PROJECT PHOENIX

BUSHFIRE IMPACTS

A NATIONAL MODEL FOR ASSESSING LOCAL LANDSCAPE RESTORATION PRIORITIES

PROJECT SUMMARY

JUNE 2021

Across all of our Project Phoenix activities and actions we pay respect to the Traditional Owners and Custodians of the lands and waters on which we work. We honour the resilience and continuing connection to country, culture and community of all Aboriginal and Torres Strait Islander people across Australia. We recognise the decisions we make today will impact the lives of generations to come.

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Greening Australia would like to acknowledge the hard work and dedication of the Project Phoenix Management Team: Samantha Craigie, Patricia Verden, Brian Ramsay, Irene Walker, Courtney Sullivan, Rowan Wood, Paul Della Libera, Kim Philliponi and Ella Campen.

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EXECUTIVE SUMMARY

About the project

> To know what we need to restore, and the seed requirements to do this, we first need to assess both pre and post-disturbance vegetation **condition**, the **severity** of the fire event and consider this in the **context** of stressors that may reduce a community's natural capacity to regenerate.

These three things together – condition, severity, and context – lead to questions of:

- ***why*** — which communities require intervention
- ***where*** — how to prioritise restoration efforts
- ***what*** — what activities are required – management of threats and/or addition of seed
- ***how*** — the amount of seed required and it's delivery.

Scope

The scope of this project was to:

- Develop restoration scenarios for fire-affected communities based on:
  - outlining a conceptual model to assess the need for intervention based on pre- and post-disturbance vegetation condition, fire severity, landscape context and community composition
  - building a decision tree/framework to assist in prioritisation of restoration activities
- Generate restoration scenarios for different threatened ecological communities (TEC) affected by the 2019–20 bushfires
- Outline potential approaches for restoration of fire-affected communities
- Prepare case studies to assess the application of these conceptual frameworks and decision tools
- Discuss restoration scenarios in the broad context of future fire mitigation strategies and climate-adjusted approaches.

Introduction

The 2019–20 fire season brought about a shift in how we see fire across the Australian landscape. During this season, known as Black Summer, the fires were unprecedented in their spatial extent, intensity, impacts on different vegetation communities (i.e. rainforest) and ecological consequences. The context of record-breaking temperature and extremely low rainfall contributed to the extreme scale and intensity of the fires.

This led to the need for new ways of thinking about how to manage and assist recovery of burnt vegetation communities — especially Threatened Ecological Communities (TECs). There is a need for a new framework that brings together fire ecology and restoration ecology to understand how best to approach the management of burnt vegetation communities.

This project aims to address a number of questions including:

- How do we best unlock regenerative potential in burnt vegetation communities?
- How do we prioritise areas for management intervention? Can this be done by using information on site history (fire history and precipitation), landscape context (e.g. proximity to cleared areas) and data on species composition?
- Can we assign potential restoration approaches to these communities to work with the inherent regenerative capacity and make sure that limited seed resources are used in the most effective way?

Specifically, this report will address the following six aims:

1. Outline a **conceptual model** to assess the need for intervention based on pre- and post-fire vegetation condition, fire severity, landscape context and community composition.
2. Establish a **decision-making framework** (including a decision tree) to assist in the prioritisation of restoration activities.
3. Outline potential **restoration approaches** for fire-affected communities based on output from the decision tree.
4. Present **case studies** of two broad vegetation types (rainforest and grassy woodland) to assess the application of these conceptual frameworks and decision tools. Highlight case studies of special case seed input for post-fire habitat restoration to support threatened fauna.
5. Generate restoration scenarios for different **Threatened Ecological Communities** (TECs) affected by the 2019–20 fires using this conceptual framework and a spatially explicit GIS model. Here we focus on 19 TECs of which >10% of their areas were burnt in the 2019–20 fires.
6. Discuss **restoration scenarios** in the broad context of future fire mitigation strategies and climate-adjusted approaches.

This project required a synthesis of information from the fields of restoration ecology, fire ecology, bush regeneration, GIS and remote sensing, conservation biology, vegetation management and restoration genetics. Given the diversity of fields covered, we present a new framework based on information from these multiple sources to inform current and future post-fire management.

