in Victorian forests. Pages 33–46 *In* Keast, A., Recher, H.F., Ford, H.A. and Saunders, D. (eds) *Birds of the eucalypt forests and woodlands: ecology, conservation and management.* Surrey-Beatty, Sydney.

Loyn, R.H. (1997). Effects of an extensive wildfire on birds in far eastern Victoria. *Pacific Conservation Biology* **3**, 221–234.

Loyn, R.H. (1998). Birds in patches of old-growth ash forest, in a matrix of younger forest. *Pacific Conservation Biology* **4**, 111–121.

Loyn, R.H., Cunningham, R.B. and Donnelly, C. (2003). *Effects of fuel reduction burning at two frequencies and seasons on bird abundance in eucalypt forests of central Victoria: a replicated experiment.* Arthur Rylah Institute, Department of Natural Resources and Environment, Heidelberg, Victoria

Loyn, R.H., Dann, P. and McCulloch, E. 2001. Important wader sites in the East Asian-Australasian flyway: 1. Western Port, Victoria, Australia. *The Stilt* **38**, 39–53.

Loyn, R.H. and Kennedy, S.J. (2009). Designing old forest for the future: Old trees as habitat for birds in forests of Mountain Ash Eucalyptus regnans. *Forest Ecology and Management* **258**, 504–515.

MacHunter, J., Menkhorst, P. and Loyn, R. (2009). *Towards a process for integrating vertebrate fauna into fire management and planning.* Arthur Rylah Institute for Environmental Research Technical Report Series No. 192. Department of Sustainability and Environment, Heidelberg, Victoria.

Menkhorst, P.W. (1995a). Common Brushtail Possum. Pages 92–93 *In* Menkhorst, P.W. (ed) *Mammals of Victoria: distribution, ecology and conservation*. Oxford University Press, Melbourne.

Menkhorst, P.W. (1995b). *Dusky Antechinus*. Pages 47–49 *In* Menkhorst, P.W. (ed) *Mammals of Victoria: distribution, ecology and conservation*. Oxford University Press, Melbourne.

Menkhorst, P.W. (1995c). European Rabbit. Pages 278–280 *In* Menkhorst, P.W. (ed) *Mammals of Victoria: distribution, ecology and conservation*. Oxford University Press, Melbourne.

Menkhorst, P.W. (1995d). House Mouse. Pages 210–212 *In* Menkhorst, P.W. (ed) *Mammals of Victoria: distribution, ecology and conservation*. Oxford University Press, Melbourne.

Menkhorst, P.W. editor. (1995e). *Mammals of Victoria: distribution, ecology and conservation.* Oxford University Press, Melbourne.

Menkhorst, P.W. (1995f). Mountain Brushtail Possum. Pages 90–91 *In* Menkhorst, P.W. (ed) *Mammals of Victoria: distribution, ecology and conservation*. Oxford University Press, Melbourne.

Menkhorst, P.W. (1995g). Short-beaked Echidna. Pages 38–39 *In* Menkhorst, P.W. (ed) *Mammals of Victoria: distribution, ecology and conservation*. Oxford University Press, Melbourne.

Menkhorst, P.W. and Seebeck, J.H. (1995). Long-nosed Bandicoot. Pages 77–78 *In* Menkhorst, P.W. (ed) *Mammals of Victoria: distribution, ecology and conservation*. Oxford University Press, Melbourne.

Minton, C. (2006) The history of wader studies in north-west *Australia. Stilt* **50**, 285–294

Nelson, J.L. and Scroggie, M.P. (2009). *Remote cameras as a mammal survey tool – survey design and practical considerations.* Arthur Rylah Institute for Environmental Research Unpublished report number 2009/36. Department of Sustainability and Environment, Heidelberg, Victoria.

Parer, I. (1982). Dispersal of the Wild Rabbit, *Oryctolagus cuniculus*, at Urana in New South Wales. *Australian Wildlife Research* **9**, 427–441.

R Development Core Team (2011). *R: A language and environment for statistical computing.* R Foundation for Statistical Computing, Vienna.

Reilly, P. (1991). The effect of wildfire on bush bird populations in a Victorian coastal habitat. *Emu* **91**, 100–106.

