PROJECT PHOENIX

BUSHFIRE IMPACTS

HOW MUCH SEED WILL I NEED?

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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CONTENTS

EXECUTIVE SUMMARY

About the project

***Bushfire impacts — How much seed will I need?* focuses on obtaining broad estimates for five Threatened Ecological Communities (TECs) representing different vegetation community types and geographical areas burnt in the 2019–20 bushfires.**

Scope

The scope of this project was to outline broad potential seedling addition estimates for five Threatened Ecological Communities (TECs) representing lower and upper scenarios for restoration. Recognising that targeted seed inputs will predominately relate to fire sensitive species, this project will specifically focus on representative fire sensitive obligate seeders.

The specific aims are:

- Following the report *Bushfire impacts — A national model for assessing local landscape restoration priorities*, broadly outline the circumstances where seed, seedling and/or propagule addition may be required in fire-affected vegetation communities, focusing on fire sensitive (obligate seeder) species.
- Present general seedling addition rates for each community type and TEC for different life form groups (i.e., trees, shrubs and herbaceous).
- Provide potential estimates of seedling requirements for a range of scenarios from reintroducing 10% of the fire sensitive species through to 100% reintroduction of fire sensitive species.
- Apply these estimates to specific examples of fire sensitive species (obligate seeders) within each TEC.

These broad estimates can be used to develop medium and long-term responses to post-fire recovery for a range of uses including habitat restoration, targeted reintroduction and/or increasing quantities of native seed in seed banks. General estimates of potential seed requirements are essential to the native seed industry to enable forward planning for seasonal collection and to maximise the likelihood of restoration success through adequate species and genetic diversity both now and in the future.

Introduction

The Black Summer bushfires of 2019–20 were unique in terms of the spatial extent of the fire scar and representation of different vegetation community types in fire-affected areas. This led to questions about the role of native seed in bushfire recovery and the amount of native seed, seedlings and/or propagules that may be needed.

In the report *Bushfire impacts — A national model for assessing local landscape restoration priorities*, we presented a science-based framework to make decisions regarding when and how to intervene to assist the recovery of fire-affected vegetation communities. Central to this framework was understanding the inherent regenerative capacity of different vegetation communities and how this relates to species' composition and traits. This trait information is then combined with assessments of habitat condition, fire severity and landscape context to assess the need for intervention.

This assessment can then be used to predict where seed might be needed for targeted reintroduction to ensure that:

- natural regeneration is supported, and
- limited seed resources are only used where required and/or appropriate. This involves a staged approach that minimises seed input through targeted seed use.

In this activity, we focus on the restoration scenarios that may require targeted seed, seedling or propagule inputs — combined reintroduction/regeneration. The goal is to present general seedling addition rates for different life form groups (trees, shrubs and herbaceous) for different vegetation community types focusing on fire sensitive obligate seeders. To provide a range of potential inputs, we provide estimates for scenarios from reintroducing 10% of the fire sensitive species through to reintroducing all (100%) of the fire sensitive species.

Of the 19 TECs that were impacted (>10% of the distribution burnt) by the 2019–20 bushfires (see *Bushfire impacts — A national model for assessing local landscape restoration priorities*), five of them, representing different community types, were extracted and used as examples to generate broad seed inputs. Vegetation composition and structure differ between these community types and these characteristics will determine general fire sensitivity and lead to variation in the degree of intervention required.

