Australia's National
Science Agency

DRAFT Monitoring Protocols Manual for the MER Pilot Network

Site Selection Module

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Important disclaimer

Contributions

J. Hodgson led the coordination, drafting and editing of this document. She also led the field trials and contributed to the design of the protocols. S. Prober, B. Sparrow and L. Broadhurst led the design of the protocols and provided revisions. L. Broadhurst also assisted in conducting field trials. N. Gellie and the TERN protocols team provided drafts, revisions and conducted field trials of the protocols. J. Carwardine, S. Nicol and E. Vanderduys provided revisions.

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CSIRO and TERN acknowledge the traditional Country and custodians of the lands on which we operate. We pay our respects to their ancestors and their descendants who continue the connection to Country. We celebrate the stories, culture and traditions of Aboriginal and Torres Strait Islander Elders of all communities who also work and live on this land.

Introduction

Site and plot selection is a key component of ecological monitoring experiments. Factors such as aspect and position of the proposed site in the landscape (e.g., ridge, lower slope) are often major drivers of vegetation communities and species composition and can also determine the impacts of processes such as fire, weed invasion and management on the location. These factors thus need to be considered during site and plot selection. The effort involved in getting site and plot selection right ensures that analyses are comparing like with like, making the findings scientifically sound.

This site selection module comprises four parts, covering the stages required for determining the location of sites and plots, and laying out the infrastructure to delineate them for the life of the project.

Part One of this module provides *an introduction to the MER Pilot Network*, the rationale and experimental design.

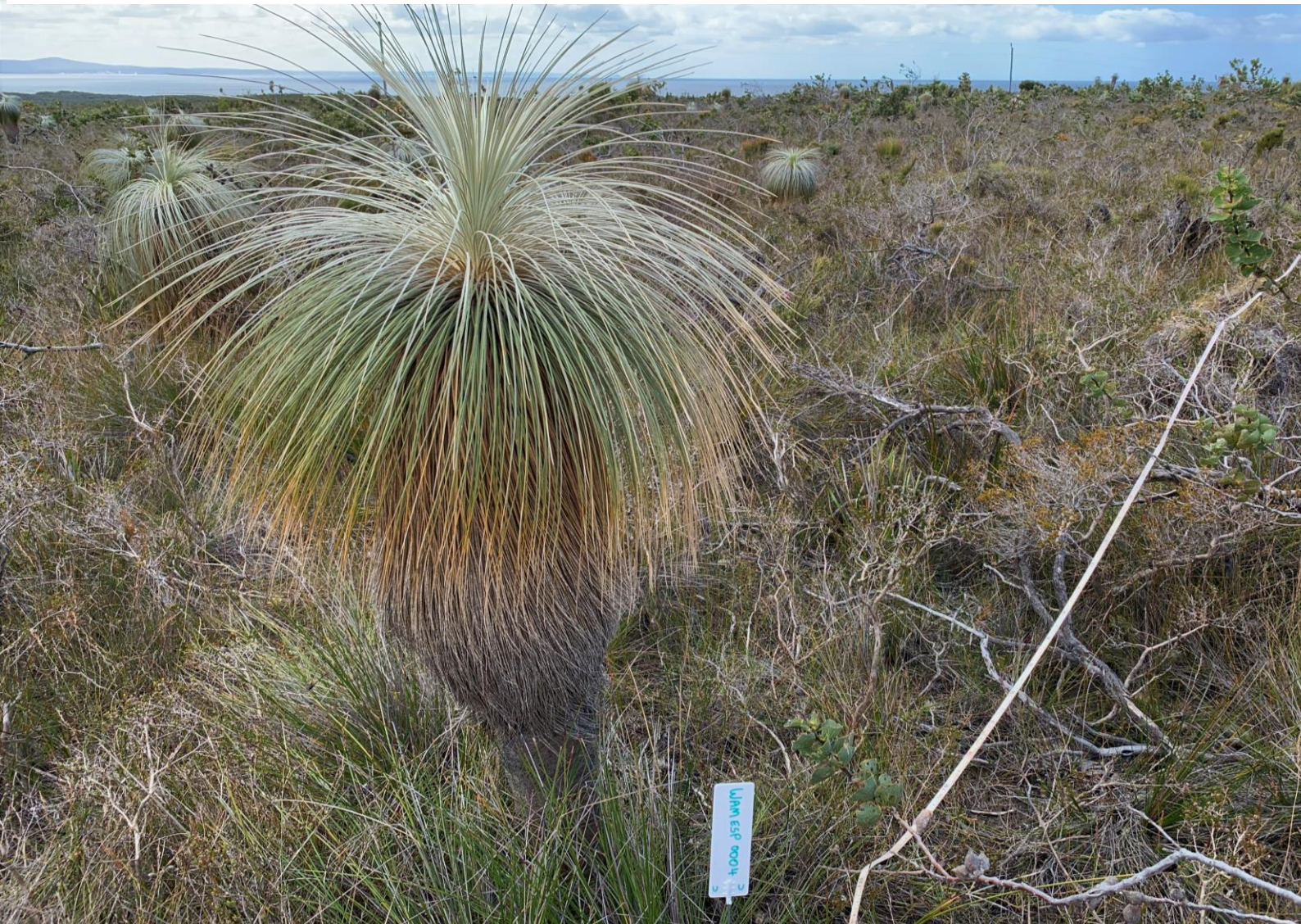
Part Two provides a guide to the *procedure of ground-truthing and selecting sites and locations of plots* in the field.