Smith, D.A. and Gehrt, S.D. (2010). Bat response to woodland restoration within urban forest fragments. *Restoration Ecology* **18**, 914–923.

Starks, J., Brown, P., Loyn, R. & Menkhorst, P. 1992. Twelve years of winter counts of the Orange-bellied Parrot Neophema chrysogaster. *Australian Bird Watcher* **14**, 305–312.

Teague, B., McLeod, R. and Pascoe, S. (2010) *The Fires and the Fire-related deaths*. Final Report Volume 1. 2009 Victorian Bushfires Royal Commission. Parliament of Victoria.

Tolsma, A., Cheal, D.C. and Brown, G.W. (2007). *Ecological burning in Box-Ironbark forests.* Phase 1 – literature review. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria

Whelan, R.J., Rodgerson, L., Dickman, C.R. and Sutherland, E.F. (2002). Critical life cycles of plants and animals: developing a process-based understanding of population changes in fire-prone landscapes. Pages 94–124 *In* Bradstock, R.A.,Williams, J.E. and Gill, M.A. (eds) *Flammable Australia: the fire regimes and biodiversity of a continent.* Cambridge University Press, Cambridge.

Appendix 1

Location and fire history of study sites near Taggerty and Beechworth used to survey diurnal birds, ground-foraging mammals and insectivorous bats.

Sites were surveyed between 23 January–16 February (Taggerty), and 12 March–2 April (Beechworth), 2011. Coordinates are in UTM GDA94 datum, Zone 55. Fire history categories comprise combinations of fire frequency (or number of fires) and year of last fire(s) between 1970 and 2010.

Site	Study Area	Location	Road	Easting	Northing	Fire History
BR01	Taggerty	Rubicon State Forest	Royston Range Track	0400175	5870841	Unburnt
BR02	Taggerty	Rubicon State Forest	Royston Range Track	0400734	5869826	Unburnt
BR03	Taggerty	Rubicon State Forest	Herbs Road	0399032	5869368	Unburnt
BR04	Taggerty	Rubicon State Forest	Herbs Road	0399312	5868358	Unburnt
BR08	Taggerty	Black Range State Forest	Boundary Road	0374707	5876007	Two fires, 2009 & various
BR09	Taggerty	Black Range State Forest	McDonald Break	0374119	5874522	Two fires, 2009 & various
BR11	Taggerty	Black Range State Forest	Morris Track	0380871	5867311	Two fires, 2009 & various
BR12	Taggerty	Black Range State Forest	Ginter Road	0373084	5869288	One fire, 2009
BR14	Taggerty	Black Range State Forest	Stanley Track	0372657	5873188	Two fires, 2009 & various
BR15	Taggerty	Black Range State Forest	Ridge Road	0374886	5871902	Two fires, 2009 & various
BR17	Taggerty	Black Range State Forest	SEC Road	0376740	5869451	Two fires, 2009 & various
BR20	Taggerty	Black Range State Forest	Black Range Road	0377196	5867307	One fire, 2009
BR22	Taggerty	Black Range State Forest	Cameron Road	0378011	5869251	One fire, 2009
BR23	Taggerty	Black Range State Forest	Cameron Road	0379129	5867296	One fire, 2009
BR25	Taggerty	Black Range State Forest	Friday Creek Road	0379012	5864982	One fire, 2009
BR26	Taggerty	Black Range State Forest	SEC Road	0376096	5868298	One fire, 2009
BR27	Taggerty	Black Range State Forest	Black Range Road	0377210	5869597	One fire, 2009
BR28	Taggerty	Black Range State Forest	Black Range Road	0375188	5872804	One fire, 2009
BR29	Taggerty	Black Range State Forest	Black Range Road	0374989	5874988	One fire, 2009
BR30	Taggerty	Black Range State Forest	Boundary Road	0372193	5876838	Two fires, 2009 & various
ST01	Beechworth	Beechworth Historic Area	Red Hill Road	0476332	5975677	Two fires, 1981 & 1977
ST02	Beechworth	Beechworth Historic Area	Kerferd Track	0476135	5975273	Two fires, 1981 & 1977
ST03	Beechworth	Adjacent Lake Kerferd	Lake Kerferd Road	0477243	5975417	Unburnt
ST04	Beechworth	Adjacent Lake Kerferd	Lake Kerferd Road	0476689	5974889	Unburnt
ST05	Beechworth	Adjacent Lake Kerferd	Hurdle Flat Road	0477386	5974831	Unburnt
ST06	Beechworth	Stanley State Forest	Rooneys Track	0475718	5970576	Two fires, 2009 & various
ST07	Beechworth	Stanley State Forest	Rooneys Track	0475712	5969978	Two fires, 2009 & various
ST08	Beechworth	Stanley State Forest	Flagstaff Road	0476844	5969401	Unburnt
ST09	Beechworth	Private land	Yule Lane	0477095	5968709	Unburnt
ST10	Beechworth	Stanley State Forest	Flagstaff Road	0476029	5967550	One fire, 2009
ST11	Beechworth	Stanley State Forest	Flagstaff Road	0475449	5966941	One fire, 2009
ST12	Beechworth	Stanley State Forest	Flagstaff Road	0475234	5966331	One fire, 2009
ST13	Beechworth	Stanley State Forest	Flagstaff Road	0475172	5964512	Two fires, 2009 & various
ST14	Beechworth	Mt Stanley Scenic Reserve	Circular Creek Road	0482061	5967822	One fire, 2009
ST15	Beechworth	Mt Stanley Scenic Reserve	Circular Creek Road	0481674	5967219	Two fires, 2009 & various
ST16	Beechworth	Mt Stanley Scenic Reserve	Circular Creek Road	0481354	5966706	Two fires, 2009 & various
ST17	Beechworth	Mt Stanley Scenic Reserve	Circular Creek Road	0480386	5967153	One fire, 2009
ST18	Beechworth	Mt Stanley Scenic Reserve	Circular Creek Road	0480924	5966964	Two fires, 2009 & various
ST19	Beechworth	Mt Stanley Scenic Reserve	Circular Creek Road	0480935	5966432	Two fires, 2009 & various
ST20	Beechworth	Mt Stanley Scenic Reserve	Granite Creek Road	0480695	5965562	One fire, 2009