We therefore provide broad seedling addition rates for five example Threatened Ecological Communities (TECs) representing different vegetation types. Actual seed inputs can only be evaluated after on-ground site assessments, but the goal of these broad estimates is to compare different communities (with different degrees of fire sensitivity) and provide a general basis for the native seed sector to plan for potential seed needs for bushfire-affected areas. These TECs are:

Table 1: Five example Threatened Ecological Communities (TEC) representing different vegetation types

Threatened Ecological Community (TEC)	Abbreviation	Community type	State
Lowland Rainforest of Subtropical Australia	LROSA	Rainforest	QLD/ NSW
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	UBEFS	Wet Sclerophyll	NSW
Lowland Grassy Woodland in the South East Corner Bioregion	LGWSEC	Grassy Woodland	NSW
Silurian Limestone Pomaderris Shrubland of the South East Corner and Australian Alps Bioregions	SLPS	Shrubland	VIC
Eastern Stirling Range Montane Heath and Thicket	ESRMHT	Heathland	WA

Issues

There were several issues with this project:

- Time constraints restricted the amount of data we were able to obtain to use for our seed/seedling rate estimates. This is especially apparent as much of the relevant data on densities in natural and restored populations/vegetation communities is held as personal knowledge and/or within internal reports of different government and environmental management organisations. Getting access to this information requires substantial time in making personal contacts by phone and email, and in some cases was not available.
- The limited literature on seed/seedling input densities for some communities (especially heathlands and shrublands) meant that only general and broad estimates of required seedling inputs could be made.
- New information came to light that the Silurian Limestone Pomaderris Shrubland was likely not burnt, contrary to initial information and GIS fire map layers. This may create uncertainty in the application of the broad seed inputs to this TEC.
- This highlights an additional problem with some large inconsistencies between the GIS modelling, fire scar data (publicly available) and personal communications about fire extent in the TECs. These areas require further ground-truthing/site assessments to determine the true extent (if any) of the fire damage. Additional state-based resolution data would need to be obtained to more accurately map the fire scar boundaries.
- Vegetation community structure differs within as well as between communities, so precise estimates of seed/seedling input requirements are not possible with desktop analysis. Ground-truthing/site assessments would need to be conducted to ascertain exact seedling requirements; consequently, we provide a range of seedling estimates from 10% through to 100% reintroduction of fire sensitive plants.
- Levels of natural regeneration will not be uniform across communities due to the patchy nature of fire intensity and interval. Hence, the restoration scenarios presented here are likely not applicable across the full extent of each priority area (see *Bushfire impacts — A national model for assessing local landscape restoration priorities* for priority areas). There will, therefore, be the likely need for a combination of restoration scenarios in each area and considerable ground truthing to provide accurate estimates of seed/seedling input needs.
- Our listed fire responses for species within each TEC is not perfect nor comprehensive. There could be additional or fewer species than listed and, in some instances, different sources within the literature 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.

- There are several limitations associated with the collection and interpretation of information that include, but are not limited to:
  - The requirement for site assessments to determine precise seed and/or seedling inputs and identify any missing species and/or functional groups.
  - The species list for each community is not definitive and may include other species not listed in the report. Hence, it is necessary to assume that the proportion of obligate seeders, resprouters and facultative species in this list for each life form group (trees, shrubs, herbaceous and climbers/vines) is generally representative of the broader community.
  - Information on fire response may be limited for some communities. Consequently, our fire response data is based on the best information currently available but is likely to be refined by further assessment of species' responses to the 2019–20 fires.
  - There was a required assumption that the community composition in terms of life form and fire response from the TEC species list is indicative of the community.

Key outputs

This report provides broad seedling input estimates for tree, shrub and herbaceous life forms for five community types (shrubland, heathland, grassy woodland, rainforest and wet sclerophyll forest) across a range of restoration levels from 10% to 100% reintroduction of fire sensitive species.

These estimates can be used to develop and refine combined reintroduction/regeneration and reconstruction restoration programs across these different vegetation communities in Australia. The estimates are grounded in the best currently available information and focus on fire sensitive species (obligate seeders). This information is intended to be complementary to local knowledge and expertise so that on-ground managers can make decisions regarding the density and location of seedling inputs that may be required to assist the recovery of vegetation communities affected by fire events. These broad estimates were applied to five TECs that had >10% of their distribution burnt in the 2019–20 fires, which also represent each of the five community types.

The following list of tables and figures (from the full report *Bushfire impacts — How much seed will I need?*) shows key outputs from the broad seed/seedling estimates across different restoration scenarios. Refer to the full report for all tables and figures.