Part Three provides the procedure for *laying out the corners of the plot*.

Part Four details the procedure for *installing plot infrastructure*.

Part I Introduction to the Pilot MER Network

MER networks are a new approach to learn about ecological management effectiveness. Through collaboration among NRM organisations, policy-makers, practitioners and researchers, these networks will embed nationally integrated research infrastructure (small, well-designed experimental monitoring plots) within local ecological restoration programs. Each network can be designed to address targeted ecological management questions at national scales, as well as enabling predictions and facilitating improved outcomes. The networks will help practitioners to learn from their actions and make cost-effective decisions to better protect the environment using robust scientific methods. Australia's first national Monitoring, Evaluation and Research (MER) pilot network investigates two ecological challenges faced by many Australian NRM regions: the responses and recovery of ecosystems after planned and unplanned fires, and associated effectiveness of weed management.



1 The Pilot MER Network

1.1 Definitions

Table 1. Key terms and their definitions as used in this document.

Term	Definition
Site	A Site is a cluster of one set of plots. These may occur in a single reserve or property or be spread across areas with differing tenures.
Plots	Plots are within sites and each one falls into one of the three experimental treatments.
Blocks (Triplets or Pairs)	Within a Site, all plots are grouped into either a Triplet or Pair (depending on whether two or three treatment types exist for the Site). One plot in each Triplet (or Pair) represents one of the treatment groups. Also referred to as a 'Block.'

1.2 Network theme

The Pilot MER Network is focused on addressing two questions of importance to Australian ecological management: (i) how do ecosystems recover or respond to a bushfire event or a prescribed burning activity? And (ii) what is the effect of weed management on the post-fire recovery response?. The network includes areas affected by the unprecedented bushfires across Australia in the summer of 2019-2020, and areas subject to planned prescribed or cultural burning.

1.3 Experimental design

The experimental design at each site will typically involve either 8 or 12 plots, with treatments and replicates as described in Figure 1. These include four replicate plots in burnt areas that have not been managed for weeds. These 'burnt, untreated' plots will be contrasted with four matched replicate plots in unburnt areas (unburnt, untreated) and/or four replicate plots in burnt areas that have been treated for weeds (burnt, treated).