Issues

There were several issues with this project:

- The project was not able to start until the Steering Committee approved the project which was delayed until September 2020.
- Due to other project commitments and personal injury, the GIS personnel essential for this project were not able start work until January 2021. This created a delay in this component of the project and developing the TEC restoration scenarios.
- Additional processing of the data from National Vegetation Inventory System layer was required before the GIS model was able to be developed (to generate the Euclidean Distance to cleared areas). This added processing time to the project.
- The GIS models within this project are new in terms of the data layers and models developed for bushfire scenarios. This novelty meant that they needed to be tested extensively to ensure that the model was running as anticipated. This testing added more computational and analysis time to the project than originally expected. However, it also increased the overall quality and confidence in the outcomes produced. Examples include:
    - the additional analysis and inclusion of the NSW fire interval data which had a finer resolution (1km grid size) compared to the national data originally (10km grid size)
    - testing of different models to calculate proximity to cleared areas
    - mapping of the distribution of 'fire affected species' (from the expert panel report) within the boundaries of the TECs
    - comparison of 'likely to occur' and 'may occur' scenarios – this was important to see how they align and to check for inconsistencies
    - the need to manipulate the output data from GIS model using R programming as these files exceeded the line limit capacity of Excel. This applied to six TECs and took more time and effort.
- Injury to the project leader (fractured arm) delayed work during January/February 2021.
- There were issues and delays in the species trait data collection including:
    - spelling errors or differences in species names, inconsistent synonyms/species names used across source documents — this meant that extra time was required to validate the species and traits
    - limited time to quality control/check for species' name spelling across TECs
    - these are not likely to be a complete/comprehensive species lists; development of a full and comprehensive list would require more time, ground truthing and expert opinion
    - different sources presented different fire responses or life history traits. This meant that extra time was required to cross-check and validate the data. Further data collection and cross checking with local experts would be needed to validate all the data.

- Extra time was required to validate and check TEC information to ensure consistency of information and data. For example, the Aquatic root mat TEC was removed due to inconsistency in information from Yanchep National Park rangers and governments' fire extent data.
- To enable further and more detailed investigation of restoration scenarios, the project would have benefitted from a longer time frame (only nine months) and more hours available.

Comments

Not applicable

Key outputs

This report provides a new, science-based framework/conceptual model which includes an assessment tool that practitioners can use to assess site condition and estimate its regenerative potential prior to a disturbance. The decision tree framework can be used to develop restoration scenarios/approaches which can be applied to the management of fire-affected vegetation communities in Australia.

The framework is grounded in the best available science and focuses on tapping into the natural regenerative capacity of fire-affected landscapes to assist recovery. It is applicable and usable by on-ground managers who need to make decisions regarding when (and how) to intervene to assist the recovery of vegetation communities affected by fire events.

This conceptual model was applied to develop restoration scenarios for 19 TECs that were burnt >10% of their area in the 2019–20 fires (refer to Table 7-1 in the full report *Bushfire impacts — A national model for assessing local landscape restoration priorities*). The TECs varied across ecosystem types (from rainforest to grassy woodland) and illustrate how this conceptual model could be tailored to different communities based on:

- vegetation composition
- fire severity and history
- existing habitat condition (from degraded to good condition)
- current threats (disease, pests, competition) and
- landscape context and connectivity.

Although GIS modelling was conducted across both the 'likely to occur' and 'may occur' distributions of each TEC, only the 'likely to occur' models were reported. The spatial modelling was based on the TEC fire history, distance to cleared land, fire intensity and precipitation. To help assess the recovery potential for each TEC, we collated fire (e.g. obligate seeder (OS), facultative seeder (FS) and resprouter (RS)) and life history traits (e.g. life form, primary and secondary primary juvenile period) for 1260* species representing 568* genera.

We processed the species trait data into an assortment of pie charts, bar graphs and tables for easy interpretation and summary of the key traits. The following list of tables, figures and appendices show key outputs from the conceptual model and restoration scenarios. Refer to the full report *Bushfire impacts—A national model for assessing local landscape restoration priorities.*

Table 2-1 Vegetation condition classification for assessment of the need for seed input post-fire (recovery category). This assessment is centred on the inherent regenerative capacity of a vegetation community based on condition indicators prior to fire. For each recovery category, the recovery mechanisms remaining relate to the inherent regenerative potential of the community which in turn relates to the restoration approach required after disturbance by fire.