Table 2: Key outputs from the broad seed/seedling estimates across different restoration scenarios

Item/ Description	Table/ Figure/ Equation number	Section	File title
Equation	1	Section 2.2.2	Methods to estimate potential seedling input for fire sensitive species.
Table	3.1-1	Section 3.1: Threatened Ecological Communities (TEC)	The vegetation community type, location and abbreviation of five of the TECs with >10% of their estimated distribution within the areas burnt in the 2019–20 fires. For further details see *Bushfire impacts — A national model for assessing local landscape restoration priorities*.
Table	3.1-2	Section 3.1: Threatened Ecological Communities (TEC)	A summary of the seedling estimates (plants ha^{-1}) for each of the five Threatened Ecological Communities (TEC) for each life form (Tree, Shrub and Herbaceous) based on a range from 10% of obligate seeders requiring reintroduction, through to 100% of obligate seeders requiring reintroduction. For details of the calculation for each TEC see Section 3.2–3.6**.**
Table	3.1-3	Section 3.1: Threatened Ecological Communities (TEC)	The broad number of seedlings (plants ha^{-1}) required for full reconstruction (100% reintroduction) for different life form groups (trees, shrubs and herbaceous) for the five TECs representing different vegetation types. These seedling density estimates are general and intended to be indicative of planting densities in relation to the potential seedling requirements for reintroduction of each life form group. See Section 2.2.1 for a full discussion of the limitations of estimating seedling requirements for post-fire recovery.

Outcomes

With the broad seedling input estimates for the five community types, we produced calculations and summary tables that provide a minimum intervention and maximum/worst case scenario outcome for seedling inputs for obligate seeders. These can then be combined with ground-truthing and local knowledge to fully assess seed/seedling addition requirements in bushfire-affected areas.

These estimates were generated for five TECs representing different vegetation communities and produced example seedling requirements for the different life forms, ranging from 10% of obligate seeders requiring reintroduction, through to 100% of obligate seeders requiring reintroduction.

Findings

Using restoration scenarios for five TECs that represent different vegetation types, we found that seedling addition rates (seedlings required per hectare (h^{-1})) varied between communities as a function of species composition (proportion of obligate seeders, facultative seeders and resprouters) and dominant life form (trees, shrubs or herbaceous). These general seed estimates that ranged from reintroducing 10% of the fire sensitive species through to reintroduction of all fire sensitive species can be used as a lower and upper bound for potential seed requirements for bushfire recovery.

These broad values can be used by the native seed industry to assess current seed availability and collection capacity, plan for seasonal seed collection, develop capacity for biobanking in seed banks, consider climate-adjusted approaches to seed collection and maximise the likelihood of restoration success through adequate species and genetic diversity.

This report found that:

- Seedling requirements for herbaceous species ranged from 132 to 73,590 seedlings h^{-1} depending on the community type, proportion of fire sensitive species and level of reintroduction/regeneration required.
- Shrub seedling requirements ranged from 10 to 2018 seedlings h^{-1} and for trees ranged from 0 to 606 seedlings h^{-1}, with both depending on community type, proportion of fire sensitive species and level of reintroduction/regeneration required.

We recognise that there is not a one-size-fits-all approach for seedling inputs and that even within a vegetation community type and fire scar, there will be areas that span the spectrum of reintroduction/regeneration to full reconstruction.

Quantifying seedling rates is a critical step in assessing the quantity of seed required to assist bushfire recovery. Due to species specific responses, there are many complexities in understanding the amount of seed required to obtain seedling numbers for each species. Consequently, refining the quantity of seed for each community will require an assessment of the quality attributes (seed viability and germinability) of seed lots of the individual species. In tandem, site assessments will need to be conducted to estimate more precise seed and/or seedling and reintroduction/regeneration level requirements for each specific community.