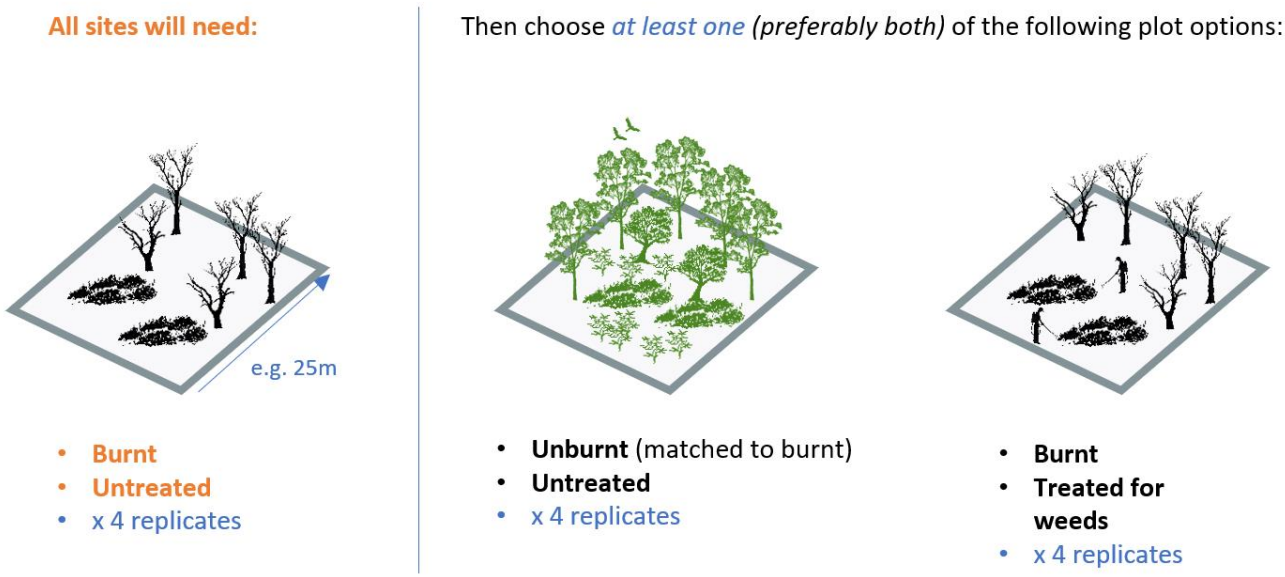


Figure 1. Experimental design and replication

Plots need to be assigned to "blocks", with one of each treatment represented in each – each block is therefore a set of triplets or pairs of plots depending whether three or two treatments are included. Blocks are the two or three plots that are most similar (other than the treatment variable). An example is shown in Figure 2.

When first assessing a site, seek four areas in which you can fit a block (i.e., a pair or Triplet of plots). Plots within blocks need to match as closely as possible. Greater variation between blocks can be tolerated and accounted for statistically. For example, blocks could be arranged from lower to mid-slope, so long as they clearly remain within the same vegetation type and burn intensity.

One challenge in our design is that we need to establish plots after a fire (and sometimes after weed treatment) has occurred. This means we cannot strictly randomise our treatment allocations as would be optimal (i.e., we would normally set-up plots first then randomly apply treatments to them within each block). Instead, we are seeking to avoid confounding when we place plots.

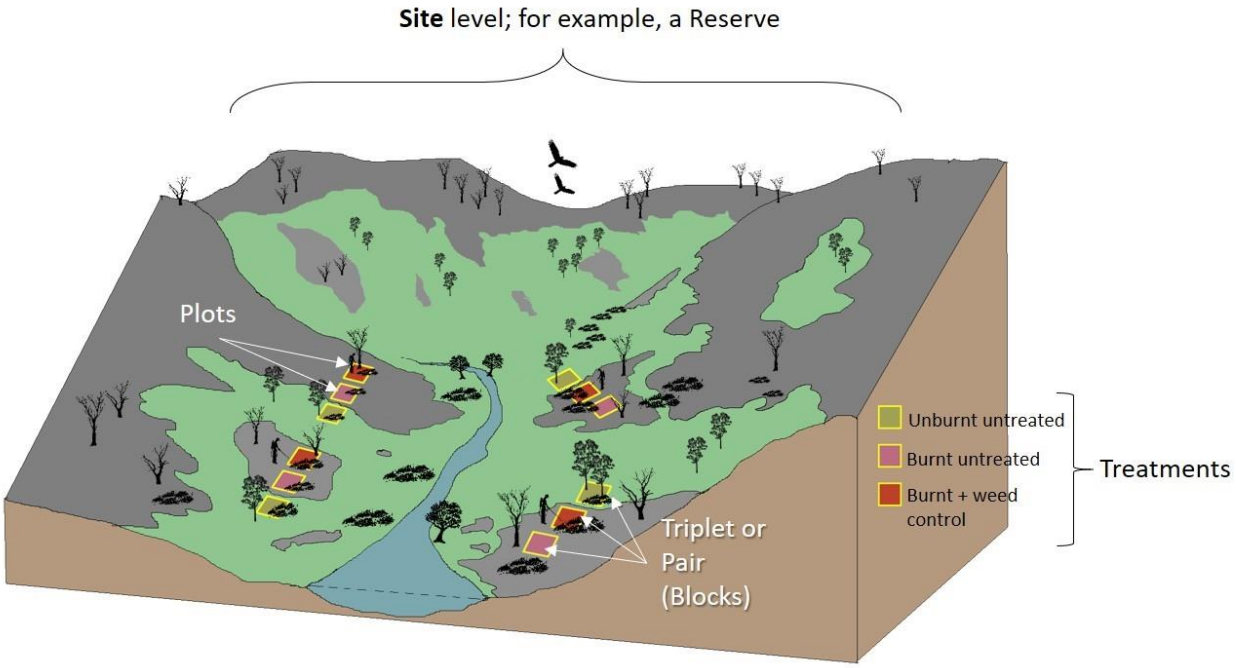


Figure 2. Example layout of plots into triplets (blocks), with each triplet containing one replicate of each of three plot types (treatments). Note that plots within blocks should be as closely matched as possible. More variation can be tolerated among blocks (e.g., if necessary, on different sides of the river or further up or downslope, so long as they are still the same vegetation type). Nevertheless, all blocks should also be as closely matched as possible.

