

RESILIENT HILLS AND COASTS

Bushfire & Biodiversity

Part B: Spotlight Studies



“South Australia’s changing environment presents an enormous challenge to maintain a balance between bushfire mitigation with environmental conservation”.

Brett Loughlin AFSM (Chief Officer, SA Country Fire Service)

Prepared for Resilient Hills & Coasts by the Nature Conservation Society of South Australia

Acknowledgements and citation

First Nations people

Resilient Hills & Coasts partners acknowledge the traditional owners of the lands and waters of the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island. We acknowledge the deep feelings of attachment and the relationship of Aboriginal people to country and respect their ongoing custodianship.

Governance and contributions

These spotlight studies are one of three milestones (Part B), delivered by the Resilient Hills & Coasts Bushfire and Biodiversity Project. The other deliverables from this project include:

- Part A: Literature Review
- Part C: Discussion and Recommendations.

The project was governed by the Resilient Hills & Coasts Steering Committee, with additional direction provided by the project's Working and Advisory Groups (see table below). The project was managed and overseen by the Resilient Hills & Coasts Coordinator Olivia Davies, and later Jen St Jack. The table below lists the people that were involved.

Representation	Organisation or group	Person
Working Group	Adelaide Hills Council Alexandrina Council Kangaroo Island Council Mount Barker District Council District Council of Yankalilla City of Victor Harbor Southern and Hills Local Government Association Resilient Hills & Coasts Landscapes Hills and Fleurieu Landscapes Kangaroo Island Regional Development Australia Adelaide Hills, Fleurieu and Kangaroo Island	Tonia Brown and Andrew Kirkley Monika Rhodes Anna Osman Greg Sarre Corey Jackson and Amy Williams Lee Jeffery Graeme Martin Olivia Davis and Jen St Jack Che Biggs and then Caroline Dorr Will Durack Sue Arlidge
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Content development and reviews

Resilient Hills & Coasts engaged the Nature Conservation Society of South Australia (NCS) as the consultant to develop and deliver the project milestones. The NCS undertook the research and content development, with advice from the Working and Advisory Groups. The NCS worked closely with Resilient Hills & Coasts Coordinators Olivia Davies and Jen St Jack. Draft versions of all documents were provided to the Steering Committee, the Working and Advisory Groups and other stakeholders, on account of their knowledge and expertise. The following people are further acknowledged.

- The NCS Project Lead Bec Duffield and the NCS Research Team Nicole Fickling, Tessa Roberts, Elen Shute and Rhys Morgan. The NCS CEO Kirsty Bevan is appreciated for her review and QA of all deliverables.
- Graeme Martin, on behalf of the Southern and Hills Local Government Association, for auspicing the project, and for providing overarching and high-level feedback.
- Monika Rhodes (Alexandrina Council), Greg Sarre (Mount Barker District Council), Lee Jeffery (City of Victor Harbor), Olivia Davies (Resilient Hills & Coasts), Amy Williams (District Council of Yankalilla) and Aidan Galpin (Country Fire Service) for their detailed and well considered editing and commentary on the project documents.
- Jason Higham and Damon Ezis (both Department for Environment and Water) for providing feedback on the project and the spotlight studies.

All members of the Working Group and Advisory Group who attended meetings, were involved in consultation, and provided input, are sincerely appreciated.

Funding

This project received grant funding from the Australian Government.

Citation

The Nature Conservation Society of South Australia, for Resilient Hills & Coasts (2023). *Bushfire and Biodiversity Part B: Spotlight Studies*. South Australia.

Version

Version	Authors	Editing	Review and finalisation	QA and approval	Date
Working draft	Bec Duffield, Nicole Fickling, Tessa Roberts, Elen Shute	Elen Shute	Bec Duffield	Kirsty Bevan	12 March 2023
Draft 1	Bec Duffield, Nicole Fickling, Tessa Roberts and Elen Shute	Bec Duffield	Bec Duffield	RH&C Steering Committee members provided feedback	N/A
Final Draft	Bec Duffield, Nicole Fickling, Tess Roberts	Bec Duffield Kirsty Bevan	Bec Duffield 12 June 2023	Kirsty Bevan	14 June 2023
Final					15 June 2023

About Resilient Hills & Coasts

Resilient Hills & Coasts (RH&C) is a collaborative, cross-sector partnership in the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region, working to strengthen the resilience of communities, economies and natural and built environments to a changing climate.

Members of the partnership include six councils (Adelaide Hills, Alexandrina, Kangaroo Island, Mount Barker, Victor Harbor and Yankalilla); the Southern Hills Local Government Association; two Landscape Boards (Kangaroo island Landscape Board and Hills and Fleurieu Landscape Board); Regional Development Australia (RDA) Adelaide Hills, Fleurieu and Kangaroo Island; and the Government of South Australia (Resilient Hills and Coasts, 2020).

The RH&C region covers 8,752km² and includes a mixture of farming, conservation, and residential land uses, within rural, semi-rural, urban, and peri-urban settings.

Methodology for developing the Spotlight Studies

These spotlight studies are intended to provide a better understanding about issues that are related to bushfires and biodiversity. Where possible, the studies:

- Explored the subject matter and used evidence to support the key findings
- Provided real life examples
- Identified where the information is lacking, or if there are conflicting viewpoints.

Initially twenty-six options were proposed for the spotlight studies, using a template provided by NCS that considered the risk of subjectivity, the information available, and criteria for scoring each option. The RH&C Working Group selected twelve priority studies from the twenty-six provided by NCS.

The key information and subheadings to guide the development of the spotlights studies were agreed between RH&C and NCS and included a) summary; b) key findings; c) relevance to RH&C, d) adaptability and climate change; e) scalability and implementation; f) social license; g) risks; h) knowledge gaps, caveats, and assumptions; and i) potential for further work in RH&C region.

The references cited in each spotlight study are provided at the end of each study and a reference list for all spotlight studies is provided at the end of this document.

List of Spotlight Studies

1. Perceptions about roadside vegetation as a fire risk	1
2. Designing restoration projects with multiple benefits- reducing exposure to bushfire, improving biodiversity, and mitigating against climate change	8
3. The multiple functions of “best practice fire management” – addressing fuel reduction, asset protection, and biodiversity resilience	15
4. The differential exposure to bushfire hazards and engagement with bushfire preparedness activities due to socio-economic factors	22
5. Strategic bushfire preparation activities to reduce long-term biodiversity impacts	27
6. Integrating biodiversity-focused representation into incident management teams	35
7. Using community connection to nature to modify behaviours and attitudes towards fire management for biodiversity, highlighting iconic species	39
8. Integrating weed management and native grass restoration to reduce bushfire risk and improve biodiversity	45
9. Management of novel habitats – balancing fire risk and biodiversity resilience	51
10. Provision of landscaping advice to landholders and households that will consider bushfire risk reduction and biodiversity conservation.....	56
11. Managing urban and peri-urban green spaces to reduce the risk of exposure to bushfires	63
12. Educating and training landholders, households and community on best practice fire management and biodiversity – the New South Wales Hotspots Program as an exemplar	68

SUMMARY

Vegetation borders many main roads and is often the only remaining remnant vegetation for an area. Roadside vegetation is valued as critical wildlife corridors and habitat for rare and threatened plant species (Tiang et al. 2021) as well as having aesthetic and amenity benefits (Native Vegetation Council 2018). Conversely, vegetation along roadsides is often thought to present a heightened fire risk (increased fuel load) (Molina et al. 2019) and/or prevent safe access and escape during an active bushfire incident.

Whether roadside vegetation increases or decreases the risk to life, assets or biodiversity, depends on many factors. In Southern Spain, the biotic and abiotic features of the roadside vegetation, such as dominant species or morphotype, connectivity to other stands of vegetation, flammability of species or communities, overall fuel load, and weather/climatic conditions, have all been used to determine the risk or impact of fire via likelihood modelling (Molina et al. 2019).

While high levels of fine fuels may cause a high fire hazard (DENR, 2012), other types of vegetation such as native grasslands and trees also serve as important fire breaks (Walker & Morgan 2022). The roadside vegetation and bushfire cause and effect discussion is complex and dependent on various factors that are often interrelated.

Indiscriminate vegetation clearing along roadsides to lower fuel levels, is not necessarily an appropriate or effective way to completely reduce fire risk as other influencers may still be present. To address this, it is critical to educate the community on how to assess and identify risk at the site-specific level.

SPOTLIGHT STUDY 1

Perceptions about roadside vegetation as a fire risk

Key findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

Roadside vegetation may be comprised of remnant native vegetation, planted introduced or re-planted native vegetation. This spotlight study considers all types of roadside vegetation as both native and introduced vegetation can contribute to wildlife habitat (Packer et al., 2016), however, there is a greater focus on the management of native vegetation.

Managing fire risk, or perceived fire risk, of roadside vegetation may negatively impact on biodiversity asset management in several ways depending on the function and location of the vegetation. This may include: whether the roadside vegetation itself is an important or threatened plant community (Native Vegetation Council 2020); if it's connected to an area of significant conservation value (i.e., a protected area or crucial habitat for threatened species) (Molina et al. 2019); or if it is considered an important wildlife corridor (New et al. 2021; Hall et al. 2018; Carthew et al. 2013). For example, in a study assessing the value of roadside vegetation in the south-east of South Australia, the diversity of animal species was found to be similar between remnant and connected roadside vegetation (Carthew et al. 2013). The native western pygmy possum (*Cercartetus cocinnus*) was detected in remnant and roadside sites, but not on farmland sites. Lentini et al. 2012 found that microbats, within an agricultural landscape, benefited from wide linear remnants as there was more bat activity here, when compared to open agricultural fields. In addition, linear roadside vegetation is also known to provide habitat for insect (New et al. 2021) and bird (Hall et al. 2018) species.

Key findings (continued)

Maintaining native roadside vegetation may help to address undesirable and overabundant species. For example, lerp densities in South Australia (Lerp are a by-product of the larval stage of psyllid insects) are regulated by birds such as pardalotes, and reduced pardalote numbers associated with the clearance of understory in roadside vegetation has led to an increased number of lerp infestations (New et al. 2021). It is therefore important to assess the function and specific structural properties of roadside vegetation to identify its biodiversity value and manage it appropriately.

South Australia's Native Vegetation Council (NVC) 'Guidelines for the Management of Roadside Native Vegetation and Regrowth Vegetation' (2020) is a valuable resource and outlines the legal requirements of management actions. However, appropriate management actions should also be guided by knowledge of specific habitats, ecological communities, and species to enable the best outcome for fire risk reduction and the maintenance of biodiversity assets.

Risks to assets and human life from roadside vegetation is critically important, but research on this is limited. The level of risk or severity of fire impact on assets may depend on biotic and abiotic factors as well as distance to assets (Molina et al. 2019). Maintaining the appropriate "defendable" space of assets, such as houses as indicated by the CFS, local councils, and the CSIRO can help to reduce the vulnerability of assets to roadside vegetation fires. There is also increasing interest in the use of roadside trees and vegetation (both native and non-native species) as "green fire breaks" (Curran et al. 2017) – see Spotlight Study #2.

While roads improve access and egress for fire preparation and response actions, they also create risks to the public and to firefighting teams due to fallen branches/trees (Shahparvari et al. 2017). The extent of this impact will depend on the characteristics of the vegetation stand. Although the NVC (2020) states that overhanging tree limbs may be removed if they are within the primary clearance envelope (defined as the space within the shoulders of the road and up to 6m high), this does not eliminate the possibility of hindered access and egress. In Victoria, the Victorian Country Fire Authority (CFA) (2023) highlights that roads are not safe for travelling during the passage of a fire front and can still present risks after a fire. While management actions can be taken to reduce the fuel levels in roadside vegetation, the CFA emphasises that the most effective solution is to avoid travel through a fire front and to focus on planning (early road closures) and education programs (encouraging leaving early).

While there are a range of factors that contribute to the fire risk associated with roadside vegetation, mitigation actions can be taken to lessen the risk. Management actions may include, mechanical fuel load reduction e.g., reducing fine fuels and litter by hand; trimming vegetation (shrubs, tree branches/canopies); slashing or mowing vegetation; control of weed species; and prescribed burns (The Royal Commission into National Natural Disaster Arrangements, 2020b). Once the fire risk or fuel hazard has been defined and biodiversity values identified, appropriate management actions can be taken to benefit both biodiversity conservation and asset protection. It is acknowledged that this will often require a trade-off and must be based on the best information available at the time. Furthermore recent research suggests that soil moisture and fuel moisture determines fire risk (Fox-Hughes et al., 2021). There are opportunities for significant and priority roadside vegetation to be regularly hydrated to reduce the likelihood of a fire igniting in these areas.

Relevance to the Resilient Hills & Coasts (RH&C) Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

The RH&C Steering Group have noted that landholders and the wider public may perceive roadside vegetation as a fire risk despite there being negligible or contested evidence that roadside vegetation is responsible for the ignition and spread of bushfires. An Independent Review into South Australia's 2019-20 Bushfire Season (Government of South Australia, 2020) expressed concern that volunteer firefighters view roadside vegetation as a "wick for fires to burn into other areas".

It is important to have and understand the right information about roadside vegetation and fire risk; to communicate this using a common language; to convey the complexity (site, weather, and land use); and to identify best management options for the region with all stakeholders. It will become increasingly important to reinforce the Country Fire Service (CFS) advice for individuals to leave early, thus avoiding the risk of being trapped by ignited roadside vegetation. Current policy and legislation require local councils and the Department for Infrastructure and Transport (DIT) to manage general roadside native vegetation (NVC 2020). Under the Native Vegetation Act 1991 and the 'Guidelines for Management of Roadside Native Vegetation and Regrowth Vegetation' (2020), councils and the DIT can clear native vegetation according to the guidelines, or under a Roadside Management Plan approved by the NVC. These plans may be prepared by the local council or DPTI. Additional consultation and approvals from both the CFS and NVC are required for further actions such as fuel reduction and the construction of fire breaks in roadside native vegetation (NVC 2020). Further requirements for vegetation management exist around electricity supply lines: "In South Australia, the electricity network operator (SA Power Networks) is responsible for establishing and maintaining clearances around all public supply lines" (Government of South Australia 2022). Landholders and occupiers are also responsible for maintaining the clearance zone (as defined by the Electricity Act 1996) around private lines.

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (Royal Commission into National Natural Disaster Arrangements 2020), mitigation action will be necessary.

Under changing climate conditions, roadside vegetation and roadside fuel assessment, and management, will need to be adaptable to take into account different vegetation communities at different trajectories such as young re-planted native vegetation versus well-

established remnant native vegetation. Additionally, biodiversity assets such as roadside vegetation, may become increasingly important as wildlife corridors and refugia for wildlife under varying climate change scenarios (New et al. 2021; Cook-Patton et al. 2021). This highlights the importance of acknowledging and managing roadside vegetation as critical ecological assets (Alkama et al. 2022).

Social license

Roadside vegetation is often seen by the community as either the cause of a fire, or a source of fuel that will

RESILIENT HILLS AND COASTS: BUSHFIRES AND BIODIVERSITY

increase the spread of a fire into the landscape (CCSA 2023). Moskwa et al. (2018) also identified similar community perceptions through interviews, with one interviewee stating that they “have the impression that it [roadside vegetation] reduces the efficiency of the roads to act as firebreaks”. Similarly, Moskwa et al. (2018) highlights public requests to remove roadside trees following the 2015 Sampson Flat bushfire due to the perceived risk of fallen branches and trees over roads during and after fires. Dedicated education and awareness-raising will be required to increase community acceptance of retaining roadside vegetation in areas where it is known to NOT present any increased fire risk. Strategic, prioritised and appropriate management of roadside vegetation, based on standardised and accepted fuel assessments, should be undertaken, and will likely be supported by organisations such as SA Power Networks (2018) and PIRSA (2021) who have highlighted the importance of roadside vegetation management to community safety.

Risks

Roadside vegetation is a widespread form of vegetation across the landscape with a range of benefits for biodiversity and people (Carthew et al. 2013; Cook-Patten et al. 2021). However, there is valid concern regarding its role in fire spread and risk of exposure to fire in the case of a bushfire (Moswka et al. 2018). Under a changing climate, the risk of exposure to fire and of bushfires with greater severity will increase (Penman et al. 2023; Royal Commission into National Natural Disaster Arrangements 2020). Therefore, roadside vegetation needs to be well-managed and well-understood to reduce the risks and impacts on biodiversity and people (Molina et al. 2019) and is a lower-risk approach than leaving vegetation unmanaged and poorly understood. Spotlight Study 2 provides information on fire probability within cropland and agricultural settings.

Knowledge gaps, caveats and assumptions

- Although there is sufficient information on how to assess fuel load, there is a deficiency of empirical information that can conclusively confirm or refute that roadside vegetation increases or decreases fire risk. Reviewing the literature confirms that the actual risk will depend on, weather conditions (pre and during the bushfire); site conditions and features (including topography and soil moisture); and the vegetation present (density, species, age and condition).
- There are many established vegetation community and fire fuel assessment guidelines such as the ‘Overall Fuel Hazard Guide for South Australia’ (2012). Some of the research cited here was conducted outside of Australia but in similar climatic conditions (Mediterranean). Although methods of vegetation and fire fuel assessment are well known, the fire risk associated specifically with roadside vegetation has not been assessed comprehensively for the RH&C region.
- Roadside vegetation management is a shared responsibility, and various organisations already engage in management activities routinely. Data on these activities are not generally available and therefore could not be analysed for this Spotlight Study.
- The most significant knowledge gap, however, is anticipating the effects of changing conditions, and the management actions that will be sufficient or appropriate in extreme climatic conditions. Following the 2019-2020 bushfires, government officers regarded existing fire plans as insufficient for the unprecedented severity of the fires (de Bie et al. 2021).

RESILIENT HILLS AND COASTS: BUSHFIRES AND BIODIVERSITY

Further work in the Resilient Hills & Coasts region

It is acknowledged that the issue of roadside vegetation as a fire risk is important, however there is not sufficient evidence to support or refute. It is suggested that more research is required, that could study and ground-truth the various factors that determine the roadside vegetation bushfire risk, and biodiversity value, to propose an assessment tool. This assessment could be undertaken by individuals, groups or agencies and the results could also consider best practice management, and ways to manage the roadside vegetation to achieve multiple outcomes.

Using an established vegetation or fire fuel hazard assessment approach (DEWNR 2012), roadside vegetation areas could be feasibly assessed at a small scale and then scaled up across the RH&C region. Priority areas may be defined using an approach like Molina et al. (2019) who prioritised areas for management using spatial layers, historical fire records, and environmental variables such as distance to assets, altitude, slope, and location of natural assets with likelihood modelling. This also may be an opportunity to establish demonstration sites to display examples of well-managed roadside vegetation as a part of a broader education program to the public (e.g., dispelling myths).

There could also be a benefit from mapping or identifying known sites where roadside vegetation was less impacted by a recent fire, even though surrounding areas were burnt.

There is an opportunity to communicate the value of roadside vegetation, as an ecological asset, and provide a FAQ fact sheet that focuses on the value of roadside

vegetation, and the ways that people can reduce their exposure to a fire within roadsides (such as weed control, ensuring they take steps to “leave early” during a fire).

Investment required

There are costs associated with the initial assessment of fire fuel hazards along roadside vegetation stands. The amount would depend on the extent of areas of interest, and specific characteristics of stands (e.g., areas not in close proximity to assets or areas of high biodiversity conservation value will require less investment). Previous studies used existing GIS layers in combination with new monitoring efforts, which involve a significant cost (Molina et al. 2019; Hall et al. 2018). Estimated: >\$500,000.

Developing a FAQ with some site specific examples is estimated to cost between \$50,000 and \$75,000. This opportunity is considered to have the greatest potential to yield a high return on the investment.

Stakeholders

Local councils should be engaged closely and act as the primary party responsible for the maintenance of roadsides which may extend to weed control and other vegetation maintenance by organisations such as the Department of Primary Industries and Regions South Australia (PIRSA). Other landowner stakeholders include the Department of Infrastructure and Transport, SA Power Networks, Forestry SA, DEW (NPWSA) and SA Water. Landscape Boards, under the *Landscape South Australia Act 2019*, are responsible for the management of declared weeds on roadsides and are likely to be asked about roadside vegetation and fire risk.

References

- Alkama, R., Forzieri, G., Duveiller, G., Grassi, G., Liang, S., & Cescatti, A. (2022). Vegetation-based climate mitigation in a warmer and greener World. *Nature Communications*, 13(1), 606. <https://doi.org/10.1038/s41467-022-28305-9>
- Carthew, S. M., Garrett, L. A., & Ruykys, L. (2013). Roadside vegetation can provide valuable habitat for small, terrestrial fauna in South Australia. *Biodiversity and Conservation*, 22(3), 737–754. <https://doi.org/10.1007/s10531-013-0445-0>
- Cook-Patton, S. C., Drever, C. R., Griscom, B. W., Hamrick, K., Hardman, H., Kroeger, T., Pacheco, P., Raghav, S., Stevenson, M., Webb, C., Yeo, S., & Ellis, P. W. (2021). Protect, manage and then restore lands for climate mitigation. *Nature Climate Change*, 11(12), 1027–1034. <https://doi.org/10.1038/s41558-021-01198-0>
- Country Fire Authority (Victoria) (CFA). (2023). Roadside Fire Management Guidelines. Viewed 18 February 2023 <https://www.cfa.vic.gov.au/ArticleDocuments/530/roadside_guide.pdf.aspx?Embed=Y>
- Curran, T., Perry, G., Wyse, S., & Alam, M. (2017). Managing Fire and Biodiversity in the Wildland-Urban Interface: A Role for Green Firebreaks. *Fire*, 1(1), 3. <https://doi.org/10.3390/fire1010003>
- de Bie, K., Currey, K., Woinarski, J., Wintle, B., Garnett, S., & Rumpff, L. (2021). Protecting threatened species and ecological communities before and during bushfire: Learning from the 2019–20 fires (Project 8.5.1). NESP Threatened Species Recovery Hub.
- Department of Environment and Natural Resources (DENR). (2012). Overall Fuel Hazard Guide for South Australia.
- Department of Primary Industries and Regions (PIRSA). (2021). Manual for Roadside Weed Management in South Australia.
- Fox-Hughes, P., Yebra, M., Shokirov, S., Dowdy, A., Delage, F., & Zhang, H. (2021). Soil and fuel moisture precursors of fire activity during the 2019-20 fire season, in comparison to previous seasons. Bushfires and Natural Hazards CRC, Melbourne.
- Government of South Australia. (2022). Vegetation near powerlines. Viewed 17 February 2023 <<https://www.sa.gov.au/topics/energy-and-environment/using-electricity-and-gas-safely/powerline-safety/vegetation-clearance-near-powerlines>>
- Hall, M., Nimmo, D., Watson, S., & Bennett, A. F. (2018). Linear habitats in rural landscapes have complementary roles in bird conservation. *Biodiversity and Conservation*, 27(10), 2605–2623. <https://doi.org/10.1007/s10531-018-1557-3>
- Molina, J. R., Lora, A., Prades, C., & Rodríguez y Silva, F. (2019). Roadside vegetation planning and conservation: New approach to prevent and mitigate wildfires based on fire ignition potential. *Forest Ecology and Management*, 444, 163–173. <https://doi.org/10.1016/j.foreco.2019.04.034>
- Moskwa, E., Bardsley, D. K., Weber, D., & Robinson, G. M. (2018). Living with bushfire: Recognising ecological sophistication to manage risk while retaining biodiversity values. *International Journal of Disaster Risk Reduction*, 27, 459–469. <https://doi.org/10.1016/j.ijdrr.2017.11.010>
- Native Vegetation Council (NVC). (2020). Guidelines for the Management of Roadside Native Vegetation and Regrowth Vegetation.
- New, T. R., Sands, D. P. A., & Taylor, G. S. (2021). Roles of roadside vegetation in insect conservation in Australia. *Austral Entomology*, 60(1), 128–137. <https://doi.org/10.1111/aen.12511>
- Packer, J. G., Delean, S., Kueffer, C., Prider, J., Abley, K., Facelli, J. M., & Carthew, S. M. (2016). Native faunal communities depend on habitat from non-native plants in novel but not in natural ecosystems. *Biodiversity and Conservation*, 25(3), 503–523. <https://doi.org/10.1007/s10531-016-1059-0>
- Penman, T., Clarke, H., Gibson, R., Collins, L., & Nolan, R. (2023). The 2019–20 Australian wildfires: Precursors, characteristics and implications for the future. In Australia's Megafires: Biodiversity Impacts and Lessons from 2019-2020: Vol. Chapter 2. CSIRO Publishing. <https://doi.org/10.1071/9781486316656>
- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.
- SA Power Networks. (2018). Protocol for vegetation management near powerlines 2019-2021.
- Shahparvari, S., Abbasi, B., & Chhetri, P. (2017). Possibilistic scheduling routing for short-notice bushfire emergency evacuation under uncertainties: An Australian case study. *Omega*, 72, 96–117. <https://doi.org/10.1016/j.omega.2016.11.007>
- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.
- Tiang, D. C. F., Morris, A., Bell, M., Gibbins, C. N., Azhar, B., & Lechner, A. M. (2021). Ecological connectivity in fragmented agricultural landscapes and the importance of scattered trees and small patches. *Ecological Processes*, 10(1), 20. <https://doi.org/10.1186/s13717-021-00284-7>
- Walker, Z. C., & Morgan, J. W. (2022). Perennial pasture grass invasion changes fire behaviour and recruitment potential of a native forb in a temperate Australian grassland. *Biological Invasions*, 24(6), 1755–1765. <https://doi.org/10.1007/s10530-022-02743-4>

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

The Spotlight Studies were produced by the Nature Conservation Society South Australia (2023) under the Resilient Hills & Coasts Bushfire and Biodiversity Project. This project received grant funding from the Australian Government. The work was overseen by the Resilient Hills & Coasts Working and Advisory Groups, comprising representatives from Adelaide Hills Council, Alexandrina Council, Kangaroo Island Council, Mt Barker District Council, District Council of Yankalilla, City of Victor Harbor, SA State Emergency Service, SA Country Fire Service, Department for Environment and Water, Landscapes Hills and Fleurieu, Landscapes Kangaroo Island, Regional Development Australia (Adelaide Hills, Fleurieu and Kangaroo Island), Southern & Hills LGA, and Resilient South.