Table 7-1 The vegetation community type, status and location of the 19 Threatened Ecological Communities (TECs) with >10% of their estimated distribution within the areas burnt in the 2019–20 fires.

Figure 2-1 The importance of pre-fire vegetation condition and post-fire context for the intrinsic regenerative capacity of obligate seeders (OS), facultative seeders (seeders/resprouters) (FS) and resprouters (RS) following disturbance by fire. Pre-fire factors can affect the capacity of individuals of different species within communities to have the seed and/or vegetative reserves (capacity) to recover after fire, while the post-fire context will influence the degree of germination, regrowth, establishment and survival.

Figure 2-2 The range of restoration approaches from protection/natural regeneration, through to facilitated regeneration to combined regeneration/reintroduction and reconstruction in relation to the spectrum of habitat damage/degradation and seed input requirements. For all intervention approaches, threat management is required to mitigate threatening processes.

Figure 2-3 Conceptual model of post-fire recovery and seed addition needs of native vegetation. This model depends on habitat condition (level of degradation) and the inherent recovery potential of its species' (community composition), which in turn dictates the restoration approach. The spectrum of intervention approaches ranges from protection/natural regeneration and facilitated regeneration (where seed addition is rarely needed) to combined regeneration/reintroduction and reconstruction (which utilise targeted and broad seed addition). All these approaches need to be placed in the context of threat management to facilitate regeneration and ensure the effective use of limited seed resources (see also Figure 2-2). The recovery categories 0–5 relate to those outlined in Table 2-1. Predicting recovery potential prior to fire is based on impact and disturbance histories, drought, habitat connectivity, the presence of intact soil profiles and knowledge of recovery traits (seed banks, resprouting and colonisation potential) of the individual species (see Figure 2-1); while after fire and sufficient rainfall, restoration approaches can be allocated on the basis of direct evidence of the species' and community recovery. Within and at the margins of an ungrazed remnant canopy, seed addition is generally unlikely to be needed (except if site assessment identifies a need for special case seed inputs for fire-killed species, particularly for threatened species or species of conservation significance). Seed of some species may need to complement regeneration in an 'overlap zone' between the remnant and the adjacent cleared area. The zone in which seed is needed may be greater in grazed, compared to un-grazed remnants. In long cleared areas with no inherent recovery potential, a full reconstruction approach involving site preparation plus broad seed inputs (i.e. a biodiverse mix of species that aligns with the reference community composition) is likely to be required.

Figure 3-1 Variables that influence the regenerative potential and contribute to the overall recovery potential of a vegetation community: (i) Fire frequency, (ii) Drought, (iii) Habitat degradation and condition, (iv) Connectivity, (v) Distance to cleared areas, and (vi) Presence of Disease. Cumulatively, and through their interaction, these variables will determine the inherent recovery potential of a community prior to a fire event. This information can be assessed to determine the Predicted Regenerative Potential (PRP) of a community, which is information that – in combination with plant trait information – can be used in step 1 of the Restoration Scenario Planning Decision Tree (Figure 3-2).

Figure 3-2 Decision tree for restoration scenarios in fire affected areas. This decision tree has five steps that relate to different stages and inputs into the decision process.

Step 1 relates to information on the Predicted Regenerative Potential (PRP), which encompasses the capacity of individuals of different species within communities to have the seed and/or vegetative reserves to recover after fire. The predicted regenerative potential (either low or moderate/high) uses information from the Predicted Regenerative Potential (PRP) framework (Figure 3-1) and plant trait data based on community composition.

The second step relates to information on the conditions associated with the most recent fire event. The fire intensity at a site is classified as either low/moderate or high/very high.

Step 3 of the decision tree requires on-ground assessment to identify which species and/or functional groups and regenerating and which groups/species are missing from the post-fire regeneration. This will inform the required restoration approach based on missing structural elements or species. Note that this assessment should be completed after sufficient rainfall (and considering seasonality) to enable an accurate assessment of post-fire regeneration.