Appendix 2

Feedback form distributed to Community Finding Fauna participants

Department of Sustainability and Environment

VBRRA/Natural Values Fire Recovery Program - Community Finding Fauna 2010-2011

Surveys for diurnal birds (timed counts), mammals (automated cameras) and bats (Anabat detectors); Black Range (Cathedral Range), Beechworth & Eildon areas. Field Naturalists Club of Victoria, Bird Observation & Conservation Australia, Birds Australia, Arthur Rylah Institute for Environmental Research (DSE)

FEEDBACK FORM

Thank you for participating in the Community Finding Fauna project. We would like to share your experiences, and what it meant to you to be involved in this project and associated activities. These may include attendance at either or all of the three camps (Cathedral Range, Beechworth & Eildon), collecting survey equipment from sites, identifying animals from photos or any other project activity. This information (including direct quotes) may be included in the published report that is being produced from this project. Please indicate if you do not want your name against any material we may use.

Name:

Organisation:

I am happy for my name to be put with any quotes used: Yes No

Camp attendance: Cathedral Range Beechworth Eildon

Other activities:

Please describe in your own words (250 or less) what it meant to you to be involved in the Community Finding Fauna project:
Some questions to consider:
What did you get out of the project?
What were some memorable experiences?
How did these experiences make you feel?

Please return this form to your group coordinator or directly to phoebe.macak@dse.vic.gov.au PO Box 137, Heidelberg Vic 3084 by 3rd June 2011

Arthur Rylah Institute for environmental research

Appendix 3

Naturalist group participants that took part in the Community Finding Fauna project