We acknowledge and respect the ongoing cultural and spiritual connection that First Nations people have with their country, and their commitment to its stewardship for future generations.

SUMMARY

Revegetation and restoration projects can be designed to benefit biodiversity and mitigate against climate change via carbon sequestration, while also contributing to reducing bushfire risk.

Many non-native species are known to increase fuel loads or the spread of fire, increasing the associated risk of exposure to fire (Setterfield et al., 2013; Ehrenfeld, 2010). There is also concern that revegetation and restoration projects will increase the risk of exposure to bushfires (Jellinek et al. 2013).

Review of the relevant literature indicates that although revegetation activities may increase the available fuel load, it does not fundamentally increase the risk of exposure to bushfires.

SPOTLIGHT STUDY 2

Designing restoration projects with multiple benefits - reducing exposure to bushfire, improving biodiversity, and mitigating against climate change

Key Findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

Revegetation for biodiversity/habitat

Revegetation and restoration projects to replace or improve habitat for biodiversity and improve landscape health are common and widespread, particularly in the Mount Lofty Ranges where approximately 90% of original woodland habitat has been removed or modified (Szabo et al. 2011). Several research papers were identified that assessed the fire risks associated with revegetation projects in agricultural areas (pasture and cropland) (Collins et al. 2013, 2015; Jenkins et al. 2019).

Collins et al. (2013, 2015) used fire simulation models (Phoenix) to examine the effects of planting/revegetation area in southeastern Australia (west of Sydney) and proximity to assets, on the probability of a bushfire affecting assets. They found that the probability of fire in a revegetation plot reaching assets depended substantially on the distance to the asset as well as the biomass of adjacent pasture/cropland. The risk of exposure to embers was also assessed, and the modelling by Collins et al. (2013) suggested that at distances greater than 270 m the risk to assets was minimal. Overall, the planting area had only a small effect on fire size and no effect on fire intensity.

Jenkins et al. (2019) investigated whether planting size (large versus small, e.g., 100 m x 100 m versus 10 m x 10 m) or configuration

Key findings (continued)

(linear versus block plantings) had an impact on landscape fire risk. They found similar results where pasture fuel loads had a stronger influence when compared to the planting.

The studies by Collins et al. (2013; 2015) and Jenkins et al. (2019) all discussed that while revegetation may pose a greater risk of fire within the canopy (crown fires), stands of revegetation may also intercept wind (slowing down the rate of spread), and generally have a lower rate of spread compared to pastures, and may reduce radiant heat that can cause further ignition of fuels. Therefore, there may be pros and cons of revegetation projects in relation to fire risk, but revegetation as green firebreaks may be worth exploring (see section on green firebreaks ‘Revegetation for fire breaks’ below).

Carbon farming

With growing interest in carbon farming to reduce carbon dioxide in the atmosphere, offset carbon dioxide emissions, or restore areas of unproductive land, the fire risks associated with these plantings should be considered. As there are different motivations behind carbon farming, there are also different types: those focused on biodiversity values (e.g., grassy, or shrubby woodlands), and those focused on carbon forestry (e.g., plantations) (DEWNR 2017). Each may present its own challenges when considering the risk of fire. Biodiversity-focused plantings will face similar risks and challenges as laid out in the above section (revegetation for biodiversity/habitat), while plantation-style carbon farming may present different risks that are less understood and potentially with reduced biodiversity value (<https://data.environment.sa.gov.au/Economy/Pages/Carbon-Farming.aspx>).

Revegetation for fire breaks

Targeted revegetation for effective “green fire breaks” is an emerging concept. Green fire breaks are areas that have been strategically planted, with low flammability and low fire risk species, to reduce the impact of a fire on people, assets, and infrastructure. They have been used extensively in China and are gaining interest in many countries susceptible to bushfires such as Australia. There is little experimental information regarding their effectiveness, but it is a growing field (Curran et al. 2017).

A New Zealand-based study assessing the plant flammability of 60 tree and shrub shoots is one of few experimental studies conducted around the effectiveness of green fire breaks (Wyse et al. 2016). Wyse et al. (2016) highlighted that their findings were similar to a qualitative review of “expert opinion”, that was sourced from a study survey. Notably, the most flammable plant in their study was the invasive shrub and Weed of National Significance, Gorse (*Ulex europaeus*), which is also present in the RH&C region. Green firebreaks are standard practice in China and there are several examples of their success. One of the documented examples was a wildfire in Guangdong province where a 10 m wide green firebreak assisted reducing the spread of a high-intensity fire (Cui et al., 2019). The trees in the green firebreak recovered a year later. Cui et al. (2019) also provide a useful framework for the selection of firebreak species (Figure 1).

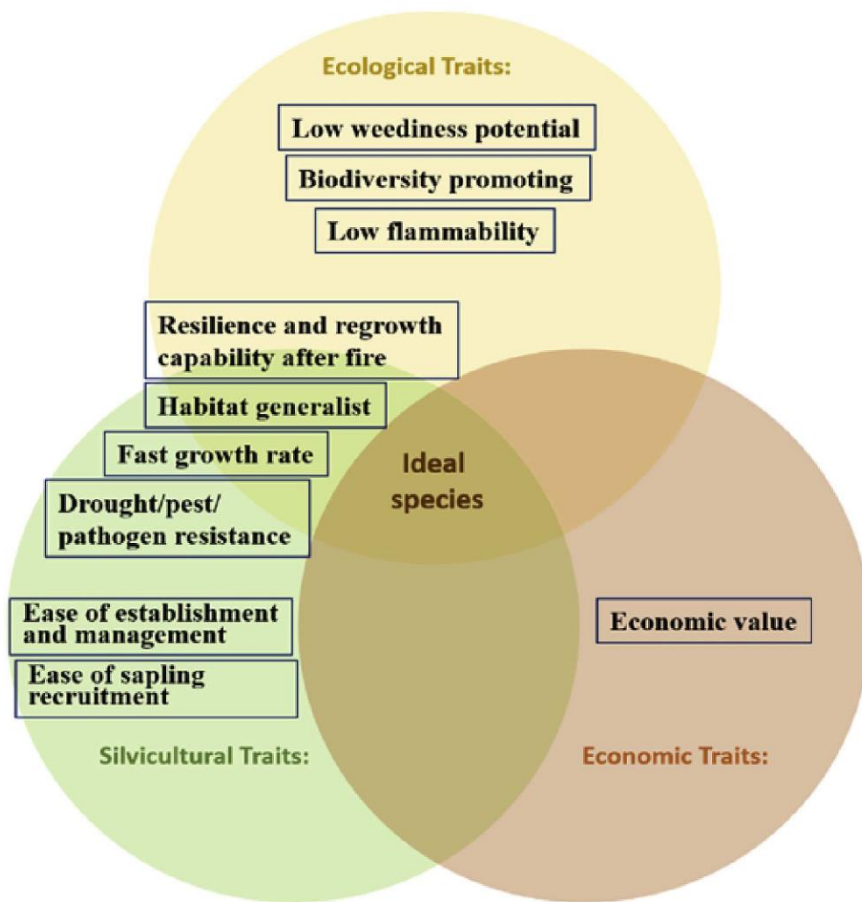


Figure 1: Framework developed by Cui et al. (2019) to select species for green firebreak plantings.

Low-flammability plants are key to green firebreaks, and Murray et al. (2018) have developed a procedure for selecting plants in an urban setting that may contribute to biodiversity and community needs while also decreasing fire risk (Figure 2). While this study provides an excellent tool to guide species selection, and the associated challenges (such as competing interests), it is not specific to a region or country and the authors acknowledge that it can be modified to suit site specific needs. The South Australian Sustainable Landscapes project was a demonstration and educational initiative that focused on suitable design and management of gardens and parks, and it produced guidelines to reducing fire risk in gardens. This is an excellent resource as it provides information about fire ecology and bushfires, and recommends landscaping and planting approaches to minimise fire risk – see [here](#). Similarly, the Adelaide Hills Council, South Australia, developed a guide to locally native plants with low flammability for urban and peri-urban gardens (Adelaide Hills Council, n.d.). Green fire breaks may also be used on larger scales as has been done in the United States (Curran et al. 2017) and China (Cui et al. 2019), as well as in smaller urban garden settings. However, it should be noted that green firebreak plantings are not a complete substitute for restoration and are not intended to replace native ecosystems but rather provide a strategic management option. Green firebreaks may function in combination with native ecosystems and will still require continued management.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

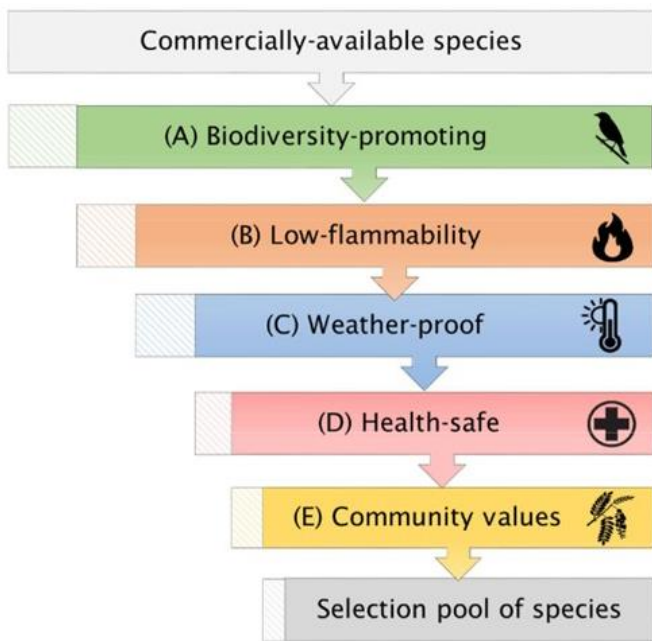


Figure 2. A process of selecting plant species with resilient characteristics for gardens in fire-prone regions at the “urban-wildland interface”, source: Murray et al. (2018).

Relevance to the Resilient Hills & Coasts (RH&C) Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

Worldwide, we are facing a biodiversity and climate crises. To address this, and the historical clearing of native vegetation for housing and farming, there is an increased commitment towards revegetating or restoring landscapes. Revegetation initiatives in the RH&C region are critical for landscape health due to the modification and fragmentation of habitat within the Mount Lofty Ranges, Fleurieu Peninsula and Kangaroo Island. Revegetation projects may have different primary goals such as carbon sequestration, aesthetic improvements, improving soil health and condition, the restoration of habitat, emission reduction activities, or for green firebreaks. However, there could also be community and agency concern that these revegetation projects may increase the risk or exposure of people and assets to bushfires due to increased fuel loads.

Scalability and implementation

Using an established vegetation or fire fuel hazard assessment approach (DENR 2012), an initial revegetation assessment should be feasible to implement across the RH&C region. Green firebreak areas could be defined according to the location of assets and areas of high

biodiversity conservation value, similar to the approach by Molina et al. (2019). Ongoing maintenance and management actions should be considered when assessing feasibility, but, if planned adequately revegetation projects could be successful in meeting multiple objectives.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (Royal Commission into National Natural Disaster Arrangements 2020), mitigation action will be necessary. However, in the context of fire, climate can heavily influence the outcomes regardless of management. Collins et al. (2013; 2015) and Jenkins et al. (2019) both highlighted that the weather/forest fire danger index had strong effects on the fire severity and risk in their simulations, often stronger than the focus predictors such as vegetation size/configuration. Selecting suitable species, and the likelihood of them surviving, will rely on using the limited information that is available. There are other considerations for species selection that includes; likelihood of survival in context of a warming and drying climate; site suitability such as location and setting; potential environmental threats (such as becoming a weed or over abundant species); habitat value or replacement of critical habitat; and life span as shorter lived species may increase fuel load.

Social license

Due to the extent of revegetation and restoration projects occurring across the region, designing them to have multiple outcomes is likely to be supported and approved by the community. Surveys conducted in other fire-prone regions of Victoria, Australia (Wimmera and Benalla) suggest that, although residents and landowners perceive that remnant and revegetation increases fire risk, they also appreciate their benefits (increased habitat connectivity and presence of native animals, aesthetic value, and reduced wind damage; Jellinek et al. 2013).

Risks

Implementation of revegetation and restoration projects is due to a range of motivations - primarily to restore and

increase habitat and biodiversity, and sequester carbon. As highlighted by Collins et al. (2015) “increased fuel biomass associated with increased native woody vegetation coverage will not unequivocally result in an increased fire size or intensity”. Therefore, all revegetation or restoration projects should not be assumed to increase the risk of exposure to fire, but be assessed on a case-by-case basis. Conversely, poorly planned and executed revegetation projects, including green fire breaks, could be unsuccessful. Another potentially perverse risk of implementing revegetation as a green fire break is if landowners then fail to undertake other fire preparation work as recommended by SA’s Country Fire Service (CFS). Similarly, the risk of carbon off-set plantings (those aiming to sequester carbon) to result in continued/increased greenhouse gas emissions, and therefore further worsened climatic and fire conditions should be considered (Calel et al. 2021).

The level of risk will depend on the planning and resources that are invested, and the evidence-based information that is available. The risk is high if generic principles are applied to revegetation and restoration, and site-specific factors are excluded. In contrast, a well-planned and evidence-based approach will have a lower risk but potentially higher cost, however this is still a good return on investment.

Knowledge gaps, caveats and assumptions

Though they provide valuable insights, many of the studies cited here used simulations. There are limited field experimental studies on the effects of revegetation/restoration on the risk or severity of bushfires. Some specific gaps and assumptions include:

- The field experiments that do exist are mostly in China and do not represent the Resilient Hills & Coasts landscape, local weather (hot and dry summers), or how bushfires behave in a Mediterranean climate.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

- Vegetation is dynamic. The simulations and models used in the above studies only assess the risk of exposure or severity of fire at a single point in time. Young stands of revegetation compared to mature stands may present different levels of risk of exposure and severity.

Further work in the Resilient Hills & Coasts region

A restoration framework for specific landscape settings within RH&C, that focusses on green fire breaks, but with consideration of biodiversity and climate change, could be developed. This would require a more detailed critique and synthesis of existing information and studies, and inclusion of new projects. An example of new projects includes; the Foundation for National Parks and Wildlife “Firewise” project (see [here](#)); and FLARES wildfire research “Green Firebreaks” (see [here](#)). Once this restoration framework is available and has been peer reviewed, there is an opportunity to establish demonstration sites that represent different circumstances (rural, urban and peri-urban) and are supported with user friendly communication material such as signage and QR codes (see the Barossa Bush gardens fire wise gardens as an example [here](#)).

Investment required

The investment required for developing and implementing a low risk (well-planned and evidence-based) restoration framework will depend on the scale, scope and objective. A research project as outlined, is estimated to cost between \$75,000 to \$100,000.

Piloting a revegetation initiative, as a demonstration site, to meet multiple objectives (including green fire breaks) is estimated to cost between \$100,000 and \$150,000 with communication material estimated at \$25,000 to \$50,000. The cost will need to be determined after developing the restoration framework as it will depend on scale and scope.

Key stakeholders

Researchers, environmental non-government organisations, CFS, local and state government – with a biodiversity and fire management focus, restoration practitioners and volunteer groups, and landholders.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

References

- Adelaide Hills Council (n.d). Native Habitat Gardening Guide for low flammability gardens [ENVIRONMENT-Low-Flammability-species_2020.pdf \(ahc.sa.gov.au\)](#)
- Calel, R., Colmer, J., Dechezleprêtre, A., & Glachant, M. (2021). Do Carbon Offsets Offset Carbon? SSRN Electronic Journal. <https://doi.org/10.2139/ssrn.3950103>
- Collins, L., Penman, T. D., Price, O. F., & Bradstock, R. A. (2015). Adding fuel to the fire? Revegetation influences wildfire size and intensity. *Journal of Environmental Management*, 150, 196–205. <https://doi.org/10.1016/j.jenvman.2014.11.009>
- Collins, L., Penman, T. D., Price, O. F., & Bradstock, R. A. (2013, December). Will environmental revegetation increase the threat wildfire poses to assets? Piantadosi, J., Anderssen, R.S. and Boland J. (Eds) MODSIM2013, 20th International Congress on Modelling and Simulation. 20th International Congress on Modelling and Simulation (MODSIM2013). <https://doi.org/10.36334/modsim.2013.A3.collins>
- Cui, X., Alam, M. A., Perry, G. L.W., Paterson, A. M., Wyse, S. V., & Curran, T. J. (2019). Green firebreaks as a management tool for wildfires: Lessons from China. *Journal of Environmental Management*, 233, 329–336. <https://doi.org/10.1016/j.jenvman.2018.12.043>
- Curran, T., Perry, G., Wyse, S., & Alam, M. (2017). Managing Fire and Biodiversity in the Wildland-Urban Interface: A Role for Green Firebreaks. *Fire*, 1(1), 3. <https://doi.org/10.3390/fire1010003>
- Department of Environment, Water and Natural Resources (DEWNR). (2017). Guide to carbon planting in South Australia – Report.
- Ehrenfeld, J.G. (2010). Ecosystem consequences of biological invasions. *Annual Review of Ecology, Evolution, and Systematics*, 41, 59-80. <https://doi.org/10.1146/annurev-ecolsys-102209-144650>
- Jellinek, S., Parris, K. M., Driscoll, D. A., & Dwyer, P. D. (2013). Are incentive programs working? Landowner attitudes to ecological restoration of agricultural landscapes. *Journal of Environmental Management*, 127, 69–76. <https://doi.org/10.1016/j.jenvman.2013.04.034>
- Jenkins, M., Price, O., Collins, L., Penman, T., & Bradstock, R. (2019). The influence of planting size and configuration on landscape fire risk. *Journal of Environmental Management*, 248, 109338. <https://doi.org/10.1016/j.jenvman.2019.109338>
- Molina, J. R., Lora, A., Prades, C., & Rodríguez y Silva, F. (2019). Roadside vegetation planning and conservation: New approach to prevent and mitigate wildfires based on fire ignition potential. *Forest Ecology and Management*, 444, 163–173. <https://doi.org/10.1016/j.foreco.2019.04.034>
- Murray, B., Martin, L., Brown, C., Krix, D., & Phillips, M. (2018). Selecting low-flammability plants as green firebreaks within sustainable urban garden design. *Fire*, 1(1), 15. <https://doi.org/10.3390/fire1010015>
- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.
- Szabo, J. K., Vesk, P. A., Baxter, P. W. J., & Possingham, H. P. (2011). Paying the extinction debt: Woodland birds in the Mount Lofty Ranges, South Australia. *Emu - Austral Ornithology*, 111(1), 59–70. <https://doi.org/10.1071/MU09114>
- Wyse, S. V., Perry, G. L. W., O’Connell, D. M., Holland, P. S., Wright, M. J., Hosted, C. L., Whitelock, S. L., Geary, I. J., Maurin, K. J. L., & Curran, T. J. (2016). A quantitative assessment of shoot flammability for 60 tree and shrub species supports rankings based on expert opinion. *International Journal of Wildland Fire*, 25(4), 466. <https://doi.org/10.1071/WF15047>

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We acknowledge and respect the ongoing cultural and spiritual connection that First Nations people have with their country, and their commitment to its stewardship for future generations.

SUMMARY

“Best practice fire management” that considers fire risk from multiple viewpoints may be able to appropriately reduce fire fuels while maximising asset protection and biodiversity resilience. Currently, there are many guidelines and information resources that claim to be “best practice” but are only considerate for certain contexts (e.g., fuel reduction only).

As defining “best practice fire management” is a complex challenge, Driscoll et al. (2010) developed a decision theory framework to help fire managers to choose the best actions to meet multiple objectives, i.e., reducing fire fuel near assets while not impacting local biodiversity or threatened species.

This approach would require substantial collaboration across organisations/groups, government sectors, and community to be effective.

SPOTLIGHT STUDY 3

The multiple functions of “best practice fire management” – addressing fuel reduction, asset protection, and biodiversity resilience

Key Findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

“Best practice” and intentions

“Best practice fire management” aims to use scientifically-supported management actions to address fuel reduction, asset protection, and biodiversity resilience in the face of bushfires. The intention of defining best practice fire management is to provide national, state, and local governments, fire authorities, landholders, and residents with clear and trusted information so they have confidence that information is based on the most up to date learnings.

It has been suggested that a best practice fire management system will have six characteristics: 1) protect community assets, human values, and biodiversity assets; 2) minimise negative long-term environmental impacts; 3) minimise risk to firefighters; 4) be adaptive and based on credible science; 5) include publicly available monitoring of outcomes; and 6) have community and political support (adapted from Underwood 2005). A review of South Australian context-specific information did not find a explicitly defined best practice fire management approach, although it is

arguably implied in existing fire management strategies and guidelines. Despite this, there is still extensive use of the term best practice across various fire management resources and communication material.

Some examples of information resources that use the term best practice include the Australasian Fire Authorities Council (AFAC) ‘National Guidelines for Prescribed Burning Strategic and Program Planning’ (2017), the ‘Ecological Fire Management Guidelines for Native Vegetation in South Australia’ (DEWNR 2013), and the ‘Bushfire Best Practice Guide’ from the CSIRO

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(2023). While these are all useful resources, each document has a different management focus. For example, the AFAC 'National Guidelines' focus on prescribed burning as a fuel management technique, while the CSIRO guide concentrates on the smaller-scale of homes and gardens. Therefore, there is a knowledge and information gap on what best practice is when taking a holistic view of the potential actions (e.g., vegetation management, nature conservation as well as prescribed burns) and multiple management goals of fuel reduction and biodiversity resilience at a regional scale.