The example in Figure 2 shows a mosaic burn, that allows plots of different treatments to be interspersed. This helps to avoid confounding, for example, if the entirety of an upper slope was burnt and all unburnt areas were downslope, then differences between burnt and unburnt plots would be confounded with any differences associated with being higher or lower on the slope.

Where possible therefore, aim to utilise any mosaic or patchiness of the burn (or prior weed control) to enable plots within blocks to be optimally matched. Where this is not possible, it will require ecological judgement as to how much potential confounding could be tolerated. For example, if a fire stops at a track passing through a relatively uniform, flat site, it would be acceptable to have all burnt plots on one side and unburnt plots on the other side of the track. They still need to be grouped into blocks, based on the sets that match most closely, or all else being equal, the sets that are closer together.

Part II Ground-truthing sites and plot selection in the field

Finding sites with suitable combinations of plots can be a challenging task. Prior to going into the field, discuss options with the local on-ground officer contact and conduct desk-based GIS investigations to isolate potential locations to ground-truth. We recommend spending time in the field with the local officer (who will have detailed on the ground knowledge of the area) investigating the identified potential sites to determine if and how these meet criteria before spending time setting up plot infrastructure.

2 Ground-truthing sites and plot selection in the field

This module provides guidelines around site selection and determining the location of plots within sites. This process involves ground-truthing locations based on previous desk-based analysis for site and plot locations. It provides criteria, guidelines and decision trees to help you choose appropriate locations.

Essential information to record for each potential plot is provided in Appendix 1. This can be used as a field datasheet or collected in the app during plot layout.

2.1 Procedure and guidelines for site and plot selection

The first consideration during site and plot selection is which of the two network questions can be investigated at the site. One question focuses on post fire recovery (requiring a comparison of burnt and unburnt areas), and the other on the effectiveness of weed management after fire (requiring a comparison of plots in burnt areas with and without weed management). Ideally, both of these questions can be addressed at each site.

To begin, use the decision tree in Figure 3 to guide your selection process. Plot locations should be representative of the vegetation type being targeted at the site. This and other criteria are explained below to assist in determining if the potential site location is suitable for two or three treatments.