Name	Organisation'	Bird Surveys*	AnaBat and Camera Setup*	AnaBat and Camera Collection*	Photo Review*	Other tasks^
Agata Pavlikova	FNCV		B, E			
Anne Finlay	BOCA	B				
Barbara Burns	FNCV		T, E			
Bradley Jenner	FNCV		T, B		T, B	
Carl Hansen	FNCV		T, E			
Catherine Payne	FNCV		T			
Cathy Sewell	FNCV		B	B		C
Daphne Hards	BOCA	B				
David Lockwood	FNCV		E			
Dean Ingwersen	BA	B				
Debbie Lustig	BOCA	T				
Emily Harris-Westrup	FNCV+			T		
Fiona Parkin	BA	T,B				
Geoff Russell	BOCA	T, B				
Gillian Steward	BOCA/ UGFNC					T
Greg Dudgeon	FNCV		B, E	T, B, E	B, E	
Hayley Davis-Harcourt	FNCV		T, B	T	T, B	
Inta Needham	BOCA	B				
Jamie Davis	FNCV+		B			
Jason Dempsey	FNCV+			E		
Jenny Lau	BOCA	T, B				O, D
Joan Broadberry	FNCV		T, B			
John Harris	FNCV		T, B, E	T, B, E	T, B, E	O, P
John Land	BOCA	T				
Jon Thornton	BA	T				
Karen Russell	BOCA	B				
Kathy Himbeck	FNCV		B, E	B	T, B, E	
Ken Griffiths	BOCA	B				
Kent Burgess	BOCA	B				
Knud Hansen	FNCV		T, E			
Lee Denis	FNCV	B	B			
Lorraine Pyke	BOCA/UGFNC					T
Lynnell Davis	FNCV		B			
Marian Sheppard	FNCV+		T			
Mary Sheppard	BOCA		T			
Michael Murray	FNCV		E			

Continued on next page

Appendix 3. continued

Name	Organisation'	Bird Surveys*	AnaBat and Camera Setup*	AnaBat and Camera Collection*	Photo Review*	Other tasks^
Mira Bednar	FNCV+		E			
Pam Land	BOCA	T				
Peter Dempsey	FNCV		E	E		
Peter Homan	FNCV		T			
Raymond Gibson	FNCV		T			
Raymond White	FNCV		B, E	B		
Richard J	Local - Beechworth	B	B			
Robin Drury	FNCV		T, E	T	T, B, E	P, C
Roger Needham	BOCA	B				
Russell Thompson	FNCV		T, B, E	T, B, E		M, C
Sally Bewsher	FNCV		T, B, E	T, E	B, E	O, P, C
Stuart Dashper	BA	T				
Su Dempsey	FNCV		E			
Tim Lau	BOCA	T	T			

FNCV = Field Naturalist Club of Victoria, BOCA = Birds Observation & Conservation Australia, BA = Birds Australia, UGFNC = Upper Goulburn Field Naturalist Club

* refers to camp at (T) Taggerty (January), (B) Beechworth (March) or (E) Eildon (April). Note that results from the Eildon camp are not presented in this report

^ (O) camp organisation, coordination and compilation of (P) photos or (D) diurnal bird data, (M) making bait and filling bait cages, and (C) cleaning bait cages

\+ guest of naturalist group

Appendix 4

Community Finding Fauna participant quotes from feedback forms

A selection of direct quotes from the feedback forms are presented below as an example of the range of responses those participants provided. They have been grouped into themes to give a general indication of the types of feedback received. All participants gave written consent for their names to be attached to these quotes.

New skills and experience

"It gave me the chance to visit sites I may not have otherwise done surveys in, and to extend and develop my fieldwork skills, particularly in the use of automated cameras and in the set-up of the Anabats."

– Sally Bewsher

"I learned (I think) to tell the difference between a common and mountain brushtail"

– Robin Drury

"Using these cameras was a terrific exercise for all of us in that we have learned something different, and beyond our normal scope. Learning how to set up the equipment has been very interesting, and we consider it a valuable new skill."

– Greg Dudgeon

"As an undergraduate ecology student I gained valuable field experience from the camp and an insight into possible career paths."

– Catherine Payne

"I believe the involvement of groups such as FNCV and Birds Australia is critical to increase our knowledge of Australian wildlife."

– Catherine Payne

"The setting of the Camera traps, and to be shown how to use a GPS properly are both new skills for me".

– Raymond White

Appreciation of the project's methods and results

"Analysing the data from some of the cameras afterwards was quite time-consuming, but very rewarding after all our efforts in the bush. The photos revealed animals and birds we would not necessarily have seen or been able to trap using our usual methods."

– Sally Bewsher

"I really enjoyed the process of going through the SD cards and seeing what the photos were, it made me feel like we still had some ownership and important part in this, and that ARI was happy for us to do so was great."