First Nations fire management

First Nations fire management practices should also be considered when developing and implementing best practice fire management. A prime example of this can be seen in the Northern Territory where Indigenous community-based ranger groups work with pastoralists, private conservation groups, and other park ranger groups to combine traditional knowledge and western science (Fisher & Altman 2020). This article, titled "The world's best fire management system is in Northern Australia, and its led by Indigenous land managers" argues that fire management, led by the Indigenous community over 20 years, effectively reduced the annual area burned, and subsequently decreased greenhouse gas emissions. (Fisher & Altman 2020). While fire management in the tropical savanna of the Northern Territory requires a specific approach, the combination of First Nations fire management practices with western science may be valuable in many South Australian contexts. Refer to literature review "A literature review on Bushfires and Biodiversity – supporting resilience and informed decision making, Resilient Hills & Coasts region".

Balancing priorities

Driscoll et al. (2010) addressed the challenge of balancing "competing" management objectives in fire management, identifying there are often multiple objectives that may be relevant at a single time, for example, reducing available fuels in large areas of native vegetation and ensuring that appropriate fire regimes are maintained for biodiversity. Driscoll et al. (2010) highlighted that the impact of different management actions on biodiversity and asset protection is variable. For example, prescribed fires within designated zones (i.e., asset-protection or buffer zones), may substantially reduce the risk of unplanned bushfires close to assets. However, depending on the location and characteristics of the zone and the area surrounding the zone, the burn could have positive or negative effects on biodiversity. If the vegetation in the asset-protection or buffer zone is part of a small patch of remnant vegetation, which is often the case surrounding housing developments, frequent burning in this area may be detrimental to species (Driscoll et al. 2010). It was noted that the impact could be less detrimental if the vegetation has good connectivity or is part of a large patch of vegetation (e.g., a large conservation park). The complexity and ambiguity of land and fire management to balance asset protection and biodiversity was similarly documented through the literature review conducted by the Royal Commission into National Natural Disaster Arrangements (2020).

To address the challenge of multiple, and possibly conflicting objectives, Driscoll et al. (2010) developed a decision theory framework (Figure 1). This framework is designed to "identify the most effective suite of management actions" for a particular situation based on cost-benefit, associated uncertainty, and constraints experienced by managers. Once the objectives are clearly defined, managers can use a quantitative or qualitative approach to assess the most effective or well-balanced action that meets the objectives. This highlights that best practice fire management cannot be minimal actions based on blanket rules, but is instead a dynamic process of critical decision-making whilst being adaptive. The framework also provides opportunities to balance both asset protection and biodiversity objectives in fire management. Similar decision

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

and management frameworks are used by the Department for Environment and Water (DEW) and National Parks and Wildlife SA (NPWSA), such as the ‘Ecological Fire Management Guidelines For Native Vegetation in South Australia’ which guides action for asset protection, buffer, and conservation zones (DEWNR 2013).

To apply this decision-making framework (figure 1), Driscoll et al. (2010) highlights the need for knowledge on “the effectiveness of the full range of management actions in protecting assets; and the influence of those management actions on biodiversity”. This is where the fundamental knowledge of fire management is needed and where resources from organisations such as DEW, the National Council for Fire and Emergency Services, and academic research is crucial.

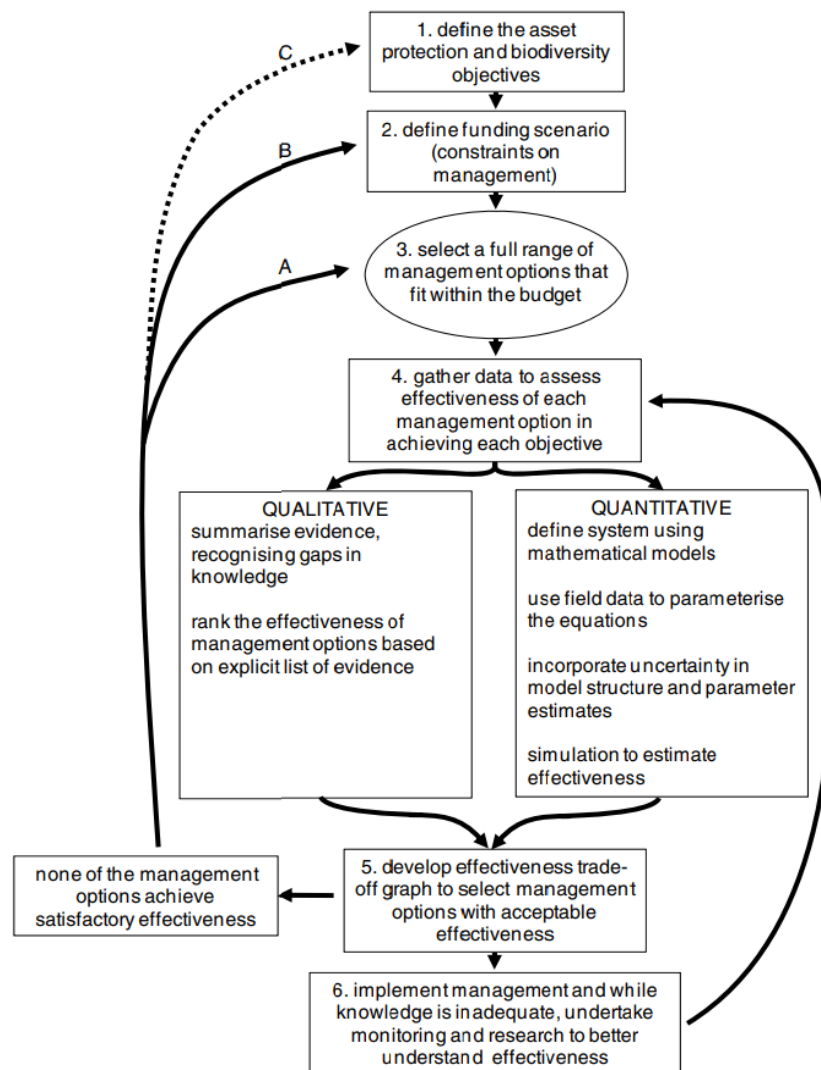


Figure 2 Conceptual flow of logic for implementing decision theory. If none of the management options are satisfactory, there are three routes (A-C) to seek a resolution, source: Driscoll et al. (2010)

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

Small-scale fire management

At a smaller scale, there is substantial information available regarding fire management addressing fuel reduction, asset protection, and biodiversity resilience. For example, the CSIRO (see [here](#)) Country Fire Service South Australia (CFS) (see [here](#)), and Country Fire Authority Victoria (CFA) (see [here](#)) have information on how landholders and residents can reduce their fire risk while also maintaining biodiversity assets. At a property scale, implemented by landholders, best practice fire management could include fire-wise landscaping and building design (see Spotlight Study #11), native vegetation management, and prescribed burns.

Relevance to the Resilient Hills & Coasts Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor. The consideration of small patch sizes due to mixed land use types is particularly important in management in the Adelaide Hills and Fleurieu Peninsula.

As a region with significant bushfire risk, ensuring that all stakeholders are aware of, agree and understand best practice fire management is crucial to reducing the risk of human and asset exposure to bushfires and enhancing biodiversity resilience. But firstly, the project should explore and agree on the definition for best practice fire management (and for what outcome/s) as it can mean different things to different people. Best practice fire management can be a key pillar for effectively reducing fire fuels, maximising asset protection, and maintaining biodiversity resilience.

Scalability and implementation

The implementation and scalability of best practice fire management across the RH&C landscape is feasible. Although it will take some initial research, knowledge, and resource development, building upon established frameworks and management practices will allow the integration of new approaches. The Department of Environment and Water and NPWS, for example, currently undertake prescribed burns (for ecological and fuel reduction purposes) and vegetation management to maximise biodiversity resilience and reduce the impact of fires (DEW 2020). These management activities are largely limited to conservation parks and surrounding areas, but expanding similar practices on private land should be feasible given appropriate support and

investment from a range of stakeholders. The decision theory framework developed by Driscoll et al. (2010) may require some adaptation for a RH&C setting, however it is considered a viable task and lends itself well to scalability and implementation in different scenarios. This framework is also useful for assessing who the users of this tool could be, and what knowledge gaps they currently have.

It should also be emphasised that management actions are often directed by organisational and agency guidelines and policy. Best practice management and the associated objectives require relevant and robust policies to be in place at various levels of administration.

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (The Royal Commission into National Natural Disaster Arrangements, 2020a), mitigation action will be necessary. However, in the context of fire, climate can heavily influence the outcomes regardless of management.

As South Australia's weather continues to change, communities and agencies can expect more frequent bushfires and the trade-off between protection of life and property and biodiversity will continue to be contentious. An evidence based, dynamic and adaptable framework will be important to reduce the impacts from bushfires and address disparate perspectives. An adaptive management framework that considers ongoing climate change implications will enable better decisions along with the implementation of best practice management.

Social license

Understanding and applying best practice management is likely to be supported by the community, landholders and relevant agencies. The key will be developing fit for purpose messaging and guidelines around best practice fire management that addresses community and household values, priorities and knowledge gaps.

Risks

In the absence of best practice fire management, on-ground management activities may result in adverse outcomes for asset protection and biodiversity. For example, if the ecology of a particular system is not well-understood, prescribed burns for hazard reduction for nearby assets may not be as effective as anticipated. Similarly, if the ecology of a natural system is not considered or well-understood, prescribed burns may result in further decline of threatened species (Santos et al. 2022).

Knowledge gaps, caveats, and assumptions

As identified by Driscoll et al. (2010) and the Royal Commission into National Natural Disaster Arrangements (2020), there are substantial knowledge gaps regarding best practice fire management. While some of these may be addressed through tools such as the decision theory framework, others remain fundamental knowledge gaps.

For example, the Royal Commission highlighted knowledge gaps about the required area for prescribed burns to substantially reduce risk to assets (see Spotlight Study #12), the effectiveness of mechanical fuel load reduction, and the uncertainty of these management actions on threatened and non-threatened species and ecological communities.

While DEW and NPWS aim to balance both asset protection and biodiversity priorities, these are generally restricted to conservation zones and surrounding areas (DEW 2020).

Although there is some research and information that specifically addresses best practice fire management and ecological assets, public access to this information is limited. Contemporary fire management information may be readily available to some organisations but is probably less accessible to others including local councils and households.

The issue of information inaccessibility has been notably highlighted by the Royal Commission into National Natural Disaster Arrangements (2020) and de Bie et al. (2021). See Spotlight Study #6 for further information on the knowledge gaps around managing fire for biodiversity resilience.

Investment required

A review and co-development of best practice fire management guidelines, for multiple outcomes, could be co-designed with key stakeholders <\$100,000. A secondary and subsequent investment would use these guidelines to implement pilot demonstration sites, or,

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

identify existing sites that satisfy the scope of the best practice fire management for multiple outcomes, and share this information with community and households – estimated investment \$100,000 to \$150,000.

Key stakeholders

This project includes almost all stakeholders due to the multi-faceted nature of fire management. Key stakeholders may include the First Nations groups, CFS,

DEW, NPWS, local fire prevention officers and biodiversity-focused staff, elected members, landholders, local communities, state office-holders such as the Minister for Climate, Environment and Water, researchers and on-ground practitioners.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

References

- Australasian Fire and Emergency Services Authorities Council (2017) National Guidelines for Prescribed Burning Strategic and Program Planning.
- CSIRO Research (2023) Bushfire best practice guide. Viewed 21 January 2023, <<https://research.csiro.au/bushfire/>>
- de Bie, K., Currey, K., Woinarski, J., Wintle, B., Garnett, S., & Rumpff, L. (2021). Protecting threatened species and ecological communities before and during bushfire: Learning from the 2019–20 fires (Project 8.5.1). NESP Threatened Species Recovery Hub.
- Department for Environment and Water. (2020). Managing Native Vegetation: How to reduce the impact of bushfire and the steps you need to take.
- Department of Environment, Water and Natural Resources (DEWNR). (2013). Ecological Fire Management Guidelines for Native Vegetation in South Australia—First Edition. <<https://cdn.environment.sa.gov.au/environment/docs/ecological-fire-management-guidelines-native-vegetation-gen.pdf>>
- Driscoll, D. A., Lindenmayer, D. B., Bennett, A. F., Bode, M., Bradstock, R. A., Cary, G. J., Clarke, M. F., Dexter, N., Fensham, R., & Friend, G. (2010). Resolving conflicts in fire management using decision theory: Asset-protection versus biodiversity conservation. *Conservation Letters*, 3(4), 215–223.
- Fisher R., & Altman, J. (2020) The world’s best fire management system is in northern Australia, and it’s led by Indigenous land managers. The Conversation. Viewed on 21 February 2023 <<https://theconversation.com/the-worlds-best-fire-management-system-is-in-northern-australia-and-its-led-by-indigenous-land-managers-133071>>
- Santos, J. L., Hradsky, B. A., Keith, D. A., Rowe, K. C., Senior, K. L., Sitters, H., & Kelly, L. T. (2022). Beyond inappropriate fire regimes: A synthesis of fire-driven declines of threatened mammals in Australia. *Conservation Letters*. <https://doi.org/10.1111/conl.12905>
- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.
- Underwood, R. (2005) Barriers to Best Practice Bushfire Management in WA. Bushfire Front. Viewed 20 February 2023 <<https://www.bushfirefront.org.au/resources-2/seminars/barriers-to-best-practice/>>

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SUMMARY

The 2019/2020 bushfires impacted 19 million hectares in Australia and caused an estimated \$4 to \$5 billion of economic loss.

Studies indicate that there is also greater and unequal bushfire exposure across different demographic groups, where those within a lower socio-economic situation are likely to be disadvantaged (Akter and Grafton 2021).

This suggests that if bushfire preparation is to be inclusive of all demographics, including vulnerable groups, then all regions and all communities should be prioritised.

Identification and quantification of the socio-economic factors that affect bushfire exposure may help to guide education and support programs to improve future resilience.

SPOTLIGHT STUDY 4

The differential exposure to bushfire hazards due to socio-economic factors

Key Findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

Akter and Grafton (2021) conducted a case study focused on Victoria and New South Wales and the relationship between socio-economic factors and wildfire exposure. The study investigated the associations between socio-economic disadvantage and remoteness of settlement with wildfire hazard exposure. Using the Index of Relative Socio-Economic Disadvantage and the National Indicative Aggregated Fire Extent, Akter and Grafton (2021) concluded that those in the most disadvantaged category were in closest proximity to wildfires compared to those in the less disadvantaged category.

Akter and Grafton (2021) also described the possible mechanisms for this association of greater wildfire exposure in the most disadvantaged populations compared to the least disadvantaged, including: lower fire suppression and hazard reduction capabilities, different prioritisation of fire equipment and services, and different levels of government support. These mechanisms and differences in fire preparation and suppression have also been noted by the 'Royal Commission into National Natural Disaster Arrangements' (Akter and Grafton 2021). Additionally, in a case study focused on Logan, Queensland, the low socio-economic group had lower levels of concern and awareness of natural disasters compared to the non-low socio-economic group (Teo et al. 2018). Less awareness or concern about natural disasters such as bushfires may lead to different levels of investment in disaster preparedness activities and therefore different exposure.

Research has highlighted the variable levels of disaster preparedness and emergency responses in different socio-economic groups (Boon et al. 2014; Howard et al. 2019; Berke et al. 2010). Boon et al. (2014) identified a number of factors that

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

affected the preferred mode of communication to receive emergency information. For example, they found that unemployed individuals relied more on television, radio, and neighbours rather than internet sources (Boon et al. 2014). Similarly, Howard et al. (2019) studied the social isolation of five population groups and how that affected their disaster preparedness. Language barriers, access to physical resources (e.g., ability to do household bushfire preparation, mode of transport in an emergency), and geographic knowledge were identified as some key obstacles for people to engage with bushfire preparation and effective emergency response (Howard et al. 2019). Developing effective modes of communication and education for vulnerable groups is necessary to reduce the unequal risk of exposure to bushfire.

Wider social impacts

Though not focused on socio-economic factors, Gangemi et al. (2003) highlighted the social impacts that are caused by bushfires. In the 2002-2003 Gippsland and North-East Victoria bushfires, when communities were on alert for up to 3 weeks, individuals and families suffered financially due to extended involvement in fire-fighting. The region also experienced economic impacts such as reduced output in agriculture, forestry, and fishing. Additionally, Filkov et al. (2020) highlighted the economic impact of the 2019-2020 bushfires on Kangaroo Island fires including the loss of homes and tourism assets, plantation wood, honeybee hives, and agricultural stock.

Relevance to the Resilient Hills & Coasts (RH&C) Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

Identifying and understanding the socio-economic impacts that bushfires and wildfire hazard exposure have on communities is crucial to any region susceptible to bushfires. The 2019/20 Kangaroo Island bushfires and the 2019 Cudlee Creek and Cherry Gardens bushfires are just a few examples of why this is relevant to the Resilient Hills and Coasts region. It is important to not only understand the impacts of bushfires to the recovery of communities post-fire, but also to aid in developing fire mitigation strategies and other forms of bushfire resilience pre-fire and post-fire.

Scalability and implementation

Identifying and understanding the inequality of bushfire hazard exposure on communities is crucial to any region susceptible to bushfires. The 'Climate Adaptation Plan' for the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region specifically prioritises the health, safety and well-being of vulnerable members of the community (Resilient Hills and Coasts 2016).

While understanding the impacts of bushfires informs the recovery of communities post-fire, it is also important to

direct the development of fire mitigation strategies and other forms of bushfire resilience to these areas.

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (The Royal Commission into National Natural Disaster Arrangements, 2020a), mitigation action will be necessary. However, in the context of fire, climate can heavily influence the outcomes regardless of management.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

Akter and Grafton (2021) focused on the relationship between socio-economic disadvantage and bushfire hazard exposure in Victoria and New South Wales. Their findings are relevant to a general Australian context when compared to case studies from other countries (i.e., remoteness is associated with fire hazard exposure in a North American context but not in an Australian context).

Additionally, the same indices used by Akter and Grafton (2021) may be used in a South Australian context since the 'National Indicative Aggregated Fire Extent' and the 'Index of Relative Socio-Economic Disadvantage' apply Australia-wide. RH&C could similarly use these indices to better understand the demography of lower socio-economic groups, their exposure to bushfires, and address their vulnerabilities accordingly.

Survey-based approaches used by other studies (Mannakkara & Wilkinson 2012; Teo et al. 2018) can also be utilised in a range of contexts and locations. This may be beneficial to identify at-risk and highly vulnerable communities or groups and what support and information they need to become better prepared and more resilient to bushfires.

Similarly, with a higher frequency and severity of bushfires, emergency response workers (career and volunteer) will experience increased exposure to dangerous conditions including physical exertion, heat, traumatic events, and extended time away from home (Smith et al., 2021). This will increase the physical and mental health risks associated with firefighting activities (Fullagar et al., 2021; Smith et al., 2021). See Part A: Literature Review section 7 for more information.

Risks

There are few risks associated with the approaches used here to investigate the relationship between socio-economic factors and bushfire exposure. Using indices and spatial mapping to look at associations and conducting surveys are low-risk and are non-invasive.

However, there may be substantial risks from not improving understanding of community-level socio-economic factors associated with bushfire risk. Due to the predicted increase in frequency and severity of bushfires in Australia (Penman et al. 2020), and the evidence suggesting unequal bushfire exposure across socio-economic groups (Akter & Grafton 2021), there is a heightened need to address this.

Social license

Improved support and education for communities is the end goal of investigating socio-economic factors related to bushfire exposure. These actions are generally well-supported by communities and a low risk to RH&C Bushfire and Biodiversity project and associated members and agencies.

Knowledge gaps, caveats, and assumptions

Although the studies cited here (Akter & Grafton 2021; Teo et al. 2018) provide an Australian context, South Australian communities may display different trends. Further study in the Resilient Hills & Coasts region using similar approaches would be highly beneficial to address these limitations.

The sources cited here address the immediate effects of bushfires rather than "consequences" such as smoke inhalation and ill-health. It is therefore possible that exposure to bushfire hazards may have further consequences for lower socio-economic groups.

Further work in the RH&C Region

In addition to identifying vulnerable communities using the approach by Akter and Grafton (2021), further work may include the development of education and communication programs to enhance the resilience of vulnerable communities and individuals. Redshaw et al. (2017) describe two programs from the Blue Mountains region that improved general community resilience and may improve the resilience of vulnerable

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

individuals/households. The “Meet Your Street” and “More than a Fire Plan” programs were community-based events that were well-received and increased the preparedness of Blue Mountains’ communities (Redshaw et al. 2017). Similarly, Berke et al. (2010) aimed to increase the community resilience of communities in the impact zone of Hurricane Isabel (North America). Key takeaways from their study were that “resiliency is based on building inter-personal skills in community organizing, strengthening ties to external resources... and holding local planning efforts”, as well as tailoring outreach to vulnerable groups. Following the identification of vulnerable groups in the RH&C region, education and outreach programs tailored for specific communities and vulnerable groups may be developed.

It is noted that the Australian Red Cross is providing climate change resilience initiatives in in the RH&C region, so community can be better prepared against extreme climate events – see [here](#). There could be an opportunity to further this by identifying the priority demographic groups and working with the Australian Red Cross to focus

on how they can be better supported for bushfire preparedness.

Investment required

The costs for the published studies were not provided. It is estimated that undertaking a study across council regions to identify the most vulnerable and high priority communities would be \$75,000 to \$100,000. The cost to implement an initiative, that will ensure that people in lower socio-economic situations can be better prepared against bushfires, is difficult to estimate as it will depend on the scale and timeframe required.

Key stakeholders

Key stakeholders include researchers (particularly social scientists), community groups, primary producers, schools and other educators, SES/CFS, local councils, emergency relief organisations (such as Red Cross) and targeted socio-economic groups.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

References

- Akter, S., & Grafton, R. Q. (2021). Do fires discriminate? Socio-economic disadvantage, wildfire hazard exposure and the Australian 2019–20 'Black Summer' fires. *Climatic Change*, 165(3–4), 53. <https://doi.org/10.1007/s10584-021-03064-6>
- Berke, P., Cooper, J., Salvesen, D., Spurlock, D., & Rausch, C. (2010). Building Capacity for Disaster Resiliency in Six Disadvantaged Communities. *Sustainability*, 3(1), 1–20. <https://doi.org/10.3390/su3010001>
- Boon, H. (2014). Investigation rural community communication for flood and bushfire preparedness. *Australian Journal of Emergency Management*, 29(4), 17-25.
- Filkov, A. I., Ngo, T., Matthews, S., Telfer, S., & Penman, T. D. (2020). Impact of Australia's catastrophic 2019/20 bushfire season on communities and environment. Retrospective analysis and current trends. *Journal of Safety Science and Resilience*, 1(1), 44–56.
- Fullagar, H. H. K., Schwarz, E., Richardson, A., Notley, S. R., Lu, D., & Duffield, R. (2021). Australian firefighters perceptions of heat stress, fatigue and recovery practices during fire-fighting tasks in extreme environments. *Applied Ergonomics*, 95, 103449. <https://doi.org/10.1016/j.apergo.2021.103449>
- Gangemi, M., Martin, J., Marton, R., Phillips, S., & Stewart, M. (2003). Socio-economic impact of bushfires on rural communities and local government in Gippsland and north east Victoria, RMIT Publishing, Melb
- Howard, A., Agllias, K., Bevis, M., & Blakemore, T. (2018). How Social Isolation Affects Disaster Preparedness and Response in Australia: Implications for Social Work. *Australian Social Work*, 71(4), 392–404. <https://doi.org/10.1080/0312407X.2018.1487461>
- <https://doi.org/10.1016/j.jnlssr.2020.06.009>
- Mannakkara, S., & Wilkinson, S. (n.d.). Build back better principles for economic recovery: Case study of the Victorian bushfires.
- Penman, T. D., Clarke, H., Cirulis, B., Boer, M. M., Price, O. F., & Bradstock, R. A. (2020). Cost-Effective Prescribed Burning Solutions Vary Between Landscapes in Eastern Australia. *Frontiers in Forests and Global Change*, 3, 79. <https://doi.org/10.3389/ffgc.2020.00079>
- Redshaw, D. S., Hicks, P. J., & Millynn, J. (2017). Emergency preparedness through community sector engagement in the blue mountains. *Australian Journal of Emergency Management*, 32(2), 35-40.
- Resilient Hills and Coasts. (2016). Climate Change Adaptation Plan for the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island Region. A report prepared for Alexandrina Council on behalf of Resilient Hills and Coasts project partners by Seed Consulting Services and URPS.
- Smith, E., Holmes, L., Larkin, B., Mills, B., & Dobson, M. (2022). Supporting Volunteer Firefighter Well-Being: Lessons from the Australian "Black Summer" Bushfires. *Prehospital and Disaster Medicine*, 37(2), 273–276. <https://doi.org/10.1017/S1049023X22000322>
- Teo, M., Goonetilleke, A., Ahankoob, A., Deilami, K., & Lawie, M. (2018). Disaster awareness and information seeking behaviour among residents from low socio-economic backgrounds. *International Journal of Disaster Risk Reduction*, 31, 1121–1131. <https://doi.org/10.1016/j.ijdr.2018.09.008>
- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.