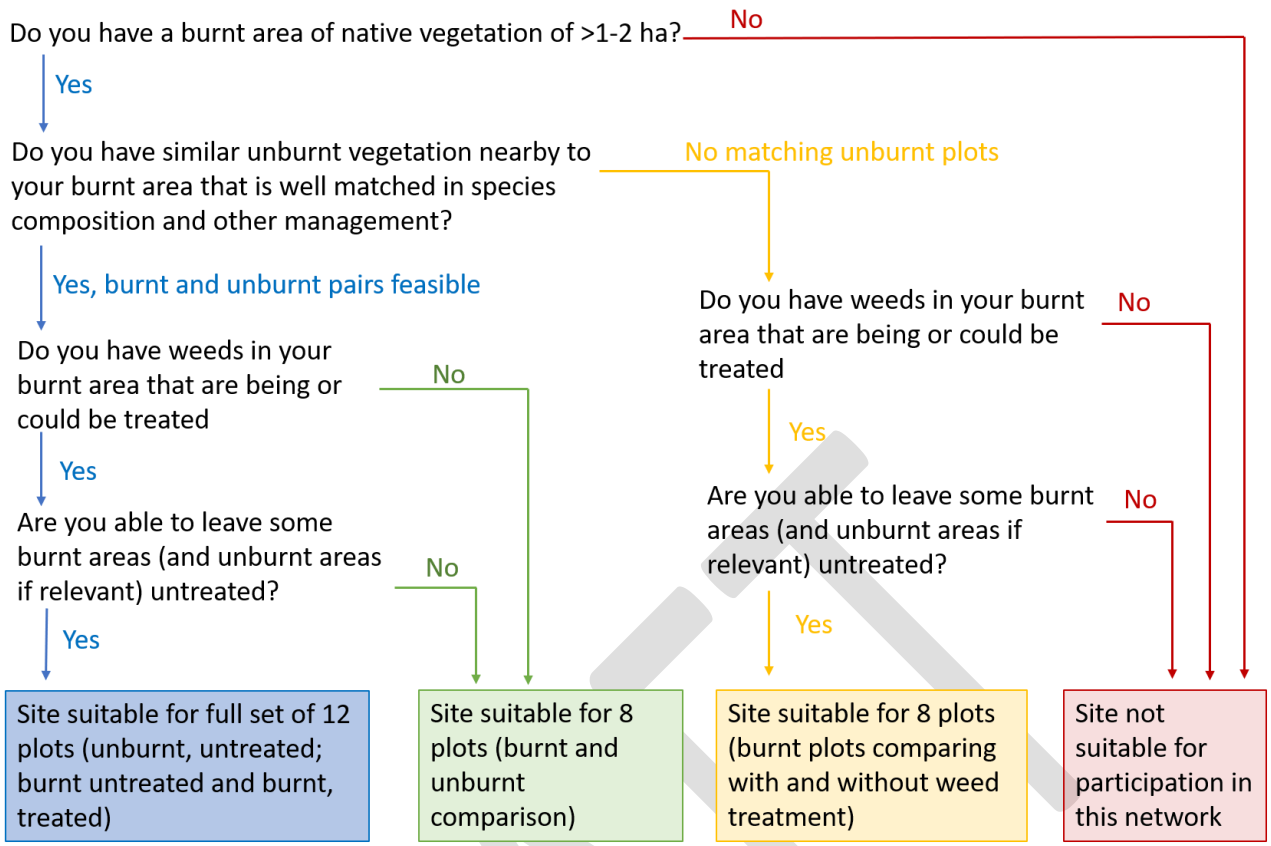


Figure 3. Decision tree to aid in identifying the potential suitability of a site in the MER Pilot Network and the questions it could address

2.1.1 Guidelines for locating plots at sites

A site is a cluster of up to 12 plots. The area selected needs to fit four replicates of each treatment, using the plot size best suited to the vegetation type, following detail below and in discussion with the MER team.

All plots need to have:

- the ***same vegetation type*** (we are not using any one classification system, discuss with the MER network team do determine the vegetation type).
- similar ***recent fire severity*** (if the fire was patchy you can still locate plots within areas of similar fire severity; see the additional guidelines in the Fire Severity Module for estimating fire severity).
- similar ***longer-term fire history*** if known (e.g. fire in dense sapling stage vs old-growth obligate-seeder forest is apparent from size of dead stems).

Allocate sites to blocks so that the following factors are relatively consistent within each block:

- Fire severity (as above)
- Aspect: the direction that the slope faces in relation to compass points e.g. N, NE, E, SE

- Slope (i.e. similar degree of steepness)
- Position in the landscape (see Figure 4)
- Patch type/microhabitat in heterogenous vegetation

Factors such as weed cover, threatening processes, and weed management are also ideally similar within each block; nevertheless, some variation can be accounted for by documenting or measuring these factors as part of the monitoring protocols.

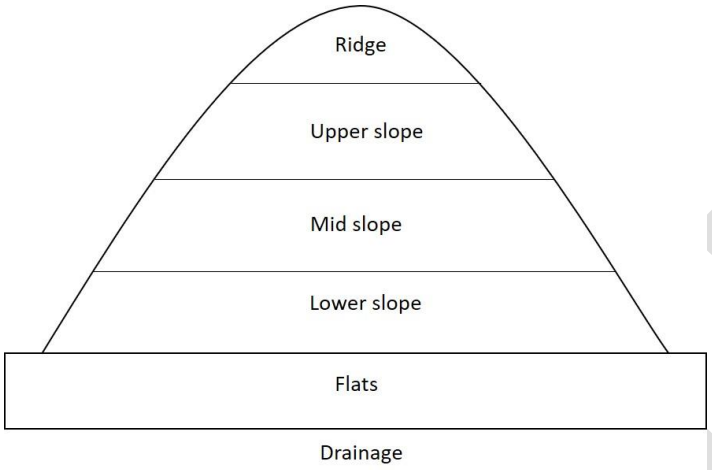


Figure 4. A schematic guide for determining position in the landscape.

2.1.2 Plot size and shape

The standard plot size established across the network is a 25 x 25 m square. Exceptions can be made to this standard size if circumstances require, as described in the next section.

2.1.3 Potential biases, challenges and solutions

If suitably matched contrasts for at least three sets of burnt plots (either unburnt control or burnt with weed control) are not available, then the location cannot be used for this pilot.