– Hayley Davis-Harcourt

"I enjoyed being involved in the project – something with a definitive direction."

– Robin Drury

"This experience will definitely assist and support our group when out in the field in the future."

– Sally Bewsher

Meeting people with similar interests

"It was also great to meet people from BOCA and Birds Australia, who share similar passions for the natural world."

– Hayley Davis-Harcourt

Seeing and being part of bushfire recovery

"Being part of the VBRRA survey was a small but unique way of being involved in the bush fire recovery."

– Russell Thompson

"It was a chance to see how the forest was recovering after the fires in many locations, and to appreciate how resilient the forest is when given half a chance."

– Russell Thompson

General enjoyment

"I felt very positively about the project"

– Robin Drury

"The whole experience was very enjoyable."

– Raymond White

Mammal and reptile species recorded from study sites.

Sites were surveyed near Taggerty (BR) in January–February and near Beechworth (ST) in April–March, 2011. Fire history categories are as follows: (1) burnt once since 1970, in 2009; (2) burnt twice since 1970, in 2009 and various other years; (3) burnt twice since 1970, in 1981 and 1977; (4) unburnt since 1970. Records have been identified from automated cameras (C) or are from incidental sightings (I). Note that the total number of sites has been calculated based on camera records only.

	Site	BR12	BR20	BR22	BR23	BR25	BR26	BR27	BR28	BR29	BR08	BR09	BR11	BR14	BR15	BR17	BR30	BR01	BR02	BR03	BR04	ST10	ST11	ST12	ST14	ST17	ST20	ST06	ST07	ST13	ST15	ST16	ST18	ST19	ST01	ST02	ST03	ST04	ST05	ST08	ST09	Total number of sites^
	Fire History	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	4	4	4	4	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	4	4	4	4	4	
Native Mammals																																										
Tachyglossus aculeatus	Short-beaked Echidna		C			C		C	C			C							C			C				C										C						**9**
Antechinus agilis	Agile Antechinus									C					C			C			C					C	C	C	C													**8**
Antechinus swainsonii	Dusky Antechinus																					C																					**1**
Perameles nasuta	Long-nosed Bandicoot																																				C	C					**2**
Phascoarcticus cinereus	Koala																		C			C														C	C	I				**4**
Vombatus ursinus	Common Wombat	C	C	C			C	C	C	C	C	C	C		C	C	C	C	C		C	C	C		C	C	C		C	C	C		C	C	C	C	C	C	C		**32**
Trichosurus cunninghami	Mountain Brushtail Possum			C	C			C			C		C	C		C			C		C	C			C	C								C			C		C	C	**16**
Trichosurus vulpecula	Common Brushtail Possum													C											C				C			C					C	C		C	C	**8**
Pseudocheirus peregrinus	Common Ringtail Possum																																				C						**1**
Macropus giganteus	Eastern Grey Kangaroo					C	C						C									C			C		C		C	I	C				C			C	C	C	**12**
Wallabia bicolor	Black Wallaby	C	C	C	C	C	C	C	C		C		C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	**38**
Rattus fuscipes	Bush Rat																									C																**1**
Introduced Mammals																																										
Rattus rattus	Black Rat																							C						C		C										**3**
Mus muculus	House Mouse																					C	C	C		C		C	C													**6**
Vulpes vulpes	Red Fox	C		C	C					C															C				C		C	C		C		C	C					**11**
Felis catus	House Cat																		C										C								C	C				**4**
Oryctolagus cuniculus	European Rabbit																	C	C		C		C	C		C			C											C	C	**9**
Cervis sp.	Deer sp.																														C											**1**
Reptiles																																										
Pseudonaja textilis	Eastern Brown Snake																															C										**1**
Notechis scutatus	Tiger Snake																																		I							**0**
Bassiana duperreyi	Eastern Three-lined Skink																													I												**0**

Bird species recorded at or near study sites.

Sites were surveyed near Taggerty (BR) in January–February and near Beechworth (ST) in April–March, 2011. Fire history categories are as follows: (1) burnt once since 1970, in 2009; (2) burnt twice since 1970, in 2009 and various other years; (3) burnt twice since 1970, in 1981 and 1977; (4) unburnt since 1970. Records are from bird surveys (B – on-site, B* – off-site), incidental observations (I) and automated camera surveys (C). Bird surveys were not conducted at BR15 due to access difficulties. Note that the total number of sites has been calculated based on on-sites records from bird surveys only.