The Spotlight Studies were produced by the Nature Conservation Society South Australia (2023) as part of the Resilient Hills & Coasts Bushfire and Biodiversity Project. This project received grant funding from the Australian Government. The work was overseen by the Resilient Hills & Coasts Steering Group and Advisory Group, comprising representatives from Adelaide Hills Council, Alexandrina Council, Kangaroo Island Council, Mt Barker Council, Yankalilla Council, Victor Harbor Council, SA Emergency Services, SA Country Fire Service, Department for Environment and Heritage, Landscapes Hills and Fleurieu, Landscapes Kangaroo Island, Regional Development Australia (Fleurieu), Southern Hills LGA.



We acknowledge and respect the ongoing cultural and spiritual connection that First Nations people have with their country, and their commitment to its stewardship for future generations.

SUMMARY

There is considerable information on biodiversity bushfire recovery and the required actions to mitigate against biodiversity loss, however, there is less focus, or evidence, on bushfire preparation activities to reduce long-term biodiversity impacts.

Prescribed burning is increasingly being implemented to reduce the likelihood of catastrophic, intense, and large-scale fires, and the inability of species to recover.

The ability to reduce bushfire impacts on biodiversity will depend on scale, intensity, connectivity, and other population mitigation strategies that have been implemented, and the specific target species and/or vegetation community.

SPOTLIGHT STUDY 5

Strategic bushfire preparation activities to reduce long-term biodiversity impacts

Key Findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

Bushfire preparation activities are a broad suite of management actions that may take place on a local or landscape scale. Bushfire preparation activities may be conducted by fire authorities such as the South Australian Country Fire Service (CFS) or local council, or by residents and landholders as guided by relevant legislation (including the South Australian *Native Vegetation Act 1991* and the *Fire and Emergency Services Act 2005*), with the correct approvals.

These activities may include management of native and non-native vegetation, fire-wise landscaping (see Spotlight Study #11), and fuel reduction strategies including prescribed burning (CSIRO 2023). While reducing the risk of bushfire exposure and severity to human lives and assets is the main priority, there is also a need to consider the long-term impacts that management actions themselves, and unplanned bushfires, can have on biodiversity (DEW 2020).

Poorly planned prescribed burns (e.g., too frequent and large scale) or catastrophic bushfires can have a negative long-term impact on biodiversity due to reduced habitat (size and quality) and the decline of populations (Santos et al. 2022; Halliday et al. 2012).

Prescribed burns

Prescribed burns in and around areas of native vegetation have typically been used as a fuel reduction technique to decrease the risk of fire on assets (Clarke et al. 2022). In a similar approach to other assets (e.g., human infrastructure), identifying biodiversity assets such as remnant vegetation communities, threatened species, and crucial habitat, may indicate priority areas for bushfire mitigation or preparation actions. In a case study described by McKemey et al. (2021), cultural burns led by Indigenous Rangers and hazard reduction burns by National Parks and Wildlife Service (NSW) were conducted to study the effects of fire on the threatened plant, Backwater grevillea (*Grevillea scortechinii sarmentosa*). These experiments

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

showed that cultural burns, hazard reduction burns, and wildfires could trigger germination events in the Backwater grevillea. However, both the cultural and hazard reduction burns involved fire of less severity than wildfire. Both the cultural burn and the hazard reduction burn, reduced fuel loads, and slowed the spread of a subsequent wildfire into the region (McKemey et al. 2012).

Similarly, Clarke et al. (2022) conducted simulations to analyse the effects of prescribed burns on fire risk and severity in four regions of New South Wales. Clarke et al. (2022) reported that prescribed burn treatments in areas of native vegetation did reduce the level of fire risk and fire severity, particularly in regions with a greater proportion of native vegetation such as the Blue Mountains, but that prescribed burns were less effective under extreme and catastrophic conditions. Further, Pastro et al. (2011) conducted experimental burns and compared these with wildfires. Like McKemey et al. (2012), Pastro et al. (2011) reported that wildfires were hotter than prescribed burns. These studies suggest that under the right conditions, planned burns (cultural and prescribed) can reduce the impact of wildfires on areas with high conservation value, thus increasing biodiversity resilience. However, it should be highlighted that an increasing body of research suggests that very large areas of prescribed burning are required to effectively reduce broad-scale impacts of fire on biodiversity and human assets (Bradstock et al. 2012, Penman et al. 2020). For example, it has been highlighted that “you need to burn up to 10 times as much area as you can expect to prevent from being burnt in a bushfire” (Driscoll via this. Deakin University, n.d.) This presents a significant challenge.

Additionally, while there is less evidence on mechanical fuel reduction techniques and the efficacy of firebreaks, this may be an alternative method of reducing the impact of wildfires on biodiversity assets (Pastro et al. 2011; Royal Commission into National Natural Disaster Arrangements 2020).

Weed management

Effective weed management in and around areas of native vegetation or crucial habitat can play an important role in reducing the risk of fire to biodiversity. In South Australia, weeds contribute substantially to the fire risk pressures on native species (Shabani et al. 2020) as they can substantially increase fuel levels compared to native species (DEW 2020; CFA 2011). For example, the Victorian Country Fire Authority (2011) describe that “*Phalaris* [an introduced grass] can grow to two metres tall, with fuel levels of 29 tonnes/hectare” in contrast with native *Themeda triandra* (kangaroo grass) grasslands with 6 tonnes/hectare. Work by Walker and Morgan (2022) supports these findings, examining the impacts of *Phalaris aquatica* compared to *T. triandra* on fire behaviour. See Spotlight Study #7 for further details on effective weed management to reduce fire risk and improve biodiversity resilience. Similarly, Wyse et al. (2016) examined 60 shrub and tree species and found that gorse (*Ulex europaeus*), a [Weed of National Significance](#) was the most flammable of those investigated. The role of weeds as habitat (e.g., blackberry *Rubus fruticosus* as novel habitat for the threatened southern brown bandicoot), should be carefully considered – see Spotlight Study #10.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

Population loss mitigation strategies

An aspect not discussed by McKemey et al. (2012) is the possibility of translocations, that relocate individuals from one area to a new and suitable area, and establishing insurance populations, by breeding or storing genetic material ex-situ. For example, during the 2019-20 bushfires, in anticipation of a firefront moving through the habitat of the threatened Coveny's zieria (*Zieria covenyi*), tissue culture and hazard reduction burns were conducted to establish insurance populations and reduce the potential impact of wildfire on existing populations (de Bie et al. 2021). Fire subsequently affected a large proportion of the existing populations, and the insurance populations were integral to the long-term survival of Coveny's zieria.

Information availability and knowledge

The importance of having robust and up to date knowledge on threatened ecosystems and species cannot be overstated. This allows appropriate planning and mitigating actions to be taken both before and during a bushfire. For example, a rescue and release operation for the eastern bristlebird (*Dasyornis brachypterus*) was conducted ahead of an approaching firefront in Howe Flat, Victoria. While conducted as an emergency response, it was only possible due to the extensive knowledge of the Eastern Bristlebird population and translocation plans that were in development (Parrott et al. 2021). Similarly, government agency officers active in fire management and biodiversity conservation during the 2019-20 bushfires reported that "significant conservation assets were more likely to be protected during fires if their locations were mapped and there were pre-existing and readily accessible plans" for their protection (de Bie et al. 2023). This knowledge and information gap was further emphasised by de Bie et al. (2021), who found that many personnel involved in the fire response believed that information was often inadequate, difficult to access, or required a specific skillset. This highlights the need for continued research and monitoring, along with an information repository that is accessible to all stakeholders, such as the CFS, Department for Environment and Water (DEW), and local fire management authorities.

Additional management approaches

There is a growing suite of bushfire preparation approaches and actions that may be used to improve biodiversity resistance to fire and biodiversity resilience. Morgain (2022) highlighted a range of approaches to addressing biodiversity resilience across Australia (Table 1). It is important to note that not all of these approaches will be suitable in all state or regional contexts and further assessment will be required. Morgain (2022) also describes multiple management actions that may increase landscape-scale biodiversity resilience such as maintaining and encouraging ecosystem diversity, protecting refugia, maintaining or developing habitat connectivity, and protecting vulnerable pockets of habitat. Encouraging species diversity in both native vegetation/habitat, and in smaller-scale contexts such as gardens, is beneficial for biodiversity, recovery and resilience in the face of bushfires (Morgain 2022). Similarly, maintaining native vegetation is necessary to address the impacts of climate change, and in the right circumstance and setting, could reduce the rate of the fire spread (Collins et al. 2015 - see Spotlight Study #2 for further details). Ensuring that fire access tracks are well-maintained around biodiversity assets is also crucial so that emergency responses can safely access an area to suppress a fire that poses a significant threat to a localised and endemic biodiversity asset.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

Table 1: Adaptation from Morgain (2022) highlighting management approaches to reduce bushfire risk and improve biodiversity resilience.

Action area	Evidence and considerations in the literature
Direct fuel load management	Fuel loads are the most significant factor for wildfire risk under particular weather conditions. Fuel load management, particularly planned burning, is deeply embedded in local and state-wide approaches to fire management. Increasing attention in Australia is also being given to First Nations fire strategies.
Fauna management for indirect fuel management	Fauna can have under-recognised benefits for reducing fire risk. Introduction of grazing animals in grassy habitats can help reduce fuel loads and fine fuel structure in some circumstances, although the timing and consumption patterns of the animals matters, and the potential for graziers to alter the vegetation structure, potentially leading to increased fire risk, must be accounted for. A less widely considered strategy includes re-introducing native digging mammals, which can potentially contribute to litter breakdown, including in forested areas.
Reducing human disturbance and incursions; restoring disturbed areas	In some ecosystems, disturbance such as logging can increase the risk of high severity wildfire. Landscape disturbance such as road cuttings or clearing can also increase the risk of weed incursions, which may be more flammable than local native vegetation. Disturbance and modification of riparian areas and waterways-including grazing, logging and flow regulation-can reduce their capacity to resist fire.
Hydrating the landscape and protecting riparian areas	Protecting waterways and riparian areas from disturbance or restoring them can support fire management as well as generating other ecological benefits. Riparian zones can act as lower-fire risk zones and potentially provide landscape-level firebreaks and critical refugia. However, greater productivity in riparian areas can also generate higher fuel loads which, in extended dry periods, can act as corridors conducting fire through landscapes, highlighting the need for ongoing management.
Introducing green firebreaks	“Green firebreaks” are plantings that are more fire-resistant than surrounding vegetation, and can in some circumstances reduce the landscape-level fire risk. Appropriate low-flammability plants must be tailored to ecological conditions, and for social considerations.

Relevance to the Resilient Hills & Coasts (RH&C) Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes a mixture of farming, conservation, and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

The Resilient Hills & Coasts Region has a range of high-value biodiversity assets including threatened ecological communities, threatened species, and regionally important habitats. Understanding how best to manage these assets, particularly with the increasing severity and frequency of fires, is crucial for long-term biodiversity conservation.

Scalability and implementation

The 'National Parks and Wildlife Fire Management' program is currently implemented through DEW. This includes a rolling prescribed burning program on public and private lands. The aim is to complete 70% of the planned and endorsed burns each year across the state. Many biodiversity assets are under the care of the Minister for Environment and Water (i.e., National Parks) and are therefore included in these burning programs. The main goal of these burning programs, however, is fuel reduction. While still useful to reduce the risk and severity of wildfires on biodiversity assets, there are still large knowledge gaps regarding the best fire regimes for different taxa and different species. As the South Australian Government already has a 'Burning on Private Lands' program, it is possible to influence prescribed burning activities on a large scale. Further work, however, may need to be done to engage with citizens on biodiversity conservation more generally. The successful establishment of insurance populations of *Coveny's zieria* prior to bushfire in the Blue Mountains (described above – see section on Population Loss Mitigation Strategies) was largely due to the support and investment of the community (de Bie et al. 2021). This highlights the need for cooperation across organisations and communities to enhance biodiversity resilience.

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (The Royal Commission into National Natural Disaster Arrangements, 2020a), mitigation action will be necessary. However, in the context of fire, climate can heavily influence the outcomes regardless of management.

Despite the reduction in available fire fuel and wildfire severity following planned burns, the effects of climate change must be considered. During the experimental

study McKemey et al. (2021), wildfire (the Crown Mountain fire 2019) affected a number of the study sites. Although the fire was slowed in areas that were subject to planned cultural and hazard reduction burns in 2015, the region had experienced recent drought, allowing the fire to have quite serious impacts. Additionally, the 'Royal Commission into National Natural Disaster Arrangements' (2020) highlighted that above a 'Forest Fire Danger Index' of 'very high', the fire becomes largely dictated by the weather rather than fuels and topography. The 'Royal Commission' also identified that the number of appropriate weather days for prescribed burning is reducing. Clarke et al. (2022) further highlight that rising extreme conditions can reduce the effectiveness of prescribed burns. These impacts are crucial to consider when creating fire strategies and reinforce the need to consider diverse strategies for fire preparedness.

Social license

Moskwa et al. (2016) synthesised the findings from a range of studies on the community perceptions of prescribed burning in Australia and found mixed perceptions and opinions. A more balanced approach to fire management of native vegetation areas may experience some resistance due to the perception that any vegetation is a fire hazard (Moskwa et al. 2016). However, the case of *Coveny's zieria* was successful due to the level of community support, suggesting support for biodiversity conservation actions in bushfire preparedness does exist.

Risks

While fire is necessary for some species and therefore prescribed burns may be beneficial to their survival, the study by McKemey et al. (2012) reinforces the limited understanding of appropriate fire regimes for all species, and some species may not respond favourably to fire. As an example, the endemic and critically endangered orchid, hindmarsh valley greenhood (*Pterostylis bryophila*), occurs in only one location in the RH&C region

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

(Hindmarsh Valley) and one of its key threats is fire (Government of South Australia 2006).

Prior to the experimental study, the acceptable fire regime for the Backwater grevillea was not known and required extensive experimentation. This is not feasible for every species in a given habitat. Pastro et al. (2011) further emphasised this through their experimental study where the response from mammals, lizards, and vegetation to fire were different.

Inappropriate fire regimes including fires that are too hot or too cold, or too frequent or not frequent enough, may compromise the persistence of certain species. Similarly, other fire management strategies such as weed management, the maintenance of insurance populations, and other vegetation management approaches may have associated risks.

As there are still knowledge gaps about ecosystem and species ecology, an adaptive approach, including continued research, and monitoring and evaluation, is required. Due to the current declining state of Australian ecosystems and rate of species extinctions, the risks of not considering biodiversity in fire management may be far more detrimental than adopting an adaptive approach (Kearney et al. 2023).

Knowledge gaps, caveats, and assumptions

There are substantial knowledge gaps regarding what the appropriate fire regimes are (spatial explicitness, fire intensity and fire frequency) for most species, and further gaps on species response to fire when coupled with unpredictable climate change. Unless there is sufficient knowledge and evidence, it could be risky to use prescribed burning as a tool to improve or maintain biodiversity, an incorrect fire regime may be detrimental if the fire has a negative impact on the ecosystem that supports that species.

Additionally, there is still uncertainty surrounding the necessary extent of prescribed burns to adequately reduce the fire risk or severity of wildfires (Royal Commission into National Natural Disaster Arrangements (2020)). The effectiveness of alternative management actions also lacks empirical evidence, and is highly complex due to the number of different species involved.

Further work in the Resilient Hills & Coasts region

It is noted that DEW and landscape boards have considerable knowledge and experience with biodiversity conservation, including actions to ensure resilience, within the RH&C region. Further work by RH&C could focus on obtaining information on priority areas or threatened species populations to better understand what interventions or protection are required. This information could then be overlaid with fire risk and bushfire preparation activities for each council region.

There is also an opportunity to design and implement a project that integrates bushfire preparation activities and biodiversity resilience objectives. This is further discussed in Spotlight Study #12.

Investment required

The investment required will depend on the scope of works and scale of implementation and if it is desktop-based (e.g., developing guidelines on bushfire preparation strategies for biodiversity <\$75,000), or implementing practical bushfire preparation activities that could also benefit biodiversity (>\$500,000).

Key stakeholders

Key stakeholders include researchers, community groups, local fire authorities, DEW, primary producers, schools and other educators, SES/CFS, local councils.

References

- Bradstock, R. A., Cary, G. J., Davies, I., Lindenmayer, D. B., Price, O. F., & Williams, R. J. (2012). Wildfires, fuel treatment and risk mitigation in Australian eucalypt forests: Insights from landscape-scale simulation. *Journal of Environmental Management*, 105, 66–75. <https://doi.org/10.1016/j.jenvman.2012.03.050>
- Clarke, H., Cirulis, B., Penman, T., Price, O., Boer, M. M., & Bradstock, R. (2022). The 2019–2020 Australian forest fires are a harbinger of decreased prescribed burning effectiveness under rising extreme conditions. *Scientific Reports*, 12(1), 11871. <https://doi.org/10.1038/s41598-022-15262-y>
- Collins, L., Penman, T. D., Price, O. F., & Bradstock, R. A. (2015). Adding fuel to the fire? Revegetation influences wildfire size and intensity. *Journal of Environmental Management*, 150, 196–205. <https://doi.org/10.1016/j.jenvman.2014.11.009>
- Country Fire Authority (CFA) Victoria (2011) Fire Ecology: Guide to Environmentally Sustainable Bushfire Management in Rural Victoria.
- CSIRO Research (2023) Bushfire best practice guide. Viewed 21 January 2023, <<https://research.csiro.au/bushfire/>>
- de Bie, K., Currey, K., Woinarski, J., Wintle, B., Garnett, S., & Rumpff, L. (2021). Protecting threatened species and ecological communities before and during bushfire: Learning from the 2019–20 fires (Project 8.5.1). NESP Threatened Species Recovery Hub.
- Department for Environment and Water. (2020). Managing Native Vegetation: How to reduce the impact of bushfire and the steps you need to take.
- Driscoll, D. (n.d.) Is Melbourne’s urban sprawl creating more bushfire risk? The Conversation. Viewed 17 February 2023 <<https://this.deakin.edu.au/society/is-melbournes-urban-sprawl-creating-more-bushfire-risk>>
- Halliday, L. G., Castley, J. G., Fitzsimons, J. A., Tran, C., & Warnken, J. (2012). Fire management on private conservation lands: Knowledge, perceptions and actions of landholders in eastern Australia. *International Journal of Wildland Fire*, 21(3), 197. <https://doi.org/10.1071/WF10148>
- Kearney, S. G., Watson, J. E. M., Reside, A. E., Fisher, D. O., Maron, M., Doherty, T. S., Legge, S. M., Woinarski, J. C. Z., Garnett, S. T., Wintle, B. A., Ritchie, E. G., Driscoll, D. A., Lindenmayer, D., Adams, V. M., Ward, M. S., & Carwardine, J. (2023). Threat-abatement framework confirms habitat retention and invasive species management are critical to conserve Australia’s threatened species. *Biological Conservation*, 277, 109833. <https://doi.org/10.1016/j.biocon.2022.109833>
- McKemei, M., Banbai Rangers, T., Patterson, M. (Lesley), Hunter, J., Ridges, M., Ens, E., Miller, C., Costello, O., & Reid, N. (2021). Indigenous cultural burning had less impact than wildfire on the threatened Backwater grevillea (*Grevillea scortechinii* subsp. *Sarmentosa*) while effectively decreasing fuel loads. *International Journal of Wildland Fire*, 30(10), 745. <https://doi.org/10.1071/WF20135>
- Morgain, R. (2022) Information sheet: Research evidence for actions to improve ecosystem resilience and resistance to fire. NRM Regions Australia.
- Moskwa, E. C., Ahonen, I., Santala, V., Weber, D., Robinson, G. M., & Bardsley, D. K. (2016). Perceptions of bushfire risk mitigation and biodiversity conservation: A systematic review of fifteen years of research. *Environmental Reviews*, 24(3), 219–232. <https://doi.org/10.1139/er-2015-0070>
- Parrott, M. L., Wicker, L. V., Lamont, A., Banks, C., Lang, M., Lynch, M., McMeehin, B., Miller, K. A., Ryan, F., Selwood, K. E., Sherwen, S. L., & Whiteford, C. (2021). Emergency Response to Australia’s Black Summer 2019–2020: The Role of a Zoo-Based Conservation Organisation in Wildlife Triage, Rescue, and Resilience for the Future. *Animals*, 11(6), 1515. <https://doi.org/10.3390/ani11061515>
- Pastro, L. A., Dickman, C. R., & Letnic, M. (2011). Burning for biodiversity or burning biodiversity? Prescribed burn vs. wildfire impacts on plants, lizards, and mammals. *Ecological Applications*, 21(8), 3238–3253. <https://doi.org/10.1890/10-2351.1>
- Penman, T. D., Clarke, H., Cirulis, B., Boer, M. M., Price, O. F., & Bradstock, R. A. (2020). Cost-Effective Prescribed Burning Solutions Vary Between Landscapes in Eastern Australia. *Frontiers in Forests and Global Change*, 3, 79. <https://doi.org/10.3389/ffgc.2020.00079>
- Santos, J. L., Hradsky, B. A., Keith, D. A., Rowe, K. C., Senior, K. L., Sitters, H., & Kelly, L. T. (2022). Beyond inappropriate fire regimes: A synthesis of fire-driven declines of threatened mammals in Australia. *Conservation Letters*. <https://doi.org/10.1111/conl.12905>
- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.
- Walker, Z. C., & Morgan, J. W. (2022). Perennial pasture grass invasion changes fire behaviour and recruitment potential of a native forb in a temperate Australian grassland. *Biological Invasions*, 24(6), 1755–1765. <https://doi.org/10.1007/s10530-022-02743-4>
- Wyse, S. V., Perry, G. L. W., O’Connell, D. M., Holland, P. S., Wright, M. J., Hosted, C. L., Whitelock, S. L., Geary, I. J., Maurin, K. J. L., & Curran, T. J. (2016). A quantitative assessment of shoot flammability for 60 tree and shrub species supports rankings based on expert opinion. *International Journal of Wildland Fire*, 25(4), 466. <https://doi.org/10.1071/WF15047>

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

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We acknowledge and respect the ongoing cultural and spiritual connection that First Nations people have with their country, and their commitment to its stewardship for future generations.

SUMMARY

Australian states and territories operate different models for incorporating biodiversity-focused representatives into fire incident management teams. Natural assets such as national parks are generally recognised as important and valuable, and individuals with biodiversity knowledge are increasingly being incorporated into emergency response teams during bushfire emergencies. These individuals advise on priorities and on the ecological impacts of firefighting strategies, e.g., identifying and protecting the highest value areas, or advising on appropriate placement of containment lines. However, “natural values” representatives have more decision-making authority in some jurisdictions than others.