For each TEC, site assessments of the priority areas (1 and 2) identified through the GIS models outlined in Activity 1.2 could be used to evaluate areas most likely to need intervention. Once these areas have been assessed and it is established that any fire sensitive species (obligate seeders) or other functional groups are missing, then facilitated regeneration could be applied to test regeneration capacity.

If these fire sensitive species (or other groups) are still not regenerating, then an assessment of the potential number of seedlings (and associated seed) required to support recovery towards a particular reference community could be undertaken. This could be done by first obtaining knowledge of the seed biology of these species (e.g., seed viability and germinability). Secondly, this information on seed biology would need to be combined with the estimated seedling addition rates and local knowledge of the vegetation community to enable the required seedling inputs to be calculated.

Vegetation communities in Australia have shown incredible resilience to the Black Summer bushfires — even communities such as rainforests that have not evolved with frequent fire. Consequently, even though it is important to consider various scenarios for post-fire reintroduction, it is possible that with facilitated regeneration, most areas will not require seed, seedling or propagule addition.

It is also likely that given enough time, many communities will re-establish and maintain a trajectory towards recovery if ongoing threats are managed. However, in some communities (e.g., rainforests) with relatively slow post-disturbance successional processes, targeted reintroduction can play a role in speeding up community recovery and counteracting ongoing threats. This is where habitat condition assessments, as well as spatial analysis, can play a role in identifying areas most likely to need management intervention.

Evidence

Refer to the full report *Bushfire impacts — How much seed will I need?* for all figures and tables.

Item/ Description	Table/Figure number	Section	File title
Figure	3.2-1	Section 3.2.1: Description	A summary of the community composition, life form and fire response of species from the Lowland Rainforest of Subtropical Australia. RS = Resprouters, OS = Obligate seeders, FS = Facultative seeders, UN = Unknown.
Table	3.2-1	Section 3.2.2: Restoration scenarios	Restoration approaches for Lowland Rainforest.

Item/ Description	Table/Figure number	Section	File title
Table	3.2-2	Section 3.2.3: Broad estimates of seedling needs	A list of the fire sensitive species (obligate seeders (OS)) from the Lowland Rainforest of Subtropical Australia TEC species list and the fire-affected species within the TEC 'likely to occur' boundary. Life form: Herbaceous (H), Shrub (S), Tree (T), Climber/Vine (C). Seed storage: Soil (S), Transient (T), Canopy (C), Unknown (UN).
Figure	3.3-1	Section 3.3.1: Description	A summary of the community composition, life form and fire response of species from the Upland Basalt Eucalypt Forest. RS = Resprouters, OS = Obligate seeders, FS = Facultative seeders, UN = Unknown.
Table	3.3-1	Section 3.3.2: Restoration scenarios	Restoration approaches for Upland Basalt Eucalypt Forest.
Table	3.3-2	Section 3.3.3: Broad estimates of seed needs	A list of the fire sensitive species (obligate seeders (OS)) from the Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion TEC species list and the fire-affected species within the TEC 'likely to occur' boundary. Life form: Herbaceous (H), Shrub (S), Tree (T). Seed storage: Soil (S), Transient (T), Canopy (C), Unknown (UN).
Figure	3.4-1	Section 3.4.1: Description	A summary of the community composition, life form and fire response of species from the Lowland Grassy Woodland. RS = Resprouters, OS = Obligate seeders, FS = Facultative seeders, UN = Unknown.