However, since plot selection can be extremely challenging, some compromises can be made, such as:

- Plots placed close together (ideally, they would have a reasonable buffer, for example, 20 m, but < 20m is acceptable if necessary)
- Using three plots of a treatment type if four plots are not possible (two or fewer is not acceptable)
- Plots only approximately organised into blocks (e.g., some plots within a 'block' may be further apart than the plots within another block, and some blocks may be more similar than others)

- Change in plot shape or orientation to fit a constricted area. If you do change plot shape, maintain the same plot area, and aim for simple adjustments such as halving the width and doubling the length. The latter will make it easier to fit the data collection app.
- A small amount of potential confounding (e.g. burnt plots on one side of road and unburnt on the other) where the ecological effect is not expected to be high
- Variation BETWEEN blocks (excluding variation that is the treatment type) is ideally also minimised, but some variation is acceptable. Variation between blocks can be accounted for statistically whereas variation within blocks reduces the statistical power more substantially. For example, it would be acceptable to have two blocks on one aspect and two on another if vegetation is still the same.
- As a last resort, 10 x 10 m (rather than 25 x 25 m) plots could be considered for some vegetation types (e.g. grassland, rainforest with small stem diameters). Discuss this with the MER team if you think in may be required. Note it may require an alternative data collection method.

If there is a need to modify the design, be as descriptive and clear as possible about why. Remember that your reasoning needs to be understood by someone else who may not be familiar with the on-ground site.

It is important to try to avoid bias in plot selection. Below are a set of common biases and strategies for avoiding them:

- Focusing only on shrubs and trees when choosing plots, particularly in vegetation types such as grassy woodlands where the ground layer is most important. To avoid this, ensure you consider all vegetation layers when aiming for homogeneity.
- Choosing a site in poorer condition for one treatment and better condition for another. This can reflect an unconscious tendency to facilitate a larger effect of treatment, when aiming to quantify an improvement in condition. Ideally, weed treatments would be applied randomly to 4 of 8 burnt plots, after they have been laid out, to avoid such biases.
- Favouring sites with easier accessibility (this is common in ecological records in general). It is important to keep in mind issues that can arise from this, for example, edge effects, disturbance etc. If the site is large enough, set a preferred distance from edge (e.g. 20 m) to avoid this.

2.2 Plot naming convention

Each plot has a code to identify it. It is important to organise the plot ID's during the scoping sessions, as this requires ensuring the plots at your site have unique ID's within the bioregion.

An example plot code is 'QDMSEQ0001.' The code is made up of;

1. 2 x characters for State
    - Northern Territory = NT
    - South Australia = SA
    - New South wales = NS
    - Queensland = QD
    - Western Australia = WA
    - Australian Capital Territory = CT

- Tasmania = TC
- Victoria = VC

2. 1 x character for Program
    - MER Pilot = M
3. 3 x characters for IBRA Bioregion
    - i.e. Flinders Lofty block = FLB, South-East QLD = SEQ
    - You can find the relevant bioregion from this link https://www.environment.gov.au/land/nrs/science/ibra/australias-bioregions-maps
4. 4 x sequential numbers for each plot (0001-9999), ensuring that each new plot has a unique number, taking account of other MER plots in the same bioregion. We would expect each site to have a set of 8-12 plots with consecutively numbered unique IDs.

5. An example plot code is QDMSEQ0001which represents; Queensland (QD), MER Pilot (M), South-East QLD IBRA region (SEQ), plot number (0001),

Part III Plot layout

Once you have decided on the general locations for your plots (Part 2), you will need to layout the plots. Setting up a plot involves; laying out and marking the plot corners, recording the locations of plots, and collecting metadata.

In most circumstances, plot lay out will be completed by the MER Pilot team using a DGPS (Trimble R1™) for high precision accuracy that is linked to a custom developed App. In some cases, the Plot Layout and Installing Plot Infrastructure (Part IV below) can be done simultaneously

3 Plot layout protocol

This chapter details the equipment necessary and two procedures for plot layout; the procedure without the DGPS and App and the procedure using the DGPS and App.

Using the App and the DGPS the MER Pilot team will be able to identify the exact points for Plot infrastructure and ensure the Plot is accurately aligned with the N-S grid for remote sensing compatibility. The MER Pilot team will mark out the Plots using hi-vis flags. Service Providers will be asked and supported to replace the hi-vis flags with permanent star pickets. Details for your site can be discussed with the MER Pilot team.