During the Black Summer bushfires, 2019–2020, where natural values officers’ roles were advisory rather than part of the decision-making hierarchy, actions to protect biodiversity assets sometimes came down to staff availability, and the confidence and assertiveness of individual natural values officers to advocate for the protection of particular assets in the incident room (de Bie et al., 2021). Biodiversity assets were sometimes sacrificed in order to protect property, such as sheds being prioritised over protecting a national park (de Bie et al., 2023).

This spotlight study examines the models that operate in South Australia, which has a large but advisory Natural Values Team, and Victoria, which designates an individual as Victoria’s Wildlife Controller during emergencies.

SPOTLIGHT STUDY 6

Integrating biodiversity-focused representation into incident management teams

Key findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

South Australia’s Natural Values Team was formalised in 2018. This team of around 50 people evolved out of a 20-year history of support provided by the Department for Environment and Water (DEW) (and precursor agencies) to the Country Fire Service (CFS). DEW connects CFS teams with personnel who have expertise in mapping, incident management and fire-fighting. Under this model, DEW staff operate within the Incident Management Team, where they provide advice on biodiversity matters. Initially this model operated in one region of South Australia (SA), and in 2019–2020 expanded to all regions. While this team can influence incident management actions by providing information and advice, for example by providing maps of biodiversity asset locations, and advising on the placement of containment lines to minimise impact on wildlife and habitats, it does not have authority make decisions during bushfire emergencies (de Bie et al., 2021). In SA’s State Emergency Management Plan, DEW is named as a “Functional Support Group” with lead responsibility for mapping (SA Government, 2022), but is not identified as a lead organisation at the higher operational levels of “Control Agency” or “Support Agency”.

In comparison, under the Victorian model, the state’s Emergency Management Framework includes the appointment of the “Level 2 State Controller – Wildlife” during an emergency (DELWP, 2020). The incumbent is authorised to make strategic conservation decisions during an emergency response, which can include actions other than fire-fighting. For example, during the 2019–2020 Black Summer bushfires (hereafter referred to as the 2019–2020 bushfires), the Wildlife Controller

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

made the strategic decision to capture and evacuate critically endangered Eastern Bristlebirds into captivity for protection (de Bie et al., 2021). This decision-making role is supported by 'Victoria's bushfire emergency: biodiversity response and recovery document' (DELWP, 2020). The biodiversity response and recovery document is continually updated, and sets out formal prioritisation assessments for habitats and species that are under most threat, and identifies which have the greatest biodiversity value. This ensures that the Wildlife Controller has access to current data during emergencies, and that biodiversity priorities are pro-actively identified prior to any bushfire emergency.

Relevance to the Resilient Hills & Coasts (RH&C) Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes a mixture of farming, conservation, and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

A key issue in bushfire emergency response and planning is prioritising which assets should be protected. The larger the scale of a bushfire emergency, the more important prioritisation becomes due to resource limitations. During bushfire emergencies in SA, Natural Values Team members can be deployed to advise local fire-fighting teams on local biodiversity priorities, including providing mapping support. However, these roles are advisory and lack decision-making authority. It may be worth exploring whether there could be a role for an overarching biodiversity/wildlife officer embedded within the state's emergency response hierarchy, like Victoria's Wildlife Controller (see Key findings). Such a position could result in better coordination between regions on which biodiversity assets to protect during large-scale bushfire emergencies. It could also enable decisive actions to protect individual and priority threatened species populations during an emergency, such as evacuating insurance populations into captivity, as occurred with the Eastern Bristle Bird in Victoria during the 2019-2020 bushfires (de Bie et al., 2021).

Scalability and implementation

The SA Natural Values Team has around 50 Natural Values officers who can be deployed state-wide to advise local fire-response teams about biodiversity priorities during a bushfire emergency. It does not seem necessary to scale up this team at present. However, there could be scope to introduce an over-arching, high-level biodiversity decision-making role with authority, akin to the Victorian "Wildlife Controller", under the 'SA Emergency Management Plan'. The incumbent could make critical strategic decisions where necessary, including where there is a need to prioritise or coordinate actions across multiple regions during large-scale bushfire emergencies.

The position could relate directly to fire management, but also include decisions that aren't about fire management per se, such as emergency responses to safeguard individual threatened species.

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (The Royal Commission into National Natural Disaster Arrangements, 2020a), mitigation action will be necessary. However, in the context of fire, climate can

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

heavily influence the outcomes regardless of management.

The frequency and severity of bushfire emergencies is likely to increase in the RH&C region under projected climate change models. It is therefore likely to become increasingly important to set clear local, regional, and state priorities for protecting biodiversity assets during bushfire emergencies. If large-scale fires that affect multiple regions simultaneously, as in the 2019-2020 bushfires, become more frequent, high-level strategic prioritisation, and decisive action to protect habitats or threatened species during bushfire emergencies, may become more important than has been the case to date.

Social license

The community acceptance of this initiative could be strong from those that value biodiversity. However it could also be incorrectly perceived that of a Wildlife Controller would diminish the focus of protecting life and assets., this will not be the case. Although this position will not have the ability to overrule the protection of life and assets, it will be able to identify and advocate for response activities that will mitigate against the loss of high priority biodiversity assets.

Risks

Under current SA bushfire response arrangements, where natural values officers advise emergency response crews but are not authorised to make operational decisions, there is a significant risk that biodiversity protection is a second-order concern that could be overlooked or overruled during emergency responses. For example, in NSW during the Black Summer bushfires, natural values officers in an advisory-only role advocated for protection of a national park, but fire-fighting crews decided instead to protect some nearby sheds, resulting in 5,000 ha of park being burnt (de Bie et al., 2023). Current arrangements in SA appear to have worked satisfactorily during the Black

Summer bushfires, with Natural Values officers, for example, able to influence fire-fighting decisions on Kangaroo Island in real time (de Bie et al., 2021). However, incorporating an easily identifiable, biodiversity-focused role into the 'SA Emergency Management Plan' decision-making hierarchy, supported by up-to-date data and with a pre-determined list of priority species and places, as in Victoria (de Bie et al., 2021), could produce a more cohesive approach, and provide a greater guarantee that biodiversity assets will be protected and not just considered during emergencies. This would align with recent recommendations from the CSIRO to "embed biodiversity expertise and responsibilities in disaster planning and fire control operations" and to "ensure legislation, planning and policy provide for representatives of conservation agencies to be embedded in the emergency management structure, *with due authority*" (our italics) (Rumpff et al. 2023).

Knowledge gaps, caveats, and assumptions

Different approaches for incorporating biodiversity-focused representation into Australia's incident management crews are examined by de Bie et al. (2021; 2023), including the views of biodiversity officers and how well these arrangements performed in practice during the 2019-2020 bushfires. These authors interviewed more than 30 government agency officers representing every fire-affected jurisdiction about their experiences with having biodiversity priorities acted upon during the bushfires. The results from these interviews provided valuable insights into the relative success of different responses in protecting biodiversity assets. Although the results are limited to Australia, the range of people interviewed, across several states, and the recentness of these publications by Bie et al., means they are probably the best available body of evidence for assessing the current approaches for biodiversity-focused representation within incident management in Australia.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

Further work in the Resilient Hills & Coasts region

A Wildlife Controller, or similar position, could be formally embedded into incident management teams, but focussed on working with councils fire prevention officers. Once this is funded and functional, the position/s could work closely with the Natural Members Team and council, to identify and prioritise local biodiversity priorities.

In the absence of this position, senior members of the Natural Values Team, could promote their role to council, particularly the planners, biodiversity staff, and fire prevention officers, so these decision makers are aware of the Natural Values Team involvement with emergency response teams. The current Natural Values Team, or representatives from the team, could work with key RH&C stakeholders to establish terms of engagement during a

fire emergency that including engaging with local council officers.

Investment required

Depending on the model, investment needed could be negligible if embedded within the existing Natural Values Team, or \$100,000 to \$150,000 if a new position was developed and filled. There are other costs from drawing up and regularly maintaining a biodiversity priority document like is in use in Victoria.

Key stakeholders

The key stakeholders for this initiative include DEW, DEW Natural Values Team, CFS, Emergency Services Minister, State Emergency Management Committee, Bushfire Management Committees, and local councils.

References

- de Bie et al. (2021). *Protecting threatened species and ecological communities before and during bushfire: learning from the 2019–2020 fires*. NESP Threatened Species Recovery Hub, Brisbane.
- de Bie et al. (2023). What did we learn about biodiversity management, policy and operations from the 2019–2020 wildfires? Chapter 29 in *Australia's Megafires – Biodiversity impacts and lessons from 2019–2020*.
- DELWP (2020). *Victoria's bushfire emergency: biodiversity response and recovery, Version 2*. State Government of Victoria.

- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.
- Rumpff et al. (2023). Recommendations. Chapter 35 in *Australia's Megafires – Biodiversity impacts and lessons from 2019–2020*.
- SA Government (2022). *State Emergency Management Plan, August 2022*.

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SUMMARY

As human populations are becoming increasingly urbanised, people have less opportunity to be immersed and connected to nature. Research has indicated that nature connectedness is positively associated with “pro-environmental” behaviours (Martin et al., 2020).

Similarly, in a survey of Adelaide Mount Lofty Ranges and Lower Eyre Peninsula residents, most people reported that they have a connection to the nature on their property and surroundings, and that they want to see more protection of biodiversity (Moskwa et al. 2018). Most of these residents (90%) also indicated that they believe biodiversity is important to consider in bushfire policy.

These findings indicate that fostering residents’ connection to nature may shift or strengthen their attitudes towards implementing fire management strategies that also benefit biodiversity.

SPOTLIGHT STUDY 7

Using community connection to nature to modify attitudes towards fire management for biodiversity - highlighting iconic species

Key findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

The key study investigated for this spotlight study was Moskwa et al. (2018), which was mostly based on data from a Mount Lofty Ranges (MLR) survey and additional data from a Lower Eyre Peninsula survey. Many people surveyed (67%) lived adjacent to native vegetation. Most of the respondents lived in areas that were considered high (50%) or medium (29%) bushfire risk by South Australia’s leading fire agency, the Country Fire Service (CFS).

When discussing current bushfire risk management in the MLR, on average, residents agreed that vegetation clearance to reduce fire risk was acceptable and supported prescribed burning both to reduce fire risk and for biodiversity. There was an even spread of survey respondents between

those that agreed that vegetation management should focus on reducing bushfire risk and those that agreed that it should focus on maximising biodiversity.

This potentially presents a conflict. The authors recognise these differences and called for an “ecological sophistication” (i.e. a refined understanding of fire and conservation ecology, amongst planners, residents and land managers alike) to live successfully with bushfire. They state that “by more fully considering the complexity of residential perspectives, decision-makers could advance policy that embraces both public safety and biodiversity protection”. Moskwa et al. (2018) concluded that to achieve this “ecological sophistication”, bushfire risk research is needed that includes social analysis, to complement the current knowledge of bushfire risk and conservation values. A sophisticated understanding of bushfire risk mitigation and conservation of biodiversity is necessary not only for researchers and landowners, but also those involved in policy, planning and land management, in order to live with bushfire on the peri-urban fringe (E. Moskwa et al., 2018).

Relevance to the Resilient Hills & Coasts (RH&C) Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

The Resilient Hills & Coasts (RH&C) seeks to balance biodiversity conservation and bushfire risk management. Much of the biodiversity in the RH&C Region is located on private land and so relies on individual landowners to carefully protect and conserve natural assets. Individual landowners also have a legal and moral responsibility to manage bushfire risk on their properties. According to Moskwa et al. (2018) landowner attitude towards, and knowledge of biodiversity, also determines their support for bushfire risk management policy in public reserves and patches of remnant vegetation. Bushfire risk management activities on private land can be contentious, and the community's connection to nature contributes to support for bushfire risk management activities in their local area targeted towards biodiversity.

Emotions formed in response to government messaging, media, and past experiences of bushfire, can influence community attitudes towards nature in relation to bushfire risk management. A review of prescribed burning found that historically, prescribed burning in south-eastern Australia has mainly been politically driven (Morgan et al., 2020). The authors argue that comprehensive fire management programs may have been obstructed due to negative public perceptions of fire, so that current levels of prescribed burning in south-eastern Australia are said to be inadequate to maintain ecological processes and reduce bushfire impacts on human life/property. Clear communication of the benefits of prescribed burning can assist in boosting public and political support, and result in increased investment in capacity to reduce bushfire risks in the future, contributing to protection of economic, social and environmental values (Morgan et al., 2020).

With much of the biodiversity in the RH&C regions is located on private land and decision makers need residents to cooperate and contribute to bushfire management activities on their own properties, in order to maintain biodiversity. Fostering residents' connection with nature, as well as engaging them in the development of bushfire risk management policy, could result in both positive outcomes for biodiversity and bushfire prevention.

Key findings (continued)

Prescribed burning is currently an important land management tool, used for the reduction of fuel levels (to slow the spread of bushfire), property management (such as regenerating a post-logging site) or for ecological objectives (Gill, 2012). Other management and planning approaches to mitigate against the impacts of bushfires in the Mount Lofty Ranges include building standards, fire-hazard planning, increasing awareness (to change

behaviours), constraining urban development or planned last-resort refuges (Bardsley et al., 2015). Morgan et al. (2020) argue that rather than commit more resources to fire suppression, prescribed burning should be used more to reduce bushfire impacts and risks.

However, prescribed burning for ecological objectives (i.e. biodiversity conservation) is complex and differs by ecosystem type. The ecological effects of fire are the

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

result of the interaction between the fire regime (i.e. fire frequency, season, intensity and patchiness) and the ecosystem, which includes unplanned fires as well as prescribed burns (Gill, 2012). Burning too frequently can exhaust the soil seedbank and destroy resprouting plants, (Bardsley et al., 2015; Driscoll et al., 2010; E. Moskwa et al., 2018). Increasing urban development in areas both important for biodiversity and vulnerable to bushfire, such as the peri-urban areas of the RH&C region, has exacerbated these conflicts (Bardsley et al., 2015).

In the RH&C region, management of vegetation (and hence, biodiversity) falls upon many different government agencies as well as individuals and local government, which have their own interests and values (E. Moskwa et al., 2018). Current policy favours risk mitigation for protection of life and assets over biodiversity as the Fire and Emergency Services Act, (South Australia, 2005) prevails over the Native Vegetation Act, (South Australia, 1991), and penalties may be applied to households for insufficient vegetation clearance under Section 105F notice of the Fire and Emergency Services Act 2005. At a national level protecting human life and property also takes priority, and in emergency situations the Environment Protection and Biodiversity Conservation (EPBC) Act 1999 can be overridden. For fire prevention activities, state/territory governments are generally responsible for managing vegetation, and national environmental laws only come into play if the fire prevention is 'likely to have a significant impact on a nationally protected matter' and is not exempt (Department of Climate Change, Energy, the Environment and Water, 2022). Many fire prevention activities are exempt from these national environmental laws, such as routine fuel burns, maintaining fire breaks or clearing around a property in line with state/territory and local government laws. For an individual landowner who values biodiversity and wants to preserve it on their property, the legal requirements may be hard to navigate, and could present a disincentive to conserve biodiversity when legislation is pushing towards clearance on so many levels.

whilst too infrequent fires can result in death of plants and loss of fire respondent seeds (Trezise et al., 2022).- This potential conflict exists between management of fire risk for asset protection versus conservation of biodiversity

Moskwa et al. (2018) explores the public perceptions of bushfire risks and ecological values, to gauge the "ecological sophistication" of residents in the Mount Lofty Ranges and found that the majority of peri-urban MLR residents value and understand local biodiversity, and that fire management policy should be more ecologically sophisticated in order to benefit biodiversity as well as mitigate bushfire risk. Residents, land managers, planners and policy makers could be better educated and engaged to achieve sustainable vegetation management in peri-urban areas (E. Moskwa et al., 2018).

Utilising iconic species, such as the threatened southern brown bandicoot, could help foster strong connections with local biodiversity, and educate the public about how fire can be managed to assist biodiversity, resulting in increased knowledge of, and connection to, nature. The species has particular habitat requirements (also see Spotlight Study #10), requiring very dense understory vegetation and benefitting from good quality interconnected native vegetation (Long, n.d.). Inappropriate land management (i.e. clearance of understory) or fire regimes (i.e. too frequent burns, or burning too much of the bandicoot's habitat patch) can threaten bandicoot populations as they need dense vegetation to hide from predators (Department for Environment and Natural Resources, n.d.), and they are particularly vulnerable in fragmented landscapes (Driscoll et al., 2021). Careful fire management, suppressing fire in good habitat patches, and utilising prescribed burning to improve habitat values in other areas can assist the species (Department for Environment and Natural Resources, n.d.), and therefore could serve to educate the public in fire management whilst promoting biodiversity connection. The dense habitat that the bandicoots require can also be a fire risk, so this is one example where

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

sophisticated ecological knowledge is required to balance risk and conservation. Public engagement in bandicoot habitat management could contribute to increased knowledge of the complexity of managing fire for biodiversity conservation in the RH&C region.

An example of an iconic species improving biodiversity conservation within the RH&C footprint is the critically endangered glossy black cockatoo on Kangaroo Island, where private landowners are vital in the recovery of this species. Most of the bird's nesting sites (70%) are on private property, which has led to raised awareness of the importance of conservation of native vegetation on private property. Suppression of high intensity fires is important for the conservation of the species young and nest hollows (100+ year old trees), whereas the species food plant, the drooping sheoak (*Allocasuarina verticillata*) rapidly regenerates after fire, but must be 5-6 years old to start producing the cockatoo's food (seeds) and 15-20 years following fire to produce enough to be suitable foraging habitat (Department of Environment, Land, Water and Natural Resources, 2015). Community support has already allowed for the protection of nests from predation by possums and enabled revegetation programs of the cockatoo's food plant (Landscapes Kangaroo Island, 2023). Hence, the species is already a useful iconic species for building connection to nature and could be further utilized to engage the public in the complexities of fire management for the species.

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (The Royal Commission into National Natural Disaster Arrangements, 2020a), mitigation action will be necessary. However, in the context of fire, climate can heavily influence the outcomes regardless of management.

Climate change can influence fire conditions by its effects on temperature, moisture, fuel conditions, and weather patterns and it is widely accepted that climate change is influencing the frequency and severity of bushfires (Bureau of Meteorology, n.d.), and high fire-risk weather. Retaining native vegetation on both public and private land is vital for biodiversity conservation, and is increasingly important in the context of climate change (E. Moskwa et al., 2018). Prescribed burning practices will likely need to change, or increase, in response to future climate change scenarios (Clarke et al., 2022). If biodiversity values are to be retained in the peri-urban Resilient Hills & Coasts region, both fire management and biodiversity conservation will need to have strong public support and awareness.

Social license

There is strong community support for considering biodiversity in fire management, with 90% of respondents in the Moskwa et al. (2018) study, supporting biodiversity conservation in fire management. The authors concluded that MLR residents support the conservation of biodiversity in fire-risk mitigation, and generally, are not fully supportive of current approaches to clearance of vegetation. Longer term residents (>20 years) were less supportive than newer residents of current vegetation management practices. It is noted that these attitudes may have changed since the 2019/20 fire and repeating this survey would provide valuable insights for future management of the region.

Knowledge gaps, caveats, and assumptions

There is debate around prescribed burning (Morgan et al., 2020) and biodiversity benefits, due to knowledge gaps on the impacts of prescribed burning on biodiversity, and competing interests (biodiversity conservation vs bushfire risk mitigation). There are still many changes required in fire management for sustainable conservation of biodiversity and protection of human values. More than 50 public inquiries, reviews and royal commissions have

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

been held into fire management, including prescribed burns, between 1939 to 2020 (Morgan et al., 2020). The Commonwealth Government established the Bushfire and Natural Hazards Cooperative Research Centre (CRC) in July 2013 in response to a 2009 inquiry. The eight-year program's research focused on "physical and social sciences relevant to wildfire and prescribed burning" rather than ecological processes and biological science (Morgan et al., 2020), representing a clear imbalance in research focus. If bushfire preparation activities are to be strategically designed and implemented to co-benefit biodiversity outcomes, additional and ongoing ecological research is required that addresses knowledge gaps on species fire-response.

Further work in the Resilient Hills & Coasts region

The RH&C project could consider revisiting household attitudes since the 2019/20 bushfires to better understand "perceived conflict" between biodiversity conservation and bushfire preparedness, and identify the opportunities for highlighting iconic species and local biodiversity. This would ensure that future initiatives would address information mistruths or ambiguity. The

project could also focus on developing or updating information sheets on iconic species that people are likely to feel connected to, highlighting their fire management requirements while addressing bushfire risk mitigation.

Investment required

The investment required of conducting a community attitude survey would be determined by the scope of work and the intended sample group or targeted sector of the community. An estimated investment is \$100,000 to \$125,000. Producing communication material that showcases iconic species of the RH&C region, and their fire management considerations, is estimated as \$50,000 to \$75,000.

Key stakeholders

Local governments would be a key stakeholder, with the highest level of interest and influence due to their communication with local residents. They could take a key role in engaging with the community and communicating the results to policymakers. Landscapes SA boards could collaborate with local government in the development of landowner communication and media once engagement had taken place.

References

Bardsley, D. K., Weber, D., Robinson, G. M., Moskwa, E., & Bardsley, A. M. (2015). Wildfire risk, biodiversity and peri-urban planning in the Mt Lofty Ranges, South Australia. *Applied Geography*, 63, 155–165. <https://doi.org/10.1016/j.apgeog.2015.06.012>

Department for Environment and Natural Resources. (n.d.). *Ecological Fire Management Strategy—Southern Brown Bandicoot* [Government of South Australia]. Retrieved 1 March 2023, from <https://cdn.environment.sa.gov.au/environment/docs/ecological-mgt-strategy-southern-brown-bandicoot.pdf>

Department of Climate Change, Energy, the Environment and Water. (2022, August 10). *Bushfire management and national environment law—DCCEEW*. Bushfire Management and National Environment Law. <https://www.dcceew.gov.au/environment/epbc/publications/factsheet-bushfire-management-and-national-environment-law>

Department of Environment, Land, Water and Natural Resources. (2015). *Ecological Fire Management Strategy—Glossy Black-cockatoo*. Government of South Australia. <https://www.environment.sa.gov.au/topics/fire-management/fire-and-the-environment/ecological-strategies-and-guidelines>

Driscoll, D. A., Armenteras, D., Bennett, A. F., Brotons, L., Clarke, M. F., Doherty, T. S., Haslem, A., Kelly, L. T., Sato, C. F., Sitters, H., Aquilué, N., Bell, K., Chadid, M., Duane, A., Meza-Elizalde, M. C., Giljohann, K. M., González, T. M., Jambhekar, R., Lazzari, J., ... Wevill, T. (2021). How fire interacts with habitat loss and fragmentation. *Biological Reviews*, 96(3), 976–998. <https://doi.org/10.1111/brv.12687>

Driscoll, D. A., Lindenmayer, D. B., Bennett, A. F., Bode, M., Bradstock, R. A., Cary, G. J., Clarke, M. F., Dexter, N., Fensham, R., & Friend, G. (2010). Resolving conflicts in fire management using decision theory: Asset-protection versus biodiversity conservation. *Conservation Letters*, 3(4), 215–223.

Gill, A. M. (2012). Fire regimes, biodiversity conservation and prescribed burning programs.pdf. *Proceedings of the Royal Society of Victoria*, 124(1), 1–6.