		Study site	BR12	BR20	BR22	BR23	BR25	BR26	BR27	BR28	BR29	BR08	BR09	BR11	BR14	BR15	BR17	BR30	BR01	BR02	BR03	BR04	ST10	ST11	ST12	ST14	ST17	ST20	ST06	ST07	ST13	ST15	ST16	ST18	ST19	ST01	ST02	ST03	ST04	ST05	ST08	ST09	Total number of sites
		Fire History	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	4	4	4	4	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	4	4	4	4	4	
Native Birds																																											
Phaps chalcoptera	Common Bronzewing																																					B*				0
Leucosarcia melanoleuca	Wonga Pigeon												B							C	C																			C		1
Aegotheles cristatus	Australian Owlet-nightjar																																						B			1
Hirundapus caudacutus	White-throated Needletail									B*				B*									B*	B*						B*												4
Aquila audax	Wedge-tailed Eagle				B																																					1
Turnix varius	Painted Button-quail													B*								C			C																	0
Calyptorhynchus funereus	Yellow-tailed Black-Cockatoo				B*																				B*							B									1
Callocephalon fimbriatum	Gang-gang Cockatoo			B*			B															B*			B				B												3
Eolophus roseicapillus	Galah																																		B	B	B*	B				3
Cacatua galerita	Sulphur-crested Cockatoo	B			B*					B	B		B*										B	B	B*	B*		B*				B*		B		B*			I			6
Glossopsitta pusilla	Little Lorikeet																													I												0
Alisterus scapularis	Australian King-Parrot																																								B	1
Platycercus elegans	Crimson Rosella	B	B	B	B*			B	B	B	B	B	B	B					B, C	B	B	B	B	B	B	B	B, C	B*	B		B	B	B	B	B	B	B, C	B	B	B	B	31
Platycercus eximius	Eastern Rosella																																								B	1
Cacomantis flabelliformis	Fan-tailed Cuckoo			B																		B*		B*								I	B*		I		B		I	I	2
Dacelo novaeguineae	Laughing Kookaburra	B	B	B	B	B	B*	B, C	B	B	B	B	B		C	B*	B	B		B*	B	B			B, C	B	B*		B	B*	B	B*	B	B* C	B*	B, C	B	B*	B	B	B	26
Todiramphus sanctus	Sacred Kingfisher						B																														I					1
Merops ornatus	Rainbow Bee-eater																											B		I												1
Menura novaehollandiae	Superb Lyrebird		B, C				C	B, C									B, C			B* C	B, C		B*			B*																4
Daphoenositta chrysoptera	Varied Sittella																									B*							B									1
Cormobates leucophaea	White-throated Treecreeper	B	B	B	B	B		B	B	B	B	B	B			B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	37
Climacteris erythrops	Red-browed Treecreeper				B																				B	B				B						B		B				6
Ptilonorhynchus violaceus	Satin Bowerbird		B										B						C	C	B								C								B	I		C, I	4