Step 4 involves allocating a restoration approach (Natural regeneration/Protection, Facilitated regeneration, Combined regeneration/reintroduction and Reconstruction), addressing whether targeted or broad seed inputs are available and whether ongoing threats can be managed.

Information from the previous steps will determine the potential outcomes for fire-affected communities; from (i) a recovery trajectory toward the identified reference community, (ii) assisted recovery towards a reference community, (iii) species loss and/or a state change, and (iv) a state change (transition from one ecological state to another, e.g. forest to shrub dominated community).

* See species naming limitations (section **Issues**)

Outcomes

With the restoration scenarios for the 19 TECs, we produced spatial analysis and maps, which provide a starting point and basis for further ground truthing. This can provide an ‘ecological triage’ approach where limited resources can be strategically directed to maximise environmental benefits in post-fire restoration.

The outcome of this activity is a framework that can be used by practitioners and land managers to assess the post-fire regenerative potential of an area (based on condition assessment and species composition) which, when combined with ground truthing, provides a means of deciding when, where and how to intervene post-fire. It provides practical tools which can be combined with local and specialist knowledge to improve ecological outcomes for burnt vegetation communities.

This conceptual model and restoration scenarios can be used to inform the amount and type of seed that may be required for fire recovery activities. We present a framework that is forward thinking, knowing that these systems will be regenerating under conditions of a rapidly changing climate. We therefore advocate a climate-adjusted approach for seed collection.

Findings

- This report found that out of the 19 TECs, two had a low predicted recovery potential and 17 had a moderate predicted recovery potential.
- The two Western Australian TECs had low predicted recovery potentials whereas all other states' TECs had a moderate predicted recovery potential.
- Despite these low/moderate recovery potentials, the restoration scenarios/approaches for each TEC could still range from protection/natural regeneration through to reconstruction, pending on-ground assessment, as illustrated in **Figure 3-2**. (Refer to the full report *Bushfire impacts — A national model for assessing local landscape restoration priorities*).
- Although the protection/natural regeneration and facilitated regeneration approaches primarily focus on threat management, some seed input will occasionally need to be applied due to prior management, historical fire regimes and other disturbances, to maintain a particular reference community composition or for threatened species conservation.
- We recognise that there is not a 'one-size-fits-all' approach and that even within a vegetation community type, there will be areas that potentially span the spectrum on interventions: from just protecting the system and letting it regenerate to targeted restoration of particular species or functional groups.
- We structure our conceptual framework and decision tree within the science of the fields of both fire ecology and restoration ecology: knowing that the inherent regenerative capacity of a vegetation community at a site depends on species composition, management history, previous fire regimes and the state along a degradation spectrum.

Evidence

Refer to full report *Bushfire impacts — A national model for assessing local landscape restoration priorities* for a full list of all tables and figures.

Trait data for species listed within each TEC — See data repository:

- Tables 7-2, 7-5, 7-6, 7-9, 7-10, 7-13, 7-14, 7-17, 7-18, 7-21, 7-22, 7-25, 7-26, 7-29, 7-30, 7-33, 7-34, 7-37, 7-38, 7-41, 7-42, 7-45, 7-46, 7-49, 7-50, 7-53, 7-54, 7-57, 7-58, 7-61, 7-62, 7-65, 7-66, 7-69, 7-70, 7-73, 7-74, 7-77

GIS model scores with associated ranges and ratings:

- Tables 8-1, 8-2, 8-4, 8-5, 8-6

GIS model Priority Area outputs for each TEC:

- Tables 7-3, 7-7, 7-11, 7-15, 7-19, 7-23, 7-27, 7-31, 7-35, 7-39, 7-43, 7-47, 7-51, 7-55, 7-59, 7-63, 7-67, 7-75

Spatial distribution map of priority areas for each TEC:

- Figures 7-3 to 7-26

RECOMMENDATIONS

There are several recommendations for the Strategy[1] that will extend and utilise the information presented in the report. This relates to both the conceptual model and decision tree as well as the application of this framework to the post-fire management of TECs.

RECOMMENDATIONS

1

The conceptual models and frameworks presented here should be integrated with data collection apps to facilitate field surveys, site assessments and ground truthing.

This would be done through partnerships between land managers, researchers, NGOs, communities and practitioners. Remote sensing tools could also be included as a complementary tool for assessing regeneration and post-fire recovery of vegetation structure and cover.