3.1 Equipment list

- Handheld GPS
- Compass (or additional handheld GPS)
- Hi-vis flags (4 per plot). (these are temporary, later to be replaced with 4 star pickets, on in each corner of the plot
- Permanent marker for annotating flags with plot name
- Flagging tape (avoid pink if colour blind people may be involved with locating plots)
- 2 x tape measures of at least 25m length
- Datasheets to record corner locations and accuracy (if not using app) and general notes

Optional – if laying out plots using the DGPS and App System:

- DGPS (Trimble R1™)
- 10 inch Tablet with the AuScribe MER App installed and set-up

3.2 Procedure

3.2.1 Without the DGPS and App system;

Standard GPS devices become more accurate when left stationary for 5-30 minutes. Without the DGPS, plan to allow time for the GPS to acquire the most satellites it can for the best waypoint accuracy as you set up the plot.

The following steps describe marking points with pin flags. If practical, the SW corner could be marked with a star picket and cap, once you are certain it's in the correct position (procedure described in Part 4).

1. Determine the southwest corner of the plot. Using a permanent, weatherproof marker, write the plot ID on the flag and securely pin in the ground (or star picket).

2. Leave the handheld GPS (with antenna pointed to sky and clear of any metallic obstructions) at the south-west corner for 5-10+ mins to increase its accuracy. Mark the waypoint when its accuracy has stopped increasing.
3. While the GPS is acquiring satellites, use a compass to guide you as you roll out your tape directly north, mark the 25 m (or other selected plot length) location with a flag (that is also labelled with Plot ID), return to the southwest corner and repeat heading east and mark the southeast corner with a pin flag.
4. By this time the GPS should be as accurate as possible. Repeat step 2 for the remaining corners and mark with pin flags.
5. To help with locating the flags from a distance, mark the location of the flags using flagging tape on a nearby branch as high as you can.
6. Record the plot name, location (Lat/Longs) of the SW corner of each plot, and key information about each plot using a spreadsheet or table as per Appendix 1. Plot names include the state, M for MER plot, bioregion, plot number and treatment type – see Section 2.2. Return the plot information to the MER Pilot team.

3.2.2 Using the DGPS and App system;

1. Determine the southwest corner of the plot
2. Use the App and DGPS to locate the plot corners (see below 'Using the Trimble R1 GNSS to lay out a plot)
3. Insert a temporary hi-vis flag (for later replacement with star picket and hi-vis cap) into each location (star picket placement can be done on the day or later when monitoring is conducted, using the flags as a guide).
4. Label the temporary flag with the plot name. Add the treatment code to the label after the plot name to assist people in the field knowing the management required.
5. Visually estimate the visual percentage cover of weeds in each plot *if* weed treatment is planned for the plot before monitoring is to occur (not needed if weed control has already been undertaken). You will need to record this on paper for the time being, and email to us.

Using the Trimble R1 GNSS to lay out a plot

1. Once the SW corner of a final plot location has been determined in the field, switch on the Trimble R1 by depressing power button in centre. It will flash green and blue as it looks to connect to Bluetooth.
2. Navigate to the mobile device's Bluetooth settings and turn Bluetooth ON.
3. Check the Devices list and wait for the "GNSS:XXX" to appear. Select it and you should be connected.
4. Navigate to the GNSS Status App and select Source. If the GNSS is in recent pick list, then select. If not, pair the device through blue tooth by selecting it through the available devices, then select the GNSS under the source menu to connect it.

5. Set the Corrections to RTX via Satellite, and the Satellite selection to 1200 (or auto works better in some locations) and Secondary to SBAS.
6. Allow some time to let the accuracy drop to submetre. When accuracy has been achieved a small RTX icon will appear on the home window.
7. Back in AuScribe, open to the Manage Visits and register your new plot by giving it a name using the prompts (select the state, M for MER plot, bioregion, plot number). Note that the treatment code is not available in the current version of the app.
8. Record the general location and your and your field colleague's name.
9. Under Site Description, use the tick boxes to select the treatment type for the plot, i.e. whether the plot is Burnt/Untreated Burnt/Weed-treated or Unburnt/Untreated.
10. Select the Yes or No buttons at the bottom of the window to define whether the plot will be permanently marked (usually yes, but select No for dummy plots, for example).
11. Decide on the SW corner of the plot. Stand at that point and select DGPS Points. The App will generate a grid of red point markers based on the plot dimensions added above. Your location is the blue dot.
12. As a standard, the plot aligns in a north–south direction with the grid.
13. Review the plot layout (repeat the above steps if you want to shift plot location or alter dimensions or alignment).
14. To finalise the plot corners, select Mark Closest Point while standing at the plot corner. The point will be saved and turn green. Repeat this step until you have walked around the plot and all corners are marked (you can also choose to mark the centre for the basal wedge measurement).
15. The app shows four additional markers in between each corner. These represent the locations for the terminus of monitoring transects. If you are monitoring during the same trip as marking out the plots, these can be marked with a tent peg or chalk/paint. They can be marked and put into AuScribe but it is not essential.
16. Once you are happy with your plot, choose the back arrow, then Manage Plots, then suspend the plot unless you are continuing with monitoring straight away. You can retrieve the plot from the same menu later.
17. We recommend you resume the plot, check your points have saved as expected, then suspend again (sometimes you may find you saved more than one point at a corner). In that case you would need to restart a new plot (with the same name) and note on your data sheets that the first version needs to be deleted.