Item/ Description	Table/Figure number	Section	File title
Table	3.4-1	Section 3.4.2: Restoration scenarios	Restoration approaches for Lowland Grassy Woodland.
Table	3.4-2	Section 3.4.3: Broad estimates of seed and/or seed needs	A list of the fire sensitive species (obligate seeders (OS)) from the Lowland Grassy Woodland in the South East Corner Bioregion TEC species list and the fire-affected species within the TEC 'likely to occur' boundary. Life form: Herbaceous (H), Shrub (S), Tree (T). Seed storage: Soil (S), Transient (T), Canopy (C), Unknown (UN).
Figure	3.5-1	Section 3.5.1: Description	A summary of the community composition, life form and fire response of species from the Silurian Limestone Pomaderris Shrubland. RS = Resprouters, OS = Obligate seeders, FS = Facultative seeders, UN = Unknown.
Table	3.5-1	Section 3.5.2: Restoration scenarios	Restoration approaches of Silurian Limestone Pomaderris Shrubland.
Table	3.5-2	Section 3.5.3: Broad estimates of seed needs	A list of the fire sensitive species (obligate seeders (OS)) from the Silurian Limestone Pomaderris Shrubland of the South East Corner and Australian Alp Bioregion TEC species list and the fire-affected species within the TEC 'likely to occur' boundary. Life form: Herbaceous (H), Shrub (S). Seed storage: Soil (S), Transient (T), Unknown (UN).

Item/ Description	Table/Figure number	Section	File title
Figure	3.6-1	Section 3.6.1: Description	A summary of the community composition, life history and fire response of species from the Eastern Stirling Ranges Montane Heath and Thicket. RS = Resprouters, OS = Obligate seeders, FS = Facultative seeders, UN = Unknown.
Table	3.6-1	Section 3.6.2: Restoration scenarios	Restoration approaches of Eastern Stirling Range Montane Heath and Thicket.
Table	3.6-2	Section 3.6.3: Broad estimates of seed needs	A list of the fire sensitive species (obligate seeders (OS)) from the Eastern Stirling Range Montane Heath and Thicket TEC species list and the fire-affected species within the TEC 'likely to occur' boundary. Life form: Herbaceous (H), Shrub (S). Seed storage: Soil (S), Canopy (C), Unknown (UN).

RECOMMENDATIONS

There are several recommendations for the Strategy[1] that will utilise and extend the information presented in this report. These relate both to the seedling estimates for each community type and their specific application to the post-fire restoration of the TEC examples.

RECOMMENDATIONS

1

A coordinated program of site assessments is required to ground truth estimates of seed and/or seedling requirements for different community types.

This will enable an evaluation of whether fire sensitive species in these groups are regenerating post-fire and if a combined regeneration/reintroduction approach is appropriate and/or effective.

A coordinated approach with standardised methods will enable replication and comparison across community types (such as within the Monitoring, Evaluation and Research (MER) Network).

2

Build capacity across the sector (through access to training, infrastructure and funding) to undertake facilitated regeneration approaches alongside any seed, seedling or propagule addition.

Native species establishment is unlikely to be achieved without effective weed management.

3

Further research into the seed biology of priority species in fire-affected areas is required to enable more accurate estimates of the seed needs to facilitate restoration potential.

This also links to the need for more research into Seed Production Areas (SPAs) as a means of increasing the availability of priority species. SPA development and biobanking for fire sensitive species will require partnerships between government, academics, NGOs, land managers, community groups and practitioners.

[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

Generate and establish an open access centralised database of seed and seedling requirements for different community types to develop collective knowledge in the native seed sector.

An assessment of species composition within each TEC is required, especially post-fire.

This will provide information on recovery trajectories and enable an assessment of current seed demand as well as help to identify populations that may be used as collections in the future (e.g., for biobanking and/or SPA development).

More information on species distribution, post-fire recovery and seed biology is required for the fire-affected species within the fire scar of these TECs.

This information will enable accurate estimates of the management interventions required for these species and provide a means of establishing conservation priorities.

Landscape level conservation planning is required to assist in estimating the seed required for reconstruction to increase landscape resilience of fire-affected TECs.

This should consider how restoration may counteract current threats and processes (e.g., by increasing connectivity, gene flow or spatial extent) as well as provide insurance against future threats (e.g., increased fire frequency and intensity, climate change).

WANT TO KNOW MORE?

For further information read the full report, *Bushfire impacts — How much seed will I need?*

Related projects

- *Bushfire impacts — ArcGIS resources*
- *Bushfire impacts — A national model for assessing local landscape restoration priorities.*
- *Join the National Seed Network!*

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