2

The application of the conceptual model to the TECs needs to be tested through site assessments that engage with community groups, land managers, practitioners and local experts.

3

Weed management — especially of transformer weeds and weeds of national significance — plays a key role in facilitated regeneration for bushfire recovery.

Fire provides the rare opportunity to exhaust or significantly reduce the weed seed bank by targeted removal of post-fire weed germinants. Continual investment in weed removal (prior to seed set) over the first few seasons can then deplete this weed seed bank and provide the chance for native regeneration.

[1]. This Report contributes to the evidence base for a ten-year strategy to guide the native seed and landscape sector. The document, which is untitled until endorsement in September 2021, is referred to as the Strategy in all Project Phoenix publications

RECOMMENDATIONS

Thus, timely post-fire weed control can be an effective and economical means of progressing towards eradication. Conversely, if weeds are not removed, and post-fire conditions are favourable, weeds may establish and reproduce prolifically after fire — thereby compounding weed issues in these systems.

It is therefore essential that weed management be included in any strategy focused on facilitating native regeneration in bushfire recovery. Moreover, investment in weed control in tandem with the development and deployment of native seed stocks will provide the chance that any seed or propagules used will contribute to improved ecological outcomes.

4

To maximise the impact of native seed inputs for bushfire recovery, it is essential that there is continuity of funding for ongoing threat management (e.g. pests, herbivores, disease).

Potential outcomes (recovery trajectory towards a particular reference community) will be negatively affected without direct management of present and ongoing threats.

5

After fires there is often a limited window of opportunity to undertake management interventions in an ecologically and cost-effective manner. This report advocates for bush-fire preparedness to ensure that ecological management interventions can be undertaken in a timely way after fire events.

For example, having predictive models of regenerative capacity across communities of conservation concern can identify potential seed needs and enable these to be collected in a sustainable and ecologically sensitive way as part of networked seed banks.

These predictions can then be tested post-fire and used to enable rapid deployment of weed control and assessment tools to evaluate levels of native regeneration. This will maximise the availability of post-disturbance niches for native species and avoid having to reintervene later when more effort and resources may be required to support recovery.

RECOMMENDATIONS

6

The success of post-fire restoration approaches will depend on defining the appropriate reference community and determining potential successional pathways. This information needs to be considered in light of rapidly changing environments (climate change and fire) and how this may influence species composition and functional traits within a community.

7

As part of the Strategy, the native seed sector needs a coordinated approach to the development of seed banking for fire sensitive native species across a range of priority vegetation communities.

This will require partnerships between government, academics, NGOs, land managers, community groups and practitioners.

8

The GIS models presented here lay the groundwork for predicting areas in greatest need of post-fire management intervention. Given the short timeframe of this project, these models are preliminary and would benefit from further extension and analysis, especially by including finer scale state-based fire history data.

9

These GIS models could be applied to:

- other fire-affected TECs
- fire-affected communities that are key habitat for (listed) threatened fauna species and
- vegetation communities that are important for biodiversity and ecological function at the landscape scale (e.g. for connectivity, large patches, protected reserves).

This broader approach will be essential to give a longer-term view of the scale of intervention required and associated seed needs in line with the Strategy. This information will be key for knowing how much the native seed industry needs to scale up to increase resilience through biobanking vulnerable species to reduce the risk of species loss from future fire events.

RECOMMENDATIONS

10

As part of the Strategy, we recommend an assessment of the seed needs to build landscape resilience to future fire events.

Broad seed inputs are required to establish new patches of a vegetation community to allow expansion and reconnection of habitat patches as well as establishing insurance populations.

Here restoration plays a key role in improving habitat value and protecting ecosystems from future detrimental fire events (e.g. by creating buffers around certain communities). This is where landscape level conservation planning can be used to identify where in the landscape these should be established to maximise environmental gains. This should also be considered using climate change and species distribution models.

WANT TO KNOW MORE?

For further information read the full report *Bushfire Impacts – A national model for assessing local landscape restoration priorities.*

Related projects

- *Bushfire impacts — ArcGIS resources*
- *Bushfire impacts — How much seed will I need?*
- *Bushfire impacts — Where will the seed come from?*

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