Part IV Installation of plot infrastructure

The final stage of site-set up includes installing the longer-term infrastructure for the plot, i.e., star pickets and labels in each plot corner.

4 Protocol for installing plot infrastructure

Service Provider will be required to replace the hi-vis flags set out by CSIRO with permanent star pickets and hi-vis caps as part of their first monitoring event (or earlier). This protocol describes the equipment required and procedure to complete this task.

CSIRO will provide you with the GPS coordinates of each plot.

4.1 Equipment list

- Handheld GPS
- 1.5 m star pickets x 4 for each plot (galvanized pickets recommended)
- Hi-vis star picket caps x 4 for each star picket
- Tie-wire or UV stable cable ties to secure caps to pickets
- Picket driver
- Flagging tape
- Heavy duty aluminium tags pre-engraved with plot code, or paint pen

4.2 Procedure

The MER team will provide you with the GPS coordinates of each plot. Using this information, navigate to the SW corner of each plot. At each plot:

1. Locate the flags for each corner of the plot and replace with a star picket (if these have not yet been laid out using the GNSS device, this can be done now, following the instructions in section 3.2.2 above.
2. Install a Hi-vis cap on the star picket and fasten securely with tie-wire or UV stable cable ties
3. Fasten a tag with the plot name engraved to each star picket or write the label with paint pen. Add the treatment code to the label after the plot name to assist people in the field knowing the management required.
4. Your plot is now set up.

Appendix 1. Plot information collection sheet

We recommend you prepare and print a table modelled on the following template (e.g. add rows if you expect 12 plots, make landscape to better fit text, update plot names). Take this the field to record as you lay out plots.

Plot name (examples given)	**Pair**	**Block**	**SW lat.**	**SW long**	**Burnt/ Unburnt**	**Treated/ untreated** (for weeds)	**Position on slope**	**Fire intensity**	**Fire evidence**	**Weed cover**
QDMWET0001					U	U				
QDMWET0002					U	U				
QDMWET0003					U	U				
QDMWET0004					U	U				
QDMWET0005					B	U				
QDMWET0006					B	U				
QDMWET0007					B	U				
QDMWET0008					B	U				

Plot name example: State (QD = Queensland); Project (M = MER Pilot), Bioregion code (WET), a four digit # from 0001-0008)

1. Pair up the most similar burnt and unburnt plots. Even if all are similar, assigning pairs is necessary for the analysis. If plots are totally similar, choose the most closely located burnt/unburnt plots for a pair.
2. Block is a number from 1-4 in this case, indicating how the pairs of sites group, i.e. block 1 for the first pair, block 2 for the second pair, etc.
3. Treatment Code (Unburnt, untreated = UU; Unburnt, treated =UT; Burnt, treated = BT; Burnt, untreated = BU), where treated refers to the presence of weed treatment.
4. Slope- position in landscape: *ridge, upper, mid, lower, flats*
5. Fire intensity:

Low	Only ground fuels and low shrubs burnt (little canopy scorch)
Moderate	Most ground and shrub vegetation burnt (little canopy scorch)
High	Ground and shrub vegetation incinerated; most tree canopies scorched
Very High	Most green vegetation including tree canopies burnt (crown fire); leaves and some woody vegetation <5mm diameter consumed by fire
Extreme	Extensive crown fires; all green vegetation burnt and fine diameter twigs (e.g. <5-10mm diameter) consumed by fire

6. Fire evidence: e.g. *dominant trees killed by fire (obligate seeders); sprouting from base only; sprouting from main stem only; sprouting from smaller branches; no apparent crown fire or canopy scorch; char height on trunks; photo*
7. Weed cover: *visual % estimate, if possible, to the nearest 5%*

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