Landscapes Kangaroo Island. (2023). *Glossy Black-cockatoo Recovery Program* [SA Government]. Landscapes Kangaroo Island. <https://www.landscape.sa.gov.au/ki/native-plants-and-animals/glossy-black-cockatoo-recovery-program>

Long, K. (n.d.). *Improving Bandicoot Habitat in the Mount Lofty Ranges A guide to weed removal, regeneration and revegetation*. Department for Environment and Heritage. Retrieved 2 February 2023, from <https://cdn.environment.sa.gov.au/landscape/docs/hf/bandicoot-habitat-restoration-fact.pdf>

Morgan, G. W., Tolhurst, K. G., Poynter, M. W., Cooper, N., McGuffog, T., Ryan, R., Wouters, M. A., Stephens, N., Black, P., Sheehan, D., Leeson, P., Whight, S., & Davey, S. M. (2020). Prescribed burning in south-eastern Australia: History and future directions. *Australian Forestry*, 83(1), 4–28. <https://doi.org/10.1080/00049158.2020.1739883>

Moskwa, E., Bardsley, D. K., Weber, D., & Robinson, G. M. (2018). Living with bushfire: Recognising ecological sophistication to manage risk while retaining biodiversity values. *International Journal of Disaster Risk Reduction*, 27, 459–469. <https://doi.org/10.1016/j.ijdrr.2017.11.010>

The Royal Commission into National Natural Disaster Arrangements. (2020). *Background Paper: Land management – hazard reduction: A literature review*. Commonwealth of Australia.

Treize, D. J., Facelli, J. M., Paton, D. C., & Davies, R. J.-P. (2022). Prescribed Burns can Favour Establishment of Threatened Swamp Flora Depending on Grazing and Fire Seasonality. *Connecting Communities. Creating Resilience*. AFAC 2022.

The Spotlight Studies were produced by the Nature Conservation Society South Australia (2023) under the Resilient Hills & Coasts Bushfire and Biodiversity Project. This project received grant funding from the Australian Government. The work was overseen by the Resilient Hills & Coasts Working and Advisory Groups, comprising representatives from Adelaide Hills Council, Alexandrina Council, Kangaroo Island Council, Mt Barker District Council, District Council of Yankalilla, City of Victor Harbor, SA State Emergency Service, SA Country Fire Service, Department for Environment and Water, Landscapes Hills and Fleurieu, Landscapes Kangaroo Island, Regional Development Australia (Adelaide Hills, Fleurieu and Kangaroo Island), Southern & Hills LGA, and Resilient South.



We acknowledge and respect the ongoing cultural and spiritual connection that First Nations people have with their country, and their commitment to its stewardship for future generations.

SUMMARY

Weed invasions and infestations are a common and ongoing issue in rural, peri-urban, and urban areas. Weeds such as perennial pasture grasses or other non-native herbs, increase fuel loads in native ecosystems such as grasslands, and across the landscape more broadly.

Within the Adelaide and Mount Lofty Ranges (AMLR) area, an estimated 99% of native grasslands and 90% of grassy woodland ecosystems have been lost since colonisation (Fairney, 2022). Native grasslands have a lower fuel load compared to exotic species (Bull, 2011-see Figure 1). Many native grass species remain green in summer and are considered by some to mitigate against bushfires (Delpratt, 2018b; Myers, 2014).

Research has shown that fuel loads increased by two times, and fire intensity by up to three times, in grasslands invaded with exotic species compared to uninvaded native kangaroo (*Themeda triandra*) grasslands (Walker & Morgan, 2022). High fire intensity and changed fire regimes negatively affect biodiversity (Gill et al., 2014). It is therefore suggested that best-practice weed management at an appropriate scale and location, may improve biodiversity outcomes, as well as reduce bushfire risk to built assets and human life. This spotlight study discusses several examples of fuel reduction restoration and weed control management.

SPOTLIGHT STUDY 8

Integrating weed management and native grass restoration to reduce bushfire risk and improve biodiversity

Key Findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

In 2012, a Roadside Fuel Reduction Trial began at seven sites in the Adelaide Hills (Mount Lofty Ranges) representing a cross-agency project trialing native perennial grasses to reduce fuel load along roadsides. Two seasons of weed control was undertaken before any native grass seeding commenced (Native Grass Resources Group, 2014). Two sites were sown in summer with C₄ grasses (warm-season active; *Themeda* sp. and *Bothriochloa* sp.), and germination was initially patchy due to low rainfall (*Themeda* was less successful because of multiple winter frosts). Other sites were sown in autumn and winter with various combinations of C₄ (*Bothriochloa* sp., *Aristida* sp. and *Chloris* sp.) and C₃ (cool-season active; *Microlaena* sp.) grasses.

The project achieved its short-term goal of compositional change from high-fuel load annual grasses to perennial native grasses. The annual weedy grasses were largely absent from most sites during the trial. Native grass seed (*Bothriochloa* sp. and *Themeda* sp.) was successfully harvested from two sites, providing a small financial return. Several sites were invaded by faster growing and competitive exotic C₄ grasses, and may have benefitted from an additional year of weed control prior to sowing (Myers, 2014). Beyond 2014, maintenance was not undertaken at any of the sites which resulted in weed invasion (both broad-leaf weeds and weeds from surrounding un-slashed/un-grazed paddocks). One of the project stakeholders believed that the project would have been successful long-term with ongoing investment in weed management (R Myers 2022, pers. comm. 24 December). More recent research (Durnin, 2021) provides

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

evidence on methods for establishing native grasses where annual weeds are dominant, which could provide guidance for future roadside projects.

A recent study in the Para Woodlands, South Australia, found that C₃ native grasses were the most effective at competing with exotic C₃ grasses, compared with native C₄ and combination C₃/C₄ (Smith et al., 2021). Exotic cool-season active grasses commonly dominate native perennial grasses in Mediterranean ecosystems. When native C₃ grasses were planted at high densities (44 plants/m²) they were most effective at reducing exotic grass biomass.

Seasonal conditions vary so combination plantings would be ideal (planting occurred after the first substantial rains in May for C₃, and August for C₄ species), as high spring rainfall favours C₃ and a dry spring with wet summer favours C₄ species. When planted as one year old tube-stock, which was done due to time restrictions of the study, these native perennial grasses were found to be strong underground competitors for soil nutrients and water. Further research would be needed to determine whether direct seeding could achieve similar results.

It is generally agreed that native perennial grasses are slow to establish (compared with annual exotic grasses), and therefore susceptible to being outcompeted by fast growing annual weeds (Durnin, 2021). One example where roadside grasslands have been successfully restored is Woorndoo in South-western Victoria (Tuck, 2018; Victorian Volcanic Plains Conservation Management News, 2018). This case study involved wide strips of roadside that were previously cropped and mostly pasture grasses which were restored to native grasslands. Delpratt (2018) suggests that *Themeda* sp. (kangaroo grass) is suitable for roadside plantings but slow to establish, and *Rhynchospora* sp. (wallaby grass), *Poa* sp. and other native grasses are also suitable.

Using the results from the Ngarri-djarrang urban grassland restoration project, Bainbridge, (2009) concluded that biomass reduction, through burning or slashing, is needed to maintain native grasslands. The Ngarri-djarrang project successfully restored a native grassland and long-term suppression of weeds, through strong community group involvement (to assist in weed control and support the project), and ecological burns for long-term maintenance of native grasses and herbs (Bainbridge, 2009).

As mentioned in the summary section, grasslands invaded with weeds can have far higher fuel and fire intensity compared to uninvaded native kangaroo grass ecosystems (Walker & Morgan, 2022; Bull, 2011: Figure 1), which reinforces the need to control annual weeds as a fire mitigation strategy.

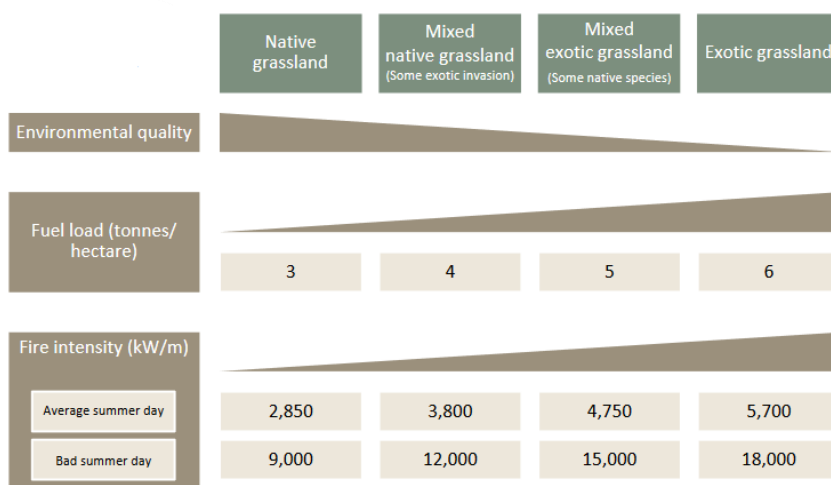


Figure 1: Exotic grasses degrade native grasslands and increase fuel load and fire intensity (Bull, 2011).

Additional key findings

Success of the Woorndoo, South-western Victoria, native grassland restoration was attributed to a dedicated community group (The Woorndoo Land Protection Group) with support from their local council and long-term maintenance, which included regular biomass reduction burns by the Country Fire Agency (CFA), Victoria (Tuck, 2018).

Native grasses produce less biomass than exotic grasses (2-5 tonnes/ha compared to up to 20 tonnes/ha) (Fairney, 2022). In northern Australia Setterfield et al. (2013) found that invading non-native grasses had substantially increased fuel loads and contributed to lengthening the season of severe fire risk by six weeks annually. The resulting higher fuel load had increased fire management costs by around nine times over a ten-year period. Similarly in temperate native grasslands (infrequently burned), invasion by exotic grasses contributed to a five times greater fuel load, or two times greater in those burned frequently (Walker & Morgan, 2022). These studies highlight both the advantages of healthy native grassland ecosystems and the importance of weed management strategies in reducing fire risk.

The benefits of native grasses are already recognised in the region and residents are being encouraged to control exotic grasses and promote native grasses to reduce fire risk (Landscapes Hills and Fleurieu, 2022a). Landholders affected by the 2019 Cudlee Creek bushfire are being shown how to establish native grass pastures to reduce bushfire risk via demonstration site workshops (Landscapes Hills and Fleurieu, 2022b). This kind of messaging and education could be expanded across the entire RH&C region to promote biodiversity and reduce summer fuel loads in grasslands ecosystems and pastures.



"Many native grasses remain green in summer and have relatively low biomass, which helps to reduce the overall fire risk to your property." source: Landscapes Hills and Fleurieu, 2022a.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

Relevance to the Resilient Hills & Coasts (RH&C) Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

Roadsides in the Mount Lofty Ranges region often contain degraded native vegetation with an understory of exotic weeds and have been found to substantially increase fire mitigation costs, by adding to summer fuel loads (Setterfield et al., 2013). Some native perennial grasses remain green in summer while introduced grasses dry during this time, contributing to a higher fuel load than in a native grassy ecosystem (Setterfield et al., 2013). Weed control for fuel reduction in Adelaide Mount Lofty Ranges is costly (slashing, mowing and other control) and is the responsibility of various stakeholders, including local government, National Parks and Wildlife, Department for Infrastructure and Transport, landscape boards and landholders.

Native grassland habitats are poorly represented in the RH&C region, and restoration projects that combined weed management with native grass restoration, at the right scale and location with adequate investment, could reduce fire risk and improve biodiversity outcomes.

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (The Royal Commission into National Natural Disaster Arrangements, 2020a), mitigation action will be necessary. However, in the context of fire, climate can heavily influence the outcomes regardless of management.

Exotic annual grasses/weeds will always be an issue in Australia, contributing to high fuel loads and degrading native ecosystems. Controlling them is important in the context of climate change where their additional fuel load contributes to increasing fire risks.

The C₄ species of native grasses are theoretically better adapted to coping with climate change (warmer temperatures) in the region as aridity favours the dominance of C₄ species (Lattanzi, 2010), though different seasonal conditions favour different functional (C₃/C₄) species (Smith et al., 2021). Hence, high biodiversity is

important in restoration, to buffer ecosystems against climatic changes.

Social license

Weeds are generally accepted as a fire risk and undesirable, so weed control is thought to have high community support and approval. However, large scale restoration plantings or maintaining areas of native grasses could be perceived as a fire risk if community are not aware of the different fuel loads for native grasses versus exotic grasses. Education and awareness would strengthen the social license and could be achieved with signage that better explains the benefits of native grasses.

Knowledge gaps, caveats, and assumptions

The results from the projects presented within this study are spatially and temporally explicit. There may be different results depending on the site, scale, timing, commitment (funding and community), the management history of the selected site, and risk of weed reinvasion from adjacent land.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

Risks

There are three key risks with the type of restoration projects outlined in this Spotlight Study: a) ongoing and widespread invasion by exotic grasses that are fast growing and dominant, creating high fuel loads in summer; b) a perceived risk if members of the community view native grasses as an increased fire risk similar to exotic weeds; and c) a high risk of failure or poor return on investment if the initiative is not undertaken at the right scale and managed longer term. When undertaking a native grassland restoration project, a high level of confidence that weeds can be managed long-term is essential to success. When establishing a new site, preparation methods such as scraping (removing topsoil to remove existing weed seeds and excess nutrients) or pre-treating the site with herbicide for several seasons can assist in reducing weed invasion, and follow-up weed control is always required.

Further work in Resilient Hills & Coasts

To reduce summer biomass and increase biodiversity, landholders in the region could be further encouraged to incorporate native grass plantings into pastures, around homes and assets, into revegetation areas and along roadsides throughout the region. Education about grass

identification, seed sourcing and provenance, and best practice management of native grasslands could be included, to assist in the promotion of native grasses and the control of exotics. Native grass restoration, coupled with introduced grass control, could be relevant and implementable within a semi-urban setting.

Investment required

The investment required would be determined by the scope of work, the number of sites and the spatial scale. At a minimum, an estimated investment of \$150,000 to \$250,000 per year for 4 years is required.

Key stakeholders

The key stakeholders will be determined by the ownership of the chosen site for restoration/weed control. It may be local council, Department for Transport and Infrastructure, National Parks and Wildlife, private landholders, or a combination. There is also potential for implementation on private properties, but it is recommended that future plantings be demonstrated on public land as this will provide an initial proof-of-concept and have a greater outreach impact due to greater visitation (if the right signage and communication accompanies the demonstration sites).

References

- Bainbridge, B. (2009). *Restoring a Native Grassland community: The Ngarrri-djarrang (Central Creek) example*.
- Delpratt, J. (2018, August 13). Kangaroo Grass communities on roadside reserves—Part 1. *Recreating the Country*. <https://www.recreatingthecountry.com.au/blog/grassland-s-and-grassy-woodlands-in-temperate-australia-kangaroo-grass-communities-on-roadside-reserves-part-1-by-guest>
- Durnin, M. (2021). *Comparison of methods for establishing native grasses in pastures dominated by annual weeds*.
- Fairney, A. (2022). *Seeding Natives—Home*. Seeding Natives. <https://seedingnatives.org.au/>
- Landscapes Hills and Fleurieu. (2022a). *Cudlee Creek bushfire recovery*. Landscape South Australia - Hills and Fleurieu. <https://www.landscape.sa.gov.au/hf/our-priorities/land/fire-recovery/cudlee-creek-fire-recovery>
- Landscapes Hills and Fleurieu. (2022b, May 31). Native Grasses [Facebook Post]. *Native Grasses*. <https://www.facebook.com/watch/?ref=saved&v=717756752676781>
- Lattanzi, F. A. (2010). C3/C4 grasslands and climate change. *Grassland Science in Europe*, 15, 3–13.
- Native Grass Resources Group. (2014, January 28). *Roadside Fuel-Reduction Trial | Australian Native Grasses*. Australian Native Grasses. <https://nativegrassresourcesgroup.wordpress.com/2014/01/28/roadside-fuel-reduction-trial/>
- Smith, M., Pound, L., & Facelli, J. M. (2021). *Resource pre-emption, rather than extending the growing season of native grass assemblages, reduces invasion by exotic species*. 24(4). <https://doi.org/10.1111/avsc.12613>
- The Royal Commission into National Natural Disaster Arrangements. (2020). *Background Paper: Land management – hazard reduction: A literature review*. Commonwealth of Australia.
- Tuck, J. (2018, November 27). *Tiptoe through the Themeda... notes from a grassland restoration day at Woorndoo—Nature Glenelg Trust*. <https://natureglenelg.org.au/ptiptoe-through-the-themeda-notes-from-a-grassland-restoration-day-at-woorndoo/>
- Victorian Volcanic Plains Conservation Management News. (2018, December 29). Bringing back a roadside grassland. *Victorian Volcanic Plains Conservation Management News*. <https://victorianvolcanicplainscmn.wordpress.com/2018/12/29/bringing-back-a-roadside-grassland/>
- Walker, Z. C., & Morgan, J. W. (2022). Perennial pasture grass invasion changes fire behaviour and recruitment potential of a native forb in a temperate Australian grassland. *Biological Invasions*, 24(6), 1755–1765. <https://doi.org/10.1007/s10530-022-02743-4>

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SUMMARY

The concept of novel ecosystems, and their role and function in biodiversity conservation, continues to be debated (Miller and Bestelmeyer, 2016). Novel ecosystems are modified components (biotic and abiotic) of an ecosystem, resulting from human induced actions and interventions. This does not mean that novel systems and habitat have no biodiversity value, and there is a risk that if community and households view these habitats (as they are usually weedy) as a fire risk and thus reduce or remove them. This has implications for the biodiversity assets that rely on them.

Dense blackberry (an introduced species) thickets occur throughout the Mount Lofty Ranges with considerable accumulation of dead plant material that is considered a high fuel load and bushfire hazard. Although an introduced species and declared weed, blackberry can also function as critical habitat for the endangered southern brown bandicoot (*Isodon obesulus obesulus*) when good quality native habitat is absent (Packer et al., 2016).

Other threatened native species have adapted to using novel habitats, such as yellow-tailed black cockatoos (*Calyptorhynchus funereus whitei*) that rely on the introduced Aleppo pines as a crucial alternate food source (Milne, 2020). An evidence based and site-specific approach is required that balances out bushfire risks with maintaining areas that are currently being used, or those that have a connectivity value, for these threatened species.

SPOTLIGHT STUDY 9

Management of novel habitats – balancing fire risk and biodiversity resilience

Key findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

Vegetation in the Resilient Hills and Coasts (RH&C) region includes both native remnant and novel ecosystems. A novel ecosystem is one that has been directly altered by humans (deliberately or unintentionally), and that has passed a threshold in the ecosystem's trajectory so that it cannot return to its previous state (Morse et al., 2014). An example would be bushland that has been invaded by introduced weeds for a long period of time, so that the previous structure, diversity, and ecosystem processes can't be returned to the state of the original natural uninvaded bushland. Novel ecosystems are present in landscapes altered by humans (Morse et al., 2014), such as the highly fragmented, cleared, and increasingly populated RH&C region.

Although novel ecosystems are not natural ecosystems, they are often important for biodiversity as they can provide valuable habitat for threatened species. One example of a weed prevalent in the Mount Lofty Ranges (MLR) is European blackberry (*Rubus fruticosus*), which is an aggressive and invasive weed species that is also a [Weed of National Significance](#). Under the *Landscape South Australia Act 2019*, landholders have a legal responsibility to control blackberry on their property (Section 192) and Regional Landscape Boards are responsible for road reserves that are situated within a declared area (Section 192; 8). Blackberry is also considered a fire hazard (NSW Department of Primary Industries 2009) as the dead material is a significant fuel load, and it can obstruct access and egress during a fire event. However, it is also valued in some locations as habitat for the endangered southern brown bandicoot.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

The southern brown bandicoot uses highly modified (novel) habitats of scattered eucalyptus and a sparse understory with introduced grasses and thickets of blackberry. These novel ecosystems can provide bandicoots with protection from predators such as foxes, particularly in fragmented and degraded peri-urban areas where quality dense native understory vegetation is absent (Packer et al., 2016). In bandicoot habitat, removal of blackberry stands will not only expose bandicoots to predation but possibly impact on their ability to disperse throughout the landscape. The importance of blackberry for bandicoots has also been documented in Tasmania (City of Hobart, 2020) and Victoria (Deakin University, 2019).

This creates a challenge for land managers in the Mount Lofty Ranges (MLR) as the decision to remove or reduce blackberry needs to consider bandicoot habitat requirements (if they are present or could potentially use the area), fire risk and legal responsibility to control blackberry (under the Landscape South Australia Act 2019).

Another example of a threatened species using novel habitat is the vulnerable yellow-tailed black cockatoo that use the Aleppo pine seeds as a major food source. Aleppo pines (*Pinus halepensis*) are an environmental weed that will usually germinate close to the parent plant, but with the ability to spread further as seeds are wind dispersed (Way, 2006). Aleppo pines are also considered a fire hazard due to their highly flammable cones (Natural Resources Adelaide Mount Lofty Ranges, 2015) and needle senescence, with its low moisture content, that can enhance the probability of canopy fire (Balaguer-Romano et al., 2020). On the Eyre Peninsula, South Australia, these birds are known to return to the same Aleppo pine stands each summer breeding season to feed (Department for Environment and Heritage, 2008) and removal of these pines is considered a threat to the long-term survival of the yellow-tailed black cockatoo on the Eyre Peninsula. This is an example of the complexities of managing fire risk in novel habitats, and the importance of evaluating biodiversity assets in land management planning before undertaking fire management strategies.

When undertaking fire preparation and risk management, biodiversity assets should be considered at each site, but also within a broader landscape and population viability context. The use of a weed patch or an area of heavily modified native habitat, for food, nesting, breeding, or shelter, should be confirmed before any control or removal is undertaken. Anecdotal or opportune observations, and the use of remote cameras, can assist in confirming the presence of threatened fauna. A current recommendation for woody weed removal to protect threatened fauna species is a slow staged removal at the rate that additional suitable natural habitat can be established (i.e. either by natural regeneration or restoration; (Long, n.d.)), but this may require the removal to occur over many years. Habitat requirements of a particular species may be very specific in terms of structure or age. For example, southern brown bandicoot habitat must be low and dense (> 70% cover), with a diverse array of understory species (up to 7 plant species per 1 m²), irregularly spaced shrubs and large variation in tree ages and sizes (Long, n.d.). These requirements may be difficult to achieve via restoration of natural regeneration in a short timeframe, therefore novel habitats that are being used by threatened species should be carefully managed and retained till suitable habitat is established. More broadly, when undertaking removal of weeds in novel ecosystems, a gradual and adaptive approach should be taken that integrates restoration of native vegetation, and considers the overarching conservation goals like habitat connectivity and ecosystem function (Kennedy et al., 2018; Packer et al., 2016).

Relevance to the Resilient Hills & Coasts (RH&C) Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

The RH&C region supports many novel habitats, such as the blackberry thickets discussed in this Spotlight Study. Landholders may be aware of their legal responsibility to control declared weeds, but unaware of the value of novel habitats in supporting threatened fauna species. Developing and communicating consistent messaging on decision making and best practice management of novel habitats can improve biodiversity resilience within the Mount Lofty Ranges.

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (The Royal Commission into National Natural Disaster Arrangements, 2020a), mitigation action will be necessary. However, in the context of fire, climate can heavily influence the outcomes regardless of management.

Distributions and composition of native ecosystems and novel ecosystems may change as the climate changes, so best practice management of novel ecosystems that are used by threatened species, such as the southern brown bandicoot, could become increasingly important. There is an opportunity to be responsive and control weedy areas if they are no longer being used or needed by target species. Conversely, as new interactions between novel ecosystems and species emerge, this information can be communicated and conveyed to land managers.

Scalability and implementation

Showcasing examples of novel systems that are needed for biodiversity conservation, and demonstrating other actions to reduce fire risk, could be applied at a property scale or multiple properties. These could serve as

demonstration sites to educate community and landowners. The demonstration sites could focus on staged removal of weed species concurrent with restoration, with regular workshops so participants could get real-life training on how to approach this over a longer-term period.

Clear and consistent communication about best practice management of novel systems for threatened species is highly adaptable to the Resilient Hills & Coasts Region. If communication material used common language, and addressed the “grey areas”, there could be a greater uptake of managing novel systems for biodiversity, without increasing fire risk.