Continued on next page

	Study site	BR12	BR20	BR22	BR23	BR25	BR26	BR27	BR28	BR29	BR08	BR09	BR11	BR14	BR15	BR17	BR30	BR01	BR02	BR03	BR04	ST10	ST11	ST12	ST14	ST17	ST20	ST06	ST07	ST13	ST15	ST16	ST18	ST19	ST01	ST02	ST03	ST04	ST05	ST08	ST09	Total number of sites
	Fire History	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**4**	**4**	**4**	**4**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**4**	**4**	**4**	**4**	**4**	
Malurus cyaneus	Superb Fairy-wren			B	B		B				B		B			B		B	B	B	B*	B, C	B		B	B	B	B	B, C	B	B	B	B	B	B	B	B	B	B	B	B, C	B, C	**28**
Sericornis frontalis	White-browed Scrubwren			B	B	B*			B				B			B	B		B	B, C	B, C	B	B	B	B	B	B	B	B	B	B	B	B	B	B		B	B	B	B	**28**
Acanthiza lineata	Striated Thornbill		B	B				B		B			B			B		B	B	B	B	B	B	B	B	B*		B			B	B	B	B	B				B	B		**22**
Acanthiza chrysorrhoa	Yellow-rumped Thornbill																																							C		**0**
Acanthiza reguloides	Buff-rumped Thornbill																									B																	**1**
Acanthiza pusilla	Brown Thornbill	B		B	B		B	B	B	B		B	B				B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	**34**
Pardalotus punctatus	Spotted Pardalote						B							B					B	B		I	B	B	B	B	B			B	B	B	B	B				B	B	I		**16**
Pardalotus striatus	Striated Pardalote			B	B								B					B	B					B	B	B	B		B	B	B*	B	B	B		I		B		B	B	**17**
Acanthorhynchus tenuirostris	Eastern Spinebill																			B	B			B	B																		**4**
Meliphaga lewinii	Lewin's Honeyeater																				B*										B*												**0**
Lichenostomus chrysops	Yellow-faced Honeyeater				B		B					B	B	B		B		B	B	B	B	B	B	B*	B		B				B			B		B	I	B	B	B	B	**21**
Lichenostomus leucotis	White-eared Honeyeater																							B			B*			B				B*		I		B	B*				**3**
Anthochaera carunculata	Red Wattlebird	B	B	B	B*	B	B		B		B	B	B	B			B		B	B		I	B	B*						B	B	B		B*		B			B			**19**
Phylidonyris pyrrhopterus	Crescent Honeyeater																				B					B*							B	B*								**2**
Melithreptus brevirostris	Brown-headed Honeyeater								B				B	B																					I	B							**4**
Melithreptus lunatus	White-naped Honeyeater						B													B							B	B		B	B	B	B		B	B		B	B			**12**
Philemon corniculatus	Noisy Friarbird																														B	B				B						**3**
Psophodes olivaceus	Eastern Whipbird																		B				B, C		B*	B*												B*		C		**2**
Coracina novaehollandiae	Black-faced Cuckoo-shrike								B									B											I						I	B*			B			**3**
Coracina tenuirostris	Cicadabird																																	B*								**0**
Falcunculus frontatus	Crested Shrike-tit																																					B		B	B	**3**
Pachycephala pectoralis	Golden Whistler		B*		B		B	B	B				B			B				B	B	B*		B*	B	B*	B	B					B*	B			B	B	B	B	**16**
Pachycephala rufiventris	Rufous Whistler						B		B	B		B												B	B	B	B*		I	B*	B	B	B*			B	B	B	B	B	B	**15**
Colluricincla harmonica	Grey Shrike-thrush	B	B	B*	B	B	B	B*		B		B	B			B					B	B, C	B, C	B*	B, C	B, C	B	B*, C	B, C	B	B, C	B, C	B	B, C	B	B	B*, C	B, C	B	B, C	B, C	**29**
Artamus cyanopterus	Dusky Woodswallow																										B*															**0**
Cracticus torquatus	Grey Butcherbird				C	B*							B																		B											**2**
Cracticus tibicen	Australian Magpie			C			C						B										B*	B	B*, C	B	B*, C		B	B	B*, C	B	B	B, C	B	B, C		B, C	B*	B*, C	B*	**15**
Strepera graculina	Pied Currawong	B	B	B*	B*			C	B*, C				B				B		B*			B, C	B*	B*	B*, C	B	B	B	B*	B	B*	B	B	B	B		B*	B	B*	B	B*		**16**

Continued on next page

Appendix 6. continued

		Study site	BR12	BR20	BR22	BR23	BR25	BR26	BR27	BR28	BR29	BR08	BR09	BR11	BR14	BR15	BR17	BR30	BR01	BR02	BR03	BR04	ST10	ST11	ST12	ST14	ST17	ST20	ST06	ST07	ST13	ST15	ST16	ST18	ST19	ST01	ST02	ST03	ST04	ST05	ST08	ST09	Total number of sites
		Fire History	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	4	4	4	4	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	4	4	4	4	4	
Strepera versicolor	Grey Currawong											B							B*		B		C			B*		B*						B						B*	B*			**3**
Rhipidura rufifrons	Rufous Fantail																				B*	B		I			B							B							B		**4**
Rhipidura albiscapa	Grey Fantail				B				B	B			B	B			B	B	B	B	B	B	B	B	B	B, C	B, C	B, C	B, C	B, C	B	B	B	B	B, C	B, C	B, C	B, C	B	B	B	B, C	**31**
Corvus coronoides	Australian Raven							B																B						B	B					B*	B		B	B*	B*		**6**
Corvus mellori	Little Raven																																		B					I		**1**
Myiagra rubecula	Leaden Flycatcher							B																																		**1**
Myiagra cyanoleuca	Satin Flycatcher																								B*																		**0**
Grallina cyanoleuca	Magpie-lark																																						B*			**0**
Corcorax melanorhamphos	White-winged Chough			B, C						B			C	B	C														B*	I		C						C, I			**3**
Petroica multicolor	Scarlet Robin																						I	B*						B					B					B			**3**
Petroica phoenicea	Flame Robin													C			B		C				B		B*				C														**2**
Eopsaltria australis	Eastern Yellow Robin			B		B*	B*			B	B			B			B	B		B, C	B, C	B, C				B	B*	B		I			B	B	B	B*	B*	B, C	B	B	B, C	B	**19**
Zosterops lateralis	Silvereye					B								B			B		B		B	B	B		B	B		B	B		B	B	B*	B	B	I	B	B	B	B	B	B	**21**
Zoothera lunulata	Bassian Thrush																			C																							**0**
Dicaeum hirundinaceum	Mistletoebird																								B			B				B				B							**4**
Neochmia temporalis	Red-browed Finch																											B		I			B		B*							**2**
Rhipidura leucophrys	Willie Wagtail																																				I					**0**
Introduced Birds																																										
Turdus merula	Common Blackbird														C	C				C	B	B*																					**1**

Appendix 7

Insectivorous bat activity (number of calls per night) recorded at study sites.

Sites were surveyed near Taggerty (BR) in January–February and near Beechworth (ST) in April–March, 2011. Activity data for each study area are presented separately due to different survey periods. Fire history categories comprise combinations of fire frequency (or number of fires) and year of last fire(s) between 1970 and 2010. Rainfall and temperature data were obtained from the Bureau of Meteorology.

Taggerty	Fire history*	25/01/2011	26/01/2011	27/01/2011	28/01/2011	Mean number of calls per night
BR01	Unburnt	1058	901	930	1426	1078.75
BR02	Unburnt	152	353	64	14	145.75
BR03	Unburnt	178	254	365	140	234.25
BR12	One fire, 2009	141	236	461	164	250.50
BR22	One fire, 2009	95	117	370	318	225.00
BR25	One fire, 2009	80	89	114	82	91.25
BR26	One fire, 2009	85	29	62	56	58.00
BR27	One fire, 2009	85	359	187	484	278.75
BR28	One fire, 2009	27	59	116	92	73.50
BR08	Two fires, 2009 & various	38	78	136	91	85.75
BR09	Two fires, 2009 & various	27	213	144	117	125.25
BR14	Two fires, 2009 & various	67	40	90	47	61.00
BR30	Two fires, 2009 & various	23	1	58	37	29.75
rainfall (mm)		**1.2**	**3.8**	**8.4**	**0.0**	
maximum daytime temperature (°C)		**21.0**	**26.9**	**24.6**	**23.7**	
minimum overnight temperature (°C)		**13.5**	**11.3**	**15.2**	**11.2**	
Beechworth		**14/03/2011**	**15/03/2011**	**16/03/2011**	**17/03/2011**	**Mean number of calls per night**
ST03	Unburnt	58	95	208	210	142.75
ST02	Two fires, 1981 & 1977	507	437	397	274	403.75
ST12	One fire, 2009	127	188	120	92	131.75
ST20	One fire, 2009	83	39	46	22	47.50
ST07	Two fires, 2009 & various	306	206	228	136	219.00
ST16	Two fires, 2009 & various	260	191	118	115	171.00
ST19	Two fires, 2009 & various	348	234	130	70	195.50
rainfall (mm)		**16.2**	**0.0**	**0.0**	**0.0**	
maximum daytime temperature (°C)		**26.2**	**26.8**	**25.9**	**25.4**	
minimum overnight temperature (°C)		**13.0**	**15.3**	**14.3**	**8.6**	

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