Social license

It is expected that the trust and approval of showcasing novel ecosystems and advising against weed control if appropriate, will be mixed. There is likely to be some fear and anxiety around fire risk, or a historical weed stewardship behaviour where landholders are committed to ongoing weed management, but without an adequate understanding about the value of novel habitats for native species. Conversely, as Moskwa et al. (2018) noted, there is community support for considering biodiversity in fire management and a broad lack of support for unnecessary vegetation clearance (Moskwa et al. (2018).

Risks

Overall, a targeted communication approach that provides information about novel ecosystems and how to make better decisions that balance fire risk and biodiversity requirements is considered low risk if it is based on evidence and the messaging is clear and specific. The key risks include a) not having up to date information about presence (or emerging needs) of threatened species using novel habitat; b) landholders misinterpreting the messages, or using the information to justify ineffective weed management, even if it has no novel habitat value; and c) if novel habitats and weed areas are the source of a fire, this will discourage others from maintaining critical areas needed for threatened species.

Knowledge gaps, caveats, and assumptions

There are some points of contention around the best practice management of weeds in novel ecosystems, such as blackberry. There is an underlying assumption that removal of the weed species will have an overall positive impact on native and threatened species. Although there is sufficient information about some threatened fauna that are dependent on novel ecosystems, it is unknown if there are other species that also rely on weedy habitats, such as nectivorous birds, as was the case in 'novel ecosystems in urban Perth', WA (Kennedy et al., 2018).

Further work in the Resilient Hills & Coasts region

A project in the RH&C region could look to review priority threatened species management, and their reliance on weeds and novel habitats (that may include weeds), based on current and predicted use. These could be balanced out against the fuel loads of the site and a decision-making-trade-off framework developed (see Spotlight Study #4). Demonstration sites that showcase the concepts as discussed in this study would also be highly valuable.

Investment required

There are two key staged investments required. The first investment would fund a desk-top and mapping assessment of threatened species that currently, or will likely, use novel habitats overlaid with fuel risk to develop a decision making framework-estimated \$75,000 to \$100,000. The next stage requires the development of communication materials (<\$25,000) and establishing demonstration sites \$50,000 to \$75,000.

Key stakeholders

Anyone undertaking fire risk management would be a key stakeholder. This includes private landholders, Department of Primary Industries and Regions (PIRSA), CFS, local councils (particularly Fire Prevention and Biodiversity Officers) and the State Government (e.g., National Parks and Wildlife Service SA).

References

- Balaguer-Romano, R., Díaz-Sierra, R., Madrigal, J., Voltas, J., & Resco de Dios, V. (2020). Needle Senescence Affects Fire Behavior in Aleppo Pine (*Pinus halepensis* Mill.) Stands: A Simulation Study. *Forests*, 11(10), 1054. <https://doi.org/10.3390/f11101054>
- City of Hobart. (2020, December). Blackberries and bandicoots [Local Government]. *The Bandicoot Times - Summer 2020-21*, No. 79. https://issuu.com/thecityofhobart/docs/bandicoot_times_summer_2020-21_-_no_79/s/11524540
- Deakin University. (2019). Deakin research show bandicoots can thrive in Melbourne’s outskirts [Deakin University]. Deakin University. <https://www.deakin.edu.au/about-deakin/news-and-media-releases/articles/deakin-research-show-bandicoots-can-thrive-in-melbournes-outskirts>
- Department for Environment and Heritage. (2008). Eyre Peninsula Yellow-tailed Black-Cockatoo Regional Recovery Plan. <https://cdn.environment.sa.gov.au/environment/docs/pa-rec-eyre-yellowtailedblackcockatoo.pdf>
- Kennedy, P. L., Fontaine, J. B., Hobbs, R. J., Johnson, T. N., Boyle, R., & Lueders, A. S. (2018). Do novel ecosystems provide habitat value for wildlife? Revisiting the physiognomy vs. floristics debate. *Ecosphere*, 9(3), e02172. <https://doi.org/10.1002/ecs2.2172>
- Long, K. (n.d.). Improving Bandicoot Habitat in the Mount Lofty Ranges A guide to weed removal, regeneration and revegetation. Department for Environment and Heritage. Retrieved 2 February 2023, from <https://cdn.environment.sa.gov.au/landscape/docs/hf/bandicoot-habitat-restoration-fact.pdf>
- Morse, N. B., Pellissier, P. A., Cianciola, E. N., Brereton, R. L., Sullivan, M. M., Shonka, N. K., Wheeler, T. B., & McDowell, W. H. (2014). Novel ecosystems in the Anthropocene: A revision of the novel ecosystem concept for pragmatic applications. *Ecology and Society*, 19(2). <https://doi.org/10.5751/ES-06192-190212>
- Moskwa, E., Bardsley, D. K., Weber, D., & Robinson, G. M. (2018). Living with bushfire: Recognising ecological sophistication to manage risk while retaining biodiversity values. *International Journal of Disaster Risk Reduction*, 27, 459–469. <https://doi.org/10.1016/j.ijdr.2017.11.010>
- Natural Resources Adelaide Mount Lofty Ranges. (2015). Aleppo Pine Fact Sheet. Weed Identification: Aleppo Pine. <https://cdn.environment.sa.gov.au/landscape/docs/hf/aleppo-pine-fact-sheet.pdf>
- Packer, J. G., Delean, S., Kueffer, C., Prider, J., Abley, K., Facelli, J. M., & Carthew, S. M. (2016). Native faunal communities depend on habitat from non-native plants in novel but not in natural ecosystems. *Biodiversity and Conservation*, 25(3), 503–523. <https://doi.org/10.1007/s10531-016-1059-0>
- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.

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SUMMARY

Attitudes and behaviours are often driven by perception rather than evidence or well-informed information. In the absence of information, or the inability to access fit-for-purpose information, individuals can decide not to act, or implement inappropriate landscaping that exposes them and the broader community to bushfires.

In response to COVID-19, the movement into peri-urban areas and well-connected regional towns such as those in Adelaide Hills and Fleurieu Peninsula, has accelerated (Plan SA 2021). As new developments are planned, and new homes constructed, owners have an opportunity to consider and use the most appropriate landscaping design and materials, for the location.

Developing a planting and landscape guide (or fact sheet) that considers topography, species, densities, heat barriers, water availability, access and egress, and biodiversity, will ensure that management is based on the best information available at the time and not on perceptions, mistruths, and fear. The guide should use terms and messaging that is agreed by key stakeholders and be conveyed using a common language approach.

SPOTLIGHT STUDY 10

Provision of landscaping advice to landholders and households that will consider bushfire risk reduction and biodiversity conservation

Key findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

Information on landscaping and vegetation management to reduce the risk of exposure or severity of bushfires has been branded or described in various ways throughout Australia. For example, “fire-wise” is being used increasingly over the more literal terminology of “low flammability plants”. Branding under “fire-wise” allows for considerations other than low flammability (or fire retardant) plants and fire breaks, such as housing design and landscaping material.

Other terms that were encountered during the literature review included “fire-smart” and “fire-ready”. A review of literature identified two key resources with examples and general recommendations on ‘fire-wise’ properties. It is also common for resources to integrate home “hardening” advice (risk reduction focused on materials and design of homes) with landscaping and vegetation management advice (CFA 2022; Bushfire Resilience Inc. 2020). An additional resource, specifically for properties in the RH&C region is the ‘Where we build, What we build’ factsheets on

building climate ready homes, and housing archetypes- [here](#).

The Country Fire Authority of Victoria (CFA) has produced a guide to help residents reduce their bushfire risk, ‘Landscaping for bushfire: Garden design and plant selection’ (CFA 2022). This guide is targeted towards residential properties and aims to provide information on how to design and manage gardens and other vegetation to reduce the risk of exposure to fire. The guide addresses the foundations of bushfire behaviour and their interactions with buildings, planning and designing gardens for new and existing houses, choosing suitable plants, maintaining the garden, and other resources. The rules and recommendations surrounding native vegetation clearance are also explicitly laid out. Advice on landscaping for bushfire also features specific models of gardens (i.e., coastal and hills gardens) to provide situational examples as well as general

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

advice. While these recommendations include non-native species as options, they also highlight when and where native vegetation could be retained, and recommend native species considered suitable for plantings.

Similarly, the book titled 'Safer Gardens: Plant Flammability and Planning for Fire', by Lesley Corbett (2021) aims to educate people on "fire-wise" garden designs and low-flammability plants. Corbett (2021) discusses specific plant recommendations as well as plant placement and arrangement options to create the most defensible and fire-resistant garden. While this publication is tailored towards a Victorian context, this may serve as a guide to establish a South Australian version. The South Australian Sustainable Landscapes project has a fact sheet on reducing fire risk in gardens, including a specific section about landscaping, and this is a useful reference that can assist households – see [here](#). The RH&C as part of the 'Where we build. What we build' project has a series of reports that provides information on having climate ready homes and properties – see [here](#).

The South Australian Country Fire Services and the Department of Environment and Water have similar information available (CFA 2022; DEW 2020), however, may benefit from referencing the above documents, or including some of the information. In response to the 2019-2020 bushfires, the Adelaide Hills Council, South Australia, developed guidelines for planting native habitat for low flammable gardens (Adelaide Hills Council, n.d). This is an excellent guide that could be adapted to focus on specific areas within the RH&C region.

Examples and general advice for creating fire-wise properties include:

- Using fire-resistant materials in garden and house design, for example: mulching with gravel/pebbles instead of bark, stone/concrete fencing instead of wood, use of non-combustible decking and decking structures (CFA 2022; Bushfire Resilience Inc. 2020).
- Fire-wise design of built aspects of gardens and homes, for example: using non-combustible fences as windbreaks, locating non-flammable surfaces near the home such as paths and paved areas, placing features such as pools/water features, tennis courts, well-maintained vegetable gardens in the most likely direction of fire approach (CFA 2022).
- Fire-wise garden design, for example: creating separation between plants/garden beds with low flammability materials between, such as paved paths, non-flammable mulch, water features, well-maintained grass lawn, etc., using low-flammability plants, and keeping plants well-watered (CFA 2022).
- Native vegetation management, for example: removal of high-risk weedy species, reduction of fuel load build-up such as dead foliage and bark caught in plants and on the ground, breaking continuity between fuels vertically and horizontally, and ensuring plants are well-watered (CFA 2022).

Below are examples of what a "fire-wise" rural garden (Figure 1) and coastal garden (Figure 2) may look like from the CFA 'Landscaping for bushfire: Garden design and plant selection' (2022).

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY



Figure 1: Adapted example of a fire-wise rural garden from the CFA (2022). “The front lawn (4), front driveway (5), turning circle (6) and kitchen garden (8) all provide further separation and areas of low fuel between the fire hazard and the house” (CFA 2022). There are also planted boundary windbreaks of species that “retain little dead leaves or twigs” (CFA 2022).



Figure 2: Adapted example of a fire-wise coastal garden from the CFA (2022). “The paved sitting area (1), lawn (2) and low-sitting wall (3) provide separation between the house and the direction of the most likely fire hazard” (CFA 2022). Similarly, the irrigated vegetable garden (6) and the “fleshy-leaved hedge” (5) have been placed in the area that will most likely be impacted by fire

In an extensive report by Moskwa et al. (2016), it was highlighted that residents in the Mount Lofty Ranges and the Lower Eyre Peninsula believed that improved education and community engagement were still necessary. They expressed disappointment in other residents’ preparation activities but acknowledge that this may be due to communication issues. One interviewee suggested there is a need to “fine tune some of the CFS policy-driven messages” such as the perception of needing to remove all vegetation close to properties. There was overall strong support for considering biodiversity in bushfire policy, (Moskwa et al. 2018) which highlights that residents within the RH&C region care not only about mitigating their risk of exposure to fire but also about maintaining and conserving biodiversity near their homes. For more information about this study, refer to the Resilient Hills & Coasts Bushfires and Biodiversity Spotlight Study #8.

Relevance to the Resilient Hills & Coasts Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

The Resilient Hills and Coasts region has many areas of high biodiversity value as well as high bushfire risk. The region has also seen considerable growth in residential development and population. Based on 2016 data, the growth is expected to continue at a rate of at least 0.82 (the medium projected growth rate) (DPTI 2019). According to 2021-2022 data, however, the population growth rate of South Australia was 1.0% (ABS 2022), indicating that we may surpass the projected population of 2 million by 2038. Therefore ensuring relevant, accurate and tailored information (to existing and new landholders) about how to reduce bushfire risk while maintaining biodiversity values, is crucial to community safety and biodiversity conservation. While there is good information available and active engagement currently undertaken by the Country Fire Service in the RH&C region, research has suggested further work is required.

Scalability and implementation

Education programs and information dissemination by CFS are the main modes of educating communities on bushfire risk, and appropriate mitigation actions. Local councils also provide information on bushfire risk and preparation. These programs may take place in a community or other education setting (e.g., schools) and should be able to integrate new recommendations as outlined above. As these programs are already implemented, scalability should not be an issue. Fine-tuning the information to be relevant and correct for a South Australian context will require additional work. However, much of the information should be easily sourced. It is also critical that outreach and messaging by stakeholders uses an agreed and common language. There are opportunities to work with developers and businesses within the landscaping sector to ensure that they provide advice, or themselves advocate for, landscaping design and materials that reduce exposure to bushfires.

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (The Royal Commission into National Natural Disaster Arrangements, 2020a), mitigation action will be necessary. However, in the context of fire, climate can heavily influence the outcomes regardless of management.

Adaptation of guidelines like the Victorian CFA 'Landscaping for bushfire: Garden design and plant selection' (2022) would be extremely useful to South Australian residents, landholders, and fire authorities, if adapted to address specific requirements of South Australian legislation and regional [Bushfire Management Area Plans](#) (BMAPs). Establishing communication outputs that highlight native South Australian plants that have low flammability or are appropriate for 'fire-wise' landscaping, and examples for specific regions of the RH&C footprint, would also be beneficial for biodiversity. Similarly, creating specific landscaping guidelines for people involved in new versus existing builds may help to provide clear and region-specific relevant information.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

This may also provide the opportunity for ‘fire-wise’ garden and house demonstration sites throughout the RH&C region.

Consideration of the impacts of climate change is required in all discourse surrounding fire management. Information and guidelines for garden and home design and management needs to be adaptive and to take climate change into account. It should also be highlighted in any education or information output that even the most “fire-wise” or well-managed property cannot be relied on solely to halt or slow down a fire, particularly under Extreme and Catastrophic conditions (CFA 2022). This needs to be conveyed to community and landowners using an agreed and common language.

Survey-based approaches to understanding individual attitudes and behaviours, as used by other studies (Mannakkara & Wilkinson 2012; Teo et al. 2018), can also be adapted to a range of contexts and locations. Surveys may be beneficial to identify at-risk and highly vulnerable communities or groups, and what financial or technical support they need to select better landscaping strategies.

Social license

As highlighted by Moskwa et al. (2016; 2018), residents of Mount Lofty Ranges, SA, demonstrated interest in improving community and household understanding of management actions for reducing risk of exposure to bushfires with biodiversity in mind. Currently, there appear to be misunderstandings about the risks associated with native vegetation in residential and other landholder settings (Moswka et al. 2018). However, Moskwa et al. (2018) reported that residents in the Adelaide Mount Lofty Ranges and Lower Eyre Peninsula were receptive to the ecological sophistication that may be needed to balance bushfire risk mitigation and biodiversity conservation policy.

Risks

The overall risk of progressing this study into a project is low to medium. As the study is focused on synthesising up-to-date and accurate information, and communicating this to residents, there are few risks involved.

There is still a risk that end-users (residents) could misinterpret the information, or unrealistic expectations if a resident or landowner undertakes the landscaping as suggested, and then assumes that they are completely protected from a bushfire. This is a medium risk that can be mitigated if people are provided with well written information using a common language to stress that under extreme conditions, any material can burn.

There may also be a conflict of fire management objectives and climate change resilience when recommending landscaping design. For example, the use of bark mulch is discouraged (for fire risk) but is likely beneficial for a cooling and greening objective. These conflicts will need to be considered and defined in all communication material to address potential risk.

Knowledge gaps, caveats, and assumptions

Although substantial information exists on landscaping for native vegetation management, further information is still required about specific plant flammability in real-life contexts. Most flammability studies have been done in controlled settings as field studies are difficult due to the high risk of experimental fire studies. More important, however, is the knowledge gap regarding how to best engage, support, and educate members of lower socio-economic groups on better landscaping. Research has highlighted that greater fire extent was associated with lower socio-economic status in Victoria and New South Wales (Akter & Grafton 2021) and suggested that this may in part be related to lesser fire suppression and hazard reduction capabilities (also see Resilient Hills & Coast Bushfires and Biodiversity Spotlight Study #5).

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

Clear pathways are also required to ensure that landscaping advice that considers both bushfire risk reduction and biodiversity benefits is championed and supported by other industry sectors such as planners, landscape architects, suppliers and other builders. This will be a crucial knowledge gap to fill to ensure appropriate information is provided to all communities.

Further work in the Resilient Hills & Coasts region

Landscaping guidelines similar to those referenced in this Spotlight Study, could be developed to advise on the use of appropriate hard and soft landscaping materials for different settings (e.g., landscape type, proximity to native vegetation) and circumstances (e.g., new builds versus existing builds).

This would involve a multi-disciplinary and across-agency approach.

Investment required

An initial feasibility study and blueprint is estimated to cost <\$25,000. This would identify information gaps, and risks to providing this information to residents. The development of the guidelines (excluding printing) for Resilient Hills and Coasts residents is estimated at \$50,000 to \$75,000.

Key stakeholders

The main stakeholders involved include the CFS, local council, local communities, businesses, schools, community groups, landholders, insurance businesses, support organisations, landscape architects, and primary producers.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

References

- Akter, S., & Grafton, R. Q. (2021). Do fires discriminate? Socio-economic disadvantage, wildfire hazard exposure and the Australian 2019–20 'Black Summer' fires. *Climatic Change*, 165(3–4), 53. <https://doi.org/10.1007/s10584-021-03064-6>
- Adelaide Hills Council (n.d). Native Habitat Gardening Guide for low flammability gardens [ENVIRONMENT-Low-Flammability-species_2020.pdf \(ahc.sa.gov.au\)](https://www.adelaidehills.gov.au/~/media/AdelaideHillsCouncil/Files/Environment/ENVIRONMENT-Low-Flammability-species-2020.pdf)
- Australian Bureau of Statistics (ABS). (2022). National, state and territory population. Viewed on 17 February 2023 <<https://www.abs.gov.au/statistics/people/population/national-state-and-territory-population/latest-release>>
- Bushfire Resilience Inc. (2020). How to harden an existing house. Viewed on 17 February 2023 <<https://bushfireresilience.org.au/webinar-recordings/2020-webinar-2/>>
- Corbett, L. (2021). Safer Gardens: Plant Flammability and Planning for Fire. Australian Scholarly Publishing, North Melbourne, Victoria.
- Country Fire Authority (CFA). (2022). Landscaping for Bushfire: Garden Design and Plant Selection.
- Department for Environment and Water. (2020). Managing Native Vegetation: How to reduce the impact of bushfire and the steps you need to take.
- Department of Planning, Transport and Infrastructure. (2019). Populations Projections for South Australia and Regions, 2016-41. <https://www.dit.sa.gov.au/__data/assets/pdf_file/0008/563813/Population_Projections_for_South_Australia_and_Regions_2016-41_-_May_2019.pdf>
- Moskwa, E., Bardsley, D. K., Weber, D., & Robinson, G. M. (2018). Living with bushfire: Recognising ecological sophistication to manage risk while retaining biodiversity values. *International Journal of Disaster Risk Reduction*, 27, 459–469. <https://doi.org/10.1016/j.ijdr.2017.11.010>
- Moskwa, E. C., Ahonen, I., Santala, V., Weber, D., Robinson, G. M., & Bardsley, D. K. (2016). Perceptions of bushfire risk mitigation and biodiversity conservation: A systematic review of fifteen years of research. *Environmental Reviews*, 24(3), 219–232. <https://doi.org/10.1139/er-2015-0070>
- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.

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SUMMARY

As there is an increasing trend towards people moving into peri-urban environments, such as those that exist within the Resilient Hills and Coast footprint, bushfire risk to property, life, and livelihood also increases.

This presents several challenges, largely around balancing bushfire “prevention” and biodiversity protection within the peri-urban setting (sometimes referred to as wildland-urban interface).

Public and private green spaces, that being open-air natural or vegetated spaces, with native or non-native plant species, are valued for their health, wellbeing, recreational, biodiversity and community connectedness benefits. However, they could also be considered a fire risk if adjacent to, or surrounding, residential properties. As development and population increases, there is growing demand for public green spaces and this could impose additional stress on owners such as local council, to create and maintain the space, and to ensure that bushfire risk is minimised. Conversely, property owners will need to be diligent with their own bushfire preparedness to reduce the risk of a fire starting on their property and moving into public green spaces.

As urban fringe development brings populations closer to conservation parks, there is an increased use of prescribed burning to address bushfire risks (Westerling 2008). The “wildland-urban interface” of South-west WA presents a strong case study with interview data suggesting that community acknowledge, and are concerned by, the prescribed burning impacts on biodiversity. More specifically, analysis found that bushfire policy within these “wildland-urban interfaces” have trade-offs for biodiversity, nature, wellbeing, and regional fiscal growth (Ruane et al 2022).

SPOTLIGHT STUDY 11

Managing urban and peri-urban green spaces to reduce the risk of exposure to bushfires

Key findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

In many Australian states, there is a commitment to increase the number and area of green spaces, in urban and semi-urban areas, as a tool for mitigating against climate change (carbon capture and reducing urban heat) and improving community wellbeing, health and connection to nature (Bush & Doyon, n.d.; Connolly, 2020; Department for Infrastructure and Transport, 2021). Similarly, residents within the peri-urban environment (defined as an area where habitable structures are located in proximity or overlapping with undeveloped bushland (Government of South Australia, 2021)) are often living near existing green spaces, such as Conservation Parks, that have a high biodiversity value. Some of these residents are aware of the conservation values of their local area and weigh this up against bushfire risk mitigation (D. E. Moskwa et al., 2017).

Review of bushfire management policies and perceptions

A review of bushfire management policies was combined with the results from surveying key bushfire stakeholders (local government, state government and environmental NGO’s) in south-west Western Australia, to identify how to adapt to bushfire risk within a “wildland-urban interface” (Ruane et al., 2022). This research by Ruane et al. (2022) proposed three key areas of action to adapt to bushfire risks in Western Australia: 1) broad-scale prescribed burning on public lands as fuel reduction; 2) local bushfire management planning; and 3) land-use planning in areas of bushfire risk.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

While broad-scale prescribed burning is a common approach used for fuel reduction and risk mitigation, Ruane et al. (2022) highlighted opposing views on the effectiveness and appropriateness of this approach both in the literature review, as well as through interview data. During the interviews, respondents expressed concern about the biodiversity values that broad-scale prescribed burns may compromise, particularly with state wide annual targets of areas burnt, and suggested an increase in targeted burn efforts that are smaller and closer to urban assets (See Spotlight Studies #4 and #6). Ruane et al. (2022) suggest that good land-use planning, at the right scale, may be critical as a precautionary approach to mitigating fire risk.

While some Australian species require fire, broad-scale prescribed burns may not be beneficial. For example, Prowse et al. (2017) highlight that bird species in the Mount Lofty Ranges require areas of long-unburnt habitat. Many bird species have specialised and diverse habitat requirements and some prefer areas that have not been burnt, or have been unburnt for an extended period of time. The application of frequent burns within the Mount Lofty Ranges are likely to favour generalist species that are already thriving in urban areas, and disadvantage specialist species such as insectivores and those that rely on tree-cavity and understory for breeding (Prowse et al., 2017). The research by Prowse et al. (2017) concluded that 22 species of declining woodland bird species will be further threatened by frequent prescribed burning in the Mount Lofty Ranges. This suggests that large-scale burning, to reduce fuels or protection of life and property, needs to take woodland bird habitat requirements into account, and alternative options, such as small, targeted and infrequent burns should be considered.

Prescribed burning

Defining best-practice vegetation management around urban and peri-urban settings is crucial for reducing the risk of fire to communities and assets. As highlighted by Ruane et al. (2022), there is debate and concern on the effectiveness of broad-scale prescribed burning for asset protection despite its continued use across Australia. Many have emphasised the small cost-benefit for broad-scale burning due to the area required to be burnt in a prescribed fire to reduce the impacts of an unplanned bushfire (Bradstock et al. 2012; Gibbons et al. 2012). For example, it has been highlighted that “you need to burn up to 10 times as much area as you can expect to prevent from being burnt in a bushfire” (Driscoll via this. Deakin University, n.d.). Further, multiple studies have emphasised the effectiveness of prescribed burning closer to properties to reduce the risk of fire (Price & Bradstock 2012; Gibbons et al. 2012; Penman et al. 2011, 2020). Penman et al. (2020) state that the effectiveness of modelled treatment was “due to the reduction in fire behaviour immediately adjacent to the asset”. Similarly, Gibbons et al. (2012) found that prescribed burning within 0.5km of assets was more effective than prescribed burn treatments at 8.5km from assets (the average distance observed). While each situation will require individualised assessment, the increasing body of literature that recommends a shift away from broad-scale prescribed burns to fuel treatments closer to properties in peri-urban communities should be considered. See Spotlight Study #4 for additional information on best-practice fire management.

Constructed green spaces

Built or constructed green spaces in urban and peri-urban areas are another aspect that requires attention. While there are many benefits of having green spaces throughout urban neighbourhoods, there is also a concern of the risk of exposure to fire they present. While not addressed explicitly by Ruane et al. (2022), those such as the Country Fire Service (South Australia, 2022), Country Fire Authority (Victoria; 2022), and the Adelaide Hills Council (Adelaide Hills Council, n.d.) have

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

guides on landscaping to reduce fire risk in gardens which may apply to residential and public lands. Strategies include using low-flammability plant species (Corbett, 2021; Murray et al., 2018), creating defensible space, reducing excess flammable materials (i.e., mulch and leaf litter), creating windbreaks, and particular plant placement recommendations. See Spotlight Study #11 for further information on landscaping advice and Spotlight Study #2 for information on revegetation and green fire breaks.

Urban planning

In addition to vegetation and green space management, mitigation of fire risk in urban and peri-urban settings is heavily reliant on effective urban planning and design. Driscoll (via. Deakin University, n.d.) emphasised the role that urban planning (e.g., the spatial arrangement of houses in the landscape, the location and connectivity of roads) has in fire preparation and emergency response. Planning and managing urban sprawl requires a balance between access to green spaces and “high-density housing in a concrete jungle that will never burn” (Driscoll via this. Deakin University n.d.). March et al. (2020) highlighted strategies that may be effective in reducing the risk of fire in the “wildland-urban interface” to ensure that housing infrastructure has good access and egress for emergency service activity and for evacuation response (March et al. 2020). Similarly, ensuring that roads are capable of handling large evacuation responses is crucial in reducing fire risk to human lives within an environment that is surrounded by native bushland and other green spaces (Driscoll via this. Deakin University, n.d.).

Relevance to the Resilient Hills & Coasts (RH&C) Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

As much of the RH&C footprint includes the peri-urban landscapes (sometimes called “wildland-urban interface” within the referenced literature), particularly within the Mount Lofty Ranges, this poses an increased fire risk to people, property and the environment (Government of South Australia 2021). Population growth within the peri-urban area of the Mount Lofty Ranges is predicted to increase, this means more people and more housing and structures in proximity to parks, gardens and other green spaces. As urban sprawl continues its outward expansion from cities and towns, the “wildland-urban interfaces” increases, and residents and communities need to be aware of their bushfire risk and the impact that bushfire mitigation strategies, such as prescribed burning or vegetation clearance, can have on local biodiversity.

Scalability and implementation

Education programs and information dissemination by SA Country Fire Service (CFS) are currently the main modes of educating communities on bushfire risk, and the appropriate mitigation actions. The CFS has also committed to reviewing principles for deploying fire and

rescue services in the peri-urban area (Government of South Australia, 2021). Information on the bushfire risk to residents living in the Mount Lofty Ranges peri-urban could be sourced, reviewed and synthesised into a targeted document that guides residents (current and future) to make informed decisions about their bushfire strategies, including planning and managing bushfires.

RESILIENT HILLS & COASTS: BUSHFIRES AND BIODIVERSITY

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (The Royal Commission into National Natural Disaster Arrangements, 2020a), mitigation action will be necessary. However, in the context of fire, climate can heavily influence the outcomes regardless of management.

The approach used by Ruane et al. (2022) to extensively review bushfire management policy and practice is highly adaptable and may be easily implemented in different locations (i.e., the Resilient Hills and Coasts region). It is proposed that this occurs prior to developing any educational or awareness material.

Further work will also be required to review the most important and effective bushfire preparation activities and urban planning design in the context of climate change.

Social license

While interviews conducted by Ruane et al. (2022) were focused on fire management and fire planning staff, it still surmised that the general public support the policy and processes regarding bushfire management if they are considered appropriate and adequate. Moskwa et al. (2017) also highlights that residents in the peri-urban areas of the Mount Lofty Ranges expressed concern about current practice and policy regarding bushfire and vegetation management.

Risks

Conducting a review of the policy and attitudes regarding bushfire management is very low risk, however, there are always risks when implementing strategies such as prescribed burning. Ruane et al. (2022) explicitly touched on some of these risks, highlighting the possibility of

escaped fires, the effects of smoke on human health and other assets, and adverse effects on biodiversity. Environmental conditions are changing, and it is crucial to ensure that policy related to bushfire management actions are appropriate and are continually kept up to date as new knowledge and information is made available (Ruane et al. 2022).

Knowledge gaps, caveats, and assumptions

The policy review by Ruane et al. (2022) was based on policy and practice in south-west Western Australia. While insightful and a good basis for conducting similar review approaches, there may be slightly different attitudes and issues present in a South Australian context. A review such as this has not yet been conducted based on South Australian policies. Additionally, there has been little empirical research on the flammability of plants, and the effectiveness of various green space/garden designs.

Further work in the Resilient Hills & Coasts region

Investment required

This requires an across-agency approach with scope for a specific and targeted review of the most important and effective bushfire preparation activities within an urban and semi-urban context. This could also include overlaying the various planning guidelines and policies, to identify conflicts or uncertainty about bushfire risk and preparedness activities within a semi-urban setting. Estimated value \$75,000 to \$100,000.

Key stakeholders

The key stakeholders for conducting a review of bushfire management policy and practice may include environmental NGOs, DEW (natural values team, ecologists, and fire management team), local council planners, state planners, biodiversity staff and bushfire prevention officers and any members of the community.

References

- Adelaide Hills Council (n.d). Native Habitat Gardening Guide for low flammability gardens [ENVIRONMENT-Low-Flammability-species_2020.pdf \(ahc.sa.gov.au\)](#)
- Bradstock, R. A., Cary, G. J., Davies, I., Lindenmayer, D. B., Price, O. F., & Williams, R. J. (2012). Wildfires, fuel treatment and risk mitigation in Australian eucalypt forests: Insights from landscape-scale simulation. *Journal of Environmental Management*, 105, 66–75. <https://doi.org/10.1016/j.jenvman.2012.03.050>
- Bush, J., & Doyon, A. (n.d.). Urban green spaces in Australian cities: Social inclusion and community participation.
- Connolly, I. (2020). How to green our cities without putting communities at risk of bushfire. <https://thefifthestate.com.au/urbanism/planning/how-to-green-our-cities-without-putting-communities-at-risk-of-bushfire/>
- Country Fire Authority (CFA). (2022). Landscaping for Bushfire: Garden Design and Plant Selection.
- Country Fire Service (CFS) South Australia. (2022). Plan & Prepare. Viewed on 11 January 2023 <https://www.cfs.sa.gov.au/plan-prepare/>
- Corbett, L. (2021). Safer Gardens: Plant Flammability and Planning for Fire.
- Department for Infrastructure and Transport. (2021). Green Infrastructure Commitment. Government of South Australia.
- Driscoll, D. (n.d.) Is Melbourne’s urban sprawl creating more bushfire risk? The Conversation. Viewed 17 February 2023 <<https://this.deakin.edu.au/society/is-melbournes-urban-sprawl-creating-more-bushfire-risk>>
- Gibbons, P., van Bommel, L., Gill, A. M., Cary, G. J., Driscoll, D. A., Bradstock, R. A., Knight, E., Moritz, M. A., Stephens, S. L., & Lindenmayer, D. B. (2012). Land Management Practices Associated with House Loss in Wildfires. *PLoS ONE*, 7(1), e29212. <https://doi.org/10.1371/journal.pone.0029212>
- Government of South Australia. (2021). SA State Bushfire Management Plan 2021-2025. State Bushfire Coordination Committee. <https://safecom-files-v8.s3.amazonaws.com/current/docs/SLD180%2520SASBM%2520Digital%2520WEB%2520%2528A1547888%2529.pdf>
- March, A., Riddell, G., de Moraes, L. N., Stanley, J., van Delden, H., Beilin, R., Dovers, S., & Maier, H. (2020). Urban planning capabilities for bushfire: Treatment categories and scenario testing. *The Australian Journal of Emergency Management*, 35(3), 32–40.
- Moskwa, D. E., Robinson, G., Bardsley, D. D., & Weber, A. D. (2017). Bushfires and Biodiversity: Optimising conservation outcomes in peri-urban areas at risk. 40.
- Murray, B., Martin, L., Brown, C., Krix, D., & Phillips, M. (2018). Selecting Low-Flammability Plants as Green Firebreaks within Sustainable Urban Garden Design. *Fire*, 1(1), 15. <https://doi.org/10.3390/fire1010015>
- Penman, T. D., Christie, F. J., Andersen, A. N., Bradstock, R. A., Cary, G. J., Henderson, M. K., Price, O., Tran, C., Wardle, G. M., Williams, R. J., & York, A. (2011). Prescribed burning: How can it work to conserve the things we value? *International Journal of Wildland Fire*, 20(6), 721. <https://doi.org/10.1071/WF09131>
- Penman, T. D., Clarke, H., Cirulis, B., Boer, M. M., Price, O. F., & Bradstock, R. A. (2020). Cost-Effective Prescribed Burning Solutions Vary Between Landscapes in Eastern Australia. *Frontiers in Forests and Global Change*, 3, 79. <https://doi.org/10.3389/ffgc.2020.00079>
- Price, O. F., & Bradstock, R. A. (2012). The efficacy of fuel treatment in mitigating property loss during wildfires: Insights from analysis of the severity of the catastrophic fires in 2009 in Victoria, Australia. *Journal of Environmental Management*, 113, 146–157. <https://doi.org/10.1016/j.jenvman.2012.08.041>
- Prowse, T. A. A., Collard, S. J., Blackwood, A., O’Connor, P. J., Delean, S., Barnes, M., Cassey, P., & Possingham, H. P. (2017). Prescribed burning impacts avian diversity and disadvantages woodland-specialist birds unless long-unburnt habitat is retained. *Biological Conservation*, 215, 268–276. <https://doi.org/10.1016/j.biocon.2017.09.005>
- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.
- Ruane, S., Babb, C., & Swapan, M. S. H. (2022). Considering sustainability trade-offs in bushfire policy for the wildland-urban interface. *Environmental Hazards*, 1–22. <https://doi.org/10.1080/17477891.2022.2130860>

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We acknowledge and respect the ongoing cultural and spiritual connection that First Nations people have with their country, and their commitment to its stewardship for future generations.

SUMMARY

Improving community expertise and confidence has been identified as a key requirement for resilience in semi-urban bushfire affected and fire prone communities (Pooley et al., 2010).

This approach is exemplified by the New South Wales Hotspots Fire program (hereafter referred to as Hotspots or the Program) that aims to “increase community understanding, confidence, and capacity to sustainably manage fire for ecological and First Nations cultural outcomes, whilst protecting life and property”.

The Program is an across-agency and across-sector partnership that utilises a multi-disciplined approach of fire preparation, fire ecology and first-nations knowledge. Through targeted and customised education materials, workshops, demonstrations and field days, community have been empowered to make better decisions.

This approach could be readily adapted to the Resilient Hills & Coasts region if co-designed and piloted with key stakeholders.

SPOTLIGHT STUDY 12

Educating and training landholders, households and community on best practice fire management and biodiversity – the New South Wales Hotspots Program as an exemplar

Key Findings

The key findings presented are based on an extensive review of available literature, at the time of developing the spotlight study. The references cited are available at the end of the document.

Educating the community about fire management has become increasingly important in recent years as climate change increases the likelihood of fires. Since the Victorian Bushfires Royal Commission in 2010 there has been a push towards a shared responsibility to fire management between landholders and fire-management authorities, with landholders taking increased ownership over fire management on their own properties (Edwards & Gill, 2016). Research has shown that the public will support fire management activities, like prescribed burning, if they understand the issues (McCaffrey, 2004). Programs such

as the New South Wales Hotspots Program (hereafter referred to as Hotspots or the Program) aim to demonstrate that fire is not just a hazard, but also a management tool. The Program is managed and implemented by the NSW Rural Fire Service (RFS) and the not-for-profit environmental agency, the Nature Conservation Council of NSW (NCCNSW) and governed by a Steering Committee with cross-agency representation from state and local government, forestry and farming industries, and research institutions.

The Program is foremost a training program that engages with landholders and land managers by delivering fire management planning workshops to provide skills and knowledge based on science and operational expertise, enabling participants to implement strategies to prepare against bushfires and enhance biodiversity on their properties (Rose & McShea, 2015). Increasing the participants’ understanding about fire ecology and management is a key focus of the Program. Potential demonstration burn sites are included, and ecologists discuss the site history, biodiversity values and best management. Landholders are provided with guidance so they can prepare their individual fire management plans using an

RESILIENT HILLS AND COASTS: BUSHFIRES AND BIODIVERSITY

aerial photograph of their property and separating it into management units, identifying the actions for each unit. The plans are reviewed and then applied at the demonstration site to thoroughly assess risk. Participants are also trained in fuel assessment and the Program staff talk about the appropriate landscape (e.g., topography) and weather conditions for applying controlled burns (Edwards, 2016).

Key findings continued

One hundred and sixty seven Program participants from 2010-2013 were interviewed as part of an external Program review (Edwards, 2016). Although the Program's success in enhancing biodiversity was not explicitly assessed, the review found that as a result of the Program, more landholders were actively burning to encourage plant diversity and maintain habitat. The review also determined that the Program:

- Was successful in connecting landholders with fire agencies;
- Resulted in landholders developing a management plan;
- Was successful in promoting fire as a management tool and raising awareness of the need to prepare properties for fire by mechanical means to achieve risk reduction and environmental goals (Edwards, 2016).

Potential improvements to the Program that were identified by participants included (Edwards, 2016):

- Emphasising the summary nature of the workshops (and that sustainable fire management is complex – direct landholders to more detailed information);
- Allowing greater flexibility with demonstration burn timing (to allow more demonstration burns to go ahead – e.g., burning on first day of workshop);
- Including small burns with landholder involvement, either into a workshop or as a follow-up (for those who are reluctant to do larger burns);
- Provide more engaging material as an alternative (e.g., videos) when a demonstration burn is cancelled;
- Arrange follow-up meetings with RFS staff/volunteers and the landholders individually to discuss implementation of the fire management plan;
- Create networks of landholders to share learnings about each other's burns. Currently this is driven by the landholders themselves, with some groups successfully doing this and others disinterested.

Another similar program discussed by Edwards (2016) is the Kosciuszko to Coast (K2C) program, which has a more practical focus and is delivered partially from a First Nations perspective of looking after, and listening to country, in the context of burning. The program is delivered in a smaller area but for a longer period of time, and the lower staff numbers involved allows flexibility with the implementation of demonstration burns.

Interview data from Nature Conservation Council NSW (K. McShea, pers. comm., February 2, 2023) identified the key factors for success of a Hotspots style program:

- Longer than annual funding cycles;
- To be its own non-affiliated identity (e.g., branding doesn't display any other logos and the program is treated as separate to any partnering organisations);
- Long-term support and ongoing engagement with community after a workshop;

RESILIENT HILLS AND COASTS: BUSHFIRES AND BIODIVERSITY

- Follow-up monitoring and evaluation, particularly on biodiversity trajectory after the demonstration burn;
- Cross-agency collaboration with agreed and consistent messaging;
- Collaboration with First Nations groups.

Relevance to the Resilient Hills & Coasts (RH&C) Region

The RH&C is approximately 8,752km² within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island region of South Australia. This includes; a mixture of farming, conservation and residential land uses; within rural, semi-rural, urban and peri-urban settings; across the local government areas of Kangaroo Island, Adelaide Hills, Mount Barker, Alexandrina, Yankalilla, and Victor Harbor.

The underlying principles of the Hotspots Program echo the objectives of the Resilient Hills & Coasts project, to build resilience by creating well-prepared and well-informed communities who can support fire agencies and land managers in their fire management planning, without compromising biodiversity conservation. A study of residents in the Mount Lofty Ranges in 2018 concluded that residents generally value biodiversity, and that local management approaches need to both acknowledge fire risks and prioritise biodiversity, achieved via a sophisticated understanding of fire risk and biodiversity values by both land holders, land managers, planners, and policy makers (Moskwa et al., 2018) – also see Resilient Hills & Coast Bushfire and Biodiversity Spotlight Study #8. This study also recommended integrating biodiversity values into engagement programs, similar to what the Hotspots Program delivers.

Scalability and implementation

The Hotspots Program was based on the earlier Queensland Fire and Biodiversity Consortium, which had already been formally operational for five years when the Hotspots pilot program commenced (K. McShea, pers. comm., February 2, 2023). A similar Resilient Hills & Coasts initiative could be modified from the larger-scale Hotspots setting and adapted to a diverse and fragmented rural/peri-urban setting. Consistent messaging would need to be developed through collaboration with partners, and disseminated communication material would need to reflect this. There are also legal barriers which need to be identified, considered, and addressed. For example, Hotspots burns are undertaken as ‘hazard reductions burns’, but have multiple outcomes such as biodiversity benefits. A RH&C program would need to work within the South Australian legislation, and existing burn frameworks that are applied by state agencies.

Adaptability and climate change

The impacts of climate change present a substantial challenge. As the intensity and frequency of bushfires is likely to increase with the effects of climate change (The Royal Commission into National Natural Disaster Arrangements, 2020a), mitigation action will be necessary. However, in the context of fire, climate can heavily influence the outcomes regardless of management.

There will be more high fire risk days as our climate changes, and south-eastern Australia has been described as one of the three most fire prone regions of the world (AFAC, 2008). As populations in bushfire prone areas increase, they must also become better equipped to deal with the increasing risk. Programs such as Hotspots that engage, educate, empower, and connect communities would facilitate increased climate change resilience.

RESILIENT HILLS AND COASTS: BUSHFIRES AND BIODIVERSITY

It is highly likely that elements of the Hotspots program could be adapted to the Resilient Hills & Coasts region, although it is strongly recommended that a three-year pilot be implemented, and evaluated, before committing to a longer-term approach.

Social license

A program such as Hotspots has a high probability of securing community approval and uptake. As identified in a study of Mount Lofty Ranges residents (Moskwa et al., 2018), people generally value their local biodiversity and want to be involved in fire management planning. However, as communities continue to heal from the 2019-2020 Black Summer bushfires and with ongoing concern by conservation groups about over-burning (or lack of evidence about its effectiveness), there will likely be some sectors that question the initiative and may therefore be unlikely to participate.

Risks

The overall risk of implementing the Hotspots Program is low if communication and messaging is appropriate and there is sufficient investment. There is a greater risk of not involving the right people or agencies, or a perception that this type of project is already being delivered. The specific risks include: a) application of a burn is impractical or viewed with fear if it occurs in a peri-urban setting where properties are smaller and the population is dense; b) limited funding and capacity could result in limited uptake on privately owned property; c) critical stakeholders could be excluded in the creation and development stage and/or the pilot may not be delivered by the right agency; d) implementation of demonstration burns could have an adverse effect on biodiversity value; and e) individuals could hear “rumours” about the Program and undertake burns without the required training and information.

Knowledge gaps, caveats and assumptions

A coordinated approach between NGOs, fire ecologists and the CFS would be required. A review found that the Hotspots program needed to be well-supported by CFS volunteers and staff, as well as other local agencies, and that follow-up one-on-one meetings and a Hotspots ‘hub’ coordinator position to connect networks of landholders is beneficial (Edwards, 2016).

Although the Hotspots program provides institutional learnings and a solid framework, there are many information gaps and assumptions that need to be addressed for application into the RH&C region. Some of these include:

- There is an assumption that community and First Nations groups want this type of program or agree with the way it could be delivered.
- The delivery of the program could be skewed towards areas where there is greater biodiversity knowledge, and these might not be priority areas for bushfire preparation.
- Vulnerable and lower socio-economic groups that have a greater exposure to bushfires might not be in areas that are a biodiversity priority.

Further work in Resilient Hills & Coasts region

Investment required

A pilot program could be developed and trialled over three years. An initial step could be working with CFS and other stakeholders to identify, understand and resolve the potential risks of implementing a similar program to Hotspots.

The Hotspots program employs three ecologists from a non-government conservation organisation (Nature Conservation Council of NSW), three Regional Fire Service

RESILIENT HILLS AND COASTS: BUSHFIRES AND BIODIVERSITY

personnel and a coordinator (K. McShea , pers. comm., February 2, 2023). Implementation for a similar pilot program in Resilient Hills & Coasts with two staff is estimated as \$750,000 to \$1,000,000 over a three-year period.

Key stakeholders

CFS and an environmental not-for-profit organisation or alliance (such as RH&C) are best placed to co-deliver a similar program, in partnership with other agencies and stakeholders including state government, local government, First Nations groups, industry and farming

associations. Involving and co-delivering with Councils Fire Prevention Officers and Biodiversity Officers is also considered important.

RESILIENT HILLS AND COASTS: BUSHFIRES AND BIODIVERSITY

References

- AFAC. (2008). Climate Change and its Impact on the Management of Bushfire. <https://www.afac.com.au/docs/default-source/fire-and-hazard-notes/025.pdf?sfvrsn=12&download=false>
- Edwards, A. (2016). More-than-human knowing, showing and sharing in human/landscape fire relationships [Doctor of Philosophy thesis, University of Wollongong]. <https://ro.uow.edu.au/theses/4754>
- Edwards, A., & Gill, N. (2016). Living with landscape fire: Landholder understandings of agency, scale and control within fiery entanglements. *Environment and Planning D: Society and Space*, 34(6), 1080–1097. <https://doi.org/10.1177/0263775816645588>
- McCaffrey, S. M. (2004). Fighting Fire with Education: What Is the Best Way to Reach Out to Homeowners? *Journal of Forestry*, 102(5), 12–19. <https://doi.org/10.1093/jof/102.5.12>
- Moskwa, E., Bardsley, D. K., Weber, D., & Robinson, G. M. (2018). Living with bushfire: Recognising ecological sophistication to manage risk while retaining biodiversity values. *International Journal of Disaster Risk Reduction*, 27, 459–469. <https://doi.org/10.1016/j.ijdrr.2017.11.010>
- Pooley, J. A., Cohen, L., & O'Connor, M. (2010, April). Bushfire communities and resilience: What can they tell us? | Australian Disaster Resilience Knowledge Hub [Australian Government]. Australia Institute for Disaster Resilience. <https://knowledge.aidr.org.au/resources/ajem-apr-2010-bushfire-communities-and-resilience-what-can-they-tell-us/>
- Rose, M., & McShea, K. (2015). Hotspots Fire Project Case Study—Community Engagement for Resilient Landscapes & Resilient Communities. NSW Hotspots Fire Project. <https://hotspotsfireproject.org.au/download/community-engagement-case-studyfinal.pdf>
- The Royal Commission into National Natural Disaster Arrangements. (2020). Background Paper: Land management – hazard reduction: A literature review. Commonwealth of Australia.

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